EFFECT OF CEMENT BRAND AND WATER CEMENT RATIO ON THE SLUMP OF FRESH CONCRETE

BY

ABUBAKAR TOYEEB ADEWALE **ND/23/CEC/FT/0010**

A PROJECT SUBMITTED TO THE DEPARTMENT OF CIVIL ENGINEERING INSTITUTE OF TECHNOLOGY, KWARA STATE POLYTECHNIC, ILORIN.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF ORDINARY NATIONAL DIPLOMA(OND) IN CIVIL ENGINEERING.

July, 2025

CERTIFICATION

This is to certify that this project was conducted by ABUBAKAR TOYEEB ADEWALE (ND/23/CEC/FT/0010) and had been read and approved as meeting the requirements for the award of Nation Diploma (ND) in Civil Engineering of the department of Civil Engineering, Institute of Technology, Kwara State Polytechnic, Ilorin.

____________________________ ______________

ENGR. M. A. WOPA **DATE**

(PROJECT SUPERVISOR)

____________________________ ______________

ENGR. N.A NAALLAH **DATE**

(HEAD OF DEPARTMENT)

____________________________ ______________

ENGR. ABDULHAMEED ABDULRASAQ ADUAGBA
(EXTERNAL SUPERVISOR) **DATE**

DEDICATION

This project is dedicated to Almighty God who by his mercy guided and protected me throughout my course of study

ACKNOWLEDGEMENT

All praises and adoration go to ALMITHY GOD, the creator of all creature s, who give me the knowledge, wisdom and understanding, also the abili ty to liaise. If not for Him, what would I, a mere mortal would have achie ved and his mercy over me and who have been providing for me and my family also for giving me the grace and privilege a scale of my life unsca ttered. All I have to say is thank God

My inestimable appreciation goes to my wonderful and irreplacea ble parent MR & MRS ABUBAKAR and my rare gold, my one in a million who have been taking care of me from my childhood you are such a goo d, loving, and wonderful mom.

I genuinely appreciate their persistence and support toward my e ducation career. If not for their insistence support. I would not have bee n a student of this prestigious institution. I pray to almighty God that you shall eat the fruit of your labour and you shall witness our testimony in A llah name (Amen).

My sincere gratitude goes to my supervisor Engr. A.W Mansur for his valuable suggestions, comments, observation and encouragement t hroughout the completion of this project, may Almighty God bless you a nd your family. And also, all my lecturer in the department of Civil Engineering, Kwara state polytechnic, Ilorin, I express my gratitude to them for their good work, may God be with you and your family.

Likewise, also my profound gratitude to my supportive mother's MRS RILIWAT ABUBAKAR, To my amazing Dad MR ABUBAKAR AYYUBA TITILOPE Thanks for all your efforts, I really appreciate I pray may God continue to bless you and enlarge your business in Allah name.

ABSTRACT

This research examines the influence of cement brand and water-cement ratio on the workability of fresh concrete using the slump test. Two prominent Nigerian cement brands, Dangote and BUA, were tested under laboratory conditions. Concrete was prepared using two standard mix ratios (1:2:4 and 1:1.5:3), with water-cement ratios of 0.4, 0.5, and 0.6. The results indicated that increasing the water-cement ratio led to higher slump values, signifying improved workability. Dangote cement consistently produced greater slump compared to BUA under similar conditions, while the richer mix (1:1.5:3) yielded higher slumps than the leaner mix (1:2:4). These findings demonstrate that both cement brand and water-cement ratio significantly affect the fresh concrete properties. The study r *ecommends a water-cement ratio of 0.5 for optimal workability in typical construction applications.*

Keywords: Cement brand, Water-cement ratio, Slump test, Workability, Fresh concrete, Dangote, BUA, Mix ratio

TABLE OF CONTENT

CONTENT

CHAPTER ONE

CHAPTER TWO: LITERATURE REVIEW

CHAPTER THREE: MATERIALS AND METHODOLOGY

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Concrete as the most widely used man-made construction materials is second only to water as the most utilized substance on the planet. It is obtained by mixing cementitious materials, water and aggregate (and s ometimes admixtures) in required proportion. According to Bamigboye, et al., (2015), concrete is composed of aggregates embedded in a ceme nt matrix which fill the space between the aggregates and bind them to gether. Concrete is a very strong building material and the use of concre te predates back before the Roman Empire. (John, 2023)

Concrete mixture when placed in form and allowed to cure hardens into rock-like mass known as concrete. In it harden state, concrete should ha ve the following properties; strength, durability, impermeability, and it sh ould have minimum dimensional changes. The strength, durability, and other characteristics of concrete depends upon the properties of its ingr edients, proportion of mix, method of compaction and other controls dur ing placing, compaction and curing. Among the various properties of the concrete, its compressive strength is considered to be the most importa nt and it is taken as an index of its overall quality. (John, 2023)

Concrete is the most widely used construction material across the worl

d. The popularity of concrete is primarily due to the ready accessibility of the raw materials required to manufacture it and because, when it is properly mixed and installed, concrete will be immensely strong and durable. A critical component in concrete mix design is the ratio between the water and cement in the concrete. The ratio between water and cement, measured by mass, is referred to as the water to cement ratio, or w/c ratio, or simply w/c (Eric, 2024).

The binding quality of Portland cement paste is due to the chemical reaction between the cement and water (Raheem and Bamigboye, 2013). The degree of cement hydration which is a function of water to cement ratio has a direct impact on the porosity and consequently on the strength. The richness of the mix is one of the factors that affect the rate of strength development in concrete mix and is a direct function of the quality and quantity of the cementitious material. This implies that cement is one of the most important ingredients influencing strength properties of concrete.

Water hydrates cement in order to form the products of hydration, which bond the aggregates together to form concrete. Any water included in the mix beyond that needed to hydrate the cement creates capillary pores in the structure of the paste. If enough excess water is used, these pores will grow and become an interconnected network of voids that significantly reduce the strength and durability of the concrete. There is a mini mum w/c ratio that provides enough water to hydrate the cement, but no excess water to create voids in the paste structure. A concrete made with that that minimum w/c would too stiff to install so a w/c above the minimum is always used in practice (Eric, 2024).

Moreover, there are various brands of Portland cement available in markets which are used in construction industries. There have been sentimental and unconfirmed analyses by various groups in the construction industry comparing between the available brands of cement on setting time, workability, fineness and compressive strength. In other to tackle the discrepancy in concrete compressive strength produced by different brands of Portland cement available in the market, this study will therefore evaluate the effect of selected brands of Portland cement on mechanical properties of concrete.

1.2 STATEMENT OF PROBLEM

Cement as one of the most important constituents influencing the strength of concrete ranges in different brands in Nigeria. There have been speculations by various groups in the construction industry that the mechanical properties of concrete especially the strength properties vary appreciably with the brand of cement used for the concrete production (Ige, 2013).

1.3 AIM AND OBJECTIVES

Aim

The aim of the project is to investigate the effect of cement brand and water-cement ratio on the slump of fresh concrete.

Objectives:

The aim of this project was achieved through the following specific obje ctives

1. To establish the effect of different brand of cement on the slump of fresh concrete.
2. To determine the effect of varying water-cement ration (0.4, 0.5, 0.6) on the slump of fresh concrete.
3. To establish the effect cement ratio on the compressive strength of concrete:

1.3 SCOPE OF THE STUDY

This study was focused on the investigation to determine the effect of T herefore, slump test procedure was used to determine the cement dens ities and workability as well as the consistency of our fresh concrete.

1.4 JUSTIFICATION OF THE STUDY

Concrete remains the most widely used construction material globally, e specially in developing countries like Nigeria. The quality and performan ce of fresh concrete depend significantly on its workability, which directly affects ease of placement, compaction, and overall structural performance. Among various tests for workability, the slump test is the most commonly used due to its simplicity, speed, and reliability for site conditions.

In practice, multiple brands of cement are available in the Nigerian market, with Dangote and BUA being two of the most popular and widely used. However, due to possible variations in chemical composition, fineness, and manufacturing processes, different cement brands may influence the workability of concrete in distinct ways, even under the same mix conditions.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 INTRODUCTION

Portland cement concrete is a composite material composed of fine and coarse aggregate bonded together with a fluid cement (cement paste) that hardens over time most frequently in the past a lime-based cement binder, such as lime putty, but sometimes with other hydraulic cements, such as a calcium aluminate cement or Portland cement. It is distinguished from other, non- cementitious types of concrete binding some form of aggregate together, including asphalt concrete with a bitumen binder, which is frequently used for road surfaces, and polymer concretes that use polymers as a binder.

According to John Nnabuenyi (2023), investigate effects of selected bra nds of Portland cement on compressive strength of concrete. The study was undertaken to assess the compressive strength of concrete produc ed with selected brands of Portland cement obtainable within south eas t Nigeria. Four different brands of Portland cement namely: Bua, Dangot e 3x, Unicem and Lafarge were adopted for the study. The slump of the fresh concrete produced with different brands of Portland cement range d from 40mm – 55mm. The hardened density and compressive strengt h of the concrete produced with Bua, Dangote 3x, Unicem and Lafarge were 2347kg/m3, 2345kg/m3, 2393kg/m3 and 2361 kg/m3 and 24.18N /mm2, 24.81N/mm2, 27.47N/mm2, 27.15N/mm2. It was observed that the highest dry density and compressive strength was recorded for conc rete produced with Unicem while the lowest dry density and compressiv e strength was recorded for concrete produced with Dangote 3x cemen t. In the light of the findings, this study therefore recommends the use o f Unicem cement for production of both structural and non- structural co ncrete due to significant attainment in dry density and compressive stre ngth.

Omotola, et. al (2011), look on to the effects of water-cement ratios on t he compressive strength and workability of concrete and lateritic concre te mixes. The variations of the compressive strengths of concrete and l ateritic concrete mixes with water cement ratios of range 0.55 and 0.80, within 7 to 28 days after casting, were experimentally investigated in thi s research work. The experiment was carried out at the same ambient t emperature and the compressive strengths of both concrete and lateriti c concrete mixes were found to increase with age but decrease as the water-cement ratio increases. However, water-cement ratio above 0.65 was observed to have a very significant reduction effect on the compres sive strength of the lateritic concrete mixes.

Huseyin, et. al (2007), Effects of cement type, water/cement ratio and c ement content on sea water resistance of concrete. In this study, effect s of cement type, cement content and water/cement (W/C) ratio level o n the sea water resistance of concrete were investigated. Test samples were exposed to sea water by wetting– drying manner. Residual splittin g tensile and compressive strength, and chloride penetration depths of s pecimens after exposure were determined. Besides, energy dispersive s pectrometer (EDS) analyses were performed on scanning electron micr oscope (SEM) images of selected mixtures. Test results indicate that bl ast furnace slag cement (SC) mixtures have considerably greater resist ance to sea water than portland cement (PC) mixtures both from the poi nt of mechanical properties and chloride penetration.

Burak, et. al (2007), investigate the effect of water/cement ratio on the fresh and hardened properties of self-compacting concrete. The use of self-compacting concrete (SCC) with its improving production techniques is increasing every day in concrete production. However, mix design methods and testing procedures are still developing. Mix design criterions are mostly focused on the type and mixture proportions of the constituents. Adjustment of the water/cement ratio and superplasticizer dosage is one of the main key properties in proportioning of SCC mixtures. In this study, five mixtures with different combinations of water/cement ratio and superplasticizer dosage levels were investigated. Several tests such as slump flow, V-funnel, L-box were carried out to determine optimum parameters for the self-compactibility of mixtures. Compressive strength development, modulus of elasticity and splitting tensile strength of mixtures were also studied.

According to Marar and Özgür (2011), Investigates the effects of cement content and water/cement ratio on workable fresh concrete properties with slump changing between 90 to 110 mm, and determines the relations among fresh concrete properties such as slump, compacting factor, Ve-Be, unit weight and setting times of mortar with temperature history. The experiments were conducted under laboratory conditions on eight d ifferent concrete mixtures prepared from ordinary Portland cement (cement contents of 300, 350, 400, 450, 500, 550, 600 and 650 kg/m3) and crushed limestone coarse and fine aggregates. Relations such as (a) Ve-Be time/unit weight/slump/K-slump/compacting factor/w/c ratio for cement content, (b) K-slump/compacting factor/unit weight/Ve-Be time for slump, (c) aggregate/cement ratio/unit weight/Ve-Be time for compacting factor, and (d) penetration resistance for elapsed time were determined. It was observed that increasing the cement content causes increase in the slump, K slump, compacting factor and fresh concrete unit weight, and reduces Ve-Be time. Proposed fresh concrete relationships are quite appropriate for concretes without using any mineral or chemical admixtures.

Nikbin, et. al (2007), Investigation into the effect of water to cement ratio and powder content on mechanical properties of self-compacting concrete. as an innovative construction material in concrete industry, offers a safer and more productive construction process due to favorable rheological performance which is caused by SCCs different mixture composition. This difference may have remarkable influence on the mechanical behavior of SCC as compared to normal vibrated concrete (NVC) in hardened state. Therefore, it is vital to know whether the use of all assumptions and relations that have been formulated for NVC in current design co des are also valid for SCC. Furthermore, this study presents an extensiv e evaluation and comparison between mechanical properties of SCC usi ng current international codes and predictive equations proposed by oth er researchers. Thus, in this experimental study, key mechanical propert ies of SCC are investigated for sixteen SCC mixes with different w/c rati os and different powder contents. In the present study, an extensive dat a reported by many researchers for SCC and NVC has been used to vali date the obtained results.

2.1 CEMENT

Cement, in general, adhesive substances of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering constr uction. Cements of this kind are finely ground powders that, when mixe d with water, set to a hard mass. Setting and hardening result from hydr ation, which is a chemical combination of the cement compounds with water that yields submicroscopic crystals or a gel-like material with a hi gh surface area. Because of their hydrating properties, constructional ce ments, which will even set and harden under water, are often called hydr aulic cements.

Cement plays a major role within a concrete mixture and affects most i mportant aspects of the mix, such as: workability, compressive strength, drying shrinkage, and durability. Through the process of hydration, ceme nt particles react with water, binding the aggregate, and the strength m atrix develops (Fapohunda, 2020). Around the world. many standards an d specifications call for the overdesign of the concrete elements under t he assumption that this creates another factor of safety (Fapohunda, A digo, and jeje 2020).

However, recent research has shed light on the relationship between ce ment

content and cracking and how overdesigning may be detrimental to con crete. As cement content in a mix increases, the compressive strength usually increases as well. However, costs also increase due to the high cost of cement relative to other concrete ingredients and lone-term effe cts caused by crack maintenance. This cracking is likely a result of incre ased drying shrinkage and heat of hydration in the early age concrete wi th higher cement content (Fapohunda et.al, 2020).

2.3 CEMENT CONTENT AND WORKABILITY

Cement content and cement fineness play crucial roles in affecting the workability of concrete. I1 a mix has too much cement in relation to its water content, the mix was difficult to place. However, with too much w ater the mixture was segregated, making it equally difficult to use for th e intended purpose on the job. Thus, selecting the required amount of c ement for a mix is integral to the concrete mixture design, affecting workability and overall construction costs. Finer cement requires increased water contents to hydrate a larger surface area and generally causes higher temperature during hydration (Famodimu, Adigo, Fapohunda 2020). Thus, adjusting cement quantities and fineness within mixes prior to placement can help to improve workability protects the concrete from additional cracking within its interfacial transition zone due to excessive heat and drying strain created during the curing process.

2.4 CEMENT CONTENT AND DURABILITY

Cement also plays a major role in the durability of a concrete mix. Durability is the way the concrete resists weathering and deterioration while retaining its form, quality, and properties when under exposure (ACI Committee 201. Durability of Concrete), Cracks are a problem for durability and can decrease service life. An increase in cement can lead to an increase in cracking density, which can ultimately lower the durability of concrete substantially (Darwin et al., 2004). Additionally. increased cement often leads to more paste which has been shown to increase shrinkage and permeability Eamodimu and Jeje, 2020). It has also been seen that the use of fly ash or slag cement in mixes can reduce permeability (Fapohunda and Adigo, 2020).

2.5 WATER

Being the most essential resource in the universe, it was an important r ole in the preparation on the concrete. Impurity in water may interfere th e setting of the cement and may adversely affect the strength of the pro perties. The chemical constituents present in the water may participate in the chemical reaction and thus affect the setting, hardening and stren gth development of mixture. The IS: 456(2000) codes stipulate the wate r quality standard for mixing and curing. In some arid areas local drinkin g water is impure and may contain an excessive amount of salt due to c ontamination by industrial waste.

2.6 EFFECT OF WATER/CEMENT RATIO

Basically w/e ratio control strength, durability and permeability of concre te and does not control the rate of corrosion but 'permeability' which is a function of w/e ratio affect the corrosion of rebar. The depth of penetrati on of a particular chloride threshold value increase with an increase in w /c ratio. Carbonation depth was found to be linearly Increasing with an i ncrease in w/c ratio. The oxygen diffusion coefficient is also found to be increasing with an increase in w/c ratio. In a study it was observe that th e permeability of hardened cement pasts in increase 100 folds by increa se the w/c ratio from 0.35 to 0.45 and the time of initiation of reinforcem ent corrosion in a sample with a w/c ratio 0.4 is 2.15 to 1.77 times more as compared to a sample with a e/c ratio of 0.55. under accelerated corr osion testing.

2.7 ADMIXTURE

They are used in concrete mixture to improve certain qualities such as workability, durability compressive strength. water tightness and wear r esistance while still providing high strength and good performance. The y maybe also be added to reduce segregation, reduce the heat of hydrat ion, entrain air and accelerate or retard setting and hardening.

2.8 APPLICATIONS OF CEMENT

Cements may be used alone (i.e., "neat," as grouting materials), but the normal use is in mortar and concrete in which the cement is mixed with inert material known as aggregate. Mortar is cement mixed with sand o r crushed stone that must be less than approximately 5 mm (0.2 inch) in size. Concrete is a mixture of cement, sand or other fine aggregate, and a coarse aggregate that for most purposes is up to 19 to 25 mm (0.75 to

1 inch) in size, but the coarse aggregate may also be as large as 150 m m (6 inches) when concrete is placed in large masses such as dams. M ortars are used for binding bricks, blocks, and stone in walls or as surfac e renderings. Concrete is used for a large variety of constructional purpo ses. Mixtures of soil and portland cement are used as a base for roads. Portland cement also is used in the manufacture of bricks, tiles, shingle s, pipes, beams, railroad ties, and various extruded products. The produc ts are prefabricated in factories and supplied ready for installation.

CHAPTER THERE

3.0 MATERIALS AND METHODOLOGY

3.1 PROCUREMENT OF MATERIALS

Coarse Aggregate: A common type of intrusive igneous rock that is gra