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Influence of Silica Fume & Steel fibers on Flexural Strength of Concrete

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Abstract -- The flexure test method measures behaviour of materials subjected to simple beam loading. It is also called a transverse beam test with some materials. Maximum fiber stress and maximum strain are calculated for increments of load. Results are plotted in a stress-strain diagram. Flexural strength is defined as the maximum stress in the outermost fiber. This is calculated at the surface of the specimen on the convex or tension side. Flexural modulus is calculated from the slope of the stress vs. deflection curve. If the curve has no linear region, a secant line is fitted to the curve to determine slope.

Indexed Terms: Steel Fibers, Silica Fume, flexural Strength

I. INTRODUCTION

A flexure test produces tensile stress in the convex side of the specimen and compression stress in the concave side. This creates an area of shear stress along the midline. To ensure the primary failure comes from tensile or compression stress the shear stress must be minimized. This is done by controlling the span to depth ratio; the length of the outer span divided by the height (depth) of the specimen. For most materials S/d=16 is acceptable. Some materials require S/d=32 to 64 to keep the shear stress low enough.

1. Types of Flexure Tests:

Flexure testing is often done on relatively flexible materials such as polymers, wood and composites. There are two test types; 3-point flex and 4-point flex. In a 3-point test the area of uniform stress is quite small and concentrated under the center loading point. In a 4-point test, the area of uniform stress exists between the inner span loading points (typically half the outer span length). Flexural strength, also known as modulus of rupture, bend strength, or fracture strength,[dubious – discuss] is measured in terms of stress, and thus is expressed in units of pressure (or stress, the two being equivalent). The value represents the highest stress experienced within the material at its moment of rupture. In a bending test, the highest stress is reached on the surface of the sample

- For a rectangular sample under a load in a three-point bending setup:

$$\sigma = \frac{3FL}{2bd^2}$$

F is the load (force) at the fracture point
L is the length of the support span
b is width
d is thickness

- For a rectangular sample under a load in a four-point bending setup where the loading span is one-third of the support span:

$$\sigma = \frac{FL}{bd^2}$$

F is the load (force) at the fracture point
L is the length of the support (outer) span
b is width
d is thickness

- For the 4 pt bend setup, if the loading span is 1/2 of the support span:

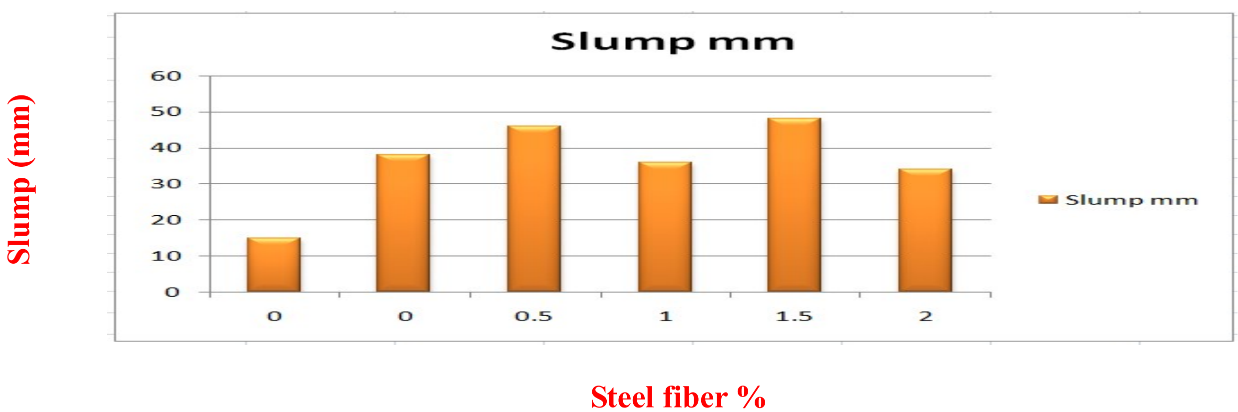
$$\sigma = \frac{3FL}{4bd^2}$$

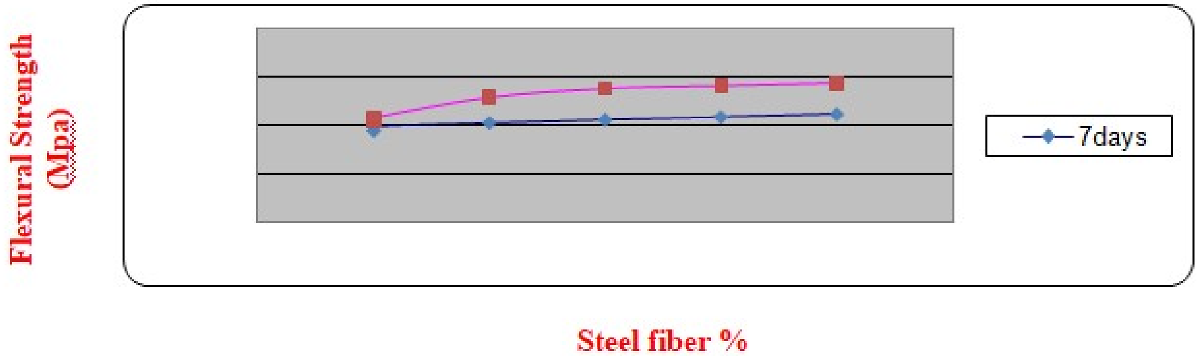
II. FLEXURAL STRENGTH (MPA)

1. Silica Fume (4%) [Table No. A]:

Sr. No.	Mix Design	Steel Fiber Length/Dia.	Cement Kg	Silica Kg	Water Lit.	F.A. Kg	C.A. (10mm) Kg	C.A. (20mm) Kg
1	M30		420	Nil	176.4	692.71	483.75	591.25
2			420	Nil	176.4	692.71	483.75	591.25
3	W/C Ratio=0.42	L=30mm	403.2	16.8	176.4	692.71	483.75	591.25
4	Cement = 420Kg	D=0.50	403.2	16.8	176.4	692.71	483.75	591.25
5	Silica Fume (4%)		403.2	16.8	176.4	692.71	483.75	591.25
6			403.2	16.8	176.4	692.71	483.75	591.25

Sr. No.	Mix Design	Steel Fiber Length/Dia.	SP(%)	Steel Fiber(%)	Slump (mm)	Flexural Strength	
						7days	28 days
1	M30		0	0	**15**	**3.8**	**4.16**
2			0.4	0	**38**	**3.98**	**4.31**
3	W/C Ratio=0.42	L=30mm	0.75	0.5	46	4.12	5.12
4	Cement = 420Kg	D=0.50	0.75	1	36	4.25	5.49
5	Silica Fume (4%)		1	1.5	48	4.36	5.61
6			1	2	34	4.48	5.72



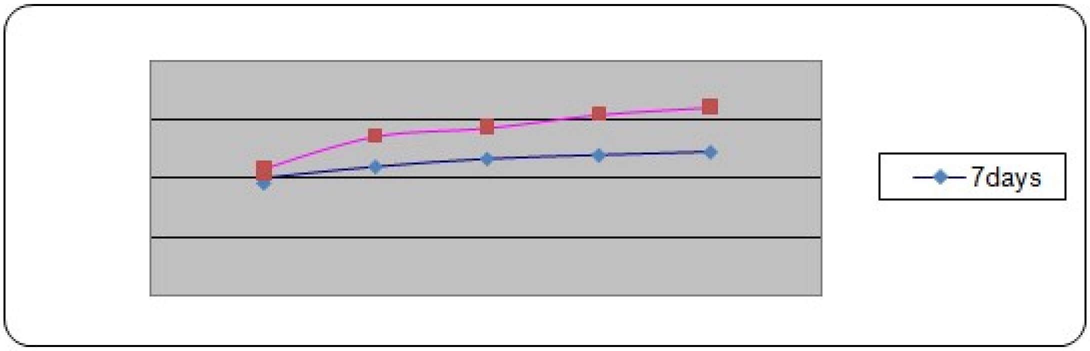


2. Silica Fume (8%) [Table No. B]:

Sr. No.	Mix Design	Steel Fiber Length/Dia.	Cement Kg	Silica Kg	Water Lit.	F.A. Kg	C.A. (10mm) Kg	C.A. (20mm) Kg
1	M30 W/C Ratio=0.42 Cement = 420Kg Silica Fume (8%)	L=30mm D=0.50	420	Nil	176.4	692.71	483.75	591.25
2			420	Nil	176.4	692.71	483.75	591.25
3			386.4	33.6	176.4	692.71	483.75	591.25
4			386.4	33.6	176.4	692.71	483.75	591.25
5			386.4	33.6	176.4	692.71	483.75	591.25
6			386.4	33.6	176.4	692.71	483.75	591.25

Sr. No.	Mix Design	Steel Fiber Length/Dia.	SP(%)	Steel Fiber(%)	Slump (mm)	Flexural Strength	
						7days	28 days
1	M30 W/C Ratio=0.42 Cement = 420Kg Silica Fume (8%)	L=30mm D=0.50	0	0	15	3.8	4.16
2			0	0	38	3.98	4.31
3			1	0.5	42	4.38	5.43
4			1	1	31	4.65	5.72
5			1.2	1.5	44	4.78	6.18
6			1.2	2	35	4.89	6.43

Flexural Strength (Mpa)



Steel fiber %

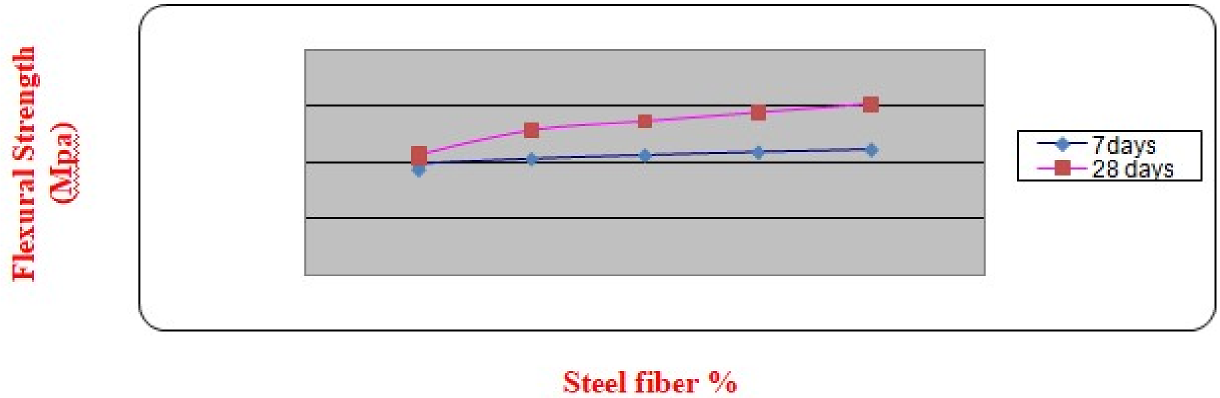
3. Silica Fume (12%) [Table No. C]:

Sr. No.	Mix Design	Steel Fiber Length/Dia.	Cement Kg	Silica Kg	Water Lit.	F.A. Kg	C.A. (10mm) Kg	C.A. (20mm) Kg
1	M30 W/C Ratio=0.42 Cement = 420Kg Silica Fume (12%)	L=30mm D=0.50	420	Nil	176.4	692.71	483.75	591.25
2			420	Nil	176.4	692.71	483.75	591.25
3			369.6	50.4	176.4	692.71	483.75	591.25
4			369.6	50.4	176.4	692.71	483.75	591.25
5			369.6	50.4	176.4	692.71	483.75	591.25
6			369.6	50.4	176.4	692.71	483.75	591.25

Sr. No.	Mix Design	Steel Fiber Length/Dia.	SP(%)	Steel Fiber(%)	Slump (mm)	Flexural Strength	
						7days	28 days
1	M30 W/C Ratio=0.42 Cement = 420Kg Silica Fume (12%)	L=30mm D=0.50	0	0	15	3.8	4.16
2			0	0	38	3.98	4.31
3			1	0.5	42	4.18	5.18
4			1	1	31	4.31	5.51
5			1.2	1.5	44	4.42	5.82
6			1.2	2	35	4.51	6.12

Slump (mm)

Steel fiber %



III. CONCLUSION

- With the increase in Steel fibers and Silica fume, the Flexural Strength of the concrete increases to a considerable limit.
- Using Steel fibers and Silica fume minimize the probability of failure to an acceptable low value.
- Silica fumes are a great binding material thus silica fume increases the ultimate strength of concrete.
- They also lower the permeability of concrete and thus reduce bleeding of water
- Structural behaviour, failure modes, deformation pattern should be known properly

IV. FUTURE SCOPE

- Silica fume can be replaced by other types of cementations material like GGBS.
- The combination of Steel fiber, Silica fume and GGBS can be studied and the results compared with normal concrete.

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