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Impact of Incorporating Polypropelene Fibres on Characteristics of Self Compacting Concrete

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Abstract: 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 hardened concrete is dense, homogeneous and has the same engineering properties and durability as traditional vibrated concrete. The inclusion of fiber reinforcement in concrete, mortar and cement paste can enhance many of the engineering properties of the basic materials, such as fracture toughness, flexural strength and resistance to fatigue, impact, thermal shock and spalling. In recent years, a great deal of interest has been created worldwide on the potential applications of natural fiber reinforced, cement based composites. Investigations have been carried out in many countries on various mechanical properties, physical performance and durability of cement based matrices reinforced with steel fibers. These fibers help to transfer loads at the internal micro cracks. The behavior of SCC as a structural material can be improved if adequate polypropelene fiber reinforcement is added to SCC mix composition. The fiber reinforcement mechanisms can convert the brittle behavior of the cement based material into a pseudo-ductile behavior up to a crack width that is acceptable under the structural design.

Keywords – FRSCC – Fiber reinforced self compacting concrete, SCC – Self compacting concrete, VMA – Viscosity Modifying Agent

I. INTRODUCTION

The concept of self compacting concrete (SCC) was proposed by prof. okamura at Tokyo. He gave the first prototype by using materials existing in the market. The SSC has now took with enthusiasm across the world in both site and precast work. Practical application has been determined by research on physical and mechanical properties of SCC. Earlier SCC consist of more cementitious paste, the mix required well specialized and controlled placing method to avoid segregation, but the higher cement paste made the better shrinkage and more heat generation.

The basic principle is that it gets compacted by its own weight without entrapped air completely while flowing in the formwork. In higher reinforced structural member, it fills all the voids and gaps to maintain concrete as horizontal level when it is placed. Along with its composition, it consist of similar components like as conventionally vibrated normal concrete that is cement, aggregates, water, admixture. Due to use of more dosage of plasticizer or super-plasticizer leads to reduction in the liquid limit and giving better workability, more the powder content as lubricant for the coarse aggregates. Using viscocity modifying agent will increase the viscocity of concrete for better handling.

For several years, the problem of the durability of concrete structures has been a major problem posed to engineers. To make durable concrete structures, sufficient compaction is required. Compaction for conventional concrete is done by vibrating. Over vibration can easily cause segregation. In conventional concrete, it is difficult to ensure uniform material quality and good density in heavily reinforced locations. If steel is not properly surrounded by concrete it leads to durability problems. The answer to the problem may be a type of concrete which can get compacted into every corner of form work and gap between steel, purely by means of its own weight and without the need for compaction. The SCC concept was introduced to overcome these difficulties. This concept can be stated as the concrete that meets special performance and uniformity requirements that cannot always be obtained by using conventional ingredients, normal mixing procedure and curing practices.

SCC is not a new material, but rather new and improved way of executing the concreting operation. SCC, similar to CVC (conventional vibrated concrete), has a wide variety of properties to achieve specific targets. A wide number of definitions can be found in the literature, but all of them describe SCC in the common way: SCC is a concrete that is able to flow under its own weight and completely fill the formwork

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and encapsulate the reinforcement, while maintaining homogeneity and can consolidate without the need for vibration compaction. The use of SCC offers benefits in the key areas such as construction process, concrete quality, energy conservation, and health and safety.

The SCC is an engineered material consisting of cement, aggregates, water and admixtures with several new constituents like colloidal silica, pozzulonic materials, port land fly ash (PFA), ground granulated blast furnace s lag (GGBS), micro silica, meta-kaolin, chemical admixtures to take care of specific requirements, such as, high-flowability, compressive strength, high workability, enhanced resistances to chemical or mechanical stresses, lower permeability, durability, resistance against segregation, and passability under dense reinforcement conditions. As with any other technology, SCC has its own limitations: it may not be suitable for every concreting application (at its current state of the development); and it should not be used to compensate for poor design, planning, or execution.

Fiber reinforced concrete(FRC) is a composite material consisting of cement, aggregate and discontinuous, discrete, uniformly dispersed suitable fibers. Reinforced concrete is a strong durable building material that can be formed into many varied shapes and sizes. Concrete must be well compacted around the reinforcement during construction. Internal micro-cracks are inherently present in the concrete and its poor tensile strength is due to propagation of such micro-cracks, leading to brittle failure of concrete. As the strength of concrete increases, its brittleness also increases. This weakness can be considerably overcome by the inclusion of polypropylene fibers in the concrete mix.

Usage of fibers in concrete as

- Fibers have proved rather effective as crack controlling reinforcement, particularly in slabs.
- Using fibers in SCC will reduces cracking, improve toughness and strength of brittle building materials.
- By replacing parts of the conventional reinforcement by fibers a new, more rational way of production has been developed.

Along with the fibers, super-plasticizers helps in improving the fresh and hardened properties of the concrete

- Super plasticizer will be added to reduce the water cement ratio.
- A decrease in water cement ratio substantially increases the compressive strength of SCC in the present work. The effect of polypropylene fibre on performance of SCC and on various strength of concrete will be investigated and test results will be obtained.

II. NECESSITY OF FIBER REINFORCED CONCRETE

1. It increases the tensile strength of the concrete.
2. It reduce the air voids and water voids the inherent porosity of gel.
3. It increases the durability of the concrete.
4. Fibres such as graphite and glass have excellent resistance to creep, while the same is not true for most resins. Therefore, the orientation and volume of fibres have a significant influence on the creep performance of rebars/tendons**.**
5. Reinforced concrete itself is a composite material, where the reinforcement acts as the strengthening fibre and the concrete as the matrix. It is therefore imperative that the behavior under thermal stresses for the two materials be similar so that the differential deformations of concrete and the reinforcement are minimized.
6. It has been recognized that the addition of small, closely spaced and uniformly dispersed fibers to concrete would act as crack arrester and would substantially improve its static and dynamic properties.

III. ADVANTAGES AND DISADVANTAGES

Some of the advantages of using FRSCC are:

1. Improved Concrete Quality:

SCC yields homogeneous concrete in situations where the castings are difficult due to congested reinforcement, difficult access etc.

SCC shows a good filling ability especially around reinforcement

SCC is very well suited for special and technically demanding structures such as tunnel linings, as the possibility to compact the concrete is limited in the closed space between formwork and rock.

Shows narrow variation in properties on site.

Most suitable for concrete filled tubes (CFT) technology construction for high rise buildings. It ensures better quality of in-situ pile foundation.

2. Environmental & Human Health Protection:

Reduces noise at sites, the pre cast factory, and neighborhood, hence, it is a silent concrete.

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Eliminates problems with blood circulation leading to "white fingers" caused by compacting equipment, hence called a healthy concrete.

SCC gives noise protection in precast industry, by introducing no restrictive measures like ear protection, marked areas, safety instructions are necessary.

Shortens the construction time by accelerating construction process, especially in pre cast industry.

3. Economy & Time Reducing:

Its ease of placement improves the productivity and the cost saving through reduced equipment and labor equipment.

Reduction in wear and tear of forms, therefore, it extends the service life of forms.

Reduction in the number of worker. Normally one cum requires 1.5 man-hours; with SCC this is reduced to 0.35man-hours.

It reduces the consumption of resources and cost, even considering a higher price per cubic meter for the concrete. Okamura has reported that it is possible to reduce the overall bridge cost by 5-15%.

4. It gives wide opportunity for the use of high-volumes of by products materials

Such as fly ash, lime stone powder, quarry dust etc., (Yahia et al. 1999, Bouzoubaa, and

Lachemi 2001, Persson 2002, Naik and Kumar 2003) since a higher volume of powder material is required for enhancing the cohesiveness and reducing the amount of superplasticizer and viscosity modifying agents.

In spite of all Some of the disadvantages of using FRSCC are

1. The production of SCC places more stringent requirements on the selection of materials in comparison with conventional concrete.

2. An uncontrolled variation of even 1% moisture content in the fine aggregate will have a much bigger impact on the rheology of SCC at very low W/C (~0.3) ratio. Proper stock pilling of aggregate, uniformity of moisture in the batching process, and good sampling practice are essential for SCC mixture,

3. A change in the characteristics of a SCC mixture could be a warning sign for quality control and while a subjective judgment, may some times be more important than the quantitative parameters.

4. The development of a SCC requires a large number of a trial batches. In addition to the laboratory trial batches, field size trial batches should be used to simulate the typical production conditions. Once a promising mixture has been established, further laboratory trial batches are required to quantify the characteristics of the mixture.

5. SCC is costlier than conventional concrete initially based on concrete materials cost due to higher dosage of chemical admixtures, i.e. high range water reducer and viscosity enhancing admixture (VEA). Increase in material cost can be easily offset with improvement in productivity, reductions in vibration cost and maintenance and proper uses of mineral admixtures.

IV. OBJECTIVES

- To obtain optimum quantity of fibers to achieve self compacting property of concrete.
- To check various fresh properties of self compacting concrete.
- To check hardened strength of concrete with various tests.
- To check improvement in the strength of fiber reinforced self compacting concrete with various tests.

V. FUNCTIONAL REQUIREMENTS

The functional requirements of fresh SCC are different from those of CVC (conventionally vibrated concrete). SCC is a liquid particle suspension and exhibits very different properties in its plastic state.

The following properties define the compliance with self-compactability:

Filling Ability – Complete filling of formwork and encapsulating of reinforcement and inserts and substantial horizontal and vertical flow of the concrete within the formwork while maintaining homogeneity. Filling ability is normally measured by either slump flow or J-Ring tests. Depending on the application, the slump flow values can vary from 550 (for precast and flat applications) to 850 mm.

Passing Ability - Passing of obstacles such as narrow sections of the formwork, closely spaced reinforcement etc. without blocking caused by interlocking of aggregate particles. Passing ability is normally measured by L-Box , or J-Ring. SCC is considered to comply with passing ability requirements when $H1/H2 \geq 0.80$.

Resistance to Segregation - Maintaining of homogeneity throughout mixing, during transportation, and casting. The dynamic stability refers to the resistance to segregation during placement. The static stability refers to the resistance to bleeding, segregation, and surface settlement after casting. It can be the most difficult property to quantify. It is normally referred to checked visually, although there have been a number of attempts to quantify the segregation resistance.

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VI. REQUIREMENTS FOR FRSCC

Materials

Cement : Ordinary Portland cement, 53 grades can be used.

Aggregates : The maximum size of aggregate is limited to 20mm. Aggregates of sizes 10 to 12 mm is desirable for structures having congested reinforcement. Well graded cubical or rounded aggregates are desirable. Aggregates should of uniform quality with respect to shape and grading. Fine aggregates can be natural or manufactured. The moisture content or absorption characteristics must be closely monitored as quality of SCC will be sensitive to such changes.

Particles smaller than 0.125mm i.e. 125 micron sizes are considered as FINES which contribute to powder content.

Mixing water : Water quality must be established on the same line as that for using reinforced concrete or pre stressed concrete.

Chemical Admixture:

Super plasticizers are the essential components of SCC to provide necessary workability. The new generation super plasticizers termed as poly-carboxylated ethers (PCE) is particularly useful for SCC.

Other types may be incorporated as necessary, such as Viscosity Modifying Agent (VMA) for stability.

Mineral Admixtures:

Ground Granulated Blast Furnace Slag (GGBFS): GGBFS which is both cementitious and pozzolanic material may be added to improve rheological properties.

Silica Fume (SF) : Silica fume may be added to improve the mechanical properties of SCC.

Fibers

Fibers may be used to enhance the properties of SCC in the same way as for normal concrete. There are so many fibers such as we used **Polypropylene Fiber**

Polypropylene is one of the cheapest & abundantly available polymers polypropylene fibers are resistant to most chemical & it would be cementitious matrix which would deteriorate first under aggressive chemical attack. Its melting point is high (about 165 degrees centigrade). So that a working temp. As (100 degree centigrade) may be sustained for short periods without detriment to fiber properties.

Polypropylene fibers being hydrophobic can be easily mixed as they do not need lengthy contact during mixing and only need to be evenly distressed in the mix.

Polypropylene short fibers in small volume fractions between 0.5 to 15 commercially used in concrete.

VI. MIX PROPORTIONS

PARTICULARS	VOLUME IN kg/m^3
CEMENT	380
WATER	152
COARSE AGGREGATE	932.8
FINE AGGREGATE	783.36
SILICA FUME	58

VII. MATERIALS PROPERTIES

Table 1. Results of coarse aggregate

TESTS	OBTAINED VALUES
SPECIFIC GRAVITY	2.62
MOISTURE CONTENT	1.16%
SIEVE ANALYSIS (FINENESS MODULUS)	2.99
ANGULARITY NUMBER	4

Table 2 : test results of fine aggregate

TESTS	OBTAINED VALUES
FINENESS MODULUS	2.7
MOISTURE CONTENT	1.4
SPECIFIC GRAVITY	2.7
BULKING	46.87%

Table 3 : represents the obtained values of tests conducted on cement

TESTS	OBTAINED VALUES
SPECIFIC GRAVITY	2.9
STANDARD CONSISTENCY	30%
INITIAL SETTING TIME FINAL SETTING TIME	55 min 320min
FINENESS TEST	5%

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VIII. METHODOLOGY

The calculated quantity of materials are added in the mixture along with selecting the water-cement ratio to get workable mix and the fresh and hardened properties of the concrete is done by varying the percentages of fibre .

1. slump flow
2. V funnel test
3. L box test

1 The Slump Flow Test

This is a test method for evaluating the flowability of SCC, where the slump flow of SCC with coarse aggregates having the maximum size of less than 40 mm is measured The basic equipment is the same as for the conventional slump test. However, the concrete placed into the mold is not rodded. When the slump cone has been lifted and the sample has collapsed, the diameter of the spread is measured rather than the vertical distance of the collapse.

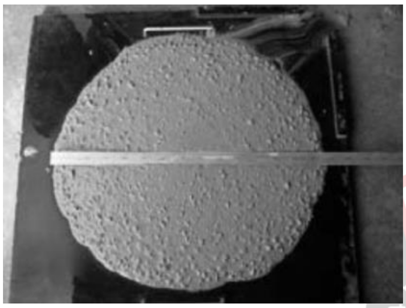

Fig. 1 slump flow

2 V - Funnel Test:

A test method for evaluating the material segregation resistance of SCC using a funnel, Where the efflux time of SCC with coarse aggregates having the maximum size of less than 25 mm is measured.

Fig. 2 V – Funnel test

T50 Test: A test method for evaluating the material segregation resistance of SCC, where the 500-mm flow reach time is measured in the slump flow test above, that is, and the time for the flow to reach 500 mm is measured in the slump flow test. SCC should give T50 = 2 . 5 seconds.

3 L-box Test:

The L-box test method uses a test apparatus comprising a vertical section and a horizontal trough into which the concrete is allowed to flow on the release of a trap door from the vertical section passing through reinforcing bars placed at the intersection of the two areas of the apparatus (Figure 5)7. The time it takes to flow a distance of 200mm (T-20) and 400 mm (T-40) into the horizontal section is measured. The concrete ends of the apparatus H1 and H2 measure the height of the concrete at both ends. The L-box test can give an indication as to the filling ability and passing ability.

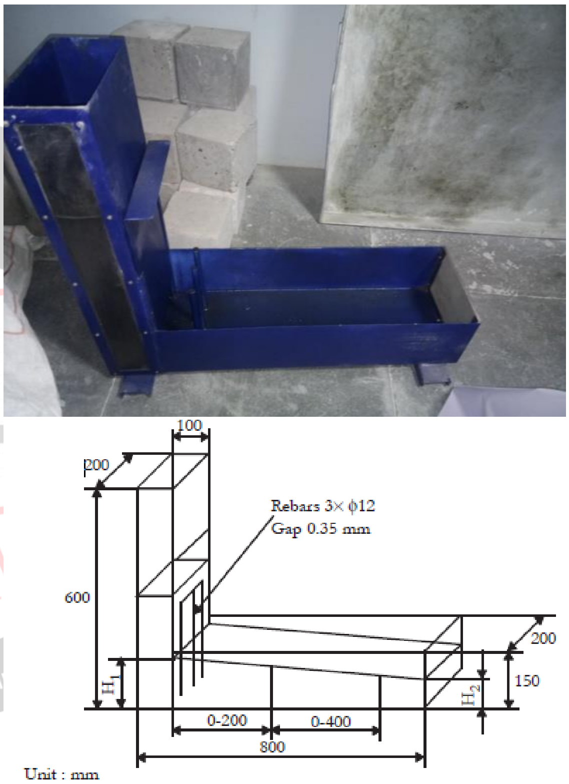

Fig.3 L – box

U-Type and Box-Type Tests:

These are methods for testing flow ability of SCC through an obstacle with coarse aggregates having the maximum size of less than 25 mm (Fig. 4 and Photo 1). Time and height to be filled in the chamber B and amount of aggregate passed through the obstacle are measured for self-Compatibility

Self-compacting concrete is a two phase (solid and liquid) particle suspension and is very fluid. The challenge than is to maintain the flowability of the suspension and to avoid the segregation of the phases. The main mechanism to control the flowability and stability of SCC is related to the surface chemistry. Thus, development of SCC has been strongly dependant on surface active admixtures as well as particle packing properties.

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Fresh SCC behaviour can not be fully comprehended without understanding its rheology. Rheology in the broad sense is the science of flow and deformation of matter. The placing, spreading, pumping and compaction of any concrete depends on rheology. Using the science rheology it is becoming possible to predict fresh properties, select materials and model processes to achieve the required performance. Rheology is now seriously considered by concrete users, rather than being seen as an area of specialized domain of cement science. The basic key rheological parameters are yield stress and plastic viscosity (Fig.3). Fresh concrete can be seen as a fluid, providing that a certain degree of flow can be achieved and the concrete maintains its homogeneity.

Flow of fresh concrete is described by Bingham model, i.e. by the equation

$\tau = \tau o + \mu\gamma$

Where τ - shear stress applied to material,

τo - yield stress

μ - plastic viscosity

γ - rate of shear

Yield stress is representing a minimum force required to start concrete flowing. For normal concrete, vibration is such a force. Plastic viscosity can be described as a resistance to flow, or the stiffness of fresh concrete. The rheological behaviour of SCC is different to vibrated concrete, as its yield stress approaches 0 (which means that SCC flows under its own weight) and viscosity increases.

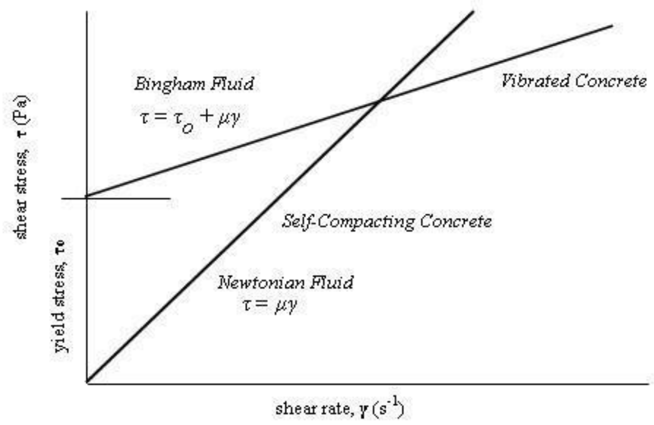

Figure 4. . Concrete rheological models

Rheology is increasingly used in understanding the mechanisms; in optimizing the constituent materials, in understanding the relation between thixotropy and formwork pressure, in the modeling the flow etc. Although rheological evaluations are seriously considered by users they are still primarily used for research and development and not yet in any significant way as a tool in quality control and quality assurance procedures. This is mainly because of the complexity and high cost of the equipment. Further developments in this area will soon provide suitable equipment. In material design, in practice, as well as in quality control and quality assurance, fresh SCC properties are evaluated by methods specifically developed for SCC. These include slump flow, L-box, J-ring, U-box, V-funnel.

Flexural strength

Flexural strength is known as bond strength or rupture modulus or transverse rupture strength is the stress in a material just before it yields in flexure test. It is used to determine the flex or bending property of the concrete. It involves placing the material between two points. the SCC bond strengths expressed in terms of the compressive strengths are higher than those of conventional concrete.

Flexural strength test

Flexural strength is a measure of the tensile strength of concrete beams or slabs. Flexural strength identifies the amount of stress and force an unreinforced concrete slab, beam or other structure can withstand such that it resists any bending failures.

Flexural strength is also known as bend strength or modulus of rupture or fracture strength.

The size of beam specimens is 10 x10 x50cm. The beam specimens were cast and tested in the laboratory.

1. The test should be conducted on the specimen immediately after taken out of the curing condition so as to prevent surface drying which decline flexural strength.
2. Place the specimen on the loading points. The hand finished surface of the specimen should not be in contact with loading points. This will ensure an acceptable contact between the specimen and loading points.
3. Center the loading system in relation to the applied force.
4. Bring the block applying force in contact with the specimen surface at the loading points.
5. specify whether any space between the specimen and the load-applying or support blocks is greater or less than each of the gages over a length of 25 mm or more. Capping or grinding should be considered to remove gaps in excess of 0.38mm.
6. Load the specimen continuously without shock till the point of failure at a constant rate (Indian standard specified loading rate of 400 Kg/min for 150mm specimen and 180kg/min for 100mm specimen, stress increase rate 0.06+/-0.04N/mm^2.s according to British standard).

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Tensile Strength

Tensile strengths are based on the indirect splitting test on cylinders. For SCC, the tensile strengths and the ratios of tensile and compressive strengths are in the same order of magnitude as the conventional vibrated concrete.

Split tensile strength test

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.

The concrete is very weak in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces. Thus, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack.

Apparatus : Compression testing machine, two packing strips and steel tamping rod

Procedure :

1. Take the wet specimen from water after 7 days of curing
2. Wipe out water from the surface of specimen
3. Draw diametrical lines on the two ends of the specimen to ensure that they are on the same axial place.
4. Note the weight and dimension of the specimen.
5. Set the compression testing machine for the required range.
6. Keep are plywood strip on the lower plate and place the specimen.
7. Align the specimen so that the lines marked on the ends are vertical and centered over the bottom plate.
8. Place the other plywood strip above the specimen.
9. Bring down the upper plate to touch the plywood strip.
10. Apply the load continuously without shock at a rate of approximately 14-21kg/cm2/minute (Which corresponds to a total load of 9900kg/minute to 14850kg/minute)
11. Note down the breaking load

Compressive Strength

SCC compressive strengths are comparable to those of conventional vibrated concrete made with similar mix proportions and water/cement ratio. There is no difficulty in producing SCC with compressive strengths up to 60MPa.

Compressive strength test

For cube test two types of specimens either cubes of 15cm X 15cm X 15cm or 10cm X 10cm x 10cm depending upon the size of aggregate are used. For most of the works cubical moulds of size 15cm x 15cm x 15cm are commonly used.

This concrete is poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds are removed and test specimens are put in water for curing. The top surface of these specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen.

These specimens are tested by compression testing machine after 7 days curing or 28 days curing. Load should be applied gradually at the rate of 140 kg/cm2 per minute till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Procedure and curing :

1. Measure the dry proportion of ingredients (Cement, Sand & Coarse Aggregate) as per the design requirements. The Ingredients should be sufficient enough to cast test cubes . Thoroughly mix the dry ingredients to obtain the uniform mixture
2. Add design quantity of water to the dry proportion (water-cement ratio) and mix well to obtain uniform texture
3. Fill the concrete to the mould with the help of vibrator for thorough compaction
4. Finish the top of the concrete by trowel & tapped well till the cement slurry comes to the top of the cubes.

Curing

- After some time the mould should be covered with red gunny bag and put undisturbed for 24 hours at a temperature of 27 ° Celsius ± 2
- After 24 hours remove the specimen from the mould.
- Keep the specimen submerged under fresh water at 27 ° Celsius. The specimen should be kept for 7 or 28 days. Every 7 days the water should be renewed. The specimen should be removed from the water 30 minutes prior to the testing.
- The specimen should be in dry condition before conducting the testing.
- The Cube weight should not be less than 8.1 Kgs

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IX. RESULTS AND DISCUSSION

The results can be analyzed by varying the percentages of polypropylene fibre to determine the optimum quantity of fibre .

Fresh Properties

1. Slump test
2. V funnel
3. L- box

Table 4 : Fresh properties of FRSCC with varying fibre quantity

TRIAL	% OF POLYPROPYLENE FIBRES	TESTS CONDUCTED	OBTAINED VALUES
1	0	SLUMP FLOW TEST	500mm
		V FUNNEL TEST	13 seconds
		L BOX TEST	0.8
2	0.15	SLUMP FLOW TEST	550mm
		L BOX TEST	0.75
		V FUNNEL TEST	24 seconds
3	0.20	SLUMP FLOW	590mm
		V FUNNEL	28 seconds
		L BOX TEST	0.72

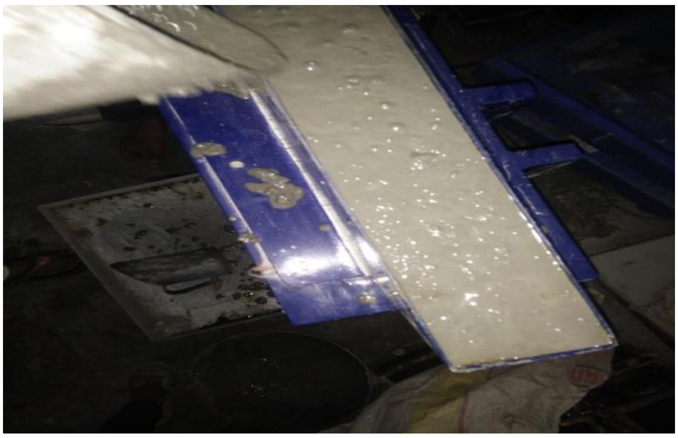

Fig.4 V funnel test

Fig.5 slump flow

Hardened Properties

1. Compressive Strength Test
2. Split Tensile Strength Test
3. Flexural Strength Test

TEST TRIALS

CUBES (150X150X150)mm

TRIAL NO	% OF POLYPROPYLENE FIBRES	COMPRESSIVE STRENGTH(Mpa)	
		7 days	28 days
1	0	25.8	35.23
2	0.15	28.1	36.41
3	0.2	30.2	38.10

Table 5 : Hardened properties of cubes (test trial 1)

Fig.6 compression test

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CYLINDERS
height-300mm, dia-150mm

Table 6 : Hardened properties of cylinders (test trial 1)

TRIAL NO	% OF POLYPROPYLENE FIBRES	SPLIT TENSILE STRENGTH(Mpa)
		28 days
1	0	2.55
2	0.15	2.67
3	0.2	2.70

BEAMS

SIZE-100*100*500mm

Table 7 : Hardened properties of beams

TRIAL NO	% OF POLYPROPYLENE FIBRES	FLEXURAL STRENGTH(Mpa)
1	0	8.50
2	0.15	8.92
3	0.20	9.68

Fig.7 cured beams

X. CONCLUSION

1. Considering the durability and workability of conventional concrete structures, it is observed that the quality and the density of the concrete cover, as well as the compaction of the concrete are main parameters that cause deterioration.
2. In general, the addition of fibers with different types and various amounts are achieved the desired improvements in mechanical behavior of reinforced concrete.
3. For the compressive strength, the better result was taken form single type fiber which is cased sufficient bond to material resulting in sufficient transfer of stress. So, the high volume percentage fibers has significant effect on compressive strength compered to low volume percentage.
4. From the flexural test results, it has been concluded that the type and volume percentage of fiber have direct effect on MOR. Because in presence of fiber which is stronger result in improving the first crack strength.
5. The results show that the fiber addition increases impact resistance in all FRCs. Irrespective to fiber content, increasing of fiber amount result in growth rate of impact resistance
6. For this, FRSCC offers new possibilities and prospects. It can be a boon considering improvement in concrete quality, significant advances towards automation and concrete construction processes, shortened construction time, lower construction cost and much improvement in working conditions as it reduces noise pollution and is rightly called as a 'silent revolution' in the field of concrete technology.
7. In our country, the special type of concrete is used on few jobs on experimental basis. However it will be more frequently used as economics and environmental pollution will become major concerns of 21st century.

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