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Experimental Investigation on Self Compacting Concrete by Replacing Natural Sand with Artificial Sand

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Abstract - *In the present situation the scarcity of natural sand has become a problem for the construction industry, after much research the developed technology gave rise to new generation sand named as M-sand or Manufacture sand or Artificial Sand. The artificial sand is produced by crushing rocks and stones to sizes and shape similar to N-sand or Natural sand. Self-Compacting Concrete (SCC) is an innovative concrete that does not require vibration for placing and compaction. It is able to flow under its own weight, completely filling formwork and achieving full compaction, even in the presence of congested reinforcement. The paper presents review of research work on effects of artificial sand on compressive strength and workability of concrete. A brief summary of the most significant investigations on the behaviour of concrete by replacing natural sand with artificial sand due to which environmental and social problems arise due to acute shortage of natural sand will be overcome*

Key Words: **Artificial Sand, N-sand- Natural Sand, SCC-Self Compacting Concrete, Manufactured Sand**

1. INTRODUCTION

The development of new technology in the material science is progressing rapidly. The development of self-compacting concrete (SCC) is a much needed revolution in concrete industry. Self-compacting concrete is highly engineered concrete with much higher fluidity without segregation and is capable of filling every corner of form work under its self-weight only (Okamura 1997). Thus SCC eliminates the needs of vibration either external or internal for the compaction of the concrete without compromising its engineering properties.[1]

Fine aggregate is an essential component of concrete. The global consumption of natural river sand is very high due to the extensive use of concrete. In particular, the demand for natural sand is quite high in developed countries owing to infrastructural growth. In this situation some developing countries are facing a shortage in the supply of natural sand. The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of the construction industry in many parts of the country. Therefore, the construction industries in developing countries are under stress to identify alternative materials to reduce the demand on river sand. In order to reduce the dependence on natural aggregates as the main source of aggregates in concrete, artificially manufactured aggregate, sand artificial aggregates generated from industrial wastes provide an alternative for the construction industry. Some alternative materials have already been used in place of natural river sand. For example, M-sand, slag, GGBS, rock dust, silica fume and quarry waste were used in concrete mixture as a partial replacement of natural sand. [9]

2. METHODS AND MATERIAL

This chapter deals with the experimental program particulars. The materials used, concrete mix details, casting procedure, curing and testing procedures are explained.

2.1 Materials:

Cement:

Portland Slag Cement, commonly known as PSC, is blended cement. Slag is, essentially, a non-metallic product comprising of more than 90% glass with silicates and alumina-silicates of lime. At JSW Cement, we use superior quality slag produced at our steel manufacturing plant, conforming to IS: 12089 standards for producing PSC. It is created with a combination of up to 45- 50% slag, 45% – 50% clinker, and 3-5% gypsum. PSC has been voted as the most suitable cement for mass construction because of its low heat of hydration.

Fine Aggregate (Natural Sand):

Locally available river sand which is free from organic impurities is used sand passing through 4.75mm sieve and retained on 150 micron IS sieve is used in this investigation. River sand confirming to IS: 2386-1975 is used.

Coarse Aggregate Properties:

The crushed coarse aggregate of 20 mm maximum size rounded obtained from the local crushing plant is used in the present study. The physical properties of coarse aggregate like specific gravity, bulk density, gradation and fineness modulus are tested in accordance with IS : 2386-1975.

Water:

Water is an important constituent of concrete, it should receive due attention in preparation and for quality control

of concrete. Strength and other properties of concrete are developed as a result of reaction of cement and water and thus water plays a critical role. Quality of mixing and curing water sometimes leads do distress and disintegration of concrete reducing the use full life of the concrete structure. Water used or concrete mixture should contain substances which can have harmful effect on strength or durability of the concrete in service. Certain substances if present, in sufficient qualities in water may have an injurious amounts of oils, acids, alkalies, salts, organic matter, sewage and other substances which are deleterious to concrete or steel reinforcement. Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen.

Manufactured Sand:

Manufactured sand is an alternative for river sand. Due to fast growing construction industry, the demand for sand has increased tremendously, causing deficiency of suitable river sand in most part of the word. Due to the depletion of good quality river sand for the use of construction, the use of manufactured sand has been increased. Another reason for use of M-Sand is its availability and transportation cost. Since this sand can be crushed from hard granite rocks, it can be readily available at the nearby place, reducing the cost of transportation from far-off river sand bed. Thus, the cost of construction can be controlled by the use of manufactured sand as an alternative material for construction. The other advantage of using M-Sand is, it can be dust free, the sizes of M-sand can be controlled easily so that it meets the required grading for the given construction.[6]

Chemical Admixture:

Chemical admixture reduces the cost of construction the cost of construction, modify the properties of concrete and improve the quality of concrete during mixing, transportation, placing and curing.

2.2 Mix Design

SCC is ushering in revolution in the concrete technology. It is not only easy to place to concrete in congested reinforcement structures but also compacts it without noisy vibrations. SCC ensures high durability since air voids and other flaws are likely to be absent in this concrete.

So, SCC requires some special properties in mix proportioning. The important property like flow ability cannot be achieved by just increasing the water content in the mixer. Adding more water to a concrete mixer will not only cause weakening of the concrete but also severe segregation.

2.3 Methods

2.3.1 Tests on Concrete:

Testing of concrete plays an important role in controlling and conforming the quality of cement works. The basic tests to be conducted in the field as well as in the lab based on its state of concrete are given below

1. Tests on Fresh SCC
2. Tests on Hardened SCC

2.3.1.1 Tests on Fresh SCC

For determining the self compatibility properties (slump flow, T-50 time, U box, L box and V funnel) tests were performed on all mixtures the order of testing was:

a) Slump flow test and measurement of T50 time

b) L -box test method

c) V-funnel test method

2.3.1.2 Tests on Hardened SCC

The main aim of flow characteristics and strength characteristics of self-compacting concrete produced from different percentages of that material partial replacement of manufacture sand. The different percentages of replacement of m-sand experimentation are 0%, 25%, 50%, 75%, 100 % and at 7, 14, and 28 days the concrete has been tested. Casting and curing of test specimen after casting, the moulded specimens were left on the casting room at room temperature for 48h. They were than de-moulded and cured in water for 7, 14, and 28 days.

Compressive Strength

Compressive strength can be defined as the measure maximum resistance of a concrete to axial loading. The specimens used in the compressive test are: 150 mm x 150 mm x 150 mm. There are three specimen were used in the compression testing for each mixes. The compression testing machine used for testing the cube specimens is of standard make. The machine has a facility to control the rate of loading with a control valve. The plates are cleaned before the testing of cubes. After the required period of curing, the cube specimens are removed from curing tank and cleaned to wipe off the surface water. It is placed on machines such that the load is placed centrally. The smooth surface of specimen is placed on the bearing surfaces.

3. RESULTS AND DISCUSSION

3.1 Results:

Compressive Strength Result and Graph:

For studied, the total number concrete cube specimens of (150 x 150 x 150 mm) was caste and tested at 7, 14, and 28

days. The result for average value of specimens, were calculated and is shown in the table below.

M 30 GRADE	
% of Replacement of M - SAND	**Compressive Strength at 28 days n/mm2**
0	34.8
25	36.8
50	39
75	31.6
100	28

4. CONCLUSIONS

Based on the experimental study on the SCC for M30 grade concrete, the following conclusions are drawn:

- There is a significant potential for growth of artificial sand as an appropriate and green solution for sustainable development in construction industry.
- Self-compacting concrete made with Artificial sand have achieved the target strength and also satisfied the fresh state properties required for SCC as per EFNARC specification.
- The optimum replacement of M-Sand is found to be 50% from the study.

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