Effect of Addition and Replacment of GGBS and Flyash with Cement in Concrete

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***Abstract*- This study is to work out the effect of mineral admixture GGBS and Fly ash in concrete of grade M-35 & M-40 when it is added in & replaced for the fresh state and hardened state i.e. for workability and strength of concrete using OPC (43 grade). As mineral admixture GGBS and Fly ash have been added to OPC which varies from 5% to 30% at interval of 5% by total weight of OPC and the same as partial replacement of OPC (43 grade) which varies from 5% to 30% at interval of 5% by total weight of OPC.various range of addition and replacement of cement by GGBS and Fly Ash in the concrete. All mixes of concrete were examined for workability as slump test of fresh concrete. Hardened concrete was examined for Compressive strength for 7days and 28 days.Slump was found higher in partial replacement at 30% (GGBS & Fly ash) as compared to that of addition of GGBS & Fly ash.**

I. INTRODUCTION

Concrete is a versatile structural material in the modern construction industries. Now a day's concrete is utilized in abundance as man utilizes water for its survival. It has no doubt that with the development of world civilization the concrete will be the major construction material in the coming future. Also looking to the environment t concern, concrete using waste shall be developed. About 1 tonne of Carbon Dioxide (CO_2)is generated in manufacturing of each tonne of Ordinary Portland cement (OPC).The cement production has 5% of total global CO2 emissions. So by replacing partially OPC by some waste materials shall not only add some additional properties to concrete but also controls the atmospheric pollution.

The quality concrete will only perform best if it improves mainly upon workability, flow ability, durability& resistance to chemical attack/corrosion and reduction in w/c ratio, heat of hydration & segregation in addition to the strength characteristic. Many researchers have performed research on mix design of concrete (normal and high strength concrete) for improving performance and strength but no researchers have performed for conventional so as to study the variation/ influence/ improvement/ enhance performance of it by using GGBS and Fly ash has been added into OPC in such a regular variation from 5% to 30% at interval of 5% by total weight of OPC and partial replacement of OPC by GGBS and Fly ash which varies from 5% to 30% at interval of 5% by total weight of OPC for M35 Containing mineral admixtures within pozzolonic concretes are used extensively throughout the world for their good performance and for ecological and economic reason and the applications of such concretes are increasing day by day due to their superior structural performance, environmental friendliness and energy conserving implications. Mineral admixture, super plasticizer and retarders etchave played effective role for producing high performance concrete. In India GGBS is a better industrial recyclable composite material for cement to mix with natural fine aggregate and coarse aggregate for improving conventional concrete performance. GGBS is a well processed product which is based on high glass content slag with high reactivity and is obtained through the progressive process of controlled granulation. The raw materials which are composed primarily of low calcium silicates. It reduces the water demand and heat of hydration which tends to improve the compressive strength and workability aid to improve flow of concrete. Hence, an attempt has been made to utilize low cost green material in this study i.e. GGBS (12000) in preparation of M35.

Table 1. Comparison of properties between GGBS (12000) and GGBS(8000)

Analysis	Range	
	GGBS (12000)	GGBS(8000)
Bulk Density (kg/m^3)	700-900	750-850
Surface Area (cm^2/gm)	12000	8000
Particle Shape	Irregular	Irregular
Particle Size	N/A	N/A
d10	1.5 micron	N/A
d50	5 micron	<7 micron
d95	9 micron	<20 micron
Specific Gravity	2.9	2.9
CaO (%)	61-64	30-34
Al_2O_3 (%)	05-5.6	18-25
Fe_2O_3 (%)	3.8-4.4	0.8-3.0
SO_3 (%)	02-2.4	0.1-0.4
MgO (%)	0.8-1.4	06-10
SiO_2 (%)	21-23	30-36

II. LITERATURE REVIEW

Jay Patel, Kunal Patel, Gaurav Patel (2013) It was investigated by them on the utilization of pond fly ash as a partial replacement in fine aggregate with using fine fly ash and GGBS in high strength concrete i.e. replacing the GGBS and fly ash partially with the cement and pond fly ash as a replacement of the fine aggregate and have made various deviation in all mixes for compressive strength for using 6% GGBS as a cement replacement and 10% pond ash as a replacement in fine aggregate got maximum strength and for flexural strength and tensile strength with using 6% GGBS as a cement replacement and 10% pond ash as a replacement in fine aggregate did not get the desire strength .

Shaikh Mohd Zubair and S.S. Jamkar His investigation was carried out by replacing 10% fly ash along with 17% of alccofine and 10% fly ash along with 17% of silica fume by weight of cementitious material forvarious water binder ratio (W/b) of 0.25, 0.3 and 0.35 in order to investigate 7 days and 28 days compressive strength of the concrete. The specimen with three mixes M1, M2 and M3 with W/B ratio as 0.25, 0.30 and 0.35 with replacement cementitious material by 10% fly ash along with 17% alccofine and 10% fly ash alongwith 17% silica fume. It was concluded that compressive strength at both the 7 Days and 28 Days with the Fly ash (10%) + alccofine (17%) replacement of cement was higher than the Fly ash (10%) + silica fume(17%) replacement of cement. At 7 days it was recorded the maximum compressive strength of 60.5 N/mm2 with Fly ash (10%) + alccofine (17%) and 58 N/mm2 with Fly ash (10%) + silica fume(17%) out of three mixes. At 28 days it was recorded the maximum compressive strength of 79 N/mm2 with Fly ash(10%) + alccofine (17%) and 76 N/mm2 with Fly ash(10%) + silica fume(17%) out of three mixes.

P. J. Patel and H. S. Patel (2013) It was studied about the effect of alccofine and Fly ash on the compressive and flexural strength of high performance concrete. They partially replaced OPC-53 by Alccofine and fly ash where percentage of Alccofine varies from 4 to 12 % at interval of 2% and Fly ash varies from 26 to 18% at interval of 2% of the total OPC. It was observed that compressive strength at 90 days was maximum compressive strength (even more than targeted mean strength) and in all the mix proportions strength gained up to 7 days was very better, between 7 to 28 days strength gain is little less, but between 28 to 56 days strength gain is high because of fly ash. They have also achieved acceptable flexural strength of beam for all proportion and got maximum flexural strength with (fly ash-20% and Alccofine-10%).

III. EXPERIMENTAL INVESTIGATION

A. Material Used

Cement- Ordinary Portland cement,43 grade specified as per the is 8112-2003 was used for casting the different grade of concrete. Potable water with pH value 7the water cement ratio w/c is fixed to 0.40 according to mix design code IS 10262:2009 and to maintain the slump Kavassu Plast SP-431/ Shaliplast SP-431 admixture is used 1.25% by weight of cement. The initial and final setting time was observed by Vicat apparatus and it was found 32 and 590 minutes respectively. The soundness tested by Le-Chetelier was 8 mm.

Fine aggregate- Fine aggregate size range 150mc to 4.75mm.in present work Banash River (from district Tonk) sand was used with % finer 99.3 with specific gravity 2.62.

Coarse aggregates- Coarse aggregates are particles greater than 4.75mm, but generally range between 9.5mm to 37.5mm in diameter. In this case consider aggregate range 20mm and 10mm particles size was used with specific gravity 2.73.

GGBS-GGBS is a specially processed product based on slag of high glass content with high reactivity obtained through the process of controlled granulation. GGBS reduces the water demand and heat of hydration which tends to improve the compressive strength and workability of concrete. Hence, an attempt has been made to utilize low cost material in this study such as GGBS in preparation of high improved concrete.

Table 2. Physical Analysis material

Physical Analysis	Range
Bulk Density	700-900 kg/m^3
Surface Area	12000cm^2/gm
Particle Shape	Irregular
Particle Size	N/A
d50	5 micron
d95	9 micron
Specific Gravity	2.9

B. Mix Design and Experimental Work

In present study work the nominal mix is taken M35 and it is mix design code IS 10262:2009. As discuss earlier the W/C ratio is fixed to 0.40 and to maintain the slump a suitable 1.25 % by weight of cement admixture is used.

Table 3. Addition of GGBS and Fly ash into OPC for M35

S. No.	Mix Name	Cement (Kg)	GGBS (Kg)	Fly ash (Kg)	Coarse Aggregate (Kg)		Fine Aggregate(Kg)	Water (Kg)	Admixture (Kg)
					20mm	10mm			
1	OPC+GGBS+FA (100+0+0)	402.5	0.00	0.00	654	425	802	160	5.1
2	OPC+GGBS+FA (100+5+5)	402.5	20.125	20.125	654	425	802	160	5.1
3	OPC+GGBS+FA (100+10+10)	402.5	40.25	40.25	654	425	802	160	5.1
4	OPC+GGBS+FA (100+15+15)	402.5	60.375	60.375	654	425	802	160	5.1
5	OPC+GGBS+FA (100+20+20)	402.5	80.50	80.50	654	425	802	160	5.1
6	OPC+GGBS+FA (100+25+25)	402.5	100.625	100.625	654	425	802	160	5.1
7	OPC+GGBS+FA (100+30+30)	402.5	120.75	120.75	654	425	802	160	5.1

Table 4. Replacement of GGBS and Fly ash into OPC for M35

S. No.	Mix Name	Cement (Kg)	GGBS (Kg)	Fly ash (Kg)	Coarse Aggregate (Kg)		Fine Aggregate(Kg)	Water (Kg)	Admixture (Kg)
					20mm	10mm			
1	OPC+GGBS+FA (100+0+0)	402.5	0.00	0.00	654	425	802	161	5.1
2	OPC+GGBS+FA (90+5+5)	362.25	20.125	20.125	654	425	802	161	5.1
3	OPC+GGBS+FA (80+10+10)	322	40.25	40.25	654	425	802	161	5.1
4	OPC+GGBS+FA (70+15+15)	281.75	60.375	60.375	654	425	802	161	5.1
5	OPC+GGBS+FA (60+20+20)	241.5	80.50	80.50	654	425	802	161	5.1
6	OPC+GGBS+FA (50+25+25)	201.25	100.625	100.625	654	425	802	161	5.1
7	OPC+GGBS+FA (40+30+30)	161	120.75	120.75	654	425	802	161	5.1

IV RESULTS AND ANALYSIS

A. Workability Test

Table 5. Slump on Addition of GGBS & Fly ash into OPC For M35 Grade

S.No	Mix (Cement + GGBS + Fly ash)	Slump (mm)
1.	OPC+GGBS+FA (100+0+0)	103
2.	OPC+GGBS+FA (100+5+5)	116
3.	OPC+GGBS+FA (100+10+10)	106
4.	OPC+GGBS+FA (100+15+15)	95
5.	OPC+GGBS+FA (100+20+20)	90
6.	OPC+GGBS+FA (100+25+25)	85
7.	OPC+GGBS+FA (100+30+30)	81

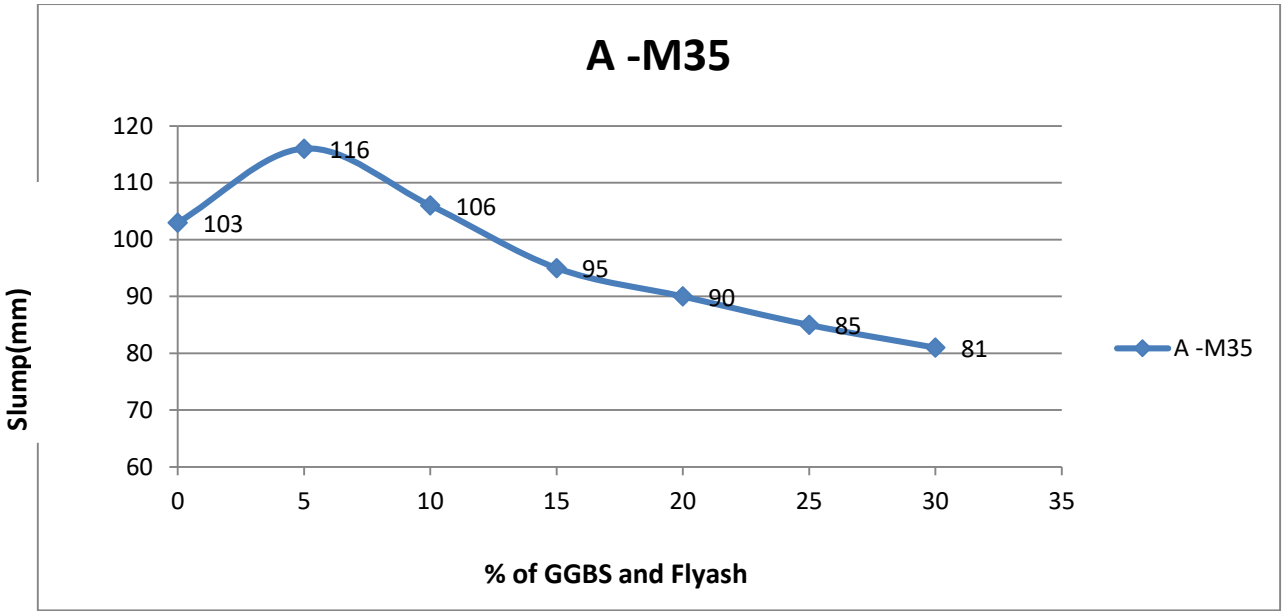

Fig. 2. Effect of GGBS and Fly ash on Slump of Concrete (M-35) on Addition

Table 6. Slump on Replacement of GGBS&Fly ash into OPC For M35 Grade

S.No	Mix (Cement + GGBS + Fly ash)	Slump (mm)
1.	OPC+GGBS+FA (100+0+0)	103
2.	OPC+GGBS+FA (90+5+5)	108
3.	OPC+GGBS+FA (80+10+10)	111
4.	OPC+GGBS+FA (70+15+15)	120
5.	OPC+GGBS+FA (60+20+20)	125
6.	OPC+GGBS+FA (50+25+25)	129
7.	OPC+GGBS+FA (40+30+30)	136

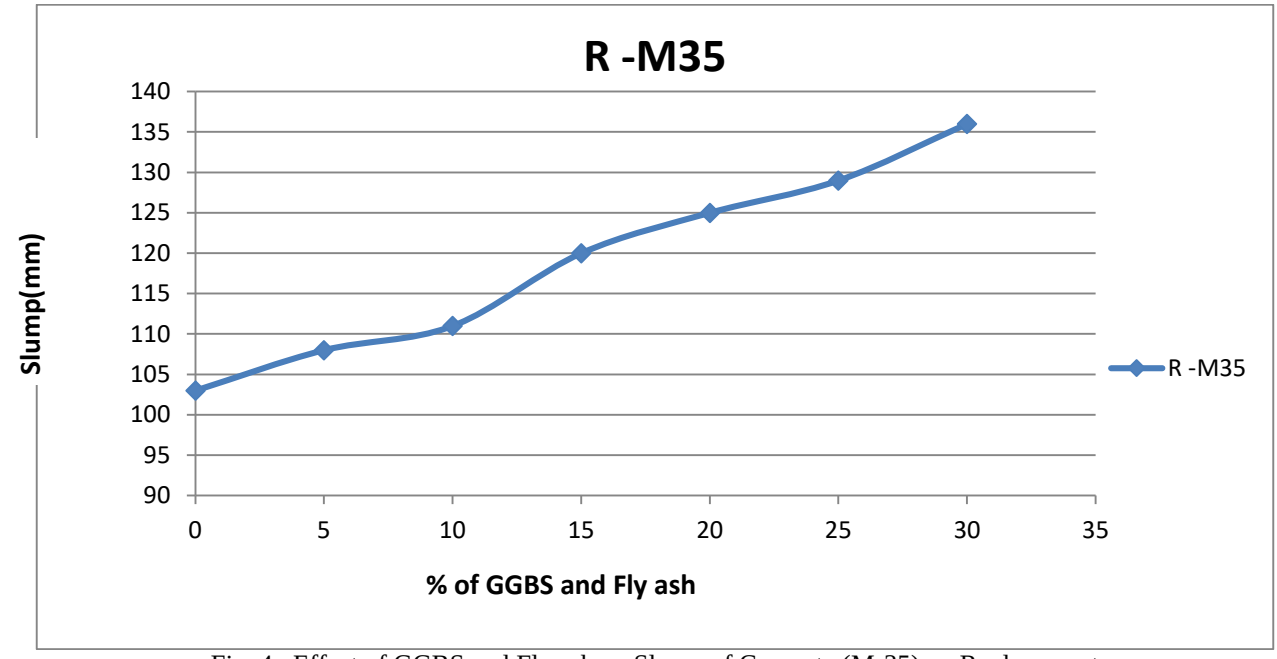

Fig. 4. Effect of GGBS and Fly ash on Slump of Concrete (M-35) on Replacement

B. Density Test Result

Table 7. Density of Hardened Concrete on Addition of GGBS and Fly ash into OPC & Replacement of OPC by GGBS and Fly ash for M35

S.No	Percentage of GGBS And Fly ash	Density of Hardened Concrete (Kg/m^3)	
		Addition	Replacement
1	0-0	2478.92	2478.92
2	5-5	2469.50	2471.54
3	10-10	2499.55	2495.75
4	15-15	2500.19	2481.59
5	20-20	2519.30	2510.52
6	25-25	2535.05	2520.79
7	30-30	2540.19	2535.59

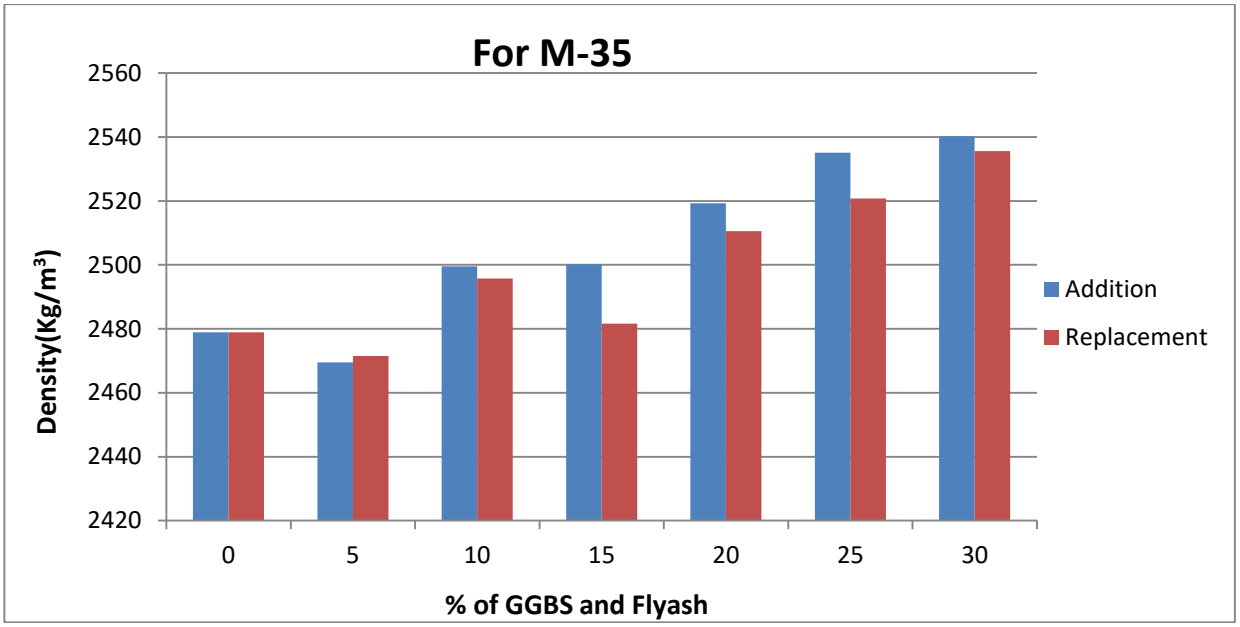

Fig. 5. Effect of GGBS and Fly ash on Density of Hardened Concrete (M-35) on Addition & Replacement

C. Compressive Strength

The compressive strength of all the mixes was determined with cubical specimens of size 150mm(length) x 150mm(width) x 150mm(depth).The specimens were tested after curing period of both 7 days and 28 days fully submerged in water as per IS 516:1959 for the method of tests for strength of concrete.

Table 8. Comparison of Compressive Strength for 7 days on Addition & Replacement For M35 Grade

S.No	Percentage of GGBS and Fly ash	Addition (N/mm^2)	Replacement (N/mm^2)
1	0-0	30.2	30.2
2	5-5	33.02	32.95
3	10-10	35.52	34.05
4	15-15	37.04	36.25
5	20-20	35.98	35.82
6	25-25	34.55	33.68
7	30-30	32.85	32.35

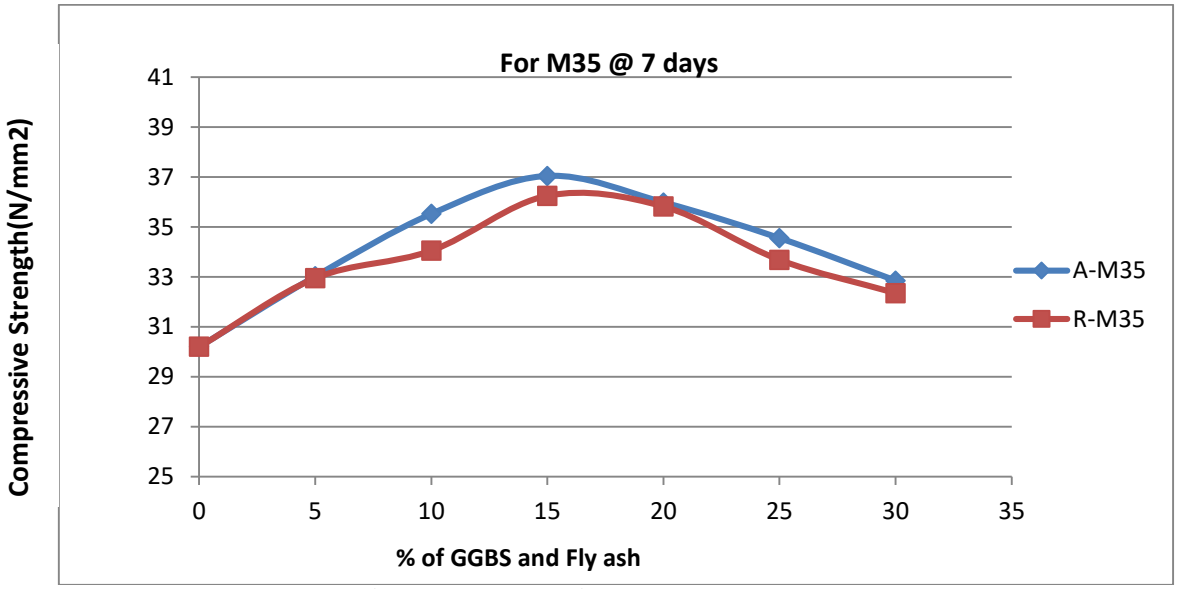

Table 9. Comparison of Compressive Strength for 28 days on Addition & Replacement For M35 Grade

S.No	Percentage of GGBS and Fly ash	Addition (N/mm^2)	Replacement (N/mm^2)
1	0-0	41.95	41.95
2	5-5	46.25	44.13
3	10-10	48.77	47.48
4	15-15	50.75	49.29
5	20-20	48.45	46.55
6	25-25	46.05	45.35
7	30-30	43.17	42.60

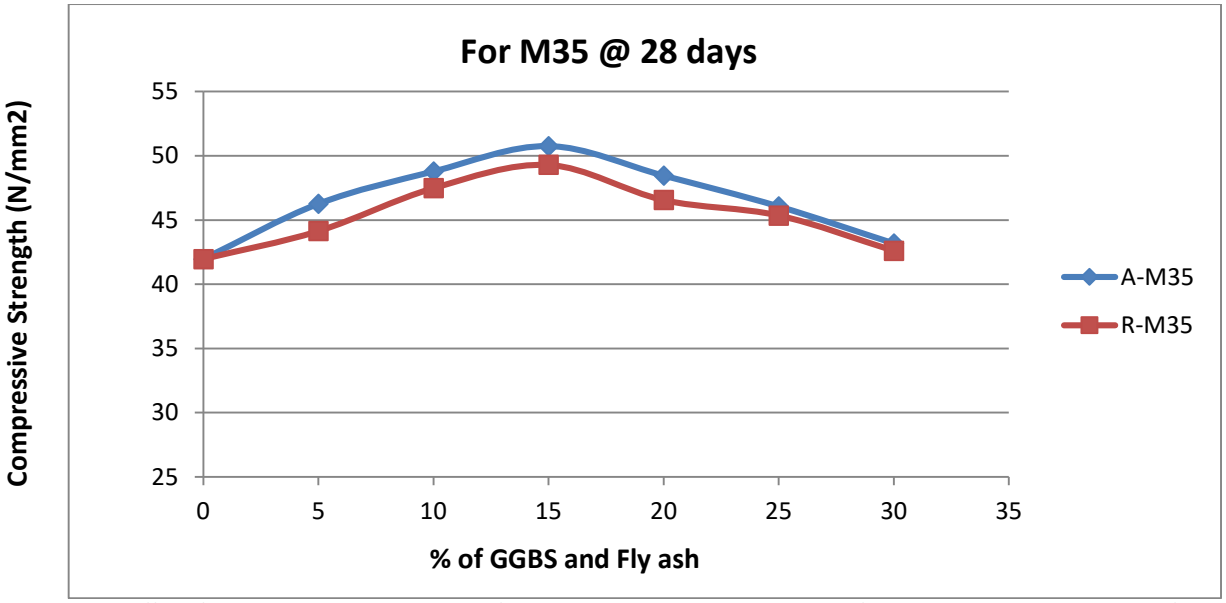

Fig. 5. Effect of GGBS and Fly ash on Concrete of M35 Grade on Addition & Replacement for 28 Days Compressive Strength of Cube

V CONCLUSION

1. By addition of GGBS and Fly ash into OPC, Slump of the concrete mix increased initially (at 5%) as compared to the slump of control mix concrete due to low water demand of GGBS and Fly ash than OPC at initial stage which tends to increase in slump but the slump gradually decreased and came near equal to the slump of control mix at 10% addition
2. On partial replacement of cement by GGBS and Fly ash, the slump of the concrete mix was initially (at 5%) increased as compare to the slump of control mix concrete and slump was gradually increased up to 30 % replacement
3. Compressive strength of concrete was increased in both the mixes of M35 at 15% addition and replacement of GGBS & Fly ash , but when further GGBS & Fly ash was added to OPC or partial replacement of OPC by GGBS & Fly ash is done the Compressive Strength goes on decreasing.
4. Density for M35 grade of hardened concrete was observed to be increased on both addition of GGBS & Fly ash into OPC & partial replacement of OPC by GGBS & Flyash at 30% but was higher on addition at 30% due to decrease in porosity (replacement of water fill by cement particle in the capillary voids), density was increased.

REFERENCES

1. Jay Patel, Kunal Patel and Gaurav Patel, "Utilization Of Pond Fly Ash As A Partial Replacement In Fine Aggregate With Using Fine Fly Ash And GGBS In HSC" *International Journal of Research in Engineering and Technology*, ISSN: 2319-1163 &ISSN: 2321-7308, volume 2, issue 12, pp.600-606, Dec 2013.
2. Shaikh MohdZubair, S.S. Jamkar, "Effect of mineral admixtures on high performance concrete with various W/B ratio", *IJRET: International Journal of Research in Engineering and Technology*, ISSN: 2319-1163 | ISSN: 2321-7308
3. P. J. Patel and H. S. Patel, "Effect On Compressive And Flexural Strength Of High-Performance Concrete Incorporating GGBS And Fly Ash'', *International Journal of Civil, Structural, Environmental and Infrastructure Engineering Research and Development*, ISSN 2249-6866 volume. 3, issue 2, pp.109-114, 2013.
4. Suthar Sunil B and Dr. (Smt.) B. K. Shah, "Study on Strength Development of High Strength Concrete Containing GGBS and Fly-Ash", *Paripex - Indian Journal Of Research*, ISSN - 2250-1991, volume 2, issue 3, pp.102-104, March 2013.
5. Deval Soni, Suhasini Kulkarni and Vilin Parekh,"Experimental Study on High-Performance Concrete, with Mixing of GGBS and Fly ash", *Paripex - Indian Journal of Research*, ISSN - 2250-1991, volume 3, issue 4, pp. 84-86, May 2013