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Investigation on Strength Properties of Concrete with Partial Replacement of Cement by Marble Powder and Fine Aggregate by Granite Powder

R.Anuradha*, C.Arulprakash

Department of Civil Engineering, SNS College of Technology, Coimbatore, Tamilnadu, India.

Abstract : The advancement of concrete technology can reduce the consumption of natural resources and energy sources and lessen the burden of pollutants on environment. Presently large number of marble dust and granite powder is generated in natural stone processing plants with an important impact on environment and humans. This project describes the feasibility of using the marble sludge and granite powder in concrete production as partial replacement of cement and fine aggregate. It should be designed to have a higher workability, high mechanical properties and greater durability than those of traditional concrete.
Marble powder and granite powder is one of the waste materials obtained during extraction, cutting and polishing granite stones from the quarries and commercial industries. The main objective of this project is to study the mechanical properties of concrete mixtures in which fine aggregate (sand) and cement were partially replaced with Granite powder and marble powder. The replacement is done by 5%, 10%, 15%, 20%, 25% of cement by marble powder and 5%, 10%, 15%, 20%, 25% of fine aggregate by granite powder to evaluate the effect of presence of these replacement materials on the strength of specimens.
Keywords : Concrete, Compressive strength, Industrial waste, Low cost, Marble powder, Granite powder, OPC cement.

1.0 Introduction

Concrete is one of the most widely used construction material throughout the world the advantage of it being is it can be mould in to any shape and can be made to take required compressive strength in additional to compressive strength by increasing flexural strength, the load bearing capacity can be increased approximately. The ingredients for making concrete are cement fine aggregate, coarse aggregate and water[3,8]. Sometimes creative additives are added to it to improve or alter some properties making concrete is an art which one has to be perfectly through otherwise that will end up with bad concrete. Hence as a civil engineer one should be through with the entire factor of concrete from which he can produce a good concrete.

1.1 Marble Powder

Marble has been commonly used as a building material since the ancient time. The industry's disposal of the marble powder material, consisting of very fine powder, today constitutes one of the environmental problems 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. as shown in fig 1. The marble dust is settled by sedimentation and then dumped away which results in environment pollution, in

addition to forming dust in summer and threatening both agriculture and public health[2,9]. Therefore, utilization of the marble dust in various industrial sectors especially the construction, agriculture, glass and paper industries would help to protect the environment.

In addition to marble powder, silica fume, fly ash, pumice powder and ground granulated blast furnace slag are widely used in the construction sector as a mineral admixtures instead of cement.

Figure 1 (marble powder)

1.2 Granite Powder:

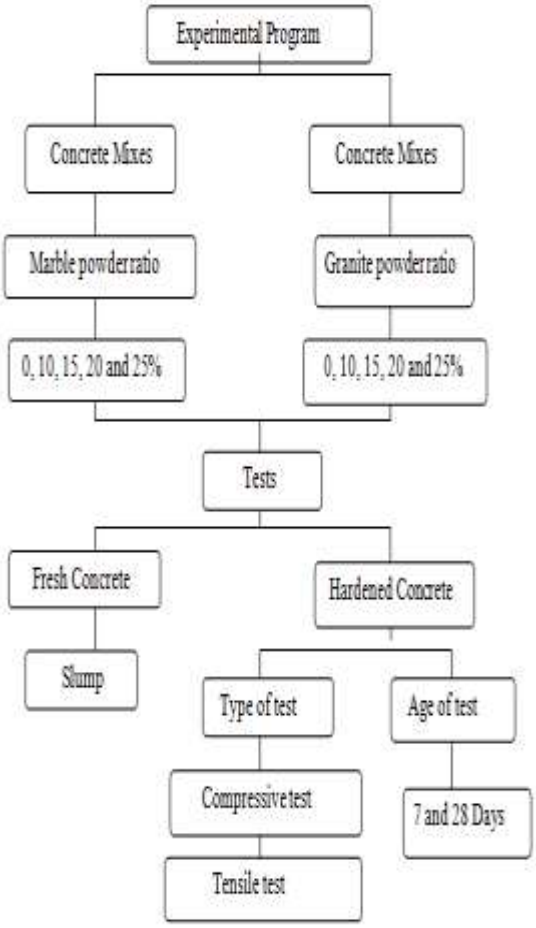
The Granite stone industry generates different types of waste. Solid waste and stone slurry, whereas solid waste is resultant from rejects at the time of cutting or at the processing unit. Stone slurry is a semi liquid substance consisting of particles originated from the sawing and polishing process and water used to cool and lubricate the sawing and polishing machines. The slurry is stored in tanks for evaporation. To conserve water the slurry is passed through filtration and slurry compacting machine. The compacted granite fine cakes are transported and disposed in landfills. Its water content are drastically reduced (Approx 2%) and the granite fines as shown in fig 2. resulting from this will have environmental impacts. The stone slurry generated during the processing will be around 40% of the final product[5,6]. Disposing of compacted granite fine slurry cakes is a major Problem anywhere. The factories were used to dispose these granite fines around their own factories

Figure 2 (granite powder)

2.0 Objectives

The main objectives of this project are as follows:

- To investigate the effect of replacing 5%,10%,15%,20%,25% of cement by marble powder and 5%,10%,15%,20%,25% of fine aggregate by granite powder to evaluate the effect of presence of these replacement materials on the strength of specimens.
- To investigate the effects of concrete mixes with different combination of granite and marble powder with Super plasticizer.
- To determine the suitability percentage of replacement by marble powder and granite with respect to strength characteristics.



3.0 Methodology

3.1 Materials

Concrete is a composite material formed by combining coarse aggregate known as blue metal with fine aggregate which is commonly known as sand using a binder named cement with right proportion of water.

Blue metal is the material which gives strength to the concrete and sand is used to fill the voids that the formed due to the angular or irregular shape of the aggregate. These materials are bonded using cement paste formed by mixing cement and water in the required proportion.

3.2 Cement

The most commonly used cement is ordinary Portland cement. Out of total cement production OPC accounts for 80-90%. In our study OPC of 53 grades is used. Many tests were conducted on cement. Some of them are consistency test, setting time test, specific gravity, etc.

3.3 Fine Aggregate

Locally available, debris free riverbed sand is used as fine aggregate. The sand particle should also be packed to give minimum void content leads to requirement of more water while mixing. In this study sand confirming to zone III as per Indian standards has been used.

3.4 Coarse Aggregate

The crushed aggregate used are of sizes 20mm and 12.5mm and are tested as per Indian standards and the results are within permissible limits.

3.5 Marble Powder

The specific gravity of marble is 2.577. Local available marble powder used as partial replacement of fine aggregate in concrete.

3.6 Granite Powder

Granite belongs to igneous rock family. Granite powder obtained from the polishing units and the properties were found. Since the granite powder was fine,Hydrometer analysis was carried out on the powder to determine the particle size distribution. From hydrometer analysis it was found that coefficient of curvature was 1.95 and coefficient of uniformity was 7.82.

Table 1.Mix Proportion

Mix	Materials		Mix Proportion
	% Marble	% Granite	C:fa:Ca
M40	5	5	1:1.8:3.5
	10	10	1:1.8:3.5
	15	15	1:1.8:3.5
	20	20	1:1.8:3.5
	25	25	1:1.8:3.5

3.7 Casting

The cube, cylinder and slab specimens were prepared for the mixes.

150 x 150 x 150 mm standard cubes for compressive strength as shown in fig 3.

150 mm diameter and 300 mm height standard cylinders for cylindrical compressive strength and split tensile strength as shown in fig 4.

Cubes and cylinders are cast with standard cube and cylinder moulds the slump were measured at the time of casting cubes and listed in table. The cube and cylinder specimens are demoulded after 24 hrs and were cured for 28 days.

Table 2. Number of Specimen

Mix	% of replacement of marble and granite powder	Number of cube specimen		Number of cylinder specimens	
		7 days	28 days	7 days	28 Days
M40	5	3	3	3	3
	10	3	3	3	3
	15	3	3	3	3
	20	3	3	3	3
	25	3	3	3	3

Figure 3 (cubes)

Figure 4 (cylinder)

4.0 Compressive Strength

Compressive strength of concrete is tested on cube at different percentage of marble powder content in concrete. The strength of concrete has been tested on cube at 7 days and 28 days.7 days test has been conducted to check the gain in initial strength of concrete shown in fig 5. And 28 days test gives the data of final strength of concrete shown in fig 6. at 28 days curing. Compression testing machine is used for testing the compressive strength test on concrete. At the time of testing the cube is taken out of water and dried and then tested keeping the smooth faces in upper and lower part.

On partial replacement of OPC by 5% and 10% of marble powder and fine aggregate by granite powder gives a gradual increase in compressive strength when compared to conventional mix. Whereas at 15% the compressive strength is equal to that of conventional concrete compressive strength decreases at 20% and 25%.

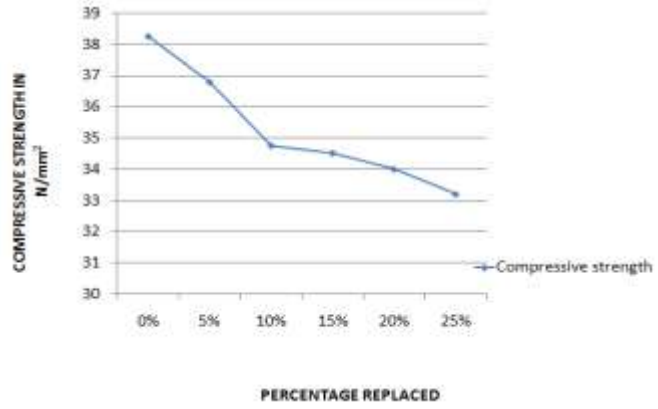


Fig 5.Test result of Compressive strength of 7 days

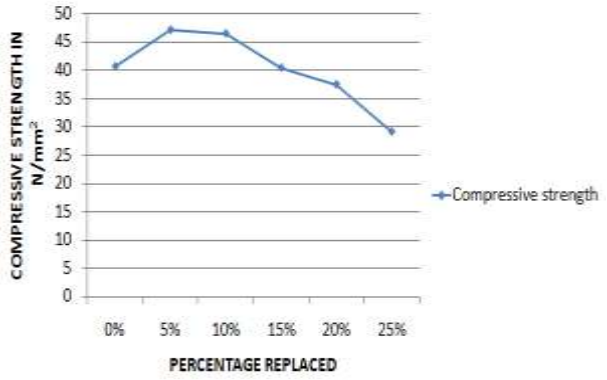


Fig 6.Test result of compressive strength of 28 days

4.1 Split tensile strength

Split Tensile strength of concrete is tested on cylinders at different percentage of marble powder Content in concrete. The strength of concrete has been tested on cylinder at 7 days curing and 28 days. 7days test has been conducted to check the gain in initial strength of concrete shown in fig 7. 28 days test gives the data of final strength of concrete shown in fig 8. At 28 days curing .Compression testing machine is used for testing the Split Tensile strength test on concrete along with two wooden boards. At the time of testing the cylinder taken out of water and dried and then tested.

On partial replacement of OPC by 5% and 10% of marble powder and fine aggregate by granite powder gives a gradual increase in tensile strength when compared to conventional mix. Whereas at 15% the tensile strength is equal to that of conventional concrete tensile strength decreases at 20% and 25%.

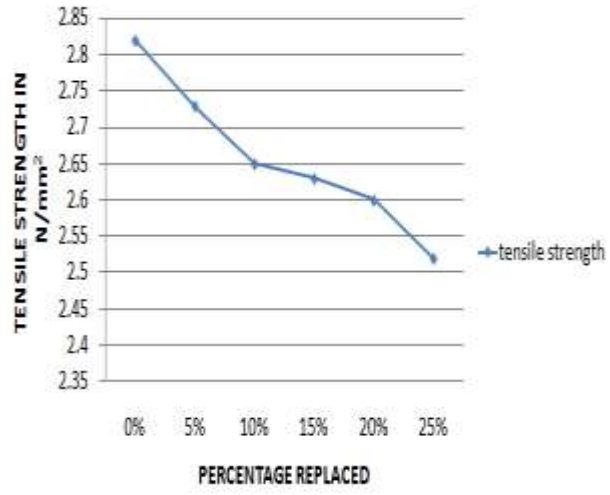


Fig 7. Test result of tensile strength of 7 days

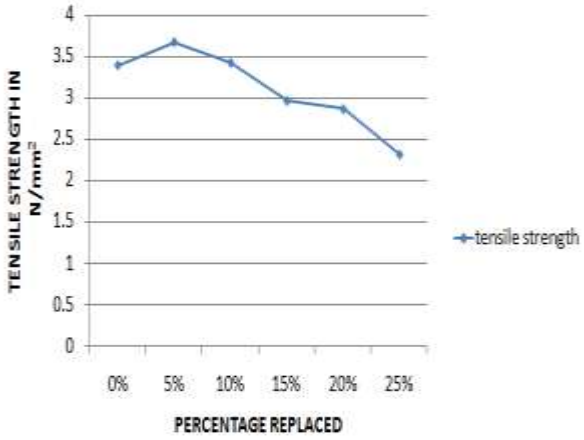


Fig 8.Test result of tensile strength of 28 days

Fig 9.Testing of specimens.

5.0 Conclusions

1. The present experimental tests indicated that the strength properties of the concrete could enhance the effect of utilization of granite powder obtained from the crusher units in the place of river sand and marble powder in the place of cement in concrete.
2. It was concluded that on partial replacement of OPC by 5% and 10% of marble powder and fine aggregate by granite powder gives a gradual increase in compressive strength and also in tensile strength when compared to conventional mix.
3. To minimize the costs for construction with usage of marble powder and granite powder which is freely or cheaply available; more importantly.
4. The cost for conventional concrete mix is Rs.6000 per m3 and for concrete mix with 5% replacement is Rs.5700 per m3 which is 5% less than the cost of conventional mix.
5. To realm of saving the environmental pollution by cement production; being our main objective as Civil Engineers.

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