Case studies on different types of retaining structures and its engineering aspects.

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Abstract: This paper presents us different types of retaining walls and how they behave in different conditions. Retaining wall is a structure that is used to retain earth or other materials which have propensity to slide at a particular inclination. While designing a retaining wall various parameter has to be taken into the consideration. If we talk about analysis lateral earth pressure is the main factor in analysis and design of retaining wall. Lateral earth is zero at the top and at ground it increases proportionally to a maximum value at lowest depth. Moreover, weight of retaining wall is determined by its dimensions if it is not able to bear the load then dimensions are changed. The main function of retaining wall is to stabilize landslides and control erosion.

Keywords: Retaining wall, Cantilever retaining wall, gravity retaining wall, counterfort retaining wall.

2.Introduction: Our earth faces lot of hazards and one among them is landslide. Landslide is just the movement of a rock, debris or earth material down a slope. There are lot reasons for landslides and some of them are when the forces that are acting down slope surpasses the strength of earth material that compose the soil, changes in groundwater, earthquakes, human activities etc. Now to prevent these retaining walls are constructed to retain the soil at a slope. Retaining wall is a rigid wall that is used to retain earth or other materials which have propensity to slide at a particular inclination. For the construction of retaining wall various kinds of materials is being used. Stone and concrete is the mostly used material for the construction purpose.it is designed to withstand the lateral earth and water pressure ,the effects of surcharge loads and the self-weight of a wall and in special cases, earthquake loads in accordance with the general principles specified in this section[12].as soil is inconsistent material so its very hard to point out the properties of the soil so the calculation of pressure exerted is very difficult and various things has to be considered like type of soil height , height of table, sub soil movement materials used in retaining wall. There are four types of conventional retaining wall they are gravity retaining wall, semi gravity retaining wall, cantilever retaining wall and counterfort retaining wall.

2.1 Gravity retaining wall: This kind of retaining wall is mainly constructed by concrete, stone or by both. it completely relies on its own weight to hold up. crib, gabion and bin retaining walls are some of the types of gravity retaining walls. While designing we must consider sliding, bearing and overturning forces.

For sliding, FOS (factor of safety) =1.5
For overturning, FOS (factor of safety) =1.5
For Bearing capacity, FOS (factor of safety) =2

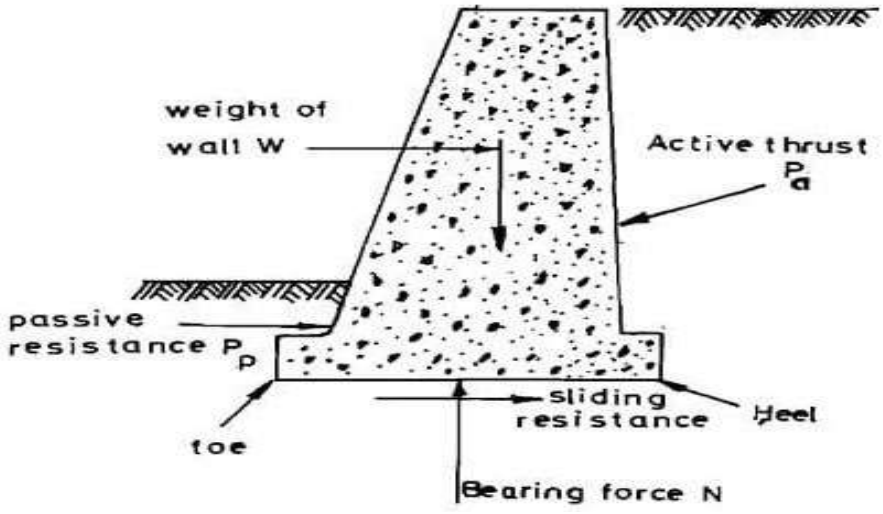

Fig 01: gravity retaining wall

2.2 Semi gravity retaining wall: It is the special form of gravity retaining wall. These walls are trapezoidal in section.in this retaining wall small amount of steel reinforcement is used at the back face in order to minimize the thickness of the wall. They are the blend of gravity and cantilever retaining wall designs. The lateral pressure is resisted by the mass of wall same as gravity retaining wall. They are mainly for earth retaining structures and bridge abutments in fill situation. They can also be used in cut situation, but for such application temporary support system is typically required [11].

2.3 Cantilever retaining wall: They consist of a relatively thin span and a base slab. And this base is divided into two parts one is heel and the other is toe. This heel is the part of the base under the backfill and the toe is other part of the base. It uses less concrete than gravity walls but while designing and construction more care has to be taken. The economical height for the cantilever retaining wall is 8-9m. for stability they are constructed on a solid foundation whose base s fixed to vertical part of the wall. They are generally of L or T shape in cross section. At the time pressure is exerted at any point of the various things has to be taken into the consideration like nature and type of soil, type of the wall, material used during construction. This kind of retaining wall is constructed of reinforced concrete.

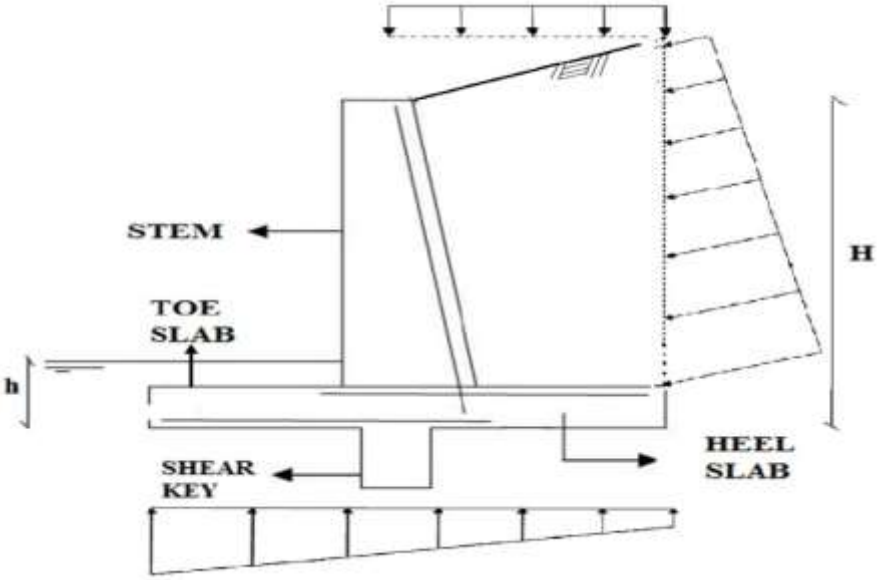

Fig 02: Cantilever retaining wall

2.4 Counterfort retaining wall: Counterfort retaining walls are similar to the cantilever walls except they have thin vertical concrete web at regular intervals along the backside of the wall and these webs are known as counterforts [1]. The counterfort that are attached to inside the face of the wall to further resist lateral thrust. The counterfort retaining wall are used for the walls that are greater than 8-12meters in height. The counterfort ties the base slab with wall stem together they brace the tension which strengthen their connection with each other. The stem bends horizontally between the counterforts hence it reduces the moment. To reduce the shear forces and bending moment that are imposed on the wall by soil the counterfort ties the slab and base together.

Bending moment for stem

Max. bending moment mid-way between counterforts=$pl^2/16$

Max. bending moment inner face at counterforts=$pl^2/16$

P=intensity of soil

l=clear distance between the counterfort

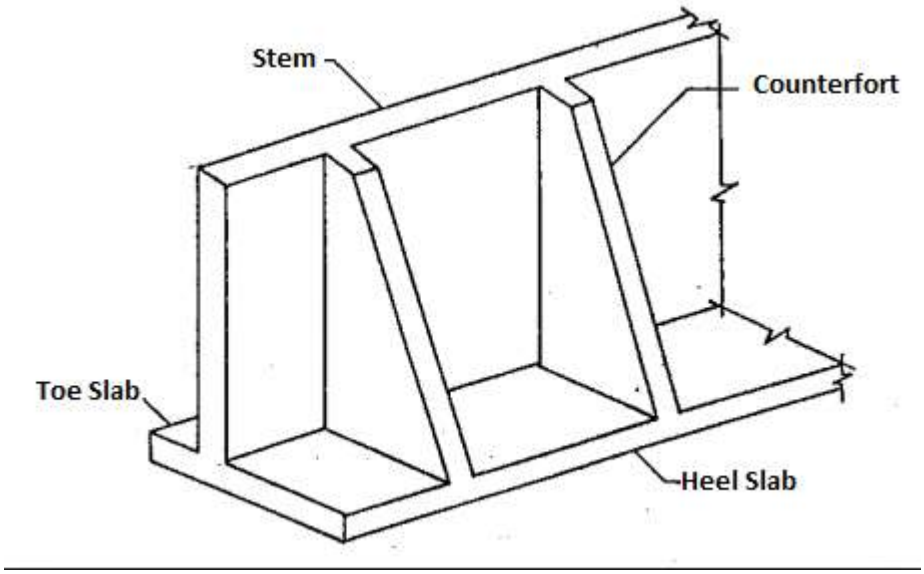

Fig 03: counterfort retaining wall

3.Objective of the study

The aim of the study is to understand different types of retaining walls and their different engineering aspects. following objectives will be achieved:

- Forces acting on retaining wall.
- Behaviour of retaining walls towards the applied forces.
- Most suitable retaining wall for different topography.

4.Literature Review

4.1 U C Sari [9]: Has found that steep slopes are formed due to erosion of river and wind. In addition, there are other reasons also such as building loads on the slopes and vehicles will increase their driving force for landslides. High failure of retaining walls will cause high damage and will affect surroundings. On basis of this right designing of retaining walls is needed. The design of retaining wall with sloping wall on the front of the retaining wall with sloping wall gives more force to retain active pressure. The greater the area of the retaining wall which results in greater the weight, the greater the safety factor. Designs which have larger perimeter turns out to be a smallest safety factor even the same area and weight.

4.2 P A Yadav [2]: Has found that retaining walls may get failed by sliding, overturning but some wall can fail in bending and this failure of the retaining wall depends upon gross pressure and point of application. To evaluate lateral earth pressure on retaining wall Rankies and Coulombs method is used in which Rankies method give us greater value of earth pressure than coulombs method in static condition and that's safe to design retaining wall. M-O method (Mononobe-okabe) is widely used in seismic condition to estimate dynamic lateral earth pressure but it does not give distribution of dynamic lateral earth pressure and point of application.

4.3 Sandeep K Chowksey [6]: Has found that probability of failure is much better way than FOS (factor of safety) for expressing geotechnical and structural stability of retaining walls. In geotechnical modes of failure sliding is the most critical one and higher factor of safety is required and based on reliability analysis geotechnical failures are critical than structural modes of failure. The condition between performance function of individual failure. The condition between performance function of individual failure modes must be evaluated to determine the system reliability.

4.4 Ankit C Mahure [8]: Has found that in a retaining wall with increase in height quantity of concrete also increases. by their analysis it showed that L-shaped wall consume more concrete than the cantilever retaining wall. Difference in steel increases with increase in height of retaining wall and the main reason is that required Ast will increase with increase in height. For L-shaped retaining wall more steel is required because of thickness of stem in L-shaped retaining wall is more than cantilever retaining wall.

5.Methadology

5.1 Design of retaining wall: Before designing the wall, all necessary parameters and requirements have to be taken under consideration that influence the earth pressure and also bearing capacity of the soil must be evaluated and some of them are:

- Unit weight of soil
- Angle of wall friction
- Angle of shearing resistance

After knowing these parameters lateral earth pressure and the bearing capacity can be evaluated.

5.2 Design parameters

1. Coefficient of soil friction= 30
2. Unit weight of soil=18kN/m^3
3. Unit weight of water=10kN/m^3
4. Unit weight of concrete=25kN/m^3
5. Surcharge=12kN/m^2
6. Grade of concrete=M25
7. Grade of steel=Fe500
8. Soil bearing capacity=100kPa

5.3 Stability Checks: There are two types of stability checks that are done to make sure the stability of retaining walls one is overturning and sliding check with addition to this bearing pressure is also checked whether it is within limits

- Check for overturning

RM/OM>1.5

Factor of safety against overturning is taken greater than 1.5

RM= moment due to weight of the retaining wall

OM=overturning moment due to lateral earth pressure

Overturning force acts at height H/3

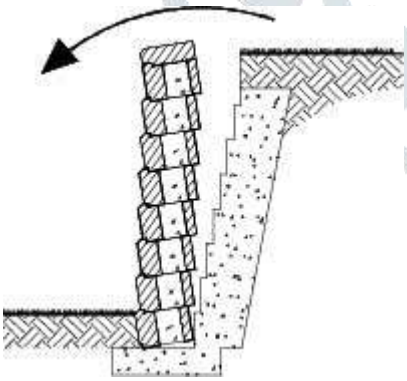

Fig 04: overturning

- Check for sliding

RF/SF>1.5

Factor of safety against sliding is taken greater than 1.5.

RF= resisting force

SF= sliding force

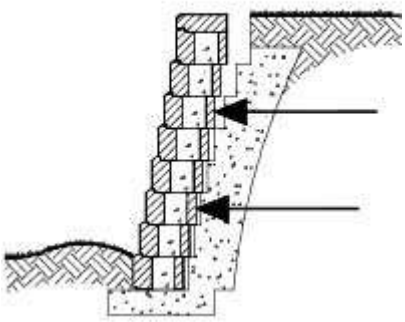

Fig 05: sliding

- Maximum and minimum bearing pressure is taken greater than 0 and less than soil bearing capacity.

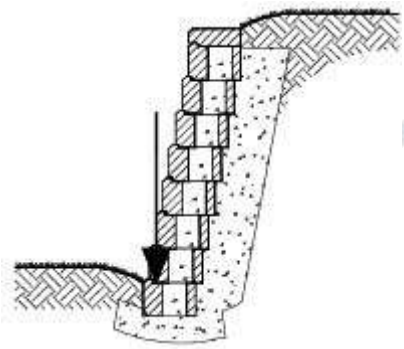

Fig 06: Bearing capacity

6.Conclusion

- Reinforced retaining wall has become most used retaining wall because it has contributed to infrastructure in terms ease of construction, economy etc.
- Material used for backfill should be of good drainage characteristics to block hydrostatic pressure to build up.
- Cantilever retaining wall is most suitable retaining wall for the project that is located on a hilly region.
- A suitable retaining wall is able to stabilize the sliding, overturning of a building, it can also help in saving construction cost.

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