

Study on Properties of Concrete with Crimped PET Fibres

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ABSTRACT: Plastics play an important role in our modern lifestyle and the pollution caused due to this plastic waste has increased immensely. Plastic pollution is simply accumulation of plastic products and plastic being non biodegradable pollutes land, water and air. This paper summarizes an effective way of using plastic fibres (crimped) from waste polyethylene Terephthalate (PET) bottles. 0%, 0.5%, 1% and 1.5% percentage of fibres are added to M30 mix concrete for three aspect ratios 15,35 and 50. The strength parameters like Compressive, Split tensile, Flexure tests and Impact tests are studied after 28 days curing. The results of the tests are compared and studied with normal concrete.

KEYWORDS: Polyethylene Terephthalate, Compressive Strength, Split Tensile Strength, Flexural Strength, Aspect ratios, Impact Strength, Polyethylene Terephthalate.

I. INTRODUCTION

Concrete is the most commonly used construction material on earth due to its advantageous properties like durability, high compressive strength, fire resistance, resistance to wind, resistance to insects etc. However concrete has some disadvantageous like its weak in tensile strength, susceptible to cracking, weak in brittleness and heavy weight. Different types of fibres were introduced in concrete to enhance the structural integrity and the concrete was termed as Fiber reinforced concrete (FRC). Fibre reinforced concrete contains short discrete fibres that are uniformly distributed and randomly oriented. Fibres include steel fibres, glass fibres, synthetic fibres and natural fibres each of which lend varying properties to the concrete.

Now a days it is very common to serve mineral water and soft drinks in plastic bottles which have led to a tremendous growth in plastic consumption thereby increasing plastic pollution. Disposal of plastic is not an effective way since plastics are non-biodegradable materials so the effective way to reduce plastic pollution is to recycle the plastic waste. This study summarizes the use of polyethylene Terephthalate (PET) bottles in form of fibres to improve the mechanical properties of concrete which is also an effective solution to reduce the plastic pollution caused by plastic waste.

II. MATERIALS

2.1 Cement

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

2.2 Fine aggregate

Manufactured sand was used as fine aggregate and the properties of the fine aggregate used are given in table 1.

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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

Coarse aggregates used in the study were 12.5 mm and 20 mm. 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

Drinkable water was used for mixing and curing of specimens throughout the study.

2.5 Super plasticizer

The super plasticizer used to impart additional workability was CONPLAST SP430 polvo. The super plasticizer was added 0.6-0.85% by weight of cement.

2.6 Poly Ethylene Terephthalate Fibres

PET fibres collected from PET bottles were used in the mix. The fibres were in form of short strips with lengths 30 mm,70 mm,100 mm and breadth 2 mm. So obtained aspect ratios were 15 (AR 15), 35 (AR 35) and 50 (AR 50).

2.7 Concrete Mix

Design mix of M 30 grade of concrete was prepared using all the materials listed above as per IS 10262:2009.The mix proportion is as shown in the table in table 3

Table-3 Concrete mix proportioning

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

III. TESTING OF MATERIALS

3.1 Compressive Strength

Compressive strength test shows resistance of concrete to compression. The cube specimens used for testing compressive strength are of size 150mmX150mm X150mm. These specimens are tested on compression testing machine after 28 days curing. The results are tabulated in table 4,5 and 6 respectively for aspect ratios 15, 30 and 50 .

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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% | 46.5 | 46.3 |
| | | 46.3 | |
| | | 46.1 | |
| | 1% | 46.8 | 47.1 |
| | | 47.4 | |
| | | 47.1 | |
| | 1.5% | 45.9 | 45.7 |
| | | 46.1 | |
| | | 45.1 | |

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% | 46.3 | 46.0 |
| | | 45.8 | |
| | | 46.2 | |
| | 1% | 46.9 | 46.9 |
| | | 46.8 | |
| | | 47.0 | |
| | 1.5% | 45.5 | 45.2 |
| | | 44.8 | |
| | | 45.3 | |

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% | 46.0 | 45.8 |
| | | 45.5 | |
| | | 45.9 | |
| | 1% | 46.0 | 46.0 |
| | | 46.0 | |
| | | 46.1 | |
| | 1.5% | 45.0 | 44.9 |
| | | 44.6 | |
| | | 45.1 | |

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3.2 Split Tensile Strength

Splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The cylindrical specimens used for testing are of size 150 mm diameter and 300 mm height. These specimens are tested on compression testing machine after 28 days curing. The results are tabulated in table 7,8 and 9 respectively for aspect ratios 15, 30 and 50 .

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% | 5.6 | 5.6 |
| | | 5.6 | |
| | | 5.5 | |
| | 1% | 5.6 | 5.7 |
| | | 5.7 | |
| | | 5.8 | |
| | 1.5% | 5.4 | 5.4 |
| | | 5.2 | |
| | | 5.6 | |

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% | 5.3 | 5.4 |
| | | 5.5 | |
| | | 5.4 | |
| | 1% | 5.6 | 5.5 |
| | | 5.5 | |
| | | 5.5 | |
| | 1.5% | 5.5 | 5.3 |
| | | 5.4 | |
| | | 5.0 | |

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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% | 5.3 | 5.3 |
| | | 5.2 | |
| | | 5.3 | |
| | 1% | 5.3 | 5.4 |
| | | 5.5 | |
| | | 5.4 | |
| | 1.5% | 5.1 | 5.1 |
| | | 5.1 | |
| | | 5.0 | |

3.3 Flexural Strength

Flexural strength is one measure of the tensile strength of concrete. The beam specimens are of size 100x100x50mm. . These specimens are tested on universal testing machine after 28 days curing. The results are tabulated in table 10,11 and 12 respectively for aspect ratios 15, 30 and 50 .

Table-10 Flexural strength of concrete 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% | 8.7 | 8.6 |
| | | 8.6 | |
| | | 8.5 | |
| | 1% | 8.9 | 8.8 |
| | | 8.8 | |
| | | 8.8 | |
| | 1.5% | 8.6 | 8.4 |
| | | 8.4 | |
| | | 8.2 | |

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Table-11 Flexural strength of concrete 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% | 8.6 | 8.5 |
| | | 8.5 | |
| | | 8.4 | |
| | 1% | 8.8 | 8.6 |
| | | 8.6 | |
| | | 8.4 | |
| | 1.5% | 8.3 | 8.3 |
| | | 8.3 | |
| | | 8.2 | |

Table-12 Flexural strength of concrete 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% | 8.3 | 8.3 |
| | | 8.2 | |
| | | 8.3 | |
| | 1% | 8.5 | 8.5 |
| | | 8.5 | |
| | | 8.4 | |
| | 1.5% | 8.0 | 8.1 |
| | | 8.2 | |
| | | 8.1 | |

3.4 Impact Strength

Impact strength is measure of the impact resistance of concrete. The cylindrical specimens used for testing are of size 150 mm diameter and 60 mm height. These specimens are tested on drop weight impact testing machine after 28 days curing. The results are tabulated in table 13,14 and 15 respectively for aspect ratios 15, 30 and 50 .

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Table-13 Impact strength of concrete 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% | 6 | 13 |
| | | 7 | 12 |
| | | 7 | 13 |
| | 1% | 9 | 14 |
| | | 9 | 14 |
| | | 7 | 13 |
| | 1.5% | 6 | 11 |
| | | 6 | 11 |
| | | 5 | 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% | 6 | 11 |
| | | 6 | 11 |
| | | 5 | 10 |
| | 1% | 8 | 13 |
| | | 7 | 13 |
| | | 8 | 12 |
| | 1.5% | 5 | 10 |
| | | 5 | 10 |
| | | 4 | 9 |

Table-15 Impact strength of concrete 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 | 10 |
| | | 5 | 9 |
| | | 4 | 10 |
| | 1% | 7 | 11 |
| | | 7 | 11 |
| | | 7 | 10 |
| | 1.5% | 4 | 9 |
| | | 4 | 9 |
| | | 4 | 9 |

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IV. CONCLUSION

1% fibre content shows maximum percentage increase in strength. Highest strength was obtained for AR 15 when comparing the strengths obtained for aspect ratios 15, 35 and 50. The study shows using low cost plastic waste to improve the properties of concrete. The study also shows an effective way of preventing environmental pollution by using plastic waste in form fibres.

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