Study on the Effect of M-Sand from Various Sources on the Workability of the Concrete

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***Abstract*— The Manufactured Sand (M-Sand) is obtained by crushing the stones and hence the properties may vary based on the type of rock from which it is manufactured. In this paper, an experimental investigation has been conducted to study the effect of m-sand collected from various sources on the workability of the concrete. The workability property has been studied for different water – cement ratios varying from 0.3, 0.35, 0.4, 0.45 and 0.5. The workability property has been studied from slump cone test and compaction factor test and results showed that there were greater variations based on the varying water-cement ratios. To achieve greater workability for lower water cement ratios, the admixtures have been added to improve the performance. Though the manufactured sand has a larger water usage and less air content it resulted in greater workability.**

Keywords— Manufactured sand (M-Sand), workability, water-cement ratio, admixtures, crushing.

I. INTRODUCTION

River sand is becoming a scarce commodity and hence exploring alternatives to it has become imminent [11]. Availability of natural sand is getting depleted and also it is becoming costly. Rock crushed to the required grain size distribution is termed as manufactured sand. In order to arrive at the required grain size distribution the coarser stone aggregates are crushed in the special rock crusher and some of the crushed material is washed to remove fines [11]. So far, crushed sand has not been used much in India for the reason that ordinarily crushed sand is flaky, badly graded rough textured and hence they result in production of harsh concrete for the given design parameters. For the last about 4-5 years the old methods of manufacturing ordinary crushed sand have been replaced by modern crushers specially designed for producing cubical, comparatively smooth textured, well graded sand, good enough to replace natural sand [8]. Many patented equipment are setup in India to produce manufactured sand of acceptable quality at the project site [8].

Therefore differ from natural sand, manufactured sand has special morphology features such as rough surface, irregular particle shape angular edges and distinguish characteristics of stone powder contained, which has some special effects on the workability, basic mechanical properties and durability of concrete. This features causes manufactured sand to have possible effect on mix proportion and workability of fresh MSC [9, 12]. It has also been reported that manufactured sand satisfies the requirements fine aggregates such as strength, gradation, shape angularity.it is also possible to produce manufactured sand falling into the desired grade. They say that the mechanical properties of manufactured sand depend upon the source of its raw material, i.e., parent rock. [6]. It has also been stated that the cohesiveness of fresh concrete was improved with the increase of stone powder content. Long term compressive strength for concrete with Manufactured sand is similar with the ordinary concrete, a suitable content of stone powder in Manufactured sand had positive effect on the long term growth of compressive strength of concrete[12]. It was also found that the workability of concrete mixes decreased with an increase in percentage of stone dust. It indicated that water requirement was higher in such concrete to maintain desired workability. The results obtained indicated that full replacement of natural sand by manufactured sand could be encouraged [5]. Some of the test results indicated that the crushed stone dust waste can be used effectively to replace natural sand in concrete [7]. Some studies also concluded that the VSI technology adopted for the manufacturing of M-Sand assures the quality of aggregate [10].

Therefore the investigations inferred that the increase of stone powder content in manufactured sand where 9 % of stone powder content was the best benefit to workability with w/c ratio ranging from 0.4-0.56, where further increase resulted in decrease of its desired workability it have also been added that complete replacement of river sand by manufactured sand have also been encouraged where the quality of the fine aggregate depends on its source and production.

In the view of the Importance of workability and based on author's former researchers the test of workability of manufactured sand of various sources like Karur ,Padalur

,Chennai and Crusher dust and based on production techniques and various water cement ratios ranging from 0.3- 0.5 have been carried out..

II. METHODOLOGY

A. Sources and Water cement ratio

Fine aggregate of two different sources in and around Trichy, Karur, Chennai have been used there are two common methods of producing manufactured sand is adopted all over Tamilnadu. They are Vertical Shaft Impactor (VSI) and Horizontal Shaft Impactor (HSI). The difference in this techniques led to a change in the gradation of the sand which resulted in a slighter variation in the workability of the concrete. Water-cement ratios ranging from 0.3 to 0.5 with a successive interval of 0.05 have been experimentally carried out to study about workability.

Two common tests for fresh concrete have been carried out for workability studies. The slump cone test have been carried out to determine the workability of the fresh concrete. Whereas the compacting factor have been carried out to determine the degree of compaction which is necessary in the concrete where the compaction is done using vibrators.

III. EXPERIMENTAL INVESTIGATION

A. Raw materials

A flyash based Portland Pozzolona cement (PPC; 300m^2/kg fineness) have been used, with 22 MPa and 33 MPa at 7 days and 28 days respectively. Coarse aggregate was gravel of size of 12 mm and 20 mm. A commercial naphthalene based super plasticizer of CERAPLAST SP300 have been incorporated in the concrete mixtures of last two lowest water cement ratios.

Fine aggregates from four different mineralogical sources and different production techniques have been used.Table 1 gives the physical properties of fine and coarse aggregate.

Table 1 Physical properties of fine and coarse aggregate

Sources	Productiio n Technique	Colour	Texture	Physical obs	Fineness modulus	Zone	Specific gravity
Karur	VSI	Dark grey	Fine	When rubbed in hand it does not hurt much	3.08	II	2.78
Padalur	HIS	Light grey	Fine	When rubbed in hand it does not hurt much	3.38	II	2.6
Chennai	VSI	Ash	Powdered	When rubbed in hand it hurted much	3.44	II	2.58
Crusher dust	HIS	Ash	Powdered	When rubbed in hand it hurted much	3.34	II	2.55
Coarse aggregate(60% of 20mm+40 % of 12mm)	-	-	-	-	-	II	2.76

B. Mis Proportion

The concrete mix proportions has been designed according to the guidelines of IS 10262 -2009 and IS 456-2000. Concrete mixes have been designed for a standard grade of M20 with varying water-cement ratios ranging from 0.3 to 0.5 with a successive interval of 0.05. Table 2 gives the detailed mix proportions of manufactured sand concrete (MSC)
(Nomenclature- KM [0.3-0.5] = Karur M-Sand
PM [0.3-0.5] = Padalur M-Sand
CM [0.3-0.5] = Chennai M-Sand
CD [0.3-0.5] = Crusher dust
MSC – Manufactured sand concrete)

C. Workability Test Method

Two common tests for workability of fresh concrete have been carried out. Slump cone test has been carried out to determine the workability of the fresh concrete, the cone of diameter 10cm in the top with a height of 30cm and a bottom diameter of 20cm have been used. Compacting factor test has been carried out to determine the degree of compaction where in case of vibrators used in the concrete casting, the equipment consist of two hoppers of height 28cm,24cm and the cylinder of height 28.5cm respectively.

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Table 2 Detailed mix proportions of Manufactured sand concrete (MSC)

Mixtures	KM 0.3	PM 0.3	CM 0.3	CD 0.3	KM 0.35	PM 0.35	CM 0.35	CD 0.35
W/C ratio	0.3	0.3	0.3	0.3	0.35	0.35	0.35	0.35
Cement (kg/m^3)	492.9	492.9	492.9	492.9	450.7	450.7	450.7	450.7

Water (kg/m^3)	147.87	147.87	147.87	147.87	157.73	157.73	157.73	157.73
Coarse aggregate (kg/m^3)	1121	1121	1121	1121	1113	1113	1113	1113
Fine aggregate (kg/m^3)	772	722	717	708	795	743	738	729
Super plasticizer (kg/m^3)	4.929	4.929	4.929	4.929	4.51	4.51	4.51	4.51
Proportions	1:1.6:2.3	1:1.46:2.3	1:1.5:2.3	1:1.4:2.3	1:1.8:2.5	1:1.7:2.5	1:1.7:2.5	1:1.7:2.5

Mixture	KM 0.4	PM 0.4	CM 0.4	CD 0.4	KM 0.45	PM 0.45	CM 0.45	CD 0.45	KM 0.5	PM 0.5	CM 0.5	CD 0.5
W/C ratio	0.4	0.4	0.4	0.4	0.45	0.45	0.45	0.45	0.5	0.5	0.5	0.5
Cement (kg/m^3)	495	495	495	495	440	440	440	440	396	396	396	396
Water (kg/m^3)	198	198	198	198	198	198	198	198	198	198	198	198
Coarse aggregate (kg/m^3)	1013	1013	1013	1013	1027	1027	1027	1027	1032	1032	1032	1032
Fine aggregate (kg/m^3)	750.8	702.23	697	689	789	739	733	724	823	770	764	755
Super plasticizer (kg/m^3)	-	-	-	-	-	-	-	-	-	-	-	-
proportions	1:1.5:2.04	1:41:2.04	1:1.4:2.04	1:1.4:2.04	1:1.79:2.33	1:1.67:2.33	1:67:2.33	1:1.65:2.33	1:2.06:2.59	1:1.93:2.6	1:1.92:2.6	1:1.91:2.6

IV. RESULTS AND DISCUSSION

A. *Particle Size Distribution*

The particle size distribution of manufactured sand collected have been shown in Figure. 1. The amount of fines were more in the samples of CD and CM, which indicates that the presence of stone powder content is more when compared to other samples collected.

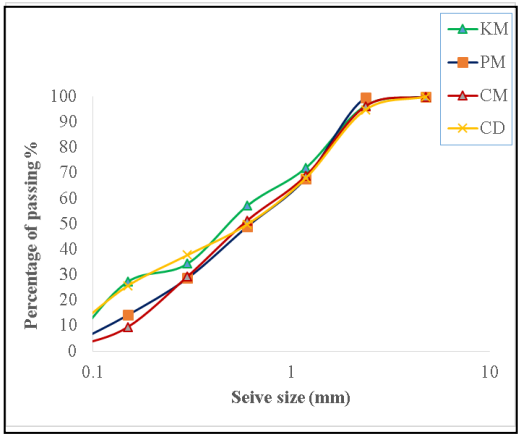

Figure. 1 Particle size distribution of the fine aggregate.

B. *Workability*

The workability of the fresh concrete have been determined by two various tests and they are slump cone and compaction factor test. The slump values of fresh concrete varied according to the sources and its water-cement ratios ranging from 0.3 to 0.5. It has been increased according to the increase in the water-cement ratios. There was a constant increase of workability in the samples of CM and CD throughout all the water cement ratios ranging from 0.3 to 0.5 due to the presence of increased stone powder content, whereas the slump values in case of water -cement ratios ranging from 0.4 to 0.5 had a gradual increase irrespective of samples. Addition of 1% of super plasticizer in the lowest water-cement ratio resulted in the insufficiency of workability, the repetition of same super plasticizer in the next lowest water cement ratio resulted in collapse.

In case of compacting factor the value gradually increased according to the increasing water-cement ratios ranging from 0.4 to 0.5, but there was a slight change over the lowest water-cement ratios due to the density of the concrete and its cohesiveness. Variations of slump and compaction factor is shown in Figure. 2 and Figure. 3.

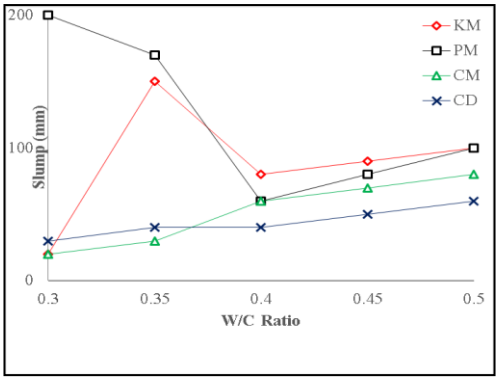

Figure 2. Variations in slump

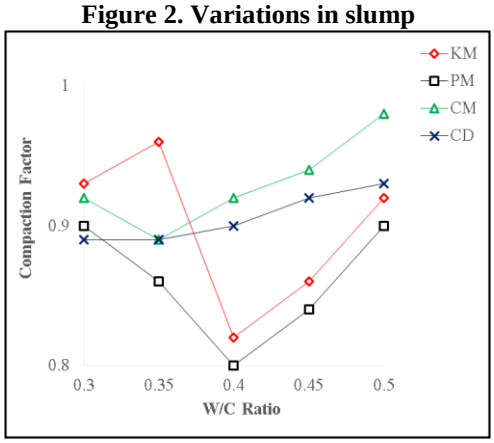

Figure 3 Variations in Compaction factor

V. CONCLUSION

In this paper the workability of the manufactured sand concrete of various sources and water-cement ratios has been experimentally studied. The main results of the study can be concluded as follow

(1) The workability of the fresh concrete improved constantly according to the increasing water cement ratios ranging from 0.4 to 0.5 with a successive interval of 0.05. In case of lowest water cement ratios the addition of super plasticizers increased the workability of the concrete by 50-100%.

(2) Workability of the samples of same water-cement ratio, with the addition of same amount of super plasticizer decreased by 85-90% due to the presence of excess stone powder content in it.

(3) Manufactured sand of various sources of had a greater effect over the workability of the concrete. Though there has been various production process like VSI and HSI the quality of the manufactured sand and workability had good result over VSI technology.

(4) Therefore all the above studies showed that the river sand can be completely replaced by manufactured sand which has a greater workability.

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