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Review on Retaining Wall Design and Analysis

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Abstract: One of the important retaining structures used in civil engineering is retaining wall. It finds application in highway engineering, irrigation and bridge engineering. The current research reviews the existing work in the field of retaining wall design and analysis. The existing analysis are based on use of experimental and numerical techniques. The results obtained from these techniques are evaluated with analytical methods. The extensive review on shelves, material type and design of retaining wall is presented.

***IndexTerms* – Retaining wall, FEA**

I. INTRODUCTION

For thousands of years the lateral support is provided to terraced field on steep slope. This lateral support is provided using retaining wall. The purpose of retaining wall is to hold back soil for any elevated topography where elevation changes abruptly.

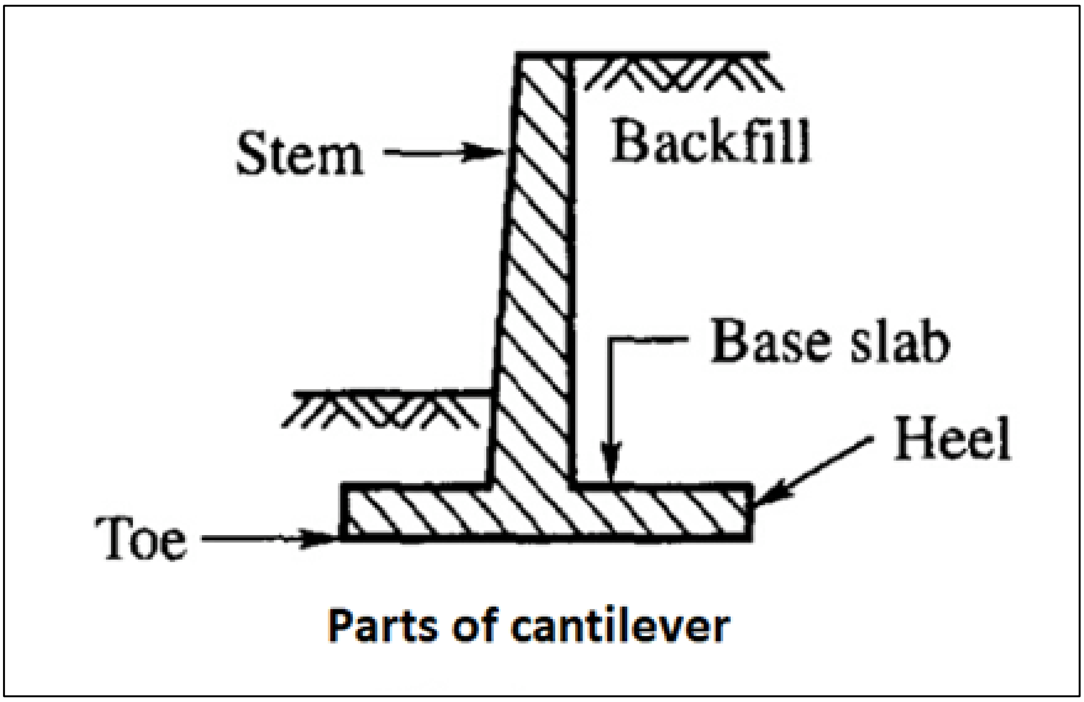

Figure 1: Cantilever Retaining Wall Terminology

The major function is to provide lateral backfill support. The material of steep slope tends to slide after threshold angle. There are basically 3 types of retaining wall i.e. hybrid, embedded and gravity type with each having its own set of benefits and limitations.

II. LITERATURE REVIEW

Donkada et. al [1], discovered that by analyzing the best design ideas for 3 different types of reinforced concrete retaining structure retaining walls, counter fort retaining walls, or retaining walls with releasing platform they might construct the best possible constructions. To develop heuristic methods for adjusting the wall sizes to match the lowest cost places, parametric studies using optimization techniques were conducted. The best engineering option for a particular height was determined by comparing the optimal cost estimates of the various retaining wall kinds. Additionally, the benefits of relieving levels and retaining walls, which are quite new in India, are explored.

Patil et. al [2] , discovered that one of the most significant categories of retaining walls is a retaining wall. It is widely employed in a wide range of contexts, including agricultural engineering, railway technology, or highway engineering. Retaining walls constructed of reinforced concrete have an angled or vertical stem that is formed with the foundation slab. These are regarded as appropriate up to a height of 6 metres. Through the cantilever motion of the stem, toe slab, and heel slab, it resists earth pressure. A parameter of 1.5 must be supplied to prevent sliding and it's important to analyze the likelihood of walls to slide forward due to lateral earth pressure. cantilever retaining walls are most effective up to a height of 6 metres. Lever arm event caused stronger forces to be created at the base at greater heights, which results in higher sections for structure and stability construction. Pressure distribution would also be higher due to retained fill due to greater heights. This work demonstrated that it is not profitable. An option to this is to use a counter for a retaining wall, which requires more base space & steel. To overcome this challenge, a novel strategy has been developed that aims to reduce the impact of forces caused by retained fill, small reinforced concrete beams equalize the locally apparent forces, and this reduces moment and shear forces along the stem. Additionally, this should lessen the bending action caused by the tension at the base.

Patil et. al [3], have discovered that when there is a desired change in gradient that exceeds the angles of repose of the soil, a retaining wall is a building built to resist the lateral pressure of soil. Recognizing & combating the inclination of the retained material to slide down slope owing to gravity is the most crucial aspect of appropriate retaining wall construction. This results in lateral earth pressure behind wall, which is sensitive to variation & size of movement the retaining structure experiences as well as the angle of internal friction (ϕ) & cohesive strength (c) of the held matter.Authors frequently have to navigate retaining walls that are 7m, 8m, or 9m high. Therefore, authors shall take into account these heights for non-cohesive soil conditions for various counter-fort spacing's. Authors researched the ideal counter-fort spacing, the effect of changing counter-fort spacing on bending moments, as well as the change in stem & heel slab thickness when changing counter-fort spacing. Authors also generated a graph of the ideal counter-fort spacing versus wall height. The information supplied in this and the sections that follow shows unequivocally that altering the placement of counter-forts for retaining walls causes changes in the bending moment in the heel slab or stem wall as well as changes in the width of the heel slab or stem wall. Additionally, it has been noted that the metal and concrete quantities per metre of the retaining wall are higher for counter-fort spacing's of 1m, 1.5m, 2m, 3m, 3.5m, 4m than at 2.5m spacing. Therefore, 2.5m is shown to be the ideal counter-fort spacing for retaining walls that are 7m, 8m, or 9m high.

Tamadher Abood et. al [4], has discovered that if there is a rapid change in ground elevation, retaining walls are effective at holding back soil or other loose material. The construction is pushed by the backfill or retained material, which causes it to tip over, slide, or do both. The popular retaining wall design, the cantilever, is utilized for barriers between three to six meters in height. In this study, a cantilever retaining wall with an interior stem of steel-reinforced, cast-in-place concrete is analyzed and designed. This research includes thorough analysis & designs for this kind of walls, including estimates of the wall's main proportions that were later verified. Simulations were made to determine the security factor versus sliding, overturning, or bearing. The stem's tension stresses, the base's tension stresses, & the base's shear resistance were all examined. Every section of the wall had its reinforcing calculated. The ACI standard is the foundation for all evaluation & design.

Inder Kumar et al[5], discovered the research for the behaviour & best layout of the concrete dam's gravity wall & counter fort RW. Concrete & steel volume & quantity are used to conduct cost analysis against each wall model. The option with the lowest cost estimate is picked as the optimal system solution after a similar evaluation.

Prof. SaritaSingla et al[6], has found that while developing land, it is frequently difficult to create a variation in topography height above a random horizontal distance. This is frequently achieved by putting retaining walls or slopes. Retaining walls are buildings built to hold back earth or other material that can't tolerate vertically on their own. The performance & best construction of 3 different reinforced concrete wall kinds, including cantilever RW, counter fort RW, retaining walls with relieving platforms, are studied in this research. Cost for each optimal design of wall for specific height is determined using the volume of concrete as well as the quantity of steel. A comparison research is carried between the estimated costs of all 3 ideal models for a given height, as well as the architectural option with the lowest cost projection is selected as the best option.

Yash Chaliawala et al [7], has discovered that two kinds of reinforced concrete walls—the cantilever RW and the counter fort retaining wall—behave in the best way possible. Utilizing the quantity of concrete as well as the weight of steel, the price of each ideal wall design for a particular height is computed. The best engineering option is picked from among the cost estimates.

D.R. Dhamdhere (2018)[8] aimed toward the best possible outcome. As the best choice, he has selected optimal price. He established the RWs base width as well as other parameters, checked its safety, established the minimal and maximum compressive force, and afterwards constructed the RWs various components as necessary. He has determined that the height of the reliving foundation is equal to the height of the heel slab and that it is one-fourth the diameter of the base slab. Placement of the living floor is thought of at the midpoint of the RW. Simulations were also used to verify the safety of the RW, like determining whether the eccentricity of the resulting reaction force fell around 0 & base width/6. And over 1.5 safety factors were used to prevent sliding or overturning. Allowable bearing force is below the soil bearing capacity as well as the lowest bearing pressure is greater than zero. Following modeling and development, authors then calculated pricing and estimated volume. He examined the prices of retaining walls with a foundation for reliving versus cantilever RW.

Indrajit Chowdhury(2013) [9] examined the effectiveness of RW of the gravity kind for earthquake loads. He used the most straightforward RW case possible, where the backfill is dry & lacks cohesiveness. The land is flat as well as the backfill dirt is sandy. Authors offered a computational formula for the same situation. His approach is predicated on the following hypothesis: inertial impact contribution will exist; active force is already mobilized, thus this could add any rigidity to the overall dynamic response. Authors has also taken into account the impact of stiffness because the thickness of the wall is sufficient, therefore the wall is seen as providing rigidity or inertia. Wall base fixing is required. Authors developed the dynamic flexural and shear responses. Authors performed the reply using the FE approach. Backfilled soil mass is supplied at the vertical face of the wall as aggregated mass. The force on backfilled soil is hydrostatic in nature. Authors employed ANSYS software for analysis.

C. Sanjei (2015) [10] Through doing preliminary calculations, different RW configurations were chosen. Authors used PLAXIS to execute a FE analysis. The first was backfilling after building the wall, as well as the second was backfilling concurrently with building the wall. For analysis used a FE model that authors created. Authors chose three shapes that had the same height and cross sectional region. Authors adopted stable section in accordance with BS 8002 using a trial procedure.

U C Sari et. al. [11] has discovered that wind & river erosion are what causes steep slopes to develop. There are additional factors as well, such as the weight of construction structures on slopes as well as the impact of automobiles on landslides. Substantial RW failure would result in high damage and have a impact on the surroundings. Based on this, proper RW design is required. The layout of the retaining wall with the sloped wall on the front provides additional force to maintain active strain. The safety margin increases as the RWs surface size increases and as weight rises as a result. Despite having the same size & weight, models with a bigger circumference find out to have a lower safety margin.

P A Yadav et. al. [12] recently discovered that while RW can collapse by slipping or overturning, certain walls also could fail by bending, so this RW failure is dependent on the application point as well as the overall pressure. The Rankies or Coulombs methods are employed to assess the effects of lateral pressure on retaining walls. In static conditions, the Rankies approach provides us with a bigger value of earth pressure than the Coulombs technique, making it safer to build retaining walls. Although the M-O technique (Mononobe-okabe) is frequently employed in seismic loading to calculate dynamic lateral earth pressure, it does not provide dispersion or site of user information.

Sandeep K Chowksey et. al. [13] have discovered that using the risk of failure to represent the geotechnical & structural integrity of RW is a much more precise method than employing the FOS (factor of safety). According to reliability assessment, geotechnical breakdowns are more dangerous than structure ones since sliding is one of the most important geotechnical failure mode therefore requires a greater level of safety. The relationship among individual failure and organizational capability To measure the reliability of the system, the relationship among both the following expression of each single failure mode should be assessed.

Ankit C Mahure et. al. [14] research discovered that the amount of concrete in a RW grows as its height does. As per their investigation, L-shaped walls use many concrete than cantilever RW. Due to the fact that more Ast is needed as the RW height rises, there is a rise in the differential in steel. Since the stem of an L-shaped retaining wall more steel is required to build one is wider than with a cantilever RW.

Zhang et al. [15] For determining the seismic earthquake forces, the intermediate wedge technique, which depends on the mobilisation of frictional resistance, has been presented. The authors came to a closed-form conclusion that accounts for the non-uniform dispersion of seismic acceleration all along vertical, the type, or wall motion in the estimation of an equivalent seismic factor.

Steedman and Zeng [16] To calculate the seismic earthquake forces, a pseudo-dynamic approach that is an analytical approach that takes into consideration specific dynamic response features within the backfill behind a RW has been developed. The researchers came to the conclusion that the backfill amplification or motion speed would raise the elevation of the dynamic active thrust as well as the loads operating on the wall. The outcomes were in excellent accord with those of the tests performed.

Choudhury and Nimbalkar [17] developed a formulation of the active dynamic lateral earth pressure distribution on a stiff RW with a fixed base using the pseudo-dynamic method. According to that approach, the Active Seismic Earth Pressure Distribution in the bottom portion of the wall exhibited a diminishing deviation from the Mononobe-Okabe Distribution's line graph.

Mylonakis et al. [18] proposed a closed-form stress plasticity method for the stresses on stiff RW brought on by earthquakes. Contrasting to the Mononobe-Okabe answer, the one that is being described is easier to understand & could be reached using logical reasoning.

III. CONCLUSION

The functionality of retaining wall depends upon the design type, number of shelve and material of retaining wall. The structural stability of retaining wall is significantly affected by these factors. The existing researches have corroborated this fact. A number of tests are conducted on retaining wall under static and dynamic loading conditions which evaluated its strength and critical regions which are prone to damage.

REFERENCES

[1]. Shravya Donkada and Devdas Menon, "Optimal design of reinforced concrete retaining walls", The Indian concrete journal. April 2012, page 9-18

[2]. S. S.Patil and A. A. R. Babgan, "analysis and design of reinforced concrete stepped cantilever retaining wall", IJRET, vol. 04, Feb-2015, page 46-67

[3]. Rupa B. Patil, G. R. Patil, "Design and detailing of counter fort retaining walls for construction site", International journal of informative & fururistic research, Vol. 3, September 2015, page 61-71

[4]. Tamadher abood, Haten E. Younis Eldawi, Faeza R. Elnaji Abdulrahim, "Design of Cantilever retaining wall with 4m height ", Imternational journal of civil and structural engineering research, vol. 3, April 2015, pp 318-326

[5]. Inder kummar Lilani, Dr. Rakesh Patel, "Analysis of counterfort retaining wall in non over flow section of gravity dam" , IJSRD, Vol. 5, May 2017, pp. 920-924

[6]. Sarita Singla and Er. Sakshi Gupta, "Optimisation of reinforced concrete walls of varing heights using relieving platform", IJERT, Vol. 4, June 2015, pp 1071-1077

[7]. Yash Chaliawala, Gunvant Solanki, Anuj K. Chandiwala, "Comparative study of cantilever and counter fort retaining wall", International journal of advanced engineering and research development, Vol. 2, Dec. 2015, pp. 221-224

[8] D.R. Dhamdhere, Dr. V. R. Rathi, Dr. P. K. Kolase "Design and analysis of Retaining wall", Volume 8, Issue IX, September/2018

[9] Indrajit Chowdhury , Jitendra Pratap Singh,"Performance Evaluation of Gravity Type Retaining Wall Under Earthquake Load" 28 October 2013_ Indian Geotechnical Society 2013

[10] C. Sanjei and L.I.N. De Silva, "Effect of Construction Sequences on the Behavior of Gravity Type Retaining Wall: A Case Study ", Annual Sessions of IESL, pp. [1 - 7] 2015© The Institution of Engineers, Sri Lanka

[11] U C Sari, M N Sholeh, and I Hermanto "The stability analysis study of conventional retaining walls variation design in vertical slope", The 8th Engineering International Conference 2019

[12] P. A. Yadav, A. H. Padade, P. P. Dahale, V. M. Meshram, "Analytical and experimental analysis of retaining wall in static and seismic conditions: a review" International Journal of Civil Engineering and Technology (IJCIET) Volume 9, Issue 2, February 2018.

[13] Sandeep K. Chouksey and Abhishek Fale, Reliability Analysis of Counterfort Retaining Wall, International Journal of Civil Engineering and Technology, 8(7), 2017, pp. 1058–1073.

[14] Ankit C. Mahure and Prof. M. N. Umare "Investigation on Dynamic Behavior of different types of Retaining Walls with Different Heights", International Journal for Research in Applied Science & Engineering Technology, Volume 7 Issue V, May 2019-

[15] Zhang J, Shamoto Y, Tokimatsu K. Seismic earth pressure theory for retaining walls under any lateral displacement. Soils Found 1998;38(2):143–63.
[16] Steedman R, Zeng X. The influence of phase on the calculation of pseudo-static earth pressure on a retaining wall. Geotechnique 1990;40(1):103–12.

[17] Choudhury D, Nimbalkar S. Pseudo-dynamic approach of seismic active earth pressure behind retaining wall. Geotech Geol Eng 2006;24:1103–13.

[18] Mylonakis G, Kloukinas P, Papantonopoulos C. An alternative to the Mononobe–Okabe equations for seismic earth pressures. Soil Dyn Earthq Eng 2007; 27(10):957–69