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# EXPERIMENTAL INVESTIGATION OF MECHANICAL PROPERTIES OF CONCRETE M20 AND M25 USING RICE HUSK ASH AND WASTE GRANITE POWDER

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**ABSTRACT**

Rice husk is an important by-product from the milling process of paddy rice, with a huge amount being produced worldwide each year and Granite powder [GP] is generated from granite cutting factories. This study presents the findings from the experimental work that was made to be evaluate the of rice husk ash to be utilised as the partial replacement for cement in the concrete grade of M20 and M25 at 28days with and without of rice husk ash. Granite powder is then replaced in the mixes with different percentages as 0% ,10%,20%,30%,40% and 50%. The compressive strength, split tensile strength are taken after 28 days the tests are conducted. By the experiment results, the mixes containing 25 % RHA and 30% of concrete in terms of compressivestrength and mixes containing 25 % RHA replacement and40 % granite powder replacement is suitable Split Tensile strength. These findings demonstrate that rice husk ash and granite powder can be partially substituted for sand and cement.

**Keywords:** Composite Material, Concrete, Granite Powder, Rice husk ash.

## I. INTRODUCTION

### 1.1 Rice Husk Ash

Rice husks are the hard protective coverings of rice grains which are separated from the grains during milling process. Rice husk is an abundantly available waste material in all rice producing countries, and it contains about 30%–50% of organic carbon. In the course of a typical milling process, the husks are removed from the raw grain to reveal whole brown rice which upon further milling to remove the bran layer will yield white rice. Current rice production in the world is estimated to be 700 million tons. Rice husk constitutes about 20% of the weight of rice and its composition is as follows: cellulose (50%), lignin (25%–30%), silica (15%–20%), and moisture (10%–15%). Bulk density of rice husk is low and lies in the range 90–150 kg/m3.

Sources of rice husk ash (RHA) will be in the rice growing regions of the world, as for example China, India, and the far-East countries. RHA is the product of incineration of rice husk. Most of the evaporable components of rice husk are slowly lost during burning and the primary residues are the silicates. The characteristics of the ash are dependent on (1) composition of the rice husks, (2) burning temperature, and (3) burning time. Every 100 kg of husks burnt in a boiler for example will yield about 25 kg of RHA. In certain areas, rice husk is used as a fuel for parboiling paddy in rice mills, whereas in some places it is field-burnt as a local fuel. However, the combustion of rice husks in such cases is far from complete and the partial burning also contributes to air pollution. The calorific value of rice husks is about 50% of that of coal, and assuming that husks have about 8%–10% of moisture content and zero bran, the calorific value is estimated to be 15 MJ/kg. Under controlled burning conditions, the volatile organic matter in the rice husk consisting of cellulose and lignin are removed and the residual ash is predominantly amorphous silica with a (microporous) cellular structure (Fig. 13.1). Due to its highly microporous structure, specific surface area of RHA as determined by the Brunauer–Emmett–Teller (BET) nitrogen adsorption method can range from 20 to as high as 270 m2/g, while that of silica fume, for example is in the range of 18–23 m2/g.

**Fig1.1: RICE HUSK ASH**

## 1.2 Waste Granite Powder

Granite belongs to igneous rock family. The density of the granite is between 2.65 to 2.75 g/cm3 and compressive strength will be greater than 200MPa. 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 powder to determine the particle size distribution. From hydrometer analysis it was found that coefficient of curvature was 1.95 and coefficient of uniformity was 7.82. The specific gravity of granite powder was found to be 2.5.

Granite is an igneous rock which is widely used as construction material in different forms. Granite industries produce lot of dust and waste materials. The wastes from the granite polishing units are being disposed to environment which cause health hazard. This granite powder waste can be utilized for the preparation of concrete as partial replacement of sand. In order to explore the possibility of utilizing the granite powder as partial replacement to sand, an experimental investigation has been carried out. The percentages of granite powder added by weight to replace sand by weight were 0, 5, 10, 15, 20 and 25. To improve the workability of concrete 0.5% Superplasticizers was added. This attempt has been done due to the exorbitant hike in the price of fine aggregate and its limited availability due to the restriction imposed by the government of Tamil Nadu in India. Fifty-four cubes and 36

cylinders were cast. Compressive strength and split tensile strength were found. The test results indicate that granite as replacement sand with granite powder has beneficial effect on the mechanical properties such as compressive strength and split tensile strength of concrete.

**Table 1.1: Chemical composition of Granite powder**

| S.No | Chemicalcompound | Weight(%) |
|---|---|---|
| 1. | $SiO_2$ | 64.5 |
| 2. | $Al_2O_3$ | 12.01 |
| 3. | $Na_2O_3$ | 5.92 |
| 4. | $Fe_2O_3$ | 5.77 |
| 5. | $K_2O$ | 5.26 |
| 6. | CaO | 4.80 |
| 7. | $TiO_2$ | 0.67 |
| 8. | MgO | 0.57 |
| 9. | MnO | 0.39 |
| 10. | $P_2O_5$ | 0.07 |

### 1.3 Objectives of the study

- To study the strength of the concrete with partial substitution of fine aggregate with waste granite powder and cement with rice husk ash.
- Compensate the scarcity of natural sand.
- To economize the cost of construction works.
- Deciding suitable percentage of waste granite powder as an alternate for conventional sand.
- Strength comparison of Conventional and Non-conventional concrete.

## II. Materials

Ordinary Portland cement, river sand, granite powder, fine aggregate and coarse aggregate are the prime constituents and granite powder is utilised as an admixture in this experimentation. The granite powder, a repercussion of the granite triturate process, is procured from an industry located about 10 km from Tekkali, Andhra Pradesh, India. Granite sludge is available in the form of waste as an industrial by-product comes directly from the sediments of granite factories, and that forms amid the sawing, shaping, and polishing processes of granite. The wet granite sludge is dried up preceding the preparation of the samples. The substance is sieved and at last, the granite powder is existed to be utilised in the experiments as fine aggregate.

The aggregate is primarily used to provide bulk to the concrete. Aggregates of two or more sizes are frequently used to increase the density of the resulting mix. The specific gravity of coarse aggregates is 2.75, and the bulk density is 6. The maximum coarse aggregate size is 20 mm.

The primary function of fine aggregates is to aid in the production of workability. The fine aggregates also help the cement paste keep the coarse aggregate particles suspended. Because aggregates constitute 75 percent of the body of concrete, their influence is enormous. Fine aggregates are made from river sand. Fine aggregates have a specific gravity of 2.60. Fine aggregates have a bulk density of 1700 Kg/m3 and a fineness modulus of 2.30. The cement used is ordinary Portland cement of grade 43. Cement has a specific gravity of 3.15 and a bulk density of 1450 Kg/m3.

Granitepowder is a material that, when used in certain percentages in reinforced concrete, increases the strength and ductility of the concrete.

Granite powder is a raw or waste material that is used in reinforced concrete to increase the strength of the concrete by varying the water cement ratio. The water cement ratio is assumed to be 0.42.

Table 2.1 represents the physical parameters of the aggregates utilized in the study

PHYSICAL PROPERTIES OF COARSE AGGREGATE, RIVER SAND AND GRANITE POWDER

| properties | Coarse aggregate | River sand | Granite powder |
|---|---|---|---|
| Specific gravity | 2.75 | 2.60 | 2.62 |
| Absorption (%) | 0.54 | 0.74 | 0.76 |
| Moisture content (%) | 0.81 | 0.97 | 0.94 |
| fineness modulus | 7.26 | 2.30 | 2.77 |
| grading | 20 mm aggregate and below | Medium | Medium |

**Mix Proportion:**

The mix proportion of M20 grade and M25 grade concrete is done by utilizing the Indian standard code 10262:2019. For whose the water-cement proportion is kept as the minimal estimation of 0.42 for the slump value is 150mm, , the coarse aggregate of size 20mm and below.

# III. METHODOLOGY

## Strength Tests on Concrete:

### I. Compressive Strength test:

The compressive strength tests on concrete are carried out on a compression testing machineaccompanied by a range of 2.5 KN/s. The specimen utilised is a 150 mm cube and is cast and cured for 7,14, 28, days. The specimens are tested after taking the cubes from the curing tank in surface dry condition.

### II. Split Tensile strength test:

The split tensile strength test is executed on a universal testing machine accompanied by a range of 2.5KN/s. A cylinder specimen of 150mm dia and 300 mm height are cast and cured for 7,14and 28 days. The specimens are tested after taking out from curing tanks in surface dry condition.

**Experimental Program:**

The major goal of this experiment is to determine the effect of replacing sand with granite powder waste in percentages of 0 %, 5%, 10% and 15% on the hardened qualities of cement concrete. The casting, curing, and testing of specimens are all part of the experimental effort. The experiments are carried out for each percentage, with Mix 1 being the reference mix with 0% granite powder (GP), Mix 2 being with 5% granite powder replacement, mix 3 being 10% GP, mix 4 being 15% GP.

The trials are all carried out at room temperature. The dry materials for concrete, namely cement, fine aggregate, and coarse aggregate, are combined first. Granite powder is used as a partial replacement for natural sand, followed by the addition of a calculated amount of water and thorough mixing to achieve a uniform mix. Concrete cubes are compacted on table vibrator. Layers of concrete are utilized for compressive strength testing and are cured in water as in Fig. for 28 days before being tested on a compressive testing machine (CTM)

Fig 3.1: Compressive Strength Test

Fig 3.2 curing of cubes and cylinders

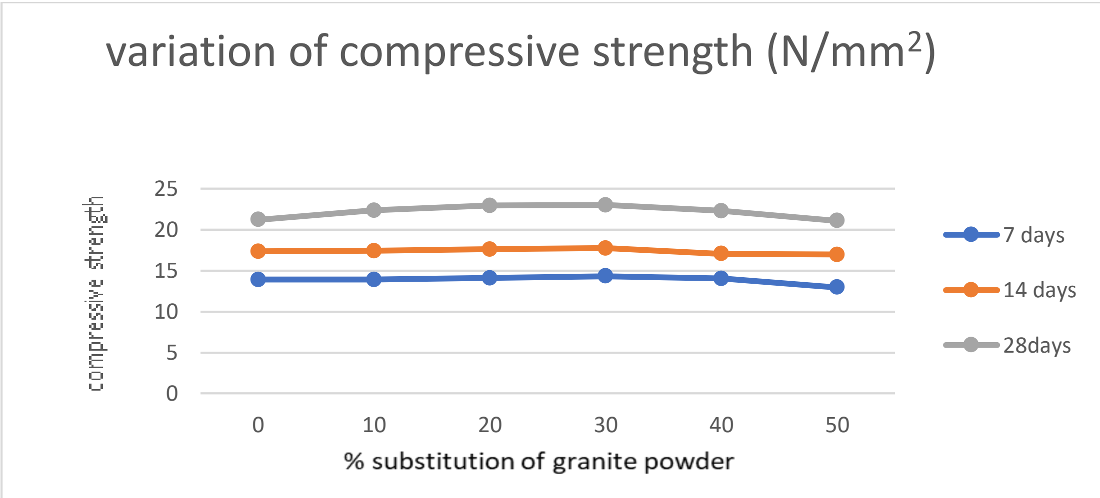
## IV. Results and Discussions

The Table 5 and fig 1 illustrates the compressive strengths of concrete of grades M20 with 25% weight substitution of cement with RHA and (0%,10%,20%, 30%, 40%, and 50%) fine aggregate with granite powder, not subjected to chemical attack.

**Table 5**

**Average Compressive Strength of Cubes (M20)**

| % of substitution of RHA | % of substitution of Granite powder | Compressive strength (N/mm$^2$) | | |
|---|---|---|---|---|
| | | 7 days | 14 days | 28days |
| 0 | 0 | 13.89 | 17.36 | 21.22 |
| 25 | 10 | 13.90 | 17.41 | 22.36 |
| 25 | 20 | 14.10 | 17.60 | 22.95 |
| 25 | 30 | 14.32 | 17.73 | 23.02 |
| 25 | 40 | 14.03 | 17.04 | 22.30 |
| 25 | 50 | 12.96 | 16.94 | 21.10 |




GRAPH-1: Compressive strength of M20 Concrete (N/mm2)

**Description of Results:**

1. From graph-1. the compressive strength of concrete is increased gradually from 20% to 40% and attained a maximum value at a substitution of 25% of RHA and 30% of substitution of granite powder

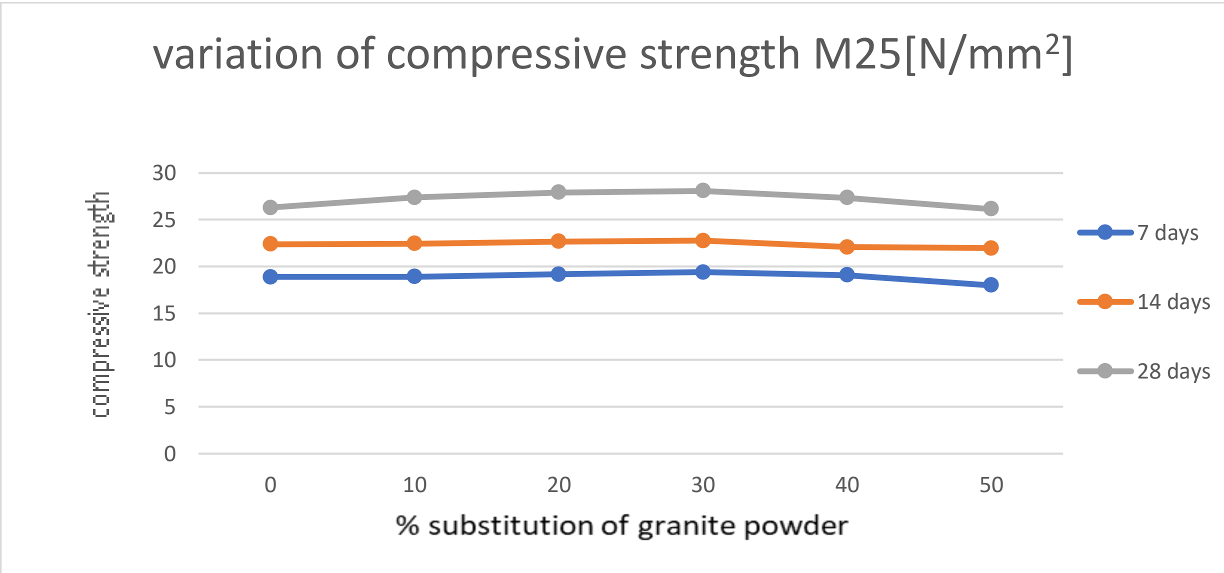
2. However compressive strength of concrete for the partial substitution of cement with RHA and fine aggregate with granite powder at 40% obtained more compressive strength. So that substitution of cement with RHA and fine aggregate with granite powder is finalized at 30% for their substitution as per my experiment result.

Table 5 and Graph 1 demonstrate the compressive properties of M25 concrete with a weight of 25% for cement substitution with RHA and fine aggregates (0%, 10%, 20%, 30%, 40% and 5%) with granite powder.

**Table 6**

**Average Compressive Strengths of Cubes (M25)**

| % of Replacement ofRHA | %ofReplacementof Granitepowder | Compressive strength (N/mm$^2$)(M25) | | |
|---|---|---|---|---|
| | | 7days | 14 days | 28days |
| 0 | 0 | 18.75 | 23.2 | 26.4 |
| 25 | 10 | 22.5 | 24.5 | 27.6 |
| 25 | 20 | 25.4 | 26.2 | 28.3 |
| 25 | 30 | 26.3 | 27.4 | 29.8 |
| 25 | 40 | 21.5 | 23.2 | 24.4 |
| 25 | 50 | 21.2 | 22.3 | 24.17 |




GRAPH-2: Compressive strength of M25 Concrete (N/mm2)

**Description of Results:**

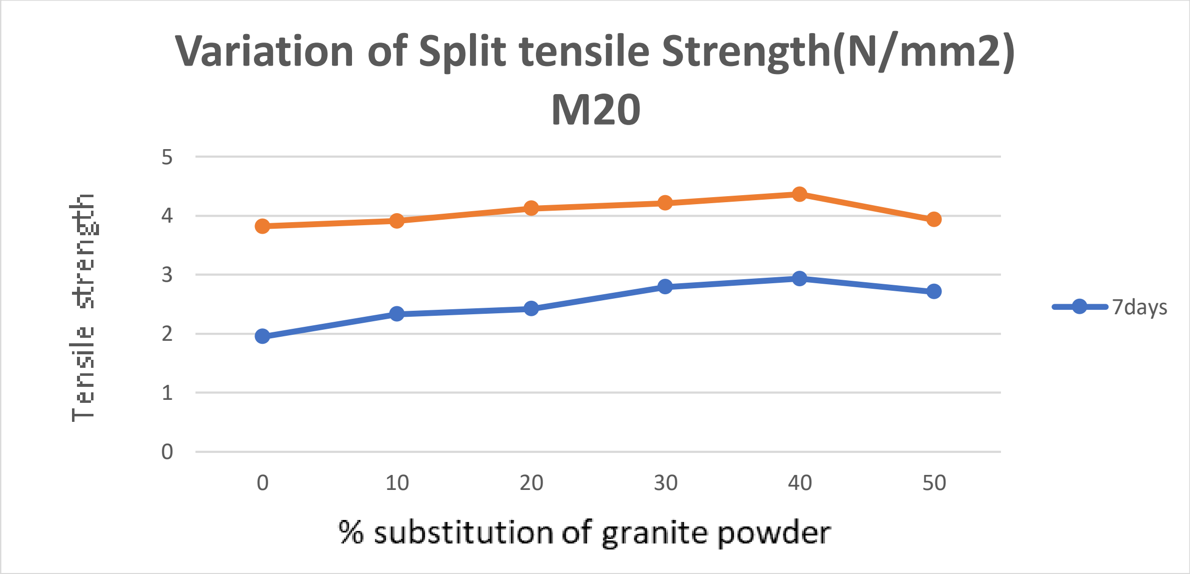
1. From graph-2. the compressive strength of concrete is increased gradually from 20% to 40% and attained a maximum value at a substitution of 25% of RHA and 30% of substitution of granite powder

2. However compressive strength of concrete for the partial substitution of cement with RHA and fine aggregate with granite powder at 40% obtained more compressive strength. So that substitution of cement with RHA and fine aggregate with granite powder is finalized at 30% for their substitution as per my experiment result

**Table 7**

**Average split tensile Strengths of Beams (M20)**

| % of substitution of RHA | % of substitution of Granite powder | Split tensile strength (N/mm$^2$) (M20) | | |
|---|---|---|---|---|
| | | 7days | 14days | 28days |
| 0 | 0 | 1.64 | 1.80 | 2.08 |
| 25 | 10 | 1.76 | 2.01 | 2.18 |
| 25 | 20 | 2.25 | 2.56 | 2.89 |
| 25 | 30 | 2.74 | 2.83 | 3.17 |
| 25 | 40 | 2.82 | 2.86 | 3.99 |
| 25 | 50 | 1.98 | 2.14 | 2.26 |



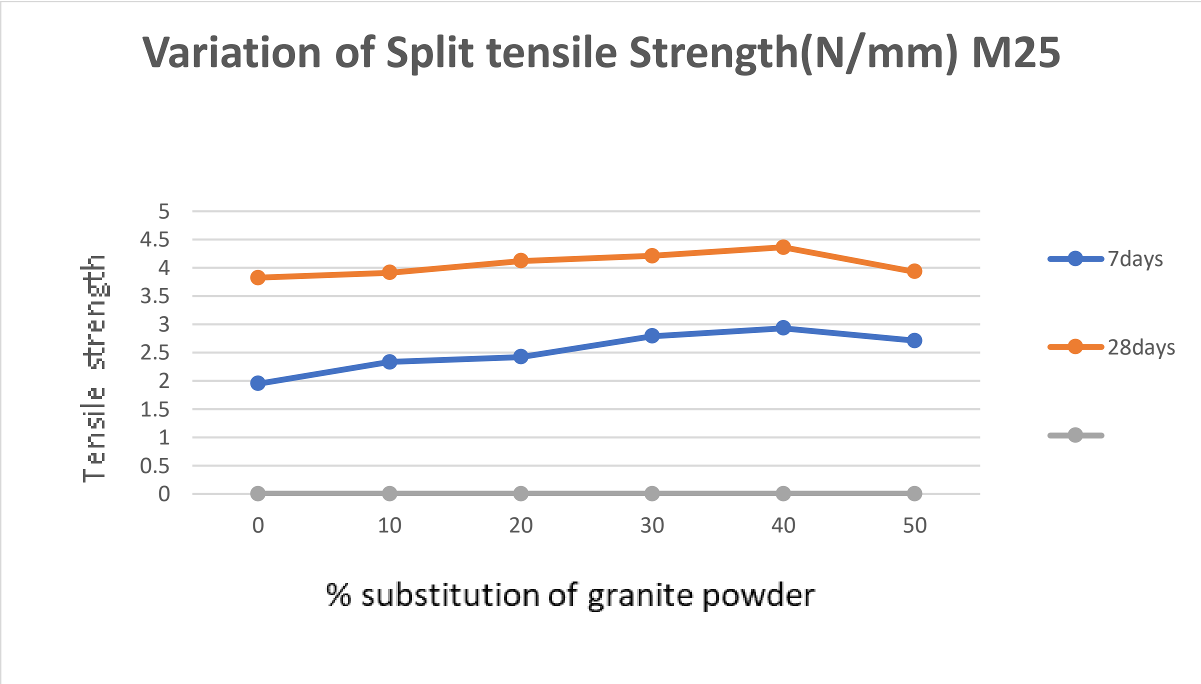

**Description of Results:**

1. The split tensile tensile strength of concrete is progressively raised from 20% to 40% and reached a maximum value at the substitution of 25% RHA and 30% granite powder substitution
2. The split tensile tensile strength with the partial substitution of cement with RHA, and the fine granite powder aggregate, however, attained more divided tensile strength at 40 percent. The cement substitution with RHA and fine aggregate with granite powder was done at 30 percent for substitution, according to my test results

**Table 8**

**Average split tensile Strengths of Beams (M25)**

| **% of substitution of RHA** | **% of substitution of Granite powder** | **Split tensile strength (N/mm$^2$) (M25)** | | |
|---|---|---|---|---|
| | | **7days** | **14days** | **28days** |
| 0 | 0 | 1.75 | 1.91 | 3.30 |
| 25 | 10 | 1.98 | 2.04 | 3.67 |
| 25 | 20 | 2.56 | 2.62 | 3.78 |
| 25 | 30 | 2.73 | 2.79 | 3.85 |
| 25 | 40 | 2.84 | 2.93 | 3.97 |
| 25 | 50 | 2.52 | 2.74 | 3.65 |

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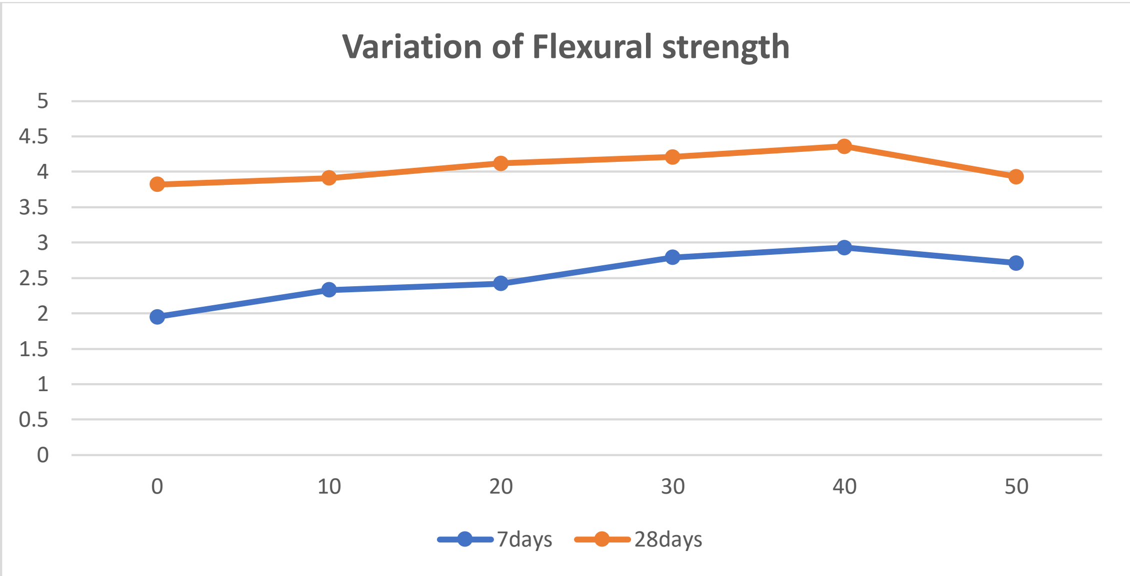
1. The split tensile tensile strength of concrete is progressively raised from 20% to 40% and reached a maximum value at the substitution of 25% RHA and 30% granite powder substitution
2. The split tensile tensile strength with the partial substitution of cement with RHA, and the fine granite powder aggregate, however, attained more divided tensile strength at 40 percent. The cement substitution with RHA and fine aggregate with granite powder was done at 30 percent for substitution, according to my test results.

The Table 9 and fig 5 illustrates the flexural strengths of concrete of grades M20 with 25% weight substitution of cement with RHA and (0%,10%,20%, 30%, 40%, and 50%) fine aggregate with granite powder, not subjected to chemical attack.

**Table 9**
**Average Flexural Strengths of Beams (M20)**

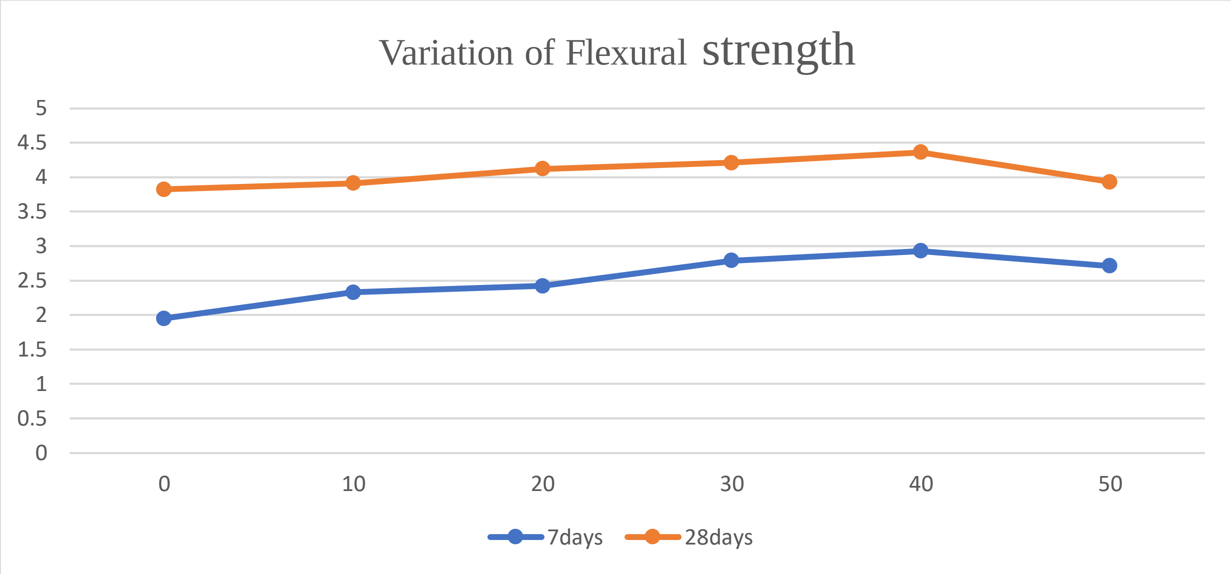
| % of substitution of RHA | % of substitution of Granite powder | Flexural strength ($N/mm^2$) (M20) | |
|---|---|---|---|
| | | **7days** | **28days** |
| 0 | 0 | 1.95 | 3.32 |
| 25 | 10 | 2.44 | 3.67 |
| 25 | 20 | 2.58 | 3.78 |
| 25 | 30 | 2.79 | 3.85 |
| 25 | 40 | 2.96 | 3.93 |
| 25 | 50 | 2.78 | 3.73 |




The Table 10 and fig 6 illustrates the flexural strengths of concrete of grades M20 with 25% weight substitution of cement with RHA and (0%,10%,20%, 30%, 40%, and 50%) fine aggregate with granite powder, not subjected to chemical attack.

**Table 10**
**Average Flexural Strengths of Beams (M25)**

| % of substitution of RHA | % of substitution of Granite powder | Flexural strength ($N/mm^2$) (M25) | |
|---|---|---|---|
| | | **7days** | **28days** |
| 0 | 0 | 1.95 | 3.82 |
| 25 | 10 | 2.33 | 3.91 |
| 25 | 20 | 2.42 | 4.12 |
| 25 | 30 | 2.79 | 4.21 |
| 25 | 40 | 2.93 | 4.36 |
| 25 | 50 | 2.71 | 3.93 |

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1. The flexural tensile strength of concrete is progressively raised from 20% to 40% and reached a maximum value at the substitution of 25% RHA and 30% granite powder substitution
2. The flexural tensile strength with the partial substitution of cement with RHA, and the fine granite powder aggregate, however, attained more divided tensile strength at 40 percent. The cement substitution with RHA and fine aggregate with granite powder was done at 30 percent for substitution, according to my test results.

## Conclusions

The following conclusions would be taken from the study of the experimental observations and discussions.

1) Comparative study on waste granite powder concrete with various percentage substitutions of granite powder showed that substitution percentage of 30% shows better results in terms of compressive and flexural tensile strengths substitution of 40% in terms of flexural strength
2) Utilization of Rice husk ash and Waste granite powder together can be utilised to manufacture conventional concrete
3) By using granite powder, the following advantages can be achieved:
   i. Cost reduction
   **ii.** Utilization of waste material is possible in construction by using granite powder a partial substitution material for fine aggregate in concrete

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