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THE SORPTIVITY AND WEIGHT CHANGE CHARACTERISTICS OF FIBER REINFORCED IN SELF COMPACTING CONCRETE

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Abstract - *Self-Compacting Concrete (SCC) is one of the most important developments in the building industry. It provides solution to the problems occurring in normal concrete such as inadequate compaction which affects the strength and durability of structures. This project is taken up with the objective to evaluate the performance of self compacting concrete for M35grade by conducting the bond behaviour strength analysis using condensed silica and recron fiber and by adding suitable super plasticizer. The optimum combination of normal conventional concrete. The condensed silica particles can fill the voids and make better resistance to permeability and also because of better bonding.*

***Key Words*: recron fiber, condensed silica, master glenium sky 8223, self-compacting concrete, etc**,

1. INTRODUCTION

Self compacting concrete produces resistance to segregation by using mineral fillers or fines and using special admixtures. Self compacting concrete is required to flow and fill special forms under its own weight, it shall be flowable enough to pass through highly reinforced areas, and must be able to avoid aggregate segregation. This type of concrete must meet special project requirements in term of placement and flow.

Current studies in scc, which are being conducted in many countries, can be divided into the following categories: i) use of rheometers to obtain data about flow behavior of cement paste and concrete, ii) mixture proportioning methods of SCC, iii) characterization of SCC using laboratory test methods iv)durability and hardened properties of scc and comparision with normal concrete and v) construction issues related to SCC. These will be relevant to the immediate needs

OBJECTIVE

1.) Investigate the workability characteristics, hardeness properties of Self-compacting concrete.

2.) Ensure the strength properties of self compacting concrete with the effect of filler materials will be experimentally compared with nominal self compacting concrete.

3.) Demand of natural M-sand is very high,so we adopt alternate materials in high strength self compacting concrete.

II. LITERATURE REVIEW

Jyothi Kumari Ganta et al, "Hybrid steel/glass fibre-reinforced self-consolidating concrete considering packing factor: Mechanical and durability characteristics" International journal of Material Structures volume28 (2020)956-972:

- This Study intends to determine the effect of fibre type and aggregate content on hardened and durability properties of self consolidating concrete.
- Materials to be used – Flyash, micro silica, Sulphonated napthalene-based formaldehyde and polycarboxylic éither as superplasticizer.
- Strength tests – Compressive strength , split tensile, flexural and impact test are conducted for measuring hardened properties
- Durablity tests – Absorption, acid attack, resistivity, potential and chloride diffusion tests are carried out.
- Results- Test results Show that packing factors plays amajor role in mechanical characteristics of fiber reinforced scc, so that optimal value of 1.12 and 1.14 is obtained for mechanical properties.

Vitor Moreira de Alencar Monteiro et al, " On Mechanical behaviour of polypropylene, steel and hybrid fibre reinforced self-consolidating concrete" International Journal of Construction and Building material, volume188 (2018) 280-291:

- The paper makes a comparision on the mechanics of different composite systems aiming its application in structural elements.

- Materials- Flyash and silica fume, Silica flour(ground quartz) and superplasticizer(Glenium 51)
- Mechanical and rheological tests- Slumpflow test, Monotonic three point bending test, Cyclic test,Structural test, Pullout tests.
- Both hooked end steel fibre and hybrid composites enhanced the resistance at yielding and promoted a lower rate of stiffness degradation, while polypropylene fibre reinforcement presented an improvement in ductile behaviour of structural composite.

Kazim Turk el at, " Workability, Strength and Flexural toughness properties of hybrid steel fibre reinforced scc with high-volume fibre" International Journal of Construction and Building Material,volume 266(2021) 120944:

- The purpose of this study was to investigate the effect of total volume fraction and combinations of macro and micro steel fibre on the workability and mechanical as well as flexural performance of hybrid reinforced scc.
- Materials- Flyash, modified polycarboxylic polymer based high range water reduced admixture(HRWRA), macro and micro steel fibre called kemerix 65/60.
- Workability tests – Slump flow, J-ring, V-Funnel
- Strength tests – Compressive strength tests, split tensile strength tests, flexural strength, load carrying capacity, flexural toughness and ductility were measured to evaluate mechanical and flexural performance of HFRSCC.
- The attained test results for fresh properties revealed that although decrease in the workability of FR-SCC mixtures happened with increase in total volume fraction of fibres, all steel fiber reinforced scc mixture provided workability limits of EFNARC.The hybrid reinforced scc specimens were exhibited superior the compressive strength, flexural toughness and ductility compared to single fibre reinforced scc specimens.

Mojtaba Tabatabaeian et al , "Experimental investigation on effects of hybrid fibres on rheological, mechanical, and durability properties of high-strength SCC", International Journal of Construction and Building Material, volume 147 (2017) 497-509:

- The aim of the study is to investigate the effects of using hybrid fibers on rheological, mechanical, and durability properties of high strength self consolidating concrete.
- Materials- Silica fume, Polycarboxylate-based superplasticizer, hooked end steel fiber nad polypropylene fibers
- Mechanical properties tests – Compressive strength tests, split tensile strength, modulus of rupture and flexural toughness tests.
- Rheological properties test- Slump flow, J-ring and V-funnel tests.
- Durability test- Electrical resistivity tests.
- Moreover, Ultrasonic pulse velocity conducted as non-destructive test to assess the quality and integrity of concrete.
- From the results it comes to know that replacement of steel fibers with polypropylene fibers led to a reduction in compressive strength of all hybrid specimen compared to control sample. The reason is attributed to polypropylene fibers increased the porosity and rate of trapped air in the concrete.

Rahesh Hari et al "Mechanical and durability properties of sisal-Nylon 6 hybrid fibre reinforced high strength SCC", International Journal of Materials and Design , volume 204 (2019) 479-491:

- In this study high strength scc is developed with sisal-nylon 6 mono and hybrid fiber combination at various proportions of total volume fiber.
- Materials- Master Glenium SKY 8233, Sisal fiber, Nylon 6, Modified Polycarboxylic ether(PCE) as superplasticizer.
- Strength tests – Compressive strength tests, split tensile strength, flexural strength test.
- Workability test- Slumpflow test,T50 test,V funnel time test and Lbox test.
- Durability Tests - water absorption test, Acid durability test.
- Although nylon fiber improved the mechanical properties when hybridised with sisa, it is found to be prone to water absorption and HCL attack that affects durability.
- Despite overall reduction in the cost of composite, drawbacks like flammability, high moisture absorption and poor bonding properties of natural fibers are identified as hurdle for their multifarious applications in structures.

Burcu Akcay et al, "Mechanical behaviour and fibre dispersion of hybrid steel fibre reinforced self-compacting concrete" , International Journal of sConstruction and Building Material,volume 28(2012) 287-293:

- In this study, Workability, fiber dispersion/orientation, mechanical properties and fracture behaviour of hybrid steel fiber reinforced scc were investigated.
- Materials- Silica fume, steel fiber.
- Workability test- Slumpflow, U- Box, V-funnel and J-ring tests.
- Strength tests – Compressive strength tests, split tensile strength tests, flexural strength test.
- The result from experimental tests showed that flexural strength increased slightly with increasing strength of long fibers ,where as splitting tensile strength remain unchanged .It was concluded that the dispersion and alignment of fibers have effects on the mechanical properties of HSFRSCCs.

Chinmaya kumar Mahapatra et al , "Hybrid fibre reinforced self compacting concrete with flyash and nano colloidal silica: A systematic study", International Journal of Construction and building materials, volume (2017):

- The current systematic study investigates properties of hybrid fiber reinforced self compacting concrete (HyFRSCC) with crimped steel fibers and polypropylene fibers along with class F fly ash and colloidal nano silica.
- Materials- Polycarboxylate ether based superplasticizer , Colloidal nano silica, Flyash
- Strength tests – Compressive strength tests, split tensile strength tests, flexural strength test.

III. EXPERIMENTAL INVESTIGATION

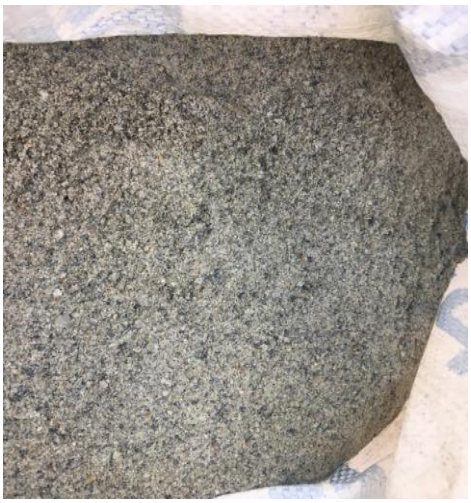
Material testing is essential for the mix design of concrete. It gives the optimum amount of material required for a given strength and workability of concrete. Hence the properties of the following materials were found.

CEMENT: The ordinary Portland cement confirming to IS 4031 was used for the preparation of specimens. OPC 53 grade was used. Physical and chemical characteristics of cement play a vital role in developing strength and controlling theology of fresh concrete. Fineness affects water requirements for consistency.

When looking for cement to be used in high performance concrete one should choose cement containing as little C3A as possible because the lower amount of C3A, then easier to control the theology and lesser the problems of cement super plasticizer compatibility. Finally from strength point of view, this cement should be finaly ground and contain a fair amount of C3S.

FINE AGGREGATE

In the present work the concrete mixes were prepared using locally available river sand free from silt, organic matter and passing through 4.75mm sieve. The sand used confining to Zone 2 of IS383-1970. In those present, we use crushed Aggregate. In crushed gravel, the amount of clay, fine silt, and fine dust should not be more than 4% by weight and in crushed stone it should not be greater than 10%.



TEST FOR FINE AGGREGATE

SI.NO	PROPERTIES	M-SAND
1	Specific Gravity	2.69
2	Fineness modulus	4.4
3	Water Absorption	5.4 %

COURSE AGGREGATE :

Crushed granite aggregate particles passing through 12.5mm and retained on 10mm I.S sieve used as the natural aggreagate which met the grading requirement of IS 383-1970. The coarse aggregate is the strongest and least porous component of concrete.

TEST FOR COARSE AGGREGATE

SI.NO	PROPERTIES	COARSE AGGREGATE
1	Specific Gravity	2.147
2	Impact Value	10.87%
3	Water Absorption	0.5 %

WATER

Water is then mixed with dry composite, which produces a semi-liquid that workers can shape (typically by pouring it into a form). Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. In general, water fit for drinking is suitable for mixing the concrete. Impurities in the water may affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. This locally available potable water which was free from concentrated of acid and organic substances, was used for mixing the concrete.

CONDENSED SILICA FUME

Condensed silica fume consists primarily of pure silica in non-crystalline form and contains more than 90% silicon dioxide (Detwiler et al., 1996). Small amounts of magnesium, iron, and alkali oxides are also present. CSF is a by product of Ferro-Silicon industry, the particle size is very small, about 100 times smaller than that of cement. It can occupy the voids in between cement particles in a concrete mix, reduce the water demand and thus contribute to a very dense concrete of high durability.

Components Chemical properties	Percentage(%)
Sio2	90 – 96
Al2o3	0.5 – 0.8
MgO	0.2 - 0.8
Cao	0.1 – 0.5

RECRON FIBRE

Recron is modified polypropylene fibre that are Engineered Micro Fibres with a unique "TRIANGULAR" cross-section. It is generally used as secondary reinforcing material in concrete and soil to increase their performance. It complements structural steel in enhancing concrete's resistance to shrinkage cracking and improves mechanical properties such as Flexural / Split Tensile and Transverse Strengths of concrete along with the desired improvement in Abrasion and Impact Strengths. Recron 3s sample used in experiment is of 12mm length. Use of recron 3s as a reinforcing material is to increase the strength in various application like cement based precast products and filtration fabrics. It also improves the quality of construction during foundation and retaining wall design. It has the diameter of 33-35 micron

MASTER GLENIUM SKY 8233

It is an admixture of a new generation based on modified polycarboxylic either. The application of product is high performace concrete where the high durability and performance is required. It is free from chloride and low

alkali.

Master glenium sky 8233 property

Aspect	Dark brown free flowing liquid
Relative Density	1.08 0.02 at 25°c
Ph	>6
Chloride ion content	< 0.2%

MIX PROPORTION

Cement (Kg/m^3)	Fine aggregate (Kg/ m^3)	Coarse aggregate (Kg/ m^3)	Water (liters/ m^3)
1	1.61	1.51	0.35

TEST FOR FRESH CONCRET

SLUMP FLOW TEST

1. About 6 liters of concrete is needed to perform the test, sampled normally.
2. Moisten the base plate and inside of slump cone.
3. Place base plate on level stable ground and the slump cone centrally on the base plate and hold down firmly.
4. Fill the cone with the scoop. Do not tamp, simply strike off the concrete level with the top of the cone with the trowel.
5. Remove any surplus concrete from around the base of the cone.
6. Raise the cone vertically and allow the concrete to flow out freely.
7. Measure the final diameter of the concrete in two perpendicular directions.
8. Calculate the average of the two measured diameters. (This is the slump flow in mm).

V-FUNNEL TEST

1. About 12 litre of concrete is needed to perform the test, sampled normally.
2. Set the V-funnel on firm ground.
3. Moisten the inside surfaces of the funnel.
4. Keep the trap door open to allow any surplus water to drain.
5. Close the trap door and place a bucket underneath.
6. Fill the apparatus completely with concrete without compacting or tamping, simply strike off the concrete level with the top with the trowel.
7. Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity.
8. Start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time). This is taken to be when light is seen from above through the funnel.
9. The whole test has to be performed within 5 minutes.

TEST FOR T50 SLUMP FLOW

1. Do not clean or moisten the inside surfaces of the funnel again.
2. Close the trap door and refill the V-funnel immediately after measuring the flow time.
3. Place a bucket underneath.
4. Fill the apparatus completely with concrete without compacting or tapping, simply strike off

the concrete level with the top with the trowel.

5. Open the trap door 5 minutes after the second fill of the funnel and allow the concrete to flow out under gravity.
6. Simultaneously start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time at T5 minutes). This is taken to be when light is seen from above through the funnel.

L-BOX TEST

1. About 14 litre of concrete is needed to perform the test, sampled normally.
2. Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it.
3. Moisten the inside surfaces of the apparatus, remove any surplus water.
4. Fill the vertical section of the apparatus with the concrete sample.
5. Leave it to stand for 1 minute.
6. Simultaneously, start the stopwatch and record the times taken for the concrete to reach the 200 and 400mm marks.
7. When the concrete stops flowing, the distances "H1" and "H2" are measured.
8. Calculate H2/H1, **the blocking ratio.**
9. The whole test has to be performed within 5 minutes.

Fresh Concrete Result

S.No	TEST FOR FRESH SCC	RESULT	EFNARC Limits
1	Slump Flow mm	710	600 to 800
2	J-ring mm	3.2	<10
3	V-funnel (SEC)	12 sec	8 to 12
4	L-box	2.0	2±0.5

RESULTS AND DISCUSSION

The compressive strength and flexural strength and split tensile strength test on conventional and condensed silica and recron fiber concrete has been conducted and its results have been discussed in this chapter.

TEST FOR HARDENED CONCRETE

1 COMPRESSIVE TEST

The determination of compressive strength has received a large amount of attention because the concrete is primarily meant to withstand compressive stresses. Generally cubes are used to determine the compressive strength. The cubes are usually of 150 X 150 X 150 mm size. In the compressive test, the cube while cleaned to wipe of the surface water, is placed with the cast faces in contact with the plates of the testing machine, i.e., the position of the cubes when tested is at right angles to that as cast. The test specimens are tested in accordance with IS 516-1959. The plates are cleaned, oil level is checked and kept ready in all respects for testing. After the required period of curing, the cube specimens are removed from the curing tank and cleaned to wipe off the surface water. Placing the smooth surfaces of the specimen on bearing surface, it is brought in contact with the top plate rotating the handling. The maximum load to failure at which the specimen breaks and the pointer starts moving back is noted. The mean value strength was recorded by conducting experiment for the three specimens.

compressive strength

MIX	Condensed silica fume	Recron Fiber	Compressive Strength (N/mm²)	
			7 Days	28 Days
Control	100	-	41.25	75.80
Mix 1	10%	0.5	44.58	74.85
	10%	1.0	48.25	81.20
	10%	1.5	49.85	83.52

SPILT TENSILE TEST

A method of determining the tensile strength of concrete using a cylinder which spilts across the vertical diameter. It is an indirect method of testing tensile strength. The procedure of making and curing tension test specimen in respect of sampling of materials ,preparation of materials, and proportioning, weighing, mixing , workability, moulds, compacting and curing shall comply in all respects with the requirements given in IS 516.

Prepare three cylindrical concrete specimen. After moulding and curing the specimen for seven days in water, they can be tested. The cylindrical specimen is placed in a manner that the longitudinal axis is perpendicular to the load. Two strips of nominal thick plywood ,free of imperfections ,approximately(25mm)wide ,and length equal to or slightly longer than that of the specimen should be provided for each specimen. The bearing strips are placed between the specimen and both upper and lower bearing blocks of the testing machine. The load shall be applied without shock and increased continuously at a nominal rate within the range 1.2N/mm^2 to 2.4 N/mm^2.Record the maximum applied load indicated by the testing machine at failure. Note the type of failure and appearance of fracture.

spilt tensile test strength

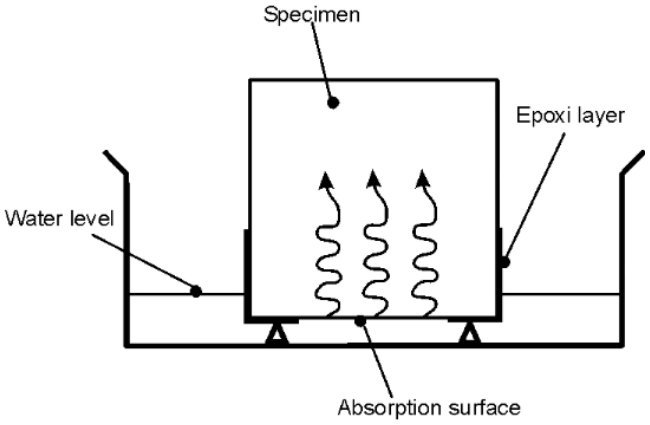
MIX	Condensed silica fume	Recron Fiber	Compressive Strength (N/mm²)	
			7 Days	28 Days
Control	100	-	4.93	7.12
Mix 1	10%	0.5	5.35	7.56
	10%	1.0	5.68	8.54
	10%	1.5	5.96	8.65

SORPTIVITY TEST

The sorptivity test was carried out, the weight and cross-sectional area of all concrete specimens were measured. A steel tray of water (at 20 degree Celsius) to a depth of 2 mm was held level to ground. Specimens were then placed over two glass rods (~1mm dia.) inside the tray to allow free water movement. After a time interval of 5,10,30, 60,120 minutes, specimens were removed from the weights were recorded. During the test, water was re-filled into the tray to maintain a water depth of 2mm. The sorptivity was then calculated by the following equation

$$i = S * t^{1/2}$$

where i (g/mm^2) represents the cumulative amount of water absorbed per unit cross-sectional area of concrete specimen, S(g/mm^2/min^1/2) is the sorptivity coefficient and t denotes the time measured in minutes.



Sorptivity test

Time ' t'(minutes)	Absorption of water Per unit area(g/mm^2)
5 min	0.471 x 10^-4
10 min	0.654 x 10^-4
30 min	1.430 x 10^-4
60 min	1.703 x 10^-4
120 min	2.158 x 10^-4

CONCLUSION

This Experimental study brief details of self compacting concrete with the effect of filler material such as condensed silica and recron fibre .The work represents the summary of literatures, parametric study of materials and collection of materials, mix design of self compacting concrete as per EFNARC guidelines. Thus the material properties are well studied for producing self compacting concrete.

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