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

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ABSTRACT

In the present scenario the scarcity of natural sand i.e. river 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 fresh concrete properties 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.

Keyword: *- 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 day by day. 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 does not need the vibration either external or internal for the compaction of the concrete without compromising its engineering properties.[1]

Fine aggregate is an important component of concrete. The global consumption of natural river sand is very high due to the extensive use of concrete day by day. In particular scenario, the demand for natural sand is quite high in developed countries owing to infrastructural growth. In this situation some developing countries are facing some shortage in the supply of natural sand to the construction. The non-availbility of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of the construction industry in 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. We use superior quality slag produced at 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. Ordinary potable water of normally pH 7 is used for mixing and curing the concrete specimen. [10]
- **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.[10]
- **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.[10]

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. We need different mix design for the self compacting concrete preparation.[10]

3. METHODS

3.1 Slump Flow Test

The slump flow is used to assess the horizontal free flow of SCC in the absence of obstructions. It was first developed in Japan for use in assessment of underwater concrete. The test method is based on the test method for determining the slump. The diameter of the concrete circle is a measure for the filling ability of the concrete.

This is a simple, rapid test procedure, though two people are needed if the T50 time is to be measured. It can be used on site, though the size of the base plate is somewhat unwieldy and level ground is essential. It is the most commonly used test, and gives a good assessment of filling ability. It gives no indication of the ability of the concrete to pass between reinforcement without blocking, but may give some indication of resistance to segregation. It can be argued that the completely free flow, unrestrained by any boundaries, is not representative of what happens in practice in concrete construction, but the test can be profitably be used to assess the consistency of supply of ready-mixed concrete to a site from load to load.[11]

3.2 V-Funnel Test

V-funnel test is used to determine the filling ability (flowability) of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12 litre of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation then the flow time will increase significantly.

Though the test is designed to measure flowability, the result is affected by concrete properties other than flow. The inverted cone shape will cause any liability of the concrete to block to be reflected in the result – if, for example there is too much coarse aggregate. High flow time can also be associated with low deformability due to a high paste viscosity, and with high inter-particle friction. While the apparatus is simple, the effect of the angle of the funnel and the wall effect on the flow of concrete is not clear.[11]

3.3 L Box Test Method

The apparatus consists of a rectangular-section box in the shape of an 'L', with a vertical and horizontal section, separated by a moveable gate, in front of which vertical lengths of reinforcement bar are fitted. The vertical section is filled with concrete, and then the gate lifted to let the concrete flow into the horizontal section. When the flow has stopped, the height of the concrete at the end of the horizontal section is expressed as a proportion of that remaining in the vertical section (H2/H1). It indicates the slope of the concrete when at rest. This is an indication passing ability, or the degree to which the passage of concrete through the bars is restricted. The horizontal section of the box can be marked at 200mm and 400mm from the gate and the times taken to reach these points measured. These are known as the T20 and T40 times and are an indication for the filling ability.

This is a widely used test, suitable for laboratory, and perhaps site use. It assesses filling and passing ability of SCC, and serious lack of stability (segregation) can be detected visually. Segregation may also be detected by subsequently sawing and inspecting sections of the concrete in the horizontal section.[11]

4. RESULTS

Table -1: Fresh Properties of SCC

Method	Property	Typical range
Slump flow	Filling ability	650-800mm
V-funnel test	Filling ability	6-12 seconds
L-box test	Passing ability	h2/h1 = 0.8-1.0

Table -2: Result of Fresh Properties of Concrete

Mix No.	% of Replacement	Slump Flow (mm)	V Funnel (Sec)	L Box
1	0%	680	8.9	0.81
2	25%	695	10.5	0.85
3	50%	720	8.5	0.88
4	75%	670	9.3	0.94
5	100%	655	11.1	0.98

5. CONCLUSION

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

- The mix design for M-Sand SCC using NAN-SU method and "EUROPEAN GUIDELINES FOR SCC" is arrived.
- Conventional Fine aggregate i.e., river sand is replaced with artificial Sand and based on the test results, the optimum dose is found from the project.
- The replacement dosage is made at a variation of 25% interval of natural sand with manufactured sand.
- The optimum replacement of M-Sand is found to be 50% from the study.

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