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ADDITION OF CARBON FIBRE IN CONCRETE WITH PARTIAL REPLACEMENT OF SAND BY WASTE FOUNDRY SAND

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Abstract: *Concrete has been used in various structures all over the world since last two decades. Recently a few infrastructure projects have also seen specific application of concrete. The development of concrete has brought about the essential need for additives i.e., chemical and mineral to improve the performance of concrete. Concrete undergoes significant volumetric changes cause internal stresses within the concrete matrix, due to which micro-cracks get developed in the concrete. These micro cracks propagate and open up resulting in inelastic deformation of the concrete. This experimental investigation was performed to evaluate the strength of concrete, in which natural sand was partially replaced with waste foundry sand (WFS). Percentages of fibres were added with respect to weight of cement. Tests were performed for 30% replacement of sand by WFS with various percentages (0.25%, 0.50%, 0.75% and 1.0%) of carbon fibre for M30 grade concrete at different curing periods (3, 14 and 28 days).*

Key words: Waste Foundry Sand (WFS), Carbon Fibre, Flexural Strength

INTRODUCTION

Fibre Reinforced Concrete (FRC) is cementing concrete reinforced mixture with randomly distributed discrete fibres. In the FRC, a numbers of small fibres are dispersed and distributed randomly in the concrete at the time of mixing, and thus improve concrete properties in all directions. Addition of loosely spaced and uniformly dispersed fibres to concrete acts as crack arrestor and substantially improves its static and dynamic properties. It has been successfully used in construction with its excellent flexural tensile strength, resistance to splitting, impact resistance and excellent permeability and frost resistance.

Concrete made from Portland cement, is relatively strong in compression but weak in tension. The weakness in tension can be overcome to some extent by mixing of a sufficient volume of certain fibers. A fibre is a small discrete reinforcing material produced from various materials like steel, plastic, polyester, basalt, glass, carbon and natural materials in various shapes and size.

Foundry sand is an industrial by-product used in a construction industry. Foundry sand is high quality silica sand that is a byproduct from the production of both ferrous and non-ferrous metal casting industry, because of unique engineering properties sand has been used for centuries as a molding material. It primarily consists of silica sand, coated with a thin film of burnt carbon, residual binder (bentonite clay, sea coal, and resins) and dust. Industry estimate are that approximately 100 million tons of sand are used in production annually. Of that, four (4) to seven (7) million tones are discarded annually at are available to recycle into other products and industries.

Carbon fibres are fibres about 5-10 micrometers in diameter and composed mostly of carbon atoms. To produce a carbon fibre, the carbon atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fibre as the crystal alignment gives the fibre high strength-to-volume ratio (making it strong for its size). Several thousand carbon fibres are bundled together to form tow, which may be woven into a fabric.

The properties of carbon fibres, such as high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion, make them very popular in aerospace, civil engineering, military and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibres, such as glass fibres or plastic fibres.

1. Materials

1.1 Cement

Cement used throughout the experimental work is ordinary Portland cement 53 grade conforming to IS 269-1967, manufacture by Ultra tech company. It is stored in laboratory under proper conditions.

Table 1.1: Test results of properties of cement

Property	Average value for OPC used in present investigation	Standard value for OPC
Fineness (%)	3	<10%
Consistency (%)	32	-
Initial setting time (min)	55	>30
Final setting time (min)	192	>600

1.2 Testing of aggregate

Table 1.2: Test results of physical properties

Sr.no	Property	CA	FA	WFS
1	Specific Gravity	2.80	2.75	2.42
2	Water Absorption	0.25%	1.72%	0.43%
3	Fineness modulus	6.1	4.3	3.96
4	Moisture content	Nil	5%	1.5%
5	Type	Crushed	Natural Sand	
6	Maximum Size	20 mm	4.75mm (Grading Zone III)	

1.3 Carbon Fibre

The carbon fibres used in the experimental work was 35-based 50k tow fibres. It is manufactured from Polyacrylonitrile (PAN) precursor. It content 50,000 filaments and has 95% carbon content.

Table 1.3: Properties of carbon fibre

Properties	Value
Tensile strength	4137 Mpa
Young's modulus	242 Gpa
Density	1.81 g/cc
Fibre length	12mm
Fibre diameter	7.2 microns
Aspect ratio	1666

Fig. 1.1: PAN based Carbon Fibre

1.4 Water

Portable water was used for the experimental work.

1.5 Waste Foundry Sand

Waste Foundry Sand was collected from the local foundry. The WFS was used as a partial replacement of natural river sand in concrete. Green sand is generally used as recycled foundry sand for beneficial reuse. Bentonite clay and water is used as a binder. Green sand is not green in color but green in the sense denotes that it is used in a wet stage. It is black in color due to carbon content.

Table 1.4: chemical properties of Waste foundry sand

Constituent	Value (%)
SiO_2	87.91
Al_2O_3	4.70
Fe_2O_3	0.94
CaO	0.14
MgO	0.30
SO_3	0.09
Na_2O	0.19
K_2O	0.25
TiO_2	0.15
P_2O_5	0.00
Mn_2O_3	0.02

SrO	0.03
Lol	5.15 (0.45 to 9.47)[1] 2.1-12.1[(3)]
TOTAL	99.87

Fig. 1.2: Waste Foundry Sand

1.6 IS Mix Design:

Indian standard method is used to prepare concrete mix design for M30.This method is covered in IS: 10262-1982.

Table 1.5: mix design proportion

Cement	Fine aggregate	Coarse aggregate	Water
394	694.91	1255.23	197.16
1	1.76	3.18	0.5
50	88	159	25
		For 0.010	
3.94	6.95	12.55	1.97

2. RESULTS AND DISCUSSIONS:

Flexural Strength for Concrete:

The flexural strength of concrete calculated by following formula

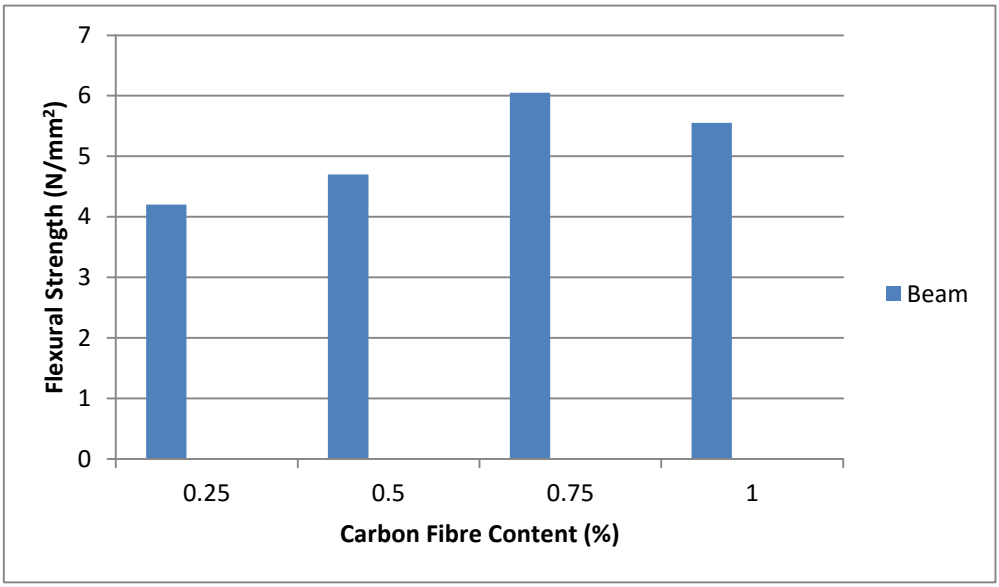
$f_b = (p \times l) / (b \times d^2)$ …… (IS: 516: 1959)

The flexural strength of concrete beams with 30% replacement of foundry sand and addition of carbon fibre in various proportions i.e., 0.25%, 0.50%, 0.75%, 1.0% were determined. Following tables and graphs shows the flexural strength for 3rd day, 14th day and 28th day.

2.1 Flexural Strength of concrete (N/mm²) for 3 days:

Table 2.1: Flexural Strength of concrete (N/mm²) for 3 days

Sr. No.	Waste Foundry Sand Content (%)	Fibre Content (%)	Flexural Strength, (3 days),(N/mm²)
1	30	0.25	4.20
2	30	0.50	4.70
3	30	0.75	6.05
4	30	1.00	5.55



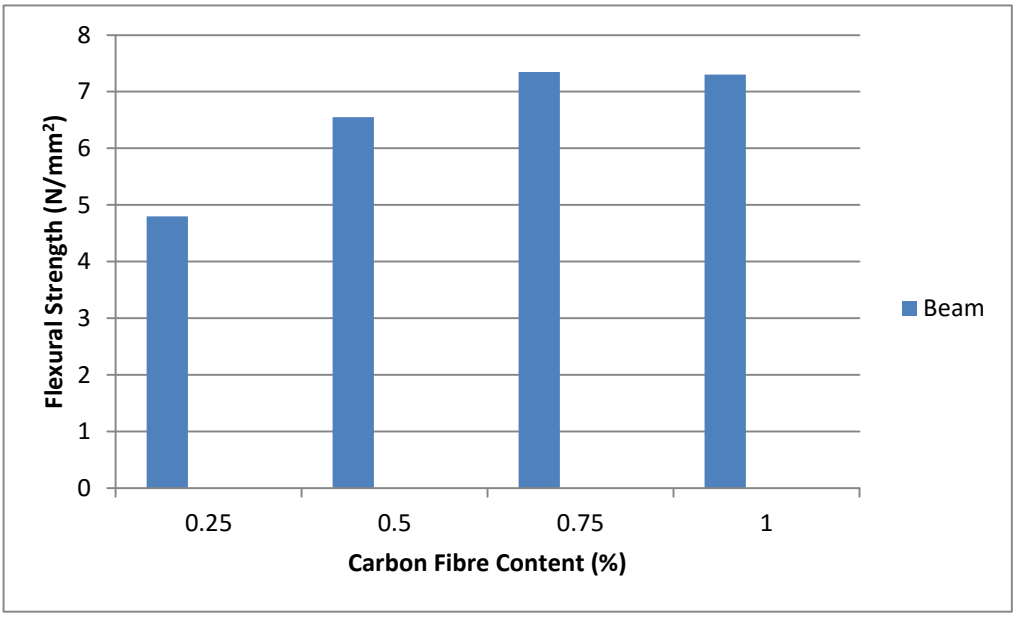
Graph 2.1: Flexural strength test results for WFS concrete with carbon fibre at 3 days

Maximum flexural strength 6.05 N/mm² achieved for WFS concrete with 0.75% carbon fibre at 3 days. Graphical representation shows increase in Flexural strength up to 0.75% addition of Carbon fibre and beyond that it decreases.

2.2 Flexural Strength of concrete (N/mm²) for 14 days:

Table 2.2: Flexural Strength of concrete (N/mm²) for 14 days.

Sr. No.	Waste Foundry Sand Content (%)	Fibre Content (%)	Flexural Strength, (14 days),(N/mm²)
1	30	0.25	4.80
2	30	0.50	6.55
3	30	0.75	7.35
4	30	1.00	7.30



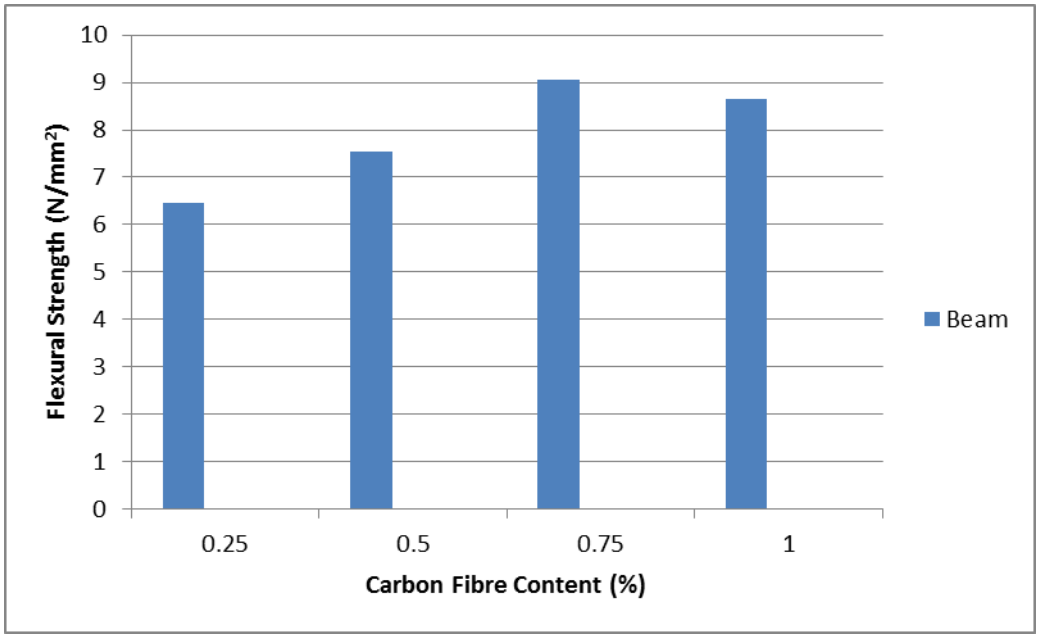
Graph 2.2: Flexural strength test results for WFS concrete with carbon fibre at 14 days

Maximum flexural strength 7.35 N/mm² achieved for WFS concrete with 0.75% carbon fibre at 14 days. Graphical representation shows increase in Flexural strength up to 0.75% addition of Carbon fibre and beyond that it decreases.

2.3 Flexural Strength of concrete (N/mm²) for 28 days:

Table 2.3: Flexural Strength of concrete (N/mm²) for 28 days.

Sr. No.	Waste Foundry Sand Content (%)	Fibre Content (%)	Flexural Strength, (28 days),(N/mm²)
1	30	0.25	6.45
2	30	0.50	7.55
3	30	0.75	9.05
4	30	1.00	8.65



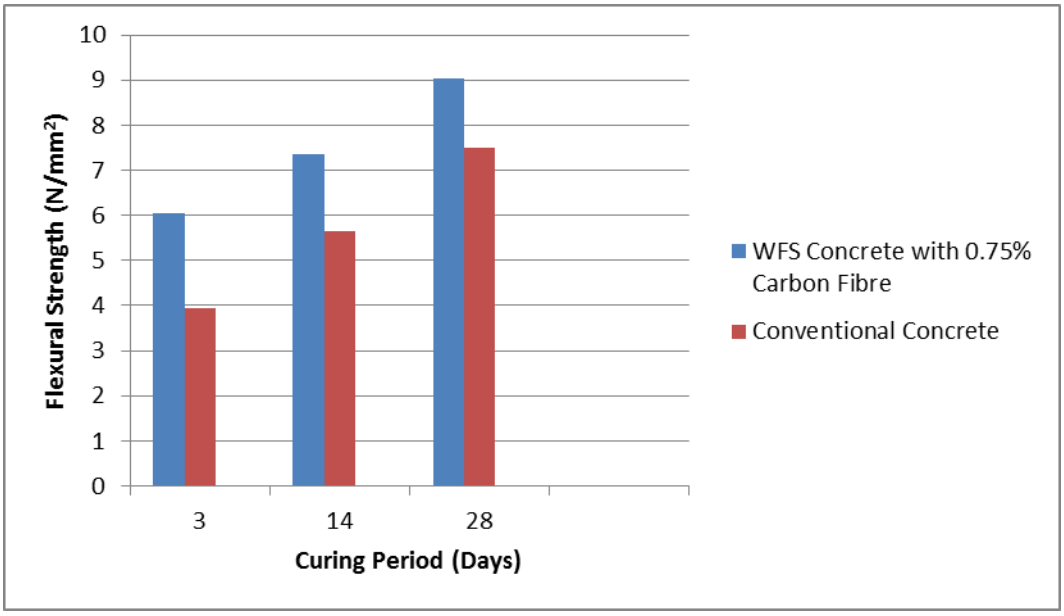
Graph 2.3: Flexural strength test results for WFS concrete with carbon fibre at 28 days

Maximum flexural strength 9.05 N/mm² achieved for WFS concrete with 0.75% carbon fibre at 28 days. Graphical representation shows increase in Flexural strength up to 0.75% addition of Carbon fibre and beyond that it decreases.

2.4 Comparison between flexural strength of conventional concrete and waste foundry sand concrete with 0.75% carbon fibre

Table 2.4: Comparison between flexural strength of conventional concrete and waste foundry sand concrete with 0.75% carbon fibre

Curing period (days)	Flexural Strength (N/mm²)	
	Conventional concrete	WFS concrete with carbon fiber
3	3.95	6.05
14	5.65	7.35
28	7.51	9.05



Graph 2.4: comparative representation of flexural strength (N/mm²)

Graphical representation shows higher flexural strength for WFS concrete with 0.75% carbon fibre as compare to conventional concrete.

3. CONCLUSIONS:

1. The maximum flexural strength 6.05 Mpa (3 days), 7.35 Mpa (14 days), 9.05 Mpa (28 days) were obtain at 30% replacement of sand by WFS with 0.75% carbon fibre addition in concrete.
2. The optimal use of 30% WFS with 0.75% carbon fibre has a better mechanical property.
3. The crack formation is very small in fibre specimen compare to the non fibre specimens.
4. Higher amount carbon fibre decreases the bonding in the concrete with results in strength degradation.

REFERENCES:

Research Papers:

1. Nayan Rathod, Mukund Gonbare, Mallikarjun Pujari, (U.G. student, Department of Civil Engineering, Rajarshi Shahu College of Engineering), "Basalt Fiber Reinforced Concrete" (IJSR) ISSN: (Online): 2319-7064 Volume 4 Issue 5, May 2015.
2. T. Subramani, A. Mumtaj, "Experimental Investigation Of Partial Replacement Of Sand With Glass Fibre" (IJAIEM) ISSN 2319 – 4847 Volume 4, Issue 5, May 2015.
3. Narayana Suresh, Vivek Bindiganavile, Mahesh Prabhu, "Compressive Behavior of Polyester Fiber Reinforced Concrete Subjected To Sustained Elevated Temperature" ISSN 2250-2459, ISO 9001:2008 Certified Journal, Volume 4, Issue 8, August 2014
4. Balasubramanian, Chandrashekaran, S. SenthilSelvan, "Experimental Investigation of Natural Fiber Reinforced Concrete in Construction Industry", e-ISSN: 2395-0056, p-ISSN: 2395-0072, Volume: 02, Issue: 01, Apr-2015.
5. Bhoite V. R., "Mechanical Properties Of Concrete Incorporating Waste Foundry Sand And Steel Fibre", IJRESTs, Online ISSN: 2395-6453, Volume 2, Number 01, and March 2016.
6. S. Durgaadevi, P. Chandrasekaran "Mechanical and durability properties of waste foundry sand concrete with carbon fibre" Volume 3 Issue 4 April 2015.

I.S. Codes:

1. "Code of practice for plain and reinforced concrete", IS: 456-2000, Bureau of Indian Standards, New Delhi.
2. "Methods of test for aggregates for concrete Part 3 Specific gravity, density, voids, absorption and bulking", IS: 2386 (Part 3)-1963, Bureau of Indian Standards, New Delhi.
3. "Recommended guidelines for concrete mix design", IS: 10262-1982, Bureau of Indian Standards, New Delhi.

4. "Specification for coarse and fine aggregates from natural sources for concrete", IS: 383-1970, Bureau of Indian Standards, New Delhi.
5. "Flexural strength of concrete", IS: 516:1959, Bureau of Indian Standards, New Delhi.

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