JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

Study On Strength Of Concrete Made With Partial Replacement Of Fine Aggregate By Granite Powder

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Abstract

This study investigates the feasibility of using locally available granite powder as a partial replacement for fine aggregate in the production of High-Performance Concrete (HPC) targeting a compressive strength of 60 MPa at 28 days. Concrete mixes were prepared by replacing natural sand with granite powder at varying levels (0%, 25%, 50%, 75%, and 100% by weight). A constant dosage of 1% superplasticizer (by weight of cementitious materials) was used. Mechanical properties were evaluated for different mixes and curing periods. Results indicate that partial replacement of sand with granite powder significantly enhances the mechanical performance of HPC. The optimum replacement level was identified at 22%, achieving the highest compressive strength. The findings support the sustainable use of granite powder as a partial fine aggregate replacement in structural concrete.

Keywords: *Cement, Compressive strength, Fine aggregate, Granite powder, High-performance concrete.*

1. Introduction:

Fine aggregate is an essential component of concrete. The global consumption of natural river sand is very high due to the extensive use of concrete. In particular, the demand for natural river sand is quite high in developed countries owing to Infrastructure growth. In this situation some developing countries are facing shortage in the supply of natural sand. The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of the construction industry in many parts of the country. Therefore, the construction industries in developing countries are under stress to identify alternative materials to reduce the demand on river sand.

In order to reduce the dependence on natural aggregates as the main source of aggregates in

2. Materials and Methods:

2.1 Materials Used:

a) Cement: OPC 53 Grade.
b) Fine Aggregate: Natural river sand.
c) Coarse Aggregate: 10 mm & 20 mm.
d) Granite Powder.
e) Water: Potable water.
f) Superplasticizer: dosage 1% by weight of cementitious material.

2.2 Mix Proportions:

a) Five mixes with 0%, 25%, 50%, 75%, and 100% replacement of sand by granite powder.
b) Water-cement ratio used 0.25, 0.30 and 0.30.
c) Dosage of superplasticizer 1 %

concrete, artificially manufactured aggregates and artificial aggregates generated from industrial wastes provide an alternative for the construction industry [1], [11]. Some alternative materials have already been used in place of natural river sand. The utilization of granite powder in high performance concrete could turn this waste material into a valuable resource with the added benefit of preserving environment. Therefore, this study focused on the possibility of using locally available granite powder and admixtures in the production of High-Performance Concrete [HPC], with 28 days strength to the maximum of 60 MPa

2.3 Test Methods:

a) Slump test for workability.
b) Compressive strength test.
c) Split tensile strength.
d) Flexural strength.
e) Modulus of Elasticity test
f) Water absorption test.

3. Methodology:

Coarse aggregate was placed in the drum first and batch water was increased to account for the adsorption of the aggregates during rotation. After mixing for 10 to 15 seconds, the fine aggregates with correct proportions were introduced and mixed in for the period of 15 to 20 seconds. This was followed by the final 20 % of the water and all the cement and cementitious materials such as fly ash, silica fume and slag were added together, which were mixed in until a total mixing time of 60 seconds was achieved.

The superplasticizer was added 30 seconds after all the other materials during the mixing. The various specimens such as cube, cylinder and slab were casted for studying the variation in strength properties, due to the replacement of sand with granite powder. Specimens were prepared with water to cementitious materials ratio of 0.25, 0.30 and 0.35 for M60 grade.

After 1 day, the specimens were demolded and cured by water ponding temperature at 35°C (± 2°C). The temperature was manually noted every hour to find out any variations in 35°C water ponding temperatures. On an average ± 2°C variation was observed in the water ponding temperatures. Different batches were adopted for 1, 7, 14, 28, 56 and 90 days of curing ages.

Further, detailed study was carried out with mix portions of GP0, GP5, GP10, GP15, GP20, GP22 and GP25, to observe the optimize quantity of Granite powder for partial replacement of fine aggregate.

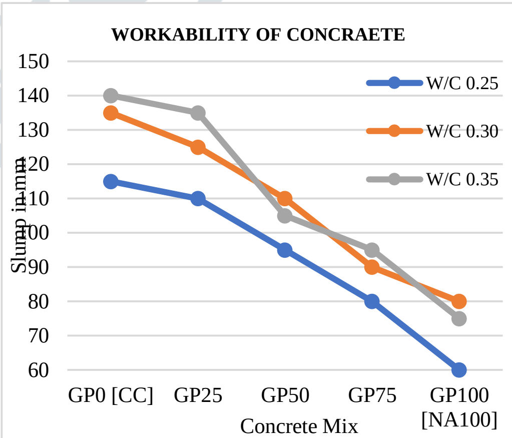
4. Results and Discussion:

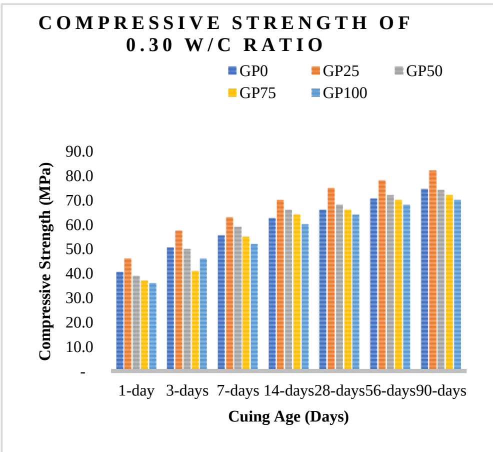
4.1 Workability Results:

- Trend in slump values with increasing granite powder

4.4 Optimum Replacement Level:

- Determination of 22% as optimum based on test results
- Beyond this point, excess fines may reduce strength due to poor interparticle bonding





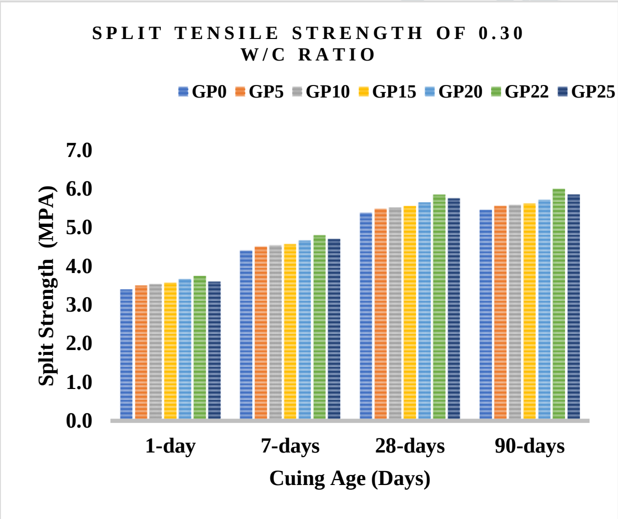
- Based on the slump values of the mix design results, the optimum W/C ratio was identified that 0.30 which has better workability than others.

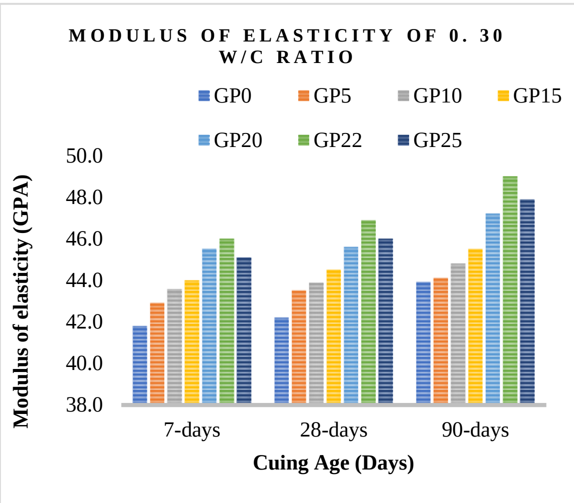
4.2 Compressive Strength:

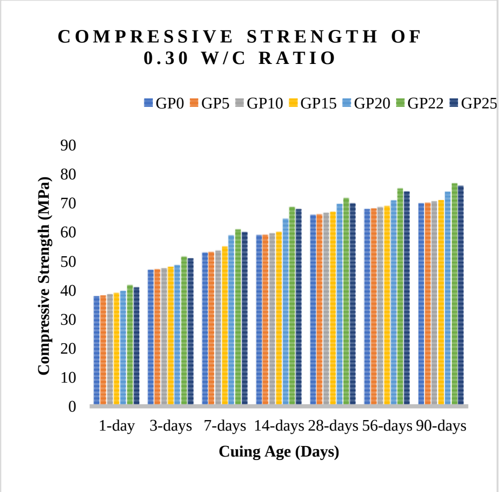
- Comparative results at 7, 14, and 28 days
- Peak strength observed at 22% granite powder replacement
- Explanation for strength development due to filler effect and particle packing

4.3 Split Tensile and Flexural Strength:

- Correlation with compressive strength
- Discussion on microstructure enhancement







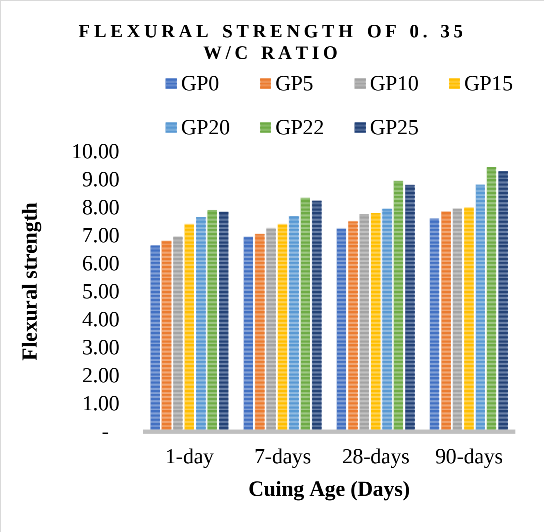
5. Conclusion:

The Concrete specimens were prepared with w/c ratio of 0.25, 0.30, 0.35 for M60 grade concrete mix and found that w/c ratio of 0.30 has got optimum result of workable mixture than others. Further, the test results show clearly that, the granite powder as a partial sand replacement has beneficial effects of the mechanical properties of high-performance concrete of all the other mixtures considered in this present experiment.

The concrete with 22 % of granite powder (GP22) was found to be superior to other percentages of granite powder concrete as well as conventional concrete and no admixtures concrete for all operating conditions.

The mechanical properties like the compressive strength, split tensile strength, modulus of elasticity and flexural strength particularly for all ages higher than that of the reference mix, GP0 [CC] as mentioned below.

1. Compressive strength is 11.1 to 14.9 % greater than that of GP0 [CC].
2. Split tensile strength is 8.7 to 10.3 % higher than that of GP0 [CC].
3. Modulus of elasticity is 10 to 11.6 % higher than that of GP0 [CC].
4. Flexural strength is 18.8 to 24.3 % higher than that of GP0 [CC].



5. The water absorption was about 14.19 to 15.89 % less than that of GP0 [CC].

Hence, the following conclusions are made based on a comparison of GP22 with the Control Concrete-GP0 [CC]. There was an increase in strength as the days of curing increased. Thus, the present experimental investigation indicates that, the strength properties of the concrete could enhance the effect of utilization of granite powder obtained from the crusher units in place of river sand in concrete.

In general, the behavior of granite aggregates with admixtures in concrete possesses the higher properties like concrete made by river sand.

6. Acknowledgement:

This paper is acknowledged to Dr. R.P. Singh professor and head of the department of civil engineering, Chhatrapati Shivaji Maharaj University, Mumbai for his valuable guidance.

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