Research study on Soil Structure Interaction of Integrated Earth Retaining Wall: A Review

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Abstract - The widespread usage of retaining walls has sparked research into novel techniques of building walls that are acceptable, clean, rapid, and cost-effective. Among several innovations, the mortar-less technique of interlocking bricks is extremely promising. This will be simplest to do with the concept and implementation of the wall's sustainability against the stress caused by its usage of the ground. Retaining walls are moderately stiff structures designed to hold soil laterally so that it may be maintained at varying levels on either side. The ANSYS software tool is used to test the strength properties of these walls. Similarly, employing the unique interlocking construction block below not only decreases the amount of human work necessary, but it also boosts power. These blocks are simply transferable from one location to another. This paper is developed for the building of such interlocking masonry, namely how to increase wall construction speed, the impacts of brick placement on wall alignment accuracy, and wall guiding (recommended deformation, deformation) under lateral stresses. This study includes an analysis of an interlocking precast structural block retaining wall and an evaluation of a precast RCC wall for numerous design parameters.

Keyword: Retaining Wall, Integrated (Precast), SSI, ANSYS, soil Pressure.

1. INTRODUCTION

A retaining wall is a structure that is used to retain soil or any other material in a position where the ground level changes suddenly. The support structure is an indispensable part of all civil construction projects. Traditionally, the gravity wall, cantilever wall, buttress wall, and reinforced earth wall are used to retain soil on a slope steeper than would naturally be expected.

Retaining wall are classified as follows of-

A. Based on material used – concrete, brick/stone masonry, clay/soil timber.

B. Based on resisting load-

1. Gravity wall – A massive wall that resists overturning by its own weight.

2. RCC Cantilever wall – Wall constructed in RCC having thin stem and base Slab resist load by cantilever action

3. RCC Counter fort wall- When height of wall is more than 6-8m stem and slab resist load at regular interval tied with counter fort for economy

Prefabricated structures (sometimes known as "off-site structures") are ones in which the majority of the structural parts are standardized and made at off-site facilities before being transported to the assembly site. Such components are manufactured utilizing current mass production processes, allowing a huge number of buildings to be constructed at a low cost in a short period of time. Precast cement is a type of construction product that is created in a reusable form or "shaped" cast concrete and then cured in a controlled atmosphere before being brought to the building site where it will be erected. Ordinary concrete, on the other hand, is dumped and cured on-site.

1.1. History of Precast Technology

Ancient Roman engineers utilized mortar, which they quickly poured into moulds to build their amazing system of water pipelines, canals, and roadways. Pre-started technologies are being used in a variety of technical and auxiliary applications, including individual parts or even complete structural systems. Prefabricated frame constructions were advocated in Liverpool during the peak era, an idea that was not widely adopted in Britain. In any event, it was widely embraced around the world, particularly in Eastern Europe and Scandinavia. Precast concrete has grown in the United States as two distinct sub-sectors that are inextricably linked. The National Prefabricated Concrete Association (NPCA) places a high value on efficiency, underground, and other non-precast things in the precast concrete goods business. Concrete precast systems Precast concrete modules and other precast concrete components utilized in overhead constructions such as installations, suspension bridges, and scaffolding dominate the market. The Institute of Precast / Prestressed Concrete is largely involved in this industry. (PCI)

1.2 Soil Structure Interaction

The interaction between the soil and the structure erected on it is referred to as soil-structure interaction. Soil-structure interaction refers to the mechanism by which soil reaction influences structure motion and structure motion influences soil response. There are two forms of soil structure interaction. There are two types of interactions: a) kinematic interaction and b) inertial interaction. Earthquake ground motion creates free field movement in soil and foundations buried in soil that do not follow the free field movement. Kinematic interaction is caused by the foundation's failure to match the motion of the free field. The mass of the superstructure imparts an inertial force to the earth, causing the soil to deform, which is known as inertial interaction. The purpose of this study is to analyse and construct an integrated retaining wall with an emphasis on soil structure interaction.

2. STATE OF DEVELOPMENT

Aikaterini Alexiou, Dimos Zachos, and others All technological works that permit a quick change in the level of the earth's surface so that the system of ground structures exhibits a restricted displacement or is marginally limited are termed retaining walls. Support structures are mostly employed when soil continuity is disrupted as a consequence of excavation below the natural surface of the ground, such as when building highways in tough geographical terrain with steep slopes. They are also commonly employed in the construction of basements in metropolitan locations when other buildings or roadways surround the perimeter. In certain circumstances, functional reasons need a local elevation of the ground surface with earthing in the region surrounding the structure, such as on bridge piers or in port developments, so that the soil mass may be sustained. Finally, retaining walls must be built to stabilise and safeguard natural slopes that are prone to kinematic instability.

Seungho Kim, Dong-Eun Lee, and others In this work, a precast concrete double wall (PCDW) technology was designed to overcome existing RC structural difficulties and boost retaining wall production. A PCDW is a precast concrete (PC) wall composed of two thin concrete panels joined parallel to one other by lattice reinforcement. PCDW may assist in ensuring integrity, reducing construction delays, and improving quality. An overall technique for the component design and construction phase of the PCDW system was presented, and its enhancements over the RC method in different aspects were evaluated.

Bora Pulatsu, Seunghee Kim, and others When the system is subjected to differential settlement, a parametric study of the masonry tensile strength is done to better understand the structure's progressive reaction. Additional static analyses are undertaken to determine the wall's bearing capability under uniform overpressure. The results show that the macro behaviour of the wall is sensitive to the tensile capacity of the masonry. This research also demonstrates that the suggested modelling technique may give important information on the performance of susceptible existing retaining walls and that numerical models verified in this manner should be utilised to identify any interventions and repairs.

S.S. Deshmukh and colleagues The model is examined using static nonlinear analysis. The results of displacement and stress along various coordinates are analyzed and compared. The acquired results are compared to an interlocking infill wall, brick infill walls, and a single-story single-bay frame with no infill.

Interlocking blocks are united by dry joints (less mortar) and the wall's integrity is maintained by prestressing pressures, according to **Hassanli, Reza, et al**. The suggested approach has several benefits over traditional methods for building cantilever retaining walls or mechanically stabilized earth barriers. Precast concrete/masonry segments, in particular, can be included, decreasing the construction time and cost of cantilever-type buildings, and when paired with a mechanically stabilized earth wall system, can minimize the number of reinforcing layers and increase design flexibility. These walls will be appropriate for both water front and soil retention.

Limit analysis of a retaining wall with relief shelves under static gravity loads using FEM, **Vinay B. Chauhan (2021)**, this work investigates the stability of a retaining wall with relief shelves and compares it to a standard cantilever wall using a limit integrating using FEM. The performance of such a wall subjected to an incremental static evenly distributed load on the backfill surface is approached in terms of the size of the walls' load-bearing capacity before the whole structure fails. The research demonstrates that providing a suitable number of relief shelves and their corresponding walls is preferable to not providing relief shelves. The key deciding element that can modify the form of the failure plane is the breadth and position of the shelves. Relief shelves are used to increase wall stability.

B.S. Tasildar (2016) Stability of retaining wall under seismic loading under exceptional conditions when the width of the base at the retaining wall has to be reduced, a relief shelf can be employed to lower the width of the base. By increasing the number of lofts in the gravity wall, it is feasible to construct a very tall retaining wall with a reduced base width. The stability of the earth retaining wall is discussed in this document. The appropriateness of the retaining wall in the field, the economics of the wall, the selection of a suitable technique for estimating the active earth pressure, and the magnitude of the decrease in the cross-section must all be considered.

Chugh, Ashoke K. (2016) Sand movement is affected by retaining wall soil structure interactions, retaining wall structural stiffness, foundation soil qualities, and construction sequencing, including the order of fill application at the front and rear of the wall. The retaining walls discussed in this article are the standard reinforced concrete kind used along freeways and dam spillways—the freeway wall is a basic cantilever, and the spillway wall in an earthen dam is the abutment. Another unusual sort of earth support structure was utilized in the construction of a second large-diameter reinforced concrete syphon next to an existing syphon of a similar size for conveying water on water projects. The results of the numerical modelling for the highway retaining wall are compared to the measured data. Because the spillway and syphon structures were not instrumented, only numerical analyses are presented.

S.M.Dasak, V.B. Chauhan (2015) Numerical analysis of the behaviour of a stiff retaining wall with relief shelves The effect of soil width on the contact pressure under the base plate, settlement profile of the backfill surface, soil deflection, and reduction of lateral earth pressure was studied numerically on a wall of 6m high width of an attic retaining wall with two attics with different widths of 0.5 - 0.8m. It was discovered that retaining walls with shelves may significantly reduce lateral strain on the wall by 10.56-12.5%.

Ajitkumar Kumbhar, R. J. Balwan (2011) The usage of a gravity wall in conjunction with a loft provides an ideal combination that leads to cost savings. This has further benefits in that no extra material is required, the width of the foundation is decreased, and the comparison of an integrated wall to another form of wall yields the most inexpensive wall as an integrated wall.

Aditya Parihar and D. K. Paul (2010) The Effect of Wall-Soil-Structure Interaction on the Seismic Response of Retaining Wall Interactions in Previous Earthquakes Typically, calculations do not account for the interaction of retained soils with the wall that happens under dynamic situations. This aspect makes the wall's soil system more adaptable than the wall itself. The conditions of wall separation during contact alter the dynamic properties of the postulated wall-soil system, which must be addressed once again. The article includes a study of the retaining wall's behaviour under static and seismic situations in relation to the aforementioned features. Modeling the contact between the wall and the soil is part of the wall-soil interaction model. The system is idealized as a two-dimensional plane strain model, with the base acceleration represented as an external load in the form of typical seismic motion.

Basha and Babu (2008) used a targeted technique to calculate the passive earth pressure factor of a cantilever retaining wall of a bridge utilizing a composite failure mechanism and the limit equilibrium method under seismic loading. The author investigated a method for optimizing the design of the dependability basis of a reinforced concrete retaining wall in this work. They conduct a parametric research to investigate the influence of design parameter uncertainties on the risk of failure of a cantilever wall. In this study, 10 failure modes are evaluated, and several graphs are made with the results for the design's dependability.

Ray Choudhari, M.D. (2006) In this retaining wall design, earth pressure is the major active force. Significant reductions in this force could be achieved by adding relief shelves to the retaining wall, as well as independently evaluating the effect of relief shelves on earth pressure, provided that the mass of soil above the relief shelf, which is contained in the failure wedge, does not contribute to the weight of the failure wedge that occurs as a result of the relief shelf's reduction in weight.

3. CONCLUSION

This article is solely concerned with a review of previously published studies. Retaining walls are moderately stiff structures used to hold the soil laterally so that it may be retained at various levels on either side. All technological constructions that allow for a dramatic shift in the level of the earth's surface are designated retaining walls. Mortarless brick building, which often uses interlocking bricks, is gaining popularity across the world, suggesting its acceptance. The stability of the retaining wall is found to be a critical concern. A retaining wall can collapse in a variety of ways, including flipping, sliding, and flexural failure. Horizontal shelves atop a retaining wall's vertical stem might be a valuable feature of the wall to withstand lateral stress.

4. REFRENCES

[1] Aikaterini Alexiou, Dimos Zachoset. al. "Construction Cost Analysis of Retaining Walls" International Journal of Engineering and Advanced Technology Volume-9 Issue-4, April 2020 pp 1-6

[2] SeunghoKim , Dong-Eun Lee et. al. "Development and Application of Precast Concrete Double Wall System to Improve Productivity of Retaining Wall Construction" MDPI April 2020, pp 1-12

[3] Pulatsu, Bora, et al. "Advanced Analysis of Masonry Retaining Walls Using Mixed Discrete-Continuum Approach." Proceedings of the Institution of Civil Engineers - Geotechnical Engineering, no. February, 2020, pp. 1–34, doi:10.1680/jgeen.19.00225

[4] S. S. Deshmukh, Volume, and Issue Vi. ISSN NO: 1076-5131 "Seismic Analysis Of Interlocking Blocks Of Wall." no. 1594, 2019, pp. 1594–615

[5] Hassanli, Reza, et al. "Pre-Stressed Segmental Retaining Walls (PSRWs)." 2019, pp. 187–96, doi: 10.1007/978-3-030-01944-0_14

[6] Vinay B. Chouhan et. al. "Limit analysis of retaining wall with relief shelves under static surcharge loading using FEM" (2021)

[7] B. S. Tasildar et. al. "Stability of retaining wall under seismic load" (2016)

[8] Ashoke K. Chugh et. al. "Soil structure interaction of retaining wall" (2016)

[9] V. B. Chauhan, S.M.Dasak et. al. "Numerical study on the behavior of rigid retaining wall with relief shelves" (2015)

[10] R. J. Balwan & Ajitkumar Kumbhar et. al. "Integrated retaining wall : A case study" (2011)

[11] D. K. Paul & Aditya Parihar et. al. "Effect of wall soil structure interaction on seismic response of retaining wall" (2010)

[12] Dr, Ray Choudhary et. al. "Comparison of Pseudo static and pseudo dynamic method for seismic earth pressure on retaining wall" (2008)

IS CODES:

i. **IS 456 : 2000** -Plain and Reinforced Concrete Code of Practice. - BUREAU OF INDIAN STANDARDS, NEW DELHI.

ii. **IS Code 1893:2002 -** Criteria For Earthquake Design of Structures