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Flexural Strength of Normal Beam by Replacing Tension Reinforcement as Waste Tyre

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Abstract: ***The disposal of waste tyres has facing major problems in India. The growing problem of waste tyre disposal in the India can be alleviated if new recycling routes can be found for the surplus tyres. It is estimated that 1.2 billions of waste tyre rubber produced globally in a year. It is estimated that 11% of postconsumer tyres are exported and 27% are sent to landfill, stockpiled or dumped illegally and only 4% is used for civil engineering projects. Hence efforts have been taken to identify the potential application of waste tyres in civil engineering projects. In this essence, our present study aims to study the use of waste tyre rubber as tension reinforcement in beam. 6 numbers of beams were cast 3 of them are 10mm x15mm flat size scrap tyre rubber as reinforcement instead of steel in tension zone and other with conventional steel. The experiments were carried out to determine flexural behavior of waste tyre reinforced concrete beam on 28 days. The result of use of waste tyre rubber as compared to normal beam are analyzed and compared.***

Key words: Waste tyre rubber, beam, flexural behavior, reinforcement.

Introduction:

The discharge of waste tyres is expensive and the continuously decreasing numbers of landfills generates significant pressure to the local authorities identifying the potential application for this waste products. One of the largest potential routes is in construction, but usage of waste tyres in civil engineering is currently very low. The sustainable management of the aforesaid waste tyre rubber is a huge task to the industries and public sectors because of the disposal of waste tyre to landfill is legally banned in all the countries due to the environmental impact. Several studies have been carried out to reuse scrap tires in a variety of rubber products, incineration for production of electricity or as a fuel for cement kilns as well as in asphalt concrete.

T. Senthil Vadivel, R. Thenmozhi[1] conducted an experimental study on waste tyre rubber concrete. Test results indicate that all the test specimens behave in a ductile manner. Siddique and Naik[4] presented an overview of some of the research published regarding the use of scrap tires in the manufacture of concrete. Studies indicate that good workable concrete mixtures can be made with scrap tyre rubber.

Material properties:

Concrete was made with 53 grade cement, natural river sand and 20mm crushed aggregate. The specific gravity and fineness modulus of fine aggregates are 3.14 and 2.8% respectively and for coarse aggregate 2.61 and 7.42%. Fe 415 grade steel and flat truck tyre rubber strips are used as reinforcement. As per manufactures specification the specific gravity of truck rubber strip was 1.14+0.002 tensile strength ranges from 35-300 Kg/cm^2.

Mix Design:

Mix design was carried out as per Indian Standard Code (IS 10262-2009) for test specimen. M_{20} grade were adopted in this study. The mix proportion adopted in this study for M_{20} grade is 1: 1.6: 3.28 with water cement ratio of 0.45.

Preparation of specimen:

Following are the details of specimen for flexural test. Total 6 numbers of specimens were cast and flexural test was carried out for present study. The specimen sizes (150 X 150 X 1000) mm with following details are used.

3 Beams were cast as concrete beam with flat tyre rubber strip of 15mm x 10mm as a tensile reinforcement.

Table 1. Specimen details

Type of Beam	BS	BT	Total
No. of specimen	3	3	6

BS - Beam reinforced with steel
BT - Beam reinforced with Waste Tire

Specimen details:

The specimens are to be prepared for flexure test.
It is to be performed in the following steps.

- Mix design- M-20 by IS 10262.
- Water cement ratio- 0.45
- Area of steel in tension - 157.08mm^2
- Area of waste tyre tension- 300mm^2

The details of specimen are shown in fig. 1 & 2

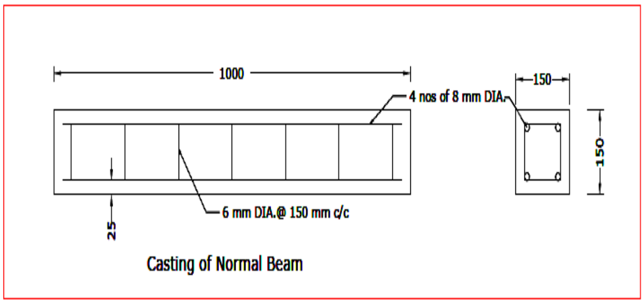

Fig.1 Reinforced Details of Concrete Beam

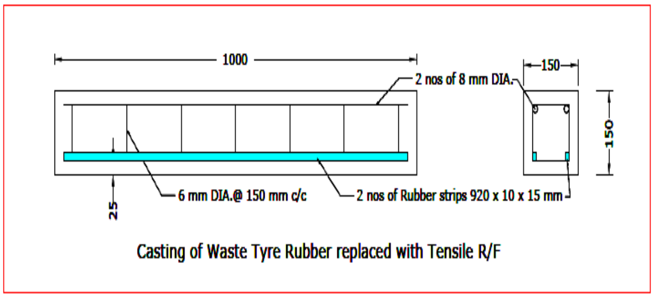

Fig.2 Details of Rubber Reinforced Beam

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Before pouring the concrete, reinforcement bars were carefully cleaned. The bars are aligned and fastened to the molds. Mold releasing compound is applied to the specimen molds. Hand compaction is performed after pouring the concrete; the specimen surface is smoothened with help of trowel. The concrete specimens are cured for 24 hour. Demoulding and transportation of the specimens are carried out with great care to avoid any disturbance to the reinforcing bar. After demoulding specimens are cured in curing tank.

Flexural testing:

Standard beams of size 150 x 150 x 1000 mm were supported symmetrically over a span of 900mm and subjected two points loading till failure of the specimen as shown in fig.3

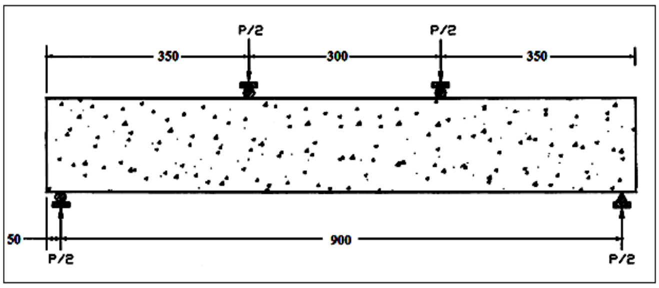

Fig. 3 Two Point Loading

The deflection at the beam is measured with sensitive dial gauge on UTM. The flexure strength is determined by the formula,

$$F_f = P_f \times L/b d^2 \quad \text{……………………. (1)}$$

Where,

F_f =Flexure strength (MPa), P_f = Central point load through two point loading system (KN), b = Width of beam in mm

d = Depth of beam in mm

Table 2 Flexure test results

Name of Specimen	First crack Load (kN)	Failure load (kN) (P_f)	Stress at Failure load f_f (N/mm^2)	Ultimate Load (kN)
BS-1	28.2	58.6	15.23	67.2
BS-2	29.8	54.9	14.27	68.9
BS-3	28.5	57	14.82	69.4
BT-1	27.7	29.7	7.72	36.9
BT-2	26.5	29.1	7.56	37.2
BT-3	21.5	25	6.50	32.4

The load deflection behaviour of the beams has been studied and discussed below

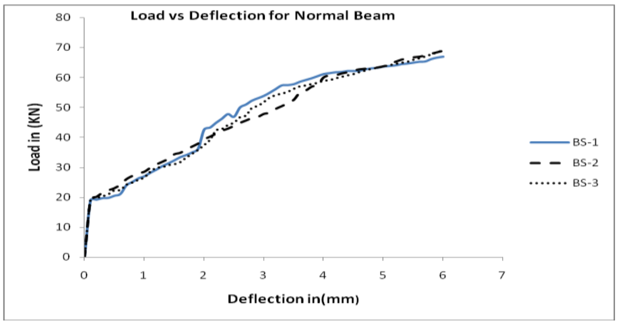

Fig.4

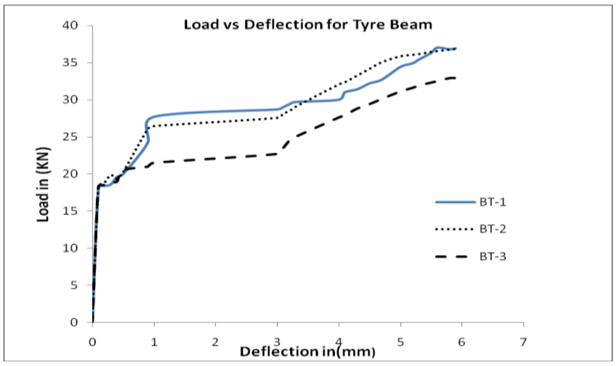

Fig. 5

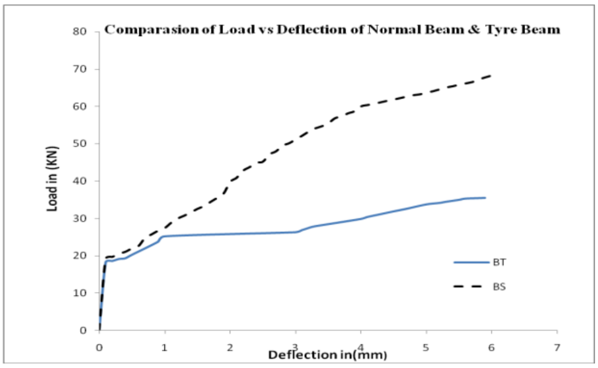

Fig.6

From fig.6 it is observed that the use of waste tyre has influence load deflection behavior substantially. The slope of load deflection curve decreases for waste tyre rubber beam. It means that the stiffness of the beam is reduces when use of waste tyre rubber instead of steel as a tensile reinforcement.

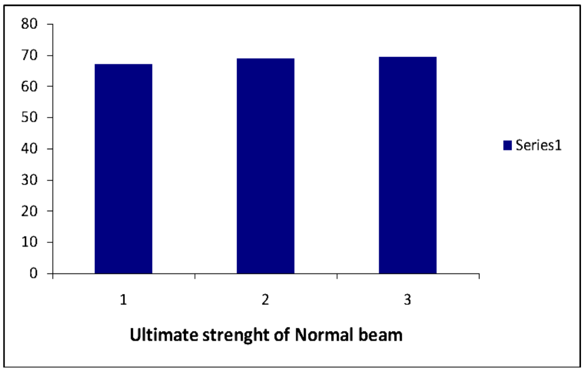

Fig.7

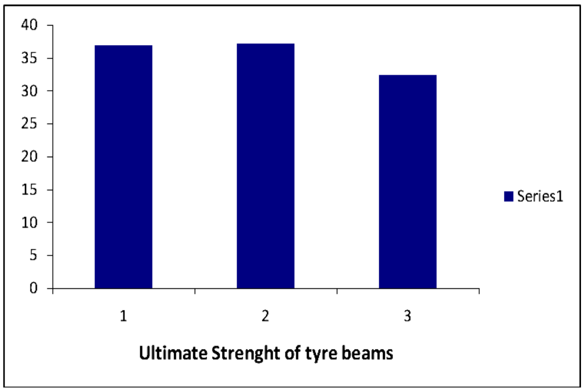

Fig.8

From fig 7 & 8 it has been observed that ultimate strenght of normal beam is more than that of rubber tyre beam.

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Cracks pattern in Beam

Fig 9. Cracks in Beams

After two points loading it is observed that beams with conventional steel gives brittle failure where as beams with tyre replacement gives more ductile failure comparatively.

Conclusion

Based on above experimental investigations, following conclusion was drawn.

1. All the rubber reinforced beams exhibited more ductile behavior that than of conventionally beam.

2. It is well known that the rubber reinforcement instead of steel decreases the strength up to 45% in M_{20} grade concrete.

3. Hence it is concluded that the waste tyre rubber strips may be used as reinforcement in lintel beams were the load carrying capacity is not governing the design.

4. Further increase in cross sectional area of rubber by 55% as a tensile reinforcement may be equalize the ultimate strength of steel reinforced concrete.

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