Experimental Analysis of M30 Concrete With Partial Substitute of Cement By Variation of GGBS And Alccofine

Zafar Ali[1], Dr Shreenivas Reddy Shahapur[2], Maneeth P.D[3], Brijbhushan S[4]
[1]Dept of Construction Technology
[2]HOD, Dept of Construction Technology
[3, 4]Professor, Dept of Construction Technology
[1, 2, 3, 4] Visvesvaraya Technological University, PG Studies, Regional Office, Kalaburagi-585103 Karnataka, India.

Abstract- *The aim of the present work is to analyze concrete of grade M30 with water cement ratio of 0.4. GGBS is replaced by 30%, 35%, 40%, and 45% by the weight of cement and Alccofine is replaced by a fixed value of 15% by weight of cement in all samples. 30 no of cubes, cylinder, prism and 15 cylindrical discs are casted for compressive strength test, split tensile strength, flexural strength test and sorptivity test respectively. Therefore concrete with GGBS and Alccofine when used as partial replacement in cement improved the properties of concrete such as good workability, strength, durability, improved permeability, cracks free surface etc.*

Keywords- Concrete, GGBS, Alccofine, Compressive Strength, Split Tensile Strength, Flexural Strength, Sorptivity.

I. INTRODUCTION

Concrete, a material required for the infrastructural growth in developing countries required in huge quantities plays an important role in the construction industry and mineral admixtures such as GGBS used in the concrete for partial replacement of cement in concrete improves the properties of concrete, it benefits the concrete with its chemical composition similar to that of cement. Another mineral admixture called as Alccofine is also added to concrete for partial replacement of cement, the addition of Alccofine improves the performance of concrete in terms of durability due its superior particle distribution, average particle size being 4 micron.

II. MATERIALS USED

Cement: Ordinary Portland cement of specification 53 grade is used in the current study, Sri Balaji brand of cement was used.

Table no- 1; Physical Characteristics of Cement

No	Test	Result Obtained
1	Normal consistency	26%
2	setting time [initial]	65 min
3	setting time [final]	310 min
4	Fineness	5%
5	Specific gravity	3.125

The Fine Aggregate: Fine aggregate that was obtained locally (Shahpur sand) was used, various tests were performed in lab and the observations obtained are tabulated below:

Table no- 2: Physical characteristics of Fine aggregate

No	Test	Results	As per IS 383-1970
1	Specific gravity	2.62	2.60 to 2.80
2	Water absorption	1%	2.30 %
3	Bulk density	1584 kg/m³	1815kg/m³

Coarse Aggregate: Locally obtained broken stone aggregate 20mm down size was adopted. Various tests were performed in lab and observations are tabulated below

Table no- 3: Physical characteristics of Coarse Aggregate

No	Test	Results	As per IS 383-1970
1	Specific gravity	2.68	2.60 to 2.80
2	Water absorption	0.88%	2.0%
3	Bulk density	1662 kg/m³	1885 kg/m³

GGBS: GGBS is used as partial substitute of cement in concrete due to its essential attributes such as chemical composition identical to that of the cement and the replacement level may vary from 30% to 80%. The slag material is mixture which consists of lime (CaO), silica (SiO^2), alumina (Al^2O^3) that are identical to that of cement but not the same as in proportion, the GGBS particles are generally smaller than 4.75mm composed mainly of glass material, so glass material suitable for blending with ordinary Portland cement varies between 90% to 100%.

Table no- 4: Chemical characteristics of GGBS obtained from Jindal Steel Works

Sl. No.	Compound	Percentage content
1	Calcium oxide	33
2	Silicon dioxide	40
3	Iron oxide	2.0
4	Magnesium oxide	8.5
5	Manganese oxide	5
6	Aluminium oxide	10

Alccofine: Alccofine is an especially processed mineral admixture material based on the slag of high amount of glass proportion with greater reactivity produced by the careful granulation procedure. Raw material substance of Alccofine mainly consists of less amount of calcium silicate. The control processing of various ingredients in Alccofine results in precise particle size distribution. Alccofine is controlled graded particle size material smaller in size that of cement and higher in size that of micro silica, Alccofine has particle range from 0.1 to 18 micron and the average size of particle being 4micron.

Alccofine in concrete has many benefits due its superior particle size distribution and chemical properties; the effective enclosure depends on the difference in particle size between admixtures and extent of hydrated substance produced in hydration process. Pores formed by the process of hydration due to the pozzalanic cementious hydration is filled by Alccofine, the benefit of filling of this pores reduces permeability to a great extent, thus improving durability of concrete.

Table no-5: Physical properties of Alccofine

Sl. No.	Parameter	Content
1	Specific gravity	2.9
2	Bulk density	600-700 kg/m³
3	Surface area	12000 cm²/gm
4	Particle size	Irregular (0.1micron-18 micron)

Table no-6: Chemical Composition of Alccofine

Sl. No.	Compound	Percentage Content
1	Calcium oxide	35
2	Silica dioxide	34
3	Alumina	24
4	Magnesium oxide	8
5	Iron oxide	1.5

III. METHODOLOGY

Mix design: It was done as per IS 10262- 2009 and the mix proportions obtained are as follows

Table no-7: Mix Proportions for M30 grade of concrete

Water to cement ratio	Cement	Sand	Coarse Aggregate
0.44	1.0	1.42	2.59

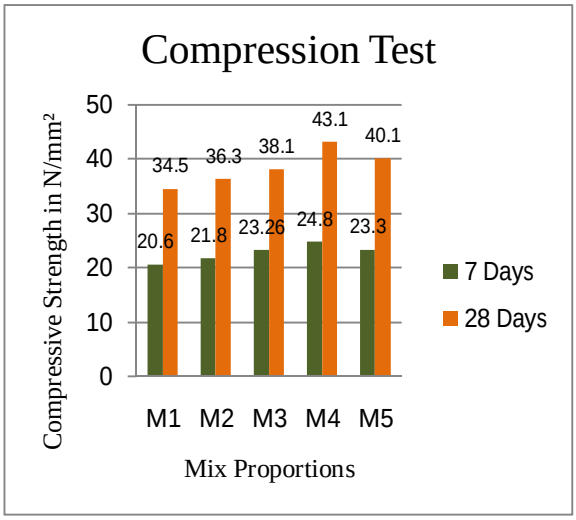
Casting and Curing: Casting of cube is done in the moulds of size 150mm×150mm×150mm, casting of cylinder was done in the moulds of size 150mm diameter×300mm height, casting of prism was done in the moulds of size 100mm×100mm×500mm and casting of cylindrical discs was done in mould of size 100mm diameter×50mm height. Oil was applied to inner surfaces of the moulds in thin layers before pouring of the fresh concrete in the mould in order to avoid the concrete material remaining in mould or sticking to mould. Specimens were kept to set for a period of 24 hours in the mould after casting. Then the samples were taken from the mould and were put in water for 7days and 28days to complete its curing process. The sorptivity test was carried on cylindrical discs, after the curing of cylindrical discs they were dried at a temperature of 100˚+10˚C. Then the discs were immersed in a tray with water level of 5mm from the bottom, and then the capillarity rise of water in the discs is noted.

IV. RESLUTS & DISCUSSIONS

1. Compression Strength test

Table no-8: Compression Test Results at 7 Days and 28 Days

Mix designation	GGBS (%)	Alccofine (%)	Compressive strength @ 7 days (N/mm²)	Compressive strength @ 28 days (N/mm²)
M1	0	0	26.33	34.20
			20.44	34.70
			20.00	34.70
M2	30	15	20.00	35.50
			21.50	36.40
			20.90	36.90
M3	35	15	23.11	38.20
			23.55	37.40
			23.11	38.70
M4	**40**	**15**	24.89	44.00
			24.00	41.77
			25.33	43.50
M5	45	15	24.00	40.00
			23.01	40.40
			23.07	40.10

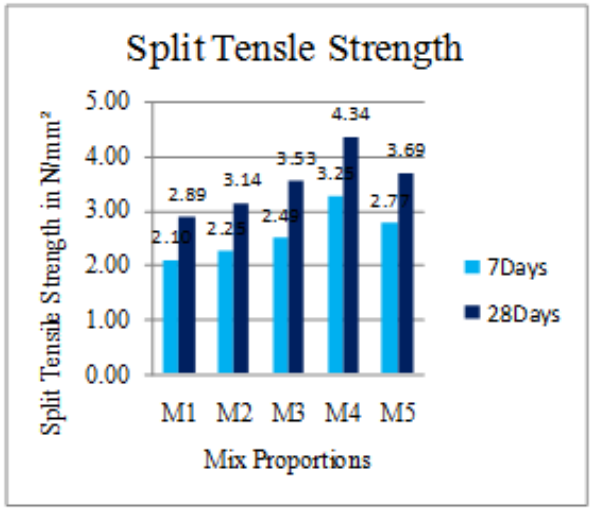


Graph no-4.3: The Compressive Strength after 7days & 28 days in N/mm²

2. The Split Tensile Strength Test:

Table no-9: Split Tensile Strength Test Results after 7 Days & 28 Days

Mix designation	GGBS (%)	Alccofine (%)	Split tensile strength @ 7 days (N/mm²)	Split tensile strength @ 28 days (N/mm²)
M1	0	0	2.12	2.83
			2.26	3.01
			2.12	2.83
M2	30	15	2.26	3.01
			2.40	3.20
			2.40	3.20
M3	35	15	2.69	3.39
			2.53	3.59
			2.54	3.39
M4	**40**	**15**	3.11	4.15
			3.40	4.53
			3.25	4.33
M5	45	15	2.82	3.76
			2.82	3.77
			2.68	3.57

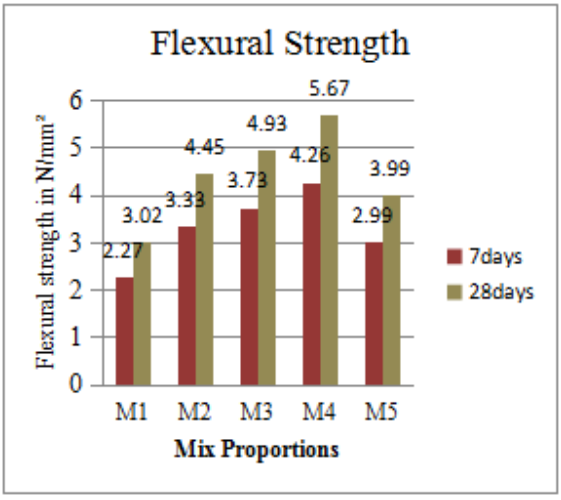


Graph no-4.4: Shows the Split Tensile Strength after 7 & 28 Days in N/mm²

3. The Flexural Strength Test:

Table no-10: Shows the Flexural strength Test Results after 7Days & 28Days

Mix designation	GGBS (%)	Alccofine (%)	Flexural strength @ 7days (N/mm²)	Flexural strength @ 28days (N/mm²)
M1	0	0	2.0	2.67
			2.4	3.20
			2.4	3.21
M2	30	15	3.2	4.27
			3.6	4.80
			3.2	4.26
M3	35	15	3.6	4.80
			3.8	5.00
			3.7	5.00
M4	**40**	**15**	4.0	5.30
			4.4	5.86
			4.4	5.87
M5	45	15	3.0	4.00
			2.94	3.92
			3.04	4.05

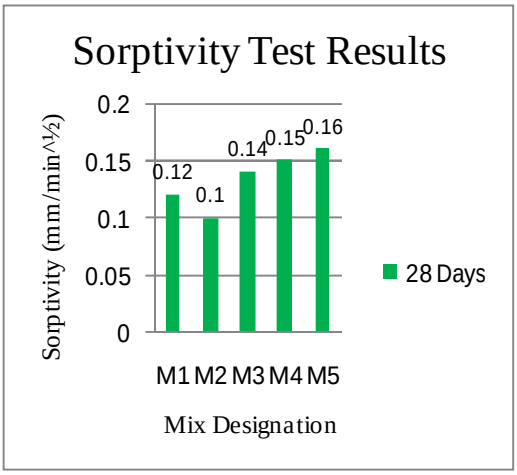


Graph no-4.5: Flexural Strength Results @ 7 and 28 Days in N/mm²

4. Sorptivity Test: Sorptivity is the property of the homogeneous material which determines the capacity of a material to absorb and transmit water through capillarity action. As the time increases when the material is placed in water, the water absorption for the surface of material increases.

Table no-11: Sorptivity Test Results at 7 Days and 28 Days

Mix designation	GGBS (%)	Alccofine (%)	Dry weight (grams)	Wet weight (grams)	Sorptivity (mm/min^½)
M1	0	0	814.16	819.15	0.12
			816.00	820.50	0.11
			815.00	820.00	0.12
M2	**30**	**15**	811.10	815.15	0.10
			812.00	816.50	0.11
			814.00	818.00	0.10
M3	35	15	816.50	822.00	0.13
			818.00	824.00	0.14
			817.50	823.50	0.14
M4	40	15	820.00	826.00	0.14
			819.50	826.00	0.15
			820.50	827.50	0.16
M5	45	15	820.00	827.50	0.17
			820.00	827.00	0.16
			819.50	826.50	0.16



Graph no-4.6: Shows the Sorptivity Test Results at 28 Days

V. CONCLUSIONS

1. From the experimental investigation with GGBS replaced by 30%, 35%, 40%, 45% and 50% by cement, along with Alccofine replaced by 15% of cement, the mix with 40%

of GGBS and 15% of Alccofine was found to be optimum.

2. The density of concrete got increased by the partial exchange of GGBS and Alccofine with weight of cement.
3. Maximum compression strength results were obtained with mix proportion of 40% of GGBS and 15% of Alccofine when compared with normal concrete.
4. The increase in compression strength was 17% at 7 days and 20% at 28 days curing with 40% of GGBS and 15% of Alccofine when compared with normal concrete.
5. The Maximum split tensile strength results were obtained with mix proportion of 40% of GGBS and 15% of Alccofine when compared by normal concrete.
6. Rise in split tensile strength was 35.3% after 7 days and 33.4% after 28 days curing with 40% of GGBS and 15% of Alccofine when compared with normal concrete.
7. Maximum flexural strength results were also obtained with mix proportion of 40% of GGBS and 15% of Alccofine when compared by normal concrete.
8. The rise in the value of flexural strength was 46% after 7 days and 46.7% after 28 days curing with 40% of GGBS and 15% of Alccofine when compared with normal conventional concrete.
9. Sorptivity value calculated increases by the increase in the quantity of GGBS.
10. Least sorptivity value is obtained with the mix proportion M2 concrete mix, the sorptivity obtained was 0.1mm/min^½.
11. Finally it can be said that GGBS could be utilized as a substitute for cement exchange, therefore lowering the usage of cement and reduction of construction cost.
12. Addition of Alccofine as mineral admixture improves the characteristics of concrete namely workability, strength & durability.

REFERENCES

[1] A. Oner, S. Akyuz. “An Experimental Study on Optimum Usage of GGBS For The Compressive Strength Of Concrete” Cement & Concrete Composite 29, 2006, 510-514

[2] Venu Malagavelli. “High Performance Concrete With GGBS and Robo Sand” International Journal of Engineering Science and Technology Vol. 2 {10}, 2010, 5107-5113

[3] A.H.L Swaroop, K. Venkateswararao, Prof P Kodandaramaro “Durability Studies on Concrete with Fly Ash and GGBS” International Journal of Engineering Research and Application, Vol. 3, Issue 4, 2013, 285- 289

[4] Yatin H Patel, P.J Patel, Prof Jingnesh M Patel, Dr. H S Patel “Study On Durability Of High Performance Concrete With Alccofine & Fly Ash” IJAERS, Vol. 2, Issue.3, 2013, 154-157.

[5] Deval Soni, Suhasini Kulkarni, Vilin Parekh “Experimental Study On High Performance Concrete With Mixing Of Alccofine And Fly Ash” Indian Journal Of Research, Vol. 3, Issue. 4, 2013, 84-86.

[6] Pj Patel & H S Patel “Effect Of Compressive And Flexural Strength Of High Performance Concrete Incorporating Alccofine And Fly Ash” IJCSEIERD, Vol. 3, Issue 2, 2013, 109-114.

[7] Praveen Nayak S, H. S. Narashimhan, Raghunandan V. Kadaba “Hardened Properties Of Concrete Made With Micro Silica And Alccofine- A Performance Optimization Based Comparative Study” International Journal Of Engineering Research And Development, Vol. 10, Issue 8, 2014, 01-09.

[8] Mohammed Qureshi, Yogendra Tandel, Bhavin Patel “An Experimental Study On High Strength Concrete Using Fly Ash And Alccofine” I-Manager’s Journal On Structural Engineering, Vol. 2, Issue 4, 2014, 8-14.

[9] S Arivalagan “Sustainable Studies On Concrete With Ggbs As A Replacement Material In Cement” Jordan Journal Of Civil Engineering, Vol. 8, Issue 3, 2014, 263-270.

[10] Mahammed Tofik Y Patel, Prof. A.R.Darji, Prof.B.M Purohit “Study On Mechanical Properties Of High Performance Concrete With Alccofine And Waste Glass Powder” IJSRD, Vol. 2, Issue 10, 2014, 598-601.

[11] Fouzia Shaheen, Mohammed Samiddin Fazil, “Effect Of Metakolin And Alccofine On Strength Of Concrete” Engineering Science And Technology, An International Journal, Vol. 5, Issue 4, 2015, 302-305.

[12] Saurabh Gupta, Dr. Sanjay Sharma, Er. Devinder Sharma “ A Review On Alccofine : A Supplementary Cementitous Material” International Journal Of Modern Trends In Engineering And Research, 2015, 114-118.

[13] Ansari U.S, Chaudhri I.M, Ghuge N.P, Phatangre R.R, “High Performance Concrete With Partial Replacement Of Cement By Alccofine And Fly Ash” Indian Research Transaction Vol. 5, Issue 2, 2015, 19-23

[14] Vikram K. Shadi, M.A Banarase, “Experimental Study On Effect Of Alccofine On Properties Of Concrete- A Review” International Journal Of Research In Engineering, Science And Technologies Vol. 1, Issue 8, 2015, 297-301

[15] IS: 10262- 2009 Concrete Mix Design Manual

[16] IS: 456- 2000 plain and reinforced concrete code of practice manual

[17] IS: 516- 1959 Code for testing compressive strength of concrete.