STRUCTURAL CHARACTERISTICS OF SOILCRETE BLOCKS

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CERTIFICATION

This is to certify that this thesis "Structural Characteristics of Soilcrete blocks" carried out by Chinenye E. Okere (B.Eng, M.Eng) with Reg. no. 20064616188 and presented at Postgraduate school, Federal University of Technology, Owerri has been approved as meeting the requirements for the award of Doctor of Philosophy.

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To my Kam-Kam

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This research work would not have been a reality without the Almighty God. I owe Him my all.

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ABSTRACT

This work investigates the structural characteristics of soilcrete blocks (laterite-cement blocks and laterite-sand-cement blocks) produced with locally available and affordable laterite. Scheffe's simplex method and Osadebe's regression theory were used to formulate mathematical models for optimisation of properties of soilcrete blocks which include compressive strength, split tensile strength, shear strength, flexural strength, Poisson's ratio, modulus of elasticity, shear modulus/modulus of rigidity and water absorption for the two types of soilcrete blocks. At the end of the day, eight (8) models were formulated for the eight characteristics based on Scheffe's method, eight (8) models based on Osadebe's method for each type of block. These made it a total of thirty-two (32) models. Consequently, thirty two (32) computer programs were written using basic language. Statistical tools were used to verify the adequacy of the models. With the aid of the computer, the models will be able to predict the mix proportions that will give the desired property. The models can also give the desired property if the mix ratios are specified. The overall result in the use of the models will lead to time, energy and cost savings in the production of soilcrete blocks. The maximum compressive strength predictable by Scheffe's model is 3.01N/mm^2 for sand-laterite blocks and 2.148N/mm^2 for soilcrete blocks. The maximum flexural strength obtainable from Scheffe's model is 1.718N/mm^2 for sand-laterite blocks and 1.452N/mm^2 for soilcrete blocks. The maximum split tensile strength predictable by Scheffe's model is 1.45N/mm^2 for sand-laterite blocks and 0.88N/mm^2 for soilcrete blocks. The maximum Poisson's ratio obtainable from Scheffe's model is 0.112 for sand-laterite blocks and 0.174 for soilcrete blocks. The maximum static modulus of elasticity predictable by Scheffe's model is 6.414GPa for sand-laterite blocks and 5.149GPa for soilcrete blocks. The maximum shear modulus/modulus of rigidity obtainable from Scheffe's model is 2.885GPa for sand-laterite blocks and 2.195GPa for soilcrete blocks. The maximum shear strength predictable by Scheffe's model is 0.43N/mm^2 for sand-laterite blocks and 0.363N/mm^2 for soilcrete blocks. The maximum water absorption predictable by Scheffe's model is 7.29% for sand-laterite blocks and 6.16% for soilcrete blocks.

The percentage difference between Scheffe's model result and Osadebe's model result (for compressive strength of sand-laterite blocks) ranges from a minimum of 0.25% to a maximum of 6.66% which is insignificant. From the laboratory cost analysis, the percentage cost savings in using soilcrete block is 46.67% while that of sand-laterite blocks is 42.1% which is very significant.

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CHAPTER ONE: INTRODUCTION

1.1 General

Block can be generally described as a solid mass used in construction. It can be made from a wide variety of materials ranging from binder, water, sand, laterite, coarse aggregate, clay to admixtures. The constituent materials determine the type of block, which includes soilcrete blocks, sandcrete blocks, clay bricks, concrete blocks, mud blocks, etc.

Soilcrete blocks are made of cement, laterite and water. The manufacturing process involves compaction of newly mixed constituent materials in a mould, followed immediately by demoulding of the pressed block so that the mould can be used repeatedly. The finished blocks are required to be self supporting and able to withstand any movement and vibration from the moment they are demoulded. This is a desired property of blocks.

Other properties that are of structural importance are compressive strength, flexural strength, modulus of elasticity, durability, shear modulus, transverse strength, split tensile strength, density, absorption, fire resistance, sound insulation, thermal conductivity and frost resistance.

Blocks are widely used in construction industry. Individual blocks when bonded together with mortar are referred to as block work or block masonry. They are predominantly used as walling units in the construction of shelter (which is one of the basic needs of man) and other infrastructures. Also, blocks are very important in construction because they are load bearing. Blocks are also used to fill up frames. Structural frames are braced by using block work which also provide lateral stability to the structures. Knowledge of the characteristics or properties of these masonry units are also important in structural computations.

To obtain the desired property of blocks, the correct mix proportion has to be used (Teychenne et.al., 1975). Various mix design methods developed in order to achieve this have some limitations (Simon et.al., 1997). The methods are not cost effective, and time and energy are spent in order to get the appropriate mix proportions. To minimise some of these limitations an optimisation procedure has been proposed. A process that seeks for a maximum and minimum value for a function of several variables while at the same time satisfying a number of other imposed requirements is called an optimisation procedure (Majid, 1974).

1.2 Statement of the problem

Blocks are predominantly used as walling units in the construction of shelter and other infrastructures. Walls which are load bearing, act as a form of bracing to structural frames and also provide lateral stability to structures. Poor/low quality blocks produced in Nigeria by profit-oriented block moulding industries has led to structural failures recorded in Nigeria. Most of the block works fail by shearing.

River sand is a major constituent used in block production in Nigeria. There is an increasing rise in the cost of river sand and this affects the production cost of block and consequently has made housing units unaffordable for middle class citizens of Nigeria.

In some parts of the country like Northern Nigeria, there is scarcity or even non availability of river sand. This also affects block production in these areas. But, an alternative material like laterite is readily available and affordable in most parts of the country.

To obtain any desired property of block, the correct mix proportion has to be used. It has been observed that block producers in Nigeria choose and use mix proportions at will in the production of blocks. In order words, they make arbitrary choice of mix proportions. This accounts for varied qualities/properties of block produced by different manufacturers.

Various mix design methods have been developed in order to achieve the desired property of concrete/blocks. It has also been observed that these methods have some limitations. They are not cost effective and time and energy are spent in order to get the appropriate mix proportions.

Apart from the compressive strength of blocks, very little is known about the other structural characteristics of blocks such as flexural strength, Poisson ratio, static modulus, shear modulus, water absorption, etc of blocks produced in Nigeria. There is little documentation with regards to these structural characteristics. These structural characteristics are required by structural engineers and related scientists for structural design computations. The lack of information on these structural characteristics leaves room for much speculation, approximations and arbitrariness, which could be detrimental to the design of structures.

Another problem is that sandcrete blocks which are widely used, are not considered the best for building in tropical countries because of their poor environmental and thermal insulating properties as a result of high degree of porosity. Cost of building is increased as a result of plastering of both the internal and external surfaces in order to improve the quality for domestic buildings (Komolafe, 1986).

The use of river sand in block production requires a reasonable quantity of binder to produce a solid mass. The most commonly used binder is cement, which is also very expensive. All these make the use of sandcrete block expensive. However it is economical to use laterite because very little cement is required in laterite block production (Agbede and Manasseh, 2008; Boeck et. al., 2000; Aguwa, 2010).

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Besides, sand is mainly gotten from dredging of river which makes them deeper and wider. This increases the tendencies of accidents occurring in our waterways thereby making them very much unsafe for those travelling by sea. Sand dredging process in the Niger-Delta and some parts of eastern Nigeria is mainly done by the use of canoes. When these canoes are loaded with sand, it endangers the lives of the paddlers.

Consequently, this thesis deals with the production of soilcrete blocks using readily available and affordable laterite, determination of structural characteristics of the blocks and optimisation of these structural characteristics using Scheffe’s and Osadebe’s method of optimisation.

1.3 Statement of objectives

This research work will be carried out with the following objectives in mind:

1. To review current block production practises in Nigeria, so as to determine the properties of the blocks produced, and compare them with standard specifications.
2. To prepare soilcrete blocks.
3. To determine the structural characteristics of soilcrete blocks.
4. To investigate the effect of partial replacement of soil (laterite) by river sand on the characteristics of soilcrete blocks.
5. To formulate mathematical models which can, with the aid of a computer, prescribe mixes that will produce the desired property of soilcrete blocks. These models can also predict the properties if mix proportions are given.
6. To reduce the arbitrary choice of constituent mix, the use of trial mix and the effort used in the traditional system of mix design.
7. To determine the overall cost savings in the use of soilcrete blocks.

1.4 Scope of study

This work is in four parts:

- Field investigation, to review current block production practises in Nigeria.

- Laboratory investigation to determine the characteristics of blocks which include compressive strength, flexural strength, split tensile strength, water absorption, Poisson's ratio, static modulus of elasticity, modulus of rigidity/shear modulus, and shear strength.

- This work deals with soilcrete blocks produced with laterite using between 4% to 10% cement stabilisation and sand-laterite blocks produced by replacing the laterite partially with river sand using 10% to 40% replacement.

- Formulation of mathematical models, for optimisation of the characteristics of the blocks using Scheffe's and Osadebe's methods of optimisation.

The presentation of this work is in five chapters as follows: Chapter one introduces the topic, presents the problem statements, project objectives, justification of study and describes the scope. Chapter two gives review of related literature and current block production practises in Nigeria. Materials and methods used are presented in chapter three as well as the experimental investigation. Chapter four contains research results and discussions based on results. Chapter five presents conclusion and recommendations. The basic computer programs are appended.

1.5 Justification of study

Successful execution of this thesis will be beneficial to the society in many ways. The society will benefit from this work in the following ways:

1. As this research work seeks to replace river sand by laterite (soil) either fully or partially, the success of the research will lead to reduced dependence on river sand which is costly and scarce (in some areas), in block production. Also, it is economical to use laterite in block production because very little cement is required unlike using river sand which requires more quantity of binder. These will lead to reduction in production cost of blocks and consequently housing units will be affordable by most Nigerians.
2. This work will provide the necessary documentation on structural characteristics of soilcrete blocks. It will serve as a reference material for students and practicing engineers.
3. The formulated mathematical models can, with the aid of a computer, prescribe mixes that will produce any desired property of soilcrete blocks. These models can also predict the soilcrete block properties if the mix proportions are given. In the overall, the use of the models will lead to cost savings in block production.
4. The mix proportions/ratios from the model can be made available to commercial block producers for use in the production of soilcrete blocks. This will reduce the arbitrary choice of constituent mix. And, the production of standard soilcrete blocks with desired quality will help in averting structural failures due to poor quality soilcrete blocks.

5. Soilcrete blocks can effectively be used in tropical areas because of their thermal insulating properties. They are advantageous in hot dry climates where extreme temperature can be moderated inside buildings of compressed stabilised earth blocks.
6. The use of soilcrete blocks will result in the construction of buildings with greater resistance to extreme weather conditions, fire, and bullet penetration (i.e. bullet proof).
7. The use of laterite in block production will provide direct and indirect employment opportunities within the local populace than would be the case with other materials.
8. The curing process of laterite blocks is environmental friendly because they are usually covered with tarpaulin and water proof devices.
9. Soilcrete blocks can be used in the construction of structures in areas where termites, bacteria and fungi pose as hazards.

CHAPTER TWO: LITERATURE REVIEW

2.1 Concrete

Concrete is in essence “man made geology” (Idorn, 2005). It is widely used in domestic, commercial, recreational, rural and educational construction. Communities around the world rely on concrete as a safe, strong and simple building material. It is used in all types of construction; from domestic work to multi-storey office blocks and shopping complexes, motor way, dams, sewerage works, etc. Concrete is the most important structural material and interest in it is unabated. Concrete is made by mixing cement, water, fine and coarse aggregates and sometimes admixtures. Well made concrete is a naturally strong and durable material. It is dense, reasonably water tight, able to resist changes in temperature as well as wear and tear from weathering (Cement and Concrete Association of Australia, 2002).

2.1.1 Constituent materials

The main constituent materials of concrete are aggregates, cement and water. As a rule, aggregates represent some 60-80% of the concrete volume.

2.1.1.1Aggregates

Aggregates are inert grains of sedimentary or crushed natural rocks bound together by means of a binder which is cement. Although inert, they introduce an important contribution to these major characteristics which make concrete the most favoured building material. Aggregate confers considerable technical advantages on concrete which has a higher volume stability and better durability than the cement paste alone (Neville, 1981). Aggregate is cheaper than cement and it is therefore cost effective/ economical to put into the mix as much of the former and as little as the latter as possible.

There are two main classes of aggregates in accordance with size. These are fine and coarse aggregates. Fine aggregates include fine and coarse sands and crusher fines. Fine aggregates are aggregates not larger than 5mm. Coarse aggregates include crushed rock, gravel or screenings. They are at least 5mm in size.

Aggregates can be regarded as normal-weight aggregate if the oven-dry particle density falls between 2000kg/m^3 and 3000kg/m^3 when determined according to British Standard Specifications (BS EN 206-1, 2000). If the oven-dry density falls below 2000kg/m^3, then it is light weight but if it is above 3000kg/m^3, then it is heavy weight aggregate.

On the basis of the source, aggregates can be classified into natural or artificial aggregates. Natural aggregates are natural as the name implies e.g. sand, crushed limestone, gravel, basalt, etc. Artificial aggregates are manufactured and synthetic e.g. slag.

Aggregates should be strong and hard. A stronger and harder aggregate will give a stronger final concrete. They should be durable to stand up to wear and tear and weathering. Aggregates should also be chemically inactive so that they will not react with cement. Graded aggregates should range in size so that they fit together well. This gives a stronger and denser concrete. Rounded aggregates give a more workable mix. Angular aggregates make concrete harder to place, work and compact, but can make concrete stronger. Aggregates should be stored where they will stay clean, separated from other materials and dry. If the aggregates are very wet, less water will be used in the mix.

2.1.1.2 Cement

Cement is a material with adhesive and cohesive properties which make it capable of binding mineral fragments into a compact whole (Neville, 1981). The cement powder, when mixed with water, forms a paste. There are four classes of cement in use. These include Portland cement, High Alumina cement, Slag cement and Pozzolanic cement (Jackson, 1984). Portland cement is the most widely used class of cement.

Portland cement

The most common Portland cement in use is the Ordinary Portland Cement. There are different types of Portland cement. These include Ordinary Portland Cement, Modified Cement, Rapid Hardening Portland Cement, Extra Rapid Hardening Portland Cement, Ultra High Early Strength Portland Cement, Low Heat Portland Cement, Sulphate Resistance Portland Cement, Portland Blast-furnace Cement, White Portland Cement, Portland-Pozzolana Cement and Slag Cement. Each type of cement will produce concrete with different properties. Portland cement is made primarily from limestone or chalk and clay or shale. It is produced by firing to partial fusion at a temperature of approximately 1500^{o}C.

Four compounds are usually regarded as the major constituents of cement. They are

Tricalcium silicate	$3CaO.SiO_2$
Dicalcium silicate	$2CaO.SiO_2$
Tricalcium aluminate	$3Cao.Al_2O_3$
Tetracalcium aluminoferrite	$4CaO.Al_2O_3.Fe_2O_3$

The table below gives the oxide composition of typical cement and the calculated compound composition.

Table 2.1: Approximate composition limits of Portland cement

Oxide	Cement content
CaO	60-67
SiO_2	17-25
Al_2O_3	3-8
Fe_2O_3	0.5-6.0
MgO	0.1-4.0
Alkalis	0.2-1.3
SO_3	1-3

When Portland cement comes in contact with water, the compound undergoes physical and chemical changes, commonly known as hydration. Double (1980) stressed that the exact nature of these changes is still not fully understood. Cement should be stored off the ground in a well aired, clean, dry place. Wrapping the cement bags in plastic sheets gives extra protection. Bulk cement will normally be stored in silos.

2.1.1.3 Water

Water is mixed with the cement powder to form a paste which holds the aggregates together like glue. Without water, there will be no concrete. Both the quality and quantity of water in a mix have vital influence on the strength properties of the resulting concrete. Water must be clean, fresh and free from any dirt, unwanted chemicals or rubbish that may affect concrete. Recycled water can be used. Sea water should not be used as it may rust the steel reinforcement in the concrete. The general rule is that "if you can drink the water, it will be ok to use" (Cement and Concrete Association of Australia, 2002).

2.1.2 Properties of concrete

The properties of concrete are its characteristics or basic qualities. The four main properties of concrete are workability, cohesiveness, strength and durability. Workability and cohesiveness are the most important properties of plastic concrete while strength and durability are properties of hardened concrete. According to Ahmed (1994), strength is an instantaneous or short term property while durability is a long term property. The properties of fresh concrete are important only in the first few hours of its history whereas the properties of hardened concrete assume an importance which is retained for the remainder of the life of the concrete. (Jackson, 1984)

The strength properties of concrete include compressive strength, shear strength, transverse strength, tensile strength, flexural strength. Strength of concrete is commonly considered its most valuable property, though in many practical cases, other characteristics such as durability and impermeability, may in fact be more important (Neville, 1981). Nevertheless, strength usually gives an overall picture of the quality of concrete because strength is directly related to the structure of the hardened cement paste.

Durability is the ability of concrete to withstand the conditions for which it has been designed, without deterioration, over a period of years. Concrete should be dense, reasonably water tight (or less permeable), able to resist changes in temperature as well as wear and tear from weathering. Penetration of concrete by materials in solution may adversely affect its durability. This penetration depends on the permeability of the concrete. Permeability can be in form of water permeability, air and vapour permeability.

Other properties include Poisson's ratio, static modulus of elasticity, shear modulus/modulus of rigidity and water absorption. Poisson's ratio is the ratio of lateral strain to axial strain. Modulus of elasticity is the ratio of stress to strain. It is a measure of stiffness or resistance to deformation in hardened concrete. Shear modulus is the ratio of shear stress to shear strain. Water absorption is a measure of the difference in weight of the specimen before and after immersion in water for a specified time, expressed as a percentage of weight before immersion.

2.1.3 Concrete mix design / mode of production

Basically, the problem of designing a concrete mix consists of selecting the proportions of cement, fine and coarse aggregates and water to produce concrete having the specified properties (Teychenne et.al., 1975). There are two methods of measuring these proportions – measurement by weight and measurement by volume. Measurement by weight is the best method. Measurement by volume is not as accurate, but is suitable for minor projects. Mixing follows measurement. The constituent materials must blend into an even mix. Mixing could be done manually or by use of machine. Manual mixing involves using shovel and hand, and mixing on a concrete platform. Machine mixing involves using mixers. The mixed concrete is finally placed on formwork. Placement is followed immediately by compaction. Compaction is done by shaking or vibrating. Mechanical vibration or hand rodding is required to provide adequate compaction. According to Montgomery (1998), particles in a cement mixture are in some way brought closer together during compaction and the greater particle intimacy results in a higher final strength. The concrete is then finished. Finishing is screeding, floating or trowelling the concrete surface to densify or further compact the surface of concrete as well as giving it the look one wants. The final stage of concrete production is curing. Curing means to cover the concrete so that it stays moist. By keeping concrete moist, the bond between the paste and the aggregates gets stronger. Concrete does not harden properly if it is left to dry out. Cured concrete is less likely to crack and more durable. Concrete is cured by applying extra water to the surface of the concrete, or by stopping water loss from the concrete. The longer concrete is cured, the closer it will be to its best possible strength and durability.

Various methods have been developed for concrete mix proportioning. All these procedures try to find the appropriate ratios of cement, sand and coarse aggregates at a particular water/cement ratio (w/c). Typical ratios often used are 1:2:4, 1:3:6, etc at 0.5, 0.6 etc w/c ratio. Simon et. al. (1997) stated that the general approach to concrete mix proportioning involves identifying a starting set of mixture proportions, performing one or more trial batches, starting with the mixture identified and adjusting the proportions in subsequent trial batches until all criteria are satisfied. Some of the methods developed include American Concrete Institute mix design method (Zaher and Fouad, 1999) and the British method of mix design. Almost all of these procedures have shortcomings or limitations. Time, energy and money are sometimes being wasted in order to get the appropriate mix proportions using trial mix approach. As the cost of materials increases, optimizing concrete mixture proportions for cost becomes more desirable. Furthermore, as the number of constituent materials increases, the problem of identifying optimal mixtures becomes increasingly complex (Simon et. al., 1997). To minimise some of these limitations, an optimisation procedure has been proposed. “A process that seeks for a maximum or minimum value for a function of several variables while at the same time, satisfying a number of other imposed requirements, is called an optimisation process” (Majid, 1974).

2.1.4 Testing of hardened concrete

Tests can be made for different purposes but the main two objectives of tests are control of quality and compliance with specifications. It should be remembered that tests are not an end in themselves. In the case of concrete, they seldom lend themselves to a neat, concise interpretation, so that in order to be of real value, tests should always be used against the background of experience (Neville, 1981).

Strength tests can be broadly classified into mechanical tests to destruction and non-destruction tests which allow repeated testing of the same specimen and thus make possible a study of the variation in properties with time. Destructive tests generally, measure the best possible strength concrete can reach in perfect conditions. They are also a measure of the concrete’s ability to resist loads which tend to destroy it.

Some of these tests include compression test, shear strength test, flexure test, tensile strength test, etc. while non-destructive test include water absorption tests, permeability tests and ultra pulse velocity tests.

2.2 Blocks

A block can be generally described as a solid mass. It can be made from a wide variety of materials ranging from binder, water, sand, laterite, coarse aggregate, clay to admixtures. The constituent materials determine the type of block which includes soilcrete blocks, sandcrete blocks, clay bricks, concrete blocks, mud blocks, etc. Blocks are widely used in construction industry. Individual blocks when bonded together with mortar are referred to as block work or block masonry. They are predominantly used as walling units in the construction of shelter (which is one of the basic needs of man) and other infrastructures. According to Project National de Researche/development (1994), block can be regarded as a member of family of concrete. Hence the properties of blocks are similar to that of concrete. The manufacturing process involves compaction of newly mixed constituent materials in a mould followed immediately by extrusion of the pressed block so that the mould can be used repeatedly. The finished blocks are required to be self supporting and able to withstand any movement and vibration from the moment they are extruded. The final stage of block production is curing just as it is in concrete production.

2.2.1 Sandcrete blocks

Sandcrete blocks, also known as common blocks are most commonly used for the construction of walls for buildings not only in Nigeria but also in other West African countries. They are generally made from a mixture of Portland cement, fine aggregates and water. The percentage of walling materials made of sandcrete blocks account for over 95% of all walling materials. Sandcrete has been in use throughout West Africa for over 50 years as a popular material for preparation of building blocks. According to Uzomaka (1977), sandcrete blocks contain only sand, cement and water and there should be no problem of instability. Sandcrete blocks appear in different forms – solid and hollow forms. A solid block has no holes or cavities other than those inherent in the material while hollow blocks have one or more formed holes or cavities. They also appear in different sizes which ranges from 390mm to 590mm in length, 190mm to 215mm in height and 60mm to 215mm in thickness. The properties of these blocks are similar to the properties of concrete and they depend to a varying degree on the type and proportions of the constituent materials, manufacturing process, and the mode and duration of curing employed (Boeck et. al., 2000).

Although sandcrete blocks are widely used, they are not considered the best for building in tropical countries because of its poor environmental and thermal insulating properties as a result of high degree of porosity. In order to improve the quality when used for domestic building, plastering of both internal and external surfaces are carried out, thus increasing the cost of building (Komolafe, 1986).

Danso, (2005) carried out a detailed experimental programme to determine the engineering properties of Ghanaian sandcrete blocks. He was able to achieve a compressive strength of over 7.0N/mm^2 for the sandcrete blocks (the minimum specified by the British Standards) with a lean mix of 1:12 cement/sand ratio using the right manufacturing and curing processes. He observed that inclusion of quarry dust (25%) and coarse aggregate (15% -18%) significantly improved the strength and permeation properties of the blocks.

Dalin, et.al., (2010) tested the shear strength of high strength stone masonry in China. They were able to come up with empirical formulae of shear strength of the masonry.
In an effort to reduce the cost of sandcrete block production, Emesiobi (2004) decided to replace cement partially with chikoko mud pozzolana. Both solid and hollow blocks were used for the test. The cement was replaced in parts of 10%, 20%, 30%, 40%, 50%, 60%, 70 and 100%. The results showed that up to 90% cement replacement with chikoko pozzalana is possible after 28 days of moist curing. Strengths in excess of the minimum 2.5N/mm^2 were obtained at all levels of replacement.

2.2.2 Soilcrete blocks

Soilcrete blocks are made of cement, laterite and water. They are also known as cement stabilized laterite blocks. Cement stabilized laterite blocks, due to its water resistant property and higher strength, is decidedly a durable construction material for low-cost building, especially for areas where laterite is in abundance (Boeck et. al., 2000). From their work, they came to a conclusion that laterite can be successfully stabilized using 4-6% cement and that the cost of cement stabilized laterite block is about half of the sandcrete block. Hence substantial saving in the material can be made by using laterite blocks, especially in rural areas where laterite is available in abundance.

According to Komolafe (1986), laterite blocks in addition to its low cost, has water resistant and insulating properties and natural beauty which might not require plastering or painting. Several researchers have reported that laterite can be used in road and building construction (Ola, 1974; Osula, 1989, Osula, 1996; Osinubi, Eberemu and Aliu, 2007). Good laterite blocks were produced from different sites in Kano when laterite was stabilized with 3 to 7% cement (Aggarwal and Holmes, 1983). The study showed that particle size distribution, cement content, compactive effort and method of curing are factors which affect the strength of the bricks.

Laterite blocks were made by the Nigerian Building and Road Research Institute (NBRRI) and used for the construction of a bungalow (Madedor, 1992). From the study, NBRRI proposed the following minimum specification as requirements for laterite blocks; bulk density of 1810kg/m^3, water absorption of 12.5%, compressive strength of 1.65N/mm^2 and durability of 6.9% with maximum cement content fixed at 5%. However, NBRRI did not specify any particle distribution curve for soil to be used in brick production.

Laterite stabilized with cement was used successfully to produce bricks in Sudan (Adam, 2001). Three pressure ranges: 2 to 4N/mm^2, 8 to 14N/mm^2 and 6 to 20N/mm^2 which were designated low, high and hyper respectively were used in the production of bricks. With cement of content of 5 to 8% and a brick size of 290 x 140 x 90mm, compressive strength ranging from 3 to 3.5N/mm^2 was achieved using a compactive effort that ranged from 8 to 14N/mm^2. The study showed that the strength of the bricks was dependent on the pressure applied during production.

Laterite was modified with 45% sand content by dry weight and stabilized up to 9% cement content respectively and used in the production of 330mm x 150mm x 150mm bricks through the application of a pressure of 3N/mm^2 with a brick moulding machine. Results showed that laterite used in this study cannot be stabilised for brick production within the economic cement content of 5% specified for use in Nigeria. However, bricks made with laterite admixed with 45% sand and 5% cement attained a compressive strength of 1.80N/mm^2 which is greater than the specified minimum strength value of 1.65N/mm^2. Cost comparison of available walling materials in

Markurdi metropolis showed that the use of bricks made from 45% sand and 5% cement resulted in a saving of 30-47% when compared with the use of sandcrete blocks while the use of fired clay bricks resulted in a savings of 19% per square meter of wall. The study therefore, recommends the use of laterite bricks in Markurdi and other locations because it is more economical and environmental friendly than fired clay bricks (Agbede and Manasseh, 2002).

Komolafe (1986) worked on the use of laterite-sand-cement as alternative materials in the making of low cost masonry blocks. He observed that the relative strength development to proportions and cost benefit analysis show that 1:5:8 cement-sand-laterite compares favourably with 1:8 sandcrete block at 28days. For the absorption capacity test, the sandcrete block attained a saturation of 13.1% in less than five seconds of total immersion in water while the specimen containing laterite attained only 2.2% absorption in the same period, thus, greatly reducing its permeability. He concluded that incorporating laterite into the aggregate content of masonry blocks will yield better quality block in terms of crushing strength and insulating relatively to sandcrete blocks. The continuous strength increase even after construction will result to better durability of the project in the long run.

An A-2-6 laterite according to AASHTO classification system was stabilized with 0-10% cement content by weight of the soil at a constant interval of 2% to produce 100mm x 100mm x 100mm blocks (Aguwa, 2010). In his work, a compressive strength of 3.22N/mm^2 with cement content of 6% was measured for laterite-cement blocks while sandcrete blocks had a compressive strength of 1N/mm^2. Aguwa observed that at 0% cement content, sandcrete blocks gained no compressive strength for all ages of curing and this is because there is no bonding between the grains of sand. Laterite-cement blocks gained small compressive strength for all the curing ages tested and this could be attributed to the cohesiveness of the laterite soil which bond particles together. This is a confirmation that only laterite could be used for non load bearing walls. In his work, Aguwa also discovered that sandcrete blocks are more porous than their laterite-cement counterparts and this could be as a result of higher value of density recorded by the laterite-cement blocks. The strength of the concrete is low and the durability is reduced drastically when the porosity of blocks is high. He came to the conclusion that there is savings of 30% per square metre of wall when compared with use of sandcrete blocks. In another work of Aguwa (2009), it was recorded that the compressive strength of laterite-cement blocks increased steadily with increase in percentage of cement content up to 20% but decreased at cement contents above 20%.

Alutu and Oghenejobo (2006) worked on cement-stabilised laterite hollow blocks to determine their strength, durability and cost effectiveness. They used 3% to 15% of cement at 2% increments. They observed that 7% cement content gave compressive strength of 2.0N/mm^2 at 28 days. Their cost analysis conclusion is that laterite blocks have 40% cost advantage over similar sandcrete blocks.

Olugbenga et. al., (2007), studied the compressive strength characteristics of laterite/sand hollow blocks. In their work, sand was partially replaced with laterite in the production of 450 x 225 x 150mm hollow blocks. The laterite content varied between 0 to 50% at 10% interval. Mix ratios of 1:6 and 1:8 were used. Water was added in every case until reasonable workable mixes were obtained. A compressive strength of 2.07N/mm^2 was obtained with a mix ratio of 1:6 and 10% laterite content. They observed that machine compacted blocks have higher compressive strength than hand compacted blocks. The difference is very pronounced at low percentage laterite content but becomes less pronounced as percentage laterite content increases. This is probably due to higher compaction pressure achieved with the former (Olugbenga et. al., 2007). This however is in line with the Nigeria Industrial Standard (2004) which states that the lowest crushing strength of individual load bearing blocks shall not be less than 2.5N/mm^2 for machine compaction and 2.0N/mm^2 for hand compaction.

In a more recent research, Ezeh, et.al.(2010) optimized the compressive strength of laterite/sand hollow block using Scheffe's simplex method. In their work, a mathematical model was developed and used to optimize the mix proportion that will produce the maximum compressive strength of laterite/sand hollow blocks. The model predicts the compressive strength of the blocks when the mix ratios are known and vice versa. The optimum value of compressive strength predicted by the model is 1.88N/mm^2 which corresponds to a mix ratio of 0.45:1:2:2 for water, cement, sand, laterite respectively.

2.2.3 Clay bricks

Clay bricks are made by shaping suitable clays and shales to units of standard size which are then fired to a temperature in the range of 900 to 1200^0C (Jackson, 1984). Many bricks are perforated and pressed bricks commonly have frogs. These features reduce brick weight. The normal size of building brick is 215mm x 102.5mm x 65mm. These bricks can be machine made or hand made. BS 3921 (1974) recognises three varieties of brick, which are differentiated on the basis of function. These are: common, for general building purposes; facing, manufactured for acceptable appearances and engineering, for use where high strength and low water absorption are required. In addition, three qualities of brick are defined, distinguished on the basis of durability; internal, for internal use only; ordinary, normally durable in the external face of a building; and special, durable under conditions of extreme exposure, where brickwork may be persistently wet. Such conditions frequently exist in retaining walls, parapets, sewerage plants and pavings (Jackson, 1984).

2.2.4 Other masonry units

There are some other materials or masonry units that are also of importance in the construction of Civil Engineering infrastructures. They include calcium silicate bricks, concrete blocks and aerated concrete blocks.

Calcium silicate bricks are made of siliceous aggregate, a high calcium, lime and water. The materials are first intimately mixed in the required proportions and are then conveyed to an automatic press where they are moulded to the required size and shape. From the press, the bricks are transferred to an autoclave where high pressure steam curing for some hours results in the combination of the lime with part of the siliceous aggregate to produce a hydrous calcium silicate known as tobernorite, which forms the binding medium in the finished brick. They are used where sulphates are present and where salt solution is absent (Jackson, 1984).

Concrete blocks are made of cement, water, fine and coarse aggregates. The manufacturing process involves compaction of newly mixed constituent materials in a mould followed immediately by extrusion of the pressed block so that the mould can be used repeatedly.

In the case of aerated concrete block, slurry of binder, pre-heated water and siliceous materials mixed together with aluminium powder is first cast as a 'cake' in large moulds. As the mix sets, air is introduced into it. After the initial set, while the aerated 'cake' is still in its plastic stage, the mould shutters are stripped off and the cake is cut into the required block sizes by thin wires on a cutting machine. This cut cake is then placed in as autoclave for high pressure steam curing for about 24 hours, when the blocks are ready for use as soon as they have cooled to the ambient temperature (Jackson, 1984).

2.3 Current block production practises in Nigeria

About 30 block industries within Owerri metropolis were visited. The survey was made to find out the mode of production of blocks, mix ratio and the nature/quality of sand. The following information was gathered.

2.3.1 Types and sizes

There are two main types of blocks moulded in Owerri. They are solid and hollow blocks. The sizes in length x breadth x height include

1. 450mm x 225mm x 225mm (hollow)
2. 450mm x 150mm x 225mm (hollow)
3. 450mm x 225mm x 225mm (solid)
4. 450mm x 150mm x 225mm (solid)
5. 450mm x 125mm x 225mm (solid)

2.3.2 Constituent materials

These include cement, fine aggregate (sharp sand), and water.

1. Fine aggregate (sand): The two major types of sand used are white sand and coloured sand. The sands were not free from materials such as dust, silt, tree roots etc. Their sources of sand include pits, rivers and sea.
2. Cement: Ordinary Portland Cement (OPC) is widely used.
3. Water: They make use of any type of water available. This includes water from streams, rivers, boreholes.

2.3.3 Mode of production/ Mix ratios

Batching by volume is adopted by block manufacturers. They use wheel barrows and paint buckets (for water). The mix ratio varies from 1 bag of cement to 3 to 7 wheel barrows of sand. The amount of water required is usually determined by trial and error. This ranges from 2 to 4 paint buckets of water depending on the moisture content of the sand.

Small scale manufacturers use manual method of mixing while large scale manufacturers use mixers. The general procedure for mixing is as follows:
Measure sand and cement unto a concrete platform on the ground. Mix with shovel about three times. Add water the fourth time and then turn the whole mix about two times.

Most of the block producers use moulds. The equipment is prefabricated steel or wooden mould box of the requisite dimension with one end open and removable steel or wooden plate resting at the bottom. Two perforated handles on either side of the device assist in the lifting and overturning the steel mould box. It is accompanied by a steel or wooden rod which is used for compaction. The procedure for moulding is as follows: Pour mixture into mould, vibrate, ram and demould immediately. Cure after 24 hours. The block moulding machine used by the large scale producers is the Rosacometta type which vibrates the block during filling and or compaction. One block is produced at a time. One bag of cement produces an average of fifty blocks.

The method generally adopted for curing is sprinkling the exposed blocks with water 24 hours after demoulding. They use long rubber hoses with nozzles. Ninety percent of the manufacturers spray their blocks once a day for a period of not more than three days. They do this because they are always in a haste to dispose of the blocks, cut cost and economise space.

2.4 Optimisation theory

A process that seeks for a maximum or minimum value for a function of several variables while at the same time, satisfying a number of other imposed requirements is called an optimisation process (Majid, 1974). This process involves using statistical techniques. This includes fitting empirical models to the data for each performance criterion. In these models, each response (resultant concrete property) such as strength is expressed as an algebraic function of factors (individual component proportions) such as water/cement (w/c) ratio, cement content, chemical admixtures dosage and percent pozzolana replacement.

After a response has been characterised by an equation (model), several analyses are possible (Simon, et.al., 1997). For instance, a user could determine which mixture proportions would yield one or more desired properties. The mixture proportion that has the highest or most desired property is the optimum mixture. A user also could optimise any property subject to constraints on other properties. Simultaneous optimisation to meet several constraints is also possible. For example one could determine the lowest cost mixture with strength greater than a specified value. These are some of the advantages of concrete mixture optimisation using statistical methods.

Some researchers have worked on this theory and they came up with interesting results. Obam, (1998) developed a model for optimisation of strength of palm kernel shell aggregate concrete using Scheffe's simplex theory. Okere, (2006) formulated models for optimisation of modulus of rupture of concrete using Scheffe's simplex theory and Osadebe's regression theory. Ogah, (2009) used Osadebe's method to study the shear modulus of rice husk ash concrete. Orie (2008) developed models for optimisation of compressive and flexural strength of mound soil concrete using Scheffe's method. From their work, one can deduce that in a factor space, different points exist. Each point yields mix proportions for a particular property. The point in factor space that produces the mixture proportions that yields the most desired property is the optimum point.

Henry Scheffe's optimisation theory and Osadebe's theory form the basis of this work which deals with the formulation of response functions for important engineering properties of soilcrete blocks.

2.4.1 Henry Scheffe's optimisation theory

Scheffe's optimisation method is based on simplex lattice design and will be discussed as follows:

2.4.1.1 The simplex lattice

A simplex lattice can be described as a structural representation of lines joining the atoms of a mixture. This lattice can be used as a mathematical space in model experiments involving mixtures by considering the atoms as the constituent components of the mixture. For instance in normal concrete mixture, the constituent elements are water, cement, fine and coarse aggregates and so normal concrete mixture gives a simplex of four components. Hence the simplex lattice of this four-component mixture is a three- dimensional solid equilateral tetrahedron. A mixture experiment involves mixing various proportions of two or more components to make different compositions of an end product (Aggarwal, 2002). Mixture components are subject to the constraint that the sum of all the components must be equal to one (Scheffe 1958). In order words: $\sum X_i = 1$, where q is the number of components of a mixture and i ranges from 1 to q. X_i is the proportion of the ith component in the mixture.

This shows that if we assume the mixture to be a unit quantity, then the sum of all the proportions must be unity. As a result, the factor space reduces to a regular (q-1) dimensional simplex. Claringbold, (1955) in a paper on joint action of hormones noted that the factor space for experiment with mixtures is a simplex.

In his brief review of statistical mixture experiments, Goelz, (2001) stated that the simplex is simply the projection of an n-dimensional space onto an n-1 dimensional coordinate system; this can be done because the proportions of the mixture are constrained to sum to 1. Thus, feasible combination of three components can be projected onto a two-dimensional triangular field. The simplex of a mixture of four components is a three-dimensional solid equilateral tetrahedron. The lattice part of the simplex lattice design shows that points are spaced regularly on the simplex. The degree of the simplex lattice is defined by the degree of the polynomial that may be used to fit the response surface over the simplex.

The simplex is also regarded as a feasible region of experimentation of the q-component mixture (Becker, 1968). A theory is developed for experiments with mixtures of q-components whose purpose is the empirical prediction of the response to any mixture of the components, when the response depends only on the proportion of the component and not on the total amount (Scheffe, 1958). Scheffe introduced the (q,m) simplex lattice designs.

2.4.1.3 Scheffe's simplex lattice design

In a (q-1) dimensional simplex, (where q represents the number of vertices)

(a) If q=2, we have 2 points of connectivity, giving a straight line simplex lattice (one dimension)

(ii) If q=3, we have a triangular simplex lattice (two dimensions).

(iii) If q=4, we have a tetrahedron simplex lattice (three dimensions)

Considering a whole factor space in design, we will have (q,m)simplex lattice whose properties are defined as follows:

(a) the factor space has uniformly spaced distribution of points.

(b) The proportions used for each factor have m+1 equally spaced values from 0 to 1 i.e. X_{ij} = 0, 1/m, 2/m, 3/m, ……,1 and all possible mixtures with these proportions for each component used.

For instance, if we have (q,2) lattice, that is a second degree polynomial, (m=2), the following levels of each factor must be used:0, ½, and 1 respectively. For (q,3) lattice, that is a third degree polynomial, (m=3) the levels of each factor are: 0, 1/3, 2/3, and 1 respectively. Scheffe showed that the number of points in (q,m) lattice is given by

$$^{q+m-1}C_m = q(q+1)\ldots\ldots\ldots(q+m-1)/m! \qquad (2.1)$$

This implies that

1. For a (3,2) lattice, the number of points equals 3(3+1)/2! = 6
2. For a (3,3) lattice, the number of points equals $\frac{3(3+1)(3+2)}{3!} = 10$
3. For a (4,2) lattice, the number of points equals $\frac{4(4+1)}{2!} = 10$
4. For a (4,3) lattice, the number of points equals $\frac{4(4+1)(4+2)}{3!} = 20$

2.4.2 Osadebe's regression theory

The formulation of the regression equation is done from first principles using the so-called absolute volume (mass) as a necessary condition. This principle assumes that the volume (mass) of a mixture is equal to the sum of the absolute volume (mass) of all the constituent components.

Osadebe (2003) assumed that the response function, $F(z)$ is continuous and differentiable with respect to its predictors, Zi. By making use of Taylor's series, the response function could be expanded in the neighbourhood of a chosen point. This would be done in chapter 3.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Materials

The materials used for this work are as follows:

3.1.1 Cement: Eagle cement brand of ordinary Portland cement with properties conforming to British standard was used.

3.1.2 Fine aggregates: The fine aggregates were fine and medium graded laterite and river sand.

(a) Laterite: This was sourced from Ikeduru LGA, Imo State. The grading and properties of this fine aggregate conformed to BS 882.

(b) River sand: This was got from Otamiri river, in Imo State. The grading and properties of this fine aggregate conformed to BS 882.

3.1.3 Water: Potable water conforming to the specification of EN 1008:2002 was used.

3.2 Analytical methods

Two analytical methods were used in this work to formulate the optimisation models. The first is Henry Scheffe's method of optimisation and the second is Osadebe's method of optimisation.

3.2.1 Scheffe's method of optimisation

Scheffe's optimisation method which is based on simplex lattice design has been discussed in chapter 2 and it can be recalled that the sum of all the components must be equal to one:

$$X_1 + X_2 + X_3 + \ldots\ldots\ldots.+ X_q = 1 \tag{3.1}$$

$$\sum X_i = 1 \tag{3.2}$$

where q is the number of components of a mixture and i ranges from 1 to q.

X_i is the proportion of the ith component in the mixture.

3.2.1.1 The simplex canonical polynomials

The (q,m) simplex lattice designs are characterised by the symmetric arrangements of points within the experimental region and a well chosen polynomial equation to represent the response surface over the entire simplex region. The polynomial has exactly as many parameters as there are number of points in the associated simplex lattice design. Recall that the number of points is given by:

$$^{q+m-1}C_m = q(q+1)\ldots\ldots\ldots(q+m-1)/m! \qquad (3.3)$$

Hence, we have 10 points for a (4,2) simplex and 6 points for a (3,2) simplex.

The response represents the property studied and is normally assumed to be a multi-varied function. In this study the responses are the block properties/characteristics.

Scheffe, (1958) introduced canonical polynomials to be used with his simplex lattice designs. These polynomials are obtained by modifying the usual polynomial model in *Xi* by using the restriction $\sum X_i = 1$. He assumed that a polynomial function of degree n in the q variables $X_1, X_2, \ldots\ldots X_q$ will be called a '(q,n) polynomial', and that it will be of the form

$$Y = b_0 + \sum b_i X_i + \sum b_{ij} X_i X_j + \sum b_{ijk} X_i X_j X_k + \sum b_{i_1 i_2 \ldots\ldots i_n} X_{i_1} X_{i_2} \ldots\ldots X_{i_n} \qquad (3.4)$$

where ($1 \le i \le q$, $1 \le i \le j \le q$, $1 \le i \le j \le k \le q$, $i \le i_1 \le i_2 \le \ldots\ldots \le i_n \le q$ respectively)

and b =constant coefficients

In general, the reduced form of Eqn (3.4) is in the form of Eqn (3.5) for a mixture with four components (i.e. n = 4) is given by

$$\begin{aligned} Y = b_0 + & b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 \\ & + b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{14} X_1 X_4 \\ & + b_{23} X_2 X_3 + b_{24} X_2 X_4 + b_{34} X_3 X_4 \\ & + b_{11} X_1^2 + b_{22} X_2^2 + b_{33} X_3^2 + b_{44} X_4^2 \end{aligned} \qquad (3.5)$$

Multiplying Eqn (3.1) by b_o gives Eqn (3.6)

$$b_0 X_1 + b_0 X_2 + b_0 X_3 + b_0 X_4 = b_0 \qquad (3.6)$$

Multiplying Eqn (3.1) successively by X_1, X_2, X_3, and X_4 and rearranging gives Eqn (3.7)

$$\begin{aligned} X_1^2 &= X_1 - X_1 X_2 - X_1 X_3 - X_1 X_4 \\ X_2^2 &= X_2 - X_1 X_2 - X_2 X_3 - X_2 X_4 \\ X_3^2 &= X_3 - X_1 X_3 - X_2 X_3 - X_3 X_4 \\ X_4^2 &= X_4 - X_1 X_4 - X_2 X_4 - X_3 X_4 \end{aligned} \qquad (3.7)$$

Substituting Eqns (3.6) and (3.7) into Eqn (3.5) and simplifying yields Eqn (3.8)

$$\begin{aligned} Y = & b_0 X_1 + b_0 X_2 + b_0 X_3 + b_0 X_4 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 \\ & + b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{14} X_1 X_4 + b_{23} X_2 X_3 + b_{24} X_2 X_4 \\ & + b_{34} X_3 X_4 + b_{11} (X_1 - X_1 X_2 - X_1 X_3 - X_1 X_4) \\ & + b_{22} (X_2 - X_1 X_2 - X_2 X_3 - X_2 X_4) \\ & + b_{33} (X_3 - X_1 X_3 - X_2 X_3 - X_3 X_4) + b_{44} (X_4 - X_1 X_4 - X_2 X_4 - X_3 X_4) \end{aligned}$$

Rearranging the Eqn, we have,

$$Y = (b_0 + b_1 + b_{11})\, X_1 + (b_0 + b_2 + b_{22})\, X_2 + (b_0 + b_3 + b_{33})\, X_3$$
$$+ (b_0 + b_4 + b_{44})\, X_4 + (b_{12} - b_{11} - b_{22})\, X_1 X_2$$
$$+ (b_{13} - b_{11} - b_{33})\, X_1 X_3 + (b_{14} - b_{11} - b_{44})\, X_1 X_4$$
$$+ (b_{23} - b_{22} - b_{33})\, X_2 X_3 + (b_{24} - b_{22} - b_{44})\, X_2 X_4$$
$$+ (b_{34} - b_{33} - b_{44})\, X_3 X_4 \qquad (3.8)$$

Let $\alpha_{i\,=}\ b_0 + b_i + b_{ii}$

and

$$\alpha_{ij} = b_{ij} - b_{ii} - b_{ij} \qquad (3.9)$$

Then Eqn (3.8) becomes

$$Y = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_{12} X_1 X_2 + \alpha_{13} X_1 X_3 + \alpha_{14} X_1 X_4$$
$$+ \alpha_{23} X_2 X_3 + \alpha_{24} X_2 X_4 + \alpha_{34} X_3 X_4 \qquad (3.10)$$

The number of coefficients in Eqn (3.8) has been reduced to 10 in Eqn (3.10).

In general, Eqn (3.10) becomes

$$Y = \sum \alpha_i X_i + \sum \alpha_{ij} X_i X_j \qquad (3.11)$$

where $1 \leq i \leq q$, $1 \leq i \leq j \leq q$

In general, the reduced form of Eqn (3.4) is in the form of Eqn (3.12) for a mixture with three components (i.e. $n = 3$) is given by:

$$Y = b_{0\,+}\ b_1 X_1 + b_2 X_2 + b_3 X_3$$
$$+ b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{23} X_2 X_3$$
$$+ b_{11} X_1^2 + b_{22} X_2^2 + b_{33} X_3^2 \qquad (3.12)$$

Multiplying Eqn (3.1) by b_0 gives Eqn (3.13)

$$b_0 X_1 + b_0 X_2 + b_0 X_3 = b_0 \qquad (3.13)$$

Multiplying Eqn (3.1) successively by X_1, X_2, and X_3, and rearranging gives Eqn (3.14)

$$X_1^2 = X_1 - X_1 X_2 - X_1 X_3$$
$$X_2^2 = X_2 - X_1 X_2 - X_2 X_3$$
$$X_3^2 = X_3 - X_1 X_3 - X_2 X_3 \qquad (3.14)$$

Substituting Eqns (3.13) and (3.14) into Eqn (3.12) and simplifying yields Eqn (3.15)

$$Y = b_0 X_1 + b_0 X_2 + b_0 X_3 + b_1 X_1 + b_2 X_2 + b_3 X_3$$
$$+ b_{12} X_1 X_2 + b_{13} X_1 X_3 + b_{23} X_2 X_3$$
$$+ b_{11} (X_1 - X_1 X_2 - X_1 X_3)$$
$$+ b_{22} (X_2 - X_1 X_2 - X_2 X_3) + b_{33} (X_3 - X_1 X_3 - X_2 X_3)$$

Rearranging the Eqn gives:

$$Y = (b_0 + b_1 + b_{11}) X_1 + (b_0 + b_2 + b_{22}) X_2 + (b_0 + b_3 + b_{33}) X_3$$
$$+ (b_{12} - b_{11} - b_{22}) X_1 X_2$$
$$+ (b_{13} - b_{11} - b_{33}) X_1 X_3$$
$$+ (b_{23} - b_{22} - b_{33}) X_2 X_3 \qquad (3.15)$$

Let $\alpha_i = b_0 + b_i + b_{ii}$

and

$$\alpha_{ij} = b_{ij} - b_{ii} - b_{ij} \qquad (3.16)$$

Then Eqn (3.16) becomes

$$Y = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \alpha_{12} X_1 X_2 + \alpha_{13} X_1 X_3 + \alpha_{23} X_2 X_3 \qquad (3.17)$$

The number of coefficients in Eqn (3.16) has been reduced to 6 in Eqn (3.17).

In general, Eqn (3.10) becomes

$$Y = \sum \alpha_i X_i + \sum \alpha_{ij} X_i X_j \qquad (3.18)$$

where $1 \le i \le q$, $1 \le i \le j \le q$

3.2.1.2 Determination of the coefficients in (4,2) and (3,2) polynomials

Assuming the response function for the pure component, i and that for the binary mixture of components i and j are y_i and y_{ii} respectively, then;

$$y_i = \sum \alpha_i X_i \qquad (3.19)$$

and

$$y_{ij} = \sum \alpha_i X_i + \sum \alpha_{ij} X_i X_j \qquad (3.20)$$

where $1 \le i \le 4$, $1 \le i \le j \le 4$

Substituting the values of X_1, X_2, X_3, and X_4 at the ith point (i.e. any of the vertices of the lattice) into Eqn (3.19), gives the following general equation:

$$y_i = \alpha_i \qquad (3.21a)$$

For example, at point one, the value of $X_1 = 1$ while the values of X_2, X_3 and X_4 are equal to zero because $\sum X_i = 0$. Substituting the values of X_1, X_2, X_3, and X_4 into Eqn (3.19) gives:

$$y_1 = \alpha_1 \qquad (3.21b)$$

Substituting the values of X_1, X_2, X_3, and X_4 at the point ij (that is at the mid point of the borderline connecting points i and j) of the lattice, into Eqn (3.20) yields:

$$y_{ij} = \tfrac{1}{2} \alpha_i + \tfrac{1}{2} \alpha_j + \tfrac{1}{4} \alpha_{ij} \qquad (3.22a)$$

For point 12, that is at the midpoint of the borderlines connecting points 1 and 2 of the lattice, the values of $X_1 = X_2 = ½$ while the values of X_3, and X_4 are equal to zero because $\sum X_i = 1$. Substituting the values of X_1, X_2, X_3, and X_4 into Eqn (3.20), gives Eqn (3.22b)

$$y_{12} = ½\,\alpha_1 + ½\,\alpha_2 + ¼\,\alpha_{12} \qquad (3.22b)$$

From Eqn (3.21a),

$$\alpha_i = y_i \qquad (3.23)$$

Similarly,

$$\alpha_j = y_j \qquad (3.24)$$

Rearranging Eqn (3.22a) yields:

$$\alpha_{ij} = 4y_{ij} - 2\alpha_i - 2\alpha_j \qquad (3.25a)$$

Substituting Eqns (3.23) and (3.24) into Eqn (3.25) gives:

$$\alpha_{ij} = 4y_{ij} - 2y_i - 2y_j \qquad (3.25b)$$

When Eqns (3.23), (3.24) and (3.25b) are substituted, Eqn (3.10) becomes:

$$\begin{aligned} \mathrm{y} = {} & y_1X_1 + y_2X_2 + y_3X_3 + y_4X_4 + (4y_{12} - 2y_1 - 2y_2)X_1X_2 \\ & + (4y_{13} - 2y_1 - 2y_3)X_2X_3 + (4y_{14} - 2\mathrm{y}_1 - 2y_4)X_1X_4 \\ & + (4y_{23} - 2y_2 - 2y_3)X_2X_3 + (4y_{24} - 2y_2 - 2y_4)X_2X_4 \\ & + (4y_{34} - 2y_3 - 2y_4)X_3X_4 \end{aligned} \qquad (3.26)$$

Let the coefficients of $y_1 = X_1 - 2X_1(X_2 + X_3 + X_4)$ (3.27)

From Eqn (3.1),

$$X_2 + X_3 + X_4 = 1 - X_1 \qquad (3.28)$$

Substituting Eqn (3.28) into Eqn (3.27) gives the coefficient of y_1 as follows:

$$\begin{aligned} y_1 &= X_1 - 2X_1\,(1 - X_1) \\ &= X_1\,(2X_1 - 1) \end{aligned} \qquad (3.29)$$

Rearranging Eqn (3.26) and transferring all the coefficients of y_1 in like manner, gives the following mixture design model for optimization of a 4-component concrete.

$$\begin{aligned} \mathrm{y} = {} & X_1(2X_1 - 1)y_1 + \mathrm{X}_2\,(2X_2 - 1)y_2 + X_3(2X_3 - 1)y_3 \\ & + X_4\,(2X_4 - 1)y_4 + 4X_1X_2y_{12} + 4X_1X_3y_{13} + 4X_1X_4y_{14} \\ & + 4X_2X_3\mathrm{y}_{23} + 4X_2X_4y_{24} + 4X_3X_4y_{14} \end{aligned} \qquad (3.30)$$

The terms y_i and y_{ii} are responses (representing the characteristics) at the points i and ij. They are determined by carrying out laboratory tests.

For a (3,2) polynomial with 3- component mix, the above expressions hold with the elimination of X_4. Hence Eqn (3.30) becomes the following for a 3-component mix.

$$y = X_1(2X_1 - 1)y_1 + X_2(2X_2 - 1)y_2 + X_3(2X_3 - 1)y_3 + 4X_1X_2y_{12} + 4X_1X_3y_{13} + 4X_2X_3y_{23} \quad (3.31)$$

3.2.1.3 Actual and pseudo components (Components transformation)

It is impossible to use the normal mix ratios such as 1:2:4 or 1:3:6 at given water /cement ratio because of the requirement of the simplex that sum of all the components must be one. Hence it is necessary to carry out a transformation from actual to pseudo components. The actual components represent the proportion of the ingredients while the pseudo components represent the proportion of the components of the ith component in the mixture i.e. X_1, X_2, X_3, X_4.

Let X represent pseudo components and Z, actual components. For component transformation we use the following equations:

$$X = BZ \quad (3.32)$$

$$Z = AX \quad (3.33)$$

where A = matrix whose elements are from the arbitrary mix proportions chosen when Eqn (3.33) is opened and solved mathematically.

B = the inverse of matrix A

Z = matrix of actual components

X = matrix of pseudo components obtained from the lattice.

Expanding and using Eqns (3.32) and (3.33) the actual components Z were determined and presented in Tables 3.1 and 3.2.

Table 3.1: Pseudo and actual components for Scheffe's (3,2) lattice for soilcrete blocks

Pseudo Components				Response, Y	Actual Components		
No	X_1	X_2	X_3		Z_1	Z_2	Z_3
1	1	0	0	Y_1	0.8	1	8
2	0	1	0	Y_2	1	1	12.5
3	0	0	1	Y_3	1.28	1	16.67
4	0.5	0.5	0	Y_{12}	0.9	1	10.25
5	0.5	0	0.5	Y_{13}	1.04	1	12.335
6	0	0.5	0.5	Y_{23}	1.14	1	14.585
Control							
7	0.25	0.25	0.5	C_1	1.09	1	13.46
8	0.25	0.5	0.25	C_2	1.02	1	12.417
9	0.67	0.33	0	C_3	0.866	1	9.485
10	0	0.67	0.33	C_4	1.0924	1	13.8761
11	0.3	0.3	0.4	C_5	1.052	1	12.818
12	0.2	0.3	0.5	C_6	1.1	1	13.685

Legend:

X_1 = Water cement ratio — Z_1 = Actual water/cement ratio

X_2 = Fraction of cement — Z_2 = Actual cement quantity

X_3 = Fraction of laterite — Z_3 = Actual laterite quantity

Table 3.2: Pseudo and actual components for Scheffe's (4,2) lattice for sand-laterite blocks

Pseudo Components					Response	Actual Components			
No	X_1	X_2	X_3	X_4		Z_1	Z_2	Z_3	Z_4
1	1	0	0	0	Y_1	0.8	1	3.2	4.8
2	0	1	0	0	Y_2	1	1	3.75	8.75
3	0	0	1	0	Y_3	1.28	1	3.334	13.336
4	0	0	0	1	Y_4	2.2	1	2.5	22.5
5	0.5	0.5	0	0	Y_{12}	0.9	1	3.475	6.775
6	0.5	0	0.5	0	Y_{13}	1.04	1	3.267	9.068
7	0.5	0	0	0.5	Y_{14}	1.5	1	2.85	13.65
8	0	0.5	0.5	0	Y_{23}	1.14	1	3.542	11.043
9	0	0.5	0	0.5	Y_{24}	1.6	1	3.125	15.625
10	0	0	0.5	0.5	Y_{34}	1.74	1	2.917	17.918
CONTROL									
11	0.25	0.25	0.5	0	C_1	1.09	1	3.4045	10.0555
12	0.25	0.5	0.25	0	C_2	1.02	1	3.5085	8.909
13	0.67	0.33	0	0	C_3	0.866	1	3.3815	6.1035
14	0	0.67	0.33	0	C_4	1.0924	1	3.6127	10.2634
15	0.3	0.3	0.4	0	C_5	1.052	1	3.4186	9.3994
16	0.2	0.3	0.5	0	C_6	1.1	1	3.432	10.253
17	0.5	0.25	0.25	0	C_7	0.97	1	3.371	7.9215
18	0.25	0.25	0.25	0.25	C_8	1.32	1	3.196	12.3465
19	0	0.25	0.25	0.5	C_9	1.67	1	3.021	16.7715
20	0	0.25	0	0.75	C_{10}	1.9	1	2.8125	19.0625

Legend:

X_1 = Water/cement ratio — Z_1 = Actual water/cement ratio

X_2 = Fraction of cement — Z_2 = Actual cement quantity

X_3 = Fraction of river sand — Z_3 = Actual river sand quantity

X_4 = Fraction of laterite — Z_4 = Actual laterite quantity

3.2.1.4 Design of experiments to fit the polynomial regression

The actual components as transformed from equation (3.33) and Tables 1 and 2 were used to measure out the quantities water (Z_1), cement (Z_2), laterite (Z_3), for soilcrete blocks and water (Z_1), cement (Z_2), river sand (Z_3) and laterite (Z_4) for sand-laterite blocks in their respective ratios for the various tests. For instance, the actual ratio for the test number 20 means that the block mix ratio is 1: 2.8125: 19.0625 at 1.9 free water/cement ratio.

There are generally two processes of designing experiments to fit the polynomial regression function. These are:

(i) The use of the (q,n) lattice with more than one observation per point

(ii) The use of a (q,m) lattice with m > n and one observation per point.

This work considers the (3,2) and (4,2) lattice polynomials. It has been shown that process (i) is preferable because it has the advantage that least-square estimates $\bar{\alpha}$ of the regression coefficients, α are easily calculated from the means $\bar{y}$ of the observations at the points of the lattice by replacing α and y by $\bar{\alpha}$ and $\bar{y}$ in equations (3.23) and (3.25). Process (ii) is rather tedious as the regression is fitted by least-squares on less distantly spaced points of the lattice giving rise to so many equations. (Scheffe, 1958).

3.2.2 Osadebe's method of optimisation

Recall Osadebe's assumption that the response function, $F(z)$ is continuous and differentiable with respect to its predictors, Zi.

$$F(z) = F(z^{(0)}) + \sum [\partial F(z^{(0)}) / \partial z_i](z_i - z_i^{(0)}) + ½! \sum\sum [\partial^2 F(z^{(0)}) / \partial z_i \partial z_j](z_i - z_i^{(0)})(z_j - z_j^{(0)}) + ½! \sum\sum [\partial^2 F(z^{(0)}) / \partial z_i^2] (z_i - z_i^{(0)})^2 + \ldots\ldots \quad (3.34)$$

where 1≤i≤4, 1≤i≤4, 1≤j≤4,and 1≤i≤4 respectively.

By making use of Taylor's series, the response function could be expanded in the neighbourhood of a chosen point:

$$Z^{(0)} = Z_1^{(0)}, Z_2^{(0)}, Z_3^{(0)}, Z_4^{(0)}, Z_5^{(0)} \quad (3.35)$$

Without loss of generality of the formulation, the point $z^{(0)}$ will be chosen as the origin for convenience sake. It is worthy of note here that the predictor, z_i is not the actual portion of the mixture component rather it is the ratio of the actual portions to the quantity of concrete. For convenience sake, let z_i be the fractional portion and s_i be the actual portions of the mixture components.

If the total quantity of concrete is designated s, then

$$\sum s_i = s \tag{3.36}$$

For concrete of four components, $1 \le i \le 4$ and so Eqn (3.36) becomes:

$$s_1 + s_2 + s_3 + s_4 = s \tag{3.37}$$

If the total quantity of concrete required is a unit quantity, then Eqn (3.37) should be divided throughout by s. Hence

$$s_1/s + s_2/s + s_3/s + s_4/s = s/s \tag{3.38}$$

But, fractional portions, $z_i = s_i/s$ (3.39)

Substituting Eqn (3.39) into Eqn (3.38) gives Eqn (3.40)

$$z_1 + z_2 + z_3 + z_4 = 1 \tag{3.40}$$

In the formulation of the regression equation, the point, $z^{(0)}$ was chosen as the origin. This implies that $z^{(0)} = 0$ and so

$$z_1^{(0)} = 0,\ z_2^{(0)} = 0,\ z_3^{(0)} = 0 \text{ and } z_4^{(0)} = 0$$

Let

$$b_0 = F(0) \tag{3.41}$$

$$b_i = \partial F(0) / \partial z_i \tag{3.42}$$

$$b_{ij} = \partial^2 F(0) / \partial z_i \partial z_j \tag{3.43}$$

$$b_{ii} = \partial^2 F(0) / \partial z_i^2 \tag{3.44}$$

Substituting Eqns (3.41) – (3.44) into Eqn (3.34) gives:

$$F(z) = b_0 + \sum b_i z_i + \sum\sum b_{ij} z_i z_j + \sum b_{ii} z_i^2 + \ldots \tag{3.45}$$

where $1 \le i \le 4$ and $1 \le j \le 4$

Multiplying Eqn (3.40) by b_0 gives the expression for b_0 i.e. Eqn (3.46)

$$b_0 = b_0 z_1 + b_0 z_2 + b_0 z_3 + b_0 z_4 \tag{3.46}$$

Multiplying Eqn (3.40) successively by z_1, z_2, z_3 and z_4, and rearranging the products, gives respectively, Eqns (3.47)-(3.50)

$$z_1^2 = z_1 - z_1 z_2 - z_1 z_3 - z_1 z_4 \tag{3.47}$$

$$z_2^2 = z_2 - z_1 z_2 - z_2 z_3 - z_2 z_4 \tag{3.48}$$

$$z_3^2 = z_3 - z_1 z_3 - z_2 z_3 - z_3 z_4 \tag{3.49}$$

$$z_4^2 = z_4 - z_1 z_4 - z_2 z_4 - z_3 z_4 \tag{3.50}$$

Substituting Eqns (3.46) – (3.50) into Eqn (3.45) and simplifying yields Eqn (3.51)

$$Y = \alpha_1 z_1 + \alpha_2 z_2 + \alpha_3 z_3 + \alpha_4 z_4 + \alpha_{12} z_1 z_2 + \alpha_{13} z_1 z_3 + \alpha_{14} z_1 z_4 + \alpha_{23} z_2 z_3 + \alpha_{24} z_2 z_4 + \alpha_{34} z_3 z_4 \quad (3.51)$$

where

$$\alpha_i = b_0 + b_i + b_{ii} \quad (3.52)$$

and

$$\alpha_{ij} = b_{ij} - b_{ii} - b_{jj} \quad (3.53)$$

In general, Eqn (3.51) is given as:

$$Y = \sum \alpha_i z_i + \sum \alpha_{ij} z_i z_j \quad (3.54)$$

where $1 \le i \le j \le 4$

Eqns (3.51) and (3.54) are the optimization model equations.

Y is the response function at any point of observation, z_i are the predictors and α_i are the coefficients of the optimization model equations.

For concrete of three components, $1 \le i \le 3$ and so Eqn (3.36) becomes:

$$s_1 + s_2 + s_3 = s \quad (3.55)$$

If the total quantity of concrete required is a unit quantity, then Eqn (3.55) should be divided throughout by s. Hence,

$$s_1/s + s_2/s + s_3/s = s/s \quad (3.56)$$

But fractional portions, $z_i = s_i/s$ (3.57)

Substituting Eqn (3.57) into Eqn (3.56) gives Eqn (3.60)

$$z_1 + z_2 + z_3 = 1 \quad (3.60)$$

In the formulation of the regression equation, the point, $z^{(0)}$ was chosen as the origin. This implies that $z^{(0)} = 0$ and so,

$$z_1^{(0)} = 0,\ z_2^{(0)} = 0, \text{ and } z_3^{(0)} = 0$$

Let

$$b_0 = F(0) \quad (3.61)$$

$$b_i = \partial F(0) / \partial z_i \quad (3.62)$$

$$b_{ij} = \partial^2 F(0) / \partial z_i \partial z_j \quad (3.63)$$

$$b_{ii} = \partial^2 F(0) / \partial z_i^2 \quad (3.64)$$

Substituting Eqns (3.61) – (3.64) into Eqn (3.34) gives:

$$F(z) = b_0 + \sum b_i z_i + \sum\sum b_{ij} z_i z_j + \sum b_{ii} z_i^2 + \ldots \quad (3.65)$$

where $1 \le i \le 3$ and $1 \le j \le 3$

Multiplying Eqn (3.60) by b_0 gives the expression for b_0 i.e. Eqn (3.66)

$$b_0=b_0z_1+b_0z_2+b_0z_3 \tag{3.66}$$

Multiplying Eqn (3.60) by z_1, z_2 and z_3, and rearranging the products, gives Eqns (3.67)-(3.70)

$$z_1^2 = z_1 - z_1z_2 - z_1z_3 \tag{3.67}$$

$$z_2^2 = z_2 - z_1z_2 - z_2z_3 \tag{3.68}$$

$$z_3^2 = z_3 - z_1z_3 - z_2z_3 \tag{3.69}$$

$$z_4^2 = z_4 - z_1z_4 - z_2z_4 \tag{3.70}$$

Substituting Eqns (3.67) – (3.70) into Eqn (3.65) and simplifying yields Eqn (3.71)

$$Y = \alpha_1z_1 + \alpha_2z_2 + \alpha_3z_3 + \alpha_{12}z_1z_2 + \alpha_{13}z_1z_3 + \alpha_{23}z_2z_3 \tag{3.71}$$

where

$$\alpha_i = b_0 + b_i + b_{ii} \tag{3.72}$$

and

$$\alpha_{ij} = b_{ij} - b_{ii} - b_{jj} \tag{3.73}$$

In general, Eqn (3.71) is given as:

$$Y = \sum\alpha_iz_i+\sum\alpha_{ij}\, z_iz_j \tag{3.74}$$

where $1 \le i \le j \le 3$

Eqns (3.71) and (3.74) are the optimization model equations.

Y is the response function at any point of observation, z_i are the predictors and α_i are the coefficients of the optimization model equations.

3.2.2.1 Determination of the coefficients of the Osadebe's regression equation

Different points of observation will have different responses with different predictors at constant coefficients. At the nth observation point, $Y^{(n)}$ will correspond with $Z_i^{(n)}$. That is to say that:

$$Y^{(n)} = \sum \alpha_iz_i^{(n)} + \sum \alpha_{ij}\, z_i^{(n)} z_j^{(n)} \tag{3.75}$$

where $1 \le i \le j \le 4$ and n = 1,2,3, ………… 10

Eqn (3.75) can be put in matrix from as

$$[Y^{(n)}] = [Z^{(n)}]\,\{\alpha\} \tag{3.76}$$

Rearranging Eqn (3.76) gives:

$$\{\alpha\} = [Z^{(n)}]^{-1}\,[Y^{(n)}] \tag{3.78}$$

The actual mix proportions, $s_i^{(n)}$) and the corresponding fractional portions, $z_i^{(n)}$ are presented on Tables 3 and 4. These values of the fractional portions $Z^{(n)}$ were used to develop $Z^{(n)}$ matrix and the inverse of $Z^{(n)}$ matrix. The values of $Y^{(n)}$ matrix will be determined from laboratory tests. With the values of the matrices $Y^{(n)}$ and $Z^{(n)}$ known, it is easy to determine the values of the constant coefficients α_i of Eqn (3.76).

Table 3.3: Values of actual mix proportions and their corresponding fractional portions for a 3-component mixture

N	S_1	S_2	S_3	RESPONSE	Z_1	Z_2	Z_3
1	0.8	1	8	Y_1	0.081633	0.102041	0.816327
2	1	1	12.5	Y_2	0.068966	0.068966	0.862069
3	1.28	1	16.67	Y_3	0.067546	0.05277	0.879683
4	0.9	1	10.25	Y_{12}	0.074074	0.082305	0.843621
5	1.04	1	12.335	Y_{13}	0.072348	0.069565	0.858087
6	1.14	1	14.585	Y_{23}	0.068161	0.059791	0.872048

Table 3.4: Values of actual mix proportions and their corresponding fractional portions for a 4-component mixture

N	S_1	S_2	S_3	S_4	RESPONSE	Z_1	Z_2	Z_3	Z_4
1	0.8	1	3.2	4.8	Y_1	0.08163	0.10204	0.32653	0.4898
2	1	1	3.75	8.75	Y_2	0.06897	0.06897	0.25862	0.60345
3	1.28	1	3.334	13.336	Y_3	0.06755	0.05277	0.17594	0.70375
4	2.2	1	2.5	22.5	Y_4	0.07801	0.03546	0.08865	0.79787
5	0.9	1	3.475	6.775	Y_{12}	0.07407	0.0823	0.28601	0.55761
6	1.04	1	3.267	9.068	Y_{13}	0.07235	0.06957	0.22727	0.63082
7	1.5	1	2.85	13.65	Y_{14}	0.07895	0.05263	0.15	0.71842
8	1.14	1	3.542	11.043	Y_{23}	0.06816	0.05979	0.21178	0.66027
9	1.6	1	3.125	15.625	Y_{24}	0.07494	0.04684	0.14637	0.73185
10	1.74	1	2.917	17.918	Y_{34}	0.07381	0.04242	0.12373	0.76004

Table 3.5: $Z^{(n)}$ matrix for a 3-component mixture

Z_1	Z_2	Z_3	Z_1Z_2	Z_1Z_3	Z_2Z_3
0.081633	0.102041	0.816327	0.00833	0.066639	0.083299
0.068966	0.068966	0.862069	0.004756	0.059453	0.059453
0.067546	0.05277	0.879683	0.003564	0.059419	0.046421
0.074074	0.082305	0.843621	0.006097	0.06249	0.069434
0.072348	0.069565	0.858087	0.005033	0.062081	0.059693
0.068161	0.059791	0.872048	0.004075	0.05944	0.05214

Table 3.6: Inverse of $Z^{(n)}$ matrix for a 3-component mixture

18404.97	174174.7	80140.91	-117638	85468.3	-240550
626.1789	20681.99	17516.23	-6749.46	6103.252	-38177.2
82.98107	533.8623	158.303	-437.313	255.0613	-591.894
-25885.6	-314971	-172687	185296.6	-143290	471536.4
-20959.6	-193994	-87422.8	132487.4	-95260.8	265150.2
-248.911	-14565.9	-14339.9	3319.676	-3197.38	29032.42

Table 3.7: $Z^{(n)}$ matrix for a 4-component mixture

Z_1	Z_2	Z_3	Z_4	Z_1Z_2	Z_1Z_3	Z_1Z_4	Z_2Z_3	Z_2Z_4	Z_3Z_4
0.08163	0.10204	0.32653	0.4898	0.00833	0.02666	0.03998	0.03332	0.04998	0.15993
0.06897	0.06897	0.25862	0.60345	0.00476	0.01784	0.04162	0.01784	0.04162	0.15606
0.06755	0.05277	0.17594	0.70375	0.00356	0.01188	0.04754	0.00928	0.03714	0.12381
0.07801	0.03546	0.08865	0.79787	0.00277	0.00692	0.06225	0.00314	0.02829	0.07073
0.07407	0.0823	0.28601	0.55761	0.0061	0.02119	0.0413	0.02354	0.04589	0.15948
0.07235	0.06957	0.22727	0.63082	0.00503	0.01644	0.04564	0.01581	0.04388	0.14337
0.07895	0.05263	0.15	0.71842	0.00416	0.01184	0.05672	0.00789	0.03781	0.10776
0.06816	0.05979	0.21178	0.66027	0.00408	0.01444	0.045	0.01266	0.03948	0.13983
0.07494	0.04684	0.14637	0.73185	0.00351	0.01097	0.05485	0.00686	0.03428	0.10712
0.07381	0.04242	0.12373	0.76004	0.00313	0.00913	0.0561	0.00525	0.03224	0.09404

Table 3.8: Inverse of $Z^{(n)}$ matrix for a 4-component mixture

0.01332	13001.9	49802.3	12247.4	-27.342	57.3161	-33.368	-51810	28134.2	-51371
4336.4	45351.5	43027.1	7008.22	-29980	33091.1	-13479	-90682	34455.1	-33126
232.977	2226.86	1262.22	25.1601	-1496.6	1206.8	-200.02	-3413.5	527.729	-370.68
1.89758	51.1618	263.944	39.7135	20.4721	-49.804	22.6794	-236.6	100.496	-212.96
-4351.6	-106933	-185459	-37916	46501.1	-67673	33602.4	286691	-132782	168321
-229.47	-4467.1	-35207	-11162	-2103.6	6325.41	-4181.2	25533.8	-15743	41235.4
-1.5929	-14684	-57317	-13682	-317.77	672.44	-385.69	59068.3	-31602	58249.5
-6582.4	-67683	-59036	-7879.1	44875.1	-47063	17553.2	129718	-45129	41225.7
-4520	-42355	-36548	-5985.4	29523.3	-31189	12581.5	80922.3	-30449	28018.9
-192.82	-2953.1	-2680.6	-128.09	1567.86	-1599.9	410.587	5728.43	-1371.2	1218.85

3.3 Testing of the fitness of the models

The results of the quadratic polynomial models and the actual experimental observation will be tested to check whether they agree or not. In order to do this, we need to state our statistical hypothesis. Let the Null hypothesis be denoted by H_0 and the Alternative hypothesis by H_1.

H_0: There is no significant difference between the experimental and the theoretically expected results at an α- level of 0.05.

H_1: There is a significant difference between the experimental and theoretically expected results at an α –level of 0.05.

The Null hypothesis, H_0 is the hypothesis that is being tested. The alternative hypothesis, H_1 is the hypothesis that becomes available alternative when the Null hypothesis has been rejected (Nwachukwu, 2005; Uwazie, 2005). Should H_0 be true, then the results expected based on the models may not be exactly the same. The slight differences may be due to some random, cumulative fluctuations from the derivation of the model equations and the actual experimentation with the experimental values. However, the percentage differences are marginal. The adequacy test for each of the models will be carried out using the student's t-test and the Fisher test.

Simplex lattice design experiments are normally 'saturated'. This means that there are no degrees of freedom and additional test points are often required for the test of adequacy of the model. The control points will be used for this test.

3.3.1 The student's t-test

Recall from Eqn (3.11) that the estimate of response is given by:

$$Y_{(x)} = \sum \alpha_i X_i + \sum \alpha_{ij} X_i X_j \quad (3.79)$$

where $1 \leq i \leq q$, $1 \leq i \leq j \leq q$

According to Aggarwal, (2002), a formula for the variance of the estimate, $Y_{(x)}$ can be obtained by replacing the parameter estimates α_i and α_{ij} by their respective linear combinations of the averages y_i and y_{ii}, then the variance of $Y_{(x)}$ can be a function of y_i and y_{ii}. Hence,

$$Y_{(x)} = \sum \alpha_i X_i + \sum \alpha_{ij} X_i X_j \quad (3.80)$$

where $1 \leq i \leq q$, $1 \leq i \leq j \leq q$

$$a_i = X_i(2X_i - 1) \text{ and } a_{ij} = 4X_iX_j \quad (3.81)$$

$i,j, = 1,2\ldots\ldots q,\ i<j$

The coefficients a_i and a_{ij} are fixed as the values of X_i are specified. Since y_i and y_{ij} are averages of n_i and n_{ij} respectively, the estimated variance is as follows:

$$S_y^2 = S^2(\sum a_i^2/n_i + \sum a_{ij}^2/n_{ij}) \quad (3.82)$$

for $1 \leq i \leq q$ and $1 \leq i \leq j \leq q$ respectively, but $n_i = n_{ij} = n$ for equal number of replicate observations at all points of the design.

Hence

$$S_y^2 = S^2\,\varepsilon/n \qquad (3.83)$$

where $\varepsilon = \sum a_i^2 + \sum a_{ij}^2$ (3.84)

and ε is the error for the predicted value of the response.

The unbiased estimate of the unknown variance is given by Cramer (1946) as

$$S_y^2 = [1/(n-1)][\sum (y_i - y)^2] \qquad (3.85)$$

where $1 \leq i \leq n$

y_i = the responses

y = the mean of responses for each control point

n = control points

n-1 = degree of freedom

The mean of the responses is given by:

$$y = \sum y/n \qquad (3.86)$$

where $1 \leq i \leq n$

Expanding Eqn (3.85) yields

$$S_y^2 = [1/(n-1)]\{\sum y_i^2 - [1/n(\sum y_i)^2]\} \qquad (3.87)$$

where $1 \leq i \leq n$

One of the assumptions is that the replication variance S_y^2 is similar at all design points.

The t-test statistic equation is given by:

$$t = \Delta y\sqrt{n} \,/\, (S_y\sqrt{1+\varepsilon}) \qquad (3.88)$$

where

$$\Delta Y = y_{(observed)} - y_{(predicted)} \qquad (3.89)$$

n = number of parallel or replicate observations at every point

ε = as defined by Eqn (3.84).

The t-statistics is compared with the tabulated value of $t_{\alpha/l}(v_e)$

where

α = significant level (taken as 0.05)

l = number of control points

v_e = number of degrees of freedom

The null hypothesis is accepted if the value got from the table is greater than the calculated value(s) using Eqn (3.88).

Replication error, S_y

$$V_e = \sum(m_{i-1}) \tag{3.90}$$

where 1≤i≤20 or 12

$$S_y^2 = 1/ V_e \sum S_i^2 \tag{3.91}$$

Replication error, $S_y = \sqrt{S_y^2}$ (3.92)

3.3.2 The Fisher test

This statistical method will be adopted to determine the differences between the experimental values observed and the predicted values calculated. It is important to determine whether the sample variances S_1^2 and S_2^2 for the two sets of data respectively, are significantly different. If $S_1^2 = S_2^2$, it implies that the error(s) from experimental procedure are similar and we can conclude that the sample variances being tested are estimates of the same population variance.

The Null hypothesis (H_0) is: $\sigma_1^2 = \sigma_2^2$, that is, the samples were drawn from population with equal variance. The Alternative hypothesis (H_1) is: $\sigma_1^2 \neq \sigma_2^2$, that is, the population variances are not equal. In order to accept the Null hypothesis, we should be able to prove that the difference between the sample variances at the specified significance level (α) is not significant by applying the fisher test.

The test statistics is given by

$$F = S_1^2/ S_2^2 \tag{3.93}$$

where S_1^2 is the larger of the two variances.

The variance is

$$S^2 = [1/(n-1)][\sum (Y\text{-}y)^2] \tag{3.94}$$

and

$$y = \sum Y/n \text{ for } 1 \leq i \leq n \tag{3.95}$$

or the mean of the sample response Y.

The upper limit of equation (3.93) is

$$S_1^2/ S_2^2 \leq F_{1\text{-}\alpha} (v_1,v_2) \tag{3.96}$$

and the lower limit is

$$S_1^2/ S_2^2 \geq 1/F_{1\text{-}\alpha} (v_2,v_1) \tag{3.97}$$

where α is significant level taken as 0.05

v is the degree of freedom which is n-1
n is the number of observation data.

According to Akhnazarova and Kafarov (1982), the lower limit is always satisfied. Test is carried out to verify if the upper limit condition is satisfied. This will enable us accept or reject the Null hypothesis. The RHS of equation (3.93) is taken or observed from F-distribution table (appendix JJ).

3.4 Experimental investigation

Two types of investigations, namely field and laboratory investigations were carried out in this research.

3.4.1 Field investigation

About 30 block firms within Owerri metropolis were visited. The survey was made in order to find out the block firms' mode of production, mix ratios, nature/quality of sand and other necessary information. Blocks were bought from different manufacturers and carried to the laboratory for the necessary tests.

3.4.2 Laboratory investigation

The blocks bought from different producers were crushed in compression testing machine to determine their compressive strengths. The materials for the experimental investigation were sourced and transferred to the laboratory where they were spread and allowed to dry. Various tests and analysis were carried out on the laterite sample before the blocks were produced.

3.4.2.1 Physical property tests

The laterite was observed and tested to determine the physical properties. These include sieve analysis, specific gravity, moisture content, bulk density and plasticity index. The sieve analysis was carried out according to standard procedures (BS 812: Section 103.1:1985 and BS 11377: 1975). The plasticity index test was carried out in accordance with BS 1377(1975).

3.4.2.2 Chemical property tests

Chemical analysis was carried out on the laterite sample to determine the chemical composition of the laterite. The quantities of various elements per kilogram of laterite sample were determined. These include calcium, iron, magnesium, potassium, sulphate, aluminium, etc.

3.4.2.3 Preparation of test specimens

Preliminary tests were carried out to determine the block size and starting mix ratios to use in the laboratory test. Using Scheffe's optimisation technique, the actual mix proportions were measured by weight and two different types of blocks of size 450mm x 150mm x 225mm (solid) were produced, namely soilcrete blocks and sand-laterite blocks. Soilcrete blocks were moulded using laterite, cement and water. Sand-laterite blocks were produced by partially replacing laterite with river sand. The blocks were demoulded immediately after manual compaction of newly mixed constituent materials in a mould. The blocks were cured for 28 days after 24 hours of demoulding using the environmental friendly method of covering with tarpaulin/water proof devices to prevent moisture loss.

3.4.2.4 Characteristics tests

In accordance to BS 2028,1364, (1968), the blocks were tested for compressive strength, flexural strength, split tensile strength, water absorption, static modulus of elasticity, shear modulus/modulus of rigidity and shear strength as follows:

A. Compressive strength

Using the universal compression testing machine, blocks were crushed and the crushing load was recorded. The compressive strength was obtained from the following equation:

$$f_c = P/A \tag{3.98}$$

where f_c = the compressive strength

P = crushing load

A = cross-sectional area of the specimen

Three blocks were tested for each point and the average taken as the compressive strength of the point.

B. Flexural strength

Blocks were tested for flexural strength using the hand operated flexural testing machine. The two point loading system was used. The load under which the specimen failed was recorded. The flexural strength was obtained from the following equation:

$$\sigma = WL/bh^2 \tag{3.99}$$

where σ = the flexural strength

W = Maximum load

L = the distance between supporting rollers

b and h are the lateral dimensions of the specimen

Three blocks were tested for each point and the average taken as the flexural strength of the point.

C. Split tensile strength

The splitting test was carried out using the testing machine. The load applied was resting against the block on centre line of two opposing faces. The load was increased until failure by splitting along the centre line occurred. The horizontal tensile stress was calculated using:

$$T_{sh} = 2P/\Pi Lb \tag{3.100}$$

where T_{sh} = horizontal tensile stress

P = compressive load on the specimen

L and b are the length and breadth of the specimen

Three blocks were tested for each point and the average taken as the split tensile strength of the point.

D. Water absorption

The blocks for this test were weighed and immersed in water for 24 hours. On removal from water, they were reweighed to determine the quantity of water absorbed. Water absorption was calculated as a measure of the difference in weight of the specimen before and after immersion in water for the specified period expressed as a percentage of weight before immersion. Three blocks were tested for each point and the average taken as the water absorption of the point.

E. Static modulus of elasticity

Blocks were tested for static modulus of elasticity using the following relationship:

$$E_c = 1.7\rho^2 f_{cu}^{0.33} \times 10^{-6} \tag{3.101}$$

where ρ = density

f_{cu} = compressive strength

Three blocks were tested for each point and the average taken as the static modulus of elasticity of the point.

F. Poisson's ratio

The initial cracking load in flexure was recorded and used to calculate tensile stress at cracking in flexure. The initial cracking load in compression specimen was recorded and used to calculate compressive stress at cracking in compression specimen. With these two parameters known, Poisson's ratio was calculated using the following equation:

$$\mu = \sigma_t / \sigma_c \quad (3.102)$$

where μ = Poisson's ratio

σ_t = tensile stress at cracking in flexure

σ_c = compressive stress at cracking in compression specimen

Three blocks were tested for each point and the average taken as the Poisson's ratio of the point.

G. Shear modulus/modulus of rigidity

The modulus of rigidity or shear modulus is not normally determined by direct measurement. It is the ratio of shear stress to shear strain. However the following equation was used for its calculation:

$$G = E_c / 2(\mu + 1) \quad (3.103)$$

where G = shear modulus

E_c = Static modulus of elasticity

μ = Poisson's ratio

Three blocks were tested for each point and the average taken as the shear modulus of the point.

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H. Shear strength

The shear load or failure load was obtained from the test carried out on the specimen under flexure. The shear strength which is a measure of the shear load divided by the cross-sectional area of the specimen was obtained using the following:

$$S = F/A \tag{3.104}$$

where S is the shear strength

F = shear load

A = cross-sectional area

Three blocks were tested for each point and the average taken as the shear strength of the point.

Having tested for all these parameters stated above, the results obtained were used in chapter four in formulating mathematical models for prediction of all the properties/characteristics, using Scheffe's method and Osadebe's method. Computer programs were written for each model. The models were tested for adequacy using student's t-test and Fisher test.

3.5 Computer method

The mathematical models cannot be used effectively without developing computer programs. An attempt to use the models without the computer programs will be a waste of precious time. Computer program is a sequence of instructions written to perform a specified task with a computer. The programmer formulates the task and expresses it in an appropriate programming language. These programming languages are used to send information to and receive information from computers. The individual instructions that make up the program are called source code. Several programming languages are available such as Q-basic, visual basic, c++ programming languages and others.

The basic steps involved in developing a basic program and other programming languages include:

- Writing down Algorithms
- Using Variables
- Using Data types

Algorithms

Before you can write software to solve a problem, you have to break it down into a step-by-step description of how the problem is going to be solved. This step-by-step process is known as algorithm. An algorithm is independent of the programming language, so, if you like, you can describe it to yourself either as a spoken language, with diagrams, or with whatever helps you visualise the problem (Wrox, 1970). The generalised flow chart for the programs is appended.

Variables

A variable is something that you store a value in as you work through your algorithm; it can be seen as a container that holds information or values (Oliver, 2003). The use of variable in programming is very important. It is in fact relatively impossible to write a fully-fledged program without using variables. Before a variable can be used it needs to be declared, then the program creates a space for the value on the computer memory, telling the computer to reserve a space for the variable. When a variable is first declared, it is given a null value until a value has been assigned.

Data types

When variables are used, it is a good idea to know ahead of time the things that one wants to store in them. When a variable is defined, one must tell visual basic the type of data that should be stored in it, this is known as the data type and all meaningful programming languages have a vast array of different data types to choose from. The data type of a variable has a great impact on how the computer will run the code.

3.5.1 Computer programs

The computer programs developed for the models are attached as appendices. The programs were written in basic language. Each program is in two parts. Any desired characteristic or property is specified as an input. The computer then prints out all the possible combinations of mixes that match the characteristic or property. The actual mix ratios can be specified as input and the computer can print out the characteristic or property that will match the mix ratio. The computer results were obtained within seconds.

The Scheffe's model programs can predict the optimum property. Osadebe's model programs are not subject to the constraint that the sum of all components must be one and as such cannot give the optimum value. However any value higher than the optimum in the case of Scheffe's program can be specified as input in Osadebe's program to obtain the mix ratios that can yield that. The executed computer programs are appended.

CHAPTER FOUR: PRESENTATION AND ANALYSIS OF RESULTS

4.1 Presentation of results

The results of the various tests conducted are presented as follows:

4.1.1 Field results

Blocks were bought from different manufacturers and their compressive strengths were tested. The standard deviation was calculated. The results are presented on Tables 4.1 to 4.12.

Table 4.1: Compressive strength test result for block firm A located at Nekede

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.03	-0.012	0.00
2	1.15	0.108	0.012
3	0.92	-0.122	0.015
4	1.12	0.078	0.006
5	0.99	-0.052	0.003
	$\sum X = 5.21$		$\sum (X - \bar{X})^2 = 0.036$

Total number of samples, N = 5

Mean compressive strength, $\bar{X} = \sum X/N = 5.21/5 = 1.042 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.036/5 = 0.0072$

Standard deviation, $\sigma = \sqrt{0.0072} = 0.08 N/mm^2$

Table 4.2: Compressive strength test result for block firm B located at Concord road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.60	0.032	0.001
2	0.66	0..028	0.0008
3	0.40	-0.232	0.054
4	0.70	0.068	0.005
5	0.80	0.016	0.028
	$\sum X = 3.16$		$\sum (X - \bar{X})^2 = 0.0888$

Total number of samples, N = 5

Mean compressive strength, X = ∑X/N = 3.16/5 = 0.632N/mm^2

Variance, σ^2 = ∑ $(X - \bar{X})^2$ / N = 0.0888/5 = 0.018

Standard deviation, σ = √0.018 = 0.134N/mm^2

Table 4.3: Compressive strength test result for block firm C located along Port Harcourt road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.16	0.008	0.00006
2	1.12	-0.032	0.0010
3	1.16	0.008	0.00006
4	1.14	-0.012	0.00014
5	1.18	0.028	0.0008
	∑X = 5.76		∑ $(X - \bar{X})^2$ = 0.00204

Total number of samples, N = 5

Mean compressive strength, $\bar{X}$ = ∑X/N = 5.76/5 = 1.152N/mm^2

Variance, σ^2 = ∑ $(X - \bar{X})^2$ / N = 0.00204/5 = 0.0004

Standard deviation, σ = √0.0004 = 0.02 N/mm^2

Table 4.4: Compressive strength test result for block firm D located along Chukwuma Nwoha street

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.02	-0.022	0.0005
2	1.12	0.078	0.006
3	1.10	0.058	0.0033
4	0.99	-0.052	0.0027
5	0.98	-0.062	0.0038
	∑X = 5.21		∑ $(X - \bar{X})^2$ = 0.0163

Total number of samples, N = 5

Mean compressive strength, $\bar{X}$ = ∑X/N = 5.21/5 = 1.042N/mm^2

Variance, σ^2 = ∑ $(X - \bar{X})^2$ / N = 0.0163/5 = 0.003

Standard deviation, σ = √0.003 = 0.055 N/mm^2

Table 4.5: Compressive strength test result for block firm E located at Nekede

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.50	0.068	0.0046
2	1.40	-0.032	0.0010
3	1.46	0.028	0.00078
4	1.38	-0.052	0.0027
5	1.42	-0.012	0.00014
	$\sum X = 7.16$		$\sum (X - \bar{X})^2 =$ 0.00922

Total number of samples, N = 5

Mean compressive strength, $\bar{X} = \sum X/N = 7.16/5 = 1.432 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.00922/5 = 0.0018$

Standard deviation, $\sigma = \sqrt{0.0018} = 0.043\ N/mm^2$

Table 4.6: Compressive strength test result for block firm F located along Okigwe Road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	1.08	0.207	0.0428
2	0.81	-0.063	0.0039
3	0.54	-0.333	0.1109
4	0.81	-0.063	0.0039
5	0.90	0.027	0.0007
6	0.99	0.117	0.0136
7	0.90	0.027	0.0007
8	0.81	-0.063	0.0039
9	0.99	0.117	0.0136
10	0.90	0.027	0.0007
	$\sum X = 8.73$		$\sum (X - \bar{X})^2 =$ 0.1811

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.73/10 = 0.873 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.1811/10 = 0.018$

Standard deviation, $\sigma = \sqrt{0.018} = 0.0134\ N/mm^2$

Table 4.7: Compressive strength test result for block firm G located along Okigwe Road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.90	0.027	0.0007
2	0.81	-0.063	0.0039
3	0.81	-0.063	0.0040
4	0.90	0.027	0.0007
5	0.99	0.117	0.0137
6	0.90	0.027	0.0007
7	0.63	-0.243	0.0590
8	1.08	0.207	0.0428
9	0.72	-0.153	0.0234
10	0.99	0.117	0.0137
	$\sum X = 8.73$		$\sum (X - \bar{X})^2 = 0.1626$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.73/10 = 0.873 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.1626/10 = 0.01626$

Standard deviation, $\sigma = \sqrt{0.01626} = 0.1275\ N/mm^2$

Table 4.8: Compressive strength test result for block firm H located along Orlu Road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.90	0.054	0.0029
2	0.72	-0.126	0.0159
3	0.81	-0.036	0.0013
4	0.81	-0.036	0.0013
5	0.90	0.054	0.0029
6	0.99	0.144	0.0207
7	0.54	-0.306	0.0936
8	0.99	0.144	0.0207
9	0.72	-0.126	0.015
10	1.08	0.234	0.0548
	$\sum X = 8.46$		$\sum (X - \bar{X})^2 = 0.23$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.46/10 = 0.846 N/mm^2$

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Variance, $\sigma^2 = \sum (X - X)^2 / N = 0.23/10 = 0.023$

Standard deviation, $\sigma = \sqrt{0.023} = 0.152$ N/mm^2

Table 4.9: Compressive strength test result for block firm I located along Orlu Road

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.81	-0.045	0.0020
2	0.90	0.045	0.0020
3	0.90	0.045	0.0020
4	0.81	-0.045	0.0020
5	0.99	-0.135	0.0182
6	0.54	-0.315	0.0992
7	0.99	0.135	0.0182
8	1.08	0.225	0.0506
9	0.72	-0.135	0.0182
10	0.81	-0.045	0.0020
	$\sum X = 8.53$		$\sum (X - \bar{X})^2 = 0.2144$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.55/10 = 0.855$N/mm^2

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.2144/10 = 0.02144$

Standard deviation, $\sigma = \sqrt{0.02144} = 0.146$ N/mm^2

Table 4.10: Compressive strength test result for block firm J located at Amakohia

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.90	0.041	0.00168
2	1.01	0.151	0.0228
3	0.81	-0.049	0.0024
4	0.90	0.041	0.00168
5	0.72	-0.139	0.0193
6	0.81	-0.049	0.0024
7	0.63	-0.229	0.0524
8	1.08	0.221	0.0488
9	0.72	-0.139	0.0193
10	1.01	0.151	0.0228
	$\sum X = 8.59$		$\sum (X - \bar{X})^2 = 0.19356$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.59/10 = 0.859 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.19356/10 = 0.019356$

Standard deviation, $\sigma = \sqrt{0.019356} = 0.139\ N/mm^2$

Table 4.11: Compressive strength test result for block firm K located at Amakohia

Block sample no	Compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
1	0.90	0.023	0.0005
2	0.81	-0.067	0.0045
3	0.90	0.023	0.0005
4	1.01	0.133	0.0177
5	0.72	-0.157	0.0246
6	0.72	-0.157	0.0246
7	0.90	0.023	0.0005
8	1.08	0.203	0.0412
9	1.01	0.133	0.0177
10	0.72	-0.157	0.0246
	$\sum X = 8.77$		$\sum (X - \bar{X})^2 = 0.1564$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 8.77/10 = 0.877 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.1564/10 = 0.01564$

Standard deviation, $\sigma = \sqrt{0.01564} = 0.125\ N/mm^2$

Calculation of standard deviation of the compressive strength of the blocks from each block firm

Table 4.12: Average compressive strength test result for all the block firms and the standard deviation

Block firm	Average compressive strength (X) in N/mm^2	$(X - \bar{X})$	$(X - \bar{X})^2$
A	1.042	0.0814	0.0066
B	0.632	-0.3286	0.1080
C	1.152	0.1914	0.0366
D	1.042	0.0814	0.0066
E	1.432	0.4714	0.2222
F	0.873	-0.0876	0.0077
G	0.873	-0.0876	0.0077
H	0.846	-0.1146	0.0131
I	0.855	-0.1056	0.0112
J	0.859	-0.1016	0.0103
	$\sum X = 9.606$		$\sum (X - \bar{X})^2 = 0.43$

Total number of samples, N = 10

Mean compressive strength, $\bar{X} = \sum X/N = 9.606/10 = 0.9606 N/mm^2$

Variance, $\sigma^2 = \sum (X - \bar{X})^2 / N = 0.43/10 = 0.043$

Standard deviation, $\sigma = \sqrt{0.043} = 0.207 N/mm^2$

The standard deviation measures the variability or diversity. The value of the standard deviation is low. This indicates that the data points tend to be very close to the mean.

4.1.2 Laboratory results

The results of the various tests conducted in the laboratory are presented as follows:

4.1.2.1 Physical property tests results of laterite

The physical property tests results are presented on Tables 4.13 to 4.17. The summaries of physical properties are presented on Table 4.18.

Table 4.13: Grain size distribution of laterite

Sieve size (mm)	Weight of Sieve (g)	Weight of Sieve & Sample (g)	Weight of Sample Retained (g)	Cumulative Weight of Sample Retained (g)	Percentage Finer
4.75	496.00	496.00	-	-	100
2.00	410.00	427.00	17.00	17.00	96.60
1.18	402.00	485.90	83.00	100.00	80.00
0.850	384.00	474.20	90.00	190.00	62.00
0.600	381.20	516.00	134.80	324.80	35.04
0.425	486.00	561.00	75.10	399.90	20.02
0.300	366.00	413.30	47.30	447.20	10.56
0.150	312.00	358.00	46.00	493.20	1.36
0.075	345.10	350.90	5.80	499.00	0.20
Pan	273.00	274.00	1.00	500.00	-

Table 4.14: Bulk density of laterite

Property	Content (Sample A)	Content (Sample B)
Mass of cutter (kg) and wet sample (kg)	0.290	0.286
Mass of cutter (kg)	0.096	0.096
Mass of sample (kg)	0.194	0.190
Volume of sample (m^3)	9.817	9.817
Bulk density = mass of sample/ volume of sample (Mg/ m^3)	1.98	1.83
Average Bulk Density (Mg/ m^3)	1.91	

Table 4.15: Moisture content of laterite

Property	Content (Sample A)	Content (Sample B)
Weight of can and wet sample (g)	77.00	77.50
Weight of can and dry sample (g)	71.00	71.30
Weight of can (g)	25.00	26.08
Weight of dry sample (g)	46.00	45.22
Weight of water loss (g)	6.00	6.20
Moisture content %	13.04	13.71
Average moisture content %	13.38	
Dry density ρ_d = Bulk density / (1 + Moisture content) (Mg/ m^3	1.68	

Table 4.16: Specific gravity of laterite

Property	Content (Sample A)	Content (Sample B)
Mass of bottle + soil + water[M3] (g)	388.00	387.00
Mass of bottle + soil [M2] (g)	153.80	154.40
Mass of bottle full of water only[M4] (g)	369.30	368.20
Mass of bottle [M1] (g)	123.80	124.40
Mass of water used [M3 - M2] (g)	234.20	232.60
Mass of soil used [M2 - M1] (g)	30.00	30.00
Volume of soil [M4 – M1] – [M3 – M2] = M5 (ml)	11.30	11.20
Specific gravity of soil particles Gs = [M2 –M1] / M5	2.65	2.68
Average specific gravity	2.67	

Table 4.17: Liquid and plastic limit determination of laterite

Type of test…Liquid Limit	Content (Sample A)	Content (Sample B)	Content (Sample C)
No of blows	22	27	30
Weight of wet soil + can (g)	36.82	36.89	30.46
Weight of soil + can (g)	29.00	31.00	25.10
Weight of can (g)	16.93	16.50	15.70
Weight of dry soil (g)	12.07	14.60	14.76
Weight of moisture (g)	6.92	5.89	5.36
Water content %	57.33	40.34	36.31
Average liquid limit	49.00		
Type of test….Plastic Limit	Content (Sample A)	Content (Sample B)	
Weight of wet soil + can (g)	34.00	33.90	
Weight of soil + can (g)	32.00	31.80	
Weight of can (g)	25.00	24.30	
Weight of dry soil (g)	17.00	17.50	
Weight of moisture (g)	2.00	2.10	
Water content %	11.76	12.00	
Average Plastic limit	11.88		

Liquid limit = 49.00 Plastic limit = 11.88 Plasticity Index = 37.12

Table 4.18: Summary of physical properties of laterite

Property	Unit	Content
Colour		Reddish brown
Consistency		Easily mouldable
Bulk density	Mg/ m^3	1.91
Initial Moisture Content	%	13.38
Dry Density	Mg/ m^3	1.68
Specific Gravity		2.67
Liquid Limit	%	49.00
Plastic Limit	%	11.88
Plasticity Index	%	37.12

4.1.2.2 Chemical property tests results of laterite

The results from the chemical property test are presented on Table 4.19

Table 4.19: Chemical analysis of laterite

Component	Unit	Content
pH		6.04
Fe	Mg/kg	29.5
Zn	Mg/kg	22.26
$S0_4^{2-}$	Mg/kg	6.08
Ca	Mg/kg	120.11
Mg	Mg/kg	100.44
K	Mg/kg	0.00
$H^+ + Al^{3+}$(Exchangeable acidity)	Mmoles/kg	15.67
CEC (Cation Exchange Capacity)	Mmoles/kg	22.86

4.1.2.3 Characteristics tests results of blocks

The characteristics test results were determined and calculated using equations given in section 3.4.2.4, and then presented on Tables 4.20 to 4.35.

Table 4.20: Compressive strength test results of soilcrete blocks (a 3-component mix)

Exp No.	Mix ratios (w/c: cement: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density ρ (kg/m^3)	Failure Load (KN)	X-sectional Area (mm^2)	Compressive Strength f_{cu} (N/ mm^2)	Average f_{cu} (N/ mm^2)
1	0.8:1:8	A	23.6	1553.91		145		2.148	
		B	23.2	1527.57	1533.89	140	67500	2.074	2.148
		C	23.1	1520.99		150		2.222	
2	1:1:12.5	A	22.0	1448.56		70		1.037	
		B	22.5	1481.48	1461.73	69	″	1.022	0.963
		C	22.1	1455.14		56		0.830	
3	1.28:1:16.67	A	21.7	1428.81		60		0.889	
		B	21.7	1428.81	1426.61	75	″	1.111	0.914
		C	21.6	1422.22		50		0.741	
4	0.9:1:10.25	A	22.7	1494.65		85		1.259	
		B	22.7	1494.65	1492.46	72	″	1.067	1.151
		C	22.6	1488.06		76		1.126	
5	1.04:1:12.335	A	21.5	1415.64		72		1.067	
		B	22.5	1481.48	1452.95	60	″	0.889	0.978
		C	22.2	1461.73		66		0.978	
6	1.14:1:14.585	A	21.6	1422.22		45		0.667	
		B	22.7	1494.65	1455.14	65	″	0.963	0.741
		C	22.0	1448.56		40		0.593	
7	1.09:1:13.46	A	21.7	1428.81		65		0.963	
		B	21.5	1415.64	1413.44	75	″	1.111	0.958
		C	21.2	1395.88		54		0.800	
8	1.02:1:12.417	A	20.4	1343.21		75		1.259	
		B	20.4	1343.21	1347.60	75	″	1.037	1.081
		C	20.6	1356.38		69		1.111	
9	0.866:1:9.485	A	22.1	1455.14		85		1.111	
		B	21.8	1435.39	1461.73	70	″	1.111	1.136
		C	22.7	1494.65		75		1.022	
10	1.0924:1:13.8761	A	20.1	1323.46		65		0.963	
		B	21.5	1415.64	1376.13	55	″	0.815	0.948
		C	21.1	1389.30		72		1.067	
11	1.052:1:12.818	A	23.0	1514.40		60		0.889	
		B	22.9	1507.82	1514.40	60	″	0.889	0.859
		C	23.1	1520.99		54		0.800	
12	1.1:1:13.685	A	20.9	1376.13		45		0.667	
		B	21.1	1389.30	1398.08	45	″	0.667	0.622
		C	21.7	1428.80		36		0.533	

Table 4.21: Compressive strength test results of sand-laterite blocks (a 4-component mix)

Exp. No.	Mix ratios (w/c: cement: sand: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density (kg/m^3)	Failure Load (KN)	X-sectiona Area (mm^2)	Compressive Strength f_{cu} (N/ mm^2)	Average f_{cu} (N/ mm^2)
1	0.8:1:3.2:4.8	A	24.5	1613.17		180		2.667	
		B	24.7	1626.34	1619.75	220	67500	3.259	3.012
		C	24.6	1619.75		210		3.111	
2	1:1:3.75:8.75	A	22.6	1448.06		130		1.926	
		B	25.1	1652.67	1569.27	140	″	2.074	2.025
		C	23.8	1567.08		140		2.074	
3	1.28:1:3.334:13.336	A	23.0	1514.40		100		1.482	
		B	23.1	1520.99	1516.60	110	″	1.630	1.630
		C	23.0	1514.40		120		1.778	
4	2.2:1:2.5:22.5	A	23.1	1520.99		80		1.185	
		B	23.5	1547.35	1534.17	90	″	1.333	1.259
		C	23.3	1534.16		85		1.259	
5	0.9:1:3.475:6.775	A	23.5	1547.35		170		2.519	
		B	23.0	1514.40	1527.58	140	″	2.074	2.321
		C	23.1	1520.99		160		2.370	
6	1.04:1:3.267:9.068	A	23.0	1514.40		100		1.482	
		B	23.1	1520.99	1516.60	180	″	2.667	2.074
		C	23.0	1514.40		140		2.074	
7	1.5:1:2.85:13.65	A	23.3	1534.16		110		1.630	
		B	23.3	1534.16	1527.57	115	″	1.704	1.704
		C	23.0	1514.40		120		1.778	
8	1.14:1:3.542:11.043	A	23.0	1514.40		140		2.074	
		B	23.0	1514.40	1518.79	120	″	1.778	1.926
		C	23.2	1527.57		130		1.926	
9	1.6:1:3.125:15.625	A	24.2	1593.42		60		0.889	
		B	24.5	1613.17	1595.61	90	″	1.333	1.185
		C	24.0	1580.25		90		1.333	
10	1.74:1:2.917:17.918	A	22.0	1448.56		60		0.889	
		B	23.9	1573.66	1512.20	90	″	1.333	1.235
		C	23.0	1514.40		100		1.482	
11	1.09:1:3.4045:10.0555	A	23.9	1573.66		120		1.778	
		B	23.7	1560.49	1560.50	150	″	2.222	2.024
		C	23.5	1547.35		140		2.074	
12	1.02:1:3.5085:8.909	A	24.0	1580.25		140		2.074	
		B	22.6	1487.21	1544.50	130	″	1.926	1.975
		C	23.78	1566.05		130		1.926	
13	0.866:1:3.3815:6.1035	A	23.5	1547.35		170		2.519	
		B	22.5	1481.48	1520.54	220	″	3.259	2.666
		C	23.28	1532.78		150		2.222	
14	1.0924:1:3.6127:10.2634	A	22.23	1463.95		140		2.074	
		B	23.17	1525.39	1487.54	120	″	1.777	1.926
		C	22.38	1473.29		130		1.926	
15	1.052:1:3.4186:9.3994	A	24.3	1600.00		140		2.074	
		B	23.5	1547.35	1578.05	120	″	1.778	1.975
		C	24.1	1586.83		140		2.074	
16	1.1:1:3.432:10.253	A	22.3	1468.05		140		2.074	
		B	23.2	1527.57	1496.16	120	″	1.778	1.876
		C	22.67	1492.85		120		1.778	
17	0.97:1:3.371:7.9215	A	23.0	1514.40		150		2.222	
		B	23.2	1527.57	1520.99	140	″	2.074	2.173
		C	23.1	1520.99		150		2.222	
18	1.32:1:3.196:12.3465	A	25.6	1685.60		110		1.630	
		B	23.8	1567.08	1610.97	98	″	1.452	1.571
		C	24.0	1580.25		110		1.630	
19	1.67:1:3.021:16.7715	A	24.1	1590.63		80		1.185	
		B	22.6	1487.83	1546.92	80	″	1.185	1.210
		C	23.7	1562.30		85		1.259	
20	1.9:1:2.8125:19.0625	A	23.8	1567.08		80		1.185	
		B	23.67	1558.67	1584.35	80	″	1.185	1.136
		C	24.71	1627.29		70		1.037	

Table 4.22: Flexural strength test results of soilcrete blocks

Exp. No.	Mix ratios (w/c: cement: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density ρ (kg/m^3)	Failure Load (KN)	Flexural Strength σ (N/mm^2)	Average σ (N/mm^2)
1	0.8:1:8	A	18.2	1797.53		15.5	1.378	
		B	18.2	1797.53	1774.49	17.5	1.556	1.452
		C	17.5	1728.40		16.0	1.422	
2	1:1:12.5	A	15.2	1501.23		2.5	0.222	
		B	16.0	1580.25	1547.32	3.5	0.311	0.261
		C	15.8	1560.49		2.8	0.249	
3	1.28:1:16.67	A	17.3	1708.64		2.5	0.222	
		B	15.3	1511.11	1609.88	2.3	0.204	0.231
		C	16.3	1609.88		3.0	0.267	
4	0.9:1:10.25	A	14.2	1402.47		3.5	0.311	
		B	14.9	1471.60	1465.02	3.0	0.267	0.279
		C	15.4	1520.99		2.9	0.258	
5	1.04:1:12.335	A	13.9	1372.84		2.1	0.187	
		B	14.7	1451.85	1409.05	4.0	0.356	0.267
		C	14.2	1402.47		2.9	0.258	
6	1.14:1:14.585	A	14.3	1412.35		2.2	0.196	
		B	14.8	1461.73	1435.39	2.5	0.222	0.228
		C	14.5	1432.10		3.0	0.267	
7	1.09:1:13.46	A	13.7	1353.09		2.5	0.222	
		B	13.8	1362.96	1339.92	2.0	0.178	0.196
		C	13.2	1303.70		2.1	0.187	
8	1.02:1:12.417	A	13.4	1323.46		2.1	0.187	
		B	13.8	1362.96	1353.09	2.1	0.187	0.208
		C	13.9	1372.84		2.8	0.249	
9	0.866:1:9.485	A	15.8	1560.49		4.6	0.409	
		B	12.8	1264.20	1389.30	5.0	0.444	0.418
		C	13.6	1343.21		4.5	0.400	
10	1.0924:1:13.8761	A	13.8	1362.96		4.0	0.356	
		B	14.9	1471.60	1412.34	2.5	0.222	0.305
		C	14.2	1402.47		3.8	0.338	
11	1.052:1:12.818	A	15.4	1520.99		4.0	0.356	
		B	14.0	1382.72	1455.15	2.5	0.222	0.255
		C	14.8	1461.73		2.1	0.187	
12	1.1:1:13.685	A	12.5	1234.57		2.0	0.178	
		B	14.6	1441.98	1326.75	2.0	0.178	0.187
		C	13.2	1303.70		2.3	0.204	

Table 4.23: Flexural strength test results of sand-laterite blocks

Exp. No.	Mix ratios (w/c: cement: sand: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density ρ (kg/m^3)	Failure Load (KN)	Flexural Strength σ (N/ mm^2)	Average σ (N/ mm^2)
1	0.8:1:3.2:4.8	A	17.6	1738.27		17.5	1.555	
		B	19.0	1876.54	1823.87	21.5	1.911	1.718
		C	18.8	1856.79		19.0	1.689	
2	1:1:3.75:8.75	A	19.8	1955.56		13.5	1.200	
		B	19.0	1876.54	1919.34	12.0	1.067	1.170
		C	19.5	1925.93		14.0	1.244	
3	1.28:1:3.334:13.336	A	19.0	1876.54		6.5	0.578	
		B	16.1	1590.12	1771.19	3.5	0.311	0.590
		C	18.7	1846.91		9.9	0.880	
4	2.2:1:2.5:22.5	A	18.9	1866.67		13.0	1.160	
		B	19.5	1925.93	1896.30	5.0	0.444	0.861
		C	19.2	1896.30		11.0	0.978	
5	0.9:1:3.475:6.775	A	18.9	1866.67		14.0	1.244	
		B	18.0	1777.78	1823.87	11.5	1.022	1.111
		C	18.5	1827.16		12.0	1.067	
6	1.04:1:3.267:9.068	A	17.5	1728.40		6.0	0.533	
		B	18.5	1827.16	1777.78	12.5	1.111	0.874
		C	18.0	1777.78		11.0	0.978	
7	1.5:1:2.85:13.65	A	19.5	1925.93		10.5	0.933	
		B	19.4	1916.05	1906.17	12.0	1.067	0.993
		C	19.0	1876.54		11.0	0.978	
8	1.14:1:3.542:11.043	A	18.9	1866.67		9.5	0.844	
		B	18.8	1856.79	1850.21	8.0	0.711	0.785
		C	18.5	1827.16		9.0	0.800	
9	1.6:1:3.125:15.625	A	18.0	1777.78		5.0	0.444	
		B	18.3	1807.41	1804.12	6.0	0.533	0.489
		C	18.5	1827.16		5.5	0.489	
10	1.74:1:2.917:17.918	A	17.7	1748.15		4.0	0.356	
		B	17.8	1758.02	1761.32	2.5	0.222	0.282
		C	18.0	1777.78		3.0	0.267	
11	1.09:1:3.4045:10.0555	A	18.4	1817.28		9.0	0.800	
		B	17.6	1738.27	1781.07	8.0	0.711	0.800
		C	18.1	1787.65		10.0	0.889	
12	1.02:1:3.5085:8.909	A	19.9	1965.43		13.0	1.156	
		B	19.1	1886.42	1925.93	13.5	1.200	1.141
		C	19.5	1925.93		12.0	1.067	
13	0.866:1:3.3815:6.1035	A	20.0	1975.31		17.0	1.511	
		B	19.7	1945.68	1972.02	17.0	1.511	1.481
		C	20.2	1995.06		16.0	1.422	
14	1.0924:1:3.6127:10.2634	A	18.6	1837.04		7.5	0.667	
		B	19.5	1925.93	1883.13	11.0	0.978	0.846
		C	19.1	1886.42		10.0	0.889	
15	1.052:1:3.4186:9.3994	A	17.9	1767.90		8.5	0.756	
		B	18.5	1827.16	1797.53	7.5	0.667	0.705
		C	18.2	1797.53		7.8	0.693	
16	1.1:1:3.432:10.253	A	18.0	1777.78		6.5	0.578	
		B	18.7	1846.91	1817.28	8.5	0.756	0.652
		C	18.5	1827.16		7.0	0.622	
17	0.97:1:3.371:7.9215	A	19.1	1886.42		9.5	0.844	
		B	20.4	2014.81	1962.14	11.5	1.022	0.918
		C	20.1	1985.19		10.0	0.889	
18	1.32:1:3.196:12.3465	A	19.5	1925.93		7.5	0.667	
		B	18.0	1777.78	1853.50	6.5	0.578	0.593
		C	18.8	1856.79		6.0	0.533	
19	1.67:1:3.021:16.7715	A	18.3	1807.41		5.0	0.444	
		B	19.1	1886.42	1843.62	5.5	0.489	0.495
		C	18.6	1837.04		6.2	0.551	
20	1.9:1:2.8125:19.0625	A	18.8	1856.79		3.0	0.267	
		B	17.9	1767.90	1807.41	3.0	0.267	0.282
		C	18.2	1797.53		3.5	0.311	

Table 4.24: Split tensile strength test results of soilcrete blocks

Exp. No.	Mix ratios (w/c: cement: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density ρ (kg/m^3)	Failure Load (KN)	Split tensile Strength T_{sh} (N/mm^2)	Average T_{sh} (N/mm^2)
1	0.8:1:8	A	23.7	1560.49		45	0.283	
		B	23.2	1527.57	1545.14	45	0.283	0.293
		C	23.5	1547.35		50	0..314	
2	1:1:12.5	A	22.7	1494.65		10	0.063	
		B	22.5	1481.48	1474.90	15	0.094	0.094
		C	22.0	1448.56		20	0.126	
3	1.28:1:16.67	A	21.8	1435.39		20	0.126	
		B	21.6	1422.22	1433.20	25	0.157	0.157
		C	21.9	1441.98		30	0.189	
4	0.9:1:10.25	A	22.4	1474.90		30	0.189	
		B	22.8	1501.23	1496.93	40	0.252	0.220
		C	22.7	1494.65		35	0.220	
5	1.04:1:12.335	A	21.9	1441.98		20	0.126	
		B	22.6	1488.07	1463.93	25	0.157	0.147
		C	22.2	1461.73		25	0.157	
6	1.14:1:14.585	A	21.7	1428.80		25	0.157	
		B	22.6	1488.06	1472.70	30	0.189	0.178
		C	22.8	1501.23		30	0.189	
7	1.09:1:13.46	A	21.9	1441.98		25	0.157	
		B	21.4	1409.05	1428.81	25	0.157	0.168
		C	21.8	1435.39		30	0.189	
8	1.02:1:12.417	A	20.6	1356.38		20	0.126	
		B	20.3	1336.63	1341.02	20	0.126	0.136
		C	20.2	1330.04		25	0.157	
9	0.866:1:9.485	A	22.2	1461.73		30	0.189	
		B	22.0	1448.56	1455.14	30	0.189	0.199
		C	22.1	1455.14		35	0.220	
10	1.0924:1:13.8761	A	21.6	1422.22		25	0.157	
		B	21.4	1409.05	1402.47	30	0.189	0.189
		C	20.9	1376.13		35	0.220	
11	1.052:1:12.818	A	22.8	1501.23		20	0.126	
		B	23.1	1520.99	1516.60	30	0.189	0.147
		C	23.2	1527.57		20	0.126	
12	1.1:1:13.685	A	20.5	1349.79		35	0.220	
		B	20.3	1336.63	1354.18	25	0.157	0.199
		C	20.9	1376.13		35	0.220	

Table 4.25: Split tensile strength test results of sand-laterite blocks

Exp. No.	Mix ratios (w/c: cement: sand: laterite)	Replicates	Mass (kg)	Density ρ (kg/m^3)	Average Density ρ (kg/m^3)	Failure Load (KN)	Split tensile Strength T_{sh} (N/ mm^2)	Average T_{sh} (N/ mm^2)
1	0.8:1:3.2:4.8	A	24.8	1632.92		80	0.503	
		B	24.5	1613.17	1621.95	70	0.440	0.472
		C	24.6	1619.75		75	0.472	
2	1:1:3.75:8.75	A	23.4	1540.74		30	0.189	
		B	24.8	1632.92	1582.44	35	0.220	0.210
		C	23.9	1573.66		35	0.220	
3	1.28:1:3.334:13.336	A	23.5	1547.35		30	0.189	
		B	23.6	1573.66	1549.53	30	0.189	0.199
		C	23.2	1527.57		35	0.220	
4	2.2:1:2.5:22.5	A	22.9	1507.82		40	0.252	
		B	23.1	1520.99	1520.99	35	0.220	0.241
		C	23.3	1534.16		40	0.252	
5	0.9:1:3.475:6.775	A	23.6	1553.91		50	0.314	
		B	23.3	1534.16	1538.55	55	0.346	0.335
		C	23.2	1527.57		55	0.346	
6	1.04:1:3.267:9.068	A	24.1	1586.83		40	0.252	
		B	23.9	1573.66	1571.47	30	0.189	0.231
		C	23.6	1553.91		40	0.252	
7	1.5:1:2.85:13.65	A	23.4	1540.74		25	0.157	
		B	23.6	1553.91	1540.74	30	0.189	0.189
		C	23.2	1527.57		35	0.220	
8	1.14:1:3.542:11.043	A	23.1	1520.99		50	0.314	
		B	23.0	1514.40	1527.58	55	0.346	0.325
		C	23.5	1547.35		50	0.314	
9	1.6:1:3.125:15.625	A	24.3	1600.00		30	0.189	
		B	23.9	1573.66	1595.61	30	0.189	0.199
		C	24.5	1613.17		35	0.220	
10	1.74:1:2.917:17.918	A	23.3	1534.16		35	0.220	
		B	23.5	1547.35	1529.77	30	0.189	0.178
		C	22.9	1507.82		20	0.126	
11	1.09:1:3.4045:10.0555	A	23.4	1540.74		40	0.252	
		B	23.8	1567.08	1542.94	35	0.220	0.231
		C	23.1	1520.99		35	0.220	
12	1.02:1:3.5085:8.909	A	23.9	1573.66		40	0.252	
		B	24.6	1619.75	1595.61	40	0.252	0.273
		C	24.2	1593.42		50	0.314	
13	0.866:1:3.3815:6.1035	A	23.9	1573.66		60	0.377	
		B	23.0	1514.40	1529.76	55	0.346	0.367
		C	22.8	1501.23		60	0.377	
14	1.0924:1:3.6127:10.2634	A	23.7	1560.49		30	0.189	
		B	23.1	1520.99	1540.74	30	0.189	0.210
		C	23.4	1540.74		40	0.252	
15	1.052:1:3.4186:9.3994	A	24.0	1580.25		35	0.220	
		B	24.2	1593.42	1582.44	40	0.252	0.252
		C	23.9	1573.66		45	0.283	
16	1.1:1:3.432:10.253	A	23.3	1534.16		40	0.252	
		B	23.4	1540.74	1529.77	35	0.220	0.218
		C	23.0	1514.40		28	0.176	
17	0.97:1:3.371:7.9215	A	23.1	1520.99		40	0.252	
		B	23.2	1527.57	1523.18	35	0.220	0.220
		C	23.1	1520.99		30	0.189	
18	1.32:1:3.196:12.3465	A	25.6	1685.60		30	0.189	
		B	23.9	1573.66	1621.95	35	0.220	0.216
		C	24.4	1606.58		38	0.283	
19	1.67:1:3.021:16.7715	A	24.7	1626.34		20	0.126	
		B	25.1	1652.67	1617.56	30	0.189	0.168
		C	23.9	1573.66		30	0.189	
20	1.9:1:2.8125:19.0625	A	23.7	1560.49		55	0.346	
		B	23.1	1520.99	1540.74	45	0.283	0.314
		C	23.4	1540.74		50	0.314	

Table 4.26: Experimental values of Poisson's ratios of soilcrete blocks

Exp No	Mix ratios (w/c: cement: laterite)	Repli-cates	Initial Cracking Load in Flexure (KN)	Tensile Stress at Cracking in Flexure σ_t (N/mm^2)	Initial Cracking Load in Compression (KN)	Compressive Stress at Cracking in Flexure σ_c (N/mm^2)	Poisson's Ratio $\mu = \sigma_t/\sigma_c$	Average Poisson's Ratio μ
1	0.8:1:8	A	15.5	0.230	80	1.185	0.194	0.174
		B	17.5	0.259	90	1.333	0.194	
		C	16.0	0.237	120	1.778	0.133	
2	1:1:12.5	A	2.5	0.037	20	0.296	0.125	0.135
		B	3.5	0.052	25	0.370	0.141	
		C	2.8	0.041	20	0.296	0.139	
3	1.28:1:16.67	A	2.5	0.037	20	0.296	0.125	0.110
		B	2.3	0.034	40	0.593	0.057	
		C	3.0	0.044	20	0.296	0.149	
4	0.9:1:10.25	A	3.5	0.052	30	0.444	0.117	0.095
		B	3.0	0.044	35	0.518	0.085	
		C	2.9	0.043	35	0.518	0.083	
5	1.04:1:12.335	A	2.1	0.031	30	0.444	0.070	0.074
		B	4.0	0.059	50	0.741	0.080	
		C	2.9	0.043	40	0.593	0.073	
6	1.14:1:14.585	A	2.2	0.033	20	0.296	0.111	0.091
		B	2.5	0.037	40	0.593	0.062	
		C	3.0	0.044	30	0.444	0.099	
7	1.09:1:13.46	A	2.5	0.037	20	0.296	0.125	0.099
		B	2.0	0.030	20	0.296	0.101	
		C	2.1	0.031	30	0.444	0.070	
8	1.02:1:12.417	A	2.1	0.031	30	0.444	0.070	0.105
		B	2.1	0.031	20	0.296	0.105	
		C	2.8	0.041	20	0.296	0.139	
9	0.866:1:9.485	A	2.5	0.037	50	0.741	0.050	0.054
		B	2.5	0.037	50	0.741	0.050	
		C	2.8	0.041	45	0.667	0.061	
10	1.0924:1:13.8761	A	4.0	0.059	40	0.593	0.099	0.079
		B	2.5	0.037	45	0.667	0.055	
		C	3.8	0.056	45	0.667	0.084	
11	1.052:1:12.818	A	4.0	0.059	30	0.444	0.133	0.092
		B	2.5	0.037	30	0.444	0.083	
		C	3.8	0.031	35	0.518	0.060	
12	1.1:1:13.685	A	2.0	0.030	20	0.296	0.101	0.098
		B	2.0	0.030	20	0.296	0.101	
		C	2.3	0.034	25	0.370	0.092	

Table 4.27: Experimental values of Poisson's ratios of sand-laterite blocks

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Repli-cates	Initial Cracking Load in Flexure(KN)	Tensile Stress at Cracking in Flexure σ_t (N/mm^2)	Initial Cracking Load inCompression (KN)	Compressive Stress at Cracking In Flexure σ_c (N/mm^2)	Poisson' Ration $\mu = \sigma_t/\sigma_c$	Average Poisson' Ratio μ
1	0.8:1:3.2:4.8	A	8.0	0.119	120	1.778	0.067	0.112
		B	21.5	0.319	120	1.778	0.179	
		C	10.0	0.148	110	1.630	0.019	
2	1:1:3.75:8.75	A	13.5	0.200	130	1.926	0.104	0.110
		B	12.0	0.178	110	1.630	0.109	
		C	14.0	0.207	120	1.778	0.116	
3	1.28:1:3.334:13.336	A	6.5	0.096	90	1.333	0.072	0.077
		B	3.5	0.052	100	1.482	0.035	
		C	9.9	0.147	80	1.185	0.124	
4	2.2:1:2.5:22.5	A	6.0	0.089	60	0.889	0.100	0.082
		B	5.0	0.074	80	1.185	0.062	
		C	5.0	0.074	60	0.889	0.083	
5	0.9:1:3.475:6.775	A	14.0	0.207	150	2.222	0.093	0.093
		B	11.5	0.170	110	1.630	0.104	
		C	10.0	0.148	120	1.777	0.083	
6	1.04:1:3.267:9.068	A	6.0	0.089	100	1.482	0.060	0.092
		B	12.5	0.185	160	2.370	0.078	
		C	11.0	0.163	80	1.185	0.138	
7	1.5:1:2.85:13.65	A	6.5	0.096	90	1.333	0.072	0.075
		B	7.0	0.104	110	1.630	0.064	
		C	8.0	0.119	90	1.333	0.089	
8	1.14:1:3.542:11.043	A	9.5	0.141	130	1.926	0.073	0.106
		B	8.0	0.119	100	1.482	0.176	
		C	7.0	0.104	100	1.482	0.070	
9	1.6:1:3.125:15.625	A	5.0	0.074	50	0.741	0.100	0.080
		B	4.0	0.059	60	0.889	0.066	
		C	4.5	0.067	60	0.889	0.075	
10	1.74:1:2.917:17.918	A	4.0	0.059	60	0.889	0.066	0.058
		B	2.5	0.037	50	0.741	0.050	
		C	3.0	0.044	50	0.741	0.060	
11	1.09:1:3.4045:10.0555	A	9.0	0.133	100	1.482	0.090	0.072
		B	8.0	0.119	130	1.926	0.062	
		C	7.0	0.104	110	1.630	0.064	
12	1.02:1:3.5085:8.909	A	13.0	0.193	140	2.074	0.093	0.114
		B	13.5	0.200	90	1.333	0.150	
		C	10.0	0.148	100	1.482	0.100	
13	0.866:1:3.3815:6.1035	A	17.0	0.252	170	2.5185	0.100	0.100
		B	17.0	0.252	160	2.370	0.106	
		C	15.0	0.222	160	2.370	0.094	
14	1.0924:1:3.6127:10.2634	A	7.5	0.111	95	1.407	0.079	0.105
		B	11.0	0.163	100	1.481	0.110	
		C	10.0	0.148	80	1.185	0.125	
15	1.052:1:3.4186:9.3994	A	8.0	0.119	140	2.074	0.057	0.073
		B	7.0	0.104	90	1.333	0.078	
		C	7.5	0.111	90	1.333	0.083	
16	1.1:1:3.432:10.253	A	6.5	0.096	85	1.259	0.076	0.080
		B	8.5	0.126	100	1.4815	0.085	
		C	7.0	0.104	90	1.333	0.078	
17	0.97:1:3.371:7.9215	A	9.5	0.141	150	2.222	0.063	0.076
		B	11.5	0.170	110	1.630	0.104	
		C	8.0	0.119	130	1.926	0.062	
18	1.32:1:3.196:12.3465	A	7.0	0.104	110	1.630	0.064	0.061
		B	6.0	0.089	95	1.407	0.063	
		C	5.0	0.074	90	1.333	0.056	
19	1.67:1:3.021:16.7715	A	5.0	0.074	60	0.889	0.083	0.085
		B	5.5	0.081	60	0.889	0.091	
		C	4.0	0.059	50	0.741	0.080	
20	1.9:1:2.8125:19.0625	A	3.0	0.044	80	1.185	0.037	0.050
		B	3.0	0.044	65	0.963	0.046	
		C	4.0	0.059	60	0.889	0.067	

Table 4.28: Experimental values of static modulus of elasticity of soilcrete blocks

Exp. No	Mix ratios (w/c: cement: laterite)	Replicates	Compressive Strength f_{cu} (MPa)	Density ρ (kg/m^3)	Static Modulus of Elasticity E_c (GPa)	Average Static Modulus of Elasticity E_c (GPa)
1	0.8:1:8	A	2.148	1553.91	5.283	5.149
		B	2.074	1527.57	5.047	
		C	2.222	1520.99	5.118	
2	1:1:12.5	A	1.037	1448.56	3.610	3.584
		B	1.022	1481.48	3.758	
		C	0.830	1455.14	3.385	
3	1.28:1:16.67	A	0.889	1428.81	3.338	3.349
		B	1.111	1428.81	3.593	
		C	0.741	1422.22	3.115	
4	0.9:1:10.25	A	1.259	1494.65	4.098	3.964
		B	1.067	1494.65	3.880	
		C	1.126	1488.06	3.915	
5	1.04:1:12.335	A	1.067	1415.64	3.481	3.559
		B	0.889	1481.48	3.589	
		C	0.978	1461.73	3.606	
6	1.14:1:14.585	A	0.667	1422.22	3.008	3.254
		B	0.963	1494.65	3.751	
		C	0.593	1448.56	3.002	
7	1.09:1:13.46	A	0.963	1428.81	3.428	3.344
		B	1.111	1415.64	3.527	
		C	0.800	1395.88	3.077	
8	1.02:1:12.417	A	1.259	1343.21	3.176	3.168
		B	1.037	1343.21	3.176	
		C	1.111	1356.38	3.150	
9	0.866:1:9.485	A	1.111	1455.14	3.884	3.792
		B	1.111	1435.39	3.545	
		C	1.022	1494.65	3.948	
10	1.0924:1:13.8761	A	0.963	1323.46	2.941	3.159
		B	0.815	1415.64	3.184	
		C	1.067	1389.30	3.352	
11	1.052:1:12.818	A	0.889	1514.40	3.750	3.707
		B	0.889	1507.82	3.718	
		C	0.800	1520.99	3.654	
12	1.1:1:13.685	A	0.667	1376.13	2.817	2.836
		B	0.667	1389.30	2.871	
		C	0.533	1428.80	2.820	

Table 4.29: Experimental values of static modulus of elasticity of sand-laterite blocks

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Replicates	Compressive Strength f_{cu} (MPa)	Density ρ (kg/m^3)	Static Modulus of Elasticity E_c (GPa)	Average Static Modulus of Elasticity E_c (GPa)
1	0.8:1:3.2:4.8	A	2.667	1613.17	6.115	6.414
		B	3.259	1626.34	6.640	
		C	3.111	1619.75	6.486	
2	1:1:3.75:8.75	A	1.926	1448.06	4.673	5.297
		B	2.074	1652.67	5.907	
		C	2.074	1567.08	5.311	
3	1.28:1:3.334:13.336	A	1.482	1514.40	4.439	4.591
		B	1.630	1520.99	4.621	
		C	1.778	1514.40	4.714	
4	2.2:1:2.5:22.5	A	1.185	1520.99	4.159	4.317
		B	1.333	1547.35	4.475	
		C	1.259	1534.16	4.317	
5	0.9:1:3.475:6.775	A	2.519	1547.35	5.521	5.236
		B	2.074	1514.40	4.960	
		C	2.370	1520.99	5.228	
6	1.04:1:3.267:9.068	A	1.482	1514.40	4.439	4.945
		B	2.667	1520.99	5.436	
		C	2.074	1514.40	4.960	
7	1.5:1:2.85:13.65	A	1.630	1534.16	4.701	4.729
		B	1.704	1534.16	4.771	
		C	1.778	1514.40	4.714	
8	1.14:1:3.542:11.043	A	2.074	1514.40	4.960	4.866
		B	1.778	1514.40	4.714	
		C	1.926	1527.57	4.925	
9	1.6:1:3.125:15.625	A	0.889	1593.42	4.152	4.561
		B	1.333	1613.17	4.864	
		C	1.333	1580.25	4.668	
10	1.74:1:2.917:17.918	A	0.889	1448.56	3.431	4.166
		B	1.333	1573.66	4.629	
		C	1.482	1514.40	4.439	
11	1.09:1:3.4045:10.0555	A	1.778	1573.66	5.090	5.219
		B	2.222	1560.49	5.388	
		C	2.074	1547.35	5.178	
12	1.02:1:3.5085:8.909	A	2.074	1580.25	5.401	5.082
		B	1.926	1487.21	4.668	
		C	1.926	1566.05	5.176	
13	0.866:1:3.3815:6.1035	A	2.519	1547.35	5.521	5.410
		B	3.259	1481.48	5.510	
		C	2.222	1532.78	5.198	
14	1.0924:1:3.6127:10.2634	A	2.074	1463.95	4.635	4.666
		B	1.777	1525.39	4.782	
		C	1.926	1473.29	4.581	
15	1.052:1:3.4186:9.3994	A	2.074	1600.00	5.537	5.301
		B	1.778	1547.35	4.921	
		C	2.074	1586.83	5.446	
16	1.1:1:3.432:10.253	A	2.074	1468.05	4.661	4.680
		B	1.778	1527.57	4.797	
		C	1.778	1492.85	4.581	
17	0.97:1:3.371:7.9215	A	2.222	1514.40	5.074	5.080
		B	2.074	1527.57	5.074	
		C	2.222	1520.99	5.118	
18	1.32:1:3.196:12.3465	A	1.630	1685.60	5.675	5.128
		B	1.452	1567.08	4.722	
		C	1.630	1580.25	4.988	
19	1.67:1:3.021:16.7715	A	1.185	1590.63	4.549	4.335
		B	1.185	1487.83	3.980	
		C	1.259	1562.30	4.477	
20	1.9:1:2.8125:19.0625	A	1.185	1567.08	4.415	4.445
		B	1.185	1558.67	4.364	
		C	1.037	1627.29	4.556	

Table 4.30: Experimental values of shear modulus of soilcrete blocks

Exp. No	Mix ratios (w/c: cement: laterite)	Replicates	Static Modulus of Elasticity E_c (GPa)	Poisson's Ration μ	Shear Modulus G (GPa)	Average Shear Modulus G (GPa)
1	0.8:1:8	A	5.283	0.194	2.212	2.195
		B	5.047	0.194	2.113	
		C	5.118	0.133	2.259	
2	1:1:12.5	A	3.610	0.125	1.604	1.572
		B	3.758	0.141	1.647	
		C	3.385	0.139	1.465	
3	1.28:1:16.67	A	3.338	0.125	1.484	1.513
		B	3.593	0.057	1.700	
		C	3.115	0.149	1.356	
4	0.9:1:10.25	A	4.098	0.117	1.834	1.810
		B	3.880	0.085	1.788	
		C	3.915	0.083	1.807	
5	1.04:1:12.335	A	3.481	0.070	1.627	1.656
		B	3.589	0.080	1.662	
		C	3.606	0.073	1.680	
6	1.14:1:14.585	A	3.008	0.111	1.354	1.495
		B	3.751	0.062	1.766	
		C	3.002	0.099	1.366	
7	1.09:1:13.46	A	3.428	0.125	1.524	1.521
		B	3.527	0.101	1.602	
		C	3.077	0.070	1.438	
8	1.02:1:12.417	A	3.176	0.070	1.484	1.475
		B	3.176	0.105	1.437	
		C	3.150	0.139	1.383	
9	0.866:1:9.485	A	3.884	0.050	1.850	1.727
		B	3.545	0.050	1.688	
		C	3.948	0.061	1.861	
10	1.0924:1:13.8761	A	2.941	0.099	1.338	1.464
		B	3.184	0.055	1.509	
		C	3.352	0.084	1.546	
11	1.052:1:12.818	A	3.750	0.133	1.655	1.699
		B	3.718	0.083	1.717	
		C	3.654	0.060	1.724	
12	1.1:1:13.685	A	2.817	0.101	1.279	1.300
		B	2.871	0.101	1.304	
		C	2.820	0.092	1.291	

Table 4.31: Experimental values of shear modulus of sand-laterite blocks

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Replicates	Static Modulus of Elasticity E_c (GPa)	Poisson's Ration μ	Shear Modulus G (GPa)	Average Shear Modulus G (GPa)
1	0.8:1:3.2:4.8	A	6.115	0.067	2.866	2.889
		B	6.640	0.179	2.816	
		C	6.486	0.019	2.973	
2	1:1:3.75:8.75	A	4.673	0.104	2.116	2.386
		B	5.907	0.109	2.663	
		C	5.311	0.116	2.397	
3	1.28:1:3.334:13.336	A	4.439	0.072	2.070	2.133
		B	4.621	0.035	2.232	
		C	4.714	0.124	2.097	
4	2.2:1:2.5:22.5	A	4.159	0.100	1.890	1.997
		B	4.475	0.062	2.107	
		C	4.317	0.083	1.993	
5	0.9:1:3.475:6.775	A	5.521	0.093	2.526	2.395
		B	4.960	0.104	2.246	
		C	5.228	0.083	2.414	
6	1.04:1:3.267:9.068	A	4.439	0.060	2.094	2.265
		B	5.436	0.078	2.521	
		C	4.960	0.138	2.179	
7	1.5:1:2.85:13.65	A	4.701	0.072	2.193	2.200
		B	4.771	0.064	2.242	
		C	4.714	0.089	2.164	
8	1.14:1:3.542:11.043	A	4.960	0.073	2.311	2.205
		B	4.714	0.176	2.004	
		C	4.925	0.070	2.301	
9	1.6:1:3.125:15.625	A	4.152	0.100	1.887	2.113
		B	4.864	0.066	2.281	
		C	4.668	0.075	2.171	
10	1.74:1:2.917:17.918	A	3.431	0.066	1.609	1.969
		B	4.629	0.050	2.204	
		C	4.439	0.060	2.094	
11	1.09:1:3.4045:10.0555	A	5.090	0.090	2.335	2.435
		B	5.388	0.062	2.538	
		C	5.178	0.064	2.433	
12	1.02:1:3.5085:8.909	A	5.401	0.093	2.471	2.285
		B	4.668	0.150	2.030	
		C	5.176	0.100	2.353	
13	0.866:1:3.3815:6.1035	A	5.521	0.100	2.510	2.459
		B	5.510	0.106	2.491	
		C	5.198	0.094	2.376	
14	1.0924:1:3.6127:10.2634	A	4.635	0.079	2.148	2.113
		B	4.782	0.110	2.154	
		C	4.581	0.125	2.036	
15	1.052:1:3.4186:9.3994	A	5.537	0.057	2.619	2.472
		B	4.921	0.078	2.282	
		C	5.446	0.083	2.514	
16	1.1:1:3.432:10.253	A	4.661	0.076	2.166	2.167
		B	4.797	0.085	2.211	
		C	4.581	0.078	2.125	
17	0.97:1:3.371:7.9215	A	5.074	0.063	2.387	2.361
		B	5.074	0.104	2.286	
		C	5.118	0.062	2.410	
18	1.32:1:3.196:12.3465	A	5.675	0.064	2.667	2.417
		B	4.722	0.063	2.221	
		C	4.988	0.056	2.362	
19	1.67:1:3.021:16.7715	A	4.549	0.083	2.100	1.999
		B	3.980	0.091	1.824	
		C	4.477	0.080	2.073	
20	1.9:1:2.8125:19.0625	A	4.415	0.037	2.129	2.136
		B	4.364	0.042	2.094	
		C	4.556	0.042	2.186	

Table 4.32: Experimental values of shear strength of soilcrete blocks

Exp No.	Mix ratios (w/c: cement: laterite)	Replicates	Failure Load in Flexure (KN)	Shear Load (KN)	X-sectional Area (mm^2)	Shear Strength S (N/mm^2)	Average Shear Strength S (N/mm^2)
1	0.8:1:8	A	15.5	7.75	22500	0.344	
		B	17.5	8.75	″	0.389	0.363
		C	16.0	8.00	″	0.356	
2	1:1:12.5	A	2.5	1.25	″	0.056	
		B	3.5	1.75	″	0.078	0.065
		C	2.8	1.40	″	0.062	
3	1.28:1:16.67	A	2.5	1.25	″	0.056	
		B	2.3	1.15	″	0.051	0.058
		C	3.0	1.5	″	0.067	
4	0.9:1:10.25	A	3.5	1.75	″	0.078	
		B	3.0	1.5	″	0.067	0.070
		C	2.9	1.45	″	0.064	
5	1.04:1:12.335	A	2.1	1.05	″	0.047	
		B	4.0	2.0	″	0.089	0.067
		C	2.9	1.45	″	0.064	
6	1.14:1:14.585	A	2.2	1.1	″	0.049	
		B	2.5	1.25	″	0.056	0.057
		C	3.0	1.5	″	0.067	
7	1.09:1:13.46	A	2.5	1.25	″	0.056	
		B	2.0	1.0	″	0.044	0.049
		C	2.1	1.05	″	0.047	
8	1.02:1:12.417	A	2.1	1.05	″	0.047	
		B	2.1	1.05	″	0.047	0.052
		C	2.8	1.40	″	0.062	
9	0.866:1:9.485	A	4.6	2.3	″	0.102	
		B	5.0	2.5	″	0.111	0.104
		C	4.5	2.25	″	0.100	
10	1.0924:1:13.8761	A	4.0	2.0	″	0.089	
		B	2.5	1.25	″	0.056	0.076
		C	3.8	1.9	″	0.084	
11	1.052:1:12.818	A	4.0	2.0	″	0.089	
		B	2.5	1.25	″	0.056	0.064
		C	2.1	1.05	″	0.047	
12	1.1:1:13.685	A	2.0	1.0	″	0.044	
		B	2.0	1.0	″	0.044	0.046
		C	2.3	1.15	″	0.051	

Table 4.33: Experimental values of shear strength of sand-laterite blocks

Exp. No.	Mix ratios (w/c: cement: sand: laterite)	Replicates	Failure Load in Flexure (KN)	Shear Load (KN)	X-sectional Area (mm^2)	Shear Strength S (N/ mm^2)	Average Shear Strength S (N/ mm^2)
1	0.8:1:3.2:4.8	A	17.5	8.75	22500	0.389	
		B	21.5	10.75	″	0.478	0.430
		C	19.0	9.5	″	0.422	
2	1:1:3.75:8.75	A	13.5	6.75	″	0.300	
		B	12.0	6.0	″	0.267	0.293
		C	14.0	7.0	″	0.311	
3	1.28:1:3.334:13.336	A	6.5	3.25	″	0.144	
		B	3.5	1.75	″	0.078	0.147
		C	9.9	4.95	″	0.220	
4	2.2:1:2.5:22.5	A	13.0	6.5	″	0.289	
		B	5.0	2.5	″	0.111	0.215
		C	11.0	5.5	″	0.244	
5	0.9:1:3.475:6.775	A	14.0	7.0	″	0.311	
		B	11.5	5.75	″	0.256	0.278
		C	12.0	6.0	″	0.267	
6	1.04:1:3.267:9.068	A	6.0	3.0	″	0.133	
		B	12.5	6.25	″	0.278	0.218
		C	11.0	5.5	″	0.244	
7	1.5:1:2.85:13.65	A	10.5	5.25	″	0.233	
		B	12.0	6.0	″	0.267	0.248
		C	11.0	5.5	″	0.244	
8	1.14:1:3.542:11.043	A	9.5	4.75	″	0.211	
		B	8.0	4.0	″	0.178	0.196
		C	9.0	4.5	″	0.200	
9	1.6:1:3.125:15.625	A	5.0	2.5	″	0.111	
		B	6.0	3.0	″	0.133	0.122
		C	5.5	2.75	″	0.122	
10	1.74:1:2.917:17.918	A	4.0	2.0	″	0.089	
		B	2.5	1.25	″	0.056	0.071
		C	3.0	1.5	″	0.067	
11	1.09:1:3.4045:10.0555	A	9.0	4.5	″	0.200	
		B	8.0	4.0	″	0.178	0.200
		C	10.0	5.0	″	0.222	
12	1.02:1:3.5085:8.909	A	13.0	6.5	″	0.289	
		B	13.5	6.75	″	0.300	0.285
		C	12.0	6.0	″	0.267	
13	0.866:1:3.3815:6.1035	A	17.0	8.5	″	0.378	
		B	17.0	8.5	″	0.378	0.371
		C	16.0	8.0	″	0.356	
14	1.0924:1:3.6127:10.2634	A	7.5	3.75	″	0.167	
		B	11.0	5.5	″	0.244	0.211
		C	10.0	5.0	″	0.222	
15	1.052:1:3.4186:9.3994	A	8.5	4.25	″	0.189	
		B	7.5	3.75	″	0.167	0.176
		C	7.8	3.9	″	0.173	
16	1.1:1:3.432:10.253	A	6.5	3.25	″	0.144	
		B	8.5	4.25	″	0.189	0.163
		C	7.0	3.5	″	0.156	
17	0.97:1:3.371:7.9215	A	9.5	4.75	″	0.211	
		B	11.5	5.75	″	0.256	0.230
		C	10.0	5.0	″	0.222	
18	1.32:1:3.196:12.3465	A	7.5	3.75	″	0.167	
		B	6.5	3.25	″	0.144	0.148
		C	6.0	3.0	″	0.133	
19	1.67:1:3.021:16.7715	A	5.0	2.5	″	0.111	
		B	5.5	2.75	″	0.122	0.124
		C	6.2	3.1	″	0.138	
20	1.9:1:2.8125:19.0625	A	3.0	1.5	″	0.067	
		B	3.0	1.5	″	0.067	0.071
		C	3.5	1.75	″	0.078	

Table 4.34: Water absorption test results of soilcrete blocks

Exp. No.	Mix ratios (w/c: cement: laterite)	Replicates	Dry Mass (kg)	Wet Mass (kg)	Absorption %	Average Absorption %
1	0.8:1:8	A	23.6	24.4	3.39	
		B	23.0	23.5	2.17	2.72
		C	23.2	23.8	2.59	
2	1:1:12.5	A	22.5	23.7	5.33	
		B	22.1	23.3	5.43	5.57
		C	21.8	23.1	5.96	
3	1.28:1:16.67	A	21.7	23.1	6.45	
		B	21.8	22.0	5.5	6.14
		C	21.6	22.9	6.48	
4	0.9:1:10.25	A	22.6	23.7	4.87	
		B	22.5	23.7	4.92	4.91
		C	22.3	23.4	4.93	
5	1.04:1:12.335	A	21.6	22.7	5.09	
		B	22.5	23.7	5.30	5.42
		C	22.1	23.4	5.88	
6	1.14:1:14.585	A	21.7	23.0	5.99	
		B	22.6	23.8	5.31	5.68
		C	22.7	24.0	5.73	
7	1.09:1:13.46	A	21.8	23.0	5.5	
		B	21.6	22.9	6.01	5.56
		C	21.3	22.4	5.16	
8	1.02:1:12.417	A	20.4	21.5	5.39	
		B	20.1	21.3	5.97	5.57
		C	20.5	21.6	5.36	
9	0.866:1:9.485	A	21.8	22.8	4.59	
		B	21.9	22.8	4.11	4.56
		C	22.1	23.2	4.98	
10	1.0924:1:13.8761	A	21.5	22.8	6.05	
		B	21.1	22.2	5.69	5.99
		C	20.9	22.2	6.22	
11	1.052:1:12.818	A	22.8	24.1	5.70	
		B	23.0	24.2	5.21	5.51
		C	23.1	24.4	5.63	
12	1.1:1:13.685	A	20.1	21.3	5.97	
		B	20.4	21.5	5.39	5.86
		C	20.9	22.2	6.22	

Table 4.35: Water absorption test results of sand-laterite blocks

Exp No.	Mix ratios (w/c: cement: sand: laterite)	Replicates	Dry Mass (kg)	Wet Mass (kg)	Absorption %	Average Absorption %
1	0.8:1:3.2:4.8	A	24.3	25.5	4.90	5.42
		B	24.7	26.1	6.07	
		C	24.5	25.8	5.30	
2	1:1:3.75:8.75	A	22.9	24.4	6.55	6.85
		B	24.8	23.6	6.05	
		C	23.9	25.8	7.95	
3	1.28:1:3.334:13.336	A	23.3	25.1	7.73	7.19
		B	23.6	25.1	6.36	
		C	23.4	23.35	7.48	
4	2.2:1:2.5:22.5	A	22.9	24.1	5.24	5.49
		B	23.1	24.5	6.06	
		C	23.2	24.4	5.17	
5	0.9:1:3.475:6.775	A	23.5	24.9	5.96	6.16
		B	23.1	24.5	6.06	
		C	23.2	24.7	6.47	
6	1.04:1:3.267:9.068	A	24.0	25.0	4.17	4.18
		B	23.8	24.7	3.78	
		C	23.7	24.8	4.64	
7	1.5:1:2.85:13.65	A	23.4	24.6	5.13	4.42
		B	23.4	24.5	4.27	
		C	23.2	24.1	3.88	
8	1.14:1:3.542:11.043	A	23.0	24.2	5.22	5.34
		B	23.0	24.1	4.78	
		C	23.2	24.6	6.03	
9	1.6:1:3.125:15.625	A	24.1	24.55	1.87	2.01
		B	23.9	24.5	2.51	
		C	24.4	24.8	1.64	
10	1.74:1:2.917:17.918	A	23.6	24.4	3.39	3.14
		B	23.5	24.3	3.40	
		C	22.9	23.5	2.62	
11	1.09:1:3.4045:10.0555	A	23.4	24.6	5.13	4.54
		B	23.8	24.8	4.20	
		C	23.2	24.2	4.29	
12	1.02:1:3.5085:8.909	A	23.9	25.2	5.44	6.24
		B	24.0	25.5	6.25	
		C	24.1	25.8	7.05	
13	0.866:1:3.3815:6.1035	A	23.5	24.6	4.68	4.91
		B	23.1	24.2	4.76	
		C	22.7	23.9	5.29	
14	1.0924:1:3.6127:10.2634	A	23.5	24.5	4.26	4.59
		B	23.0	24.2	5.22	
		C	23.3	24.3	4.29	
15	1.052:1:3.4186:9.3994	A	24.1	25.4	5.39	5.12
		B	24.2	25.4	4.96	
		C	23.9	25.1	5.02	
16	1.1:1:3.432:10.253	A	23.2	24.6	6.03	5.60
		B	23.5	24.7	5.11	
		C	23.0	24.3	5.65	
17	0.97:1:3.371:7.9215	A	23.1	23.9	3.46	3.46
		B	23.2	23.9	3.02	
		C	23.0	23.9	3.91	
18	1.32:1:3.196:12.3465	A	25.3	26.0	2.77	2.84
		B	23.9	24.4	2.09	
		C	24.5	25.4	3.67	
19	1.67:1:3.021:16.7715	A	24.8	25.4	2.42	2.31
		B	25.0	25.6	2.40	
		C	23.7	24.2	2.11	
20	1.9:1:2.8125:19.0625	A	23.6	24.5	3.81	3.70
		B	23.2	24.0	3.45	
		C	23.4	24.3	3.85	

4.1.2.4 Characteristics tests results and replication variances of sand-laterite blocks (a four-component mix)

The test results, average values and replication variances of the characteristics of sand-laterite blocks (4-component mix) are presented below:

Table 4.36: Compressive strength test result and replication variance

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	2.667 3.259 3.111	Y_1	9.037	3.012	27.412	0.095
2	2A 2B 2C	1.926 2.074 2.074	Y_2	6.074	2.025	12.312	0.007
3	3A 3B 3C	1.482 1.630 1.778	Y_3	4.890	1.630	8.015	0.022
4	4A 4B 4C	1.185 1.333 1.259	Y_4	3.777	1.259	4.766	0.005
5	5A 5B 5C	2.519 2.074 2.370	Y_{12}	6.963	2.321	16.264	0.051
6	6A 6B 6C	1.482 2.667 2.074	Y_{13}	6.223	2.074	13.610	0.234
7	7A 7B 7C	1.630 1.704 1.778	Y_{14}	5.112	1.704	8.722	0.004
8	8A 8B 8C	2.074 1.778 1.926	Y_{23}	5.778	1.926	11.172	0.022
9	9A 9B 9C	0.889 1.333 1.333	Y_{24}	3.555	1.185	4.344	0.066
10	10A 10B 10C	0.889 1.333 1.482	Y_{34}	3.704	1.235	4.764	0.095
			Control				
11	11A 11B 11C	1.778 2.222 2.074	C_1	6.073	2.024	12.400	0.053
12	12A 12B 12C	2.074 1.926 1.926	C_2	5.926	1.975	11.720	0.007
13	13A 13B 13C	2.519 3.259 2.222	C_3	8.000	2.666	21.904	0.285
14	14A 14B 14C	2.074 1.777 1.926	C_4	5.777	1.926	11.161	0.022
15	15A 15B 15C	2.074 1.778 2.074	C_5	5.926	1.975	11.764	0.029
16	16A 16B 16C	2.074 1.778 1.778	C_6	5.630	1.876	10.624	0.029
17	17A 17B 17C	2.222 2.074 2.222	C_7	6.518	2.173	14.176	0.007
18	18A 18B 18C	1.630 1.452 1.630	C_8	4.712	1.571	7.422	0.011
19	19A 19B 19C	1.185 1.185 1.259	C_9	3.629	1.210	4.394	0.002
20	20A 20B 20C	1.185 1.185 1.037	C_{10}	3.407	1.136	3.884	0.007
						$\sum$	1.053

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.36, replication variance $S_y^2 = 1.053/19 = 0.055$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.055} = 0.235$

4.1.2.4.1 Mathematical models for compressive strength of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for compressive strength of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for compressive strength of sand-laterite blocks

From Eqns (3.24) and (3.25), and Table 4.36, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 3.01$, $\alpha_2 = 2.03$, $\alpha_3 = 1.63$, $\alpha_4 = 1.26$

$\alpha_{12} = 4(2.32) - 2(3.01) - 2(2.03) = -0.8$

$\alpha_{13} = 4(2.07) - 2(3.01) - 2(1.63) = -1$

$\alpha_{14} = 4(1.70) - 2(3.01) - 2(1.26) = -1.74$

$\alpha_{23} = 4(1.93) - 2(2.03) - 2(1.63) = 0.4$

$\alpha_{24} = 4(1.19) - 2(2.03) - 2(1.26) = -1.82$

$\alpha_{34} = 4(1.24) - 2(1.63) - 2(1.26) = -0.82$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 3.01X_1 + 2.03X_2 + 1.63X_3 + 1.26X_4 - 0.8X_1X_2 - 1X_1X_3 - 1.74X_1X_4 + 0.4X_2X_3 - 1.82X_2X_4 - 0.82X_3X_4 \quad (4.1)$$

Eqn (4.1) is the Scheffe's mathematical model for optimisation of compressive strength of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for compressive strength of sand-laterite block

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.37

Table 4.37: T-statistics test computations for Scheffe's compressive strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25		2.024	1.950	0.074	0.426
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406				
		1	2	-0.125	0.5	0.0156	0.25					
		1	3	-0.125	0.25	0.0156	0.0625					
		1	4	-0.125	0	0.0156	0					
2	C_2	2	3	0	0.5	0	0.25		1.975	2.063	0.088	0.509
		2	4	0	0	0	0					
		3	4	-0.125	0	0.0156	0					
		4	-	0	-	0	0					
					∑	0.0624	0.5625	0.625				
		1	2	0.2278	0.8844	0.0519	0.7822					
		1	3	0.2278	0	0.0519	0					
		1	4	0.2278	0	0.0519	0					
3	C_3	2	3	-0.1122	0	0.0126	0		2.666	2.510	0.156	0.821
		2	4	-0.1122	0	0.0126	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.1809	0.7822	0.963				
		1	2	0	0	0	0					
		1	3	0	0	0	0					
		1	4	0	0	0	0					
4	C_4	2	3	0.2278	0.8844	0.0519	0.7822		1.926	1.986	0.06	0.032
		2	4	0.2278	0	0.0519	0					
		3	4	-0.1122	0	0.0126	0					
		4	-	0	-	0	0					
					∑	0.1164	0.7822	0.899				
		1	2	-0.12	0.36	0.0144	0.1296					
		1	3	-0.12	0.48	0.0144	0.2304					
		1	4	-0.12	0	0.0144	0					
5	C_5	2	3	-0.12	0.48	0.0144	0.2304		1.975	2.020	0.045	0.261
		2	4	-0.12	0	0.0144	0					
		3	4	-0.18	0	0.0064	0					
		4	-	0	-	0	0					
					∑	0.0784	0.5904	0.669				
		1	2	-0.12	0.24	0.0144	0.0576					
		1	3	-0.12	0.4	0.0144	0.16					
		1	4	-0.12	0	0.0144	0					
6	C_6	2	3	-0.12	0.6	0.0144	0.36		1.876	1.938	0.062	0.356
		2	4	-0.12	0	0.0144	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.072	0.5776	0.650				
		1	2	0	0.5	0	0.25					
		1	3	0	0.5	0	0.25					
		1	4	0	0	0	0					
7	C_7	2	3	-0.125	0.25	0.0156	0.0625		2.173	2.220	0.047	0.278
		2	4	-0.125	0	0.0156	0					
		3	4	-0.125	0	0.0156	0					
		4	-	0	-	0	0					
					∑	0.0468	0.5625	0.609				

Table 4.37 Continued

		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.0625					
		1	4	-0.125	0.25	0.0156	0.0625					
8	C_8	2	3	-0.125	0.25	0.0156	0.0625		1.571	1.621	0.050	0.308
		2	4	-0.125	0.25	0.0156	0.0625					
		3	4	-0.125	0.25	0.0156	0.0625					
		4	-	-0.125	-	0	0					
					∑	0.1092	0.375	0.484				
		1	2	0	0	0	0					
		1	3	0	0	0	0					
		1	4	0	0	0	0					
9	C_9	2	3	-0.125	0.25	0.0156	0.0625		1.210	1.240	0.030	0.174
		2	4	-0.125	0.5	0.0156	0.25					
		3	4	-0.125	0.5	0.0156	0.25					
		4	-	0	-	0	0					
					∑	0.0468	0.5625	0.609				
		1	2	0	0	0	0					
		1	3	0	0	0	0					
		1	4	0	0	0	0					
10	C_{10}	2	3	-0.125	0	0.0156	0		1.136	1.111	0.025	0.139
		2	4	-0.125	0.75	0.0156	0.5625					
		3	4	0	0	0	0					
		4	-	0.375	-	0.1406	0					
					∑	0.1718	0.5625	0.734				

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.37). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.38: F-statistics test computations for Scheffe's compressive strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	2.024	1.95	0.1708	0.0841	0.029173	0.007073
C_2	1.975	2.063	0.1218	0.1971	0.014835	0.038848
C_3	2.666	2.51	0.8128	0.6441	0.660644	0.414865
C_4	1.926	1.986	0.0728	0.1201	0.0053	0.014424
C_5	1.975	2.02	0.1218	0.1541	0.014835	0.023747
C_6	1.876	1.938	0.0228	0.0721	0.00052	0.005198
C_7	2.173	2.22	0.3198	0.3541	0.102272	0.125387
C_8	1.571	1.621	-0.2822	-0.2449	0.079637	0.059976
C_9	1.21	1.24	-0.6432	-0.6259	0.413706	0.391751
C_{10}	1.136	1.111	-0.7172	-0.7549	0.514376	0.569874
∑	18.532	18.659			1.835298	1.651143
	$Y_{(obs)}$=1.8532	$y_{(pre)}$=1.8659				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 1.835298/9 = 0.2039 and $S^2_{(pre)}$ = 1.651143/9 = 0.183

With reference to Eqn (3.93), S_1^2 = 0.2039 and S_2^2 = 0.183

Therefore, F = 0.2039/0.183 = 1.114

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated F-value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for compressive strength of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.36) into Eqn (3.78) gives the values of the coefficients, α as:

α_1 = -6966.045, α_2 = -14802.675, α_3 = -418.035, α_4 = -27.196, α_5 = 47847.731

α_6 = 1380.941, α_7 = 7862.325, α_8 = 20697.830, α_9 = 13162.925, α_{10} = 842.339

Substituting the values of these coefficients, α into Eqn (3.76) yields

$$Y = -6966.045Z_1 - 14802.675Z_2 - 418.035Z_3 - 27.196Z_4 + 47847.731Z_5 + 1380.941Z_6 + 7862.325Z_7 + 20697.830Z_8 + 13162.925Z_9 + 842.339Z_{10} \quad (4.2)$$

Eqn (4.2) is the Osadebe's mathematical model for optimisation of compressive strength of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for compressive strength of sand-laterite blocks

(i) Student's t-test

Table 4.39: T-statistics test computations for Osadebe's compressive strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625	0.6406	2.024	1.985	0.039	0.224
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625					
Similarly												
2		-	-	-	-	-	-	0.625	1.975	2.104	0.129	0.223
3		-	-	-	-	-	-	0.963	2.666	2.493	0.173	0.910
4		-	-	-	-	-	-	0.899	1.926	1.991	0.065	0.348
5		-	-	-	-	-	-	0.669	1.975	2.058	0.083	0.474
6		-	-	-	-	-	-	0.650	1.876	1.971	0.095	0.545
7		-	-	-	-	-	-	0.609	2.173	2.239	0.066	0.383
8		-	-	-	-	-	-	0.484	1.571	1.568	0.003	0.018
9		-	-	-	-	-	-	0.609	1.210	1.232	0.022	0.128
10		-	-	-	-	-	-	0.734	1.136	1.185	0.049	0.274

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II)

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.39). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.40: F-statistics test computations for Osadebe's compressive strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	2.024	1.985	0.1708	0.1024	0.029173	0.010486
C_2	1.975	2.104	0.1218	0.2214	0.014835	0.049018
C_3	2.666	2.493	0.8128	0.6104	0.660644	0.372588
C_4	1.926	1.991	0.0728	0.1084	0.0053	0.011751
C_5	1.975	2.058	0.1218	0.1754	0.014835	0.030765
C_6	1.876	1.971	0.0228	0.0884	0.00052	0.007815
C_7	2.173	2.239	0.3198	0.3564	0.102272	0.127021
C_8	1.571	1.568	-0.2822	-0.3146	0.079637	0.098973
C_9	1.21	1.232	-0.6432	-0.6506	0.413706	0.42328
C_{10}	1.136	1.185	-0.7172	-0.6976	0.514376	0.486646
∑	18.532	18.826			1.835298	1.618342
	$y_{(obs)}$=1.8532	$Y_{(pre)}$=1.8826				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 1.835298/9 = 0.2039$ and $S^2_{(pre)} = 1.618342/9 = 0.1798$

With reference to Eqn (3.93), $S_1^2 = 0.2039$ and $S_2^2 = 0.1798$

Therefore, $F = 0.2039/0.1798 = 1.134$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.41: Flexural strength test result and replication variance

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A	1.555					
	1B	1.911	Y_1	5.155	1.718	8.923	0.032
	1C	1.689					
2	2A	1.200					
	2B	1.067	Y_2	3.511	1.170	4.126	0.008
	2C	1.244					
3	3A	0.578					
	3B	0.311	Y_3	1.769	0.590	1.205	0.081
	3C	0.880					
4	4A	1.160					
	4B	0.444	Y_4	2.582	0.861	2.499	0.138
	4C	0.978					
5	5A	1.244					
	5B	1.022	Y_{12}	3.333	1.111	3.731	0.014
	5C	1.067					
6	6A	0.533					
	6B	1.111	Y_{13}	2.622	0.874	2.475	0.092
	6C	0.978					
7	7A	0.933					
	7B	1.067	Y_{14}	2.978	0.993	2.965	0.005
	7C	0.978					
8	8A	0.844					
	8B	0.711	Y_{23}	2.355	0.785	1.858	0.005
	8C	0.800					
9	9A	0.444					
	9B	0.533	Y_{24}	1.466	0.489	0.720	0.002
	9C	0.489					
10	10A	0.356					
	10B	0.222	Y_{34}	0.845	0.282	0.247	0.005
	10C	0.267					
			Control				
11	11A	0.800					
	11B	0.711	C_1	2.399	0.800	1.936	0.009
	11C	0.889					
12	12A	1.156					
	12B	1.200	C_2	3.423	1.141	3.915	0.005
	12C	1.067					
13	13A	1.511					
	13B	1.511	C_3	4.444	1.481	6.588	0.003
	13C	1.422					
14	14A	0.667					
	14B	0.978	C_4	2.534	0.846	2.192	0.026
	14C	0.889					
15	15A	0.756					
	15B	0.667	C_5	2.116	0.705	1.497	0.002
	15C	0.693					
16	16A	0.578					
	16B	0.756	C_6	1.956	0.652	1.293	0.009
	16C	0.622					
17	17A	0.844					
	17B	1.022	C_7	2.755	0.918	2.547	0.009
	17C	0.889					
18	18A	0.667					
	18B	0.578	C_8	1.778	0.593	1.063	0.005
	18C	0.533					
19	19A	0.444					
	19B	0.489	C_9	1.484	0.495	0.740	0.003
	19C	0.551					
20	20A	0.267					
	20B	0.267	C_{10}	0.845	0.282	0.239	0.001
	20C	0.311					
						$\sum$	0.454

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.41, replication variance, $S_y^2 = 0.454/19 = 0.024$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.024} = 0.155$

4.1.2.4.2 Mathematical models for flexural strength of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for flexural strength of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for flexural strength of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.41, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 1.72$, $\alpha_2 = 1.17$, $\alpha_3 = 0.59$, $\alpha_4 = 0.86$

$\alpha_{12} = 4(1.11) - 2(1.72) - 2(1.17) = -1.34$

$\alpha_{13} = 4(0.87) - 2(1.72) - 2(0.59) = -1.14$

$\alpha_{14} = 4(0.99) - 2(1.72) - 2(0.86) = -1.2$

$\alpha_{23} = 4(0.79) - 2(1.17) - 2(0.59) = -0.36$

$\alpha_{24} = 4(0.49) - 2(1.17) - 2(0.86) = -2.1$

$\alpha_{34} = 4(0.28) - 2(0.59) - 2(0.86) = -1.78$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 1.72X_1 + 1.17X_2 + 0.59X_3 + 0.86X_4 - 1.34X_1X_2 - 1.14X_1X_3 - 1.2X_1X_4 - 0.36X_2X_3 - 2.1X_2X_4 - 1.78X_3X_4 \quad (4.3)$$

Eqn (4.3) is the Scheffe's mathematical model for optimisation of flexural strength of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for flexural strength of sand-laterite blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.42.

Table 4.42: T-statistics test computations for Scheffe's flexural strength model

N	CN	i	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.800	0.746	0.054	0.471
Similarly												
2		-	-	-	-	-	-	0.625	1.141	0.879	0.262	2.300
3		-	-	-	-	-	-	0.963	1.481	1.242	0.239	1.906
4		-	-	-	-	-	-	0.899	0.846	0.899	0.053	0.430
5		-	-	-	-	-	-	0.669	0.705	0.802	0.097	0.839
6		-	-	-	-	-	-	0.650	0.652	0.742	0.090	0.783
7		-	-	-	-	-	-	0.609	0.918	0.967	0.049	0.432
8		-	-	-	-	-	-	0.484	0.593	0.590	0.003	0.028
9		-	-	-	-	-	-	0.609	0.495	0.363	0.132	1.163
10		-	-	-	-	-	-	0.734	0.282	0.544	0.262	2.223

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.42). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.43: F-statistics test computations for Scheffe's flexural strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.8	0.746	0.0087	-0.0314	7.57E-05	0.000986
C_2	1.141	0.879	0.3497	0.1016	0.12229	0.010323
C_3	1.481	1.242	0.6897	0.4646	0.475686	0.215853
C_4	0.846	0.899	0.0547	0.1216	0.002992	0.014787
C_5	0.705	0.802	-0.0863	0.0246	0.007448	0.000605
C_6	0.652	0.742	-0.1393	-0.0354	0.019404	0.001253
C_7	0.918	0.967	0.1267	0.1896	0.016053	0.035948
C_8	0.593	0.59	-0.1983	-0.1874	0.039323	0.035119
C_9	0.495	0.363	-0.2963	-0.4144	0.087794	0.171727
C_{10}	0.282	0.544	-0.5093	-0.2334	0.259386	0.054476
∑	7.913	7.774			1.030452	0.541076
	$Y_{(obs)}$=0.7913	$y_{(pre)}$=0.7774				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 1.030452/9 = 0.114$ and $S^2_{(pre)} = 0.541076/9 = 0.06$

With reference to Eqn (3.93), $S_1^2 = 0.114$ and $S_2^2 = 0.06$

Therefore, $F = 0.114/0.06 = 1.9$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for flexural strength of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.41) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 13727.236$, $\alpha_2 = 10481.001$, $\alpha_3 = 439.4409$, $\alpha_4 = 58.13296$, $\alpha_5 = -41182.584$

$\alpha_6 = -12990.640$, $\alpha_7 = -15587.254$, $\alpha_8 = -14572.876$, $\alpha_9 = -9466.841$,

$\alpha_{10} = -556.93912$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 13727.236Z_1 + 10481.001Z_2 + 439.4409Z_3 + 58.13296Z_4 - 41182.584Z_5 - 12990.640Z_6 - 15587.254Z_7 - 14572.876Z_8 - 9466.841Z_9 - 556.93912Z_{10} \quad (4.4)$$

Eqn (4.4) is the Osadebe's mathematical model for optimisation of flexural strength of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for flexural strength of sand-laterite blocks

(i) Student's t-test

Table 4.44: T-statistics test computations for Osadebe's flexural strength model

N	CN	i	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$Y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.800	0.785	0.015	0.102
Similarly												
2		-	-	-	-	-	-	0.625	1.141	0.911	0.230	2.016
3		-	-	-	-	-	-	0.963	1.481	1.203	0.278	2.217
4		-	-	-	-	-	-	0.899	0.846	0.888	0.042	0.341
5		-	-	-	-	-	-	0.669	0.705	0.836	0.131	1.133
6		-	-	-	-	-	-	0.650	0.652	0.779	0.127	1.105
7		-	-	-	-	-	-	0.609	0.918	0.966	0.048	0.423
8		-	-	-	-	-	-	0.484	0.593	0.508	0.085	0.780
9		-	-	-	-	-	-	0.609	0.495	0.372	0.123	1.084
10		-	-	-	-	-	-	0.734	0.282	0.641	0.359	3.046

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in appendix II)

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.44). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.45: F-statistics test computations for Osadebe's flexural strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.800	0.785	0.0087	-0.0039	7.57E-05	1.52E-05
C_2	1.141	0.911	0.3497	0.1221	0.12229	0.014908
C_3	1.481	1.203	0.6897	0.4141	0.475686	0.171479
C_4	0.846	0.888	0.0547	0.0991	0.002992	0.009821
C_5	0.705	0.836	-0.0863	0.0471	0.007448	0.002218
C_6	0.652	0.779	-0.1393	-0.0099	0.019404	9.8E-05
C_7	0.918	0.966	0.1267	0.1771	0.016053	0.031364
C_8	0.593	0.508	-0.1983	-0.2809	0.039323	0.078905
C_9	0.495	0.372	-0.2963	-0.4169	0.087794	0.173806
C_{10}	0.282	0.641	-0.5093	-0.1479	0.259386	0.021874
∑	7.913	7.889			1.030452	0.504489
	$y_{(obs)}$=0.7913	$y_{(pre)}$=0.7889				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 1.030452/9 = 0.114$ and $S^2_{(pre)} = 0.504489/9 = 0.056$

With reference to Eqn (3.93), $S_1^2 = 0.114$ and $S_2^2 = 0.056$

Therefore, $F = 0.114/0.056 = 2.03$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.46: Split tensile strength test result and replication variance

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	0.503 0.440 0.472	Y_1	1.415	0.472	0.669	0.001
2	2A 2B 2C	0.189 0.220 0.220	Y_2	0.629	0.210	0.1325	0.000
3	3A 3B 3C	0.189 0.189 0.220	Y_3	0.598	0.199	0.1198	0.000
4	4A 4B 4C	0.252 0.220 0.252	Y_4	0.724	0.241	0.175	0.000
5	5A 5B 5C	0.314 0.346 0.346	Y_{12}	1.006	0.335	0.338	0.000
6	6A 6B 6C	0.252 0.189 0.252	Y_{13}	0.693	0.231	0.1627	0.001
7	7A 7B 7C	0.157 0.189 0.220	Y_{14}	0.566	0.189	0.109	0.108
8	8A 8B 8C	0.314 0.346 0.314	Y_{23}	0.974	0.325	0.3169	0.000
9	9A 9B 9C	0.189 0.189 0.220	Y_{24}	0.598	0.199	0.1198	0.000
10	10A 10B 10C	0.220 0.189 0.126	Y_{34}	0.535	0.178	0.0999	0.002
Control							
11	11A 11B 11C	0.252 0.220 0.220	C_1	0.692	0.231	0.1603	0.000
12	12A 12B 12C	0.252 0.252 0.314	C_2	0.818	0.273	0.2256	0.001
13	13A 13B 13C	0.377 0.346 0.377	C_3	1.101	0.367	0.404	0.000
14	14A 14B 14C	0.189 0.189 0.252	C_4	0.630	0.210	0.1349	0.001
15	15A 15B 15C	0.220 0.252 0.283	C_5	0.755	0.252	0.1920	0.001
16	16A 16B 16C	0.252 0.220 0.176	C_6	0.648	0.218	0.1429	0.001
17	17A 17B 17C	0.252 0.220 0.189	C_7	0.661	0.220	0.1476	0.001
18	18A 18B 18C	0.189 0.220 0.283	C_8	0.647	0.216	0.1642	0.012
19	19A 19B 19C	0.126 0.189 0.189	C_9	0.504	0.168	0.0873	0.001
20	20A 20B 20C	0.346 0.283 0.314	C_{10}	0.943	0.314	0.2984	0.001
						$\sum$	0.131

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.46, replication variance, $S_y^2 = 0.131/19 = 0.00689$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.00689} = 0.083$

4.1.2.4.3 Mathematical models for split tensile strength of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for split tensile strength of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for split tensile strength of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.46, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1=0.47$, $\alpha_2 = 0.21$, $\alpha_3 = 0.20$, $\alpha_4 = 0.24$

$\alpha_{12} = 4(0.34) - 2(0.47) - 2(0.21) = 0$

$\alpha_{13} = 4(0.23) - 2(0.47) - 2(0.2) = -0.42$

$\alpha_{14} = 4(0.19) - 2(0.47) - 2(0.24) = -0.66$

$\alpha_{23} = 4(0.33) - 2(0.21) - 2(0.20) = 0.5$

$\alpha_{24} = 4(0.20) - 2(0.21) - 2(0.24) = -0.1$

$\alpha_{34} = 4(0.18) - 2(0.2) - 2(0.24) = -0.16$

Substituting the values of these coefficients, α into equation (3.10) yields

$$Y = 0.47X_1 + 0.21X_2 + 0.20X_3 + 0.24X_4 + 0X_1X_2 - 0.42X_1X_3 - 0.66X_1X_4 + 0.5X_2X_3 - 0.1X_2X_4 - 0.16X_3X_4 \quad (4.5)$$

Eqn (4.5) is the Scheffe's mathematical model for optimisation of split tensile strength of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for split tensile strength of sand-laterite blocks

(i) Student's t-test

Table 4.47: T-statistics test computations for Scheffe's split tensile strength model

N	CN	I	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.231	0.280	0.049	0.798
Similarly												
2		-	-	-	-	-	-	0.625	0.273	0.309	0.036	0.589
3		-	-	-	-	-	-	0.963	0.367	0.384	0.017	0.253
4		-	-	-	-	-	-	0.899	0.210	0.317	0.107	1.620
5		-	-	-	-	-	-	0.669	0.252	0.294	0.042	0.678
6		-	-	-	-	-	-	0.650	0.218	0.290	0.072	1.170
7		-	-	-	-	-	-	0.609	0.220	0.316	0.096	1.579
8		-	-	-	-	-	-	0.484	0.216	0.227	0.011	0.188
9		-	-	-	-	-	-	0.609	0.168	0.221	0.053	0.872
10		-	-	-	-	-	-	0.734	0.314	0.214	0.100	1.585

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.47). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.48: F-statistics test computations for Scheffe's split tensile strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.231	0.28	-0.0159	-0.0053	0.000253	2.81E-05
C_2	0.273	0.309	0.0261	0.0237	0.000681	0.000562
C_3	0.367	0.384	0.1201	0.0987	0.014424	0.009742
C_4	0.21	0.317	-0.0369	0.0317	0.001362	0.001005
C_5	0.252	0.294	0.0051	0.0087	2.6E-05	7.57E-05
C_6	0.218	0.29	-0.0289	0.0047	0.000835	2.21E-05
C_7	0.22	0.316	-0.0269	0.0307	0.000724	0.000942
C_8	0.216	0.228	-0.0309	-0.0573	0.000955	0.003283
C_9	0.168	0.221	-0.0789	-0.0643	0.006225	0.004134
C_{10}	0.314	0.214	0.0671	-0.0713	0.004502	0.005084
∑	2.469	2.853			0.029987	0.024878
	$y_{(obs)}$=0.2469	$y_{(pre)}$=0.2853				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.029987/9 = 0.0033$ and $S^2_{(pre)} = 0.024878/9 = 0.0028$

With reference to Eqn (3.93), $S_1^2 = 0.0033$ and $S_2^2 = 0.0028$

Therefore, $F = 0.0033/0.0028 = 1.18$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated value. Hence the regression equation is adequate.

(b) Determination of mathematical model (Osadebe's model) for split tensile strength

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.46) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = -4793.1952$, $\alpha_2 = -11636.6975$, $\alpha_3 = -495.8746$, $\alpha_4 = -21.4279$, $\alpha_5 = 32454.1714$

$\alpha_6 = 1728.8517$, $\alpha_7 = 5464.9272$, $\alpha_8 = 17027.7607$, $\alpha_9 = 10547.8890$, $\alpha_{10} = 763.6065$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = -4793.1952Z_1 - 11636.6975Z_2 - 495.8746Z_3 - 21.4279Z_4 + 32454.1714Z_5 + 1728.8517Z_6 + 5464.9272Z_7 + 17027.7607Z_8 + 10547.8890Z_9 + 763.6065Z_{10} \quad (4.6)$$

Eqn (4.6) is the Osadebe's mathematical model for optimisation of split tensile strength of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for split tensile strength of sand-laterite blocks

(i) Student's t-test

Table 4.49: T-statistics test computations for Osadebe's split tensile strength model

N	CN	I	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.231	0.292	0.061	0.994
Similarly												
2		-	-	-	-	-	-	0.625	0.273	0.324	0.051	0.835
3		-	-	-	-	-	-	0.963	0.367	0.381	0.014	0.209
4		-	-	-	-	-	-	0.899	0.210	0.323	0.113	1.711
5		-	-	-	-	-	-	0.669	0.252	0.307	0.055	0.888
6		-	-	-	-	-	-	0.650	0.218	0.300	0.082	1.332
7		-	-	-	-	-	-	0.609	0.220	0.323	0.103	1.695
8		-	-	-	-	-	-	0.484	0.216	0.211	0.005	0.086
9		-	-	-	-	-	-	0.609	0.168	0.204	0.036	0.592
10		-	-	-	-	-	-	0.734	0.314	0.219	0.095	1.506

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II). This value is greater than any of the t-values obtained by calculation (as shown in Table 4.49). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.50: F-statistics test computations for Osadebe's split tensile strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.231	0.292	-0.0159	0.0036	0.000253	1.3E-05
C_2	0.273	0.324	0.0261	0.0356	0.000681	0.001267
C_3	0.367	0.381	0.1201	0.0926	0.014424	0.008575
C_4	0.210	0.323	-0.0369	0.0346	0.001362	0.001197
C_5	0.252	0.307	0.0051	0.0186	2.6E-05	0.000346
C_6	0.218	0.3	-0.0289	0.0116	0.000835	0.000135
C_7	0.220	0.323	-0.0269	0.0346	0.000724	0.001197
C_8	0.216	0.211	-0.0309	-0.0774	0.000955	0.005991
C_9	0.168	0.204	-0.0789	-0.0844	0.006225	0.007123
C_{10}	0.314	0.219	0.0671	-0.0694	0.004502	0.004816
∑	2.469	2.884			0.029987	0.03066
	$y_{(obs)}$=0.2469	$y_{(obs)}$=0.2884				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.029987/9 = 0.0033$ and $S^2_{(pre)} = 0.03066/9 = 0.0034$

With reference to Eqn (3.93), $S_1^2 = 0.0034$ and $S_2^2 = 0.0033$

Therefore, $F = 0.0034/0.0033 = 1.03$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated value. Hence the regression equation is adequate.

Table 4.51: Poisson's ratio test result and replication variance

Expt. No.	Replicates	Response Y_i	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	0.067 0.179 0.091	Y_1	0.337	0.112	0.045	0.003
2	2A 2B 2C	0.104 0.109 0.116	Y_2	0.329	0.110	0.036	0.000
3	3A 3B 3C	0.072 0.035 0.124	Y_3	0.231	0.077	0.022	0.002
4	4A 4B 4C	0.100 0.062 0.083	Y_4	0.245	0.082	0.021	0.000
5	5A 5B 5C	0.093 0.104 0.083	Y_{12}	0.280	0.093	0.026	0.000
6	6A 6B 6C	0.060 0.078 0.138	Y_{13}	0.276	0.092	0.029	0.002
7	7A 7B 7C	0.072 0.064 0.089	Y_{14}	0.225	0.075	0.017	0.000
8	8A 8B 8C	0.073 0.176 0.070	Y_{23}	0.319	0.106	0.041	0.004
9	9A 9B 9C	0.100 0.066 0.075	Y_{24}	0.241	0.080	0.020	0.000
10	10A 10B 10C	0.066 0.050 0.060	Y_{34}	0.176	0.058	0.010	0.000
Control							
11	11A 11B 11C	0.090 0.062 0.064	C_1	0.216	0.072	0.016	0.000
12	12A 12B 12C	0.093 0.150 0.100	C_2	0.343	0.114	0.041	0.001
13	13A 13B 13C	0.100 0.106 0.094	C_3	0.30	0.100	0.030	0.000
14	14A 14B 14C	0.079 0.110 0.125	C_4	0.314	0.105	0.034	0.001
15	15A 15B 15C	0.057 0.078 0.083	C_5	0.218	0.073	0.016	0.000
16	16A 16B 16C	0.076 0.085 0.078	C_6	0.239	0.080	0.019	0.000
17	17A 17B 17C	0.063 0.104 0.062	C_7	0.229	0.076	0.019	0.001
18	18A 18B 18C	0.064 0.063 0.056	C_8	0.183	0.061	0.007	0.002
19	19A 19B 19C	0.083 0.091 0.080	C_9	0.254	0.085	0.022	0.000
20	20A 20B 20C	0.037 0.046 0.067	C_{10}	0.150	0.050	0.008	0.000
						$\sum$	0.016

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.51, replication variance $S_y^2 = 0.016/19 = 0.000842$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.000842} = 0.029$

4.1.2.4.4 Mathematical models for Poisson's ratio of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for Poisson's ratio of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for Poisson's ratio of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.51, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 0.112$, $\alpha_2 = 0.11$, $\alpha_3 = 0.077$, $\alpha_4 = 0.082$

$\alpha_{12} = 4(0.093) - 2(0.112) - 2(0.11) = -0.072$

$\alpha_{13} = 4(0.092) - 2(0.112) - 2(0.077) = -0.01$

$\alpha_{14} = 4(0.075) - 2(0.112) - 2(0.082) = -0.088$

$\alpha_{23} = 4(0.106) - 2(0.11) - 2(0.077) = 0.05$

$\alpha_{24} = 4(0.078) - 2(0.11) - 2(0.082) = -0.072$

$\alpha_{34} = 4(0.058) - 2(0.077) - 2(0.082) = -0.086$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 0.112X_1 + 0.11X_2 + 0.077X_3 + 0.082X_4 - 0.072X_1X_2 - 0.01X_1X_3 - 0.088X_1X_4 + 0.05X_2X_3 - 0.064X_2X_4 - 0.086X_3X_4 \qquad (4.7)$$

Eqn (4.7) is the Scheffe's mathematical model for optimisation of Poisson's ratio of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for Poisson's ratio of sand-laterite blocks

(i) Student's t-test

Table 4.52: T-statistics test computations for Scheffe's Poisson's ratio model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.072	0.095	0.023	1.072
Similarly												
2		-	-	-	-	-	-	0.625	0.114	0.099	0.015	0.703
3		-	-	-	-	-	-	0.963	0.100	0.095	0.005	0.213
4		-	-	-	-	-	-	0.899	0.105	0.110	0.005	0.217
5		-	-	-	-	-	-	0.669	0.073	0.096	0.023	1.063
6		-	-	-	-	-	-	0.650	0.080	0.096	0.016	0.744
7		-	-	-	-	-	-	0.609	0.076	0.096	0.020	0.942
8		-	-	-	-	-	-	0.484	0.061	0.078	0.017	0.833
9		-	-	-	-	-	-	0.609	0.085	0.072	0.013	0.612
10		-	-	-	-	-	-	0.734	0.040	0.077	0.037	1.814

T-value from table

For a significant level, $\alpha = 0.05$, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.52). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.53: F-statistics test computations for Scheffe's Poisson's ratio model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.072	0.095	-0.0096	0.00358	9.22E-05	1.28E-05
C_2	0.114	0.099	0.0324	0.00758	0.00105	5.75E-05
C_3	0.1	0.095	0.0184	0.00358	0.000339	1.28E-05
C_4	0.105	0.1102	0.0234	0.01878	0.000548	0.000353
C_5	0.073	0.096	-0.0086	0.00458	7.4E-05	2.1E-05
C_6	0.08	0.096	-0.0016	0.00458	2.56E-06	2.1E-05
C_7	0.076	0.096	-0.0056	0.00458	3.14E-05	2.1E-05
C_8	0.061	0.078	-0.0206	-0.01342	0.000424	0.00018
C_9	0.085	0.072	0.0034	-0.01942	1.16E-05	0.000377
C_{10}	0.05	0.077	-0.0316	-0.01442	0.000999	0.000208
∑	0.816	0.9142			0.00357	0.001264
	$y_{(obs)}$=0.0816	$y_{(pre)}$=0.09142				

Legend: $y = \sum Y/n$
where Y is the response and n the number of responses.
Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.00357/9 = 0.00039667$ and $S^2_{(pre)} = 0.001264/9 = 0.00014044$

With reference to Eqn (3.93), $S_1^2 = 0.0004769$ and $S_2^2 = 0.00015$

Therefore, $F = 0.00039667/0.00014044 = 2.824$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for Poisson's ratio of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.51) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 48.8363$, $\alpha_2 = -169.8921$, $\alpha_3 = -13.9647$, $\alpha_4 = -0.9482$, $\alpha_5 = 508.6242$

$\alpha_6 = -231.8932$, $\alpha_7 = -35.8359$, $\alpha_8 = 316.7788$, $\alpha_9 = 116.5684$, $\alpha_{10} = 34.27694$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 48.8363Z_1 - 169.8921Z_2 - 13.9647Z_3 - 0.9482Z_4 + 508.6242Z_5 - 231.8932Z_6 - 35.8359Z_7 + 316.7788Z_8 + 116.5684Z_9 + 34.27694Z_{10} \quad (4.8)$$

Eqn (4.8) is the Osadebe's mathematical model for optimisation of Poisson's ratio of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for Poisson's ratio of sand-laterite blocks

(i) Student's t-test

Table 4.54: T-statistics test computations for Osadebe's Poisson's ratio model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.072	0.097	0.025	1.166
Similarly												
2		-	-	-	-	-	-	0.625	0.114	0.104	0.010	0.469
3		-	-	-	-	-	-	0.963	0.100	0.093	0.007	0.140
4		-	-	-	-	-	-	0.899	0.105	0.111	0.006	0.260
5		-	-	-	-	-	-	0.669	0.073	0.100	0.027	1.248
6		-	-	-	-	-	-	0.650	0.080	0.099	0.019	0.883
7		-	-	-	-	-	-	0.609	0.076	0.074	0.023	1.083
8		-	-	-	-	-	-	0.484	0.061	0.070	0.013	0.637
9		-	-	-	-	-	-	0.609	0.085	0.080	0.015	0.706
10		-	-	-	-	-	-	0.734	0.050	0.077	0.030	1.361

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9)$ = 3.250 (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.54). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.55: F-statistics test computations for Osadebe's Poisson's ratio model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.072	0.097	-0.0096	0.0043	9.22E-05	1.85E-05
C_2	0.114	0.104	0.0324	0.0113	0.00105	0.000128
C_3	0.100	0.093	0.0184	0.0003	0.000339	9E-08
C_4	0.105	0.111	0.0234	0.0183	0.000548	0.000335
C_5	0.073	0.100	-0.0086	0.0073	7.4E-05	5.33E-05
C_6	0.080	0.099	-0.0016	0.0063	2.56E-06	3.97E-05
C_7	0.076	0.099	-0.0056	0.0063	3.14E-05	3.97E-05
C_8	0.061	0.074	-0.0206	-0.0187	0.000424	0.00035
C_9	0.085	0.07	0.0034	-0.0227	1.16E-05	0.000515
C_{10}	0.050	0.08	-0.0316	-0.0127	0.000999	0.000161
∑	0.816	0.927			0.00357	0.00164
	$y_{(obs)}$=0.0816	$y_{(pre)}$=0.0927				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 0.00357/9 = 0.00039667 and $S^2_{(pre)}$ = 0.00164/9 = 0.000182

With reference to Eqn (3.93), S_1^2 = 0.00048 and S_2^2 = 0.000182

Therefore, F = 0.00039667/0.000182 = 2.179

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated value. Hence the regression equation is adequate.

Table 4.56: Static modulus of elasticity result and replication variance

Expt. No.	Replicates	Response Y_i (GPa)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	6.115 6.640 6.486	Y_1	19.241	6.414	123.551	0.073
2	2A 2B 2C	4.673 5.907 5.311	Y_2	15.891	5.297	84.936	0.381
3	3A 3B 3C	4.439 4.621 4.714	Y_3	13.774	4.591	63.280	0.020
4	4A 4B 4C	4.159 4.475 4.317	Y_4	12.951	4.317	55.959	0.025
5	5A 5B 5C	5.521 4.960 5.228	Y_{12}	15.709	5.236	82.415	0.079
6	6A 6B 6C	4.439 5.436 4.960	Y_{13}	14.835	4.945	73.856	0.249
7	7A 7B 7C	4.701 4.771 4.714	Y_{14}	14.186	4.729	67.084	0.001
8	8A 8B 8C	4.960 4.714 4.925	Y_{23}	14.599	4.866	71.079	0.018
9	9A 9B 9C	4.152 4.864 4.668	Y_{24}	13.684	4.561	62.688	0.135
10	10A 10B 10C	3.431 4.629 4.439	Y_{34}	12.499	4.166	52.904	0.415
Control							
11	11A 11B 11C	5.090 5.388 5.178	C_1	15.656	5.219	81.750	0.023
12	12A 12B 12C	5.401 4.668 5.176	C_2	15.245	5.082	77.752	0.141
13	13A 13B 13C	5.521 5.510 5.198	C_3	16.229	5.410	87.861	0.034
14	14A 14B 14C	4.635 4.782 4.581	C_4	13.998	4.666	65.336	0.011
15	15A 15B 15C	5.537 4.921 5.446	C_5	15.904	5.301	84.534	0.111
16	16A 16B 16C	4.661 4.797 4.581	C_6	14.039	4.680	65.722	0.012
17	17A 17B 17C	5.074 5.074 5.118	C_7	15.239	5.080	77.412	0.0013
18	18A 18B 18C	5.675 4.722 4.988	C_8	15.345	5.128	79.383	0.447
19	19A 19B 19C	4.549 3.980 4.477	C_9	13.006	4.335	56.577	0.096
20	20A 20B 20C	4.415 4.364 4.556	C_{10}	13.335	4.445	59.294	0.010
						$\sum$	2.2823

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.56, replication variance, $S_y^2 = 2.2823/19 = 0.12012$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.12012} = 0.347$

4.1.2.4.5 Mathematical models for static modulus of elasticity of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for static modulus of elasticity of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for static modulus of elasticity of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.56, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 6.41$, $\alpha_2 = 5.30$, $\alpha_3 = 4.59$, $\alpha_4 = 4.32$

$\alpha_{12} = 4(5.24) - 2(6.41) - 2(5.30) = -2.46$

$\alpha_{13} = 4(4.95) - 2(6.41) - 2(4.59) = -2.2$

$\alpha_{14} = 4(4.73) - 2(6.41) - 2(4.32) = -2.54$

$\alpha_{23} = 4(4.87) - 2(5.30) - 2(4.59) = -0.3$

$\alpha_{24} = 4(4.56) - 2(5.30) - 2(4.32) = -1$

$\alpha_{34} = 4(4.17) - 2(4.59) - 2(4.32) = -1.14$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 6.41X_1 + 5.3X_2 + 4.59X_3 + 4.32X_4 - 2.46X_1X_2 - 2.2X_1X_3 - 2.54X_1X_4 - 0.3X_2X_3 - 1X_2X_4 - 1.14X_3X_4 \quad (4.9)$$

Eqn (4.9) is the Scheffe's mathematical model for optimisation of static modulus of elasticity of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for static modulus of elasticity of sand-laterite blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.57

Table 4.57: T-statistics test computations for Scheffe's static modulus of elasticity Model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	5.219	4.756	0.463	1.804
Similarly												
2		-	-	-	-	-	-	0.625	5.082	4.917	0.165	0.646
3		-	-	-	-	-	-	0.963	5.410	5.500	0.090	0.321
4		-	-	-	-	-	-	0.899	4.666	4.999	0.333	1.206
5		-	-	-	-	-	-	0.669	5.301	4.827	0.474	1.831
6		-	-	-	-	-	-	0.650	4.680	4.754	0.074	0.288
7		-	-	-	-	-	-	0.609	5.080	5.076	0.004	0.016
8		-	-	-	-	-	-	0.484	5.128	4.552	0.576	2.360
9		-	-	-	-	-	-	0.609	4.335	4.346	0.011	0.043
10		-	-	-	-	-	-	0.734	4.445	4.377	0.068	0.258

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.57). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.58: F-statistics test computations for Scheffe's static modulus of elasticity Model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	5.219	4.756	0.2844	-0.0544	0.080883	0.002959
C_2	5.082	4.917	0.1474	0.1066	0.021727	0.011364
C_3	5.41	5.5	0.4754	0.6896	0.226005	0.475548
C_4	4.666	4.999	-0.2686	0.1886	0.072146	0.03557
C_5	5.301	4.827	0.3664	0.0166	0.134249	0.000276
C_6	4.68	4.754	-0.2546	-0.0564	0.064821	0.003181
C_7	5.08	5.076	0.1454	0.2656	0.021141	0.070543
C_8	5.128	4.552	0.1934	-0.2584	0.037404	0.066771
C_9	4.335	4.346	-0.5996	-0.4644	0.35952	0.215667
C_{10}	4.445	4.377	-0.4896	-0.4334	0.239708	0.187836
∑	49.346	48.104			1.257604	1.069714
	$y_{(obs)}$=4.9346	$y_{(pre)}$=4.8104				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 1.257604/9 = 0.13973 and $S^2_{(pre)}$ = 1.069714/9 = 0.118857

With reference to Eqn (3.93), S_1^2 = 0.13973 and S_2^2 = 0.118857

Therefore, F = 0.13973 /0.118857 = 1.175

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated F-value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for static modulus of elasticity of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.56) into Eqn (3.78) gives the values of the coefficients, α as:

α_1 = 12567.3099, α_2 = 16631.9596, α_3 = 631.9009, α_4 = 54.42123, α_5 = -51077.9249

α_6 = -10239.1755, α_7 = -14205.4906, α_8 = -23413.1739, α_9 = -15505.7063,

α_{10} = -801.3047

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 12567.3099Z_1 + 16631.9596Z_2 + 631.9009Z_3 + 54.42123Z_4 - 51077.9249Z_5 - 10239.1755Z_6 - 14205.4906Z_7 - 23413.1739Z_8 - 15505.7063Z_9 - 801.3047Z_1 \quad (4.10)$$

Eqn (4.10) is the Osadebe's mathematical model for optimisation of static modulus of elasticity of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for static modulus of elasticity of sand-laterite blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.59.

Table 4.59: T-statistics test computations for Osadebe's static modulus of elasticity model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	5.219	4.833	0.386	1.504
Similarly												
2		-	-	-	-	-	-	0.625	5.082	4.987	0.095	0.372
3		-	-	-	-	-	-	0.963	5.410	5.425	0.015	0.053
4		-	-	-	-	-	-	0.899	4.666	4.990	0.324	1.174
5		-	-	-	-	-	-	0.669	5.301	4.896	0.405	1.565
6		-	-	-	-	-	-	0.650	4.680	4.830	0.150	0.583
7		-	-	-	-	-	-	0.609	5.080	5.073	0.007	0.045
8		-	-	-	-	-	-	0.484	5.128	4.585	0.543	2.225
9		-	-	-	-	-	-	0.609	4.335	4.345	0.010	0.039
10		-	-	-	-	-	-	0.734	4.445	4.411	0.034	0.129

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.59). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.60: F-statistics test computations for Osadebe's static modulus of elasticity model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	5.219	4.833	0.2844	-0.0045	0.080883	2.03E-05
C_2	5.082	4.987	0.1474	0.1495	0.021727	0.02235
C_3	5.410	5.425	0.4754	0.5875	0.226005	0.345156
C_4	4.666	4.99	-0.2686	0.1525	0.072146	0.023256
C_5	5.301	4.896	0.3664	0.0585	0.134249	0.003422
C_6	4.680	4.83	-0.2546	-0.0075	0.064821	5.63E-05
C_7	5.080	5.073	0.1454	0.2355	0.021141	0.05546
C_8	5.128	4.585	0.1934	-0.2525	0.037404	0.063756
C_9	4.335	4.345	-0.5996	-0.4925	0.35952	0.242556
C_{10}	4.445	4.411	-0.4896	-0.4265	0.239708	0.181902
∑	49.346	48.375			1.257604	0.937937
	$y_{(obs)}$=4.9346	$y_{(pre)}$=4.8375				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 1.257604/9 = 0.13973 and $S^2_{(pre)}$ = 0.937937/9 = 0.104215

With reference to Eqn (3.93), S_1^2 = 0.13973 and S_2^2 = 0.104215

Therefore, F = 0.13973 /0.104215 = 1.34

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.61: Shear modulus/modulus of rigidity results and replication variance

Expt. No.	Replicates	Response Y_i (GPa)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	2.866 2.816 2.973	Y_1	8.655	2.885	24.983	0.006
2	2A 2B 2C	2.116 2.663 2.379	Y_2	7.158	2.386	17.229	0.075
3	3A 3B 3C	2.070 2.232 2.097	Y_3	6.399	2.133	13.664	0.008
4	4A 4B 4C	1.890 2.107 1.993	Y_4	5.990	1.997	11.984	0.012
5	5A 5B 5C	2.526 2.246 2.414	Y_{12}	7.186	2.395	17.253	0.020
6	6A 6B 6C	2.094 2.521 2.179	Y_{13}	6.794	2.265	15.589	0.102
7	7A 7B 7C	2.193 2.242 2.164	Y_{14}	6.599	2.200	14.519	0.002
8	8A 8B 8C	2.311 2.004 2.301	Y_{23}	6.616	2.205	14.639	0.024
9	9A 9B 9C	1.887 2.281 2.171	Y_{24}	6.339	2.113	13.477	0.041
10	10A 10B 10C	1.609 2.204 2.094	Y_{34}	5.907	1.969	11.831	0.100
			Control				
11	11A 11B 11C	2.335 2.538 2.433	C_1	7.306	2.435	17.813	0.010
12	12A 12B 12C	2.471 2.030 2.353	C_2	6.854	2.285	15.763	0.052
13	13A 13B 13C	2.510 2.491 2.376	C_3	7.377	2.459	18.151	0.005
14	14A 14B 14C	2.148 2.154 2.036	C_4	6.338	2.113	13.399	0.004
15	15A 15B 15C	2.619 2.282 2.514	C_5	7.415	2.472	18.387	0.030
16	16A 16B 16C	2.166 2.211 2.125	C_6	6.502	2.167	14.096	0.002
17	17A 17B 17C	2.387 2.286 2.410	C_7	7.083	2.361	16.732	0.004
18	18A 18B 18C	2.667 2.221 2.362	C_8	7.250	2.417	17.625	0.052
19	19A 19B 19C	2.100 1.824 2.073	C_9	5.997	1.999	12.034	0.023
20	20A 20B 20C	2.129 2.094 2.186	C_{10}	6.409	2.136	13.696	0.002
						$\sum$	0.574

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.61, replication variance, $S_y^2 = 0.574/19 = 0.03021$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.03021} = 0.174$

4.1.2.4.6 Mathematical models for shear modulus of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for shear modulus of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for shear modulus of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.61, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 2.89$, $\alpha_2 = 2.39$, $\alpha_3 = 2.13$, $\alpha_4 = 2.0$

$\alpha_{12} = 4(2.40) - 2\,(2.89) - 2\,(2.39) = -0.96$

$\alpha_{13} = 4(2.27) - 2\,(2.89) - 2(2.13) = -0.96$

$\alpha_{14} = 4\,(2.20) - 2\,(2.89) - 2(2.0) = -0.98$

$\alpha_{23} = 4\,(2.21) - 2\,(2.39) - 2\,(2.13) = -0.2$

$\alpha_{24} = 4\,(2.11) - 2(2.39) - 2(2.0) = -0.34$

$\alpha_{34} = 4\,(1.97) - 2(2.13) - 2(2.0) = -0.38$

Substituting the values of these coefficients, α into Eqn (3.10) yields

$$Y = 2.89X_1 + 2.39X_2 + 2.13X_3 + 2.0X_4 - 0.96X_1X_2 - 0.96X_1X_3 - 0.98X_1X_4 - 0.2X_2X_3 - 0.34X_2X_4 - 0.38X_3X_4 \quad (4.11)$$

Eqn (4.11) is the Scheffe's mathematical model for optimisation of shear modulus/modulus of rigidity of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for shear modulus of sand-laterite blocks

(i) Student's t-test

Table 4.62: T-statistics test computations for Scheffe's shear modulus model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	2.435	2.180	0.255	1.980
Similarly												
2		-	-	-	-	-	-	0.625	2.285	2.245	0.040	0.312
3		-	-	-	-	-	-	0.963	2.459	2.513	0.054	0.384
4		-	-	-	-	-	-	0.899	2.113	2.260	0.147	1.062
5		-	-	-	-	-	-	0.669	2.472	2.210	0.262	2.019
6		-	-	-	-	-	-	0.650	2.167	2.176	0.009	0.070
7		-	-	-	-	-	-	0.609	2.361	2.322	0.039	0.306
8		-	-	-	-	-	-	0.484	2.417	2.114	0.303	2.476
9		-	-	-	-	-	-	0.609	1.999	2.027	0.028	0.220
10		-	-	-	-	-	-	0.734	2.136	2.034	0.102	0.770

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.62). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.63: F-statistics test computations for Scheffe's shear modulus model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	2.435	2.18	0.1506	-0.0281	0.02268	0.00079
C_2	2.285	2.245	0.0006	0.0369	3.6E-07	0.001362
C_3	2.459	2.513	0.1746	0.3049	0.030485	0.092964
C_4	2.113	2.26	-0.1714	0.0519	0.029378	0.002694
C_5	2.472	2.21	0.1876	0.0019	0.035194	3.61E-06
C_6	2.167	2.176	-0.1174	-0.0321	0.013783	0.00103
C_7	2.361	2.322	0.0766	0.1139	0.005868	0.012973
C_8	2.417	2.114	0.1326	-0.0941	0.017583	0.008855
C_9	1.999	2.027	-0.2854	-0.1811	0.081453	0.032797
C_{10}	2.136	2.034	-0.1484	-0.1741	0.022023	0.030311
∑	22.844	22.081			0.258446	0.183779
	$y_{(obs)}$=2.2844	$y_{(pre)}$=2.2081				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.258446/9 = 0.028716$ and $S^2_{(pre)} = 0.183779/9 = 0.02042$

With reference to Eqn (3.93), $S_1^2 = 0.028716$ and $S_2^2 = 0.02042$

Therefore, $F = 0.028716 / 0.02042 = 1.406$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for shear modulus of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.61) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 5756.0577$, $\alpha_2 = 7608.4804$, $\alpha_3 = 295.5701$, $\alpha_4 = 27.2924$, $\alpha_5 = -23975.4721$

$\alpha_6 = -4390.2850$, $\alpha_7 = -6543.877$, $\alpha_8 = -10799.9256$, $\alpha_9 = -6999.4520$,

$\alpha_{10} = -407.6375$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 5756.0577Z_1 + 7608.4804Z_2 + 295.5701Z_3 + 27.2924Z_4 - 23975.4721Z_5 - 4390.2850Z_6 - 6543.877Z_7 - 10799.9256Z_8 - 6999.4520Z_9 - 407.6375Z_{10} \quad (4.12)$$

Eqn (4.12) is the Osadebe's mathematical model for optimisation of shear modulus/modulus of rigidity of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for shear modulus of sand-laterite blocks

(i) Student's t-test

Table 4.64: T-statistics test computations for Osadebe's shear modulus model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	2.435	2.206	0.229	1.780
Similarly												
2		-	-	-	-	-	-	0.625	2.285	2.263	0.022	0.172
3		-	-	-	-	-	-	0.963	2.459	2.480	0.021	0.149
4		-	-	-	-	-	-	0.899	2.113	2.250	0.137	0.990
5		-	-	-	-	-	-	0.669	2.472	2.231	0.241	1.857
6		-	-	-	-	-	-	0.650	2.167	2.202	0.035	0.271
7		-	-	-	-	-	-	0.609	2.361	2.311	0.050	0.932
8		-	-	-	-	-	-	0.484	2.417	2.134	0.283	2.312
9		-	-	-	-	-	-	0.609	1.999	2.030	0.031	0.243
10		-	-	-	-	-	-	0.734	2.136	2.045	0.091	0.688

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.64). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.65: F-statistics test computations for Osadebe's shear modulus model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	2.435	2.206	0.1506	-0.0092	0.02268	8.46E-05
C_2	2.285	2.263	0.0006	0.0478	3.6E-07	0.002285
C_3	2.459	2.48	0.1746	0.2648	0.030485	0.070119
C_4	2.113	2.25	-0.1714	0.0348	0.029378	0.001211
C_5	2.472	2.231	0.1876	0.0158	0.035194	0.00025
C_6	2.167	2.202	-0.1174	-0.0132	0.013783	0.000174
C_7	2.361	2.311	0.0766	0.0958	0.005868	0.009178
C_8	2.417	2.134	0.1326	-0.0812	0.017583	0.006593
C_9	1.999	2.03	-0.2854	-0.1852	0.081453	0.034299
C_{10}	2.136	2.045	-0.1484	-0.1702	0.022023	0.028968
∑	22.844	22.152			0.258446	0.153162
	$y_{(obs)}$=2.2844	$y_{(pre)}$=2.2152				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.258446/9 = 0.028716$ and $S^2_{(pre)} = 0.153162/9 = 0.017018$

With reference to Eqn (3.93), $S_1^2 = 0.028716$ and $S_2^2 = 0.017018$

Therefore, $F = 0.028716 / 0.017018 = 1.69$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.66: Shear strength test results and replication variance

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A	0.389					
	1B	0.478	Y_1	1.289	0.430	0.558	0.002
	1C	0.422					
2	2A	0.300					
	2B	0.267	Y_2	0.878	0.293	0.258	0.001
	2C	0.311					
3	3A	0.144					
	3B	0.078	Y_3	0.442	0.147	0.055	0.005
	3C	0.220					
4	4A	0.289					
	4B	0.111	Y_4	0.644	0.215	0.155	0.009
	4C	0.224					
5	5A	0.311					
	5B	0.256	Y_{12}	0.834	0.278	0.235	0.001
	5C	0.267					
6	6A	0.133					
	6B	0.278	Y_{13}	0.655	0.218	0.155	0.006
	6C	0.244					
7	7A	0.233					
	7B	0.267	Y_{14}	0.744	0.248	0.185	0.000
	7C	0.244					
8	8A	0.211					
	8B	0.178	Y_{23}	0.589	0.196	0.116	0.000
	8C	0.200					
9	9A	0.111					
	9B	0.133	Y_{24}	0.366	0.122	0.045	0.000
	9C	0.122					
10	10A	0.089					
	10B	0.056	Y_{34}	0.217	0.071	0.016	0.000
	10C	0.067					
Control							
11	11A	0.200					
	11B	0.178	C_1	0.600	0.200	0.121	0.000
	11C	0.222					
12	12A	0.289					
	12B	0.300	C_2	0.856	0.285	0.245	0.000
	12C	0.267					
13	13A	0.378					
	13B	0.378	C_3	1.112	0.371	0.413	0.000
	13C	0.356					
14	14A	0.167					
	14B	0.244	C_4	0.633	0.211	0.137	0.002
	14C	0.222					
15	15A	0.189					
	15B	0.167	C_5	0.529	0.176	0.094	0.000
	15C	0.173					
16	16A	0.144					
	16B	0.189	C_6	0.489	0.163	0.081	0.001
	16C	0.156					
17	17A	0.211					
	17B	0.256	C_7	0.689	0.230	0.159	0.001
	17C	0.222					
18	18A	0.167					
	18B	0.144	C_8	0.444	0.148	0.066	0.000
	18C	0.133					
19	19A	0.111					
	19B	0.122	C_9	0.371	0.124	0.046	0.000
	19C	0.138					
20	20A	0.067					
	20B	0.067	C_{10}	0.212	0.071	0.0151	0.000
	20C	0.078					
						$\sum$	0.028

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.66, replication variance $S_y^2 = 0.028/19 = 0.0014737$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.0014737} = 0.038$

4.1.2.4.7 Mathematical models for shear strength of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for shear strength of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for shear strength of sand-laterite blocks

From Eqns (3.24) and (3.25) and Table 4.66, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 0.43, \quad \alpha_2 = 0.293, \quad \alpha_3 = 0.147, \quad \alpha_4 = 0.215$

$\alpha_{12} = 4(0.278) - 2(0.43) - 2(0.293) = -0.334$

$\alpha_{13} = 4(0.218) - 2(0.43) - 2(0.147) = -0.282$

$\alpha_{14} = 4(0.248) - 2(0.43) - 2(0.215) = -0.298$

$\alpha_{23} = 4(0.196) - 2(0.293) - 2(0.147) = -0.096$

$\alpha_{24} = 4(0.122) - 2(0.293) - 2(0.147) = -0.528$

$\alpha_{34} = 4(0.071) - 2(0.147) - 2(0.215) = -0.44$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 0.43X_1 + 0.293X_2 + 0.147X_3 + 0.215X_4 - 0.334X_1X_2 - 0.282X_1X_3 - 0.298X_1X_4 - 0.096X_2X_3 - 0.528X_2X_4 - 0.44X_3X_4 \quad (4.13)$$

Eqn (4.13) is the Scheffe's mathematical model for optimisation of shear strength of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for shear strength of sand-laterite blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.67.

Table 4.67: T-statistics test computations for Scheffe's shear strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
1	C_1	2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					$\sum$	0.0781	0.5625	0.6406	0.200	0.186	0.014	0.498
Similarly												
2		-	-	-	-	-	-	0.625	0.285	0.219	0.066	2.360
3		-	-	-	-	-	-	0.963	0.371	0.311	0.060	1.966
4		-	-	-	-	-	-	0.899	0.211	0.224	0.013	0.430
5		-	-	-	-	-	-	0.669	0.176	0.200	0.024	0.847
6		-	-	-	-	-	-	0.650	0.163	0.185	0.022	0.781
7		-	-	-	-	-	-	0.609	0.230	0.242	0.012	0.431
8		-	-	-	-	-	-	0.484	0.148	0.148	0	0
9		-	-	-	-	-	-	0.609	0.124	0.091	0.033	1.186
10		-	-	-	-	-	-	0.734	0.071	0.136	0.065	2.250

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.67). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.68: F-statistics test computations for Scheffe's shear strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.2	0.186	0.0021	-0.0082	4.41E-06	6.72E-05
C_2	0.285	0.219	0.0871	0.0248	0.007586	0.000615
C_3	0.371	0.311	0.1731	0.1168	0.029964	0.013642
C_4	0.211	0.224	0.0131	0.0298	0.000172	0.000888
C_5	0.176	0.2	-0.0219	0.0058	0.00048	3.36E-05
C_6	0.163	0.185	-0.0349	-0.0092	0.001218	8.46E-05
C_7	0.23	0.242	0.0321	0.0478	0.00103	0.002285
C_8	0.148	0.148	-0.0499	-0.0462	0.00249	0.002134
C_9	0.124	0.091	-0.0739	-0.1032	0.005461	0.01065
C_{10}	0.071	0.136	-0.1269	-0.0582	0.016104	0.003387
$\sum$	1.979	1.942			0.064509	0.033788
	$y_{(obs)}$=0.1979	$y_{(pre)}$=0.1942				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 0.064509/9 = 0.007168 and $S^2_{(pre)}$ = 0.033788/9 = 0.0037542

With reference to Eqn (3.93), S_1^2 = 0.007168 and S_2^2 = 0.0037542

Therefore, F = 0.007168 /0.0037542 = 1.909

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for shear strength of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.66) into Eqn (3.78) gives the values of the coefficients, α as:

α_1 = 3390.553, α_2 = 2598.652, α_3 = 110.0613, α_4 = 14.36977, α_5 = -10166.3354

α_6 = -3214.0872, α_7 = -3850.1384, α_8 = -3619.0367, α_9 = -2349.1569,

α_{10} = -138.8260

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 3390.553Z_1 + 2598.652Z_2 + 110.0613Z_3 + 14.36977Z_4 - 10166.3354Z_5 - 3214.0872Z_6 - 3850.1384Z_7 - 3619.0367Z_8 - 2349.1569Z_9 - 138.8260Z_{10} \quad (4.14)$$

Eqn (4.14) is the Osadebe's mathematical model for optimisation of shear strength of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for shear strength of sand-laterite blocks

(i) Student's t-test

Table 4.69: T-Statistics test computations for Osadebe's shear strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	0.200	0.196	0.004	0.142
Similarly												
2		-	-	-	-	-	-	0.625	0.285	0.228	0.057	2.038
3		-	-	-	-	-	-	0.963	0.371	0.301	0.070	2.277
4		-	-	-	-	-	-	0.899	0.211	0.222	0.011	0.364
5		-	-	-	-	-	-	0.669	0.176	0.209	0.033	1.164
6		-	-	-	-	-	-	0.650	0.163	0.194	0.031	1.100
7		-	-	-	-	-	-	0.609	0.230	0.241	0.011	0.395
8		-	-	-	-	-	-	0.484	0.148	0.127	0.021	0.786
9		-	-	-	-	-	-	0.609	0.124	0.093	0.031	1.114
10		-	-	-	-	-	-	0.734	0.071	0.160	0.089	3.081

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.68). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.70: F-statistics test computations for Osadebe's shear strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.200	0.196	0.0021	-0.0011	4.41E-06	1.21E-06
C_2	0.285	0.228	0.0871	0.0309	0.007586	0.000955
C_3	0.371	0.301	0.1731	0.1039	0.029964	0.010795
C_4	0.211	0.222	0.0131	0.0249	0.000172	0.00062
C_5	0.176	0.209	-0.0219	0.0119	0.00048	0.000142
C_6	0.163	0.194	-0.0349	-0.0031	0.001218	9.61E-06
C_7	0.230	0.241	0.0321	0.0439	0.00103	0.001927
C_8	0.148	0.127	-0.0499	-0.0701	0.00249	0.004914
C_9	0.124	0.093	-0.0739	-0.1041	0.005461	0.010837
C_{10}	0.071	0.16	-0.1269	-0.0371	0.016104	0.001376
∑	1.979	1.971			0.064509	0.031577
	$y_{(obs)}$=0.1979	$y_{(pre)}$=0.1971				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.064509/9 = 0.007168$ and $S^2_{(pre)} = 0.031577/9 = 0.003509$

With reference to Eqn (3.93), $S_1^2 = 0.007168$ and $S_2^2 = 0.003509$

Therefore, $F = 0.007168 / 0.003509 = 2.04$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.71: Water absorption test results and replication variance

Expt. No.	Replicates	Response Y_i (%)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	4.90 6.07 5.30	Y_1	16.27	5.42	88.945	0.354
2	2A 2B 2C	6.55 6.05 7.95	Y_2	20.55	6.85	142.708	0.970
3	3A 3B 3C	7.73 6.36 7.48	Y_3	21.57	7.19	156.153	0.532
4	4A 4B 4C	5.24 6.06 5.17	Y_4	16.47	5.49	90.910	0.245
5	5A 5B 5C	5.96 6.06 6.47	Y_{12}	18.49	6.16	114.106	0.073
6	6A 6B 6C	4.14 3.78 4.64	Y_{13}	12.59	4.18	53.207	0.185
7	7A 7B 7C	5.13 4.27 3.88	Y_{14}	13.28	4.42	59.604	0.409
8	8A 8B 8C	5.22 4.78 6.03	Y_{23}	16.03	5.34	86.458	0.402
9	9A 9B 9C	1.87 2.54 1.64	Y_{24}	6.02	2.01	12.638	0.279
10	10A 10B 10C	3.39 3.40 2.62	Y_{34}	9.41	3.14	29.917	0.200
Control							
11	11A 11B 11C	5.13 4.20 4.29	C_1	13.62	4.54	62.361	0.263
12	12A 12B 12C	5.44 6.25 7.05	C_2	18.74	6.24	118.359	0.648
13	13A 13B 13C	4.68 4.76 5.29	C_3	14.73	4.91	72.544	0.110
14	14A 14B 14C	4.26 5.22 4.29	C_4	13.a77	4.59	63.800	0.298
15	15A 15B 15C	5.39 4.96 5.02	C_5	15.37	5.12	78.854	0.054
16	16A 16B 16C	6.03 5.11 5.65	C_6	16.79	5.60	94.396	0.214
17	17A 17B 17C	3.46 3.02 3.91	C_7	10.39	3.46	36.380	0.198
18	18A 18B 18C	2.77 2.09 3.67	C_8	8.53	2.84	25.510	0.628
19	19A 19B 19C	2.42 2.40 2.11	C_9	6.93	2.31	16.069	0.030
20	20A 20B 20C	3.81 3.45 3.85	C_{10}	11.11	3.70	41.241	0.049
						$\sum$	6.1409

Using Eqn (3.90), $V_e = 19$.

With reference to Eqn (3.91) and Table 4.71, replication variance, $S_y^2 = 6.1409/19 = 0.323205$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.323205} = 0.569$

4.1.2.4.8 Mathematical models for water absorption of sand-laterite blocks

Scheffe's and Osadebe's mathematical models for water absorption of sand-laterite blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for water absorption

From Eqns (3.24) and (3.25) and Table 4.71, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 5.4, \quad \alpha_2 = 6.8, \; \alpha_3 = 7.2, \quad \alpha_4 = 5.5$

$\alpha_{12} = 4(6.2) - 2(5.4) - 2(6.8) = 0.4$

$\alpha_{13} = 4(4.2) - 2\,(5.4) - 2(7.2) = -8.4$

$\alpha_{14} = 4\,(4.4) - 2(5.4) - 2(5.5) = -4.2$

$\alpha_{23} = 4\,(5.3) - 2\,(6.8) - 2(7.2) = -6.8$

$\alpha_{24} = 4\,(2.0) - 2(6.8) - 2(5.5) = -16.6$

$\alpha_{34} = 4\,(3.1) - 2(7.2) - 2(5.5) = -13$

Substituting the values of these coefficients, α into Eqn (3.10) yields:

$$Y = 5.4X_1 + 6.8X_2 + 7.2X_3 + 5.5X_4 + 0.4X_1X_2 - 8.4X_1X_3 - 4.2X_1X_4 - 6.8X_2X_3 - 16.6X_2X_4 - 13X_3X_4 \quad (4.15)$$

Eqn (4.15) is the Scheffe's mathematical model for optimisation of water absorption of sand- laterite block based on 28-day strength.

Test of adequacy of Scheffe's model for water absorption of sand-laterite blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.72.

Table 4.72: T-Statistics test computations for Scheffe’s water absorption model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	4.54	4.78	0.24	0.57
Similarly												
2		-	-	-	-	-	-	0.625	6.24	5.23	1.01	2.41
3		-	-	-	-	-	-	0.963	4.91	5.95	1.04	2.26
4		-	-	-	-	-	-	0.899	4.59	5.43	0.84	1.86
5		-	-	-	-	-	-	0.669	5.12	4.75	0.37	0.87
6		-	-	-	-	-	-	0.650	5.60	4.88	0.78	1.85
7		-	-	-	-	-	-	0.609	3.46	4.78	1.32	3.16
8		-	-	-	-	-	-	0.484	2.84	3.19	0.35	0.87
9		-	-	-	-	-	-	0.609	2.31	2.12	0.19	0.46
10		-	-	-	-	-	-	0.734	3.70	2.71	0.99	2.29

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.72). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.73: F-statistics test computations for Scheffe’s water absorption model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	4.54	4.78	0.209	0.398	0.043681	0.158404
C_2	6.24	5.23	1.909	0.848	3.644281	0.719104
C_3	4.91	5.95	0.579	1.568	0.335241	2.458624
C_4	4.59	5.43	0.259	1.048	0.067081	1.098304
C_5	5.12	4.75	0.789	0.368	0.622521	0.135424
C_6	5.6	4.88	1.269	0.498	1.610361	0.248004
C_7	3.46	4.78	-0.871	0.398	0.758641	0.158404
C_8	2.84	3.19	-1.491	-1.192	2.223081	1.420864
C_9	2.31	2.12	-2.021	-2.262	4.084441	5.116644
C_{10}	3.7	2.71	-0.631	-1.672	0.398161	2.795584
∑	43.31	43.82			13.78749	14.30936
	$y_{(obs)}$=4.331	$y_{(pre)}$=4.382				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 13.78749/9 = 1.531943 and $S^2_{(pre)}$ = 14.30936/9 = 1.589929

With reference to Eqn (3.93), S_1^2 = 1.589929and S_2^2 = 1.531943

Therefore, F = 1.589929/1.531943 = 1.038

From Fisher table (Appendix JJ), $F_{0.95}(9,9)$ = 3.25 which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for water absorption of sand-laterite blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.71) into Eqn (3.78) gives the values of the coefficients, α as:

α_1 = 132881.6333, α_2 = 57058.3803, α_3 = 2340.5313, α_4 = 764.5559,

α_5 = -353028.8804, α_6 = -117079.7326, α_7 = -153864.3383, α_8 = -78303.4399,

α_9 = -44261.7187, α_{10} = -4804.2857

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 132881.6333Z_1 + 57058.3803Z_2 + 2340.5313Z_3 + 764.5559Z_4 - 353028.8804Z_5 - 117079.7326Z_6 - 153864.3383Z_7 - 78303.4399Z_8 - 44261.7187Z_9 - 4804.2857Z_{10} \quad (4.16)$$

Eqn (4.16) is the Osadebe's mathematical model for optimisation of water absorption of sand- laterite block based on 28-day strength.

Test of adequacy of Osadebe's model for water absorption of sand-laterite blocks

(i) Student's t-test

Table 4.74: T-statistics test computations for Osadebe's water absorption model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.0156	0.0625					
		1	3	-0.125	0.25	0.0156	0.25					
		1	4	-0.125	0	0.0156	0					
		2	3	-0.125	0.5	0.0156	0.25					
		2	4	-0.125	0	0.0156	0					
		3	4	0	0	0	0					
		4	-	0	-	0	0					
					∑	0.0781	0.5625	0.6406	4.54	4.80	0.26	0.618
Similarly												
2		-	-	-	-	-	-	0.625	6.24	4.94	1.30	3.104
3		-	-	-	-	-	-	0.963	4.91	5.91	1.00	2.170
4		-	-	-	-	-	-	0.899	4.59	5.33	0.74	1.635
5		-	-	-	-	-	-	0.669	5.12	4.60	0.52	1.225
6		-	-	-	-	-	-	0.650	5.60	4.92	0.68	1.611
7		-	-	-	-	-	-	0.609	3.46	4.30	0.84	2.016
8		-	-	-	-	-	-	0.484	2.84	2.41	0.43	1.074
9		-	-	-	-	-	-	0.609	2.31	2.38	0.07	0.168
10		-	-	-	-	-	-	0.734	3.70	3.49	0.21	0.485

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/10}(9) = t_{0.005}(9) = 3.250$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.74). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.75: F-statistics test computations for Osadebe's water absorption model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	4.54	4.8	0.209	0.492	0.043681	0.242064
C_2	6.24	4.94	1.909	0.632	3.644281	0.399424
C_3	4.91	5.91	0.579	1.602	0.335241	2.566404
C_4	4.59	5.33	0.259	1.022	0.067081	1.044484
C_5	5.12	4.6	0.789	0.292	0.622521	0.085264
C_6	5.60	4.92	1.269	0.612	1.610361	0.374544
C_7	3.46	4.3	-0.871	-0.008	0.758641	6.4E-05
C_8	2.84	2.41	-1.491	-1.898	2.223081	3.602404
C_9	2.31	2.38	-2.021	-1.928	4.084441	3.717184
C_{10}	3.70	3.49	-0.631	-0.818	0.398161	0.669124
$\sum$	43.31	43.08			13.78749	12.70096
	$y_{(obs)}$=4.331	$y_{(pre)}$=4.308				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 13.78749/9 = 1.531943$ and $S^2_{(pre)} = 12.70096/9 = 1.4112178$

With reference to Eqn (3.93), $S_1^2 = 1.531943$and $S_2^2 = 1.4112178$

Therefore, $F = 1.531943/ 1.4112178 = 1.09$

From Fisher table (Appendix JJ), $F_{0.95}(9,9) = 3.25$ which is higher than the calculated F-value. Hence the regression equation is adequate.

4.1.2.5 Characteristics tests results and replication variances of soilcrete blocks (a three-component mix)

The test results and replication variances of the characteristics of soilcrete blocks (3-component mix) are presented on Tables 4.76 to 4.115

Table 4.76: Compressive strength test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	2.148 2.074 2.222	Y_1	6.444	2.148	13.853	0.005
2	2A 2B 2C	1.037 1.022 0.830	Y_2	2.889	0.963	2.809	0.013
3	3A 3B 3C	0.889 1.111 0.741	Y_3	2.741	0.914	2.574	0.035
4	4A 4B 4C	1.259 1.067 1.126	Y_{12}	3.452	1.151	3.991	0.0097
5	5A 5B 5C	1.067 0.889 0.978	Y_{13}	2.934	0.978	2.885	0.008
6	6A 6B 6C	0.667 0.963 0.593	Y_{23}	2.223	0.741	1.724	0.038
Control							
7	7A 7B 7C	0.963 1.111 0.800	C_1	2.874	0.958	2.802	0.024
8	8A 8B 8C	1.111 1.111 1.022	C_2	3.244	1.081	3.513	0.003
9	9A 9B 9C	1.259 1.037 1.111	C_3	3.407	1.136	3.895	0.013
10	10A 10B 10C	0.963 0.815 1.067	C_4	2.845	0.948	2.730	0.016
11	11A 11B 11C	0.889 0.889 0.800	C_5	2.578	0.859	2.2206	0.003
12	12A 12B 12C	0.667 0.667 0.533	C_6	1.867	0.622	1.174	0.006
					V	$\sum$	0.1737

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.76, replication variance S_y^2 = 0.1737/11 = 0.01579 and from Eqn (3.92), replication error, $S_y = \sqrt{0.01579} = 0.126$

4.1.2.5.1 Mathematical models for compressive strength of soilcrete blocks

Scheffe's and Osadebe's mathematical models for compressive strength of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for compressive strength of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.76, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 2.15, \quad \alpha_2 = 0.96, \; \alpha_3 = 0.91$

$\alpha_{12} = 4(1.15) - 2(2.15) - 2(0.96) = -1.62$

$\alpha_{13} = 4(0.98) - 2(2.15) - 2(0.91) = -2.2$

$\alpha_{23} = 4(0.74) - 2(0.96) - 2(0.91) = -0.78$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 2.15X_1 + 0.96X_2 + 0.91X_3 - 1.62X_1X_2 - 2.2X_1X_3 - 0.78X_2X_3 \qquad (4.17)$$

Eqn (4.17) is the Scheffe's mathematical model for optimisation of compressive strength of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for compressive strength of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.77: T-statistics test computations for Scheffe's compressive strength model

N	CN	I	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
		1	2	-0.125	0.25	0.01562	0.0625					
1	C_1	1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25		0.958	0.759	0.199	2.16
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094				
		1	2	-0.125	0.5	0.01562	0.25					
2	C_2	1	3	-0.125	0.25	0.01562	0.0625					
		2	3	0	0.5	0	0.25		1.081	0.809	0.272	2.95
		3	-	-0.125	-	0.01562	0					
					∑	0.04686	0.5625	0.6094				
		1	2	0.2278	0.8844	0.0519	0.7822					
3	C_3	1	3	0.2278	0	0.0519	0					
		2	3	-0.1122	0	0.0126	0		1.136	1.399	0.263	2.63
		3	-	0	0	-	0					
					∑	0.1164	0.7822	0.899				
		1	2	0	0	0	0					
4	C_4	1	3	0	0	0	0					
		2	3	0.2278	0.8844	0.0519	0.7822		0.948	0.771	0.177	1.79
		3	-	-0.1122	-	0.0126	0					
					∑	0.0645	0.7822	0.8467				
		1	2	-0.12	0.36	0.0144	0.1296					
5	C_5	1	3	-0.12	0.48	0.0144	0.2304					
		2	3	-0.12	0.48	0.0144	0.2304		0.859	0.794	0.065	0.70
		3	-	-0.18	-	0.0064	0					
					∑	0.0496	0.5904	0.640				
		1	2	-0.12	0.24	0.0144	0.0576					
6	C_6	1	3	-0.12	0.4	0.0144	0.16					
		2	3	-0.12	0.6	0.0144	0.36		0.622	0.739	0.117	1.26
		3	-	0	-	0	-					
					∑	0.0432	0.5776	0.6208				

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.77). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.78: F-statistics test computations for Scheffe's compressive strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.958	0.759	0.024	-0.1195	0.000576	0.01428
C_2	1.081	0.809	0.147	-0.0695	0.021609	0.00483
C_3	1.136	1.399	0.202	0.5205	0.040804	0.27092
C_4	0.948	0.771	0.014	-0.1075	0.000196	0.011556
C_5	0.859	0.794	-0.075	-0.0845	0.005625	0.00714
C_6	0.622	0.739	-0.312	-0.1395	0.097344	0.01946
$\sum$	5.604	5.271			0.166154	0.328188
	$Y_{(obs)}$=0.934	$y_{(pre)}$=0.8785				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.166154/5 = 0.0332$ and $S^2_{(pre)} = 0.328188/5 = 0.0656$

With reference to Eqn (3.93), $S_1^2 = 0.0656$ and $S_2^2 = 0.0332$

Therefore, $F = 0.0656/\ 0.0332 = 1.977$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for compressive strength of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.76) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 50451.9949$, $\alpha_2 = 7182.6767$, $\alpha_3 = 144.55032$, $\alpha_4 = -94207.4007$,

$\alpha_5 = -55938.0435$, $\alpha_6 = -5461.3655$,

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 50451.9949Z_1 + 7182.6767Z_2 + 144.55032Z_3 - 94207.4007Z_4 - 55938.0435Z_5 - 5461.3655Z_6 \quad (4.18)$$

Eqn (4.18) is the Osadebe's mathematical model for optimisation of compressive strength of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for compressive strength of soilcrete blocks

(i) Student's t-test

Table 4.79: T-statistics test computations for Osadebe's compressive strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$Y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	0.958	0.811	0.147	1.593
Similarly												
2		-	-	-	-	-	-	0.6094	1.081	0.827	0.254	2.752
3		-	-	-	-	-	-	0.899	1.136	1.355	0.219	2.185
4		-	-	-	-	-	-	0.8476	0.948	0.755	0.193	1.952
5		-	-	-	-	-	-	0.640	0.859	0.825	0.034	0.365
6		-	-	-	-	-	-	0.6208	0.622	0.790	0.168	1.814

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.79). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.80: F-statistics test computations for Osadebe's compressive strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.958	0.811	0.024	-0.08283	0.000576	0.006861
C_2	1.081	0.827	0.147	-0.06683	0.021609	0.004467
C_3	1.136	1.355	0.202	0.461167	0.040804	0.212675
C_4	0.948	0.755	0.014	-0.13883	0.000196	0.019275
C_5	0.859	0.825	-0.075	-0.06883	0.005625	0.004738
C_6	0.622	0.79	-0.312	-0.10383	0.097344	0.010781
∑	5.604	5.363			0.166154	0.258797
	$y_{(obs)}$=0.934	$y_{(obs)}$=0.893833				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.166154/5 = 0.0332$ and $S^2_{(pre)} = 0.258797/5 = 0.0517594$

With reference to Eqn (3.93), $S_1^2 = 0.0517594$ and $S_2^2 = 0.0332$

Therefore, $F = 0.0517594/\ 0.0332 = 1.56$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.81: Flexural strength test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	1.378 1.556 1.422	Y_1	4.356	1.452	6.342	0.009
2	2A 2B 2C	0.222 0.311 0.249	Y_2	0.782	0.261	0.208	0.002
3	3A 3B 3C	0.222 0.204 0.267	Y_3	0.693	0.231	0.162	0.001
4	4A 4B 4C	0.311 0.267 0.258	Y_{12}	0.836	0.279	0.235	0.001
5	5A 5B 5C	0.187 0.356 0.258	Y_{13}	0.801	0.267	0.228	0.007
6	6A 6B 6C	0.196 0.222 0.267	Y_{23}	0.685	0.228	0.159	0.001
Control							
7	7A 7B 7C	0.222 0.178 0.187	C_1	0.587	0.196	0.116	0.001
8	8A 8B 8C	0.187 0.187 0.249	C_2	0.623	0.208	0.132	0.0013
9	9A 9B 9C	0.409 0.444 0.400	C_3	1.253	0.418	0.524	0.001
10	10A 10B 10C	0.356 0.222 0.338	C_4	0.916	0.305	0.290	0.005
11	11A 11B 11C	0.356 0.222 0.187	C_5	0.765	0.255	0.211	0.008
12	12A 12B 12C	0.178 0.178 0.204	C_6	0.560	0.187	0.105	0.000
						$\sum$	0.0373

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.81, replication variance, $S_y^2 = 0.0373/11 = 0.003391$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.003391} = 0.058$

4.1.2.5.2 Mathematical models for flexural strength of soilcrete blocks

Scheffe's and Osadebe's mathematical models for flexural strength of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for flexural strength of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.81, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 1.45, \quad \alpha_2 = 0.26, \quad \alpha_3 = 0.23$

$\alpha_{12} = 4(0.28) - 2(1.45) - 2(0.26) = -2.3$

$\alpha_{13} = 4(0.27) - 2(1.45) - 2(0.23) = -2.28$

$\alpha_{23} = 4(0.23) - 2(0.26) - 2(0.23) = -0.06$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 1.45X_1 + 0.26X_2 + 0.23X_3 - 2.3X_1X_2 - 2.28X_1X_3 - 0.06X_2X_3 \qquad (4.19)$$

Eqn (4.19) is the Scheffe's mathematical model for optimisation of flexural strength of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for flexural strength of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.82: T-statistics test computations for Scheffe's flexural strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					$\sum$	0.04686	0.5625	0.6094	0.196	0.106	0.09	2.12
Similarly												
2		-	-	-	-	-	-	0.6094	0.208	0.113	0.095	2.24
3		-	-	-	-	-	-	0.899	0.418	0.549	0.131	2.84
4		-	-	-	-	-	-	0.8476	0.305	0.237	0.068	1.49
5		-	-	-	-	-	-	0.640	0.25	0.12	0.13	3.03
6		-	-	-	-	-	-	0.6208	0.187	0.108	0.079	1.85

T-value from table

For a significant level, $\alpha = 0.05$, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.82). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.83: F-statistics test computations for Scheffe's flexural strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.196	0.106	-0.06467	-0.0995	0.004182	0.0099
C_2	0.208	0.113	-0.05267	-0.0925	0.002774	0.008556
C_3	0.418	0.549	0.157333	0.3435	0.024754	0.117992
C_4	0.305	0.237	0.044333	0.0315	0.001965	0.000992
C_5	0.25	0.12	-0.01067	-0.0855	0.000114	0.00731
C_6	0.187	0.108	-0.07367	-0.0975	0.005427	0.009506
$\sum$	1.564	1.233			0.039215	0.154258
	$y_{(obs)}$=0.260667	$y_{(pre)}$=0.2055				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.039215/5 = 0.007843$ and $S^2_{(pre)} = 0.154258/5 = 0.0308516$

With reference to Eqn (3.93), $S_1^2 = 0.0308516$ and $S_2^2 = 0.007843$

Therefore, $F = 0.0308516 / 0.007843 = 3.9$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for flexural strength of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.81) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 25849.80898$, $\alpha_2 = 1395.529798$, $\alpha_3 = 107.533606$, $\alpha_4 = -38734.20114$,

$\alpha_5 = -29276.94695$, $\alpha_6 = -783.7572037$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 25849.80898Z_1 + 1395.529798Z_2 + 107.533606Z_3 - 38734.20114Z_4 - 29276.94695Z_5 - 783.7572037Z_6 \quad (4.20)$$

Eqn (4.20) is the Osadebe's mathematical model for optimisation of flexural strength of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for flexural strength of soilcrete blocks

(i) Student's t-test

Table 4.84: T-statistics test computations for Osadebe's flexural strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$Y_{(predicte)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	0.196	0.188	0.008	0.188
Similarly												
2		-	-	-	-	-	-	0.6094	0.208	0.185	0.023	0.541
3		-	-	-	-	-	-	0.899	0.418	0.481	0.063	1.365
4		-	-	-	-	-	-	0.8476	0.305	0.234	0.071	1.560
5		-	-	-	-	-	-	0.640	0.25	0.190	0.065	1.516
6		-	-	-	-	-	-	0.6208	0.187	0.188	0.001	0.023

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.84). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.85: F-statistics test computations for Osadebe's flexural strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} – y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} -y_{(obs)})^2$	$(Y_{(pre)} -y_{(pre)})^2$
C_1	0.196	0.188	-0.0655	-0.05633	0.00429	0.003173
C_2	0.208	0.185	-0.0535	-0.05933	0.002862	0.00352
C_3	0.418	0.481	0.1565	0.236667	0.024492	0.056011
C_4	0.305	0.234	0.0435	-0.01033	0.001892	0.000107
C_5	0.255	0.19	-0.0065	-0.05433	4.23E-05	0.002952
C_6	0.187	0.188	-0.0745	-0.05633	0.00555	0.003173
∑	1.569	1.466			0.03913	0.068937
	$Y_{(obs)}$=0.2615	$y_{(pre)}$=0.244333				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.03913/5 = 0.007826$ and $S^2_{(pre)} = 0.068973/5 = 0.0137874$

With reference to Eqn (3.93), S_1^2 =0.0137874 and S_2^2 = 0.007843

Therefore, F = 0.0137874/ 0.007826 = 1.76

From Fisher table (Appendix JJ), $F_{0.95}(5,5)$ = 5.1 which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.86: Split tensile strength test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	0.283 0.283 0.314	Y_1	0.88	0.293	0.259	0.000
2	2A 2B 2C	0.063 0.094 0.126	Y_2	0.283	0.094	0.029	0.001
3	3A 3B 3C	0.126 0.157 0.189	Y_3	0.472	0.157	0.076	0.001
4	4A 4B 4C	0.189 0.252 0.220	Y_{12}	0.661	0.220	0.148	0.001
5	5A 5B 5C	0.126 0.157 0.157	Y_{13}	0.440	0.147	0.065	0.000
6	6A 6B 6C	0.157 0.189 0.189	Y_{23}	0.535	0.178	0.096	0.000
			Control				
7	7A 7B 7C	0.157 0.157 0.189	C_1	0.503	0.168	0.085	0.000
8	8A 8B 8C	0.126 0.126 0.157	C_2	0.409	0.136	0.056	0.000
9	9A 9B 9C	0.189 0.189 0.220	C_3	0.598	0.199	0.1198	0.000
10	10A 10B 10C	0.157 0.189 0.220	C_4	0.566	0.189	0.1088	0.001
11	11A 11B 11C	0.126 0.189 0.126	C_5	0.441	0.147	0.067	0.0013
12	12A 12B 12C	0.220 0.157 0.220	C_6	0.597	0.199	0.1214	0.004
						$\sum$	0.0093

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.86, replication variance $S_y^2 = 0.0093/11 = 0.000845$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.000845} = 0.029$

4.1.2.5.3 Mathematical models for split tensile strength of soilcrete blocks

Scheffe's and Osadebe's mathematical models for split tensile strength of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for split tensile strength of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.86, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 0.29, \quad \alpha_2 = 0.09, \quad \alpha_3 = 0.16$

$\alpha_{12} = 4(0.22) - 2(0.29) - 2(0.09) = 0.12$

$\alpha_{13} = 4(0.15) - 2(0.29) - 2(0.16) = -0.3$

$\alpha_{23} = 4(0.18) - 2(0.09) - 2(0.16) = 0.22$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 0.29X_1 + 0.09X_2 + 0.16X_3 + 0.12X_1X_2 - 0.3X_1X_3 + 0.22X_2X_3 \quad (4.21)$$

Eqn (4.21) is the Scheffe's mathematical model for optimisation of split tensile strength of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for split tensile strength of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.87: T-statistics test computations for Scheffe's split tensile strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	0.168	0.173	0.005	0.24
Similarly												
2		-	-	-	-	-	-	0.6094	0.136	0.181	0.045	2.12
3		-	-	-	-	-	-	0.899	0.199	0.250	0.051	2.21
4		-	-	-	-	-	-	0.8476	0.189	0.162	0.027	1.19
5		-	-	-	-	-	-	0.640	0.147	0.179	0.032	1.49
6		-	-	-	-	-	-	0.6208	0.199	0.175	0.024	1.13

T-value from table

For a significant level, $\alpha = 0.05$, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.87). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.88: F-statistics test computations for Scheffe's split tensile strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.168	0.173	-0.005	-0.01367	2.5E-05	0.000187
C_2	0.136	0.181	-0.037	-0.00567	0.001369	3.21E-05
C_3	0.199	0.25	0.026	0.063333	0.000676	0.004011
C_4	0.189	0.162	0.016	-0.02467	0.000256	0.000608
C_5	0.147	0.179	-0.026	-0.00767	0.000676	5.88E-05
C_6	0.199	0.175	0.026	-0.01167	0.000676	0.000136
$\sum$	1.038	1.12			0.003678	0.005033
	$y_{(obs)}$=0.173	$y_{(pre)}$=0.186667				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.003678/5 = 0.0007356$ and $S^2_{(pre)} = 0.005033/5 = 0.0010066$

With reference to Eqn (3.93), $S_1^2 = 0.0010066$ and $S_2^2 = 0.0007356$

Therefore, $F = 0.0010066 / 0.0007356 = 1.368$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for split tensile strength of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.86) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = -21787.2053$, $\alpha_2 = -2505.6179$, $\alpha_3 = -64.7220$, $\alpha_4 = 39331.58097$,

$\alpha_5 = 24238.6029$, $\alpha_6 = 1734.5961$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = -21787.2053Z_1 - 2505.6179Z_2 - 64.7220Z_3 + 39331.58097Z_4 + 24238.6029Z_5 + 1734.5961Z_6 \quad (4.22)$$

Eqn (4.22) is the Osadebe's mathematical model for optimisation of split tensile strength of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for split tensile strength of soilcrete blocks

(i) Student's t-test

Table 4.89: T-statistics test computations for Osadebe's split tensile strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$Y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	0.168	0.175	0.007	0.330
Similarly												
2		-	-	-	-	-	-	0.6094	0.136	0.183	0.047	2.213
3		-	-	-	-	-	-	0.899	0.199	0.255	0.056	2.427
4		-	-	-	-	-	-	0.8476	0.189	0.166	0.023	1.011
5		-	-	-	-	-	-	0.640	0.147	0.181	0.034	1.586
6		-	-	-	-	-	-	0.6208	0.199	0.177	0.022	1.032

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.89). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.90: F-statistics test computations for Osadebe's split tensile strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.168	0.175	-0.005	-0.0145	2.5E-05	0.00021
C_2	0.136	0.183	-0.037	-0.0065	0.001369	4.23E-05
C_3	0.199	0.255	0.026	0.0655	0.000676	0.00429
C_4	0.189	0.166	0.016	-0.0235	0.000256	0.000552
C_5	0.147	0.181	-0.026	-0.0085	0.000676	7.23E-05
C_6	0.199	0.177	0.026	-0.0125	0.000676	0.000156
∑	1.038	1.137			0.003678	0.005324
	$Y_{(obs)}$=0.173	$y_{(pre)}$=0.1895				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.003678/5 = 0.0007356$ and $S^2_{(pre)} = 0.005324/5 = 0.0010648$

With reference to Eqn (3.93), $S_1^2 = 0.0010648$ and $S_2^2 = 0.0007356$

Therefore, $F = 0.0010648/ 0.0007356 = 1.45$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.91: Poisson's ratio test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	0.194 0.194 0.133	Y_1	0.521	0.174	0.093	0.0012
2	2A 2B 2C	0.125 0.141 0.139	Y_2	0.405	0.135	0.055	0.000
3	3A 3B 3C	0.125 0.057 0.149	Y_3	0.331	0.110	0.041	0.002
4	4A 4B 4C	0.117 0.085 0.083	Y_{12}	0.285	0.095	0.028	0.000
5	5A 5B 5C	0.070 0.080 0.073	Y_{13}	0.223	0.074	0.017	0.000
6	6A 6B 6C	0.111 0.062 0.099	Y_{23}	0.272	0.091	0.026	0.001
Control							
7	7A 7B 7C	0.125 0.101 0.070	C_1	0.296	0.099	0.031	0.001
8	8A 8B 8C	0.070 0.105 0.139	C_2	0.314	0.105	0.035	0.0012
9	9A 9B 9C	0.050 0.050 0.061	C_3	0.161	0.054	0.0087	0.000
10	10A 10B 10C	0.099 0.055 0.084	C_4	0.238	0.079	0.020	0.001
11	11A 11B 11C	0.133 0.083 0.060	C_5	0.276	0.092	0.0282	0.001
12	12A 12B 12C	0.101 0.101 0.092	C_6	0.294	0.098	0.0289	0.000
						$\sum$	0.0084

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.91, replication variance, $S_y^2 = 0.0084/11 = 0.0007636$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.0007636} = 0.028$

4.1.2.5.4 Mathematical models for Poisson's ratio of soilcrete blocks

Scheffe's and Osadebe's mathematical models for Poisson's ratio of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for Poisson's ratio of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.91, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 0.17, \quad \alpha_2 = 0.14, \quad \alpha_3 = 0.11$

$\alpha_{12} = 4(0.10) – 2(0.17) – 2(0.14) = -0.22$

$\alpha_{13} = 4(0.07) – 2(0.17) – 2(0.11) = -0.28$

$\alpha_{23} = 4(0.09) – 2(0.14) – 2(0.11) = -0.14$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 0.17X_1 + 0.14X_2 + 0.11X_3 – 0.22X_1X_2 – 0.28X_1X_3 – 0.14X_2X_3 \qquad (4.23)$$

Eqn (4.23) is the Scheffe's mathematical model for optimisation of Poisson's ratio of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for Poisson's ratio of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.92: T-statistics test computations for Scheffe's Poisson's ratio model

N	CN	i	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$Y_{(predicte)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					$\sum$	0.04686	0.5625	0.6094	0.099	0.066	0.033	1.59
Similarly												
2		-	-	-	-	-	-	0.6094	0.105	0.078	0.027	1.32
3		-	-	-	-	-	-	0.899	0.054	0.111	0.057	2.56
4		-	-	-	-	-	-	0.8476	0.079	0.099	0.020	0.91
5		-	-	-	-	-	-	0.640	0.092	0.067	0.025	1.21
6		-	-	-	-	-	-	0.6208	0.098	0.069	0.029	1.41

T-value from table

For a significant level, $\alpha = 0.05$, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.92). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.93: F-statistics test computations for Scheffe's Poisson's ratio model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}$-$y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.099	0.066	0.011167	-0.01567	0.000125	0.000245
C_2	0.105	0.078	0.017167	-0.00367	0.000295	1.34E-05
C_3	0.054	0.111	-0.03383	0.029333	0.001145	0.00086
C_4	0.079	0.099	-0.00883	0.017333	7.8E-05	0.0003
C_5	0.092	0.067	0.004167	-0.01467	1.74E-05	0.000215
C_6	0.098	0.069	0.010167	-0.01267	0.000103	0.00016
$\sum$	0.527	0.49			0.001763	0.001795
	$y_{(obs)}$=0.087833	$y_{(pre)}$=0.081667				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.001763/5 = 0.0003526$ and $S^2_{(pre)} = 0.001795/5 = 0.000359$

With reference to Eqn (3.93), $S_1^2 = 0.000359$ and $S_2^2 = 0.0003526$

Therefore, $F = 0.000359/\ 0.0003526 = 1.02$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F- value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for Poisson's ratio of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.91) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 8790.55199$, $\alpha_2 = 1164.1268$, $\alpha_3 = 27.3908$, $\alpha_4 = -16111.1579$, $\alpha_5 = -9787.0468$, $\alpha_6 = -866.3843$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 8790.55199Z_1 + 1164.1268Z_2 + 27.3908Z_3 - 16111.1579Z_4 - 9787.0468Z_5 - 866.3843Z_6 \quad (4.24)$$

Eqn (4.24) is the Osadebe's mathematical model for optimisation of Poisson's ratio of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for Poisson's ratio of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively and presented in Table 4.94.

Table 4.94: T-statistics test computations for Osadebe's Poisson's ratio model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$Y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	0.099	0.075	0.024	1.170
Similarly												
2		-	-	-	-	-	-	0.6094	0.105	0.079	0.026	1.268
3		-	-	-	-	-	-	0.899	0.054	0.101	0.047	2.110
4		-	-	-	-	-	-	0.8476	0.079	0.096	0.017	0.774
5		-	-	-	-	-	-	0.640	0.092	0.073	0.019	0.918
6		-	-	-	-	-	-	0.6208	0.098	0.078	0.020	0.972

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.94). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.95: F-statistics test computations for Osadebe's Poisson's ratio model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.099	0.075	0.011167	-0.00867	0.000125	7.51E-05
C_2	0.105	0.079	0.017167	-0.00467	0.000295	2.18E-05
C_3	0.054	0.101	-0.03383	0.017333	0.001145	0.0003
C_4	0.079	0.096	-0.00883	0.012333	7.8E-05	0.000152
C_5	0.092	0.073	0.004167	-0.01067	1.74E-05	0.000114
C_6	0.098	0.078	0.010167	-0.00567	0.000103	3.21E-05
∑	0.527	0.502			0.001763	0.000695
	$y_{(obs)}$=0.087833	$y_{(pre)}$=0.083667				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.001763/5 = 0.0003526$ and $S^2_{(pre)} = 0.000695/5 = 0.000139$

With reference to Eqn (3.93), $S_1^2 = 0.0003526$ and $S_2^2 = 0.000139$

Therefore, $F = 0.0003526/\ 0.000139 = 2.54$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.96: Static modulus of elasticity test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (GPa)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	5.283 5.047 5.118	Y_1	15.448	5.149	79.576	0.015
2	2A 2B 2C	3.610 3.758 3.385	Y_2	10.753	3.584	38.613	0.035
3	3A 3B 3C	3.338 3.593 3.115	Y_3	10.046	3.349	33.755	0.057
4	4A 4B 4C	4.098 3.880 3.915	Y_{12}	11.893	3.964	47.175	0.014
5	5A 5B 5C	3.481 3.589 3.606	Y_{13}	10.676	3.559	38.002	0.005
6	6A 6B 6C	3.008 3.751 3.002	Y_{23}	9.761	3.254	32.130	0.186
			Control				
7	7A 7B 7C	3.428 3.527 3.077	C_1	10.032	3.344	33.659	0.056
8	8A 8B 8C	3.176 3.176 3.150	C_2	9.502	3.168	30.096	0.0002
9	9A 9B 9C	3.884 3.545 3.948	C_3	11.377	3.792	43.239	0.047
10	10A 10B 10C	2.941 3.184 3.352	C_4	9.477	3.159	30.023	0.043
11	11A 11B 11C	3.750 3.718 3.654	C_5	11.122	3.707	41.238	0.0024
12	12A 12B 12C	2.817 2.871 2.820	C_6	8.508	2.836	24.131	0.001
						$\sum$	0.4616

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.96, replication variance, $S_y^2 = 0.4616/11 = 0.04196$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.04196} = 0.205$

4.1.2.5.5 Mathematical models for static modulus of elasticity of soilcrete blocks

Scheffe's and Osadebe's mathematical models for static modulus of elasticity of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for static modulus of elasticity

From Eqns (3.24) and (3.25) and Table 4.96, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 5.15$, $\alpha_2 = 3.58$, $\alpha_3 = 3.35$

$\alpha_{12} = 4(3.96) - 2(5.15) - 2(3.58) = -1.62$

$\alpha_{13} = 4(3.56) - 2(5.15) - 2(3.35) = -2.76$

$\alpha_{23} = 4(3.25) - 2(3.58) - 2(3.35) = -0.86$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 5.15X_1 + 3.58X_2 + 3.35X_3 - 1.62X_1X_2 - 2.76X_1X_3 - 0.86X_2X_3 \quad (4.25)$$

Eqn (4.25) is the Scheffe's mathematical model for optimisation of static modulus of elasticity of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for static modulus of elasticity of soilcrete blocks

Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively.

Table 4.97: T-statistics test computations for Scheffe's static modulus of elasticity model

N	CN	I	J	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	3.344	3.304	0.04	0.27
Similarly												
2		-	-	-	-	-	-	0.6094	3.168	3.433	0.265	1.76
3		-	-	-	-	-	-	0.899	3.792	4.274	0.481	2.95
4		-	-	-	-	-	-	0.8476	3.159	3.314	0.155	0.96
5		-	-	-	-	-	-	0.640	3.707	3.379	0.328	2.16
6		-	-	-	-	-	-	0.6208	2.836	3.277	0.441	2.92

T-value from table

For a significant level, $\alpha = 0.05$ and $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.97). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.98: F-statistics test computations for Scheffe's static modulus of elasticity model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	3.344	3.304	0.009667	-0.19283	9.34E-05	0.037185
C_2	3.168	3.433	-0.16633	-0.06383	0.027667	0.004075
C_3	3.792	4.274	0.457667	0.777167	0.209459	0.603988
C_4	3.159	3.314	-0.17533	-0.18283	0.030742	0.033428
C_5	3.707	3.379	0.372667	-0.11783	0.13888	0.013885
C_6	2.836	3.277	-0.49833	-0.21983	0.248336	0.048327
$\sum$	20.006	20.981			0.655177	0.740887
	$y_{(obs)}$=3.334333	$y_{(pre)}$=3.496833				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.655177/5 = 0.1310354$ and $S^2_{(pre)} = 0.740887/5 = 0.1481774$

With reference to Eqn (3.93), $S_1^2 = 0.1481774$and $S_2^2 = 0.1310354$

Therefore, $F = 0.1481774/\ 0.1310354 = 1.13$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(b) Determination of Osadebe's mathematical model for static modulus of elasticity of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.96) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 42516.3796$, $\alpha_2 = 6748.3372$, $\alpha_3 = 119.0178$, $\alpha_4 = -81541.5502$,

$\alpha_5 = -47030.25902$, $\alpha_6 = -5258.9632$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 42516.3796Z_1 + 6748.3372Z_2 + 119.0178Z_3 - 81541.5502Z_4 - 47030.25902Z_5 - 5258.9632Z_6 \quad (4.26)$$

Eqn (4.26) is the Osadebe's mathematical model for optimisation of static modulus of elasticity of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for static modulus of elasticity of soilcrete blocks

(i) Student's t-test

Table 4.99: T-statistics test computations for Osadebe's static modulus of elasticity model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	3.344	3.363	0.019	0.127
Similarly												
2		-	-	-	-	-	-	0.6094	3.168	3.451	0.283	1.885
3		-	-	-	-	-	-	0.899	3.792	4.235	0.443	2.716
4		-	-	-	-	-	-	0.8476	3.159	3.301	0.142	0.883
5		-	-	-	-	-	-	0.640	3.707	3.413	0.294	1.940
6		-	-	-	-	-	-	0.6208	2.836	3.335	0.499	3.312

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.99). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.100: F-statistics test computations for Osadebe's static modulus of elasticity model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	3.344	3.363	0.009667	-0.15333	9.34E-05	0.023511
C_2	3.168	3.451	-0.16633	-0.06533	0.027667	0.004268
C_3	3.792	4.235	0.457667	0.718667	0.209459	0.516482
C_4	3.159	3.301	-0.17533	-0.21533	0.030742	0.046368
C_5	3.707	3.413	0.372667	-0.10333	0.13888	0.010678
C_6	2.836	3.335	-0.49833	-0.18133	0.248336	0.032882
∑	20.006	21.098			0.655177	0.634189
	$y_{(obs)}$=3.334333	$y_{(pre)}$=3.516333				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.655177/5 = 0.1310354$ and $S^2_{(pre)} = 0.634189/5 = 0.1268378$

With reference to Eqn (3.93), $S_1^2 = 0.1310354$ and $S_2^2 = 0.1268378$

Therefore, $F = 0.1310354/0.1268378 = 1.03$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.101: Shear modulus/ modulus of rigidity test results and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (GPa)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	2.212 2.113 2.259	Y_1	6.584	2.195	14.461	0.006
2	2A 2B 2C	1.604 1.647 1.465	Y_2	4.716	1.572	7.432	0.009
3	3A 3B 3C	1.484 1.700 1.356	Y_3	4.540	1.513	6.931	0.281
4	4A 4B 4C	1.834 1.788 1.807	Y_{12}	5.429	1.810	9.826	0.001
5	5A 5B 5C	1.627 1.662 1.680	Y_{13}	4.969	1.656	8.232	0.001
6	6A 6B 6C	1.354 1.766 1.366	Y_{23}	4.486	1.495	6.818	0.055
			Control				
7	7A 7B 7C	1.524 1.602 1.438	C_1	4.564	1.521	6.957	0.007
8	8A 8B 8C	1.546 1.405 1.421	C_2	4.372	1.475	6.383	0.006
9	9A 9B 9C	1.775 1.727 1.678	C_3	5.180	1.727	8.949	0.002
10	10A 10B 10C	1.338 1.509 1.546	C_4	4.393	1.464	6.457	0.012
11	11A 11B 11C	1.655 1.717 1.724	C_5	5.096	1.699	8.659	0.0014
12	12A 12B 12C	1.279 1.304 1.291	C_6	3.874	1.300	5.003	0.0002
						$\sum$	0.38056

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.101, replication variance $S_y^2 = 0.38056/11 = 0.034596$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.034596} = 0.186$

4.1.2.5.6 Mathematical models for shear modulus / modulus of rigidity of soilcrete blocks

Scheffe's and Osadebe's mathematical models for shear modulus of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for shear modulus/ modulus of rigidity of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.101, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 2.2, \quad \alpha_2 = 1.57, \ \alpha_3 = 1.51$

$\alpha_{12} = 4(1.81) - 2(2.2) - 2(1.57) = -0.3$

$\alpha_{13} = 4(1.66) - 2(2.2) - 2(1.51) = -0.78$

$\alpha_{23} = 4(1.50) - 2(1.57) - 2(1.51) = -0.16$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 2.2X_1 + 1.57X_2 + 1.51X_3 - 0.3X_1X_2 - 0.78X_1X_3 - 0.16X_2X_3 \qquad (4.27)$$

Eqn (4.27) is the Scheffe's mathematical model for optimisation of shear modulus / modulus of rigidity of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for shear modulus of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.102: T-statistics test computations for Scheffe's shear modulus/modulus of rigidity model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	1.521	1.561	0.040	0.29
Similarly												
2		-	-	-	-	-	-	0.6094	1.457	1.606	0.149	1.09
3		-	-	-	-	-	-	0.899	1.727	1.926	0.199	1.34
4		-	-	-	-	-	-	0.8476	1.464	1.515	0.051	0.35
5		-	-	-	-	-	-	0.640	1.699	1.595	0.104	0.76
6		-	-	-	-	-	-	0.6208	1.300	1.546	0.246	1.80

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.102). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.103: F-statistics test computations for Scheffe's shear modulus/modulus of rigidity model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	1.521	1.561	-0.007	-0.06383	4.9E-05	0.004075
C_2	1.457	1.606	-0.071	-0.01883	0.005041	0.000355
C_3	1.727	1.926	0.199	0.301167	0.039601	0.090701
C_4	1.464	1.515	-0.064	-0.10983	0.004096	0.012063
C_5	1.699	1.595	0.171	-0.02983	0.029241	0.00089
C_6	1.3	1.546	-0.228	-0.07883	0.051984	0.006215
$\sum$	9.168	9.749			0.130012	0.114299
	$y_{(obs)}$=1.528	$Y_{(pre)}$=1.624833				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.130012/5 = 0.0260024$ and $S^2_{(pre)} = 0.114299/5 = 0.0228598$

With reference to Eqn (3.93), $S_1^2 = 0.0260024$ and $S_2^2 = 0.0228598$

Therefore, $F = 0.0260024/\ 0.0228598 = 1.14$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for shear modulus/modulus of rigidity of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.101) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 4443.3105$, $\alpha_2 = 1204.1692$, $\alpha_3 = 6.8498$, $\alpha_4 = -10182.2272$, $\alpha_5 = -4786.3671$, $\alpha_6 = -1023.0122$

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 4443.3105Z_1 + 1204.1692Z_2 + 6.8498Z_3 - 10182.2272Z_4 - 4786.3671Z_5 - 1023.0122Z_6 \quad (4.28)$$

Eqn (4.28) is the Osadebe's mathematical model for optimisation of shear modulus/modulus of rigidity of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for shear modulus/modulus of rigidity of soilcrete blocks

(a) Student's t-test

Table 4.104: T-statistics test computations for Osadebe's shear modulus/ modulus of rigidity model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	1.521	1.569	0.048	0.352
Similarly												
2		-	-	-	-	-	-	0.6094	1.457	1.602	0.145	1.064
3		-	-	-	-	-	-	0.899	1.727	1.919	0.192	1.297
4		-	-	-	-	-	-	0.8476	1.464	1.507	0.043	0.295
5		-	-	-	-	-	-	0.640	1.699	1.595	0.104	0.756
6		-	-	-	-	-	-	0.6208	1.300	1.553	0.253	1.851

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.104). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.105: F-statistics test computations for Osadebe's shear modulus/modulus of rigidity model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	1.521	1.569	-0.007	-0.05517	4.9E-05	0.003043
C_2	1.457	1.602	-0.071	-0.02217	0.005041	0.000491
C_3	1.727	1.919	0.199	0.294833	0.039601	0.086927
C_4	1.464	1.507	-0.064	-0.11717	0.004096	0.013728
C_5	1.699	1.595	0.171	-0.02917	0.029241	0.000851
C_6	1.3	1.553	-0.228	-0.07117	0.051984	0.005065
∑	9.168	9.745			0.130012	0.110105
	$y_{(obs)}$=1.528	$y_{(pre)}$=1.624167				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 0.130012/5 = 0.0260024 and $S^2_{(pre)}$ = 0.110105/5 = 0.022021

With reference to Eqn (3.93), S_1^2 = 0.0260024 and S_2^2 = 0.022021

Therefore, F = 0.0260024/0.022021 = 1.18

From Fisher table (Appendix JJ), $F_{0.95}(5,5)$ = 5.1 which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.106: Shear strength test results and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (N/mm^2)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	0.344 0.389 0.356	Y_1	1.089	0.363	0.396	0.001
2	2A 2B 2C	0.056 0.078 0.062	Y_2	0.196	0.065	0.013	0.0001
3	3A 3B 3C	0.056 0.051 0.067	Y_3	0.174	0.058	0.010	0.0001
4	4A 4B 4C	0.078 0.067 0.064	Y_{12}	0.209	0.070	0.015	0.0001
5	5A 5B 5C	0.047 0.089 0.064	Y_{13}	0.200	0.067	0.014	0.0004
6	6A 6B 6C	0.049 0.056 0.067	Y_{23}	0.172	0.057	0.010	0.0001
			Control				
7	7A 7B 7C	0.056 0.044 0.047	C_1	0.147	0.049	0.0073	0.000
8	8A 8B 8C	0.047 0.047 0.062	C_2	0.156	0.052	0.0083	0.0001
9	9A 9B 9C	0.102 0.111 0.100	C_3	0.313	0.104	0.0327	0.000
10	10A 10B 10C	0.089 0.056 0.084	C_4	0.229	0.076	0.018	0.0003
11	11A 11B 11C	0.089 0.056 0.047	C_5	0.192	0.064	0.0133	0.0005
12	12A 12B 12C	0.044 0.044 0.051	C_6	0.139	0.046	0.0065	0.000
						$\sum$	0.0027

Using Eqn (3.90), V_e = 11.

With reference to Eqn (3.91) and Table 4.106, replication variance S_y^2 = 0.0027/11 = 0.000245 and from Eqn (3.92), replication error, S_y = √0.000245 = 0.0157

4.1.2.5.7 Mathematical models for shear strength of soilcrete blocks

Scheffe's and Osadebe's mathematical models for shear strength of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for shear strength of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.106, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 0.36, \quad \alpha_2 = 0.07, \; \alpha_3 = 0.06$

$\alpha_{12} = 4(0.07) – 2(0.36) – 2(0.07) = -0.58$

$\alpha_{13} = 4(0.07) – 2(0.36) – 2(0.06) = -0.56$

$\alpha_{23} = 4(0.06) – 2(0.07) – 2(0.06) = -0.02$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 0.36X_1 + 0.07X_2 + 0.06X_3 – 0.58X_1X_2 – 0.56X_1X_3 – 0.02X_2X_3 \qquad (4.29)$$

Eqn (4.29) is the Scheffe's mathematical model for optimisation of shear strength of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for shear strength of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.107: T-statistics test computations for Scheffe's shear strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	0.049	0.029	0.020	1.74
Similarly												
2		-	-	-	-	-	-	0.6094	0.052	0.030	0.022	1.91
3		-	-	-	-	-	-	0.899	0.104	0.136	0.032	2.56
4		-	-	-	-	-	-	0.8476	0.076	0.062	0.014	1.14
5		-	-	-	-	-	-	0.640	0.064	0.031	0.033	2.84
6		-	-	-	-	-	-	0.6208	0.046	0.029	0.017	1.47

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.107). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.108: F-statistics test computations for Scheffe's shear strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.049	0.029	-0.01617	-0.02383	0.000261	0.000568
C_2	0.052	0.03	-0.01317	-0.02283	0.000173	0.000521
C_3	0.104	0.136	0.038833	0.083167	0.001508	0.006917
C_4	0.076	0.062	0.010833	0.009167	0.000117	8.4E-05
C_5	0.064	0.031	-0.00117	-0.02183	1.36E-06	0.000477
C_6	0.046	0.029	-0.01917	-0.02383	0.000367	0.000568
$\sum$	0.391	0.317			0.002429	0.009135
	$y_{(obs)}$=0.065167	$y_{(pre)}$=0.052833				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.002429/5 = 0.0004858$ and $S^2_{(pre)} = 0.009135/5 = 0.001827$

With reference to Eqn (3.93), $S_1^2 = 0.001827$ and $S_2^2 = 0.0004858$

Therefore, $F = 0.001827/ 0.0004858 = 3.76$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for shear strength of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.106) into Eqn (3.78) gives the values of the coefficients, α as:

$\alpha_1 = 6430.9013$, $\alpha_2 = 347.9295$, $\alpha_3 = 26.7439$, $\alpha_4 = -9637.4776$, $\alpha_5 = -7283.2872$, $\alpha_6 = -195.8522$

Substituting the values of these coefficients, α into Eqn (3.76) yields

$$Y = 6430.9013Z_1 + 347.9295Z_2 + 26.7439Z_3 - 9637.4776Z_4 - 7283.2872Z_5 - 195.8522Z_6 \quad (4.30)$$

Eqn (4.30) is the Osadebe's mathematical model for optimisation of shear strength of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for shear strength of soilcrete blocks

(i) Student's t-test

Table 4.109: T-statistics test computations for Osadebe's shear strength model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	0.049	0.047	0.002	0.174
Similarly												
2								0.6094	0.052	0.046	0.006	0.522
3								0.899	0.104	0.121	0.017	1.478
4								0.8476	0.076	0.058	0.018	1.461
5								0.640	0.064	0.048	0.016	1.378
6								0.6208	0.046	0.047	0.001	0.087

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.109). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.110: F-statistics test computations for Osadebe's shear strength model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	0.049	0.047	-0.01617	-0.01417	0.000261	0.000201
C_2	0.052	0.046	-0.01317	-0.01517	0.000173	0.00023
C_3	0.104	0.121	0.038833	0.059833	0.001508	0.00358
C_4	0.076	0.058	0.010833	-0.00317	0.000117	1E-05
C_5	0.064	0.048	-0.00117	-0.01317	1.36E-06	0.000173
C_6	0.046	0.047	-0.01917	-0.01417	0.000367	0.000201
∑	0.391	0.367			0.002429	0.004395
	$y_{(obs)}$=0.065167	$y_{(pre)}$=0.061167				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 0.002429/5 = 0.0004858$ and $S^2_{(pre)} = 0.004395/5 = 0.000879$

With reference to Eqn (3.93), $S_1^2 = 0.000879$ and $S_2^2 = 0.0004858$

Therefore, $F = 0.000879 / 0.0004858 = 1.81$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

Table 4.111: Water absorption test result and replication variance (3-component mix)

Expt. No.	Replicates	Response Y_i (%)	Response Symbol	$\sum Y_i$	Y	$\sum Y_i^2$	S_i^2
1	1A 1B 1C	3.39 2.17 2.59	Y_1	8.15	2.72	22.909	0.384
2	2A 2B 2C	5.33 5.43 5.96	Y_2	16.72	5.57	93.415	0.115
3	3A 3B 3C	6.45 5.50 6.48	Y_3	18.43	6.14	113.843	0.311
4	4A 4B 4C	4.87 4.92 4.93	Y_{12}	14.72	4.91	72.228	0.001
5	5A 5B 5C	5.09 5.30 5.88	Y_{13}	16.27	5.42	88.573	0.167
6	6A 6B 6C	5.99 5.31 5.73	Y_{23}	17.03	5.68	96.909	0.118
Control							
7	7A 7B 7C	5.50 6.01 5.16	C_1	16.67	5.56	92.996	0.122
8	8A 8B 8C	5.39 5.97 5.36	C_2	16.72	5.57	93.423	0.118
9	9A 9B 9C	4.59 4.11 4.98	C_3	13.68	4.56	62.761	0.190
10	10A 10B 10C	6.05 5.69 6.22	C_4	17.96	5.99	107.667	0.073
11	11A 11B 11C	5.70 5.21 5.63	C_5	16.54	5.51	91.331	0.070
12	12A 12B 12C	5.97 5.39 6.22	C_6	17.58	5.86	103.381	0.181
						$\sum$	1.85

Using Eqn (3.90), $V_e = 11$.

With reference to Eqn (3.91) and Table 4.111, replication variance, $S_y^2 = 1.85/11 = 0.168$ and from Eqn (3.92), replication error, $S_y = \sqrt{0.168} = 0.029$

4.1.2.5.8 Mathematical models for water absorption of soilcrete blocks

Scheffe's and Osadebe's mathematical models for water absorption of soilcrete blocks are determined as follows:

(a) Determination of Scheffe's mathematical model for water absorption of soilcrete blocks

From Eqns (3.24) and (3.25) and Table 4.111, the coefficients, α of the second degree polynomial are determined as follows:

$\alpha_1 = 2.72$, $\alpha_2 = 5.57$, $\alpha_3 = 6.14$

$\alpha_{12} = 4(4.91) - 2(2.72) - 2(5.57) = 3.06$

$\alpha_{13} = 4(5.42) - 2(2.72) - 2(6.14) = 3.96$

$\alpha_{23} = 4(5.68) - 2(5.57) - 2(6.14) = -0.7$

Substituting the values of these coefficients, α into Eqn (3.17) yields:

$$Y = 2.72X_1 + 5.57X_2 + 6.14X_3 + 3.06X_1X_2 + 3.96X_1X_3 - 0.7X_2X_3 \quad (4.31)$$

Eqn (4.31) is the Scheffe's mathematical model for optimisation of water absorption of soilcrete block based on 28-day strength.

Test of adequacy of Scheffe's model for water absorption of soilcrete blocks

(i) Student's t-test

For this test, ε, Δ_Y and t are evaluated using Eqns (3.84), (3.89), and (3.88) respectively

Table 4.112: T-statistics test computations for Scheffe's water absorption model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1	2	-0.125	0.25	0.01562	0.0625					
		1	3	-0.125	0.5	0.01562	0.25					
		2	3	-0.125	0.5	0.01562	0.25					
		3	-	0	-	0	-					
					∑	0.04686	0.5625	0.6094	5.56	5.741	0.181	0.60
Similarly												
2		-	-	-	-	-	-	0.6094	5.57	5.543	0.027	0.09
3		-	-	-	-	-	-	0.899	4.56	4.337	0.223	0.68
4		-	-	-	-	-	-	0.8476	5.99	5.603	0.387	1.20
5		-	-	-	-	-	-	0.640	5.51	5.610	0.100	0.33
6		-	-	-	-	-	-	0.6208	5.86	5.760	0.100	0.33

T-value from table

Significant level, $\alpha = 0.05$, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.112). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.113: F-statistics test computations for Scheffe's water absorption model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)} - y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	5.56	5.741	0.051667	0.308667	0.002669	0.095275
C_2	5.57	5.543	0.061667	0.110667	0.003803	0.012247
C_3	4.56	4.337	-0.94833	-1.09533	0.899336	1.199755
C_4	5.99	5.603	0.481667	0.170667	0.232003	0.029127
C_5	5.51	5.61	0.001667	0.177667	2.78E-06	0.031565
C_6	5.86	5.76	0.351667	0.327667	0.123669	0.107365
$\sum$	33.05	32.594			1.261483	1.475335
	$Y_{(obs)}$=5.508333	$y_{(pre)}$=5.432333				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)}$ = 1.261483/5 = 0.2522966 and $S^2_{(pre)}$ = 1.475335/5 = 0.295067

With reference to Eqn (3.93), S_1^2 = 0.295067and S_2^2 = 0.2522966

Therefore, F = 0.295067/ 0.2522966 = 1.17

From Fisher table (Appendix JJ), $F_{0.95}(5,5)$ = 5.1 which is higher than the calculated F-value. Hence the regression equation is adequate.

(a) Determination of Osadebe's mathematical model for water absorption of soilcrete blocks

Substituting the values of $Y^{(n)}$ from test results (given in Table 4.111) into Eqn (3.78) gives the values of the coefficients, α as:

α_1 = 31592.2624, α_2 = 7544.8764, α_3 = 44.56584, α_4 = -73590.9539,

α_5 = -34082.1748, α_6 = -5982.1470

Substituting the values of these coefficients, α into Eqn (3.76) yields:

$$Y = 31592.2624Z_1 + 7544.8764Z_2 + 44.56584Z_3 - 73590.9539Z_4 - 34082.1748Z_5 - 5982.1470Z_6 \quad (4.32)$$

Eqn (4.32) is the Osadebe's mathematical model for optimisation of water absorption of soilcrete block based on 28-day strength.

Test of adequacy of Osadebe's model for water absorption of soilcrete blocks

(i) Student's t-test

Table 4.114: T-statistics test computations for Osadebe's water absorption model

N	CN	i	j	a_i	a_{ij}	a_i^2	a_{ij}^2	ε	$y_{(observed)}$	$y_{(predicted)}$	Δ_Y	t
1	C_1	1 1 2 3	2 3 3 -	-0.125 -0.125 -0.125 0	0.25 0.5 0.5 -	0.01562 0.01562 0.01562 0	0.0625 0.25 0.25 -					
					∑	0.04686	0.5625	0.6094	5.56	5.61	0.05	0.167
Similarly												
2		-	-	-	-	-	-	0.6094	5.57	5.41	0.16	0.533
3		-	-	-	-	-	-	0.899	4.56	4.42	0.14	0.429
4		-	-	-	-	-	-	0.8476	5.99	5.59	0.40	1.243
5		-	-	-	-	-	-	0.640	5.51	5.49	0.02	0.066
6		-	-	-	-	-	-	0.6208	5.86	5.63	0.23	0.763

T-value from table

For a significant level, α = 0.05, $t_{\alpha/l}(v_e) = t_{0.05/6}(5) = t_{0.01}(5) = 3.365$ (see standard t-table given in Appendix II).

This value is greater than any of the t-values obtained by calculation (as shown in Table 4.114). Therefore, we accept the Null hypothesis. Hence the model equation is adequate.

(ii) Fisher Test

Table 4.115: F-statistics test computations for Osadebe's water absorption model

Response Symbol	$Y_{(observed)}$	$Y_{(predicted)}$	$Y_{(obs)} - y_{(obs)}$	$Y_{(pre)}-y_{(pre)}$	$(Y_{(obs)} - y_{(obs)})^2$	$(Y_{(pre)} - y_{(pre)})^2$
C_1	5.56	5.61	0.051667	0.251667	0.002669	0.063336
C_2	5.57	5.41	0.061667	0.051667	0.003803	0.002669
C_3	4.56	4.42	-0.94833	-0.93833	0.899336	0.880469
C_4	5.99	5.59	0.481667	0.231667	0.232003	0.053669
C_5	5.51	5.49	0.001667	0.131667	2.78E-06	0.017336
C_6	5.86	5.63	0.351667	0.271667	0.123669	0.073803
∑	33.05	32.15			1.261483	1.091283
	$y_{(obs)}$=5.508333	$y_{(pre)}$=5.358333				

Legend: $y = \sum Y/n$

where Y is the response and n the number of responses.

Using Eqn (3.94), $S^2_{(obs)}$ and $S^2_{(pre)}$ are calculated as follows:

$S^2_{(obs)} = 1.261483/5 = 0.2522966$ and $S^2_{(pre)} = 1.091283/5 = 0.2182566$

With reference to Eqn (3.93), $S_1^2 = 0.2522966$ and $S_2^2 = 0.2182566$

Therefore, $F = 0.2522966/0.2182566 = 1.17$

From Fisher table (Appendix JJ), $F_{0.95}(5,5) = 5.1$ which is higher than the calculated F-value. Hence the regression equation is adequate.

4.1.3 Model results

The results predicted by Scheffe's and Osadebe's model programs for the characteristics of soilcrete and sand-laterite blocks are presented in this sub-section.

4.1.3.1 Model results for the eight characteristics of sand-laterite blocks

The results predicted by Scheffe's and Osadebe's models for the characteristics of sand-laterite blocks are presented along side with the laboratory results on Tables 4.116 to 4.123

Table 4.116: Compressive strength results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Compressive Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:3.2:4.8	3.012	3.009	3.012
2	1:1:3.75:8.75	2.025	2.030	2.025
3	1.28:1:3.334:13.336	1.630	1.630	1.630
4	2.2:1:2.5:22.5	1.259	1.260	1.259
5	0.9:1:3.475:6.775	2.321	2.320	2.321
6	1.04:1:3.267:9.068	2.074	2.070	2.074
7	1.5:1:2.85:13.65	1.704	1.700	1.704
8	1.14:1:3.542:11.043	1.926	1.930	1.926
9	1.6:1:3.125:15.625	1.185	1.190	1.185
10	1.74:1:2.917:17.918	1.235	1.240	1.235
11	1.09:1:3.4045:10.0555	2.024	1.950	1.985
12	1.02:1:3.5085:8.909	1.975	2.063	2.104
13	0.866:1:3.3815:6.1035	2.666	2.510	2.493
14	1.0924:1:3.6127:10.2634	1.926	1.986	1.991
15	1.052:1:3.4186:9.3994	1.975	2.020	2.058
16	1.1:1:3.432:10.253	1.876	1.938	1.971
17	0.97:1:3.371:7.9215	2.173	2.220	2.239
18	1.32:1:3.196:12.3465	1.571	1.621	1.568
19	1.67:1:3.021:16.7715	1.210	1.240	1.232
20	1.9:1:2.8125:19.0625	1.136	1.111	1.185

Table 4.117: Flexural strength results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Flexural Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:3.2:4.8	1.718	1.720	1.718
2	1:1:3.75:8.75	1.170	1.170	1.170
3	1.28:1:3.334:13.336	0.590	0.590	0.590
4	2.2:1:2.5:22.5	0.861	0.860	0.861
5	0.9:1:3.475:6.775	1.111	1.110	1.111
6	1.04:1:3.267:9.068	0.874	0.870	0.874
7	1.5:1:2.85:13.65	0.993	0.990	0.993
8	1.14:1:3.542:11.043	0.785	0.790	0.785
9	1.6:1:3.125:15.625	0.489	0.490	0.489
10	1.74:1:2.917:17.918	0.282	0.280	0.282
11	1.09:1:3.4045:10.0555	0.800	0.746	0.785
12	1.02:1:3.5085:8.909	1.141	0.879	0.911
13	0.866:1:3.3815:6.1035	1.481	1.242	1.203
14	1.0924:1:3.6127:10.2634	0.846	0.899	0.888
15	1.052:1:3.4186:9.3994	0.705	0.802	0.836
16	1.1:1:3.432:10.253	0.652	0.742	0.779
17	0.97:1:3.371:7.9215	0.918	0.967	0.966
18	1.32:1:3.196:12.3465	0.593	0.590	0.508
19	1.67:1:3.021:16.7715	0.495	0.363	0.372
20	1.9:1:2.8125:19.0625	0.282	0.544	0.641

Table 4.118: Split tensile strength results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Split Tensile Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:3.2:4.8	0.427	0.430	0.427
2	1:1:3.75:8.75	0.210	0.210	0.210
3	1.28:1:3.334:13.336	0.199	0.199	0.199
4	2.2:1:2.5:22.5	0.241	0.240	0.241
5	0.9:1:3.475:6.775	0.335	0.335	0.335
6	1.04:1:3.267:9.068	0.231	0.231	0.231
7	1.5:1:2.85:13.65	0.189	0.189	0.189
8	1.14:1:3.542:11.043	0.325	0.325	0.325
9	1.6:1:3.125:15.625	0.199	0.199	0.199
10	1.74:1:2.917:17.918	0.178	0.178	0.178
11	1.09:1:3.4045:10.0555	0.231	0.280	0.292
12	1.02:1:3.5085:8.909	0.273	0.309	0.324
13	0.866:1:3.3815:6.1035	0.367	0.384	0.381
14	1.0924:1:3.6127:10.2634	0.210	0.317	0.323
15	1.052:1:3.4186:9.3994	0.252	0.294	0.307
16	1.1:1:3.432:10.253	0.218	0.290	0.300
17	0.97:1:3.371:7.9215	0.220	0.316	0.323
18	1.32:1:3.196:12.3465	0.216	0.228	0.211
19	1.67:1:3.021:16.7715	0.168	0.221	0.204
20	1.9:1:2.8125:19.0625	0.314	0.214	0.219

Table 4.119: Poisson's ratio results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Poisson's Ratio Results	Scheffe's Model Results	Osadebe's Model Results
1	0.8:1:3.2:4.8	0.112	0.112	0.112
2	1:1:3.75:8.75	0.110	0.110	0.110
3	1.28:1:3.334:13.336	0.077	0.080	0.077
4	2.2:1:2.5:22.5	0.082	0.082	0.082
5	0.9:1:3.475:6.775	0.093	0.093	0.093
6	1.04:1:3.267:9.068	0.092	0.092	0.092
7	1.5:1:2.85:13.65	0.075	0.075	0.075
8	1.14:1:3.542:11.043	0.106	0.106	0.106
9	1.6:1:3.125:15.625	0.080	0.080	0.080
10	1.74:1:2.917:17.918	0.058	0.060	0.058
11	1.09:1:3.4045:10.0555	0.072	0.095	0.097
12	1.02:1:3.5085:8.909	0.114	0.099	0.104
13	0.866:1:3.3815:6.1035	0.100	0.095	0.093
14	1.0924:1:3.6127:10.2634	0.105	0.110	0.111
15	1.052:1:3.4186:9.3994	0.073	0.096	0.100
16	1.1:1:3.432:10.253	0.080	0.096	0.099
17	0.97:1:3.371:7.9215	0.076	0.096	0.099
18	1.32:1:3.196:12.3465	0.061	0.078	0.074
19	1.67:1:3.021:16.7715	0.085	0.072	0.070
20	1.9:1:2.8125:19.0625	0.050	0.077	0.080

Table 4.120: Static modulus of elasticity results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Static Mod. of Elasticity Results (GPa)	Scheffe's Model Results (GPa)	Osadebe's Model Results (GPa)
1	0.8:1:3.2:4.8	6.414	6.410	6.414
2	1:1:3.75:8.75	5.297	5.299	5.297
3	1.28:1:3.334:13.336	4.591	4.590	4.591
4	2.2:1:2.5:22.5	4.317	4.317	4.317
5	0.9:1:3.475:6.775	5.236	5.235	5.236
6	1.04:1:3.267:9.068	4.945	4.950	4.945
7	1.5:1:2.85:13.65	4.729	4.730	4.729
8	1.14:1:3.542:11.043	4.866	4.867	4.866
9	1.6:1:3.125:15.625	4.561	4.561	4.561
10	1.74:1:2.917:17.918	4.166	4.167	4.166
11	1.09:1:3.4045:10.0555	5.219	4.756	4.833
12	1.02:1:3.5085:8.909	5.082	4.917	4.987
13	0.866:1:3.3815:6.1035	5.410	5.500	5.425
14	1.0924:1:3.6127:10.2634	4.666	4.999	4.990
15	1.052:1:3.4186:9.3994	5.301	4.827	4.896
16	1.1:1:3.432:10.253	4.680	4.754	4.830
17	0.97:1:3.371:7.9215	5.080	5.076	5.073
18	1.32:1:3.196:12.3465	5.128	4.552	4.585
19	1.67:1:3.021:16.7715	4.335	4.346	4.345
20	1.9:1:2.8125:19.0625	4.445	4.377	4.411

Table 4.121: Shear modulus results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Shear Modulus Results (GPa)	Scheffe's Model Results (GPa)	Osadebe's Model Results (GPa)
1	0.8:1:3.2:4.8	2.885	2.890	2.885
2	1:1:3.75:8.75	2.386	2.390	2.386
3	1.28:1:3.334:13.336	2.133	2.133	2.133
4	2.2:1:2.5:22.5	1.997	1.998	1.997
5	0.9:1:3.475:6.775	2.395	2.390	2.395
6	1.04:1:3.267:9.068	2.265	2.260	2.265
7	1.5:1:2.85:13.65	2.200	2.201	2.200
8	1.14:1:3.542:11.043	2.205	2.205	2.205
9	1.6:1:3.125:15.625	2.113	2.113	2.113
10	1.74:1:2.917:17.918	1.969	1.968	1.969
11	1.09:1:3.4045:10.0555	2.435	2.180	2.206
12	1.02:1:3.5085:8.909	2.285	2.245	2.263
13	0.866:1:3.3815:6.1035	2.459	2.513	2.480
14	1.0924:1:3.6127:10.2634	2.113	2.260	2.250
15	1.052:1:3.4186:9.3994	2.472	2.210	2.231
16	1.1:1:3.432:10.253	2.167	2.176	2.202
17	0.97:1:3.371:7.9215	2.361	2.322	2.311
18	1.32:1:3.196:12.3465	2.417	2.114	2.134
19	1.67:1:3.021:16.7715	1.999	2.027	2.030
20	1.9:1:2.8125:19.0625	2.136	2.034	2.045

Table 4.122: Shear strength results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Shear Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:3.2:4.8	0.430	0.430	0.430
2	1:1:3.75:8.75	0.293	0.293	0.293
3	1.28:1:3.334:13.336	0.147	0.147	0.147
4	2.2:1:2.5:22.5	0.215	0.215	0.215
5	0.9:1:3.475:6.775	0.278	0.278	0.278
6	1.04:1:3.267:9.068	0.218	0.218	0.218
7	1.5:1:2.85:13.65	0.248	0.248	0.248
8	1.14:1:3.542:11.043	0.196	0.196	0.196
9	1.6:1:3.125:15.625	0.122	0.122	0.122
10	1.74:1:2.917:17.918	0.071	0.071	0.071
11	1.09:1:3.4045:10.0555	0.200	0.186	0.196
12	1.02:1:3.5085:8.909	0.285	0.219	0.228
13	0.866:1:3.3815:6.1035	0.371	0.311	0.301
14	1.0924:1:3.6127:10.2634	0.211	0.224	0.222
15	1.052:1:3.4186:9.3994	0.176	0.200	0.209
16	1.1:1:3.432:10.253	0.163	0.185	0.194
17	0.97:1:3.371:7.9215	0.230	0.242	0.241
18	1.32:1:3.196:12.3465	0.148	0.148	0.127
19	1.67:1:3.021:16.7715	0.124	0.091	0.093
20	1.9:1:2.8125:19.0625	0.071	0.136	0.16

Table 4.123: Water absorption results of sand-laterite blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Water Absorption Results %	Scheffe's Model Results %	Osadebe's Model Results %
1	0.8:1:3.2:4.8	5.42	5.40	5.42
2	1:1:3.75:8.75	6.85	6.80	6.85
3	1.28:1:3.334:13.336	7.19	7.20	7.19
4	2.2:1:2.5:22.5	5.49	5.499	5.49
5	0.9:1:3.475:6.775	6.16	6.199	6.16
6	1.04:1:3.267:9.068	4.18	4.20	4.18
7	1.5:1:2.85:13.65	4.42	4.40	4.42
8	1.14:1:3.542:11.043	5.34	5.30	5.34
9	1.6:1:3.125:15.625	2.01	2.00	2.01
10	1.74:1:2.917:17.918	3.14	3.10	3.14
11	1.09:1:3.4045:10.0555	4.54	4.78	4.80
12	1.02:1:3.5085:8.909	6.24	5.23	4.94
13	0.866:1:3.3815:6.1035	4.91	5.95	5.91
14	1.0924:1:3.6127:10.2634	4.59	5.43	5.33
15	1.052:1:3.4186:9.3994	5.12	4.75	4.60
16	1.1:1:3.432:10.253	5.60	4.88	4.92
17	0.97:1:3.371:7.9215	3.46	4.78	4.30
18	1.32:1:3.196:12.3465	2.84	3.19	2.41
19	1.67:1:3.021:16.7715	2.31	2.12	2.38
20	1.9:1:2.8125:19.0625	3.70	2.71	3.49

4.1.3.2 Model results for the eight characteristics of soilcrtete blocks

The results predicted by Scheffe's and Osadebe's models for the characteristics of sand-laterite blocks are presented along side with the laboratory results on Tables 4.124 to 4.131.

Table 4.124: Compressive strength results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Compressive Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:8	2.148	2.149	2.148
2	1:1:12.5	0.963	0.960	0.963
3	1.28:1:16.67	0.914	0.910	0.914
4	0.9:1:10.25	1.151	1.150	1.151
5	1.04:1:12.335	0.978	0.979	0.978
6	1.14:1:14.585	0.741	0.740	0.741
7	1.09:1:13.46	0.958	0.759	0.811
8	1.02:1:12.417	1.081	0.809	0.827
9	0.866:1:9.485	1.136	1.399	1.355
10	1.0924:1:13.8761	0.948	0.771	0.755
11	1.052:1:12.818	0.859	0.794	0.825
12	1.1:1:13.685	0.622	0.739	0.790

Table 4.125: Flexural strength results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Flexural Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:8	1.452	1.450	1.452
2	1:1:12.5	0.261	0.260	0.261
3	1.28:1:16.67	0.231	0.230	0.231
4	0.9:1:10.25	0.279	0.280	0.279
5	1.04:1:12.335	0.267	0.270	0.267
6	1.14:1:14.585	0.228	0.230	0.228
7	1.09:1:13.46	0.196	0.106	0.188
8	1.02:1:12.417	0.208	0.113	0.185
9	0.866:1:9.485	0.418	0.549	0.481
10	1.0924:1:13.8761	0.305	0.237	0.234
11	1.052:1:12.818	0.250	0.120	0.19
12	1.1:1:13.685	0.187	0.108	0.188

Table 4.126: Split tensile strength results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Split Tensile Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:8	0.293	0.290	0.293
2	1:1:12.5	0.094	0.090	0.094
3	1.28:1:16.67	0.157	0.160	0.157
4	0.9:1:10.25	0.220	0.220	0.220
5	1.04:1:12.335	0.147	0.147	0.147
6	1.14:1:14.585	0.178	0.178	0.178
7	1.09:1:13.46	0.168	0.173	0.175
8	1.02:1:12.417	0.136	0.181	0.183
9	0.866:1:9.485	0.199	0.250	0.255
10	1.0924:1:13.8761	0.189	0.162	0.166
11	1.052:1:12.818	0.147	0.179	0.181
12	1.1:1:13.685	0.199	0.175	0.177

Table 4.127: Poisson's ratio results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Poisson's Ratio Results	Scheffe's Model Results	Osadebe's Model Results
1	0.8:1:8	0.174	0.170	0.174
2	1:1:12.5	0.135	0.140	0.135
3	1.28:1:16.67	0.110	0.110	0.110
4	0.9:1:10.25	0.095	0.099	0.095
5	1.04:1:12.335	0.074	0.074	0.074
6	1.14:1:14.585	0.091	0.090	0.091
7	1.09:1:13.46	0.099	0.066	0.075
8	1.02:1:12.417	0.105	0.078	0.079
9	0.866:1:9.485	0.054	0.111	0.101
10	1.0924:1:13.8761	0.079	0.099	0.096
11	1.052:1:12.818	0.092	0.067	0.073
12	1.1:1:13.685	0.098	0.069	0.078

Table 4.128: Static Modulus of elasticity results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Static Mod. of Elasticity Results (GPa)	Scheffe's Model Results (GPa)	Osadebe's Model Results (GPa)
1	0.8:1:8	5.149	5.149	5.149
2	1:1:12.5	3.584	3.580	3.584
3	1.28:1:16.67	3.349	3.349	3.349
4	0.9:1:10.25	3.964	3.964	3.964
5	1.04:1:12.335	3.559	3.559	3.559
6	1.14:1:14.585	3.254	3.254	3.254
7	1.09:1:13.46	3.344	3.304	3.363
8	1.02:1:12.417	3.168	3.433	3.451
9	0.866:1:9.485	3.792	4.274	4.235
10	1.0924:1:13.8761	3.159	3.314	3.301
11	1.052:1:12.818	3.707	3.379	3.413
12	1.1:1:13.685	2.836	3.277	3.335

Table 4.129: Shear modulus results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Shear Modulus Results (GPa)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:8	2.195	2.199	2.195
2	1:1:12.5	1.572	1.570	1.572
3	1.28:1:16.67	1.513	1.510	1.513
4	0.9:1:10.25	1.810	1.810	1.810
5	1.04:1:12.335	1.656	1.656	1.656
6	1.14:1:14.585	1.495	1.495	1.495
7	1.09:1:13.46	1.521	1.561	1.569
8	1.02:1:12.417	1.457	1.606	1.602
9	0.866:1:9.485	1.727	1.926	1.919
10	1.0924:1:13.8761	1.464	1.515	1.507
11	1.052:1:12.818	1.699	1.595	1.595
12	1.1:1:13.685	1.300	1.546	1.553

Table 4.130: Shear strength results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Shear Strength Results (N/mm^2)	Scheffe's Model Results (N/mm^2)	Osadebe's Model Results (N/mm^2)
1	0.8:1:8	0.363	0.360	0.363
2	1:1:12.5	0.065	0.070	0.065
3	1.28:1:16.67	0.058	0.060	0.058
4	0.9:1:10.25	0.070	0.070	0.070
5	1.04:1:12.335	0.067	0.067	0.067
6	1.14:1:14.585	0.057	0.057	0.057
7	1.09:1:13.46	0.049	0.029	0.047
8	1.02:1:12.417	0.052	0.030	0.046
9	0.866:1:9.485	0.104	0.136	0.121
10	1.0924:1:13.8761	0.076	0.062	0.058
11	1.052:1:12.818	0.064	0.031	0.048
12	1.1:1:13.685	0.046	0.029	0.047

Table 4.131: Water absorption results of soilcrete blocks from Scheffe's model, Osadebe's model and laboratory investigation

Exp. No	Mix ratios (w/c: cement: laterite)	Laboratory Water Absorption Results %	Scheffe's Model Results %	Osadebe's Model Results %
1	0.8:1:8	2.72	2.72	2.72
2	1:1:12.5	5.57	5.57	5.57
3	1.28:1:16.67	6.14	6.14	6.14
4	0.9:1:10.25	4.91	4.91	4.91
5	1.04:1:12.335	5.42	5.42	5.42
6	1.14:1:14.585	5.68	5.68	5.68
7	1.09:1:13.46	5.56	5.741	5.61
8	1.02:1:12.417	5.57	5.543	5.41
9	0.866:1:9.485	4.56	4.337	4.42
10	1.0924:1:13.8761	5.99	5.603	5.59
11	1.052:1:12.818	5.51	5.61	5.49
12	1.1:1:13.685	5.86	5.76	5.63

4.2 Analysis of results

4.2.1 Physical analysis of laterite

The laterite used in this work is reddish-brown in colour. It has an easily mouldable consistency. A study of the particle size distribution curve shows that the laterite is well graded.

The bulk density of laterite is 1.91 Mg/m^3. From literature, soil which shows massive structure and less porosity will show high bulk density from 1.6 to 1.7 Mg/m^3. Movement of water is hindered in such soils. Bulk density value of the laterite used in this work, is higher than this range of value stipulated. Bulk density, which is an indicator of soil compaction, is inversely related to porosity of the same soil. It reflects the soil's ability to function as structural support, water and solute movement.

The specific gravity of the laterite is 2.67. According to the British Soil Classification System (BSCS), the general range for specific gravity of clay and silty clay is 2.67 – 2.9. Therefore, the laterite falls under this category. Specific gravity number indicates how much heavier or lighter a material is than water.

The liquid limit value of the laterite is 49%. From BSCS, soils having liquid limit between 35% and 50% are said to have intermediate plasticity. Thus, with a liquid limit of 49%, the laterite used in this work can be said to have intermediate plasticity.

The plasticity index (PI) of the laterite is 37.12%. PI is the measure of the plasticity of a soil. It is the size of the range of water contents required for the soil to exhibit plastic properties. Its value is determined by measuring the difference between the liquid limit and plastic limit. According to BSCS, soils with plasticity index between 20 and 40% are said to be of high plasticity which tend to be clay. Therefore, the laterite used in this work falls under this category of high plasticity.

Using the American Association of State Highway and Transportation Officials (AASHTO) classification system, this laterite can be described as clayey sand under group A-2-7.

4.2.2 Chemical analysis of laterite

Table 4.19 shows the results of the chemical analysis of laterite. It shows that the laterite contains 120.11mg of calcium (Ca) per kilogram of laterite sample. The oxide of the element, calcium constitutes about 63% of Ordinary Portland Cement (OPC). The presence of calcium (Ca) in the laterite enhances the complete hydration of OPC and consequently, the development of strength. According to Neville (1981), the raw materials used in the manufacture of Portland cement, consist mainly of lime, silica, alumina and iron oxide. Generally, the chemical analysis of the laterite reveals that it contains some quantities of these elements.

The iron content is 29.5mg/kg (a high range value), and this accounts for the reddish colour of the laterite. About 0.5 to 6.0% of oxide of iron is present in OPC.
The laterite contains 15.67mmoles of $H^+ + Al^{3+}$ per kilogram of laterite sample. In addition, 3 to 8% of the oxide of aluminium is present in OPC. Table 4.19 also shows that the laterite contains 100.44mg of magnesium (Mg) per kilogram of laterite sample. OPC contains about 0.1 to 4.0% of magnesium oxide.

The laterite contains 6.08mg of sulphate (SO_4^{2-}) per kilogram of laterite sample. A combination of calcium, sulphate and water gives gypsum ($Ca\ SO_4.2H_2O$). Gypsum is usually added to cement clinker to prevent ‘flash set’ (immediate stiffening of paste).
Potassium (K) was not detected in the analysis. The oxide of potassium is a minor compound which is not of importance as far as strength is concerned. The Cation Exchange Capacity (CEC) is 22.86mmoles/kg which is very effective.

4.2.3 Effect of partial replacement of laterite with sand on the properties of the blocks

The arbitrary mix ratios prescribed for the vertices of soilcrete blocks (made with water, cement and laterite) are presented on Table 4.132.

Table 4.132: Arbitrary mix ratios for vertices (Soilcrete blocks)

Vertices	Mix ratios(w/c: cement: laterite)	Cement content (%)
A_1	0.8:1:8	10
A_2	1:1:12.5	8
A_3	1.28:1:16.67	6

Laterite was replaced partially with sand using 10 – 40% replacement to produce the sand-laterite blocks. The arbitrary mix ratios prescribed for the vertices of the sand-laterite blocks are presented on Table 4.133.

Table 4.133: Arbitrary mix ratios for vertices (Sand-laterite blocks)

Vertices	Mix ratios(w/c: cement: sand: laterite)	% Replacement	Cement content (%)
A_1	0.8: 1: 3.2: 4.8	40	10
A_2	1: 1: 3.75: 8.75	30	8
A_3	1.28: 1: 3.334: 13.336	20	6
A_4	2.2: 1: 2.5: 22.5	10	4

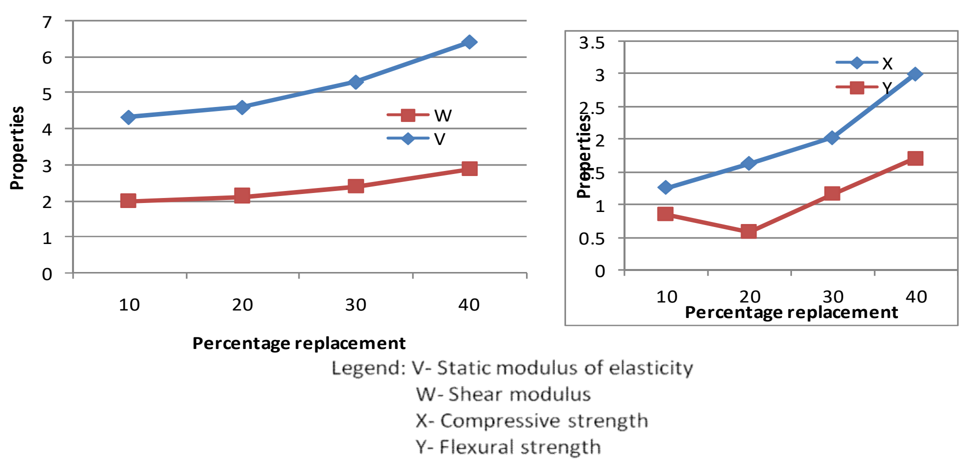

Fig 4.1 Graph of some properties against percentage replacement

Generally, it can be observed from the tests results and graghs in Fig. 4.1 that the partial replacement of laterite with sand improved the quality of the blocks. The compressive strength, flexural strength, split tensile strength, static modulus of elasticity, shear modulus and shear strength values increased significantly with inclusion of sand in the mix. The Poisson’s ratio values reduced with the inclusion of sand in the mix. This also confirms that the strength of blocks increased with partial replacement of laterite with sand. This is because high strength concrete has lower Poisson’s ratio value than low strength concrete.

However, the soilcrete blocks have lower water absorption values than the sand-laterite blocks which contain sand in the mix. Considering experiment number one, the soilcrete blocks attained a saturation of 2.72% while the sand-laterite blocks attained a saturation of 5.42% under 24 hours of total immersion in water. This shows that soilcrete blocks are less permeable than sand-laterite blocks.

In as much as the strength increased with inclusion of sand in the mix, it should be noted that the permeability increased with addition of sand hence reducing its durability.

4.2.4 Analysis of optimisation models

The characteristics test results and replication variances of the 4-component mix (sand-laterite blocks), formulation of models and adequacy tests are presented on Tables 4.36 - 4.75, while that of 3-component mix (soilcrete blocks) are presented on Tables 4.76 – 4.115. The characteristics of blocks tested include: compressive strength, flexural strength, split tensile strength, Poisson's ratio, static modulus of elasticity, shear modulus/modulus of rigidity, water absorption.

For each block type, eight models were formulated for the eight characteristics based on Scheffe's theory and eight models based on Osadebe's method. This makes it a total of thirty two models. Thirty two computer programs were written using basic language. The models were tested for adequacy using student's t-test and fisher test. They all agreed to the acceptance of the models. There were no significant differences between the experimentally observed results and the predicted results from the models. The results predicted from the models are presented on Tables 4.116 - 4.131.

The maximum compressive strength predictable by Scheffe's model is 3.01N/mm^2 for sand-laterite blocks and 2.148N/mm^2 for soilcrete blocks. The maximum flexural strength obtainable from Scheffe's model is 1.718N/mm^2 for sand-laterite blocks and 1.452N/mm^2 for soilcrete blocks. The maximum split tensile strength predictable by Scheffe's model is 1.45N/mm^2 for sand-laterite blocks and 0.88N/mm^2 for soilcrete blocks. The maximum Poisson's ratio obtainable from Scheffe's model is 0.112 for sand-laterite blocks and 0.174 for soilcrete blocks. The maximum static modulus of elasticity predictable by Scheffe's model is 6.414GPa for sand-laterite blocks and 5.149GPa for soilcrete blocks. The maximum shear modulus/modulus of rigidity obtainable from Scheffe's model is 2.885GPa for sand-laterite blocks and 2.195GPa for soilcrete blocks. The maximum shear strength predictable by Scheffe's model is

0.43N/mm^2 for sand-laterite blocks and 0.363N/mm^2 for soilcrete blocks. The maximum water absorption predictable by Scheffe's model is 7.29% for sand-laterite blocks and 6.16% for soilcrete blocks.

4.2.5 Cost analysis

The average quantities of materials used (cement, laterite, sand and water) per block were calculated and used in determining the cost per block. It is worthy of note here that laterite can be used in areas where it is locally abundant. Hence, the cost of laterite is zero Nigerian Naira (NGN). The cost per block for the soilcrete block and sand-laterite block is as follows:

(a) Soilcrete block

(i)	Cement:	1.4kg @ NGN36 per kg	NGN50.40
(ii)	Laterite:	23.58kg @ NGN0	NGN0
(iii)	Water:	1.8kg @NGN2 per kg	NGN3.60
(iv)	Labour:		NGN10
	Total cost per block:		**NGN64.00**

(b) Sand-laterite block

(i)	Cement:	1.4kg @ NGN36 per kg	NGN50.40
(ii)	Laterite:	18.87kg @ NGN0	NGN0
(iii)	Sand:	4.7kg @ NGN1.17 per kg	NGN5.48
(iv)	Water:	1.8kg @ NGN2 per kg	NGN3.60
(v)	Labour:		NGN10
	Total cost per block:		**NGN69.48**

The average current market price of block within Owerri metropolis is NGN120. However, these blocks are generally substandard. A difference of NGN56.00 is obtained for soilcrete block and a difference of NGN50.52 is obtained for sand-laterite block. This difference can be referred to as the cost savings. The percentage cost savings in using soilcrete block is 46.67% while that of sand-laterite blocks is 42.1% which is very significant. Moreso, savings will be achieved by using the models.

4.2.6 Comparison of results from Scheffe's model and Osadebe's model

The results from the models for compressive strength test result of sand-laterite blocks (chosen sample from 4.1.3) of the controlled points are presented on Table 4.138

Table 4.138: Comparison of compressive strength test results of sand-laterite blocks for Scheffe's model and Osadebe's model and percentage difference

Exp No	Mix ratios (w/c: cement: sand: laterite)	Laboratory Compressive Strength Results (N/mm^2)	Scheffe's Model Compressive Strength Results (N/mm^2)	Osadebe's Model Compressive Strength Results (N/mm^2)	Percentage Difference btw Lab. & Scheffe's Results (%)	Percentage Difference btw Lab & Osadebe's Results (%)	Percentage Difference btw Scheffe's & Osadebe's Model Results(%)
11	1.09:1:3.4045:10.0555	2.024	1.950	1.985	3.66	1.93	1.79
12	1.02:1:3.5085:8.909	1.975	2.063	2.104	4.45	6.53	1.99
13	0.866:1:3.3815:6.1035	2.666	2.510	2.493	5.85	6.49	0.68
14	1.0924:1:3.6127:10.2634	1.926	1.986	1.991	3.12	3.37	0.25
15	1.052:1:3.4186:9.3994	1.975	2.020	2.058	2.28	4.20	1.88
16	1.1:1:3.432:10.253	1.876	1.938	1.971	3.30	5.06	1.70
17	0.97:1:3.371:7.9215	2.173	2.220	2.239	2.16	3.04	0.86
18	1.32:1:3.196:12.3465	1.571	1.621	1.568	3.18	0.19	3.27
19	1.67:1:3.021:16.7715	1.210	1.240	1.232	2.48	1.82	0.65
20	1.9:1:2.8125:19.0625	1.136	1.111	1.185	2.20	4.31	6.66

Table 4.138 shows compressive strength test results from laboratory/experimental investigation, Scheffe's model and Osadebe's model. A comparison of predicted results from Scheffe's model with the laboratory results shows that the percentage difference ranges from a minimum of 2.16% to a maximum of 5.85% which is insignificant. A comparison of predicted results from Osadebe's model with the laboratory results shows that the percentage difference ranges from a minimum of 0.19% to a maximum of 6.53% which is also insignificant.

The percentage difference between Scheffe's model result and Osadebe's model result (for compressive strength of sand-laterite blocks) ranges from a minimum of 0.25% to a maximum of 6.66% which is insignificant. This can be used as a representative for other properties determined. This comparison shows that both models are adequate and any of them can be used for optimisation of the block properties. However, the following differences can be noted:

(i) Scheffe's model programs can predict the maximum value of any property while Osadebe's model program cannot give the maximum value.

(ii) In formulation of Scheffe's model, the mixture components are subject to the constraint that the sum of all the components must be equal to one whereas Osadebe's model is not subject to this constraint. Consequently, component transformation is required in Scheffe's model development while the transformation is not needed in Osadebe's case.

(iii) Any value of property higher than the maximum in the case of Scheffe's model program can be specified as input in Osadebe's model program to obtain the mix ratios that can yield that. This is not obtainable with Scheffe's model program.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

1. Current block production practises in Nigeria have been reviewed. The properties of the blocks produced by commercial producers have been determined. The maximum compressive strength obtained was 1.5N/mm^2 from a large scale industry and 1.15N/mm^2 from a small scale industry. However the mean compressive strength from all the block industries is 0.96N/mm^2. These values are not up to the values recommended by Nigerian Industrial Standard (NIS) (2004). NIS recommends that the lowest crushing strength of individual load bearing blocks shall not be less than 2.5N/mm^2 for machine compacted and 2.0N/mm^2 for hand compacted sandcrete blocks. The standard deviation of the compressive strength of the blocks from each block industry is 0.207N/mm^2 which is low. The standard deviation measures the variability or diversity. This indicates that the data points tend to be very close to the mean.
2. Soilcrete blocks have been successfully produced with laterite using between 4% to 10% cement stabilisation. Sand-laterite blocks were also produced by replacing the laterite partially with river sand using 10% to 40% replacement.
3. The structural characteristics of these blocks have been determined. These include compressive strength, flexural strength, split tensile strength, Poisson's ratio, static modulus of elasticity, shear modulus/modulus of rigidity, shear strength and water absorption. The highest value of compressive strength from laboratory work is 2.15N/mm^2 for soilcrete blocks and 3.01N/mm^2 for sand-laterite blocks. This was obtained with 10% cement content. Higher values can be obtained using Osadebe's models. Nigerian Building and Road Research Institute (NBRRI) proposed a compressive strength of 1.65N/mm^2 for laterite blocks (Madedor, 1992). The strength values of blocks produced in this work are higher than the recommended values.
4. The effect of partial replacement of laterite with sand on the properties of soilcrete block has been determined. The values of the properties of the blocks increased with inclusion of sand in the mix. In other words the partial replacement of laterite with river sand improved the quality of the blocks. However, the increase in water absorption as a result of the partial replacement reduces the durability of the blocks.

5. Thirty two mathematical models for optimisation of the characteristics of the blocks as stated in conclusion (3) above have been formulated. These include sixteen models for the characteristics of soilcrete blocks and sixteen models for the characteristics of sand-laterite blocks. For each type of block, eight models based on Scheffe's method of optimisation and eight models based on Osadebe's method of optimisation were developed. These models with the aid of computer programs developed, can predict the desired property/characteristic if the mix ratios are given. The models can also yield all the possible mix ratios for any specified property/characteristic. Scheffe's models can predict the optimum value of the properties. The models were tested for adequacy using student's t-test and the fisher test. They all agreed to the acceptance of the models.
6. With the models formulated, the arbitrary choice of constituent mix, the use of trial mix and the effort used in the traditional system of mix design have been greatly reduced.
7. The cost savings in production of the blocks have been analysed. The percentage cost savings in using soilcrete block is 46.67% while that of sand-laterite blocks is 42.1% which is very significant. Moreso, savings can be achieved by using the models.

5.2 Recommendations

1. Block production practices in Nigeria should be looked into by the government. Quality control should be introduced to assist block producers to produce strong and durable blocks at minimum cost.
2. The use of sand-laterite blocks is strongly recommended. To reduce the ingress of aggressive liquids, attention should be paid to the quality of plastering of the blocks.
3. The relationship between the properties of the blocks should be established.

5.3 Contribution to knowledge

1. This research work which has been successfully completed, presents structural characteristics of soilcrete blocks which include compressive strength, flexural strength, split tensile strength, water absorption, static modulus of elasticity, shear modulus, shear strength, and Poisson's ratio.
2. This work also offers mathematical models for optimisation of these structural characteristics. The models can predict the characteristics using mix ratios and vice versa. The overall result in the use of the model leads to cost savings in the production of soilcrete blocks.
3. The effects of partial replacement of laterite by river sand on the characteristics of these blocks have been established.
4. This work reduces the arbitrary choice of constituent mix, the use of trial mix and the effort used in the traditional system of mix design.

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APPENDIX A
Basic computer program for Scheffe's compressive strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '  SCHEFFE'S SIMPLEX MODEL FOR COMPRESSIVE STRENGTH
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls

'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant

   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
COMPRESSIVE STRENGTH OR CALCULATING COMPRESSIVE STRENGTH GIVEN MIX RATIO?", "IF
THE STRENGTH IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED COMPRESSIVE STRENGTH?"): YY = YY * 1

     Q = -4
10    X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11    X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12    X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13    X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

        Rem TWO COMPONENTS
14    E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
     If F + 1 > 4 Then GoTo 30
25    X(E) = Y1: X(F + 1) = Y2
```

```
      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50    Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210

      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
```

```
240    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 270
       T = T + 1
       GoTo 2000
265    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270    Rem FOUR COMPONENTS

       Rem FIRST ROUND
 '      Print " THIS IS CHINENYE"
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
        If T = 79 Then GoTo 300
        T = T + 1
        GoTo 2000
295     GoTo 280
300    Rem SECOND ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       If T = 79 Then GoTo 330
       T = T + 1
       GoTo 2000
325    GoTo 310

330    Rem THIRD ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 79 Then GoTo 360
       T = T + 1
       GoTo 2000
355    GoTo 340

360    Rem FOURTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       If T = 69 Then GoTo 390
       T = T + 1
       GoTo 2000
385    GoTo 370

390    Rem FIFTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 69 Then GoTo 420
       T = T + 1
       GoTo 2000
415    GoTo 410

420    Rem SIXTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       If T = 59 Then GoTo 450
       T = T + 1
       GoTo 2000
445    GoTo 430
```

```
450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
```

```
      T = T + 1
      GoTo 2000
655   GoTo 640

660   Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685   GoTo 670

690   Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715    GoTo 700

720   Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755   Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760   Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795   Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000     Rem PRINTING OF RESULTS


      Y = 3.01 * X(1) + 2.03 * X(2) + 1.63 * X(3) + 1.26 * X(4) - 0.8 * X(1) * X(2) - 1 * X(1) * X(3) - 1.74 * X(1)
* X(4) + 0.4 * X(2) * X(3) - 1.82 * X(2) * X(4) - 0.82 * X(3) * X(4)

       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 3.01 * X(1) + 2.03 * X(2) + 1.63 * X(3) + 1.26 * X(4) - 0.8 * X(1) *
X(2) - 1 * X(1) * X(3) - 1.74 * X(1) * X(4) + 0.4 * X(2) * X(3) - 1.82 * X(2) * X(4) - 0.82 * X(3) * X(4)

       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810   NP = NP + 1
      CT = CT + 1
      For I = 1 To 4: Z(I) = 0: Next I
```

```
      For I = 1 To 4
      For J = 1 To 4
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830

      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")
      MIX(NP, 4) = Format(Z(4), "0.00#")


830   If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)

   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX

   oSheet1.Range("B1:G1").Value = Array("COMP STRENGTH", " ", "WATER", "CEMENT", "SAND",
"LATERITE")

    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM COMPRESSIVE STRENGTH OF BLOCK
PREDICTABLE BY THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
```

```
  oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")


 oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit
    GoTo 22222

900
    Cls
  Y = 0
  For I = 1 To 5: X(I) = 0: Next I
  Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

    GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

    B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
    B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
    B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
    B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


    Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF SAND")
    Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

    Rem   ***   PSEUDO MIXTURE COMPONENTS    ***
    For I = 1 To 4
    For J = 1 To 4
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I


    Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 3.01 * X(1) + 2.03 * X(2) + 1.63 * X(3) + 1.26 * X(4) - 0.8 * X(1) * X(2) - 1 * X(1) * X(3) - 1.74 *
X(1) * X(4) + 0.4 * X(2) * X(3) - 1.82 * X(2) * X(4) - 0.82 * X(3) * X(4)


     'Add headers to the worksheet on row 1
 Set oSheet1 = oBook.Worksheets(1)
 Set oSheet2 = oBook.Worksheets(2)


    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")
    MIXX(1, 4) = Format(Z(4), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "SAND", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit


22222

End Sub
```

APPENDIX B
Basic computer program for Scheffe's flexural strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '  SCHEFFE'S SIMPLEX MODEL FOR FLEXURAL STRENGTH
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'  CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN
DESIRED STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", "IF THE
STRENGTH IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK
and do so"): GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


     Q = -4
10    X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11    X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12    X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
```

```
13    X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

        Rem TWO COMPONENTS
14    E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If F + 1 > 4 Then GoTo 30
25    X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50    Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120    Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160    Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
```

```
      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210

      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
```

```
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
```

```
560    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       If T = 39 Then GoTo 570
       T = T + 1
       GoTo 2000
565    GoTo 550

570    Rem TENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 39 Then GoTo 600
       T = T + 1
       GoTo 2000
595    GoTo 580

600    Rem ELEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       If T = 29 Then GoTo 630
       T = T + 1
       GoTo 2000
625    GoTo 610

630    Rem TWELVETH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 29 Then GoTo 660
       T = T + 1
       GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       'GoTo 2000
       If T = 19 Then GoTo 690
       T = T + 1
       GoTo 2000
685    GoTo 670


690    Rem FOURTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      ' GoTo 2000
       If T = 19 Then GoTo 720
       T = T + 1
        GoTo 2000
715     GoTo 700
```

```
720    Rem THREE COMPONENTS CONTIUES
       Rem SEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 760
       T = T + 1
       GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 800
       T = T + 1
       GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000       Rem PRINTING OF RESULTS

       Y = 1.72 * X(1) + 1.17 * X(2) + 0.59 * X(3) + 0.86 * X(4) - 1.34 * X(1) * X(2) - 1.14 * X(1) *
X(3) - 1.2 * X(1) * X(4) - 0.36 * X(2) * X(3) - 2.1 * X(2) * X(4) - 1.78 * X(3) * X(4)


        If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
        If Y > OPSTRENGTH Then YOP = 1.72 * X(1) + 1.17 * X(2) + 0.59 * X(3) + 0.86 * X(4) - 1.34
* X(1) * X(2) - 1.14 * X(1) * X(3) - 1.2 * X(1) * X(4) - 0.36 * X(2) * X(3) - 2.1 * X(2) * X(4) - 1.78 *
X(3) * X(4)
        If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) +
A(I, J) * X(J): Next J: Next I


       If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
       CT = CT + 1
       For I = 1 To 4: Z(I) = 0: Next I
       For I = 1 To 4
       For J = 1 To 4
       Z(I) = Z(I) + A(I, J) * X(J)
       Next J
       Next I
       If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
       If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
      ' If QQQ = 15 Then QQQQ = InputBox("PRESS OK TO CONTINUE", , , 5500, 6000): QQQ = 1:
Cls
       QQQ = QQQ + 1

       YM = 6.2 * X(1) + 5.8 * X(2) + 5.6 * X(3) + 5.9 * X(4) - 3.2 * X(1) * X(2) - 6 * X(1) * X(3) +
3.4 * X(1) * X(4) - 4.8 * X(2) * X(3) + 1.8 * X(2) * X(4) + 0.6 * X(3) * X(4)
820

       STRGTH(NP, 1) = Format(Y, "0.00#")
       MIX(NP, 1) = Format(Z(1), "0.00#")
       MIX(NP, 2) = Format(Z(2), "0.00#")
```

```
      MIX(NP, 3) = Format(Z(3), "0.00#")
      MIX(NP, 4) = Format(Z(4), "0.00#")


830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795

2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGHT", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM FLEXURAL STRENGTH OF BLOCKS
PREDICTABLE BY THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS
FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit

      GoTo 22222

900
      Cls
   Y = 0
```

```
  For I = 1 To 5: X(I) = 0: Next I
  Rem  ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE
MODEL  ***
    GoTo 3010

3010   Rem   ***  CONVERSION MATRIX   ****

    B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
    B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
    B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
    B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


    Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF SAND")
    Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

    Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
    For I = 1 To 4
    For J = 1 To 4
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I

   Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 1.72 * X(1) + 1.17 * X(2) + 0.59 * X(3) + 0.86 * X(4) - 1.34 * X(1) * X(2) - 1.14 * X(1) *
X(3) - 1.2 * X(1) * X(4) - 0.36 * X(2) * X(3) - 2.1 * X(2) * X(4) - 1.78 * X(3) * X(4)


     'Add headers to the worksheet on row 1
 Set oSheet1 = oBook.Worksheets(1)
 Set oSheet2 = oBook.Worksheets(2)


    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")
    MIXX(1, 4) = Format(Z(4), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "SAND",
"LATERITE")

  oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

22222

End Sub
```

APPENDIX C
Basic computer program for Scheffe's split tensile strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
       Cls
       ReDim X(4)

       '   SCHEFFE'S SIMPLEX MODEL FOR SPLIT STRENGTH
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls

'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", "IF THE STRENGTH IS KNOWN
TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
    A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
    A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
    YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


       Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

           Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

       X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If F + 1 > 4 Then GoTo 30
```

```
25    X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50    Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R =  1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '    Print " THIS IS CHINENYE"
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If T = 79 Then GoTo 300
      T = T + 1
      GoTo 2000
295   GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 59 Then GoTo 450
```

```
     T = T + 1
     GoTo 2000
445  GoTo 430

450  Rem SEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 59 Then GoTo 480
     T = T + 1
     GoTo 2000
475  GoTo 460

480  Rem EIGTHTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 49 Then GoTo 510
     T = T + 1
     GoTo 2000
505  GoTo 490

510  Rem NINETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 49 Then GoTo 540
     T = T + 1
     GoTo 2000
535  GoTo 520

540  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 39 Then GoTo 570
     T = T + 1
     GoTo 2000
565  GoTo 550

570  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 39 Then GoTo 600
     T = T + 1
     GoTo 2000
595  GoTo 580

600  Rem ELEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 29 Then GoTo 630
     T = T + 1
     GoTo 2000
625  GoTo 610

630  Rem TWELVETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
```

```
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 29 Then GoTo 660
       T = T + 1
       GoTo 2000
655    GoTo 640
660    Rem THIRTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       'GoTo 2000
       If T = 19 Then GoTo 690
       T = T + 1
       GoTo 2000
685    GoTo 670


690    Rem FOURTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      ' GoTo 2000
       If T = 19 Then GoTo 720
       T = T + 1
        GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
       Rem SEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 760
       T = T + 1
       GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 800
       T = T + 1
       GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000       Rem PRINTING OF RESULTS


       Y = 0.47 * X(1) + 0.21 * X(2) + 0.2 * X(3) + 0.24 * X(4) + 0 * X(1) * X(2) - 0.42 * X(1) * X(3) - 0.66 * X(1)
* X(4) + 0.5 * X(2) * X(3) - 0.1 * X(2) * X(4) - 0.16 * X(3) * X(4)


        If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
        If Y > OPSTRENGTH Then YOP = 0.47 * X(1) + 0.21 * X(2) + 0.2 * X(3) + 0.24 * X(4) + 0 * X(1) * X(2)
- 0.42 * X(1) * X(3) - 0.66 * X(1) * X(4) + 0.5 * X(2) * X(3) - 0.1 * X(2) * X(4) - 0.16 * X(3) * X(4)
        If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


       If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830
```

```
810    NP = NP + 1
       CT = CT + 1
       For I = 1 To 4: Z(I) = 0: Next I
       For I = 1 To 4
       For J = 1 To 4
       Z(I) = Z(I) + A(I, J) * X(J)
       Next J
       Next I
       If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
       If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
       QQQ = QQQ + 1

820


       STRGTH(NP, 1) = Format(Y, "0.00#")
       MIX(NP, 1) = Format(Z(1), "0.00#")
       MIX(NP, 2) = Format(Z(2), "0.00#")
       MIX(NP, 3) = Format(Z(3), "0.00#")
       MIX(NP, 4) = Format(Z(4), "0.00#")


830    If Q = -3 Then GoTo 11
       If Q = -2 Then GoTo 12
       If Q = -1 Then GoTo 13
       If Q = 0 Then GoTo 14
       If Q = 1 Then GoTo 28
       If Q = 2 Then GoTo 75
       If Q = 3 Then GoTo 115
       If Q = 4 Then GoTo 155
       If Q = 5 Then GoTo 195
       If Q = 6 Then GoTo 235
       If Q = 7 Then GoTo 265
       If Q = 8 Then GoTo 295
       If Q = 9 Then GoTo 325
       If Q = 10 Then GoTo 355
       If Q = 11 Then GoTo 385
       If Q = 12 Then GoTo 415
       If Q = 13 Then GoTo 445
       If Q = 14 Then GoTo 475
       If Q = 15 Then GoTo 505
       If Q = 16 Then GoTo 535
       If Q = 17 Then GoTo 565
       If Q = 18 Then GoTo 595
       If Q = 19 Then GoTo 625
       If Q = 20 Then GoTo 655
       If Q = 21 Then GoTo 685
       If Q = 22 Then GoTo 715
       If Q = 23 Then GoTo 755
       If PP = 7 Then GoTo 2100
       PP = PP + 1
       If Q = 24 Then GoTo 795


2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGHT", " ", "WATER", "CEMENT", "SAND", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM SPLIT TENSILE STRENGTH OF BLOCK
PREDICTABLE BY THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")
```

```
  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

     GoTo 22222

900
     Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

     GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

     B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
     B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
     B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
     B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


     Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
     Z(1) = InputBox("ENTER THE VALUE OF WATER")
     Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
     Z(3) = InputBox("ENTER THE VALUE OF SAND")
     Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

     Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
     For I = 1 To 4
     For J = 1 To 4
     X(I) = X(I) + B(I, J) * Z(J)
     Next J
     Next I

     Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****


     YM = 0.47 * X(1) + 0.21 * X(2) + 0.2 * X(3) + 0.24 * X(4) + 0 * X(1) * X(2) - 0.42 * X(1) * X(3) - 0.66 *
X(1) * X(4) + 0.5 * X(2) * X(3) - 0.1 * X(2) * X(4) - 0.16 * X(3) * X(4)


      'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)


     MIXX(1, 1) = Format(Z(1), "0.00#")
     MIXX(1, 2) = Format(Z(2), "0.00#")
     MIXX(1, 3) = Format(Z(3), "0.00#")
     MIXX(1, 4) = Format(Z(4), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "SAND", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit


22222

End Sub
```

APPENDIX D
Basic computer program for Scheffe's Poisson's ratio model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
       Cls
       ReDim X(4)

       '  SCHEFFE'S SIMPLEX MODEL FOR POISSON'S RATIO
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
POISSON'S RATIO OR POISSON'S RATIO GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1
ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
    A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
    A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
    YY = InputBox("WHAT IS THE DESIRED POISSON'S RATIO?"): YY = YY * 1


       Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

          Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

       X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
    If F + 1 > 4 Then GoTo 30
25    X(E) = Y1: X(F + 1) = Y2


    If T = 100 Then T = 1: GoTo 30
    T = T + 1
    GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
    X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
    V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
    X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50    Rem THREE COMPONENTS
    Rem FIRST ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
    If T = 99 Then GoTo 80
    T = T + 1:
    GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
    Rem

    If T = 99 Then GoTo 120
    T = T + 1
    GoTo 2000
115    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120    Rem THIRD ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 160
    T = T + 1
    GoTo 2000
155    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160    Rem FOURTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 200
    T = T + 1
    GoTo 2000
195    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200    Rem FIFTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 240
    T = T + 1
    GoTo 2000
235    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS OWUS"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
        If T = 59 Then GoTo 450
        T = T + 1
        GoTo 2000
445     GoTo 430

450     Rem SEVENTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
        If T = 59 Then GoTo 480
        T = T + 1
        GoTo 2000
475     GoTo 460

480     Rem EIGTHTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
        If T = 49 Then GoTo 510
        T = T + 1
        GoTo 2000
505     GoTo 490

510     Rem NINETH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
        If T = 49 Then GoTo 540
        T = T + 1
        GoTo 2000
535     GoTo 520

540     Rem TENTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
        If T = 39 Then GoTo 570
        T = T + 1
        GoTo 2000
565     GoTo 550

570     Rem TENTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
        If T = 39 Then GoTo 600
        T = T + 1
        GoTo 2000
595     GoTo 580

600     Rem ELEVENTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
        If T = 29 Then GoTo 630
        T = T + 1
        GoTo 2000
625     GoTo 610

630     Rem TWELVETH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000       Rem PRINTING OF RESULTS


      Y = 0.112 * X(1) + 0.11 * X(2) + 0.077 * X(3) + 0.082 * X(4) - 0.072 * X(1) * X(2) - 0.01 * X(1) * X(3) -
0.088 * X(1) * X(4) + 0.05 * X(2) * X(3) - 0.064 * X(2) * X(4) - 0.086 * X(3) * X(4)


       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 0.112 * X(1) + 0.11 * X(2) + 0.077 * X(3) + 0.082 * X(4) - 0.072 * X(1)
* X(2) - 0.01 * X(1) * X(3) - 0.088 * X(1) * X(4) + 0.05 * X(2) * X(3) - 0.064 * X(2) * X(4) - 0.086 * X(3) * X(4)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830
```

```
810    NP = NP + 1
       CT = CT + 1
       For I = 1 To 4: Z(I) = 0: Next I
       For I = 1 To 4
       For J = 1 To 4
       Z(I) = Z(I) + A(I, J) * X(J)
       Next J
       Next I
       If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
       If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
 Cls
       QQQ = QQQ + 1

820

       STRGTH(NP, 1) = Format(Y, "0.00#")
       MIX(NP, 1) = Format(Z(1), "0.00#")
       MIX(NP, 2) = Format(Z(2), "0.00#")
       MIX(NP, 3) = Format(Z(3), "0.00#")
       MIX(NP, 4) = Format(Z(4), "0.00#")


830    If Q = -3 Then GoTo 11
       If Q = -2 Then GoTo 12
       If Q = -1 Then GoTo 13
       If Q = 0 Then GoTo 14
       If Q = 1 Then GoTo 28
       If Q = 2 Then GoTo 75
       If Q = 3 Then GoTo 115
       If Q = 4 Then GoTo 155
       If Q = 5 Then GoTo 195
       If Q = 6 Then GoTo 235
       If Q = 7 Then GoTo 265
       If Q = 8 Then GoTo 295
       If Q = 9 Then GoTo 325
       If Q = 10 Then GoTo 355
       If Q = 11 Then GoTo 385
       If Q = 12 Then GoTo 415
       If Q = 13 Then GoTo 445
       If Q = 14 Then GoTo 475
       If Q = 15 Then GoTo 505
       If Q = 16 Then GoTo 535
       If Q = 17 Then GoTo 565
       If Q = 18 Then GoTo 595
       If Q = 19 Then GoTo 625
       If Q = 20 Then GoTo 655
       If Q = 21 Then GoTo 685
       If Q = 22 Then GoTo 715
       If Q = 23 Then GoTo 755
       If PP = 7 Then GoTo 2100
       PP = PP + 1
       If Q = 24 Then GoTo 795


2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("POISSON'S RATIO", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM POISSON'S RATIO OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
```

```
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")


   oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit

  GoTo 22222

900
      Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

      GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

      B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
      B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
      B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
      B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


      Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
      Z(1) = InputBox("ENTER THE VALUE OF WATER")
      Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
      Z(3) = InputBox("ENTER THE VALUE OF SAND")
      Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

      Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
      For I = 1 To 4
      For J = 1 To 4
      X(I) = X(I) + B(I, J) * Z(J)
      Next J
      Next I

      Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

      YM = 0.112 * X(1) + 0.11 * X(2) + 0.077 * X(3) + 0.082 * X(4) - 0.072 * X(1) * X(2) - 0.01 * X(1) * X(3) -
0.088 * X(1) * X(4) + 0.05 * X(2) * X(3) - 0.064 * X(2) * X(4) - 0.086 * X(3) * X(4)

       'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)


      MIXX(1, 1) = Format(Z(1), "0.00#")
      MIXX(1, 2) = Format(Z(2), "0.00#")
      MIXX(1, 3) = Format(Z(3), "0.00#")
      MIXX(1, 4) = Format(Z(4), "0.00#")

     oSheet1.Range("B2").Value = YM
     oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
     oSheet1.Range("B1:G1").Value = Array("POISSON'S RATIO", " ", "WATER", "CEMENT", "SAND",
"LATERITE")

    oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit


22222

End Sub
```

APPENDIX E
Basic computer program for Scheffe's static modulus of elasticity model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '   SCHEFFE'S SIMPLEX MODEL FOR STATIC MODULUS OF ELASTICITY
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STATIC MODULUS OR CALCULATING STATIC MODULUS GIVEN MIX RATIO?", "IF THE STATIC
MODULUS IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED STATIC MODULUS?"): YY = YY * 1


     Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

         Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1
```

```
        X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
        If F + 1 > 4 Then GoTo 30
25      X(E) = Y1: X(F + 1) = Y2


        If T = 100 Then T = 1: GoTo 30
        T = T + 1
        GoTo 2000
28      GoTo 20
30      If U = 3 Then U = 1: GoTo 40
        X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40      If V = 3 Then GoTo 50
        V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
        X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50      Rem THREE COMPONENTS
        Rem FIRST ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60      Rem
70      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
        If T = 99 Then GoTo 80
        T = T + 1:
        GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80      Rem SECOND ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
        Rem

        If T = 99 Then GoTo 120
        T = T + 1
        GoTo 2000
115     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120     Rem THIRD ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 160
        T = T + 1
        GoTo 2000
155     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160     Rem FOURTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 200
        T = T + 1
        GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 240
        T = T + 1
```

```
      GoTo 2000
235   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210

      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '    Print " THIS IS CHINENYE"
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If T = 79 Then GoTo 300
      T = T + 1
      GoTo 2000
295   GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
```

```
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 59 Then GoTo 450
    T = T + 1
    GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 59 Then GoTo 480
    T = T + 1
    GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 49 Then GoTo 510
    T = T + 1
    GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 49 Then GoTo 540
    T = T + 1
    GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 39 Then GoTo 570
    T = T + 1
    GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 39 Then GoTo 600
    T = T + 1
    GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
    E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 29 Then GoTo 630
    T = T + 1
    GoTo 2000
625   GoTo 610
```

```
630    Rem TWELVETH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 29 Then GoTo 660
       T = T + 1
       GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       'GoTo 2000
       If T = 19 Then GoTo 690
       T = T + 1
       GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      ' GoTo 2000
       If T = 19 Then GoTo 720
       T = T + 1
        GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
       Rem SEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 760
       T = T + 1
       GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 800
       T = T + 1
       GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000       Rem PRINTING OF RESULTS

       Y = 6.41 * X(1) + 5.3 * X(2) + 4.59 * X(3) + 4.32 * X(4) - 2.46 * X(1) * X(2) - 2.2 * X(1) * X(3) - 2.54 * X(1) * X(4) - 0.3 * X(2) * X(3) - 1 * X(2) * X(4) - 1.14 * X(3) * X(4)


        If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
        If Y > OPSTRENGTH Then YOP = 6.41 * X(1) + 5.3 * X(2) + 4.59 * X(3) + 4.32 * X(4) - 2.46 * X(1) * X(2) - 2.2 * X(1) * X(3) - 2.54 * X(1) * X(4) - 0.3 * X(2) * X(3) - 1 * X(2) * X(4) - 1.14 * X(3) * X(4)
        If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) * X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
      CT = CT + 1
      For I = 1 To 4: Z(I) = 0: Next I
      For I = 1 To 4
      For J = 1 To 4
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
     ' If QQQ = 15 Then QQQQ = InputBox("PRESS OK TO CONTINUE", , , 5500, 6000): QQQ = 1: Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")
      MIX(NP, 4) = Format(Z(4), "0.00#")

830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STATIC MODULUS", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM STATIC MODULUS OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
```

```
 oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
 oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
 oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")

 oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

 GoTo 22222

900
    Cls
 Y = 0
 For I = 1 To 5: X(I) = 0: Next I
 Rem  ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

    GoTo 3010

3010   Rem  ***  CONVERSION MATRIX   ****

    B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
    B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
    B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
    B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


    Rem  ***  ACTUAL MIXTURE COMPONENTS   ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF SAND")
    Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

    Rem  ***  PSEUDO MIXTURE COMPONENTS   ***
    For I = 1 To 4
    For J = 1 To 4
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I

    Rem  ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 6.41 * X(1) + 5.3 * X(2) + 4.59 * X(3) + 4.32 * X(4) - 2.46 * X(1) * X(2) - 2.2 * X(1) * X(3) - 2.54 *
X(1) * X(4) - 0.3 * X(2) * X(3) - 1 * X(2) * X(4) - 1.14 * X(3) * X(4)


      'Add headers to the worksheet on row 1
 Set oSheet1 = oBook.Worksheets(1)
 Set oSheet2 = oBook.Worksheets(2)


    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")
    MIXX(1, 4) = Format(Z(4), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "SAND", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

22222

End Sub
```

APPENDIX F
Basic computer program for Scheffe's shear modulus model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '  SCHEFFE'S SIMPLEX MODEL FOR SHEAR MODULUS
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
SHEAR MODULUS OR CALCULATING SHEAR MODULUS GIVEN MIX RATIO?", "IF THE SHEAR
MODULUS IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED VALUE OF SHEAR MODULUS?"): YY = YY * 1


     Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

        Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
      If F + 1 > 4 Then GoTo 30
25      X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28      GoTo 20
30      If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40      If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50      Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60      Rem
70      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80      Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '    Print " THIS IS CHINENYE"
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If T = 79 Then GoTo 300
      T = T + 1
      GoTo 2000
295   GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
```

```
       E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 29 Then GoTo 660
       T = T + 1
       GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       'GoTo 2000
       If T = 19 Then GoTo 690
       T = T + 1
       GoTo 2000
685    GoTo 670



690    Rem FOURTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      ' GoTo 2000
       If T = 19 Then GoTo 720
       T = T + 1
        GoTo 2000
715     GoTo 700



720    Rem THREE COMPONENTS CONTIUES
       Rem SEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 760
       T = T + 1
       GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 800
       T = T + 1
       GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000       Rem PRINTING OF RESULTS


       Y = 2.89 * X(1) + 2.39 * X(2) + 2.13 * X(3) + 2# * X(4) - 0.96 * X(1) * X(2) - 0.96 * X(1) * X(3) - 0.98 *
X(1) * X(4) - 0.2 * X(2) * X(3) - 0.34 * X(2) * X(4) - 0.38 * X(3) * X(4)

        If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
        If Y > OPSTRENGTH Then YOP = 2.89 * X(1) + 2.39 * X(2) + 2.13 * X(3) + 2# * X(4) - 0.96 * X(1) * X(2)
- 0.96 * X(1) * X(3) - 0.98 * X(1) * X(4) - 0.2 * X(2) * X(3) - 0.34 * X(2) * X(4) - 0.38 * X(3) * X(4)
```

```
 If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


     If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
     CT = CT + 1
     For I = 1 To 4: Z(I) = 0: Next I
     For I = 1 To 4
     For J = 1 To 4
     Z(I) = Z(I) + A(I, J) * X(J)
     Next J
     Next I
     If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
     If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
     QQQ = QQQ + 1

820
     STRGTH(NP, 1) = Format(Y, "0.00#")
     MIX(NP, 1) = Format(Z(1), "0.00#")
     MIX(NP, 2) = Format(Z(2), "0.00#")
     MIX(NP, 3) = Format(Z(3), "0.00#")
     MIX(NP, 4) = Format(Z(4), "0.00#")

830    If Q = -3 Then GoTo 11
     If Q = -2 Then GoTo 12
     If Q = -1 Then GoTo 13
     If Q = 0 Then GoTo 14
     If Q = 1 Then GoTo 28
     If Q = 2 Then GoTo 75
     If Q = 3 Then GoTo 115
     If Q = 4 Then GoTo 155
     If Q = 5 Then GoTo 195
     If Q = 6 Then GoTo 235
     If Q = 7 Then GoTo 265
     If Q = 8 Then GoTo 295
     If Q = 9 Then GoTo 325
     If Q = 10 Then GoTo 355
     If Q = 11 Then GoTo 385
     If Q = 12 Then GoTo 415
     If Q = 13 Then GoTo 445
     If Q = 14 Then GoTo 475
     If Q = 15 Then GoTo 505
     If Q = 16 Then GoTo 535
     If Q = 17 Then GoTo 565
     If Q = 18 Then GoTo 595
     If Q = 19 Then GoTo 625
     If Q = 20 Then GoTo 655
     If Q = 21 Then GoTo 685
     If Q = 22 Then GoTo 715
     If Q = 23 Then GoTo 755
     If PP = 7 Then GoTo 2100
     PP = PP + 1
     If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH
     oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("SHEAR MODULUS", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM SHEAR MODULUS OF BLOCK PREDICTABLE BY
THIS MODEL IS"
```

```
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit

      GoTo 22222

900
      Cls
    Y = 0
    For I = 1 To 5: X(I) = 0: Next I
    Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

      GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

      B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
      B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
      B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
      B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


      Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
      Z(1) = InputBox("ENTER THE VALUE OF WATER")
      Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
      Z(3) = InputBox("ENTER THE VALUE OF SAND")
      Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

      Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
      For I = 1 To 4
      For J = 1 To 4
      X(I) = X(I) + B(I, J) * Z(J)
      Next J
      Next I

      Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

      YM = 2.89 * X(1) + 2.39 * X(2) + 2.13 * X(3) + 2# * X(4) - 0.96 * X(1) * X(2) - 0.96 * X(1) * X(3) - 0.98 *
X(1) * X(4) - 0.2 * X(2) * X(3) - 0.34 * X(2) * X(4) - 0.38 * X(3) * X(4)

        'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)


      MIXX(1, 1) = Format(Z(1), "0.00#")
      MIXX(1, 2) = Format(Z(2), "0.00#")
      MIXX(1, 3) = Format(Z(3), "0.00#")
      MIXX(1, 4) = Format(Z(4), "0.00#")

     oSheet1.Range("B2").Value = YM
     oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
     oSheet1.Range("B1:G1").Value = Array("MODULUS", " ", "WATER", "CEMENT", "SAND", "LATERITE")

    oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit


22222

End Sub
```

APPENDIX G
Basic computer program for Scheffe's shear strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
      Cls
      ReDim X(4)

      '  SCHEFFE'S SIMPLEX MODEL FOR SHEAR STRENGTH
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
SHEAR STRENGTH OR CALCULATING SHEAR STRENGTH GIVEN MIX RATIO?", "IF THE SHEAR
STRENGTH IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED VALUE OF SHEAR STRENGTH?"): YY = YY * 1

      Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

        Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If F + 1 > 4 Then GoTo 30
```

```
25    X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50    Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295    GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 59 Then GoTo 450
```

```
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
```

```
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
       If T = 29 Then GoTo 660
       T = T + 1
       GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
       'GoTo 2000
       If T = 19 Then GoTo 690
       T = T + 1
       GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      ' GoTo 2000
       If T = 19 Then GoTo 720
       T = T + 1
        GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
       Rem SEVENTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 760
       T = T + 1
       GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
       E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
       If T = 99 Then GoTo 800
       T = T + 1
       GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000       Rem PRINTING OF RESULTS

       Y = 0.43 * X(1) + 0.293 * X(2) + 0.147 * X(3) + 0.215 * X(4) - 0.334 * X(1) * X(2) - 0.282 * X(1) * X(3) - 0.298 * X(1) * X(4) - 0.096 * X(2) * X(3) - 0.528 * X(2) * X(4) - 0.44 * X(3) * X(4)


        If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
        If Y > OPSTRENGTH Then YOP = 0.43 * X(1) + 0.293 * X(2) + 0.147 * X(3) + 0.215 * X(4) - 0.334 * X(1) * X(2) - 0.282 * X(1) * X(3) - 0.298 * X(1) * X(4) - 0.096 * X(2) * X(3) - 0.528 * X(2) * X(4) - 0.44 * X(3) * X(4)
        If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) * X(J): Next J: Next I


       If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
```

```
      CT = CT + 1
      For I = 1 To 4: Z(I) = 0: Next I
      For I = 1 To 4
      For J = 1 To 4
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
     ' If QQQ = 15 Then QQQQ = InputBox("PRESS OK TO CONTINUE", , , 5500, 6000): QQQ = 1: Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")
      MIX(NP, 4) = Format(Z(4), "0.00#")


830   If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795

2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("SHEAR STRENGTH", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM SHEAR STRENGTH OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")
```

```
  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

   GoTo 22222

900
      Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

      GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

      B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
      B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
      B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
      B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802


      Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
      Z(1) = InputBox("ENTER THE VALUE OF WATER")
      Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
      Z(3) = InputBox("ENTER THE VALUE OF SAND")
      Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

      Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
      For I = 1 To 4
      For J = 1 To 4
      X(I) = X(I) + B(I, J) * Z(J)
      Next J
      Next I


      Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****


      YM = 0.43 * X(1) + 0.293 * X(2) + 0.147 * X(3) + 0.215 * X(4) - 0.334 * X(1) * X(2) - 0.282 * X(1) * X(3)
- 0.298 * X(1) * X(4) - 0.096 * X(2) * X(3) - 0.528 * X(2) * X(4) - 0.44 * X(3) * X(4)


        'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)


      MIXX(1, 1) = Format(Z(1), "0.00#")
      MIXX(1, 2) = Format(Z(2), "0.00#")
      MIXX(1, 3) = Format(Z(3), "0.00#")
      MIXX(1, 4) = Format(Z(4), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("SHEAR STRENGTH", " ", "WATER", "CEMENT", "SAND",
"LATERITE")

    oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

22222

End Sub
```

APPENDIX H
Basic computer program for Scheffe's water absorption model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '  SCHEFFE'S SIMPLEX MODEL FOR WATER ABSORPTION
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
WATER ABSORPTION OR CALCULATING WATER ABSORPTION GIVEN MIX RATIO?", "IF THE
WATER ABSORPTION IS KNOWN TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28: A(1, 4) = 2.2
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1: A(2, 4) = 1
   A(3, 1) = 3.2: A(3, 2) = 3.75: A(3, 3) = 3.334: A(3, 4) = 2.5
   A(4, 1) = 4.8: A(4, 2) = 8.75: A(4, 3) = 13.336: A(4, 4) = 22.5
   YY = InputBox("WHAT IS THE DESIRED VALUE OF WATER ABSORPTION?"): YY = YY * 1


     Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0: X(4) = 0: Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1: X(4) = 0: Q = Q + 1: GoTo 2000:
13     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 1: Q = Q + 1: GoTo 2000:

        Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

     X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
        If F + 1 > 4 Then GoTo 30
25      X(E) = Y1: X(F + 1) = Y2


        If T = 100 Then T = 1: GoTo 30
        T = T + 1
        GoTo 2000
28      GoTo 20
30      If U = 3 Then U = 1: GoTo 40
        X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40      If V = 3 Then GoTo 50
        V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
        X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: GoTo 20

50      Rem THREE COMPONENTS
        Rem FIRST ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60      Rem
70      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
        If T = 99 Then GoTo 80
        T = T + 1:
        GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80      Rem SECOND ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
        Rem

        If T = 99 Then GoTo 120
        T = T + 1
        GoTo 2000
115     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120     Rem THIRD ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 160
        T = T + 1
        GoTo 2000
155     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160     Rem FOURTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 200
        T = T + 1
        GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
        Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
        E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

        If T = 99 Then GoTo 240
        T = T + 1
        GoTo 2000
235     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
     If T = 59 Then GoTo 450
     T = T + 1
     GoTo 2000
445  GoTo 430

450  Rem SEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 59 Then GoTo 480
     T = T + 1
     GoTo 2000
475  GoTo 460

480  Rem EIGTHTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 49 Then GoTo 510
     T = T + 1
     GoTo 2000
505  GoTo 490

510  Rem NINETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 49 Then GoTo 540
     T = T + 1
     GoTo 2000
535  GoTo 520

540  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 39 Then GoTo 570
     T = T + 1
     GoTo 2000
565  GoTo 550

570  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 39 Then GoTo 600
     T = T + 1
     GoTo 2000
595  GoTo 580

600  Rem ELEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
     E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 29 Then GoTo 630
     T = T + 1
     GoTo 2000
625  GoTo 610

630  Rem TWELVETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655   GoTo 640

660   Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685   GoTo 670


690   Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715    GoTo 700

720   Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755   Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760   Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: X(4) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795   Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000      Rem PRINTING OF RESULTS


      Y = 5.4 * X(1) + 6.8 * X(2) + 7.2 * X(3) + 5.5 * X(4) + 0.4 * X(1) * X(2) - 8.4 * X(1) * X(3) - 4.2 * X(1) *
X(4) - 6.8 * X(2) * X(3) - 16.6 * X(2) * X(4) - 13 * X(3) * X(4)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 5.4 * X(1) + 6.8 * X(2) + 7.2 * X(3) + 5.5 * X(4) + 0.4 * X(1) * X(2) -
8.4 * X(1) * X(3) - 4.2 * X(1) * X(4) - 6.8 * X(2) * X(3) - 16.6 * X(2) * X(4) - 13 * X(3) * X(4)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
      CT = CT + 1
      For I = 1 To 4: Z(I) = 0: Next I
      For I = 1 To 4
      For J = 1 To 4
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
 Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")
      MIX(NP, 4) = Format(Z(4), "0.00#")



830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("WATER ABSORPTION", " ", "WATER", "CEMENT", "SAND",
"LATERITE")
```

```
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM WATER ABSORPTION OF BLOCK PREDICTABLE
BY THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "SAND", "LATERITE")


   oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit

       GoTo 22222

900
       Cls
    Y = 0
    For I = 1 To 5: X(I) = 0: Next I
    Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***
       GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

       B(1, 1) = -0.00833: B(1, 2) = 5.007994: B(1, 3) = -1.10133: B(1, 4) = -0.09939
       B(2, 1) = 5.560589:  B(2, 2) = -10.1382: B(2, 3) = 2.301246: B(2, 4) = -0.34881
       B(3, 1) = -8.32723: B(3, 2) = 7.994138: B(3, 3) = -1.32569: B(3, 4) = 0.606222
       B(4, 1) = 2.774965: B(4, 2) = -1.86397: B(4, 3) = 0.125774: B(4, 4) = -0.15802

       Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
       Z(1) = InputBox("ENTER THE VALUE OF WATER")
       Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
       Z(3) = InputBox("ENTER THE VALUE OF SAND")
       Z(4) = InputBox("ENTER THE VALUE OF LATERITE")

       Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
       For I = 1 To 4
       For J = 1 To 4
       X(I) = X(I) + B(I, J) * Z(J)
       Next J
       Next I

       Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

       YM = 5.4 * X(1) + 6.8 * X(2) + 7.2 * X(3) + 5.5 * X(4) + 0.4 * X(1) * X(2) - 8.4 * X(1) * X(3) - 4.2 * X(1) *
X(4) - 6.8 * X(2) * X(3) - 16.6 * X(2) * X(4) - 13 * X(3) * X(4)

        'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)

       MIXX(1, 1) = Format(Z(1), "0.00#")
       MIXX(1, 2) = Format(Z(2), "0.00#")
       MIXX(1, 3) = Format(Z(3), "0.00#")
       MIXX(1, 4) = Format(Z(4), "0.00#")

      oSheet1.Range("B2").Value = YM
      oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
      oSheet1.Range("B1:G1").Value = Array("WATER ABSORPTION", " ", "WATER", "CEMENT", "SAND",
"LATERITE")

     oBook.SaveAs "D:\Book1.xls"

   oExcel.Quit

22222

End Sub
```

APPENDIX I
Basic computer program for Scheffe's compressive strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
        Cls
        ReDim X(4)

        '   SCHEFFE'S SIMPLEX MODEL FOR COMPRESSIVE STRENGTH (3-COMPONENT MIX)
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR STRENGTH GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1 ELSE TYPE 0",
"TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
    A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

    YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


        Q = -4
10      X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11      X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12      X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

            Rem TWO COMPONENTS
14      E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

        X(1) = 0: X(2) = 0: X(3) = 0
20      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
    If F + 1 > 4 Then GoTo 30
25   X(E) = Y1: X(F + 1) = Y2


    If T = 100 Then T = 1: GoTo 30
    T = T + 1
    GoTo 2000
28   GoTo 20
30   If U = 3 Then U = 1: GoTo 40
    X(1) = 0: X(2) = 0: X(3) = 0
    U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40   If V = 3 Then GoTo 50
    V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
    X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50   Rem THREE COMPONENTS
    Rem FIRST ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60   Rem
70   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
    If T = 99 Then GoTo 80
    T = T + 1:
    GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80   Rem SECOND ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
    Rem

    If T = 99 Then GoTo 120
    T = T + 1
    GoTo 2000
115   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120   Rem THIRD ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 160
    T = T + 1
    GoTo 2000
155   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160   Rem FOURTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 200
    T = T + 1
    GoTo 2000
195   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200   Rem FIFTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 240
    T = T + 1
    GoTo 2000
235   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
'     Print " THIS IS CHINENYE"
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
      If T = 79 Then GoTo 300
      T = T + 1
      GoTo 2000
295   GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655     GoTo 640

660     Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685     GoTo 670

690     Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715      GoTo 700

720     Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755     Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760     Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795     Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000        Rem PRINTING OF RESULTS


      Y = 2.15 * X(1) + 0.96 * X(2) + 0.91 * X(3) - 1.62 * X(1) * X(2) - 2.2 * X(1) * X(3) - 0.78 * X(2) * X(3)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 2.15 * X(1) + 0.96 * X(2) + 0.91 * X(3) - 1.62 * X(1) * X(2) - 2.2 * X(1)
* X(3) - 0.78 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810   NP = NP + 1
      CT = CT + 1
      For I = 1 To 3: Z(I) = 0: Next I
      For I = 1 To 3
      For J = 1 To 3
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")



830   If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100  'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM STRENGTH OF BLOCK PREDICTABLE BY THIS
MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
```

```
 oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
 oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")


oBook.SaveAs "D:\Book1.xls"

oExcel.Quit




    GoTo 22222

900
    Cls
 Y = 0
 For I = 1 To 5: X(I) = 0: Next I
 Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***
    GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

    B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
    B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
    B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



    Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


    Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
    For I = 1 To 3
    For J = 1 To 3
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I


    Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 2.15 * X(1) + 0.96 * X(2) + 0.91 * X(3) - 1.62 * X(1) * X(2) - 2.2 * X(1) * X(3) - 0.78 * X(2) * X(3)


     'Add headers to the worksheet on row 1
Set oSheet1 = oBook.Worksheets(1)
Set oSheet2 = oBook.Worksheets(2)

    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"
oExcel.Quit
 22222

End Sub
```

APPENDIX J
Basic computer program for Scheffe's flexural strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
       Cls
       ReDim X(4)

       '   SCHEFFE'S SIMPLEX MODEL FOR FLEXURAL STRENGTH (3-COMPONENT MIX)
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR STRENGTH GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1 ELSE TYPE 0",
"TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
    A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

    YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


       Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

         Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

       X(1) = 0: X(2) = 0: X(3) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
     If F + 1 > 4 Then GoTo 30
25     X(E) = Y1: X(F + 1) = Y2


     If T = 100 Then T = 1: GoTo 30
     T = T + 1
     GoTo 2000
28     GoTo 20
30     If U = 3 Then U = 1: GoTo 40
     X(1) = 0: X(2) = 0: X(3) = 0
     U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40     If V = 3 Then GoTo 50
     V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
     X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50     Rem THREE COMPONENTS
     Rem FIRST ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60     Rem
70     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
     If T = 99 Then GoTo 80
     T = T + 1:
     GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80     Rem SECOND ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
     Rem

     If T = 99 Then GoTo 120
     T = T + 1
     GoTo 2000
115    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120    Rem THIRD ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 160
     T = T + 1
     GoTo 2000
155    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160    Rem FOURTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 200
     T = T + 1
     GoTo 2000
195    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200    Rem FIFTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 240
     T = T + 1
     GoTo 2000
235    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
     Rem SIXTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
     If T = 99 Then GoTo 270
     T = T + 1
     GoTo 2000
265  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270  Rem FOUR COMPONENTS

     Rem FIRST ROUND
 '   Print " THIS IS CHINENYE"
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290  Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
     If T = 79 Then GoTo 300
     T = T + 1
     GoTo 2000
295  GoTo 280
300  Rem SECOND ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 79 Then GoTo 330
     T = T + 1
     GoTo 2000
325  GoTo 310

330  Rem THIRD ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 79 Then GoTo 360
     T = T + 1
     GoTo 2000
355  GoTo 340

360  Rem FOURTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 69 Then GoTo 390
     T = T + 1
     GoTo 2000
385  GoTo 370

390  Rem FIFTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 69 Then GoTo 420
     T = T + 1
     GoTo 2000
415  GoTo 410

420  Rem SIXTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655   GoTo 640

660   Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685   GoTo 670

690   Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715    GoTo 700

720   Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755   Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760   Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795   Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800

2000     Rem PRINTING OF RESULTS

      Y = 1.45 * X(1) + 0.26 * X(2) + 0.23 * X(3) - 2.3 * X(1) * X(2) - 2.28 * X(1) * X(3) - 0.06 * X(2) * X(3)


       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 1.45 * X(1) + 0.26 * X(2) + 0.23 * X(3) - 2.3 * X(1) * X(2) - 2.28 * X(1)
* X(3) - 0.06 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810   NP = NP + 1
```

```
      CT = CT + 1
      For I = 1 To 3: Z(I) = 0: Next I
      For I = 1 To 3
      For J = 1 To 3
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
 Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")



830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM STRENGTH OF BLOCK PREDICTABLE BY THIS
MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")
```

```
  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

      GoTo 22222

900
      Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

      GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

      B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
      B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
      B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



      Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
      Z(1) = InputBox("ENTER THE VALUE OF WATER")
      Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
      Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


      Rem   ***   PSEUDO MIXTURE COMPONENTS    ***
      For I = 1 To 3
      For J = 1 To 3
      X(I) = X(I) + B(I, J) * Z(J)
      Next J
      Next I


      Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****


      YM = 1.45 * X(1) + 0.26 * X(2) + 0.23 * X(3) - 2.3 * X(1) * X(2) - 2.28 * X(1) * X(3) - 0.06 * X(2) * X(3)


       'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)


      MIXX(1, 1) = Format(Z(1), "0.00#")
      MIXX(1, 2) = Format(Z(2), "0.00#")
      MIXX(1, 3) = Format(Z(3), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

22222

End Sub
```

APPENDIX K
Basic computer program for Scheffe's split tensile strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
      Cls
      ReDim X(4)

      '   SCHEFFE'S SIMPLEX MODEL FOR SPLIT TENSILE STRENGTH (3-COMPONENT MIX)
4   Print "    THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR STRENGTH GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1 ELSE TYPE 0",
"TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
    A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

    YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


      Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

         Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

      X(1) = 0: X(2) = 0: X(3) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
      If F + 1 > 4 Then GoTo 30
25      X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28      GoTo 20
30      If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40      If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50      Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60      Rem
70      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80      Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000      Rem PRINTING OF RESULTS


      Y = 0.29 * X(1) + 0.09 * X(2) + 0.16 * X(3) + 0.12 * X(1) * X(2) - 0.3 * X(1) * X(3) + 0.22 * X(2) * X(3)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 0.29 * X(1) + 0.09 * X(2) + 0.16 * X(3) + 0.12 * X(1) * X(2) - 0.3 *
X(1) * X(3) + 0.22 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
      CT = CT + 1
      For I = 1 To 3: Z(I) = 0: Next I
      For I = 1 To 3
      For J = 1 To 3
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")

830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM STRENGTH OF BLOCK PREDICTABLE BY THIS
MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")
```

```
  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

      GoTo 22222

900
      Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

      GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

      B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
      B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
      B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948


      Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
      Z(1) = InputBox("ENTER THE VALUE OF WATER")
      Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
      Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


      Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
      For I = 1 To 3
      For J = 1 To 3
      X(I) = X(I) + B(I, J) * Z(J)
      Next J
      Next I


      Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****


      YM = 0.29 * X(1) + 0.09 * X(2) + 0.16 * X(3) + 0.12 * X(1) * X(2) - 0.3 * X(1) * X(3) + 0.22 * X(2) * X(3)


       'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)


      MIXX(1, 1) = Format(Z(1), "0.00#")
      MIXX(1, 2) = Format(Z(2), "0.00#")
      MIXX(1, 3) = Format(Z(3), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

22222

End Sub
```

APPENDIX L
Basic computer program for Scheffe's Poisson's ratio model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '  SCHEFFE'S SIMPLEX MODEL FOR POISSON'S RATIO (3-COMPONENT MIX)
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
POSSON'S RATIO OR POISSON'S RATIO GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1
ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
   A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

   YY = InputBox("WHAT IS THE DESIRED POISSON'S RATIO?"): YY = YY * 1


     Q = -4
10    X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11    X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12    X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

        Rem TWO COMPONENTS
14    E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

     X(1) = 0: X(2) = 0: X(3) = 0
20    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
    If F + 1 > 4 Then GoTo 30
25  X(E) = Y1: X(F + 1) = Y2


    If T = 100 Then T = 1: GoTo 30
    T = T + 1
    GoTo 2000
28  GoTo 20
30  If U = 3 Then U = 1: GoTo 40
    X(1) = 0: X(2) = 0: X(3) = 0
    U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40  If V = 3 Then GoTo 50
    V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
    X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50  Rem THREE COMPONENTS
    Rem FIRST ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60  Rem
70  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
    If T = 99 Then GoTo 80
    T = T + 1:
    GoTo 2000
75   Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80  Rem SECOND ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
    Rem

    If T = 99 Then GoTo 120
    T = T + 1
    GoTo 2000
115  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120  Rem THIRD ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 160
    T = T + 1
    GoTo 2000
155  Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160  Rem FOURTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 200
    T = T + 1
    GoTo 2000
195  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200  Rem FIFTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 240
    T = T + 1
    GoTo 2000
235  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
    If T = 59 Then GoTo 450
    T = T + 1
    GoTo 2000
445 GoTo 430

450 Rem SEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 59 Then GoTo 480
    T = T + 1
    GoTo 2000
475 GoTo 460

480 Rem EIGTHTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 49 Then GoTo 510
    T = T + 1
    GoTo 2000
505 GoTo 490

510 Rem NINETH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 49 Then GoTo 540
    T = T + 1
    GoTo 2000
535 GoTo 520

540 Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 39 Then GoTo 570
    T = T + 1
    GoTo 2000
565 GoTo 550

570 Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 39 Then GoTo 600
    T = T + 1
    GoTo 2000
595 GoTo 580

600 Rem ELEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 29 Then GoTo 630
    T = T + 1
    GoTo 2000
625 GoTo 610

630 Rem TWELVETH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000      Rem PRINTING OF RESULTS


      Y = 0.17 * X(1) + 0.14 * X(2) + 0.11 * X(3) - 0.22 * X(1) * X(2) - 0.28 * X(1) * X(3) - 0.14 * X(2) * X(3)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 0.17 * X(1) + 0.14 * X(2) + 0.11 * X(3) - 0.22 * X(1) * X(2) - 0.28 *
X(1) * X(3) - 0.14 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
      CT = CT + 1
      For I = 1 To 3: Z(I) = 0: Next I
      For I = 1 To 3
      For J = 1 To 3
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
 Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")

830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("POISSON'S RATIO", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM POISSON'S RATIO OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
    oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")
```

```
  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

     GoTo 22222

900
     Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

     GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

     B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
     B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
     B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



     Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
     Z(1) = InputBox("ENTER THE VALUE OF WATER")
     Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
     Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


     Rem   ***   PSEUDO MIXTURE COMPONENTS    ***
     For I = 1 To 3
     For J = 1 To 3
     X(I) = X(I) + B(I, J) * Z(J)
     Next J
     Next I

     Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

     YM = 0.17 * X(1) + 0.14 * X(2) + 0.11 * X(3) - 0.22 * X(1) * X(2) - 0.28 * X(1) * X(3) - 0.14 * X(2) * X(3)


      'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)


     MIXX(1, 1) = Format(Z(1), "0.00#")
     MIXX(1, 2) = Format(Z(2), "0.00#")
     MIXX(1, 3) = Format(Z(3), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("POISSON'S RATIO", " ", "WATER", "CEMENT", "LATERITE")

   oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit


22222

End Sub
```

APPENDIX M
Basic computer program for Scheffe's static modulus of elasticity model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
     Cls
     ReDim X(4)

     '   SCHEFFE'S SIMPLEX MODEL FOR STATIC MODULUS OF ELASTICITY (3-COMPONENT MIX)
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STATIC MODULUS OR STATIC MODULUS GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1
ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
   A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

   YY = InputBox("WHAT IS THE DESIRED STATIC MODULUS?"): YY = YY * 1


      Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

         Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

      X(1) = 0: X(2) = 0: X(3) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
     If F + 1 > 4 Then GoTo 30
25     X(E) = Y1: X(F + 1) = Y2


     If T = 100 Then T = 1: GoTo 30
     T = T + 1
     GoTo 2000
28     GoTo 20
30     If U = 3 Then U = 1: GoTo 40
     X(1) = 0: X(2) = 0: X(3) = 0
     U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40     If V = 3 Then GoTo 50
     V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
     X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50     Rem THREE COMPONENTS
     Rem FIRST ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60     Rem
70     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
     If T = 99 Then GoTo 80
     T = T + 1:
     GoTo 2000
75     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80     Rem SECOND ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
     Rem

     If T = 99 Then GoTo 120
     T = T + 1
     GoTo 2000
115    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120    Rem THIRD ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 160
     T = T + 1
     GoTo 2000
155    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160    Rem FOURTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 200
     T = T + 1
     GoTo 2000
195    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200    Rem FIFTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

     If T = 99 Then GoTo 240
     T = T + 1
     GoTo 2000
235    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295    GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
     If T = 59 Then GoTo 450
     T = T + 1
     GoTo 2000
445  GoTo 430

450  Rem SEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 59 Then GoTo 480
     T = T + 1
     GoTo 2000
475  GoTo 460

480  Rem EIGTHTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 49 Then GoTo 510
     T = T + 1
     GoTo 2000
505  GoTo 490

510  Rem NINETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 49 Then GoTo 540
     T = T + 1
     GoTo 2000
535  GoTo 520

540  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 39 Then GoTo 570
     T = T + 1
     GoTo 2000
565  GoTo 550

570  Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590  Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 39 Then GoTo 600
     T = T + 1
     GoTo 2000
595  GoTo 580

600  Rem ELEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620  Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 29 Then GoTo 630
     T = T + 1
     GoTo 2000
625  GoTo 610

630  Rem TWELVETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685    GoTo 670


690    Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000       Rem PRINTING OF RESULTS

      Y = 5.15 * X(1) + 3.58 * X(2) + 3.35 * X(3) - 1.62 * X(1) * X(2) - 2.76 * X(1) * X(3) - 0.86 * X(2) * X(3)


       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 5.15 * X(1) + 3.58 * X(2) + 3.35 * X(3) - 1.62 * X(1) * X(2) - 2.76 *
X(1) * X(3) - 0.86 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830
```

```
810    NP = NP + 1
       CT = CT + 1
       For I = 1 To 3: Z(I) = 0: Next I
       For I = 1 To 3
       For J = 1 To 3
       Z(I) = Z(I) + A(I, J) * X(J)
       Next J
       Next I
       If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
       If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
      ' If QQQ = 15 Then QQQQ = InputBox("PRESS OK TO CONTINUE", , , 5500, 6000): QQQ = 1: Cls
       QQQ = QQQ + 1

820


       STRGTH(NP, 1) = Format(Y, "0.00#")
       MIX(NP, 1) = Format(Z(1), "0.00#")
       MIX(NP, 2) = Format(Z(2), "0.00#")
       MIX(NP, 3) = Format(Z(3), "0.00#")



830    If Q = -3 Then GoTo 11
       If Q = -2 Then GoTo 12
       If Q = -1 Then GoTo 13
       If Q = 0 Then GoTo 14
       If Q = 1 Then GoTo 28
       If Q = 2 Then GoTo 75
       If Q = 3 Then GoTo 115
       If Q = 4 Then GoTo 155
       If Q = 5 Then GoTo 195
       If Q = 6 Then GoTo 235
       If Q = 7 Then GoTo 265
       If Q = 8 Then GoTo 295
       If Q = 9 Then GoTo 325
       If Q = 10 Then GoTo 355
       If Q = 11 Then GoTo 385
       If Q = 12 Then GoTo 415
       If Q = 13 Then GoTo 445
       If Q = 14 Then GoTo 475
       If Q = 15 Then GoTo 505
       If Q = 16 Then GoTo 535
       If Q = 17 Then GoTo 565
       If Q = 18 Then GoTo 595
       If Q = 19 Then GoTo 625
       If Q = 20 Then GoTo 655
       If Q = 21 Then GoTo 685
       If Q = 22 Then GoTo 715
       If Q = 23 Then GoTo 755
       If PP = 7 Then GoTo 2100
       PP = PP + 1
       If Q = 24 Then GoTo 795


2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STATIC MODULUS", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM STATIC MODULUS OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
    oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
```

```
 oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")


oBook.SaveAs "D:\Book1.xls"

oExcel.Quit

    GoTo 22222

900
    Cls
 Y = 0
 For I = 1 To 5: X(I) = 0: Next I
 Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

    GoTo 3010

3010    Rem    ***  CONVERSION MATRIX    ****

    B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
    B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
    B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



    Rem   ***   ACTUAL MIXTURE COMPONENTS    ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


    Rem   ***   PSEUDO MIXTURE COMPONENTS    ***
    For I = 1 To 3
    For J = 1 To 3
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I


    Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 5.15 * X(1) + 3.58 * X(2) + 3.35 * X(3) - 1.62 * X(1) * X(2) - 2.76 * X(1) * X(3) - 0.86 * X(2) * X(3)


     'Add headers to the worksheet on row 1
 Set oSheet1 = oBook.Worksheets(1)
 Set oSheet2 = oBook.Worksheets(2)


    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("STATIC MODULUS", " ", "WATER", "CEMENT", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

22222

End Sub
```

APPENDIX N
Basic computer program for Scheffe's shear modulus model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
       Cls
       ReDim X(4)

       '   SCHEFFE'S SIMPLEX MODEL FOR SHEAR MODULUS (3-COMPONENT MIX)
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
SHEAR MODULUS OR SHEAR MODULUS GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1
ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
    A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

    YY = InputBox("WHAT IS THE DESIRED SHEAR MODULUS?"): YY = YY * 1


       Q = -4
10      X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11      X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12      X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

          Rem TWO COMPONENTS
14      E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

       X(1) = 0: X(2) = 0: X(3) = 0
20      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
    If F + 1 > 4 Then GoTo 30
25  X(E) = Y1: X(F + 1) = Y2


    If T = 100 Then T = 1: GoTo 30
    T = T + 1
    GoTo 2000
28  GoTo 20
30  If U = 3 Then U = 1: GoTo 40
    X(1) = 0: X(2) = 0: X(3) = 0
    U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40  If V = 3 Then GoTo 50
    V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
    X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50  Rem THREE COMPONENTS
    Rem FIRST ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60  Rem
70  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
    If T = 99 Then GoTo 80
    T = T + 1:
    GoTo 2000
75  Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80  Rem SECOND ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90  X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
    Rem

    If T = 99 Then GoTo 120
    T = T + 1
    GoTo 2000
115 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120 Rem THIRD ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 160
    T = T + 1
    GoTo 2000
155 Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160 Rem FOURTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 200
    T = T + 1
    GoTo 2000
195 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200 Rem FIFTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 240
    T = T + 1
    GoTo 2000
235 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270   Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295    GoTo 280
300   Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325   GoTo 310

330   Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355   GoTo 340

360   Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385   GoTo 370

390   Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415   GoTo 410

420   Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
    If T = 59 Then GoTo 450
    T = T + 1
    GoTo 2000
445 GoTo 430

450 Rem SEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 59 Then GoTo 480
    T = T + 1
    GoTo 2000
475 GoTo 460

480 Rem EIGTHTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 49 Then GoTo 510
    T = T + 1
    GoTo 2000
505 GoTo 490

510 Rem NINETH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 49 Then GoTo 540
    T = T + 1
    GoTo 2000
535 GoTo 520

540 Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 39 Then GoTo 570
    T = T + 1
    GoTo 2000
565 GoTo 550

570 Rem TENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590 Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
    If T = 39 Then GoTo 600
    T = T + 1
    GoTo 2000
595 GoTo 580

600 Rem ELEVENTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610 X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620 Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
    If T = 29 Then GoTo 630
    T = T + 1
    GoTo 2000
625 GoTo 610

630 Rem TWELVETH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655    GoTo 640

660    Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685    GoTo 670

690    Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715     GoTo 700

720    Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755    Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760    Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795    Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000       Rem PRINTING OF RESULTS


      Y = 2.2 * X(1) + 1.57 * X(2) + 1.51 * X(3) - 0.3 * X(1) * X(2) - 0.78 * X(1) * X(3) - 0.16 * X(2) * X(3)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 2.2 * X(1) + 1.57 * X(2) + 1.51 * X(3) - 0.3 * X(1) * X(2) - 0.78 * X(1)
* X(3) - 0.16 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
      If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
      CT = CT + 1
      For I = 1 To 3: Z(I) = 0: Next I
      For I = 1 To 3
      For J = 1 To 3
      Z(I) = Z(I) + A(I, J) * X(J)
      Next J
      Next I
      If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
      If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
      QQQ = QQQ + 1

820

      STRGTH(NP, 1) = Format(Y, "0.00#")
      MIX(NP, 1) = Format(Z(1), "0.00#")
      MIX(NP, 2) = Format(Z(2), "0.00#")
      MIX(NP, 3) = Format(Z(3), "0.00#")



830    If Q = -3 Then GoTo 11
      If Q = -2 Then GoTo 12
      If Q = -1 Then GoTo 13
      If Q = 0 Then GoTo 14
      If Q = 1 Then GoTo 28
      If Q = 2 Then GoTo 75
      If Q = 3 Then GoTo 115
      If Q = 4 Then GoTo 155
      If Q = 5 Then GoTo 195
      If Q = 6 Then GoTo 235
      If Q = 7 Then GoTo 265
      If Q = 8 Then GoTo 295
      If Q = 9 Then GoTo 325
      If Q = 10 Then GoTo 355
      If Q = 11 Then GoTo 385
      If Q = 12 Then GoTo 415
      If Q = 13 Then GoTo 445
      If Q = 14 Then GoTo 475
      If Q = 15 Then GoTo 505
      If Q = 16 Then GoTo 535
      If Q = 17 Then GoTo 565
      If Q = 18 Then GoTo 595
      If Q = 19 Then GoTo 625
      If Q = 20 Then GoTo 655
      If Q = 21 Then GoTo 685
      If Q = 22 Then GoTo 715
      If Q = 23 Then GoTo 755
      If PP = 7 Then GoTo 2100
      PP = PP + 1
      If Q = 24 Then GoTo 795


2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("SHEAR MODULUS", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM SHEAR MODULUS OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
```

```
  oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
  oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")


 oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

     GoTo 22222

900
     Cls
  Y = 0
  For I = 1 To 5: X(I) = 0: Next I
  Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

     GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

     B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
     B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
     B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



     Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
     Z(1) = InputBox("ENTER THE VALUE OF WATER")
     Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
     Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


     Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
     For I = 1 To 3
     For J = 1 To 3
     X(I) = X(I) + B(I, J) * Z(J)
     Next J
     Next I


     Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

     YM = 2.2 * X(1) + 1.57 * X(2) + 1.51 * X(3) - 0.3 * X(1) * X(2) - 0.78 * X(1) * X(3) - 0.16 * X(2) * X(3)

      'Add headers to the worksheet on row 1
 Set oSheet1 = oBook.Worksheets(1)
 Set oSheet2 = oBook.Worksheets(2)


     MIXX(1, 1) = Format(Z(1), "0.00#")
     MIXX(1, 2) = Format(Z(2), "0.00#")
     MIXX(1, 3) = Format(Z(3), "0.00#")

   oSheet1.Range("B2").Value = YM
   oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
   oSheet1.Range("B1:G1").Value = Array("SHEAR MODULUS", " ", "WATER", "CEMENT", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"

 oExcel.Quit

22222

End Sub
```

APPENDIX O
Basic computer program for Scheffe's shear strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
 Dim oExcel As Object
  Dim oBook As Object
  Dim oSheet1 As Object
  Dim oSheet2 As Object

  'Start a new workbook in Excel
  Set oExcel = CreateObject("Excel.Application")
  Set oBook = oExcel.Workbooks.Add
 Rem ONE COMPONENT
      Cls
      ReDim X(4)

      '  SCHEFFE'S SIMPLEX MODEL FOR SHEAR STRENGTH (3-COMPONENT MIX)
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "    CHINENYE OKERE"
   Print:
   WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

   ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
   Dim NP As Variant


   KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
   ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
   XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
   Cls

   E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR STRENGTH GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN TYPE 1 ELSE TYPE 0",
"TYPE 1 OR 0 and CLICK OK")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
   If QQ = 0 Then GoTo 900
   Rem   ***   CONVERSION MATRIX   ***
   A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
   A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
   A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

   YY = InputBox("WHAT IS THE DESIRED STRENGTH?"): YY = YY * 1


      Q = -4
10     X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11     X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12     X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

         Rem TWO COMPONENTS
14     E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

      X(1) = 0: X(2) = 0: X(3) = 0
20     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
    If F + 1 > 4 Then GoTo 30
25    X(E) = Y1: X(F + 1) = Y2


    If T = 100 Then T = 1: GoTo 30
    T = T + 1
    GoTo 2000
28    GoTo 20
30    If U = 3 Then U = 1: GoTo 40
    X(1) = 0: X(2) = 0: X(3) = 0
    U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40    If V = 3 Then GoTo 50
    V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
    X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50    Rem THREE COMPONENTS
    Rem FIRST ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60    Rem
70    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
    If T = 99 Then GoTo 80
    T = T + 1:
    GoTo 2000
75    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80    Rem SECOND ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
    Rem

    If T = 99 Then GoTo 120
    T = T + 1
    GoTo 2000
115    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120    Rem THIRD ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 160
    T = T + 1
    GoTo 2000
155    Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160    Rem FOURTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 200
    T = T + 1
    GoTo 2000
195    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200    Rem FIFTH ROUND
    Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
    E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

    If T = 99 Then GoTo 240
    T = T + 1
    GoTo 2000
235    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
     If T = 59 Then GoTo 450
     T = T + 1
     GoTo 2000
445    GoTo 430

450    Rem SEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 59 Then GoTo 480
     T = T + 1
     GoTo 2000
475    GoTo 460

480    Rem EIGTHTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 49 Then GoTo 510
     T = T + 1
     GoTo 2000
505    GoTo 490

510    Rem NINETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 49 Then GoTo 540
     T = T + 1
     GoTo 2000
535    GoTo 520

540    Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 39 Then GoTo 570
     T = T + 1
     GoTo 2000
565    GoTo 550

570    Rem TENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590    Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     If T = 39 Then GoTo 600
     T = T + 1
     GoTo 2000
595    GoTo 580

600    Rem ELEVENTH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
     E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620    Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
     If T = 29 Then GoTo 630
     T = T + 1
     GoTo 2000
625    GoTo 610

630    Rem TWELVETH ROUND
     Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655     GoTo 640

660     Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685     GoTo 670

690     Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715      GoTo 700

720     Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755     Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760     Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795     Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000        Rem PRINTING OF RESULTS


      Y = 0.36 * X(1) + 0.07 * X(2) + 0.06 * X(3) - 0.58 * X(1) * X(2) - 0.56 * X(1) * X(3) - 0.02 * X(2) * X(3)



       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
       If Y > OPSTRENGTH Then YOP = 0.36 * X(1) + 0.07 * X(2) + 0.06 * X(3) - 0.58 * X(1) * X(2) - 0.56 *
X(1) * X(3) - 0.02 * X(2) * X(3)
       If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I
```

```
        If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810     NP = NP + 1
        CT = CT + 1
        For I = 1 To 3: Z(I) = 0: Next I
        For I = 1 To 3
        For J = 1 To 3
        Z(I) = Z(I) + A(I, J) * X(J)
        Next J
        Next I
        If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
        If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
 Cls
        QQQ = QQQ + 1

820

        STRGTH(NP, 1) = Format(Y, "0.00#")
        MIX(NP, 1) = Format(Z(1), "0.00#")
        MIX(NP, 2) = Format(Z(2), "0.00#")
        MIX(NP, 3) = Format(Z(3), "0.00#")



830     If Q = -3 Then GoTo 11
        If Q = -2 Then GoTo 12
        If Q = -1 Then GoTo 13
        If Q = 0 Then GoTo 14
        If Q = 1 Then GoTo 28
        If Q = 2 Then GoTo 75
        If Q = 3 Then GoTo 115
        If Q = 4 Then GoTo 155
        If Q = 5 Then GoTo 195
        If Q = 6 Then GoTo 235
        If Q = 7 Then GoTo 265
        If Q = 8 Then GoTo 295
        If Q = 9 Then GoTo 325
        If Q = 10 Then GoTo 355
        If Q = 11 Then GoTo 385
        If Q = 12 Then GoTo 415
        If Q = 13 Then GoTo 445
        If Q = 14 Then GoTo 475
        If Q = 15 Then GoTo 505
        If Q = 16 Then GoTo 535
        If Q = 17 Then GoTo 565
        If Q = 18 Then GoTo 595
        If Q = 19 Then GoTo 625
        If Q = 20 Then GoTo 655
        If Q = 21 Then GoTo 685
        If Q = 22 Then GoTo 715
        If Q = 23 Then GoTo 755
        If PP = 7 Then GoTo 2100
        PP = PP + 1
        If Q = 24 Then GoTo 795


2100    'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
   oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")
    oSheet1.Range("J3").Resize(2).Value = "MAXIMUM SHEAR STRENGTH OF BLOCK PREDICTABLE BY
THIS MODEL IS"
    oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
    oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
```

```
 oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
 oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")


oBook.SaveAs "D:\Book1.xls"

oExcel.Quit

    GoTo 22222

900
    Cls
 Y = 0
 For I = 1 To 5: X(I) = 0: Next I
 Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***
    GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

    B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
    B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
    B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948



    Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
    Z(1) = InputBox("ENTER THE VALUE OF WATER")
    Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
    Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


    Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
    For I = 1 To 3
    For J = 1 To 3
    X(I) = X(I) + B(I, J) * Z(J)
    Next J
    Next I


    Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

    YM = 0.36 * X(1) + 0.07 * X(2) + 0.06 * X(3) - 0.58 * X(1) * X(2) - 0.56 * X(1) * X(3) - 0.02 * X(2) * X(3)


     'Add headers to the worksheet on row 1
Set oSheet1 = oBook.Worksheets(1)
Set oSheet2 = oBook.Worksheets(2)


    MIXX(1, 1) = Format(Z(1), "0.00#")
    MIXX(1, 2) = Format(Z(2), "0.00#")
    MIXX(1, 3) = Format(Z(3), "0.00#")

  oSheet1.Range("B2").Value = YM
  oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
  oSheet1.Range("B1:G1").Value = Array("STRENGTH", " ", "WATER", "CEMENT", "LATERITE")

 oBook.SaveAs "D:\Book1.xls"

oExcel.Quit

22222

End Sub
```

APPENDIX P
Basic computer program for Scheffe's water absorption model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
  Dim oExcel As Object
   Dim oBook As Object
   Dim oSheet1 As Object
   Dim oSheet2 As Object

   'Start a new workbook in Excel
   Set oExcel = CreateObject("Excel.Application")
   Set oBook = oExcel.Workbooks.Add
  Rem ONE COMPONENT
        Cls
        ReDim X(4)

        '   SCHEFFE'S SIMPLEX MODEL FOR WATER ABSORPTION(3-COMPONENT MIX)
    Print "     THE PROGRAM WAS WRITTEN BY"
    Print: Print
    Print "    CHINENYE OKERE"
    Print:
    WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls


'   CIVIL ENGINEERING DEPARTMENT, FUTO

    ReDim MIX(300, 4), STRGTH(300, 1), MIXX(1, 4)
    Dim NP As Variant


    KK = 0: MM = 1: CT = 0: OPSTRENGTH = 0: OPT1 = 0: OPT = 0: KKK = 0
    ReDim X(10), A(4, 4), Z(4), N(15), M(15), B(4, 4), XX(4), ZZ(4): QQQ = 1
    XX(1) = 0: XX(2) = 0: XX(3) = 0: XX(4) = 0
    Cls

    E1 = 1: E2 = 2: E3 = 3: E4 = 4:  J1 = 1: J2 = 0: J3 = 0: J4 = 0:  TT = 1
5  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
WATER ABSORPTION OR WATER ABSORPTION GIVEN MIX RATIO?", "IF THE RATIO IS KNOWN
TYPE 1 ELSE TYPE 0", "TYPE 1 OR 0 and CLICK OK")
    If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK and do so"):
GoTo 5
    If QQ = 0 Then GoTo 900
    Rem   ***   CONVERSION MATRIX   ***
    A(1, 1) = 0.8: A(1, 2) = 1: A(1, 3) = 1.28
    A(2, 1) = 1: A(2, 2) = 1: A(2, 3) = 1
    A(3, 1) = 8: A(3, 2) = 12.5: A(3, 3) = 16.67

    YY = InputBox("WHAT IS THE DESIRED WATER ABSORPTION?"): YY = YY * 1


        Q = -4
10      X(1) = 1: X(2) = 0: X(3) = 0:  Q = Q + 1: GoTo 2000:
11      X(1) = 0: X(2) = 1: X(3) = 0:  Q = Q + 1: GoTo 2000:
12      X(1) = 0: X(2) = 0: X(3) = 1:  Q = Q + 1: GoTo 2000:
13

            Rem TWO COMPONENTS
14      E = 1: R = 1: F = R: Y1 = 1: Y2 = 0: Y3 = 0: Y4 = 0: T = 1: U = 1: V = 1: Q = 1: QQ = 1

        X(1) = 0: X(2) = 0: X(3) = 0
20      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
```

```
      If F + 1 > 4 Then GoTo 30
25      X(E) = Y1: X(F + 1) = Y2


      If T = 100 Then T = 1: GoTo 30
      T = T + 1
      GoTo 2000
28      GoTo 20
30      If U = 3 Then U = 1: GoTo 40
      X(1) = 0: X(2) = 0: X(3) = 0
      U = U + 1: F = F + 1: Y1 = 1: Y2 = 0: GoTo 20

40      If V = 3 Then GoTo 50
      V = V + 1: E = E + 1: F = R + 1: R = F: Y1 = 1: Y2 = 0
      X(1) = 0: X(2) = 0: X(3) = 0: GoTo 20

50      Rem THREE COMPONENTS
      Rem FIRST ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0.1: Y4 = 0: T = 1
60      Rem
70      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3
      If T = 99 Then GoTo 80
      T = T + 1:
      GoTo 2000
75      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 70

80      Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0.01: Y4 = 0: T = 1
90      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      Rem

      If T = 99 Then GoTo 120
      T = T + 1
      GoTo 2000
115     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 90

120     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.01: Y3 = 0: Y4 = 0.1: T = 1
130     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 160
      T = T + 1
      GoTo 2000
155     Y1 = Y1 - 0.01: Y2 = Y2 + 0.01: GoTo 130

160     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0.1: Y3 = 0: Y4 = 0.01: T = 1
170     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 200
      T = T + 1
      GoTo 2000
195     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 170

200     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.01: Y4 = 0.1: T = 1
210     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4

      If T = 99 Then GoTo 240
      T = T + 1
      GoTo 2000
235     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01: GoTo 210
```

```
      Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.89: Y2 = 0: Y3 = 0.1: Y4 = 0.01: T = 1
240     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 270
      T = T + 1
      GoTo 2000
265     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01: GoTo 240

270     Rem FOUR COMPONENTS

      Rem FIRST ROUND
 '     Print " THIS IS CHINENYE"
       Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
       E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.01: Y3 = 0.1: Y4 = 0.1: T = 1
280      X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
290      Y1 = Y1 - 0.01: Y2 = Y2 + 0.01
       If T = 79 Then GoTo 300
       T = T + 1
       GoTo 2000
295      GoTo 280
300     Rem SECOND ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.01: Y4 = 0.1: T = 1
310     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
320     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 79 Then GoTo 330
      T = T + 1
      GoTo 2000
325     GoTo 310

330     Rem THIRD ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.79: Y2 = 0.1: Y3 = 0.1: Y4 = 0.01: T = 1
340     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
350     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 79 Then GoTo 360
      T = T + 1
      GoTo 2000
355     GoTo 340

360     Rem FOURTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.01: Y4 = 0.1: T = 1
370     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
380     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 69 Then GoTo 390
      T = T + 1
      GoTo 2000
385     GoTo 370

390     Rem FIFTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.69: Y2 = 0.2: Y3 = 0.1: Y4 = 0.01: T = 1
400     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
410     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 69 Then GoTo 420
      T = T + 1
      GoTo 2000
415     GoTo 410

420     Rem SIXTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.01: Y4 = 0.1: T = 1
430     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
440     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
```

```
      If T = 59 Then GoTo 450
      T = T + 1
      GoTo 2000
445   GoTo 430

450   Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.59: Y2 = 0.3: Y3 = 0.1: Y4 = 0.01: T = 1
460   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
470   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 59 Then GoTo 480
      T = T + 1
      GoTo 2000
475   GoTo 460

480   Rem EIGTHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.01: Y4 = 0.1: T = 1
490   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
500   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 49 Then GoTo 510
      T = T + 1
      GoTo 2000
505   GoTo 490

510   Rem NINETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.49: Y2 = 0.4: Y3 = 0.1: Y4 = 0.01: T = 1
520   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
530   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 49 Then GoTo 540
      T = T + 1
      GoTo 2000
535   GoTo 520

540   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.01: Y4 = 0.1: T = 1
550   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
560   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 39 Then GoTo 570
      T = T + 1
      GoTo 2000
565   GoTo 550

570   Rem TENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.39: Y2 = 0.5: Y3 = 0.1: Y4 = 0.01: T = 1
580   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
590   Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 39 Then GoTo 600
      T = T + 1
      GoTo 2000
595   GoTo 580

600   Rem ELEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.01: Y4 = 0.1: T = 1
610   X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
620   Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      If T = 29 Then GoTo 630
      T = T + 1
      GoTo 2000
625   GoTo 610

630   Rem TWELVETH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
```

```
      E = 1: R = 1: F = R: Y1 = 0.29: Y2 = 0.6: Y3 = 0.1: Y4 = 0.01: T = 1
640     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
650     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
      If T = 29 Then GoTo 660
      T = T + 1
      GoTo 2000
655     GoTo 640

660     Rem THIRTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.01: Y4 = 0.1: T = 1
670     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
680     Y1 = Y1 - 0.01: Y3 = Y3 + 0.01
      'GoTo 2000
      If T = 19 Then GoTo 690
      T = T + 1
      GoTo 2000
685     GoTo 670



690     Rem FOURTEENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0.19: Y2 = 0.7: Y3 = 0.1: Y4 = 0.01: T = 1
700     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
710     Y1 = Y1 - 0.01: Y4 = Y4 + 0.01
     ' GoTo 2000
      If T = 19 Then GoTo 720
      T = T + 1
       GoTo 2000
715      GoTo 700



720     Rem THREE COMPONENTS CONTIUES
      Rem SEVENTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.01: Y4 = 0.1: T = 1

750    X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 760
      T = T + 1
      GoTo 2000
755     Y2 = Y2 - 0.01: Y3 = Y3 + 0.01: GoTo 750

760     Rem EIGHTH ROUND
      Q = Q + 1: X(1) = 0: X(2) = 0: X(3) = 0: P = 1
      E = 1: R = 1: F = R: Y1 = 0: Y2 = 0.89: Y3 = 0.1: Y4 = 0.01: T = 1

790     X(E) = Y1: X(F + 1) = Y2: X(F + 2) = Y3: X(F + 3) = Y4
      If T = 99 Then GoTo 800
      T = T + 1
      GoTo 2000
795     Y2 = Y2 - 0.01: Y4 = Y4 + 0.01: GoTo 790
800


2000        Rem PRINTING OF RESULTS


      Y = 2.72 * X(1) + 5.57 * X(2) + 6.14 * X(3) + 3.06 * X(1) * X(2) + 3.96 * X(1) * X(3) - 0.7 * X(2) * X(3)


       If Y > OPSTRENGTH Then For I = 1 To 4: ZZ(I) = 0: Next I
```

```
        If Y > OPSTRENGTH Then YOP = 2.72 * X(1) + 5.57 * X(2) + 6.14 * X(3) + 3.06 * X(1) * X(2) + 3.96 *
X(1) * X(3) - 0.7 * X(2) * X(3)
        If Y > OPSTRENGTH Then OPSTRENGTH = Y: For I = 1 To 4: For J = 1 To 4: ZZ(I) = ZZ(I) + A(I, J) *
X(J): Next J: Next I


       If Y > YY - 0.1 And Y < YY + 0.1 Then GoTo 810 Else GoTo 830

810    NP = NP + 1
       CT = CT + 1
       For I = 1 To 3: Z(I) = 0: Next I
       For I = 1 To 3
       For J = 1 To 3
       Z(I) = Z(I) + A(I, J) * X(J)
       Next J
       Next I
       If Z(2) > 1.01 Or Z(2) < 0.9998 Then GoTo 830
       If Z(1) < 0 Or Z(2) < 0 Or Z(3) < 0 Or Z(4) < 0 Then GoTo 830
Cls
       QQQ = QQQ + 1

820

       STRGTH(NP, 1) = Format(Y, "0.00#")
       MIX(NP, 1) = Format(Z(1), "0.00#")
       MIX(NP, 2) = Format(Z(2), "0.00#")
       MIX(NP, 3) = Format(Z(3), "0.00#")



830    If Q = -3 Then GoTo 11
       If Q = -2 Then GoTo 12
       If Q = -1 Then GoTo 13
       If Q = 0 Then GoTo 14
       If Q = 1 Then GoTo 28
       If Q = 2 Then GoTo 75
       If Q = 3 Then GoTo 115
       If Q = 4 Then GoTo 155
       If Q = 5 Then GoTo 195
       If Q = 6 Then GoTo 235
       If Q = 7 Then GoTo 265
       If Q = 8 Then GoTo 295
       If Q = 9 Then GoTo 325
       If Q = 10 Then GoTo 355
       If Q = 11 Then GoTo 385
       If Q = 12 Then GoTo 415
       If Q = 13 Then GoTo 445
       If Q = 14 Then GoTo 475
       If Q = 15 Then GoTo 505
       If Q = 16 Then GoTo 535
       If Q = 17 Then GoTo 565
       If Q = 18 Then GoTo 595
       If Q = 19 Then GoTo 625
       If Q = 20 Then GoTo 655
       If Q = 21 Then GoTo 685
       If Q = 22 Then GoTo 715
       If Q = 23 Then GoTo 755
       If PP = 7 Then GoTo 2100
       PP = PP + 1
       If Q = 24 Then GoTo 795

2100   'Add headers to the worksheet on row 1
   Set oSheet1 = oBook.Worksheets(1)
   Set oSheet2 = oBook.Worksheets(2)
   oSheet1.Range("A2").Resize(NP + 1, 2).Value = STRGTH

   oSheet1.Range("C2:F2").Resize(NP + 1, 5).Value = MIX
```

```
  oSheet1.Range("B1:G1").Value = Array("WATER ABSORPTION", " ", "WATER", "CEMENT", "LATERITE")
   oSheet1.Range("J3").Resize(2).Value = "MAXIMUM WATER ABSORPTION OF BLOCK PREDICTABLE
BY THIS MODEL IS"
   oSheet1.Range("J4").Resize(2).Value = Format(OPSTRENGTH, "0.##")
   oSheet1.Range("J5").Resize(2).Value = "THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:"
   oSheet1.Range("I7:L7").Resize(1, 5).Value = ZZ
   oSheet1.Range("J6:M6").Value = Array("WATER", "CEMENT", "LATERITE")

  oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

     GoTo 22222

900
     Cls
   Y = 0
   For I = 1 To 5: X(I) = 0: Next I
   Rem   ***  RESPONSE AT THE CHOSEN 10 POINTS ON THE FACTOR SPACE FOR THE MODEL  ***

     GoTo 3010

3010    Rem   ***  CONVERSION MATRIX   ****

     B(1, 1) = 9.788732: B(1, 2) = -1.57277: B(1, 3) = -0.65728
     B(2, 1) = -20.3521:  B(2, 2) = 7.267606: B(2, 3) = 1.126761
     B(3, 1) = 10.56338: B(3, 2) = -4.69484: B(3, 3) = -0.46948

     Rem   ***   ACTUAL MIXTURE COMPONENTS   ****
     Z(1) = InputBox("ENTER THE VALUE OF WATER")
     Z(2) = InputBox("ENTER THE VALUE OF CEMENT")
     Z(3) = InputBox("ENTER THE VALUE OF LATERITE")


     Rem   ***   PSEUDO MIXTURE COMPONENTS   ***
     For I = 1 To 3
     For J = 1 To 3
     X(I) = X(I) + B(I, J) * Z(J)
     Next J
     Next I

     Rem   ***  CALCULATING THE STRENGTH (RESPONSE)  ****

     YM = 2.72 * X(1) + 5.57 * X(2) + 6.14 * X(3) + 3.06 * X(1) * X(2) + 3.96 * X(1) * X(3) - 0.7 * X(2) * X(3)

       'Add headers to the worksheet on row 1
  Set oSheet1 = oBook.Worksheets(1)
  Set oSheet2 = oBook.Worksheets(2)

      MIXX(1, 1) = Format(Z(1), "0.00#")
     MIXX(1, 2) = Format(Z(2), "0.00#")
     MIXX(1, 3) = Format(Z(3), "0.00#")

    oSheet1.Range("B2").Value = YM
    oSheet1.Range("C1:F1").Resize(2, 5).Value = MIXX
    oSheet1.Range("B1:G1").Value = Array("WATER ABSORPTION", " ", "WATER", "CEMENT",
"LATERITE")

   oBook.SaveAs "D:\Book1.xls"

  oExcel.Quit

22222

End Sub
```

APPENDIX Q
Basic computer program for Osadebe's compressive strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS COMPRESSIVE STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem        ***      COEFFICIENTS OF REGRESSION     ***
   A1 = -6966.04490315801: A2 = -14802.6749056224: A3 = -418.03499523052: A4 = -27.1957522479186: A5 =
47847.7314225008
   A6 = 1380.9410175828: A7 = 7862.32541420528: A8 = 20697.8300338606: A9 = 13162.9245724559: A10 =
842.338961088947

   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     GRANITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
   Next Z2
   Next Z1
```

```
111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is Periwinkle value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CACCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      GRANITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX R
Basic computer program for Osadebe's flexural strength model (4-component mix)

```
Private Sub ENDMNU_Click()

End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'  CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS FLEXURAL STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'  CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem      ***    COEFFICIENTS OF REGRESSION    ***

  A1 = 13727.2363480504: A2 = 10481.001122677: A3 = 439.440864179556: A4 = 58.1329643513326: A5 = -
41182.5842876454
  A6 = -12990.6399989161:  A7 = -15587.2539152075: A8 = -14572.8760065522: A9 = -9466.84133468021:
A10 = -556.939121454224



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
```

```
   Next Z2
   Next Z1

111  GoTo 222


100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX S
Basic computer program for Osadebe's split tensile strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SPLIT TENSILE STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem        ***     COEFFICIENTS OF REGRESSION     ***
  A1 = -4793.19523436804:     A2 = -11636.6975206017: A3 = -495.874636263993: A4 = -21.4279101612862:
A5 = 32454.1714272563
  A6 = 1728.85172268577: A7 = 5464.9271960969:          A8 = 17027.7606626524:       A9 = 10547.8890241626:
A10 = 763.606463880637



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
   Next Z2
```

```
   Next Z1

111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CACCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX T
Basic computer program for Osadebe's Poisson's ratio model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS POISSON'S RATIO OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem        ***      COEFFICIENTS OF REGRESSION     ***

   A1 = 48.8362759827578: A2 = -169.892092009225: A3 = -13.9646612684239: A4 = -0.948185631372473: A5
= 508.624210259233
   A6 = -231.893286043821: A7 = -35.8359189746238: A8 = 316.77880796184: A9 = 116.568428450998: A10 =
34.2769360903508


   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED POISSON'S RATIO OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
POISSON'S RATIO OR CALCULATING POISSON'S RATIO GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF POISSON'S RATIO DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED POISSON'S RATIO?"): YY = 1 * YY
   Rem    *** Here is where the Actual Poisson's ratio is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL POISSON'S RATIO
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Poisson's ratio" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
```

```
    Next Z2
    Next Z1

111  GoTo 222


100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
    Cls
    Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
    Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
    Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
    Z4 = InputBox("What is laterite value"): Z4 = Z4 * 1

    TZT = Z1 + Z2 + Z3 + Z4 + Z5
    Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
    Z4 = Z4 / TZT
    Rem    ***    The Binary Predictors will be calculated here   ***
    Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
    Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


    Rem CALCULATING ACTUAL poisson's ratio
    YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
    YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



    Text1.Text = Text1.Text + CStr("POISSON'S RATIO" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX U
Basic computer program for Osadebe's static modulus of elasticity model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS STATIC MODULUS OF ELASTICITY OPTIMIZATION PROGRAM BASED ON OSADEBE'S
MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem        ***     COEFFICIENTS OF REGRESSION     ***

   A1 = 12567.3099340923: A2 = 16631.9595594516: A3 = 631.900936117473: A4 = 54.4212315507641: A5 = -
51077.9249580376
   A6 = -10239.1754943973: A7 = -14205.4905996808: A8 = -23413.1739503925: A9 = -15505.7063333306:
A10 = -801.304747304491



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STATIC MODULUS OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STATIC MODULUS OR CALCULATING STATIC MODULUS GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STATIC MODULUS DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STATIC MODULUS VALUE?"): YY = 1 * YY
   Rem    *** Here is where the Actual Value is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("YOUNG'S MOD." & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
```

```
   Next Z2
   Next Z1

111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is Laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("STATIC MOD." & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX V
Basic computer program for Osadebe's shear modulus model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SHEAR MODULUS OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem       ***     COEFFICIENTS OF REGRESSION     ***

   A1 = 5756.05770997565: A2 = 7608.48041925483: A3 = 295.570091113285: A4 = 27.2924362221864: A5 = -
23975.4721158656
   A6 = -4390.28501306319: A7 = -6543.87705518656: A8 = -10799.9256341465: A9 = -6999.45201811421:
A10 = -407.637531109557



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED SHEAR MODULUS OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
SHEAR MODULUS OR CALCULATING SHEAR MODULUS GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF SHEAR MODULUS DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED SHEAR MODULUS?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("SHEAR MODULUS" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
   Next Z2
```

```
   Next Z1

111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CACCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("SHEAR MOD.." & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX W
Basic computer program for Osadebe's shear strength model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SHEAR STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem       ***     COEFFICIENTS OF REGRESSION     ***

   A1 = 3390.55317892353: A2 = 2598.65157488401: A3 = 110.061300418883: A4 = 14.3697659198775: A5 = -
10166.3354160786
   A6 = -3214.08720209585: A7 = -3850.13841698824: A8 = -3619.03666908252: A9 = -2349.15691642073:
A10 = -138.826021828407



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED SHEAR STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
   Next Z2
```

```
   Next Z1

111  GoTo 222


100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is Laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX X
Basic computer program for Osadebe's water absorption model (4-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS WATER OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem        ***     COEFFICIENTS OF REGRESSION     ***

   A1 = 132881.633295192: A2 = 57058.3802569897: A3 = 2340.53127688977: A4 = 764.555891976722: A5 = -
353028.880416606
   A6 = -117079.732579241: A7 = -153864.338298255: A8 = -78303.4398639571: A9 = -44261.7186689423:
A10 = -4804.28572771013


   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED WATER ABSORPTION OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
WATER ABSORPTION OR CALCULATING WATER ABSORPTION GIVEN MIX RATIO?", " IF THE
STRENGHT IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF WATER ABSORPTION DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED WATER ABSORPTION?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.066 To 0.082 Step 0.0001
   For Z2 = 0.033 To 0.11 Step 0.001
   For Z3 = 0.11 To 0.33 Step 0.001
   Z4 = 1 - Z1 - Z2 - Z3
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4
   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10
   If Z1 + Z2 + Z3 + Z4 > 1 Or Z1 + Z2 + Z3 + Z4 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Water Absorption" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     GRANITE  =" & vbTab & Format(Z4 / Z2, "0.00#")) & vbCrLf


30
   Next Z3
   Next Z2
   Next Z1
```

```
111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Sand value"): Z3 = Z3 * 1
   Z4 = InputBox("What is Laterite value"): Z4 = Z4 * 1

   TZT = Z1 + Z2 + Z3 + Z4 + Z5
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT
   Z4 = Z4 / TZT
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z5 = Z1 * Z2: Z6 = Z1 * Z3: Z7 = Z1 * Z4
   Z8 = Z2 * Z3:    Z9 = Z2 * Z4: Z10 = Z3 * Z4


   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Water Absorption" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      SAND  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z4 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX Y
Basic computer program for Osadebe's compressive strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS COMPRESSIVE STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem      ***    COEFFICIENTS OF REGRESSION     ***

   A1 = 50451.9949226952: A2 = 7182.67670488176: A3 = 144.550318278863
   A4 = -94207.4007347599: A5 = -55938.0434543685: A6 = -5461.36552988365



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1
```

```
111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf





222

End Sub
```

APPENDIX Z
Basic computer program for Osadebe's flexural strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS FLEXURAL STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem       ***     COEFFICIENTS OF REGRESSION     ***

  A1 = 25849.8089754967: A2 = 1395.52979839331: A3 = 107.533606096612
  A4 = -38734.2011427185: A5 = -29276.9469510115: A6 = -783.757203684392


   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1


111  GoTo 222
```

```
100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX AA
Basic computer program for Osadebe's split tensile strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
      WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SPLIT TENSILE STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem       ***     COEFFICIENTS OF REGRESSION     ***

  A1 = -21787.2052689432: A2 = -2505.61787917168: A3 = -64.7220318058017
  A4 = 39331.580968004: A5 = 24238.6028505548: A6 = 1734.59606500223


   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED STRENGTH OR OTHER
WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1


111  GoTo 222
```

```
100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6


   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX BB
Basic computer program for Osadebe's Poisson's ratio model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS POISSON'S RATIO OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem        ***      COEFFICIENTS OF REGRESSION     ***


   A1 = 8790.55198816118: A2 = 1164.12680329505: A3 = 27.390833873326
   A4 = -16111.1579269419: A5 = -9787.04681699152: A6 = -866.384338105587



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED POISSON'S RATIO OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
POISSON'S RATIO OR CALCULATING POISSON'S RATIO GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF POISSON'S RATIO DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED POISSON'S RATIO?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Poisson's ratio" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30
```

```
    Next Z2
    Next Z1

111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
    Cls
    Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
    Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
    Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


    TZT = Z1 + Z2 + Z3 + Z4
    Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

    Rem    ***    The Binary Predictors will be calculated here   ***
    Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



    Rem CALCULATING ACTUAL STRENGTH
    YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6




    Text1.Text = Text1.Text + CStr("Poisson's ratio" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf




222

End Sub
```

APPENDIX CC
Basic computer program for Osadebe's static modulus of elasticity model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS STATIC MODULUS OF ELASTICITY OPTIMIZATION PROGRAM BASED ON OSADEBE'S
MODEL (3 COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem        ***      COEFFICIENTS OF REGRESSION     ***

  A1 = 42516.379586759: A2 = 6748.3371689363: A3 = 119.017771407667
  A4 = -81541.550174363: A5 = -47030.2590186952: A6 = -5258.96320937351



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED YOUNG'S MODULUS OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STATIC MODULUS OR CALCULATING STATIC MODULUS GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STATIC MODULUS DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STATIC MODULUS?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Young's modulus" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1
```

```
111  GoTo 222


100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6
   YACT = YACT + A7 * Z7 + A8 * Z8 + A9 * Z9 + A10 * Z10



   Text1.Text = Text1.Text + CStr("Young's modulus" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf





222

End Sub
```

APPENDIX DD
Basic computer program for Osadebe's shear modulus model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SHEAR MODULUS/MODULUS OF RIGIDITY OPTIMIZATION PROGRAM BASED ON
OSADEBE'S MODEL (3 COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

  Rem        ***      COEFFICIENTS OF REGRESSION     ***

  A1 = 4443.31053151004: A2 = 1204.16918141107: A3 = 6.84979765917819
  A4 = -10182.2271906562: A5 = -4786.36713345669: A6 = -1023.01218433733



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED SHEAR MODULUS OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
SHEAR MODULUS OR CALCULATING SHEAR MODULUS GIVEN MIX RATIO?", " IF THE STRENGHT
IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF SHEAR MODULUS DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED SHEAR MODULUS?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Shear Modulus" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1
```

```
111  GoTo 222


100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here    ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6



   Text1.Text = Text1.Text + CStr("Shear modulus" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf



222

End Sub
```

APPENDIX EE
Basic computer program for Osadebe's shear strength model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS SHEAR STRENGTH OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem       ***     COEFFICIENTS OF REGRESSION     ***

  A1 = 6430.90131937387: A2 = 347.92945639152: A3 = 26.7439487094557
  A4 = -9637.47755570148: A5 = -7283.2872393516: A6 = -195.852212367246



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED SHEAR STRENGTH OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
STRENGTH OR CALCULATING STRENGTH GIVEN MIX RATIO?", " IF THE STRENGHT IS KNOWN
TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF STRENGTH DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED STRENGHT?"): YY = 1 * YY
   Rem    *** Here is where the Actual Strength is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1
```

```
111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3



   Rem CALCULATING ACTUAL STRENGTH
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6




   Text1.Text = Text1.Text + CStr("Strength" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf

222

End Sub
```

APPENDIX FF
Basic computer program for Osadebe's water absorption model (3-component mix)

```
Private Sub ENDMNU_Click()
End
End Sub

Private Sub STARTMNU_Click()
Cls
   Print "     THE PROGRAM WAS WRITTEN BY"
   Print: Print
   Print "     CHINENYE OKERE"
   Print:
     WWWWW = InputBox("CLICK OK. TO CONTINUE"): Cls
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   ' IT IS WATER ABSORPTION OPTIMIZATION PROGRAM BASED ON OSADEBE'S MODEL (3
COMPONENTS)
'   CIVIL ENGINEERING DEPARTMENT, FUTO
   CT = 0: YMAX = 0: KK = 0

   ReDim X(10), A(5, 5), Z(5), N(15), B(5, 5)

 Rem       ***     COEFFICIENTS OF REGRESSION     ***

 A1 = 31592.2623645663: A2 = 7544.87640308548: A3 = 44.5658361435185
 A4 = -73590.953947736: A5 = -34082.1748412533: A6 = -5982.14703748509



   Rem  ***   DECISION FOR CALCULATING MIX RATIOS GIVEN DESIRED WATER ABSORPTION OR
OTHER WISE  ***
10  QQ = InputBox("WHAT DO YOU WANT TO DO? TO CALCULATE MIX RATIOS GIVEN DESIRED
WATER ABSORPTION OR CALCULATING WATER ABSORPTION GIVEN MIX RATIO?", " IF THE
STRENGHT IS KNOWN TYPE 1 ELSE TYPE 0", "Type 1 or 0  and CLICK OK.")
   If QQ <> 1 And QQ <> 0 Then EE = InputBox("No Way! You must ENTER 1 or 0", , "CLICK OK  and do so"):
GoTo 10
   If QQ = 0 Then GoTo 100
   Rem PUT IN THE VALUE OF WATER ABSORPTION DESIRED HERE
   YY = InputBox("WHAT IS THE DESIRED WATER ABSORPTION?"): YY = 1 * YY
   Rem    *** Here is where the Actual value is calculated    ***
   For Z1 = 0.06 To 0.082 Step 0.0001
   For Z2 = 0.05 To 0.11 Step 0.001

   Z3 = 1 - Z1 - Z2
   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3

   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6

   If Z1 + Z2 + Z3 > 1 Or Z1 + Z2 + Z3 < 1 Then GoTo 30
   If YACT > YY - 0.001 And YACT < YY + 0.001 Then GoTo 20 Else GoTo 30

20    Text1.Text = Text1.Text + CStr("Water Absorption" & vbTab & Format(YACT, "0.0#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("     LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf


30

   Next Z2
   Next Z1
```

```
111  GoTo 222

100 Rem *** Here is where the INPUT of the Principal Predictors will be made   ***
   Cls
   Z1 = InputBox("What is Water/Cement ratio"): Z1 = Z1 * 1
   Z2 = InputBox("What is Cement value"): Z2 = Z2 * 1
   Z3 = InputBox("What is Laterite value"): Z3 = Z3 * 1


   TZT = Z1 + Z2 + Z3 + Z4
   Z1 = Z1 / TZT: Z2 = Z2 / TZT: Z3 = Z3 / TZT

   Rem    ***    The Binary Predictors will be calculated here   ***
   Z4 = Z1 * Z2: Z5 = Z1 * Z3: Z6 = Z2 * Z3


   Rem CALCULATING ACTUAL VALUE
   YACT = A1 * Z1 + A2 * Z2 + A3 * Z3 + A4 * Z4 + A5 * Z5 + A6 * Z6


   Text1.Text = Text1.Text + CStr("Water Absorption" & vbTab & Format(YACT, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      WATER   =" & vbTab & Format(Z1 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      CEMENT  =" & vbTab & Format(Z2 / Z2, "0.00#") & ",") & vbTab
      Text1.Text = Text1.Text + CStr("      LATERITE  =" & vbTab & Format(Z3 / Z2, "0.00#") & ",") & vbCrLf

222

End Sub
```

APPENDIX GG
SCHEFFE'S PROGRAM OUTPUT

COMPRESSIVE STRENGTH OUTPUT (for a specified strength of 3.0N/mm^2)

STRENGTH	WATER	CEMENT	SAND	LATERITE
3.01	0.8	1	3.2	4.8
2.992	0.802	1	3.206	4.84
2.975	0.804	1	3.211	4.879
2.957	0.806	1	3.217	4.919
2.94	0.808	1	3.222	4.958
2.923	0.81	1	3.228	4.998
2.986	0.805	1	3.201	4.885
2.963	0.81	1	3.203	4.971
2.94	0.814	1	3.204	5.056
2.916	0.819	1	3.205	5.141
2.975	0.814	1	3.193	4.977
2.941	0.828	1	3.186	5.154

MAXIMUM COMPRESSIVE STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS
3.01
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

COMPRESSIVE STRENGTH OUTPUT 2 (for specified mix ratios)

STRENGTH	WATER	CEMENT	SAND	LATERITE
3.009985	0.8	1	3.2	4.8
STRENGTH	WATER	CEMENT	SAND	LATERITE
2.03002	1	1	3.75	8.75
STRENGTH	WATER	CEMENT	SAND	LATERITE
1.63001	1.28	1	3.334	13.336
STRENGTH	WATER	CEMENT	SAND	LATERITE
1.260007	2.2	1	2.5	22.5
STRENGTH	WATER	CEMENT	SAND	LATERITE
2.320004	0.9	1	3.475	6.775

COMPRESSIVE STRENGTH OUTPUT 2 (for varied w/c ratio)

STRENGTH	WATER	CEMENT	SAND	LATERITE
1.856709	0.6	1	3.2	4.8
STRENGTH	WATER	CEMENT	SAND	LATERITE
2.709835	0.7	1	3.2	4.8
STRENGTH	WATER	CEMENT	SAND	LATERITE
2.757158	0.9	1	3.2	4.8
STRENGTH	WATER	CEMENT	SAND	LATERITE
2.056819	0.99	1	3.2	4.8
STRENGTH	WATER	CEMENT	SAND	LATERITE
1.951355	1	1	3.2	4.8

FLEXURAL STRENGTH OUTPUT (for a desired strength of 1.72N/mm^2)

FLEXURAL STRENGTH	WATER	CEMENT	SAND	LATERITE
1.72	0.8	1	3.2	4.8
1.701	0.802	1	3.206	4.84
1.683	0.804	1	3.211	4.879
1.665	0.806	1	3.217	4.919
1.647	0.808	1	3.222	4.958
1.629	0.81	1	3.228	4.998
1.697	0.805	1	3.201	4.885
1.675	0.81	1	3.203	4.971
1.653	0.814	1	3.204	5.056
1.631	0.819	1	3.205	5.141
1.7	0.814	1	3.193	4.977
1.679	0.828	1	3.186	5.154
1.659	0.842	1	3.179	5.331
1.64	0.856	1	3.172	5.508
1.62	0.87	1	3.165	5.685

MAXIMUM FLEXURAL STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS

1.72

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

FLEXURAL STRENGTH OUTPUT 2 (for desired mix ratios)

STRENGTH	WATER	CEMENT	SAND	LATERITE
10.04543	0.5	1	2	4

FLEXURAL STRENGTH	WATER	CEMENT	SAND	LATERITE
1.720008	0.8	1	3.2	4.8

FLEXURAL STRENGTH	WATER	CEMENT	SAND	LATERITE
1.170012	1	1	3.75	8.75

FLEXURAL STRENGTH	WATER	CEMENT	SAND	LATERITE
0.590043	1.28	1	3.334	13.336

FLEXURAL STRENGTH	WATER	CEMENT	SAND	LATERITE
0.790028	1.14	1	3.542	11.043

SPLIT OUTPUT (for a desired strength of 0.47N/mm^2)

STRENGHT	WATER	CEMENT	SAND	LATERITE
0.47	0.8	1	3.2	4.8
0.467	0.802	1	3.206	4.84
0.465	0.804	1	3.211	4.879
0.462	0.806	1	3.217	4.919
0.46	0.808	1	3.222	4.958
0.457	0.81	1	3.228	4.998
0.454	0.812	1	3.233	5.037
0.452	0.814	1	3.239	5.077
0.449	0.816	1	3.244	5.116
0.447	0.818	1	3.25	5.156
0.444	0.82	1	3.255	5.195
0.441	0.822	1	3.261	5.235
0.439	0.824	1	3.266	5.274
0.436	0.826	1	3.272	5.314
0.434	0.828	1	3.277	5.353
0.431	0.83	1	3.283	5.393
0.428	0.832	1	3.288	5.432
0.426	0.834	1	3.294	5.472
0.423	0.836	1	3.299	5.511
0.421	0.838	1	3.305	5.551
0.418	0.84	1	3.31	5.59
0.415	0.842	1	3.316	5.63
0.413	0.844	1	3.321	5.669
0.41	0.846	1	3.327	5.709
0.408	0.848	1	3.332	5.748
0.405	0.85	1	3.338	5.788
0.402	0.852	1	3.343	5.827
0.4	0.854	1	3.349	5.867

MAXIMUM SPLIT STRENGTH OF BLOCKS PREDICTABLE BY THIS MODEL IS 0.47N/mm^2

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

SPLIT OUTPUT 2 (for a specified mix ratio)

STRENGTH	WATER	CEMENT	SAND	LATERITE
0.210006	1	1	3.75	8.75

POISSON'S OUTPUT (for a specified ratio of 0.11)

POISSON'S RATIO	WATER	CEMENT	SAND	LATERITE
0.112	0.8	1	3.2	4.8
0.11	1	1	3.75	8.75
0.111	0.802	1	3.206	4.84
0.111	0.804	1	3.211	4.879
0.11	0.806	1	3.217	4.919
0.109	0.808	1	3.222	4.958
0.108	0.81	1	3.228	4.998
0.108	0.812	1	3.233	5.037
0.107	0.814	1	3.239	5.077
0.107	0.816	1	3.244	5.116
0.106	0.818	1	3.25	5.156
0.105	0.82	1	3.255	5.195
0.105	0.822	1	3.261	5.235
0.104	0.824	1	3.266	5.274
0.104	0.826	1	3.272	5.314
0.103	0.828	1	3.277	5.353
0.103	0.83	1	3.283	5.393
0.102	0.832	1	3.288	5.432
0.102	0.834	1	3.294	5.472
0.101	0.836	1	3.299	5.511
0.101	0.838	1	3.305	5.551
0.1	0.84	1	3.31	5.59
0.1	0.966	1	3.657	8.079
0.101	0.968	1	3.662	8.118
0.101	0.97	1	3.668	8.158
0.102	0.972	1	3.673	8.197
0.102	0.974	1	3.679	8.237
0.103	0.976	1	3.684	8.276
0.103	0.978	1	3.69	8.316
0.104	0.98	1	3.695	8.355
0.104	0.982	1	3.701	8.395

MAXIMUM POISSON'S RATIO OF BLOCK PREDICTABLE BY THIS MODEL IS
0.12

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
1.044	1	3.7524	9.5246

POISSON'S OUTPUT 2 (for a specified mix ratio)

POISSON'S RATIO	WATER	CEMENT	SAND	LATERITE
0.110163	1.092	1	3.613	10.263

STATIC MODULUS OUTPUT (for a desired modulus of 6.41)

STATIC MODULUS	WATER	CEMENT	SAND	LATERITE
6.41	0.8	1	3.2	4.8
6.375	0.802	1	3.206	4.84
6.34	0.804	1	3.211	4.879
6.37	0.805	1	3.201	4.885
6.33	0.81	1	3.203	4.971
6.364	0.814	1	3.193	4.977
6.318	0.828	1	3.186	5.154

MAXIMUM YOUNG'S MODULUS OF BLOCK PREDICTABLE BY THIS MODEL IS
6.41
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

STATIC MODULUS OUTPUT 2 (for a specified mix ratios)

STATIC MODULUS	WATER	CEMENT	SAND	LATERITE
4.756187	1.09	1	3.405	10.056

STATIC MODULUS	WATER	CEMENT	SAND	LATERITE
6.409926	0.8	1	3.2	4.8
MODULUS	WATER	CEMENT	SAND	LATERITE
5.299882	1	1	3.75	8.75
MODULUS	WATER	CEMENT	SAND	LATERITE
4.589946	1.28	1	3.334	13.336

SHEAR MODULUS OUTPUT (for a desired value)

SHEAR MODULUS	WATER	CEMENT	SAND	LATERITE
2.89	0.8	1	3.2	4.8
2.875	0.802	1	3.206	4.84
2.861	0.804	1	3.211	4.879
2.847	0.806	1	3.217	4.919
2.833	0.808	1	3.222	4.958
2.819	0.81	1	3.228	4.998
2.806	0.812	1	3.233	5.037
2.793	0.814	1	3.239	5.077
2.873	0.805	1	3.201	4.885
2.856	0.81	1	3.203	4.971
2.839	0.814	1	3.204	5.056
2.823	0.819	1	3.205	5.141
2.806	0.824	1	3.207	5.227
2.79	0.829	1	3.208	5.312
2.871	0.814	1	3.193	4.977
2.853	0.828	1	3.186	5.154
2.835	0.842	1	3.179	5.331
2.817	0.856	1	3.172	5.508
2.799	0.87	1	3.165	5.685

MAXIMUM SHEAR MODULUS OF BLOCK PREDICTABLE BY THIS MODEL IS

2.89

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

SHEAR MODULUS OUTPUT 2 (for specified mix ratios)

MODULUS	WATER	CEMENT	SAND	LATERITE
2.179968	1.09	1	3.405	10.056

SHEAR MODULUS	WATER	CEMENT	SAND	LATERITE
2.889959	0.8	1	3.2	4.8

SHEAR STRENGTH OUTPUT (for a desired value of $0.4N/mm^2$)

SHEAR STRENGTH	WATER	CEMENT	SAND	LATERITE
0.43	0.8	1	3.2	4.8
0.425	0.802	1	3.206	4.84
0.421	0.804	1	3.211	4.879
0.416	0.806	1	3.217	4.919
0.412	0.808	1	3.222	4.958
0.407	0.81	1	3.228	4.998
0.403	0.812	1	3.233	5.037
0.399	0.814	1	3.239	5.077
0.394	0.816	1	3.244	5.116
0.39	0.818	1	3.25	5.156
0.386	0.82	1	3.255	5.195
0.382	0.822	1	3.261	5.235
0.378	0.824	1	3.266	5.274
0.374	0.826	1	3.272	5.314
0.371	0.828	1	3.277	5.353
0.367	0.83	1	3.283	5.393
0.363	0.832	1	3.288	5.432
0.36	0.834	1	3.294	5.472
0.356	0.836	1	3.299	5.511
0.353	0.838	1	3.305	5.551
0.349	0.84	1	3.31	5.59
0.346	0.842	1	3.316	5.63
0.343	0.844	1	3.321	5.669
0.339	0.846	1	3.327	5.709
0.336	0.848	1	3.332	5.748
0.333	0.85	1	3.338	5.788

MAXIMUM SHEAR STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS

0.43 N/mm^2

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
0.8	1	3.2	4.8

SHEAR STRENGTH OUTPUT 2 (for specified mix ratios)

SHEAR STRENGTH	WATER	CEMENT	SAND	LATERITE
0.310945	0.866	1	3.382	6.104

SHEAR STRENGTH	WATER	CEMENT	SAND	LATERITE
0.293003	1	1	3.75	8.75

SHEAR STRENGTH	WATER	CEMENT	SAND	LATERITE
0.147011	1.28	1	3.334	13.336

WATER ABSORPTION OUTPUT (for a desired absorption of 7.2%)

WATER ABSORPTION	WATER	CEMENT	SAND	LATERITE
7.2	1.28	1	3.334	13.336
7.194	1.286	1	3.385	13.475
7.293	1.29	1	3.386	13.56

MAXIMUM WATER ABSORPTION OF BLOCK PREDICTABLE BY THIS MODEL IS
7.29
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	SAND	LATERITE
1.2904	1	3.38632	13.56028

WATER ABSORPTION OUTPUT (for a desired absorption of 5%)

WATER ABSORPTION	WATER	CEMENT	SAND	LATERITE
5.034	0.829	1	3.208	5.312
4.979	0.834	1	3.209	5.398
4.948	1.141	1	3.295	10.861
5.003	1.146	1	3.296	10.946
5.058	1.15	1	3.298	11.031
5.099	0.912	1	3.144	6.216
5.065	0.926	1	3.137	6.393
5.032	0.94	1	3.13	6.57
5	0.954	1	3.123	6.747
4.968	0.968	1	3.116	6.924
4.938	0.982	1	3.109	7.101
4.908	0.996	1	3.102	7.278
4.92	1.976	1	2.612	19.668
4.95	1.99	1	2.605	19.845
4.98	2.004	1	2.598	20.022
5.012	2.018	1	2.591	20.199
5.032	1.132	1	3.613	10.263
4.915	2.152	1	2.55	21.95
5.056	2.164	1	2.538	22.088
5.077	1.436	1	3.192	14.894
4.975	1.446	1	3.184	14.986
4.968	2.154	1	2.542	22.042
5.069	2.163	1	2.533	22.133

WATER ABSORPTION OUTPUT 2 (for specified mix ratios)

ABSORPTION	WATER	CEMENT	SAND	LATERITE
5.399761	0.8	1	3.2	4.8
ABSORPTION	WATER	CEMENT	SAND	LATERITE
6.800215	1	1	3.75	8.75

SCHEFFE'S OUTPUT FOR 3-COMPONENT MIX

COMP STRENGTH OUTPUT (for a desired strength of 2.15N/mm^2)

STRENGTH	WATER	CEMENT	LATERITE
2.15	0.8	1	8
2.122	0.802	1	8.045
2.094	0.804	1	8.09
2.067	0.806	1	8.135
2.116	0.805	1	8.087
2.082	0.81	1	8.173

MAXIMUM STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS
2.15
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
0.8	1	8

COMPRESSIVE STRENGTH OUTPUT 2 (for specified mix ratos)

STRENGTH	WATER	CEMENT	LATERITE
0.758734	1.09	1	13.46
STRENGTH	WATER	CEMENT	LATERITE
2.149907	0.8	1	8
STRENGTH	WATER	CEMENT	LATERITE
0.960003	1	1	12.5
STRENGTH	WATER	CEMENT	LATERITE
0.910057	1.28	1	16.67
STRENGTH	WATER	CEMENT	LATERITE
1.149942	0.9	1	10.25

FLEXURAL STRENGTH OUTPUT (for a desired strength of 1.45N/mm^2)

STRENGTH	WATER	CEMENT	LATERITE
1.45	0.8	1	8
1.415	0.802	1	8.045
1.415	0.805	1	8.087

MAXIMUM FLEXURAL STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS
1.45N/mm^2
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
0.8	1	8

FLEXURAL STRENGTH OUTPUT 2 (for specified mix ratios)

STRENGTH	WATER	CEMENT	LATERITE
0.108	1.1	1	13.685
STRENGTH	WATER	CEMENT	LATERITE
0.260044	1	1	12.5

SPLIT TENSILE STRENGTH OUTPUT (for a specified value of 0.29N/mm^2)

STRENGTH	WATER	CEMENT	LATERITE
0.29	0.8	1	8
0.289	0.802	1	8.045
0.288	0.804	1	8.09
0.287	0.806	1	8.135
0.287	0.808	1	8.18
0.286	0.81	1	8.225
0.285	0.812	1	8.27
0.284	0.814	1	8.315
0.283	0.816	1	8.36
0.282	0.818	1	8.405
0.281	0.82	1	8.45
0.28	0.822	1	8.495
0.279	0.824	1	8.54
0.278	0.826	1	8.585
0.276	0.828	1	8.63
0.275	0.83	1	8.675
0.274	0.832	1	8.72
0.273	0.834	1	8.765
0.272	0.836	1	8.81
0.27	0.838	1	8.855
0.269	0.84	1	8.9
0.268	0.842	1	8.945
0.267	0.844	1	8.99
0.265	0.846	1	9.035
0.264	0.848	1	9.08
0.263	0.85	1	9.125
0.261	0.852	1	9.17
0.26	0.854	1	9.215

MAXIMUM SPLIT TENSILE STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS 0.29N/mm^2

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
0.8	1	8

SPLIT TENSILE STRENGTH OUTPUT 2(for specified mix ratios)

STRENGTH	WATER	CEMENT	LATERITE
0.172504	1.09	1	13.46

STRENGTH	WATER	CEMENT	LATERITE
0.289993	0.8	1	8

STRENGTH	WATER	CEMENT	LATERITE
0.090001	1	1	12.5

STRENGTH	WATER	CEMENT	LATERITE
0.160017	1.28	1	16.67

POISSON'S RATIO OUTPUT (for a specified mix ratio)

POISSON'S RATIO	WATER	CEMENT	LATERITE
0.111451	0.866	1	9.485

SHEAR MODULUS OUTPUT (for a specified value of 2.2GPa)

SHEAR MODULUS	WATER	CEMENT	LATERITE
2.2	0.8	1	8
2.191	0.802	1	8.045
2.182	0.804	1	8.09
2.172	0.806	1	8.135
2.163	0.808	1	8.18
2.154	0.81	1	8.225
2.145	0.812	1	8.27
2.136	0.814	1	8.315
2.128	0.816	1	8.36
2.119	0.818	1	8.405
2.11	0.82	1	8.45
2.101	0.822	1	8.495
2.185	0.805	1	8.087
2.171	0.81	1	8.173
2.157	0.814	1	8.26
2.142	0.819	1	8.347
2.128	0.824	1	8.434
2.115	0.829	1	8.52
2.101	0.834	1	8.607

MAXIMUM SHEAR MODULUS OF BLOCK PREDICTABLE BY THIS MODEL IS

2.2

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
0.8	1	8

SHEAR MODULUS OUTPUT 2 (for a specified mix ratio)

SHEAR MODULUS	WATER	CEMENT	LATERITE
1.925758	0.866	1	9.485

SHEAR MODULUS	WATER	CEMENT	LATERITE
2.199982	0.8	1	8

SHEAR MODULUS	WATER	CEMENT	LATERITE
1.570011	1	1	12.5

SHEAR STRENGTH OUTPUT (for a desired value of 0.2N/mm^2)

STRENGTH	WATER	CEMENT	LATERITE
0.222	0.836	1	8.81
0.216	0.838	1	8.855
0.209	0.84	1	8.9
0.203	0.842	1	8.945
0.197	0.844	1	8.99
0.191	0.846	1	9.035
0.185	0.848	1	9.08
0.179	0.85	1	9.125
0.173	0.852	1	9.17
0.167	0.854	1	9.215
0.162	0.856	1	9.26
0.156	0.858	1	9.305
0.151	0.86	1	9.35

SHEAR STRENGTH OUTPUT (for a desired value of 0.36N/mm^2)

STRENGTH	WATER	CEMENT	LATERITE
0.36	0.8	1	8
0.351	0.802	1	8.045
0.343	0.804	1	8.09
0.334	0.806	1	8.135
0.326	0.808	1	8.18
0.318	0.81	1	8.225
0.31	0.812	1	8.27
0.302	0.814	1	8.315
0.351	0.805	1	8.087
0.343	0.81	1	8.173
0.335	0.814	1	8.26
0.326	0.819	1	8.347
0.318	0.824	1	8.434

MAXIMUM SHEAR STRENGTH OF BLOCK PREDICTABLE BY THIS MODEL IS
0.36
THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
0.8	1	8

SHEAR STRENGTH OUTPUT 2 (for specified mix ratios)

STRENGTH	WATER	CEMENT	LATERITE
0.06229	1.092	1	13.876

STRENGTH	WATER	CEMENT	LATERITE
0.359972	0.8	1	8

STRENGTH	WATER	CEMENT	LATERITE
0.070011	1	1	12.5

WATER ABSORPTION OUTPUT (for a specified absorption of 6.16%)

WATER ABSORPTION	WATER	CEMENT	LATERITE
6.14	1.28	1	16.67
6.079	1.179	1	14.849
6.09	1.184	1	14.936
6.1	1.189	1	15.023
6.109	1.194	1	15.109
6.117	1.198	1	15.196
6.125	1.203	1	15.283
6.132	1.208	1	15.37
6.138	1.213	1	15.456
6.143	1.218	1	15.543
6.148	1.222	1	15.63
6.151	1.227	1	15.716
6.154	1.232	1	15.803
6.157	1.237	1	15.89
6.158	1.242	1	15.976
6.158	1.246	1	16.063
6.158	1.251	1	16.15
6.157	1.256	1	16.237
6.155	1.261	1	16.323
6.153	1.266	1	16.41
6.149	1.27	1	16.497
6.145	1.275	1	16.583
6.066	1.263	1	16.42
6.078	1.266	1	16.462
6.09	1.269	1	16.503
6.103	1.272	1	16.545
6.115	1.274	1	16.587
6.127	1.277	1	16.628

MAXIMUM WATER ABSORPTION OF BLOCK PREDICTABLE BY THIS MODEL IS

6.16

THE CORRESPONDING MIXTURE RATIO IS AS FOLLOWS:

WATER	CEMENT	LATERITE
1.2464	1	16.0631

WATER ABSORPTION OUTPUT 2 (for desired mix ratios)

ABSORPTION	WATER	CEMENT	LATERITE
5.54253	1.02	1	12.417

ABSORPTION	WATER	CEMENT	LATERITE
2.720297	0.8	1	8

ABSORPTION	WATER	CEMENT	LATERITE
5.680109	1.14	1	14.585

APPENDIX HH
OSADEBE'S PROGRAM OUTPUT

OSADEBE'S OUTPUT 4 COMPONENTS
COMPRESSIVE STRENGTH OUTPUT (for specified strength of $2.6N/mm^2$)

Strength 2.6,	WATER = 0.944,	CEMENT = 1.00,	SAND = 3.643,	LATERITE = 8.699
Strength 2.6,	WATER = 0.837,	CEMENT = 1.00,	SAND = 4.025,	LATERITE = 6.796
Strength 2.6,	WATER = 0.946,	CEMENT = 1.00,	SAND = 3.686,	LATERITE = 8.654
Strength 2.6,	WATER = 0.946,	CEMENT = 1.00,	SAND = 3.70,	LATERITE = 8.64
Strength 2.6,	WATER = 0.919,	CEMENT = 1.00,	SAND = 3.847,	LATERITE = 8.122
Strength 2.6,	WATER = 0.907,	CEMENT = 1.00,	SAND = 3.521,	LATERITE = 8.271
Strength 2.6,	WATER = 0.883,	CEMENT = 1.00,	SAND = 3.48,	LATERITE = 7.971
Strength 2.6,	WATER = 0.798,	CEMENT = 1.00,	SAND = 3.398,	LATERITE = 6.853
Strength 2.6,	WATER = 0.712,	CEMENT = 1.00,	SAND = 3.355,	LATERITE = 5.686
Strength 2.6,	WATER = 0.896,	CEMENT = 1.00,	SAND = 3.50,	LATERITE = 8.118
Strength 2.6,	WATER = 0.85,	CEMENT = 1.00,	SAND = 3.987,	LATERITE = 6.983
Strength 2.6,	WATER = 0.81,	CEMENT = 1.00,	SAND = 3.402,	LATERITE = 6.983
Strength 2.6,	WATER = 0.831,	CEMENT = 1.00,	SAND = 4.00,	LATERITE = 6.669
Strength 2.6,	WATER = 0.912,	CEMENT = 1.00,	SAND = 3.534,	LATERITE = 8.252
Strength 2.6,	WATER = 0.912,	CEMENT = 1.00,	SAND = 3.822,	LATERITE = 7.964
Strength 2.6,	WATER = 0.926,	CEMENT = 1.00,	SAND = 3.583,	LATERITE = 8.379
Strength 2.6,	WATER = 0.844,	CEMENT = 1.00,	SAND = 3.962,	LATERITE = 6.852
Strength 2.6,	WATER = 0.823,	CEMENT = 1.00,	SAND = 3.407,	LATERITE = 7.115
Strength 2.6,	WATER = 0.768,	CEMENT = 1.00,	SAND = 3.368,	LATERITE = 6.359
Strength 2.6,	WATER = 0.734,	CEMENT = 1.00,	SAND = 3.352,	LATERITE = 5.903
Strength 2.6,	WATER = 0.929,	CEMENT = 1.00,	SAND = 3.694,	LATERITE = 8.265
Strength 2.6,	WATER = 0.826,	CEMENT = 1.00,	SAND = 3.975,	LATERITE = 6.544
Strength 2.6,	WATER = 0.719,	CEMENT = 1.00,	SAND = 3.344,	LATERITE = 5.689
Strength 2.6,	WATER = 0.905,	CEMENT = 1.00,	SAND = 3.797,	LATERITE = 7.811
Strength 2.6,	WATER = 0.859,	CEMENT = 1.00,	SAND = 3.91,	LATERITE = 7.051
Strength 2.6,	WATER = 0.895,	CEMENT = 1.00,	SAND = 3.493,	LATERITE = 7.945
Strength 2.6,	WATER = 0.799,	CEMENT = 1.00,	SAND = 3.381,	LATERITE = 6.725
Strength 2.6,	WATER = 0.699,	CEMENT = 1.00,	SAND = 3.333,	LATERITE = 5.384
Strength 2.6,	WATER = 0.884,	CEMENT = 1.00,	SAND = 3.474,	LATERITE = 7.80
Strength 2.6,	WATER = 0.873,	CEMENT = 1.00,	SAND = 3.455,	LATERITE = 7.66
Strength 2.6,	WATER = 0.922,	CEMENT = 1.00,	SAND = 3.603,	LATERITE = 8.174
Strength 2.6,	WATER = 0.922,	CEMENT = 1.00,	SAND = 3.671,	LATERITE = 8.105
Strength 2.6,	WATER = 0.911,	CEMENT = 1.00,	SAND = 3.541,	LATERITE = 8.062
Strength 2.6,	WATER = 0.90,	CEMENT = 1.00,	SAND = 3.507,	LATERITE = 7.927
Strength 2.6,	WATER = 0.90,	CEMENT = 1.00,	SAND = 3.76,	LATERITE = 7.673
Strength 2.6,	WATER = 0.75,	CEMENT = 1.00,	SAND = 3.344,	LATERITE = 6.017
Strength 2.6,	WATER = 0.742,	CEMENT = 1.00,	SAND = 3.341,	LATERITE = 5.907
Strength 2.6,	WATER = 0.915,	CEMENT = 1.00,	SAND = 3.649,	LATERITE = 7.95
Strength 2.6,	WATER = 0.846,	CEMENT = 1.00,	SAND = 3.413,	LATERITE = 7.241
Strength 2.6,	WATER = 0.846,	CEMENT = 1.00,	SAND = 3.875,	LATERITE = 6.779
Strength 2.6,	WATER = 0.904,	CEMENT = 1.00,	SAND = 3.707,	LATERITE = 7.723
Strength 2.6,	WATER = 0.848,	CEMENT = 1.00,	SAND = 3.413,	LATERITE = 7.24
Strength 2.6,	WATER = 0.827,	CEMENT = 1.00,	SAND = 3.39,	LATERITE = 6.978
Strength 2.6,	WATER = 0.699,	CEMENT = 1.00,	SAND = 3.32,	LATERITE = 5.291
Strength 2.6,	WATER = 0.905,	CEMENT = 1.00,	SAND = 3.533,	LATERITE = 7.895
Strength 2.6,	WATER = 0.799,	CEMENT = 1.00,	SAND = 3.365,	LATERITE = 6.601
Strength 2.6,	WATER = 0.907,	CEMENT = 1.00,	SAND = 3.547,	LATERITE = 7.88
Strength 2.6,	WATER = 0.84,	CEMENT = 1.00,	SAND = 3.864,	LATERITE = 6.642
Strength 2.6,	WATER = 0.81,	CEMENT = 1.00,	SAND = 3.917,	LATERITE = 6.179
Strength 2.6,	WATER = 0.812,	CEMENT = 1.00,	SAND = 3.369,	LATERITE = 6.724
Strength 2.6,	WATER = 0.749,	CEMENT = 1.00,	SAND = 3.33,	LATERITE = 5.91
Strength 2.6,	WATER = 0.741,	CEMENT = 1.00,	SAND = 3.326,	LATERITE = 5.802
Strength 2.6,	WATER = 0.876,	CEMENT = 1.00,	SAND = 3.449,	LATERITE = 7.496
Strength 2.6,	WATER = 0.865,	CEMENT = 1.00,	SAND = 3.785,	LATERITE = 7.009
Strength 2.6,	WATER = 0.854,	CEMENT = 1.00,	SAND = 3.413,	LATERITE = 7.234
Strength 2.6,	WATER = 0.719,	CEMENT = 1.00,	SAND = 3.316,	LATERITE = 5.492

COMPRESSIVE STRENGTH OUTPUT 2(for a specified mix ratio)

Strength 3.012,	WATER = 0.80,	CEMENT = 1.00,	SAND = 3.20,	LATERITE = 4.80,

FLEXURAL STRENGTH OUTPUT2 (for a specified mix ratio)
Strength 0.785, WATER = 1.09, CEMENT = 1.00, SAND = 3.405, LATERITE = 10.056,

FLEXURAL STRENGTH OUTPUT (for a desired strength of 1.5N/mm^2)
Strength 1.5, WATER = 1.437, CEMENT = 1.00, SAND = 4.391, LATERITE = 14.911
Strength 1.5, WATER = 1.224, CEMENT = 1.00, SAND = 2.87, LATERITE = 13.424
Strength 1.5, WATER = 1.14, CEMENT = 1.00, SAND = 3.034, LATERITE = 12.067
Strength 1.5, WATER = 1.002, CEMENT = 1.00, SAND = 3.364, LATERITE = 9.786
Strength 1.5, WATER = 1.003, CEMENT = 1.00, SAND = 3.348, LATERITE = 9.80
Strength 1.5, WATER = 0.959, CEMENT = 1.00, SAND = 3.797, LATERITE = 8.736
Strength 1.5, WATER = 0.946, CEMENT = 1.00, SAND = 3.614, LATERITE = 8.726
Strength 1.5, WATER = 1.745, CEMENT = 1.00, SAND = 4.605, LATERITE = 18.966
Strength 1.5, WATER = 1.275, CEMENT = 1.00, SAND = 4.25, LATERITE = 12.706
Strength 1.5, WATER = 1.205, CEMENT = 1.00, SAND = 2.891, LATERITE = 13.085
Strength 1.5, WATER = 1.143, CEMENT = 1.00, SAND = 4.121, LATERITE = 10.978
Strength 1.5, WATER = 1.124, CEMENT = 1.00, SAND = 3.051, LATERITE = 11.775
Strength 1.5, WATER = 0.975, CEMENT = 1.00, SAND = 3.426, LATERITE = 9.304
Strength 1.5, WATER = 1.953, CEMENT = 1.00, SAND = 4.735, LATERITE = 21.724
Strength 1.5, WATER = 1.413, CEMENT = 1.00, SAND = 4.362, LATERITE = 14.502
Strength 1.5, WATER = 1.277, CEMENT = 1.00, SAND = 4.25, LATERITE = 12.704
Strength 1.5, WATER = 1.145, CEMENT = 1.00, SAND = 3.00, LATERITE = 12.097
Strength 1.5, WATER = 1.038, CEMENT = 1.00, SAND = 3.234, LATERITE = 10.353
Strength 1.5, WATER = 0.976, CEMENT = 1.00, SAND = 3.868, LATERITE = 8.862
Strength 1.5, WATER = 0.949, CEMENT = 1.00, SAND = 3.529, LATERITE = 8.809
Strength 1.5, WATER = 1.511, CEMENT = 1.00, SAND = 4.432, LATERITE = 15.784
Strength 1.5, WATER = 1.108, CEMENT = 1.00, SAND = 3.067, LATERITE = 11.492
Strength 1.5, WATER = 1.023, CEMENT = 1.00, SAND = 3.262, LATERITE = 10.10
Strength 1.5, WATER = 1.008, CEMENT = 1.00, SAND = 3.303, LATERITE = 9.841
Strength 1.5, WATER = 0.964, CEMENT = 1.00, SAND = 3.841, LATERITE = 8.688
Strength 1.5, WATER = 0.95, CEMENT = 1.00, SAND = 3.50, LATERITE = 8.836
Strength 1.5, WATER = 0.937, CEMENT = 1.00, SAND = 3.592, LATERITE = 8.556
Strength 1.5, WATER = 1.129, CEMENT = 1.00, SAND = 3.017, LATERITE = 11.803
Strength 1.5, WATER = 1.11, CEMENT = 1.00, SAND = 4.083, LATERITE = 10.473
Strength 1.5, WATER = 1.025, CEMENT = 1.00, SAND = 3.969, LATERITE = 9.391
Strength 1.5, WATER = 1.009, CEMENT = 1.00, SAND = 3.288, LATERITE = 9.855
Strength 1.5, WATER = 0.938, CEMENT = 1.00, SAND = 3.549, LATERITE = 8.597
Strength 1.5, WATER = 0.938, CEMENT = 1.00, SAND = 3.746, LATERITE = 8.40
Strength 1.5, WATER = 1.588, CEMENT = 1.00, SAND = 4.476, LATERITE = 16.745
Strength 1.5, WATER = 1.39, CEMENT = 1.00, SAND = 4.333, LATERITE = 14.11
Strength 1.5, WATER = 1.059, CEMENT = 1.00, SAND = 3.159, LATERITE = 10.656
Strength 1.5, WATER = 1.484, CEMENT = 1.00, SAND = 4.40, LATERITE = 15.338
Strength 1.5, WATER = 1.31, CEMENT = 1.00, SAND = 2.667, LATERITE = 14.631
Strength 1.5, WATER = 1.285, CEMENT = 1.00, SAND = 2.712, LATERITE = 14.235
Strength 1.5, WATER = 1.26, CEMENT = 1.00, SAND = 2.755, LATERITE = 13.853
Strength 1.5, WATER = 1.26, CEMENT = 1.00, SAND = 4.226, LATERITE = 12.381
Strength 1.5, WATER = 1.113, CEMENT = 1.00, SAND = 3.033, LATERITE = 11.52
Strength 1.5, WATER = 1.095, CEMENT = 1.00, SAND = 4.066, LATERITE = 10.233
Strength 1.5, WATER = 1.012, CEMENT = 1.00, SAND = 3.955, LATERITE = 9.185
Strength 1.5, WATER = 0.968, CEMENT = 1.00, SAND = 3.87, LATERITE = 8.655
Strength 1.5, WATER = 0.941, CEMENT = 1.00, SAND = 3.493, LATERITE = 8.651
Strength 1.5, WATER = 0.941, CEMENT = 1.00, SAND = 3.789, LATERITE = 8.355
Strength 1.5, WATER = 1.968, CEMENT = 1.00, SAND = 4.706, LATERITE = 21.738
Strength 1.5, WATER = 1.262, CEMENT = 1.00, SAND = 4.226, LATERITE = 12.379
Strength 1.5, WATER = 1.045, CEMENT = 1.00, SAND = 3.172, LATERITE = 10.408
Strength 1.5, WATER = 0.942, CEMENT = 1.00, SAND = 3.803, LATERITE = 8.339
Strength 1.5, WATER = 0.929, CEMENT = 1.00, SAND = 3.542, LATERITE = 8.418
Strength 1.5, WATER = 1.367, CEMENT = 1.00, SAND = 4.306, LATERITE = 13.735
Strength 1.5, WATER = 1.218, CEMENT = 1.00, SAND = 2.818, LATERITE = 13.145
Strength 1.5, WATER = 1.098, CEMENT = 1.00, SAND = 3.049, LATERITE = 11.246
Strength 1.5, WATER = 1.081, CEMENT = 1.00, SAND = 4.048, LATERITE = 10.00
Strength 1.5, WATER = 0.971, CEMENT = 1.00, SAND = 3.884, LATERITE = 8.638
Strength 1.5, WATER = 0.957, CEMENT = 1.00, SAND = 3.40, LATERITE = 8.929
Strength 1.5, WATER = 0.944, CEMENT = 1.00, SAND = 3.451, LATERITE = 8.69
Strength 1.5, WATER = 0.918, CEMENT = 1.00, SAND = 3.63, LATERITE = 8.151
Strength 1.5, WATER = 0.918, CEMENT = 1.00, SAND = 3.644, LATERITE = 8.137
Strength 1.5, WATER = 0.918, CEMENT = 1.00, SAND = 3.658, LATERITE = 8.123

SPLIT TENSILE STRENGTH OUTPUT (for a specified mix ratio)

Strength 0.381,	WATER = 0.866,	CEMENT = 1.00,	SAND = 3.382,	LATERITE = 6.104,

SPLIT TENSILE STRENGTH OUTPUT 2 9for a desired strength of 0.4N/mm^2)

Strength 0.4,	WATER = 1.049,	CEMENT = 1.00,	SAND = 3.635,	LATERITE = 10.189
Strength 0.4,	WATER = 1.049,	CEMENT = 1.00,	SAND = 3.683,	LATERITE = 10.141
Strength 0.4,	WATER = 0.987,	CEMENT = 1.00,	SAND = 3.761,	LATERITE = 9.178
Strength 0.4,	WATER = 0.958,	CEMENT = 1.00,	SAND = 3.783,	LATERITE = 8.752
Strength 0.4,	WATER = 0.905,	CEMENT = 1.00,	SAND = 3.521,	LATERITE = 8.273
Strength 0.4,	WATER = 0.893,	CEMENT = 1.00,	SAND = 3.824,	LATERITE = 7.796
Strength 0.4,	WATER = 0.858,	CEMENT = 1.00,	SAND = 3.844,	LATERITE = 7.284
Strength 0.4,	WATER = 1.034,	CEMENT = 1.00,	SAND = 3.609,	LATERITE = 9.981
Strength 0.4,	WATER = 1.018,	CEMENT = 1.00,	SAND = 3.723,	LATERITE = 9.643
Strength 0.4,	WATER = 1.003,	CEMENT = 1.00,	SAND = 3.576,	LATERITE = 9.573
Strength 0.4,	WATER = 0.974,	CEMENT = 1.00,	SAND = 3.765,	LATERITE = 8.968
Strength 0.4,	WATER = 0.946,	CEMENT = 1.00,	SAND = 3.786,	LATERITE = 8.554
Strength 0.4,	WATER = 0.895,	CEMENT = 1.00,	SAND = 3.514,	LATERITE = 8.105
Strength 0.4,	WATER = 0.828,	CEMENT = 1.00,	SAND = 3.488,	LATERITE = 7.185
Strength 0.4,	WATER = 0.779,	CEMENT = 1.00,	SAND = 3.471,	LATERITE = 6.515
Strength 0.4,	WATER = 1.02,	CEMENT = 1.00,	SAND = 3.708,	LATERITE = 9.657
Strength 0.4,	WATER = 1.005,	CEMENT = 1.00,	SAND = 3.576,	LATERITE = 9.571
Strength 0.4,	WATER = 1.005,	CEMENT = 1.00,	SAND = 3.727,	LATERITE = 9.42
Strength 0.4,	WATER = 0.896,	CEMENT = 1.00,	SAND = 3.811,	LATERITE = 7.807
Strength 0.4,	WATER = 0.884,	CEMENT = 1.00,	SAND = 3.507,	LATERITE = 7.943
Strength 0.4,	WATER = 0.829,	CEMENT = 1.00,	SAND = 3.85,	LATERITE = 6.821
Strength 0.4,	WATER = 0.819,	CEMENT = 1.00,	SAND = 3.481,	LATERITE = 7.046
Strength 0.4,	WATER = 0.737,	CEMENT = 1.00,	SAND = 3.456,	LATERITE = 5.919
Strength 0.4,	WATER = 0.705,	CEMENT = 1.00,	SAND = 3.447,	LATERITE = 5.486
Strength 0.4,	WATER = 1.038,	CEMENT = 1.00,	SAND = 3.625,	LATERITE = 9.962
Strength 0.4,	WATER = 1.038,	CEMENT = 1.00,	SAND = 3.641,	LATERITE = 9.947
Strength 0.4,	WATER = 1.038,	CEMENT = 1.00,	SAND = 3.656,	LATERITE = 9.931
Strength 0.4,	WATER = 1.022,	CEMENT = 1.00,	SAND = 3.692,	LATERITE = 9.671
Strength 0.4,	WATER = 0.991,	CEMENT = 1.00,	SAND = 3.731,	LATERITE = 9.203
Strength 0.4,	WATER = 0.781,	CEMENT = 1.00,	SAND = 3.871,	LATERITE = 6.113
Strength 0.4,	WATER = 1.023,	CEMENT = 1.00,	SAND = 3.60,	LATERITE = 9.762
Strength 0.4,	WATER = 1.023,	CEMENT = 1.00,	SAND = 3.677,	LATERITE = 9.685
Strength 0.4,	WATER = 0.993,	CEMENT = 1.00,	SAND = 3.567,	LATERITE = 9.366
Strength 0.4,	WATER = 0.899,	CEMENT = 1.00,	SAND = 3.797,	LATERITE = 7.818
Strength 0.4,	WATER = 0.875,	CEMENT = 1.00,	SAND = 3.50,	LATERITE = 7.783
Strength 0.4,	WATER = 0.811,	CEMENT = 1.00,	SAND = 3.476,	LATERITE = 6.909
Strength 0.4,	WATER = 0.801,	CEMENT = 1.00,	SAND = 3.855,	LATERITE = 6.392
Strength 0.4,	WATER = 0.764,	CEMENT = 1.00,	SAND = 3.46,	LATERITE = 6.27
Strength 0.4,	WATER = 1.025,	CEMENT = 1.00,	SAND = 3.615,	LATERITE = 9.745
Strength 0.4,	WATER = 1.025,	CEMENT = 1.00,	SAND = 3.662,	LATERITE = 9.698
Strength 0.4,	WATER = 0.994,	CEMENT = 1.00,	SAND = 3.567,	LATERITE = 9.364
Strength 0.4,	WATER = 0.865,	CEMENT = 1.00,	SAND = 3.494,	LATERITE = 7.629
Strength 0.4,	WATER = 0.854,	CEMENT = 1.00,	SAND = 3.821,	LATERITE = 7.146
Strength 0.4,	WATER = 0.802,	CEMENT = 1.00,	SAND = 3.47,	LATERITE = 6.776
Strength 0.4,	WATER = 0.724,	CEMENT = 1.00,	SAND = 3.446,	LATERITE = 5.70
Strength 0.4,	WATER = 1.011,	CEMENT = 1.00,	SAND = 3.591,	LATERITE = 9.55
Strength 0.4,	WATER = 1.011,	CEMENT = 1.00,	SAND = 3.682,	LATERITE = 9.459
Strength 0.4,	WATER = 0.996,	CEMENT = 1.00,	SAND = 3.701,	LATERITE = 9.228
Strength 0.4,	WATER = 0.901,	CEMENT = 1.00,	SAND = 3.784,	LATERITE = 7.828
Strength 0.4,	WATER = 0.855,	CEMENT = 1.00,	SAND = 3.487,	LATERITE = 7.478
Strength 0.4,	WATER = 1.012,	CEMENT = 1.00,	SAND = 3.667,	LATERITE = 9.473
Strength 0.4,	WATER = 0.982,	CEMENT = 1.00,	SAND = 3.559,	LATERITE = 9.165
Strength 0.4,	WATER = 0.968,	CEMENT = 1.00,	SAND = 3.725,	LATERITE = 8.80
Strength 0.4,	WATER = 0.891,	CEMENT = 1.00,	SAND = 3.787,	LATERITE = 7.656
Strength 0.4,	WATER = 0.856,	CEMENT = 1.00,	SAND = 3.808,	LATERITE = 7.156
Strength 0.4,	WATER = 0.846,	CEMENT = 1.00,	SAND = 3.481,	LATERITE = 7.332
Strength 0.4,	WATER = 0.825,	CEMENT = 1.00,	SAND = 3.827,	LATERITE = 6.694
Strength 0.4,	WATER = 0.751,	CEMENT = 1.00,	SAND = 3.449,	LATERITE = 6.036
Strength 0.4,	WATER = 1.014,	CEMENT = 1.00,	SAND = 3.606,	LATERITE = 9.532
Strength 0.4,	WATER = 1.014,	CEMENT = 1.00,	SAND = 3.621,	LATERITE = 9.517
Strength 0.4,	WATER = 1.014,	CEMENT = 1.00,	SAND = 3.636,	LATERITE = 9.502
Strength 0.4,	WATER = 0.984,	CEMENT = 1.00,	SAND = 3.559,	LATERITE = 9.163

POISSON’S RATIO OUTPUT (for a specified value of 0.25)

Poisson's ratio 0.25,	WATER =	0.703,	CEMENT =	1.00,	SAND = 3.351,	LATERITE =	5.584
Poisson's ratio 0.25,	WATER =	0.703,	CEMENT =	1.00,	SAND = 3.362,	LATERITE =	5.573
Poisson's ratio 0.25,	WATER =	0.696,	CEMENT =	1.00,	SAND = 3.211,	LATERITE =	5.62
Poisson's ratio 0.25,	WATER =	0.696,	CEMENT =	1.00,	SAND = 3.221,	LATERITE =	5.609
Poisson's ratio 0.25,	WATER =	0.689,	CEMENT =	1.00,	SAND = 3.135,	LATERITE =	5.593
Poisson's ratio 0.25,	WATER =	0.689,	CEMENT =	1.00,	SAND = 3.146,	LATERITE =	5.582
Poisson's ratio 0.25,	WATER =	0.681,	CEMENT =	1.00,	SAND = 3.082,	LATERITE =	5.545
Poisson's ratio 0.25,	WATER =	0.674,	CEMENT =	1.00,	SAND = 3.041,	LATERITE =	5.489
Poisson's ratio 0.25,	WATER =	0.668,	CEMENT =	1.00,	SAND = 3.00,	LATERITE =	5.433
Poisson's ratio 0.25,	WATER =	0.661,	CEMENT =	1.00,	SAND = 2.96,	LATERITE =	5.379
Poisson's ratio 0.25,	WATER =	0.654,	CEMENT =	1.00,	SAND = 2.921,	LATERITE =	5.326
Poisson's ratio 0.25,	WATER =	0.648,	CEMENT =	1.00,	SAND = 2.892,	LATERITE =	5.264
Poisson's ratio 0.25,	WATER =	0.636,	CEMENT =	1.00,	SAND = 2.827,	LATERITE =	5.153
Poisson's ratio 0.25,	WATER =	0.63,	CEMENT =	1.00,	SAND = 2.80,	LATERITE =	5.094
Poisson's ratio 0.25,	WATER =	0.624,	CEMENT =	1.00,	SAND = 2.774,	LATERITE =	5.037
Poisson's ratio 0.25,	WATER =	0.618,	CEMENT =	1.00,	SAND = 2.748,	LATERITE =	4.98
Poisson's ratio 0.25,	WATER =	0.612,	CEMENT =	1.00,	SAND = 2.722,	LATERITE =	4.925
Poisson's ratio 0.25,	WATER =	0.697,	CEMENT =	1.00,	SAND = 3.221,	LATERITE =	5.608
Poisson's ratio 0.25,	WATER =	0.697,	CEMENT =	1.00,	SAND = 3.232,	LATERITE =	5.598
Poisson's ratio 0.25,	WATER =	0.697,	CEMENT =	1.00,	SAND = 3.242,	LATERITE =	5.587
Poisson's ratio 0.25,	WATER =	0.697,	CEMENT =	1.00,	SAND = 3.453,	LATERITE =	5.377
Poisson's ratio 0.25,	WATER =	0.697,	CEMENT =	1.00,	SAND = 3.463,	LATERITE =	5.366
Poisson's ratio 0.25,	WATER =	0.69,	CEMENT =	1.00,	SAND = 3.146,	LATERITE =	5.581
Poisson's ratio 0.25,	WATER =	0.69,	CEMENT =	1.00,	SAND = 3.156,	LATERITE =	5.571
Poisson's ratio 0.25,	WATER =	0.682,	CEMENT =	1.00,	SAND = 3.093,	LATERITE =	5.534
Poisson's ratio 0.25,	WATER =	0.676,	CEMENT =	1.00,	SAND = 3.041,	LATERITE =	5.488
Poisson's ratio 0.25,	WATER =	0.669,	CEMENT =	1.00,	SAND = 3.00,	LATERITE =	5.432
Poisson's ratio 0.25,	WATER =	0.662,	CEMENT =	1.00,	SAND = 2.96,	LATERITE =	5.378
Poisson's ratio 0.25,	WATER =	0.649,	CEMENT =	1.00,	SAND = 2.892,	LATERITE =	5.263
Poisson's ratio 0.25,	WATER =	0.63,	CEMENT =	1.00,	SAND = 2.80,	LATERITE =	5.093
Poisson's ratio 0.25,	WATER =	0.625,	CEMENT =	1.00,	SAND = 2.774,	LATERITE =	5.036
Poisson's ratio 0.25,	WATER =	0.619,	CEMENT =	1.00,	SAND = 2.748,	LATERITE =	4.979
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.232,	LATERITE =	5.597
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.242,	LATERITE =	5.586
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.253,	LATERITE =	5.576
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.263,	LATERITE =	5.565
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.421,	LATERITE =	5.407
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.432,	LATERITE =	5.397
Poisson's ratio 0.25,	WATER =	0.698,	CEMENT =	1.00,	SAND = 3.442,	LATERITE =	5.386
Poisson's ratio 0.25,	WATER =	0.691,	CEMENT =	1.00,	SAND = 3.156,	LATERITE =	5.57
Poisson's ratio 0.25,	WATER =	0.691,	CEMENT =	1.00,	SAND = 3.167,	LATERITE =	5.559
Poisson's ratio 0.25,	WATER =	0.684,	CEMENT =	1.00,	SAND = 3.093,	LATERITE =	5.533
Poisson's ratio 0.25,	WATER =	0.684,	CEMENT =	1.00,	SAND = 3.103,	LATERITE =	5.523
Poisson's ratio 0.25,	WATER =	0.677,	CEMENT =	1.00,	SAND = 3.051,	LATERITE =	5.477
Poisson's ratio 0.25,	WATER =	0.67,	CEMENT =	1.00,	SAND = 3.00,	LATERITE =	5.431
Poisson's ratio 0.25,	WATER =	0.663,	CEMENT =	1.00,	SAND = 2.96,	LATERITE =	5.377
Poisson's ratio 0.25,	WATER =	0.656,	CEMENT =	1.00,	SAND = 2.931,	LATERITE =	5.314
Poisson's ratio 0.25,	WATER =	0.65,	CEMENT =	1.00,	SAND = 2.892,	LATERITE =	5.262
Poisson's ratio 0.25,	WATER =	0.644,	CEMENT =	1.00,	SAND = 2.864,	LATERITE =	5.201
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.253,	LATERITE =	5.575
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.263,	LATERITE =	5.564
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.274,	LATERITE =	5.554
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.284,	LATERITE =	5.543
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.295,	LATERITE =	5.533
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.379,	LATERITE =	5.448
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.389,	LATERITE =	5.438
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.40,	LATERITE =	5.427
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.411,	LATERITE =	5.417
Poisson's ratio 0.25,	WATER =	0.699,	CEMENT =	1.00,	SAND = 3.421,	LATERITE =	5.406
Poisson's ratio 0.25,	WATER =	0.692,	CEMENT =	1.00,	SAND = 3.167,	LATERITE =	5.558
Poisson's ratio 0.25,	WATER =	0.692,	CEMENT =	1.00,	SAND = 3.177,	LATERITE =	5.548
Poisson's ratio 0.25,	WATER =	0.685,	CEMENT =	1.00,	SAND = 3.103,	LATERITE =	5.522
Poisson's ratio 0.25,	WATER =	0.678,	CEMENT =	1.00,	SAND = 3.051,	LATERITE =	5.476
Poisson's ratio 0.25,	WATER =	0.671,	CEMENT =	1.00,	SAND = 3.01,	LATERITE =	5.42
Poisson's ratio 0.25,	WATER =	0.664,	CEMENT =	1.00,	SAND = 2.97,	LATERITE =	5.366
Poisson's ratio 0.25,	WATER =	0.657,	CEMENT =	1.00,	SAND = 2.931,	LATERITE =	5.313
Poisson's ratio 0.25,	WATER =	0.645,	CEMENT =	1.00,	SAND = 2.864,	LATERITE =	5.20
Poisson's ratio 0.25,	WATER =	0.638,	CEMENT =	1.00,	SAND = 2.837,	LATERITE =	5.14
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.284,	LATERITE =	5.542
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.295,	LATERITE =	5.532
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.305,	LATERITE =	5.521
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.316,	LATERITE =	5.511
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.326,	LATERITE =	5.50
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.337,	LATERITE =	5.489
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.347,	LATERITE =	5.479
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.358,	LATERITE =	5.468
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.368,	LATERITE =	5.458
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.379,	LATERITE =	5.447
Poisson's ratio 0.25,	WATER =	0.70,	CEMENT =	1.00,	SAND = 3.389,	LATERITE =	5.437
Poisson's ratio 0.25,	WATER =	0.693,	CEMENT =	1.00,	SAND = 3.177,	LATERITE =	5.547
Poisson's ratio 0.25,	WATER =	0.693,	CEMENT =	1.00,	SAND = 3.188,	LATERITE =	5.536
Poisson's ratio 0.25,	WATER =	0.686,	CEMENT =	1.00,	SAND = 3.113,	LATERITE =	5.51
Poisson's ratio 0.25,	WATER =	0.679,	CEMENT =	1.00,	SAND = 3.061,	LATERITE =	5.464
Poisson's ratio 0.25,	WATER =	0.672,	CEMENT =	1.00,	SAND = 3.01,	LATERITE =	5.419
Poisson's ratio 0.25,	WATER =	0.665,	CEMENT =	1.00,	SAND = 2.97,	LATERITE =	5.365
Poisson's ratio 0.25,	WATER =	0.658,	CEMENT =	1.00,	SAND = 2.931,	LATERITE =	5.312
Poisson's ratio 0.25,	WATER =	0.646,	CEMENT =	1.00,	SAND = 2.864,	LATERITE =	5.199
Poisson's ratio 0.25,	WATER =	0.639,	CEMENT =	1.00,	SAND = 2.837,	LATERITE =	5.139
Poisson's ratio 0.25,	WATER =	0.694,	CEMENT =	1.00,	SAND = 3.188,	LATERITE =	5.535
Poisson's ratio 0.25,	WATER =	0.694,	CEMENT =	1.00,	SAND = 3.198,	LATERITE =	5.525
Poisson's ratio 0.25,	WATER =	0.687,	CEMENT =	1.00,	SAND = 3.113,	LATERITE =	5.509
Poisson's ratio 0.25,	WATER =	0.687,	CEMENT =	1.00,	SAND = 3.124,	LATERITE =	5.499
Poisson's ratio 0.25,	WATER =	0.68,	CEMENT =	1.00,	SAND = 3.061,	LATERITE =	5.463
Poisson's ratio 0.25,	WATER =	0.673,	CEMENT =	1.00,	SAND = 3.02,	LATERITE =	5.408
Poisson's ratio 0.25,	WATER =	0.666,	CEMENT =	1.00,	SAND = 2.97,	LATERITE =	5.364

POISSON’S OUTPUT 2 (for a specified mix ratio)

POISSON'S RATIO	0.099,	WATER =	1.10,	CEMENT =	1.00,	SAND = 3.432,	LATERITE =	10.253,

STATIC MODULUS OUTPUT (for a specified mix ratio)

STATIC MOD.	4.585,	WATER =	1.32,	CEMENT =	1.00,	SAND =	3.196,	LATERITE =	12.347,

STATIC MODULUS OUTPUT 2 (for a desired value of 8.0GPa)

STATIC MOD.	8.0,	WATER =	1.017,	CEMENT =	1.00,	SAND =	4.477,	LATERITE =	8.891
STATIC MOD.	8.0,	WATER =	0.881,	CEMENT =	1.00,	SAND =	2.92,	LATERITE =	8.532
STATIC MOD.	8.0,	WATER =	0.788,	CEMENT =	1.00,	SAND =	3.107,	LATERITE =	7.01
STATIC MOD.	8.0,	WATER =	1.257,	CEMENT =	1.00,	SAND =	4.547,	LATERITE =	12.064
STATIC MOD.	8.0,	WATER =	0.994,	CEMENT =	1.00,	SAND =	2.672,	LATERITE =	10.26
STATIC MOD.	8.0,	WATER =	0.709,	CEMENT =	1.00,	SAND =	3.255,	LATERITE =	5.674
STATIC MOD.	8.0,	WATER =	1.191,	CEMENT =	1.00,	SAND =	4.518,	LATERITE =	11.148
STATIC MOD.	8.0,	WATER =	0.866,	CEMENT =	1.00,	SAND =	2.935,	LATERITE =	8.186
STATIC MOD.	8.0,	WATER =	1.423,	CEMENT =	1.00,	SAND =	4.596,	LATERITE =	14.257
STATIC MOD.	8.0,	WATER =	1.097,	CEMENT =	1.00,	SAND =	4.475,	LATERITE =	9.821
STATIC MOD.	8.0,	WATER =	1.079,	CEMENT =	1.00,	SAND =	2.484,	LATERITE =	11.566
STATIC MOD.	8.0,	WATER =	1.063,	CEMENT =	1.00,	SAND =	4.46,	LATERITE =	9.349
STATIC MOD.	8.0,	WATER =	0.705,	CEMENT =	1.00,	SAND =	3.253,	LATERITE =	5.568
STATIC MOD.	8.0,	WATER =	2.033,	CEMENT =	1.00,	SAND =	4.818,	LATERITE =	22.452
STATIC MOD.	8.0,	WATER =	1.243,	CEMENT =	1.00,	SAND =	4.519,	LATERITE =	11.757
STATIC MOD.	8.0,	WATER =	1.065,	CEMENT =	1.00,	SAND =	2.508,	LATERITE =	11.30
STATIC MOD.	8.0,	WATER =	1.032,	CEMENT =	1.00,	SAND =	4.446,	LATERITE =	8.906
STATIC MOD.	8.0,	WATER =	0.789,	CEMENT =	1.00,	SAND =	3.082,	LATERITE =	6.893
STATIC MOD.	8.0,	WATER =	0.737,	CEMENT =	1.00,	SAND =	3.187,	LATERITE =	6.065
STATIC MOD.	8.0,	WATER =	1.68,	CEMENT =	1.00,	SAND =	4.675,	LATERITE =	17.645
STATIC MOD.	8.0,	WATER =	1.003,	CEMENT =	1.00,	SAND =	4.433,	LATERITE =	8.49
STATIC MOD.	8.0,	WATER =	0.873,	CEMENT =	1.00,	SAND =	2.909,	LATERITE =	8.205
STATIC MOD.	8.0,	WATER =	1.496,	CEMENT =	1.00,	SAND =	4.60,	LATERITE =	15.127
STATIC MOD.	8.0,	WATER =	1.052,	CEMENT =	1.00,	SAND =	2.531,	LATERITE =	11.042
STATIC MOD.	8.0,	WATER =	0.935,	CEMENT =	1.00,	SAND =	2.778,	LATERITE =	9.176
STATIC MOD.	8.0,	WATER =	1.376,	CEMENT =	1.00,	SAND =	4.551,	LATERITE =	13.482
STATIC MOD.	8.0,	WATER =	1.162,	CEMENT =	1.00,	SAND =	2.293,	LATERITE =	12.786
STATIC MOD.	8.0,	WATER =	0.702,	CEMENT =	1.00,	SAND =	3.25,	LATERITE =	5.465
STATIC MOD.	8.0,	WATER =	1.038,	CEMENT =	1.00,	SAND =	2.554,	LATERITE =	10.792
STATIC MOD.	8.0,	WATER =	0.978,	CEMENT =	1.00,	SAND =	2.681,	LATERITE =	9.833
STATIC MOD.	8.0,	WATER =	0.938,	CEMENT =	1.00,	SAND =	4.403,	LATERITE =	7.549
STATIC MOD.	8.0,	WATER =	1.026,	CEMENT =	1.00,	SAND =	2.576,	LATERITE =	10.55
STATIC MOD.	8.0,	WATER =	0.903,	CEMENT =	1.00,	SAND =	4.387,	LATERITE =	7.044
STATIC MOD.	8.0,	WATER =	1.331,	CEMENT =	1.00,	SAND =	4.51,	LATERITE =	12.767
STATIC MOD.	8.0,	WATER =	1.013,	CEMENT =	1.00,	SAND =	2.597,	LATERITE =	10.315
STATIC MOD.	8.0,	WATER =	0.871,	CEMENT =	1.00,	SAND =	2.897,	LATERITE =	8.053
STATIC MOD.	8.0,	WATER =	0.707,	CEMENT =	1.00,	SAND =	3.229,	LATERITE =	5.48
STATIC MOD.	8.0,	WATER =	1.259,	CEMENT =	1.00,	SAND =	4.481,	LATERITE =	11.778
STATIC MOD.	8.0,	WATER =	1.621,	CEMENT =	1.00,	SAND =	4.595,	LATERITE =	16.593
STATIC MOD.	8.0,	WATER =	1.064,	CEMENT =	1.00,	SAND =	2.484,	LATERITE =	11.077
STATIC MOD.	8.0,	WATER =	1.001,	CEMENT =	1.00,	SAND =	2.618,	LATERITE =	10.087
STATIC MOD.	8.0,	WATER =	0.92,	CEMENT =	1.00,	SAND =	4.378,	LATERITE =	7.215
STATIC MOD.	8.0,	WATER =	0.758,	CEMENT =	1.00,	SAND =	3.122,	LATERITE =	6.231
STATIC MOD.	8.0,	WATER =	1.366,	CEMENT =	1.00,	SAND =	4.50,	LATERITE =	13.134
STATIC MOD.	8.0,	WATER =	1.051,	CEMENT =	1.00,	SAND =	2.508,	LATERITE =	10.826
STATIC MOD.	8.0,	WATER =	0.99,	CEMENT =	1.00,	SAND =	2.638,	LATERITE =	9.865
STATIC MOD.	8.0,	WATER =	0.976,	CEMENT =	1.00,	SAND =	4.386,	LATERITE =	7.924
STATIC MOD.	8.0,	WATER =	1.291,	CEMENT =	1.00,	SAND =	4.472,	LATERITE =	12.106
STATIC MOD.	8.0,	WATER =	1.671,	CEMENT =	1.00,	SAND =	4.585,	LATERITE =	17.134
STATIC MOD.	8.0,	WATER =	1.223,	CEMENT =	1.00,	SAND =	4.446,	LATERITE =	11.188
STATIC MOD.	8.0,	WATER =	1.105,	CEMENT =	1.00,	SAND =	2.387,	LATERITE =	11.637
STATIC MOD.	8.0,	WATER =	0.881,	CEMENT =	1.00,	SAND =	2.859,	LATERITE =	8.081
STATIC MOD.	8.0,	WATER =	1.966,	CEMENT =	1.00,	SAND =	4.657,	LATERITE =	20.949
STATIC MOD.	8.0,	WATER =	1.092,	CEMENT =	1.00,	SAND =	4.397,	LATERITE =	9.384
STATIC MOD.	8.0,	WATER =	0.969,	CEMENT =	1.00,	SAND =	4.366,	LATERITE =	7.749
STATIC MOD.	8.0,	WATER =	1.06,	CEMENT =	1.00,	SAND =	4.385,	LATERITE =	8.94
STATIC MOD.	8.0,	WATER =	0.757,	CEMENT =	1.00,	SAND =	3.11,	LATERITE =	6.122
STATIC MOD.	8.0,	WATER =	1.19,	CEMENT =	1.00,	SAND =	4.414,	LATERITE =	10.638
STATIC MOD.	8.0,	WATER =	1.03,	CEMENT =	1.00,	SAND =	4.373,	LATERITE =	8.522
STATIC MOD.	8.0,	WATER =	0.704,	CEMENT =	1.00,	SAND =	3.214,	LATERITE =	5.286
STATIC MOD.	8.0,	WATER =	1.41,	CEMENT =	1.00,	SAND =	4.469,	LATERITE =	13.529
STATIC MOD.	8.0,	WATER =	0.803,	CEMENT =	1.00,	SAND =	3.012,	LATERITE =	6.813
STATIC MOD.	8.0,	WATER =	1.69,	CEMENT =	1.00,	SAND =	4.537,	LATERITE =	17.163
STATIC MOD.	8.0,	WATER =	1.006,	CEMENT =	1.00,	SAND =	2.58,	LATERITE =	9.907
STATIC MOD.	8.0,	WATER =	1.418,	CEMENT =	1.00,	SAND =	4.449,	LATERITE =	13.541
STATIC MOD.	8.0,	WATER =	1.933,	CEMENT =	1.00,	SAND =	4.583,	LATERITE =	20.261
STATIC MOD.	8.0,	WATER =	1.267,	CEMENT =	1.00,	SAND =	4.40,	LATERITE =	11.515
STATIC MOD.	8.0,	WATER =	1.143,	CEMENT =	1.00,	SAND =	2.279,	LATERITE =	11.972
STATIC MOD.	8.0,	WATER =	1.072,	CEMENT =	1.00,	SAND =	2.431,	LATERITE =	10.882
STATIC MOD.	8.0,	WATER =	0.968,	CEMENT =	1.00,	SAND =	4.333,	LATERITE =	7.587
STATIC MOD.	8.0,	WATER =	1.892,	CEMENT =	1.00,	SAND =	4.541,	LATERITE =	19.595
STATIC MOD.	8.0,	WATER =	0.769,	CEMENT =	1.00,	SAND =	3.066,	LATERITE =	6.154
STATIC MOD.	8.0,	WATER =	1.669,	CEMENT =	1.00,	SAND =	4.476,	LATERITE =	16.664
STATIC MOD.	8.0,	WATER =	0.779,	CEMENT =	1.00,	SAND =	3.044,	LATERITE =	6.288
STATIC MOD.	8.0,	WATER =	1.21,	CEMENT =	1.00,	SAND =	2.121,	LATERITE =	12.91
STATIC MOD.	8.0,	WATER =	1.21,	CEMENT =	1.00,	SAND =	4.362,	LATERITE =	10.669
STATIC MOD.	8.0,	WATER =	0.789,	CEMENT =	1.00,	SAND =	3.022,	LATERITE =	6.425
STATIC MOD.	8.0,	WATER =	1.328,	CEMENT =	1.00,	SAND =	4.377,	LATERITE =	12.162
STATIC MOD.	8.0,	WATER =	0.992,	CEMENT =	1.00,	SAND =	2.592,	LATERITE =	9.501
STATIC MOD.	8.0,	WATER =	0.869,	CEMENT =	1.00,	SAND =	2.852,	LATERITE =	7.625
STATIC MOD.	8.0,	WATER =	1.64,	CEMENT =	1.00,	SAND =	4.442,	LATERITE =	16.174
STATIC MOD.	8.0,	WATER =	1.216,	CEMENT =	1.00,	SAND =	2.103,	LATERITE =	12.922
STATIC MOD.	8.0,	WATER =	0.979,	CEMENT =	1.00,	SAND =	4.306,	LATERITE =	7.604
STATIC MOD.	8.0,	WATER =	1.502,	CEMENT =	1.00,	SAND =	4.404,	LATERITE =	14.37
STATIC MOD.	8.0,	WATER =	0.861,	CEMENT =	1.00,	SAND =	2.866,	LATERITE =	7.468
STATIC MOD.	8.0,	WATER =	0.831,	CEMENT =	1.00,	SAND =	2.929,	LATERITE =	7.005
STATIC MOD.	8.0,	WATER =	0.735,	CEMENT =	1.00,	SAND =	3.125,	LATERITE =	5.556
STATIC MOD.	8.0,	WATER =	0.699,	CEMENT =	1.00,	SAND =	3.198,	LATERITE =	5.004
STATIC MOD.	8.0,	WATER =	0.842,	CEMENT =	1.00,	SAND =	2.905,	LATERITE =	7.158
STATIC MOD.	8.0,	WATER =	1.221,	CEMENT =	1.00,	SAND =	2.086,	LATERITE =	12.934
STATIC MOD.	8.0,	WATER =	1.203,	CEMENT =	1.00,	SAND =	4.322,	LATERITE =	10.424
STATIC MOD.	8.0,	WATER =	1.004,	CEMENT =	1.00,	SAND =	2.549,	LATERITE =	9.531

SHEAR MODULUS OUTPUT (for a desired value of 10.0GPa)

SHEAR MODULUS	10.0,	WATER =	1.406,	CEMENT =	1.00,	SAND = 6.34,	LATERITE =	12.53
SHEAR MODULUS	10.0,	WATER =	0.934,	CEMENT =	1.00,	SAND = 1.704,	LATERITE =	10.446
SHEAR MODULUS	10.0,	WATER =	0.644,	CEMENT =	1.00,	SAND = 2.485,	LATERITE =	5.58
SHEAR MODULUS	10.0,	WATER =	0.647,	CEMENT =	1.00,	SAND = 2.476,	LATERITE =	5.586
SHEAR MODULUS	10.0,	WATER =	0.617,	CEMENT =	1.00,	SAND = 2.556,	LATERITE =	5.087
SHEAR MODULUS	10.0,	WATER =	1.421,	CEMENT =	1.00,	SAND = 6.298,	LATERITE =	12.557
SHEAR MODULUS	10.0,	WATER =	0.65,	CEMENT =	1.00,	SAND = 2.466,	LATERITE =	5.593
SHEAR MODULUS	10.0,	WATER =	0.619,	CEMENT =	1.00,	SAND = 2.546,	LATERITE =	5.094
SHEAR MODULUS	10.0,	WATER =	1.675,	CEMENT =	1.00,	SAND = 6.675,	LATERITE =	15.65
SHEAR MODULUS	10.0,	WATER =	1.491,	CEMENT =	1.00,	SAND = 6.378,	LATERITE =	13.353
SHEAR MODULUS	10.0,	WATER =	0.686,	CEMENT =	1.00,	SAND = 2.367,	LATERITE =	6.151
SHEAR MODULUS	10.0,	WATER =	1.246,	CEMENT =	1.00,	SAND = 5.981,	LATERITE =	10.291
SHEAR MODULUS	10.0,	WATER =	0.689,	CEMENT =	1.00,	SAND = 2.357,	LATERITE =	6.158
SHEAR MODULUS	10.0,	WATER =	0.639,	CEMENT =	1.00,	SAND = 2.491,	LATERITE =	5.305
SHEAR MODULUS	10.0,	WATER =	1.789,	CEMENT =	1.00,	SAND = 6.737,	LATERITE =	16.789
SHEAR MODULUS	10.0,	WATER =	0.782,	CEMENT =	1.00,	SAND = 2.103,	LATERITE =	7.609
SHEAR MODULUS	10.0,	WATER =	0.673,	CEMENT =	1.00,	SAND = 2.396,	LATERITE =	5.832
SHEAR MODULUS	10.0,	WATER =	0.811,	CEMENT =	1.00,	SAND = 2.024,	LATERITE =	8.07
SHEAR MODULUS	10.0,	WATER =	0.842,	CEMENT =	1.00,	SAND = 1.938,	LATERITE =	8.565
SHEAR MODULUS	10.0,	WATER =	1.289,	CEMENT =	1.00,	SAND = 5.962,	LATERITE =	10.617
SHEAR MODULUS	10.0,	WATER =	1.668,	CEMENT =	1.00,	SAND = 6.512,	LATERITE =	15.21
SHEAR MODULUS	10.0,	WATER =	0.963,	CEMENT =	1.00,	SAND = 1.606,	LATERITE =	10.515
SHEAR MODULUS	10.0,	WATER =	0.659,	CEMENT =	1.00,	SAND = 2.433,	LATERITE =	5.524
SHEAR MODULUS	10.0,	WATER =	2.079,	CEMENT =	1.00,	SAND = 7.091,	LATERITE =	20.133
SHEAR MODULUS	10.0,	WATER =	0.879,	CEMENT =	1.00,	SAND = 1.833,	LATERITE =	9.108
SHEAR MODULUS	10.0,	WATER =	0.715,	CEMENT =	1.00,	SAND = 2.281,	LATERITE =	6.421
SHEAR MODULUS	10.0,	WATER =	1.762,	CEMENT =	1.00,	SAND = 6.615,	LATERITE =	16.264
SHEAR MODULUS	10.0,	WATER =	0.695,	CEMENT =	1.00,	SAND = 2.333,	LATERITE =	6.073
SHEAR MODULUS	10.0,	WATER =	0.788,	CEMENT =	1.00,	SAND = 2.08,	LATERITE =	7.497
SHEAR MODULUS	10.0,	WATER =	0.738,	CEMENT =	1.00,	SAND = 2.213,	LATERITE =	6.687
SHEAR MODULUS	10.0,	WATER =	1.511,	CEMENT =	1.00,	SAND = 6.174,	LATERITE =	13.054
SHEAR MODULUS	10.0,	WATER =	0.848,	CEMENT =	1.00,	SAND = 1.915,	LATERITE =	8.433
SHEAR MODULUS	10.0,	WATER =	1.365,	CEMENT =	1.00,	SAND = 5.961,	LATERITE =	11.282
SHEAR MODULUS	10.0,	WATER =	0.968,	CEMENT =	1.00,	SAND = 1.583,	LATERITE =	10.338
SHEAR MODULUS	10.0,	WATER =	0.645,	CEMENT =	1.00,	SAND = 2.463,	LATERITE =	5.151
SHEAR MODULUS	10.0,	WATER =	1.586,	CEMENT =	1.00,	SAND = 6.25,	LATERITE =	13.891
SHEAR MODULUS	10.0,	WATER =	0.921,	CEMENT =	1.00,	SAND = 1.711,	LATERITE =	9.526
SHEAR MODULUS	10.0,	WATER =	0.787,	CEMENT =	1.00,	SAND = 2.079,	LATERITE =	7.371
SHEAR MODULUS	10.0,	WATER =	0.815,	CEMENT =	1.00,	SAND = 2.00,	LATERITE =	7.813
SHEAR MODULUS	10.0,	WATER =	0.738,	CEMENT =	1.00,	SAND = 2.211,	LATERITE =	6.578
SHEAR MODULUS	10.0,	WATER =	1.463,	CEMENT =	1.00,	SAND = 6.042,	LATERITE =	12.329
SHEAR MODULUS	10.0,	WATER =	0.846,	CEMENT =	1.00,	SAND = 1.916,	LATERITE =	8.287
SHEAR MODULUS	10.0,	WATER =	2.068,	CEMENT =	1.00,	SAND = 6.853,	LATERITE =	19.491
SHEAR MODULUS	10.0,	WATER =	1.326,	CEMENT =	1.00,	SAND = 5.849,	LATERITE =	10.692
SHEAR MODULUS	10.0,	WATER =	0.964,	CEMENT =	1.00,	SAND = 1.589,	LATERITE =	10.145
SHEAR MODULUS	10.0,	WATER =	0.646,	CEMENT =	1.00,	SAND = 2.459,	LATERITE =	5.07
SHEAR MODULUS	10.0,	WATER =	0.918,	CEMENT =	1.00,	SAND = 1.714,	LATERITE =	9.355
SHEAR MODULUS	10.0,	WATER =	0.786,	CEMENT =	1.00,	SAND = 2.078,	LATERITE =	7.248
SHEAR MODULUS	10.0,	WATER =	0.695,	CEMENT =	1.00,	SAND = 2.324,	LATERITE =	5.785
SHEAR MODULUS	10.0,	WATER =	0.877,	CEMENT =	1.00,	SAND = 1.827,	LATERITE =	8.642
SHEAR MODULUS	10.0,	WATER =	1.653,	CEMENT =	1.00,	SAND = 6.209,	LATERITE =	14.393
SHEAR MODULUS	10.0,	WATER =	0.677,	CEMENT =	1.00,	SAND = 2.371,	LATERITE =	5.475
SHEAR MODULUS	10.0,	WATER =	1.32,	CEMENT =	1.00,	SAND = 5.759,	LATERITE =	10.439
SHEAR MODULUS	10.0,	WATER =	0.66,	CEMENT =	1.00,	SAND = 2.417,	LATERITE =	5.182
SHEAR MODULUS	10.0,	WATER =	0.953,	CEMENT =	1.00,	SAND = 1.613,	LATERITE =	9.767
SHEAR MODULUS	10.0,	WATER =	1.351,	CEMENT =	1.00,	SAND = 5.774,	LATERITE =	10.743
SHEAR MODULUS	10.0,	WATER =	1.793,	CEMENT =	1.00,	SAND = 6.325,	LATERITE =	15.883
SHEAR MODULUS	10.0,	WATER =	1.236,	CEMENT =	1.00,	SAND = 5.621,	LATERITE =	9.384
SHEAR MODULUS	10.0,	WATER =	0.755,	CEMENT =	1.00,	SAND = 2.158,	LATERITE =	6.614
SHEAR MODULUS	10.0,	WATER =	1.561,	CEMENT =	1.00,	SAND = 6.022,	LATERITE =	13.157
SHEAR MODULUS	10.0,	WATER =	0.711,	CEMENT =	1.00,	SAND = 2.277,	LATERITE =	5.913
SHEAR MODULUS	10.0,	WATER =	1.263,	CEMENT =	1.00,	SAND = 5.632,	LATERITE =	9.649
SHEAR MODULUS	10.0,	WATER =	1.291,	CEMENT =	1.00,	SAND = 5.643,	LATERITE =	9.923
SHEAR MODULUS	10.0,	WATER =	2.074,	CEMENT =	1.00,	SAND = 6.571,	LATERITE =	18.926
SHEAR MODULUS	10.0,	WATER =	1.32,	CEMENT =	1.00,	SAND = 5.655,	LATERITE =	10.207
SHEAR MODULUS	10.0,	WATER =	1.731,	CEMENT =	1.00,	SAND = 6.143,	LATERITE =	14.936
SHEAR MODULUS	10.0,	WATER =	1.78,	CEMENT =	1.00,	SAND = 6.171,	LATERITE =	15.439
SHEAR MODULUS	10.0,	WATER =	0.925,	CEMENT =	1.00,	SAND = 1.684,	LATERITE =	9.049
SHEAR MODULUS	10.0,	WATER =	0.74,	CEMENT =	1.00,	SAND = 2.192,	LATERITE =	6.169
SHEAR MODULUS	10.0,	WATER =	0.699,	CEMENT =	1.00,	SAND = 2.305,	LATERITE =	5.52
SHEAR MODULUS	10.0,	WATER =	1.269,	CEMENT =	1.00,	SAND = 5.517,	LATERITE =	9.455
SHEAR MODULUS	10.0,	WATER =	0.956,	CEMENT =	1.00,	SAND = 1.597,	LATERITE =	9.434
SHEAR MODULUS	10.0,	WATER =	0.81,	CEMENT =	1.00,	SAND = 2.00,	LATERITE =	7.179
SHEAR MODULUS	10.0,	WATER =	0.839,	CEMENT =	1.00,	SAND = 1.92,	LATERITE =	7.605
SHEAR MODULUS	10.0,	WATER =	1.997,	CEMENT =	1.00,	SAND = 6.324,	LATERITE =	17.705
SHEAR MODULUS	10.0,	WATER =	0.869,	CEMENT =	1.00,	SAND = 1.835,	LATERITE =	8.06
SHEAR MODULUS	10.0,	WATER =	1.453,	CEMENT =	1.00,	SAND = 5.686,	LATERITE =	11.469
SHEAR MODULUS	10.0,	WATER =	2.061,	CEMENT =	1.00,	SAND = 6.361,	LATERITE =	18.356
SHEAR MODULUS	10.0,	WATER =	2.129,	CEMENT =	1.00,	SAND = 6.40,	LATERITE =	19.043
SHEAR MODULUS	10.0,	WATER =	0.931,	CEMENT =	1.00,	SAND = 1.663,	LATERITE =	8.906
SHEAR MODULUS	10.0,	WATER =	1.735,	CEMENT =	1.00,	SAND = 5.953,	LATERITE =	14.567
SHEAR MODULUS	10.0,	WATER =	0.794,	CEMENT =	1.00,	SAND = 2.043,	LATERITE =	6.802
SHEAR MODULUS	10.0,	WATER =	0.724,	CEMENT =	1.00,	SAND = 2.233,	LATERITE =	5.751
SHEAR MODULUS	10.0,	WATER =	0.685,	CEMENT =	1.00,	SAND = 2.339,	LATERITE =	5.15
SHEAR MODULUS	10.0,	WATER =	1.783,	CEMENT =	1.00,	SAND = 5.976,	LATERITE =	15.05
SHEAR MODULUS	10.0,	WATER =	0.70,	CEMENT =	1.00,	SAND = 2.299,	LATERITE =	5.347
SHEAR MODULUS	10.0,	WATER =	1.531,	CEMENT =	1.00,	SAND = 5.694,	LATERITE =	12.184
SHEAR MODULUS	10.0,	WATER =	0.915,	CEMENT =	1.00,	SAND = 1.707,	LATERITE =	8.573
SHEAR MODULUS	10.0,	WATER =	1.233,	CEMENT =	1.00,	SAND = 5.361,	LATERITE =	8.80
SHEAR MODULUS	10.0,	WATER =	0.809,	CEMENT =	1.00,	SAND = 2.00,	LATERITE =	6.944
SHEAR MODULUS	10.0,	WATER =	1.371,	CEMENT =	1.00,	SAND = 5.491,	LATERITE =	10.32
SHEAR MODULUS	10.0,	WATER =	0.754,	CEMENT =	1.00,	SAND = 2.15,	LATERITE =	6.096
SHEAR MODULUS	10.0,	WATER =	1.238,	CEMENT =	1.00,	SAND = 5.344,	LATERITE =	8.811

SHEAR MODULUS OUTPUT 2 (for a specified mix ratio)

Shear mod.	2.045,	WATER =	1.90,	CEMENT =	1.00,	SAND = 2.813,	LATERITE =	19.063,

SHEAR STRENGTH OUTPUT (for a desired strength of $1.0N/mm^2$)

Strength	1.0,	WATER =	1.14,	CEMENT =	1.00,	SAND =	2.293,	LATERITE =	12.809
Strength	1.0,	WATER =	0.944,	CEMENT =	1.00,	SAND =	2.70,	LATERITE =	9.641
Strength	1.0,	WATER =	0.944,	CEMENT =	1.00,	SAND =	4.614,	LATERITE =	7.727
Strength	1.0,	WATER =	0.893,	CEMENT =	1.00,	SAND =	2.811,	LATERITE =	8.809
Strength	1.0,	WATER =	0.826,	CEMENT =	1.00,	SAND =	2.963,	LATERITE =	7.711
Strength	1.0,	WATER =	0.703,	CEMENT =	1.00,	SAND =	3.266,	LATERITE =	5.669
Strength	1.0,	WATER =	0.674,	CEMENT =	1.00,	SAND =	3.347,	LATERITE =	5.183
Strength	1.0,	WATER =	1.351,	CEMENT =	1.00,	SAND =	5.082,	LATERITE =	12.976
Strength	1.0,	WATER =	1.161,	CEMENT =	1.00,	SAND =	2.246,	LATERITE =	13.137
Strength	1.0,	WATER =	1.018,	CEMENT =	1.00,	SAND =	2.538,	LATERITE =	10.828
Strength	1.0,	WATER =	0.946,	CEMENT =	1.00,	SAND =	4.614,	LATERITE =	7.726
Strength	1.0,	WATER =	0.919,	CEMENT =	1.00,	SAND =	2.75,	LATERITE =	9.219
Strength	1.0,	WATER =	0.798,	CEMENT =	1.00,	SAND =	3.024,	LATERITE =	7.227
Strength	1.0,	WATER =	0.72,	CEMENT =	1.00,	SAND =	3.217,	LATERITE =	5.933
Strength	1.0,	WATER =	1.95,	CEMENT =	1.00,	SAND =	5.706,	LATERITE =	20.756
Strength	1.0,	WATER =	1.441,	CEMENT =	1.00,	SAND =	5.174,	LATERITE =	14.124
Strength	1.0,	WATER =	1.087,	CEMENT =	1.00,	SAND =	2.393,	LATERITE =	11.913
Strength	1.0,	WATER =	0.947,	CEMENT =	1.00,	SAND =	2.686,	LATERITE =	9.653
Strength	1.0,	WATER =	0.896,	CEMENT =	1.00,	SAND =	2.797,	LATERITE =	8.82
Strength	1.0,	WATER =	0.839,	CEMENT =	1.00,	SAND =	2.924,	LATERITE =	7.895
Strength	1.0,	WATER =	0.684,	CEMENT =	1.00,	SAND =	3.309,	LATERITE =	5.316
Strength	1.0,	WATER =	2.012,	CEMENT =	1.00,	SAND =	5.758,	LATERITE =	21.533
Strength	1.0,	WATER =	1.107,	CEMENT =	1.00,	SAND =	4.80,	LATERITE =	9.76
Strength	1.0,	WATER =	0.976,	CEMENT =	1.00,	SAND =	4.647,	LATERITE =	8.082
Strength	1.0,	WATER =	0.922,	CEMENT =	1.00,	SAND =	2.736,	LATERITE =	9.231
Strength	1.0,	WATER =	0.874,	CEMENT =	1.00,	SAND =	2.842,	LATERITE =	8.442
Strength	1.0,	WATER =	0.82,	CEMENT =	1.00,	SAND =	2.963,	LATERITE =	7.563
Strength	1.0,	WATER =	0.692,	CEMENT =	1.00,	SAND =	3.281,	LATERITE =	5.444
Strength	1.0,	WATER =	1.705,	CEMENT =	1.00,	SAND =	5.436,	LATERITE =	17.50
Strength	1.0,	WATER =	1.583,	CEMENT =	1.00,	SAND =	5.31,	LATERITE =	15.917
Strength	1.0,	WATER =	1.478,	CEMENT =	1.00,	SAND =	5.20,	LATERITE =	14.544
Strength	1.0,	WATER =	1.073,	CEMENT =	1.00,	SAND =	4.758,	LATERITE =	9.298
Strength	1.0,	WATER =	1.039,	CEMENT =	1.00,	SAND =	2.484,	LATERITE =	11.102
Strength	1.0,	WATER =	1.039,	CEMENT =	1.00,	SAND =	4.719,	LATERITE =	8.867
Strength	1.0,	WATER =	1.008,	CEMENT =	1.00,	SAND =	4.682,	LATERITE =	8.462
Strength	1.0,	WATER =	0.95,	CEMENT =	1.00,	SAND =	2.671,	LATERITE =	9.664
Strength	1.0,	WATER =	0.853,	CEMENT =	1.00,	SAND =	2.885,	LATERITE =	8.083
Strength	1.0,	WATER =	0.792,	CEMENT =	1.00,	SAND =	3.024,	LATERITE =	7.089
Strength	1.0,	WATER =	0.782,	CEMENT =	1.00,	SAND =	3.047,	LATERITE =	6.935
Strength	1.0,	WATER =	0.707,	CEMENT =	1.00,	SAND =	3.234,	LATERITE =	5.697
Strength	1.0,	WATER =	1.903,	CEMENT =	1.00,	SAND =	5.629,	LATERITE =	20.04
Strength	1.0,	WATER =	1.332,	CEMENT =	1.00,	SAND =	5.04,	LATERITE =	12.628
Strength	1.0,	WATER =	1.211,	CEMENT =	1.00,	SAND =	4.909,	LATERITE =	11.062
Strength	1.0,	WATER =	1.11,	CEMENT =	1.00,	SAND =	2.333,	LATERITE =	12.223
Strength	1.0,	WATER =	0.833,	CEMENT =	1.00,	SAND =	2.925,	LATERITE =	7.742
Strength	1.0,	WATER =	1.516,	CEMENT =	1.00,	SAND =	5.227,	LATERITE =	14.984
Strength	1.0,	WATER =	1.283,	CEMENT =	1.00,	SAND =	4.981,	LATERITE =	11.967
Strength	1.0,	WATER =	1.17,	CEMENT =	1.00,	SAND =	4.86,	LATERITE =	10.514
Strength	1.0,	WATER =	1.131,	CEMENT =	1.00,	SAND =	2.288,	LATERITE =	12.531
Strength	1.0,	WATER =	1.042,	CEMENT =	1.00,	SAND =	2.469,	LATERITE =	11.114
Strength	1.0,	WATER =	0.996,	CEMENT =	1.00,	SAND =	2.567,	LATERITE =	10.363
Strength	1.0,	WATER =	0.953,	CEMENT =	1.00,	SAND =	2.657,	LATERITE =	9.676
Strength	1.0,	WATER =	0.804,	CEMENT =	1.00,	SAND =	2.988,	LATERITE =	7.257
Strength	1.0,	WATER =	1.805,	CEMENT =	1.00,	SAND =	5.514,	LATERITE =	18.708
Strength	1.0,	WATER =	1.363,	CEMENT =	1.00,	SAND =	5.061,	LATERITE =	12.984
Strength	1.0,	WATER =	1.152,	CEMENT =	1.00,	SAND =	2.241,	LATERITE =	12.848
Strength	1.0,	WATER =	1.132,	CEMENT =	1.00,	SAND =	4.814,	LATERITE =	10.003
Strength	1.0,	WATER =	1.06,	CEMENT =	1.00,	SAND =	2.429,	LATERITE =	11.384
Strength	1.0,	WATER =	0.777,	CEMENT =	1.00,	SAND =	3.047,	LATERITE =	6.805
Strength	1.0,	WATER =	0.696,	CEMENT =	1.00,	SAND =	3.25,	LATERITE =	5.471
Strength	1.0,	WATER =	1.858,	CEMENT =	1.00,	SAND =	5.556,	LATERITE =	19.364
Strength	1.0,	WATER =	1.174,	CEMENT =	1.00,	SAND =	2.193,	LATERITE =	13.177
Strength	1.0,	WATER =	1.097,	CEMENT =	1.00,	SAND =	4.77,	LATERITE =	9.526
Strength	1.0,	WATER =	0.999,	CEMENT =	1.00,	SAND =	2.552,	LATERITE =	10.375
Strength	1.0,	WATER =	0.956,	CEMENT =	1.00,	SAND =	2.643,	LATERITE =	9.687
Strength	1.0,	WATER =	0.942,	CEMENT =	1.00,	SAND =	4.592,	LATERITE =	7.551
Strength	1.0,	WATER =	0.869,	CEMENT =	1.00,	SAND =	2.831,	LATERITE =	8.287
Strength	1.0,	WATER =	0.816,	CEMENT =	1.00,	SAND =	2.951,	LATERITE =	7.428
Strength	1.0,	WATER =	0.735,	CEMENT =	1.00,	SAND =	3.143,	LATERITE =	6.111
Strength	1.0,	WATER =	0.727,	CEMENT =	1.00,	SAND =	3.163,	LATERITE =	5.979

SHEAR STRENGTH OUTPUT 2 (for a specified mix ratio)

Strength	0.093,	WATER =	1.67,	CEMENT =	1.00,	SAND =	3.021,	LATERITE =	16.772,

WATER ABSORPTION OUTPUT (for a specified mix ratio)

Water Absorption	4.801,	WATER =	1.09,	CEMENT =	1.00,	SAND = 3.405,	LATERITE =	10.056,

WATER ABSORPTION OUTPUT 2 (for a specified absorption of 6.0%)

Water Absorption	6.0,	WATER =	1.224,	CEMENT =	1.00,	SAND = 4.259,	LATERITE =	12.035
Water Absorption	6.0,	WATER =	1.184,	CEMENT =	1.00,	SAND = 4.143,	LATERITE =	11.53
Water Absorption	6.0,	WATER =	1.897,	CEMENT =	1.00,	SAND = 5.543,	LATERITE =	20.131
Water Absorption	6.0,	WATER =	1.581,	CEMENT =	1.00,	SAND = 4.976,	LATERITE =	16.252
Water Absorption	6.0,	WATER =	1.392,	CEMENT =	1.00,	SAND = 4.583,	LATERITE =	13.858
Water Absorption	6.0,	WATER =	1.193,	CEMENT =	1.00,	SAND = 4.161,	LATERITE =	11.504
Water Absorption	6.0,	WATER =	1.861,	CEMENT =	1.00,	SAND = 3.25,	LATERITE =	21.667
Water Absorption	6.0,	WATER =	1.731,	CEMENT =	1.00,	SAND = 3.231,	LATERITE =	19.679
Water Absorption	6.0,	WATER =	1.612,	CEMENT =	1.00,	SAND = 4.881,	LATERITE =	16.317
Water Absorption	6.0,	WATER =	1.741,	CEMENT =	1.00,	SAND = 3.179,	LATERITE =	19.721
Water Absorption	6.0,	WATER =	1.063,	CEMENT =	1.00,	SAND = 3.75,	LATERITE =	9.812
Water Absorption	6.0,	WATER =	1.051,	CEMENT =	1.00,	SAND = 3.60,	LATERITE =	9.734
Water Absorption	6.0,	WATER =	1.425,	CEMENT =	1.00,	SAND = 4.50,	LATERITE =	13.908
Water Absorption	6.0,	WATER =	1.557,	CEMENT =	1.00,	SAND = 3.182,	LATERITE =	16.989
Water Absorption	6.0,	WATER =	1.062,	CEMENT =	1.00,	SAND = 3.80,	LATERITE =	9.523
Water Absorption	6.0,	WATER =	1.868,	CEMENT =	1.00,	SAND = 3.00,	LATERITE =	21.159
Water Absorption	6.0,	WATER =	1.238,	CEMENT =	1.00,	SAND = 3.25,	LATERITE =	12.37
Water Absorption	6.0,	WATER =	1.10,	CEMENT =	1.00,	SAND = 3.349,	LATERITE =	10.424
Water Absorption	6.0,	WATER =	1.006,	CEMENT =	1.00,	SAND = 3.638,	LATERITE =	8.849
Water Absorption	6.0,	WATER =	0.993,	CEMENT =	1.00,	SAND = 3.514,	LATERITE =	8.779
Water Absorption	6.0,	WATER =	1.392,	CEMENT =	1.00,	SAND = 3.14,	LATERITE =	14.468
Water Absorption	6.0,	WATER =	1.265,	CEMENT =	1.00,	SAND = 4.145,	LATERITE =	11.771
Water Absorption	6.0,	WATER =	1.517,	CEMENT =	1.00,	SAND = 3.065,	LATERITE =	16.157
Water Absorption	6.0,	WATER =	1.205,	CEMENT =	1.00,	SAND = 3.207,	LATERITE =	11.829
Water Absorption	6.0,	WATER =	1.113,	CEMENT =	1.00,	SAND = 3.873,	LATERITE =	9.887
Water Absorption	6.0,	WATER =	1.095,	CEMENT =	1.00,	SAND = 3.844,	LATERITE =	9.686
Water Absorption	6.0,	WATER =	0.987,	CEMENT =	1.00,	SAND = 3.62,	LATERITE =	8.477
Water Absorption	6.0,	WATER =	0.966,	CEMENT =	1.00,	SAND = 3.356,	LATERITE =	8.377
Water Absorption	6.0,	WATER =	1.139,	CEMENT =	1.00,	SAND = 3.177,	LATERITE =	10.813
Water Absorption	6.0,	WATER =	0.968,	CEMENT =	1.00,	SAND = 3.589,	LATERITE =	8.141
Water Absorption	6.0,	WATER =	1.729,	CEMENT =	1.00,	SAND = 2.878,	LATERITE =	18.783
Water Absorption	6.0,	WATER =	0.961,	CEMENT =	1.00,	SAND = 3.27,	LATERITE =	8.282
Water Absorption	6.0,	WATER =	0.923,	CEMENT =	1.00,	SAND = 3.338,	LATERITE =	7.726
Water Absorption	6.0,	WATER =	1.398,	CEMENT =	1.00,	SAND = 4.176,	LATERITE =	13.033
Water Absorption	6.0,	WATER =	1.114,	CEMENT =	1.00,	SAND = 3.125,	LATERITE =	10.386
Water Absorption	6.0,	WATER =	1.064,	CEMENT =	1.00,	SAND = 3.746,	LATERITE =	9.115
Water Absorption	6.0,	WATER =	0.903,	CEMENT =	1.00,	SAND = 3.367,	LATERITE =	7.389
Water Absorption	6.0,	WATER =	0.915,	CEMENT =	1.00,	SAND = 3.295,	LATERITE =	7.61
Water Absorption	6.0,	WATER =	0.904,	CEMENT =	1.00,	SAND = 3.443,	LATERITE =	7.311
Water Absorption	6.0,	WATER =	0.918,	CEMENT =	1.00,	SAND = 3.256,	LATERITE =	7.646
Water Absorption	6.0,	WATER =	1.16,	CEMENT =	1.00,	SAND = 3.839,	LATERITE =	10.131
Water Absorption	6.0,	WATER =	1.897,	CEMENT =	1.00,	SAND = 4.632,	LATERITE =	18.787
Water Absorption	6.0,	WATER =	0.858,	CEMENT =	1.00,	SAND = 3.369,	LATERITE =	6.677
Water Absorption	6.0,	WATER =	2.066,	CEMENT =	1.00,	SAND = 4.771,	LATERITE =	20.734
Water Absorption	6.0,	WATER =	0.841,	CEMENT =	1.00,	SAND = 3.302,	LATERITE =	6.485
Water Absorption	6.0,	WATER =	0.967,	CEMENT =	1.00,	SAND = 3.573,	LATERITE =	7.793
Water Absorption	6.0,	WATER =	0.833,	CEMENT =	1.00,	SAND = 3.345,	LATERITE =	6.316
Water Absorption	6.0,	WATER =	1.052,	CEMENT =	1.00,	SAND = 3.043,	LATERITE =	9.397
Water Absorption	6.0,	WATER =	0.809,	CEMENT =	1.00,	SAND = 3.311,	LATERITE =	5.991
Water Absorption	6.0,	WATER =	1.139,	CEMENT =	1.00,	SAND = 3.75,	LATERITE =	9.736
Water Absorption	6.0,	WATER =	1.043,	CEMENT =	1.00,	SAND = 3.014,	LATERITE =	9.229
Water Absorption	6.0,	WATER =	0.839,	CEMENT =	1.00,	SAND = 3.149,	LATERITE =	6.506
Water Absorption	6.0,	WATER =	0.937,	CEMENT =	1.00,	SAND = 3.064,	LATERITE =	7.819
Water Absorption	6.0,	WATER =	0.928,	CEMENT =	1.00,	SAND = 3.051,	LATERITE =	7.68
Water Absorption	6.0,	WATER =	1.034,	CEMENT =	1.00,	SAND = 2.986,	LATERITE =	9.065
Water Absorption	6.0,	WATER =	0.864,	CEMENT =	1.00,	SAND = 3.435,	LATERITE =	6.466
Water Absorption	6.0,	WATER =	0.773,	CEMENT =	1.00,	SAND = 3.305,	LATERITE =	5.448
Water Absorption	6.0,	WATER =	1.148,	CEMENT =	1.00,	SAND = 3.719,	LATERITE =	9.758
Water Absorption	6.0,	WATER =	0.766,	CEMENT =	1.00,	SAND = 3.302,	LATERITE =	5.349
Water Absorption	6.0,	WATER =	1.227,	CEMENT =	1.00,	SAND = 2.883,	LATERITE =	11.557
Water Absorption	6.0,	WATER =	1.638,	CEMENT =	1.00,	SAND = 4.133,	LATERITE =	15.451
Water Absorption	6.0,	WATER =	1.417,	CEMENT =	1.00,	SAND = 3.942,	LATERITE =	12.871
Water Absorption	6.0,	WATER =	1.117,	CEMENT =	1.00,	SAND = 2.924,	LATERITE =	10.111
Water Absorption	6.0,	WATER =	0.867,	CEMENT =	1.00,	SAND = 3.047,	LATERITE =	6.851
Water Absorption	6.0,	WATER =	0.792,	CEMENT =	1.00,	SAND = 3.097,	LATERITE =	5.863
Water Absorption	6.0,	WATER =	1.425,	CEMENT =	1.00,	SAND = 3.904,	LATERITE =	12.902
Water Absorption	6.0,	WATER =	1.347,	CEMENT =	1.00,	SAND = 2.80,	LATERITE =	13.035
Water Absorption	6.0,	WATER =	0.926,	CEMENT =	1.00,	SAND = 3.488,	LATERITE =	7.086
Water Absorption	6.0,	WATER =	1.093,	CEMENT =	1.00,	SAND = 3.618,	LATERITE =	8.996
Water Absorption	6.0,	WATER =	2.067,	CEMENT =	1.00,	SAND = 4.361,	LATERITE =	20.35
Water Absorption	6.0,	WATER =	1.146,	CEMENT =	1.00,	SAND = 3.646,	LATERITE =	9.592
Water Absorption	6.0,	WATER =	0.71,	CEMENT =	1.00,	SAND = 3.048,	LATERITE =	4.767
Water Absorption	6.0,	WATER =	1.132,	CEMENT =	1.00,	SAND = 3.621,	LATERITE =	9.398
Water Absorption	6.0,	WATER =	0.934,	CEMENT =	1.00,	SAND = 3.475,	LATERITE =	7.091
Water Absorption	6.0,	WATER =	1.169,	CEMENT =	1.00,	SAND = 3.641,	LATERITE =	9.816
Water Absorption	6.0,	WATER =	1.469,	CEMENT =	1.00,	SAND = 2.706,	LATERITE =	14.433
Water Absorption	6.0,	WATER =	0.927,	CEMENT =	1.00,	SAND = 3.457,	LATERITE =	6.962
Water Absorption	6.0,	WATER =	0.989,	CEMENT =	1.00,	SAND = 2.868,	LATERITE =	8.30
Water Absorption	6.0,	WATER =	1.793,	CEMENT =	1.00,	SAND = 4.00,	LATERITE =	17.017
Water Absorption	6.0,	WATER =	1.068,	CEMENT =	1.00,	SAND = 3.507,	LATERITE =	8.51
Water Absorption	6.0,	WATER =	0.828,	CEMENT =	1.00,	SAND = 2.848,	LATERITE =	6.193
Water Absorption	6.0,	WATER =	0.857,	CEMENT =	1.00,	SAND = 3.382,	LATERITE =	5.997
Water Absorption	6.0,	WATER =	0.749,	CEMENT =	1.00,	SAND = 2.853,	LATERITE =	5.202
Water Absorption	6.0,	WATER =	0.805,	CEMENT =	1.00,	SAND = 2.832,	LATERITE =	5.889
Water Absorption	6.0,	WATER =	2.016,	CEMENT =	1.00,	SAND = 3.868,	LATERITE =	19.432
Water Absorption	6.0,	WATER =	1.023,	CEMENT =	1.00,	SAND = 2.76,	LATERITE =	8.551
Water Absorption	6.0,	WATER =	1.567,	CEMENT =	1.00,	SAND = 2.592,	LATERITE =	15.249
Water Absorption	6.0,	WATER =	0.853,	CEMENT =	1.00,	SAND = 3.367,	LATERITE =	5.891
Water Absorption	6.0,	WATER =	1.40,	CEMENT =	1.00,	SAND = 2.636,	LATERITE =	13.145
Water Absorption	6.0,	WATER =	1.205,	CEMENT =	1.00,	SAND = 3.469,	LATERITE =	9.952

Osadebe output for 3-component mix

Compressive strength output (for a specified mix ratio)

Strength	2.148,	WATER	=	0.80,	CEMENT =	1.00,	LATERITE =	8.00,

Compressive strength output 2 (for a desired strength of 2.0N/mm^2)

Strength	2.0,	WATER	=	0.947,	CEMENT =	1.00,	LATERITE =	12.339,
Strength	2.0,	WATER	=	1.373,	CEMENT =	1.00,	LATERITE =	17.235,
Strength	2.0,	WATER	=	1.153,	CEMENT =	1.00,	LATERITE =	13.472,
Strength	2.0,	WATER	=	0.992,	CEMENT =	1.00,	LATERITE =	10.828,

Flexural strength output (for a specified mix ratio)

Strength	0.185,	WATER	=	1.02,	CEMENT =	1.00,	LATERITE =	12.417,

Flexural output 2 (for a desired value of 1.5N/mm^2)

Strength	1.5,	WATER	=	0.753,	CEMENT =	1.00,	LATERITE =	9.483,
Strength	1.5,	WATER	=	0.699,	CEMENT =	1.00,	LATERITE =	8.505,

SPLIT TENSILE STRENGTH OUTPUT (for a specified value of 0.3N/mm^2)

Strength	0.3,	WATER	=	0.81,	CEMENT =	1.00,	LATERITE =	8.606,
Strength	0.3,	WATER	=	0.82,	CEMENT =	1.00,	LATERITE =	8.706,
Strength	0.3,	WATER	=	0.821,	CEMENT =	1.00,	LATERITE =	8.705,
Strength	0.3,	WATER	=	0.822,	CEMENT =	1.00,	LATERITE =	8.704,
Strength	0.3,	WATER	=	0.823,	CEMENT =	1.00,	LATERITE =	8.703,
Strength	0.3,	WATER	=	0.782,	CEMENT =	1.00,	LATERITE =	8.218,
Strength	0.3,	WATER	=	0.824,	CEMENT =	1.00,	LATERITE =	8.702,
Strength	0.3,	WATER	=	0.822,	CEMENT =	1.00,	LATERITE =	8.595,
Strength	0.3,	WATER	=	0.752,	CEMENT =	1.00,	LATERITE =	7.771,
Strength	0.3,	WATER	=	0.819,	CEMENT =	1.00,	LATERITE =	8.491,
Strength	0.3,	WATER	=	0.731,	CEMENT =	1.00,	LATERITE =	7.443,
Strength	0.3,	WATER	=	0.811,	CEMENT =	1.00,	LATERITE =	8.29,

SPLIT TENSILE STRENGTH OUTPUT 2(for a specified mix ratio)

Strength	0.181,	WATER	=	1.052,	CEMENT =	1.00,	LATERITE =	12.818,

WATER ABSORPTION OUTPUT (for a desired mix ratio)

Water Absorption	6.0,	WATER	=	1.138,	CEMENT =	1.00,	LATERITE =	13.735,

WATER ABSORPTION OUTPUT 2 (for a specified absorption of 3.0%)

Water Absorption	3.0,	WATER	=	0.78,	CEMENT =	1.00,	LATERITE =	7.836,
Water Absorption	3.0,	WATER	=	0.767,	CEMENT =	1.00,	LATERITE =	7.667,

WATER ABSORPTION OUTPUT 3 (for a specified mix ratio)

Water Absorption	4.417,	WATER	=	0.866,	CEMENT =	1.00,	LATERITE =	9.485,

POISSON’S RATIO OUTPUT (for a desired value of 3.0)

Poisson's ratio	0.3,	WATER	=	1.20,	CEMENT =	1.00,	LATERITE =	17.031,
Poisson's ratio	0.3,	WATER	=	1.147,	CEMENT =	1.00,	LATERITE =	16.035,
Poisson's ratio	0.3,	WATER	=	1.116,	CEMENT =	1.00,	LATERITE =	15.428,
Poisson's ratio	0.3,	WATER	=	1.059,	CEMENT =	1.00,	LATERITE =	14.334,
Poisson's ratio	0.3,	WATER	=	1.033,	CEMENT =	1.00,	LATERITE =	13.84,
Poisson's ratio	0.3,	WATER	=	0.998,	CEMENT =	1.00,	LATERITE =	13.153,
Poisson's ratio	0.3,	WATER	=	0.967,	CEMENT =	1.00,	LATERITE =	12.526,
Poisson's ratio	0.3,	WATER	=	0.822,	CEMENT =	1.00,	LATERITE =	9.542,
Poisson's ratio	0.3,	WATER	=	1.295,	CEMENT =	1.00,	LATERITE =	15.563,
Poisson's ratio	0.3,	WATER	=	0.785,	CEMENT =	1.00,	LATERITE =	8.741,
Poisson's ratio	0.3,	WATER	=	1.107,	CEMENT =	1.00,	LATERITE =	12.386,
Poisson's ratio	0.3,	WATER	=	0.759,	CEMENT =	1.00,	LATERITE =	8.142,
Poisson's ratio	0.3,	WATER	=	0.748,	CEMENT =	1.00,	LATERITE =	7.867,
Poisson's ratio	0.3,	WATER	=	1.021,	CEMENT =	1.00,	LATERITE =	10.966,
Poisson's ratio	0.3,	WATER	=	0.993,	CEMENT =	1.00,	LATERITE =	10.508,
Poisson's ratio	0.3,	WATER	=	0.974,	CEMENT =	1.00,	LATERITE =	10.221,
Poisson's ratio	0.3,	WATER	=	0.925,	CEMENT =	1.00,	LATERITE =	9.439,

POISSON’S RATIO OUTPUT 2 (for a specified mix ratio)

Poisson’s ratio	0.075,	WATER	=	1.09,	CEMENT =	1.00,	LATERITE =	13.46,

STATIC MODULUS OUTPUT (for a desired strength of 5.0 (GPa)

Static modulus	5.0,	WATER	=	0.95,	CEMENT =	1.00,	LATERITE =	12.756,
Static modulus	5.0,	WATER	=	0.797,	CEMENT =	1.00,	LATERITE =	8.203,
Static modulus	5.0,	WATER	=	0.81,	CEMENT =	1.00,	LATERITE =	8.19,

STATIC MODULUS OUTPUT (for a specified mix ratio)

Static modulus	3.451,	WATER	=	1.02,	CEMENT =	1.00,	LATERITE =	12.417,

SHEAR MODULUS OUTPUT (for a desired value of 3.0GPa)

Shear Modulus	3.0,	WATER	=	0.686,	CEMENT =	1.00,	LATERITE =	8.022,
Shear Modulus	3.0,	WATER	=	0.683,	CEMENT =	1.00,	LATERITE =	7.576,

SHEAR MODULUS OUTPUT 2 (for a desired mix rati)

Shear modulus	1.919,	WATER	=	0.866,	CEMENT =	1.00,	LATERITE =	9.485,

SHEAR STRENGTH OUTPUT (for a specified mix ratio)

Strength	0.07,	WATER	=	0.90,	CEMENT =	1.00,	LATERITE =	10.25,

SHEAR STRENGTH OUTPUT 2 (for a desired strength of 1.0N/mm^2)

Strength	1.0,	WATER	=	0.745,	CEMENT =	1.00,	LATERITE =	10.45,
Strength	1.0,	WATER	=	1.502,	CEMENT =	1.00,	LATERITE =	16.366,
Strength	1.0,	WATER	=	1.453,	CEMENT =	1.00,	LATERITE =	15.729,

APPENDIX KK: Flow chart

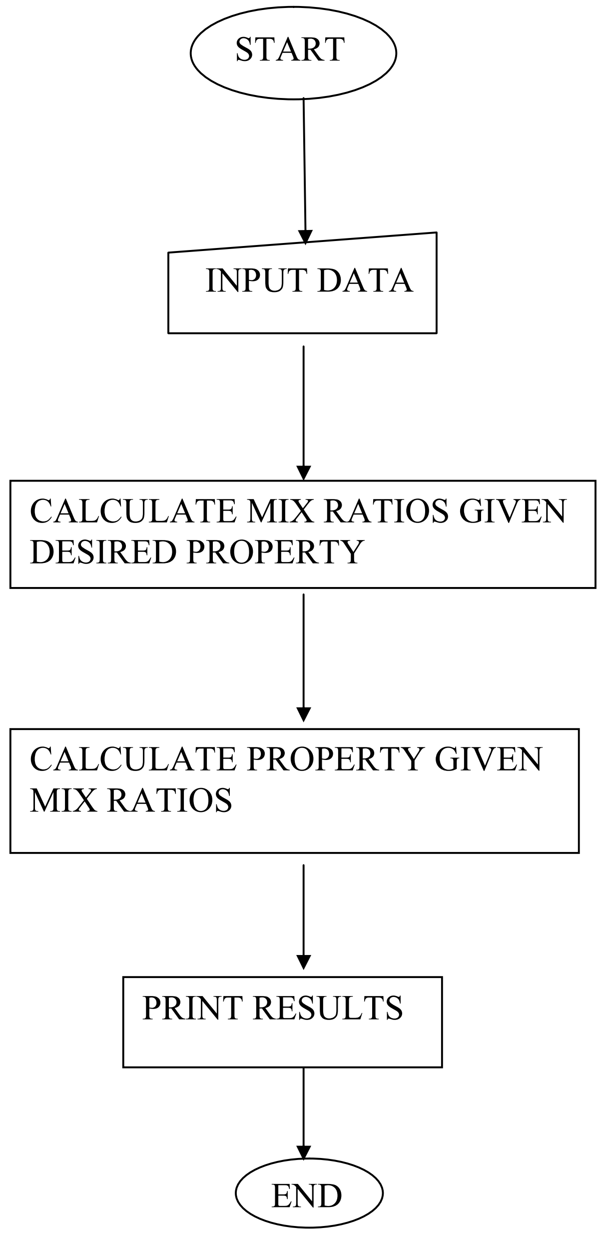

Fig. 1: Generalized flow chart for all the programs