PhD Dissertation Title:

**"Verification of Methods for Calculating Horizontal Displacements of Steel Sheet Piles"**

**Author:** MSc Eng. Tomasz Żyrek

**Supervisor:** Dr. habil. Eng. Marian Łupieżowiec, Prof. PŚ

## Abstract

This thesis involves the verification of methods for calculating horizontal displacements of steel sheet pile walls, based on a comparison of results from analyses conducted using selected calculation methods with field measurement results. The thesis is divided into several chapters.

The first chapter, introductory in nature, provides a general overview of steel sheet pile walls.

The second chapter outlines the aim, scope, and the thesis statement of the work.

In the third chapter, various calculation methods used in engineering are analyzed. The review includes both classical methods and the dependent earth pressure method. The differences between these methods, their advantages, disadvantages, and practical usefulness in design are discussed. Special attention is given to the finite element method (FEM), which accurately represents the interaction between the structure and the ground. The thesis extensively discusses the *"HS-Brick"* model, the latest version of the *"Hardening Soil"* model, which accounts for changes in soil stiffness under small deformations.

The fourth chapter addresses the measurement methods for horizontal displacements of sheet pile walls. Geodetic techniques and inclinometer measurements, which allow for monitoring of structural displacements, are described. A characterization of four test sites, where displacement measurements of sheet pile walls were conducted in various static configurations (such as cantilever walls and walls anchored at one or several levels), is also provided.

The fifth chapter describes the computational analysis and modeling of sheet pile walls using the finite element method (FEM). The chapter presents the modeling assumptions and the method of determining geotechnical parameters based on laboratory and field tests. The interaction between the wall and the ground is also discussed.

The sixth chapter is the key part of the thesis, involving a comparison of results obtained from calculations using different methods with actual displacements measured *in-situ*. This analysis allowed for identifying the differences between the calculation results and actual measurements, enabling an assessment of the usefulness of the various calculation methods.

The final part presents conclusions based on the comparative analysis of calculated and measured displacements. The study achieved qualitative and quantitative agreement between the results of 2D FEM analyses and *in-situ* measurements.

Gliwice, 15.10.2024r.