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"ECONOMICAL DESIGN OF LOFT RETAINIG WALL"

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Abstract

A cantilever retaining wall is a structure commonly used in civil engineering to retain soil and other materials. Its design involves a horizontal base, called the footing, and a vertical wall extending above the ground. The wall is typically thicker at the base and tapers towards the top, providing stability against the pressure exerted by the retained material. It has been observed that use of loft considered for alleviate the magnitude of earth pressure itself at the back of retaining wall and the factor of safety against sliding as well as overturning improved. Looking towards the present scenario an attempt has been made. To examine the reduction in quantities of construction material in the retaining wall. Cantilever retaining wall with and without lofts cohesion less backfill of constant height considered for analysis. Various sections of retaining wall with and without loft has been evaluated and designed. Work has been carried out at the different sections and many comparisons has been made on the construction material. This comparison clearly indicates a considerable reduction in quantities. The overall effect will result in reduction in the cost of retaining wall structure. In this case details are made to analyse and the remarks indicating reduction in quantities of these kind of materials by providing provisions of loft at back of retaining wall.

INDEX TERM:- CANTILEVER, LOFT, RETAINING WALL, OVERTURING, AGAIST SLIDING, FACTOR OF SAFETY.

1. INTRODUCTION

A retaining wall is a structure designed to hold back soil or other materials and prevent erosion or sliding. It's commonly used in landscaping, construction, and civil engineering to create level areas on sloped terrain or to prevent soil movement. Retaining walls can be made from various materials such as concrete, stone, brick, or timber, and they come in different designs and styles to suit different purposes and aesthetic preferences. Retaining walls are the structures used for supporting soil laterally so that it can be retained at different levels. To design retaining walls it is necessary to calculate active and passive earth pressure on wall.

This paper deals with two types of reinforced concrete retaining walls namely:

1) Cantilever retaining wall: A Cantilever structure is used by a cantilever retaining wall to withstand the lateral pressure of the earth behind it. Usually made of reinforced concrete, the wall is composed of three slabs : a horizontal slab , a vertical stem, and a horizontal top slab . A Heel at the bottom and a toe at the top of the wall connect the base and top slabs.

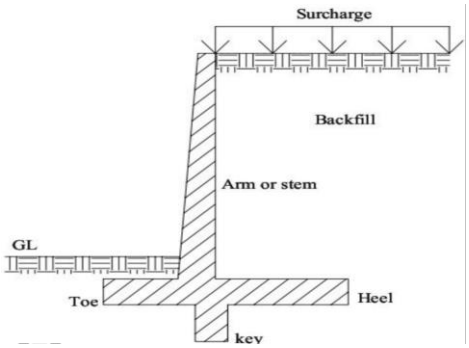
2) Retaining wall with loft: The concept of providing pressure relief platform toward the backfill side of retaining wall reduce the earth pressure on the wall which make the pressure diagram discontinuous at the level of platform which result in reducing the thickness of wall and ultimately to get an economic design.

2. LITERATURE REVIEW

Ghazavi and Heidarpur, (2003), presented Optimization of cantilever retaining walls. They present an optimization algorithm for the design of reinforced concrete cantilever retaining walls. A special efficient program has been developed for this purpose. In the analysis, the geometry of the wall was optimized and compare with the recommended values. It will be shown that optimization of counterfort retaining wall can reduce the cost involved.

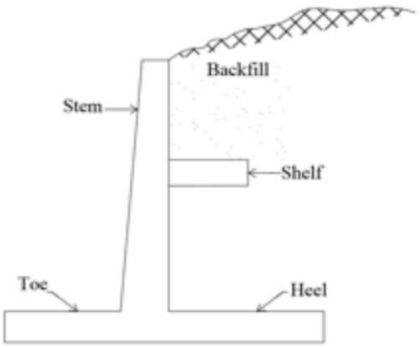
Patil et al., (2015), have been Designed and detailing of cantilever retaining walls for construction site. They observed that changing spacing of counter fort of retaining wall results that reduction in thickness of heel slab and stem wall. They also worked out for optimum spacing of cantilever at height of 7.0 m, 8.0 m, 9.0 m is observed at 2.50 m spacing.

Dhamdhere, (2018), have worked for optimal solution. He has chosen optimal cost as best solution. He fixed base width



and other dimensions of retaining wall then performed stability check and determined minimum and maximum bearing pressure and then accordingly designed all portions of retaining wall. He has taken reliving platform length equal to heel slab length and reliving platform's length is considered one fourth of base slab thickness. At mid height of retaining wall, location of reliving platform considered. Then after design and analysis he estimated quantity and worked out costing. He compared the costing of cantilever retaining wall and retaining wall with reliving platform.

Diwalkar, (2020), selected various retaining wall's shape by performing preliminarycalculations. As conducted finite element Analysis, for that he used PLAXIS and considered twoways of construction first one is Backfilling after the wall construction and other is backfilling parallel to wall construction. She selected three different shapes with constant height and cross-sectional area. She used trial method to adopt stable section as per BS 8002. She estimated exerted force on retaining wall first by using Coulomb's method of analyze and wedge
method.



3. OBJECTIVES

In order to analyse loft retaining wall, following objectives were considered:

1. To analyse and design R.C.C retaining wall with loft.
2. To study characteristics of earth pressure of loft retaining wall.
3. To study the effect of provision of single loft at different heights i.e. Hs/2, Hs/3, 2Hs/3, 5Hs/3.

4. To study the effect of width and number of lofts in retaining wall.
6. To analyse the cost for retaining wall with and without lofts

4. DESIGN OF RETAINING WALLS

For the designing of retaining wall all the necessary parameters are intended and possible outcomes are generated. The total overview and calculation are taken and intending all parameters involving cost, risk and uncertainties involved. In design of retaining wall, Rankine's theory is used for calculation of lateral earth pressure.

The following steps are included for the design of retaining wall:

1. Base width fixation and other wall dimensions
2. Checking stability and calculation of maximum and minimum bearing pressure
3. Design of various parts like stem, toe slab, hill slab, loft.

Table 1: Parameters of Retaining Wall

Sr. No.	Types of Retaining wall	Parameter
1	Cantilever retaining Wall	H = 20m $\phi = 30^0$ $\gamma = 18$ KN/m^3
2	Cantilever retaining wall with loft	

5. STABILITY CHECKS

The following stability checks are used in the design of retaining wall:

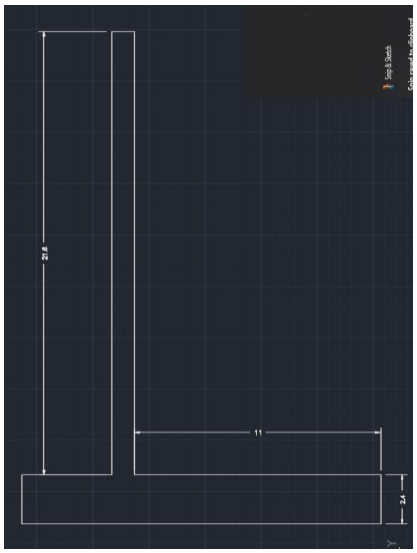
1. Factor of saftey against sliding is taken greater than 1.55.
2. Factor of saftey against overturning is also taken greater than 1.55.
3. Eccentricity of the resultant reaction force should lie between 0 and base width/6.

6. FORMULA FOR OPTIMAL COST DESIGN

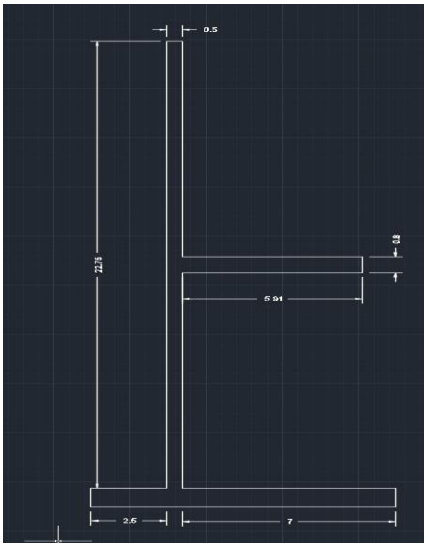
As mentioned in the objective, the design with the absolute cost is chosen as the best solution, the formula involved in calculation of the optimal cost is given below:

Optimal Cost = (Volume of concrete * Cost of concrete per m^3) + (Cost of reinforcement)

7. AUTO CAD DRAWING AND MODEL



(1) Cantilever retaining wall



(2) Cantilever retaining wall with loft

8.RESULT AND ANALYSIS

Analysis includes finding F.O.S for sliding, overturning (O.T) and calculation of concrete quantity per 1m run. Stability analysis is carried out for 2 types of retaining walls i.e., R.C.C Cantilever retaining wall and retaining wall with loft.

The theoretical calculation on stability of retaining walls are as shown below:

Table 2: Design Results of Retaining Walls with and without Loft

Types of Retaining Walls	Cantilever retaining wall	Cantilever retaining wall with loft
FOS of Overturning	3.563	2.27
FOS of Sliding	1.786	2.14
Quantity of Concrete (m^3)	667.68	331.53
Rate (Rs.)	4500	5500
Per	m3	m3
Cost (Rs.)	3,003660	1823415

Table 3: Percentage Reduction of Earth Pressure in 20 m Retaining Wall

	20m	
	Earth Pressure KN/M²	% Reduction
Cantilever RW	1728	-
Cantilever RW with 1 loft	844.15	50.9
Cantilever RW with 2 lofts	563.66	67.23

Table 4: Analysis of Retaining Walls

Types of Retaining wall	Cantilever Retaining Wall	Cantilever Retaining Wall with Loft	
Height of Retaining Wall	20 m	20m	
Thickness of Loft (m)	-	0.8	
Number of Loft	-	1	2
Width of Loft (m)	-	5.91	5.91
Base width of RW (m)	16	10	8.5
Earth Pressure (KN/m^2)	1728	844.15	563.66
Mo (KN.m)	13824	8132.5	5749.2
FOS for overturning	3.56	2.27	2.32
FOS for sliding	1.78	2.14	2.73
Eccentricity	0.8447	1.31	1.07
q_{max} (KN/m^2)	244.1	597.62	588.68
q_{min} (KN/m^2)	244.1	71.74	82.01

8. CONCLUSIONS

From above study we concluded that:

1. The provision of single loft reduces the earth pressure by 50.97% while with two loft 67%.
2. As the number of lofts are increases, the earth pressure reduces & percentage reduction in earth pressure increases.
3. The provision of the loft to the wall leads to significant improvement in the stability of the retaining wall due to reduction in earth pressure.
4. The provision of single loft at Hs/2 produces minimum earth pressure.

5. The cost of RCC cantilever retaining wall with loft are economical than conventional retaining walls.

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