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Study of Compressive Strength of Cement Concrete with Stone and Marble Dust

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Abstract: ***This paper presents the experimental study to compare the properties of traditional concrete and concrete made up of other supplementary materials. In this study partial replacement of natural sand by marble dust and stone dust and cement by fly ash so as to provide an environmentally and consistent way of disposal. The experiments were performed by replacing 20%,25% &30% of cement with fly ash and 30% & 40% of fine aggregate with marble dust and stone dust.***

Keywords: Ordinary Portland Cement (OPC),Waste Materials Fly Ash, Marble Dust, Stone Dust

1. Introduction

The cement is the costliest and energy intensive component of concrete. The unit cost of concrete can be reduced as much as possible by partial replacement of cement with Fly ash.In recent studies, many researchers foundthat the use of additional cementitious materials like fly-ash in concrete is economical and reliable. Many studies have been carried out in different countries to use natural stone waste in mortar and concrete. Most of these researchers used marble, granite and lime stone waste as a replacement of cement or sand in concrete mix in order to investigate their effects on the physical and mechanical properties of concrete.

Berryman et al(2007) investigated thatthe maximum compressive strength was found at a fly ash replacement percentage of 35% for concrete containing class C fly ash . The mean values of compressive strength for 35% type C fly ash was slightly above 41.5 N/mm². The maximum compressive strength for concrete where cement was replaced with Class F fly ash was 25% replacement. Maximum compressive strength for concrete containing type F fly ash was approximately 36.0N/mm².

Ashle and Quadori, (2013) reported that the compressive strength of concrete of grade M25 & M30 madewith stone dustis increased at all the replacement level between 30-60% at an interval of 10%. However, maximumincreased strength is observed at a replacement level of 40%**.**

2. Material and Methodology

I. Cement: The cement used was ordinary Portland cement (43 grades). The properties of cement based on various test results conducted are as following:
Normal consistency = 31
Specific Gravity = 3.12
Initial setting time= 30 min.
Final setting time= 436 min.

II. Fly ash: Residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal – fired power plants.Fly ash was used obtained from Raj Ratan Recycling Industries, Shastri Market, Indore (M.P.)India. The specific gravity of fly ash is 2.11.

III. Stone dust: Stone dust was obtained Atma Malik Infrastructure, Indore (M.P.) India. The specific gravity of stone dust is 2.64 and fineness modulus is 2.76.

IV. Marble dust: Marble stone industry generates marble dust. Whereas marble dust results from the rejects at the mine sites or at the processing units, obtained from Maheshwari Traders, Jawahar Marg Indore (M.P.) India. The fineness modulus of marble stone used in the study is 1.55 and specific gravity of marble stone is 2.25.

V. Aggregates:
a) Fine aggregate
Specific gravity = 2.02
Fineness modulus = 3.10

b) Coarse aggregate
Specific gravity = 2.70
Fineness modulus = 5.0

3. Experimental Investigation

The experimental investigation was done for the comparative study of compressive strength of concrete mix with addition of fly ash, stone dust and marble dust. Fifteen types of concrete mixes were prepared. The various mix proportions and their compressive strength are shown in the table 2. The concrete of grade M30 was designed as per IS standards.

Table 1: Control concrete mix (M30)

Water	Cement	Fine Aggregate	Coarse Aggregate
0.45	1	1.41	2.90
182.7ltrs	400kg	564kg	1160kg

Table 2: Preparation of material with FLY ASH,MD& SD and compressive strength

S.NO.	MIX	CEMENT	FLY ASH	FINE AGG.			COARSE AGG.		W/C	COMPRESSIVE STRENGTH	
				SAND	MD	SD	10MM	20MM		7Days (N/mm²)	28Days (N/mm²)
1	CC	100%	0%	100%	0%	0%	40%	60%	0.45	25.70	38.58
2	M1	65%	35%	70%	20%	10%	40%	60%	0.45	19.25	28.05
3	M2	65%	35%	70%	15%	15%	40%	60%	0.45	20.24	28.87
4	M3	65%	35%	70%	10%	20%	40%	60%	0.45	21.43	30.35
5	M4	65%	35%	60%	30%	10%	40%	60%	0.45	19.25	27.25
6	M5	65%	35%	60%	20%	20%	40%	60%	0.45	17.57	25.65
7	M6	65%	35%	60%	10%	30%	40%	60%	0.45	18.56	26.65
8	M7	75%	25%	70%	20%	10%	40%	60%	0.45	20.78	29.75
9	M8	75%	25%	70%	15%	15%	40%	60%	0.45	22.02	32.04
10	M9	75%	25%	70%	10%	20%	40%	60%	0.45	23.01	35.45
11	M10	75%	25%	60%	30%	10%	40%	60%	0.45	21.35	30.29
12	M11	75%	25%	60%	20%	20%	40%	60%	0.45	22.28	31.54
13	M12	75%	25%	60%	10%	30%	40%	60%	0.45	20.87	29.87
14	M13	77.5%	20%	70%	10%	20%	40%	60%	0.45	24.20	35.49
15	M14	80%	20%	70%	10%	20%	40%	60%	0.45	25.00	38.87

Figure 1. indicates the 7- and 28-days compressive strength of 6 concrete mixes. The highest value is 30.35 N/mm² for 30% of cement replacement and 30% of sand replacement.

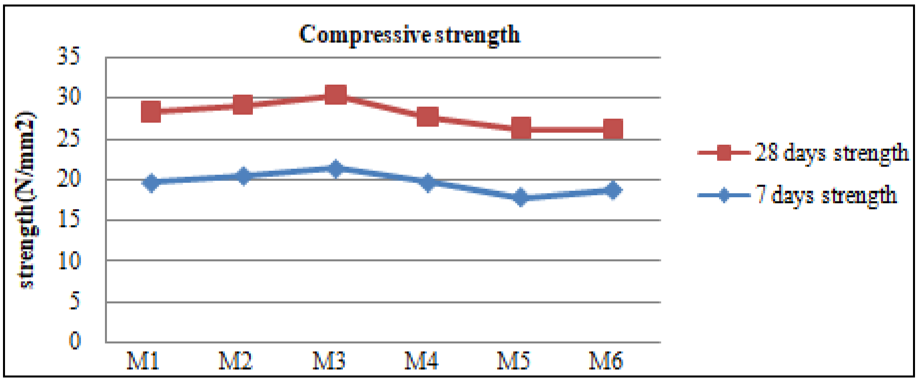

Figure 1: Variation in compressive strength with 30% fly ash

Figure 2 indicate the 7- and 28-days compressive strength of 6 samples. The highest value is 32.04N/mm² for 25% of cement and 30% of sand replacement.

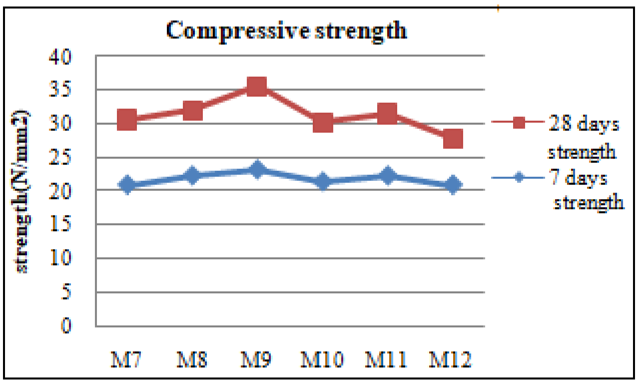

Figure 2: Variation of compressive strength with 25% FLY ASH

The curve in fig. 3 shows the rate of compressive strength development of M13 and M14 mix over a span of 7 and 28 days. Concrete with 20% of cement and 30% of sand replacement has the highest rate of increase in compressive strength.

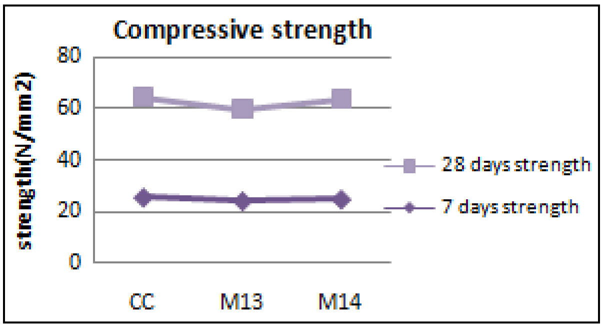

Figure 3: Variation in compressive strength with 20% fly ash

4. Conclusions

The following observations were made as result of experiments conducted to compare the strength of concrete with conventional and supplementary materials.

1) Compressive strength increases when the replacement of cement and fine aggregate percentage is up to 20% and 30% respectively.
2) By using supplementary materials in preparation of concrete, it is the possible to safely dispose the fly ash, stone dust and marble dust.Using fly ash, marble dust and stone dust in concrete mix proved to be very useful to solve environmental problems and up to some extent

one can minimize the requirement of cement in large quantity. Therefore, it is recommended to re-use these wastes in concrete to move towards sustainable development in construction industry.

3) Use of fly ash and stone waste materials in concrete leads to saving of cost.
4) 4.The mix M14 had high value of compressive strength, remaining mix (M1-M13) were comparatively less. But the workability value of mix M4, M5 and M6 had good values as compare to other mixes.
5) 5.This investigation focuses on the comparison between control concrete and modified concrete with alternative materials. The strength of modified concrete is at comparable range with control concrete at 28 days. Thus, the fly ash, stone dust and marble dust can be introduced as functional construction materials.

Scope for Future Work: This study proposes the use of all three waste products (fly ash,marble dust and stone dust) together for making a concrete mix. Also the observations of the work reveals that there is considerable improvement in the characteristic compressive strength of the concrete. Compressive strength can be determined at 60, 90 and 120 days also to compare the change in strength for both control and alternative mixes.

Usage of marble powder and stone dust needs to be studied further, so that these waste materials can contribute to be large constituents of concrete mixes which in turn will optimize the cost of the project and at the same time not compromising with strength and other properties of the concrete for sustainable development.

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