Partial Replacement of Sand by Tyre Chips as Alternative Backfill Material

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Abstract— Disposal of industrial waste is a major problem facing by the present world. The efficient means of their disposal would be the reuse of these waste in construction industry. Sand tyre chip (STC) mixtures can be used in many geotechnical applications. The reuse of scrap tyres in STC mixture can effectively address the growing environmental concerns and at the same time provide solutions to geotechnical problems associated with low shear strength. This study investigates the suitability of mixtures of sand and tyre chips to be used as alternative backfill material in retaining wall applications. Backfill mix is prepared by adding various percentages of shredded tyre to sand and different laboratory tests are to be conducted to determine the initial properties. The low unit weight of tyre imparts the advantage to be used as the light weight fill. A model load test was conducted to study the settlement and facing displacement under vertical load.

Key words: Sand Tyre Chip Mixture, Alternative Backfill, Rataining Wall, Light Weight Fill

I. INTRODUCTION

By the advancement of human societies and the increasing use of vehicles, millions of scrap tires around the world is taking out of the consumption cycle and collecting as garbage every year. Due to high volume of scrap tires, dangerous fire occurrence, and the high cost of hygiene disposal, this issue has become one of the biggest environmental problems. Therefore, providing some solutions to this problem seems to be necessary. Some of the solutions are reusing them as filler materials in construction projects such as road construction, retaining walls and drainage systems. Discharging of waste tyre on any form became a severe environmental issue. Supplementary disposal of used tyres in landfill and stockpiles increase the risk of accidental fires occur due to uncontrolled emissions of potentially harmful compounds. Ponding of water on discard tyres is an easy platform for spreading of diseases. Waste tyre can neither be subjected to fire nor disposed to open areas. The above mentioned issues will cause serious issues on human health, remediation for the above issues is that can be reused in all useful manner. Tyre chips are reused as embankment fill, backfill of retaining wall, liners in drainage system and the vibration damping layers. One of the remediation that we suggest is inclusion of tyre with sand for backfill construction.

Earth retaining structures such as retaining walls, bridge abutments, bulk heads and mechanically stabilized walls play a important role in public life. Performance of retaining wall depend upon the type of backfill soil. Generally, clean granular cohesionless backfill materials are preferred. Now-a-days new light weight fill materials are used as alternative backfill materials. These lightweight materials are beneficial in reducing earth pressure and lateral displacements of retaining walls.

A study carried out by cecich (1996) explained the applicability of pure tyre chips in retaining wall backfill by achieving the higher factors of safety against sliding and overturning compared to the sand as backfill. Lee and Roh (2006) proved that the dynamic earth pressures behind a retaining wall were reduced on using a backfill material having lesser elastic modulus and higher damping ratio and demonstrated that tyre chips possesses these reliable properties. Numerical analysis on retaining walls backfilled with pure tyre chips and pure sand carried out by Huggins and Ravichandran (2014) showed that the bending moments, shear forces and the displacement of the walls backfilled with tyre chips were reduced significantly than that of walls backfilled with the sand considered.

This paper presents the investigations on the use of recycled tyre chips mixed with sand as light weight backfill material for retaining wall applications and the effect of addition of tyre into sand on bearing capacity of soil. A model load test was conducted to study the settlement and facing displacement under vertical load.

II. OBJECTIVES

- To evaluate the effect of varying percentage of tyre on the geotechnical properties of sand and to determine the optimum percentage.
- To evaluate the suitability of sand tyre chip mixture as light weight backfill material.
- To study the effect of tyre on bearing capacity of soil

III. MATERIALS

Materials Used:

A. Sand
B. Tyre chips
C. Rectangular tank

A. Sand

Experiments were carried out on locally available cohesionless soil collected from Trivandrum district, Kerala.

Fig. 1: Sand

The properties of sand are shown in the table below:

Table 1: Properties of sand

PROPERTY	VALUE
Specific Gravity	2.66
% of gravel	0
% of sand	97.75
% of silt and clay	2.25
Uniformity coefficient	2.736
Coefficient of curvature	.851
Angle of internal friction	38˚

B. Tyre Chips

Tyre chips similar to the size of sand was collected from automobile workshop

The properties of tyre chips are shown in table below:

PROPERTY	VALUE
Specific Gravity	1.27
Density (gm/cc)	56
Angle of internal friction	28˚
Cohesion	Negligible

Table 2 Properties of tyre chips

C. Rectangular Tank

A rectangular tank of 50cm width, 50cm height, 100cm length is used, with 3 faces concreted and one face is made up of plywood board.

IV. METHODOLOGY

The soil which was collected was completely dried and the dust particles were removed. Experiment were conducted in two steps. First a retaining wall model with sandy backfill and second model wall with different sand tyre chip mixtures (10, 20, 30, 40) as backfill. The sand tyre chip mixtures were prepared by mixing sand and tyre chips in different proportions by weight. Static load up to 35kN/m^2 was applied in the form of concrete cubes was applied. A square plate of 30cm x 30cm size was used as loading platform. Settlements were measured by a dial gauges of .01mm accuracy. To monitor the lateral deformation of the wall, linear variable magnetic dial gauge were positioned on the front face of the wall.

Percentage of tyre	Specific gravity	Dry Unit weight(kN/m^3)	Angle of internal friction(˚)
100	1.27	6.45	28
10	2.63	14.60	41
20	2.61	13.50	43
30	1.83	12.98	46
40	1.75	10.60	41

Table 3: properties of different sand tyre mixture

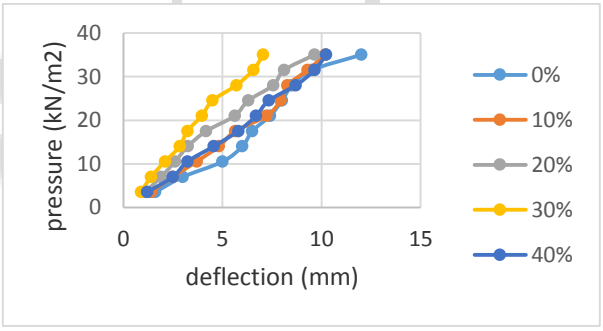
Fig. 3: Experimental setup

V. RESULT AND DISCUSSIONS

Based on the test results, it was observed that the percentage shredded tyre content in the backfill of model wall was found to have influence on the pressure settlement characteristics and the facing displacement of the model wall.

A. Effect of different percentage of sand tyre chip mix under vertical loading

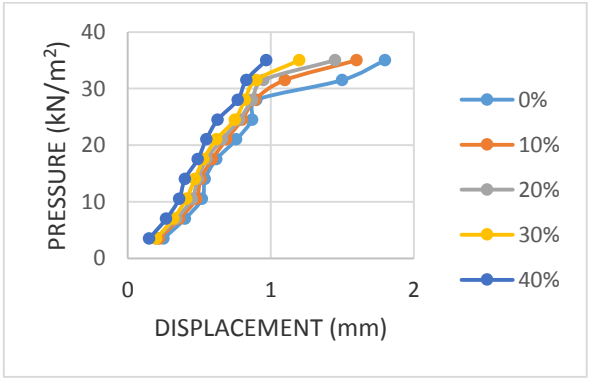
The maximum load was taken by model wall constructed with backfill mix containing 30% tyre content. With the addition of 40% tyre content the mix showed very high vertical settlement.



Graph 1: Pressure – Settlement curve

B. Effect of different percentage of sand tyre chip mixture on facing displacement

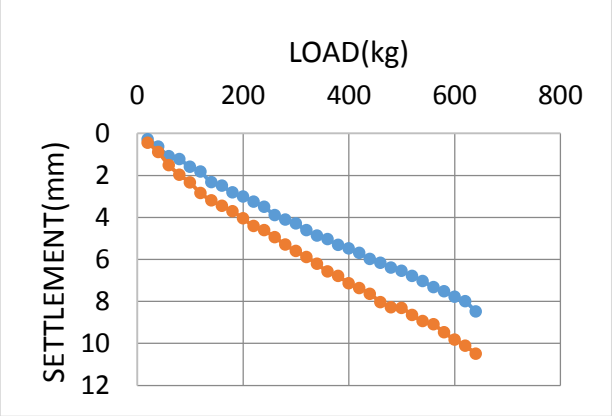
By varying the tyre content, variation in facing displacement was observed. It was observed that the facing displacement decreased with increase in tyre content in the backfill of model wall.



Graph 2: Pressure – Facing displacement curve

C. Effect of tyre content on bearing capacity of the soil

From the plate load test results it was observed that the bearing capacity and settlement increases for the mix with 30% tyre content compared to sand alone.



Graph 3: Load settlement curve

VI. CONCLUSIONS

- Mixing tyre to the sand reduces the density and thereby forming a lightweight mixture.
- The light weight mixture when used as backfill material it will reduces the soil pressure.
- From the model study it was observed that the tyre content up to 30% reduces the settlement of backfill.
- The facing displacement decreased with the increase in tyre content
- By adding tyre to the 30% the bearing capacity of the soil is increasing
- Sand can be replaced by 30% of tyre as light weight backfill material.

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