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Partial Replacement of River Sand with Robo Sand in Concrete Production

P. MohanaRao, Y.Sombabu, M.AradhanaRao

Assistant Professor, Department of Civil Engineering, Sree Vahini Institute of Science & Technology, Tiruvuru, A.P.India

ABSTRACT: Now a day the construction industry in the India is facing one of the major problems that is natural fine aggregate. And court awarded that totally band on excavation of fine aggregate from river because they effect on environment and changing the river direction Cement, sand and aggregate are basic needs for any construction industry. Sand is a prime material used for preparation of mortar and concrete and which plays a major role in mix design. Now a day's erosion of rivers and considering environmental issues, there is a scarcity of river sand. The non-availability or shortage of river sand will affect the construction industry; hence there is a need to find the new alternative material to replace the river sand, such that excess river erosion and harm to environment is prevented. Many researchers are finding different materials to replace sand and one of the major materials is quarry stone dust (Artificial/Robo/M - SAND). Using different proportion of this robo sand along with sand the required concrete mix can be obtained. Replacement of natural fine aggregate with artificial fine aggregate by 0%, 10%, 20%, 50%, 70, 100% and also finding the compressive Strength of that concrete cube This Project presents a review of the different alternatives to natural sand in preparation of concrete. The project emphasizes on the physical and mechanical properties and strength aspect on concrete

KEY WORDS: Robo sand, compressive Strength, river sand, workability, split tensile strength

I. INTRODUCTION

Concrete is an artificial conglomerate stone made essentially of Portland cement, water, sand and coarse aggregates. The mixture of the materials results in a chemical reaction called hydration and a change in the mixture from plastic to a solid state. It has found use in different fields of civil engineering, in highway engineering concrete is used in the production of slabs used as rigid pavement. The high cost of concrete used in rigid pavement construction stems from the cost of the constituent materials. Such cost can be reduced through the use of locally available alternative material, to the conventional ones normally used in concrete work, of interest to this research is an alternative to sand.

River Sand:

A thorough study by experts has shown that the riverbed sand supplied for construction purpose is virtually worthless and is not fit for use unless it is tested. It contains 25-30 per cent of silt against the permissible 5 %. Mud content in it is between 20 per cent and 25 per cent against the permissible limit of 2 % to 5 % showing rock sand as a viable substitute for river sand, he said it could be used in reinforced concrete, brick work. Explaining the efficacy of rock sand, Mr. Raja ling, unlike river sand, which was less effective in concrete mixing because sand particles travel long distance in the river water thus losing most of its strength, rock material was obtained by crushing it in the VS (vertical soft impacted) crusher, which added to its strength and made it highly dependable. The river sand collected from different locations and quarries widened the scope for a varied quality, but the same could not be said about ROBO sand, he pointed out.

The worldwide consumption of sand as fine aggregate in concrete production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years. A situation that is responsible for increase in the price of sand, and the cost of concrete. This research is aimed at determining the suitability of ROBO sand to replace river sand in the production of concrete, using compressive strength and flexural strength tests as basis for assessment.

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ROBO Sand:

ROBO sand is an ideal substitute to river sand. It is manufactured just the way nature has done for over a million years. ROBO sand is created by a rock-hit-rocking crush technique using state of the art plant & machinery with world class technology. Created from specific natural rock, it is crushed by a three-stage configuration of a Jaw Crusher followed by a Cone Crusher and finally a Vertical Shaft Impactor (VSI) to obtain sand that is consistence in its cubical particle shapes and gradation. ROBO sand is the environmentally friendly solution that serves as a perfect substitute for the fast depleting and excessively mined river sand, which is so essential for percolating and storing rain water in deep underground pockets and protects the ground water tables. ROBO sand 0-4.75mm is suitable for all concrete preparations and is used across all segments such as Independent Houses, Builders, RMC Plants, Concrete Batching Plants and Infrastructure Concrete Works.

The cubical particle shape helps make concrete more cohesive A perfect gradation ensures fewer voids and increases the compressive strength. Well balanced physical and chemical properties of ROBO sand make for more durable buildings. ROBO sand is produced under controlled conditions with raw material from a single source resulting in very consistent quality with no seasonal fluctuations. The complete absence of deleterious materials eliminates wastage and works out economical for use in concrete. An optimum level of fineness content helps overcome deficiencies of concrete such as segregation, bleeding, voids and honey combing. Easy availability of ROBO sand in huge quantities around the year leads to execution of construction projects on time. ROBO sand is an eco-friendly product and its helps to conserve nature by preventing depletion of ground water levels.

Advantages of ROBO Sand:

- Greater Durability:

ROBO Sand has balanced physical and chemical properties that can withstand any aggressive environmental and climatic conditions as it has enhanced durability, greater strength and overall economy. Usage of ROBO Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary etc.

- High Strength:

The superior shape, proper gradation of fines, smooth surface texture and consistency in production parameter of chemically stable sands provides greater durability and higher strength to concrete by overcoming deficiencies like segregation, bleeding, honey combing, voids and capillary.

- Greater Workability:

The crusher dust is flaky and angular in shape which is troublesome in working. There is no plasticity in the mortar which makes it even difficult for the mason to work, whereas the cubical shape with grounded edge and superior gradation gives good plasticity to mortar providing excellent workability.

- Offsets Construction Defects:

ROBO Sand has optimum initial and final setting time as well as excellent fineness which will help to overcome the deficiencies of concrete such as segregation, bleeding, honeycombing, voids and capillary.

- Economy:

Usage of ROBO Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastage is NIL. In International Construction Scenario, no river sand is used at all, only sand is manufactured and used, which gives superior strength and its cubical shape ensures significant reduction in the cement.

- Eco-Friendly:

ROBO Sand is the only alternative to river sand. Dredging of river beds to get river sand will lead to environmental disaster like ground water depletion, water scarcity, threat to the safety of bridges, dam's etc. Beside with the Government contemplating ban on dredging of River beds to quarry river sand, as part of the growing concern for environment protection, ROBO Sand will be the only available option.

II. LITERATURE REVIEW

Ilangovanaetal.(2008) studied the feasibility ofusage of Robo Sand as hundred percent substitutesfor natural sand in concrete. Mix design has beendeveloped for three grades using design approach ofIS, ACI, USBR, RN.No.4 and

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BRITISH codes forboth conventional concrete and quarry dust concrete. Tests were conducted on cubes and beams to studythe strength of concrete made of Robo Sand and the results were compared with the natural sandConcrete. An attempt has also been made to durability studies on Robo Sand when compared withthe natural sand concrete. It is found that the compressive, flexural strength and Durability Studiesof concrete made of Robo Sand are nearly 10% more than the conventional concrete

Nagabhushana and H. Sharada baiStudied that Concrete is a major building material which is used in construction throughout the world. Itis extremely versatile and is used for all types of structures. Due to rapid growth in construction activity, the consumption of concrete is increasing every year. This results in excessive extraction of natural aggregates. The use of these materials isbeing constrained by urbanization, zoning regulations, increased cost and environmental concern. Thus, it is becoming inevitable to use alternative materials for aggregates in concrete whichinclude recycled aggregates, fly ash, manufactured sand, crushed rock powder etc. The use of such materials not only results in conservation of natural resources but also helps in maintaining good environmental conditions.

V. Bhikshma, R. Kishore & C.V. Raghu Path experimented that Sand is basic concrete making construction material required in large quantities.Hence, in the present scenario, it is necessary to findthe most suitable substitute for sand, easy to produceand has all the required qualities for use in concrete. Manufactured sand is one among such materials to replace river sand, which can be used as an alternative fine aggregate in mortars and concretes. To attain the set-out objectives of the present investigation, M50 grade concrete has been considered. Strength properties such as cube compressive strength and flexural strength of beams, and load carrying capacity, moment carrying capacity, behavior of strains in compression as wellas tension fibers and cracking patterns have been studied for the grade of concrete. In this paper a totalof 15 cube specimens 150 × 150 × 150 mm and 10beam specimens of size 1500 × 150 × 230 mm werecast for testing. The results have been compared for the specimens made with natural fine aggregate

III. EXPERIMENTAL PROGRAM

The materials that are used in manufacturing concrete are as follows:

- Cement
- Fine Aggregate
- ROBO Sand
- Coarse Aggregate
- Water

S.NO	Physical Property	Result
1	Fineness	2.8%
2	Standard consistency	27%
3	Specific gravity	3.09
4	Initial setting time	50 minutes
5	Final setting time	290 minutes

Table 1: Physical properties of cement

S.NO	Physical Property	Result
1	Fineness modulus	2.8% (zone -II)
2	Specific gravity	2.67
3	% of water absorption	2.8
4	% of bulking	2.23

Table 2: Physical properties of river sand

S.NO	Physical Property	Result
1	Fineness modulus	2.6%
2	Specific gravity	2.67

Table 3: Physical properties of robosand

S.NO	Physical Property	Result
1	Fineness modulus	2.6%
2	Specific gravity	2.67
3	% of water absorption	1.73

Table 4: Physical properties of coarse aggregate

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IV. MIX DESIGN

M30 GRADE:

The concrete mix design has been done as per IS method

- Details of materials

a. Grade of concrete – M30
b. Type of cement – OPC 53 grade
c. Maximum nominal size of Coarse aggregate – 20mm
d. Exposure condition – Severe
e. Degree of Supervision – good
f. Type of aggregate – Angular aggregate

Assuming state of surface to be SSD (Surface Saturated Dry state)

- Test data of materials

a. Specific gravity of OPC- 3.11
b. Specific gravity of Natural Sand – 2.673
c. Specific gravity of ROBO sand – 2.67
d. Specific gravity of Coarse aggregate - 2.66
a. Sieve analysis
a. Sand – Conforming to zone-II of IS 383-1970
b. Aggregate 20 mm nominal size

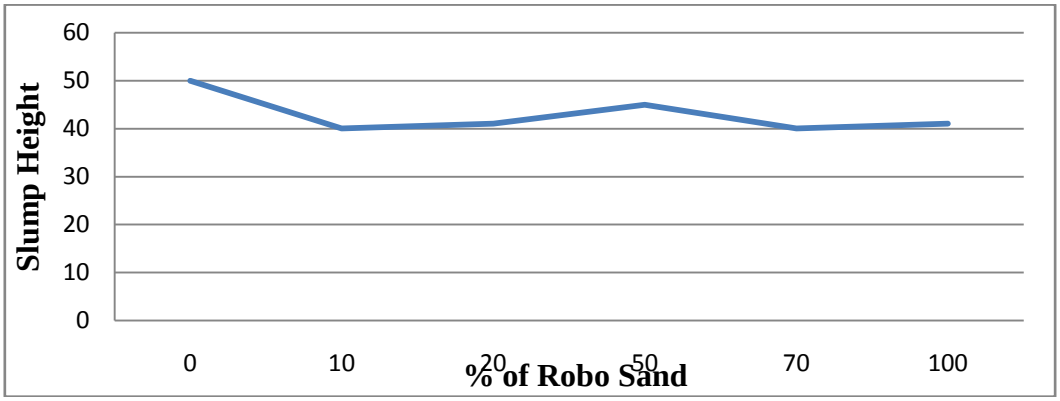
V. RESULTS AND DISCUSSIONS

Tests on fresh concrete:

Slump Cone Test

Sl. No	Materials	Slump height (mm)
1	Normal concrete	50
2	Concrete with 10% Replacement of ROBO Sand	40
3	Concrete with 20% Replacement of ROBO Sand	41
4	Concrete with 50% Replacement of ROBO Sand	45
5	Concrete with 70% Replacement of ROBO Sand	40
6	Concrete with 100% Replacement of ROBO Sand	41

Table 5. Slump cone Test



Graph: 1. Slump cone for various percentages of ROBO sand

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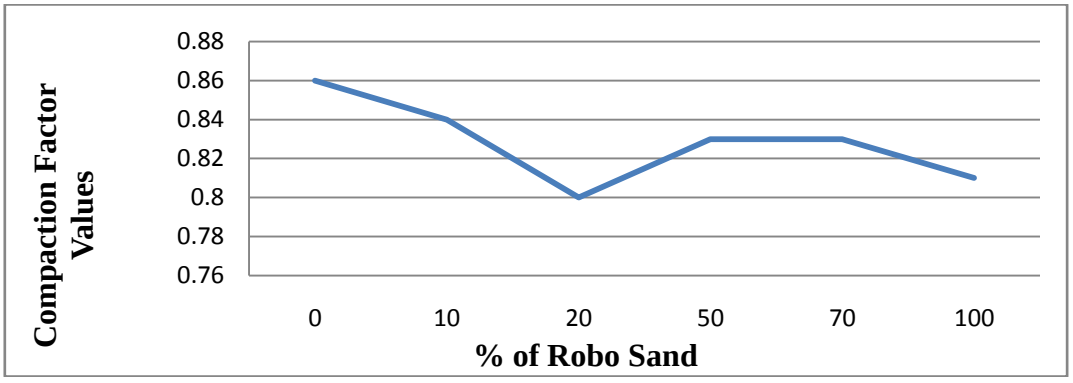
Compaction Factor:

S.No	Concrete	Weight of partially compactedconcrete(w1) (kg)	Weight of fully compacted concrete (w2) (kg)	Compaction factor = [w1 / w2]
1	Normal concrete	16.86	19.57	0.86
2	10% Replacement	16.96	20.22	0.84
3	20% Replacement	17.11	21.45	0.80
4	50% Replacement	17.42	21.05	0.83
5	70% Replacement	17.59	21.09	0.83
6	100% Replacement	18.42	22.65	0.81

Table 6. Compaction Factor



Graph: 2. Compaction factor for various percentages of ROBO sand

Based on values obtained during experimentation a graph is plotted between % of ROBO sand replaced and the values of workability tests like Slump cone test and Compaction factor test. ROBO sand consumes high amount of water to satisfy the workability. Not only has the water content Shape, Size and other factors also affected the workability. As ROBO sand is a finest particle than the fine aggregate, there will be decrease in workability of concrete when there is a increase in % of ROBO sand replacement up to a maximum of 50%.

Test on Hard Concrete:

Compressive Strength of Concrete

Sl. No	Materials	Compressive Strength ($\frac{N}{mm^2}$)		
		3 Days	7 Days	28 Days
1	Normal concrete	18.85	27.29	38.81
2	Concrete with 10% Replacement of ROBO Sand	19.45	28.25	39.70
3	Concrete with 20% Replacement of ROBO Sand	19.98	28.50	40.18
4	Concrete with 50% Replacement of ROBO Sand	20.12	29.77	40.45
5	Concrete with 70% Replacement of ROBO Sand	18.22	26.96	37.03
6	Concrete with 100% Replacement of ROBO Sand	18.51	27.40	37.85

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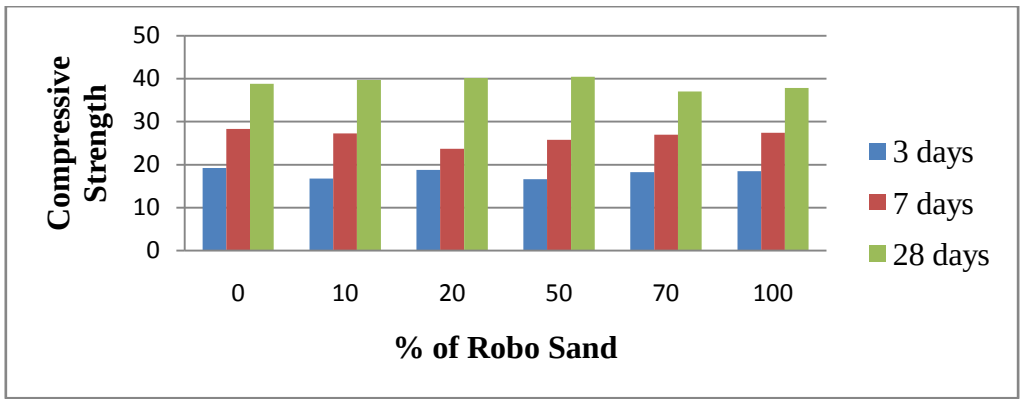
Table 7. Compressive Strength



Graph: 3. Compressive strength of concrete

A graph is plotted between % of ROBO sand replaced and the values of compressive strength for 3days, 7days & 28 days. It is observed that the variation is about 2-3% increment in compressive strength for ROBO sand concrete (50%) when compared to conventional concrete.

We can also observe the declinment of strength for 70% and 100% of ROBO sand concrete. therefore, partial replacement of sand by ROBO Sand increases the compressive strength up to 50%. Further increase in percentage of replacement, decreases the compressive strength. It is observed that there is consistent increase in the strength of concrete when partial replacement of natural sand by ROBO Sand. The sharp edges of the particles in ROBO Sand provide better bond with cement than rounded particles of natural sand resulting in higher strength up to optimum replacement. The optimum replacement of sand by M- Sand is 50%. The dwindling sources of natural sand and its high cost could encourage the adoption of M-sand by 50% replacement of natural sand

Split Tensile Strength:

Sl. No	**Materials**	**Split Tensile Strength ($\frac{N}{mm^2}$)**		
		3 Days	7 Days	28 Days
1	Normal concrete	1.78	2.79	3.27
2	Concrete with 10% Replacement of ROBO Sand	1.85	2.85	3.36
3	Concrete with 20% Replacement of ROBO Sand	1.95	2.92	3.58
4	Concrete with 50% Replacement of ROBO Sand	1.93	2.98	3.64
5	Concrete with 70% Replacement of ROBO Sand	1.86	2.68	3.26
6	Concrete with 100% Replacement of ROBO Sand	1.74	2.49	3.30

Table 8. Split Tensile Strength

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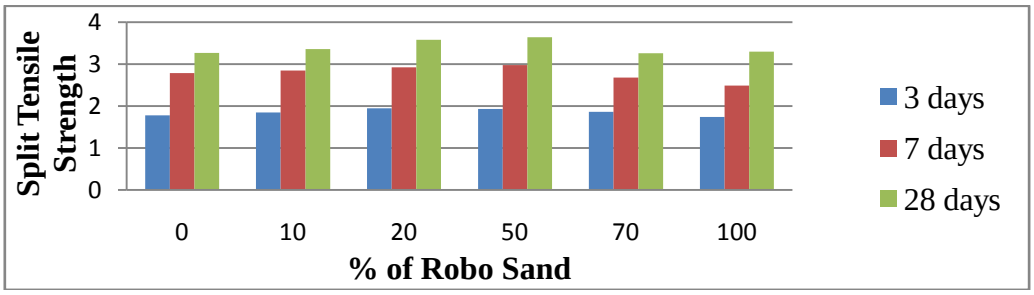

Graph: 4. Split Tensile strength

Graph is plotted between % of ROBO san replaced in concrete and the split tensile strength values. From the graph we can observe the there is a 1-2% increase in Split tensile strength of ROBO sand in concrete up to 50% and then decreases for 70% and 100%.

It is shown that, as the percentage of ROBO sand increases with an increase up to 50% replacement with conventional concrete, the split tensile strength values increased, after which a decline was observed. The graph shows that the split tensile strength relation for both conventional concrete and quarry dust concrete, at the age of 3days, 7days and 28days.

VI. CONCLUSION

Finally, it could be concluded that the use of ROBO sand as a substitute of river sand in concrete production is a good choice. The quality of the river sand normally depends on its source and most of the time it varies quite a lot. Hence manufactured sand has been identified as a substitute for river sand thereby solving the issue of mining of sand from river beds and improving the quality of fine aggregate. The dwindling sources of natural sand and its high cost could encourage the adoption of ROBO sand by 50% replacement of natural sand.

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