Strength Properties Of Self Compacting Concrete With Steel Fibers

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ABSTRACT

Over the last few decades, the astonishing of super plasticizers technology allowed great achievements on the conception of concrete mixes exhibiting self- compacting ability .Since the eighties some methodologies have been proposed to achieveself-compacting requirements in fresh concrete mixes based on the evaluation of the flowing properties of these mixes There still persist, however some doubts about the most appropriate strategy to define the optimum composition of a self-compacting concrete(SCC) mixbased on a required performance. The behavior of SCC as a structural material can be improved if adequate steel fiber reinforcement is added to SCC mix composition In fact the fiber reinforcement mechanisms can convert the brittle behavior of this cement based material into a pseudo-ductile behavior up to a crack width that is acceptable under the structural design point of view Fiber addition however increases the complexity of the mix design process due to the strong perturbation effect the steel fibers cause on fresh concrete flow In the present work, a mix design method is proposed to develop cost effective and high performance steel fiber reinforcedThe steel fiber were used at different aspect ratio (80, 50) with 2.5% volume making the concrete the comparative study on steel fiber reinforced cum control concrete steel fibers of 50, 60 and 67 aspect ratio at volume fraction of 0%, 1%,2% and 3% were used it was observed that compressive strength tensile strength and flexural strength from steel fiber were on higher side from 3% fiber as compared to that properties were observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67 through utilization of steel fiber the compressive strength increased from 11 to 28%, flexural strength increased from 18 to 58% and tensile strength from 9 to 29%.Self compacting concrete (SFRSCC).construction of durable concrete structures requires skilled labor for placing and compacting concrete Self-compacting concrete achieves this by its unique fresh state properties. In the plastic state, it flows under its own weight and homogeneity while completely filling any formwork and passing around congested reinforcement. In the hardened state, it equals or excels standard concrete with respect to strength and durability This work is aimed to study the performance of steel fiber reinforced self-compacting as plain self-compacting concrete is studied in depth but the fiber reinforced self-compacting concrete is not studied to that extent. The effect of fibers on the fresh and hardened properties was studied.

1.1General

Self-Compacting Concrete (SCC) can be defined as a concrete that is able to flow in the interior of the formwork, filling it in a natural manner and passing through the reinforcing bars and other obstacles flowing and Consolidating under the action of its own weight. Self - Compacting Concrete was originally developed with the intention of simplifying Casting operations in Civil Engineering constructions of large dimensions where high Percentage of reinforcement or complex geometries difficult concrete flow soon it became clear though that the great productivity increase associated to SSC technology Also habilitates it as a solution The fresh Self-Compacting Concrete are mainly resumed to the filling ability The passing capacity and the resistance to segregation these properties are evaluated At the mix design stage based on a series of tests in fresh samples with distinct apparatus.

Self-Compacting Concrete ability in concrete depends on the performance level reached by the fresh mix in these tests the introduction of steel fibers in concrete is another issue of interest on the Concrete technology steel fibers proved to have the potential to increase the post cracking absorption capacity of cement based materials enhancing the Ductile character of structures behavior mainly of those with high redundant supports The advantages associated to the addition of steel fibers to concrete mixes may be joined with the ones resulting the self-compacting ability concept in concrete with the formulation of steel fiber reinforced concrete mixes exhibiting self-compacting ability. The resulting material is in this works designated by Steel Fiber Reinforced Self Compacting Concrete (SFRSCC) and when compared to conventional concretes presents. Clear technical advantages in terms of costs/benefits ratio there exist however some drawbacks associated to the SFRSCC formulations and the most relevant one is related to the strong perturbation effect produced by steel fibers on the flowing ability of fresh. Concrete the functional requirement of a fresh vibrated fresh normal concrete filling of formwork with a liquid suspension requires workability performance like filling ability. Passing ability and resistance against segregation filling ability of concrete is the ability Of concrete to flow under its own weight both horizontally and vertically upwards if Necessary and to completely fill the formwork of any dimension and shape without leaving voids passing ability is the ability of concrete to pass through obstacle such as Narrow section of the work closely spaced reinforcement without blocking caused by Interlocking of aggregate particles resistance to segregation is maintaining homogeneity Throughout mixing, 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 in the present work the procedure followed to develop a cost effective and high performance SFRSCC is briefly Described a detailed exposition can be found elsewhere the hardened SFRSCC performance in terms of material Self Compacting Concrete is a concrete which flow.

- And compacts only under gravity it fills the mould completely without any defects
- Usually self-compacting concretes have Compressive strength in the range of 60-100 N/mm^2.

Several European countries recognized the significance and potentials of SCC developed in Japan. During 1989, they founded European federation of natural trade associations representing producers and applicators of specialist building products (EFNARC). The utilization of SCC started growing rapidly. EFNARC, making use of board practical experiences of all members of European federation of SCC, has drawn up specification and guide lines to provide a framework for design and use of high quality SCC, during 2002.Self-Compacting Concrete has been desired as ‘The Most Revolutionary Development in Concrete Construction for Several Decades. The objective of this study is to optimize the Steel Fiber Reinforced Self Compacting Concrete (SFRSCC) in the fresh and hardened state. But the literature indicates that some studies are available on plain SCC but sufficient literature is not available on SFRSCC with different mineral admixtures. Hence an attempt is made in this work to study the mechanical properties of both plain and SFRSCC.

1.2 Self Compacting Concrete

Self Compacting Concrete (SCC) can be defined as a concrete that is able to flow in the interior of the formwork, filling it in natural manner and passing through the reinforcing bars and other obstacles, flowing and consolidating under the action of its own weight(Okamura1997). SCC was originally developed with the intention of simplifying casting operation in civil engineering constructions of large dimension where high percentage of reinforcement or complex geometries difficult concrete flow soon it became clear though That the great productivity increase associated to SCC technology also habilitates it as a good solution for housing construction precast industry the fresh self-compacting concrete Requirements are mainly resumed to the filling ability the passing ability and the resistance These properties are evaluated at the mix design stage based on a series of tests in fresh samples with distinct apparatus(EFNARC) self-compacting ability in concrete depends on The performance level reached by the fresh mix in these tests.

1.3 Mechanism for Achieving Self-Compact Ability Simply increasing the water content in a mix to achieve a flow able concrete like self-compact concrete is obviously not a viable option. Instead the challenge is to increase the flow ability of the particle suspension and at the same time avoid segregation of the phases the main mechanism controlling the balance between higher flow ability and stability are related to surface chemistry the development of SCC has thus been strongly dependent on Surface active admixtures as well as on the increased specific surface area obtained through The used fillers The method for achieving self-compact ability involves not only high deformability of paste or mortar but also resistance to segregation between coarse aggregate and mortar when the concrete flows through the confined zone of reinforcing bars Hajime Okamura and Ozawa have employed the following method to achieve Self-Compact ability Limited aggregate content.

(a) Low water-powder ration
(b) Use of Super of Plasticizer (SP)
(c) Use of Viscosity Modifying Agent (VMA)

The frequency of collision and contact between aggregate particles increases as the relative distance between the particles decreases and the internal stress increases when concrete is deformed particularly near obstacles it has been revealed that energy required for flowing is consumed by the increased internal stresses resulting in blockage of aggregate particles limiting the coarse aggregate content whose energy consumption is particularly intense to a level lower than normal proportions is effective in a voiding this kind of blockage Highly viscous paste is also required to avoid the blockage of coarse aggregate when concrete Flows through obstacles when concrete is deformed the paste with high viscosity also prevents localized increase in the internal stress due to the approach of coarse aggregate particles high deformability can be achieved only by the employment of as super plasticizer Viscosity Modifying Agent keeping the water-powder ratio at a very lower level.

1.4 Constituents of Self-Compact Concrete

The construction industry uses concrete to large concrete is used in infrastructure and in buildings it is composed of granular materials of different sizes and the size range of the composed solid mix covers wide intervals. The overall grading of the mix containing particles from 300 nm to 32mm determines the mix properties of the particle size distribution but also the properties of the concrete in hardened state such as strength and durability are affected by the solid size range by including particles with sizes below 300nmPossible materials which are currently available are limestone and silica fines leaks silica Flavor silica fume and nana-silica

1.4.1 Coarse aggregate

These are the inert materials forming the bulk of the cement herds tones are Crushed to the required size and are used as coarse aggregates the material that is retained on IS sieve of size 4.75 mm is called coarse aggregates the largest size used varies depending on the work involved these aggregates bound together by the cement and fine aggregates in the presence of water to from concrete.

Shape: Shape of the particles may be rounding, regular or angular or angular as rounded particles do not exhibit good interlocking irregular angular particles are preferred Flat elongated and flaky particles do not give strong concrete and hence they should be avoided.

Texture: surface texture is the property the measure of which depend upon the relative degree to which particle surfaces are polished or dull smooth and rough surface Texture depends hardness grain size pore structures of the rock and the degree to which forces acting on the particle surface have soothed or roughened it hard dense fine-grained Materials will generally have smooth fracture surfaces as surface smooth increases contact Area decreases, aggregates with rough surfaces are preferred since they give good bonding.

Size: Aggregates should have varying size ranging from the maximum size prescribed to the minimum the size of the aggregates to be used in concrete depends upon the following factors

- One-fourth of the minimum thickness of the member
- 5mm less than the minimum clear distance between the main bars
- 5mm less than the minimum cover to the reinforcement
- U1/3 the depth of the section of slab

Usually for all normal R.C.C works, 20 mm size is preferred for mass concrete work like Abutments piers dams.40mm size aggregates are used.

1.4.2 Fine Aggregate

Fine Aggregate should consist of natural sand or crushed stone sand. It should be Hard durable and be free from organic matter fine aggregate should not contain any appreciable amount of clay ball and harmful impurities such as alkalis salts coal decayed vegetation the silt content should not exceed 4%.

Classification of sand: Classification of sand is given below

- Fine sand 0.075mm to 0.425mm
- Medium sand 0.425mm to 2mm

Coarse sand 2mm to 4.75 mm

Various Types of sand:

Pit Sand
River Sand
Sea Sand

Pit Sand (Coarse Sand)

Pit Sand is obtained by forming pits into soil from 'Qsuarries'. It consists of sharp angular grains which are free from salts. It is coarse sand which is usually used in concreting and has reddish yellow color normally.

River Sand

This sand is obtained from banks or beds of rivers. River sand is fine and consists of fine rounded grains. The color of river sand is almost white and grayish. River sand is usually available in clean condition and is used for plastering.

Sea Sand

This sand is obtained from sea shores. It has fine rounded grains and light brown color. Sea Sand contains salts which attract moisture from atmosphere. Such absorption causes dampness and disintegration of work. Sea sand also retards setting action of cement. Due to these reasons, sea sand is generally avoided for engineering purposes. It is used only as a local material for non structural purposes.

Sand for construction works

Different construction works require different standards of sand for construction.

- Brick Works: Finest modulus of fine sand should be 1.2 to 1.5 and silt contents should not be more than 4%.
- Plastering Works: Finest modulus of fine sand should not be 1.5 and silt contents should not be more than 4%.
- Concreting Works: Coarse and should be used with finest modulus 2.5 to 3.5 and silt contents should not be more than 4%.

Note:

- If the above quality of sand is not available due to any reason, the blending of sand should be done by adding more coarse sand to achieve the required finest modulus.
- Washed sand should be used at site for getting more strength in construction work.

Bulking of sand

Due to moisture in each particle of sand, sand gets a coating of water due to surface tension which keeps the particles apart. This causes an increment in volume of sand known as Bulking.

Checking the Quality of Sand

The following methods are used to check the quality of sand

- To check the quality of fine aggregates or sand; put some quantity of sand in a glass of water. Then it is vigorously shaken and allowed to settle. If the clay is present in sand, its distinct layer is formed at the top of sand.

- To detect the presence of organic impurities in sand, a solution of sodium hydroxide or caustic soda is added to sand and stirred. If the color of solution changes into brown, it shows presence of impurities.

1.4.3 Cement

Ordinary port land cement is the most important type of cement. The Ordinary Portland cement was classified into three grades namely

- Ordinary Portland Cement 33 grade-IS269:1989
- Ordinary Portland Cement 43 grade-IS8112:1989
- Ordinary Portland Cement 53grade-IS12269:1987

depending upon the strength of the cement at 28 days when tested as per IS 4031-1988

If the 28 days strength is not less than 33N/mm^2 it is called 33 grade cement if the strength is not less than 43N/mm^{2}it is called 43grade cement and if the strength is not less than53N/mm^2 it is called 53grede cement

1.4.5 Chemical Admixtures

Chemical Admixtures used shall comply with EN 934-2: 2000 (including annex A) where appropriate. Super plasticizers are an essential component of self-compacting concrete to provide the necessary workability other may be incorporated such as Viscosity Modifying Agents (VMA).

1.8.1 Types of Fiber

Fibers are classified into two categories namely hard intrusion and soft intrusion fibers having a higher elastic modulus than the cement matrix can be termed as hard intrusion and intrusion and fibers having a lower elastic modulus are called as soft intrusion.

1.8.2 Steel Fibers

Steel fibers are probably the only fibers that can be used for long-term load bearing applications they are stable in cement matrix and need no longer be a design or cost-inhibiting factor steel fiber are classified as collated steel fiber stainless steel fibers epoxy coated steel fibers steel fabric reinforcement straight indented crimped, twisted hooked saddled or deformed end tri-dimensional are the forms of steel fibers steel fibers have high tensile strength (0.5-2 GPA) and modulus of elasticity (200 MPA),a ductile/plastic stress-strain characteristic and low creep.

1.8.3 Glass Fibers

Glass fibers are produced in a process in which molten glass is drawn in the form of filaments through the bottom of a heated platinum tank glass fibers reinforced cementations composites have been developed mainly for the production of thin sheets components with a paste or mortar mix and about 5% fiber content. Other applications have considered, either making in forcing bars with plastics or by making similar short, rigid units impregnated with epoxy, to be dispersed in the concrete during mixing. In the practice, the main applications of the glass fiber reinforcement are in thin sheets. Glass fibers are classifies as E-glass, alkali resistant resin coated and resin bonded glass fiber, second generation of alkali resistant fibers also known ascem-filetc. Alkali resistant glass fibers are produced in U.S.A, England, Canasda and Japan.

1.8.4 Synthetic Fibers

Synthetic fibers are manufactured fibers resulting from research and developed in the petrochemical and textile industries there are two different physical fiber from monofilament fibers and fibers produced from fibrillated tape fiber type that have been tried in cement concrete matrices include acrylic carbon nylon polyester polyethylene and polypropylene.

1.8.5 Carbon Fibers

Carbon fibers are substantially more expensive than other fiber type but the strength and stiffness characteristics are superior to steel carbon fiber is inert in aggressive environment abrasion resistant and stable at high temperatures with relatively high stiffness however carbon fibers are more vulnerable than glass fiber to surface damage and subsequent weakening and must be used in the clumped form embedded in or sized with resin coating this include random addition of short fibers in matrix.

1.8.6 Acrylic Fibers

Acrylic fibers have been used to replace asbestos fiber in many fiber reinforced concrete products acrylic fibers have also been added to conventional concrete at low volumes to reduce the effects of plastic shrinkage cracking.

1.8.7Aramid Fibers

Aramid fibers are two and half times as strong as glass fibers and five times as strong as steel fibers, per unit mass. Due to relatively high cost of these fibers aramid- fiber-reinforced concrete has been primarily used as an asbestos cement replacement in certain strength applications.

1.8.8 Nylon Fibers

Nylon is a generic name that identifies the family of polymers. Nylon fiber properties are import by the base polymer type, addition of different levels of additive, manufacturing conditions and fiber dimensions. Currently only two types of nylon fibers are marketed for concrete. Nylon is heat stable hydrophilic, relatively inert and resistant to a wide variety of materials. Nylon is particularly effective in imparting impact resistant and flexural toughness, sustain and increasing the load carrying capacity of concrete following first crack.

1.8.9 Polyester Fibers

Polyester fibers are available in monofilament form and belong to the thermoplastic polyester group they are temperature sensitive and above normal service temperatures their properties may be altered polyester fibers have been used at low contents (0,1% by volume) to control plastic shrinkage cracking in concrete.

1.8.10 Polyethylene Fiber

Polyethylene fiber has been produced for concrete in form with wart-like surface deformation polyethylene in pulp form may be an alternative to asbestos fiber concrete reinforced with polyethylene fibers at contents between 2 and 4% by volume exhibits linear flexural load deflection behavior up to first crack followed by an apparent transfer of load to the fibers break

1.8.11 Polypropylene Fiber

Polypropylene fiber was first used to reinforce concrete in the 1960s.polypropylene is a synthetic hydrocarbon polymer the fiber of which is made using extrusion by hot drawing the material through the bye

Polypropylene fibers are tough but have low tensile strength and modulus of elasticity they have a plastic stress strain characteristics polypropylene fibers have been reported to reduce unrestrained plastic and drying shrinkage of concrete at fiber content of 0.1 to 0.3% by volume.

1.8.12 Natural Fiber

Natural reinforcing materials can be obtained at low cost and low levels of energy using local manpower and technology utilization of natural fibers as from of concrete reinforcement is of particular interest to less developed regions where conventional construction materials are not readily available or are too expensive sisal fiber reinforcement concrete has been used for making roof tiles corrugated sheets pipes silos and tanks elephant grass reinforced mortar has been used for low-cost housing projects. Wood –cellulose-fiber reinforced cement has commercial applications in the manufacture of flat and corrugated and non-pressure pipes natural fiber can be either unprocessed or processed.

1.8.13 Unprocessed Natural Fiber

Products made with unprocessed natural fibers such as coconut coir sisal sugarcane biogases bamboo jute wood and vegetable fiber have been tested in a number of countries problems have been reported with the long term durability of some of the products.

The properties of concrete made using unprocessed natural fiber depend on a number of factors including the type and length of fiber as well as volume fraction to show some improvement in mechanical properties the minimum fiber content is of the order of 3% by volume.

1.8.14 Processed Natural Fiber

Wood cellulose is the most frequently used in natural fiber. It is most commonly obtained using the Kraft process this process involves cooking wood chips in a sodium hydroxide sodium carbonate and sodium sulphide different grades of wood cellulose fiber containing more or less of the three main constituents cellulose fiber have relatively good mechanical properties compares with many man-made fiber such as polypropylene, polyethylene and acrylic.

1.9 Role of Fibers

The role of fibers is especially to arrest any advancing crack by applying pinching force at the crack tips thus delaying their propagation across the matrix the ultimate cracking strain of the composite is increased to many times greater than that of reinforced matrix unlike the convention bars the discrete fibers are dispersed uniformly throughout the matrix hence they can be more beneficial in arresting the growth of any advancing crack.

In natural concrete failure will be just after the appearance of first crack at the bottom most layer of specimen it would fail in a very brittle manner and cater strophic there will not be any time lapse between the first crack and collapse where at the failure in fiber reinforced concrete specimen will be very slow the crack which starts from bottom most layer will progress slowly in the upward direction and its growth will be resisted by the bridging fiber at the ultimate stage either the fiber gets pulled out from the matrix or yielding of the fiber occurs this slow process of crack would lead to ductile failure and would give sufficient time between the onset of first flexural crack and ultimate failure still after the complete failure it is very difficult to separate the cracked portion of the specimen.

Romualdi and Botson by considering a direct tensile stress field and applying the principle of linear elastic fracture mechanism, show that, the first cracking strength was inversely proportional, to the geometrical spacing of fibers for a given fiber volume content. The reinforcing action by fibers occurs through fiber-matrix interfacial bond stress. Cracks in the matrix will occur through when the composite strain exceeds the cracking strain of the matrix. Since the fibers are stiffer than the matrix i.e., Young's Modulus of the fiber is more than the Young's modulus of the matrix; they deform less and hence exert a pinching force at the **1**aggregate as cracks arrestors in composite. Hence, the cracks are prevented from propagation until the composite ultimate strain is reached. Finally, the failure occurs either by the simultaneous yielding of the fibers and the matrix or by the fiber-matrix interfacial bond failure. The crack controlling property of the fibers has the following three major effects on the behavior of concrete composite.

1. Fibers delay the onset of flexural cracking an increase the strain at first crack. The increase in tensile strain being as much as 100%. The ultimate strain may be as large as 20 to 50 times that of Natural concrete.
2. The fiber imparts a well-defined post cracking behavior of the composite.
3. The crack arresting property and consequent increase in the ductility imparts greater energy absorption property to the composite prior to failure. With 2.5% fiber content, the energy absorbing capacity is increased more than 10 times as compared to unreinforced concrete.

1.10 Rheology of fiber reinforced concrete

The rheological properties of the fiber reinforced concrete depend on the size and type of fiber and on the method of production. Since fibers tend to have relatively large water requirement as well as exhibiting a tendency to interlock or ball. In addition, the W/C ratio and ratio of fine to coarse aggregate must be considered, as with conventional concrete. In general, the workability is decreased as the fibers increases, or as the coarse aggregate content increases. It is however, difficult to define a satisfactory method of testing the workability. The mix is considered unworkable when balling of fiber occurs. The aspect ratio of the fiber, cement content and maximum size of aggregate, the addition of a large fiber volume is possible before the occurrence of balling. Apart from difficulties with workability, it is also hard to compare fiber reinforced concrete.

As already stated, fiber reinforced concrete can be defined as a composite material consisting of cement based matrix containing an orderly or randomly distribution of fibers. The fibers act as crack arrestors that restrict the growth of flaws in the matrix, controlling them, enlarging under stress into crack, which is eventually leads to failure, by inhabiting the propagation of cracks originating from internal flaws, considerable improvement in static and dynamic properties can be obtained. Fibers impact the composite quality of crack control, toughness, ductility and impact resistance to the natural concrete.

The use of continuous aligned fibers in a cement matrix is fundamentally no different from conventional reinforced or pre stressed concrete, where the large diameter reinforced bars or the smaller diameter pre stressing wire behaves analogous to the continuous aligned fibers. The phenomenon of multiple cracking and composite action in such material have been well established for over century. A more exciting challenge that will find a wider practical application is the use of short, discontinuous fibers that are uniformly distributed in the matrix. It is true that due to random orientation of fibers, not all are equally effective in crack control as well as strengthening and stiffening aspects.

1.11 Introduction of Steel Fiber Reinforced Self-Compacting Concrete

Self-compacting concrete was developed in Japan in the 1980s to be mainly used for highly congested reinforced structures in seismic region SCC can also provide a better working environment by eliminating the vibration noise there are many advantages of using SCC especially the when the material cost is minimized these include reducing the construction time and labor cost eliminating the need for vibration reducing the noise pollution improving the filling capacity of highly congested structural members such concrete requires a high slump that can easily be achieved by super plasticizer in addition to the concrete mixture also to enhance stability a viscosity-modifying admixture is incorporated fibers are generally discontinuous randomly distributed throughout the cement matrices fiber reinforced self compacted concrete (FRSCC) is formed from cement various sizes of aggregate which incorporate with discrete discontinuous fiber the objective of this study is to assess the effects of steel fiber replacement on the fresh and hardened properties of SCCs incorporating steel fiber. The steel fiber were used at different aspect ratio (80, 50) with 2.5% volume making the concrete the comparative study on steel fiber reinforced cum control concrete steel fibers of 50, 60 and 67 aspect ratio at volume fraction of 0%, 1%,2% and 3% were used it was observed that compressive strength tensile strength and flexural strength from steel fiber were on higher side from 3% fiber as compared to that properties were observed to be on higher side for aspect ratio of 50 as compared to those for aspect ratio 60 and 67 through utilization of steel fiber the compressive strength increased from 11 to 28%, flexural strength increased from 18 to 58% and tensile strength from 9 to 29%.

1.2 Hook end Steel Fiber

Hook end fiber can be used in almost any known application for steel fiber reinforced concrete for ArcelorMittl s HE 55/35 and 75/35 are primarily used in shotcrete hook end steel fiber does not perform as well as undulated fibers with regard to shrinkage control but it provides excellent workability when using fiber with up to an aspect ratios up to and including 80 provide satisfactory workability concrete mix and high concrete density is less mandatory then for undulated or for flat-end fibers load transfer in the crack is very good with this fiber shape the first crack the loss of load-bearing capacity occurs quickly but then stabilizes and in some cases even begins to increase again after large crack have developed.

- Aspect ratio = 60
- Length = 30 mm
- Diameter = 0.5 mm
- Tensile strength > 1100 Map

1.13 Need for Present work

Theadventofhigh strength concrete has helped construction activity in many ways for example to build high rise building by reducing column sizes and increasing available space and to put the concrete into service at much earlier age concrete the most widely used structural material in the world is prone to cracking for a variety of reasons these may be attributed to structural or environmental factors but most of the crack are formed due to inherent weakness of the material to resist tensile forces when it is restrained it will crack the randomly oriented fibers assist in controlling the propagation of micro-cracks present in the matrix first by improving the cracking resistance of the matrix and later by bridging across even smaller cracks after the application of load on to the member there by preventing their widening into major cracks thus proper introduction of fibers in concrete improves both mechanical properties and durability.

3.5 Tests for Fresh Properties of Self-Compacting Concrete:

At the stage before solidification, self-compacting concrete is required to have three qualities: high-flow ability, resistance against segregation and possibility, i.e. ability that is necessary to pass the space between reinforcing bars. Therefore, it is important to test whether the concrete is self-compactable or not and also to evaluate deformability or viscosity for estimating proper mix proportioning if the concrete does not have sufficient self-compatibility. The common tests currently used, although not standardized for assessment of fresh SCC, are described here.

3.5.1 Slump flow + T50 (Reference method for filling ability)

Principle:

The slump flow test aims at investigating the filling ability of SCC. It measures two parameters: flow spread and flow time T50 (optional). The former indicates the free, unrestricted deformability and the latter indicates the rate of deformation within a defined flow distance.

Equipment:

(a) Base plate of size 900 × 900 mm, made of impermeable and rigid material (steel or Glass) with smooth and plane test surface (deviation of the flatness not exceed 3 mm), and clearly marked with circles of Ø200mm and Ø500mm and Ø600mm at the centre, as shown In Figure 4.1.

(b) Abrams cone with the internal upper/lower diameter equal to 100/200 mm and the height of 300 mm, as shown in Figure 6.

(c) Stopwatch with the accuracy of 0.1 second for recording the flow time T50.

(d) Ruler (graduated in mm) for measuring the diameters of the flow spread.

(e) Bucket with a capacity of larger than 6 liters for sampling fresh concrete.

(f) Moist sponge or towel for wetting the inner surface of the cone and the test surface of the base plate.

(g) Rag for cleaning spilled concrete if any.

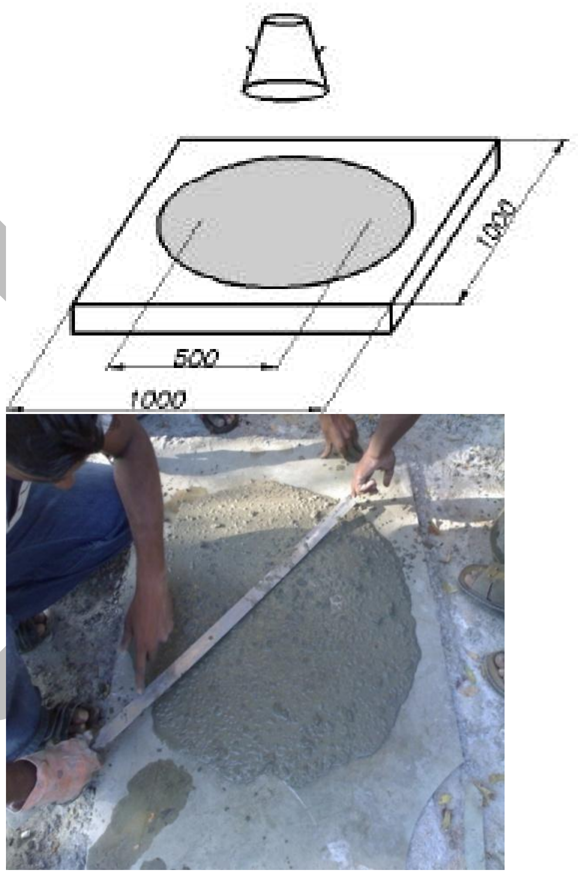


Fig.2: Abrams Slump flow Equipment

Test procedure:

- Place the cleaned base plate in a stable and level position fill the bucket with 6-7 liters of representative fresh SCC and let the sample stand still for about 1 minute (± 10 seconds).During the 1 minute waiting period pre-wet the inner surface of the cone and the test surface of the base plate using the moist sponge or towel, and place the

- Cone in the centre on the 200 mm circle of the base plate and cone is kept in position by hand one to keep it in place.
- Fill the cone with the sample from the bucket without any external compacting action such as rodding or vibrating. The surplus concrete above the top of the cone should be struck off, and any concrete remaining on the base plate should be removed Check and make sure that the test surface is neither too wet nor too dry. No dry area on the base plate is allowed and any surplus of the water should be removed – the moisture state of the plate has to be 'just wet'.
- After a short rest (no more than 30 seconds for cleaning and checking the moist state of the test surface), lift the cone perpendicular to the base plate in a single movement, in such a manner that the concrete is allowed to flow out freely without obstruction from the cone, and start the stopwatch the moment the cone looses contact with the base plate Stop the stopwatch when the front of the concrete first touches the circle of diameter 500 mm. The stopwatch reading is recorded as the T50 value. The test is completed when the concrete flow has ceased.
- Measure the largest diameter of the flow spread $d_{max}$and the one perpendicular to it, d_{per}, using the ruler (reading to nearest 5 mm). Care should be taken to prevent the ruler from bending. Clean the base plate and the cone after testing.
- The slump flow spread *S* is the average of diameters d_{max} and d_{per}, as shown in Equation. *S* is expressed in mm to the nearest 5 mm.

$$\mathbf{S= (d_{max}+d_{per}) / 2}$$

- The slump flow time T50 is the period between the moment the cone eaves the base plate and SCC first touches the circle of diameter 500 mm. T50 is expressed in seconds to the nearest 1/10 seconds.

Interpretation of result:

The higher the slump flow (SF) value, the greater its ability to fill formwork under its own weight. A value650mm is required for SCC. There is no generally accepted advice on what are reasonable tolerances about a specified value, though ± 50mm, as with the related flow table test, might be appropriate. The T50 time is a secondary indication of flow. A lower time indicates greater flowability.

4.3.3 V-funnel test and V-funnel test at T 5minutes

Principle:

The V-funnel flow time is the period a defined volume of SCC needs to pass a narrow opening and gives an indication of the filling ability of SCC provided that blocking and/or segregation do not take place; the flow time of the V-funnel test is to some degree related to the plastic viscosity.

Equipment:

(a)V-funnel **(b)** Bucket (±12 liter) **(c)**Trowel **(d)**Scoop **(e)**Stopwatch

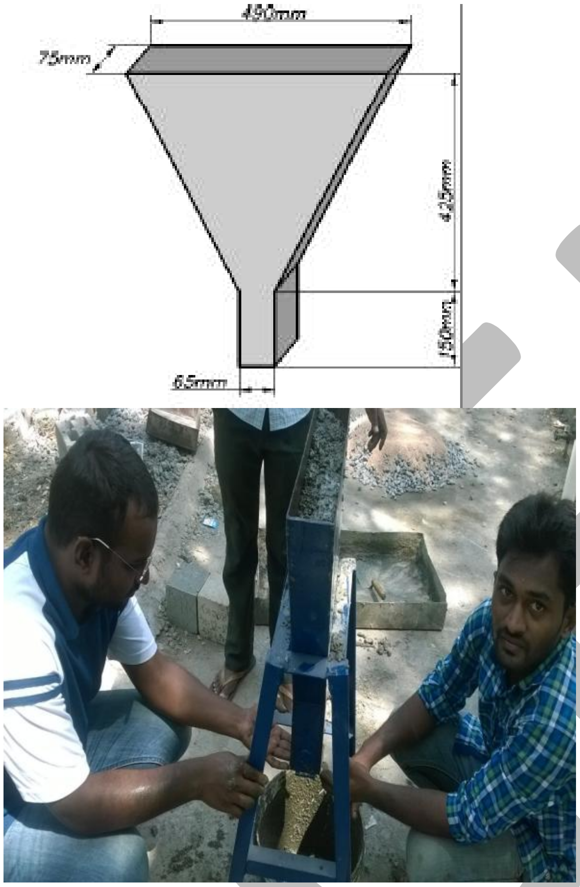


Fig .3: V-Funnel equipment

Procedure flow time:

- About 12 liter of concrete is needed to perform the test, sampled normally. Set the V-funnel on firm ground. Moisten the inside surfaces of the funnel. Keep the trap door open to allow any surplus water to drain. Close the trap door and place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tamping simply strike off the concrete level with the top with the trowel. Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity.
- 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 the whole test has to be performed within 5 minutes. Fig.8 shows the setup of V-Funnel test.

Procedure flow time at T 5 minutes:

- Do not clean or moisten the inside surfaces of the funnel again. Close the trap door and refill the V-funnel immediately after measuring the flow time. Place a bucket underneath.
- Fill the apparatus completely with concrete without compacting or tapping, simply strike off the concrete level with the top with the trowel. Open the trap door 5 minutes after the second fill of the funnel and allow the concrete to flow out under gravity.
- Simultaneously start the stopwatch when the trap door is opened, and record the time for the discharge to complete (the flow time at T 5 minutes). This is taken to

be when light is seen from above through the funnel.

Interpretation of result:

This test measures the ease of flow of the concrete; shorter flow times indicate greater flowability. For SCC a flow time of 10 seconds is considered appropriate. The inverted cone shape restricts flow, and prolonged flow times may give some indication of the susceptibility of the mix to blocking.

After 5 minutes of settling, segregation of concrete will show a less continuous flow with an increase in flow time.

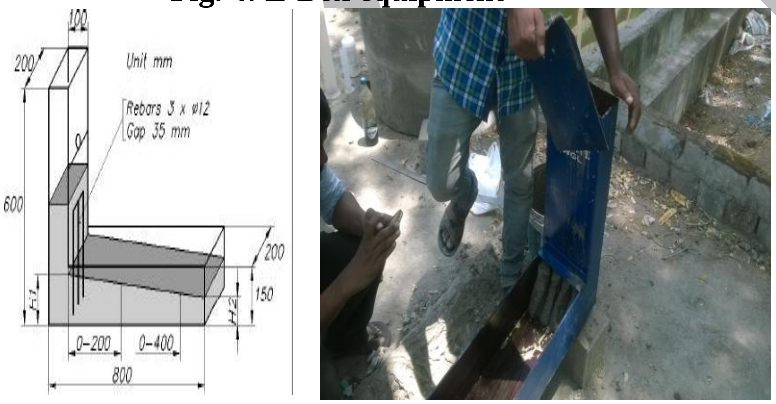
4.3.4 L-box test method

Principle:

The method aims at investigating the passing ability of SCC. It measures the reached height of fresh SCC after passing through the specified gaps of steel bars and flowing within a defined flow distance. With this reached height, the passing or blocking behavior of SCC can be estimate

Equipment (a)L-box of a stiff non absorbing material **(b)** Trowel **(c)** Scoop **(d)** Stopwatch

Fig. 4: L-Box equipment



Procedure:

- About 14 liter of concrete is needed to perform the test, sampled normally. Set the apparatus level on firm ground, ensure that the sliding gate can open freely and then close it. Moisten the inside surfaces of the apparatus, remove any surplus water
- Fill the vertical section of the apparatus with the concrete sample. Leave it to stand for 1 minute. Lift the sliding gate and allow the concrete to flow out into the horizontal section. Simultaneously, start the stopwatch and record the times taken for the concrete to reach the 200 and 400 mm marks.
- When the concrete stops flowing, the distances “H1” and “H2” are measured. Calculate H2/H1, theblockingratio. The whole test has to be performed within 5 minutes. Fig.4 shows the setup of L-Box test.

Interpretation of result:

If the concrete flows as freely as water, at rest it will be horizontal, so H2/H1 = 1. Therefore the nearer this test value, the ‘blocking ratio’, is to unity, the better the flow of the concrete. Obvious blocking of coarse aggregate behind the reinforcing bars can be detected visually. The values obtained are checked against the acceptance criterion by EFNARC as shown in the table 1

The details of fresh properties of SCC mix for M30 developed shown in Table

S.No.	Method	Units	Fresh Concrete Properties of M30	EFNARC Specifications (Min – max values)

			grade	
1	Slump flow by Abrams cone	Mm	710	650-800
2	T_{50cm}slump flow	Sec	4.20	2 – 5
3	V-funnel (Time for complete discharge)	Sec	6.79	0 – 10
4	V-funnel at T_5minutes	Sec	9.0	6 – 12
5	L-box(h2/h1)		0.91	0.8 – 1.0

From Table 1 it can be noted that the fresh properties are satisfied according to EFNARC specifications.

Conclusion:

This research project is to determine the strength characteristics of steel fiber reinforced concrete for potential application in the structural concrete based on the experimental results of following conclusions were drawn.

- The compressive strength of steel fiber concrete is found to be maximum at 1.5%
- Higher percentages of steel from 1.5% affect the workability of concrete and may require super plasticizer to maintain the workability.
- With the use of steel fiber in concrete it has shown an improvement in mechanical properties such as compressive strength.
- The method proposed has yielded mix proportions which with very less number of trials would satisfy the EFNARC guidelines. Hence, the time taken from arriving the final mix proportion is reduced to a great extent.

References:

- **Hajime Okamura and Masahiro Ouchi (2003)**, “Self-Compacting Concrete”, Journal of Advanced Concrete Technology Vol.1, No.1, 5-15, April 2003.
- **“Specifications and guidelines for self-compacting concrete.”** published by **EFNARC** in February 2005.
- **P.J.M. Bartos, M. Sonebi and A.K. Tamimi, “**Workability and Rheology of Fresh Concrete**”,** The international association RILEM, France, Technical Committee TC145-WSM,2002
- **Domone, P.L., Jin, J., Chai, H.W., (1999)**, “Optimum mix proportion of Self Compacting Concrete”, Innovation in concrete structures: Design and Construction Proceedings of Creating with Concrete, University of Dundee, Dundee September pp. 277-285
- **Petersson, Billberg, p., Van, B.K., (1996)**, “A model for Self Compacting Concrete ” , Proceeding of RILEM International Conference on Production methods and workability of fresh concrete, Paisley, June.
- **Nan Su, Kung-Chung Hsu, His-Wen Chai**, “A simple mix design method for self-compacting concrete”, Cement and

Concrete Research, 6 June 2001, pp1799-1807.

- **Japanese Society of Civil Engineering**, “Guide to Construction of High Flowing Concrete”, Gihoudou Pub., Tokyo, 1998 (in Japanese)
- **Okamura, H. and Ozawa, K.(1995)**, “Mix Design for Self Compacting Concrete.”, Concrete Library of JSCE,25, 107-12.
- **Surabhi.C.S, Mini Soman, SyamPrakash.V,** “Influence of Limestone Powder on Properties of Self-Compacting Concrete” 10th National Conference on Technological Trends (NCTT09) 6-7 Nov 2009
- **Mayur B. Vanjare, Shriram H. Mahure**, “Experimental Investigation on Self Compacting Concrete Using Glass Powder”, International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 3, May-Jun 2012, pp.14881492.
- **Suraj N. Shah., Shweta S. Sutar, YogeshBhagwat,** “Application of industrial Waste- in the manufacturing of Self compacting concrete” Govrnment college of engineering, karad.
- **N. Bouzouba and M. Lachemi,** “Self Compacting Concrete Incorporating High-Volumes of Class F Fly Ash” Cement and Concrete Research, Vol. 31, No. 3, Mar. 2001, pp. 413-420.
- **Manu Santhanam and Subramanian, S.** “Current developments in self-compacting concrete” Indian Concrete Journal, June, Vol., pp11-22.
- **JagadishVengalaSudarsan, M.S., and Ranganath, R.V.** “Experimental study for obtaining self

S.PRAVEEN, et al , Civil Engineering International Journal [CEIJ]™ Volume-1-Nov/2015-Jan / 2016

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