Experimental Studies on Fibre Reinforced High Strength Concrete as per IRC Guidelines

T Maruthi, H M Yajnodbhavi, C M Ravi Kumar, S R Pruthviraj and Namrata S Naragundkar

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EXPERIMENTAL STUDIES ON FIBRE REINFORCED HIGH STRENGTH CONCRETE AS PER IRC GUIDELINES

Maruthi T
Assistant Professor
Department of Civil Engineering
Jain Institute of Technology, Davangere
Karnataka, India
maruthimanoj3@gmail.com

Yajnodbhavi H M
PhD Research Scholar
Department of Civil Engineering
PES Institute of Technology and Management, Shivamogga
yagna.hm@pestrust.edu.in

Ravi Kumar C M
Associate Professor
Department of Studies in Civil Engg
University B. D.T College of Engg.Davangere
cmravibdt@gmail.com

Pruthvi Raj S R
Lecturar, Department of Studies in Civil Engg
University B. D.T College of Engg. Davangere
pruthvi960637@gmail.com

Namrata S Naragundkar
Assistant Professor, Dept. of Civil Engineering
Jain Institute of Technology, Davangere
namrata91996@gmail.com

ABSTRACT

Concrete as a construction material is widely used in India with annual consumption exceeding 100 million cubic meters. Conventional Ordinary Concrete which is designed on the basis of compressive strength does not meet many functional requirements. So, there is a need to design High strength Concrete (HSC) which is far superior to conventional concrete. It has now become imperative to look for alternatives of constituent materials of concrete. In last few decades, several studies have been conducted to investigate the effect of addition of waste foundry sand as partial replacement of 0% to 40% in the interval of 10% by adding with and without poly propylene fibers to the regular sand in concrete and also Construction and demolitions activities have increased phenomenally for the past two decades. With these construction activities going up, we are falling short for the construction materials, especially aggregates, therefore finding an alternate resource is the need of hour. The construction and demolition waste also partially replacement of 0% to 20% in the interval of 5% by adding with and without poly propylene fibers as per IRC44-2017 for an M50 grade of Concrete. The aim of this study is to evaluate the optimum percentage replacement of both foundry sand and C&D waste by Compressive strength, split tensile strength and flexural strength of concrete for 7, 14 and 28 days.

Keywords: *High strength Concrete (HSC), foundry sand, Construction and Demolition Waste.*

1. INTRODUCTION

1.1 General

Concrete is the most extensively used in construction material in the world, second to water. Increasing rate of industrialization and urbanization has led to over exploitation of natural resource such as gravel and river sand, which is giving rise to sustainability issues. High Strength Concrete (HSC) is the latest catch phrase in concrete technology. A High Strength Concrete is a special concrete in which certain characteristics are developed for a particular application and environment so that it will give excellent performance in the structure in which it will be placed, in the environment to which it will be exposed and with the loads to which it will be subjected importance during its design life.

The development of High Strength Concrete (HSC) is a giant step in making concrete a High-tech material with enhanced its characteristics and durability. High Strength Concrete is an engineered concrete obtained through a careful Selection and proportioning of its constituents like cement, fine aggregate, course aggregate and water. The concrete is with the same basic ingredients but has a totally different microstructure than ordinary concrete. The low water cement ratio of HSC results in a very dense microstructure having a very fine and less or more well connected capillary system. On the basis of their use, they offer different advantages such as enhanced ductility, reduced permeation of water, durability higher strength etc. at an economical cost.

1.2 Materials Used in HSC

1.2.1 Cement

The standard strength performance of a given Ordinary Portland cement measured using the mortar cubes does not always correlate well with the actual strength, which can be reached when the cement is used at a very low water cement ratio.

1.2.2 Fine Aggregates

In High strength concrete, the size of aggregates, texture, shape, mineralogy, and cleanness needs a special attention. Many studies have found that the size of aggregates from 9.5 mm to 12.5 mm nominal maximum size gives optimum strength or more strength, in High strength concretes.

1.2.2.1 Some of the wastages used as partially replacement for fine aggregates such as:-

a) Steel slag
b) Copper slag
c) Bottom ash
d) Quarry dust
e) Spent fire bricks
f) Foundry sand

1.2.3 Foundry sand

❖ ***World scenario:-***

The World Scenario there is about 35,000 foundries in the world with annual production of 90 million tonnes. These countries have been contemplating to shift their business to the low labour cost centres i.e. the developing countries.

Table 1.1:- Table shows ranks of country and quantities produced by them of foundry sand

COUNTRY	2010		2011		2012		2013	
	M.T.	RANK	M.T.	RANK	M.T.	RANK	M.T.	RANK
CHINA	39.6	1	41.26	1	42.5	1	44.5	1
US	8.24	3	10.01	2	12.82	2	12.25	2
JAPAN	4.76	5	5.47	4	5.34	4	5.54	4
INDIA	9.05	2	9.99	3	9.34	3	9.81	3
GERMANY	4.79	4	5.46	5	5.21	5	5.19	5
BRAZIL	3.24	7	3.34	7	2.86	7	3.07	7
ITALY	1.97	9	2.21	9	1.96	9	1.97	9
FRANCE	1.96	10	2.04	10	1.8	10	1.75	10
KOREA	2.23	8	2.34	8	2.44	8	2.56	8
RUSSIA	4.20	6	4.3	6	4.3	6	4.1	6

M.T. = million tons **(Source: *-IJLTE)***

❖ ***Indian scenario:-***

India ranks second in the world based on the number of foundry units present (4550 units) after china and Fourth in terms of total production (9.9 million tonnes). The foundry produces a wide variety of castings such as manhole covers, sanitary items, pipe and pipe fittings, electric motor, tube well body, automobile components, railway parts, metric weights, fan body etc.

1.2.3 Course Aggregates

1.2.3.1 Some of the wastages used as partially replacement for Course aggregates such as:-

a) Recycled aggregate
b) Coconut shell
c) Construction and Demolition waste

a) Construction and Demolition waste

In developing countries, Construction and Demolition (C&D) waste involves a major portion of solid waste production. In this field Research by engineers has clearly suggested that the possibility of appropriately treating and reusing such waste as aggregate in new concrete, The use of recycled aggregates for the production of concrete involves breaking, removing mortar and crushing existing concrete into a material with specified size and quality.

Fig 1:- C & D Waste for the Road Pavement

As per the Indian Road Congress Specification the materials used in Pavement Quality Concrete (PQC) should confirm to the following requirements:

Table 1.2:- Aggregate properties as per IRC: 121-2017 Specification

Properties	As per IRC
Impact value, %	29.9
Crushing value, %	35.7
Los Angeles Abrasion, %	50.2
Water absorption	4.7
Flakiness index (%)	15.6
Elongation index (%)	17.5

1.2.4 Admixtures for High strength concrete

An admixture is a material other than cement, water and fine and course aggregates that is used as an ingredient of concrete and is added to the bath immediately before or during mixing.

Admixture is also used to modify the properties of concrete so as to make it more suitable for any situation.

The commonly used admixture for most Engineering constructions works.

i. Plasticizers
ii. Super plasticizers
iii. Retarders
iv. Accelerators
v. Air- Entraining Admixture

1.2.5 Fibre reinforced concrete (FRC)

Fibres are reinforcing materials of consist smallpiecewhichplaysimportantroleinsignificantimprove mentsofductility of concrete. In this experimental work taken as poly propylene fibres.

Table 1.3:-Properties of polypropylene fibre

SL	Characteristics	Specifications
1	Density	910 - 950 kg/m^3
2	Melting point	>2500C
3	Tensile strength	600kg/cm^2
4	Ability to protest friction	Excellent
5	Ability to protest heat	Moderate
6	Elasticity and Resilience	Good
7	Alkali resistance	Good
8	Acid resistance	Good

2. MATERIALS AND METHEDOLOGY

2.1 General

This chapter deals with the materials and their properties used in the present investigation. Also, tests related to the properties of materials as per code of practice are reported below.

2.2 Materials Used in this Project are:-

- 2.2.1 Cement
- 2.2.2 Fine aggregate
  - a) Manufactured sand
  - b) Foundry sand
- 2.2.3 Course aggregate
  - a) Natural aggregate
  - b) Construction Demolition waste
- 2.2.4 Water
- 2.2.5 Super plasticizer
- 2.2.6 Polypropylene fiber

2.2.1 Cement

Cement in concrete acts as a binding material that harden after the addition of water. It plays an important role in construction sector.

⌗ **Basic Test on Cement**

- ✓ Grade of Cement : 43 grade (ACC)
- ✓ Specific Gravity : 3.15
- ✓ Fineness of Cement: 4
- ✓ Normal Consistency : 30 %
- ▪ Initial Setting time : 28 minutes
- ▪ Final Setting Time : 600 minutes

2.2.2 Fine Aggregates (FA)

a. Manufactured sand

Aggregate that pass through a IS sieve 4.75 mm and having not more than 5 per cent coarser material are known as fine aggregate. Main function of fine aggregate is to fill the voids in between coarser particles and also helps in producing workability and uniformity in mixture.

⌗ **Basic Test on M-Sand**

- ✓ Specific Gravity :2.46
- ✓ Fineness Modulus :2.6
- ✓ Grading of Sand :Zone – II

b. Foundry sand

Foundry sand consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder and dust. Foundry sand is typically sub angular to round in shape and also dark brown or black in colour.

⌗ **Basic Test on Foundry sand**

- ✓ Specific gravity : 2.47
- ✓ Water absorption : 0.45%
- ✓ Bulking of sand : 4%
- ✓ Silt content : Nil

2.2.3 Course Aggregate (CA)

Aggregate that do not pass through a IS sieve 4.75 mm. It occupies almost of volume in concrete and hence shows influence on various properties such as strength, workability, durability and economy of concrete.

a. Natural aggregate (NA)

The aggregate having size more than 4.75 mm is termed as coarse aggregate.

⌗ **Basic Test on Natural aggregate**

- ✓ Specific Gravity : 2.60
- ✓ Fineness Modulus : 6.53
- ✓ Water Absorption : 0.4%
- ✓ Shape : Angular

b. Construction Demolition waste

This Construction Demolition Waste is taken from the pavement demolished aggregate waste. this aggregates are taken passing through 20 mm sieve and retained on 12.5 mm sieve as per given in IRC:121-2017 is used for all the specimens.

⌗ **Basic Test on C&D Waste**

- ✓ Specific Gravity : 2.45
- ✓ Flakiness index :15.6%
- ✓ Elongation index :17.5%
- ✓ Water Absorption: 4.7 %

2.2.4 Water

Potable water is used for mixing concrete.

2.2.5 Super Plasticizer

The super plasticizer used in this experiment is SP 430. It is manufactured by FOSROC Company in India.

⌗ **Properties of Super plasticizer**

- ✓ Specific gravity :1.2
- ✓ Colour :Light brown
- ✓ Plasticizer type :High

2.2.6 Poly Propylene Fibres (PPF)

A fibre grating does not corrode like steel grating and is therefore used in corrosive environments to reduce maintenance costs. The poly propylene fibers are used in this project 0.3%.

⌗ **Properties of Poly propylene fibre**

- ✓ Material : Polypropylene fibre
- ✓ Type : CT 2424
- ✓ Filament diameter : 25 Microns
- ✓ Cut length : 12mm

2.3 Methodology

2.3.1 The Following methodology is adopted for the present work:

Fig 2:- Methodology Flowchart

2.4 Experimental Details

2.4.1 Mix Design, Means, Modes and Methods

In this experiment conducted the grades of concrete M-50. The mix design was carried out as per IRC 44-2017. The trials have been prepared and M-50 grade was design for this experiment having the mix proportion 1:1.11:3.34 and the water cement ratio are 0.3. All locally available materials are used during the preparation of the mix proportion.

2.4.2 IRC Method of Concrete Mix Design

Primarily it implemented in the design of Concrete Rigid Pavements on Road Construction. Flexural strength is more often specified than the compressive strength in the design of concrete mixes for pavement construction.

Table 2.1:- Mix Proportion as per IRC 44-2017

Materials	Quantity in Kg/m^3	Proportion
Cement	420.58	1
Fine aggregate	466.90	1.11
Coarse aggregate	1405.10	3.34
Water	126	0.3

2.4.3 Mixing of Samples

The mixing of ingredients is done with proper care and all materials were weighted properly and mixed in the laboratory concrete mixer. The water is added after all materials are feed into in mixer in proper order to enhance workability. In addition to the water super plasticizes was used in this experiment. To find the optimum dosage of super plasticizer we conducted Marsh Cone test.

2.4.3.1 Marsh Cone Test (Optimum Dosage of Super Plasticizer)

Marsh cone testing method is used for finding the saturation dosage.

Table 2.2:- Marsh Cone Test results

SL	Dosage in %	Time in seconds
1	0	37.70
2	0.25	27.50
3	0.50	25.60
4	0.75	26.20
5	1.0	24.50
6	1.25	23.10
7	**1.5**	**22.90**
8	1.75	22.90
9	2.0	23.00

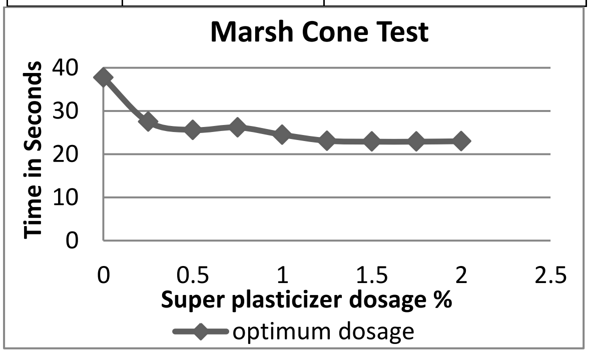

Fig 3:- Graphical representation of Optimum Dosage of super plasticizer

By observing the graph in fig 3, the optimum dosage of super plasticizer is taken 1.5%.

2.4.5 Casting of Specimens

After all the materials are collected and mixed with proper manner. The cubes were filled of size 15x15x15cm by partially replacement of foundry sand (0%, 10%, 20%, 30% and 40%) and also partially replaced C&D waste as (0%, 5%, 10%, 15% and 20%) and also specimens casted for the test on hardened concrete like cubes in size 15x15x15cm, cylinders in size 10x50cm and beams in size 10x10x50cm.

Compacted by using table vibrating machine or compacted using the tamping rod for around 25 times. The moulds were levelled properly and casted moulds, beams and cylinders.

Fig 4:- Preparing and Casting of Cubes

2.4.6 Curing of Specimens

After casting the specimens like cubes, beams and cylinders. All the specimens were kept for 24 hours and then it is removed from mould and kept in curing tank till the testing days up to 7, 14, and 28 days.

Fig 5:- Prepared specimens are curing

2.4.7 Testing of Specimens

After completion of the curing the testing samples are dry about half an hour. After completely surface drying is done then testing was done by universal testing machine of each percentage of three cubes. The prepared specimens are tested Mechanical properties of concrete such as Compressive strength, Split tensile strength and Flexural strength of concrete for 7, 14, and 28 days.

Fig 6:- Testing of cubes after surface drying

3. RESULTS AND DISCUSSION

3.1 Test On Fresh Concrete

3.1.1 Slump cone test

3.1.2 Compaction factor test

3.1.1 Slump Cone test

The concrete slump test measures the consistancy of fresh concrete before it sets. İt can be also used as an indicator of improparly mixed batch.

Table 3.1:- Slump test results

Sample	Slump Valve in mm
Trial 1	47
Trial 2	50
Trial 3	52

3.1.2 Compaction factor test

The Compaction factor test is used for concrete which have low workability for which slump test is not suitable.

Table 3.2:- Compaction factor test results

Sample	Compaction factor in mm
Trial 1	0.742
Trial 2	0.710
Trial 3	0.735

3.2 Compressive Strength to Find Optimum Dosage

In this research work, to find the optimum dosage of compressive strength of concrete for both foundry sand and C&D waste by weight for both with and without fibers. The compressive strength at 7, 14 and 28 days of cured concrete specimen are shown in below tables.

3.2.1 Partially Replacement of foundry sand to find optimum dosage

A. With and without PPF as replaced Foundry Sand for 7 days of curing.

Table 3.3:- Without PPF as replaced Foundry Sand at 7 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	39.70
2	10%	38.96
3	**20%**	**43.25**
4	30%	42.22
5	40%	40.00

Table 3.4:- With PPF as replaced Foundry Sand at 7 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	44.29
2	10%	44.55
3	**20%**	**47.55**
4	30%	45.33
5	40%	43.25

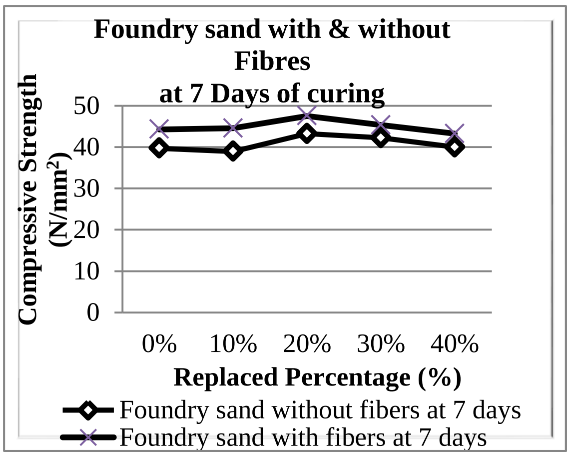

Fig 7:-Graphical Representation of Foundry sand with & without fiber for 7days

B. With and without PPF as replaced Foundry Sand for 14 days of curing.

Table 3.5:- Without PPF as replaced Foundry Sand at 14 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	56.59
2	10%	55.40
3	**20%**	**57.77**
4	30%	56.44
5	40%	54.22

Table 3.6:- With PPF as replaced Foundry Sand at 14 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	58.22
2	10%	58.66
3	**20%**	**60.29**
4	30%	58.96
5	40%	57.18

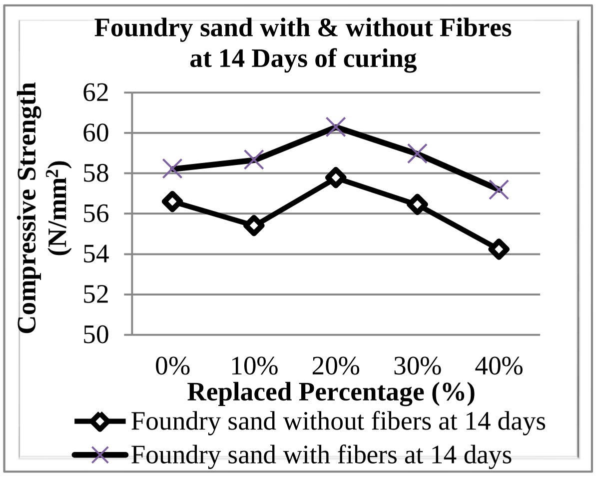

Fig 8:-Graphical Representation of Foundry sand with & without fiber for 14 days

C. With and without PPF as replaced Foundry Sand for 28 days of curing.

Table 3.7:- Without PPF as replaced Foundry Sand at 28 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	61.48
2	10%	62.37
3	**20%**	**64.59**
4	30%	62.51
5	40%	59.55

Table 3.8:- With PPF as replaced Foundry Sand at 28 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	65.18
2	10%	66.07
3	**20%**	**68.88**
4	30%	65.77
5	40%	63.85

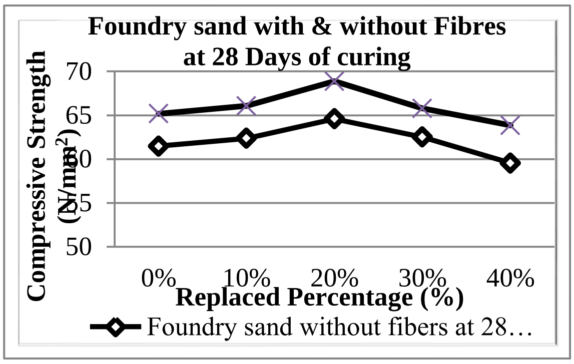

Fig 9:-Graphical Representation of Foundry sand with & without fiber for 28 days

Inference:-

From the above Tables4.3, 4.4, 4.5, 4.6, 4.7 and 4.8 represents the compressive strength of concrete with partially replacement of foundry sand for 0%, 10%, 20%, 30% and 40% by weight of fine aggregates for both with and without poly propylene fibers and above graph represents the **20%** optimum percentage of foundry sand by comparing with and without fibers. For all the tables showsincrease in compressive strength then without fiber and for 7, 14 and 28 days of curing.

3.2.2 Partially replacement of C & D waste to find optimum dosage.

3.2.2.1 With and without PPF as replaced C & D waste for 7 days of curing.

Table 3.9:- Without PPF as replaced C & D Waste at 7 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	39.70
2	5%	41.77
3	**10%**	**42.37**
4	15%	41.18
5	20%	40.29

Table 3.10:- With PPF as replaced C & D Waste at 7 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	44.29
2	5%	45.33

3	**10%**	**46.37**
4	15%	42.96
5	20%	42.07

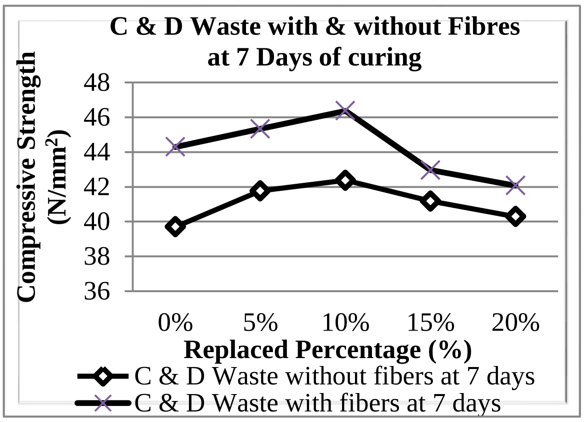

Fig 10:-Graphical Representation of C &D waste with & without fiber for 7days

3.2.2.2 With and without PPF as replaced C & D waste for 14 days of curing.

Table 3.11:- Without PPF as replaced C & D Waste at 14 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	56.59
2	5%	57.48
3	**10%**	**58.37**
4	15%	56.44
5	20%	53.62

Table 3.12:- With PPF as replaced C & D Waste at 14 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	58.22
2	5%	58.51
3	**10%**	**60.44**
4	15%	57.33
5	20%	55.40

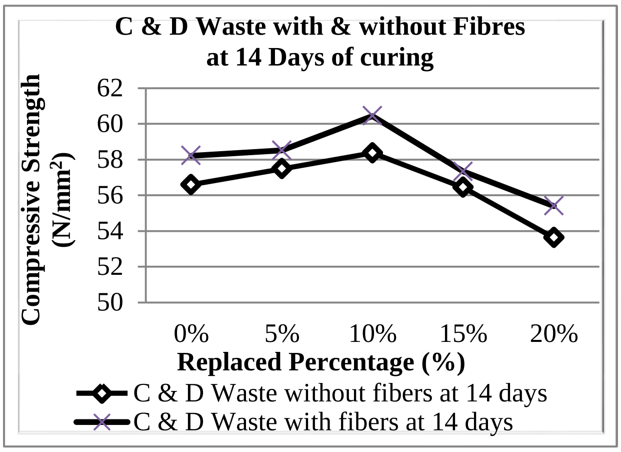

Fig 11:-Graphical Representation of C &D waste with & without fiber for 14days

3.2.2.3 With and without PPF as replaced C & D waste for 28 days of curing.

Table 3.13:- Without PPF as replaced C & D Waste at 28 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	61.48
2	5%	62.66
3	**10%**	**64.29**
4	15%	61.03
5	20%	58.66

Table 3.14:- With PPF as replaced C & D Waste at 28 days of curing.

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	0%	65.18
2	5%	64.29
3	**10%**	**66.07**
4	15%	64.29
5	20%	60.74

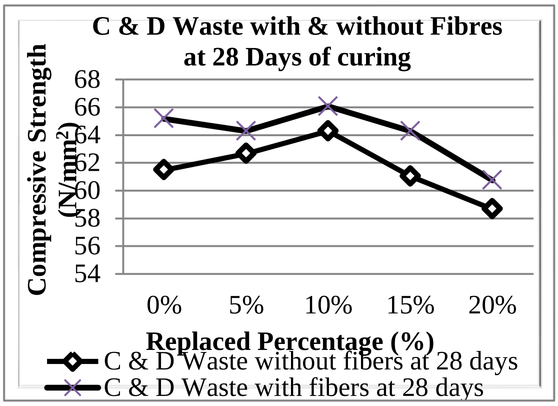

Fig 12:-Graphical Representation of C &D waste with & without fiber for 28 days

Inference:-

From the above Tables4.9, 4.10, 4.11, 4.12, 4.13 and 4.14 represents the compressive strength of concrete with partially replacement of construction and demolition waste for 0%, 5%, 10%, 15% and 20% by weight of coarse aggregates for both with and without poly propylene fibers and above graph represents the 10% optimum percentage of construction and demolition waste by comparing with and without fibers. For all the tables shows increase in compressive strength then without fiber and for 7, 14 and 28 days of curing.

3.3 Tests on Hardened Concrete

3.3.1 Compressive Strength

3.3.2 Splt Tensile Strength

3.3.3 Fluxtural Strength

3.3.4 Shear Strength

3.3.1 Compression Strength Tests for Optimum Replaced Materials.

3.3.1.1 Compression strength test for 7 days.

Table 3.15:- Compression strength test for 7 days

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	Conventional	44.29
2	FS 20% + C&D 10%	50.07

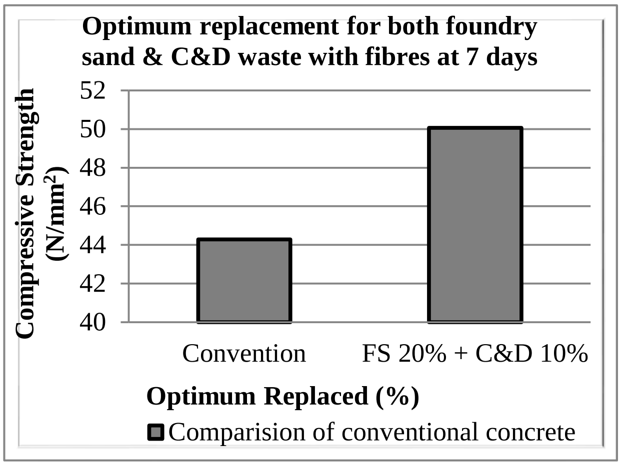

Fig 13:-Graphical Representation of Optimum Replaced % v/s Compressive Strength for 7 days

3.3.1.2 Compression strength test for 14 days of curing.

Table 3.16:- Compression strength test for 14 days results

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	Conventional	58.22
2	FS 20% + C&D 10%	63.70

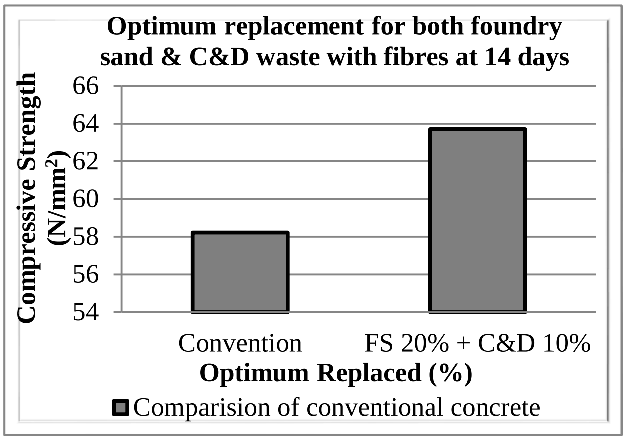

Fig 14:-Graphical representation of Optimum replaced % v/s Compressive strength for 14 days

3.3.1.3 Compression strength test for 28 days of curing.

Table 3.17:- Compression strength test for 28 days results

SL	Replacement of Materials	Avg. Compressive Strength in MPA
1	Conventional	65.18
2	FS 20% + C&D 10%	72.78

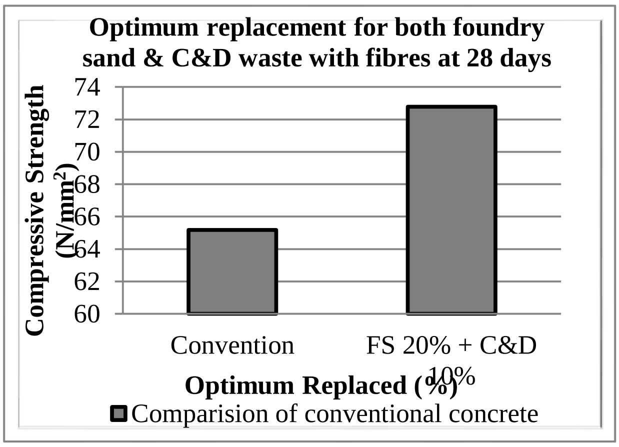

Fig 15:-Graphical representation of Optimum replaced % v/s Compressive strength for 28 days

3.3.2 Split Tensile Strength Test for Optimum Replaced Materials.

3.3.2.1 Split tensile strength test for 7 days

Table 3.18:-Split tensile strength test for 7 days results

SL	Replacement of Materials	Avg. Split Tensile Strength in MPA
1	Conventional	2.45
2	FS 20% + C&D 10%	3.25

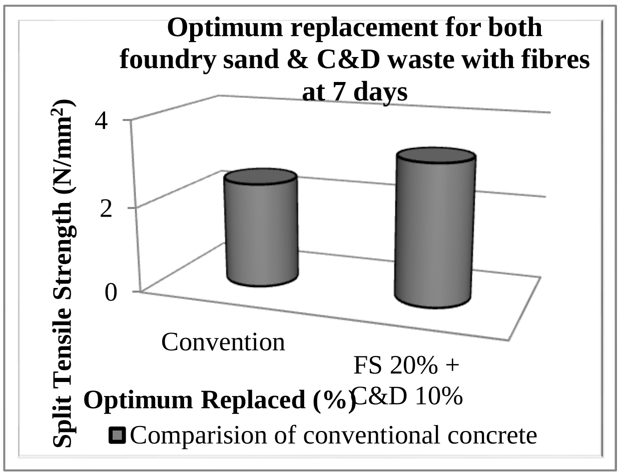

Fig 16:-Graphical representation of Optimum replaced % v/s Split tensile strength for 7 days

3.3.2.2 Split tensile strength test for 28 days of curing.

Table 3.19:-Split tensile strength test for 28 days results

SL	Replacement of Materials	Avg. Split Tensile Strength in MPA
1	Conventional	3.77
2	FS 20% + C&D 10%	4.33

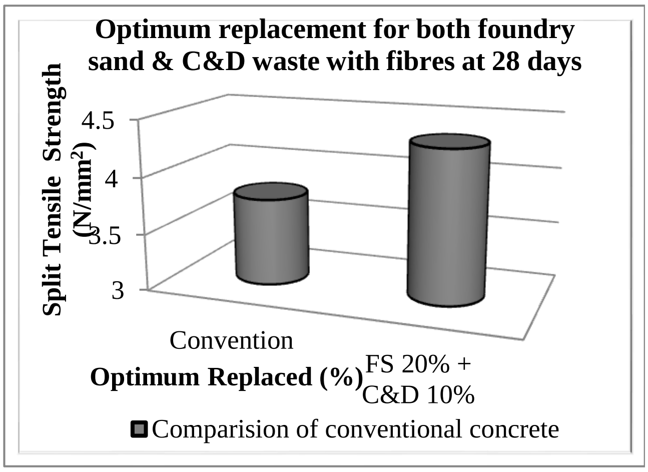

Fig 17:-Graphical representation of Optimum replaced % v/s Split tensile strength for 28 days

3.3.3 Flexural Strength Test for Optimum Replaced Materials.

3.3.3.1 ***Flexural tensile strength test for 7 days***

Table 3.20:- Flexural tensile strength test for 7 days results

SL	Replacement of Materials	Avg. Flexural Strength in MPA
1	Conventional	3.38
2	FS 20% + C&D 10%	4.75

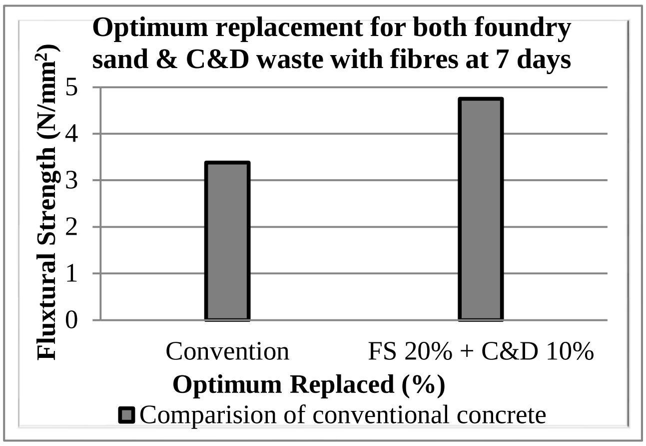

Fig 18:-Graphical representation of Optimum replaced v/s Flexural tensile strength for 7 days

3.3.3.2 ***Flexural tensile strength test for 28 days*** **Table 3.21:- Flexural tensile strength test for 28 days results**

SL	Replacement of Materials	Avg. Flexural Strength in MPA
1	Conventional	4.02
2	FS 20% + C&D 10%	6.41

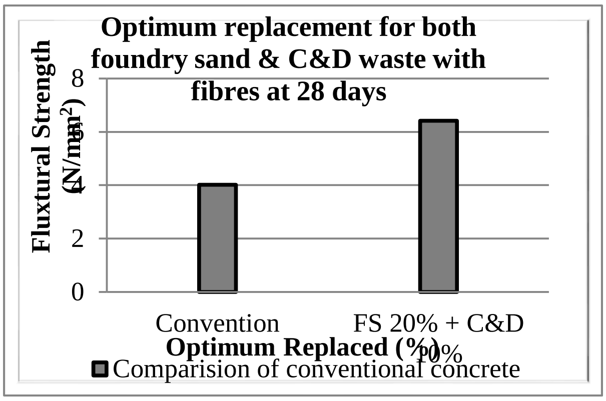

Fig 19:-Graphical representation of Optimum replaced % v/s Flexural strength for 28 days

3.3.4 Shear Strength Test For Optimum Replaced Materials.

3.3.4.1 Shear Strength test for 7 days of curing.

Table 3.22:- Shear Strength test for 7 days results

SL	Replacement of Materials	Avg. Shear Strength in MPA
1	Conventional	10.74
2	FS 20% + C&D 10%	13.70

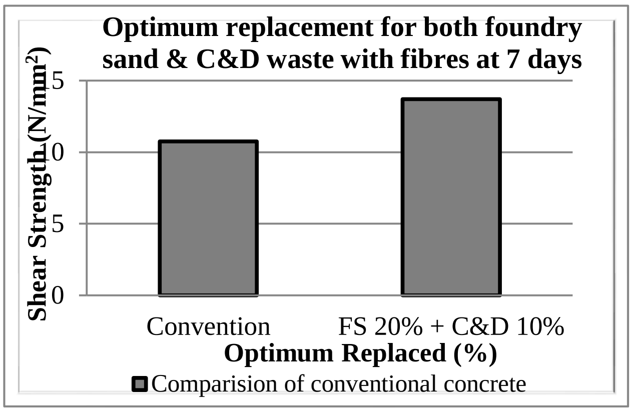

Fig 20:-Graphical Representation of Optimum Replaced % v/s Shear Strength for 7 days

3.3.4.2 Shear strength test for 28 days of curing.

Table 3.23:- Shear strength test for 28 days results

SL	Replacement of Materials	Avg. Shear Strength in MPA
1	Conventional	15.55
2	FS 20% + C&D 10%	20.00

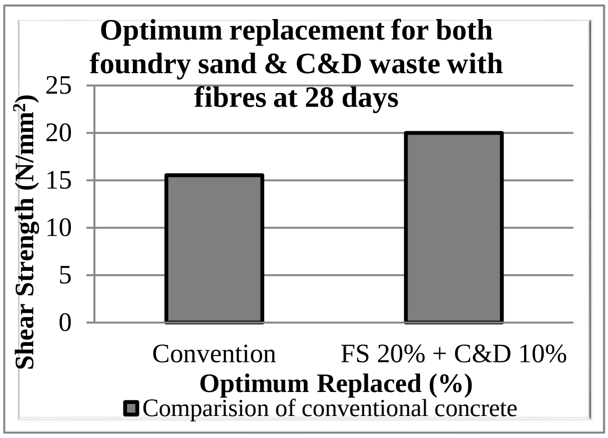

Fig 21:-Graphical representation of Optimum replaced % v/s Shear strength for 28 days

CONCLUSIONS

After completion of this project it is concluded that, from the experimental study of partially replacement of foundry sand from 0% to 40% in the interval of 10% by weight of fine aggregate and partially replacement of C& D waste from 0% to 20% the interval of 5% by weight of course aggregate and also addition of this replacements 0.3% of poly propylene fibres are also added to the concrete. From these different percentage replacements the obtained optimum percentage of foundry sand was 20% and C & D Waste was 10%. By the combination of both optimum percentages we can conclude the hardened concrete test results by comparing with the conventional concrete for High Strength Concrete (M50) as per IRC Guidelines.

- The Compressive strength of Conventional concrete cubes is 65.18Mpa at 28 days, whereas Compressive strength of optimum amount of partially replaced both foundry sand as 20% and C&D waste as 10% at 28 days found to be 72.78Mpa. Also it is found that the compressive strength of partially replaced concrete have 10.44% higher strength than the conventional concrete respectively.
- The Split tensile strength of Conventional concrete cylinders is 3.77Mpa at 28 days, whereas Split tensile strength of optimum amount of partially replaced both foundry sand as 20% and C&D waste as 10% at 28 days found to be 4.33Mpa. Also it is found that the Split tensile strength of partially replaced concrete have 12.93% higher strength than the conventional concrete respectively.
- The Flexural strength of Conventional concrete cylinders is 4.02Mpa at 28 days, whereas Flexural strength of optimum amount of partially replaced both foundry sand as 20% and C&D waste as 10% at 28 days found to be 6.41Mpa. Also it is found that the Flexural strength of partially replaced concrete have 37.28% higher strength than the conventional concrete respectively.
- The Shear strength of Conventional concrete cubes is 15.55Mpa at 28 days, whereas Shear strength of optimum amount of partially replaced both foundry sand as 20% and C&D waste as 10% at 28 days found to be 20.00Mpa. Also it is found that the Shear strength of partially replaced concrete have 22.25% higher strength than the conventional concrete respectively.

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