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A STUDY ON PROPERTIES OF CONCRETE BY REPLACING CEMENT WITH MARBLE POWDER AND FLY ASH

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Abstract: In this study, marble powder and fly ash are replaced with cement. Since Marble powder and Fly ash is a developing composite material that will allow the concrete industry to optimize usage of material, generate economic benefits and built structures that will be strong, durable, and sensitive to environment. Marble powder is a byproduct obtained during quarrying process of parent marble rock. The potential use of marble powder can be ideal choice for substituting in a cementitious binder due to presence of high calcium oxide content of more than 50%. Fly ash is another major byproduct of thermal power plant after combustion of coal at high temperature. Dumping these waste materials to the environment directly can cause serious environmental problems. So, using these materials in an economic way is recommended. In this project test results were obtained for M30 by replacing cement with marble powder at 0%, 5%, 10%, 15%, and 20% by volume has been made. The results were also determined by keeping fly ash constant at 10% which was accepted by Indian Standard and marble powder content was increased by 0%, 5%, 10%, and 15% All specimens were cured for 7,14, and 28 days before performing the lab tests such as compressive strength test and split tensile test. Further, the optimistic percentage of marble powder and fly ash was also determined.

Keywords- Cement, Compressive test, Fly ash, Marble Powder and Split Tensile Test

I. INTRODUCTION

Due to the ever-increasing demand of cement in infrastructure projects, it is essential to find a material to replace cement in concrete mix up to an acceptable percentage. Cement contributes almost 70% of the total embodied energy in the constituents used for production of concrete and it accounts for 5% of the manmade production of carbon dioxide. If an alternative material for cement which is eco-friendly is used, it would aid in mitigating the indiscriminate dumping of wastes and also simultaneously helps in reducing the amount of carbon dioxide produced up to a certain extent and contribute for better environment. As the marble processing industry continues to expand, large amounts of bi-product in the form of marble slurry and powder is generated and released into the environment. A significant growth in marble waste has been seen, but the increase in extent has not been documented. It is estimated that almost five to six million tons of marble powder waste is generated per annum. This waste is dumped along road sides and near processing units, thus causing environmental degradation and escalating health problems in the surrounding areas. Hence, there is a direct need to utilize this waste material in one or the other way to minimize its harmful impact on the environment. Additionally, with advancement in technology finding viable options to reuse or treat this waste is also important. Fly ash is formed during combustion of coal. As the fused material rises, it cools and solidifies into spherical glassy particles called fly ash. Fly ash is collected from the exhaust gases by electrostatic precipitators or bag filter sand then it is generally stored at coal power plants or placed in landfills and about 150 million tons of fly ash generated every year during burning of coal. Hence, this secondary material which is of no use must be emphasized from environmental point of view.
So, it is necessary to use these materials effectively and on the other hand, development of recycling waste without proper scientific research might result in major environmental problems. So, the main aim of the project is regarding maximum utilization of waste materials such as fly ash and marble powder to reduce the usage of cement in order to lessen the carbon dioxide emission and also to make the construction activity economical.

II. MATERIALS AND METHODOLOGY

The different materials and methods used in this study are given as follows.

A. Materials

1. Cement

Cement used in this study was 53 grade (KCP) Ordinary Portland cement (OPC). It is brought from Aishwarya enterprises near Rajivnagar, Visakhapatnam. The properties are shown in Table 1.

TABLE 1
Properties of Cement

S. No.	Description	OPC 53
1.	Fineness (%)	4
2.	Normal consistency (%)	34
3.	Setting time (min.)	
	Initial	25
	final	300

2. Fine aggregate

The aggregate size is lesser than 4.75mm is considered as fine aggregate. The sand particles should be free from any clay or in-organic materials and found to be hard and durable. The materials are procured from Rajivnagar, Vishakhapatnam. Natural sand of river bed is used confirming to grading zone –II of table 4 of IS 383 were procured. The properties are shoen in Table 2.

TABLE 2
Properties of sand

Description	Sand
Fineness modulus	2.731
Zone	II
Specific gravity	2.621

3. Coarse Aggregate

Coarse aggregates of 10mm and 20mm size is used for the study which is taken from Rajivnagar area, Vishakhapatnam. The aggregate size is bigger than 4.75mm is considered as coarse aggregate. Dried angular coarse aggregate of 20mm maximum size and 10mm minimum size locally available was used for experiment. The properties are shown in Table 3.

TABLE 3
Properties of coarse aggregate

Description	Coarse aggregate
Fineness Modulus (%)	2.78
Zone	II
Specific Gravity	2.83
Particle size (mm)	10 to 20

4. Marble powder

Marble powder (see Fig. 1) is obtained during sawing, shaping and polishing of parent marble rock. In India marble processing is the most thriving industry. The marble powder for cement replacement was brought from universal marble company in Chennai. Marble powder passing 90microns was used.



Fig.1 Marble powder

5. Fly ash

Fly ash (see Fig. 2) is a residue material of energy production using coal, which has been found to have numerous advantages for use in concrete. About 150 million tons of fly ash is being generated every year. Hence this reuse can be emphasized. The fly ash from cement replacement was brought from NTPC.



Fig.2 Fly ash

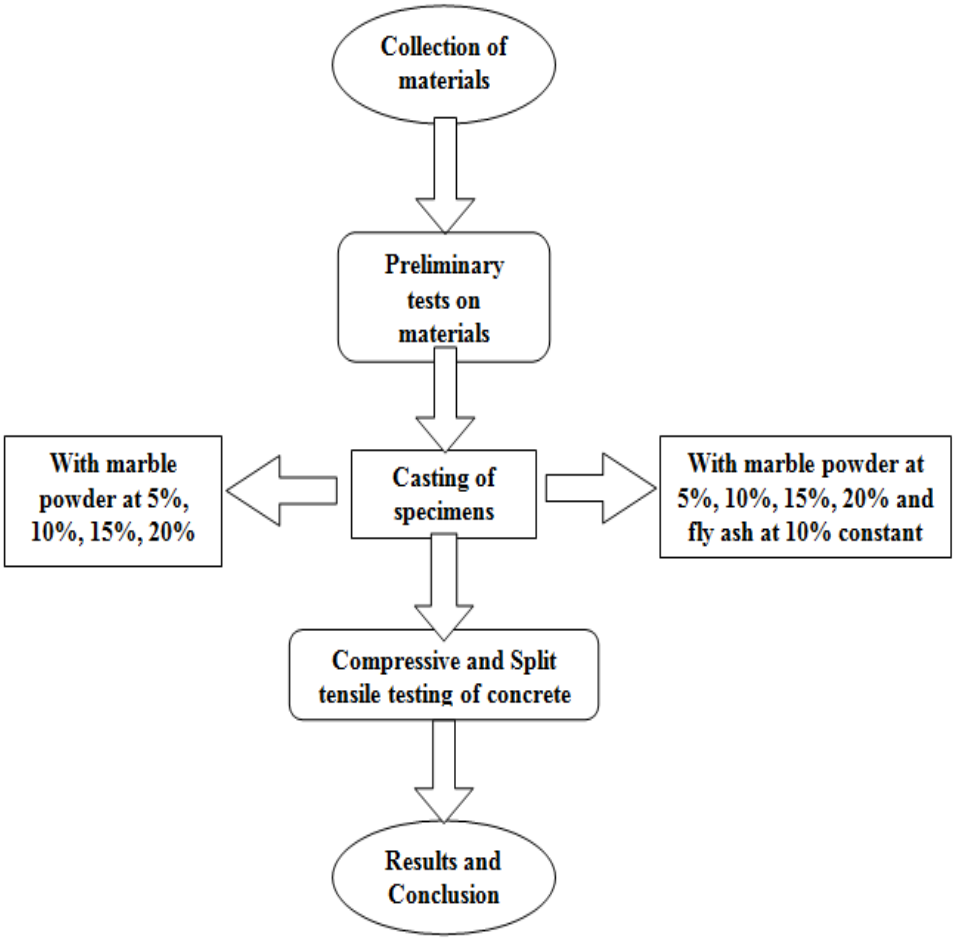


Fig. 3 Flow chart representation of methodology

B. Methodology

TABLE 4
Mix Design and Proportion: M30 mix design was prepared according to IS 12062: 2009 and proportioning.

S.no.	Percentage replacement for cement	0	Flyash	Marble dust powder	Fine aggregate	Coarse aggregate		water
						10mm	20mm	
1	0	425.73	0	0	652.1	479.54	719.31	191.58
2	10	383.15	42.573	0	652.1	479.54	719.31	191.58
3	15	361.87	42.573	21.28	652.1	479.54	719.31	191.58
4	20	340.58	42.573	42.57	652.1	479.54	719.31	191.58
5	25	319.29	42.573	63.85	652.1	479.54	719.31	191.58

III. EXPERIMENTAL WORK

A. Compressive Strength Test

Concrete is strong in compressive strength. For cube test two types of specimens either cubes of 15cm x 15cm x 15cm or 10cm x 10cm x 10cm depending upon the size of aggregate are used as shown in Fig. 3. For most of the works cubical molds of size 15cm x 15cm x 15cm are commonly used.

Compressive strength = Maximum load at failure / Area of surface $\left(\frac{N}{mm^2}\right)$



Fig. 4 Compressive strength test

B. Split Tensile Strength Test

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete as shown in Fig. 4. The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete and to determine the load at which the concrete members may crack.

Split tensile strength calculations:

As per IS456, split tensile strength of concrete= $0.7f_{ck}$

The splitting tensile strength is calculated using the formula

$$T_{sp} = \frac{2P}{\Pi DL}$$

Where, P = applied load, D = diameter of the specimen, L = length of the specimen.



Fig. 5 Split tensile strength test

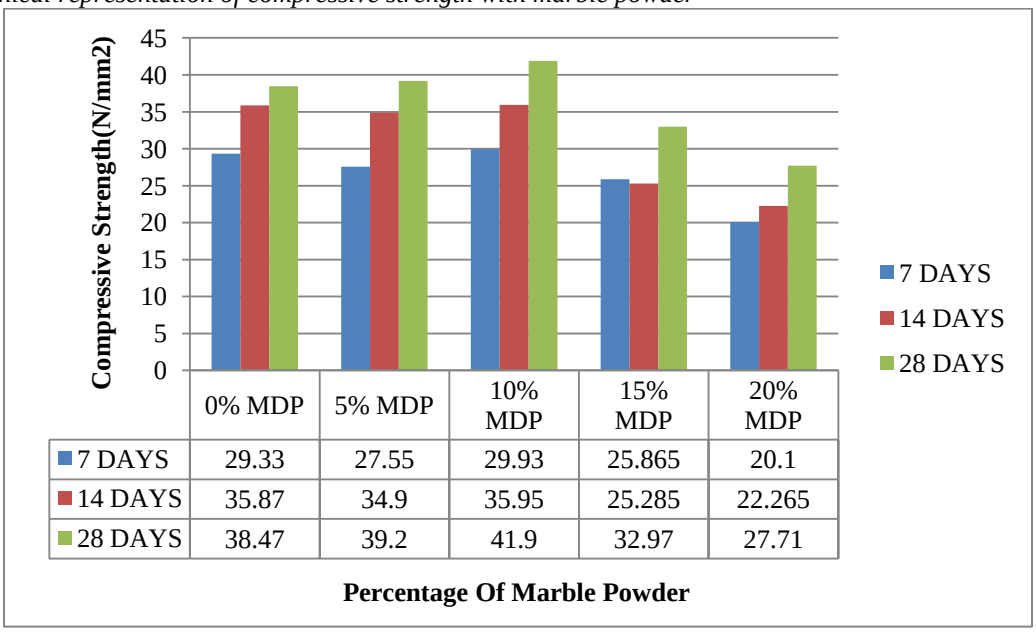
IV. RESULTS AND DISCUSSION

A. Compressive strength results are given in Table 5.

TABLE 5
Compressive Strength results of Marble powder

S.NO.	TYPE OF MIX	7 DAYS	14 DAYS	28 DAYS
1	0% MDP	29.33	35.87	38.47
2	5% MDP	27.55	34.90	39.2
3	10% MDP	29.93	35.95	41.9
4	15% MDP	25.865	25.285	32.97
5	20% MDP	20.1	22.265	27.71

➢ *Graphical representation of compressive strength with marble powder*



	0% MDP	5% MDP	10% MDP	15% MDP	20% MDP
7 DAYS	29.33	27.55	29.93	25.865	20.1
14 DAYS	35.87	34.9	35.95	25.285	22.265
28 DAYS	38.47	39.2	41.9	32.97	27.71

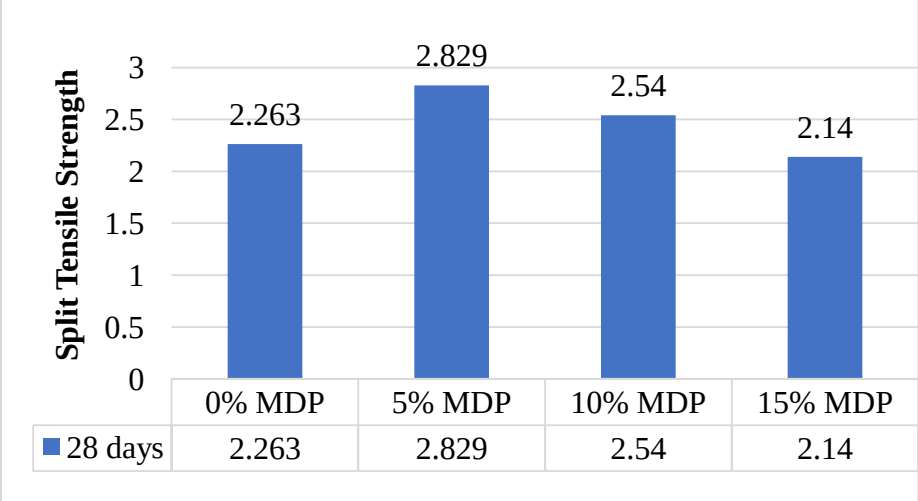
Graph1: Compressive strength versus percentage of marble powder

B. Split tensile strength results are given in Table 6.

TABLE 6
Split Tensile test results by replacing Marble Powder

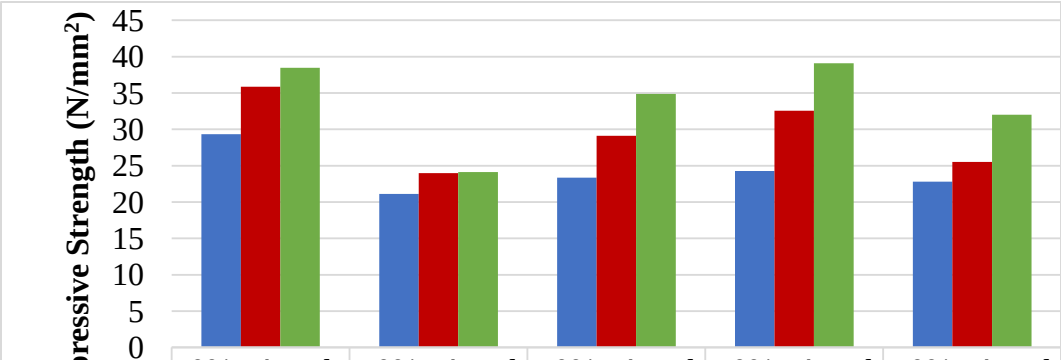
S.NO.	TYPE OF MIX	28 DAYS
1	0%	2.263
2	5%	2.829
3	10%	2.54
4	15%	2.14

➢ *Graphical representation of split tensile strength*



Graph2: Split tensile strength versus percentage replacement of marble powder

➢ *Graphical representation of Compressive strength*



	0% FA and 0% MDP	10% FA and 0% MDP	10% FA and 5% MDP	10% FA and 10% MDP	10% FA and 15% MDP
7 days	29.33	21.1	23.34	24.26	22.8
14 days	35.87	23.97	29.11	32.56	25.51
28 days	38.47	24.13	34.88	39.1	32

Graph 3: Compressive strength vs % replacement of Fly ash and Marble powder

C. Compressive strength results with marble powder and fly ash are given in Table 7.

TABLE 7
Compressive Strength Results with Marble Powder And 10% Fly Ash

S.NO.	TYPE OF MIX	7 DAYS	14 DAYS	28 DAYS
1	0%FA and 0% MP	29.33	35.87	38.47
2	10%FA and 0% MP	21.1	23.97	24.13
3	10%FA and 5% MP	23.34	29.11	34.88
4	10%FA and 10% MP	24.26	32.56	39.1
5	10%FA and 15% MP	22.8	25.51	32

V. CONCLUSIONS

The compressive and tensile behavior of concrete cubes was tested. In this project the cubes and cylinders were casted by varying percentages of marble powder such as 0%, 5%, 10%, 15% and 20% replaced with cement. Along with this the cubes were also casted cubes by replacing cement with 10% fly ash and increasing marble powder percentage by 0%, 5%, 10%, 15%. Based on the analysis of experimental results and discussion, the following conclusions can be drawn.

1. The compressive strength of concrete is optimum at 10% replacement of cement with marble powder and then it goes on decreasing on further addition of marble powder.
2. The split tensile strength of concrete is optimum when 5% of marble powder is replaced with cement and on further addition of marble powder, the strength goes on decreasing.
3. The compressive strength of concrete is optimum when 10% fly ash and 10% marble powder were replaced with cement and it also maximum when compared to conventional concrete.
4. From all the test results obtained, we can conclude that when marble powder with or without fly ash is replaced with cement, it gained more strength when compared to ordinary M30 cubes compressive strength.
5. The best possible way of disposal of waste marble powder and fly ash can be by using it in concrete, which will reduce environmental burden.

Therefore, from this project, we can conclude that it is potential step to minimize the costs for construction with usage of marble powder and fly ash which is freely or cheaply available significantly and also reduce environmental pollution by controlling the production of cement through replacement.

VI. ACKNOWLEDGMENT

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