SLOPE STABILITY ANALYSIS FOR TREATED SOIL USING PULVERIZED GLASS POWDER

MAJOR PROJECT-II

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REQUIREMENTS FOR THE AWARD OF THE DEGREE

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GEOTECHNICAL ENGINEERING

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JULY- 2020

CANDIDATE'S DECLARATION

I,UTTAM KUMAR , belonging to Master of Technology, Geotechnical Engineering, Delhi Technological University hereby certify that the work being presented in the minor entitled "SLOPE STABILITY ANALYSIS FOR TREATED SOIL USING PULVERIZED GLASS POWDER" in partial fulfillment for the award of degree of Master of Technology in the Geotechnical Engineering and submitted in the Department of Civil Engineering of Delhi Technological University, Delhi is an authentic record of my own work carried out under the supervision of Prof. Kongan Aryan, Department of Civil Engineering, Delhi Technological University, Delhi, India.

The matter presented in this minor has not been submitted by us for the award of any other degree in this or any other institution.

DATE: 30 JUNE 2020.
UTTAM KUMAR.
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This is to certify that the above statement made by the candidates is correct to the best of my knowledge and belief.

Supervisor.
Prof. Kongan Arya.
DATE: 30 JUNE 2020.

CERTIFICATE

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Bawana Road, Delhi-110042

I hereby certify that the Project Dissertation titled " **SLOPE STABILITY ANALYSIS FOR TREATED SOIL USING PULVERIZED GLASS POWDER** " by UTTAM KUMAR, belonging to Master of Technology, Geotechnical engineering, Civil Engineering Department, Delhi Technological University, Delhi in partial fulfillment of the requirement for the award of degree of Master of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge, this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place- Delhi **Prof. Kongan Aryan**

DATE: 30 JUNE 2020

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It gives me immense pleasure in expressing my gratitude to all those people who supported us and have had their contribution in making this major project possible. We would like to express our gratitude to our mentor as well as our HOD who gave us the golden opportunity to do this wonderful project on the topic "**SLOPE STABILITY ANALYSIS FOR TREATED SOIL USING PULVERIZED GLASS POWDER**".

We owe a debt of gratitude to my guide **Prof. Kongan Aryan** for incorporating in us the idea of a creative Minor Project, helping us in undertaking this project and for being there whenever we needed his assistance. We are immensely grateful to all those who have helped us in making this project better, by providing us their valuable comments and guidance.

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UTTAM KUMAR **(2K18/GTE/16)**

ABSTRACT

Soil has main problem is that it undergoes consolidation settlement due to the application of long term loading. Another problem is it shrinks significantly if it is dried and expands significantly if it absorbs moisture which exerts much pressure on the substructure. This paper was evaluated the engineering properties on utilizing waste crushed glass as additive on subgrade improvement. The research were conducted soil engineering properties, standard compaction,Atterberg limits to expansive soil, Direct Shear Test. The variation of additive content on stabilized soil: 5%, 10%, 15%, 20% by dry total weight of soil sample respectively. From the results it was found that the liquid limit, the plastic limit and the optimum water content decreased by increasing of added percentage, but the maximum dry density. Friction Angle and cohesion increase. Clay soil also have very low angle of friction due to which it gave low shear strength. When soil come in contact of water its effective strength also decrease due to which shear strength decrease.

Glass powder is industrial waste product .which are generally deposited as landfill and dumping from environmental and economical point of view it can be use as admixture in sub base soil , embankment or filling material. As economy of our country increases and construction works also increases and new techniques in construction are develop to increase the standard of civil engineering projects. These methods should also be environmental friendly and cost effective. By using glass powder we can improve the property of soil by economical way.

Some experimental investigation was done to analysis the change in property of soil by addition of pulverizeddd glass power inclusion on Plastic limit, Liquid limit, Optimum moist content (OMC), Maximum dry density, Direct shear test (DST). The test was done with varying the percentage of pulverise glass power of 0%, 5%, 10%, 15%. Etc. Glass power was obtained from Moti Nagar Industrial area. Measurement of shear stress parameters was done by performing Direct shear test (DST) in undrained condition on three normal stress of different load i.e., 50N/mm, 100N/mm ,150N/mm2 on 5 sample contain 0%, 5%, 10%, 15%, 20% of glass power of soil. Result of these experiments are use to find the variation of shear stress parameter i.e., angle of friction and cohesion. By plotting the normal stress vs. shear stress curve.

A slope in a soil encountered when the elevation of the ground surface gradually changes from a lower level to a higher one. Such a slope may be either natural (in hilly region) or manmade (in artificially constructed embankment or excavations).

The soil mass bounded by a slope has a tendency to slide down. The principle factor causing such a sliding failure is the self-weight of the soil. However, the failure may be aggravated due to seepage of water or seismic forces. Every man-made slope has to be properly designed to ascertain the safety of the slope against sliding failure.

The aim of this research paper is to study the behavior of slope by different Analysis methods of slope analysis on SLOPE/W software by limit equilibrium method . Slope/W is a commercial software by GEOSTUDIO.

Slope/W is used to determine the minimum FOS in critical slip surface for profile .The pore water pressure contour and piezometric lines are also shown in this software .In this paper a model is produce in Slope/w to understand how it works and gives results, The assumptions considered and the limitations observed.

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CHAPTER 1
INTRODUCTION

1.1 SOIL PROPERTY.

1.1.1 INTRODUCTION.

Clay soil has tendency to increase in volume in presence of water and decrease in volume in absence of water. Expensive soil and swelling in nature of these soil poses many problems to the structure constructed on them such as buildings, roads, foundation of bridge.
Clay soil also have very low angle of friction due to which it gave low shear strength. When soil come in contact of water its effective strength also decrease due to which shear strength decrease
Glass powder are industrial waste product . which are generally deposited as landfill and dumping . from environmental and economical point of view it can be use as admixture in sub base soil embankment or filling material. As economy of our country increases day and day and construction works also increase and new technics in construction are develop day by day to increase the standard of civil engineering projects.

1.1.2 SOIL CLASSIFICATION.

Soil is an unconsolidated material, composed of solid particles, produced by disintegrated of rocks. The void space between the particles may contain air, water or both. Soil are of many different type like gravel, sand, soil, clay etc, all soil exhibited different properties having different pros and cons. Soil for this experimental study was taken from MOTI NAGAR area at depth of approx. 3m.

1.1.3 GLASS POWDER.

Glass powder are industrial waste product . which are generally deposited as landfill and dumping . from environmental and economical point of view it can be use as admixture in sub base soil , embankment or filling material. As economy of our country increases and construction works also increases and new technics in construction are develop to increase the standard of civil engineering projects. These methods should also be environmental friendly and cost effective. By using glass powder we can improve the property of soil by economical way

1.1.4 MIXTURE OF SOIL WITH GLASS POWDER.

Glass powder are added to the soil at the ratio of 5%, 10% ,15% with weight to the soil for analyzing the properties of soil.

1.1.5 ADVANTAGES.

Following are the advantages of glass powder with soil

- decrease liquid limit.
- Increase plastic limit.
- Decrease OMC.
- Increase dry density.
- Increase angle of friction.

- Increase cohesion.
- Decrease lot in post peak strength.

1.1.6 APPLICATION.

Clay soil also have very low angle of friction due to which it gave low shear strength. When soil come in contact of water its effective strength also decrease due to which shear strength decrease with addition of glass power angle of friction increase and cohesion also increase due to which shear strength of soil increase. Glass powder are industrial waste product . which are generally deposited as landfill and dumping . from environmental and economical point of view it can be use as admixture in sub base soil , embankment or filling material. As economy of our country increases and construction works also increases and new technics in construction are develop to increase the standard of civil engineering projects. These methods should also be environmental friendly and cost effective. By using glass powder we can improve the property of soil by economical way.

1.2 SOFTWERE

1.2.1 INTRODUCTION

Slope/W is a commercial software use to analysis the slope. Stability analyses are the most common type of numerical analysis in geotechnical engineering. This is in part because stability is obviously a key issue in any civil engineering work. Concepts associated with the method of slices are not difficult to grasp and the techniques are rather easy to implement in computer software. The simpler methods can even be done on a spreadsheet. Consequently, slope stability software became available soon after the advent of computers. Modern limit equilibrium software is making it possible to handle ever-increasing complexity within an analysis.

It is now possible to deal with complex stratigraphy, highly irregular pore-water pressure conditions, various linear and nonlinear shear strength models, almost any kind of slip surface shape, concentrated loads, and structural reinforcement. Limit equilibrium formulations based on the method of slices are also being applied more and more to the stability analysis of structures. While modern software is making it possible to analyze ever-increasingly complex problems, the same tools are also making it possible to better understand the limit equilibrium method itself. Computer assisted graphical viewing of data used in the calculations makes it possible to look beyond the factor of safety.

Graphically viewing all the detailed forces on each slice in the potential sliding mass, or viewing the distribution of a variety of parameters along the slip surface, helps greatly to understand the details of the technique. While the graphical viewing of computed details has led to a greater understanding of the method, particularly the differences between the various methods available, it has also led to the exposure of limitations in the limit equilibrium formulations. Exposure of the limitations has revealed that the method is perhaps being pushed too far beyond its initial intended purpose. The method of slices was initially conceived for the situation where the normal stress along the slip surface is primarily influenced by gravity (weight of the slice). Including reinforcement in the analysis goes far beyond the initial intention. Even though the limitations do not necessarily prevent using the method in practice, understanding the limitations is vital to understanding and relying on the results.

1.2.2 Slope/W

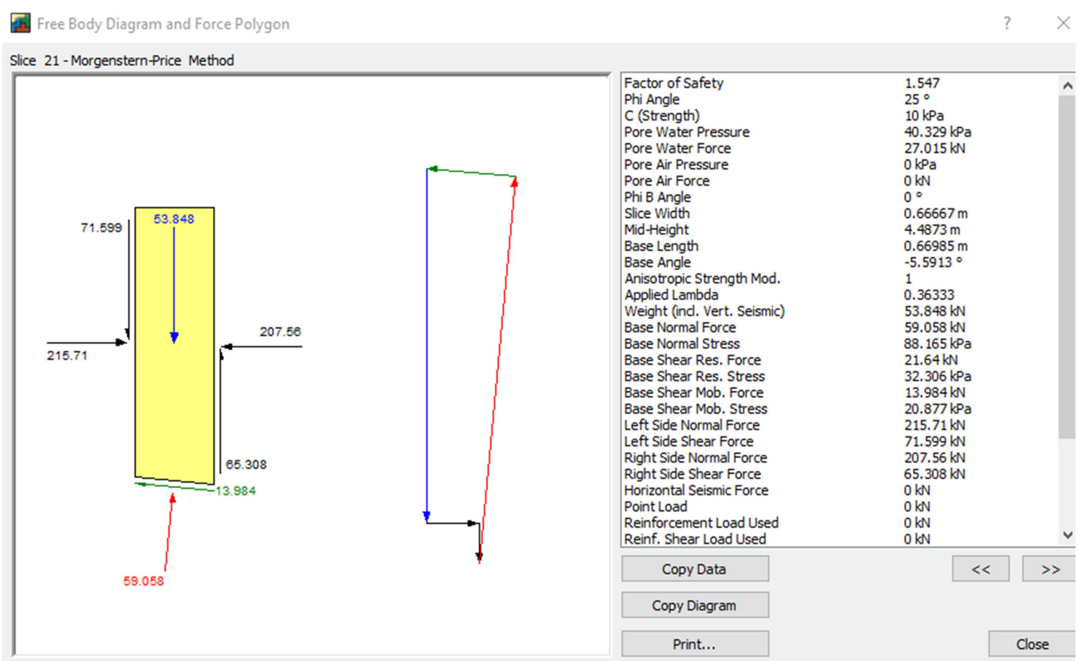
SLOPE/W is one component in a complete suite of geotechnical products called **GeoStudio**. One of the powerful features of this integrated approach is that it opens the door to types of analyses of a much wider and more complex spectrum of problems, including the use of finite element computed pore-water pressures and stresses in a stability analysis. Not only does an integrated approach widen the analysis possibilities, it can help overcome some limitations of the purely limit equilibrium formulations. Although, it is not necessary to use this advanced feature as SLOPE/W can be used as an individual product, there is certainly an increase in the capability of the program by using it as one component of a complete suite of geotechnical software programs.

1.2.3 SOURCE OF THE SOFTWARE

I got the student version from site **https://www.geoslope.com/** 2012 edition.

1.2.3 LIMIT EQUILIBRIUM METHOD

Many different solution techniques for the method of slices have been developed over the years. Basically, all are very similar. The differences between the methods are depending on: what equations of statics are included and satisfied and which interslice forces are included and what is the assumed relationship between the interslice shear and normal forces. Figure 1 illustrates a typical sliding mass discretized into slices and the possible forces on the slice. Normal and shear forces act on the slice base and on the slice sides.



. Figure 1: Typical sliding mass discretized into slices and the possible forces on the slice. Normal and shear forces act on the slice base and on the slice sides.

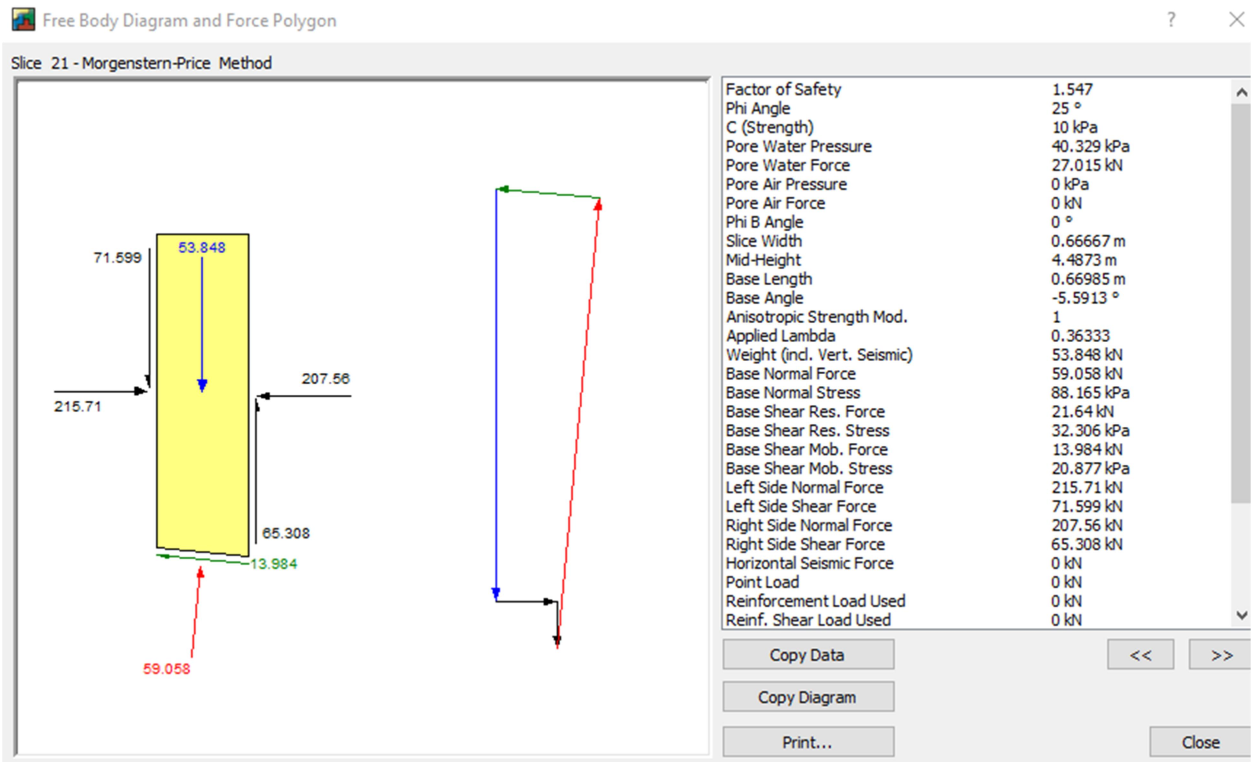


Figure 2 Slice discretization and slice forces in a sliding mass.

1.2.4 Interslice force functions.

The Spencer method, for example, uses a constant function which infers that the ratio of shear to normal is a constant between all slices. We do not need to select the function; it is fixed to be a constant function in the software when the Spencer method is selected. Only the Morgenstern-Price allows for user-specified interslice functions. Some of the functions available are the constant, half-sine, clipped-sine, trapezoidal and data-point specified. The most commonly used functions are the constant and half-sine functions. A Morgenstern-Price analysis with a constant function is the same as a Spencer analysis. SLOPE/W by default uses the half-sine function for the Morgenstern-Price method. The half-sine function tends to concentrate the interslice shear forces towards the middle of the sliding mass and diminishes the interslice shear in the crest and toe areas. Defaulting to the half-sine function for these methods is based primarily on experience and intuition and not on any theoretical considerations. Other functions can be selected if deemed necessary.

1.2.5 Slip surface shapes

The importance of the interslice force function depends to a large extent on the amount of contortion the potential sliding mass must undergo to move. The function is not important for some kinds of movement while the function may significantly influence the factor of safety for other kinds of movement. The following examples illustrate this sensitivity.

- **Circular slip surface**

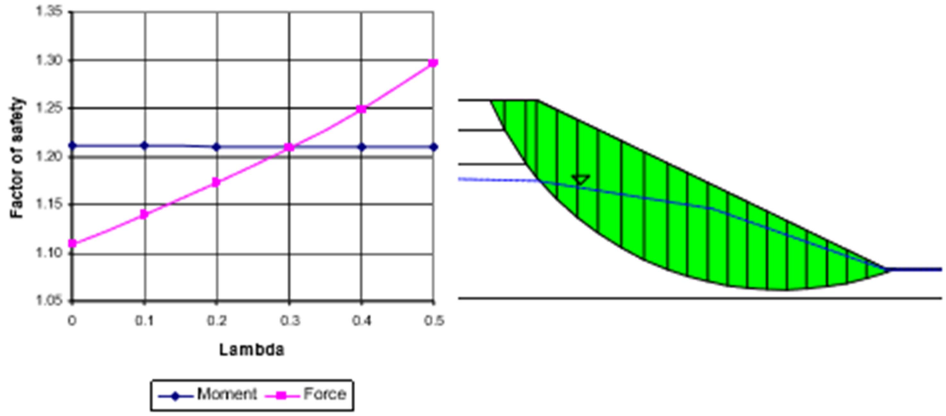


Figure 3: Circular slip surface.

- **Planar slip surface**

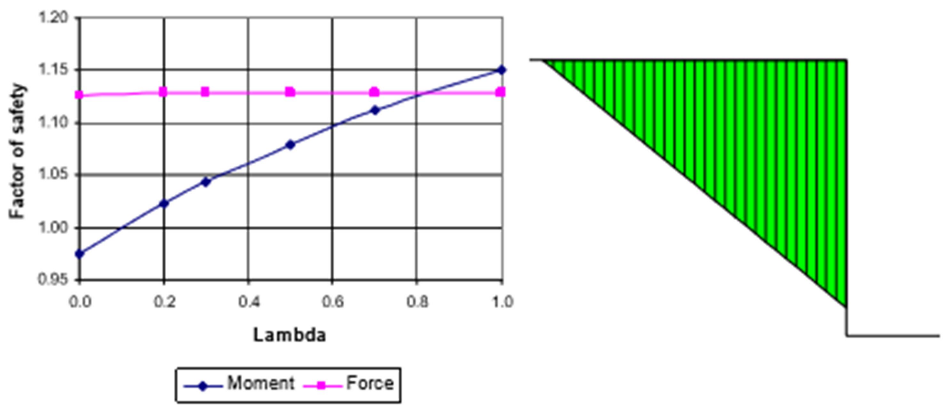


Figure 4 : Planar slip surface.

- **Composite slip surface**

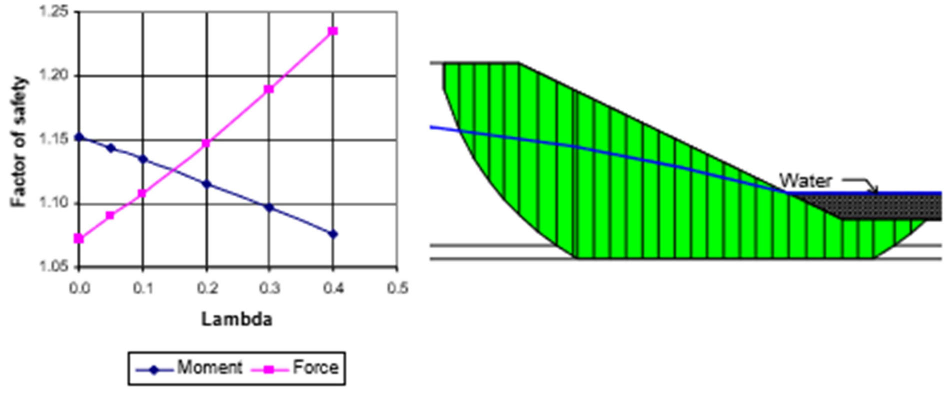


Figure 5 : Composite slip surface

- **Block slip surface**

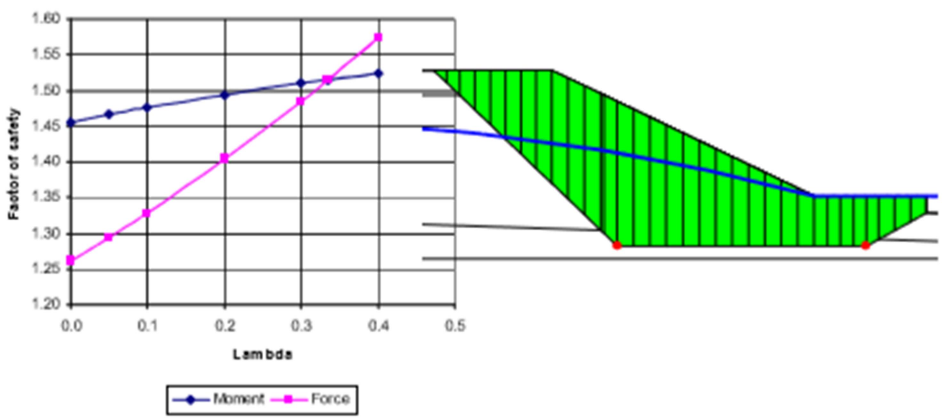


Figure 6: Block slip surface

- **Shoring wall**

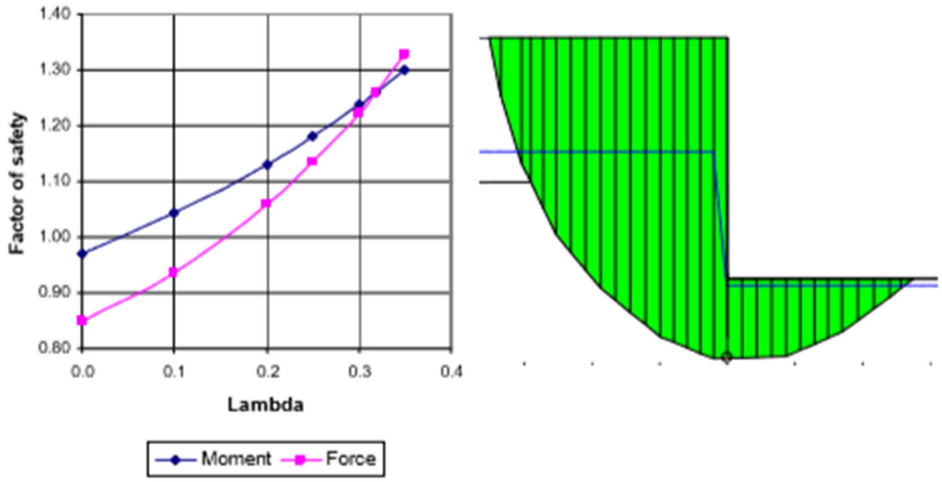


Figure 7: Shoring wall

1.2.6 Factor of Safety Methods

Many different methods have been developed for computing factors of safety. All the methods are based on limit equilibrium formulations except for one method, the finite element method, which uses finite element computed stresses.

- **General limit equilibrium Formulation.**
- **Ordinary or Fellenius method.**
- **Bishop's simplified method.**
- **Janbu's simplified method.**
- **Spencer method.**
- **Morgenstern-Price method.**

CHAPTER 2
LITERATURE REVIEW

2.1 LITERATURE REVIEW ON GLASS POWERD SOIL.

2.1.1 Ender basaei (2012) studied the effect of addition of glass waste granules on atterberg limits and the compaction characteristics of the clayey soil. Where both the liquidity limit and the plasticity limit and optimum moisture were found to decrease by increasing the added ratio while increasing the maximum dry density. Nebojsa Davidovic 2012 also studies the effect of adding 20% crushed glass on the clayey soil in the sub-layer of road works. Both maximum dry density and California bearing ratio were found to be increase, while decrease in optimum moist content.

2.1.2 Nurruzman (2014) also studies the effect of soda lime glass dust on the property of the clayey soil he found that max dry density increase, optimum moisture content decrease, liquid limit decrease, plastic limit increase, plasticity index decrease, compression index and swell index decreases with the addition of glass dust with soil.

2.1.3 Achmad fwazi (2016) also studies the effect of addition of crushed glass waste on expansive soil engineering properties, he found plasticity index, optimum moisture decreased, while maximum dry density increase.

2.1.4 Beisner et. al. (2011) Study an approach to evaluate the stability of slopes in the extreme case of growth fault movement towards earthen embankments such as water reservoirs. The embankment fill and the underlying foundation soils lose a specific percentage of their strength, based on the clay content, liquid limit, clay size fraction, and effective normal stress. The drained strengths were reduced and then utilized under steady-state seepage conditions in the growth fault analysis, which was performed using Seep/W and Slope/W software.

2.1.5 Biringen et. al. (2013) This paper proposes an approach to evaluate the stability of slopes in the extreme case of growth fault movement towards earthen embankments such as water reservoirs. The evaluation is based on the supposition that, if the growth faults traverse an embankment, the embankment fill and the underlying foundation soils lose a specific percentage of their strength, based on the clay content, liquid limit, clay size fraction, and effective normal stress. The evaluation focuses on the long term effects of strength loss on slope stability due to the gradual growth fault movement towards a water reservoir embankment.

2.1.6 Frempong et. al. (2019) Landscape projects often require steep sandy slopes of low height, say 1–3 m. Geosynthetic reinforcements may greatly help in constructing such steep slopes. In this paper an attempt has been made to analyze the stability of a low-height medium dense sandy slope, reinforced with geosynthetic layers. The slope stability analysis was carried out using the limit equilibrium method as available in a commercial software, Slope/W. The analysis shows that installing a single geosynthetic reinforcement layer with in the 40° slope at the optimum embedment depth(u) to slope height (H) ratio, u/H=0.5 ,results in a stable slope with a factor of safety Fr (max) of 1.61, but this depth is not suitable for stabilizing the 50° and 60° slopes. Reinforcing the 50° and 60° slopes with two geosynthetic reinforcement layers at the optimum embedment depth of u/H=0.14 and0.5 in the 50° slope and u/H= 0.19and 0.5 in the 60° slope improves the factor of safety over the unreinforced case, by 57% and 86%, to Fr(max) =1.46 and Fr(max)=1.36, respectively.

2.1.7 Zhang et. al. (2014) The rain-induced soil-slope is taken as an example, the percolation process of rainfall in landslide mass is described, and the relationship between slope failure mode and slope moisture content increase in high intensity rainfall is studied. Transit seepage caused by rainfall infiltration is simulated by adopting the SEEP/W software, and moisture contents of shallow soil are analyzed from the back to the front of landslide. And by using SLOPE/W software, the landslide stabilities are calculated during continuous precipitation process.

2.1.8 Zukowski et. al. (2017) In this a model was produced in GeoStudio to show how infiltration from a rain garden can affect slope stability. Decreases in slope stability from rain garden infiltration were quantifiable, implying that these types of models should be considered during the design phase of retrofit rain gardens because engineers that designed existing infrastructure likely did not consider additional infiltration from green infrastructure.

2.1.9 Minh et. al. (2012) Desiccation cracking occurring in expansive clays during seasonal changes poses a serious threat to the structural integrity of foundations, slopes and retaining walls. Soil treatment with compost additive has been successful in the past in reducing soil cracking due to dessication.

2.2 CONCLUSION.

Study of these literature suggest the inclusion of glass powder in soil increase the mechanical property of the soil It increase the plastic limit and decrease the liquid limit and plasticity index. It increase the dry density and decrease the optimum moisture content. It increase the cohesion and friction angle. And when this treated soil is added in slope the its strength and FOS also increases.

CHAPTER 3

ASSESSING OF SOIL PROPERTY

3.1INTRODUCTION.

Soil is one of the most common construction material which is used from ancient time. As we assume soil as homogenous material for analysis but vin actual is is no and there mechanical property are poor. So or good result and stability engineers must attempt to increase the engineering property of the soil. Soil generally compress when load are applied on it , swell when come in contact with water, shrink when dry. Etc., are the main problem of soil. To overcome these problem stabilization is essential for such type of soil by mixing of soil with different material . In this paper an attempt is made to improve the mechanical property of the soil by adding POWERED GLASS to make soil more stable.

3.2 GLASS POWERED SOIL.

In now a days disposal of different industrial waste is a big problem. And act as a threat environmental. Since most of them are non-biodegradable and they cannot be reused. Glass is a industrial waste which cannot be reuse for any thing so the are deposited as landfills. If we use this material for any other purpose this will lead to cost effective and also environmental friendly .In this paper we add fine glass powder of size finer than 2microns. And check the chance in property of the soil.

3.3 PROPERTIES OF POWDER GLASS.

Table1 : property of glass powder,Brought from KUMAR material Ramesh nagar Delhi.

S.No	Name	Property
1	Material	Glass
2	Density	2500 Kg/m^3
3	Compressive strength	1000 N/mm^2
4	Tensile strength	40N/mm2
5	Effective size	<2µ
6	Specific gravity	2.5
7	Melting point	120
8	Poission's Ratio	.22
9	Young's Modulas	70GPa
10	Colour	White
11	Co-efficient of Thermal Expansion	9x 10-6 $m/^0C$

Figure 9: Glass powder.

Figure 10:Soil sample.

3.4 ASSESSING OF SOIL PROPERTY BEFORE ADDING OF GLASS POWDER.

Soil properties will be determined in laboratory to determine the condition and physical properties of soil chosen. The natural water content will be determined first. Then unit weight of the sample will be determined. Liquid limit, Plastic limit, Sieve analysis will also be carried out to classify the soil sample. Proctor compaction test will be done to determine the optimum moisture content and maximum dry density of the sample. Then the sample will be tested for optimum Glass powder content and maximum density when mixed with Glass powder. Direct shear test will be conducted before and after mixing with Glass powder.

3.4.1 Water content.

Physical examination of soil was done and soil appeared to be sand. Natural Water content of soil was determined as

Water content (ω) = $\frac{W2-W3}{W3-W1}$

Where, W1= weight of container= 0.905 gm

W2= weight of container with moist sample = 42.84 gm

W3= weight of container with dried sample = 40.4 gm

Thus;

$$\omega = \frac{42.84-40.4-.905}{40.4-.905} = 3.886\ \%$$

3.4.2 Sieve analysis.

Total Weight of Soil=500 gm

Table 2: Grain size distribution.

Sieve size(mm)	**Retained weight (gm)**	**Percentage weight retained (%)**	**Cumulative Percentage weight retained**	**Percentage finer**
4.75	37	7.4	7.4	92.6
2.36	9	1.8	9.2	90.8
1.18	23	4.6	13.8	86.2
.60	54	10.8	24.6	75.4
.30	76	15.2	39.8	60.2
.15	23.5	4.7	44.2	55.8
.075	83	16.6	60.8	39.2
PAN	194.5	38.9	100	0

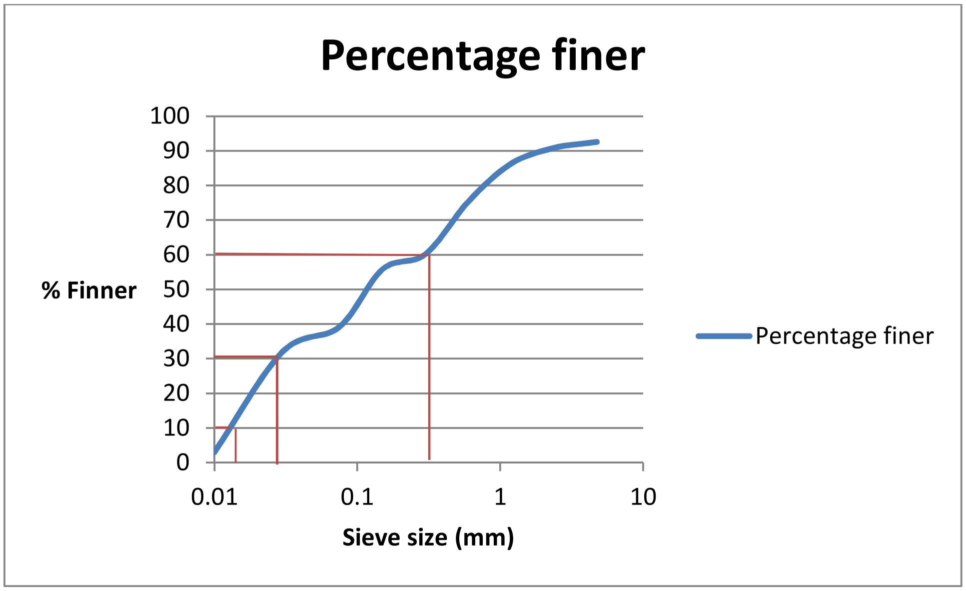


Figure 11: Grain size distribution.

From grain size distribution curve,

D_{60} = 0.3 mm

D_{30} = .07 mm

D_{10} = .015 mm

Coefficient of uniformity Cu = $\frac{D60}{D10} = \frac{0.3}{0.015} = 20$

Coefficient of curvature Cc = $\frac{D302}{D60 \times D10} = \frac{0.07\text{^}2}{0.3x0.015} = 1.089$

3.4.3 LIQUID LIMIT.

Min water content of which soil have tendency to flow is called liquid limit. All soils at liquid limit will have similar shear strength (13pprox.. 2.7Kn/m^2). Liquid limit is found out using Casagrande's tool – soil is taken and water is added and the soil is put inside casagrande's apparatus. A groove of 2mm size is cut and the apparatus is given blows over a rubber pad No of blows required to close the 2mm grove is noted. Water content at which 25 blows closes the groove is called liquid limit.

Cone penetration - the cup is placed below the cone, and the cone is gradually lowered so as to just touch the surface of the soil in the cup. The graduated scale is adjusted to zero. The cone is released, and allowed to penetrate the soil for 30 seconds. The water content at which the penetration is 25mm is the liquid limit.

Table 3: Reading of water content with no of blows.

No. of blows	48	38	29	20	14
Water content (%)	32.1	35.9	37.6	42.2	48.3

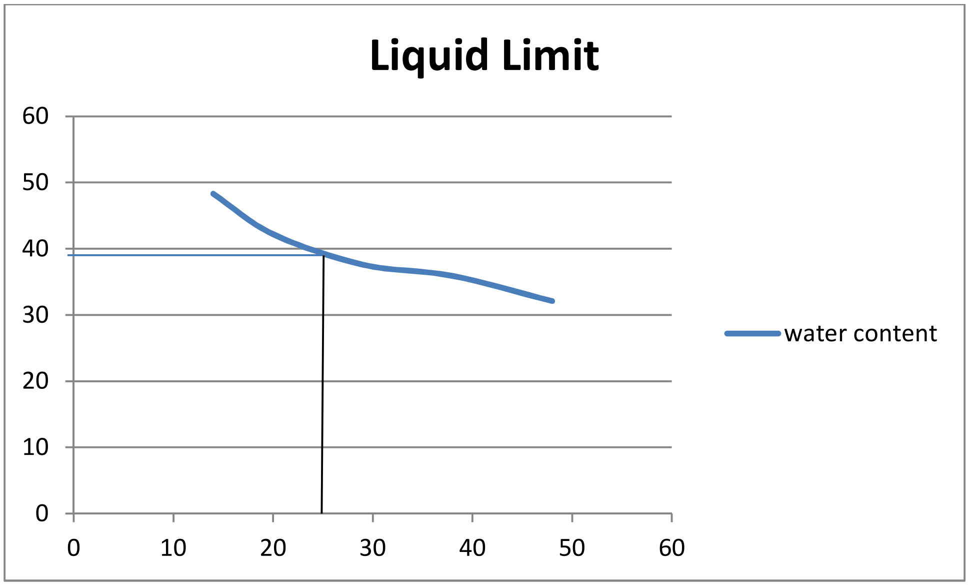


Figure 12: water content VS. no of blows.

Liquid limit= 39%

3.4.4 PLASTIC LIMIT

Min water content at which soils is in plastic stage is called plastic limit water content. At plastic limit water content, a soil when rolled into a thread of 3mm starts to crumble.

Plastic limit of sample 1=18

Plastic limit of sample 1=23

Plastic limit of sample 1=28

PLASTIC LIMIT=$\frac{18+23+28}{3}$=**23%**

3.4.5 STANDARD PROCTOR COMPACTION TEST.

It is use to find max dry density and optimum moist content for which soil gave max dry density. It is find by proctor test. As per proctor, a definite relationship exist between the soil moisture content and the degree of dry density to which a soil may be compacted.. For a specific amount of compaction energy applied on the soil, these is one moisture content term as per factor optimum moisture content at which a particular soil attain maximum dry density.. Max dry density is function of compactive effort and method of compaction for a particular type of soil.

Table 4: standard proctor test reading.

Weight of mould + base plate (gm)	**Weight of mould + base plate + soil (gm)**	**Weight of soil (gm)**	**Bulk Density (gm/cc) γ**	**Water Content(%) ω**	**Dry densities (gm/cc) γ_d**

4210	5968	1758	1.758	9.22	1.61
4210	6066	1856	1.85	11.86	1.65
4210	6142	1932	1.93	13.53	1.70
4210	6228	2018	2.018	15.32	1.75
4210	6145	1935	1.935	18.74	1.63

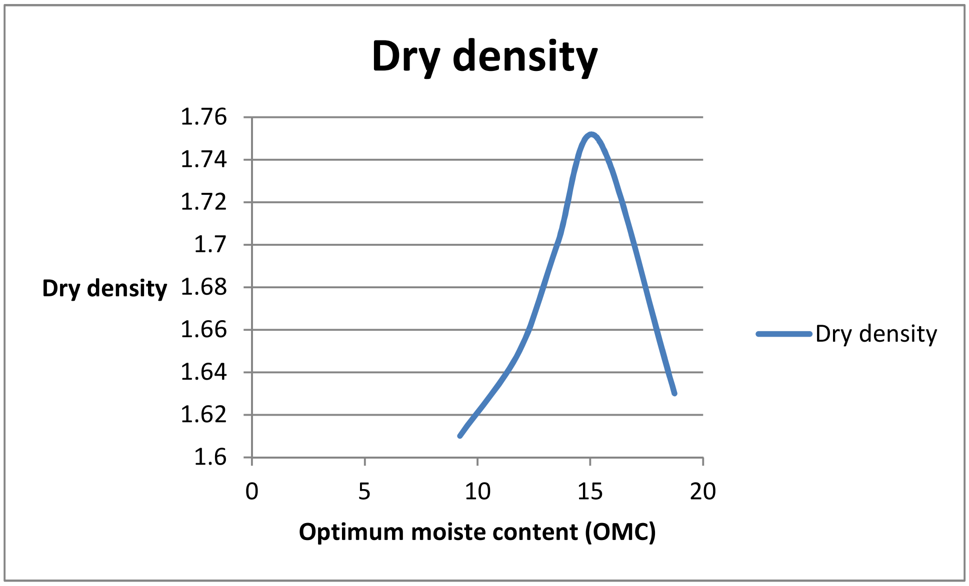


Figure 13: OMC vs. Dry density.

3.4.5 DIRECT SHEAR TEST

It is a laboratory test performed to find out C & ϕ. And this load is applied through loading plate. Soil is sheared gradually by applying horizontal force. Shear is normally applied at constant rate of strain. Magnitude of shear load is measured by proving ring. Shear deformation and vertical deformation are measure during test using dial gauge. Shear stress and normal stress are found out by dividing the shear and normal load by nominal area of specimen. As drainage cannot be controlled in this test hence rate of loading should be such that pore water pressure does not develop i.e., it will be a drained condition testing.

1. Pressure = .5KG/cm^2
   Load = 0.0178N
   Horizontal displacement = 2.56mm
   Vertical Displacement = 0.38mm

Table 5: DIRECT SHEAR TEST Reading on 50 KN/m^2 Load.

Pressure. (Kg/cm^2)	**Normal stress.(KN/m^2)**	**Horizontal displacement.(cm)**	**Aj=A_0 (1- δ/3)**	**Shear load.(N)**	**Shear stress (KN/m^2) X 10^{-3}**
.5	50	0.256	32.93	0.0106	32.1

2. Pressure = 1KG/cm^2
   Load = 0.0206N
   Horizontal displacement = 2.78mm
   Vertical Displacement = 0.42mm

Table 6: DIRECT SHEAR TEST Reading on 100 KN/m^2 Load.

Pressure. (Kg/cm^2)	**Normal stress.(KN/m^2)**	**Horizontal displacement.(cm)**	**Aj=A_0 (1- $\delta/3$)**	**Shear load.(N)**	**Shear stress (KN/m^2) X 10^{-3}**
1	100	0.278	33.91	0.0205	60.42

3. Pressure = 1.5KG/cm^2
   Load = 0.0441N
   Horizontal displacement = 5.25mm
   Vertical Displacement = 0.mm

Table 7: DIRECT SHEAR TEST Reading on 50 KN/m^2 Load.

Pressure. (Kg/cm^2)	**Normal stress.(KN/m^2)**	**Horizontal displacement.(cm)**	**Aj=A_0 (1- $\delta/3$)**	**Shear load.(N)**	**Shear stress (KN/m^2) X 10^{-3}**
1.5	150	0.525	29.66	0.0249	85.04

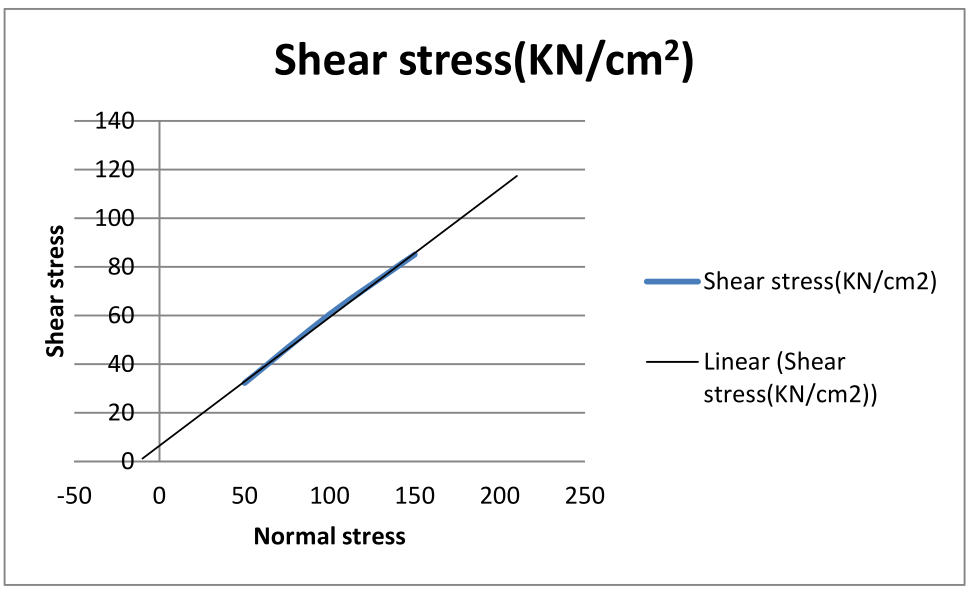


Figure 14:SHEAR STRESS vs. NORMAL STRESS.

By intercepting we get

Cohesiont=6.38

Angle of Friction =26^O

3.5PROPERTIES OF SOIL

Table8 : PROPERTIES OF SOIL.

S.No	Property of soil	Result
1	Specific Gravity	2.19
2	Water content	3.886%
3	Bulk density	1.389gm/cc
4	Maximum dry density	1.75gm/cc
5	Optimum dry density	15.32
6	Effective size , D_{10}	.015mm
7	D_{30}	.07mm
8	D_{60}	.3mm
9	Cu	20
10	Cc	1.089
11	Cohesion	6.38
12	Friction Angle	26

CHAPTER 4

VARIATION OF PROPERTY WITH GLASS POWDER

4.1 INTROCUCTION

In this chapter we analysis the variation of property of soil by adding Glass powder in ration of 0%, 5%, 10%, 15%, 20%.

4.2 PLASTIC LIMIT

Table 9: Variation of plastic limit with glass powder.

S.NO	ADDITRION PERCENTAGE	PLASTIC LIMIT
1.	0%	23.8
2.	5%	24.2
3.	10%	26
4.	15%	26.32
5.	20%	27.11

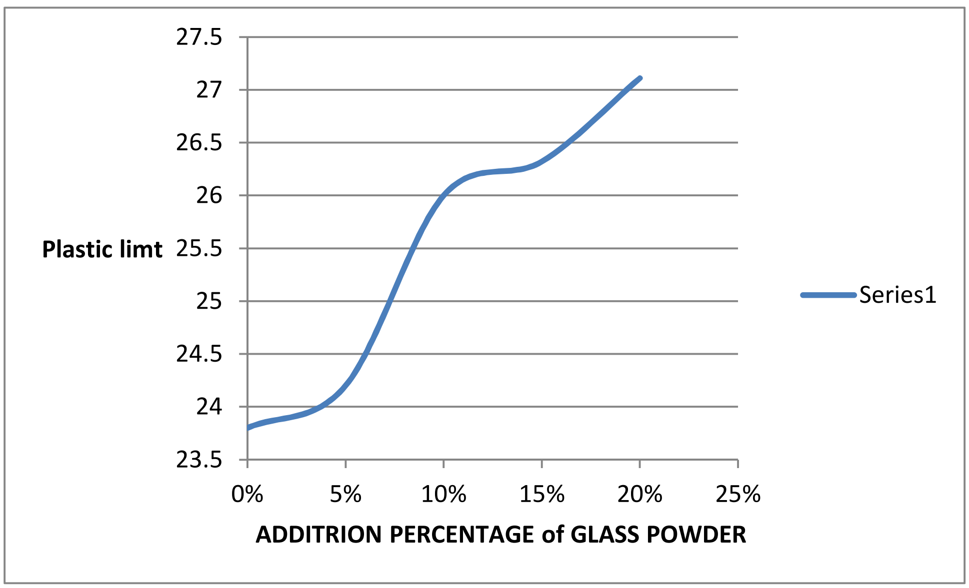


Figure 15: Variation of plastic limit with glass powder.

4.3 LIQUID LIMIT

Table 10 : Variation of liquid limit with glass powder.

S.NO	ADDITION PERCENTAGE	LIQUID LIMIT
1.	0%	39
2.	5%	34
3.	10%	29
4.	15%	22

5.	20%	21

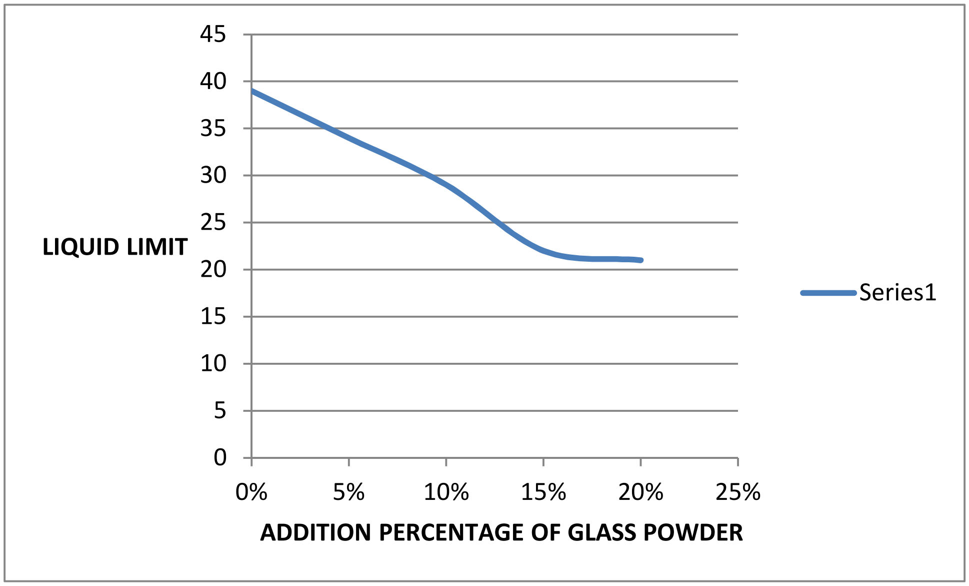


Figure 16: Variation of liquid limit with glass powder.

4.4 COMPACTION TEST

Table 11: Variation of OMC and dry density with glass powder.

S.NO	ADDITION PERCENTAGE	OMC	BULK DENSITY(gm/cc)
1.	0%	15.32	1.75
2.	5%	15.02	1.77
3.	10%	14.53	1.81
4.	15%	14.50	1.84
5.	20%	13.85	1.89

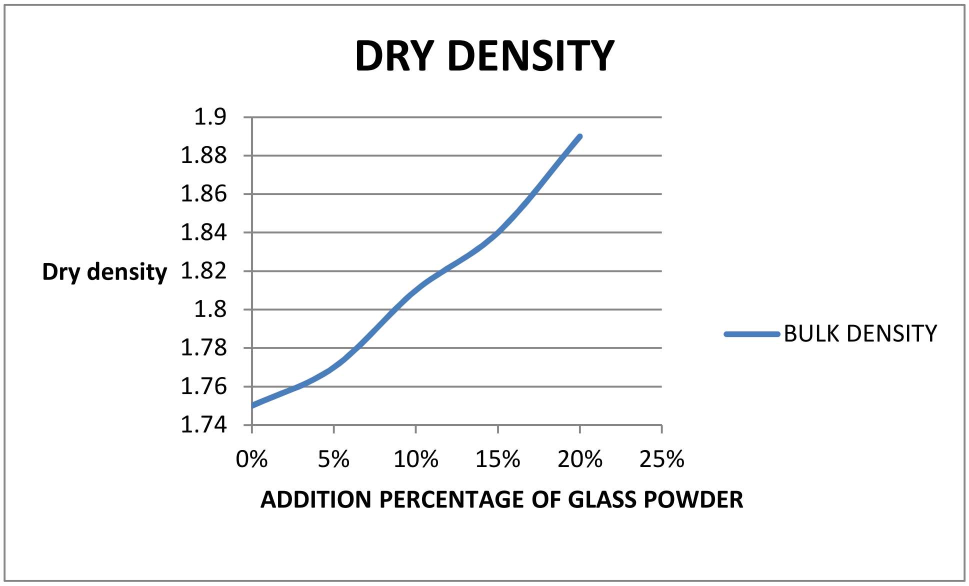


Figure 17: Variation of dry density with glass powder.

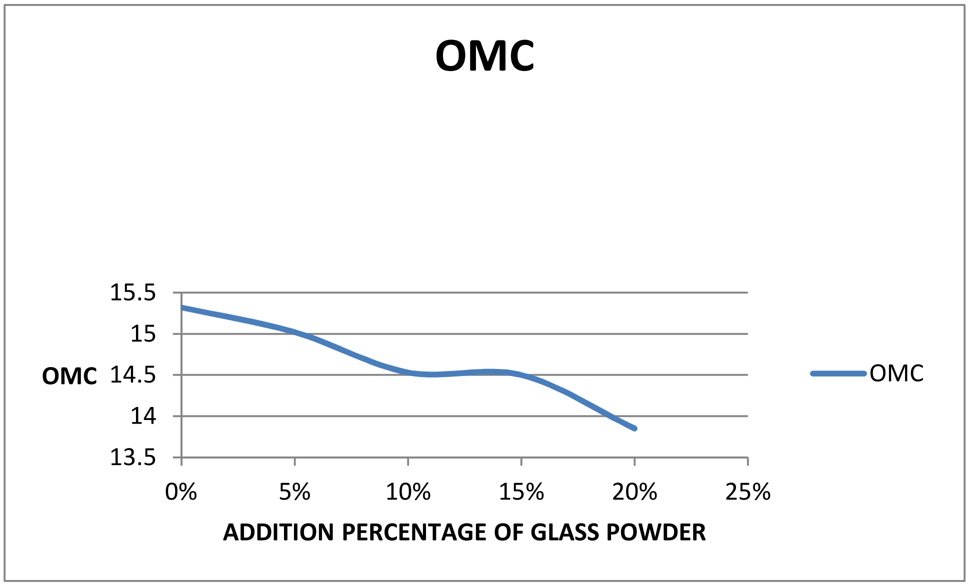


Figure 18: Variation of OMC with glass powder.

4.5 DIRECT SHAER TESR (DST)

Table 12: Variation of Direct shear test result (C & ϕ) with glass powder.

S.NO	ADDITION PERCENTAGE	Cohesion (kN/m^2)	Φ (DEGREE)
1.	0%	**6.38**	**26^O**
2.	5%	**6.78**	**27^O**
3.	10%	**6.95**	**29^O**
4.	15%	**7.21**	**31^O**
5.	20%	**7.3**	**32^O**

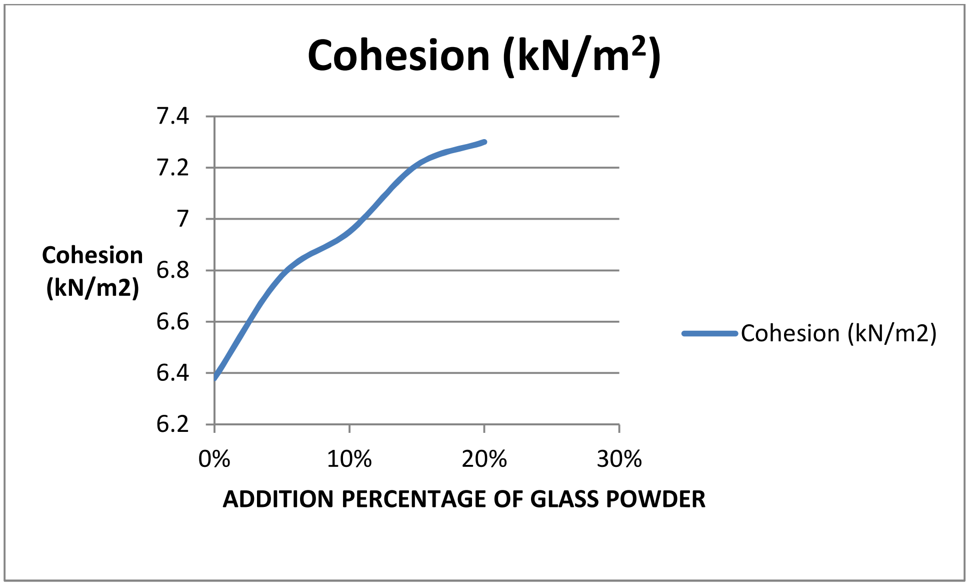


Figure 19: Variation of Direct shear test result (Cohesion) with glass powder.

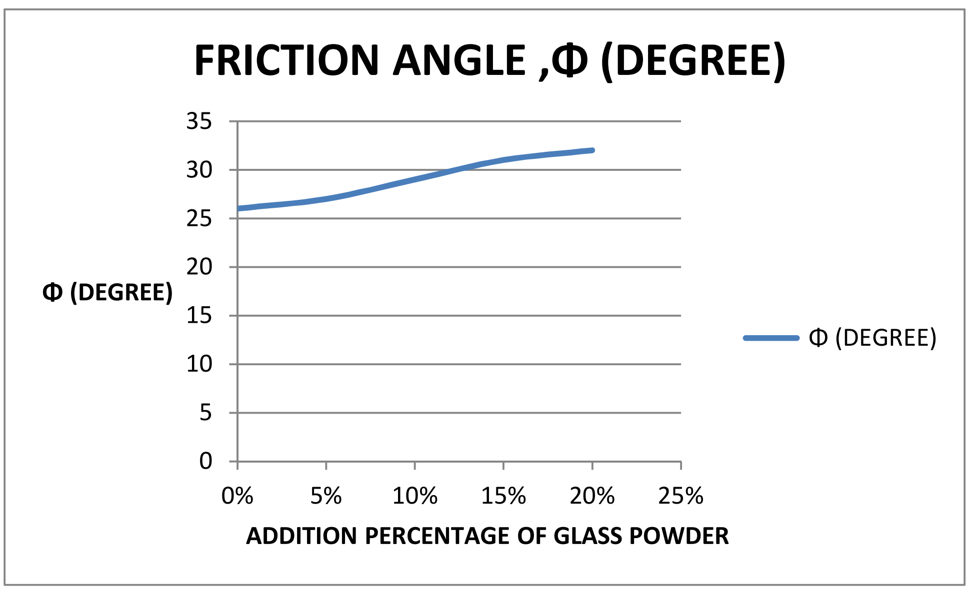


Figure 20: Variation of Direct shear test result (Friction angle ϕ) with glass powder.

CHAPTER 5

STABITITY ANALYSIS

5.1 OBJECTIVE

Slope/W is used to determine the minimum FOS in critical slip surface for profile .The pore water pressure contour and piezometric lines are also shown in this software .In this paper a model is produce in Slope/w to understand how it works and gives results, The assumptions considered and the limitations observed

5.2 MODEL PREPRATION

For deep understanding of SLOPE/W software let consider a simple model.

Let consider a slope model having a layer of treated soil layer of 1m on its top of slope side of Joe Pool Dam (Minh Le, Anand J.Puppala) (2748-2757). And soil sample is from Moti Nagar.

In this experiment we take 5 model in which in 1st model we use natural soil in whole slope. In other model we add glass powdered treated soil in on top 1m on slope.

- **Model 1 – slope soil are natural soil.**
- **Model 2 slope soil are treated soil in which we add 5% pulverizeds white glass powdered soil.**
- **Model 3 slope soil are treated soil in which we add 10% pulverizeds white glass powdered soil.**
- **Model 4 slope soil are treated soil in which we add 15% pulverizeds white glass powdered soil.**
- **Model 5 slope soil are treated soil in which we add 20% pulverizeds white glass powdered soil.**

- Its coordinate of soil model are given below.

Table 13: coordinate of soil model

	X (m)	Y (m)
Point 1	9	15
Point 2	9	14

Point 3	28	7
Point 4	30	7
Point 5	40	3
Point 6	28	8
Point 7	30	8
Point 8	40	4
Point 9	0	15
Point 10	0	0
Point 11	46	0
Point 12	46	4

- Coordinate of water level (Piezometric Line) also given below.

Table 14: Coordinate of water level

	X (m)	Y (m)
Coordinate 1	0	2
Coordinate 2	46	2

Figure 21: Diagram of MODEL

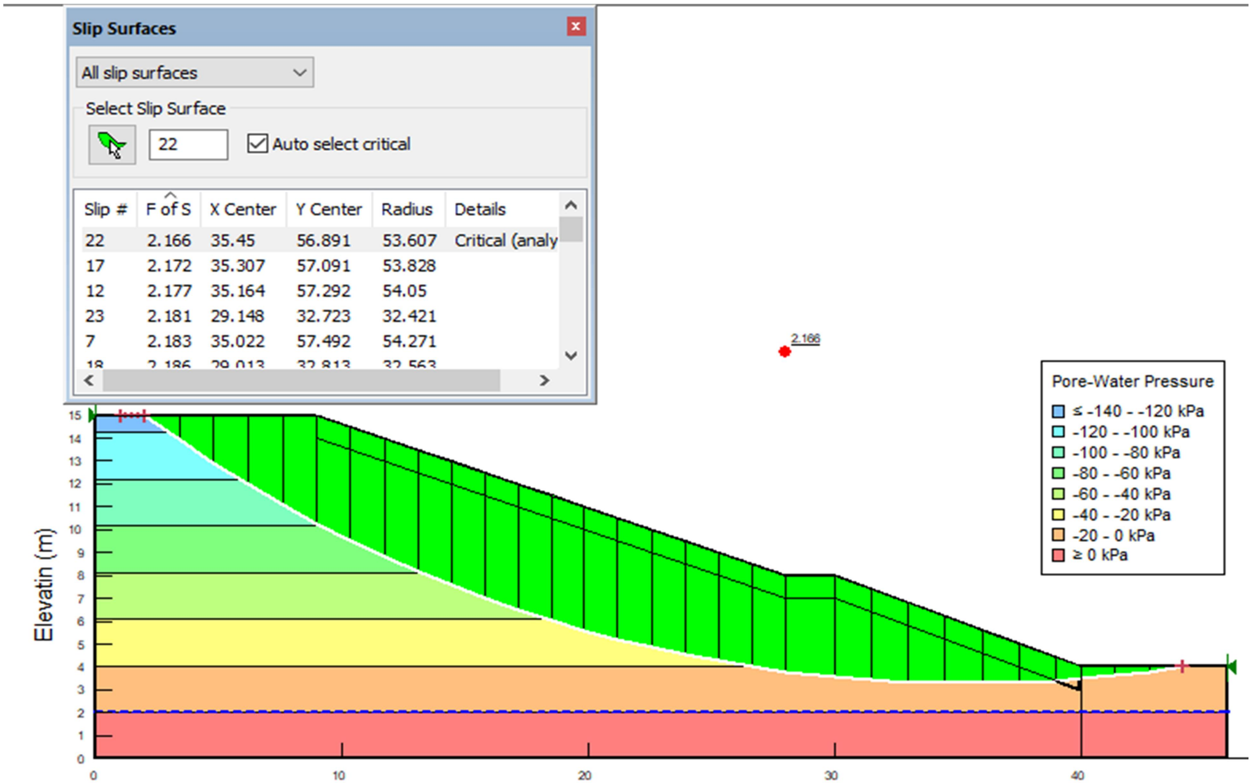


Figure 22 : PWP variation.

5.3 SOIL PROPETIES

5.3.1 Region 1 (Treated soil Forv model 1). It change in every model.

Table 15: SOIL PROPETIES of Upper layer (Region 1)

Model	Mohr-Coulomb
Unit Weight	17.17 kN/m³
Cohesion	6.38 kPa
Phi'	26 °
Pore Water Pressure	Piezometric Line: 1

5.3.2 Region 2 (Compacted Core soil).

Table 16: SOIL PROPETIES of Lower layer (Region 2).

Model	Mohr-Coulomb
Unit Weight	17.17 kN/m³
Cohesion	6.38 kPa
Phi'	26 °
Pore Water Pressure	Piezometric Line: 1

5.3.3 Area of Regions.

Table 17: Area of Regions.

Region name	Material	Points	Area (m^2)
Region 1	Treated soil	1,6,7,8,5,4,3,2	31
Region 2	Compacted Core soil	1,9,10,11,12,8,5,4,3,2	422.5

.

CHAPTER 6

MODEL IN SLOPE/W

6.1 SLIP SURFACE

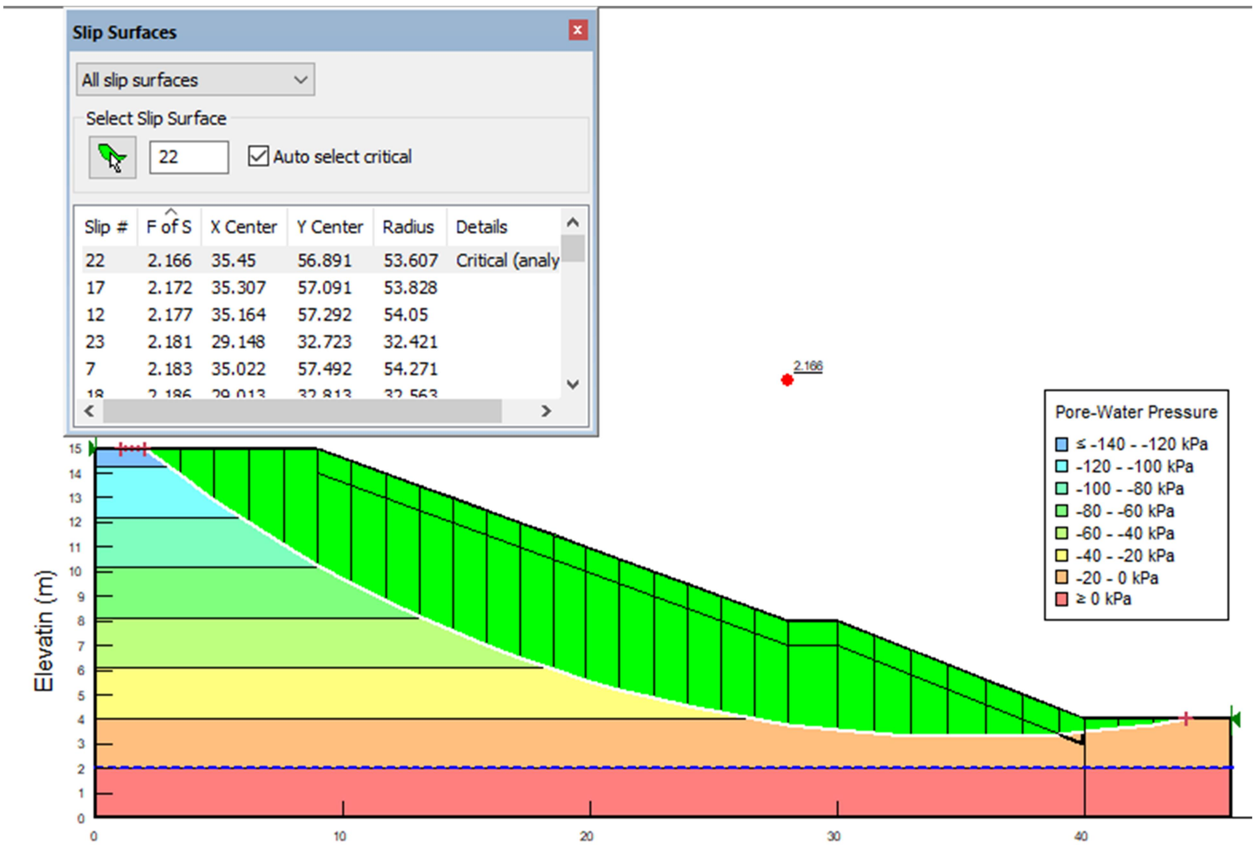


Figure 23 Slip surface.

6.2 Property of Slip Surface

Slip Surface Entry and Exit

Table 18: Slip Surface Entry and Exit

Left Projection:	Point
Left Coordinate:	(0, 14) m
Left-Zone Increment:	4
Right Projection:	Point
Right Coordinate:	(40, 4) m
Right-Zone Increment:	4
Radius Increments:	4

Slip Surface Limits

Table 19: Slip Surface Limits

Left Coordinate	(0,14) m
Right Coordinate	(40,4) m

6.3 INTER SLICES FORCES

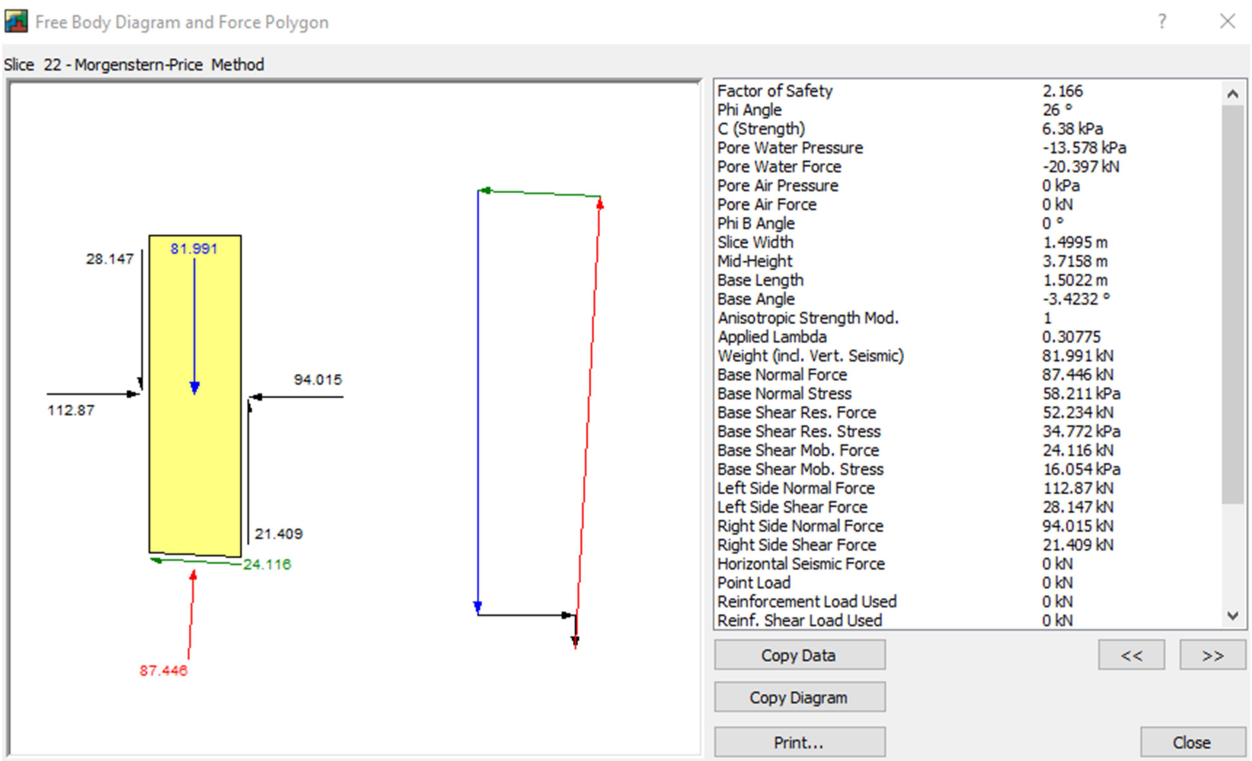


Figure 24: Free body diagram and force diagram of slice 22.

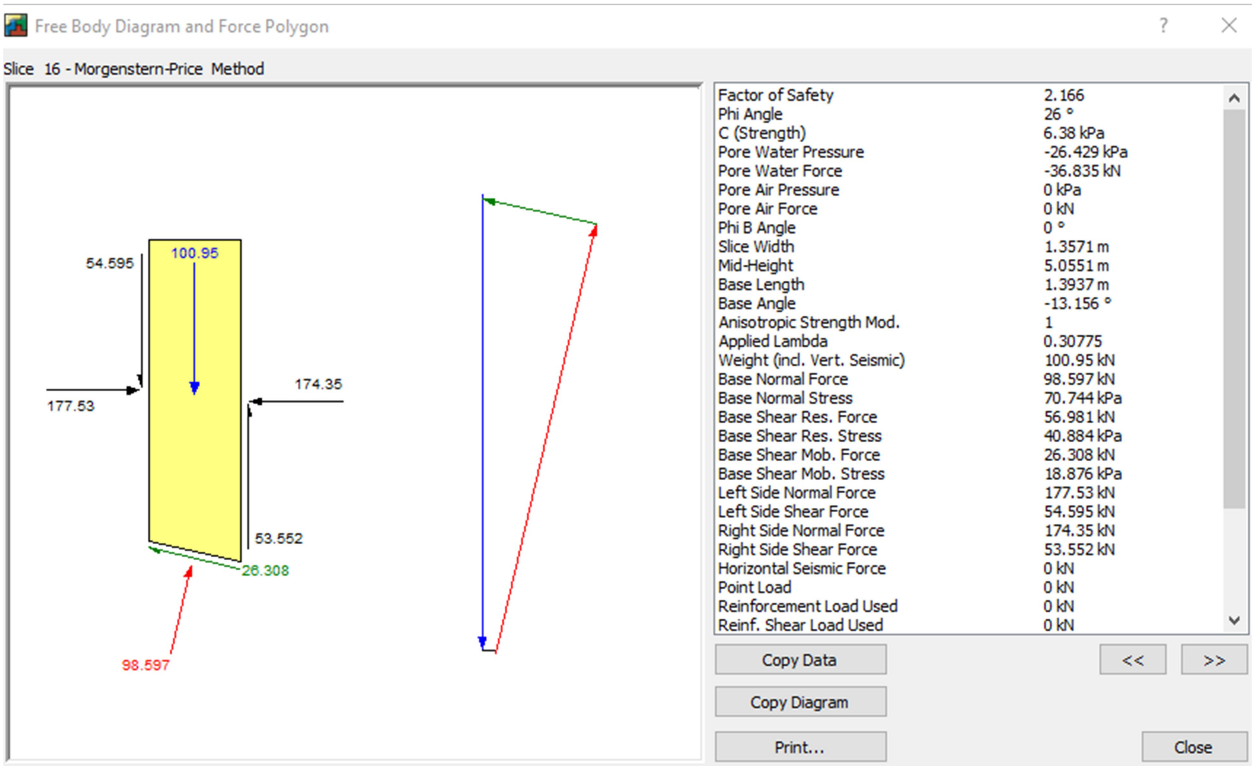


Figure 25: Free body diagram and force diagram of slice 16.

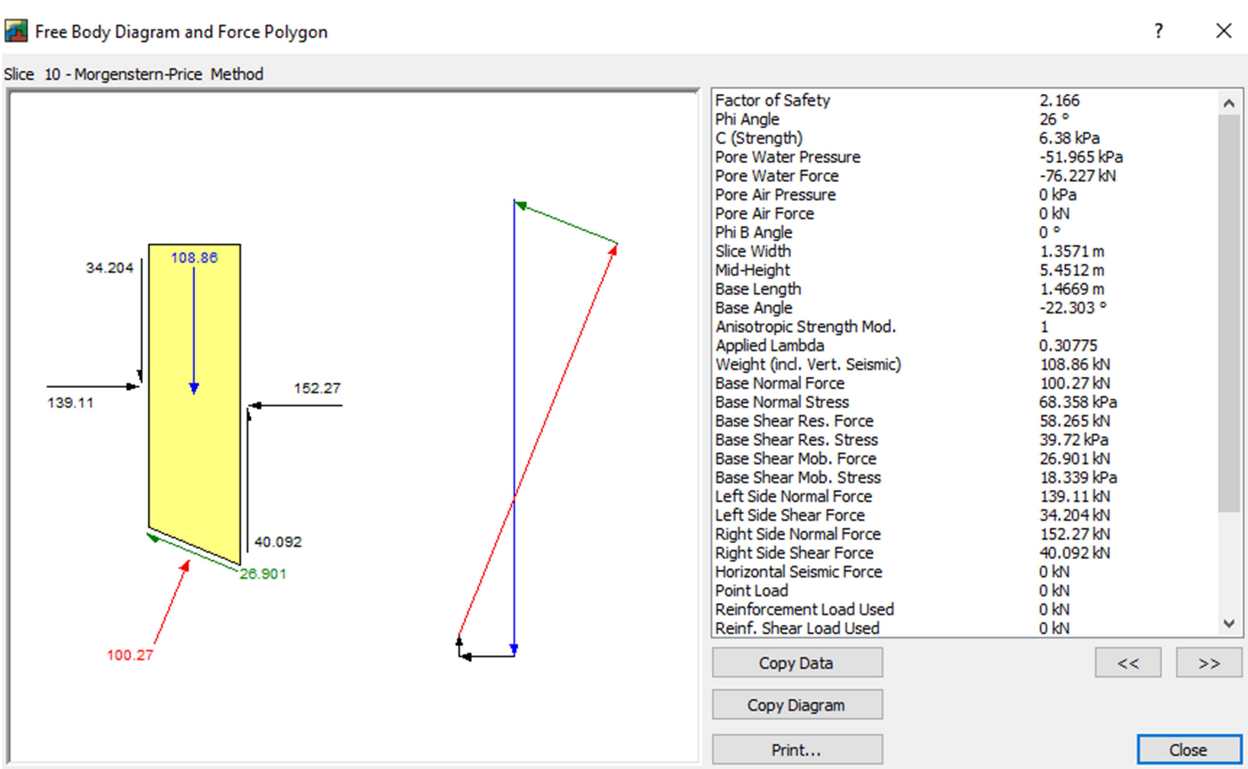


FIGURE 26: Free body diagram and force diagram of slice 10.

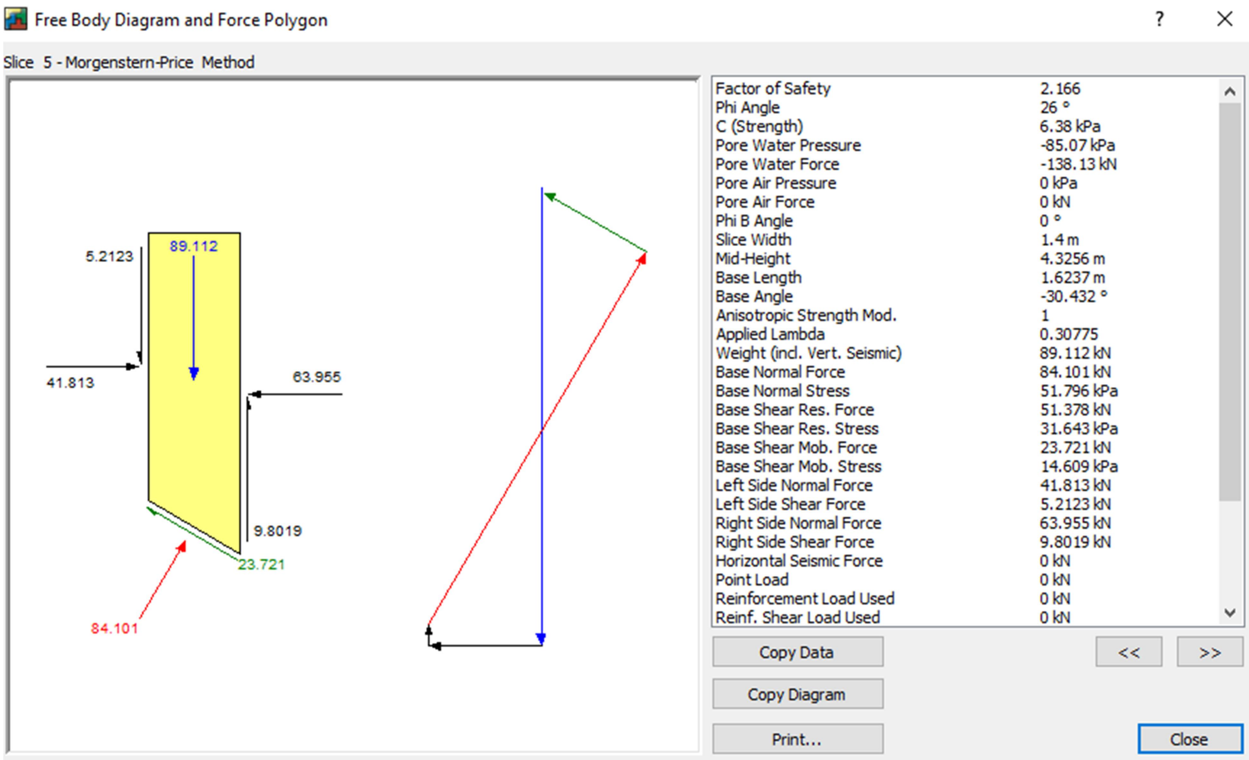


FIGURE 27: Free body diagram and force diagram of slice 5.

CHAPTER 7
RESULT FROM SLOPE/W

7.1 RESULT RESULT OF MODEL 1.

7.1.1 Result obtained from model 1.

Critical Slip Surface: 22.
F of S: 2.100.
Volume: 151.1438 m³.
Weight: 2,595.1391 kN.
Resisting Moment: 81,770.579 kN-m.
Activating Moment: 38,932.577 kN-m.
Resisting Force: 1,440.8523 kN.
Activating Force: 686.0424 kN.
F of S Rank (Analysis): 1 of 25 slip surfaces.
F of S Rank (Query): 1 of 25 slip surfaces.
Exit: (44.184615, 4) m.
Entry: (2, 15) m.
Radius: 53.607473 m.
Center: (35.449939, 56.891083) m.

7.1.2 Slice data obtained from model 1.

Table 20: Result of Slice of model 1.

Slice No.	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	2.7	14.459717	-122.19244	5.8716836	2.8638115	6.38
Slice 2	4.1	13.414678	-111.94375	21.023019	10.253612	6.38
Slice 3	5.5	12.438299	-102.3684	35.009404	17.075227	6.38
Slice 4	6.9	11.526139	-93.422843	48.04712	23.434146	6.38
Slice 5	8.3	10.674387	-85.069716	60.320811	29.420425	6.38
Slice 6	9.6785714	9.891094	-77.387959	68.193121	33.260007	6.38
Slice 7	11.035714	9.1718427	-70.334261	71.742958	34.991379	6.38
Slice 8	12.392857	8.50134	-63.758642	74.829678	36.496873	6.38
Slice 9	13.75	7.877583	-57.641457	77.473725	37.786461	6.38
Slice 10	15.107143	7.2988058	-51.965389	79.680865	38.862955	6.38
Slice 11	16.464286	6.7634489	-46.715143	81.443655	39.722725	6.38
Slice 12	17.821429	6.2701331	-41.877196	82.742653	40.356288	6.38
Slice 13	19.178571	5.8176393	-37.439589	83.54754	40.748858	6.38
Slice 14	20.535714	5.4048902	-33.391758	83.81837	40.88095	6.38
Slice 15	21.892857	5.030936	-29.724389	83.507133	40.72915	6.38
Slice 16	23.25	4.6949422	-26.429298	82.559791	40.267101	6.38

Slice 17	24.607143	4.3961793	-23.499331	80.918857	39.466763	6.38
Slice 18	25.964286	4.1340145	-20.92828	78.526509	38.299937	6.38
Slice 19	27.321429	3.907904	-18.710814	75.328159	36.739998	6.38
Slice 20	29	3.6825796	-16.501058	76.425934	37.275419	6.38
Slice 21	30.74977	3.4953609	-14.665004	75.769316	36.955165	6.38
Slice 22	32.24931	3.3845129	-13.577918	67.962349	33.147453	6.38
Slice 23	33.74885	3.3158573	-12.904612	58.992542	28.772585	6.38
Slice 24	35.24839	3.2892318	-12.643497	48.901154	23.850686	6.38
Slice 25	36.74793	3.3045738	-12.793956	37.761427	18.417479	6.38
Slice 26	38.247471	3.3619194	-13.356343	25.675356	12.522708	6.38
Slice 27	39.49862	3.4390804	-14.113061	15.002339	7.3171295	6.38
Slice 28	40.697436	3.5456626	-15.158313	9.243985	4.5085927	6.38
Slice 29	42.092307	3.7013644	-16.685281	6.19555	3.0217717	6.38
Slice 30	43.487179	3.8942303	-18.576717	2.510983	1.2246883	6.38
Slice 1	2.7	14.459717	-122.19244	5.8716836	2.8638115	6.38

7.2 RESULT RESULT OF MODEL 2.

7.2.1 Result obtained from model 2.

Critical Slip Surface: 22.
F of S: 2.102.
Volume: 151.1438 m³.
Weight: 2,600.9836 kN.
Resisting Moment: 81,965.515 kN-m.
Activating Moment: 38,997.256 kN-m.
Resisting Force: 1,444.3832 kN.
Activating Force: 687.22791 kN.
F of S Rank (Analysis): 1 of 25 slip surfaces.
F of S Rank (Query): 1 of 25 slip surfaces.
Exit: (44.184615, 4) m.
Entry: (2, 15) m.
Radius: 53.607473 m.
Center: (35.449939, 56.891083) m.

7.2.2 Slice data obtained from model 2.

Table 21: Result of Slice of model 2.

	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	2.7	14.459717	-122.19244	5.8736495	2.8647703	6.38
Slice 2	4.1	13.414678	-111.94375	21.026382	10.255252	6.38
Slice 3	5.5	12.438299	-102.3684	35.014016	17.077477	6.38
Slice 4	6.9	11.526139	-93.422843	48.05277	23.436902	6.38

Slice 5	8.3	10.674387	-85.069716	60.327237	29.42356	6.38
Slice 6	9.6785714	9.891094	-77.387959	68.360068	33.341433	6.38
Slice 7	11.035714	9.1718427	-70.334261	71.909577	35.072644	6.38
Slice 8	12.392857	8.50134	-63.758642	74.996312	36.578145	6.38
Slice 9	13.75	7.877583	-57.641457	77.640713	37.867906	6.38
Slice 10	15.107143	7.2988058	-51.965389	79.84854	38.944735	6.38
Slice 11	16.464286	6.7634489	-46.715143	81.612346	39.805001	6.38
Slice 12	17.821429	6.2701331	-41.877196	82.912683	40.439218	6.38
Slice 13	19.178571	5.8176393	-37.439589	83.719226	40.832595	6.38
Slice 14	20.535714	5.4048902	-33.391758	83.992016	40.965643	6.38
Slice 15	21.892857	5.030936	-29.724389	83.683031	40.814941	6.38
Slice 16	23.25	4.6949422	-26.429298	82.738213	40.354123	6.38
Slice 17	24.607143	4.3961793	-23.499331	81.100044	39.555134	6.38
Slice 18	25.964286	4.1340145	-20.92828	78.710663	38.389756	6.38
Slice 19	27.321429	3.907904	-18.710814	75.515429	36.831336	6.38
Slice 20	29	3.6825796	-16.501058	76.616837	37.368528	6.38
Slice 21	30.74977	3.4953609	-14.665004	75.963928	37.050083	6.38
Slice 22	32.24931	3.3845129	-13.577918	68.160309	33.244004	6.38
Slice 23	33.74885	3.3158573	-12.904612	59.193531	28.870614	6.38
Slice 24	35.24839	3.2892318	-12.643497	49.104665	23.949945	6.38
Slice 25	36.74793	3.3045738	-12.793956	37.96676	18.517626	6.38
Slice 26	38.247471	3.3619194	-13.356343	25.881626	12.623312	6.38
Slice 27	39.49862	3.4390804	-14.113061	15.224031	7.757031	6.78
Slice 28	40.697436	3.5456626	-15.158313	9.2422106	4.5077273	6.38
Slice 29	42.092307	3.7013644	-16.685281	6.1943784	3.0212002	6.38
Slice 30	43.487179	3.8942303	-18.576717	2.5103564	1.2243826	6.38

7.3 RESULT RESULT OF MODEL 3.

7.3.1 Result obtained from model 3.

Critical Slip Surface: 22.
F of S: 2.104.
Volume: 151.1438 m³.
Weight: 2,613.288 kN.
Resisting Moment: 82,337.143 kN-m.
Activating Moment: 39,133.423 kN-m.
Resisting Force: 1,451.0995 kN.
Activating Force: 689.70731 kN.
F of S Rank (Analysis): 1 of 25 slip surfaces.
F of S Rank (Query): 1 of 25 slip surfaces.
Exit: (44.184615, 4) m.
Entry: (2, 15) m.

Radius: 53.607473 m.

7.3.2 Slice data obtained from model 3.

Table 22: Result of Slice of model 3.

	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	2.7	14.459717	-122.19244	5.8764776	2.8661496	6.38
Slice 2	4.1	13.414678	-111.94375	21.031272	10.257637	6.38
Slice 3	5.5	12.438299	-102.3684	35.02081	17.08079	6.38
Slice 4	6.9	11.526139	-93.422843	48.061186	23.441006	6.38
Slice 5	8.3	10.674387	-85.069716	60.336904	29.428274	6.38
Slice 6	9.6785714	9.891094	-77.387959	68.707744	33.511006	6.38
Slice 7	11.035714	9.1718427	-70.334261	72.256883	35.242037	6.38
Slice 8	12.392857	8.50134	-63.758642	75.344055	36.747751	6.38
Slice 9	13.75	7.877583	-57.641457	77.989676	38.038106	6.38
Slice 10	15.107143	7.2988058	-51.965389	80.199479	39.1159	6.38
Slice 11	16.464286	6.7634489	-46.715143	81.965989	39.977484	6.38
Slice 12	17.821429	6.2701331	-41.877196	83.269725	40.613358	6.38
Slice 13	19.178571	5.8176393	-37.439589	84.080319	41.008712	6.38
Slice 14	20.535714	5.4048902	-33.391758	84.357768	41.144033	6.38
Slice 15	21.892857	5.030936	-29.724389	84.05399	40.99587	6.38
Slice 16	23.25	4.6949422	-26.429298	83.114854	40.537823	6.38
Slice 17	24.607143	4.3961793	-23.499331	81.482752	39.741794	6.38
Slice 18	25.964286	4.1340145	-20.92828	79.099711	38.579507	6.38
Slice 19	27.321429	3.907904	-18.710814	75.910952	37.024245	6.38
Slice 20	29	3.6825796	-16.501058	77.019814	37.565073	6.38
Slice 21	30.74977	3.4953609	-14.665004	76.374234	37.250203	6.38
Slice 22	32.24931	3.3845129	-13.577918	68.576787	33.447134	6.38
Slice 23	33.74885	3.3158573	-12.904612	59.615304	29.076326	6.38
Slice 24	35.24839	3.2892318	-12.643497	49.530525	24.157651	6.38
Slice 25	36.74793	3.3045738	-12.793956	38.395177	18.726579	6.38
Slice 26	38.247471	3.3619194	-13.356343	26.310774	12.832622	6.38
Slice 27	39.49862	3.4390804	-14.113061	15.628384	8.6629546	6.95
Slice 28	40.697436	3.5456626	-15.158313	9.2396073	4.5064576	6.38
Slice 29	42.092307	3.7013644	-16.685281	6.1926758	3.0203698	6.38
Slice 30	43.487179	3.8942303	-18.576717	2.5094546	1.2239428	6.38

7.4 RESULT RESULT OF MODEL 4.

7.4.1 Result obtained from model 4.

Critical Slip Surface: 22.
F of S: 2.106.
Volume: 151.1438 m³.
Weight: 2,622.2086 kN.
Resisting Moment: 82,629.251 kN-m.
Activating Moment: 39,232.144 kN-m.
Resisting Force: 1,456.3892 kN.
Activating Force: 691.51466 kN.
F of S Rank (Analysis): 1 of 25 slip surfaces.
F of S Rank (Query): 1 of 25 slip surfaces.
Exit: (44.184615, 4) m.
Entry: (2, 15) m.
Radius: 53.607473 m.
Center: (35.449939, 56.891083) m.

7.4.2 Slice data obtained from model 4.

Table 23: Result of Slice of model 4.

	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	2.7	14.459717	-122.19244	5.8792599	2.8675067	6.38
Slice 2	4.1	13.414678	-111.94375	21.036041	10.259963	6.38
Slice 3	5.5	12.438299	-102.3684	35.027363	17.083987	6.38
Slice 4	6.9	11.526139	-93.422843	48.069225	23.444928	6.38
Slice 5	8.3	10.674387	-85.069716	60.34606	29.43274	6.38
Slice 6	9.6785714	9.891094	-77.387959	68.962032	33.635031	6.38
Slice 7	11.035714	9.1718427	-70.334261	72.51071	35.365836	6.38
Slice 8	12.392857	8.50134	-63.758642	75.597957	36.871587	6.38
Slice 9	13.75	7.877583	-57.641457	78.244181	38.162237	6.38
Slice 10	15.107143	7.2988058	-51.965389	80.455107	39.240577	6.38
Slice 11	16.464286	6.7634489	-46.715143	82.223247	40.102957	6.38
Slice 12	17.821429	6.2701331	-41.877196	83.529107	40.739868	6.38
Slice 13	19.178571	5.8176393	-37.439589	84.342309	41.136493	6.38
Slice 14	20.535714	5.4048902	-33.391758	84.622826	41.27331	6.38
Slice 15	21.892857	5.030936	-29.724389	84.322553	41.126857	6.38
Slice 16	23.25	4.6949422	-26.429298	83.387321	40.670714	6.38
Slice 17	24.607143	4.3961793	-23.499331	81.759473	39.876759	6.38
Slice 18	25.964286	4.1340145	-20.92828	79.38097	38.716686	6.38
Slice 19	27.321429	3.907904	-18.710814	76.19695	37.163736	6.38
Slice 20	29	3.6825796	-16.501058	77.311325	37.707253	6.38

Slice 21	30.74977	3.4953609	-14.665004	76.671332	37.395107	6.38
Slice 22	32.24931	3.3845129	-13.577918	68.878859	33.594464	6.38
Slice 23	33.74885	3.3158573	-12.904612	59.921836	29.225832	6.38
Slice 24	35.24839	3.2892318	-12.643497	49.840727	24.308947	6.38
Slice 25	36.74793	3.3045738	-12.793956	38.707977	18.879142	6.38
Slice 26	38.247471	3.3619194	-13.356343	26.624834	12.985799	6.38
Slice 27	39.49862	3.4390804	-14.113061	15.958019	9.5885451	7.21
Slice 28	40.697436	3.5456626	-15.158313	9.2370923	4.505231	6.38
Slice 29	42.092307	3.7013644	-16.685281	6.1910176	3.019561	6.38
Slice 30	43.487179	3.8942303	-18.576717	2.5085688	1.2235108	6.38

7.5 RESULT OF MODEL 5.

7.5.1 Result obtained from model 5.

Critical Slip Surface: 22.
F of S: 2.108.
Volume: 151.1438 m³.
Weight: 2,637.2814 kN.
Resisting Moment: 83,052.701 kN-m.
Activating Moment: 39,398.948 kN-m.
Resisting Force: 1,464.0265 kN.
Activating Force: 694.5373 kN.
F of S Rank (Analysis): 1 of 25 slip surfaces.
F of S Rank (Query): 1 of 25 slip surfaces.
Exit: (44.184615, 4) m.
Entry: (2, 15) m.
Radius: 53.607473 m.
Center: (35.449939, 56.891083) m.

7.5.2 Slice data obtained from model 5.

Table 24: Result of Slice of model 5.

	X (m)	Y (m)	PWP (kPa)	Base Normal Stress (kPa)	Frictional Strength (kPa)	Cohesive Strength (kPa)
Slice 1	2.7	14.459717	-122.19244	5.8816257	2.8686605	6.38
Slice 2	4.1	13.414678	-111.94375	21.040188	10.261986	6.38
Slice 3	5.5	12.438299	-102.3684	35.033218	17.086842	6.38
Slice 4	6.9	11.526139	-93.422843	48.076584	23.448517	6.38
Slice 5	8.3	10.674387	-85.069716	60.354621	29.436915	6.38
Slice 6	9.6785714	9.891094	-77.387959	69.384827	33.841241	6.38
Slice 7	11.035714	9.1718427	-70.334261	72.933324	35.571959	6.38

Slice 8	12.392857	8.50134	-63.758642	76.021454	37.078141	6.38
Slice 9	13.75	7.877583	-57.641457	78.669583	38.369719	6.38
Slice 10	15.107143	7.2988058	-51.965389	80.883387	39.449464	6.38
Slice 11	16.464286	6.7634489	-46.715143	82.655327	40.313697	6.38
Slice 12	17.821429	6.2701331	-41.877196	83.965849	40.952881	6.38
Slice 13	19.178571	5.8176393	-37.439589	84.784503	41.352165	6.38
Slice 14	20.535714	5.4048902	-33.391758	85.071183	41.491988	6.38
Slice 15	21.892857	5.030936	-29.724389	84.777684	41.348839	6.38
Slice 16	23.25	4.6949422	-26.429298	83.849724	40.896243	6.38
Slice 17	24.607143	4.3961793	-23.499331	82.229508	40.106011	6.38
Slice 18	25.964286	4.1340145	-20.92828	79.858837	38.949757	6.38
Slice 19	27.321429	3.907904	-18.710814	76.682662	37.400633	6.38
Slice 20	29	3.6825796	-16.501058	77.80599	37.948517	6.38
Slice 21	30.74977	3.4953609	-14.665004	77.174542	37.640539	6.38
Slice 22	32.24931	3.3845129	-13.577918	69.388847	33.843202	6.38
Slice 23	33.74885	3.3158573	-12.904612	60.437349	29.477265	6.38
Slice 24	35.24839	3.2892318	-12.643497	50.360164	24.562293	6.38
Slice 25	36.74793	3.3045738	-12.793956	39.229417	19.133465	6.38
Slice 26	38.247471	3.3619194	-13.356343	27.146085	13.24003	6.38
Slice 27	39.49862	3.4390804	-14.113061	16.400396	10.248105	7.3
Slice 28	40.697436	3.5456626	-15.158313	9.2348991	4.5041612	6.38
Slice 29	42.092307	3.7013644	-16.685281	6.1895977	3.0188685	6.38
Slice 30	43.487179	3.8942303	-18.576717	2.5078214	1.2231462	6.38

CHAPTER 8

CONCLUSION

8.1 CONCLUSION

From above experiment we can see that by adding glass powder mechanical property of the soil increase. The plastic limit of the soil increase from 23.8 to 2.11 by adding 15% of glass powder. Liquid limit decrease from 39 to 21 by adding 15% of glass powder. Optimum moisture content decrease from 15.32 to 13.85 and also MAX dry density increase from 1.75 to 1.89. It also effect on cohesion and angle of friction which increase 6.38 to .3 and 26 to 32. And CBR value also increase for 2.5mm 18.34 to 23.51 and for 5mm 18.59 to 25.06.
When we glass glass powdered treated soil on yop 1m of the top side of slope FOS of the slope increase in the Critical Slip Surface no 22. Other slip surface have FOS greater than slip surface on 22. So slip surface no 22 is critical.
For model 1 in which we did not add any glass powder min FOS of that model is 2.100. For model 2 in which we add 5% glass powder min FOS of that model is 2.102. For model 3 in which we add 10% glass powder min FOS of that model is 2.104. For model 4 in which we add 15% glass powder min FOS of that model is 2.106. For model 5 in which we add 20% glass powder min FOS of that model is 2.108.

As glass waste not recycle when it mix with soil its property increase. so it become ecofriendly and cost effective also.

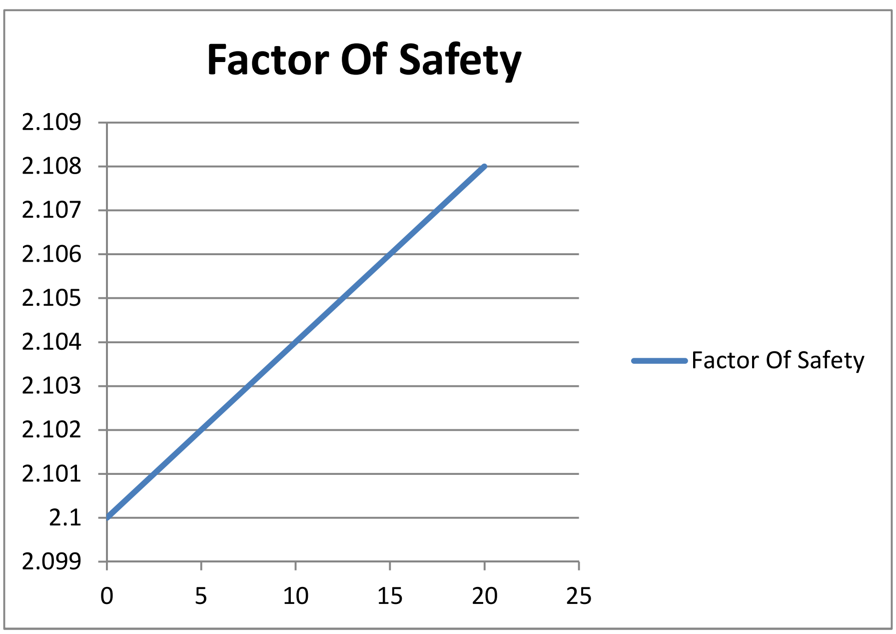


Figure 28: Variation of Factor Of Safety with glass powder.

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