International Journal of Recent Technology and Engineering (IJRTE)
ISSN: 2277-3878, Volume-8 Issue-3, September 2019

# Ductile Behaviour of Beam Made from Modified Tyre Rubber Concrete

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***Abstract:** In last little decade technology being guided by the sustainability and environmental issues. Civil engineering is not exceptional ion this matter. As concrete is deriving from natural resource, a big question is being asked all time what will be the future technology and future path. Last few years researchers tried to incorporate the waste material in concrete especially in cement and in fine aggregate. Waste tyres can be an alternate material to replace mineral aggregate. But the mechanical properties decrease with the increase of tyre rubber. So in present study we replaced 40% cement with fly ash and use 5% extra silica of the weight of cement to enhanced the property of tyre rubber concrete which made by replacing 5% coarse aggregate by chipped rubber. Made beams with the modified concrete and check the ductility factor of both types.*

***Key Words:** Rubber concrete, Chipped rubber concrete, Fly ash Concrete, Silica induced concrete, Beam from rubber concrete.*

## I. INDRODUCTION

Mushunje, Otieno and Ballim (2018)[1] proposed a review on Waste Tyre Rubber as an Alternative Concrete Constituent Material. The brief review shows that it is possible to manipulate rubber particles in order to achieve desired concrete strengths. An example is that when silica fume is used to increase the strength of concrete the thermal conductivity of rubberised concrete is comparable to that of plain concrete. **Jose and Sasi (2018)** [2] studied on partial replacement of concrete below neutral axis of beam using seeding trays and polythene balls: Replacing concrete below neutral axis is an effective way to reduce the wt. and the construction cost. Abubaker M. almaleeh, Stanley M. Shitote and Timothy Nyomboi (2016) [3] investigated recycling of waste rubber can be used as construction material. Tires cut into pieces with maximum size of 20 mm to use as course aggregate and crumb rubber tires used as fine aggregate.

Manuscript published on 30 September 2019
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The replacement was done in 3 phases. One was rubber tires replaced 50 percent of normal sand. Second was course rubber tires replaced 50 percent of normal gravel. And final one was both fine and coarse rubber tires are used to replace the sand and gravel by 25, 50, 75 and 100 percent. Compressive strength, splitting tensile and flexural strength tests are conducted.

Although, concrete made of tires have lower strength than normal concrete, **Zeineddine Boudaoud et al. (2012) [4]** studied the effects of recycled tires rubber aggregates on the characteristics of cement concrete. The study of the substitution effects of coarse traditional aggregates by rubber aggregates resulting from worn tires showed a decrease in the mechanical characteristics of the tested concretes. Efforts have been taken to identify the potential application of waste tyres in civil engineering projects. The ductile behaviour f the rubber concrete is investigated.

## II. MATERIALS USED IN INVESTIGATION

### 2.1 Cement

In the present study 53 grade Ordinary Portland Cement conforming to IS 12269:1987 was used. The properties of cement was tested as per IS 4031-1988 & IS 4032-1985.

### 2.2 Fly Ash

Class F fly ash obtain from thermal power plant from Bhatinda in India where it was available was used in this work. The physical property of fly ash is shown in table 3.3.

### 2.3 Silica Fume

Silica fume is a very fine powder; the particles are approximately 1 ⁄100 the diameter of Portland cement grains. When used to produce high-performance concrete, silica fume is typically 4-15% of the cement weight. The physical and chemical properties are listed in table 3.5 & 3.6 respectively.

### 2.4 Fine Aggregate

Local river sand which is available in Chennai was used as fine aggregate in the concrete. The fine aggregate used in the investigation complied with the requirements of IS 383:1970. The river sand conforming to grading Zone III of IS 383:1970 was used as fine aggregate. The sand was tested as per the procedure given in IS 2386:1968(Part-3) in the laboratory. The details of physical properties of fine aggregates are given in Table 3.6.

### 2.5 Coarse Aggregate

Crushed granite stone of size between 12.5 mm and 20 mm were used as coarse aggregate. The coarse aggregate used in the investigation complied with the requirements of IS 383: 1970.In the present investigation, locally available crushed blue granite stone aggregate of size between 20mm and 12.5mm was used.

The physical properties of the coarse aggregates are given below in Table 3.7.

### 2.6 Tyre Rubber

Chipped tyre rubber making hand cutting average size 20 mm was used in the experiment. Rubber was collected from Kolkata

### 2.7 Water

In the present investigation, potable water was used.

### 2.8 Super plasticizer

Glenium Super plasticizer is used for higher workability. Master Glanium 51 of BASF Company India was used. In this study 0.5% of cementitious material is used..

### 2.9 Strain Gauge

Strain gauges are frequently used in mechanical engineering research and development to measure the stresses generated by machinery. Strain gauges made by Tokyo Sokki Kenkyujo co. ltd of Japan was used for measuring the strain in steel and concrete.

### 2.10 Steel Reinforcement

Fe 500 bar of tata tiscon was use as reinforcement in concrete beam. The diameter of steel was different type.

## III. CONCRETE MIX DESIGN

The test results of the materials were used to design the concrete mix as per the recommendations of IS 10262:2009. The grade of concrete used in the present investigation is M 20.

**TABLE 1 Proportion of 1653aterial**

| Grade of concrete | Target mean strength (n/mm$^2$) | W/c ratio | Mix proportion |
|---|---|---|---|
| M20 | 26.60 | 0.5 | 1:1.4:3.1 |

## IV. TEST SETUP

### 4.1 Detail of beam

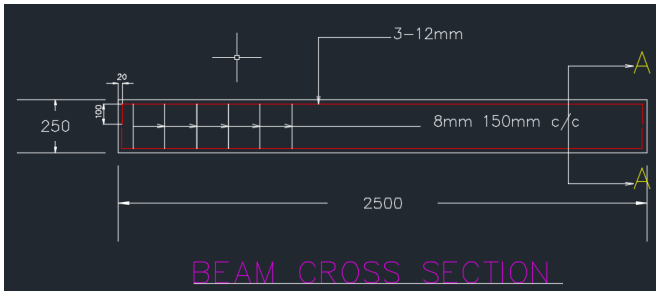


**Fig 1 detail of the beams**

The length of the beams was 2.5m and cross section 250mm X 250mm.


**Fig 2 cross section of he beams**

3 nos of 12mm dia rod used in top and 3 nos of 16mm dia bar used in bottom. 8 mm dia rod used as 2 legged stirrups at 150mm c/c.

### 4.2 labelling of the beams

**Table 2 labelling of the beams**

| Type of beam | Marking |
|---|---|
| Conventional concrete | C1,C2,C3 |
| Concrete with rubber, silica and fly ash | R1,R2,R3 |

**Fig 3 beam specimen**


**Fig 4 test setup**

## V. RESULT

**Table 3 ultimate load and first crack of beam**

| | ultimate load(kN) | ultimate load (kN) | ultimate load(kN) | initial crack(kN) | initial crack (kN) | initial crack (kN) |
|---|---|---|---|---|---|---|
| NORMAL CONCRETE | 100.5 | 102.4 | 104.2 | 40.3 | 46.6 | 48.1 |
| RUBBER CONCRETE | 96 | 99.1 | 95.3 | 45.7 | 46.9 | 42.4 |

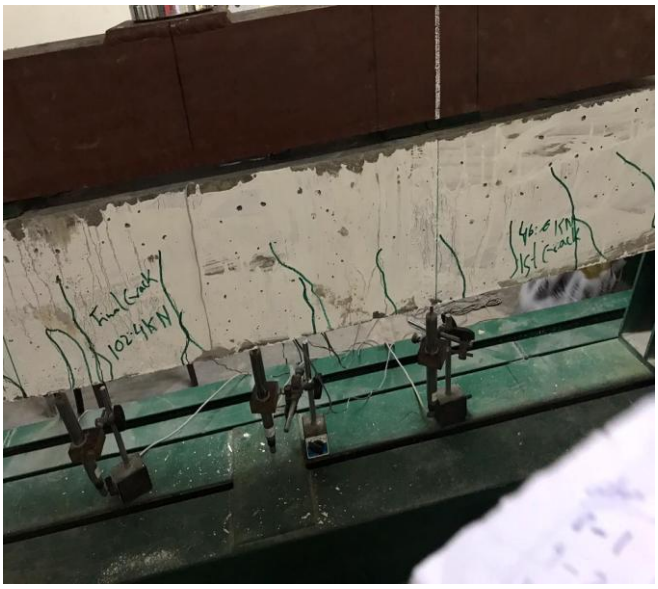

**Fig 5 crack pattern of normal beam**

**Fig 6 crack pattern of rubber concrete beam**

**Table 4 ultimate load and ultimate deflection**

| | Ultimate load (kN) | Ultimate deflection(mm) |
|---|---|---|
| C1 | 102.4 | 11.1 |
| C2 | 100.5 | 13.3 |
| C3 | 104.2 | 11.5 |
| R1 | 96 | 12.9 |
| R2 | 99.1 | 14.7 |
| R3 | 95.3 | 13.2 |

Ductility factor of beams was investigate from load at failure and load at yield deflection

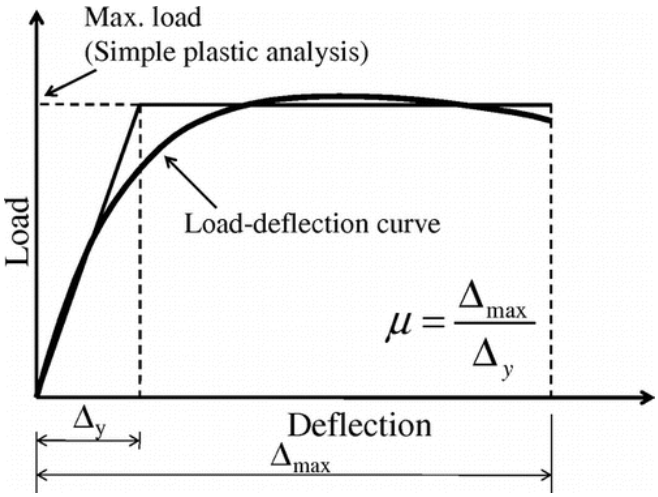


**Fig 7 procedure of determine of ductilityfactor**

**Table 5 DF of normal beam**

| Beam | final deflection(mm) | yield deflection(mm) | DF |
|---|---|---|---|
| C1 | 11.1 | 6 | 1.85 |
| C2 | 13.3 | 8.7 | 1.52 |
| C3 | 11.5 | 7.6 | 1.51 |

**Table 6 DF of rubber concrete beam**

| | (mm) | | |
|---|---|---|---|
| R1 | 12.9 | 6.4 | 2.01 |
| R2 | 14.7 | 6.5 | 2.26 |
| R3 | 13.2 | 5.4 | 2.44 |

## VI. DISCUSSION

1. The results of ultimate load are satisfactory as the decreases in capacity within 6 present and that can be compensated by reduced self-weight of beam.

2. The first crack in rubber concrete beam is delayed.
3. Ductility factor is more in case of rubber concrete beam, so it will be more ductile.

## REFERENCES


1. A review of Waste Tyre Rubber as an Alternative Concrete Constituent Material by Kudzai Mushunje , Mike Otieno and Yunus Ballim, (2018).
2. Comparative Study on Partial Replacement of Concrete below Neutral Axis of Beam Using Seeding Trays and Polythene Balls by Basil tom jose and Divya Sasi, (2018).
3. Use of waste rubber tyres as aggregate in concrete by Abubaker M. Almaleeh1, Stanley M. Shitote and Timothy Nyomboi, (2016).
4. Effects of Recycled Tires Rubber Aggregates on the Characteristics of Cement Concrete in Open Journal of Civil Engineering 02(04):193-197 · January 2012


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