

**Slope Stability Analysis for Optimal Tree
Density of Cedrus Deodar Tree in Kumaon
Region of Uttarakhand**

Thesis

Submitted to the



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By

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*Pantnagar
August, 2019*


(Pratul Raj)
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CERTIFICATE

This is to certify that the thesis entitled **“Slope Stability Analysis for Optimal Tree Density of Cedrus Deodar Tree in Kumaon Region of Uttarakhand”**, submitted in partial fulfilment of the requirements for the degree of **Master of Technology (Civil Engineering)** with major in **Soil Mechanics & Foundation Engineering** of the College of Post Graduate Studies, G. B. Pant University of Agriculture & Technology, Pantnagar, is a record of bonafide work carried out by **Mr. Pratul Raj**, Id. No. **52778** under my supervision and no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been acknowledged.

Pantnagar
August, 2019



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We, the undersigned, members of the Advisory Committee of **Mr. Pratul Raj**, Id. No. **52778**, a candidate for the degree of **Master of Technology (Civil Engineering)** with Major in **Soil Mechanics & Foundation Engineering** agree that the thesis entitled **“Slope Stability Analysis for Optimal Tree Density of Cedrus Deodar Tree in Kumaon Region of Uttarakhand”** may be submitted in partial fulfilment of the requirements for the degree.



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LIST OF ABBREVIATIONS AND SYMBOLS

A	Area
ASTM	American Society For Testing and Materials
BSM	Bishop Slice Methods
C	Cohesion
C _C	Coefficient of Curvature
Cm	Centimetre
C _U	Coefficient of Uniformity
CSR	Critical Shear Plane
D	Diameter of tree
D	Diameter of Roots Spread
d ₁	Diameter of Artemisia Annua
D/S	Downstream
FEM	Finite Element Method
FLAC	Fast Lagrangian Analysis of Continua
FOS	Factor of Safety
ft	Feet
Gm	Gram
GPS	Generalised Procedure of Slices
GSD	Grain Size Distribution
H	Height
HSM	Horizontal Slice Methods
ILDSA	Inclinable Large Scale Direct Shear Apparatus
IS	Indian Standards
ISF	India State of Forest
Kg	Kilogram
KM	Kilometre

kN	Kilo Newton
L	Length
LDST	Large Direct Shear Test
LEM	Limit Equilibrium Method
MC	Moisture Content
mm	Millimetre
M-PM	Morgenstern –Price Method
MRDC	Medicinal Plant Research Development Centre
MSE	Mechanically Stabilised Earth
NAT	North Almora Thrust
NH	National Highway
ϕ	Angle of Internal Friction
RMR	Rock Mass Rating
RT	Ramagarh Thrust
SFI	Swiss Ferial Institute
SM	Spencer's Method
SRM	Strength Reduction Methods
U/S	Upstream
VSM	Vertical Slice Methods
W	Width



Introduction

1.1 General

Slopes are a common feature of the world around us, whether they are of a geological, geomorphological or human origin. In most instances, slopes are naturally unstable unless they have been stabilized through geological time. Unstable slope creates numerous management and engineering issues as we try to maintain order and prevent slope failure from affecting our transport infrastructure, leisure activities and human life.

Landslide and soil erosion are two major concerns to geologists and geotechnical engineers all over the world. Landslide is defined as the movement of soil, rock and organic material downward slope under the action of gravitational force. Whereas soil erosion, it is defined as degradation of the top layer of soil. This natural process is caused by water effect, ice, snow, and air.

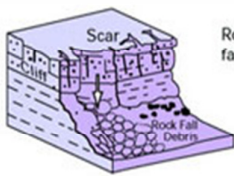
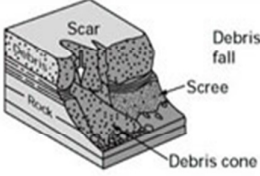
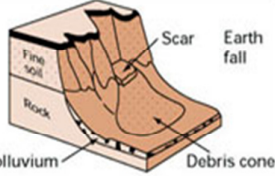
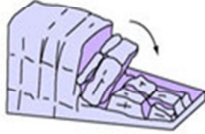
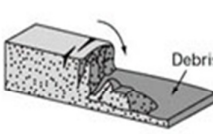
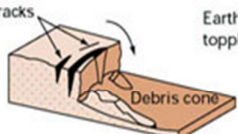
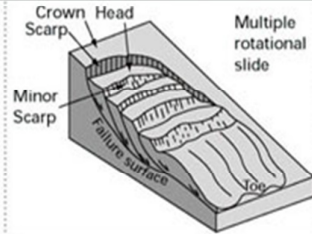
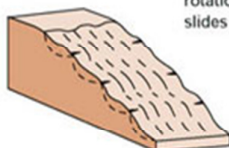
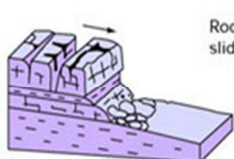
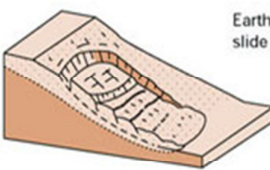
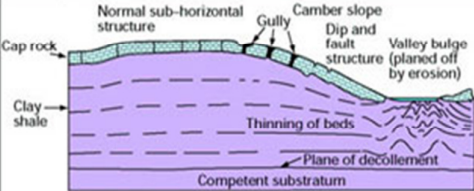
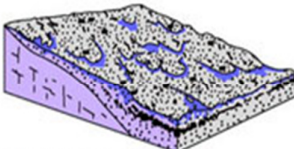
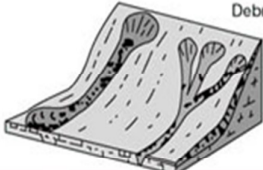
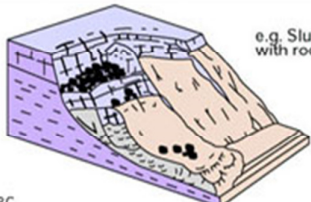
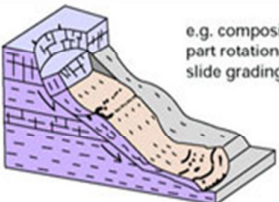
Landslides triggered by human activities are on the rise around the world and India is among the most-affected countries. The study conducted by researchers at UK's Sheffield University was published in the European Geosciences Union journal, Natural Hazards and Earth System Sciences. Researchers compiled data on over 4,800 fatal landslides which occurred from 2004 to 2016, leaving out those caused by earthquakes. More than 56,000 people were killed by landslides around the world during the period, a majority of which involved a single slope, according to the study based on the Global Fatal Landslide Database (GFLD). At least 700 of these fatal landslides were caused by construction works, illegal mining and unregulated hill-cutting.

The major reason responsible for the occurrence of landslides and soil erosion is human interference and natural calamities, which includes deforestation, unplanned construction, weathering action, earthquakes etc. Slope failure may cause due geological effect (wreathing of materials, adversely oriented, discontinuity, etc.) morphological effect (erosion of soil, removal of vegetation, thawing etc.), and human effect (unplanned excavation of slope, mining, artificial vibration etc.). The classification of landslides has been divided into two categories i.e. based on types of material and types of movement (Varnes 1978) are shown in table 1.1

Table 1.1 Classification of Landslide

Types of Movement	Types of Material		
	Bed rock	Engineering soil	
		Predominantly coarse	Predominantly fine
Falls	Rock fall	Debris fall	Earth fall
Topples	Rock topple	Debris topple	Earth topple
Rotational	Rock slide	Debris slide	Earth slide
Translational			
Lateral spreads	Rock spread	Debris spread	Earth spread
Flows	Rock flow (deep creep)	Debris flow	Earth flow
Complex	Combination of two or more principal types of movement		

In Indian sub-continent, a landslide is more frequent in the hilly terrain of the Himalayan region. The fragility of the terrain with losses of rock mass and soil mass (debris) over the steep slope also enhances the potentiality of landslides. Every year losses of property, human life, infrastructure, natural resource etc. are caused by a landslide in the hilly region of India. Failure of the slope which usually develops due to the formation of rupture surface as a strain discontinuity. The hilly regions of India are presently confronting the dilemma of maintaining a balance among various developmental activities and environmental conservation. In the hilly areas, land available for developmental activities is limited and its utilisation is further restricted by environmental guidelines due to the restriction people are bound to construct on the slope, which is causing landslide and loss of property of human life. Landslide is defined as the movement of soil, rock and organic material downward slope under the action of gravitational force. The types of landslide occurs are as below the figure 1.1.

Material		Movement type		
		ROCK	DEBRIS	EARTH
FALLS				
		Rock fall	Debris fall	Earth fall
TOPPLES				
		Rock topple	Debris topple	Earth topple
SLIDES	Rotational			
	Translational (Planar)			
SPREADS			e.g. cambering and valley bulging	
				
FLOWS				
		Solifluction flows (Periglacial debris flows)	Debris flow	Earth flow (mud flow)
COMPLEX			e.g. composite, non-circular part rotational/part translational slide grading to earthflow at toe	
		e.g. Slump-earthflow with rockfall debris		

BGS © NERC

Source: slideplayer.com (2019)

Figure 1.1 Types of Landslide

India is a country with one of most precipitous sub-continent in the world, around 19.20% of its territories are covered by hilly and mountainous terrain. Uttarakhand has situated in the lesser Himalayan region around 64% of its landmass covered by Himalayan peak and Glacier. The lesser Himalaya at Uttarakhand in India predominantly consists of sedimentary and low grade metamorphic rocks along with some crystalline rocks, which are soft, brittle and fragile in nature and are exposed to the adverse atmospheric conditions. Which results in the occurrence of landslides frequently and have caused huge damage in human life. On 16 June 2013, divesting flood and landslides near Gobindat, Kedar Done, Rudraprayay district in Uttarakhand, becomes the country natural disaster. The debris blocked up the rivers and causes major over floods in downstream areas. According to official data of Government of Uttarakhand 4000 people died, 10,000 were injured and 1, 00,000 were struck in the valley. Around 400 house were destroyed, 265 damaged, 4,200 villages were struck by flood and landslide causing a loss Rs.20, 000 crores amounting to a value of 30% of state income. (en.wikipedia.org/wiki/2013_North_India_floods).

Slope failure, landslide, and natural disaster is also contributing the huge loss in state of Uttarakhand. The annual loss of human lives, property, infrastructures like roads and highways *etc.*, occurred due to natural disasters as shown in table 1.2 (Dmmu.ux.govt.in).

Table 1.2 Annual losses due to natural disaster in uttarakhand (Dmmu.ux.govt.in)

S.No	Year	Loss of property		Total no. of person		Total no. of houses damaged
		Bridge	Roads	Injured	Dead	
1	2016	08	1295	118	130	3318
2	2017	28	1825	74	92	1580
3	2018	27	1305	58	105	1915

In Uttarakhand at Kumaon region, most of its population live below the poverty line and are in vulnerable landslide conditions with their normal social and economic activities. In Kumaon region landslide had frequently occurred every year and the problem to landslide are related to the topography, climate condition (monsoon rain), and human activity. Therefore it necessary to search for the solutions or alternatives to cope with a landslide in a hilly region of Kumaon, Uttarakhand.



Source: www.abpnews.in (2018)

(a)

Source: www.khabarnonstop.com (2017)

(b)

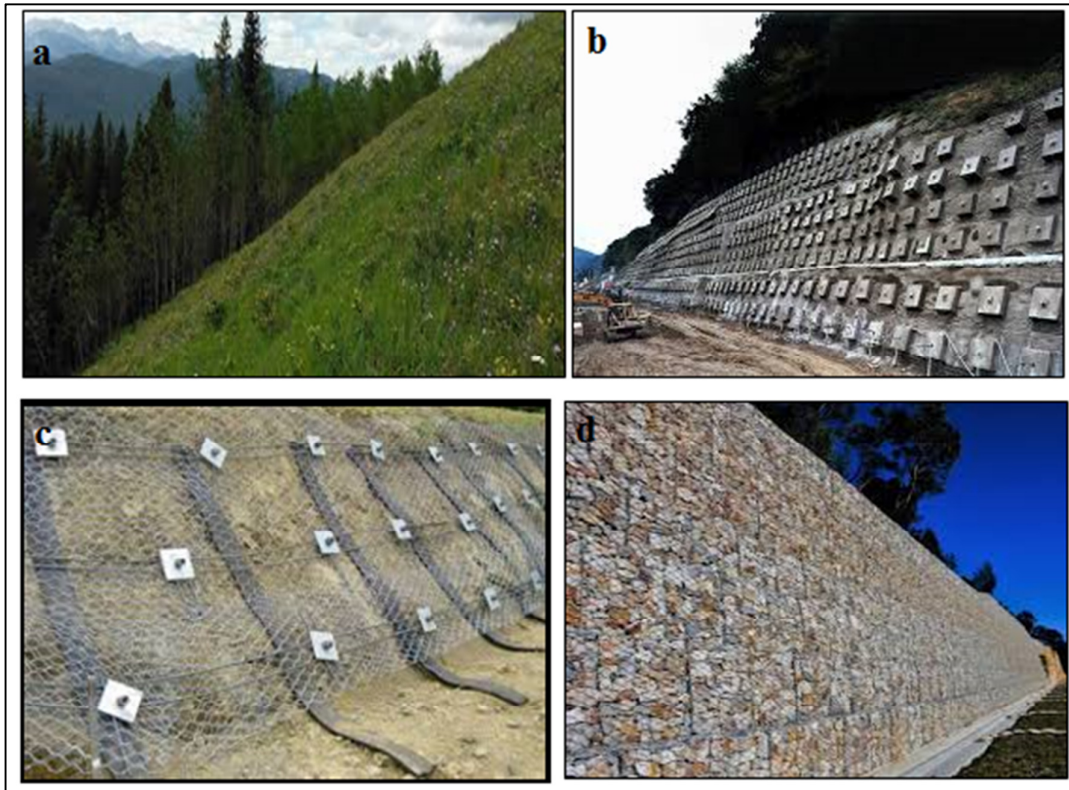
Fig. 1.2 Landslide in (a) Mussoorie and (b) Dharchula in Uttarakhand

1.2 Slope Stability

Slope stability involves analysis whether a slope of soil is safe or not, how to possibly enhance the stability of slope. The various technique are used to stabilize the slope such as:

- Vegetation
- Nailing
- Rock Bolting
- Gabion Wall
- Provide Geogrid on Slope
- Retaining Wall Structure

The above techniques used to stabilize the slope, vegetation is one of the most economical and eco-friendly technique. Fig. 1.3 shows different types of technique used for stabilization of slope.



Source: www.geostructure.com

Fig. 1.3 Technique for slope stability (a) vegetation (b) nailing (c) geogrid (d) gabion wall

1.3 Vegetation as Slope Stability Technique

The use of vegetation has also been recognized and incorporated in engineering practice to prevent erosion and stabilization of slopes. Vegetation influences slope stability and erosion process by both mechanical and hydrological efforts. Various researchers have investigated the following research area to identify the specific role of vegetation in soil reinforcement applications as

- I. Factor affecting root reinforcement in soil.
- II. An experimental study to investigate root and soil system interaction.
- III. Analytical and theoretical models of root and soil system.

The use of vegetation (grasses, shrubs and trees) has also been recognized and incorporated in engineering practice from as early as the thirteenth and fourteenth centuries for erosion control and stabilization of slope. Starting 1960s several researchers have investigated the role of the root system on soil reinforcement. Seeding or live planting (e.g. live poles and brush layer) is the main method used to establish

the vegetation on slopes. Therefore it is important to investigate the effect of vegetation on the slope stability of the slope critical to landslides.

1.4 Need of Research and Problem Statement

Engineering techniques such as nailing, rock bolting, retaining structures and geogrids can be used to control landslide or slope failure. Applicability of these techniques require considerable monetary investments and over the time the effectiveness is reduced like any other construction works. The application of plants for slope stabilization is known as bioengineering. Bio-engineering is a less expensive and long term alternative, which is more beneficial than just stabilizing the slope. It also improves the quality of life of people living in an area prone to landslide.

A wide variety of plant species (Bamboo, Cedrus Deodar, Teak, Semal, Khair, Artemisia Annua etc.) can be used for bio-engineering to reduce shallow landslide in landslide prone areas. Cedrus Deodar tree is a large evergreen, dioecious tree to 131ft – 165ft long. It is found in height altitude in between 750m to 3500m. Its mean annual temperature is 12°C - 17°C. It is Native found in Afghanistan, Indian, Nepal and Pakistan. This is a fast grown tree and deep-rooted, that holds the soil masses and to increase the stability of a slope. Also control the soil surface erosion. Deodar is an important structural timber used for (building, beams and furniture, etc.) and also used for medicine purpose.

The vegetation not only stabilized the slopes but it is also found that the excess amount of vegetation adversely affects the slope stability on the critical slope. There are an adverse effect of excess vegetation on the stability of slope as the roots and stem increase the roughness of the ground surface and may increase the permeability of the soil. Also, the weight of trees act as a surcharge on the slope and increase normal and downhill force components. (R. Myer, 1993). Therefore, we can easily understand that vegetation improves the stability of slope, but excessive vegetation reduces the slope stability because of its vertical normal load.

The need for research proposes a study to find optimum number of plants that can be planted to achieve the maximum stability of slope. Therefore, a parametric study has been carried out with variation in plant density on the soil slope.

1.5 Objectives of Thesis

Followings are the brief objectives of this study:

1. To perform extensive review of literature on Cedrus Deodar used for slope stability in Kumaon region and research regarding analysis and slope stability by various authors in past.
2. To find the geotechnical properties of collected soil samples from different landslide location.
3. To perform the laboratory tests to ascertain the effect of varied plant density on slope stability of different soil types and also analysis, to calculate the change in factor of safety with varied density of plantation (effect of vegetation) for different slopes and soil types.
4. To find optimum number of Cedrus Deodar that can be planted to achieve the maximum stability of the varied slope of different soil types.

1.6 Study Methodology

In order to achieve the above mentioned objectives of study the following methodologies were adopted.

- Review of literature on slope stability and the use of Cedrus Deodar for the slope stability of Kumaon region.
- To select the appropriate sites of landslide in Kumaon region and collection of soil samples from there.
- Collection of soil samples from the landslide area and laboratory testing of soil samples for their geotechnical properties.
- Selection of suitable plant in comparison with Cedrus Deodar that can be grown in varied density (in laboratory) to find the effects of vegetation on different types of soil.
- Preparation of laboratory samples with varied plant density for testing in large shear box apparatus.
- Performance of large shear box test to find the shear parameter of prepare soil sample (with varied plant density), to study the effect of varied plant density on the slope stability of different soil types.

- Slope stability analysis using Swedish slip circle and Bishop's method considering the effects of varied plant density and its effect on slope stability.
- Validation of calculated results with Geostudio software.
- Preparations of graphical relationship between tree density of Cedrus Deodar and FOS in slope stability with different slope and soil types.
- Performance of study of find the optimum tree density of Cedrus Deodar for different slopes and soil types.

1.7 Organisation of the Thesis

- **Chapter – 1:** It is a general introduction. It includes a description of the motivation to carry out the research project, as well as the stated objectives.
- **Chapter – 2:** It includes a review of the theoretical background. First the effect of vegetation on slope stability through different process is described, giving emphasis in mechanical effects. Then the characteristics of vegetation that affect slope stability are mentioned. After, there is description of the models used to calculate the factor of Safety of a slope including the influence of vegetation. Finally, a section describing the vegetation used in Slope Stability and the benefits that it can provide is included.
- **Chapter – 3:** It is described the study area as well as the methodology followed to obtain a list of plant species, their characteristics and benefits that they can provide. The species is used to evaluate this performance on slope stability.
- **Chapter – 4:** The detailed work analysis performed including the methodology.
- **Chapter - 5:** The chapter summarized the whole study including the conclusion and scope of further research.

*Review
of
Literature*

2.1 General

The beneficial effect of vegetation on slope stability has been demonstrated in many research results. Vegetation helps to reduce erosion (Marden *et al.*, 2014) and also to reduce the susceptibility to landslide due to the mechanical and hydrological effect it provides which influence the soil properties (Mulyono A. *et al.*, 2017). In this chapter a review of how vegetation can play a role on slope stability and the processes involved is presented, as well as vegetal characteristics according to plant species form related with such effect, giving emphasis on the aspects of root cohesion and surcharge will be analysed in the subsequent chapters. And transitory assessment of the studies on geotechnical parameters of soil slope stability analyses is being done.

2.2 Methods of Slope Stability Analysis

2.2.1 Conventional Methods of Slope Analysis

The Fellenius (1936) method is the simplest method of slope stability analysis which is also known as ordinary or Swedish circle method. Interslice forces are neglected in this method. This method deals with moment equilibrium only and neglects force equilibrium. Hence factor of safety (FOS) obtained is the moment factor of safety. For purely cohesive soil (*i.e.* $\phi_u = 0$), maximum resisting moment available is equal to the summation of the cohesive strengths multiplied by the areas or lengths over which they act and radius of slip circle.

$$M_R = R \sum l cu$$

In comparison, the overturning moment is simply defined as the sum of Slice weights multiplied by the distance of their centroids from center of the slip circle, measured horizontally.

$$M_O = \sum Wx$$

These two moments are expressed as a Ratio to determine factor of safety.

$$F = \frac{M_R}{M_O}$$

For c - ϕ soil the FOS is given as

$$F = \frac{\sum (cu l + N * \tan \phi)}{\sum W \sin \alpha}$$

Where, $N = W \cos \alpha$

2.2.2 Bishop's Method

Bishop (1955) assumed only horizontal forces (i.e. No shear stresses between slices) acting on the sides of the slices, which were neglected in the Swedish method. This method neglects the inter slices shear forces but considers the normal inter slice forces and also considers the pore pressure acting on the slices. This is one of the versatile methods for calculating the factor of safety of the slope. This method also satisfy vertical force equilibrium to determine the base normal force. The expression for normal forces is given by

$$N = \frac{W - \left(\frac{1}{F}\right) (cl - ul \tan \phi) \sin \alpha}{\cos \alpha + \frac{(\sin \alpha * \tan \phi)}{F}}$$

The factor of safety is defined as the ratio of resisting moment to the driving moment and the expression is given as

$$F = \sum \frac{\frac{(cl \cos \alpha + (W - ul \cos \alpha) \tan \phi)}{\cos \alpha + \frac{\sin \alpha \tan \phi}{F}}}{W \sin \alpha}$$

Where,

c = cohesion

L = b sec α (b = width of Slices)

W = weight of Slices

F = factor of safety

ϕ = angle of internal friction

α = angle which slices made with horizontal

N= base normal force

Salient features of Bishop's method

- Considers interslice normal force.
- Satisfy moment equilibrium for factor of safety.
- Satisfy vertical forces equilibrium for N.
- More common in practice and applied mostly for circular shear surfaces and for homogeneous soil slopes (*e.g.* embankment of highways and railways).

2.2.3 Janbu's Simplified Method

JSM is based on non-circular slip surfaces (i.e. composite slip surfaces) and the FOS (factor of safety) is determined by horizontal force equilibrium. As in BSM, this method also considers interslice normal forces but ignores the shear force. In this method the vertical component of the inter slices forces are assumed to be based on the numerical approximation of the following differential equation for equilibrium of moments for a slice of infinitesimal width.

$$X = \frac{E \tan \phi + h dE}{dX}$$

Where, X and E represents the vertical and horizontal components of the interslice forces respectively. The quantity h_t represents the height of the line of thrust above the slip surface. The line of thrust is the imaginary line passed through the points where the interslice forces E or X acts. The term θ is an angle measured from the horizontal that signifies the slope of the line of thrust. In this procedure the position of line of thrust is assumed by the operator. The derivative dE/dX is approximated numerically in the generalized procedure of slices (GPS). Equations is based on consideration of moment equilibrium.

Janbu's FOS = modification factor * Bishop's FOS

Where, modification factor = $1 + b_1 \left(\frac{d}{L} - 1.4 \left(\frac{D}{L} \right)^2 \right)$

Salient features of Janbu's simplified method

- This method Satisfy both force equilibrium but it does not satisfy moment equilibrium.
- Consider inter slices normal forces and is commonly used for composite shear forces.

2.2.4 Morgenstern-Price Method (M-PM)

M-PM (1965) assumed the interslice force function and it also satisfies both force and moment equilibrium. In this method the shear forces among slices are associated to normal forces as $X = \lambda (f(x) * E)$ where, E and X are the parallel and normal forces between slices. The term λ is an unknown scaling factor and $f(x)$ is assumed force function that has prearranged values at each slice boundary. In Morgenstern and Price procedure the location of the normal forces on the base of slice is also obviously or subtly implicit. The normal force is assumed to act at the midpoint of the base of slices or at a point on the base of the slice that is reliably below the centre of gravity. The unknown parameters involved in this procedure are the scaling parameter (λ), factor of safety (FOS), normal forces on the base of slices (N) and the line of action of the horizontal interstices forces. The vertical component of the interslice forces is considered from the self-governing calculation.

Salient features of Morgenstern-Price method

- Assumes a interslice force function $f(x)$.
- Consider both inter slices forces.
- Computes FOS for both force and moment equilibrium.
- Allow the selection for inter slice force function.

2.2.5 Spencer's Method.

The difference between Spencer's Method (**SM**) (1967) and M-PM is of the assumption made for interslices forces. A constant inclination is assumed for interslices force and the FOS is computed for both equilibriums. Spencer's (1967) procedure is based on the conventions that the interslices forces are parallel (*i.e.* all interslices forces have the same inclination. The precise inclination of the interslices forces is identified and figured as one of the unknowns in the explanation of equilibrium equation. Spencer

procedure adopts that the normal force (N) acts at the center of base of each slice. This postulation has insignificant inspiration on the calculated values for unknown provided that practically large number of slices are used; almost all scheming with Spencer procedure are achieved by computer and adequately large number of slices are effortlessly accomplished. Spencer formerly offered his practice for circular slip surfaces, but the technique is simply prolonged to non-circular slip surfaces. Non circular slip surfaces are presumed here. In Spencer's technique two equilibrium equation are cracked first. The reckoning characterizes complete basis and moment equilibrium for entire soil mass, consisting for all slices. The two equilibrium equation for interslices force inclination and unknown factor of safety (FOS) because interslices forces are assumed to be parallel, there is only one unknown inclination for interslices forces to be solved for.

Salient features of Spencer's method

- Consider both interslices forces.
- Assumes a constant interslices force function and satisfy both moment and force equilibrium and compute force, moment equilibrium and the unknown factor of safety (FOS).

2.3 Literature Review on Slope Stability Analysis with Vegetation

Miles *et al.* (1986) the deal with vegetation composition on recent landslide in Cascade Mountains of western region, shallow rapid landslide are common events and significant cause of vegetation distribution in the Pacific Northwest. Landslides remove surface soil vegetation cover and frequency were sampled on 25 landslides aged 0-28 years in the Cascade Mountains of western region. Landslide sampled were debris audanehes ranging in surface area from 36 to 1287 m², in elevation from 460 to 1100 m and in slope from 40 to 173% vegetation covered averaged 51% overall and cover ranged from 7 to 88% among landslide sites. Franes was the most common tree species overall and dominated all substrates except bedrock, where no single tree species occurred on more than 20% of the plots. Rubus ursin chain and Schleeht was most common shrub shrubs on all substrates.

Ekanyake *et al.* (1997) authors explained the contribution of roots on soil strength. They used the two different types of tree species first one is Pinus Radiata

and the second one is Kanuka. Ekanyake selected the east coast region of the north island of New Zealand, where a wide range of the landslide occurs. It took two different sites, Waimata and Kanakanaia, Waimata site was silty clay with 19% clay content and soil of Kanakanaia site was classed as a poorly graded sandy-clay with 28% clay content. Firstly planted the Kanuka species of tree and replanted with *Pinus Radiata* species, they find the contribution of roots to soil strength was first estimated by calculating the difference between the maximum shear stress of the shear stress-displacement curve obtained for the soil with and without roots. The result suggested that the contribution of each individual's roots to soil strength on a root cross-section area per unit shear area basis was independent of species for the two tree species tested. These result used to obtain relationships shear stress and shear displacement at the peak of the shear stress-displacement curve, and between the cross- section areas of roots per unit shear area. The displacement curve obtained from the in-situ direct shear test performed on a corresponding potential shear plane and also by here indirect takes into account the ability of soil to undergo large shear displacement and provide a realistic way to compare the contribution of roots to soil strength. They developed the model using the relationship between the shear strength of the soil-root system, slope angle and root-cross section area to determine the factor of safety for a typical density of naturally regenerating Kanuka for comparison with different *Pinus radiata* species of trees at a different stage of growth. Authors find that first 8years stands of fully-stocked regenerating of Kanuka would provide a better level of protection against the initiation of a shallow landslide than stands of planted and managed *P. radiata*. In still later years (16 to 25 years after establishment) and irrespective of differences in silvicultural practices, *P. radiata* would be expected to afford a high level of slope stability. For similar-aged Kanuka, safety factors would likely show a gradual decline with increasing age, though changes would be small and unlikely to affect the overall stability of Kanuka-covered slopes unless stands were severely damaged or in the longer term had reached senescence. The model does not take into account the effect of buttressing by mature tree roots. The application of this method is limited to vegetated infinite hillslopes where the location and the orientation of shear plane are well defined, the eastern north island cover with much erosion- prone, steep, and ash-covered tertiary.

Collison and Simon (2001) it deal with the hydrological of riparian vegetation on river bank stability. This type of vegetation has many well- documented beneficial properties for river restrain and bank stabilization. The hydrological effect of vegetation on bank stability are more ambiguous, poorly quantified and potential detrimental in some cases. This paper give a quantified relation to the bank stability. The canopy interception was relativity insignificant especially during the winter and spring period. Interception remained insignificant during the summer as model rain fall in high intensity events that exceeded the storage capacity of the canopy many times over. During the serval period in spring 2001 the hydrological effects of the three cover reduced bank stability through this was always affect by the stability mechanical effect.

Jagath *et al.* (2002) this paper we need to know about the slope stability. The paper deals with the location of critical shear plane (CSP) with play a major role in determine landslide. The tree root provide considerable depth to improve the stability. Studies get to know about the how vegetation can be used to change the location of critical shear plane this will lead to us to compare the combination of plant species and densities to build any situation to increase landslide-initiation thresholds and improve slope stability. The energy approach model is used to develop the depth of the critical shear plane. One the depth has been found then the time for the wetting front to reach it is found using soil water infiltration model. This model may be used as a simple tool to choose most appropriate plant density to maximize the stability of a given hill slope.

Ali and Osman (2008) they pointed out four different types of plant species namely *Vertiveria zizanoides*, *Leucaena leucocephala* , *Bixa orellana* and *Bauhinia Purpurea* where planted in special boxes containing residual soil compacted to know density and they have found the shear strength of soil by using modified large shear box apparatus after 6 months and 12 months. The laboratory test were chosen instead of field test so that, identical soil sample can prepared, sample at various depth can be obtained easily and saturation of sample at various depths. Study reveal roots strength increases or decreases with the time and depth. After 12 months it is observed the cohesion of increase three-fold of the 6 months growth period at 0.1 m depth. Roots significantly increase in soil shear strength. The contribution mainly arises from the cohesion but not the angle of friction. The effect varies with increase depth and age of plant depending on the root length density of the plants. A higher residual strength observed in his study also indicates a high contribution of the root system to soil-root

reinforcement and root of all types of species he studies, the contribution of roots enhance of soil shear strength and rapid growth of cohesion with increase in root length density. The roots of vetiver grass also play an important role in strengthening the soil. It concludes the shear strength is not only influenced by root profile but also by some physiological parameter of the plants.

Kumar and Kumar *et al.* (2010) the main focus is on the slope instability in upper Alaknanda valley Uttarakhand Himalaya, India. Landslide is the generally occurring in the mountains region of the world. The Himalayan region the landslides. In the Himalayan region the landslide may occur due to many factor such as change in rainfall pattern, deforestation, construction on old landslide and quaternary deposit. Habitation and infrastructure development initiative in close proximity of streams and river as also our quaternary deposit and unplanned disposal of excavate the fury of both, landslide and flash flood in the region. During monsoon season torrential rainfall and cloud burst event are common which act as basis factor for triggering the landslide in the area. It is therefore necessary to analyse the cause of landslide so as to suggest viable mitigation measures.

Nordin *et al.* (2011) it deal with the soil root shear strength. The study area is generally is in Malaysia. Where there is a failure of slope in thick hilly area. In this paper we should know about the vegetation which play a big role in reinforcement function via anchoring the soil layer that tied the mass together. In this the site was selected within the university of Malya campus near the institute of mathematical science 03° 07' 27.9" N, 101° 39' 16.7" E. Three plant species namely Acaci mangium, Dilenia suffruticosa and Leucaena leucephala where chosen based on their prominent and physiological characteristics in order to achieve actual result, customized filled shear box test was used to across the shear strength of root reinforced soil block. The test was carried out with a shear rate of 1.5 mm per minute. Leucaena Leucephala should the highest in the cohesion factor, which was almost double the value of Dilenia and Acaci.

Jain (2013) studied the shear data for un-vegetated soil samples. The two types of soil vegetation is studied Thysanolaena maxima, and Saccharum after 4, 8, and 12 weeks of growth. The soil stabilization effect of plant roots is based on two components firstly friction between the soil particles that transfer the shear from the soil to the root

reinforcement system, and second by soil arches that build up between cylindrical soil units that are reinforced by roots and stabilized areas that are not rooted. Shear increase in rooted soil is based on the model of combined matrix of a material that consists of fiber of relatively higher shear strength and adhesion to a matrix of lower tensile strength. The existing root area occupied by roots on a potential shear surface at a certain depth or by using the relationship of shear strength increases in the soil versus the root area ratio or the bulk weight of root per unit volume of soil. Together all these three plants are effective in this.

Shahriar *et al.* (2013) the paper deal with the contribution of area root on enhance the slope stability of embankment. It is one of the cost effective and environment friendly solution to enhance ground slope stability in coastal area by plant vegetation such as grass, herbs. The study includes the comparison of the experimental work and numerical simulation to evaluate the effect of plant roots. The soil sample with the grass roots and without grass roots are collected from Ruston, Louisiana and direct shear test was performed on it. Its study also include the tensile strength of grass root based upon the tensile and direct shear tests, slope stability analysis were performed to demonstrate the grass soil binding capabilities. In analysis the root is taken as anchor reinforcement for which tensile strength were specified from test sample with different root diameters. Variations in factor of safety of the slope with or without root reinforcement subjected to different root diameters and different depths were investigated for the collected plants.

Sati and Sundriyal (2016) the study say that some of tree species occurring in Garhwal Himalayan forests in slope instability. Mostly 14% landslide occur in poor vegetative slopes and 41% landslide occur in the cultivate land and roads etc. Authors revel the three types of slope conditions that landslide are commonly occur (i) very steep rock slopes with no soil. Such slope are in rock terrains and also they come in tectonically active zones. This slope are highly fractured and jointed, it contain some little amount of soil where the vegetation like (grass, shrubs, and very few trees) are sustain. Tree roots deeply penetrate inside cause a fracture in rock masses. (ii) Steep slopes, well vegetated with trees, grass, and shrubs are planted. (iii) Gentle slope, it is thickly cover by old landslide material. Thickly covered by forests. They took three types of vegetation (a) Pine (b) *Alnus nepalensis* (c) Other tree vegetation especially oak, they found that the uprooting of tree is common and it also

cause the landslide. *Alnus* tree developed a short span increase the downhill force component which cause downward slide. On other hand oak tree causing rock mass failure. They observed the slope in Garhwal lesser Himalaya are thick in vegetation but they cause the landslides. Finally concluded that the all vegetation is not to increase the slope stability some of vegetation may cause of the failure of slope.

Hubble *et al.* (2017) this paper deals with the use of vegetation to improve slope stability and successful application of soil bio-engineering and eco-engineering techniques to stabilized slope in a variety of climatic and geomorphic settings. As the field enters a more mature phase, the conference also generated a review of the fundamental data gathering technique used by the discipline's researchers and practitioners as well as a proposed framework for evaluating the sustainability of soil bio-ecoengineering approaches. The paper are divided into the following categories like vegetation and slope stability, root-soil interaction, slope stability modelling, eco-engineering, and land restoration. The emerging generation of scientists and engineers will continue to build the advances presented at SBEE 2016 dealing with slope stability problems, mitigation landslide risk, over-coming land restoration challenges and enabling sustainable land-use in hilly and mountains terrains with ecologically and environmentally responsible methods.

Khanduri (2018) the paper deals with landslide area of Uttarakhand. He has studies the various papers and on the basis of that he has investigated a particular area on Kunwari village. There is a Wazri landslide took place on 12 September 2017. The 106 houses and around 400 persons were affected in Kunwari landslide while around 250 meters road got blocked in Wazri landslide. The areas are highly affected by the structural elements like thrusts and faults. Due to the seismic activity the disturbance are created which may cause landslide. In addition to this the slope aspect, slope angle, high relief, low cohesion and friction of slope forming materials and seepage are some factors which are responsible for slope instability in the area. Construction of houses beside drainage network, unplanned agricultural practices and excavation for road construction over steep slopes further increases the chances of slope failure. It is, therefore, important to adopt fine blend of relocation, mitigation, capacity building, and awareness. These studies could also help the local administration to take necessary step for safety of inhabitant and other people.

Mulyono *et al.* (2018) they discussed the hydrological and mechanical role in slope stabilization. Through the hydrological effect of the plant the water content of soil particles or soil mass reduced to time to time by the transpiration process, interception, and evapotranspiration process. The mechanical impact of vegetation on slope stability is to stabilize the slope by anchoring of the root into the soil, they hold the soil masses and increase the shear strength of slope but if it's not anchor properly through wind pressure destabilizing a tree must occur which causes destabilization of slope. Authors took some trees species like (*Eucalyptus deglupta*, *Acacia mangium*, *Albizia chinensis*, *Melaleuca leucadendra*, *Swietenia macrophylla*, *Calophyllum inophyllum* *etc.*). *Acacia mangium* has higher evapotranspiration rate as compared to other tree species and *Swietenia macrophylla* has lowest evapotranspiration rate. *Leucaena leucocephala*, *Acacia mangium* and *Dillenia suffruticosa* species have excellent potential as slope plant because it pertaining root and shear strength properties increase and *Acacia* species had the highest shear strength as compared to *Leucaena leucocephala* and *Dillenia suffruticosa*. *Acacia mangium* had high shear strength value, 30.4kPa, and 50.2kPa at load 13.3 kPa and 24.3 kPa. The tensile strength of *Leucaena leucocephala* has highest than other above tree species which discussed. They pointed out the factor of safety in slopes with tree and shrubs are at two different slope angle (i) 21.08 degree the factor of safety (FOS) of tree root at depth of 5 metre is 2.35 and FOS of shrub is 2.09 and (ii) 50.00 degree the FOS of tree root at 5 metre of depth is 1.06 and FOS of shrub is 0.94. Tree species that can be selected in preventing slope instability or landslide with the value of root anchoring and root binding index. The higher the value of root anchoring and root binding than the tree, the more significant the potential to maintain stability.

In steep slope, the deep roots and large or dense fiber roots types increase the slope stability. Vegetation with high ability to absorb water from the soil and release into the atmosphere through a transpiration process will reduce the pore water stress and increase slope stability, vegetation with deep root anchoring and strong root binding was potentially more significant to maintain the stability of the slope. The characteristics of tree roots affecting soil shear strength are distribution, density, diameter, specific gravity, and root strength.

Yildiz *et al.* (2018) authors discussed the shearing behaviour of root-permeated soil with help inclinable large-scale direct shear apparatus (ILDSA). The soil sample is

collected from the Moraine of a subalpine landslide location, Hexenruebi in Dallenwil, in canton Nidwalden, Switzerland. The area is a gully, the technical stabilization measures have been taken and investigation over the three decades by SFI (Swiss Federal Institute for Forest), Snow and Landscape Research (WSL) (eg. Burri *et al.*, 2009). The liquid limit was 13.3% and the plastic limit was 16.8%. Here plastic limit of soil was greater than the liquid limit, the soil is classified as non-plastic (Allen, 1942). The specific gravity of soil is 2.69. Two different categories of plant are taken, namely wood plant (*Alnus incana* (L.) Moench, *Salix appendiculata* vill.) and non- wood plants (*Achillea milleforlium* L., *Anthyllis vulneraia* L., *Poa pratensis* L., *Trifloium pratense* L.) is used in order to investigate the shearing behaviour of root-permeated soils. The plant breeding starts by filling germination pots of 100-mm- diameter with a peat sand mixture of high water retention capacity. After 6-8 month of germination of plant, they planted the four individual species plant of each species are transferred carefully to eight individual spots are distributed on the surface of soil in the shear boxes. Germination pots kept controlled temperature and humidity in a climate chamber, condition of daylight are 24 degree centigrade, 70% of humidity and 2400lx light intensity between 05:00 to 20:00 and 17 degree centigrade and 55% humidity with no light condition (night). All sample inclined with 30 degree from the horizontal in order to simulate the natural growth of roots on vegetated slope. The sample is taken dry and saturated soil both of sample is compacted in three layer using 4.5 kg of compaction rammer with drop height of 460.

The investigation the shearing behaviour of root permeated soil sample indicated dilatancy under saturated condition and also find the combined method of dilatancy and root- biomass to explain the shear strength of root-permeated soils. The shear behaviour of root-permeated soil was explained by relationships of peak stress ratio, maximum dilatancy angle, root biomass, and void ratio. The authors give the relationship between the Normal-shear displacements, dilatancy angle shear displacement, dry weight of biomass and root of all specimen, peak shear stress to effective normal stress, peak stress ratio vs voids ratio etc. or more relationship found. By this relationship he found that the maximum dilatancy angle and the dry weight of the roots explained the most variance in peak stress ratio. Lastly it conclude that slope stability of soil are depend upon the all above relationship parameter but some

particular parameter in which they depend most are void ratio, dilatancy, and biological parameter.

Pngli *et al.* (2018) examined the importance of soil conservation on the basis of root distribution pattern and thick effects on soil erosion. Current knowledge regarding root morphology and its impact on soil erosion by water is limited. Therefore detailed analysis of the role of root system play in controlling soil erosion is needed. In this, stratified runoff scouring at different soil depth in the field was conducted in a grassland area. The result indicated that both root biomass and soil water stable aggregate decreased as soil depth increased at all three sites, while there was almost no change in soil bulk density at 1.3 g/cm^3 . Further analysis revealed that close relationship existed between root biomass and the amount of water-stable aggregate and soil organic matter content, and these factor greatly influenced soil erosion.

2.4 Literature Review on Numerical Modelling Analysis

Sarkar *et al.* (2012) examined the stability of slopes of the Amiyan area, near Kathgodam Nainital (Uttarakhand). This area belong to lower Shivalik formation, which is landslide susceptible zone due to presence of numerous weak planes and fragile geology. In Amiyan area a major landslide had occurred in 1999, which blocked the flow of Gaula River and cause huge loss of agricultural land and property along with submergence of u/p side. This area experiencing frequent landslides. The stability analysis of slopes of these region was carried out using FLAC 3-D 3.0 software based on finite difference method. The 3-D slope stability studies provide the better understanding of failure mechanism and zone of influence in comparison to 2-D analysis. The results (deformation, stress distribution along the failure surface) obtained through FLAC 3-D 3.0 software have been compared with field measurements and found to be in good agreement with field observation.

The current work involves the stability analysis of 430 m high slope with slope angle ranging between 38° to 58° . The study was conducted assuming gravity loading only. The factor of safety evaluated through numerical method is 1.52 after use of the liner. So it is clear from the results (FOS) that the slope is critically stable even after the use of liner due to the presence of week rock. The considerable increase in factory of safety conferred that the rock mass can be stabilized using appropriate thickness of liner. The study reveals that the slope is unstable and need supports from engineered structure.

Kumar *et al.* (2016) studied the slope stability investigation of ravine/valley along Balia Nala, which is the outlet of Nainital Lake. Present study indicate that the various types of discontinuities such as Joints, Faults, and Shear zone, and continuous erosion by stream action affect the stability of slope. The studied area confronted the frequent mass movement due to the presence of fragile lithology and deep V-shaped valley. The current work involves the study of factor of safety, rock mass rating (RMR) and graphical analysis of joints, which indicate that these regions are landslide susceptible zone. Along a section of Balia Nala fifteen locations are identified for slope stability investigation. The study demonstrated that out of fifteen locations, five locations are prone to wedge failure and three locations to plane failure.

Basudhar *et al.* (2017) studied stability assessment of nailed soil slopes by limit Equilibrium method (LEM). In this analysis a 3-D rigid body rotational failure mechanism with a slip surface being a part of sphere is considered. In present study a computer program was developed for computation of factor of safety. This program is also capable of analyzing an unreinforced and nailed slopes. Using this program the critical slip surface and the corresponding minimum FOS of the unreinforced slope were initially determined, considering all possibilities of failures (base, slope, and toe). For the potential failure surface so obtained, nails were then introduced at desired locations, and the FOS value for the nailed slope was then computed with the developed code.

The nails inclination affects the FOS value of nailed slopes. In common practice nails are installed at an angle of 10° to 20° with horizontal. It is suggested that the nails should not provide with an angle of less than 10° in order to ensure the effective grouting. Study says that nails at higher inclination more than 45° are avoided so that the stability of slopes can be increased. In order to determine the optimum inclination of nails, nail inclination was varied from 0° to 50° for a given slope of 9 meter height and 50° slope angle. The study reveals that with increase in nail inclination from 0° to 25° , the FOS values increased from 1.55 to 1.76. Further increment in inclination to 50° results in a decreased FOS as 1.43. The study was also carried out to determine the effects of varying slope angles on nail inclination. It reflects that the optimum nail inclination changed with a change in slope angle.

For some benchmark problems the factor of safety values are calculated using developed procedure and computer code, and it is compared with FOS values reported

in literature and obtained through LEM (Geo 5) software and FLAC (Slope 5) software. Following conclusions can be drawn from present study. The results showed that the developed method and computer program gives satisfactory results. The 3-D FOS values obtained through the developed method were found to be higher than the 2-D FOS values. When nail spacing is increases from 0.5m to 2.5m the factor of safety is reduced quickly for a given slope and spacing more than 2.5m there are no considerable change in factor of safety.

Hazari *et al.* (2017) the stability of soil slope has been studied using pseudo static method in limit equilibrium approach considering log spiral failure surface. The current enquiry comprises the method of vertical slices. The FOS as obtained in present analysis are given in tabular format. The parametric study with respect to diverse constraints viz. seismic acceleration, soil friction angle, and slope angle are studied here which prove the acceptability of present model. Present pseudo-static analysis is well compared with available existing studies of slope stability. It is obvious that factor of security obtained from present analysis are useful for check the stability of slope.

Sarkar *et al.* (2017) at present, the composite supporting technology of soil nailing has been extensively used in the perpetual retentive walls, slope maintenance, supporting and fortification of prevailing cuts, so the related existing work have been approved out on a high risk and expensive site. A properly design soil nailing technique may minimize the earthwork, time and lower the risk at the time of construction. Therefore, it is more judicious to discuss numerical investigation of soil nailing through numerical simulation. In this paper, a geotechnical software called FLAC 3D was used by considering a soil mass of size 29 m (L) x 29 m (H) x 0.5 m (W) of flat terrain without surcharge. The ideal elastic plastic constitutive model for soil and cable structural element for nail had been selected. The ground water table was considered significantly below the nail wall and total height of soil excavation was taken as 8 m by maintaining excavation of 2 m at each step. Here, slope stability and effect of various parameters with affiliation between horizontal displacement, horizontal stress and vertical stress with elevation of soil nailed walls was analyzed and a comparative result was discussed.

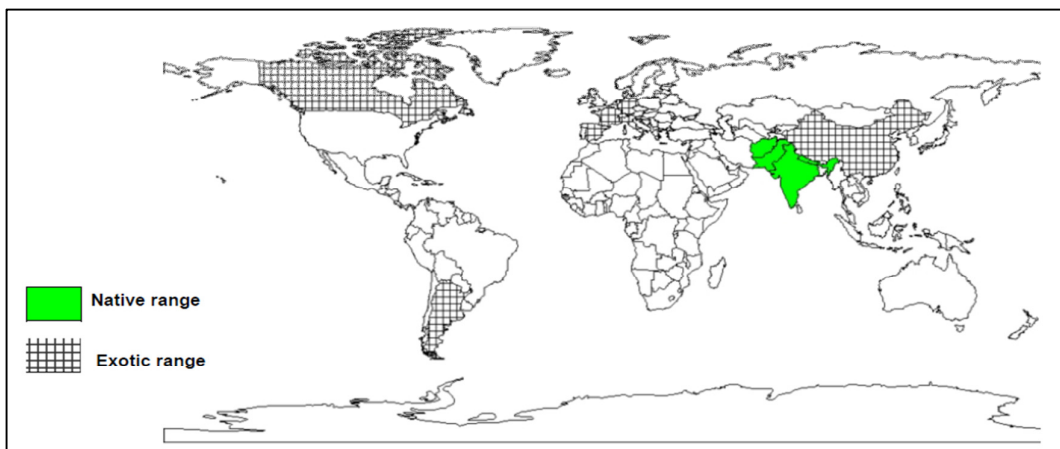
Upreti *et al.* (2017) the total height of the slope on right bank is 122m above the foundation at S-50. There are total eight cut slopes. All the slopes have been

excavated systematically with rock bolts and shotcrete fitted instantaneously behind the excavation. The geological logging of the slopes was carried out immediately after excavation. Based on geological data, the slopes were analyzed by DIPS software to ascertain the possibility of planer, wedge and toppling failures. Based on the kinematic analyses further detailed inspection were approved out. Detailed wedge failure enquiry were conceded out to validate the initial designs. The designed rock bolts were installed systematically to ensure there long term behavior. The rock bolts have been pre-tensioned to 25% of the capacity.

2.5 An Overview: Cedrus Deodar

Cedrus Deodar is a large evergreen, dioecious tree to 140ft – 165ft and more than 4 m DBH, crowns become rounded or broad and flat with horizontal or slightly ascending or descending branches, which are not whorled but arise irregularly from stem. It is found in height altitude in between 900m to 3500m. It mean annual temperature is 12°C - 17°C. It is Native found in Afghanistan, Indian, Nepal, Pakistan and Exotic found in Germany, Italy and Spain. The wood is white to light yellowish brown, with a characteristic odour and oily fed.

Cedrus Deodar occurs on moderate to precipitous slopes on rocky precipitous slopes, generally dominating cool northern slopes where it usually forms pure crops of considerable extent. It is typically a gregarious tree, a light demander, frequently found in the form of pure stands. It tolerates drought at advanced age, but not at the seedling stage. The trees are also resistant to atmospheric pollution *Agroforestry Database 4.0* (Orwa et al.2009).



Source: *Agroforestry Database 4.0* (Orwa et al.2009)

Figure 2.1 The map shows countries where the species has been planted

The map above shows countries where the species has been planted. It does neither suggest that the species can be planted in every ecological zone within that country, nor that the species cannot be planted in other countries than those depicted. Since some tree species are invasive, you need to follow biosafety procedures that apply to your planting site.

Products

Fuel: It provides an excellent fuelwood

Timber: The wood is white to light yellowish brown, with a characteristic odour and oily feel. It is straight-grained, medium fine and somewhat uneven-textured. Its average weight is 560 kg/m³. The heartwood is very durable but insects and fungi attack sapwood. Deodar is an important structural timber tree. Its wood is highly valuable and extensively used for building, railway sleepers, carriage and railway wagon work and other purposes for which durability is required. It is used in house building, beams, floorboards, door and window frames, furniture and general carpentry. It also produces quality plywood.

Medicine: Essential oils extracted from deodar and from cedar of Lebanon have been used as antiseptics and against tuberculosis, in Asia. Its oil and extracts are used as insecticides and herbal remedies against many animal diseases in India. The herbal pesticide Pesto ban is a liquid concentrate of three Indian medicinal plants including Cedrus Deodar.

Other products: It is a possible substitute of pines as a Christmas tree.

Services

Erosion control: It's a soil conservation and erosion control species in the Himalayas.

Shade or shelter: Its shelter woods increases dry land pasture productivity as in New Zealand.

Reclamation: It's a good re-vegetation species.

Ornamental: This species is grown as an ornamental and in amenity plantations in its native range and many countries into which it was introduced.

2.6 Geostudio 2019 (Slope/W): An Overview

Geostudio 2019 (slope/w) is a software which is being used to study the various problems related to slope stability. The Geostudio software helps you to combine

various analyses using different products into a one model. Using such approaches for modelling construction sequences, establishing initial conditions, performing sensitivity analyses, modelling complex time sequences, or simply decomposing a complex problem into a number of small, more manageable analyses.

2.7 Concluding Remarks

The evaluation of literature regarding various principles of slope stability, conventionally and numerical modelling carried by different methods and different software to analyse slope failure respectively was carried out in this chapter. Based on the complete review and analysis of their works, following major points are noted:

1. Vegetation can be used as one major slope stability technique.
2. Study can be carried out to know effect of vegetation and how the shear parameter of soil varies when vegetation planted on slopes.
3. The mathematical recreation by software is promising in order to analyze slope failure and also safety factor can be articulated once after counteractive measures has been proposed.
4. The mathematical simulation done by software is similar to conventional methods.
5. The real-world problem allied with slope failure can be straightforwardly watched by such tools.



*Materials
and
Methods*



3.1 General

The present chapter discuss about the study area and detailed methodology adopted for the laboratory testing of soil samples collected from different landslide sites. It also describes the selection criteria to select suitable plant for laboratory study in comparison to Cedrus Deodar.

3.2 Site Investigation

Based on the site visit, physical observation, discussion with native people as well as geotechnical engineer's two different sites are investigated. The first one is Kakri Ghat site belong to Almora District and second one is Salri site belong to Nainital District. These sites comes under landslide prone zone and a study to ascertain the effect of vegetation for slope stability may be conducted for soil investigation. The information about the common species of vegetation for slope stability and the common used tree for area where stabilization of slope was gathered.

3.3 Study Area

The study area for the thesis is the Central sector of the Kumaon Himalaya, Uttarakhand which, constitutes a part of the Lesser Himalayan terrane. The sedimentary of the lesser Himalayan in kumaon are separated by two major tectonic trends, the Ramgarh Thrust (RT) and North Almora Thrust (NAT) (Mishra and Sharma). The study is located in west from Almora District for site 1 (Kakri Ghat) and East from Nainital District for site 2 (Salri site), Uttarakhand, between the coordinate 29° 32' 47'' N and 79° 31' 39'' E for site 1 and coordinate 29° 18' 09'' N and 79° 33' 22'' E for site 2 shown in fig. 3.2 and 3.5. In this region as per Indian Metrological Department (IMD), during the monsoon season the amount of rainfall is usually recorded approximately 1130 mm per year causing recurrent landslide in that area. Figure 3.3 and 3.4 shows the picture of the site before and after vegetation cover. The former one shows the site area with full vegetation cover and no landslide occurred and later one shows the site area prone to landslide due to continuous cutting down and uprooting of trees due to widening of road which is causing instability of soil slope and thereby occurrence of recurrent landslides. The brief description of site are mention below.

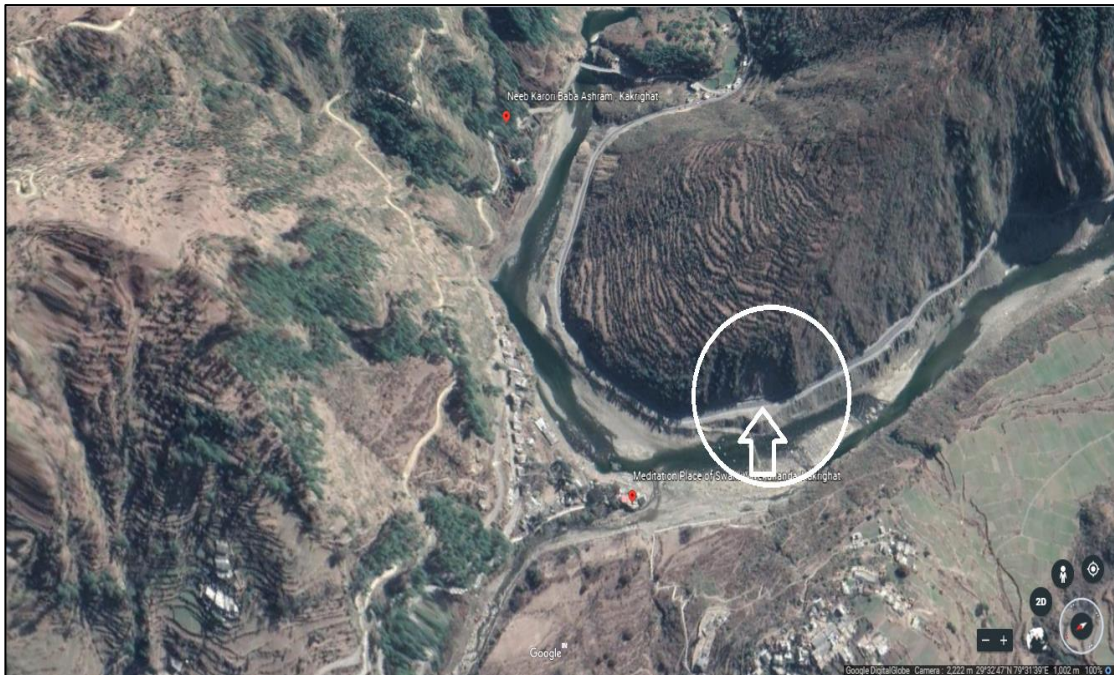


Source : www.sewainternational.org

Figure 3.1 Location and approach map of study area Uttarakhand region

3.3.1 Kakri Ghat NH-109

Kakri Ghat is small village in Tarikhet block, Almora District of Uttarakhand state, India. It comes under Naugaon Panchayath. It is located 28 KM towards west from District headquarters Almora. Sandy deposits from Kakri Ghat was collected from a site where landslides frequently occurred. The elevation of this site is about 1001m above mean sea level (earth google 2019). River Kosi is flowing parallel to Kakri Ghat. The NH-109 is one of the most important routes to connect the entire Kumaon region. This place is in the border of the Almora District and Nainital District. Fig. 3.2 and fig. 3.4 show the satellite and site image of Kakri Ghat respectively.



Source: Earth google 2019

Figure 3.2 Satellite View of Kakri Ghat NH 109



Source: Uttarakhand photos.blogspot.com (2013)

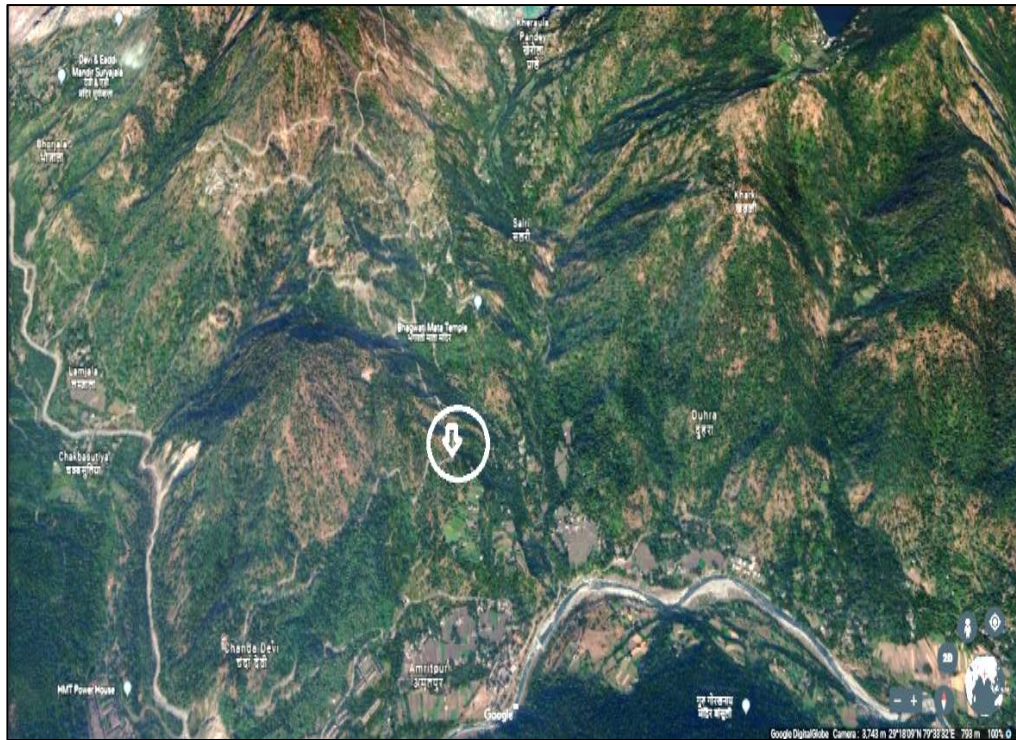
Fig. 3.3 Kakri Ghat NH 109 with vegetation before landslide in 2013



Fig. 3.4 Site View of Kakri Ghat NH 109 (after landslide 2018)

3.3.2 Site Salri

Salri is a village in Bhimatal Block in Nainital District of Uttarakhand state, India. It is located 11 KM towards East from District Nainital. Sandy deposits from Salri was collected from a site where sever landslide had occurred previously. Such slide are very common in these area and should be given much concern to prevent huge loss. The elevation of this site is about 793 m above mean sea level (earth google 2019). Fig. 3.5 and fig. 3.6 show the satellite and site image are respectively.



Source: Earth google 2019

Fig. 3.5 Satellite view of Salri



Fig. 3.6 Site View of Salri

The soil samples were collected from the above two sites and brought to the Soil Mechanics Laboratory of Department of Civil Engineering at G.B. Pant University of Agriculture and Technology Pantnagar, Uttarakhand for performing the laboratory test.

3.4 Selection of Suitable Plant for Laboratory Test

A suitable plant as similar as Cedrus Deodar in hill region was required for its plantation with varied plant density in controlled laboratory condition to conduct the laboratory tests for studying the effect of root system on the shear parameter of collected soil sample.

The selection of plant for laboratory test was discussed to expertise of vegetation, Department of Agroforestry, Department of Agriculture and Science and Department of Medicinal Plants Research and Development Centre (MRDC), Pantnagar, Uttarakhand. After discussion with Professor Dr. S.S. Gupta, Dr. Rajesh Kumar, Dr. M.S. Negi, Dr. S.K. Verma and Dr. N.K. Singh it was found that various species of plants such as (*Ocimum Tenuiflorum*, Vetiver grass, Juniper, *Artemisia Annua* etc.) can easily grow in the soil samples collected from sites, to perform the laboratory test. The suggested species were compared for it's correlation with Cedrus Deodar tree on the basis:

- Roots spreading system
- Height upon diameter ratio
- Density of tree

On comparison with *Artemisia Annua* to Cedrus Deodar tree it was found most suitable for this study.

➤ Root Spreading System

Artemisia Annua has single main taproot, that grow downwards into the soil and from which number of smaller, more horizontal oriented lateral roots will branch. The depth of root can penetrate into the soil can mirror the height of the aerial part of the plant and thus it provides excellent anchorage (sauces *et al.*). Whereas, Cedrus Deodar has also deep root grown downwards into soil and has also wide lateral roots system. It can holds the soil masses and thus it provides excellent anchorage. The photographic comparison of root system is shown in figure number 3.7.



Fig. 3.7 Spreading of roots of Cedrus Deodar and Artemisia is similar

Table 3.1 Compression between Artemisia Annua and Cedrus Deodar (Agroforestry Database 4.0 (Orwa *et al.*2009) and ISF Report 2017 (ANNEXURE-1))

S.No.	Parameter	Artemisia Annua	Cedrus Deodar
1	Diameter(avg.)	0.95 cm	50 cm
2	Height(avg.)	3 ft. avg.	155 ft. avg.
3	Weight (avg.)	0.036 kg	5304.30 kg
4	Density	555.4 kg/m ³	560 kg/m ³
5	Height/ Diameter	96.301	94.56

➤ Height upon Diameter Ratio

The study the height and diameter ratio of Cedrus Deodar and Artemisia Annua was conducted and the data about the Cedrus Deodar and Artemisia Annua was collected based upon the literature available as shown in above table 3.1. As shown in table 3.1 the height upon diameter ratio of Artemisia Annua is 96.301 and for Cedrus Deodar is 94.56 which is approximately equal.

➤ Density of Tree

The data for density of Artemisia Annua was not available therefore the calculation was of stem density on the basis of measure/available weight and stem diameter is calculated as shown below.

Calculation for density of *Artemisia Annua*

$$(\text{Density})_{\text{Artemisia Annua}} = (\text{Weight}) / (\text{Volume})$$

Weight of *Artemisia Annua* is 36g by table 3.1

$$\text{Volume} = \frac{\pi}{4} \times (d1)^2 \times h = 64.86 \text{ cm}^3$$

$d1$ = diameter of *Artemisia Annua* is given by table 3.1

h = height of plant (by table 3.1)

$$\text{Density} = \frac{36}{64.86} = 0.55542 \frac{\text{g}}{\text{cm}^3} = 555.42 \frac{\text{kg}}{\text{m}^3}$$

When compared with *Cedrus Deodar* it was found that the density of *Cedrus Deodar* and *Artemisia Annua* is same *i.e.* for *Cedrus Deodar* density is 5560 kg/m³ and for *Artemisia Annua* it is 555.42 kg/m³ which approximately equal.

3.5 An Overview: *Artemisia Annua*

Artemisia Annua belong to the plant family of Asteraceae and is an annual short-day plant. *Artemisia Annua* is fragrant annual herb widely distributed in Asia, Europe and North America. This annual species grown rapidly in fertile, sandy and alluvial soils. This plant has dense single stem, which preferred for bonding to the infusion because of prior experience of infusion polymer into this plant. It has single main taproot, that grow downwards into the soil and from which number of smaller, more horizontal oriented lateral roots will branch. The depth of root can penetrate into the soil can mirror the height of the aerial part of the plant and thus it provides excellent anchorage (sourced *et al.*).

Artemisia Annua display a remarkable phenotypic plasticity, comparable to successful weed. The roots of *Artemisia Annua* plants were infused with a mixture of epoxy resin and poly oxyalkylamine bond hardener. Compared with non-infused roots, polymer-infused roots provided an additional 22 kPa (28%) of shear strength for elastic silt and an additional 13.1 kPa (25%) of shear strength for low-plasticity clay with a corresponding 13.6 kPa (55%) increase in tensile strength for the low-plasticity clay (Barhar Wyslouzil *et al.*). This plant is used for medicinal purpose. The benefits of this plant are as:

- Anti- inflammatory
- Anti- pyretic (fever reducer)

- Chemotherapeutic (kill cancer cell)
- Anti- microbial & Anti- fungal (kill bacteria, viruses and funguses)
- Anti- parasitic (kill parasites)

This plants were easily available in Mdicinal Plant Research and Development Centre (MRDC) of G.B.P.U.A.T Pantnagar which were inducted and brought to Soil Mechanics Laboratory of Department of Civil Engineering for engineering study.



Fig. 3.8 Plant Sample collected



Fig. 3.9 Plants of Artemisia Annua

3.6 Sample Preparation and Experimental Program

The soil sample were collected from two different sites *i.e.* Kakri Ghat and Salri Site. Approximately 1800 kg (28 to 30 bags) of soil samples were collected from sites. The representative soil samples were brought to the soil mechanics laboratory of G.B. Pant University of Agriculture and Technology Pantnagar, Uttarakhand. After tagged with their site name. Laboratory test were conduct to find the types of soil and its geotechnical properties.



Fig. 3.10 Soil sample collected from two different site



Fig. 3.11 University Vehicle indented to collect the soil samples from sites

University vehicle was indented from the transport pool of G.B. Pant University of Agriculture and Technology Pantnagar, Uttarakhand to collect the soil samples for different sites location.

3.6.1 Sample Preparation:

The following Methodology for the sample preparation to conduct the large direct shear test was adopted:

- The representative soil samples were collected from the two sites (Kakri Ghat and Salri site) and were then brought to soil mechanics laboratory for soil testing. Forty- eight numbers of wooden boxes identical to the standard size dimension (30 cm x 30cm x 20cm)of large direct shear test (LDST) box were prepare for further conduction of test as shown in fig. 3.12 and 3.13.



Fig. 3.12 Soil Sample taken from Sites



Fig. 3.13 Boxes having same size of LDST

- Sampling of soil was done by sieves analysis, passing it through sieves of 12.5mm. The soil passed through 12.5mm IS sieves was collected and then filled in wooden box in there equal layer with light compaction. Each layer of soil was compacted with 2.5kg hammer and then similar procedure was followed for other two layers as shown in fig. 3.14.



Fig. 3.14 Soil sample filled in boxes

- Forty- two wooden boxes were divided into equal area distribution with varying plant density and six of them were left undisturbed for the determination of soil shear parameter shown in fig.3.15. It was important that the plant should be planted in varied plant density in the prepared soil sample of large shear box to check the effect of roots system on shear parameter. The area of the sample surface is divided into seven equal parts and the Artemisia was planted at the approximately of the centroid of that area at equal density as shown in figure. 3.15.

Table 3.2 Number of sample prepared for conduction the Large Direct Shear Test

S.No	Plant distribution	Soil sample form kakri ghat	Soil sample form Salri site
1	Without plantation	3	3
2	One plant per box	3	3
3	Two plant per box	3	3
4	Three plant per box	3	3
5	Four plant per box	3	3
6	Five plant per box	3	3
7	Six plant per box	3	3
8	Seven plant per box	3	3
9	Total samples preparation		48

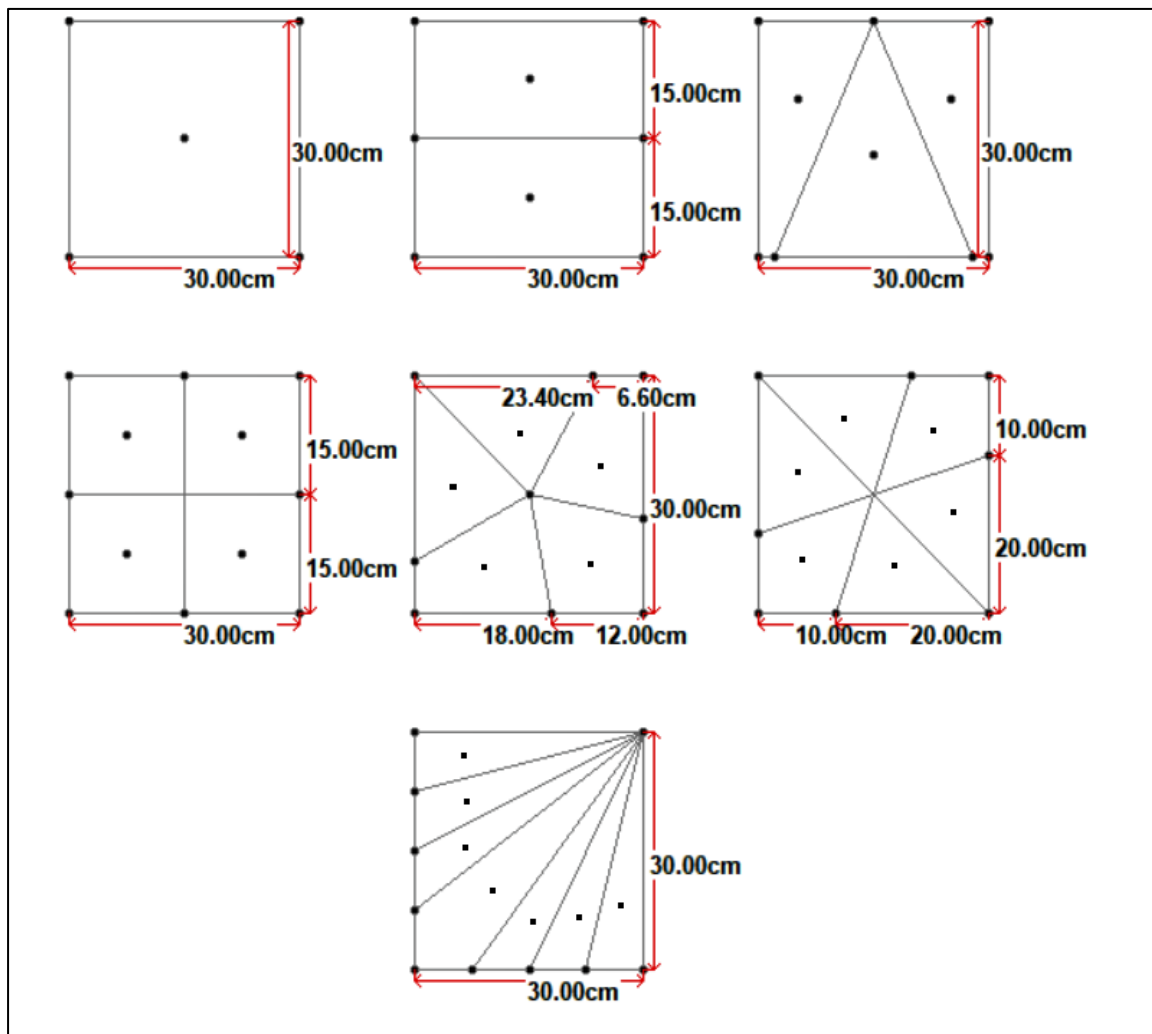


Fig. 3.15 Schematic diagram showing plantation of *Artemisia Annua* into soil sample by varying plants density

- For first sample condition, the surface area of the wooden box was left undivided and then a plant of *Artemisia Annua* was planted at the centroid of the entire wooden box area as shown the above fig. 3.15 (single plant).
- Further, the area was divided into two equal half's and then two plant were planted at the centroid of the each divided area with corresponding varying plant density.
- For the third condition, the wooden box area was divided into three equal areas. Subsequently, three plants were planted at the centre of the three divided area.



Fig. 3.16 Plantation of *Artemisia Annua* into soil sample with varying plant densities

- Similarly, the above procedure was followed for four, five, six and seven plants embedded at the centroid of each divided area respectively.



Fig. 3.17 Plantation in to soil samples of LBST test

- After plantation, the wooden box specimens were subjected to 50 days of curing for development of desired root system. Thereafter, the stem of each plant was chooped –off for futher LDST test for finding the shear parameter of soil specimen.



Fig. 3.18 Curing of plantation for around 50 days



Fig. 3.19 Chopping of plant stem



Fig. 3.20 Spreading of roots in soil sample

3.6.2 Laboratory Test:

In order to investigate the various geotechnical properties of soil various experimental programme were carried out as per IS standard procedures. The brief description of the tests conducted in the study follows as under are listed as:

- Laboratory test were carried out to determine Grain size distribution, bulk density in Free State, and Large Direct Shear Test.
- The GSD test was performed to classify the soil samples collected.
- Large Direct Shear Test was carried to determine the shear strength (C , and ϕ). Further this test carried out on soil sample with and without roots.

Table 3.3 Experimental Programme

S. No.	Specimen Name	Test Conducted	No. of Test Conducted
1.	Kakri Ghat soil sample	Grain size distribution	1
2.	Kakri Ghat soil sample	Bulk density	1
3.	Kakri Ghat soil sample with varying plant density	Bulk density	7
4.	Kakri Ghat soil sample	Direct shear test	3
5.	Kakri Ghat soil sample with roots system	Direct shear test	21
6.	Salri soil sample	Grain size distribution	1
7.	Salri soil sample	Bulk density	1
8.	Salri soil sample with varying plant density	Bulk density	7
9.	Salri soil sample	Direct shear test	3
10.	Salri soil sample With roots system	Direct shear test	21
9.	Total number of test conducted		66

3.7 Testing Methodology

The experimental programme is carried out by conduction following tests as per IS standard procedures. The brief description of the tests conducted in the study follows as under are listed as:

- Grain Size Distribution (IS: 2720 Part IV-1985)
- Bulk density
- Large Direct Shear Test

3.7.1 Grain Size Distribution (IS: 2720 Part IV-1985)

The percentage of various size of particles in the dry sample of soil was found by mechanical analysis.

Grain size analysis was carried out for the material used in this work as per IS: 2720 (Part IV)-1985. The GSD of coarse grained soil is determined through the sieve analysis using the set of sieves consisting of 20mm, 12.5mm, 10mm, 6.5mm, 4.75mm, 2mm, 1mm, 600 μ , 425 μ , 300 μ , 150 μ and 75 μ (Fig. 3.5). Sieving was done by arranging the sieves one after the other as per the order of their mesh openings.

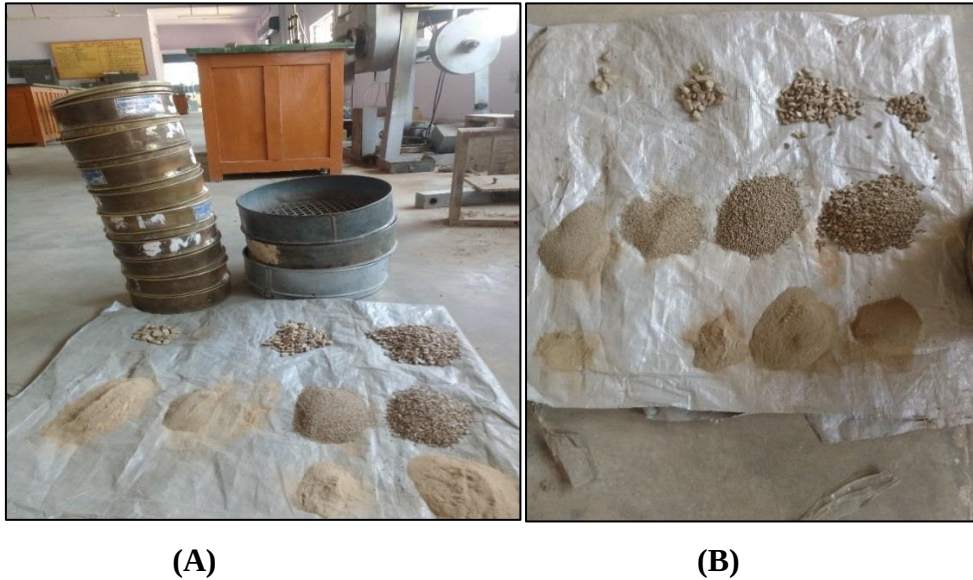


Figure 3.21 Typical Photograph of Gravelly Soil Deposits Collected from (A) Kakri Ghat Site and (B) Salri site

The largest aperture of the above sieves being kept at top and the smallest at the bottom. A receiver is kept at the bottom and a cover plate at the top of the whole assembly. The sample was placed on the top sieve and subjected to mechanical shaking of the assembly. The soil sample retained on each sieve was weighed and the percentage of soil retained on each sieve was calculated as shown in fig. 3.21.

3.7.2 Bulk Density in Natural State



Figure 3.22 Calibrating Cylinder

Soil sample was brought from site and bulk density was determined in compacted state by pouring it in calibrated cylinder of known dimension. Weight of cylinder and soil was tabulated and bulk density was determined in the laboratory as shown in fig. 3.22.

3.7.3 Large Direct Shear Test

- Dimensions of large shear box was measured and set up by fixing its lower part to the upper part with aid of clamping screws and a porous stone was put at the base.
- For conducting undrained test, base plates was put on porous stone and plain gripper plates was put on base plates with the plain gripper plate at 90 degree to the direction of shear. In order to conduct drained tests, a perforated grid plate was placed over the base plate.
- Initially amount of soil taken was weighed in a pan. Then soil taken was placed into the shear box in 3 layers and was compacted with a light compaction of 2.5kg rammer 25 nos. of blows for each layer. The upper grid plate, loading pad and porous stone was placed in sequence on the soil specimen.
- The weight of pan was taken and the mass of soil used was tabulated.
- The box placed inside container and was placed on loading frame. Upper half of the box was kept in contact with the horizontal proving ring assembly. Then container was filled with water in case soil is to be saturated.
- Then clamping screws was removed from the box, and set vertical displacement gauge and proving ring gauge to zero.
- The vertical normal stress was kept to a determined value. For drained tests, the soil was consolidated fully under normal load.
- After this motor was started with a required speed and shear load was applied at a constant rate of strain. Readings were taken until the horizontal shear load peaks and falls or the horizontal displacement reached twelve percent of the specimen length.
- The moisture content of the specimen is found after the test. The test was repeated on same specimens for different normal stress values.



Fig. 3.23 Large Shear Box Apparatus



Fig. 3.24 Sample test on Large Shear Box test



Fig. 3.25 Performing LDST on soil sample

3.8 Conclusion Remark:

The site study and experimental programme, as discussed in this chapter was carried out in view of the objectives of the study. The results obtained by conducting different types of tests on the soil and soil with vegetation are presented and discussed in the following chapter.



Results and Discussion



4.1 General

This chapter presents the results of different laboratory tests conducted on soil sample collection from landslide and results of slope stability analysis for assessment of effect of effect of varied tree density soil collected soil samples. The analysis of slope stability has been conducted by Swedish Slip Circle and Bishop's methods to determine the factory of safety (FOS) with the excel spread sheets. The results obtained in determination of FOS with varied slope are plotted to obtain the optimum tree density of Cedrus Deodar tree for the soil collected from two different landslide sites.

4.2 Geotechnical Parameters of Soil

After the collection of samples collected from landslide sites, there was a need for proper tagging of sample for easy identification. Therefore, the sample were tagged with their site name, they were dried in oven with temperature varying between 105°C to 110°C for a duration of 24 hour. Following tests were performed as Indian Standard Code of Practices on all soil samples to determine their geotechnical properties.

- Grain Size Distribution (GSD)
- Bulk Density in Free State and with Varied Plant Density.
- Large Direct Shear test

4.2.1 Grain Size Distribution

Grain Size Analysis was performed on oven- dried soil samples to determine the percentage of sand, silt and clay fraction present in soil. The Grain Size Analysis are presented in the form of a semi-log plot between the diameter of soil particles (mm) plotted finer (N) by weight corresponding to any given size plotted on the arithmetic scale as ordinate. The curve indicates the combined particles size analysis curve plotted for sieves analysis. Figure 4.1 and 4.2 show the Grain Size Distribution Curve of two soil types.

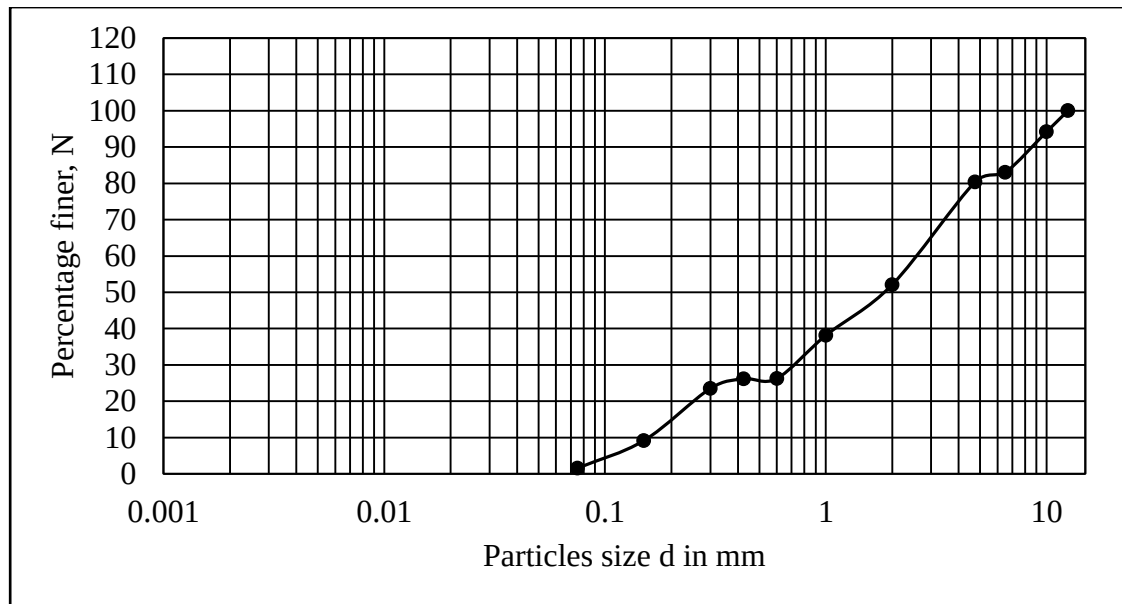


Figure 4.1 GSD of soil samples collected from Kakri Ghat

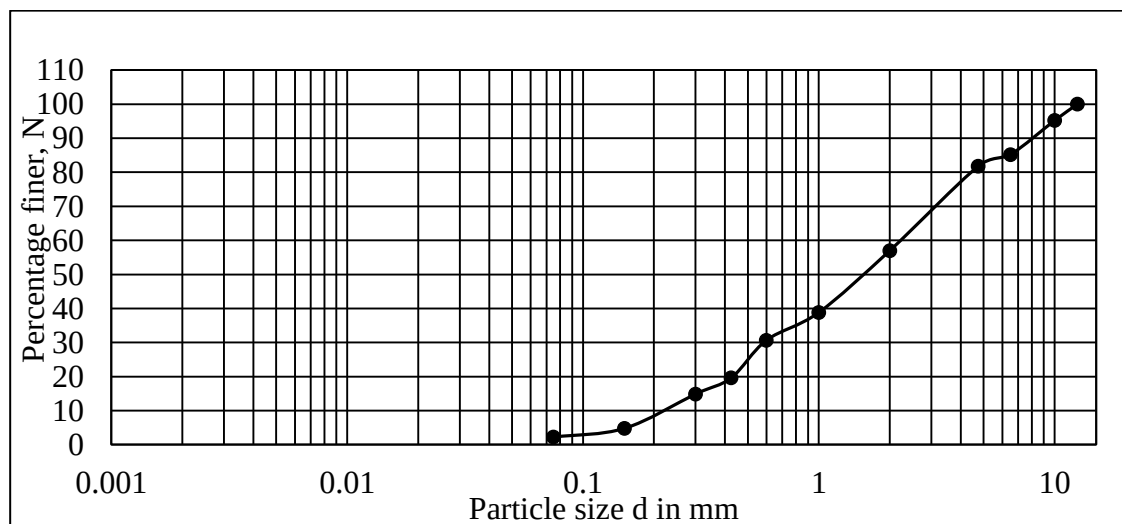


Fig. 4.2 GSD of soil samples collected from Salri Site

Table 4.1 Classification of soils

S. No.	Site	D ₁₀ (μ)	D ₃₀ (μ)	D ₆₀ (mm)	C _u	C _c	Classification
1	Kakri Ghat	165	750	2.7	16.36	1.26	Well graded sandy deposit
2	Salri site	230	600	2.29	9.956	0.683	Poorly graded sandy deposit

GSD helps in classification of soil, so from the results it was clear that the soil from Kakri Ghat is well graded sandy deposit while soil collected from Salri site is poorly graded sandy deposit.

4.3 Co- relation between Artemisia plant and Cedrus Deodar tree

The representative soil samples were collected from the two sites (Kakri Ghat and Salri site) and were then brought to soil mechanics laboratory for soil testing. Forty- eight numbers of wooden boxes identical to the standard size dimension (30 cm x 30cm x 20cm) of large direct shear test (LDST) box were prepared. Sampling of soil was done by sieves analysis, passing it through sieves of 12.5mm. The soil passed through 12.5mm IS sieves was collected and then filled in wooden box in there equal layer for light compaction. Each layer of soil was compacted with 2.5kg hammer and then similar procedure was followed for other two layers.

Forty- two wooden boxes were divided into equal area distribution with varying plant density. For initial condition, the surface area of the wooden box was left undivident and then a plant of Artemisia Annua was planted at the centroid of the entire wooden box area as shown in fig 4.3.



Fig. 4.3 One Artemisia Annua is planted at the centroid of the entire wooden box area reported as one plant density

Further, the area was divided into two equal half's and then two plant were planted at the centroid of the each divided area with corresponding varying plant density. Similarly, the above procedure was followed for three, four, five, six and seven plants embedded at the centroid of each divided area respectively. As shown in fig. 4.4.

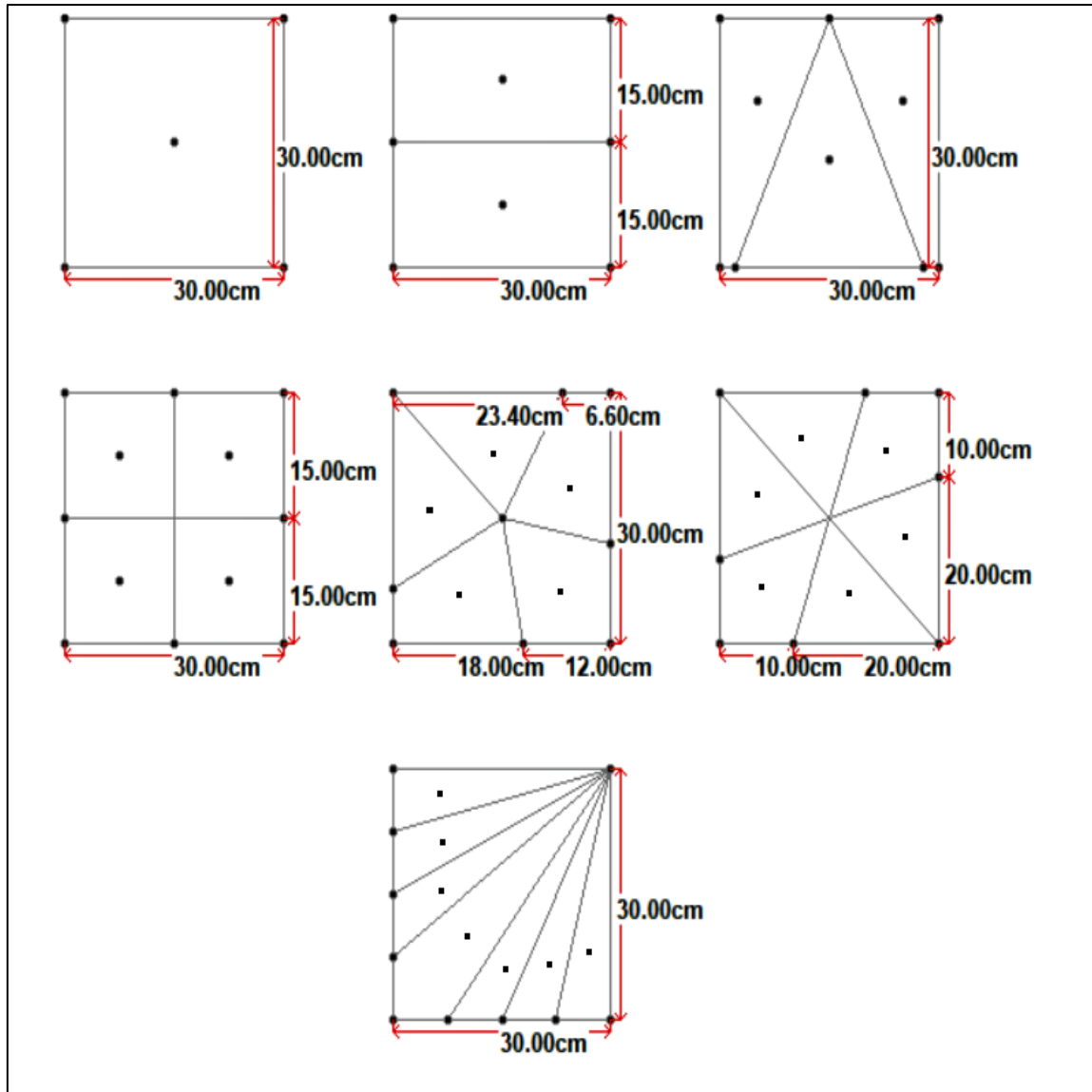


Fig. 4.4 Schematic diagram showing plantation of *Artemisia Annua* into soil sample by varying plants density

It was observed that in specimen where two plants of *Artemisia Annua* were planted the root system develop after the curing of 50 days covered the whole soil mass without substantial overlap. Now it was important step of this study that these varied plant density of *Artemisia Annua* has to be converted in to the equivalent tree density of *Cedrus Deodar* tree. Therefore if the root system two plant of *Artemisia Annua* planted in 30cm × 30cm i.e. 900 cm² area has contributed in the improvement in shear parameter of soil sample, the two *Cedrus Deodar* tree planted in 2A area (where root system is not overlapping substantially) will have the same effect. So, we compare two trees of *Cedrus Deodar* that will produce same affect in 2A m² area as two *Artemisia* plants are producing in 900 cm² area.



Fig. 4.5 The roots of two Artemisia Annua plant cover the whole soil samples



Fig. 4.6 The roots of Artemisia Annua plant

From the available literature of forestry Richard Hoyt is researcher of U.S. Department of Agriculture plant hardiness suggested that the Cedrus Deodar tree roots can radially spread up to 4.88 m. So the calculated area.

$$\begin{aligned}\text{Area covered by one Deodar tree} &= \frac{\pi}{4} \times d^2 \\ &= \frac{\pi}{4} \times 9.76^2 = 74.834 \text{ m}^2\end{aligned}$$

Where, d = diameter of root spread

There, two Deodar tree can cover the 150 m² area may (without substantial overlapping root system), which produce same effect as two Artemisia Annua plant in 900 cm² area.

Table 4.3 Distribution of area (150 sqm.)

S.No.	Number of Cedrus Deodar Tree	Area cover by equivqlent one Cedrus Deodar tree (sqm)	No. of Artemisia Annua per 900 cm ²	Equivalent of Cedrus Deodar tree Density as tree/ 150 sqm
1	1	149.668	1	1
2	2	74.834	2	2
3	3	49.88	3	3
4	4	37.417	4	4
5	5	29.9336	5	5
6	6	24.944	6	6
7	7	21.3811	7	7

4.4 Bulk Unit Weight of Soil

Bulk density of soil sample were determined in natural compacted state by pouring it in calibrating cylinder of known dimension. Bulk unit weight plays a vital role in slope stability. Higher the value bulk unit weight of slope may increase the chances of failure due to higher self-weight of soil mass.

The calibrated cylinder filled with soil samples in to three layer with 25 number of blows in each layer. Weight of cylinder and compaction soil was tabulated and bulk density was determined in the laboratory. As shown in table 4.3.

4.4.1 Calculation of Bulk Unit Weight of Soil Including Weight of Tree

As the weight of tree acting downward on the soil mass act as the surcharge weight on the soil mass. The effect of tree weight is considered and bulk density of soil including weight of average Cedrus Deodar tree with varied plantation density is calculated. As discussed in chapter 3 the varied density of plant be planted into box which shown in fig. 3.13. The calculation of bulk unit density of soil with one plant of Kakri Ghat soil samples as shown below.

$$\text{Bulk unit weight} = \frac{\text{weight of soil}}{\text{Volume}}$$

Here, assumed the slope.

Now, Mass = weight of soil and weight of tree

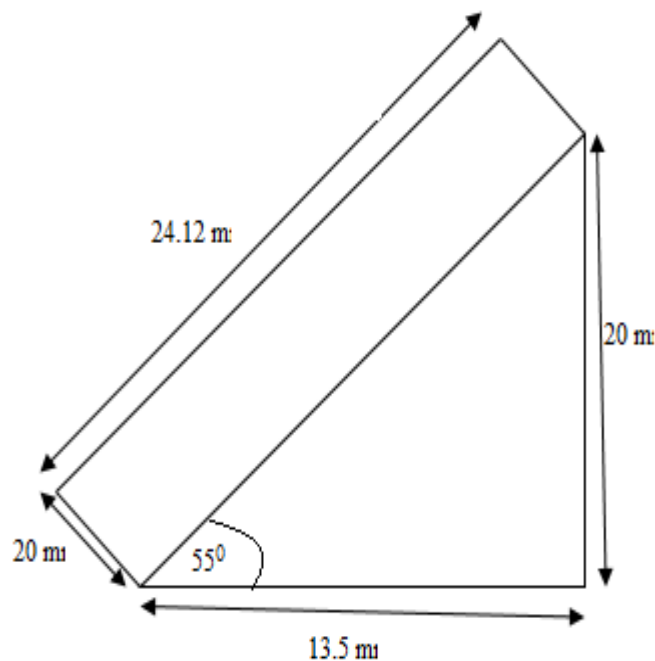


Fig. 4.7 Slope for finding the bulk density

So, Volume of soil = $\frac{1}{2} \times \text{base} \times \text{height} \times \text{width}$

$$= \frac{1}{2} \times 13.5 \times 20 \times 20$$

$$= 2700 \text{ m}^3 \quad (1)$$

Now, weight of soil = Density of soil $\times$ Volume of soil (a)

Compacted density of soil samples without plantation is calculated by calibrating cylinder, which is 17.2 kN/m^3 as shown in table 4.2 (b)

So, weight of assumed soil mass is

$$= 17.12 \text{ kN/m}^3 \times 2700 \text{ m}^3 \quad \text{using (1, a and b)}$$

Then,

Find out the weight of tree

$$\text{So, weight of Cedrus Deodar tree} = \text{Density of tree} \times \text{Volume of tree (V}_t\text{)} \quad (c)$$

$$\text{Density of tree} = 560 \text{ kg/m}^3 \text{ (by Agroforestry Database 4.0 Orwal et al. 2009)} \quad (d)$$

As per Agroforestry Database 4.0 Orwal et al. published in his literature that the density of Cedrus Deodar tree is 560 kg/m^3 .

$$V_t = 10.0382D^2 - 1.28703D + 0.07307 \text{ (by ISF Report 2017, ANNEXURE-1)} \quad (2)$$

$$\begin{aligned} V_t &= 10.0382 \times 0.50 \times 2 - 1.2870 \times 0.50 + 0.07307 \quad \text{Using (table 3.1 and 2)} \\ &= 9.47197 \text{ m}^3 \quad (e) \end{aligned}$$

Here, calculated the weight of one Deodar tree

$$\begin{aligned} \text{Weight of tree} &= 560 \text{ kg/m}^3 \times 9.47197 \text{ m}^3 \quad \text{using (c, d and e)} \\ &= 5304.306 \text{ kg} \\ &= 53.047 \text{ KN} \end{aligned}$$

Area of assumed slope = 482.4 sqm.

Now, one number of Cedrus Deodar tree planted in 150sqm then area cover one Cedrus Deodar tree is 150sqm. (Table 4.2)

$$\begin{aligned} \text{So, number of Cedrus Deodar tree planted in 482.4sqm area} &= \frac{482.4}{150} \\ &= 3.21 \end{aligned}$$

At lastly,

Bulk Density of soil including one Cedrus Deodar tree per 150sqm

$$\begin{aligned} &= \frac{\text{weight of soil} + \text{weight of tree} \times \text{number of tree}}{\text{volume of soil}} \\ &= \frac{46224 + 53.047 \times 3.21}{2700} \end{aligned}$$

$$\text{Bulk Density of soil with one tree} = 17.18 \text{ kN/m}^3$$

Similarly, for Bulk Density of soil including five Cedrus Deodar tree per 150sqm

Area of slope = 482.4 sqm.

Now, five number of Cedrus Deodar tree planted in 150sqm then area cover one Cedrus deodar tree is 29.9336sqm. (Table 4.2)

$$\begin{aligned}\text{So, number of Cedrus Deodar tree planted in 482.4sqm area} &= \frac{482.4}{29.9336} \\ &= 16.115\end{aligned}$$

At lastly,

Bulk Density of soil including one Cedrus Deodar tree per 150sqm

$$\begin{aligned}&= \frac{\text{weight of soil} + \text{weight of tree} \times \text{number of tree}}{\text{volume of soil}} \\ &= \frac{46224 + 53.047 \times 16.115}{2700}\end{aligned}$$

Bulk Density of soil with one tree = 17.43 kN/m³

Similarly, the density of soil with two, three and so on up to seven varying Cedrus Deodar density was determined for Kakri Ghat and for Salri site. Table 4.3 shows the bulk unit density of soil with varied Cedrus Deodar including its weight. This calculation is further used to find the normal surcharge weight while calculating the slope stability FOS.

Table 4.3 Compacted bulk unit weight of soil

S.No	Site	Material	No. of plants	Bulk unit weight (kN/m ³)
1	Kakri Ghat	Soil	0	17.12
			1	17.18
			2	17.24
			3	17.30
			4	17.37
			5	17.43
			6	17.49
			7	17.56
2	Salri site	Soil	0	15.06
			1	15.12
			2	15.18
			3	15.24
			4	15.31
			5	15.37
			6	15.43
			7	15.50

4.2.3 Large Direct Shear Test

Large Direct Shear Test (LDST) gives the shear strength parameters (C and ϕ) for soil samples at known density. As disused in chapter 3 48 specimen were prepared. 42 specimen were prepared with varying the plant density and rest six specimen were prepared with only soil sample collected for two different sites.

For Kakri Ghat the LDST result are represent in the form of arithmetic graph between the Normal stress (kN/m^2) plotted on abscissa and the Shear stress (kN/m^2) plotted on the ordinate. The curve variation shows gradually increase in the value of (c and ϕ) with increase the plant density up to five number of plant planted (*i.e.* Cedrus Deodar per 150sqm). Futher, for plant density six and seven *i.e.* equivalent Cedrus Deodar as six Cedrus Deodar tree per 300sqm and seven Cedrus Deodar tree per 3000sqm respectively. There is decrease in shear parameter value (c and ϕ) for Kakri Ghat which is shown in fig.4.8.

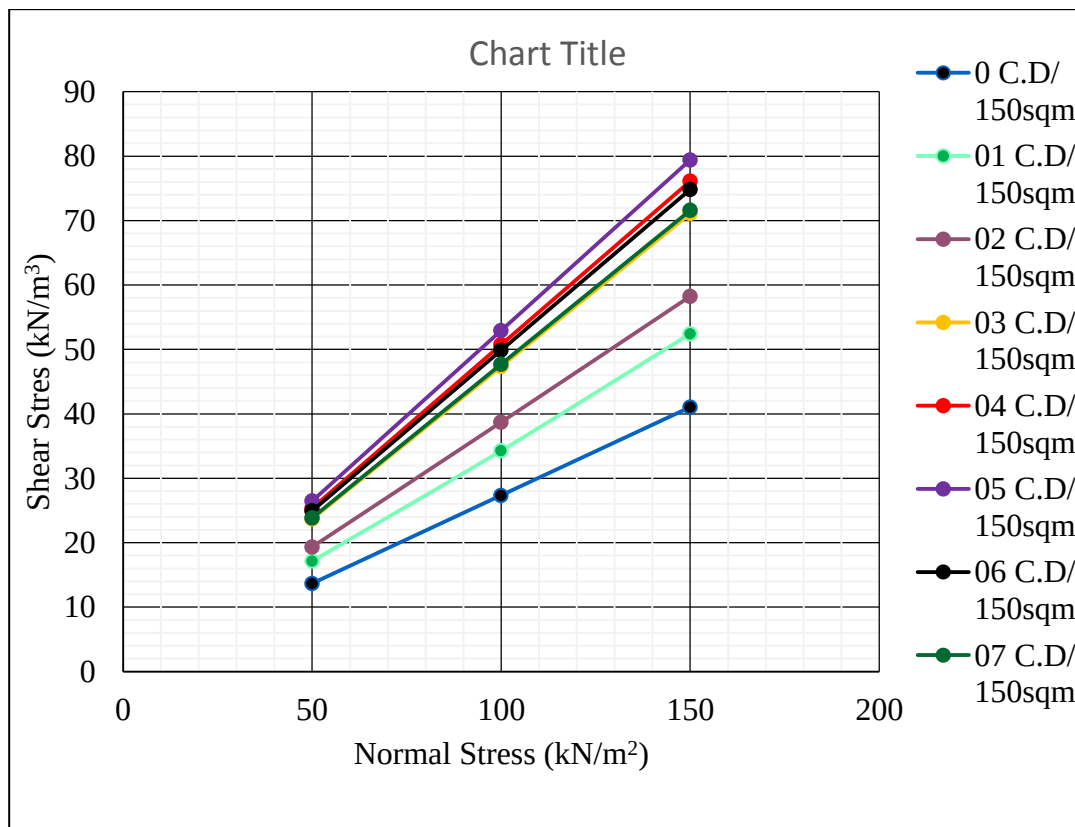


Fig. 4.8 LDST test on Kakri Ghat soil Sample for varied plant density (*Artemisia Annua*) on equivalent to Cedrus Deodar tree density

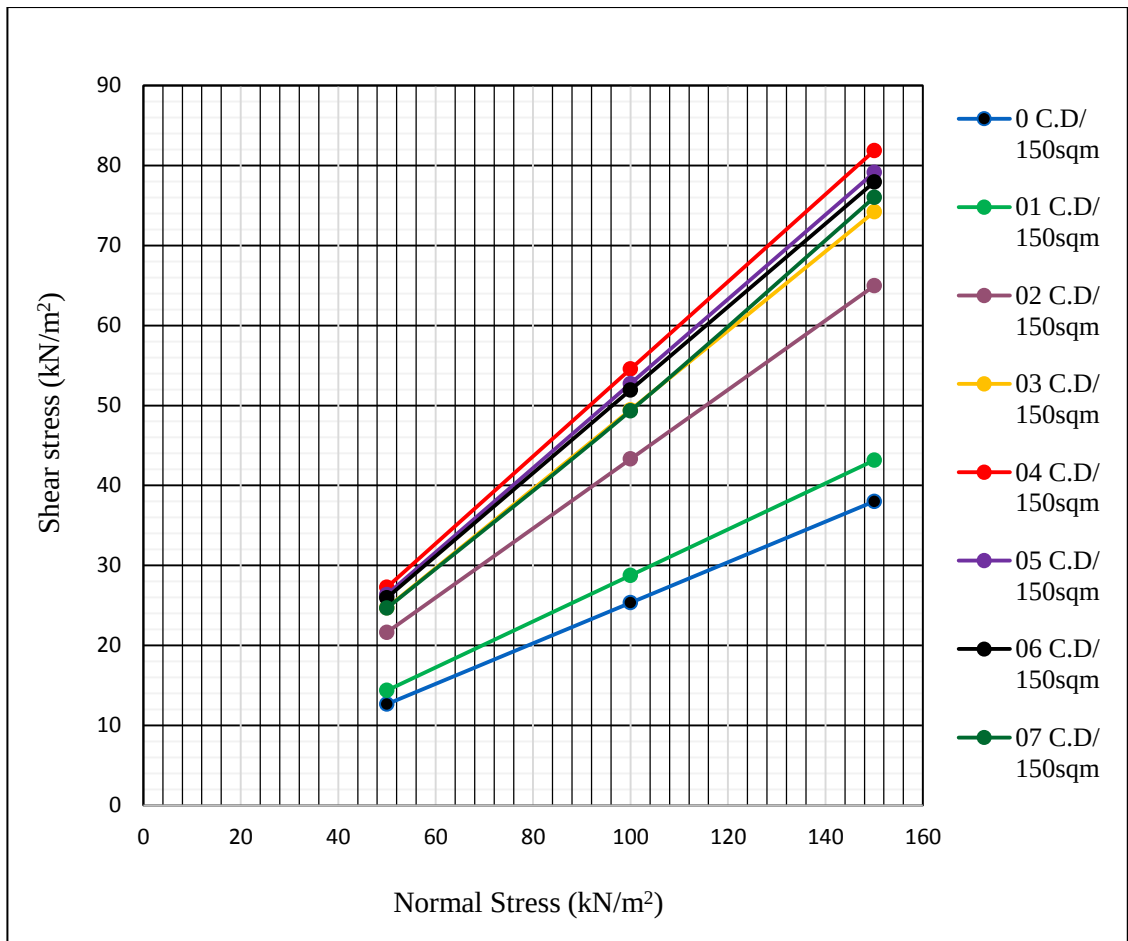


Fig. 4.9 LDST test on Salri site soil Sample for varied plant density (*Artemisia Annua*) on equivalent to Cedrus Deodar tree density

For Sarli Site the LDST result are represent in the form of arithmetic graph between the Normal stress (kN/m^2) plotted on abscissa and the Shear stress (kN/m^2) plotted on the ordinate. The curve variation shows gradually increase in the value of (c and ϕ) with increase the plant density up to four number of plant planted (*i.e.* Cedrus Deodar per 150sqm). Futher, for plant density five, six and seven *i.e.* equivalent Cedrus Deodar as five,six Cedrus Deodar tree per 300sqm and seven Cedrus Deodar tree per 300sqm respectively. There is decrease in shear parameter value (c and ϕ) for Kakri Ghat which is shown in fig. 4.9. The shear parameter and change as observed in shear parameter with presence of tree root system plays the significant role in stability of slope and affect analysis of soil slope stability and also helps in deciding slope remedial measure very accurately.

Table 4.3 Shear parameter of Kakri Ghat and Salri Site with varying plant density

S.No.	Number of Plant	Kakri Ghat		Salri Site	
		c (kN/m ²)	Φ in degree	c (kN/m ²)	Φ in degree
1	Without plant	13.6	21°	12.67	24°
2	One	17.14	23°	14.36	22°
3	Two	19.35	22°	21.65	25°
4	Three	23.67	24°	24.73	25°
5	Four	25.37	26°	27.28	24°
6	Five	26.47	25°	26.37	25°
7	Six	24.94	24°	25.97	25°
8	Seven	23.86	23°	24.67	24°

The Fig. 4.10 shows the variation of cohesion of soil sample collected from two different sites (Kakri Ghat and Salri Site) with varying numbers of tree per 150sqm. The curve highlighted that the cohesion of soil specimen from Kakri Ghat and Salri Site are increase with increases the number of tree per 150sqm from five and four number of tree respectively. Further, as the increase the tree density up to seven the cohesion value start to decrease for two sites respectively. This is decreases because the root in soil sample increase and the bonding between root and soil system is less.

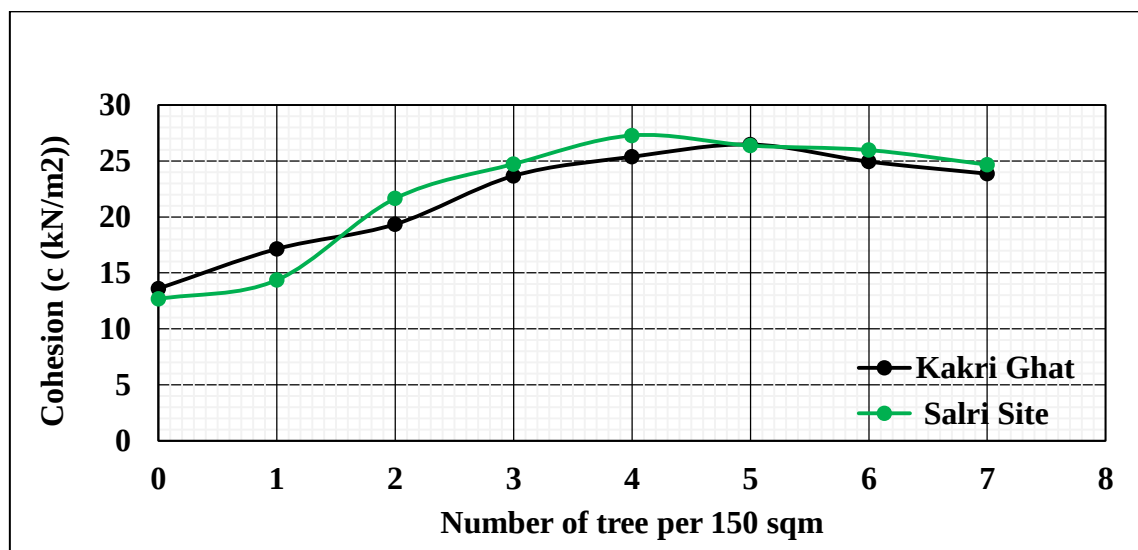


Fig. 4.10 Variation of cohesion (c) of soil samples collected from Kakri Ghat and Salri Site with varying number of tree per 150 sqm

4.5 Slope Stability Analysis

Slope stability analysis is performed to assess the safe design of a human-made or natural slopes (e.g. embankments, road cuts, open-pit mining, excavations, landfills etc.) and the equilibrium conditions. Slope stability is the resistance of inclined surface

to failure by sliding or collapsing. The main objectives of slope stability analysis are finding endangered areas, investigation of potential failure mechanisms, determination of the slope sensitivity to different triggering mechanisms, designing of optimal slopes with regard to safety, reliability and economics, designing possible remedial measures, e.g. barriers and stabilization. The analysis of is conducted by Swedish Slip Circle method and Bishop's method.

4.5.1 Swedish Slip Circle Method

The Fellenius (1936) method is the simplest method of slope stability analysis which is also known as ordinary or Swedish circle method. Interslice forces are neglected in this method. This method deals with moment equilibrium only and neglects force equilibrium. Hence factor of safety (FOS) obtained is the moment factor of safety. For purely cohesive soil (*i.e.* $\phi_u = 0$), maximum resisting moment available is equal to the summation of the cohesive strengths multiplied by the areas or lengths over which they act and radius of slip circle.

$$M_R = R \sum l c_u$$

In comparison, the overturning moment is simply defined as the sum of Slice weights multiplied by the distance of their centroids from center of the slip circle, measured horizontally.

$$M_O = \sum Wx$$

These two moments are expressed as a Ratio to determine factor of safety.

$$F = \frac{M_R}{M_O}$$

For c - ϕ soil the FOS is given as

$$F = \frac{\sum (c_u l + N * \tan \phi)}{\sum W \sin \alpha}$$

Where, $N = W \cos \alpha$

4.5.2 Bishop's Method

Bishop (1955) assumed only horizontal forces (*i.e.* No shear stresses between slices) acting on the sides of the slices, which were neglected in the Swedish method. This method neglects the inter slices shear forces but considers the normal inter slice

forces and also considers the pore pressure acting on the slices. This is one of the versatile methods for calculating the factor of safety of the slope. This method also satisfy vertical force equilibrium to determine the base normal force. The expression for normal forces is given by

$$N = \frac{W - \left(\frac{1}{F}\right) (cl - ul \tan\phi) \sin\alpha}{\cos\alpha + \frac{(\sin\alpha * \tan\phi)}{F}}$$

The factor of safety is defined as the ratio of resisting moment to the driving moment and the expression is given as

$$F = \sum \frac{\frac{(cl \cos\alpha + (W - ul \cos\alpha) \tan\phi)}{\cos\alpha + \frac{\sin\alpha \tan\phi}{F}}}{W \sin\alpha}$$

Where,

c = cohesion

L = b sec α (b = width of Slices)

W = weight of Slices

F = factor of safety

ϕ = angle of internal friction

α = angle which slices made with horizontal

N= base normal force

Salient features of Bishop's method

- Considers interslice normal force.
- Satisfy moment equilibrium for factory of safety.
- Satisfy vertical forces equilibrium for N.
- More common in practice and applied mostly for circular shear surfaces and for homogeneous soil slopes (*e.g.* embankment of highways and railways).

The analysis of slope stability has been conducted by Swedish Slip Circle and Bishop's methods to determine the factory of safety (FOS) with the excel spread sheets. The results are given below in tabulated from. Geostudio 2019 (slope/w) software was also used to analyze the slope stability for Kakri Ghat of slope angle 60 degree by Swedish Method.

Table 4.5 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height(m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.48	22.29	64.75	24.86	57.87	0.78
	2	0.44	4.00	273.92	115.76	248.26	95.33	60.38	
	3	0.58	6.00	410.88	223.78	344.59	132.32	65.25	
	4	0.72	7.00	479.36	314.49	361.78	138.92	72.50	
	5	0.87	7.50	513.60	393.44	330.14	126.77	85.13	
	6	1.05	4.00	273.92	237.22	136.96	52.59	109.44	
					1306.99		570.80	450.57	
2	1	0.40	1.00	59.92	23.41	55.16	21.18	52.01	0.95
	2	0.52	2.50	149.80	74.90	129.73	49.82	55.29	
	3	0.63	4.00	239.68	140.88	193.91	74.46	59.18	
	4	0.77	4.50	269.64	187.31	193.96	74.48	66.56	
	5	0.91	4.00	239.68	188.87	147.56	56.66	77.77	
	6	1.08	2.50	149.80	132.27	70.33	27.01	101.99	
					747.64		303.61	412.80	
3	1	0.42	1.00	77.04	31.33	70.38	27.03	67.39	0.87
	2	0.49	4.00	268.78	126.19	237.32	91.13	69.72	
	3	0.56	6.00	403.18	213.65	341.91	131.29	72.59	
	4	0.68	7.50	503.97	317.16	391.66	150.40	79.21	
	5	0.79	8.00	537.57	380.12	380.12	145.97	87.06	
	6	0.87	3.00	201.59	154.43	129.58	49.76	95.77	
					1222.87		595.57	471.74	

Table 4.6 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.52	22.31	64.79	27.47	72.51	0.91
	2	0.44	4.00	274.08	115.83	248.40	105.32	75.65	
	3	0.58	6.00	411.12	223.91	344.79	146.19	81.75	
	4	0.72	7.00	479.64	314.67	361.99	153.48	90.84	
	5	0.87	7.50	513.90	393.67	330.33	140.06	106.66	
	6	1.05	4.00	274.08	237.36	137.04	58.10	137.12	
					1307.75		630.63	564.53	
2	1	0.40	1.00	59.96	23.43	55.19	23.40	65.17	1.13
	2	0.52	2.50	149.89	74.94	129.81	55.04	69.27	
	3	0.63	4.00	239.82	140.96	194.02	82.26	74.15	
	4	0.77	4.50	269.80	187.42	194.08	82.29	83.40	
	5	0.91	4.00	239.82	188.98	147.65	62.60	97.44	
	6	1.08	2.50	149.89	132.34	70.37	29.84	127.78	
					748.07		335.43	517.21	
3	1	0.42	1.00	77.09	31.35	70.42	29.86	84.43	0.95
	2	0.49	4.00	308.34	144.76	272.25	115.43	87.36	
	3	0.56	6.00	462.51	245.09	392.23	166.31	90.95	
	4	0.68	7.50	578.14	363.83	449.30	190.50	99.25	
	5	0.79	8.00	616.68	436.06	436.06	184.89	109.08	
	6	0.87	3.00	231.26	177.15	148.65	63.03	119.99	
					1398.25		750.01	591.05	

Table 4.7 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.60	22.33	64.86	26.20	81.86	0.94
	2	0.44	4.00	274.40	115.97	248.69	100.47	85.40	
	3	0.58	6.00	411.60	224.17	345.20	139.46	92.29	
	4	0.72	7.00	480.20	315.04	362.41	146.41	102.56	
	5	0.87	7.50	514.50	394.13	330.71	133.61	120.41	
	6	1.05	4.00	274.40	237.64	137.20	55.43	154.80	
					1309.28		601.59	637.32	
2	1	0.40	1.00	60.03	23.45	55.25	22.32	73.57	1.20
	2	0.52	2.50	149.80	74.90	129.73	52.41	78.20	
	3	0.63	4.00	239.68	140.88	193.91	78.34	83.71	
	4	0.77	4.50	269.64	187.31	193.96	78.36	94.15	
	5	0.91	4.00	239.68	188.87	147.56	59.61	110.00	
	6	1.08	2.50	149.80	132.27	70.33	28.41	144.26	
					747.68		319.46	583.90	
3	1	0.42	1.00	77.18	31.39	70.50	28.48	95.32	0.98
	2	0.49	4.00	308.70	144.93	272.57	110.12	98.62	
	3	0.56	6.00	463.05	245.38	392.69	158.65	102.68	
	4	0.68	7.50	578.81	364.26	449.82	181.73	112.04	
	5	0.79	8.00	617.40	436.57	436.57	176.37	123.14	
	6	0.87	3.00	231.53	177.36	148.82	60.12	135.46	
					1399.88		715.47	667.26	

Table 4.8 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.68	22.36	64.94	28.90	100.14	1.10
	2	0.44	4.00	274.72	116.10	248.98	110.80	104.47	
	3	0.58	6.00	412.08	224.43	345.60	153.79	112.89	
	4	0.72	7.00	480.76	315.41	362.83	161.46	125.45	
	5	0.87	7.50	515.10	394.59	331.10	147.34	147.30	
	6	1.05	4.00	274.72	237.91	137.36	61.13	189.36	
					1310.81		663.41	779.60	
2	1	0.40	1.00	60.10	23.48	55.32	24.62	90.00	1.42
	2	0.52	2.50	150.24	75.12	130.11	57.90	95.66	
	3	0.63	4.00	240.38	141.29	194.47	86.54	102.40	
	4	0.77	4.50	270.43	187.85	194.53	86.57	115.17	
	5	0.91	4.00	240.38	189.42	147.99	65.86	134.56	
	6	1.08	2.50	150.24	132.65	70.53	31.39	176.46	
					749.82		352.86	714.26	
3	1	0.42	1.00	77.27	31.43	70.59	31.41	116.60	1.15
	2	0.49	4.00	309.06	145.09	272.88	121.43	120.64	
	3	0.56	6.00	463.59	245.67	393.15	174.95	125.60	
	4	0.68	7.50	579.49	364.68	450.35	200.40	137.06	
	5	0.79	8.00	618.12	437.08	437.08	194.50	150.63	
	6	0.87	3.00	231.80	177.57	148.99	66.30	165.71	
					1401.51		789.00	816.23	

Table 4.9 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T=W* (Sin α)	N=W (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.76	22.39	65.01	31.73	107.33	1.19
	2	0.44	4.00	275.04	116.24	249.27	121.64	111.97	
	3	0.58	6.00	412.56	224.70	346.00	168.85	121.00	
	4	0.72	7.00	481.32	315.77	363.26	177.27	134.46	
	5	0.87	7.50	515.70	395.05	331.49	161.76	157.87	
	6	1.05	4.00	275.04	238.19	137.52	67.11	202.96	
					1312.33		728.36	835.60	
2	1	0.40	1.00	60.17	23.51	55.38	27.03	96.46	1.53
	2	0.52	2.50	150.41	75.21	130.26	63.57	102.53	
	3	0.63	4.00	240.66	141.46	194.70	95.01	109.76	
	4	0.77	4.50	270.74	188.07	194.76	95.04	123.44	
	5	0.91	4.00	240.66	189.64	148.17	72.30	144.23	
	6	1.08	2.50	150.41	132.81	70.61	34.46	189.14	
					750.69		387.41	765.56	
3	1	0.42	1.00	77.36	31.46	70.67	34.49	124.97	1.24
	2	0.49	4.00	309.42	145.26	273.20	133.32	129.30	
	3	0.56	6.00	464.13	245.95	393.60	192.08	134.62	
	4	0.68	7.50	580.16	365.11	450.87	220.03	146.90	
	5	0.79	8.00	618.84	437.59	437.59	213.54	161.45	
	6	0.87	3.00	232.07	177.77	149.17	72.79	177.61	
					1403.14		866.25	874.86	

Table 4.10 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.84	22.41	65.09	30.33	111.98	1.19
	2	0.44	4.00	275.36	116.37	249.56	116.30	116.83	
	3	0.58	6.00	413.04	224.96	346.40	161.42	126.25	
	4	0.72	7.00	481.88	316.14	363.68	169.47	140.29	
	5	0.87	7.50	516.30	395.51	331.87	154.65	164.72	
	6	1.05	4.00	275.36	238.47	137.68	64.16	211.76	
					1313.86		696.34	871.83	
2	1	0.40	1.00	60.24	23.54	55.45	25.84	100.65	1.55
	2	0.52	2.50	150.59	75.29	130.41	60.77	106.98	
	3	0.63	4.00	240.94	141.62	194.92	90.83	114.52	
	4	0.77	4.50	271.06	188.29	194.98	90.86	128.79	
	5	0.91	4.00	240.94	189.86	148.34	69.13	150.48	
	6	1.08	2.50	150.59	132.96	70.70	32.94	197.34	
					751.57		370.38	798.75	
3	1	0.42	1.00	77.45	31.50	70.75	32.97	130.39	1.23
	2	0.49	4.00	309.78	145.43	273.52	127.46	134.91	
	3	0.56	6.00	464.67	246.24	394.06	183.63	140.46	
	4	0.68	7.50	580.84	365.53	451.40	210.35	153.27	
	5	0.79	8.00	619.56	438.10	438.10	204.15	168.45	
	6	0.87	3.00	232.34	177.98	149.34	69.59	185.31	
					1404.78		828.16	912.79	

Table 4.11 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.92	22.44	65.17	29.00	105.51	1.13
	2	0.44	4.00	275.68	116.51	249.85	111.18	110.07	
	3	0.58	6.00	413.52	225.22	346.81	154.33	118.95	
	4	0.72	7.00	482.44	316.51	364.10	162.03	132.18	
	5	0.87	7.50	516.90	395.97	332.26	147.85	155.20	
	6	1.05	4.00	275.68	238.75	137.84	61.34	199.52	
					1315.39		665.73	821.43	
2	1	0.40	1.00	60.31	23.56	55.51	24.70	94.83	1.47
	2	0.52	2.50	150.76	75.38	130.56	58.10	100.79	
	3	0.63	4.00	241.22	141.79	195.15	86.84	107.90	
	4	0.77	4.50	271.37	188.51	195.21	86.87	121.35	
	5	0.91	4.00	241.22	190.08	148.51	66.09	141.78	
	6	1.08	2.50	150.76	133.12	70.78	31.50	185.93	
					752.44		354.10	752.58	
3	1	0.42	1.00	77.54	31.54	70.83	31.52	122.85	1.17
	2	0.49	4.00	310.14	145.60	273.84	121.86	127.11	
	3	0.56	6.00	465.21	246.52	394.52	175.56	132.34	
	4	0.68	7.50	581.51	365.96	451.92	201.10	144.41	
	5	0.79	8.00	620.28	438.60	438.60	195.18	158.72	
	6	0.87	3.00	232.61	178.19	149.52	66.53	174.60	
					1406.41		791.76	860.03	

Table 4.12 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm at 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	1.00	68.92	22.44	65.17	29.00	105.51	1.13
	2	0.44	4.00	275.68	116.51	249.85	111.18	110.07	
	3	0.58	6.00	413.52	225.22	346.81	154.33	118.95	
	4	0.72	7.00	482.44	316.51	364.10	162.03	132.18	
	5	0.87	7.50	516.90	395.97	332.26	147.85	155.20	
	6	1.05	4.00	275.68	238.75	137.84	61.34	199.52	
					1315.39		665.73	821.43	
2	1	0.40	1.00	60.31	23.56	55.51	24.70	94.83	1.47
	2	0.52	2.50	150.76	75.38	130.56	58.10	100.79	
	3	0.63	4.00	241.22	141.79	195.15	86.84	107.90	
	4	0.77	4.50	271.37	188.51	195.21	86.87	121.35	
	5	0.91	4.00	241.22	190.08	148.51	66.09	141.78	
	6	1.08	2.50	150.76	133.12	70.78	31.50	185.93	
					752.44		354.10	752.58	
3	1	0.419	1	77.535	31.536	70.832	31.520	122.851	1.174
	2	0.489	4	310.140	145.602	273.837	121.858	127.108	
	3	0.559	6	465.210	246.524	394.520	175.562	132.339	
	4	0.681	7.5	581.513	365.958	451.920	201.104	144.413	
	5	0.785	8	620.280	438.604	438.604	195.179	158.717	
	6	0.873	3	232.605	178.186	149.516	66.534	174.599	
					1406.410		791.757	860.028	

Table 4.13 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.48	27.85	62.56	24.02	59.90	0.77
	2	0.52	4.00	273.92	136.96	237.22	91.09	63.19	
	3	0.59	6.50	445.12	248.91	369.02	141.70	66.00	
	4	0.70	8.50	582.08	374.15	445.90	171.23	71.43	
	5	0.82	8.00	547.84	400.66	373.63	143.47	80.23	
	6	0.96	3.00	205.44	168.29	117.84	45.25	95.40	
					1356.83		616.77	436.16	
2	1	0.45	1.00	59.92	26.27	53.86	20.68	53.27	0.78
	2	0.52	3.50	209.72	104.86	181.62	69.74	55.29	
	3	0.63	6.00	359.52	211.32	290.86	111.69	59.18	
	4	0.75	6.50	389.48	265.62	284.85	109.38	65.47	
	5	0.87	7.00	419.44	321.31	269.61	103.53	74.49	
	6	1.05	3.00	179.76	155.68	89.88	34.51	95.76	
					1085.06		449.54	403.46	
3	1	0.28	2.00	154.08	42.47	148.11	56.87	64.04	0.81
	2	0.40	6.00	403.18	157.53	371.13	142.51	66.88	
	3	0.52	9.00	604.76	302.38	523.74	201.12	71.08	
	4	0.65	12.00	806.35	485.27	643.98	247.29	77.08	
	5	0.79	9.50	638.36	451.39	451.39	173.33	87.06	
	6	0.98	4.00	268.78	222.83	150.30	57.72	110.09	
					1661.88		878.84	476.23	

Table 4.14 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm at 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.52	27.87	62.60	26.54	75.05	0.90
	2	0.52	4.00	274.08	137.04	237.36	100.64	79.17	
	3	0.59	6.50	445.38	249.05	369.24	156.56	82.70	
	4	0.70	8.50	582.42	374.37	446.16	189.17	89.50	
	5	0.82	8.00	548.16	400.90	373.84	158.51	100.53	
	6	0.96	3.00	205.56	168.38	117.90	49.99	119.53	
					1357.62		681.41	546.47	
2	1	0.45	1.00	59.96	26.28	53.89	22.85	66.74	0.92
	2	0.52	3.50	209.84	104.92	181.73	77.05	69.27	
	3	0.63	6.00	359.73	211.44	291.03	123.40	74.15	
	4	0.75	6.50	389.71	265.78	285.01	120.85	82.03	
	5	0.87	7.00	419.69	321.50	269.77	114.38	93.33	
	6	1.05	3.00	179.87	155.77	89.93	38.13	119.98	
					1085.69		496.66	505.50	
3	1	0.28	2.00	154.17	42.50	148.20	62.84	80.24	0.89
	2	0.40	6.00	462.51	180.72	425.74	180.51	83.79	
	3	0.52	9.00	693.77	346.88	600.82	254.75	89.06	
	4	0.65	12.00	925.02	556.69	738.75	313.23	96.58	
	5	0.79	9.50	732.31	517.82	517.82	219.56	109.08	
	6	0.98	4.00	308.34	255.63	172.42	73.11	137.93	
					1900.23		1103.99	596.68	

Table 4.15 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.60	27.90	62.67	25.32	84.72	0.93
	2	0.52	4.00	274.40	137.20	237.64	96.01	89.37	
	3	0.59	6.50	445.90	249.34	369.67	149.35	93.36	
	4	0.70	8.50	583.10	374.81	446.68	180.46	101.04	
	5	0.82	8.00	548.80	401.37	374.28	151.21	113.49	
	6	0.96	3.00	205.80	168.58	118.04	47.69	134.94	
					1359.20		650.03	616.93	
2	1	0.45	1.00	60.03	26.31	53.95	21.80	75.35	0.96
	2	0.52	3.50	209.72	104.86	181.62	73.38	78.20	
	3	0.63	6.00	359.52	211.32	290.86	117.51	83.71	
	4	0.75	6.50	389.48	265.62	284.85	115.08	92.60	
	5	0.87	7.00	419.44	321.31	269.61	108.92	105.36	
	6	1.05	3.00	179.76	155.68	89.88	36.31	135.45	
					1085.10		472.99	570.68	
3	1	0.28	2.00	154.35	42.54	148.37	59.94	90.58	0.90
	2	0.40	6.00	463.05	180.93	426.24	172.20	94.59	
	3	0.52	9.00	694.58	347.29	601.52	243.01	100.55	
	4	0.65	12.00	926.10	557.34	739.62	298.81	109.03	
	5	0.79	9.50	733.16	518.42	518.42	209.44	123.14	
	6	0.98	4.00	308.70	255.92	172.62	69.74	155.72	
					1902.45		1053.14	673.61	

Table 4.16 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.68	27.93	62.74	27.92	103.64	1.08
	2	0.52	4.00	274.72	137.36	237.91	105.87	109.33	
	3	0.59	6.50	446.42	249.63	370.10	164.69	114.20	
	4	0.70	8.50	583.78	375.25	447.20	199.00	123.60	
	5	0.82	8.00	549.44	401.83	374.72	166.75	138.83	
	6	0.96	3.00	206.04	168.78	118.18	52.59	165.07	
					1360.79		716.83	754.66	
2	1	0.45	1.00	60.10	26.34	54.01	24.04	92.17	1.12
	2	0.52	3.50	210.33	105.17	182.15	81.06	95.66	
	3	0.63	6.00	360.57	211.94	291.71	129.81	102.40	
	4	0.75	6.50	390.62	266.40	285.68	127.13	113.28	
	5	0.87	7.00	420.67	322.25	270.40	120.33	128.88	
	6	1.05	3.00	180.29	156.13	90.14	40.11	165.69	
					1088.23		522.47	698.09	
3	1	0.28	2.00	154.53	42.59	148.54	66.10	110.81	1.04
	2	0.40	6.00	463.59	181.14	426.74	189.90	115.71	
	3	0.52	9.00	695.39	347.69	602.22	267.99	122.99	
	4	0.65	12.00	927.18	557.99	740.48	329.51	133.37	
	5	0.79	9.50	734.02	519.03	519.03	230.97	150.63	
	6	0.98	4.00	309.06	256.22	172.82	76.91	190.48	
					1904.67		1161.38	824.00	

Table 4.17 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.76	27.97	62.82	30.65	111.08	1.17
	2	0.52	4.00	275.04	137.52	238.19	116.24	117.18	
	3	0.59	6.50	446.94	249.93	370.53	180.82	122.41	
	4	0.70	8.50	584.46	375.68	447.72	218.49	132.47	
	5	0.82	8.00	550.08	402.30	375.15	183.07	148.80	
	6	0.96	3.00	206.28	168.97	118.32	57.74	176.92	
					1362.37		787.01	808.87	
2	1	0.45	1.00	60.17	26.37	54.08	26.39	98.79	1.21
	2	0.52	3.50	210.58	105.29	182.37	88.99	102.53	
	3	0.63	6.00	360.99	212.18	292.05	142.52	109.76	
	4	0.75	6.50	391.07	266.71	286.01	139.57	121.41	
	5	0.87	7.00	421.16	322.62	270.71	132.11	138.14	
	6	1.05	3.00	180.50	156.31	90.25	44.04	177.59	
					1089.50		573.63	748.22	
3	1	0.28	2.00	154.71	42.64	148.72	72.57	118.77	1.13
	2	0.40	6.00	464.13	181.35	427.23	208.49	124.02	
	3	0.52	9.00	696.20	348.10	602.92	294.23	131.83	
	4	0.65	12.00	928.26	558.64	741.34	361.77	142.95	
	5	0.79	9.50	734.87	519.63	519.63	253.58	161.45	
	6	0.98	4.00	309.42	256.52	173.03	84.44	204.16	
					1906.89		1275.08	883.18	

Table 4.18 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.84	28.00	62.89	29.31	115.90	1.17
	2	0.52	4.00	275.36	137.68	238.47	111.13	122.26	
	3	0.59	6.50	447.46	250.22	370.96	172.87	127.71	
	4	0.70	8.50	585.14	376.12	448.24	208.88	138.22	
	5	0.82	8.00	550.72	402.77	375.59	175.03	155.25	
	6	0.96	3.00	206.52	169.17	118.46	55.20	184.60	
					1363.96		752.41	843.94	
2	1	0.45	1.00	60.24	26.41	54.14	25.23	103.08	1.21
	2	0.52	3.50	210.82	105.41	182.58	85.08	106.98	
	3	0.63	6.00	361.41	212.43	292.39	136.25	114.52	
	4	0.75	6.50	391.53	267.02	286.35	133.44	126.68	
	5	0.87	7.00	421.65	323.00	271.03	126.30	144.13	
	6	1.05	3.00	180.71	156.50	90.35	42.10	185.29	
					1090.763		548.402	780.666	
3	1	0.28	2.00	154.89	42.69	148.89	69.38	123.92	1.12
	2	0.40	6.00	464.67	181.56	427.73	199.32	129.40	
	3	0.52	9.00	697.01	348.50	603.62	281.29	137.54	
	4	0.65	12.00	929.34	559.29	742.20	345.87	149.15	
	5	0.79	9.50	735.73	520.24	520.24	242.43	168.45	
	6	0.98	4.00	309.78	256.82	173.23	80.72	213.01	
					1909.10		1219.02	921.47	

Table 4.19 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	68.92	28.03	62.96	28.02	109.20	1.11
	2	0.52	4.00	275.68	137.84	238.75	106.24	115.19	
	3	0.59	6.50	447.98	250.51	371.39	165.27	120.33	
	4	0.70	8.50	585.82	376.56	448.76	199.70	130.23	
	5	0.82	8.00	551.36	403.24	376.03	167.33	146.28	
	6	0.96	3.00	206.76	169.37	118.59	52.77	173.93	
					1365.54		719.33	795.16	
2	1	0.45	1.00	60.31	26.44	54.20	24.12	97.12	1.15
	2	0.52	3.50	211.07	105.53	182.79	81.34	100.79	
	3	0.63	6.00	361.83	212.68	292.73	130.26	107.90	
	4	0.75	6.50	391.98	267.33	286.68	127.57	119.35	
	5	0.87	7.00	422.14	323.37	271.34	120.75	135.80	
	6	1.05	3.00	180.92	156.68	90.46	40.25	174.58	
					1092.03		524.30	735.54	
3	1	0.28	2.00	155.07	42.74	149.06	66.33	116.75	1.06
	2	0.40	6.00	465.21	181.77	428.23	190.56	121.92	
	3	0.52	9.00	697.82	348.91	604.33	268.92	129.59	
	4	0.65	12.00	930.42	559.94	743.07	330.66	140.53	
	5	0.79	9.50	736.58	520.84	520.84	231.77	158.72	
	6	0.98	4.00	310.14	257.12	173.43	77.18	200.70	
					1911.32		1165.43	868.21	

Table 4.20 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	1.00	69.00	28.06	63.03	26.73	104.47	1.05
	2	0.52	4.00	276.00	138.00	239.02	101.35	110.20	
	3	0.59	6.50	448.50	250.80	371.82	157.65	115.12	
	4	0.70	8.50	586.50	376.99	449.29	190.50	124.59	
	5	0.82	8.00	552.00	403.71	376.46	159.62	139.94	
	6	0.96	3.00	207.00	169.56	118.73	50.34	166.39	
					1367.13		686.18	760.72	
2	1	0.45	1.00	60.38	26.47	54.26	23.01	92.91	1.10
	2	0.52	3.50	211.31	105.66	183.00	77.59	96.43	
	3	0.63	6.00	362.25	212.93	293.07	124.26	103.22	
	4	0.75	6.50	392.44	267.64	287.01	121.69	114.19	
	5	0.87	7.00	422.63	323.75	271.66	115.18	129.92	
	6	1.05	3.00	181.13	156.86	90.56	38.40	167.02	
					1093.30		500.14	703.69	
3	1	0.28	2.00	155.25	42.79	149.24	63.28	111.70	1.01
	2	0.40	6.00	465.75	181.98	428.73	181.78	116.64	
	3	0.52	9.00	698.63	349.31	605.03	256.53	123.98	
	4	0.65	12.00	931.50	560.59	743.93	315.43	134.44	
	5	0.79	9.50	737.44	521.45	521.45	221.09	151.84	
	6	0.98	4.00	310.50	257.42	173.63	73.62	192.01	
					1913.54		1111.73	830.61	

Table 4.21 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	59.92	26.27	53.86	20.68	53.27	0.71
	2	0.52	4.00	239.68	119.84	207.57	79.71	55.29	
	3	0.63	7.00	419.44	246.54	339.33	130.30	59.18	
	4	0.73	9.00	539.28	360.85	400.76	153.89	64.43	
	5	0.87	8.50	509.32	390.16	327.38	125.72	74.49	
	6	1.01	3.50	209.72	177.85	111.13	42.68	90.35	
					1321.51		552.98	397.01	
2	1	0.37	2.50	171.20	61.35	159.83	61.37	58.61	0.74
	2	0.47	6.00	410.88	186.54	366.10	140.58	61.41	
	3	0.58	9.00	616.32	335.67	516.89	198.49	65.25	
	4	0.70	12.00	821.76	528.22	629.50	241.73	71.43	
	5	0.84	8.00	547.84	407.12	366.58	140.77	81.78	
	6	0.99	3.00	205.44	172.30	111.89	42.97	100.47	
					1691.20		825.90	438.95	
3	1	0.54	1.00	51.36	26.45	44.02	16.91	47.88	0.72
	2	0.63	3.00	154.08	90.57	124.65	47.87	50.73	
	3	0.72	5.00	256.80	168.48	193.81	74.42	54.38	
	4	0.82	6.50	333.84	244.16	227.68	87.43	60.18	
	5	0.93	7.50	385.20	307.63	231.82	89.02	68.19	
	6	1.08	3.50	179.76	158.72	84.39	32.41	87.42	
					996.00		348.05	368.77	

Table 4.22 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.03	26.31	53.95	22.87	66.74	0.83
	2	0.52	4.00	240.10	120.05	207.93	88.16	69.27	
	3	0.63	7.00	420.18	246.97	339.93	144.13	74.15	
	4	0.73	9.00	540.23	361.48	401.47	170.22	80.72	
	5	0.87	8.50	510.21	390.85	327.96	139.05	93.33	
	6	1.01	3.50	210.09	178.16	111.33	47.20	113.21	
					1323.83		611.65	497.43	
2	1	0.37	2.50	171.30	61.39	159.92	67.81	73.44	0.86
	2	0.47	6.00	411.12	186.64	366.31	155.32	76.95	
	3	0.58	9.00	616.68	335.87	517.19	219.29	81.75	
	4	0.70	12.00	822.24	528.53	629.87	267.07	89.50	
	5	0.84	8.00	548.16	407.36	366.79	155.52	102.46	
	6	0.99	3.00	205.56	172.40	111.96	47.47	125.88	
					1692.19		912.47	549.97	
3	1	0.54	1.00	51.39	26.47	44.05	18.68	59.99	0.84
	2	0.63	3.00	154.17	90.62	124.73	52.88	63.56	
	3	0.72	5.00	256.95	168.57	193.92	82.22	68.13	
	4	0.82	6.50	334.04	244.30	227.81	96.59	75.40	
	5	0.93	7.50	385.43	307.81	231.95	98.35	85.44	
	6	1.08	3.50	179.87	158.81	84.44	35.80	109.53	
					996.58		384.53	462.04	

Table 4.23 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.03	26.31	53.95	21.80	75.35	0.86
	2	0.52	4.00	240.10	120.05	207.93	84.00	78.20	
	3	0.63	7.00	420.18	246.97	339.93	137.33	83.71	
	4	0.73	9.00	540.23	361.48	401.47	162.19	91.13	
	5	0.87	8.50	510.21	390.85	327.96	132.50	105.36	
	6	1.01	3.50	210.09	178.16	111.33	44.98	127.80	
					1323.83		582.80	561.56	
2	1	0.37	2.50	171.50	61.46	160.11	64.68	82.91	0.88
	2	0.47	6.00	411.60	186.86	366.74	148.16	86.87	
	3	0.58	9.00	617.40	336.26	517.80	209.19	92.29	
	4	0.70	12.00	823.20	529.14	630.61	254.77	101.04	
	5	0.84	8.00	548.80	407.84	367.22	148.36	115.67	
	6	0.99	3.00	205.80	172.60	112.09	45.28	142.11	
					1694.16		870.44	620.89	
3	1	0.54	1.00	51.45	26.50	44.10	17.82	67.72	0.89
	2	0.63	3.00	154.35	90.72	124.87	50.45	71.75	
	3	0.72	5.00	257.25	168.77	194.15	78.44	76.92	
	4	0.82	6.50	334.43	244.58	228.08	92.14	85.12	
	5	0.93	7.50	385.88	308.17	232.23	93.82	96.46	
	6	1.08	3.50	180.08	159.00	84.54	34.15	123.65	
					997.748		366.818	521.61 9	

Table 4.24 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.10	26.34	54.01	24.04	92.17	1.00
	2	0.52	4.00	240.38	120.19	208.18	92.64	95.66	
	3	0.63	7.00	420.67	247.26	340.33	151.44	102.40	
	4	0.73	9.00	540.86	361.90	401.93	178.86	111.48	
	5	0.87	8.50	510.81	391.30	328.34	146.11	128.88	
	6	1.01	3.50	210.33	178.37	111.46	49.60	156.34	
					1325.37		642.69	686.93	
2	1	0.37	2.50	171.70	61.53	160.30	71.33	101.42	1.01
	2	0.47	6.00	412.08	187.08	367.17	163.39	106.26	
	3	0.58	9.00	618.12	336.65	518.40	230.69	112.89	
	4	0.70	12.00	824.16	529.76	631.34	280.95	123.60	
	5	0.84	8.00	549.44	408.31	367.65	163.60	141.50	
	6	0.99	3.00	206.04	172.80	112.22	49.94	173.84	
					1696.14		959.90	759.50	
3	1	0.54	1.00	51.51	26.53	44.15	19.65	67.72	0.92
	2	0.63	3.00	154.53	90.83	125.02	55.63	71.75	
	3	0.72	5.00	257.55	168.97	194.38	86.50	76.92	
	4	0.82	6.50	334.82	244.87	228.34	101.61	85.12	
	5	0.93	7.50	386.33	308.53	232.50	103.46	96.46	
	6	1.08	3.50	180.29	159.18	84.64	37.66	123.65	
					998.91		404.52	521.62	

Table 4.25 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.17	26.37	54.08	26.39	98.79	1.08
	2	0.52	4.00	240.66	120.33	208.42	101.71	102.53	
	3	0.63	7.00	421.16	247.55	340.72	166.27	109.76	
	4	0.73	9.00	541.49	362.32	402.40	196.37	119.49	
	5	0.87	8.50	511.40	391.76	328.72	160.42	138.14	
	6	1.01	3.50	210.58	178.58	111.59	54.46	167.56	
					1326.91		705.61	736.27	
2	1	0.37	2.50	171.90	61.60	160.48	78.32	108.70	1.10
	2	0.47	6.00	412.56	187.30	367.59	179.39	113.89	
	3	0.58	9.00	618.84	337.04	519.00	253.27	121.00	
	4	0.70	12.00	825.12	530.38	632.08	308.45	132.47	
	5	0.84	8.00	550.08	408.79	368.08	179.62	151.66	
	6	0.99	3.00	206.28	173.00	112.35	54.83	186.33	
					1698.11		1053.88	814.05	
3	1	0.54	1.00	51.57	26.56	44.20	21.57	88.79	1.12
	2	0.63	3.00	154.71	90.94	125.16	61.08	94.08	
	3	0.72	5.00	257.85	169.16	194.60	94.97	100.85	
	4	0.82	6.50	335.21	245.15	228.61	111.56	111.60	
	5	0.93	7.50	386.78	308.89	232.77	113.59	126.47	
	6	1.08	3.50	180.50	159.37	84.74	41.35	162.12	
					1000.07		444.12	683.90	

Table 4.26 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
	1	0.45	1.00	60.24	26.41	54.14	25.23	103.08	1.08
	2	0.52	4.00	240.94	120.47	208.66	97.24	106.98	
	3	0.63	7.00	421.65	247.84	341.12	158.96	114.52	
	4	0.73	9.00	542.12	362.75	402.87	187.74	124.67	
	5	0.87	8.50	512.00	392.21	329.11	153.36	144.13	
	6	1.01	3.50	210.82	178.79	111.72	52.06	174.83	
					1328.46		674.59	768.19	
	1	0.37	2.50	172.10	61.68	160.67	74.87	113.41	1.09
	2	0.47	6.00	413.04	187.52	368.02	171.50	118.83	
	3	0.58	9.00	619.56	337.44	519.61	242.14	126.25	
	4	0.70	12.00	826.08	530.99	632.81	294.89	138.22	
	5	0.84	8.00	550.72	409.26	368.50	171.72	158.24	
	6	0.99	3.00	206.52	173.20	112.48	52.42	194.40	
					1700.09		1007.54	849.35	
	1	0.54	1.00	51.63	26.59	44.26	20.62	92.64	1.13
	2	0.63	3.00	154.89	91.04	125.31	58.39	98.16	
	3	0.72	5.00	258.15	169.36	194.83	90.79	105.22	
	4	0.82	6.50	335.60	245.44	228.88	106.66	116.44	
	5	0.93	7.50	387.23	309.25	233.04	108.60	131.95	
	6	1.08	3.50	180.71	159.55	84.84	39.53	169.15	
					1001.24		424.59	713.55	

Table 4.27 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.31	26.44	54.20	24.12	97.12	1.02
	2	0.52	4.00	241.22	120.61	208.90	92.96	100.79	
	3	0.63	7.00	422.14	248.12	341.51	151.97	107.90	
	4	0.73	9.00	542.75	363.17	403.34	179.49	117.46	
	5	0.87	8.50	512.59	392.67	329.49	146.62	135.80	
	6	1.01	3.50	211.07	179.00	111.85	49.77	164.72	
					1330.00		644.94	723.79	
2	1	0.37	2.50	172.30	61.75	160.86	71.58	106.86	1.03
	2	0.47	6.00	413.52	187.73	368.45	163.96	111.96	
	3	0.58	9.00	620.28	337.83	520.21	231.49	118.95	
	4	0.70	12.00	827.04	531.61	633.55	281.93	130.23	
	5	0.84	8.00	551.36	409.74	368.93	164.17	149.09	
	6	0.99	3.00	206.76	173.40	112.61	50.11	183.17	
					1702.06		963.25	800.25	
3	1	0.54	1.00	51.69	26.62	44.31	19.72	87.29	1.07
	2	0.63	3.00	155.07	91.15	125.45	55.83	92.48	
	3	0.72	5.00	258.45	169.56	195.05	86.80	99.14	
	4	0.82	6.50	335.99	245.72	229.14	101.97	109.71	
	5	0.93	7.50	387.68	309.61	233.31	103.82	124.32	
	6	1.08	3.50	180.92	159.74	84.93	37.80	159.37	
					1002.40		405.93	672.31	

Table 4.28 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.45	1.00	60.38	26.47	54.26	23.01	92.91	0.98
	2	0.52	4.00	241.50	120.75	209.15	88.68	96.43	
	3	0.63	7.00	422.63	248.41	341.91	144.97	103.22	
	4	0.73	9.00	543.38	363.59	403.81	171.21	112.37	
	5	0.87	8.50	513.19	393.12	329.87	139.87	129.92	
	6	1.01	3.50	211.31	179.20	111.98	47.48	157.59	
					1331.55		615.21	692.45	
2	1	0.37	2.50	172.50	61.82	161.04	68.28	102.23	0.99
	2	0.47	6.00	414.00	187.95	368.88	156.40	107.11	
	3	0.58	9.00	621.00	338.22	520.81	220.83	113.80	
	4	0.70	12.00	828.00	532.23	634.28	268.94	124.59	
	5	0.84	8.00	552.00	410.22	369.36	156.61	142.63	
	6	0.99	3.00	207.00	173.60	112.74	47.80	175.24	
					1704.04		918.86	765.60	
3	1	0.54	1.00	51.75	26.65	44.36	18.81	83.51	1.02
	2	0.63	3.00	155.25	91.25	125.60	53.25	88.48	
	3	0.72	5.00	258.75	169.76	195.28	82.80	94.84	
	4	0.82	6.50	336.38	246.01	229.41	97.27	104.96	
	5	0.93	7.50	388.13	309.97	233.58	99.04	118.94	
	6	1.08	3.50	181.13	159.92	85.03	36.05	152.47	
					1003.566		387.222	643.196	

Table 4.29 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	149.80	51.23	140.77	54.05	50.95	0.65
	2	0.45	6.50	389.48	170.74	350.06	134.42	53.27	
	3	0.58	10.00	599.20	326.35	502.53	192.97	57.09	
	4	0.75	12.50	749.00	510.82	547.78	210.35	65.47	
	5	0.91	13.50	808.92	637.44	498.02	191.24	77.77	
	6	1.06	3.00	179.76	157.22	87.15	33.47	98.76	
					1853.80		816.50	403.31	
2	1	0.51	1.50	83.46	40.46	73.00	28.03	50.83	0.69
	2	0.56	5.50	306.02	162.17	259.52	99.66	52.43	
	3	0.66	8.50	472.94	291.17	372.68	143.11	56.42	
	4	0.80	11.00	612.04	440.26	425.16	163.26	64.00	
	5	0.94	7.00	389.48	315.10	228.93	87.91	75.64	
	6	1.10	2.00	111.28	99.15	50.52	19.40	97.93	
					1348.31		541.37	397.25	
3	1	0.30	2.00	134.39	39.29	128.52	49.35	56.15	0.72
	2	0.42	7.50	503.97	204.98	460.40	176.79	58.78	
	3	0.56	12.25	823.15	436.20	698.07	268.06	63.31	
	4	0.72	12.50	839.95	551.06	633.92	243.42	71.15	
	5	0.87	9.50	638.36	489.01	410.33	157.57	83.53	
	6	1.08	3.00	201.59	177.99	94.64	36.34	114.37	
					1898.54		931.54	447.29	

Table 4.30 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	149.89	51.26	140.85	59.72	63.84	0.75
	2	0.45	6.50	389.71	170.84	350.27	148.51	66.74	
	3	0.58	10.00	599.55	326.54	502.82	213.20	71.53	
	4	0.75	12.50	749.44	511.12	548.10	232.40	82.03	
	5	0.91	13.50	809.39	637.81	498.31	211.28	97.44	
	6	1.06	3.00	179.87	157.31	87.20	36.97	123.74	
					1854.88		902.08	505.32	
2	1	0.51	1.50	83.51	40.49	73.04	30.97	63.69	0.80
	2	0.56	5.50	306.20	162.26	259.67	110.10	61.32	
	3	0.66	8.50	473.22	291.34	372.90	158.11	70.69	
	4	0.80	11.00	612.40	440.52	425.41	180.37	80.19	
	5	0.94	7.00	389.71	315.28	229.06	97.12	94.77	
	6	1.10	2.00	111.35	99.21	50.55	21.43	122.70	
					1349.10		598.11	493.36	
3	1	0.30	2.00	134.47	39.32	128.59	54.52	70.35	0.83
	2	0.42	7.50	504.26	205.10	460.67	195.32	73.64	
	3	0.56	12.25	823.63	436.46	698.48	296.16	79.33	
	4	0.72	12.50	840.44	551.38	634.29	268.94	89.14	
	5	0.87	9.50	638.73	489.30	410.57	174.08	104.66	
	6	1.08	3.00	201.71	178.10	94.70	40.15	143.30	
					1899.65		1029.17	560.42	

Table 4.31 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.06	51.32	141.01	56.97	72.07	0.77
	2	0.45	6.50	390.16	171.04	350.68	141.67	75.35	
	3	0.58	10.00	600.25	326.92	503.41	203.38	80.75	
	4	0.75	12.50	750.31	511.71	548.74	221.69	92.60	
	5	0.91	13.50	810.34	638.55	498.89	201.55	110.00	
	6	1.06	3.00	180.08	157.50	87.30	35.27	139.69	
					1857.04		860.54	570.48	
2	1	0.51	1.50	83.61	40.53	73.12	29.54	71.90	0.85
	2	0.56	5.50	306.56	162.45	259.97	105.03	74.16	
	3	0.66	8.50	473.77	291.68	373.33	150.83	79.81	
	4	0.80	11.00	613.11	441.04	425.90	172.07	90.53	
	5	0.94	7.00	390.16	315.65	229.33	92.65	106.99	
	6	1.10	2.00	111.48	99.32	50.61	20.45	149.18	
3					1350.67		570.56	572.56	0.84
	1	0.30	2.00	134.63	39.36	128.74	52.01	79.42	
	2	0.42	7.50	504.85	205.34	461.21	186.33	83.14	
	3	0.56	12.25	824.59	436.97	699.29	282.52	89.56	
	4	0.72	12.50	841.42	552.02	635.03	256.55	100.63	
	5	0.87	9.50	639.48	489.87	411.05	166.06	118.16	
	6	1.08	3.00	201.94	178.30	94.81	38.30	161.77	
					1901.87		981.77	632.68	

Table 4.32 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.24	51.38	141.18	62.82	88.24	0.88
	2	0.45	6.50	390.62	171.24	351.08	156.23	92.25	
	3	0.58	10.00	600.95	327.30	504.00	224.28	98.86	
	4	0.75	12.50	751.19	512.31	549.38	244.48	113.37	
	5	0.91	13.50	811.28	639.30	499.48	222.27	134.68	
	6	1.06	3.00	180.29	157.68	87.40	38.89	172.54	
					1859.21		948.97	699.94	
2	1	0.51	1.50	83.70	40.58	73.21	32.58	88.03	0.97
	2	0.56	5.50	306.91	162.64	260.28	115.82	90.79	
	3	0.66	8.50	474.32	292.02	373.77	166.33	97.70	
	4	0.80	11.00	613.83	441.55	426.40	189.75	110.84	
	5	0.94	7.00	390.62	316.02	229.60	102.17	130.99	
	6	1.10	2.00	111.61	99.44	50.67	22.55	169.59	
					1352.25		629.20	687.94	
3	1	0.30	2.00	134.78	39.41	128.90	57.36	97.23	0.95
	2	0.42	7.50	505.44	205.58	461.74	205.48	101.78	
	3	0.56	12.25	825.56	437.48	700.11	311.55	109.64	
	4	0.72	12.50	842.40	552.67	635.77	282.92	123.20	
	5	0.87	9.50	640.23	490.44	411.53	183.13	144.66	
	6	1.08	3.00	202.18	178.51	94.92	42.24	198.06	
					1904.09		1082.67	774.58	

Table 4.33 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.41	51.44	141.34	68.97	94.49	0.96
	2	0.45	6.50	391.07	171.43	351.49	171.53	98.79	
	3	0.58	10.00	601.65	327.68	504.59	246.24	105.88	
	4	0.75	12.50	752.06	512.91	550.02	268.41	121.41	
	5	0.91	13.50	812.23	640.04	500.06	244.03	144.23	
	6	1.06	3.00	180.50	157.86	87.51	42.70	183.15	
					1861.37		1041.88	747.96	
2	1	0.51	1.50	83.80	40.63	73.29	35.77	94.27	1.05
	2	0.56	5.50	307.27	162.83	260.58	127.16	97.23	
	3	0.66	8.50	474.87	292.36	374.21	182.61	104.63	
	4	0.80	11.00	614.54	442.06	426.90	208.33	118.70	
	5	0.94	7.00	391.07	316.38	229.87	112.17	140.28	
	6	1.10	2.00	111.74	99.56	50.73	24.75	181.62	
					1353.82		690.80	736.72	
3	1	0.30	2.00	134.94	39.45	129.05	62.97	104.13	1.06
	2	0.42	7.50	506.03	205.82	462.28	225.59	109.00	
	3	0.56	12.25	826.52	437.99	700.93	342.05	117.42	
	4	0.72	12.50	843.38	553.31	636.51	310.62	131.94	
	5	0.87	9.50	640.97	491.01	412.01	201.06	154.91	
	6	1.08	3.00	202.41	178.72	95.03	46.37	212.10	
					1906.30		1188.67	829.51	

Table 4.34 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.59	51.50	141.51	65.94	98.59	0.95
	2	0.45	6.50	391.53	171.63	351.90	163.99	103.08	
	3	0.58	10.00	602.35	328.06	505.17	235.41	110.47	
	4	0.75	12.50	752.94	513.50	550.66	256.61	126.68	
	5	0.91	13.50	813.17	640.79	500.64	233.30	150.48	
	6	1.06	3.00	180.71	158.05	87.61	40.83	191.10	
					1863.54		996.07	780.39	
2	1	0.51	1.50	83.90	40.67	73.38	34.19	98.36	1.05
	2	0.56	5.50	307.63	163.02	260.88	121.57	101.44	
	3	0.66	8.50	475.43	292.70	374.64	174.58	109.17	
	4	0.80	11.00	615.26	442.58	427.39	199.17	123.84	
	5	0.94	7.00	391.53	316.75	230.13	107.24	146.36	
	6	1.10	2.00	111.87	99.67	50.79	23.67	189.49	
					1355.40		660.42	768.66	
3	1	0.30	2.00	135.10	39.50	129.20	60.21	108.64	1.04
	2	0.42	7.50	506.62	206.06	462.82	215.67	113.73	
	3	0.56	12.25	827.48	438.50	701.74	327.01	122.51	
	4	0.72	12.50	844.37	553.95	637.25	296.96	137.66	
	5	0.87	9.50	641.72	491.58	412.49	192.22	161.63	
	6	1.08	3.00	202.65	178.93	95.14	44.33	221.30	
					1908.52		1136.40	865.47	

Table 4.35 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.76	51.56	141.67	63.04	92.89	0.90
	2	0.45	6.50	391.98	171.83	352.31	156.78	97.12	
	3	0.58	10.00	603.05	328.44	505.76	225.06	104.08	
	4	0.75	12.50	753.81	514.10	551.30	245.33	119.35	
	5	0.91	13.50	814.12	641.53	501.22	223.04	141.78	
	6	1.06	3.00	180.92	158.23	87.71	39.03	180.05	
					1865.70		952.28	735.27	
2	1	0.51	1.50	84.00	40.72	73.46	32.69	92.67	1.04
	2	0.56	5.50	307.99	163.21	261.19	127.46	97.23	
	3	0.66	8.50	475.98	293.04	375.08	183.04	104.63	
	4	0.80	11.00	615.97	443.09	427.89	208.81	118.70	
	5	0.94	7.00	391.98	317.12	230.40	112.44	140.28	
	6	1.10	2.00	112.00	99.79	50.84	24.81	181.62	
					1356.97		689.25	735.12	
3	1	0.30	2.00	135.26	39.54	129.35	57.56	102.36	0.99
	2	0.42	7.50	507.21	206.30	463.36	206.19	107.15	
	3	0.56	12.25	828.44	439.01	702.56	312.64	115.43	
	4	0.72	12.50	845.35	554.60	637.99	283.91	129.70	
	5	0.87	9.50	642.46	492.16	412.97	183.77	152.29	
	6	1.08	3.00	202.88	179.14	95.25	42.39	208.51	
					1910.74		1086.45	815.45	

Table 4.36 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.50	150.94	51.62	141.83	60.14	88.87	0.86
	2	0.45	6.50	392.44	172.03	352.72	149.55	92.91	
	3	0.58	10.00	603.75	328.83	506.35	214.69	99.57	
	4	0.75	12.50	754.69	514.70	551.94	234.02	114.19	
	5	0.91	13.50	815.06	642.28	501.80	212.76	135.64	
	6	1.06	3.00	181.13	158.42	87.81	37.23	172.25	
					1867.87		908.40	703.44	
2	1	0.51	1.50	84.09	40.77	73.55	31.19	88.66	0.95
	2	0.56	5.50	308.34	163.40	261.49	110.87	91.44	
	3	0.66	8.50	476.53	293.38	375.51	159.22	98.41	
	4	0.80	11.00	616.69	443.61	428.39	181.64	111.63	
	5	0.94	7.00	392.44	317.49	230.67	97.80	131.93	
	6	1.10	2.00	112.13	99.90	50.90	21.58	170.81	
					1358.55		602.30	692.87	
3	1	0.30	2.00	135.41	39.59	129.50	54.91	97.93	0.94
	2	0.42	7.50	507.80	206.54	463.90	196.69	102.51	
	3	0.56	12.25	829.40	439.52	703.37	298.23	110.43	
	4	0.72	12.50	846.33	555.24	638.73	270.82	124.09	
	5	0.87	9.50	643.21	492.73	413.45	175.30	145.69	
	6	1.08	3.00	203.12	179.34	95.36	40.43	199.48	
					1912.96		1036.38	780.14	

Table 4.37 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	179.76	73.11	164.22	63.06	52.41	0.66
	2	0.51	8.50	509.32	246.92	445.46	171.06	54.74	
	3	0.63	13.50	808.92	475.47	654.43	251.30	59.18	
	4	0.75	12.50	749.00	510.82	547.78	210.35	65.47	
	5	0.91	9.00	539.28	424.96	332.01	127.49	77.77	
	6	1.06	3.00	179.76	157.22	87.15	33.47	98.76	
					1888.51		856.73	408.34	
2	1	0.33	3.50	239.68	78.03	226.62	87.02	57.87	0.72
	2	0.44	10.50	719.04	303.88	651.67	250.24	60.38	
	3	0.56	16.00	1095.68	580.62	929.19	356.81	64.52	
	4	0.70	13.00	890.24	572.24	681.96	261.87	71.43	
	5	0.84	9.00	616.32	458.02	412.40	158.36	81.78	
	6	1.03	4.00	273.92	234.80	141.08	54.17	106.24	
					2227.58		1168.48	442.23	
3	1	0.56	2.00	102.72	54.43	87.11	33.45	48.39	0.63
	2	0.63	6.50	333.84	196.23	270.08	103.71	50.73	
	3	0.72	10.50	539.28	353.80	407.00	156.29	54.38	
	4	0.82	11.50	590.64	431.97	402.82	154.68	60.18	
	5	0.94	6.00	308.16	249.31	181.13	69.55	69.82	
	6	1.06	3.50	179.76	157.22	87.15	33.47	84.65	
					1442.95		551.15	368.15	

Table 4.38 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	179.87	73.16	164.31	69.67	65.67	0.77
	2	0.51	8.50	509.62	247.07	445.72	188.99	68.59	
	3	0.63	13.50	809.39	475.75	654.81	277.64	74.15	
	4	0.75	12.50	749.44	511.12	548.10	232.40	82.03	
	5	0.91	9.00	539.60	425.21	332.21	140.86	97.44	
	6	1.06	3.00	179.87	157.31	87.20	36.97	123.74	
					1889.61		946.52	511.61	
2	1	0.33	3.50	239.82	78.08	226.75	96.14	72.51	0.82
	2	0.44	10.50	719.46	304.06	652.05	276.47	75.65	
	3	0.56	16.00	1096.32	580.96	929.73	394.21	80.84	
	4	0.70	13.00	890.76	572.57	682.36	289.32	89.50	
	5	0.84	9.00	616.68	458.28	412.64	174.96	102.46	
	6	1.03	4.00	274.08	234.93	141.16	59.85	133.12	
					2228.88		1290.95	554.08	
3	1	0.56	2.00	102.78	54.47	87.16	36.96	60.63	0.74
	2	0.63	6.50	334.04	196.34	270.24	114.58	63.56	
	3	0.72	10.50	539.60	354.01	407.24	172.67	68.13	
	4	0.82	11.50	590.99	432.22	403.05	170.89	75.40	
	5	0.94	6.00	308.34	249.45	181.24	76.84	87.48	
	6	1.06	3.50	179.87	157.31	87.20	36.97	106.06	
					1443.797		608.919	461.263	

Table 4.39 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	180.08	73.24	164.51	66.46	74.13	0.78
	2	0.51	8.50	510.21	247.36	446.24	180.28	77.43	
	3	0.63	13.50	810.34	476.30	655.58	264.85	83.71	
	4	0.75	12.50	750.31	511.71	548.74	221.69	92.60	
	5	0.91	9.00	540.23	425.70	332.60	134.37	110.00	
	6	1.06	3.00	180.08	157.50	87.30	35.27	139.69	
					1891.82		902.93	577.58	
2	1	0.33	3.50	240.10	78.17	227.02	91.72	81.86	0.83
	2	0.44	10.50	720.30	304.41	652.81	263.74	85.40	
	3	0.56	16.00	1097.60	581.64	930.82	376.05	91.27	
	4	0.70	13.00	891.80	573.24	683.16	276.00	101.04	
	5	0.84	9.00	617.40	458.82	413.12	166.90	115.67	
	6	1.03	4.00	274.40	235.21	141.33	57.10	150.28	
					2231.48		1231.50	625.52	
3	1	0.56	2.00	102.90	54.53	87.26	35.25	68.45	0.76
	2	0.63	6.50	334.43	196.57	270.56	109.30	71.75	
	3	0.72	10.50	540.23	354.42	407.71	164.72	76.92	
	4	0.82	11.50	591.68	432.72	403.52	163.02	85.12	
	5	0.94	6.00	308.70	249.74	181.45	73.31	98.76	
	6	1.06	3.50	180.08	157.50	87.30	35.27	119.74	
					1445.48		580.87	520.74	

Table 4.40 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	180.29	73.33	164.70	73.29	90.69	0.89
	2	0.51	8.50	510.81	247.64	446.76	198.81	94.72	
	3	0.63	13.50	811.28	476.86	656.34	292.07	102.40	
	4	0.75	12.50	751.19	512.31	549.38	244.48	113.28	
	5	0.91	9.00	540.86	426.20	332.98	148.18	134.56	
	6	1.06	3.00	180.29	157.68	87.40	38.89	170.88	
					1894.0218		995.7202	706.5287	
2	1	0.33	3.50	240.38	78.26	227.28	101.14	100.14	0.95
	2	0.44	10.50	721.14	304.77	653.57	290.84	104.47	
	3	0.56	16.00	1098.88	582.32	931.90	414.70	111.64	
	4	0.70	13.00	892.84	573.91	683.96	304.36	123.60	
	5	0.84	9.00	618.12	459.35	413.60	184.05	141.50	
	6	1.03	4.00	274.72	235.48	141.49	62.96	183.83	
					2234.08		1358.06	765.17	
3	1	0.56	2.00	103.02	54.59	87.37	38.88	83.73	0.88
	2	0.63	6.50	334.82	196.80	270.87	120.54	87.77	
	3	0.72	10.50	540.86	354.83	408.19	181.64	94.09	
	4	0.82	11.50	592.37	433.23	403.99	179.78	104.12	
	5	0.94	6.00	309.06	250.03	181.66	80.84	120.81	
	6	1.06	3.50	180.29	157.68	87.40	38.89	146.47	
					1447.17		640.57	637.00	

Table 4.41 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	180.50	73.41	164.89	80.47	97.20	0.97
	2	0.51	8.50	511.40	247.93	447.28	218.27	101.52	
	3	0.63	13.50	812.23	477.42	657.11	320.67	109.76	
	4	0.75	12.50	752.06	512.91	550.02	268.41	121.41	
	5	0.91	9.00	541.49	426.70	333.37	162.69	144.23	
	6	1.06	3.00	180.50	157.86	87.51	42.70	183.15	
					1896.23		1093.21	757.27	
2	1	0.33	3.50	240.66	78.35	227.55	111.04	107.33	1.03
	2	0.44	10.50	721.98	305.12	654.34	319.32	111.97	
	3	0.56	16.00	1100.16	583.00	932.99	455.30	119.66	
	4	0.70	13.00	893.88	574.57	684.75	334.16	132.47	
	5	0.84	9.00	618.84	459.89	414.08	202.07	151.66	
	6	1.03	4.00	275.04	235.76	141.66	69.13	197.03	
					2236.69		1491.02	820.13	
3	1	0.56	2.00	103.14	54.66	87.47	42.68	89.75	0.95
	2	0.63	6.50	335.21	197.03	271.19	132.34	94.08	
	3	0.72	10.50	541.49	355.25	408.66	199.43	100.85	
	4	0.82	11.50	593.06	433.73	404.46	197.38	111.60	
	5	0.94	6.00	309.42	250.33	181.87	88.75	129.49	
	6	1.06	3.50	180.50	157.86	87.51	42.70	156.99	
					1448.85		703.29	682.75	

Table 4.42 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	180.71	73.50	165.08	76.93	101.41	0.96
	2	0.51	8.50	512.00	248.22	447.80	208.68	105.93	
	3	0.63	13.50	813.17	477.97	657.87	306.57	114.52	
	4	0.75	12.50	752.94	513.50	550.66	256.61	126.68	
	5	0.91	9.00	542.12	427.19	333.76	155.53	150.48	
	6	1.06	3.00	180.71	158.05	87.61	40.83	191.10	
					1898.43		1045.14	790.11	
2	1	0.33	3.50	240.94	78.44	227.81	106.16	111.98	0.86
	2	0.44	10.50	722.82	305.48	655.10	305.28	116.83	
	3	0.56	16.00	1101.44	583.67	934.07	435.28	124.85	
	4	0.70	13.00	894.92	575.24	685.55	319.47	138.22	
	5	0.84	9.00	619.56	460.42	414.57	193.19	158.24	
	6	1.03	4.00	275.36	236.03	141.82	66.09	205.58	
					2239.29		1045.14	855.69	
3	1	0.56	2.00	103.26	54.72	87.57	40.81	93.64	0.95
	2	0.63	6.50	335.60	197.26	271.50	126.52	98.16	
	3	0.72	10.50	542.12	355.66	409.14	190.66	105.22	
	4	0.82	11.50	593.75	434.24	404.93	188.70	116.44	
	5	0.94	6.00	309.78	250.62	182.08	84.85	135.10	
	6	1.06	3.50	180.71	158.05	87.61	40.83	163.80	
					1450.54		672.36	712.35	

Table 4.43 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	180.92	73.58	165.27	73.55	95.55	0.91
	2	0.51	8.50	512.59	248.51	448.32	199.50	99.80	
	3	0.63	13.50	814.12	478.53	658.63	293.09	107.90	
	4	0.75	12.50	753.81	514.10	551.30	245.33	119.35	
	5	0.91	9.00	542.75	427.69	334.15	148.70	141.78	
	6	1.06	3.00	180.92	158.23	87.71	39.03	180.05	
					1900.64		999.20	744.44	
2	1	0.331613	3.5	241.5	78.624709	228.3427	96.81732	100.9393	0.922
	2	0.436332	10.5	724.5	306.18693	656.62	278.40688	105.3064	
	3	0.558505	16	1104	585.03087	936.2451	396.96792	112.5408	
	4	0.698132	13	897	576.58049	687.1419	291.34815	124.5881	
	5	0.837758	9	621	461.49294	415.5301	176.18477	142.6328	
	6	1.029744	4	276	236.57817	142.1505	60.271816	185.3067	
					2244.49		1299.99	771.31	
3	1	0.558505	2	103.5	54.846644	87.77298	37.21574	84.40559	0.84
	2	0.628319	6.5	336.375	197.71626	272.1331	115.3844	88.47775	
	3	0.715585	10.5	543.375	356.48607	410.0903	173.8783	94.84443	
	4	0.820305	11.5	595.125	435.24687	405.8743	172.0907	104.9563	
	5	0.942478	6	310.5	251.19978	182.5073	77.3831	121.7792	
	6	1.064651	3.5	181.125	158.41549	87.81114	37.23192	147.6456	
					1453.9111		613.1842	642.1088	

Table 4.44 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.42	3.00	181.13	73.67	165.47	70.16	91.41	0.88
	2	0.51	8.50	513.19	248.80	448.84	190.31	95.48	
	3	0.63	13.50	815.06	479.08	659.40	279.59	103.22	
	4	0.75	12.50	754.69	514.70	551.94	234.02	114.19	
	5	0.91	9.00	543.38	428.19	334.54	141.84	135.64	
	6	1.06	3.00	181.13	158.42	87.81	37.23	172.25	
					1902.85		953.15	712.20	
2	1	0.33	3.50	241.50	78.62	228.34	96.82	100.94	0.92
	2	0.44	10.50	724.50	306.19	656.62	278.41	105.31	
	3	0.56	16.00	1104.00	585.03	936.25	396.97	112.54	
	4	0.70	13.00	897.00	576.58	687.14	291.35	124.59	
	5	0.84	9.00	621.00	461.49	415.53	176.18	142.63	
	6	1.03	4.00	276.00	236.58	142.15	60.27	185.31	
					2244.49		1300.00	771.31	
3	1	0.56	2.00	103.50	54.85	87.77	37.22	84.41	0.83
	2	0.63	6.50	336.38	197.72	272.13	115.38	88.48	
	3	0.72	10.50	543.38	356.49	410.09	173.88	94.84	
	4	0.82	11.50	595.13	435.25	405.87	172.09	104.96	
	5	0.94	6.00	310.50	251.20	182.51	77.38	121.78	
	6	1.06	3.50	181.13	158.42	87.81	37.23	147.65	
					1453.91		613.18	642.11	

Table 4.45 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	308.16	115.44	285.72	109.72	59.02	0.73
	2	0.47	13.00	890.24	404.16	793.21	304.59	61.41	
	3	0.58	15.50	1061.44	578.10	890.20	341.84	65.25	
	4	0.70	12.50	856.00	550.23	655.73	251.80	71.43	
	5	0.82	8.50	582.08	425.71	396.98	152.44	80.23	
	6	0.99	3.00	205.44	172.30	111.89	42.97	100.47	
					2245.93		1203.35	437.81	
2	1	0.44	4.00	239.68	101.29	217.22	83.41	52.83	0.64
	2	0.54	11.50	689.08	354.90	590.66	226.81	55.86	
	3	0.65	15.00	898.80	540.91	717.81	275.64	59.95	
	4	0.75	12.50	749.00	510.82	547.78	210.35	65.47	
	5	0.87	9.00	539.28	413.11	346.64	133.11	74.49	
	6	1.03	4.00	239.68	205.45	123.44	47.40	92.96	
					2126.48		976.73	401.56	
3	1	0.56	3.00	154.08	81.65	130.67	50.18	48.39	0.59
	2	0.65	9.50	487.92	293.64	389.67	149.63	51.39	
	3	0.73	14.50	744.72	498.31	553.43	212.52	55.22	
	4	0.82	11.50	590.64	431.97	402.82	154.68	60.18	
	5	0.96	8.00	410.88	336.57	235.67	90.50	71.55	
	6	1.08	3.00	154.08	136.04	72.34	27.78	87.42	
					1778.19		685.28	374.15	

Table 4.46 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	308.34	115.51	285.89	121.22	73.94	0.83
	2	0.47	13.00	890.76	404.40	793.67	336.52	76.95	
	3	0.58	15.50	1062.06	578.44	890.72	377.66	81.75	
	4	0.70	12.50	856.50	550.55	656.12	278.19	89.50	
	5	0.82	8.50	582.42	425.96	397.21	168.42	100.53	
	6	0.99	3.00	205.56	172.40	111.96	47.47	125.88	
					2247.24		1329.47	548.547	
2	1	0.44	4.00	239.82	101.35	217.35	92.16	66.19	0.74
	2	0.54	11.50	689.48	355.11	591.00	250.58	69.99	
	3	0.65	15.00	899.33	541.23	718.23	304.53	75.12	
	4	0.75	12.50	749.44	511.12	548.10	232.40	82.03	
	5	0.87	9.00	539.60	413.35	346.84	147.06	93.33	
	6	1.03	4.00	239.82	205.57	123.52	52.37	116.48	
					2127.72		1079.10	503.12	
3	1	0.56	3.00	154.17	81.70	130.74	55.44	60.63	0.68
	2	0.65	9.50	488.21	293.81	389.90	165.32	64.38	
	3	0.73	14.50	745.16	498.61	553.76	234.79	69.19	
	4	0.82	11.50	590.99	432.22	403.05	170.89	75.40	
	5	0.96	8.00	411.12	336.77	235.81	99.98	89.65	
	6	1.08	3.00	154.17	136.12	72.38	30.69	109.53	
					1779.22		757.11	468.78	

Table 4.47 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	308.70	115.64	286.22	115.63	83.48	0.83
	2	0.47	13.00	891.80	404.87	794.60	321.02	86.87	
	3	0.58	15.50	1063.30	579.11	891.76	360.27	92.29	
	4	0.70	12.50	857.50	551.19	656.88	265.38	101.04	
	5	0.82	8.50	583.10	426.45	397.67	160.66	113.49	
	6	0.99	3.00	205.80	172.60	112.09	45.28	142.11	
					2249.87		1268.25	619.28	
2	1	0.44	4.00	240.10	101.47	217.60	87.91	74.73	0.74
	2	0.54	11.50	690.29	355.52	591.69	239.04	79.01	
	3	0.65	15.00	900.38	541.86	719.07	290.50	84.80	
	4	0.75	12.50	750.31	511.71	548.74	221.69	92.60	
	5	0.87	9.00	540.23	413.84	347.25	140.29	105.36	
	6	1.03	4.00	240.10	205.81	123.66	49.96	131.50	
					2130.21		1029.40	568.00	
3	1	0.56	3.00	154.35	81.79	130.90	52.88	68.45	0.70
	2	0.65	9.50	488.78	294.15	390.35	157.70	72.69	
	3	0.73	14.50	746.03	499.19	554.40	223.98	78.11	
	4	0.82	11.50	591.68	432.72	403.52	163.02	85.12	
	5	0.96	8.00	411.60	337.16	236.08	95.38	101.21	
	6	1.08	3.00	154.35	136.28	72.46	29.28	123.65	
					1781.30		722.24	529.23	

Table 4.48 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	309.06	115.78	286.56	127.52	102.12	0.95
	2	0.47	13.00	892.84	405.34	795.53	354.01	106.26	
	3	0.58	15.50	1064.54	579.79	892.80	397.30	112.89	
	4	0.70	12.50	858.50	551.83	657.65	292.65	123.60	
	5	0.82	8.50	583.78	426.95	398.14	177.17	138.83	
	6	0.99	3.00	206.04	172.80	112.22	49.94	173.84	
					2252.49		1398.58	757.53	
2	1	0.44	4.00	240.38	101.59	217.86	96.95	91.41	0.85
	2	0.54	11.50	691.09	355.94	592.38	263.61	96.65	
	3	0.65	15.00	901.43	542.49	719.91	320.36	103.73	
	4	0.75	12.50	751.19	512.31	549.38	244.48	113.28	
	5	0.87	9.00	540.86	414.32	347.65	154.71	128.88	
	6	1.03	4.00	240.38	206.05	123.80	55.09	160.85	
					2132.69		1135.19	694.80	
3	1	0.56	3.00	154.53	81.89	131.05	58.32	83.73	0.81
	2	0.65	9.50	489.35	294.50	390.81	173.91	88.91	
	3	0.73	14.50	746.90	499.77	555.05	247.00	95.55	
	4	0.82	11.50	592.37	433.23	403.99	179.78	104.12	
	5	0.96	8.00	412.08	337.56	236.36	105.18	123.80	
	6	1.08	3.00	154.53	136.44	72.55	32.28	151.26	
					1783.38		796.46	647.38	

Table 4.49 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	309.42	115.91	286.89	140.00	109.45	1.04
	2	0.47	13.00	893.88	405.81	796.45	388.67	113.89	
	3	0.58	15.50	1065.78	580.47	893.84	436.19	121.00	
	4	0.70	12.50	859.50	552.48	658.42	321.31	132.47	
	5	0.82	8.50	584.46	427.45	398.60	194.52	148.80	
	6	0.99	3.00	206.28	173.00	112.35	54.83	186.33	
					2255.11		1535.51	811.94	
2	1	0.44	4.00	240.66	101.71	218.11	106.44	97.97	0.92
	2	0.54	11.50	691.90	356.35	593.07	289.42	103.59	
	3	0.65	15.00	902.48	543.12	720.75	351.73	111.18	
	4	0.75	12.50	752.06	512.91	550.02	268.41	121.41	
	5	0.87	9.00	541.49	414.80	348.06	169.85	138.14	
	6	1.03	4.00	240.66	206.29	123.95	60.49	172.40	
					2135.18		1246.33	744.71	
3	1	0.56	3.00	154.71	81.98	131.20	64.03	89.75	0.87
	2	0.65	9.50	489.92	294.84	391.26	190.94	95.30	
	3	0.73	14.50	747.77	500.35	555.70	271.18	102.42	
	4	0.82	11.50	593.06	433.73	404.46	197.38	111.60	
	5	0.96	8.00	412.56	337.95	236.63	115.48	132.69	
	6	1.08	3.00	154.71	136.60	72.63	35.44	162.12	
					1785.46		874.44	693.87	

Table 4.50 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	309.78	116.05	287.22	133.85	114.20	1.02
	2	0.47	13.00	894.92	406.29	797.38	371.58	118.83	
	3	0.58	15.50	1067.02	581.14	894.88	417.01	126.25	
	4	0.70	12.50	860.50	553.12	659.18	307.18	138.22	
	5	0.82	8.50	585.14	427.94	399.06	185.96	155.25	
	6	0.99	3.00	206.52	173.20	112.48	52.42	194.40	
					2257.74		1468.00	847.14	
2	1	0.44	4.00	240.94	101.83	218.37	101.76	102.22	0.92
	2	0.54	11.50	692.70	356.77	593.76	276.69	108.08	
	3	0.65	15.00	903.53	543.75	721.59	336.26	116.00	
	4	0.75	12.50	752.94	513.50	550.66	256.61	126.68	
	5	0.87	9.00	542.12	415.28	348.46	162.38	144.13	
	6	1.03	4.00	240.94	206.53	124.09	57.83	179.88	
					2137.66		1191.53	777.00	
3	1	0.56	3.00	154.89	82.08	131.35	61.21	93.64	0.87
	2	0.65	9.50	490.49	295.18	391.72	182.54	99.43	
	3	0.73	14.50	748.64	500.93	556.34	259.26	106.86	
	4	0.82	11.50	593.75	434.24	404.93	188.70	116.44	
	5	0.96	8.00	413.04	338.34	236.91	110.40	138.45	
	6	1.08	3.00	154.89	136.76	72.72	33.89	169.15	
					1787.53		835.99	723.96	

Table 4.51 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	310.14	116.18	287.56	127.96	107.59	0.97
	2	0.47	13.00	895.96	406.76	798.31	355.25	111.96	
	3	0.58	15.50	1068.26	581.82	895.92	398.68	118.95	
	4	0.70	12.50	861.50	553.76	659.95	293.68	130.23	
	5	0.82	8.50	585.82	428.44	399.53	177.79	146.28	
	6	0.99	3.00	206.76	173.40	112.61	50.11	183.17	
					2260.36		1403.47	798.18	
2	1	0.44	4.00	241.22	101.94	218.62	97.29	96.31	0.87
	2	0.54	11.50	693.51	357.18	594.45	264.53	101.84	
	3	0.65	15.00	904.58	544.39	722.43	321.48	109.30	
	4	0.75	12.50	753.81	514.10	551.30	245.33	119.35	
	5	0.87	9.00	542.75	415.77	348.87	155.25	135.80	
	6	1.03	4.00	241.22	206.77	124.24	55.29	169.48	
					2140.15		1139.16	732.08	
3	1	0.56	3.00	155.07	82.17	131.51	58.52	88.23	0.82
	2	0.65	9.50	491.06	295.52	392.17	174.52	93.68	
	3	0.73	14.50	749.51	501.52	556.99	247.86	100.68	
	4	0.82	11.50	594.44	434.74	405.40	180.40	109.71	
	5	0.96	8.00	413.52	338.74	237.19	105.55	130.44	
	6	1.08	3.00	155.07	136.92	72.80	32.40	159.37	
					1789.61		799.25	682.11	

Table 4.52 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.38	4.50	310.50	116.32	287.89	122.07	102.94	0.92
	2	0.47	13.00	897.00	407.23	799.23	338.87	107.11	
	3	0.58	15.50	1069.50	582.49	896.96	380.31	113.80	
	4	0.70	12.50	862.50	554.40	660.71	280.14	124.59	
	5	0.82	8.50	586.50	428.94	399.99	169.60	139.94	
	6	0.99	3.00	207.00	173.60	112.74	47.80	175.24	
					2262.98		1338.79	763.61	
2	1	0.44	4.00	241.50	102.06	218.87	92.80	92.14	0.83
	2	0.54	11.50	694.31	357.60	595.14	252.34	97.43	
	3	0.65	15.00	905.63	545.02	723.26	306.66	104.57	
	4	0.75	12.50	754.69	514.70	551.94	234.02	114.19	
	5	0.87	9.00	543.38	416.25	349.27	148.09	129.92	
	6	1.03	4.00	241.50	207.01	124.38	52.74	162.14	
					2142.63		1086.66	700.38	
3	1	0.56	3.00	155.25	82.27	131.66	55.82	84.41	0.78
	2	0.65	9.50	491.63	295.87	392.63	166.47	89.63	
	3	0.73	14.50	750.38	502.10	557.64	236.44	96.32	
	4	0.82	11.50	595.13	435.25	405.87	172.09	104.96	
	5	0.96	8.00	414.00	339.13	237.46	100.68	124.80	
	6	1.08	3.00	155.25	137.08	72.89	30.90	152.47	
					1791.69		762.41	652.58	

Table 4.53 Swedish slip circle Analysis for soil sample of Kakri Ghat for without tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.48	46.70	50.08	19.23	37.41	0.51
	2	0.82	7.00	239.68	175.29	163.46	62.77	40.12	
	3	0.93	12.50	428.00	341.82	257.58	98.91	45.46	
	4	1.01	11.50	393.76	333.93	208.66	80.13	51.63	
	5	1.10	7.50	256.80	228.81	116.58	44.77	60.27	
	6	1.22	3.00	102.72	96.53	35.13	13.49	80.00	
					1223.07		319.30	314.88	
2	1	0.65	3.00	128.40	77.27	102.54	39.38	42.82	0.52
	2	0.73	10.00	428.00	286.39	318.07	122.14	46.02	
	3	0.82	19.50	834.60	610.39	569.20	218.57	50.15	
	4	0.91	11.50	492.20	387.86	303.03	116.36	55.55	
	5	1.01	7.50	321.00	272.22	170.10	65.32	64.54	
	6	1.12	3.00	128.40	115.41	56.29	21.61	78.02	
					1749.54		583.38	337.09	
3	1	0.91	1.50	38.52	30.35	23.72	9.11	33.33	0.39
	2	0.98	4.50	192.60	159.67	107.70	41.36	36.70	
	3	1.05	8.50	363.80	315.06	181.90	69.85	41.04	
	4	1.13	11.50	492.20	446.08	208.01	79.88	48.55	
	5	1.22	8.00	342.40	321.75	117.11	44.97	60.00	
	6	1.33	3.50	149.80	145.35	36.24	13.92	84.82	
					1418.27		259.08	304.44	

Table 4.54 Swedish slip circle Analysis for soil sample of Kakri Ghat for one tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.52	46.73	50.11	21.25	46.87	0.61
	2	0.82	7.00	239.82	175.39	163.56	69.35	50.26	
	3	0.93	12.50	428.25	342.02	257.73	109.28	56.96	
	4	1.01	11.50	393.99	334.12	208.78	88.52	64.69	
	5	1.10	7.50	256.95	228.94	116.65	49.46	75.51	
	6	1.22	3.00	102.78	96.58	35.15	14.90	100.23	
					1223.79		352.76	394.52	
2	1	0.65	3.00	128.48	77.32	102.60	43.50	53.65	0.60
	2	0.73	10.00	428.25	286.56	318.25	134.94	57.66	
	3	0.82	19.50	835.09	610.74	569.53	241.48	62.83	
	4	0.91	11.50	492.49	388.09	303.21	128.56	69.60	
	5	1.01	7.50	321.19	272.38	170.20	72.17	80.86	
	6	1.12	3.00	128.48	115.47	56.32	23.88	97.75	
					1750.56		644.53	422.35	
3	1	0.91	1.50	38.54	30.37	23.73	10.06	41.76	0.64
	2	0.98	4.50	115.63	95.86	64.66	27.42	45.98	
	3	1.05	8.50	218.41	189.15	109.20	46.30	51.42	
	4	1.13	11.50	295.49	267.81	124.88	52.95	60.84	
	5	1.22	8.00	205.56	193.16	70.31	29.81	75.17	
	6	1.33	3.50	89.93	87.26	21.76	9.22	106.27	
					863.61		175.76	381.44	

Table 4.55 Swedish slip circle Analysis for soil sample of Kakri Ghat for two tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.60	46.79	50.17	20.27	52.92	0.63
	2	0.82	7.00	240.10	175.60	163.75	66.15	56.75	
	3	0.93	12.50	428.75	342.41	258.03	104.24	64.31	
	4	1.01	11.50	394.45	334.51	209.03	84.45	73.03	
	5	1.10	7.50	257.25	229.21	116.79	47.18	85.24	
	6	1.22	3.00	102.90	96.69	35.19	14.22	113.15	
					1225.22		336.51	445.39	
2	1	0.65	3.00	128.63	77.41	102.72	41.50	60.57	0.62
	2	0.73	10.00	428.75	286.89	318.62	128.72	65.09	
	3	0.82	19.50	836.06	611.46	570.19	230.36	70.93	
	4	0.91	11.50	493.06	388.54	303.56	122.64	78.57	
	5	1.01	7.50	321.56	272.70	170.40	68.84	91.29	
	6	1.12	3.00	128.63	115.61	56.39	22.78	110.35	
					1752.60		614.84	476.81	
3	1	0.91	1.50	38.59	30.41	23.76	9.60	47.14	0.69
	2	0.98	4.50	115.76	95.97	64.73	26.15	51.91	
	3	1.05	8.50	218.66	189.37	109.33	44.17	58.05	
	4	1.13	11.50	295.84	268.12	125.03	50.51	68.68	
	5	1.22	8.00	205.80	193.39	70.39	28.44	84.86	
	6	1.33	3.50	90.04	87.36	21.78	8.80	119.98	
					864.62		167.67	430.62	

Table 4.56 Swedish slip circle Analysis for soil sample of Kakri Ghat for three tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.68	46.84	50.23	22.35	64.73	0.74
	2	0.82	7.00	240.38	175.80	163.94	72.95	69.41	
	3	0.93	12.50	429.25	342.81	258.33	114.96	78.66	
	4	1.01	11.50	394.91	334.90	209.27	93.13	89.33	
	5	1.10	7.50	257.55	229.48	116.93	52.03	104.28	
	6	1.22	3.00	103.02	96.81	35.23	15.68	138.41	
					1226.65		371.10	544.83	
2	1	0.65	3.00	128.78	77.50	102.84	45.77	59.28	0.65
	2	0.73	10.00	429.25	287.22	318.99	141.95	63.70	
	3	0.82	19.50	837.04	612.17	570.86	254.03	69.41	
	4	0.91	11.50	493.64	388.99	303.91	135.24	76.89	
	5	1.01	7.50	321.94	273.02	170.60	75.92	89.33	
	6	1.12	3.00	128.78	115.74	56.45	25.12	107.99	
					1754.65		678.03	466.61	
3	1	0.91	1.50	38.63	30.44	23.78	10.58	57.67	0.82
	2	0.98	4.50	115.90	96.08	64.81	28.84	63.49	
	3	1.05	8.50	218.92	189.59	109.46	48.71	71.01	
	4	1.13	11.50	296.18	268.43	125.17	55.70	84.01	
	5	1.22	8.00	206.04	193.61	70.47	31.36	103.81	
	6	1.33	3.50	90.14	87.46	21.81	9.70	146.76	
					865.63		184.90	526.76	

Table 4.57 Swedish slip circle Analysis for soil sample of Kakri Ghat for four tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.76	46.89	50.29	24.54	69.38	0.80
	2	0.82	7.00	240.66	176.01	164.13	80.10	74.40	
	3	0.93	12.50	429.75	343.21	258.63	126.21	84.31	
	4	1.01	11.50	395.37	335.29	209.51	102.24	95.75	
	5	1.10	7.50	257.85	229.75	117.06	57.13	111.76	
	6	1.22	3.00	103.14	96.92	35.28	17.21	148.35	
					1228.07		407.43	583.96	
2	1	0.65	3.00	128.93	77.59	102.96	50.25	79.42	0.77
	2	0.73	10.00	429.75	287.56	319.37	155.85	85.35	
	3	0.82	19.50	838.01	612.88	571.52	278.90	93.00	
	4	0.91	11.50	494.21	389.44	304.27	148.48	103.02	
	5	1.01	7.50	322.31	273.34	170.80	83.35	119.69	
	6	1.12	3.00	128.93	115.88	56.52	27.58	144.68	
					1756.69		744.41	625.15	
3	1	0.91	1.50	38.68	30.48	23.81	11.62	61.81	0.88
	2	0.98	4.50	116.03	96.20	64.88	31.66	68.05	
	3	1.05	8.50	219.17	189.81	109.59	53.48	76.11	
	4	1.13	11.50	296.53	268.75	125.32	61.16	90.05	
	5	1.22	8.00	206.28	193.84	70.55	34.43	111.27	
	6	1.33	3.50	90.25	87.57	21.83	10.65	157.30	
					866.63		203.00	564.59	

Table 4.58 Swedish slip circle Analysis for soil sample of Kakri Ghat for five tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.84	46.95	50.35	23.46	72.39	0.81
	2	0.82	7.00	240.94	176.21	164.32	76.57	77.62	
	3	0.93	12.50	430.25	343.61	258.93	120.66	87.97	
	4	1.01	11.50	395.83	335.68	209.76	97.75	99.90	
	5	1.10	7.50	258.15	230.01	117.20	54.61	116.61	
	6	1.22	3.00	103.26	97.03	35.32	16.46	154.79	
					1229.50		389.52	609.28	
2	1	0.65	3.00	129.08	77.68	103.08	48.04	82.86	0.77
	2	0.73	10.00	430.25	287.89	319.74	149.00	89.05	
	3	0.82	19.50	838.99	613.60	572.19	266.64	97.03	
	4	0.91	11.50	494.79	389.90	304.62	141.95	107.49	
	5	1.01	7.50	322.69	273.65	171.00	79.69	124.88	
	6	1.12	3.00	129.08	116.01	56.58	26.37	150.96	
					1758.73		711.68	652.26	
3	1	0.91	1.50	38.72	30.51	23.84	11.11	64.49	0.90
	2	0.98	4.50	116.17	96.31	64.96	30.27	71.00	
	3	1.05	8.50	219.43	190.03	109.71	51.13	79.41	
	4	1.13	11.50	296.87	269.06	125.46	58.47	93.95	
	5	1.22	8.00	206.52	194.07	70.63	32.92	116.09	
	6	1.33	3.50	90.35	87.67	21.86	10.19	164.12	
					867.64		194.07	589.07	

Table 4.59 Swedish slip circle Analysis for soil sample of Kakri Ghat for six tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	68.92	47.00	50.40	22.43	68.20	0.76
	2	0.82	7.00	241.22	176.42	164.51	73.21	73.14	
	3	0.93	12.50	430.75	344.01	259.23	115.36	82.88	
	4	1.01	11.50	396.29	336.07	210.00	93.45	94.13	
	5	1.10	7.50	258.45	230.28	117.33	52.21	109.87	
	6	1.22	3.00	103.38	97.15	35.36	15.73	145.84	
					1230.93		372.39	574.06	
2	1	0.65	3.00	129.23	77.77	103.20	45.93	78.07	0.73
	2	0.73	10.00	430.75	288.23	320.11	142.45	83.90	
	3	0.82	19.50	839.96	614.31	572.85	254.92	91.42	
	4	0.91	11.50	495.36	390.35	304.98	135.71	101.27	
	5	1.01	7.50	323.06	273.97	171.20	76.18	117.66	
	6	1.12	3.00	129.23	116.15	56.65	25.21	142.23	
					1760.78		680.40	614.56	
3	1	0.91	1.50	38.77	30.55	23.87	10.62	60.76	0.85
	2	0.98	4.50	116.30	96.42	65.04	28.94	66.90	
	3	1.05	8.50	219.68	190.25	109.84	48.88	74.82	
	4	1.13	11.50	297.22	269.37	125.61	55.90	88.52	
	5	1.22	8.00	206.76	194.29	70.72	31.47	109.38	
	6	1.33	3.50	90.46	87.77	21.88	9.74	154.64	
					868.65		185.54	555.02	

Table 4.60 Swedish slip circle Analysis for soil sample of Kakri Ghat for seven tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.75	2.00	69.00	47.06	50.46	21.40	65.25	0.73
	2	0.82	7.00	241.50	176.62	164.70	69.83	69.97	
	3	0.93	12.50	431.25	344.41	259.53	110.04	79.29	
	4	1.01	11.50	396.75	336.46	210.25	89.14	90.05	
	5	1.10	7.50	258.75	230.55	117.47	49.81	105.11	
	6	1.22	3.00	103.50	97.26	35.40	15.01	139.52	
					1232.36		355.23	549.20	
2	1	0.65	3.00	129.38	77.86	103.32	43.81	74.69	0.70
	2	0.73	10.00	431.25	288.56	320.48	135.88	80.27	
	3	0.82	19.50	840.94	615.02	573.52	243.17	87.46	
	4	0.91	11.50	495.94	390.80	305.33	129.46	96.89	
	5	1.01	7.50	323.44	274.29	171.40	72.67	112.56	
	6	1.12	3.00	129.38	116.28	56.71	24.05	136.07	
					1762.82		649.04	587.94	
3	1	0.91	1.50	38.81	30.58	23.90	10.13	58.13	0.81
	2	0.98	4.50	116.44	96.53	65.11	27.61	64.00	
	3	1.05	8.50	219.94	190.47	109.97	46.63	71.58	
	4	1.13	11.50	297.56	269.68	125.76	53.32	84.69	
	5	1.22	8.00	207.00	194.52	70.80	30.02	104.64	
	6	1.33	3.50	90.56	87.87	21.91	9.29	147.94	
					869.66		176.99	530.99	

Table 4.61 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.48	31.18	116.37	51.79	52.47	1.13
	2	0.37	4.50	271.08	97.15	253.07	112.62	54.29	
	3	0.45	6.50	391.56	171.65	351.93	156.61	56.39	
	4	0.59	8.50	512.04	286.33	424.50	188.90	61.13	
	5	0.72	6.00	361.44	237.13	272.78	121.39	67.15	
	6	0.87	2.00	120.48	92.29	77.44	34.46	78.84	
					915.73		665.77	370.27	
2	1	0.35	1.50	79.07	27.04	74.30	33.06	47.19	1.07
	2	0.42	3.00	158.13	64.32	144.46	64.28	48.54	
	3	0.52	5.00	263.55	131.78	228.24	101.57	51.21	
	4	0.63	6.50	342.62	201.38	277.18	123.35	54.81	
	5	0.73	6.00	316.26	211.62	235.03	104.59	59.67	
	6	0.87	2.50	131.78	100.95	84.70	37.69	68.99	
					737.08		464.54	330.41	
3	1	0.37	1.00	45.18	16.19	42.18	18.77	40.71	1.13
	2	0.47	2.50	112.95	51.28	100.64	44.78	42.66	
	3	0.58	3.50	158.13	86.12	132.62	59.02	45.32	
	4	0.68	4.00	180.72	113.73	140.45	62.50	48.91	
	5	0.80	4.50	203.31	146.25	141.23	62.85	54.72	
	6	0.94	2.50	112.95	91.38	66.39	29.54	64.67	
					504.95		277.46	296.99	

Table 4.62 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.56	31.20	116.45	47.05	59.55	1.14
	2	0.37	4.50	271.26	97.21	253.24	102.31	61.61	
	3	0.45	6.50	391.82	171.76	352.17	142.27	64.00	
	4	0.59	8.50	512.38	286.52	424.78	171.61	69.38	
	5	0.72	6.00	361.68	237.28	272.96	110.28	76.21	
	6	0.87	2.00	120.56	92.35	77.49	31.31	89.49	
					916.33		604.83	54.72	
2	1	0.35	1.50	79.22	27.10	74.44	30.08	53.56	1.07
	2	0.42	3.00	158.45	64.45	144.75	58.48	55.09	
	3	0.52	5.00	264.08	132.04	228.70	92.39	58.12	
	4	0.63	6.50	343.30	201.79	277.73	112.20	62.21	
	5	0.73	6.00	316.89	212.04	235.50	95.14	67.73	
	6	0.87	2.50	132.04	101.15	84.87	34.29	78.30	
					738.55		422.58	375.01	
3	1	0.37	1.00	45.21	16.20	42.21	17.05	46.21	1.16
	2	0.47	2.50	113.03	51.31	100.71	40.69	48.42	
	3	0.58	3.50	158.24	86.18	132.71	53.61	51.44	
	4	0.68	4.00	180.84	113.81	140.54	56.78	55.51	
	5	0.80	4.50	203.45	146.35	141.32	57.10	62.10	
	6	0.94	2.50	113.03	91.44	66.43	26.84	73.39	
					505.29		252.06	337.07	

Table 4.63 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.72	31.24	116.61	54.34	89.65	1.45
	2	0.37	4.50	271.62	97.34	253.58	118.17	92.76	
	3	0.45	6.50	392.34	171.99	352.63	164.33	96.35	
	4	0.59	8.50	513.06	286.90	425.35	198.21	104.46	
	5	0.72	6.00	362.16	237.60	273.33	127.37	114.75	
	6	0.87	2.00	120.72	92.48	77.60	36.16	134.73	
					917.55		698.57	632.70	
2	1	0.35	1.50	79.22	27.10	74.44	34.69	80.64	1.42
	2	0.42	3.00	158.45	64.45	144.75	67.45	82.95	
	3	0.52	5.00	264.08	132.04	228.70	106.57	87.50	
	4	0.63	6.50	343.30	201.79	277.73	129.42	93.66	
	5	0.73	6.00	316.89	212.04	235.50	109.74	101.97	
	6	0.87	2.50	132.04	101.15	84.87	39.55	117.88	
					738.55		487.43	564.59	
3	1	0.37	1.00	45.27	16.22	42.26	19.69	69.57	1.57
	2	0.47	2.50	113.18	51.38	100.84	46.99	72.90	
	3	0.58	3.50	158.45	86.30	132.88	61.92	77.44	
	4	0.68	4.00	181.08	113.96	140.73	65.58	83.58	
	5	0.80	4.50	203.72	146.54	141.51	65.94	93.50	
	6	0.94	2.50	113.18	91.56	66.52	31.00	110.50	
					505.96		291.13	507.48	

Table 4.64 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.88	31.29	116.76	54.41	102.41	1.54
	2	0.37	4.50	271.98	97.47	253.92	118.32	105.96	
	3	0.45	6.50	392.86	172.22	353.10	164.54	110.06	
	4	0.59	8.50	513.74	287.28	425.91	198.47	119.32	
	5	0.72	6.00	362.64	237.91	273.69	127.54	131.07	
	6	0.87	2.00	120.88	92.60	77.70	36.21	153.89	
					918.77		699.50	722.71	
2	1	0.35	1.50	79.33	27.13	74.54	34.74	92.11	1.53
	2	0.42	3.00	158.66	64.53	144.94	67.54	94.75	
	3	0.52	5.00	264.43	132.21	229.00	106.71	99.95	
	4	0.63	6.50	343.75	202.05	278.10	129.60	106.99	
	5	0.73	6.00	317.31	212.32	235.81	109.89	116.47	
	6	0.87	2.50	132.21	101.28	84.98	39.60	134.66	
					739.53		488.08	644.92	
3	1	0.37	1.00	45.33	16.24	42.32	19.72	79.47	1.71
	2	0.47	2.50	113.33	51.45	100.97	47.05	83.27	
	3	0.58	3.50	158.66	86.41	133.06	62.01	88.46	
	4	0.68	4.00	181.32	114.11	140.91	65.67	95.46	
	5	0.80	4.50	203.99	146.73	141.70	66.03	106.80	
	6	0.94	2.50	113.33	91.68	66.61	31.04	126.22	
					506.63		291.52	579.68	

Table 4.65 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.04	31.33	116.92	52.03	112.97	1.593
	2	0.37	4.50	272.34	97.60	254.25	113.14	116.88	
	3	0.45	6.50	393.38	172.45	353.57	157.34	121.41	
	4	0.59	8.50	514.42	287.66	426.47	189.78	131.62	
	5	0.72	6.00	363.12	238.23	274.05	121.95	144.59	
	6	0.87	2.00	121.04	92.72	77.80	34.62	169.76	
					919.98		668.86	797.23	
2	1	0.35	1.50	79.43	27.17	74.64	33.22	101.61	1.590
	2	0.42	3.00	158.87	64.62	145.13	64.58	104.52	
	3	0.52	5.00	264.78	132.39	229.30	102.04	110.25	
	4	0.63	6.50	344.21	202.32	278.47	123.92	118.02	
	5	0.73	6.00	317.73	212.60	236.12	105.07	128.48	
	6	0.87	2.50	132.39	101.41	85.10	37.87	148.54	
					740.51		466.70	711.42	
3	1	0.37	1.00	45.39	16.27	42.38	18.86	87.66	1.80
	2	0.47	2.50	113.48	51.52	101.11	44.99	91.85	
	3	0.58	3.50	158.87	86.52	133.24	59.29	97.58	
	4	0.68	4.00	181.56	114.26	141.10	62.79	105.31	
	5	0.80	4.50	204.26	146.93	141.89	63.14	117.81	
	6	0.94	2.50	113.48	91.80	66.70	29.68	139.23	
					507.30		278.75	639.45	

Table 4.66 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.20	31.37	117.07	54.55	109.20	1.59
	2	0.37	4.50	272.70	97.73	254.59	118.64	112.98	
	3	0.45	6.50	393.90	172.67	354.03	164.98	117.36	
	4	0.59	8.50	515.10	288.04	427.04	199.00	127.23	
	5	0.72	6.00	363.60	238.54	274.41	127.88	139.76	
	6	0.87	2.00	121.20	92.84	77.91	36.30	164.10	
					921.20		701.35	770.63	
2	1	0.35	1.50	79.54	27.20	74.74	34.83	98.22	1.58
	2	0.42	3.00	159.08	64.70	145.32	67.72	101.03	
	3	0.52	5.00	265.13	132.56	229.60	107.00	106.57	
	4	0.63	6.50	344.66	202.59	278.84	129.94	114.08	
	5	0.73	6.00	318.15	212.88	236.43	110.18	124.20	
	6	0.87	2.50	132.56	101.55	85.21	39.71	143.59	
					741.49		489.37	687.68	
3	1	0.37	1.00	45.45	16.29	42.43	19.77	84.74	1.79
	2	0.47	2.50	113.63	51.58	101.24	47.18	88.79	
	3	0.58	3.50	159.08	86.64	133.41	62.17	94.33	
	4	0.68	4.00	181.80	114.41	141.29	65.84	101.80	
	5	0.80	4.50	204.53	147.12	142.08	66.21	113.88	
	6	0.94	2.50	113.63	91.92	66.79	31.12	134.59	
					507.97		292.29	618.12	

Table 4.67 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.36	31.41	117.22	54.63	107.54	1.58
	2	0.37	4.50	273.06	97.86	254.92	118.79	111.27	
	3	0.45	6.50	394.42	172.90	354.50	165.20	115.58	
	4	0.59	8.50	515.78	288.42	427.60	199.26	125.30	
	5	0.72	6.00	364.08	238.86	274.77	128.04	137.64	
	6	0.87	2.00	121.36	92.97	78.01	36.35	161.61	
					922.41		702.28	758.94	
2	1	0.35	1.50	79.64	27.24	74.84	34.88	96.73	1.57
	2	0.42	3.00	159.29	64.79	145.51	67.81	99.50	
	3	0.52	5.00	265.48	132.74	229.91	107.14	104.96	
	4	0.63	6.50	345.12	202.85	279.21	130.11	112.35	
	5	0.73	6.00	318.57	213.16	236.74	110.32	122.31	
	6	0.87	2.50	132.74	101.68	85.32	39.76	141.41	
					742.47		490.01	677.25	
3	1	0.37	1.00	45.51	16.31	42.49	19.80	80.24	1.72
	2	0.47	2.50	113.78	51.65	101.37	47.24	84.07	
	3	0.58	3.50	159.29	86.75	133.59	62.25	89.32	
	4	0.68	4.00	182.04	114.56	141.47	65.93	96.39	
	5	0.80	4.50	204.80	147.32	142.26	66.29	107.84	
	6	0.94	2.50	113.78	92.05	66.88	31.16	127.44	
					508.64		292.68	585.31	

Table 4.68 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 45 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.52	31.45	117.38	52.23	102.16	1.50
	2	0.37	4.50	273.42	97.98	255.26	113.59	105.70	
	3	0.45	6.50	394.94	173.13	354.97	157.96	109.79	
	4	0.59	8.50	516.46	288.80	428.16	190.53	119.03	
	5	0.72	6.00	364.56	239.17	275.14	122.44	130.75	
	6	0.87	2.00	121.52	93.09	78.11	34.76	153.52	
					923.63		671.51	720.95	
2	1	0.35	1.50	79.75	27.28	74.94	33.35	91.89	1.49
	2	0.42	3.00	159.50	64.87	145.71	64.84	94.52	
	3	0.52	5.00	265.83	132.91	230.21	102.44	99.70	
	4	0.63	6.50	345.57	203.12	279.57	124.41	106.73	
	5	0.73	6.00	318.99	213.45	237.06	105.49	116.19	
	6	0.87	2.50	132.91	101.82	85.43	38.02	134.33	
					743.45		468.55	643.35	
3	1	0.37	1.00	45.57	16.33	42.54	18.93	79.28	1.68
	2	0.47	2.50	113.93	51.72	101.51	45.17	83.06	
	3	0.58	3.50	159.50	86.87	133.76	59.52	88.25	
	4	0.68	4.00	182.28	114.71	141.66	63.04	95.23	
	5	0.80	4.50	205.07	147.51	142.45	63.39	106.54	
	6	0.94	2.50	113.93	92.17	66.96	29.80	125.91	
					509.31		279.85	578.27	

Table 4.69 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.48	31.18	116.37	51.79	52.47	1.14
	2	0.35	5.00	301.20	103.02	283.04	125.95	53.93	
	3	0.47	8.00	481.92	218.79	429.39	191.08	56.88	
	4	0.56	9.00	542.16	287.30	459.78	204.60	59.76	
	5	0.70	6.00	361.44	232.33	276.88	123.21	66.16	
	6	0.80	2.00	120.48	86.67	83.69	37.24	72.96	
					959.28		733.87	362.16	
2	1	0.33	1.50	79.07	25.74	74.76	33.27	46.90	1.05
	2	0.42	3.50	184.49	75.04	168.54	75.00	48.54	
	3	0.52	6.00	316.26	158.13	273.89	121.88	51.21	
	4	0.63	8.50	448.04	263.35	362.47	161.30	54.81	
	5	0.75	5.50	289.91	197.71	212.02	94.35	60.63	
	6	0.86	2.00	105.42	79.56	69.16	30.78	67.59	
					799.53		516.57	329.69	
3	1	0.42	1.00	45.18	18.38	41.27	18.37	41.61	0.98
	2	0.51	3.00	135.54	65.71	118.55	52.75	43.46	
	3	0.59	4.50	203.31	113.69	168.55	75.01	45.85	
	4	0.70	6.00	271.08	174.25	207.66	92.41	49.62	
	5	0.79	6.50	293.67	207.66	207.66	92.41	53.75	
	6	0.87	2.50	112.95	86.52	72.60	32.31	59.13	
					666.20		363.25	293.42	

Table 4.70 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.56	31.20	116.45	47.05	59.55	1.15
	2	0.35	5.00	301.40	103.08	283.22	114.42	61.21	
	3	0.47	8.00	482.24	218.93	429.68	173.59	64.56	
	4	0.56	9.00	542.52	287.49	460.08	185.87	67.83	
	5	0.70	6.00	361.68	232.48	277.06	111.93	75.09	
	6	0.80	2.00	120.56	86.72	83.75	33.83	82.80	
					959.92		666.70	54.72	
2	1	0.33	1.50	79.22	25.79	74.91	30.26	53.23	1.05
	2	0.42	3.50	184.85	75.19	168.87	68.22	55.09	
	3	0.52	6.00	316.89	158.45	274.43	110.87	58.12	
	4	0.63	8.50	448.93	263.87	363.19	146.73	62.21	
	5	0.75	5.50	290.48	198.11	212.45	85.83	68.82	
	6	0.86	2.00	105.63	79.72	69.30	28.00	76.72	
					801.13		469.91	374.18	
3	1	0.42	1.00	45.21	18.39	41.30	16.69	47.22	0.99
	2	0.51	3.00	135.63	65.75	118.62	47.92	49.32	
	3	0.59	4.50	203.45	113.77	168.66	68.14	52.04	
	4	0.70	6.00	271.26	174.36	207.80	83.95	56.32	
	5	0.79	6.50	293.87	207.79	207.79	83.95	61.01	
	6	0.87	2.50	113.03	86.58	72.65	29.35	67.11	
					666.65		330.00	333.02	

Table 4.71 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.72	31.24	116.61	54.34	89.65	
	2	0.35	5.00	301.80	103.22	283.60	132.16	92.16	
	3	0.47	8.00	482.88	219.22	430.25	200.50	97.19	
	4	0.56	9.00	543.24	287.87	460.69	214.68	102.12	1.44
	5	0.70	6.00	362.16	232.79	277.43	129.28	113.05	
	6	0.80	2.00	120.72	86.84	83.86	39.08	124.67	
					961.19		770.04	618.84	
2	1	0.33	1.50	79.22	25.79	74.91	34.91	80.14	
	2	0.42	3.50	184.85	75.19	168.87	78.69	82.95	
	3	0.52	6.00	316.89	158.45	274.43	127.89	87.50	
	4	0.63	8.50	448.93	263.87	363.19	169.25	93.66	1.37
	5	0.75	5.50	290.48	198.11	212.45	99.00	103.61	
	6	0.86	2.00	105.63	79.72	69.30	32.29	115.50	
					801.13		542.03	563.36	
3	1	0.42	1.00	45.27	18.41	41.36	19.27	71.10	
	2	0.51	3.00	135.81	65.84	118.78	55.35	74.26	
	3	0.59	4.50	203.72	113.92	168.89	78.70	78.34	
	4	0.70	6.00	271.62	174.59	208.07	96.96	84.79	1.32
	5	0.79	6.50	294.26	208.07	208.07	96.96	91.85	
	6	0.87	2.50	113.18	86.70	72.75	33.90	101.04	
					667.53		381.15	501.38	

Table 4.72 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	120.88	31.29	116.76	54.41	102.41	1.53
	2	0.35	5.00	302.20	103.36	283.98	132.33	105.27	
	3	0.47	8.00	483.52	219.51	430.82	200.76	111.02	
	4	0.56	9.00	543.96	288.25	461.30	214.97	116.64	
	5	0.70	6.00	362.64	233.10	277.80	129.45	129.13	
	6	0.80	2.00	120.88	86.95	83.97	39.13	142.40	
					962.47		771.06	706.87	
2	1	0.33	1.50	79.33	25.83	75.01	34.95	91.54	1.47
	2	0.42	3.50	185.10	75.29	169.09	78.80	94.75	
	3	0.52	6.00	317.31	158.66	274.80	128.06	99.95	
	4	0.63	8.50	449.52	264.22	363.67	169.47	106.99	
	5	0.75	5.50	290.87	198.37	212.73	99.13	118.35	
	6	0.86	2.00	105.77	79.83	69.39	32.34	131.93	
					802.19		542.75	643.50	
3	1	0.42	1.00	45.33	18.44	41.41	19.30	81.21	1.42
	2	0.51	3.00	135.99	65.93	118.94	55.43	84.83	
	3	0.59	4.50	203.99	114.07	169.11	78.81	89.49	
	4	0.70	6.00	271.98	174.83	208.35	97.09	96.85	
	5	0.79	6.50	294.65	208.35	208.35	97.09	104.92	
	6	0.87	2.50	113.33	86.81	72.84	33.95	115.42	
					668.42		381.65	572.71	

Table 4.73 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.04	31.33	116.92	52.03	112.97	1.57
	2	0.35	5.00	302.60	103.50	284.35	126.54	116.12	
	3	0.47	8.00	484.16	219.80	431.39	191.97	122.47	
	4	0.56	9.00	544.68	288.64	461.91	205.55	128.67	
	5	0.70	6.00	363.12	233.41	278.17	123.78	142.45	
	6	0.80	2.00	121.04	87.07	84.08	37.42	157.08	
					963.74		737.28	779.76	
2	1	0.33	1.50	79.43	25.86	75.10	33.42	100.98	1.52
	2	0.42	3.50	185.34	75.39	169.32	75.35	104.52	
	3	0.52	6.00	317.73	158.87	275.16	122.45	110.25	
	4	0.63	8.50	450.12	264.57	364.15	162.05	118.02	
	5	0.75	5.50	291.25	198.63	213.01	94.79	130.55	
	6	0.86	2.00	105.91	79.93	69.48	30.92	145.54	
					803.25		518.97	709.86	
3	1	0.42	1.00	45.39	18.46	41.47	18.45	89.59	1.48
	2	0.51	3.00	136.17	66.02	119.10	53.00	93.57	
	3	0.59	4.50	204.26	114.22	169.34	75.35	98.72	
	4	0.70	6.00	272.34	175.06	208.62	92.84	106.83	
	5	0.79	6.50	295.04	208.62	208.62	92.84	115.74	
	6	0.87	2.50	113.48	86.93	72.94	32.46	127.32	
					669.30		364.94	631.77	

Table 4.74 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.20	31.37	117.07	54.55	109.20	1.58
	2	0.35	5.00	303.00	103.63	284.73	132.68	112.25	
	3	0.47	8.00	484.80	220.09	431.96	201.29	118.38	
	4	0.56	9.00	545.40	289.02	462.53	215.54	124.38	
	5	0.70	6.00	363.60	233.72	278.53	129.80	137.69	
	6	0.80	2.00	121.20	87.18	84.19	39.23	151.84	
					965.02		773.10	753.75	
2	1	0.33	1.50	79.54	25.89	75.20	35.05	97.61	1.53
	2	0.42	3.50	185.59	75.49	169.54	79.01	101.03	
	3	0.52	6.00	318.15	159.08	275.53	128.40	106.57	
	4	0.63	8.50	450.71	264.92	364.63	169.92	114.08	
	5	0.75	5.50	291.64	198.90	213.29	99.39	126.20	
	6	0.86	2.00	106.05	80.04	69.58	32.42	140.68	
					804.31		544.18	686.18	
3	1	0.42	1.00	45.45	18.49	41.52	19.35	86.60	1.48
	2	0.51	3.00	136.35	66.10	119.25	55.57	90.45	
	3	0.59	4.50	204.53	114.37	169.56	79.01	95.42	
	4	0.70	6.00	272.70	175.29	208.90	97.35	103.27	
	5	0.79	6.50	295.43	208.90	208.90	97.35	111.88	
	6	0.87	2.50	113.63	87.04	73.04	34.04	123.07	
					670.19		382.66	610.69	

Table 4.75 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.36	31.41	117.22	54.63	107.54	1.56
	2	0.35	5.00	303.40	103.77	285.10	132.86	110.55	
	3	0.47	8.00	485.44	220.39	432.53	201.56	116.59	
	4	0.56	9.00	546.12	289.40	463.14	215.82	122.49	
	5	0.70	6.00	364.08	234.03	278.90	129.97	135.61	
	6	0.80	2.00	121.36	87.30	84.30	39.29	149.54	
					966.29		774.12	742.32	
2	1	0.33	1.50	79.64	25.93	75.30	35.09	96.13	1.51
	2	0.42	3.50	185.83	75.58	169.77	79.11	99.50	
	3	0.52	6.00	318.57	159.29	275.89	128.56	104.96	
	4	0.63	8.50	451.31	265.27	365.12	170.14	112.35	
	5	0.75	5.50	292.02	199.16	213.57	99.52	124.28	
	6	0.86	2.00	106.19	80.14	69.67	32.46	138.55	
					805.37		544.90	675.77	
3	1	0.42	1.00	45.51	18.51	41.58	19.37	82.00	1.43
	2	0.51	3.00	136.53	66.19	119.41	55.65	85.65	
	3	0.59	4.50	204.80	114.52	169.78	79.12	90.36	
	4	0.70	6.00	273.06	175.52	209.18	97.48	97.79	
	5	0.79	6.50	295.82	209.17	209.17	97.47	105.94	
	6	0.87	2.50	113.78	87.16	73.13	34.08	116.54	
					671.07		383.17	578.27	

Table 4.76 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 50 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.26	2.00	121.52	31.45	117.38	52.23	102.16	1.49
	2	0.35	5.00	303.80	103.91	285.48	127.04	105.01	
	3	0.47	8.00	486.08	220.68	433.10	192.73	110.75	
	4	0.56	9.00	546.84	289.78	463.75	206.37	116.36	
	5	0.70	6.00	364.56	234.33	279.27	124.27	128.82	
	6	0.80	2.00	121.52	87.41	84.41	37.56	142.06	
					967.56		740.21	705.16	
2	1	0.33	1.50	79.75	25.96	75.40	33.55	91.32	1.44
	2	0.42	3.50	186.08	75.68	169.99	75.65	94.52	
	3	0.52	6.00	318.99	159.50	276.25	122.93	99.70	
	4	0.63	8.50	451.90	265.62	365.60	162.69	106.73	
	5	0.75	5.50	292.41	199.42	213.85	95.16	118.06	
	6	0.86	2.00	106.33	80.25	69.76	31.04	131.61	
					806.43		521.03	641.94	
3	1	0.42	1.00	45.57	18.53	41.63	18.53	81.01	1.39
	2	0.51	3.00	136.71	66.28	119.57	53.21	84.62	
	3	0.59	4.50	205.07	114.67	170.01	75.65	89.27	
	4	0.70	6.00	273.42	175.75	209.45	93.21	96.61	
	5	0.79	6.50	296.21	209.45	209.45	93.20	104.67	
	6	0.87	2.50	113.93	87.27	73.23	32.59	115.14	
					671.96		366.38	571.32	

Table 4.77 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.48	37.23	114.58	50.99	53.29	0.90
	2	0.42	6.00	361.44	147.01	330.19	146.94	55.48	
	3	0.49	9.50	572.28	268.67	505.29	224.86	57.40	
	4	0.65	12.00	722.88	435.04	577.32	256.91	63.46	
	5	0.75	8.00	481.92	328.67	352.45	156.84	69.30	
	6	0.94	3.00	180.72	146.21	106.22	47.27	86.22	
					1362.82		883.80	385.14	
2	1	0.37	1.50	79.07	28.33	73.81	32.85	47.50	0.88
	2	0.47	5.00	263.55	119.65	234.82	104.50	49.77	
	3	0.58	7.50	395.33	215.31	331.55	147.54	52.88	
	4	0.72	10.00	527.10	345.81	397.81	177.02	58.76	
	5	0.84	6.50	342.62	254.61	229.25	102.02	66.27	
	6	0.94	2.50	131.78	106.61	77.46	34.47	75.44	
					1070.32		598.39	350.62	
3	1	0.52	1.00	45.18	22.59	39.13	17.41	43.89	0.80
	2	0.59	3.00	135.54	75.79	112.37	50.00	45.85	
	3	0.66	5.50	248.49	152.99	195.81	87.14	48.24	
	4	0.79	7.50	338.85	239.60	239.60	106.62	53.75	
	5	0.89	7.00	316.26	245.78	199.03	88.57	60.40	
	6	1.03	4.00	180.72	154.91	93.08	41.42	73.80	
					891.66		391.16	325.93	

Table 4.78 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.48	37.23	114.58	46.29	60.48	0.93
	2	0.42	6.00	361.44	147.01	330.19	133.40	62.96	
	3	0.49	9.50	572.28	268.67	505.29	204.14	65.15	
	4	0.65	12.00	722.88	435.04	577.32	233.24	72.02	
	5	0.75	8.00	481.92	328.67	352.45	142.39	78.65	
	6	0.94	3.00	180.72	146.21	106.22	42.91	97.86	
					1362.82		802.37	437.12	
2	1	0.37	1.50	79.07	28.33	73.81	29.82	53.91	0.87
	2	0.47	5.00	263.55	119.65	234.82	94.87	56.49	
	3	0.58	7.50	395.33	215.31	331.55	133.95	60.01	
	4	0.72	10.00	527.10	345.81	397.81	160.71	66.69	
	5	0.84	6.50	342.62	254.61	229.25	92.62	75.22	
	6	0.94	2.50	131.78	106.61	77.46	31.29	85.63	
					1070.32		543.26	397.94	
3	1	0.52	1.00	45.21	22.61	39.15	15.82	49.81	0.81
	2	0.59	3.00	135.63	75.84	112.44	45.43	52.04	
	3	0.66	5.50	248.66	153.09	195.94	79.16	54.75	
	4	0.79	7.50	339.08	239.76	239.76	96.86	61.01	
	5	0.89	7.00	316.47	245.94	199.16	80.46	68.55	
	6	1.03	4.00	180.84	155.01	93.14	37.63	83.76	
					892.25		355.36	369.92	

Table 4.79 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.72	37.30	114.81	53.50	91.06	1.16
	2	0.42	6.00	362.16	147.30	330.85	154.18	94.80	
	3	0.49	9.50	573.42	269.20	506.30	235.94	98.08	
	4	0.65	12.00	724.32	435.91	578.47	269.57	108.43	
	5	0.75	8.00	482.88	329.32	353.16	164.57	118.41	
	6	0.94	3.00	181.08	146.50	106.44	49.60	147.33	
					1365.54		927.35	658.11	
2	1	0.37	1.50	79.22	28.39	73.96	34.47	81.17	1.14
	2	0.47	5.00	264.08	119.89	235.29	109.65	85.04	
	3	0.58	7.50	396.11	215.74	332.21	154.81	90.35	
	4	0.72	10.00	528.15	346.50	398.60	185.75	100.40	
	5	0.84	6.50	343.30	255.12	229.71	107.05	113.24	
	6	0.94	2.50	132.04	106.82	77.61	36.17	128.92	
					1072.45		627.88	599.12	
3	1	0.52	1.00	45.27	22.64	39.20	18.27	75.00	1.08
	2	0.59	3.00	135.81	75.94	112.59	52.47	78.34	
	3	0.66	5.50	248.99	153.29	196.20	91.43	82.42	
	4	0.79	7.50	339.53	240.08	240.08	111.88	91.85	
	5	0.89	7.00	316.89	246.27	199.43	92.93	103.21	
	6	1.03	4.00	181.08	155.22	93.26	43.46	126.11	
					893.44		410.44	556.93	

Table 4.80 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.88	37.35	114.96	53.57	104.01	1.23
	2	0.42	6.00	362.64	147.50	331.29	154.38	108.28	
	3	0.49	9.50	574.18	269.56	506.97	236.25	112.03	
	4	0.65	12.00	725.28	436.48	579.23	269.92	123.86	
	5	0.75	8.00	483.52	329.76	353.62	164.79	135.26	
	6	0.94	3.00	181.32	146.69	106.58	49.66	168.29	
					1367.35		928.58	751.74	
2	1	0.37	1.50	79.33	28.43	74.06	34.51	92.71	1.22
	2	0.47	5.00	264.43	120.05	235.60	109.79	97.14	
	3	0.58	7.50	396.64	216.02	332.65	155.01	103.21	
	4	0.72	10.00	528.85	346.96	399.13	185.99	114.69	
	5	0.84	6.50	343.75	255.46	230.02	107.19	129.35	
	6	0.94	2.50	132.21	106.96	77.71	36.21	147.26	
					1073.88		628.71	684.36	
3	1	0.52	1.00	45.33	22.67	39.26	18.29	85.67	1.17
	2	0.59	3.00	135.99	76.04	112.74	52.54	89.49	
	3	0.66	5.50	249.32	153.49	196.46	91.55	94.15	
	4	0.79	7.50	339.98	240.40	240.40	112.03	104.92	
	5	0.89	7.00	317.31	246.60	199.69	93.06	117.89	
	6	1.03	4.00	181.32	155.42	93.39	43.52	144.05	
				0.00	894.62		410.98	636.16	

Table 4.81 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.04	37.40	115.12	51.23	114.74	1.25
	2	0.42	6.00	363.12	147.69	331.73	147.62	119.45	
	3	0.49	9.50	574.94	269.92	507.64	225.90	123.59	
	4	0.65	12.00	726.24	437.06	580.00	258.10	136.63	
	5	0.75	8.00	484.16	330.20	354.09	157.57	149.20	
	6	0.94	3.00	181.56	146.89	106.72	47.49	185.65	
					1369.16		887.91	829.25	
2	1	0.37	1.50	79.43	28.47	74.16	33.00	102.27	1.26
	2	0.47	5.00	264.78	120.21	235.92	104.98	107.16	
	3	0.58	7.50	397.16	216.31	333.09	148.22	113.85	
	4	0.72	10.00	529.55	347.42	399.66	177.85	126.51	
	5	0.84	6.50	344.21	255.80	230.32	102.49	142.69	
	6	0.94	2.50	132.39	107.10	77.82	34.63	162.44	
					1075.30		601.17	754.92	
3	1	0.52	1.00	45.39	22.70	39.31	17.49	94.50	1.22
	2	0.59	3.00	136.17	76.15	112.89	50.24	98.72	
	3	0.66	5.50	249.65	153.70	196.72	87.54	103.86	
	4	0.79	7.50	340.43	240.72	240.72	107.12	115.74	
	5	0.89	7.00	317.73	246.92	199.95	88.98	130.05	
	6	1.03	4.00	181.56	155.63	93.51	41.61	158.90	
					895.80		392.98	701.76	

Table 4.82 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.20	37.45	115.27	53.71	110.91	1.3
	2	0.42	6.00	363.60	147.89	332.17	154.79	115.46	
	3	0.49	9.50	575.70	270.27	508.31	236.87	119.46	
	4	0.65	12.00	727.20	437.64	580.77	270.64	132.08	
	5	0.75	8.00	484.80	330.63	354.56	165.23	144.23	
	6	0.94	3.00	181.80	147.08	106.86	49.80	179.45	
					1370.97		931.04	801.59	
2	1	0.37	1.50	79.54	28.50	74.25	34.60	98.86	1.26
	2	0.47	5.00	265.13	120.36	236.23	110.08	103.59	
	3	0.58	7.50	397.69	216.60	333.53	155.42	110.05	
	4	0.72	10.00	530.25	347.88	400.18	186.49	122.29	
	5	0.84	6.50	344.66	256.13	230.62	107.47	137.93	
	6	0.94	2.50	132.56	107.25	77.92	36.31	157.02	
					1076.72		630.38	729.74	
3	1	0.52	1.00	45.45	22.73	39.36	18.34	91.35	1.21
	2	0.59	3.00	136.35	76.25	113.04	52.68	95.42	
	3	0.66	5.50	249.98	153.90	196.98	91.79	100.39	
	4	0.79	7.50	340.88	241.04	241.04	112.32	111.88	
	5	0.89	7.00	318.15	247.25	200.22	93.30	125.71	
	6	1.03	4.00	181.80	155.83	93.63	43.63	153.60	
					896.99		412.07	678.35	

Table 4.83 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.36	37.50	115.42	51.36	114.74	1.253
	2	0.42	6.00	364.08	148.08	332.60	148.01	119.45	
	3	0.49	9.50	576.46	270.63	508.98	226.50	123.59	
	4	0.65	12.00	728.16	438.22	581.53	258.78	136.63	
	5	0.75	8.00	485.44	331.07	355.03	157.99	149.20	
	6	0.94	3.00	182.04	147.27	107.00	47.62	185.65	
					1372.78		890.25	829.25	
2	1	0.367	1.500	79.643	28.541	74.353	34.648	97.362	1.252
	2	0.471	5.000	265.475	120.523	236.540	110.228	102.014	
	3	0.576	7.500	398.213	216.882	333.969	155.630	108.380	
	4	0.716	10.000	530.950	348.335	400.713	186.732	120.437	
	5	0.838	6.500	345.118	256.472	230.929	107.613	135.840	
	6	0.942	2.500	132.738	107.387	78.021	36.358	154.640	
					1078.140		631.208	718.673	
3	1	0.52	1.00	45.51	22.76	39.41	18.37	89.96	1.20
	2	0.59	3.00	136.53	76.35	113.19	52.75	93.98	
	3	0.66	5.50	250.31	154.10	197.24	91.92	98.87	
	4	0.79	7.50	341.33	241.35	241.35	112.47	110.18	
	5	0.89	7.00	318.57	247.58	200.48	93.42	123.80	
	6	1.03	4.00	182.04	156.04	93.76	43.69	151.27	
					898.17		412.61	668.06	

Table 4.84 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 55 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.52	37.55	115.57	51.43	114.74	1.25
	2	0.42	6.00	364.56	148.28	333.04	148.20	119.45	
	3	0.49	9.50	577.22	270.99	509.66	226.80	123.59	
	4	0.65	12.00	729.12	438.80	582.30	259.12	136.63	
	5	0.75	8.00	486.08	331.51	355.50	158.20	149.20	
	6	0.94	3.00	182.28	147.47	107.14	47.68	185.65	
					1374.59		891.43	829.25	
2	1	0.37	1.50	79.75	28.58	74.45	33.13	92.49	1.19
	2	0.47	5.00	265.83	120.68	236.85	105.40	96.91	
	3	0.58	7.50	398.74	217.17	334.41	148.81	102.95	
	4	0.72	10.00	531.65	348.79	401.24	178.55	114.41	
	5	0.84	6.50	345.57	256.81	231.23	102.90	129.04	
	6	0.94	2.50	132.91	107.53	78.12	34.77	146.90	
					1079.56		603.56	682.70	
3	1	0.52	1.00	45.57	22.79	39.46	17.56	85.46	1.14
	2	0.59	3.00	136.71	76.45	113.34	50.44	89.27	
	3	0.66	5.50	250.64	154.31	197.50	87.89	93.92	
	4	0.79	7.50	341.78	241.67	241.67	107.54	104.67	
	5	0.89	7.00	318.99	247.90	200.75	89.33	117.60	
	6	1.03	4.00	182.28	156.24	93.88	41.78	143.70	
					899.36		394.54	634.62	

Table 4.85 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.50	150.70	46.57	143.32	63.78	53.29	0.84
	2	0.40	8.00	482.24	188.43	443.90	197.54	55.06	
	3	0.49	12.50	753.50	353.75	665.30	296.06	57.40	
	4	0.63	11.00	663.08	389.75	536.44	238.72	62.64	
	5	0.73	7.50	452.10	302.51	335.98	149.51	68.20	
	6	0.93	3.50	210.98	168.50	126.97	56.50	84.21	
					1449.50		1002.10	380.80	
2	1	0.38	2.00	105.42	39.49	97.74	43.50	47.83	0.85
	2	0.47	6.00	316.26	143.58	281.79	125.40	49.77	
	3	0.58	10.00	527.10	287.08	442.06	196.72	52.88	
	4	0.72	10.50	553.46	363.10	417.70	185.88	58.76	
	5	0.84	7.50	395.33	293.78	264.52	117.71	66.27	
	6	0.98	2.50	131.78	109.25	73.69	32.79	79.30	
					1236.28		701.99	354.80	
3	1	0.49	1.50	67.77	31.82	59.84	26.63	43.05	0.79
	2	0.58	2.50	112.95	61.52	94.73	42.15	45.32	
	3	0.66	8.00	361.44	222.52	284.82	126.74	48.24	
	4	0.79	10.50	474.39	335.44	335.44	149.27	53.75	
	5	0.91	7.00	316.26	249.22	194.71	86.65	61.74	
	6	1.05	2.00	90.36	78.25	45.18	20.11	76.02	
					978.77		451.55	328.12	

Table 4.86 Swedish slip circle Analysis for soil sample of Salri Site for onet tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.48	37.23	114.58	46.29	60.48	0.90
	2	0.42	6.00	361.44	147.01	330.19	133.40	62.96	
	3	0.49	9.50	572.28	268.67	505.29	204.14	65.15	
	4	0.65	12.00	722.88	435.04	577.32	233.24	72.02	
	5	0.75	8.00	481.92	328.67	352.45	142.39	78.65	
	6	0.94	3.00	180.72	146.21	106.22	42.91	97.86	
					1362.82		802.37	437.12	
2	1	0.37	1.50	79.07	28.33	73.81	29.82	53.91	0.87
	2	0.47	5.00	263.55	119.65	234.82	94.87	56.49	
	3	0.58	7.50	395.33	215.31	331.55	133.95	60.01	
	4	0.72	10.00	527.10	345.81	397.81	160.71	66.69	
	5	0.84	6.50	342.62	254.61	229.25	92.62	75.22	
	6	0.94	2.50	131.78	106.61	77.46	31.29	85.63	
					1070.32		543.26	397.94	
3	1	0.52	1.00	45.21	22.61	39.15	15.82	49.81	0.81
	2	0.59	3.00	135.63	75.84	112.44	45.43	52.04	
	3	0.66	5.50	248.66	153.09	195.94	79.16	54.75	
	4	0.79	7.50	339.08	239.76	239.76	96.86	61.01	
	5	0.89	7.00	316.47	245.94	199.16	80.46	68.55	
	6	1.03	4.00	180.84	155.01	93.14	37.63	83.76	
					892.25		355.36	369.92	

Table 4.87 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.72	37.30	114.81	53.50	91.06	1.16
	2	0.42	6.00	362.16	147.30	330.85	154.18	94.80	
	3	0.49	9.50	573.42	269.20	506.30	235.94	98.08	
	4	0.65	12.00	724.32	435.91	578.47	269.57	108.43	
	5	0.75	8.00	482.88	329.32	353.16	164.57	118.41	
	6	0.94	3.00	181.08	146.50	106.44	49.60	147.33	
					1365.54		927.35	658.11	
2	1	0.37	1.50	79.22	28.39	73.96	34.47	81.17	1.14
	2	0.47	5.00	264.08	119.89	235.29	109.65	85.04	
	3	0.58	7.50	396.11	215.74	332.21	154.81	90.35	
	4	0.72	10.00	528.15	346.50	398.60	185.75	100.40	
	5	0.84	6.50	343.30	255.12	229.71	107.05	113.24	
	6	0.94	2.50	132.04	106.82	77.61	36.17	128.92	
					1072.45		627.88	599.12	
3	1	0.52	1.00	45.27	22.64	39.20	18.27	75.00	1.08
	2	0.59	3.00	135.81	75.94	112.59	52.47	78.34	
	3	0.66	5.50	248.99	153.29	196.20	91.43	82.42	
	4	0.79	7.50	339.53	240.08	240.08	111.88	91.85	
	5	0.89	7.00	316.89	246.27	199.43	92.93	103.21	
	6	1.03	4.00	181.08	155.22	93.26	43.46	126.11	
					893.44		410.44	556.93	

Table 4.88 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	120.88	37.35	114.96	53.57	104.01	1.23
	2	0.42	6.00	362.64	147.50	331.29	154.38	108.28	
	3	0.49	9.50	574.18	269.56	506.97	236.25	112.03	
	4	0.65	12.00	725.28	436.48	579.23	269.92	123.86	
	5	0.75	8.00	483.52	329.76	353.62	164.79	135.26	
	6	0.94	3.00	181.32	146.69	106.58	49.66	168.29	
					1367.35		928.58	751.74	
2	1	0.37	1.50	79.33	28.43	74.06	34.51	92.71	1.22
	2	0.47	5.00	264.43	120.05	235.60	109.79	97.14	
	3	0.58	7.50	396.64	216.02	332.65	155.01	103.21	
	4	0.72	10.00	528.85	346.96	399.13	185.99	114.69	
	5	0.84	6.50	343.75	255.46	230.02	107.19	129.35	
	6	0.94	2.50	132.21	106.96	77.71	36.21	147.26	
					1073.88		628.71	684.36	
3	1	0.52	1.00	45.33	22.67	39.26	18.29	85.67	1.17
	2	0.59	3.00	135.99	76.04	112.74	52.54	89.49	
	3	0.66	5.50	249.32	153.49	196.46	91.55	94.15	
	4	0.79	7.50	339.98	240.40	240.40	112.03	104.92	
	5	0.89	7.00	317.31	246.60	199.69	93.06	117.89	
	6	1.03	4.00	181.32	155.42	93.39	43.52	144.05	
					894.6197		410.982	636.1622	

Table 4.89 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.04	37.40	115.12	51.23	114.74	1.25
	2	0.42	6.00	363.12	147.69	331.73	147.62	119.45	
	3	0.49	9.50	574.94	269.92	507.64	225.90	123.59	
	4	0.65	12.00	726.24	437.06	580.00	258.10	136.63	
	5	0.75	8.00	484.16	330.20	354.09	157.57	149.20	
	6	0.94	3.00	181.56	146.89	106.72	47.49	185.65	
					1369.16		887.91	829.25	
2	1	0.37	1.50	79.43	28.47	74.16	33.00	102.27	1.26
	2	0.47	5.00	264.78	120.21	235.92	104.98	107.16	
	3	0.58	7.50	397.16	216.31	333.09	148.22	113.85	
	4	0.72	10.00	529.55	347.42	399.66	177.85	126.51	
	5	0.84	6.50	344.21	255.80	230.32	102.49	142.69	
	6	0.94	2.50	132.39	107.10	77.82	34.63	162.44	
					1075.30		601.17	754.92	
3	1	0.52	1.00	45.39	22.70	39.31	17.49	94.50	1.22
	2	0.59	3.00	136.17	76.15	112.89	50.24	98.72	
	3	0.66	5.50	249.65	153.70	196.72	87.54	103.86	
	4	0.79	7.50	340.43	240.72	240.72	107.12	115.74	
	5	0.89	7.00	317.73	246.92	199.95	88.98	130.05	
	6	1.03	4.00	181.56	155.63	93.51	41.61	158.90	
					895.80		392.98	701.76	

Table 4.90 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.20	37.45	115.27	53.71	110.91	1.27
	2	0.42	6.00	363.60	147.89	332.17	154.79	115.46	
	3	0.49	9.50	575.70	270.27	508.31	236.87	119.46	
	4	0.65	12.00	727.20	437.64	580.77	270.64	132.08	
	5	0.75	8.00	484.80	330.63	354.56	165.23	144.23	
	6	0.94	3.00	181.80	147.08	106.86	49.80	179.45	
					1370.97		931.04	801.59	
2	1	0.37	1.50	79.54	28.50	74.25	34.60	98.86	1.26
	2	0.47	5.00	265.13	120.36	236.23	110.08	103.59	
	3	0.58	7.50	397.69	216.60	333.53	155.42	110.05	
	4	0.72	10.00	530.25	347.88	400.18	186.49	122.29	
	5	0.84	6.50	344.66	256.13	230.62	107.47	137.93	
	6	0.94	2.50	132.56	107.25	77.92	36.31	157.02	
					1076.72		630.38	729.74	
3	1	0.52	1.00	45.45	22.73	39.36	18.34	91.35	1.22
	2	0.59	3.00	136.35	76.25	113.04	52.68	95.42	
	3	0.66	5.50	249.98	153.90	196.98	91.79	100.39	
	4	0.79	7.50	340.88	241.04	241.04	112.32	111.88	
	5	0.89	7.00	318.15	247.25	200.22	93.30	125.71	
	6	1.03	4.00	181.80	155.83	93.63	43.63	153.60	
					896.99		412.07	678.35	

Table 4.91 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.31	2.00	121.36	37.50	115.42	51.36	114.74	
	2	0.42	6.00	364.08	148.08	332.60	148.01	119.45	
	3	0.49	9.50	576.46	270.63	508.98	226.50	123.59	
	4	0.65	12.00	728.16	438.22	581.53	258.78	136.63	1.26
	5	0.75	8.00	485.44	331.07	355.03	157.99	149.20	
	6	0.94	3.00	182.04	147.27	107.00	47.62	185.65	
					1372.78		890.25	829.25	
2	1	0.37	1.50	79.64	28.54	74.35	34.65	97.36	
	2	0.47	5.00	265.48	120.52	236.54	110.23	102.01	
	3	0.58	7.50	398.21	216.88	333.97	155.63	108.38	
	4	0.72	10.00	530.95	348.33	400.71	186.73	120.44	1.25
	5	0.84	6.50	345.12	256.47	230.93	107.61	135.84	
	6	0.94	2.50	132.74	107.39	78.02	36.36	154.64	
					1078.14		631.21	718.67	
3	1	0.52	1.00	45.51	22.76	39.41	18.37	89.96	
	2	0.59	3.00	136.53	76.35	113.19	52.75	93.98	
	3	0.66	5.50	250.31	154.10	197.24	91.92	98.87	
	4	0.79	7.50	341.33	241.35	241.35	112.47	110.18	1.20
	5	0.89	7.00	318.57	247.58	200.48	93.42	123.80	
	6	1.03	4.00	182.04	156.04	93.76	43.69	151.27	
					898.17		412.61	668.06	

Table 4.92 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 60 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.314	2.000	121.520	37.552	115.572	51.430	114.736	
	2	0.419	6.000	364.560	148.280	333.042	148.204	119.447	
	3	0.489	9.500	577.220	270.988	509.655	226.796	123.586	
	4	0.646	12.000	729.120	438.795	582.301	259.124	136.633	1.25
	5	0.750	8.000	486.080	331.506	355.496	158.196	149.203	
	6	0.942	3.000	182.280	147.468	107.141	47.678	185.646	
					1374.589		891.428	829.250	
2	1	0.37	1.50	79.75	28.58	74.45	33.13	92.49	
	2	0.47	5.00	265.83	120.68	236.85	105.40	96.91	
	3	0.58	7.50	398.74	217.17	334.41	148.81	102.95	
	4	0.72	10.00	531.65	348.79	401.24	178.55	114.41	1.19
	5	0.84	6.50	345.57	256.81	231.23	102.90	129.04	
	6	0.94	2.50	132.91	107.53	78.12	34.77	146.90	
					1079.56		603.56	682.70	
3	1	0.52	1.00	45.57	22.79	39.46	17.56	85.46	
	2	0.59	3.00	136.71	76.45	113.34	50.44	89.27	
	3	0.66	5.50	250.64	154.31	197.50	87.89	93.92	
	4	0.79	7.50	341.78	241.67	241.67	107.54	104.67	1.14
	5	0.89	7.00	318.99	247.90	200.75	89.33	117.60	
	6	1.03	4.00	182.28	156.24	93.88	41.78	143.70	
					899.36		394.54	634.62	

Table 4.93 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	97.89	33.48	91.99	40.93	43.82	0.79
	2	0.47	8.00	391.56	177.76	348.88	155.25	46.21	
	3	0.58	12.50	611.81	333.22	513.11	228.33	49.10	
	4	0.70	11.00	538.40	346.07	412.43	183.53	53.75	
	5	0.84	8.00	391.56	290.99	262.00	116.59	61.54	
	6	1.01	4.00	195.78	166.03	103.75	46.17	77.71	
					1347.55		770.81	332.13	
2	1	0.30	1.50	56.48	16.51	54.01	24.03	33.12	0.83
	2	0.58	6.25	235.31	128.16	197.35	87.82	37.77	
	3	0.70	12.50	470.63	302.51	360.52	160.43	41.35	
	4	0.80	10.50	395.33	284.37	274.62	122.20	45.60	
	5	0.93	7.50	282.38	225.51	169.94	75.62	52.63	
	6	1.10	2.50	94.13	83.87	42.73	19.02	69.77	
					1040.94		489.13	280.24	
3	1	0.38	3.00	158.13	59.24	146.62	65.24	47.83	0.85
	2	0.47	8.50	448.04	203.40	399.20	177.64	49.77	
	3	0.58	13.50	711.59	387.56	596.79	265.57	52.88	
	4	0.68	11.00	579.81	364.89	450.60	200.52	57.06	
	5	0.79	7.50	395.33	279.54	279.54	124.39	62.71	
	6	0.96	3.00	158.13	129.53	90.70	40.36	77.31	
					1424.15		873.73	347.56	

Table 4.94 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	97.96	33.50	92.05	37.19	49.73	0.81
	2	0.47	8.00	391.82	177.88	349.11	141.04	52.45	
	3	0.58	12.50	612.22	333.44	513.45	207.43	55.73	
	4	0.70	11.00	538.75	346.30	412.71	166.73	61.01	
	5	0.84	8.00	391.82	291.18	262.18	105.92	69.84	
	6	1.01	4.00	195.91	166.14	103.82	41.94	88.19	
					1348.45		700.26	376.96	
2	1	0.30	1.50	56.51	16.52	54.04	21.83	37.59	0.86
	2	0.58	6.25	235.47	128.25	197.48	79.78	42.87	
	3	0.70	12.50	470.94	302.71	360.76	145.75	46.93	
	4	0.80	10.50	395.59	284.56	274.80	111.02	51.75	
	5	0.93	7.50	282.56	225.66	170.05	68.70	59.74	
	6	1.10	2.50	94.19	83.92	42.76	17.28	79.19	
					1041.63		444.36	318.06	
3	1	0.38	3.00	158.24	59.28	146.71	59.27	54.28	0.83
	2	0.47	8.50	448.33	203.54	399.47	161.38	56.49	
	3	0.58	13.50	712.06	387.81	597.18	241.26	60.01	
	4	0.68	11.00	580.20	365.13	450.90	182.16	64.76	
	5	0.79	7.50	395.59	279.72	279.72	113.01	71.18	
	6	0.96	3.00	158.24	129.62	90.76	36.67	87.75	
					1425.10		793.76	394.47	

Table 4.95 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.09	33.55	92.17	42.95	74.88	1.01
	2	0.47	8.00	392.34	178.12	349.58	162.90	78.97	
	3	0.58	12.50	613.03	333.88	514.13	239.59	83.90	
	4	0.70	11.00	539.47	346.76	413.26	192.58	91.85	
	5	0.84	8.00	392.34	291.57	262.53	122.34	105.16	
	6	1.01	4.00	196.17	166.36	103.95	48.44	132.78	
					1350.24		808.80	567.53	
2	1	0.30	1.50	56.59	16.54	54.11	25.22	56.60	0.95
	2	0.58	6.25	235.78	128.42	197.74	92.15	64.54	
	3	0.70	12.50	471.56	303.11	361.24	168.34	70.66	
	4	0.80	10.50	396.11	284.94	275.16	128.23	77.92	
	5	0.93	7.50	282.94	225.96	170.28	79.35	89.94	
	6	1.10	2.50	94.31	84.03	42.82	19.95	119.22	
					1043.01		513.23	478.86	
3	1	0.38	3.00	158.45	59.35	146.91	68.46	55.49	1.00
	2	0.47	8.50	448.93	203.81	400.00	186.40	57.74	
	3	0.58	13.50	713.00	388.33	597.97	278.66	61.35	
	4	0.68	11.00	580.97	365.61	451.49	210.40	66.20	
	5	0.79	7.50	396.11	280.09	280.09	130.52	72.76	
	6	0.96	3.00	158.45	129.79	90.88	42.35	89.70	
					1426.99		916.78	403.25	

Table 4.96 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.22	33.59	92.29	43.01	85.53	1.07
	2	0.47	8.00	392.86	178.35	350.04	163.12	90.20	
	3	0.58	12.50	613.84	334.32	514.81	239.90	95.83	
	4	0.70	11.00	540.18	347.22	413.80	192.83	104.92	
	5	0.84	8.00	392.86	291.95	262.87	122.50	120.11	
	6	1.01	4.00	196.43	166.58	104.09	48.51	151.67	
					1352.03		809.87	648.27	
2	1	0.30	1.50	56.66	16.57	54.19	25.25	64.65	1.01
	2	0.58	6.25	236.09	128.59	198.00	92.27	73.72	
	3	0.70	12.50	472.19	303.52	361.72	168.56	80.71	
	4	0.80	10.50	396.64	285.32	275.53	128.40	89.00	
	5	0.93	7.50	283.31	226.26	170.50	79.45	102.73	
	6	1.10	2.50	94.44	84.14	42.87	19.98	136.18	
					1044.39		513.91	546.99	
3	1	0.38	3.00	158.66	59.43	147.10	68.55	93.35	1.11
	2	0.47	8.50	449.52	204.08	400.53	186.65	97.14	
	3	0.58	13.50	713.95	388.84	598.77	279.03	103.21	
	4	0.68	11.00	581.74	366.10	452.09	210.68	111.38	
	5	0.79	7.50	396.64	280.47	280.47	130.70	122.41	
	6	0.96	3.00	158.66	129.96	91.00	42.41	150.90	
					1428.88		918.00	678.39	

Table 4.97 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.35	33.64	92.41	41.12	94.35	1.10
	2	0.47	8.00	393.38	178.59	350.50	155.97	99.51	
	3	0.58	12.50	614.66	334.77	515.49	229.39	105.71	
	4	0.70	11.00	540.90	347.68	414.35	184.39	115.74	
	5	0.84	8.00	393.38	292.34	263.22	117.13	132.50	
	6	1.01	4.00	196.69	166.80	104.23	46.38	167.31	
					1353.82		774.40	715.12	
2	1	0.30	1.50	56.74	16.59	54.26	24.14	71.32	1.04
	2	0.58	6.25	236.41	128.76	198.27	88.23	81.32	
	3	0.70	12.50	472.81	303.92	362.20	161.18	89.03	
	4	0.80	10.50	397.16	285.69	275.89	122.77	98.18	
	5	0.93	7.50	283.69	226.56	170.73	75.97	113.32	
	6	1.10	2.50	94.56	84.26	42.93	19.10	150.22	
					1045.78		491.40	603.39	
3	1	0.38	3.00	158.87	59.51	147.30	65.55	102.98	1.13
	2	0.47	8.50	450.12	204.35	401.06	178.47	107.16	
	3	0.58	13.50	714.89	389.36	599.56	266.80	113.85	
	4	0.68	11.00	582.51	366.58	452.69	201.45	122.86	
	5	0.79	7.50	397.16	280.84	280.84	124.97	135.03	
	6	0.96	3.00	158.87	130.13	91.12	40.55	166.46	
					1430.77		877.79	748.34	

Table 4.98 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.48	33.68	92.54	43.12	91.20	1.11
	2	0.47	8.00	393.90	178.83	350.97	163.55	96.19	
	3	0.58	12.50	615.47	335.21	516.18	240.54	102.19	
	4	0.70	11.00	541.61	348.14	414.90	193.34	111.88	
	5	0.84	8.00	393.90	292.72	263.57	122.82	128.08	
	6	1.01	4.00	196.95	167.02	104.37	48.64	161.73	
					1355.61		812.01	691.26	
2	1	0.30	1.50	56.81	16.61	54.33	25.32	68.94	1.04
	2	0.58	6.25	236.72	128.93	198.53	92.51	78.61	
	3	0.70	12.50	473.44	304.32	362.67	169.01	86.06	
	4	0.80	10.50	397.69	286.07	276.26	128.74	94.90	
	5	0.93	7.50	284.06	226.86	170.95	79.66	109.54	
	6	1.10	2.50	94.69	84.37	42.99	20.03	145.21	
					1047.16		515.27	583.26	
3	1	0.38	3.00	159.08	59.59	147.49	68.73	99.54	1.12
	2	0.47	8.50	450.71	204.62	401.59	178.71	103.59	
	3	0.58	13.50	715.84	389.87	600.35	267.16	110.05	
	4	0.68	11.00	583.28	367.07	453.29	201.71	118.76	
	5	0.79	7.50	397.69	281.21	281.21	125.14	130.52	
	6	0.96	3.00	159.08	130.31	91.24	40.60	160.91	
					1432.664		882.0482	723.3754	

Table 4.99 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.61	33.72	92.66	43.18	89.82	1.10
	2	0.47	8.00	394.42	179.06	351.43	163.77	94.73	
	3	0.58	12.50	616.28	335.65	516.86	240.86	100.64	
	4	0.70	11.00	542.33	348.60	415.45	193.60	110.18	
	5	0.84	8.00	394.42	293.11	263.92	122.99	126.14	
	6	1.01	4.00	197.21	167.24	104.51	48.70	159.27	
					1357.39		813.08	680.78	
2	1	0.30	1.50	56.89	16.63	54.40	25.35	67.89	1.04
	2	0.58	6.25	237.03	129.10	198.79	92.64	77.41	
	3	0.70	12.50	474.06	304.72	363.15	169.23	84.75	
	4	0.80	10.50	398.21	286.45	276.62	128.91	93.46	
	5	0.93	7.50	284.44	227.16	171.18	79.77	107.88	
	6	1.10	2.50	94.81	84.48	43.04	20.06	143.01	
					1048.54		515.95	574.41	
3	1	0.38	3.00	159.29	59.67	147.69	68.82	98.03	1.14
	2	0.47	8.50	451.31	204.89	402.12	187.39	102.01	
	3	0.58	13.50	716.78	390.39	601.14	280.13	108.38	
	4	0.68	11.00	584.05	367.55	453.89	211.51	116.96	
	5	0.79	7.50	398.21	281.58	281.58	131.22	128.54	
	6	0.96	3.00	159.29	130.48	91.36	42.57	158.47	
					1434.56		921.64	712.40	

Table 4.100 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 65 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.35	2.00	98.74	33.77	92.78	41.29	85.32	1.04
	2	0.47	8.00	394.94	179.30	351.89	156.59	89.99	
	3	0.58	12.50	617.09	336.09	517.54	230.30	95.60	
	4	0.70	11.00	543.04	349.06	415.99	185.12	104.66	
	5	0.84	8.00	394.94	293.50	264.27	117.60	119.82	
	6	1.01	4.00	197.47	167.46	104.64	46.57	151.30	
					1359.18		777.47	646.70	
2	1	0.30	1.50	56.96	16.65	54.47	24.24	64.49	0.98
	2	0.58	6.25	237.34	129.27	199.05	88.58	73.54	
	3	0.70	12.50	474.69	305.12	363.63	161.82	80.51	
	4	0.80	10.50	398.74	286.83	276.99	123.26	88.78	
	5	0.93	7.50	284.81	227.46	171.40	76.27	102.48	
	6	1.10	2.50	94.94	84.59	43.10	19.18	135.85	
					1049.92		493.35	545.66	
3	1	0.38	3.00	159.50	59.75	147.88	65.81	93.13	1.08
	2	0.47	8.50	451.90	205.16	402.65	179.18	96.91	
	3	0.58	13.50	717.73	390.90	601.94	267.86	102.95	
	4	0.68	11.00	584.82	368.04	454.49	202.25	111.11	
	5	0.79	7.50	398.74	281.95	281.95	125.47	122.11	
	6	0.96	3.00	159.50	130.65	91.48	40.71	150.54	
					1436.45		881.27	676.74	

Table 4.101 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	271.08	88.26	256.31	114.06	53.60	0.95
	2	0.44	13.50	813.24	343.69	737.05	327.99	55.92	
	3	0.52	13.00	783.12	391.56	678.20	301.80	58.52	
	4	0.65	10.00	602.40	362.53	481.10	214.09	63.46	
	5	0.77	7.00	421.68	292.92	303.33	134.98	70.45	
	6	0.91	2.50	150.60	118.67	92.72	41.26	82.32	
					1597.64		1134.17	384.27	
2	1	0.42	2.50	131.78	53.60	120.38	53.57	48.54	0.83
	2	0.51	11.50	606.17	293.87	530.16	235.92	50.70	
	3	0.59	12.50	658.88	368.44	546.23	243.07	53.49	
	4	0.70	10.50	553.46	355.75	423.97	188.67	57.89	
	5	0.79	7.50	395.33	279.54	279.54	124.39	62.71	
	6	0.91	3.00	158.13	124.61	97.35	43.32	72.03	
					1475.81		888.95	345.36	
3	1	0.52	3.00	135.54	67.77	117.38	52.23	43.89	0.75
	2	0.61	9.00	406.62	233.23	333.08	148.22	46.40	
	3	0.68	13.00	587.34	369.63	456.45	203.12	48.91	
	4	0.77	10.00	451.80	313.85	325.00	144.62	52.84	
	5	0.87	7.00	316.26	242.27	203.29	90.46	59.13	
	6	0.99	2.50	112.95	94.73	61.52	27.38	69.79	
					1321.47		666.04	320.96	

Table 4.102 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	271.26	88.31	256.48	103.62	60.83	0.92
	2	0.44	13.50	813.78	343.92	737.54	297.96	63.47	
	3	0.52	13.00	783.64	391.82	678.65	274.18	66.42	
	4	0.65	10.00	602.80	362.77	481.42	194.49	72.02	
	5	0.77	7.00	421.96	293.12	303.53	122.63	79.96	
	6	0.91	2.50	150.70	118.75	92.78	37.48	93.43	
					1598.70		1030.36	436.13	
2	1	0.42	2.50	131.86	53.63	120.46	48.67	55.09	0.79
	2	0.51	11.50	606.57	294.07	530.52	214.33	57.55	
	3	0.59	12.50	659.31	368.68	546.59	220.82	60.71	
	4	0.70	10.50	553.82	355.99	424.25	171.40	65.70	
	5	0.79	7.50	395.59	279.72	279.72	113.01	71.18	
	6	0.91	3.00	158.24	124.69	97.42	39.36	81.75	
					1476.79		807.58	391.97	
3	1	0.52	3.00	135.63	67.82	117.46	47.45	49.81	0.81
	2	0.61	9.00	406.89	233.38	333.30	134.66	52.66	
	3	0.68	13.00	587.73	369.87	456.75	184.53	55.51	
	4	0.77	10.00	452.10	314.06	325.21	131.39	59.97	
	5	0.87	7.00	316.47	242.43	203.42	82.18	67.11	
	6	0.99	2.50	113.03	94.79	61.56	24.87	79.21	
					1322.34		605.07	364.28	

Table 4.103 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	271.62	88.43	256.82	119.68	91.59	1.15
	2	0.44	13.50	814.86	344.37	738.51	344.15	95.55	
	3	0.52	13.00	784.68	392.34	679.55	316.67	100.00	
	4	0.65	10.00	603.60	363.26	482.06	224.64	108.43	
	5	0.77	7.00	422.52	293.51	303.94	141.63	120.39	
	6	0.91	2.50	150.90	118.91	92.90	43.29	140.66	
					1600.82		1190.06	656.62	
2	1	0.42	2.50	132.04	53.70	120.62	56.21	82.95	1.02
	2	0.51	11.50	607.37	294.46	531.22	247.55	86.64	
	3	0.59	12.50	660.19	369.17	547.32	255.05	91.40	
	4	0.70	10.50	554.56	356.46	424.82	197.96	98.92	
	5	0.79	7.50	396.11	280.09	280.09	130.52	107.16	
	6	0.91	3.00	158.45	124.86	97.55	45.46	123.08	
					1478.75		932.76	590.14	
3	1	0.52	3.00	135.81	67.91	117.61	54.81	75.00	0.94
	2	0.61	9.00	407.43	233.69	333.75	155.53	79.29	
	3	0.68	13.00	588.51	370.36	457.36	213.13	83.58	
	4	0.77	10.00	452.70	314.47	325.65	151.75	90.29	
	5	0.87	7.00	316.89	242.75	203.69	94.92	101.04	
	6	0.99	2.50	113.18	94.92	61.64	28.72	119.25	
					1324.10		698.86	548.45	

Table 4.104 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	271.98	88.55	257.16	119.84	104.62	1.21
	2	0.44	13.50	815.94	344.83	739.49	344.60	109.15	
	3	0.52	13.00	785.72	392.86	680.45	317.09	114.22	
	4	0.65	10.00	604.40	363.74	482.70	224.94	123.86	
	5	0.77	7.00	423.08	293.90	304.34	141.82	137.51	
	6	0.91	2.50	151.10	119.07	93.03	43.35	160.67	
					1602.94		1191.64	750.04	
2	1	0.42	2.50	132.21	53.78	120.78	56.28	94.75	1.09
	2	0.51	11.50	608.18	294.85	531.92	247.88	98.96	
	3	0.59	12.50	661.06	369.66	548.05	255.39	104.40	
	4	0.70	10.50	555.29	356.94	425.38	198.23	112.99	
	5	0.79	7.50	396.64	280.47	280.47	130.70	122.41	
	6	0.91	3.00	158.66	125.02	97.68	45.52	140.59	
					1480.71		933.99	674.10	
3	1	0.52	3.00	135.99	68.00	117.77	54.88	85.67	1.02
	2	0.61	9.00	407.97	234.00	334.19	155.73	90.57	
	3	0.68	13.00	589.29	370.85	457.96	213.41	95.46	
	4	0.77	10.00	453.30	314.89	326.08	151.95	103.14	
	5	0.87	7.00	317.31	243.07	203.96	95.05	115.42	
	6	0.99	2.50	113.33	95.04	61.72	28.76	136.22	
					1325.85		699.79	626.48	

Table 4.105 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	272.34	88.67	257.50	114.59	115.41	1.22
	2	0.44	13.50	817.02	345.29	740.47	329.51	120.40	
	3	0.52	13.00	786.76	393.38	681.35	303.20	126.00	
	4	0.65	10.00	605.20	364.22	483.33	215.08	136.63	
	5	0.77	7.00	423.64	294.29	304.74	135.61	151.69	
	6	0.91	2.50	151.30	119.23	93.15	41.45	177.24	
					1605.06		1139.45	827.38	
2	1	0.42	2.50	132.39	53.85	120.94	53.82	104.52	1.10
	2	0.51	11.50	608.98	295.24	532.63	237.02	109.17	
	3	0.59	12.50	661.94	370.15	548.77	244.20	115.17	
	4	0.70	10.50	556.03	357.41	425.94	189.54	124.64	
	5	0.79	7.50	397.16	280.84	280.84	124.97	135.03	
	6	0.91	3.00	158.87	125.19	97.81	43.52	155.09	
					1482.67		893.08	743.61	
3	1	0.52	3.00	136.17	68.09	117.93	52.48	94.50	1.022
	2	0.61	9.00	408.51	234.31	334.63	148.91	99.91	
	3	0.68	13.00	590.07	371.34	458.57	204.06	105.31	
	4	0.77	10.00	453.90	315.31	326.51	145.30	113.77	
	5	0.87	7.00	317.73	243.40	204.23	90.88	127.32	
	6	0.99	2.50	113.48	95.17	61.80	27.50	150.26	
					1327.61		669.13	691.07	

Table 4.106 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	272.70	88.78	257.84	120.15	111.56	1.24
	2	0.44	13.50	818.10	345.74	741.45	345.52	116.38	
	3	0.52	13.00	787.80	393.90	682.25	317.93	121.80	
	4	0.65	10.00	606.00	364.70	483.97	225.53	132.08	
	5	0.77	7.00	424.20	294.67	305.14	142.20	146.63	
	6	0.91	2.50	151.50	119.38	93.27	43.47	171.33	
					1607.18		1194.80	799.78	
2	1	0.42	2.50	132.56	53.92	121.10	56.43	101.03	1.11
	2	0.51	11.50	609.79	295.63	533.33	248.53	105.53	
	3	0.59	12.50	662.81	370.64	549.50	256.07	111.33	
	4	0.70	10.50	556.76	357.88	426.50	198.75	120.48	
	5	0.79	7.50	397.69	281.21	281.21	131.04	130.52	
	6	0.91	3.00	159.08	125.35	97.94	45.64	149.91	
					1484.63		936.46	718.80	
3	1	0.52	3.00	136.35	68.18	118.08	55.03	91.35	1.03
	2	0.61	9.00	409.05	234.62	335.07	156.14	96.58	
	3	0.68	13.00	590.85	371.83	459.18	213.98	101.80	
	4	0.77	10.00	454.50	315.72	326.94	152.35	109.98	
	5	0.87	7.00	318.15	243.72	204.50	95.30	123.07	
	6	0.99	2.50	113.63	95.29	61.88	28.84	145.25	
					1329.36		701.64	668.02	

Table 4.107 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	273.06	88.90	258.18	120.31	27.47	0.97
	2	0.44	13.50	819.18	346.20	742.43	330.38	28.66	
	3	0.52	13.00	788.84	394.42	683.16	304.00	29.99	
	4	0.65	10.00	606.80	365.18	484.61	215.65	32.52	
	5	0.77	7.00	424.76	295.06	305.55	135.97	36.11	
	6	0.91	2.50	151.70	119.54	93.40	41.56	42.19	
					1609.31		1147.88	196.94	
2	1	0.42	2.50	132.74	53.99	121.26	56.51	99.50	1.11
	2	0.51	11.50	610.59	296.02	534.04	248.86	103.93	
	3	0.59	12.50	663.69	371.13	550.22	256.40	109.64	
	4	0.70	10.50	557.50	358.35	427.07	199.01	118.65	
	5	0.79	7.50	398.21	281.58	281.58	131.22	128.54	
	6	0.91	3.00	159.29	125.52	98.07	45.70	147.64	
					1486.59		937.70	707.90	
3	1	0.52	3.00	136.53	68.27	118.24	55.10	89.96	1.02
	2	0.61	9.00	409.59	234.93	335.52	156.35	95.11	
	3	0.68	13.00	591.63	372.32	459.78	214.26	100.25	
	4	0.77	10.00	455.10	316.14	327.37	152.56	108.31	
	5	0.87	7.00	318.57	244.04	204.77	95.42	121.21	
	6	0.99	2.50	113.78	95.42	61.97	28.88	143.05	
					1331.12		702.56	657.89	

Table 4.108 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 70 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.33	4.50	273.42	89.02	258.52	115.04	104.37	1.17
	2	0.44	13.50	820.26	346.66	743.41	330.82	108.88	
	3	0.52	13.00	789.88	394.94	684.06	304.40	113.95	
	4	0.65	10.00	607.60	365.66	485.25	215.94	123.56	
	5	0.77	7.00	425.32	295.45	305.95	136.15	137.18	
	6	0.91	2.50	151.90	119.70	93.52	41.62	160.28	
					1611.43		1143.96	748.22	
2	1	0.42	2.50	132.91	54.06	121.42	54.03	94.52	1.05
	2	0.51	11.50	611.40	296.41	534.74	237.96	98.72	
	3	0.59	12.50	664.56	371.62	550.95	245.17	104.15	
	4	0.70	10.50	558.23	358.82	427.63	190.30	112.72	
	5	0.79	7.50	398.74	281.95	281.95	125.47	122.11	
	6	0.91	3.00	159.50	125.68	98.19	43.70	140.25	
					1488.55		896.62	672.46	
3	1	0.52	3.00	180.45	90.23	156.27	69.54	85.46	0.89
	2	0.61	9.00	541.35	310.51	443.45	197.33	90.35	
	3	0.68	13.00	781.95	492.10	607.69	270.42	95.23	
	4	0.77	10.00	601.50	417.84	432.68	192.54	102.89	
	5	0.87	7.00	421.05	322.54	270.65	120.44	115.14	
	6	0.99	2.50	150.38	126.12	81.90	36.45	135.89	
					1759.32		886.72	624.96	

Table 109 Swedish slip circle Analysis for soil sample of Salri Site for without tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.24	36.25	48.11	21.41	31.73	0.68
	2	0.72	7.00	210.84	138.32	159.12	70.81	33.58	
	3	0.80	12.00	361.44	260.00	251.08	111.73	36.48	
	4	0.87	8.50	256.02	196.12	164.57	73.23	39.42	
	5	0.96	6.00	180.72	148.04	103.66	46.13	44.18	
	6	1.06	2.50	75.30	65.86	36.51	16.25	52.27	
					844.59		339.55	237.65	
2	1	0.52	3.00	112.95	56.48	97.82	43.53	36.58	0.74
	2	0.61	11.00	414.15	237.55	339.25	150.97	38.67	
	3	0.72	11.50	432.98	284.06	326.77	145.41	41.97	
	4	0.80	9.00	338.85	243.75	235.38	104.75	45.60	
	5	0.91	6.00	225.90	178.01	139.08	61.89	51.45	
	6	1.05	2.50	94.13	81.51	47.06	20.94	63.35	
					1081.35		527.49	277.61	
3	1	0.82	1.50	33.89	24.78	23.11	10.28	27.87	0.70
	2	0.87	5.50	124.25	95.18	79.86	35.54	29.57	
	3	0.94	9.50	214.61	173.62	126.14	56.13	32.33	
	4	1.05	7.50	169.43	146.73	84.71	37.70	38.01	
	5	1.15	4.50	101.66	92.87	41.35	18.40	46.73	
	6	1.24	1.50	33.89	32.04	11.03	4.91	58.37	
					565.21		162.96	232.88	

Table 4.110 Swedish slip circle Analysis for soil sample of Salri Site for one tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.28	36.28	48.14	19.45	36.01	0.68
	2	0.72	7.00	210.98	138.42	159.23	64.33	38.11	
	3	0.80	12.00	361.68	260.17	251.24	101.50	41.40	
	4	0.87	8.50	256.19	196.25	164.68	66.53	44.74	
	5	0.96	6.00	180.84	148.14	103.73	41.91	50.14	
	6	1.06	2.50	75.35	65.90	36.53	14.76	59.32	
					845.15		308.47	269.73	
2	1	0.52	3.00	113.03	56.51	97.88	39.54	41.51	0.73
	2	0.61	11.00	414.43	237.70	339.48	137.15	43.89	
	3	0.72	11.50	433.26	284.25	326.99	132.10	47.63	
	4	0.80	9.00	339.08	243.91	235.54	95.16	51.75	
	5	0.91	6.00	226.05	178.13	139.17	56.22	58.39	
	6	1.05	2.50	94.19	81.57	47.09	19.03	71.90	
					1082.07		479.21	315.08	
3	1	0.82	1.50	33.91	24.80	23.12	9.34	31.63	0.72
	2	0.87	5.50	124.33	95.24	79.92	32.29	33.56	
	3	0.94	9.50	214.75	173.73	126.23	51.00	36.70	
	4	1.05	7.50	169.54	146.82	84.77	34.25	43.14	
	5	1.15	4.50	101.72	92.93	41.37	16.72	53.03	
	6	1.24	1.50	33.91	32.06	11.04	4.46	66.25	
					565.59		148.05	264.31	

Table 4.111 Swedish slip circle Analysis for soil sample of Salri Site for two tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.36	36.33	48.21	22.46	54.22	0.90
	2	0.72	7.00	211.26	138.60	159.44	74.30	57.37	
	3	0.80	12.00	362.16	260.52	251.58	117.24	62.33	
	4	0.87	8.50	256.53	196.51	164.89	76.84	67.36	
	5	0.96	6.00	181.08	148.33	103.86	48.40	75.49	
	6	1.06	2.50	75.45	65.99	36.58	17.05	89.31	
					846.28		356.28	406.09	
2	1	0.52	3.00	158.45	79.22	137.22	63.94	62.50	0.82
	2	0.61	11.00	580.97	333.23	475.90	221.77	66.07	
	3	0.72	11.50	607.37	398.47	458.39	213.61	71.72	
	4	0.80	9.00	475.34	341.93	330.20	153.87	77.92	
	5	0.91	6.00	316.89	249.71	195.10	90.92	87.91	
	6	1.05	2.50	132.04	114.35	66.02	30.76	108.25	
					1516.91		774.87	474.37	
3	1	0.82	1.50	33.95	24.83	23.16	10.79	47.62	1.00
	2	0.87	5.50	124.49	95.37	80.02	37.29	50.52	
	3	0.94	9.50	215.03	173.96	126.39	58.90	55.25	
	4	1.05	7.50	169.76	147.02	84.88	39.55	64.95	
	5	1.15	4.50	101.86	93.05	41.43	19.31	79.84	
	6	1.24	1.50	33.95	32.10	11.05	5.15	99.75	
					566.34		170.99	397.93	

Table 4.112 Swedish slip circle Analysis for soil sample of Salri Site for three tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.44	36.37	48.27	22.49	61.93	0.96
	2	0.72	7.00	211.54	138.78	159.65	74.40	65.54	
	3	0.80	12.00	362.64	260.86	251.91	117.39	71.20	
	4	0.87	8.50	256.87	196.77	165.11	76.94	76.95	
	5	0.96	6.00	181.32	148.53	104.00	48.46	86.23	
	6	1.06	2.50	75.55	66.08	36.63	17.07	102.02	
					847.40		356.76	463.86	
2	1	0.52	3.00	113.33	56.66	98.14	45.73	71.39	1.01
	2	0.61	11.00	415.53	238.34	340.38	158.62	75.47	
	3	0.72	11.50	434.41	285.00	327.86	152.78	81.92	
	4	0.80	9.00	339.98	244.56	236.17	110.05	89.00	
	5	0.91	6.00	226.65	178.60	139.54	65.03	100.42	
	6	1.05	2.50	94.44	81.79	47.22	22.00	123.65	
					1084.94		554.21	541.85	
3	1	0.82	1.50	34.00	24.86	23.19	10.80	54.39	1.10
	2	0.87	5.50	124.66	95.49	80.13	37.34	57.71	
	3	0.94	9.50	215.32	174.20	126.56	58.98	63.11	
	4	1.05	7.50	169.99	147.21	84.99	39.61	74.19	
	5	1.15	4.50	101.99	93.17	41.48	19.33	91.20	
	6	1.24	1.50	34.00	32.15	11.07	5.16	113.94	
					567.09		171.22	454.54	

Table 4.113 Swedish slip circle Analysis for soil sample of Salri Site for four tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.52	36.42	48.33	21.51	68.32	1.00
	2	0.72	7.00	211.82	138.97	159.86	71.14	72.29	
	3	0.80	12.00	363.12	261.21	252.24	112.25	78.54	
	4	0.87	8.50	257.21	197.03	165.33	73.57	84.88	
	5	0.96	6.00	181.56	148.73	104.14	46.34	95.12	
	6	1.06	2.50	75.65	66.16	36.68	16.32	112.54	
					848.52		341.13	511.69	
2	1	0.52	3.00	113.48	56.74	98.27	43.73	78.75	1.03
	2	0.61	11.00	416.08	238.65	340.83	151.67	83.26	
	3	0.72	11.50	434.99	285.38	328.29	146.09	90.37	
	4	0.80	9.00	340.43	244.88	236.48	105.23	98.18	
	5	0.91	6.00	226.95	178.84	139.72	62.18	110.78	
	6	1.05	2.50	94.56	81.89	47.28	21.04	136.40	
					1086.38		529.94	597.73	
3	1	0.82	1.50	34.04	24.90	23.22	10.33	60.00	1.17
	2	0.87	5.50	124.82	95.62	80.23	35.70	63.66	
	3	0.94	9.50	215.60	174.43	126.73	56.39	69.62	
	4	1.05	7.50	170.21	147.41	85.11	37.87	81.84	
	5	1.15	4.50	102.13	93.30	41.54	18.48	100.61	
	6	1.24	1.50	34.04	32.19	11.08	4.93	125.69	
					567.84		163.72	501.41	

Table 4.114 Swedish slip circle Analysis for soil sample of Salri Site for five tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.60	36.47	48.40	22.55	66.04	1.00
	2	0.72	7.00	212.10	139.15	160.07	74.59	69.88	
	3	0.80	12.00	363.60	261.55	252.58	117.70	75.92	
	4	0.87	8.50	257.55	197.29	165.55	77.15	82.05	
	5	0.96	6.00	181.80	148.92	104.28	48.59	91.95	
	6	1.06	2.50	75.75	66.25	36.72	17.11	108.78	
					849.64		357.70	494.62	
2	1	0.52	3.00	113.63	56.81	98.40	45.86	76.12	1.04
	2	0.61	11.00	416.63	238.97	341.28	159.04	80.48	
	3	0.72	11.50	435.56	285.75	328.72	153.19	87.35	
	4	0.80	9.00	340.88	245.20	236.79	110.34	94.90	
	5	0.91	6.00	227.25	179.08	139.91	65.20	107.08	
	6	1.05	2.50	94.69	82.00	47.34	22.06	131.85	
					1087.82		555.68	577.79	
3	1	0.82	1.50	34.09	24.93	23.25	10.83	58.00	1.15
	2	0.87	5.50	124.99	95.75	80.34	37.44	61.54	
	3	0.94	9.50	215.89	174.66	126.90	59.13	67.29	
	4	1.05	7.50	170.44	147.60	85.22	39.71	79.11	
	5	1.15	4.50	102.26	93.42	41.59	19.38	97.25	
	6	1.24	1.50	34.09	32.23	11.10	5.17	121.50	
					568.59		171.67	484.69	

Table 4.115 Swedish slip circle Analysis for soil sample of Salri Site for six tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.68	36.52	48.46	22.58	65.04	0.95
	2	0.72	7.00	212.38	139.33	160.29	71.33	68.82	
	3	0.80	12.00	364.08	261.90	252.91	112.55	74.77	
	4	0.87	8.50	257.89	197.56	165.77	73.77	80.80	
	5	0.96	6.00	182.04	149.12	104.41	46.46	90.55	
	6	1.06	2.50	75.85	66.34	36.77	16.36	107.13	
					850.76		343.05	487.12	
2	1	0.52	3.00	113.78	56.89	98.53	45.92	74.97	1.03
	2	0.61	11.00	417.18	239.28	341.73	159.25	79.26	
	3	0.72	11.50	436.14	286.13	329.16	153.39	86.03	
	4	0.80	9.00	341.33	245.53	237.10	110.49	93.46	
	5	0.91	6.00	227.55	179.31	140.09	65.28	105.46	
	6	1.05	2.50	94.81	82.11	47.41	22.09	129.85	
					1089.25		556.41	569.02	
3	1	0.82	1.50	34.13	24.96	23.28	10.85	57.12	1.14
	2	0.87	5.50	125.15	95.87	80.45	37.49	60.60	
	3	0.94	9.50	216.17	174.89	127.06	59.21	66.27	
	4	1.05	7.50	170.66	147.80	85.33	39.76	77.91	
	5	1.15	4.50	102.40	93.54	41.65	19.41	95.77	
	6	1.24	1.50	34.13	32.27	11.11	5.18	119.65	
					569.34		171.90	477.33	

Table 4.116 Swedish slip circle Analysis for soil sample of Salri Site for seven tree density per 150sqm for 75 degree slope angle

Trial	Slice no.	Angle in radians	Slice height (m)	Weight of slice (W)	T = W* (Sin α)	N = W* (Cos α)	N*tan (ϕ)	c*L	FOS
1	1	0.65	2.00	60.76	36.57	48.53	21.59	61.78	0.94
	2	0.72	7.00	212.66	139.52	160.50	71.42	65.38	
	3	0.80	12.00	364.56	262.24	253.24	112.69	71.03	
	4	0.87	8.50	258.23	197.82	165.99	73.86	76.76	
	5	0.96	6.00	182.28	149.32	104.55	46.53	86.02	
	6	1.06	2.50	75.95	66.43	36.82	16.39	101.77	
					851.88		342.48	462.74	
2	1	0.52	3.00	113.93	56.96	98.66	43.90	71.22	0.98
	2	0.61	11.00	417.73	239.60	342.18	152.27	75.29	
	3	0.72	11.50	436.71	286.51	329.59	146.67	81.72	
	4	0.80	9.00	341.78	245.85	237.42	105.65	88.78	
	5	0.91	6.00	227.85	179.55	140.28	62.42	100.18	
	6	1.05	2.50	94.94	82.22	47.47	21.12	123.35	
					1090.69		532.04	540.54	
3	1	0.82	1.50	45.11	32.99	30.77	13.69	54.26	0.83
	2	0.87	5.50	165.41	126.71	106.33	47.31	57.57	
	3	0.94	9.50	285.71	231.15	167.94	74.73	62.96	
	4	1.05	7.50	225.56	195.34	112.78	50.19	74.01	
	5	1.15	4.50	135.34	123.64	55.05	24.50	90.98	
	6	1.24	1.50	45.11	42.65	14.69	6.54	113.66	
					752.49		216.96	453.44	

Table 4.117: Bishops Analysis for soil sample of Kakri Ghat for 45 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN (φ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.33	1.00	68.48	22.29	81.02	1.12	1.09	1.08	72.07	74.15	75.22	FOS1 0.78 FOS2 0.82 FOS3 0.85
	2	0.44	4.00	273.92	115.76	159.91	1.14	1.10	1.08	140.50	145.74	148.45	
	3	0.58	6.00	410.88	223.78	212.50	1.14	1.08	1.06	186.82	195.90	200.69	
	4	0.72	7.00	479.36	314.49	238.79	1.11	1.05	1.02	214.24	227.19	234.14	
	5	0.87	7.50	513.60	393.44	251.94	1.06	0.99	0.95	237.01	254.78	264.53	
	6	1.05	4.00	273.92	237.22	159.91	0.98	0.89	0.85	163.99	179.42	188.11	
	Σ =		1306.99				1014.63		1077.17		1111.14		
1	1	0.33	1.00	68.52	22.31	97.61	1.12	1.09	1.09	87.30	89.85	89.49	FOS1 0.90 FOS2 0.86 FOS3 0.95
	2	0.44	4.00	274.08	115.83	184.77	1.13	1.09	1.09	163.47	169.65	168.75	
	3	0.58	6.00	411.12	223.91	242.87	1.13	1.07	1.08	215.44	226.08	224.52	
	4	0.72	7.00	479.64	314.67	271.93	1.10	1.04	1.05	246.66	261.83	259.59	
	5	0.87	7.50	513.90	393.67	286.45	1.05	0.97	0.98	273.13	294.03	290.91	
	6	1.05	4.00	274.08	237.36	184.77	0.96	0.87	0.89	192.67	211.24	208.42	
	Σ =		1307.75				1178.68		1252.68		1241.68		
2	1	0.33	1.00	68.60	22.33	105.11	1.10	1.08	1.08	95.54	96.97	97.35	FOS1 0.94 FOS2 0.97 FOS3 0.98
	2	0.44	4.00	274.40	115.97	188.26	1.11	1.09	1.08	170.03	173.34	174.23	
	3	0.58	6.00	411.60	224.17	243.69	1.10	1.07	1.06	222.03	227.68	229.20	
	4	0.72	7.00	480.20	315.04	271.40	1.07	1.03	1.03	254.47	262.55	264.74	
	5	0.87	7.50	514.50	394.13	285.26	1.01	0.97	0.96	283.31	294.52	297.58	
	6	1.05	4.00	274.40	237.64	188.26	0.91	0.87	0.86	206.51	216.81	219.67	
	Σ =		1309.28				1231.89		1271.88		1282.77		
3	1	0.33	1.00	68.68	22.36	125.24	1.10	1.11	1.09	114.06	113.19	114.55	FOS1 1.02 FOS2 1.06 FOS3 1.09
	2	0.44	4.00	274.72	116.10	216.93	1.10	1.12	1.10	196.45	194.51	197.53	
	3	0.58	6.00	412.08	224.43	278.06	1.09	1.11	1.09	254.21	250.96	256.04	
	4	0.72	7.00	480.76	315.41	308.62	1.06	1.08	1.05	290.60	286.00	293.19	
	5	0.87	7.50	515.10	394.59	323.90	1.00	1.02	0.99	323.38	317.07	326.96	
	6	1.05	4.00	274.72	237.91	216.93	0.91	0.93	0.89	239.53	233.71	242.86	
	Σ =		1310.81				1418.22		1395.43		1431.13		

Table 4.118: Bishops Analysis for soil sample of Kakri Ghat for 45 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.33	1.00	68.76	22.39	135.03	1.13	1.11	1.11	119.24	121.35	121.91	FOS1 1.10 FOS2 1.14 FOS3 1.15
	2	0.44	4.00	275.04	116.24	235.70	1.15	1.12	1.12	205.15	209.81	211.06	
	3	0.58	6.00	412.56	224.70	302.81	1.15	1.12	1.11	263.00	270.74	272.83	
	4	0.72	7.00	481.32	315.77	336.36	1.13	1.09	1.08	297.31	308.11	311.05	
	5	0.87	7.50	515.70	395.05	353.14	1.08	1.04	1.02	326.20	340.77	344.78	
	6	1.05	4.00	275.04	238.19	235.70	1.00	0.94	0.93	236.36	249.45	253.10	
	$\Sigma =$		1312.33				1447.26		1500.24		1514.73		
5	1	0.33	1.00	68.84	22.41	137.96	1.11	1.11	1.12	123.83	124.83	122.74	FOS1 1.13 FOS2 1.15 FOS3 1.11
	2	0.44	4.00	275.36	116.37	234.20	1.13	1.11	1.14	208.15	210.30	205.80	
	3	0.58	6.00	413.04	224.96	298.36	1.12	1.11	1.14	266.23	269.80	262.35	
	4	0.72	7.00	481.88	316.14	330.44	1.09	1.08	1.11	301.93	306.95	296.52	
	5	0.87	7.50	516.30	395.51	346.48	1.04	1.02	1.06	333.33	340.16	326.02	
	6	1.05	4.00	275.36	238.47	234.20	0.95	0.92	0.97	246.94	253.24	240.26	
	$\Sigma =$		1313.86				1480.42		1505.28		1453.67		
6	1	0.33	1.00	68.92	22.44	130.43	1.10	1.09	1.11	118.79	119.29	117.88	FOS1 1.10 FOS2 1.11 FOS3 1.09
	2	0.44	4.00	275.68	116.51	222.44	1.10	1.10	1.12	201.43	202.55	199.45	
	3	0.58	6.00	413.52	225.22	283.78	1.09	1.09	1.11	259.44	261.31	256.12	
	4	0.72	7.00	482.44	316.51	314.45	1.06	1.05	1.08	296.08	298.73	291.40	
	5	0.87	7.50	516.90	395.97	329.78	1.00	0.99	1.02	329.25	332.90	322.82	
	6	1.05	4.00	275.68	238.75	222.44	0.91	0.89	0.93	245.61	249.02	239.64	
	$\Sigma =$		1315.39				1450.60		1463.80		1427.31		
7	1	0.33	1.00	69.00	22.46	124.70	1.09	1.09	1.10	114.31	114.78	113.47	FOS1 1.07 FOS2 1.08 FOS3 1.05
	2	0.44	4.00	276.00	116.64	212.46	1.09	1.09	1.11	194.04	195.07	192.20	
	3	0.58	6.00	414.00	225.48	270.98	1.08	1.07	1.10	250.50	252.23	247.41	
	4	0.72	7.00	483.00	316.88	300.23	1.05	1.04	1.06	286.61	289.09	282.23	
	5	0.87	7.50	517.50	396.43	314.86	0.98	0.97	1.00	319.76	323.19	313.71	
	6	1.05	4.00	276.00	239.02	212.46	0.89	0.87	0.91	239.66	242.90	233.99	
	$\Sigma =$		1316.91				1404.88		1417.27		1383.01		

Table 4.119: Bishops Analysis for soil sample of Kakri Ghat for 50 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.28	2.00	154.08	42.47	120.73	1.11	1.09	1.08	108.52	110.40	111.90	FOS1 0.77 FOS2 0.80 FOS3 0.83
	2	0.40	6.00	462.24	180.61	239.06	1.13	1.11	1.09	210.65	215.75	219.88	
	3	0.52	9.00	693.36	346.68	327.81	1.14	1.11	1.08	287.47	296.39	303.71	
	4	0.65	12.00	924.48	556.37	416.56	1.13	1.09	1.06	369.04	383.04	394.69	
	5	0.79	9.50	731.88	517.52	342.60	1.10	1.05	1.01	312.88	327.37	339.61	
	6	0.98	4.00	308.16	255.48	179.89	1.01	0.96	0.91	177.41	187.95	197.05	
	$\Sigma =$		1899.12				1465.98		1520.90		1566.85		
1	1	0.28	2.00	154.17	42.50	142.50	1.11	1.09	1.10	128.68	130.60	129.69	FOS1 0.89 FOS2 0.92 FOS3 0.90
	2	0.40	6.00	462.51	180.72	273.23	1.13	1.10	1.12	242.32	247.36	244.96	
	3	0.52	9.00	693.77	346.88	371.29	1.13	1.10	1.12	328.27	337.05	332.86	
	4	0.65	12.00	925.02	556.69	469.34	1.12	1.08	1.10	419.95	433.71	427.12	
	5	0.79	9.50	732.31	517.82	387.63	1.08	1.04	1.06	358.29	372.64	365.75	
	6	0.98	4.00	308.34	255.63	207.87	1.00	0.95	0.97	208.16	218.86	213.69	
	$\Sigma =$		1900.23				1685.68		1740.22		1714.08		
2	1	0.28	2.00	154.35	42.54	149.43	1.10	1.08	1.08	135.79	138.56	137.73	FOS1 0.90 FOS2 0.94 FOS3 0.92
	2	0.40	6.00	463.05	180.93	274.15	1.12	1.09	1.10	245.25	252.28	250.16	
	3	0.52	9.00	694.58	347.29	367.68	1.12	1.08	1.09	328.72	340.87	337.18	
	4	0.65	12.00	926.10	557.34	461.22	1.10	1.05	1.07	418.32	437.36	431.54	
	5	0.79	9.50	733.16	518.42	383.27	1.06	1.01	1.02	360.15	380.30	374.10	
	6	0.98	4.00	308.70	255.92	211.79	0.98	0.91	0.93	216.59	232.29	227.40	
	$\Sigma =$		1902.45				1704.82		1781.66		1758.10		
3	1	0.28	2.00	154.53	42.59	175.28	1.09	1.10	1.09	160.75	159.70	161.34	FOS1 1.04 FOS2 1.02 FOS3 1.05
	2	0.40	6.00	463.59	181.14	312.81	1.10	1.11	1.10	283.46	280.88	284.91	
	3	0.52	9.00	695.39	347.69	415.96	1.10	1.11	1.09	378.07	373.65	380.55	
	4	0.65	12.00	927.18	557.99	519.11	1.08	1.10	1.07	480.42	473.55	484.29	
	5	0.79	9.50	734.02	519.03	433.15	1.04	1.06	1.03	417.16	409.90	421.28	
	6	0.98	4.00	309.06	256.22	244.05	0.95	0.97	0.94	257.56	251.83	260.83	
	$\Sigma =$		1904.67				1977.42		1949.51		1993.19		

Table 4.120: Bishops Analysis for soil sample of Kakri Ghat for 50 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN (φ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.28	2.00	154.71	42.64	189.66	1.12	1.10	1.10	169.42	171.98	172.65	FOS1 1.07 FOS2 1.10 FOS3 1.11
	2	0.40	6.00	464.13	181.35	340.66	1.14	1.12	1.12	297.56	303.83	305.51	
	3	0.52	9.00	696.20	348.10	453.91	1.15	1.12	1.12	393.65	404.24	407.09	
	4	0.65	12.00	928.26	558.64	567.16	1.14	1.11	1.10	495.70	511.98	516.39	
	5	0.79	9.50	734.87	519.63	472.78	1.11	1.07	1.06	424.76	441.71	446.35	
	6	0.98	4.00	309.42	256.52	265.16	1.04	0.99	0.97	256.16	269.18	272.79	
	Σ =		1906.89				2037.24		2102.92		2120.78		
5	1	0.28	2.00	154.89	42.69	191.29	1.10	1.10	1.11	173.28	174.46	171.97	FOS1 1.08 FOS2 1.10 FOS3 1.06
	2	0.40	6.00	464.67	181.56	335.65	1.12	1.11	1.13	298.94	301.80	295.80	
	3	0.52	9.00	697.01	348.50	443.92	1.12	1.11	1.14	394.63	399.46	389.35	
	4	0.65	12.00	929.34	559.29	552.19	1.11	1.09	1.13	497.36	504.81	489.28	
	5	0.79	9.50	735.73	520.24	461.96	1.07	1.05	1.09	430.44	438.31	421.97	
	6	0.98	4.00	309.78	256.82	263.47	0.99	0.97	1.01	266.55	272.79	259.91	
	Σ =		1909.10				2061.19		2091.64		2028.29		
6	1	0.28	2.00	155.07	42.74	181.24	1.09	1.09	1.10	166.21	166.82	165.13	FOS1 1.05 FOS2 1.06 FOS3 1.04
	2	0.40	6.00	465.21	181.77	319.25	1.10	1.10	1.11	289.30	290.77	286.66	
	3	0.52	9.00	697.82	348.91	422.76	1.10	1.09	1.11	384.24	386.76	379.75	
	4	0.65	12.00	930.42	559.94	526.27	1.08	1.07	1.10	487.04	490.96	480.08	
	5	0.79	9.50	736.58	520.84	440.01	1.04	1.03	1.06	423.77	427.95	416.39	
	6	0.98	4.00	310.14	257.12	250.24	0.95	0.94	0.97	264.10	267.45	258.22	
	Σ =		1911.32				2014.66		2030.72		1986.23		
7	1	0.28	2.00	155.25	42.79	173.20	1.08	1.08	1.09	159.73	160.29	158.73	FOS1 1.02 FOS2 1.03 FOS3 1.00
	2	0.40	6.00	465.75	181.98	304.85	1.09	1.09	1.10	278.43	279.79	275.98	
	3	0.52	9.00	698.63	349.31	403.59	1.09	1.08	1.10	370.54	372.88	366.37	
	4	0.65	12.00	931.50	560.59	502.33	1.07	1.06	1.08	470.68	474.33	464.19	
	5	0.79	9.50	737.44	521.45	420.04	1.02	1.01	1.04	410.72	414.64	403.80	
	6	0.98	4.00	310.50	257.42	239.02	0.93	0.92	0.95	257.23	260.41	251.67	
	Σ =		1913.54				1947.33		1962.34		1920.74		

Table 4.121: Bishops Analysis for soil sample of Kakri Ghat for 55 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.45	1.00	59.92	26.27	70.89	1.16	1.12	1.14	61.23	63.11	62.22	FOS1 0.78 FOS2 0.82 FOS3 0.85
	2	0.52	4.00	239.68	119.84	139.92	1.16	1.12	1.14	120.47	124.70	122.70	
	3	0.63	7.00	419.44	246.54	208.94	1.16	1.11	1.13	180.71	188.24	184.67	
	4	0.73	9.00	539.28	360.85	254.96	1.14	1.09	1.11	223.96	234.83	229.65	
	5	0.87	8.50	509.32	390.16	243.46	1.10	1.04	1.06	222.27	235.23	229.03	
	6	1.01	3.50	209.72	177.85	128.41	1.03	0.96	1.00	124.56	133.19	129.04	
	$\Sigma =$		1321.51				933.19		979.30		1111.14		
1	1	0.45	1.00	60.03	26.31	85.44	1.15	1.13	1.16	74.52	75.54	73.38	FOS1 0.82 FOS2 0.84 FOS3 0.80
	2	0.52	4.00	240.10	120.05	161.79	1.15	1.13	1.17	140.85	143.05	138.42	
	3	0.63	7.00	420.18	246.97	238.14	1.14	1.12	1.17	208.66	212.53	204.41	
	4	0.73	9.00	540.23	361.48	289.05	1.12	1.10	1.15	257.75	263.30	251.68	
	5	0.87	8.50	510.21	390.85	276.32	1.08	1.05	1.11	256.84	263.47	249.66	
	6	1.01	3.50	210.09	178.16	149.07	1.01	0.98	1.04	147.69	152.20	142.84	
	$\Sigma =$		1323.83				1086.29		1110.08		1060.39		
2	1	0.45	1.00	60.03	26.31	91.98	1.13	1.12	1.11	81.04	82.11	83.07	FOS1 0.84 FOS2 0.86 FOS3 0.87
	2	0.52	4.00	240.10	120.05	164.73	1.14	1.12	1.10	145.09	147.27	149.25	
	3	0.63	7.00	420.18	246.97	237.48	1.13	1.11	1.09	210.97	214.75	218.19	
	4	0.73	9.00	540.23	361.48	285.98	1.10	1.08	1.06	259.13	264.53	269.49	
	5	0.87	8.50	510.21	390.85	273.85	1.06	1.03	1.01	259.47	265.97	271.98	
	6	1.01	3.50	210.09	178.16	152.60	0.99	0.96	0.93	154.65	159.26	163.56	
	$\Sigma =$		1323.83				1110.35		1133.88		1155.54		
3	1	0.54	1.00	51.51	26.53	93.93	1.14	1.11	1.16	82.13	84.48	80.78	FOS1 0.97 FOS2 1.01 FOS3 0.95
	2	0.63	3.00	154.53	90.83	139.78	1.14	1.10	1.16	123.05	127.11	120.73	
	3	0.72	5.00	257.55	168.97	185.62	1.12	1.08	1.14	165.78	172.01	162.26	
	4	0.82	6.00	309.06	226.03	208.54	1.09	1.04	1.12	191.53	199.83	186.88	
	5	0.93	7.50	386.33	308.53	242.92	1.05	1.00	1.08	232.23	243.73	225.84	
	6	1.08	3.50	180.29	159.18	151.24	0.96	0.91	0.99	157.44	166.92	152.25	
	$\Sigma =$		980.08				952.16		994.09		928.73		

Table 4.122: Bishops Analysis for soil sample of Kakri Ghat for 55 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice (kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.45	1.00	60.17	26.37	118.16	1.14	1.11	1.12	103.97	106.19	105.12	FOS1 1.04 FOS2 1.07 FOS3 0.95
	2	0.52	4.00	240.66	120.33	206.24	1.14	1.11	1.12	181.37	185.79	183.67	
	3	0.63	7.00	421.16	247.55	294.32	1.13	1.10	1.11	260.98	268.57	264.92	
	4	0.73	9.00	541.49	362.32	353.04	1.11	1.07	1.09	319.21	330.04	324.82	
	5	0.87	8.50	511.40	391.76	338.36	1.06	1.02	1.04	319.76	332.83	326.51	
	6	1.01	3.50	210.58	178.58	191.56	0.99	0.94	0.97	193.54	202.97	198.39	
	Σ =		1326.91				1378.83		1426.40		1403.44		
5	1	0.45	1.00	60.24	26.41	120.71	1.11	1.14	1.10	108.38	106.23	109.43	FOS1 1.06 FOS2 1.02 FOS3 1.07
	2	0.52	4.00	240.94	120.47	204.92	1.11	1.14	1.10	184.40	180.24	186.46	
	3	0.63	7.00	421.65	247.84	289.13	1.10	1.13	1.08	263.48	256.43	266.99	
	4	0.73	9.00	542.12	362.75	345.27	1.07	1.11	1.05	322.27	312.26	327.28	
	5	0.87	8.50	512.00	392.21	331.24	1.02	1.06	1.00	325.20	313.11	331.31	
	6	1.01	3.50	210.82	178.79	190.89	0.95	0.99	0.93	201.80	192.92	206.34	
	Σ =		1328.46				1405.54		1361.20		1427.82		
6	1	0.45	1.00	60.31	26.44	114.13	1.10	1.10	1.12	103.36	103.95	102.30	FOS1 1.02 FOS2 1.03 FOS3 1.00
	2	0.52	4.00	241.22	120.61	194.63	1.10	1.09	1.11	176.90	178.06	174.83	
	3	0.63	7.00	422.14	248.12	275.14	1.08	1.08	1.10	253.74	255.73	250.21	
	4	0.73	9.00	542.75	363.17	328.81	1.06	1.05	1.07	311.20	314.06	306.16	
	5	0.87	8.50	512.59	392.67	315.39	1.00	0.99	1.02	314.88	318.38	308.74	
	6	1.01	3.50	211.07	179.00	181.22	0.93	0.92	0.95	195.45	198.05	190.91	
	Σ =		1330.00				1355.54		1368.22		1333.15		
7	1	0.45	1.00	60.38	26.47	107.90	1.11	1.09	1.09	97.62	98.59	99.13	FOS1 0.94 FOS2 0.96 FOS3 0.97
	2	0.52	4.00	241.50	120.75	181.08	1.10	1.09	1.08	164.38	166.25	167.30	
	3	0.63	7.00	422.63	248.41	254.25	1.09	1.07	1.06	234.13	237.32	239.11	
	4	0.73	9.00	543.38	363.59	303.03	1.06	1.04	1.03	286.32	290.88	293.45	
	5	0.87	8.50	513.19	393.12	290.84	1.00	0.98	0.97	289.77	295.36	298.53	
	6	1.01	3.50	211.31	179.20	168.88	0.93	0.91	0.90	181.70	185.91	188.31	
	Σ =		1331.55				1253.92		1274.30		1285.84		

Table 4.123: Bishops Analysis for soil sample of Kakri Ghat for 60 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN (ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.42	3.00	154.08	62.67	100.21	1.11	1.17	1.20	90.38	85.37	83.68	FOS1 0.65 FOS2 0.71 FOS3 0.64
	2	0.51	8.50	436.56	211.65	208.68	1.11	1.18	1.21	188.45	176.12	172.02	
	3	0.63	13.50	693.36	407.55	307.29	1.09	1.19	1.22	281.62	259.27	252.00	
	4	0.75	12.50	642.00	437.84	287.57	1.06	1.17	1.21	271.62	246.24	238.15	
	5	0.91	9.00	462.24	364.25	218.54	0.99	1.12	1.17	219.88	195.13	187.45	
	6	1.06	3.00	154.08	134.76	100.21	0.90	1.04	1.10	110.77	95.93	91.48	
	Σ =		1618.72				1162.72		1058.05		1024.78		
1	1	0.42	3.00	154.17	62.71	116.79	1.17	1.18	1.11	100.06	99.07	105.67	FOS1 0.76 FOS2 0.81 FOS3 0.73
	2	0.51	8.50	436.82	211.77	236.63	1.18	1.19	1.10	201.06	198.70	214.53	
	3	0.63	13.50	693.77	407.78	345.58	1.18	1.19	1.09	293.98	289.81	318.23	
	4	0.75	12.50	642.38	438.10	323.79	1.16	1.18	1.05	279.95	275.28	307.59	
	5	0.91	9.00	462.51	364.46	247.52	1.11	1.13	0.99	223.60	219.11	250.81	
	6	1.06	3.00	154.17	134.84	116.79	1.03	1.06	0.90	113.37	110.66	130.22	
	Σ =		1619.67				1212.01		1192.63		1327.06		
2	1	0.42	3.00	154.35	62.78	120.41	1.15	1.10	1.13	104.86	109.85	106.31	FOS1 0.75 FOS2 0.82 FOS3 0.79
	2	0.51	8.50	437.33	212.02	234.73	1.15	1.09	1.14	203.33	214.91	206.67	
	3	0.63	13.50	694.58	408.26	338.66	1.15	1.07	1.13	294.93	315.66	300.86	
	4	0.75	12.50	643.13	438.61	317.87	1.12	1.04	1.10	282.56	306.38	289.31	
	5	0.91	9.00	463.05	364.89	245.12	1.07	0.97	1.04	228.99	252.86	235.66	
	6	1.06	3.00	154.35	135.00	120.41	0.99	0.88	0.96	121.67	137.23	125.96	
	Σ =		1621.556				1236.347		1336.887		1264.767		
3	1	0.42	3.00	154.53	62.85	139.78	1.10	1.14	1.13	126.60	122.63	123.23	FOS1 0.90 FOS2 0.84 FOS3 0.91
	2	0.51	8.50	437.84	212.27	265.85	1.10	1.14	1.14	241.30	232.32	233.67	
	3	0.63	13.50	695.39	408.74	380.46	1.08	1.14	1.13	350.86	334.92	337.28	
	4	0.75	12.50	643.88	439.12	357.53	1.05	1.11	1.10	340.24	321.90	324.60	
	5	0.91	9.00	463.59	365.31	277.31	0.98	1.05	1.04	281.59	263.10	265.80	
	6	1.06	3.00	154.53	135.15	139.78	0.89	0.97	0.96	156.26	143.90	145.68	
	Σ =		1623.45				1496.86		1418.77		1430.26		

Table 4.124: Bishops Analysis for soil sample of Kakri Ghat for 60 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.42	3.00	154.71	62.93	144.96	1.12	1.11	1.11	129.88	130.12	130.35	FOS1 0.91 FOS2 0.97 FOS3 0.98
	2	0.51	8.50	438.35	212.51	271.17	1.12	1.11	1.11	242.98	243.51	244.04	
	3	0.63	13.50	696.20	409.21	385.92	1.10	1.10	1.10	350.29	351.23	352.16	
	4	0.75	12.50	644.63	439.63	362.97	1.07	1.07	1.06	338.92	340.01	341.08	
	5	0.91	9.00	464.13	365.74	282.65	1.01	1.00	1.00	280.39	281.50	282.59	
	6	1.06	3.00	154.71	135.31	144.96	0.92	0.92	0.91	157.50	158.26	159.01	
	Σ =		1625.34				1499.96		1504.62		1509.23		
5	1	0.42	4.50	231.26	86.63	152	1.10	1.11	1.14	125	136	132	FOS1 0.94 FOS2 0.89 FOS3 0.96
	2	0.51	13.00	668.07	303.30	284	1.09	1.12	1.15	230	254	245	
	3	0.63	15.50	796.55	433.83	404	1.07	1.11	1.14	325	366	351	
	4	0.75	12.50	642.38	412.91	380	1.04	1.08	1.12	308	354	337	
	5	0.91	8.50	436.82	319.47	296	0.97	1.04	1.06	247	293	275	
	6	1.06	3.00	154.17	129.30	152	0.88	0.96	0.98	134	164	152	
	Σ =		1685.43				1368.51		1567.36		1492.89		
6	1	0.42	3.00	155.07	63.07	143.83	1.13	1.11	1.10	127.68	129.03	130.27	FOS1 0.84 FOS2 0.93 FOS3 0.93
	2	0.51	8.50	439.37	213.01	270.34	1.13	1.11	1.10	239.57	242.60	245.38	
	3	0.63	13.50	697.82	410.17	385.35	1.12	1.10	1.08	345.06	350.43	355.37	
	4	0.75	12.50	646.13	440.66	362.35	1.09	1.07	1.05	332.92	339.10	344.82	
	5	0.91	9.00	465.21	366.59	281.84	1.03	1.01	0.98	274.11	280.36	286.19	
	6	1.06	3.00	155.07	135.63	143.83	0.94	0.92	0.89	152.57	156.80	160.79	
	Σ =		1629.12				1471.90		1498.31		1522.83		
7	1	0.42	3.00	155.25	63.15	137.41	1.14	1.12	1.10	120.16	123.08	125.48	FOS1 0.81 FOS2 0.87 FOS3 0.88
	2	0.51	8.50	439.88	213.26	258.09	1.15	1.12	1.09	224.68	231.17	236.56	
	3	0.63	13.50	698.63	410.64	367.80	1.14	1.10	1.07	322.26	333.69	343.30	
	4	0.75	12.50	646.88	441.17	345.86	1.12	1.07	1.04	309.65	322.76	333.92	
	5	0.91	9.00	465.75	367.02	269.06	1.06	1.01	0.97	253.55	266.73	278.14	
	6	1.06	3.00	155.25	135.78	137.41	0.98	0.92	0.88	140.32	149.18	157.01	
	Σ =		1631.01				1370.62		1426.60		1474.40		

Table 4.125: Bishops Analysis for soil sample of Kakri Ghat for 65 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.38	4.50	231.12	86.58	129.79	1.13	1.25	1.34	114.59	104.09	96.99	FOS1 0.72 FOS2 0.65 FOS3 0.63
	2	0.47	13.00	667.68	303.12	297.43	1.14	1.28	1.39	260.89	232.66	214.12	
	3	0.58	15.50	796.08	433.58	346.73	1.14	1.30	1.44	304.84	266.02	241.42	
	4	0.70	12.50	642.00	412.67	287.57	1.12	1.31	1.47	257.06	218.76	195.46	
	5	0.82	8.50	436.56	319.28	208.68	1.08	1.31	1.48	192.65	159.77	140.58	
	6	0.99	3.00	154.08	129.22	100.21	1.00	1.26	1.46	99.74	79.51	68.41	
	Σ =		1684.45				1229.77		1060.81		956.98		
1	1	0.38	4.50	231.26	86.63	149.47	1.22	1.14	1.31	122.92	131.24	114.51	FOS1 0.75 FOS2 0.74 FOS3 0.84
	2	0.47	13.00	668.07	303.30	334.68	1.24	1.15	1.35	269.69	291.62	248.04	
	3	0.58	15.50	796.55	433.83	389.16	1.26	1.15	1.39	309.21	339.41	280.27	
	4	0.70	12.50	642.38	412.91	323.79	1.26	1.13	1.41	256.65	286.68	228.83	
	5	0.82	8.50	436.82	319.47	236.63	1.25	1.10	1.42	189.94	216.01	166.60	
	6	0.99	3.00	154.17	129.30	116.79	1.19	1.02	1.39	98.04	114.64	83.94	
	Σ =		1685.43				1246.46		1379.59		1122.19		
2	1	0.38	4.50	231.53	86.73	151.59	1.20	1.13	1.26	126.07	134.27	119.97	FOS1 0.76 FOS2 0.82 FOS3 0.78
	2	0.47	13.00	668.85	303.65	328.27	1.22	1.14	1.30	268.08	289.08	252.79	
	3	0.58	15.50	797.48	434.34	380.23	1.24	1.13	1.33	306.95	335.88	286.40	
	4	0.70	12.50	643.13	413.39	317.87	1.24	1.11	1.34	256.72	285.78	236.67	
	5	0.82	8.50	437.33	319.84	234.73	1.22	1.08	1.34	192.53	218.16	175.36	
	6	0.99	3.00	154.35	129.45	120.41	1.16	1.00	1.30	103.74	120.84	92.79	
	Σ =		1687.40				1254.10		1384.01		1163.97		
3	1	0.38	4.50	231.80	86.83	174.16	1.25	1.11	1.21	139.58	156.56	144.53	FOS1 0.92 FOS2 0.87 FOS3 0.88
	2	0.47	13.00	669.63	304.01	369.00	1.28	1.12	1.23	288.39	330.80	300.55	
	3	0.58	15.50	798.41	434.84	426.30	1.30	1.11	1.24	326.73	384.76	343.07	
	4	0.70	12.50	643.88	413.87	357.53	1.32	1.08	1.24	271.66	329.87	287.69	
	5	0.82	8.50	437.84	320.21	265.85	1.31	1.04	1.22	203.27	254.74	217.12	
	6	0.99	3.00	154.53	129.60	139.78	1.26	0.96	1.17	110.73	145.70	119.81	
	Σ =		1689.37				1340.34		1602.43		1412.77		

Table 4.126: Bishops Analysis for soil sample of Kakri Ghat for 65 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.38	4.50	232.07	86.93	189.36	1.19	1.13	1.26	159.35	167.53	150.34	FOS1 0.92 FOS2 0.93 FOS3 0.94
	2	0.47	13.00	670.41	304.36	403.27	1.21	1.14	1.29	333.97	354.63	311.69	
	3	0.58	15.50	799.34	435.35	466.19	1.22	1.13	1.32	382.63	411.10	352.66	
	4	0.70	12.50	644.63	414.36	390.69	1.21	1.11	1.34	321.78	350.52	292.35	
	5	0.82	8.50	438.35	320.59	290.02	1.19	1.08	1.33	243.34	268.90	217.91	
	6	0.99	3.00	154.71	129.75	151.61	1.13	1.00	1.29	134.25	151.70	117.64	
	Σ =		1691.33				1575.31		1704.38		1442.59		
5	1	0.38	4.50	232.34	87.03	187.68	1.18	1.13	1.23	159.51	165.71	152.81	FOS1 0.84 FOS2 0.86 FOS3 0.92
	2	0.47	13.00	671.19	304.71	392.18	1.19	1.14	1.26	328.67	344.05	312.31	
	3	0.58	15.50	800.27	435.86	452.33	1.20	1.14	1.28	376.55	397.74	354.42	
	4	0.70	12.50	645.38	414.84	380.15	1.19	1.12	1.28	318.40	339.90	296.42	
	5	0.82	8.50	438.86	320.96	283.92	1.17	1.08	1.27	242.90	262.17	223.63	
	6	0.99	3.00	154.89	129.90	151.59	1.10	1.00	1.22	137.44	150.92	124.41	
	Σ =		1693.30				1563.48		1660.49		1464.00		
6	1	0.38	4.50	232.61	87.14	178.33	1.18	1.12	1.23	150.66	158.75	144.95	FOS1 0.90 FOS2 0.92 FOS3 0.93
	2	0.47	13.00	671.97	305.07	373.85	1.20	1.13	1.26	311.07	331.22	297.10	
	3	0.58	15.50	801.20	436.36	431.35	1.21	1.12	1.28	356.04	383.83	337.17	
	4	0.70	12.50	646.13	415.32	362.35	1.21	1.10	1.29	300.43	328.64	281.74	
	5	0.82	8.50	439.37	321.33	270.34	1.18	1.06	1.27	228.58	253.87	212.24	
	6	0.99	3.00	155.07	130.05	143.83	1.12	0.98	1.22	128.55	146.21	117.58	
	Σ =		1695.27				1475.32		1602.52		1390.78		
7	1	0.38	4.50	232.88	87.24	170.32	1.24	1.11	1.19	136.82	152.88	142.90	FOS1 0.84 FOS2 0.87 FOS3 0.90
	2	0.47	13.00	672.75	305.42	356.83	1.28	1.12	1.21	279.65	319.32	294.45	
	3	0.58	15.50	802.13	436.87	411.68	1.30	1.11	1.22	316.55	370.77	336.46	
	4	0.70	12.50	646.88	415.80	345.86	1.31	1.09	1.22	263.78	318.27	283.42	
	5	0.82	8.50	439.88	321.70	258.09	1.30	1.05	1.20	198.20	246.55	215.28	
	6	0.99	3.00	155.25	130.20	137.41	1.26	0.96	1.14	109.41	142.69	120.82	
	Σ =		1697.24				1304.41		1550.47		1393.34		

Table 4.127: Bishops Analysis for soil sample of Kakri Ghat for 65 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.38	4.50	231.12	86.58	129.79	1.13	1.25	1.34	114.59	104.09	96.99	FOS1 0.73 FOS2 0.63 FOS3 0.57
	2	0.47	13.00	667.68	303.12	297.43	1.14	1.28	1.39	260.89	232.66	214.12	
	3	0.58	15.50	796.08	433.58	346.73	1.14	1.30	1.44	304.84	266.02	241.42	
	4	0.70	12.50	642.00	412.67	287.57	1.12	1.31	1.47	257.06	218.76	195.46	
	5	0.82	8.50	436.56	319.28	208.68	1.08	1.31	1.48	192.65	159.77	140.58	
	6	0.99	3.00	154.08	129.22	100.21	1.00	1.26	1.46	99.74	79.51	68.41	
	Σ =		1684.45				1229.77		1060.81		956.98		
1	1	0.38	4.50	231.26	86.63	149.47	1.22	1.14	1.31	122.92	131.24	114.51	FOS1 0.74 FOS2 0.82 FOS3 0.67
	2	0.47	13.00	668.07	303.30	334.68	1.24	1.15	1.35	269.69	291.62	248.04	
	3	0.58	15.50	796.55	433.83	389.16	1.26	1.15	1.39	309.21	339.41	280.27	
	4	0.70	12.50	642.38	412.91	323.79	1.26	1.13	1.41	256.65	286.68	228.83	
	5	0.82	8.50	436.82	319.47	236.63	1.25	1.10	1.42	189.94	216.01	166.60	
	6	0.99	3.00	154.17	129.30	116.79	1.19	1.02	1.39	98.04	114.64	83.94	
	Σ =		1685.43				1246.46		1379.59		1122.19		
2	1	0.38	4.50	231.53	86.73	151.59	1.20	1.13	1.26	126.07	134.27	119.97	FOS1 0.74 FOS2 0.82 FOS3 0.69
	2	0.47	13.00	668.85	303.65	328.27	1.22	1.14	1.30	268.08	289.08	252.79	
	3	0.58	15.50	797.48	434.34	380.23	1.24	1.13	1.33	306.95	335.88	286.40	
	4	0.70	12.50	643.13	413.39	317.87	1.24	1.11	1.34	256.72	285.78	236.67	
	5	0.82	8.50	437.33	319.84	234.73	1.22	1.08	1.34	192.53	218.16	175.36	
	6	0.99	3.00	154.35	129.45	120.41	1.16	1.00	1.30	103.74	120.84	92.79	
	Σ =		1687.40				1254.10		1384.01		1163.97		
3	1	0.38	4.50	231.80	86.83	174.16	1.25	1.11	1.21	139.58	156.56	144.53	FOS1 0.79 FOS2 0.95 FOS3 0.84
	2	0.47	13.00	669.63	304.01	369.00	1.28	1.12	1.23	288.39	330.80	300.55	
	3	0.58	15.50	798.41	434.84	426.30	1.30	1.11	1.24	326.73	384.76	343.07	
	4	0.70	12.50	643.88	413.87	357.53	1.32	1.08	1.24	271.66	329.87	287.69	
	5	0.82	8.50	437.84	320.21	265.85	1.31	1.04	1.22	203.27	254.74	217.12	
	6	0.99	3.00	154.53	129.60	139.78	1.26	0.96	1.17	110.73	145.70	119.81	
	Σ =		1689.37				1340.34		1602.43		1412.77		

Table 4.128: Bishops Analysis for soil sample of Kakri Ghat for 70 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.38	4.50	232.07	86.93	189.36	1.19	1.13	1.26	159.35	167.53	150.34	FOS1 0.93 FOS2 1.01 FOS3 0.85
	2	0.47	13.00	670.41	304.36	403.27	1.21	1.14	1.29	333.97	354.63	311.69	
	3	0.58	15.50	799.34	435.35	466.19	1.22	1.13	1.32	382.63	411.10	352.66	
	4	0.70	12.50	644.63	414.36	390.69	1.21	1.11	1.34	321.78	350.52	292.35	
	5	0.82	8.50	438.35	320.59	290.02	1.19	1.08	1.33	243.34	268.90	217.91	
	6	0.99	3.00	154.71	129.75	151.61	1.13	1.00	1.29	134.25	151.70	117.64	
	Σ =		1691.33				1575.31		1704.38		1442.59		
5	1	0.38	4.50	232.34	87.03	187.68	1.18	1.13	1.23	159.51	165.71	152.81	FOS1 0.92 FOS2 0.98 FOS3 0.86
	2	0.47	13.00	671.19	304.71	392.18	1.19	1.14	1.26	328.67	344.05	312.31	
	3	0.58	15.50	800.27	435.86	452.33	1.20	1.14	1.28	376.55	397.74	354.42	
	4	0.70	12.50	645.38	414.84	380.15	1.19	1.12	1.28	318.40	339.90	296.42	
	5	0.82	8.50	438.86	320.96	283.92	1.17	1.08	1.27	242.90	262.17	223.63	
	6	0.99	3.00	154.89	129.90	151.59	1.10	1.00	1.22	137.44	150.92	124.41	
	Σ =		1693.30				1563.48		1660.49		1464.00		
6	1	0.38	4.50	232.61	87.14	178.33	1.18	1.12	1.23	150.66	158.75	144.95	FOS1 0.87 FOS2 0.95 FOS3 0.82
	2	0.47	13.00	671.97	305.07	373.85	1.20	1.13	1.26	311.07	331.22	297.10	
	3	0.58	15.50	801.20	436.36	431.35	1.21	1.12	1.28	356.04	383.83	337.17	
	4	0.70	12.50	646.13	415.32	362.35	1.21	1.10	1.29	300.43	328.64	281.74	
	5	0.82	8.50	439.37	321.33	270.34	1.18	1.06	1.27	228.58	253.87	212.24	
	6	0.99	3.00	155.07	130.05	143.83	1.12	0.98	1.22	128.55	146.21	117.58	
	Σ =		1695.27				1475.32		1602.52		1390.78		
7	1	0.38	4.50	232.88	87.24	170.32	1.24	1.11	1.19	136.82	152.88	142.90	FOS1 0.77 FOS2 0.91 FOS3 0.82
	2	0.47	13.00	672.75	305.42	356.83	1.28	1.12	1.21	279.65	319.32	294.45	
	3	0.58	15.50	802.13	436.87	411.68	1.30	1.11	1.22	316.55	370.77	336.46	
	4	0.70	12.50	646.88	415.80	345.86	1.31	1.09	1.22	263.78	318.27	283.42	
	5	0.82	8.50	439.88	321.70	258.09	1.30	1.05	1.20	198.20	246.55	215.28	
	6	0.99	3.00	155.25	130.20	137.41	1.26	0.96	1.14	109.41	142.69	120.82	
	Σ =		1697.24				1304.41		1550.47		1393.34		

Table 4.128: Bishops Analysis for soil sample of Kakri Ghat for 75 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.65	3.00	128.40	77.27	83.51	1.26	1.38	1.31	66.23	60.67	63.64	FOS1 0.51 FOS2 0.46 FOS3 0.49
	2	0.73	10.00	428.00	286.39	198.55	1.26	1.39	1.31	157.95	143.31	151.09	
	3	0.82	19.50	834.60	610.39	354.69	1.24	1.38	1.31	285.19	256.26	271.56	
	4	0.91	11.50	492.20	387.86	223.20	1.22	1.37	1.29	182.83	162.67	173.28	
	5	1.01	7.50	321.00	272.22	157.46	1.18	1.34	1.25	133.31	117.16	125.61	
	6	1.12	3.00	128.40	115.41	83.51	1.13	1.30	1.21	73.99	64.18	69.28	
	Σ =		1749.54				899.50		804.23		854.47		
1	1	0.65	3.00	128.48	77.32	97.32	1.22	1.26	1.19	79.52	77.08	81.70	FOS1 0.60 FOS2 0.58 FOS3 0.63
	2	0.73	10.00	428.25	286.56	224.43	1.22	1.26	1.18	184.56	178.26	190.25	
	3	0.82	19.50	835.09	610.74	396.93	1.20	1.25	1.16	331.10	318.61	342.45	
	4	0.91	11.50	492.49	388.09	251.66	1.17	1.22	1.13	214.64	205.75	222.77	
	5	1.01	7.50	321.19	272.38	179.03	1.13	1.18	1.08	158.55	151.25	165.30	
	6	1.12	3.00	128.48	115.47	97.32	1.07	1.13	1.02	90.66	86.03	94.98	
	Σ =		1750.56				1059.02		1016.99		1097.46		
2	1	0.65	3.00	128.63	77.41	100.34	1.10	1.17	1.24	91.01	85.56	80.87	FOS1 0.69 FOS2 0.63 FOS3 0.59
	2	0.73	10.00	428.75	286.89	221.59	1.08	1.16	1.23	204.98	191.18	179.48	
	3	0.82	19.50	836.06	611.46	386.14	1.05	1.14	1.22	367.29	339.75	316.72	
	4	0.91	11.50	493.06	388.54	247.57	1.01	1.11	1.19	244.25	223.96	207.26	
	5	1.01	7.50	321.56	272.70	178.29	0.96	1.06	1.15	186.07	168.67	154.65	
	6	1.12	3.00	128.63	115.61	100.34	0.89	1.00	1.10	112.46	100.64	91.34	
	Σ =		1752.60				1206.04		1109.76		1030.31		
3	1	0.65	3.00	128.78	77.50	116.48	1.08	1.16	1.29	107.80	100.79	90.61	FOS1 0.80 FOS2 0.73 FOS3 0.63
	2	0.73	10.00	429.25	287.22	250.19	1.06	1.14	1.28	236.79	219.43	194.77	
	3	0.82	19.50	837.04	612.17	431.66	1.02	1.12	1.27	421.30	386.81	338.89	
	4	0.91	11.50	493.64	388.99	278.84	0.98	1.08	1.25	283.15	257.42	222.50	
	5	1.01	7.50	321.94	273.02	202.44	0.93	1.03	1.22	218.34	195.95	166.47	
	6	1.12	3.00	128.78	115.74	116.48	0.86	0.97	1.17	135.54	119.88	99.93	
	Σ =		1754.65				1402.92		1280.29		1113.17		

Table 4.129: Bishops Analysis for soil sample of Kakri Ghat for 75 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.65	3.00	128.93	77.59	126.34	1.22	1.17	1.10	103.71	108.38	115.03	FOS1 0.74 FOS2 0.79 FOS3 0.85
	2	0.73	10.00	429.75	287.56	273.14	1.21	1.15	1.08	225.81	237.24	253.77	
	3	0.82	19.50	838.01	612.88	472.38	1.19	1.13	1.05	396.34	418.73	451.52	
	4	0.91	11.50	494.21	389.44	304.60	1.17	1.10	1.01	261.46	277.83	302.17	
	5	1.01	7.50	322.31	273.34	220.71	1.12	1.05	0.95	196.87	210.76	231.79	
	6	1.12	3.00	128.93	115.88	126.34	1.06	0.99	0.89	118.63	128.05	142.61	
	Σ =		1756.69				1302.81		1380.99		1496.89		
5	1	0.65	3.00	129.08	77.68	126.32	1.17	1.09	1.13	107.73	115.49	111.93	FOS1 0.76 FOS2 0.84 FOS3 0.80
	2	0.73	10.00	430.25	287.89	266.67	1.16	1.07	1.11	230.11	248.91	240.25	
	3	0.82	19.50	838.99	613.60	457.14	1.14	1.04	1.08	402.27	439.25	422.13	
	4	0.91	11.50	494.79	389.90	296.75	1.11	1.00	1.05	268.48	296.09	283.24	
	5	1.01	7.50	322.69	273.65	216.55	1.06	0.95	0.99	204.90	228.93	217.67	
	6	1.12	3.00	129.08	116.01	126.32	1.00	0.88	0.93	126.73	143.67	135.67	
	Σ =		1758.73				1340.22		1472.34		1410.89		
6	1	0.65	3.00	129.23	77.77	119.86	1.13	1.07	1.21	105.75	111.81	99.00	FOS1 0.76 FOS2 0.82 FOS3 0.69
	2	0.73	10.00	430.75	288.23	254.03	1.12	1.05	1.20	227.76	242.63	211.48	
	3	0.82	19.50	839.96	614.31	436.13	1.09	1.01	1.18	400.56	430.07	368.76	
	4	0.91	11.50	495.36	390.35	282.79	1.05	0.97	1.16	268.30	290.49	244.81	
	5	1.01	7.50	323.06	273.97	206.11	1.00	0.92	1.11	205.77	225.26	185.60	
	6	1.12	3.00	129.23	116.15	119.86	0.94	0.85	1.05	127.73	141.59	113.75	
	Σ =		1760.78				1335.88		1441.86		1223.39		
7	1	0.65	3.00	129.38	77.86	114.51	1.07	1.10	1.16	107.29	104.21	98.44	FOS1 0.79 FOS2 0.75 FOS3 0.70
	2	0.73	10.00	431.25	288.56	242.50	1.04	1.08	1.15	232.77	225.18	211.15	
	3	0.82	19.50	840.94	615.02	416.21	1.01	1.05	1.12	412.74	397.59	369.97	
	4	0.91	11.50	495.94	390.80	269.93	0.97	1.01	1.09	279.03	267.59	246.97	
	5	1.01	7.50	323.44	274.29	196.79	0.91	0.95	1.04	216.63	206.50	188.57	
	6	1.12	3.00	129.38	116.28	114.51	0.84	0.89	0.98	136.39	129.13	116.51	
	Σ =		1762.82				1384.85		1330.21		1231.61		

Table 4.130: Bishops Analysis for soil sample of Salri Site for 45 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(φ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.35	1.50	79.07	27.04	79.53	1.10	1.11	1.09	72.31	71.73	72.63	FOS1 1.06 FOS2 1.05 FOS3 1.07
	2	0.42	3.00	158.13	64.32	114.71	1.10	1.11	1.10	103.90	102.91	104.45	
	3	0.52	5.00	263.55	131.78	161.62	1.10	1.11	1.09	146.90	145.18	147.86	
	4	0.63	6.50	342.62	201.38	196.81	1.08	1.10	1.08	181.50	178.97	182.92	
	5	0.73	6.00	316.26	211.62	185.08	1.06	1.07	1.05	175.17	172.33	176.77	
	6	0.87	2.50	131.78	100.95	102.98	1.00	1.02	0.99	102.82	100.81	103.96	
	Σ =		737.08			782.59			771.94		788.60		
1	1	0.35	1.50	79.12	27.06	82.29	1.09	1.15	1.09	75.84	71.42	75.28	FOS1 1.06 FOS2 0.96 FOS3 1.05
	2	0.42	3.00	158.24	64.36	114.26	1.09	1.17	1.10	105.16	97.96	104.24	
	3	0.52	5.00	263.73	131.86	156.87	1.08	1.18	1.09	145.44	133.31	143.86	
	4	0.63	6.50	342.84	201.52	188.84	1.06	1.17	1.07	178.32	160.80	176.01	
	5	0.73	6.00	316.47	211.76	178.18	1.03	1.16	1.04	173.38	153.73	170.75	
	6	0.87	2.50	131.86	101.01	103.60	0.97	1.12	0.99	106.97	92.59	105.00	
	Σ =		737.57			785.10			709.82		775.14		
2	1	0.35	1.50	79.22	27.10	112.69	1.10	1.11	1.13	102.23	101.76	99.98	FOS1 1.33 FOS2 1.32 FOS3 1.28
	2	0.42	3.00	158.45	64.45	149.61	1.11	1.11	1.14	135.16	134.41	131.64	
	3	0.52	5.00	264.08	132.04	198.83	1.10	1.11	1.14	180.14	178.92	174.39	
	4	0.63	6.50	343.30	201.79	235.75	1.09	1.10	1.13	216.58	214.84	208.40	
	5	0.73	6.00	316.89	212.04	223.45	1.06	1.07	1.11	210.54	208.56	201.31	
	6	0.87	2.50	132.04	101.15	137.30	1.01	1.02	1.06	136.34	134.80	129.20	
	Σ =		738.55			980.99			973.30		944.91		
3	1	0.35	1.50	79.33	27.13	123.52	1.11	1.12	1.10	111.54	110.60	112.06	FOS1 1.40 FOS2 1.38 FOS3 1.41
	2	0.42	3.00	158.66	64.53	160.49	1.11	1.12	1.11	144.19	142.76	144.98	
	3	0.52	5.00	264.43	132.21	209.78	1.11	1.12	1.10	188.77	186.48	190.05	
	4	0.63	6.50	343.75	202.05	246.74	1.10	1.11	1.09	224.86	221.62	226.68	
	5	0.73	6.00	317.31	212.32	234.42	1.07	1.09	1.06	218.81	215.14	220.88	
	6	0.87	2.50	132.21	101.28	148.17	1.02	1.04	1.01	145.47	142.55	147.13	
	Σ =		739.53			1033.62			1019.16		1041.78		

Table 4.131: Bishops Analysis for soil sample of Salri Site for 45 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.35	1.50	79.43	27.17	130.83	1.10	1.09	1.11	118.94	119.48	117.99	FOS1 1.45 FOS2 1.46 FOS3 1.49
	2	0.42	3.00	158.87	64.62	166.17	1.10	1.10	1.11	150.51	151.31	149.08	
	3	0.52	5.00	264.78	132.39	213.30	1.10	1.09	1.11	193.87	195.14	191.61	
	4	0.63	6.50	344.21	202.32	248.65	1.08	1.08	1.10	229.31	231.11	226.12	
	5	0.73	6.00	317.73	212.60	236.87	1.06	1.05	1.07	224.19	226.24	220.55	
	6	0.87	2.50	132.39	101.41	154.39	1.00	0.99	1.02	154.14	155.85	151.13	
	Σ =		740.51				1070.97		1079.13		1056.48		
5	1	0.35	1.50	79.54	27.20	129.36	1.11	1.12	1.10	116.81	115.83	117.35	FOS1 1.44 FOS2 1.42 FOS3 1.45
	2	0.42	3.00	159.08	64.70	166.42	1.11	1.12	1.11	149.52	148.04	150.34	
	3	0.52	5.00	265.13	132.56	215.84	1.11	1.12	1.10	194.23	191.88	195.55	
	4	0.63	6.50	344.66	202.59	252.91	1.10	1.11	1.09	230.47	227.16	232.34	
	5	0.73	6.00	318.15	212.88	240.55	1.07	1.09	1.06	224.53	220.77	226.65	
	6	0.87	2.50	132.56	101.55	154.07	1.02	1.04	1.01	151.26	148.22	152.99	
	Σ =		741.49				1066.82		1051.91		1075.23		
6	1	0.35	1.50	79.64	27.24	128.01	1.11	1.12	1.10	115.59	114.62	116.13	FOS1 1.43 FOS2 1.41 FOS3 1.45
	2	0.42	3.00	159.29	64.79	165.12	1.11	1.12	1.11	148.35	146.89	149.17	
	3	0.52	5.00	265.48	132.74	214.61	1.11	1.12	1.10	193.11	190.78	194.43	
	4	0.63	6.50	345.12	202.85	251.72	1.10	1.11	1.09	229.39	226.09	231.25	
	5	0.73	6.00	318.57	213.16	239.35	1.07	1.09	1.06	223.40	219.67	225.52	
	6	0.87	2.50	132.74	101.68	152.75	1.02	1.04	1.01	149.97	146.96	151.68	
	Σ =		742.47				1059.81		1045.00		1068.17		
7	1	0.35	1.50	79.75	27.28	121.83	1.10	1.11	1.09	110.77	109.88	111.26	FOS1 1.37 FOS2 1.36 FOS3 1.39
	2	0.42	3.00	159.50	64.87	157.32	1.10	1.11	1.10	142.49	141.14	143.25	
	3	0.52	5.00	265.83	132.91	204.64	1.10	1.11	1.09	185.99	183.82	187.21	
	4	0.63	6.50	345.57	203.12	240.12	1.08	1.10	1.08	221.45	218.37	223.18	
	5	0.73	6.00	318.99	213.45	228.30	1.06	1.07	1.05	216.07	212.57	218.05	
	6	0.87	2.50	132.91	101.82	145.49	1.00	1.02	0.99	145.26	142.42	146.87	
	Σ =		743.45				1022.02		1008.19		1029.82		

Table 4.132: Bishops Analysis for soil sample of Salri Site for 50 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.42	1.00	45.18	18.38	58.12	1.10	1.11	1.13	52.64	52.14	51.59	FOS1 0.99 FOS2 0.97 FOS3 0.96
	2	0.51	3.00	135.54	65.71	98.33	1.10	1.11	1.13	89.25	88.24	87.13	
	3	0.59	4.50	203.31	113.69	128.48	1.09	1.11	1.12	117.77	116.22	114.53	
	4	0.70	6.00	271.08	174.25	158.64	1.07	1.08	1.10	148.66	146.37	143.88	
	5	0.79	6.50	293.67	207.66	168.69	1.04	1.06	1.08	162.47	159.64	156.59	
	6	0.87	2.50	112.95	86.52	88.27	1.00	1.02	1.04	88.13	86.41	84.57	
	Σ =		666.20				658.91		649.01		638.30		
1	1	0.42	1.00	45.21	18.39	61.40	1.15	1.10	1.09	53.47	56.02	56.52	FOS1 0.91 FOS2 0.98 FOS3 1.00
	2	0.51	3.00	135.63	65.75	97.93	1.15	1.09	1.08	84.83	89.66	90.61	
	3	0.59	4.50	203.45	113.77	125.33	1.15	1.08	1.07	108.82	116.04	117.48	
	4	0.70	6.00	271.26	174.36	152.73	1.14	1.05	1.04	134.32	144.82	146.94	
	5	0.79	6.50	293.87	207.79	161.86	1.12	1.02	1.01	145.14	157.99	160.61	
	6	0.87	2.50	113.03	86.58	88.80	1.08	0.99	0.97	81.85	90.00	91.68	
	Σ =		666.65				608.44		654.54		663.84		
2	1	0.42	1.00	45.27	18.41	86.05	1.11	1.11	1.12	77.31	77.73	76.54	FOS1 1.23 FOS2 1.24 FOS3 1.21
	2	0.51	3.00	135.81	65.84	128.24	1.11	1.11	1.13	115.28	116.04	113.92	
	3	0.59	4.50	203.72	113.92	159.88	1.10	1.09	1.12	144.91	146.02	142.93	
	4	0.70	6.00	271.62	174.59	191.52	1.08	1.07	1.10	177.12	178.71	174.29	
	5	0.79	6.50	294.26	208.07	202.07	1.05	1.04	1.07	191.73	193.68	188.28	
	6	0.87	2.50	113.18	86.70	117.69	1.02	1.01	1.04	115.55	116.87	113.23	
	Σ =		667.53				821.88		829.04		809.20		
3	1	0.42	1.00	45.33	18.44	95.31	1.11	1.11	1.12	85.63	86.10	84.79	FOS1 1.31 FOS2 1.33 FOS3 1.29
	2	0.51	3.00	135.99	65.93	137.56	1.11	1.11	1.13	123.66	124.47	122.21	
	3	0.59	4.50	203.99	114.07	169.25	1.10	1.09	1.12	153.40	154.57	151.31	
	4	0.70	6.00	271.98	174.83	200.93	1.08	1.07	1.10	185.82	187.49	182.85	
	5	0.79	6.50	294.65	208.35	211.49	1.05	1.04	1.07	200.67	202.71	197.06	
	6	0.87	2.50	113.33	86.81	127.00	1.02	1.01	1.04	124.69	126.11	122.18	
	Σ =		668.42				873.86		881.46		860.40		

Table 4.133: Bishops Analysis for soil sample of Salri Site for 50 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.42	1.00	45.39	18.46	102.04	1.10	1.10	1.11	92.42	92.91	91.54	FOS1 1.36 FOS2 1.37 FOS3 1.34
	2	0.51	3.00	136.17	66.02	142.44	1.10	1.09	1.11	129.29	130.11	127.82	
	3	0.59	4.50	204.26	114.22	172.73	1.09	1.08	1.11	158.33	159.50	156.25	
	4	0.70	6.00	272.34	175.06	203.03	1.07	1.06	1.08	190.26	191.92	187.32	
	5	0.79	6.50	295.04	208.62	213.13	1.04	1.03	1.06	205.26	207.29	201.69	
	6	0.87	2.50	113.48	86.93	132.34	1.00	0.99	1.02	132.12	133.59	129.54	
	Σ =		669.30						907.68		915.31		
5	1	0.42	1.00	45.45	18.49	100.29	1.11	1.11	1.12	90.10	90.60	89.21	FOS1 1.35 FOS2 1.36 FOS3 1.33
	2	0.51	3.00	136.35	66.10	142.65	1.11	1.11	1.13	128.23	129.08	126.73	
	3	0.59	4.50	204.53	114.37	174.42	1.10	1.09	1.12	158.08	159.30	155.93	
	4	0.70	6.00	272.70	175.29	206.19	1.08	1.07	1.10	190.68	192.39	187.64	
	5	0.79	6.50	295.43	208.90	216.78	1.05	1.04	1.07	205.68	207.77	201.99	
	6	0.87	2.50	113.63	87.04	132.06	1.02	1.01	1.04	129.65	131.13	127.05	
	Σ =		670.19						902.43		910.27		
6	1	0.42	1.00	45.51	18.51	99.12	1.11	1.11	1.12	89.05	89.54	88.17	FOS1 1.34 FOS2 1.35 FOS3 1.32
	2	0.51	3.00	136.53	66.19	141.53	1.11	1.11	1.13	127.23	128.07	125.74	
	3	0.59	4.50	204.80	114.52	173.34	1.10	1.09	1.12	157.11	158.31	154.97	
	4	0.70	6.00	273.06	175.52	205.16	1.08	1.07	1.10	189.72	191.43	186.70	
	5	0.79	6.50	295.82	209.17	215.76	1.05	1.04	1.07	204.71	206.80	201.04	
	6	0.87	2.50	113.78	87.16	130.93	1.02	1.01	1.04	128.54	130.01	125.96	
	Σ =		671.07						896.37		904.16		
7	1	0.42	1.00	45.57	18.53	94.29	1.10	1.10	1.11	85.40	85.85	84.59	FOS1 1.29 FOS2 1.30 FOS3 1.27
	2	0.51	3.00	136.71	66.28	134.85	1.10	1.09	1.11	122.40	123.17	121.01	
	3	0.59	4.50	205.07	114.67	165.26	1.09	1.08	1.11	151.48	152.60	149.49	
	4	0.70	6.00	273.42	175.75	195.68	1.07	1.06	1.08	183.37	184.97	180.54	
	5	0.79	6.50	296.21	209.45	205.82	1.04	1.03	1.06	198.22	200.18	194.77	
	6	0.87	2.50	113.93	87.27	124.71	1.00	0.99	1.02	124.51	125.89	122.08	
	Σ =		671.96						865.38		872.66		

Table 4.134: Bishops Analysis for soil sample of Salri Site for 55 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.52	1.00	45.18	22.59	58.12	1.10	1.16	1.09	52.82	49.98	53.17	FOS1 0.87 FOS2 0.80 FOS3 0.87
	2	0.59	3.00	135.54	75.79	98.33	1.09	1.16	1.08	90.13	84.70	90.79	
	3	0.66	5.50	248.49	152.99	148.59	1.08	1.15	1.07	138.04	128.84	139.18	
	4	0.79	7.50	338.85	239.60	188.80	1.04	1.13	1.03	181.83	167.57	183.62	
	5	0.89	7.00	316.26	245.78	178.75	0.99	1.09	0.98	179.94	163.92	181.98	
	6	1.03	4.00	180.72	154.91	118.43	0.92	1.02	0.90	129.21	115.70	130.97	
	Σ =		891.66			771.97			710.72		779.72		
1	1	0.52	1.00	45.21	22.61	61.40	1.07	1.14	1.10	57.27	54.08	55.64	FOS1 0.88 FOS2 0.80 FOS3 0.84
	2	0.59	3.00	135.63	75.84	97.93	1.06	1.13	1.09	92.43	86.65	89.45	
	3	0.66	5.50	248.66	153.09	143.60	1.04	1.12	1.08	137.83	128.25	132.88	
	4	0.79	7.50	339.08	239.76	180.13	1.00	1.09	1.04	180.38	165.56	172.67	
	5	0.89	7.00	316.47	245.94	170.99	0.95	1.05	1.00	180.05	163.17	171.22	
	6	1.03	4.00	180.84	155.01	116.20	0.87	0.98	0.92	133.81	118.96	125.97	
	Σ =		892.25			781.77			716.68		747.83		
2	1	0.52	1	45.27	22.64	86.05	1.14	1.11	1.10	75.47	77.43	77.96	FOS1 0.88 FOS2 0.80 FOS3 0.84
	2	0.59	3	135.81	75.94	128.24	1.14	1.10	1.09	112.92	116.23	117.12	
	3	0.66	5.5	248.99	153.29	180.98	1.13	1.09	1.08	160.79	166.03	167.45	
	4	0.79	7.5	339.53	240.08	223.17	1.09	1.05	1.04	203.85	211.74	213.90	
	5	0.89	7	316.89	246.27	212.62	1.06	1.01	1.00	201.46	210.40	212.86	
	6	1.03	4	181.08	155.22	149.33	0.98	0.94	0.92	151.61	159.63	161.86	
	Σ =		893.44			906.11			941.47		951.14		
3	1	0.52	1.00	45.33	22.67	95.31	1.12	1.11	1.10	84.73	85.77	86.35	FOS1 1.09 FOS2 1.11 FOS3 1.12
	2	0.59	3.00	135.99	76.04	137.56	1.12	1.10	1.09	122.98	124.68	125.63	
	3	0.66	5.50	249.32	153.49	190.37	1.11	1.09	1.08	172.00	174.65	176.14	
	4	0.79	7.50	339.98	240.40	232.62	1.07	1.05	1.04	216.75	220.71	222.95	
	5	0.89	7.00	317.31	246.60	222.06	1.03	1.01	1.00	215.23	219.74	222.31	
	6	1.03	4.00	181.32	155.42	158.69	0.96	0.94	0.92	165.49	169.63	171.99	
	Σ =		894.62			977.18			995.17		1005.39		

Table 4.135: Bishops Analysis for soil sample of Salri Site for 55 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.52	1.00	45.39	22.70	102.04	1.10	1.09	1.11	92.74	93.35	91.66	FOS1 1.15 FOS2 1.16 FOS3 1.13
	2	0.59	3.00	136.17	76.15	142.44	1.09	1.08	1.11	130.56	131.52	128.84	
	3	0.66	5.50	249.65	153.70	192.93	1.08	1.07	1.09	179.24	180.72	176.61	
	4	0.79	7.50	340.43	240.72	233.33	1.04	1.03	1.06	224.72	226.93	220.80	
	5	0.89	7.00	317.73	246.92	223.23	0.99	0.98	1.01	224.72	227.27	220.24	
	6	1.03	4.00	181.56	155.63	162.63	0.92	0.90	0.94	177.44	179.85	173.23	
	Σ =		895.80				1029.42		1039.65		1011.38		
5	1	0.52	1.00	45.45	22.73	100.29	1.11	1.12	1.10	90.25	89.15	90.86	FOS1 1.14 FOS2 1.12 FOS3 1.15
	2	0.59	3.00	136.35	76.25	142.65	1.10	1.12	1.09	129.29	127.53	130.28	
	3	0.66	5.50	249.98	153.90	195.60	1.09	1.11	1.08	179.45	176.73	180.98	
	4	0.79	7.50	340.88	241.04	237.96	1.05	1.07	1.04	225.77	221.72	228.07	
	5	0.89	7.00	318.15	247.25	227.37	1.01	1.03	1.00	225.00	220.38	227.63	
	6	1.03	4.00	181.80	155.83	163.83	0.94	0.96	0.92	175.12	170.86	177.57	
	Σ =		896.99				1024.88		1006.37		1035.39		
6	1	0.52	1.00	45.51	22.76	99.12	1.11	1.10	1.12	89.19	89.80	88.11	FOS1 1.13 FOS2 1.15 FOS3 1.11
	2	0.59	3.00	136.53	76.35	141.53	1.10	1.09	1.12	128.28	129.26	126.53	
	3	0.66	5.50	250.31	154.10	194.55	1.09	1.08	1.11	178.49	180.01	175.78	
	4	0.79	7.50	341.33	241.35	236.97	1.05	1.04	1.07	224.84	227.12	220.80	
	5	0.89	7.00	318.57	247.58	226.36	1.01	1.00	1.03	224.00	226.62	219.41	
	6	1.03	4.00	182.04	156.04	162.74	0.94	0.92	0.96	173.96	176.39	169.72	
	Σ =		898.17				1018.76		1029.21		1000.35		
7	1	0.52	1.00	45.57	22.79	94.29	1.10	1.11	1.09	85.70	84.70	86.26	FOS1 1.10 FOS2 1.08 FOS3 1.11
	2	0.59	3.00	136.71	76.45	134.85	1.09	1.11	1.08	123.60	121.97	124.52	
	3	0.66	5.50	250.64	154.31	185.54	1.08	1.09	1.07	172.37	169.85	173.80	
	4	0.79	7.50	341.78	241.67	226.10	1.04	1.06	1.03	217.75	213.96	219.90	
	5	0.89	7.00	318.99	247.90	215.96	0.99	1.01	0.98	217.41	213.07	219.87	
	6	1.03	4.00	182.28	156.24	155.12	0.92	0.94	0.90	169.25	165.23	171.55	
	Σ =		899.36				986.08		968.77		995.90		

Table 4.136: Bishops Analysis for soil sample of Salri Site for 60 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.49	1.50	67.77	31.82	68.17	1.10	1.14	1.16	61.81	59.58	58.69	FOS1 0.85 FOS2 0.81 FOS3 0.79
	2	0.58	2.50	112.95	61.52	88.27	1.09	1.14	1.16	80.70	77.32	75.98	
	3	0.66	8.00	361.44	222.52	198.85	1.08	1.13	1.15	184.74	175.90	172.42	
	4	0.79	10.50	474.39	335.44	249.11	1.04	1.10	1.13	239.92	226.38	221.11	
	5	0.91	7.00	316.26	249.22	178.75	0.98	1.05	1.08	181.51	169.59	165.01	
	6	1.05	2.00	90.36	78.25	78.22	0.91	0.98	1.01	86.37	79.68	77.15	
	Σ =		978.77				835.04		788.45		770.36		
1	1	0.49	1.50	67.82	31.84	70.54	1.11	1.14	1.09	63.77	62.10	64.49	FOS1 0.82 FOS2 0.79 FOS3 0.84
	2	0.58	2.50	113.03	61.56	88.80	1.10	1.13	1.08	80.91	78.44	81.98	
	3	0.66	8.00	361.68	222.67	189.26	1.08	1.12	1.06	175.14	169.03	177.81	
	4	0.79	10.50	474.71	335.67	234.92	1.04	1.09	1.02	225.19	215.92	229.30	
	5	0.91	7.00	316.47	249.38	170.99	0.99	1.04	0.97	172.69	164.40	176.39	
	6	1.05	2.00	90.42	78.31	79.67	0.91	0.97	0.89	87.39	82.43	89.64	
	Σ =		979.42				805.09		772.33		819.63		
2	1	0.49	1.50	67.91	31.88	96.59	1.11	1.11	1.13	87.32	86.77	85.78	FOS1 1.04 FOS2 1.03 FOS3 1.01
	2	0.58	2.50	113.18	61.64	117.69	1.10	1.11	1.12	107.22	106.43	105.02	
	3	0.66	8.00	362.16	222.97	233.72	1.08	1.09	1.11	216.25	214.42	211.17	
	4	0.79	10.50	475.34	336.11	286.46	1.04	1.05	1.07	274.56	271.79	266.91	
	5	0.91	7.00	316.89	249.71	212.62	0.99	1.00	1.02	214.69	212.15	207.70	
	6	1.05	2.00	90.54	78.41	107.14	0.91	0.92	0.95	117.51	115.85	112.97	
	Σ =		980.72				1017.54		1007.41		989.55		
3	1	0.49	1.50	68.00	31.92	105.88	1.11	1.13	1.11	95.11	94.03	95.71	FOS1 1.08 FOS2 1.06 FOS3 1.09
	2	0.58	2.50	113.33	61.72	127.00	1.11	1.12	1.10	114.85	113.32	115.70	
	3	0.66	8.00	362.64	223.26	243.18	1.09	1.11	1.08	223.10	219.72	225.01	
	4	0.79	10.50	475.97	336.56	295.99	1.05	1.07	1.04	280.84	275.79	283.69	
	5	0.91	7.00	317.31	250.04	222.06	1.00	1.02	0.99	221.57	216.92	224.22	
	6	1.05	2.00	90.66	78.51	116.44	0.92	0.95	0.91	125.90	122.77	127.70	
	Σ =		982.02				1061.36		1042.55		1072.03		

Table 4.137: Bishops Analysis for soil sample of Salri Site for 60 degree slope angle

Tree density per 150sqm	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice (kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.49	1.50	68.09	31.96	112.14	1.10	1.10	1.12	101.68	102.30	100.57	FOS1 1.11 FOS2 1.12 FOS3 1.093
	2	0.58	2.50	113.48	61.80	132.34	1.09	1.09	1.11	120.99	121.86	119.44	
	3	0.66	8.00	363.12	223.56	243.43	1.08	1.07	1.09	226.15	228.02	222.83	
	4	0.79	10.50	476.60	337.00	293.92	1.04	1.03	1.06	283.07	285.87	278.15	
	5	0.91	7.00	317.73	250.37	223.23	0.98	0.97	1.01	226.68	229.31	222.06	
	6	1.05	2.00	90.78	78.62	122.24	0.91	0.89	0.93	134.97	136.85	131.69	
	Σ =		983.32				1093.54		1104.21		1074.73		
5	1	0.49	1.50	68.18	32.01	110.88	1.11	1.13	1.11	99.60	98.47	100.24	FOS1 1.11 FOS2 1.097 FOS3 1.12
	2	0.58	2.50	113.63	61.88	132.06	1.11	1.12	1.10	119.42	117.84	120.31	
	3	0.66	8.00	363.60	223.85	248.55	1.09	1.11	1.08	228.02	224.57	229.97	
	4	0.79	10.50	477.23	337.45	301.50	1.05	1.07	1.04	286.06	280.92	288.97	
	5	0.91	7.00	318.15	250.71	227.37	1.00	1.02	0.99	226.87	222.11	229.58	
	6	1.05	2.00	90.90	78.72	121.47	0.92	0.95	0.91	131.35	128.08	133.22	
	Σ =		984.62				1091.32		1071.99		1102.29		
6	1	0.49	1.50	68.27	32.05	109.72	1.11	1.13	1.11	98.56	97.44	99.19	FOS1 1.10 FOS2 1.08 FOS3 1.11
	2	0.58	2.50	113.78	61.97	130.93	1.11	1.12	1.10	118.40	116.83	119.28	
	3	0.66	8.00	364.08	224.15	247.57	1.09	1.11	1.08	227.13	223.68	229.07	
	4	0.79	10.50	477.86	337.89	300.59	1.05	1.07	1.04	285.20	280.08	288.10	
	5	0.91	7.00	318.57	251.04	226.36	1.00	1.02	0.99	225.87	221.13	228.57	
	6	1.05	2.00	91.02	78.83	120.33	0.92	0.95	0.91	130.11	126.87	131.96	
	Σ =		985.92				1085.26		1066.04		1096.17		
7	1	0.49	1.50	68.36	32.09	104.43	1.10	1.12	1.10	94.69	93.65	95.27	FOS1 1.06 FOS2 1.05 FOS3 1.07
	2	0.58	2.50	113.93	62.05	124.71	1.09	1.11	1.09	114.01	112.55	114.83	
	3	0.66	8.00	364.56	224.45	236.24	1.08	1.09	1.07	219.47	216.25	221.29	
	4	0.79	10.50	478.49	338.34	286.94	1.04	1.06	1.03	276.34	271.53	279.07	
	5	0.91	7.00	318.99	251.37	215.96	0.98	1.01	0.97	219.30	214.82	221.84	
	6	1.05	2.00	91.14	78.93	114.57	0.91	0.93	0.89	126.50	123.43	128.26	
	Σ =		987.22				1050.32		1032.24		1060.56		

Table 4.138: Bishops Analysis for soil sample of Salri Site for 65 degree slope angle

Tree density per 150sqm	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.30	1.50	73.42	21.47	73.85	1.14	1.09	1.11	64.66	67.55	66.57	FOS1 0.73 FOS2 0.82 FOS3 0.79
	2	0.58	6.25	305.91	166.61	177.31	1.18	1.09	1.12	149.64	162.10	157.77	
	3	0.70	12.50	611.81	393.27	313.43	1.17	1.07	1.10	266.83	293.71	284.28	
	4	0.80	10.50	513.92	369.68	269.87	1.15	1.03	1.07	234.27	261.60	251.92	
	5	0.93	7.50	367.09	293.17	204.53	1.11	0.98	1.02	184.34	209.58	200.54	
	6	1.10	2.50	122.36	109.03	95.63	1.02	0.87	0.92	93.72	109.75	103.89	
	Σ =		1353.22				993.45		1104.29		1064.97		
1	1	0.30	1.50	73.47	21.48	76.42	1.13	1.09	1.08	67.92	70.26	70.71	FOS1 0.73 FOS2 0.79 FOS3 0.80
	2	0.58	6.25	306.11	166.72	170.40	1.15	1.08	1.07	147.79	157.32	159.21	
	3	0.70	12.50	612.22	393.53	294.07	1.14	1.05	1.04	258.63	278.85	282.92	
	4	0.80	10.50	514.26	369.93	254.50	1.11	1.02	1.00	229.31	250.11	254.35	
	5	0.93	7.50	367.33	293.36	195.14	1.06	0.96	0.94	183.62	203.20	207.27	
	6	1.10	2.50	122.44	109.10	96.20	0.97	0.85	0.83	99.36	112.66	115.50	
	Σ =		1354.12				986.63		1072.40		1089.98		
2	1	0.30	1.50	73.56	21.51	104.64	1.10	1.10	1.11	95.15	95.54	94.47	FOS1 0.93 FOS2 0.94 FOS3 0.92
	2	0.58	6.25	306.52	166.94	213.20	1.11	1.10	1.12	192.80	194.23	190.24	
	3	0.70	12.50	613.03	394.05	356.04	1.08	1.07	1.10	329.25	332.22	324.00	
	4	0.80	10.50	514.95	370.42	310.33	1.05	1.04	1.07	296.25	299.34	290.81	
	5	0.93	7.50	367.82	293.75	241.77	0.99	0.98	1.02	243.33	246.30	238.12	
	6	1.10	2.50	122.61	109.24	95.74	0.89	0.88	0.92	107.44	109.08	104.59	
	Σ =		1355.91				1264.23		1276.71		1242.23		
3	1	0.30	1.50	73.66	21.54	114.70	1.10	1.10	1.11	104.30	104.72	103.55	FOS1 1.00 FOS2 1.01 FOS3 0.98
	2	0.58	6.25	306.92	167.16	223.40	1.11	1.10	1.12	202.02	203.52	199.34	
	3	0.70	12.50	613.84	394.57	366.42	1.08	1.07	1.10	338.86	341.91	333.46	
	4	0.80	10.50	515.63	370.91	320.66	1.05	1.04	1.07	306.11	309.30	300.49	
	5	0.93	7.50	368.31	294.14	252.00	0.99	0.98	1.02	253.63	256.73	248.20	
	6	1.10	2.50	122.77	109.39	137.58	0.89	0.88	0.92	154.40	156.76	150.31	
	Σ =		1357.71				1359.33		1372.94		1335.34		

Table 4.139: Bishops Analysis for soil sample of Salri Site for 65 degree slope angle

Tree density per 150sqm	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.30	1.50	73.76	21.56	121.48	1.09	1.09	1.10	111.12	111.55	110.35	FOS1 1.02 FOS2 1.03 FOS3 1.00
	2	0.58	6.25	307.33	167.38	225.42	1.09	1.09	1.11	206.09	207.57	203.46	
	3	0.70	12.50	614.66	395.09	362.18	1.07	1.06	1.08	339.40	342.35	334.16	
	4	0.80	10.50	516.31	371.40	318.42	1.03	1.02	1.05	308.66	311.78	303.16	
	5	0.93	7.50	368.79	294.53	252.77	0.98	0.96	1.00	259.01	262.09	253.61	
	6	1.10	2.50	122.93	109.53	143.36	0.87	0.86	0.89	164.53	166.98	160.27	
	Σ =		1359.51				1388.81		1402.32		1365.00		
5	1	0.30	1.50	73.86	21.59	120.12	1.10	1.10	1.11	109.23	109.67	108.44	FOS1 1.02 FOS2 1.03 FOS3 1.01
	2	0.58	6.25	307.73	167.60	229.11	1.11	1.10	1.12	207.18	208.72	204.44	
	3	0.70	12.50	615.47	395.62	372.51	1.08	1.07	1.10	344.49	347.59	339.00	
	4	0.80	10.50	516.99	371.89	326.62	1.05	1.04	1.07	311.81	315.06	306.08	
	5	0.93	7.50	369.28	294.92	257.79	0.99	0.98	1.02	259.46	262.63	253.90	
	6	1.10	2.50	123.09	109.68	143.06	0.89	0.88	0.92	160.56	163.00	156.30	
	Σ =		1361.31				1392.72		1406.67		1368.15		
6	1	0.30	1.50	73.95	21.62	118.86	1.10	1.10	1.11	108.09	108.52	107.31	FOS1 1.02 FOS2 1.03 FOS3 1.00
	2	0.58	6.25	308.14	167.83	228.00	1.11	1.10	1.12	206.18	207.71	203.45	
	3	0.70	12.50	616.28	396.14	371.59	1.08	1.07	1.10	343.64	346.73	338.16	
	4	0.80	10.50	517.68	372.39	325.64	1.05	1.04	1.07	310.87	314.11	305.16	
	5	0.93	7.50	369.77	295.31	256.71	0.99	0.98	1.02	258.38	261.53	252.84	
	6	1.10	2.50	123.26	109.82	141.84	0.89	0.88	0.92	159.18	161.61	154.96	
	Σ =		1363.10				1386.33		1400.21		1361.87		
7	1	0.30	1.50	74.05	21.65	113.13	1.09	1.09	1.10	103.48	103.88	102.76	FOS1 0.98 FOS2 0.99 FOS3 0.97
	2	0.58	6.25	308.55	168.05	217.48	1.09	1.09	1.11	198.83	200.26	196.29	
	3	0.70	12.50	617.09	396.66	354.78	1.07	1.06	1.08	332.46	335.36	327.33	
	4	0.80	10.50	518.36	372.88	310.85	1.03	1.02	1.05	301.32	304.36	295.95	
	5	0.93	7.50	370.26	295.70	244.94	0.98	0.96	1.00	250.99	253.97	245.75	
	6	1.10	2.50	123.42	109.97	135.10	0.87	0.86	0.89	155.04	157.35	151.03	
	Σ =		1364.90				1342.13		1355.18		1319.12		

Table 4.140: Bishops Analysis for soil sample of Salri Site for 70 degree slope angle

Tree density per 150sqm	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice (kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.52	3.00	135.54	67.77	98.33	1.18	1.10	1.09	83.05	89.37	89.95	FOS1 0.72 FOS2 0.84 FOS3 0.82
	2	0.61	9.00	406.62	233.23	218.96	1.18	1.09	1.08	184.96	201.28	202.81	
	3	0.68	13.00	587.34	369.63	299.38	1.18	1.07	1.06	254.31	279.29	281.66	
	4	0.77	10.00	451.80	313.85	239.06	1.16	1.04	1.03	205.92	228.83	231.03	
	5	0.87	7.00	316.26	242.27	178.75	1.13	1.00	0.99	158.21	178.46	180.44	
	6	0.99	2.50	112.95	94.73	88.27	1.08	0.94	0.93	81.90	94.16	95.38	
	Σ =		1321.47				968.36		1071.37		1081.27		
1	1	0.52	3.00	135.63	67.82	97.93	1.15	1.14	1.08	84.82	86.26	90.79	FOS1 0.73 FOS2 0.74 FOS3 0.80
	2	0.61	9.00	406.89	233.38	207.52	1.15	1.13	1.06	180.43	183.96	195.21	
	3	0.68	13.00	587.73	369.87	280.58	1.14	1.12	1.04	246.05	251.39	268.56	
	4	0.77	10.00	452.10	314.06	225.79	1.12	1.09	1.01	201.55	206.48	222.51	
	5	0.87	7.00	316.47	242.43	170.99	1.08	1.06	0.97	157.61	162.01	176.54	
	6	0.99	2.50	113.03	94.79	88.80	1.03	1.00	0.90	86.33	89.12	98.53	
	Σ =		1322.34				956.79		979.21		1052.14		
2	1	0.52	3.00	135.81	67.91	128.24	1.11	1.12	1.12	115.40	114.57	114.00	FOS1 0.95 FOS2 0.91 FOS3 0.93
	2	0.61	9.00	407.43	233.69	254.81	1.10	1.11	1.12	231.54	229.63	228.30	
	3	0.68	13.00	588.51	370.36	339.20	1.09	1.10	1.10	312.38	309.51	307.52	
	4	0.77	10.00	452.70	314.47	275.91	1.06	1.07	1.08	260.27	257.57	255.70	
	5	0.87	7.00	316.89	242.75	212.62	1.02	1.03	1.04	208.75	206.27	204.56	
	6	0.99	2.50	113.18	94.92	117.69	0.96	0.97	0.98	123.10	121.40	120.23	
	Σ =		1324.10				1251.44		1238.94		1230.31		
3	1	0.52	3.00	135.99	68.00	137.56	1.11	1.10	1.12	123.79	124.63	122.29	FOS1 0.98 FOS2 0.99 FOS3 0.97
	2	0.61	9.00	407.97	234.00	264.30	1.10	1.09	1.12	240.17	242.06	236.80	
	3	0.68	13.00	589.29	370.85	348.80	1.09	1.08	1.10	321.22	324.04	316.23	
	4	0.77	10.00	453.30	314.89	285.43	1.06	1.05	1.08	269.25	271.92	264.53	
	5	0.87	7.00	317.31	243.07	222.06	1.02	1.01	1.04	218.01	220.50	213.63	
	6	0.99	2.50	113.33	95.04	127.00	0.96	0.94	0.98	132.84	134.61	129.74	
	Σ =		1325.85				1305.28		1317.77		1283.22		

Table 4.141: Bishops Analysis for soil sample of Salri Site for 70 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.52	3.00	136.17	68.09	142.44	1.10	1.09	1.11	129.46	130.31	127.95	FOS1 1.00 FOS2 1.01 FOS3 0.98
	2	0.61	9.00	408.51	234.31	263.63	1.09	1.08	1.10	242.34	244.19	239.06	
	3	0.68	13.00	590.07	371.34	344.42	1.07	1.06	1.09	321.31	324.04	316.47	
	4	0.77	10.00	453.90	315.31	283.83	1.04	1.03	1.06	271.67	274.29	267.05	
	5	0.87	7.00	317.73	243.40	223.23	1.00	0.99	1.02	222.87	225.34	218.52	
	6	0.99	2.50	113.48	95.17	132.34	0.94	0.93	0.96	141.16	142.99	137.95	
	Σ =		1327.61				1328.81		1341.16		1307.00		
5	1	0.52	3.00	136.35	68.18	142.95	1.11	1.10	1.12	128.63	129.51	127.08	FOS1 1.01 FOS2 1.02 FOS3 0.99
	2	0.61	9.00	409.05	234.62	270.03	1.10	1.09	1.12	245.37	247.30	241.93	
	3	0.68	13.00	590.85	371.83	354.75	1.09	1.08	1.10	326.70	329.57	321.62	
	4	0.77	10.00	454.50	315.72	291.21	1.06	1.05	1.08	274.70	277.43	269.88	
	5	0.87	7.00	318.15	243.72	227.67	1.02	1.01	1.04	223.52	226.07	219.03	
	6	0.99	2.50	113.63	95.29	132.36	0.96	0.94	0.98	138.45	140.29	135.21	
	Σ =		1329.36				1337.37		1350.18		1314.75		
6	1	0.52	3.00	136.53	68.27	141.53	1.11	1.12	1.10	127.36	125.82	128.23	FOS1 1.00 FOS2 0.98 FOS3 1.01
	2	0.61	9.00	409.59	234.93	268.78	1.10	1.12	1.09	244.23	240.81	246.16	
	3	0.68	13.00	591.63	372.32	353.61	1.09	1.10	1.08	325.65	320.59	328.51	
	4	0.77	10.00	455.10	316.14	289.99	1.06	1.08	1.05	273.55	268.75	276.27	
	5	0.87	7.00	318.57	244.04	226.36	1.02	1.04	1.01	222.24	217.78	224.78	
	6	0.99	2.50	113.78	95.42	130.93	0.96	0.98	0.94	136.95	133.75	138.78	
	Σ =		1331.12				1329.99		1307.50		1342.72		
7	1	0.52	3.00	136.71	68.36	134.85	1.11	1.09	1.11	121.72	123.36	121.13	FOS1 0.96 FOS2 0.97 FOS3 0.95
	2	0.61	9.00	410.13	235.24	256.52	1.10	1.08	1.10	233.92	237.60	232.62	
	3	0.68	13.00	592.41	372.82	337.63	1.08	1.06	1.09	312.18	317.65	310.24	
	4	0.77	10.00	455.70	316.56	276.80	1.06	1.03	1.06	262.28	267.50	260.44	
	5	0.87	7.00	318.99	244.36	215.96	1.01	0.99	1.02	213.12	218.00	211.40	
	6	0.99	2.50	113.93	95.55	124.71	0.95	0.93	0.96	131.23	134.75	130.00	
	Σ =		1332.87				1274.45		1298.87		1265.82		

Table 4.142: Bishops Analysis for soil sample of Salri Site for 75 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(ϕ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
0	1	0.65	2.00	60.24	36.25	52.15	1.21	1.13	1.18	43.07	46.01	44.15	FOS1 0.673 FOS2 0.73 FOS3 0.69
	2	0.72	7.00	210.84	138.32	119.16	1.20	1.12	1.17	98.98	106.43	101.70	
	3	0.80	12.00	361.44	260.00	186.18	1.19	1.09	1.15	156.83	170.06	161.62	
	4	0.87	8.50	256.02	196.12	139.27	1.17	1.07	1.13	119.32	130.29	123.27	
	5	0.96	6.00	180.72	148.04	105.76	1.13	1.03	1.09	93.23	102.76	96.64	
	6	1.06	2.50	75.30	65.86	58.85	1.08	0.97	1.04	54.31	60.59	56.54	
	Σ =		844.59				565.75		616.14		583.92		
1	1	0.65	2.00	60.28	36.28	53.11	1.17	1.12	1.15	45.29	47.30	46.35	FOS1 0.678 FOS2 0.71 FOS3 0.69
	2	0.72	7.00	210.98	138.42	114.00	1.16	1.11	1.13	98.06	102.87	100.58	
	3	0.80	12.00	361.68	260.17	174.88	1.14	1.08	1.11	153.17	161.60	157.57	
	4	0.87	8.50	256.19	196.25	132.26	1.12	1.06	1.08	118.20	125.31	121.91	
	5	0.96	6.00	180.84	148.14	101.82	1.08	1.01	1.05	94.04	100.33	97.31	
	6	1.06	2.50	75.35	65.90	59.20	1.03	0.96	0.99	57.57	61.93	59.82	
	Σ =		845.15				566.33		599.36		583.55		
2	1	0.65	2.00	60.36	36.33	71.43	1.08	1.09	1.11	65.84	65.30	64.34	FOS1 0.93 FOS2 0.92 FOS3 0.90
	2	0.72	7.00	211.26	138.60	141.75	1.07	1.08	1.09	132.89	131.67	129.52	
	3	0.80	12.00	362.16	260.52	212.07	1.04	1.05	1.07	204.56	202.45	198.73	
	4	0.87	8.50	256.53	196.51	162.84	1.01	1.02	1.04	161.70	159.88	156.67	
	5	0.96	6.00	181.08	148.33	127.68	0.96	0.98	1.00	132.58	130.90	127.98	
	6	1.06	2.50	75.45	65.99	78.46	0.90	0.91	0.94	87.11	85.86	83.68	
	Σ =		846.28				784.68		776.06		760.90		
3	1	0.65	2.00	60.44	36.37	77.63	1.09	1.11	1.08	70.97	69.92	71.56	FOS1 0.96 FOS2 0.94 FOS3 0.97
	2	0.72	7.00	211.54	138.78	148.04	1.08	1.09	1.07	137.51	135.27	138.78	
	3	0.80	12.00	362.64	260.86	218.45	1.05	1.07	1.04	208.54	204.71	210.71	
	4	0.87	8.50	256.87	196.77	169.16	1.02	1.04	1.01	166.08	162.74	167.98	
	5	0.96	6.00	181.32	148.53	133.96	0.98	1.00	0.96	137.33	134.26	139.09	
	6	1.06	2.50	75.55	66.08	84.67	0.91	0.94	0.90	92.65	90.29	94.00	
	Σ =		847.40				813.09		797.20		822.12		

Table 4.143: Bishops Analysis for soil sample of Salri Site for 75 degree slope angle

Tree density per 150sqm.	Slice no.	Angle (rad.)	Slice ht.(m)	Weight of slice(kN)	T	X= cb+ (W-Ub) TAN(φ)	M for trial 1	M for trial 2	M for trial 3	X/M1	X/M2	X/M3	FOS
4	1	0.65	2.00	60.52	36.42	81.49	1.08	1.07	1.10	75.42	76.02	74.34	FOS1 0.98 FOS2 0.99 FOS3 0.96
	2	0.72	7.00	211.82	138.97	148.82	1.06	1.05	1.08	140.13	141.38	137.91	
	3	0.80	12.00	363.12	261.21	216.15	1.03	1.02	1.05	209.52	211.64	205.79	
	4	0.87	8.50	257.21	197.03	169.02	1.00	0.99	1.02	168.75	170.62	165.45	
	5	0.96	6.00	181.56	148.73	135.35	0.96	0.95	0.98	141.39	143.15	138.31	
	6	1.06	2.50	75.65	66.16	88.22	0.89	0.88	0.92	98.63	100.03	96.18	
	Σ =		848.52				833.84		842.85		817.99		
5	1	0.65	2.00	60.60	36.47	80.98	1.09	1.11	1.08	74.03	72.94	74.65	FOS1 0.98 FOS2 0.96 FOS3 0.98
	2	0.72	7.00	212.10	139.15	151.58	1.08	1.09	1.07	140.80	138.50	142.10	
	3	0.80	12.00	363.60	261.55	222.18	1.05	1.07	1.04	212.10	208.20	214.31	
	4	0.87	8.50	257.55	197.29	172.76	1.02	1.04	1.01	169.61	166.21	171.55	
	5	0.96	6.00	181.80	148.92	137.46	0.98	1.00	0.96	140.93	137.77	142.73	
	6	1.06	2.50	75.75	66.25	88.04	0.91	0.94	0.90	96.34	93.89	97.75	
	Σ =		849.64				833.82		817.52		843.08		
6	1	0.65	2.00	60.68	36.52	80.22	1.09	1.13	1.08	73.34	71.08	73.95	FOS1 0.98 FOS2 0.94 FOS3 0.99
	2	0.72	7.00	212.38	139.33	150.91	1.08	1.11	1.07	140.18	135.42	141.48	
	3	0.80	12.00	364.08	261.90	221.60	1.05	1.09	1.04	211.55	203.49	213.75	
	4	0.87	8.50	257.89	197.56	172.12	1.02	1.06	1.01	168.98	161.95	170.91	
	5	0.96	6.00	182.04	149.12	136.77	0.98	1.02	0.96	140.22	133.74	142.01	
	6	1.06	2.50	75.85	66.34	87.29	0.91	0.96	0.90	95.52	90.52	96.91	
	Σ =		850.76				829.79		796.19		839.01		
7	1	0.65	2.00	60.76	36.57	76.38	1.08	1.16	1.11	70.69	66.09	68.58	FOS1 0.94 FOS2 0.86 FOS3 0.91
	2	0.72	7.00	212.66	139.52	143.97	1.06	1.14	1.10	135.57	125.85	131.10	
	3	0.80	12.00	364.56	262.24	211.57	1.03	1.12	1.07	205.09	188.65	197.50	
	4	0.87	8.50	258.23	197.82	164.25	1.00	1.10	1.04	163.99	149.69	157.35	
	5	0.96	6.00	182.28	149.32	130.45	0.96	1.06	1.00	136.28	123.12	130.14	
	6	1.06	2.50	75.95	66.43	83.14	0.89	1.00	0.94	92.94	82.83	88.19	
	Σ =		851.88				804.54		736.23		772.86		

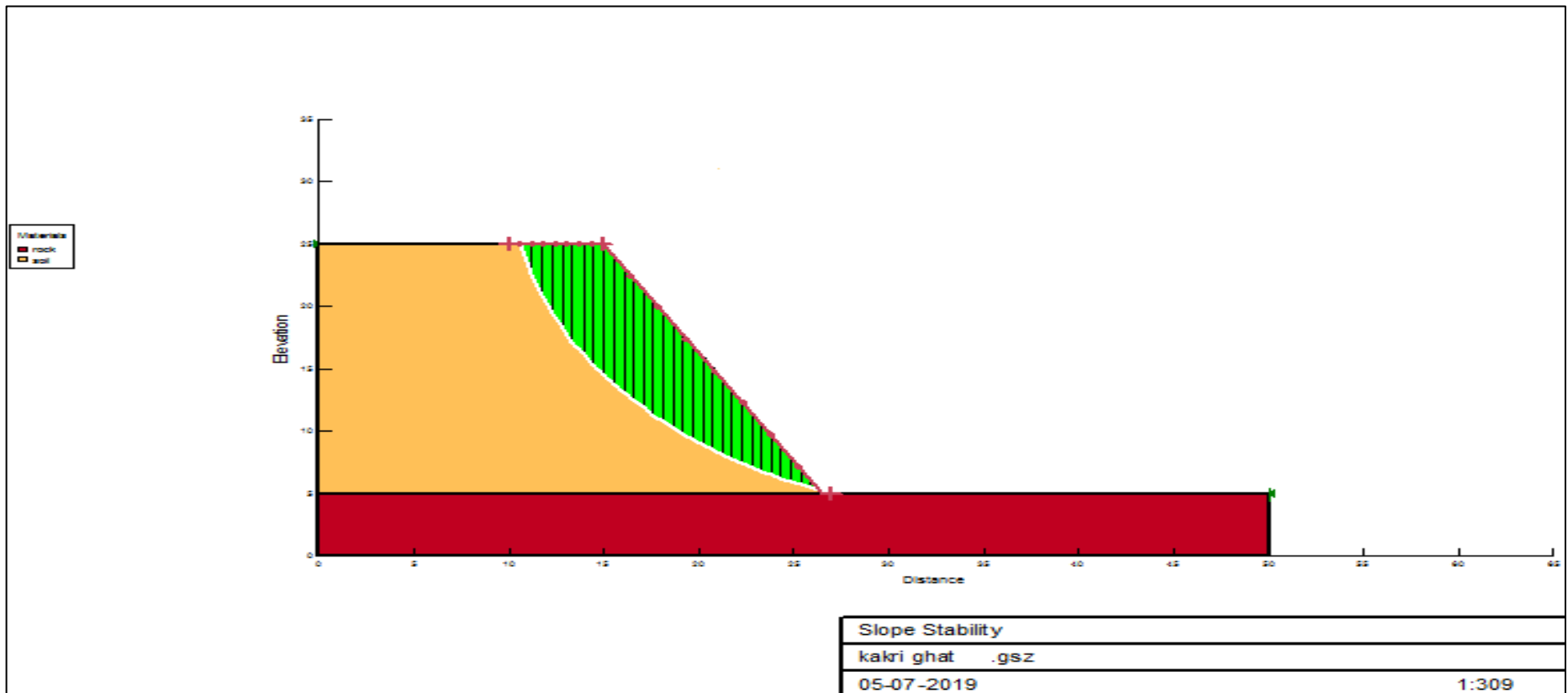


Figure 4.11: Geostudio Analysis of Kakri Ghat with 60 Degree Slope
 Swedish Methods: FOS=0.654
 Cardinal Colour: Slip Circle
 Grey Colour: Bed Rock

Buuff pms 167 Colour: Sandy Deposite
 $c = 13 \text{ kPa}$
 $\phi = 21^\circ$
 $\gamma = 17.12 \text{ kN/m}^3$

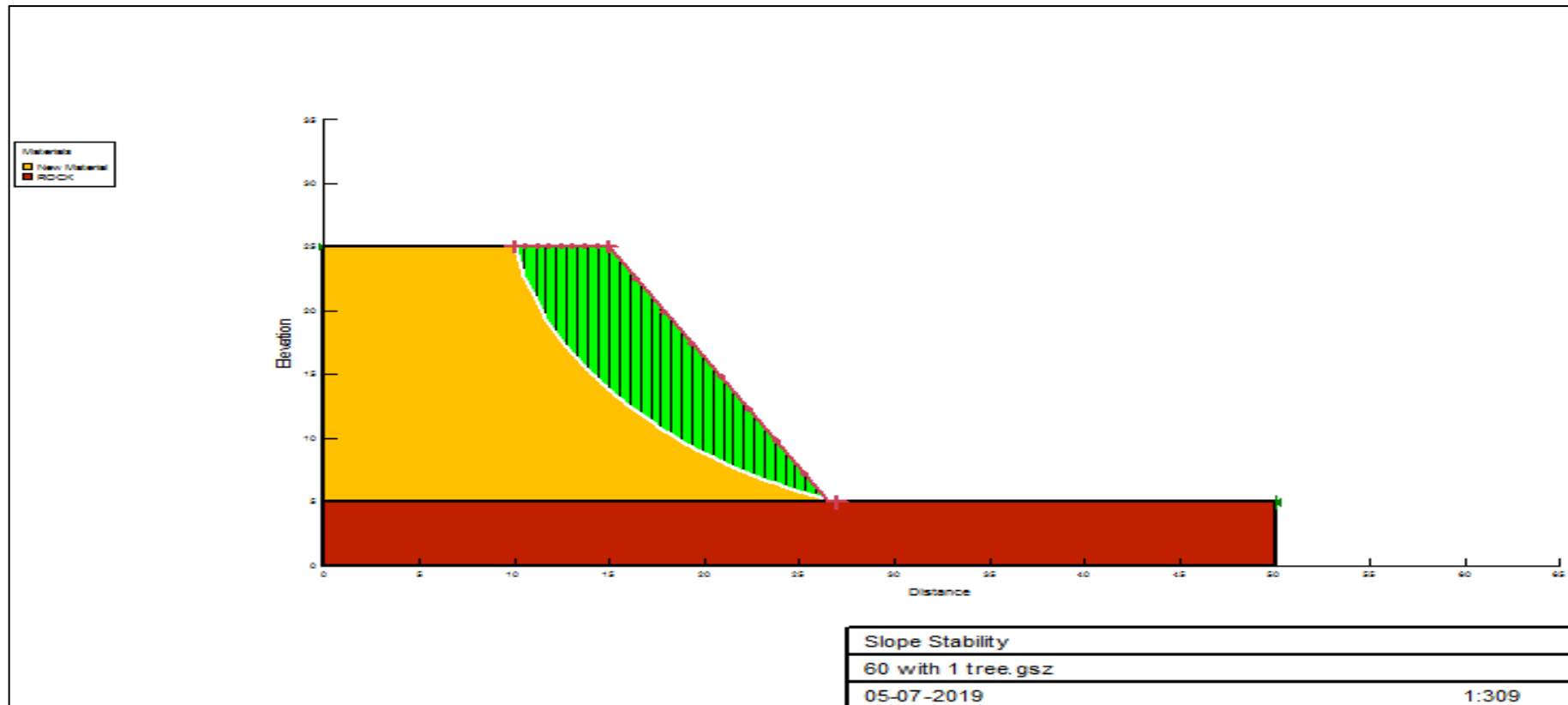


Figure 4.12: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with one plant
Swedish Methods: FOS=0.703
Cardinal Colour: Slip Circle
Grey Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 17.14 \text{ kPa}$
 $\phi = 23^\circ$
 $\gamma = 17.13 \text{ kN/m}^3$

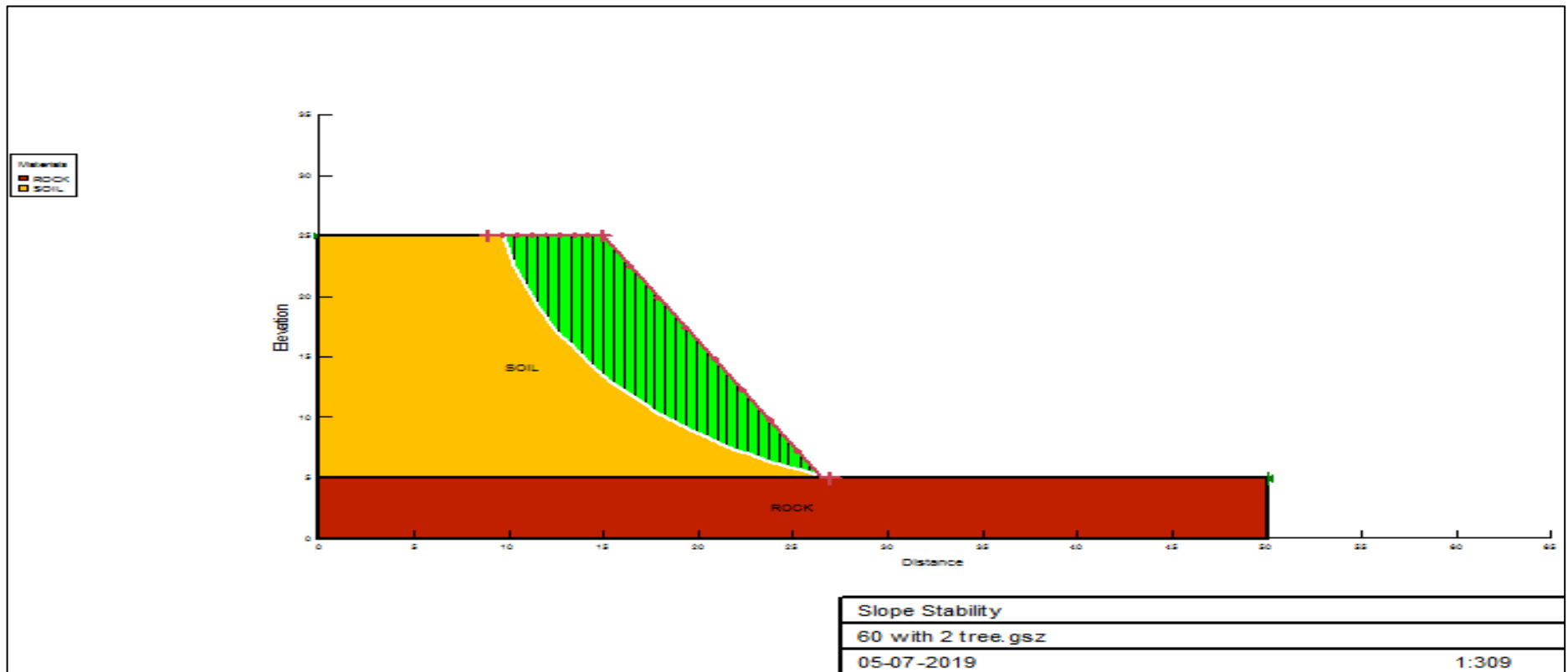


Figure 4.13: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with two plant
 Swedish Methods: FOS=0.734
 Green Colour: Slip Circle
 Cardinal Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 19.35 \text{ kPa}$
 $\phi = 22^\circ$
 $\gamma = 17.15 \text{ kN/m}^3$

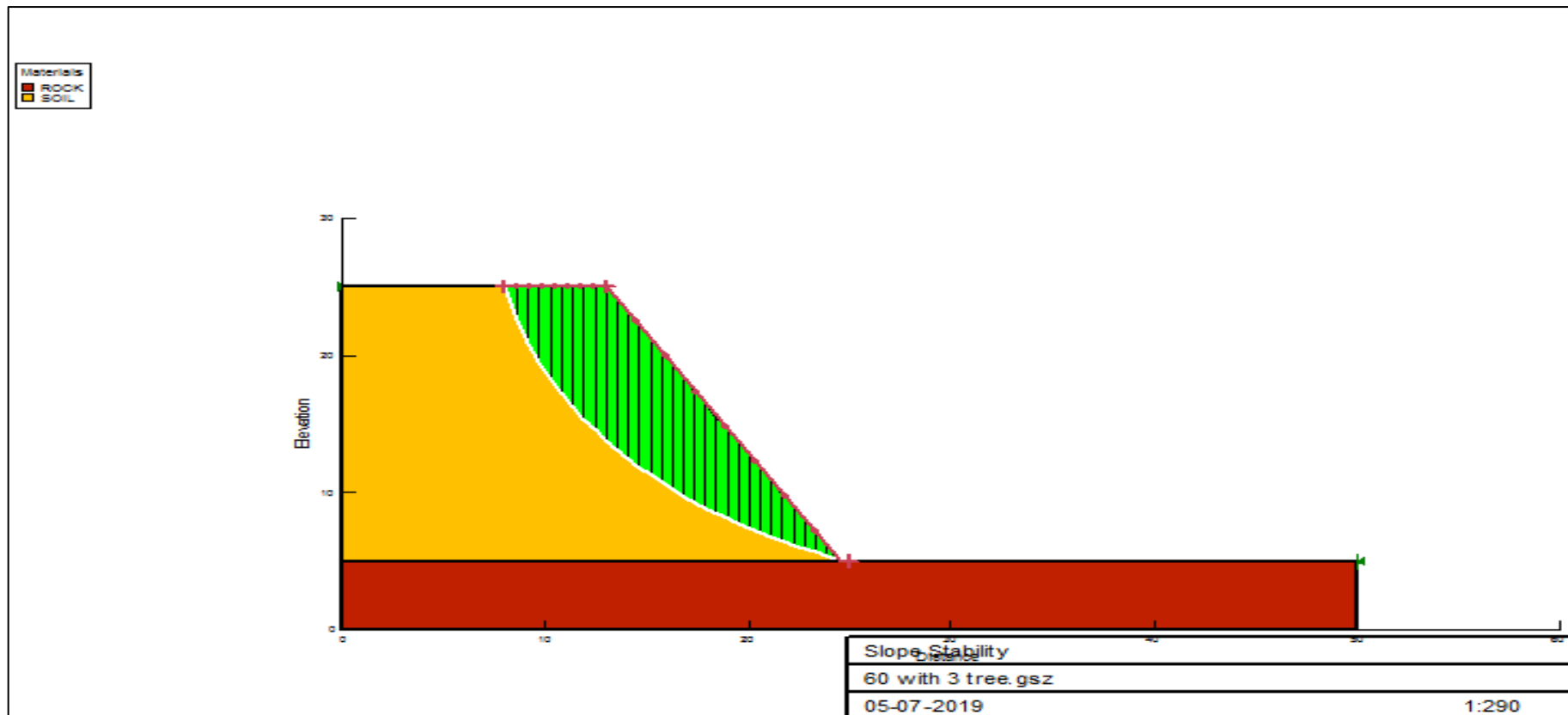


Figure 4.14: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with three plant
 Swedish Methods: FOS=0.858
 Green Colour: Slip Circle
 Cardinal Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 23.67 \text{ kPa}$
 $\phi = 24^\circ$
 $\gamma = 17.17 \text{ kN/m}^3$

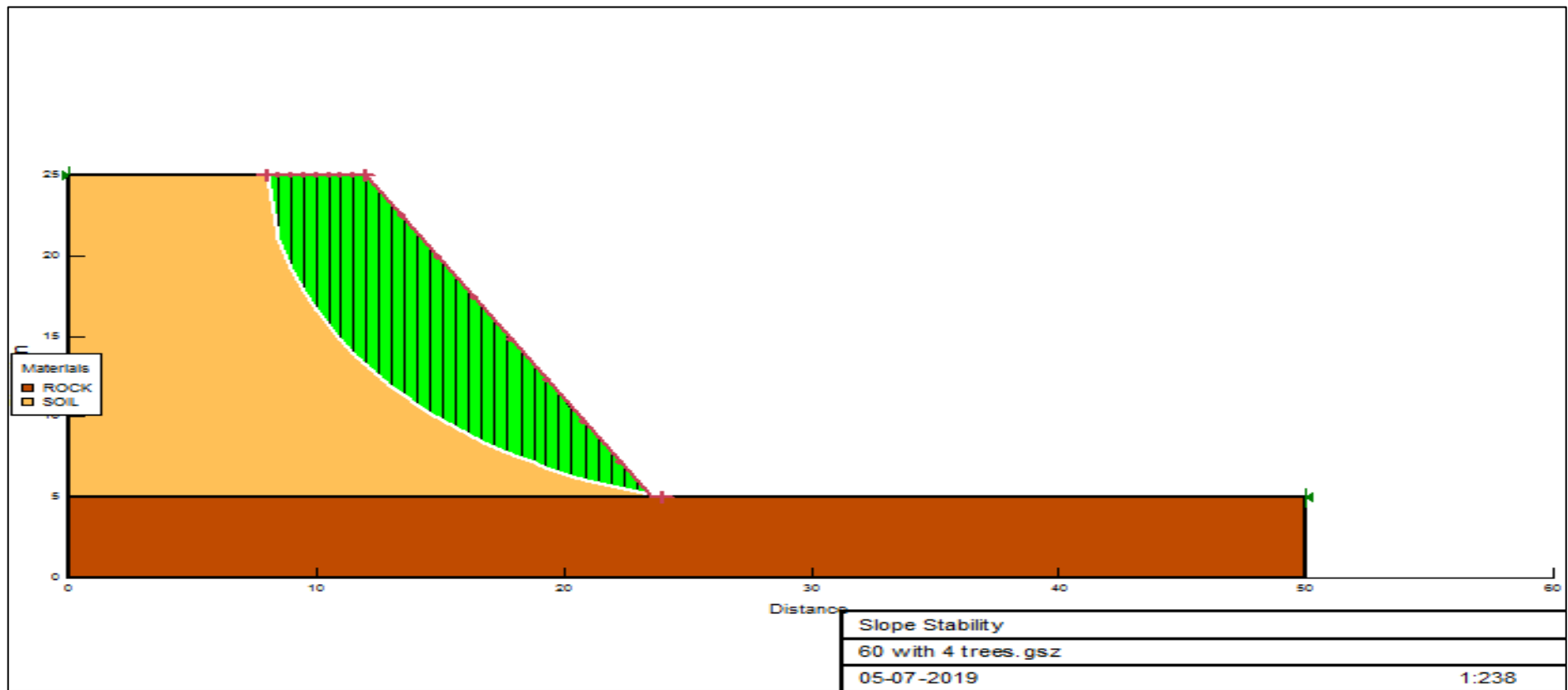


Figure 4.15: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with four plant
 Swedish Methods: FOS=0.917
 Green Colour: Slip Circle
 Khaki psm108 Colour: Bed Rock

Amber psm 157 Colour: Sandy Deposit
 $c = 25.37 \text{ kPa}$
 $\phi = 26^\circ$
 $\gamma = 17.19 \text{ kN/m}^3$

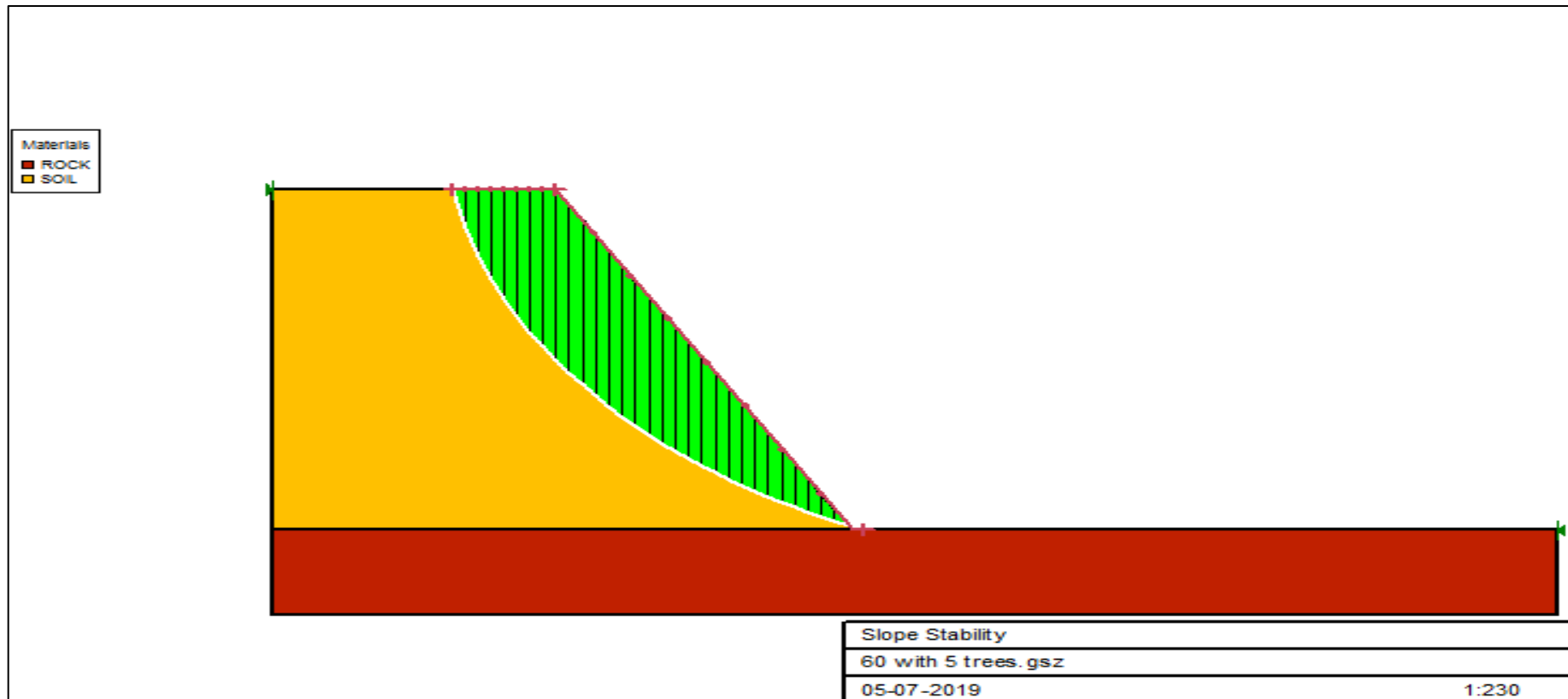


Figure 4.16: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with five plant
Swedish Methods: FOS=0.884
Green Colour: Slip Circle
Cardinal Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 26.47 \text{ kPa}$
 $\phi = 25^\circ$
 $\gamma = 17.21 \text{ kN/m}^3$

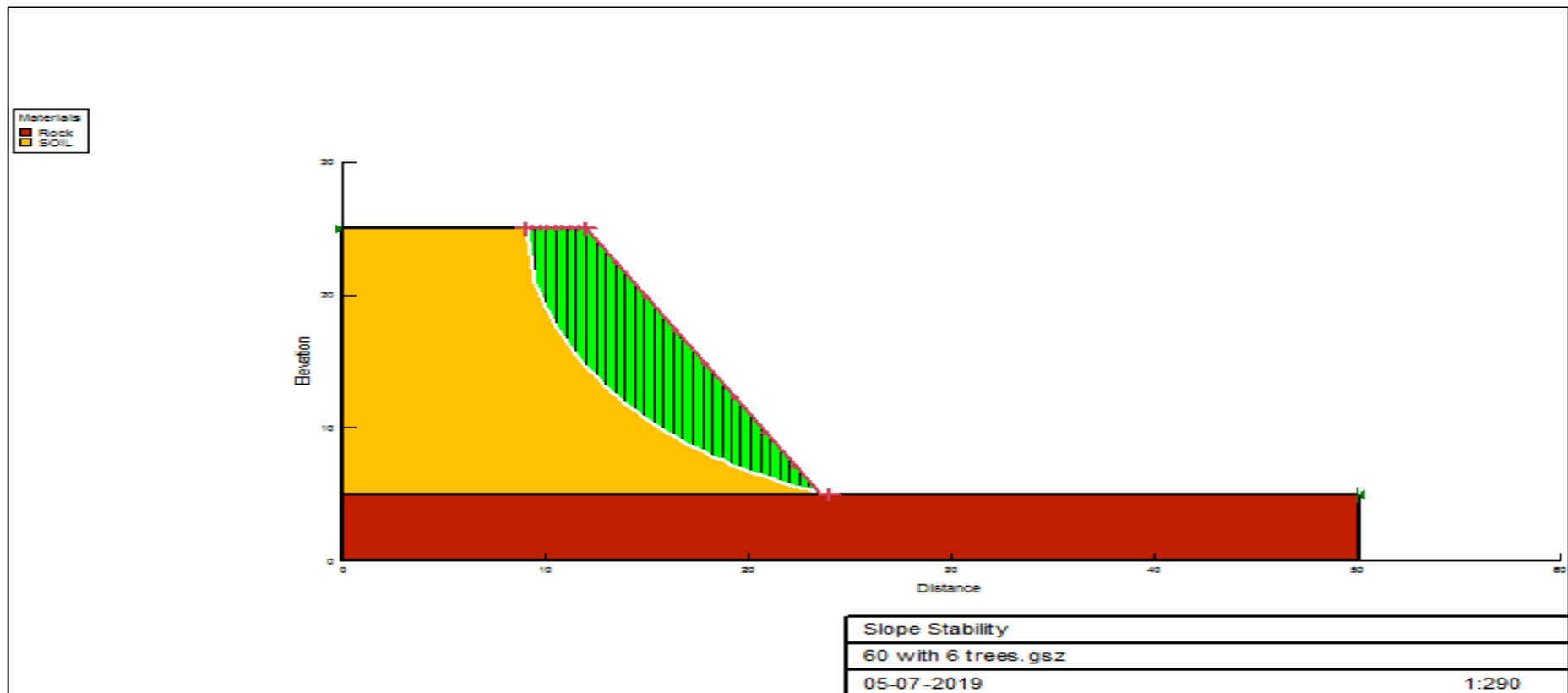


Figure 4.17: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with six plant
 Swedish Methods: FOS=0.865
 Green Colour: Slip Circle
 Cardinal Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 24.94 \text{ kPa}$
 $\phi = 24^\circ$
 $\gamma = 17.23 \text{ kN/m}^3$

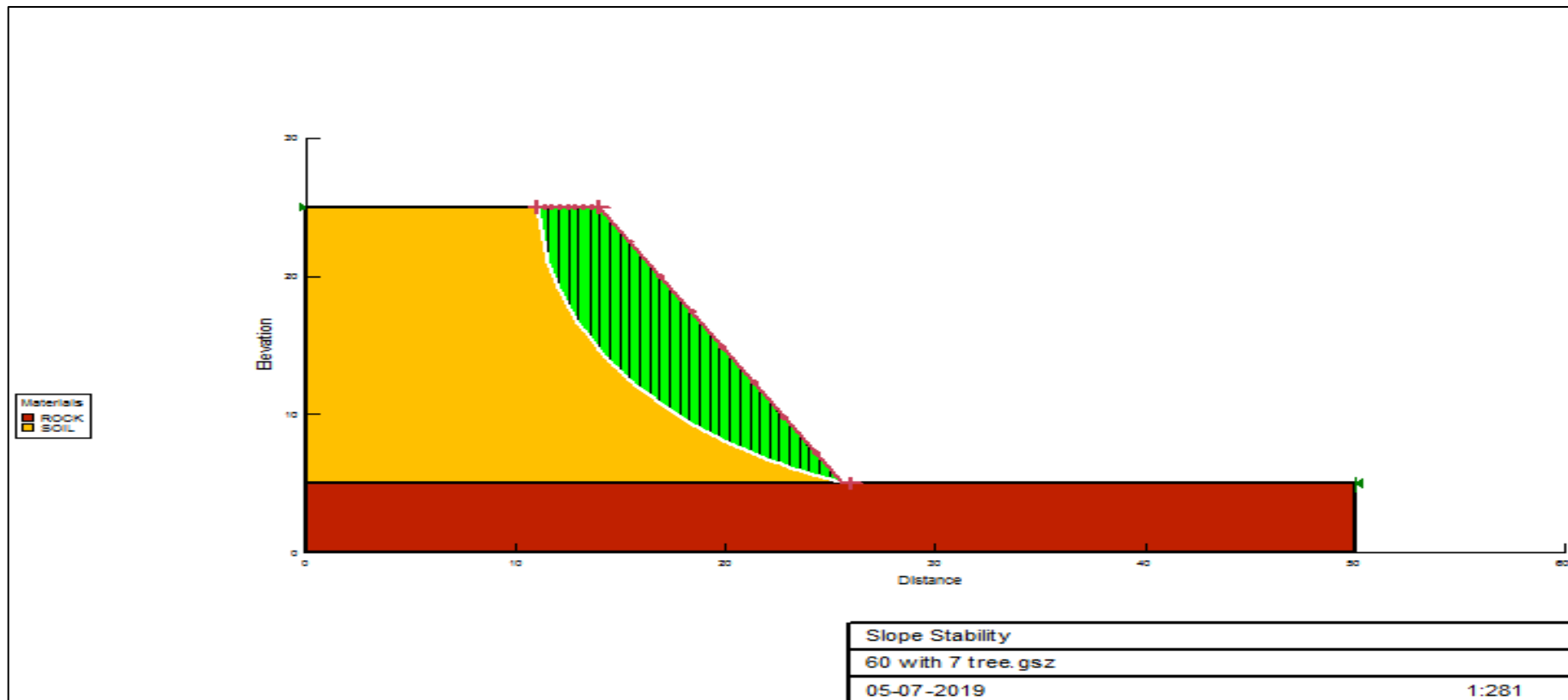


Figure 4.18: Geostudio Analysis of Kakri Ghat with 60 Degree Slope with seven Plants
 Swedish Methods: FOS=0.821
 Green Colour: Slip Circle
 Cardinal Colour: Bed Rock

Tan pms 4685 Colour: Sandy Deposit
 $c = 23.86 \text{ kPa}$
 $\phi = 23^\circ$
 $\gamma = 17.25 \text{ kN/m}^3$

Table 4.144 Swedish Analysis of Stability Numbers for different angles for Kakri Ghat site

Number of tree	Factor of Safety (FOS)																				
	45° slope angle			50° slope angle			55° slope angle			60° slope angle			65° slope angle			70° slope angle			75° slope angle		
	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03
0	0.78	0.95	0.87	0.77	0.78	0.81	0.71	0.74	0.72	0.65	0.69	0.73	0.66	0.72	0.63	0.73	0.84	0.59	0.51	0.52	0.39
1	0.91	1.13	0.95	0.9	0.92	0.82	0.83	0.86	0.84	0.75	0.8	0.83	0.77	0.82	0.74	0.83	0.74	0.68	0.61	0.6	0.64
2	0.94	1.2	0.98	0.93	0.96	0.9	0.86	0.88	0.89	0.77	0.85	0.84	0.78	0.83	0.76	0.835	0.749	0.7	0.63	0.62	0.69
3	1.1	1.42	1.15	1.03	1.12	1.04	1	1.01	0.92	0.88	0.97	0.95	0.89	0.95	0.88	0.95	0.85	0.81	0.74	0.65	0.82
4	1.19	1.53	1.24	1.17	1.21	1.13	1.086	1.1	1.12	0.96	1.05	1.06	0.97	1.03	0.95	1.04	0.928	0.878	0.8	0.77	0.88
5	1.192	1.47	1.23	1.178	1.215	1.12	1.087	1.09	1.13	0.95	1.052	1.04	0.96	0.86	0.954	1.02	0.92	0.872	0.81	0.78	0.9
6	1.13	1.55	1.74	1.11	1.15	1.06	1.02	1.03	1.07	0.9	1.04	0.99	0.91	0.96	0.84	0.97	0.87	0.82	0.76	0.73	0.85
7	1.07	1.404	1.32	1.05	1.1	1.01	0.98	0.99	1.02	0.88	0.95	0.94	0.88	0.92	0.83	0.92	0.83	0.78	0.73	0.7	0.81

Table 4.145 Swedish Analysis of Stability Numbers of different angles for Salri site

Number of tree	Factor of Safety (FOS)																				
	45° slope angle			50° slope angle			55° slope angle			60° slope angle			65° slope angle			70° slope angle			75° slope angle		
	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03	trail 01	trail 02	trail 03
0	1.13	1.078	1.13	1.14	1.05	0.98	0.99	0.88	0.8	0.84	0.85	0.796	0.79	0.83	0.85	0.95	0.83	0.75	0.681	0.74	0.7
1	1.14	1.079	1.16	1.15	1.052	0.99	0.93	0.87	0.81	0.9	0.87	0.81	0.81	0.86	0.83	0.92	0.79	0.81	0.684	0.73	0.72
2	1.45	1.42	1.57	1.44	1.37	1.32	1.16	1.14	1.08	1.16	1.14	1.08	1.01	0.95	0.92	1.15	1.02	0.94	0.9	0.82	1
3	1.54	1.53	1.71	1.53	1.47	1.42	1.23	1.22	1.17	1.23	1.22	1.17	1.07	1.01	1.11	1.21	1.09	1.02	0.96	1.01	1.1
4	1.56	1.59	1.8	1.57	1.52	1.489	1.25	1.26	1.224	1.25	1.268	1.225	1.1	1.04	1.13	1.22	1.1	1.022	1	1.03	1.17
5	1.593	1.58	1.79	1.58	1.53	1.482	1.22	1.267	1.22	1.27	1.26	1.22	1.11	1.04	1.12	1.24	1.11	1.03	1.03	1.04	1.15
6	1.59	1.57	1.72	1.56	1.51	1.43	1.26	1.25	1.2	1.26	1.25	1.2	1.1	1.05	1.14	0.97	1.11	1.02	0.95	1.03	1.14
7	1.58	1.49	1.68	1.49	1.44	1.39	1.25	1.18	1.14	1.25	1.19	1.14	1.04	0.98	1.08	1.17	1.05	0.89	0.94	0.98	0.83

Table 1.446 Comparative Analysis of Stability Numbers by Two Slope Stability Method for Kakri Ghat Site

Number of tree	Factor of Safety (FOS)													
	45° Slope angle		50° Slope angle		55° Slope angle		60° Slope angle		65° Slope angle		70° Slope angle		75° Slope angle	
	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops
0	0.78	0.78	0.77	0.77	0.71	0.71	0.65	0.64	0.63	0.63	0.59	0.57	0.39	0.46
1	0.91	0.90	0.82	0.89	0.83	0.82	0.75	0.73	0.74	0.74	0.68	0.67	0.61	0.58
2	0.94	0.94	0.90	0.90	0.84	0.84	0.77	0.75	0.76	0.76	0.70	0.69	0.62	0.59
3	1.10	1.02	1.04	1.02	1.00	0.95	0.88	0.90	0.88	0.87	0.81	0.79	0.65	0.63
4	1.19	1.10	1.13	1.07	1.086	1.04	0.96	0.91	0.95	0.92	0.878	0.86	0.77	0.74
5	1.19	1.11	1.12	1.06	1.087	1.02	0.95	0.94	0.842	0.87	0.872	0.85	0.78	0.76
6	1.13	1.09	1.06	1.04	1.02	1.00	0.90	0.84	0.848	0.85	0.82	0.82	0.73	0.69
7	1.07	1.05	1.01	1.00	0.98	0.94	0.88	0.81	0.86	0.82	0.78	0.77	0.70	0.68

Table 4.147 Comparative Analysis of Stability Numbers by Two Slope Stability Method for Salri Site

Number of tree	Factor of Safety (FOS)													
	45° Slope angle		50° Slope angle		55° Slope angle		60° Slope angle		65° Slope angle		70° Slope angle		75° Slope angle	
	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops	Swedish	Bishops
0	1.078	1.02	0.98	0.97	0.90	0.801	0.79	0.791	0.81	0.732	0.75	0.72	0.681	0.67
1	1.079	1.05	0.99	0.98	0.93	0.804	0.81	0.794	0.73	0.735	0.92	0.73	0.684	0.678
2	1.42	1.28	1.32	1.21	1.08	0.809	1.08	1.01	1.00	0.92	0.94	0.93	0.82	0.9
3	1.53	1.38	1.42	1.29	1.17	1.09	1.17	1.08	1.01	0.98	1.02	0.97	0.96	0.94
4	1.59	1.45	1.489	1.34	1.22	1.13	1.222	1.094	1.046	1.00	1.022	0.98	1.00	0.967
5	1.58	1.44	1.482	1.33	1.21	1.12	1.224	1.097	1.049	1.01	1.03	0.99	1.003	0.962
6	1.57	1.41	1.43	1.32	1.20	1.11	1.20	1.08	1.029	1.00	0.85	0.98	0.97	0.94
7	1.49	1.37	1.39	1.27	1.14	1.08	1.14	1.05	0.98	0.97	0.83	0.95	0.89	0.86

4.6 Optimal Number of Tree Density for Different Slope Angles

The main objective of this thesis is to find optimum number of Cedrus Deodar that can be planted to achieve the maximum stability of the varied slope of different soil types. To achieve objective, the analysis of slope stability has been conducted by Swedish Slip Circle and Bishop's methods to determine the factory of safety (FOS) with the excel spread sheets. The results obtained in determination of FOS with varied slope are plotted to obtain the optimum tree density of Cedrus Deodar tree for the soil collected from two different landslide sites. The result are represent in from of arithmetic graph between the number of tree per 150sqm plotted on abscissa and the FOS plotted on the ordinate. The curve shows gradually increase in the value of FOS as increase the number of tree but at certain point it start decrease as the number of tree increase which is shown in fig.4.19 to fig. 4.22. This graph shows that if we planted less number of tree that reduce the FOS and also if you planted excessive tree on slope that may cause the destabilize the slope. For this reason author find that optimum value of tree to achieve the maximum stability of slope.

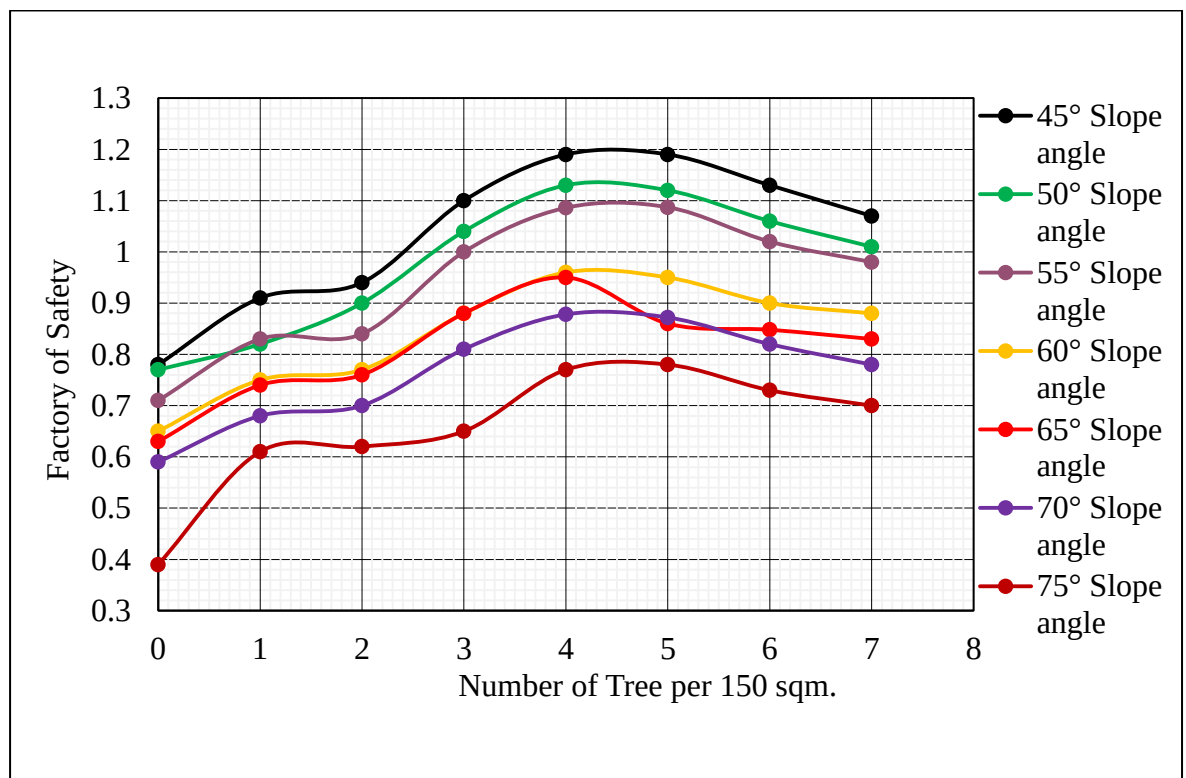


Fig. 4.19 Optimal Number of Trees Density in Different Angles by Swedish Method for well graded sandy deposits soil (Kakri Ghat Site)

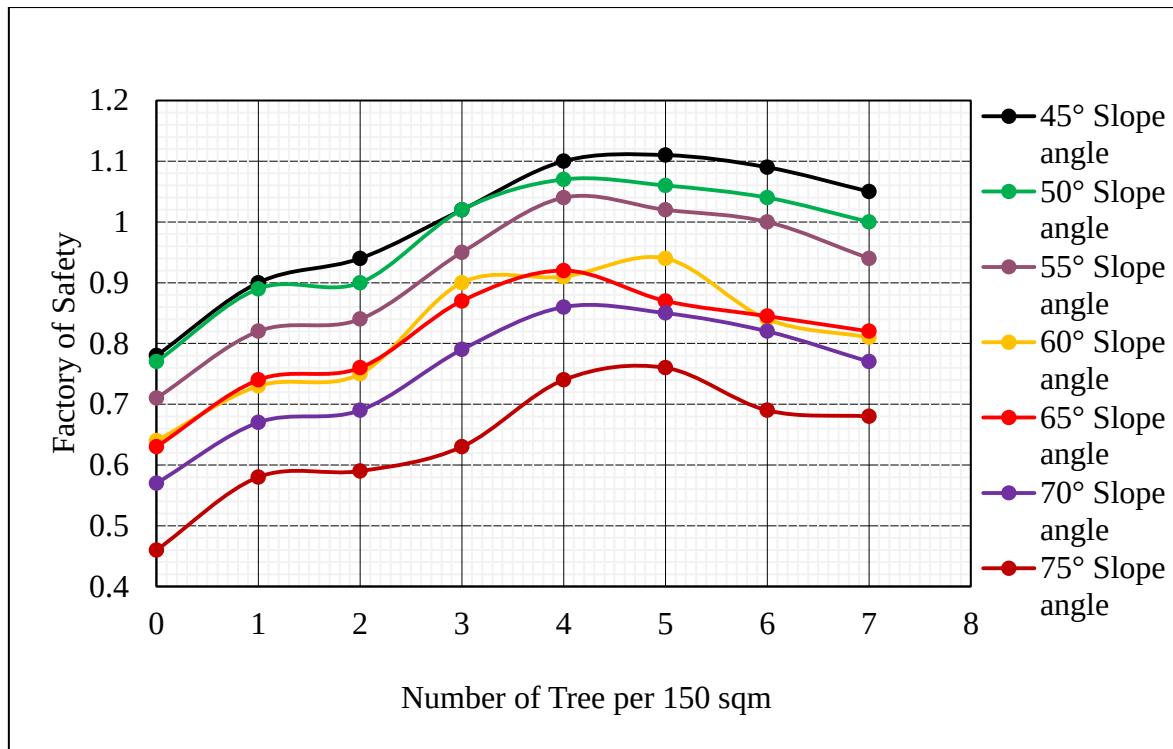


Fig. 4.20 Optimal Number of Trees Density in Different Angles by Bishop Method for well graded sandy deposits soil (Kakri Ghat Site)

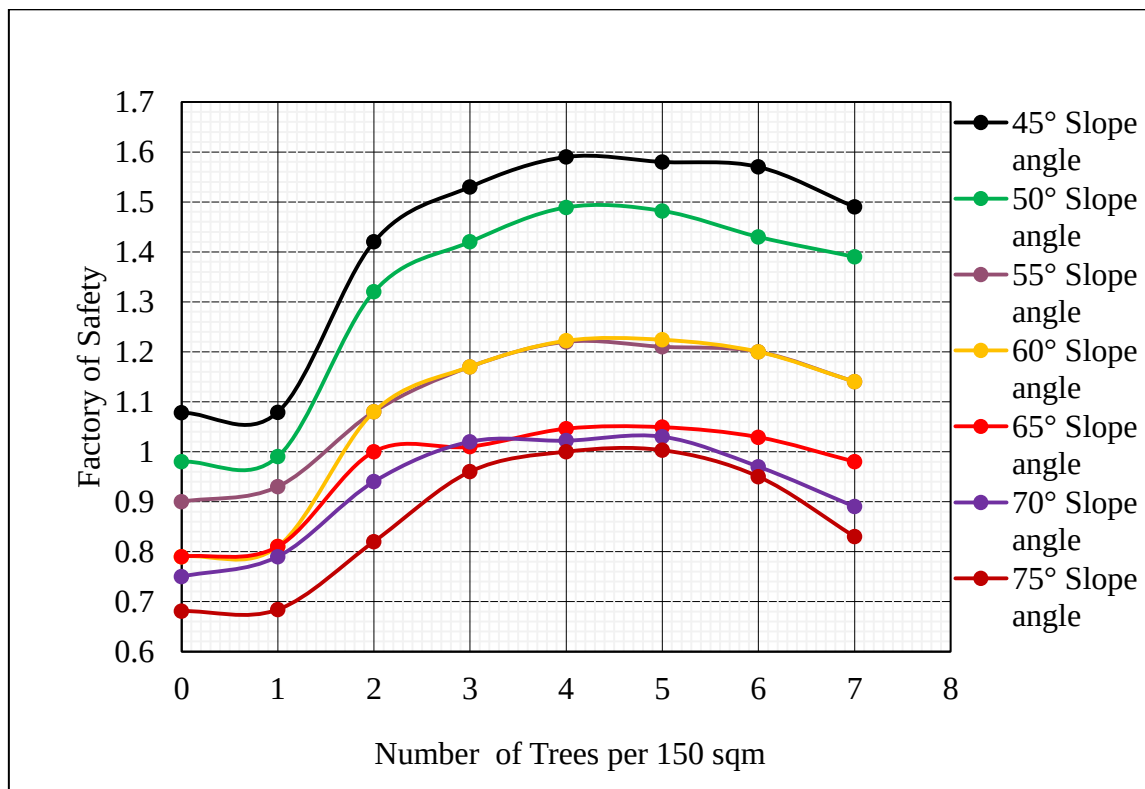


Fig. 4.21 Optimal Number of Trees Density in Different Angles by Swedish Method for poorly graded sandy deposits soil (Salri Site)

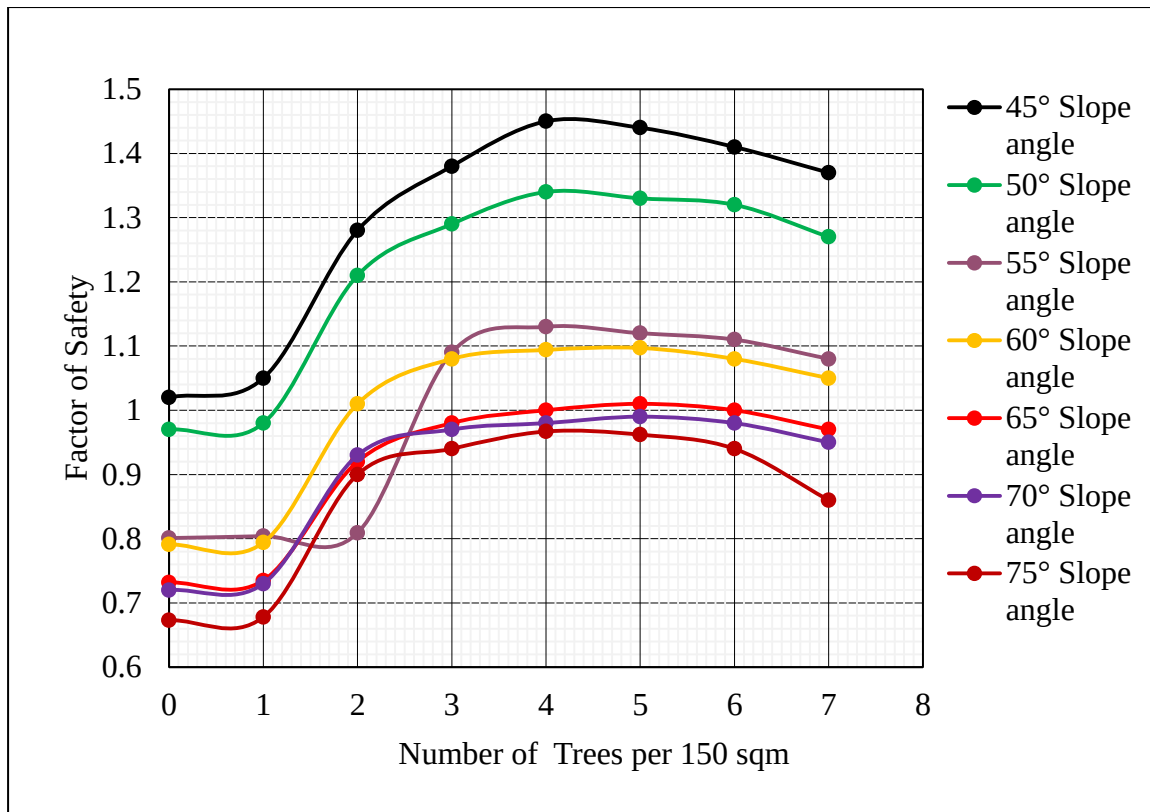


Fig. 4.22 Optimal number of trees density in different angles by Bishop Method for poorly graded sandy deposits soil (Salri Site)

Table 4.148 Comparative Analysis of Optimal Tree Density of Cedrus Deodar by Two Slope Stability Method for well graded Sandy deposits soil

Slope angles	Optimal Tree Density of Cedrus Deodar			
	By Swedish Method		By Bishops Method	
	Number of Tree 150 sqm. area	FOS	Number of Tree150 sqm. area	FOS
45°	4.4	1.2	4.5	1.12
50°	4.4	1.12	4.2	1.09
55°	4.4	1.097	4.2	1.04
60°	4.3	0.989	5	0.94
65°	4.2	0.956	4.2	0.875
70°	4.2	0.89	4.2	0.85
75°	4	0.82	4	0.78

Table 4.149 Comparative Analysis of Optimal Tree Density of Cedrus Deodar by Two Slope Stability Method for poorly graded sandy deposits soil

Slope angles	Optimal Tree Density of Cedrus Deodar			
	By Swedish Method		By Bishops Method	
	Number of Tree in 150 sqm. area	FOS	Number of Tree 150 sqm. area	FOS
45°	4.1	1.598	4.2	1.46
50°	4.1	1.498	4.2	1.35
55°	4.1	1.24	4.4	1.13
60°	4.3	1.18	5	1.097
65°	4.5	1.062	5	1.01
70°	4.4	1.055	4	0.99
75°	4	1.005	4	0.967

4.7 Validation of Result with GeoStudio Software

The validation of calculated FOS was carried out by using the GeoStudio 2019 (Slope/W) software and the calculated results of FOS for 60° was compared and found correct as shown in table 4.149. The fig. 4.23, curve shows gradually increase in the value of FOS as increase the number of tree but at certain point it start decrease as the number of tree increase.

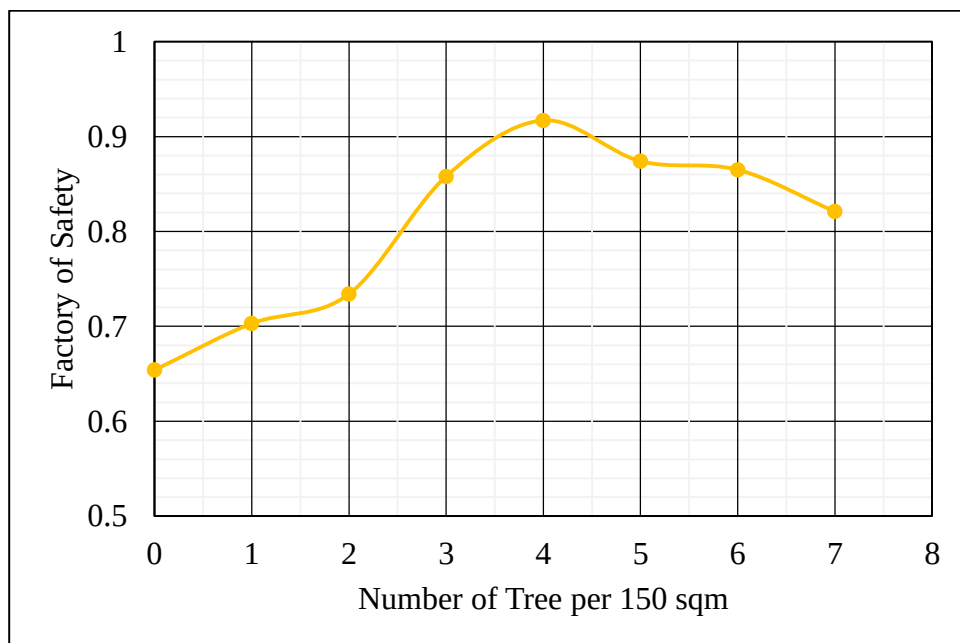


Fig. 4.23 Optimal Number of Trees Density of 60° Angles by Geostudio Software (Swedish method) for Kakri Ghat Site

Table 4.150 Comparative Analysis of Stability Numbers by Swedish Method and Geostudio Software for 60° Slope Angle for Kakri Ghat Site

Number of tree		0	1	2	3	4	5	6	7
FOS	Swedish	0.65	0.75	0.77	0.88	0.96	0.95	0.90	0.88
	Geostudio	0.654	0.703	0.734	0.858	0.917	0.874	0.865	0.821

Observations of Slope Stability Analysis

- For analysis the effect of root system in slope stability of two different types of soil collected from landslide area of Uttarakhand *i.e.* Kakri Ghat and Salri Site Shear Box Testing were prepared with varied plant density. The selection of suitable plant *Artemisia Annua* is carried out with appropriate comparison with *Cedrus Deodar* tree. So that the effect of root system of *Cedrus Deodar* tree on the slope of Uttarakhand region may be represented effectively in the controlled laboratory conditions.
- The value of unit bulk density of soil specimen was gradually increased as the increased in the varied plant density. It is because the roots system can hold the soil masses and also compacted the soil masses. Also the weight of tree act as the surcharge load on the soil masses due to this soil become denser.
- The extensive laboratory studies of around 48 sample of Large Shear Box Test for varied plant density shows the improvements in shear parameter with increase in tree density. It was found for the soil of Kakri Ghat (well graded sandy deposit) the value of c and ϕ is enhanced around 13.6 kN/m^2 to 26.24 kN/m^2 when the tree density were increased from *Cedrus Deodar* tree 0 to 5. Further the c and ϕ value was found to be decrease when the tree density was more than 5 tree/ 150sqm the variations of value was 26.47 kN/m^2 to 23.86 kN/m^2 .
- It was found for the soil of Salri Site (poorly graded sandy deposit) the value of c and ϕ was enhanced around 12.67 kN/m^2 to 27.28 kN/m^2 when the tree density were increased from *Cedrus Deodar* tree 0 to 4. Further the c and ϕ value was found to be decrease when the tree density is more than 4 tree/ 150sqm the variation of value was 27.28 kN/m^2 to 24.67 kN/m^2 .
- These improved value of shear parameter (c and ϕ) for calculated tree density of *Cedrus Deodar* tree (tree/150sqm area) are used to calculated the FOS from slope stability analysis by using two methods for varied slope angles.

- The slope stability analysis was carried out by two different method (Swedish and Bishop's methods). The result shows that the FOS was less than one when plantation was not happened on soil sample. It means the slope are unstable. While the varied density of plantation was takes place it was found that the FOS was gradually increased up to peak point after that they start decreased with increased the density of plants in 150sqm area.
- When Factor of Safety is calculated taking into consideration different slope angles and the effect of surcharge *i.e.* weight of trees. It was observed that the Factory of Safety value decreased as the slope angle increased.
- The factor of safety increased as the slope angle decreased while factor of safety decreased the slope angle increased. For 45° of slope angle the FOS was 0.78 for well graded sand deposit soil without plantation and for 75° of slope angle the FOS was 0.39 for Kakri Ghat site. Similarly for Salri site soil sample without plantation the FOS for 45° slope angle is 1.078 and for 75° slope angle the FOS is 0.681.
- Curve plotted between number of tree per 150sqm and FOS was found that the different slope angle the optimum number of Cedrus Deodar tree per 150 sqm, firstly increase for 45° slope angle and then decrease for slope angle of 75°.
- For 45° slope angle the optimum tree density of Cedrus Deodar in 150 sqm area is 4.2 number of plant are planted. While increase in slope angle at 75° the optimum number of tree is 4. Because the excessive vegetation increase the downward load on soil masses which may lead to increase the slope instability.
- The validation of calculated FOS was carried out by using the GeoStudio 2019 (Slope/W) software and the calculated results of FOS for 60° was compared and found correct.

4.8 Concluding Remarks

The results obtained by conducting different types of tests on the soil required in order to check slope instability is tabulated later slope stability analysis carried conventionally and numerically are presented and discussed in this chapter. The important conclusions drawn from there are presented in the succeeding chapter.

*Summary
and
Conclusions*

5.1 General

This chapter summarizes and concludes the work done and the findings evolved from this thesis. With increase in the awareness regarding failure of structure and blockage of roads *etc.*, occurring due to weak soil mass, it has become utmost important to gather the reliable geotechnical data of soil to avoid future losses of human life and property with the damage of structure. Vegetation technique as Bio-Engineering can be used to stabilize the soil slope masses. In the previous chapter the methodology is explained in detail which demonstrates the methods and process to stabilize the slope.

5.2 Conclusions

From the research work presented in this thesis the following conclusions may be drawn:

1. Failure of Slope are causing economical and human casualties in major parts of Uttarakhand states especially in monsoon reasons. The catastrophe caused by landslides in previous year have been reported as loss in revenue around Rs. 200 core per year by State Disaster Management and Mitigation Department.
2. Literature recommends the various mechanical and hydrological methods of slope stabilization which are less economical and hard to be adopted due to financial constraints especially in developing countries in Indian.
3. It is found that inadequate vegetation may not adequately stabilize the slopes but on the other hand excess vegetation may also cause the slope failure due to excess normal load on slopes. Therefore there must be an optimum vegetation density for which the maximum slope stability may be attained.
4. For analysis the effect of root system in slope stability of two different types of soil collected from landslide area of Uttarakhand *i.e.* Kakri Ghat and Salri Site Shear Box Testing were prepared with varied plant density. The selection of suitable plant *Artemisia Annua* is carried out with appropriate comparison with *Cedrus Deodar* tree. So that the effect of root system of *Cedrus Deodar* tree on

the slope of Uttarakhand region may be represented effectively in the controlled laboratory conditions.

5. The extensive laboratory studies of around 48 sample of Large Shear Box Test for varied plant density shows the improvements in shear parameter with increase in tree density. It is obtained for the soil of Kakri Ghat (well graded sandy deposit) the value of c and ϕ is enhanced around 13.6 kN/m^2 to 26.24 kN/m^2 when the tree density were increased from Cedrus Deodar tree 0 to 5. Further the c and ϕ value is also observed to be decrease when the tree density is more than 5 tree/ 150sqm.
6. It is obtained for the soil of Salri Site (poorly graded sandy deposit) the value of c and ϕ is enhanced around 12.67 kN/m^2 to 27.28 kN/m^2 when the tree density were increased from Cedrus Deodar tree 0 to 4. Further the c and ϕ value is also observed to be decrease when the tree density is more than 4 tree/ 150sqm.
7. These improved value of shear parameter (c and ϕ) for calculated tree density of Cedrus Deodar tree (tree/150sqm area) are used to calculated the FOS from slope stability analysis by using two methods for varied slope angles.
8. Curve plotted between number of tree per 150sqm and FOS it is observed that the different slope angle the optimum number of Cedrus Deodar tree per 150 sqm, firstly increase for 45° slope angle and then decrease for slope angle of 75° .
9. The validation of calculated FOS is observed by using the GeoStudio 2019 (Slope/W) software and the calculated results of FOS for 60° is compared and found correct.
10. Finally, the optimum value of Cedrus Deodar tree for soil types may be adopted by Forestry Department and other Department. To plant the more tree on the slope where the tree density is less than optimum value as to curtail the excess tree density near to optimum value so that the maximum FOS may be achieve.

5.3 Limitation of Study

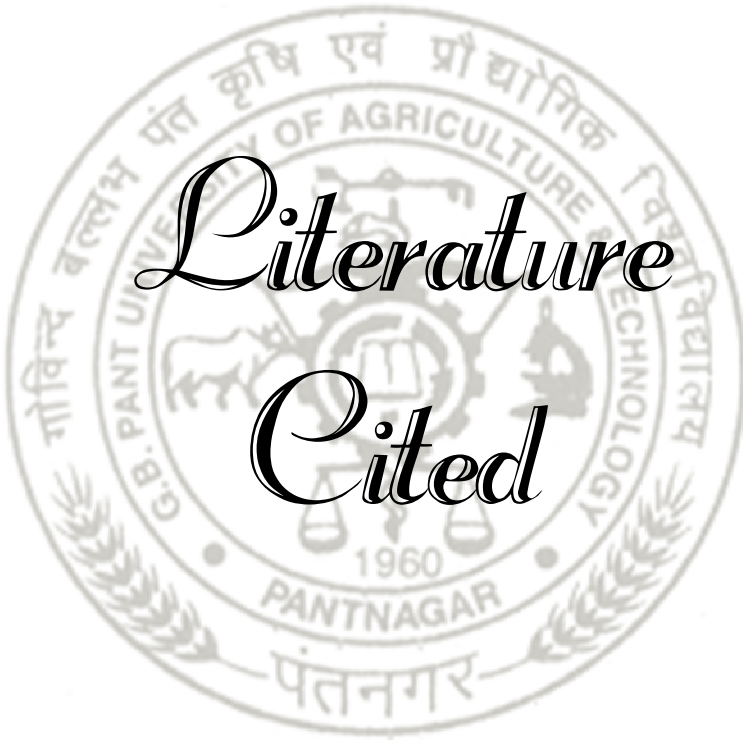
The study has significant results in terms of plant species that have a better performance stabilizing slope basically on landslides. However, the lack of direct data

root area ratio, tensile strength *etc.* the result taken with caution because these types of factors are specific, even varying between the same species. The results can be taken indicative and an approximation of performance of plant species that have reported as useful in slope stabilization but for most of them no specific studies have been done.

5.4 Scope of Further Study

Following work are further carried out to improve the slope stability through vegetation:

- Future research should focus in quantifying the additional benefits that plant species used for slope stability can provide to the community and assess their potential economic benefit.
- The combination of plant species included one species of each group of grasses, shrubs and trees will may increase the value of the FOS as comparad to single species.
- Surcharge added by trees would also be included; such information could be derived by using remote sensing for example. Such information can be incorporated in the analysis of FOS and validate the information provided here. Hydrological aspects should also be included to provide a complete assessment of the role of vegetation on slope stability.
- Studies on non-homogeneous and layered soil deposits can be carried out which become cumbersome by conventional methods.
- Studies on reinforced soil can be further carried.



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ABSTRACT

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Advisor : Dr. Sanjeev Suman

Slopes are common feature of the world around us, usually they are of a geological, geomorphological or human man-made. In most instances, slopes are naturally unstable unless they have been stabilized through geological time. Unstable slope create numerous management and engineering issues. The fragile Himalayan terrain of Uttarakhand often face challenging and tough situation due to landslides, particularly in monsoon season. To cope up with this kind of hazards, use of effective vegetation as Bio- Engineering is considered a good alternative as this management of ecosystem can provide benefits like stabilizing slope, medicinal resources and other environmental benefits.

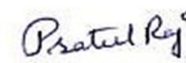
The present study analysed the mechanical effect of plant root system on slope stability. Root cohesion and surcharge effects were analysed and Factor of Safety (FOS) was evaluated for a slope angles (45° , 50° , 55° , 60° , 65° to 70° and 75°). For analysis the effect of root system in slope stability of two different types of soil collected from landslide area of Uttarakhand *i.e.* Kakri Ghat and Salri Site Shear Box Testing were prepared, with varied plant densities. The selection of suitable plant “*Artemisia Annua*” was carried out with appropriate comparison with Cedrus Deodar tree, so that the effect of root system of Cedrus Deodar tree on the slope of Uttarakhand region may be represented effectively in the controlled laboratory conditions.

The extensive laboratory studies of around 48 sample of Large Shear Box Test for varied plant densities shows the improvements in shear parameter with increase in tree density. These improved value of shear parameter (c and ϕ) for calculated tree densities of Cedrus Deodar tree (tree/150sqm area) are used to calculate the FOS from slope stability analysis by using two methods *i.e.* Swedish and Bishop’s method for varied slope angle (45° , 50° , 55° , 60° , 65° to 70° and 75°). The validation of calculated FOS was carried out by using the GeoStudio 2019 (Slope/W) software and the calculated results of FOS for 60° was compared and found correct.

Variation between FOS (for different slope angle 45° , 50° , 55° , 60° , 65° to 70° and 75°) was plotted against different densities of Cedrus Deodar tree (tree/150sqm) and it was found that the FOS increased with increasing the tree densities and after attaining a maximum value it, further decreased with increase Cedrus Deodar tree densities. The graphical representation of this variation between FOS and tree densities of Cedrus Deodar tree clearly indicate that there is an optimum tree density that will maximize the FOS for a particular soil types. The value of optimum tree density of Cedrus Deodar tree were obtained and recommended for the different slope condition (45° to 75°) and for soil types *i.e.* well graded sandy deposits and poorly graded sandy deposits soil collected from the landslide sites Kakri Ghat and Salri Site from Almora and Nainital District respectively from Uttarakhand State, India.

The present work gives the methodology to ascertain the effect of root system vegetation in slope stability quantitatively for the different slope condition for particular soil types with certain limitation and may these optimum value may be adopted for plantation of Cedrus Deodar tree for particular slope types and thus can prevent the slope failure caused by deficient vegetation as well as failure because of excess vegetation.


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शोध का शीर्षक	: "उत्तराखण्ड के कुमाऊँ क्षेत्र में सेडरस देवदार वृक्ष के अनुकूलता घनत्व के लिए दलान स्थिरता विश्लेषण"
सलाहकार	: डॉ संजीव सुमन

दलान भौगोलिक दुनिया की सामान्य विशेषता है, जो प्राकृतिक, भूवैज्ञानिक, भू-आकृति विज्ञान तथा मानव-निर्मित होती है। ज्यादातर उदाहरणों में, दलान स्वभाविक रूप से अस्थिर होते हैं जब तक कि उन्हें भूवैज्ञानिक माध्यम से स्थिर नहीं किया गया हो। अस्थिर दलान कई प्रबंधन और अभियांत्रिकी समस्या का कारण बनते हैं। खासकर मानसून के मौसम में, उत्तराखण्ड का हिमालयी इलाका अक्सर भूस्खलन के कारण चुनौतीपूर्ण और कठिन हो जाता है। अतः इस तरह के खतरों से निपटने के लिए, जैव-अभियांत्रिकी एक प्रभावी विकल्प माना गया, क्योंकि पारिस्थितिकी तंत्र में वनस्पति का उपयोग प्रबंधन दलान, औषधि संसाधनों और अन्य पर्यावरणीक लाभों को स्थिरता प्रदान करता है।

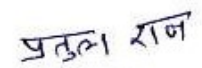
इस अध्ययन में दलानों की स्थिरता पर जड़ प्रणाली के यांत्रिक प्रभाव और अधिभार प्रभावों का विश्लेषण किया गया है। विभिन्न कोण (45° , 50° , 60° , 65° , 75° और 75°) के लिए फैक्टर ऑफ सेफ्टी (एफ.ओ.एस.) का मूल्यांकन प्रदर्शित है। विश्लेषण के लिए उत्तराखण्ड के भूस्खलन क्षेत्रों काकड़ी घाट और सालरी साइट, दो विभिन्न क्षेत्रों के मिट्टी की दलान स्थिरता में जड़ प्रणाली के प्रभाव को विभिन्न पौधों के घनत्व के साथ तैयार किया और उपयुक्त पौधे अटिमिसिया एना का चयन सेडरस देवदार के पेड़ के साथ तुलनात्मक रूप में किया गया है। ताकि उत्तराखण्ड क्षेत्र की दलान पर सेडरस देवदार वृक्ष की जड़ प्रणाली, नियंत्रित प्रयोगशाला स्थितियों में प्रणाली के प्रभावी ढंग को दर्शाया जा सके।

विभिन्न पादप घनत्व के लिए लार्ज शीयर बॉक्स टेस्ट के 48 नमूनों पर प्रयोगशाला अध्ययन से पेड़ के घनत्व में वृद्धि और शीयर पैरामीटर में सुधार को दर्शाया गया है। सेडरस देवदार ट्री (पेड़/150 वर्गमीटर क्षेत्र) के संशोधित शीयर पैरामीटर आंकड़ों (c और Φ) को दलान स्थिरता विश्लेषण के एफ.ओ.एस. की गणना के लिए प्रयोग में लाये गए, जो इस प्रकार हैं, स्वीडिश और बिशप विधि तथा विभिन्न दलान कोण (45° , 50° , 55° , 60° , 65° और 75°)। गणना किए गए एफ.ओ.एस. का सत्यापन जीओ स्टूडियो 2019 (स्लोप/डब्ल्यू) सॉफ्टवेयर का प्रयोग करके कोण 60° के एफ.ओ.एस. की गणना के परिणामों के साथ तुलनात्मक रूप में देखा गया तथा परिणामों को लगभग सही पाया गया है।

एफ.ओ.एस. में होने वाले विभिन्न परिवर्तनों (दलान कोणों 45° , 50° , 55° , 60° , 65° , 70° और 75°) को सेडरस देवदार ट्री के अलग-अलग घनत्व के प्रतिकूल आलेखित किया और पाया गया कि वृक्षों के घनत्व में वृद्धि होने पर उनके एफ.ओ.एस. में भी संवृद्धि हुई और अधिकतम मान प्राप्त करने के बाद सेडरस देवदार ट्री के घनत्व में वृद्धि होने पर एफ.ओ.एस. में कमी आई। देवदार के पेड़ के एफ.ओ.एस. और पेड़ के घनत्व के बीच इस भिन्नता का आरेखित निरूपण स्पष्ट रूप में दर्शाता है कि एक अनुकूलतम पेड़ घनत्व है जो एक विशेष मिट्टी के प्रकारों के लिए एफ.ओ.एस. का मान अधिकतम देगा। देवदार पेड़ के अनुकूलतम घनत्व मूल्यांकन को अलग-अलग दलान की स्थिति (45° से 75°) में मृदा के लिए किया जाकि वैल ग्रेडेड सेन्ड डिपोजिट तथा पुअर्ली ग्रेडेड सेन्ड डिपोजिट है जोकि भारत के उत्तराखण्ड राज्य में स्थित अल्मोड़ा तथा नैनीताल जिले के क्षेत्रों काकरी और सालरी घाट के भूस्खलन क्षेत्रों से एकत्र की गई है।

इस कार्य में दलान की स्थिरता पर वनस्पति के जड़ प्रणाली प्रभाव का पता लगाने के लिए कुछ परिसीमन के साथ भिन्न मिट्टी के प्रकार के लिए विधि दलान की स्थिरता का अध्ययन किया गया है और बताया गया कि वृक्षारोपण दलान के प्रकारों के लिए अपनाया जा सकता है और पेड़ दलान की विफलता को कम करता है, परन्तु अधिक वनस्पति के रोपण के कारण से भी दलान में विफलता आ सकती है।


(संजीव सुमन)
सलाहकार


(प्रतुल राज)
लेखक