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Experimental Studies On Slope failure in clay

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Abstract: A slope failure is a common occurrence that a slope collapses instantaneously due to weakened the self-retainability of the earth under the influence of various factors such as rainfall, earthquake, geological features, construction activities, external loading rapid drawdown erosion, etc. Generally, four types of failures are Translational, Rotational, Wedge, and rotational failure. This study is to examine and create a wedge failure slope by introducing a shear zone in the slope in clay soil. When the slope is prepared manually in clay with optimum moisture content and proper compaction, the clay itself gives enough stability for the slope. However, in the case of field conditions, the slope will have different strata and not have homogenous soil conditions. To make the manually prepared slope with field condition, a layer of filler material added as a predefined failure plane or shear zone in the slope. The index and engineering properties soil is studied, and three samples such as wood chips sawdust and thermocol balls used to make the shear zone. The interaction study conducted in clay soil with each sample separately using the direct shear test. From the test result, Sawdust with cohesion C – 1.37, which gives the least value among the taken samples. Hence, it has chosen to use it in the slope to make it a failure by getting the lowest shear stress and friction between soil and filler material.

***Index Terms* - slope failure, soil interaction study, filler materials, predefined shear zone.**

I. INTRODUCTION

A slope failure is a common occurrence that a slope collapses instantaneously due to weaken the self-retainability of the earth. Slope failure is the downslope motion of rock debris and soil react to gravitational stresses which is also called as mass wasting. The type of downslope movement classifies three major types of mass wasting: falls, slides, and flows. Slopes are of different types, Natural types are Hill side and valleys Coastal and river cliffs Man-made types are Cuttings and embankments for highways and rail roads, Earth and ash pond for dams, landfill slopes , Landscaping in site development Temporary excavations. They failed by face or toe or base.

Sometimes slope failures leads to broad harm and loss of life. Slope stability issues have been looked all through history when human or nature has disturbed the sensitive adjustment of normal soil slopes. The growing demand for engineered cut and fill works on construction projects has only need to understand, investigative instruments, logical techniques and stabilization technique to pamper slope stability issues.

Objectives

To find out the basic parameters of soil sample and materials to be chosen for filler material.
To discover out the behavior of filler materials with soil when they placed as a layer inside the soil slope
To determine one of the filler materials as pre-defined failure plane of slope using the results.

II. RESEARCH METHODOLOGY

The methodology section figures the plan and method, which shows how the study conducted. This includes data collection, literature review, collection of samples, laboratory investigation of soil samples, and interaction study of filler materials with soil sample, results and discussion.

III. LABORATORY INVESTIGATIONS

In laboratory investigations, the sample analyzed in the laboratory for determination of its specific gravity, particle size distribution, optimum moisture content, maximum dry density and Atterberg's limits.

3.1 Collection of samples

The sample collected from near the main entrance of Government College of Technology, Coimbatore. The latitude and longitude of the site is 11.02oN and 76.93oE respectively. Filler materials such as sawdust and woodchips collected in local carpentry factory and thermocol balls in nearby shops.

3.2 Index and Engineering properties of soil

The index and engineering properties of the soil sample is determined by various laboratory tests such as 1. Particle Size Distribution – Wet sieve analysis 2. Specific Gravity test 3. Moisture Content test 4. Atterberg's limits test, 5. Standard Proctor Compaction Test (Light Compaction) 6. Free Swell test. From the tests conducted the results which get such as specific gravity of 2.73, moisture content of 20%, liquid limit of 48% plastic limit 22%, free swell index 52%, and optimum moisture content of 22% and maximum dry density of 1.44g/cc. From the above results in basic properties, the taken sample classified as intermediate clay.

IV. EXPERIMENTAL INVESTIGATIONS

The main objective of model study was to evaluate the correct filler material to prepare a shear zone. Hence, the soil sample tested with the chosen filler materials to perform the interaction study between them. It assumed that the difference in procedure in field and laboratory would not have or have little effect. Design of foundation, slab bridges, pipes, retaining walls, sheet piling are some of the engineering issues which required angle of internal friction and cohesion of the soil for the design. Direct shear test method used to predict these parameters quickly.

To prepare the soil sample for carry over the test a square steel mold of size 6 cm x 6 cm x 5 cm used.

4.1 Filler Materials

The main objective of using filler materials is to prepare a failure slope in the laboratory manually. To do the experimental analysis of slope stability using micro piles first, the slope has to be prepared. The chosen soil sample is clay. When the slope is prepared manually in clay with optimum moisture content and proper compaction, clay itself give enough stability for the slope. But in case of field condition slope will have different strata and not have homogenous soil condition. To make the manually prepared slope with field condition, a layer of filler material added as a predefined failure plane in the slope. For this purpose, the samples, which have chosen such as, follows.

4.1.2 Woodchips

Woodchips prepared by braking and trimming larger pieces of wood, such as trees their branches, all other parts such logging residues stump wood waste and roots. The water content of the material influenced the young's modulus. In the case of dry woodchips, modulus of elasticity of 0.33 MPa obtained, while at 50% of water content, the young's modulus was of 0.25 MPa. Mean value of angle of internal friction for woodchips was approximately equal to 330. Effective angle of internal friction ranged up to 420 for woodchips. (M. Stasiak et al. /Fuel 159 (2015) 900–908)

4.1.3 Sawdust

Sawdust obtained as a waste product of woodworking operations such as sawing, milling, planning, drilling, and sanding, routing. It made up of fine particles of wood. The mean value of the angle of internal friction for sawdust found 270. Effective angle of internal friction ranged from 340 for sawdust. (M. Stasiak et al. /Fuel 159 (2015) 900–908)

4.1.4 Thermocol balls

Thermocol manufactured from a petroleum-based plastic compound known as polystyrene. It contains an essential thermoplastic compound called polystyrene obtained by the polymerization of styrene or phenylethene It does not have the property of absorbing moisture since it is a petroleum-based product. It is incompressible, easily regains its original shape no matter how much load given. Polyethylene balls are lightweight and not mix-up with soil when is used as a layer in the middle of soil layers.


Woodchips


Thermocole balls


sawdust

From these samples, anyone material will be going to use it in the slope to make it failure by getting the lowest shear stress and friction angle between soil and filler material.

4.1.5 Sample preparation

The soil sample taken from site used for prepared to do direct shear test. At Initial, the soil mixed with 22% water content (OMC), mixed well then compacted by modified proctor compaction method as three layers. Then the square shaped sample mold inserted into the soil. The square mold inserted in the compacted soil and then, the soil taken out by removing the mold from the soil.

4.1.4 Proceedings and testing

All initial sets up has fixed in the direct shear test apparatus. The first sample tested is soil of three specimens.

The second sample is soil with woodchips. Sample is prepared as one layer of soil and the other layer is woodchips and well compacted. The woodchips of about 200gm taken and mixed with its optimum moisture content (OMC) of 10%. Then in the proctor mold, the first layer of soil is compacted by giving 30 blows to compact well as it is a modified proctor compaction method doing manually. The second layer is prepared woodchips with its OMC, similarly is compacted by 30 blows. Then the third layer is again soil.

Fig. 4.1 Sample I – Clay

Fig. 4.2 Sample II – Clay + Woodchips

Table. 4.1 Specifications of sample I – Clay

Properties	Trial I	Trial II	Trial III
Density(gm/cc)	1.917	1.898	1.935
Weight(gm)	207	205	209
Normal Stress(kPa)	10	20	30

Table. 4.2 Specifications of sample II – Clay + Woodchips

Properties	Trial I	Trial II	Trial III
Density(gm/cc)	1.537	1.546	1.528
Weight(gm)	166	167	165
Normal Stress(kPa)	10	20	30

The second filler material is sawdust, which is the third sample to be tested. A 200gm of this material was taken and it has the OMC value of 50%, mixed well with the water. The sample prepared as per the previous sample preparation procedure.

The third filler material is thermocol balls, which is the fourth sample to be tested. 200gm of this material is taken and it has no OMC value since this is mixed well with the water. Since thermocol has more volumes and very much less density, hence to make a bonding between thermocol balls and soil, the soil sample is mixed with thermocol balls of about 750gm for 10gm of thermocol by giving 23% of water. Now the procedure followed to carry out the test with different normal stresses.

Fig 4.3 Sample III – Clay + Sawdust

Fig 5.13 Sample IV – Clay + Thermocol

Table. 4.3 Specifications of sample I – Clay + Sawdust

Properties	Trial I	Trial II	Trial III
Density(gm/cc)	1.417	1.398	1.389
Weight(gm)	153	151	150
Normal Stress(kPa)	10	20	30

Table. 4.4 Specifications of sample IV – Clay + Thermocol

Properties	Trial I	Trial II	Trial III
Density(gm/cc)	1.322	1.287	1.256
Weight(gm)	184	183	185
Normal Stress(kPa)	10	20	30

V. RESULTS AND DISCUSSION

Each sample has a area of 3600mm^2, thickness 30 mm normal stress and normal load for the trial, I is 10kPa - 36kN, trial II is 20kPa – 72 kN and for trial III is 30 kPa – 108 kN. Only the density changed for each specimens of all samples.

5.1 Horizontal deformation and vertical Displacement

The results obtained in direct shear test on four different samples varies each of them by their mechanical properties and behavior with clay. From the direct shear test, the shear strength parameters of each of the sample were determined, and plotted in graphical representation. Comparison of graphs made with respect to c and ϕ value for each of the samples.

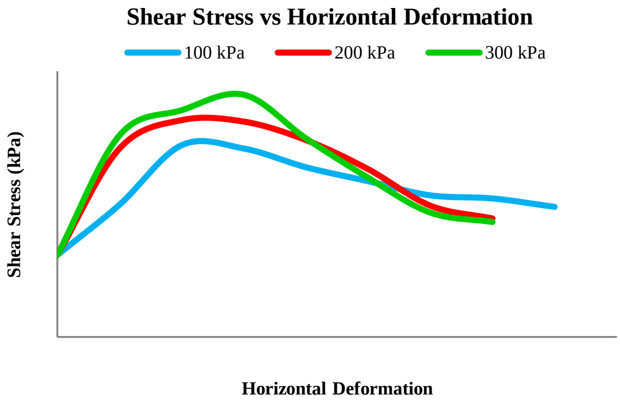

Fig. 5.1 Sample I – Horizontal Deformation

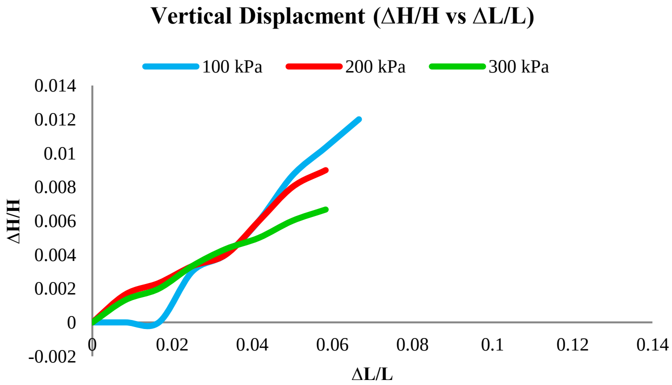

Fig. 5.2 sample I – Vertical Displacement

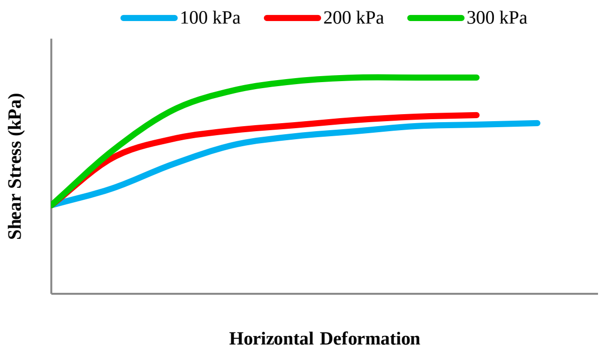

Fig. 5.3 Sample II – Horizontal Deformation

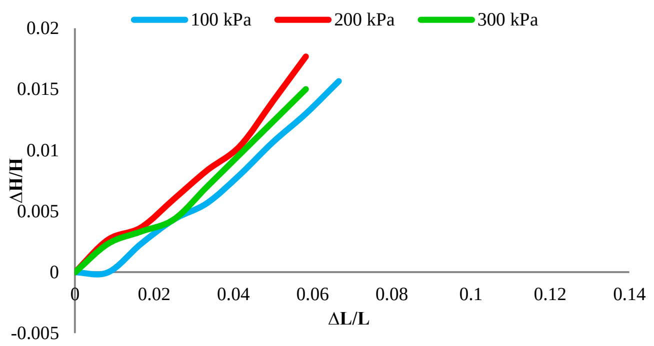

Fig. 5.4 sample II – Vertical Displacement

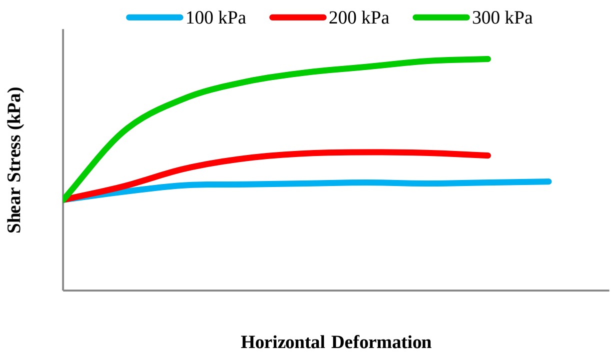

Fig. 5.5 Sample III – Horizontal Deformation

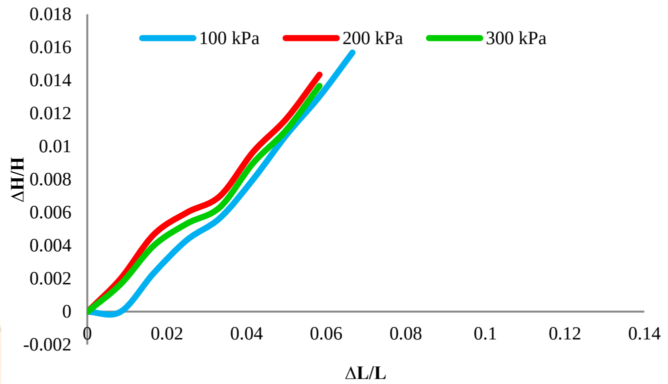

Fig. 5.6 sample III – Vertical Displacement

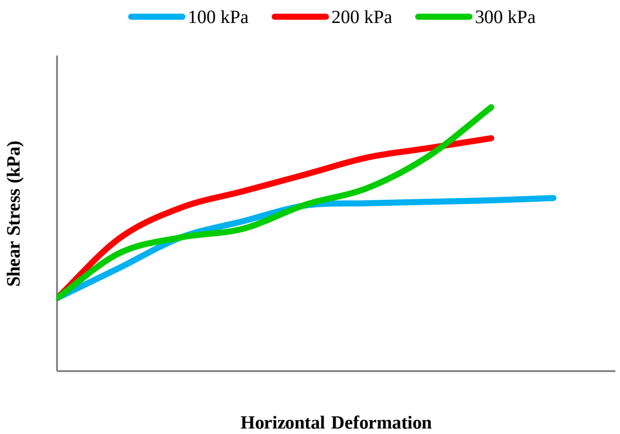

Fig. 5.7 Sample IV – Horizontal Deformation

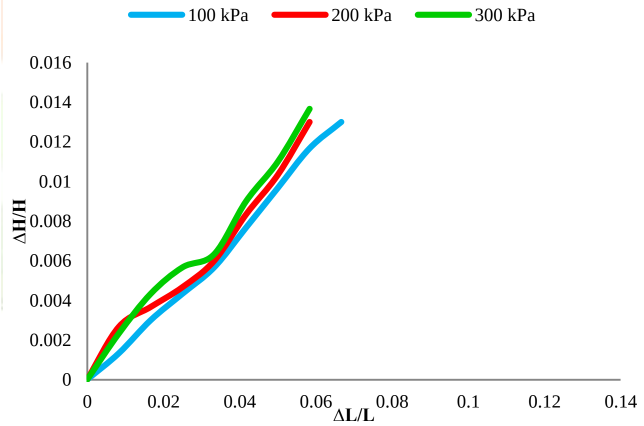

Fig. 5.8 sample IV – Vertical Displacement

5.2 Normal stress Vs Shear stress

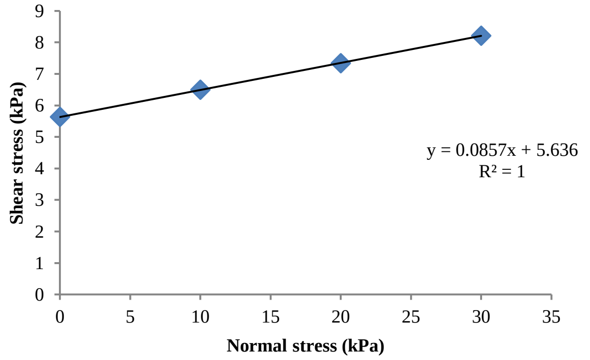

Fig. 5.9 Sample I - Clay

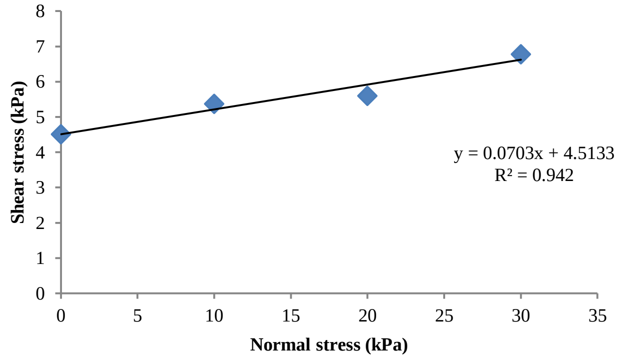

Fig. 5.10 Sample II – Clay + Woodchips

Table 5.1 Normal stress Vs Shear stress - Sample I

Normal Stress(kPa)	Shear Stress(kPa)
10	6.497
20	7.34
30	8.21

Table 5.1 Normal stress Vs Shear stress - Sample I

Normal Stress(kPa)	Shear Stress(kPa)
10	5.375
20	5.600
30	6.780

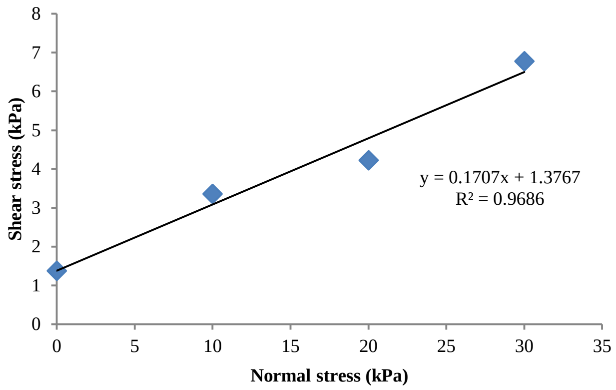

Fig. 5.11 Sample II – Clay + Sawdust

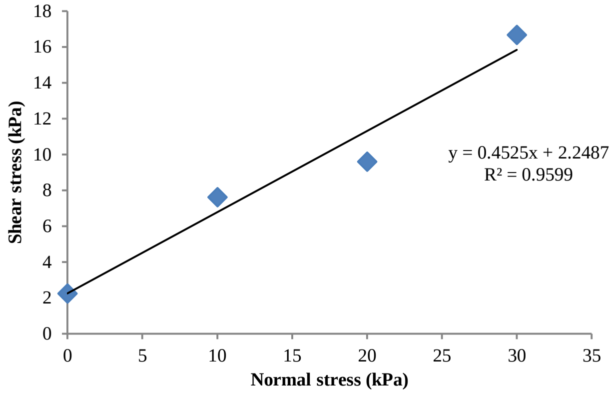

Fig. 5.12 Sample IV – Clay + Thermocol Balls

Table 5.1 Normal stress Vs Shear stress - Sample III

Normal Stress(kPa)	Shear Stress(kPa)
10	3.365
20	4.23
30	6.78

Table 5.1 Normal stress Vs Shear stress - Sample IV

Normal Stress(kPa)	Shear Stress(kPa)
10	
20	
30	

5.3 Resultant Shear stress Parameters

Table 5.1 findings - shear strength parameters

Sample	Angle of Internal Friction	Cohesion value
Clay	5^0	5.636
Clay + Woodchips	4^0	4.51
Clay + Sawdust	9^0	1.37
Clay + Thermocol balls	14^0	2.24

Table 5.1 displayed the shear strength parameters such as internal friction between soil and filler materials cohesion. To get a failure in a slope the cohesion between filler material and soil should be the least. Direct shear test ultimately gives the result that sawdust is the filler material which is having least cohesion value of 1.37 with soil. Hence, from the taken filler materials sawdust is the resultant material to get the slope fail.

VI. CONCLUSION

The present study carried out to create a failure slope manually in the laboratory. It proposed that a predefined failure plane would inject in the slope. For this purpose, some locally available and feasible materials chosen randomly of such as Woodchips, Sawdust and Thermocol. The behavior of these filler materials found out by direct shear test. The results indicate that, these filler materials samples has different C and ϕ values. However, all of them having the shear parameters, which is less than the soil (clay), sample.

Based on the experimental study, the following conclusions drawn

1. Moisture content plays predominant role by influencing the shear parameters it affects the preparation of sample for the test. The shear strength and shear parameters, varies by changing the moisture content.
2. Moisture content influence the ϕ value by increasing percentages. From 10% to 50% (M. Stasiak et al. /Fuel 159 (2015) 900–908). We need lowest value hence sawdust mixed with 50% of water as it has lower friction angle value (16^0)
3. Woodchip has not influenced by moisture content. Hence, friction angle maintained almost same value and maintained as 33^0 (M. Stasiak et al./Fuel 159 (2015) 900–908)
4. Thermocol balls is a very light material having less density of 15-30 kg/m3 and maximum volume. As it was difficult to handle, it not mixed up with soil. Therefore, 10% of soil and 7% of water mixed separately for 10 mg of thermocol. This proportion was taken by trial and error method.
5. From the result, the sample II = clay + Woodchips has nearer Friction angle and cohesion value of 40 54', 5.64 respectively so is rejected. The wood chips' friction angle had changed because of added soil in it and it cannot be used since it has lesser density and workability.

We can conclude with the Sawdust result, which has the Cohesion value of 1.37, considerably, that gives less value when compared to other materials. Hence, the failure for can be prepared using, "Sawdust" as filler material.

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