"Partial replacement of cement & fine aggregate with MDP & GGBS"

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ABSTRACT

The speed of development in infrastructure sector is huge because of rapid growth in population and innovations, it covers the growing construction projects in different sectors like social infrastructure, manufacturing infrastructure, extraction infrastructure, transportation infrastructure. Due to this speedy growth in construction sector it turns out to be very important to find eco-friendly concepts and products. And here we have a option to replace cement partially with marble dust powder (MDP) to optimize material use in concrete industry and reduce hazardous effect on environment. Partial replacement of fine aggregate with ground granulated blast furnace slag (GGBS), percentage of replacement is 0,5,10,15% to overcome environmental problems fine aggregate mining and also the problem of waste disposal of slag. This project represents the results of an investigations accomplish to understand the suitability of marble dust powder MDP and ground granulated blast furnace slag GGBS in the production of concrete.

KEY WORDS: MDP, GGBS, infrastructure, compressive strength, flexural strength, drying shrinkage.

1. INTRODUCTION:

Million metric tonnes of MDP are produced worldwide during currying. Marble is a metamorphic rock, colour and appearance of marble is because of its purity. It is used for construction and decoration, if the limestone is composed solely of calcite (100% $CaC0_3$) then it is white. It is durable, has noble appearance and has great demand. The main impurities in raw cement (limestone) are magnesia, zinc, phosphate, leads, alkalis, Sulfieds. Huge quantity of marble dust powder is generated during the cutting process which results the mass of marble waste. If this millions of tons of waste leave to the environment creates adverse effects. The manufacturing of cement results in emission of large amount of CO_2.

Earth crust has limited energy sources and we have to save it or find alternative energy resources for the future generations. There is need to create awareness in Construction field too. Consumption of lime is second environmental issue. As there is no alternative binding material to replace cement totally by 100% so utilization of partial replacement of binding material (cement) is well accepted for concrete composite.

Ground granulated blast furnace slag (GGBS) is a by-product from the iron and steel making blast furnaces. GGBS is used to make durable concrete structures combination with OPC and other pozzolanic materials. So the problem is related to environment and cost minimization and this research will give answer to use industrial waste material by proper analysing and studying the properties of concrete.

2. OBJECTIVE:

The compressive strength, tensile strength & flexural strength of ordinary Portland cement (43 Grade) M30 grade of concrete are obtained.
To determine the performance of concrete by partial replacement of fine aggregate by Ground Granulated Blast Furnace Slag (GGBS) in 10%, 15%, 20% variants.

3. MATERIALS USED:

1. Cement
2. Fine Aggregate
3. Coarse Aggregate
4. Marble Dust Powder (MDP)
5. Ground Granulated Blast Furnace Slag (GGBS)
6. Water

4. TESTING ON MATERIALS:

The material quality differs from place to place, for that there is need to carried out various testing on to the material. The various testing on material is carried out determining its eligibility towards the main construction material into the concrete as a main ingredient. There are various test in the material like physical test and chemical test

4.1 Cement-

Specific Gravity:

The specific gravity is normally defined as the ratio between the weight of a given volume of material and weight of an equal volume of water. The ordinary Portland cement have a specific gravity of value around 3.1 to 3.2.

Based on the moisture content present in the cement, the specific gravity can either increase or decrease. The cement particles have pores or particles that can contain water within it. A nominal mix is prepared with a cement of specific gravity 3.15. Any change in this value of specific gravity will affect the mix design. Hence, it is necessary to test the specific gravity of the cement procured before mixing process.

This is the main reason why we ignore the use of old stock cement. Old stock cement may be affected by external moisture content.

A value of specific gravity of cement greater than 3.19 shows that the cement was not properly minced into fine powder during its production or the cement has more moisture content. The presence of moisture content in cement is easily identified by the presence of chunks in cement.

The specific gravity of cement observed as 3.15

4.2 Fine Aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 4.75 mm sieve. Fine aggregate size less than 4.75 mm.

Specific Gravity:

Specific Gravity is the ratio of the weight of a given volume of aggregate to the weight of an equal volume of water. Water, at a temperature of 73.4°F (23°C) has a specific gravity of 1. Specific Gravity is important for several reasons. Some deleterious particles are lighter than the good aggregates.

Table-1: Specific gravity

Sr. No.	Particulars	Sample (Gm)
1	Mass of Pycnometer(M1)	665
2	Mass of Pycnometer+ Sand (M2)	1160
3	Mass of Pycnometer+ Sand + Distilled Water(M3)	1867
4	Mass of Pycnometer Distilled Water(M4)	1556
	Specific Gravity(M2-M1) / [(M2-M1)- (M3-M4)]	2.53

Specific Gravity of fine aggregate is 2.5

Water Absorption:

The water Absorption of fine Aggregate should not more than 0.6 percent of its unit weight.

The given sample water absorption is 0.45 percent of its unit weight.

4.3 Test on Coarse Aggregate

Sp. Gravity and water Absorption

A= Weight of saturated aggregate in water (A1- A2) = 2.1kg B= weight of saturated surface dry aggregate in air = 2kg C = weight of oven dry aggregate in air=1.998kg A1=Weight of aggregate and basket in waterA2=Weight of empty basket in water

Specific Gravity =C/(A-B) = 2.7

Water Absorption=100(B-C)/C

= 3%

4.4 Ground Granulated Blast Furnace Slag

Ground-granulated blast-furnace slag (GGBS or GGBFS) is obtained by quenching molten iron slag (a by-product of iron and steel-making) from a blast furnace in water or steam, to produce a glassy, granular product that is then dried and ground into a fine powder. Ground - granulated blast furnace is highly cementitious and high in CSH (calcium silicate hydrates) which is a strength enhancing compound which increases the strength, durability and appearance of the concrete. The specific gravity of GGBS is 2.8.

4.5 Marble Dust Powder

Marble is a metamorphic rock composed of recrystallized carbonate minerals, most commonly calcite or dolomite. Marble is typically not foliated, although there are exceptions. In geology, the term "marble" refers to metamorphosed limestone, but its use in stonemasonry more broadly encompasses unmetamorphosed limestone. Marble is commonly used for sculpture and as a building material.

Dust produced by cutting marble could cause lung disease but more research needs to be carried out on whether dust filters and other safety products reduce this risk.

In the United States, the Occupational Safety and Health Administration (OSHA) has set the legal limit (permissible exposure limit) for marble exposure in the workplace as 15 mg/m^3 total exposure and 5 mg/m^3

respiratory exposure over an 8-hour workday. The National Institute for Occupational Safety and Health (NIOSH) has set a recommended exposure limit (REL) of 10 mg/m³ total exposure and 5 mg/m³ respiratory exposure over an 8-hour workday.

Specific Gravity of Marble Powder is 2.4.

5. METHODOLOGY:

Preparation of material:

- All materials are brought to room temperature, preferably 27° ± 3°C before commencing the tests. The cement, marble dust powder, ground granulated glass furness slag samples, on arrival at the laboratory, was thoroughly mixed dry by in such a manner as to ensure the greatest possible blending and uniformity in the material, cares being taken to avoid the on of foreign matter. The cement was stored in a dry place, preferably in air-tight metal containers.
- Samples of aggregates for each batch of concrete are of the desired grading and in an air-dried condition. Aggregate were separated into fine and coarse fractions and recombined for each concrete hatch in such a manner as to produce the desired grading. Following steps used for preparation of material –

1. Proportioning
2. Weighing
3. Mixing concrete
4. Curing

6. TESTING OF SPECIMEN

6.1 TEST RESULTS

- **GREEN CONCRETE**

Table-2: Results of green concrete

Sr no.	Type of test	Results			
		M	M1	M2	M3
1)	Vee bee consistency	17sec	21sec	21sec	26sec
2)	Compaction factor	0.93	0.92	0.89	0.9
3)	Slump cone test	122	125	133	140
4)	Initial setting time for cement	30min	30min	30min	30min

- **HARDEND CONCRETE**

Table-3: Hardend concrete (Strength in N/mm²)

SR. NO.	TYPE OF SPECIMEN	Days Of Curing	M0	M1	M2	M3
1	Cube	7 Days	24.8	27.568	30.44	29.332
		28 Days	35.3	38.47	42.46	40.98
2	Cylinder	7 Days	2.4	3.1	4.2	3.46
		28 Days	3.64	4.872	5.61	3.375
3	Beam	7 Days	2.8	2.92	3.08	3.024
		28 Days	4.78	4.8772	5.158	5.01

- **COMPRESSIVE TEST ON CONCRETE**

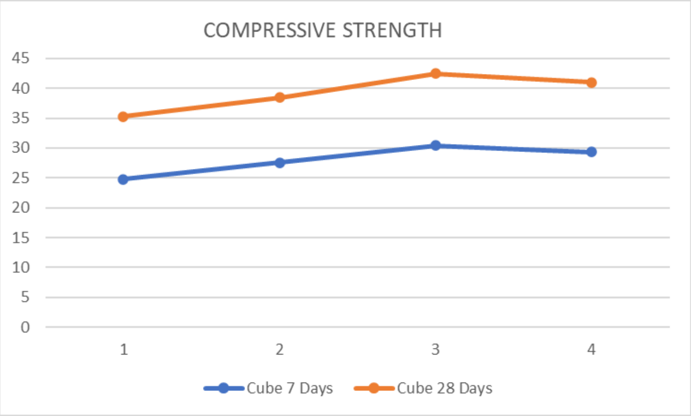

Chart-1: compressive strength.

- **SPLIT TENSILE STREGTH ON CONRETE**

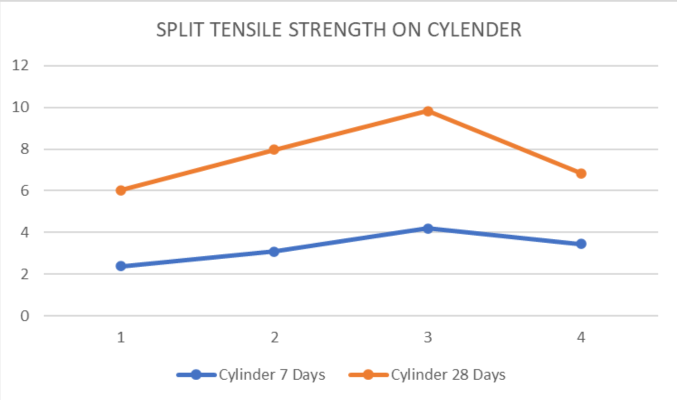

Chart-2: split tensile strength on cylinder.

- **FLEXURAL STRENGTH ON CONCRETE**

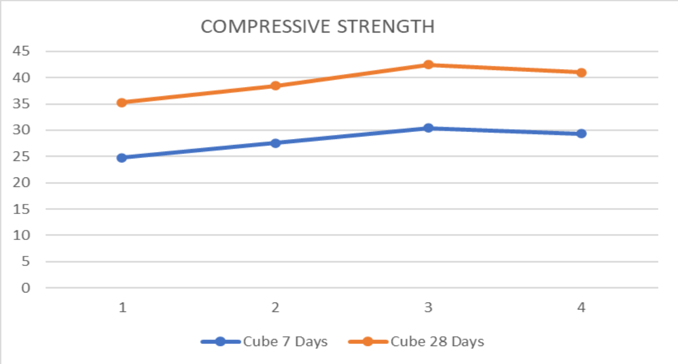

Chart-3: flexural strength on concrete

7. Conclusion:

1. The project gives idea about using appropriate proportion of MDP and GGBS for the partial replacement of cement and fine aggregate.

2. Since natural river sand has been drastically depleted since decade this replacement provide better alternative to natural one usual GGBS is done.

3. MDP is a residue from huge quarries left out which is either disposal or used for landfill.

4. We can used it as a partial replacement to cement in appropriate proportion, sustainable of these would help in producing economical concrete mix which would be used for paver concrete pavements and various other elements of concrete hence material variation would surely result to efficient and economical mix design.

The mix (M3) proves to be weak. So M1 &M2 can be used for various purposes Since the workability of M3 is reduced due to which the strength is also affected and considerably reduced.

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