EXPERIMENTAL STUDY ON CONCRETE WITH REPLACEMENT OF COARSE AGGREGATE BY USING GRANITE WASTE

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ABSTRACT

Aggregates are the important constituents in concrete. Nowadays some alternative materials have been already used as part of coarse aggregates in concrete. For example light weight aggregate, Recycled aggregate etc. In this paper is mainly focused on utilizing the Granite waste as a replacement of coarse aggregate in concrete work is investigated. Granite is an igneous rock which is widely used as construction material in different forms. Granite industries produce lot of waste materials. The wastes from the granite industries are being disposed to open land which is cause hazard to environment. This granite waste can be utilized for the preparation of concrete as replacement of coarse aggregate. In order to explore the possibility of utilizing the granite waste as replacement to coarse aggregate, an experimental investigation has been carried out. The percentages of granite waste added by 25%, 50%, 75% and100% Replace for coarse aggregate in concrete. Tests conducted for material using in concrete. Design mix of M30 is adopted for this paper and mix compositions were calculated by IS method. Cubes, Cylinders and Beams are to be casted. Compressive strength, split tensile strength and flexural strength are to be found at 7, 14 and 28 days. The test results indicate that the replacement of coarse aggregate by granite waste has beneficial effect on the mechanical properties such as compressive strength, split tensile strength and flexural strength of concrete.

Keyword –*Granite Waste, Coarse Aggregate, Light weight aggregate, Igneous Rock, Split Tensile Strength*

1. INTRODUCTION

The most popular engineering material is concrete. Concrete is generally considered a proper construction material for many civil (such as highways and streets, bridges, dams, large buildings, airport runways, irrigation structures, breakwaters, piers and docks, sidewalks, silos, farm buildings, homes, even barges and ships) and military applications. It can be strong and produced to be durable; It can be placed in many shapes and is economical. Since it is much stronger in compression weak in tension, concrete is primarily used for its compressive strength. Therefore, intensive research efforts have been devoted to the improvement of the compressive strength of concrete .The compressive strength of concrete depends on the water cement ratio, degree of compaction, ratio of cement to aggregate, bond between mortar and aggregate, and grading, shape, strength and size of the aggregate. The coarse aggregate in normal concrete are mainly from rock fragment characterized by high strength. The effect of using crushed granite as coarse aggregate on the mechanical properties of concrete was investigated. It has become very popular not only among civil engineers but among people also. The secret of its popularity lies in the simple fact that except cement, all other ingredients of concrete are commonly available local materials like aggregate and water. A new concept of concrete which has significantly improved the quality of concrete is 'Ready Mix Concrete' (RMC).RMC is manufactured in controlled conditions of batching plants were it has to pass through the strictest quality control. Then it is transported to the destination through truck mixers ensuring the required workability. As a result of many developments and improvements in the concrete technology, we have come a long way in production of concrete and 'concrete' has eventually been established as a reliable construction material. As infrastructure of the entire world is keep on developing, the construction industry is in need of large amount of raw materials. As the construction of raw materials increases so demand of usage also increases. So we are in need of alternative source

for the raw materials. In that we have made an attempt to use on alternative source of coarse aggregate by using replacement of granite waste stone basis on the percentage of 25%, 50%, 75% and100% respectively. Every day the quality of concrete is improving, to achieve better characteristics, lower prices and to be environmentally acceptable.

1.1 GRANITE

Granites may be defined as the plutonic light colored igneous rock. It is generally coarse to medium grained, polycrystalline and granular rock. It occurs on the surface of the earth is attributed to prolonged weathering and erosion of the strata. It is comes from magma that erupted on the ground surface. Granite as a building material especially in palaces and monuments has been in use for ages. However the use is limited as stone bricks in wall or arches or as lining slabs in walls, roofs or floors, leaving its wastage at quarry or at the sizing industry generally unattended for use in the building industry itself as filler or plasticizer in mortar or concrete. The result is that the mass which is 40% of total granite quarried has reached as high as millions of tones. This huge unattended mass of granite waste consisting of very fine particles is today one of the environmental problems around the world. One of the logical means for the waste marble masses calls for utilizing them in building industry itself. Some attempts have been made to find and assess the possibilities of using waste granite aggregate in mortars and concretes and results about strength and workability were compared with control samples of conventional cements -sand mortar/concrete.

1.2 TYPES OF GRANITES

1.Muscovite-Granite: When white mica, is present as a prominent accessory mineral, the granite may be distinguished on basis of relative abundance.

2. Biotite-Granite: It is the black mica, and intergrowth structures and usual intrusive bodies of the texture.

3.Hornblende-Granite: It is coarse to medium grained igneous rock that has been utilized as a regular arrangements of mica.
4. Augite-Granite: It is Brown-Green, Brown-Black in color. it has a luster to dull hematite.
5. Tourmaline-Granite: It is most common range of violet, green. it is a crystal silicate mineral elements.
6. Graphic-Granite: It is light colored intrusive rock having quartz crystals.
7.Porphyritic-Granite: It contains feldspar in distinct crystals.

1.3 USES OF GRANITE ROCKS

GRANITE SIZE	APPLICATIONS
0-2 mm, 0-5 mm	Paving paths, Covering sports Grounds, Gardening.
2-5 mm	Paving slabs and other construction products.
5-10 mm	Road constructions and Production of concrete structures.
10-20 mm	Concrete Roads, Sub base, Walls, Floors and Ceilings of buildings.
20-40 mm	Construction of highways and Railways as used as sub bases.
40-70 mm	Production of concrete and Solid concrete structures.
70-120 mm, 120-150mm, 150-300mm	Decorative purposes, Catchment areas, Reservoirs and Basins

Table:1 Uses Of Granite Rocks

2. METHODOLOGY

1. To collect the journals about this project
2. Collection of materials like Cement, Sand, Aggregate and granite waste

3. To study the properties of materials
4. Mix Design using IS:10262:1982 for M30 grade
5. Casting of Cubes, Beams & Cylinder(Control specimens)
6. Casting of Cubes, Beams & Cylinders(Granite waste specimens with various percentages)
7. To place the casted specimens into curing process.
8. Study on mechanical characteristics of concrete
    - Compressive Strength
    - Split Tensile Strength
    - Flexural Strength
9. Comparison of test results on strength of control and granite waste added specimens.
10. Conclusion.

3. MATERIALS USED AND ITS PROPERTIES

Locally available Granite waste was the primary material used in this project work. Besides that, for concrete mixing purposes, Ordinary Portland Cement, crushed stone coarse aggregate, river sand were used. Normal tap water was used for both concrete mixing and curing purposes.

3.1 CEMENT

The choice of the cement content depends on the strength requirements, exposure class for durability and the minimum amount of fines requires in the mix.The cement used for this study is ordinary Portland cement (OPC) of 53-grade "JAYPEE".

Fig:1. Cement

3.2 SAND

The sand is of river sand screened and washed to remove all the organic and inorganic compounds that are likely to present in it. Sand has been sieve in 4.75mm (passed).

Fig:2. Sand

3.3 COARSE AGGREGATE

The coarse aggregates that are used for the concrete are 20mm of maximum size and they should be angular and well graded.

Fig:3. Coarse Aggregate

3.4 GRANITE WASTE

The size of particles is same that of coarse aggregate (16mm to 20mm). It is taken from **MSP GRANITES**, The chemical properties of granite waste are as follows.

Fig:4. Granite Waste

4. MATERIAL TESTS

4.1 CEMENT TESTS

TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 12269-1970
Fineness of Cement (%)	3	3-7
Specific Gravity	3.10	3.10-3.15
Normal Consistency (%)	32	30-35
Initial Setting Time(minutes)	75	30
Final Setting Time (hours)	10 hours	10
Compressive Strength (MPa)	53	53

Table:2 Cement Test Results

4.2 FINE AGGREGATE TESTS:

TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 12269-1970
Specific Gravity	2.60	2.6-2.9
Fineness Modulus	2.492	-
Water Absorption (%)	0.7	MAX 1%

Table:3 Fine Aggregate Test Results

4.3 COARSE AGGREGATE TESTS

TEST PARTICULARS	RESULT OBTAINED	REQUIREMENTS AS PER IS 12269-1970
Specific Gravity	2.77	2-3
Crushing Value	40.9	40-45
Impact Test	15.11	15-20
Water Absorption (%)	2	1-3

Table:4 Coarse Aggregate Test Results

4.4 Comparsion Between Coarse aggregate and Granite waste Properties Tests

TEST PARTICULARS	COARSE AGGREGATE PROPERTIES	GRANITE WASTE PROPERTIES
Specific Gravity	2.77	2.64
Crushing Value	40.9	43.13
Impact Test	15.11	18.31
Water Absorption(%)	2	0.7

Table:5 Comparsion Between Coarse aggregate and Granite waste Properties Test Results

5. CONCRETE MIX DESIGN

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
189.35	498 kg	525 kg	1189 kg
0.38	1	1.05	2.39

Table: 6 Mix proportion

6. MIXING OF MATERIALS

6.1 FORMWORK

For casting cubes and cylinders, standard moulds with smooth machined inner faces were used. The inner dimensions of the cube mould were 150X150X150mm.For casting cylinders, standard cast iron mould of 150mm diameter and 300mm height were used. The size of the flexure beam used was 500X100X100mm. The mould was completely watertight during concreting.

6.2 MIXING OF MATERIALS

Concrete for all the specimens were mixed by using handling equipment.

Fig:5 Mixing of Concrete

6.3 COMPACTION

Compaction was done through using tamping rod.

6.4 CASTING PROCEDURE AND CURING PROCESS

In this study fiber reinforced concrete of M_{30} grade was considered. The mix design of concrete was done .The mix proportion obtained was 1 : 1.05 : 2.39 : 0.38 (cement , sand , coarse agg ,water).the mix design gives the cement content of 498 kg/m^3 of concrete .Using the above mix proportion, a total number of 15 standard concrete specimens are 150X150X150mm size of cubes and 15 number of cylinders specimens are having size of 150 mm diameter, 300mm height and also 15 number of flexure beam concrete specimens of 100X100X500mm were cast with and without Granite waste (in the above specimen granite waste are used). Cast iron and Wooden moulds are used for casting. For casting specimen , four different proporation fraction of granite waste are 25%, 50%, 75%, 100%. The concrete was mixed by tilting type laboratory mixer and then it was poured in to the moulds in layer by layer. Compaction was done by a tamping rod .The specimens were removed after 24 hours of casting and then cured under water for 7,14, and 28 days. The specimens were taken out from the curing tank and dried itself of 24 hours before the period of testing.

Fig:6 Casting and Curing of concrete specimens

7.TEST ON SPECIMEN

i. Study on Workability
   - Slump test
   - Compacting factor test

ii. Study on strength
   - Compressive strength test
   - Split tensile strength

7.1 SPLITTING TENSILE STRENGTH TEST (f_{sp}): (ASTMC 496-90)

For the determination of splitting tensile strength of concrete, cylinder specimens of diameter to length ratio1:2 was selected **,** with diameter as 150 mm and the length as 300 mm. specimens were dried in open air after 7,14 and 28 days of curing and subjected to splitting tensile test under universal testing machine. The rate of loading was adjusted as 0.11 to 0.023 MPa/sec as per ASTM C496-90. While testing the specimens, plywood pieces one at the top and the other at the bottom.

The splitting tensile strength (f_{sp}) was obtained using the formula,

$$\mathbf{f_{sp} = 2P/\pi dl} (N/mm^2)$$

Where,

P = load at failure (N)

d = diameter of specimen (mm)

l = length of specimen (mm)

7.2 FLEXURAL STRENGTH TEST: (ASTM C 78-09)

For the determination of flexural strength of concrete, Beam specimens of 500X100X100 mm. specimens were dried in open air after 7,14 and 28 days of curing and subjected to flexural strength test under flexural testing machine.

The rate of loading was adjusted as 0.11 to 0.023 Mpa/sec as per ASTM C 78-09.The specimen continuously and without shock. The load shall be applied at a constant rate to the breaking point. Apply the load at a rate that constantly increases the maximum stress on the tension face between 125 and 175 psi/min (0.86 and 1.21 Mpa/min) until rupture occurs.

8.RESULTS AND DISCUSSION

8.1 COMPRESSIVE STRENGTH

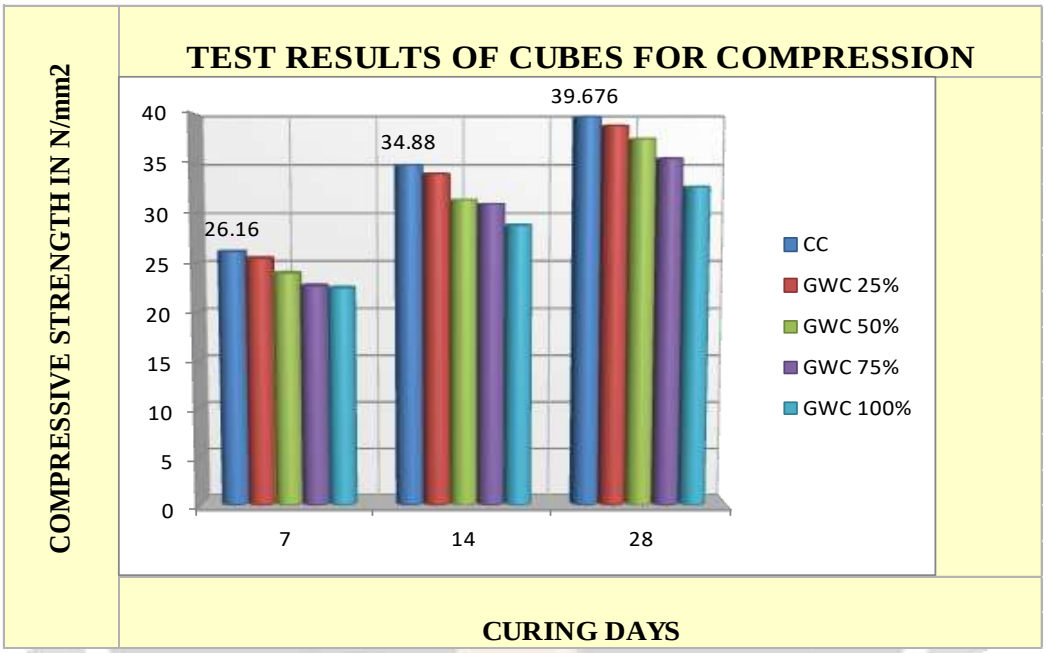

Chart:1. Comparison of Compressive Strength of cubes

8.2 SPLIT TENSILE STRENGTH

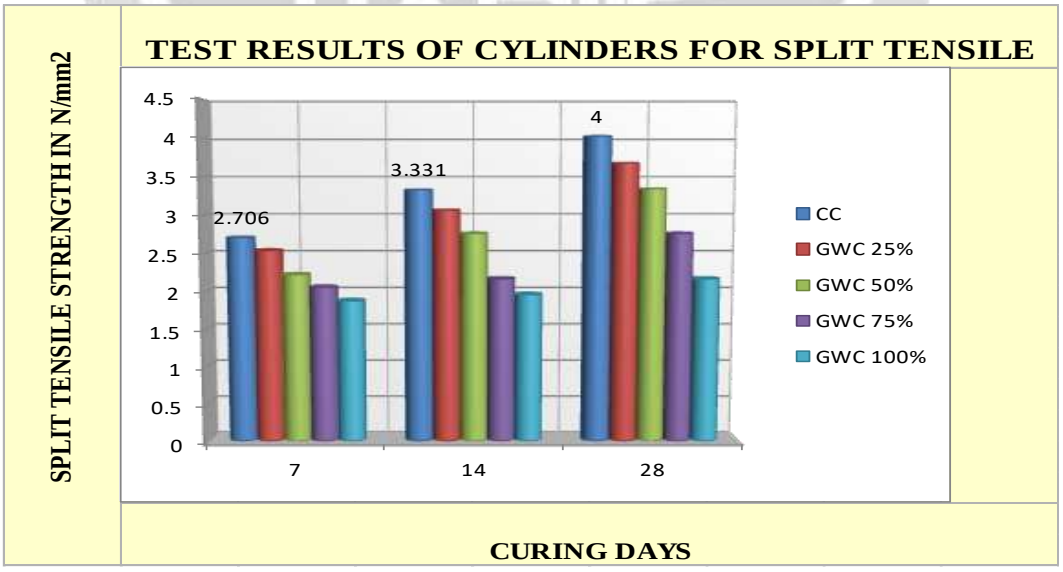

Chart:2 Comparison of Split Tensile Strength of Cylinders

8.3 FLEXURAL STRENGTH

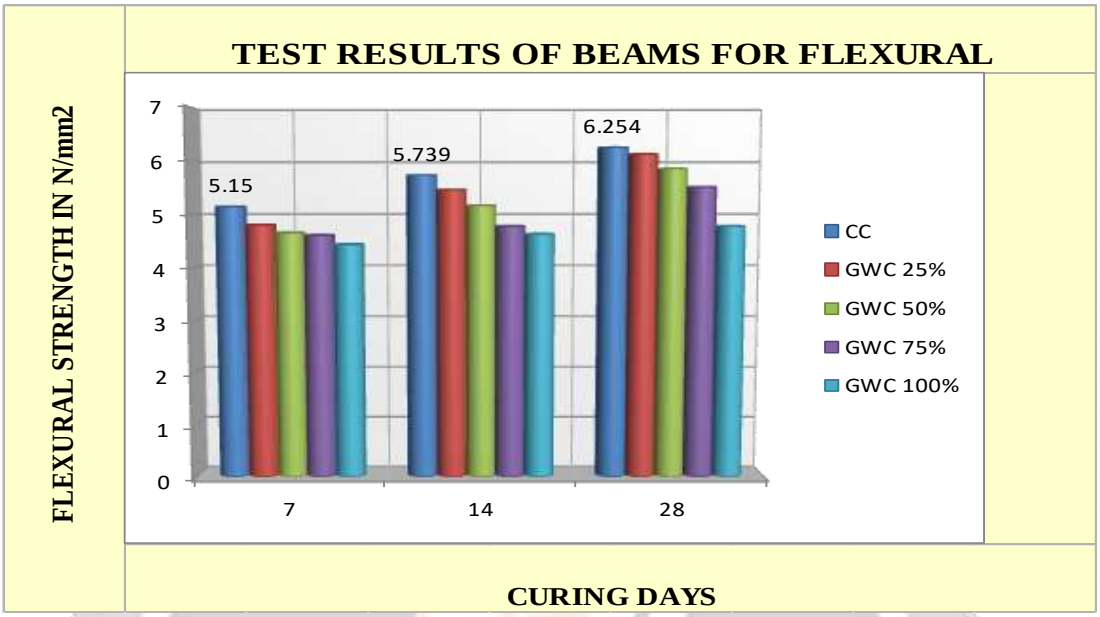

Chart:3 Comparison of Flexural Strength of Beams

9. CONCLUSION

The development of concrete with granite waste as coarse aggregate has been successfully completed and the results were presented and analyzed in the previous chapter. Based on the test results of M30 grade concrete the following conclusions are given below.

- Depending upon the percentages of replacement of coarse aggregate with granite waste is found to be increase strength compared to ordinary concrete.
- In 25% replacement of granite aggregates, the compressive strength of concrete is increased by 22.68%, when compared to 50%,75% & 100%.
- In 25% replacement of granite aggregates, the split tensile strength of concrete is increased by 25.03%, when compared to 50%,75% & 100%..In 25% replacement of granite aggregates, the flexural strength of concrete is increased by 12.01% when compared to 50% ,75% & 100%.

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