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CHARACTERISTICS OF HIGH PERFORMANCE CONCRETE BY ROBOSAND AND FLYASH AS A PARTIAL REPLACEMENT OF SAND AND CEMENT

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ABSTRACT

River sand is the one of the basic material in the manufacture of concrete. High Performance Concrete (HPC) is a concrete meeting special combinations of performance and uniformity requirements that cannot be always achieved routinely by using conventional constituents and normal mixing. Recently natural sand is becoming very costly because of its demand in the construction industry and BAN of sand mining in rivers. So research for the alternatives of natural sand is going to find in economical way to meet the high performance characteristics. In this path the manufactured sand called ROBOSAND is the new material i.e., arrived in the world of concrete to fulfill the requirements of Natural sand. The other material FLYASH comes from the industries as a byproduct which is freely available is a good replacement for cement. Codes such as ACI are also suggesting that flyash will be useful material to replace cement. This present paper mainly focuses on achieving high performance characteristics of concrete of M80 and M90 grades. The strength and workability properties for both grades are compared by varying the percentages of ROBOSAND with natural sand by 0%, 25%, 50%, 75%, 100% together with flyash of 20%. The compressive strength, split tensile strength and flexural strength are compared for both grades and results are concluded.

Keywords: *High performance concrete, Robosand, High performance concrete, Compressive strength, flyash, silicafume.*

I. INTRODUCTION

Concretes of strengths above 40 Mpa are generally confirmed to produce high strengths. HPC is nothing but high strength concrete not only gives high ultimate strength but performs better in many aspects like durability, abrasion resistance and sulphate attack etc.

High rise buildings and off shore structures and long span bridges, structures at marine environment are requires high strength concrete for its more stability and durability for lifetime. There is a possibility of obtaining required high performance characteristics for concrete with low water cement ratios by superplastisizers. Mineral admixtures such as silica fume and flyash are used to fill microscopic voids to get required strengths.

The developing country like India facing shortage of good quality natural sand and particularly in India, natural sand deposits are being used up and creating serious problem to environment and society. The sand mining from riverbeds is causing a serious threat to environment such as erosion of riverbed and banks, degrading landslides, loss of vegetation on the river banks, lowering the underground water table etc. Hence, sand mining from riverbeds is being restricted or banned by the authorities.

Hence Robosand has become a viable alternative to the natural sand. Robosand or Manufactured sand is crushed fine aggregate produced from crusher units and designed for use in normal strength and high strength concretes and other specific products. Use of Manufactured Sand as an alternative to river sand will giving same results as of the natural sand and it will gives high strength with some of the additives in it. Many construction authorities and Ready Mix plants are using Robosand because of its good constructional properties as natural sand.

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The use of Flyash in cement is also confirmed by the ACI code up to 40%. The present activities in constructions are already working with Robosand. In high performance concrete need of alternatives is necessary for the sustainable growth and to overcome the demand of conventional materials. So i hope Robosand and Flyash are using in this study to produce high strength concrete as a replacement of sand and cement will definitely becomes as a good alternative materials.

II. MATERIALS

Cement used is of Ordinary Portland Cement of 53 grade confirming to IS 12269-1987. Fine aggregate used are of Natural River sand from nearest locality and Robosand from VNS plant, Vijayawada. The maximum size of coarse aggregates of 12.5mm is used. The coarse aggregates are of crushed granite aggregates obtained from nearest crusher unit.

A good quality of class- C flyash is obtained from Vijayawada Thermal Power Station. Silica Fume is used as mineral admixture to fill the microscopic voids and for better results. In order to improve the workability GLENIUM B233 of 0.3% by cement weight is used. It is confirming to IS 9103-1999 specifications.
Detailed sieve analysis is done for both sand and Robosand
And they are confirming to Zone-II

Properties of materials are shown below in Table.1

Material	Specific gravity	Fineness modulus
Cement	3.11	285 m^2/kg
Sand	2.66	2.88
Robosand	2.78	2.91
Coarse aggregate	2.80	7.11
Flyash	2.15	380 m^2/kg
Silica fume	2.20	20000 m^2/kg

III. EXPERIMENTAL INVESTIGATIONS

The mix design is prepared according to the guidelines in the code ACI 211.1-91. The W/C ratios for M80 grade are taken as 0.32 and for M90 grade is 0.30. Several trail mixes have been done to finalize the mix ratios for both these grades.
The final mix ratios for both grades are given in the Table.2

Table.2 Mix proportion ratios

Grade	Mix Ratio	W/C ratio
M80	1: 0.87: 1.75	0.32
M90	1: 0.78: 1.67	0.30

For calculating the compressive strength, cube specimens are casted of size 150mm x 150mm x 150mm. For split tensile strength cylindrical specimens are of size 300mm height and 150mm diameter are used. Flexural strength is calculated by casting beam specimens are of size 500mm x 100mm x 100mm. These are tested for 7days and 28days curing.

For testing fresh concrete workability is the main property of concrete. Workability of concrete is calculated by Slump Cone method.

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The trail mixes finalized are shown below in Table.3

Table.3 trail mix details

Mix	Cementitious material (%)			Fine aggregate (%)	
	Cement	Flyash	SF	Sand	Robosand
Control	100%	0%	0%	100%	0%
Trail 1	75%	20%	5%	100%	0%
Trail 2	75%	20%	5%	75%	25%
Trail 3	75%	20%	5%	50%	50%
Trail 4	75%	20%	5%	25%	75%
Trail 5	75%	20%	5%	0%	100%

IV. RESULTS AND DISCUSSIONS

Compressive strength:
The compressive strength results are tabulated below in Table.5

Table.5 compressive strength

Mix	Compressive strength (N/mm^2)			
	M 80 grade		M 90 grade	
	7 days	28days	7days	28days
Control	56.1	85.5	68.8	95.5
Trail 1	57.5	89.6	70.5	96.2
Trail 2	58.9	90.5	71.8	98.2
Trail 3	60.2	91.1	72.0	105.5
Trail 4	58.5	89.2	71.2	99.5
Trail 5	56.4	88.9	69.9	98.6

Split tensile strength:
The split tensile strengths are listed below in Table.6

Table.6 Split tensile strength

Mix	Split tensile strength (N/mm^2)			
	M 80 grade		M 90 grade	
	7 days	28days	7days	28days
Control	4.28	5.55	5.65	6.25
Trail 1	4.24	5.58	5.62	6.26
Trail 2	4.30	5.60	5.75	6.30
Trail 3	4.38	5.65	5.80	6.65
Trail 4	4.32	5.62	5.65	6.50
Trail 5	4.22	5.56	5.60	6.45

Flexural strength:

The modulus of rupture is calculated here and the results are tabulated below in Table.7

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Table.7 Flexural strength

Mix	Flexural strength (N/mm^2)			
	M 80 grade		M 90 grade	
	7days	28days	7days	28days
Control	6.20	8.66	6.65	8.95
Trail 1	6.45	8.65	6.68	9.05
Trail 2	6.50	9.25	6.70	10.45
Trail 3	6.65	10.5	6.82	11.12
Trail 4	6.53	8.86	6.75	10.26
Trail 5	6.30	8.72	6..62	9.12

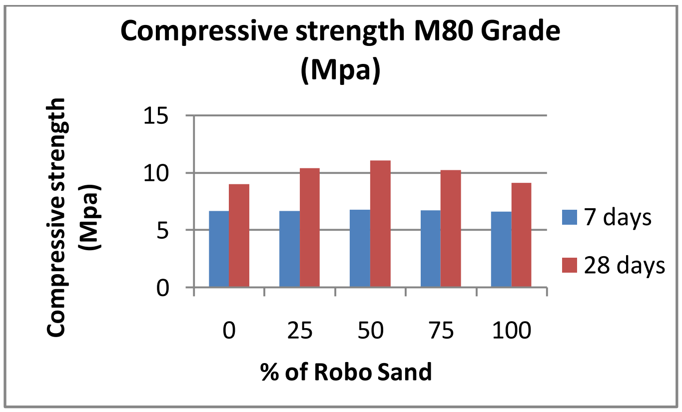

Fig 1 Compressive strength of M80 Grade

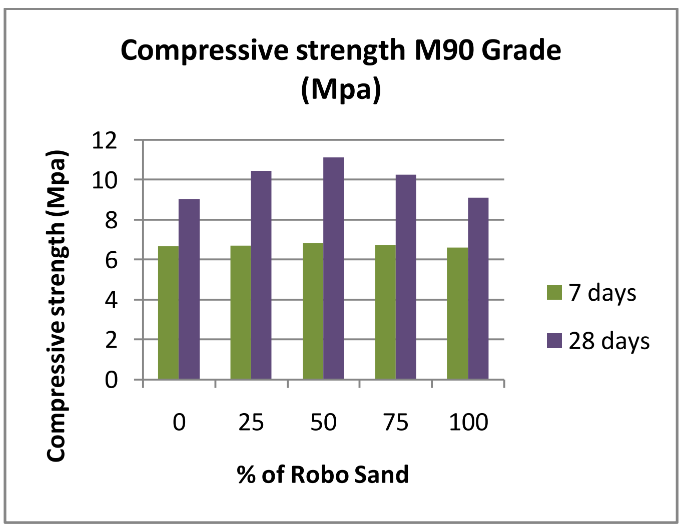

Fig 2 Compressive strength of M90 Grade

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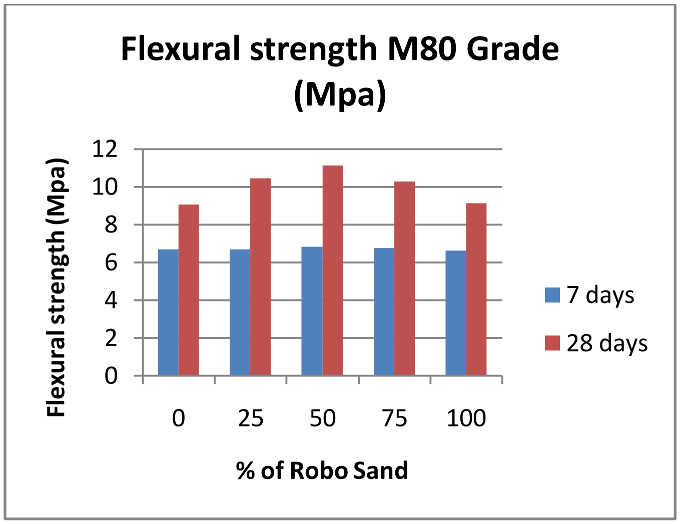

Fig 3 Split tensile strength M80 Grade

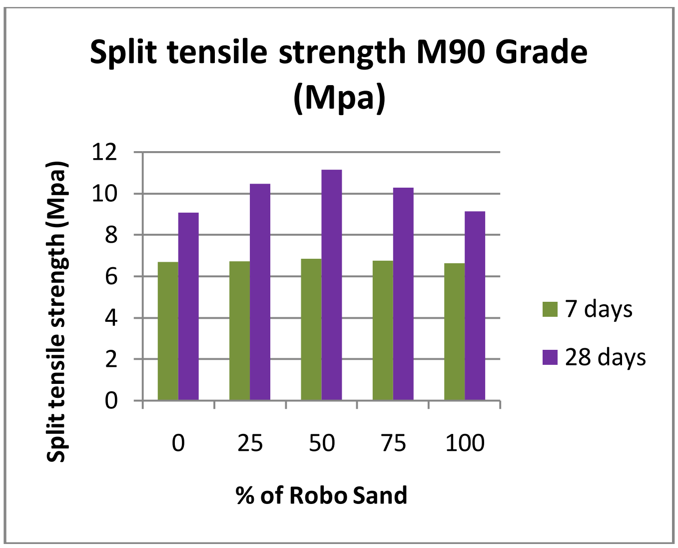

Fig 4 Split tensile strength M90 Grade

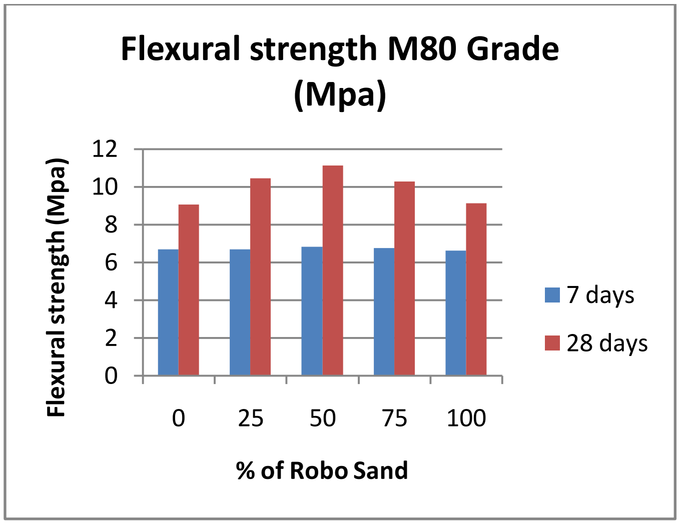

Fig 5 Flexural strength of M80 Grade

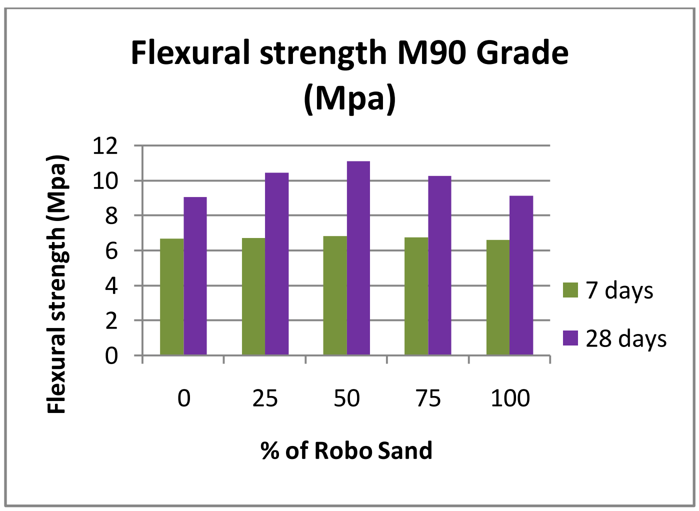

Fig 6 Flexural strength of M90 Grade

V. CONCLUSIONS

These following conclusions are given based on the above experimental results

1. In the present investigation possibility of high strengths are observed for M80 and M90 grades that are successfully achieved.
2. The material Robosand is a good alternative to replace River sand that it satisfied all the requirements as well as natural sand and it can be used for all constructional purposes in place of natural sand for sustainable constructions.
3. Cement is replaced with 20% Flyash and 5% silica fume shows better results in producing high strengths of M80 and M90 grades.
4. The coarse aggregates of maximum size of 12.5mm are used to reduce the amount of area occupied by 20mm aggregates, thereby reducing amount of voids and gives better bonding.
5. At the replacement of 50% Robosand for M80grade, from 7days to 28days the rate of increase in compressive strength is of 3.4% and flexural strength is of 3.5% and split tensile strength is of 3%.

6. And for M90 grade, from 7days to 28days the rate of increase in compressive strength is of 3.5% and flexural and split tensile strengths are of 4%, 2%.
7. By comparing both M80and M90 grades, it is concluded that robosand can be useful to produce high strengths and the optimum percentage is obtained at 50% Robosand, 20% flyash and 5% silica fume.

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