



Combining Bored Tunnels: Optimal Construction Order of Multiple Independent Shield-Driven Tunnels

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Abstract

A three-tunnel configuration was proposed to strengthen the North-South connection in Brussels. The optimal construction order of the bored tunnels, mainly focusing on the settlements and deformations of the surrounding soil mass is investigated here. All two-tunnel and three-tunnel construction orders are investigated by mainly focusing on the surface settlements calculated with Plaxis 2D. An extended variant of the grout pressure method is developed to also incorporate the relative magnitude of the different settlement components due to shield tunneling. The accuracy of a simplified version is simultaneously tested by comparison of the obtained final settlement troughs. The influence of the constitutive model on the settlement values is also verified. More specifically, the difference in results between the Mohr-Coulomb model and the Hardened Strain model with small strain stiffness is investigated. Finally, a simple empirical superposition principle is established based on the method of Peck to approximate the Plaxis results. The research is based on the geometry of and other assumptions made for a new tunnel connection in Brussels but presents a general overall design concept. The results can thus be generalized to other multiple tunnel configurations.

Keywords: Multiple tunnels, Settlements, Construction order, Grout pressure method, Plaxis 2D.

1 Introduction

Brussels has the largest mobility issues in Belgium. To tackle these issues, kilometers of new metro lines including new substations are going to be built. Part of the plan is to strengthen the North-South connection starting from Schaarbeek. To minimize the amount of disruption to the daily city life, that part of the metro expansion is completely tunneled.

For the tunneled part between the main North and Central stations, a new type of tunnel design was proposed. In general, a tunnel diameter is chosen in function of the required space that is

requested. The tunnel diameter is limited, therefore when more space is desired the roads or rails are fitted into two tunnels. The idea was to construct three smaller tunnels with TBMs and to also utilize the area, enclosed by the three tunnels, as functional space. Combining multiple tunnel tubes into a larger whole of independently drilled tunnels is a delicate operation. The University of Ghent has been asked to further investigate the feasibility of the idea for the North-Central connection. Focusing on the settlements and deformations of the surrounding soil mass is investigated here.