# Properties of concrete with straight PET fibres

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**Abstract**— Plastics have become an essential part of our modern lifestyle, and the global plastic production has increased immensely which contributed greatly to the production of plastic-related waste.This paper summarizes the benefits of using straight fibres from waste polyethylene Terephthalate (PET) bottles.The percentage of fibres added to M30 mix concrete were 0%, 0.5%, 1% and 1.5% for three aspect ratios 15,35 and 50.The strength parameters like Compressive, Split tensile ,Flexure tests and Impact tests are studied for 28 days curing.The results of the tests are compared with conventional concrete without any fibre.

**Index Terms**— Polyethylene Terephthalate, Compressive Strength, Split Tensile Strength, Flexural Strength, Aspect ratios,Impact Strength

## 1 Introduction

Concrete literally plays an important role in infrastructure due to its workability,durability and strength.However concrete is weak in tension,brittlesness,resistance to cracking,impact strength and heavy weight.To improve these weakness of concrete different types of fibres are introduced in concrete and so formed concrete is termed as fibre reinforced concrete. Fiber reinforced concrete (FRC) is concrete containing fibrous material which increases its structural integrity.

Plastic consumption has grown at a tremendous rate worldwide. Plastics play a critical role in all aspects of modern life and are used in the manufacture of all sorts of items including protective packaging, mobile phones, domestic appliances, furniture items, medical devices etc. Disposal of plastic waste has emerged as an important environmental challenge and its recycling is facing roadblocks due to its non-degradable nature.

Bottles made of polyethylene terephthalate (PET) can be recycled to reduce the amount of waste going into landfills.PET bottles in fibre forms can be used to get mechanical properties of concrete.

## 2 Materials

### 2.1 Cemet

Cement used to prepare the specimens was 53 grade Ordinary Portland cement, conforming to IS 12269:2013 with a fineness of 1%, standard consistency of 32% and initial setting time 80 min.

### 2.2 Fine aggregate

Type of fine aggregate used was manufactured sand which is the most preferred alternative to river sand and the preoerties of the same are given in table 1.

Table-1 Physical properties of fine aggregate

| Tests | Fineness Modulus | Specific Gravity | Bulk Density | Void Ratio |
|---|---|---|---|---|
| | 3.85 | 2.87 | 1.403 kg/l | 0.44 |

### 2.3 Coarse aggregate

12.5 mm aznd 20 mm coarse aggregates were used in the study.The Physical properties aggregates are shown in Table.2

Table-2 Physical properties of Coarse aggregate

| Tests | Fineness Modulus | Specific Gravity | Bulk Density | Void Ratio |
|---|---|---|---|---|
| | 3.79 | 2.82 | 1.61 kg/l | 0.81 |

### 2.4 Water

Portable water was used for mixing and curing of specimens.

### 2.5 Superplasticizer

Conplast SP430 polvo was the superplasticizer used to provide additional workability and was added for about 0.6-0.85% by weight of cement to all mixes.

### 2.6 Poly Ethylene Terephthalate Fibres

PET fibre had been used in the concrete mix in the shape of short stripsThe length of fibre was kept as 30 mm,70 mm,100 mm and breadth was maintained as 2 mm.The aspects obtained were 15 (AR 15) ,35 (AR 35) and 50 (AR 50).

### 2.7 Concrete Mix

Using the above mentioned materials a Design mix for M 30 grade of concrete was prepared as per IS 10262:2009.The mix proportion is given in table 3

Table-3 Concrete mix proportioning

| Cement | Fine Aggregate | Coarse Aggregate | W/c ratio |
|---|---|---|---|
| 1 | 1.49 | 2.8 | 0.43 |

## 3 Testing of materials

### 3.1 Compressive Strength

Compressive strength was tested in compressive testing machine .Cube specimens of size 150mmX150mm X150mm were adopted for the test.Compressive strength was tested after 28 days of curing .The results of the tests for aspect ratios 15,30 and 50are tabulated below in table 4, 5 and 6 respectievly .

Table-4 28th day Compressive strength of concrete with AR 15 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Compressive strength | Average strength |
|---|---|---|---|
| Cube | 0% | 39.8 | 40.1 |
| | | 40.4 | |
| | | 40.8 | |
| | 0.5% | 45.4 | 44.2 |
| | | 43.2 | |
| | | 44.1 | |
| | 1% | 47.0 | 46.4 |
| | | 46.2 | |
| | | 45.9 | |
| | 1.5% | 45.0 | 45.9 |
| | | 45.9 | |
| | | 46.7 | |

Table-5 28th day Compressive strength of concrete with AR 35 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Compressive strength | Average strength |
|---|---|---|---|
| Cube | 0% | 39.8 | 40.1 |
| | | 40.4 | |
| | | 40.8 | |
| | 0.5% | 44.1 | 43.3 |
| | | 43.0 | |
| | | 42.7 | |
| | 1% | 45.1 | 44.8 |
| | | 44.8 | |
| | | 44.4 | |
| | 1.5% | 43.5 | 44.0 |
| | | 44.1 | |
| | | 44.5 | |

Table-6 28th day Compressive strength of concrete with AR 50 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Compressive strength | Average strength |
|---|---|---|---|
| Cube | 0% | 39.8 | 40.1 |
| | | 40.4 | |
| | | 40.8 | |
| | 0.5% | 42.5 | 42.3 |
| | | 42.3 | |
| | | 42.2 | |
| | 1% | 45.8 | 44.1 |
| | | 43.6 | |
| | | 42.8 | |
| | 1.5% | 43.10 | 42.6 |
| | | 42.70 | |
| | | 41.9 | |

### 3.2 Split Tensile Strength

The test was conducted in compression testing machine.Cylindrical specimens were 150 mm diameter and 300 mm height. The results of the tests conducted are tabulated below in table 7,8 and 9.

Table-7 Split tensile strength of concrete with AR 15 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Split tensile strength | Average strength |
|---|---|---|---|
| Cylinder | 0% | 4.0 | 4.0 |
| | | 4.0 | |
| | | 4.0 | |
| | 0.5% | 5.3 | 5.2 |
| | | 5.2 | |
| | | 5.1 | |
| | 1% | 5.6 | 5.5 |
| | | 5.5 | |
| | | 5.5 | |
| | 1.5% | 5.4 | 5.3 |
| | | 5.2 | |
| | | 5.4 | |

Table-8 Split tensile strength of concrete with AR 35 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Split tensile strength | Average strength |
|---|---|---|---|
| Cylinder | 0% | 4.0 | 4.0 |
| | | 4.0 | |
| | | 4.0 | |
| | 0.5% | 5.1 | 5.1 |
| | | 5.1 | |
| | | 5.0 | |
| | 1% | 5.4 | 5.3 |
| | | 5.3 | |
| | | 5.1 | |
| | 1.5% | 5.3 | 5.2 |
| | | 5.2 | |
| | | 5.0 | |

Table-9 Split tensile strength of concrete with AR 50 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Split tensile strength | Average strength |
|---|---|---|---|
| Cylinder | 0% | 4.0 | 4.0 |
| | | 4.0 | |
| | | 4.0 | |
| | 0.5% | 5.2 | 5.0 |
| | | 5.0 | |
| | | 5.0 | |
| | 1% | 5.4 | 5.2 |
| | | 5.1 | |
| | | 5.0 | |
| | 1.5% | 5.3 | 5.1 |
| | | 50 | |
| | | 5.1 | |

### 3.3 Flexural Strength

Flexural strength was conducted in Universal Testing Machine .The test was carried out on beams of size 100x100x50mm.The results of tests are tabulated below in tables 10,11 and 12.

Table-10 Flexural strength ofconcrete with AR 15 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Flexural strength | Average strength |
|---|---|---|---|
| Beam | 0% | 5.4 | 5.3 |
| | | 5.1 | |
| | | 5.4 | |
| | 0.5% | 8.2 | 8.1 |
| | | 8.0 | |
| | | 8.1 | |
| | 1% | 8.5 | 8.6 |
| | | 8.6 | |
| | | 8.6 | |
| | 1.5% | 8.4 | 8.4 |
| | | 8.4 | |
| | | 8.5 | |

Table-11 Flexural strength ofconcrete with AR 35 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Flexural Strength | Average strength |
|---|---|---|---|
| Beam | 0% | 5.4 | 5.3 |
| | | 5.1 | |
| | | 5.4 | |
| | 0.5% | 8.1 | 7.9 |
| | | 7.8 | |
| | | 7.9 | |
| | 1% | 8.1 | 8.3 |
| | | 8.5 | |
| | | 8.3 | |
| | 1.5% | 7.9 | 8.0 |
| | | 8.1 | |
| | | 8.0 | |

Table-12 Flexural strength ofconcrete with AR 50 and fibre percentage 0%, 0.5%, 1% and 1.5%

| Specimen | Fibre percentage | Flexural Strength | Average strength |
|---|---|---|---|
| Beam | 0% | 5.4 | 5.3 |
| | | 5.1 | |
| | | 5.4 | |
| | 0.5% | 7.6 | 7.7 |
| | | 7.9 | |
| | | 7.5 | |
| | 1% | 7.9 | 8.1 |
| | | 8.3 | |
| | | 8.2 | |
| | 1.5% | 7.1 | 7.9 |
| | | 7.9 | |
| | | 7.7 | |

### 3.4 Impact Strength

Impact strength was conducted in drop weight impact testing machine.The test was conducted on 150mm(diameter) X60mm (length) concrete cylindrical tests. The results of tests are tabulated below in tables 13, 14 and 15.

Table-13 Impact strength ofconcrete with AR 15 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Initial Crack | Ultimate crack |
|---|---|---|---|
| Cylinder | 0% | 2 | 7 |
| | | 3 | 7 |
| | | 2 | 8 |
| | 0.5% | 4 | 11 |
| | | 6 | 11 |
| | | 6 | 10 |
| | 1% | 7 | 12 |
| | | 7 | 12 |
| | | 6 | 11 |
| | 1.5% | 5 | 9 |
| | | 4 | 9 |
| | | 4 | 10 |

Table-14 Impact Strength of concrete with AR 35 and fibre percentage 0%,0.5%,1% and 1.5%

| Specimen | Fibre percentage | Initial Crack | Ultimate crack |
|---|---|---|---|
| Cylinder | 0% | 2 | 7 |
| | | 3 | 7 |
| | | 2 | 8 |
| | 0.5% | 4 | 10 |
| | | 5 | 10 |
| | | 5 | 11 |
| | 1% | 6 | 11 |
| | | 6 | 11 |
| | | 7 | 10 |
| | 1.5% | 4 | 9 |
| | | 4 | 10 |
| | | 4 | 10 |

Table-15 Impact strength ofconcrete with AR 50 and fibre percentage 0%, 0.5%, 1% and 1.5%

| Specimen | Fibre percentage | Initial Crack | Ultimate crack |
|---|---|---|---|
| Cylinder | 0% | 2 | 7 |
| | | 3 | 7 |
| | | 2 | 8 |
| | 0.5% | 5 | 9 |
| | | 4 | 10 |
| | | 4 | 11 |
| | 1% | 6 | 10 |
| | | 7 | 9 |
| | | 5 | 10 |
| | 1.5% | 4 | 9 |
| | | 4 | 9 |
| | | 5 | 10 |

## 4 Conclusions

- The maximum percentage increase in strength of concrete is for1% fibre content.
- In respect with the effect of aspect ratio it is noted that strength obtained was highest for AR15.
- Inclusion of fibres in concrete affects the flow properties of concrete thus imparting more strength to the same design mix.
- The study imparts an effective way of incorporating PET bottles in concrte to resolve solid waste problem and prevent environmental pollution.

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