Analysis of Embankments with Different Fill Materials using Plaxis-2D

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ABSTRACT

Slope stability analysis is one of the most important topic in geotechnical Engineering. For construction of Railway embankments, canal, road Embankments, earth dams etc. we go for different slopes with different geometric conditions. If the slope is natural made, the kind of problem is to check the sustainability of slope. If it is manmade type, the problem of choosing soils to build and other conditions which required for stable. The clear idea of this topic is to know the best suitability of locally available fill material. For this particular analysis done in latest version of 2016 PLAXIS-2D. This particular software has the 5 stages of sequential computation like soil, structure, mesh generation, flow conditions, staged construction. Each individual stage having maximum number options regarding all the properties of soil, loading conditions, water table effect, geometry, reinforcements. Analysis contains usage of different fill materials and different slope angles with different heights. Present slope study includes the homogeneous soils, as well as slope section with different soils layers.

Keywords *slope stability, plaxis-2d, Fill materials*

I. INTRODUCTION

Slope is the one which is inclined and unsupported mass. It can create by nature as well as man. We can observe these as embankment and cuttings. In slope stability studies instability of any slope is challenging now a days. Instability may occur with number of factors. Even natural slopes also failure once it disturb by geometry change, forces act externally, shear strength lose etc. Large soil mass in inclined position obviously it can leads to slide from high level to low level. This is because shear stresses in soil greater than corresponding shear strength of soil. So in this particular study the how shear parameters of different fill materials influence the instability of embankment. Similarly to know the locally available fill material behavior when it used in embankment. Plaxis-2d 2016 viewer is used for this analysis.

Generally parameters like water pressure, presence of bad quality of soil on surface, subsoil, non-linear behavior of ground etc. are neglected by simplified approach methods. But when it comes to finite element method recent studies states that FEM based computational tabs are providing better results even when it undergoes earthquake analysis. Plaxis-2D is the one tool which also is the same and giving accurate results by comparing with all other tools. So this particular study also executed on plaxis-2D.

FINITE ELEMENT MODEL

Embankment height consider as 20ft,30ft,40ft.Different slope parameters were consider was 2H:1v,2.5H:1v,3H:1. Embankment crest width is 10ft. 15 nodded plain strain elements have been used in the Analysis. Similarly Project

properties [x_{min}, x_{max}, y_{min}, y_{max}] varies as per Height and slope of Embankment we consider. Mesh generation coarseness factor used as medium. The height of layer below the actual height of embankment is 10ft.FEM was generated using plaxis-2d 2016 viewer .Actual section of Analysis given Figure 1.

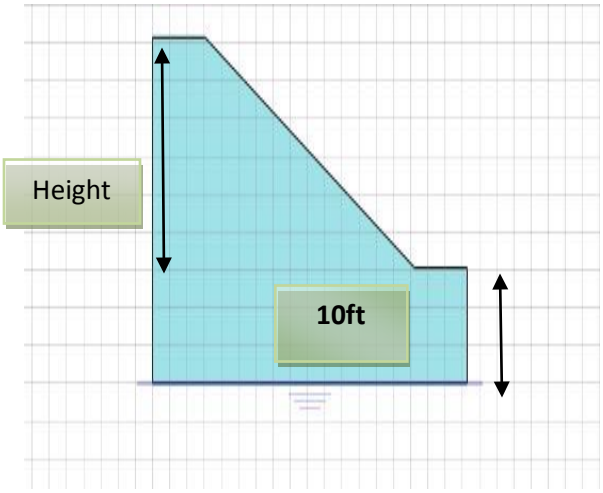

Figure. 1 considered Embankment section in the Analysis

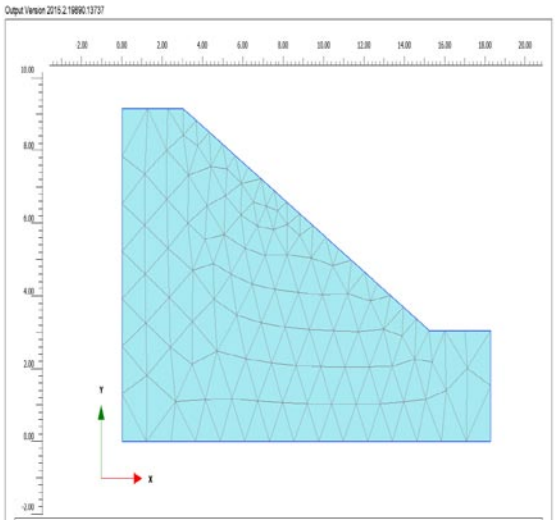

Figure. 2 Mesh generation with global coarseness medium

Material models

Different availability fills materials used in the analysis and modeled using Mohr-coulomb soil model. Each fills material used as homogenous fill material. Similarly for another case two layers of fill materials that is 10ft base as one fill material and remaining height one fill material. Different fill materials which were used in analysis are listed in Table I.

	FILL1	FILL2	FILL3	units
Υ_{sat}	19	21.70	20	KN/m^3
Υ_{Dry}	16	18.82	18	KN/m^3
É	3000	6000	5800	KN/m^2
υ	0.33	0.3	0.35	-
Ć	5	37	20	KN/m^2
φ	30	12	30	Deg

Table I material properties

Mesh generation

Global coarseness input given as medium for generating Mesh. Below figure 2 shows the mesh generation

Calculation

Before actual calculation, it needs to go for initial stress. This analysis requires K_o procedure to produce initial stresses. Jacky's provided the K_o procedure. So this procedure was performed in initial phase. In Phase-I Total Embankment analysis was carried out and factor of safety can be estimated.

II. RESULTS AND DISCUSSION

Analysis of homogeneous embankment for 20ft Height

Slope	Fill1	Fill2	Fill3
2H:1V	**1.849**	**2.789**	**2.97**
2.5H:1V	**2.187**	**3.002**	**3.39**
3H:1V	**2.528**	**3.239**	**3.782**

Table II 20ft homogeneous embankment with different fills and slopes

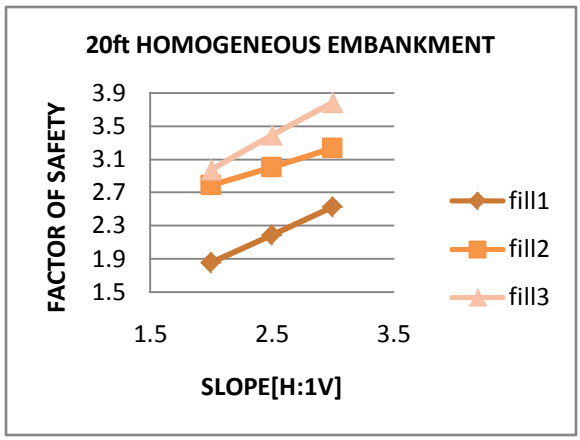

Figure. 3 Slope Vs Factor of Safety For 20ft Embankment With Different Soil Fills

From the above Table II and Figure 3 most of the factor of safety values are above 2.0 irrespective of soil type and slope of homogeneous 20ft embankment , except for embankment having fill 1 & slope 2H:1V. The smallest value is 1.849. Which means the embankments built with uniform soils are reliable in the short-term conditions. Embankment built with fill3 is most stable and safest.

Analysis of homogeneous embankment for 30ft height

Slope	Fill1	Fill2	Fill3
2H:1V	1.655	2.473	2.62
2.5H:1V	1.981	2.317	2.887
3H:1V	2.318	2.534	3.255

Table III 30ft homogeneous embankment with different fills and slopes

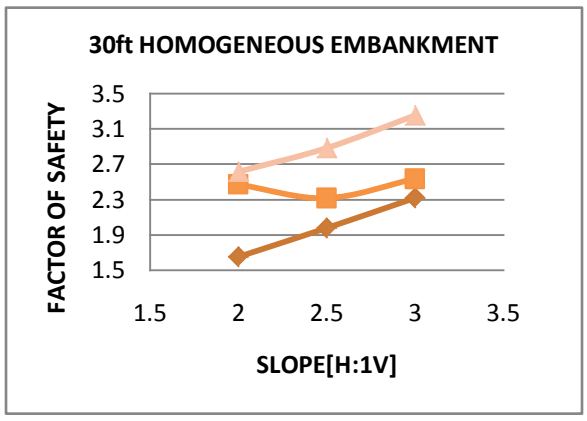

Figure. 4 Slope Vs Factor of Safety For 30ft Embankment With Different Soil Fills

From the above Table 3 and Figure 4 all the factor of safety values are above 1.5 irrespective of soil type and slope of homogeneous 20ft embankment. The smallest value is 1.655. The variation among the factor of safety is same like 20ft height embakment.

Analysis of homogeneous embankment for 40ft height

Slope	FILL1	FILL2	FILL3
2H:1V	1.573	1.775	2.218
2.5H:1V	1.880	1.959	2.60
3H:1V	2.210	2.162	2.947

Table IV 40ft homogeneous embankment with different fills and slopes

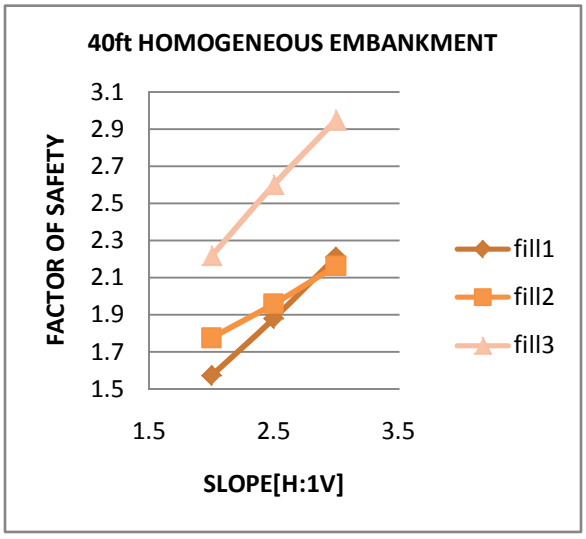

Figure.5 Slope Vs Factor of Safety For 40ft Embankment With Different Soil Fills

From the above Table 4 and Figure 5 all the factor of safety values are above 1.5 irrespective of soil type and slope of homogeneous embankment. The smallest value is 1.573. The variation among the factor of safety is same which already observed above. Less separation can be observed in between curves.

Analysis of embankment with two layers for 20ft height

Type	FILL1+ FILL2	FILL1+ FILL3	FILL2+ FILL3
2H:1V	1.855	2.339	2.821
2.5H:1V	2.213	2.638	3.021
3H:1V	2.57	2.95	3.28

Table V 20ft embankment with different soil layers and slopes

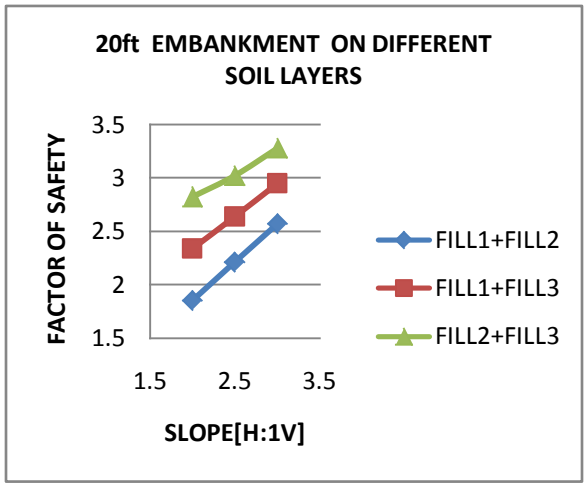

Figure. 6 Slope Vs. Factor of Safety For 20ft Embankment With Two Soil Layers

Analysis of embankment with two layers for 30ft height

Type	FILL1+ FILL2	FILL1+ FILL3	FILL2+ FILL3
2H:1V	1.646	2.091	2.200
2.5H:1V	2.005	2.384	2.415
3H:1V	2.343	2.671	2.646

Table VI 30ft embankment with different soil layers and slopes

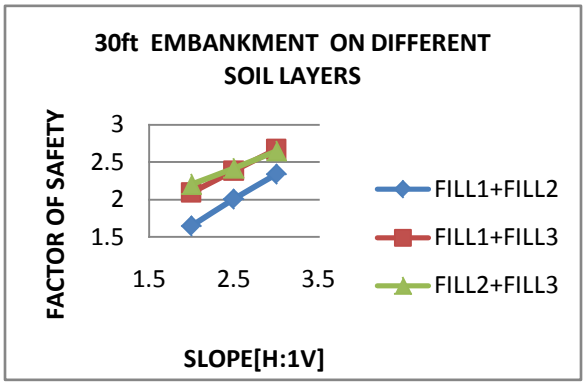

Figure. 7 Slope Vs. Factor of Safety For 30ft Embankment With Two Soil Layers

Analysis of embankment with two layers for 40ft height

Type	FILL1+ FILL2	FILL1+ FILL3	FILL2+ FILL3
2H:1V	1.541	1.93	1.886
2.5H:1V	1.891	2.218	2.098
3H:1V	2.205	2.53	2.338

Table VII 40ft embankment with different soil layers and slopes

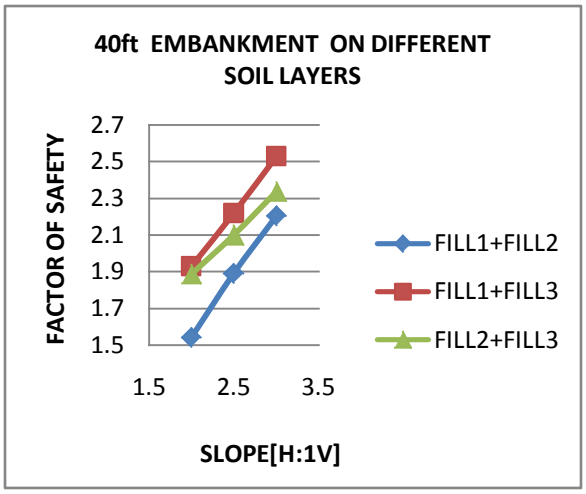

Figure. 8 Slope Vs. Factor of Safety For 40ft Embankment With Two Soil Layers

III. CONCLUSIONS

- If embankment height generally increases the factor of safety decreases, but within the same height of embankment , slope increases then the factor of safety increases.

- Out of all the homogeneous embankment analysis for short term analysis of slope stability the minimum factor of safety irrespective of slope and height is 1.573. The minimum value for the section 40ft height, 2H: 1V slope and fill 1 material used.

- For analysis of embankment in two soil layers case, almost the minimum factor of safety is same compare with above but only differ is fill1+fill2 used as fill material.

IV. REFERENCES

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