学　位　論　文　内　容　の　要　旨

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学　位　論　文　題　名

Numerical modelling and geomechanical analyses of soil slope stability evaluation in seasonal cold regions

(積雪寒冷地における斜面安定性の数値モデル化と地盤力学的解析)

Soil slope instabilities occur frequently in snowy cold regions like Hokkaido, Japan. Stability assessment and predictions of soil slope failures in cold regions have always been highly multifaceted. The research focused on investigating the key influencing factors of soil slope failures in snowy cold regions for the mitigation of such disasters. As a result, a stability assessment approach based on two-dimensional numerical modelling incorporating non-isothermal seepage flow and pseudo coupled mechanical analyses is recommended which considers the water content changes of the soil induced by the seasonal climatic effects i.e. freeze-thaw action and snowmelt water infiltration etc.

Case studies of soil slope failures in Hokkaido have been studied using the recommended approach. Site investigations, monitoring of weather and related parameters, geotechnical data assessments, soil characterisations and soil property estimations have been performed as a limited part of this study. It has been found that the freeze-thaw action and snowmelt water infiltration both influence the soil slope stability significantly. The investigation of the slope failures using the recommended numerical modelling approach revealed the robustness of the approach in analysing soil slope instabilities in seasonal cold regions.

The second part of the study focused on soil slope failure predictions. For the prediction of snowmelt induced soil slope failures in seasonal cold regions, an early warning criterion is required. The applicability of existing early warning criteria i.e. 60-minute cumulative rainfall and Soil-Water-Index (SWI) relationships, Effective Rainfall (ER) indexes etc. to predict the snowmelt induced soil slope failures are examined using the recommended slope stability assessment approach. An empirical method to quantify the amount of snowmelt water is presented. As a result, a revision for the SWI and ER index incorporating the amount of snowmelt water with rainfall is introduced and the slope failure scenarios are examined.

In conclusion, a new criterion Effective Precipitation (EP) index is proposed for the prediction and early warning of snowmelt induced soil slope failures. It is found that the new criterion introduced in this study perform well for the prediction of snowmelt induced soil slope failures.