STUDY THE EFFECT OF WASTE RUBBER MATERIALS ON SHEAR STRENGTH OF RESIDUAL SOILS

M.G.B.T Balasooriya1, W.G.S.D Kumari2, M.A.S.N. Mallawarachchi3, Dr. D de S.Udakara4.
Email:1instheja@gmail.com

Abstract

One of the problems associated with the socio-economic development of Sri Lanka is waste disposal. One of the wastes generated in engineering and transportation sector is scrap tire and it poses serious environmental problem, worst when it is burnt. This Paper presents study the effect of waste rubber materials on shear strength of residual soils. Series of laboratory direct shear tests were carried out on soil reinforced with randomly distributed rubber strips. The soil was collected from the university premises and rubber strips were obtained from scraped tire tubes. 20mm × 5mm tire tube strip sizes were used as the reinforcement of the residual soil and 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5%, 3.0% increments were used until reached to the optimum rubber percentage. According to the tests results, the soil type was identified as CVG according to the BS 5930 1990 and the optimum rubber content is 2.0% for the maximum shear strength.

Keywords: Shear strength, Rubber content, Direct shear

1. Introduction

This study focuses on the utilization of the waste rubber material as reinforcement to increase the shear strength of residual soils. A series of laboratory direct shear tests are carried out on soil reinforced with randomly distributed rubber strips to determine its effect on the shear strength of residual soils. From results of the experiments, the optimum rubber content for the maximum shear strength are determined.

2. Literature Review

One of the wastes generated in engineering and transportation sector is scrap tire and it causes serious environmental problem. Some researchers showed that strength and compressibility of shredded tire can be used for the engineering requirements.

L Martin Christ et al. evaluated the strength properties of rubber sand mixtures at various rubber contents as0%, 10%, 15%, 20% & 30 %.They found the Shear strength decreased and optimum rubber content is 15%.

Suat Akbulut et al. evaluated the effect of the waste rubber on strength parameters of clayey soils. The contents of scrap fiber rubber has been used is 1%, 2%, 3%, 4%, 5% by total weight of reinforced samples. They determined the shear strength increased up to 2% rubber and decreased after 2% rubber content.

S Thenmozhi et al. evaluated the performance of soil and rubber waste mix as sub grade material. Natural soil and 30mm to 45mm rubber strips with 7mm thickness were used as materials. They evaluated shear Strength increased with rubber content.

3. Material and Methods

3.1 soil

The soil was collected from the university premises and Series of laboratory tests were carried out to identify its properties.

3.2 Rubber Strips

Rubber strips were obtained from scraped tire tubes and strip sizes were 20mm × 5mm.

3.3 Testing procedure

The entire laboratory tests are carried out according to BS 1377.The soil sample was prepared in a CBR mould using 6 kg of soil and rubber strips which were in size of 20mm × 5mm randomly distributed with soil. The compaction was done using the Standard Proctor Compaction method by adding the amount of water which requires for 95% $\rho_{dmax.}$ Increase the rubber content with the various percentages (0%, 0.5%, 1%, 1.5%, 2%,2.5%....) of rubber strips for each samples and three specimens were trimmed from each samples. Then Direct Shear Test was done for each sample by applying 30lb, 60lb and 90lb normal loads.

After that variation of shear stress with the shear displacement was plotted for each rubber content.

Finally the variation of friction angle (Φ) and cohesion (C) with the rubber content was analysed to find out the optimum rubber content.

4. Results and Discussion

4.1 Soil classification test results

Sieve analysis test and attereberge limit test was carreied out to identify the type of soil.

Particle percentage finer than 0.06 mm = 60%
Plastic Limit - 37%
Liquid Limit - 73%
Plasticity Index - 36%

According to BS 1377 the soil was classified as Very High Plasticity Gravelly Clay (CVG).

4.2 Specific Gravity Test Result

According to Pycnometer method, Specific Gravity of soil sample was obtained as 2.90.

4. 3 Compaction test Results

Standered Proctor compaction test was done to obtain following results

Optimum Moisture Content = 27 %
Maximum dry density (ρ_{dmax}) = 1.6 Mg/m^3
Moisture content at 95% ρ_{dmax} = 24%

4. 4 Direct shear test Resuts

Following results were obtained from the series of direct shear tests, which were carried for various rubber percentages.

Table 2: Cohesion and Friction angle for each soil sample

Rubber Content	Cohesion/(Kpa)	Friction Angle/(deg)
0.0%	21	11
0.5%	3	33
1.0%	5	33
1.5%	3	37
2.0%	3	38
2.5%	9	28

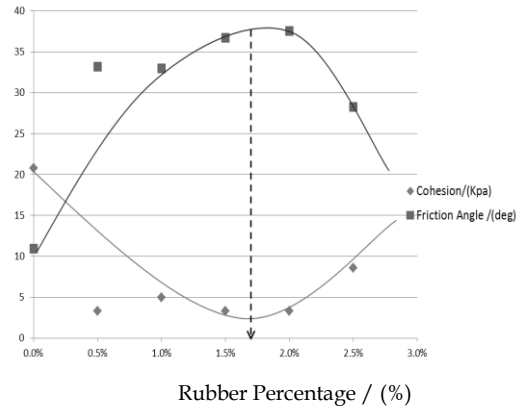

Figure 1: Variation of Cohesion and Friction angle with rubber content

According to above graph friction angle has increased up to 1.7% rubber content and it has decreased when increasing the rubber content. Cohesion of each sample gradually decreased up to 1.7% rubber content and increased when further adding of rubber. So the optimum rubber content of our study is 1.7%,is recommend to increase the strength of a residual soil which can be used as a backfill material.

5. Conclusions

Direct shear tests were carried out to determine the maximum shear strength of each sample**.** 20mm × 5mm tire tube strip sizes were used as the reinforcement of the residual soil and 0%, 0.5%, 1.0%, 1.5%, 2.0%, 2.5% increments were used until reach to the optimum rubber percentage.

Maximum friction angle and the minimum cohesion were obtained at the sample of 1.7 % randomly distributed rubber. So according to the Mohr-Coulomb failure criteria maximum shear strength can be obtained at 1.7% rubber mixed soil.

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