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Slope Stability Analysis Using Soil Reinforcement

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ABSTRACT: *Slopes ides oil has low shear strength due to heavyrainit increase the flow ability of soil. From the recent studies we observed that soil stabilization with waste materials, vegetation, grouting, soil bolting, soil nailing and retaining wall are used to reduce the flow ability of soil . In this study the soil strength was improved by providing vertical and horizontal reinforcement with different spacing. Slope model was made with* 25^{o} *inclination. From that we conclude which spacing gives most efficient and economical results. Soil reinforcement causes significant improvement in shear strength, bearing capacity as well as economy.*
KEY WORD: *slope stability analysis, soil, soil reinforcement*

I. INTRODUCTION

In recent years there are numbers of landslide occur everywhere. Most of the landslides happens on the cut slopes or embankment along roads, highways and sometimes within the vicinity of the highly populated residential area especially those in the highly terrain. Thus a proper understanding, monitoring and management of slope stability are essentially important to minimize the severity or casualty in any landslides.The slope stability analyses in geotechnical engineering have followed closely developmentsinsoilandrockmechanicsasawhole.Slopeseitheroccurnaturally or are engineered by humans. Slope stability problems have been faced throughout history when men and women or nature has disrupted the balance of naturalsoilslopes.Furthermoretheincreasingdemandforengineeredcutandfill slopes on construction projects has only increased the need to understand the analytical methods, investigative tools and stabilization methods to solve slope stabilityproblems.Slope stabilization methods involve specialty construction techniques that must be understood and modelled in realistic ways. An understanding of geology, hydrology, and soil properties is central to applying slope stability principles properly. Analyses must be based upon a model that accurately represents site subsurface conditions, ground behaviour and applied loads. Judgements regarding acceptable risk or safety factors must be made to access the results of analysis. The analyses are generally carried out at the beginning, and sometimes throughout the life, of projects during planning, design, construction, improvement, rehabilitation, and maintenance. This chapter is intended for individuals who deal with slope stability problem, including most geotechnical engineersandgeologistswhohaveanunderstandingofgeotechnicalengineering principles andpractice. In most applications, the primary purpose of slope stability analysis is to contributetothesafeandeconomicdesignofexcavations,embankments,earthen dams,landfillsandspoilheaps.Slopestabilityevaluationsareconcernedwith identifyingcriticalgeological,material,environmentalandeconomicparameters that will affect the project, as well as understanding the nature, magnitude, and frequency of potential slope problems. When dealing with slopes in general and slope stability analysis in particular, previous geological and geotechnical experience in an area isvaluable.

Classification ofslope:
Naturalslope
Man-madeslope

Factors affecting the slopestability
Strength of soil androck.
Topography and its surrounding physicalconditions.
Geological conditions such as the nature and depth of its subsoil.
Shear strength of the slope-formingmaterials.
Pore waterpressure.
External loading and surcharges such as from traffic, nearby structuresetc,.
Geometry of theslope.

II. AIMS OF SLOPESTABILITY

Theaimofthisstudyistostabilizetheslopesoilbyproviding reinforcement using steelrods.

Scope andobjectives:

To understand the development and form of natural and manmade slopes and the process responsible for different features.

To assess the stability of slopes under short term (often during construction) and long termconstruction.

To analyse the slope stability and to understand failure mechanism and the influence of environmentalfactors.

To enable the redesign of failed slopes and the planning and design of preventive and remedial measures, wherenecessary.

Stability analysis are routinely performed in order to access the safe and functional design of an excavated slope (e.g. open pit mining, road cuts, etc..) and or the equilibrium conditions of a natural slope. The analysis technique chosen depends on both site conditions and the potential mode of failure, with careful consideration being given to the varying strengths, weaknesses, and limitations inherent in each technology.

III. MATERIALS FOR STUDY :

Soil:

The soil used for the project investigations are collected from **Thirukazhukundram**, Kanchipuram district, Tamil nadu, India. The samples are collected from by digging the pit of 2 feet on the slope in order to get the virgin soil. The soil is taken in to the Thirukazhukundram by using jute bag

Latitude and longitude for location

Latitude 12.625042
Longitude 80.029991

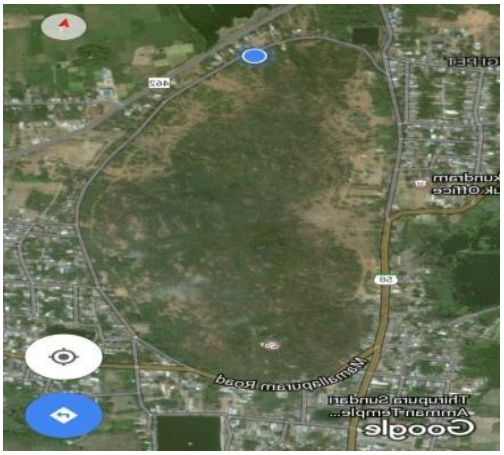

Fig:1 location map

TABLE :1
Properties of soil

S.NO	Properties	Result value
1	Specific gravity	G = 2.3
2	Initial water content	11%
3	Grain size distribution	%gravel = 1.03% % sand = 98.47% % fines =0.5%
4	Liquid limit	**25.5%**
5	Plastic limit	**21.4%**
6	Plasticity index	4.1%
7	Soil classification	SW-well graded sand
8	Optimum moisture content and Maximum dry density	10 % and 2.05g/cc

STEELRODS:
Steelisanalloyofironandotherelements,primarilycarbonthatiswidely used in construction and other applications because of its high tensile strength and lowcost.
Inthisstudywehaveusedsteelbarsofabout1.6mmdiaand1mmdiaasvertical andhorizontalreinforcementbecauseinfieldweareused16mmand10mmrods as main and distribution bars .The steel rods improve the shear strength of soil along with the natural shear strength of the soil for thestabilization

RECTANGULARTRAY
A rectangular tray of size 3′x2′ dimension is used. The tray is made up of wood and coated which helps to act as a water proof. The tray height isof
½ ′. And the tray is filled with the soil of 110 kg.

IV EXPERIMENTAL WORKS

SLOPEMODEL:
A rectangular box model was taken for testing, which is of dimension 3′x2′. The soil was sieved in 4.75mm

Fig:2 rectangular tray with natural soil with compaction

sieve. The slope taken was 25˚. Artificial rainfall setup was provided with an intensity of 8 litres per minute. The compaction character of soil is analysed from standard proctor test, from that the OMC and MDDvalueare10%and2.05g/ccrespectively.Compactionisdonewithhelpof compactionequipmentwithadditionof11.1lit/110kg.Thetestswereperformed under three different cases.

Fig:3 slope model with artificial rainfall set up

Case I: compacted natural soil
Case II: compacted natural soil +Reinforcement with 15 cm spacing
Case III: compacted natural soil +Reinforcement with 10cm spacing
CASE 1: COMPACTED NATURALSOIL
In first case, the test was carried out with the natural soil. The soil has been compacted and slope was set up at 25˚. The further process is proceeded by flowing a rainfall for 15mins.
Onceitreaches15minutestherainfallisstoppedandtheerodedsoilareallowed tosettledown.Thesettledsoiliscollectedandallowedtodryforaoneday.This testisperformedtoknowtherealflowabilityoftheslope.Therainfallisallowed tofallatanintensityof8lit/min.Thenthedriedsoilisweighedandthevaluesare noted down.
The weight of the natural soil with compaction =110 kg
The weight of the erodible soil **= 12.639kg**

The weight of the non erodible soil **=110 -12.639=97.361kg**

CASE2:COMPACTEDNATURALSOIL+REINFORCEMENTWITH 15CMSPACING

In the second case, soil is compacted with its optimum moisture content. Grid wasformedbyprovidingverticalandhorizontalreinforcementsofspacing15cm with steel rods. Then the slope wassetup.

The artificial rainfall of intensity 8 litres per hour was allowed to flow for 15 mins. The soil eroded from the slope is collected and allowed to settle for few hours. The collected soil is dried and weighed. The values were noted and compared. The soil eroded is less compared to the first trial. The reinforcement provided is to lessen the erosion of soil by the stabilization of soil.

The weight of the natural soil with compaction =110 kg

The weight of the erodible soil **=4.504kg**

The weight of the non erodible soil **=110 -4.504=105.496kg**

Fig :**4 compacted natural soil + reinforcement with 15cm spacing**

CASE3:COMPACTEDNATURALSOIL+REINFORCEMENTWITH 10CMSPACING

In the third case, soil is compacted with its optimum moisture content. Grid was formedbyprovidingverticalandhorizontalreinforcementsofspacing10cmwith steel rods. Then the slope wassetup.

The artificial rainfall of intensity 8 litres per hour was allowed to flow for 15 mins. The soil eroded from the slope is collected and allowed to settle for few hours. The collected soil is dried and weighed. The values were noted and compared. Due to the reduction in spacing the soil stabilized in high rate and the amount of soil eroded is less comparing with the rest cases.

The weight of the natural soil with compaction =110 kg

The weight of the erodible soil **=2.365kg**

Fig : 5 compacted natural soil + reinforcement with 10cm spacing

The artificial rainfall setup is to know the effect of rainfall at high intensity. The soilerodediscomparedwiththeothercasestotheknowtheeffectivecaseamong the rest.

The weight of the non erodible soil **=110 -2.365 =107.635kg**

V RESULT AND DISCUSSION

The percentage of the non erodible soil
(case I) =88.51%
The percentage of the non erodible soil
(case II) =95.90%
The percentage of the non erodible soil
(case III) =97.85%

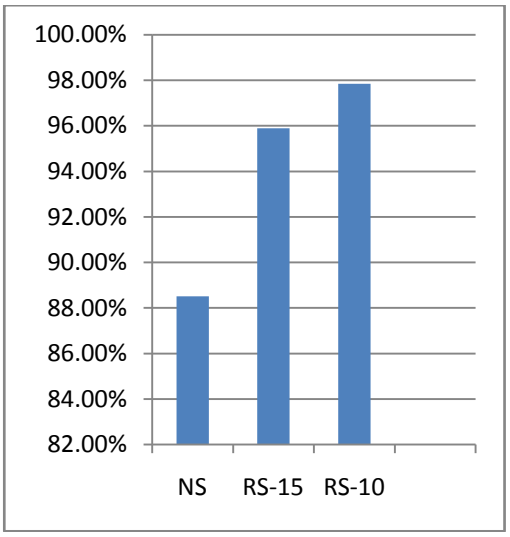

Fig : 6 comparison chart

NS= Natural Soil
RS-15=Reinforced Soil with spacing 15 cm
RS-15=Reinforced Soil with spacing 10 cm
From the above comparison chart reinforced soil with less spacing give good result .the horizontal and vertical reinforcement give more strength and gripness to the slope soil so that the soil erodability reduced from hiher value to lower value .

IV. CONCLUSION

This paper analyses the slope stability of soil using reinforcement to the soil from this analysis it is observed and concluded the theerodibility of the soil reduced 10% with the use of soil reinforcement with spacing 15 cm and 7% with the use oof soil reinforcement with spacing 10cm ..hense spacing increased to the some extent gives good result in this study .it is very effective method comparatively using natural fibers from my experimental study .

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