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EXPERMENTAL STUDY ON SPLIT TENSILE STRENGTH OF FLY ASH, GGBS BASED M25 CONCRETE

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Abstract :

The Present research study deals with the effect of Class F Fly ash (FA)[1, 2] , Ground Granulated Blast Furnace Slag (GGBS)[3,4].These materials may be naturally occurring industrial waste or by-products that are less energy intensive. Most commonly used pozzolanas are FA, GGBS. The present research work focuses on investigating the characteristic strengths of M25[5] grade concrete with partial replacement of cement[6] by GGBS and FA (F5G5), (F10G10), (F15G15), (F20G20), (F25G25), (F30G30), (F35G35), (F40G40), (F45G45) and (F50G50). The cylinder specimens are tested for split tensile strength[7,8] for 7days and 28days. In the present experimental study, the influence of FA and GGBS on M25 grade concrete by replacing the cement with FA and GBBS in suitable proportions is carried out. The experimental results are discussed and presented with necessary tables and graphs.

***Index Terms* – Fly ash, Ground Granulated Blast Furnace Slag, Cement, Fine aggregate, coarse aggregate.**

I. INTRODUCTION

Concrete is the mixture of cement, water, additives or sometimes super-plasticizers. Concrete is considered as durable and strong material and is one of the most popular materials used for construction all around the world. Concrete will be exposed to deterioration in some regions, in order to overcome this problem many researches are being carried out. Production Cement not only consumes natural resources, but also releases harmful gases in to the atmosphere. Since carbon di- oxide is a major pollutant in atmosphere, reducing its production is inevitable. The most effective way to cut off the CO_2 emission is to replace it with by suitable substitute pozzolanic materials. These materials are called supplementary cementing materials (SCM's)[9]. The supplementary cementing materials used in this present research work are Ground Granulated Blast Furnace Slag (GGBS), Fly ash (FA). In the present experimental study, the influence of FA and GGBS on M25 grade concrete by replacing the cement with FA and GBBS in suitable proportions is carried out.

II. **Experimental investigation:** The experimental program consists of determination of the partial replacement of cement with FA and GGBS. The experimental program includes casting and testing of cylindrical specimens (150mm diameter and 300mm height) for split tensile strength[5]. All the specimens are of M25 grade concrete. The mixture is prepared with various percentages of FA, GGBS. Eleven different cement to combination of FA, GGBS proportions (100:0, 90:10, 80:20, 70:30, 60:40, 50:50, 40:60, 30:70, 20:80, 10:90 and 0:100) are used. Six identical specimens for each variation were cast and tested after 7 days and 28 days of curing.

III. **Materials:** Fly ash, GGBS, Cement, Coarse aggregate, Fine aggregate. The standard value of Specific gravity of GGBS are 2.17 and 2.90 . The physical properties of GGBS are mentioned in table 2. Zone II of IS 383:1970 natural river sand was used. Specific gravity and fineness modulus of sand used were 2.32 and 2.81 respectively. 12 mm size coarse aggregate from local source was used.

Table 1: Physical properties of FLY ASH:

Sl.no	Properties	Values
1.	Fineness	45 µ
2.	Specific gravity	1.90 to 2.96
3.	Size and shape	10 to 100µ

Table 2: Physical properties of GGBS:

Sl.no	**Properties**	**Values**
1	Color	Off white
2	Specific gravity	2.9
3	Bulk density	1200kg/m^3
4	Dry density	350m^2/kg

Table 3: Chemical Composition of Fly ash and GGBS percentage by mass.

Component	**Bituminous**	**Sub-bituminous**	**Lignite**
SiO_2(%)	20-60	40-60	15-45
AlO_3(%)	5-35	20-30	20-25
FeO_3(%)	10-40	4-10	4-15
CaO(%)	1-12	5-30	15-40
LOI(%)	0-15	0-3	0-5

IV. **Mix proportions:**

Mix calculations:

Area of cylinder = $\pi/4 \times d^2$

$= \pi/4 \times 0.1^2$

$= 0.00787\ m^2$

Area of cylinder $= 7087\ mm^2$

Volume of cylinder $= 7.87 \times 200$

$= 1574\ mm^2$ or $1.574\ m^2$

Quantity of concrete $= 1.574 \times 10^{-3} \times 2400$

$= 3.77$kg

Total quantity $= 3.77 \times 6$

$= 22.62$kg

Quantity of cement for M25 grade concrete (1:1:2)

$= 22.62 \div 4$

$= 5.65$ kg

Quantity of fine aggregate =5.65 kg

Quantity of coarse aggregate =11.3 kg

SL.NO	designation	Cement	FLY ASH	GGBS	SLUMP
1	F0G0	100%	0%	0%	80
2	F5G5	90%	5%	5%	75
3	F10G10	80%	10%	10%	71
4	F15G15	70%	15%	15%	68
5	F20G20	60%	20%	20%	65
6	F25G25	50%	25%	25%	62

Table 4: Mix proportions

Mix	Binder Proportions			Weight of Cement (kg)	Weight of FA (kg)	Wt.of GGBS (kg)
	Cement	Fly ash	GGBS			
M0	100	0	0	5.65	0	0
M1	90	5	5	5.08	0.16	0.16
M2	80	10	10	4.52	0.60	0.60
M3	70	15	15	3.95	0.85	0.85
M4	60	20	20	3.39	1.10	1.10
M5	50	25	25	2.82	1.45	1.45
M6	40	30	30	2.26	1.75	1.75
M7	30	35	35	1.69	2.00	2.00
M8	20	40	40	1.13	2.26	2.26
M9	10	45	45	0.56	2.54	2.54
M10	0	0	0	0	2.82	2.82
			Total	31.05	15.53	15.53

Table 5: SLUMP TEST RESULTS

V. **Casting of specimens:** Concrete consists of GGBS, FA, coarse aggregate, fine aggregate are firstly mixed dryly and then mixed with the sufficient water. The dry mixture of concrete is mixed for 3-4 minutes and the wet mixture is mixed for 4-5 minutes. Six cylindrical specimen moulds were prepared. The concrete mixture is usually very cohesive in nature. The workability of concrete can be tested by the slump cone test[10]. For casting the cylinder, the moulds should be cleaned and oil has to be applied with lubricate in all sides, before concrete is filled in to the casting moulds. Thoroughly mixed concrete is filled in to the mould layer by layer and tamped with the tamping rod to reduce the voids. Whole casting is followed according to IS code 10086-1882. The standard size of cylinder specimen is 150mm diameter and 300mm length.. After 24 hours the casted specimens were de-moulded and then cured. The specimens should be cured as explained above and are tested as per Indian Standard: 516-1959 after removal from the curing tank and allowed to dry under shade. The tensile strength of concrete is the method of a cylinder which splits across the vertical diameter. The strength should be the average of six tested specimens. Cylinders were tested for their split tensile strength.

Table 6: SPLIT TENSILE STRENGTH OF M20 GRADE CONCRETE WITH DIFFERENT % OF GGBS & FA

SL.NO	MIX	PROPORTIONS (percentage)			SPLITE TENSILE STRENGTH		
		CEMENT	FA	GGBS	7 DAYS	28 DAYS	$\frac{7DAYS}{28\ DAYS}$
1.	M1	10	45	45	1.81	2.74	0.66
2.	M2	20	40	40	2.01	2.85	0.69
3.	M3	30	35	35	2.09	3.07	0.70
4.	M4	40	30	30	2.27	3.19	0.71
5.	M5	50	25	25	2.30	3.25	0.73
6.	M6	60	20	20	2.45	3.31	0.74
7.	M7	70	15	15	2.50	3.42	0.75
8.	M8	80	10	10	2.63	3.60	0.76
9.	M9	90	5	5	2.79	3.79	0.77
10.	M10	100	0	0	2.90	3.95	0.80

2.1 Results and Discussions

The effect of GGBS to FA ratio on Split tensile Strength of Geopolymer concrete is shown in fig 1.

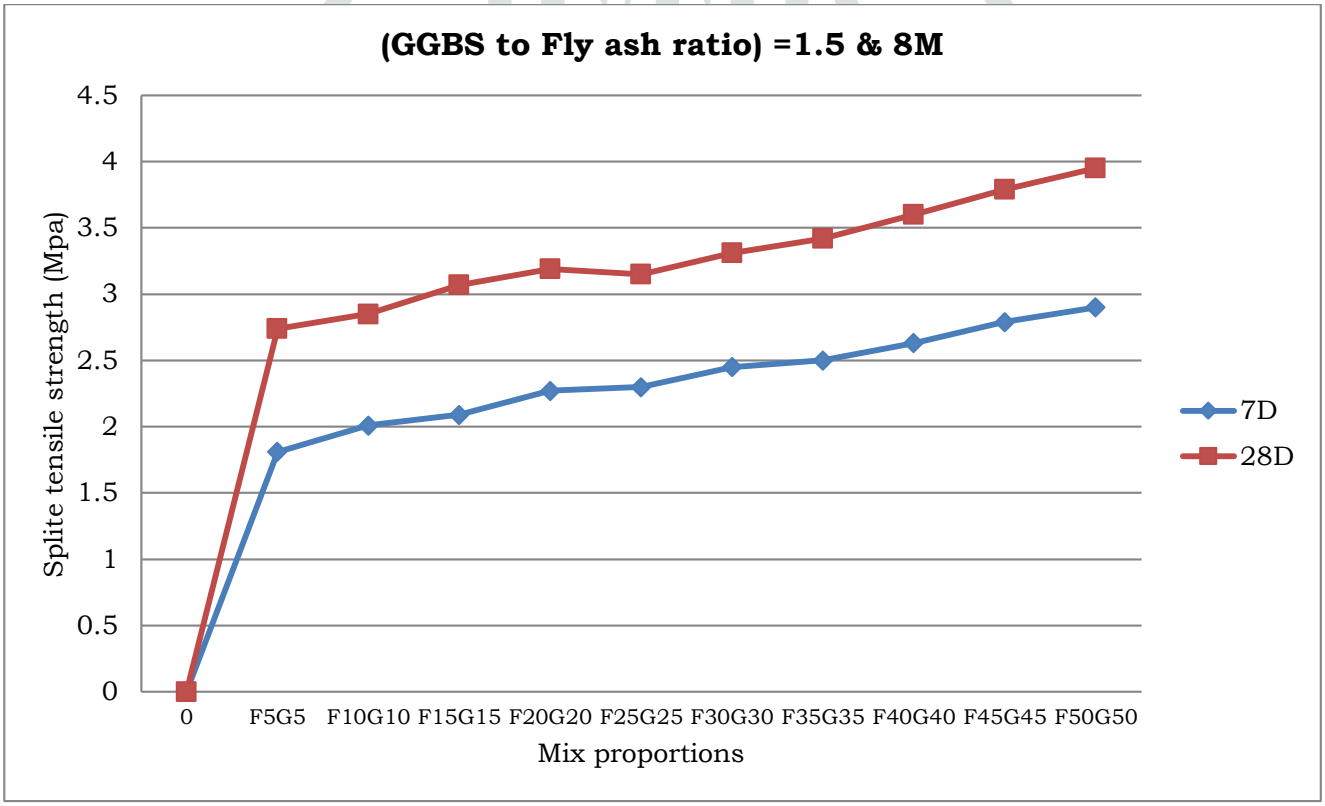

Fig 1: Variation of Split tensile strength of FA-GGBS based M25 concrete

3. Conclusion

The following conclusion can be made from the analysis of test results.

1. The GGBS increases the workability as compared to normal concrete.
2. The 7 days and 28 days Split tensile strength of fly ash-GGBS based M25 grade concrete increased, with increase in GGBS proportion.
3. It is proved that the GGBS can be used in addition to fly ash for improvement of split tensile strength of concrete as fly ash has hot low binding properties.
4. Usage of fly ash and GGBS reduces the consumption of cement which will reduce the cost, also helps in controlling the depletion of natural resources used in the manufacturing of cement.

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