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Effect of Manufactured Sand on Durability Properties of Concrete

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***Abstract*: -** Volume of concrete consumed by the construction industry is very large. In India, conventional concrete contains natural sand obtained from riverbeds as fine aggregates. In recent times with a boost in construction activities, there is a significant increase in the consumption of concrete causing the dwindling of natural sand. This has led to several environmental issues thereby government imposing a ban on the unrestricted use of natural sand. This has resulted in the scarcity and significant rise in the cost of natural sand. Therefore, an alternative to river sand has become the need of the hour. The promotional use of manufactured sand will conserve the natural resources for the sustainable development of the concrete in construction industry.

Here various durability tests were conducted for concrete. From the test results, it is observed that with increasing proportion of manufactured sand the penetration of water into concrete decreases.

Keywords: *- Durability, Natural Sand, Manufactured sand, Water Permeability test, Rapid Chloride Penetration test.*

I. INTRODUCTION

Durability of concrete is defined as its ability to withstand weathering action, chemical attack or any other process of deterioration. A durable concrete requires little or no maintenance and retains its original form, quality and serviceability when exposed to its environment expect harsh or highly aggressive environment. With increasing pollution level it has become necessary to check the durability of concrete. Concrete Mix design procedure considers only the compressive strength of concrete. Although compressive strength is a measure of durability of concrete to a great extent but it is not always true that a strong concrete is a durable concrete. In order to predict the durability of concrete Rapid Chloride Penetration Test and Water Permeability Test were conducted.

II. LITERATURE REVIEW

P.M. Shanmugavadiv etal. have shown from water permeability test that permeability reduced with increase in proportion of manufactured sand. This may be due to less voids present in concrete with manufactured sand showing better bonding between the aggregate and cement paste. Results of rapid chloride penetration test shows that chloride ion penetrability is high for concrete with natural sand while it is reduced using manufactured sand. They attribute this due to coarser grain size of manufactured sand resulting in better packing of particles. They suggest that 70% of manufactured sand in concrete is the optimum replacement for natural sand for better results.

Experimental results of M.G. Shaikh et al. suggest that the sharp edges of the particles in artificial sand provide better bond with the cement than the rounded part of the natural sand. Both concrete made using artificial sand and natural sand are moderate to chloride permeability.

III. EXPERIMENTAL INVESTIGATION

3.1. Cement

The materials used are Ordinary Portland cement Grade53, natural and manufactured sand from obtained from a local supplier, 20mm and 10mm down size coarse aggregate. The properties of material are shown in the following tables

Table 1: Table showing physical properties of cement

Component	Results	Requirements
Fineness m^2/kg	1.63%	<10%
Initial setting time, minutes	135mins	Minimum 30mins
Final setting time. Minutes	315mins	Maximum 10hrs
Standard consistency	30%	----
Soundness	5.53mm	Maximum 10mm

Results show that the properties of cement are within the permissible limits.

3.2. Fine aggregates

Sieve analysis of natural and manufactured sand show that the fineness modulus of manufactured sand is greater than that of natural sand. i.e. the fine aggregate changes from zone III to zone I. This indicates that fine aggregates are coarser in case of manufactured sand.

3.3. Coarse aggregates

Crushed angular aggregate with maximum grain size of 20mm and downgraded was used and having bulk density 1.38 kg/m3. The specific gravity and fineness modulus was found to be 2.82 and 8 respectively

3.4. Mix proportions and Mix details

Concrete mix design in this investigation was designed as per the guidelines specified. The Table 3 shows the mix proportions of Concrete (kg/m3).Concrete mixtures with different proportions of manufactured sand for natural sand ranging from 0% to 100% were casted.

Table 2: Table showing mix proportion details

Proportion Materials	100% natural sand (0% manufactured sand	50% natural sand +50% manufactured sand	100%manufacturd sand(0% natural sand)
Cement+ fly ash+ micro silica	1	1	1
Coarse aggregate 20mm 10mm	 1.69 1.56	 1.41 1.3	 0.88 0.81
Fine aggregate	3.25	1.79	1.69
Water	0.28	0.28	0.28

3.5. Testing Details

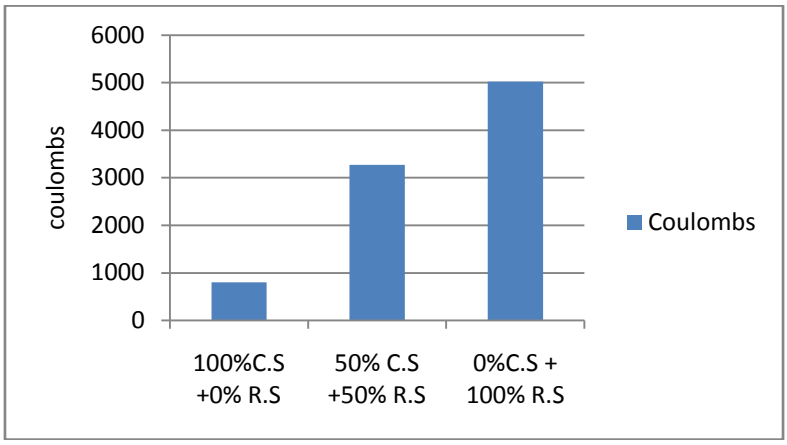
3.5.1. Rapid Chloride Penetration Test

Concrete cubes of 150mmx150mm were casted and cured for a period of 28days. A sample of dia 100mm and thickness 50mm are subjected to a direct current of 60 volts across two faces. The specimens are placed in between two chambers one with NaOH(0.3N) and other with sodium chloride (3%) solutions. The current passing through the specimen, the specimen is monitored regularly over six hours. The total charge that has passed through the specimen is calculated and is the value of product of time in seconds and current in amperes and unit is "Coulomb".

Table 3: Table showing permeability values

Mix proportion	Coulombs	Permeability
100% natural sand	5024	High
50% natural sand+50% manufactured sand	3276	Moderate
100% manufactured sand	798	Very low

Figure 1: Graph showing permeability of various mix proportion of concrete

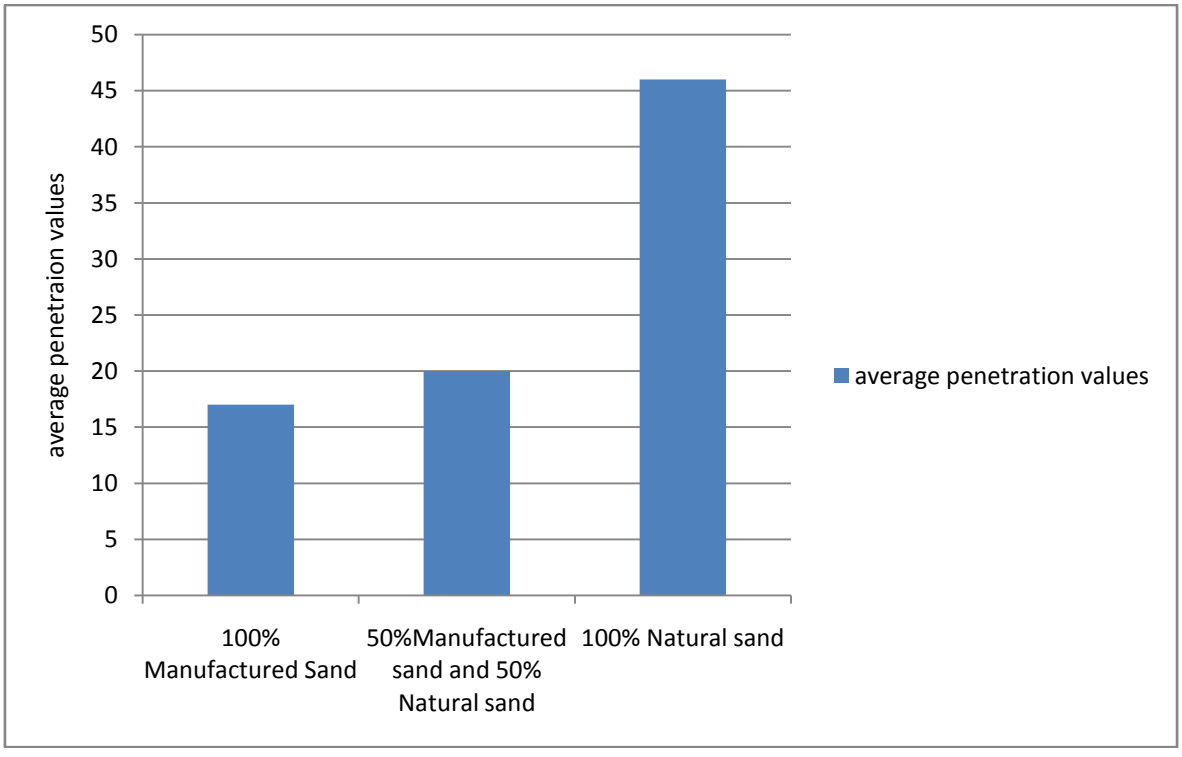


3.5.2. Water Permeability Test

Concrete cubes of 150mmx150mm are casted and cured for a period of 28 days. The surfaces of the cubes are wiped dry and they are placed in the Water Permeability Test apparatus as per DIN 1048. The compressor is started and the pressure is applied at a rate of 0.5MPa for a period of 72 hours. The specimens are later removed and split open. The actual penetration of water into the specimen were measured at three different points from the edges of the split cube and the average was found.

Table 4: Table showing penetration values for water

Mix Proportion	Penetration of water (mm)	Average
100% Manufactured Sand	10,32,11	17
50%Manufactured sand and 50% Natural sand	32,18,10	20
100% Natural sand	51,34,54	46



3.6. Results and Discussions

Manufactured sands are made by crushing aggregate to sizes appropriate for use as a fine aggregate. During the crushing process the manufactured sand have irregular shapes.Due to irregular shape of the aggregates there is a better packing among the particles thereby reducing the voids in concrete.

Results of the experimental studies show that resistance to penetration of water as proved by rapid chloride penetration test and water permeability test, is increased with increasing proportion of manufactured sand in concrete. Results show that river sand can be fully replaced by manufactured sand. The use of manufactured sand in the construction industry helps to prevent unnecessary damages to the environment and provide optimum exploitation of the resources.

IV. REFERENCES

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