Sudan University of Science and Technology

College of Graduate Studies

Partial Replacing Of Ordinary Portland Cement With Corncob Ash In Concrete

احلال جزئى للاسمنت البورتلاندي العادي برماد كوز الذرة في الخرسانة

A thesis Submitted in Partial Fulfillment of Requirements for the

Degree of Master of Science in Civil Engineering

(Construction Engineering)

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الآيـــة

بسم الله الرحمن الرحيم

﴿ وَأَلْقَى فِي الأَرْضِ رَوَاسِيَ أَنْ تَمِيدَ بِكُمْ وَأَنْهَاراً وَسُبُلاً لَعَلَّكُمْ تَهْتَدُونَ ﴾

صدق الله العظيم

﴿ النحل اية ١٥ ﴾

Dedication

TO …

My beloved parents (mother and father)

TO …

My sister and brothers…

TO …

The Sudan University …

TO …

All Teachers…

TO …

My lovely sister kids

(saleh,moneeb,Maab,&hamody)

TO …

My friends and all whom

I love for their encouragement

& support.

ACKNOWLEDGMENT

Initially thanks my God for this conciliate

I wish to acknowledge all the support, encouragement and assistance given throughout this research by Dr. ***Maaz Osman Boshara*** *a supervisor This work would not have been possible without the generous support from her ,sincere thanks*

*Special thanks to Eng .****Salah Aldeen A. Yousif*** *general manager of Material Test engineering and all his team I am very grateful for their sponsorship.*

I would like also to express my gratitude to my father ;for understanding & endless love.

Abstract

The purpose of this study is to investigate the feasibility of using corn cob ash in concrete mixes. concrete is the most important engineering material and the addition or replacement of some materials may change the properties of the concrete .In recent years a lot of of research work has been carried out in order to obtain more durable and long performance of concrete structures in the dynamic environment an experimental program is set up to test the effect of corncob ash with variation of percentages in concrete mixes. Different Corncob Ash percentage were tested in this study (0%, 5%,7.5%, 10%)respectively. The laboratory investigation include measurement of compressive strengths and workability .the mix was designed by British Standard method ,characteristic compressive strengths [25N/mm2]. An experimental study was carried out to test forth types of concrete mixes designed and compressive strength of concrete was measured in the re construction of curing for 7,28 and 56 days. one of those mentioned mixes is a (control mix) .finally all the result are compared. The study shown the effect of corncob ash on workability of fresh concrete by increasing with the proportion corncob ash(slump equal 44, 50 and 56 mm in proportion 5%,7.5%, and 10% Respectively).and of hardened concrete the compressive strength increasing with increasing the age of curing and decreasing with increase the proportion corncob ash .

المستخلص

الغرض من الدراسة هو إمكانية إستخدام الرماد الناتج من حرق كوز الذره الشامية في الخلطات الخرسانية.تعتبر الخرسانة من اهم المواد المستخدمه في التشييد لذلك إضافة بعض المواد او استبدال مواد باخري متاحة يمكن ان يكون له تأثير إيجابي علي خواص الخرسانة.

في السنوات الاخيرة إهتمت البحوث بهذا الموضوع لتحسين خواص الخرسانة علي المدي الطويل .الدراسة التجريبية انشئت لدراسة تأثير إستخدام رماد كوز الذرة الشامية بإزاحة جزء من الاسمنت في الخلطه الخرسانية ،تم إستخدام اربعة نسب من رماد كوز الذرة الشامية كالأتي: (٠% ،٥% ،٧.٥% ، ١٠%) من وزن الاسمنت .

تم تصميم الخلطة الخرسانية وفق الطريقة البريطانية بمقاومة ٢٥ ميقا باسكال في ٢٨ يوم .تم تجهيز اربعة خلطات خرسانية مختلفة احدى هذه الخلطات هي خلطة قياسية وثلاث خلطات خرسانية بإستخدام نسب مختلفة من رماد كوز الذرة الشامية .

تم اختبار الهبوط لكل خلطة لقياس قابلية التشغيل حيث أوضحت الدراسة ان قابلية التشغيل تزداد بشكل ملحوظ عند زيادة نسبة المضاف،(الهبوط يساوي ٤٤، ٥٠،و ٥٦ في النسب ٥%،٧.٥%،١٠%علي التوالي).كما تم قياس مقاومة الخرسانة للضغط في ٧ ايام و ٢٨ يوم و٥٦ يوم فكانت مقاومة الخرسانة تزداد بزيادة مدة المعالجه وتقل بزياددة نسبة المضاف.

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Chapter one

Introduction

1 .1 General

Concrete is the most widely used construction material in the world. It is used in many different structures such as dam, pavement, building frame or bridge .Also, it is the most widely used material in the world, far exceeding other materials Its worldwide production exceeds that of steel. Concrete is a composite material composed of coarse granular material (the aggregate or filler) embedded in a hard matrix of material (the cement or binder) that fills the space between the aggregate particles and glues them together. Concrete also consider composite material that consists essentially of a binding medium within which are embedded particles or fragments of aggregates. The simplest representation of concrete is filler plus binder. Also we can use partial replacement corn cob ash in concrete mixtures and so on. .[Neville]

In this study, Portland cement (MASS) (42.5N/mm2) was used assuming its properties hold for other types of cement. It will be majorly dealing with the analysis of the properties of Corn Cob Ash to be used as partial replacement of cement in concrete.

the workability and compressive strengths at 7,28 and 56 days of curing of concrete cubes will be analyses.Four trial mixes by partial replacement of cement by weight were prepared by using British standard method, namely:

•One Control mix, reference mix by ratio of replacement.

•Three mixes, using Corn Cob Ash by replacement ratio (5%,7.5%& 10%) of cement.

1.2 Research Problem

The significance of this research is to help reduce the cost of concrete production from arising cost of cement and reduce the volume of solid waste generated from Corn Cob using this waste wealth initiative.

1.3 Hypothesis

- Corn Cob Ash effects on the properties of fresh and hard concrete.

1.4 Objectives of the research:

1- Studying the effect of Corn Cob Ash by replacing partial of cement to detect its impact on the properties of the fresh and hardened concrete .

2- To carry out different tests on Corn Cob Ash and compare their result.

3- to enhance the reduction of Corn Cob wastes and reduce the cost of concrete production by using locally available materials.

1.5 Methodology

Cement was substituted with partial replacement Corn Cob Ash by weight in percentages of 0, 5% ,7.5% and 10%.with the 0% being control specimen. Compressive strength tests were carried out on concrete cubes having varying composition of Corn Cob Ash as as replacement for cement in concrete. Batching operation by volume approach was used adopting a mix of 1:2:4 (cement: fines: coarse aggregates) with water/cement ratio of 0.50. Grade 25 MPa . The following samples were cured in 7days, 28days, and 56 days .all preparation an testing were done in acordance with B.S.

1.6 Research structural

This Research is divided in to five chapters as follow:

- Chapter 1: introduction and objective of the research.
- Chapter 2: The literature review of related previous research.
- Chapter3 : Including the experimental study
- Chapter4: Show result of experiment and discussion.
- Chapter5: Including conclusion and recommendations

Chapter two

Literature review and background

2.1 Introduction

Concrete a composite man-made material, is the most widely used building material in the construction industry. It consists of a rationally chosen mixture of binding material such as lime or cement, well graded fine and coarse aggregates, water and admixtures (to produce concrete with special properties). In a concrete mix, cement and water form a paste or matrix which in addition to filling the voids of the fine aggregate, coats the surface of fine and coarse aggregates and binds them together.

Freshly mixed concrete before set is known as wetor green concrete whereas after setting and hardening it is known as setor hardened concrete. The moulded concrete mix after sufficient curing becomes hard like stone due to chemical action between the water and binding material. It would be impossible to discuss all the aspects of this material in few pages and the discussion is confined to the general characteristics and quality tests necessary for its use by civil engineers and architects .

A good quality concrete is essentially a homogeneous mixture of cement, coarse and fine aggregates and water which consolidates into a hard mass due to chemical action between the cement and water. Each of the four constituents has a specific function. The coarse aggregate acts as a filler. The fine aggregate fills up the voids between the paste and the coarse aggregate. The cement in conjunction with water acts as a binder. The mobility of the mixture is aided by the cement paste, fines and nowadays, increasingly by the use of admixtures. Most of the properties of the hardened concrete depend on the care exercised at every stage of the manufacture of concrete. .[K. Duggal]

2.2 Concrete Material:-

A composite material is made up of various constituents. The properties and characteristics of the composite are functions of the constituent materials" properties as well as the various mix proportions. Before discussing the properties of the composite, it is necessary to discuss those of the individual constituents as well as the effects of the mix proportions and methods of production. .[Neville]

2.2.1 : Cement

There are many different kinds of cements. In concrete, the most commonly used is portland cement, a hydraulic cement which sets and hardens by chemical reaction with water and is capable of doing so under water. Cement is the "glue" that binds the concrete ingredients together and is instrumental for the strength of the composite.

Although cements and concrete have been around for thousands of years, 5modern Portland cement was invented in 1824 by Joseph Aspin of Leeds, England. The name derives from its resemblance of the natural building stone quarried in Portland, England. Portland cement is made up primarily of four mineral components (tricalcium silicate, declaim silicate, tricalcium aluminate, and tetra calcium aluminoferrite), each of which has its own hydration characteristics. By changing the relative proportions of these components, cement manufacturers can control the properties of the product The primary product of cement hydration is a complex and poorly crystalline calciumsilicate hydroxide gel (or CSH).

A secondary product of hydration is calcium hydroxide, a highly crystalline material. A category of siliceous materials known as pozzolans have little or no cementitious value, but will react chemically with calcium hydroxide to form additional CSH. This secondary hydration process has a generally beneficial effect on the final concrete properties. Examples of pozzolans are fly ash, ground granulated blast-furnace slag, and microsilica or silica fume.

The American Society for Testing and Materials (ASTM) defines five types of cement, specifying for each the mineral composition and chemical and physical characteristics such as fineness. The most common cement is Type I . Type III cement is used if more rapid strength development is required. The other types are characterized by either lower heat of hydration or better sulfate resistance than that of Type I cement. .[Neville]

Nomenclature Differences

In the US, three separate standards may apply depending on the category of Cement for Portland cement types, ASTM C150 describes in Table (2.1) .

Cement chemistry

In all the Portland Cements, there are four major compounds. variation in percentage composition of compounds influences the properties of cement. These compounds are given in table (2.3).

Table (2.1): Portland cement types ASTM C150

Cement Type	Description
Type I	Normal
Type II	Moderate Sulfate Resistance
Type II (MH)	Moderate Heat of Hydration (andModerate SulfateResistance)
Type III	High Early Strength
Type IV	Low Heat Hydration
Type V	High Sulfate Resistance
For blended hydraulic cements – specified by ASTM C595 – the following nomenclature is used:	
Cement Type	Description
Type IL	Portland-Limestone Cement
Type IS	Portland-Slag Cement
Type IP	Portland-Pozzolan Cement
Type IT	Ternary Blended Cement

Table (2.2): General Features of the Main Types of Portland cement according to British standard

Type	Classification	Characteristics	Applications
Type II	General purpose	Fairly high C3S content for good early strength development	General construction(most buildings,bridges,pavements,precast units etc
Type III	High early strength	Ground more finely, may have slightly more C3S	Rapid construction,cold weather concreting
Type V	High sulfat resistance	Very low C3A content (<5%)	Structures exposed tohigh levels of sulfate ions
Type IV	Low heat of hydration (slow reacting)	Low content ofC3S (<50%) and C3A	Massive structures such as dams.

Table (2.3) cement compounds:

Abbreviation of compound	Name of compound	Oxide composition
C3S	Tri calcium Silicate	3CaO.SiO2
C2S	Di calcium Silicate	2CaO.SiO2
C3A	Tri calcium Aluminate	3CaO.AI2O3
C4AF	Tetracalcium Alumino ferrite	4CaO.AI2O3Fe2O3

There are two ways in which compounds of the type present in cement can react with water. In the first, a direct addition of some molecules of water takes place, this being a true reaction of hydration. The second type of reaction with water is hydrolysis, in which its nature can be illustrated using the C3S hydration equation

3CaO.SiO2 + H2O → Ca(OH)2 + xCaO.ySiO2.aq. (calcium silicate hydrate)

2 C3S +6H → 3 Ca(OH)2 + C3S2H3

The reaction of C3S with water continue even when the solution is saturated with lime and the resulted amounts of lime precipitate in crystals form Ca(OH)2.Calcium silicate hydrate → remains stable when it is in contact with the solution saturated with lime.Calcium silicate hydrate → hydrolyzed when being in water – some of lime form, and the process continues until the water saturate with lime.If the calcium silicate hydrate remains in contact with water → it will leave the hardened compound only as hydrated silica due to the hydrolysis of all of the lime.

The rates of the chemical reactions of the main compounds are different:

Aluminates - React with the water in the beginning

- Affect the route of the chemical reactions at early periods of hydration.
- Silicates – Affect the later stage reactions.
- The main hydrates of the hydration process are:
- Calcium silicates hydrate, including hydrated products of C3S (notpure) named as Alite, and C2S (not pure) named as Belite.
- Tricalcium aluminates hydrate.
- C4AF hydrates to tricalcium aluminates hydrate and calcium ferrite CaO.Fe2 O3in amorphous form.
- Since calcium silicates (C3S and C2S) – are the main cement compounds (occupies about 75% of cement weight) – they are responsible for the final strength of the hardened cement paste.
- With time:
- The rate of hydration decreases continuously.
- The size of unhydrated cement particles decrease. For instance, after 28 days in contact with water, grains of cement have been found to have hydrated to a depth of only 4 µm, and 8µm after a year.

This is due to:

- Accumulation of hydration products around the unhydrated cement grains which lead to prevent water from channeling to them.
- Reduction of the amount of water either due to chemical reaction or evaporation.
- Reduction of the amount of cement due to reaction.

2.2.2 Aggregate

Since approximately three-quarters of the volume of concrete is occupied by aggregate, it is not surprising that its quality is of considerable importance . Not only may the aggregate limit the strength of concrete but the aggregate properties greatly affect the durability and structural performance of concrete.

Aggregate was originally viewed as an inert, inexpensive material dispersed throughout the cement paste so as to produce a large volume of concrete. In fact, aggregate is not truly inert because its physical, thermal and, sometimes, chemical properties influence the performance of concrete, for example, by improving its volume stability and durability over that of the cement paste. From the economic viewpoint, it is advantageous to use a mix with as much aggregate and as little cement as possible, but the cost benefit has to be balanced against the desired properties of concrete i n its fresh and hardened state.

Natural aggregates are formed by the process of weathering and abrasion, or by artificially crushing a larger parent mass. Thus, many properties of the aggregate depend on the properties of the parent rock, e.g. chemical and mineral composition, petrographic classification, specific gravity, hardness, strength, physical and chemical stability, pore structure, colour etc. In addition, there are other properties of the aggregate which are absent in the parent rock: particle shape and size, surface texture and absorption. All these properties may have a considerable influence on the quality of fresh or hardened concrete .Even when all these properties are known, it is difficult to define a good aggregate for concrete. Whilst aggregate whose properties are all satisfactory will always make good concrete, aggregates appearing to have some inferior property may also make good concrete, and this is why the criterion of performance in concrete has to be used. For instance, a rock sample may disrupt on freezing but need not do so when embedded in concrete. However, in general, aggregate considered poor in more than one respect is unlikely to make a satisfactory concrete, so that aggregate testing is of value in assessing its suitability for use in concrete. [Neville]

2.2.2.1 Size classification

Concrete is made with aggregate particles covering a range of sizes up to a maximum size which usually lies between 10 mm and 50 mm is typical. The particle size distribution is called grading. Low -grade concrete may be made with aggregate from deposits containing a whole range of sizes, from the largest to the smallest, known as all-in or pit-run aggregate. The alternative, very much more common, and always used in the manufacture of good quality concrete, is to obtain the aggregate in at least two separate lots, the main division being at a size of 5 mm or No. 4 ASTM sieve. This divides fine aggregate (sand), from coarse aggregate (see Table 2.4) and fig (2.3) It should be noted that the term aggregate is sometimes used to mean coarse aggregate in contradistinction to sand, a practice which is not correct.Sand is generally considered to have a lower size limit of about 0.07 mm (0.003 in.) or a little less. Material between 0.06 mm (0.002 in.) and 0.02 mm (0.0008 in.) is classified as silt, and smaller particles are termed clay. Loam is a soft deposit consisting of sand, silt and clay in about equal proportions.

Table (2.4) BS, ASTM and BS EN sieve sizes normally used for grading of aggregate.

Coarse aggregate		Fine aggregate	
BS	ASTM	BS	ASTM
Aperture	Aperture		
	125 mm (5 in.)		
	100 mm (4 in.)		
75 mm (3 in.)	75 mm (3 in.)		
63 mm (2.5 in.)	63 mm (2.5 in.)		
50 mm (2 in.)	50 mm (2 in.)		
37.5 mm (1.5 in.)	37.5 mm (1.5 in.)	5 mm (0.197 in.)	4.75 mm (0.187 in)
28 mm (1.1 in.)	25 mm (1 in.)	2.36mm(0.0937in.)	2.36 mm (0.093 in)
20 mm (0.786 in.)	19 mm (0.75 in.)	1.18(0.046in)	1.18(0.046in)
14 mm (0.51 in.)	12.5 mm (0.5 in.)	600Mm(.028in)	600Mm(.028in)
10 mm (0.393 in.)	9.5 mm (0.374 in.)	300Mm(.0117in)	300Mm(.0117in
6.3 mm (0.248 in.)	6.3 mm (0.248 in.)	150Mm(.oo59in)	150Mm(.0059in)

2.2.2.2 Shape and texture classification

The external characteristics of the aggregate, in particular the particle shape and surface texture, are of importance with regard to the properties of fresh and hardened concrete. The shape of three-dimensional bodies is difficult to describe, and it is convenient to define certain geometrical characteristics of such bodies.

Roundness measures the relative sharpness or angularity of the edges and corners of a particle. The actual roundness is the consequence of the strength and abrasion resistance of the parent rock and of the amount of wear to which the particle has been subjected. In the case of crushed aggregate, the shape depends on the nature of the parent material and on the type of crusher and its reduction ratio, i.e. the ratio of initial size to that of the crushed product. A convenient broad classification of particle shape is given in Table(2.6) and figure(2.1)and figure(2.2)below

Table(2.5) Particle shape classification of aggregates with example

Classification	Description	Examples
Rounded	Fully water-worn or completely shaped by attrition	River or seashore gravel; desert, seashore and wind-blown sand
Irregular	Naturally irregular, or partly shaped by attrition and having rounded edges	Other gravels; land or dug flint
Flaky	Material of which the thickness is small relative to the other two dimensions	Laminated rock
Angular	Possessing well-defined edges formed at the intersection of roughly planar faces	Crushed rocks of all types; talus; crushed slag
Elongated	Material, usually angular, in which the length is considerably larger than the other two dimensions	
Flaky and Elongated	Material having the length considerably larger than the width, and the width considerably larger than the thickness	

Figure(2.1): fine aggregate(sand)

Figure(2.2) :different surface texture of course aggregate

Characteristic Of Aggregate:

The properties to be considered while selecting aggregate for concrete are strength, particle shape, specific gravity, bulk density, voids, porosity, moisture content and bulking.

2.2.3 Water

The purpose of using water with cement is to cause hydration of the cement. Water in excess of that required for hydration acts as a lubricant between coarse and fine aggregates and produces a workable and economical concrete. Almost any natural potable water that has no pronounced taste or odour is acceptable for the concrete mix. Many sources of water unsuitable for drinking may also be used. In case of a doubt, water samples should be tested for suitability. Excessive impurities may affect setting time, strength, durability and may cause efflorescence, surface discoloration, and corrosion of steel. [Neville

2.3 Admixtures

Admixtures are the materials other than the three basic ingredients of cement concrete cement, aggregate and water added to the concrete mix before or during mixing to improve certain of its properties in fresh or hardened state. The properties commonly modified are rate of hydration or setting time, workability, dispersion and air entrainment. A degree of control must also be exercised to ensure proper quantity of admixture. .[K. Duggal]

2.3.1 Function

The functions of admixtures are to accelerate the initial set of concrete, i.e., to speed up the rate of development of strength at early ages, retard the initial set, increase the strength of concrete, improve workability, reduce heat of evolution, increase durability of concrete resistance to freezing and thawing, control expansion caused by aggregate-alkali reaction, decrease capillary flow of water and to make it impermeable, increase the penetration and pump ability of concrete, reduce segregation in grouts, strengthen the bond between old and new concrete surfaces and that between steel reinforcement and concrete, inhibit corrosion of concrete, increase resistance to chemical attack, produce colored and cellular concrete, produce concrete of fungicidal, germicidal and insecticidal properties, and produce non-skid concrete surfaces.

2.3.2 Classification

Admixtures may be classified as accelerators, retarders, water proofers, workability agents,surface active agents, puzzolanas. .[K. Duggal]

2.4 Corn Cob Ash

Corn Cob is the hard thick cylindrical central core of maize (on which are borne the grains or kernels of an ear of Corn).it was obtained in dry form and sundried for one week. The collected sample was then burnt separately into ash by open burring in a metal container. Finally the product was sieve using sieve number 200. The chemical composition of pozzolana varies considerably , depending on the source and preparation technique .generally ,apozzolana will contain silica,aluminia, iron oxide and variety of oxides and alkalis, each varing degrees. The purpose of this study was to evaluate the benefits of replacing Ordinary Portland Cement (OPC) with Corn Cob Ash (CCA) blended cements. The cement industry contributes considerable amount of Carbon Dioxide (CO_2) emissions into the atmosphere. The main contribution of CO_2 emissions from cement production results from the process of creating Calcium Oxide (CaO) from limestone ($CaCO_3$) commonly known as the calcination process. Blending OPC witha pozzolanic material will assist in the reduction of CO_2emissions due to calcination as well as enhance the quality of OPC. There are various pozzolanic materials such as fly ash, rice husk, silica fume and CCA that could be promising partial replacement for OPC. In this study, CCA will serve as the primary blending agent with OPC. An experiment was performed to designate an appropriate percentage replacement of CCA that would comply with specific standards of cement production. The experimental plan was designed to analyze compressive strength, and workability of various CCA blended cements. When a pozzolan is blended with Portland cement it reacts with the lime to produce additional calcium-silicate-hydrate (C-S-H), which is the main cementing compound. Thus the pozzolanic material reduces the quantity of lime and increases the quantity of C-S-H. Therefore, the cementing quality is enhanced if a pozzolan is blended in suitable quantity with Portland cement .

2.5 Fresh Concrete Properties

2.5.1 Workability

Freshly mixed concrete should be plastic or in a semi fluid state that can be molded by hand or by mechanical means. In a plastic concrete mixture, all the particles of sand and coarse aggregate are encased and held in suspension. The ingredients should not segregate or separate during transport or handling.

A uniform distribution of aggregate particles helps control segregation. After the concrete hardens, it becomes a homogeneous mixture of all the components. Concrete of plastic consistency should not crumble but should flow sluggishly without segregation. Concrete consistency is measured by the slump test, ASTM C 143. Slumps of 1 to 3 in. (25 to 75 mm) are used for pavements and slabs. Slumps of 3 to 5 in. (75 to 125 mm) are used for columns and walls. Higher slump concretes, made with plasticizers, are used in thin applications, in locations with large amounts of reinforcing steel, or where concrete needs to be essentially self-consolidating.

Workability reflects the ease of placing, consolidating, and finishing freshly mixed concrete. Concrete should be workable but should not segregate or bleed excessively. Normal-strength concrete usually has good workability as long as concrete ingredients are used in proper proportions and an adequate aggregategradation is used; however, high-strength concrete is often sticky and difficult to handle and place, even with the aid of plasticizers, due to its high cement content. Concrete temperature also affects workability. .[K. Duggal]

2.5.2 Factors Afecting Workability

A workable concrete exhibits very little internal friction between the particles forming the concrete and overcomes the frictional resistance offered by the internal surface of formwork as well as that by the reinforcement contained in the concrete with just the amount of compacting efforts for thcoming. The factors helping concrete to achieve these are as follows:

Water Content :The fluidity of concrete increases with water content. At site the normal practice is to increase the water content to make the concrete workable which lowers strength.

Aggregate size :For big size aggregate the total surface area to be wetted is less, also less paste is required for lubricating the surface to reduce internal friction. For a given water content big size aggregate give high workability.

Shape aggregate: For a given water content, round and cubical shape aggregates are more workable than rough, angular or flaky aggregates, because the former type of aggregates requires less cement paste for lubrication as these have less surface area and lesser voids. In case of round aggregates frictional resistance is also small so less lubrication is required. For this reason river sand and gravel provide greater workability than crushed sand and aggregates.

Grading Of aggregate: Properly graded aggregates are more workable. It is so because such a mix will have least voids and thus excess cement paste will be available as lubricant. This also prevents segregation. [K. Duggal]

2.5.3 Measurement Of Workability

There are many methods to measure of workability:

-Slump Test :

This method of test specifies the procedure to be adopted, either in the laboratory or during the progress of work in the field, for determining the consistency of concrete where the nominal maximum size of the aggregate does not exceed 38 mm.The mould used for the test specimen is shown in Fig (3.4). The internal dimensions of the mould are bottom diameter =200 mm, top diameter = 100 mm, and height = 300 mm.The mould is filled in with fresh concrete in four layers,each approximately one-quarter of the height and tamped with twenty-five strokes of the rounded end of the tamping rod. The strokes are distributed in a uniform manner over the cross-section and for the second and subsequent layers should penetrate into the underlying layer. The bottom layer is tamped throughout its depth. After the top layer has been rodded, the concrete is struck off level with a trowel or the tamping rod, so that the mould is exactly filled. The mould is removed immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside and the slump is measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested . The slump measured is recorded in terms of millimetres of subsidence of the specimen. [Neville, K. Duggal]

2.6 Strength Of Concrete

The most useful property of concrete is its compressive strength. However, it is weak in tension. Till date no relation exists between compressive, tensile, bending, and shear strengths of concrete. However, it may be mentioned here that typically the tensile and bending strength of the concrete are of the order of 10 and 15 per cent, respectively of the compressive strength. The shear is approximately 20 per cent of the uniaxial compressive strength. [Neville, K. Duggal]

2.6.1 Factors Influencing Sterngth Of Concrete

Factors affecting the strength of concrete can be broadly grouped into those depending upon the testing methods and the others independent of the testing methods. Factors depending on testing methods are size of test specimen, size of specimen relative to maximum size of aggregate, moisture condition of specimen, rate of loading adopted, and type of testing machine used; and those independent of testing method are type of cement and age of cement, type and size of aggregates, degree of compaction, water-cement ratio, aggregate-cement ratio, airvoids, curing method and curing temperature, and type of stress situation that may exist (uniaxial, biaxial and triaxial).

2.7 Concrete Mix Design procedure

Conventional nominal mix proportioning often specified by rule of thumb such as 1:1:2; 1:2:4; 1:3:6, etc. have limited significance as these are with little consideration for the materials that will be used. Since the quantity of fine aggregate is fixed irrespective of the cement and the maximum size of aggregate, considerable variations in quality are obtained by this method. Therefore, nominal mix proportions, arbitrarily fixed, have little use in concrete mix design. Another reason not in favour of nominal mix concept is that the water-cement ratio, a most important factor governing concrete quality, is not specified for nominal mixes, and has to be kept as low as possible provided that the mix is fully compacted concrete. A more realistic approach is to specify a minimum strength for the concrete and to choose the proportions of cement, fine aggregate, coarse aggregate and water-cement ratio. There is trend away from the specification of nominal mixes on the strength basis.

Step-1: Determining the Water/ Cement Ratio

Set the required characteristic strength at a specified age, fc Calculation of the margin, M.

M = K* S …. [1]

Where:

K = A value appropriate to the defect percentage permitted below the Characteristic strength.

[k = 1.64 for 5 % defect] (Obtained from Table 2.4).

S = the standard deviation (obtained from Figure 2.1)

Table (2.6) K Value:

Defective	Constant
1%	2.3
2.5%	1.96
5%	1.65

Step-2: Calculation of the target mean strength, FM

FM =fc +m ….. [2]

Where:

FM = Target mean strength

fc= the specified characteristic strength

Table (2.7): Compressive Strength (N/mm2) of Concrete Mixes Made With water/cement Ratio of 0.5.

Approximate compressive strength N/mm2 of concrete mixes made with free-water/cement ratio of 0.5					
Cement Strength classType of coarse aggregate		Compressive strength N/mm2 Age(days)			
		3	7	28	91
42.5	uncrushed	22	30	42	49
	crushed	27	36	49	59
52.5	uncrushed	29	37	48	54
	crushed	34	43	55	61

A value is obtained from Table (2.7) for the strength of a mix made with awater/cement ratio of 0.5 according to the specified age, the strength class of the cement and the aggregate to be used. This strength value is then plotted on Figure (2.3) and a curve is drawn from this point and parallel to the printed curves until it intercepts a horizontal line passing through the ordinate representing the target mean strength.

Step-3: Determination of the Free-Water Content

The free-water content can be determined from Table (2.8) depending upon the type and maximum size of the aggregate to give a concrete of the specified slump or Vebe time.

Table (2.8) Approximate free-water contents (kg/m3) required to give various levels of workability.

Slump(mm) VebeTime(s)		0-10 >12	10-30 6-12	30-60 3-6	60-80 0-3
Max Size Of Aggregate(mm)	Type of aggregate				
10	Uncrushed	150	180	205	225
	crushed	180	205	230	250
20	Uncrushed	135	160	180	195
	crushed	170	190	210	225
30	Uncrushed	115	140	160	175
	crushed	155	175	190	205

Step-4: Determination of Cement Content

The cement content can be determined from equation 3...

Cement Content = Free Water Content / water-Cement Ratio ….. [3]

The resulting value should be checked against any maximum or minimum value may be that specified. If the calculated cement content from equation 3 is below a specified minimum, this minimum value must be adopted and a modified free water/cement ratio calculated. If the design method indicates a cement content that is higher than a specified maximum then it is probable that the specification cannot be met simultaneously on strength and workability requirements with the selected materials.Consideration should then be given to changing the type or strength class, or both,of cement, the type and maximum size of aggregate or the level of workability of the concrete, or to the use of a water-reducing admixture.

Step 5: Determining the Total Aggregate Content

Density of fully compacted concrete can be estimated from Figure (2.5). This value depends up on the free-water content and the relative density of the combined aggregate in the saturated surface dry condition. If no information is available regarding the relative density of value of 2.6 for un-crushed aggregate and 2.7 for crushed aggregate.

The total aggregate content can be calculated using equation 4:

Total Aggregate Content ... [4]

Where:

D = The wet density of concrete (kg/m3)

C = The cement content (kg/m3)

W = The free-water content (kg/m3)

Step 6: Determining of the Fine and Coarse Aggregate Contents

Current step demonstrate how to find out total fine aggregate (materials smaller than 5 mm, i.e. the sand or fine aggregate content). The Figure (2.6) shows recommended values for the proportion of fine aggregate depending on the maximum size of aggregate, the workability level, the grading of the fine aggregate (defined by the percentage passing a 600 μm sieve) and the free-water/ cement ratio. The best proportion of fines to use in a given concrete mix design will depend on the shape of the particular aggregate, the grading and the usage of the concrete.

Determination of fine and coarse aggregate can be made using the proportion of fine aggregate obtained from Figure (2.6) and the total aggregate content derived from Step-5

Fine Aggregate Content = Total Aggregate Content*Proportion of Fines Coarse [4]
Aggregate Content = Total Aggregate Content – Fine Aggregate …[5]

2.8 Previous Studies

This chapter presented a comprehensive literature review of related previous researches:

Ahangba Augustine , studied concern the investigation of concrete produced by partial replacement of cement with Corn Cob Ash (CCA) in specified ratios of 5%, 10%, 15%, 20% and 25%.Concrete cubes were cast and cured in ages of 7, 14 and 28 days respectively Compressive strength test was carried out on the cubes. The results showed that the concrete strength decreased with increasing replacement with the Corn Cob Ash (CCA). It was concluded that CCA can be used as partial replacement for cement in concrete production as well as for walls of building units and other mild construction works, and replacement should not exceed 10% as strength produced above this replacement level may not be adequate for strength requirements.

Olafusi Oladipupo, Olutoge Festus they were varying percentage of CCA cement concrete and 100% cement concrete of mix1:2:4 and 0.5 water-cement ratios were examined and compared. A total of 72 concrete cubes of size 150 × 150 × 150 mm^3 with different percentages by volume of CCA to Portland cement in the order were cast, tested and their physical and mechanical properties determined. A high strength (35MPa) concrete was further designed using CCA as a partial replacement for 0% and 10% partial replacements. the mechanical properties which included compressive strength tests showed that 10% of the CCA in replacement for cement was quite satisfactory with no compromise in compressive strength requirements for concrete mix ratios1:2:4 at 7days, but did not meet the standard strength at14, 21 and 28 days. test results showed that the use of CCA as a partial replacement for cement in concrete. Though CCA could be used as a partial replacement for cement in high strength concrete, but the CCA concrete would take longer time to achieve its designed strength .

Bala, M. Abubakar, H. S. Abdulrahman They were investigated the effects of partial replacement of cement with Corn Cob Ash (CCA). Physical properties of the aggregates and mechanical properties of CCA cement concrete at 0.5 water–cement ratio and mix ratio of 1:2:4 were examined different percentages by mass of corncob ash to Portland cement in order of 0%, 3%, 6%, 9% and 12% corncob ash were cast and crushed. They was obtained at 3% replacement level, which shows that the 3% CCA replacement for cement is the optimum. While 12% CCA replacement for cement offers the lowest strength.

Chapter Three

Experimental Study

3.1 Introduction

Concrete is the most versatile heterogeneous construction material and the most impetus of infrastructural development of any nation .Concrete a synthetic construction material made by mixing cement , fine aggregates, coarse aggregates , and water in the proportion . each of these components contributes to the strength of concrete.

In this chapter gain knowledge of the testes and use of concrete materials. The Specifications contain requirements for all concrete materials. Inspect all materials used in the construction of concrete work at their source, on the job, or both.The Engineers and Inspectors must inspect all materials to assure they meet all requirements prior to incorporation.

3.2 Cement tests

Portland cement is made up primarily of four mineral components (tricalcium silicate, dicalcium silicate, tricalcium aluminate, and tetracalcium aluminoferrite), each of which has it is own hydration characteristics. By changing the relative proportions of these components, cement manufacturers can There are many tests to determine quality of cement before use it in any construction the there are below.

3.2.1 Fineness

To determine the fineness of cement by dry sieving as per IS: 4031 (Part 1). 1996.

Apparatus

1. standard balance with 100gm weighing capacity

2. IS75 micron sieve confirming to IS: 4031 (Part 1) 1996.

3.stop watch

figure 3.1 Sieve No 200

Procedure

- Break down any air-set lumps in the cement sample with fingers
- weight 100 gm accurately of the cement and place at the Is standard sieve.
- continuously sieve the sample for 15minutes
- weight the residue left after 15 minutes sieving.

The test Result

The percentage of residue weight over the total sample is reported

%Weight of residue = (Wt of sample retained on the sieve)/(total weight of the sample)

Limits

The percentage residue should not exceed 10%.

3.2.2 Consistency

The standard consistency of a cement paste is defined as that consistency which will permit the vicat plunger to penetrate to a point 5 to 7mm from the bottom of the vicat mould.

Apparatus

1. Vicat Apparatus Conforming to IS: 1988.(See fig 3.2)

2. Balance of capacity 600gms.

3. Gauging trowel conforming to IS: 1988

Procedure

- Prepare a paste of weighed quantity of cement (400gms) with weighed quantity of potable or distilled water, taking care that the time of gauging is not less than not less than 3minutes nor more than 5minutes and the gauging is completed before any sign of setting occurs.
- The gauging is counted from the time of adding water to the dry cement until commencing to fill the mold.
- Fill the vicat mold with this paste resting upon a non-porous plate.

- Smoothen the surface of the paste, making it level with the top of the mould.
- Slightly shake the mold to expel the air.
- In filling the mold operators hands and the blade of the gauging trowel shall only be used.

Figure 3.2: Vicat Apparatus

- Immediately place the test block with the non-porous resting plate, under the rod bearing the plunger.
- Lower the plunger gently to touch the surface of the test block and quickly release, allowing it sink into the paste.

- Record the depth of penetration.
- Prepare trial pastes with varying percentages of water and test as described above until the plunger is 5mm to 7mm from the bottom of the vicat mould.

Calculations

standard consistency(% =(Weight of water added)/(Weight of cement)X100 Express the amount of water as a percentage of the weight of dry cement to the first place of decimal.

3.2.3 Initial and Final Setting Time

To determine the initial and final setting times of cement IS: 4031 (Part 1988.

Apparatus

1.Vicat apparatus conforming to IS: 5513-1976.

2. Balance of capacity 1kg and sensitivity 1 gram.

3. Gauging trowel conforming to IS: 10086-1982.

Procedure

- Prepare a paste of 300 grams of cement with 0.85 times the water required to a give a paste of standard consistency IS: 4031 (Part 4) 1988.
- The time of gauging in any case shall not be less than 3 minutes not more than 5 minutes and the gauging shall be completed before any sign of setting occurs.
- Count the time of gauging from the time of adding water to the dry cement until commencing to fill the mould.

- Fill the vicat mould with this paste making it level with the top of the mould. see Figure (3.2):
- Slightly shake the mould to expel the air.
- In filling the mould the operator hands and the blade the gauging trowel shall only be used.

3.2.3 Initial and Final Setting Time

Initial Setting Time

1. Immediately place the test block with the non-porous resting plate, under the rod bearing the initial setting needle.

2. Lower the needle and quickly release allowing it to penetrate in to the mould.

3. In the beginning the needle will completely pierce the mould.

4. Repeat this procedure until the needle fails to pierce the mould for 5 + 0.5mm.

5. Record the period elapsed between the time of adding water to the cement to the time when needle fails to pierce the mould by 5 + 0.5mm as the initial setting time.

Final Setting Time

1. Replace the needle of the vicat apparatus by the needle with an annular ring See

2. Lower the needle and quickly release.

3. Repeat the process until the annular ring makes an impression on the mould.

4. Record the period elapsed between the time of adding water to the cement to the time when the annular ring fails to make the impression on the mould as the final setting time.

- Report the initial setting time and final setting time in minutes.

- The time of gauging in any case shall not be less than 3 minutes not more than 5minutes..

Result of Cement Tests

It was conducted cement tests (fineness, consistency ,sitting time) The results as shown in Table(3.1) below:

Table (3.1) Results of Cement tests

Test No	Test Name	Test Result	BS No (12-1996)
1	Fineness	1.9%	Not more than 10%
2	Consistency	33%	26-33%
3	Sitting Time		
	Sitting Initial Time	110 min	Not less than 45 min
	Sitting Final Time	6.20 hr	Not more than 10 hr

3.3 Test of Aggregate

Aggregate is the very important component of concrete it is constitutes typically 75% of the concrete volume and therefore its properties largely determine the properties of the concrete ,To determine the quality of aggregate there are many testes are doing explain below.

3.3.1 Sieve Analysis

Sieve analysis is the name of the operation of dividing as ample of aggregate into fractions, each consisting of particles of the same size. In practice each fraction contains particles between specific limits, these being the openings of standard test sieves.

Apparatus

To determine the particle size distribution of fine and coarse aggregates by sieving as per IS:2386 (Part I)-1963.Table(3.4)(3.5)& Figure (3.6).

standard balance with 1000gm(1kg) weighing capacity see Figure(3.3)

Figure (3.3): sieves opening.

Procedure

1. The test sample is dried to a constant weight at a temperature of 110 +5oC and weighed.

2. The sample is sieved by using a set of IS Sieves.

3. On completion of sieving, the material on each sieve is weighed.

4. Cumulative weight passing through each sieve is calculated as percentage of the total sample weight.

5. Fineness modulus is obtained by adding cumulative percentage of aggregates retained on each sieve and dividing the sum by 100.

Then the results should be calculated and reported as:

•The cumulative percentage by weight of the total sample.

•The percentage by weight of the total sample passing through one sieve and retained on the next smaller sieve, to the nearest 0.1 percent.

The results of the sieve analysis may be recorded graphically on a semi-log graph with particle size as abscissa (log scale) and the percentage smaller than the specified diameter as ordinate. Table (3.1) Sieves Commonly Used For Sieve Analysis of Concrete Aggregate .

Table (3.2) Sieve designations Coarse and Fine Aggregate

British standards (millimeters)	**American standards**	**Nominal openings (inches)**
75	3	3
37.5	1 ½	1.5

20	¾	0.75
12.5	½	0.5
6.3	¼	0.25
Fine Aggregate		
4.75	No 4	0.187
2.36	No 8	0.0937
1.15	No 16	0.0469
0.600	No 30	0.0234
0.300	No 50	0.0117
0.150	No 100	0.0059
0.075	No 200	0.0029

Table (3.3): Result of Sieve Analysis of Coarse Aggregate &Grading According to British Standard

Sieve Size	MassRetrain(g)	Percentage Retrain	Cumulated Re Retrain	Percentage Passing
50	14	1.480	1.480	98.52
37.5	42	4.440	5.92	94.08
20	154	16.28	22.20	77.80
12.5	94	9.94	32.14	67.86
10	242	25.58	57.72	42.28
4. 75	280	29.60	87.32	12.68
2.36	90	9.51	96.82	3.18
Pan	30	3.17	99.99	.01

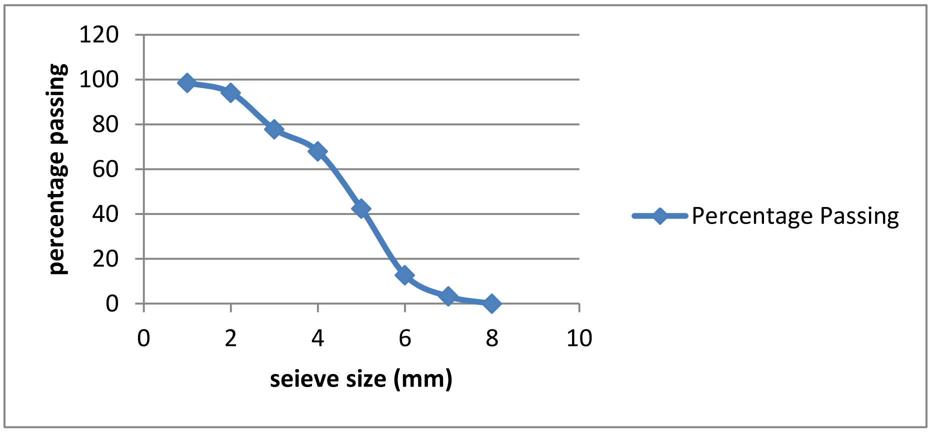

Figure (3.4)Sieve Analysis of Coarse Aggregate &Grading According to British Standard

Table (3.4): Result of Sieves Analysis of Fine Aggregate &Grading According British Standard

Sieve Size Mm	MassRetrain(g)	Percentage Retrain	Cumulated Re Retrain	Percentage Passing
10	0	0	0	100
5	0	0	0	100
2.36	250	.25	.25	99.75
1.18	438	43.28	43.53	56.22
.63	216	21.6	65.13	34.87
.3	300	30.0	90.13	9.87
.16	20	2	92.13	7.87
Pan	0	0	-	-

Table (3.5): Ranges In physical Prosperities for Normal Weight Aggregate

Property	Typical Ranges
Fine Modulus of fine Aggregate	2.0-3.30
Nominal size of coarse aggregate	9.5-37.5 mm
Absorption	2.30-2.90
Surface Moisture Content of coarse	0-2%
Surface Moisture Content of fine	0-10%

3.3.2 Specific Gravity and Water Absorption

The test covers the procedures for determining the specific gravity, apparent specific gravity and water absorption of aggregates.

Appartus

1. vessels.

2. oven.

3. standard.

4. Balance

Procedure

- sample shall be screened on an I0-mm IS sieve, washed to remove dust.
- immersed the sample in distilled water in the glass vessel; it shall remain immersed at a temperature of 22 to 32°C for 24 f l/2 hours. 3.

- air entrapped in or bubbles on the surface of the aggregate shall be removed by gentle agitation. This may be achieved by rapid clockwise and anti-clockwise rotation of the vessel between the operator" s hands.
- The vessel shall be overfilled by adding distilled water and the plane ground glass disc slid over the mouth so as to ensure that no air is trapped in the vessel.
- The vessel shall be dried on the outside and weighed (weight A).
- The vessel shall be emptied and the aggregate allowed draining Refill the vessel with distilled water
- The vessel shall be dried on the outside and weighed (Weight B).
- The aggregate shall be placed on a dry cloth and gently surface dried with the cloth, transferring it a second dry cloth when the first will remove no further moisture.
- The aggregate shall then be weighed (weight C).
- The aggregate shall be placed in the oven in the shallow tray, at a temperature of 100 to 110°C for 24 f l/2 hours. It shall then be cooled in airtight container and weighed (weight D).

Finally, calculations Specific gravity, apparent specific gravity and water absorption shall be calculated as follows:

Specific gravity = (100*(D/(C-(A-B))

Apparent specific gravity = (100*(D/(D-(A-B))

Water absorption = = (100*(C/(B-(A-C))

A = weight in g of vessel containing sample and filled with distilled water

B = weight in g of vessel filled with distilled water only,

C = weight in g of saturated surface-dry sample, and

D = weight in g of oven-dry sample.

3.3.3 Moisture Content

One of the properties of the aggregate which should be known to design a concrete mix is its moisture content .it is necessary in order to determine the net water – cement ratio in abatch of concrete made with job aggregate .

Appartus

1- container
2- . oven.
3- standard.
4- Balance

Procedure

-Prepare the container clear,record its empty weight.(A)

-Weight the suitable sample of aggregate and keep it in container .

-The weight of container and aggregate (B)

-Put the sample in the oven at 105C for 24 hours.

-Remove the sample from the oven and weight (D)

-Calculation and Results

M.C % = ((B-D)/(D-A)) X100

Results of Fine, Coarse Aggregate Test The most important tests of fine and coarse aggregate given in Table (3.5) below:

Table (3.6) Result of Fine, Natural Coarse Aggregate

Property	Fine Aggregate	Coarse Aggregate
Specific Gravity	2.47%	2.65%
Moisture Content	0.38%	0.5%
Water Absorption%	0.78%	0.67%

3.4 Tests on fresh and hardened concrete

To determine and check the quality of fresh concrete there are many tests .

3.4.1 Workability:

This property describes the relative ease or difficulty of placing and consolidating concrete in the form. Workability is largely determined by the proportions of fine and coarse aggregate added to a given quantity of paste. One characteristic of workability is consistency ,which is measured by the slump test .A specific amount of slump is necessary to obtain the workability required by the intended conditions and method of placement. A very stiff mix has a low slump and, although difficult to place in heavily reinforced sections, is desirable for many uses. A more fluid mix is necessary when placing concrete around reinforcing steel.

3.4.1.1 Slump

This test can do on site to determine workability and consistency between individual batches as Per IS: 1199 – 1959.

Apparatus:

1/Slump cone.

2/ Tamping rod.

3/ Metal plate.See fig 3.4

Figure (3.4) : Slump Test tools

Procedure:

- The internal surface of the mould is thoroughly cleaned and applied with a light coat of oil.
- The mould is placed on a smooth, horizontal, rigid and nonabsorbent surface.
- The mould is then filled in four layers with freshly mixed concrete, each approximately to one-fourth of the height of the mould. Each layer is tamped 25 times by the rounded end of the tamping rod (strokes are distributed evenly over the cross section).
- After the top layer is rodded, the concrete is struck off the level with a trowel.
- The mould is removed from the concrete immediately by raising it slowly in the vertical direction.
- The difference in level between the height of the mould and that of the highest point of the subsided concrete is measured.
- This difference in height in mm is the slump of the concrete.

*The slump measured should be recorded in mm of subsidence of the specimen during the test. Any slump specimen, which collapses or shears off laterally gives incorrect result and if this occurs, the test should be repeated with another sample. If, in the repeat test also, the specimen shears, the slump should be measured and the fact that the specimen sheared, should be recorded. .[6]

Figure(3.5)Slump test mold

3.4.2 Test of hardened concrete

This is the end product of any concrete design. To check the quality of hardened concrete and ensure the design strength of concrete there are various tests done.

3.4.2.1 Compression Test:

Means The ability of concrete to resist a load in compression (To determine the compressive strength of concrete specimens as per IS: 516 - 1959.

Apparatus

1- Compression Testing Machine see figure (3.8)

Figure (3.6) compression test machine.

Procedure

The specimens, prepared according to IS: 516 - 1959 and stored in water, should be tested immediately on removal from the water and while still in wet condition. Specimens when received dry should be kept in water for 24hrs. before they are taken for testing. The dimensions of the specimens, to the nearest 0.2mm and their weight should be noted before testing.

- The bearing surfaces of the compression testing machine should be wiped clean and any loose sand or other material removed from the surfaces of the specimen, which would be in contact with the compression platens.

- In the case a of cubical specimen, the specimen should be placed in the machine in such a manner that the load could be applied to the opposite sides of the cubes, not to the top and the bottom. The axis of the specimen should be carefully aligned with the centre of thrus of the spherically seated platen. No packing should be used between the faces of the test specimen and the steel platen of the testing machine. As the spherically seated block is brought to rest on the specimen, the movable portion should be rotated gently by hand So that uniform seating is obtained.

The load should be applied without shock and increased continuosly at a rate of approximately 140kg/sq.cm/minute until the resistance of the specimen to the increasing load breaks down and no greater load can be sustained. The Maximum load applied to the specimen should then be recorded and the appearance of the concrete and any unusual features in the type of failure should be noted.

Calculation

The measured compressive strength of the specimen should be calculated by dividing the maximum load applied to the specimen during the test by the cross - sectional area, calculated from the mean dimensions of the section and should be expressed to the nearest kg/sq.cm. An average of three values should be taken as the representative of the batch, provided the individual variation is not more than ±15% of the average. Otherwise repeat tests should be done.

3.5 Mix of Materials

The properties of the end product depend not only on the various constituent materials listed below but also on the way they are proportioned and mixed, as well as on the methods of placing and curing the composite.

3.5.1Cement (OPC)

Portland cement is made up primarily of four mineral components (tri calcium silicate, di calcium silicate, tri calcium aluminate, and tetra calcium alumino ferrite),each of which has its own hydration characteristics. By changing the relative proportions of these components, cement manufacturers can control the properties of the

product The primary product of cement hydration isa complex and poorly crystalline calcium-silicate hydroxide gel (or CSH). A secondary product of hydration is calcium hydroxide, a highly crystalline material.A category of siliceous materials known as pozzolans have little or no cementitious value, but in finely divided form and in the presence of moisture will react chemically with calcium hydroxide to form additional CSH. This secondary hydration process as a generally beneficial effect on the final concrete properties.

3.5.2 Aggregate

The aggregate is a granular material, such as sand, gravel, crushed stone, or iron blast furnace slag. It is graded by passing it through a set of sieves with progressively smaller mesh sizes. All material that passes through sieve #4 [0.187 in. (4.75 mm) openings] is conventionally referred to as fine aggregate or sand, while all material that is retained on the #4 sieve is referred to as coarse aggregate, gravel, or stone.

By carefully grading the material and selecting an optimal particle size distribution, a maximum packing density can be achieved, where the smaller particles fill the void spaces between the larger particles. Such dense packing minimizes the amount of cement paste needed and generally leads to improved mechanical and durability properties of The aggregate constitutes typically 75% of the concrete the concrete. volume, or more, and therefore its properties largely determine the properties of the concrete.

3.5.3 Water

Nile river water uses .unless tests or experience indicates that a particular water source is satisfactory, mixing water should be free from acids, alkalis,oils, and organic purities. The basic ratio of water to cement determines the strength of concrete. Less water in mix, as long as it is workable and not too stiff, the stronger, more durable, and water tight the concrete. Too much water dilutes cement paste (binder), resulting in weak and porous concrete. Concrete quality varies widely, depending on the characteristics of its ingredients and the proportion of the mix.

3.6Concrete Samples Preparation

constituent materials for a particular concrete is a necessary, but not sufficient, condition for the production of high-quality concrete. The materials must be proportioned correctly, and the concrete must then be mixed, placed, and cured properly. In addition, there must be careful quality control of every part of the concrete making process. This requires full cooperation among the materials or ready-mixed concrete supplier, the engineer, and the contractor.

A composite material is made up of various constituents The properties and characteristics of the composite are functions of the constituent materials" proportions Portland cement, water, fine & natural coarse aggregate ,Corn cob ash, after tested all materiales according to BS mixed materials by the mixer about3-4 minutes after that take sample for slump test and compressive strength mould in three equal layers in cube (100*100*100) each layer compacted for 35 times, then recorded all values.(The samples obtained from Htab in Sharg Elneil of Khartom, and corn cob for west of sudan).

3.6.1 Mix Design by British Standard Method

Step-1

*Characteristic Strength =25 N/mm2 at 28days.

*Proportion defective =5%

*From Table (2.4) K =1.64

*From Figure (2.1) standard deviation= 4

*Target mean strength(Fm) = 25+(1.64*4) =31.56N/mm2

Step-2

*Compressive strength from Table (2.5)

*Type of cement O.P.C

*type of aggregate =Uncrushed

*Approximate compressive strength at 28 days =42 N/mm2

Step - 2

*From Figure (2.2) we draw parallel line to the nearest curve strength

31.56 N/mm2

*w/c = 0.5

Step -3

*The water requirement from Table (2.9)

*max size aggregate 20mm - uncrushed - slump (30mm-60mm)

*water requirement=180 kg/

Used=180kg/

Step-4

* Cement content= water content/percentage w/c

=180/0.5=360 kg/ m3

Step-5

*Fresh density of concrete water require =180kg/m3

*Specific gravity aggregate=2.65

*From Figure (2.3) Fresh density of concrete=2410

*step-6

Total aggregate content

Aggregate =density -cement-water

All aggregate =2410-180-360=1870kg/m3

Step-8

*From Figure (2.4) max size=20mm, slump (30-60), fine aggregate passing 600mm=34.87%, w/c = 0.5

*Property fine aggregate=42%

*fine aggregate= 0.42×1870 = 785.4 kg/m3

*Coarse aggregate=All aggregate –fine aggregate.

Coarse aggregate=1870 – 785.4 = 1084.6 kg/m3

Figure (3.8) mix design preparation and casting

Chapter four

Results and discussion

4.1 General

Tests were conduct on the components of concrete (mix) and fresh and Hardened concrete in order to determine how quality grade of these Components and their influence on the compressive strength and slump With the corn cob ash.

4.2 Presentation of Result

The result of hardened concrete testes conducted by adding different ratios of corn cob ash (5%,7.5%,and 10%) is replace of cement in concrete mix are shown in tables(4.1- 4.4) and in figure(4.1-4.2)

Table (4-1) :Compressive strength of CCA replaced 0% (N/mm2).

Using Corn Cob Ash 0%					
Age Day	Area(mm2)	Slump(mm	Failure Load (KN)	Strength (N/mm2)	Average Strength (N/mm2
7	1000	40	220	22	22.1
			230	23	
			210	21	
28			280	28	30.7
			310	32	
			350	35	
56			330	33	34
			340	34	
			360	36	

Table (4-2) :Compressive strength of CCA replaced 5% (N/mm2)

Using Corn Cob Ash 5%					
Age Day	Area(mm2)	Slump(mm	Failure Load (KN)	Strength (N/mm2)	Average Strength (N/mm2
7	1000	44	210	21	19.7
			200	20	
			180	18	
28			240	24	24
			220	22	
			260	26	
56			320	32	31.6
			290	29	
			300	30	

Table (4-3) :Compressive strength of CCA replaced 7. 5% (N/mm2)

Using Corn Cob Ash 7. 5%					
Age Day	Area(mm2)	Slump(mm	Failure Load (KN)	Strength (N/mm2)	Average Strength (N/mm2
7	1000	50	150	15	16.5
			180	18	
			170	17	
28			180	18	19.8
			200	20	
			210	21	
56			280	28	27.7
			240	24	
			290	29	

Table (4-4) :Compressive strength of CCA replaced 10 % (N/mm2)

Using Corn Cob Ash10%					
Age Day	Area(mm2)	Slump(mm	Failure Load (KN)	Strength (N/mm2)	Average Strength (N/mm2
7	1000	56	110	11	12.7
			130	13	
			140	14	
28			160	16	17.3
			190	19	
			170	17	
56			220	22	25.5
			290	29	
			250	25	

Table (4-5) : Compressive strength of CCA replaced against curing age

Age Curing(days) %CCA content	7	28	56
0	22.1	30.7	34
5	19.7	24	31.6
7.5	16.5	19.8	27.7
10	12.9	17.2	25.5

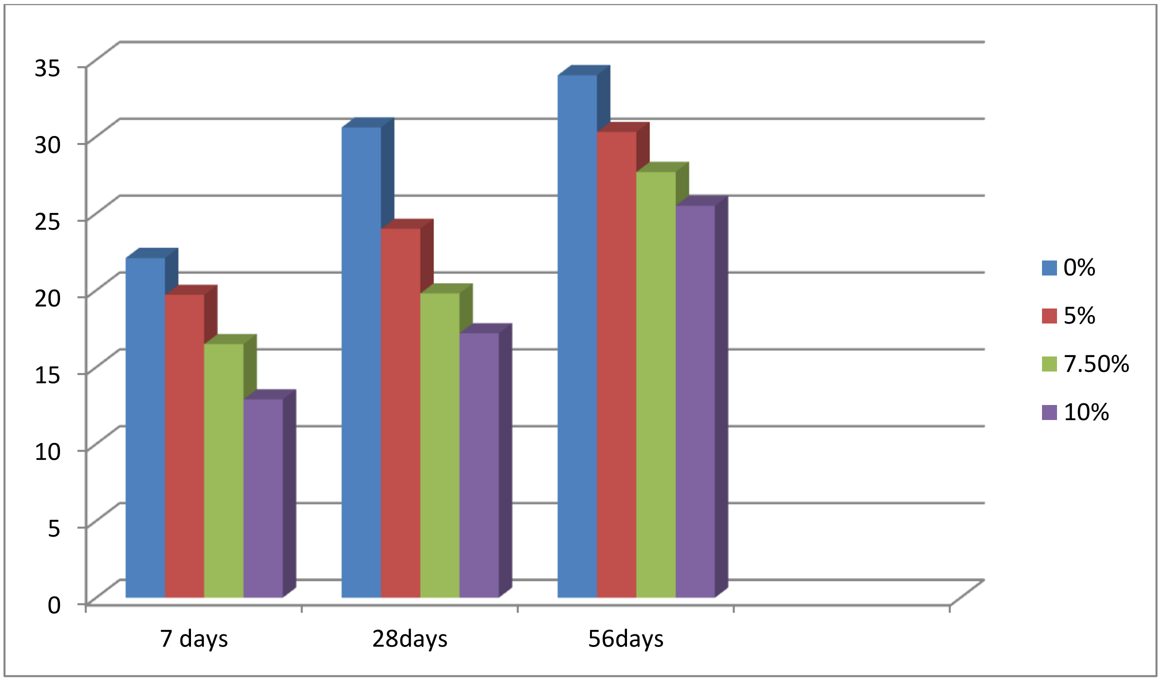

Figure 4- 1:Compressive strength of CCA replaced concrete.

Table 4-5 and Figure 4.1 show the compressive strengths achieved at different ages with different CCA replacements. The highest compressive strength was found at 5%, with maximum stresses of 31.6 N/mm2 recorded at 56 days.

Table(4-7) Slump of the designed grade 25 concrete (mm)

CCA content	0%	5%	7.5%	10%
Slump	40	44	50	56

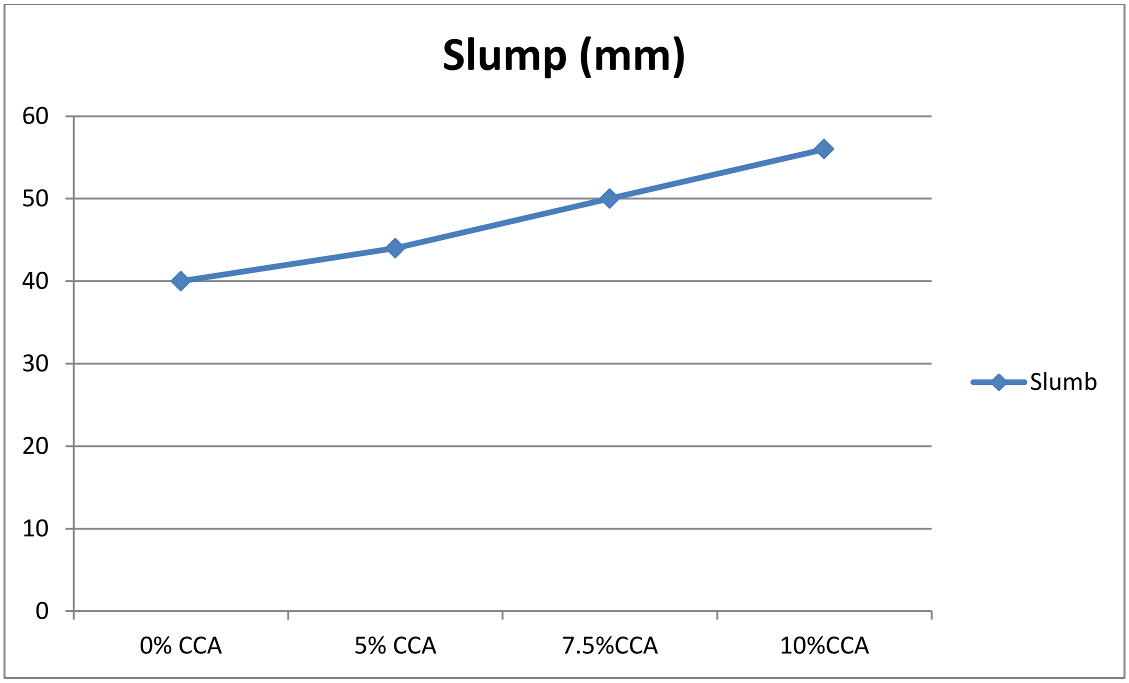

Figure 4-2 The slump of concrete (mm) in Various Corn Cob Ash Contents.

Table (4-7) and Figure (4-2) show the slump testes with different CCA replacements. The workability of CCA replaced mixes increased with increase replacement.

Chapter five

Conclusion and recommendations

5.1 Conclusions

For generations OPC has been the only form of cement available .Considering high amount of cement annual consumption more sustainable practices in cement production . corn cob ash replacement of cement provide a unique and a valuable alternative to conventional methods

Based on the findings from this study, the following conclusions can be arrived at;

- The compressive strengths of Concrete made of OPC/CCA increases with curing age and decreases with increasing percentage of Corn Cob Ash .
- Workability Time of CCA Replacement of Cement Increases With increase of CCA percentages , With the 10%CCA Showing the highest Workability time.
- The Optimum Replacement level of OPC With CCA in 5%.
- The Utlization of the Corn Cob Ash for production of concrete will go along way is not only a reduction of over all cost of concrete, but also reduce the quantity of waste in the environment.
- The strengths of Corn Cob Ash concrete are dependent on its pozzolanic activities.

5.2 Recommendations

In this experimental study discussed percent Corn Cob Ash replacement of cement in concrete and compressive strength was achieved according to British Standard method and compare.

5.2.1 Recommendation from the studies can follow as:

- 5 percent replacement level of cement with CCA is satisfactory and thus, recommended
- Concretes with the presence of ash content should be allowed to cure for 90days, by which pozzolanic activity of ash would have been concluded.
- The use of locally available materials in infrastructural development will be met with the use of Corn Cob Ash as a construction material .thereby also enhancing the economic power of the rural dwellers if they are encouraged to plant maize from which these Corn Cobs could be gotten.
- The volume replacement attempted to get high strength concrete should be enhanced with super plasticizers and a further reduction in the water-cement ratio so that concrete of very high strength can be achieved.

5.2.2 Recommendation for future studies can follow as:

- Use another percent replacement level of cement with CCA.
- Use another concrete mixture proportion with CCA ratio in cement.

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Appendex (A)

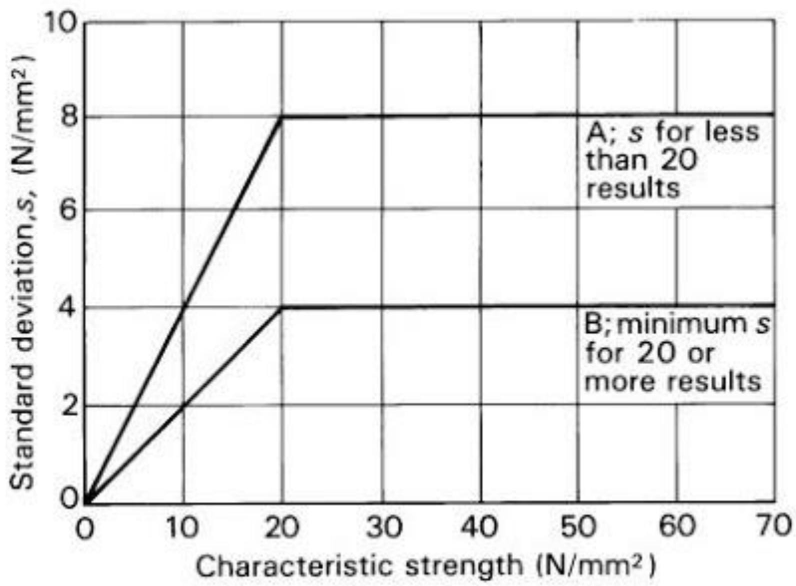


Figure (2.7): Relationship between standard deviation and characteristic strength.

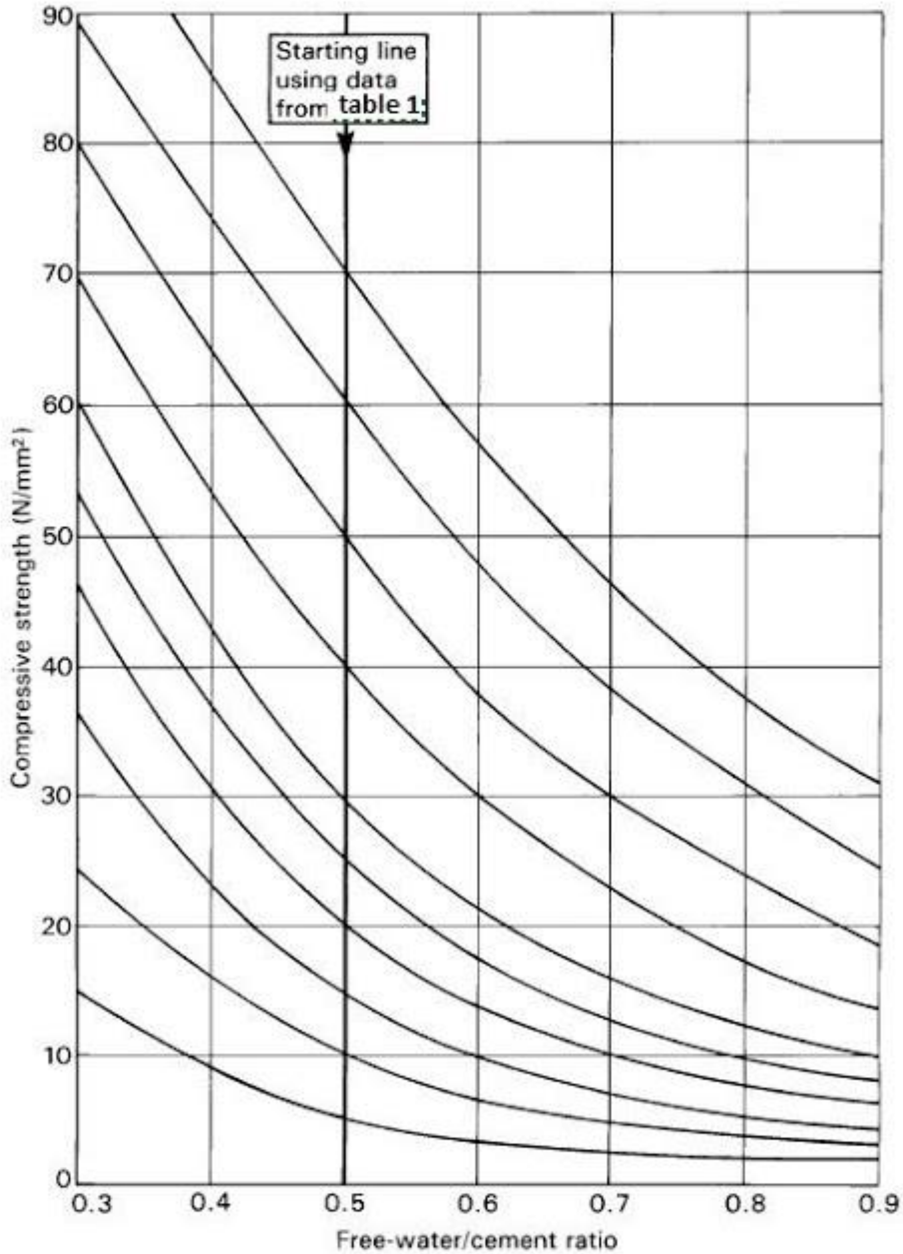


Figure (2.8): Relationship between compressive strength and water/ cement ratio

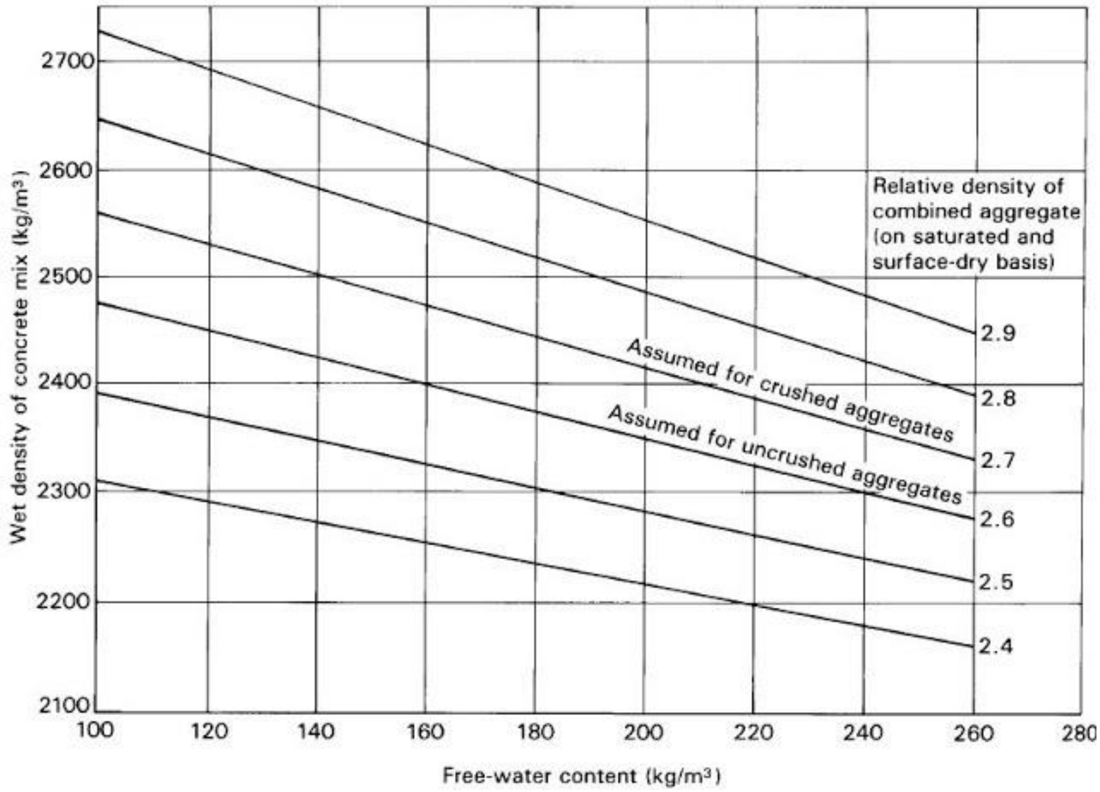


Figure (2.9) Estimated wet density of fully compacted concrete.

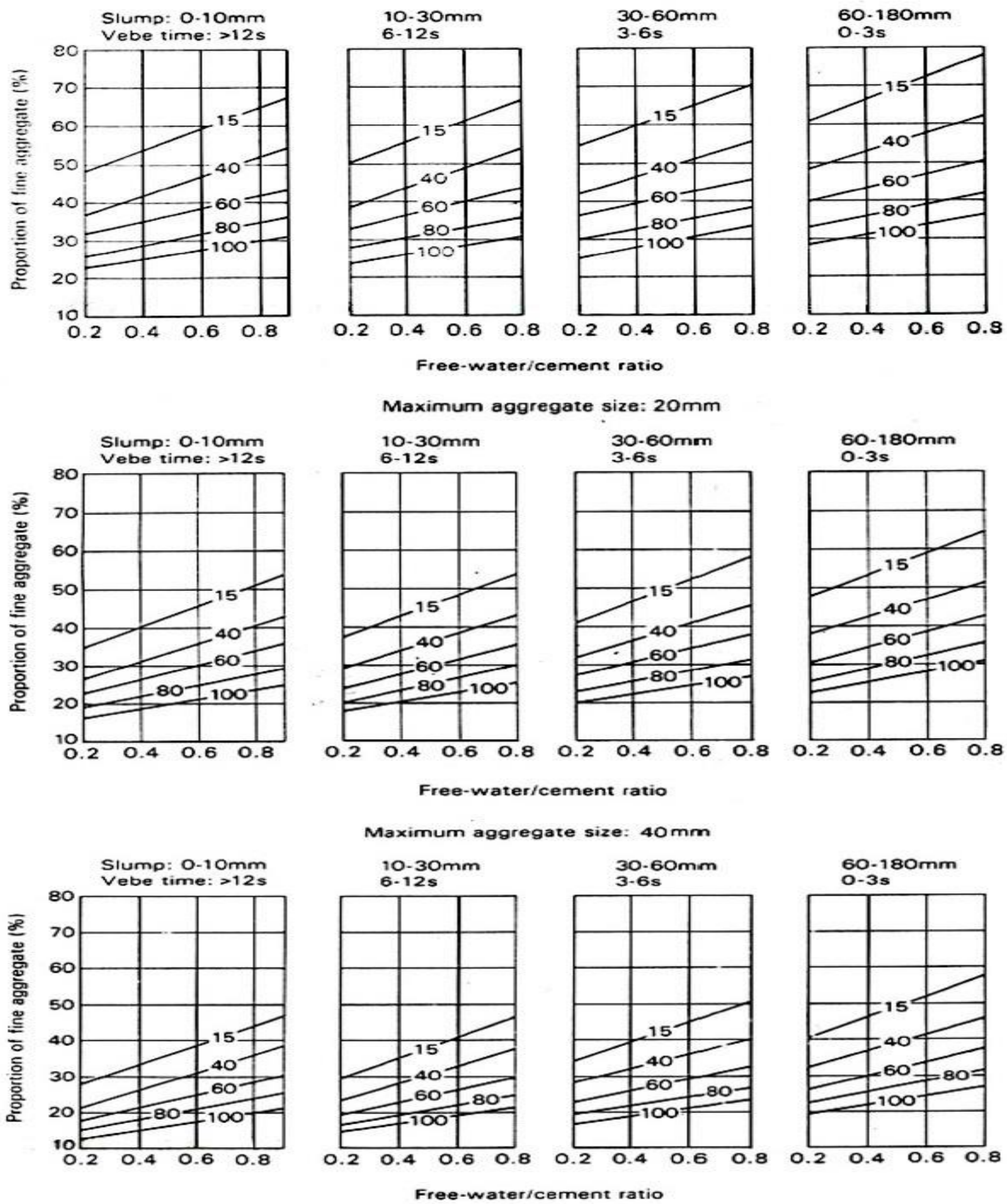


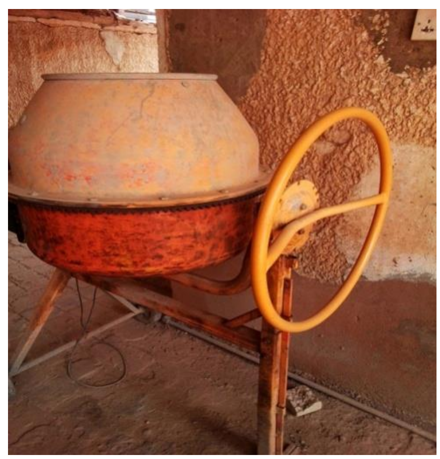
Figure (2.10) Recommended proportions of fine aggregate according to percentage passing a 600 µ m sieve.

Appendex(A-1) Sand test

Appendex(A-2) **Water of Mixing**

Appendex(c-7): cubes of control mix

Appendex



Appendex Slump test

Appendex Initial setting time test