Is stereographic projection valid for predicting slope stability? A prooffrom a topographically controlled plane failure at KhunYongJe village, Korea

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1. Introduction

Massive talus flow has been threatening the KhunYongJe village (Figure 1), and the new construction activities, which may reactivation the talus flow, have been a threat to the village. According to the new road construction plan, the cause of the talus flow of the area was investigated. Simple stereographic analyses of the fracture networks at this area show that plane failure of the broken rocks along the sheeting joints are the major cause of the talus flow.

Stereographic projection is one of the most widely used methods to evaluate rock slope stability, and the methodology is described in every geotechnical textbook. However, very few valid examples, supporting the method, have been published. This study attempts to demonstrate the validity of the simple stereographic analyses of the slope stability through an example at KhunYongJe Village, Jinhae City.

2. Slope stability analysis of the area

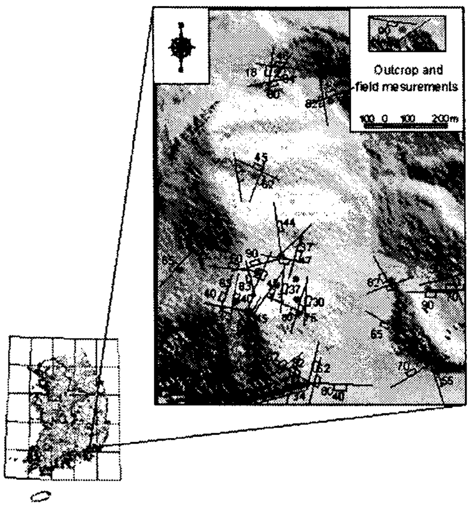

Figure 1. *Study area and fracture data from field survey. Unloading joints are presented in red symbols.*

Keywords: Stereographic projection, rock slope, stability, KhunYongJe

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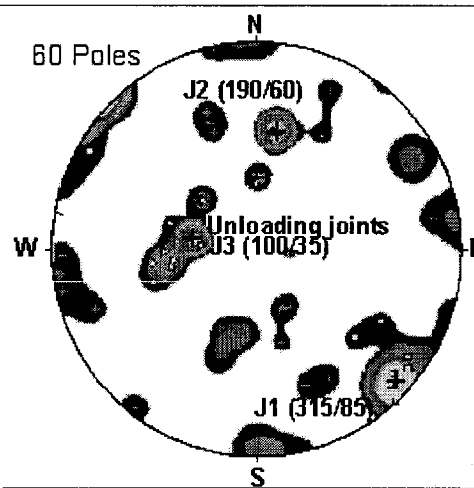
Previous rock slides stripped vegetation cover from the mountain slopes and expose barren wide fracture surfaces. The stripped vegetation areas are mapped by detailed satellite images and aerial photographs and the occurrence of talus are confirmed during field survey. Fractures orientation (strike/dip) and their properties (space, length, roughness, JRC, rock strength) are investigated at these source sites of the rock falls. Field survey indicated that the sliding surfaces are sheeting joint planes which are parallel to the topographic slope geometry.

Three major joint sets (J1, J2 and J3 in Figure 2) are found at the back slope of the KhunYongJe village. Field survey indicated that the joint group J3 (100/35) is the unloading joints which are sub-parallel to the topographic slope faces. Other high angle joint sets J1 and J2 intersects the J3 joints and the intersections create separated rock blocks as is shown in Figure 5. Sliding of these blocks along the J3 plane is the cause of the talus flow.



Set	Dip direction (^{0})	Dip (^{0})
J1	315 ± 16	85 ± 05
J2	190 ± 12	60 ± 14
J3	100 ± 18	35 ± 12

Figure 2. Lower hemisphere projection of joints in study area.

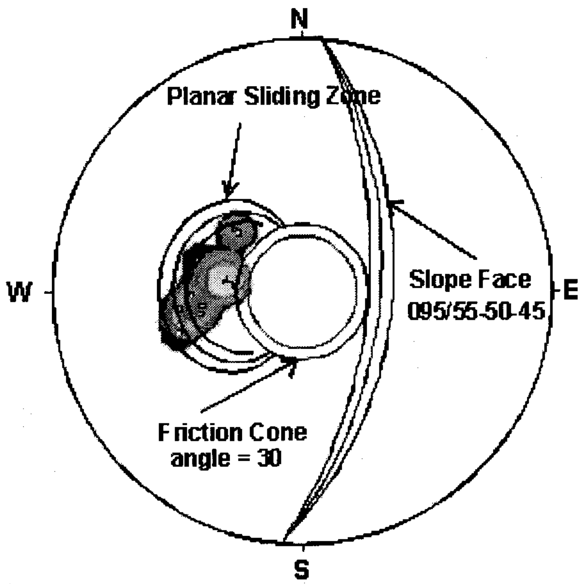


Figure 3. Plane failure analyses of unloading joints (J3), The data are concentrated in the daylight zone which is defined by 30^0 friction angle and 50^0 of slope angle.

Figure 3 illustrates the stereographic analyses of the plane failure of J3 joints. The natural slope of this area dips toward 095^0 (±30) with 55^0 (±25) dipping angle. Fixing the dip direction of the natural slope at 95^0, different sizes of daylight zones of the plane failure can be generated by changing the friction angles and the dipping angles of the natural slope as in Figure 3. The resulting plots in figure 3, clearly shows that the concentration of unloading joints starts when the slope angle is higher than 50^0 and a friction angle is larger than 30^0. This result implies that the rock sliding (plane failure) occur in areas where the dipping angle of natural slope exceeds 50^0 and the friction angle of the fracture surface in this area is about 30^0. Friction angle of the sheeting joint (J3) has not been investigated; however, the 30^0 could be general angle for fractures with smooth surface as the sheeting joint set J3.

To verify the instability of the sheeting joints at over 50^0 dipping angle of the natural slope, a topographic analyses is conducted. Area with topographic slope angle higher than 50^0 are delineated by DEM analyses in GIS, and they are illustrated in Figure 4. The source area of the talus, that are defined by area photos and satellite images and verified by field survey, are overlapped to the high slope locations as in Figure 4. It can be seen that, the source area of talus are mostly located in the areas where the slope angle is over 50^0. This matching proves that the daylight zone, which is bounded by the friction angle and the slope angle, is valid. Assuming that the J3 joints have 30 friction angle, if the dipping angle of the sheeting joint is less than 50^0, then they are outside of the daylight zone of the plane failure. Since sheeting joints in this area are sub-parallel to the topographic surface, the sheeting joints at areas with less than 50^0 slope angle of this area were stable from the talus flow.

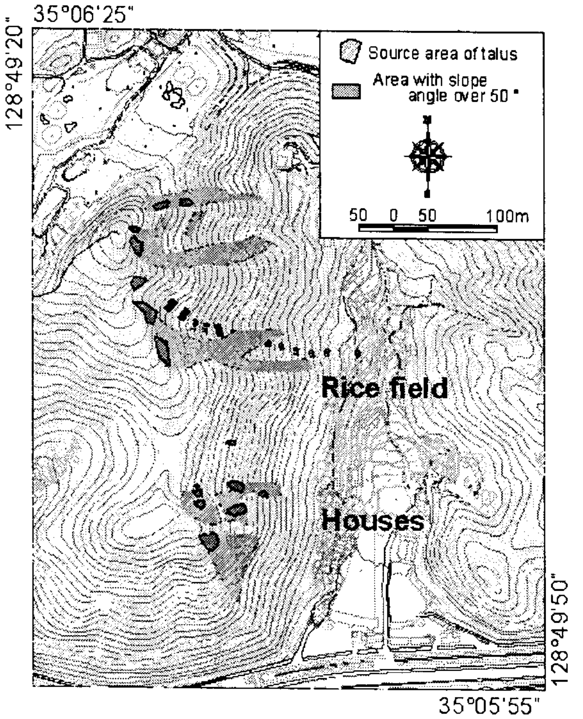


Figure 4. Location of talus sources overlaid in areas where slope angle are higher than 50^0.

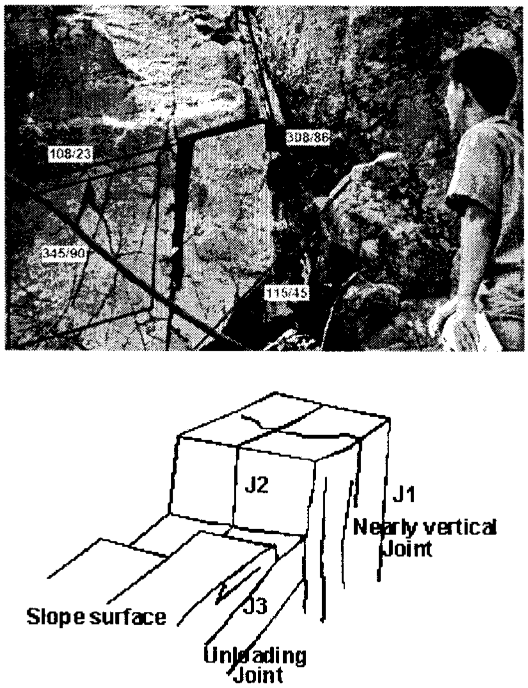


Figure 5. Field photo and schematic model of planar slides

3. Conclusion

Stereographic projection has been widely used for slope stability studies. However, very few examples have been published. The study conducted in KhunYongJe village proved to be a good example for this claim. The study showed that plane failure along unloading joints tends to occur if the slope angle exceeds 50^0. By overlaying the talus sources on the areas where slope angle over 50^0, we find that they are clearly matching. This matching obviously shows the control of topography to planar failure in the area. This example validates the strength of the slope stability analyses by simple stereographic projection method

4. References

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