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MECHANICAL BEHAVIOUR OF M40 CONCRETE AS PARTIALLY REPLACEMENT OF CEMENT BY GRANITE POWDER

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ABSTRACT

The production of Ordinary Portland Cement (OPC), the chief ingredient of normal concrete unfortunately, emits vast amounts of carbon-dioxide gas into the atmosphere which causes global warming. Hence it is imperative to use either alternate or other materials as partial replacement. Granite Powder is the most commonly used mineral admixture in high strength concrete. It has become the chosen favorites for high strength concrete and is a good pozzolan and can be used in a big way. Adding Granite powder to the concrete mix will dramatically enhance the strength and impermeability of concrete mixes while making the concrete durable against chemical attacks, abrasion as well as reinforcement corrosion apart from increasing the compressive strength. In concrete mix of M40 grade, with w/c=0.4 cement is replaced by as 10%, 20%, 30% and 40% with Granite Powder. In the preset work compressive strength and Tensile strength of Cube and beams Specimens were casted. The cubes and beam samples were tested after curing them for a period of 7, 14 and 28 days.

The test results revealed that there is an increase in the Compressive strength and Flexural Strength up to 20% replacement by Granite powder compared to the conventional concrete. Further addition of Granite Powder beyond 20% replacement resulted in slight decrease in strength.

Keywords: Cement, Natural Sand, Granite Powder and Coarse aggregate.

I. INTRODUCTION

Concrete is the most widely used man-made construction material in civil engineering applications such as buildings, roads, bridges, dams, power plants, flooring, etc. Compared to other building materials, concrete can be formed into a variety of shapes and sizes right at the construction site or in the form of precast elements.

It has been reported that, if alternative aggregates are not utilized in the near future, the concrete industry will globally consume 8-12 billion tons of natural aggregates annually after the year 2010.

Leaving the waste material to the environment directly can cause environmental problems. Hence the reuse of waste material has been emphasized. Waste can be used to produce new products or can be used as admixtures so that natural resources are used more efficiently and the environment is protected from waste deposits. It is estimated that cement production is responsible for about 3% of the global androgenic greenhouse gas emission and for 5% of the global androgenic CO₂ emission. As about 50% of the CO₂ released during cement production is related to the decomposition of limestone during burning mixing of clinker with supplementary material called blending is considered as a very effective way to reduce CO₂ emission.

In India, the marble and granite stone processing is one of the most thriving the effects of varying marble dust contents on the physical and mechanical properties of fresh and hardened concrete have been investigated. Concrete technology can be reducing the consumption of natural and energy resources for burden pollutants on environment. Now a day the cost of construction materials is increasing incrementally. In India the cost of cement during 1995 was Rs. 1.25 per kg but in 2012 the price is increased nearly 5 times. Due to these reason only I have replaced the granite powder in place of cement. By adding the waste material also we have decreased a lot of environmental problem.

S.Arulkesavan1 [1] et al (2017) This project report summarizes the strength behavior of partial replacement of fine aggregate in concrete by Granite fine. Granite fines are the byproduct of granite industries while cutting huge granite rocks to the desired shapes. The granite powder from factory is carried by the water and stored in tanks. After evaporation of water the granite dust remained in the tank. Then it is transported and disposed on the land. The major problem of disposing the fines in land leads to various environmental hazards like pollution in air and land. The granite fines exhibit the properties of fine aggregate such as size, fineness and filler capabilities. Concrete is prepared with granite fines as a partial replacement of fine aggregate in different proportions namely 10%, 15%, and 20%. The various tests to be conducted on concrete such as compressive strength, split tensile strength and flexural strength. The tests values are computed and compared with the conventional concrete.

P.Madan Mohan Reddy1 [2] (2017) In the present day, it deals with effect of fine granite waste based on sisal fiber concrete with results presented in this study from part of an investigation on the use of granite waste as partial replacement for natural sand as fine aggregate and sisal fiber is additionally added to the weight of cement in concrete. Hence, an attempt has made to study the compressive strength and the tensile strength of concrete using different proportions i.e., Granite waste at an interval of 10% up to 50% and Sisal fiber at 0.5% in concrete mixes to finalize the optimum % of mix which can yield better strength properties. "In the present study, we are investigate on mechanical (compressive strength and split tensile test). Properties of concrete by adding fine granite waste as partially replacement of sand in various percentages i.e., 10%, 20%, 30%, 40% and 50% respectively and by adding sisal fiber additionally to the wt. of cement in 0.5% .Test results showed that there is increase in the strength properties up to 30% partial replacement of fine aggregate with fine granite waste & 0.5% addition of sisal fiber and also its observed that there is decrease in strength properties when more than 30% of fine granite waste is added."

S.Vishnu Shankar1 et al[3] (2015) Nowadays many researchers are being carried out to find an alternative that could be used as a partial replacement of cement in concrete and mortar, since production of cement causes major environmental concerns. Granite powder (dust) which is a waste product obtained during the cutting and polishing of granite, is a result of such researches. This paper focuses on the durability studies on cement mortar in which cement is partially replaced with granite powder. The replacement levels are taken as 20%, 25%, 30%, 35% and 40% by the weight of cement. Suitable specimens for various durability tests such as corrosion resistance test, fire resistance test, sulphate resistance tests, are cast. After curing for 28 days in water, the various tests are performed as per the standards. The results concluded that 30% replacement level showed better performance in terms of durability compared to other mixes.

Mr. G. Raja et al[4] (2016) Granite fines which are the by-product produced in granite factories while cutting huge granite rocks to the desired shapes, while cutting the granite rocks, the powder produced is carried by the water and this water is stored in tanks. After drained of water the granite dust remained is disposed on the lands. Disposing this granite fines is a major problem due its fineness. Hence an effect is made to utilize this fine granite powder in as a filler material in concrete. For that the basic properties of granite fines such as size, fineness, specific gravity, and moisture content were tested. The result shows that the property of granite fines is similar to that of ordinary sand. Therefore, granite fines can be effectively used as a replacement material for fine aggregate in concrete. For investigation purpose cubes are casted with 7 different proportions of granite fines and fine aggregate. The replacement percentage

of granite fines to fine aggregate are 0, 10, 20, 30, 40, 50 and 100 for M20 mix proportions, specimens are tested after 28 days of curing, for compression strength, flexural and split tensile strength. The specimen casted with 40 % replacement of granite fines to fine aggregate gives higher strength when compared to control specimen

K.Chiranjeevi reddy1 [5] et al (2015) Granite fines which are the byproduct produced in granite factories while cutting huge granite rocks to the desired shapes. Granite fines are used as a filler material in the concrete, replacing the fine aggregate which will help in filling up the pores in the concrete. Concrete is prepared with granite fines as a replacement of fine concrete in 4 different propositions namely 2.5%, 5%, 7.5% and 10% and various tests such as compressive strength, split tensile strength and flexural strength are investigated and these values are compared with

the conventional concrete without the granite fines. It was observed that substitution of 7.5% of cement by weight with Granite fines in concrete resulted in an increase in compressive strength for both 7 & 28 days to 33.14 & 43.40 N/mm² compared to 23.26 & 39.41 N/mm² of conventional concrete. Tensile strength too followed a similar pattern with a 7.5% substitution with granite fines increasing the tensile strength for 7 & 28 days to 2.87 & 4.19 N/mm² compared with a 2.4 & 3.4 N/mm² of conventional concrete. However flexure strength of 7.5% granite fine replacement exhibited a good improvement of flexural strength for 28 days to 6.34 N/mm² compared to a 3.35 N/mm² of conventional concrete.

Dr.T. Felix Kala [6] et al (2013) This paper focuses on the experimental study of using locally available granite powder as fine aggregate and partial replacement of cement with admixtures in the production of HPC with 28 days strength to the maximum of 60 MPa. The influence of water cement ratio and curing days on mechanical properties for the new concrete mixes were premeditated. The percentage of granite powder added by weight was 0, 25, 50, 75 and 100% as a replacement of sand used in concrete and cement was replaced with 7.5 % silica fume, 10% fly ash, 10% slag and the dosage of superplasticiser added 1% by weight of cement. The test results show clearly that granite powder of marginal quantity, as partial sand replacement has *beneficial* effect on the above properties. The highest strength has been achieved in samples containing 25% granite powder together with admixtures. Based on the results presented in this paper, it can be concluded that concrete mixture can be prepared with granite powder as an additive together with admixtures to improve the strength of concrete structure.

Allam [7] (2012) This paper aims to assess the durability performance of green concrete containing granite waste powder as partial replacement to cement and sand with various percentages. Physical tests including slump test, indirect fire resistance, water absorption, and permeability experimental work are conducted on the concrete samples as indicators for durability. Scanning Electron Microscope (SEM) is also used to investigate the microstructure of concrete by examining the Inter-facial Transition Zone (ITZ) as well as investigating the voids inside concrete specimens at micro-structural level. The study revealed that the workability of the green concrete decreased than that of the control mix without granite waste powder for all mixes having the same w/c ratio 0.45. Adding 5% of the granite waste powder as a partial replacement for cement showed minimum voids in the SEM images indicating denser concrete mix with the lowest number of pores and the best impermeable properties with the least water absorption among all mixes. The general conclusion of this study is that the incorporation of fine granite waste powder to the concrete mix was beneficial to some durability-related characteristics. Furthermore, adding the granite waste powder whether as a cement or sand replacement, showed a positive response in terms of enhancement of strength of concrete under elevated temperatures.

II. EXPERIMENTAL PROGRAMME

Objectives:

The main objective of this experimental work is to search an replacement of cement by Granite Powder (Industrial Waste).

It is aimed to study the performance of Granite Powder in the concrete with respect to the strength and durability properties.

Objectives of the experimental investigation are as follows:

- To study the mechanical properties such as compressive strength, Flexural strength of concrete at the end of 7, 14 and 28 days of curing period using replacement of cement by Granite Powder
- The percentage replacement levels of Granite powder used were 10%, 20%, 30% and 40%
- To compare the mechanical properties of concrete with replacement of Granite Powder to that of conventional concrete.
- To determine the optimum replacement of cement by Granite Powder.

Materials Used

The materials used in this experiment were cement, Granite powder, fine aggregate, coarse aggregate and water.

1) Cement:

OPC 53 grade cement conforming to IS 8112-1989, from a single batch was used throughout the course of the project work. In laboratory various tests were conducted on cement and its results are shown in Table 1

Table 1. Properties of Cement

S.No	Characteristics	Values
1	Consistency	33%
2	Initial Setting Time	40min
3	Final Setting Time	280 min
4	Finesse of cement	2%
5	Soundness of cement	2mm

2) Fine Aggregate:

Locally available river sand belonging to zone II was used in the present work (IS 383-1970). The sieve analysis data and physical properties of fine aggregates used are shown in Table 2.

Table 2. Properties of Fine aggregates

S.No	Characteristics	Values
1.	Type	Uncrushed (natural)
2.	Specific gravity	2.67
3.	Bulk Density	1668 kg/m ³
4.	Fineness modulus	2.74
5.	Grading zone	Zone II

3) Coarse Aggregate:

Locally available coarse aggregate having the maximum size of (10-20mm) were used in the study. Properties of the coarse aggregate are tabulated in Table 3

Table 3. Properties of Coarse aggregates

S.No	Characteristics	Values
1.	Type	Crushed
2.	Specific gravity	2.62
3.	Bulk Density	1765 kg/m ³
4.	Fineness modulus	6.55
5.	Maximum size	20mm

4) Water:

Potable clean water was used in the present investigation for both casting and curing of concrete.

5) Granite Powder:

SiO₂ -59.58%, Al₂O₃-13.01%, TiO₂-0.35%, Fe₂O₃-9.77%, MnO-.17%, MgO-.29%, CaO-3.8%, K₂O-4.76%, Na₂O-5.92-LoI-1.56%

III. MIX PROPORTION OF CONCRETE**3.1 Trail Mix Design***Table 4: Mix proportions for varying replacement proportions of cement with Granite Powder with water cement ratio = 0.4*

S/No	Components	Replacement of Fine aggregate by Granite powder (Kg/m ³)				
		0%	10%	20%	30%	40%
1	Water	197	197	197	197	197

2	Cement	389.73	350.76	311.79	273.82	233.84
3	Sand	677.49	677.49	677.49	677.49	677.49
4	Granite powder	0	38.97	77.94	116.91	155.89
5	Coarse aggregate	1059.66	1059.66	1059.66	1059.66	1059.66
6	Water Cement Ratio = 0.4					
7	Super Plasticizer = 3.8 kg/m ³					

IV. RESULT AND DISCUSSION

Compressive Strength:

The result of compressive strength tests are tabulated in Tables 5 and 6. From the results, it was observed that the compression strength of the concrete increases with increase in the replacement level of cement by Granite Powder up to 30%, beyond that level there was a marginal decrease in the strength of the concrete.

Comparison of strength of concrete with replacement of Cement by Granite Powder to the conventional concrete:

For 7 days curing period, the strength of the concrete is increased about **7.52%, 10.68%, 2.23%, and 12.21%** for 10% 20%, 30% and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 14 days curing period, the strength of the concrete is increased about **3.40%, 6%, 7.48%** and **20.70%** for 10%, 20% 30%, and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete is increased about **6.39%, 9.21%, 7.86%** and **19.25%** for 10%, 20% 30% and 40% replacement of Granite Powder respectively when compared with that of conventional concret

Table: 5 Compressive strength of Cubes with Granite Powder Replacement

Compressive strength of cubes in N/mm ²				
S.NO	Proportions	7days	14days	28 days
1	OPC + 0% Granite Powder	39.3	45.4	48.3
2	OPC + 10% Granite Powder	42.5	47	51.6
3	OPC + 20% Granite Powder	44	48.3	53.2
4	OPC + 30% Granite Powder	40.2	42	44.5
5	OPC + 40% Granite Powder	34.5	36	39

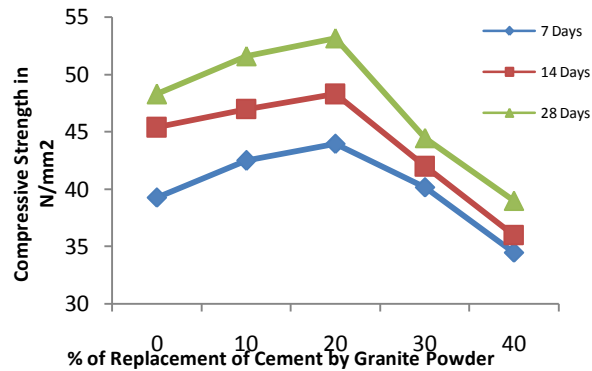


Fig. 1 Compressive strength V/s %Replacement of Cement by Granite Powder

Flexural Strength of beams:

The result of Flexural strength tests are tabulated in Tables 5 and 6. From the results, it was observed that the Flexural strength of the concrete increases with increase in the replacement level of cement by Granite Powder up to 30%, beyond that level there was a marginal decrease in the strength of the concrete.

Comparison of strength of concrete with replacement of Cement by Granite Powder to the conventional concrete:

For 7 days curing period, the strength of the concrete is increased about **5.70%, 7.32%, .93%, and 19.76%** for 10% 20%,30% and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 14 days curing period, the strength of the concrete is increased about **1.67%,3.08%, 3.82% and 17.62%** for 10%, 20% 30%, and 40 % replacement of Granite Powder respectively when compared with that of conventional concrete.

For 28 days curing period, the strength of the concrete is increased about **3.18%, 4.70%, 4.11% and 10.08%** for 10%, 20% 30% and 40% replacement of Granite Powder respectively when compared with that of conventional concrete

Table: 6 Flexural strength of Beams with replacement of Granite Powder

Flexural strength of Beams in N/mm ²				
S.no	Proportions	7 days	14 days	28 days
1	OPC + 0% Granite Powder	4.3	4.71	4.86
2	OPC + 10% Granite Powder	4.56	4.79	5.02
3	OPC + 20% Granite Powder	4.64	4.86	5.1
4	OPC + 30% Granite Powder	4.26	4.53	4.66
5	OPC + 40% Granite Powder	3.45	3.88	4.37

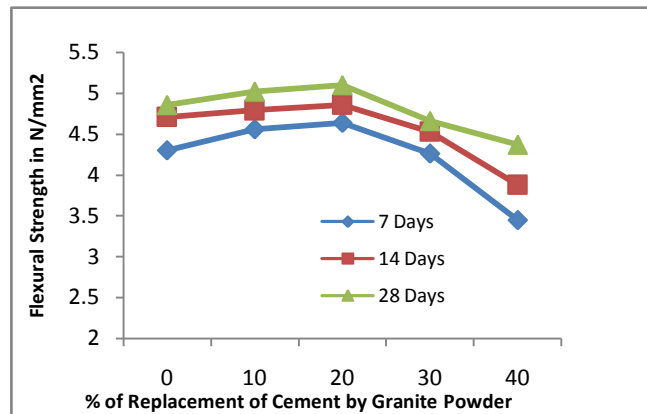


Fig. 2 Flexural strength V/s %Replacement of Cement by Granite Powder

V. CONCLUSIONS

The experimental results obtained show that partial substitution of cement by Granite Powder gives better result over the verified range from 0%, 10%, 20%, 30% and 40% replacement. The conclusions are drawn as below:

1. From the result tables, it is concluded that the in a concrete mix 20% replacement of cement by Granite Powder has shown good results in Compressive strength for 7,14 and 28 days curing period.
2. The increase in Compressive strength for 20% replacement of Granite Powder was observed in the range of 9.21% compared to conventional concrete.
3. The increase in Flexural strength for 20% replacement of Granite Powder was observed in the range of 4.70% compared to conventional concrete.
4. There is marginal decrease in compressive and Flexural strength by further replacement of Granite Powder
5. Up to 20% replacement of Cement by Granite Powder Can be used for structural elements.

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