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# An Experimental Investigation on Normal Conventional Concrete with Dolomite and GGBS

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**ABSTRACT**

Concrete is the predominant material utilized in civil engineering due to its excellent compressive strength and stability. The concrete sector is actively seeking supplementary cementitious materials or industrial by-products to mitigate carbon dioxide emissions, which pose a threat to the environment. Dolomite powder, derived from the pulverization of dolostone, serves as a supplementary cementitious material. This study examines the effective incorporation of dolomite powder in concrete production as a partial substitute for cement. The mechanical properties of M30 grade concrete are analyzed with varying percentages of dolomite powder replacing cement at 5%, 10%, 15%, 20%, and 25%. The research aims to determine the optimal percentage of dolomite that yields maximum strength. Once this optimal percentage is established, cement will be further substituted with Ground Granulated Blast Furnace Slag (GGBS) at rates of 5%, 10%, 15%, and 20%. The findings reveal that the highest strength is achieved with a mix containing 10% dolomite and 10% GGBS. This paper emphasizes the investigation of M30 concrete's performance through the partial replacement of cement with dolomite powder and granulated blast furnace slag..

**KEYWORDS**: Dolomite, GGBS, Compressive strength, Split tensile strength, M30 grade concrete.

## Introduction:

Concrete ranks among the most widely utilized construction materials globally, with an annual placement of two billion tons. Its appeal in various applications stems from its substantial strength combined with relatively low costs. Typically, concrete can be produced using locally sourced materials, allowing for a diverse range of structural forms. Additionally, it necessitates minimal maintenance throughout its lifespan. The Portland cement industry contributes approximately 7% to global CO2 emissions. By partially substituting Portland cement with one or more additives to create blended cements, it is possible to reduce CO2 emissions and energy consumption during cement production while also providing durable cementitious solutions for the construction sector.

Fresh concrete refers to the material in a relatively fluid state, making it easy to mold; however, if the mold is removed too soon, the shape of the fresh concrete may gradually alter. In its mixed state, fresh concrete encapsulates all grains of sand and gravel, maintaining a homogeneous structure. The quality and characteristics of the final product are typically influenced by the level of plasticity and any significant changes in the properties of the fresh concrete mix. Hardened concrete represents the final outcome of any concrete design. The key properties of hardened concrete include strength, stress-strain characteristics, shrinkage and creep deformation, permeability, and durability. Among these, concrete strength is of paramount importance, as it relates to the structure of the hardened cement paste and provides a comprehensive assessment of the concrete's quality. The strength of hardened concrete is determined at a specific age and under particular curing conditions.

## Materials:

Dolomite powder is produced by grinding the sedimentary rock mineral known as dolomite, which can serve as a partial substitute for cement in concrete up to a specified percentage. This powder exhibits several properties akin to those of cement. Incorporating dolomite powder into concrete can lead to cost savings and may enhance strength to a certain degree. Dolomite is a carbonate mineral consisting of calcium magnesium carbonate (CaMg(CO3)2). Recognized as a rock-forming mineral, dolomite is distinguished by its excellent wettability and dispersibility. Additionally, it demonstrates significant resistance to weathering. Due to its superior surface hardness and density, dolomite is favored as a construction material. Its higher strength and hardness make it particularly suitable for applications in asphalt and concrete. The effective use of dolomite powder can contribute to achieving the goal of reducing construction costs.

### *Formation of Dolomite*

Dolomite is thought to have originated through the substitution of a portion of the calcium in a calcium carbonate limestone deposit with magnesium during the lithification process. This transformation occurs as layers of deceased clams and other marine organisms' shells are converted into crystallized calcite or calcium carbonate. The resulting mineral, dolomite, with the chemical formula CaMg(CO3)2, is classified as a true double salt. Within the crystal structure of dolomite, calcium and magnesium ions are arranged in distinct layers. Specifically, the structure consists of a calcium layer followed by a carbonate layer, then a magnesium layer, and this sequence continues. Dolomite exhibits greater hardness and density compared to the calcite variant of calcium carbonate or limestone, and it is also more chemically stable and resistant to acid attack. The powdered form of dolomite is produced by grinding the sedimentary rock known as dolostone.

Ground Granulated Blast Furnace Slag (GGBS) is a non-metallic byproduct generated during the reduction of iron ore to pig iron in a blast furnace. The molten slag is rapidly cooled to create granules, which are subsequently ground to a fineness comparable to that of Portland cement. When utilized as a cementitious material, GGBS must adhere to standard specifications, with three defined grades—80, 100, and 120—according to ASTM C 989, where higher grades offer increased strength potential. While GGBS possesses inherent cementitious properties, these are significantly enhanced when combined with Portland cement. The proportion of slag used typically ranges from 20% to 70% by mass of the total cementitious materials.

### *Mixing of Concrete*

The process of mixing concrete is crucial for achieving a consistent and uniform product. It is imperative that the mixing process ensures the concrete attains a homogeneous quality and uniform consistency. The mixing procedure adheres to the guidelines set forth in I.S: 516-1959. A pan mixer is utilized for this purpose, where the components—cement, fine aggregates, coarse aggregates, and water—are introduced into the mixer. Initially, the dry cement is combined with fine aggregates, followed by the addition of coarse aggregates, which are then mixed thoroughly.

### *Slump Cone Test*

The slump test is the most widely employed method for assessing the consistency of concrete, applicable in both laboratory settings and on construction sites. However, it is not suitable for extremely wet or dry concrete mixtures. This method does not account for all factors influencing workability, nor does it always accurately represent the workability of the concrete. Nevertheless, it serves as a convenient control test, providing an indication of the uniformity of concrete across different batches.

### *Compaction factor test*

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959. The apparatus used is Compacting factor apparatus this test is adopted to determine workability of concrete where nominal size of aggregate does not exceed 40 mm. It is based on the definition, that workability is that property of concrete, which determines the amount of work required to produce full compaction. The test consists essentially of applying a standard amount of work to standard quantity of concrete and measuring the resulting compaction. The compaction factor is defined as the ratio of the weight of partially compacted concrete to the weight of fully compacted concrete. It shall be stated to the nearest second decimal place..

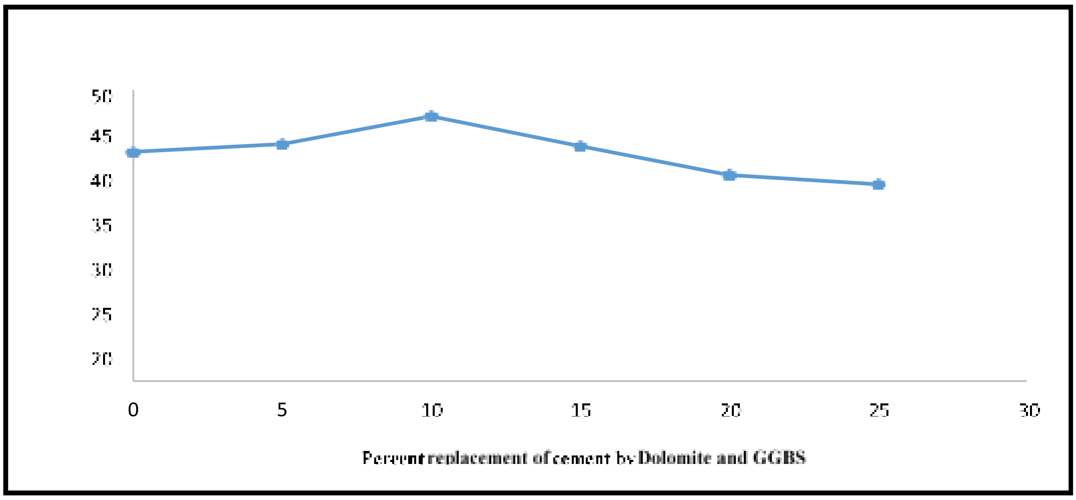
### *Cube Compressive strength*

Compressive test was done confirming to IS: 516-1959. All the concrete specimens were tested in a Universal Testing Machine (UTM) of capacity 200 tones. Concrete cubes of size 150 mm x 150 mm x 150 mm were tested. Crushing strength of concrete was determined by applying load at the rate of 140 kg/sq. cm/minute till the specimens failed. The maximum load applied to the specimens was recorded dividing the failure load by area of the specimens, ultimate compressive strength.

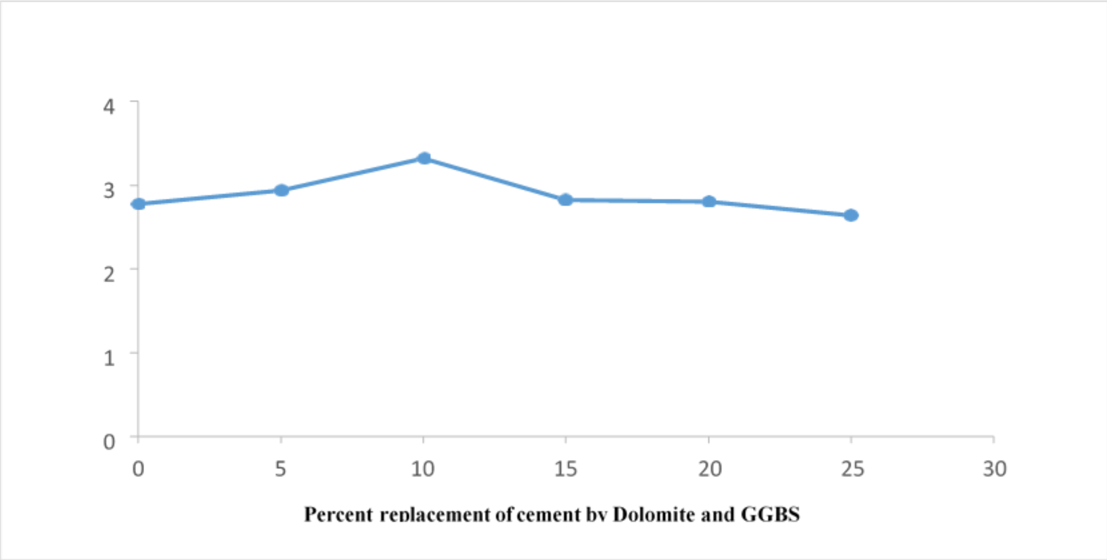
### *Split Tensile Strength*

Split Tensile Strength test was done confirming to IS: 516-1959. All the concrete specimens were tested in a Universal Testing Machine (UTM) of capacity 200 tones. Concrete cubes of size 150 mm x 300 mm ht. were tested for split tensile strength of concrete was determined by applying load at the rate of 140 kg/sq. cm/minute till the specimens failed. The cylinder specimens of concrete was placed horizontal, so that its axis is horizontal between the plates of the testing machine. Narrow strips of the packing material i.e. ply wood was placed between the plates and the cylinder, to receive the compressive stress.

## Results and Discussion




**Compressive Strength of 28days of Dolomite.**




**Split Tensile Strength of 28days strength**

## Conclusions

The following conclusions are drawn from physical tests and experimental investigations conducted over normal conventional concrete (control mix) and blended concrete mix (cement along with Dolomite powder and GGBS)

Dolomite powder along with GGBS can be used as pozzolonic materials to replace cement partially up to 10% in preparing concrete. Use of dolomite powder along with GGBS may enhance strength at 28 days.

Dolomite along with GGBS may act as a filler material which acts as a volume matrix to reduce the porosity of concrete.

Workability characteristics of concrete admixture with Dolomite and GGBS are similar to those of normal conventional concrete.

Plastic and shrinkage properties in concrete with Dolomite powder and GGBS are to be investigated.

Dolomite and GGBS may be used partially to enhance the strength properties of concrete which makes the mix economical than conventional concrete.

Based on the experimental investigations, the strength properties of concrete are significantly improved with the use of Dolomite powder and GGBS in preparing concrete.

Applications of Dolomite powder and GGBS as pozzolonas in partial replacement of cement in preparing self-compacting concrete mixes are to be studied for future investigations.

Improvement of Bond strength characteristics of normal conventional concrete and self-compacting concrete mixes with the applications of Dolomite powder and GGBS are to be investigated.

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