Feasibility Study of using Stone Dust as Substitute for Sand in Construction

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Abstract **- The global consumption of natural sand is very high due to the extensive use of concrete in particular the demand of natural sand is quite high in developing countries owing to rapid infrastructural growth. In this situation some developing countries are facing a shortage in the supply of natural sand. The maximum strength of test 7 (40% dust +60% sand) was found as 16.44 N/mm2 and 28.66 N/mm2 for 7 and 28 days respectively which more among all the combinations. Thus cement, stone dust, sand and coarse aggregate proportion of 6:4.8:7.2:24 gave optimum result. For all mixes observed slump value lies between 30 to 45 mm. Which categories as low slump as for Indian standard Code of practice, hence such type of mixes may be suitable for Mass concrete; lightly reinforced sections in slabs; beams; walls; columns; floors; hand packed pavements; canal lining; strip footing.**

Index Terms **- Stone dust, Compressive strength, Slump Value, universal testing machine, Coarse Aggregate**

INTRODUCTION

Currently India has taken major initiative on developing the infrastructure such as express highways, power projects and industrial structures etc. to meet the requirements of globalization in the construction of buildings and other structures. Concrete plays the rightful role and a large quantum of concrete is being utilized. The global consumption of natural sand is very high due to the extensive use of concrete in particular the demand of natural sand is quite high in developing countries owing to rapid infrastructural growth. In this situation some developing countries are facing a shortage in the supply of natural sand.

Reddy (2007) reported that the effectiveness of rock flour as fine aggregate and partial replacement of convention at coarse aggregate by ceramic scrap up to 20% without affecting the design strength. Safiuddin et al., (2007) stated that the four different types of concrete mixture were prepared and tested. The effects of quarry waste fine aggregate on slump, slump flow unit weight and air content of the fresh concretes. In addition, this study has examined the effect of quarry waste fine aggregate on compressive strength, dynamic modulus of elasticity, ultrasonic pulse velocity and initial surface absorption of the hardened concretes. Itangovana et.al. (2008) reported that the quarry rock dust can be an economic alternative to the river sand natural river sand, if replaced by 100% quarry rock dust from quarries, may some items give equal or better than the reference concrete made with natural sand in terms of compressive and flexural strength studies. Strength of quarry rock dust concrete is comparatively 10-12% more than that of similar mix of conventional concrete. Nagraj et al: (2008) suggested that the possibilities of ensuring the workability by wise combination of rock dust and sand use of supper plasticizer of optimum water content using generalized Lyses rule. Sahu et al., (2008) reported that significant increase in compressive strength, modulus of rupture and split tensile strength when 40% of sand is replaced by quarry rock dust in concrete.

Considering all aspect this research work was undertaken for objectives like preparation of concrete cube using different proportions of cement coarse aggregate sand, stone dust and study compressive strength of the cube prepared. Also conduct slump test of concrete.

MATERIALS AND METHODS

Cement

Ordinary Portland Cement (43 Grade) with 28 percent normal consistency conforming to IS: 8112-1989 (3) was used.

Stone Dust

The Stone Dust obtained from local resource Pallavi construction (p) Ltd, Gangakhed road, Parbhani was used in concrete to cast test cubes. The physical properties of Stone Dust obtained by testing the samples as per Indian standards are listed in Tables1.

Nature River Sand

River sand is obtained from Godavari River, Gangakhed having density of 1460 kg /m3 and fineness Modulus (FM) of 2.53 was used. The specific gravity was found to be 2.6.

Coarse Aggregate

Coarse aggregate is obtained from local resource Pallavi construction (p) Ltd, Gangakhed road, Parbhani having density of 2700 kg/m^3 and fineness modules (FM) of 6.80 was used. The specific gravity was found to be 2.60 and water absorption as 0.45%.

Table 1 Physical properties of Stone Dust and Natural Sand

Property	Stone Dust	Natural Sand
Specific gravity	2.54-2.60	2.60
Bulk relative density (kg/m^3)	1720-1810	1460
Fine particles less than 0.075 mm (%)	12-15	06

Preparation of concrete cubes

In the process of manufacturing of the concrete cube the preparation of raw material is of important. Concrete mix M-15 grade in which 1:2:4 proportion were taken for the preparation of the mixture of raw material is cement, stone dust, sand and course aggregate were taken in the eleven difference proportions as mix-1 to mix-11

Tests conducted in laboratory.

Density

The densities of cubes were calculated. The mass of dry cubes was taken, and average mass was determined. The average volumes of cubes were calculated.

M = Mass of dry cubes in (gms)

V = Volume of dry cubes (cm^3)

Density= M/V

Compression test

The procedure to determine the compressive strength universal testing machine was used. It was working on the principle of hydraulic pressure. The cube was placed on lower plate and the load was applied using the upper plate. Load at which the cube failed was noted. The compressive strength was obtained by dividing this load by actual area of cube under the compression.

Compressive strength = $\frac{\text{load on cube in newton}}{\text{Area of cube in mm}^2}$

Slump test

Clean the internal surface of thoroughly by removing set concrete, dust or moisture etc. and apply a light film of oil. Place the mould on a smooth, horizontal, rigid and non-absorbent surface and held firmly in place before the concrete is filled in.

Assume suitable proportion for concrete (say 1:2:4) and calculate in-gradients for each batch to fill the cone at full compaction. Mix all ingredients with water at selected water / cement ratio. Fill concrete in to the mould in four layers and each layer is tamped with 25 strokes of the rounded end of tamping rod. After the top layer has been rodded, bring the surface of concrete to the level with top of the mould using trowel so that the mould is exactly filled. Raise the mould up vertically. On raising the mould, the concrete in the mould will subside. Take appropriate measures if the slump is of shear or collapse type. Measure the slump immediately by determining the difference between the original height and subsided heap of concrete, which gives the value of slump in mm.

RESULT AND DISCUSSION

Table 2 Compression test and slump test for cubes

Sr. No.	Combination D+ S (Dust +Sand)	Cement kg	CA Kg	No. of cubes	Area of cube cm^2	Water in Lit.	Crushing load KN		Compressive strength N/mm^2		Slump mm
							7 days	28 days	7 days	28 days	
Test-1	100%D+0%S	6	24	6	225	3	275	505	12.22	22.44	30
Test-2	90%D+10%s	6	24	6	225	3	260	425	11.55	18.88	35
Test-3	80%D+20%S	6	24	6	225	3	275	430	12.22	19.11	35

Test-4	70%D+30%S	6	24	6	225	3	245	475	10.88	21.11	40
Test-5	60%D+40%S	6	24	6	225	3	360	525	16.00	23.33	40
Test-6	50%D+50%S	6	24	6	225	3	345	540	15.33	24.00	40
Test-7	40%D+60%S	6	24	6	225	3	370	645	16.44	28.66	45
Test-8	30%D+70%S	6	24	6	225	3	340	615	15.11	27.33	40
Test-9	20%D+80%S	6	24	6	225	3	285	510	12.66	22.66	35
Test-10	10%D+90%S	6	24	6	225	3	260	440	11.55	19.55	40
Test-11	0%D+100%S	6	24	6	225	3	325	495	14.44	22.00	35

From table 2, it is observed that.

1. The maximum strength of test 7 was found as 16.44 N/mm^2 and 28.66 N/mm^2 for 7 and 28 days respectively which more among all the combinations. Thus cement, stone dust, sand, and coarse aggregate proportion of 6:4.8:7.2:24 gave optimum result.
2. Compression strength of mix test no. 5, 6, and 8 in which compressive strength after 7 days was formed to be 16, 15.33 and 15.11mpa. Which is more than Indian standard Code recommendation i.e. 14.47 mpa also compressive strength test no. 5, 6, 7and 8 compression strength of mix test no. 5, 6, and 8 in which compressive strength after 28 days was formed to be 23.33, 24 and 27.33mpa. Which is more than Indian standard Code recommendation i.e.21.6mpa.
3. For all mixes observed slump value lies between 30 to 45 mm. Which categories as low slump as for Indian standard Code of practice.

CONCLUSION

The maximum strength of test 7 was found as 16.44 N/mm^2 and 28.66 N/mm^2 for 7 and 28 days respectively which more among all the combinations. For all mixes observed slump value lies between 30 to 45 mm. Thus cement, stone dust, sand and coarse aggregate proportion of 6:4.8:7.2:24 gave optimum result. hence such type of mixes may be suitable for Mass concrete; lightly reinforced sections in slabs; beams; walls; columns; floors; hand packed pavements; canal lining; strip footing.

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