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Experimental Investigation on The Effect Of M-Sand In High Performance Concrete

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Abstract: - The natural river sand was the cheapest resource of sand. However the excessive mining of river bed to meet the increasing demand for sand in construction industry has led to the ecological imbalance in the country. Now the sand available in the river bed is very coarse and contains very high percentage of silt and clay. The silt and clay present in the sand reduce the strength of the concrete and holds dampness. A few alternatives have come up for the industry to bank on of which manufactured sand or M-sand, as it is called, is found to be the most suitable one to replace river sand. M-sand has caught the attention of the construction industry and environmentalists alike for its quality and the minimum damages it causes to nature. Usage of M-Sand can drastically reduce the cost since like river sand, it does not contain impurities and wastages is nil since it is made with modern technology and machinery. Once the M-sand becomes more popular in the construction industry, the demand for river sand and illegal sand-mining would come down. Compared to the river sand, the M-sand has a better quality consistency high Strength concrete with signifance saving instrument. M-sand that is available is graded, sieved and washed. The particles are more rounded and granular and do not have sharp edges. Usage of M-Sand can overcome the defects occurring in concrete such as honey combing, segregation, voids, capillary, etc.
The purpose of this research is to experimentally investigate the effect of M-Sand in structural concrete by replacing river sand and develop a high performance concrete. It is proposed to determine and compare the differences in properties of concrete containing river sand and M-sand. It is also proposed to use steel fibres and chemical admixtures to increase the strength and workability of concrete respectively. The investigations are to be carried out using several test which include workability test, compressive test, tensile test, and flexural test

Keywords: - *M-Sand, Steel fibre, Compressive strength, Split tensile strength and Flexural Strength*

I. INTRODUCTION

Concrete is a material used in building construction, consisting of a hard ,chemically inert substance ,known as aggregate ;usually made from different type of sand and gravel ,that is bonded together by element and water. The word concrete comes from the Latin word 'Concreters' the past participle of 'Concrescere'. 'Con' means together and 'crescere' means to grow. Concrete was used for construction in many ancient structures. The wide spread use of concrete in many Roman structures has ensured that many survive to the present day. Concrete is a composition of many material composed primarily of aggregates, cement and water. There are many formations that have varied properties. The aggregate is generally a coarse gravel or crushed rock such as limestone or granite along with fine aggregate.

1.2 MANUFACTURED SAND:

For aggregate produces concrete aggregate are end products while for concrete manufacturers, aggregates are raw materials to be used for concrete production. The quality of aggregates can be influenced while raw materials, gravel or rock may have characteristics which can't be modified by the production process. One extremely important factor is consistent supply of course, fine aggregate. In this regard a course aggregate produced

by crushing basaltic stone and river sand is the major natural source of fine aggregate in our country. However the intense construction activity is resulting in growing shortage and price increase of the natural sand in the country in addition the aggregate and concrete industry are presently facing a growing public awareness related to environmental threats.

Therefore, looking for a viable alternative for natural sand is a must. One alternative used as replacement is the use of M sand. Due to the forecast shortfall in supply of natural sand and increased construction practices time will come when M sand will play a significant role as an ingredient in concrete production.

M sand characteristics:

When rock is crushed and sized in quarry the main aim has generally been to produce course aggregate and road construction materials. M sand is defined as a purpose made crushed fine aggregate produced from suitable source materials. Manufactured sand has been produced by variety of crushing equipments including cone crushers, impact crushers, roll crushers, road rollers etc., The raw material for M sand production is the parent mass of rock. It is based on the parent rock that the chemical, mineral properties, texture, composition of sand would change.

II. MATERIALS USED

The materials usually used in the concrete mix are cement, fine aggregate (M-Sand & River Sand), coarse aggregate. The materials used in this project for concrete mix are,

2.1 CEMENT

The cement used in this experimental study is 43 grade Ordinary Portland Cement. All properties of cement are tested by referring IS 12269-1987 specification of 43 grade Ordinary Portland Cement. The properties of cement are given in table 1.

Table 1: Properties of Cement

Sl.No.	Property	Value
1	Specific Gravity	3.15
2	Fineness	97.25
3	Initial Setting Time	45 min
4	Final Setting Time	385 min
5	Fineness Modulus	6 %

2.2 FINE AGGREGATE (M-SAND)

Fine aggregate used in this research is M- sand. Fine aggregates are the aggregates whose size is less than 4.75mm.

Table 2: Properties of M-Sand

Sl.No.	Property	Value
1	Specific Gravity	2.68
2	Fineness modulus	5.2
3	Water Absorption	7.0%
4	Surface texture	smooth

2.3 FINE AGGREGATE (RIVER SAND)

Good quality natural river sand is readily available in many areas and may be easily obtained and processed. As with the gravels that they often accompany, the sand deposits may not have been laid uniformly, meaning a potential change in quality. Generally fines are classified based on size, i.e.; below 4.75mm is regarded as fine aggregate.

Table 3: Properties of Fine Aggregate (River Sand)

Sl.No.	Property	Value
1	Specific Gravity	2.55
2	Fineness modulus	4.45
3	Water Absorption	6.2%
4	Surface texture	smooth

2.4 COARSE AGGREGATE

Coarse aggregate of nominal size of 20mm is chosen and tests to determine the different physical properties as per IS 383-1970. Test results conform to the IS 383 (PART III) recommendations.

Table 4: Properties of Coarse Aggregate

Sl.No.	Property	Value
1	Specific Gravity	2.70
2	Fineness modulus	7.15
3	Water Absorption	8.0%
4	Particle Shape	Angular
5	Impact value	8.5%
6	Crushing Value	18.5

2.5 Chemical Admixtures

Super plasticizers or high range water reducing admixtures (HRWRA) are an important component of High Performance Concrete. Viscosity modifying admixtures (VMA) may also be used to help reduce segregation and the sensitivity of the mix due to variations in other constituents, especially to moisture content. Other admixtures including air entraining, accelerating and retarding may be used in the same way as in traditional vibrated concrete but advice should be sought from the admixture manufacturer on use and the optimum time for addition. Choice of admixture for optimum performance may be influenced by the physical and chemical properties of the binder. Admixtures will normally be very consistent from batch to batch but moving to another source or to another type from the same manufacturer is likely to have a significant effect on Concrete performance and should be fully checked before any change is made.

2.6 STEEL FIBRES:

In this study corrugated steel fibre with an aspect ratio 60 was chosen. Corrugated steel fibres offer cost efficient concrete reinforcement. They were evenly distributed in concrete mixtures to improve the tensile strength of concrete and to avoid the micro cracks in the concrete.

III. EXPERIMENTAL TESTS

Mix design was done for M_{30} concrete as per the Indian standard code specifications (IS 10262-2007). Initial tests on all the ingredients of concrete were done and the results were tabulated. Fresh concrete tests such as slump cone test, flow table test etc., were also conducted. Testing of hardened concrete plays an important role in controlling and confirming the quality of cement concrete works

3.1 Cube Compressive Strength

The compressive strength, as one of the most important properties of hardened concrete, in general is the characteristic material value for classification of concrete. 28 days cube compressive strength is tested on cubes of size 150mmx150mmx150mm and 28 days compressive strength is tested.

3.2 Splitting Tensile Strength

Splitting tensile strength is an indirect method used for determining the tensile strength of concrete. Tests are carried out on 150mmx300mm cylinders conforming to IS 5816: 1976 to obtain the splitting tensile strengths at the age of 28 days. In the splitting tensile test, the concrete cylinder is placed with its axis horizontal, between plates of the testing machine, and the load is increased until the failure occurred by splitting in the plane containing the vertical diameter of the specimen. The magnitudes of the tensile stress is given by $2P/\pi DL$, were P is the applied load and D, L, are the diameter, length of the cylinder respectively.

3.3 Flexural Strength (Modulus of Rupture)

Tests are carried out on 100mmx100mmx500mm beams conforming to IS 516: 1959 to obtain the flexural strength at the age of 28 days. In the flexural test a standard plain concrete beam of rectangular cross section is simply supported and subjected to central point loading until failure.

IV. RESULTS AND DISCUSSIONS

4.1 Cube Compressive Strength

Four cube samples each for various percentage of river sand replaced by M-Sand were tested to determine the 7 days and 28 days compressive strength using a 3000kN Compression Testing Machine. The compressive strength test on cubes is conducted as per standards. It is seen that 28-days compressive strength increases upto 50% replacement of M-Sand.

Table 5. Cube compressive strength of Concrete @ 28 days

Specimens (S)	River Sand (%)	M-Sand (%)	Steel Fibers (%)	Average cube compressive strength @ 28 days (N/mm^2)
S1	70	30	1	35.84
S2	60	40	1	38.62
S3	50	50	1	39.80
S4	40	60	1	37.70

4.2 Split Tensile Strength

Four cylinder samples each of the mix with various percentages of M-Sand were tested to determine the split tensile strength after 28 day using a 3000kN Compression Testing Machine. The tests were conducted as per standard specifications. The test results are tabulated in Table 4.15. It is seen that 28-day split tensile strength increases upto 50% replacement of M-Sand.

Table 6. Split tensile strength strength of Concrete @ 28 days

Specimens (S)	River Sand (%)	M-Sand (%)	Steel Fibers (%)	Average Split tensile strength @ 28 days (N/mm^2)
S1	70	30	1	2.95
S2	60	40	1	3.58
S3	50	50	1	4.12
S4	40	60	1	3.62

4.3 Flexural Strength

Four beam samples each of the mix with various percentage of M-Sand were tested to determine the flexural strength after 28 days using a 30 Tone Schimadzu Universal Testing Machine. The tests were conducted as per standard specifications. The flexural strength of Concreteis given in Table 4.16. It is seen that the 28-day flexural strength increases upto 50% replacement of M-Sand.

Table 7. Flexural strength of strength of Concrete @ 28 days

Specimens (S)	River Sand (%)	M-Sand (%)	Steel Fibers (%)	Average Flexural strength @ 28 days (N/mm^2)
S1	70	30	1	7.2
S2	60	40	1	7.8
S3	50	50	1	8.6
S4	40	60	1	7.4

GRAPH

The graph showing the compressive strength, split tensile strength and flexural strength of the various mix proportional at 28 days of curing as shown in fig 1,2 ,and 3 respectively.

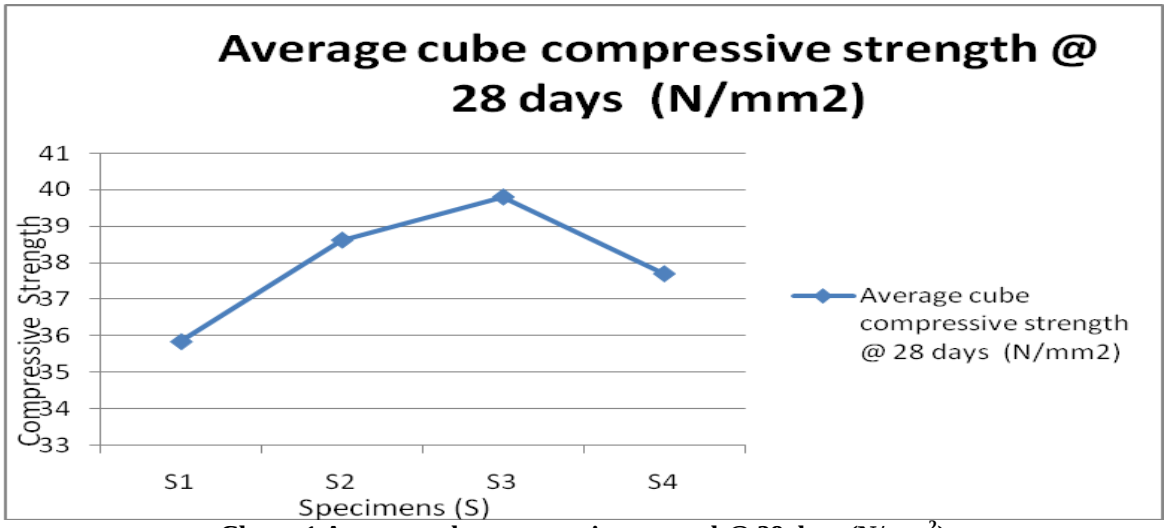

Chart: 1 Average cube compressive strength@ 28 days (N/mm^2)

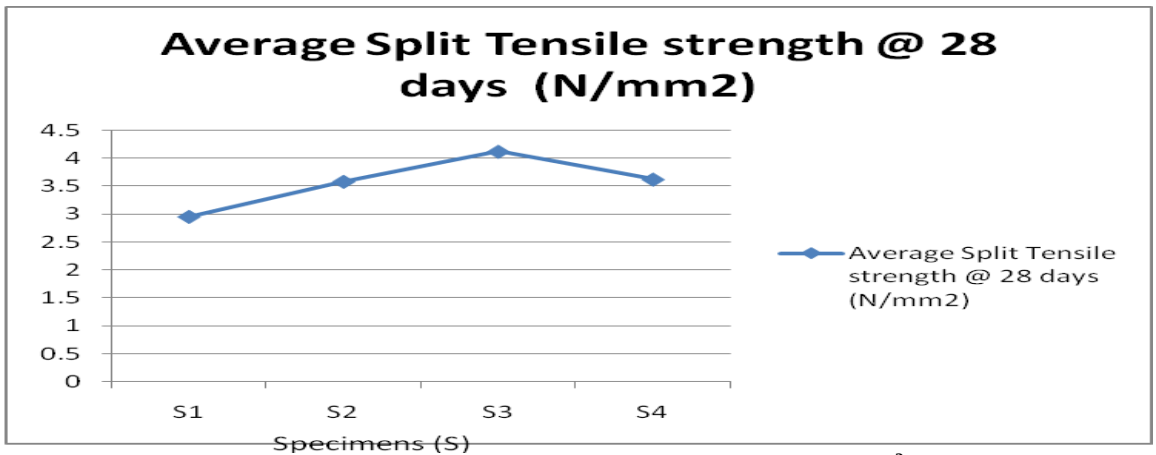

Chart: 2 Average Split Tensile strength@ 28 days (N/mm^2)

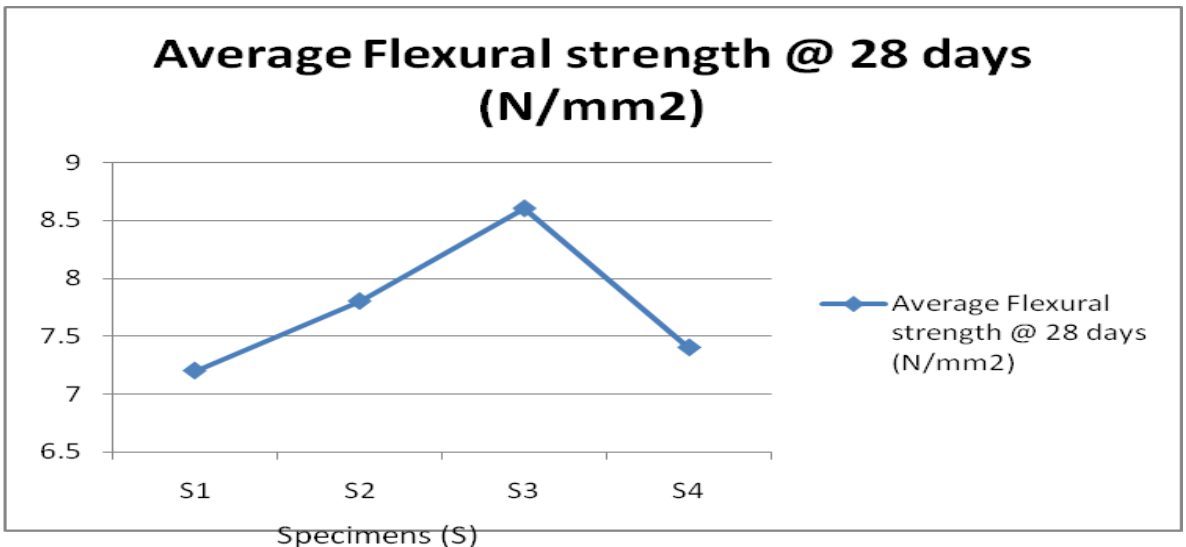

Chart: 3 Average Flexural strength@ 28 days (N/mm^2)

V. CONCLUSION

From the results it is concluded that the M-Sand can be used as a replacement for fine aggregate. It is found that 50% replacement of fine aggregate by M-Sand give maximum result in strength and durability aspects than the conventional concrete. The results proved that the replacement of 50% of fine aggregate by M-Sand induced higher compressive strength, higher split tensile strength, higher flexural strength. Thus the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced.

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