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An Experimental Work on Green Blocks Composed of Industrial Waste Materials with Polypropylene Fiber.

Comparison of compressive strength, Split tensile strength and Flexural strength in between Normal mix & Green concrete.

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Abstract—More recently fibers such as those used in traditional composite materials have been introduce to increase it's toughness or ability to resist crack growth. Compared with full-dispersed polypropylene fiber has advantages in its thinness, large amount, non-water absorbency, strong acid & alkali resistance and similar elastic modulus with that of concrete. Mainly application is Increase seepage resistance, Improve steel protection, Increase cracking resistance, Increase fire resistance, Strengthen spurt & fatigue, Improve plastic deformity. And It's uses are Projects like concrete road, bridge, airport road and factory floor which strictly require cracking resistance. In this research study aim is comparison of compressive strength between normal mix concrete & green concrete blocks composed by locally available waste materials with Polypropylene fiber and reduce the cost of concrete. In this research study the (OPC) cement has been 50% replaced by waste ceramic powder by weight of M-30 grade concrete & fine aggregate (sand) has been 25% replaced by waste tyre rubber by weight of M-30 grade concrete and also used polypropylene fiber as a additional material. Concrete mixtures were produced, tested and compared in terms of compressive strength, Split tensile strength and Flexural strength to the conventional concrete. These tests were carried out to evaluate the mechanical properties for 3, 14 and 28 days. Then after 3, 14, & 28 days of curing work, we will perform analysis and measure compressive strength, Split tensile strength and Flexural strength in normal mix concrete and green blocks with polypropylene fiber concrete.

Keywords- Waste ceramic powder, Waste tyre rubber, Polypropylene fiber, Compressive Strength, Split tensile strength, Flexural strength, Eco-Friendly, Low Cost, OPC Cement, Sustainable.

I. INTRODUCTION

Management of waste-tyre rubber is very difficult for municipalities to handle because the waste tyre rubber is not easily biodegradable even after long-period of landfill treatment (Guneyisi et al. 2004). However, recycling of waste tire rubber is an alternative. Recycled waste-tyre rubber have been used in different application. It has been used as a fuel for cement kiln, as feedstock for making carbon black, and as artificial reefs in marine environment (Siddique and Naik, 2004). It has also been used as a playground matt, erosion control, highway crash barriers, guard rail posts, noise barriers, and in asphalt pavement mixtures (Toutanji, 1996). Over the past two decades, research had been performed to study the availability of using waste tyre rubber in concrete mixes (Eldin and Senouci, 1993, Toutanji, 1996, Khatib and Bayomy, 1999, Siddique and Naik, 2004, Batayneh et al, 2008, Aiello and Leuzzi, 2010, and Najim and Hall, 2010). [1]

Indian ceramic production is 100 Million ton per year. In the ceramic industry, about 15%- 30% waste material generated from the total production. This waste is not recycled in any form at present. However, the ceramic waste is durable, hard and highly resistant to biological, chemical, and physical degradation forces. The Ceramic industries are dumping the powder in any nearby pit or vacant spaces, near their unit although notified areas have been marked for dumping. [3]
This leads to serious environmental and dust pollution and occupation of a vast area of land, especially after the powder dries up so it is necessary to dispose the Ceramic waste quickly and use in the construction industry. As the ceramic waste is piling up every day, there is a pressure on ceramic industries to find a solution for its disposal. [3]
The advancement of concrete technology can reduce the consumption of natural resources. They have forced to focus on recovery, reuse of natural resources and find other alternatives. The use of the replacement materials offer cost reduction, energy savings, arguably superior products, and fewer hazards in the environment. [3]

II. EXPERIMENTAL MATERIALS

2.1 Standard Concrete Materials:

2.1.1 Cement (OPC):
The Ordinary Portland Cement of 53 grades conforming to IS: 8112 is being used. [3]

Table-1:Physical properties of Cement (OPC) [3]

Property	**IS CODE (IS : 8112 – 1989)**
Specific Gravity	3.12
Consistency	33
Initial setting time	30 minimum
Final setting time	600 maximum

2.1.2 Aggregate:
Aggregates are the important constituents in concrete. They give body to the concrete, reduce shrinkage and effect economy. One of the most important factors for producing workable concrete is a good gradation of aggregates. Good grading implies that a sample fraction of aggregates in required proportion such that the sample contains minimum voids. Samples of the well graded aggregate containing minimum voids require minimum paste to fill up the voids in the aggregates. Minimum paste means less quantity of cement and less water, which are further mean increased economy, higher strength, lower shrinkage and greater durability. [3]

2.1.3 Coarse Aggregate:
The fractions from 20 mm to 4.75 mm are used as coarse aggregate. The Coarse Aggregates from crushed Basalt rock, conforming to IS: 383 is being use. The Flakiness and Elongation Index were maintained well below 15%. [3]

2.1.4 Fine aggregate:
Those fractions from 4.75 mm to 150 microns are termed as fine aggregate. The river sand is used in combination as fine aggregate conforming to the requirements of IS: 383. The river sand is washed and screen, to eliminate deleterious materials and oversize particles. [3]

Table-2: Properties of fine aggregate, Course aggregate [3]

Property	Fine Aggregate	Coarse Aggregate (20mm down)	Coarse Aggregate (10 mm down)
Fineness modulus	3.35	7.54	3.19
Specific Gravity	2.38	2.76	2.69
Bulk Density (gm/cc)	1753	1741	1711
Water absorption (%)	1.20	1.83	1.35

2.1.5 Water:
Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water are required to be looked into very carefully. [3]

2.2 Waste Materials:

2.2.1 Waste tyre rubber:
Crumb rubber that replaces for sand (Figure 1), is manufactured by special mills in which big rubbers change into smaller torn particles. In this procedure, different sizes of rubber particles may be produced depending on the kind of mills used and the temperature generated (Ganjian et al.,2009). Sieve analysis for the sand and the crumb rubber was performed according to the ECP 203-2003 to determine the gradation of these materials. [1]

Figure 1: Waste crumb tire rubber [1]

2.2.2 Waste Ceramic powder:
Ceramic waste is one of the most active research areas that encompass a number of disciplines including civil engineering and construction materials. Ceramic waste powder is settled by sedimentation and then dumped away which results in environmental pollution, in addition to forming dust in summer and threatening both agriculture and public health. The principle waste coming into the ceramic industry is the ceramic powder, specifically in the powder forms. Ceramic wastes are generated as a waste during the process of dressing and polishing. It is estimated that 15 to 30% waste are produced of total raw material used, and although a portion of this waste may be utilized on-site, such as for excavation pit refill, The disposals of these waste materials acquire large land areas and remain scattered all around, spoiling the aesthetic of the entire region. It is very

difficult to find a use of ceramic waste produced. Ceramic waste can be used in concrete to improve its strength and other durability factors. Ceramic waste can be used as a partial replacement of cement or as a partial replacement of fine aggregate sand as a supplementary addition to achieve different properties of concrete. [3]

Figure 2: Waste Ceramic powder

2.3 Additional Material:

2.3.1 Polypropylene fiber:

Commercial success of polypropylene fibers as a filler material in Portland cement concrete (PCC) is due to their advantageous properties. The fibers are chemically inert, have hydrophobic surfaces, are very stable in the alkaline environment of concrete and resist plastic shrinkage cracking. Nevertheless, they also have some disadvantages – including poor fire resistance, sensitivity to sunlight and oxygen, a low modulus of elasticity, and poor bonding with the concrete matrix. The use of relatively low-modulus PP fibers does not yield substantial improvement of the tensile strength – but does significantly improve the flexural strength, toughness and ductility. Concrete reinforced with collated fibrillated PP-fibers (at relatively low volume fractions <0.3%) are used for: secondary temperature shrinkage reinforcement, overlays and pavements, slabs, flooring systems, crash barriers, precast pile shells and shotcrete for tunnel linings, canals and reservoirs. [4]

Figure 3: Polypropylene fiber

III. DESIGN MIX

A mix M30 grade was designed as per Indian Standard method (IS 10262-2009) and the same was used to prepare the test samples. The design mix proportion is done in Table 4.

3.1 Quantity of Normal mix M30 (As per IS code method):

Table-3: Quantity of Normal mix M30

Name of Materials	Quantity of 9 Cube	Quantity of 18 Cylinder
Coarse Aggregate: 20mm	25 kg	78 kg
Coarse Aggregate: - 10mm	10 kg	32 kg
Fine Aggregate	17 kg	54 kg
Cement	15 kg	46 kg
Water	6 lit.	20 lit.

3.2 Quantity of 3 Beam mould (As per IS code method):

Table-4: Quantity of Normal mix M30(150mm x 150mm x 700mm):

Name Of Materials	Quantity Of 3 Beam
Coarse Aggregate: - 20mm	38.88 kg
Coarse Aggregate: - 10mm	15.55 kg
Fine Aggregate	26.43 kg
Cement	23.33 kg
Water	9.33 lit.

3.3 Quantity of Green concrete M30:

Waste Ceramic powder use dosage : cement to be replaced by 50% of total weight.
Waste Tyre rubber use dosage : sand to be replaced by 25% of total weight.
Polypropylene fiber use dosage : 3% to 5% of cubic meter of concrete.

3.3.1 Quantity of 9 Cubic moulds:

Table-5: Quantity of Green concrete M30 for 9 cubic moulds (150mm X 150mm X 150mm):

Name of Materials	Total Quantity	Name of Waste Materials	Replaced % of Waste Materials	Replaced Quantity of Waste Materials	Final quantity of Material
C.A.(20mm)	25 kg	Nil	Nil	Nil	25 kg
C.A.(10mm)	10 kg	Nil	Nil	Nil	10 kg
F.A.	17 kg	Tyre rubber	25%	4.25 kg	12.75 kg
Cement	15 kg	Waste Ceramic powder	50%	7.5 kg	7.5 kg
Water	6 lit.	Nil	Nil	Nil	6 lit.

3.3.2 Quantity of 18 Cylindrical moulds:

Table-6: Quantity of Green concrete M30 for 18 cylindrical moulds (diameter: 150mm and depth: 300mm):

Name of Materials	Total Quantity	Name of Waste Materials	Replaced % of Waste Materials	Replaced Quantity of Waste Materials	Final quantity of Material
C.A.(20mm)	78 kg	Nil	Nil	Nil	78 kg
C.A.(10mm)	32 kg	Nil	Nil	Nil	32 kg
F.A.	54 kg	Tyre rubber	25%	13.5 kg	40.5 kg
Cement	46 kg	Waste Ceramic powder	50%	23 kg	23 kg
Water	20 lit.	Nil	Nil	Nil	20 lit.

3.3.3 Quantity of 3 Green Beam mould:

Table-7: Quantity of Green concrete M30 for 3 beam moulds (150mm X 150mm X 700mm):

Name of Materials	Total Quantity	Name of Waste Materials	Replaced % of Waste Materials	Replaced Quantity of Waste Materials	Final quantity of Material
C.A.(20mm)	38.88 kg	Nil	Nil	Nil	38.88 kg
C.A.(10mm)	15.55 kg	Nil	Nil	Nil	15.55 kg
F.A.	26.43 kg	Tyre rubber	25%	6.60 kg	19.82 kg
Cement	23.33 kg	Waste Ceramic powder	50%	11.65 kg	11.65 kg
Water	9.33 lit.	Nil	Nil	Nil	9.33 lit.

Where, C.A. = Coarse Aggregate, F.A. = Fine Aggregate
After calculate the all quantity, we have to perform the concrete mix in mixer as per the above quantity and prepare 18 cube (9 Normal mix, 9 Green concrete) and 36 cylinder (18 Normal mix, 18 Green concrete) and 6 beam (3 Normal mix, 3 Green concrete).

IV. RESULTS & SUMMARY

4.1 Comparison of compressive strength in between normal mix and green blocks after 3, 14 & 28 days curing of cube.

Table-8: Comparison of compressive strength in between normal mix and green blocks after 3, 14, & 28 days curing of cube.

	NORMAL MIX	GREEN BLOCK
No. of Days	Average Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
3	11.00	2.22
14	18.50	5.00
28	30.10	7.00

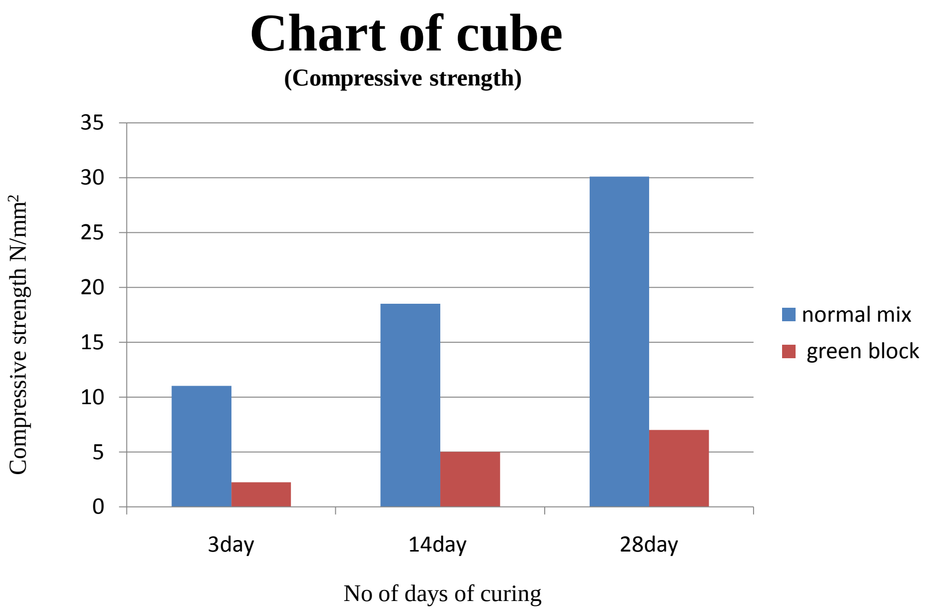

Figure 4: Chart of Compressive strength v/s no. of days curing for cube

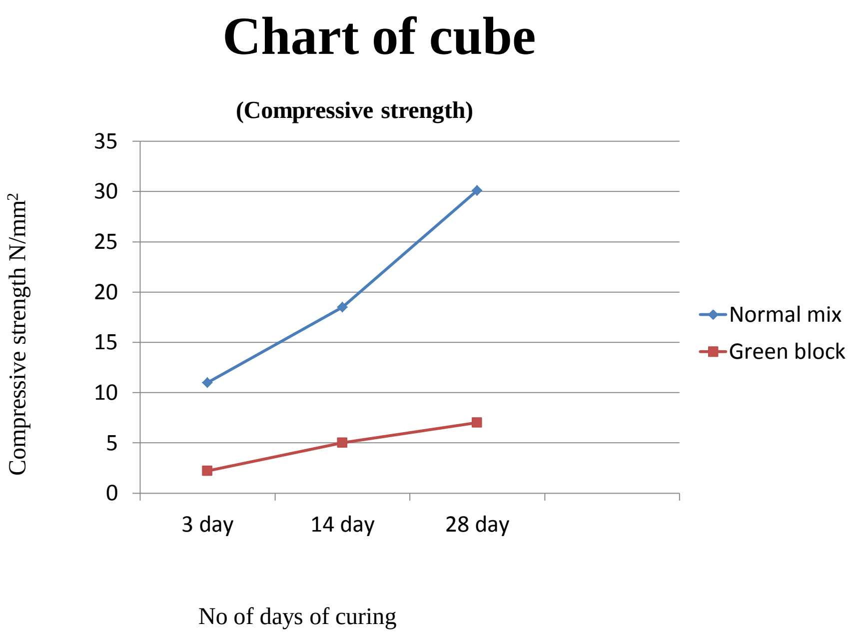

Figure 5: Chart of Compressive strength v/s no. of days curing for cube

4.2 Comparison of compressive strength in between normal mix and green blocks after 3, 14 & 28 days curing of cylinder.

Table-9: Comparison of compressive strength in between normal mix and green blocks after 3, 14 & 28 days curing of cylinder.

	NORMAL MIX	GREEN BLOCK
No. of Days	Average Compressive Strength (N/mm^2)	Average Compressive Strength (N/mm^2)
3	13.13	3.11
14	19.50	4.24
28	31.00	8.13

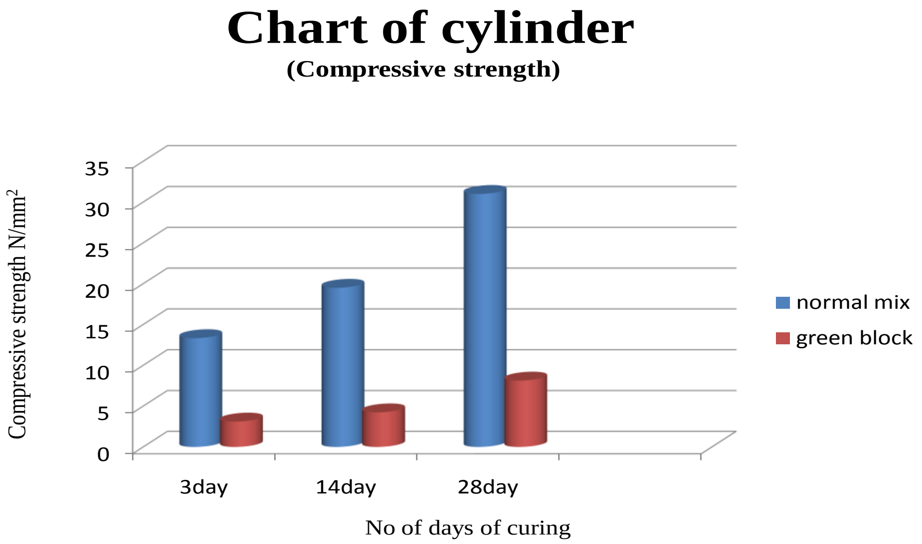

Figure 6: Chart of Compressive strength v/s no. of days curing for cylinder

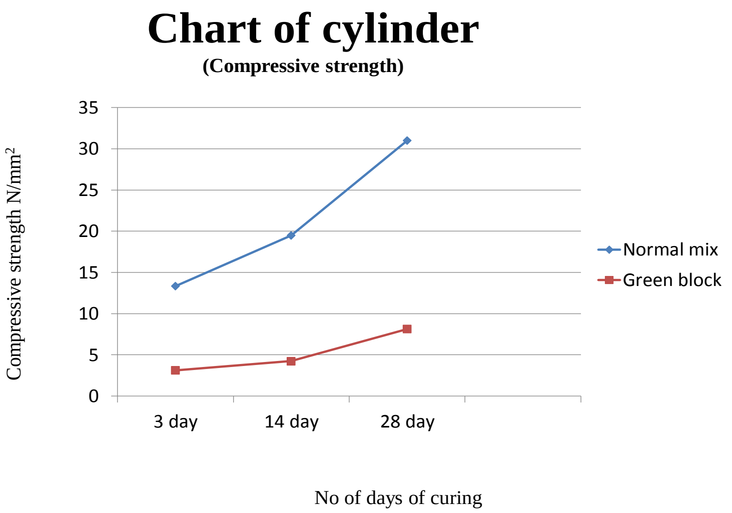

Figure 7: Chart of Compressive strength v/s no. of days curing for cylinder

4.3 Comparison of split tensile strength in between normal mix and green blocks after 3, 14 & 28 days curing of cylinder.

Table-10: Comparison of split tensile strength in between normal mix and green blocks after 3, 14 & 28 days curing of cylinder.

	NORMAL MIX	GREEN BLOCK
No. of Days	Average Split tensile Strength (N/mm^2)	Average Split tensile Strength (N/mm^2)
3	2.19	0.21
14	1.88	0.51
28	1.53	1.03

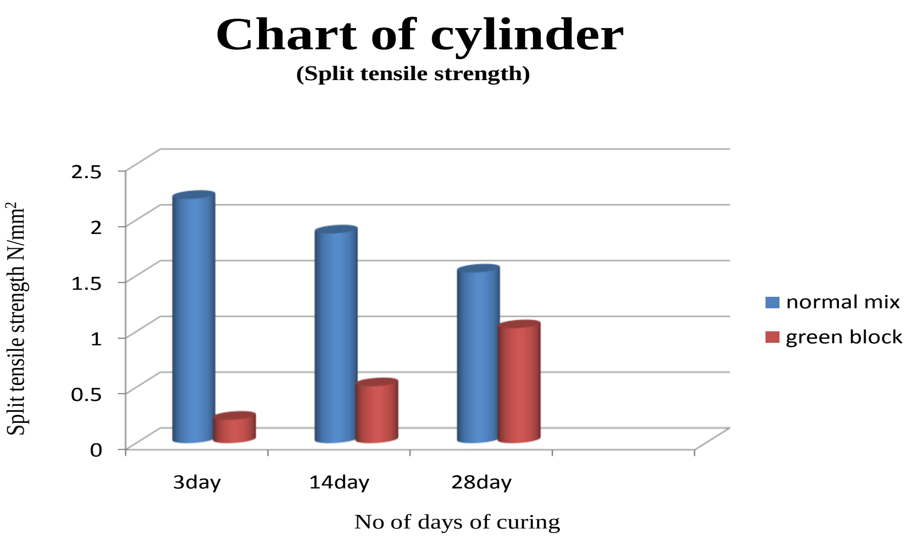

Figure 8: Chart of Split tensile strength v/s no. of days curing for cylinder

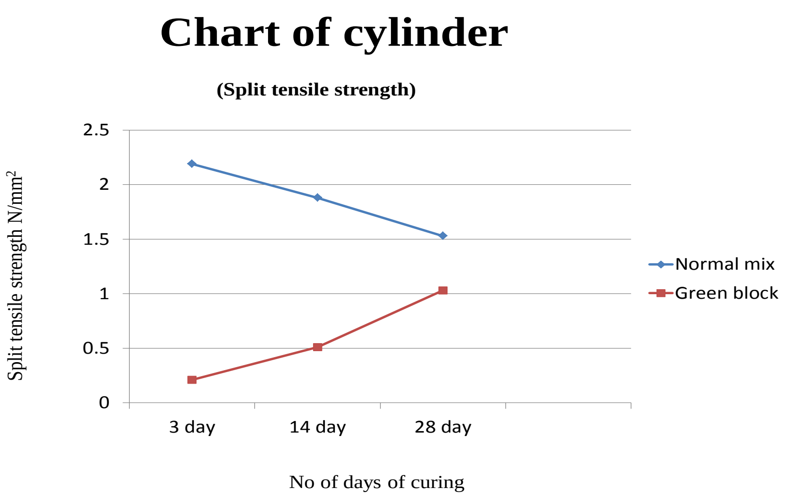

Figure 9: Chart of Split tensile strength v/s no. of days curing for cylinder

4.4 Comparison of Flexural strength in between normal mix and green blocks after 28 days curing of beam.

Table-11: Comparison of flexural strength in between normal mix and green blocks after 28 days curing of beam.

	NORMAL MIX	GREEN BLOCK
No. of Days	**Average flexural Strength (N/mm^2)**	**Average flexural Strength (N/mm^2)**
28	6.69	2.95

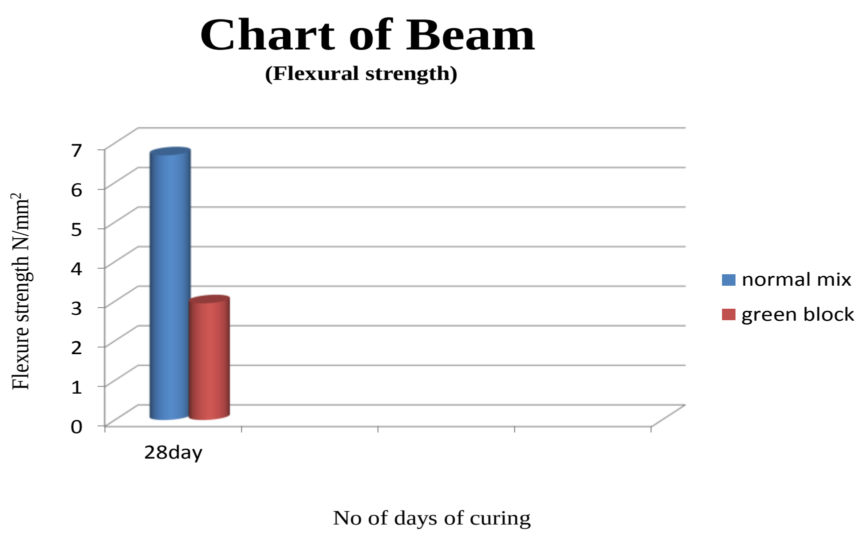

Figure 10: Chart of Flexural strength v/s no. of days curing for beam

V. CONCLUSION

Based on the above discussions the following conclusions are made:

1. An experimental work on green blocks, we conclude that after 28 days of curing, green blocks composed of Industrial waste materials with polypropylene fiber, which gives lower compressive strength at 3, 14 and 28 days compare to normal mix concrete.
2. We can use Industrial waste materials with polypropylene fiber but there is no increase in compressive strength of green concrete blocks. After experiment we have getting compressive strength of green blocks only around 25% compare to Compressive strength of normal mix M30.
3. After experiment we have getting Split tensile strength of green cylinder which is equivalent compare to normal mix M30.
4. After experiment we have getting flexural strength of green beam is 45% compare to flexural strength of normal mix M30.
5. Green concrete is very chipper than normal mix concrete. Because, waste material is easily available and nominal cost.
6. This type of Green concrete is used in the Low cost house and low strength structure construction.

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