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Flexural Behaviour of RCC Beam with Partial Replacement of Fine Aggregate with Manufactured Sand

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Abstract - Cement concrete is most widely used building material because of its high strength. As there is development in infrastructure, demand for production concrete is also increased. The consumption of natural sand is high due to extensive use in concrete and mortar. The demand of natural sand is high in developing countries. In this situation the developing country like India, natural sand deposits are depleted and causing serious threat to environment. Properties of aggregate affect the durability and performance of concrete. The most commonly used fine aggregate is river sand or pit sand. Natural sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon extent of wearing. Now-a-days good sand is not readily available; it is transported from long distances. The manufactured sand produced by proper machines can be beater substitute to river sand. Sand should have particles from 150 microns to 4.75 mm. fine particles should be in proper proportion then it will have minimum voids. The day by day as river sand cannot meet the rising demand of construction section because of its limited supply, the cost of river sand has sky rocketed and its consistent supply cannot be guaranteed. River sand in many parts of the country is not graded properly and has excessive silt and organic impurities and these can be detrimental to durability of steel in concrete whereas manufactured sand has no silt or organic matter. The flexural behavior of RCC beams of under loading the corresponding deflections are examined such that flexural behavior of RCC beam of under reinforce, balanced and over reinforced sections are analyzed. In the present study analyze the flexural behavior of RCC beam in replacement of natural sand as M-sand.

Key Words: Compressive strength, Flexural strength, Natural sand, Manufactured sand.

1. INTRODUCTION

1.1 Natural and Manufactured Sand

The Natural sand is one of the main constituents of the concrete making about 35% of volume of concrete used in building construction industry. It is mainly excavated from the riverbeds. Due to the construction of dams on river. These natural resources are erasing fast .in hilly areas and other such places where sand is not abundantly available this becomes a good substitute. Natural sand always contains high percentage of inorganic salts of chlorides, sulphate sand other deleterious organic salts and impurities. Chlorides and sulphate adversely affect on the strength and durability of concrete and reinforcing steel thereby reducing the life of structure. Due to excessive excavation silt in natural sand has been found more in volume. Excessive silt causes reduction in strength of concrete affecting durability. Manufactured sand(M-sand) is different in shape, grading and content of very fine sand as compared with river sand and it is well known that the material properties of M-sand concrete are also different from those of river sand concrete.

1.2 Compressive strength

The compressive strength is the resistance of material to breaking under compression. Concrete specimens are a cast and tested under the action of compressive loads to determine the strength of concrete. The compressive strength of concrete strength of 150mm size cubes tested at 28 days(fck). The characteristic strength is defined as the strength of concrete below which not more than 5% of the test results are excepted to fall. Average 28 days compressive strength of at least three 150 mm concrete cubes prepared with water proposed to be used shall not be less than 90% of average of strength of three similar concrete cubes prepared with distilled water. For compressive strength test prepare cubes with 25%, 50% and 75% replacement levels and with 100% natural sand to compare the results. From these compressive strength results find out the max strength for replacement and that replacement level is used to find out flexural strength of beam.

1.3 Flexural strength

Flexural strength also known as modulus of rupture or bend strength or transverse rupture strength is a material property defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most frequently employed, in which a specimen having either circular rectangular cross-section is bent until fracture or yielding using two point loading. The flexural strength represents the highest stress experienced within the

material at its moment of yield. It is measured in terms of stress. to estimate and analyze the basic properties of and behavior of RCC an experimental study is needed. In the present study an experiment in which flexural behavior of RCC under various constrains is the major criteria. For experimental analysis simply supported beams of under reinforced, balanced and over reinforced sections are considered. When the beam is simply supported and is subjected to some external loading the corresponding deflections are examined such that the flexural behavior of RCC beams of under loading the corresponding deflections are examined such that flexural behavior of RCC beam of under reinforce, balanced and over reinforced sections are analyzed. In the present study analyze the flexural behavior of RCC beam in replacement of natural sand as M-sand.

2. LITERATURE REVIEW

B Balapgol, S.A.Kulkarni, K.M.Bajoria (2002),This paper presents the results of an experimental study on strength and durability of concrete with crushed basalt stone fine aggregates as a substitute to diminishing natural sand. The strength and durability properties of concrete viz. compressive strength, flexural strength and permeability of hardened concrete where investigated. An experimental study was performed to observe the performance of concrete incorporating crushed basalt stone fine aggregates replacing the natural sand. The test results indicate that the performs of concrete crushed basalt stone fine aggregates were excellent. The compressive strength of concrete for different grades increased from 8% to 26 %, the flexural strength was increased from 1% to 5% and coefficient of permeability was decreased significantly. The test result indicated that strength and durability of concrete would be better with crushed sand replacing the natural sand. The flexural strength of concrete was determined by bending test in accordance with Indian standards [4]. To find flexural strength three beam specimens of size 700x150x150 mm for each of 8 mixes were tested after 7 days and 28 days curing under universal testing machine with two -point loading. The average flexural strengths for concrete with crushed sand and natural sand were reported and compare the results. The concrete with crushed sand performed better than concrete with natural sand as the grade of concrete mix increased. The flexural strength of concrete with crush sand was marginally increased on strength of concrete with natural sand.

SunilaaGeorge, Jino John, P.N.Magudeswaran and R. Thenmozhi (2008), The river sand is used as fine aggregate in concrete. Large scale construction activities have led to increased cost of river sand which leads to illegal sand mining. Hence, several state governments have imposed restrictions on sand quarry. Another problem noted is environmental degradation. For the past 4-5 years, the crushed sand has not been used much in India as the ordinary crushed sand is flaky, badly graded with rough texture (Prithvi et al. 1991). It produces harsh concrete; but now many improved types of equipment's are set up in India to produce crushed sand of acceptable quality at project site. With manufactured sand as a fine aggregate, the Pune-Mumbai express highway, one of biggest projects undertaken in India, has been completed. The total quantity involved was 20,000,00 m3 of concrete. In this study , concrete mix M30 has been designed using quarry dust and manufactured sand by replacing the river sand. Four mixes proportions were made to test the effect of inclusion of quarry dust and manufactured sand in concrete and the results were compared with the control specimens. It was found that the strength of the concrete is enhanced in both types of replacements.

Anil Kulkarni, Rajeeb Kumar, Vikram Kumar (2011),From crushed stone sand is manufactured sand, which is better in terms of quality and fulfils the requirements of suitable material for use in concrete. M-sand is manufactured by any of the methods by crushing of coarse aggregate (20mm & 10mm) in separate sand plants or using 3 stage vs/ crushed then this material is further processed either by washing with water or dry sieving. If required to improve the grading & reduce fine powder content. This comparison study gives an insight into the various characteristics of fine aggregate playing role in making good pumpable concrete along with other important hardened concrete properties.

T.Shanmugapriya,R.N.Uma (2012),This paper represents the optimization of partial replacement of manufactured sand by natural sand with silica fume in high performance concrete (HPC). The OPC was partially replaced with silica fume by 1.5%, 2.5% and 5% and the natural sand is replaced with M-sand by four proportions (i.e. 10%, 30%, 50%, 70%). The results indicated that there is an increase in compressive and flexural strength of HPC nearly 20% and 15% respectively with the increase of manufacturing sand percentage addition of up to 50% of M-sand as a sand replacement yielded comparable strength with that of control mix. However further additions of M-sand caused reduction in the strength. The optimum percentage of replacement of natural sand by M-sand is 50% results also reveled that increase in percentage of partial replacement of silica fume increased compressive and flexural strength of high performance concrete.

Rajendra.P.Mogre,Dhananjay.K.Parbat,Shirish.D.Dhobe(2015),The paper present experimental results based analysis of compressive and flexural strength of concrete acquired with combination of artificial sand and natural sand utilizes indigenously prepared concrete mixture in the laboratory the experimental plan has been organized on 125 orthogonal array design parametric analysis has made based on Taguchi methodology the mathematical models have also been developed to correlate compressive strength (6fs)and average flexural strength (6fs)with different three parameters.

3. OBJECTIVES

- The main aim of this investigation is to examine flexural test of RCC beam with partial replacement of Fine Aggregate by M-sand.
- To evaluate the ultimate load carrying capacity of RCC beam with partial replacement of M-sand.
- To study the cracking characteristics and Design Over-Reinforce, Under-Reinforce, Balanced sections of RCC beam.
- To study the behavior of beam deflection under two point loading.
- To compare the experimental results of M-sand with natural sand.

4. METHODOLOGY

In order to accomplish the objectives, the project work has been divided into five major parts. They are:

- Collection of required data to carry out the analysis from journals, technical magazines, reference books and web source.
- Casting of RCC beam with M40, M50 Concrete.
- Preparation of RC beam with number of specimen for Natural sand and M-sand.
- Comparison to be made between these analyses to know possibility and feasibility.
- From the results of Experimental analysis the final conclusion will be drawn.

4. MATERIALS AND EXPERIMENTAL PROCEDURE

To attain objectives, materials were collected from various sources. However, the material that is utilized as a part of a work should not make any harm to the environment. To find out the goal of this examination, the experimental work was completed on thirty six beams. The source of the materials utilized for experimental work of the RCC beam and testing strategies are given in the upcoming article.

4.1 Concrete

The concrete used for casting was prepared in the testing laboratory using a hand mix method of concrete. The concrete was (M40 Grade) & (M50 Grade) with mix proportion adopted was (1:1.579:2.755) with water /cement ratio of 0.45. and for M50 proportion adopted was (1:1.363:2.3794)with water cement ratio 0.40.The material proportions per cubic meter of concrete:

M-40

1) 1206.26 kg/m^3 of coarse aggregate (maximum size 20mm)

2) 691.35 kg/m3 of natural river sand (sp.gr =2.60)

3) 437.77 kg/m^3 of ordinary port land cement (53 grades)

4) 197 liters of water

M-50

1) 1174.21kg/m^3 of coarse aggregate (maximum size 20mm)

2) 673.031 kg/m3 of natural river sand (sp.gr =2.60)

3) 493.50 kg/m^3 of ordinary port land cement (53 grades)

4) 197 liters of water

4.2 Details of beam specimen

While reviewing literature of beam come to knew that the beam size is 700X150X150 mm. Accorded to the IS (10086-1982) & IS (516-1959) minimum size of specimen for beam mould is 700X150X150mm. There is no specified mould size was found in Indian standard codes, hence select the beam size as 700X150X150 mm which satisfies provision of IS (10086-1982) & IS (516-1959).

4.3 Preparation of beam specimens

After all the collection of material next step was go through the specimen making from the collected material. The details of Specimen making is enlisted below.

Casting of Beams Specimens

Nine wooden moulds of the same dimensions were fabricated for casting the beam specimens to be tested in this study. The moulds were properly cleaned and greased for easy de-moulding after casting. The concrete required for casting was prepared using a concrete hand mix. Before

pouring concrete, the reinforcement cages were placed inside the mould with suitable sized cover. The concrete was properly compacted. All the beams were cast to the same dimensions of 150 mm depth, 150 mm width and 700 mm overall length.

Placing of the cage in the mould

Beam cast

4.4 Experimental Set-up for Deep Beams Testing

The testing of deep beams in this work was carried out using a 1000 kN Universal Testing Machine (UTM) that was available at the institution for conducting the experiments. The beam specimens were designed to be of the maximum possible dimensions that the UTM can support during testing. The beams are tested as simply supported beam with Two point loads until failure.The load positions were spaced at 210 mm c/c which is one-third of span.

Applying a load on deep beam

Shear failure and cracks on beam

Flexure failure shows in beam

Data acquisition on UTM for beam

5. RESULTS

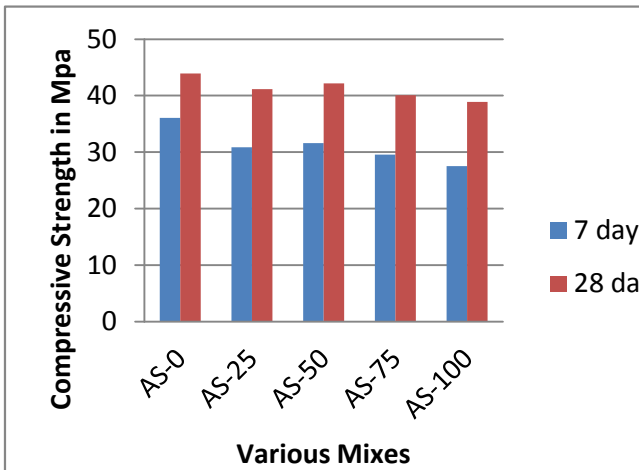
5.1 Compressive strength Test

Standard cube specimens were casted and were kept as it is for 24 hours and then kept in water tank for 7 and 28 days of curing. The concrete cube specimens cast by replacing natural

sand with artificial sand at different replacement levels and tested under compression testing machine. A set of 3 cubes were tested. Find out the compressive strength of cubes. For compressive strength of M40 grade concrete for 7 & 28 days Ref Table no.5.1. and for M50 grade concrete for 7 & 28 days Ref Table no.5.2

Table No.5.1

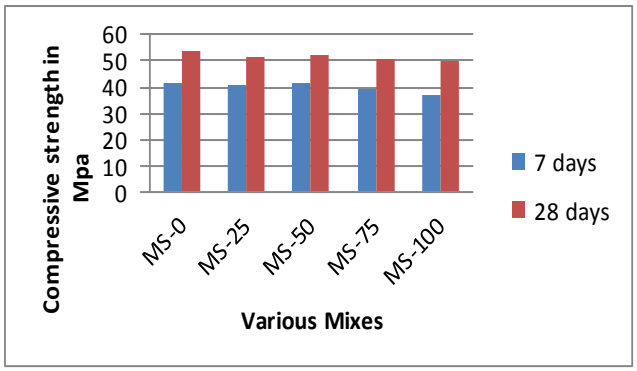
Mix Designation	Average Compressive strength 7 days (mpa) M-40 grade	Average Compressive strength 28 days (mpa) M-40 grade
MS-0	36.06	43.93
MS-25	30.86	41.17
MS-50	31.57	42.16
MS-75	29.58	40.06
MS-100	27.55	38.89



Graph 5.1 Variation in compressive strength (7 & 28 days) for various mixes of M-40 grade concrete.

Table no.5.2

Mix designation	Average Compressive strength 7 days (mpa) M-50 grade	Average compressive strength 28 days (mpa) M-50 grade
MS-0	41.86	53.60
MS-25	40.79	51.10
MS-50	41.53	52.30
MS-75	39.58	50.51
MS-100	37.15	49.79



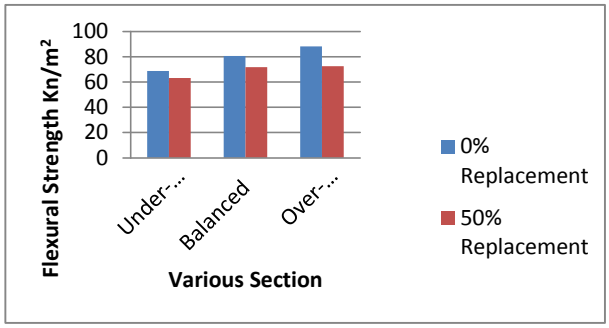
Graph 5.2 Variation in compressive strength (7 & 28 days) for various mixes of M-50 grade concrete

5.2Flexural strength test

The beams were casted with size 700mm x 150mm x 150mm. The beams were in balanced, Over-reinforced , Under-reinforced section. The flexural test was conducted on Universal Testing Machine. The results of flexural test are as below. Ref Table no.5.3 & 5.4 for flexural strength results.

Table no.5.3

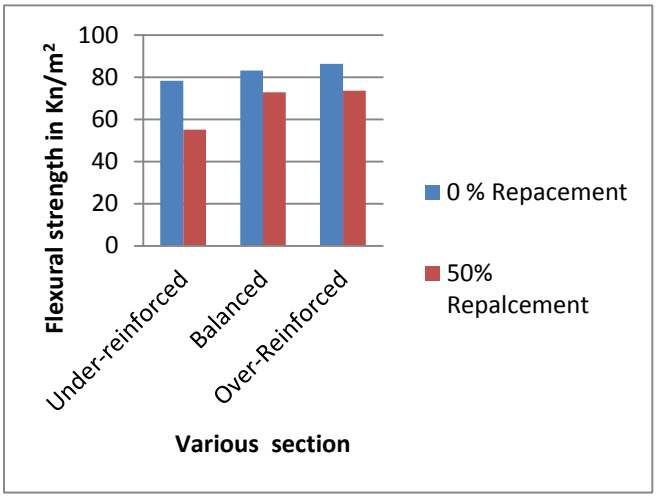
Mix design M40	Under-reinforced section	Balanced section	Over-reinforced section
Reinforcement	Top- 2No.s 8mm ϕ Bottom- 2No.s12mm ϕ	Top- 2No.s 8mm ϕ Bottom- 3No.s12mm ϕ	Top- 2No.s 8mm ϕ Bottom- 4No.s12mm ϕ
Load at Failure Nominal	68.65	80.60	88.30
50% Replacement	63.20	71.70	72.50



Graph No.5.3 Variation in Flexural strength (28 days) for Various section of M40 Grade

Table no.5.4

Mix design M50	Under-reinforced section	Balanced section	Over-reinforced section
Reinforcement	Top- 2No.s 8mm ϕ Bottom- 3No.s12mm ϕ	Top- 2No.s 8mm ϕ Bottom- 4No.s12mm ϕ	Top- 2No.s 8mm ϕ Bottom- 5No.s12mm ϕ
Load at failure Nominal	78.25	83.10	86.25
50% Replacement	55.10	72.88	73.50



Graph No. 5.4 Variation in Flexural strength (28 days) for Various section of M50 Grade

6. CONCLUSIONS

From the data received after all the secession of test carried out on deep beam with different material such as steel, BFRP & bamboo from that following conclusion are drawn.

The result of present work concludes that compressive strength is significantly improved. And we can use M-sand as Fine aggregate in 50 % replacement.

1) The experimental results proved that the compressive strength of cubes with 50% M-sand gives the strength nearby same as that with 0% M-sand. From the results it concludes upto 50% there is increase in strength but beyond 50% replacement it gives lower in strength.

2) The flexural strength test result proves that we can replace M-sand with 50% replacement effectively and it gives the strength nearby same as it with 0% replacement.

3) From above we can conclude that we can replace Natural sand with 50% of M-sand effectively and it proves to be economical.

7. FUTURE SCOPE OF PRESENT STUDY

The present work can be proceed to check the durability of concrete with Replacement with Manufactured sand. We check only the strength and load carrying capacity of concrete. But in future we check durability for long time period.

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BIOGRAPHIES

She is an excellent academic person and PG student with intend in Research work. Working on number of projects which is related with structural engineering.

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