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EFFECT OF STONE DUST ON COMPRESSIVE STRENGTH OF CONCRETE AN EXPERIMENTAL INVESTIGATION

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ABSTRACT

Concrete is the most used construction material having basic ingredients as binding material, fine aggregate, coarse aggregate and water in predetermined proportion all the ingredients are homogeneously mixed to obtain resulting mixed of desired strength. In the present investigation, stone dust, a waste material obtain from crusher plant is used as partial replacement of fine aggregate. M25 grade of concrete was considered for this investigation with a final mix proportion of 1:1.65:3 at w/c ratio of 0.50. The replacement levels of natural fine aggregate with stone dust were 30-70% at an interval of 10%. The compressive strength of specimens (100mm cubes) cast for different proportions of stone dust was determined and compare the same with referral concrete. The result showed that the stone dust can effectively been used as partial replacement of natural fine aggregate without compromising the compressive strength.

KEYWORDS: concrete, compressive strength, flexural strength, stone dust, fine aggregate.

INTRODUCTION

In the present era of development due to advanced techniques/ material available and growing standard of living beings the construction activities are increasing exponentially with time. The increasing construction activities exploiting the available natural resources drastically and posing serious environmental problem. However construction activities, leading to development in social and economic aspects cannot be stopped or reduced for the sake of conservation of natural resources. In view use of non-conventional materials could be an alternative to overcome the problem stated above.

Concrete is most used construction material globally. In India about 370 million cubic meter concrete is used in construction industry every year. The same quantity is expected to increase 30 million m3/ year.

Stone dust is a waste material obtain from crusher plants during the process of making of coarse aggregate of different sizes, about 175 million ton stone dust is produced every year, which is kept in abundance. This used quantity of stone dust requires a suitable disposal site for its easy and safe disposal a large land area is required to accomplish the requirement which would again be a great problem in a country of thickly populated like India. Stone dust, being final part of a coarse aggregate is an inert material and may be used in concrete making as partial replacement of fine aggregate. Natural sand is basically and mostly used fine aggregate all over India, but as compare to some advanced countries the volume of concrete manufactured in India has not been much, many infrastructure and industrial development are increasing and demand of huge amount of natural sand is growing drastically. Due to the arised demand of natural sand the illegal and over dredging of river sand are also increased that causes deepening of river beds which is a very serious environmental threat. The natural sand is one of the main constituent of concrete but due involvement of local sand mafia and its non-availability at time increases its cost. So Governments are restricting the collection of river sand from river bed. In such a situation the crusher dust can be an economical alternative to river sand. Crusher dust is a byproduct generated from quarrying activities involved in the production of crushed coarse aggregate. It is possible to use such manufactured sand

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as fine aggregate in concrete which will reduce not only the demand for natural river sand but also the environmental burden. In the present investigation, stone dust, a waste material obtain from crusher plant is used as partial replacement of fine aggregate. M25 grade of concrete was considered for this investigation with a final mix proportion of 1:1.65:3 at w/c ratio of 0.50. The replacement levels of natural fine aggregate with stone dust were 30-70% at an interval of 10%. The compressive strength of specimens (100mm cubes) cast for different proportions of stone dust was determined and compare the same with referral concrete. The result showed that the stone dust can effectively been used as partial replacement of natural fine aggregate without compromising the compressive strength.

Celik et al. (1996) have reported that on increasing the dust content up to 10%, improved the compressive strength, flexural strength of concrete and drying shrinkage improved. However, the dust content exceeding 10 % decreased the compressive strength, flexural strength and drying shrinkage gradually.Jain et al. (1999) reported that the use of quarry dust in concrete is desirable because of its benefits such as useful disposal of byproducts, reduction of river sand consumption as well as increasing the strength parameters and increasing the workability of concrete. Patel et al. (2013) reported that the construction activities are taking place on huge scale all over the world and demand of construction materials are increasing day-by-day. Production of concrete and utilization of concrete has rapidly increased, which results in increased consumption of natural aggregate and sand. Nagabhusana et al. (2011) reported that crushed stone powder can be effectively used to replace natural sand without reduction in the strength of concrete at replacement level up to 40%.Pofale and Quadri (2013) reported that compressive strength of concrete (M25 & M30) made using crusher dust increased at all the replacement level between 30 to 60% at a interval of 10%. However maximum increased in strength is observed at a replacement level of 40%. Sahu et al. (2009) concluded that adding 40% sand may be replaced by stone waste in concrete without compromising quality of concrete. It is used for different activities in the construction industries such as road construction, manufacture of building materials, bricks, tiles and autoclave blocks. Patel and Pitroda (2013) reported that every year 200-400 tons of stone dust is generated by the stone cutting plants, and is dumped as waste. This leads to serious environmental and dust pollution. So it is necessary to dispose the stone dust waste quickly and efficiently. Sivakumar et al. (2014) reported that aggregate is one of the main ingredients in concrete production. It accounts for about 75% of any concrete mix. The strength of the concrete produced is depended on the properties of aggregate used. Monish et al. (2013) reported that recycled aggregate can be used in concrete as partial replacement of coarse aggregate up to 30% with marginally compromise of compressive strength. However up to 30% replacement of coarse aggregate with recycled aggregate compressive strength of same was comparable to conventional concrete.

MATERIALS AND METHODS

An experimental investigation was conducted to get the strength of specimen (cube and beam) made with the use of stone dust in partial replacement of fine aggregate. The strength of conventional concrete and other mixes were determined at the end of 7 and 28 days of moist curing. To study the effect of stone dust inclusion, cubes and beams of a design mix M25 grade concrete were cast. The 100 mm cubes were tested for compressive strength and the beam of size (500mm×100mm × 100 mm) were tested for flexural strength. The M25 mix proportion was (1:1.65:3) at w/c ratio of 0.50.

Cement

In the present study, Portland Pozzolana Cement (PPC) of Prism brand of single batches was used throughout the investigation. The physical and chemical properties of PPC as determined are given in table 1. The cement satisfies the requirement of IS: 1489:1985.

Table1. Properties of cement (Method of test refers to IS: 1489: 1985)

Properties	**Experimental**	**Codal requirement [IS 1489 (Pt-1)-1985]**
Normal consistency %	31.5%	
Initial setting time	165 min	(Not less than 30 min)
Final setting time	215 min	(Not more than 600 min)

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Soundness of cement (Le chatelier expansion)	0.75 mm	(Not more than 10 mm)
Fineness of cement (% retained on 90 micron IS sieve)	3.77%	10%
Specific gravity of cement	2.67	3.15
Compressive strength		
7 days testing	33.0	22 N/mm^2(min)
28 days testing	43.2	33 N/mm^2(min)

Fine Aggregate

The fine aggregate used was locally available river sand, which passed through 4.75 mm. Result of sieve analysis of fine aggregate is given in table 2. The specific gravity of fine aggregate is 2.43 and fineness modulus is 2.87.

Table 2. Sieve analysis for fine aggregate

S. NO.	Sieve Size	Weight Retained (gm)	Cumulative Weight Retained	Cumulative % Weight Retained	Passing %	Standard % Weight Passing for Zone II
1	4.75mm	-	-	-	100	100
2	2.36 mm	50	50	5.0	95	75-100
3	1.18 mm	232	282	28.2	71.8	55-90
4	600µ	348	630	63.0	37	35-59
5	300 µ	296	926	92.6	7.4	8-30
6	150 µ	60	986	98.6	1.4	0-10
7	Pan	12	998	100	0	0
			Total = 287.4			

Fineness Modulus = 287.4/100= 2.87

Stone dust

Stone dust was collected from local stone crushing units of Mirzapur, Vindhyachal Road, Uttar Pradesh. It was initially dry in condition when collected, and was sieved before mixing in concrete. Result of sieve analysis of stone dust is give in table 5. Specific gravity of stone dust was 2.50 and Water absorption was 0.5%.

Table 3. Sieve analysis for stone dust

S. No.	Sieve Size	Weight Retained (gm.)	Cumulative Weight Retained	Cumulative % Weight Retained	Passing %	Standard % Weight Passing for Zone II
1	**4.75mm**	**4**	**4**	**0.4**	**99.6**	**100**
2	**2.36 mm**	**80**	**84**	**8.4**	**91.6**	**75-100**
3	**1.18 mm**	**336**	**420**	**42.0**	**58.0**	**55-90**
4	**600µ**	**510**	**930**	**93.0**	**7.0**	**35-59**
5	**300 µ**	**70**	**1000**	**100.0**	**0**	**8-30**

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6	**150 µ**	**-**	**-**	**-**	**-**	**0-10**
7	**Pan**	**-**	**-**	**-**	**-**	**0**
			Total Cumulative % Retained = 243.8			

Fineness Modulus=243.8/100=2.44.

Water
Potable water was used for mixing and curing.

Mix Design
The design mix proportion of 1:1.65:3 at W/C ratio of 0.50 were used for M25 grade of concrete and the cement content was 380 kg/m3, satisfying the requirements of IS-10262-2009.

RESULTS AND DISCUSSION

1. The compressive strength of concrete made using stone dust at different proportion is shown in table 6.
2. The same results are presented in fig.1 for visual observation

Table 4. Compressive Strength of Different Mixes

Sl. No.	Cube designation	%age replacement of stone dust	Average Compressive strength (N/mm^2)	
			7 days	28days
1	A1	0	22.8	33.4
2	A2	30	16.3	25.1
3	A3	40	18.6	29.9
4	A4	50	21.3	33.1
5	A5	60	21.8	34.4
6	A6	70	17	29.6

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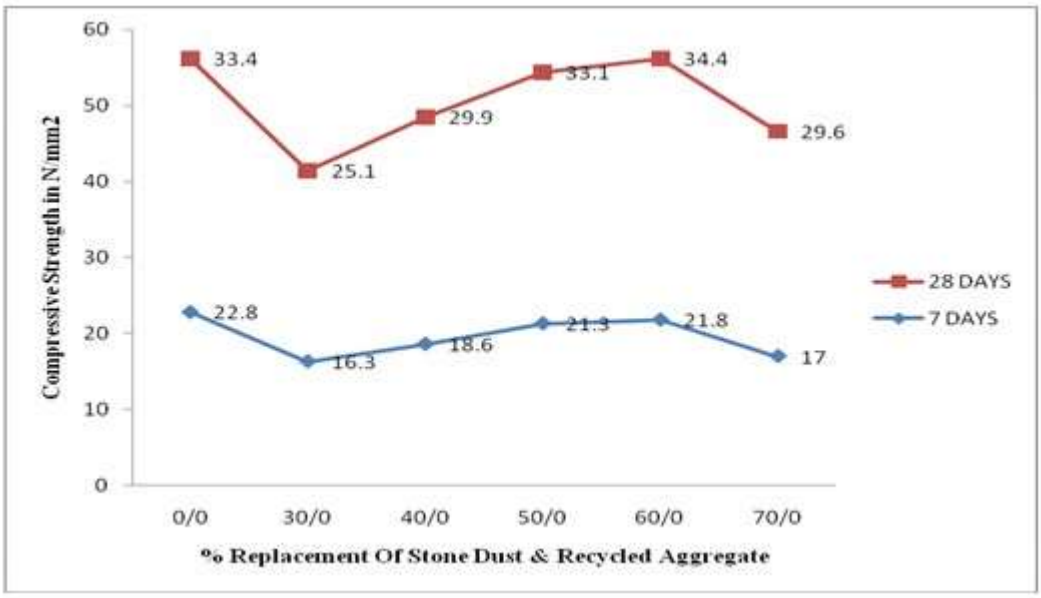
Fig. 1 Variation of Compressive Strength with Replacement Level



DISCUSSION

It is evident from the table that compressive strength is decreased while using stone dust as partial replacement of fine aggregate up to 40%. This may be due to the fact that replaced fine particles may not be sufficient to fill the voids resulting in comparatively in less dense concrete as compare to the referral concrete. However strength is comparable at 50% replacement level and slightly more at 60% replacement than that of referral concrete. Again compressive strength increasing beyond 60% replacement level may be due to the change of matrix composition

CONCLUSION

From the above study, the following conclusions are obtained.

1.Compressive strength of concrete make using stone dust at 50% replacement level is comparable to that of referral concrete both at 7 and 28 days.

2.At 60% replacement level strength is slightly higher than that of referral concrete both at 7 and 28 days.

3.Beyond 60% replacement level compressive strength of concrete make using stone dust lower than that of conventional concrete both at 7 and 28 days.

4.Optimum replacement level of stone dust is 60%.

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