

MICROSTRUCTURAL STUDY ON THE CONCRETE CONTAINING MANUFACTURED SAND

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ABSTRACT: The present study focuses on evaluating the micro structural characteristics of medium strength concrete, in which manufactured sand (M-sand) is used as a partial and full substitution for natural sand. This paper presents a scanning electron microscopy (SEM) study performed on the medium strength concrete containing manufactured sand. SEM images of manufactured sand shows that the surface is rough and the particles are elongated and angular in nature. From the SEM observation, it was noticed that manufactured sand has more micro roughness and has more angular particles in comparison with river sand. This elongated angular particles of manufactured sand creates better interlocking between the particles and thereby reduces the porosity. Due to better interlocking between the particles, the strength and durability characteristics of manufactured sand in concrete is enhanced in comparison to river sand.

Key Words: River sand, Manufactured sand, SEM analysis.

I. INTRODUCTION

In the world concrete is the most widely used building material. More than ten billion Tonnes of concrete are consumed annually. Everyday more sand and gravel are mined than any other material, reliable data on their extraction in certain developed countries are available only for recent years as said by Krausmann et al [1].

Natural sand, shaped by erosive procedures through a number of years are presently being extracted at a speedier rate than their re-establishment, as given by Padmalal.D and Maya.K [2]. Continuous extraction of sand is having a huge impact on the river beds which has resulted in lowering of water table and a decrease in the amount of sediment supply. Despite the quantity of sand used in our day-to-day activities, our dependence on sand is significantly increasing, as said by Marius Dan Gavriletea [3].

Shortage of good quality common river sand has made engineers search for an appropriate elective fine aggregate. One such elective material is "Manufactured Sand (M-sand)". With the shortage of natural sand for the construction sector, manufactured sand gradually gained popularity, as given by Illangovan et al [4]. River sand which is available in the river beds contains about 5 to 20% silt and clay impurities, as given by Swapnil S Fate [5]. Presence of even minor quantities of silt and clay impurities affects the strength and will damage the screed and concrete, as per Sreenivasa.G [6]. Manufactured sand is utilized in many nations such as Norway, South Africa, India and Australia. In USA limestone and granite record for 86% of the rock used to produce manufactured sand, while the rest are from basalt, dolomite, sandstone and quartzite, as said by Ahn and Fowler [7]. Hence river sand should be processed well before use in order to bring the impurities to the acceptable limit. According to reports, M-sand is broadly utilized across the globe and the specialists from all over the world demand the mandatory utilization of M-sand owing to its consistent gradation and zero contamination.

II. IMPACT OF USING M-SAND ON CONCRETE PROPERTIES

The scarcity of river sand is forcing the builders to look for an alternative material and many have started using manufactured sand as a substitute for construction activity. With the river sand supply dropping by over 80%, the necessity for the use of manufactured sand is increasing. This M-sand has been well defined in IS 383-1970 under

clause 2 [8]. The permissible limit for fines as per IS 383-1970 less than 150 microns is limited to 20%. In the case of M-sand the fines fraction below 150 microns is about 18%, and hence M-sand falls under clause 2. The International centre for aggregate research (ICAR) has given promising results on the use of manufactured micro fines up to 17% in concrete. The Cement Concrete and Aggregates Australia, (CCAA) have carried out extensive research and developed the guidelines to support the replacement of natural sand with manufactured sand [9].

Table 1: Comparison of Impurities in River Sand and M-Sand

SI.No	Impurities Present	River sand	Manufactured sand
1	Clay and silt	5 to 20 %	Nil
2	Marine products	2 to 4 %	Nil
3	Oversized materials	6 to 10%	Nil

Table 1. shows the number of impurities present in river sand. River sand contains 5 to 20% of clay and silt, 2 to 4% of marine products and 6 to 10 % of oversized materials, whereas manufactured sand is free from these impurities [10].

III. TEXTURE OF RIVER SAND AND M-SAND PARTICLES

It has been checked and found at different areas crosswise over south India that, it has turned out to be progressively hard to get river sand of reliable quality with minimal silt/clay content. Thus in the normal procedure, the control over the quality is not conceivable. The texture and shape of manufactured sand bear a close resemblance to that of river sand. The Figure 1, 2 and 3 shows the coarse fraction, medium fraction and fine fraction of river sand and M-sand.

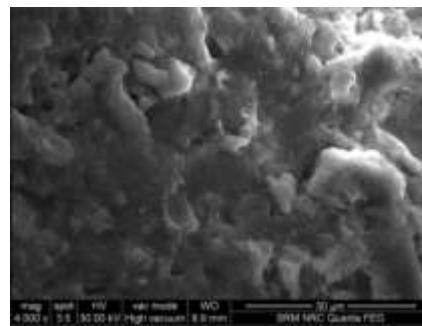
**Figure 1. Texture of Coarse Fraction of River Sand and M-Sand Particles****Figure 2. Texture of Medium Fraction of River Sand and M-Sand Particles**

**Figure 3.Texture of of River Sand Fine Fraction and M-Sand Particles**

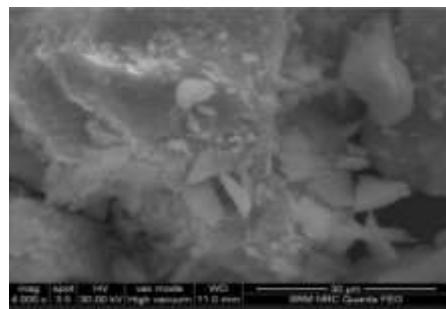
From the Figure1, 2 and 3, it is clear that M-sand is generally more angular and has a rougher surface texture. Manufactured sand has the consistent gradation and zero impurity due to its controlled process of manufacturing through VSI crusher. The coarse fraction in river sand is generally rounded in shape, but in case of M-sand the coarse fraction is generally angular and have broken surfaces due to the controlled process of manufacturing.

IV. SCANNING ELECTRON MICROSCOPE (SEM) ANALYSIS

SEM is used to study the microstructure of the specimen with high resolution. SEM achieves resolution better than 1 nanometer. SEM is useful for the qualitative and semi-quantitative analysis of selected point locations on the sample. SEM analysis is also considered as a non-destructive analysis. Figure 4 shows the scanning electron microscope.

**Figure.4 Scanning Electron Microscope (SEM)****Figure.5 SEM Image of River Sand**

From the SEM image of river sand, it was clear that the surface texture of river sand is smooth and the particle is spherical in nature which increases the workability of concrete. The SEM image of natural sand shows that the surface is rough with the presence of microvoids.

**Figure.6 SEM Image of M-Sand**

The SEM image of M-sand shows that the particles are angular in nature with a larger rough surface which enhances the better bonding between the aggregate particles.

V. CONCLUSION

- The observations from the SEM images depicts that the natural sand particles are more round in shape and have a smooth surface texture when compared with M-sand.
- SEM images show that the M-sand particles are sharp-edged and this creates better interlocking between the cement particles and thereby reduces the porosity.
- SEM images of M-sand shows that the surface is rough and the particles are elongated and angular in nature.
- From the SEM observation, it was noticed that M-sand has more micro roughness and has more angular particles in comparison with river sand.

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