Utilization of Waste Rubber Tyre as Reinforcement in Flexible Pavement

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Abstract—Discarded tyres are becoming globally problematic because recycling them cause environmental related problems. Thus, making use of them needs to be considered and solutions must be sustainable. Now a day, the waste tyres are increasingly being considered as construction material with technical development in different fields like use in construction of flexible pavements. This work investigated the utilization of waste rubber tyres as a reinforced material in soft cohesive soil subgrade. For that laboratory soak and Unsoak C.B.R with and without waste rubber tyre reinforcement performed while in field soak C.B.R with and without tyre reinforced performed at different depth i.e. 2cm, 5cm, 8cm.The result of these tests shows that soak C.B.R of reinforced soil in lab 208% increase and in field 225%increases compare to unreinforced soil and this C.B.R value help in design of flexible pavement for reduction of thickness using IRC method.

Keywords— Waste rubber tyre, Flexible pavement, soft cohesive soil, field c.b.r, IRC method

I. INTRODUCTION

Pavement consists of multiple layers namely, subgrade, sub base, base course and wearing course. Among these layers pavement mainly depend on subgrade. Transportation engineers often face problems in pavement due to soft subgrade. Soft subgrade has low density and high affinity towards moisture. In general soft subgrades are identified by their insitu density and CBR value. For improving soft soil properties modification, stabilization and reinforcement any of them implies. For improvement of engineering property of soil many waste materials use like industrial waste, plastic waste, waste rubber tyre etc.As waste tyres has been a disposal problem in the past and are being generated at an increased rate throughout the world today. One of the alternative ways of disposing of waste tyre is to use them for civil engineering applications such as slope stability, insulation beneath roads, lightweight backfill retaining walls, pavement etc. Actually, use of waste tyres for civil engineering applications has certain advantages. The waste tyres provide some properties including flexibility, resiliency, strength, and high frictional resistance. As use inland filling it will help in saving huge spaces occupied by tyres and tubes and the environmental health hazards will also be reduced. The consumption of natural soil will be reduced, there by rendering cost saving benefits. The various properties such as bearing capacity, shear strength, drainage etc. can be improved by reinforcing it waste tyre rubber. Whole tires are difficult to landfill because they tend to float to the surface. In present study for improving soil property soil reinforced with waste rubber tyre. Reinforcement is an effective and reliable technique for increasing strength and stability of soils. Most of the Indian highways system consists of flexible pavement; there are different methods of design of flexible pavement. The California Bearing Ratio (CBR) test is an empirical method of design of flexible pavement design. It is a load test applied to the surface and used in soil investigations as an aid to the design of pavements. The design for new construction should be based on the strength of the samples prepared at optimum moisture content (OMC) corresponding to the Proctor Compaction and soaked in water for a period of four days before testing. In case of existing road requiring strengthening, the soil should be moulded at the field moisture content and soaked for four days before testing. This test method is used to evaluate the potential strength of subgrade, subbase, and base course material for use in road .From C.B.R test result improved C.B.R value use for pavement design using C.B.R method as per IRC guideline.

II. MATERIAL AND METHODOLOGY

Material:

1) Waste Rubber Tyre Cuts
The properties of the waste tyre Cuts are given in Table.2.1

Table.2.1. Property of waste rubber tyre

Property	Tyre Waste
Colour	Black
Shape	Rounded
Size	>300mm
Wired/Unwired	Wired

Fig 1. Waste Rubber Tyre

2) Soil

The soil used for this investigation is obtained from near Rajkot. The dried material passing from I.S. 4.75mm sieve is taken for the study. The properties of soil are given in Table.2.

Table 2.2. Property of soil

SI .No.	Property	Value
1	Liquid Limit (%)	40.78
2	Plastic Limit (%)	24
3	Max. Dry Density(gm/cm3)	1.66
4	Optimum Moisture Content (%)	18
5	C.B.R Value in unsoaking at (%)	
a)	2.5mm	8.92
b)	5mm	8.51
6	C.B.R Value in Soaking at (%)	
a)	2.5mm	1.48
b)	b)5mm	1.28

Methodology:

A) Lab Test
- Particle Size Distribution Test
- Liquid Limit Test
- Plastic Limit Test
- Proctor Compaction Test
- California Bearing Ratio Test (Soak & Unsoak)
- Tensile Test (Rubber Tyre)

B) Field Test
- Field California Bearing Ratio Test With and Without Waste Tyre Grid
- Traffic volume study

A) Lab Test

In lab test basic test of virgin soil is perform for find properties of soil. The grain size analysis is widely used in classification of soil. Liquid limit and Plastic limit of soil are very important property of fine grained soil and its value is used to classify fine grained soil and calculate activity of soil and toughness index of soil. This limit also gives information regarding the state of consistency of soil on site. The proctor compaction test is used to determine optimum moisture content for soil. This test is

especially useful when determining the relationship between water content and the dry unit weight of soils to establish the maximum density of soil. The California bearing ratio test is penetration test meant for the evaluation of subgrade strength of road. The results obtained by these test are used with the empirical curves to determine the thickness of pavement and its component layers. The tensile test of rubber tyre is performing using universal testing machine for find out tensile strength of rubber tyre.

B) Field Test

Field CBR tests were conducted on soil fill reinforcement with geogrid of tyre in test pit. Test pit of size 0.72x0.72x 0.72m are excavated and filled with the soil maintaining moisture and density. In order to ensure density and moisture after filling, core cutter test carried out on filled soil. The density and moisture content in field are recorded. C.B.R tests were conducted on soil fill with and without tyre grid. Tyre grid is placed at 8cm, 5cm, and 2cmdepth. Typical test Setup for CBR in field is shown in below figure 2 and 3.

Fig 2. Field C.B.R setup

Fig 3. Field C.B.R Performance

III. Result

In the present study ,field C.B.R tests are carried out on soil specimens with and without tyre grid reinforcement.The results of tests are presented below table

Table 3.1 C.B.R result

	Without tyre waste	With tyre waste at 8 cm	With tyre waste at 5 cm	With tyre waste at 2 cm
Lab Soak C.B.R value At a) 2.5mm	2.01	3.5	3.85	4.2
b) 5mm	1.75	3.09	3.44	3.79
Increase in C.B.R (%) value At a) 2.5mm	100	104	191	208
Field Soak C.B.R value At a) 2.5mm	2.72	3.74	5.45	6.13
b) 5mm	2.49	3.4	4.54	5.68
Increase in C.B.R (%) value At				
a)2.5mm	100	137	200	225

IV. Conclusion

In this research work rubber tyre were used at various depth in subgrade layer to evaluate the change in engineering properties of soil. On the basis of results obtained, it has been found that soak C.B.R value in lab test increased by 208% at a depth of 2cm and field soak C.B.R increased by 225% at same depth. Increase in C.B.R value leads to decrease in overall pavement thickness. It can be concluded that waste rubber tyre proves effective tool for engineering properties of soil.

References

[1] Arwan Apriyano, Sumiyanto, Dadan Deri Gusmawan,2017.Application of Woven Tires Waste as Soft Clay Subgrade Reinforcement for Preventing Highway Structural Failure.American Institute of Physics.

[2] Ali Firat Cabalar, Zuheir Karabash & Waleed Sulaiman Mustafa,02 February 2015.Stabilising a clay using tyre buffings and lime. Road material and pavement design.

[3] Amit Srivastavaa, Shikha Pandey & Jeeshant Rana,30 Apr 2014.Use of shredded tyre waste in improving the geotechnical properties of expansive black cotton soil. Geomechanics and geoengineering,

[4] C.E. Piercea, M.C. Blackwell, 2003.Potential of Scrap Tire Rubber As Lightweight Aggregate In Flowable Fill.Waste Management, 23 197–208.

[5] Jie Hana, Jitendra K. Thakurb, January, 2014. Sustainable roadway construction using recycled aggregates with geosynthetics. Elsevier, Sustainable Cities and Society, 342–350,.

[6] N. Hataf, M.M. Rahimi ,2006. Experimental investigation of bearing capacity of sand reinforced with randomly distributed tire shreds. Construction and Building Material, 20 910–916.

[7] SuatAkbulut, SeracettinArasan, EkremKalkan, 2007.Modification of clayey soils using scrap tire rubber and synthetic fibers.Applied Clay Science, 23–32.

[8] Satishsajja, V. K. Chakravati ,2014. Laboratory and Field Performance of stabilized soft subgrade.American Journal of Engineering Research (AJER), pp-273-283.

[9] Unnam Rajesh, Satish Sajja, V K Chakravarthi,2016.Studies on Engineering Performance of Geogrid Reinforced Soft Subgrade. Transportation Research Procedia, 164 – 173.

[10] Munnoli P M, Suhail Sheikh, Taqudas Mir, Vijay Kesavan, Rohit Jha,august 2013.Utilization of Rubber Tyre Waste in Subgrade Soil.IEEE.

[11] Yeo Won Yoona,, Sung Han Cheon, Dae Seong Kang, 2004. Bearing capacity and settlement of tire-reinforced sands.Geotextiles and Geomembranes, 22 (2004) 439–453.