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A Numerical Investigation of Segmental Lining Joints Interactions in Tunnels-Qomrud Water Conveyance Tunnel

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Abstract

A comprehensive analysis of segmental lining joints can assist to guarantee a safe construction during tunnelling and serviceably stages. This paper has thoroughly investigated the interaction mechanism of precast concrete lining joints in tunnels. The Universal Distinct Element Code (UDEC), a two-dimensional numerical program based on the distinct element method (DEM) for discontinuum modelling, was implemented to simulated a typical segmental lining model consisting of six segment rings. In the analyses, the typical segmental lining design parameters of Qomrud water conveyance tunnel, aimed to transfer 100 million cu. m. water from the origins of Dez River to central Iranian desert, were employed to fulfil the purpose of the research. In the conducted analyses, the worst-case scenario of the loading faced during the boring of Qomrud tunnel was considered. This was highly associated with the existence of the crushed zone dipping at 75 degree at the location of the key segment. The worst scenario based on the condition that concerns the crushed zone intersect segmental lining at the location of key segment has been taken into consideration. In this study, the load acting on the joints of the segments includes the gravity load from the tunnel overburden and the crushed zone stratum force that intersects tunnel with 75 slopes at the location of the key segment, the gravity force of the segments and the earth pressure. The numerical investigation has been used for the different coefficients of stress concentration of 0.5, 1, 1.5, 2 and also different geological conditions of the saturated crushed zone under critical scenario.

Keywords: The Universal Distinct Element Code (UDEC); DEM Method; Contact Problem; Longtidunal Joint; Interface; Key Segment.

1. Introduction

One of the most challenging scenarios of mechanized tunneling is driving a tunnel boring machine (TBM) consistently through the mixed-face ground. In many cases, underground space development has reached the critical stage in which more favorable grounds for the excavation of underground structures have already been occupied. Tunnel layouts are often not determined according to the ground conditions, but the convenient available location and leading TBM through mixed/changing ground is an inevitable issue (Akos, 2013). Nowadays, due to lack of underground spaces for tunneling, many tunneling projects have been carried out in unfavorable ground conditions; this attitude certainly affects the precast system lining assemble by TBM after the excavation phase of tunneling. In the last decade, tunnels constructed with tunnel boring machine (TBM) have shown an increase of their diameter (Haak, 2000), and also the already congested underground space has obligated the excavation of tunnel at greater depths with unfavorable conditions leading to higher load levels [1].

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