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Study on Mechanical Properties of Granite Powder and Foundry Sand Replaced with Natural Sand in Concrete

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Abstract: Concrete is the most widely used construction material on the planet. And day by day varied transformation is taking place in the type and quality of concrete being used. Quality in terms of better fresh and hardened properties of concrete is the main necessities for construction of structures. In the present study, sand in normal concrete was replaced with Granite powder and foundry sand by 10%, 15%, 20% and 25% by weight respectively. Specimens of each mix with a varying percentage of granite powder and foundry slab separately (10%, 15%, 20% and 25%) as a replacement tonatural sand was prepared and were tested for compressive, flexure and split tensile strength.

Keywords: Granite Powder, Foundry Sand, Mechanical properties

I. INTRODUCTION

Worldwide cement concrete is the main construction material, with the global trend towards preserving changing environment, the concrete must be such that it can conserve resources, protect the environment, economize and lead to proper utilization of energy. To achieve this, major emphasis must be laid on the use of wastes and byproducts in cement and concrete used for new constructions. Sand is one of the key ingredients of concrete and naturally available in abundance due to which threat to illegal mining as enhanced. In view use of non-conventional materials sand as waste foundry sand, granite powder, etc could be an alternative to overcome the problem. In this study granite powder and foundry sand are replaced with natural sand in concrete.

II. RELATEDWORK

- A. In 2013 G. Prince Arulraj et al.cited that the study Granite powder was added to replace sand by its weight with percentages of 0, 5, 10, 15, 20 and 25% respectively. 0.5% of Super plasticizer was added to improve the workability of concrete. Mixes of grade M20, M30, M40 were made with different percentages of the replacements as per Indian Standard 10262: 2009..
- B. In 2011, Baboo Rai et al. studied the properties like workability, compressive and flexural strength of the concrete by varying the ratio of marble powder as a replacement in concrete mix of M30 grade as the weight of cement at one time then as the weight of sand. Percentages of replacement were 0%, 5%, 10%, 15% and 20% and properties of specimen were tested after 7, 14 and 28 days respectively.
- C. In 2010, T. Felixkalaand et al. cited that the percentage of granite powder added by weight was 0, 25, 50, 75 and 100 as a replacement of sand used in concrete and cement was replaced with 7.5% silica fume, 10% fly ash, 10% slag and 1% super plasticizer. Of all the 6 mixtures considered, concrete with 25% of granite powder (GP25) was found to be superior to other mixtures
- D. In 2001,Naik et al. studied the concrete mixtures with a ratio of used foundry sand to regular sand between 20% and 40%, and up to 25% cementitious materials replacement with Class C fly ash. They found that the 40% foundry sand mixes showed slightly higher strength than the control mix. The effect of the foundry sand and fly ash on the flexural strength of the concrete mixes was similar to that observed for the compressive strength, while the modulus of elasticity was not considerably affected. Both concrete mixes exhibited high abrasion resistance.
- E. In 2010, Guney et al.also studied the effect of waste foundry sand on the splitting tensile strength of concrete as partial replacement of fine aggregates. The study concluded that the splitting tensile strength (TS)at replacement of 5% and 15% WFS was found to be lower than that of the control sample; the specimens at 10% replacement of WFS have slightly higher than control mix.
- F. In 2010, Etzeberria et al. used separately chemical foundry sand and green foundry sand to determine their effect on the splitting tensile strength (TS) of concrete. The study uses 53%chemical foundry sand and 42 % green foundry sand in partial replacement of fine aggregate. Tensile strength of concretes made with chemical foundry sand and green sand was found to be the same strength of 2.9 MPa.

III. EXPERIMENTAL PROGRAMME

A. Materials

Granite belongs to igneous rock family. Granite powder was obtained from the polishing units and easily available. Foundry sand can be found in the workshop of automobile industry. The aggregates (coarse and fine) are obtained from Pathankot. For approval of source of supply, aggregates were tested for specific gravity, water absorption, deleterious material and organic impurities. Ordinary Portland cement (OPC-43 grade) as per IS: 12269- 1987 was used for the making concrete mixtures.

B. Development of Concrete Mix

Mix design of concrete to be prepared as per IS: 10262-1982 - M30 grade of concrete. First of all, a standard grade M30 concrete sample is to be prepared as a reference. Specimens of each mix with a fixed proportion granite powder and foundry sand separately (10%, 15%, 20% and 25%) as a replacement to sand prepared from the selected mix proportion were tested for compressive, flexure and split tensile strength. For each mix three samples are prepared and tested at the age of 7 and 28 days moist curing. Trial mixes were prepared by incorporating different replacement percentage of granite powder and foundry sand. The water/cement ratio was fixed to 0.43.

IV. RESULTS AND DISCUSSION

A. Fresh Concrete Behavior

Rheological properties were determined: slump flow test was executed to evaluate fresh properties of concrete. The cohesiveness and the absence of segregation of the mixtures were visually estimated.

Slump flow value is achieved were shown in Table-1 below.

Table-1: Slump flow Test with varying % age of Granite Powder and Foundry Sand

With Granite Powder	Slump (mm)	With Foundry Sand	Slump (mm)
0%	81	0%	84
2.5%	84	2.5%	86
5%	87	5%	88
7.5%	89	7.5%	90
10%	91	10%	93

From the Table- 1 it can be seen that the slump flow within the design mix range

B. Effect on Compressive Strength

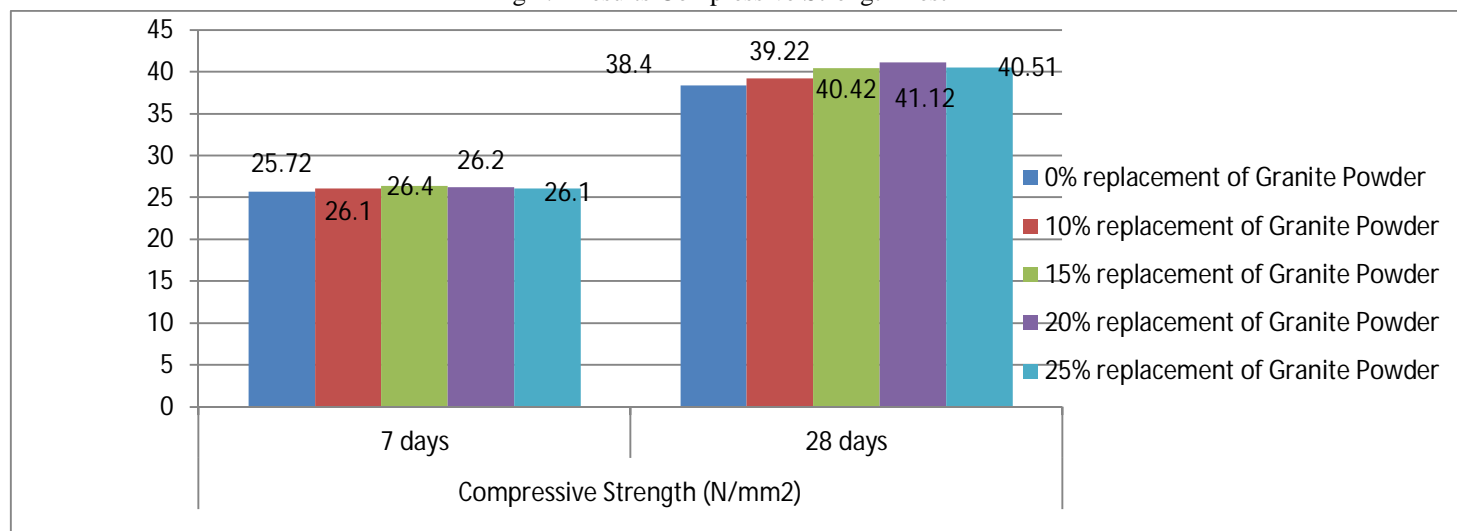
For compressive strength concrete cubic samples (150×150×150 mm) were casted and cured for 28 days. The results of compressive strength are shown in table-1 below:

- Compressive Strength:** In this plain concrete and with varying proportion of Granite powder as a fine aggregate material concrete was taken. The specimens of size 150×150×150 mm were cast and tested for its compressive strength at 2 different curing periods which is 7 and 28 days as given in the Table 2.1 and plain concrete and foundry sand as a fine aggregate material were cast and tested for its compressive strength at 2 different curing periods which is 7 and 28 days as given in the Table 2.2. The results obtained from the tests are represented as under in tabular form.

Table 2.1: Compressive Strength for Cube 150x150x150 mm

Mix Sample	Average Compressive Strength (N/mm ²)	
	7 days	28 days
0% replacement of Granite Powder	25.72	38.40
10% replacement of Granite Powder	26.10	39.22
15% replacement of Granite Powder	26.40	40.42
20% replacement of Granite Powder	26.20	41.12
25% replacement of Granite Powder	26.10	40.51

Fig 1.1 Results Compressive Strength Test

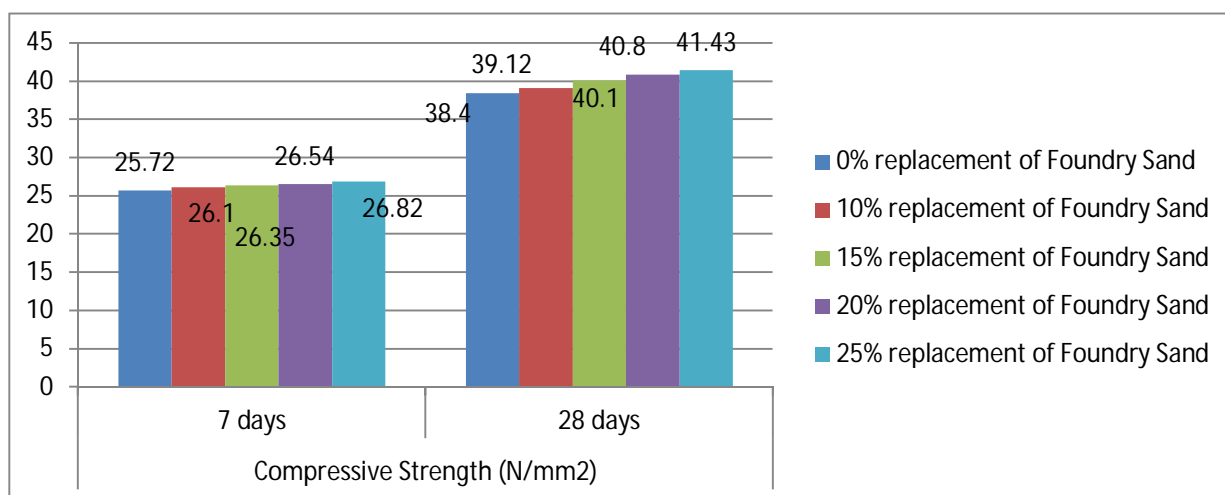


The comparison was done only between plain concrete and concrete with varying replacement proportion of granite powder in concrete for its compressive strength. The values of compressive strength at 7 days and 28 days are represented in Fig 1.1. Concrete made with replaced with 20 % granite powder showed maximum compressive strength among all other concrete samples.

Table 2.2: Compressive Strength for Cube 150x150x150 mm

MixSample	Average Compressive Strength (N/mm ²)	
	7 days	28 days
0% replacement of Foundry Sand	25.72	38.40
10% replacement of Foundry Sand	26.10	39.12
15% replacement of Foundry Sand	26.35	40.10
20% replacement of Foundry Sand	26.54	40.80
25% replacement of Foundry Sand	26.82	41.43

Fig.1.2 Results Compressive Strength Test



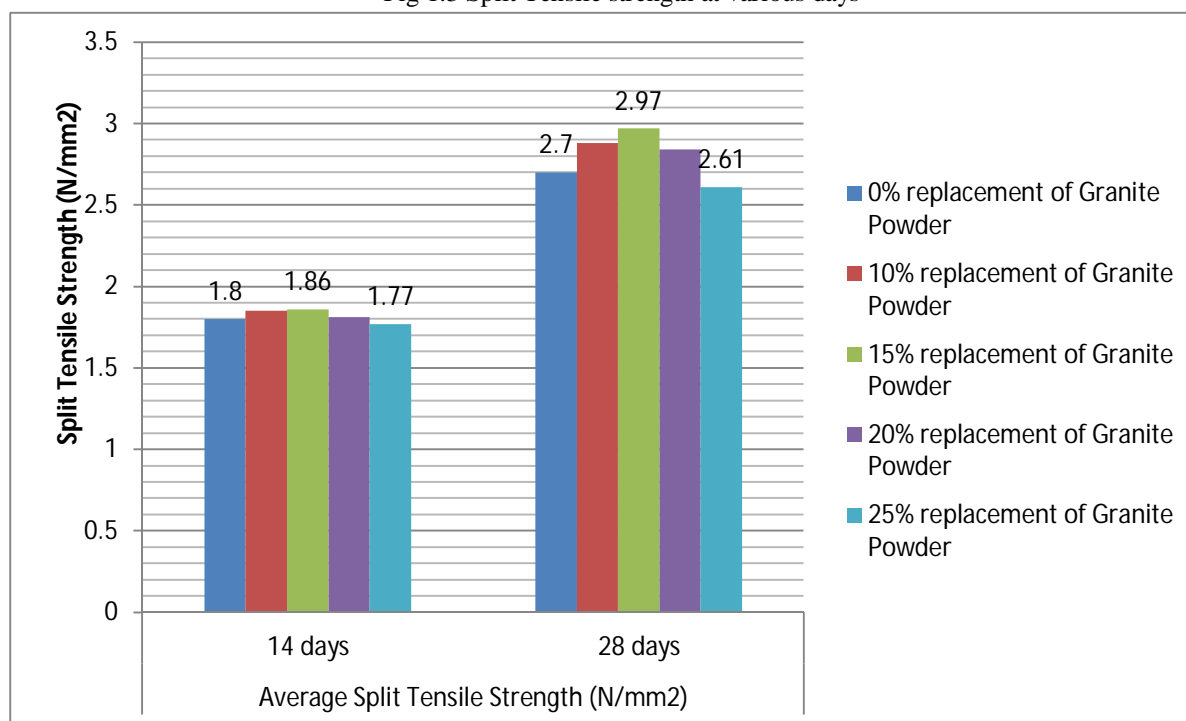
The comparison was done only between plain concrete and concrete with varying replacement proportion of foundry sand in concrete for its compressive strength. The values of compressive strength at 7 days and 28 days are represented in Fig 1.2. Concrete made with 25 % foundry sand showed maximum compressive strength among all other concrete samples.

2) Split Tensile Strength

Table 2.3: Results of Split Tensile Strength Test

MixSample	Average Split Tensile Strength (N/mm ²)	
	14 days	28 days
0% replacement of Granite Powder	1.80	2.70
10% replacement of Granite Powder	1.85	2.88
15% replacement of Granite Powder	1.86	2.97
20% replacement of Granite Powder	1.81	2.84
25% replacement of Granite Powder	1.77	2.61

Fig 1.3 Split Tensile strength at various days

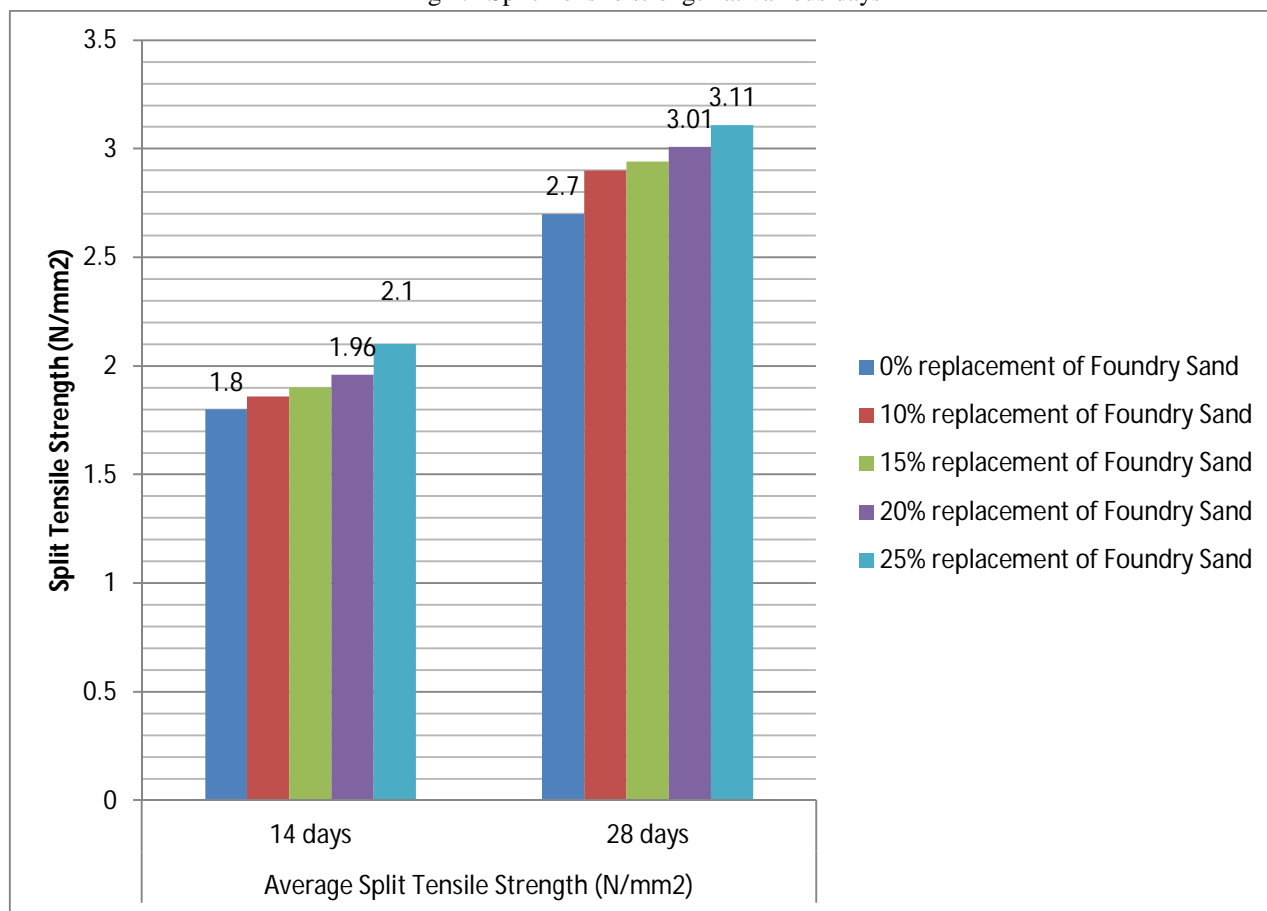


Split tensile strength kept on increasing up to 15% percentage replacement of sand with granite powder in the designed mix and then it fall down for rest of the two percentage replacements i.e. 20 and 25%. Maximum split tensile strength was observed at 15 % replacement.

Table 1.4: Results of Split Tensile Strength Test

MixSample	Average Split Tensile Strength (N/mm ²)	
	14 days	28 days
0% replacement of Foundry Sand	1.80	2.70
10% replacement of Foundry Sand	1.86	2.90
15% replacement of Foundry Sand	1.90	2.94
20% replacement of Foundry Sand	1.96	3.01
25% replacement of Foundry Sand	2.10	3.11

Fig 1.4 Split Tensile strength at various days



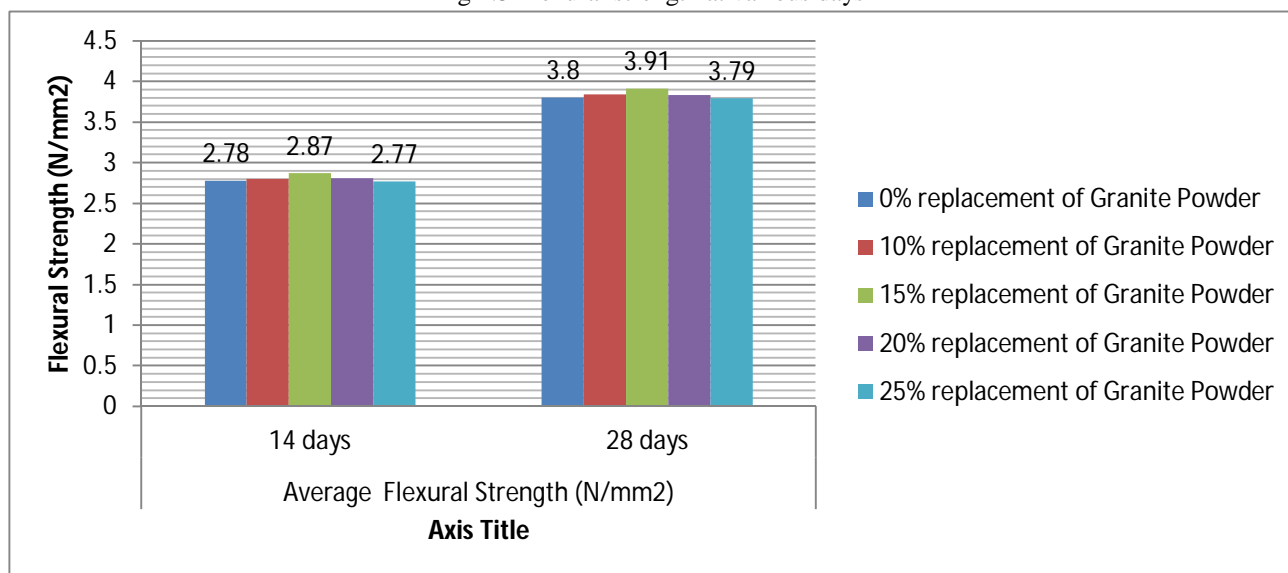
Split tensile strength kept on increasing with an increase in the percentage of foundry sand in the designed mix. Maximum split tensile strength was observed at 25 % replacement.

3) *Flexural Strength*: The Flexural strength of concrete is the ability of concrete beam or slab to resist failure in bending.

Table 1.5: Results of Flexural Strength Test

MixSample	Average Flexural Strength (N/mm ²)	
	14 days	28 days
0% replacement of Granite Powder	2.78	3.80
10% replacement of Granite Powder	2.80	3.84
15% replacement of Granite Powder	2.87	3.91
20% replacement of Granite Powder	2.81	3.83
25% replacement of Granite Powder	2.77	3.79

Fig 1.5 Flexural strength at various days

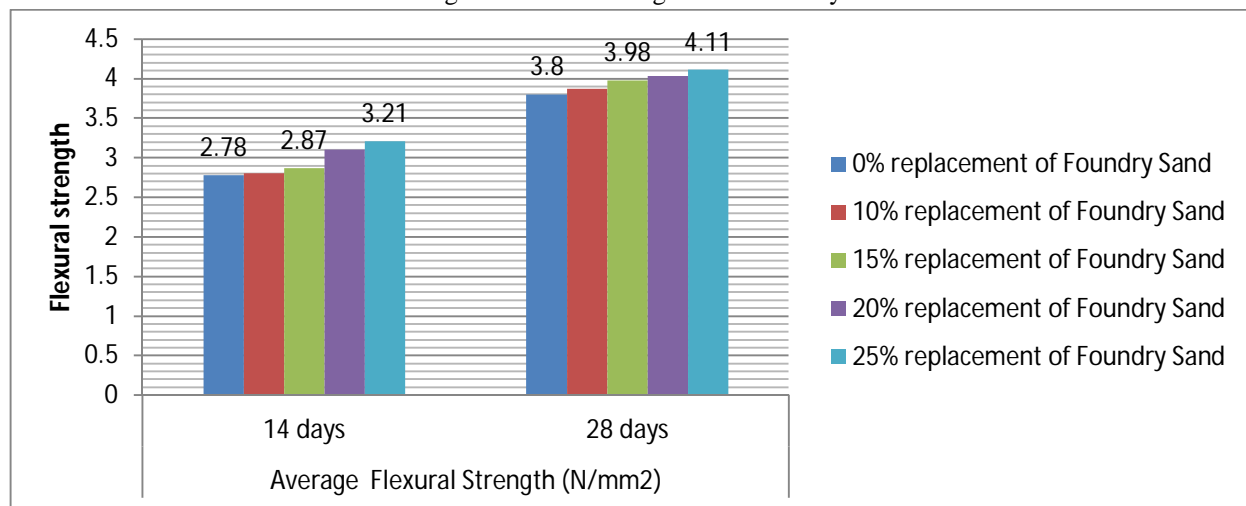


Flexural strength kept on increasing up to 15% percentage replacement of sand with granite powder in the designed mix and then it fall down for rest of the two percentage replacements i.e. 20 and 25%. Maximum flexural strength was observed at 15 % replacement.

Table 1.6: Results of Flexural Strength Test

MixSample	Average Flexural Strength (N/mm ²)	
	14 days	28 days
0% replacement of Foundry Sand	2.78	3.80
10% replacement of Foundry Sand	2.80	3.87
15% replacement of Foundry Sand	2.87	3.98
20% replacement of Foundry Sand	3.10	4.03
25% replacement of Foundry Sand	3.21	4.11

Fig 1.6 Flexural strength at various days



Flexural strength kept on increasing with an increase in the percentage of foundry sand in the designed mix. Maximum flexural strength was observed at 25 % replacement.

V. CONCLUSIONS

From the results and analysis of this experimental work, carried out, the following conclusions were arrived:

- A. The compressive strength increases as compared to reference mix as the varying percentage of granite is increased up to 20% and then it is slightly decreased for 25% and of foundry sand the strength of design mix goes on increasing for its varying percentage with respect to reference mix.
- B. All the trial mixes has shown different results rather than desired compressive strength for granite powder + foundry sand.
- C. The percentage increase of compressive strength at 7 days for 10%, 15 %, 20 and 25% granite powder is 1.47%, 2.64%, 1.86% and 1.47% and at 28 days it was 2.13%, 5.26%, 7.08% and 5.49% respectively.
- D. The percentage increase of compressive strength at 7 days for 10%, 15 %, 20 and 25% foundry sand is 1.47%, 2.44%, 3.18% and 4.27% and at 28 days it was 1.87%, 4.42%, 6.25% and 7.87% respectively.
- E. Split tensile strength and Flexural strength kept on increasing up to 15% percentage replacement of sand with granite powder in the designed mix and then it fall down for rest of the two percentage replacements i.e. 20 and 25%. Maximum split tensile strength was observed at 15 % replacement
- F. Split tensile and Flexural strength kept on increasing with an increase in the percentage of foundry sand in the designed mix. Maximum flexural strength was observed at 25 % replacement.
- G. The study illustrate that it is possible to design M-30 grade of concrete using granite powder and foundry sand as a replacement of natural sand.
- H. Use of using granite powder and foundry sand reduces the utilization of natural sand due to which illegal mining can be controlled.
- I. By adding using granite powder and foundry sand the problem of its disposal is eliminated and encroachment on the costly land and pollution is avoided.

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