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Modulus of Elasticity on High Performance Glass Fibre Rcc Beams With Partial Replacement of Cement by Silica Fume

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Abstract— ***The present paper contains, Seven blends Mix1 to Mix7 are thrown with 0%, 5%, 7.5% and 10% substitution of bond utilizing SF and another arrangement of examples with 0%, 5%, 7.5% and 10% substitution of concrete utilizing SF alongside 0.2% consistent substitution of Glass fiber to contemplate the mechanical property modulus of versatility. The outcome demonstrates that the ideal substitution of silica smoke is 7.5%. On the off chance that the fiber of 0.2% is included the malleable and flexural quality got expanded. Absolutely seven RC beams 200 x 200 x 750mm size were thrown for assessing the flexural test and restored for 28 days. These beams are tested in loading frame of 1000 kN at 28 days, two point burdens are connected over the beam. The Heap from the start split, diversion, and a definitive burden are noted for each blend and similar examination is accomplished for Burden – redirection (P-Δ), first break - extreme burden, Moment – Curvature (M-φ) and Moment – rotation with Control and HPC blend examples lastly different malleable natures is plotted.***

Keywords: optimum replacement of silica fume, Moment – Curvature, Moment – Rotation, modulus of elasticity, flexural behavior.

I. INTRODUCTION

The modulus of flexibility most ordinarily utilized practically speaking is secant modulus. There is no standard technique for deciding the secant modulus. At some point it is estimated at stresses going from 3 to 14MPa and at some point the secant is attracted to point speaking to a feeling of anxiety of 15, 25, 33 or 50 percent of extreme quality. Since the estimation of secant modulus diminishes with increment in stress, the worry at which the secant modulus has been discovered must to consistently be expressed.

Table 1 Maximum Stress Strain Values

Mix	Stress (MPa)	Strain in Microns
Mix1	60.51	2490
Mix2	57.32	3050
Mix3	70.06	3470
Mix4	63.69	3175
Mix5	66.24	3300
Mix6	71.34	3350
Mix7	62.42	3125

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II. REVIEW ON LITERATURE

M Newtson Craig (2014) he investigated that the fracture response of RC deep beams and also investigated on the strength and size of beams. RC deep beams and also investigated on the strength and size of beams.

P Kumar Mehta (2004) he studied the RC beams under two point loading conditions.

Zhenhua Wu. (2007) studied that the RC beam for different shear reinforcement patterns

Aruna Munikrishna (2011) mentioned the RC beams under pure torsion. The torsional strength due to the changes in the length of beam and cracks propagation due to various loading conditions were studied and analyzed. He has tested six beams with different length and same reinforcement ratios as per the ACI318-05 code. The author considered multilinear isotropic stress-strain curve for the concrete model.

Table 2 Modulus of Elasticity

Mix	Stress N/mm²	33% of Ultimate strength N/mm²	Strain	Young's Modulus N/mm²
Mix1	60.51	20.17	0.00048	42462.84
Mix2	57.32	19.11	0.00043	44960.65
Mix3	70.06	23.35	0.00045	51899.03
Mix4	63.69	21.23	0.00048	44697.73
Mix5	66.24	22.08	0.00053	42058.43
Mix6	71.34	23.78	0.00053	45293.7
Mix7	62.42	20.81	0.0005	41613.58

Stress-Strain Behavior

Tests were led to study pressure strain conduct of HPC on chamber examples of size 100x300mm for all the blends in the pressure testing machine of limit 2000kN. These examples were tried under hub pressure and the estimations of pivotal pressure and hub strain were recorded at standard interims. The pressure versus strain bends are appeared for the blends Mix1 to Mix7 in Figs. The most extreme pressure and greatest strain esteems for different blends are given in Table.It is discovered that Mix3 (with 7.5% silica rage) indicates higher quality and extreme strain contrasted with ordinary cement.

Preparation of Beam Specimen

All the reinforced beam specimens were cast at the structural laboratory. The raw materials for concrete mixes already described in the previous section were mixed by a rotary mixer. The wooden mould were prepared and lubricated with oil before the concrete was poured. The reinforcement bars were cut to the required lengths. The longitudinal bars and stirrups were secured to each other at correct spacing by means of binding wires.

A mixing time of 3 to 5 minutes was given to ensure uniform mixing. Wooden moulds were used to cast the beams. The specimens were demoulded after 24 hours and cured for 28 days using gunny bags. After curing period, the beams were kept for 24 hours in a dry state. After drying they were cleaned with a sand paper to remove all grit and dirt. Then all the specimens were prepared by white washing from all sides. White washing was done to facilitate easy detection of crack propagation

Experimental Test Setup for Beam Specimens

A total of seven beams were cast. Out of those seven beams cast, one is conventionally reinforced concrete beam. Remaining six beams were separated into two categories and were cast with concrete, one with the 5%, 7.5% & 10% silica fume replacement and the other with above mentioned replacement of silica fume in addition to the glass fibers. All the beams were tested for flexure under a loading frame of capacity 1000kN. These beams were tested on a effective span of 750mm with simply supported conditions under two point loading. Deflections were measured under the loading point and at the mid span using Linear Variable Differential Transducers (LVDTs). The crack patterns were also recorded at every load increment. All the beams were tested up to failure.

Design of Flexure Beams

Grade of Concrete	M80
Grade of steel	Fe 415
Length of Beam	750mm
Breath of beam	200mm
Depth of Beam	200mm
Loading Method	Two Point Load (Equal Distance (L/3))
End Condition	Simply Supported Beam

We have to design a Beam failures occurs in the mode of flexure

$$\frac{x_u}{d-x_u} = \frac{\varepsilon_{cu}}{\varepsilon_s}$$

$$\frac{x_u}{d} = \frac{\varepsilon_{cu}}{\varepsilon_{cu}+\varepsilon_s}$$

$\varepsilon_{cu} = 0.0035$ (IS 456-2000 38.1(b))

$\varepsilon_s = 0.002 + \frac{0.87 f_y}{E_s}$ (IS 456-2000 38.1)

$$\varepsilon_s = 0.002 + \frac{0.87x415}{2x10^5} = 0.00366$$

$$\frac{x_u}{d} = \frac{0.0035}{0.0035+0.00366} = 0.479 \approx 0.48$$

$\frac{x_{u,max}}{d} = \frac{0.87 f_y A_{st}}{0.36 f_{ck} bd} = 0.48$ (IS 456-2000 Note 38.1)

Clear cover =20mm

Effective cover= (20+12/2) = 26mm

Effective depth= 200- 31 = 174mm

f_{ck} = 80 N/mm^2

b = 200 mm

$M_{u,lim} = 0.36 \frac{x_{u,max}}{d}\left[1-0.42\frac{x_{u,max}}{d}\right] bd^2 f_{ck}$ (IS 456-2000 Annex G 1.1(c))

=33.42 kNm

$A_{st} = \frac{0.5 f_{ck}}{f_y}\left[1-\sqrt{1-\frac{4.6M_u}{f_{ck}bd^2}}\right]bd$ A_{st}=664 mm^2

Provide $A_{st} = 2x\frac{\pi x 12^2}{4} = 226mm^2$

Moment carrying capacity of under reinforced section

$$M_u = 0.87 f_y A_{st} d\left[1-\left(\frac{A_{st} f_y}{bdf_{ck}}\right)\right]$$

M_u = 13.24 kNm < $M_{u.lim}$

A_{st} = 314 mm^2

The section is failure mode of flexure.

Increase the shear resistance capacity of the beam.

$$M = \frac{Wl}{3}$$

$$w = \frac{3M}{l}$$

$$w = 3X\frac{13.24}{1.5}$$

w = 26.48 kN

Jack load (2w) = 52.96 kN

Design of shear Resistance:

$$\%ofsteel = \frac{100x226}{100X174} = 1.30\ \%$$

From Table 19,IS 456 -2000,

For fck = 80 N/mm^2 & pt=1.30

Design shear strength of concrete τ_c = 0.75 N/mm^2

From Table 20,

Maximum shear stress $\tau_{c\ max}$ = 4 N/mm^2

$$\frac{v}{bd} = \frac{26.48x10^3}{100X174} = 1.52\ \text{N/mm}^2$$

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$\tau_v < \tau_{cmax}$

$V_{us} = (\tau_v - \tau_c) x\ bd = (1.52-0.75) \times 100x174 = 13.40$ kN

IS 456 clause no : 40.4 (a)

$$S_v = \frac{0.87 f_y A_{sv} d}{V_{us}}$$

A_{sv}= total cross sectional area of stirrup legs

Using 8mm φ (2 legged stirrup)

$$A_{sv} = \frac{2\pi X 8^2}{4} = 101 mm^2$$

$$s_v = \frac{0.87 X 415 X 101 X 174}{13.4 X 10^3} = 473 \text{ mm}$$

Provide maximum spacing of shear resistance

As per IS 456 –2000 26.5.1.5

1. Shall not exceed 0.75d for vertical stirrups (131.25mm)
2. Spacing should not exceed 300mm

We choose 8mm φ 2 legged vertical stirrups at a 125mm c/c distance

Beam with stand upto $V_u = V_c+V_s$

$$Vs = \frac{0.87x415x101x174}{125}$$

V_s = 50.76 kN

V_c = 0.75x100x174 = 13.05 kN

$V_u = V_c+V_s$ = 63.81 kN > 26.48 kN

The section is failure mode of flexure.

Beam Test Results

Testing of beam was carried out as per the procedure. The test results for beam tested for Flexure are shown in Tables.

Table 3 Test Results for Flexure Beam

Specimens	% Of SF	Fiber (%)	First Crack Load (kN)	Ultimate load (kN)	Deflection at Ultimate Load (mm)
M1	0	0	26	46	12.46
M2	5	0	28	48	14.65
M3	7.5	0	32	54	17.75
M4	10	0	30	52	16.26
M5	5	0.2	35	52	17.89
M6	7.5	0.2	38	58	21.77
M7	10	0.2	37	54	19.08

Table 4 Displacement Ductility

Beams	Ultimate Displacement Δ_u (mm)	First Yield Displacement Δ_y (mm)	Displacement Ductility $\mu = \Delta_u / \Delta_y$
M1	12.46	3.88	3.21
M2	14.65	4.26	3.44
M3	17.75	5.01	3.54
M4	16.26	4.69	3.47
M5	17.89	5.11	3.50
M6	21.77	5.39	4.04
M7	19.08	4.85	3.93

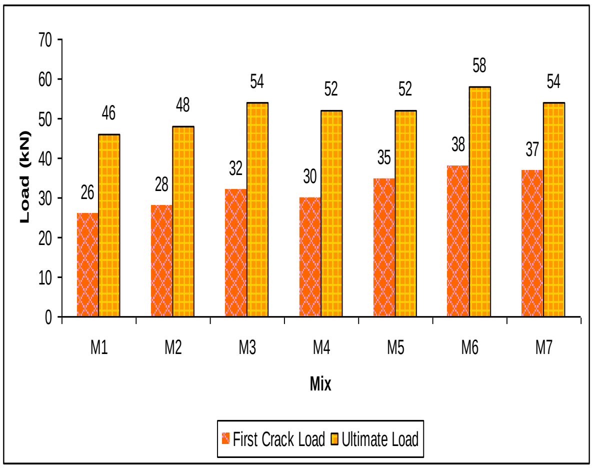

Fig 1.comparison For First Crack Load And Ultimate Load

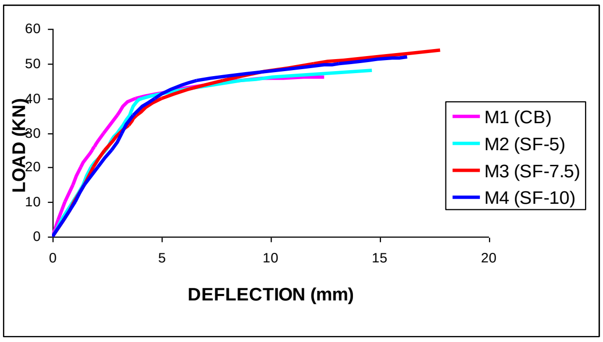

Fig2. Load Vs Def curves for Flexure Beam

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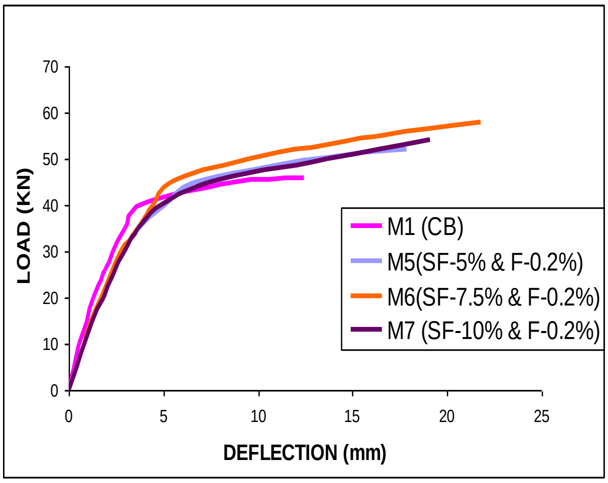

Fig 3. Load Vs Def curves for Flexure Beam (M1, M5, M6, and M7)

Table 5 Curvature Ductility

Beams	Maximum Curvature φ_u (rad/mm) x 10^{-6}	Curvature at First Yield φ_y (rad/mm)x10^{-6}	Curvature Ductility $\mu = \varphi_u / \varphi_y$
M1	152.14	53.68	2.83
M2	155.84	42.68	3.65
M3	167.35	44.11	3.79
M4	160.66	43.82	3.67
M5	167.42	45.34	3.69
M6	196.25	49.29	3.98
M7	181.25	46.89	3.87

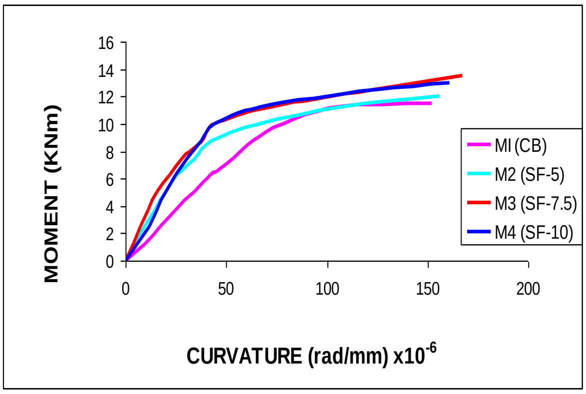

Fig.4. M-φ relationship for Flexure beam (M1, M2, M3, and M4)

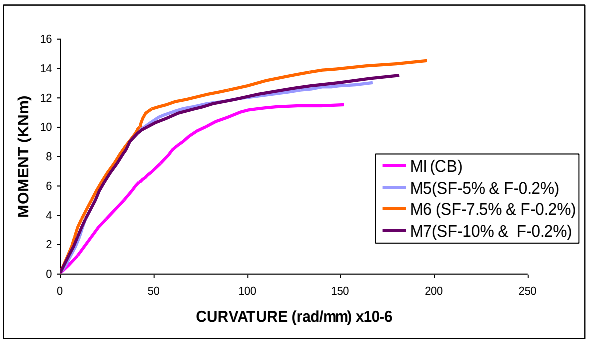

Fig.5 M-φ relationship for Flexure beam

Table 6 Rotation Ductility

Beams	Maximum Rotation θ_u (rad)	First Yield Rotation θ_y (rad)	Rotation Ductility $\mu = \theta_u / \theta_y$
Mix 1	0.0182	0.0055	3.309
Mix 2	0.0215	0.006	3.583
Mix 3	0.0257	0.0067	3.836
Mix 4	0.0237	0.00654	3.624
Mix 5	0.0263	0.0068	3.868
Mix 6	0.0321	0.00796	4.033
Mix 7	0.0282	0.00718	3.928

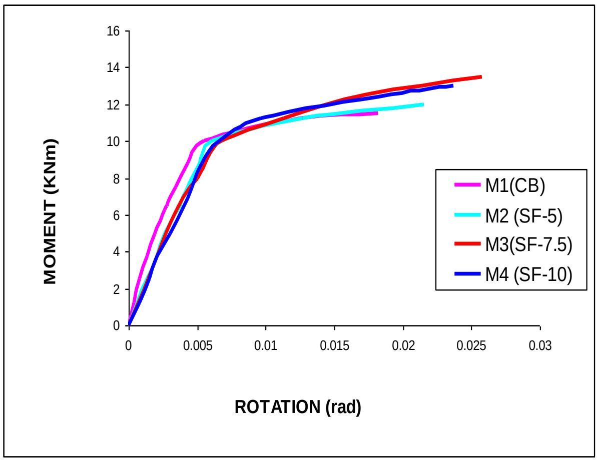

Fig.6. M-θ relationship for Flexure beam (M1, M2, M3 and M4)

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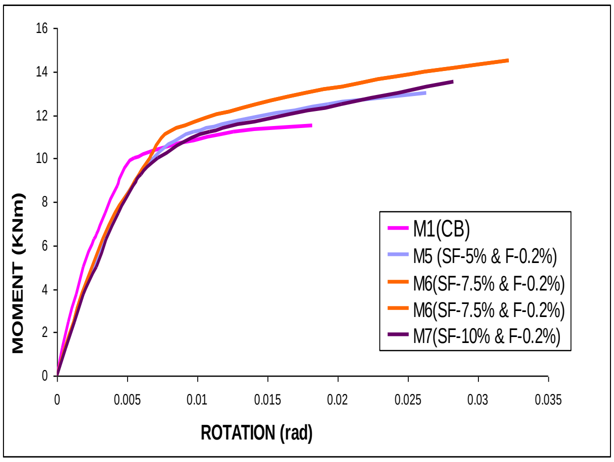

Fig 7. M-θ relationship for Flexure beam (M1, M5, M6 and M7)

III. DISCUSSION OF BEAM TEST RESULTS

Test consequences of pillars under flexure show that, the bar with 7.5% of silica seethe (M6) has the most astounding burden conveying limit of 58 kN. This is about 1.26 occasions higher than that of the control bar (CB).

A definitive burden conveying limit acquired tentatively is more prominent than the worth got hypothetically. The principal break showed up at the jack heap of 26kN for M1 shaft where as the primary split burden was 32 kN for M3 bar which is 23.07% higher than that of the control bar. A definitive heap of M3 shaft is 54kN which is 17% higher than that of a definitive heap of the M1.

From the Occasion Ebb and flow relationship, inside the yielding stage the 5% silica smoke shafts show higher solidness than the control and 7.5% silica smoke pillars. In any case, in the plastic stage, the 7.5% bars (M3) show better malleability conduct contrasted with that of customary and 5% silica smoke supplanted shafts.

The arch pliability, turn malleability and ebb and flow flexibility is incredibly expanded in the bars which contains SF of 7.5% substitution.

The incorporation of fiber expands the heap conveying limit with regards to M6 bar about 26.08% contrasted and the Control example M1 and with the ideal SF substance of 7.5 % the addition is 7.41%.

IV. CONCLUSION

The following conclusions ware made

a. The Mix3 blend which is without fiber give most extreme flexural quality of cement without expansion of fiber (ie) 6.05 MPa which is 11.42% more noteworthy than control blend.

b. The Mix6 blend which is with fiber give most extreme flexural quality of cement without expansion of fiber (ie) 6.70 MPa which is 23.39% more noteworthy than control blend.

c. The consideration of fiber expands the heap conveying limit with regards to M6 shaft about 26.08% contrasted and the Control example M1 and with the ideal SF substance of 7.5 % the augmentation is 7.41%.

d. The introductory break is deferred when contrasted and the pillars without incorporation of strands.

V. SCOPE FOR FURTHER INVESTIGATION

The following are the some of the aspects recommended for further in depth study.

1.Water Cement Ratio can be varied.
2.Durability studies can be extended.
3.Corrosion resistance test can be studied for long term durations.
4.Shear beams can be cast to study the shear behavior of Silica fume and Fiber.
5.Varying Percentage replacement of admixtures,
6.Different Combination of Fiber and dosage of Superplasticizer can be varied.

Various fibers like steel, Synthetic fibers can be mixed and the properties can be studied.

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