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Experimental Investigation on Retrofitting of High Performance Reinforced Concrete Beam Using Bamboo Mat

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Abstract

The justification of Present study to find recital of flexure and shear beams produced from high performance concrete (HPC) by means of inorganic admixture like Silica Fume and Fly ash at numerous replacements. The cement binder ratio (w/c) adopted is 0.35. The main aim of designed mix is to attain 60 MPa. Seven different combinations were examined M1 to M7 are cast with different percentages of 0%, 5%, 7.5% and 10% auxiliary of Silica Fume and alternative set of examples with 0%, 5%, 7.5% and 10% spare of SF (Silica Fume) with 10% constant supernumerary of FA (Fly Ash) to revise the involuntary properties. That end result shows that the best potential substitutes of silica fume 7.5%. and 10% of Fly ash is added the optimum substitution of SF is 5%. Totally fourteen beams of 100 x 200 x 2000mm size were cast, every specimen has tested for flexure and shear. The Load at first crack, deflection, and the ultimate load are noted for each mix and comparative study is done for Load – deflection (P-Δ), first crack - ultimate load, the identical failed beams are rehabilitated with Bamboo mat with one layer and again tested for shear and flexure. The results are then compared with the initial results. Comparison has been made between the high performance reinforced concrete beams and rehabilitated beams using Bamboo mat.

Keywords: Concrete Beam, HPC, Bamboo mat

Introduction

HPC is a concrete that assemble meticulous mixture of custom and equality necessities which cannot constantly be accomplish habitually by means of conservative component and usual mixing and introduction and curing carry out. To make high performance concrete it is normally crucial to utilize chemical and mineral admixtures in accumulation to the same component, which are usually worn for ordinary concrete.

In modern times, numerous studies are available on for improving the property of concrete with admiration to strength, durability, and performance as a structural substance. There are many resources similar to Fly Ash, Furnace Slag, and Silica Fume etc. One along with these particular concretes is the Silica Fume utilized concrete which is a novel budding as a new invention building substantial in manufacture of high strength and performance concrete for extraordinary structures.

The importance in Silica Fume track to air pollution control. This involve that the manufacturing had to stop let unfastened SF with additional very well blasts into the ambiance. To discover the explanation to difficulty studies were kick off and afterwards a quantity of examination, it originate that the SF might be recycled as a extremely functional factual in concrete. Silica Fume is being used in concrete for quirt some time in other countries.

Bamboo Mat

Bamboo mat was handmade with the thickness of 5mm, available of the size of 4X6 feet were used for external wrapping it shown in fig 1

Fig 1 Bamboo Mat

Mix Proportioning Details

In this study the charity of concrete was balanced to achieve strength of 60 MPa. The recommendation of ACI committee has situated contributions for M60 design The various mixes form M1 to M4 were found through substituting 0, 5, 7.5 and 10 percentages of the form of cement by SF, and the mixes M5 to M7 be attained as a result of substituting form of content from cement with directly greater than percentage of SF and 10% of FA. The water content is taken as 0.35**.** The report of various mixes used are given in table 1 & table 2

Table 1 Picture of Mixes

MIX Combination	% of FA	% of SF
M1	0	0
M2	0	5
M3	0	7.5
M4	0	10
M5	10	5
M6	10	7.5
M7	10	10

Table 2 Mixture Quantities in kg/m3

Mix Combination	Cement (kg/m^3)	SF (kg/m^3)	FA (kg/m^3)	Fa (Fine Aggregate) (kg / m^3)	Ca (Coarse Aggregate) (kg / m^3)	Super Plasticizers (Lit / m^3)
M1	570.39	0	0	609.86	1170.76	6.86 (1.4%)
M2	540.37	27.39	0	598.97	1170.76	8.34 (1.8%)
M3	529.31	41.89	0	595.24	1170.76	9.36 (2.0%)
M4	515.03	58.12	0	584.36	1170.76	9.78 (2.2%)
M5	484.98	27.34	56.78	576.82	1170.76	16.39 (3.4%)
M6	472.63	43.24	58.12	571.35	1170.76	17.32 (3.6%)
M7	458.23	57.43	57.12	567.12	1170.76	17.26 (3.7%)

Investigational Results

Trial research carried out on the examination samples to find the workability and strength belongings of HPC by SF and FA.

Samples like cubes, cylinders and prism beams casted to study the following properties

1. Compressive Strength.
2. Split Test.
3. Flexural Test.

3.1 Compressıve Strength

Strength of concrete cube was founded with the recommendation of IS*:* 516 –1959. Sample was positioned in the compressive testing apparatus; Realistic must be bottom of the cubes as casted. Investigation is conducted to find compressive strength by compressive machine with the capacity of 2000 kN, the experiment set up outcome is shown in Fig 1 and Table 3

Table 3 Results for Compressive Strength

Mix	% of Silica Fume	% of Fly Ash	3 days result (MPa)	7 days result (MPa)	28 days result (MPa)	56 days result (MPa)	90 days result (MPa)
M1	0	0	35.67	42.33	54.67	61.33	66.67
M2	5	0	32	40.67	55.00	61.67	67.67
M3	7.5	0	34.33	44.67	61.33	69.67	76.33
M4	10	0	32.67	40.33	56.33	65.67	71.67
M5	5	10	33.67	42.33	58.67	68.67	74.33
M6	7.5	10	31.33	41	57.33	68.33	73.67
M7	10	10	29	39.33	55.33	60.33	67.33

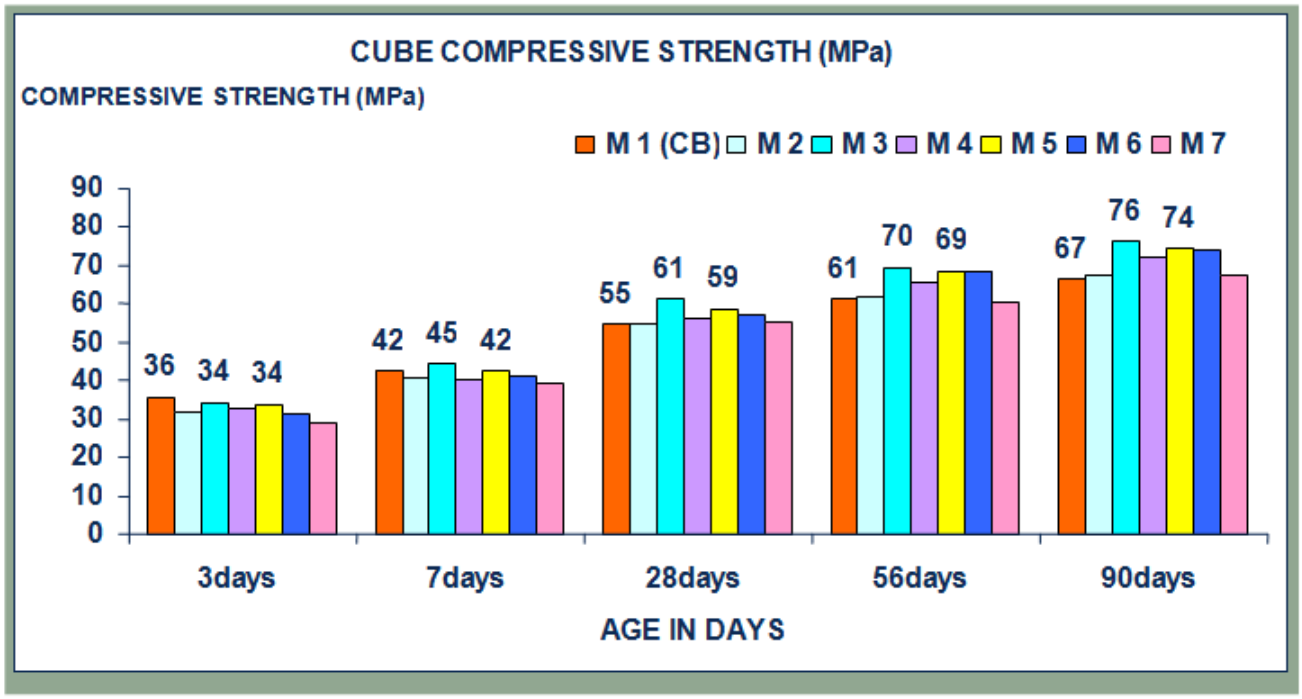

Fig 1 Compressive strength at various concrete ages

(Values were shown for M1, M3 & M5 Mixes)

3.2 Split Tensile Strength

Splitting potency of concrete was established as per recommendation of IS: 5816 –1999. The nominal load applied rate of vary from 1.20 N/ (mm^2/min) to 2.40 N/ (mm^2/min)

Table 4 Split Strength of Specimens

Mix Proportion	% of FA	% of SF	28 days strength (MPa)
M1	0	0	4.68
M2	0	5	5.12
M3	0	7.5	6.20
M4	0	10	5.16
M5	10	5	5.82
M6	10	7.5	5.46
M7	10	10	5.16

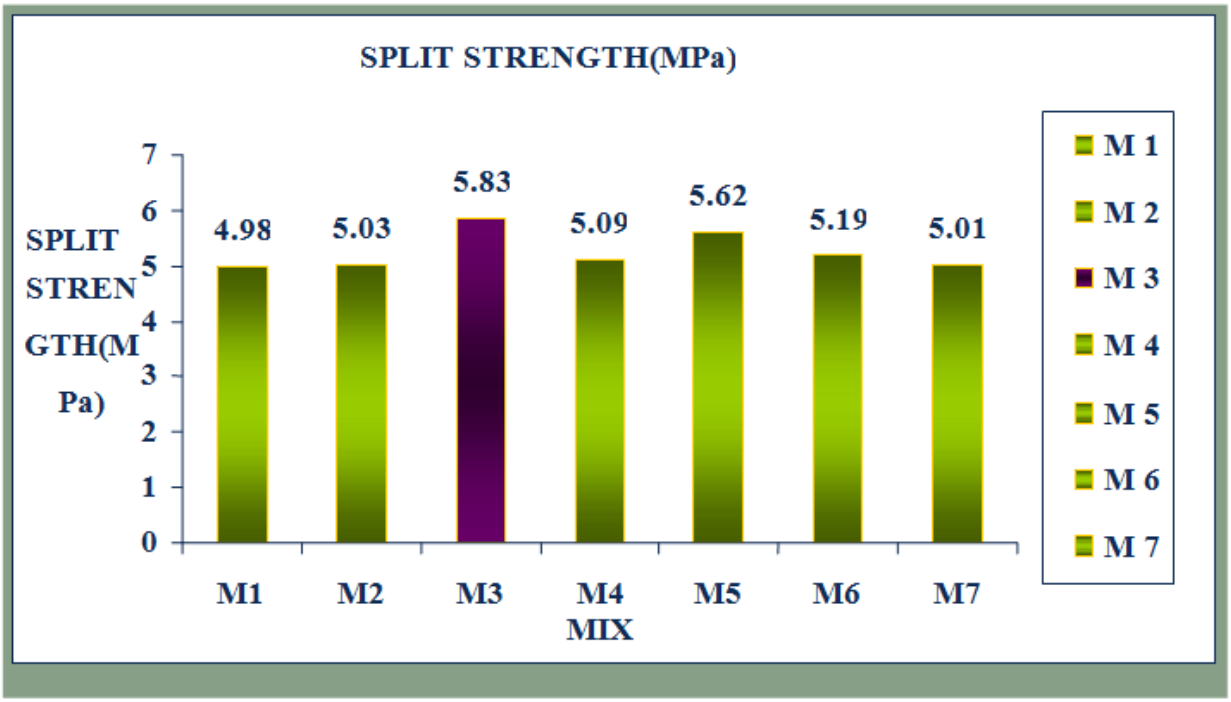

Fig 2 Split tensile strength

3.3 Experimental Set up for Wrapped Beams

The tested beams are wrapped with bamboo mat wrapping after straightening and filling the cracks.

Procedure for affixing sheets:

- The outer surface of the beam is well cleaned and the cracks are filled with either resin when the cracks are relatively small or with cement mortar when cracks are large.
- In Isopthalic resin, catalyst (6%) and accelerator (2%) is added and care has been taken that it has to be stirred well to get appropriate mix.
- Initially this mix fills minor cracks also.
- Resin is applied over the beam and is allowed to dry for 10 min.
- When the resin is at the hardening stage, the woven rings bamboo mat 300gms/Sq.m is wrapped around the beam. Roller weights are used to fix the mat firmly over the beam.
- After two minutes again a second coat of the mix is applied over the mat and allowed to set.

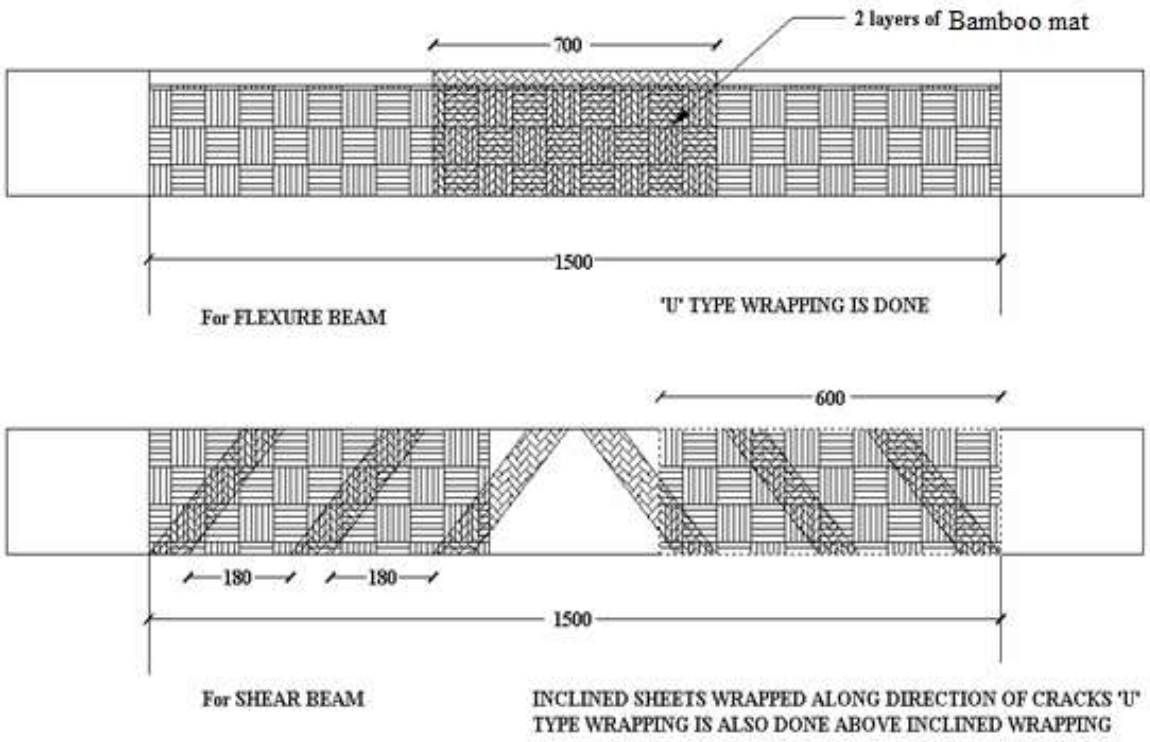

Fig 3 Wrapping Pattern for Flexure and Shear

Beam was passed as per the practice of investigational set up. The Failure and the Crack form were checked.

The beam with 7.5% of Silica Fume (M3) consumed the maximum critical load carrying capability of 69 kN in flexure. This is 1.47 times higher than the load resonant capacity of control beam (M1) in flexure. The deflection at critical load is also 1.28 times higher when compared with control beam (CB). It was perceived that the beams cast with Silica Fume and Silica Fume with Fly Ash spectacles higher load carrying capability associated to control beam. The escalation in ultimate carrying ability for other beams associated to the control beam is 34.04%, 46.80%, 23.40%, 40.42%, 36.17% and 14.89% of M2, M3, M4, M5, M6, M7 respectively compared with M1.

The initial crack load values increases when compared to normal beam. The increment of weight is 32.14%, 42.86%, 14.28%, 39.29%, 17.86%, and 7.14% of respective M2 to M7.

Table 3.1 - Flexural strength of Beam Specimens Results

Description	% of Silica Fume	% of Fly Ash	Initial Load (kN)	Ultimate Load (kN)	Beam Deflection (mm)
M1	0	0	28	47	14.28
M2	5	0	37	63	17.87
M3	7.5	0	40	69	18.32
M4	10	0	32	58	18.59
M5	5	10	39	66	16.88
M6	7.5	10	33	64	18.65
M7	10	10	30	54	17.24

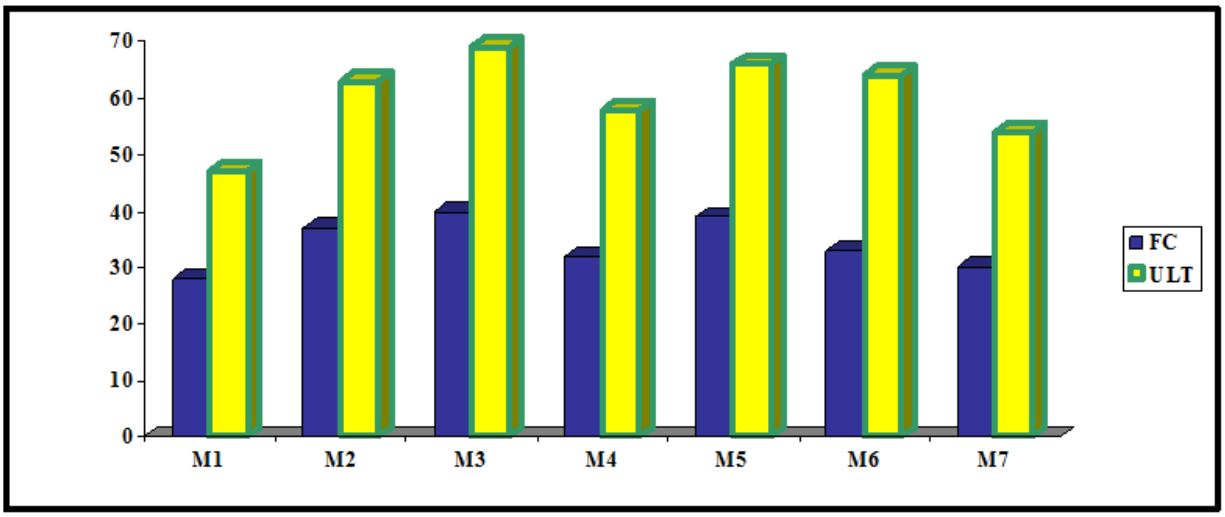

Fig 4 Comparison for Initial Crack & Ultimate Load

3.4 Curves of Load Vs Deflection (P-Δ)

Curves for Load against Deflection of the beam sample verified for Flexure strength it shown in below figures. Curves of P-Δ for Comparison to beam samples M1 (CB), M2, M3 and M4 are shown in fig. 3.4 whereas for those of M1 (CB), M5, M6 and M7 in fig 3.5.

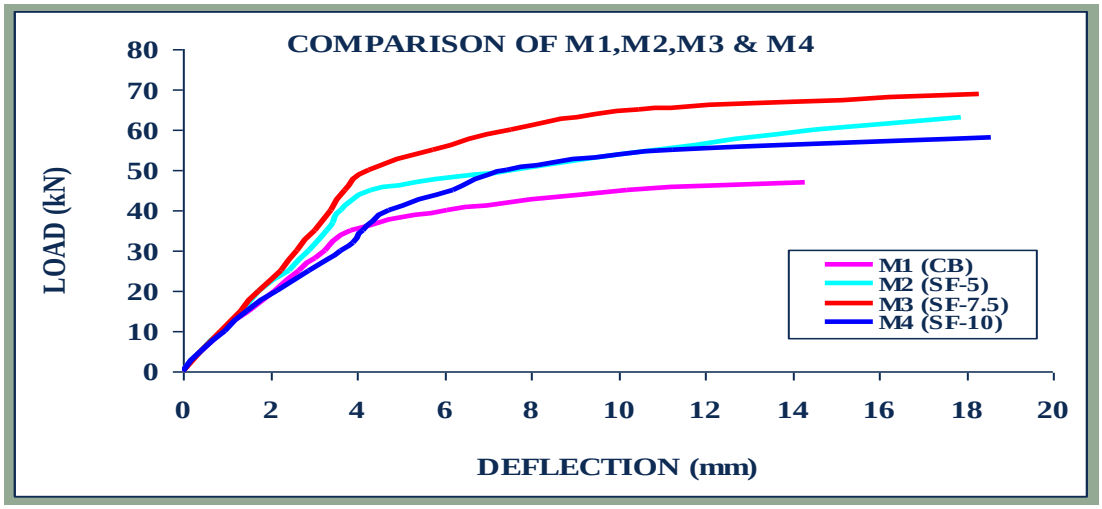

Fig 5 Comparison of P-Δ Curve for M1 (CB), M2, M3 & M4

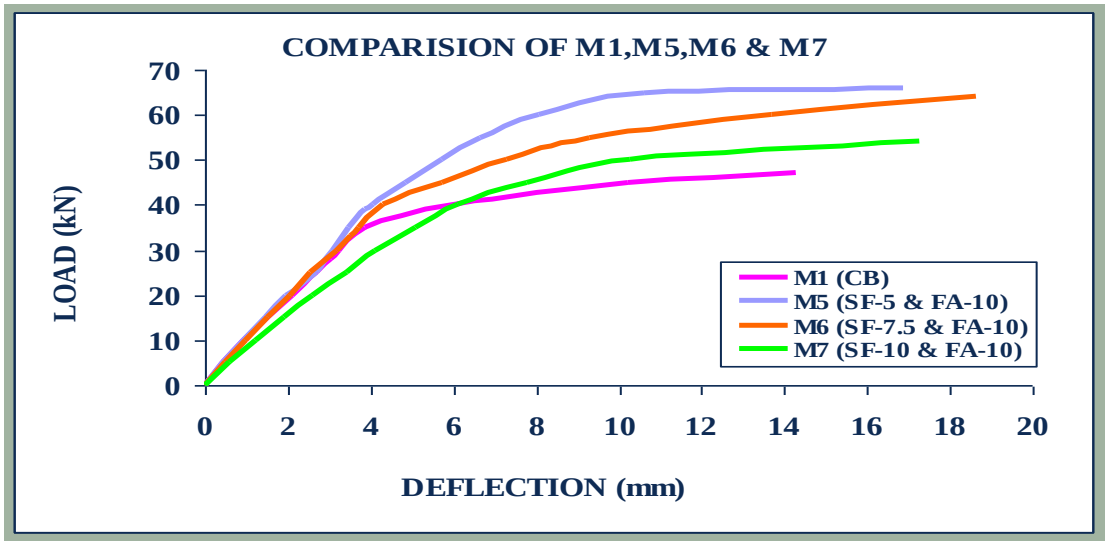

Fig 6 Comparison of P-Δ Curve for M1 (CB), M5, M6 & M7

Conclusion

➢ The critical load carrying ability of beam with Silica Fume of 7.5% gives the greater result when compared with other beams in flexure and shear studies.

➢ In all the examinations, failures of the flexure beams remained by yielding of the steel in the workable zone in flexure studies.

➢ In all the examinations, disappointments of the shear beams were by cracking at the hinged sustenance in shear studies.

➢ The beam with 7.5% of Silica Fume (M3) had the maximum load resonant capacity of 38 kN in Shear. This is 1.31 times developed than the load resonant of control beam (M1) in Shear.

➢ The Critical load resonant of wrapped beams is slightly increased when compared to unwrapped beam for flexure. The increase in strength was 12.76%, 12.06%, 9.37% and 5.50% for M1, M4, M6 and M7 respectively.

➢ By wrapping the beams, the deflection is reduced and it augments the load resonant of the beams.

Hence bamboo mat will allow for a major role in the field of repairing of damaged buildings structures.

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