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Comparative Study on Concrete Using Stone Dust As A Full Replacement of Fine Aggregate

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ABSTRACT: *The scarcity of natural sand and increase in its cost is the reason behind searching for a suitable alternative that can be used in construction activities. During the process of production of coarse aggregate in crushing plants, a huge quantity of stone dust is produced which is considered worth less for any substantial use. This stone dust being a waste material can effectively be used in concrete making, as a replacement of fine aggregate.The present investigation is an attempt to determine the suitability of stone dust as a fine aggregate replacement. Three grades of concrete,M20, M25 and M30 were used as referral mixes .Stone dust was introduced as a full replacement of fine aggregate in all the mixes and specimen cubes of size 150mm*150mm*150mm were casted. The specimen cubes were subjected to 7-day and 28-day moist curing.*

I. INTRODUCTION

Concrete is the most commonly used construction material due to its ease of availability, rigidity and durability. Major components of concrete are aggregates, which are usually available in natural form.The large-scale depletion of natural sand sources creates environmental problems such as erosion and failure of riverbanks, lowering of riverbeds and saline water intrusion into the land. Thus an investigation is needed to identify suitable substitute that is eco-friendly, inexpensive and better for strength and durability performance. The use of the replacement materials will offer cost reduction, energy savings, arguably superior products, and pose fewer hazards to the environment. In this connection the use of stone dust as fine aggregate with partial or full replacement may be a promising alternative in concrete making. Stone dust is such an alternative material which can be effectively beused in construction as replacement of natural sand.This is a waste product obtained from aggregate crushing plant.The main concern of using stone dust in concrete is to minimizing of waste accumulation, reuse of the waste material and thereby the conservation of natural resource.The compressive strength of concrete from stone powder showed 14.76% higher value than that of the concrete made of normal sand (Mahzuz*et al*., 2011)[1]. It is found that the compressive and flexural strength of concrete made of Quarry Rock Dust are nearly 10% more than the conventional concrete (Suribabu*et al*., 2015)[2]. 40 percent fine aggregate can be effectively replaced with stone dust (Franklin et al 2014)[3]. The compressive strength of concrete mix had increased by 22% with the use of crusher dust at 40% replacement of natural sand (Pofale et al 2013)[4].Quarry dust can be utilized in concrete mixtures as a good substitute for natural river sand giving higher strength at 50% replacement (Balamurgan*et al*., 2013)[5]. While using crushed stone dust as fine aggregate in concrete it is found that there is increase in compressive, flexural and tensile strength of concrete (Nagpal*et al*., 2013)[6].The present study was aimed at utilizing stone dust as fine aggregate in concrete in place of natural fine aggregate. For that an experimental program was carried out to study the potential use of stone dust as a replacement of fine aggregate in concrete. To accomplish this task concrete cubes of M20,M25 and M30 grade with stone dust as 100%replacement of fine aggregate to determine compressive strength of concrete. The study shows that compressive strength of concrete made using stone dust as fine aggregate as a full replacement has greater value in comparison of conventional concretefor M20 grade. A slight decrease in compressive strength was observed for M25 grade whereas for M30 grade, the compressive strength remained almost the same with a full replacement of fine aggregate with stone dust.

II. MATERIAL AND METHODS

2.1.CEMENT

OPC (Ordinary Portland Cement) 43 grade of ACC brand confirming to IS 8112(1989) was used in the study.The properties are shown below.

TABLE 1: PROPERTIES OF CEMENT

Standard Consistency	32%
Initial Setting Time	49 minutes
Final Setting Time	610 minutes
7 days Compressive Strength	33 N/mm^2
28 days Compressive Strength	43.2 N/mm^2
Specific Gravity	3.15

2.2 Fine Aggregate

Coarse sand available in Lucknowconfirming to IS 383-1997[5], zone III used in this study. It was completely passed by 4.75 mm sieve. Fineness modulus and specific gravity of this material was 2.76 and 2.59 respectively.

2.3 Coarse Aggregate

Locally available coarse aggregate having two fraction 20mm and 10mm sizes individually sieved was used in the present study. One fraction was passed through 20 mm sieve and another through 10 mm sieve. The specific gravity of coarse aggregate was 2.61 for both fractions. Fineness modulus was 6.9 for 10 mm aggregate and 7.7 for 20 mm aggregate. For concrete mix a proportion of 2:1 of coarse aggregate was used.

2.4 Stone Dust

Grey colour stone dust was collected from local stone crushing units of Lucknow, Uttar Pradesh. It was initially dry in condition and thoroughly retained on IS 75 μ sieve before preparation of mix. The stone dust also confirmed zone III of IS 383-1997[5].Fineness modulus of stone dust was 2.85 and specific gravity was 2.4.

In this experimental study,design mix of M20, M25 and M30 grades of concrete were used. The design was done as per IS:10262-2009 [7] method of mix design.With the mix design of referral concrete 100% fine aggregate is replaced with stone dust,the data from the stone waste is compared with data from a standard concrete without stone dust. Three cube samples were cast on the mould of size 150*150*150 mm for each of the nominal concrete mix and also of the mixes with full replacement of fine aggregate with stone dust.After about 24 hours the specimens were de-moulded and moist curing was continued till the respective specimens were tested after 7 and 28 days for compressive strength test.

Table 2: Design Mix

REFERRAL GRADE	W/C RATIO	CEMENT Kg/m3	FINE AGGREGATE Kg/m3	COARSE AGGREGATE Kg/m3	WATER Kg/m3
M20	0.495	298.1	647.76	1325.30	147.52
M25	0.45	336.33	627.87	1284.60	151.35
M30	0.405	383.16	618.0	1264.3	155.18

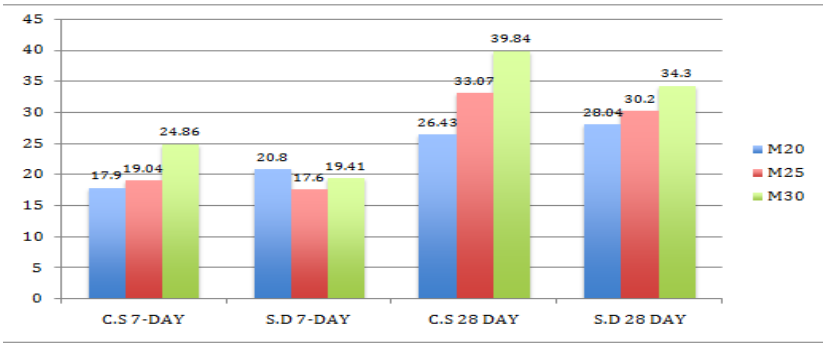
III. RESULTS AND DISCUSSIONS

The average compressive strength of concrete for 7^{th}day and 28^{th}day were tested as per IS 516 – 2004. It was observed that the compressive strength of specimen at a full replacement level of natural fine aggregate with stone dust was more than designed value of conventional concrete which shows suitability of stone dust in concrete as a full replacement of natural fine aggregate from compressive strength point of view. For M20 grade,the stone dust replacement led to a 137% increase in compressive strength,for M25 grade there was a 105% increase in the strength and for M30 grade the compressive strength remained almost the same as nominal mix compressive strength at 7 days. The variation in compressive strength may be due to different water absorption capacity of stone dust and sand and different angularity of particles etc.Finally it can be stated that the stone dust can be used in concrete with full replacement of fine aggregate.

Table 3: Compressive Strength Results

REFERRAL GRADE	COARSE SAND		STONE DUST	
	7-DAY AVERAGE COMPRESSIVE STRENGTH N/mm2	28-DAY AVERAGE COMPRESSIVE STRENGTH N/mm2	7-DAY AVERAGE COMPRESSIVE STRENGTH N/mm2	28-DAY AVERAGE COMPRESSIVE STRENGTH N/mm2
M20	17.8	26.43	20.8	28.4
M25	19.94	33.07	17.6	30.2
M30	24.86	39.84	19.41	34.37

Figure-1 Compressive Strength Comparison



IV. CONCLUSION

1. For M20 grade nominal mix concrete, compressive strength showed an increase of 16.2 % after 7-day test and 6 % increase after 28-day test at 100 % replacement, hence stone dust can be used as a full replacement of fine aggregate in M20 grade.

2. For M25 grade nominal mix concrete ,the compressive strength showed a decrease of 8% after 7-day test and 9 % decrease after 28-day test at 100 % replacement, therefore it would be advisable to use stone dust only in unavailability of good quality fine aggregate.

3. For M30 grade nominal mix concrete ,the compressive strength showed a decrease of 22% after 7-day test and 14 % decrease after 28-day test at 100 % replacement, hence stone dust cannot be recommended as a replacement of fine aggregate in M30 grade.

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