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Geotechnical and rheological characteristics of waste materials taken from abandoned mine deposit

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According to the Ministry of Trade, Industry & Energy in Korean (MOTIE), approximately 5,000 metal mines are spread in the Republic of Korea, but almost 80% mines are still left without any proper remediation and cleanup. The physic-chemical properties of waste materials in the mountainous area are strongly affected by heavy rainfall. Failed sediments pose the largest threat to the mountain communities and environments. In particular, a significant amount of heavy metals, such as arsenic, cadmium, copper, zinc, lead etc., is introduced to soil systems. This study examined the geotechnical and rheological characteristics of waste rock materials collected from mine deposits, located in Imgi-ri, Busan Metropolitan City, Korea. We used a ring shear apparatus for geotechnical properties and a rheometer for rheological properties. The materials collected from mines are classified as gravelly sand soils. A series of drained and undrained ring shear tests were performed to examine the stress characteristics with regard to (i) shearing time dependency, (ii) shear speed dependency, and (iii) normal stress dependency. In addition, the grain crushing in the shear zone was examined to explain a high mobile failed masses. This work is also concerned with post-failure characteristics of rainfall-induced debris flows. From the rheological tests, the materials examined exhibited the shear-thinning behavior, which is the viscosity decreases with increasing shear rates. In the relationship between shear stress and shear rate, one of simplest rheological models, i.e. the ideal Bingham fluid model, is selected to examine the debris flow potential. There are positive relationships between the volumetric concentration of sediment ranging from 50% to 65% and rheological values (i.e. yield stress and viscosities). However, the difference in rheological parameters is of significance for given shear rates. The effect of wall-slip in different geometries between ball and vane-penetrated system is emphasized.