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MECHANICAL STRENGTH STUDIES OF SCC IN PRESENCE OF FLY ASH

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Abstract- In the last two decades, SCC's vast studies and output have led to a large and growing number of publications of all kinds. The most significant ones for the current research are addressed and listed in this segment. A brief introduction of fresh and hardened properties will be followed by a study of testing methods, materials and prototypes for mixing. A detailed analysis of fly ash & brick dust and silica smoke as concrete additives and SCC is seen. Although SCC uses a variety of technical advantages, both social and economic, it costs two to three times as much production as regular concrete depending on the type of the mixture and its quality control. Somehow the implementation of the SCC was limited to the general house. SCC is specified only where it is most relevant. This involves places in which the relation to typical vibrations is difficult or reinforcements congested. The key problems faced in the design of the SCC were the contradictory explanations why the concrete could flow entirely, but without bleeding or separation. A higher viscosity of the SCC cement mortar is required to ensure the flow potential while maintaining the non-sedimentation of larger aggregates. Self-compacting concrete (SCC) is a sensitive mixture that relies heavily on its form and material properties. It must have the contradictory characteristics of high flow ability and high segregation resistance, a combination made possible by the water-reduction mixture's dispersal operation in combination with the long life that a high concentration of fine particles offers. The social problem of the durability of concrete structures which emerged around 1983 was the driving force behind the development of self-compacting concrete. Due to a gradual decline in the number of professional workers in the building industry, the quality of building employment has declined similarly. The main objectives of this analysis were to compare the mechanical characteristics of self-compacting and regular concrete samples. These parameters have been based on a compressive, splitting tensile strength and flexicurity of seven days, 28 days and 56 days, and on traditional and self-compressing concrete for five Fly ash & brick dust ratios.

Keywords: Self-Containing Concrete (SCC), Normal Vibrated Concrete (NVC), Viscosity-Modifying Mixture (VMA), Electrical Static Precipitators (ESP), Hydroxy Propyl Methyl Cellulose (HPMC), Ordinary Portland Cement (OPC).

1. INTRODUCTION

Self-Compacting Concrete is a concrete that flows completely under gravity influence without the effect of external compacting energy and often fills the reinforced spaces and the shape. Its main characteristics are high fluidity and excellent sedimentation stability. These characteristics can be obtained by the use of enhanced flour grain (meal maize type), stabilizing additives (stabilizer type) and their combination of highly efficient flow agents. Many people don't know any about it or they don't like it too much at least, but there is concrete around us. In the center of a desert or the sea, whether you don't live alone, just transform your mind to discover it. There is no argument that for houses and structures concrete is of significant importance. It is also at the height of the list in terms of overall consumption compared to the majority of the world, between other building and construction materials (e.g., concrete, stone asphalt, timber, etc.).

2. LITERATURE SURVEY

In the last two decades, SCC's vast studies and output have led to a large and growing number of publications of all kinds. The most significant ones for the current research are addressed and listed in this segment. A brief introduction of fresh and hardened properties will be followed by a study of testing methods, materials and prototypes for mixing. A detailed analysis of fly ash & brick dust and silica smoke as concrete additives and SCC is seen. Since this study is focused on laboratory experiments, a brief comparison to concrete development and site testing occurs.

S. Girish (2010) submitted the results of an experimental analysis to test the impact of paste and powder on selfcompacting concrete mixtures. The 63 water-containing mixtures of 175 l/m^3 to 210 l/m^3 with three different paste contents were checked. The utility of SCC was tested by slumping acceleration, V funnel and J-ring tests. The results showed that the SCC enhanced its flow properties by improving the paste length. The slump flow of fresh SCC increased almost linearly and drastically as the SCC powder quality improved. They concluded that paste plays an important role in the flow properties of fresh SCC in addition to water quality. As seen by the J-ring, the passing potential improved as the paste content expanded.

Paratibha Aggarwal (2008) suggested an experimental research-based approach for the design of self-compacting concrete mixtures. The test results for slump flow, V-funnel and L-box were found to be reasonable at the water/powder ratio of 1,180 to 1,215 that is passed capacity; filling capacity and segregation resistance are well within the limits. In this study, SCC was developed without the use of VMA. Compressive strength has also been assessed at the age of 7, 28 and 90 days. With the OPC 43 grade a standard strength of 25 MPa to 33 MPa was achieved in 28 days and a cement content of around 350 kg / m3 to 414 kg/m^3 was obtained.

Felekoglu (2005) published research on the influence of the w / c ratio on the SCC's fresh and hardened materials. One of the main characteristics in proportioning the SCC mixtures is the author's adjustment of the w / c ratio and the super plasticizer dosage. This study has discussed fine mixtures of different combinations of the w / c ratio and super plasticizer dosage ratios. The results show that the optimum w/c ratio for SCC production is between 0.84 and 1.07 by quantity. The ratio above and below this range will block or split the mixture.

3. EXPERIMENTAL

The purpose of the experimental programme is to compare the properties of self-compacting concrete rendered with and without Fly ash & Brick dust, used as a substitute for fine aggregates. The basic experiments carried out on concrete samples are addressed in this portion, accompanied by a brief overview of the mixing design and curing protocol adopted. At the end, the different experiments carried out on the specimens are addressed;

a) Fine sand with dimensions as 0.075 to 0.425 mm

b) Medium sand with dimensions as 0.425 to 2.0 mm

c) Coarse Sand with dimensions as 2.0 to 4.75 mm

MATERIAL USED

3.1 Cement

Cement is a thin, grey substance. It is combined with water and ingredients such as sand, gravel and crushed stone for the manufacture of concrete. Cement and water shape a paste that ties the other ingredients together as hardens the concrete.

Fig (1): Sample of Cement used

3.2 Fine Aggregates

The sand used for the experimental programmed was locally procured in compliance with Indian Quality Standards IS: 383-1970. The sand was then sieved into a 4.75 mm sieve to eliminate all debris bigger than 4.75 mm and was then cleaned to extract the mud. The properties of the fine aggregate used in laboratory work. The aggregates are sieved by a series of sieves for the intent of obtaining a sieve analysis. The fine aggregates belonged to zone III classification.

3.3 Coarse Aggregate

The substance which is contained in IS sieve No. 4.75 is referred to as a gross aggregate. The crushed stone is commonly seen as a rough aggregate. The essence of the function defines the maximum size of the gross aggregate. The locally accessible gross aggregate with a maximum size of 10 mm was used in our work. The aggregates were cleaned to extract dust and soil and dried to a dry base. The aggregates were tested according to IS: 383-1970. The sample of fine & Coarse aggregates are shown below

Fig (2): Coarse and Fine Aggregate

3.4 Water

Water that is ideal for drinking is usually acceptable for use in concrete. Water from lakes and streams that include aquatic organisms is often commonly acceptable. No sampling is required when water is collected from the sources described above. If it is believed that water can include sewage, mining water or waste from processing plants or canneries, it cannot be included in concrete until the tests prove that it is sufficient. Water from such sources should be avoided as the consistency of the water could shift due to low water levels or to the usage of occasional tap water for casting.

3.5 Fly-ash

Pozzolanic behavior of fly ash is greatly affected by the quantity and composition of the present glass process. Low calcium fly ash, a result of bituminous coal calcination, containing aluminosilicate glass, tends to be significantly less reactive than the calcium aluminosilicate glass, found in high calcium fly ash.

3.6 Brick Dust

Brick dust as a mineral blend has the potential to react with lime in the presence of moisture to form hydraulic goods. As Portland cement releases lime during hydration over time, this released lime is leached out of a porous matrix (Samanta et al., 1997). Due to the acidic environment, CO_2 interacts with $Ca(OH)_2$ and forms calcium carbonate and water, then releases the white material.

Portland cement + water > C-H-S (Glue) + $Ca(OH)_2$ (Fast Reaction)

3.7 Admixture

Conplast SP430 complies with IS: 9103:1979 and BS: 5075 Section 3 and ASTM-C-494 as a high range water-reducing mixer. Conplast SP430 is focused on Sulphonated Naphthalene Polymers and is supplied as a brown solvent that is immediately spread in water and precisely designed to have a strong water reduction of up to 25 percent without lack of workability, with a specific gravity of 1.22 to 1.225 at 30° C.

4. MIX DESIGN & TESTS

4.1 The combination designations followed by the Table are given below,

• Monitor mix: 100.0 percent of cement 100.0 percent of fine aggregate

• Mix-1: 100.0 per cent of cement, 90 per cent of fine aggregate material and 5.0 per cent of ash and 5.0 per cent of Brick particles.

• Mix-2: 100.0 per cent of cement, 80 per cent of fine aggregate material and 10.0 per cent of ash and 10.0 per cent of Brick particles.

• Mix-3: 100.0 per cent of cement, 70 per cent of fine aggregate material and 15.0 per cent of ash and 15.0 per cent of Brick particles.

• Mix-4: 100.0 per cent of cement, 60 per cent of fine aggregate material and 20.0 per cent of ash and 20.0 per cent of Brick particles.

Table 1: Mix Proportions of SCC

Mix design	Normal mix	Mix1	Mix2	Mix3	Mix4
Brick Dust	0	41	82	123	164
Cement(Kg/m3)	440	440	440	440	440
Coarse Aggregate	720	720	720	720	720
FineAggregate	820	738	656	574	492
Flyash	0	41	82	123	164
Super Plasticizer	1.25%	1.25%	1.25%	1.25%	1.25%
Water	0.4	0.4	0.4	0.4	0.4

4.2 Fresh Concrete Test

SCC varies from standard concrete in that its fresh properties are critical for deciding whether or not it can be positioned in a suitable manner. The numerous aspects of workability which govern its Filling capacity, its Passing capacity and its Segregation Resistance must all be closely supervised to ensure that its ability to be installed remains appropriate (EFNARC, 2000). A concrete mix may only be labeled as Self-Compressing Concrete if the criteria for all three characteristics are met.

Filling Strength: Strength to fill the formwork entirely under its own weight.

Passing Capacity: Capacity to conquer challenges without hindrance under its own weight. Obstacles are, for example, reinforcing and limited holes, etc.

Segregation Resistance: homogeneous composition of concrete before and after the transport and construction phase.

4.3 U- Box Test Method

The test was established by the Science Testing Center of the Taisai Company in Japan. Often the apparatus is called a U–box-shaped acronym exam. The test is used to calculate the potential of self-compacting concrete to fill. The apparatus consists of a vessel which is separated into two compartments by the middle wall. There is an opening with a sliding gate between the two pieces. Reinforcement bars with a nominal diameter of 13 mm are mounted at a gate with a center-to-center spacing of 50 mm. This provides a simple 35 mm spacing between the bars. The left-hand portion is loaded with about 20 liters of concrete, then the gate is raised and the water flows upwards towards the other part. The height of the concrete shall be determined in both parts.

4.4 Box Test Method

The test is based on a Japanese template for underwater concrete. The test assesses the movement of concrete and therefore the degree to which it is prone to reinforcing blocking. The apparatus consists of a rectangular box in the form of an L, with a vertical and horizontal portion, divided by a movable gate, in front of which the vertical lengths of the reinforcement bar are fitted. The vertical portion is filled with concrete, and then the gate is raised to enable the concrete to move through the horizontal section. As the flow ends, the height of the concrete at the end of the horizontal segment is represented as a proportion of that left in the vertical section (H_2/H_1 in the diagram). It implies the angle of the concrete at rest. This is an indicator of the willingness to move or the degree to which the movement of concrete through the bars is prohibited. The horizontal part of the box may be marked at a distance of 200 mm and 400 mm from the gate and the times required to enter these sections. Both are classified as T20 and T40 periods and are an example of the potential to fill. Bar parts can be of varying diameters and spaced at different intervals: in compliance with standard reinforcement considerations, an overall aggregate size of 3x may be sufficient. The bars should, in theory, be placed at any spacing in order to enforce a more or less extreme evaluation on the possibility of the concrete.

5. RESULTS AND DISCUSSION

5.1 Fresh Concrete Properties

Table 2: Properties of Fresh Concrete

Mixture ID	Slump (mm)	V-funnel (seconds)	L-Box (H2/H1)	U-box(H1-H2)
Mix 1	590	13	-	-
Mix 2	704	11	-	35
Mix 3	740	12	0.9	35
Mix 4	720	9	1	-
Normal mix	687	9	0.9	30

5.2 Compressive Strength

In this section, the results obtained for measuring the compressive strength (N/mm2), flexible strength test with varied load, for normal and bacterial concrete are discussed. The test is conducted for 14 to 28 days. The test has been conducted on normal as well as on bacterial concrete. The comparison between the performance of normal and bacterial concrete have been drawn to analyze the effectiveness of the concrete. Initially, Slump test has been performed for both normal and bacterial concrete M-25. This test is performed to determine the workability of the concrete that represents the strength of the material. Workability is the characteristic of concrete that describes the ease with which the concrete can be mixed which again depends upon the amount of water, aggregate grade. In this research work, the slump test value ranges from 55 to 78 mm.

In order to research the impact on compressive strength as Fly ash & Brick dust is applied to self-compacting concrete as a fine aggregate substitute, a cube comprising various proportions of Fly ash & Brick dust has been prepared and processed for 7, 28 and 56 days. The test was carried out on ASTM with a power of 3000 KN. The findings (Table 3) suggest that the 56-days strength of both mixtures is invariably greater than the corresponding 7-days and 28-days strength due to constant hydration of cement with concrete.

Table 3: Comparison of Compressive Strength

MIX	Compressive Strength (N/mm²)			Avg. Compressive Strength (N/mm²)		
	7 days	28 days	56 days	7 days	28 days	56 days
Normal mix	38.96	51.19	67.34	38.36	51.99	66.35
	37.78	52.14	65.23			
	38.34	52.65	66.49			
Mix1	39.98	53.98	68.83	39.92	54.29	69.01
	39.67	54.12	69.89			
	40.12	54.78	68.32			
Mix2	41.21	55.65	69.89	41.54	55.44	69.41
	41.2	54.89	69.02			
	42.23	55.78	69.34			

Mix3	43.12	56.78	71.67	43.43	57.96	71.29
	43.85	58.67	70.97			
	43.34	58.45	71.23			
Mix4	44.89	61.78	73.2	44.63	62.7	74.15
	44.89	61.78	73.2			
	44.45	62.89	74.02			

5.3 Splitting Tensile Strength

Similarly, the findings (Table 4) suggest that the 56-days strength of both mixtures is invariably greater than the corresponding 7-days and 28-days strength due to constant hydration of cement with concrete.

Table 4: Comparison of Tensile Strength

MIX	Tensile Strength (N/mm²)			Avg. Tensile Strength (N/mm²)		
	7 days	28 days	56 days	7 days	28 days	56 days
Normal mix	2.74	3.45	4.21	2.72	3.45	4.2
	2.45	3.67	4.15			
	2.98	3.23	4.23			
Mix1	2.88	3.67	4.44	3	3.77	4.39
	3.1	3.76	4.49			
	3.02	3.88	4.23			
Mix2	3.31	3.89	4.56	3.22	3.85	4.68
	3.21	3.69	4.78			
	3.15	3.97	4.71			
Mix3	3.56	4.11	4.89	3.59	4.26	4.95
	3.78	4.21	4.95			
	3.43	4.45	5.01			
Mix4	3.87	4.62	5.23	3.92	4.62	5.37
	3.92	4.78	5.34			
	3.97	4.45	5.55			

5.4 CONCLUSION

Taking into account the results of this report, which are previously presented, the following conclusions can be drawn:

• Using the slump flow and other studies, it has been checked that self-compacting concrete (SCC) has achieved stability and self-compacting under its own weight, without any external vibration or compaction. SCC also reached a density of between 2400 and 2500 kg/m^3, which was higher than that of standard concrete, 2370-2321 kg/m^3, owing to the unique mixtures used. Self-compacting concrete can be obtained by incorporating chemical and mineral materials in such a way that its tensile power, flexicurity and compressive strength are greater than those of regular vibrating concrete.

• In terms of slump flow property, both SCCs have exhibited adequate slump flow in the region of 590– 740 mm, which is a clear indicator of deformity.

• The compressive intensity is improved by increasing the percentage of Fly ash & Brick particles. A rise of around 37 percent in intensity at 7 days, 15 percent in intensity at 28 days and 8 percent at 56 days is observed with an increase in Fly ash & Brick dust content from 5 percent (SCC MIX1) to 20 percent (SCC MIX4).

• The percentage rise in the era of compressive intensity is found to be more prominent at an early age.

• The intensity is also increased at later ages, but not so rapidly, since the pozzolanic reaction of the fly ash is faster at an early age, and the brick dust acts as filler, along with pozzolanic operation, against the fine aggregate which acts only as a filler substance.

• The break tensile power of the SCC after 7 days is equal to that of the NC after 28 days. This is possible owing to the usage of Fly ash & Brick dust as a fine aggregate substitute, which helps to improve the early strength of the concrete.

• Flexural power is also observed to improve both the mixtures at all stages relative to the control blend.

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