

Modelling of Damage as Hinges in Segmented Tunnels

Authors : Gelacio Juárez-Luna, Daniel Enrique González-Ramírez, Enrique Tenorio-Montero

Abstract : Frame elements coupled with springs elements are used for modelling the development of hinges in segmented tunnels, the spring elements modelled the rotational, transversal and axial failure. These spring elements are equipped with constitutive models to include independently the moment, shear force and axial force, respectively. These constitutive models are formulated based on damage mechanics and experimental test reported in the literature review. The mesh of the segmented tunnels was discretized in the software GID, and the nonlinear analyses were carried out in the finite element software ANSYS. These analyses provide the capacity curve of the primary and secondary lining of a segmented tunnel. Two numerical examples of segmented tunnels show the capability of the spring elements to release energy by the development of hinges. The first example is a segmental concrete lining discretized with frame elements loaded until hinges occurred in the lining. The second example is a tunnel with primary and secondary lining, discretized with a double ring frame model. The outer ring simulates the segmental concrete lining and the inner ring simulates the secondary cast-in-place concrete lining. Spring elements also modelled the joints between the segments in the circumferential direction and the ring joints, which connect parallel adjacent rings. The computed load vs displacement curves are congruent with numerical and experimental results reported in the literature review. It is shown that the modelling of a tunnel with primary and secondary lining with frame elements and springs provides reasonable results and save computational cost, comparing with 2D or 3D models equipped with smeared crack models.

Keywords : damage, hinges, lining, tunnel

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