

Investigation on AR Glass Fibre Concrete with Dolomite and GGBS

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ABSTRACT: This study investigates the mechanical behavior of concrete incorporating Alkali Resistant (AR) glass fibres, Ground granulated blast furnace slag(GGBS), and dolomite powder as partial replacements. First maintaining 0.03% AR glass fibre constant with varying GGBS of 20%,40% and 60% to assess strength gain. Secondly optimum GGBS and 0.03% AR glass fibre were kept constant while dolomite powder was varied from 0% to 20% to evaluate combined effects.M20 grade concrete specimens were cast and tested for compressive and split tensile strength at 7 and 28 days.AR glass fibres improves tensile capacity and crack resistance due to their modulus. GGBS enhances long-term strength and durability through pozzolanic reaction, while dolomite powder acts as a micro – filler improving packing density. Results showed compressive and split tensile strength increased upto an optimum GGBS content, beyond which strength declined due to dilution. With constant AR glass fibre and optimum GGBS ,addition of dolomite powder further improved strength upto specific limit by densifying microstructure. Hence the ternary blend AR glass fibre, GGBS, and dolomite powder proves effective for producing high-performance sustainable concrete.

KEYWORDS: AR glass fibre, Ground granulated blast furnace slag(GGBS), dolomite powder, microstructure, resistance, Compressive strength and Split tensile strength.

I. INTRODUCTION

The concrete is a combination of material like cement, coarse aggregate, fine aggregate and water in which the cement is binding agent. when cement comes contact to water there will be an exothermic reaction takes place such that the contents of the concrete are being hardened.

Dolomite is a calcium magnesium carbonate sedimentary rock widely crushed and used in the construction industry. When mixed into concrete, it primarily serves as a sturdy coarse or fine aggregate to replace standard gravel and sand. Additionally, it can be ground into an ultra-fine powder to act as a micro-filler or partial replacement for industrial cement.

GGBS, which stands for Ground Granulated Blast-Furnace Slag, is a sustainable, recycled byproduct obtained from the manufacturing of iron in a blast furnace. When molten slag is rapidly quenched with water, it forms a glassy, granular material that is subsequently dried and ground into a fine, off-white powder. In the construction industry, it is widely utilized as a direct partial replacement for ordinary Portland cement in concrete mixes.

AR (Alkali-Resistant) glass fibre is a specialized reinforcing material manufactured with a high concentration of zirconia to withstand the highly alkaline environment of curing cement. Unlike standard glass fibres that dissolve and lose structural integrity when mixed with concrete, AR variants are physically and chemically stable over decades of environmental exposure.

II. OBJECTIVES

1. To determine the effect of varying percentages of GGBS on the compressive strength and split tensile strength of concrete with a constant 0.03% AR glass fibre.
2. To evaluate the combined influence of dolomite powder at different replacement levels on the mechanical properties of concrete contain optimum GGBS and 0.03% AR glass fibre.

III. MATERIALS

a. Cement: Cement is a binding agent, a material used for construction for the purpose of holding the building materials together. Concrete consists of coarse aggregate as main content and fine aggregate is used to fill the voids between the coarse aggregates.

b. Fine aggregate: Fine aggregate is the essential ingredient in concrete that consists of natural sand and crushed stone. The quality and fine aggregate density strongly influence the hardened properties of the concrete. Sand is a granular material composed of finely divided rock and mineral properties. Sand has various compositions but defined by its grain size. Sand grain smaller than gravel and coarse than silt. Sand can also refer to as soil type containing more than 85 percent sand-sized particles by mass.

c. Coarse aggregate: The aggregate is a broad category of coarse to medium – grained particulate material used in construction. Aggregates are the most mined materials in the world, Aggregates are a component of composite materials such as concrete and asphalt concrete.

d. Water: When water is obtained from sources mentioned above, no sampling is necessary. When it is suspected that water may contain sewage, mine water, or wastes from industrial plants or canneries, it should not be used in concrete unless tests indicate that it is satisfactory. Water from such sources should be avoided since the quality of the water could change due to low water or by intermittent tap water is used for casting.

e. Dolomite Powder : Dolomite is an anhydrous carbonate mineral composed of calcium magnesium carbonate, ideally $CaMg(CO_3)_2$. The term is also used for a sedimentary carbonate rock composed mostly of the mineral dolomite. The mineral dolomite crystallizes in the trigonal- rhombohedral system. It forms white, tan, grey, or pink crystals. Dolomite is a double carbonate, having an alternating structural arrangement of calcium and magnesium ions. Unless it is in fine powder form, it does not rapidly dissolve.

f. GGBS : Ground Granulated Blast-Furnace Slag (GGBS) is a eco-friendly cementitious material obtained as a by-product during the manufacture of iron in a blast furnace. When molten slag is rapidly chilled with water, it forms a glassy, granular product that is subsequently dried and ground into a fine powder.

g. AR Glass Fibre : Alkali resistant (AR) glass fibre is glass fibre with added zirconium oxide to help resist attack from alkalinity. This is an important element of these fibre, as concrete is an alkaline environment. Normal fiberglass (e-glass) degrades in concrete due to the aggregate alkaline environment.

IV. RESULTS AND DISCUSSIONS

a. Compressive strength test: The test 150 x 150 x 150 mm cube specimens were cast, and for varying concrete mix proportions, they were tested in a compression testing equipment for 7 and 28 days of curing time.

Table 1:- Compressive strength result of 0.03% ARGF concrete with GGBS as partial replacement of cement.

Sl.no	0.03% ARGF+ different of GGBS	Compressive Strength Result N/mm ²	
		7 days	28 days
1	0%	18.66	27.69
2	0.03%ARGF+20%GGBS	22.83	33.38
3	0.03%ARGF+40%GGBS	24.57	35.15
4	0.03%ARGF+60%GGBS	23.14	33.63

Table 2:- Compressive strength result of 0.03% ARGF +40%GGBS concrete with dolomite Powder as partial replacement of cement.

Sl.no	0.03% ARGF+40% GGBS+ different % of DP	Compressive Strength Results, N/mm ²	
		7 days	28 days
1	0%	18.66	27.69
2	0.03%ARGF+40%GGBS+5%DP	24.74	36.47
3	0.03%ARGF+40%GGBS+10%DP	25.98	37.89
4	0.03%ARGF+40%GGBS+15%DP	27.45	38.94
5	0.03%ARGF+40%GGBS+20%DP	27.21	37.38

b. Split tensile strength: At the Age of 7 and 28days, measuring 300 mm in length and 150 mm in diameter positioned horizontally between the loading platens of a Compression Testing Machine (CTM). A compressive load is applied diametrically and uniformly across the cylinder's length until it fails along its vertical diameter.

Table 3:- Split tensile strength result of 0.03% ARGF concrete with GGBS as partial replacement of cement.

Sl.no	0.03% ARGF+ different of GGBS	Split tensile Strength Result N/mm ²	
		7 days	28 days
1	0%	1.82	2.69
2	0.03%ARGF+20%GGBS	2.23	3.28
3	0.03%ARGF+40%GGBS	2.58	3.65
4	0.03%ARGF+60%GGBS	2.34	3.32

Table 4:- Split tensile strength result of 0.03% ARGF +40%GGBS concrete with dolomite Powder as partial replacement of cement.

Sl.no	0.03% ARGF+40% GGBS+ different % of DP	Split tensile Strength Results, N/mm ²	
		7 days	28 days
1	0%	1.82	2.69
2	0.03%ARGF+40%GGBS+5%DP	2.34	3.47
3	0.03%ARGF+40%GGBS+10%DP	2.56	3.68
4	0.03%ARGF+40%GGBS+15%DP	2.67	3.75
5	0.03%ARGF+40%GGBS+20%DP	2.42	3.51

V. CONCLUSION

1. The compressive strength for conventional concrete for 7 and 28 days is 18.66 and 27.69 N/mm².
2. By maintaining Constant 0.03%ARGF+40% replacement of cement with GGBS the compressive strength for 7 and 28 days is 24.57 and 35.15 N/mm².
3. By maintaining Constant 0.03%ARGF+40%GGBS+15%DP replacement of cement with GGBS the compressive

strength for 7 and 28 days is 27.45 and 38.94 N/mm².

4. The Split tensile strength for conventional concrete for 7 and 28 days is 1.82 and 2.69 N/mm².
5. By maintaining Constant 0.03%ARGF+40% replacement of cement with GGBS the Split tensile strength for 7 and 28 days is 2.58 and 3.65 N/mm².
6. By maintaining Constant 0.03%ARGF+40%GGBS+15%DP replacement of cement with GGBS the Split tensile strength for 7 and 28 days is 2.67 and 3.75 N/mm².

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