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Studying the compressive strength of concrete with Granite as partial replacement to sand

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Abstract – *Availability of natural sand is insufficient to meet the requirements of rapidly developing construction industry. This experimental work is carried out to investigate suitability of Granite sand as replacement of natural sand in concrete. In present situation industrial waste material are used for sand replacing material. Granite waste is easily available in market or Granite factories; also Granite waste improves compressive strength. Based on Results it is recommended that up to 60% of natural sand can be replaced with granite. The concrete produced with 60% replacement gives considerable compressive strength as compared to conventional concrete.*

Key Words: Natural Sand, Granite Sand, Replacement, Concrete

1. INTRODUCTION

Concrete is the most popular building material is the world after aggregate; cement is the major components of concrete. Rock dust/sludge which is an abundant waste from granite rock quarries and crusher units is such a material. Studied on Recycled aggregate concrete produced with red granite dust as a partial fine aggregate replacement .The experiment test results showed that the use of granite dust at 20 to 50% level reduces significantly the concrete tensile strength. 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.

The non- availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of construction industry in many part of the country .recently Tamil Nadu government has imposed restrictions on sand removals 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 utilized and the rest has been dumped unscrupulously resulting in pollution problems.

The cement pastes modified with granite dust were examined using thermo gravimetric analysis, X-rays, and SEM. Granite dust cement replacement or addition of 5.0%, 7.5%, 10.0%, &15.0% were used. The test result showed an improvement on concrete compressive strength at 5.0% granite dust as cement replacement and improvement on compressive strength at most levels of granite dust as cement addition. Finally a reduction in water cement ratio around 0.03 was enough to cancel the reduction in concrete compressive strength as a result of granite dust up to 15.0% as cement replacement reviewed on effect granite powder on properties of concrete. An experimental study on the high performance concrete made with granite powder as fine aggregate and partial replacement of cement with 7.5% silica fume, 10% slag subjected to water curing is conducted for finding the mechanical properties such as compressive strength, split tensile strength, modulus of elasticity, flexural strength and water absorption characteristics of concrete mixtures. The test result show clearly that granite powder as a partial sand replacement has beneficial effects of the mechanical properties of high performance concrete. Of all six mixture considered, concrete with 25% of granite powder was found to be superior to other percentage of granite powder concrete as well as conventional concrete and no admixtures concrete for all operating conditions.

2. EXPERIMENTS FOR PHYSICAL PROPERTIES OF CONCRETE INGREDIENTS

The ingredients of concrete i.e. cement, fine aggregate and coarse aggregate are tested before producing the concrete. The relevant Indian standard codes were followed for conducting various tests on the concrete.

2.1 Test on cement

The cement used in this experimental work is Dalmia – Portland pozzolona Cement. All properties of cement are tested by referring IS 1489-1967. Cement used in this study was Portland Pozzolona Cement confirming to IS:12269-1987. The specific gravity of cement is 3.15.

2.2 Tests on aggregates

Natural sand from river confirming to IS 383 – 1970 is used. Various tests such as specific gravity, water absorption, impact strength, crushing strength, sieve analysis etc. have been conducted on CA and FA to know their quality and grading. The fine aggregate confirming to IS: 383 used. The

sand is obtained from Local River Krishna & confirming to Zone III was used. Grading of sand was done strictly as per IS 383-1970.

The specific gravity of sand was found to be 2.66 and Fineness Modulus was 2.57.

The average percentage of silt by volume given sand is found to be =1.77% Volume of water=50ml

Average specific gravity of given soil sample is =2.97
The coarse aggregate of 20mm size is used. The specific gravity was found to be 2.96 and fineness modulus of coarse aggregate was 3.25.

Granite belongs to igneous rock family. The density of granite is between 2.65 to 2.75 g/cm3 and compressive strength will be greater than 200 MPa. Granite powder obtained from the polishing units and the properties were found. Since the granite powder was fine, hydrometer analysis was carried out on 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 powder was found to be 2.61.

2.3 Properties of granite

Granite belongs to igneous rock family. The density of granite is between 2.65 to 2.75 g/cm3 and compressive strength will be greater than 200 MPa. Granite powder obtained from the polishing units and the properties were found. Since the granite powder was fine, hydrometer analysis was carried out on 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 powder was found to be 2.61.

2.4 Mix Design of M20 Grade Concrete

After determining the various properties of concrete constituents, the concrete mix was designed for M20 grade concrete as per the procedure laid down in an I.S 10262-2009. The results of Mix Proportion are 1: 1.53: 3.55

3. PREPARATIONS OF SPECIMEN

3.1 Measurement of ingredients:

All cement, sand coarse aggregate 20mm respectively are measured with Digital balance. The water is measured with measuring cylinder of capacity 1 liter and measuring jars of capacity 1000 ml and 2000 ml.

3.2 Preparation of surface before placing concrete

It is very essential to prepare a proper base or place before placing the concrete mix in order to develop proper bond between the base and fresh concrete. Before placing concrete, the different types of bases should be prepared as below.

3.3 Mixing of concrete

The ingredients were thoroughly mixed over a G.I. sheet. The sand, cement and aggregate were measured accurately and were mixed in dry state for normal Concrete. For granite mix concrete, the required quantities of granite mix (i.e. from 20%, 40%, and 60%) were measured by weight of cement. The required weighted quantity of granite mix was then uniformly sprinkled by hands on dry concrete mix containing CA, FA, and cement. The dry concrete mix was then thoroughly and uniformly mixed till uniform and homogeneous mixing of granite waste in dry mix was observed.

3.4 Transportation of concrete

The process of carrying the concrete mix from the place it's mixing to final position of deposition is called as transportation of concrete. The time factor is very important in case of transportation of concrete. The concrete mix should be transported as quickly as possible.

3.5 Placing of concrete

The fresh concrete was placed in the molds by trowel. It was ensured that the representative volume was filled evenly in all the specimens to avoid segregation, accumulation of aggregates etc. While placing concretes, the compaction in vertical position was given to avoid gaps in molds.

3.6 Compaction of concrete

Molds are oiled and cleaned from inside for smooth de-molding. Concrete is mixed thoroughly and placed in the mold in three layers and compacted by hand compaction for beam specimens and table vibrator with suitable fixing frame for cubes and cylinders. It is vibrated till concrete woes out from mold. The vibration is continued till cement slurry just ooze out on surface of molds. Care is taken of cement slurry not to spill over, due to vibration and segregation. The process of consolidating concrete mix after placing it in position is called as compaction of concrete. The object of compaction is to remove air from the concrete and to give maximum density to the concrete. Presence of more air voids will reduce the strength. It also ensures an intimate contact between the concrete and the surfaces of reinforcing steel and other embedded parts of the structure. During the process of compaction it is important to note that the reinforcement should not be disturbed and the forms should not be damaged or displaced. If the compaction is not uniform, the concrete becomes porous, non-homogeneous and attains less strength. The mix to be used should have adequate workability for placing without any difficulty.

3.7 Finishing of concrete

After removing from vibrating table, the molds were kept on ground for finishing and covering up for any leftover position. The concrete is worked with trowel to give uniform surface. Care is taken not to add any extra cement, water or cement mortar for achieving good surface finish. The additional

concrete is chopped off from top surface of the molds for avoiding over sizes etc. Identification marks are given on the specimens by embossing over the surface after initial drying. The operations adopted for obtaining a true, uniform concrete surface are called as finishing operations.

3.8 Curing of test specimens

The specimens were de-molded after 24 hours of casting and immediately stored in the curing tank for continuous curing. M-20 grade plain cement is cured in curing tank for 7 days. Granite mix concrete specimens of different mix proportion content are water cured for 7 days for same grade of concrete. The process of hardening the concrete mixes by keeping its surface moist for a certain period after compaction and finishing is called curing of concrete.

Curing is one of the important factors for obtaining better strength. The concrete hardens because of the chemical reaction between water and cement, i.e. hydration. The chemical action that accompanies the setting of concrete is dependent on the presence of water. Although there is sufficient water at the time of mixing yet it is necessary to ensure that the water is retained to enable the chemical action to continue till the concrete is fully hardened. Properties of concrete such as strength, durability, and wear resistance, water-tightness and volume stability improve with the passage of time. If the loss due to evaporation is more from newly placed concrete, the hydration process will stop and concrete will shrink thus creating tensile stresses at the drying surface. The development of these stresses will result into the formation of plastic shrinkage cracks.

4. RESULT AND DISCUSSION

4.1 Details of test specimens for tests on hardened concrete

The specimens used were cubes specimens. Dimensions of each test specimen are

Cube: 150mm x 150mm x 150mm

Compressive strength of cubes is determined at 7 days and 28 days using compression testing machine (CTM) of capacity 2000 KN.

4.2 Compressive strength test on cube:

A cube compression test was performed on standard cubes of plain and granite mix concrete of size 150 x 150 x 150 mm at 7 days and 28 days of immersion in water for curing. Results are shown in Table (4.3) and graphical presentation between compressive strength and percentage granite mix concrete volume fraction is shown in Fig. 4.3.

Table -1: Compressive strength test on cube

Compressive Strength of various combinations			
Description	Average Compressive Strength for 7 days testing on 3 cube	Average Compressive Strength for 14 days testing on 3 cube	Average Compressive Strength for 28 days testing on 3 cube
Normal concrete	17.94	23.47	30.5
20% Fine aggregate Replacement with Granite sand	19.43	27.91	32.3
40% Fine aggregate Replacement with Granite sand	21.57	31.56	39.61
60% Fine aggregate Replacement with Granite sand	28.4	36.79	42.24

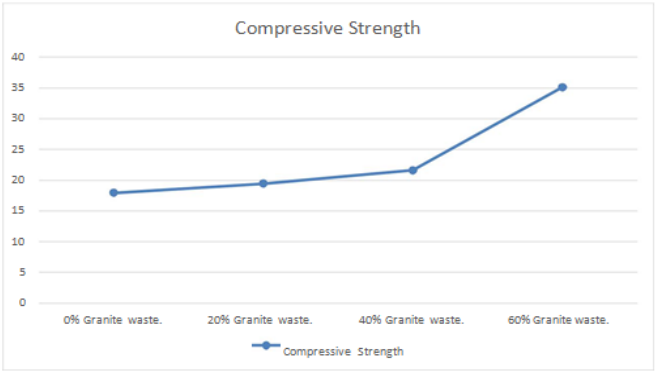


Chart -1: 7days Compressive strength

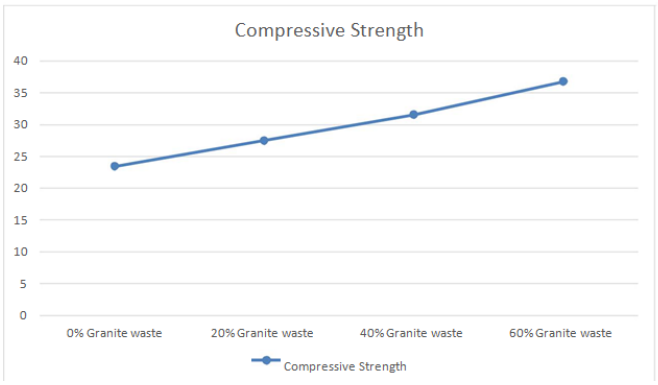


Chart -2: 14 days Compressive strength

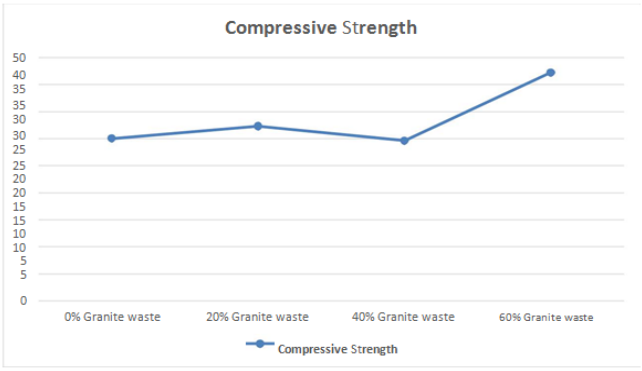
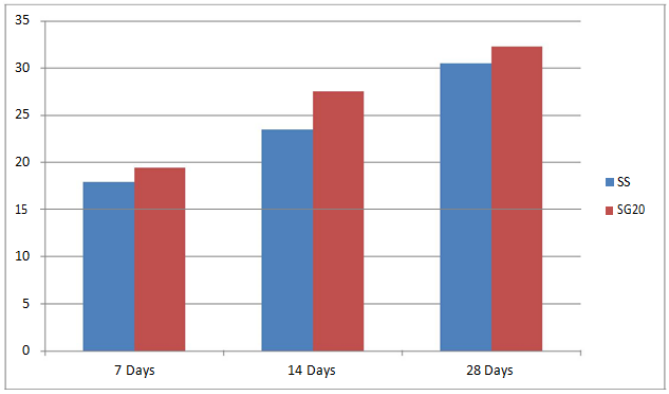
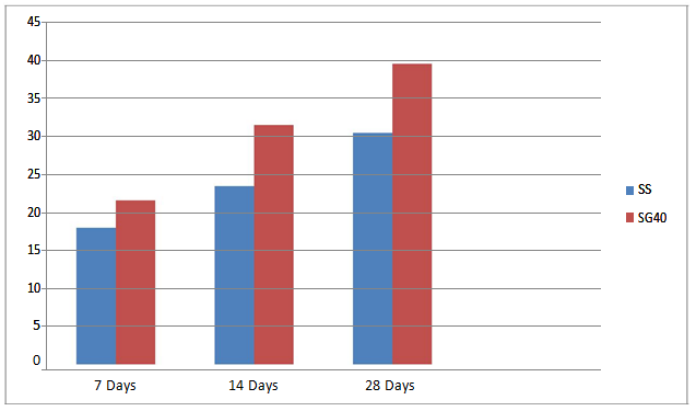


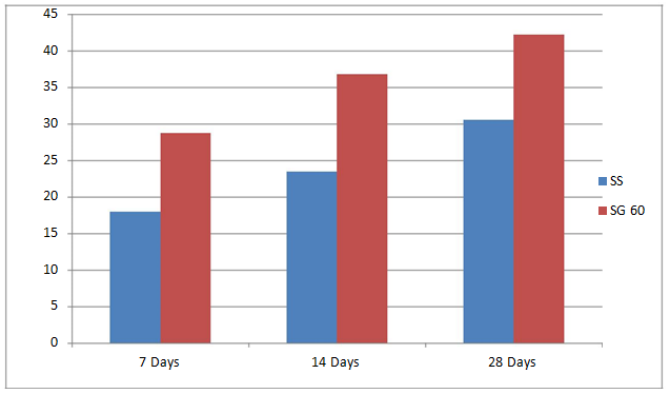
Chart -3: 28 days Compressive strength



Graph -1: Compression between conventional design and 20% replacement for compressive strength.



Graph -2: Compression between conventional design and 40% replacement for compressive



Graph -3: Compression between conventional design and 60% replacement for compressive

3. CONCLUSIONS

The following conclusions are drawn from the test results and discussion of this investigation:

1. As granite percentage replacement of sand in concrete increases the compressive strength also increases.
2. 7 days compressive strength increases by 11.11% for 20% replacement by granite, by 23.30% for 40% replacement by granite and 62.50% for 60% of replacement by granite.
3. 14 days compressive strength increases by 17.21% for 20% replacement by granite, 34.47% for 40% replacement by granite and 56.75% for 60% replacement by granite.
4. 28 days compressive strength increases by 6.10% for 20% replacement by granite, 29.87% for 40% replacement by granite and 38.49% for 60% replacement by granite.
5. Economic feasibility of the work can be achieved as the granite waste is available at much cheaper rate as compared to natural sand.

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