

SLOPE STABILITY ANALYSIS OF SOIL STRATA-IN NATURAL AND MAN MADE CONDITIONS

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Slope stability analysis in soil strata helps in optimizing slope for cost and time effective construction. This article describes about procedure of carrying out slope stability analysis by using Geo-studio and Phase 2 software's.

Slope stability analysis has numerous application in various constructions such as of road embankments, sewerage pumping station, Master Balance Reservoir, Ash Ponds, Mining, slope beneath berthing structure, dredging, site grading, basements and structures like wagon tippler, pump house, nuclear buildings, hilly terrain etc. This article briefly covers the design procedure adopted with some photos showing the same.

(a) Geotechnical investigation

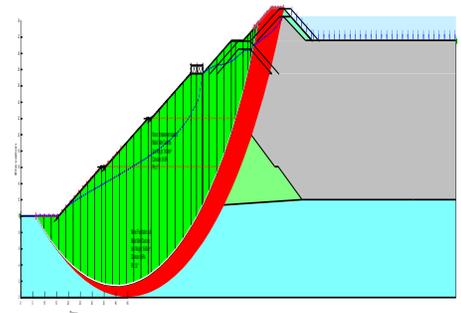
It is planned to obtain cohesion, angle of internal friction, field density, grain size analysis and atterberg limit of each layer of substrata. General site information such as ground water table, seismic zone, annual rainfall data and presence of any water bodies nearby are to be captured in the investigation report. In case of slope to be formed by filling, suitable borrow area needs to be identified and its properties as discussed above shall also be determined.

(b) Design

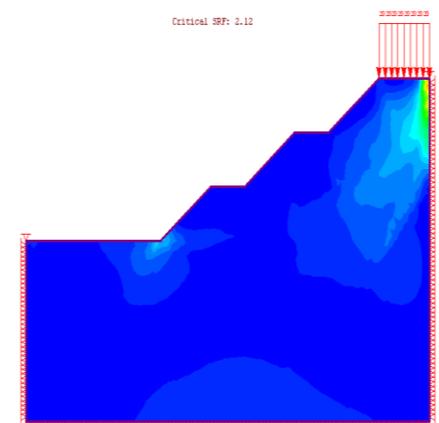
Conventionally, the slope stability analyses are done manually which is very tedious to workout most economical profile. With evolution of software's it is possible to quickly carryout different iterations considering various profiles. In soil strata, as much variation is not expected, the design carried out based on the parameters obtained from geotechnical investigation revision with real time parameter is rear.



Installing soil nails



Analysis using Geo studio



Analysis using Phase 2

Geostudio works in limit equilibrium principle and Phase 2 work in finite element principle. Limit equilibrium is a conventional approach to analyze the slopes. Though both the software's are based on different principles, their final output is of similar order due to which both the software are equally useful for analyzing the stability of slopes.

The accuracy of software output depends on skill of defining geometry of the slope with the properties of the strata along with other site conditions.

Water storage structures involves the verification of stability under steady seepage condition. Stability of such structures mostly requires provision of very low permeability layer for minimizing water seepage / controlling phreatic line , Cutoff wall and core by using low permeability clay, concrete etc are some of the methods used for reducing seepage/ controlling phreatic line. Geotextile and Geo-membranes are modern geo-synthetic products which also help in reducing seepages/ controlling phreatic line. Application of each varies with site conditions. All this can be analyzed by using both software's. Analysis of Phreatic line is used to design toe filters in earthen embankments to avoid soil erosion through piping action.

In slope constraint area, it may be difficult to adopt the slopes obtained from slope stability analysis, in such situation design is based on the combination of steeper slope strengthened with soil nailing. The design of soil nailing is carried out as per FHWA-NHI-14-007 manual which can be also modeled in the software's for verifying the overall stability.

The slope stability analysis for excavation also involves preparation of dewatering scheme. Suitable method of dewatering like deep well, multipoint dewatering system or dewatering with open sump is determined based on the estimated water head, estimated water flow , depth of excavation and nature of the strata. Special Care is taken to avoid erosion of fine soils during dewatering (suction pressure of pump).

Generally, expansive soil strata shall not be considered for construction without soil treatment .



(c) Facia elements

The slope is protected from surface erosion / rain cuts by either stone pitching or grass turfing. Grass turfing is an environmental friendly protection method which will also enhance the stability with the help of grass roots which works like reinforcement in the soil and holds the soil in place. Grass turfing requires periodic maintenance and provision of irrigation system for providing adequate water at regular intervals. Initial cost of installation stone pitching is more and it is generally adopted in the area

- having scarcity of water
- Periodic maintenance is not warranted
- Stones are available easily.

List of reference:

- 1) IS 7894 (1975): Code of practice for stability analysis of earth dams
- 2) Stability modeling with SLOPE/W- Geostudio Design manual
- 3) Phase 2 Design manual
- 4) IRC 36 : Recommended practice for construction of earth embankment
- 5) IRC 75: Guideline for the design of high embankment.
- 6) FHWA-NHI-14-007: geotechnical engineering circular no. 7 -Soil nail walls - reference manual



Grass Turfing



Stone Pitching