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A Study On Strength Of Terinery Blended Fiber Reinforced Self Compacting Concrete

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Abstract— Generally SCC requires a large content of binder and chemical admixtures compared to ordinary concrete; its material cost is generally 20-50% higher, which has been a major hindrance to a wider implementation of its use. There is growing evidence that incorporating high volumes of mineral admixtures and micro fillers as partial replacement for Portland cement in SCC can make it cost effective. However, the strength and durability of such SCC needs to be proven. Compared to normally vibrated concrete, self-compacting concrete possesses enhanced qualities and improves productivity and working conditions due to elimination of compaction. SCC generally has higher powder content than Normally Vibrated Concrete (NVC) which can increase cost and also cause temperature rise during hydration as well as possibly affect other properties such as creep and shrinkage, thus it is necessary to replace some of the cement by additions to achieve an economical and durable concrete.

Concrete is most widely used construction material because of ease of construction and its properties like compressive strength and durability. It is difficult to point out another material of construction which is versatile as concrete. It is well known that plain concrete is very good in resisting compressive strength but possesses low specific modulus, limited ductility and little resistance to cracking. Internal micro cracks inherently present in the concrete and its poor tensile strength is due to propagation of such micro cracks eventually leading to brittle failure of concrete.

The inclusion of fibers in SCC will extend its benefits. To improve strength properties it is useful to reinforce the concrete with fibers. Steel fibers are having good tensile strength and are also chemically inert, so a trail is made to improve the Self Compacting Concrete properties.

In this article steel fibers were used, and the effects of fiber inclusion on the workability of fiber reinforced self-compacting concrete (FR-SCC) is studied.

Introduction

Concrete is the age old building material which is abundantly used in construction, and it is most likely that it will continue to have the same influence in future. However, these construction and engineering materials must meet new and higher demands. One direction in this evolution is towards self-compaction concrete (SCC) modified product that, without additional compaction energy, flows and consolidation under the influence of its own weight. The use of SCC offers a more industrial production. Not only will is reduce the risky tasks for labours, it can also reduce the in situ cast concrete constructions, due to fast construction quality, durability, surface finish and reliability of concrete structures.

Generally SCC requires a large content of binder and chemical admixtures compared to ordinary concrete; its material cost is generally 20-50% higher, which has been a major hindrance to a wider implementation of its use. There is growing evidence that incorporating high volumes of mineral admixtures and micro fillers as partial replacement for Portland cement in SCC can make it cost effective. However, the strength and durability of such SCC needs to be proven. Compared to normally vibrated concrete, self-compacting concrete possesses enhanced qualities and improves productivity and working conditions due to elimination of compaction. SCC generally has higher powder content than Normally Vibrated Concrete (NVC) and thus it is necessary to replace some of the cement by additions to achieve an economical and durable concrete.

literature review

E.B. Pereira, J.A.O. Barros, A.F. Ribeiro, A. Camoes[8] (2003) had conducted the post cracking behavior of SFRSCC, adding the benefit of SCC to those resulting from the addition of discrete fibers to cement based materials, a high performance material, designated by SFRSCC, is obtained. In the present work the strategy followed to design SFRSCC is described, as well as, the experimental research carried out to characterize its flexural and compression behavior. A special effort is done to assess the post cracking behavior, carrying out three point notched beam tests.

Kong hyun, Joon[9] (2003) Developed hydrophobic polyethlyene fiber reinforced SCC by combining micro mechanical and rheological parameters in a compatible manner which exhibits in the fresh state and ductile strain hardening performance in the hardened state. The micromechanics method selects material ingredients for tensile ductility in the hardened state while the rheological behavior modifies the material ingredients for SCC behavior in the greed state.

N.Ganesan, P.V.Indhira & P.T.Santosh Kumar[10] (2005) have studied the behavior of SFRSCC. They have taken different aspect ratios(15,25,35) and the percentage of volume fraction (0,2.5,0.5,0.75) of fibers. First crack load and the post cracking behavior were found to have improved due to the addition of fibers. A marginal improvement in the ultimate strength was observed. The addition of fibers enhanced the ductility significantly. The optimum volume of fibers was found to be 0.5 %. It was found that when fibers with aspect ratio 35 and volume fraction 0.75% are added, the SCC was not affected.

materials

The materials used in this experimental study are Cement, Fine aggregate, Coarse aggregate, Water, Fly ash, Rice Husk Ash, Fibers, Superplasticiser and Viscosity Modifying Agent.

Cement

Ordinary Portland cement (Ultra tech cement) of 53 grade confirming to IS: 12269-1987 was used. It was tested for its physical properties as per IS 4031 (part II)-1988 and chemical properties as per IS: 12269.

Aggregate

The size, shape and gradation of the aggregate play an important role in achieving a proper concrete. The flaky and elongated particles will lead to blocking problems in confined zones. The sizes of aggregates will depend upon the size of rebar spacing.

The coarse aggregate chosen for Ternary Blended Concrete is typically angular in shape, is well graded, and smaller in maximum size that suited for SCC. It should have a maximum aggregate size of 20mm. Gradation is an important factor in choosing a coarse aggregate, especially in typical uses of ternary blended concrete. Gap-graded coarse aggregate promotes segregation to a greater degree than the well graded coarse aggregate.

Fine Aggregate

The locally available sand is used as fine aggregate in the present investigation. The sand is free from clayey matter, salt and organic impurities. The sand is tested for various properties like specific gravity, sieve analysis, bulk density etc., and in accordance with IS 2386-1963. The fine aggregate is conforming to standard specifications. The details of test results are given in Table 3.3and 3.4. Fineness modulus was found based on sieve analysis results for fine aggregate. Weight of the sample taken was 1000 grams.

Coarse Aggregate

Machine crushed angular granite of 16mm nominal size from the local source is used as coarse aggregate. It is free from impurities such as dust, clay particles and organic matter etc. The physical properties of coarse aggregate were investigated in accordance with IS 2386 -1963

Water

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Locally available water is used for mixing and curing which is potable and is free from injurious amounts of oils, acids, alkalis, salts, sugar, organic materials or other substances that may be deleterious to concrete or steel.

Fly Ash

The fly ash obtained from Hyderabad Industries, Andhra Pradesh is used in the present experimental work.

The chemical composition of Flyash is rich in silica content which react with calcium hydroxide to form C-S-H gel. This gel is responsible for the strength mortar or concrete.

Rice Husk Ash

SILPOZZ Rice husk ash obtained from Orissa is used. The specific gravity of rice husk ash is 2.4. The rice husk ash is in conformity with the general requirement of Pozzolona.

Fibers

Dramix steel fibers with aspect ratio 80/60 were used. Typical properties of Dramix steel fibers.

MIX DESIGN

Design parameters for M30 grade

Characteristic compressive strength required in the field

at 28-days

: 30 Mpa

a) Max size of aggregate

: 16mm (rounded)

b) Degree of workability

: 0.90 CF

c) Degree of quality control

: Good

d) Type of exposure

: Mild

e) Compressive strength of cement

: 53 N/mm2 at 28 days

Test data of materials

Specific gravity of cement

: 3.14

Specific gravity of coarse aggregate

: 2.72

Specific gravity of fine aggregate

: 2.53

Water absorption

a) Fine aggregate

: 0.71%

b) Coarse aggregate

: 1.78%

Free surface moisture

a) Fine aggregate

: 2.0%

b) Coarse aggregate

: Nil

Fineness modulus of coarse aggregate

: 7.86

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Fineness modulus of fine aggregate

: 3.02

50

Determination of target mean strength:

From table, 39 of SP: 23-1982, standard deviation of M30 grade concrete is 5.0.

From table 30, of SP: 23-1982, probability factors for 5% results below characteristic strength is 1.65.

Therefore the target mean strength (ft) = Fck+K.S

= 30+1.65x5

= 38.25 Mpa

Determination of Water/Cement ratio:

- From fig 43 of SP: 23-1982, from strength considerations for the given compressive strength of 38.25Mpa, the total Water/Cement ratio is 0.43.
- From fig 43 of SP: 23-1982, from durability considerations for (mild exposure) the maximum Water/Cement ratio is 0.65.
- Hence adopting a W/C ratio of 0.43.

Selection of Water content:

- From sieve analysis of fine aggregate and coarse aggregate, and referring to table 4 of IS 383-1970, it can be concluded that the fine aggregate confirms to Zone II.

CONCLUSION

This study shows that Rice Husk Ash can be used as replacement to cement in SCC.

By using RHA heat of hydration is reduced and also cost analysis shows not much variation in cost, though it is economic than ordinary concrete.

Optimum percentage of SCC mix containing RHA and Fly Ash as partial replacement of cement was found to be 6% and 30%.

Ternary mix exhibited better consistency in compressive strength development, which indicates a synergy of inert particle interaction between Ordinary Portland Cement, Rice Husk Ash and Fly Ash which enhanced compressive strength property.

The SCC developed compressive strength ranging from 24.00 MPa to 29 MPa and from 33.00 MPa to 40 MPa at 7 and 28 days respectively.

The Dramix steel fibers are suitable for SCC up to 2% by volume of concrete.

The Dramix steel fibers of aspect ratio 80/60 have shown overall improvements of all the properties.

The SFRSCC developed compressive strength ranging from 26.00 MPa to 35.00 MPa and from 39.00 MPa to 42 MPa at 7 and 28 days respectively.

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The SCC developed split tensile strengths ranging from 3.25 to 5.13 Mpa at 28days.

The SCC developed flexural strengths ranging from 4.69 to 6.62Mpa at 28 days.

This study has shown that FRSCC can also be applied locally for construction of concrete pavements, base slabs which require not much higher strength.

- From table 42 of SP 23-1982 (applicable for concrete up to Grade M35) for 16mm.
- Water content per cubic meter of concrete = 200kg.
- Sand as percentage of total aggregate by absolute volume = 40.0%.
- As per table 44 of SP 23-1982, adjustment of values in water content and sand percentage for other conditions is as under:

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