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Self-Compacting Concrete using Silica Fume, GGBS and SCBA

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Abstract: *Concrete is a most widely used construction material in the world. As the use of concrete becomes almost a necessary the specifications of concrete like durability, quality, workability and compactness of concrete becomes more important. Conventional concrete is cast normally in the form of vibration in order to move the concrete to all corner of the form work, removes entrapped air, and to fully surround the reinforcement. With the introduction of the latest generation of super plasticizing admixtures it became possible to produce concrete that does not require mechanical vibration, thus leading uslo so called Self Compacting Concrete (SCC). This SCC has proved beneficially and economically because of some factors. The requirement led to the development of SCC and its development was first reported in 1989. Self-Compacting Concrete is also a type of high performance concrete that has high workability and Self Compacting nature, i.e. the compaction occurs because of high flowing nature and there is need for external vibrators for compacting purpose. The concrete is cohesive enough to escape bleeding or segregation. For production of Self compacting in order to achieve the water cement ratio should be kept as much as the minimum.*

Keywords: seed-sowing robot

I. INTRODUCTION

Relevance to civil engineering

- Waste reduction and environmental benefit.
- Cement replacement and pollution reduction.
- Improve quality of self-compacting concrete such as workability, durability,flowability, etc.
- Formation of low cost self-compacting concrete.

Need for the study

- To reduce the cement content in concrete.
- To create high quality structure.
- To make self-compacting concrete economical.
- To minimize voids in the highly-reinforced areas.
- Prevents pollution caused by industrial waste.

Aims and objectiveAim:

- To prepare sustainable self-compacting concrete with production process waste.

Objectives:

- To prepare self-compacting concrete with silica fume, GGBS and bagasse ash.
- To perform laboratory analysis to check concrete feasibility.
- To compare modified self- compacting concrete with conventional self

II. LITERATURE REVIEW

G. Naga Venkat , K. Chandramouli , Ezaz ahmed, (2020)

In this experimental work the main objective is to improve strength of concrete by using pozzolanic materials such as silica fume, Metakaolin, GGBS as partial replacement to weight of cement by varying percentages (5, 10, and 15) and M-Sand as complete replacement to river sand. In this article the experimental work is mainly concentrated on examining the mechanical strength, split tensile strength and also non-destructive tests likerebound hammer and ultra sonic pulse velocity tests was performedat an age of 7 days and28 days. In this investigation at 10% replacement all the materials gives higher strengths, silica fume gave higher strength compared to Metakaolin and GGBS and At Replacement of 10% to weight of cement with silica fume, Metakaolin, GGBS using M-Sand instead ofriver sand gives higher compressive and split tensile strengths.

(Bangla Gayaz Basha, Burugapalli Kameswara Rao, Chappidi HanumanthaRao,2020)

In this work ground granulated blast furnace slag (GGBS) is added to concrete at differentlevels of replacement of cement at the rate of 0%, 30%, 50%, 70% along with 5% silica fume and 0.3, 0.4 & 0.5 w/c ratios to calculate its strength and chloride penetration of concrete is determined. 12 mixes each of 15 cubes were casted. The process of concrete byconducting the experimental work on 180 cubes (150 mm 150 mm 150 mm). The specimens were tested for 28, 56 and 90 days of compressive strength and 6, 12 weeks of 3.5% NaCl solution ponding tests at different depths from the exposed chloride surface. Second law of Fick's is used for prediction of chloride content at different depths. Chemicalanalysis is carried out for exposed NaCl specimens. Comparing the results betweenreplacement and non-replacement of GGBS. Thus, the workability is improved by the partial replacement of the GGBS & silica fume with cement. As GGBS & silica fume is partial replaced with cement. Both GGBS & silica fume are efficient to resist the chloride ion penetration. for compressive strength when replacement of 50% GGBS & 5% silica fume in all water cement ratio gives better results compared with and without replacement, For 0.3 water cementitious material ratio with 70%GGBS and 5% silica fume, for all 0.4 water cementitious material ratio all replacements, for 0.5 50% GGBS shows better resistance to chloride ingress.

Aukkadet Rerkpiboon, Weerachart Tangchirapat, Chai Jaturapitakkul, (2015)

This research examines the strength and durability properties of concrete containing up to 50% ground bagasse ash (GBA) replacing ordinary Portland cement (OPC) by weight of binder. The setting times, compressive strength, modulus of elasticity, chloride resistance, and expansion due to a 5% Na_2SO_4 solution of concrete containing ground bagasse ash were investigated. The results showed that concrete with 50% of GBA produced at least 90% compressive strength as compared to control concrete (CT concrete) at the age of 28 days. The rapid chloride ion penetration in term of charge passed (Coulombs) was at a very low level when 20–50% of GBA was used to replace OPC in the concrete. Moreover, the same trend of chloride penetration depth was found by the immersion test, i.e., the chloride resistance increased with the increase of GBA replacement. The results suggest that the use of GBA of upto 50% to replace OPC by weight of binder can increase the durability properties of concrete, especially its chloride penetration resistance

III. METHODOLOGY

3.1 General

Materials:

1. Cement

Cement has different properties and characteristics which depend upon their chemical compositions. By changing in fineness of grinding, oxide compositions cement has exhibit different properties and different kind of cement. The use of additives, changing chemical composition, and use of different raw materials have resulted in the availability of many types of cements. Cement used in the experimental work is ordinary portland cement of 53 grades conforming to IS: 12269 -2013. The physical properties & chemical properties of the cement as per IS: 12269-2013 are given in the Table 3.1 & Table 3.2.

2. Silica Fume

The high level of fineness and practically spherical shape of silica fume results in good cohesion and improved resistance to segregation. However, silica fume is also very effective in reducing or eliminating bleed and this can give rise to problems of rapid surface crusting. This can result in cold joints or surface defects if there are any breaks in concrete delivery and also to difficulty in finishing the top surface. Also, since silica fume has to be imported it is a costly alternative. The silica fume shall confirm to IS15388-2003. Typically, substantial part of micro silica should be below 1μm size, and silica fume should have particles below 0.1μm.

3. Ground granulated blast furnace slag (GGBS)

Ground granulated blast furnace slag (GGBS) provides reactive fines with a low heat of hydration. GGBS is already present in some cement but is also available as an addition and may be added at the mixer. A high proportion of GGBS may affect stability of SCC resulting in reduced robustness with problems of consistence control while slower setting can also increase the risk of segregation. The GGBS shall confirm to IS12089.Typically active hydraulic slag has particle size smaller than cement.

4. Sugarcane Bagasse Ash

Sugarcane is main food crop in tropical and subtropical countries. It is the major resource for the sugar production. Sugarcane bagasse (SCB) is the waste created after juice extraction from sugarcane. The Sugarcane bagasse ash (SCBA) is acquired through the control burning of sugarcane bagasse. The SCB creates the environmental nuisance due to direct disposal on the open lands and forms garbage heaps in that area According to Barroso that one ton sugarcane generates the 280 kg of bagasse waste. To reduce the environmental burden, the usage of waste materials in concrete is a significant aspect, the sugarcane bagasse ash (SCBA) is a waste material of sugar industry, which has a good potential to utilize in concrete as cement replacement. Sugarcane is main crop and besides that high worth crop of south Asia normally termed as cash-crop.

5. Aggregates

Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. The fact that the aggregates occupy 70-80 present of volume of concrete, it has some impact on various characteristics and properties of concrete. Earlier, aggregates were considered as chemically inert material but now it has been recognized that some of the aggregate are chemical active and also certain aggregates ere exhibit chemical bond at the interface of aggregate and paste.

5.1 Coarse Aggregate

Crushed granite of 12.5mm and 10mm size are used as coarse aggregate. The sieve analysis of aggregates confirms to the specifications of IS: 383-2016. The Physical Properties are given in the Table 3.3

5.2 Fine Aggregate

Fine aggregate which satisfied the required properties for experimental work and conforms to zone as per the specification of IS: 383-2016. The Physical Properties are given in the Table 3.4.

6 Admixtures

Superplasticizers are a water reducing admixture that causes a significant increase in flowability. Polycarboxylate Ester based superplasticizer Aura mix was used.

7 Mixing Water

Water used in SCC mixes shall be in accordance with the requirements of IS456. Where recycled water, recovered from processes in the concrete industry, is used the type/content and in particular, any variation in content of suspended particles should be taken into account as this may affect batch-to-batch uniformity of the mix. Clean potable water as obtained from laboratory of SITS was used for mixing and curing of concrete

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IV. FLOW CHART

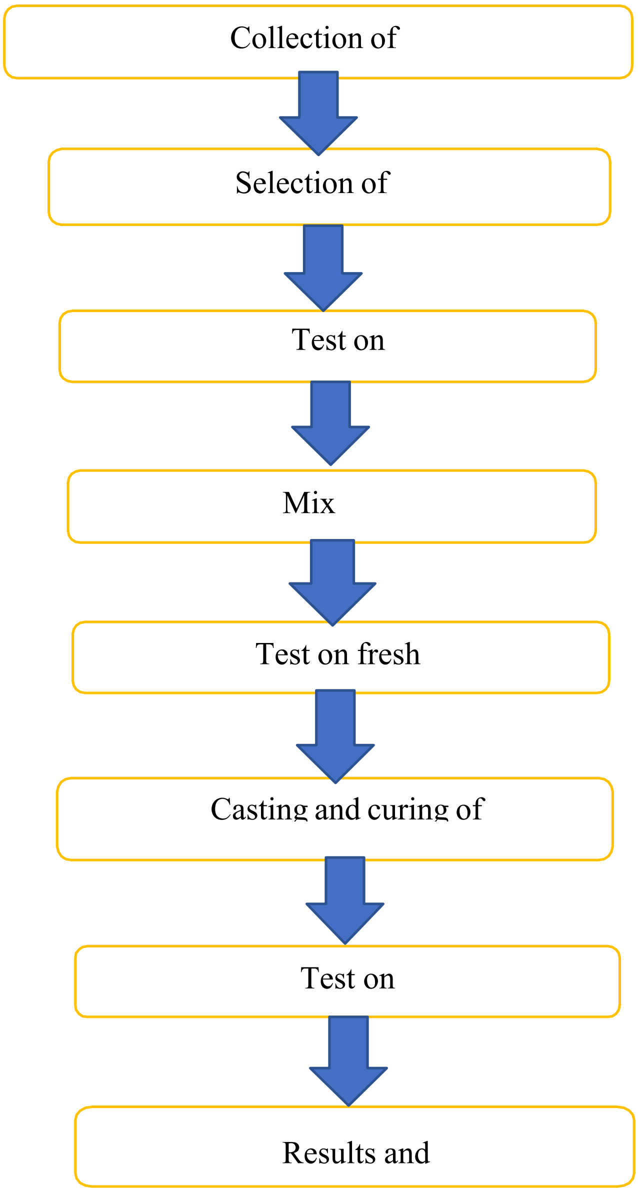

Fig : Flow Chart

Tests on materials are conducted such as,

Test on Cement

- Fineness test
- Standard consistency, initial and final setting time test.

Test on Coarse Aggregate

- Water absorption and specific gravity test
- Crushing value test
- Impact Value test
- Abrasion value test
- Elongation Index and Flakiness Index test

Mix Design of Self-Compacting Concrete

Workability test on self-compacting concrete

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V. MODELING AND ANALYSIS

Mix Design of Self-Compacting Concrete:

Data:

Grade designation = M30

Type of cement = OPC 53 grade

Nominal max. size of aggregate =12.5mm

Exposure conditions as per table 3 and table 5 of IS 456 = severe (for reinforcementConcretes)

Characteristics of SCC

Slump flow class = SF3 (760mm-850m)

Passing ability by L-box test = Ratio of h2/b2 =0.9

V-funnel flow time = Class V1(flow time<85)

Sieve segregation resistance SR I (<15%)

Degree of site control = Good

Max. cement content = 450Kg/m3

Chemical admixture = Superplasticizer normal [PCE type]

Target strength for proportioning:

fck' = fck+1.65 x S Or fck'= fck +X

=30+1.65 x 5 = 38.25 N/mm² Or =30x 6.5= 36.5 N/mm²

Approximate Air Content :

Air content = 1.0 percent

Selection of water cement ratio:

water cement ratio= 0.43 (from fig 1 IS 10262-2019)

0.43 <0.45

Hence ok.

Selection of water content & cement:

for slump flow 750 & 850mm

water content = 190 kg/m³ along @ 0.6% superplasticizerw/c ratio =0.43

The cementitious material = W/C = 190/0.43 = 441.86 ~ 442 kg/m³

Chemical admixture:

0.6 /100 x 442 = 2.65 Kg/m3

Fine aggregate content:

The power (Fines <0.125mm) req. for scc generally in range 400-600 kg/m3 select520 Kg/m3

Fineness req. to be contributed by fine aggregate = Total powder content - cementcontent = 520-442 = 78 kg/m2.The fine aggregate has 8% material <0.125mm The fire aggregate quantity = 78/0.08 = 975 kg/m³

Selection of coarse Aggregate Content:

Assuming 1 m² of concrete Vca = (1-Air content) - (vol. of water + Vol. of cement + volume of fine aggregate) =(1-0.01) - (190 / 1x1000 + 442/3.15X1000 +2.65/1.08/1000 + 975/2.651x1000)

= 0.289 m3

Mass of coarse aggregate

=Vca x specific gravity of coarse aggregate x1000

= 0.289 x 2.74 x1000 = 780.9 kg/m³ ~ 781kg/m3

Calculation of vol of powder content:

volume of power content = Volume of OPC + Volume of portion of fine aggregate <0.125mm

= (442 / 3.15x1000) +(78 / 2.65×1000) = 0.191 m3

Ratio of water of powder by volume

= 0.190/0·191 = 0·99

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Table - Mix Proportions

Sr No.	Mix Proportions
1	Cement = 442 Kg/m³
2	Water (net mixing) = 190kg/m² Fine aggregate = 975 kg/m²
3	Coarse aggregate = 737 kg/m³
4	Chemical admixture = 2.65 kg/m3
5	Free-water-cement ratio = 0.43
6	Powder content = 520 kg/m³
7	Water powder ratio by volume = 0.99

VI. RESULTS AND DISCUSSION

Compression test on self-compacting concrete

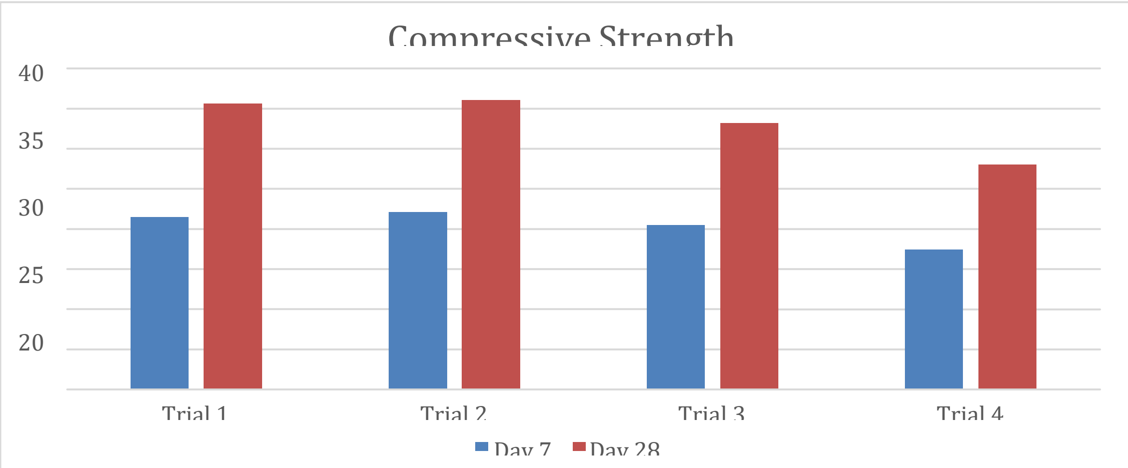

Fig : Compressive Strength Results

Table: Mix Proportions Compressive Strength

Days Trial	7 Days (MPA)	28Days (MPA)
T1	21.5	35.64
T2	22.3	36.1
T3	20.48	33.2
T4	17.43	28

VII. CONCLUSION

i. The percentage of silica fume, GGBS (ground granulated blast furnace slag) and sugarcane bagasse ash in the mix will affects the workability and mechanical characteristics of self-compacting concrete.

ii. For T2 trial we get more compressive strength than T1 trail

iii. Slump flow increases with the increase of water/cement ratio.

iv. L-box value increase with the w/c ratio and compressive strength are decreasing as the w/c ratio increases.

REFERENCES

[1] T. 1. Dhiyaneshwaran, S. Ramanathan, P. Baskar, 1. and Venkatasubramani. R- Study an Durability Characteristics of Self-Compacting Concrete with Fly Ash Jordan Journal of Civil Engineering Volne 7, No. 3, 2013

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[2] Raissa P. Dougkis Properties of Self-Consolidating Concrete Containing Type F Fly Ash - PCA R&D Serial No. 2619.
[3] Arivalagan S Experiments Analysis of Self-Compacting Concrete Incorporating different range of High-Volumes of Class F Fly Ash Scholars Journal of Engineering and Technology (SJET) Sch. J. Eng. Tech. 2013: 1(3):104-111.
[4] Mio Liu Wider Application of Additions in Self-Compacting Concrete Thesis submitted to University College London, for the degree of Doctor of Philosophy.
[5] R Getti J Izquierdo, PCC Gomes, A Josa Development of high-strength self- compacting concrete with fly ash: a four-step experimental methodology 27th Conference on Our World in Concrete & Structures: 29 30 August 2002, Singapore. Artick Online Id:100027026.
[6] Deepa Bakikrishnan S., Paukose K.C "Workability and strength characteristics of self- compacting concrete containing fly ash and dolomite powder American Journal of Engineering Research (AJER) e-ISSN: 2320-0847, p-ISSN: 2320-0936 Volume -2.
[7] Dr. Sablaklein Akadey Influence of Superplasticizer on Concrete International Journal of Research in Engineering and Technology (ERT) Vol 1, No. 3, 2012, ISSN 2277 4378.
[8] Tann R Naik, Yoon-moon Chun, Rakesh Kumar and Bruce W. Ramme "Development of High-Strength Self-Consolidating Concrete' Report No. CBU- 2003-14, REP-508, Department of Civil Engineering and Mechanics, College of Engineering and Applied Science. The University of Wisconsin-Milwaukee.
[9] Rua Okrajnov-Bajić, Dejan Vasović Self-compacting concrete and its application in contemporary architectural practise SPATIUM International Review UDK 666.97.033.14. No. 20, September 2009, P. 28-34 Review paper.
[10] Okamura, Hajime, Ouchi, Masahiro Self-Compacting Concrete Journal of Advanced Concrete Technology, 1(1): 5-15, 2003. Liana lures and Comeliu Bob- The Future Concrete: Self-Compacting Concrete" - Bul Inst. Polit. laşi LLVI (LX), 1, 2010.
[14] Ms. Priyanka P. Naik, Prof M. R. Vyawahare "Comparative ady of Effect of Silica Fune and Quarry Dust on Strength of Self-Compacting Concrete" International Journal of Engineering Research and Applications (JERA), ISSN: 2248-9622, Vol 3, Issue 3, May-Jun 2013. pp. 1497-1500.

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