JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

TO STUDY THE EFFECT OF RICE HUSK ASH, ALCOFINE, SILICA FUMES AND GGBS ON HIGH STRENGTH CONCRETE

Subodh Mulchandani[1], Dr. Sanjay Sharma[2]
[1](M.E. Student, Civil Engineering Department, N.I.T.T.T.R. Chandigarh,) [2](Professor, Civil Engineering Department, N.I.T.T.T.R. Chandigarh)

***Abstract*:** *In current study, an attempt has been made to replace the cement content with GGBS, Silica Fume and Rice husk ash at proportion of 10%, 15% and 20% each with varying proportion of alccofine of 5%, 10%, 15%. Various laboratory tests (slump test, compression strength test, split tensile strength test and flexural strength test) were carried out and results were noted for M60 grade of concrete. From the results, it can be concluded that the addition of GGBS, Silica Fume and Rice husk ash at proportion of 10%, 15% and 20% each with varying proportion of alccofine of 5%, 10%, 15% surely enhances the properties of concrete mix and it is recommended that 10% of GGBS, 10% of Silica Fume, 10% of Rice husk ash and 10% of alccofine shall be used to obtain the maximum strength values for M60 concrete.*

***Keywords*:** **Concrete, GGBS, Silica Fumes, Rice Husk Ash, Alccofine**

1. INTRODUCTION

Concrete is a building material made up of different types of raw material such as coarse and fine aggregate mixed together with a slurry paste of OPC or PPC cement in the presence of water which hardens with the passage of time. Cement is a pozzolanic material that helps in binding the material. The exothermic reaction occurs and the concrete starts to harden and gain strength. The production of cement, throughout the world, is carried out on a very large scale as the demand for raw cement in the construction industry is huge. Whereas, the extraction of coarse and fine aggregates from river bed is a complex procedure and its demand and availability are also large as it gives mass to the concrete material.

The potential and the utilization of waste and end product, which is inspired by the drawbacks of using raw material in concrete and the abundance of such replacing materials in surroundings, can differ significantly according to the location from where it is obtained and where it is being used. As the development is being carried out in the infrastructure sector, the generation of waste products is enormous due to which there is a huge demand that it shall be utilized in one way or the other so that its environmental impact can be minimized and we can get rid of the disposal issues. Every researcher in the field of material is carrying the research work by using substitute material by replacing raw material and exploring the benefits of such materials in construction industries. replacement of cement by fly ash, bagasse ash, rice husk ash, silica fumes, etc, replacement of aggregates by different kinds of slag are being done to obtained higher strength and enhanced physical and chemical properties of concrete.

2. MATERIAL

RICE HUSK ASH (RHA)

After harvesting the rice crops, the removal of husk is being carried out for further use. This rice husk is a kind of waste material that sometimes can be used as a fuel in different kinds of boilers and industries for the generation of energy. This waste product is a very useful material as it is an organic volatile matter. The end product of combustion is ash which is known as rice husk ash or RHA.

Table: 1. Properties of Rice Husk Ash.

Test	Value Obtained
Particle size	< 45Micron
Specific gravity	2.25
Appearance	Very Fine
Color	Gray

GROUND-GRANULATED BLAST-FURNACE SLAG (GGBS)

Ground-granulated blast-furnace slag (GGBS or GGBFS) is collected from stifling molten iron slag when iron and steel are produced. It is collected from a furnace in water or steam which is a granular material. This granular material is dried and the obtained material is then converted into smaller particles like a fine powder. GGBFS or GGBS particles are extremely cementitious and contains a large amount of CSH (calcium silicate hydrates) composition which results in increasing the strength, durability parameters, and physical features of the concrete mix. The Specific gravity of GGBS is 2.65 g/cc. The physical Properties and Chemical composition is represented in table 3.7 and 3.8 respectively.

Table 2. Physical Properties of GGBS.

Test	Value Obtained
Fineness (m2 /kg)	388
Specific gravity	2.65
Residue on 45 micron sieve	4.21

SILICA FUMES

Silica fume is a result of electrostatic seizing and soothing of silica dust with gasses emitted from electric arcs or alloys in the generation method of silicon metal, especially ferrosilicon alloys. This substance has more than eighty percent non-crystalline silica with a dia ranging between 0.01 and 0.3 microns, which is approximately 50 to 100 times finer than particles of cement.

ALCCOFINE

Alccofine 1203 is an innovative, super-fine substance with less content of calcium silicate. It gives a high initial rate of strength to the concrete because it makes the initial reaction while hydration. It also throws away the trash calcium hydroxide which is formed during the formation of C-S-H gel.

3. RESULTS

The different concrete mixes were prepared under present experimental study mentioned in table 3.

Table 3. Different Mix Designs

Concrete Mix	GGBS	Silica Fume	RHA	Alccofine
CM	-	-	-	-
M1	10	10	10	5
M2	15	15	15	5
M3	20	20	20	5
M4	10	10	10	10
M5	15	15	15	10
M6	20	20	20	10
M7	10	10	10	15
M8	15	15	15	15
M9	20	20	20	15

SLUMP TEST

Graphs was plotted to understand the behavior of replacement materials in concrete for the slump test results and are shown in Fig. 1.

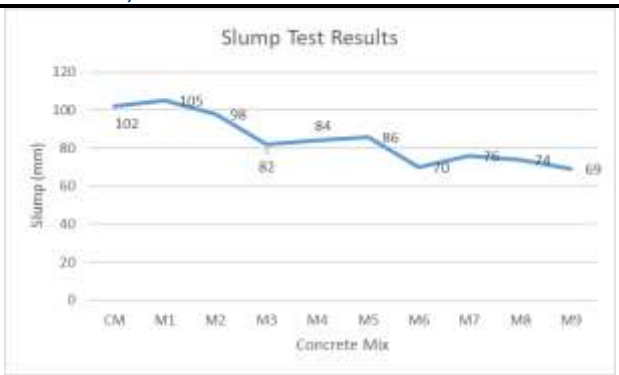

Figure 1. Slump Test Results

The test results of workability at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) are 105 mm, 98 mm and 82 mm for the concrete mix M1, M2 and M3 respectively. The test results of workability at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) are 84 mm, 86 mm and 70 mm for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) are 76 mm, 74 mm and 69 mm for the concrete mix M7, M8 and M9 respectively. Although the slump value is reducing as the proportion of replacement material increases, the workable concrete was obtained.

COMPRESSIVE STRENGTH TEST

The compressive strength of control mix concrete at 7 and 28 days of curing was 66.24 MPa and 73.44 MPa which is greater than the target mean strength of M60 grade of concrete.

Figure 2. Compressive strength at 7 days.

The test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 7 days are 65.4 MPa, 67.44 MPa, 68.30 MPa for the concrete mix M1, M2 and M3 respectively. The test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 7 days are 73.2MPa, 75.65 MPa, 69.6Mpa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 7 days are 63.42 MPa, 65.4 MPa, 64.8Mpa for the concrete mix M7, M8 and M9 respectively. Therefore, it is observed from the above data that all the test results of compressive strength at 07 days are greater than the characteristic strength of M60. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Compressive strength at 7 days is 3.1%, 14.2% and -4.3% respectively than the results of control mix.

Figure 3. Compressive strength at 28 days.

The test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 28 days are 73.80 MPa, 75.78 MPa, 75.60 MPa for the concrete mix M1, M2 and M3 respectively. The test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 28 days are 85.56 MPa, 82.74 MPa, 78.61 MPa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of compressive strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 28 days are 72.50 MPa, 75.78 MPa, 73.20Mpa for the concrete mix M7, M8 and M9 respectively. Therefore, it is observed from the above data that all the test results of compressive strength at 28 days are greater than the characteristic strength of M60. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase of Compressive strength at 28 days is 3.2%, 16.5% and 3.2% respectively than the results of control mix.

SPLIT TENSILE STRENGTH TEST

The Split Tensile strength of control mix concrete at 7 and 28 days of curing was 3.57 MPa and 4.58 MPa.

Figure 4. Split Tensile Strength at 7 days.

The test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 7 days are 3.91 MPa, 4.36 MPa, 4.06 MPa for the concrete mix M1, M2 and M3 respectively. The test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 7 days are 4.98 MPa, 4.56 MPa, 4.67 Mpa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 7 days are 4.10 MPa, 4.49 MPa, 4.37 Mpa for the concrete mix M7, M8 and M9 respectively. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Split Tensile strength at 7 days is 22.1%, 39.5% and 25.8% respectively than the results of control mix.

Figure 5. Split Tensile Strength at 28 days.

The test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 28 days are 5.02 MPa, 5.67 MPa, 5.21 MPa for the concrete mix M1, M2 and M3 respectively. The test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 28 days are 6.16 MPa, 5.76 MPa, 5.99 Mpa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of Split Tensile strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 28 days are 5.24 MPa, 5.62 MPa, 5.64 MPa for the concrete mix M28, M8 and M9 respectively. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Split Tensile strength at 28 days is 23.8%, 34.5% and 22.7% respectively than the result of control mix.

FLEXURAL STRENGTH TEST

The Flexural strength of control mix concrete at 7 and 28 days of curing was 4.12 MPa and 5.1 MPa.

Figure 6. Flexural Strength at 7 days.

The test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 7 days are 4.61 MPa, 5.27 MPa, 4.77 MPa for the concrete mix M1, M2 and M3 respectively. The test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 7 days are 5.53 MPa, 5.48 MPa, 5.64 Mpa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 7 days are 4.85 MPa, 5.38 MPa, 5.42 MPa for the concrete mix M7, M8 and M9 respectively. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Flexural strength at 7 days is 27.9%, 36.9% and 31.6% respectively than the results of control mix.

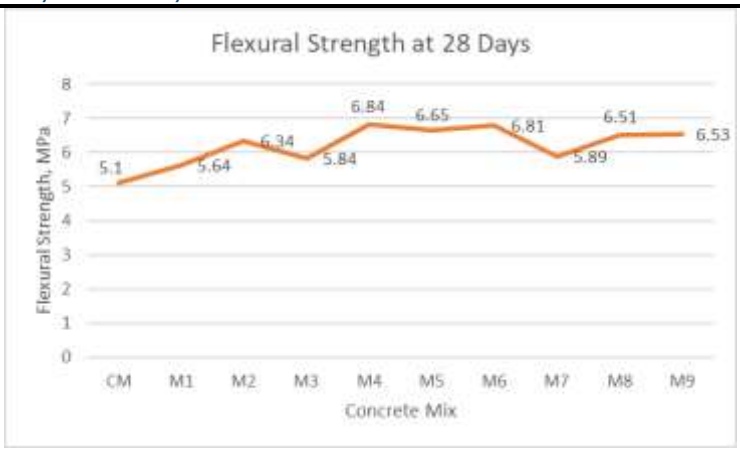

Figure 7. Flexural Strength at 28 days.

The test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (5%) after curing period 28 days are 5.64 MPa, 6.34 MPa, 5.84 MPa for the concrete mix M1, M2 and M3 respectively. The test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (10%) after curing period 28 days are 6.84 MPa, 6.65 MPa, 6.81 Mpa for the concrete mix M4, M5 and M6 respectively. Whereas, the test results of Flexural strength at different proportions (i.e. 10%, 15% and 20%) of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and fixed proportion of Alccofine (15%) after curing period 28 days are 5.89 MPa, 6.51 MPa, 6.53 MPa for the concrete mix M28, M8 and M9 respectively. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Flexural strength at 28 days is 24.3%, 34.1% and 28.0% respectively than the results of control mix.

4. CONCLUSIONS

Following are the conclusions drawn from the current experimental study:

1. The Slump of control mix concrete is 102 mm whereas, the slump of concrete entailing different proportions of Ground Granulated Blast Furnace Slag, Silica Fume, Rice Husk Ash and Alccofine are 105 mm, 98 mm, 82 mm, 84 mm, 86 mm, 70 mm 76 mm, 74 mm and 69 mm for M1, M2, M3, M4, M5, M6, M7, M8 and M9 respectively. Although the slump value is reducing as the proportion of replacement material increases, the workable concrete was obtained.
2. The compressive strength of control mix concrete at 7 and 28 days of curing was 66.24 MPa and 73.44 MPa which is greater than the target mean strength of M60 grade of concrete. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Compressive strength at 7 days is 3.1%, 14.2% and -4.3% respectively than the results of control mix. And at fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Compressive strength at 28 days is 3.2%, 16.5% and 3.2% respectively than the results of control mix.
3. The Split Tensile strength of control mix concrete at 7 and 28 days of curing was 3.57 MPa and 4.58 MPa. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Split Tensile strength at 7 days is 22.1%, 39.5% and 25.8% respectively than the results of control mix. And at fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Split Tensile strength at 28 days is 23.8%, 34.5% and 22.7% respectively than the results of control mix.
4. The Flexural strength of control mix concrete at 7 and 28 days of curing was 4.12 MPa and 5.1 MPa. At fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Flexural strength at 7 days is 27.9%, 36.9% and 31.6% respectively than the results of control mix. And at fixed 5%, 10% and 15% alccofine while varying the proportion of GGBS, silica fume and RHA (i.e. 10%, 15% and 20%), the maximum increase/decrease of Flexural strength at 28 days is 24.3%, 34.1% and 28.0% respectively than the results of control mix.

Therefore, it can be concluded that the addition of GGBS, Silica Fume and Rice husk ash at proportion of 10%, 15% and 20% each with varying proportion of alccofine of 5%, 10%, 15% surely enhances the properties of concrete mix and it is recommended that 10% of GGBS, 10% of Silica Fume, 10% of Rice husk ash and 10% of alccofine shall be used to obtain the maximum strength values for M60 concrete.

REFERENCES

[1] *Kishore Ravande, Bhikshma V. And Prakash P. Jeevana "Study on Strength Characteristics of High Strength Rice Husk Ash Concrete", The Twelfth East Asia-Pacific Conference on Structural Engineering and Construction, (2011) pp: 2666-2672.*

[2] *Pawar M.S. and Saoji A.C., "Effect of Alccofine on Self Compacting Concrete", The International Journal Of Engineering And Science, (2013) Volume-2, Issue-6, pp: 5-9.*

[3] *Patil Yogendra O., Patil P.N. and Dwivedi Arun K. "GGBS as Partial Replacement of OPC in Cement Concrete–An Experimental Study", International Journal of Scientific Research, (2013) Volume: 2, Issue: 11, pp: 189-191.*

[4] *G Nair Deepa, Sivaraman K., and Thomas Job "Mechanical Properties of Rice Husk Ash (RHA) - High strength Concrete", American Journal of Engineering Research, (2013) Volume-3 pp-14-19.*

[5] *Qureshi Mohammed, Tandel Yogendra and Patel Bhavin "An Experimental Study On High Strength Concrete Using Fly Ash And Alccofine", Journal on Structural Engineering, (2014) Vol. 2, No 4, pp: 1-9.*

[6] *Saurav and Gupta Ashok Kumar "Experimental study of strength relationship of concrete cube and concrete cylinder using ultrafine slag Alccofine", International Journal of Scientific & Engineering Research, (2014) Volume 5, Issue 5, pp: 102-107.*

[7] *Ansari U.S., Chaudhri I.M., Ghuge N.P., Phatangre R.R "Concrete With ALCCOFINE & Fly Ash An Economical & Environment Friendly Approach", International Journal of Modern Trends in Engineering and Research, (2015) pp: 279-285.*

[8] *Ardra Mohan, K.M. Mini "Strength and durability studies of SCC incorporating silica fume and ultra-fine GGBS" Construction and Building Materials, (2018) pp: 919-928.*

[9] *Reddy P. Narasimha, Naqash J. Ahmed, "Effect of Alccofine on Mechanical and Durability Index Properties of Green Concrete", International Journal of Engineering, (2019) Vol. 32, No. 6, pp: 813—818.*

[10] *Balamuralikrishnan R, Saravanan J, "Effect of Alccofine and GGBS Addition on the Durability of Concrete", Civil Engineering Journal, (2019) Vol. 5, No. 6, pp: 1273-1288.*

[11] *C. Vaidevi, T. Felix Kala, A.R.R. Kalaiyarrasi, "Mechanical and durability properties of self-compacting concrete with marble fine aggregate", Materials Today: Proceedings, (2019) pp: 1-7.*

[12] *Reddy G. Gautham K., Ramadoss P., "Influence of alccofine incorporation on the mechanical behavior of ultrahigh performance concrete (UHPC)", Materials Today: Proceedings, (2020) pp: 1-9.*

[13] *Kavyateja Bode V., Jawahar J. G., Sashidhar C., "Efect of alccofne and fy ash on analytical methods of self-compacting concrete", Innovative Infrastructure Solutions, (2020) pp: 1-11.*

[14] *Das Shaswat Kumar, Mishra Jyotirmoy, Kumar Saurabh, Mustakim Syed Mohammed, Patel Alok, Das Sitansu Kumar, Behera Umakanta "Characterization and utilization of rice husk ash (RHA) in fly ash – Blast furnace slag based geopolymer concrete for sustainable future" Materials Today: Proceedings, (2020) pp: 1-6.*

[15] *Das S.K., Singh S.K., Mishra J., S.M. Mustakim, "Effect of rice husk ash and silica fume as strength-enhancing materials on properties of modern concrete- a comprehensive review", Lect. Notes Civil Eng. 61, (2020) pp: 253–266.*

[16] *Vaidevi C, Kala TF, Kalaiyarrasi ARR "Mechanical and durability properties of self-compacting concrete with marble fine aggregate", Mater Today Proc. https://doi.org/10.1016/j.matpr .2019.11.019. (2020)*

[17] *B. Selvarani, V. Preethi "Investigational study on optimum content of GGBS and fibres in fibre non-breakable self-compacting concrete" Materials Today: Proceedings-ELSEVIER, (2021) pp-1-5.*

[18] *K.I.M. Ibrahim "Recycled waste glass powder as a partial replacement of cement in concrete containing silica fume and fly ash" Case Studies in Construction Materials-ELSEVIER, (2021) pp-1-10.*

[19] *ZaidatulSyahida Adnan , Nur FarhayuAriffin , Sharifah Maszura Syed Mohsin, Nor Hasanah Abdul Shukor Lim "Review paper: Performance of rice husk ash as a material for partial cement replacement in concrete" Materials Today: Proceedings -ELSEVIER, (2021) pp-1-7.*