EXPERIMENTAL STUDY ON UTILIZATION OF GGBS AS PARTIAL SUBSTITUTE IN FERROCEMENT

Shwetha R A[1], Divya G R[2], Siddeshwar Patil[3], Shravani K A[4], Ulli Gurumurthy5

[1]*Assistant professor, Department of Civil Engineering, Citech Bangalore, Karnataka, India*

[2,3,4,5] *Students, Department of Civil Engineering, Citech Bangalore, Karnataka, India*

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Abstract - *Ferro cement is regarded as highly versatile thin material possessing superior properties which cannot be matched by other conventional infill materials, reduced weight and good thermal insulation characteristics. The Ferro cement panels being light in weight need less strong supporting structures. The study was conducted in two phases. First phase includes the casting of Ferrocement panel each of 25cm X 25cm X 5cm and cubes of 7.06 cm X7.06 cm X7.06cm were tested after7, 28 days of curing for compression and flexural strength. The second phase of the study embarked on development of high workability and high performance Ferrocement by partial replacement of cement by GGBS at 15%,30%,45%,60% and 75%. As the percentage increased the strength is also increased but only up to 60% further the strength is decreased. An estimate of the cost is also shows that using Ferro cement panel is economical.*

Key Words: Ferrocement, Wire mesh, GGBS, Compressive Strength, flexural strength, Ductility ratio.

1. INTRODUCTION

Ferrocement can be considered a type of thin reinforced concrete construction in which large amounts of small diameter wire meshes are used uniformly throughout the cross-section instead of discretely placed reinforcing bars and in which Portland cement partially replaced with GGBS at different dosages. The performance of concrete with partial replacement of GGBS. It is found that the compressive strength of concrete increases at 28 days age compared to conventional concrete. Super plasticizers are the improved chemical admixtures over plasticizing effects on wet concrete is used in concrete mix. These are mainly used to improve workability, Speed finishing, increase strength and helps in reducing Shrinkage and thermal cracking. The compressive strength and flexural strength of M40 grade concrete with partial replacement of GGBS at 0%,15%,30%,45%, 60% and 75% in ferrocement. Tests were conducted on ferrocement panels to study strength properties. The results are compared with normal conventional concrete.

1.1. Objectives

- Determining compressive strength and flexural strength of ferrocement.
- Determining the compressive strength and flexural strength of ferrocement with different proportions of GGBS i.e.15%,30%,*45%,60% and 75%*

2. Materials and Methodology

2.1 Materials

2.1.1Cement

Ordinary Portland cement of grade 53(ultra tech) available in local market was used in the research. The properties of cement are as follows.

Sl. No	Characteristics	Results	As per IS 12269-1987
1	Normal Consistency(%)	32	5-6mm depth from bottom
2	Initial Setting time(minutes)	40	Not less than 30
3	Final setting time(minutes)	480	Not more than 600
4	Specific gravity	3.1	3.14

2.1.2 Fine Aggregates

Clean River sand is used for present investigation as fine aggregates. Tests on sand as per IS specification are conducted and results are as follows.

Sl. No	Characteristics	Results
1	Specific gravity	2.6
2	Fineness modulus	3.14
4	Moisture content (%)	3.1
5	Grading Zone	II

2.1.3 Ground Granulated Blast Furnace Slag

Ground granulated blast furnace slag is a hydraulic binder, Obtained by quenching molten iron slag from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder.

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Sl. No	Characteristics	Values	As per IS 12089-1987
1	Normal Consistency (%)	30	-
2	Initial Setting time(minutes)	58	Not less than 30
3	Final setting time(minutes)	540	Not more than 600
4	Specific gravity	2.82	2.92

2.1.4 Wire Mesh

Chicken wire mesh is formed by twisting two adjacent wires at least four times, forming a strong honeycomb mesh structure. Its hexagonal shape prevents the formation of internal stresses. Due to its flexibility structure, chicken wire is convenient for mounting or curved and angled surface.

2.2Ferrocement mixes

Two concrete mixes were prepared. The conventional mix (A) in which 100% OPC. In mixes B the cement was partially replaced with 15%, 30%, 45%, 60% and 75% of GGBS by weight respectively. The fine aggregate content was kept constant for all mixes. The Indian standard method was used for the mix design process. This method of design comprises of tables and charts available at the IS456-2000 and IS10262-2000. The target strength of all mixes was 48.25N/mm^2 and the target slump was 100mm. The proportions of materials for each concrete mix are shown in below table.

2.3Mix Proportions

The concrete mix is designed as per IS code for ferrocement panels. For M_{40}grade with the water cement ratio of 0.4.The mix proportions used for ferrocement are 1:5

Grade	Cement	Fine aggregate	w/c ratio
M_{40}	1.33kg/m^3	7.12kg/ m^3	0.4

2.4Casting and Curing

For each mix of size 70.6×70.6×70.6mm mortar cubes and of size 250×250×50mm panels were casted, after 24hours the specimens were de-moulded and kept for curing.

2.5Testing

2.5.1Axial compressive strength

The axial compressive strength of panels were determined in accordance with IS 516-1959 after 7 and 28 days curing.

2.5.2Flexural strength

The flexural strength of panels were determined in accordance with IS 516-1959 (two point loading method) after 7 and 28 days curing

3. Results and discussion

3.1Compressive strength

The axial compressive mean strength of the test specimens for mixes A and B at 7 and 28 days are summarized below.

Table 1:FINE AGGREGATE+0%GGBS

Sl. No	Age (days)	Maximum load (N)	Compressive strength (N/mm^2)	Average N/mm^2
1	7	25×10^3	5.01	5.336
	7	28×10^3	5.6	
	7	26×10^3	5.4	
2	28	91×10^3	18.25	17.25
	28	81×10^3	16.25	
	28	86×10^3	17.25	

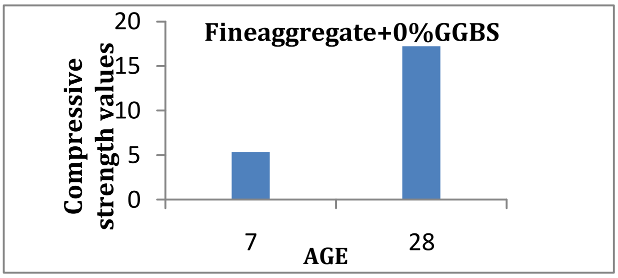


Table 2: FINE AGGREGATE+15%GGBS

Sl. No	Age (days)	Maximum load (N)	Compressive strength (N/mm^2)	Average N/mm^2
1	7	64×10^3	12.84	13.31
	7	94×10^3	18.86	
	7	41×10^3	8.23	
2	28	97×10^3	19.46	18.58
	28	93×10^3	18.65	
	28	88×10^3	17.65	

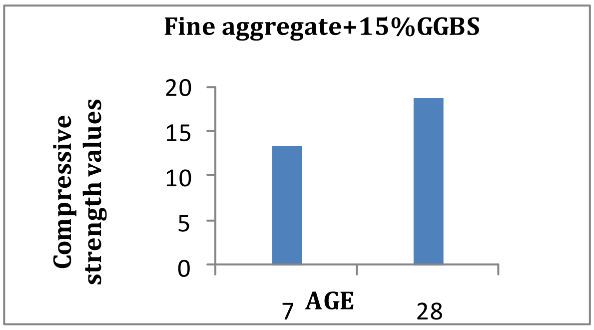


Table 3: FINE AGGREGATE+30%GGBS

Sl.No	Age (days)	Maximum load (N)	Compressive strength (N/mm^2)	Average N/mm^2
1	7	97.99×10^3	19.66	18.56
	7	80.94×10^3	16.24	
	7	98.89×10^3	19.84	
2	28	100×10^3	20.06	20.39
	28	106×10^3	21.26	
	28	99×10^3	19.86	

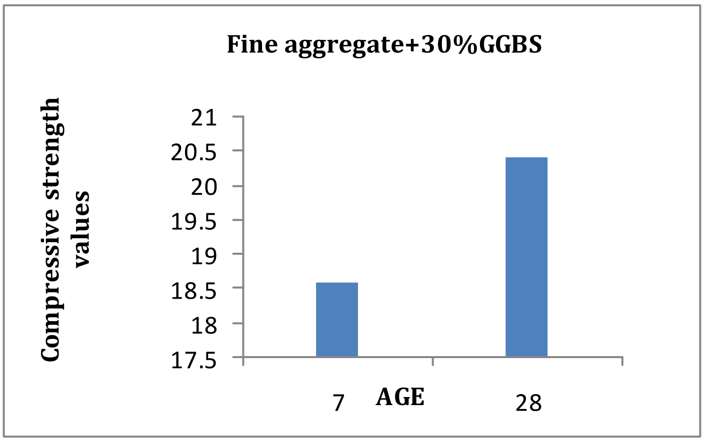


Table 4: FINE AGGREGATE+45%GGBS

Sl. No	Age (days)	Maximum load (N)	Compressive strength (N/mm^2)	Average N/mm^2
1	7	137×10^3	27.6	26.68
	7	125×10^3	25.23	
	7	132×10^3	26.63	
2	28	150×10^3	30.09	29.57
	28	149×10^3	29.89	
	28	146×10^3	29.29	

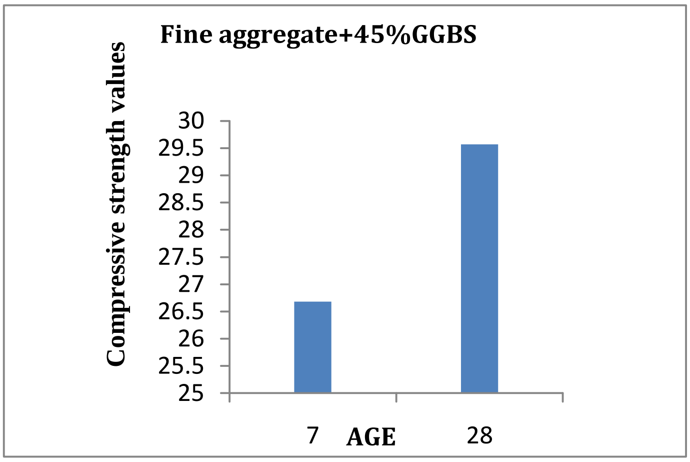


Table5: FINE AGGREGATE+60%

Sl. No	Age (days)	Maximum load (N)	Compressive strength (N/mm²)	Average N/mm²
1	7	145×10^3	29.09	32.57
	7	171×10^3	34.31	
	7	171×10^3	34.31	
2	28	158×10^3	31.69	36.17
	28	194×10^3	38.92	
	28	189×10^3	37.9	

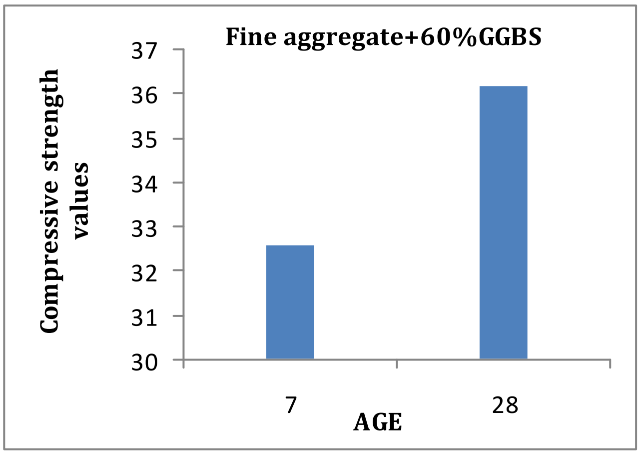
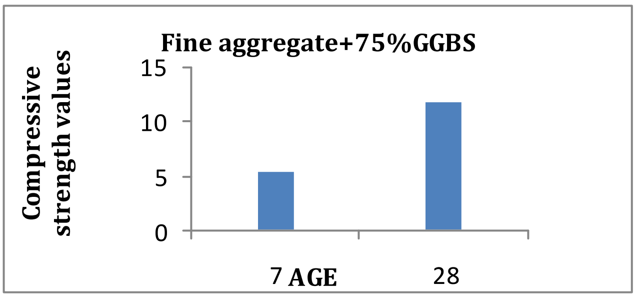


Table 6:FINE AGGRGATE+75%GGBS

Sl. No	Age (days)	Maximum loadn(N)	Compressive strength (N/mm²)	Average N/mm²
1	7	22×10^3	4.41	5.34
	7	26×10^3	5.21	
	7	32×10^3	6.42	
2	28	66×10^3	13.24	11.63
	28	57×10^3	11.43	
	28	51×10^3	10.23	



AXIAL COMPRESSIVE STRENGTH VARIATIONS AT 7 AND 28 DAYS FOR FERROCEMENT CUBES AT DIFFERENT PROPORTIONS OF GGBS

Table 7:FINE AGGREGATE+0%GGBS

Sl. No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	32×10^3	2.56
2	28	65×10^3	5.2

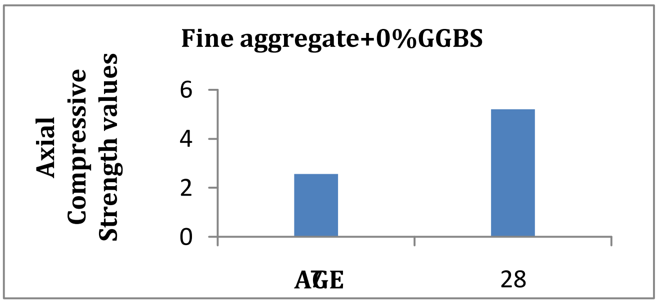


Table 8: FINE AGGREGATE+15%GGBS

Sl. No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	36×10^3	2.88
2	28	70×10^3	5.60

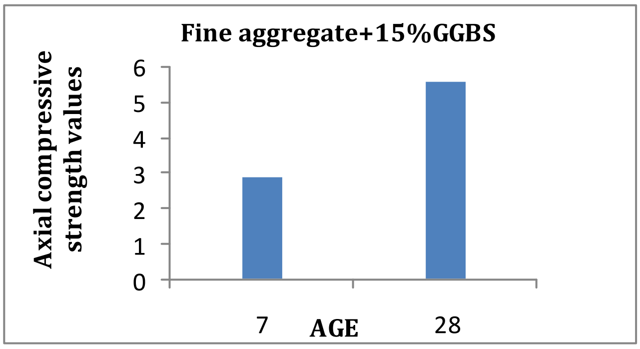


Table 9:FINE AGGREGATE+30%GGBS

Sl.No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	42×10^3	3.36
2	28	82×10^3	6.56

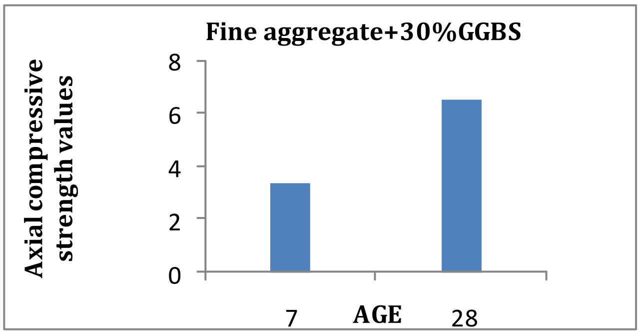


Table 10:FINE AGGREGATE+45%GGBS

Sl. No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	67×10^3	5.36
2	28	90×10^3	7.20

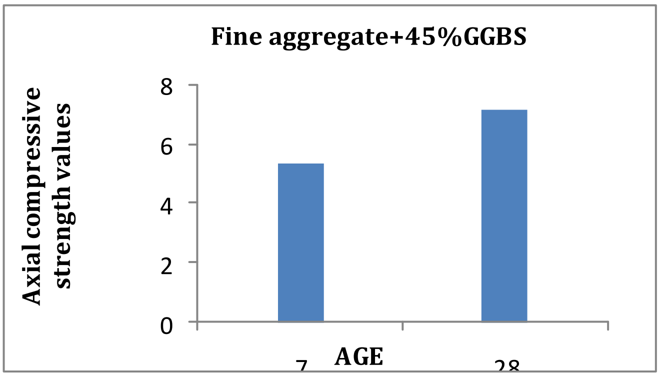


Table 11: FINE AGGREGATE+60%GGBS

Sl. No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	81×10^3	6.48
2	28	120×10^3	9.60

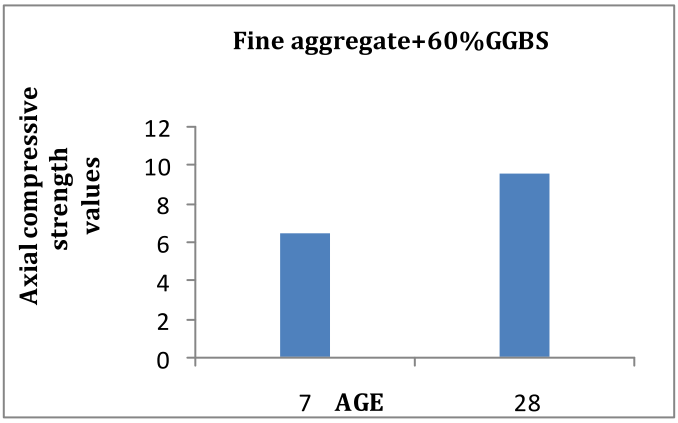


Table 12: FINE AGGREGATE+75%GGBS

Sl. No	Age (days)	Maximum load (N)	Axial Compressive strength (N/mm²)
1	7	12×10^3	0.96
2	28	32×10^3	2.56

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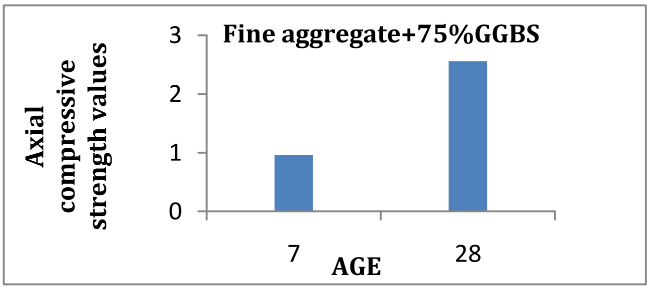
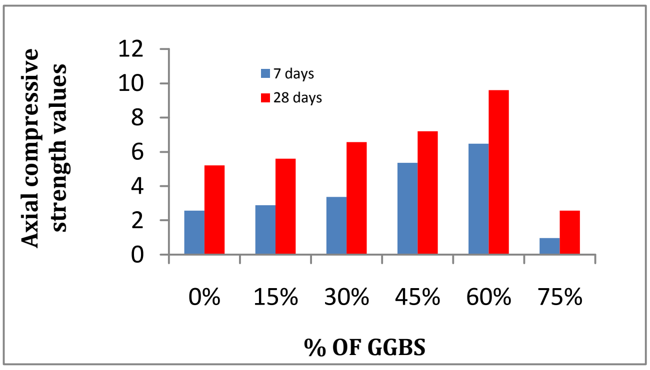


AXIAL COMPRESSIVE STRENGTH VARIATIONS AT 7 AND 28 DAYS FOR FERROCEMENT PANELS AT DIFFERENT PROPORTIONS OF GGBS

DAYS	COMPRESSIVE STRENGTH VALUES (N/mm²)					
	0% GGBS	15% GGBS	30% GGBS	45% GGBS	60% GGBS	75% GGBS
7	2.56	2.88	3.36	5.36	6.48	0.96
28	5.20	5.60	6.56	7.20	9.60	2.56



3.2Flexural strength

The flexural mean strength of the test specimens for mixes A and B at 7 and 28 days are summarized as follows

Table 13: FINE AGGREGATE+ 0% GGBS

Sl.No	Age (days)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	24×10^3	36.00
2	28	32×10^3	59.25

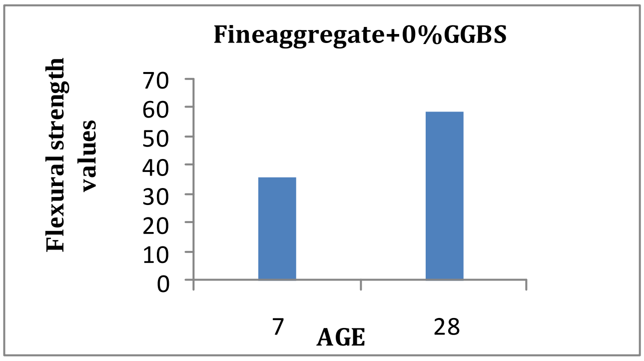


Table 14:FINE AGGREGATE+ 15% GGBS

Sl. No	Age (days)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	26×10^3	39.00
2	28	37×10^3	98.67

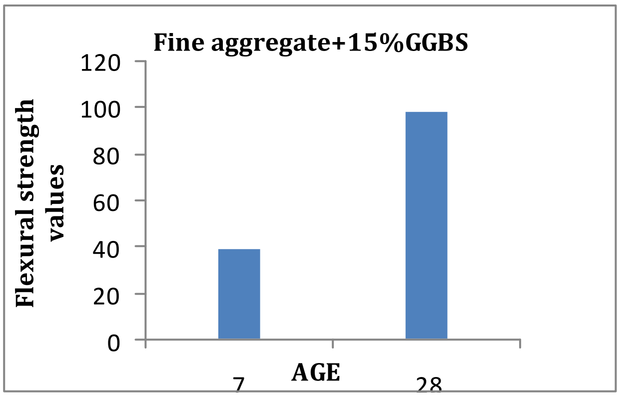


Table 15:FINE AGGREGATE+ 30% GGBS

Sl.No	Age (days)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	50×10^3	52.08
2	28	89×10^3	110

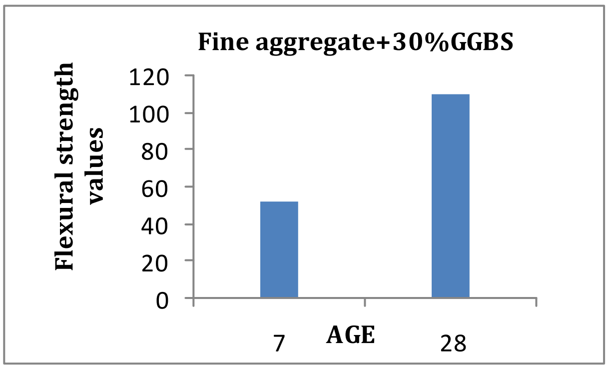


Table 16:FINE AGGREGATE+45%GGBS

Sl.No	Age (days)	Mass (kg)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	6.350	85×10^3	56.67
2	28	6.800	98×10^3	121.48

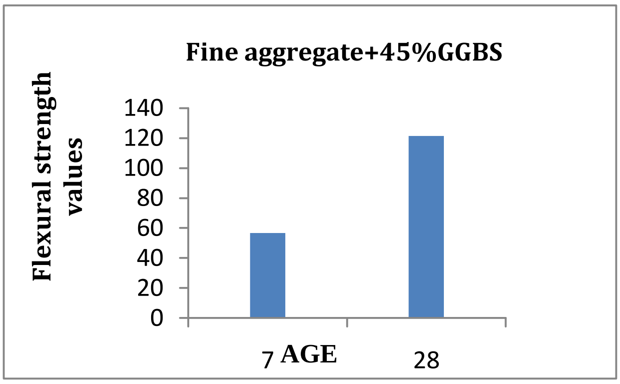


Table 17:FINE AGGREGATE+60%GGBS

Sl. No	Age (days)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	105×10^3	86.42
2	28	122×10^3	202.77

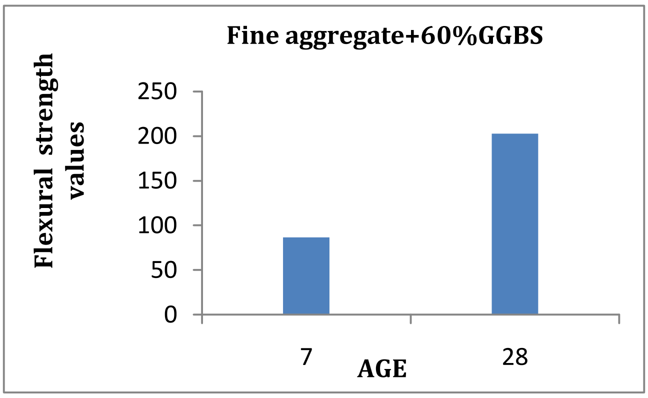
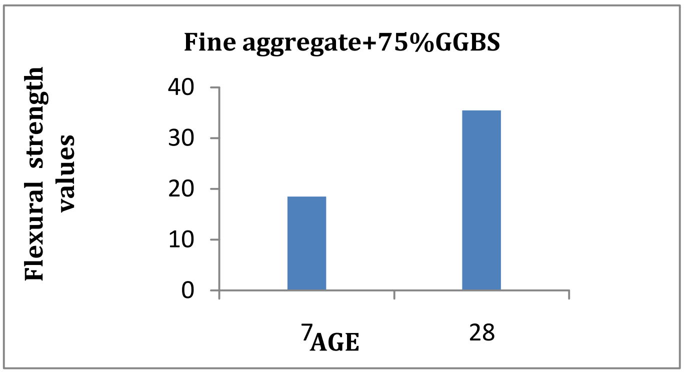


Table 18:FINE AGGREGATE+ 75% GGBS

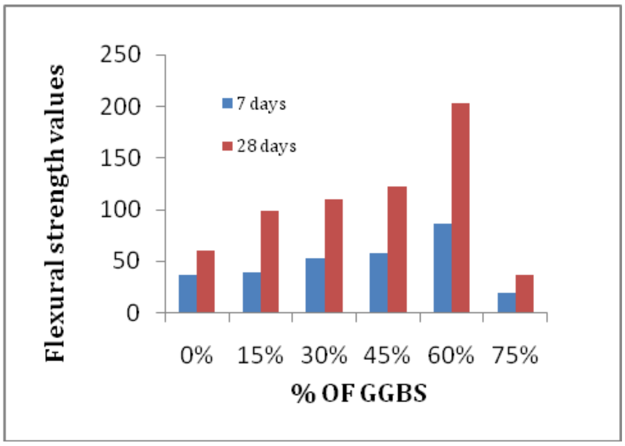
Sl.No	Age (days)	Maximum Load (N)	Flexural strength (N/mm²)
1	7	10×10^3	18.52
2	28	29×10^3	35.45



FLEXURAL STRENGHT VARIATIONS AT 7 AND 28 DAYS FOR FERROCEMENT PANELS AT DIFFERENT PROPORTIONS OF GGBS

DAYS	FLEXURAL STRENGTH VALUES					
	0% GGBS	15% GGBS	30% GGBS	45% GGBS	60% GGBS	75% GGBS
7	36.00	39.00	52.08	56.67	86.42	18.52
28	59.25	98.67	110	121.48	202.77	35.95

PROPORTIONS OF GGBS



4. Conclusion

- The partial replacement of OPC with GGBS improves the workability but causes a decrease in the plastic density of the concrete.
- The axial compressive and flexure increases with increasing GGBS content.
- As the percentage increased the strength is also increased but only up to 60% further the strength is decreased. An estimate of the cost is also shows that using Ferrocement panel is economical.
- Ferrocement elements undergo high deformations before collapse. It has high level of impact and cracking resistances, toughness and ductility.
- The ferrocement structures are thin and light weight compared to conventional reinforced concrete, hence there is considerable reduction in self-weight of the structure and saving in foundation cost.

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