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EXPERIMENTAL INVESTIGATION ON STRENGTHENING OF FOUNDRY SAND USED CONCRETE BEAM WITH FERROCEMENT

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Abstract — *The aim of repairing and strengthening of concrete members is to improve the strength and durability. In this paper a trial is made to investigate a new strengthening method for foundry sand used concrete beam. It consists of several stages .First stage consists of partial replacement of fine aggregate by foundry sand (0%, 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%, and 22.5%). The second stage consists of optimum percentage used foundry sand concrete beam externally wrapped with ferrocement .The suitability of using wire meshes for the purpose of strengthening the foundry sand used concrete beam was experimentally studied. The wire meshes used in ferrocement are of hexagonal and square shapes.*
M30 concrete mix is used for experimental investigation. The materials used are 53 grade cement, M sand coarse aggregate, potable water, foundry sand and ferrocement.

Keywords-*Strengthening, Foundry sand, Ferrocement, Wire meshes*

I. INTRODUCTION

Economic growth of a country mainly depends on the transportation and infrastructural developments. Concrete the widely used as a construction material in the construction industry. River sand is one of the main ingredients in concrete production and it is used as a fine aggregate. Due to the lack of river sand M sand is commonly used in construction area. The heavy demand for concrete has resulted in the over-exploitation of river sand in the river bed and quarry resources. Foundry sand (FS) is a by-product from the metal casting industry with high silica content. Silica sand is bonded with clay or chemicals, and is used for the metal casting process. Foundries recycle the sand many times, and when the sand is no longer recyclable, it is disposed off, this is called foundry sand.It is used as an alternative for fine aggregate.
Most of the buildings fail to meet the design life span. The structural component failure is mainly due to improper design and environmental conditions.Failure of structural components can be avoided or minimized by analyzing the inefficiency of load carrying capacity in the initial stage and adopting the valid strengthening technique. The cost, ease of application and the efficiency of the strengthening process are major considerations in selecting the materials and techniques. Strengthening of beams using externally wrapped steel plate is a contemporary research work. But weight to the strength ratio for steel plate is high when it is used for strengthening works. Another disadvantage for using steel plate is that strength of the plate may reduce due to corrosion since it is used for external strengthening work. To overcome the disadvantages of using steel plate in this work foundry sand used concrete beam are strengthened with different shape of wire meshes and the meshes are attached to concrete with cement mortar.

II. OBJECTIVE

The main objective of this study is to formulate a low-cost and eco-friendly concrete and the suitability of using wire meshes for the purpose of strengthening foundry sand used concrete beam.

III. EXPERIMENTAL METHODOLOGY

Strength is one of the most important properties of concrete, since the first consideration in structural design is that the structural members should be withstanding the live and dead loads. The mix of concrete used in this study is M30. Water cement ratio used is 0.5 .The percentage replacement of fine aggregate by foundry sand was (0%, 2.5%, 5%, 7.5%, 10%, 12.5%, 15%, 17.5%, 20%, and 22.5%). Tests were performed for compressive strength, flexural strength and spilt tensile strength of concrete for all replacement levels of foundry sand at different curing periods (7, 14,28 days). Then strengthening of foundry sand used concrete beam with ferrocement was done. The wire meshes used in ferrocement are of hexagonal and square shapes. Then the initial cracking load and ultimate load of strengthened beam were found.

3.1 Material Properties

Material properties of cement, fine aggregate, coarse aggregate, foundry sand, water and admixture are given in the following tables

3.1.1 Cement

The Ordinary Portland Cement of 53 grades conforming to IS: 12269 is used. Physical properties of cement are as in Table 1.

Table 1: Material Properties of (OPC) Cement

Properties	Value
Fineness	2.66%
Specific Gravity	3.15
Standard Consistency	29.5%
Initial Setting Time	45 Minute
Final Setting Time	400Minute

3.1.2 Fine Aggregate

M sand is used as fine aggregate conforming to the Requirements of IS: 383.

Table 4: Material Properties of Fine Aggregate

Properties	Value
Fineness Modulus	2.602(Zone II)
Specific Gravity	2.5
Water Absorption	2%
Effective Size	0.24 mm
Uniformity Coefficient	3.625

3.1.3 Coarse Aggregate

20mm coarse aggregate is used.

Table 3: Material Properties of Coarse Aggregate

Properties	Value
Fineness Modulus	3.16
Specific Gravity	2.97
Water Absorption	0.324%
Bulk Density	1.622g/cc
Void Ratio	0.81
Porosity	0.44

3.1.4 Foundry sand

The material properties of foundry sand is as in Table 4

Table 4: Material Properties of Foundry Sand

Properties	Value
Fineness Modulus	2.585
Specific Gravity	2.608
Water Absorption	2.66%
Effective Size	0.34
Uniformity Coefficient	2.058

3.1.5 Water

The clean drinking fresh water is used for mixing and curing puposes.It was free from impurities.

3.1.6 Admixture - CERAPLAST 300

The material properties of ceraplast 3oo is shown in table 5

Table 5: Material Properties of ceraplast 300

Properties	Value
Supply Form	Liquid
Colour	Brown
Specific Gravity	1.2
Dosage	0.3 To 1.5% Weight of cement

3.1.7 Meshes

The properties of meshes used for strengthening purposes are given table 6

Table 6: Properties of meshes used

Mesh Name	Mesh Type	Opening Shape	Opening Dimensions in mm
MS1	Steel	Square	6x6
MS2	Steel	Hexagonal	16x24

3.2 Mix Ratio

For experimental work M30 grade concrete was used and the mix ratio was calculated based on Indian Standard method (IS 10262-2009). Water cement ratio of o.5 was considered for experimental work. The design mix proportion is as in Table 7.

Table 7: Mix Proportion

Cement	Fine Aggregate	Coarse Aggregate	Water
1	1.63	3.16	0.5

3.3 Specimen Preparation

Mould of size 150mm×150mm×150mm were used to prepare the cube specimens and moulds of size 150mm×300mm were used to prepare cylinder specimens and mould of size 500mmx100mmx100mm were used to prepare beam specimens for determining the compressive strength, split tensile strength and flexural strength of concrete. The details of the strengthened beam are given the table 8.The beam specimens were strengthened with externally wrapped ferrocement layer on the tension side.

Table 8: Details of the strengthened beam samples used

Beam Samples	Layer thickness	Strengthening Material
Control	-	-
MS1	2cm	Steel mesh type 1 (square shape) in concrete layer(Cement: Sand – 1:3)
MS2	2cm	Steel mesh type 2(hexagonal shape) in concrete layer (Cement:Sand-1:3)

Fig 1: Casting of specimens

Fig 2: Beam strengthened with steel mesh

VI.TEST SETUP

Compression testing machine, Split tensile strength testing machine and UTM are used for experimental study. A two-point bending system was adopted for the testing of beams. The load at first crack, ultimate load etc were carefully observed and recorded.

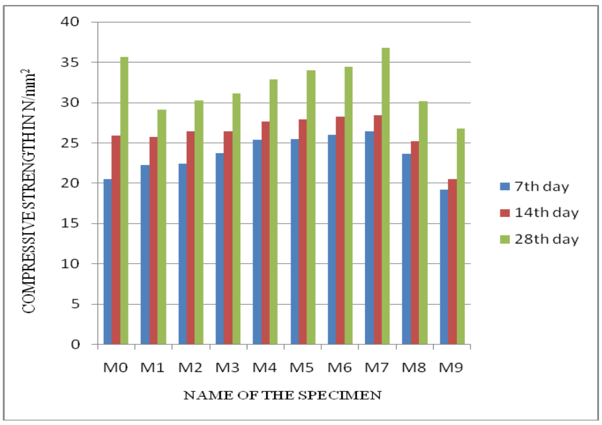
Fig 3: Compression testing machine

Fig 4: Split tensile strength testing machine

Fig 5: UTM

V. RESULT ANALYSIS

Figure 6, Figure 7, Fig 8, Fig 9, Fig 10& Fig 11 represent the result value of compressive strength of cube, split tensile strength of cylinder, flexural strength of beam, Comparison of plain VS strengthened FS used beams after 7, 14, 28 days curing, initial cracking load, ultimate load at 7,14,28 days respectively. And table 9 shows the increase in strength of optimum percentage used foundry sand concrete beam and Steel mesh type 1 in foundry sand used beam compared to plain cement concrete .



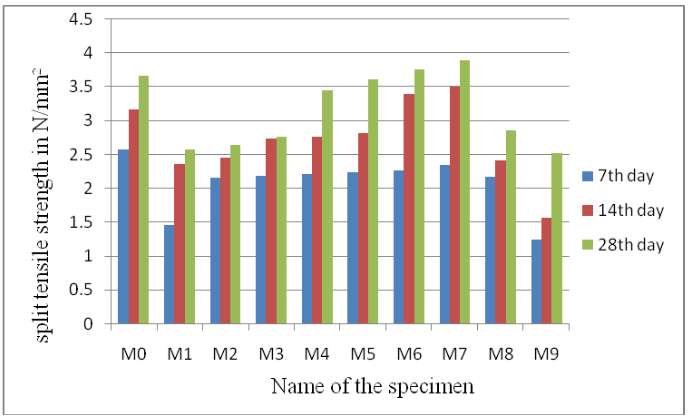


Fig 6: Compressive strength for various replacement level of FS after 7, 14, 28 days curing

Fig 7: Split tensile strength for various replacement level of FS after 7, 14, 28 days curing

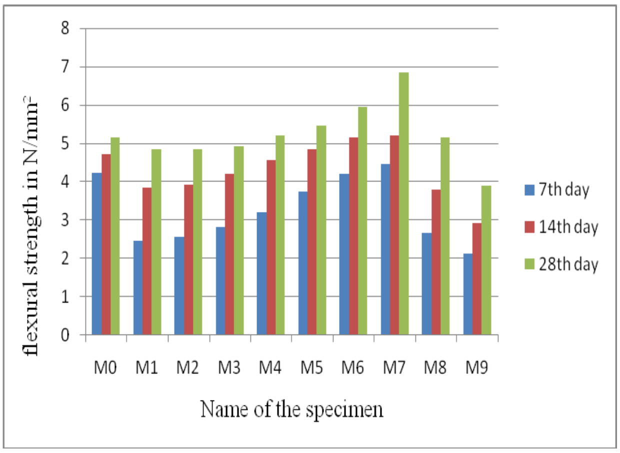


Fig 8: Flexural strength for various replacement level of FS after 7, 14, 28 days curing

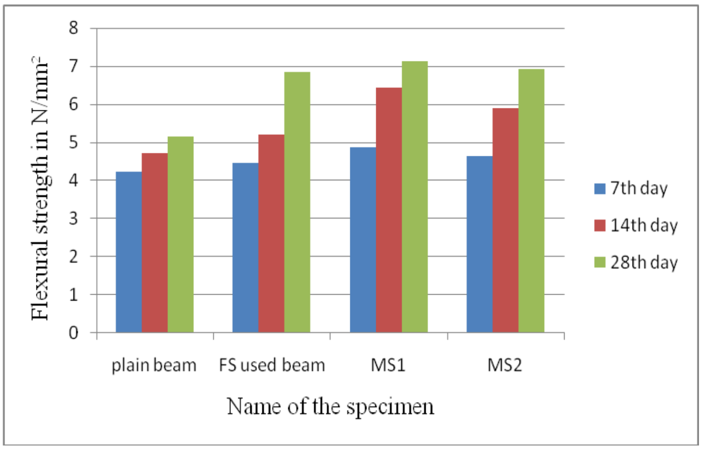


Fig 9: Comparison of plain VS strengthened FS used beams

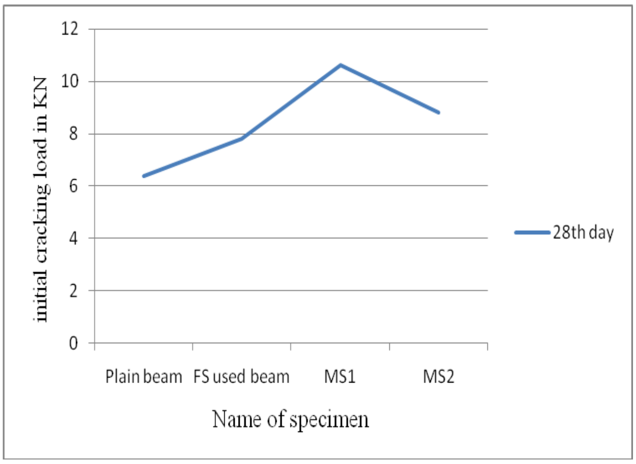


Fig 10: Initial cracking load for plain and strengthened FS used beam

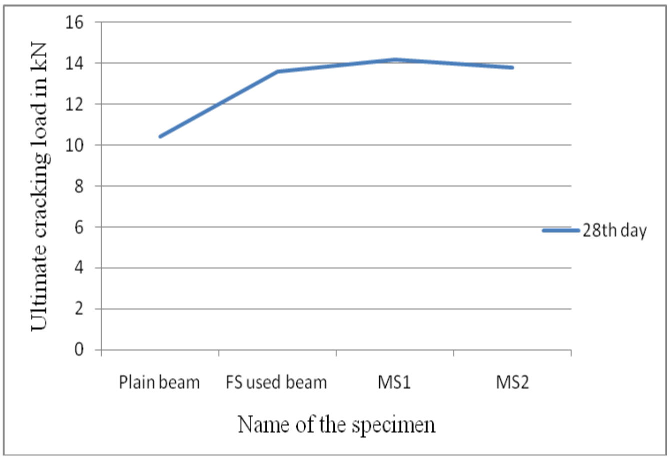


Fig 11: Ultimate load for plain and strengthened FS used beam

Table 9 Increase in strength compared to PCC

Sl No	Beam	Increase in strength compared to pcc
1	Optimum percentage foundry sand used concrete beam	33%
2	Steel mesh type 1 in foundry sand used beam	38%

V.CONCLUSIONS

The following conclusions are drawn from this study:

- Compressive strength, split tensile strength and flexural strength of concrete increased with the increase in sand replaced with various replacement levels of foundry sand upto a certain limit.
- In this study maximum compressive strength, split tensile strength and flexural strength is obtained at 17.5% replacement of fine aggregate by foundry sand.
- Use of foundry sand in concrete reduces the production of waste from metal casting industry i.e., it is an ecofriendly building material.
- Strengthening of foundry sand used beam with steel mesh on the tension face performs well and satisfactorily enhance the load carrying capacity.The efficiency of load carrying capacity varies depending upon the parameter such as the mesh shape and dimensions.
- Based on the experiments, failure load of foundry sand used beam strengthened with steel mesh type 1(square) increased 38% compared to the plain beam.

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