Plasticity index and mechanical bifurcation of soils and rocks

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In the field of soil mechanics, triaxial compression test is widely used to investigate mechanical properties of soils. Yielded specimens characterized by Mohr's stress circles have various deformation patterns depending on loading stages and stress ratios in spite of the same ground materials. Failure patterns of ground materials bifurcationally change to diamond, bulge and a pair of oblique shear patterns. The symmetry of deformation patterns (e.g. shear band patterns) has been illuminated by bifurcation analysis of governing equation of soil mechanics based on Cam-clay model. On the other hand, plasticity index, an empirical parameter to characterize the range of water contents where the soil exhibits plastic property, is known to describe mechanical characteristics (e.g. compressibility) of soils. However, it is an unknown theoretical relationship between mechanical bifurcation controlling the evolution of deformation patterns and plasticity index. Also the theoretical relationships between the empirical laws of soil strength and plasticity index have not been clear yet. Hence, we show that plasticity index theoretically determines deformation patterns of soils by Cam-clay model, and we prove that the index closely affects the bifurcation formulas on the basis of Shibi and Kamei (2002)’s bifurcation analysis. From the view point of the plasticity index, deformation facies representing various deformation patterns of rocks in geologic condition are controlled by mean ductility and ductility contrast, as quantitatively proposed by Uemura (1981).

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