EXPERIMENT INVESTIGATION ON BEHAVIOUR OF TERNARY BLENDED CEMENTITIOUS MATERIALS USING GGBS AND FLYASH

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Abstract

This paper investigates the compressive strength properties of concrete with Ground Granulated Blast Furnace Slag (GGBS) and Fly Ash in concrete by partial replacement of cement. The incremental demand of cement in the construction field is a concern for environmental degradation, in this regard; replacement of cement is carried out with waste materials by using GGBS and Fly Ash. On optimum level of GGBS and Fly Ash was assessed with varied percentage from 0 to 30% for different curing days. Replaced concrete were tested with the slump, compaction factor and compressive strength. Cement to water ratio was maintained at 0.47 for all mixes.

The compressive strength tests were conducted for 7, 14 and 28 days of curing on a M25 grade concrete. The results obtained from the slump, compaction factor and compressive strength of concrete containing GGBS and Fly Ash was increased as the curing time increases. The workability of replaced concrete improved when slump value achieved 30% as compared to controlled one TMO and the compressive strength obtained 26.30% improvement at TM9 as compared to TM0. The outcomes indicated that the addition of GGBS and Fly Ash enhances the workability and compressive strength which eventually improved the mechanical properties of concrete.

Keyword: Cement, Fly ash, GGBS.

1.INTRODUCTION

Construction industry has become one of the most important parts 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.

1.1. Research gap

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. Moreover, quarrying for the raw materials to produce ordinary cement destroys wildlife sanctuaries. Hence, the main object of the responsible authorities is either to eliminate the wide spread use of ordinary cement or use some other environment friendly method for concrete making to reduce the danger posed by the extensive use of ordinary cement on environment.

1.2. Necessity of reduce the 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 cementations because of their pozzolanie 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. Currently plenty of research carried out on the application of cementations material such as, silica fume, Fly Ash, ground granulated blast furnace slag, rice husk, and metakaolin, subtly utilized those cementations materials in replacement for Portland cement. Impacts of those material can be judged through concrete durability also reduce thermal cracking risk in mass concrete, consumed less energy along with eco-friendly as compared to cement and are considered throughout world as a filling material, roofing construction, tiles making and concrete blocks. 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.

1.3. Scope and objecive of the study

In this research the two best choices of cementations material GOBS and Fly Ash were assessed partially with ordinary Portland cement. The aim of this research is to examine the effects on fresh and hardened state when addition of blast furnace slag and Fly Ash in concrete with cement and the determination of concrete workability and compressive resistance at varied curing days that reduces the expenditure cost incurring than conceding the concrete strength.

To evaluate the fresh properties of control concrete of M-25 grade and concrete made with partial replacement of cement by fly ash and ground granulated blast furnace slag for fresh properties, slump cone test, compaction factor test are conducted.

To find out the compressive strength of control concrete of M-25graile and concrete made with fly ash and ground granulated blast furnace slag asa partial replacement of cement at 7 days, 14 days and 28 days, tests are conducted.

2.LITERATURE REVIEWS

1. (Jul-Aug, 2013) Durability studies on concrete with fly ash and GGBS by AHL 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 (GACI) and concrete made by replacing 40% replacement of cement by GGBS (GAC2). The effect of 1% of H2SO4 and sea water on these concrete mixes is 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.

2. (2014) 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.

3. From the study they concluded that the compressive strengths of concrete (with 0%, 5%, 10%, 15% and 20%, weight replacement of cement with FA) cured in Normal water for 28, 60 and 90 days have reached the target mean strength. The compressive strengths of concrete (with 0%, 5%, 10%, 15% and 20%, weight replacement of cement with FA) cured in different concentrations of (1%, 3%, and 5%) Sulphuric acid solution for 28, 60 and 90 days indicate that at 10%replacement there is increase in strength and beyond that the strengths decreased. The strength decreases in acidic environment with age of concrete. In concrete cement can be replaced with 10% FA with maximum increase in strength beyond starts decreases. Due to slow pozzolanic reaction the FA concrete achieves significant improvement in its mechanical properties at later ages.

In this research paper they concluded that, compressive strength reduces when cement replaced fly ash. As fly ash percentage increases compressive strength and split strength decreases. Use of fly ash in concrete can save the coal & thermal industry disposal costs and produce a 'greener' concrete for construction. The cost analysis indicates that percent cement reduction decreases cost of concrete, but at the same time strength also decreases. This research concludes that fly ash can be innovative supplementary cementations Construction material but judicious decisions are to be taken by engineers.

3. MIX DESIGNATION

Mix Designation	Description
TMO	100% CEMENT + 0% FLY ASH + 0% GGBS
TM1	95% CEMENT + 3% FLY ASH + 2% GGBS
TM2	95% CEMENT + 2.5% FLY ASH + 2.5% GGBS
TM3	95%% CEMENT + 2% FLY ASH + 3% GGBS
TM4	85% CEMENT + 10% FLY ASH + 5% GGBS
TM5	85% CEMENT + 7.5% FLY ASH + 7.5% GGBS
TM6	85% CEMENT + 5% FLY ASH + 10% GGBS
TM7	70% CEMENT + 20% FLY ASH + 10% GGBS
TM8	70% CEMENT + 15% FLY ASH + 15% GGBS
TM9	70% CEMENT + 10% FLY ASH + 20% GGBS

4.COMPRESSIVE STRENGTH

For this test, cubic moulds of 15cm x 15cm x 15cm size in grade 25 ratios were used. Compaction was achieved via table vibrator of the hand filled concrete cubes for

the compaction. After 24 hours the specimens were de molded and subsequently placed water tank basin for

different ages for curing. Number of three specimens was used to get the mean value of each partial percentage for compressive strength and test was operated on compression testing machine having load capacity 200 MT. The cubes were placed under water for curing after keeping molded for 24 hours. Compressive strength tests of the cubes were carried out after curing at 7, 14 and 28 days. Respectively in confirmation with L.S. 516- 1959.

The compressive strength has clearly shown improvement as the caring days gradually increased from TM1 to TM9 than the control one (OPC) as shown in Table 5. Furthermore, TM9 achieved 26.30% more compressive strength than the control one as well as the

targeted strength on 25 grade concrete being 31 MPA as clearly shown in Figure 6. The targeted compressive strength readily crossed by TM7, TM8 and TM9. These results are in line with who achieved 39 MPa at 30% replacement of Copper slag and 20% Fly Ash with M40 grade. Therefore, it can be said that 30% is optimal percentage on which safely achieved the desired hardened of concrete and reduce the cost of cement and recycling of unwanted waste.

4.1 Average compressive strength

Mix Proportion	Compressive Strength (MPA)		
	7 days	14 days	28 days
TMO	16.87	21.45	25.23
TM1	17.23	22.11	26.15
TM2	18.14	23.46	27.37
TM3	19.32	24.33	28.68
TM4	20.22	25.37	29.22
TM5	20.93	26.14	29.98
TM6	21.56	27.46	30.72
TM7	22.65	25.44	31.39
TM8	22.17	26.13	32.51
TM9	23.43	26.78	34.33

5. CONCULSION

The following observations and conclusions were drawn based on the results obtained from the investigation of Ground Granulated Blast Furnace Slag (GGBS) and Fly Ash a partial replacement of cement in concrete.

- The workability of concrete tends to increase initially with increasing replacement percentage up to an optimum limit, but then decreases partially.
- GGBS and Fly Ash content increases the workability reduces at the same water containing and w/c
- This study also has an aim of controlling the environmental pollution.
- The optimum workability was observed at replacement percentage of 15% as compared to control one that achieved 30%
- The concrete specimens with 30% replacement of cement with GGBS and Fly Ash TM9 obtained the highest compressive strength 34.33 MPA than the control one TMO.
- 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.

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