A Review of the Characterization of Ordinary Portland Cement (OPC) and Ground Dranulated Blast Furnace Slag (GGBFS) Blended Cementious System with Respect to Strength and Durability

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Abstract- With six billion tonnes produced each year, concrete is arguably the most widely utilised construction material in the world. In terms of proximity to water, it merely consumption per person. However, the sustainability of the environment is in jeopardy due to harm brought on by the exploitation of raw materials as well as CO_2 emissions during the production of cement, hence there is a need to reduce cement use by partially replacing cement with additional materials. These resources could consist of naturally occurring substances, industrial leftovers, or less energy-intensive byproducts. When mixed with calcium hydroxide, these substances, known as pozzalonas, exhibit cementetious qualities. Fly ash, silica fume, metakaolin, and ground granulated blast furnace slag (GGBS) are the most frequently utilised pozzalonas. This paper tries to shade light on the state of the art pertaining to use of and Ground Granulated Blast Furnace Slag (GGBFS) Blended Cementious Systems

Key Words- Ground Granulated Blast Furnance Slag (GGBS), Fly Ash, Silica Fume, Metakolin, Blended Cement, Pozzalonas, calcium Hydroxide

I. INTRODUCTION

Cement manufacturing is highly energy intensive which leads to emission of co_2 . 381 million metric tons[Garside,2023]. In the long run, there are opposing arguments for continuing the practise of partially replacing cement with processed materials with pozzolanic qualities. Recently, the possibility of using natural pozzolans like GGBS as a partial substitute for cement has received some attention. The use of GGBS is a relatively new technique among those used to increase concrete's durability and generate high performance concrete; the main issue is that, when combined with ordinary Portland cement, it requires an excessive amount of skill and water. 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 commonly used supplementary cementitious because of their pozzolanic properties. Slag formed additional C-S-H gel after reaction with portlandite whose structure is similar type that is accrued by cement hydration. Therefore, GGBS reaction makes a huge contribution to the characteristics and development of concrete. The quantity of GGBS waste from industries are increasing on daily basis and main issue of their disposal.

- COMPRESSION TEST-

Compression test for concrete with Ground Granulated Blast Furnace Slag (GGBFS) helps us to understand as compared to normal concrete, replacement concret's strength will significantly rise and it is also observed that the compression strength values of the GGBFS concrete mix rise more than those of the control mix as the curing time is extended. Additionally Santosh Kumar Karri et. al. Chose 30%, 40%, and 50% as cement replacement amounts and cured the concrete

specimens of grades M20 and M40 for 28 and 90 days. He discovered that as the GGBS replacement level rises, concrete becomes more workable. He noted that for both M20 and M40 grade concrete, the maximum compressive strength, split tensile strength and flexural strength arereached at 40% cement substitution, after which the strength marginally declines. The partial substitution of GGBS in concrete production is the subject of research by B.Mangamma et al. He replaced GGBS in a concrete mix to study the compressive strength of the material. For M20 and M40 the binding substance comprises 10%, 20%, 30%, 40%, 50%. He comes to conclusion that the partial replacement of GGBS for 10%, 20%, 30% strength is increased and for 40% and 50% strength is decreased.

Compression Test Of Concrete For M20 (N/mm^2)

Sr.No	% of GGBS	28 Days	90 Days
1	0	33	46
2	30	35	50
3	40	36	52
4	50	32	48

- Rapid Chloride Permeability Test (RCPT)

All concrete sample's durability was assessed using the the electrical resistivity technique and the rapid chloride permeability testing method in accordance with ASTMC 1202 after the samples had been removed from the curing tank after 28 days of curing. The result shows that the concrete mix with 50% GGBS has the lowest chloride penetration while also exhibiting the highest electrical resistivity, according to the data. Due to the high amount of alumina in GGBS, mix aids in filling the pore structure and has the greatest potential to bind chloride, giving such concrete the greatest resistance to chloride penetration.Concrete mix with partial substitution of regular portland cement with GGBS exhibits the least amount of chloride ions penetrationand the greatest amount of electrical resistivity.Combining GGBS with regular portland cement increase the concret's resistance to chloride ions penetrating it because the microstructural pores in GGBS based concrete are better filled and GGBS has a higher percentage of aluminium oxide than in convential portland cement, which improves its ability to bind chloride

- Heat of Hydration Test-

At the same curing ages, the temperature near the concrete core is greater while its slightly lowers along the radius. This is mostly because the equipment's heat loss compensation is insufficient.In the initial days of curing, there is a wide range in temperature at the testing spots. Since more heat is lost through the top and bottom of the adiabatic chamber, the temperature of the testing points closest to the concrete core is the greatest among the spots at same time. It is just a result of the fact that during the pouring process, the top of the concrete is exposed to the air while the ambient temperature is higher, improving the top's temperature due to heat transmission and promoting quicker hydration. As a result, the top's temperature is higher in the initial stages than in the later ones. After pouring, the top and bottom have identical exterior condition, but throughout the hydration process, the bottom's heat insulation effect is superior to that of the top.

II. LITERATURE REVIEW

1.Abdullah Laskar, Partha Ghosh

In this study, RCPT and electrical resistivity were utilized to assess the durability of several types of concrete samples. The experiment's findings indicate that concrete samples with lesser chloride permeability exhibit higher electrical resistance. Therefore, the durability of concrete can be assessed using the Electrical Resistivity & RCPT technique since this method is based on the ability to resist ion transportation through concrete microstructural pores.

2.Rahul Kumar, Sagar Shivhare

The performance of concrete when subjected to the strength of RCC members is the subject of a review of experimental and analytical research in this work. Because it is used as a source of heat in concrete constructions, hydration heat is one of the most crucial components. To determine the heat of hydration of samples of various sizes, he utilize a calorimeter (UTCM-0347 HEAT OF HYDRATION CALORIMETER). concrete's quality Although concrete's performance at room temperature has received a lot of attention, research on how RCC behaves when subjected to higher strength is picking up steam.

3.Eskinder Desta Shumuye

His study examines the usage of GGBS in concrete as a partly pozzolanic alternative for cement. The

literature demonstrates that GGBS was discovered to improve the older concrete's characteristics are subject to replacement level. This research examines a number of studies on alternate partial cement replacement materials, with a focus on Ground Granulated Blast Furnace Slag (GGBFS).

4.Santosh Kumar, P. Markandeya Raju

The current study focuses on analyzing the effect of M20 and M40 grade concrete that has had 30%, 40%, or 50% of its cement replaced with GGBS. The compressive strength, split tensile strength, and flexural strength of the cubes, cylinders, and prisms are tested. Sulfuric acid and hydrochloric acid durability trials were also carried out. Researchers from all over the world have produced a great deal of work, some of which is displayed here.

5.K.Ganesh Babu, V.Sree Rama Kumar

It was discovered that the method previously used to define the overall strength efficiency of GGBS concretes may also be used to other cementitious ingredients including fly ash and silica fume. The general efficiency factor, which varies with age, and a percentage efficiency component were determined to make up the general strength efficiency.

6.Shaik Mujeeb, Shaik Athar

An experimental analysis of the M20 grade concrete's compressive strength is presented in this research. Jawergi sand from the Bheema River, which is black in color and was permitted to pass through 4.75mm IS sieve, is used as fine aggregate. The quantities of crushed, granulated blast furnace slag used to substitute Ordinary Portland Cement in the cubes varied from 0% to 30%. The cure time was calculated as 3, 7, and 28 days. According to the investigation, the amount of ground granulated blast furnace slag used to substitute cement has an inverse relationship with the strength of concrete that contains GGBS.

7.D.Suresh and K. Nagaraju

The current scientific paper focuses on analyzing the properties of concrete that has had some of its cement GGBS or Ground Granulated Blast Furnace Slag, was used in its place. The discussion centers on the practical application of GGBS and its benefits and drawbacks. This GGBS application serves as a byproduct and a recent substitute for conventional building materials that are already running short, it serves as an environmentally friendly approach to use product without pouring it on the ground.

8..M.Rajaram, A.Muthadhi

The current scientific report focuses on analyzing the properties of concrete that has had some of its cement GGBS or Ground Granulated Blast Furnace Slag. GGBS replacement levels in concrete range from 0% to 5% to 20% to 35% to 50% of the total cement weight. 150 samples in total have been cast and put through testing in accordance with the IS Code. For the purpose of measuring compressive strength, split tensile strength, and flexural strength, all specimens were damp cured for 7, 14, and 28 days. The test findings demonstrated that adding more GGBS increases concrete mixtures' compressive strength, split tensile strength and flexural strength..

III. CONCLUSION

1.OPC is partially replaced with concrete with GGBFS, which not only reduces construction cost but also makes it easier to dispose of waste in an environmentally responsible manner that large amounts of waste slag are produced by the steel industry.

2.There will be a decrease in concrete's price.

3.With an increase in GGBFS replacement level, concrete becomes more workable.

4. In the case of GGBFS cement, heat of hydration is slower, which reduces the risk of shrinkage cracking and makes this cement more advantageous in high construction sites with temperature.

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