On valuation of toppling base in a critical slope

Shoji Ueno[1]

[1] OYO Technical Center

A slope with reverse dip strata is generally considered as to be more stable than that with dip slope strata. However, the slope can be become to be unstable and then the detached planes (bedding plane, schistosity, fault plane, and etc.) in the stratum have a reverse dip structure with high angle and a toppling failure can be occurred. The primary causes to toppling failure are showed as follows.

1.The detached plane in the stratum may have the reverse dip structure of the high angle.

2.Both of the slope direction and the strike of detached plane have almost parallel trends within a limitation of 30 degrees intersecting angle.

3.The weak stratum should be placed in the lower part of slope.

4.The slope is restricted by side-block (i.e. the side of slope is in open state).

On the other hand, the loosening of shallow depth due to stress release and uplifting pore water pressure in the detached plane are shown as the exciting causes of toppling failure. Here, it explains three methods about the evaluation of the toppling base.

1)Evaluation from displacement of the surface observation data.

When a toppling movement on the slope is founded, it is easy to estimate the depth of toppling base from the field observation data on horizontal surface displacement and rotational displacement. That is, it is considered that ground surface displacement is caused by the rotational change from the fulcrum of toppling base. So finding the rotational angle (i.e. change of dip of strata) and horizontal displacement, the depth of toppling base is evaluated using analogical procedure based on circle line from the toppling base point.

2)Evaluation from borehole survey.

The angle of detached plane to the toppling base obtained from borehole core have lower angle than that of deeper stable part. Furthermore, the stratum is crushed in the toppling zone and permeability of those zone becomes higher. Therefore, it is necessary to pay attention to the dip of the detached plane in the core and the rate of crushing in the core and the water leak during drilling work to estimate the depth of toppling base by the core observation data.

3)Evaluation from inclinometer measurement.

A very small amount of displacement can be continued to move immediately after toppling failure to start. In such a case, it is very effective to measure inclination change using borehole casing. From the measuring data, toppling shape can be confined. Good data showing a toppling displacement can be given by careful filling of cement grout between inclinometer casing and borehole wall. Using such a procedure, toppling base was founded in the 14.5m depth and a small amount of displacement, 20mm could be evaluated with a good accuracy.