Utilization of Marble and Granite Waste as Partial Replacement of Coarse Aggregate in Concrete

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A thesis submitted to the Department of Civil Engineering in partial fulfillment for the degree of Bachelor of Science in Civil Engineering



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Fall-2024

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Dedicated

to

"Our Parents & Honourable Teachers"

ACKNOWLEDGEMENTS

The report is titled as on **Utilization the Marble & Granite Waste on Partial Replacement of Coarse Aggregate of Concrete** has been prepared to fulfil the requirements as instructed. We would like to express our deepest sincere gratitude to our thesis supervisor Hemlita Mondal, Lecturer, Department of "Civil" Engineering at Sonargaon University, for giving us a unique opportunity to work on such an important topic. Her continuous guidance, invaluable suggestions, affectionate encouragement, generous help, and invaluable acumen are greatly acknowledged. Her keen interest in the topic and enthusiastic support to us and her effort were a source of inspiration to carry out the study. Without her regular mentoring, direction, and inspection this research work would have been more difficult like impossible. We consider it fortunate to work under her guidance.

We also thank her from the deepest of our hearts for her sincere cooperation, precious advice and motivation. We have got the previous as well as the present data from our supervisor which helped us to make the thesis paper successfully at last.

We are grateful to every member of our team for their friendly behaviour and sacrifice.

ABSTRACT

Disposal of solid waste materials is a great concern in cities all around the world. Some of these waste materials are not biodegradable, which often leads to disposal crisis and environmental pollution. Many efforts are being made for the recycling of different types of solid wastes to utilize them in the production of various construction materials. The granite & marble industries produce vast amounts of by-product rock waste and as a result, many residential and agricultural areas are settled over the landfills which are basically composed of these waste materials.

This paper reveals the use of polished granite and marble waste from discarded tiles as a partial replacement for coarse aggregates in cement concrete. It was observed that the incorporation of polished granite and marble waste in while better results were observed for water absorption, Unit weight, FM, Compressive strength and water permeability. By comparing the compressive strength between granite and marble when 5% replacement of marble (by weight) gives maximum compressive strength than 0%, 10%, and 20% replacement (by weight) And also for 20% replacement of granite (by weight) gives maximum compressive strength. than 0%, 5% and 10% replacement (by weight). But 100% replacement of marble reduces the compressive strength than 5%. On the other hand, 100% replacement of granite we get more compressive strength than 20%. could be recommended for non-structural applications, pavement, etc.

The main objective of this paper is to assess the potential of using marble and granite waste as a replacement of coarse aggregates of concrete mixes.

TABLE OF CONTENTS

ABSTRACT VII

LIST OF FIGURES IX

LIST OF TABLES X

CHAPTER 1 1

INTORDUCTION 1

1.1 Background and Motivation 1

1.2 Research Objectives and Overview 2

1.3 Organization of the Thesis 2

CHAPTER 2 3

LITERATURE REVIEW 3

2.1 Introduction 3

2.2 Content 3

2.3 Summary 4

CHAPTER 3 5

METHODLOGY 5

3.1 General 5

3.2 Summary 20

CHAPTER 4 21

RESULT AND DISCUSSION 21

4.1 Introduction 21

4.2 Summary 30

CHAPTER 5 31

CONCLUSION AND RECOMMENDATION 31

5.1 Conclusion 31

5.2 Limitations 32

5.3 Recommendations for Future Works 32

REFERENCES 33

LIST OF FIGURES

Fig 1.1: The Picture shows that the waste granite and marble (Jatrabari, Dhaka) ……1

Fig 3.1.1: Used Materials……..6

Fig 3.1.2: Flowchart of Recherché……... 8

Fig 3.1.3: Sieve analysis of Fine aggregate……..10

Fig 3.1.4: Sieve analysis of Coarse aggregate (Marble)……..11

Fig 3.1.5: Sieve analysis of Coarse aggregate (Granite)……..12

Fig 3.1.6: Sieve analysis of Coarse aggregate (Brick Chips) ……..13

Fig 3.1.7: Specific Gravity of Used Materials Figure……..14

Fig 3.1.8: Water Absorption Capacity of Used Materials……15

Fig 3.1.9: Cylinders Cleaning and Oiling Before Casting Figure……17

Fig 3.1.10, 3.1.11: Materials mixing for casting……..17

Fig 3.1.12: After casting of cylinders……..18

Fig 3.1.13: Mold Placed in the water tank for curing……..18

Fig 3.1.14: Dry Mold after curing……19

Fig 3.1.15: Compressive Strength Test……20

Fig 4.1.1: Compressive strength after 14 days (Granite)…….22

Fig 4.1.2: Compressive strength after 28 days (Granite)…….23

Fig 4.1.3: Compressive strength after 14 days (Marble)……..24

Fig 4.1.3: Compressive strength after 28 days (Marble)……..25

LIST OF TABLES

Table1.1: Percentage (%) of replacement……...……..7

Table1.2: Sieve Analysis of fine aggregate. ……...10

Table1.3: Sieve analysis of Marble west aggregate…….....11

Table1.4: Sieve analysis of Granite west aggregate……....12

Table1.5: Sieve analysis of Brick Chips…….....13

Table1.6: Specific gravity of used materials.....14

Table1.7: Unit Weight of Used Materials...……...…..15

Table1.8: Water Absorption Capacity of Used Materials..……..15

Table 1.9: Materials Requirement as per mixed design.....……..16

Table 1.10: Materials Estimation for Cylinder Casting..……16

Table 1.11: Total Materials for 32nos Cylinders..……..16

Table 2.1: Compressive strength after 14 days (Granite)...……..22

Table 2.2: Compressive strength after 28 days (Granite)...……..23

Table 2.3: Compressive strength 14 days' vs 28 days (Granite)..……24

Table 2.4: Compressive strength after 28 days (Marble).……25

Table 2.5: Compressive strength 14 days vs 28 days (Marble).……..26

Table 2.6: Compressive strength 28 days (Marble vs granite).……27

Table2.7: Compressive strength 14 days vs 28 days (Granit) …….28

CHAPTER 1

INTORDUCTION

1.1 Background and Motivation

In Turkey many residential areas are settled over landfills, which are basically composed of marble and granite aggregates. Marble and granite aggregates, which are called as by-products, come from the marble and granite stone industries. [4]

The civil engineering construction industry is believed to be one of the most potential consumers of mineral resources, thus generating a great amount of solid waste as a by-product. [5]

Many studies evaluating the use of industrial by-products as aggregate in concrete have been reported. [6]

In this paper, we study the marble and granite waste of Bangladesh recycling in the process before use. The natural and recycled aggregates were characterized. Concrete mix designs with 5%, 10%, 20%, and 100% of aggregate substitutions is formulated. The performances of the ‘‘recycled aggregates” concrete is measured through tests of compressive strength.



Fig 1.1: The Picture shows that the waste granite and marble (Jatrabari, Dhaka)

1.2 Research Objectives and Overview

- To study the strength behaviour of cement concrete as the partial replacement of course aggregate (Granite and Marble waste aggregate).
- To reduce the environmental pollution by granite and marble waste

1.3 Organization of the Thesis

This section should have a brief description of the thesis outline of the thesis. It should contain chapter no. with a title and brief descriptions of the content of each chapter. An example guide is provided below.

Chapter 1: Introduction and Objective: This chapter introduces the use of waste marble and granite in concrete as a partial replacement for coarse aggregates. It outlines the objectives, including comparing the compressive strength of concrete cylinders with these replacements.

Chapter 2: Literature Review. The study presents the partial replacement of coarse aggregate in concrete by using waste marble and granite coarse aggregate obtained from the crushing of waste marble and granite.

Chapter 3: Methodology. The research methodology involves designing concrete mixes with waste marble and granite as coarse aggregate replacements. This chapter explains the mix design process and evaluates the suitability of these replacements for concrete mixtures.

Chapter 4: Results and Discussion. This chapter presents the experimental results, including the compressive strength tests conducted on hardened concrete. The findings are discussed, focusing on the performance of concrete with different replacement percentages. The compressive strength of concrete is expressed in N/mm^2.

Chapter 5: Conclusions and Future Work. The final chapter summarizes the conclusions drawn from the study, including the effectiveness of partial replacements. Recommendations for future research and potential applications of recycled waste aggregates are also provided.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Some of the significant research works that have been reported in the literature review in the context of the different waste materials cited in the afore-mentioned section are discussed in brief in the subsequent paragraphs. Besides, the marble and granite have a low density compared to the stone aggregate. As a result, Compressive strength decreases from 0% of Granite waste when using 40%, 60%, 80%, and 100% of Granite waste in concrete and compressive strength increases slightly when using 20% of granite waste use and after 14 days of curing. As a result, it is proposed that using wastes that may enhance concrete properties will lower the need for normal coarse and fine aggregates, enabling natural resource conservation

2.2 Content

In a 2019 study by M.A. Danish and D. Budhlani, coarse aggregates in M25 grade concrete were replaced with crushed waste mosaic tiles at varying percentages (10%, 20%, 30%, 40%, and 50%), while fine aggregates were substituted with granite powder (10%). The results showed that workability increased with higher replacements of mosaic tiles. Additionally, the compressive and split tensile strengths reached their peak with a 30% replacement of ceramic coarse tiles after 7, 14, and 28 days of curing.

In a 2016 study by A. Sugathan, broken marble pieces were used as partial replacements for coarse aggregates in M20 grade concrete at various replacement levels (0%, 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, and 50%). The results indicated that optimal compressive strength was achieved at lower replacement levels, although the strength was found to be 16% to 26.34% lower than that of conventional concrete. The study concluded that broken marble tiles could serve as suitable alternative materials for construction, especially in reconstruction projects.

In a 2020 study by K. Ostrowski and D. Stefaniuk, the effect of granite waste as a partial replacement for coarse aggregates in M25 grade concrete was investigated at replacement levels of 20%, 40%, 60%, 80%, and 100%. The results showed a slight increase in compressive strength at the 20% replacement level after 14 days of curing, but the strength decreased as the replacement percentage increased. Additionally, split tensile strength consistently declined across all replacement levels after 28 days, indicating that while granite waste could be used as a partial replacement, its impact on concrete's tensile properties was generally negative.

In a 2016 study by S. Singh, R. Nagar, and V. Agrawal, granite cutting waste (GCW) and marble slurry (MS) were compared as replacements for fine aggregates in concrete. The results

indicated that the optimum replacement levels for compressive strength were 25% for GCW and 15% for MS after 7 and 28 days of curing. However, further increases in replacement beyond these levels led to reductions in strength, which were attributed to the increased surface area of the waste materials and the fixed cement content, which affected the overall bonding and strength of the concrete.

2.3 Summary

This study reviews research on Utilization waste marble and granite in concrete mixtures as partial replacements for coarse aggregates. The use of these materials helps conserve natural resources, reduce environmental pollution, and promote sustainable practices by recycling industrial waste. Experiments involved replacing coarse aggregates with waste marble and granite in varying proportions (0%, 5%, 10%, and 20%) and evaluating the compressive strength of concrete cylinders after 28 days of curing. The findings provide insights into the potential of these materials to enhance concrete properties while supporting eco-friendly construction practices.

CHAPTER 3

METHODLOGY

3.1 General

This research investigates the utilization of waste marble and granite as a replacement for coarse aggregate in concrete mixtures. The study aims to evaluate the feasibility and acceptability of incorporating waste marble and granite into concrete production. Conventional coarse aggregate, fine aggregate (sand), brick chips, and Portland cement are typically used in concrete. In this research, these traditional materials are partially or entirely replaced by waste marble and granite aggregate, which are obtained in crushed form and subjected to rigorous testing.

The tests conducted on the aggregates include specific gravity, bulk density, unit weight, water absorption, and sieve analysis. Based on the results of these tests, mix designs are developed to assess the properties and performance of the concrete produced with varying replacement levels of waste marble and granite. Replacement levels are set at 0%, 5%, 10%, 20%, and 100% by weight-volume ratio.

For the hardened concrete, compressive strength tests are performed after 28 days of curing. The results at each replacement level are averaged and compared with those of reference concrete to determine the effects of waste marble and granite replacement. The study also evaluates the engineering properties of concrete containing waste marble and granite aggregate against conventional concrete.

In the research materials:

Cement: Ordinary Portland Cement (OPC) was used as the binding agent of concrete for this test.

Fine Aggregate: Best quality coarse sand (brown in color) locally known as ‘Sylhet Sand’ was used as the fine aggregate. One type of fine aggregate was used throughout the experimental work so as to keep the aggregate variable constant. For the mix deign purpose and for characterization the following tests were performed on the fine aggregate.

Coarse aggregate: In the present study, brick aggregate produced by crushing well-burnt bricks were used as coarse aggregates. The maximum size of coarse aggregate used as 20 mm.

Water: Water is a key ingredient in the concrete production. The property of water that was used in the concrete work is being potable, free from oil and other organic impurities. Ordinary tap water was used as mixing water throughout the mixing procedure.

Marble and Granite Aggregate: Waste marble and granite were collected from disposal areas, sorted to ensure quality, and prepared to meet the required size specifications for concrete production.



Fig: Portland Composite Cement



Fig: Sylhet Sand F.M 3.5



Fig: Brick Chips



Fig: Waste Marble



Fig: Waste Granite

Figure: 3.1.1: Used Materials

Percentage of Replacement:

Concrete grade M15

Mixing Ratio 1:2:4

Table1.1: Percentage (%) of replacement

SL	% Replacement	Number of Cylinders	
		Marble	Granite
1	0%	4 Nos	
2	5%	4 Nos	4 Nos
3	10%	4 Nos	4 Nos
4	20%	4 Nos	4 Nos
5	100%	2 Nos	2 Nos
	Total =	32 Nos	

Methodology Overview

The methodology adopted for this study is outlined as follows:

i. **Literature Review**

- Conducted a detailed study of existing research on the partial replacement of coarse aggregate with marble and granite waste in concrete.

ii. **Material Collection**

- Waste marble and granite were collected from construction material dumping areas located in Dhaka city, Bangladesh.

iii. **Material Preparation**

- Collected marble and granite waste were broken into pieces of the required size suitable for use as coarse aggregate.

iv. **Proportion Selection**

- Proportions of marble and granite waste coarse aggregates were determined based on findings from the literature review.

v. **Material Testing**

- Conducted tests including sieve analysis, specific gravity, water absorption, and unit weight measurements to establish mix design parameters.

vi. **Mix Design Development**

- Developed concrete mix designs incorporating different proportions of marble and granite waste coarse aggregate and performed tests to evaluate the mechanical properties of each mix.

vii. **Adopted Combinations**

- Based on the literature review and the outcomes of the mix design tests, the following combinations of marble and granite waste replacement levels were adopted for the study.

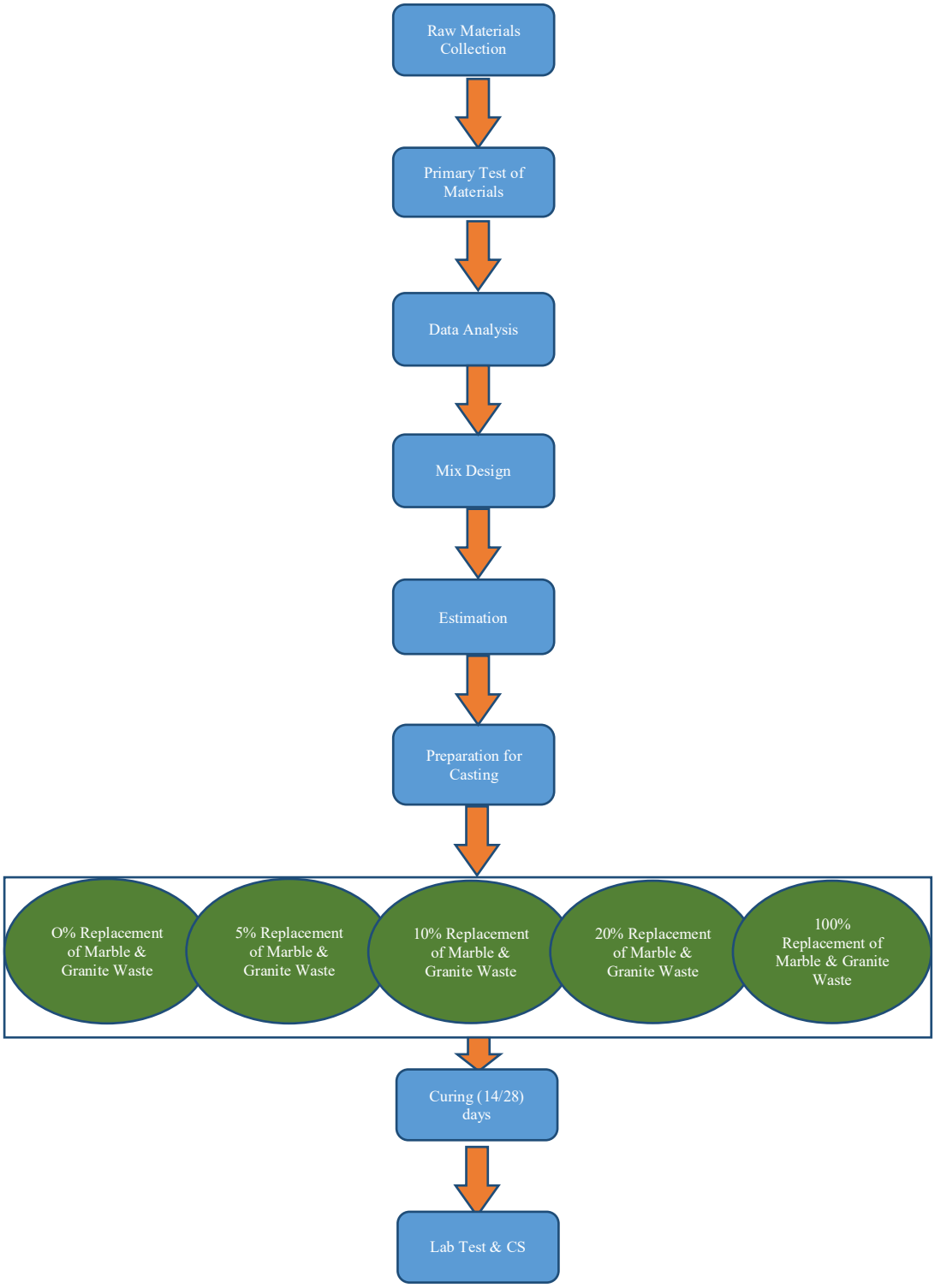


Fig: 3.1.2: Flowchart of Recherché

Below are some Materials tests for our research:

i. **Sieve Analysis**
   - Conducted in accordance with **ASTM C136**, which specify the method for determining particle size distribution in aggregates.

ii. **Unit Weight**
   - Measured following **ASTM C29**, which provides guidelines for the bulk density ("unit weight") of aggregates.

iii. **Specific Gravity**
   - Determined as per **ASTM C127** for coarse aggregates and **ASTM C128** for fine aggregates, outlining procedures for relative density and absorption.

iv. **Water Absorption Capacity**
   - Tested according to **ASTM C127** for coarse aggregates and **ASTM C128** for fine aggregates, detailing the water absorption properties of the materials.

v. **Concrete Mix Design**
   - Developed based on the principles of **ACI 211.1** to ensure appropriate proportions for desired performance.

vi. **Compressive Strength Testing**
   - Conducted following **ASTM C39**, specifying procedures for testing hardened concrete.

Table1.2: Sieve Analysis of fine aggregate

Sieve Analysis of Fine Aggregate-ASTM C136-01	
Sample Weight Taken	1000 gm

Sieve Number	Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Weight Retained (%)	FM
#4	4.75mm	32	32	3.2	3.45
#8	2.36mm	100	132	13.2	
#16	1.18mm	380	512	51.2	
#30	0.6mm	315	827	82.7	
#50	0.3mm	130	957	95.7	
#100	0.15mm	33	990	99	
Pan		10			
Total		1000		345	



Figure: 3.1.3: Sieve analysis of Fine aggregate

Table1.3: Sieve analysis of Marble west aggregate

Sieve Analysis of Coarse Aggregate-Marble Waste	
Sample Weight Taken	2000 gm

Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Weight Retained (%)	FM
100mm	0	1370	68.5	10.9
90mm	0	1370	68.5	
75mm	0	1370	68.5	
63mm	0	1370	68.5	
50mm	0	1370	68.5	
37.5mm	0	1370	68.5	
25mm	0	1370	68.5	
19mm	1370	2740	137	
12.5mm	0	2740	137	
9.5mm	620	3360	168	
4.75mm	10	3370	168.5	
Pan				
Total	2000		1090	



Figure:3.1.4: Sieve analysis of Coarse aggregate (Marble)

Table1.4: Sieve analysis of Granite west aggregate

Sieve Analysis of Coarse Aggregate-Granite Waste	
Sample Weight Taken	2000 gm

Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Weight Retained (%)	FM
100mm	0	1210	60.5	9.85
90mm	0	1210	60.5	
75mm	0	1210	60.5	
63mm	0	1210	60.5	
50mm	0	1210	60.5	
37.5mm	0	1210	60.5	
25mm	0	1210	60.5	
19mm	1210	2420	121	
12.5mm	0	2420	121	
9.5mm	770	3190	159.5	
4.75mm	16	3206	160.3	
Pan	4			
Total	2000		985.3	



Figure:3.1.5: Sieve analysis of Coarse aggregate (Granite)

Table1.5: Sieve analysis of Brick Chips

Sieve Analysis of Coarse Aggregate-Brick Chips	
Sample Weight Taken	1500 gm

Sieve Size	Weight Retained (gm)	Cumulative Weight Retained (gm)	Cumulative Percentage Weight Retained (%)	FM
100mm	0	648	43.20	7.40
90mm	0	648	43.20	
75mm	0	648	43.20	
63mm	0	648	43.20	
50mm	0	648	43.20	
37.5mm	0	648	43.20	
25mm	0	648	43.20	
19mm	648	1296	86.40	
12.5mm	0	1296	86.40	
9.5mm	620	1916	127.73	
4.75mm	140	2056	137	
Pan	92			
Total	1500		740	



Figure:3.1.6: Sieve analysis of Coarse aggregate (Brick Chips)

Table 1.6: Specific gravity of used materials

Specific Gravity of Used Materials	
Materials Name	Specific Gravity
Cement	3.15
Sylhet Sand	2.71
Coarse Aggregate (Brick Chips)	2.27
Coarse Aggregate (Marble Waste)	2.82
Coarse Aggregate (Granite waste)	2.75



Fig: 3.1.7: Specific Gravity of Used Materials

Table 1.7: Unit weight of Used Materials

Unit Weight of Used Materials	
Materials Name	**Unit Weight**
Cement	1440kg/m3
Sylhet Sand	1568kg/m3
Coarse Aggregate (Brick Chips)	904kg/m3
Coarse Aggregate (Marble Waste)	1531.43kg/m3
Coarse Aggregate (Granite waste)	1508kg/m3

Table1.8: Water Absorption Capacity of Used Materials

Water Absorption Capacity of Used Materials	
Materials Name	**Water Absorption**
Sylhet Sand	2.54%
Coarse Aggregate (Brick Chips)	12.34%
Coarse Aggregate (Marble Waste)	1.90%
Coarse Aggregate (Granite waste)	1.64%

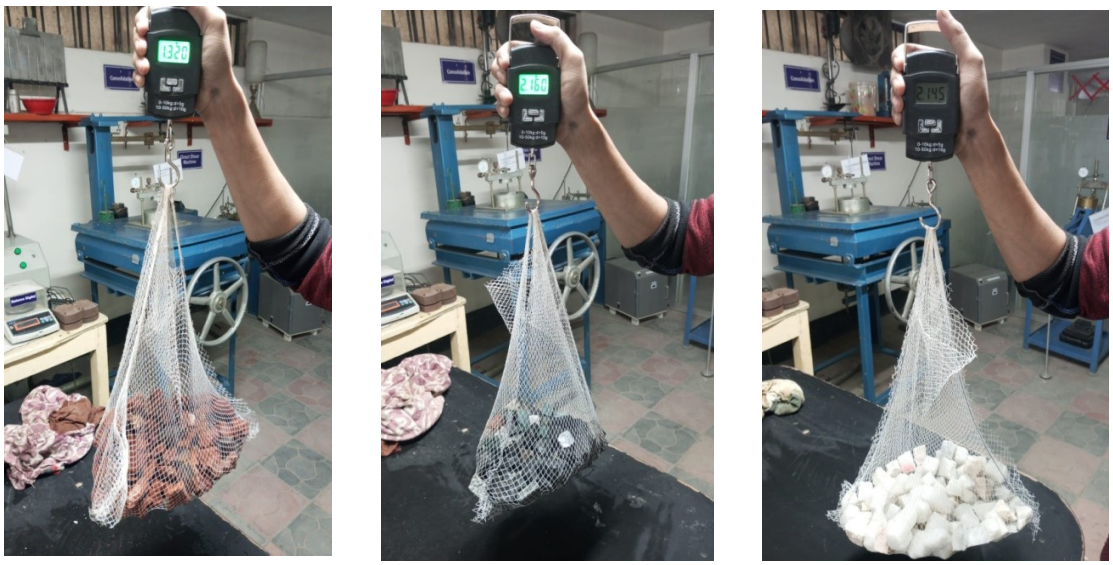


Fig 3.1.8 Water Absorption Capacity of Used Materials

Table 1.9: Materials Requirement as per mixed design

Materials Required for 1 cum of Concrete	
Cement	350 kg
Coarse	879.79 kg
Fine	773.49 kg
Water	175 kg
Shrinkage Factor	1.15
Wastage Factor	1.25

Table 1.10: Materials Estimation for Cylinder Casting

1 set=4 nos Cylinder			Actual Volume (cft)	Volume with (Shrinkage factor & Wastage factor) (cft)	Volume m^3
			0.229	0.330	0.009
Case-1	Cement(kg)	Fine Agg. (kg)	Brick Chips(kg)	Marble(kg)	Water(kg)
0% Marble	3.266	7.217	8.209	0.000	1.633
5% Marble	3.266	7.217	7.798	0.410	1.633
10% Marble	3.266	7.217	7.388	0.821	1.633
20% Marble	3.266	7.217	6.567	1.642	1.633
Total Case-1	13.064	28.868	29.962	2.873	6.532
Case-2	Cement(kg)	Fine Agg. (kg)	Brick Chips(kg)	Granite(kg)	Water(kg)
0% Granite	3.266	7.217	8.209	0.000	1.633
5% Granite	3.266	7.217	7.798	0.410	1.633
10% Granite	3.266	7.217	7.388	0.821	1.633
20% Granite	3.266	7.217	6.567	1.642	1.633
Total Case-2	13.064	28.868	29.962	2.873	6.532

Table 1.11: Total Materials for 32nos Cylinders

Total Materials (Case-1+Case-2)	
Cement	26.128kg
Sand	57.736kg
Brick Chips	59.924kg
Marble	2.873kg
Granite	2.873kg
Water	13.064kg



Figure 3.1.9: Cylinders Cleaning and Oiling before casting



Figure 3.1.10: Materials mixing for casting



Figure 3.1.11: Materials mixing for casting

The specimens were prepared according to the specified mix proportions. The required quantities of materials were measured and mixed by hand. Cylindrical specimens with a height of 300 mm and a diameter of 150 mm were created to test the compressive strength of the concrete mix. The materials were weighed based on the mix proportions, and aggregates and cement were

mixed thoroughly. The admixture was dissolved in the water before it was added to the dry mix. Water was then gradually incorporated into the dry mix. In total, 28 cylinders were cast: 14 cylinders for testing at 14 days and 14 cylinders for testing at 28 days.



Fig 3.1.12: After casting of cylinders

After 24 hours of casting, the Specimens were removed from the cylinders and placed in the curing tank for further curing.



Figure 3.1.13: Mold Placed in the water tank for curing

After casting the concrete specimens, they were tested for compressive strength at 14 and 28 days of curing. Cylinder specimens were used to evaluate the compressive strength. After 28 days of curing, the specimens were removed from the curing tank and surface-dried.

The specimens were then placed in a Universal Testing Machine (UTM), where a load was applied until the specimen failed. The peak load at which failure occurred was recorded.



Figure 3.1.14: Dry mold after curing

Compressive Strength = P/A

Where:

- P is the peak load in kilonewtons (kN)
- A is the cross-sectional area of the cylinder in square millimeters (mm^2)







Figure 3.1.15: Compressive Strength Test

3.2 Summary

The process begins with collecting and separating marble and granite waste from other types of trash. The waste marble and granite are then broken into small pieces. Once this is done, a thorough mixture is created. Concrete is produced by replacing the coarse aggregate with different percentages of marble and granite waste: 0%, 5%, 10%, 20%, and 100% by weight, using the volume method. The concrete is cured for 28 days in fresh distilled water. Various tests are carried out on these concretes, including the slump test for fresh concrete. For hardened concrete, the compressive strength is determined.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This test was performed on freshly prepared concrete mixes to check the workability of concrete. Workability of concrete is defined as the case to do work with it. Workability of concrete is an important property of fresh concrete. Concrete materials used in this study included type Portland cement, Sylhet sand, ¾ inch crushed brick chips, marble, granite and water.

4.2 Compressive Strength Test

Compressive strength test results are primarily used to determine that the concrete mixture as delivered meets the requirements of the Specified strength, fc′, in the job specification. Cylindrical specimens are tested in according with ASTM C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.

Concrete cylinders are simple and inexpensive to produce. Typically, one technician stationed at the point of discharge or placement can sample and test concrete batches for properties such as slump, air content, unit weight, and cylinders. Technicians must adhere to standard practices and be certified in most regions, although the training requirements are not extensive or complex.

A compressive axial load is applied to molded cylinders or cores until failure occurs. The compressive strength of the specimen is determined by dividing the maximum load achieved during the test by the cross-sectional area of the specimen. The results from this test method are used as a basis for quality control in concrete production.

This test is conducted on hardened concrete to assess its strength. The concrete specimens are subjected to uniaxial compression, with the load applied per unit area of the cross-section at a fixed rate. The compressive strength of the concrete is expressed in N/mm^2. In this study, standard cylinders with dimensions of 150mm x 300mm were used. Concrete mixes with different proportions were prepared and filled into cylinder molds, which were left for 24 hours to allow for initial setting. For each mix proportion, 28 specimens were prepared for testing at 28 days. After completing the curing period, 14 specimens were tested at 14 days, and the remaining 14 specimens were tested at 28 days using compression testing.

Table 2.1: Compressive strength after 14 days (Granite)

Compressive strength after 14 days (Granite)									
% of Granite	Sample	d_1 (mm)	d_2 (mm)	d_{AV} (mm)	A $(mm)^2$	W (gm)	Load (KN)	CS (Mpa)	CS_{AV} (Mpa)
0%	1	101.47	101.93	101.7	8123.31	3468	95	11.69	11.70
5%	1	104.06	103.3	103.68	8442.69	3549	105	12.44	12.15
	2	104.26	103	103.63	8434.55	3527	100	11.86	
10%	1	103.42	102.62	103.02	8335.54	3502	100	12.60	12.56
	2	103.51	103.11	103.31	8382.54	3630	100	12.53	
20%	1	102.69	103.25	102.97	8327.46	3673	92	13.21	13.22
	2	103.81	101.95	102.88	8312.90	3577	100	13.23	
100%	1	103.99	101.67	102.83	8304.83	3858	120	15.65	15.65



Fig 4.1.1: Compressive strength after 14 days (Granite)

Table 2.2: Compressive strength after 28 days (Granite)

Compressive strength after 28 days (Granite)									
% of Granite	Sample	d_1 (mm)	d_2 (mm)	d_{AV} (mm)	A $(mm)^2$	W (gm)	Load (KN)	CS (Mpa)	CS_{AV} (Mpa)
0%	1	103.65	102.7	103.18	8360.65	3511	115	13.755	14.20
	2	101.91	102.4	102.16	8196.15	3443	120	14.641	
5%	1	100.22	103.98	102.1	8187.33	3561	120	14.657	14.69
	2	101.56	102.2	101.88	8152.09	3488	120	14.720	
10%	1	100.38	101.3	100.84	7986.50	3462	120	15.025	14.83
	2	102.05	102.33	102.19	8201.77	3542	120	14.631	
20%	1	100.4	101.96	101.18	8040.45	3580	120	14.925	15.25
	2	101.14	101.24	101.09	8026.15	3603	125	15.574	
100%	1	103.61	102.69	103.15	8356.60	4140	140	16.753	16.76



Fig 4.1.2: Compressive strength after 28 days

Table2.3: Compressive strength after 14 days (Marble)

Compressive strength after 14 days (Marble)									
% of Marble	Sample	d_1 (mm)	d_2 (mm)	d_{AV} (mm)	A $(mm)^2$	W (gm)	Load (KN)	CS (Mpa)	CS_{AV} (Mpa)
0%	1	101.4	101.74	101.57	8102.55	3408	90	11.108	11.11
5%	1	99.198	100.92	100.059	7863.27	3468	105	13.353	13.65
	2	99.69	100.77	100.23	7890.17	3590	110	13.941	
10%	1	99.56	100.86	100.21	7887.02	3510	105	13.313	13.33
	2	99.8	100.4	100.1	7869.72	3567	105	13.342	
20%	1	103.3	102.2	102.78	8296.75	3620	100	12.053	12.59
	2	102.92	103.72	103.32	8384.16	3682	110	13.120	
100%	1	100.34	101.9	101.12	8030.91	3974	85	10.584	10.58



Fig 4.1.3: Compressive strength after 14 da

Table 2.4: Compressive strength after 28 days (Marble)

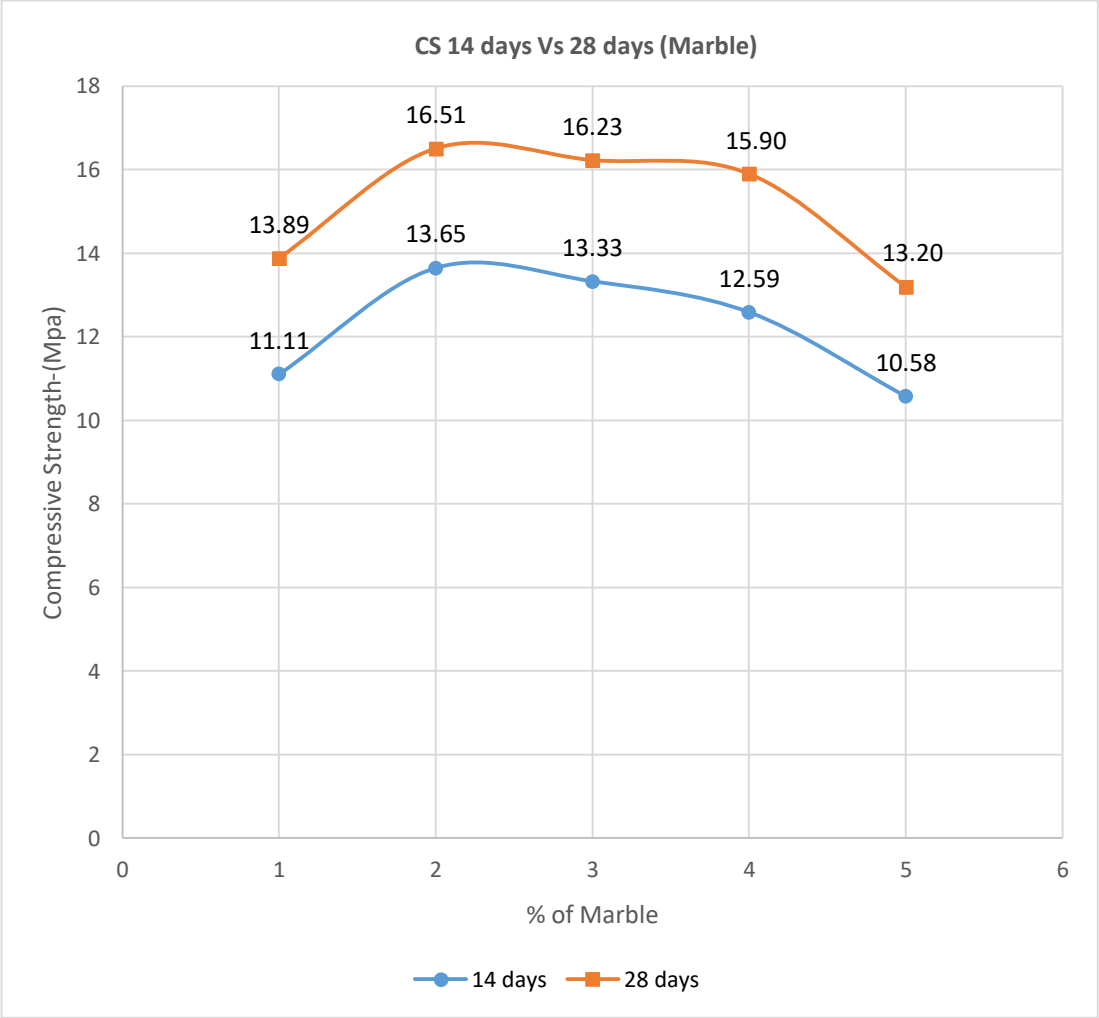
Compressive strength after 28 days (Marble)									
% of Marble	Sample	d_1 (mm)	d_2 (mm)	d_{AV} (mm)	A $(mm)^2$	W (gm)	Load (KN)	CS (Mpa)	CS_{AV} (Mpa)
0%	1	103.65	102.7	103.18	8360.65	3511	115	13.755	13.89
	2	101.91	102.4	102.16	8196.15	3443	115	14.031	
5%	1	102.6	103.53	103.07	8342.83	3605	135	16.182	16.51
	2	103.58	102.16	102.87	8311.29	3630	140	16.845	
10%	1	104.79	101.65	103.22	8367.94	3563	135	16.133	16.23
	2	101.62	103.58	102.6	8267.72	3579	135	16.329	
20%	1	100.75	101.41	101.02	8015.04	3551	130	16.220	15.90
	2	102.62	103.38	101.08	8024.56	3625	125	15.577	
100%	1	101.3	103.38	103	8332.31	4028	110	13.202	13.20



Fig 4.1.3: Compressive strength after 28 days (Marble)

Table 2.5: Compressive strength 14 days vs 28 days (Marble)

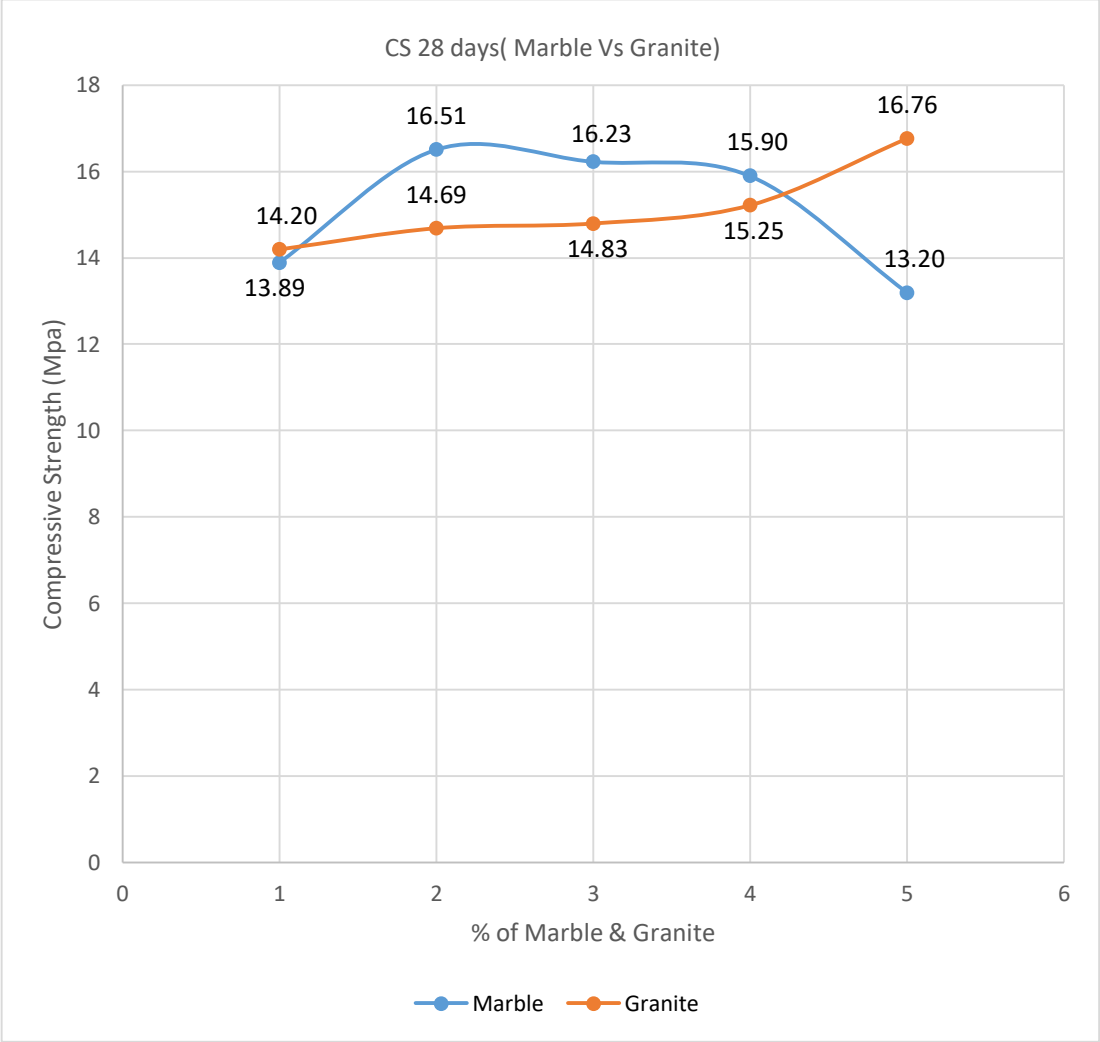
CS 14 days Vs 28 days (Marble)					
Days	0%	5%	10%	20%	100%
14 days	11.11	13.65	13.33	12.59	10.58
28 Days	13.89	16.51	16.23	15.90	13.20



Graph: Compressive strength 14 days vs 28 days (Marble)

Table 2.6: Compressive strength 28 days (Marble vs granite)

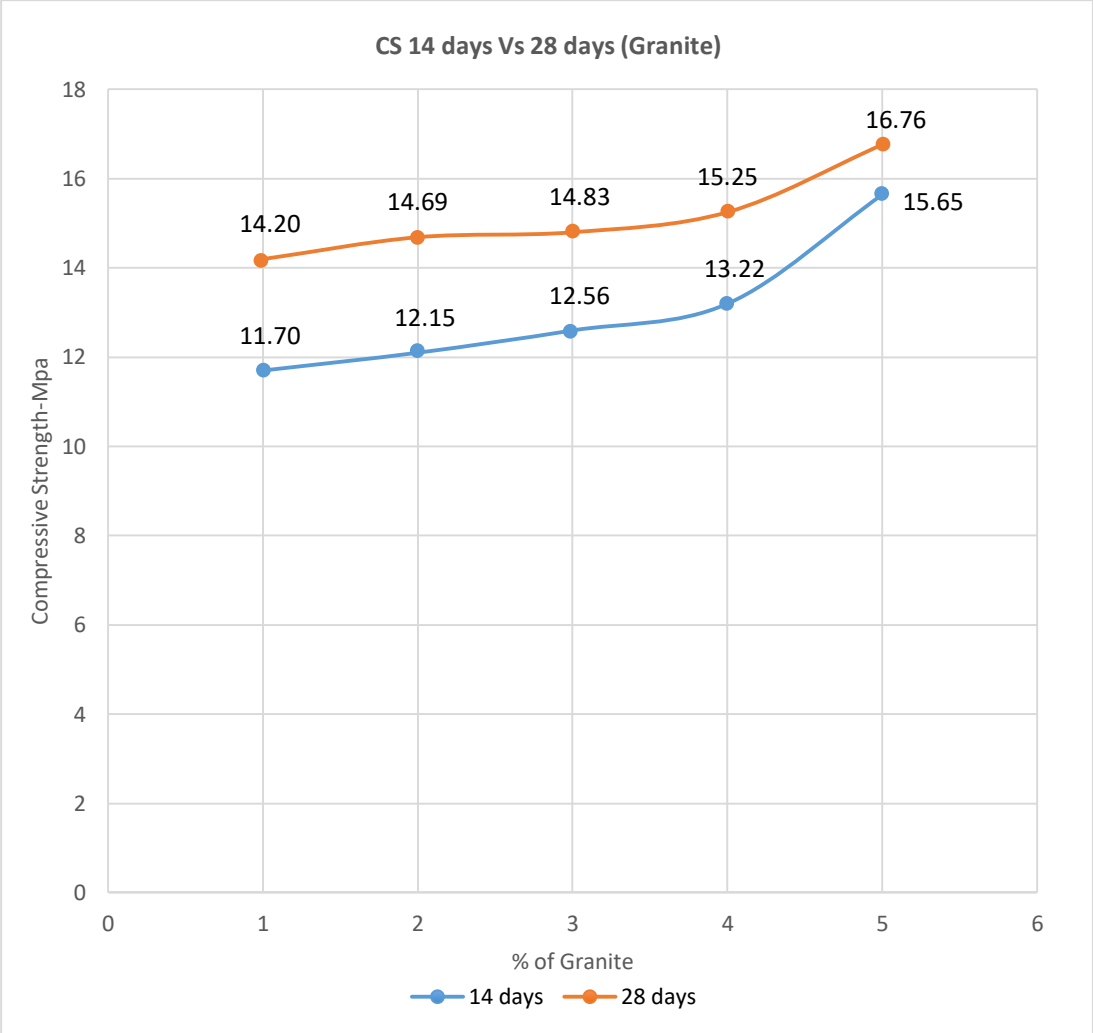
CS 28 days (Marble Vs Granite)					
Aggregates	0%	5%	10%	20%	100%
Marble	13.89	16.51	16.23	15.90	13.20
Granite	14.20	14.69	14.83	15.25	16.76



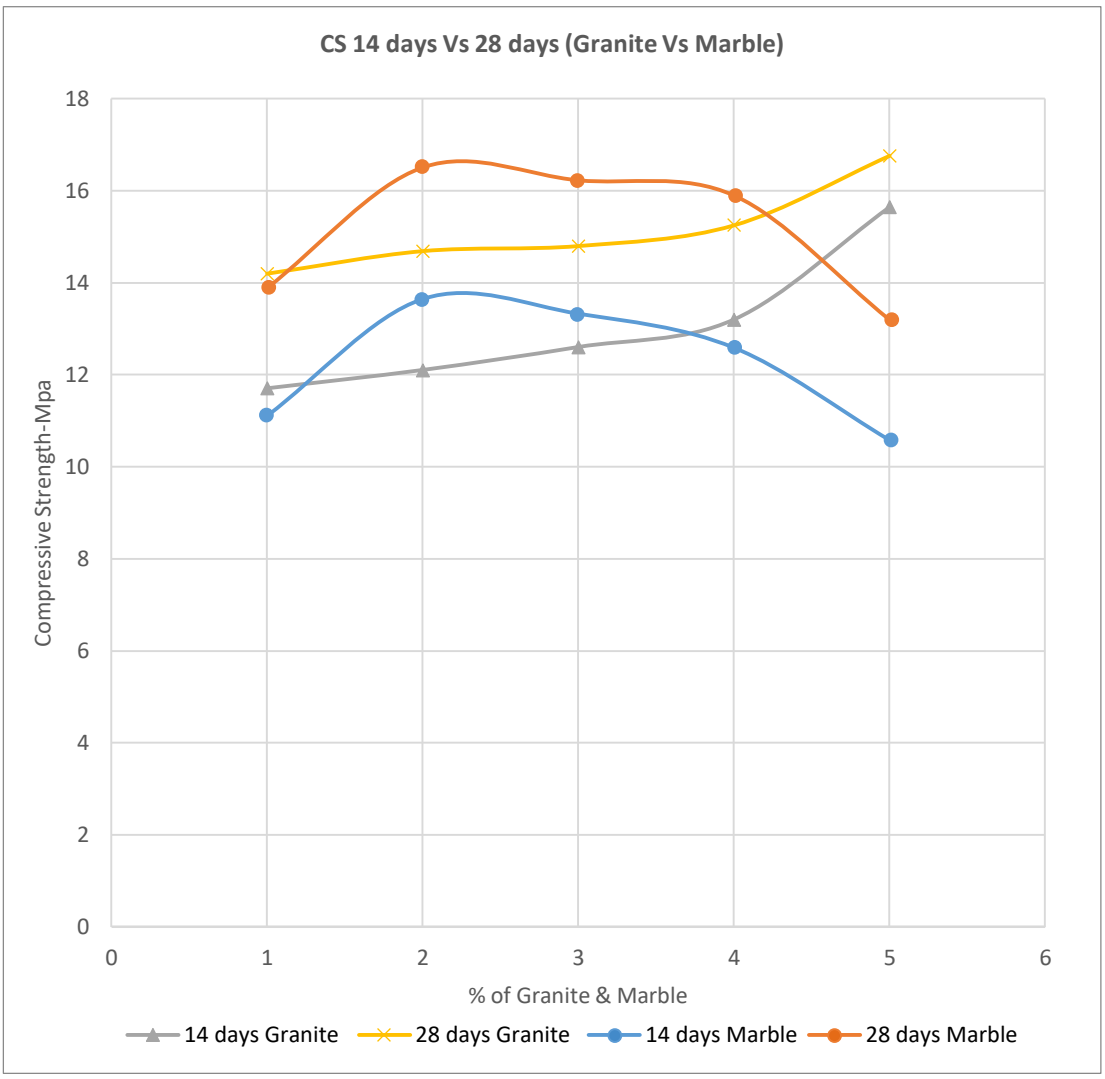
Graph: Compressive strength 28 days (Marble vs Granite)

Table 2.7: Compressive strength 14 days vs 28 days (Granite)

CS 14 days Vs 28 days (Granite)					
Days	0%	5%	10%	20%	100%
14 days	11.70	12.15	12.56	13.22	15.65
28 Days	14.20	14.69	14.83	15.25	16.76



Graph: Compressive strength 14 days vs 28 days (Granite)



Graph: Compressive strength 14 days vs 28 days (Granite vs Marble)

4.3 Summary

The compressive strength test is one of the most crucial tests performed on concrete, as it provides valuable information about the material's properties. Compressive strength refers to the concrete's ability to withstand loads before failure. Partial replacement of coarse aggregates with waste marble and granite results in lightweight concrete.

When comparing the compressive strength between granite and marble, it was observed that a 5% replacement of marble (by weight) yields the maximum compressive strength, outperforming 0%, 10%, and 20% replacement levels. Similarly, a 20% replacement of granite (by weight) results in the highest compressive strength compared to 0%, 5%, and 10% replacement levels. However, a 100% replacement of marble reduces compressive strength when compared to the 5% replacement. Conversely, a 100% replacement of granite provides higher compressive strength than the 20% replacement. This variation in strength may be attributed to factors such as the arrangement of aggregate particles, compaction efficiency, and reduction in voids.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

During the last decade, a lot of research works have studied the performance of cement composite with waste marble and granite aggregates. The main purpose of this paper, which was the development of a review of scientific research works in that field, was achieved. Ten papers were analyzed in-depth and remarkable results were found and discussed. Hereunder, conclusions and recommendations for future research works are presented.

The researchers have represented forms of marble and granite waste as coarse aggregate which can be use in production of concrete. The main focus of researchers was on the compressive strength of concrete containing waste marble and granite and very less attention was given to other properties of concrete. These proposals were based on results obtained from experimentation of various casted concrete samples. Waste Marble and granite was added to concrete in replacement of coarse aggregates by weight volume by proportion of 0%, 5%, 10%, 20% and 100%. On the basis of the results from the present study, following conclusions were drawn

- Partial replacement of coarse aggregates with waste marble results in lightweight concrete. The highest compressive strength is achieved with a 5% marble replacement, while 100% marble replacement reduces strength.
- Partial replacement of coarse aggregates with waste granite also produces lightweight concrete. The highest compressive strength is observed with a 20% granite replacement, but 100% granite replacement performs better than 20%, likely due to better compaction and reduced voids.
- Bangladesh's growing construction industry offers an opportunity to incorporate waste marble and granite, reducing reliance on traditional materials and supporting sustainable practices.
- Waste marble and granite are durable materials, contributing to the long-lasting nature of concrete. Their use helps reduce the consumption of natural stone and brick chips, mitigating environmental concerns.
- Meanwhile in some cases where concrete is used there, we can use waste marble and granite & so that we can reduce the use of concrete.

- Using waste marble and granite in concrete helps reduce environmental pollution by recycling materials and minimizing the need for natural aggregates, thus reducing landfill waste.
- We have so many wastages marble and granite while we can use in so many constructions & it would be also helpful for our economic.
- The study used varying replacement percentages of 0%, 5%, 10%, 20%, and 100% for marble and granite waste. Future research could explore other replacement percentages or further investigate the long-term performance of concrete with these aggregates.
- The variation in replacement percentages can lead to improvements in the mechanical properties of concrete. Using multiple variations could enhance the quality of the resulting concrete.
- This concrete can be applied in lightweight structures, such as footpaths, garages, and roadside constructions. Its reduced weight and strength properties make it suitable for these applications.
- Using waste marble and granite helps reduce the pressure on natural concrete production, promoting more sustainable building practices.

5.2 Limitations

- The marble waste collected from the construction site was broken manually, resulting in non-angular particles, which may affect the overall performance of the concrete.
- Due to a shortage of Molds in the lab, we were unable to manufacture enough concrete cylinders to conduct more tests and gather additional strength data.

5.3 Recommendations for Future Works

- Since the best results were found with 5% marble and 20% granite replacement, further studies on particle interlocking, compaction, and void reduction could help explain these findings in more detail.
- Future studies could focus on measuring direct tensile strength or split tensile strength to evaluate the concrete's performance under tension.
- Investigating the impact of reducing the water-cement ratio and using water-reducing admixtures could lead to better strength results in concrete mixtures.

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