UTILIZATION OF CORN COB AS PARTIAL REPLACEMENT FOR FINE AGGREGATE IN CONCRETE

THESIS

MARIA ASHLEY A. CLIMACOSA

ROBERT L. ETES

College of Engineering and Information Technology

CAVITE STATE UNIVERSITY

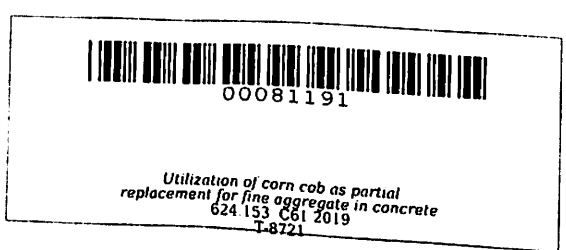
Indang, Cavite

June 2019

UTILIZATION OF CORN COB AS PARTIAL REPLACEMENT FOR FINE AGGREGATE IN CONCRETE

Undergraduate Thesis
Submitted to the Faculty of the
College of Engineering and Information Technology
Cavite State University
Indang, Cavite

In partial fulfilment
of the requirements for the degree
Bachelor of Science in Civil Engineering



MARIA ASHLEY A. CLIMACOSA
ROBERT L. ETES

June 2019

ABSTRACT

CLIMACOSA, MARIA ASHLEY A. and ETES, ROBERT L. Utilization of Corn Cob as Partial Replacement for Fine Aggregate in Concrete. Undergraduate Thesis. Bachelor of Science in Civil Engineering. Cavite State University, Indang, Cavite. June 2019. Adviser: Engr. Roslyn P. Peña

The greatest crisis faced by the construction industry is the availability of sand. Getting river sand is really expensive nowadays as its availability is very limited. The researchers introduced some substitution of material which is cheaper in cost and easily available like corn cob that has utilized as fine aggregates. Corn is a major commodity and is used throughout the world. According to United States Department of Agriculture – Foreign Agricultural Service (USDA-FAS), since 1990 global corn consumption has increased 116%, from 473 million metric tons to just over 1 billion metric tons. The main objective of this research was to study the possibility of using corn cob as partial replacement for fine aggregate in concrete.

The proximate analysis of grained corn cob shows fineness modulus of 0.20 as compared to sand having a result of fineness modulus of 2.23, loose and compacted density of 165 kg/m^3 and 184 kg/m^3 which is relatively lower than sand yielding a loose and compacted density of 1472.46 kg/m^3 and 1613.35 kg/m^3; The color and texture of concrete were observed through visual inspection. It was observed that the color of the concrete did not vary that much even after increasing the amount of grained corn cob to the mixture. Texture of concrete cylinders and beams varied from smooth to rough. Rough surface was observed in cylinders and beams with higher percentage of grained corn cob due to the honeycombing that was formed on the concrete. Treatment A and Treatment E found to be the heaviest, while Treatment D and Treatment H found to be the lightest in concrete

cylinder and concrete beam respectively. Treatment A and E, B and F, C and G, and D and H, obtained a slump of 8 inches (20.32 cm), 7.25 inches (18.42 cm), 7.20 inches (18.29 cm), and 7.15 inches (18.16 cm) respectively. For compressive strength, all treatments from A to D are not significantly different. All treatments exceeded the design strength of 13.79 MPa at 28th day, and for flexural strength Treatment E up to Treatment H have the same flexural strength at 7th and 28th day, thus, not manifesting variation. The cost of the concrete with corn cob compared to the local market value has the highest price due to the raw materials used in the experiment were bought in retail price.

The effect in compressive and flexural strength of grained corn cob as fine aggregate in concrete after 28 days of curing period - all treatments in concrete cylinder and beam are not significantly different, therefore statistically using corn cob as partial replacement for fine aggregates doesn't have effect. The optimum mix proportion of concrete cylinder was treatment having 90% sand and 10% grained corn cob, while the optimum mix proportion of concrete beam was treatment having 70% sand and 30% grained corn cob.

All the concrete cylinders and beams needed for the study were tested at Cavite Testing Center at Imus, Cavite. Statistically, grained corn cob when used as partial replacement with sand did not affect the strength of concrete cylinder and concrete beam.

The study recommends further research on incorporating corn wastes, study the effect of grained corn cob as fly ash for concrete and conduct experimental study of the concrete with corn cob in its application as a building material

TABLE OF CONTENTS

	Page
APPROVAL SHEET	ii
BIOGRAPHICAL DATA	iii
ACKNOWLEDGEMENT	v
ABSTRACT	xi
LIST OF TABLES	xvi
LIST OF FIGURES	xviii
LIST OF APPENDIX TABLES	xix
LIST OF APPENDIX FIGURES	xxi
LIST OF APPENDICES	xxii
INTRODUCTION	1
Statement of the Problem	3
Objectives of the Study	4
Significance of the Study	4
Scope and Limitation	5
Time and Place of the Study	6
Definition of Terms	7
REVIEW OF RELATED LITERATURE	9
METHODOLOGY	24
Data Gathering	24
Materials and Apparatus	24
Preparation of Corn and Corn Cob	25
Fine Modulus Test	26

Proportioning and Mixing Concrete 27
Slump Test 28
Production of Concrete Cylinders 29
Production of Concrete Beams 30
Curing of Concrete Cylinders and Beams 31
Determination of Physical Properties of Concrete Cylinder 31
Determination of Water Absorption Capacity of Concrete Cylinder ... 32
Compressive Test of Concrete Cylinder 33
Flexural Test of Concrete Beam 33
Experimental Results 33
Statistical Design 34
Cost Analysis 34
Comparison of Cost 34
Data on Hand 34
Data Gathered 35
RESULTS AND DISCUSSION 36
Data Gathering 36
Corn Cob 37
Preparation of Samples 37
Concrete with Grained Corn Cob 38
Physical Properties of Corn 39
Fineness Modulus of Aggregates 40
Unit Weight of Aggregates 40
Moisture Content of Aggregates 41
Slump Test 41

Physical Properties of Concrete Cylinder 42
Physical Properties of Concrete Beam 45
Compressive Strength 48
Compressive Strength of Concrete Cylinder 48
Flexural Strength of Concrete Beam 50
Water Absorption of Concrete Cylinder 51
Cost Analysis 52
SUMMARY, CONCLUSION AND RECOMMENDATION 56
Summary 56
Conclusion 59
Recommendation 60
REFERENCES 62
APPENDICES 66

LIST OF TABLES

Table		Page
1	Summary of world construction aggregates demand	12
2	Properties of corn cobs, leaves and stalks	16
3	Physical and chemical properties of grained corn cob	16
4	Maximum permissible water cement for concrete	18
5	Proportion of sand and grained corn cob	27
6	Mix design of concrete	28
7	Fineness modulus of aggregates	40
8	Unit weight of aggregates	41
9	Moisture content of aggregates	41
10	Slump of samples in different proportions	42
11	Average weight of concrete cylinders at 7^{th}, 14^{th} and 28^{th} day	43
12	Average density of concrete cylinders at 7^{th}, 14^{th} and 28^{th} day	44
13	Average weight of concrete beams at 7^{th} and 28^{th} day	46
14	Average density of concrete beams at 7^{th} and 28^{th} day	47
15	Average compressive strength (MPa) of concrete cylinders	49
16	Average flexural strength (F) of concrete beams	50
17	Water absorption of concrete cylinder	52
18	Cost of production per concrete cylinder	53

19	Cost of production per concrete beam	53
20	Cost of production of concrete cylinder per cubic meter	53
21	Cost of production of concrete beam per cubic meter	54
22	Comparison of cost for concrete per cubic meter to local market price	54
23	Summary of cost analysis for concrete cylinder (mixture proportion 1:2:4)	55

LIST OF FIGURES

Figure		Page
1	Volume of agricultural production of the Philippines in year 2014 (PSA, 2015)	14
2	Average weight of concrete cylinders	44
3	Average density of concrete cylinders	45
4	Average weight of concrete beams	47
5	Average density of concrete beams	48
6	Average compressive strength of concrete cylinders	50
7	Average flexural strength of concrete beams	51
8	Water absorption of concrete cylinder	52

LIST OF APPENDIX TABLES

Appendix Table		Page
1	Fineness modulus of sand	68
2	Fineness modulus of grained corn cob	68
3	Unit weight of sand	69
4	Unit weight of grained corn cob	69
5	Weight of corn per sack	69
6	Weight of corn with and without husk	70
7	Weight and volume of grained corn cob	71
8	Average weight of concrete cylinder at 7^{th} day	72
9	Average weight of concrete cylinder at 14^{th} day	72
10	Average weight of concrete cylinder at 28^{th} day	73
11	Average weight of concrete beam at 7^{th} day	73
12	Average weight of concrete beam at 28^{th} day	74
13	Average compressive strength of concrete cylinder at 7^{th} day	74
14	Average compressive strength of concrete cylinder at 14^{th} day	75
15	Average compressive strength of concrete cylinder at 28^{th} day	76
16	Average flexural strength of concrete beam at 7^{th} day	77
17	Average flexural strength of concrete beam at 28^{th} day	77
18	Water absorption of concrete cylinder	78
19	ANOVA for weight of concrete cylinder at 7^{th} day	79

20	Comparison among means	79
21	ANOVA for weight of concrete cylinder at 14th day	80
22	Comparison among means	80
23	ANOVA for weight of concrete cylinder at 28th day	81
24	Comparison among means	81
25	ANOVA for compressive strength of concrete cylinder at 7th day	82
26	Comparison among means	82
27	ANOVA for compressive strength of concrete cylinder at 14th day	83
28	Comparison among means	83
29	ANOVA for compressive strength of concrete cylinder at 28th day	84
30	Comparison among means	84
31	ANOVA for weight of concrete beam at 7th day	85
32	Comparison among means	85
33	ANOVA for weight of concrete beam at 28th day	86
34	Comparison among means	86
35	ANOVA for flexural strength of concrete beam at 7th day	87
36	Comparison among means	87
37	ANOVA for flexural strength of concrete beam at 28th day	88
38	Comparison among means	88

LIST OF APPENDIX FIGURES

Appendix Figure		Page
1	Corn machine	90
2	Collection of corn cob	90
3	Sieving of corn cob	91
4	Grained corn cob	91
5	Corn cob placed in plastic bags	92
6	Applying oil in the cylinders	92
7	Cylindrical molds	93
8	Metal beam molds and cylindrical molds	93
9	Gravel, sand, cement and grained corn cob in the mixer	94
10	Pouring of fresh concrete on the mixing pan	94
11	Removing of slump cone	95
12	Slump of conrete	95
13	Tamping of concrete mix in the cylinders	96
14	Molding of cylinders and beams	96
15	Molding of cylinders and beams	97
16	Covering the samples with plastic	97
17	Hardened concrete cylinders and beams ready for demolding	98
18	Removing of cylinders from the mold	98
19	Curing of beams and cylinders	99
20	Universal Testing Machine with beam and cylinder	100
21	Crushed cylinders and beams	101
22	Oven drying of concrete cylinders	101
23	Determining physical properties of corn	102

LIST OF APPENDICES

Appendix		Page
1	Appendix Tables	67
2	Appendix Figures	89
3	Computation	103
4	Compression Test Results	121
5	Flexural Test Results	125
6	Sieve Analysis, Unit Weight and Fine Modulus Test Results	128

UTILIZATION OF CORN COB AS PARTIAL REPLACEMENT FOR FINE AGGREGATE IN CONCRETE

Maria Ashley A. Climacosa
Robert L. Etes

An undergraduate thesis submitted to the faculty of the Department of Civil Engineering, College of Engineering and Information Technology, Cavite State University, Indang, Cavite in partial fulfilment of the requirements for the degree of Bachelor of Science in Civil Engineering with Contribution No. CEIT 2018-19-2-082 Prepared under the supervision of Engr. Roslyn P. Peña.

INTRODUCTION

With the ever increase in the demand of natural sand and decrease in its availability, there is an immediate need for finding suitable alternatives which can replace sand partially or at a high proportion (Aravind, 2018). According to Yadhu (2015), the greatest crisis faced by the construction industry is the availability of sand. Getting river sand is really expensive nowadays as its availability is very limited.

The worldwide consumption of natural sand as fine aggregate in mortar/concrete production is very high and several developing countries have met some struggle in the supply of natural sand in order to meet the increasing demands of construction development. Natural sand is most common material which used as natural fine aggregate. In general, in the last 15 years, it has become clear that the availability of good quality of natural sand continues in decreasing (Rashad, 2016).