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Potency Variation Analysis of Fly Ash and GGBS with Micro (Polypropylene) Fiber for M_{45} Concrete

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***Abstract*: Concrete a widely used, strong and versatilely mould able construction material consist of binding material, aggregates, and water. Concrete can be made of different binding materials but in the present scenario cement concrete is the most preferable concrete all over the world. Due to globalization and industrialization, the infrastructure growth is at a faster rate, which requires a huge amount for development. One of such overused construction material is cement concrete, the survey indicates that the concrete is the world's second most consumed material, after water. It shows that material consumption for the preparation of concrete is very high. Which will directly lead to overuse of natural resources, increasing environmental pollution and also raise the cost of construction**

The experimental investigation of OPC-53 grade replacement by GGBS 5%, 10%, 15%, 20%, 25% and fly ash 5%, 10%, 15%, 20%, 25% then also adding polypropylene microfiber 1%. Tests on fresh properties and harden properties like compression, Tensile strength, Flexural strength was conducted. Superplasticizer was used to have good workability for all replacement levels. The mix design is carried out for M45 grade of concrete as per, IRC 44-2008.

***Keywords*: Fly Ash, GGBS, PolyPropylene microfibers, superplasticizer conplast sp- 430**

I. INTRODUCTION

[1.] Concrete is widely used, strong and adaptable moldable construction material consist of binding material, aggregates, and water. Concrete can be made of different binding materials but in the present scenario cement concrete is the most preferable concrete all over the world. Due to globalization and industrialization, the infrastructure growth is at a faster rate, which requires a huge amount for improvement. Another major problem with rapid infrastructure development is the excess usage of the resources as construction materials.

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One of such overused construction material is cement concrete. The survey indicates that concrete is the world's second most consumed material after water. This shows the material consumption for the preparation of concrete is very high, which will directly lead to overuse of the natural resources, increasing environmental pollution and an increase in the cost of construction.

II. MATERIALS AND METHODS

Sl No	Materials
01	Ordinary Portland Cement-53 Grade
02	Ground Granulated Blast Slag
03	River Sand
04	Natural Coarse Aggregates
05	Fly Ash
07	Polypropylene Micro Fiber
08	Super Plasticizer

A. CEMENT

The local available OPC-53 grade conforming to IS 12269-1987 was used in an investigation. The laboratory test conducted on cement as given below.

Fig No: 1 Sample of OPC-53 Grade Cement

Table No:2 Material Characteristics Of Cement

Sl No	Description	Results	Recommended As Per IS 12269-198
01	Fineness of cement	2.2	Less than 10 Mm
02	Normal consistency of cement	34%	-
03	Initial setting time	30 min.	Not lesser than 30 minute
04	Final setting time	210 min.	Not more than 600 minute
05	Soundness test	6 mm	Less than 10 mm

06	The specific gravity of cement	3.106	-

B. Ground Granulated Blast Slag:

[5]GGBS is gain from quenching molten iron slag a by using-made from iron and steel-making from a blast furnace in water, to provide a glassy, granular product this is then dried with ground right into exceptional dirt. Used the GGBS (JSW Cement LTD Vijayanagar works Bellary)is conforming to as per IS 12089-1987 tested various parameters show in below table

Fig No:2 Sample Of GGBS

Table No:3 chemical composition of GGBS

Sl No	Characteristics	Recommended As Per BS EN15167-1:2006	Test Results
	Chemical Requirements		
01	Magnesia Content (%)	18.00 (max)	7.95
02	Sulphide Sulphur (%)	2.00	0.51
03	Sulphite Content (%)	2.51	0. 29
04	Loss On Ignition (%)	3.0	0.22
05	Chloride Content (%)	0.10	0.008
06	Glass Content (%)		93
07	Moisture Content (%)	1.0	0.13

Table no:4 physical properties of GGBS

Sl NO	Characteristics	Recommended As Per BS EN15167-1:2006	Test Results
01	Fineness of GGBS	275(min)	395
02	Specific gravity of GGBS		2.88
03	45 micron (residue) (%)		6.10

C. Fine Aggregate :

The nearby available material is used in this project. The fine aggregate is taken from Deodurga (Raichur district). As per IS 383-1970 conforming to the material characteristics of fine aggregate like sieve analysis, specific gravity, etc..

Fig No: 3 Sample Of Fine Aggregate

Table No:5 Physical Characteristics Of Fine Aggregate

Sl No	Description	Results
1	Fineness modules	2.24
2	Specific gravity	2.663
3	Water absorption	1.4%
4	Grade zone	2

D. Natural Coarse Aggregates:

In this project work using a 20 mm down size aggregate, the aggregate is obtained from the local available crush machine at Raichur. The characteristics of coarse aggregate are conformed from IS 383-1970, the characteristics of coarse aggregate listed below the table

Fig no:4 Natural Coarse Aggregate

Table No: 6 Physical Properties Of Coarse Aggregate

Sl No	Description	Results
1	Fineness modules	4.27
2	Specific gravity	2.747
3	Water absorption	0.4%
4	Impact test	26.87%

E. Fly Ash:

This material is used in this project obtained from RTPS, the tests are conforming that as per IS 3812: 2003 (PART 1 & 2).

Fig No: 5 Sample Of Fly Ash

Table No 7: Chemical Components Of Fly Ash

Sl No	Components	Percentages
01	Silica	55-60
02	Alumina	20-35
03	Calcium Oxide	5-15
04	Ferric Oxide	4-18
05	Loss On Ignition	1-5

F. Polypropylene Micro Fiber:[12] The polypropylene microfibers are used in a project, the use of fiber it reduces the frequency of plastic cracking, improves durability, the fibers are obtained from Kanakadurga industries Hyderabad.

Fig No: 6 Polypropylene Microfiber

Table no 8: The Physical Properties Of Polypropylene Micro Fiber

Sl No	Properties	Technical Data
01	Appearance	White fiber
02	Fiber denier	6.0 +/ -10%
03	Length	12mm
04	Breaking tenacity	4.4 + /- 10%
05	Breaking elongation %	100 + /-30
06	Wettability	Excellent in water
07	Dispersibility	Excellent in water
08	Melting point	1675-170
09	Specific gravity	0.91

G. Super Plasticizer:

The used superplasticizer Fosroc conplast SP430 in project work, it is taken from Sree Vinayaka agencies authorized stockiest-fosroc chemicals(India) Pvt Ltd, Bangalore. The conplast SP430 complies with IS 9103:1999.

Table No 9: Physical Characteristics Of Super Plasticizer

Sl No	Description	Results
01	Colour	Brown
02	Specific Gravity	1.22 - 1.225
03	Chloride Content	IS- 456
04	Air Entrainment	Approx 1%

Fig No: 7 Sample Of Superplasticiser

H. Water :

According to IS 456-2000 specification for all works on concrete potable water without excess salt is used in works

III. MIX DESIGN:

Table No:10 Obtain Quantity And Proportion of Materials For 1 Meter-Cube of M-45 Grade of Concrete.

Particular	Cement (Kg/m^3)	Fine Aggregate(Kg/m^3)	Coarse Aggregate (Kg/m^3)	W/C Ratio (Kg/m^3)
Quantity	414	667	1277	149
Proportion	1	1.611	3.08	0.36

Table No:11 Mix Type And Description Details As Follows

Sl No	Mix Type	Description
01	MIX-1	100%OPC+100%F.A+100%C.A+0.8% super plasticizer
02	MIX-2	90%OPC+100%F.A+100%C.A+5%GGBS+5 %Fly ash +0.9%super plasticizer
03	MIX-3	80%OPC+100%F.A%+100%C.A+10%GGBS +10%Fly Ash+0.9% super plasticizer
04	MIX-4	70% OPC +100%F.A+100%C.A+15%GGBS+15%Fly Ash+0.9% super plasticizer
05	MIX-5	60%OPC+100%F.A+100%C.A+20%GGBS+ 20%Fly Ash +0.9% super plasticizer
06	MIX-6	50%OPC +100%F.A+100%C.A+25%GGBS+25%Fly Ash +0.9% super plasticizer
07	MIX-7	100%OPC+100%F.A+100%C.A+0.8% super plasticizer+1% fiber
08	MIX-8	90%OPC+100%F.A+100%C.A+5%GGBS+5 %Fly ash +0.9%super plasticizer+1% fiber
09	MIX-9	80%OPC+100%F.A%+100%C.A+10%GGBS +10%Fly Ash+0.9% super plasticizer+1% fiber
10	MIX-10	70% OPC +100%F.A+100%C.A+15%GGBS+15%Fly Ash+0.9% super plasticizer+1%fiber
11	MIX-11	60%OPC+100%F.A+100%C.A+20%GGBS+ 20%Fly Ash +0.9 %super plasticizer+1% fiber
12	MIX-12	50%OPC +100%F.A+100%C.A+25%GGBS+25%Fly Ash +0.9% super plasticizer+1% fiber

IV. EXPERIMENTAL METHODOLOGY:

A. Compression Strength Test :

The dimension of the mould 150mm x 150mm x 150 mm. the moulds are cast as per mix design, Then casting moulds with various percentage of replacement 0%, 5%, 10%, 15%, 20%, 25% of cement through GGBS and Fly Ash with the addition of 1% of Polypropylene microfiber. The moulds are cast for 3,7, and 28 days. After completion of the curing period, the compression test will be conducted using CTM machine. It is calculated by using formula

$$\text{Compression strength} = \frac{P}{A}\ N/mm^2$$

∴ P = compression load
A = Cross section area

Fig No: 8 Cube Coasting And Testing

B. Tensile Strength Test :

The dimension of the cylinder 100mm x 200mm. the cylinders are cast as per mix design, Then casting cylinder with various percentage of replacement 0%, 5%, 10%, 15%, 20%, 25% of cement through GGBS and Fly Ash with the addition of 1% of Polypropylene microfiber. The cylinder is cast for 7, and 28 days. After completion of the curing period, the tensile strength test will be conducted using CTM machine. It is calculated by using formula

$$\text{Tensile Strength Test} = \frac{2P}{\pi DL}\ \text{N/mm}^2$$

∴ P = Failure of load D= diameter of cylinder
L = length of cylinder

Fig No: 9 Tensile Testing Of Samples

C. Flexural Test :

The dimension of the beam100mm x 100mm x 500mm. the beams are cast as per mix design, Then casting beams with various percentage of replacement 0%, 5%, 10%, 15%, 20%, 25% of cement through GGBS and Fly Ash with the addition of 1% of Polypropylene microfiber. The beams are cast for 7, and 28 days. After completion of the curing period, the flexural strength test will be conducted. It is calculated by using formula

$$\text{Flexural strength} = \frac{Pl}{bd2}$$

∴ P = failure of load L = length of beam
b = thickness of beam d = depth of the beam

Fig No:10 Flexural Testing Of Samples

V. RESULTS AND DISCUSSION

A. Slump Cone Test: The slump cone is conducted to know the workability of concrete. the dimensions of the specimens are a top diameter of the cone is 10cm, the bottom diameter of the cone are 20cm, the height of the cone is 30 cm. the test was confirmed as per IS 1199-1959 specifications.

Fig No: 11 Slump Test

Table No: 12 Slump Cone Test Values

Mix Type	Slump Results (Cm)
MIX-1	2.5
MIX-2	1.2
MIX-3	1.3
MIX-4	2
MIX-5	2.1
MIX-6	1.5
MIX-7	2
MIX-8	1.3
MIX-9	1.6
MIX-10	1.4
MIX-11	1.2
MIX-12	1.5

B. Compaction Factor Test: The experiment was conducted as per the requirement of IS-1199-1959. The workability was found outs, the following are the dimension of upper hopper, lower hopper, cylinder. the following formula used to find out the compaction factor

$$\text{Compaction factor} = \frac{\text{weight of partially compacted concrete}}{\text{weight of hand compacted concrete}}$$

Fig No:12 Test On Samples Of Workability

Table No: 13 Compaction Factor Test Values

Mix type	Values
MIX-1	0.86
MIX-2	0.79
MIX-3	0.86
MIX-4	0.84
MIX-5	0.87
MIX-6	0.84
MIX-7	0.84
MIX-8	0.85
MIX-9	0.85
MIX-10	0.85
MIX-11	0.85
MIX-12	0.85

C. Compression Test:

Table No: 14 the compression strength results for 3 days, on various mixes as shown in below

Mix type	Area (mm^2)	Avg Compression Strength (N/mm^2)
MIX-1	150X150	16.29
MIX-2	150X150	16.73
MIX-3	150X150	17.18
MIX-4	150X150	17.99
MIX-5	150X150	17.77
MIX-6	150X150	17.03
MIX-7	150X150	16.66
MIX-8	150X150	17.33
MIX-9	150X150	17.99
MIX-10	150X150	18.51
MIX-11	150X150	17.18
MIX-12	150X150	16.88

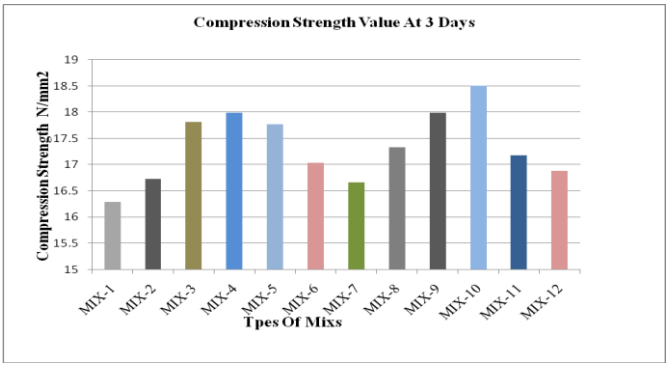

Chart No: 1 Compression Strength At 3 Days

Table No:15 the compression strength results for 7 days, on various mixes as shown in below

Mix Type	Area (mm^2)	Avg Compression Strength (N/mm^2)
MIX-1	150X150	32.36
MIX-2	150X150	33.18
MIX-3	150X150	34.07
MIX-4	150X150	35.92
MIX-5	150X150	35.03
MIX-6	150X150	33.92
MIX-7	150X150	33.39
MIX-8	150X150	34.52
MIX-9	150X150	35.92
MIX-10	150X150	37.18
MIX-11	150X150	34.51
MIX-12	150X150	33.77

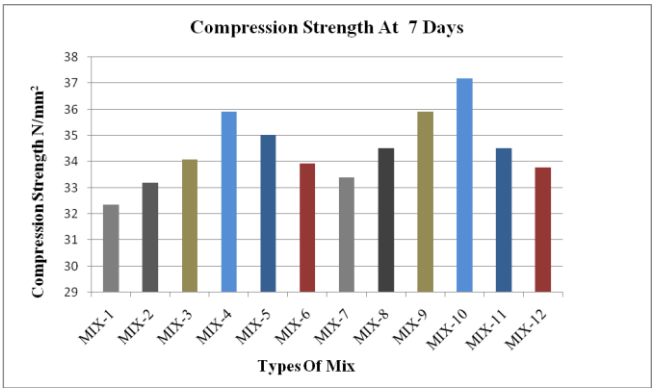

Chart No: 2 Compression Strength At 7 Days

Table No:16 the compression strength results for 28days, on various mixes as shown in below

Mix types	Area (mm^2)	Avg Compression Strength (N/mm^2)
MIX-1	150X150	53.99
MIX-2	150X150	55.84
MIX-3	150X150	57.18
MIX-4	150 X150	59.99
MIX-5	150 X150	59.12
MIX-6	150X150	56.66
MIX-7	150 X150	55.47
MIX-8	150 X150	57.92
MIX-9	150 X150	59.98
MIX-1O	150 X150	61.75
MIX-11	150 X150	57.33
MIX-12	150 X150	56.44

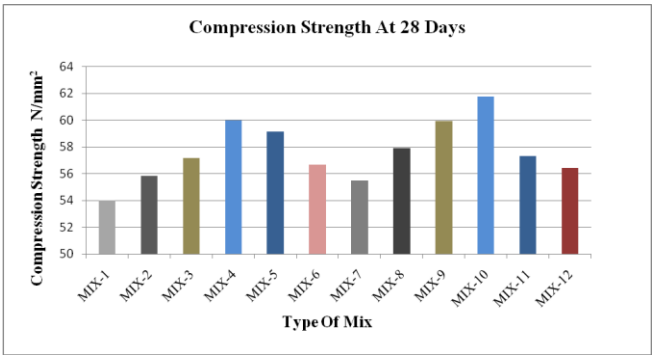

Chart No :3 Compression Strength At 28 Days

D. Split Tensile Test :

Table No : 17 Split Tensile Strength Values At 7 Days

Mix Types	Size of cylinder (mm^2)	Average Split Tensile Strength (N/mm^2)
MIX-1	100X200	3.81
MIX-2	100X200	3.95
MIX-3	100X200	4.09
MIX-4	100X200	4.31
MIX-5	100X200	4.24
MIX-6	100X200	4.05
MIX-7	100X200	4.00
MIX-8	100X200	4.11
MIX-9	100X200	4.31
MIX-10	100X200	4.47
MIX-11	100X200	4.19
MIX-12	100X200	4.05

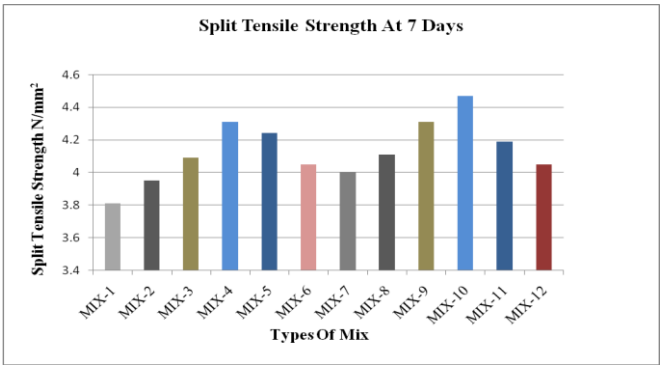

Chart No: 4 Split Tensile Strength At 7 Days

Table No: 18 Split Tensile Strength at 28 Days

Mixes Types	Size of cylinder (Mm^2)	Average Split Tensile Strength (N/mm^2)
MIX-1	100X200	5.37
MIX-2	100X200	5.64
MIX-3	100X200	5.92
MIX-4	100X200	6.16
MIX-5	100X200	6.04
MIX-6	100X200	5.75
MIX-7	100X200	5.62
MIX-8	100X200	5.99
MIX-9	100X200	6.21
MIX-1O	100X200	6.35
MIX-11	100X200	5.90
MIX-12	100X200	5.66

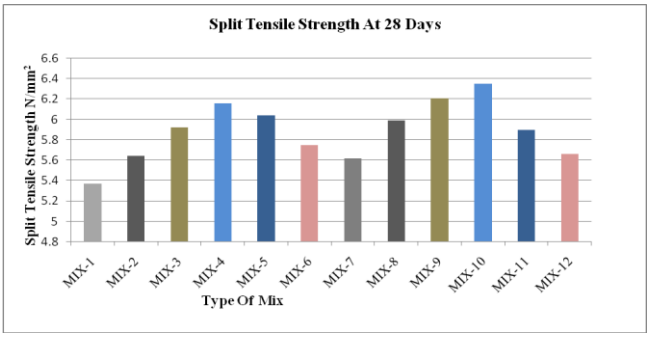

Chart no: 5 split tensile strength at 28 days

E. Flexural Test:

Table No : 19 Flexural Test Value For 7 Days

Mix types	Size of beam(Mm^2)	Avg Flexural Strength (N/mm^2)
MIX-1	100X100X500	3.23
MIX-2	100X100X500	3.37
MIX-3	100X100X500	3.43
MIX-4	100X100X500	3.65
MIX-5	100X100X500	3.33
MIX-6	100X100X500	3.30
MIX-7	100X100X500	3.39
MIX-8	100X100X500	3.47
MIX-9	100X100X500	3.69
MIX-10	100X100X500	3.76
MIX-11	100X100X500	3.42
MIX-12	100X100X500	3.33

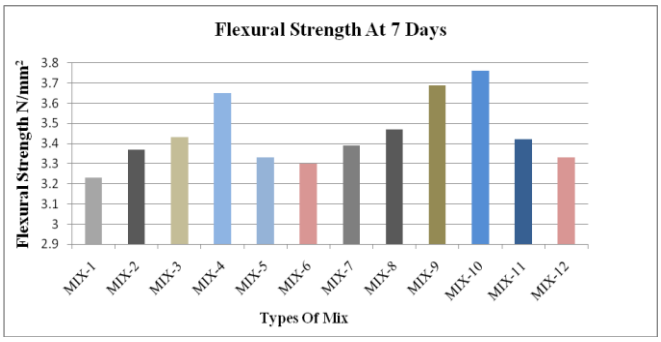

Chart No: 6 Flexural Strength At 7 Days

Table No: 19 Flexural Test For 28 Days.

Mix types	Size of beam(Mm^2)	Avg Flexural Strength (N/mm^2)
MIX-1	100X100X500	6.52
MIX-2	100X100X500	6.62
MIX-3	100X100X500	6.85
MIX-4	100X100X500	7.13
MIX-5	100X100X500	7.00
MIX-6	100X100X500	6.82
MIX-7	100X100X500	6.59
MIX-8	100X100X500	6.89
MIX-9	100X100X500	7.26
MIX-1O	100X100X500	7.45
MIX-11	100X100X500	6.84
MIX-12	100X100X500	6.71

VI. CONCLUSION

The mechanical properties like compression, split and flexural strength is increasing the various type of mix. The strength increases more than normal concrete.

1) The compression strength increases more than normal concrete, The mix-4 is increasing the strength, for replacement of OPC by 15%GGBS, 15%Fly ash, without adding fiber, the compressive strength is increased mix-4 59.99 N/mm^2 at 28 days,

2) The compression strength is increasing mix- 10 more than mix-4 concrete, the mix-10 increases the strength, for replacement of OPC by 15% GGBS, 15% Fly ash and adding 1% fiber, the increases compressive strength concrete mix-10 61.75 N/mm^2 for 28 days.

3) The Tensile strength is increased mix-4 more than normal concrete, the replacement of cement by 15% GGBS,15%Fly Ash, without adding fiber, the split tensile strength is increasing mix-4 6.16N/mm^2 at 28days.

4) The Tensile strength is increased mix-10 more than mix-4, replacement of OPC by 15%GGBS, 15% Fly Ash and adding 1% fiber, The split tensile strength is increasing mix-10 6.35N/mm^2 for 28 days.

5) The flexural strength improved more than normal concrete, the mix-4 has increased the strength, replacement of OPC by 15% GGBS, 15 Fly Ash, without adding fiber, the flexural strength is increasing mix-4 7.13 N/mm^2 for 28 days.

6) The flexural values are increased mix-10 more than mix-4, replacement of OPC by 15%GGBS, 15% Fly Ash, with adding 1% fiber, the flexural strength is increasing mix-10 7.45N/mm^2 at 28 days.

7) The present research using materials like GGBS, Fly Ash, Fiber, etc are given more strength for concrete.

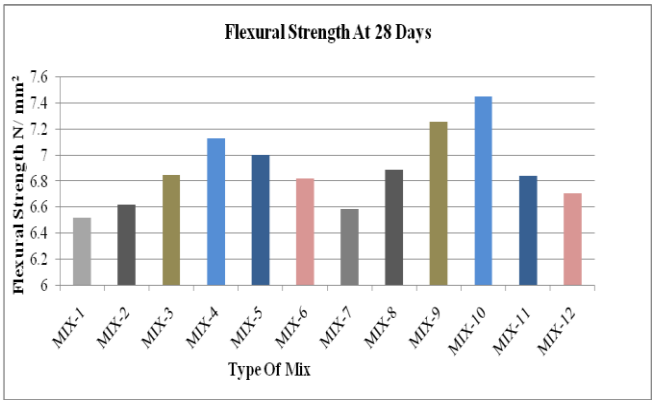

Chart No:7 Flexural Strength At 28 Days

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