International Journal of Engineering and Advanced Technology (IJEAT)
ISSN: 2249-8958 (Online), Volume-6 Issue-5, June 2017

A Study on Unconfined Compressive Strength, Permeability and Swelling Characteristics of Clay and Shredded Tyres Mixture

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Abstract: ***Soil is the basic foundation for any civil engineering structures. It is required to bear the loads without failure. In some places soil may be weak which cannot resist the oncoming loads in such cases soil stabilization is needed, The clay often is weak and has no enough stability in heavy loading. Stabilization is being used for a variety of engineering works, the most common application being in the construction of road and airfield pavements, where the main objective is to increase the strength or stability of soil and to reduce the construction cost by making best use of locally available materials. With ongoing rise in use of motor vehicles hundreds of millions of tyres are discarded each year throught the world. Many are added to existing tyre dumps or landfills and a significant number for recycling into a useful products.Since highway construction requires large volumes of materials, highway agencies have been encouraged to participate in the recycling effort. Recovering these materials for use in construction requires an awareness of the properties of the materials and the limitations associated with their use. Use of shredded tyres in geotechnical engineering for improving soil properties has received great attention in recent times. Present an attempt has been made through laboratory study to understand the potential of shredded tyres in soil stabilization, which help not only in soil stabilization but also in utilization of waste. Shredded tyres having size 5mm, 10mm, 30mm and 50mm after removing steel belting are used. This paper presents the investigation of clay soil stabilized with shredded tyre. It is found that unconfined compressive strength of clay-shredded tyre mixture were found to be between 0.23 and 0.37kg/cm2. Permeability of clay –shredded tyres is higher compared with that to clay alone. Less swelling and swelling pressure observed on addition of shredded tyres compared with clay alone.***

Keywords: Shredded tyres, unconfined compressive strength test, permeability, Swelling, Clay soil.

I. INTRODUCTION

In developing countries like India transportation sector plays a vital role in uplifting that national economy. With the ongoing rise in use of motor vehicles, hundreds of millions of tyres are discarded each year throughout the world , hence waste generated will be more. One solution to disposal crisis lies in recycling waste into useful products. Use of shredded tyres for civil engineering application has several advantages.

Manuscript published on 30 June 2017.
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The aim of the study was to use the waste material for stabilization of soil in order to reduce the environmental impact. Since pavement construction requires large volumes of materials highway agencies have been encouraging to participate in the recycling effort. This paper aims to study the improvement in the strength of clay soil on mixing the shredded tyres to soil.

II. MATERIALS USED

The soil used in this study is natural clay collected near Chethukadavu in Calicut city (India) . The classification of soil as per IS specifications is CI (as per IS 1498-1970) which is inorganic clay of medium plasticity. Shredded tyres used were obtained commercially in sizes 5mm, 10mm, 30mm and 50mm. These shredded tyres were mixed with dry clay in percentages of 10, 25 and 50 by weight and water was then added.

A. Unconfined Compressive Test:

Unconfined compressive (UCS) test is conducted on clay and shredded tyres. It was observed that the length and percentage of shredded tyres influenced the compressive strength of the soil sample. When compared to all the sizes of shredded tyres used 5mm size is giving better value. Fig 1 and Fig 2 shows that the introduction of the shredded tyres caused a considerable decrease in the UCS. A reduction in UCS due to the introduction of shredded tyres particles is consistent with the results of others but the degree of reduction is found to be dependent on the type of soil tested such that as the clay content increased a smaller reduction was observed in the UCS.

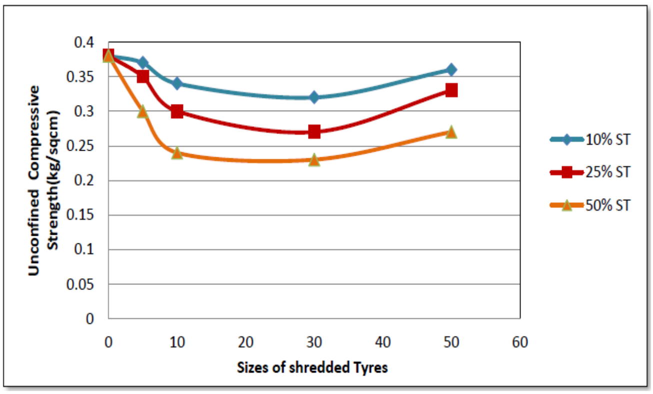

Fig1: Variation of unconfined compressive strength with sizes of shredded tyres.

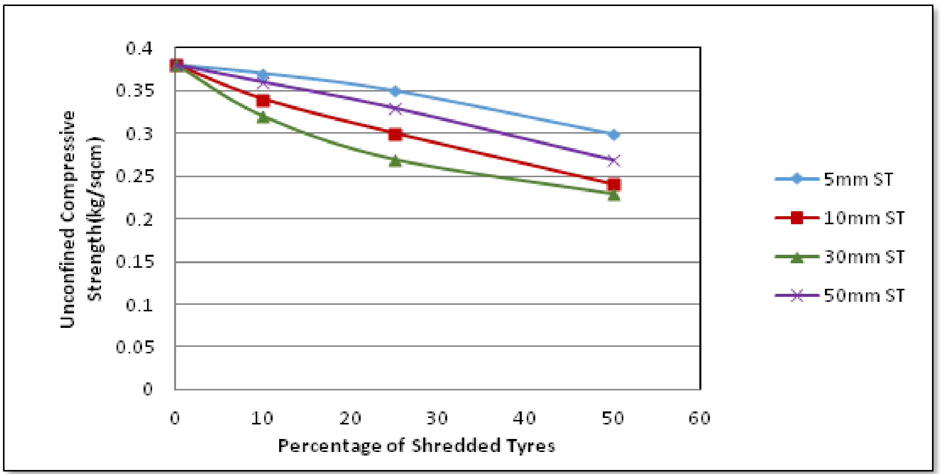

Fig 2: Variation of unconfined compressive strength with percentage of shredded tyres

B. Permeability Test:

Permeability was measured using water as permeant. The diameter of the sample used is 10cm and height of the sample used is 13cm. In the Table 1 the results show that when using water as permeant, the permeability of the clay-tyre mixture increased compared with the clay alone. It was observed that as the length of shredded tyres increase the permeability of clay-shredded tyres mixture increased, however if the increase is not significant it indicates 'good bonding' between the clay and shredded tyre and that the development of large pores and cracks was minimal.

Table 1: Permeability (cm/sec) of clay and clay-shredded tyre mixture

Materials \ Permeability	10%	25%	50%
Clay	1×10^{-5}	1×10^{-5}	1×10^{-5}
Clay- Shredded Tyre (5mm)	1.58×10^{-4}	2.5×10^{-4}	9.5×10^{-4}
Clay- Shredded Tyre (10mm)	1.84×10^{-4}	4.2×10^{-4}	12.92×10^{-4}
Clay- Shredded Tyre (30mm)	7.62×10^{-4}	9.2×10^{-4}	19.1×10^{-4}
Clay- Shredded Tyre (50mm)	21×10^{-4}	23×10^{-4}	25×10^{-4}

C. Swelling and Swelling Pressure Test:

This test is conducted to find out the increase in volume of the soil that is the amount of swelling taking place with and without the addition of shredded tyres and to find swell pressure required to bring back to the original height. Fig3 shows how the swelling reduce due to the introduction of shredded tyres, which could be attributed to the presence of hair line cracks that accommodate the water. Very limited swelling is observed on addition of shredded tyres to the soil whereas in case of clay alone the swelling is high. This is probably related to the fact that many types of clay become non-plastic in the presence of hydrocarbons and hence do not swell. From the Fig 3,4,5 it has been observed that as the percentage of shredded tyres decreased the swelling also decreased. It can be said that the swelling is directly proportional to the percentage of shredded tyres. It is also same in the case of swelling pressure as it is consistent with swelling behavior.

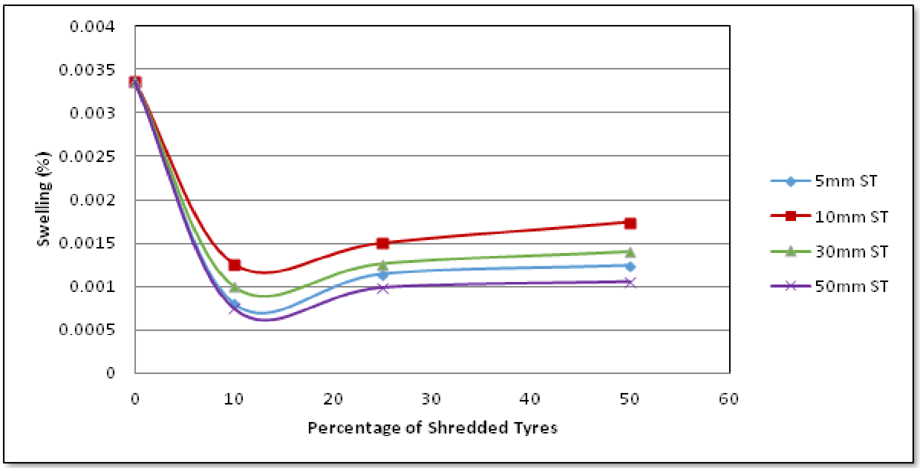

Fig3: Variation of swelling with respect to size of shredded tyres.

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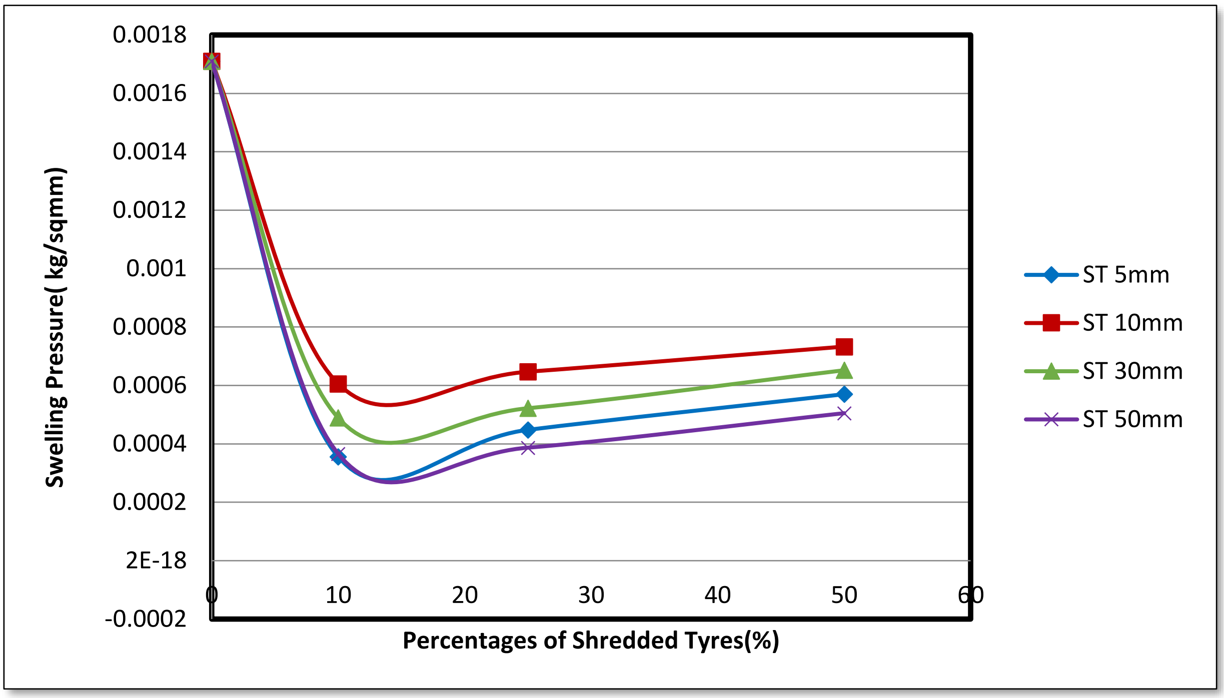

Fig 4: Variation of swelling pressure with respect to percentages of shredded tyres

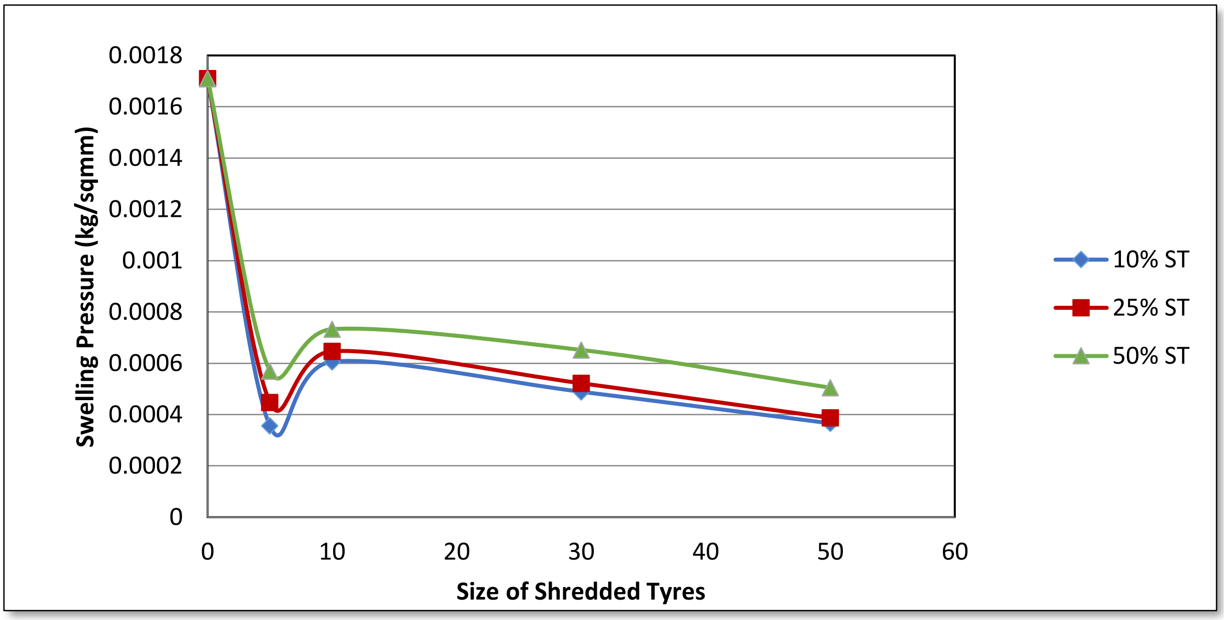

Fig 5: Variation of swelling pressure with respect to Size of shredded tyres

III. CONCLUSIONS

Based on the experiments carried out on soil and soil-shredded tyre mixture, the following conclusion is drawn:

1. Unconfined compressive strength of Clay-Shredded tyres mixture were found to be between 0.23 and 0.37Kg/sqcm. The values observed at 10% of 5mm is 0.37Kg/sqcm, 10%of 10mm is 0.34Kg/sqcm, 10% of 30mm is 0.32Kg/sqcm and 10% of 50mm is 0.36Kg/sqcm which are low as of the strength of the clay alone.
2. Permeability of Clay-shredded tyres is higher compared with that to clay alone. If there is no increase it indicates that there is good bonding between the clay and shredded tyres and that the development of large pores and cracks are minimal.
3. Less swelling is observed on addition of shredded tyres compared with clay alone, it is because some clay become non-plastic in the presence of hydrocarbons and hence do not swell.
4. Swelling pressure observed is less on addition of shredded tyres compared with clay alone, which means that it is consistent with swelling behavior.

The range of results produced shows the high dependency of behavior of the clay shredded tyre mixtures on the moisture content and the shredded tyre content.

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Hence, each situation will need to be considered separately to arrive at a clay-shredded tyre mixture suitable for the site and problem conditions.

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