"FLEXURAL BEHAVIOUR OF POST TENSIONED BEAM"

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ABSTRACT*:* *This paper presents an experimental study on the Flexural behaviour of post tensioned beam. The main objective of this work was to study about the deflection, initial load carrying capacity, ultimate load carrying capacity and flexural behavior of the beam. With increase in the innovation of concrete and prestressed members, the whole construction industry is heading towards a new era. Different Admixture like GGBS, Silica Fume, and Fly Ash etc. have been used in the concrete from ancient times.*

A research project has been undertaken to investigate the role of Admixture under Compressive Strength, Deflection and Flexural Behaviour of post Tensioned Beam using Admixtures to concrete. Strength properties such as 28 days compressive strength of cubes are determined before performing the casting of beam in order to confirm the design mix and characteristic compressive strength of concrete. Three Beams were casted for this study with M60 Concrete. In that Type-1 is the Conventional Concrete, Type-2 is replacement of 20 % of cement with GGBS and Type-3 is replacement of 5 % of cement with Silica Fume. All the three beams are post tensioned with required prestressing forces according to the Design. The beam dimension is 400 mm width, 300mm depth and 2000mm length. Flexural Strength or Modulus of Rupture and deflection are measured using Flexural strength Testing machine. The Deflection, Cracking load, Ultimate load and Failure loads are recorded. From the results, Load v/s deflection graph are plotted and the results are compared. Conclusion is draw based on the experimental results obtained.

Keywords*:* *GGBS, Silica Fume, Post Tensioned, Prestressed Forces, Flexural Strength Test, Deflection, Cracking Load, Ultimate Load*

I.INTRODUCTION

Post-tensioning is a method of reinforcing (strengthening) concrete or other materials with high-strength steel strands or bars, typically referred to as tendons. Prestressed concrete has emerged very quickly as predominant material in field of construction industry. This method of reinforcing concrete enables a designer to take advantage of the considerable benefits provided by prestressed concrete while retaining the flexibility afforded by the cast-in-place method of building concrete structures.

Over year has of time the efficiency of the cement is increased with addition of different admixtures with replacement to cement such as GGBS, Silica fume and Fly ash etc. Admixtures are added to concrete with replacement of cement to increase the strength and efficiency. In the following research the three post tension beams are designed with different admixtures such 20% replacement of cement with GGBS, 5% replacement with Silica fume and conventional concrete of M60. In the present research paper the use of GGBS and Silica Fume in the post tension beam are studied in detail.

GGBS is a by-product of steel manufacturing process, as improving the sustainability of the project. This is provided that the slower setting time for casting of the superstructure is justified. It has a higher proportion of the strength-enhancing calcium silicate hydrates (CSH) than concrete made with Portland cement only, and a reduced content of free lime, which does not contribute to concrete strength. Therefore, we are using this slag to natural earth to increase the strength.

Silica fume is a by-product of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolana. A silica fume to be added in the concrete is only about 5 – 15% to that of volume of cement.

II. Literature Review

Research on the behavior of the Post tensioned beam has carried out from several researchers. There are number of investigation carried out on the flexural behavior of the post tensioned beam and their parameters such as deflection, ultimate load carrying capacity and initial cracking load are also studied.

Andrea Dall'Asta., et.al. Have carried out the research on the flexural strength of reinforced concrete beams prestressed by external tendons. From this, it has been confirmed that the flexural strength of the post tension beam depends on the deformation profile of the tendons.

Gouda Ghanem., **et.al**. Presented paper on the flexural behaviour of strengthened RC beams using external post-tensioning technique under the effect of cyclic loads. Finally, the study stated that the ultimate loading capacity of the post tensioned beam is 50% more than non strengthen beam.

Hamid Saadatmanesh., **et.al**. Have conducted experimental research on behaviour of prestressed, composite steel-concrete beams. From this, it is concluded that adding prestressed bars to composite beams significantly increased the yield load and the ultimate load.

Mohd Majiduddin., et.al. Study aimed to investigate the physical, chemical and mechanical properties of fly ash and blast furnace slag cement concrete. This study investigated that GGBS increase the compressive strength of concrete and also achieves the maximum strength faster.

Fayaz. Shaik., et.al. Investigation on the performance by using supplementary cementitious materials to achieve high strength multi blended concrete mixes. It was observed that optimum performance of the concrete increased due to addition of the admixtures.

III. Material Used

- Cement: Ordinary Portland cement of brand Birla super of grade 53 with specific gravity 3.2 and fineness 0f 2.83% conforming as per IS-12269:1987.
- Fine Aggregates: locally available river sand was used by conforming to zone II. The specific gravity was 2.65 and bulk density was 1736 kg/m^3.
- Coarse Aggregate: locally available crushed coarse aggregate was used of 20mm and 12mm. the specific gravity was 2.63 and bulk density 1629 kg/m^3.
- GGBS: Dry powder from Ultra Tech Aditya Birla was used. The specific gravity 2.8
- Silica fume: Dry powder available from Ultra Tech Aditya Birla was used. The specific gravity 2.26.
- Reinforcement steel: 12mm diameter of 4 bars were used in each beam with 200mm C/C of 10mm diameter bars of Fe 415 was used.
- Tendon: 15.4mm single tendon was adopted in the post tensioned beams.
- Water: Potable water with PH of 6.5 was used for mixing and curing purpose.

IV. Details of Beam

The post tension beam is designed as per IS: 1343-1980. The live load considered for this study is 50kN/m^2. The design details of all three post tension beam are as given below in the table.

Table 1.1: Details of the beam design.

Mix designation	Dimension of beam(mm)	Main Steel (dia in mm)	Distribution steel (dia in mm)	Length (mm)	Spacing (mm)
Conventional concrete	400x300	12 mm dia 4 No's	10	2000	200mm c/c
20% GGBS+Cement	400x300	12 mm dia 4 No's	10	2000	200mm c/c
5% Silica fume +Cement	400x300	12 mm dia 4 No's	10	2000	200mm c/c

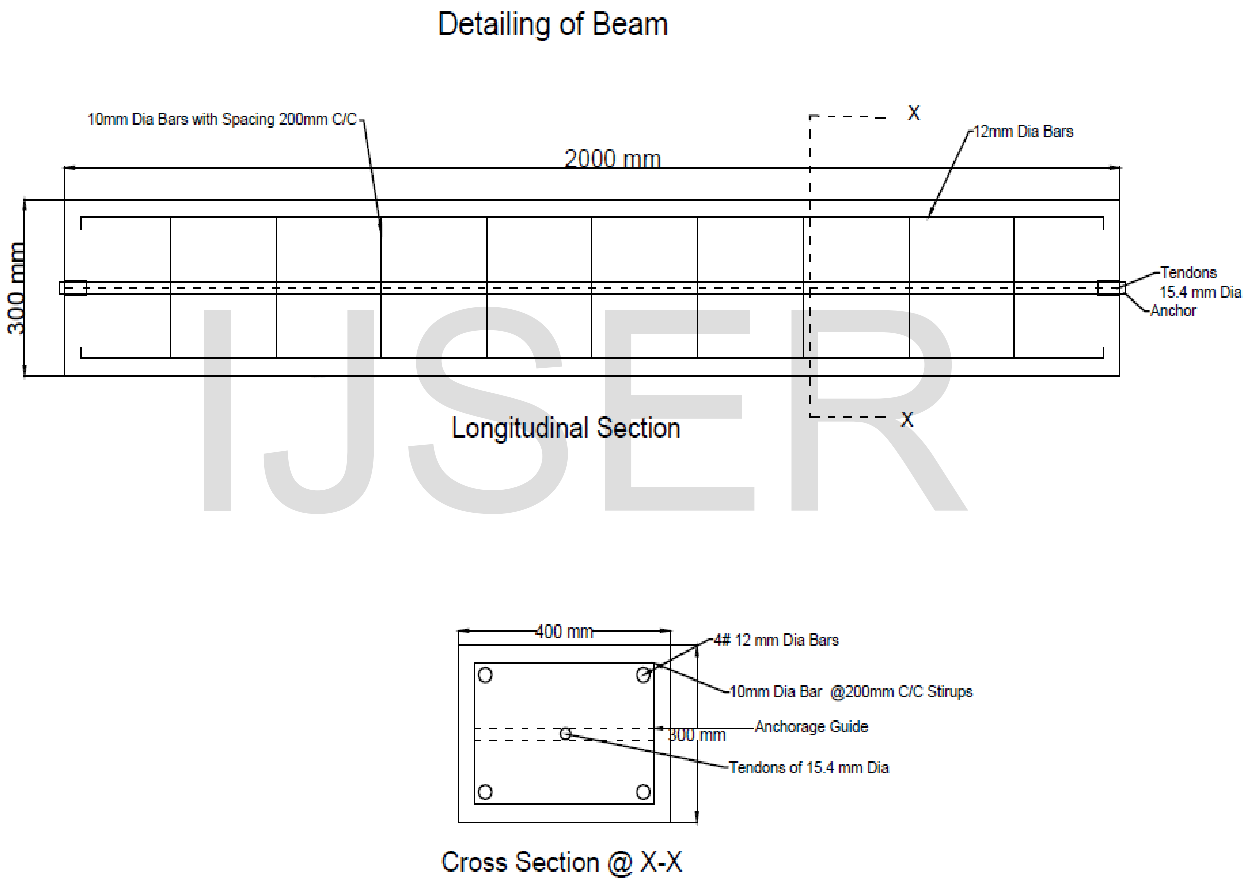

Figure 1.1: Detailing of Beam

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V. Mix Proportion

Table 1.2: Mix Proportion

Mix proportion						
	Water	Cement	GGBS	Silica Fume	Fine Aggregate	Coarse Aggregate
Conventional Concrete	150 ltr /m^3	428.57 kg/m^3	Nil	Nil	642.78 kg/m^3	1064.90 kg/m^3
	0.35	1			1.5	2.5
20% GGBS + Cement	150 ltr /m^3	342.85 kg/m^3	85.71 kg /m^3	Nil	642.78 kg/m^3	1064.90 kg/m^3
	0.35	0.8	0.2		1.5	2.5
5%silica fume +cement	150 ltr /m^3	407.14 kg/m^3	Nil	21.42 Kg /m^3	642.78 kg/m^3	1064.90 kg/m^3
	0.35	0.95		0.05	1.5	2.5

VI. Casting of Specimen

Three post tensioned beams are named sequentially as type-1 conventional concrete, type - 2 20%GGBS +cement and type-3 5% silica fume +cement of size 400mm x300mm x2000mm were casted. The moulded were coated initially with oil so as to easy removal of the moulds.

The moulds were removed after 24 hours of duration and curing of specimen was carried out for 28 days continuously using gunny bags.

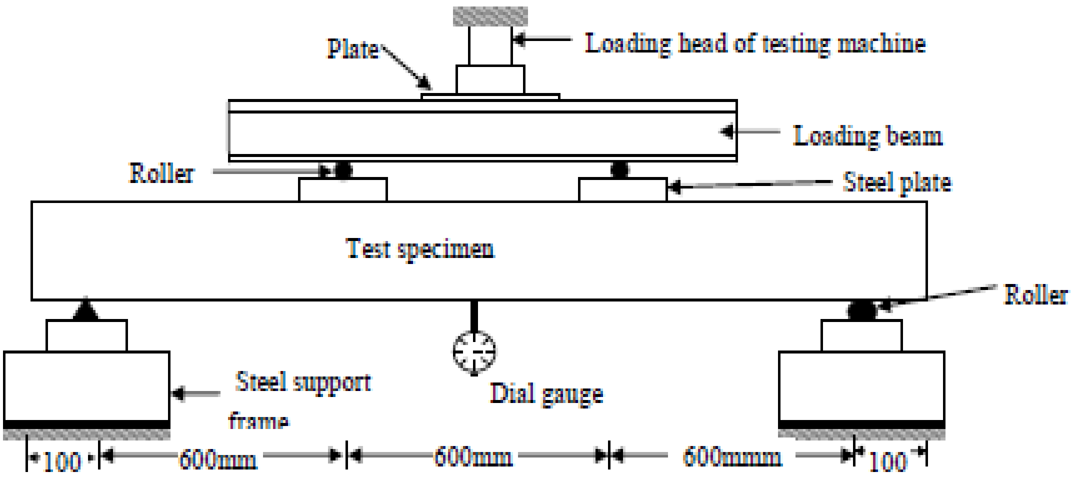

Figure 1.2: Experiment Setup

VII. Testing of Specimen

The beams after curing for 28 days were placed vertically for surface cleaning. The beam is placed on the on the instrument as simply supported with a bearing width 100mm on either side, with an effective span of 1800mm. The two point

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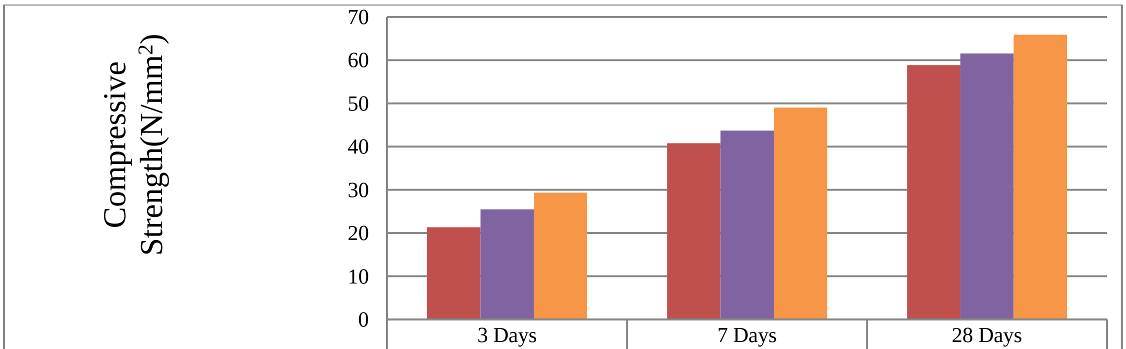
loading is setup with dial gauge reading with initial reading of 0 value, gradually the load is applied on the beam with initial load of 100 KN. The deflection value of beam was noted for every 100 KN increase of load. The initial cracking load was recorded for all the three beams. The loading was carried out till the failure of the beam and the ultimate loading capacity of the beam is recorded.

VIII. Result and Discussion

Testing of the hardened concrete place an important role in controlling and confirming the quality of cement concrete works. The purpose of testing the hardened concrete is to know the development strength of the concrete. The tests are made by casting cubes and cylinders from the respective concrete mix before casting of beams.

Mechanical Properties of concrete

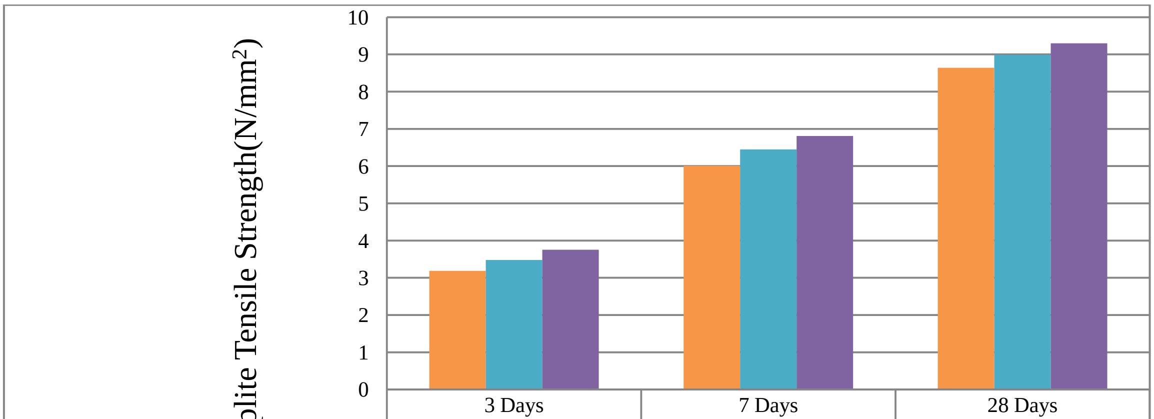
- **Compressive strength**



	3 Days	7 Days	28 Days
M60 Conventional concrete	21.34	40.76	58.85
M60 20% repacement of cement with GGBS	25.49	43.68	61.53
M60 5% replacement of cement with silica fume	29.32	49.04	65.86

Figure 1.3: Compressive Strength Chart

- **Splite Tensile strength**



	3 Days	7 Days	28 Days
M60 Conventional concrete	3.185	6.01	8.64
M60 20% repacement of cement with GGBS	3.48	6.45	8.99
M60 5% replacement of cement with silica fume	3.755	6.81	9.3

Figure 1.4: Splite Tensile Strength

- **Flexural Strength**

Table 1.3: Flexural Strength test Result

Mix Designation	Initial cracking load (KN)	Ultimate load (NK)	Deflection (mm)	Flexural strength (N/mm^2)
conventional concrete	500	1000	0.6	55.55
GGBS + Cement Post Tensioned Beam	800	1500	0.8	83.33
Silica Fume + Cement Post Tensioned Beam	900	1800	1	100

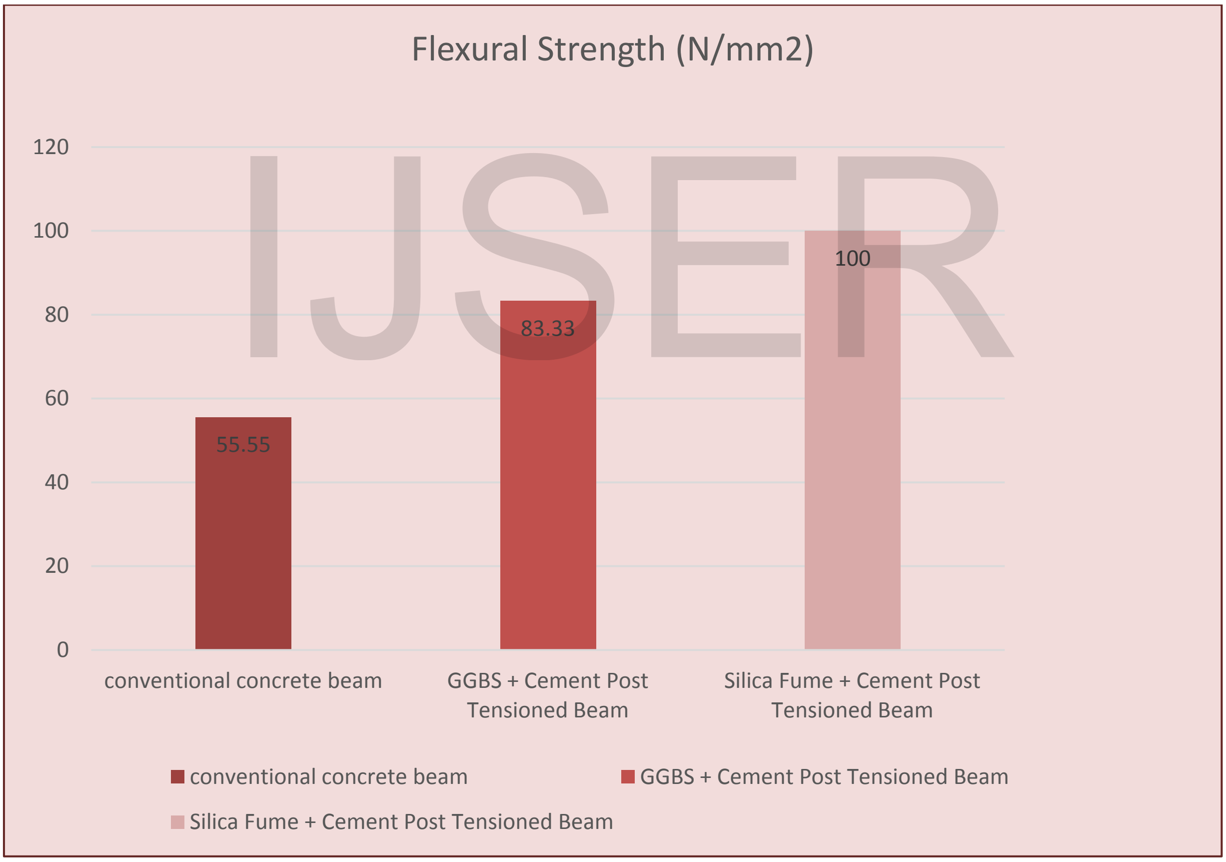


Figure 1.5: Flexural Strength test Graph

Load Deflection Behaviour

The load deflection curve for the testes beams are illustrated in the graph below.

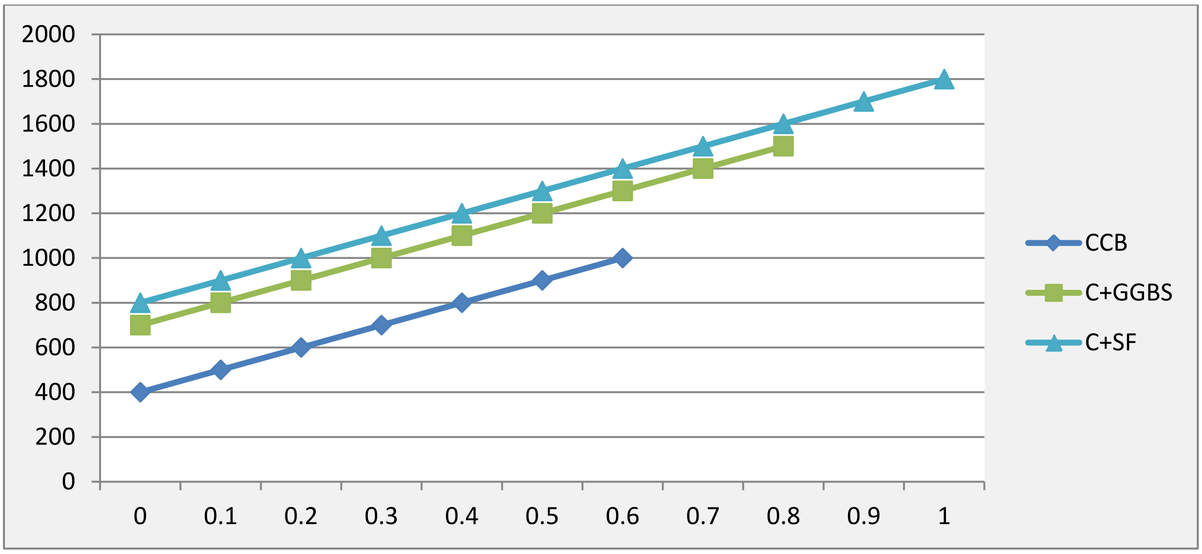


Figure 1.6: Comparison of Load vs Deflection

IX. Conclusion

- **Compressive Strength**:

Among the three mixes in the present investigation Conventional Concrete Beam, 20% GGBS + Cement Concrete Beam and 5% Silica Fume + Cement Concrete Beam the compressive strength obtained at 28 days are 58.85 N/mm^2, 61.53 N/mm^2 and 65.86 N/mm^2 respectively. It is observed that addition of 20% GGBS with replacement of cement and 5% replacement of cement increases the Compressive Strength by 3% and 5% respectively when compared with Conventional Concrete Beam. The result shows an increase in the compressive strength of the mixes with addition of admixture.

- **Split Tensile Strength**

The split tensile strength of the different mixes Conventional Concrete Beam, 20% GGBS + Cement Concrete Beam and 5% Silica Fume + Cement Concrete Beam obtained at 28 days are 8.64 N/mm^2, 8.99 N/mm^2 and 9.30 N/mm^2 respectively.

Based on the above conclusions on Mechanical Properties of specimens with different concrete matrices, we can conclude that use of Silica Fume with 5% replacement of cement in Post tensioned on M60 grade of concrete is the most efficient mix as compared with other mixes.

- **Flexural Strength**

Flexural strength results show a significant increase with the addition of admixtures with replacement of cement in Post tensioned beam. The strength increases by 50% with addition of GGBS and 80% with addition of Silica Fume when compared to Conventional concrete beam.

1. The Flexural Strength tests performed on the beam shows that the ultimate load carrying capacity of 1000 KN for M60 post tensioned Conventional concrete beam. The deflection of the post tensioned beam has 0.6mm at load application of 1000 KN and Initial cracking load at 500KN with 0.1mm deflection and flexural strength is 55.55 N/mm^2.

2. The Flexural Strength test performed on 20% GGBS addition in replacement of cement in post tensioned beam showed the ultimate load carrying capacity of 1500 KN. The deflection of post tensioned beam with GGBS has 0.8 mm at load application of 1500 KN and Initial cracking load at 800KN with 0.1mm deflection and flexural strength is 83.33 N/mm^2.

3. The Flexural Strength test performed on 5% Silica Fume addition in replacement of cement in post tensioned beam showed the load carrying capacity of 1800 KN. The deflection of post tensioned beam with GGBS has 1 mm at load application of 1800 KN and Initial cracking load at 900KN with 0.1mm deflection and flexural strength is 100 N/mm^2.

Based on the above conclusions on Flexural behaviour of beam with different concrete matrices, it can be state that post tension beam with 5% Silica Fume is the most efficient of all the specimens. Post tension beam with 5% Silica Fume showed a significant resistance to the load of 1800 KN with 1 mm and Flexural strength of 100 N/mm^2.

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