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Effect of accounting rockbolts in the numerical analysis on the surface settlements of Steinhaldenfeld tunnel

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ABSTRACT

The Steinhaldenfeld tunnel is located in the north-eastern part of the city of Stuttgart, Germany. The construction of this tunnel was carried out between the Hauptfriedhof and Steinhaldenfeld station, including two cut and cover parts of each 110 m length at the tunnel portals and a conventionally constructed part of 940 m length in between. Several numerical studies have been performed to predict the magnitude of induced surface settlements (Ref. [4], Ref. [6]).Throughout the studies some simplifying assumptions have accounted for modelling of tunnel installation procedures, like assuming a zone with increased cohesion around tunnel instead of modelling of rockbolts. Thus, the reported results from numerical studies differ from what discovered in the field. These differences consist of steepness of the settlement trough, which is more steeped in the case of discovered data, and the magnitude of settlements, which are smaller in the case of field data. This research is focusing on how modelling of rockbolts in the numerical analysis can affect the induced surface settlements and the settlement trough shape. Results indicate that the modelling using rockbolts (instead of grouting zone) yields more accurate surface settlements with regard to the discovered data in the field. However, both modelling cases supply wider settlement troughs with less inclined shape relative to the settlement trough in the field, which means they do not provide conservative results for risk assessment of surface structures.

KEYWORDS

Steinhaldenfeld tunnel, Numerical analysis, Rockbolt, Surface settlement.

1. INTRODUCTION

The new Austrian Tunnelling Method (NATM) emerged in the years 1957 to 1965 and was entitled in this way to be distinguished from the old Austrian tunnelling method. Its main idea is to head the tunnel conventionally, to apply support (mainly shotcrete and systematic installation of anchors) and to follow the principles of the observational method. The NATM requires the distortion of the ground to be kept to a minimum in order to avoid softening and consequently loss of strength. Nevertheless, at the same time sufficient ground deformations should be allowed in order to mobilise the strength of the ground. Consequently, thick and stiff linings that do not completely abut on the rock are no longer in use. The use of versatile supporting means to increase the stability of softer grounds is also associated with a reduction of ground deformations. This is of utmost importance for the control of tunnel-induced deformations to nearby existing structures.

The mechanical properties of surrounding medium (from hard rock to soft soil) of a tunnel in terms of stiffness and strength can be improved by the installation of various types of reinforcement such as rockbolts, dowels and anchors. In this way, the surrounding medium is compressed and, consequently, its stiffness and its strength increase (Ref. [2]). Application of such reinforcements is essential to protect