THE EFFECT OF KEROSENE-CONTAMINATED WATER ON THE COMPRESSIVE STRENGTH OF CEMENT MORTAR

BY

EHIKHUEMHEN EMMANUEL AIGBOKHAN

ENG1704010

A PROJECT SUBMITTED IN PARTIAL FULFILMENT OF

THE REQUIREMENTS FOR THE AWARD OF

BARCHELOR OF ENGINEERING (B.eng.) DEGREE

IN

THE DEAPARTMENT OF CIVIL ENGNEERING

FACULTY OF ENGINEERING

UNIVERSITY OF BENIN, BENIN CITY, NIGERIA

SEPTEMBER, 2023

CERTIFICATION

This work was carried out by Ehikhuemhen Emmanuel Aigbokhan with the matriculation number ENG1704010 in the Department of Civil Engineering, Faculty of Engineering, University Of Benin, Benin City Nigeria.

____________________________ __________________

ENGR. E. ORIA USIFO **DATE**

PROJECT CO-ORDNATOR

____________________________ __________________

Dr. L. O. BOBOR **DATE**

PROJECT SUPERVISOR

____________________________ __________________

Dr.(MRS) N. IHIMEKPEN **DATE**

HEAD OF DEPARTMEN

DEDICATION

This work is honorably dedicated to God almighty, whose great inspiration guidance and protection have been the source of my drive and energy throughout the period of this great endeavor.

I also dedicate this academic work to my parents Mr. Ehikhuemhen Sunday my dad and Mrs. Ehikhuemhen Victoria who with great and love and care, unwavering support and guidance have generously support me throughout my time at the university.

ACKNOWLEDGMENT

First and foremost I wish to use this medium to express my profound gratitude to the divine and the almighty God for his staunch grace and enablement that have ultimately guided me throughout this academic endeavor and all my time at the university.

I also extend my utmost appreciation to all those who have contributed to the completion of this this work. A special note of thanks goes to my ever reliable project supervisor, Dr. L. O. Bobor, her invaluable guidance insightful suggestions, corrections and counsel and provision of innovative solutions have played a pivotal role in ensuring the successful completion of this academic work.

I am deeply indebted to the esteemed department of civil engineering, who have consistently gone above and beyond in imparted unmeasurable knowledge and instilling in all the students a strong sense of discipline, even beyond the four walls of the university. I extend my gratitude to head of the department, Engr. Dr.(Mrs) Ngozi Ihimekpen as well as prof. O.C. Izinyon, prof. O. Orie, prof. H.A.P Audu, prof. S.O Osuji and all the academic staffs including Engr. Dr. S.D. Iyeke, Dr. R.I. Umasabor, Dr. R.O. Ogirigbo, Dr. R.I. Ilaboya, Dr(Mrs) l.O. Bobor, Dr(Mrs) A. Rawlings, Engr. J.O. Ekhodiachi, Engr. U. Ukeme, Engr. E. Oria Usifo, Engr. C.M. Okolie, Engr. P. Ogbeifun, Engr. S.A. Adegbemileke, Engr. Nosakhare kent, Engr. O. Osasu, Engr. Blessing Omosefe E. and Engr. O. Oriakhi as well as all the incredible laboratory staff God bless you all.

Last but not the least I wish to express my profound gratitude to all my ever loving siblings. I must confess you did a deal of help to me through calls, financial support and emotional support you all were there for me, and I appreciate all that. I pray that God almighty bless you

ABSTRACT

All over Nigeria as well as to the overseas the fuel oils as well as crude oils are transported through distribution pipes, tankers cargo ships. Although the processes are well laid out to avoid leakages of pipes, accidents of service tankers these events still happens on a regular bases especially in the niger delta region of the country where pipe vandalism due to oil bunkery is on the rise. All these processes leads to the leakages of fuel oils e.g kerosene which eventually settles on coastal waters. The leaked oil products would result in contaminating the water which are used in the concrete mortar and the sandcrete industry which are the cement dependent industry. In this study, the effect of water contaminated with kerosene on the compressive strength of conventional normal ordinary Portland cement has been evaluated in various exposure conditions.

Kerosene (0, 2, 4 and 6%) by weight of water) was used to contaminate water to prepare cement mortar cubes specimens. A number of nine uncontaminated samples were prepared with fresh water. A number of nine samples each were prepared with contaminated water at 2%, 4%, 6% Kerosene replacement. Three samples each of percentage replacement and three uncontaminated samples were crushed at the age of three days, seven days and 28 days of curing.

From the results gotten the maximum reduction in the compressive strength of 9.21% occurred at the six percentage contamination at the age of seven days. From results obtained it was seen that as the percentage of contamination increase the compressive strength decreased.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

1. IS; indian standard
2. C3S; tricalcium silicate
3. C2S; Dicalcium silicate
4. C-S-H; calcium silicate hydrate
5. CH; calcium hydroxide
6. ASR; alkali silicate reaction
7. VOCs; volatile organic compound
8. LC-MS; liquid chromatography-mass spectrometry
9. GC-MS; gas chromatography-mass spectrometry
10. FTIR; fourier-transform infrared
11. XRF; X-ray fluorescence spectroscopy
12. ASTM; American society for testing materials
13. DNA; deoxyribonucleic acd
14. EPA; environmental protection age

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of Study

An essential building component that is widely employed in construction projects all around the world is cement. The compressive strength of cement-based materials has a considerable impact on the quality and longevity of concrete constructions. The qualities of concrete, notably its compressive strength, can be negatively impacted by the presence of pollutants in the mixing water.

Kerosene is one such potentially hazardous substance that might mistakenly mix with water in storage facilities or building sites. Being a hydrocarbon-based chemical, kerosene may interact with cement in a way that alters the hydration process and weakens the finished product. Reduced compressive strength as a result of contaminated water used in the mixing process can compromise the long-term durability and structural integrity of concrete constructions. Inadvertent spills of the frequently used fuel kerosene into surrounding water sources during storage or transportation could have severe impact on construction projects. The safety and longevity of building projects depend on knowing how kerosene-contaminated water affects cement's compressive strength.

Numerous research have examined how different pollutants, such as hydrocarbons, affect the characteristics of cement. For instance, Mehta and Monteiro's (2006) research highlighted the value of using pure water when mixing cement to preserve the quality of the concrete. Additionally, Neville's (2011) research sheds light on how pollutants affect cement hydration and, ultimately, concrete strength. The effects of sugar on cement paste and grade C35 concrete curing at 3, 7, 14, and 28 days were examined in the study using regular Portland cement at concentrations of 0, 0.05, 0.06, 0.08, 0.10, 0.20, 0.40, 0.60, and 1% by weight of cement. An important issue for construction and environmental safety was the effect of kerosene-contaminated water on cement's compressive strength.

This study expands on earlier studies on the vulnerability of cementitious materials to contamination (Elsawy et al., 2021). It makes use of the IS 4031 (Part-6) 1998 standards for compressive strength testing to assess how different kerosene concentrations and exposure times affect cement samples. It tries to provide light on how much the kerosene contamination has reduced compressive strength. Understanding this phenomenon is essential for maintaining the security of buildings close to potential sources of contamination and creating efficient mitigation plans. This study advances our knowledge of the effects of water contamination on materials for building and provides significant data to the environmental and construction industries.

1.2 Statement of problem

This study's main goal is to determine how kerosene contamination of water affects cement's compressive strength. There is an urgent need to comprehend how such contamination may jeopardize the foundational strength of cement-based projects because kerosene spills into water sources are not commonplace. The main issue to be solved is figuring out how much different kerosene-contaminated amounts of water and exposure times affect cement's compressive strength. Due to its potential effects on construction safety and environmental preservation, this issue is significant. In order to support informed decision-making for construction practices and risk reduction for the environment, the study seeks to give quantitative data and insights into the detrimental impacts of kerosene pollution on cement.

1.3 Aim and Objectives

The aim of this study is to assess the impact of kerosene-contaminated water on the compressive strength of cement mortar.

Objectives:

1. To conduct standardized compressive strength tests on both contaminated and uncontaminated cement mortar samples using IS 4031 (Part-6) 1988

2. To analyze and compare the compressive strength data between contaminated and uncontaminated samples to quantify the extent of strength reduction.

3. To assess the relationship between kerosene concentration, exposure duration, and compressive strength reduction

1.4 Scope of study

To guarantee that the conclusions are applicable to a wider range of construction techniques, this study will take into account Portland cement and mix ratios typical of those practices. The experiment will simulate various contamination scenarios by examining a variety of kerosene concentrations at 2%, 4%, and 6%. To assess their effect on the compressive strength of the cement, these concentrations will be changed consistently. To determine how kerosene contamination on cement changes over time, different exposure times will be examined. In order to precisely gauge and contrast the strength of contaminated and uncontaminated cement samples, standardized compressive strength tests in accordance with IS 4031 (Part-6) 1998 will be used. To determine relationships between kerosene content, exposure time, and strength degradation, statistical analytic techniques will be used to assess the degree of compressive strength reduction.

The study will briefly discuss the possible environmental effects of kerosene pollution in water sources while highlighting the significance of preventing such occurrences.

Practical suggestions for building procedures and environmental risk management will be offered based on the findings. Any restrictions on sample size, environmental factors, and the particular cement types and kerosene grades utilized will be acknowledged in the study. Despite the fact that the research's primary focus is on cement's compressive strength, its findings could have an impact on a wider range of materials for construction and methods.

1.5 Justification of Work

The initiative deals with a relevant and useful issue. Accidental kerosene spills into water sources close to building sites can seriously jeopardize environmental safety and construction safety. Therefore, it is crucial and extremely significant to look at how kerosene contamination affects cement. The study adheres to established testing protocols to guarantee the reliability and accuracy of the data gathered. The trustworthiness of the study's conclusions is increased by this dedication to scientific rigor. The project's findings may have practical repercussions for environmental management procedures as well as the building sector. Making informed judgments can assist prevent building failures and reduce environmental damage, so it is important to understand the degree of strength reduction in contaminated cement samples.

Overall, the study's applicability to real-world situations, adherence to scientific standards, likelihood of having an impact on practice, and contribution to the body of knowledge in the fields of construction materials and environmental safety support its justification.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction to Cement and Contamination

Cement is one of the fundamental building blocks used in construction and is essential to the development of strong, long-lasting structures. When this powder is combined with water, it goes through a process called as hydration, which creates a solid matrix with remarkable compressive strength and durability. The main binding component of concrete, the most used building material worldwide, is cement.

Since ancient times, cement has been used in construction. Early cement-like compounds have been found in Egypt and Mesopotamia. The foundation for a wide variety of construction applications can be made of cement due to its extreme adaptability and versatility. Cement-based materials serve as the structural backbone of contemporary infrastructure, including buildings, bridges, highways, and dams. The strength and durability of structures and infrastructure depend on cement because of its capacity to produce a solid, load-bearing structure. The ability to withstand applied forces is mostly determined by the material's compressive strength. The building sector is constantly working to improve cement and concrete technology, creating high-performance variations with enhanced qualities like increased strength, decreased permeability, and increased sustainability.

A core component of construction, cement enables the accomplishment of several architectural and engineering accomplishments. Its durability and relevance as a key element of the built environment are highlighted by its strength, adaptability, and historical significance. The materials and technologies that use cement as their main building block will change as the construction industry does.

2.1.1 Introduction to Contamination Issues in Construction

The threat of contamination becomes a pressing issue in the field of construction, where a building's durability and resistance are crucial factors. As was previously said, cement is the fundamental component of construction, but exposure to numerous pollutants can undermine its integrity. These impurities, which may include organic substances like kerosene, may seep into building materials, weakening their structural integrity and jeopardizing public safety (Elsawy et al., 2021). Such contamination problems affect the entire construction ecology and go beyond just cement. One of the most often used building materials, concrete is renowned for its sturdiness and durability. However, over time, its effectiveness may be impacted by a variety of external conditions. There are several different ways contamination happens, including industrial spills, transportation mishaps, and inappropriate disposal of garbage containing oil.

The effect of oil-contaminated water on concrete's compressive strength is one of the main issues it raises. Studies have revealed that the presence of oil can prevent the cementitious connections inside the concrete matrix from forming strongly. As the oil molecules cover cement particles' surfaces, proper hydration is inhibited and the interfacial adhesion between cement and aggregates is decreased. Because of this, the concrete's total strength is reduced along with its capacity to withstand compressive forces.

Contamination is the unintentional introduction of foreign chemicals into building materials or the environment as a whole, endangering the structural integrity and the safety of the environment. These contaminants have the ability to harm building materials like concrete and cement and can come in a variety of shapes, including chemicals, pollutants, or organic components.

Contamination in the building industry has several negative effects. Contaminants have the potential to weaken building materials, reducing their overall durability and ability to support loads. Additionally, it is important to carefully assess the effects of construction-related contamination on the environment, such as soil and water pollution.

Understanding contamination issues is crucial for assuring the safety, durability, and sustainability of structures because construction projects frequently involve interacting with a variety of environments and materials. To understand the impacts of pollutants on construction materials and to develop practical mitigation solutions, in-depth research and inquiry are required.

2.2 Cement Hydration and compressive strength

2.2.1 Explanation of the Cement Hydration Process

Dry cement powder is converted into a solid structure with exceptional strength and durability by a chemical mechanism known as cement hydration. This procedure is essential for making concrete and is crucial for building. The method by which cement is hydrated is described as follows:

A. Combining

When making concrete, aggregates (such as sand and gravel) are combined with cement, often in the form of Portland cement, water, and as needed. The hydration process cannot start unless water is consumed.

Secondly, hydration starts.

A variety of intricate chemical processes are started when water is added to cement. Tricalcium silicate (C3S) and dicalcium silicate (C2S), the two principal cement constituents that cause this reaction. Calcium silicate hydrate (C-S-H) and calcium hydroxide (CH) are produced when these substances interact with water.

C-S-H synthesis, third

In cement hydration, the C-S-H gel is the primary byproduct. The substance that combines the other elements of the concrete mixture into a cohesive whole is a non-crystalline, gel-like substance. Concrete benefits from C-S-H's cohesiveness and strength.

Calcium Oxide Production 4

Calcium hydroxide (CH), a byproduct, is created concurrently. Although less significantly than C-S-H, CH also adds to the concrete's strength. It affects how concrete develops over time in terms of strength.

5. Setup and Hardening

The concrete mixture transitions from a fluid to a solid state as the hydration process continues. Setting is followed by hardening throughout this phase of development. The concrete loses workability as it sets, but as it hardens, it gradually grows stronger.aaa

6. Production of Heat

It produces heat because the hydration process is exothermic. In order to keep the concrete from cracking, this heat must be controlled because it can be substantial, especially in big concrete pours.

7. Persevering Strength Gain

Because the C-S-H gel keeps forming and adding to the strength of the concrete, the hydration process lasts for a long time—often several years.

2.2.2 Cement's compressive strength as a characteristic

Unquestionably, one of the most important characteristics of cement is its compressive strength, which has a big impact on how useful and appropriate it is for construction. A material's capacity to endure axial loads or pressures pressing it together is measured by its compressive strength. This feature is crucial in construction because buildings, bridges, and other structures need to be able to withstand both their own weight and any additional loads that are placed on them. These structures' structural integrity is guaranteed by cement with a high compressive strength, reducing the likelihood of collapse. Safety and high compressive strength go hand in hand. It ensures that a building or structure can survive unpredictable stressors like earthquakes, wind, or large snow loads by giving a margin of safety against structural failures. The lifespan of a structure is more likely to be longer if it was constructed with cement that has strong compressive strength. Over time, they withstand deterioration, which lowers maintenance costs and the frequency of repairs or replacements. The compressive strength of the materials employed determines a structure's ability to support loads. Taller buildings and more robust infrastructure can be built using cement with high compressive strength. Testing for compressive strength is an essential component of the quality control process used in the manufacture of cement and concrete. It guarantees consistency and dependability in construction projects by ensuring that the material satisfies the necessary strength standards. Engineers and architects may construct structures confidently, customizing them to meet specific requirements without sacrificing safety, thanks to knowledge of cement's compressive strength. Construction materials must frequently meet minimum compressive strength criteria set forth in building rules and regulations. These requirements must be met in order to obtain the required permits and guarantee that buildings follow safety regulations.

Environmentally friendly construction techniques can benefit from the use of cement with high compressive strength. By requiring less material overall, stronger materials may help to conserve resources and lessen waste.

2.2.3 How Contaminants Affect the Strength and Hydration of Cement

The normal hydration process of cement can be hampered by some pollutants, such as specific organic compounds or excessive concentrations of sulfate ions (Shi, 2016). They might have an inhibitory effect, delaying the production of the crucial calcium silicate hydrate (C-S-H) gel that gives concrete its strength. This postponed hydration can increase the setting time and slow the development of young children's muscles. The C-S-H gel, which is principally responsible for the strength of concrete, can be affected by contaminants. The final compressive strength of the concrete

may be drastically reduced in cases of severe pollution, making the structure structurally unstable (Elsawy et al., 2017). Concrete can become more porous as a result of contaminants, opening up channels for the entry of moisture, chemicals, and other dangerous substances. According to Nehdi et al. (2003), this increased permeability can cause the corrosion of steel reinforcing and a reduction in the resistance of concrete to environmental conditions. Concrete can expand and crack as a result of certain pollutants, such as sulfates or alkali-silica reaction (ASR) aggregates. For instance, ASR happens when reactive aggregates in concrete react with cement's alkalis, causing gel to form and expand, which can result in cracking and decreased strength (Thomas, 2009). Concrete constructions' long-term endurance may be compromised by contaminants. Reduced durability can show itself as a decreased resistance to abrasion, chemical assaults, and freeze-thaw cycles, all of which hasten the deterioration of materials (Tang et al., 2015). Environmental dangers can be caused by contaminants, particularly those having environmental origins. For instance, contaminants like hydrocarbons or chlorides from contaminated groundwater can seep into concrete and cause harmful chemical reactions. (Lothenbach et al., 2016).

2.3 Past Research on Pollutants in Cement Materials

1. Elsawy et al.'s study on the impact of hydrocarbons on concrete (2017)

This study examined how diesel and kerosene, two hydrocarbon pollutants, affect the mechanical characteristics of concrete. Results showed that when exposed to these hydrocarbons, concrete's compressive strength and stiffness were significantly reduced. The study emphasized the need of comprehending how organic pollutants can jeopardize concrete's structural integrity.

2. Sulfate Attack on Cementitious Materials (Nehdi et al., 2003): The effects of sulfate ions on cementitious materials, particularly concrete, were the subject of this study. The findings showed that elevated sulfate ion concentrations may cause delayed setting times, increased porosity, and

decreased compressive strength. In sulfate-rich areas, the study stressed the significance of sulfate-resistant cement compositions.

3. Concrete's Alkali-Silica Reaction (ASR) (Thomas, 2009)

The alkali-silica reaction, a frequent type of contamination in concrete, was the subject of this study. Certain reactive aggregates in concrete interact with alkalis from cement, causing ASR, which results in the expansion and gelation of the gel. The study brought attention to the danger of cracking brought on by ASR and the demand for precautionary measures in concrete mix design.

4. Lothenbach et al. (2016)'s study, "Influence of Limestone on Cement Hydration,"

investigated the function of limestone as an additional cementitious component in the hydration of cement. The results showed that adding limestone can have an impact on the hydration process and change the characteristics of cementitious materials. The results of this study have significance for making sustainable concrete mixtures with limestone.

5. Effects on Cementitious Systems of Mixtures (Shi, 2016):

examined how different admixtures affected cementitious systems. The setting time, workability, and strength of cementitious materials can all be changed by additives. The study underscored the significance of thoughtfully choosing and utilizing admixtures in concrete mix design.

The variety of pollutants that can alter cementitious materials' characteristics and the intricacy of contamination issues in those materials are both highlighted by the research articles reviewed here. The results highlight the importance of careful material selection, quality control, and preventive measures in building procedures to guarantee the resilience and functionality of structures in the face of contamination concerns.

6. Petrochemicals and concrete strength (Vikas.k. et al., 2019): The study looked at how petroleum compounds affected the characteristics of concrete. The properties of concrete produced in areas where petroleum products are extracted can significantly vary, having a negative impact on the cement mix. The inquiry was conducted in the following order: material collection, petroleum product addition, slump test, compression test performed on days 3, 7, and 28 after concrete hardening, and results. According to the study's findings, petroleum compounds have a negative impact on concrete and should be classified as detrimental to the cement mix.

2.4 Kerosene as a pollutants

The flexible fuel kerosene, which is based on hydrocarbons, is frequently found as a pollutant in a variety of environmental and industrial environments. Kerosene poses a serious threat of contamination due to its extensive use and the possibility of unintentional spills and leaks.

Kerosene has far-reaching effects on soil, water, air quality, and even building materials like cement, thus it is crucial to comprehend it as a contaminant. Kerosene is used for many things, such as heating, lighting, aircraft, and as an engine and generator fuel. It is widely found in various places due to its extensive use in homes, businesses, and transportation. Kerosene spills can happen accidentally while storage, during transportation, or as a result of equipment leaks. These occurrences take place in industrial, rural, and urban contexts, which adds to kerosene's widespread use as a contaminant. Particularly concerning is kerosene contamination of aquatic environments. Kerosene spills have the potential to harm aquatic ecosystems and drinking water supplies by contaminating groundwater or surface water. The environment and human health are both at risk from this contamination. Soil contamination can result from kerosene spills on the ground. Kerosene's hydrophobic properties can interfere with water infiltration and alter soil structure, which can affect plant development and soil quality. Kerosene vapor emissions can cause air pollution in industrial settings, lowering air quality and posing health concerns to people living nearby. Cement-based building materials can become contaminated with kerosene from nearby water sources. This may jeopardize the concrete's structural integrity, which raises questions regarding worker safety.

Kerosene's interactions with cement and effects on building materials are greatly influenced by its physical characteristics. awareness how kerosene can affect cement requires an awareness of a few crucial features. It naturally repels water because it has a hydrophobic nature. When kerosene-tainted water comes into touch with cementitious materials, this feature can prevent cement from hydrating normally. lower compressive strength may result from the lower water-cement ratio's propensity to obstruct the production of critical hydration products such calcium silicate hydrate (C-S-H). Since it is a non-polar hydrocarbon, the polar chemicals in cement are less likely to form bonds with its non-polar molecules. Due to its non-polar nature, concrete's final strength and durability may be hampered by the chemical processes required for the development of the cement matrix (Shi, 2016). Kerosene only partially dissolves in water. It can create distinct phases or droplets when it's a dispersible phase in water. These kerosene droplets can serve as actual barriers, preventing water from reaching the cement particles. As a result, the distribution of water required for hydration may be unequal, which could have an impact on the process as a whole. Volatile organic compounds (VOCs) can be released into the atmosphere by kerosene. Exposure to kerosene vapor emissions can cause surface contamination in building materials, which can impair the adhesion of future coatings or treatments used on concrete surfaces. Kerosene's interaction with cement can be affected by its precise chemical makeup, which can change based on its source and grade. Kerosene's impurities or additives can affect cement's hydration and strength in a variety of ways.

2.5 Overview of popular testing procedures and approaches for contamination studies

The systematic methods for evaluating the influence of pollutants on different materials and surroundings can be better understood by taking a look at typical methodology and testing standards used in contamination studies. The precision, reproducibility, and reliability of contamination studies are guaranteed by these procedures and standards. Here is a quick summary:

1. Sampling and sample preparation: Researchers gather representative samples from polluted sites using recognized techniques. The sampling plan takes into account elements including site features, sample location, and the choice of the best sampling tools.

Sample Preservation: To prevent changes in the content or properties of the contaminants during transport and storage, contaminated samples are normally maintained in suitable containers.

2. Analytical Methods

Chemical Evaluation To find and measure pollutants in samples, many analytical techniques are used, such as gas chromatography-mass spectrometry (GC-MS) and liquid chromatography-mass spectrometry (LC-MS).

Spectroscopic Methods To determine the chemical make-up of substances and pollutants, spectroscopic techniques such as Fourier-transform infrared (FTIR) and X-ray fluorescence (XRF) spectroscopy are utilized.

3. Techniques for Physical Testing

Compressive Strength Testing: Standardized tests like ASTM C39/C39M are used in construction-related contamination studies to evaluate the compressive strength of materials like concrete or cement subjected to pollutants (ASTM International, 2021).

Testing for Permeability: The ability of a material to allow the passage of contaminants is tested for permeability using techniques like ASTM D5084 for soil (ASTM International, 2021).

4. Biological and Microbiological Evaluations:

Microbial Analysis: Microbial evaluations may be used in contamination studies to assess the effects of contaminants on soil or water ecosystems. For this, methods like DNA sequencing and microbiological culturing are employed.

5. Environmental Assessment: Field Evaluations In order to monitor environmental factors on-site and determine contamination levels in real-time, equipment including gas detectors, pH meters, and water quality analyzers are used.

6. Standardization and Regulatory Compliance: ASTM Standards A comprehensive range of standards for contamination studies are available from the American Society for Testing and Materials (ASTM), covering topics like sampling, testing techniques, and reporting protocols (ASTM International, 2021).

Environmental Assessment and Contamination Remediation guideline: The U.S. Environmental Protection Agency (EPA) provides methodology and guideline documents for environmental assessments.

7. Data interpretation and analysis:

Statistical Analysis: In order to detect patterns, correlations, and important conclusions, contamination study data are statistically analyzed.

Risk Assessment: To calculate potential health and environmental concerns related to pollutant exposure, risk assessment models are used.

The thorough conduct of contamination studies is ensured by these methodology and testing standards, enabling precise evaluations of the effects of pollutants on materials, ecosystems, and human health. Following these accepted procedures improves the validity and dependability of study findings in the area of contamination investigations.

2.5.1 Discussion of IS 4031 (Part-6) 1998 testing standards for compressive strength evaluation.

IS 4031 (Part-6): 1998 is an Indian Standard that outlines the testing procedures for the determination of compressive strength of hydraulic cement other than masonry cement. It is part of the larger IS 4031 series, which covers various aspects of cement testing. Here is a discussion of some key points regarding IS 4031 (Part-6) 1998 testing standards for compressive strength evaluation:

1. Scope: IS 4031 (Part-6) specifies the method for the determination of compressive strength of hydraulic cement other than masonry cement, using standard sand as a reference material. It provides guidelines for preparing test specimens, conducting tests, and calculating the compressive strength.
2. Test Specimens: The standard outlines the preparation of cube specimens (typically 70.6 mm on a side) from the cement sample. These cubes are cast in a manner that ensures they are representative of the material being tested.
3. Curing Conditions: IS 4031 (Part-6) specifies the curing conditions for the test specimens. The cubes are typically stored in a moist environment at a temperature of 27 ± 2°C for a specific curing period, which is usually 7 or 28 days.
4. Testing Procedure: The compressive strength test involves subjecting the cured specimens to a compressive load using a compression-testing machine. The rate of loading is specified in the standard. The load is applied until failure, and the maximum load sustained by the specimen is recorded.

5. Calculation of Compressive Strength: The compressive strength of the cement specimen is calculated by dividing the maximum load sustained by the cross-sectional area of the cube. The result is expressed in megapascals (MPa).
6. Reporting: The standard provides guidelines on reporting the test results, including the average compressive strength of multiple specimens and the variation between individual specimens.
7. Quality Control: IS 4031 (Part-6) helps ensure the quality control of cement by providing a standardized method for evaluating compressive strength. Consistency in testing procedures is crucial for comparing cement products and assessing their suitability for various construction applications.
8. Applicability: These testing standards are widely used in the construction industry and are essential for assessing the quality and performance of hydraulic cement. Engineers, contractors, and quality control personnel rely on these standards to make informed decisions about the selection and use of cement in construction projects.

In summary, IS 4031 (Part-6) 1998 is an Indian Standard that outlines the procedures for evaluating the compressive strength of hydraulic cement using cube specimens and standardized testing conditions. These standards are critical for quality control in the cement industry and ensure that cement products meet the necessary strength requirements for safe and reliable construction.

2.5.2 Summary of findings from previous studies and variations in results.

Previous studies on kerosene contamination of cement have provided valuable insights into the impact of this contaminant on construction materials. Here's a summary of findings from some of these studies, highlighting variations in results based on factors such as kerosene concentration and exposure time:

1. Impact on Compressive Strength:

Studies have consistently demonstrated that kerosene contamination can lead to a reduction in the compressive strength of cementitious materials (Elsawy et al., 2017).

The extent of strength reduction varies depending on the concentration of kerosene. Higher concentrations tend to result in more substantial decreases in compressive strength.

2. Delayed Setting Time: Kerosene-contaminated cement often exhibits delayed setting times. This means that the cement takes longer to harden and cure (Elsawy et al., 2017).

The delay in setting time can be influenced by both the concentration of kerosene and the duration of exposure.

3. Prolonged Exposure and Strength Loss:

Longer exposure durations to kerosene typically result in more significant reductions in compressive strength (Elsawy et al., 2017).

This suggests that the detrimental effects of kerosene on cementitious materials are cumulative over time.

4. Saturation Effects:

Studies have indicated that once a certain threshold of kerosene concentration is reached, the compressive strength may decrease dramatically (Shi, 2016). Below this threshold, the reduction in strength may be less pronounced.

5. Interaction with Other Contaminants:

Kerosene contamination often occurs in conjunction with other contaminants, such as diesel or hydrocarbons. The combined presence of multiple contaminants can lead to complex interactions and may have different effects on cementitious materials (Elsawy et al., 2017).

6. Remediation Challenges:

Studies have also highlighted the challenges of remediating kerosene-contaminated construction materials. Once cement is contaminated, it can be challenging to restore its original strength (Shi, 2016).

In summary, previous research has consistently shown that kerosene contamination adversely affects the compressive strength and setting time of cementitious materials. The degree of impact varies with factors such as kerosene concentration and exposure duration. These findings emphasize the importance of careful handling and storage of construction materials to prevent kerosene contamination, as well as the need for effective remediation strategies in cases of contamination. Additionally, the interactions between kerosene and other contaminants add complexity to the assessment of its effects on cementitious materials.

CHAPTER TREE

3.0 METHODOLOGY

3.1 introduction

This chapter discusses the various tests, materials and methods used in the Mix, test, moulding and curing of the various samples used in the experiment. The control samples were prepared without any kerosene contamination while the contaminated samples are prepared with 2%, 4%, 6% replacement with kerosene

All The experiments used in this research project was carried out at the structural engineering laboratory of the University of benin, ugbowo campus.

3.2 MATERIALS

1.Cement : accordance with the requirements of Is:3535-1986

Table 3.1 Chemical composition of opc(singh, 2020)

Chemical Compositi0n	Amount (%)
CaO	60-67
SiO_2	17-25
$CaSO_4$	2-4
Al_2O_3	3-8
MgO	0.1-4
Fe_2O_3	0.5-6
S	1-3

Is 650 : 1991 Standard sand, The sieves shall conform to IS 460 (Part I) : 1985, Water: As per requirements, Petroleum by Product (kerosene), IS 10080 : 1982 standard viberator, Universal Testing Machine, Mole. A 70.7mm×70.7mm×mm internal dimensions of mould is used for casting the cement motar mould, Sieves: the sieves shall conform to IS 460(Part 1) 1985,

Poking rod conforming to IS 10080-1982, vicat apparatus (conforming to IS: 5513-1976)weighing balance, sensitive weighing balance stop watch gauging trowel(conforming to IS: 10086-1982)

SOURCES OF MATERIALS

The water used in this experiment is the clean water available at the University of benin structural engineering laboratory. The cement used is the dangote manufactured cement of grade S43, which I bought from a local cement supply which used freshly. Kerosene was bought at the fagcoop filling station located at University of Benin ugbowo campus. The timber mould was fabricated at

production engineering laboratory of the University of benin under my supervision. The timber used was bought from a local sawmill located at the ugbowo axis of benin.

The compressive strength test machine i used is that of the structural engineering laboratory of civil engineering department, University of Benin. I prepared the standard sand my self according to the IS 650 : 1991 guidelines.

The viberator and vicat appparatus used I used is that of the structural engineering laboratory of civil engineering department, University of Benin.

3.3 SIEVE ANALYSIS:

Sieve analysis is used to determine the amount of soil that would Move through several sieves with different mesh diameters. A nested column of wire-mesh sieves is typically used in sieve analyses. According to IS 460(Part I) 1985, this test was performed. A spokesperson for SA When a granular substance is put onto the top sieve with the largest screen opening, sieve analysis is a technique used to determine the particle size distribution of the substance being studied. (The sieves at the lower end of the column have narrower openings than those at the top. At the base was where the receiver was. At the scheduled exact moment, the sieve column was shaken. The amount of fine aggregates retained in each sieve was determined by weighting, and the proportion of each sieve that was maintained was calculated by dividing that amount by the total number samples collected and multiplying the result by 100. The sieving procedure was performed at the university of benin soil laboratory.

3.3.1 METHORD

The sample (fine aggregates) of 500g each was soaked for 24hr in water in other to evacuate all the deleterious materials which were removed by decantation method. After decanting, the samples were dried at room temperature in a thermostatically, controlled oven at 110ºC. The dry and clean sieves were arranged in series where the size of the smaller sieve is one-half the size of the larger one in the decreasing order of size. The samples were weighed and put into the largest sieve. Shaking of the stacked sieves followed for two minutes with a varied motion, backwards and forward, left to right, circular, clockwise and anticlockwise and with frequent jarring so that the material is kept moving over the sieve surface in frequently changing direction for hand sieving. Materials retained on each sieve were weighed together with any material cleaned from the mesh. The materials on the pan or receiver were also weighed. As we are Working from the finest size upwards, the cumulative percentage (to the nearest one percent) passing each sieve was calculated.

3.4 COMPRESSIVE STRENGHT OF CEMENT:

Compressive strength is the capacity of material or structure to resist or withstand under compression. The compressive strength of a material is determined by the ability of the material to resist failure in the form of cracks and fissure. In this test, the impact force applied on both faces of mortar specimen made with cement and the maximum compression that cement specimen bears without failure recorded. In technical terms compressive strength of cement means, the ability of cement specimen to resist the compressive stress when tested under the compressive test machine at 28 days.

Compressive strength $= \frac{crushing\ load}{area}$

3.4.1 PROCEDURES;

This session comprises of all the various process taken to determine the compressive strength of both the control and contaminated samples.

3.4.1.1 MIXING SPECIMENS WITH STANDARD SAND AND WATER:

In order to create a paste with a standard (or normal) consistency, the following amounts of cement, standard sandy soil, and water was used: 200g of cement, 600g of standard sand that's in the ration of 1:3 (cement:sand), and (p/4+3.0) percent of the total quantity of cement and sand. the cement and regular sand mixture was poured inside the mortar mixer . Firstly, a trowel was used to combine cement and regular sand in dry form lasting one minute. Then, water was added and continued the mixing until the mixture had a consistent color. After adding the calculated amount of water, the mixer was turned on and the entire mixing operation was completed in about 3 minutes and 20 seconds, in accordance with the recommended mixing time. The combining procedure was performed in the structural laboratory of the University of Benin is depicted in Fig. 3.1

Fig 3.1 mixing of samples

Fig 3.2 graded fine aggregates and weighed cement ready to be mixed

3.4.2 MOULDING SPECIMENS

After constructing the molds and getting them ready for use, A thin layer of petroleum jelly was applied to the internal faces of the mold.

The assembled mold was set down on the vibration machine's table, an appropriate clamp was used to secure it there.

To make filling easier, a hopper was securely fastened at the top of the mold with the appropriate form and size, and it was left there until the whole vibration time was over.

As soon as the mixing of the mortar was finished, it was put into the cube mold and was viberated by the use of the viberation machine which was switched on after the filing process rod in a matter of 8 seconds. There were 36 cubes cast in all. Nine cubes are used for each percentage of contamination, while Nine more samples serve as the control. After which the samples was viberated

The vibration lasted for two minutes at the prescribed frequency of (12000 400) vibrations per minute.

After the vibration stopped, the mould and base plate was taken from the machine and finished smoothing the top surface of the cube in the mould using a trowel's blade.

Fig. 3.3 standard mould

3.4.3 CURING SPECIMENS: the full moulds were kept in a humid closet for 24 hours following the end of vibration.

After that time period, the samples were taken them out of the molds and put them right into clean, fresh water, and were kept therw until they were ready for the crushing process.

Every seven days, the water that the cubes are submerged in was replaced, and the temperature was kept constant at 27.2 °C.

The cubes were not allowed to dry out after being removed from the water and up until they were shattered.

Curing was carried out so that the motar could be fully hydrated by accessible moisture.

2. Reduce the early drying shrinkage as quickly as possible.

3 lessen the possibility of cracking

4 to boost the motar's longevity by decreasing permeability

Fig 3.4curing

3.4.4 CONTAMINATED SPECIMENS:

The procedure for preparing, moulding and curing the water-contaminated specimens is as that for the control specimens. For the contaminated specimens the required weight of water was partially replaced with 2%, 4% and 6% of kerosene and thoroughly mixed.

3.4.5 CRUSHING OF MORTAR CUBES.

The samples to be tested was removed from the curing room at the completion of their respective curing periods. The weight of each sample measured and recorded.

Three cubes from each samples of control, 2%, 4%, 6% was tested for compressive strength for each period of curing mentioned under the relevant specifications (i.e. 3 days, 7 days and 28 days) for the hydraulic cements specimens, the periods being reckoned from the completion of vibration.

The cubes was tested on their sides without any packing between the cube and the steel platen of the testing machine.

One of the platens was carried on a base and will be self-adjusting, and the load was steadily and uniformly applied, starting from zero at a rate of 35 $N/mm^2/min$.

Fig 4.5 crushing process

3.5 SETTING TIME OF CEMENT

INITIAL SETTING TIME AND FINAL SETTING TIME OF CEMENT

The initial setting time of cement is the time when cement paste starts hardening while the final setting time is the time when cement paste has hardened sufficiently in such a way that a 1 mm needle makes an impression on the paste in the mould but 5 mm needle does not make any impression.

Theoretically, Initial setting time of concrete is the time period between the addition of water to cement till the time at 1 mm square section needle fails to penetrate the cement paste, placed in the Vicat's mould 5mm to 7mm from the bottom of the mould. Final setting time is that time period between the time water is added to cement and the time at which 1 mm needle makes an impression on the paste in the mould but 5 mm attachment does not make any impression.

3.5.1 PROCEDURE.

4. Procedure Preparation of Test Block 1.

A neat cement paste was prepared by gauging the cement with 0.85 times the water required to give a paste of standard consistency. Potable water was used in preparing the paste. The paste was gauged in the manner and under the conditions prescribed in IS:4031 (Part 4)-1988. 2. Started is a stop-watch at the instant when water is added to the cement. Filled is the Vicat mould with a cement paste gauged as above, the mould resting on a nonporous plate. The mould completely was filled and the surface of the paste was smoothened off making it level with the top of the mould. The cement block thus prepared in the mould is the test block. 3. Immediately after moulding, it was ready to be tested for the both the initial and final setting time. Determination of Initial Setting Time 1. the test block confined in the mould and resting on the non-porous plate, was placed under the rod bearing the needle (C); the needle was lowered gently until it comes in contact with the surface of the test block and it was quickly released, allowing it to penetrate into the test block. In the beginning, the needle did completely pierce the test block. This procedure was repeated until the needle, when brought in contact with the test block and released as described above, fails to pierce the block beyond 5.0 ± 0.5 mm measured from the bottom of the mould. The period elapsing between the time when water is added to the cement and the time at which the needle fails to pierce the test block to a point 5.0 ± 0.5 mm measured from the bottom of the mould is the initial setting time. Determination of Final Setting Time

The needle (C) of the Vicat apparatus was replaced by the needle with an annular attachment (F). The cement is to be considered as finally set when, upon applying the needle gently to the surface of the test block, the needle makes an impression thereon, while the attachment fails to do so. The period elapsing between the time when water is added to the cement and the time at which the needle makes an impression on the surface of test block while the attachment fails to do so is the final setting time.

Fig 4.6 setting time process

CHAPTER FOUR

4.0 RESULTS AND DISCUSSONS

This chapter reflects the results that are obtained from all the studies done in this project. The results presented are the sieve analysis, initial and final setting time and the results of the compressive strength at various percentages of kerosene replacement and the ages of 3, 7 and 28 days

4.1 Sieve analysis

sieve analysis of soil is a simple operation of separating a sample of aggregate into fractions each consisting of particles of the same size. In practice, each fraction contains particles between definite limits, these being the openings of standard test sieves. The actual sieving operation was hand done although it done in a modern way by the use of sieve shaker. Table 4.1 gives the results of the sieve analysis. From the table 4.1 it can be seen that 100% of the fine aggregate passed through the 20mm sieve, 84% passed through the 14mm sieve, 38.91% passed through the 9.5mm sieve, 6.17% passed through the 4.75mm sieve, 0.83% passed through the 2.35mm sieve.

Table 4.1: sieve analysis result of fine aggregates

Set of sieves	Mass retained(g)	% retained	Cumulative % retained	% passing
				100
2.36mm	**3**	**0.6**	**0.6**	**99.4**
2.00mm	2	**0.4**	**1.0**	**99.0**
1.18mm	24	**19.4**	**5.8**	**94.2**
600um	**97**	**4.0**	**25.2**	**74.8**
425um	**20**	**10.6**	**29.2**	**70.8**
300um	**53**	**40.6**	**39.8**	**60.2**
212um	**204**	**40.8**	**80.6**	**19.4**
150um	**34**	**6.8**	**87.4**	**12.6**
25um	**51**	**10.2**	**97.6**	**2.4**
Pan	**3**	**0.6**	**98.2**	**1.8**
Losses	**9**	**1.8**	**100**	**0**

Mass of soil =500g

Percentage retained = $\frac{mass\ of\ soil\ retained}{500}$*100

Cumulative percentage retained = % retained_a + % retained_b

Percentage passing = 100% - % retained

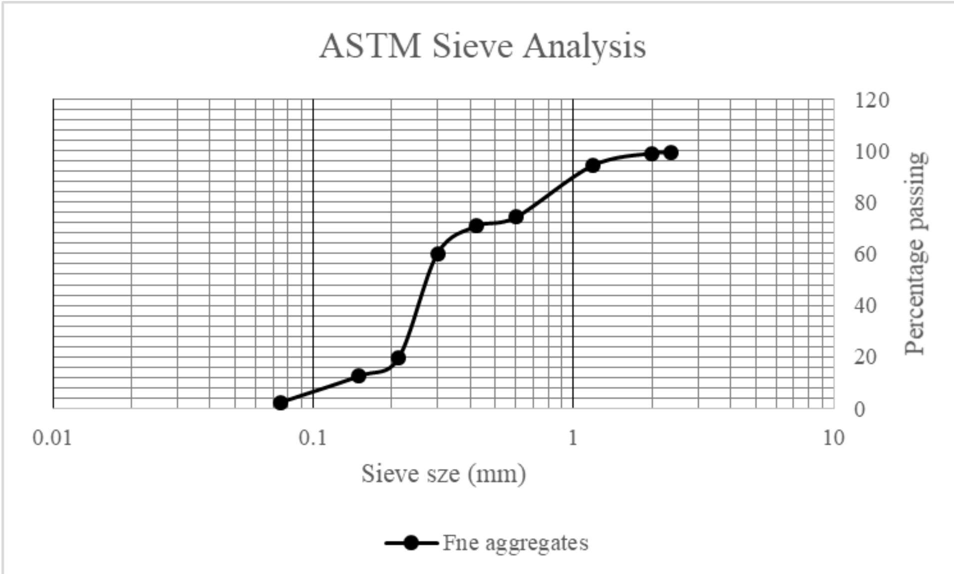

Fig 4.1 graph of sieve analysis

4.2 COMPRESSIVE STRENGHT RESULTS

The compressive strength of cement is an important factor in determining the condition the brand, type and condition of cement to be used in construction works. The knowledge of the compressive strength one can determine how much load a cement based construction material can carry without failing. The compressive strength was carried out in the laboratory for various concentrations of 2%, 4% and 6% of kerosene contamination and also the control experiment was done without any kerosene contamination. The results of compressive strengths of the control samples and the and the contaminated samples are presented in tables 4.2 to 4.13

Table 4.2: result of compressive strength of control after three days

Samples	Weight(kg)	Load(kN)	Compressive Strength(N/mm^2)
A	1.134	83.04	16.61
B	1.137	88.52	17.70
C	1.127	91.69	18.34

Average compressive strength $=\frac{16.61+17.70+18.34}{3}$ = 17.55N/mm^2

Table 4.2 shows the compressive strength of the three control samples the age of three days. The average compressive strength is calculated to be 17.55N/mm^2. This will serve as the basis for comparing the three days strength of the contaminated samples

Table 4.3: result of compressive strength at 2% kerosene contamination after three days

Sample	Weight(Kg)	Load(kN)	Compressive Strength(N/mmm^2)
A'	1.091	80.21	16.66
B'	1.082	92.61	18.58
C'	1.087	88.24	17.70

Average compressive strength = $\frac{16.66+18.58+17.70}{3}$ =

17.65N/mm^2

Table 4.3 shows the results of the 2% replacement samples at the age of three days. The compressive strength was calculated to be 17.65N/mm^2. In comparison the compressive strength of the 2% replacement at three days old is greater than that of the control by 0.1N/mm^2. Which is 0.56% increament from that of the control. As this value is rather insignificant we can say the at 2% replacement the three days compressive strength is not affect.

Table 4.4: result of compressive strength at 4% kerosene contamination after three days

Sample	Weight(Kg)	Load(K/N)	Compressive Strength (N/mm^2)
A"	1.101	84.10	16.87
B"	1.092	85.86	17.22
C"	1.097	86.16	17.29

Average compressive strength = $\frac{16.87+17.22+17.29}{3}$ = 17.13N/mm^2

Table 4.4 shows the results of the three days compressive strength at 4% replacement. The calculated value of the compressive strength is 17.13N/mm^2. It can be seen that the compressive strength is 0.42N/mm^2. Which is 2.39% fall in compressive strength. The fall is most likely due to the lack of the amount of water required for the complete hydration of the cement, as 4% of the required amount of water has been lost due to the presence of the kerosene(Osuji et Nwankwo, 2015)

Table 4.5: result of compressive strength at 6% kerosene contamination

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2
A'''	1.089	77.22	15.49
B'''	1.098	83.21	16.69
C'''	1.091	92.05	18.47

Average compressive strength $=\frac{15.49+16.69+18.47}{3} = 16.97N/mm^2$

Table 4.5 shows the results of the compressive strength at the age of 3 days at 6% replacement. The calculated compressive strength is 16.97N/mm^2 which is less than the control compressive strength by 0.58N/mm^2. Which is a 3.3% fall in compressive strength. From this, it can be seen that the compressive strength decrease as the percentage replacement increases.

Table 4.6: result of compressive strength of control after seven days

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2
D	1.144	92.26	18.51
E	1.147	98.35	19.73
F	1.151	111.26	22.32

Average compressive strength = $\frac{18.51+19.73+22.32}{3}$ =

20.19N/mm^2.

Table 4.6 shows the results of the compressive strength of the control specimens at the age of seven days. This compressive strength of 20.19N/mm^2 will be standard to assess the behavior of the contaminated samples at the age of seven days.

Table 4.7: result of compressive strength at 2% kerosene contamination after seven days

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2
D'	1.071	113.48	22.76
E'	1.077	93.43	18.74
F'	1.093	89.49	17.98

Average compressive strength $= \frac{22.76+18.74+17.98}{3} =$

19.83N/mm^2

Table 4.7 shows the result of the compressive strength at 2% replacement at the age of seven days. The calculated value of the compressive strength is calculated to be 19.83N/mm^2 which is 0.36N/mm^2 this shows a fall of 1.78% from the result of the control.

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2
D''	1.097	85.80	17.21
E''	1.098	102.28	20.52

F''	1.104	106.81	21.43

Table 4.8: Compressive strength result at 4% kerosene contamination after seven days

Average Compressive strength = $\frac{17.21+20.52+21.43}{3}$ = 19.72N/mm^2

Table 4.8 shows the results of the compressive strength of 2% replacement at the age of seven days. The compressive strength is calculated to be 19.72N/mm^2 which shows a decrease of 0.47N/mm^2 which is a fall of 2.3% from that of the control specimens

Table 4.9: Compressive strength result at 6% kerosene contamination after seven days.

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2
D'''	1.101	89.46	17.39
E'''	1.097	97.90	17.95
F'''	1.092	86.72	19.64

Average compressive strength = $\frac{17.39+17.95+19.64}{4}$ = 18.33N/mm2

Table 4.9 shows the results of the compressive strength of the samples at 6% replacement at the age of seven days. The calculated compressive strength is 18.33N/mm^2 this shows a decrease of 1.86% which is a drop of 9.21% in compressive strength from the compressive strength of the control specimens. Such a huge drop s only observed due to the fact the amount of water required from complete hydration has been replaced by the kerosene.

(Osuji et Nwankwo, 2015)

Table 4.10: Compressive strength result of control after twenty eighth days.

Samples	Weight(K/g)	Load(K/N)	Compressive Strength (N/mm^2)
G	1.152	130.14	26.10
H	1.145	154.93	31.08
I	1.121	134.16	26.92

Average compressive strength = $\frac{26.10+31.08+26.92}{3}$ = 28.08N/mm^2

Table 4.10 shows the compressive strength results of the control samples at twenty eight days. This calculated compressive strength 28.08N/mm^2 will be used as the standard compressive strength to assess the compressive strength of the contaminated.

Table 4.11: Compressive strength results at 2% kerosene contamination after twenty eighth days.

Samples	Weight(K/g)	Load(k/N)	Compressive Strength (N/mm^2)
G'	1.131	132.74	26.63
H'	1.096	150.28	30.15
I'	1.087	141.75	28.44

Average compressive strength = $\frac{26.63+30.15+28.44}{3}$ = 28.41N/mm^2

Table 4.11 shows the results of the compressive strength of the contaminated samples at 2% replacement at the age of 28 days. The calculated values of the compressive strength s 28.41N/mm^2 this value of compressive strength shows an increase of 0.33N/mm^2 which is 1.17% increase in its compressive strength.

Table 4.12: Compressive strength results at 4% kerosene contamination after twenty eighth days.

Samples	Weight(K/g)	Load(k/N)	Compressive Strength (N/mm^2)
G"	1.069	121.03	24.28
H"	1.101	148.13	29.71
I"	1.077	136.08	27.30

Average compressive strength = $\frac{24.28+29.71+27.30}{3}$ =

27.09N/mm^2

Table 4.12 shows the results compressive strength of the contaminated samples at 4% replacement at the age of twenty eight days. The calculated value of compressive strength is 27.09N/mm^2 this value shows a decrease of 0.99N/mm^2 which shows a drop of 3.5% from the standard value of 28.08N/mm^2. This significant drop of compressive is will mostly due to the presence kerosene contamination which reduces the amount of water available for complete hydration(Osuji et Nwankwo, 2015).

Table 4.13: Compressive strength results at 6% kerosene contamination after twenty eighth days.

Samples	Weight(K/g)	Load(k/N)	Compressive Strength (N/mm^2)
G”’	1.108	122.33	24.54
H’’’	1.070	140.99	28.29
I’’’	1.107	118.06	23.69

Average Compressive strength = $\frac{24.54+28.29+23.69}{3}$ = 25.51N/mm^2

Table 4.13 shows the results of the compressive strength of the contaminated samples at 2% replacement at the age of 28 days. The calculated compressive strength is found to be 25.51N/mm^2 which shows a decrease of 2.58N/mm^2 which is a drop of 9.1% from the compressive strength of the control samples at the age 28 days.

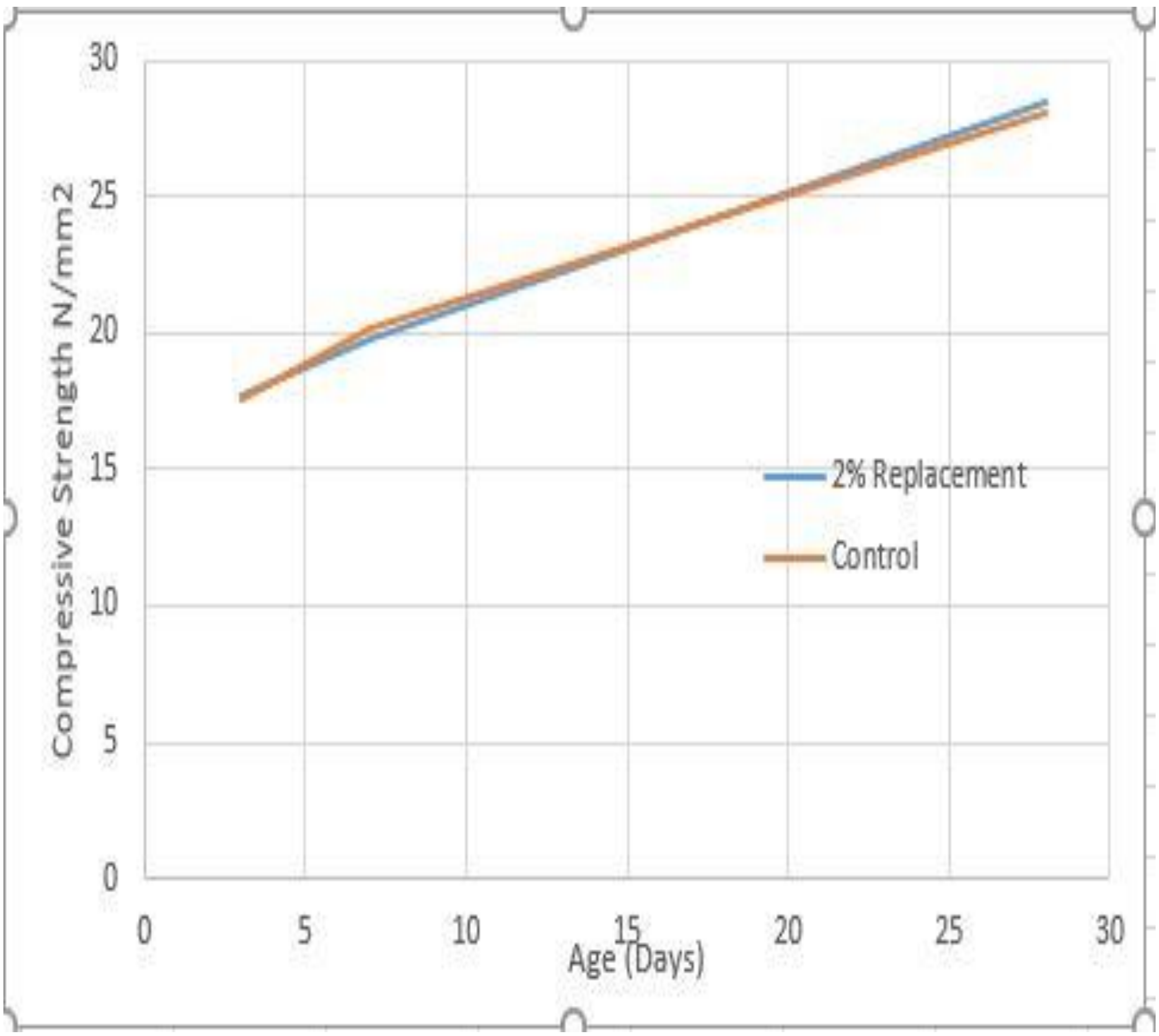

Fig.4.2 graph of control and 2% replacement compressive strength(N/mm^2) against age (days)

From the graph in figure 4.1 we can infer that the compressive strength of the control specimen and the 2% contaminated sample are not different. At the age of about 3 days the compressive strength of the 2% contamination is higher than that of the control, but as they progress in age the compressive strength of that of the control tends to be more. Although the differences are very close and of not much significance. This can be so if we say that the amount of water lost at 2% replacement does not hamper complete hydration(Osuji et Nwankwo, 2015).

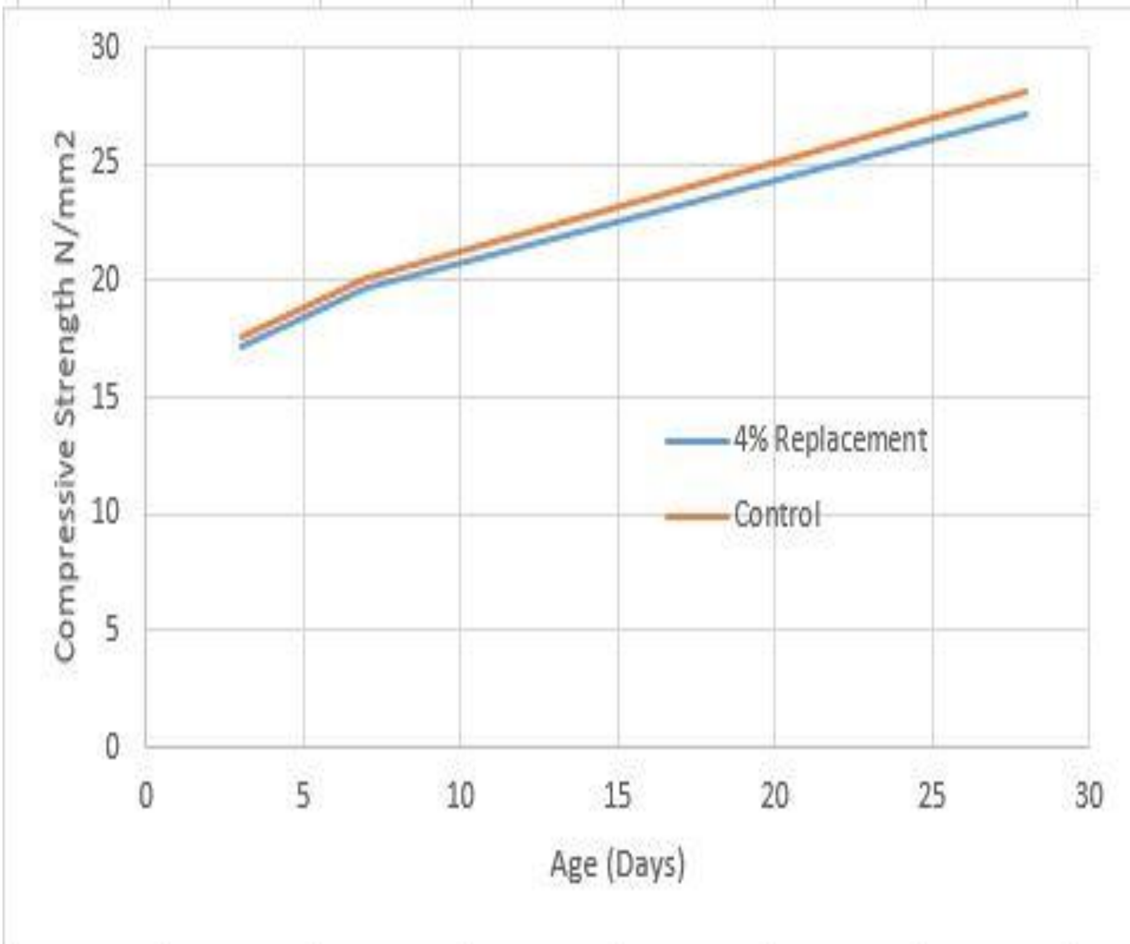

Fig 4.2 graph of control and 4% replacement compressive strength(N/mm^2) against age(days).

It is evident from the graph in figure 4.2 that the control specimen's compressive force is higher than that of the 4% replacement, and that as the cases' ages increase, so do the disparities in their compressive strengths. This can be seen as meaning that at 4% kerosene pollution, there is a big enough decrease in the volume of water available for hydration to interfere with the hydration process. Additionally, as the hydration process intensifies, the amount of water required for hydration rises noticeably. For this reason, as we age, both the compressive strength of the control specimen and the one obtained with 4% kerosene replenishment diminish.

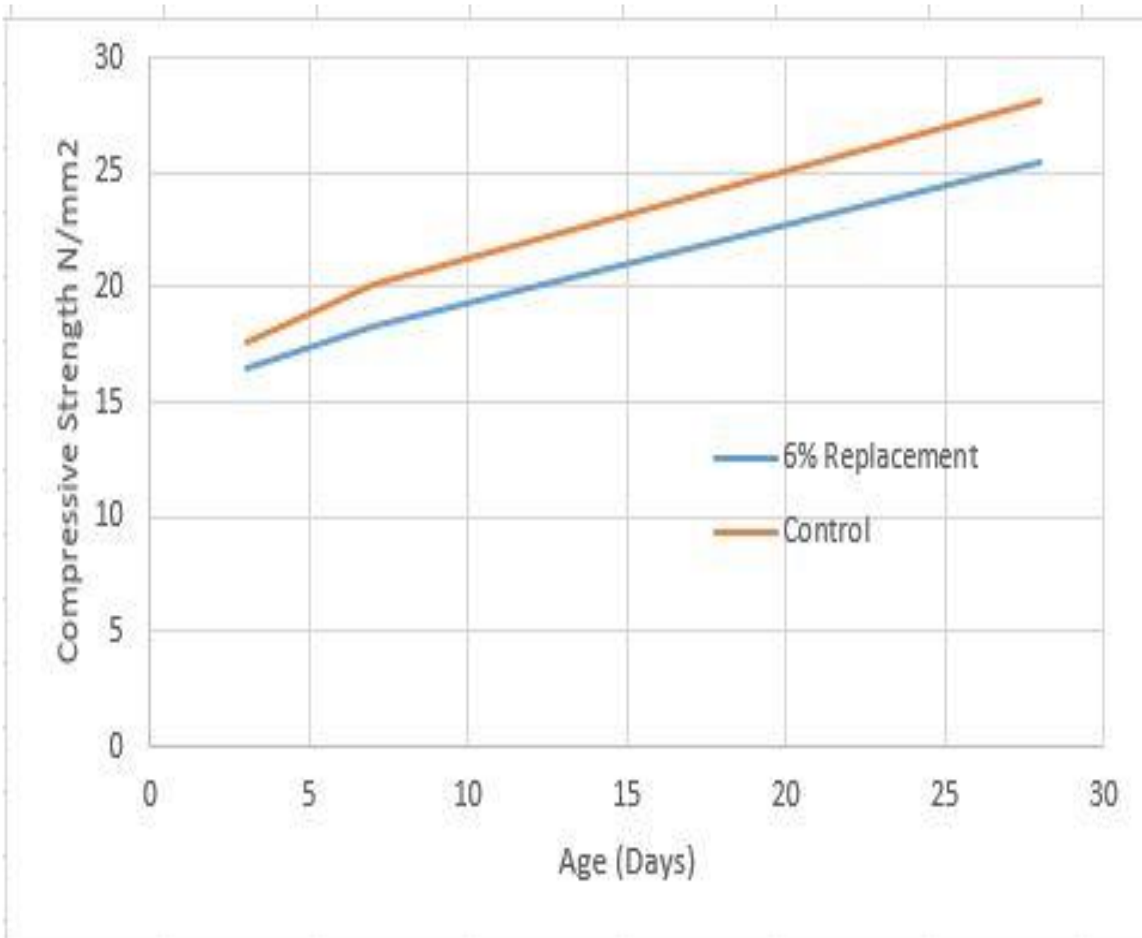

Fig 4.3 graph of control and 6% replacement compressive strength(N/mm2) against age(days).

It is clear from the curve in figure 4.3 that there is a significant difference between the compressive strength of the control and that of the 6% replacement, and that this difference also grows with age. From this finding, we may infer that the hydration process was significantly constrained as the amount of water required for hydration decreased and that

6% kerosene replacement is particularly detrimental to the OPC's compressive capacity. There was a significant decline in the compressive strength of the contaminated samples compared to those of the control samples as the ages increased because more water required for complete hydration was not present. The opc used has the characteristic strength of 33mpa at 28days but my result shows a strength of 28.08N/mm^2 this differences in the compressive strength maybe due to discrepancies in the curing conditions, effectiveness of the mixing process, the viberation machine age, the accuracy of the crushing machine and human errors

4.3 CEMENT SETTING TIME

The right amount of water is added to cement to begin the reaction between it and its numerous valuable characteristics. Cement turns into a paste when water is added, and for the first few minutes, it is in a plastic condition. Due to the paste's fluidity during the first few minutes, any desired shape can be created with it. But at this particular period, the interaction between the cement and the water continues. The paste hardens and loses its flexibility as a result of this reaction. After that, it becomes challenging to shape the hardened paste into the proper shape. The early stage of the cement paste is referred to as the cement setting period.

Setting time is the period of time that is necessary for concrete or mortar to transform from a liquid to a plastic state and from a plastic state to a solid state, resulting in a surface that is stiff enough to sustain a specified level of pressure.

This research investigates how kerosene concentrations may impact cement's first setting time. Three additional samples were created as controls using fresh water that had not been polluted. Later, three different percentages (2%, 4%, and 6%) of kerosene were used in place of the water, with three separate samples being made for each percentage substitution.

Table 4. 14 results of setting time of control specimens.

SETTING TIME	MOULD1(min)	MOULD2(min)	MOULD3(min)	AVERAGE SETTING TIME(min)
INITIAL	115	130	125	123
FINAL	223	219	228	223

Av. Initial Setting time = $\frac{115+130+125}{3}$ = 123

Av. Final setting time = $\frac{223+219+228}{3}$ = 223

Table 4.14 shows the result of the setting of the control specimen. This result shall be used as the standard of setting time to check what the use of kerosene contaminated water would do to both the initial and final setting of cement

Table 4.15 results of setting time at 2% kerosene contamination

SETTING TIME	MOULD1	MOULD2	MOULD3	AVERAGE SETTING TIME
INITIAL	12O	125	125	123
FINAL	225	220	225	223

Av. Initial setting time = $\frac{120+125+125}{3}$ = 123

Av. Final setting time = $\frac{225+220+225+}{3}$ = 223

Table 4.15 shows the result of the setting time of the cement at 2% kerosene contamination. From observation of both setting time of the control and at 2% kerosene contamination it is seen that they both have similar average setting time. This may be interpreted as saying that 2% kerosene contamination of water has little or no impact on the setting time of the cement

Table 4.16 result of setting time at 4% kerosene contamination

SETTING TIME	MOULD1	MOULD2	MOULD3	AVERAGE SETTING TIME
INITIAL	110	115	120	115
FINAL	205	205	210	206

Av. Initial setting time = $\frac{110+1115+120}{3}$ = 115(min)

Av. Final setting time = $\frac{205+205+210+}{3}$ = 206(min)

Table 4.16 shows the results of the setting time of the cement at 4% kerosene contamination. From calculated result of the average initial and final setting time of the cement we see that the values gotten for the contaminated samples is less than that of the uncontaminated samples. Therefore at 4% kerosene replacement there is a reduction of both the initial and final setting time of cement

Table 4.17 result of the setting time at 6% kerosene contamination

SETTING TIME	MOULD1	MOULD2	MOULD3	AVERAGE SETTING TIME
INITIAL	115	105	125	115
FINAL	205	203	204	204

Av. Initial setting time = $\frac{110+1115+120}{3}$ = 115(min)

Av. Final setting time = $\frac{205+203+2o4}{3}$ = 206(min)

From the shown in table 4.17 and the calculated initial and final setting time, it can be seen that there is a reduction in the initial and final setting time of the cement as compared to the control samples.

From the overall result we can observe that kerosene causes a reduction in the setting time of the cement of cement and although as the concentration of the kerosene increases the setting time increases(results at 2% contamination to 6% contamination) there is no established linear relationship between kerosene concentration and reduction in the setting time of cement.

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMEDATIONS

5.1 CONCLUSION

From the results of the experiment the following conclusions are determined.

1. The compressive strength of the uncontaminated(control) samples has a compressive strength of 28.08N/mm^2
2. The addition of kerosene has an adverse effect on the compressive strength of water. The control specimen has a twenty eight days strength of 28.08N/mm^2 at 2% replacement the specimens gives a compressive strength of 28.41N/mm^2, at 4% replacement the specimens gave a compressive strength of 27.09N/mm^2, while at 6% replacement the specimens gave a compressive strength of 25.51N/mm^2
3. As the concentration of kerosene contamination in the water increases the compressive strength of the cement decreases
4. At low concentration of 2% replacement there is no noticeable change in the compressive strength. But at the highest concentration of 6% a fall of 9.18% in the compressive strength is observed.
5. As the age of the control and contaminated specimens increases the compressive strength increase which has a maximum value of 28.41N/mm^2 at 2% replacement
6. From table 3.1 we see the chemical composition of cement which aid the cement in undergoing a complete hydration reaction with water**,** Which tends to contribute majorly to the compressive strength of the cement. But as the volume of water is

reduced due to the partial replacement with kerosene the compressive strength reduces.

7. From the results gotten from the setting time experiment, it can be seen that the presence of kerosene at about 4% and above concentrations causes the reduction in the setting time of cement

5.2 RECCOMMEDATIONS

From the analysis of the results, it is clearly observed that water contaminated with kerosene has a negative effect on the compressive strength of the cement.

For construction purposes, care must be taken to ensure that water contaminated with kerosene are not used in the construction process. The water to be used should be purified by simple available processes to ensure there are no crude oil or crude oil by-product present in the water, as this have an adverse effect on the structural integrity of the structure.

Further investigations and experiments needs to be carried out to study the effect of kerosene contaminated water on the setting time of cement.

As much as possible kerosene should be avoided wen concrete or sandcrete are be prepared because its presence would reduce the setting time of the cement and therefore would not permit the workers the time needed to mix and place the concrete before the limit of setting time is exceeded.

The effect of kerosene-contaminated water on the compressive strength, slump of concrete was not carried out, It is recommended that further research should be carried out on these fronts.

REFERENCES

Akpofure, E.A., 2000. Efere, M.L. and Ayawei, P. ‘ The Adverse Effects of Crude Oil Spill in the Niger Delta’ Urhobo Historical Society.

Alexandra Gas and Oil Connections, ‘Forms Oil Spill Detection Agency’, Available on

ASTM International. (2021). ASTM C39/C39M-20a: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens. ASTM International.

ASTM International. (2021). ASTM D5084-16: Standard Test Methods for Measurement of of Saturated Porous Materials Using a Flexible Wall Permeameter. ASTM International.Hydraulic Conductivity

Atlas, R. M.,1995. ‘Petroleum Biodegradation and Oil spill Bioremediation’. M a r i n e P o l l u t i o n B u l l e t i n 31, pp.178-182.

Ayininuola, G.M., 2009. ‘Influence of Diesel Oil and Bitumen on Compressive Strength of Concrete’, J o u r n a l o f Civil Engineering (IEB), Vol.37 (1) pp.65-71.

British Cement Association. Specifying Concrete to BS EN 206-1/BS 5500, 2001 [1] Benka-Coker, M.O. and Ekundayo, J.A., 1994. ‘Effects of an Oil Spill on Soil Physico-Chemical Properties of a Spill Site in the Niger Delta Area of Nigeria’, J o u r n a l o f Environmental Monitoring and Assessment , Volume 36, Number 2, pp.93-104.

British Standard Institution, 1988 BS: 1881- 102, Method for determination of compressive Strength of Concrete cubes.

Calabrese, E.J., Kostecki, P.T and Bonazountas, 1991 M. Hydrocarbon Contaminated Soils ’, CRC Press, Taylor and Francis Group, Taiwan, Vol II.

Ejeh, S.P. and Uche, O.A.U., 2009 ‘Effect of Crude Oil Spill on Compressive Strength of Concrete Materials’, J o u r n a l o f A p p l i e d S c i e n c e s R e s e a r c h , 5(10): pp.1756-1761.

Elsawy, A. S., El-Sayed, A. A., & Al-Harbi, T. A. (2017). Effect of diesel and kerosene contamination on the mechanical properties of concrete. Journal of Materials in Civil Engineering, 29(7), 04017016.

Hoff, R., 1993 'Bioremediation: An Overview of its Development and Uses for Oil Spill Cleanup', Mar. POLLUT. Bull. 26, 476-481.

IS:3535.1986 Methord of sampling hydraulic cement(first revision)

IS:4031(part 5), 1998. Methord of physical tests for hydraulic cement.

Lothenbach, B., Le Saout, G., Gallucci, E., & Scrivener, K. (2016). Influence of limestone on the hydration of Portland cements. Cement and Concrete Research, 78, 124-144.

Mehta, P. K., & Monteiro, P. J. (2006). Concrete: Microstructure, Properties, and Materials. McGraw-Hill Education

Nehdi, M. L., Duquette, J., & El Damatty, A. A. (2003), 1799-1806 Effect of high-range water reducers on properties of concretes exposed to high sulfate environments. Cement and Concrete Research, 33(11).

Neville, A. M. (2011). Properties of Concrete. Pearson Education.

Neville, A. M. and Brooks, J. J., 1999 ' Concrete Technology ', First Edition ELBS Publishers.

Nwilo P. C and Badejo O. T., 2005 'Impacts and Management of Oil Spill Pollution', I n t e r n a t i o n a l O i l S p i l l Conference , Miami, Florida.

Onabolu, O. A., 1989. ' Effect of Hot Crude Oil on Concrete for Offshore Storage Application ', PhD Thesis, University of London, pp. 298.

Parthiphan, K., 1994 'Oil Spill Sensitivity Mapping Using a Geographical Information System', Department of Geography, University of Aberdeen. EGIS Foundation.

Prince, R., 1993 'Petroleum Spill Bioremediation in Marine Environments', C r i t i c a l R e v . M i c r o b i a l , 19(4), 217242.

Shi, C. (2016). Effects of admixtures on the hydration of cementitious systems. In Advances in Cement-Based Materials (pp. 1-42). Springer.

Teychenné, D.C., Franklin, R.E., and Erntroy H.C., 1978. ' D e s i g n o f N o r m a l C o n c r e t e M i x e s ' , Building Research Establishment, Transport and Road Research Laboratory, Department of Environment.

Thomas, M. D. (2009). Durability of concrete: Degradation phenomena involving detrimental chemical reactions. Cement and Concrete Research, 39(12), 1123-1139.

Ukoli, M. K., 2005. 'Environmental Factors in the Management of the Oil and Gas Industry in Nigeria', Available on http://www.warmofloor.co.uk/pages/environmenta lpdf [Accessed on 09/12/2023].

Van der Sloot, H. A., Kosson, D. S., Sanchez, F., & Garrabrants, A. C. (2015). Assessment of chemical contaminant leaching and permeability in concrete: State of the science and knowledge gaps.

Vazirani, V. N. and Chandola, S. P., 2008. ' Concise Handbook of Civil Engineering ', S Chand and Company Ltd, Ram Nagar, New Delhi-110055.

Wardley-Smith, J., 1976. ' The Control of Oil Pollution on t h e S e a a n d I n l a n d W a t e r s ', Graham and Trotman Ltd. United Kingdom.

Wilson, S. A., Langdon, N. J. and Walden, P. J., 2001. 'The Effects of Hydrocarbon Contamination on Concrete Strength', Proceedings Institution of Civil Engineers Geotechnical Engineering, Thomas Telfords, London, pp.189-193.