Effect on strength by partially replacement of fine aggregate with stone dust in PPC concrete

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Abstract- *Owing to increased huge continued industrial growth and human overcome development. Concrete, being the world's largest construction material, construction activities for different regions and utilities scaring of natural resources is being forced due to its over exploitation. Depleting natural resources posed threat to the environment. Hence conservation of natural resources is great challenge for civil engineers since construction activities cannot be diminished as it is intimate able. The only way is to search alternatives material which can fully or partially replaced naturally available material in construction. Stone dust is such an alternative material which can be effectively being used in construction as partial replacement of natural sand. In the present investigation, an experimental program was carried out to study the compressive strength of concrete prepared using stone dust as partially and fully replacement of fine aggregate in the range of 10% to 100%, cast the specimen cube at an interval of 10%. M25 grade of concrete was designed using Portland Pozzolana cement (PPC) for referral concrete. Compressive strength was determined at different replacement level of fine aggregate to referral concrete and optimum replacement level was determined based on compressive strength. Results showed that by replacing 60% of fine aggregate with stone dust concrete of maximum compressive strength can be made as compared to all other replacement levels.*

Keywords- Stone dust, Aggregate replacement, PPC Concrete, Compressive Strength.

I. INTRODUCTION

Concrete is commonly used construction material due to its simplicity of availability, mouldability, rigidity and durability. It generally consists of binding material, fine aggregate, coarse aggregate and required quantity of water, where sand is normally used as fine aggregate. Due to rapid growth of construction activity, the available sources of natural sand are getting exhausted. Hence conservational consumption of natural river sand is very high due to its extensive use in concrete. In particular, the demand for natural river sand is quite high in developed countries owing to infrastructural growth. The non-availability of sufficient quantity of natural river sand for making cement concrete is affecting the growth of construction industry in many parts of the country. Recently, many stats government (India) has imposed restrictions on sand removal from the river beds due to its undesirable impact on the environment. Alternatively, the stone dust (waste) generated by the industry has accumulated over the years. Only insignificant quantity has been utilized and the rest has been dumped dishonestly causing in pollution problems. With the huge increase in the quantity of waste required disposal, discriminating shortage of dumping sites, a sharp increase in the transportation and dumping costs. There is a required for effective utilization of this stone dust waste. Stone dust as alternative and supplementary material which can be used as partial or full replacement of conventional material can play a vital role in. (Hameed et al, 2009) investigated that the dust content increasing up to 30%, improved compressive strength of concrete and minimum absorption obtained when dust content was 20%, Dust content higher than 30% decreased the compressive strength and dust content more than 20% increased the absorption of the concrete. (Sahu et al., 2009) In the study of utilization of crushed stone waste in concrete it was concluded that adding 40% sand may be replaced by stone waste in concrete without compromising the quality of concrete. (Sivakumar et al., 2014) investigated that the 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 depends on the properties of aggregate used. (L.Kumar et al.,2015) investigated that the compressive strength, flexural strength and split tensile strength of concrete for grade M25 and M30 with stone dust as fine aggregate were found to be comparable with the concrete made with the river bed sand. The increase in compressive strength of concrete with 20% replacement and 50% replacement of fine aggregate with stone dust is found to be 8 to 10%. Stone dust can effectively be used in plain cement concrete in place of fine aggregate. (Franklin et al., 2014) investigated that experimental study was shown that the replacement of natural sand by crusher dust increased the

compressive strength of concrete by 5-22% and it was also found that amongst all the mixes, the highest compressive strength was obtained for 40% replacement of sand by crush conservation of natural resourcesher dust.

II. METHOD AND METHODOLOGY

1. **Cement-** In this study, Portland Pozzolana Cement (fly ash based) of single batch was used conforming to IS 1489(part I):1991 specification. Properties of PPC are as listed below in table 1.

Table 1.Properties of Portland Pozzolana cement (PPC)

Properties	**Result value**
Initial setting time	138 minutes
Final setting time	275 minutes
Standard consistency %	32%
Fineness(% retained on 90µ in sieve)	3.8%
Specific gravity	2.73
Soundness(lechatelier expansion)	0.5 mm

2. **Fine Aggregate-** Fine aggregate (FA) used in this investigation was the natural river sand passing completely through 4.75 mm aperture size sieve and conforming to zone II as per IS:383-1970 specification. Its fineness modulus and specific gravity were 2.73 and 2.34 respectively.

3. **Coarse Aggregate-** A Combined grading of the two individual 20 mm and 10 mm Nominal size coarse aggregate (20mm CA & 10mm CA) gradings was used with the ratio of these coarse aggregates as 60:40 respectively. Particle size distribution curve of the Achieved Combined coarse aggregate with these two (20 mm and 10 mm) coarse aggregate by the Recorded sieve analysis test result with permissible limits (UPL & LPL), Properties of the Achieved Combined coarse Aggregate (CCA) of 20 mm Nominal size are shown in Table 2.

Table 2. Properties of Coarse Aggregate (CA)

Properties		**Result value**
Fineness Modulus	10 mm Aggregate(10mm CA)	5.843
	20 mm Aggregate(20mm CA)	7. 102
	Combined Coarse Aggregate(CCA)	6.472
Water absorption (%)		0.85
Specific gravity		2.60

4. **Stone Dust-** Stone dust obtained from the KABRAI crushing plant of Mahoba district in Uttar Pradesh with co-operation of the locally working VIL.Ltd highway and Construction Company was Grey in colour, dry in condition, used as thoroughly retained on 150 µm IS Sieve for entire investigation. Fineness modulus and Specific gravity of stone dust were 2.60 and 2.40 respectively. Particle size distribution curve of stone dust (SD) for the recorded sieve analysis test result with conforming to the grading zone II as per IS:383-1970 specification with upper and lower permissible limits (UPL & LPL).

5. **Super Plasticizer –** Sulphonated naphthalene formaldehyde (SNF) based Super plasticizer (KEM SUPLAST 101 S) of Chembond chemicals was used which conforms to IS:9103-1999 specifications. It was in liquid form compatible with the used Cement, brown in colour having specific gravity 1.2 and It showed good deflocculation and dispersion with cement particles to enhance the workability of concrete mix.

6. **Mix Design of the Referral Concrete -** M-25 grade of concrete conforming to IS:10262-2009 guidelines was designed as the referral concrete with the mix proportion of (1:1.54:3)and water-cement ratio(W/C) of 0.44 by weight taking with 0.6% super plasticizer dose by weight of cement.

7. **Water –** Potable water was used for mixing the concrete mix in entire investigation and for curing the concrete in the determination of the optimal percentage of stone dust as fine aggregate replacement.

Experimental design

The cubes were cast in steel moulds of inner dimensions of 150 x 150 x 150 mm, all the materials are weighed as per mix proportion of 1:1.54:3 with a W/C ratio of 0.44 which correspond to M25 grade of concrete. Fine Aggregate is replaced by stone dust. Each mix comprises of various percentages of Fine Aggregate replacement material in increasing order i.e. 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% respectively in replacement. The specimens were cured for a period of 7days and 28 days.

III. RESULT AND DISCUSSION

Compressive Strength:-

Compressive strength of the concrete cube specimen was calculated by dividing the maximum load applied to the

specimen during the test by the cross sectional area. The average of three values of compressive strength was taken as the representative compressive strength. In test, cube specimen was placed in the CTM machine in such manner that the load was applied to the opposite sides of the concrete cube as cast, that is, not to the top and bottom as per IS:516-2004 specification. Result of compressive strength of specimens cast for different replacement levels of fine aggregate with stone dust in Portland Pozzolana Cement (PPC) concrete, and a constant dose of super plasticizer are discussed here in after.

The average compressive strength of concrete for 7 days and 28 days were tested as per IS 516 – 2004 guidelines and results are tabulated in table-3 and its graphical representation on figure-1 (line chart) and figure-2 (bar chart). It was observed that the compressive strength of specimen at all 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 partial or full replacement of natural fine aggregate from compressive strength point of view. The 7 days compressive strength variations within 28.93% maximum strength and attains on 60 percent replacement of fine aggregate with stone dust. The 28 days strength gradually increased within variation of 5% up to 40% replacement level, at 50 percent replacement of natural fine aggregate in concrete the strength slightly (3%) decreases with respect to 30 – 40% replacement of fine aggregate. At 60 percent replacement of fine aggregate concrete attains maximum value and then strength decreases or increases within variation of 4%. The variation in compressive strength may be due to different water absorption capacity of stone dust and sand, different dose of super plasticizer in mix, different angularity of particles etc. For attain good strength in this study the concrete with above 50% replacement level of natural fine aggregate casted on 1 - 1.5% dose of super plasticizer. Finally it can be stated that the stone dust is to be used in concrete with partially or fully replacement of fine aggregate.

Table 3. Compressive strength of stone dust concrete (w/c=0.44)

Sl.No.	Cube Designation	Replacement Level (%) of Stone dust	Average Compressive strength (N/mm^2)	
			7 Days	28 Days
1.	A0	0	23.88	34.28
2.	A1	10	24.94	36.12
3.	A2	20	26.32	37.94
4.	A3	30	28.52	38.56
5.	A4	40	27.05	39.74
6.	A5	50	30.46	40.38
7.	A6	60	30.79	42.26
8.	A7	70	27.84	41.64
9.	A8	80	26.38	41.36
10.	A9	90	26.18	41.88
11.	A10	100	25.10	40.16

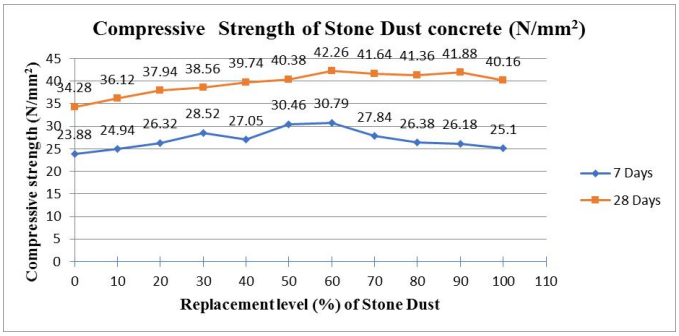

Figure 1. Compressive strength of stone dust concrete (line chart) (W/C = 0.44).

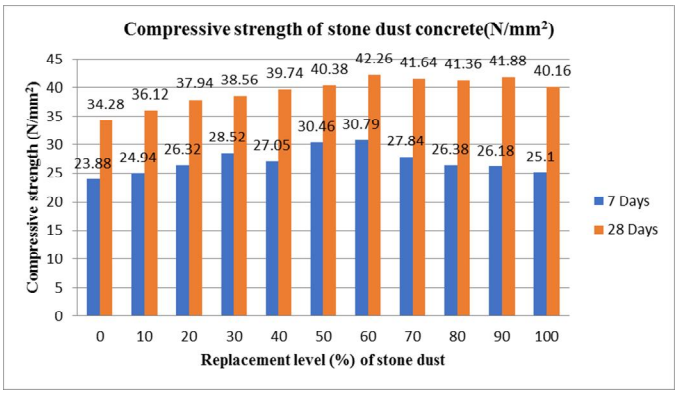

Figure 2. Compressive strength of stone dust concrete (bar chart) (W/C = 0.44).

IV. CONCLUSION

On the basis of above investigation it can be concluded that –

- Stone dust is to be used as fine aggregate replacement in concrete as partially or fully.
- Use of stone dust as fine aggregate in concrete is beneficial in different manners such as environmental aspects, non-availability of good quality of fine aggregate, and strength criteria also.
- Compressive strength of cubes with stone dust as fine aggregate replacement attains maximum value on 60 percent replacement level of natural sand with stone dust.
- It to be used at that place where setting time is not much important because excess dose of super plasticizer increase the setting time.

- Stone dust can be used as an opposite substitute for fine aggregate in the case of non-availability of natural river sand at reasonable cost.

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