

**EFFECT OF CRUDE OIL CONTAMINATED SAND ON THE
ENGINEERING PROPERTIES OF CONCRETE**

BY

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ABSTRACT

A considerable fraction of sand in Niger Delta Area of Nigeria is contaminated with crude oil. The contaminated sand is largely utilised by local contractors for the production of concrete. However, there is need to establish its suitability in concreting. Previous works have centered on hardened uncontaminated concrete in crude oil environment but not on concrete made with Crude Oil Contaminated Sand (COCS). This research was designed to evaluate the effect of COCS on some engineering properties of fresh and hardened COCS concrete.

Levels of crude oil contamination were determined using gravimetry method of Total Petroleum Hydrocarbon (TPH) test on nine sand samples randomly collected from some oil spill sites in Rivers State. Based on the test results, seven types of artificially contaminated sand were prepared with crude oil levels of 0.0, 2.5, 5.0, 10.0, 15.0, 20.0 and 25.0%. Workability (slump, compacting factor and flow), compressive strength, linear shrinkage, water absorption, and fire resistance were determined using concrete cubes, flexural strength using concrete beams, and surface resistivity using concrete cylinders in accordance with standard methods. Data obtained were analysed using ANOVA at $p = 0.05$. Eight models were developed using historic response surface methodology to predict the engineering properties of COCS concrete at water-cement ratio (w/c) of 0.5. Also, COCS concrete design mixes with contamination level and w/c ratio suitable for reinforced concrete were formulated.

The TPH varied from 8.6 ± 0.2 to $14.1 \pm 1.3\%$. The workability of concrete was improved by the presence of COCS. Slump, compacting factor and flow of the fresh concrete increased with increase in contamination from 30.0 to 200.0 mm, 0.5 to 0.9 and 15.0 to 85.0%, respectively. Compressive strength, flexural strength, linear shrinkage and water absorption of the hardened concrete reduced with levels of contamination from 31.5 ± 2.3 to 3.5 ± 0.0 N/mm², 5.9 ± 0.8 to 0.1 ± 0.0 N/mm², 0.1 ± 0.0 to 0.0 cm and 0.2 to 0.0 kg respectively. At a temperature of 200.0°C, the percentage strength reduction increased from 18.4 to 94.8% for 2.5 to 25.0% contamination. Surface resistivity ranged from 25.1 ± 0.2 to 32.3 ± 0.2 kΩ-cm. The compressive and flexural strengths of COCS concrete were reduced by more than 50.0% at crude oil contamination level greater than 10.0%. The water absorption and surface resistivity values indicated that COCS concrete exhibited greater resistance to water and chloride penetration respectively, it shrank less when compared with the

uncontaminated concrete, but exhibited poor fire resistance. Coefficient of determination, R^2 , of the models developed ranged from 0.823 to 0.999. Concrete design mix ratio of 1 part of cement to 1.6 part of COCS (10.0% crude oil) to 2.4 part of coarse aggregate was found to be appropriate at 0.45 w/c. This mix gave minimum compressive strength of 21.0 N/mm² which is acceptable for reinforced concrete structures.

Concretes produced with sand contaminated with less than ten percent crude oil were found suitable for use in low strength structures. Mix re-design using lower w/c improved the strength of the concrete.

Keywords: Crude oil-contaminated sand, Concrete properties, Compressive strength.

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DEDICATION

This thesis is dedicated to my late father, and brothers and sisters on the path of
ALLAH.

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CERTIFICATION

I certify that this work was carried out by W. O. Ajagbe in the Department of Civil Engineering, Faculty of Technology, University of Ibadan.

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TABLE OF CONTENTS

TITLE PAGE	i
ABSTRACT	ii
DEDICATION	iv
ACKNOWLEDGEMENT	v
CERTIFICATION	vii
TABLE OF CONTENT	viii
LIST OF TABLE S	xii
LIST OF FIGURES	xiii
LIST OF PLATES	xiv

CHAPTER ONE: INTRODUCTION

1.1. Background to the Research	1
1.2. Research Problems	5
1.3. Research Objectives	5
1.4. Justification of Research	6
1.5. Scope of Research	6
1.6. Area of Study	6

CHAPTER TWO: LITERATURE REVIEW

2.1. Concrete	10
2.2. Concrete Materials/Composition	10
2.3. Properties of Concrete	12
2.3.1. Fresh Concrete	12
2.3.1.1. Workability and its measurement	12
2.4. Concrete in its Hardened State	13
2.4.1. Concrete Strength	14
2.4.1.1. Effects of Mixing Water on Concrete Strength	15
2.4.1.2. Effects of Water/Cement Ratio on Concrete strength	15
2.4.1.3. Influence of Properties of Coarse Aggregate on Strength of Concrete	16
2.4.1.4. Effects of Aggregate/Cement Ratio on Concrete Strength	17
2.4.1.5. Concrete Strength in Tension	18
2.4.1.6. Influence of Early Temperature on Concrete Strength	18
2.4.1.7. Flexural Strength Test of Concrete	19

2.4.2.	Durability of concrete	19
2.4.2.1.	Significance of Durability	20
2.4.2.2.	Strength and Durability Relationship	22
2.4.2.3.	Volume Change in Concrete	23
2.4.2.4.	Permeability of concrete	24
2.4.2.5.	Fire Resistance of concrete	25
2.5.	Crude Oil	26
2.5.1.	Nigeria Oil Coastal Area	27
2.5.2.	Oil spills and its consequences	27
2.6.	Contamination	29
2.6.1.	Concrete in hydrocarbon product environment	30
2.6.2.	Effect of crude oil on concrete	32
2.7.	Modelling of Concrete Properties and Optimization	34

CHAPTER THREE: METHODOLOGY

3.1.	Materials	37
3.1.1.	Cement	37
3.1.2.	Water	37
3.1.3.	Coarse aggregate	37
3.1.4.	Fine aggregate	37
3.1.5.	Crude oil	37
3.1.6.	Contaminated sand	37
3.2.	Sample Preparation	38
3.2.1.	Aggregate	38
3.2.2.	Contaminated sand	38
3.2.3.	Contamination of Sand with Crude Oil	38
3.3.	Materials Testing	42
3.3.1.	Cement	42
3.3.2.	Water	42
3.3.3.	Aggregates	42
3.3.4.	Extraction of crude oil	43
3.4.	Concrete Mix Design	44
3.4.1.	British Method of Concrete Mix Design	44

3.5.	Production of Concrete	45
3.6.	Concrete Test Procedures	47
3.6.1.	Tests on Fresh Concrete	47
3.6.1.1.	Slump test	47
3.6.1.2.	Compacting factor test	48
3.6.1.3.	Flow Table test	50
3.6.2.	Tests on Hardened Concrete	51
3.6.2.1.	Strength tests	51
3.6.2.1.1	Compressive strength test	54
3.6.2.1.2.	Flexural Strength (Modulus of Rupture) Test	54
3.6.2.2.	Durability tests	56
3.6.2.2.1.	Water absorption test	56
3.6.2.2.2.	Shrinkage test	58
3.6.2.2.3.	Surface Resistivity indication of concrete's ability to resist Chloride ion penetration	58
3.6.2.2.4.	Fire Resistance test	59
3.7.	Experimental Control	59
3.7.1.	Casting of Concrete Sample	59
3.8.	Development of Models	60
3.8.1.	Design Summary for Compressive Strength Model	60
3.8.2.	Design Summary for Other Properties	60
3.9.	Mix Proportioning for High Strength COIS Concrete	65

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1.	Results of Preliminary Studies	67
4.1.1.	Sieve analysis	67
4.1.2.	Result of Total Petroleum Hydrocarbon (TPH)	67
4.2.	Results and Discussions of Tests on Concrete Samples	74
4.2.1.	Results of tests on fresh concrete	74
4.2.1.1.	Slump test	74
4.2.1.2.	Compacting Factor test	74
4.2.1.3.	Result of Flow Table test	74
4.2.2.	Effect of COCS on the fresh properties of concrete	78
4.3.	Results and Discussions of Tests on Hardened Concrete	78

4.3.1.	Strength test results	78
4.3.1.1.	Compressive strength test results	78
4.3.1.2.	Flexural strength test results	81
4.3.2.	Effect of COCS on the strength of concrete	81
4.3.3.	Durability test results	82
4.3.3.1.	Water absorption test result	82
4.3.3.2.	Shrinkage test result	82
4.3.3.3.	Concrete Electrical Resistivity test result	86
4.3.3.4.	Fire Resistance test result	86
4.3.4.	Effect of COCS on the durability of concrete	90
4.4.	Mathematical Models	90
4.4.1.	Compressive Strength Model	90
4.4.2.	Models for Other Properties	91
4.5.	Mix Proportioning Compressive Strength Test Result	99

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.1.	Conclusions	102
5.2.	Recommendations	103

REFERENCES	104
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APPENDICES	114
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LIST OF TABLES

Table 3.1. Mix Proportions of Materials	48
Table 3.2. Experimental Factor Input for Compressive Strength	63
Table 3.3. Measured Response Input for Compressive Strength	64
Table 3.4. Experimental Factor Input for Other Properties	65
Table 3.5. Measured Response Input for Other Properties	66
Table 3.6. Mix Proportion of Materials	68
Table 4.1. TPH Test Results	75
Table 4.2. Results of Slump Test	77
Table 4.3. Results of Compacting Factor Test	78
Table 4.4. Result of Flow Table Test	79
Table 4.5. Flexural Strength Test Results	85
Table 4.6. Water Absorption Test Results	86
Table 4.7. Shrinkage Test Result	87
Table 4.8. Chloride Ion Penetrability Based	89
Table 4.9. Concrete Surface Resistivity Test Results	90
Table 4.10. Compressive Strength of Heated COIS Concrete Cubes	91
Table 4.11. Input Details Showing Factors and Response	94
Table 4.12. Model Summary Statistics	96
Table 4.13. Input Parameters for the Responses and the Model Type	99
Table 4.14. Statistical Models for the other Responses	100
Table 4.15. Compressive Strength for Different Mix Proportions	102
Table 4.16. Designed Mix Ratios and their 28 days Compressive Strength	103

LIST OF FIGURES

Fig. 1.1.	Map Showing Area of Study	8
Fig. 1.2.	Map Showing Sample Locations in Gokana Local Government Area	9
Fig. 4.1.	Particle Size Distribution Curve of Bodo Spill Location	70
Fig. 4.2.	Particle Size Distribution Curve of Bomu Spill Location	71
Fig. 4.3.	Particle Size Distribution Curve of B-Dere Spill Location	72
Fig. 4.4.	Particle Size Distribution Curve of Uncontaminated Fine Aggregate	73
Fig. 4.5.	Particle Size Distribution Curve of Coarse Aggregate	74
Fig. 4.6.	Compressive Strength Development of Concrete	81
Fig. 4.7.	Percentage Reduction of Compressive Strength of Concrete Cubes	82
Fig. 4.8.	Compressive Strength Measured Values Vs Predicted Values	97
Fig. 4.9.	Response Surface for Desirability Effects of Variables Interactions	98

LIST OF PLATES

Plate 3.1. Oil Spill Location at B-Dere	41
Plate 3.2. Oil Spill Location at Bomu	42
Plate 3.3. Oil Spill Location at Bodo	43
Plate 3.4. Preparing Soil Sample for TPH Test	74
Plate 3.5a. Measuring of the Slump of a Contaminated Concrete	51
Plate 3.5b. The Slump of a Contaminated Concrete	51
Plate 3.6a. The Compacting Factor Apparatus Ready for Use	54
Plate 3.6b. Compacting Factor Test in Progress	54
Plate 3.7a. Flow Table (Locally fabricated) Test in Progress	55
Plate 3.7b. Spread of Concrete being measured in a Flow Table Test in Progress	55
Plate 3.8. Cube in a Compression Machine Ready for Crushing	57
Plate 3.9a. Concrete Beams after Curing Ready for Weighing	59
Plate 3.9b. Concrete Beams in Universal Machine being inspected prior to Flexural Test	59