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Earthquake Induced Damage Assessment of Coal Mine Overburden Dump Slope using Extended Finite Element Method Coupled with Voronoi Tessellation Scheme

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Abstract

Seismotectonic activity in the coal mining areas is a threat to the stability of overburden (OB) dump slopes. The consequent dump failures cause the loss of innocent lives, hamper the mining infrastructure and disturb the mining activities. Thus, there is an undesirable delay in the production of coal. The challenges in obtaining the material properties of the OB dump and the heterogeneous nature of its particles forbid the assessment of earthquake induced damage in an appropriate manner. The present study utilizes multi-channel analysis of surface waves (MASW) test based material properties of an OB dump slope situated at an Indian opencast coal mine located in Jam-bad. The representation of heterogeneity in size and shape of the dump particles was done by coupling extended finite element method (XFEM) with Voronoi tessellation scheme through RS2 software. The earthquakes, Coyote (1979) and Kobe (1995) were used to perform the dynamic analysis of a coal mine OB dump consisting of two benches. Finally, the effect of peak ground acceleration (PGA) on amplification ratio and permanent deformation at different key locations of the OB dump was investigated after ten seconds of the cease of the input seismic motion. In the absence of guide-lines regarding the threshold of damage due to seismic forces on the coal mine OB dump, this work would prove beneficial for the mining authorities in the preparation of guidelines for ensuring the safety of coal mine OB dumps in earthquake prone areas.

Keywords: Coal mine overburden dump slope, Extended finite element method (XFEM), Voronoi tessellation scheme, Amplification ratio, Permanent deformation