Rubber Concrete: The Revolution in Concrete Technology

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Abstract

The scarcity and availability at reasonable rates of sand and aggregate are now giving anxiety to the construction industry. Over years, deforestation and extraction of natural aggregates from river beds, lakes and other water bodies have resulted in huge environmental problems. Erosion of the existing topography usually results in flooding and landslides. Moreover, the filtration of rain water achieved by deposits of natural sand is being lost, thereby causing contamination of water reserves used for human consumption. Hence, to prevent pollution authorities are imposing more and more stringent restrictions on the extraction of natural aggregates and its crushing. The best way to overcome this problem is to find alternate aggregates for construction in place of conventional natural aggregates. Rubber aggregates from discarded tyre rubber in sizes 20-10 mm, 10-4.75 mm and 4.75 mm down can be partially replaced natural aggregates in cement concrete construction. About one crore 10 lacks all types of new vehicles are added each year to the Indian roads. The increases of about three crores discarded tyres each year pose a potential threat to the environment. New tyre is made of natural rubber (also called virgin rubber), styrene-Butadiene Rubber (SBR), Poly-butadiene Rubber (PBR), Carbon black, Nylon tyre cord, rubber chemicals, steel tyre card and Butyl rubber.
Keyword- SBR, PBR, Rubber Concrete

I. INTRODUCTION

There is increasing demand and interest in aggregates from non-traditional sources such as from industrial by-products and recycled construction and demolition (C&D) wastes. The recently introduced European Standards for aggregates do not discriminate between different sources, and are for 'aggregates from natural, recycled and manufactured materials'. The focus is on fitness for purpose rather than origin of the resource.

In many countries, including Australia, recycled concrete aggregates (RCA) have been proven to be practical for low-strength concretes and to a limited extent for some structural grade concrete. The processing and quality control cost associated with their use plus the premium paid for mix design adjustment to achieve the same strength grade as concrete with natural aggregates can vary considerably. Aggregates from selected materials and industrial by-products, on the other hand, have greater potential for use in concrete and/or as road construction materials. The availability and consistency of supply are prerequisites for the use of manufactured and recycled aggregates in the various applications.

A. Classification of Aggregates

1) Natural Aggregate
Construction aggregates produced from natural sources such as gravel and sand, and extractive products such as crushed rock.

2) Manufactured Aggregate
Aggregates manufactured from selected naturally occurring materials, by-products of industrial processes or a combination of these.

3) Recycled Aggregate
Aggregates derived from the processing of materials previously used in a product and/or in construction.

4) Reused By-Product
Aggregates produced from by-products of industrial processes.

B. Recycled Concrete Aggregate
Recycled concrete aggregate (RCA) is produced by crushing sound, clean demolition waste of at least 95% by weight of concrete, and having a total contaminant level typically lower than 1% of the bulk mass. Other materials that may be present in

RCA are gravel, crushed stone, hydraulic cement concrete or a combination thereof deemed suitable for premix concrete production.

C. *Uses of Old Tyres*

Rubber from discarded tyres use in, floor mats, belts, gaskets, shoe soles, dock bumpers, seal, muffler hangers, shims and washers. 3 to 5% Rubber crumbs and up to 10% reclaimed rubber is particularly used in automobile tyres. Tyre pieces are used as fuel in cement and brick kiln. However, various local authorities are now banning the tyre burning due to atmosphere pollution. Whole tyres also used as highway crash barriers, furniture, boat bumpers on marine docks, etc. Land filling or burning tyres for energy have limited prospects as environmental authorities are acknowledging the need for its greener alternatives.

II. Effect of Surface Texture of Rubber Particles

Various studies show that the rougher the rubber particles used in concrete mixtures the better the bonding they develop with the surrounding matrix and, therefore, the higher the compressive strength of rubber concrete may be obtained by improving the bond between rubber particles and the surrounding cement paste. Pre-treatment to improve bond of rubber.

Aggregates vary from merely washing them with water to acid etching. About 57% improvement in compressive strength was obtained when rubber aggregates before use treated with carbon tetrachloride (CCl_4). The treatment increase in surface roughness of the rubber, which improves its attachment to the cement paste. Upon loading weak bonding of rubber aggregates to surrounding cement paste is one of the main causes of lower compressive strength of rubber concrete. There are various methods by which rubber aggregates bonds may be improved. The waste rubber recycling factories should supply the rubber aggregates in pre-treated and specified grading for their better performance. This will build confidence to users and improve the mass sale of rubber aggregates as a new construction material of cement concrete construction. Quality rubber aggregates should be manufactured and supplied by waste rubber recycling factories in grading 20-10 mm, 10-4.75 mm and 4.75 mm down sizes.

III. Toughness, Impact Resistance, Heat and Sound Insulation

Rubberized concrete did not exhibit brittle failure when specimens loaded in compression. It is due to its ability to with stand large tensile deformations, the rubber particles act as springs, delaying the widening of cracks and preventing full disintegration of the concrete mass. Rubberized concrete will give better performance than conventional concrete where vibration damping is required, such as in building as an earthquakes shock-wave absorber, in foundation pads for machinery, and in Railway stations.
When rubber aggregates were added to the mixture, the impact resistance of concrete is increased, Rubber aggregates in concreter also make the material a better thermal insulator, which could be very useful especially in the wake of energy conservation requirements. From fire test it was observed that flammability of rubber in rubber concrete mixture was much reduced by the presence of cement and aggregates. It is believed that fire resistance of rubber concrete mixture is satisfactory. In this connection more testing is needed.

Fig. 1:

A. Benefits Of Using Rubber As Concrete

– Recycling of scrap tires suggesting an environmental solution.
– Reduction of plastic shrinkage cracking.
– Diminishment of the vulnerability of concrete to catastrophic failure.

B. Experimental Analysis

1) Materials and Mixes

– OPC 53-Grade as per IS: 8112-1989 Compressive strength: 7- Days = 39.8 N/mm^2, 28- days = 49.5 N/mm^2.
– River sand and 20 mm crushed aggregate are used in our concrete sample.
– Tyre rubber aggregate. About 30 cm long waste tyre rubber pieces were obtained from local market; the pieces were cleaned with soap water and rinse with clean water. After drying under sun at open place, both faces of the tyre pieces were rubbed with hard wire brush to make surfaces as rough as can be done by hand. Pieces were then cut as per the grading.
– We have used the mix proportion of M_{20} concrete. the proportion of various components are as follows:

- Weight of OPC-53 cement- 2 kg
- Weight of river sand : 3 kg
- Weight of 20 mm crushed aggregate: 4.2 kg
- Weight of rubber aggregate: 1.8 kg
- Water cement ratio: 0.45

2) Procedure

– The dry materials comprising cement, sand, aggregate and rubber aggregate was well mixed before the water and Normal Super plasticizer was gradually included. 150 mm cubes were cast on a vibrating table remoulded 24 hours after casting, placed in a concrete tub of water to cure up to specified age. The cubes were tested in saturated and surface dry conditions. The temperatures of curing water remain 26^0 c to 28^0 c.

3) Figures and Setup

The following images show the setup and the rubber aggregate used during the experimental study:

Fig. 1: Rubber Tyre Aggregate Used In the Experiment

Fig. 2: Experimental Setup of the Test

Fig. 3: Image of Rubber Concrete after the Test

C. Result Analysis

The following test results were obtained after the experimental study:

Sr. No.	*Age of ubberized concrete (days)*	*Compressive strength (N/mm²)*
1	*14*	*12.96*
2	*28*	*17.82*

IV. CONCLUDING REMARKS

From the experimental study that we carried out we can say that the use of rubber aggregate is highly beneficial for concrete industry. The experimental results showed that the compressive strength of concrete is least affected by the use of rubber aggregate.

With the overdeveloping industries the demand of aggregate is going to raise quick and high. With this situation arising of scarcity of aggregates, the alternative of rubber as an aggregate is the best alternative available till date.

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