

A Numerical Investigation of Segmental Lining Joints Interactions in Tunnels

Authors : M. H. Ahmadi, A. Mortazavi, H. Zarei

Abstract : Several authors have described the main mechanism of formation of cracks in the segment lining during the construction of tunnels with tunnel boring machines. A comprehensive analysis of segmental lining joints may help to guarantee a safe construction during Tunneling and serviceable stages. The most frequent types of segment damage are caused by a condition of uneven segment matching due to contact deficiencies. This paper investigated the interaction mechanism of precast concrete lining joints in tunnels. The Discrete Element Method (DEM) was used to analyze a typical segmental lining model consisting of six segment rings. In the analyses, typical segmental lining design parameters of the Ghomrood water conveyance tunnel, Iran were employed in the study. In the conducted analysis, the worst-case scenario of loading faced during the boring of Ghomrood tunnel was considered. This was associated with the existence of a crushed zone dipping at 75 degree at the location of the key segment. In the analysis, moreover, the effect of changes in horizontal stress ratio on the loads on the segment was assessed. The boundary condition associated with K (ratio of the horizontal to the vertical stress) values of 0.5, 1, 1.5 and 2 were applied to the model and separate analysis was conducted for each case. Important parameters such as stress, moments, and displacements were measured at joint locations and the surrounding rock. Accordingly, the segment joint interactions were assessed and analyzed. Moreover, rock mass properties of the Ghomrood in Ghom were adopted. In this study, the load acting on segments joints are included a crushed zone stratum force that intersect tunnel with 75 slopes in the location of the key segment, gravity force of segments and earth pressures. A numerical investigation was used for different coefficients of stress concentration of 0.5, 1, 1.5, 2 and different geological conditions of saturated crushed zone under the critical scenario. The numerical results also demonstrate that maximum bending moments in longitudinal joints occurred for crushed zone with the weaken strengths (Sandstone). Besides that, increasing the load in segment-stratum interfaces affected radial stress in longitudinal joints and finally the opening of joints occurred.

Keywords : joint, interface, segment, contact

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