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Strength and Characteristics of Concrete By Granite Waste

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Abstract-- The paper examines the possibility of using granite powder as replacement of sand and partial replacement of cement with flyash, silica fume, slag and super plasticizer in concrete. The percentage of granite powder added by weight was 0,10,20,30% as a replacement of sand used in concrete and cement was replaced with 7.5%silicafume,10%flyash,10%slag,and 1%superplasticiser.The effects of curing temperature at 32 c at 0.40water–to-binder(w/b)ratio for 7 and 28 days on compressive strength, flexural strength, and tensile strength test concrete were studied .The chemical composition of the granite powder and the compressive strength, flexural strength and split tensile strength of concrete containing granite waste was determined. The concrete used was of grade M20,ratio of 1:1.5:3 and granite was replaced partially by 10%,20%,30%,and 40% to the weight of cement. The compressive strength, flexural strength and split tensile strength was determined at curing ages 7 and 28 days. The decrease in compressive strength beyond 30% substitution for 7 days and beyond 20% for 28 days. A sharp decrease was observed in split tensile strength beyond 30% granite powder substitution for 7 days and beyond 20% for 28 days. A sharp decrease was observed in flexural strength beyond 20% granite powder substitution for 7 days and 28 days. Experimentally results that the increases in the proportions of granite powder resulted in a decreases in the compressive strength of concrete finally, the overall performance revealed that granite powder can be utilized as a partial replacement of fine aggregate and cement.

Keywords: Granite waste, fly ash, silica fume, super plasticizer, slag, strength.

1. INTRODUCTION

Fine aggregate is an essential component of concrete. The most commonly used fine aggregate is natural river sand. The global consumption of natural river sand is very high due to the extensive use of concrete. In particular, the demand of natural river sand is quite high in developed countries owing to infrastructure growth. The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of construction industry in many parts of the country. Recently, Tamil Nadu government (India) has imposed restrictions on sand removal from the river beds due to its undesirable impact on the environment. On the other hand, the granite waste generated by the industry has accumulated over years. Only insignificant quantity has been utilized and the rest has been dumped unscrupously resulting in pollution problems. With the enormous increases in the quantity of waste needing disposal, acute shortage of dumping costs necessitate the need for effective utilization of this waste. The present work is aimed at developing a concrete using the granite an industrial waste as a replacement material for the fine aggregate and cement. By doing so, the objective of reduction of cost of construction can be met and it will also help to overcome the problem associated with its disposal including the environmental problems of the region. Accordingly this project work will examine M20 grade of concrete were cast by varying the percentage replacement of sand and cement with granite waste. The cost difference between the conventional concrete and the granite powder concrete required were also found.

2. EXPERIMENTALWORK

The experimental program included first the preliminary investigation on the materials used in the study i.e. ingredients of concrete. The results are indicated below.

2.1 Materials used

a) **Cement**

The most commonly available Portland Cement of grade 53 conforming to IS: 12269-1987 has been used. The physical properties of the cement obtained on conducting appropriate tests as per IS: 269/4831 and the requirements as per IS 12269-1987are given in Table 2.1.

2.1 PROPERTIES OF CEMENT

Sl. No.	Properties	Tested values
1	Standard consistency test	33%
2	Initial setting time	35 min
3	Final setting time	290 min
4	Specific gravity	3.15
5	Fineness test	3.2%

b) **Coarse Aggregate**

Hard broken granite stones were used as a coarse aggregate in concrete. Size of the coarse aggregate used in the investigation was 10 to 20mm. The specific gravity of the coarse aggregate is 2.89.

c) **Fine Aggregate**

In the present work, the concrete mixes were prepared using locally available river sand. The sand used was confining to Zone 3. Fineness modulus and specific gravity of the sand were found to be 2.33 and 2.76 respectively.

d) **Water**

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement .In general, water fit for drinking is suitable for mixing concrete. Impurities in the water may affect setting time, strength, shrinkage of concrete or promote corrosion of reinforcement. Locally available drinking water was used in the present work.

e) **Granite waste**

Granite belongs to igneous rock family. The density of granite is between 2.65 to 2.75 g/cm^{3}and compressive strength will be greater than 200Mpa. Granite powder obtained from the polishing units and the properties were found. Since the granite powder to determine the particle size distribution. From hydrometer analysis it was found that the coefficient of curvature was 1.95 and coefficient of uniformity was 7.82. The specific gravity of the granite waste was found to be 2.61. Table 2.2 gives the chemical composition of granite powder.

2.2. PROPERTIES OF GRANITE WASTE

Sl. No.	Properties	Values
1	Porosity	Very low
2	Absorption	0.5 to 1.5%
3	Specific gravity	2.6 to2.8
4	Density	2500-2650kg/m^3
5	Crushing strength	1000-2500kg/m^3
6	Frost resistance	Good
7	Fire resistance	Low
8	Color	Mostly light colored

f) **Admixture**

a) Super plasticizer was used during investigation to improve the workability of concrete per Indian Standards; the dosage of super plasticizer should not exceed 2% by weight of cement. A higher dosage of super plasticizer may delay the hardening process. After trails the optimal dosage of super plasticizer was found to be 0.5% to produce slump of 100mm.

b) Condensed silica fume is considered as the most efficient micro filler for high performance concrete. Its two fold effects are reduction of w/c ratio and increases of hardened concrete. The silica fume used in this study was in the powder form and contained 95%SiO,0.39%2CAO,0.21%MgO,0.11%KO, 0.15% NaO,0.13%AlO,40%FeO The properties of silica fume result in more efficient gel.

c) Fly ash was considered in the present study as a replacement of cement in 10%. It is a fine, glass the production of electricity. Fly ash improves considerably the performance of binder phase and increase the bonding action with aggregate and reinforcement. The properties of fly ash may vary. Considerably according to several factors such as the geographical origin of the source coal. Conditions during combustion and sampling position within the

2.3. CHEMICALPROPERTIES

S.No	Chemical composition	Cement	Granite waste	Flyash	silicafume	GGBS

1	CaO	63.8%	2.61%	5.0%	0.5%	0.8%
2	SiO	21.4%	82.25%	52%	96%	56%
3	Al_2O_3	5.1%	5.11%	23%	1.0%	1.5%
4	Fe_2O_3	2.6%	2.63%	11%	1.5%	2.0%
5	MgO	0.36%	0.65%	Nil	2.0%	2.2%
6	Na_2O	0.14%	0.98%	0.8%	0.4%	0.6%
7	K_2O	1.88%	0.98%	1.0%	3.0%	5.0%
8	SO_3	3.38%	4.36%	1.0%	0.5%	0.5%
9	Specific gravity	3.15%	2.72%	2.17%	2.2%	2.4%

power plant.The major elemental constituents of fly ash are Si,Al,Fe,Ca,C,Mg,K,Na,S,Ti,P and Mn.

d) Slag The ground granulated blast furnace slag was used 10% along with other admixtures as a replacement of cement.

3. DETAILS AND MIX PROPORTIONS

Concrete mix with w/c ratio of 0.40 was prepared. The details of mix proportions for $1m^3$ of concrete are given in Table 3.1.

Grade	Cement	Fine aggregate	Coarse aggregate	Water
M20	478.95	626.7	1215.18	191.58

3.1 Material required for 1 m^3 of Concrete (kg/m^3)

Mortar cubes of 1:3 proportions are made with metal moulds of size 70.6 x 70.6 x70.6mm. (1 part of OPC 53 grade and 3 parts of sand by weight. Percentage of granite waste replaced with cement and fine aggregate with by weight was 0%, 10%, 20%, 30%. Three cube specimens were casted for each mentioned proportions and are cured for 7 and 28 days. After curing, mortar cubes are subjected to compression testing. The quality of said combinations was assessed. With these new combinations of fly ash, silica fume slag and super plasticizer admixtures are made with respect to concrete in varying proportions of 10% 20%, 30%, 40%. Admixtures adopted as a fly ash, silica fume, and slag and are conveniently designated.

3.2 Preparation of Test Specimens

The granite Waste collected from polishing units was dried. As per the mix proportions, the quantities of various ingredients were weighted. Initially sand and granite powder were mixed thoroughly. Further cement and coarse aggregate to the mix. Once all the materials were mixed well, 1%of superplasticiser was added to water and water containing superplasticiser was added to the dry mix to form concrete. Cubes of size

150x150x150mm and cylinder 150 x 300mm, prism 500 x 100 x100mm were cast.The specimens were cured in curing tank for a period of 28 days.

3.3 Test results

a) Compressive strength

The compressive loading tests on concrete were carried out on a compression testing machine of capacity 2000KN. For the compressive strength test, a loading rate of 1KN/min. was applied as per IS: 516-1959.The specimen used was 150mm cube. The test was performed at 7, 28 days. The specimens were tested immediately after taking the cubes from curing tank in surface dry condition.

Fig. 1.1 Compressive strength test

b) Split tensile strength

The split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size 150 x 300mm were used to determine the split tensile strength. After curing, the specimens were tested for split tensile strength using a calibrated compression testing machine of 2000KN capacity.

Fig. 1.2 Split tensile strength test

c) Flexural strength

The flexural strength of concrete is usually carried out on a flexural testing prism of size 700 x100x100mm were used to determine the flexural strength. After curing, the specimens were tested for flexural test using a universal testing mchine of 2000KN capacity.

Fig. 1.3 Flexural strength test

4. RESULTS AND DISCUSSIONS

4.1Replacement of Granite waste with Fine aggregate

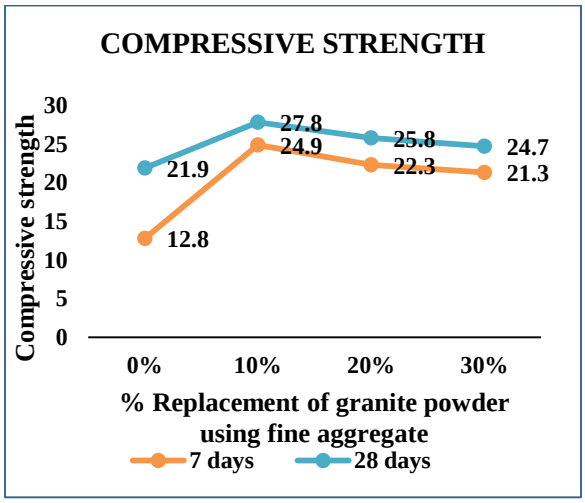
Mix designation	Compressive strength	Split tensile strength	Flexural strength

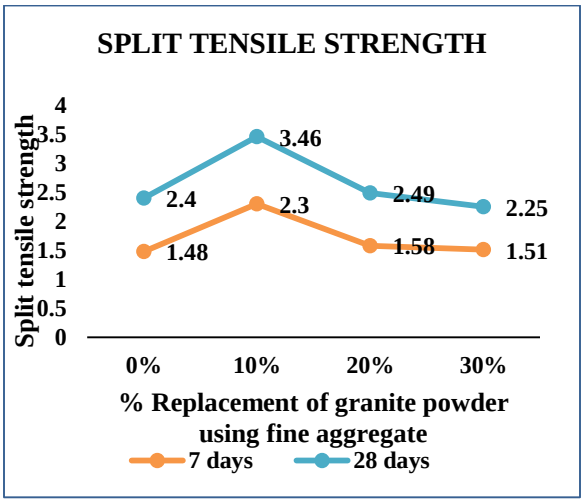
	7 days	28 days	7 days	28 days	7 days	28 days
GP0	12.8	21.9	1.48	2.40	3.12	4.18
GP10	24.9	27.8	2.30	3.46	4.08	5.34
GP20	22.3	25.8	1.58	2.49	3.92	5.22
GP30	21.3	24.7	1.51	2.25	3.38	4.45

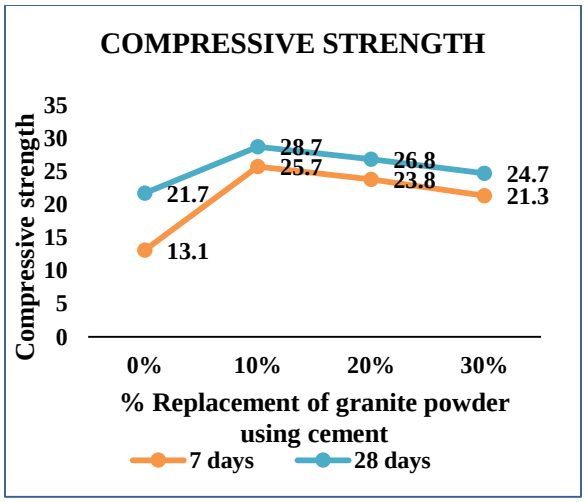
4.2 Replacement of Granite waste With Cement

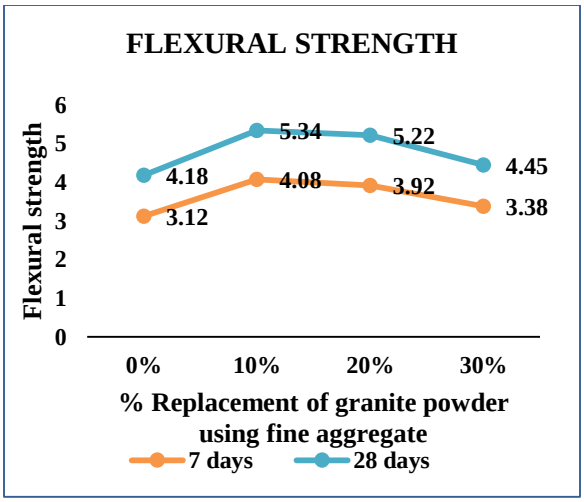
Mix designation	Compressive strength		Split tensile strength		Flexural strength	
	7 days	28 days	7 days	28 days	7 days	28 days
GP0	13.1	21.7	1.02	2.07	3.12	4.18
GP10	25.7	28.7	1.52	2.56	3.96	4.46
GP20	23.8	26.8	1.38	2.36	3.58	4.32
GP30	21.3	24.7	1.18	2.27	3.23	4.16

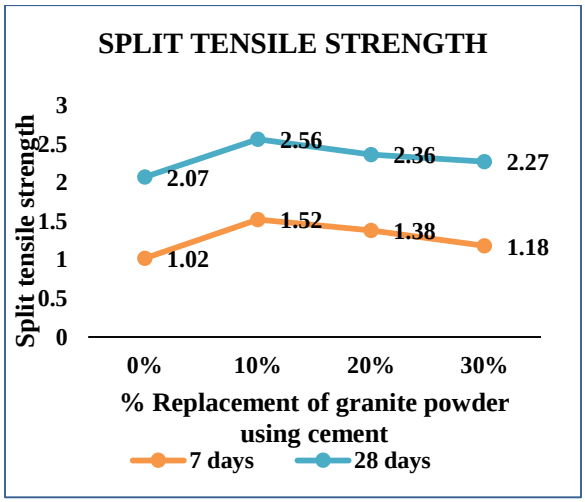
GRAPHS FOR COMPRESSIVE, SPLIT TENSILE AND FLEXURAL STRENGTH

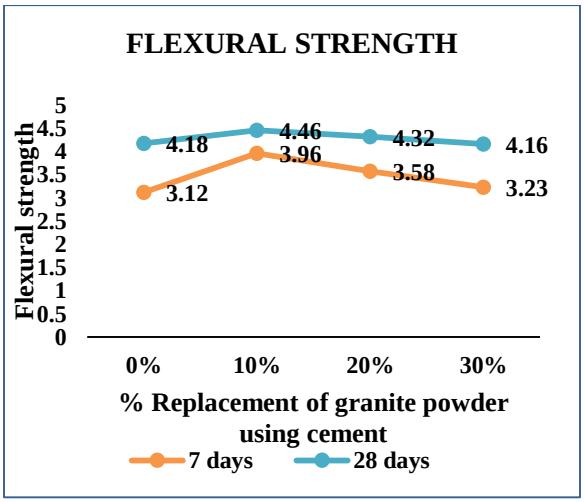












5. CONCLUSION

Replacement of cement and fine aggregate with granite waste is found to improve the strength of concrete.The optimal percentage dosage of replacement is found to be 10%. Utilization of granite powder will avoid the disposal problems and related environment issues. Utilization of granite waste will reduce the usage of river sand and conserve natural resources.

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