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Experimental Investigation On The Properties Of Concrete Partially Replacing Natural Sand With Robo Sand

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***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 affect 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 20%, 40% 60% 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 emphasize on the physical and mechanical properties and strength aspect on concrete.**

Keywords—robo sand, quarry stone dust, natural sand, mortar, artificial fine aggregate.

I. INTRODUCTION

Concrete is the most popular building material in the world. However, the production of cement has diminished the limestone reserves in the world and requires a great consumption of energy. River sand has been the most popular choice for the fine aggregate component of concrete in the past, but overuse of the material has led to environmental concerns, the depleting of securable river sand deposits and a concomitant price increase in the material. Therefore, it is desirable to obtain cheap, environmentally friendly substitutes for cement and river sand that are preferably by-products. Fly ash (pulverized fuel ash) is used extensively as a partial replacement of cement. However, though the inclusion of fly ash in concrete gives many benefits, such inclusion causes a significant reduction in early strength due to the relatively slow hydration of fly ash. Nevertheless, fly ash causes an increase in workability of concrete.

ROBO sand has been proposed as an alternative to river sand that gives additional benefit to concrete. ROBO sand is known to increase the strength of concrete over concrete made with equal quantities of river sand, but it causes a reduction in the workability of concrete.

When examining the above qualities of fly ash and ROBO sand it becomes apparent that if both are used together, the loss in early strength due to one may be alleviated by the gain in strength due to the other, and the loss of workability due to the one may be partially negated by the improvement in workability caused by the inclusion of the other.

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-rock crushing technique using state-of-the art plant and machinery with world class technology. ROBO sand is the environmental-friendly solution that serves as a perfect substitute for the fast depleting and excessively mined river sand, which is so essential and percolating and storing rain water in deep underground pockets and protects the ground water table.

ROBO sand having size from 0-4.75mm is suitable for all concrete preparation and is used across in all segments such as independent houses, Builders, RMC plants, concrete batching plants and infrastructure concrete works. Production generally involves crushing, screening and possibly washing.

II. REVIEW OF LITERATURE

M. R. Chitlange et al. (2010) study shows that mixes with artificial sand as fine aggregate gives consistently higher strength than the mixes with natural sand. The sharp edges of the particles in artificial sand provide better bond with cement than the rounded particles of natural sand resulting in higher strength. The excessive bleeding of concrete is reduced by using artificial sand.

Mukesh and charkha (2012) have conducted experiments on concrete to study the effect of the flexural and tensile strength with partial replacement of ingredients. 40% sand was replaced by crushed stone dust and cement was replaced by fly ash from 0-40% at increment of 10%. Flexure and split tensile tests were conducted in M20 mix using PPC. From the test results it was observed that the maximum flexure and split-tensile strength were obtained 0% fly ash and 40% sand replacement. If the cement was replaced by fly ash then flexure and split tensile strength were reduced. So the optimum fly ash content was 0% for

PPC cement. It was concluded that crushed stone dust can be partially used as fine aggregate with conventional river sand in concrete.

Vinayak R. Supekar, Popat D. Kumbhar's et al. (2012) study shows the replacement of natural sand by 60% artificial sand results in producing the concrete of satisfactory workability and strength properties. It is also possible to minimize the area of surface cracks of concrete, thus achieving the durable concrete. However, for more than 60% replacement of natural sand by artificial sand causes reduction in compressive strength of concrete mixes with increase in the area of cracks. The replacement of natural sand with artificial sand will help in conserving the natural resources of sand and maintain the ecological balance of the nature.

Prakash Rao D.S. and Giridhar kumar. V et al. (2014) investigated the concrete with stone crusher dust which is available abundantly from crusher unit at low cost, the test conducted pertain to concrete with reverse sand of strength 28.1mpa and that with granite stone crusher dust of strength 32.8mpa. Test on strength of concrete and on flexural behaviour of RC beam under 2 point loading sustained about 6 percent more load.

A. Anbarasan and M.Venkatesan et al. (2015) performed an experiment on effect of ROBO Sand on strength characteristics of recycled aggregate concrete by adding in different proportions. They added both Recycled and ROBO Sand in 16 set of 6 cubes each were cast and tested. From this they studied that by the combination of 30% Recycled Coarse Aggregates and 100% ROBO Sand. The compressive strength and split tensile strength were increased and for 30%, 50% and 100% proportions of ROBO sand same strength values are observed.

Priyanka A. Jadhava and Dilip K. Kulkarni et al. (2015) study shows the effect of partial replacement of natural sand by manufactured sand on the compressive strength of cement mortar of proportion 1:2, 1:3 and 1:6 with water cement ration as 0.5 and 0.55 are studied. Results are compared with reference mix of 0% replacement of natural sand by manufactured sand. The compressive strength of cement mortar with 50% replacement of natural sand by manufactured sand reveals higher strength as compared to reference mix. The overall strength of mortar linearly increases for 0%, 50% replacement of natural sand by manufactured sand as compared with reference mix (Mix 1). Manufactured sand has a potential to provide alternative to natural sand and helps in maintaining the environment as well as economical balance.

III. MATERIAL PROPERTIES

The materials used in the manufacture of concrete are Cement, Fine aggregate, Coarse aggregate, Robosand and Water.Ordinary Portland cement of 53 grade cement is used confirming to various specifications as per IS: 12269-1987. Results showed that specific gravity 3.10, Initial setting time 37min and Normal consistency 32%. The aggregate which is passing through 4.75 mm sieve is known as fine aggregate. River sand confirming to IS: 2386-1975 is used. Results showed that the specific gravity 2.70, Fineness modulus 2.72, and a bulk density of 1710 Kg/m3 which is confirms to Zone II.Crushed coarse aggregate of 20mm down size is used which is confirming to IS: 2386-1975.Results showed that the specific gravity 2.75, Fineness modulus 5.9 and a bulk density of 1530 Kg/m3.

Robo sand or M-Sand was used as replacement of fine aggregate. Robo sand is a product of crushed stone, here the stones are crushed into smaller granular size of river sand granules and washed to remove the fine rock dust to enhance the quality as per IS: 2386-1975. Below table shows the properties of Robo sand.

TABLE 3.1.Properties Of Fine Aggregate(Robosand)

Properties	*Fineness Modulus*
Observations	2.52
Specific Gravity	2.68
Bulk Density	1688

IV. EXPERIMENTALMETHODOLOGY

In this section, tests on fresh and hardened concrete have been discussed. The workability test including slump are conducted on fresh concrete whereas hardened concrete specimen are tested for direct compression and split tensile strength.

The main objective of this experimentation is to find out the effect of replacement of natural sand by manufactured sand with 20%, 40% and 60% on hardened properties of cement concrete. The experimental work includes the casting, curing and testing of specimens. Concrete mix is prepared with proportion of 1:2.56:3.26 with water cement ratio of 0.40 respectively. Three trials are carried out for each water cement ratio and concrete mix proportion, where Mix 1 is the reference mix with 20% manufactured sand, Mix 2 is with 40% replacement of natural sand by manufactured sand and Mix 3 is with 60% manufactured sand. All of the experiments are performed in normal room temperature. The mortar ingredients namely cement, fine aggregate and coarse aggregate first mixed in dry state. Manufactured sand is used as a partial replacement to the natural sand then calculated amount of water is added and mix it thoroughly to get a homogeneous mix and then tested for workability. Mortar is poured in the moulds layer by layer and compact thoroughly. Cubes are used for compressive strength test having size 150 mm x 150 mm x 150 mm and Cylindrical specimens are used for split tensile strength test having size 150 mm diameter and 300 mm length were cured in water for 7 & 28 days and tested at 7 & 28 day's on Universal testing Machine (UTM).

V. EXPERIMENTAL RESULTS

Results obtained from experimental investigations are the workability, compressive strength and split tensile strength of various concrete mixtures containing Ordinary Portland Cement along with the natural sand and ROBO sand respectively.

M40 grade concrete with varying dosages of ROBO sand by weight of cement and sand at 7, 14 and 28 days have been presented and discussed.

TABLE 5.1 Workability Of Freshly Mixed Concrete

S.No	Mix designation (robo sand)	Slump value
1	0%	75mm
2	20%	68mm
3	40%	60mm
4	60%	50mm

5.1 Compression test

Tables shows 7 days, 14 days and 28 days compressive strength values of M40 grades concrete made using natural sand, ROBO sand of zone-2 and the variation of the strength represents in the graphs

TABLE 5.2 Compressive Strength

S.No	Mix design (robo sand)	Compressive strength (7Days) N/mm^2	Compressive strength (14Days) N/mm^2	Compressive strength (28Days) N/mm^2
1	0%	26	36.88	41.88
2	20%	28.33	40.44	45.11
3	40%	35.66	44.83	47.33
4	60%	37.44	49.66	52.11

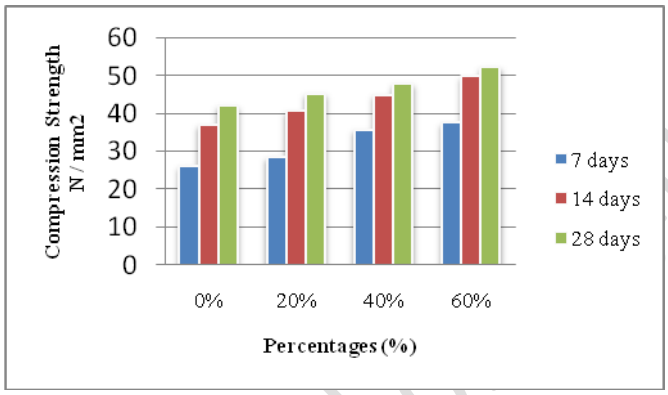

Fig 5.1 Variation of ROBO sand on compressive strength of different concrete mixes

- **Effect of compressive strength**

Tables shows the results of compressive strength values for 7, 14, 28 days for ROBO sand as a replacement of sand of proportions 0 %, 20%, 40%, 60%.

Finally from the results the compressive strength is increasing from 0 to 40 percent and then decreasing up to 100 percent with reference to conventional concrete.

5.3 Split Tensile Test

Table shows 7 days, 14 days, 28 days split tensile strength test results of M40 grade concrete made with natural sand, ROBO sand of zone-2. and the variation of the strength represents in the graphs.

Table 5.3 Split tensile strength

S.No	Mix design (robo sand)	Split Tensile strength (7Days) N/mm^2	Split Tensile strength (14Days) N/mm^2	Split Tensile strength (28 Days) N/mm^2
1	0%	9.62	10.05	11.31
2	20%	10.18	10.18	11.88
3	40%	10.75	11.03	12.16
4	60%	12.16	12.16	13.01

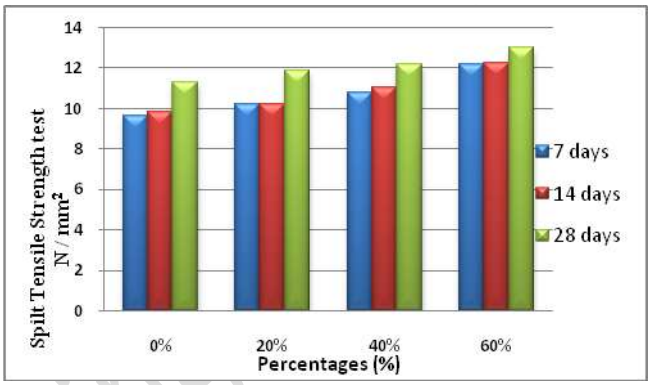

Fig 5.2 Variation of ROBO sand on Split tensile strength of different concrete mixes

VI. EXPERIMENTAL RESULTS

Based on results obtained, the conclusions are

1. The effect of partial replacement of Natural sand by ROBO sand on the compressive strength of cement concrete of grade M40 (1:2.56:3.26-Design mix) with water cement ratio as 0.40 are studied.
2. Results are compared with reference mix of 0% replacement of Natural sand by ROBO sand. The compressive strength of cement concrete with 20%, 40%, 60%replacement of Natural sand by ROBO sand reveals higher strength as compared to reference mix.
3. The replacement of sand as has been done up to 60 percent as a fine aggregate in concrete by using ROBO sand.
4. The overall strength of concrete linearly increases for 0%,20%, 40%, 60% replacement of Natural sand by ROBO sand as compared with reference mix.
5. Coming to workability it is observed that workability is increasing when compared to conventional concrete.
6. A compressive strength result there is a nominal increase in the ROBO sand concrete up to 60 percent replacement.
7. From the split tensile strength results there is a nominal increase in the ROBO sand concrete with reference to conventional concrete at 28 days.
8. This indicates that ROBO sand can be replaced for fine aggregate without any correction while designing the concrete mix.
9. ROBO sand has a potential to provide alternative to Natural sand and helps in maintaining the environment as well as economical balance.

10. Non-availability of natural sand at reasonable cost, forces to search for alternative material.
11. ROBO sand qualifies itself as suitable substitute for river sand at reasonable cost.
12. The ROBO sand found to have good gradation and better bonding which is comparatively less in natural sand.
13. According to price – service ratio the use of ROBO sand gives effective results, as far as we concern the cost of ROBO sand is 30-50% less in market which is good for production of economical concrete.
14. The service of ROBO sand is also as good enough for as Natural sand concrete.

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