



Stability Analysis Of Reinforced Soil Retaining Wall (Rs Wall) By Limit Equilibrium Method (Lem) And Finite Element Method (Fem)

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Abstract: This study has been undertaken stability analysis of Reinforced Soil (RS) Wall by both the limit equilibrium method (LEM) and Finite element method (FEM) methods have been studied. The design of RS Wall is based on its stability against Internal, external and Global analysis. Three RS Wall heights of 6.4m, 7.2m and 8.0m which are normally the heights of RS Wall have been considered for design, however in this paper only the height of 6.4m has been highlighted. Based on the requirement of bearing pressure and available bearing capacity of existing ground, the requirement of Ground Improvement also evaluated. An economic mode of Ground Improvement such as with Prefabricated Vertical Drain, Woven Geotextile and Geocell have been considered. There is not enough relevant analysis of RS Wall through numerical method available in the literatures so far available. An attempt has been made to find out comparison between analysis of RS Wall through LEM and FEM methods.

I. INTRODUCTION

The present Investigation aims to study the behaviour of Reinforced Soil Wall by different design methods. The construction of Reinforced Soil Retaining Wall has been very popular in recent times in place of RCC Retaining Wall because of the various advantages. With the growth of Infrastructural projects, requirement of Reinforced Earth Wall has also increased. Therefore, the importance of designing Reinforced Earth Wall has also increased. Thus, this thesis topic has been chosen. The designing of Reinforced Earth is to some extent similar to the principle of designing of Reinforced concrete as the reinforced mass may be considered a composite material with improved properties, particularly in tension and shear, over the soil or concrete alone.

Soil has an inherently low tensile strength but a high compressive strength which is only limited by the ability of the soil to resist applied shear stresses. An objective of incorporating soil reinforcement is to absorb tensile loads, or shear stresses, thereby reducing the loads that might otherwise cause the soil to fail in shear or by excessive deformation.

II. OBJECTIVE AND SCOPE

Objectives

- Analysis of RS Wall by different methods (both LEM and FEM) to carry out a parametric study.
- Study of behaviour of RS Wall on weak soil and necessary Ground Improvement to allow the soil to bear the required load.

Scope of the work

The scope of work is outlined below.

- Collection of required data (such as Geotechnical Investigation report of the, Properties of Reinforced Soil and Retained Soil, Plan and Profile drawing, loading conditions, Seismic zone etc.).
- Manual design of RS Wall as per the provision of following codes of Limit Equilibrium such as BS 8006, FHWA, IRC:SP:102.
- Global Stability analysis through LEM Software such as ReSSA, GEO 5 for seismic and non-seismic conditions.
- Numerical analysis through PLAXIS 2D Ultimate (Version V21).
- Parametric study with wall height and soil parameters with standard loading Comparison of Results obtained by various methods.

A. Reinforced and Retained Soil

The property values of Reinforced and Retained Soil considered in the analysis are provided below in Table 2.1.

Table 2.1 Reinforced and Retained Soil Properties

Property Value →	Cohesion, c in Kg/cm ²	Angle of friction (φ) in degree	Unit weight (γ) in kN/m ³
1 st set of Sample	0.0	29.5	21.5
2 nd set of Sample	0.0	31.5	22.68
3 rd set of sample	0.0	33.5	23.20

B. Foundation Soil

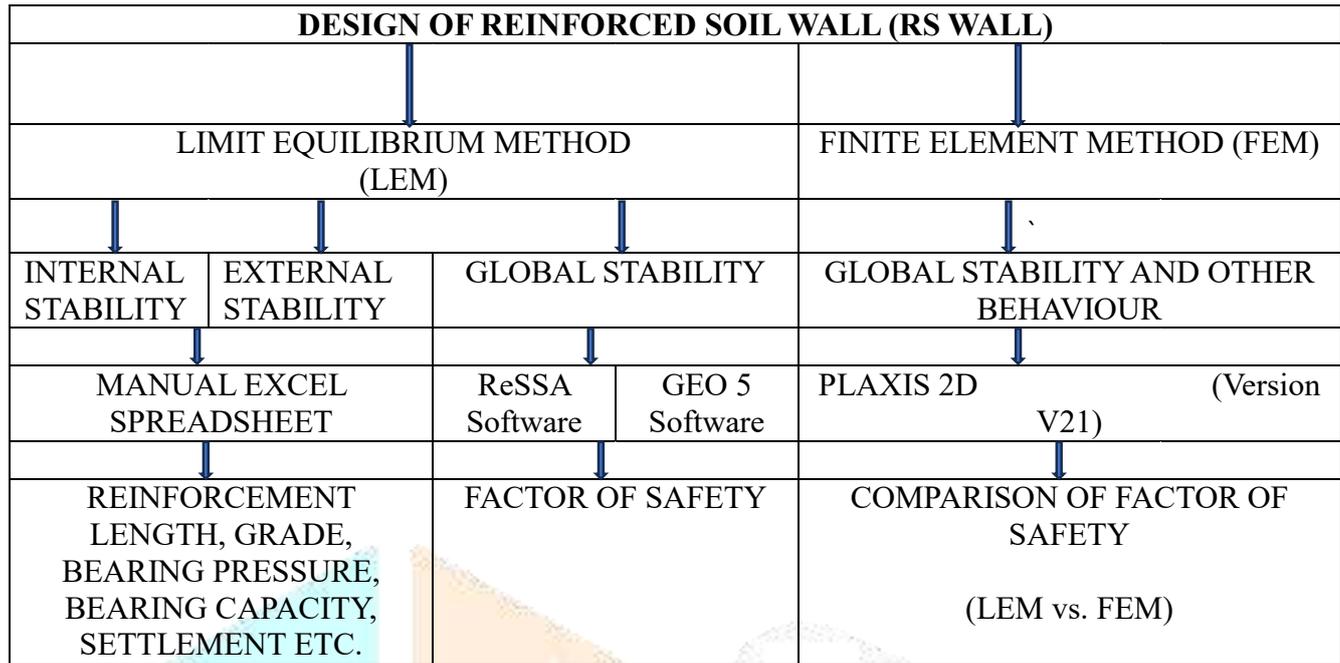
The following property values of Foundation soil provided below.

Cohesion, $c = 0.0 \text{ kg/cm}^2$; Angle of friction (ϕ) = 32^0 .

Unit weight (γ) = 22.68 kN/m^3

III. METHODOLOGY

The methodology is explained in brief in the form of following Flow Chart.



A. Principle of designing by excel spreadsheet by LEM

Limit State principles are applied to the design of Reinforced Soil Walls. The two limit states considered in design are the Ultimate limit state and the serviceability limit state.

Ultimate limit states are associated with collapse or other similar forms of structural failure. These states are attained, for a specific mode of failure, when disturbing design effects equal or exceed restoring design effects. Margins of safety, against attaining the limit state considered are provided by the use of partial material factors, partial load factors and partial resistance factors. These partial factors assume prescribed numerical values of unity or greater.

Nominal loads are increased by multiplying by prescribed load factors, greater than unity for loads with a disturbing effect, to produce design loads. Material properties such as reinforcement capacity or soil properties are reduced by dividing by prescribed material factors (greater than unity) to produce design material properties. Resistances such as fill/reinforcement interaction or bearing capacity are modified by prescribed resistance factors (greater than unity).

Serviceability limit states are attained if the magnitudes of deformation occurring within the design life exceed prescribed limits or if the serviceability of the structure is otherwise impaired. Construction tolerances are subject to separate limits and are considered separately from any serviceability limit state. In assessing deformations or strains to determine compliance with the appropriate limit state, the prescribed numerical values of load factors are different to those used in assessing the ultimate limit state of collapse and usually assume a value of unity. In assessing magnitudes of total or differential settlements all partial factors set to a value of unity, except for those pertaining to the reinforcements.

B. Principle of designing by excel spreadsheet by ReSSA+

ReSSA+ allows for analysis of complex walls, slopes and embankments. Such structures may accommodate up to 25 different layers of soil, up to 90 layers of geosynthetic reinforcement at any elevation above the 'toe' and up to 10 layers below the toe, or up to 100 layers above the toe without any layer below the toe. It allows for porewater pressure as implied by a phreatic or piezometric surface. The geometry represents most practical problems. The tiered option may be utilized to facilitate the input data for General geometry if the desired geometry resembles tiered slopes and the number of soils exceeds three. After inputting the initial data using

the Tiered option and then upon clicking on General Geometry in Main Menu, all data get converted to the General mode format. In such a case only minor modifications of data in General may be needed.

Input Data: Upon clicking on Input Data, it may be specified. The specific Input Data menu depends on the selected Geometry. In ReSSA+, facing units are specified which are considered in rotational failure (Bishop) and 2-part wedge sliding (Spencer).

Rotational Failure Mode: Bishop Analysis: Global Stability: The long term strength of the reinforcement is given and the program calculates the safety factors associated with the analysed circular surfaces.

C. Analysis through Geo-structural Analysis GEO5 Software (Version V16)

This program is used for verification of mechanically stabilized earth walls and segmental retaining walls reinforced by geogrids or other geo-reinforcements. The slip surface is considered as circular or polygonal. The main features of GEO5 MSE Wall program are:

- Analysis according to the theory of limit states and safety factor.
- Built-in database of available geo-reinforcement (such as geogrids) – Fortrac, Tensar, Miragrid, KB-grid, Acegrid, Secugrid, Enkagrid, Paralink, Paragrid etc.
- Verification analysis can be performed employing EN 1997-1, LRFD or classical approach (limit states, factor of safety)
- Verification of fictitious wall against slip and overturning
- Verification of slip and overturning of arbitrary part of the wall (dimensioning)
- Verification of bearing capacity of foundation soil
- Verification of slip on geo-reinforcement
- Verification of internal stability
 - for extensible reinforcements
 - Standard - straight slip surface
 - AASHTO – Extensible
 - FHWA NHI-10-024
 - for inextensible reinforcements
 - AASHTO – Inextensible
 - JTGD30 - 2004 Highway China Code
 - BS 8006 - Coherent Gravity Method
- Verification of global stability at circular slip surface (Bishop, Spencer) incl. optimization

D. Numerical Analysis

- The major advantage of numerical models relative to analytical models is the ability to model more complex conditions that generally are representative of the field conditions. PLAXIS 2D (Version 2021) is one such model for designing the Reinforced Soil Wall through numerical method. PLAXIS 2D (Version 2021) is a special purpose two-dimensional finite element program being used to perform deformation, stability and flow analysis for various types of Geotechnical problems including the designing of Reinforced Soil Wall. Real situations may be modelled either by a plane strain or an axisymmetric model. The program uses a convenient graphical user interface that enables to quickly generate a geometry model and finite element mesh based on a representative vertical cross section of the situation at hand.
- In **plane strain** analysis, the calculated forces resulting from prescribed displacements represent forces per unit length in the out of plane direction (Z-direction).
- The generation of a two-dimensional finite element model in PLAXIS 2D is based on the creation of a geometry model. The geometry model involves a composition of surfaces, lines and points. Multiple vertical boreholes are defined to define the stratigraphy at different locations. In between the boreholes the soil layer positions are interpolated. Soil layers and ground surfaces may be non-horizontal.
- Although PLAXIS 2D is a 2D program, stresses are based on the 3D Cartesian coordinate system. Either 6-node or 15-node triangular elements are selected to model soil layers and other volume clusters. The 15 -node triangle is the default element. It provides a fourth order interpolation for

displacements and the numerical integration involves twelve Gauss points (stress points). The type of element for structural elements and interfaces is automatically taken to be compatible with the soil element type. The 15-node triangle is a very accurate element that produces high quality stress results for difficult problems. The 15-node triangle is particularly recommended to be used in axisymmetric analysis. The use of 15-node triangles leads to more memory consumption and slower calculation and operation performance.

- In the Numerical analysis of RS Wall, subsurface profile and the location of Geogrid/Geostraps are shown in the main model. A two-dimensional mesh was used to model the problem as shown in the Figure of the next chapter. 15-node elements have been preferred when failure loads or safety-factors are to be predicted. The size of the smallest element and the average element size was kept in such a way maintaining the mesh quality equal to 1. Fascia was modelled using elements of negligible bending rigidity to capture bending moments. Axial Stiffness of Geogrid/Geostrap has been considered as 1750 kN/m. Simple elastic perfectly plastic Mohr Columb material model was chosen for all the layers of properties. Likewise, the modulus of elasticity of in-situ soil, reinforced soil and weathered slate were chosen as the standard values. The average Poisson's ratio was taken of about 0.3. Water table has been considered at Ground Level.

Properties of select Reinforced Fill and Foundation material are given below.

Reinforced Fill:

- Mohr-Columb model
- Density, $\gamma = 23.2 \text{ kN/m}^3$
- Internal angle of friction; $\phi = 33.5^\circ$
- Cohesion, $c = 0.0 \text{ kg/cm}^2$
- Young's modulus; $E = 80,000 \text{ kPa}$
- Poission's ratio; $\nu = 0.3$

Foundation material:

- Mohr-Columb model
- Density, $\gamma = 23.2 \text{ kN/m}^3$
- Internal angle of friction; $\phi = 33.5^\circ$
- Cohesion, $c = 0.0 \text{ kg/cm}^2$
- Young's modulus; $E = 80,000 \text{ kPa}$
- Poission's ratio; $\nu = 0.3$

IV. ANALYSIS

A. Results of manual design by excel spreadsheet

i. The design of Reinforced Soil Wall (RS Wall) through manual calculation has been done as per the codal provision mentioned in BS 8006 and other relevant codes. Here, the parameters of Reinforced fill considered as Cohesion (c) = 0.0 kg/cm^2 , friction angle (ϕ) = 29.5° , and unit weight (γ) = 21.5 kN/m^3 . The outcome of the results is furnished here in Table 4.1.

Table 4.1 Outcome of results Cohesion $c = 0 \text{ kg/cm}^2$, friction, (ϕ) = 29.5° , and unit wt. (γ) = 21.5 kN/m^3

C =		0	kg/cm ²	φ =	29.5°	γ =	21.5 kN/m ³		
DESIGN HEIGHT = 6.4M	<i>Layer from bottom</i>	<i>z_j</i> (m)	<i>h_j</i> (m)	<i>Length of Reinf.</i> (m)	<i>T_{ult}</i> (kN/m)	<i>no. of strip per m</i>	<i>T_d</i>	<i>Type of Geo-strip</i>	<i>Coefficient of active earth pressure (ka)</i>
	-	0.00	-	-	-	-	-	-	0.3401
	1	0.40	6.00	6.20	85.00	2.00	110.27	GEOSTRAP 85	
	2	1.20	5.20	5.20	85.00	2.00	110.27	GEOSTRAP 75	
	3	2.00	4.40	5.00	75.00	2.00	97.30	GEOSTRAP 75	
	4	2.80	3.60	5.20	60.00	2.00	77.84	GEOSTRAP 60	
	5	3.60	2.80	5.90	50.00	2.00	64.86	GEOSTRAP 50	
	6	4.40	2.00	7.20	40.00	2.00	51.89	GEOSTRAP 40	
	7	5.20	1.20	11.40	50.00	2.00	64.86	GEOSTRAP 50	
	8	6.00	0.40	12.90	40.00	2.00	51.89	GEOSTRAP 40	
-	6.40	-	-	-	-	-	-		
$q = R_v / (L - 2e) =$					330.23	kN/m ²			

ii. The design of Reinforced Soil Wall (RS Wall) through manual calculation has been done as per the codal provision mentioned in BS 8006 and other relevant codes. Here, the parameters of Reinforced fill considered as Cohesion (c) = 0.0 kg/cm², friction angle (φ) = 31.5⁰, and unit weight (γ) = 22.68 kN/m³. The outcome of the results is furnished here in Table 4.2.

Table 4.2 Outcome of results Cohesion c = 0 kg/cm², friction, (φ) = 31.5⁰, and unit wt. (γ) = 22.68 kN/m³

C =		0	kg/cm ²	φ =	31.5°	γ =	22.68 kN/m ³		
DESIGN HEIGHT = 6.4M	<i>Layer from bottom</i>	<i>z_j</i> (m)	<i>h_j</i> (m)	<i>Length of Reinf.</i> (m)	<i>T_{ult}</i> (kN/m)	<i>no. of strip per m</i>	<i>T_d</i>	<i>Type of Geo-strip</i>	<i>Coefficient of active earth pressure (ka)</i>
	-	0.00	-	-	-	-	-	-	0.3136
	1	0.40	6.00	5.80	85.00	2.00	110.27	GEOSTRAP 85	
	2	1.20	5.20	5.00	75.00	2.00	97.30	GEOSTRAP 75	
	3	2.00	4.40	5.00	75.00	2.00	97.30	GEOSTRAP 75	
	4	2.80	3.60	5.00	60.00	2.00	77.84	GEOSTRAP 60	
	5	3.60	2.80	5.20	50.00	2.00	64.86	GEOSTRAP 50	
	6	4.40	2.00	6.20	40.00	2.00	51.89	GEOSTRAP 40	
	7	5.20	1.20	8.20	50.00	2.00	64.86	GEOSTRAP 50	
	8	6.00	0.40	11.60	40.00	2.00	51.89	GEOSTRAP 40	
-	6.40	-	-	-	-	-	-		
$q = R_v / (L - 2e) =$					350.55	kN/m ²			

iii. The design of Reinforced Soil Wall (RS Wall) through manual calculation has been done as per the codal provision mentioned in BS 8006 and other relevant codes. Here, the parameters of Reinforced fill considered as Cohesion (c) = 0.0 kg/cm², friction angle (φ) = 33.5⁰, and unit weight (γ) = 23.20 kN/m³. The outcome of the results is furnished here in Table 3.

Table 4.3 Outcome of results Cohesion $c = 0 \text{ kg/cm}^2$, friction, $(\phi) = 33.5^0$, and unit wt. $(\gamma) = 23.20 \text{ kN/m}^3$

C =		0	kg/cm ²	$\phi =$	33.5°	$\gamma =$	23.20	kN/m ³	
DESIGN HEIGHT = 6.4M	Layer from bottom	z_j (m)	h_j (m)	Length of Reinf. (m)	T_{ult} (kN/m)	no. of strip per m	T_d	Type of Geo-strip	Coefficient of active earth pressure (ka)
	-	0.00	-	-	-	-	-	-	
	1	0.40	6.00	6.00	75.00	2.00	97.30	GEOSTRAP 75	
	2	1.20	5.20	5.00	75.00	2.00	97.30	GEOSTRAP 75	
	3	2.00	4.40	5.00	60.00	2.00	77.84	GEOSTRAP 60	
	4	2.80	3.60	5.00	50.00	2.00	64.86	GEOSTRAP 50	
	5	3.60	2.80	5.00	40.00	2.00	51.89	GEOSTRAP 40	
	6	4.40	2.00	5.80	40.00	2.00	51.89	GEOSTRAP 40	
	7	5.20	1.20	7.50	40.00	2.00	51.89	GEOSTRAP 40	
	8	6.00	0.40	10.50	40.00	2.00	51.89	GEOSTRAP 40	
-	6.40	-	-	-	-	-	-	-	
q = $R_v / (L - 2e)$		=	346.67	kN/m ²					

B. Analysis through ReSSA

The model and results out of ReSSA+ software analysis is provided with Figure 4.1 and Figure 4.2.

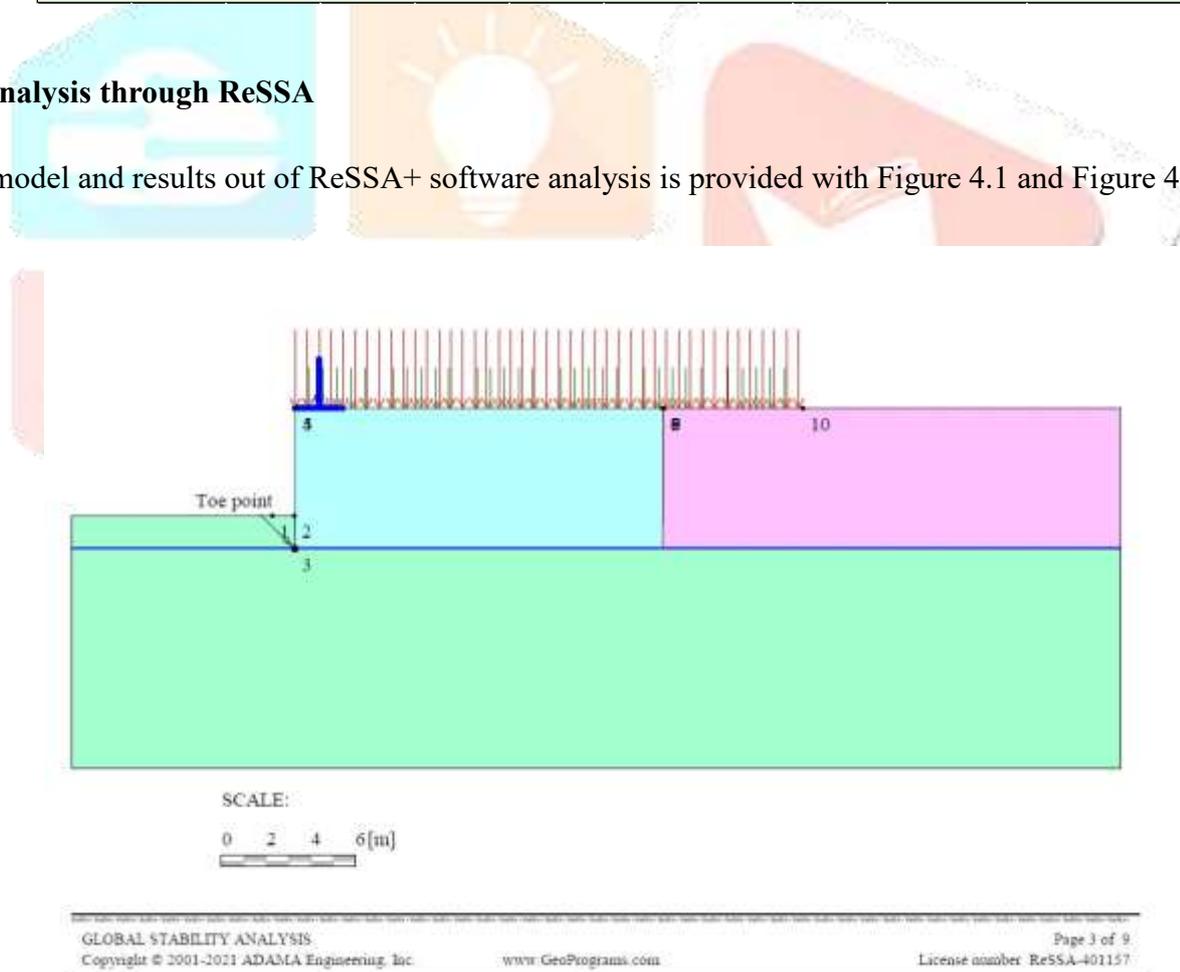


Figure 4.1 Output results of ReSSA + under Static & Seismic conditions, ht. – 6.4m - Model

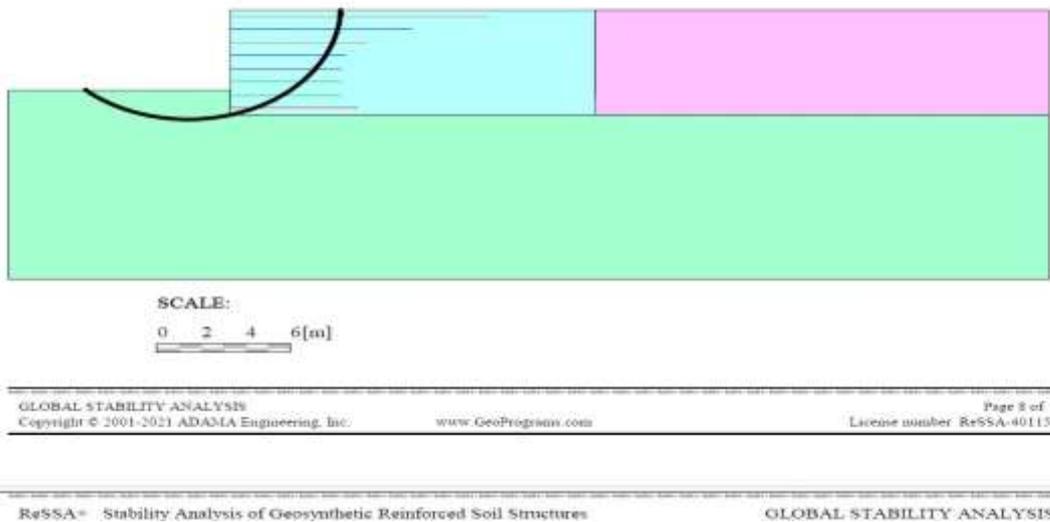


Figure 4.2 Output results of ReSSA+ under Static and Seismic conditions - Critical Failure Plane

The factor of safety out of the analysis considering rotational failure is given below.

- Against STATIC analysis - 1.57.
- Against Seismic analysis - 1.50.

C. Output of MSE Wall – analysis through GEO5

The results of analysis of design of 6.4m high RS Wall through GEO5 are provided below.

- a) Model and Factor of Safety against Static analysis: The results of Static analysis is provided with Figure 4.3.

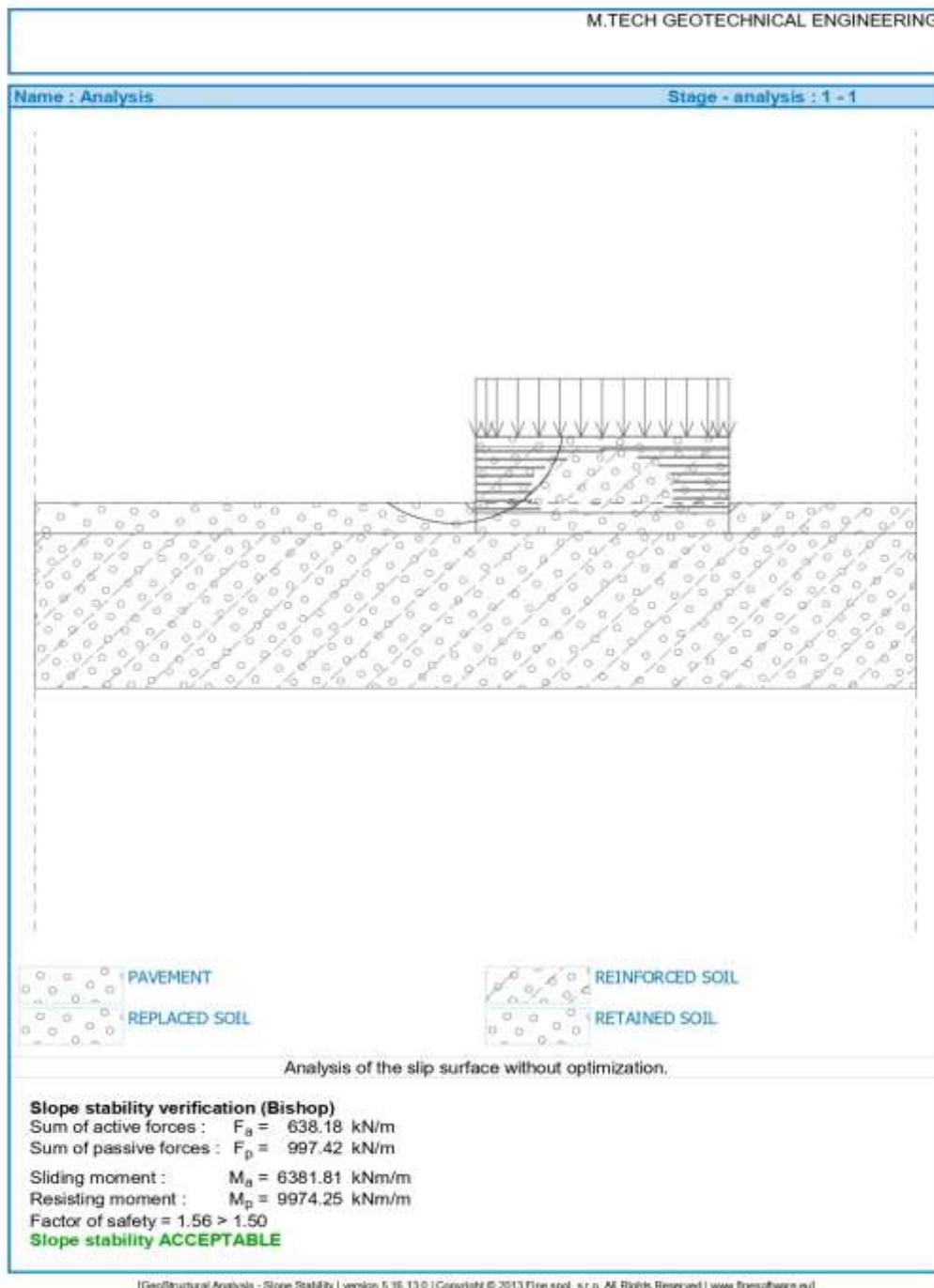


Figure 4.3 Output results of GEO 5 analysis under Static condition, ht. – 6.4m

b) **Model and Factor of Safety against Seismic analysis:** The results of Static analysis is provided with Figure 4.4.

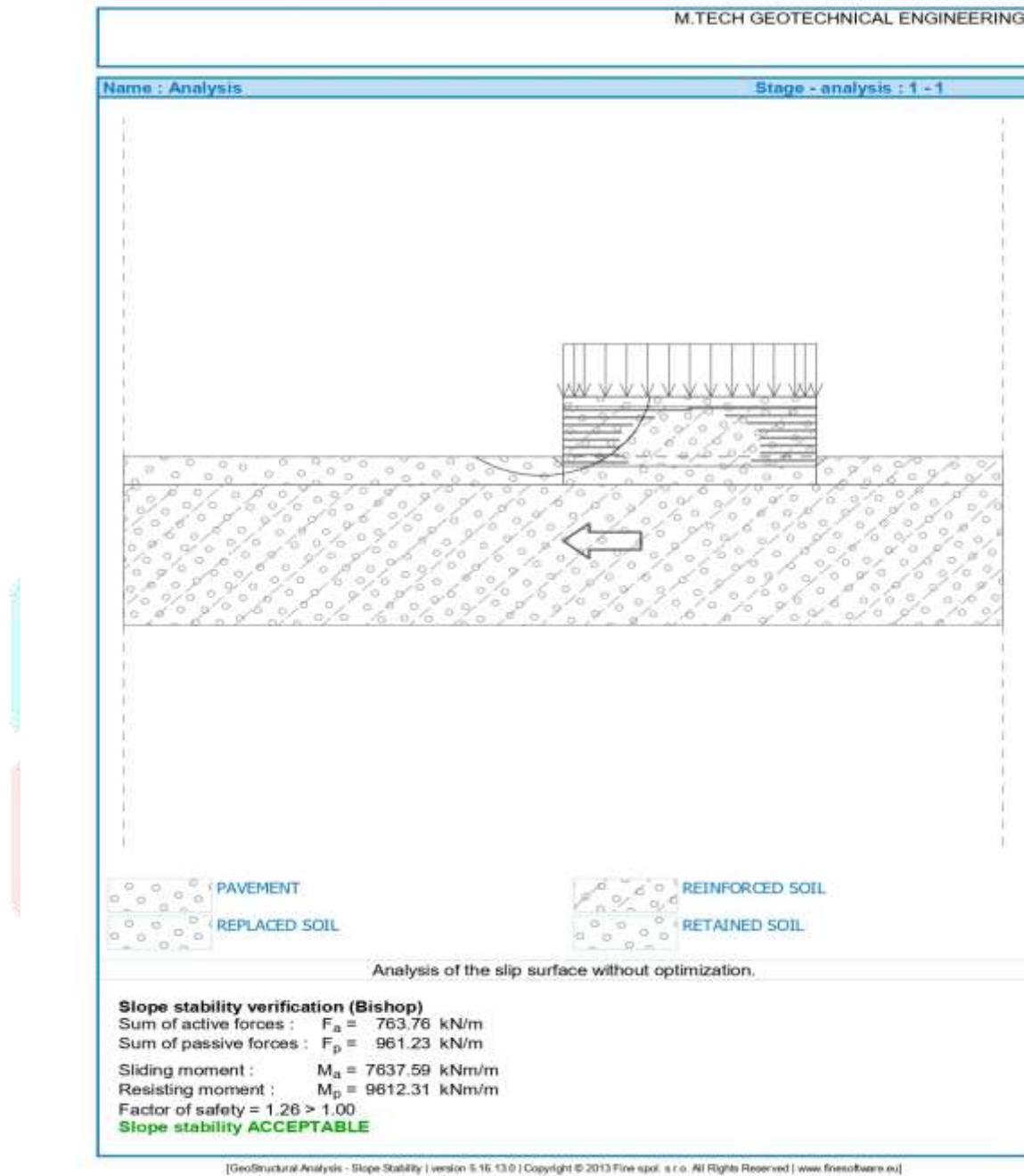


Figure 4.4 Output results of GEO 5 analysis under Seismic condition, ht. – 6.4m

D. Numerical analysis

In the earlier sections of this chapter, the design has been done at first for RS Wall of three heights through manual calculations. Considering the analysis out of manual calculations, Global Factors of safety have been calculated through ReSSA, GEO5. In this section, the Numerical analysis has been done on the basis of length & Grades of Geo-strap obtained from manual design.

RS Wall - 6.4m high

In this section, numerical analysis of 6.4m high RS Wall have been done. The model of the PLAXIS analysis of 6.4m height is shown in Figure 4.5.

a) Model for PLAXIS analysis

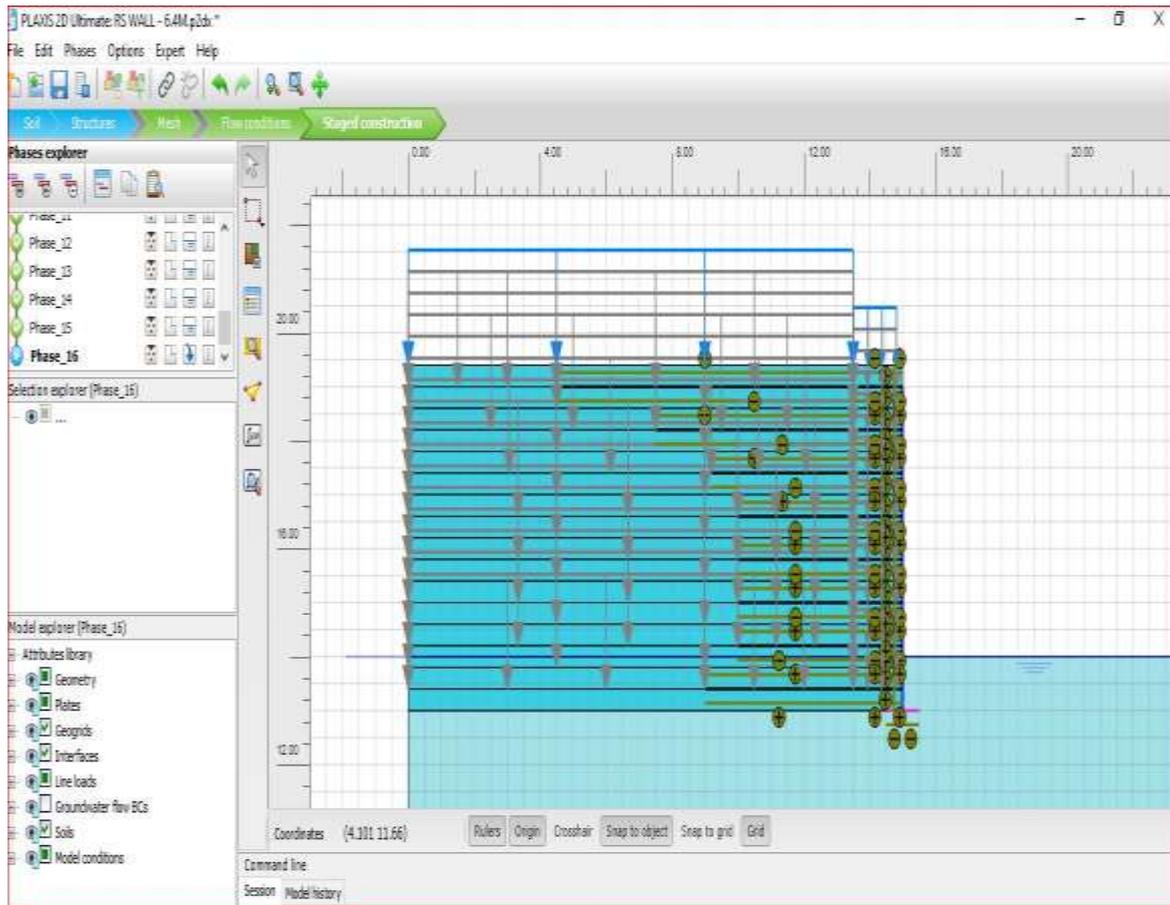


Figure 4.5 Model of 6.4m high RS Wall for analysis through PLAXIS 2D (version v21)

b) Deformed mesh

The deformed mesh for the 6.4m high RS Wall is shown below in Figure 4.6.

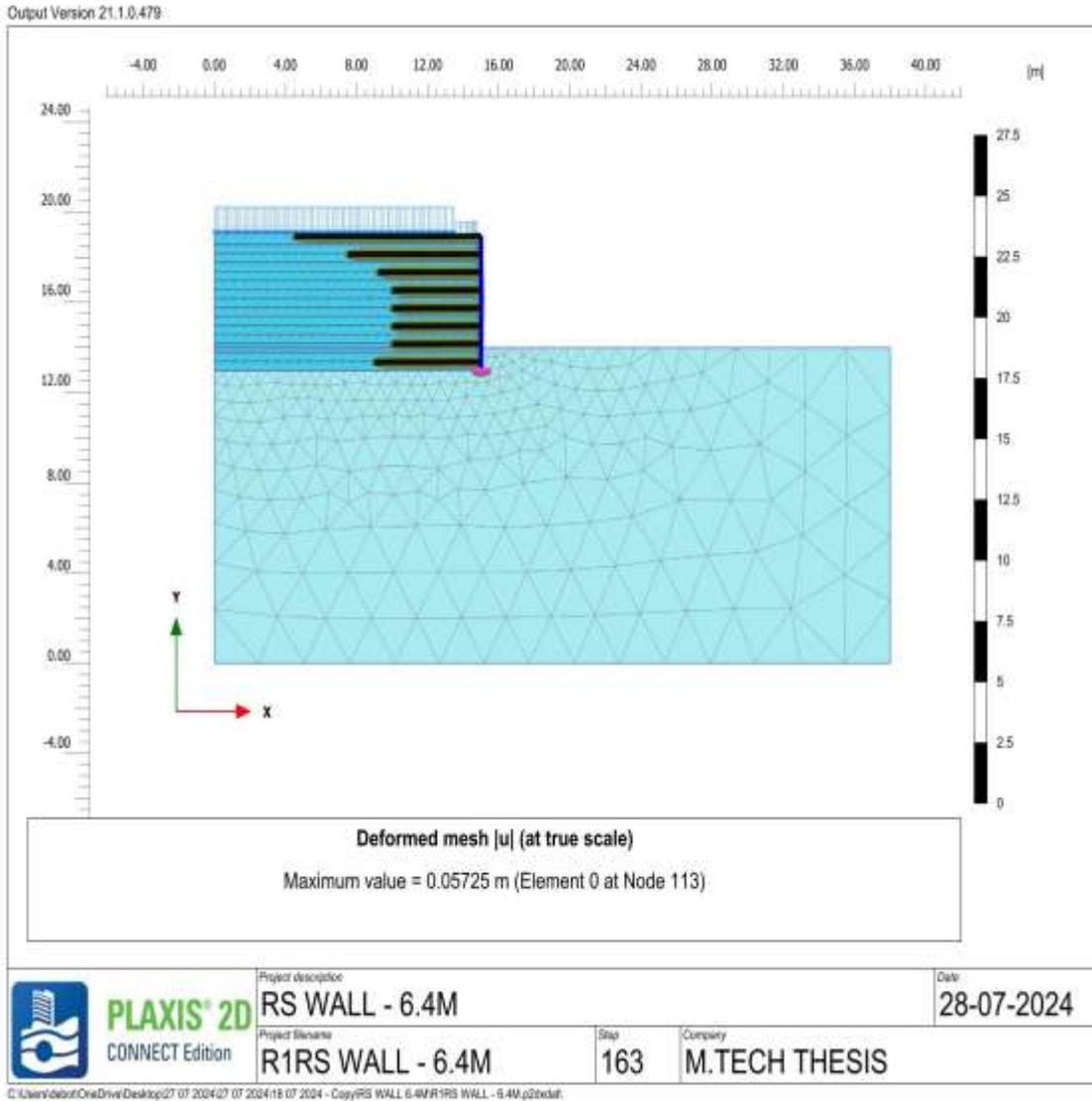


Figure 4.6 Deformed Mesh of 6.4m high RS Wall for analysis through PLAXIS 2D

c) Total Displacement

The total displacement of 6.4m height RS wall is shown in Figure 4.7.

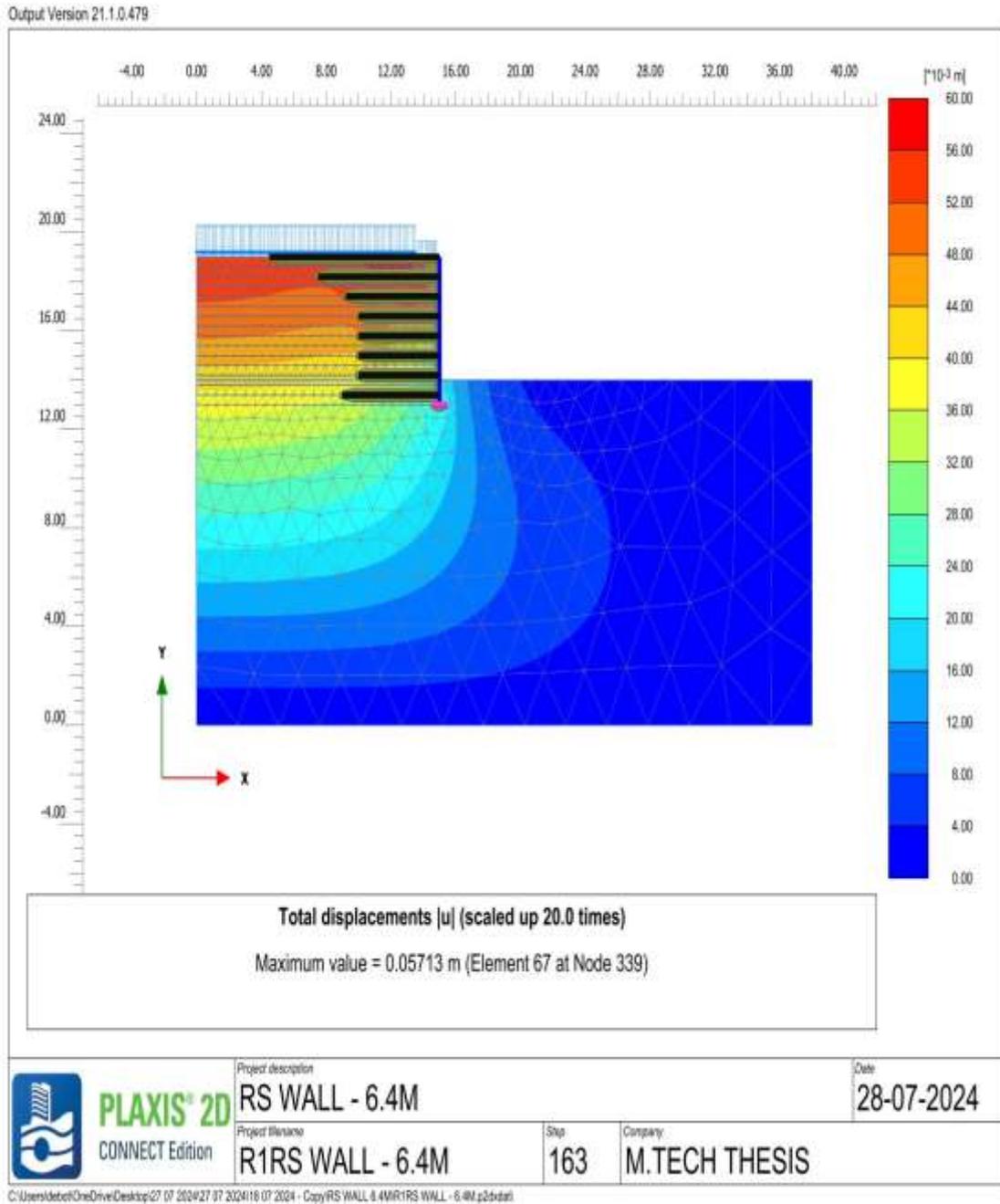


Figure 4.7 Total displacements of 6.4m high RS Wall out of analysis by PLAXIS 2D

d) Factor of Safety

The factor of safety out of 6.4m high RS Wall = 2.124 as per the graph shown in Figure 8.

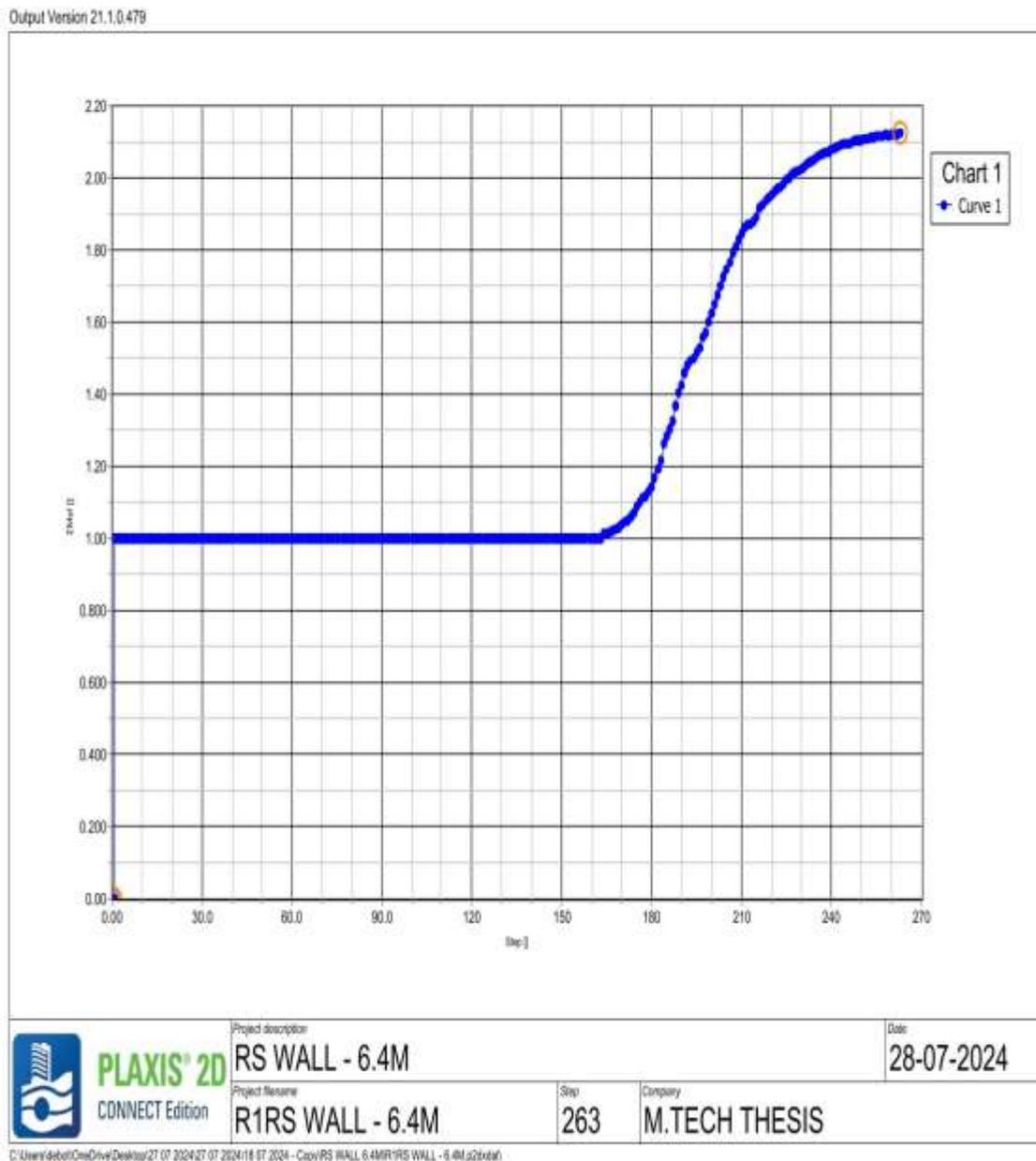


Figure 4.8 Factor of safety of 6.4m high RS Wall out of analysis by PLAXIS 2D

E. Summary of Results out of LEM and FEM

The results of analysis have been provided in this chapter. In this section, the summary of results of designing of Reinforced Soil Wall through various methods have been summarized. The summary of results is provided below in Table 4.

Table 4 Summary of Results

RS WALL Height (m)	FACTOR OF SAFETY AGAINST BEARING CAPACITY		FACTOR OF SAFETY AGAINST GLOBAL STABILITY ANALYSIS				
	Manual Design		ReSSA Analysis		GEO5 Analysis		Numerical Analysis
	STATIC	SEISMIC	STATIC	SEISMIC	STATIC	SEISMIC	STATIC
6.4	2.103	2.625	1.57	1.50	1.56	1.26	2.124

V. Evaluation of behaviour of RS Wall

Overview

The Input and Output results of design of RS Wall have been provided. In this chapter, it has been evaluated the results and tried to form a regression equation out of the results. Out of Analysis and outcome of the Results, the comparison of the Test Results is given below.

Bearing Pressure *vis-à-vis* heights of RS Wall

For the Reinforced with parameters $c = 0.0 \text{ kg/cm}^2$, $\phi = 29.5^\circ$, $\gamma = 21.5 \text{ kN/m}^3$

The following Figure 5.1 has been plotted out of the results of Bearing Pressure with respect to various Height of RS Wall and property values of the Reinforced Soil.

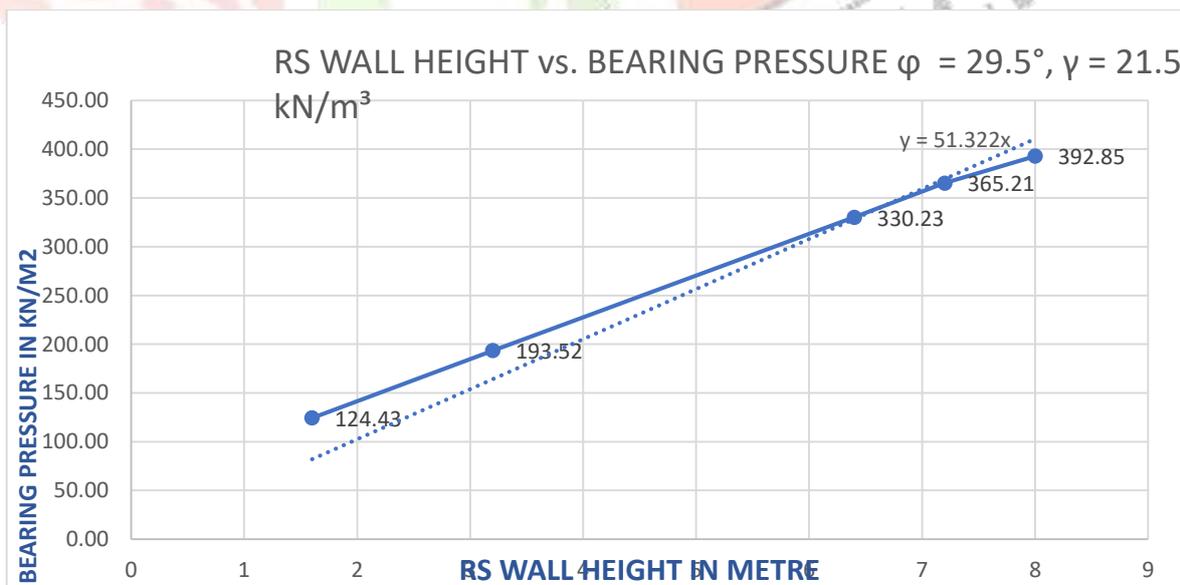


Figure 5.1 RS Wall Height vs. Bearing Pressure

Bearing Pressure *vis-à-vis* unit weight of RS Wall

The variations of Bearing Pressure with respect to Unit weight is given below in Figure 5.2.

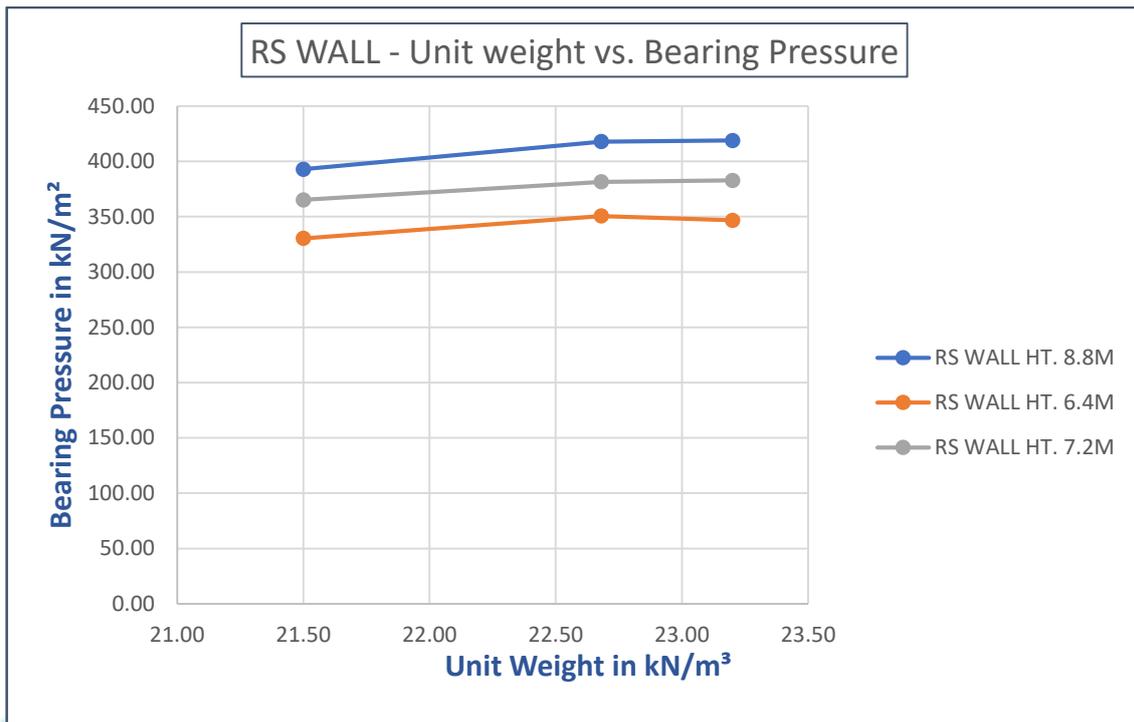


Figure 5.2 RS Wall Height vs. Bearing Pressure

Reinforcement Length w.r.t RS Wall heights

RS Wall has been designed through LEM process. For a particular design height of RS Wall, the length of Geosynthetic Reinforcement varies. The average length of the Reinforcement for a particular height of RS Wall has been considered. There are other factors that also influence the Reinforcement length. In most of the cases, Reinforcement length increases with respect to Height of RS Wall.

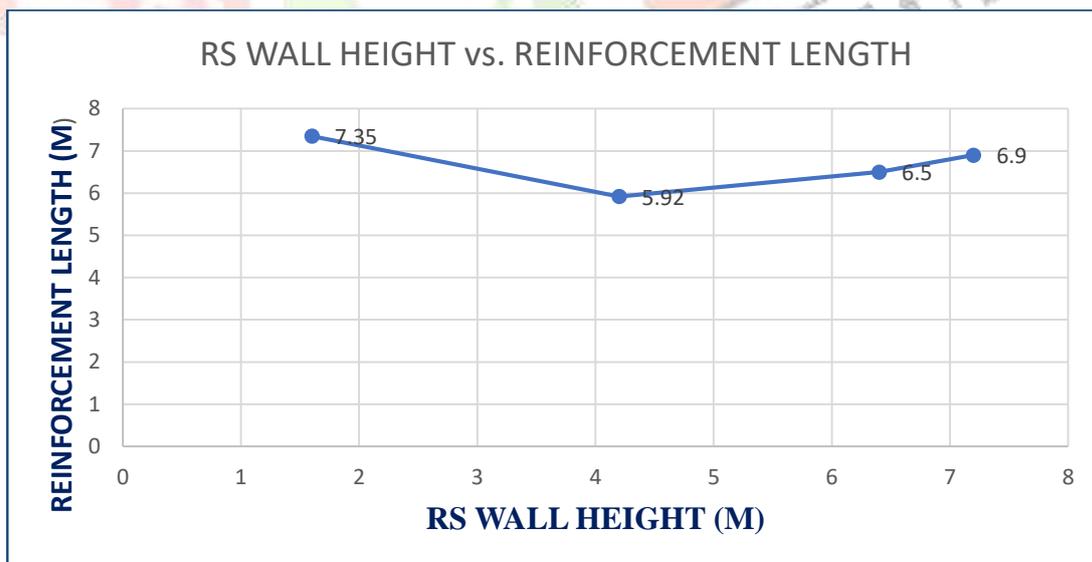


Figure 5.3 RS Wall Height vs. Reinforcement length

From the Figure 11, it appears the requirement of average length of the reinforcement decreases by 5.51% for increase of 1m height of RS Wall considering the standard loading conditions and economy of the project. The reason of decrease of reinforcement length with increase of height from 6.4m to 7.2m and its further increase with increase of height up to 8m may be attributed because of adherence factor, concentration of loading at edges and abrupt increase or decrease of reinforcement length in design.

Reinforcement Grade w.r.t RS Wall heights

RS Wall has been designed through LEM process. For a particular design height of RS Wall, the Grade of Geosynthetic Reinforcement varies. The average Grade of the Reinforcement for a particular height of RS Wall has been considered. There are other factors that also influence the Reinforcement grades. In most of the cases, Reinforcement Grade increases with the increase in height of RS Wall.

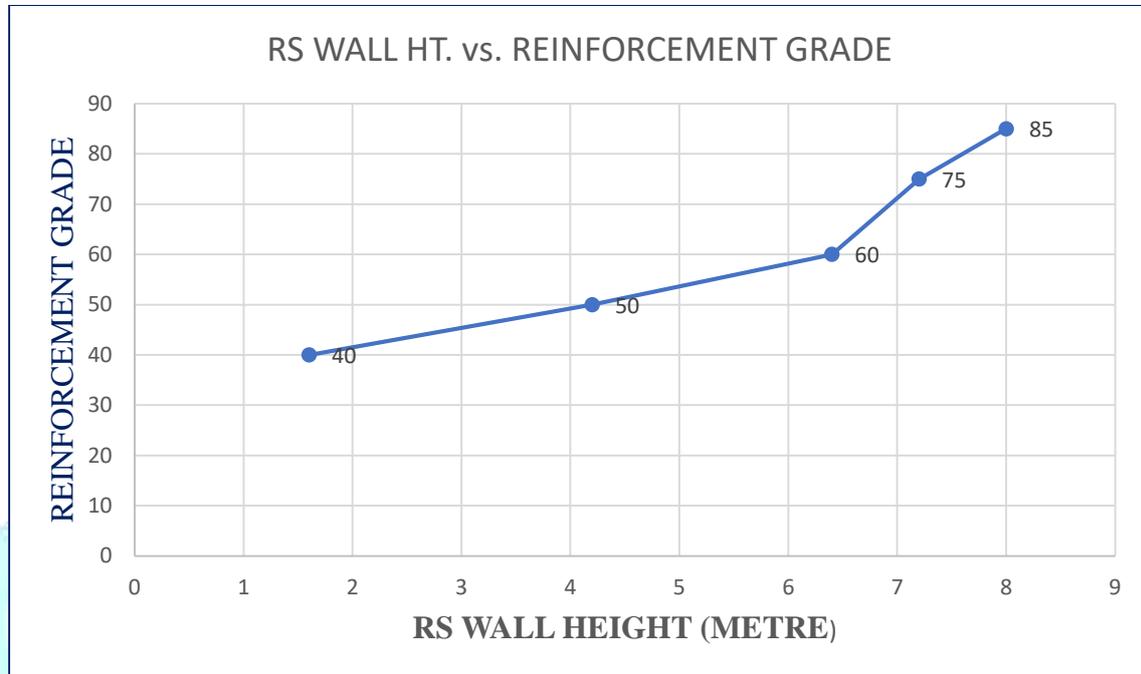


Figure 5.4 RS Wall Height vs. Reinforcement Grade

In this Figure 12, it shows that the Reinforcement grade increases with respect to the height of Wall. The reinforcement grade increases because of increase in heights of RS Wall. It appears the requirement of reinforcement grade increases by 15.63% for 1m increase in height of RS Wall.

Factor of Safety against Global Stability

The Factor of Safety against Global Stability with the Software for the following conditions has been calculated and found as below.

- i. ReSSA SOFTWARE - FOR BOTH STATIC & SEISMIC CONDITIONS.
- ii. GEO5 SOFTWARE - FOR BOTH STATIC & SEISMIC CONDITIONS.
- iii. PLAXIS 2D ULTIMATE – STATIC CONDITION.

The results of the Global Stability analysis are as below.

Table 5.1 Factor of Safety against Global Stability

RS WALL HEIGHT (M)	ReSSA		GEO5		PLAXIS 2D	
	STATIC	SEISMIC	STATIC	SEISMIC	STATIC	SEISMIC
6.4	1.57	1.50	1.56	1.26	2.124	-
7.2	1.51	1.45	1.69	1.45	1.993	
8.0	1.45	1.40	1.61	1.35	1.922	

The data have been plotted the data in the Graph in Figure 6.8 and Figure 6.9.

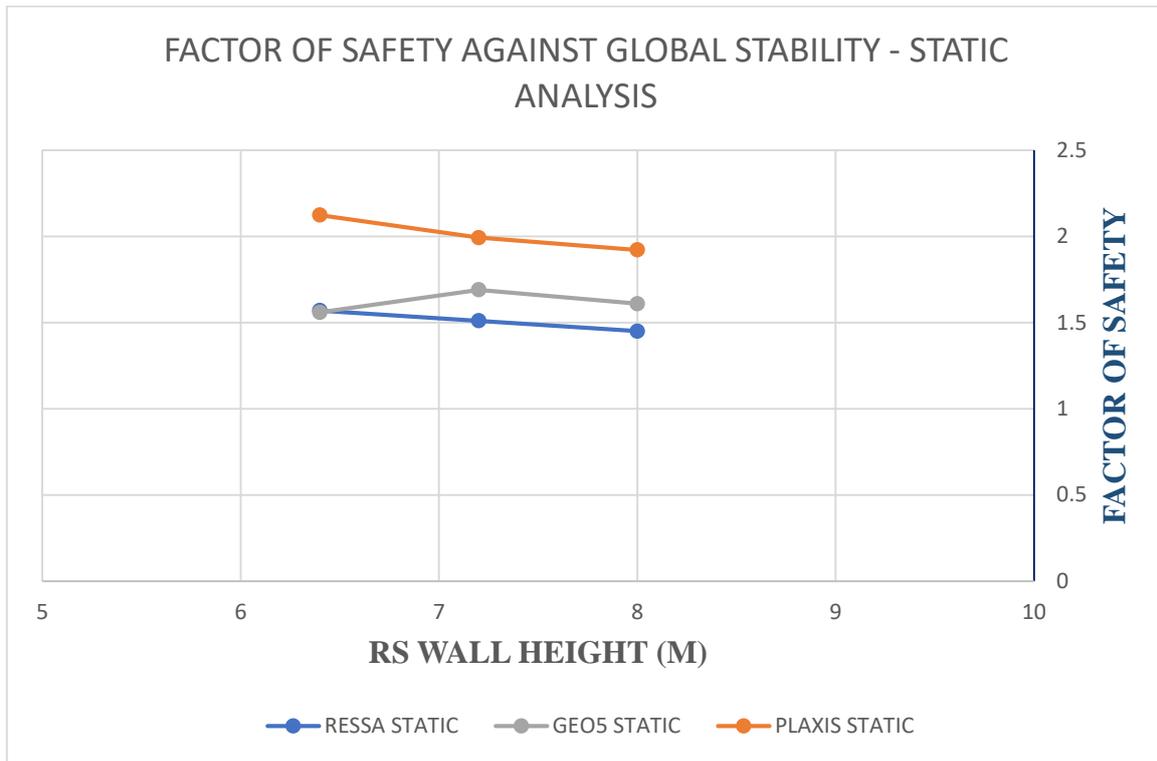


Figure 13 Static Condition – Factor of Safety with respect to RS Wall height

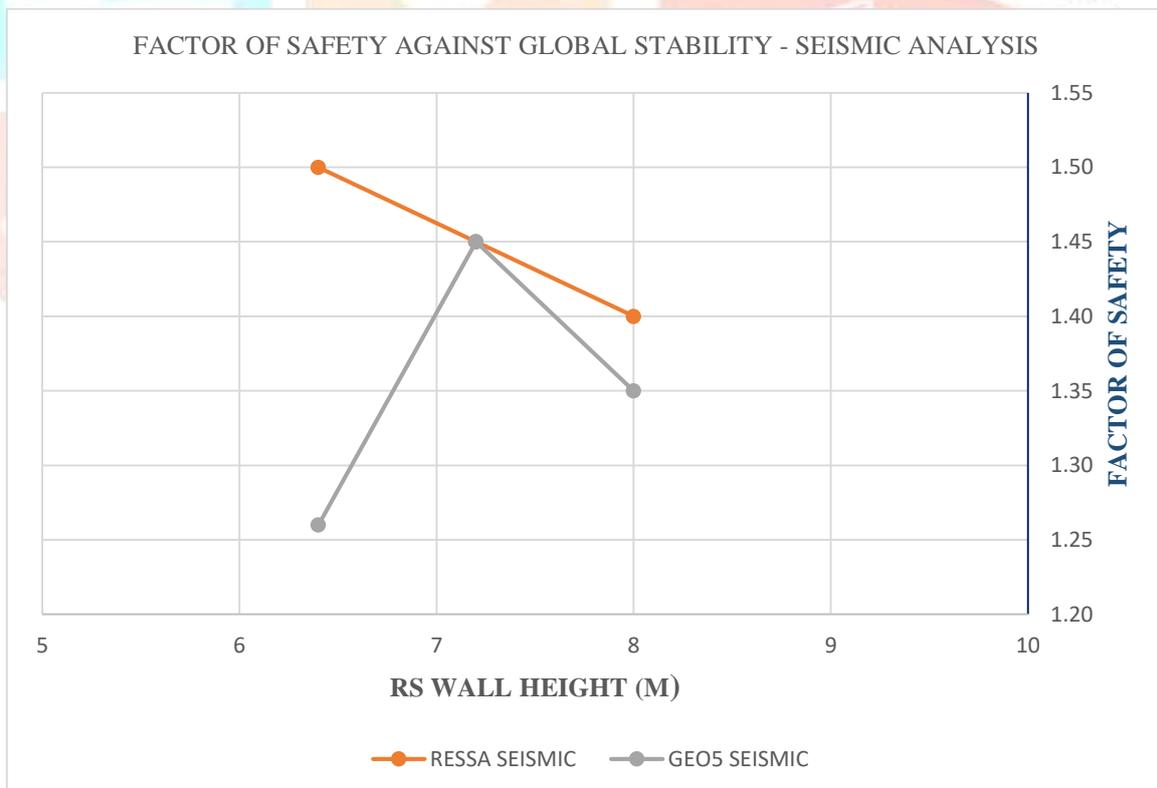


Figure 14 Seismic Condition – Factor of Safety w.r.t RS Wall height

From the Figure 14, it appears that there has been an average trend of decreasing Factor of Safety with the increase in height for both the static and seismic conditions. The FS decreases by about 10% considering analysis of these 3 heights. Reasons may be increase in load due to increase in height. It is to be noted here that Global stability depends on both Structural stability and Subsoil conditions.

V. SUMMARY, CONCLUSIONS AND LIMITATIONS

SUMMARY

In the present research, an attempt has been made to carry out analysis of Reinforced Soil Structure (RS Wall). The design of RS Wall has been chosen as it is popular and widely used in the infrastructural growth in the field of Highways. The analysis has been done through Limit Equilibrium method (LEM) and Finite element method (FEM). In the LEM, analysis through ReSSA software and Geo structural analysis GEO5 (Version v16) Software have been done; and in FEM, the analysis has also been conducted through PLAXIS 2D (version V21). Compilation of results have been done along with a parametric study to have an insight into the behaviour of RS wall.

CONCLUSIONS

The following conclusions may be drawn from the present study:

1. Bearing Pressure of Reinforced Soil Wall increases as the height of RS Wall increases. It happens because of more pressure come to the base of the wall for the increase in height. For 1m increase in height of RS Wall, bearing pressure increases by about 12%.
2. If the unit weight of Reinforced fill increases, then Bearing Pressure increases. With the increase in unit weight by 1 kN/m^3 , Bearing Pressure increases by 4.94%.
3. The requirement of average length of the reinforcement decreases by 5.51% for increase of 1m height of RS Wall considering the standard loading conditions and economy of the project. Although, in general, Reinforcement increases with the increase in height of RS Wall.
4. Requirement of Grade increases by 15.63% for 1m increase in height of RS Wall as per the present study and considering these three heights., unit weights etc.
5. The Bearing Capacity increases with respect to Angle of Friction values (ϕ) of the subsoil. With the increase in the angle of friction by about 1° , the bearing capacity increases by 15.71%.
6. The PLAXIS 2D (version - V21) overestimates Factor of Safety (FOS) in comparison to both ReSSA and GEO5. The FS decreases with the increase in height.

LIMITATIONS

The present study has some limitations. The limitations are presented below.

1. The design of Reinforced Soil Wall has been done through Software only and not by field or laboratory study.
2. Only three heights (6.4m, 7.2m and 8.0m) of Reinforced Soil Wall have been considered in the present study.
3. Only typical soil properties and properties of geotextile have been considered.

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