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Analysis and Design of RCC Retaining Wall to Overcome Landslide

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Abstract: This article examines and designs the 3.5 m cantilever retaining wall and the SBC 200 T/M3 reinforced concrete retaining wall. Retaining walls provide vertical support for the soil. They are often used in poorly sloping areas or where landscaping is heavy and must be designed for various purposes such as hillside planting or road overpasses. The purpose of this article is to discuss the different types of retaining walls, their behaviour and different types of failure. Retaining walls are usually walls that support the soil behind them.

The purpose of this study is to understand the analysis of retaining walls. Lateral earth pressure is important in the analysis and design of retaining walls. Also, about the stability of the wall bars against tipping and sliding. When there is a sudden change in ground height, the system retains soil or other loose material. Cantilever retaining wall is the most common type of retaining wall and is used for walls 3 to 6 meters high.

In this study, detailed analysis and design of this type of wall, which includes the dimensions of the wall, is made and then these dimensions are checked. Safety features against slipping, tipping and tilting have been calculated. The shear strength of the sole, the tensile stress in the body and the tensile stress in the sole are checked.

Keywords: Retaining wall, RCC retaining wall, Staad Pro(v8i), Seepage in Retaining Walls, causes in Retaining wall.

I. INTRODUCTION

A retaining wall is one of the most important types of soil retaining structures. The primary purpose of retaining wall is to retain earth or other material at or near vertical position. It is extensively used in variety of situations such as highway engineering, railway engineering, bridge engineering, dock and harbour engineering, irrigation engineering, land reclamation and coastal engineering etc. Reinforced concrete retaining walls have a vertical or inclined stem cast monolithic with a base slab. These are considered suitable up to a height of 6m.

The bone protects the outside world from the work of the toe and heel plate. Provide necessary reinforcement to reduce bending stress. The tendency of the walls to slide forward due to the external earth pressure should be investigated, and if the safety factor is insufficient, shear wedges should be designed so that they do not move inside the building. Retaining walls are walls used to support the soil behind so that it can be stored at different heights on either side.

A retaining wall is a structure designed to confine soil to a slope (usually a steep, near-vertical, or horizontal slope) that it will not hold. Walls that are used to hold a mass of soil or other loose materials in a vertical (or near-vertical) position and that experience a sudden change in ground level are called "retaining walls".

Sudden changes in the ground can occur when excavation, cleavage or embankment width is limited by property, structural use, or industry.

For example, in railway or road construction, the right-of-way has a fixed width and the excavation of embankments must be of this width. Likewise, the walls of the basement of the house should be inside the property and the soil around the basement should remain. Retaining walls are mainly used in mountain roads, swimming pools, underground pools, under houses, in the construction of places that need to be filled, and as buttresses at the ends of the bridge between the two. The retaining wall protects the earth from getting the correct stand angle. This allows the retaining wall to be built outside the wall, making it easier for the retaining wall to bend, topple and slide. Walls must be properly constructed so that they can remain stable in the high-altitude world and meet their strength and service needs.

A. Types of Retaining Walls

1) *Cantilever Wall:* The most common type of retaining wall, usually economical up to 7 m high, consisting of vertical arms (called shafts) supporting earth and foundation slabs. The base plate consists of two separate areas. heel plate and toe.

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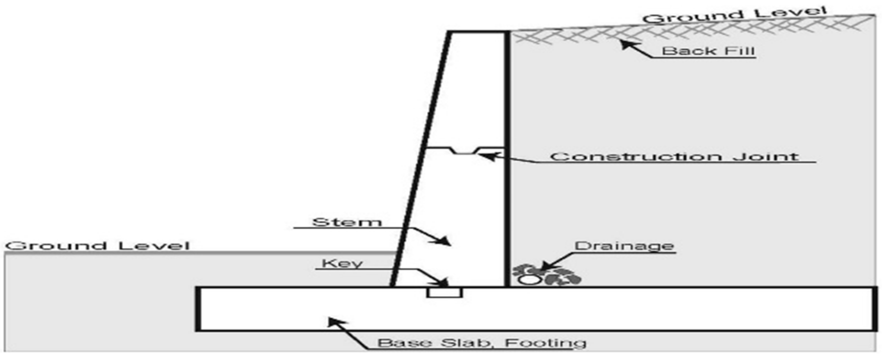

Figure:1 Cantilever retaining wall

2) *Counterfort Walls:* These walls consist of thin vertical slabs known as buttresses, spaced at regular intervals across a vertical shaft. Supports connect vertical bars to the foundation slab. Thus, vertical bars and foundation slabs pass between the supports. The purpose of providing supports is to reduce the shear forces and bending moments of vertical bars and base plates. Retaining walls are economical at heights of 6–8 m or more.

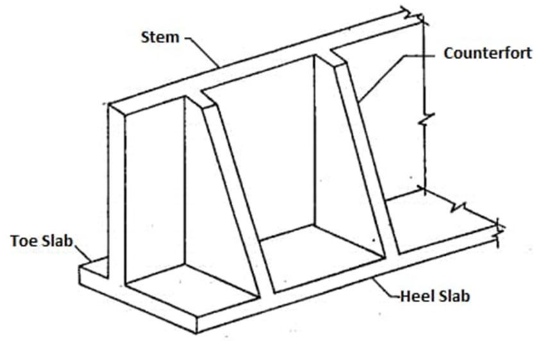

Figure:2 Counterfort retaining wall

B. Design Of Cantilever Wall

1) Initial Thickness of Base Slab and Stem

For preliminary calculations, the thickness of the base slab may be taken as about 8 per cent of the height of the wall plus surcharge (if any); it should not be less than 300 mm. The base thickness of the vertical stem may be taken as slightly more than that of the base slab. For economy, the thickness may be tapered linearly to a minimum value (but not less than 150 mm) at the top of the wall; the front face of the stem is maintained vertical.

2) Design of Toe Slab, Heel Slab and Stem

The three elements of the retaining wall, viz., stem, toe slab und heel slab have to be designed as cantilever slabs to resist the factored moments and shear forces. For this a load factor of 1.5 is to be used.

C. Design Principal of Cantilever Retaining Wall

The various dimensions of wall are so proportioned that the various failure criteria discussed above are taken care of. The design of wall consists of the fixation of base width, design of stem, design of toe slab, design of heel slab.

1) *Fixation of Base Width:* The base width of wall is so chosen that the resultant of forces remains within middle third of base slab, the uplift pressure is zero at heel slab side also it should be safe from consideration of sliding.
2) *Design of Stem:* The vertical stem is designed as cantilever for triangular loading with $K a \gamma h$ as base of triangle h as height of it. The main reinforcement is provided at 0.3 % of the area of cross section along the length of wall.
3) *Base Plate Structure:* It is also a cantilever beam or slab structure. Main reinforcement is provided on the bottom or bottom face. This is because these surfaces are subjected to upward earth pressure loads. Check thickness against maximum cantilever moment and deflection criteria.

4) *Heel Plate Structure:* They are also made in the form of cantilever beams or slabs. Since there is an active load in the form of overpressure, the main reinforcing bars are provided on the upper or upper surface of the heel plate. In addition, the design reinforcement for the effective moment due to the upward pressure of the soil should also be applied to the bottom of the heel plate. Thickness is checked against maximum cantilever moment and cantilever motion deflection criteria.

II. LITRATURE REVIEW

Prachi S. Bhoyar1, Dr. G. D. Avachat (2019) This article presents the static analysis and design of retaining walls with and without flanges. Cantilever retaining walls with pressure relief shelves are considered a special type of retaining wall. The concept of creating a pressure relief ledge on the backfill side of a reinforced concrete retaining wall reduces the overall earth pressure in the wall, reducing wall thickness and ultimately creating an economical cantilever wall design. The conclusions of this paper are based on the discussion and results obtained analytically using Staad-Pro. modelling studies. Adding a shelf significantly modifies the pressure distribution diagram.

The pressure relief shelf has been extended to the failure side to ensure structural stability. Realistically, there are limits to using more shelves, but for high retaining walls, up to three shelves can be economically used. It has also been observed that average construction costs are reduced between 15% and 25% by providing high ledges over existing cantilevered retaining walls. The analytical results of active earth pressure, nodal response and bending moment with pressure relief flanges are in full agreement with Staad-Pro. software results.

Pei and Xia (2012) designed a reinforced cantilever retaining wall using a heuristic optimization algorithm. The main purpose of this study was to design a wall with a minimum retaining wall cost, including concrete and rebar costs per 1 m of wall length.

Poursha (2011) used a harmony search algorithm to study the optimal cost of a reinforced cantilever retaining wall that satisfies various geotechnical and structural constraints. The design variables were top bar thickness, bottom bar thickness, toe width, heel width, bar height, base plate thickness, and key depth. The purpose of the feature was to minimize the total cost of design and construction per ACI 318-05. The optimal design procedure was divided into two phases. First, a stability test that includes tilt, slip and load-bearing failures? Second, make sure each section of the cantilever wall has strength and required steel.

Rajesh D. Padhye and Prabhuling B. Ulagaddy (2010) In their study, they used active earth pressure and lever arm and found a significant reduction in the moment of the base plate as well as a reduction in the flange.

Basudhar (2006) investigated the cost-effective design of a cantilever retaining wall of a certain height that meets some structural and geotechnical design constraints. Seven design variables were considered: base width, toe width, shank thickness, base thickness, minimum embedment width, reinforced shank diameter, and shank top width. The continuous unconditional minimization method, the Powell algorithm for multivariate search, and the quadratic interpolation method for one-dimensional search were adopted. It was observed that by increasing the top of the stem from 10 cm to 30 cm, the cost increased from 9% to 15%.

Medhekar (1990) investigated the optimal design of a cantilever extension wall. Two types of foundations were chosen: rigid and flexible. The goal was to minimize the overall cost of the structure. A priori penalty function method was used to solve the nonlinear optimal design problem. Structural stability and strength requirements have been redrawn as constraints. The results showed that the minimum cost of a wall with a height of design for a rigid base is slightly higher than that for that wall and a flexible base. This means that the flexibility of the foundation does not significantly affect the cost of the retaining wall.

III. METHODOLOGY

Site selected for study

we got opportunity to conduct our case study at site of J.W. Consultant under guidance of vishal nawane sir in wagholi. we have studied on RCC retaining wall over the landsliding. after we studied designed the RCC retaining wall for the chances of seepage in retaining wall and how to prevent them.

Figure:3 site at wagholi, Pune

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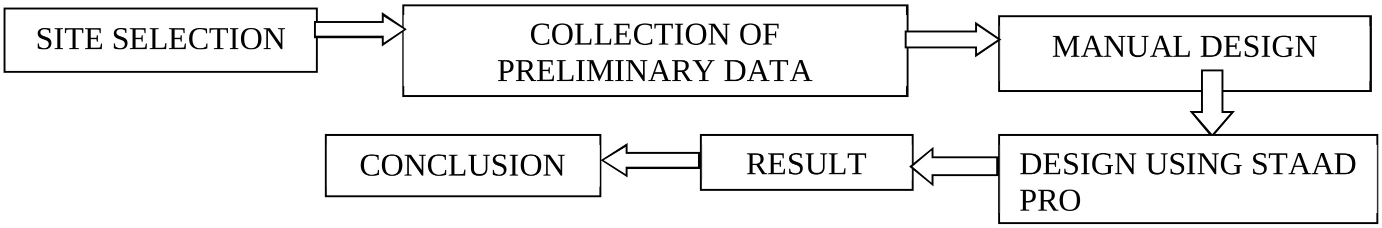

1) Pressure Coefficients:

	Active Pressure Coefficients =(cosΘ-√(cos2Θ-cos2ϕ)*cosΘ)/	C_a	0.171
i)	(CosΘ+√(cos2Θ-cos2ϕ))		
ii)	Passive Pressure Coefficient =(1+Sinϕ)/(1+Sinϕ)	C_p	5.82

2) Preliminary Dimensions: -

i	Height of RW	h	3.5meters
ii	Soil Density	γs	18 KN/M
iii	SBC	q.	200 T/M3
iv	Angle of repose	ϕ	45 degrees
			radian
v	Surcharge Angle	Θ	0 degrees
			0.000 radian
vi	Coefficient of Friction	µ	0.58
vii	Surcharge Load	Ws	1KN/sqm

STAAD PRO DESIGN:

STEPS

STEP 1. To model the retaining wall using STAAD Pro software

STEP 2. Give the all forces acting on it and analyse the same structure using STAAD Pro.

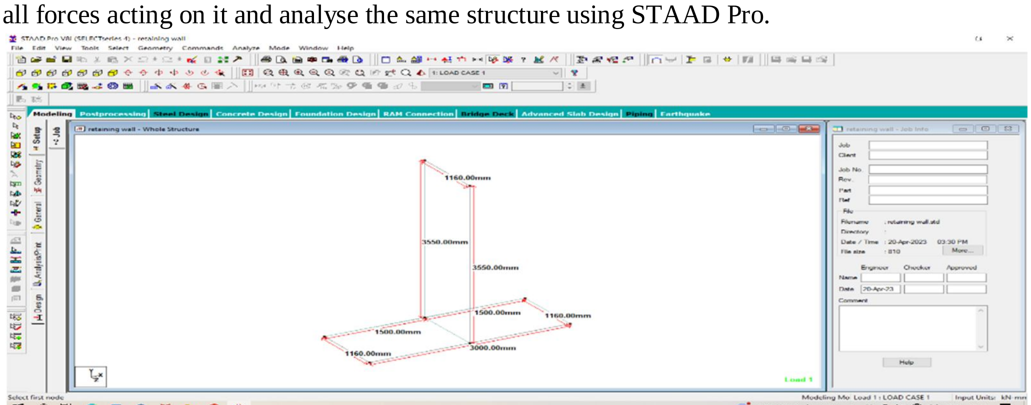

Figure:4 Model in Software

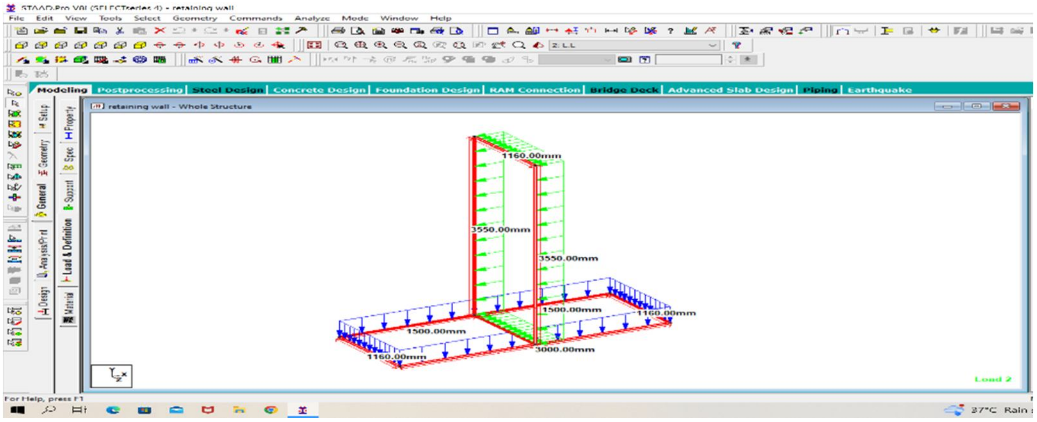

Figure:5 Pressure Distribution

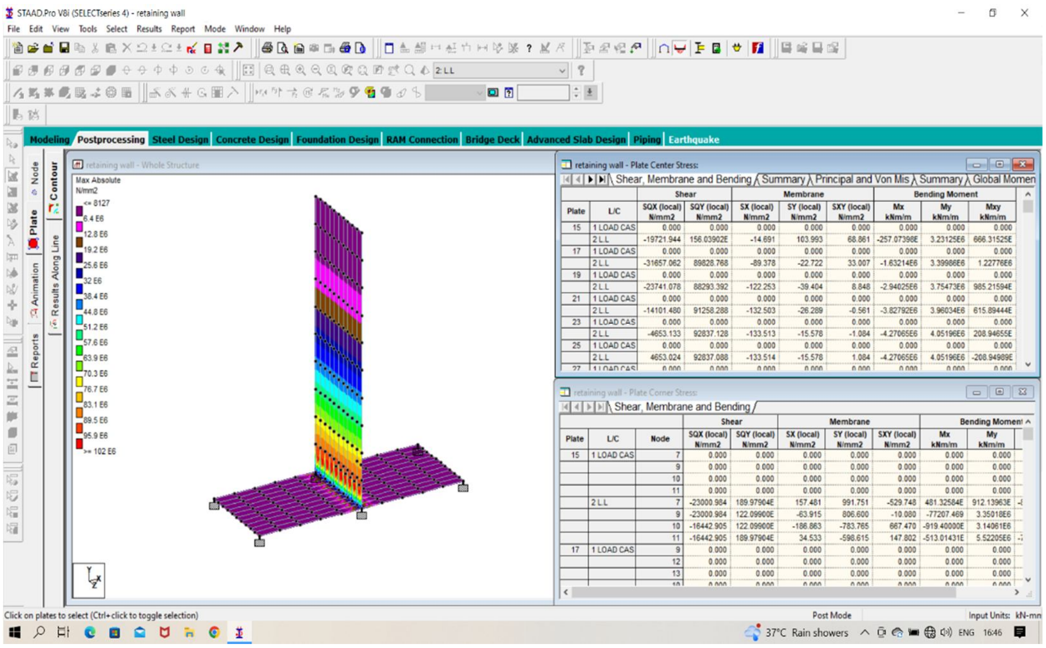

Figure:6 Stress Distribution

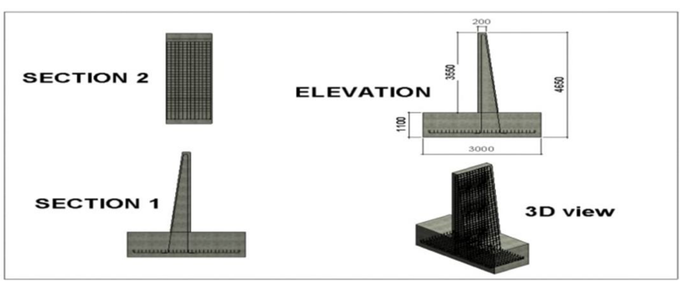

Figure:7 Reinforcement Placement

STAAD PRO (v8i): STAAD or (STAAD.Pro) is a structural analysis and design software application originally developed by Research Engineers International in 1997. In late 2005, Research Engineers International was acquired by Bentley Systems. STAAD.Pro® is one of the most widely used programs for the design and analysis of various structures such as petrochemical plants, tunnels, bridges, etc. The latest version of STAAD.Pro® v8i allows civil engineers to gain professional-level software experience in construction companies, government agencies, architectural firms, and more through the Multisoft Virtual Academy STAAD.Pro® v8i online training.

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STAAD Pro software feature information:

1) Analysis of time-dependent effects
2) Check cold formed profile design
3) Design and analysis using finite element meshes and structural models.
4) Design of beams, columns, walls and load-bearing framing.
5) Design according to international design standards
6) Loads and Load Combinations
7) Integration of floor and foundation structure
8) Model reinforced concrete, steel
9) Structural design documentation

leak in retaining wall

introduction

A common problem with most containment structures is leakage through the structure and cold joints. Construction joints are formed by sequential pouring of concrete in several stages. these joints can be horizontal, vertical, inclined or curved depending on how the concrete is poured. Harmful effects of leaks: In the case of repair structures such as elevated water tanks and swimming pools, leaks are unsightly and slowly corrode the steel inside the concrete. There is also water loss. In basements, the rise in water level outside the building can cause water to seep into the basement and render the basement unusable. Final roof slabs with joints can allow water to seep into the building, destroying expensive interiors. Retaining walls are built to support soil as the ground level changes. Drains in retaining walls help water seep through. A filter protector must be installed behind the drain to prevent soil erosion around the drain.

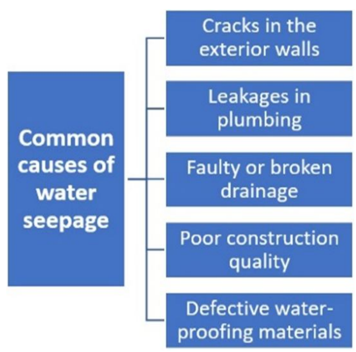

Figure: 9 causes of water seepage

How to prevent water penetration through retaining walls

a) Application of liquid waterproofing membrane Cover the sides of the retaining wall with a suitable liquid waterproofing membrane. The Wrimco Waterproofing website recommends pouring the liquid film into a paint tray and applying it to the wall with a paint roller. Before applying to the wall, dip a paint roller into the tray and roll it back and forth to remove excess sealant. Cover the entire wall with a liquid film.
b) Let's set the curtain Allow the liquid film to dry for the time specified by the manufacturer.
c) Add gravel layer in the bottom of the trench behind the retaining wall, spread a 4 to6 inch thick layer of washed gravel along the full length of the retaining wall.
d) Laying perforated pipe Place the 4-inch perforated pipe on top of the gravel. The House Logic website recommends using pipes designed specifically for French drains. The pipe is solid at the bottom and has holes at the top and sides to collect. inventory. Use pipe that has an American Society for Testing and Materials stamp for the type of pipe being used.
e) drain pipe connection Connect a drain pipe to the end of the French drain pipe to direct runoff away from the house or retaining wall. Coat the inside of the connector and the outside of the drain pipe with pipe thinner. Let dry for 60 seconds and then coat with pipe adhesive. Attach the connector to the drain pipe, turn 1/4 turn, and hold for 60 seconds until the adhesive hardens. Repeat this procedure to connect additional drain pipes or join pipes.
f) Cover the pipe with gravel. Cover the perforated pipe within 1 foot of the top of the retaining wall with 1 inch of wash gravel.
g) Cover in mud Add soil over the gravel until the gravel completely covers the top of the retaining wall. Spray the area with plants or grass. If desired, add landscape fabric before adding dust.

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IV. CONCLUSION

After studying various types of retaining wall, we have concluded that cantilever wall is more feasible than other type of retaining wall. Cantilever retaining wall are most economical type of retaining wall for greater heights and can be used in projects without site restrictions.

The distribution of earth pressure in the vertical direction did not become triangle and the comparatively large pressure was measured at the lower part of the wall both in the state at rest and the active state, but the location of the application point of resultant force was approximately regarded as the height of about H/3, According to data from the site the soil bearing capacity was 200t/m3 and the retaining height was 3.5 m, The angle of repose 45°, Its mechanism is proven and used in many civil engineering structures.

How to avoid seepages in retaining wall? Apply Liquid Waterproofing Membrane, Allow the Membrane to Cure, add a Layer of Gravel, Position the Perforated Pipe, Cover the Pipe with Gravel, Cover the Pipe with Grave.

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