Shredded Waste Tyre: General Approach as A Construction Material

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ABSTRACT

Production of huge quantities of solid wastes not only require large space for their disposal but also creates a lot of geo environmental problems. Stabilization is one of the different methods to handle such problems. Carbide sludge and shredded waste tyre are two such type of solid wastes. The optimum percentage of shredded waste tyre was found out by addition of shredded waste tyre up to 20% at an increment of 5% to a lateritic soil and finding the Compaction properties, UCS and soaked CBR of lateritic soil-shredded waste tyre mixes. The optimum percentage of shredded waste tyre for stabilization of lateritic soil was found to be 10%. Compaction properties, UCS, soaked CBR, Hydraulic conductivity and Volumetric shrinkage strain of carbide sludge stabilized lateritic soil –shredded waste tyre mixes were found out.

Keywords: Lateritic Soil, Shredded Waste Tyre, UCS, CBR

CHAPTER 1
INTRODUCTION

India is a peninsular country bounded by oceans and mountain ranges. It is the 2nd populous country as well as the 7th largest country of the world. To give a proper transportation network for the people India now headed towards the road era. But there will be the problem for this wide network maintenance and repair cost. To overcome these problems engineers have developed certain techniques which will benefit us in near future. Odisha, India’s best kept secret, is prone to the natural disasters like cyclone, flood. As a state of very low per capita income we have to employ certain techniques which will benefit us. Odisha has a very large area of laterite soil which contains mineral and compound content including contents like – Aluminium Oxides, Micas, Potash mica, Black mica, Hematite, Iron Oxides, Manganese Oxides, Pyroxene, Plagioclase, etc. Laterite deposits are porous and clay like which are found in tropical and subtropical regions where the climate is humid. The engineering properties of lateritic soils differ significantly, depending on some factors such as climate, parent material, topography, vegetation, drainage and age (Townsend, 1985). Lateritic soils are used successfully in road construction as base and sub-base materials (Jackson, 1980). Laterite soils are used in construction of highways and airfields (Vallerge et al., 1969).

According to Moh and Mazhar (1969), the increasing degree of laterization results in an increase of the thickness of free iron oxide coating of the soil particles. Lateritic soils have higher plastic limits, Maximum Dry Densities (MDD) and California Bearing Ratios (CBR) while their liquid limits, plasticity indices and Optimum Moisture Contents (OMC) are lower. The engineering properties of lateritic soils vary considerably from top layer to bottom layer. The thickness of the lateritic soil formation is generally limited to a few metres. The PH value of the lateritic soils varies from 4.5 to 6.0.Therefore, lateritic soils are acidic soil. Lateritic soil contains high amount clay therefore, it has low strength and low bearing capacity. Due to low strength in presence of high amount of clay it cannot with stand in moisture under load (Alhassan, 2008). The major problems associated with most of the lateritic soils in its direct usage in the road construction are (IFG, 2007)

- It does not satisfy conventional specifications for road construction materials especially road base.
- It undergoes property changes during construction.

Lateritic soils constitute an important group of residual soils of India, covering an area of about 10,000 sq. km. They are found mainly on the Western and Eastern coasts over a large area and in small quantities in the Southern and Eastern States of India. Lateritic soils covering an area of 0.70m ha of Odisha in the districts of Puri, Khurda, Nayagarh, Cuttack, Dhenkanal, Keonjhar, Mayurbhanja and Sambalpur. Laterites are two types in Odisha are lateritic rock and laterite murrum. Laterites both rock and soil forms occur extensively in and around Bhubaneswar, the capital city and are used as masonry blocks or aggregates for pavement construction. Laterite quarrying is an important activity on the area supporting families. Lateritic soils of Khurda and Bhubaneswar are derived from Athgarh sand stones. The lateritic moorland constitutes the main parts of the district. This forms an undulate land enclosed by lateritic cap above Gondwana sand stone and Precambrian rocks. In Khurda district lateritic soils are present northen and north central part of the district. The soils of central research station, Bhubaneswar developed on laterite parent material have been classified as Arenic, Kandic and Ultic Haplustalfs (Uplands), Fluventic and VerticUstochrepts (Medium lands) and TypicFluvaquents and AquicUdort-hents (Low lands) (Nayak, 1998). In Bhubaneswar 65% lateritic soil, 25% alluvial, 10% sand stone present. Degraded laterites are honey combed structure and found in the districts of Khurda and Cuttack.

1.2 PRODUCTION OF SHREDDED WASTE TYRE (SWT) AND ITS ENVIRONMENTAL EFFECT

SWT are generated from automobile industries, industry aviation sectors, construction work as waste products of construction equipment in millions of tons every year. In India, annually 37 million car and truck tires are being discarded and to increase due to growth in car owner ship and road traffic. In India 39% of waste tyre disposed off in 2011, which will be increase to 63% in 2021. Every year 13.5 million tons of SWT disposed off worldwide. Disposal of the SWT creates problem of environmental pollution also is the requirement of large space for their disposal.The disposal of SWT cannot use as land fill due to its huge quantities and also creates breading space for insects, mosquito which increases risk and disease spreading. SWT contaminates both underground and above ground water systems and burning of SWT also causes air pollution.

Amu et al. (2005) performed stabilization on CBR of lateritic Soil with effect of lime and wood ash. Vysakh and Bindu (2012) had investigated that stabilization of lateritic soil using coconut leaf, shell and husk ash as a stabilizing agent. Osinubi et al. (2012) had investigated the utilization of municipal solid waste (MSW) leachate and bagasse ash for stabilizing lateritic soil, which became suitable for use as liner and compatible with leachate. Abdulfatah et al. (2013) worked on the utilization of MSW as soil stabilizer in lateritic soil, which is suitable for landfill or road construction material. Marto et al. (2013) had studied the stabilization of lateritic soilby using GKS (Liquid Polymer) as a soil stabilizer. Joel and Joseph (2015) carried out a research work for the treatment of lateritic with calcium carbide waste (CCW) for use in road work as the most economic compactive effort. Phummiphan et al. (2016) had investigated the stabilization of lateritic soil as a base of pavement by using fly ash and calcium carbide residue (CCR) as a soil stabilizer for improving geopolymer binders.

CHAPTER 2
MATERIALS USED

The materials used in the experiments are mainly lateritic soil and shredded waste tyre (SWT)

2.1 Lateritic Soil

The Geotechnical properties of lateritic soil are shown in Table 2.1.

Table 2.1: Geotechnical Properties of Lateritic soil

Properties	Values
1) Grain Size Analysis	
Gravel size (%)	9
Sand size (%)	61
Silt size (%)	22
Clay size (%)	08
2) Atterberg's Limit	
W_L (%)	36
W_P (%)	22
I_P (%)	14
3) Compaction Properties (Modified Proctor)	
OMC (%)	11.2
MDD (kN/m^3)	19.65
4) Specific gravity	2.69
5) UCS (kN/m^2)	165
6) K (cm/sec.)	2.81×10^{-7}
7) VSS (%)	1.82
8) Soaked CBR (%)	7.1
9) Cohesion (kN/m^2)	40
10) Angle of Internal friction (in degree)	24
11) IS Classification	SC

2.2 Shredded Waste Tyre(SWT)

The SWT passing 4.75mm and retained in 75μ sieve was used in experimental programme. Particle size analysis of SWT is given in Table 2.2.

Table 2.2:Particle size analysis of SWT

Particle size	Percentage (%)
Gravel size	0
Coarse sand size	22

Medium sand size	42
Fine sand size	36
Clay size	0

2.3 TESTING PROCEDURE

After preparation of samples/mixes testing was done according to the procedures described below.

2.3.1 Unconfined Compressive Strength (UCS) Test

An unconfined Compressive Strength (UCS) test for different mixes were conducted according to code IS: 2720 part 10- 1973, "Determination of Unconfined Compressive Strength". The samples/mixes were prepared according to their proportions at the respective MDD and OMC by replacing soil by SWT-CS on dry weight basis. Once the samples/mixes were prepared then they were kept. The usual procedure to determine the UCS of soil was adopted. This has been described in paragraphs given below.

1. The initial length and diameter of the specimen was measured.
2. The specimen was put on the bottom plate of the loading device. The upper plate was adjusted to make contact with the specimen. The load dial gauge and the strain (compression) dial gauge were set to zero.
3. The specimen was compressed until cracks have definitely developed. The load dial gauge readings were taken approximately at every 1mm deformation of the specimen.
4. The axial strain $\epsilon = \Delta L/L_0$ was measured. Where ΔL =change in length of specimen, as read from the strain dial, L_0 = initial length of the specimen.
5. The average cross-sectional area A, at a particular strain was determined from the relation $A = A_0/(1-\epsilon)$
6. The UCS was determined by $\sigma = P/A$.

Figure 1: Shear failure after UCS test

2.3.2 Soaked California Bearing Ratio (CBR) Test

A Soaked California bearing ratio (CBR) test for different mixes were conducted according to code IS: 2720 (part 16) - 1979, "Determination of California bearing ratio". The samples/mixes were prepared according to their proportions at the respective MDDand OMC by replacing soil by SWT-CS on dry weight basis. Once the samples/mixes were prepared then they were kept. The usual procedure to determine the CBR of soil was adopted. This has been described in paragraphs given below.

1. The empty weight of mould (2250 cm^3 volume) was taken. Then, 5 kg of lateritic soil and SWT-CS were taken and mixed thoroughly with the required water. Extension collar and the base plate were fixed to the mould. The spacer disc was inserted over the base. The filter paper was placed on the top of the spacer disc. The mixed sample was compacted in the mould using heavy compaction. The lateritic soil and SWT-CS were compacted in 5 equal layers, each layer being given 56 blows by the 4.9 kg rammer. The collar was removed and the sample was trimmed off. The mould was turned upside down and the base plate and the displacer disc were removed. The mould was weighed with compacted soil and the bulk density and dry density were determined. Filter paper was put on the top of the compacted lateritic soil-SWT-CS mix sample (collar side) and the perforated base plate was clamped on to it. Annular weights were put to produce a surcharge equal to weight of base material. The mould assembly was immersed and weighed in a tank of water and it was soaked for 96 hours. The mould was removed from tank.
2. The mould assembly was placed with the surcharge weights on the penetration test machine. The penetration piston was seated at the centre of the specimen with the smallest possible load, but in no case in excess of 4 kg so that full contact of the piston on the sample was established. The stress and strain dial gauge was set to read zero. The load was applied on the piston so that the penetration rate is about 1.25 mm/min. The load readings were recorded at penetrations of 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 4.0, 5.0, 7.5, 10 and 12.5 mm. The mould was detached from the loading equipment.

CHAPTER 3
RESULT & DISCUSSION

Different types of samples were prepared in desired proportion, weight etc. and different tests were conducted on these samples according to the procedure discussed in chapter 2. The test results are analyzed and discussed in this chapter.

3.1 EFFECT OF SWT ON MDD OF LATERITIC SOIL

Sl No.	SWT (%)	MDD (KN/m^3)
1	0	19.65
2	5	19.20
3	10	18.80
4	15	18.36
5	20	17.98

It is observed that with increase in percentage addition of SWT the MDD of lateritic soil goes on decreasing which is due to the replacement soil having high specific gravity (2.69) with rubber which has low specific gravity (1.12).

3.2 EFFECT OF SWT ON OMC OF LATERITIC SOIL

Sl No.	SWT (%)	OMC (%)
1	0	11.2
2	5	10.8
3	10	10.3
4	15	9.98
5	20	9.62

It is observed that the OMC of soil decreases with increase in percentage addition of SWT which may be due to the negligible water absorption capacity of the shredded waste tyre.

3.3 EFFECT OF SWT ON UCS OF LATERITIC SOIL

Sl No.	SWT (%)	UCS (kN/m^2)
1	0	165
2	5	177
3	10	190
4	15	180
5	20	169

It is observed that the UCS value increases / decreases with increase / decrease in SWT content indicating addition of SWT increases shear strength of the soil.

3.4 EFFECT OF SWT ON SOAKED CBR OF LATERITIC SOIL

Sl No.	SWT (%)	Soaked CBR (%)
1	0	7.1
2	5	8
3	10	9.5
4	15	8.9
5	20	8.1

It is observed that the soaked CBR value increases / decreases with increase / decrease percentage of SWT indicating addition of SWT increases shear strength of the soil. From the UCS and soaked CBR test results the optimum percentage of SWT in stabilization of Lateritic soil is found to be 10%.

CHAPTER 4

CONCLUSION

A series of laboratory tests were conducted to study the effect of SWT on OMC, MDD, UCS and soaked CBR of an lateritic soil to get optimum percentage of SWT for its stabilization. The following conclusions are drawn from this study.

- With increase in percentage addition of SWT the MDD of soil goes on decreasing. The MDD decreases to a value of 17.98kN/m^3 from 19.65kN/m^3 when the percentage addition of SWT is 20%.
- With increase in percentage addition of SWT the OMC of soil goes on decreasing. The OMC decreases to a value of 9.62% from 11.2% when the percentage addition of SWT is 20%.
- With increase in percentage addition of SWT the UCS of soil goes on increasing. The UCS increases to a value of 180kN/m^2 from 165kN/$m^2$when the percentage addition of SWT is 10% thereafter it decreases. The maximum increase in UCS is 9.09% as compared to the UCS of virgin lateritic soil when the percentage addition of SWT is 10%.
- With increase in percentage addition of SWT the soaked CBR of soil goes on increasing. The soaked CBR increases to a value of 9.5 % from 7.1% when the percentage addition of SWT is 10% thereafter it decreases. The maximum increase in percentage of soaked CBR is 33.80% as compared to the soaked CBR of virgin lateritic soil soil when the percentage addition of SWT is 10%.
- The optimum percentage of SWT for stabilization of lateritic soil is found to be 10%.

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