*International Journal of Research in Advent Technology (IJRAT) Special Issue "*ICADMMES 2018*"*
E-ISSN: 2321-9637
Available online at www.ijrat.org

Stability Analysis of Reinforced Soil Structures

Huchegowda BK[1], Shivaraj Biradar[2] Dr. Kalyan Kumar G[3]
[1, 2] *M.Tech Student, Dept. of Civil Engineering, NIT Warangal,*
[3]*Assistant Professor, Dept. of Civil Engineering, NIT Warangal,*

Abstract— All the structures supported on soil. It is neces sary to consider the soil structure interaction and its subsequent effect on structure during an earthquake. Soil strata can alter the seismic waves as they pass through them. When a structure is subjected to an earthquake, it interacts with foundation and soil. It changes the motion of the ground. It means movement of the whole ground structure system is influenced by type of soil as well as by the type of structure. In the current project, a n attempt has been made to study the effect of Various Reinforced Soil (RS) Structures. RS structures are analyzed by BISHOP'S method using Talrensoftware. The stability of slopes is analyzed using this software. There sponse of RS structures safety value such as "FS" values for all Reinforced Soil structure frames were presented in this project

1. INTRODUCTION

Most of the civil engineering structures involve some type of structural element with direct contact with ground. When the external forces, such as earthquakes, act on these systems, the structural displacements and ground displacements, are dependent of each other.

The process in which the response of the soil influences the motion of the structure and the motion of the structure influences the response of the soil is termed as soil-structure interaction (SSI).

Conventional structural design methods neglect the SSI effects. Neglecting SSI is reasonable for light structures in relatively stiff soil such as low rise buildings and simple rigid retaining walls.

The effect of SSI, however, becomes prominent for heavy structures resting on relatively soft soils for example nuclear power plants, high-rise buildings and elevated-highways on soft soil. The SSI are enormous effect on the civil engineering structures

Normally macro structures like: Multi – storey buildings, Bridges, Earthen & Concrete gravity Dams, Tunnels, Harbor & Nuclear power plant structures.

Undergoing effects like earthquake in the form of seismic effect and also including the problems of soil. The future research concludes that the effect undergoing the above structures, there deformations and safety measures adopt during the construction. By help of suitable properties of soil as well as structure using in the analysis process.

Scope of this work: all structures include safe transfer of load from the structure to the ground. The amount of load transferred through each foundation depends on the location of the foundation in the structure. Two exactly same structures can have different load distribution if they are constructed in soils having different properties, hence the SSI is required. SSI gives more confidence on the design.

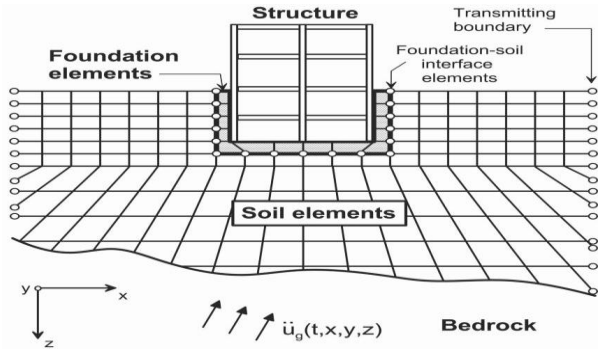

Fig1: Soil-Structure interaction of a Building

2. METHODOLOGY

VariousReinforced Soil Structures involved in this Analysisare:

Earth Embankment.
Soil nailing work for slopes. Retaining wall.
Road Embankment.

Fieldinvestigation:

For the Earth embankment fieldinvestigationwas carried out bycollectingsoilsamplesfromDavanagere(Karnataka India).For Retaining wall thefield investigationwas carried out byNICE, Bangalore. For Road embankment thefield investigationwas carried out bycollectingsoilsamplesfromBellary (Karnataka, India) roadat different chainage.

Laboratory testing:

The following laboratory tests were conducted on the soils amples collected fromVarious Locations as per IS 2720:

a. Sieveanalysis
b. Liquid limit and plastic limit
c. Free Swell Index
d. Direct shear test

Table1: Grainsize analysis for Earth embankment.

Sl.no	Chainage (m)	Gravel (%)	Sand (%)	Fine soil(%)
1 2 3	120 210 390	21 7 4	57 29 50	22 64 46

Table2: Different soilproperties forEarth embankment.

SL NO	Atterberg Limits (%)			Free Swell Index (%)	UCS KN/m^2	C KN/ M^2	Ø (º)
	LL	PL	SL				
1 2 3	45 45 41	22 21 20	23 24 21	10 40 20	11.19 4.13 6.93	10 25 20	29 26 27

Table3: Shear strength parameters of soil for embankment with nailing.

SL NO	Layer of soil	C	Ø
1 2 3	Layer 1 Layer 2 Layer 3	20 16 22	10 20 6

Table4: shear strength parameters of soil for Retaining Wall

Sl.No	Layer of soil	C(KN/m^2)	Ǿ(º)
1	Layer 1	20	10
2	Layer 2	15	20
3	Layer 3	22	5
4	Layer 4	25	10

Table5: shear strength parameters of soil for road embankment.

Sl.No	Type of soil	C(KN/m^2)	Ǿ(º)
1 2 3 4	Layer 1 Layer 2 Subgrade Pavement	22 26 30 26	7 6 2 4

Earth embankment:
Analyzing the Earthen embankment for SSI by using Talren Softwareunder Seismic zone ii. Input data are given below.

For Layer1: Density of soil is 17KN/m^2, Ø=25º,
C=10KPa. Layer2: Density of soil is 17KN/m^2, Ø=26º, C=6KPa. Layer3: density of soil is 24KPa, Ø=40º, C=10KPa. Top width of bund is 3m.soil properties is given in table 1& 2 and result is shown in fig 2.

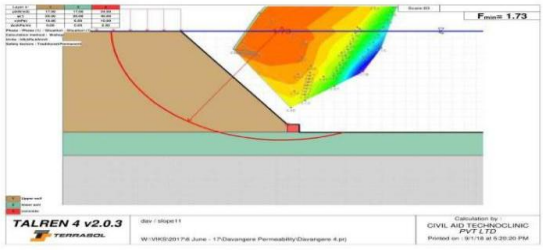

Fig2: stability analysis for Embankment with different strata.

Embankment of soil with nailing:

Density of soil for different layer is 18KN/m^2, other data was given in table3 and results were shown in fig 3.

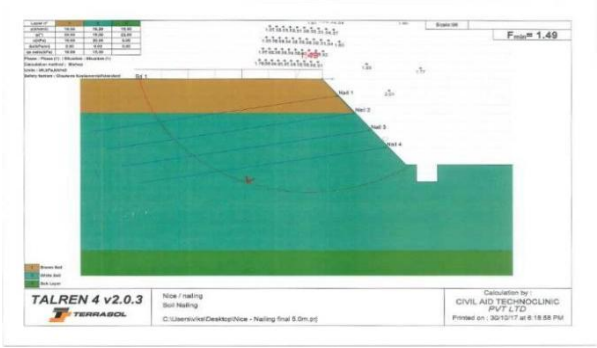

Fig3: Stability analysis for slopes with soil nailing.
Retaining wall:
Density of soil for different layer is 18KN/m^2, shear strength parameter was given in table 4 and results were shown in fig 4.

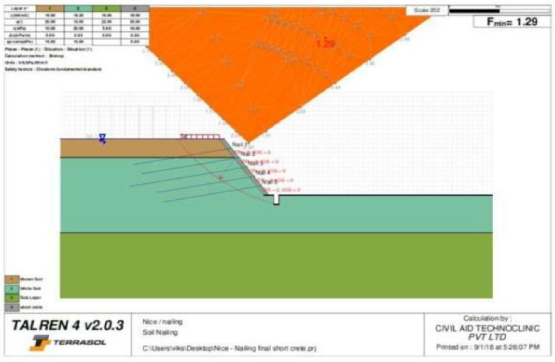

Fig4: Stability analysis for Retaining wall

Road embankment:

Density of soil for different layer is 18, 16, 19, 18KN/m2 respectively, other data was given in table 5 and results were shown in fig 5

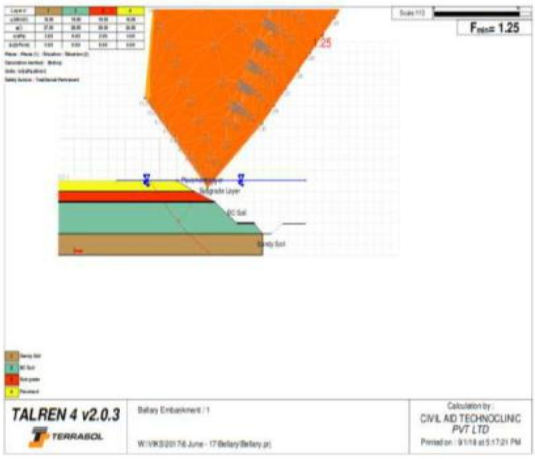

Fig 5: Stability analysis for Road embankment

3. RESULTS AND DISCUSSIONS:

Stability analysis was carried out using the Talren Software for the different sites and different geotechnical works like earth embankment, retaining wall with and without nailing, road embankment etc.All the slopes are safe without seismic loading. If seismic load is applied only theFS of earth embankment is more than 1.5 and others are less than 1.5 as shown in table 6. The earthquake data is selected based on the Seismic zone II as per IS 1893.

Table6: Results of different soil structures

Sl.no	Type of structures	FS
1	Earth embankment	1.73
2	Soil nailing work	1.49
3	Retaining wall	1.29
4	Road embankment	1.25

4. CONCLUSIONS:

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Factor of safety for Earth embankment, Retaining wall and Road embankment are carried out using Talren software by applying the seismic loadforexisting soilconditions. FS values are more than 1.5 only for earth embankment and for others they are less than 1.5.These structures were designed were not safe in the presence of earthquake loading. It can be concluded from the study that consideration of soil-structure interaction and its subsequent effect in case of dynamic loading like earthquakes is necessary for safe design of civil engineering structures

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