

# Optimization of Granite and Iron Powder as Partial Replacement of Fine Aggregate in Concrete

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**ABSTRACT:** Now a days large number of studies are going on to improve the performance of concrete with the help of innovative chemical admixtures and supplementary materials. These materials used are majority by-products or industrial waste from other processes. This paper presents experimental investigations on effect of addition of industrial by products as partial replacement of fine aggregates on the mechanical properties of concrete such as compressive strength, split tensile strength and flexural strength. The fine aggregate has been replaced by granite and iron powder accordingly in the range of 5% increment level. Optimum value is obtained at 10% replacement level. Optimization is carried by 10% granite powder and various percentages of iron powder. At 20% replacement of iron powder better strength properties were obtained.

**KEYWORDS:** Granite powder, Iron powder, Compressive strength, Split tensile strength, Flexural strength

## I. INTRODUCTION

Fine aggregate is an essential component of concrete. The global consumption of natural river sand is very high due to the extensive use of concrete. In particular, the demand for natural river sand is quite high in developed countries owing to infrastructural growth. In this situation some developing countries are facing a shortage in the supply of natural sand. The non-availability of sufficient quantity of ordinary river sand for making cement concrete is affecting the growth of the construction industry in many parts of the country. Therefore, the construction industries in developing countries are under stress to identify alternative materials to reduce the demand on river sand. In order to reduce the dependence on natural aggregates as the main source of aggregates in concrete, artificially manufactured aggregates and artificial aggregates generated from industrial wastes provide an alternative for the construction industry. Some alternative materials have already been used in place of natural river sand. For example, fly ash, slag and lime stone, siliceous stone powder, rock dust and quarry waste were used in concrete mixture as a partial replacement of natural sand.

Granite powder, a waste material from the granite polishing industry, is a promising material for use in concrete similar to those of pozzolanic materials such as silica fume, fly ash, slag, and others. These products can be used as a filler material (substituting sand) to reduce the void content in concrete. Granite powder is an industrial by product obtained from crushing of granite stone and granite stone polishing industry in a powder form. It is also generated from recycling marble tops, terrazzo, granite pavers, and stone scraps and discards. If left on its own and is not properly collected and stored, Industrial wastes from the steel industry such as iron ore tailings and iron powder wastes from steel production can be hazardous to the environment. Stockpiling this material near production sites can result in soil and groundwater contamination. The results showed that both the compressive strength and tensile strength increased with the addition of iron fillings to the mix.

This study deals with fresh and hardened properties of normal concrete with partial replacement of fine aggregate by waste materials such as granite and iron powder. Super plasticizer also added to the mix in order to get workability.

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Fresh properties as slump can carry out. Hardened properties checked by conducting compressive strength, flexural strength test and split tensile strength.

## II. LITERATURE REVIEW

**G. Raja et.al** (2016) investigates experimental study on partial replacement of fine aggregate by granite powder in concrete. Replacement percentage of granite fines to fine aggregate are 0, 10, 20, 30, 40, 50 and 100. M20 mix proportion. Specimen casted with 40 % replacement of granite fines gives higher strength. **Rachit Saxena et.al** (2015) investigates effect on compressive strength of concrete with partial replacement of sand using iron slag. Fineness modulus of iron slag was 2.1 and black grey colour. Varying percentages of iron slag as 0%, 15%, 30%, 45%, 60%. Compressive strength increases up to 45% of iron slag. Workability of concrete decreases with increase in percentage of iron slag. **Karthik et.al** (2016) investigates experimental investigation on concrete with partially replacement of cement and fully replacement of sand. Fluorescent lamp powder as one of the new material into the concrete replaces the cement. Physical and chemical properties of fluorescent lamp powder satisfy the requirements of Ordinary Portland Cement. Replacement of the sand with quarry dust increases the workability. Increase of percentages of iron slag in the concrete mix, the compressive strength also increases. **N.Kiran Kumar et.al** (2015) investigates an experimental investigation on strength of granite-fines concrete. Weight ranging from 0 to 40% as a replacement of sand was used in concrete. Gravels of size 20 mm passing 10 mm retained are taken. The slump value increases with increase in % replacement of sand with granite fines for the same w/c ratio. Concrete mix with 30 % addition of granite fines proves to be better. **Prema Kumar W.P et.al** (2014) investigates effect of replacing sand by iron ore tailings on the compressive strength of concrete and flexural strength of reinforced concrete beams. Sand in cement concrete is successively replaced by 10%, 20%, 30%, 40%, 60%, 80% and 100% by iron ore tailing. The maximum increase in compressive strength occurs for about 40 percent of sand replacement. Greatly reduces the water and land pollution. **T. Felix Kala** (2013) investigates effect of granite powder on strength properties of concrete. Percentage of granite powder added by weight was 0, 25, 50, 75 and 100% as a replacement of sand. Cement was replaced with 7.5 % silica fume, 10% fly ash, 10% slag and the dosage of superplasticiser added 1% by weight of cement. Concrete specimens were prepared with w/c ratio of 0.25, 0.30, 0.35, for M60 grade concrete mix. Highest strength has been achieved in samples containing 25% granite powder together with admixtures. **Divakar. Y** (2012) investigates Y-experimental investigation on behaviour of Concrete with the use of granite fines. Strength behaviour of Concrete with the use of Granite Fines as an additive. Different proportions namely 5%, 15%, 25%, 35% and 50%. Overall increase in strength with 35% replacement of fine aggregates with granite fines. Water cement ratio has been considered for all the mixers as 0.6. Presence of Fe<sub>2</sub>O<sub>3</sub> is due to addition of iron grits we may have to give a protective coating to the concrete. **T. Felixkala et.al** (2010) investigates granite powder concrete. Percentage of granite powder added by weight was 0, 25, 50, 75 and 100 as a replacement of sand. Effects of water ponding temperatures at 26°C and 38°C with 0.4 water-to-binder (w/b) ratios. Increase in strength as the days of curing increases and decreases as the curing temperature increases. **Manasseh Joel** (2010) investigates use of crushed granite fine as replacement to river sand in concrete production. Concrete of grade 35 using. Size of the gravel used as coarse aggregate was 37.50mm. 0-100% replacement can be done. Water to cement ratio and slump value increased with the replacement of sand with crushed granite fine. 20% replacement gives better strength. **Kanmalai Williams C et.al** (2008) investigates mechanical properties of high performance concrete incorporating granite powder as fine aggregate. 0, 25, 50, 75 and 100% as a replacement of sand. Cement was replaced with 7.5% Silica fume, 10% fly ash, 10% slag and 1% superplasticiser. Water penetrability was about 5% less than the conventional concrete mixture. Shrinkage performance of these concrete is high.

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## III. MATERIAL DETAILS

### 3.1 Cement

Portland pozzolana cement conforming to IS: 269-1976 and IS: 7031-1968 was used in this study. The cement is of 53 grade and the tests conducted on cement are tabulated in Table No.1

Table 1.Properties of cement

Sl.No	Properties	Values obtained
1	Specific gravity	3.17
2	Standard consistency	30%
3	Initial setting time	71 minutes
4	Final setting time	310 minutes
5	Average compressive strength(Mpa)	56.4

### 3.2 Fine aggregate

The particle whose size ranges between 4.75mm and 150 microns are termed as fine aggregate. Their particle size distribution helps in higher packing density which enhances durability of the concrete.IS 383-1970 recognize manufacture sand as 'crushed stone sand' under clause2.

Table 2 Physical properties of fine aggregate

Sl.No	Properties	Values obtained
1	Specific gravity	2.79
2	Fineness modulus	3.178(Zone II)
3	Water absorption	2.8%
5	Moisture content	3.09%

### 3.3 Coarse aggregate

Aggregates are component of composite materials such as concrete gives strength to the overall composite material. Size of aggregate is usually greater than 4.75 mm. Nominal size of aggregate of 20 mm was used.

Table 3 Physical properties of coarse aggregate

Sl.No	Properties	Values obtained
1	Specific gravity	2.68
2	Water absorption	0.4%

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### 3.4 Granite powder

Granite is a common type of igneous rock. The rest of the portion which remains inside the earth undergoes cooling at a slow rate and results in formation of rock of crystalline variety known as granite. Its main constituent minerals are quartz, felspar and mica. Its colour depends upon that of felspar. Water absorption is less than 1.6% and finely grained granite takes a fine polish. Specific gravity is 2.72 and moisture content is 1.5%.



Fig.1 Granite powder

### 3.5 Iron powder

Iron slag is an industrial waste material. It is a by-product of the iron and steel making process. Specific gravity of iron powder is 2.58. Water absorption iron powder is 8.46%, higher than natural sand. Therefore mixes are weak in terms of liquidity. It confirms zone III.



Fig.2 Iron powder

### 3.6 Mix proportion

Mix design was done as per IS 10262:1982. Using trial and error method, the water cement ratio was adopted as 0.40. The superplasticizer dosage was adopted as 1.9% weight of cement. Also M<sub>30</sub> mix is used for this study.

Table 4. Material for 1m<sup>3</sup> of concrete

Cement	Coarse aggregate	Fine aggregate	Water	Admixture
400Kg	1044Kg	748Kg	5.8litre	64ml

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## IV. RESULTS AND DISCUSSIONS

### 4.1 Compressive strength results

It has been observed that the compressive strength of concrete replaced with granite powder increases as the amount of replacement increases up to a certain percentage (10% in the present study). The mix with 10% replacement of fine aggregate with granite powder showed an increase in compressive strength by 4.2%.

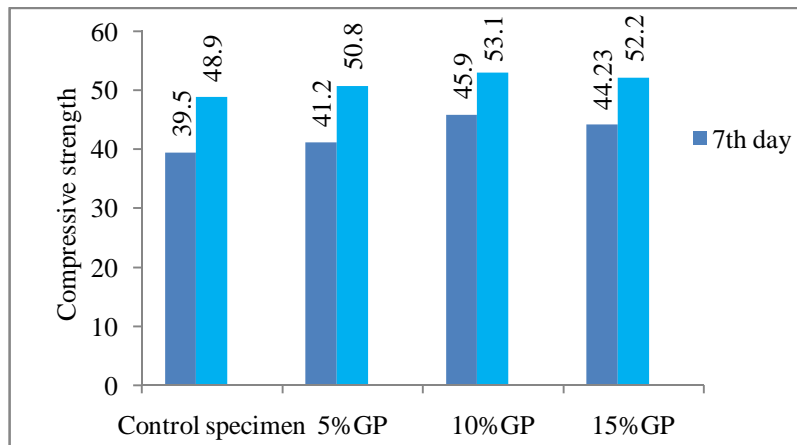


Fig 4 Variation of compressive strength (replacement by granite powder)

### 4.2 Split tensile strength results

The determination of tensile strength of concrete is necessary to determine the load at which the concrete members may crack. The cracking is a form of tension failure. The test consists of applying a compressive line load along the opposite generators of a concrete cylinder placed with its axis horizontal between the compressive platens.

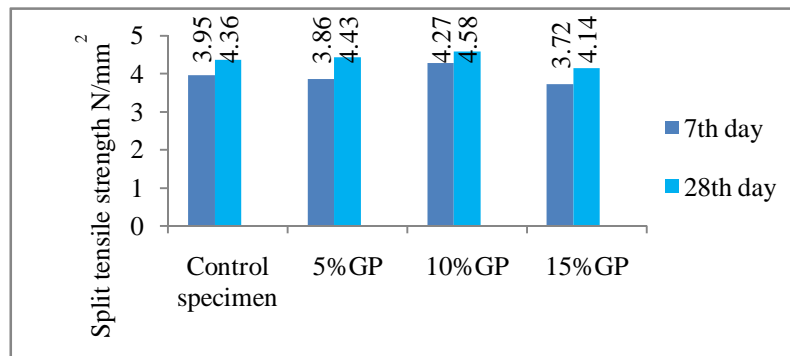


Fig 5. Variation of split tensile strength (replacement by granite powder)

Due to addition of granite powder, there is considerable improvement in tensile strength up to certain percentage. With the replacement of fine aggregate in concrete by granite powder, the concrete prepared is eco-friendly and cost effective. Maximum split tensile strength of 4.58 N/mm<sup>2</sup> was obtained at 10% replacement level. Even after the replacement of fine aggregate by 15%, the split tensile strength was lesser than control mix.

#### 4.3 Flexural strength test results

The determination of flexural strength is essential to estimate the load at which the concrete members may crack. Since it is difficult to determine the strength of concrete by conducting direct tension test, it is computed by flexure testing. The flexural tensile strength or modulus of rupture is determined by testing standard beam specimens of 10 x 10 x 50 cm over a span of 40 cm under symmetrical two point loading. The flexural strength is determined according to IS: 516 – 1975.

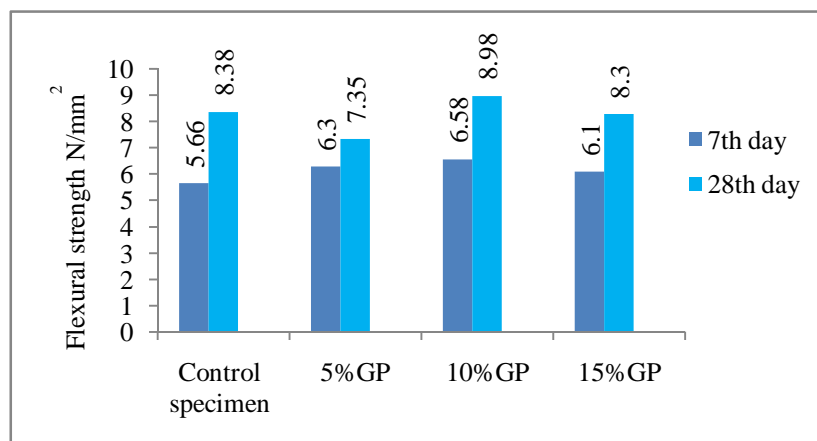


Fig.5.variation of flexural strength (replacement by granite powder)

Maximum flexural strength of 8.98 N/mm<sup>2</sup> was obtained at 10% replacement level. Even at 15% replacement level the flexural strength was similar to that control mix.

#### 4.4 Effect of iron powder after optimization with granite powder

In this present study, above results shows that replacement of fine aggregate using 10% granite powder shows higher strength So the optimization will carried out using 10% granite powder and varying percentages of iron powder. The replacement of iron powder varies at 5% increment level.

#### Evaluation of Cube compressive strength

It has been observed that the compressive strength of concrete replaced with granite and iron powder increases as the amount of replacement increases up to a certain percentage (10% GP+20% IP in the present study). Up to 20% replacement of iron powder, an increase in strength was observed, after that compressive strength decreased. The mix with 10% replacement of fine aggregate with granite powder and 20% showed an increase in compressive strength by 10.46%.The compressive strength of fine aggregate replaced with granite powder and iron powder is shown in fig 7.

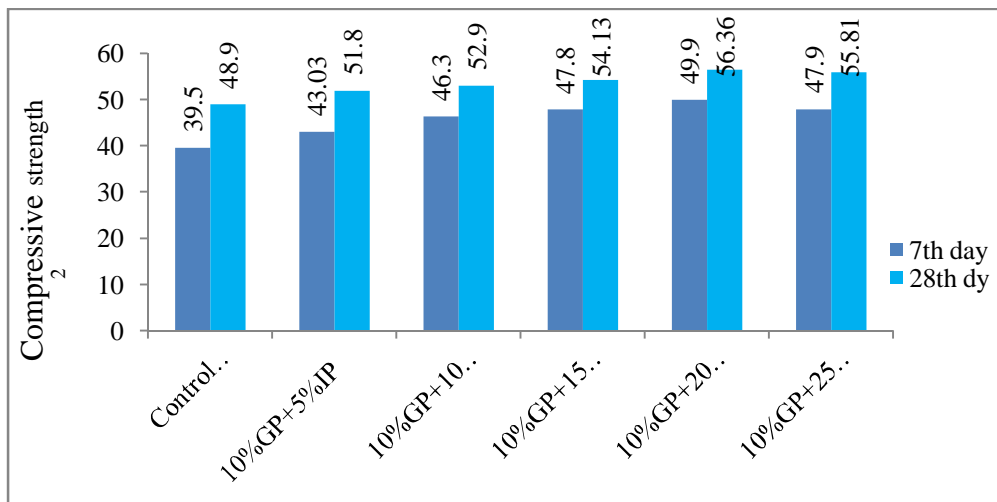


Fig 6 Variation of compressive strength (replacement by GP and IP)

### Evaluation of split tensile strength

Due to optimization of granite and iron powder, there is considerable improvement in tensile strength up to certain percentages. With the replacement of fine aggregate in concrete by granite and iron powder, the concrete prepared is eco-friendly and cost effective. Maximum split tensile strength of 4.72 N/mm<sup>2</sup> was obtained at 10% replacement with granite powder and 20% replacement with iron powder. The split tensile strength decreases after 20% replacement with iron powder.

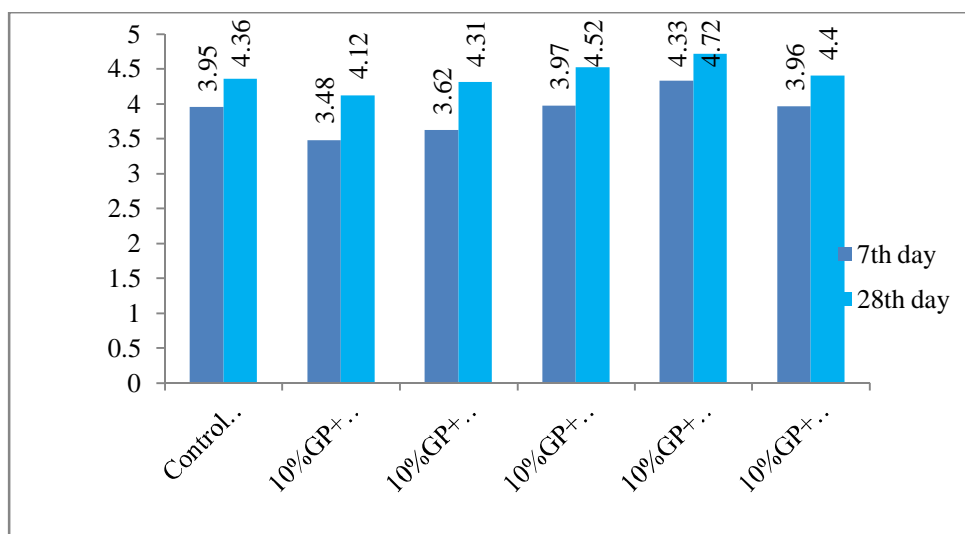


Fig 7 Variation of split tensile strength (replacement by GP and IP)

### Evaluation of flexural strength

When concrete was tested for flexural strength maximum value of 8.75 N/mm<sup>2</sup> was obtained at 20% replacement with iron powder. Again when the replacement level increased modulus of rupture decreased.

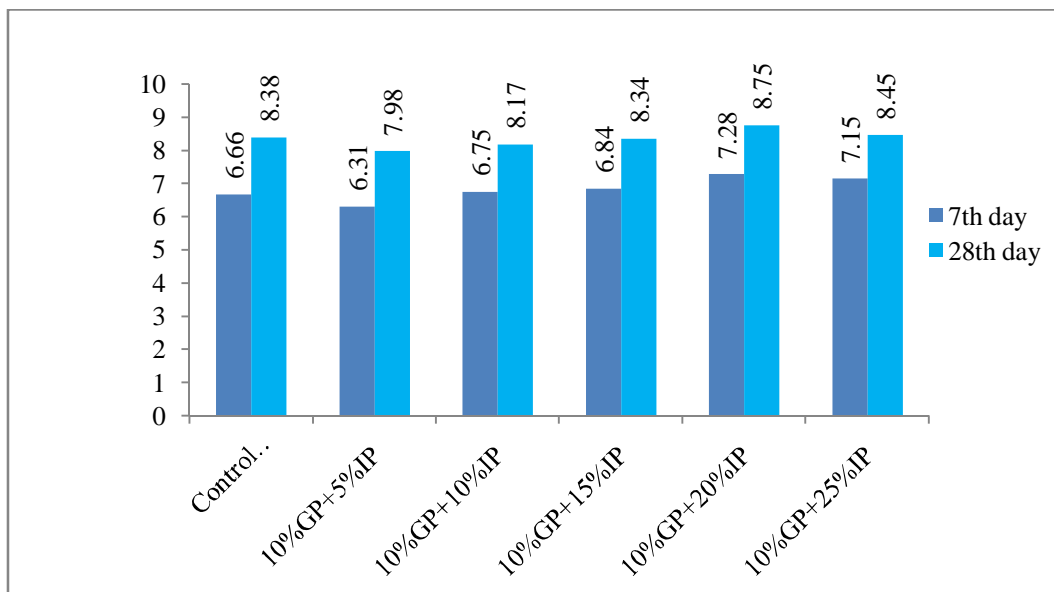


Fig 8 Variation of flexural strength (replacement by GP and IP)

### V. CONCLUSIONS

- (i) The replacement of fine aggregate is carried out at 5% increment level using granite and iron powder.
- (ii) The strength of concrete increases with increase in percentage of replacement with granite powder. Optimum value is obtained at 10% replacement level since increase in percentage of granite powder strength decreases and percentage increase in strength is 4.2.
- (iii) After optimization, replacement is carried out at various percentages of iron powder. The strength increases at 20% replacement and then decreases due to decrease in workability. Percentage increase in strength is 7.46.

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