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Slope Stability Analysis of Dragline Dump: A Case Study

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ABSTRACT

In the acculturated world mining exercises are inseparable from the norm of life as well as the condition of any country. It brings about both monetary and uneconomic materials being created. The Uneconomic materials (Wastes) are stacked at better places known as waste dumps. The solidness of these dumps has been a main pressing issue throughout the long term. The issue turns out to be progressively troublesome with the decreased accessibility of land regions for unloading. In this project, a sensitivity analysis is carried out for finding out the influence of different parameters on stability of dragline dump. Factor of safety was calculated using phase² software and sensitivity indexes of different parameters were carefully calculated

KEYWORDS: dragline dump, slopestability, sensitivity,Factor of safety

1. INTRODUCTION

Power consumptionin modern world miningIt has turned into a fundamental represent the creation of economic minerals. At the production process largenumber of wastes isproduced. Those waste materials are put away in a helpful spot for its further use or removal, or are put away forever. They are put away as an incline or dike. In both of the reasons the dependability of slope has been a main issue. The dependability of slanted land regions, avalanche, is a fundamental concern where movements of existing or planned slopes may have a effect on the safety of people andproperty.The debacles and obliteration incorporate the regular occasions (heavy rains), uncased excavations, road embankments and landfills. Thecited peculiarities happen because of either a mistaken way to deal with the appraisal of their steadiness, or missteps made at the phase of geotechnical examinations, mistaken suppositions made in the stage completing computation, or an unpredictable area of machines on the incline overcharge.

One of the reasons for the wrong appraisal of incline soundness might be incorrect assurance of the topographical design of the slant being referred to. As the mine stretches out to throughout some undefined time frame, these waste dumps and the issues in regards to their soundness issues different methodologies have been embraced and reated throughout the long term. The methodologies is more for computational instead of the manual. Numerous virtual products are available to break down the slants that are responsible to disappointment by the computing the element of wellbeing. In this task phase² programming is utilized to ascertain the element of security and analyze the stability

of the dragline dump.Slope stability analysis is followed by sensitivity analysisto findout the sensitivity indexesofdifferent parameters influencing the stability of the dragline dump.

Responsiveness investigation is utilized to decide how "touchy" a model is to changes in the worth of the boundaries of the model and to changes in the design of the model. Boundary awareness is typically proceeded as a progression of tests in which the modeler sets different boundary values to perceive how an adjustment of the boundary causes an adjustment of the powerful way of behaving of the stocks. By introducing in how model way of behaving answers changes w.r.t parameter values.Sensitivity analysis is the useful tool in model development as well as in model evaluation. Sensitivity analysis helps tobuild confidenceby concentrating on the vulnerabilities that are frequently connected with boundaries in models. Numerous boundaries in framework elements models address amounts that are extremely challenging, or even difficult to quantify to a lot of exactness in reality. Likewise, a few parametric qualities change in reality.

Awareness investigation demonstrates basic info boundaries for slope design. Awareness is communicated by a dimensionless file I, which is determined as the proportion between the general difference in model result and the overall difference in an info boundary. The responsiveness file (I) as characterized by Lenhart et al. (2002) is communicated in the situation given beneath. Sensitivityindex, $I = \frac{(y2-y1)x0}{(x2-x1)y0}$

Some of the factors affect the stability of any slope. Those are[1].

1. Gravitational Force.
2. Material properties of the slope.
3. Geology and hydrogeology of the dumping area.
4. Inclination of the dumping area.
5. Erosion of the surface slopes due to flowing water.
6. The sudden lowering of water adjacent to a slope.
7. Forces due to earthquakes.

2. LITERATURE

HuseinMalkawi A.I., Nusairat J.H., Alkasawneh W., Albataineh N., A near look at of various monetarily to be had bundles in slant balance examination. PCs and Geotechnics 35; 428-435 (2008).The goal of this paper is to examine the impact of various slip floor seek strategies at the elements of protection acquired the usage of the restrict equilibrium (LE) slope balance techniques. This goal is done with the aid of using evaluating effects from the finite detail technique, the linear grid technique, the square grid technique, and the Monte-Carlo looking strategies the usage of specific commercially to be had packages. The effects confirmed that the LE techniques are very green techniques whilst coupled with a sturdy looking method particularly the Monte-Carlo technique. In addition, the chosen slip floor seek method relatively stimulated the region of the vital slip surfaces in addition to the price of the calculated elements of protection[3].

Dash, A. K.(2019) Opencast mining operation entails the elimination of bulk portions of overburden, dumping, and backfilling in excavated areas.

A extraordinary boom in the percentage of opencast production (93%) withinside the Indian coal enterprise has resulted withinside the massive hassle of waste dumps at gift with a more top of the selloff built over the minimal vicinity and giving upward thrust to the growing threat of sell off failures. Dangerous occurrences, incidents, injuries, and failures because of sell off failure in Indian opencast mines are pretty common, ensuing in accidents and fatalities. In 2016, a catastrophe because of sells off failure withinside the Raajmahal coalfield of ECL killed 23 workers. Even eleven though all such injuries are being analyzed and guidelines made in every case, comparable injuries aren't prevented. Unfortunately, we appear to overlook the training whenever from those beyond incidents or injuries.

3. PROPOSED WORK

In many applications, the main role of slope stability analysis is to add the protected and financial plan of excavations, banks, earth dams, landfills, and ruin piles. Incline security assessments are worried about distinguishing basic topographical, material, ecological, and monetary boundaries that will influence the task, as well as figuring out the nature, extent, and recurrence of potential slant issues. While managing inclines overall and slant strength examination specifically, past geographical and geotechnical experience in a space is important.

The points of slope stability analysis are

(1) To grasp the turn of events and structure a characteristic slide and the cycles answerable for various regular elements.
(2) To survey the stability of slopes under present moment (frequently during development) and longterm conditions.
(3) To survey the chance of landslides including regular or existing designed slides.
(4) To break down landslides and to grasp disappointment instruments and the impact of natural elements.
(5) To empower the upgrade of failed slopes and the preparation and plan of preventive and therapeutic measures, were vital.
(6) To concentrate on the impact of seismic loadings on slopes and banks.es.

Phase2 is a strong 2D elasto-plastic limited component stress examination program for underground or surface unearthing in rock or soil. It very well may be utilized a wide for designing ventures and incorporates support plan, limited component slant steadiness, groundwater leakage and probabilistic examination. Complex, multi-stage models can be effectively made and immediately dissected - burrows in feeble or jointed rock, underground stalwart caves, open pit-mines and slants, banks, MSE settled earth designs, and significantly more. Moderate disappointment, support connection and an assortment of different issues can be addressedPhase2 offers a wide scope of help demonstrating choices. Liner components can be applied in the demonstrating of shotcrete, concrete, steel set frameworks, holding dividers, heaps, multi-facet composite liners, geotextiles from there, the sky is the limit. Liner configuration devices incorporate help limit plots which permit you to decide the wellbeing element of supported liners. Bolt types incorporate end moored, completely fortified, link bolts, split sets and grouted tie backs. One of the significant highlights of Phase2 is limited component incline solidness investigation utilizing the shear strength decrease technique. This choice is completely robotized and can be utilized with either Mohr-Coulomb or Hoek-Brown strength boundaries. Incline models can be imported/traded among slide and Phase2 permitting simple examination of cutoff harmony and limited component results. Phase2 incorporates consistent state, limited component groundwater drainage examination incorporated solidly into the program. There is compelling reason need to utilize a different groundwater program. Pore not set in stone as well as stream and slope, in light of client characterized water driven limit conditions and material conductivity. Pore pressure results are consequently integrated into the pressure examination[7].

Calculation Of Factor Of Safety By Shear Strength Reduction Method [8].

Start the phase^2 model program

1. Add required excavation with the help of "Add Excavation"option

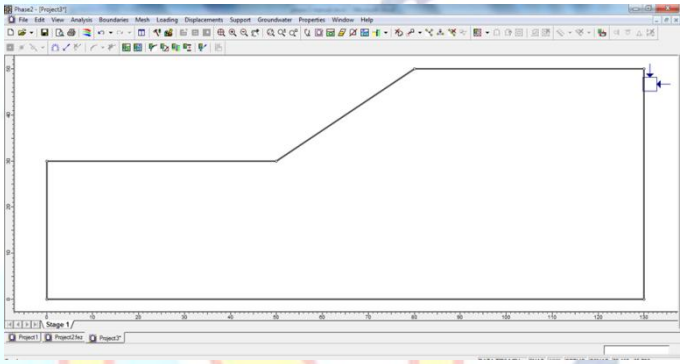


Figure 1. start the phase^2 model program.

2. Project Settings

a) step1-Open undertaking settings a dialog present at toolbar or at the investigation menu. Underneath the "general" tab, characterize the units as being "Metric, stress as kpa

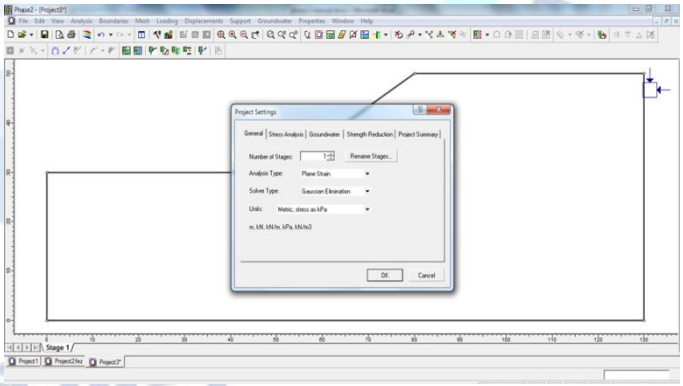


Figure 2.a. Project setting.

b) stage 2 - switch on to the "strength decrease" tab present in the venture settings discourse. presently, turn in the "decide strength decrease factor "checkbox. Leave other ssr settings at the default values. Excessively close the task setting dialog

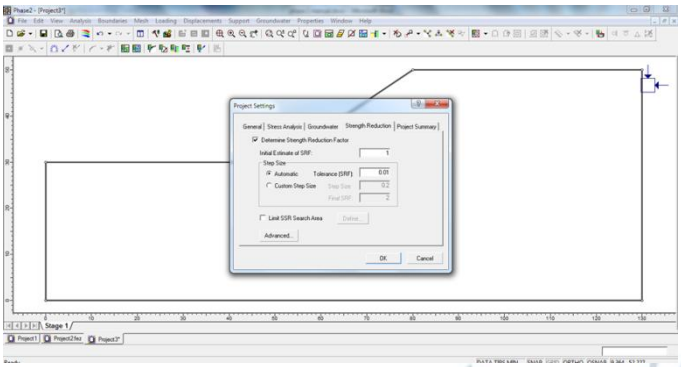


Figure 2.b. strength decrease factor.

3. Boundaries

a) This technique requires an outside limit for assurance of the calculation. select "Add External" choice present at the limits menu and enter the co-ordinates displayed in the uncovering.

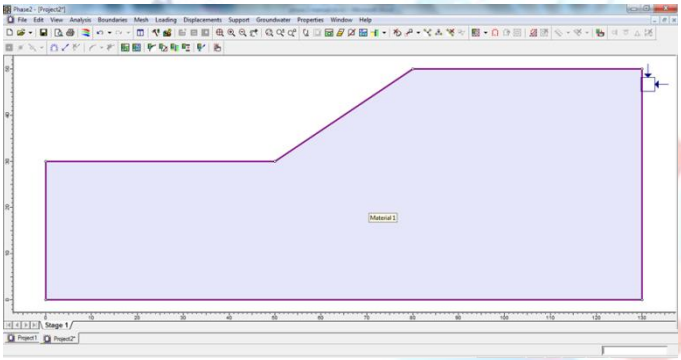


Figure 3. Boundaries.

4. Mesh

a) at "network arrangement" exchange box can change the cross-section type to "uniform", the component type to "6 noded triangles" and number of components to 800. Close the cross-section arrangement discourse

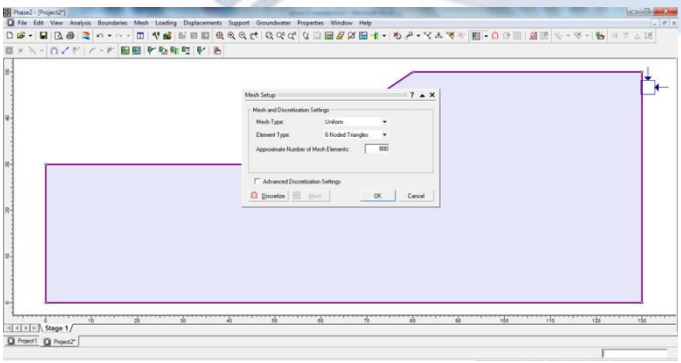


Figure 4.a. Mesh.

b) mesh and slope by choosing the "Discretize and Mesh" present at the toolbar or the cross section menu.

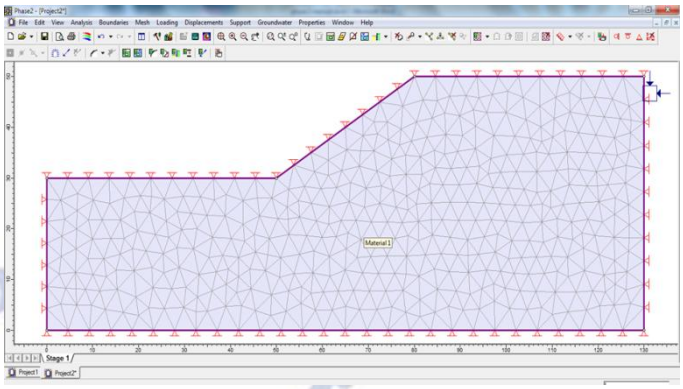


Figure 4.b. Mesh and slope by choosing the "Discretize and Mesh".

5. **Boundary Conditions**

a) Presently select the limit conditions, the piece of the outside limit addressing the ground surface should be allowed to move toward any path

1) click the free option presentat the displacement's menu
2) Use the mouse for selection ofthree-line segments defining the ground surface of slope
3) Right click and then select Done Selection.

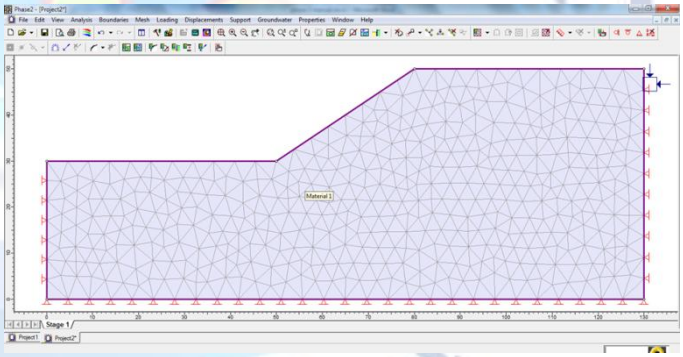


Figure 5.a. Boundary conditions.

The slope surface is free now,
1)Then Rightclick mouse directly at the upper left vertex at the pop-up menu selectthe restrain X, Y option
2)And rightclick mouse directly on the upper right vertex at the pop-up menu select restrain X, Y option
This dislodging limit conditions are currently accurately applied.

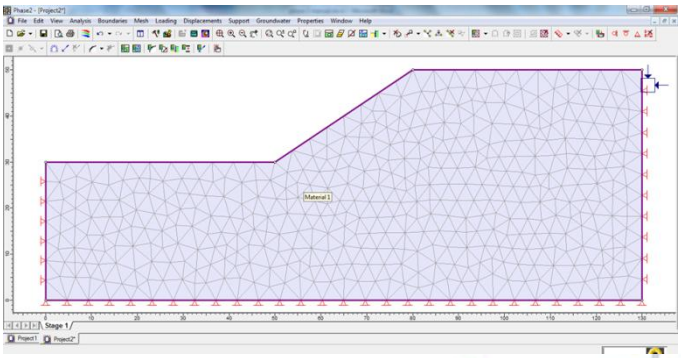


Figure 5.b. Boundary simulations.

6. Field Stress

A) Select "Field Stress" Option PresentatThe Loading Menu

B) Change The Field Stress Type From "Constant" To "GRAVITY"

C) Check The "USE Actual Ground Surface" Check Box

D) Leave Remaining Field Stress Parameters as Default.

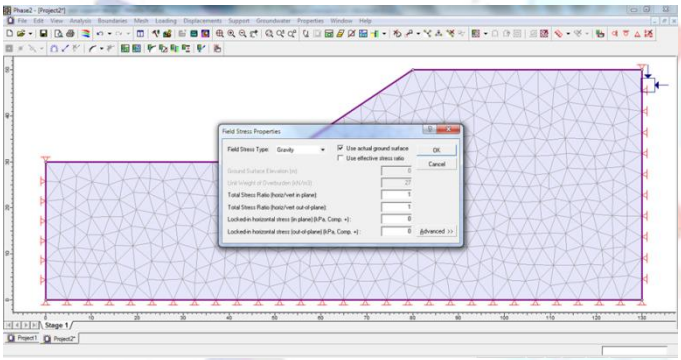


Figure 6. Field stress.

7.Material Properties

a) Select "Define Materials" present at the toolbar or the properties

b) Assign required material properties.

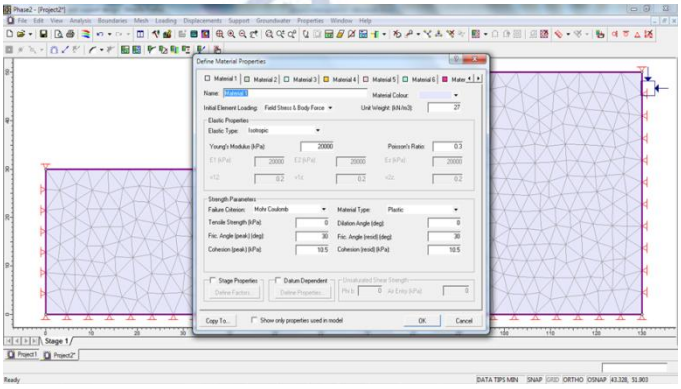


Figure 7. Material Properties.

8.Compute and Interpret

a) Use the model by using compute option present in the analysis menu.

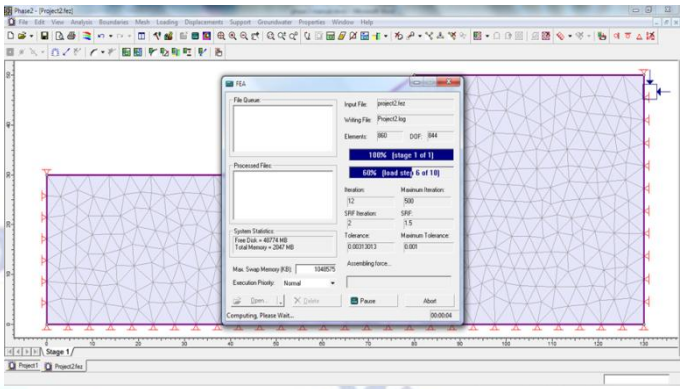


Figure 8. Compute and interpret.

a) After computing select the interpret option to view the results.

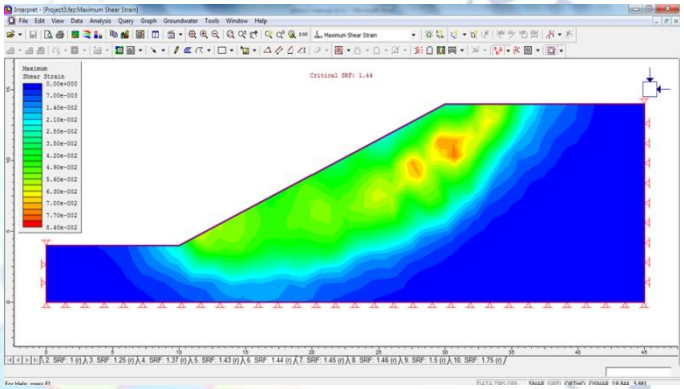


Figure 9. Result after computing select the interpret option to view the results.

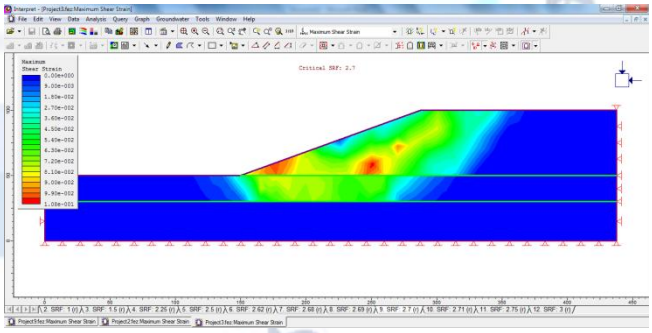


Figure10.Slope stability analysis conducted by phase2 showing critical SRF for

Cohesion	=	100 kpa
Friction angle	=	17 deg
Height of the dump	=	50 m
Slope angle of the dump	=	20 deg

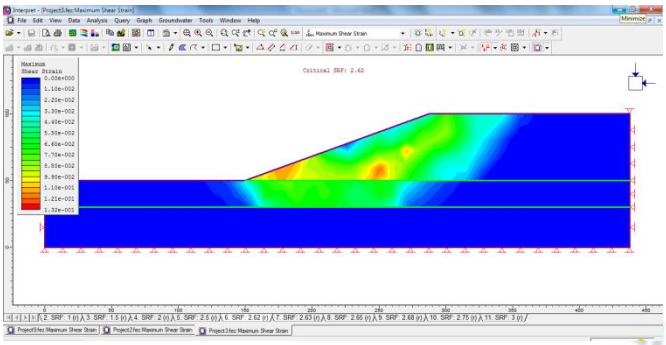


Figure11.Slope stability analysis conductedby phase2 showing critical SRF for

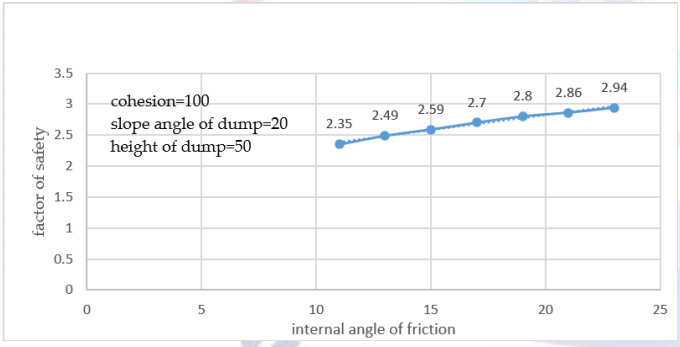
Cohesion = 90 kpa
Friction angle = 17 deg
Height of the dump = 50 m
Slope angle of the dump = 20 deg

4. RESULTS

Sensitivity Analysis

4.1.Calculation Of Sensitivity Index For "Internal Angleof Friction"

We obtained a graph with x axis as internal angle of friction and y axis as factor of safety in this graph we take cohesion=100 and slope angle of dump=20deg and height of dump=50m as constant and we observe the variation w.r.t internal angle of friction and factor of safety[6].

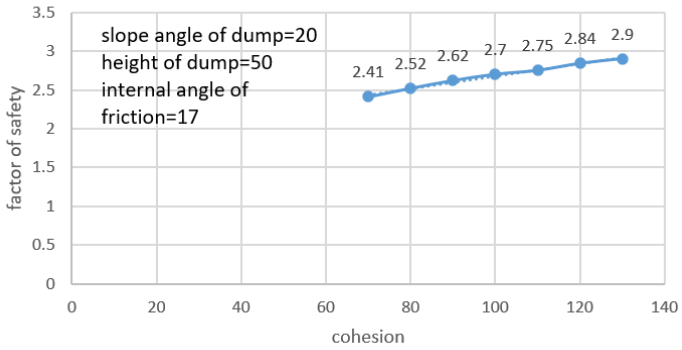


Graph 1. A graph plotted between internal angle of friction and factor of safety.

X_0 =17 degrees, Y_0 = 2.70
ΔX = 5 degrees
$X_1 = X_0 - \Delta X = 17 - 5 = 12$ degrees
$X_2 = X0 + \Delta X = 17 + 5 = 22$ degrees
y1 and y2 are calculated from the equation obtained from the graph between factor of safety and internal angle of friction
We have $Y = -0.0015x^2 + 0.1012x + 1.4275$

Substituting the values of x1 and x2 in the equation we get
Y_1= 2.8579
Y_2=4.3799
We know sensitivity index , $I = \frac{(y2-y1)x0}{(x2-x1)y0}$
Substituting the values X_0,X_1 ,X_2 ,Y_0 , Y_1, Y_2 in sensitivity index formula, we get
I=0.5637

4.2 Calculation of Sensitivity Index For "Cohesion" and variation of factor of safety with cohesion



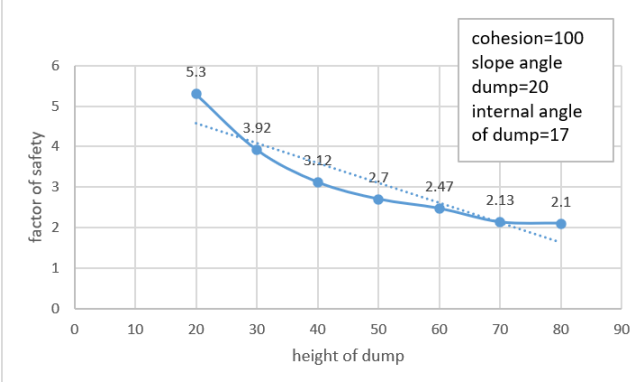
Graph 2.A graph plotted between cohesion and factor of safety.

We obtained a graph with x axis cohesion and y axis factor of safety; in this graph we take slope angle of dump=20deg and height of dump=50m and internal angle of friction=17deg as constant and we observe the variation w.r.t cohesion and factor of safety
(Cohesion vs factor of safety)

X_0 =100 kpa, Y_0 = 2.70
ΔX = 20 kpa
$X_1 = X_0 - \Delta X = 100 - 20 = 80$
$X_2 = X_0 + \Delta X = 100 + 20 = 120$
Y_1 and Y_2 are calculated from the equation obtained from the graph between factor of safety and internal angle of friction we have Y= 0.008x + 1.8771
Substituting the values of x1 and x2 in the equation we get
Y_1= 2.52, Y_2= 2.84
we know sensitivity index, $I = \frac{(y2-y1)x0}{(x2-x1)y0}$
Substituting the values X_0,X_1,X_2,Y_0,Y_1,Y_2 in sensitivity index formula, we get
I =0.29

64

4.3 Calculation of Sensitivity Index For "Dump Height "



Graph 3.A graph plotted between height of dump and factor of safety.

We obtained a graph with x axis height of dump and y axis factor of safety, in this graph we take cohesion=100,slope angle of the dump=20deg, internal angle of friction=17deg as constant and we observe the variation w.r.t height of the dump and factor of safety

X_0 =50, Y_0= 2.70

$\Delta X = 20$

$X_1 = X_0 - \Delta X$ = 50-20 =30

$X_2 = X_0 + \Delta X$= 50 +20= 70

y1 and y2 are calculated from the equation obtained from

parameter	Factor of safety	sensitivity
Internal angle of friction	0.56	high
cohesion	0.29	Slightly high
Height of the dump	-0.83	high
Slope angle of the dump	-0.49	high

the graph between factor of safety and internal angle of friction

We have $y = 0.0011x^2 - 0.1617x + 7.9329$

Substituting the values of x1 and x2 in the equation we get

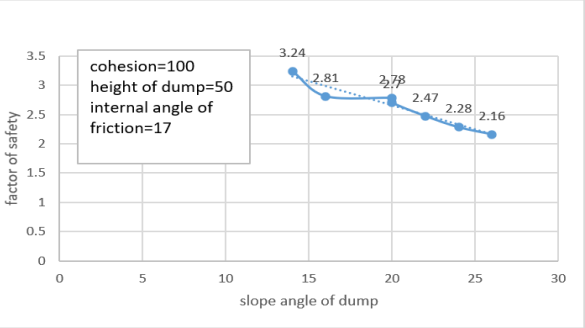
Y_1= 3.92, Y_2= 2.13

We know, sensitivity index, $I = \frac{(y2-y1)x0}{(x2-x1)y0}$

I= -0.83

4.4. Calculation Of Sensitivity Index For "Slope Angle of The Dump

Variation Of Factor of Safety With "Slope Angle of The Dump"



Graph 4. A graph plotted between slope angle of dump and factor of safety.

We obtained a graph with x axis slope angle of dump and y axis factor of safety, in this graph we take cohesion=100, height of dump=50m, internal angle of friction=17deg as constant and we observe the variation w.r.t slope angle of dump and factor of safety

X_0 =20,Y_0 = 2.70

$\Delta X = 4$

$X_1 = X_0 - \Delta X$ =20 -4 =16

$X_2 = X_0 + \Delta X$=20+4= 24

Y_1 and Y_2 are calculated from the equation obtained from the graph between factor of safety and internal angle of friction

we have Y= 1.604ln(x) + 7.4071

Substituting the values of x1 and x2 in the equation we get Y_1= 2.81; Y_2= 2.28

we know sensitivity index, $I = \frac{(y2-y1)x0}{(x2-x1)y0}$

Substituting the values X_0, X_1, X_2, Y_0, Y_1, Y_2in sensitivity index formula, we get

I = -0.49

The sensitivity indexes of important parameters arecalculated and the results are found out to be:

The negative indicates with increase in that particular parameter the factor of safety decreases

5. CONCLUSION

In this paper,a detailed analysis for the slope stability of a dragline dump was studied w.r.t various parameters influencing the stability.we observed that the above-mentioned factors affect the stability with high sensitivity,from the above calculations we observed that change in factory of safety for the variable factors like

internal angle of friction, cohesion, height of dump, slope angle of the dump. Among the variable factors the height of the dump and cohesion is influencing the factors of safety in higher scale hence the height of dumpand cohesion is the significant parameters in measuring the factor of safety

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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