Experimental Investigation on Concrete by Partial Replacement of Fine Aggregate with Granite Powder

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Abstract: Many industries are producing waste by-products and their disposal without creating any disturbance in the public, environment, and eco-system is a major challenging task to the researchers, engineers and environmentalists. Since construction materials are being exploited by mankind, identifying the waste materials which are being disposed off and the properties of these materials which resembles any constituent in concrete mixture can reduce the problem to some extent. The main objective of this study is to investigate the characteristic compressive strength of M30 grade concrete in which major constituents such as cement and fine aggregate are replaced with granite dust which is a waste by-product from the industry. The replacement is done in various proportions i.e., 5%, 10%, 15% and 20% and are compared with the strength of concrete prepared by nominal mix which has no replacements. It is concluded that cement and fine aggregate replaced with granite dust at a proportion 15% has obtained maximum compressive strengths of M30 grade concrete at 28 days standard duration. It is also apparent from the study that the compressive strength is maximum for concrete in which fine aggregate is replaced with granite dust than the strength of concrete which replaces cement.

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I. INTRODUCTION

Concrete is the most popular building material in the world. Construction Industry contributes huge amounts to Indian economy and concrete is one of the best materials used in construction. The ingredients used in it include Cement, Sand, Gravel and Water. Now-a-days sand is not easily available. The worldwide consumption of sand as fine aggregate in concrete production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years. A situation that is responsible for increase in the price of sand, and the cost of concrete. Expensive and scarcity of river sand which is one of the constituent material used in the production of conventional concrete. The use of Crushed Granite Fine (CGF) as an alternative to natural sand. The Granite fines use up to 20% as a partial replacement for natural sand in the production of concrete.

NECESSITY:

1. To reduce noise pollution.
2. To reduce the dust nuisance.
3. To reduce the cost of construction.
4. To increase the concrete strength.

2 LITERATURE REVIEW

S.A. Abukersh and C.A. Fairfield (2011) examined the potential for using recycled red granite dust (RGD) from a crusher as a partial sand substitute in concrete. The successful production of RAC, with this sand-replacing RGD, could lead to its large-scale structural use, rather than the prevailing low-value uses for many such materials. Concrete mixes containing 30% RGD showed good fresh properties, better than expected mechanical properties and excellent surface finish.

Vijayalakshmi et.al (2013) study is to experimentally investigate the suitability of granite powder (GP) waste as a substitute material for fine/natural aggregate in concrete production. It is recommended that the replacement of natural sand by GP waste upto15% of any formulation is favorable for the concrete making without adversely affecting the strength and durability criteria.

Yaswanth Kumar et al.(2015) observed that substitution of 10% of fine aggregate by weight with granite dust powder (GDP) in concrete resulted in an increase in compressive strength to 48 N/mm² compared to conventional concrete which has a compressive strength of 35N/mm². Tensile strength showed a similar trend with a 10% substitution with GDP increasing the tensile strength to 3.6N/mm² compared with conventional concrete which has 2.4 N/mm² tensile strength. However, flexure strength of 10% GDP replacement exhibited a good improvement of flexural strength to 4.6 N/mm² compared to flexural strength of conventional concrete which is 3.2 N/mm².Split tensile strength and flexural strength also got increased at 10% of replacement of cement and strength values are 3.43 N/mm² and 4.62 N/mm² respectively.

Arivumangai et al.(2016) experimental study on compressive strength, split tensile strength 28, 56 and 90 days. Durability study on chloride attack was also studied and percentage of weight loss is compared with normal concrete. The strength and durability properties of the concrete could enhance the effect of utilization of granite powder obtained from the crusher units. Sarbjeet Singh et al. (2016) strength and durability behavior of concrete containing Granite waste is examined to determine its viability in concrete production. Concrete was prepared with GCW in 4 different proportions i.e. 10%, 20%, 30%, and 50% and various tests such as compressive strength, flexural strength, abrasion resistance and permeability test were performed and the experimental values were compared with the control mix.The study shows that the partial replacement of fine aggregate by granite cutting waste produces concrete that has better strength and durability characteristics compared to control mix.

MATERIALS USED

3.1 Materials

Cement

Coarse Aggregate

Fine Aggregate

Replacement of Granite fines (partial Replacement of fine aggregate 10%, 15% & 20%)

Water

3.1.1 Cement:

The materials of cement was used in an ordinary Portland cement super grade (53grade) is used. This cement is most commonly used in concrete construction.

TABLE-1 Physical Properties of Cement

S.NO	Properties Cement	Result
1	Specific Gravity	3.13
2	Standard consistency	30.5%
3	Initial Setting Time	31 mins
4	Final Setting Time	9.0 Hrs

3.1.2 Coarse Aggregate:

These are most important to reduce shrinkage and economy. Analysis of combined aggregates confirms the specifications for graded aggregates.

TABLE-2 Properties of Coarse Aggregate

S.NO	Properties of Coarse Aggregate	Result
1	Specific Gravity	2.79
2	Impact value	39.8
3	Water absorption	2.5
4	Bulk Density	0.85
5	Crushing Test	12.8
6	Flakiness Test	20.9
7	Elongation Test	26.30
8	Abrasion Test	14.5

3.1.3 Fine aggregate

Sand collected from nearby river is used for this project.

The various properties of sand are tabulated in Table II

TABLE-3 Properties of Fine Aggregate

S.NO	Description	Value
1	Specific Gravity	2.89
2	Bulk Density	0.75
3	Sieve Analysis	Zone-III

3.1.4 Granite powder

The granite powder (GP), which is a by-product obtained from granite processing industry was used in this study. Approximately 250-400 tons of granite waste is generated every year from cutting and finishing of granite block. These byproducts are left largely unused and are hazardous materials to human health because they are airborne and can be easily inhaled and disposal of this waste is a major problem that creates Air pollution, Land pollution and Water pollution. It is aimed at developing a new building material from the granite dust, an industrial waste as a replacement material of cement and fine aggregate in concrete.

TABLE-4 Physical Properties of Granite Fines

S.NO	Description	Value
1	Specific Gravity	2.65
2	Bulk Density	0.73
3	Sieve Analysis	Zone-IV

3.1.5 Water

Water is an important ingredient of the concrete as it actually participates in the chemical reaction with cement. In general, water fit for drinking purpose 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 usedin the present work.

4 EXPERIMENTAL INVESTIGATION TEST ON HARDENED CONCRETE

1. The Compressive Strength
2. The Split Tensile Strength
3. The Flexural Strength

4.1 Compressive Strength Test

The concrete cubes were crushed at 7, 14, and 28 days in order to determine the compressive strength of the cubes. The compressive strength is determined by dividing the maximum of failure load of the specimen during the test by the cross sectional area of the specimen.

Compressive strength = $\frac{P}{A}$

(N/mm) Where,

P - Load (N)

A - Area (mm^2)

4.2 Split Tensile Strength

Split tensile strength of concrete is usually found by testing plain concrete cylinders. Cylinders of size150mm x 300 mm 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 4000kN capacity. It can be observed that at a 10, 15 and 20% replacement of granite powder, an optimum for7,14 & 28 days.

RESULT AND DISCUSSIONS

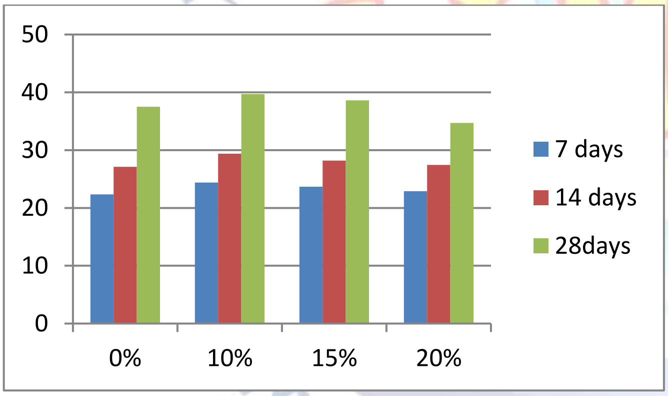
Table- 5

compressive strength of conventional vs Granite fine concrete:

S.No	Mix(%)	Average compressive strength(N/mm²)		
		7days	14days	28days
1	0	22.34	27.12	37.5
2	10	24.4	29.37	39.7
3	15	23.67	28.2	38.6
4	20	22.9	27.45	34.7

CHART-1:

Graphical representation of compressive strength of conventional vs Granite fine concrete:



X-axis:-'%' of replacement

Y-axis:-compressive strength

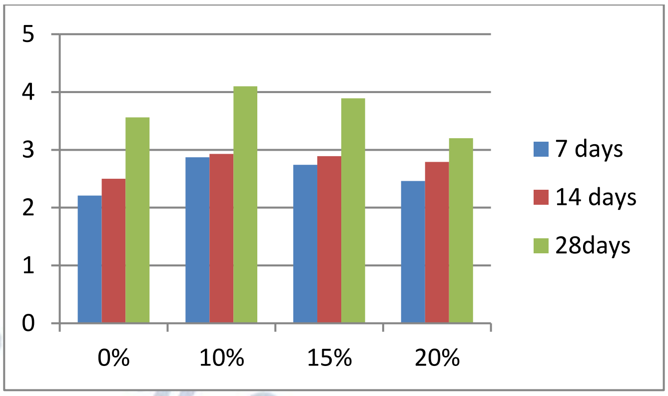
TABLE-6

Split tensile strength of conventional vs Granite fine concrete:

S.No	Mix(%)	Average split tensile strength(N/mm²)		
		7days	14days	28days
1	0	2.12	2.5	3.56
2	10	2.87	2.93	4.1
3	15	2.74	2.89	3.83
4	20	2.46	2.79	3.2

CHART-2

Graphical representation of split tesnsile strength of conventional vs Granite fine concrete:



X-axis:-'%' of replacement

Y-axis:-flexural strength

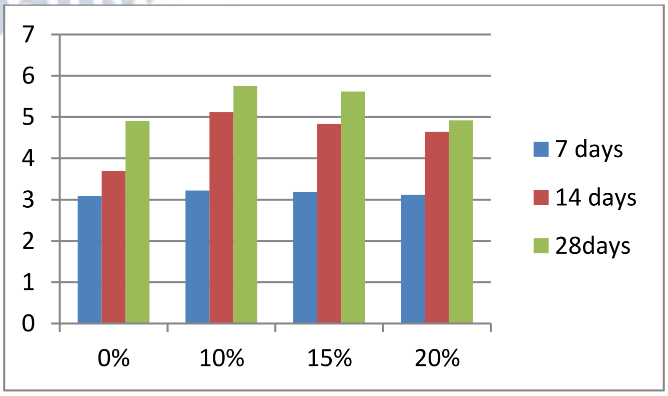
TABLE-7

Flexural strength of conventional vs Granite fine concrete:

S.No	Mix(%)	Average flexural strength(N/mm²)		
		7days	14days	28days
1	0	3.09	3.69	4.9
2	10	3.22	5.12	5.75
3	15	3.19	4.83	5.62
4	20	3.12	4.64	4.92

CHART-3

Graphical representation of flexural strength of conventional vs Granite fine concrete:



X-axis:-'%' of replacement

Y-axis:-flexural strength

RECOMMENDATION:

Based on the results of the test, it is recommended that 10% CGF is optimum forreplacement Fine aggregate. it is as well economical foruse in concrete works.

CONCLUSION:

1. The compressive strength of concrete with 10% granite powder is 5% greater than compressive strength of conventional concrete.

The split tensile strength of concrete with 10% granite powder is 13% greater than split tensile strength of conventional concrete.

3.The flexural strength of concrete with 10% granite powder is 14.7% greater than flexural strength of conventional concrete.

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