International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 08 Issue: 04 | Apr 2021 www.irjet.net p-ISSN: 2395-0072

Study on Performance of Concrete Incorporated With Mineral Admixtures

Abdul Rahman[1], Mohammed Omer Farooq[2], Mohammed Abubakar[3], Mr. Touseeq Anwar Wasif[4]

[1, 2, 3] B.E Students, Dept. of Civil Engineering, ISL Engineering College, Hyderabad
[4]Assistant Professor, Dept. of Civil Engineering, ISL Engineering College, Hyderabad

---

Abstract –*Cement is the most effective building material, but its production has a negative impact on the environment by releasing carbon dioxide into the atmosphere. Reducing these emissions while meeting the ever-increasing demand for infrastructure around the world is a challenge for the industry's long-term viability, and it has drawn academics, domain experts, and researchers to objectivize their work in order to investigate alternatives to cement. As a result of the researchers' efforts, a number of alternatives have emerged for further investigation in order to substantiate their use in the industry. This paper examines the compressive strength properties of concrete by partially substituting cement in concrete with Ground Granular Blast Furnace Slag (GGBS) and Fly Ash. The increasing demand for cement in the construction industry is causing environmental degradation; as a result, waste materials such as GGBS and Fly Ash are being used to substitute cement. The main aim of this work is to study the fresh and hardened properties of M-30 grade control concrete and concrete made with partial replacement of fly ash and GGBS with various percentages. To study the fresh properties slump tests, compaction factor tests are conducted. To study hardened properties compressive strength tests is conducted and comparison study will be done.*

***Key Words*: Fly Ash, GGBS, Fresh and Hardened Test on Concrete, Reducing Emissions.**

1. INTRODUCTION

Construction industry has become one of the most important part of a country's economic and social development. Concrete has been utilized by the construction industry for the construction of most of the infrastructures which range from construction of foundations to retaining walls, dams to bridges, residential houses to tall skyscrapers. The most predominately used binder in concrete is blended cement. Today, public and private organizations have been giving considerable importance to different construction materials on account of their environmental behavior. The growing use of cement made concrete in building projects and subsequent emission of harmful gases into the atmosphere causes a significant rise in earth's temperature. One thousand kilograms of cement produce nearly similar amount of carbon dioxide (CO2). According to an estimate, around 6–8% of the total CO2 globally emitted comes from ordinary cement production. The concrete has been investigated currently in favor of depleting carbon dioxide emissions and enhancing the performance eventually reducing in the cost of construction. Keeping in view eco-friendly approaches and utilization of industrial solid waste or by-product materials as replacement of cement has been considered under construction for the generation of cement and concrete because it shares less amount of consumption of natural resources.

Among many additional minerals such as, waste materials, by-product and industrial solid waste have pozzolanic qualities that matched as a cement or concrete properties. In this case, ground granulated blast furnace slag (GGBS) and Fly Ash commonly used supplementary cementitious because of their pozzolanic properties. Slag and Fly Ash formed additional C-S-H gel after reaction with portlandite whose structure is similar type that is accrued by cement hydration. Therefore, GGBS and Fly Ash reaction makes a huge contribution to the characteristics and development of concrete. The quantity of GGBS and Fly Ash waste from industries are increasing on daily basis and main issue of their disposal. GGBS is derived through metal ores during smelting procession. Iron is extracted in the form of iron silicate usually called so as slag. Disposal of slag may create toxic health hazards. Thermal power plants are one of the main sources and other new thermal power plants of electricity in our country due to which the utilization of coal is on rise to generate more energy consequently in producing plenty of ash. Round about 75-80 per cent of the total amount of ash by product is generated via power plant is Fly Ash. Hence, reuse of industrial by-products or secondary materials has been motivated in construction as well as cement production because it contributes to reduce the consumption of natural resources.

2. LITERATURE REVIEW

Durability studies on concrete with fly ash and ggbs by A.H.L. Swaroop, K. Venkateswararao, and Prof P. Kodandaramarao:

In this paper they mainly concentrated on evaluation of changes in both compressive strength and weight reduction in five different mixes of M30 Grade, namely conventional aggregate concrete (CAC), concrete made by replacing 20% of cement by Fly Ash (FAC1), concrete made by replacing 40% of cement by Fly Ash (FAC2), concrete made by replacing 20% replacement of cement by GGBS (GAC1) and concrete made by replacing 40% replacement of cement by GGBS (GAC2). The effect of 1% of H_2SO_4 and sea water on these concrete mixes are determined by immersing those cubes for 7days, 28days, and 60days in above solutions. They observed the respective changes in both compressive strength and weight reduction.

From the study they concluded that, the early strength is compared to less in fly ash and GGBS concretes than conventional aggregate concrete. The results of fly ash and GGBS concretes when replaced with 20% of cement are more than compared to CAC at the end of 28 days and 60 days for normal water curing. In sea water curing the GGBS when they replaced with 20% of cement shows good response for durability criteria. In H_2SO_4 solution curing the Fly Ash when replaced with 20% of cement shows good response for durability criteria. In case of weight loss GGBS offer more resistance than fly ash. They concluded that, the strength of fly ash concrete when replaced with 20% cement is increased and the strength of fly ash concrete when replaced with 40% cement is decreased, they recommend that the use of fly ash between 20- 40% replacement with cement for better results.

Partial replacement of cement by ground granulated blast furnace slag in concrete by Reshma Rughooputh and Jaylina Rana :

In this paper the main aim of the work was to investigate the effects of partially replaced Ordinary Portland Cement (OPC) by ground granulated blast furnace slag (GGBS) on the properties of concrete including compressive strength, tensile splitting strength, flexure, modulus of elasticity, drying shrinkage and initial surface absorption. Results showed that the compressive and tensile splitting strengths, flexure and modulus of elastic increased as the GGBS content increased. The percentage drying shrinkage showed a slight increment with the partial replacement of OPC with GGBS. However, concrete containing GGBS failed the initial surface absorption test confirming that GGBS decreases the permeability of concrete.

From the study they concluded that, the partial replacement of OPC with GGBS improves the workability but causes a decrease in the plastic density of the concrete. The compressive and tensile splitting strengths, flexure and modulus of elasticity increases with increasing GGBS content. The drying shrinkage shows a slight increment with GGBS. GGBS fails the initial surface absorption test confirming that the surfaces of their concrete mixes were practically impermeable. Based on the results, the optimum mix is the one with 50% OPC and 50% GGBS

Triple blending of cement concrete with fly ash and ground granulated blast furnace slag by K.V. Pratap, M. Bhasker, and P.S.S.R.Teja :

In this paper they mainly concentrated on compressive strength, split tensile strength and flexural strength of concrete mix of M-60 grade, with partial replacement of cement with Ground Granulated Blast furnace Slag and FLY-ASH. They use the concept of triple blending of cement with GGBS and FLY-ASH, this triple blend cement exploits the beneficial characteristics of both pozzolanic materials in producing a better concrete.

They concluded that, the compressive strength, flexural strength and split tensile strength of concrete are improved with the addition of fly ash and GGBS as partial replacement to cement. The compressive strength of concrete is increased by a maximum of 11.13 % at 28days with (4+16) % replacement. The flexural strength of concrete is increased by a maximum of 11.74% at 28days with (4+16) % replacement. The split tensile strength of concrete is increased by a maximum of 23.01 %at 28 days with (4+16) % replacement.

OBJECTIVES OF THE STUDY:

• To determine the most optimized mix of GGBS,Flyash-based concrete.
• To optimize strength characteristics of concrete by partially replacement of cement by GGBS and flyash.
• To determine the variation of workability of concrete by partially replacing the cement by GGBS and flyash.
• To study the fresh properties of concrete.
• To understand the mechanical properties of concrete.

3 MATERIALS:

High performance concrete was made of cement, sand, fly ash, GGBS, aggregate, water and chemical Admixture.

1) Cement: Ordinary Portland cement, 53 grade conforming to IS: 12269-1987.
2) Sand: Locally available sand confined to zone II of IS: 383-1970.
3)Fly ash: It is the alumino silitcate source material used for synthesis of geopolymeric binder. There are two types of fly ash. They are but in this stud they prefer class F fly ash.

- Class F fly ash
- Class C fly ash

Class F fly ash:

This fly ash is pozzolanic in nature, and contains less than7% lime. Possessing pozzolanic
properties, the glassy silica and aluminium of class F fly ash requires a cementing agent, such as Portland cement, quick lime, or hydrated lime-mixed with water to react and produce cementitious compounds.

Chemical composition of raw materials by XRF analysis

Composition	Fly ash	GGBS
Sio_2	53.71	29.96
Al_2o_3	27.20	12.25
fe_2o_3	11.71	0.52
Cao	1.90	45.45
Na_2o	0.36	0.31
k_2o	0.54	0.38
so_3	0.30	3.62
P_2O_5	0.71	0.04
Tio_2	1.62	0.46
LOI^a	0.68	2.39

Table: 1 Chemical Composition of Raw Materials

4) GGBS: GGBS is used to fill voids between fly ash and fine aggregate sodium hydroxide and sodium silicate or sodium nitrate solution used as alkaline liquids react with fly ash and GGBS to form the polymer gel binding the aggregates to produce GPC[2].GGBS is the by-product of steel industry. Blast furnace slag is defined as the non-metallic product consisting essentially of calcium silicates and other bases. About 10% by mass of binders was replaced with GGBS. The chemical composition of fly ash and GGBS predicted by X-ray fluorescence were given.

5) COARSE AGGREGATE:
Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. Earlier, aggregates were considered as chemically inert materials but now it has been recognized that some of the aggregates are chemically active and also that certain aggregates exhibit chemical bond at the interface of aggregate and paste. The mere fact that the aggregates occupy 70–80 per cent of the volume of concrete, their impact on various characteristics and properties of concrete is undoubtedly considerable. To know more about the concrete it is very essential that one should know more about the aggregates which constitute major volume in concrete. Without the study of the aggregate in depth and range, the study of the concrete is incomplete. Cement is the only factory made standard component in concrete. Other ingredients, namely, water and aggregates are natural materials and can vary to any extent in many of their properties. The depth and range of studies that are required to be made in respect of aggregates to understand their widely varying effects and influence on the properties of concrete cannot be underrated.

6) Water: Fresh, odorless, colorless and tasteless water free form any organic matter was used. Water is an important ingredient of concrete as it actively participates in the chemical reaction with cement. Since it helps to form the strength giving cement gel, the quantity and quality of water is required to be looked into very carefully. It has been discussed enough in chapter about the quantity of mixing water but so far the quality of water has not been discussed. In practice, very often great control on properties of cement and aggregate is exercised, but the control on the quality of water is often neglected. Since quality of water affects the strength, it is necessary for us to go into the purity and quality of water.

7) Chemical admixture: They are chemically different from normal plasticizers. Uses of superplasticizers permit the reduction of water to the extent up to 30 per cent without reducing workability in contrast to the possible reduction up to 15 per cent in case of plasticizers. The use of superplasticizers is practiced for production of flowing, self-levelling and self-compacting and for the production of high strength and high performance concrete. The mechanisms of action of superplasticizers are more or less same as explained earlier in case of ordinary plasticizer. Only thing is that the superplasticizers are more powerful as dispersing agents and they are high range water reducers. They are called High Range Water Reducers in American literature. It is the use of superplasticizers which has made it possible to use w/c as low as 0.25 or even lower and yet to make flowing concrete to obtain strength of the order 120 MPa or more. It is the use of superplasticizers which has made it possible to use fly ash, slag and particularly silica fume to make high performance concrete.

The mix design procedure adopted in the present work to obtain M-30 grade concrete is in accordance with IS: 10262-2009 and IS: 456-2000.
W/C Ratio -0.44
Cement (kg/m3) -447.73
Fine aggregate (kg/m3) -632.44
Coarse aggregate (kg/m3) -1115.4
Water (kg/m3)-197

Mix Designation	Description
M0	100% CEMENT + 0% FLY ASH + 0% GGBS
M1	60% CEMENT + 10% FLY ASH +30% GGBS
M2	60% CEMENT + 20% FLY ASH +20% GGBS
M3	60% CEMENT + 30% FLY ASH +10% GGBS
M4	40% CEMENT + 10% FLY ASH +50% GGBS
M5	40% CEMENT + 20% FLY ASH +40% GGBS
M6	40% CEMENT + 30% FLY ASH +30% GGBS
M7	40% CEMENT + 40% FLY ASH +20% GGBS
M8	40% CEMENT + 50% FLY ASH 10% GGBS
M9	50% CEMENT +25 % FLY ASH +25% GGBS

Table: 2 Mix Designations

Fig.1: Material Mixing and Handling

4. RESULTS AND DISCUSSIONS

4.1. Workability

4.1.1. Slump

The mixed fresh concrete workability was measured immediately after mixing of the concrete according to IS: 1199-1959 and blended cement concrete specimens are given in Figure 3

Slump test was assessed to determine the consistency of concrete mixture. The main function of slump is to indirectly utilized or testing of the correct amount of waste added in the medium paste.

Compacting factor was assessed as per IS 456-2000. The Slump and compacting factor investigation are usually adopted test for fresh concrete. The degree of workability of concrete depends on the value of test results obtained from slump and compacting factor as shown in Figure 4.

MIX	Slump	Compaction Factor
M0	95	0.91
M1	105	0.91
M2	170	0.95
M3	160	0.95
M4	70	0.89
M5	150	0.94
M6	155	0.96
M7	160	0.96
M8	130	0.94
M9	155	0.95

Table.3: Slump and Compaction Factor Values

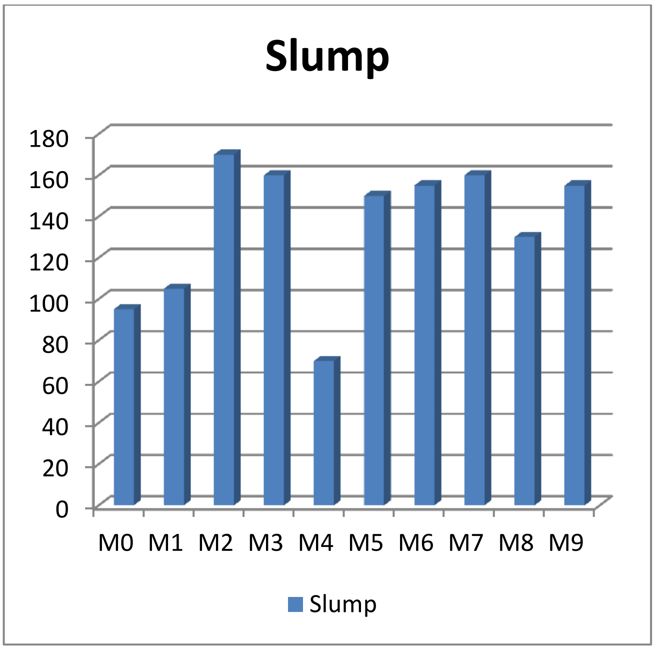

Fig.2: Slump Values

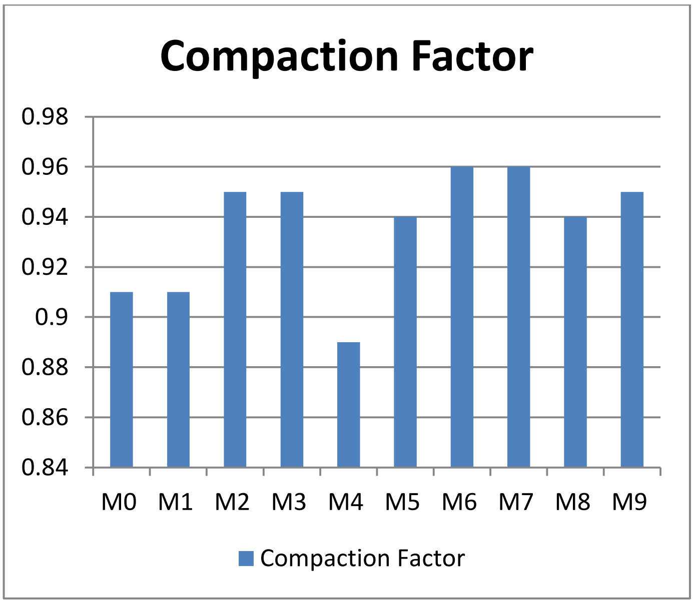

Fig.3: Compaction Factor Values

4.2 Compressive strength

For each concrete mix, the compressive strength is determined on three 150x150x150 mm cubes at 7 & 28days of curing. Following table gives the compressive strength test results of control concrete and concrete made with fly ash and GGBS as partial replacement of cement.

MIX	Compressive strength N/mm²	
	7 days	28 days
M0	21.32	32.81
M1	23.95	36.85

M2	25.8	39.7
M3	23.3	35.85
M4	18.2	28
M5	20.31	31.26
M6	16.03	24.67
M7	22.5	34.67
M8	13	20.15
M9	13	20.01

Table.4: Compressive Strength Values

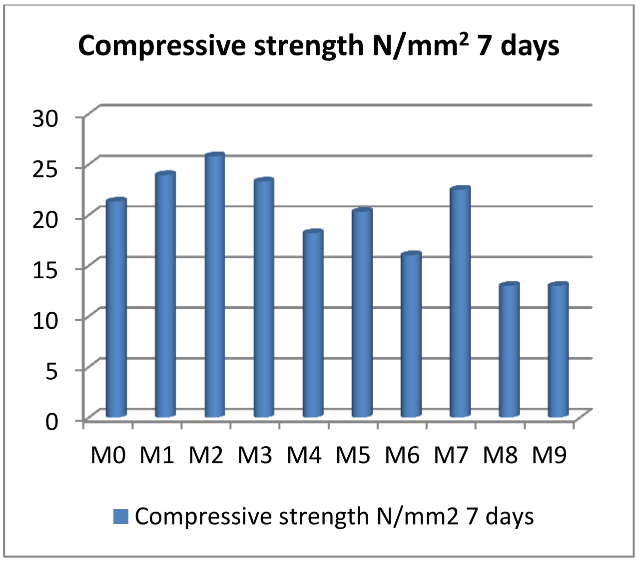

Fig.4: Compressive strength N/mm2 7 days Values

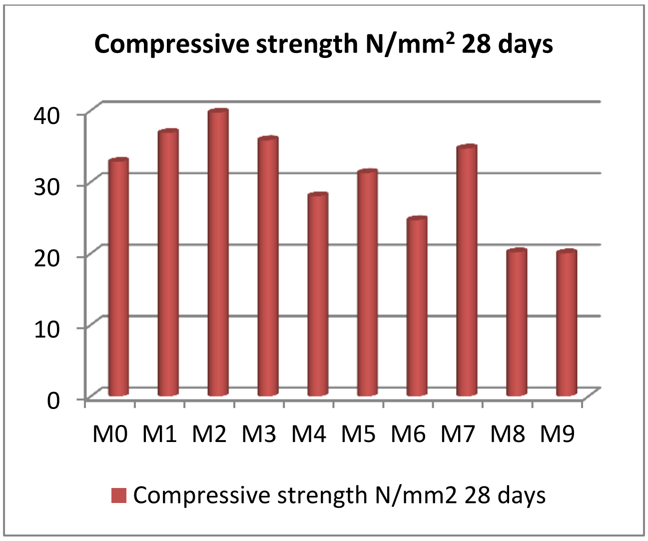

Fig.5: Compressive strength N/mm2 28 days Values

5. SUMMARY AND CONCLUSIONS

In the present work, an attempt has been made to use fly ash and GGBS as a blending supplementary material for cement. The effect of fly ash and GGBS blending on cement concrete in fresh and hardened state is slump test and compaction factor test investigated and the following observations were made from the experiment conducted. From the results obtained from workability test, it is clearly observed that increasing in fly ash and decrease in the GGBS content leads to the increase in workability.

The mix M2 (20% Flyash+20%GGBS+60%OPC) is giving good result in all ages of curing and it is compared in low volume replacement category.

The study reveals that low volume replacement mix M2 (20% Flyash+20% GGBS+60% OPC) is giving good result than high volume replacement Mix M7 (40%Flyash+20% GGBS+40% OPC) at all ages of curing.

Making concrete with the combination of Fly ash and GGBS and cement with different percentages gives good results compared to control concrete. So the best way to use these materials is in combination.

Due to environmental issues in the production of cement, industrial by products like fly ash and GGBS are used as supplementary materials in concrete and it saves cost of production of concrete, and makes it eco-friendly.

ACKNOWLEDGEMENT

We are thankful to **Dr. Mohammed Masood,** Principal, ISLEC, for his encouragement throughout the project. We would also like to express our heartfelt thanks to **Ms. K. Nanchari,** Head of Civil Engineering Department, ISLEC for her help and unending cooperation with us during completion of this work.

REFERENCES

[1] Jhatial, Ashfaque Ahmed, Samiullah Sohu, Nadeem-ul-Karim Bhatti, Muhammad Tahir Lakhiar, Raja Oad, et al. "Effect of Steel Fibres on the Compressive and Flexural Strength of Concrete." International Journal of ADVANCED AND APPLIED SCIENCES 5, no. 10 (October 2018): 16–21. doi:10.21833/ijaas.2018.10.003.

[2] Sandhu, A.R., Lakhiar, M.T., Jhatial, A.A., Karira, H. and Jamali, Q.B. "Effect of River Indus Sand and Recycled Concrete Aggregates as Fine and Coarse Replacement on Properties of Concrete", Engineering, Technology & Applied Science Research vol. 9, no. 1, (2019), 3832 – 3835.

[3] Kajaste, Raili, and Markku Hurme. "Cement Industry Greenhouse Gas Emissions – Management Options and Abatement Cost." Journal of Cleaner Production 112 (January 2016): 4041–4052. doi:10.1016/j.jclepro.2015.07.055.

[4] O'Rourke, Brian, Ciaran McNally, and Mark G. Richardson. "Development of Calcium sulfate–ggbs–Portland Cement Binders." Construction and Building Materials 23, no. 1 (January 2009): 340–346. doi:10.1016/j.conbuildmat.2007.11.016.

[5] Ogbeide, S. O. "Developing an Optimization Model for CO2 Reduction in Cement Production Process." Journal of Engineering Science and Technology Review 3, no. 1 (June 2010): 85–88. doi:10.25103/jestr.031.15.

[6] McLaren, Robert J., and A. M. DiGioia. "The typical engineering properties of fly ash." In Geotechnical Practice for Waste Disposal'87, pp. 683-697. ASCE, 1987.

[7] Davidovits, Joseph. "Properties of geopolymer cements." In First international conference on alkaline cements and concretes, vol. 1, pp. 131-149. Scientific Research Institute on Binders and Materials Kiev, Ukraine, (1994): 131-149.

[8] Habert, G., J.B. d' Espinose de Lacaillerie, and N. Roussel. "An Environmental Evaluation of Geopolymer Based Concrete Production: Reviewing Current Research Trends." Journal of Cleaner Production 19, no. 11 (July 2011): 1229–1238. doi:10.1016/j.jclepro.2011.03.012.

BIOGRAPHIES

Touseeq Anwar Wasif,
Assistant, Department of Civil Engineering, ISLEC, Hyderabad, India

Abdul Rahman,
Student, Department of Civil Engineering, ISLEC, Hyderabad, India

Mohammed Omer Faarooq,
Student, Department of Civil Engineering, ISLEC, Hyderabad, India

Mohammed Abubakar,
Student, Department of Civil Engineering, ISLEC, Hyderabad,
India