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Flow Test of Self Compacting Concrete using V-Funnel Test

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***Abstract:** This paper gives a review on Self Compacting Concrete (SCC) to be made using various Mineral Admixtures and Fibres. In current scenario of construction industries due to demand in the construction of large and complex structures, which often leads to difficult concreting conditions. When large quantity of heavy reinforcement is to be placed in a reinforced concrete (RC) member, it is difficult to ensure fully compacted without voids or honeycombs. Compaction by manual or by mechanical vibratos is very difficult in this situation. That leads to the invention of new type of concrete named as self-compacting concrete (SCC). This type of concrete flows easily around the reinforcement and into all corners of the formwork. Self- compacting concrete describes a concrete with the ability to compact itself only by means of its own weight without the requirement of vibration. Self –compacting concrete also known as Self-consolidating Concrete or Self Compacting High Performance Concrete. It is very fluid and can pass around abstractions and fill all the nooks and corners without the risk of either mortar or other ingredients of concrete separating out, at the same time there are no entrapped air or rock pockets. This type of concrete mixture does not require any compaction and is saves time, labour and energy.*

This review paper explains the utilization of fibres and various mineral admixtures in the properties of Self Compacting Concrete. The Benefits and Uses of SSC are discussed in this paper and Self-Compacting Concrete is compared with Cement Concrete. A V-Funnel is used to measure the flowability of concrete, and cost of Manufacturing a V-Funnel using Mild steel and Stainless Steel is estimated.

***Keywords:** Self Compacting Concrete, Mix design, Mineral Admixtures, Fibres, Durability, Workability.*

I. INTRODUCTION

Self-compacting concrete (SCC) has been described as "The most revolutionary development in concrete construction for several decades". Self-consolidating concrete or self-compacting concrete (commonly abbreviated to SCC) is a concrete mix which has a low yield stress, high deformability, good segregation resistance (prevents separation of particles in the mix), and moderate viscosity (necessary to ensure uniform suspension of solid particles during transportation, placement (without external compaction), and thereafter until the concrete sets). Self-consolidating concrete is a highly flowable type of concrete that spreads into the form without the need for mechanical_vibration. Self-compacting concrete is a non-segregating concrete that is placed by means of its own weight. The importance of self-compacting concrete is that maintains all concrete’s durability and characteristics, meeting expected performance requirements.

In everyday terms, when poured, SCC is an extremely fluid mix with the following distinctive practical features – it flows very easily within and around the formwork, can flow through obstructions and around corners (Passing ability) is close to self-leveling (although not actually self-levelling), does not require vibration or tamping after pouring, and follows the shape and surface texture of a mold (or form) very closely once set.

As a result, pouring SCC is also much less labor-intensive compared to standard concrete mixes. Once poured, SCC is usually similar to standard concrete in terms of its setting and curing time (gaining strength), and strength. SCC does not use a high proportion of water to become fluid – in fact SCC may contain less water than standard concretes. Instead, SCC gains its fluid properties from an unusually high proportion of fine aggregate, such as sand (typically 50%), combined with superplasticizers (additives that ensure particles disperse and do not settle in the fluid mix) and viscosity-enhancing admixtures (VEA).

Ordinarily, concrete is a dense, viscous material when mixed, and when used in construction, requires the use of vibration or other techniques (known as compaction) to remove air bubbles (cavitation), and honeycomb-like holes, especially at the surfaces, where air has been trapped during pouring. This kind of air content (unlike that in aerated concrete) is not desired and weakens the concrete if left. However, it is laborious and takes time to remove by vibration, and improper or inadequate vibration can lead to undetected problems later.

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Additionally, some complex forms cannot easily be vibrated. Self-consolidating concrete is designed to avoid this problem, and not require compaction, therefore reducing labor, time, and a possible source of technical and quality control issues.

SCC was conceptualized in 1986 by Prof. Okamura at Kochi University, Japan, at a time when skilled labor was in limited supply, causing difficulties in concrete-related industries. The first generation of SCC used in North America was characterized by the use of relatively high content of binder as well as high dosages of chemicals admixtures, usually superplasticizer to enhance flowability and stability. Such high-performance concrete had been used mostly in repair applications and for casting concrete in restricted areas. The first generation of SCC was therefore characterized and specified for specialized applications.

Table 1: Difference between Self-compacting concrete and Normal cement concrete

No.	Self-Compacting Concrete	Normal Cement Concrete
1.	Concrete has high flowability to undergo compaction by its own weight	Concrete is compacted by external means of vibration
2.	High Workability	Less workable mix
3.	Workability gained through superplasticizer and Viscosity modifying agents	Workability gained through increased moisture content
4.	Addition of Superplasticizer increase the bond between aggregate and cement matrix	The aggregate-cement matrix is weak
5.	Water content is low	High water content
6.	Fines content – Cement and Fine aggregate is high	The fines content is less compared to SCC
7.	Lower water content decreases the bleeding	Bleeding is high
8.	Increased fines content gives a Homogeneous mix with less segregation issues	Segregation is higher
9.	Low viscosity due to high fines content	High viscosity
10.	SCC structure give good aesthetic finish	Aesthetic finish is not satisfactory
11.	Good choice for thick reinforcement work	Normal concrete is limited in thick reinforcement areas due to external compaction difficulties

A. Uses of SCC

Self-compacting concrete has been used in bridges and even on pre-cast sections. This type of concrete is ideal to be used in the following applications:

1) Drilled shafts
2) Columns
3) Earth retaining systems
4) Areas with a high concentration of rebar and pipes/conduits

SCC can be used for casting heavily reinforced sections, places where there can be no access to vibrators for compaction and in complex shapes of formwork which may otherwise be impossible to cast, giving a far superior surface than conventional concrete. The relatively high cost of material used in such concrete continues to hinder its widespread use in various segments of the construction industry, including commercial construction, however the productivity economics take over in achieving favorable performance benefits and works out to be economical in pre-cast industry.

The incorporation of powder, including supplementary cementitious materials and filler, can increase the volume of the paste, hence enhancing deformability, and can also increase the cohesiveness of the paste and stability of the concrete. The reduction in cement content and increase in packing density of materials finer than 80 µm, like fly ash etc. can reduce the water-cement ratio, and the high-range water reducer (HRWR) demand.

B. Benefits of SCC

Originally developed to offset a growing shortage of skilled labor, it has proved beneficial economically because of a number of factors, including:

1) Faster construction
2) Reduction in site manpower
3) Better surface finishes
4) Easier placing
5) Improved durability
6) Greater freedom in design
7) Thinner concrete sections
8) Reduced noise levels, absence of vibration
9) Safer working environment

C. Constituents of SCC

Generally, SCC has to have a proper flowability and viscosity, so that the coarse aggregate can float in the mortar without segregating. To achieve a balance between flowability and stability, the total content of particles finer than the 150 ppm has to be high, usually about 520 to 560 kg/m3.

Self-compacting concretes are divided into three different types according to the composition of the mortar: Powder type, Viscosity-modifying agent (stabilizer) type & Combination type.

For the powder type, a high proportion of fines produce the necessary mortar volume, whilst in the stabilizer type, the fines content can be in the range admissible for vibrated concrete. The viscosity required to inhibit segregation will then be adjusted by using a stabilizer. The combination type is created by adding a small amount of stabilizer to the powder type to balance the moisture fluctuations in the manufacturing process. However, after completion of proper proportioning, mixing, placing, curing and consolidation, hardened concrete becomes a strong, strong, durable and practically impermeable building material that requires no maintenance.

1) Cement

In the most general sense of the word, cement is a binder, a substance that sets and hardens independently, and can bind other materials together. The most important use of cement is the production of mortar and concrete for bonding of natural or artificial aggregates to form a strong building material that is durable in the face of normal environmental effects. Concrete is a combination of cement, aggregate and water.

Table 2: Chemical composition of OPC – 53 grades

Name and Composition	Mass content %
Calcium oxide (Lime)	61.3
Silicon Dioxide (Silica)	20.1
Aluminium Oxide (Alumina)	4.51
Ferrous and Ferric Oxide (Iron Oxide)	0.51
Magnesium Oxide (Magnesia)	1.0
Sulphur Trioxide (Sulfuric Anhydrite)	3.0
Alkaline Oxides (Alkalis)	1.1
C_2S, C_3S, C_3A, C_4AF	24-26, 48-52, 7-8, 11-20.

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2) *Fly Ash*

Fly ash is one of the most extensively used by-product materials in the construction field resembling Portland cement. It is an inorganic, noncombustible, finely divided residue collected or precipitated from the exhaust gases of any industrial furnace. Most of the fly ash particles are solid spheres and some particles called ecospheres are hollow. Also present are pedospheres, which are spheres containing smaller spheres inside. The particle sizes in fly ash vary from less than 1 ppm to more than 100 ppm with the typical particle size measuring under 20 ppm. Their surface are is typically 300 to 500 sqm/kg. Fly ash is primarily silicate glass containing silica, alumina, iron, and calcium. The relative density or specific gravity of fly ash generally ranges between 1.9 and 2.8 and the color is generally gray or tan.

Table 3: Properties & Chemical constituents of fly ash used

Constituent property	% by mass for Fly Ash used	Requirement as per IS: 3812-2003
Source	Vanikorid thermal power plant, Gujarat, India	
Class & Color	Class "F", Grey	
Specific gravity	2.13	
Fineness, specific surface area	338 m2/kg	>320
Loss on ignition	1.03	5% Max.
Silica (SiO2)	63.98	35 % Min. by mass
Iron Oxide (Fe2O3)	3.44	Silica+Al2O3+ Fe2O3 > 70%
Alumina (Al2O3)	28.20	
Calcium Oxide (Cano)	2.23	
Magnesium Oxide (MgO)	1.45	5.0 % Max.
Total Sulphur trioxide (SO3)	0.165	3.0 % Max.
Alkalis: Sodium Oxide (Na2O) Potassium Oxide (K2O)	 0.28 0.26	1.5 % Max. by mass

3) *Aggregates*

Generally, aggregates occupy 70% to 80% of the volume of concrete and have an important influence on its properties. They are granular materials, derived for the most part from natural rock (crushed stone, or natural gravels) and sands, although synthetic materials such as slags and expanded clay or shale are used to some extent, mostly in lightweight concretes. In addition to their use as economical filler, aggregates generally provide concrete with better dimensional stability and wear resistance. Although aggregate strength can play sometimes an important role, for example in high-strength concretes, for most applications the strength of concrete and mix design are essentially independent of the composition of aggregates. However, in other instances, a certain kind of rock may be required to attain certain concrete properties, e.g., high density or low coefficient of thermal expansion.

In order to obtain a good concrete quality, aggregates should be hard and strong, free of undesirable impurities, and chemically stable. Aggregates should also be free of impurities like silt, clay, dirt, or organic matter. Due to these coatings on the aggregates, they will isolate the aggregate particles from the surrounding concrete, causing a reduction in strength. Silt, clay and other fine materials will increase the water requirements of the concrete, and the organic matter may interfere with the cement hydration.

4) *Types of Aggregates*

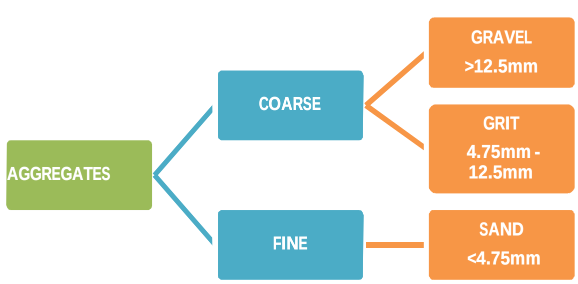

Fig. 1: Types of Aggregate

5) Water

Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. In practice normally if water is fit for drinking it is considered suitable for making concrete but it may not be true always. Water with pH value between 6 to 8 is acceptable but the best course to find out whether a particular source of water is suitable for concrete or not. If the compressive strength is up to 90 percent, the source is acceptable. We have used normal tap water for making concrete. The tap water did not contain any objectionable substances causing colour or odour. The water was not tested to verify the acceptance criteria based on the physical tests assuming that the quality of potable water is acceptable for making concrete.

6) Admixtures

Admixture is defined as a material, other than cement, water and aggregates, which is used as an ingredient of concrete and is added immediately before or during mixing. It is a material which is added at the time of grinding cement clinker at the cement factory. Various admixtures are categorized based on their function in the concrete namely Plasticizers, Superplasticizers, Retarders and Retarding Plasticizers, Accelerators and Accelerating Plasticizer, Air-entraining Admixtures, Damp-proofing and Waterproofing Admixtures, Gas forming Admixtures, Workability Admixtures, Grouting Admixtures, Bonding Admixtures, Colouring Admixtures.

7) Chemical Admixtures

New generation superplasticizers are commonly used in SCC mix design. In order to improve the freeze and thaw resistance of the concrete structure, air entraining agents are used. To control the setting time, retarders are employed.

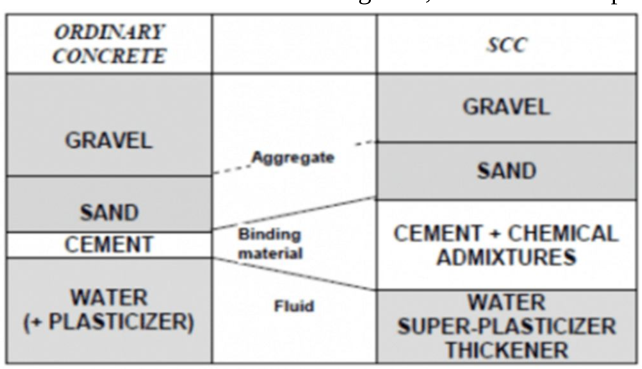

Fig. 2: Material Composition of Ordinary Concrete and SCC

D. Factors Affecting SCC

Using self-compacting concrete must not be used indiscriminately. These factors can affect the behavior and performance of self-compacting concrete:

1) Hot weather.
2) Long haul distances can reduce flowability of self-compacting concrete.
3) Delays on job site could affect the concrete mix design performance.
4) Job site water addition to Self-Compacting Concrete may not always yield the expected increase in flowability and could cause stability problems.

E. Tests and Properties of SCC

The requirements of the self-compacting concrete are achieved by the properties in its fresh state. The three main properties of SCC are:

1) *Filling Ability:* This property of the concrete is the ability to flow under its own weight without any vibration provided intentionally.
2) *Passing Ability:* This property is the ability of the concrete to maintain its homogeneity.
3) *Segregation Resistance:* This is the resistance of the concrete not to undergo segregation when it flows during the self-compaction process.

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The tests conducted for Self-compacting concrete can be categorized into three categories:

a) Filling Ability Tests
b) Passing Ability Tests

Table 4: Different Tests conducted on Self Compacted Concrete

S. No	Method	Unit	Typical range of values	
			Minimum	Maximum
1	Slump flow by Abrams cone	mm	650	800
2	T50cmslumpflow	sec	2	5
3	J-ring	mm	0	10
4	V-funnel	mm	6	12
5	Time increase, V-funnel at T5minutes	sec	0	+3
6	L-box	h2/h1	0,8	1,0
7	U-box (h2-h1)	(h2-h1) mm	0	30
8	Fill-box	%	90	100
9	GTM Screen stability test	%	0	15
10	Orimet	sec	0	5

Table 5: Acceptance Criteria for Self-Compacted Concrete

Filling Ability Tests	Passing Ability Tests	Segregation Resistance Tests
Slump flow test	L-Box Test	V- funnel test at T5 minutes
T50cm Slump Flow	J- ring test	GTM screen stability Tests
Orimet	U- Box Test	
V-funnel Test	Fill – Box Test	

F. V-Funnel Test

The test was developed in Japan and used by Ozawa et al (5). The equipment consists of a V-shaped funnel. The described V-funnel test is used to determine the filling ability (flowability) of the concrete with a maximum aggregate size of 20mm. The funnel is filled with about 12 litre of concrete and the time taken for it to flow through the apparatus measured. After this the funnel can be refilled concrete and left for 5 minutes to settle. If the concrete shows segregation, then the flow time will increase significantly.

Fig. 3: V-Funnel test apparatus

II. LITERATURE REVIEW

Wajde S. Alyhya, Bhushan L. Karihaloo et.al, April 2016, studied about the “Simulation of self-compacting concrete in v-funnel”. The study was aimed to find the Computational modelling of the flow for a viscous fluid such as self-compacting concrete (SCC). SCC is a potential tool for understanding its rheological behavior and for mix proportioning as well. The present paper describes a simple approach to simulate the flow of SCC. The paper concluded that without performing the V-funnel test, concrete discharge time and consequently its suitability for application as SCC can be established when the plastic viscosity and yield stress are known.

Hardik Upadhyay, Pankaj Shah et.al, May 2011, studied about the "Testing and mix design method of self-compacted concrete". This paper deals with the history of SCC development and its basic principle, different testing methods to test high-flowability, resistance against segregation, and possibility. Different mix design methods using a variety of materials has been discussed in this paper. The paper 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.

P. Sachin Prabhu, Ha. Nishaant et.al, December 2018, studied about the "Behavior of Self-Compacting Concrete with Cement Replacement Materials". The study was aimed to improve the workability of the concrete 1.5 % of superplasticizer (glenium B233) by weight of the cement is used as chemical admixture. It can be concluded that the optimum replacement of 10% of wood ash and fly ash in self- compacting concrete increases the compressive strength of the of the concrete mixture.

Dinesh A., Harini S. et.al, March 2017, studied about the "Experimental Study on Self Compacting Concrete". This project deals with the self- compacting concrete where the cement is partially replaced with fly-ash and silica fume. Here Ordinary Portland Cement is replaced with 5%, 10%, 15%, 20% and 25% of fly-ash and 2.5%, 5%, 7.5%, 10% and 12.5% of silica fume. From the experimental investigations, it is observed that there is increase in the fresh properties (workability) and increase in the hardened properties (split-tensile strength and compressive strength) for replacement of silica fume. Similarly, there is increase in the fresh properties (workability) and decrease in the hardened properties (split-tensile strength and compressive strength) for replacement of fly ash.

Ravichandran Subbarayalu, A. M. Vasumathi, et.al, January 2017, studied about the "Performance analysis of self-compacting concrete without super plasticizer". This paper reviewed the feasibility of preparing a SCC without using super-plasticizer but with only mineral admixtures that are available locally, with the coarse aggregate size of with 20 mm well graded aggregates which is entirely a different way of preparation of SCC. The hardened properties of SCC were tested and compared with control concrete of M25 grade. The tests were performed in two phases. In both the phases of investigation, the results revealed that this type of SCC will be promising and effective combination to that of the traditional type of SCC prepared by Glenium product and also cost effective.

Hajime Okamura and Masahiro Ouchi, et.al, March 2003, studied about the "Self-Compacting Concrete". Investigations for establishing a rational mix-design method and self- compact-ability testing methods have been carried out from the viewpoint of making self- compacting concrete a standard concrete. Since a rational mix-design method and an appropriate acceptance testing method at the job site have both largely been established for self-compacting concrete, the main obstacles for the wide use of self-compacting concrete can be considered to have been solved. In addition, new structural design and construction systems making full use of self-compacting concrete should be introduced. When self-compacting concrete becomes so widely used that it is seen as the "standard concrete" rather than a "special concrete," we will have succeeded in creating durable and reliable concrete structures that require very little maintenance work.

III. METHODOLOGY

A. V Funnel Test

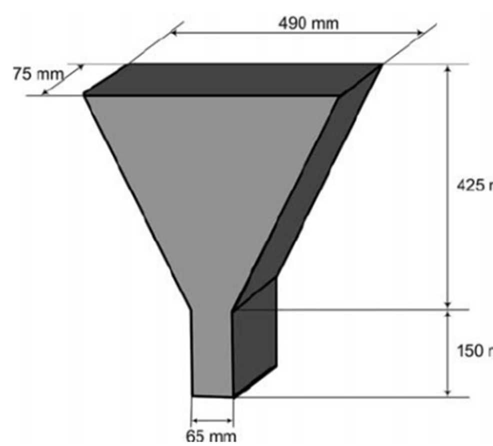

Fig. 4: V-funnel test equipment (Rectangular section Equipment)

From the code: EFNARC 2002\

1) *V-funnel apparatus consist of:*
   a) V-funnel
   b) Bucket (12 liters)
   c) Trowel
   d) Scoop
   e) Stopwatch

2) *Procedure*
   a) About 12 liter of concrete is needed to perform the test, sampled normally.
   b) Set the V-funnel on firm ground.
   c) Moisten the inside surface of the funnel.
   d) Keep the trapdoor to allow any surplus water to drain.
   e) Close the trap door and place a bucket underneath.
   f) Fill the apparatus completely with the concrete without compacting or tamping; simply strike off the concrete level with the top with the trowel.
   g) Open within 10 sec after filling the trap door and allow the concrete to flow out under gravity.
   h) Start the stopwatch when the trap door is opened, and record the time for the complete discharge (the flow time).
   i) This is taken to be when light is seen from above through the funnel. The whole test has to be performed within 5 minutes. For SCC a flow time of 10 seconds is considered appropriate.

3) *Procedure for Flow time at T5 Minutes*
   a) Do not clean or moisten the inside surface of the funnel gain.
   b) Close the trapdoor and refill the V-funnel immediately after measuring the flow time. Place a bucket underneath.
   c) Fill the apparatus completely with concrete without compacting or tapping, simply strike off the concrete level with the top with the trowel.
   d) Open the trapdoor 5 minutes after the second fill of the funnel and allow the concrete to flow out under gravity.
   e) Simultaneously start the stopwatch when the trap door is opened and record the time discharge to complete flow (the flow time at T5 minutes). This is to be taken when light is seen from above through the funnel.

4) *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.

5) *Calculation*

When two or more tests were conducted, calculate the average to the nearest 0.1 sec, and take this as the flow-through time. Calculate the average flow-through speed at the orifice by the following equation to 0.01 sec.

V-funnel $Vm = 2.05/ t0$

where Vm = average flow-through speed (m/s); t0 = flow-through time (s)

Remark: 2.05 is the values obtained by dividing a volume of 0.01 m3 by the cross-sectional area of respective orifices.

Calculate the relative flow-through speed by the following equation to the nearest 0.01 sec.

$Rm=10/t0$

where Rm = relative flow-through speed; t0 = now-through time (s)

Calculate the flow-through index by the following equation to the nearest 0.01 using the flow-times measured under two test conditions: $Sf= (t5 - t0)/t0$

where Sf = flow-through index

t0, t5 = flow-through time (s)

if t5< t0, then Sf is assumed to be zero.

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B. Mix Design of Self-compacting concrete (As per IS-10262:2019)

1) Stipulations for Proportioning

a) Grade designation: M30
b) Type of cement: OPC 43 grade conforming to IS 269
c) Nominal maximum size of aggregate: 20mm
d) Exposure conditions as per Table 3 and Table 5 of IS 456: Severe (for reinforced concrete)
e) Characteristics of SCC:

- Slump flow class: SF3 (slump flow 760mm – 850mm)
- Passing ability by L box test: Ratio of h2/h1 = 0.9
- V-Funnel flow time (Viscosity): Class V1 (flow time 8s)
- Sieve segregation resistance: SR1 (15percent)

f) Degree of site control: Good
g) Type of aggregates: Crushed angular aggregate
h) Maximum cement content (OPC Content) :450Kg/m^3
i) Chemical admixtures type – PCE and VMA
j) Mineral admixtures: Fly ash conforming to IS 3812 (part 1)

2) Test Data for Materials

a) Cement used: OPC 43 Grade conforming to IS 269
b) Specific gravity of cement = 3.15
c) Chemical admixtures: Superplasticizer conforming to IS 9103
d) Specific gravity of:

- Coarse aggregate (at SSD condition) = 2.74
- Fine aggregate (at SSD condition) = 2.65
- Chemical admixtures = 1.08

e) Water absorption:

- Coarse aggregate = 0.5 percent
- Fine Aggregate = 1%

f) Free (surface) moisture:

- Coarse aggregate: Nil (absorbed moisture also nil)
- Fine aggregate: Nil (absorbed moisture also nil)

3) Target Mean Strength for concrete proportioning:

F'ck = fck + 1.65x5 = 30 + 1.65x5 = 38.25 mPa
F'ck = fck + K
F'ck = Target mean strength at 28 days.
fck = Characteristics strength at 28 days.
S = Standard Deviation

4) Air Contents

20mm Aggregates – 1%

5) Selection of Water/Cement ratio

From figure – 5, for required target strength of 38.25 mPa is 0.43
0.43<0.45 OK

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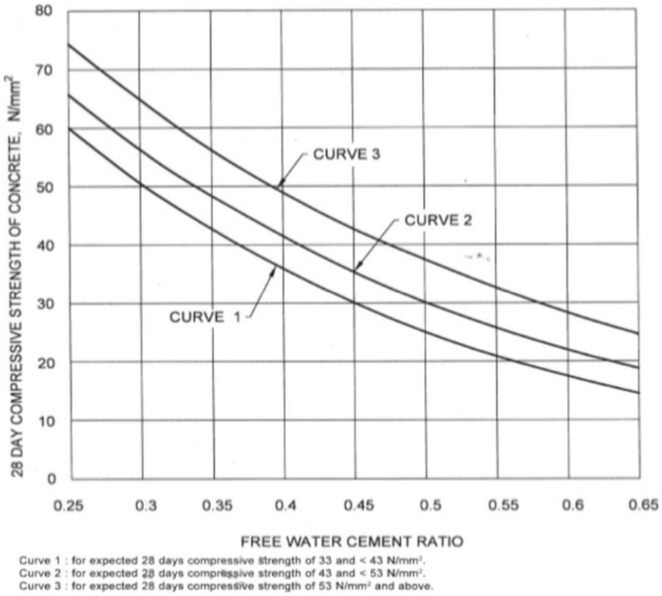

Fig. 5: Relationship between free water cement ratio and 28 days compressive strengths of concrete for cements of various expected 28 days compressive strength

6) Proportion of initial mix:

Let's consider SF = 3 (750 – 850mm)
Let water content of 190 liter/m³
Superplasticizer – 0.6%
Water contents = 190/0.43 = 442 Kg/m³
As per IS-456:2000, maximum fly ash contents allowed in Self-compacting concrete is 50% and in example we will take 35%
Therefore
Cement – 287 Kg/m³
Fly Ash – 155 Kg/m³
Admixture Dosage – 0.6% of weight of cementitious contents
0.6% x 442 = 2.65 Kg/cum

7) Selection of coarse aggregate:

Let Vca be the volume of coarse aggregate. Assuming 1m³ of concrete,
Vca = (1- Air content) (Vol of Water + Vol of cement + Vol of fly ash + Vol of admixture + Volume of fine aggregate)
Vca = (1- 0.01) – 190/1000 + 287/3150 + 155/2200 + 265/1080 +975/1000
Vca = (0.19 + 0.091 + 0.07 +0.0025 + 0.368) = 0.269m³

Mass of coarse aggregate = Vca x specific gravity of coarse aggregate x 1000
= 0.268 x 2.74 x 1000
= 737.06Kg/m³

8) Calculation of volume of powder content:

Vol. Of powder content = Vol of OPC + Vol of Fly ash + Vol. Of portion of fine aggregate
= (287/3150) + (155/2200) + (78/2650)
= 0.191 m³
Ratio of water to powder by volume
= 0.190/0.191
= 0.99 (Required Ratio 0.85 to 1.10)

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9) Mix Proportion for Trial

Cement = 287kg/m³
Fly Ash = 155kg/m³
Water (net mixing) = 190kg/m³
Fine aggregate (SSD) = 975kg/m³
Coarse aggregate (SSD) = 737kg/m³
Chemical admixture = 2.65 kg/m³
Free water-cement ratio = 0.43
Powder content = 520 kg/m³
Water powder ratio by volume = 0.99
Viscosity (V funnel) shall be carried out and values obtained shall be verified as per the data

IV. RESULT AND DISCUSSION

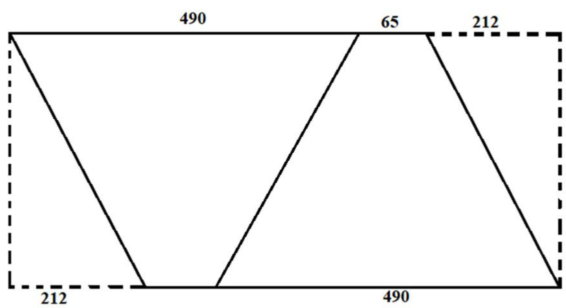

Fig.6: Dimensions of Plate

A. Calculations

[Note: 1m*1m*1m thick plate of mild steel weighs 7.85 kg/m²**]**

Considering 2mm thick plate.
Weight Calculations

- Total Length = 490 + 65 + 212
  = 767 mm
  ~ 770 mm
- Area of Plate = 770mm * 425mm
  = 0.327 m²
- Area of Strip (Side):
  a. (0.075 * 0.475) 2 = 0.071 m²
  b. (0.075 * 0.150) 2 = 0.022 m²
  c. (0.065 * 0.150) 2 = 0.020 m²
- Total Area = 0.327 + 0.71 + 0.022 + 0.02
  = 0.44 m² (With Wastage)
- Total Weight of Funnel =
  (0.44 * 7.85) 2 = 6.9 kg ~ 7 kg

- Angles required for funnel body = 3.63 Running Meter
  For Stand = 7.1 Running Meter
- Total = 3.63 + 7.1
  = 10.63 Meter ~ 11 Meter
  (Weight of 25 * 25 * 2mm MS angle is 0.785 kg/Running Meter)
  Therefore, Total Weight of angles

= 11 * 0.785
= 8.635 kg
Total Weight of Equipment = 7 kg of Funnel + 8.635 kg of angles
= 15.635 kg ~ 16 kg

B. Costing

Considering material cost, fabrication cost, transportation cost etc.

- For MS (Mild Steel): Rs. 125/kg
  Total Weight = 16 kg
  Total Cost of Equipment using MS = Rs. 2000/-
- For SS (Stainless Steel): Rs. 500/kg
  Total Weight = 16 kg
  Total cost of Equipment using SS = Rs. 8000/-

V. CONCLUSION

1) It is important to understand workability of concrete in terms of flowing ability, flowability test is very useful.
2) Self-Compacting Concrete (SCC) can save time, cost, enhance quality, durability and moreover it is a green concept.
3) Due to its ability to guide itself into every nook and cranny in the form, SCC can produce nearly nil defects concrete.
4) Number of pouring points can be reduced, thus eliminating the cumbersome activity of pipe laying over the pour.
5) About 40 to 50% of cement content can be replaced by materials like fibers; cost of the concrete is greatly reduced.
6) The number of skilled supervisors, engineers, vibrator operators and pipe fitters can drastically be reduced.
7) Formwork can be used for more number of times. Cost of repairing the structure is reduced as the numbers of defects are reduced to a great extent.
8) Since the concrete is capable of self-consolidating and reaching the difficult areas in moulds, manual variables in terms of placing and compacting concrete is nil. This factor ultimately yields defect less, better-quality concrete structures.
9) Self-compacting concrete is different from ordinary concrete in the composition and requirements of raw materials, so strengthening the environmental service behavior of self-compacting concrete is needful, such as the carbonation resistance, shrinkage cracking performance of self-compacting concrete, which benefit to the life of self-compacting concrete
10) Total weight of a V-Funnel is about 16 Kgs.
11) Cost of Manufacturing a V-Funnel using Mild Steel is Rs. 2000/-
12) Cost of Manufacturing a V-Funnel using Stainless Steel is Rs. 8000/-

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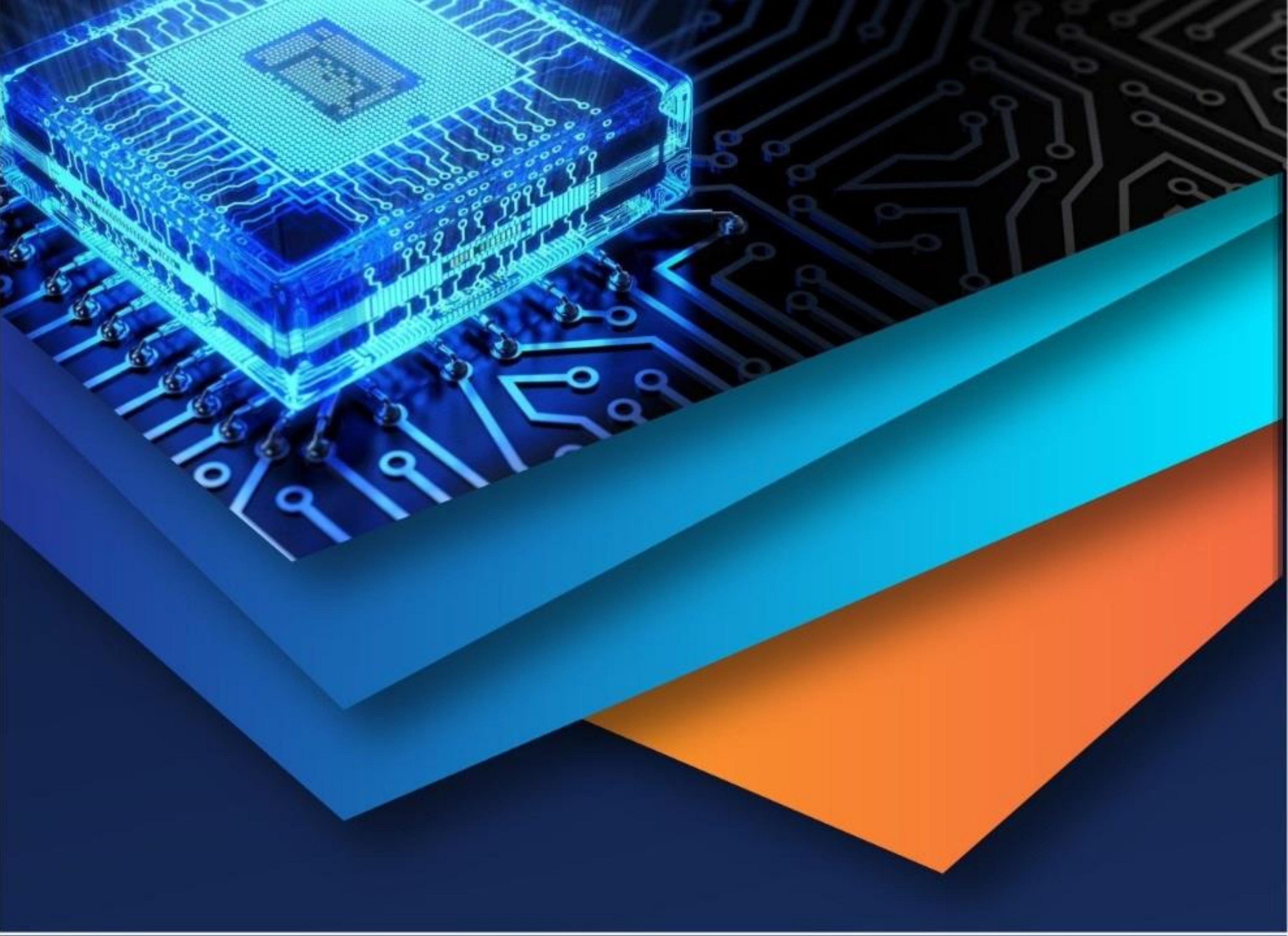

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