Mechanical Properties Of Fiber Reinforced High Performance Cocrete Using Marine Sand

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Abstract—This paper generalized the result of study on Marine sand based High performance concrete The Land Reclamation and Development Board (Sri Lanka) plans to popularize the use of sea sand as a substitute to river sand. According to the experts in the global construction trade, Sea sand is being used in the construction industry in the Asian Region and some leading European countries. This study is to experiment the suitability to use sea sand as a substitute for river sand as fine aggregate for concrete. The attempt has been made to find the various results by using sea sand and polypropylene fiber with normal concrete of M_{60} grade with maintaining the water cement ratio of 0.32. The objective of this study is to develop concrete with good strength and durability will be reached. For this purpose, the experiment is carried out on M_{60} grade of concrete using marine sand, different percentages (0%, 0.5%, 1%, 1.5% and 2%) of polypropylene fiber to the weight of cement. Super plasticizer Conplast SP430 was used to maintain workability with constant Water-cement ratio. Strength properties was determined such as compressive, split tensile and flexural strength test. This is done to determine the efficiency and optimum percentage of replacement at which maximum strength is achieved. Higher grade concrete is produced by adding polypropylene fiber.

Keywords— Durability, High Performance Concrete, Marine Sand, Polypropylene fiber, Strength.

I. INTRODUCTION

The boom in the construction sector is a direct result of economic growth. This fast growth leads to severe competition for resource rights of fine aggregate and coarse aggregate from riverbeds. This results in unlawful mining of river beds for river sand which in turn causes environmental problems. Due to this scarcity of river sand, the contractors are mixing sea sand with river sand.

Over-exploitation of river sand to meet the demand has led to various harmful consequences such as increase in the depth of the river bed, lowering of the water table, and salinity interference into the rivers. Because of these environmental problems, there is a necessity to restrict river sand mining especially at vulnerable locations. As a remedial measure, the government imposes various restrictions on the mining of river sand with consequent increases in prices. Not only has this inconvenienced the users directly, but also indirectly impacted on the overall stability of the construction industry owing to related increases in construction prices

This study is a basic practical study on the compressive strength of concrete made by using sea sand as a replacement to fine aggregate. In this the fine aggregate was replaced completely by sea sand.

II. MATERIALS

Experimental program has been designed to provide sufficient information for ascertaining the quality of Sea sand based reinforced High Performance concrete. To evaluate the behavior of sea sand based reinforced High Performance concrete, both mechanical strength and durability aspects have been studied in this investigation.

A. Cement

Ordinary Portland cement-53 grade have used in examination. The cement was tested according to IS 4031:1988. It confirmed to IS 12269:1987. Its Properties is given in Table 2.1.

B. Fine Aggregate

The fine aggregate used in the experimental investigation was natural Sea sand confirming to Zone IV of IS 383-1987. Sand used in the work which has particle size less than 4.75 mm

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C. Coarse Aggregate

Crushed granite aggregate particles passing through 12.5mm and retained on 10mm I.S sieve used as the natural aggregate which met the grading requirement of IS 383-1970.

D. Polypropylene Fiber

Polypropylene fibers can improve the compressive strength, tensile strength and flexural strength of concrete. It is also enhance the durability properties of concrete. The Recron 3S Polypropylene fibres are used in this study. The aspect ratio is 12. The shape of the fibre helps in better bonding with the concrete.

E. Super Plasticizer

Generally super plasticizers are used to improve the workability and reduce water content. According to this the super plasticizer Conplast SP 430 is a high range water reducing agent. There are difficulties and limitations to obtain high workability in the field for a given set of condition. Specific gravity and Chloride content of super plasticizer are 1.220 to 1.225 at 300ºC and Nil as per IS: 456 respectively.

The test data determined from the materials are as follows,

Table 2.1: Properties of Materials used

S.no	Name of the material	Properties of material	Result	
1	OPC 53 grade	Specific gravity	3.13	
		Fineness modulus	3.6%	
		Consistency	32%	
		Initial setting time	30 min	
		Final setting time	10 hrs	
2	Fine aggregate	Comparison	River sand	Marine sand
		Specific gravity	2.54	2.73
		Fineness modulus	4.83	3.46
		Bulk density	1782.46kg/ m^3	1700.12kg/ m^3
3	Coarse aggregate	Specific gravity	2.63	
		Water absorption	0.56%	
		Fineness modulus	84	
		Bulk density	1915.2kg/m^3	
		Impact test	15%	
4	Chloride content test	Washed sea sand	45 ppm	
		Unwashed sea sand	170 ppm	

III. MIX PROPORTION

The very first step to assure the workability requirement of HPC is to determine the optimum dosage of calcium nitrate and super plasticizer. Various mixes were prepared and tested to satisfy the ACI 211.4R-08 guidelines. Finally a mix is chosen which gave fulfilling fresh properties. The addition of different percentage of Polypropylene would be done in this mix. The optimum dosage of Polypropylene fiber is 2% and 1% of super plasticizer added to each mix.

The mix proportion was done based on the ACI 211.4R-08. The mix design was carried out for M60 normal grade of High Performance concrete with the addition of Polypropylene fiber.

Mix Ratio

WATER	CEMENT	FINE AGGREGATE	COARSE AGGREGATE
501.19 l/m^3	155.37 kg/m^3	616.98 kg/m^3	1302 kg/m^3
1	0.32	1.23	2.59

Sea sand (SS) is used as the fine aggregate, polypropylene fiber (PF) is varied from 0.5%-2% and superplastizier (SP) are kept in constant of 3.5% and 1% respectively

Combinations of mixes

Specimen	Explanation
MIX RS	Conventional mix using river sand + 1% SP
MIX SS	Conventional mix using sea sand + 1% SP
MIX 1	Concrete mix using SS + 0.5% PF + 1% SP
MIX 2	SS + 1% PF + 1%SP
MIX 3	SS + 1.5% PF + 1%SP
MIX 4	SS + 2% PF + 1%SP

IV. EXPERIMENTAL WORKS

A Slump test

Workability is defined as the ability or case with which the concrete is handled, transported and placed in the form with minimum loss of homogeneity. In the present study, workability was determined using slump cone test for the concrete using sea sand. The slump test was performed as per IS 1199- 1959, the slump test is the most well-known and widely used test to characterize the workability of fresh concrete.

B Mechanical properties

All the mixes were tested for various hardened properties like compressive strength, flexural strength & Split Tensile Strength test as per Indian Standards. The six different combination mixes were prepared including conventional for testing. In this investigations, Specimens prepared such as cube size is 150X150X150 mm, cylinder size is 300X150 mm and prism (500X100X100 mm) for each combinations. The testing was done on specimens after 28 days curing. All tests was repeated for three specimens and average value was taken as the mechanical strength.

1. *Compressive Strength*

In this investigation, the cube specimen of size 150mm x 150mm x 150mm were cast, cured and tested in accordance with BIS: 516 – 1959 (method of test for test of concrete). The testing was done on compressive testing machine of 2000kN capacity.

2. *Split Tensile Strength*

The objective of this is to find the splitting tensile strength of the concrete cylinders. This cones under indirect tension test methods. A concrete cylinder of size 150mm diameter and 300mm height was subjected to the action of the compressive forces along two opposite edges. The test was conducted using compressive testing of 200kN capacity.

Horizontal Tensile Stress = $2P/\pi DL$

Where, P = Compressive load on the cylinder.
L = Length of cylinder.
D = Diameter of cylinder.

3. *Flexural Strength*

Flexural tests were conducted on beams of size of 100 mm x 100mm X 500 mm subjected to two point loading at 28 days in UTM. The maximum load applied to the specimen shall be recorded and the flexural strength of concrete expressed as the modulus of rupture (f_b) is calculated.

Modulus of rupture $f_b = 3Pl / 2bd^2$

V. RESULT AND DISCUSSION

1. Slump Value

Table-5.1: Slump values of HPC mixes with river and sea sand

MIX ID	Slump value in mm
MIX RS	70
MIX SS	62
MIX 1	58
MIX 2	56
MIX 3	49
MIX 4	31

2. Compressive and Split Tensile Strength

The Compressive and Split Tensile Strength of High Performance Concrete with various percentage of Polypropylene fiber. These results are given in table.

Table-5.2: Influence of River sand and Sea sand on Compressive and Split tensile strength of HPC

Concrete label	Compressive Strength (MPa)		Split Tensile Strength (MPa)	
	7 days	28 days	7 days	28 days
MIX RS	30.5	64.03	2.91	4.38
MIX SS	29.67	60.68	2.57	4.00
MIX 1	35.25	63.73	3.97	5.72
MIX 2	38.22	64.05	3.45	5.20
MIX 3	33.56	61.39	3.21	4.81
MIX 4	28.51	58.34	2.50	3.71

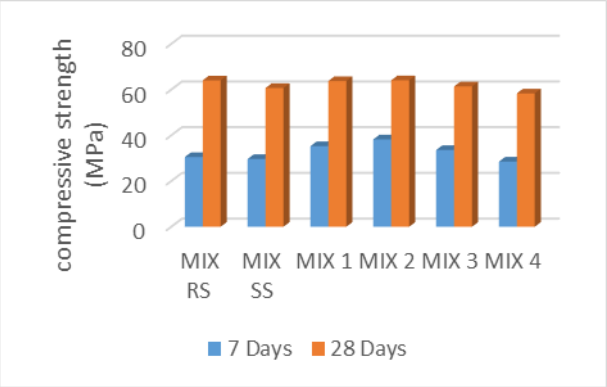

Fig-5.1: Influence of Sea sand on Compressive strength of Concrete

From the test results, the compressive strength obtained for the MIX RS 28 days is greater than the MIX SS. The compressive strength for 1% of polypropylene fiber (64.05MPa) is higher than the control mix (MIX SS). The result show that for all ages, the polypropylene fiber ranging from 0.5%, 1% and 1.5% yields higher compressive strength when compared to conventional concrete mix. Beyond that there is a decrease in strength for addition 2% of polypropylene fiber.

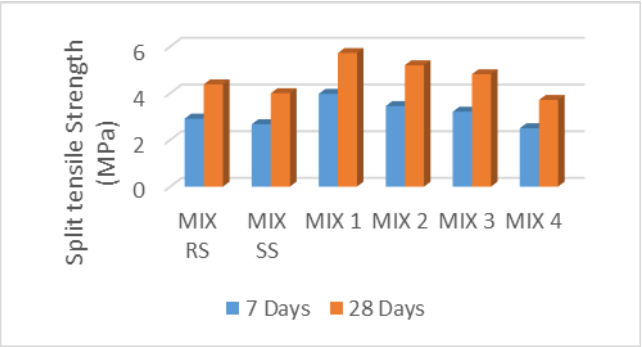

Fig-5.2: Split tensile strength of sea sand based concrete

From the test results, the Split Tensile strength obtained for the MIX RS 28 days is greater than the MIX SS. The Split tensile strength for 0.5% of polypropylene fiber (5.72MPa) is higher than the control mix (MIX SS). The result show that for all ages, the polypropylene fiber ranging from 0.5%, 1% and 1.5% yields higher tensile strength when compared to conventional concrete mix. Beyond that there is a decrease in strength for addition 2% of polypropylene fiber.

3. Flexural Strength

The flexural Strength of High Performance Concrete with various percentage of Polypropylene fiber. These results are given in table.

Table-5.3: Flexural strength of HPC

S.No	Combination	Flexural strength of concrete N/mm2 28 DAYS
1	MIX SS	5.865
2	MIX 1	6.425
3	MIX 2	6.515
4	MIX 3	5.825
5	MIX 4	4.035

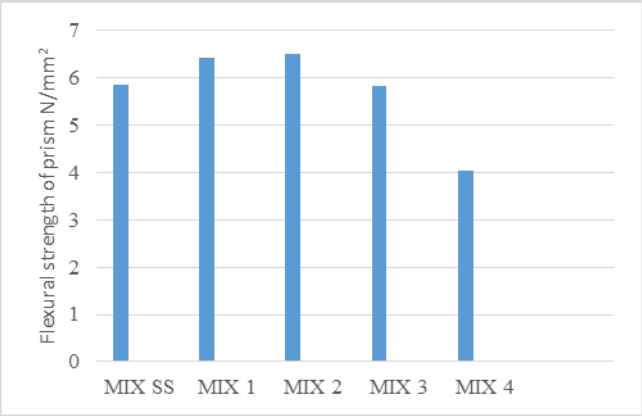

Fig-5.3: Flexural strength of River sand based HPC

From the test results, the Split Flexural strength obtained for the MIX 1, 28 days is greater than the MIX SS (nominal). The Split flexural strength for 1% of polypropylene fiber (6.425 MPa) is higher than the all the replacement mixes also control mix (MIX SS). The result show that for all ages, the polypropylene fiber ranging from 0.5% and 1% yields higher tensile strength when compared to conventional concrete mix. Beyond that there is a decrease in strength for 1.5% and 2% of polypropylene fiber.

VI. CONCLUSION

The following conclusions are drawn for feasibility study conducted on reinforced High Performance compacting concrete with Polypropylene fiber as includes,

The conclusion based on the limited observations from the present investigation on study of compressive, split tensile strength and flexural strength of the concrete made using sea sand as fine aggregate as a replacement of river sand by using polypropylene fiber (0% to 2%) and super plasticizer (1%). The addition of polypropylene fiber ranging from 0.5%, 1%, and 1.5% yields higher compressive strength than the conventional concrete mix. Beyond that there is a decrease in the compressive strength of concrete by adding 2% of polypropylene fiber.

- Sea sand based HPC has 5.5% lower compressive strength when compared to its counterpart mix made of river sand
- The addition of polypropylene fiber and calcium nitrate increases the compressive strength and split tensile strength containing sea sand as a fine aggregate.
- The addition of polypropylene fiber by 1% and sea sand as a fine aggregate had shown 5.5% increase in compressive strength and at 0.5% of polypropylene fiber 42.5% increase in compressive strength when compared to the conventional concrete mix (MIX SS)
- Compressive strength, split tensile strength and flexural strength variation for the addition of polypropylene fiber indicate as an optimum replacement level. The observed maximum strength in compression, tension and flexural was 64.05MPa, 5.72MPa and 6.515MPa respectively at 28 days.
- The addition of alccofine in SCC improves microstructure of concrete that also helpful to enhance all mechanical properties of concrete.

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