FLEXURAL BEHAVIOUR OF REINFORCED RUBBERISED CONCRETE BEAM

A.P.I. Jayanath [1], J.C.P.H. Gamage [1, *], E.R.K. Chandrathilaka [1]

[1] Department of Civil Engineering, University of Moratuwa, Moratuwa

A considerable number of tires in worldwide, approach end of their service life each year, and a significant portion of these discarded tires are disposed to the environment by landfilling and tire burning without proper treatment. Therefore, disposal of rubber into the environment has created major issues in terms of health, environment, and economics in the world. People looked for an effective way to stop further destruction caused by these discarded rubbers. The utilisation of discarded tires as aggregate for concrete can reduce environmental pollution, and the usage as raw materials, leads to sustainable development and efficient economic growth. Majority of research studies have been focused on the development of rubber-based concrete for non-structural applications. Even though little research studies had shown the suitability of rubberised concrete for structural purposes, none of them have assessed the feasibility for structural applications. This investigation aims to thoroughly explore the structural behaviour of reinforced rubberised concrete beams subjected to transient and cyclic loads, encompassing an assessment of rubberised concrete properties, strength development techniques and flexural behaviour of these beams. Rubberised concrete was prepared by replacing 10% of the fine and coarse aggregates, with rubber particles which were obtained from discarded vehicle tires. Those rubber particles were pre-treated using a 10% NaOH aqueous solution. As for the test specimens, cubes, cylinders, and five reinforced concrete beams were cast to assess the compressive strength, water absorption, splitting tensile strength, and flexural strength. Rubberised concrete samples, both with and without pre-treatment, showed reduced compressive strength compared to normal concrete, with reductions ranging from 35.5 % to 42.58 %. SEM analysis revealed that the presence of rubber particles in the concrete matrix increased porosity and decreased microstructural compactness, leading to weaker interfacial bonding between rubber particles and the cement matrix. Rubberised concrete exhibited higher water absorption compared to normal concrete with an increment of 116.3% when compare with normal concrete due to its higher porosity. Splitting tensile strength tests demonstrated a 53 % decrease in the strength of rubberised concrete mixes compared to normal concrete, primarily attributed to the limited bond strength between rubber particles and the cement paste. In series of four point bending tests were conducted to investigate the behaviour of reinforced rubberised concrete beams under flexure. The results indicate a reduction of 23.07% and 12.5% in moment capacity and workability and increment of deflection compared to normal reinforced concrete beam. However, it exhibited 32.66% higher flexural toughness, indicating its ability to absorb and dissipate energy. As for the recommendations, comprehensive cost analysis should be conducted to evaluate the economic feasibility and life cycle assessment should be conducted to evaluate the environmental feasibility of rubberised concrete compared to conventional concrete.

Keywords: Rubberised concrete, Flexural strength, Cyclic load response, Load-deflection

[*] Correspondence: kgamage@uom.lk

Investigation on Flexural Behavior of Reinforced Rubberized Concrete Beam

Tire burning

Tire landfilling

Scarcity of Natural aggregates

Sustainable and economic viable solution

Rubberized concrete

Test setup

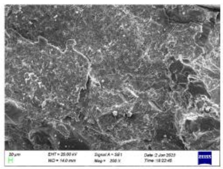
Results & Analysis

Compressive strength test results

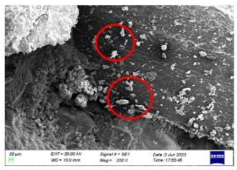
No	Type	7 days test		28 days test	
		Compressive strength (MPa)	weight (kg)	Compressive strength (MPa)	weight (kg)
1	Normal concrete (OPC)	44.65	8.6	62.7	8.85
2	Rubberized concrete with pre-treatment (10% rubber)	29.05	8.1	40.45	8.1
3	Rubberized concrete without pre-treatment (10% rubber)	25.2	7.75	36	7.7

Concrete type	Water Absorption (%)	Splitting tensile strength (MPa)
NC	3.49	3.539
RuC	7.55	1.664

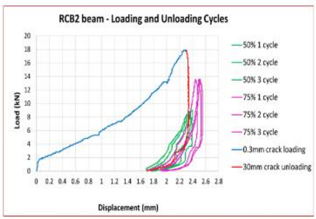
SEM results

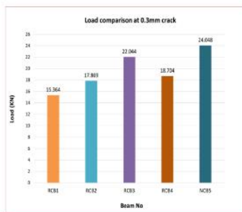


Normal concrete



Rubberized concrete





Experimental Program

Material	Quantity (kg/m3)
Cement	340
Silica fume	42.5
Fly ash	42.5
Fine aggregate (0-5 mm)	820
Coarse aggregate (5-10 mm)	364
Coarse aggregate (10-20 mm)	637
Water	150
Superplasticizer	7.66

Rubberized concrete is prepared by replacing fine and coarse aggregates by 10%of the volume

0-5mm

5-10mm

10-20mm

Specimen preparation

Conclusions

- Rubberized concrete beam indicates a reduction of 23.07% and 12.5% in moment capacity and workability and increment of de-flection compared to normal reinforced concrete beam
- RuC exhibited 32.66% higher flexural toughness, indicating its ability to absorb and dissipate energy.