New developments in the design of Z-shaped steel sheet pile walls

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Abstract

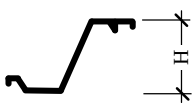
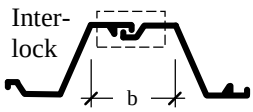
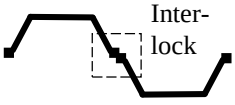
Harbour constructions like quay walls or excavation supports in civil engineering are often built up with steel sheet pile walls. Aside of U-steel sheet piles also Z-shaped piles with interlocks are widely used in such constructions. The pressure on costs and efficiency and the competition in this field leads to the necessity of increased efficiency in the design of steel sheet pile. To benefit from the potentials in the bending moment capacity of semi-compact Z-shaped steel sheet piles, the University of Stuttgart carried out four-point bending tests. A FE-model was developed and validated by back calculating the experiments. Investigations on the bending moment capacity were executed with the validated model followed by an extensive parametric study. Among different Z-piles, the actual geometries and the steel grades were varied leading to a different compression flange slenderness. In addition, different lock states were taken into account to investigate the impact on the bending moment capacity. In the end, three resistance models were evaluated for further development of Eurocode 3 Part 5.

Keywords: steel sheet piles; development of design rules; quay walls; harbour constructions;

1 Introduction

The cross-sections of steel sheet piles can be classified in class 1, 2 and 3 according to Eurocode 3 Part 5 [6]. Developments regarding to the bending moment resistance of semi-compact cross-section are planned in the draft EC-3 Part 1-1 [15], taking into account a partially plastic state to design double symmetric steel cross-section in building construction.

Table 1. U- and Z-shaped steel sheet pile sections as a single- and double-pile with interlock detail.

	Single Pile	Double Pile
Z-Piles		
U-Piles		

A semi-plastic design leads to a more economical design of steel sheet pile walls and fits better with regard to experimental results. The cross section of Z-shaped intermediate piles must be designed under high normal forces and bending moments due to earth pressure as well as vertical loads. With regard to the cross section verification, Eurocode 3 Part 5 [6] differs from the draft EC-3 Part 1-1 [15]. The aim here is to ensure the consistency of the codes and at the same time guarantee an economical design. Thus, experiments and numerical investigations were carried out at the Institute of Structural Design and the Materials Testing Institute at the University of Stuttgart within the FOSTA research project together with Prof. Grabe and his team, as a partner from Geotechnics at the TU Hamburg Harburg. A FE-Model was validated to execute a parametric study with different Z-shaped steel sheet piles leading to direct design recommendations for practice. The close collaboration between geotechnics and steel design allows an interesting transfer of knowledge.