WWW.IJRPR.COM

International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

A Review on Numerical Study of Secant Pile Wall Behavior

Dharmendra Vishwakarma[1], Dr. Ashish Kant Ahirwar[2]

[1]M.Tech. Scholar, School of Civil Engineering, Faculty of Engineering and Technology, Madhyanchal Professional University Bhopal, M.P
[2]Assistant Professor, School of Civil Engineering, Faculty of Engineering and Technology, Madhyanchal Professional University Bhopal, M.P

ABSTRACT

The implementation of fast and cost-effective shoring systems has become essential to address technical challenges such as variable soil and rock profiles, high groundwater tables, and restrictions imposed by urban environments. Secant pile walls, constructed by overlapping reinforced and unreinforced piles, offer a versatile solution for almost all subsurface conditions. They are particularly effective in hard ground where diaphragm walls are impractical and in rocky terrains. This study examines the behavior of secant pile walls, emphasizing their application in diverse ground conditions and their role in mitigating vibrations in machine foundation design. Key aspects analyzed include earth pressure distributions exerted on the wall, as well as its performance under varying soil and rock conditions. The research also evaluates the impact of ground vibrations on surrounding structures, considering mitigation strategies such as open trenches, in filled trenches, and pile rows. Numerical simulations provide insights into the structural and geotechnical performance of secant pile walls, contributing to the optimization of design parameters for challenging construction scenarios.

Keywords: Underground structures, Geo-factual reports, dynamically changes, GFR/GIR, Crete concrete.

Introduction

The three alternatives for primary piles in secant pile walls typically depend on the project-specific requirements and constraints. Each alternative is chosen based on a balance of project requirements such as cost, construction speed, lateral load capacity, water-tightness, and durability. Applications Ideal in situations with high groundwater presence or where impermeability is a key requirement. Composition Primary piles made with a mix of cement, betonies, or soil-cement slurry. More expensive and time-consuming to construct compared to unreinforced lean concrete. Secant pile walls are an advanced retaining wall system that is especially effective in environments requiring resistance to groundwater infiltration.

Primary Piles: The first set of piles, referred to as primary piles, are constructed. These typically serve as the foundational structure of the wall.

Secondary Piles: Once the primary piles achieve sufficient strength, secondary piles are installed between the primary piles. These overlap with the primary piles to create a continuous barrier.

Auguring: Piles are constructed using auger drilling techniques to excavate the soil before filling the void with concrete and reinforcement.

Continuous Flight Auger (CFA): A specialized technique where concrete is pumped through a hollow stem auger as it is withdrawn, reducing the risk of soil collapse and ensuring efficient pile formation.

Cased CFA Technology: Enhances the process by using a casing, offering improved control over pile formation in challenging soil conditions.

Overlap: The typical overlap between the piles is approximately **8 cm**, ensuring structural.

The **Secant Piling Method** is a construction technique used to build retaining walls, often employed in situations where space is limited, watertight walls are required, or the wall will be integrated into a larger structural system.

Basements and Underground Structures: For supporting excavations and providing watertight walls.

Motorway Cuttings and Bridge Abutments: To secure slopes and minimize space usage.

Urban Construction Sites: Particularly where space is constrained due to nearby buildings or infrastructure.

Literature Review

Bontha Dhileep Surya at all (2023) – NUMERICAL MODELING OF SECANT PILES. - This study presents numerical modeling of a secant pile wall and investigates the lateral displacements, as well as the pressure exerted on the secant pile wall due to the existing soil. The analysis was performed

using a finite element method software package, which simulates the behavior of the soil-pile interaction system under various soil conditions. The numerical model considers the geometrical and material properties of the soil, pile, and concrete infill, as well as the effects of water pressure, soil swelling, and ground movement on the stability of the wall.

V. j. Gowthaman at all (2023) – PARAMETRIC STRUDY ON THE PERFORMANCE OF THE TEMPORRY SECANT PILE WALL. - This paper is focusing on the performance of secant pile wall due to various parameters like diameter of secant pile, overlapping distance of primary and secondary piles, material of pile, drained and untrained conditions of the soil, and struts and anchor configuration using finite element analysis.

V Silva at all (2023) – FINITE ELEMENT ANALYSIS OF A DEEP EXCAVATION SUPPORT USING A SECANT PILE WALL: A CASE STUDY. - This study suggests recommendations for selecting appropriate parameters and correct modelling procedures in the FEM of deep excavations using measured field data using two dimensional analysis. Previous studies indicate that the elastic modulus (E50) of the soil can be increased several times to obtain the unloading-reloading stiffness (Euro) of the soil during deep excavation.

Jigar Shah at all (2020) - COMPARATIVE STUDY OF DIAPHRAGM WALL SUPPORTED BY ANCHORS VERSUS TUBE SHORING. - case study of mixed use of diaphragm wall and secant pile wall as an earth retaining structure for deep excavation is reported. A shoring wall of approx. 26m deep from existing ground level is designed for proposed construction of four basements and multi-story building. Diaphragm wall of 1m width and Secant pile wall of 1.2m diameter have been analyses by using finite element method with Plax is 2D software in which they have been modelled as plate elements, ground anchors as node to node-to-node elements with embedded piles for fixed length, strut pipes as fixity points and soil layer and rock layers modelled as Harding Soil and Mohr Coulomb models respectively.

D N Sunjaya at all (2020) - ANALYSIS OF SOME FAILURE REDUCTION ON PRIMARY PILE IN THE SECANT PILE SYSTEM. - The analysis on this study is the failure analysis on retaining wall type secant pile. This analysis will be focusing on the failure that happen on primary pile. The analysis is done by reducing the strength of the primary pile based on the potential failure that might happen. This aims to test the deformation on the secant pile system, if there's a failure on the primary pile. It will be done in two different types of soil, clay and sand.

Aswin Lim, at all (2019) – PERFORMANCE AND MODELING OF SECANT PILE REINFORCED BY SOIL NAILING FOR URBAN EXCAVATION IN JAKARTA. - The results showed that the measured soil modulus obtained from Pressure meter could be used a basis for determining soil modulus input parameters, rather than using empirical correlations. The shape of wall deflection was a cantilever shape and the maximum wall deflection was 45 mm. Also, the computed wall deflection was agreed with the measured data. Moreover, the parametric study on the soil nailing length and inclination also conducted to investigate the deformation characteristic of this retaining wall system.

A. Mahesh at all (2019) – EFFECT OF DIAMETER OF SECANT PILE WALL IN DEEEP EXCAVATION ANALYSIS. - In this paper, an attempt has been made to study the effect of secant pile wall capacity, lateral displacement and bending moment of wall from elastic and plastic stage by using Time History analysis.

Meng Cui at all (2019) – APPLICATION OF SECANT PILES FOR EXCAVATION PIT IN COMPLICATED ENVIRONMENT. - this paper takes an actual foundation pit project as the research background and combines the characteristics of the deep excavation of the foundation pit and the large influence of the groundwater level. Propose the design scheme of partition and segment and use finite element analysis method for numerical calculation.

Jitesh T. Chavda at all (2019) – LATERAL RESPONSE OF CONTINGENCIES PILE WALL SUBJECTED TO STAGED EXCAVATION: PHYSICAL AND NUMERICAL INVESTIGATIONS. - In this paper, the lateral response of a contiguous pile wall retaining system under staged excavation is investigated using physical modelling. The effect of pile stiffness on pile wall deformation is studied by changing the diameter of pile. Numerical simulation of the physical response of the pile wall is studied using the finite element program PLAXIS-3D.

Julius Emmanuel Emuriat at all (2017) – PARAMETRIC STUDY ON ANALYSIS AND DESIGN OF PERMANENTLY ANCHORED SECANT PILE WALL FOR EARTHQUAKE ENGINEERING. - , this study is focused on secant pile walls. The secant pile methodology comprised the formation of overlapping concrete piles. The overlap between the piles is achieved to prevent soil and ground water ingress. The analysis of these deep excavations requires considerations of; nonlinear, dynamic and complicated system and involves consideration of soil parameters, deformation, interaction of soil and retaining configuration.

Amin Eslami (2015) – STUDY OF BORED PILE RETAINING WALL USING PHYSICAL MODELING. - n this study, the behavior of one important type of supporting systems called Contiguous Bored Pile (CBP) retaining wall is investigated using a physical model. Besides, a comparison is made between two modes of free end piles (soft bed) and fixed end piles (stiff bed).

Hadi Suroor Tolunay at all (2008) - DESIGN AND CONSTRUCTION OF CIRCULAR SECANT PILE WALLS IN SOFT CLAYS. - This paper presents design and construction aspects of two similar circular Liquefied Natural Gas (LNG) impoundment basins in deep soft clays. Each basin has a design spill containment volume of 70,630 cubic feet. The inside diameter of each basin is 60 ft; bottom of the excavation is 32 ft below grade and the excavation retained permanently by concrete secant pile walls. The circular wall is constructed of 3 ft nominal diameter concrete piles overlapping adjacent piles by 6 in; the wall penetrates 60 ft below grade. Excavation stability during construction is the primary concern in soft clays; an inadequate retention system could experience large wall movements and stresses as well as excavation bottom heave often resulting in failure. A finite element analysis (FEA) was performed to evaluate overall stability of the wall and excavation using axis-symmetric model and to design an excavation-wall system which yields a minimum factor of safety of 1.3 during construction.

Hong Won Pyo at all (1985) – A STUDY ON DESIGN OF EARTH-RETAINING STRUCTURES CONSTRUCTED BY A ROW OF BORED PILES. - A row of bored piles has been used in several excavation works to retain the earth. This excavation bracing system has much effect on low-vibration and low-noise during construction. The system is also effective to provide protection to the adjacent existing ground and structures. For the purpose of establishment of a logical design method for the bored piles, first, a theoretical equation to estimate the resistance of piles is derived. Because arching action of soils between piles is considered in the equation, the characteristics of soils and the installation condition of piles would be considered logically from the beginning.

Conclusion

Secant piling is a versatile and robust method for deep excavation support, particularly in challenging conditions involving high groundwater levels and variable soil or rock profiles. Here's an overview of how secant piling addresses these challenges. Secant pile walls form an overlapping barrier that significantly reduces water ingress into excavation sites. By using techniques like incorporating grout or specialized waterproofing materials between piles, these walls can achieve excellent water tightness. The overlapping nature of secant piles allows for the construction of continuous retaining walls in heterogeneous ground conditions, accommodating changes in soil and rock strength or stratification. The interlocking piles provide a combination of rigidity and flexibility to withstand lateral loads and high hydrostatic pressures, making them suitable for deep excavations. Piles can be reinforced (with steel or concrete) to varying extents based on load and soil conditions, enabling tailored designs for specific projects.

References

1. Ali Chehadeh,AlperTuran,Farid Abed, Numerical investigation of soil structure interaction for secant pile wall circular shafts, Journal of computers and geotechnics,Issue 69,June 2015,pages 452-461.
2. Shao-Ming Liao,Wen-Lin Li,Model test on lateral loading performance of secant pile walls, Journal of performance of constructed facilities,ASCE,Volume 28,April 2014,pages 391-401.
3. Venkat RamasubbaraoGodavarthi,DineshbabuMallavalli, Contiguous pile wall as a deep excavation supporting system,Journal of Practices and Technologies,Issue 19, December 2011Pages 144-160
4. Development of secant pile retaining wall construction in urban New Zealand, Project report by Nick Wharmby. 5.Farmer I. W., &Attewell P. B.,"Ground Movements Caused by a BentoniteSupported Excavation in London Clay," Geotechnique, 1973, 23
5. Ng C. W., & Yan R. W., "Stress Transfer and Deformation Mechanisms around a Diaphragm Wall Panel," Journal of geotechnical and geoenvironmental engineering, 1998, 124(7), pp. 638-648
6. FHWA-NHI-14-007 (2015): Soil Nail Walls Reference Manual
7. LITTLEJOHN G.S. (1980), "Design Estimation of Ultimate Load-Holding Capacity of Ground Anchors".
8. JB Burland, JR Standing, "Building response to tunneling Case studies from construction of the Jubilee Line Extension, London VOLUME 1".
9. IS:10270-1982: Guidelines for Design and Construction of Prestressed Rock Anchors.
10. Building response to tunneling Case studies from construction of the Jubilee Line Extension, London VOLUME 1; JB Burland, JR Standing. Page-62