FACTORS AFFECTING FAILING MATERIAL FLUIDIZATION AND A METHOD FOR PREDICTING THE RUN-OUT DISTANCE OF MASS MOVEMENTS

Yoshiharu Ishikawa[1]

A considerable number of studies have been made on methods of predicting the run-out distance of failing material in slope failure and the deposition zone of debris flow, and many prediction approaches have been proposed. Those studies, however, dealt with slope failures and debris flows as separate types of mass movement and did not consider intermediate or transitional forms. The mechanism by which failing material is altered into a debris flow through fluidization also remains largely unknown. This study, therefore, investigates factors affecting the fluidization of failing material and attempts to develop a unifying method for predicting the run-out distance of failing material in mass movements including slope failures, debris flows and intermediate types between them.

STUDY METHOD

By analyzing aerial photographs and topographic maps showing the slope failures and debris flows caused by heavy rains in southern Fukushima Prefecture in August 1998 and Hiroshima Prefecture in June 1999, factors affecting the fluidization of failing material by slope failures were identified (Fig.1, 2) and the degree of influence of each factor on the fluidization of the failing material was investigated through simple regression analysis. Multiple regression analysis was also performed, and multiple regression formulas thus obtained were used to develop a method for predicting the run-out distance of failing material by evaluating the equivalent coefficient of friction.

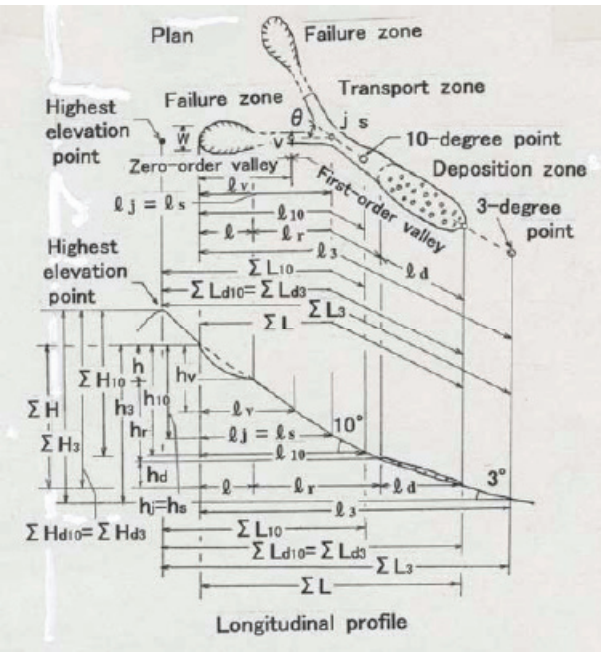

Fig.1: Schematic figure of measurement of gradient -related factors.

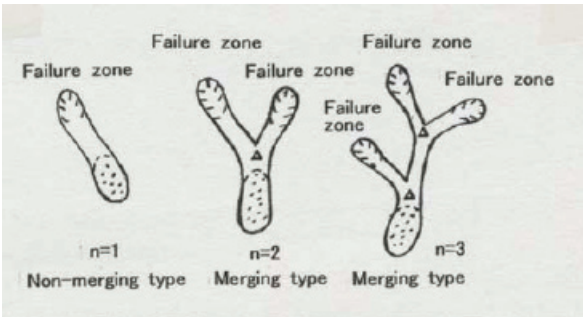

Fig.2: Examples of merging masses and number of merging masses (n).

[1] Professor, Institute of Symbiotic Science and Technology, Tokyo University of Agriculture and Technology, Saiwai-cho 3-5-8, Fuchu, Tokyo 183-8509, Japan (Tel.&Fax:+81-42-367-5826,e-mail:y_ishi@cc.tuat.ac.jp)

RESULTS

It was found that merging of two or more masses of failing material greatly influences the fluidization of the failing material (Fig. 3). It was also found that as the number of merging masses of failing material increases, the degree of fluidization increases and the equivalent coefficient of friction decreases (Fig. 4), indicating that the slope failure is altered into a debris flow. Mass movement involving a single mass of failing material can be classified as slope failure, while mass movement involving many merging masses of failing material can be classed as debris flow.

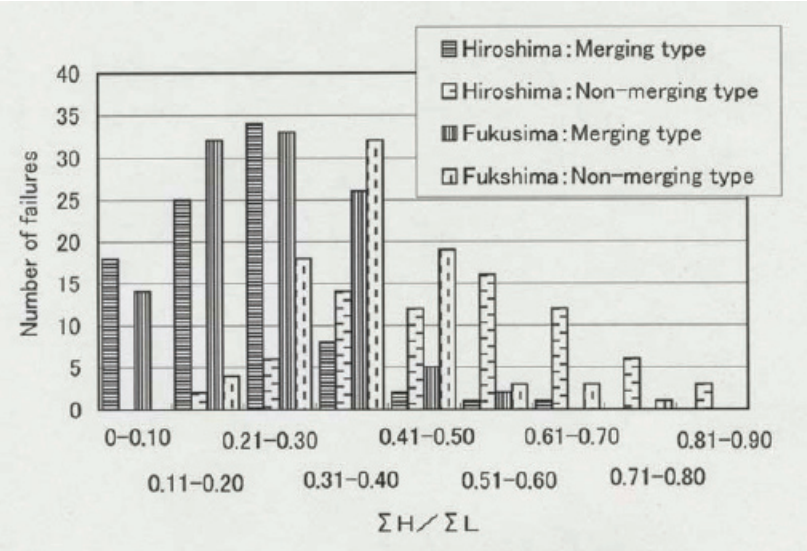

Fig.3: Frequency distribution of equivalent coefficient of friction, ΣH / ΣL.

Mass movement involving an intermediate number of merging masses (about two to five) may be regarded as an intermediate or transitional state.

Previous studies have dealt with slope failures and debris flows as phenomena of completely different types and tried to develop methods for predicting the extent of run-out separately.

This study presents a unifying method for predicting the run-out distance (equivalent coefficient of friction) of failing material by mass movements including slope failures, debris flows and intermediate types between them (Fig.5).

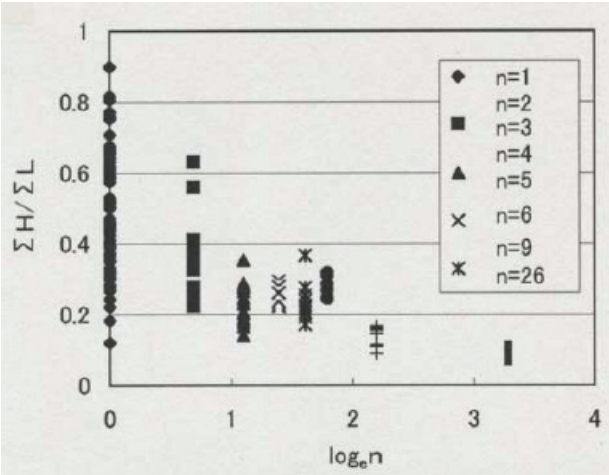

Fig.4: Relationship between natural logarithm of number of merging masses $\log_e n$, and equivalent coefficient of friction ΣH/ΣL in Hiroshima area.

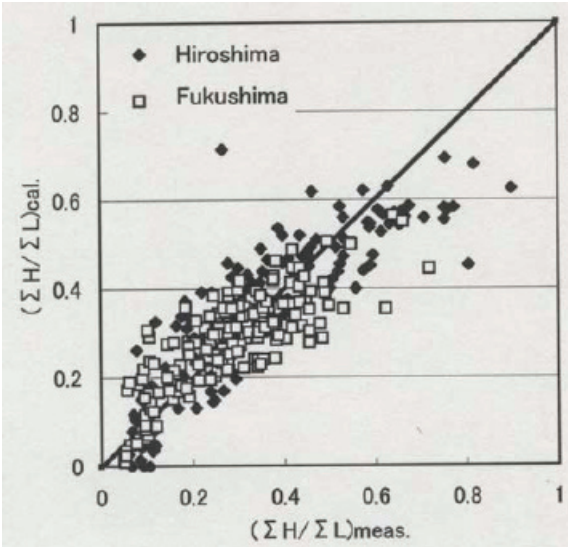

Fig.5: Comparison between measured and calculated equivalent coefficient of friction, (ΣH/ΣL) measured and (ΣH/ΣL) calculated, respectively.

Keywords: failing material, fluidization, slope failure, debris flow, run-out distance