

# Design and Analysis of Lateral Earth Pressure Effect on Cantilever Retaining Wall

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**ABSTRACT:** Retaining walls provide support for vertical or near vertical grade changes, while also preventing erosion or down slope movement. The backfill is usually associated with an amount of surface strip load, thereby creating lateral pressure which acts onto the non yielding retaining wall. The purpose of this report is to calculate the lateral earth pressures and how stability of a retaining structure is influenced by these pressures. Calculations are made which will involve Rankine earth pressure theory. Rankine's theory is then taken further to investigate the bearing, sliding and overturning with various soil foundation and backfill material.. Various models of the structures have been created using staad.pro software. All analysis and design are based on the ACI code

**KEYWORDS:** Retaining wall, Lateral earth pressure, Overturning, Sliding, Soil bearing capacity.

## I.INTRODUCTION

The concrete cantilever retaining wall can be defined as a construction of reinforced concrete to support backfill soil by cantilever action. The base slab serves as a permanent support and prevents against overturning and sliding. The cantilevered stem portion is rigid at the bottom and is free at the top. The walls will provide long-standing stability and serviceability.

Retaining walls are structures that are used to retain earth (or any other material) in a position where the ground level changes abruptly. They can be of many types such as gravity wall, cantilever wall, counterfort wall and buttress wall among others. The lateral force due to earth pressure is the main force that acts on the retaining wall which has the tendency to bend, slide and overturn it. The present research focuses on designing the cantilever type of wall for overturning, sliding and bearing. The main considerations are the external stability of the section with the help of codal provision i.e ACI Satisfying the external stability criteria is primarily based on the section giving the required factor of safety. The ratio of resisting forces to the disturbing forces is the factor of safety, and this factor of safety should always be greater than unity for the structure to be safe against failure with respect to that particular criteria. Different modes of failure have different factors of safety. In this paper stability check for a cantilever wall is obtained using a computer program that calculates various sections satisfying the stability criteria, according to the height and properties of earth that the wall is required to support.

## II.OBJECTIVES OF THE STUDY

In subsequent report comparison of structural analysis of cantilever retaining wall along with different height are studied in detail:

- To calculate the lateral earth pressures and how stability of a retaining structure is influenced by these pressures.

- To compare displacement of retaining wall with different height using staad pro.
- To compare principal stresses of retaining wall with different height.

### III. METHODOLOGY

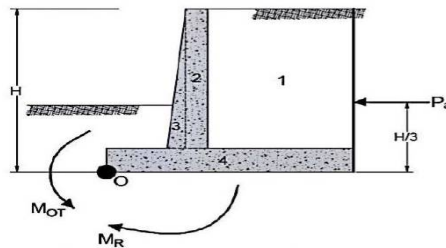
#### 3.1 LATERAL EARTH PRESSURE:

Lateral earth pressure is the force exerted by the soil mass upon an earth-retaining structure, such as a retaining wall. Proper design and construction of these structures require a thorough knowledge of the lateral forces that act between the retaining structures and the soil masses being retained. These lateral forces are caused by lateral earth pressure. The three categories of lateral earth pressure:

- At rest earth pressure
- Active earth pressure
- Passive earth pressure

#### 3.2 STABILITY CHECK BY USING RANKINE'S THEORY:

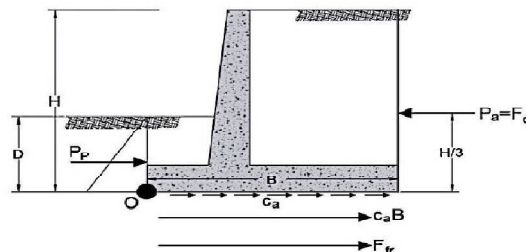
##### 3.2.1 STABILITY FOR OVERTURNING :



The **horizontal** component of active force will causes overturning on retaining wall about point O by moment called “overturning moment”

$$FSOT = MR / MOT \geq 2$$

##### 3.2.2 STABILITY FOR SLIDING ALONG THE BASE :



The force of resistance, F is given by

$$F = \mu \Sigma W$$

The factor of safety F2 due to sliding is given by

$$F = \mu \Sigma W / H$$

Where  $H = Pa$

##### 3.2.3 CHECK STABILITY FOR BEARING CAPACITY FAILURE:

The various forces acting on the wall

$$M_O = M_R - M_{OT}$$

$$X = (M_R - M_{OT}) / \Sigma V$$

Hence eccentricity :

$$e = B/2 - x$$

$$q_{max} = \Sigma V/B \times (1 + 6e/B)$$

$$q_{min} = \Sigma V/B \times (1 - 6e/B)$$

The factor of safety :

$$F = q_u / q_{max} \geq 3$$

### VI. MODELLING

FIG.4.1- Major Principal stress

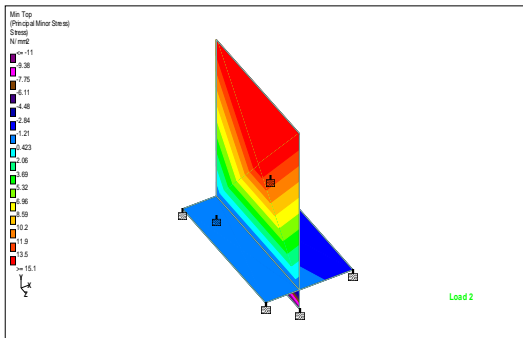


FIG.4.2- Minor principal stress

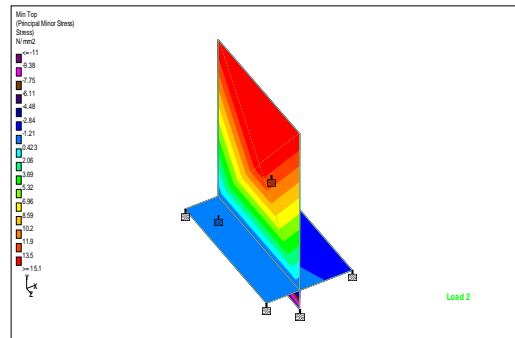
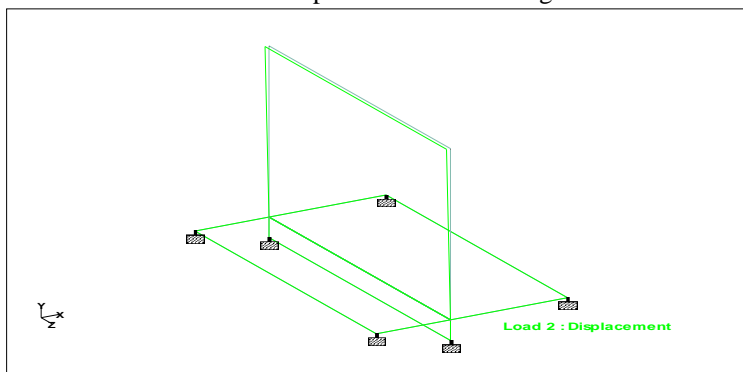


FIG4.3-Displacement of retaining wall



**V.RESULTS AND DISCUSSIONS**

The comparison of factor of safety for bearing, sliding and overturning for different height of retaining wall with various soil foundation and backfill material. The values are tabulated given below:

**Table .1 Factor of safety for bearing, sliding and overturning**

Case	Height	Foundation soil	Backfill soil	FOS Bearing	FOS Sliding	FOS Overturning
1	2.5	Clay	Clay	15.35	1.53	20.21
2	5	Clay	Clay	13.59	1.84	22.58
3	7.5	Clay	Clay	11.39	1.89	26.54
4	10	Clay	Clay	9.77	2.31	30.88
5	2.5	Clay	Sand	25.46	1.45	16.37
6	5	Clay	Sand	17.76	1.60	16.60
7	7.5	Clay	Sand	14.06	1.68	18.56
8	10	Clay	Sand	11.82	2.18	20.95
9	2.5	Clay	Gravel	25.29	2.70	5.52
10	5	Clay	Gravel	19.67	1.35	3.51
11	7.5	Clay	Gravel	22.07	1.67	2.88
12	10	Clay	Gravel	30.75	1.83	2.57

The results from Table 1 details that the FoS for bearing is largest when founded on soils with low soil friction angles, it is clear that the soils lack the ability to prevent sliding. It is clear that the soils resisting moments are greater than the overturning moments. It's noticed that cohesive materials have a considerably larger overturning factor of safety; this is due to a dramatic reduction in lateral thrust due to their shear strength parameters.

**COMPARISON OF PRINCIPAL STRESS:**

FIG5.1-Major principal stress for various backfill soil

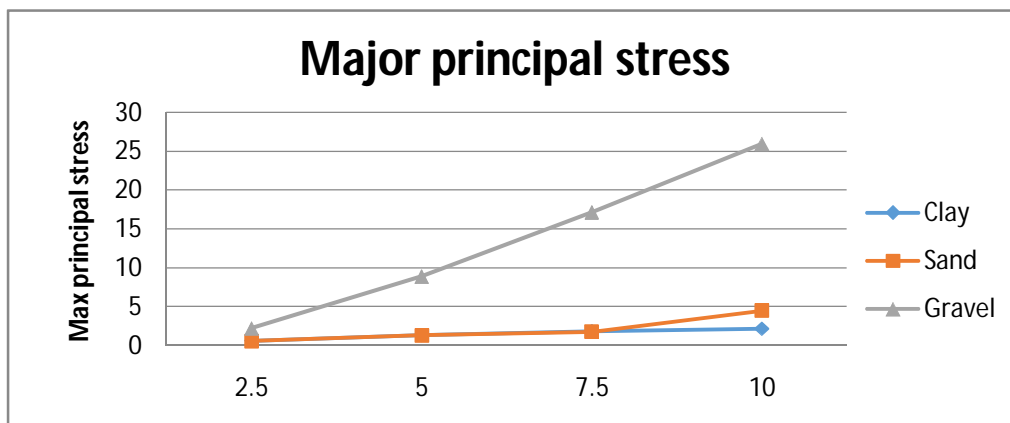


FIG5.1-Minor principal stress for various backfill soil

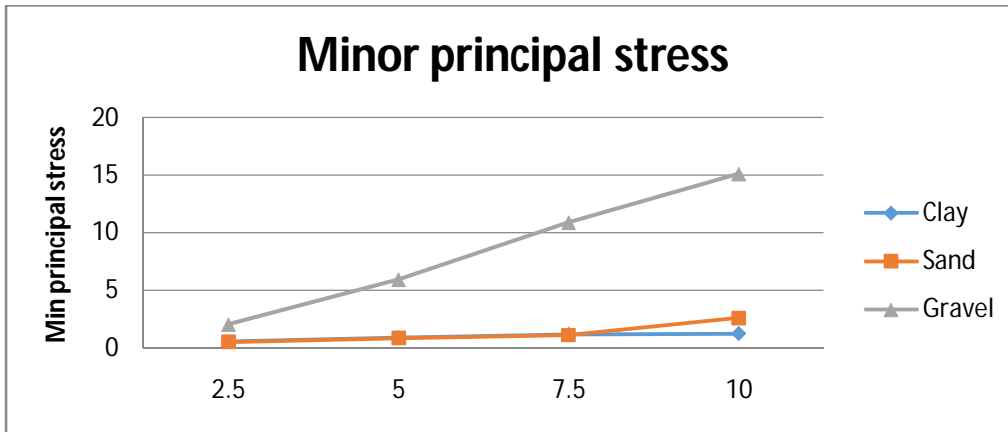
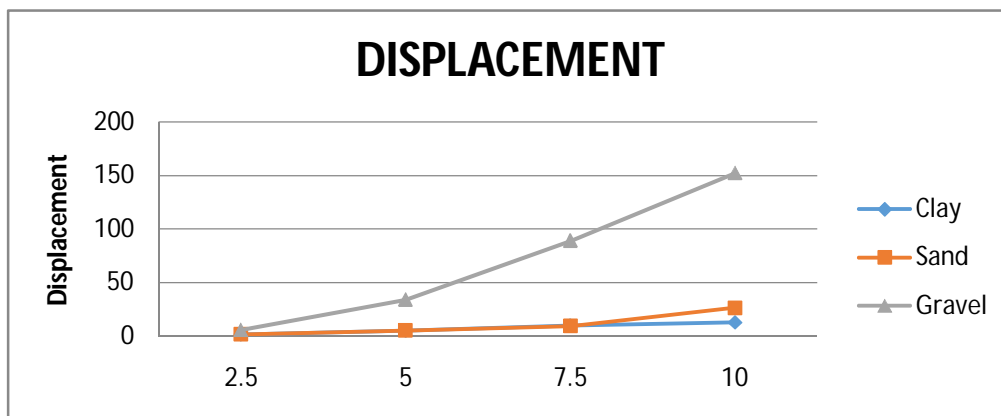


FIG5.1-Graph of displacement for various backfill soil



## VI. CONCLUSION

The analysis & computing are done for many sections that satisfy the check conditions and displaying the dimension of the corresponding section and the steel requirement in these sections. In this study of earth pressures, it's been concluded that shear strength parameters (cohesion and friction angle) of the soil are significant parameters affecting lateral pressures. As a result, an increase in the shear strength parameter results in a significant decrease in the total lateral thrust. The variations in the aforementioned parameter is studied by varying the following parameters, viz, Soil type (Clay,Sand,Gravel) and Height of the cantilever retaining wall (2.5m, 5m,7.5m& 10m). The calculated FOS for bearing is largest when founded on soils with low soil friction angles, it is clear that the soils lack the ability to prevent sliding, it is clear that the soils resisting moments are greater than the overturning moments. The displacement is greater when low soil friction angle.The calculated factor of safety can be used in designing a retaining wall efficiently.

**International Journal of Innovative Research in Science, Engineering and Technology**

*An ISO 3297: 2007 Certified Organization*

*Volume 7, Special Issue 5, April 2018*

**1<sup>st</sup> International Conference on Recent Innovation in Civil Engineering and Management (ICRICEM '18)**

**22<sup>nd</sup> March 2018**

**Organized by**

**Department of Civil Engineering & MBA, Loyola Institute of Technology, Chennai, Tamilnadu, India**

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