Experimental Studies on Self Compacting Concrete with Partial Replacement of Cement and Sand by Granite Waste and Foundry Sand

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Abstract: The assurance of nature is a fundamental aspect, which is specifically associated with the survival of civilization. Parameters like ecological awareness, defense of natural resources, maintainable improvement assume a fundamental part in present day necessities for development. Remembering this, in this review the fresh and harden properties of self compacting concrete (SCC) utilizing granite waste as partial replacement for cementitious material along with foundry sand as partial replacement for fine aggregate and addition of polypropylene fibers were assessed. Cementitious material in the mix was replaced with granite waste at 0, 5%, 10%, 15% and 20%. For every granite waste replacement level, 20% of fine aggregate was replaced with foundry sand and 0.03% polypropylene fibers are added for M-50 Grade of concrete. The results show that use of Industrial waste will build the quality of the self-compacting concrete when compared and Normal self compacting concrete. But it should not exceed 10% of granite waste and 20% of foundry sand.

***IndexTerms* - Granite waste, self compacting concrete, foundry sand, polypropylene fibers and Conplast SP-430.**

I. INTRODUCTION

The improvement of new innovation in the material science is advancing quickly. In most recent three decades, a great deal of research was completed all through globe to enhance the execution of concrete as far as strength and Durability qualities. Consequently concrete has never again remained a construction material consisting of cement, aggregate, and water just, however has turns into a designed uniquely customized material with a few new constituents to meet the particular needs of construction industry.

Self compacting concrete (SCC) is a streaming concrete mix that can consolidate under its own particular weight. The extremely fluid nature of SCC makes it reasonable for placing in difficult conditions and in section with congested reinforce ment. Utilization of SCC can likewise help limit hearing related harms on the worksite that are incited by vibration of concrete. Another advantage of SCC is that the time required to place huge section is extensively condensed.

The insertion of concrete in limited regions, where consolidation may not be reasonable. For instance, the Repair of the base sides of pillars, girders, and slabs often necessitates filling limited and hard to get access areas. Different ranges where SCC can be utilized to encourage concrete placement and assure durability can include the filling of complex formwork and the casting of tunnel lining sections with restricted access to consolidation. Because of industrialization there is enormous quantify of Granite waste, Foundry sand and so on are industrial Waste and causing threat to environment so the lessen the cost of the construction likewise to make structure more durable, diminish issue of this materials.

1.1 Significance of this Project

The project has been undertaken so that it can be used for construction trend subsequent points attempted.

- Propose to develop suitable SCC mixes.
- To study the properties of Self-Compacting Concrete.
- Designed by replacing cement by Granite waste and Sand by Foundry sand.
- To study the effect of Polypropylene fibers are used in addition of SCC.
- To ascertain Fresh and Harden properties of SCC by different methods.
- To study the comparativeness

II. LITERATURE REVIEW

Now a day's Concrete is all around approved and most generally utilized construction materials. Essentially concrete is made out of cement, Fine aggregate, Coarse aggregate, Water and furthermore a few times with the increments of Mineral and chemical admixture. Because of increment in development the demand of concrete is raising and at one point of time the accessibility of cement and different constituents of concrete may be exhausted. This can diminish by the utilization of industrial by products as a substitution material which won't influence the properties of concrete. Past research have reasoned that utilization of Granite waste and foundry sand builds the mechanical property of concrete and furthermore expansion of these materials in Self compacting concrete the properties won't change much. In [1,2,3] The quantify of aggregates, binders, mixing water and in addition type and dosage of super plasticizer to be utilized are the major point affecting the properties of SCC. Thus they proposed another mix design method for self-compacting concrete. Finally Nan Su method could be used to produce effectively SCC of high quality. Compared with the other technique created by the Japanese Ready-Mixed Concrete Association (JRMCA), this method is less complex, easier for implementation and less time-consuming, requires a smaller amount of binders and saves cost.

From [4, 5, 6, 7, 8] Maximum 20% partial replacement of cement with granite waste has expanded the quality parameter of self compacting concrete. In [9, 10, 11, 12] fine aggregate replaced with foundry sand up to 30%. Also, [13, 14] Up to 0.10% addition of polypropylene fibers gives better strength. It has been found that with an increasing in replacement rate of fine aggregate with foundry sand the compressive strength, split tensile strength and flexure strength increments. To keep up same trade for concrete the replacement rate kept as 5%, 10%, 15% and 20%, and fine aggregate is replaced by foundry sand with kept constant as 20% with an addition of polypropylene fibers is likewise kept consistent 0.03%.

III. MATERIALS USED

3.1 Cement:

The choice of the type of cement and its substance depend on strength. In present study Ordinary Portland bond of BIRLA 53 Grade conforming it with IS 8112-1989 is used. The specific gravity was observed to be 3.15.

3.2 Water:

Versatile water was utilized as a part of present investigation for both casting and curing.

3.3 Fine Aggregate:

The sand used for the investigative work was locally procured and conformed to with Indian Standard Specifications IS: 383-1970. The sand was first sieved through 4.75 mm strainer to remove any particles more prominent than 4.75 mm and afterwards washed to expel the dust. The fine aggregate belonged to grading zone III. The specific gravity was observed to be 2.6.

3.4 Coarse Aggregate:

The material which is held on IS sieve no. 4.75 is named as a coarse aggregate. The crushed stone is generally used as a coarse aggregate. The way of work chooses the most maximum size of the coarse total. Locally accessible coarse aggregate having the maximum size of 10-12.5 mm was utilized as a part of our work. The aggregates were washed to remove dust and mud be dried to surface dry condition. The aggregates were tested according IS: 383-1970. The specific gravity was observed to be 2.74.

3.5 Foundry sand:

Foundry sand is a byproduct of ferrous and non-ferrous metal casting industries. Foundries effectively reuse the sand many times in the foundry. At the point When the sand can no longer be reused in the foundry, it is expelled from the foundry and is named as utilized foundry sand. Classification of foundry sands depends on the type of binder system utilized as a part of metal casting. For the most part two types of binder system are used, and based on that foundry sands are delegated clay bonded systems (green sand) and chemically bonded systems. Green foundry sand was used as a part of this study. The specific gravity was observed to be 2.61.

3.6 Super plasticizer:

Chemical admixture CONPLAST SP 430 is used. CONPLAST SP 430 depends on sulphonated naphthalene polymers and provided as a brown colored fluid in a flash dispersible in water. Conforming in with IS 9103-(1999).

3.7 Granite Waste:

Were granite waste is replaced by cement. granite waste is a Mineral admixture which is waste item acquired during the way toward sawing of rock shakes in granite industries. This dust is creating great issues because of transfer, as it is making ecological risks. The specific gravity was observed to be 2.63.

3.8 Polypropylene fiber:

Polypropylene fiber is non metallic fiber Polypropylene fiber is acting as a bridge retard. It diminishes the crack and crack propagation of a concrete. The impact of polypropylene on compressive strength and flexure strength is less because of its low modulus of elasticity and high elongation. I used 12mm fabricated polypropylene fibers for this work.

IV. EXPERIMENTAL PROGRAM

4.1 Mix Proportion:

The mix proportion was chosen in order to satisfy all the criteria for the concrete in both fresh and hardened state. Since there is no particular methods for SCC mix design many academic institutions, precast and contracting companies have developed their own proportioning methods. The use of ultrafine materials and chemical admixture is a must in case of SCC. The components are better coordinated one by one preventing segregation, bleeding and sedimentation. Based on the [15] EFNARC guidelines are used for developing a mix proportion for M-50.

4.2 Mix design procedure for M-50

This SCC mix design was proposed by Nan-Su, method: Characteristic Strength = 50 Mpa
Maximum size of aggregates = 12 mm Specific gravity of coarse aggregates, Gg = 2.74 Specific gravity of fine aggregates, Gs = 2.65 Bulk density of loose coarse aggregates = 1385.50 kg/m³ Bulk density of loose fine aggregates = 1450.19 kg/m³ Specific gravity of cement, Gc = 3.15 Volume of fine/course aggregate ratio(s/a) = 0.55

4.2.1 Determination of Coarse aggregate

W_{ca} = PF x W_{cal} x (1-s/a) Assume P.F = 1.15
Amount of coarse aggregate, W_{ca} = 1.15 x 1385.50 x 0.45 W_{ca} = 717.177 kg/ m³

4.2.2 Determination Fine aggregate

W_{fa} =PF x W_{fal} x (s/a)
Amount of fine aggregate, W_{fa} = 1.15 x 1450.19 x 0.55 W_{fa} = 917.125kg/m³

4.2.3 Determination of cement

C = F´c/0.110 given 0.11 Mpa C = 58.25/0.110
C = 529.540 kg/m³

4.2.4 Determination of water

For W/C ratio for 58.25 Mpa is = 0.34 W/C = 0. 34 W = (W/C)xC
= 0.34 X (529.54) W = 180.64kg/m³

4.2.5 Determination of SP dosage

SP dosage = 1.2 % of (529.54) SP = 6.35 kg/ m³

RATIO OF M50 GRADE OF SCC- 1:1.73:1.35 W/C ratio = 0.34

V. RESULTS AND DISCUSSION

The hardened properties of self-compacting concrete for various replacement percentages of Foundry Sand and granite waste are determined.

5.1 Fresh Properties

In order to find out the fresh properties of SCC Slump flow, J-ring, L-Box, V-funnel were conducted for each combination. The Fresh properties of SCC mix results are given Table 1.

Table 5.1: Fresh Properties Results of SCC

Mix Proportions Title	Slump flow (mm)	J-ring (mm)	L-Box (mm)	V-funnel T_{5m} (Sec)
NSCC	692	8	0.85	14.50
MSCC-I	715	8.6	0.90	13.20
MSCC-II	700	8.7	0.92	12.45
MSCC-III	695	8.9	0.87	13.20
MSCC-IV	690	8.9	0.89	14.50

5.2 HARDENED PROPERTIES

The mechanical properties are determined by conducting Compressive strength tests at 7 and 28 and 56days of cube (150 x 150 x 150 mm) specimens. Two specimens were tested for each combination. Test results are discussed in below tables.

Table 5.2: Compressive Strength Results at 7-Days

MIX PROPORTIONS TITLE	REPLACEMENT IN PERCENTAGE			COMPRESSIVE STRENGTH (MPA)
	GRANITE WASTE IN %	FOUNDARY SAND IN %	POLYPROPLENE FIBER IN %	7 DAYS
NSCC	0	0	0	27.12
MSCC-I	5	20	0.03	29.20
MSCC-II	10	20	0.03	32.24
MSCC-III	15	20	0.03	30.00
MSCC-IV	20	20	0.03	24.25

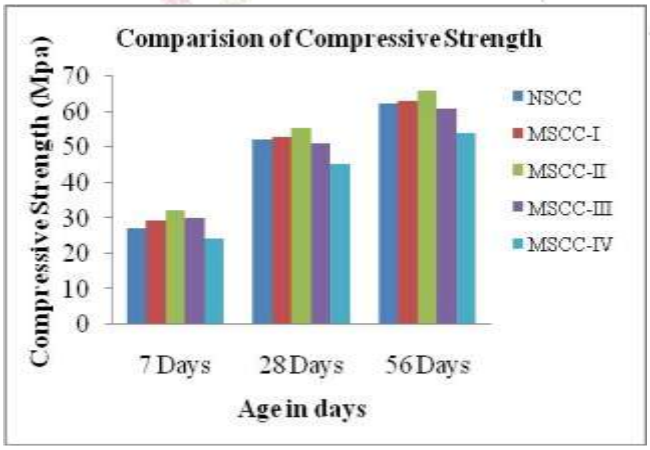
Table 5.3: Compressive Strength Results at 28-Days

MIX PROPORTIONS TITLE	REPLACEMENT IN PERCENTAGE			COMPRESSIVE STRENGTH (MPA)
	GRANITE WASTE IN %	FOUNDARY SAND IN %	POLYPROPLENE FIBER IN %	28 Days
NSCC	0	0	0	52.05
MSCC-I	5	20	0.03	52.89
MSCC-II	10	20	0.03	55.44
MSCC-III	15	20	0.03	51.00
MSCC-IV	20	20	0.03	45.45

Table 5.4: Compressive Strength Results at 56-Days

Mix Proportions Title	Replacement in Percentage			Compressive Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	56 Days
NSCC	0	0	0	62.28
MSCC-I	5	20	0.03	63.25
MSCC-II	10	20	0.03	66.16
MSCC-III	15	20	0.03	61.00
MSCC-IV	20	20	0.03	54.10

Fig.5.1 Comparison between 7, 28 and 56 days Compressive Strength



The split tensile strength of concrete was determined by testing cylinders (150 x 300 mm) for 7, 8, and 56days. Two specimens were tested for each combination Test results are discussed in below tables.

Table 5.5: Split Tensile Strength Results at 7-Days

Mix Proportions Title	Replacement in Percentage			Split tensile Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	7 Days
NSCC	0	0	0	2.64
MSCC-I	5	20	0.03	2.80
MSCC-II	10	20	0.03	3.06
MSCC-III	15	20	0.03	2.69
MSCC-IV	20	20	0.03	2.25

Table 5.6: Split Tensile Strength Results at 28-Days

Mix Proportions Title	Replacement in Percentage			Split tensile Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	28 Days
NSCC	0	0	0	3.94
MSCC-I	5	20	0.03	4.10
MSCC-II	10	20	0.03	4.36
MSCC-III	15	20	0.03	3.75
MSCC-IV	20	20	0.03	3.10

Table 5.7: Split Tensile Strength Results at 56-Days

Mix Proportions Title	Replacement in Percentage			Split tensile Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	56 Days
NSCC	0	0	0	4.42
MSCC-I	5	20	0.03	4.92
MSCC-II	10	20	0.03	5.24
MSCC-III	15	20	0.03	4.31
MSCC-IV	20	20	0.03	3.90

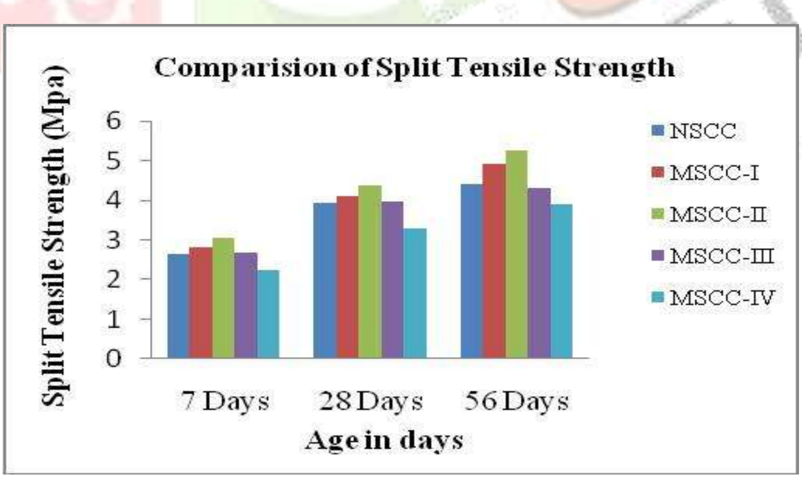


Fig.5.2 Comparison between 7, 28 and 56 days Split Tensile Strength

The Flexure strength of concrete was determined by testing beam (150 x 150 x 700) for 7, 28 and 56 days. Two specimens were tested for each combination.

Table 5.8: Flexure Strength Results at 7-Days

Mix Proportions Title	Replacement in Percentage			Flexure Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	7 Days
NSCC	0	0	0	4.56
MSCC-I	5	20	0.03	4.95
MSCC-II	10	20	0.03	5.39
MSCC-III	15	20	0.03	4.45
MSCC-IV	20	20	0.03	3.56

Table 5.9: Flexure Strength Results at 28- Days

Mix Proportions Title	Replacement in Percentage			Flexure Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	28 Days
NSCC	0	0	0	7.12
MSCC-I	5	20	0.03	7.26
MSCC-II	10	20	0.03	7.86
MSCC-III	15	20	0.03	7.09
MSCC-IV	20	20	0.03	6.01

Table 5.11: Flexure Strength Results at 56- Days

Mix Proportions Title	Replacement in Percentage			Flexure Strength (Mpa)
	Granite Waste in %	Foundry Sand in %	Polypropylene Fiber in %	56 Days
NSCC	0	0	0	7.92
MSCC-I	5	20	0.03	8.00
MSCC-II	10	20	0.03	8.35
MSCC-III	15	20	0.03	7.69
MSCC-IV	20	20	0.03	6.54

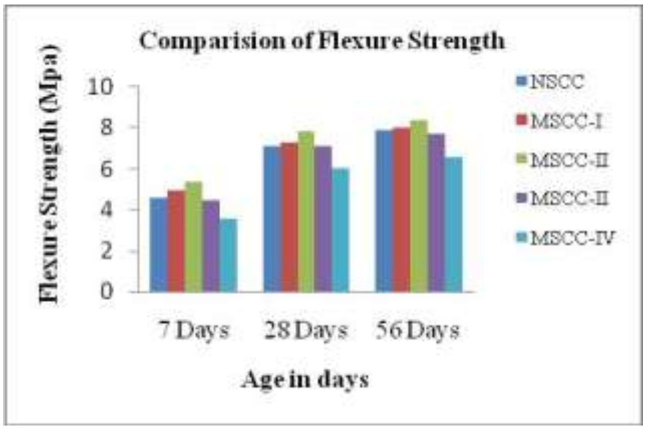


Fig. 5.2 Comparison between 7, 28 and 56 days Flexure Strength

VI. CONCLUSION

Based on the results of this study, the following conclusions are drawn:

- All the concrete types (SCC, MSCC-I, MSCC-II, MSCC-III and MSCC-IV) developed satisfied the requirements of self compacting concrete specified by EFNARC.
- Granite waste increase compressive strength up to 10% partial replacement with cement without affecting concrete properties.
- Use of foundry sand increase compressive strength up to 20% partial replacement of sand with waste foundry sand.
- Further increase in percentage of granite waste and foundry sand waste results in reduction of strength in flexure and split tensile strength test of concrete.
- So the addition of polypropylene fibers of 0.03% at constant into the concrete mixture. To marginally improves the better strength of concrete.
- Using granite waste and foundry sand in concrete mix to be produce green concrete. Therefore it is recommended to re-use of these wastes in concrete will become eco-friendly and cost effective.

VII. SCOPE FOR FUTURE WORKS

The work is extended to study some of other important parameters with respect to granite waste and foundry sand as an alternative to cement and fine aggregate along with addition of polypropylene fibers.

- To study the short term and long term durability of blended self-compacting concrete.
- Further investigation can be done to evaluate the creep and shrinkage properties of self compacting concrete.
- Further study can be performed by the addition of different percentage of polypropylene fibers and its effect on strength properties of SCC.
- Similarly there are lot more mineral admixtures which are the wastage of the industry. The other type of ingredients wastages used for manufacturer of concrete to reduce the problems of environmental attack.

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