Review on Non Linear Dynamic Analysis of Precast Retaining Wall

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Abstract- *The global utilization of keeping walls has stimulated a study for suitable, clean, rapid and cost-effective new methods of wall creation. Mortarless technology the use of interlocking bricks is very promising amongst many technologies. This will simplest be performed with the idea and implementation of sustainability of wall toward the strain exerted by using soil. The examination accomplished and shown in this paper is one such paradigm closer to the sustainability of the wall. They have a look at in this paper is done on the layout idea, modeling of the interlocking structural block, the use of it as a keeping wall. The strength parameters of these walls are checked via the ANSYS software program. Similarly, observe pondered that the application of interlocking structural block special below no longer handiest increases electricity however additionally decreases the number of human exertions required. Those blocks can without difficulty switch from one region to any other. This report is ready for such interlocking walling generation and especially: a way to improve the speed of wall construction, the effects of brick layout on wall alignment accuracy and wall conduct (precept strain, deformation) whilst situation to lateral forces. This research paper consists of an analytical study of a keeping wall made of the interlocking precast structural blocks and an assessment of the RCC wall to precast for a few design parameters.*

Keywords- ANSYS, Precast Elements, Retaining Walls, Stability

I. INTRODUCTION

The concept of precast construction includes those buildings, in which most people of structural additives are standardized and produced in vegetation in a region away from the construction, and then transported to the web page for assembly. Those components are synthetic by using industrial methods based totally on mass manufacturing as a way to construct a huge range of homes in a brief time at a low cost. Precast concrete is a production product produced by casting concrete in reusable mildew or "shape" that's then cured in controlled surroundings, transported to the development website online and lifted into place.

In contrast, widespread concrete is poured into website-specific forms and cured on websites online. Modular creation has been broadly adopted for low-to-medium-upward thrust homes, however pretty constrained for high rises. A particular knowledge gap is living with the lateral force resistance of modular excessive-rises. Maximum such buildings adopt solid-in-situ cores for lateral force resisting, which remains labour-in depth. This paper's objective is to expand a new lateral force resisting gadget the use of precast shear walls as a part of the modules for excessive rises.

A. Retaining wall

Retaining walls are exceedingly rigid walls used for supporting soil laterally so that they may be retained at specific stages on the 2 sides. Preserving walls are systems designed to restrain soil to a slope that it'd no longer naturally preserve to (generally a steep, close to-vertical or vertical slope). They're used to sure soils among exceptional elevations regularly in areas of terrain owning unwanted slopes or in areas wherein the panorama desires to be formed severely and engineered for extra precise functions like hillside farming or roadway overpasses.

B. Classification of retaining wall

- Gravity wall-Masonry or Plain concrete
- Cantilever retaining wall-RCC (Inverted T and L)
- Counterfort retaining wall-RCC
- Buttress wall-RCC

C. Methodology

- Study of precast system with interlocking blocks.
- Design and analyze precast retaining walls with interlocking structural blocks in ANSYS software.
- Compare these walls for two cases:

CASE A: All sides are fixed.
CASE B: The only bottom is fixed.

- Case A and case B analyzed with the five conditions as follows:
  1. Dry leveled backfill.

2. Moist two-layered leveled backfill.
3. Submerged leveled backfill.
4. Leveled backfill with uniform surcharge
5. Backfill with the inclined surface

- Compare precast retaining wall and RCC wall of height 5m to El Centro data to check the stability of wall to earthquake forces, under dynamic loading conditions.

II. STATE OF DEVELOPMENT

Young Je Kim, Hyuk Sang Jung, Yong Joo Lee, Dong Wook Oh, Min Son and Hwan Hee Yoon (2020) These walls are advantageous because they can be used not only in simple construction compared with reinforced concrete retaining walls but also when the height of the wall needs to be higher. However, unlike reinforced concrete retaining walls, in which the walls are integrated and resist the earth pressure on the back, the block-type reinforced earth retaining wall method secures its structural stability by the frictional force between the buried land and reinforcements. [1]

Bora Pulatsu, Seunghee Kim, Ece Erdogmus1, and Paulo B. Lourenço (2020) This study expands further the use of the mixed discrete-continuum (MDC) approach for the analysis of 7 masonry retaining walls. Particular contributions include the incorporation of soil plasticity, irregular wall 8 morphology, and an application of the approach to a real-life scenario to identify the causes of observed 9 damage patterns. Backfill soil is simulated via a deformable continuous medium, while masonry units are 10 represented as polyhedral rigid blocks, interacting with each other. Upon the validation, the MDC approach 11 is used to simulate the behavior of a historical masonry retaining wall, suffering from severe cracks, large 12 deflections, and even a partial collapse due to material degradation and differential soil settlement. [2]

Aikaterini Alexiou, Dimos Zachos, Nikolaos Alamanis, Ioannis Chouliaras and Grigorios Papageorgiou (2020) Retaining walls are considered all technical works, which allow the implementation of a sharp change in the level of the earth's surface, in such a way that the ground-construction system presents limited displacement or is marginally restrained. Support structures are mainly used in cases of disruption of soil continuity resulting from an excavation, below the natural surface of the ground, such as when building roads in difficult geographical terrain with steep slopes. It is also common for them to be used in the construction of basements in urban areas when there are other buildings or roads around the perimeter. The purpose of the present work is to compare the cost of constructing three retaining walls (gravity, cantilever, braced) subject to identical ground pressures. The retaining walls were designed using the same finite element software (GEO5), taking into account common parameters for the soil stress, the strength properties of the soil mass, the wall material as well as the diameter of the reinforcing steel bars, so that the results can be comparable. The market research that followed produced interesting conclusions on the comparison of the cost estimates for the three retaining walls. [3]

Seungho Kim, Dong-Eun Lee, Yonggu Kim and Sangyong Kim (2020) The construction of most apartment underground parking lots utilizes reinforced concrete (RC) structures composed mainly of rebar work and formwork. RC structures lower construction efficiency and significantly delay construction because they require a large number of temporary materials and wooden formwork. In this study, a precast concrete double-wall (PCDW) system was developed to address the existing problems of RC structures and to improve the productivity of retaining wall construction. PCDW is a precast concrete (PC) wall in which two thin concrete panels are connected parallel to each other with truss-shaped reinforcement between them. PCDW can contribute to securing integrity, reducing the delay in construction, and improving quality. An overall process for the member design and construction stage of the PCDW system was proposed, and its improvement effects were examined regarding various aspects in comparison to the RC method. [4]

Reza Hassanli, Md Rajibul Karim(&), Md Mizanur Rahman, Arman Kamalzadeh, Julie Mills, and Mehdi Javadi (2019) This paper introduces an innovative system of retaining walls named “pre-stressed segmental retaining walls (PSRWs)”. In this system, interlocking blocks are assembled together with dry joints (mortarless) and the integrity of the wall is maintained by pre-stressing forces. The proposed system has a collection of advantages over the conventional systems for the construction of cantilever retaining walls or mechanically stabilized earth walls. In particular precast concrete/masonry segments can be incorporated which reduces the construction time and cost for cantilever type structures and if combined with a mechanically stabilized earth wall system, it can reduce the number of layers of reinforcement and add flexibility to the design. [5]

S. S. Deshmukh, Prof. G. H. Kumbhar, Prof. M. N. Shirsath (2019) in this project, the attempt is made to analyze the structure when the infill wall is modeled using interlocking blocks. In this study building frame, wall, foundation, the soil is modeled using ANSYS Civil FEM software. In analyzing the building different conditions considered are (a) Single story with single-bay frame without considering the interlocking infill on well-graded soil with earthquake load along x-direction; (b) Single bay frame with interlocking infill

walls built along x-direction; (c) Single bay frame with brick infill walls built along x-direction; (d) Single story with single-bay frame without considering the interlocking infill with earthquake load along z-direction;(e) Single story single bay frame with interlocking infill walls built along z-direction; (f)) Single story single bay frame with brick infill walls built along z-direction on gravel well-graded soil. The static nonlinear analysis is used to analyze the model. The displacement and stress results obtained along with different coordinates are studied and compared. [6]

Ganesh C. Chikute and Ishwar P. Sonar (2019) For a particular local condition selection of inappropriate conventional methods used in the construction of retaining wall proves not only time consuming but also costlier due to the transportation of required materials and its associated cost. Selecting the most technically appropriate, safe and cost-effective system out of the various available types including rubble masonry gravity wall, RCC cantilever wall, RCC counterfort wall and gabion retaining wall is a rigorous task. While performing the design procedure the input data including height, backfill, foundation strata and loading conditions are kept constant for all the four types of retaining walls. From the design output in the form of section and steel, it is observed that the retaining wall of Gabion type proves economical and effective compared to other walls considered for analysis. The locally available materials are the key elements that can be used in the construction of gabion walls makes the project time-bound and cost-effective. [7]

Moamen E. Abd El Raouf (**2019)** Structures that are built to retain vertical or nearly vertical earth banks or any other material are called retaining walls. Retaining walls may retain water also. The earth retained may be natural soil or fill. Some of the purposes for which retaining walls to basements are subject to lateral pressure from retained earth, liquids or a combination of soil and water. At a certain depth, the residual lateral pressure may be high enough to cause passive failure in the soil behind the retaining wall. The present paper analyses the effect of compaction of the backfill behind the retaining walls. The values of the residual lateral earth pressure induced by common compacting equipment the most parts of the world especially in Egypt are calculated by the classical methods (the method of Canadian code of Practice). The study compares the method of Canadian Practice results and the results of the analysis using the finite element to enhance the method of calculation the lateral earth pressure due to compaction. [8]

Xiong Zhang, Xiaoping Zhang, Xuanbo Qi and Nansheng Li (**2019)** Retaining wall in Honeycomb block is an ecological wall. It combines the advantages of gravity retaining wall and cantilever retaining wall from the structural point of view. It has the advantages of quick and convenient construction, controllable quality and beautiful appearance, and excellent ecological effects and other advantages. In this paper, the finite element method is used to analyze the nonlinear contact stress distribution between the soil and the structure of the retaining wall in honeycomb block to confirm the structural stability of the ecological retaining wall. The results show that the soil arching phenomenon occurs in the soil pressure behind the retaining wall of the honeycomb block. The soil pressure near the height of 1/3 retaining wall is higher than the active earth pressure, but the combined force of the soil pressure and the action point and the Coulomb active earth pressure are basically the same. The stress distribution of the wall is similar to that of the cantilever beam, and stress concentration occurs at the joint of the block. [9]

Mubeena Salam and S. Siva Rama Krishana (2018) In the soft story, columns are severely stressed and unable to provide adequate shear resistance during the earthquake. Hence a combination of two structural system components i.e., Rigid frames and RC shear walls or Rigid frames and Bracings leads to a highly efficient system in which shear wall and bracings resist the majority of the lateral loads and the frame supports a majority of the gravity loads. [10]

Mohammad Vekas Wani1 and Mr. Chitranjan Kumar (2018) the provision of affordable housing for these poor people needs to be facilitated by certain provisions. This can be possible only by introducing such technologies and materials that can be beneficial for building low-cost houses. Researchers worldwide have made significant efforts to find sustainable and affordable technologies to arrest the situation. The appropriate solution for affordable housing will vary from one location to another. Some general rules, however, apply to construction methods and housing systems. [11]

Aram Mohammed Raheem (2018) A numerical method through finite element(FEM) with two models: Elastic &Equivalent Linear was used to investigate the seismic behavior of retaining wall supporting saturated, liquefiable, cohesionless backfill soil. Horizontal/Vertical displacement, pore water pressure, horizontal total stress in the soil at the face of the wall, and Max. Shear stress in the soil at the base was measured. It was shown that the Equivalent model gives more reasonable results and the liquefaction zones are concentrated in the passive side more than the active side. [12]

Ryszard Chmielewski (2018) During The Second World War many of these historic buildings in Warsaw were completely or partially destroyed and until these days their remains constitute elements of the existing building development of

the capital of Poland. This may be connected with a change like applied loads as well as the current functions of these buildings. The results of expert opinions and investigations are presented, regarding the operational and technical state of two retaining walls submitted to an expert before the repair works. When designing the design concept, both the historic character of structures, the technical feasibility of performing construction works in the densely urbanized area, as well as determining water and ground conditions were considered. The first of the analyzed cases concerns the retaining wall localized in the vicinity of Ordynacka Street and Tamka street. After analyzing the historical aerial photographs, it was found that the retaining wall constitutes an underground part of the apartment house destroyed during the warfare. [13]

D.R. Dhamdhere, Dr. V. R. Rathi and Dr. P. K. Kolase (2018) A retaining wall is a structure designed to sustain the earth behind it. It retains a steep faced slope of an earth mass against rupture of slopes faced slopes in cuts and fills and against sliding down. The retained material exerts a push on structures and this tends to overturn and slide it. This paper consists of analysis and design of cantilever and relieving platform retaining wall with the varying height from 3m to 10m and SBC 160KN/m2. It also shows comparative study such as cost, economy, bending moment, stability against overturning &sliding between both the retaining wall. The comparative study is carried out along with the cost and optimum or least cost estimate is chosen as the best option. In this paper, it is also shown that the relieving platform retaining wall is economical, more stable than the cantilever retaining wall and it also relives the bending moment of the heel portion. [14]

T T Bui , H V Tran , A Limam, M Bost, Q B Bui, P Robit (2018) A new concept for the soil nail walls is here proposed and validated through experimental and numerical approaches. This process, based on the use of precast elements that are easier to install, is cheaper and more aesthetic than the classical methods, but the main advantage is reducing the cement consumption which conducts to divided carbon footprint by three. To characterize the structural capacity of this new process, this article presents an investigation on two *in-situ* representative walls, one in shotcrete which is the old way of construction, and the other, consisting the precast reinforced concrete slabs, which is the new process. We thus have a demonstrator on a real scale, and perfectly representative, since the constructive modes, as well as the mechanical, thermal, and hydric loadings are the real ones associated with the environment in situ. Substantial instrumentation has been realized over a long period (nearly 2 years), enabling to follow the evolution of the displacements of each wall and the efforts in the anchor nails. To determine the bearing capacity of the constituent elements of the precast nail wall, an experimental study coupled with a numerical simulation has been conducted in the laboratory on a single precast slab. This study allows the evaluation of the load associated to crack initiation and the bearing capacity associated with the ultimate state, at the scale of the constituent elements. Finally, to evaluate the behaviour of the two concepts of nail walls in the case of extreme solicitation, a dynamic loading induced by an explosion has been conducted on the site. [15]

Ashutosh Kumar and P. Roy (2017) A copula-based approach is presented to investigate the impact of copulas for modeling trivariate distributions on system reliability under incomplete probability information. The objective of this study is to use the trivariate copula concept in a common geotechnical problem like retaining wall to make it more realistic and efficient since the conventional design method considers only lumped factor of safety. We have treated three parameters i.e., cohesion, internal angle of friction and unit weight of soil material as random variables, other parameters are assumed as constant. [16]

S. K. Ghosh Ned M. Cleland Clay J. Naito (2017) This report was produced by the Applied Technology Council (ATC). While endeavoring to provide practical and accurate information, ATC, the authors, and the reviewers assume no liability for, nor express or imply any warranty concerning, the information contained herein. Users of information in this report assume all liability arising from such use. It intended to imply that such software, equipment, instruments, or materials are necessarily the best available for the purpose. [17]

Bhavani Shankar and Anusha (2016) in this study, attempt is made to analyze the structure when the infill wall is modeled using interlocking blocks. In this study building frame, wall, foundation, the soil is modeled using ANSYS civil FEM software. In analyzing the building different conditions considered are Single story with single-bay frame without considering the interlocking infill on Gravel well-graded soil with earthquake load along with x-direction Single bay frame with interlocking infill walls built along x-direction; Single bay frame with brick infill walls built along x-direction; Single storey with single-bay frame without considering the interlocking infill with earthquake load along with z-direction Single story single bay frame with interlocking infill walls built along the z-direction. [18]

Machhindra S. Purkar and Sunil Kute (2015) In this paper a rigid wall retaining a reinforced backfill with self-weights as well as with a uniform surcharge load has been analyzed by finite element method. The reinforcement is assumed in the

form of strips that are not attached to the wall. Analyses are performed using a software code that is developed in FORTRAN-77 and validated for reported case histories in the literature. This study also can be extended to the other types of reinforced earth systems like segmental walls, mechanically stabilized reinforced earth walls, etc. The system is modeled as a plane strain two-dimensional problem. [19]

Zoran Bonic Zoran Bonic Nebojsa Davidovic, Verka Prolovic, Nikola Romic (2015) in contemporary construction practice is increasingly being applied flexible retaining structures of mechanically stabilized earth, gabions and precast elements. Although widely used only recently, their benefits are proven and widely accepted. The first part of the paper provides an overview of the possible ways of using precast elements in the construction of retaining walls. The second part gives a detailed overview of the experimental testing of the stability of retaining walls of prefabricated Beton Blok elements. [20]

Bindurani.P, A. Meher Prasad, Amlan K. Sengupta (2013) Precast concrete systems represent an efficient alternative for building construction. The behavior of a precast system depends on connections and it should be modeled properly in the computational models for analysis and design. This study presents the modeling of connections in a wall-type precast building system. A case study on a 23-storeyed building, made up of precast wall panels and slabs, to study the modeling of vertical joints in terms of shear transfer, is presented in the paper. Two computational models were investigated to find the effect of modeling the vertical joints between the wall panels, on the drifts and the generated forces in the walls. It was observed that the model, which was not considering any shear transfer through the vertical joints, tends to provide conservative results in terms of the amount of steel requirement. [21]

Fabio Biondini, Alessandro Palermo & Giandomenico Toniolo (2010) this paper aims to investigate the seismic performance of this type of structure considering the material degradation induced by the diffusive attack of aggressive agents, like sulphate and chloride, that may lead to deterioration of concrete and corrosion of reinforcement. The time-variant structural performance of the critical cross-sections of the columns, where plastic hinges are expected to occur during a seismic event, is investigated in terms of bending moment versus curvature relationships. [22]

Anitha Nelson And P. K. Jayasree (2010) This paper discusses the response of these walls in terms of lateral facing deflection, reinforcement tensile force and crest surface settlement when subjected to seismic loading simulated utilizing a variable amplitude harmonic vibration using the finite element analysis package, PLAXIS V8. From the study, it was found that there is a significant effect of seismic loading on the response of reinforced soil walls and the analyses and design of these walls are to be done only after considering the dynamic earthquake loading in seismic prone areas. [23]

Jiri Witzany, Tomas Cejka And Radek Zigler (2010) In particular the determination of residual strength and modulus of elasticity in compression included research oriented towards the effect of moisture and porosity on the respective characteristics of masonry units – bricks, sandstone and arenaceous mark partial results published in and in this paper testify to the need for further research into the effects of porosity, moisture and chemist on the development of characteristics of building materials applied on historical structures. [24]

E. Guler, M. Hamderi and M. M. Demirkan (2007) the failure mechanisms of reinforced soil segmental walls with extensible reinforcements were studied by performing a numerical analysis using the finite element method. The numerical approach was first verified against the results of three instrumented full-scale structures reported in the literature. Finite element models with different combinations of reinforcement spacing, reinforcement length and backfill soil were analyzed. The –c reduction method, which is a special shear strength parameter reduction technique, was applied to simulate the failure conditions. [25]

Stefano Pampanin (2005) In this paper, an overview of recent developments and on-going research on precast concrete buildings with jointed ductile connections, relying on the use of unbounded post-tensioned tendons with self-centering capabilities, is given. A critical discussion on the conceptual behavior, design criteria and modeling aspects is carried out along with an update on current trends in major international seismic code provisions to incorporate these emerging systems. Examples of existing on-site applications based on a recently developed cable-stayed and suspended solution for frame systems are provided as further confirmation of the easy constructability and speed of erection of the overall system. [26]

III. CONCLUSION

This paper focuses only on the literature review of previously published studies. The gap findings of this study the presence of masonry infill influences the overall behaviour of structures when subjected to lateral forces Joint. When compared the displacement result of the frame with an interlocking block wall, brick wall, and frame without any

infill wall (bare frame) it has been observed. Numerical analysis based, on the one hand, on mathematical models and, on the other hand, on insufficiently accurate material and physical models, may lead to erroneous conclusions, but it may also be the cause of a faulty reconstruction concept and a subsequent appearance of structural failures and defects. The conceptual innovation introduced by capacity design principles as part of the design approach for ductile systems has led in the mid-1970s to the revolutionary implication in seismic design philosophy. The future scope for the study is that one can analyze precast retaining wall built using interlocking blocks on ANSYS software for maximum principal stress, normal stress, and deformation and compare the results with the RCC wall to see which is more economical. Further compare both walls with El Centro data to check earthquake stability, under dynamic loading conditions.

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