ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Experimental Study on Effects of Polypropylene Fiber and Granite Powder in Concrete

Siddharth Sen
Post Graduate Student,
Department of Civil Engineering,
SRM University.

R.Nagavinothini
Assistant Professor(O.G),
Department of Civil Engineering,
SRM University.

ABSTRACT:

The paper deals with the effects of addition of various proportions of polypropylene fibers and granite powder on the properties of concrete. An experimental study was carried out to test for split tensile strength and compressive strength of concrete. Tests are conducted for finding the strength of the concrete in 7 days and 28 days strength. Finally the results are compared with the normal conventional concrete. The main aim of this investigation is first to prepare the strength of concrete of grade M25 with locally available ingredient and then to study the effect of different proportion of Polypropylene fiber and granite powder in the mix and to find the optimum range of Polypropylene fiber and Granite powder. The various proportions considered are 0.5%,1.0%,1.5% of fiber and 5%,10%,15% of granite powder in the mix.

Keywords:
Concrete, Polypropylene fiber (PP), Granite powder (GP), Fine aggregate(F.A),Coarse aggregate (C.A).

1. Introduction:

The development of new technology in the material science is progressing rapidly. In last three decades, a lot of research was carried out throughout globe to improve the performance of concrete in terms of strength and durability qualities. Consequently concrete has no longer remained a construction material consisting of cement, aggregate, and water only, but has becomes an engineered custom tailored material with several new constituents to meet the specific needs of construction industry. The growing use of concrete in special architectural configurations and closely spaced reinforcing bars have made it very important to produce concrete that ensures proper filling ability, good structural performance and adequate durability.

In recent years, a lot of research was carried out throughout the world to improve the performance of concrete in terms of its most important properties, i.e. strength and durability. Concrete technology has under gone from macro to micro level study in the enhancement of strength and durability properties from 1980 onwards.Fiber reinforcement in concretecan enhance many of the engineering properties of the basic materials, such as fracture toughness, flexural strength and resistance to fatigue, impact, thermal shock and spalling. Fibers have always been considered promising as reinforcement of cement based matrices because of their availability and low consumption of energy.

Short discrete vegetable fibres namely sisal, coir and jute have been examined for their suitability for incorporation in cement concrete. The physical properties of this fibre have shown no deterioration in a concrete medium Polypropylene (PP) is a thermoplastic polymer used in a wide variety of applications including packaging and labeling, textiles (e.g., ropes, thermal underwear and carpets), stationery, plastic parts and reusable containers of various types, laboratory equipment, loudspeakers, automotive components, and polymer banknotes.

As polypropylene is resistant to fatigue, most plastic living hinges, such as those on flip-top bottles are made from this material. However, it is important to ensure that chain molecules are orie 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. The granite waste generated by the industry has accumulated over years. Only insignificant quantities have been utilized and the rest has been dumped unscrupulously resulting in environment problem. nted across the hinge to maximize strength.

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With the enormous increase in the quantity of waste needing disposal acute shortage of dumping sites, sharp increase in the transportation and dumping costs, affecting the environment, preventing the sustainable development. The waste disposal problem is assuming serious. On the other hand, the non-availability of the sufficient quantity of ordinary river sand for the making of cement concrete is affecting the growth of construction industry in many parts of the country. Using granite powder as a partial replacement of sand can enhance the mechanical properties of concrete greatly such as compressive strength, split tensile strength and modulus of elasticity. Granite powder as a partial sand replacement has beneficial effects of the mechanical properties of concrete.

2. Experimental Program:

Materials Used:

Cement:

The cement used was Ordinary Portland cement (53Grade) conforming to IS: 12269–1987 with a specific gravity of 3.15. Initial and final setting times of the cement were 20 min and 265 min, respectively.

Fine Aggregate:

The sand used for experimental program was locally procured and conforming to zone II. The sand was first sieved through 4.75 mm sieve to remove any particles greater than 4.75 mm. The fine aggregates were tested as per Indian Standard Specification IS: 383-1970. The bulk density of sand was found out to be 1.6 g/cm3 and the specific gravity was found to be 2.6.

Coarse Aggregate:

The natural broken stone (coarse aggregate) used for the study was of 20mm size maximum. It is conforming to IS: 383-1970. It was retrieved from a local quarry near Chengalpattu, Kancheepuram District, and Tamil Nadu. The shape and quality of aggregate was uniform throughout the project work.

Granite Powder :

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 was obtained from the polishing units and the properties were found. The specific gravity of the granite powder was found to be 2.59.

Polypropylene Fiber:

In this project, Polypropylene was chosen, because it is not expensive, inert in high pH Cementious environment and easy to disperse. Polypropylene (PP) fibers have good ductility; hence, they can restrain plastic cracks. The polypropylene fibers increase concrete resistance to fire temperatures. Polypropylene fibers are mainly used to prevent formation of shrinkage cracks or, more precisely, to reduce micro cracking in a new concrete. Specific gravity of Polypropylene was found to be .91

3. Mix Design:

Mix design is done as per IS: 10262: 1982. In order to study the mechanical properties of polypropylene fiber and granite powder concrete,nine mix proportions were made. The percentage replacements of aggregates by PP and GP were 0.5%, 1%, and 1.5% for polypropylene and 5%, 10%and 15% percent. This was done to determine the proportion that would give the most favorable result. The 0% replacement was to serve as control for other sample which is finally used for the comparison. The mix proportions studied for the polypropylene fiber and granite powder concrete are totally 9 proportions as shown in Table 1.

Table 1: Mix proportions for M25 grade concrete

S No.	Mix	Polypropylene fiber	Granite Powder
1	M0	0%	0%
2	M1	0.5%	5%
3	M2	1%	5%
4	M3	1.5%	5%
5	M4	0.5%	10%
6	M5	1%	10%
7	M6	1.5%	10%
8	M7	0.5%	15%
9	M8	1%	15%
10	M9	1.5%	15%

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4.Mixing, compaction, preparation of specimen and curing:

For each mix, the required quantities of the constituents were batched by weight. The mix design is using maximum size of aggregate as 20mm conventional aggregate and Granite Powder with replacement of fine aggregate. The concrete is poured into the moulds in 3 layers by placing on vibrating table. The cast specimens are removed after 24 hours and these are immersed in a water tank. After curing 7 & 28 days the specimens are removed and these are tested for Compression, Split Tensile strength and the results compared with conventional concrete. The mix design is given in table 2 and the final mix proportion arrived is given in table 3.

Table 2: Mix design for M25

S. No	Content	Value
1	Target strength	33.745N/mm²
2	Water cement ratio	0.45
3	Entrapped air	2%
4	Water content per cubic meter	186 kg
5	Sand as percentage of total aggregate by absolute volume	31%
6	Water	197.16 kg
7	Cement	438 kg
8	Fine aggregate	527.26 kg
9	Coarse aggregate	1154.96 kg

Table 3: Mix proportion

Water	Cement	Fine aggregate	Coarse aggregate
197.16	438	527.26	1154.96
0.45	1	1.2	2.6

5.Test methods:

The cubes of 150x150x150 mm size and cylinders of 150mm dia. 300mm height were tested for Compression, and Split Tensile. Tests were done as per codes of Bureau of Indian Standards. The test for Compressive Strength on cubes were measured at 7 and 28 days of curing as per IS:516-1959, and test for Split Tensile Strength on cylinder was measured at 7 and 28 days of curing as per IS:5816-1999.

6.Results and Discussion:

The compressive strength test and split tensile strength test for all proportions of cubes and cylinders were carried out and the results are provided in table 4.

The comparative results of 7 days compressive strength is shown in figure 1 and 28 days compressive strength is shown in figure 2. The comparative results of 7 days split tensile strength is shown in figure 3 and 28 days split tensile strength is shown in figure 4.

Table 4: Averagetest results in for M25

Mix Type	Compressive Strength (N/mm²)		Split Tensile Strength (N/mm²)	
	7 days	28 days	7 days	28 days
M0	22.7	35.4	2.79	3.66
M1	28.7	35.8	2.82	3.84
M2	30.6	36.7	2.94	3.94
M3	33.3	37.1	2.99	4.32
M4	26.9	36.2	3.26	4.01
M5	27.06	38.04	3.52	4.05
M6	27.5	38.8	3.77	4.64
M7	22.9	38.4	3.5	4.15
M8	24.4	41.1	3.73	4.22
M9	28.2	42.3	4.15	5.15

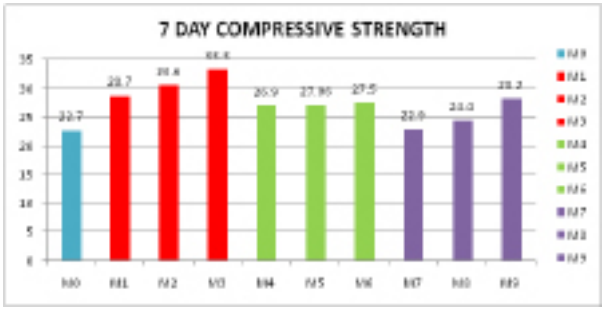

Figure 1:- 7Day Compressive Strength

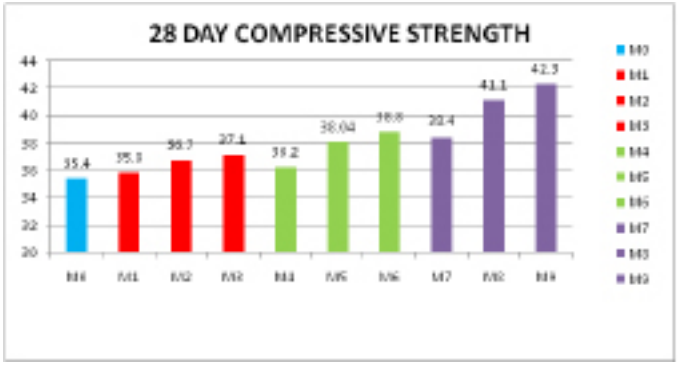

Figure 2:- 28Day Compressive Strength

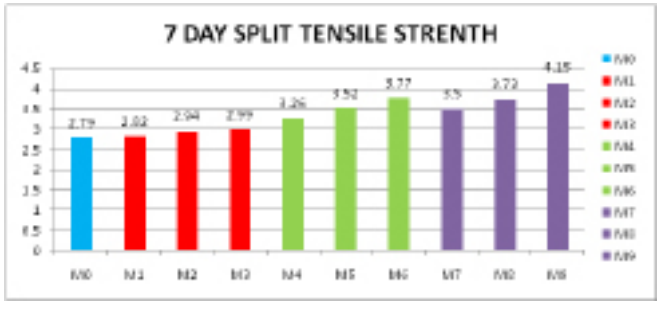

Figure 3:- 7Day Split Tensile Strength

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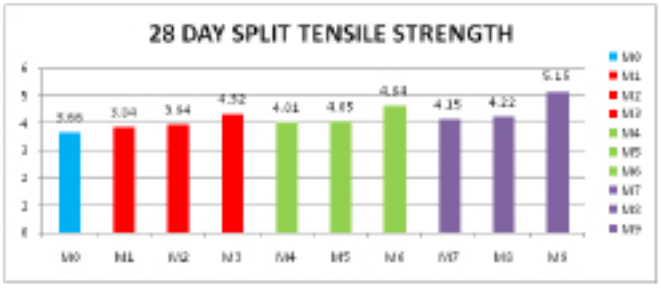

Figure 4:28DaySplit Tensile Strength

7. Conclusions:

As polypropylene is lightest fiber therefore the bulk density will be more so it will have a positive effect on the strength of concrete.The mechanical properties like the compressive strength, split tensile strength, for all proportions are higher than that of the reference mix. Granite powder usage will help in waste reduction caused due to waste generated by the granite cutting industry.Results of this investigation suggest that Polypropylene fiber and granite powder could be very conveniently used in structural concrete.The maximum value of split tensile strength and compressive strength is found at 1.5% PP and 15%GP.There is considerable amount of decrease in micro cracking of concrete. There is an appreciable increase in the 28 days compressive strength of concrete comparing to 7 days compressive strength, this indicates that the strength of the proportioned concrete increases with age.

8. Future Study:

In this experimental study, only a handful of trails were done. Polypropylene fiber percentage can be increased beyond 1.5% and its effects on concrete can be studied. Also sand replacement with granite powder can be increased beyond 15%. Various combinations of polypropylene fiber and granite powder can be studied to get the better results for compressive strength and split tensile strength of concrete. Also using polypropylene fiber and granite powder tests can be done for studying the effect on flexural strength of concrete.

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Authors Details:

Siddharth Sen
Post Graduate Student,
Department of Civil Engineering,
SRM University.

R.Nagavinothini
Assistant Professor(O.G),
Department of Civil Engineering,
SRM University.