Performance of Steel Scrap in Concrete

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Abstract— Today the construction industry is in need of finding cost effective materials for increasing the strength of concrete structures. It is inevitable to think about sustainable development by reducing the wastes generated or reusing it. Hence an attempt has been made in the present investigations to study the performance of addition of waste materials like binding wire, steel nails, steel lathe waste fiber (turn fiber) from workshop at a dosage of 0.5%, 1% and 1.5% of total weight of concrete. Experimental investigation was done using M25 mix and tests were carried out as per recommended procedures by relevant codes. Total of 162 specimens of scrap concrete and PCC were made. This paper aims to have a comparative study between turn fiber, binding wire and steel nail in M25 concrete. The test parameters include compressive strength, split tensile strength and flexural strength of conventional concrete and steel scrap in concrete.

Key words: Steel Scrap, Waste Fiber, Turn Fiber, Binding Wire, Nails

I. INTRODUCTION

Today construction industry is in need of finding a cost-effective material to increase the strength of concrete structures. It is inevitable to think about sustainable development by reducing the wastes generated or reusing it. This project work emphasis on the study of using industrial steel scraps such as binding wire, scrap nail and lathe waste (turn fiber) as fibre reinforced concrete in the innovative construction industry at a percentage of 0.5%, 1%, 1.5% by weight of concrete. Every day about 8 to 10 kg of lathe waste are generated by each lathe industries in the kerala and dumped in the barren soil there by contaminating the soil and ground water, which creates an environmental issue. Many constructional industries also dispose there wastes likewise, which include binding wires, nails and other types of scraps. Hence by adopting proper management by recycling the steel scrap with concrete is considered to be one of the best solutions. These industrial steel scrap wastes can effectively be used for making high strength low-cost Fiber Reinforced Concrete after exploring their suitability. The test were conducted as per the Indian standard procedure for its mechanical properties such as flexural, split tensile, compressive strength and compared with conventional PCC. The workability of fresh concrete that containing different ratios of steel scrap was carried out by using slump test.

II. SCOPE OF THE WORK

In India, steel scraps are increasing day by day as a part of industrialization. These scraps are produced mainly due to industrial wastes, constructional waste, steel industry wastes etc. The rapid progress of steel industry has aggravated environmental and waste management problems. This has led to increasing pressure from Government and the public to speed up action plan for effective industrial waste management. The waste management in steel industry is an emerging complex issue and can be implemented after regulating through monitoring, analysis, legalization, addition of infra-structural facilities for enforcement, waste auditing, change of process technology etc. Development of steel industry has brought with it environmental degradation. Environmental conservation has become an increasingly more important aspect of our daily lives. With the rapid and extensive industrialization and urbanization in many parts of India, there is a dawning realization that ultimate prerequisite for man's survival could well be the preservation of environment. We live under horns of dilemma. However, our expectations and our perceptions of what constitutes a minimum standard of living have put increasing pressure on both the public and private industrialists to ensure clean and healthy environment. The present investigation uses waste turn fibers from lathe industry, constructional waste fiber ie; binding wire and scrap nails which clearly showed that waste fibres reinforcement significantly improves the behaviour of composite materials, especially enhancing the post-cracking behaviour of the cement matrix. The results have indicated that waste fibres properly selected and designed could reach quite the same performance that may obtained when using standard industrial fibres. These waste fibres might be, in same cases, a valuable alternative material to regular fibres. Thus a major issue of waste management.

III. MATERIALS USED

MATERIALS	SPECIFICATION
Cement	Ramco Cement (PPC)
Fine Aggregate	Manufactured Sand (M. Sand)
Coarse Aggregate	20mm, 12mm
Water	Portable Water
Super Plasticizer	Rheobuild 1125
Steel Scrap: Turn Fiber	Irregular Size
Binding Wire	0.1mm Diameter
Nail	1 Inch
Concrete	M25 (1:1:2)

Table 1: Material Used

TESTS	MATERIALS	EQUIPMENT USED	VALUES
Specific Gravity	Ramco Cement (PPC)	Le Chatelier Flask	2.9
Specific Gravity	Fine Aggregate	Pycanometer	2.63
Specific Gravity	Coarse Aggregate	Wire Basket	2.85
Water Absorption	Fine Aggregate	Vessel	1.42%
Water Absorption	Coarse Aggregate	Vessel	0.35%

Workability	M25 Concrete	Slump Cone Apparatus	75mm

Table 2: Material tests

Fig. 1: Turn Fiber

Fig. 2: Binding Wire

Fig. 3: Nail

Fig. 4: Slump Test

IV. MIX DESIGN

MATERIALS		AMOUNT
Cement		394 Kg/m^3
Sand (FA)		812.71 Kg/m^3
Aggregate (CA)		1076.4 Kg/m^3
Water		177.3 lit/m^3
Ratio		1: 2.06: 2.73
Steel scrap	**% of scrap added**	
	0.5% weight of concrete	12.302 Kg/m^3
	1% weight of concrete	24.604 Kg/m^3
	1.5% weight of concrete	36.906 Kg/m^3

Table 3: Mix Proportion of M25 (1m3 of concrete)

V. EXPERIMENTAL WORKS

To test the concrete for compression, split tensile strength and flexural various cubes (150mm x150mmx150mm), cylinders (300mmx150mm dia) and beam (500mmx100mmx100mm) were cast respectively. The mix adopted is M25 (1:1:2) and to this steel scraps are added. For each percentage of steel scrap in concrete 9cubes, 6 cylinders and 3 beams are casted. Total of 162 specimens are casted. Specimen is tested and strength is obtained for 3 days, 7 days and 28 days in N/mm^2. Compression of cubes and split tensile test on cylinder is carried in compression testing machine of capacity 2000 kN. Flexural test of beam is carried out using flexural testing machine of 100 kN.

Fig. 5: Compression Test

Fig. 6: Split Tensile Test

VI. RESULTS AND DISCUSSIONS

Fig 7:Flexural Test

Fig 8: Binding Wire

Fig. 9: Nail In Concrete

Fig. 10: Beams inFlexure

VII. RESULTS AND DISCUSSIONS

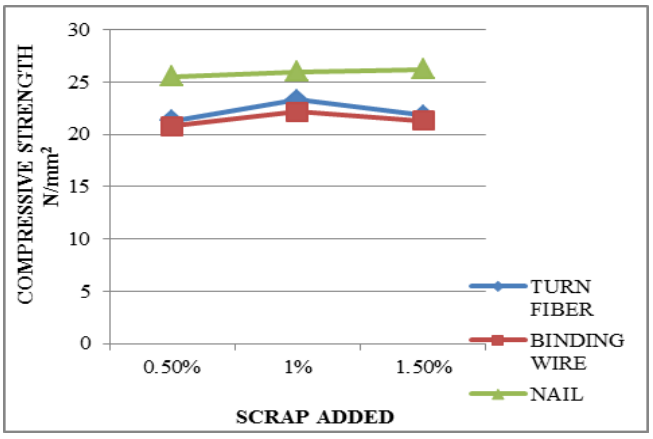

Fig. 11: 3 Day Compression Test

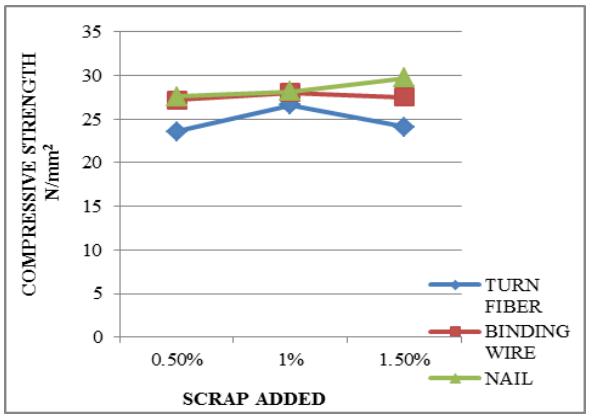

Fig. 12: 7 Day Compression Test

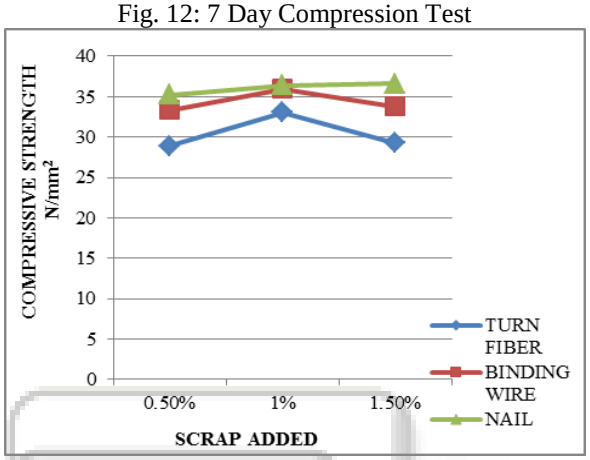

Fig. 13: 28 Day Compression Test

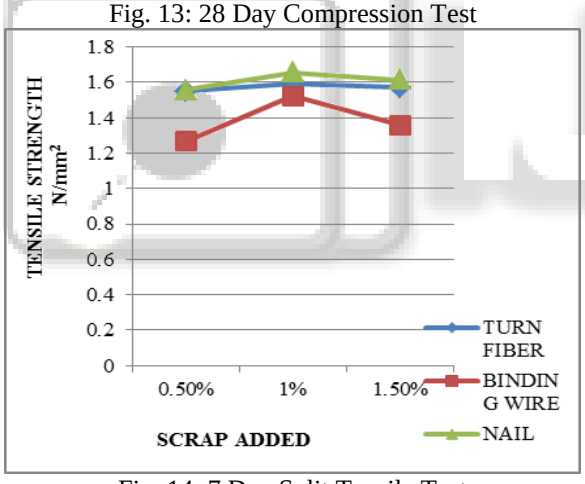

Fig. 14: 7 Day Split Tensile Test

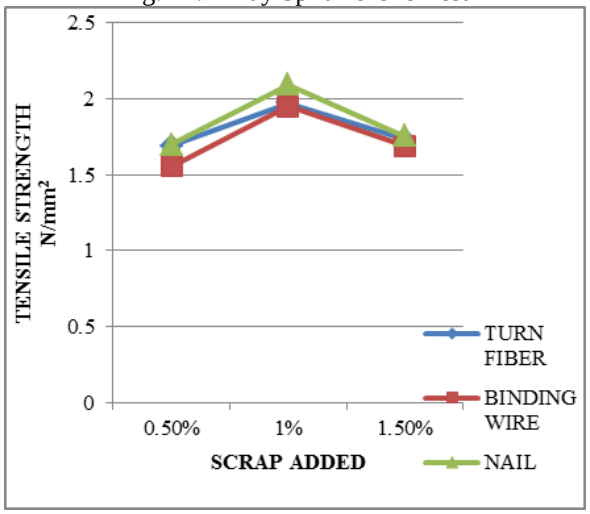

Fig. 15: 28 Day Split Tensile Test

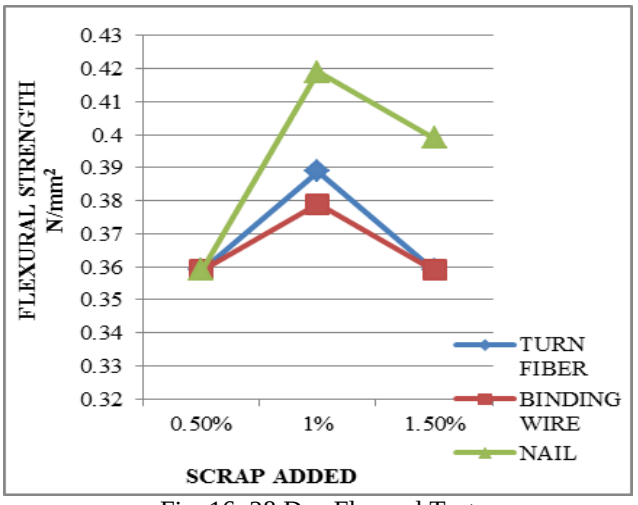

Fig. 16: 28 Day Flexural Test

VIII. EVALUATION FROM RESULTS

A. Interpretation of Results:

From the evaluation of results we can conclude that the performance of various fibers when added by 1% weight of concrete gives an optimum value, rather than adding 0.5% and 1.5%. Scarp nail gave optimum at 1.5% for compression and 1% for tensile and flexure strength whereas turn fiber and binding wire gives optimum at 1% for compression, tensile and flexural. Thus performance of turn fiber, binding wire and scrap nail are compared at their optimum percentage and found that scrap nail performs superior than turn fiber and binding wire.

B. Discussions;

From the graphical analysis, it is noticed that the scrap nail performed superior than others whereas the turn fiber and binding wire obtained a better value than the control specimens.

1) Compressive Behaviour:

- Turn fiber and binding wire obtained an optimum value at 1% weight of concrete and nail obtained 1.5% weight of concrete for compression.
- For 7 days and 28 days strength of nail is greater than binding wire, then turn fiber.
- But for 3 days strength of nail is greater than turn fiber, then binding wire.

2) Tensile Behaviour:

- The optimum value obtained was 1% for turn fiber, binding wire and nail for tensile strength.
- For 7 days and 28 days strength of nail is greater than turn fiber, then binding wire.
- 0.5% and 1.5% values was less than the control specimen

3) Flexural Behaviour:

- Scraps had no effect for flexure.
- Optimum value was obtained for 1%.
- For 28 days of strength of nail is greater than turn fiber, then binding wire.

C. Applications:

1) Residential: including driveways, sidewalks, pool construction, basements, colored concrete, foundations, drainage, etc.

2) Commercial: exterior and interior floors, slabs and parking areas, roadways.
3) Warehouse /Industrial: light to heavy duty loaded floors and roadways.
4) Highways/Roadways/Bridges: conventional concrete paving, barrier rails, curbs and gutter work.
5) Ports and Airports: runways, taxiways, aprons, seawalls, dock areas, parking and loading ramps.
6) Waterways: Dams, channel linings, ditches, storm-water structures, etc.
7) Mining and Tunneling: Precast segments and shortcrete, which may include tunnel lining, shafts, slope stabilization, sewer work, etc.
8) Elevated Decks: including commercial and industrial composite metal deck construction and elevated formwork at airports, commercial buildings, shopping centers, etc.
9) Agriculture: farm and animal storage, walls, silos, paving, etc.
10) Precast Concrete and Products: architectural panels, walls, fencing, septic tanks, burial vaults.
11) Other Applications: includes any other FRC related applications not specifically described above.

D. Cost Analysis:

The cost of different types of industry available fibers is compared with that of industry waste fibers. From this analysis it is clearly observed that the scrap steel fiber can be used as a substitute for factory made steel fiber.

FIBERS	**COST/Kg**
Steel Fiber	Rs. 150/-
Glass Fiber	Rs. 344/-
Polypropylene Fiber	Rs.920/-
Scrap fibers (Turn fibers, Binding Wire, Nail)	Rs. 20/- to Rs. 25/-

Table 4: Cost Analysis of Fibers

IX. CONCLUSIONS

The results shows that scrap nail when used by 1.5% weight of concrete provide a good concrete mix of strength 36.61N/mm^2 in compression. Also other scrap fibers exhibit a better performance in concrete. The optimum value was obtained by adding scrap by 1% weight of concrete for turn fiber & binding wire in compression, tension and flexure and 1.5% for nail in compression and 1% for nail in tension and flexure. This steel scrap fiber reinforced concrete showed excellent performance in compression and in tension but no significant effects was observed in flexure.

Thus scrap steel fiber obtained from industry as a waste can be used in an innovative way in minor amount as an additive to enhance the properties of concrete. In this way, the scrap steel fiber can be used as a substitute for factory made steel fiber.

A. Scope for Further Study:

Further investigations can be carried out in this field by utilizing other types of scraps from industry or with steel powder. The work can be extended by adopting other mixes like M30, M40 etc with varying percentages of scraps either by weight of concrete or by volume of concrete or any kind of replacements. Several other parameters can also be tested like impact resistance, abrasion, fatigue resistance, crack propagation etc.

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