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ANALYSIS AND DESIGN OF A RETAINING WALL

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ABSTRACT

Retaining walls are structures that are used to provide stability for earth or materials where conditions prevent the materials from summing their nature as slope or stability. Many factors influence or work against the stability of retaining walls. These include the level of the water table behind the wall, the size of the wall's base, and the type of soil retained. The angle of internal content between the particles, cohesion, which is the bodily contact or binding of the soil particles, and the unit weight of the soil are all effects of the nature of soil. Reduced delays in road construction and quicker soil mass security on a mountainous hillside are the major goals of managing a standard proposal of retaining walls. A standard proposal can lead to speedier production and a safer workplace.

Keywords: *Retaining wall, cantilever retaining wall, relieving platform retaining wall, design and analysis.*

INTRODUCTION

A retaining wall is a building intended to support the ground behind it. It prevents a steep facing slope of an earth mass from rupturing in cuts and fills as well as from slipping downward. Structures are pushed by the retained material, which causes it to topple and slide. The lateral earth pressure is the primary dominant force for analysis and construction of the retaining wall in addition to the self-weight. The angle of internal friction, the cohesiveness of the retained material, the direction and amount of stem movement, as well as other factors, determine the lateral earth pressure behind the wall. It is often triangular in distribution, growing toward the bottom of the wall and decreasing at the top. [1] If not addressed properly, the earth pressure could push the wall forward or overturn it. Retaining walls are encountered and built in a variety of engineering fields, including roads, harbours, dams, subways, railroads, tunnels, mines, and military fortifications.

A retaining wall is a type of assembly designed to withstand the pressure of the terrain beneath it. It prevents a landmass abrupt-faced slant from tearing and aids in the resistance of the retained material slithering downward, which applies propel on the assembly, causing it to overturn and slide down. [2] Apart from one's own weight, lateral earth restriction is the most frequently encountered force in retaining wall studies. Lateral earth pressure describes the horizontal restraint imposed by the soil. The lateral earth strain is determined by the speed and direction of root motion, the angle of inner rubbing, and the tenacious hardness of the retained material. It typically has a triangle distribution, with the lowest concentration at the top and the largest concentration at the bottom of the wall. Failure will result from the earth restriction pushing the wall upward and causing it to topple. [3]

The type of wall that will be used is determined by the facts of each case. Before deciding on the best solution, soil type, slope angle, groundwater characteristics, and other factors will be considered. The main force acting on the retaining wall, which has a tendency to bend, slide, and overturn, is the lateral force caused by earth pressure. The current thesis is concerned with stability analysis and the design of a counterfort type of wall. The main considerations are the section's external stability and compliance with IS 456:2000 recommendations. [4] Satisfying the external stability criteria is primarily determined by the section that provides the required factor of safety. The factor of safety is the ratio of resisting forces to disturbing forces, and this factor of safety should always be greater than unity for the structure to be safe against failure with respect to that specific criterion. Different modes of failure have different safety factors.

CANTILEVER RETAINING WALL

A cantilever retaining wall is the most common type of terrain-retaining assembly. The main goal of this research is to optimise the requirements of retaining walls such as tension reinforcement, cross sectional area, and economy under different loading conditions. In this study, two different models have been analysed for various loading conditions (Cantilever retaining wall and Relieving platform retaining wall) at different heights, and the horizontal compulsion at the back of the wall is converted to vertical compulsion on the deck by these walls. The wall is made up of a sufficiently thin stem and base slab. These barriers are constructed using the theory of leverage. [5] The heel and toe portions are the separated parts of the base slab. The heel is the area of the foundation beneath the backfill. The bottom segment is the toe.

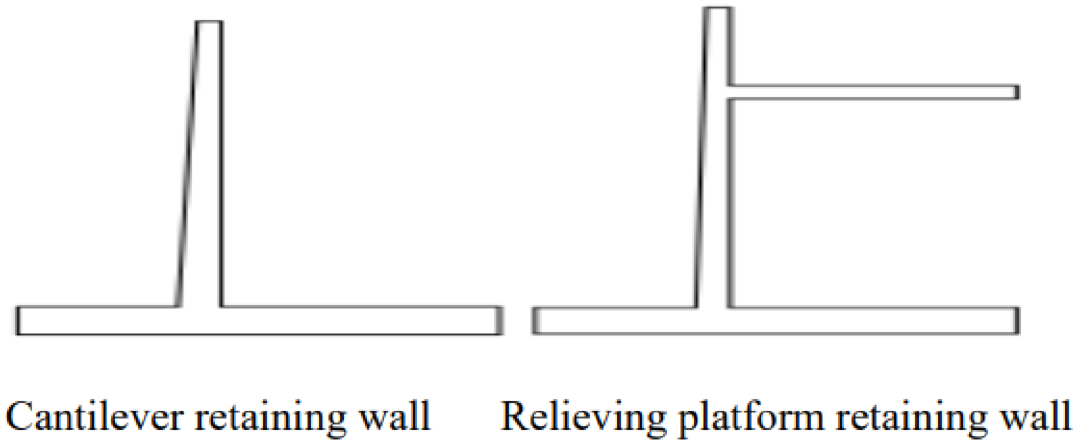

Fig. 1 Types of retaining walls

RETAINING WALL WITH RELIEVING PLATFORM

This is a modified version of a cantilever retaining wall. A relieving plate is attached to the stem. Depending on the design requirements, there could be one or more platforms. The idea behind having a relieving platform on the backfill margin of the partition wall is to reduce overall earth pressure on the retaining wall, which reduces the broadness of the partition wall and allows for a more cost-effective design with less BM (bending moment). [6] As a result, it is critical to investigate this type of retaining wall in order to evaluate its performance.

REVIEW OF LITERATURE

Mikio Futaki and Osamu SakaguchiI (1992): The experimental study on a real scale cantilever retaining wall for seismic loadings was the subject of this paper. Soil-Structure Interaction has been studied using a model test in this paper. The purpose of this paper is to investigate the safety and evaluate the force acting on the wall due to seismic loadings.

OBJECTIVES

• Investigate the behaviour of various retaining wall components under different loading conditions and at different heights.
• Create a stable and cost-effective retaining wall.
• Investigate and optimise the various design outputs.
• Cost optimization of both types of retaining walls and recommendation of the best option for a given height.

RESEARCH METHODOLOGY

A research methodology is a universal approach to addressing a study subject through data collection, data evaluation, and study results. A research technique is a strategy for conducting a research study. Research is the systematic gathering and analysis of facts and information for the advancement of knowledge in any field. The study's goal is to use systematic techniques to solve intellectual and practical problems. "Scholarly inquiry or investigation; specifically, inquiry or experimentation directed at the exploration and clarification of data, modification of existing techniques or laws in light of new facts, or practical application of such new or updated theories or laws," according to Webster's Collegiate Dictionary. Some people consider research to be a journey from the known to the unknown. A close reading and detailed analysis of secondary sources is required in order to apply the analytical and descriptive methods to the research. It is critical to obtain additional perspectives in order to expand on the textual analysis, which would necessitate close reading analysis of a few secondary materials.

RESULT AND DISCUSSION

The wedge is a retaining wall component that supports soil that extends beyond the failure plane of the soil type present at the retaining wall site. Once the soil friction angle has been determined, the wedge can be calculated. The size of the slithering wedge shrinks as the retaining wall setback increases, reducing the load on the retaining wall. The most important aspect of proper retaining wall design and construction is identifying and preventing the slithering down of retained substance due to gravity. [8] This causes earth constraint laterally at the back of the wall, which is measured by the internal abrasion angle, cohesive firmness of the retained substance, and the direction and magnitude of movement experienced by the retained material. In uniform terrain, the lateral earth constraint is zero at the assembly tip and increases proportionally to the highest value at the deepest depth. If the wall is not properly planned and built, the Earth constraint will force it laterally forward or topple it. [9] The hydrostatic constraint on the wall is caused by groundwater at the back of the wall that is not dissolute by seeping. For longitudinal spans of uniform elevation, the cumulative constraint or thrust is expected to operate at one-third of the lowest bed. Figures 2 and 3 show the shift in constraint distribution caused by the presence of a relieving platform. [10]

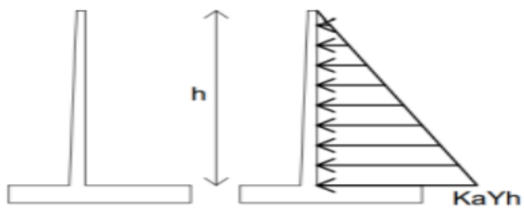

Fig. 2 Pressure distribution diagram of CRW

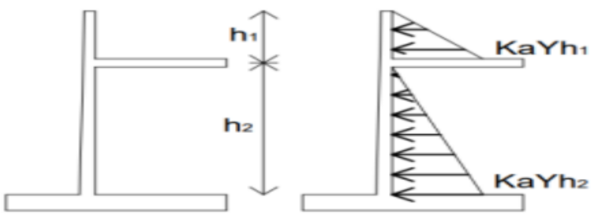

Fig. 3 Pressure distribution diagram of CRW with relieving platform

Table 1. Bending moment variation

height of retaining wall	Cantilever retaining wall bending moment(KN-m)			retaining wall with relieving platform bending moment(KN-m)			
	steam	heel	toe	steam	heel	toe	relieving platform
3	30.52	26.8	12.73	20.2	5.85	7.18	15.71
3.5	44.85	39.99	18.42	29.68	8.26	10.46	20.19
4	63.07	56.93	25.61	41.75	11.24	14.61	25.24
4.5	85.67	78.08	34.45	56.71	14.85	19.72	30.85
5	113.11	103.91	45.14	74.87	19.15	25.90	37.02
5.5	145.85	134.9	57.83	96.54	24.19	33.24	43.76
6	184.38	171.51	72.71	122.04	30.03	41.85	51.06
6.5	229.16	214.21	89.95	151.68	36.74	51.82	58.92
7	280.65	263.47	109.71	185.76	44.38	63.26	67.34
7.5	339.33	319.76	132.19	224.61	52.99	76.26	76.33
8	405.67	383.54	157.54	268.52	62.64	90.93	85.88
8.5	480.14	455.28	185.94	317.81	73.39	107.36	95.99
9	563.20	535.47	217.56	372.79	85.3	125.65	106.66
9.5	655.33	624.55	252.59	433.77	98.43	145.92	117.90
10	757.00	723	291.19	501.06	112.83	168.24	129.69

As can be seen, the bending moment for the heel and toe is less in the retaining wall with the relieving platform because the relieving wall relieves some BM. [11]

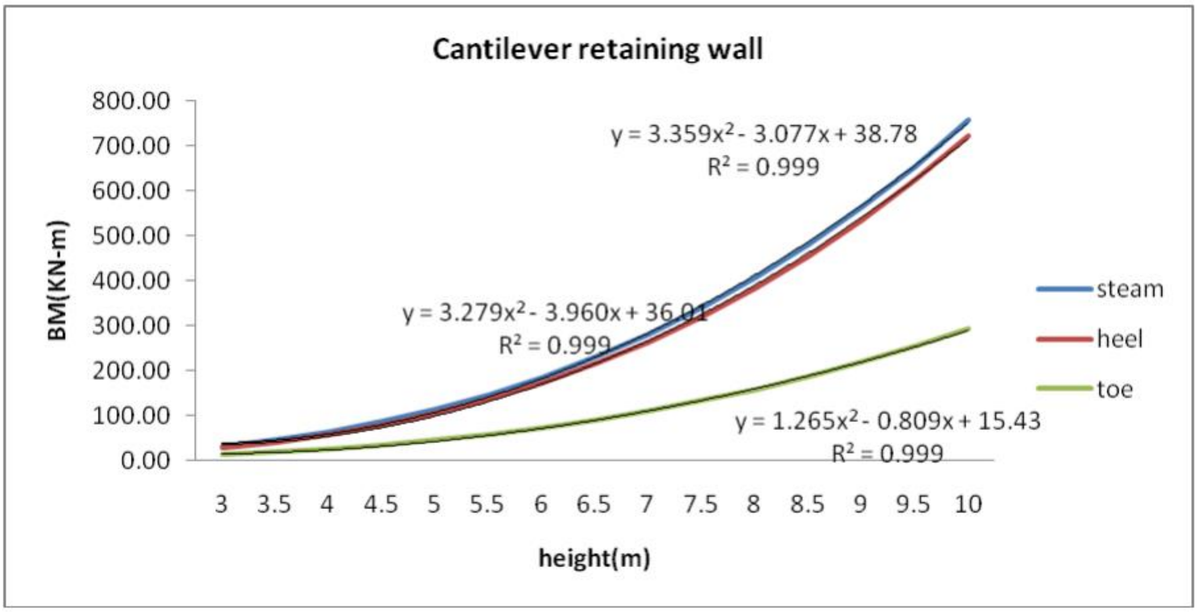

Fig. 4 BM vs. height of wall for cantilever retaining wall

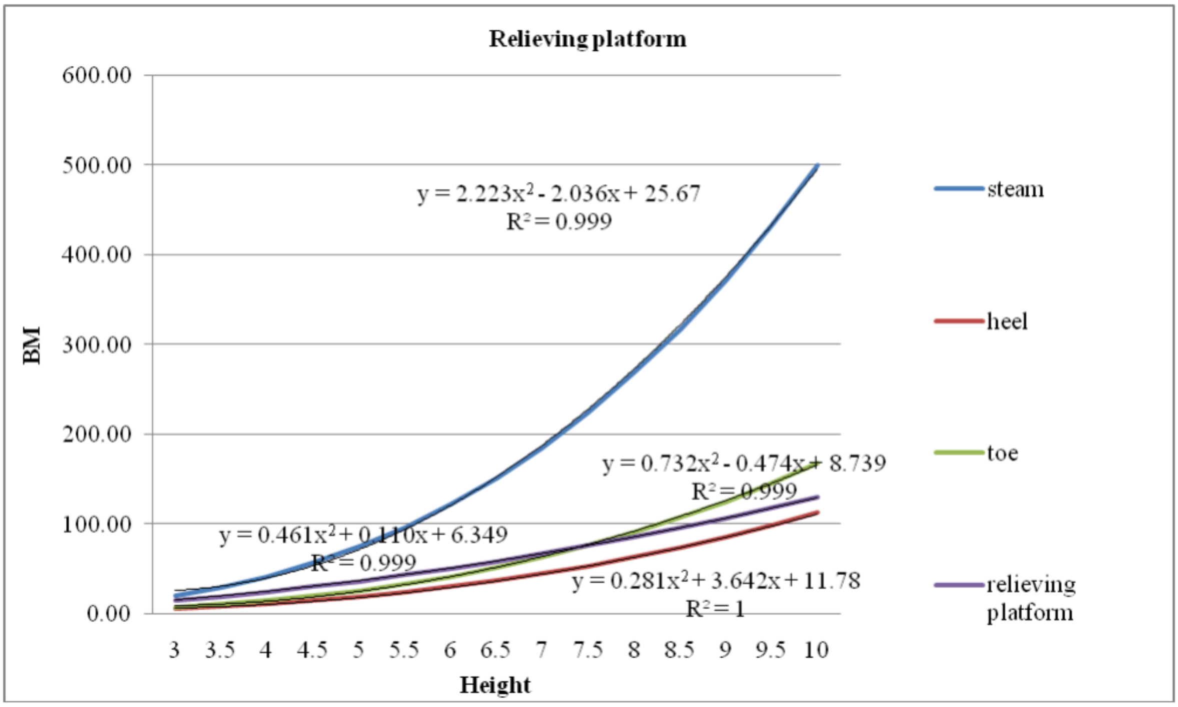

Fig. 5 BM vs. height of wall for retaining wall with relieving platform

We can see from graphs 4 and 5 that as the height of the wall increases, so does the bending moment of the stem, toe, and heel in both cases. However, the bending moment of the heel and toe is less in the retaining wall with relieving platform than in the cantilever retaining wall. [12-15]

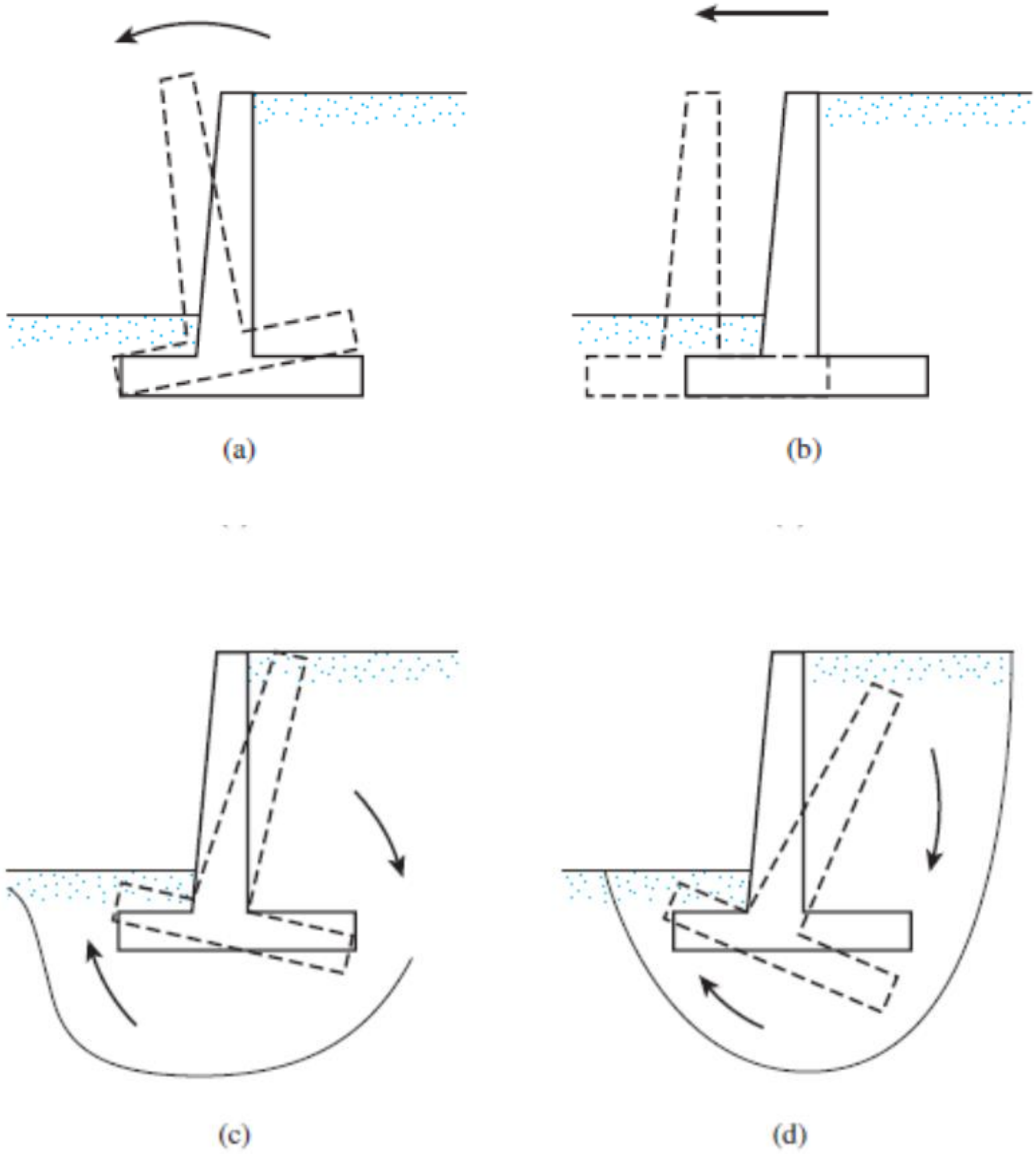

Fig. 6 Failure modes of retaining walls

Figure 6 depicts four possible failure modes for a retaining wall. If (a) earth pressure exceeds the strength of retaining walls, a tilting movement on retaining walls occurs, which is frequently followed by landslides. Case (b) occurs when the earth pressure acting on the retaining wall generates a force greater than the friction force between the retaining wall and the soil mass, resulting in a horizontal movement. Case (c) is a failure that occurs when the load from retaining walls exceeds the soil bearing capacity. When the soil masses exceed the shear strength of the retaining walls, case (d) occurs.

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CONCLUSION

A retaining wall is one of the most important types of retaining structures. It is widely used in a variety of situations such as highway engineering, railway engineering, bridge engineering, and irrigation engineering. The retaining wall with relieving platform is much safer against overturning and sliding than the cantilever retaining wall. Retaining walls are structures that are designed to keep soil on a slope that it would not naturally stay on (typically a steep, near-vertical or vertical slope). They are commonly used to join soils between two different elevations in areas of terrain with undesirable slopes or in areas where the landscape must be shaped severely and engineered for more specific purposes such as hillside farming or roadway overpasses. A retaining wall that holds soil on the backside.

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