

Rheological Behavior of Ordinary Concrete, SCC with and without Glass and Steel Fibers

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Abstract: Rheology indicates its flowability and deformation. These two parameters indicate directly workability. It measures the normal and shearing forces in fresh concrete state. In this article the flowability and its measurement are discussed for ordinary and SCC with Glass and steel fibers are demonstrated. The strength parameter for a particular concrete mix is demonstrated with sampling and acceptance criteria. The new draft code on design of concrete mix (IS-10262) verified by compliance with specifications. The different parameters like percentage of Glass and Steel fibers, different percentages of silica fume, and different dosages of superplasticizer are tested and reported. A comparative analysis for, with and without glass fibers on ordinary and SCC predicted.

Key words: Rheology of ordinary concrete, Flowability of SCC, Workability of SCC with Glass fibers, Rheology of SCC with steel fibers, Sampling and acceptance criteria for SCC, Compliance with specification for SCC.

I. INTRODUCTION

Rheology¹ deals with the deformation and flow of materials. It indicates the workability of concrete. So deals with the properties of fresh concrete, which includes mixing, transporting, placing, compacting, finishing. To define good workability, the concrete contains workable water/ cement ratio. To obtain good rheological property it should not segregate and bleeding effect. Rheology of concrete depends on water/ cement ratio, aggregate/ cement ratio, size of aggregate, shape of aggregate, texture of aggregates and the admixtures used. Rheology also defines the strength of concrete in hardened state. The effect of Rheology on compressive strength and to obtain proper design concrete grade, mix design using sampling² and acceptance criteria² is used. Specifications with compliance³ demonstrate the Rheological property for good concrete.

II. LITERATURE REVIEW

Oladipupo⁴ reports the rheological properties and compressive strengths of SCC and conventional cement concrete.

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The flowability and segregation resistance properties are examined by V-funnel apparatus. The spread of SCC is incomparable (Flowability) compared to ordinary concrete because of using super plasticizers. The 28 days strength of SCC is marginally less compared to ordinary concrete, but its strength at 90 days is appreciably more. Effect of water cement ratio on plastic property of SCC negligible compared to conventional concrete.

M. Benaicha⁵: It reports that rheology and its measurement can be certified by characterization of fresh concrete. Many equations have been proposed to characterize the rheology of fresh concrete, but only Bingham model and Herschel-Bulkle model received wide acceptance. Rheological behavior of concrete A Vennila⁶: In this article the importance of SCC is predicted. Its disadvantage is the cost. To overcome this cement is replaced by mineral additives. Use of mineral additives improves durability property with strength. It is also reported that the use of conventional sand in concrete is replaced by manufacture sand.

A.M. Neville⁷: It is reported that design of concrete structures based on the assumption of certain minimum properties of concrete, such as strength. But actual strength varies in laboratory and site. The sources of variability are many, variations in mix ingredients, changes in concrete making and placing, and also, with respect to test results, the variations in the sampling procedure and the very testing. To minimize this variability by quality control measures and by adopting the standard testing procedures. To interpret strength values properly, detect statically significant changes in strength, as opposed to random fluctuations. The knowledge of variability forms the basis of devising satisfactory compliance scheme for the strength of designed mixes. Properties such as mix proportions, density, air content and workability have to comply with specifications so as to satisfy both strength and durability requirements.

III. EXPERIMENTS:

Effect of Rheology on:

1. Compressive Strength
2. Split tensile strength

Compressive strength: The most important property of concrete which defines the quality and its usability in structure is the compressive strength. Here a relationship between the compressive strength and flowability property is established. Tests conducted are on flowability such as slump, spread test and V – funnel tests are conducted and the results are tabulated as follows.



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Aggregate size 12 to 20 mm Size

Table: 1 Description of Mix, Glass Fibers (GF) Steel Fibers (SF) and Super Plasticizers (SP)

Mix	% Fibers(G.F,S.F)	% Of Super Plasticizers
M1	0.2	0.5
M2	0.4	1.0
M3	0.8	1.5
M4	1	2

Table: 2 Ordinary concrete of M30 without fibers

Type of Strength	3 Days Strength	28 Days Strength
Compressive Strength	15.2 MPa	40.44Mpa
Split Tensile Strength	1.203MPa	2.87

Table: 3 Ordinary concrete with Glass Fibers (Slump cone Test) M30 concrete.

M1	M2	M3	M4	Mix
115mm	150mm	130mm	120mm	Slump
1.5Sec	2Sec	2.5 Sec	2.2Sec	Time

Table: 4 Ordinary concrete of M30 with Steel Fibers

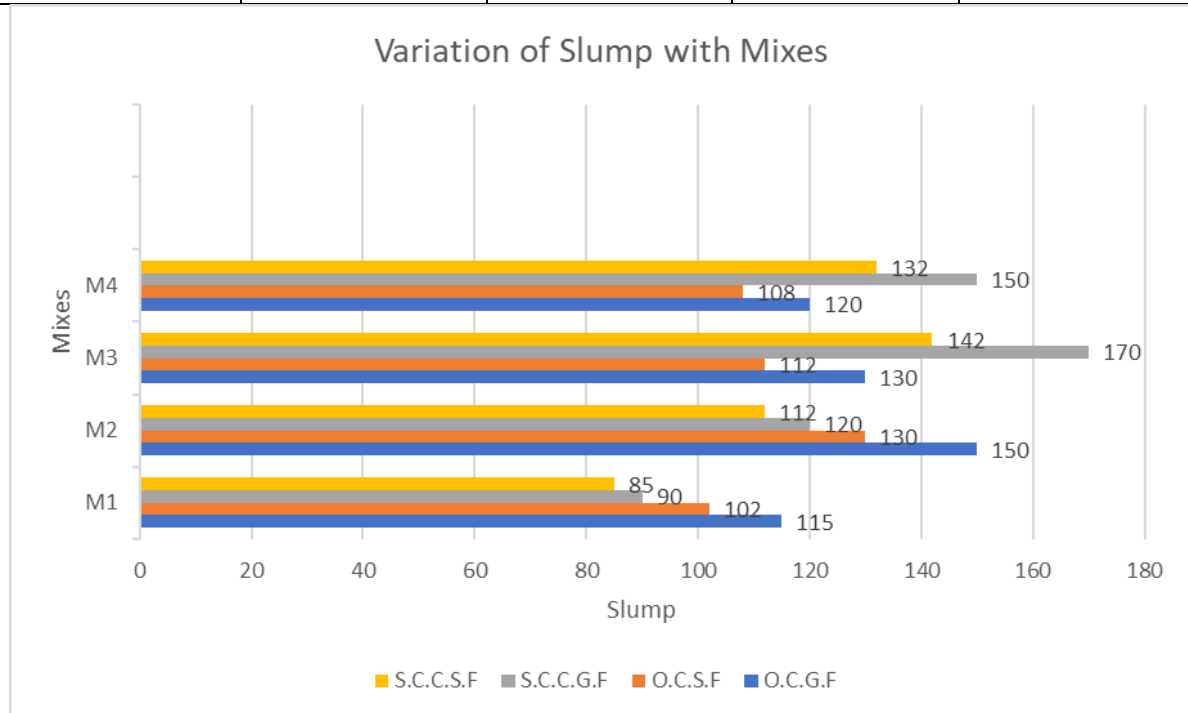
M1	M2	M3	M4	Mix
102mm	130mm	112mm	108mm	Slump
1.3Sec	1.6Sec	2.2Sec	1.8Sec	Time

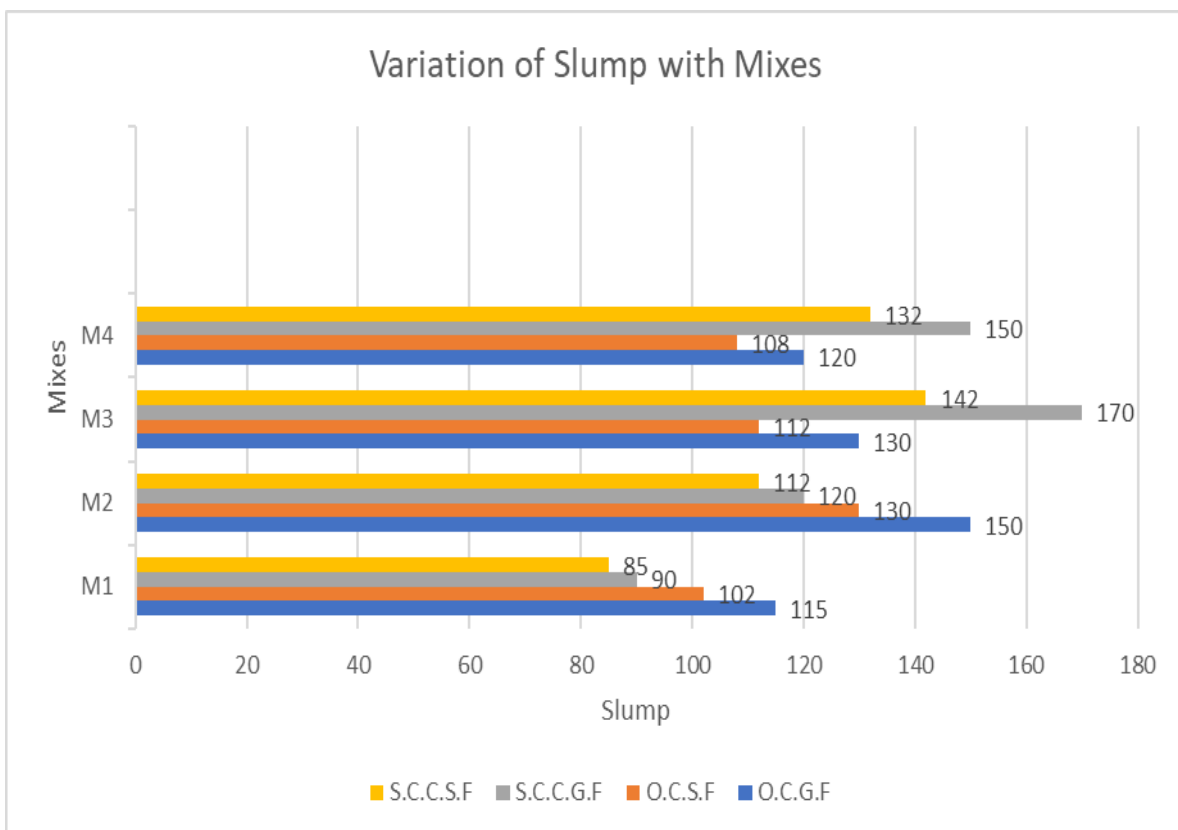
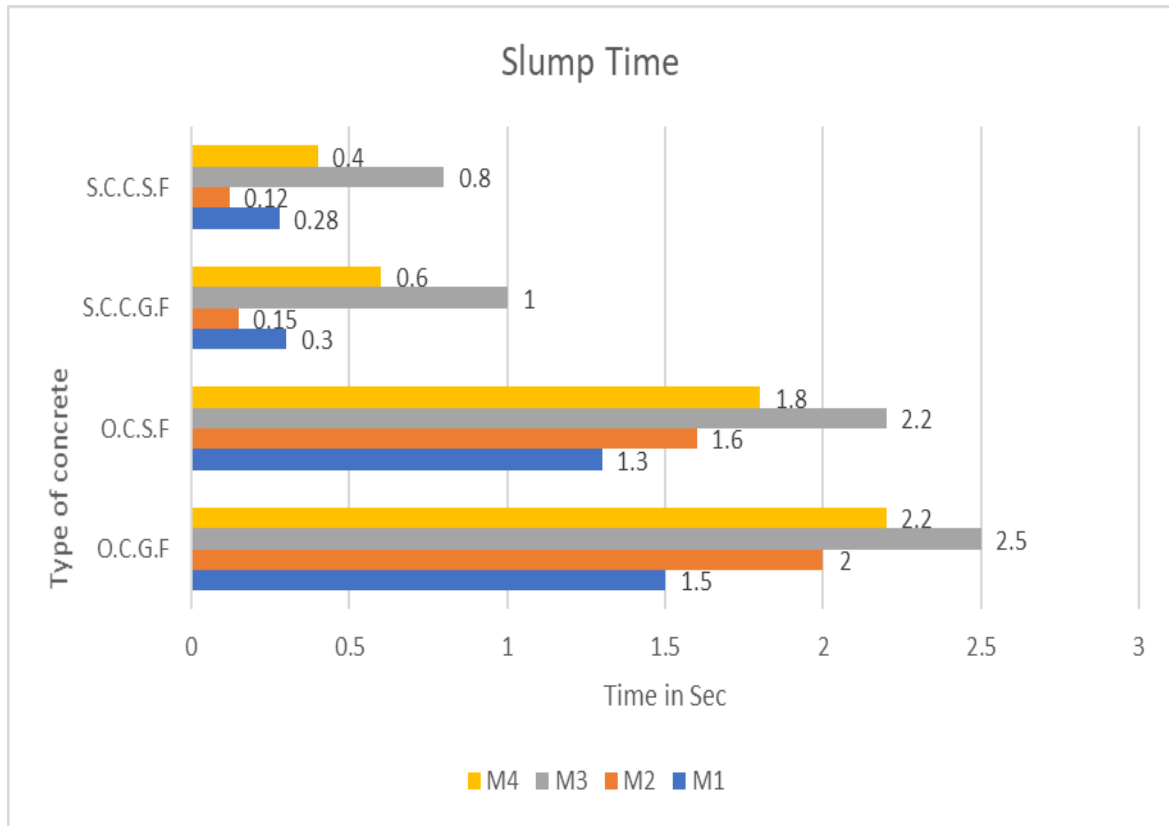
Table: 5 Self compacted concrete of M30 with Glass fibers

M1	M2	M3	M4	Mix
90mm	120mm	170mm	150mm	Slump
0.3Sec	0.15Sec	1 Sec	0.6Sec	Time

Table: 6 Self Compacted concrete of M30 with Steel Fibers

M1	M2	M3	M4	Mix
85mm	112mm	142mm	132mm	Slump
0.28Sec	0.12Sec	0.8Sec	0.4Sec	Time





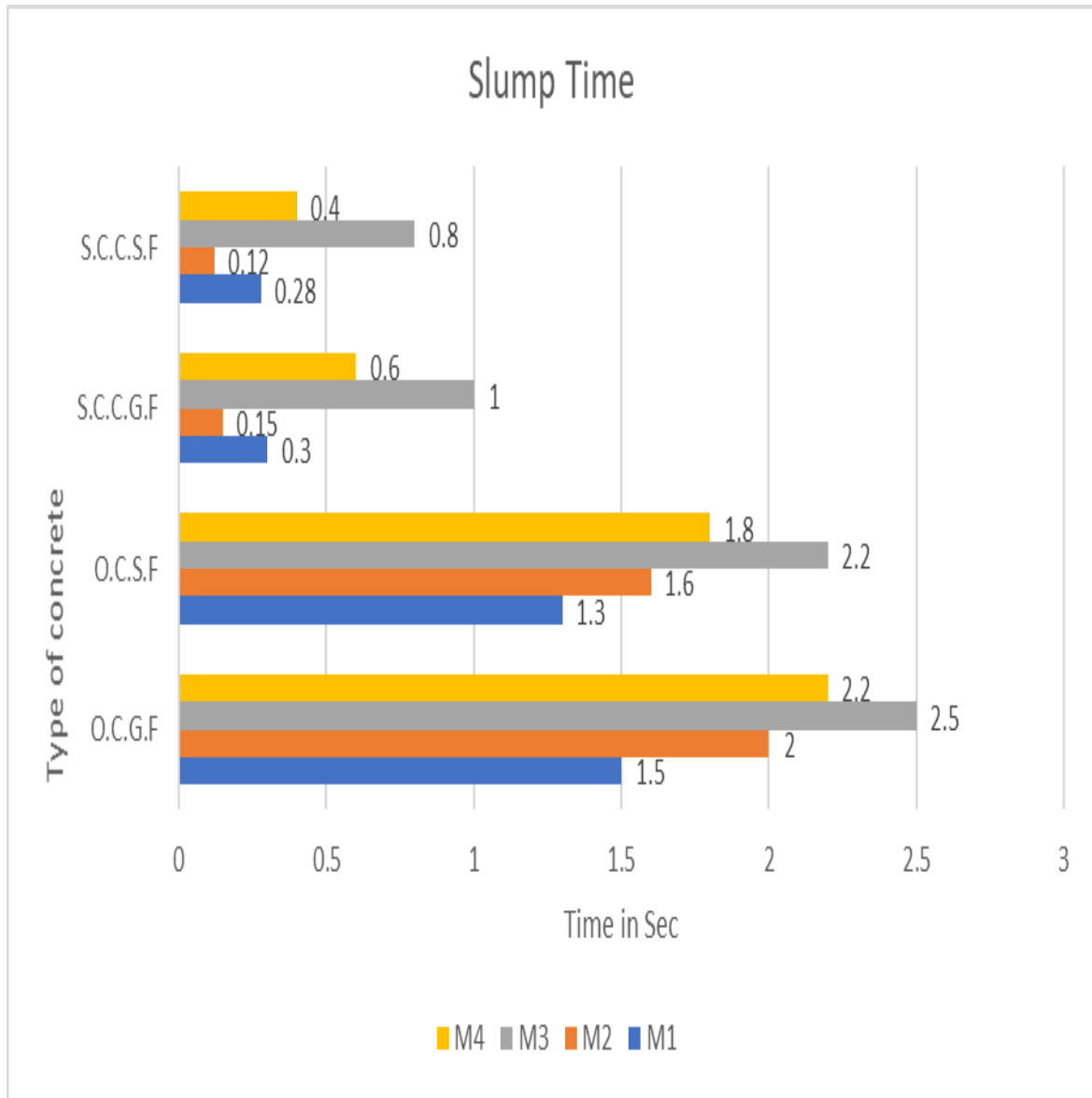


Table:7 compressive strength of M30 ordinary concrete with glass fibers

M1	M2	M3	M4	Mix
42.2Mpa	38.5Mpa	36.2Mpa	30.6Mpa	Compressive strength.

Table: 8 compressive strength of M30 ordinary concrete with Steel fibers

M1	M2	M3	M4	Mix
48.2Mpa	42.5Mpa	37.2Mpa	33.6Mpa	Compressive strength.

Table: 9 compressive strength of M30 Self compacted concrete with Glass fibers

M1	M2	M3	M4	Mix
38.2Mpa	31.5Mpa	30.2Mpa	29.6Mpa	Compressive strength.

Table: 10 Compressive strength of M30 Self Compacted concrete with Steel fibers

M1	M2	M3	M4	Mix
49.2Mpa	44.5Mpa	39.2Mpa	36.6Mpa	Compressive strength.

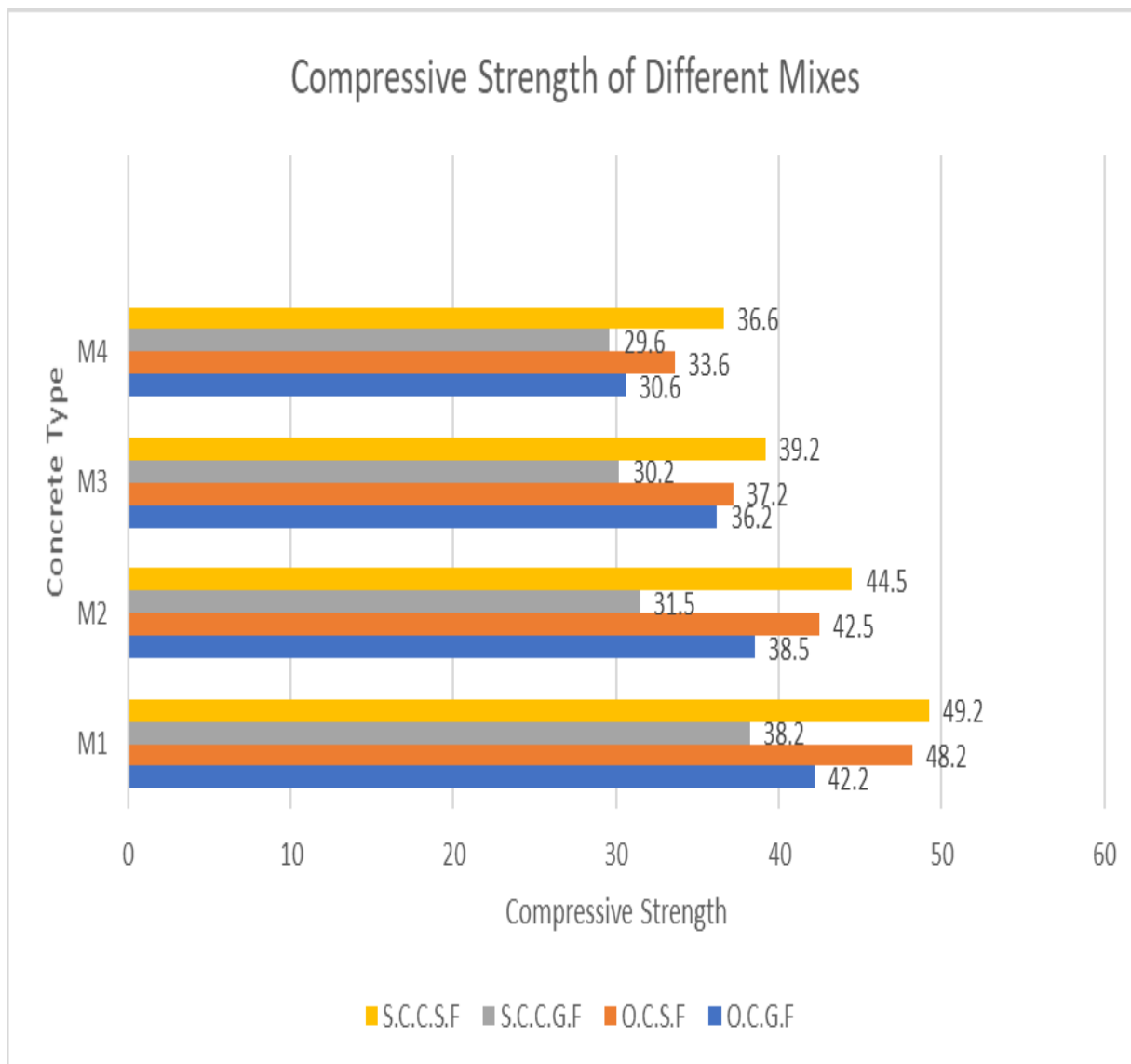


Table:11 Split Tensile strength of M30 ordinary concrete with glass fibers

M1	M2	M3	M4	Mix
3.33	3.26	3.058	2.63	Split tensile strength

Table:12 Split Tensile strength of M30 ordinary concrete with Steel fibers

M1	M2	M3	M4	Mix
3.8	3.62	3.25	2.8	Split tensile strength

Table:13 Split Tensile strength of M30 Self compacted concrete with Glass Fibers

M1	M2	M3	M4	Mix
2.8	2.32	2.19	2.02	Split tensile strength

Table:14 Split Tensile strength of M30 Self Compacted concrete with Steel fibers

M1	M2	M3	M4	Mix
2.89	2.37	1.87	1.67	Split tensile strength



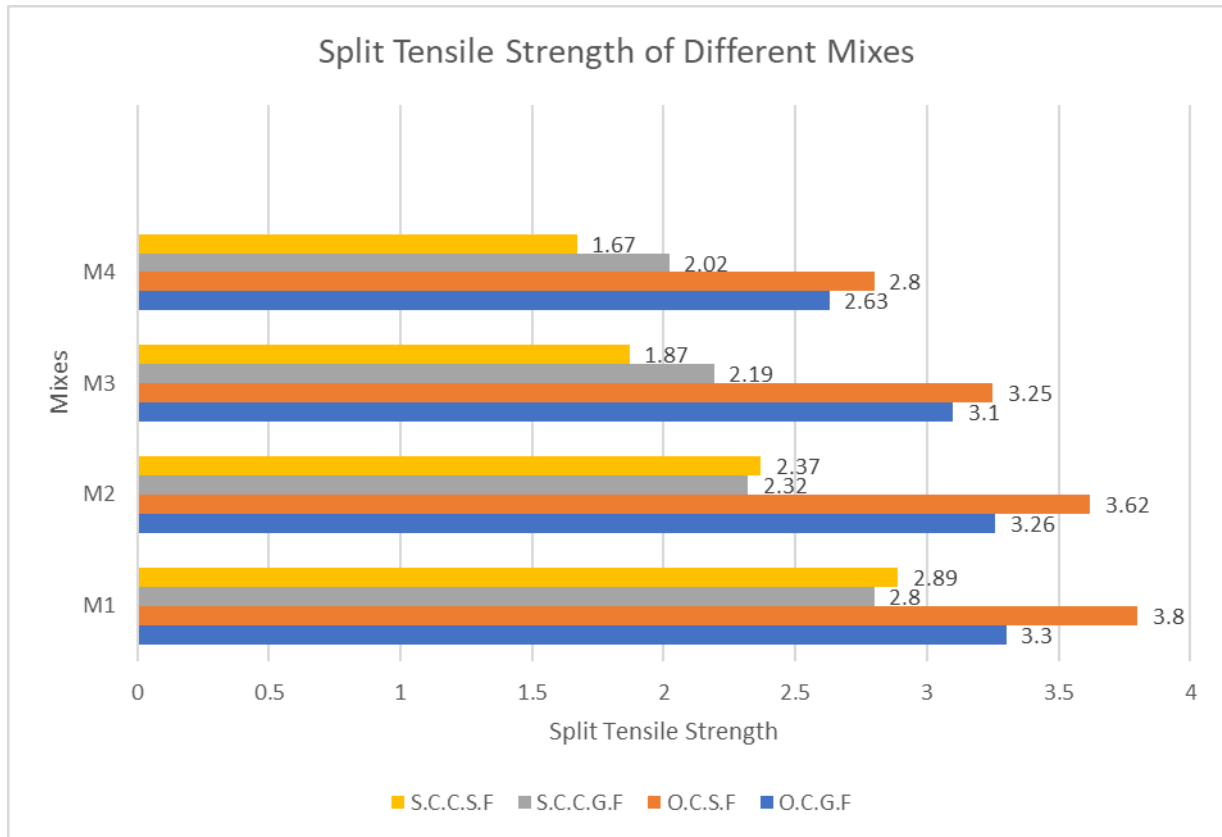


Table: 15 Spread of Self Compacted Concrete with super plasticizer with glass fibers

Mix	Spread or Flow	% Fiber (Glass Fiber)	Slump in (mm)	Time (Sec)
Ordinary Concrete	650	0	0	5Sec
M1	520	0.2%	120mm	16Sec
M2	320	0.4%	180mm	13Sec
M3	400	0.8%	140mm	14Sec
M4	440	1%	130mm	15Sec

IV. CONCLUSIONS AND REMARKS:

The slump of ordinary concrete with and without G.F and S.F (also for SCC) increases with 0.2% and 0.4% of fibers but decreases with 0.8% and 1%. But time taken to undergo slump at higher % of fibers increases. This indicates that flow ability and slump affected with the use of fibers giving an idea that the internal friction between the concrete ingredients are increased. Even time of slump also indicates the same effect. The strength of concrete mix in all the case indicates that at 0.2% the compressive strength is maximum, but decreases with increase of fiber %. So it happens that minimum % of fibers at 0.15 gives good compressive strength may be corollary to RCC that minimum % of steel is fixed to 0.15%.

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