Effect of Domestic Waste PP Bag Fibre in Concrete

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Abstract--- *In conventional concrete, micro-cracks develop before structure is loaded because of drying shrinkage and other causes of volume change. When the structure is loaded, the micro cracks open up and propagate because of development of such micro-cracks, results in inelastic deformation in concrete. PP Fiber reinforced concrete (PPFRC) is cementing concrete reinforced mixture with more or less randomly distributed small fibers. In the PP FRC, a numbers of small fibers are dispersed and distributed randomly in the concrete at the time of mixing, and thus improve concrete properties in all directions. The fibers help to transfer load to the internal micro cracks. PP FRC is cement based composite material that has been developed in recent years. It has been successfully used in construction with its excellent flexural-tensile strength, resistance to spitting, impact resistance and excellent permeability and frost resistance. It is an effective way to increase toughness, shock resistance and resistance to plastic shrinkage cracking of the mortar. These fibers have many benefits. Durability of the concrete is improved to reduce in the crack widths. Polypropylene and Nylon fibers are used to improve the impact resistance. Many developments have been made in the fiber reinforced concrete. In this study, the results of the Strength properties of Polypropylene fiber reinforced concrete are to present. The compressive strength, splitting tensile strength of concrete samples made with different fibers amounts varies from 0%,0.5%,1% 1.5% and 2.0% are to study.*

Keywords: *PPFRC, OPC, LWC.*

1.0 INTRODUCTION

Development of lightweight concrete (LWC) has been one the most interesting subjects in sustainable construction materials and concrete industry; as lightweight concrete gives economic and structural benefits. Lightweight concrete decreases the total dead load of a structure, which allows the structural engineers to reduce the size of structural members such as columns, foundation and other load bearing structures while contribute and maintain the structural performance. In the concrete industry, lightweight concrete is developed through replacement In recent years, many studies have been conducted in the mechanical characteristics of reinforced fibre concrete. Such concrete is also used in retrofitting and repairing the covering of concrete structure, tunnels, etc.

Polypropylene fibres (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.

Two kinds of fibre that very often used in the concrete are: steel fibre and polypropylene fibre. The evaporation of concrete surface water is a factor in creating the contract paste fracture in concrete which leads to the formation of tension stress since the concrete starts to strengthen. Such stress is developed during the concrete strengthening and the concrete is cracked where the stress is more than the concrete strength. The cracks caused by paste contracting in the concrete are formed in the first hours after pouring the concrete in the frames and before the concrete reaches its initial strength.

THE CHARACTERISTICS OF DIFFERENT FIBRES

Type	S.G (g/cm^3)	Tensile Strength (Mpa)	E(GN/m^2)
Poly propylene	0.91	550-700	3.5-6.8
Steel	7.86	400-1200	200
Glass	2.7	1200-1700	73
Asbestos	2.55	210-2000	159
Polyester	1.4	400-600	8.4-16
Concrete for comparison	2.4	-6	20-50

2.0 POLYPROPYLENE FIBRES

Polypropylene is available in two forms, monofilament fibers and film fibers. Monofilament fibers are produced by an extrusion process through the orifices in a spinneret and then cut to the desired length. The fibrillated fibres have a net-like physical structure. The tensile strength of the fibres is developed by the molecular orientation obtained during the extrusion process. Polypropylene has a melting point of 165 degrees C and can withstand temperatures of over **100** degrees C for short periods of time before softening'.

It is chemically inert and any chemical that can harm these fibres will probably be much more detrimental to the concrete matrix'. The fibre is susceptible to degradation by **UV** radiation (sunlight) and oxygen; however, in the concrete matrix this problem is eliminated'.Monofilament fibres were the first type of polypropylene fibre introduced as an additive in PFRC. Monofilament fibres are available in lengths of 1/2, 3/4, and 1-1/2 inches **.**The monofilament fibres have also been produced with end buttons or in twisted form to provide for greater mechanical anchorage and better performance. The majority of fibre manufacturers recommend the fibrillated type of fibre for use in paving applications. The exact chemical composition and method of manufacture may vary slightly among producers. The main types or geometry of fibres currently available from most producers are monofilament and fibrillated.

Polypropylene macro fibers

3.0 OBJECTIVES OF THE PROJECT

• To Increase Toughness, shock resistance.
• To resist plastic shrinkage cracking of the mortar.
• Steel fibers can improve the structural strength.
• To reduce in the heavy steel reinforcement requirement

4.0 MATERIALS AND PROPERTIES

4.1 CEMENT

The cement used was Ordinary Portland cement (OPC) with a specific gravity of 3.15. Initial and final setting times of the cement were 39 min and 495 min, respectively.

4.2 AGGREGATES

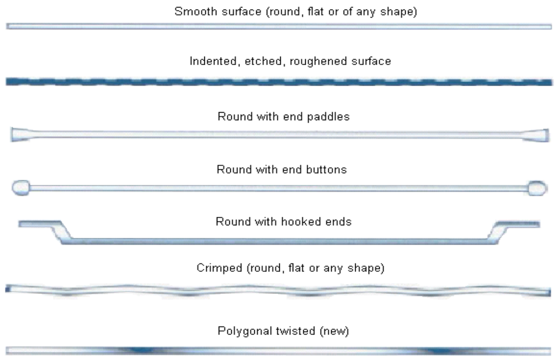
Good quality river sand was used as a fine aggregate of SAND. The material whose particles are of size as are retained on I.S Sieve No.480 (4.75mm) is termed as coarse aggregate. The size of coarse aggregate depends upon the nature of work. The coarse aggregate used in this experimental investigation are of 20mm size crushed angular in shape. The aggregates are free from dust before used in the concrete.

4.3 FIBRES

Fibres vary in types, geometry, properties and availability in construction industry. Most common types of fibres are steel fibres, glass fibres, and polypropylene fibres. These usages may alter in concrete for different applications. The fibres are selected from their properties like, effectiveness, cost and availability.

Different types of fibers used in the construction of different structures are,

1. Steel fibre.
2. Glass fibre.
3. Polypropylene fibre.



Steel fibre geometries

4.4 WATER

The quality of water is important, because impurities in it may interfere with the setting of the cement and it may adversely affect the strength of the concrete or cause staining of its surface and may also lead to corrosion of the reinforcement. Water used for mixing and curing shall be clean and free from injurious amounts of oils, acids, alkalis, salts, sugar, organic material they may be deleterious to concrete or steel permissible limits

4.5 PLASTICIZERS

The plasticizers are the most usual additives and are added to increase the workability of the fresh concrete so that it's easier to cast, without having to add more water and thereby reduce the concrete's capacity. The plasticizers belong to two categories; plasticizers and super plasticizers. The plasticizers are based on a material called lignosulphonate which originates from the wood processing industry. At high dosages the plasticizer may have a retarding side effect. This means that the concrete dries slower and this is not always desirable.

4.6 RETARDERS

Retarders restrain the hydration of the cement by forming a slowly dissolving membrane around the cement grains. They are used when it's desirable to delay the solidification time of the concrete.

5.0 TESTING OF MATERIALS

Table5.1 Cement

S.NO	Physical property	Value obtained
1.	Fineness	2%
2.	Consistency	31.25%
3.	Initial Setting Time	36 minutes
4.	Final Setting Time	390minutes
5.	Specific Gravity	3.15

Table5.2 Fine aggregate

S.NO	Physical property	Value obtained
1.	Fineness modulus	3.8
2.	Grading zone	II
3.	Specific Gravity	2.624
4.	Moisture Content	2.4%
5.	Water Absorption	0.8%

Table5.3 Coarse aggregate

S.NO	Physical property	Value obtained
1.	Fineness modulus	5.39
2.	Nominal size	12.5 mm
3.	Specific Gravity	0.405
4.	Moisture Content	Nil
5.	Water Absorption	6.752%

6.0 MIX DESIGN FOR CONCRETING

DESIGN STIPULATIONS FOR PROPORTIONING

a. **Characteristic compressive strength required in the field at 28 days** - 20 N/mm^2

b. **Maximum size of aggregate**: 20mm

c. **Workability** (Compaction Factor) : 0.90

d. **Degree of quality control**: Good

e. **Type of exposure:** Mild

6.1 TEST DATA FOR MATERIALS

Cement used : OPC

Specific gravity of cement : 3.15

Specific gravity Of

a. Coarse aggregate : 2.60

b. Fine aggregate : 2.60

Water absorption

a. Coarse aggregate : 0.5%

b. Fine aggregate : Nil

Free (surface) moisture

a. Coarse aggregate : Nil

b. Fine aggregate : Nil

The mix proportion per meter cube of concrete then becomes:

Water 191.6

Cement 395.87

Fine aggregate 516.93

Coarse aggregate 1206.16

Mix proportion ratio:

Mix Grade	Water	Cement	Fine Aggregate	Coarse Aggregate
M20	0.484	1	1.306	3.047

PREPARATION AND CASTING OF SPECIMENS

Production of good quality concrete requires meticulous care exercised at every stage of manufacture of concrete. It is interesting to note that the ingredients of good and bad concrete are the same. If meticulous care is not exercised, and good rules are not observed, the resultant concrete is going to be of bad quality. With the same material if intense care is taken to exercise control at every stage, it will result in good concrete.

7.0 CASTING OF TEST SPECIMENS

7.1 Batching

The measurement of materials for making concrete is known as batching. Here, we have adopted weigh-batching method, and it is the correct method too. Use of weigh system in batching, facilitates accuracy, flexibility and simplicity. Different types of weigh batchers are available; the particular type to be used depends upon the nature of the job. When weigh batching is adopted, the measurement of water must be done accurately. Addition of water in terms of litre will not be accurate enough for the reasons of spillage of water, etc.

7.2 Preparation of the Mould

The moulds which are used for testing are cube, cylinder and beam, which are made up of cast iron and the inside faces are machined plane. All the faces of the mould are assembled by using nuts and bolts and are clamped to the base plate. It is to be noted that, all the internal angle of the mould must be 90°. The faces must be thinly coated with mould oil to prevent leakage during filling. The inside of the mould must also be oiled to prevent the concrete from sticking to it.

DETAILS OF MOULDS

Table no:7.1

Type of Mould	Size (in mm)
Cube	150 x150
beam	750 x150x150

7.3 Mixing

Thorough mixing of materials is essential for the production of uniform course. The mixing should ensure that the mass becomes homogeneous, uniform in colour and consistency. In this project, we adopted machine mixing. As the mixing cannot be thorough, it is desirable to add 10% more materials.

A concrete mixer of capacity 500 litres is used in the mixing of concrete and appropriate rotation is given for proper mixing of materials without segregation.

7.4 Pouring of Concrete

After the materials have been mixed, the moulds are filled immediately by pouring the concrete in to it. Concrete is filled in three layers, and each layer is compacted well by using a tamping rod of standard size, so as to avoid entrapped air inside the concrete cubes and honey combing effect on the sides. During pouring of concrete, it is better to avoid wasting of concrete for effective and economical usage. In order to avoid wastage, small trowels are used to collect the concrete that is coming out the mould while pouring, and it is again used in the process.

7.5 Compaction of Concrete

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete. In the process of mixing, transporting and placing of concrete, air is likely to get entrapped in the concrete. The lower the workability, higher is the amount of air entrapped. Here, we adopted hand compaction by using a tamping rod. When hand compaction is adopted, the consistency of concrete is maintained at a higher level.

Concrete is filled in layers of 15 – 20 mm, and each layer is compacted well using the compacting rod. After the top layer has been compacted, a strike-off bar is used to strike out the excess concrete, and a trowel is used to finish off the surface with the top of the mould, and the outside of the mould should be wiped clean.

7.6 Demoulding

Test cube specimens are demoulded after 24 hours from the process of moulding. If, after this period of time, the concrete has not achieved sufficient strength to enable demoulding without damaging the cube specimens, then the process must be delayed for another 24 hours. Care should be taken not to damage the specimen during the process because, if any damage is caused, the strength of the concrete may get reduced.

After demoulding, each specimen is marked with a legible identification on any of the faces by using a waterproof paint. The mould is then thoroughly cleaned after the process.

7.7 Curing

The test specimens after compaction were kept as such for a period of 24 hours. After that period of time the moulds were removed and the specimens were kept in ordinary curing tank and allowed to cure for a period of 7 and 28 days.

8.0 TESTING OF SPECIMENS

The testing of specimen includes following processes:

a. Slump Test
b. Compressive Strength Test
c. Flexural Strength Test

8.1 SLUMP TEST

PROCEDURE

1 Before starting the casting, it’s important to control whether the fresh concrete has the desired properties for the casting.

2.It is essential that the concrete will be able to spread out and fill all parts of the casting frame.

3.To check this we use a slump test. It consists of filling a standardized cone with fresh concrete, and then lift it carefully straight upwards.

4.When the concrete stops spreading the diameter is measured to see if it is close to what is desired.

Fig.No:8.0 Slump tests

8.2 COMPRESSIVE STRENGTH FOR CUBE

A way of finding the compressive strength of concrete is to test the Beam with Single Point Load. The principle of this test is to load a specified test piece in a compression testing machine until failure. The test piece should be a cube, a cylinder or a core. In this thesis cube, Beam specimens were used. The load should be subjected perpendicular to the direction of the casting and should be applied by a constant rate of 0.6 ± 0.2 MPa/s until failure.

Fig.No:8.1Casting of Cubes

Cubes of size 150 x 150 x 150 mm were cast. Three numbers of specimens were tested for 7 and 28 days. A total of 18

Procedure

1. The specimen was taken out from the curing tank and allowed to dry for few hours.
2. The specimen was placed in compression testing machine in such a way that the load was applied in casted surface.
3. The load was applied in uniform rate until the sample gets failed

Then the load at failure has been noted.

Fig.No:8.2 Testing of Cube Specimens

COMPRESSIVE STRENGTH FOR BEAM

The test specimen is subjected to moment by two point loads symmetrically placed on the testing beam. The load-deflection relation is registered, and the residual flexural strength by first cracking and the equivalent residual tensile strength by given deflections are calculated.

The testing is performed in a testing machine with accuracy. The testing machine must be able to apply deflection with a constant rate. The load is applied by a rig consisting of a standard beam with two bearing rollers and a load distributing beam with two rollers.

Fig.No:8.3Reinforcement for beam

Fig.No:8.4The Beam casting process

Fig.No:8.5Testing of beam Specimens

8.3FLEXURAL STRENGTH TEST

Another important property of concrete is that Flexural strength. The flexural strength in concrete denotes the ultimate deflection that a member can bear in its life time.

Beams of 750 x 150 x 150 were casted. Three number of samples were tested for 28 days curing of beams.

A total of 9 beams of M-20, M-30, M-40 grade concrete full replacement of aggregate were tested.

Procedure

1. The specimen is taken out of curing tank and let to dry for few hours
2. Then the specimen is marked for the loading position on the surface with the marker for clearance.
3. The specimen is then placed in the UTM in such a way that the plain surface is facing the loading face.
4. Then the magnetic deflectometer is placed at the bottom of the specimen to record the deflection of the beam during loading.
5. The load is applied gradually till the specimen is failed
6. Then the failure load is noted.

Fig.No:8.6Standard beam in testing rigs

Fig.No:8.7Lumping of PP fibres

9.0 TEST RESULTS AND DISCUSSION

The 7day and 28 day cube compressive strength of plain concrete and PP fiber Mixed concrete specimens obtained from tests are given in tables.

9.1 DETAILS OF TEST SPECIMENS

Table 9.1.0 Results for 7 days cube Compressive Strength Test

Grade of Concrete	% of PP Fibre used	Sample no.	Load (N)	Compressive Strength (N/mm^2)
M20	0	1	505000	22.44
		2	500000	22.22
		3	485000	21.56
	0.5	1	510000	22.67
		2	500000	22.22
		3	490000	21.78

Results for 28days cube Compressive Strength Test

Table 9.1.1 Results for 28 days cube Compressive Strength Test

Grade of Concrete	% of PP Fibre used	Sample no.	Load (N)	Compressive Strength(N/mm^2)
M20	0	1	635000	28.22
		2	640000	28.44
		3	645000	28.67
	0.5	1	655000	29.11
		2	662000	29.42
		3	660000	29.33

Table 9.1.2Results of 28 days cube Compressive Strength Test (0, 1.0, and 1.5%)

Grade of Concrete	% of PP Fiber used	Sample no.	Load (KN)	Compressive Strength (N/mm^2)
M20	0	PNK1	636	28.27
		PNK 2	638	28.36
		PNK 3	637	28.31
	1.0	PNK11	669	29.73
		PNK 12	668	29.69
		PNK 13	671	29.82
	1.5	PNK 21	676	30.04
		PNK 22	678	30.13
		PNK 23	683	30.36

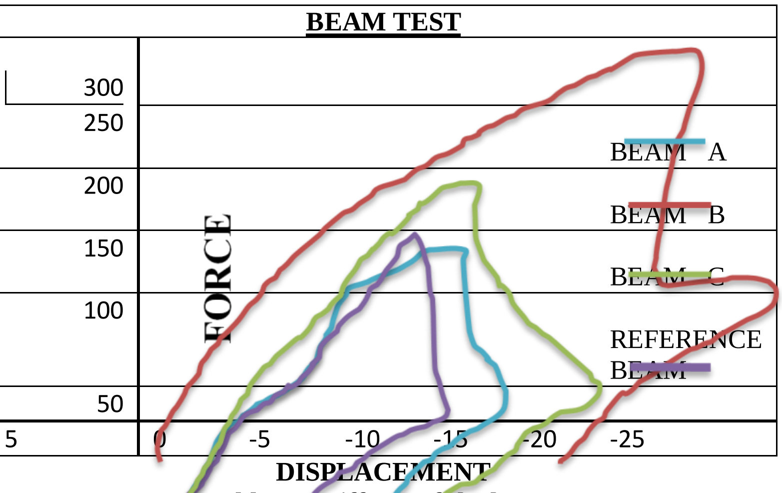


Table 4.8 Stiffness of the beams

Figure 4.1 Force-displacement curves for all the beams

Table 9.1.3 Stiffness of the beams

Beam A	28.31 kN/mm
Beam B	28.71 kN/mm
Beam C	31.72 kN/mm
Ref.beam	24.40 kN/mm

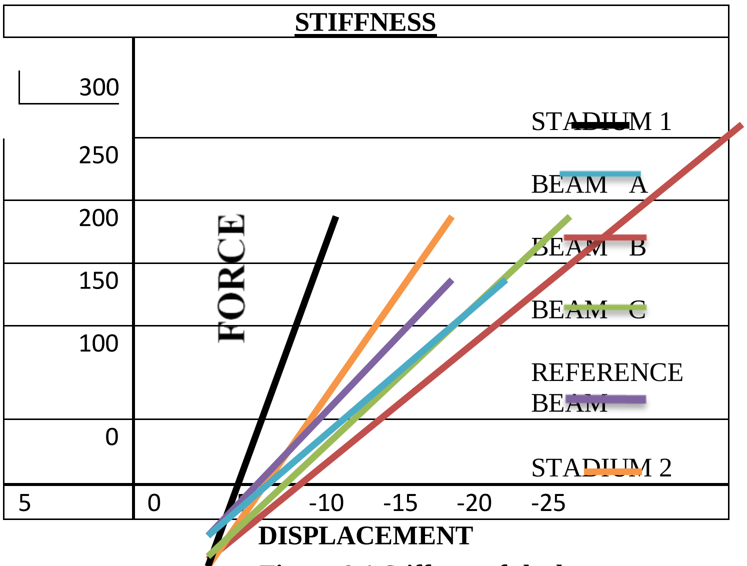


Figure 9.1 Stiffness of the beams

Table 9.1.4 Summary of test and calculation results

BEAM	Real Capacity	Pre-test Calculation	Post-test Calculation	Calculation with Tensile Trajectory
A	163.9kN	121.8kN	-	-
B	242.2kN	153.8kN	187.0kN	228.0kN
C	199.5kN	53.3kN	86.4kN	180.0kN
Reference Beam	178.8kN	122.4kN	-	-

10.0 CONCLUSION

The object of this report was to test whether it would be possible to replace Steel Fibre reinforcement in beams with PP fibre reinforcement. Steel Fibre addition is a time consuming and hard work and finding an alternative to this would be valuable for the building industry.

On the other hand as the strength of the beam with only fibre reinforcement surpassed the strength of the regularly reinforced beam it might be possible to decrease the amount of fibres in the mix. With a higher fibre content the flow ability should improve.

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