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A High Impact on Environmental Upgradation- A Hybridization of M sand (Manufactured Sand) as alternative of River Sand in Construction Industries

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ABSTRACT

A huge amount of concrete is consumed by the construction industry. About 40% volume of concrete is comprised of sand. A good quality concrete is produced by careful mixing of cement, fine and coarse aggregates, water and admixtures as needed to obtain an optimum quality and economy. Generally cement and coarse aggregates is factory made products and their quality and standards can be easily controlled and maintained. Water used for mixing of concrete is usually tap water. The fine aggregates or sand used is usually obtained from natural sources specially river beds or river banks. Now-a-days due to constant sand mining the natural sand is depleting at an alarming rate. Sand dragging from river beds led to several environmental issues. Due to various environmental issues Government has banned the dragging of sand from rivers. This has led to a scarcity and significant increase in the cost of natural sand. There is an urgent need to find an alternative to river sand. The only long term replacement for sand is M sand which may improve the quality of fine aggregate and make hassle free environment

KEY WORDS: M Sand, Environment, Hybridization, Industries

1. INTRODUCTION

Natural or River sand are weathered and worn out particles of rocks and are of various grades or sizes depending upon the amount of wearing. Now-a-days good sand is not available when required due to transported from long distance. Those resources are also exhausting very rapidly. So it is a need of the time to find some substitute to natural river sand. The artificial sand produced by proper machines can be a better substitute to river sand. The sand must be of proper gradation (it should have particles from 150 microns to 4.75 mm in proper proportion). When fine particles are in proper proportion, the sand will have fewer voids. The quantity of cement required will be less. Such sand will be more economical. Demand for manufactured fine aggregates for making concrete is increasing day by day as river sand cannot meet the rising demand of construction sector. Natural river sand takes millions of years to form and is not easily regenerated. Because of its limited supply, the cost of Natural River sand has sky rocketed and its consistent supply cannot be guaranteed. Under this situation use of manufactured sand becomes inevitable. 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 impurities

2. ISSUES IN DEVELOPMENT OF MANUFACTURED SAND

1. The Civil engineers, Architects, Builders, and Contractors agree that the river sand, available is not sufficient to meet the demand of construction industry. It does content very high silt fine particles.
2. Presence of other impurities such as coal, bones, shells, mica and silt etc makes it inferior for the use in cement concrete. The decay of these materials, due to weathering effect, shortens the life of the concrete.

3. Now-a-days, the Government have put ban on lifting sand from River bed.
4. Transportation of sand damages the roads.
5. Removing sand from river bed impact the environment, as water table goes deeper & ultimately dry.

Environmental factors and shortage of good quality river sand has also led to the invention of Manufactured Sand Also known as **M Sand**

However, many people in India have doubts about quality of concrete / mortars when manufactured or artificial sand are used. Manufactured sand has been regularly used to make quality concrete for decades in India and abroad.

3. GENERAL REQUIREMENTS OF MANUFACTURED SAND

1. All the sand particles should have higher crushing strength.
2. The surface texture of the particles should be smooth.
3. The edges of the particles should be grounded.
4. The ratio of fines below 600 microns in sand should not be less than 30%.
5. There should not be any organic impurities
6. Silt in sand should not be more than 2%, for crushed sand.
7. In manufactured sand the permissible limit of fines below 75 microns shall not exceed 15%.

4. I S CODE PROVISIONS BIS Guidelines IS: 383-1970 states for selection and testing of Coarse and Fine aggregates. Generally, Sand is classified as Zone I, Zone II, Zone III and Zone IV (i.e. Coarser to Finer). There is sieve designation for each zone. Gradation is made in accordance with the usage of the sand. There are testing sieves, consists of 4.75mm, 2.36mm, 1.183mm, 600microns, 300 microns, 150 microns and a pan

Typical Sieve analysis: Comparison of River & Manufactured Sand			
IS Sieve	% of passing(River Sand)	% of passing (Manufactured Sand)	Zone II (As per IS:383)
4.75mm	100	100	90-100
2.36mm	99.7	90.7	75-100
1.18mm	89	66.2	55-90
600micron	60.9	39.8	35-59
300micron	17.7	25.5	8-30
150micron	3.1	9.9	0-20
75micron	Max 3	Max 15	Max 15
	Zone II	Zone II	
Note: The gradation of manufactured sand can be controlled at crushing plant			

Technical specification – comparison between M Sand and River sand				
Sl No	**Property**	**River sand**	**Manufactured sand**	**Remarks**
1	Shape	Spherical particle	Cubical particle	Good
2	Gradation	Cannot be controlled	Can be controlled	
3	Particle passing 75micron	Presence of silt shall be less than 3%(IS:383-1970)reaffirmed 2007	Presence of dust particle shall be less than 15%	Limit 3% for uncrushed & limit 15% for crushed sand
4	Silt and Organic impurities	Present (Retard the setting & Compressive Strength)	Absent	Limit of 5% for Uncrushed & 2% for Crushed sand
5	Specific gravity	2.3 – 2.7	2.5 – 2.9	May vary
6	Water absorption	1.5 - 3%	2 – 4%	Limit 2%
7	Ability to hold surface moisture	Up-to 7%	Up-to 10%	
8	Grading zone(FM)	Zone II and III FM 2.2 -2.8	Zone II FM 2.6 – 3.0	Recommends Zone II for Mass Concrete
9	Soundness (Sodium sulphate - & Magnesium sulphate) (ss&ms) (5 cycles)	Relatively less sound (Ex. >5)	Relatively sound (Ex. <5)	Limit 10% ss and 15% ms
10	Alkali Silica Reactivity	0.002 -0.01	0.001- 0.008	Limit 0.1%expansio

5. EXPERIMENTAL PROGRAMME

The experimental programme involves testing of materials and designing of mix for M_{100} grade using in both M sand as well as R sand. The mixes were compared for strength properties such as Compressive strength, Flexural Strength and Split Tensile strength ,Water Penetration test and Drying Shrinkage test. For all the strength and durability studies of various curing periods, 3 specimens of each were cast to conduct the tests.

The mix design was carried by absolute volume method.First three mixes were with manufactured sand (M sand) and the next three mixes were with river sand (R sand). The water binder used in all the mixes used in the study is 0.2

5.1 ABSOLUTE VOLUME METHOD OF MIX DESIGN

The absolute volume method of mix design was used to arrive at the quantity of mix ingredients as per IS10262:2009. Here the absolute volume of materials are calculated according to their specific gravity. The total quantity of materials amount to 1m^3.The target strength required will be 100 + (1.65 × 5) = 108.25 N/mm^2. Total cement content of 900kg/m^3 was used with a free water content of 180 litres per m^3. The free water binder ratio was 0.2.

An example calculation to arrive the mix ingredients for the Mix 1 is shown below.

Cement = 1060kg = 0.32m^3

Free Water = 180kg = 0.18m^3

Total Volume = 0.50m^3

Remaining Volume of aggregate is 1-0.5 = 0.50m^3

The weighted specific gravity is (70×2.80 +30×2.72)/100 = 2.776

Volume of aggregate = 0.50 m^3 which is equal to 0.50 × 2.776 = 1388 kg

The aggregate are divided as

Coarse aggregate 10 mm = 1405× 70% = 983 kg

Manufactured sand = 1405× 30% = 421 kg

Water absorption is added to free water as

10 mm = 671 × 0.35% = 4.92 kg

Manufactured sand = 447 × 0.50% = 10.11 kg

Total water absorption is = 15.03 kg

Total water = 180 + 15.03= 195.03 kg

The above mix design calculation was carried out for mix1using manufactured sand. Similarly the quantities of materials in M_{100} concrete are arrived with both manufactured sand and river sand.

6. RESULTS AND DISCUSSIONS

6.1 COMPRESSIVE STRENGTH

Compressive strength is by far the most important property checked for the concrete and even more important in high strength concrete. The compressive strength was carried out as per IS 1199: 1959. The tests were conducted on 7thand 28th days and the test results are shown

It is evident from the Table 3, that the compressive strength has been achieved well above the target strength of 108.25 N/mm^2. The strength of the concrete depends upon water cement ratio and porosity. Since the water cement ratio used was very less (0.2) and also the compressive strength was very high in the tests. The compressive strength was more in manufactured sand concrete than river sand concrete.

Compressive strength of concrete - Unit in N/mm^2						
Age in Days	Mix1	Mix2	Mix3	Mix4	Mix5	Mix6
7	80.33	78	82.33	80	78.67	83.33
28	109	106	110	107.33	106	108

6.2 FLEXURAL STRENGTH

A concrete beam of size (150×150×700 mm) is supported on a steel roller bearing near each end is loaded through similar steel bearings placed at the third points on the top surface (2-point loading). Test details are as described in IS 1199:1959. The tests were conducted on 28th day and the test results are as shown.

The flexural strength usually varies between 8-10% of compressive strength in normal strength concrete. But in high strength concrete the flexural strength will be comparatively less. The average flexural strength was about 6.23%percent of compressive strength at 28 days. The flexural strength was more in manufactured sand concrete than river sand concrete in all the mixes

Flexural strength of concrete – Unit in N/mm^2						
Age in Days	Mix1	Mix2	Mix3	Mix4	Mix5	Mix6
28	109	106	110	107.33	106	108

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6.3 SPLIT TENSILE STRENGTH

The split tensile strength was tested on 150mm diameter × 300 mm length cylinders. The tests were conducted on 28th day and the test results are shown.

Split tensile strength of concrete – Unit in N/mm^2						
Age in Days	Mix1	Mix2	Mix3	Mix4	Mix5	Mix6
28	6.41	6.27	6.13	6.18	6.13	6.18

The split tensile strength usually varies between 8-10% of compressive strength in normal strength concrete.

But in high strength concrete the split tensile strength will be comparatively less. The average split tensile strength was about 5.77 percent of compressive strength at 28 days. Also the split tensile strength was marginally less than the flexural strength at the same age. The split tensile strength was found to be slightly higher in manufactured sand concrete than river sand concrete in all the mixes

Behavior of M Sand & River Sand when used in Concrete:				
S No	**Property**	**River sand**	**M sand**	**Remedies**
1	Workability & its retention	Good & Good retention	Less & Less retention	Control of fines & apply water absorption correction, use of plasticizers
2	Setting	Normal	Comparatively faster	Apply water absorption correction, use retarders
3	Compressive strength	Normal	Marginally higher	As above
4	Permeability	Poor	Very poor	-
5	Cracks	Nil	Tend to surface crack	Early curing & protection of fresh concrete

Cost comparison of M Sand and River sand:				
S no	Rate availability	River sand	Artificial sand	Remarks
1	Market rate	Rs 1100 per MT	Rs 600 per MT	50% Cheaper
2	In Concrete - Rs per m^3	Rs 770 – 880	Rs 420 – 480	Saving of Rs 350-400 per cum
3	In Mortar(1:5) for 100kgs	Rs 198	Rs 156	20% less

7. ADVANTAGES OF ORIGINAL M SAND

- Original M Sand is free from elongated and flaky particle since it is shaped cubically using VSI shaping machine. The cubically shaped particles give high strength and long life to concrete
- Original M Sand is manufactured strictly adhering to IS 383 (1970) zone II grading. Perfect grading and cubical shape of M Sand provides 10-15% more compressive strength for concrete and 25-30% more strength for masonry works compared to crusher dust.
- Original M Sand has minus 150 micron less than 10% and minus 45 micron less than 2% only. This helps the concrete to maintain water absorption rate of concrete less than 2% which helps to produce concrete of consistent quality.
- Original M Sand is graded with precession by removing the micro fines correctly and thus it has higher 'Fineness Modules Index' compared to river sand and crusher dust. This gives good workability for concrete and masonry that help in easy and quick construction.

8. M SAND-ENVIRONMENTAL IMPACT REPLACING RIVER SAND The lifting of river sand from river bed impact the environment in the following ways:

- Due to digging of the sand from river bed reduces the water head, so less percolation of rain water in ground, which result in lower ground water level.
- The roots of the tree may not be able to get water.
- The rainwater flowing in the river contents more impurities.
- Erosion of nearby land due to excess sand lifting
- Digging & Lifting of sand from river bed cause the disturbances and destroys flora & fauna in the surrounding areas
- The connecting village roads will be badly damaged due to over- loading of trucks causes difficulties to road users and also become accidents prone,
- Diminishing of Natural Rivers or river beds creates environment disasters and insufficient sand for future generations.

9. CONCLUSION

- Considering, the acute shortage of river sand, huge compromise in quality of river sand, its high cost, greater impact on road damages and environmental effects necessitates the Construction Industry to start using the M sand as alternative at full extent and its use reduces the impacts on environmental issues at the maximum extent.

- The usage of M sand for high strength high performance concrete provides stronger and durable concrete structures which will be economical as well as environment friendly by preserving natural resources such as river sand.
- The Local Authorities, PWD's and other Governmental departments should encourage the use of M sand in Public Construction Works, if possible, shall make mandatory to full extent to use M. sand wherever possible with immediate effect.
- The Govt. Shall come out with, Policy on Sand – encourage the industry people to set up more no of Sand crushing Units across the all Districts, States to meet the sand requirements of the Construction Industry

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