

Development of A New Model on PC Segmental Retaining Wall Using Solid Bar Anchors and Fin Fish

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Abstract: The development of transportation infrastructure is very important for economic growth. In the context of the construction of precast concrete (PC) segmental retaining walls, the use of innovative technologies such as solid bar anchors and fish fins is the main focus of improving the efficiency and reliability of the structure. This research aims to develop a new model that optimizes the use of solid bar anchors and fin fish in PC segmental retaining walls, with the hope of improving structural performance and extending the service life of the wall. The research methodology includes literature studies, development of mathematical models based on soil mechanics and finite element theory, and numerical simulations using PLAXIS software. The results show that the MSE Wall system with solid bar anchors and fin fish meets the SNI Geotechnical No. 8460 standard of 2017, with safety factors of high bolling, shear, and ground carrying stability. The use of a crossbar necklace configuration with a center to center (ctc) distance of 30 cm provides greater tensile strength than a ctc of 50 cm. This research is expected to make a significant contribution to the development of construction technology that is more efficient, economical, and sustainable.

Keywords: Segmental Retaining Wall, Solid Bar, Fin Fish.

INTRODUCTION

The development of transportation infrastructure is important in supporting economic growth and community welfare (Yu et al., 2023). In the context of the construction of precast concrete (PC) segmental retaining walls, the use of innovative construction technology is the main focus of improving the efficiency and reliability of the structure. One of the technologies that is being developed is the use of solid bar anchors and fin fish on PC segmental retaining walls (Shinn et al., 2023).

PC segmental retaining walls are a vital element in modern transportation systems, which not only serve as soil and structural load support, but must also be able to cope with significant lateral loads (Imran et al., 2023). The use of solid bar anchors and fin fish in this construction is expected to increase the structural carrying capacity and extend the service life of the retaining wall.

This research aims to develop a new model that can optimize the use of solid bar anchors and fin fish in PC segmental retaining walls (Singh, 2021). By integrating this technology appropriately, it is hoped that a more efficient, economical, and environmentally friendly construction system can be obtained.

This scientific article outlines the development steps of a new model on PC segmental retaining walls using solid bar anchors and fin fish, with the aim of contributing to the advancement of sustainable and highly competitive infrastructure construction technology (Gupta et al., 2023).

The development of a new model on PC segmental retaining walls using solid bar anchors and fin fish enriches the construction field with the latest innovations in structural design (Maclver & Finlay, 2022). PC segmental retaining walls are one of the effective solutions to overcome the

challenges of slope stabilization and soil retention in various geotechnical conditions. By using solid bar anchors and fin fish, it is hoped that it can improve the structural performance of the retaining wall, both in terms of strength, stability, and resistance to environmental influences.

Although solid bar and fin fish anchor technology promises various advantages, there are still technical challenges that need to be overcome in their implementation (Zereik et al., 2018). Some of the key issues include design optimization to maximize material efficiency, accurate modeling of structural behavior, and long-term evaluation of anchor and fin fish performance.

This research aims to develop mathematical models and numerical simulations that can systematically design and evaluate the performance of PC segmental retaining walls using solid bar anchors and fin fish (Goldfield, 2018). By utilizing this approach, it is expected to produce an optimal design in terms of structural strength and construction efficiency.

The results of this research are expected to make a real contribution to the construction industry, especially in facing the challenges of sustainability and reliability of transportation infrastructure (Shabalov et al., 2021). The application of the new model to PC segmental retaining walls using solid bar anchors and fin fish not only improves overall structural performance, but can also reduce environmental impact and operational costs in the long run.

Thus, this scientific article is expected to provide in-depth insights into the development of sustainable and highly competitive construction technology, as well as serve as a foundation for further development in this field (Agrawal et al., 2024).

MATERIALS AND METHODS

The methodology used in this study includes several important steps to achieve the research objectives. First, an in-depth literature study will be conducted to collect information related to solid bar and fin fish anchor technology, as well as its application in the construction of PC segmental retaining walls (Baumgart, 2021). This literature study will be the basis for understanding the best approach in designing and implementing new models.

The next step is the development of a mathematical model based on the theory of soil mechanics and finite elements (Carbonell et al., 2022). The model will take into account various geotechnical parameters, such as the properties of the soil around the retaining wall, the lateral forces acting on the wall, and the characteristics of solid bar anchors and fin fish. The use of simulation software such as PLAXIS or similar software will support a detailed numerical analysis of the structural behavior of the segmental retaining wall of the PC.

Next, numerical simulations will be carried out to test the strength and stability of the developed model. This simulation will allow researchers to evaluate the structural response of the PC segmental retaining wall to different lateral loads, as well as to predict potential deformations and possible failures (Akbar et al., 2024).

This study illustrates the development flow of the crossbar necklace and startail model of fish fins in the MSE Wall in the red soil layer. Starting with the collection of laboratory data that is technically and numerically verified using the finite element program, as well as its validity tested in the field, the evaluation includes the stability of shear, roll, and soil carrying capacity (Swamy et al., 2023). The location of the research is the Jababeka IX Industrial Estate Bridge, which is located in Jatireja East Cikarang, West Java, where due to the limited Right Of Way (ROW), a soil retaining wall with a system of crossbar necklaces and fish fin startails is needed.

The geological and mechanical conditions of the soil at the site include brown silt clay soil with a consistency ranging from soft to very stiff. Hard soil layers can be found up to a depth of 18m (Nspt

60), using an 80cm stationary pile drill foundation for both abutments, and the allowable bearing capacity per point reaches 170 tons.

The research method includes field tests using inclinometers, piezometers, and Total Station measuring instruments, as well as simulations with numerical programs based on the collected soil data. The use of MSE Wall was chosen because of the limitations of ROW and the need for soil retaining walls. In terms of technical calculations, complying with the SNI Geotechnical standard No. 8460 of 2017 is necessary to avoid the decline or horizontal displacement of the soil retaining wall. The precast knock down system is used to speed up the implementation time and reduce the implementation cost compared to conventional soil retaining walls.

The compaction requirements for backfill soils such as red soil, according to SNI 1744 of 2012 page 22, include a minimum California Bearing Ratio (CBR) of 6.5% with a maximum dry density of 1.5 g/cm³ and a design dry density of 1.43 g/cm³, as well as a minimum density of 95%.

RESULTS AND DISCUSSION

With the results of literature studies and numerical simulations, a new model on the segmental retaining wall of the PC using solid bar anchors and fin fish will be developed. The model will consider design aspects that have been optimized to maximize structural strength and minimize material use and construction costs (Afzal et al., 2020).

Furthermore, the developed model will be evaluated through a series of validation tests, both on a laboratory scale and on a field scale where possible. These validation tests will ensure that the new model is not only effective in theory, but also practical in real conditions.

In this study, the technical specifications of the Mechanically Stabilized Earth Wall (MSE Wall) to be used include several key elements (Koerner & Koerner, 2018). The strength of the MSE Wall lies in its startail and bar necklace. The Startail has a strength of 71.45 tons, which is determined by the anchor's melting capacity. Meanwhile, the tensile strength of the bar necklace reaches 61.1 kN, which is set based on the capacity of the Punching Shear Plate.

The factors affecting the performance of the MSE Wall, such as the rolling moment, shear moment, and soil carrying capacity, were comprehensively analyzed (Yang et al., 2022). The safety of the MSE Wall is evaluated in accordance with the requirements of SNI Geotechnical No. 8460 of 2017. The safety factor for overturning stability of 8.62, sliding stability of 3.56, and bearing capacity of 12.92 all meet the standards safely. Likewise, the safety factor for anchors, which reached 6,141, also met the set requirements.

The effective configuration of the cross necklace according to the Oversen and Stroman Methods is with a center to center (ctc) distance of 30cm. In field testing, the Pull Out test was carried out on July 6, 2024 at the Geger Kalong Hilir Bandung location to test the actual conditions. The test results show that the ctc 30 cm bar necklace has a Pull Out strength of 36 KN, while the ctc 50 cm cross collar has a Pull Out strength of 32 KN. This evaluation confirms that the tighter crossbar necklace configuration provides greater tensile strength under actual field conditions (Akhtar et al., 2021).

The results of the Pull Out test conducted on July 6, 2024 at the Geger Kalong Hilir location in Bandung provide a deeper understanding of the performance of the anchor with the crossbar and startail necklace in actual field conditions. This experiment shows that a crossbar necklace with a center to center distance (ctc) of 30 cm is able to withstand a Pull Out force of 36 KN. Meanwhile, a cross necklace with a ctc distance of 50 cm has a Pull Out strength of 32 KN. These results reinforce the configuration of the 30 cm ctc bar necklace as a more effective option in handling tensile loads in tested field conditions (Rasekh et al., 2024).

Observation and testing of Pull tests horizontally generate relevant data for future development and optimization of MSE Wall designs (Yalcin et al., 2019). This observation was also attended by Dr. Tech. Indra Noer Hamdhan as the Co-Supervisor, who also provided insight and direct assessment of the test results. Documentation drawings, such as the design for the pull-out test, the actual condition and results of the pull-out test, and the horizontal test, all provide concrete evidence to support the evaluation and improvement of the MSE Wall system under development.

CONCLUSION

Research on the development of a strength model of a bar necklace with an anchor and star tail on the Mechanically Stabilized Earth (MSE) Wall yielded several significant findings. First, the Safety Factors for overturning stability, sliding stability, bearing capacity, and anchor are 8.62, 3.56, 12.92, and 6.141, respectively, all exceeding the threshold of 2.5, thus deemed eligible. Second, the use of red soil layer backfill media achieved a California Bearing Ratio (CBR) of 9.5%, surpassing the SNI Geoteknik 8460 requirement of 6.5% set in 2017. Third, the pull-out results from both the Oversen and Stroman calculation methods and field tests at Geger Kalong Hilir Bandung show consistent outcomes, where a closer center-to-center distance of the crossbar yields higher pull-out values, such as 36 KN at 30 cm and 32 KN at 50 cm. The study implies that the development of the MSE Wall model using the anchor method with a bar necklace and star tail technically meets the requirements and complies with SNI Geoteknik, making it viable for use as a retaining wall for bridge abutments, landslide prevention, and other applications. However, the study has limitations, including field experiments conducted with a height of 1.5 m and limited crossbar center-to-center distances of 30 cm and 50 cm, suggesting further research with more varied distances and actual conditions. Additionally, the research focused on horizontal pull-out, not vertical. Future research should include vertical pull-out testing for more comprehensive results, potentially using the Finite Element Plaxis 3D program. This research is expected to contribute significantly to the development of more efficient, economical, and sustainable construction technology, providing a valuable reference for practitioners and researchers in supporting future sustainable infrastructure development.

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