INVESTIGATION OF BEAMS BY CFRP FIBRE SHEETS USING HIGH PERFORMANCE CONCRETE WITH THE PARTIAL REPLACEMENT OF CEMENT WITH SILICA FUME AND FLYASH

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ABSTRACT

High Performance Concrete now a days used widely in the construction industries world-wide. To produce HPC with normal ingredients we use mineral admixtures Silica fume and fly ash, chemical admixtures SulphonatedNapthalienFormaldiehyde (CONPLAST SP 430) are used in the concrete not only enhance its strength properties, But also durability. Casting of cube of size 150x150x150 mm, Cylinder of size 100mm diameter and 200 mm height, Prism of size 100x100x500 mm are done. For conventional mix (0% Fly ash and 0% silica fume), HP1 mix (20% Fly ash and 10% silica fume), HP2 mix (25% Fly ash and 12.5% Silica fume) and HP3 mix (30% Fly ash and 15% silica fume). Curing period was takes place for 28 days. The tests such as compressive strength test, Split tensile test and Flexural strength test are carried out. From the test results we obtained the optimum use of mineral admixtures is 20% fly ash and 10% silica fume. For that optimum use of mineral admixture of Silica fume and Fly ash, the Beam is casted with a size 3200 x 125 x 250 mm and Retrofitted with CFRP (Carbon Fibre Reinforced Polymer) using single, Double and Triple layer s. The beams retrofitted with single layer of CFRP sheet enhance capacity at all stage of loading and the deflection is reduced at ultimate load level when compared to control beam

Key Words: High Performance Concrete, Silica Fume, Fly Ash, Super plasticizer, Compressive Strength, Flexural Strength, Beam, CFRP.

1. INTRODUCTION:

High Performance Concrete is used for concrete mixture which Possess high workability, high strength, high modulus of elasticity, high density, high dimensional stability, low permeability and resistance to chemical attack. There is a little between the terms high strength and high performance concrete. High performance concrete is also a high strength concrete but it has a few more attributes specifically designed. A substantial reduction of quantity of mixing water is the fundamental step for making HPC. Reduction of w/c ratio will result in high strength concrete. But reduction in W/C ratio to less than 0.3 will greatly improve the qualities of transition zone to give inherent qualities expecting HPC. Therefore, use of appropriate superplasticizer. Is a key material in making HPC.

2. SCOPE AND OBJECTIVES:

- The present investigation more emphasis is given to study the strength characteristics of HPC using mineral and chemical admixtures like Silica fume, Fly ash and Super plasticizer (CONPLAST SP 430), for achieving the better composite.
- The main objective of this present investigation is to develop a mix design procedure, for HPC with partially replacement of cement by Fly Ash and Silica Fume at 20% and 10% , 25% and 12.5% & 30% and 15% at constant dosage of super plasticizer of 0.6% by the weight of cement and other Ingredients, literature available on HPC and ACI code methods.

- Experiments were carried out on HPC using the above procedure for M70 concrete to obtain good workability and achieve mechanical properties of the mix design.
- To cast the RC beams
- To study the flexural behaviour of RC beams
- To compare with control beam.
- To study the effect of multiple layers of CFRP laminate.
- To study flexural performance of CFRP strengthened RC beams.

3. EXPERIMENTAL METHODOLOGY:

- The materials are collected and the mix proportions are to be obtained.
  For acquiring the mix proportions basic tests are to be carried to find the specific gravity of cement, Fine aggregate, Coarse aggregate.
- In our project we have partially replaced the cement by silica fume and fly ash at three different constituents of mix. The mixes contains the fly ash and silica fumes are 20% & 10%, 25% & 12.5% and 30% & 15%.The chemical admixture as CONPLAST SP 430 to be used with a constant percentage of 0.6.
- Compressive strength of cube having a size of 150 x 150 x 150mm and Cylinder which having 100mm diameter and 200mm height. Split tensile strength of cylindrical specimen which having a same dimension and Flexural Strength of Prism having a size of 100 x 100 x 500mm to be determined for the conformation of the grade of concrete.
- The grade which we are adopted in our project is M70. The Design Mix for M70 grade of Concrete should be achieved using the American Code of Specification ACI 211.1-91.
- The Total Quantity of Cement, Fine Aggregate, Coarse Aggregate is to be procured for M70 Grade of Concrete. Also Silica Fume, Fly Ash and the Super Plasticizer is estimated.
- For that optimum use of mineral admixture of Silica fume and Fly ash, Totally 4 Beam is to be casted with a size 3200 x 125 x 250 mm and Retrofitted with CFRP (Carbon Fibre Reinforced Polymer) using single, Double and Triple layer and finally to analyse with the Best Composition of Beam.

Table 1: Preliminary Tests

1.	Consistency of Cement	31%
2.	Initial setting time of cement	30 minutes
3.	Final setting time of cement	390 minutes
4.	Specific gravity of cement	3.14
5.	Sieve analysis for fine aggregate	Sand confirming to zone-II
6.	Specific gravity of fine aggregate	2.60
7.	Water absorption of coarse aggregate	0.3%
8.	Slump value of concrete	70mm

The Design Mix that obtained for Grade M70 Concrete.

4. RESULTS AND DISCUSSION:

Table 2: Compressive Strength Test

S. NO	Specimens	Fly ash & Silica fume in %	Compressive Strength N/mm²			
			7 Days		28 Days	
			Cube	Cylinder	Cube	Cylinder
1	CM	0 & 0	47.56	37.53	69.30	53.44
2	HP1	20 & 10	48.75	38.65	70.76	54.60
3	HP2	25 & 12.5	46.74	36.37	68.82	53.05
4	HP3	30 & 15	45.67	35.53	66.75	51.40

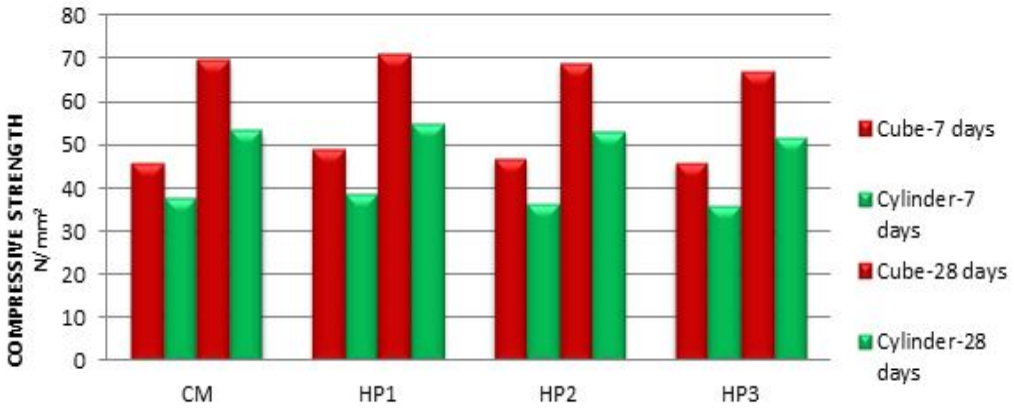


Chart 1: compressive strength

Table3: SplitTensileStrengthTest

S.NO	SPECIMEN	FLY ASH & SILICA FUME IN %	SPLIT TENSILE STRENGTH AT 28 DAYS (N/mm²)
			CYLINDER
1	CM	0 & 0	2.25
2	HP1	20 & 10	2.30
3	HP2	25 & 12.5	2.23
4	HP3	30 & 15	2.20

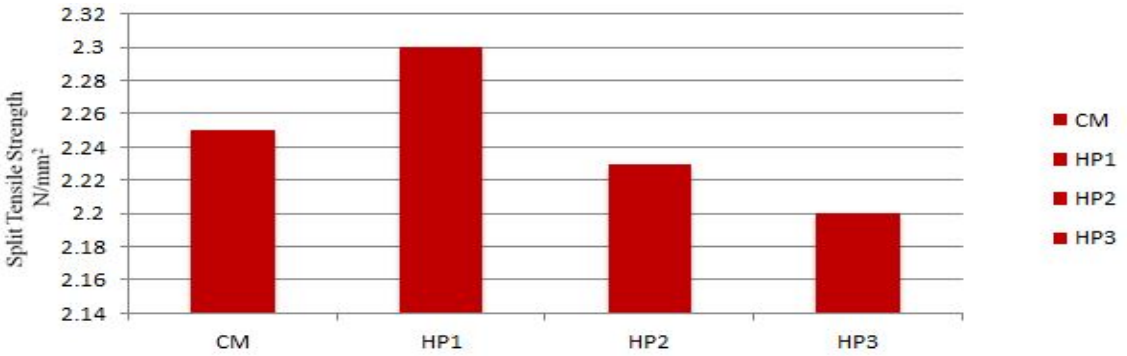


Chart 2: Split Tensile Strength Test

4.1 FLEXURAL STRENGTH TEST

Table 4: flexural strength test

S.NO	SPECIMEN	FLY ASH & SILICA FUME IN %	FLEXURAL STRENGTH AT 28 DAYS (N/mm²)
			PRISM
1	CM	0 & 0	2.25
2	HP1	20 & 10	2.30
3	HP2	25 & 12.5	2.23
4	HP3	30 & 15	2.20

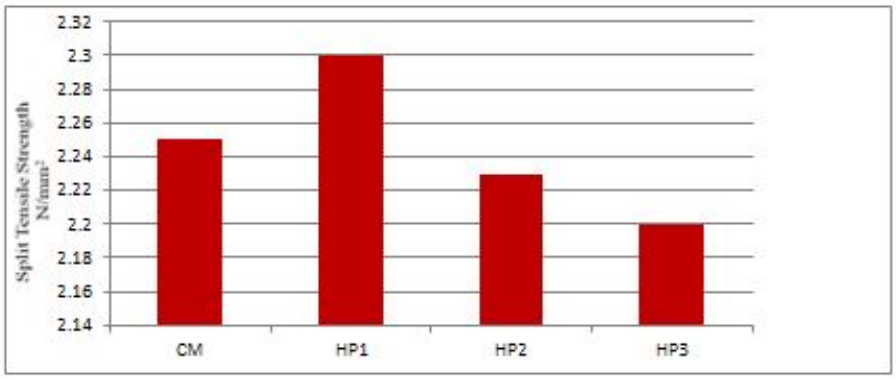


Chart 3: flexural strength

THEORETICAL ANALYSIS ON FLEXURAL BEHAVIOUR OF BEAM:

Table 5: Theoretical load and deflection Values:

Sl.no	Description	Load (KN)	Deflection (mm)
1	Just before 1st crack	12.64	1.16
2	Position at which start of non – linearity stage	60.16	10.23
3	Position at which yielding stage	62	10.59
4	Position at which ultimate	21.19	58.7

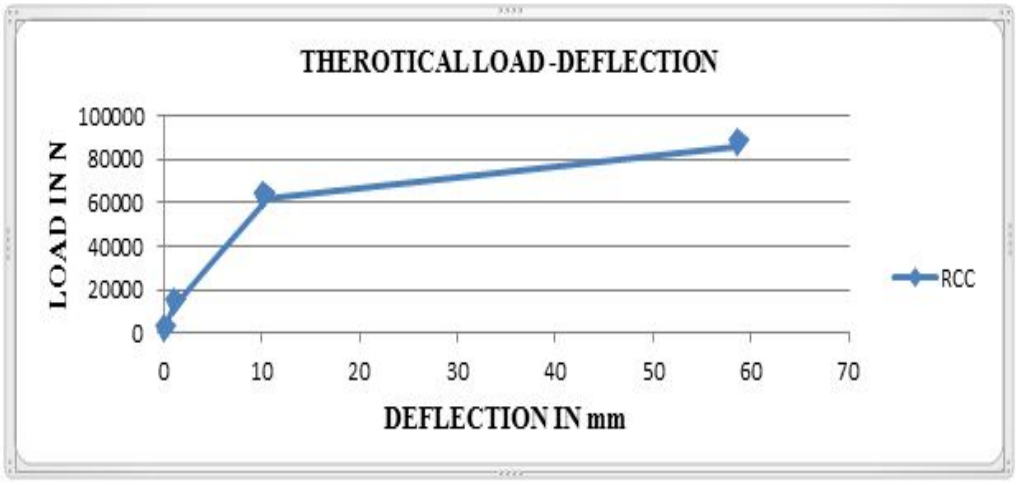
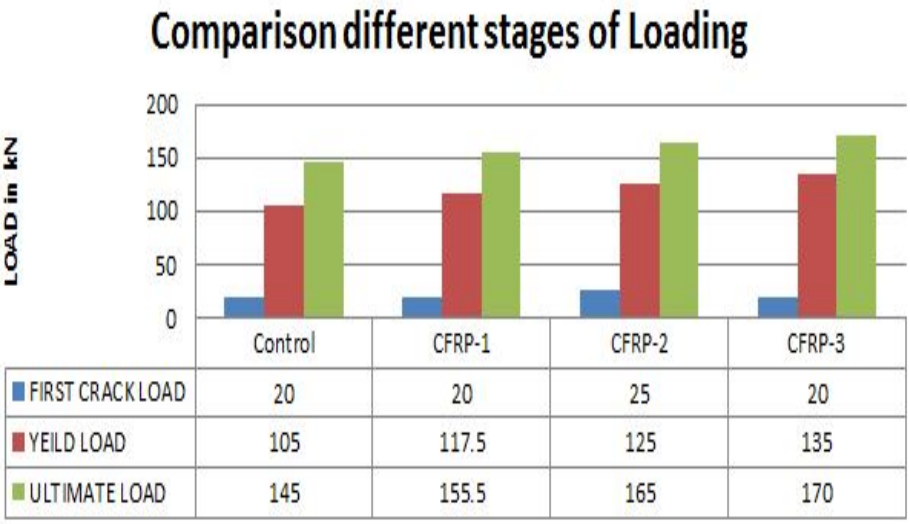


Chart 4:Theoretical Analysis on Flexural Behaviour Of Beam

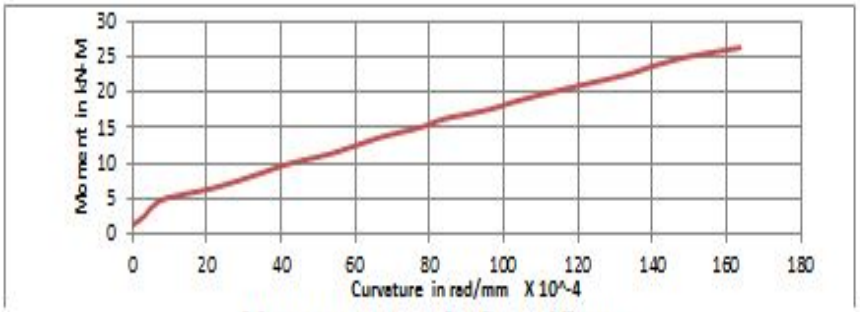
The results of beam tested for flexure is given. One beam is cast for control beam and three for retrofitted beams. The first crack load observed in control beams is 20 kN and the same observed in CFRP retrofitted beams with single, double and triple are 20 kN,25 kN and 20 kN respectively. The retrofitted beam with double layer shows 20% increase in first crack load of control beam.

The yield load of control beams is 105kN.Beam retrofitted with single,double and triple layer yield at 117.5 kN,125kN and 135 kN respectively. The retrofitted beam with single, double and triple layer shows 10.6%,16% and 22.2% increase in yield load capacity compared to control beam.

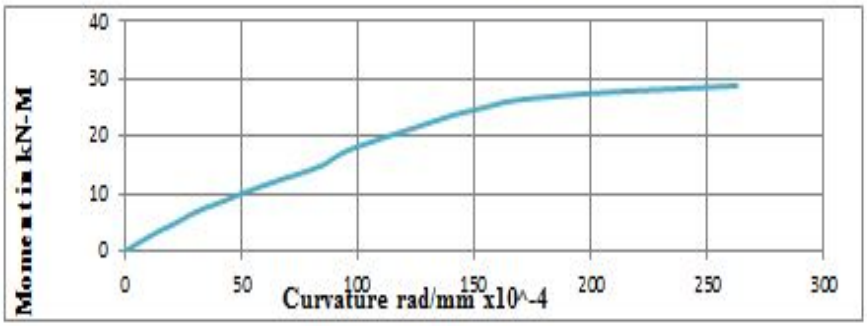
The yield load capacity increases compared to retrofitted beam with single layer and double layered beam is 6%, with double layered and three layered beam is 7.4%, with single layered and triple layered beam is 13%. The ultimate load carrying capacity of control beam is 145Nand the same in retrofitted beam is 155.5 kN,165 and 170kN the retrofitted beam shows 44% increase in ultimate load carrying capacity when compared to control beam. The maximum deflection observed in control beam is 60 mm and 46mm and the same is reduced to 44.5 mm and 40mm in retrofitted beam.



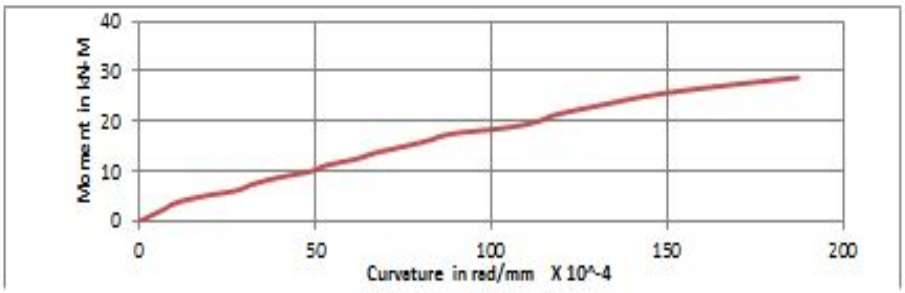
	Control	CFRP-1	CFRP-2	CFRP-3
FIRST CRACK LOAD	20	20	25	20
YEILD LOAD	105	117.5	125	135
ULTIMATE LOAD	145	155.5	165	170



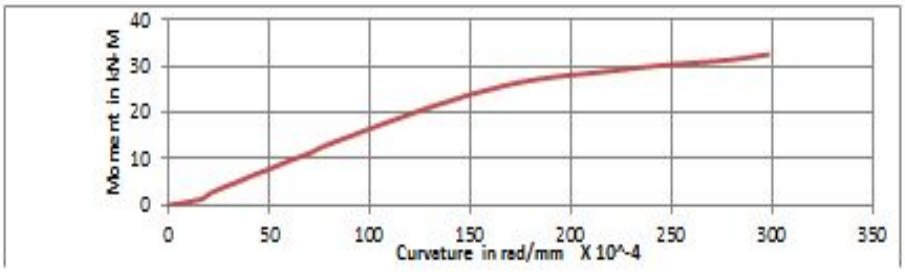
Moment curvature for Control Beam



Moment curvature for Retro fitted Beam-1



Moment curvature for Retro fitted Beam-2



Moment curvature for Retro fitted Beam-3

5. CONCLUSIONS:

The following conclusions are made from this present study

1. M70 grade concrete mix is designed based on ACI 211.1-91 guide lines and the mix proportion obtained as 1: 0.88 : 1.50 with w/c ratio of 0.3. The superplsticizer of 0.6 % dosage is used to obtain 70 mm slump.
2. The Compression strength, Split Tensile Strength and Flexural Strength for 28 days of Concrete at 20% & 10% replacement of fly ash and silica fume has a following strength 70.76 N/mm^2, 2.30 N/mm^{2}and 6.02 N/mm^2 .From the results, It is concluded that compare to other mix proportions, the Compression strength, Split Tensile Strength and Flexural Strength is achieved optimum at 20% & 10% replacement of fly ash and silica fume.
3. The first crack load observed in control beams is 20kN and the same observed in CFRP retrofitted beams with single, double and triple are 20 kN,25kN and 20kN respectively. The retrofitted beam with double layer shows 20% increase in first crack load of control beam.
4. The yield load of control beams is 105kN.Beam retrofitted with single, double and triple layer yield at 117.5 kN,125kN and 135kN respectively. The retrofitted beam with single, double and triple layer shows 10.6%,16% and 22.2% increase in yield load capacity compared to control beam. The yield load capacity increases compared to retrofitted beam with single layer and double layered beam is 6%, with double layered and three layered beam is 7.4%, with single layered and triple layered beam is 13%.
5. The ultimate load carrying capacity of control beam is 145 Nand the same in retrofitted beam is 155.5 kN,165 and 170kN the retrofitted beam shows 44% increase in ultimate load carrying capacity when compared to control beam.
6. The deflections of retrofitted beam are reduced when compared to control beams. The maximum deflection observed in control beam is 60 mm and 46mm and the same is reduced to 44.5 mm and 40mm in retrofitted beam
7. The beams retrofitted with single layer of CFRP sheet enhance capacity at all stage of loading and the deflection is reduced at ultimate load level when compared to control beam

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