STUDY ON PARTIAL REPLACEMENT OF CEMENT WITH THE COMBINATION OF GLASS POWDER AND MARBLE DUST

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ABSTRACT

The utilization of solid waste for manufacturing concrete blocks will help in conservation of natural resources. The use of waste marble powder as a partial replacement of cement can reduce the cost of cement and also, control the emission of harmful dust into environment and proving to be eco-friendly to the environment. Waste glass is also a major component of solid waste stream in India. At present, a small proportion of post-consumer glass has been recycled with high performances and unique aesthetic properties which make it suitable for wide spread uses. As marble dust is a waste product during the sawing and polishing of parent marble block and about 20-25% of the processed marble is turned into dust form. The production of cheaper concrete using waste marble dust and glass powder can solve to some extent the ecological and environmental problems.

Keyword: - *Marble Dust Powder, Glass powder, Strength, Sustainability.*

1. INTRODUCTION

These days apart from steel, concrete is the most and widely used as structural material in the construction field. Concrete defined as a composite material made up of composed granular materials (the aggregate and filler) embedded in a hard matrix of materials (cement or binder) and water that fills spaces between the aggregate particles and binds them together. There are many types of concrete with different materials used and mix design. Marble is a metamorphic rock resulting from the transformation of pure lime stone. Turkey has the 40% of total marble reserve in the world. 7,000,000 tons of marble have been produced in Turkey annually and 75% of these productions have been processed in nearly 5000 processing plants. It can be seen that the waste materials of these kind of plants reach millions of tons. Stocking of these waste materials is impossible. These types of solid waste materials should be inactivated properly without polluting the environment. The most well suited inactivating method nowadays is found to be recycling. Recycling provides us with some advantages such as protecting the natural resources, contributing to economy, energy saving, decreasing the waste materials and investing in the future.

Glass is an amorphous (non-crystalline), its not a solid but a super cooled liquid. Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibres to meter-sizes pieces. Primarily glass is made up of sand, soda ash, limestone and other additives.

Constituents of Glass:
Silica (SiO2) - 72.5%
Alumina (Al2O3) - 1.06%

Lime (CaO+3) - 0.8%
Iron Oxide (Fe2O3) - 0.36%
Magnesia (MgO) - 4.18%
From the literature survey, it is understood that for all the experiments the characteristics of the marble powder and glass powder gives good results comparing to normal concrete. Five concrete mixtures containing 5%, 10%, and 15% marble dust powder and 10%, 20% and 30% glass powder respectively as cement replacement by weight basis has been prepared. Water/cement ratio was kept constant at 0.40, in all the concrete mixes. Compressive strength, split tensile strength & flexural strength of the concrete mixtures has been obtained at 7 & 28 days. [11]

2. METHODOLOGY

The method followed for the experiment involved, collection of materials at first. The glass powder was procured online and the marble dust was collected from one of the quarries and the cement, sand and coarse aggregate was procured from a construction site nearby to college. The second stage involves, casting of the concrete cubes in the lab and then curing them in a fresh water tank. The last step in the test involves testing and comparison of results. Figure 1 shows the step-by-step method followed for the experiment.

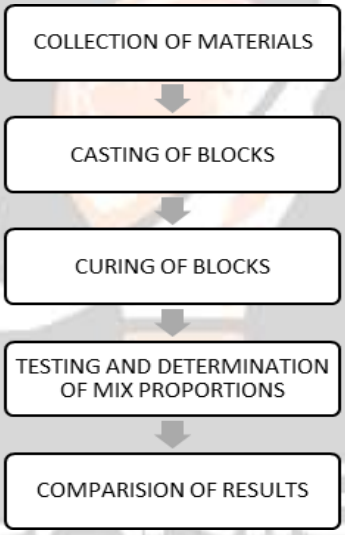

Figure -1

3. CEMENT

Cement is a finely milled mineral powder, grey in colour. The most important raw materials for the production of cement are found to be limestone, clay, and marl. Mixed with water, cement serves as an adhesive to bind sand, gravel, and hard rock in concrete. Cement hardens both in the air and under water, and remains in its hardened state once reached.
Cements are classified according to their early and final strength as their composition. In addition to cements that consist of 100% clinker, there are so-called composite cements, in which a portion of the clinker is replaced by alternative raw materials, such as fly ash, ground slag, or limestone. As the production of clinker is energy-intensive and releases huge amounts of CO2, the use of alternative raw materials can conserve natural resources and reduce CO2 emissions by a large margin.

4. FINE AGGREGATE

The fine aggregate used in manufacturing of concrete should be free from debris, fungi and chemical attack. It plays a vital role in concrete, so it should durable, angular and sharp edges then only it and gives a rich mix concrete and workability.

- It should be clean and coarse.
- It should be free any organic or vegetable matter.
- It is usually 3 to 4 % of clay in permitted.
- It is chemically alert and well graded.
- The fineness modulus of sand should be between 2 & 3.

5. COARSE AGGREGATE

Aggregates are the important constituents in concrete. They give body to the concrete, reduces shrinkage and effect economy. Earlier aggregates were considered as chemically insert materials but now it's as to been recognized that some of aggregates are chemically active and also that certain aggregate exhibit chemical bon at interface of aggregate and paste.

- Important parameter of coarse aggregate are shape, texture, grading, cleanliness and nominal maximum size
- Angular coarse aggregate provides mechanical bond and are generally more suitable for use in high strength concrete that smooth textured aggregates.
- Coarse aggregates with greater stiffness can increase the elastic modulus while at the same time decrease the strength capacity.

6. WATER

Water is an important element in gradient of concrete as it actively participates in the chemical reactions with cement. The strength of cement concrete mainly from binding action of the hydration of cement. It is very important to have compatibility between the given cement and the chemical materials admixtures along with the water used for mixing. It is generally stated in the concrete codes (IS Codes) and also in the literature that the water fit for making concrete. This may not to true always but the water that's fit for drinking is generally good for concrete.

7. MARBLE DUST

Marble has been commonly used as a building material since the early 50s. The industry's disposal of the waste marble powder material, consisting of very fine powder, today constitutes to a huge environmental problem around the world. Marble blocks are cut into smaller blocks in order to give them the desired smooth shape. During the cutting process about 25% the original marble mass is lost in the form of dust with the use of these waste material the quantity of waste material can be minimize. Hence it is a waste optimization technique. With the replacement of cement by marble dust powder we can achieve a greener construction.

8. GLASS POWDER

Glass is an amorphous (non-crystalline) that in essence, a supercooled liquid and not a solid. Glass can be made with excellent homogeneity in a variety of forms and sizes from small fibres to meter-sizes pieces. Primarily glass is made up of sand, soda ash, limestone and other additives (Iron, Chromium, Alumina, Lead and Cobalt).

9. TESTS CONDUCTED

9.1 Compressive Strength

Compressive strength test out is completed at particular ages about cubes. A specimen of size 100mm x 100mm x 100mm is used. The concrete was filled in distinct layers inside the mould and layer was compacted with the aid of tamping rod. The example was taken out of mould after 24 hours, cured in water for 7s and 28 days. After 7 days of curing, the specimen is wiped dry out and analysed for compressive strength according to the IS code in compression testing equipment. The maximum load applied is noted.

9.2 Flexural Strength

Flexural strength of the sample was tested at 28 days only. A specimen of size 100mm x 100mm x 500mm was used to calculate the flexural strength. The materials were measured and then, were blended physically. The mould was filled in various layers in the shape and each layer was compacted with the assistance of tamping rod. The sample was expelled from the mould after 24 hours and put in clean water for 28 days. After 28 days of curing, the sample are taken out, cleaned dry and afterward tried for flexural quality according to IS code in the testing machine.

9.3 Tensile Strength

Tensile strength is one of the basic and important properties of concrete. A knowledge of its value is required for the design of concrete structural elements. Direct tensile strength of concrete is difficult to determine; recourse is often taken to the determination of splitting tensile strength and computing the direct tensile. A cylinder of diameter 150mm diameter and height 300mm is casted. The specimen is removed from the mould 24 hours after casting it and then put into fresh water for 24 days of curing. It is then removed, cleaned dry and tested for its split tensile strength according to the IS code.

9.4 Workability

Workability of Concrete is a broad and subjective term describing how easily freshly mixed concrete can be mixed, placed, consolidated, and finished with minimal loss of homogeneity. Workability is a property that directly impacts strength, quality, appearance, and even the cost of labour for placement and finishing operations. The testing method for workability consists of a slump cone with a base diameter of 8 inches, a top diameter of 4 inches, and a height of 12 inches. The cone is filled with freshly mixed concrete, and then removed. The shape of the concrete after the cone removal is then assessed to determine the workability.

10. RESULTS

SLUMP VALUE (mm)

Conventional Concrete	80
MDP_5GP_{10}	79
$MDP_{10}GP_{20}$	81
$MDP_{15}GP_{30}$	77

Table -1

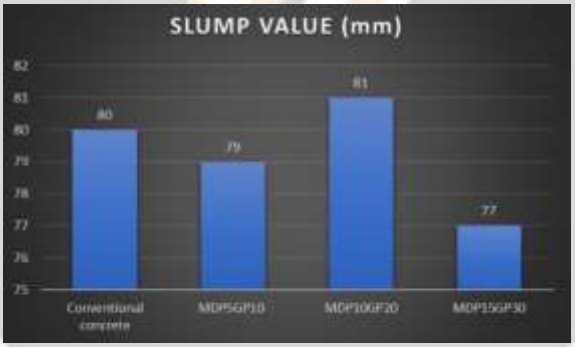

Fig -2

COMPRESSIVE STRENGTH (MPa)

	7 DAYS	28 DAYS
Conventional Concrete	20	32.24
MDP_5GP_{10}	17.7	31.11
$MDP_{10}GP_{20}$	23.3	33.34
$MDP_{15}GP_{30}$	18.5	22.56

Table -2

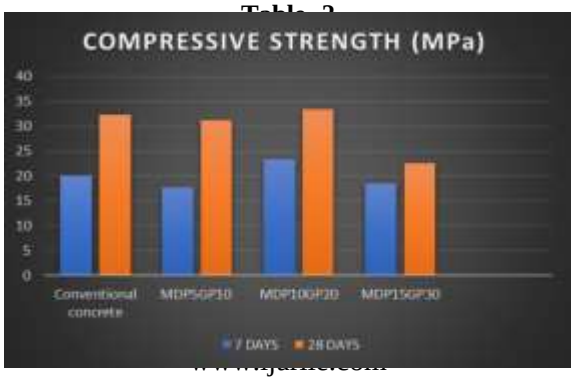

Fig -3

SPLIT TENSILE (N/mm^2)

	7 DAYS	28 DAYS
Conventional Concrete	2.01	3.26
MDP_5GP_{10}	1.3	2.34
$MDP_{10}GP_{20}$	2.43	3.95
$MDP_{15}GP_{30}$	1.16	2.19

Table -3

Fig -4

FLEXURAL STRENGTH(MPa)

	7 DAYS	28 DAYS
Conventional Concrete	4.29	5.04
MDP_5GP_{10}	3.87	4.28
$MDP_{10}GP_{20}$	4.68	6.39
$MDP_{15}GP_{30}$	3.65	4.56

Table -3

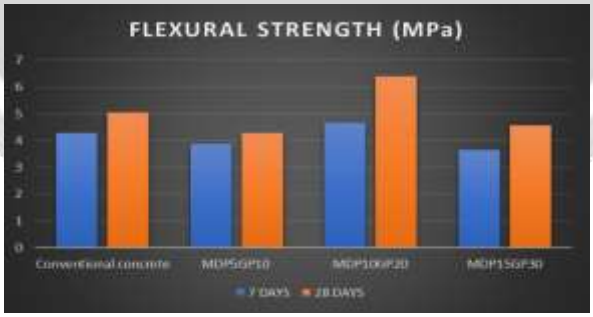

Fig -4

11. CONCLUSION

From the experimental work carried out following results were achieved. Slump of fresh concrete tended to increase at 30% replacement (10% marble dust powder, 20% glass powder) and the obtained slump value was 81mm. Strength loss in compressive strength starts increasing after 30% replacement of cement by waste marble dust and glass powder for all the ratios. Loss in compressive strength is more in 45% replacement, so the results shows that compressive strength is optimum at 30%. Strength loss in flexural strength starts increasing after 30% replacement

of cement by waste marble dust and glass powder. It is more for 45% replacement. Similarly, strength loss in split tensile is more at 45% replacement of cement with waste marble dust and glass powder. For the mix proportion where admixture is added the strength is more at 30% replacement as compared to 15% and 45%.

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