APCOM & ISCM
11-14th December, 2013, Singapore

Factor of Safety of Tunnel

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Factor of safety has been popularly adopted for assessing the stability of slopes, while it has never been used for assessing the stability of tunnels. This may be due to the fact that the factor of safety is hardly estimated in tunnel particularly excavated in elasto-plastic medium. It should be noted that the factor of safety is in general defined as the ratio of the maximum strength of material to stress occurring in it. If we apply this definition of the factor of safety to a tunnel around which a plastic zone exists, we might have some difficulty in estimating it. Since material in the plastic zone has already been in a yielding condition, both the strength and stress of the material are identical with each other. The factor of safety therefore always becomes FS = 1.0, that is, the factor of safety does not work well for assessing the stability of tunnel.

In order to overcome this difficulty, the author proposes a strain-based approach for assessing the stability of tunnels. In the proposed approach the factor of safety of tunnels is defined as the ratio of allowable strain of material to strain occurring in the medium around tunnel. The author has proposed critical strain as an allowable strain of soil and rock, which could be well applicable for assessing the stability of tunnels. On the basis of practical experiences, however, tunnels do not fail even though strain around the tunnels becomes greater than the critical strain. This means that the tunnels are still stable even though the factor of safety becomes smaller than $FS \leq 1.0$. This may be due to the fact that a plastic zone occurring around the tunnels must be stable because it is supported by an elastic medium existing around it. In slope, on the other hand, when strain occurring in a sliding plane becomes same as the critical strain, that is FS = 1.0, the sliding plane surely slides down because there is no medium to support the sliding plane.

Considering the above mentioned difficulty in the estimation of the factor of safety of tunnel, the author proposes hazard warning levels (Level Ⅰ、Ⅱ、Ⅲ), instead of the factor of safety, for assessing the stability of tunnels. According to the hazard warning levels, a tunnel in the level Ⅲ, for instance, might not fail, even though many of problems such as large deformation, cracks in shotcrete, heaving of floor, etc occur.