Concrete Aggregates From Discarded Tyre Rubber

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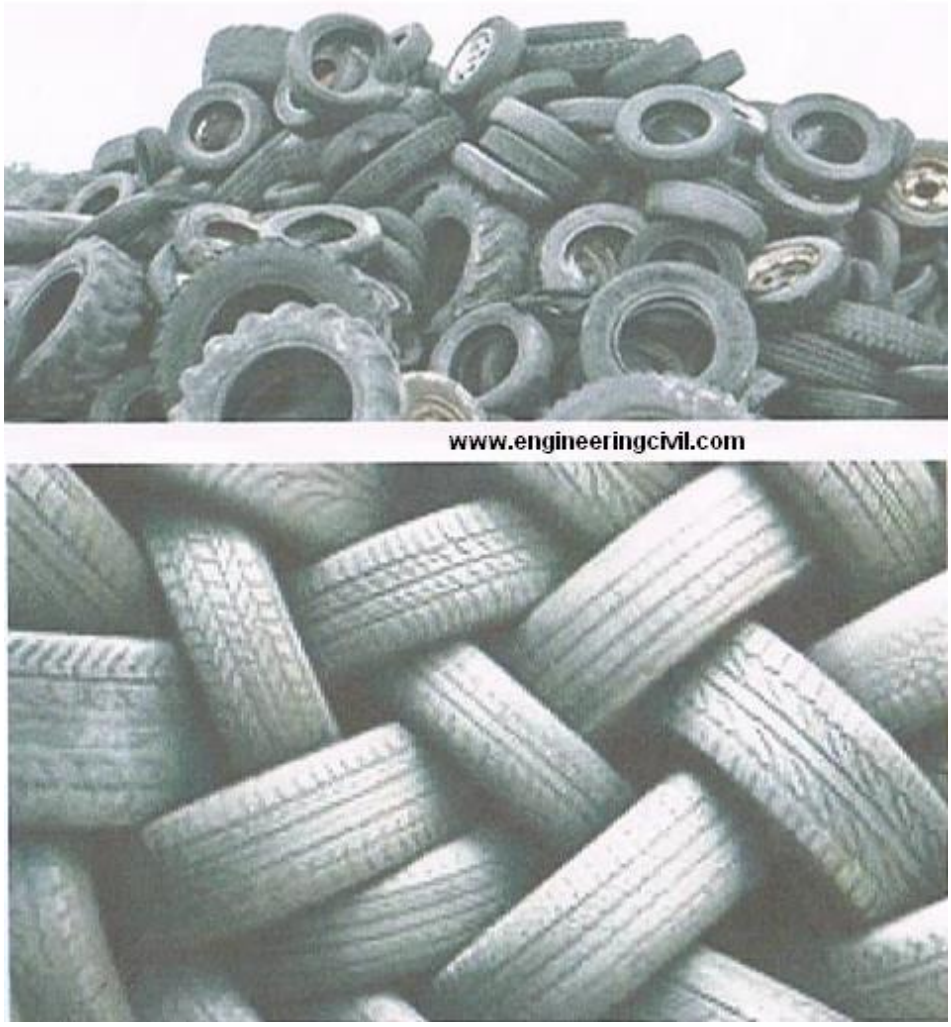
The scarcity and availability at reasonable rates of sand and aggregate are now giving anxiety to the construction industry. Over years, deforestation and extraction of natural aggregates from river beds, lakes and other water bodies have resulted in huge environmental problems. Erosion of the existing 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 lakhs all types of new vehicles are added each year to the Indian roads. The increase 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-Butadien Rubber (SBR), Polybutadienc Rubber (PBR), Carbon black, Nylon tyre cord, rubber chemicals, steel tyre card and Butyl rubber.

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 upto 10% reclaimed rubber is particularly used in automobile tyres. Tyre pieces is used as fuel in cement and brick kilin. 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.



DISCARDED TYRE AS CONCERTE AGGREGATES

Early studies in the use of worn-out tyres in asphalt mixes were very promising, They showed that rubberized asphalt had better skid resistance, reduced fatigue cracking, and achieved longer pavement life then conventional asphalt. So far very little work has been done in the use of rubber from scrap tyres in Portland Cement Concrete (PCC) mixture. The work done so far in the use of tyre rubber as aggregates in concrete is given below:

SLUMP

It was observed slump decreases with increase rubber content by total aggregates volume, the results show that at rubber content 40% by total aggregates volume. The slump was zero and the concrete was not workable by hand. Such mixes had to be compated using a mechanical vibrator.

DENSITY

The general density reduction was to be expected due to the low specific gravity of the

rubber aggregates with respect to that of the natural aggregates. The reduction in density can be a desirable feature in a number of application, including architectural application such as nailing concrete, false facades, stone backing and interior construction as well as precast concrete, light weight hollow and solid blocks, slabs etc.

AIR CONTEST

The air content increases in rubcrete mixture with increase amount of ground tyre rubber.

PLASTIC SHRINKAGE

The addition of rubber shreds to mortar reduced plastic shrinkage cracking compared to a control mortar. Despite their apparently weak bonding to the cement paste, rubber shreds provided sufficient restrain to prevent microracks from propagating.

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 rubcrete concrete may be obtained by improving the bond between rubber particles and the surrounding cement paste. Pretreatment to improve bond of rubber aggregates very 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 cause of lower compressive strerngth of rubcrete concrete. There are various methods by which rubber aggregates bonds may be improved. The waste rubber recycling factories should suplly the rubber aggregates in pretreated and specified gradings 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 recyling factories in grading 20-10 mm, 10-4.75 mm and 4.75 mm down sizes.

TOUGHNESS, IMPACT RESISTANCE, HEAT AND SOUND INSULATION

Rubberized concrete did not exibit 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 rubcrete mixture was much reduced by the presense of cement and aggregates. It is believed that fire resistance of rubcrete mixture is satisfactory. In this connection more testing is needed.

EXPERIMENTAL PROCEDURE, MATERIALS AND MIXES

1. OPC 43-Grade as per IS: 8112-1989 Compressive strength: 7- Days = 39.8 N/mm^2, 28-days = 49.5 N/mm^2

2. River sand and 20 mm crushed aggregate as given in table.1

3. 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 given in table.1

4. Mix Design as given in table .2 was carried out as per guide lines of ref.5. the dry materials comprising cement, sand, aggregate and rubber aggregate was well mixed before the water and Normal Superplasticizer was gradually Included. 150 mm cubes were cast on a vibrating table demoulded 24 hours after casting, placed in a steel tub of water to cure upto specified age. The cubes were tested in saturated and surface dry conditions. The temperature of curing water remain between 26 to 28^oC

Table 1. Grading of aggregates

I.S. Sieve size	Percentage passing		
	River sand	Crushed aggregate	Rubber aggregate
40 mm	X	100	100
20 m	X	100	100
10 mm	100	33	38
4.75 mm	97	4	6
2.36 mm	86	0	0
1.18 mm	74		
600 Micron	42		

300 Micron	23		
150 Micron	5		
Specific gravity	2.65	2.65	1.14
Water absortion	0.8	0.5	——

REMARKS:

Sand is of Zone-II as per IS:383-1970, Crushed aggregate and rubber aggregate both are 20 mm graded aggregates as per IS: 383-1970

Table .2. Mix Design details

Meterials,	Control mix for M-25 grade of concrete	Modified mix with 30% rubber aggregate by mass replacement of coarse aggregate. The rubber aggregate having specific gravity of 1.14 with the given concrete control mix, the reduction in density will be 20 %
Free water (kg/m^3)	155	155
OPC 43- Grade (kg/m^3)	310	310
River sand (kg/m^3)	755	570
Crushed aggregate (kg/m^3)	1180	620
Rubber aggregate (kg/m^3)		265
Normal Superplasticizer (kg/m^3)	3.100	3.100
Density (kg/m^3)	2403	1923
W/C Ratio	0.5	0.5
Slump (mm)	63	25
150 mm 3 cubes average compressive strength (N/mm^2)		
7 days	22.7	9.7
28 days	32.8	12.3

DISCUSSION OF TEST RESULTS

The addition of rubber aggregate in concrete mixes reduces the concrete density, which can be utilize in light weight concrete . Rubcrete concrete reduces the concrete strength, however, this may be used where M- 10 and M- 15 grade concrete is needed. Further researches are needy for its use in RCC Work. Other properties as obtained by various researches are given else where in the paper

CONCLUSIONS

1. From experimental study and literature review it can be concluded that despite the reduced compressive strength of rubberized concrete in comparison to conventional concrete there is a potential large market for concrete products in which inclusion of rubber aggregates would be feasible which will utilize the discarded rubber tyres the disposal of which is a environment pollution problem.

2. Rubberised concrete strength may be improved by improving the bond properties of rubber aggregates. In India out of 36 tyre manufacturers the tyre recyclers are about 20, the major players number only about four or five. In these M/S Gujrat Reclaim has an annual turnover of over Rs.15 Crore from its Haridwar (Uttrakhand) tyre recycling plants, with a production of 20 tonnes of reclaim rubber per day. The tyre recycling factories should supply quality rubber aggregates in 20-10mm, 10-4.75mm and 4.75mm down sizes to be used as cement concrete aggregate.

3. The light unit weight qualities of rubberized concrete may be suitable for architectural application, false facdes, stone baking, interior construction, in building as an earthquake shock wave absorber, where vibration damping is required such as in foundation pads for machinery railway station, where resistance to impact or explosion is required, such as in jersey barrier, railway buffers, bunkers and for trench filling.

4. One of the possible application of rubcrete may be its application in rendering of roof top surfaces for insulation and waterproofing. With proper Mixed Design a 20mm thick rendering on roof top surfaces may be done with 4.75 mm down rubber aggregate

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*We at engineeringcivil.com are thankful to **Sir Kaushal Kishore** for submitting this research paper and helping all civil engineers understand how to save our environment by using Discarded Tyre Rubber as Concrete Aggregate.*

Source: http://www.engineeringcivil.com/concrete-aggregates-from-discarded-tyre-rubber.html