AN EXPERIMENTAL STUDY ON EFFECT OF MINERAL ADMIXTURE ON CONFINEMENT OF SHORT COLUMNS BY WRAPPING WITH AND WITHOUT FERRO MESH TO REINFORCEMENT

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Abstract – *Columns are major structural element of a building, it resists entire load and transmit it to foundation. The failure of the column leads to the total collapse of the Whole frame structure as it transmits the vertical loads to the foundation. Under the implementation of load, column condense longitudinally and enlarge laterally. On implementation of maximum axial load, the concrete crushes and the longitudinal reinforcement buckles outwards. In this project, cement is replaced with Ground Granulated Blast Furnace Slag (GGBS) by 10%, 20%, 30% and 40% of weight. The mix design used in this project is M20 To Study the mechanical properties by conducting compression, split-tensile strength test. The performance of specimen will be scrutinized on the basis of Load Carrying capacity, axial displacement, Lateral displacement and Ductility factor. Three sets of circular reinforced columns having cross sectional dimension as 150mm diameter and 700mm height, for each set three columns were casted and tested for axial compression. This experimental investigation is performed on nominal column, control column by wrapping with and without Ferro mesh jacket in each set. The performance of specimen will be scrutinized on the basis of Load Carrying capacity, axial displacement, Lateral displacement and Ductility factor. Finally the test results were compared with nominal concrete column to evaluate the property enhancements.*

***Key Words*: GGBS, Ferro mesh, Fe-415 steel, axial compressive load, axial displacement, lateral displacement, ductility factor.**

1. INTRODUCTION

Columns plays a vital role in construction field as compression members in the structure. The main objective of the column is to withstand entire load coming from top level of the structure to foundation level. A wide range of research techniques are applied practically for providing the sufficient amount of ductility to the column. In those, one of the technique is using of Ferro cement to construct a column. Ferro cement is a type of the reinforcing the small diameter bars by wrapping them and encapsulated with concrete. Materials used in the Ferro cement is selected organic, synthetic fiber and steel. Steel is the mostly used Ferro cement material. This Ferro cement can be used for repair and rehabilitation for damaged column as RC jacketing. Researchers noticed that Ferro cement with external confinement show the improvement in stiffness, ductility, strength and energy dissipation capacity in columns. High strength columns with Ferro cement can have the capacity to change the mode of failure from shear failure to flexure failure and reduction in displacement ductility. For achieving this displacement ductility level, we have an option is to changing the confinement of reinforcement in a way that give more amount of reinforcement in column. The ultimate strength also increases on increasing the amount of reinforcement up to certain limit.

2. MATERIALS USED

Materials required for this concrete preparation are as follows:

1. Cement
2. Fine Aggregate
3. Coarse Aggregate
4. Ground Granulated Blast Furnace Slag (GGBS)
5. Ferro Mesh
6. water

2.1 Cement

Cement is a binding material and generates the heat of hydration for process and mixing of concrete. The physical properties obtained from the investigations are tabulated in Table 1 as per IS 4031.

Table 1: Test results of cement

S.No	Description	Values
1	Specific Gravity	2.94
2	Normal Consistency of the cement	30%
3	Initial Setting Time	45 min
4	Final Setting Time	395 min

2.2 Fine Aggregate

The size of the fine aggregate is below 4.75mm, natural sand used as the fine aggregate in concrete mix. Sand may be obtained from rivers, lakes but when used in concrete mix, it should be properly washed and tested to ascertain that total percentage of clay silt, silt and other organic matters does not exceed the specified limit. For the experimental investigation locally available river sand which is free from organic impurities is used. Sand used in this study conformed to Zone-III of Indian standard specifications IS 383-1970.

Table 2: Test results of Fine Aggregate

S.No	Description	Values
1	Specific Gravity	2.67
2	Grading Zone	III
3	Fineness Modulus	2.6

2.3 Coarse Aggregate

The coarse aggregates are granular materials obtained from rocks and crushed stones. They may be also obtained from synthetic material like slag, shale, fly ash and clay for use in light-weight concrete. In this project coarse aggregate of size 20mm are used.

Table 3: Test results of Coarse Aggregate

S.No	Description	Values
1	Specific Gravity	2.88
2	Aggregate Size	20 mm
3	Fineness Modulus	7.17

2.4 Ground Granulated Blast Furnace Slag (GGBS)

Ground granulated blast furnace slag is a by-product from the blast furnaces used to make iron. The iron ore is reduced to iron and the remaining materials from a slag that floats on top of the iron. This slag is periodically tapped off as a molten liquid and if it is to be used for the manufacture of GGBS it has to be rapidly quenched in large volumes of water. The cost of the GGBS is the low compare to cement. This have high durability and best reaction is sodium based alkaline solutions.

Figure 1: GGBS

2.5 Ferro Mesh (chicken wire mesh)

Chicken net is made of thin, flexible, galvanized steel with hexagonal openings, many times it is known as hexagonal netting. The shape of wire mesh available in Rectangle, Diamond and Hexagon. It's look like a chain links, for example if any wire is chop, it doesn't break totally like in chain link. It may be reverse twisted, straight twisted or double twisted. It is available in 1 inch (2.5 cm) diameter, 2 inch (about 5 cm) and ½ inch (1.3 cm) Ferro mesh is available in various gauges –usually 19 gauge (about 1 mm wire) to 22 gauge (about 0.7 mm wire).

Figure 2: Ferro Mesh

2.7 Water

Clean potable water was used for making concrete. This project distilled and marine water is used to casting of specimens. Water fit for drinking is generally considered fit for making concrete. Water has two functions in a concrete mix. Firstly water permissible limits observed IS: 456-2000.

3. TEST AND RESULTS

3.1 Hardened Concrete

Concrete is casted into cubes, cylinders and prisms as per IS 516 recommendations and curing should be done for 7days, and 28 days. In each set 9 specimens are made i.e. 3 cubes, 3 cylinder for each concrete mix of M20 grade concrete added with GGBS of different proportions. Test performed in this research are:

1. Compression Strength test
2. Split Tensile Test

The results of above test after curing period for 7 days and 28 days are tabulated below

Table 4: Compression Strength of concrete added with GGBS

MIX PROPORTION	COMPRESSIVE STRENGTH (Mpa)	
	7 DAYS	28 DAYS
100 % OPC	16.5	25.1
90% OPC+ 10% GGBS	15.12	26.96
80% OPC + 20% GGBS	14	28
70% OPC + 30% GGBS	22.5	32
60% OPC + 40% GGBS	14	24

Chart 1: Compression Strength of concrete added with GGBS

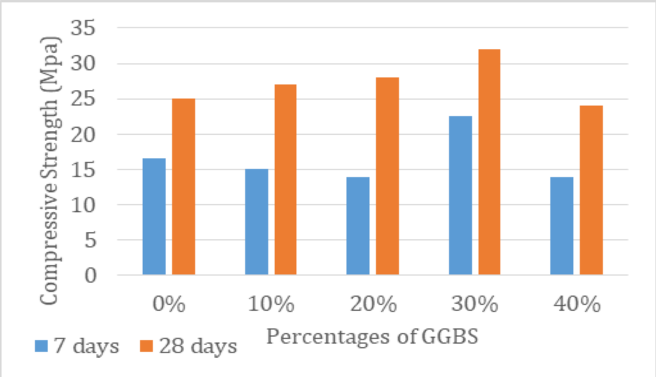
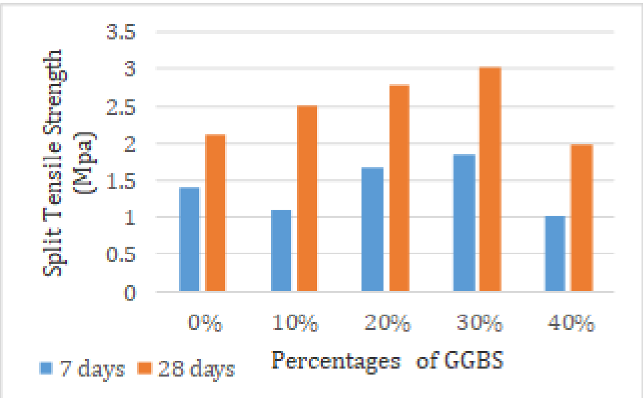


Table 5: Split Tensile Strength of concrete added with GGBS

MIX PROPORTION	SPLIT TENSILE STRENGTH (Mpa)	
	7 DAYS	28 DAYS
100 % OPC	1.40	2.1
90% OPC+ 10% GGBS	1.1	2.5
80% OPC + 20% GGBS	1.67	2.8
70% OPC + 30% GGBS	1.85	3.02
60% OPC + 40% GGBS	1.02	1.98

Chart 2: Split Tensile Strength of concrete added with GGBS



Three columns per set are casted on basis of optimum values of mix proportion (70% OPC + 30% GGBS) with and without Ferro Mesh and the deflections of each column are evaluated using the universal testing machine and those values are represented in below tables and charts. On the basis of winding the Ferro Mesh to reinforcement, columns are classified into

C1 - Reinforcement without Ferro Mesh casted with Nominal concrete

C2 - Reinforcement without Ferro Mesh casted with mix proportion (70% OPC + 30% GGBS) concrete

C3 - Reinforcement with Ferro Mesh casted with mix proportion (70% OPC + 30% GGBS) concrete

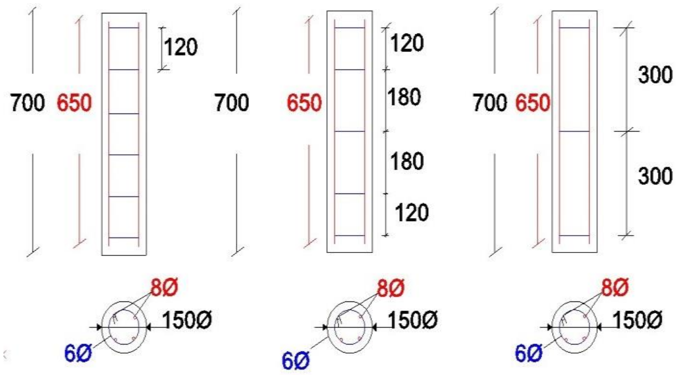


Figure 3: Column Details

Description	Type - 1	Type - 2	Type - 3
Length of column	700mm	700mm	700mm
Diameter of column	150mm	150mm	150mm
Length of longitudinal bar	650mm	650mm	650mm
No of bars	4	4	4
Diameter of longitudinal bar	8mm	8mm	8mm
Diameter of lateral	6mm	6mm	6mm
Spacing between Ties	120mm C/C	120mm at Ends & 180mm at Middle	300mm C/C
Clear cover	25mm	25mm	25mm

Figure 4: Reinforcement

Figure 5: Casting of Column

Figure 6: Testing of Column in UTM

Table 6: Comparison of load vs axial displacement for uniform and Non-uniform spacing with and without mesh

Load	Type 1			Type 2			Type 3		
(kN)	C1	C2	C3	C1	C2	C3	C1	C2	C3
0	0	0	0	0	0	0	0	0	0
30	1.5	1	1.2	0.9	1	0.9	1.5	1.3	0.5
60	2.2	1.5	1.6	2	1.6	1.5	2.4	2.1	2.5
90	3.2	2	2.1	2.5	2.2	2	3.2	2.5	3
120	4.2	2.9	2.5	3	3.2	2.7	4.3	3.5	3.2
150	5.6	3.2	3.2	3.6	3.9	3.8	5.3	4	5
180	7.2	4.9	4.5	4.2	4.6	4.7	7.9	6	6
210	8	5.6	5.6	5.6	5.2	5	9	6.8	6.8
240		6.4	7.9	6	6.4	6.2		7	7.9
270		7.5	9.2		7.6	8		9.5	9
300			10		8	8.4			11
330						9.2			12.5
360						10.4			
390						11.2			

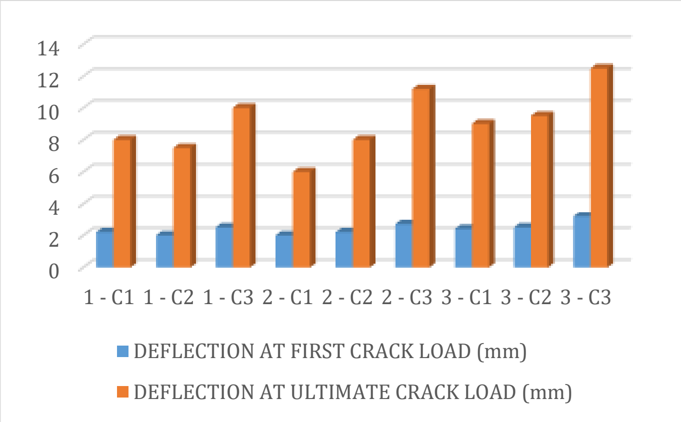
Table 7: Comparison of load vs Lateral displacement for uniform and Non-uniform spacing with and without mesh

Load	Type 1			Type 2			Type 3		
(kN)	C1	C2	C3	C1	C2	C3	C1	C2	C3
0	0	0	0	0	0	0	0	0	0
30	0.06	0.01	0.05	0.1	0.05	0.04	0.6	0.6	0.7
60	0.1	0.013	0.4	0.19	0.1	0.3	0.95	0.96	1
90	0.3	0.15	0.9	1.1	0.2	0.8	1.3	1.2	1.4
120	0.7	0.2	1	1.3	0.4	1.12	2.1	2.4	1.5
150	1.2	0.6	1.3	1.5	0.6	1.2	2.9	2.9	1.9
180	2.1	0.9	1.5	1.7	1.1	1.26	3.6	3.2	2.1
210	2.5	1.2	1.9	1.9	1.5	1.6	4	3.9	2.9
240		1.8	2.6	2.1	1.8	1.8		4.3	3.6
270		2	2.7		2.2	2		4.9	3.9
300			2.8		2.6	2.3			4
330						2.6			4.9
360						2.85			
390						3			

Table 8: Deflection of OPC and Optimum at different spacing

Mix		Deflection at first crack load (mm)	Deflection at ultimate crack load (mm)
Type 1	C1	2.2	8
	C2	2	7.5
	C3	2.5	10
Type 2	C1	2	6
	C2	2.2	8
	C3	2.7	11.2
Type 3	C1	2.4	9
	C2	2.5	9.5
	C3	3.2	12.5

Chart 8: Deflection of OPC and Optimum at different spacing



5. CONCLUSIONS

The following main conclusions were drawn from the experimental results obtained this study:

- ❖ In this project, we can say that load carrying capacity of the column increases with decrease in lateral reinforcement.
- ❖ By comparing the test results of cubes, the optimum percentage (70%OPC+30%GGBS) of compressive strength attained is 27.49% higher than the conventional concrete for 28 days of curing.
- ❖ By comparing the test results of cylinders, the optimum percentage (70%OPC+30%GGBS) of Split-Tensile strength attained is 43.80% higher than the conventional concrete or 28 days of curing.
- ❖ At 120mm uniform spacing without Ferro mesh, Ultimate crack load of optimum concrete column attained is 28.57 % more than the conventional concrete column.
- ❖ At 120mm uniform spacing, Ultimate crack load of optimum concrete column with Ferro mesh, attained is 11.11 % more than the optimum concrete column without Ferro mesh.
- ❖ Spacing of 120mm at ends & 180mm at middle without Ferro mesh, Ultimate crack load of optimum concrete column attained is 25 % more than the conventional concrete column.
- ❖ Spacing of 120mm at ends & 180mm at middle, Ultimate crack load of optimum concrete column with Ferro mesh, attained is 30 % more than the optimum concrete column without Ferro mesh.
- ❖ At 300 mm spacing center to center without Ferro mesh, Ultimate crack load of optimum concrete column attained is 28.57 % more than the conventional concrete column.
- ❖ At 300 mm uniform spacing, Ultimate crack load of optimum concrete column with Ferro mesh, attained is 22.22 % more than the optimum concrete column without Ferro mesh.
- ❖ Ductility is more, when compared to different spacing of columns and its factor is 4.14 at 120mm at ends and 180mm at middle spacing with Ferro mesh.
- ❖ The energy absorption curve of column confined with Ferro mesh at 120mm at ends and 180mm at middle spacing is more than that of conventional column.
- ❖ From the mode of failure of columns it was observed that the longitudinal cracks are formed at the top and bottom ends of the short columns.
- ❖ The zone of rupture is observed near one forth height of the column either from top and bottom, this length decreases with decrease in spacing of lateral reinforcement.

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