



HOKKAIDO UNIVERSITY

Title	Stability assessment approach for soil slopes in seasonal cold regions
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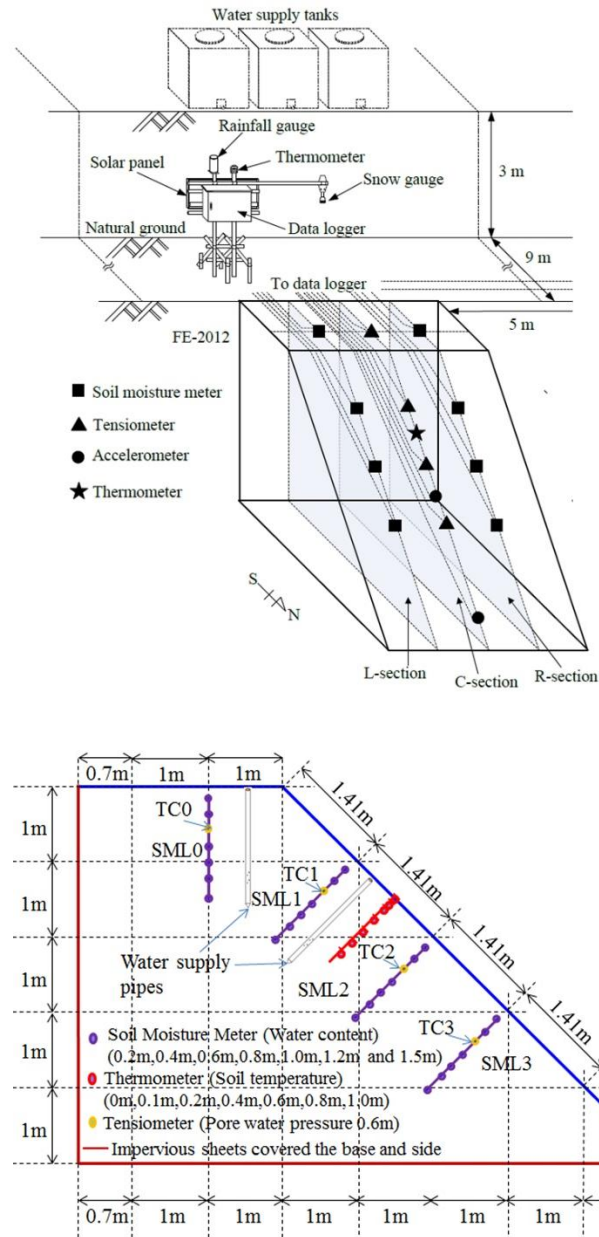


Fig. 1. (a) Three dimensional schematic view and (b) two dimensional cross-sectional view of embankment slope showing installed monitoring instruments (adapted from Matsumura, 2014)

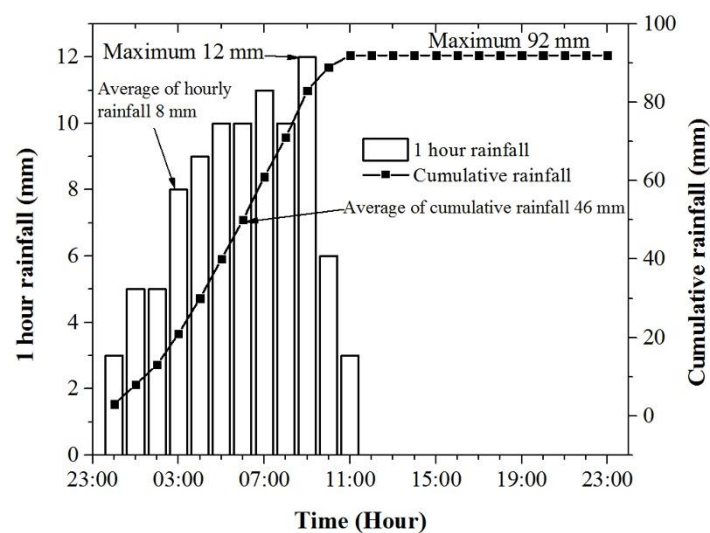
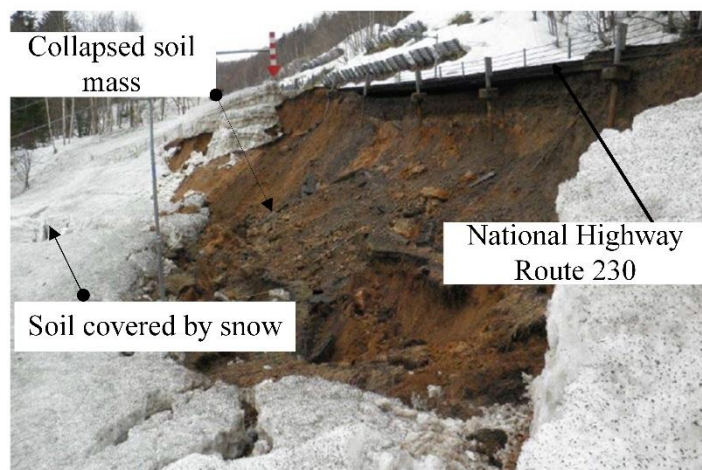
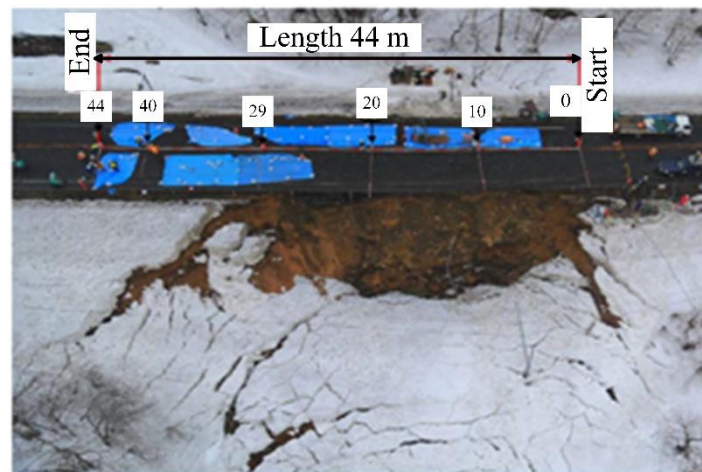


Fig. 2. (a) Aerial and (b) panoramic views of the slope failure (after Hokkaido regional development

bureau, 2013) and (c) Rainfall recorded on 07-04-2013 at Mui Ne meteorological telemetry

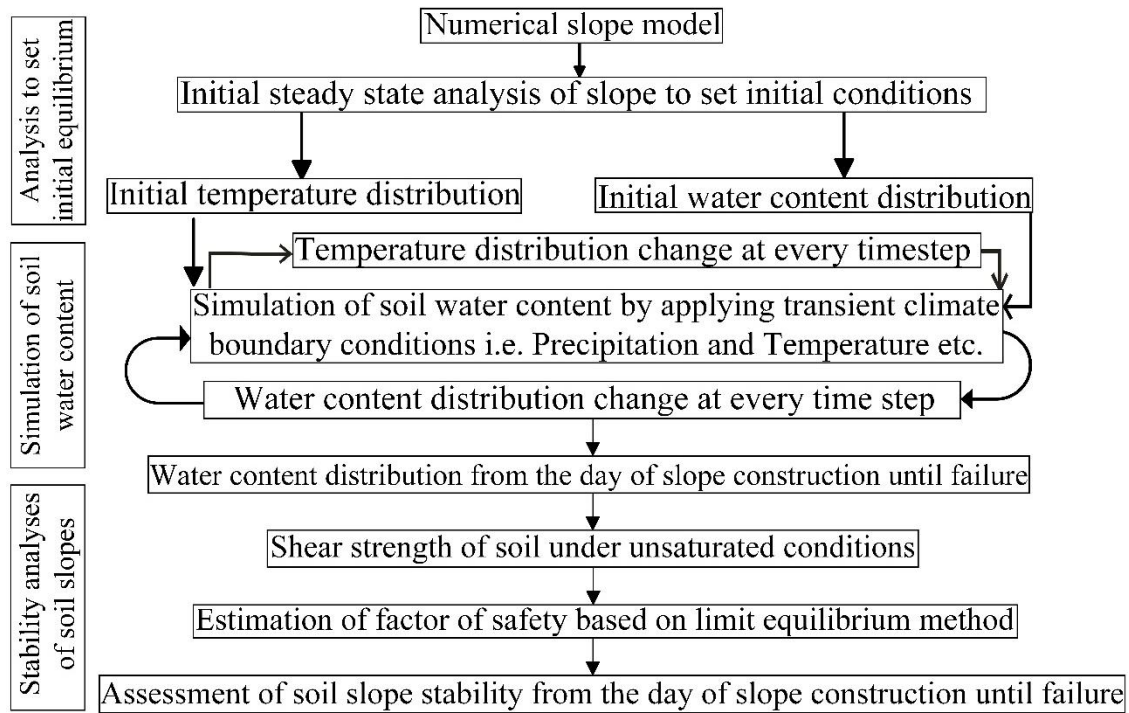


Fig. 3. Recommended stability assessment approach for soil slopes in seasonal cold region

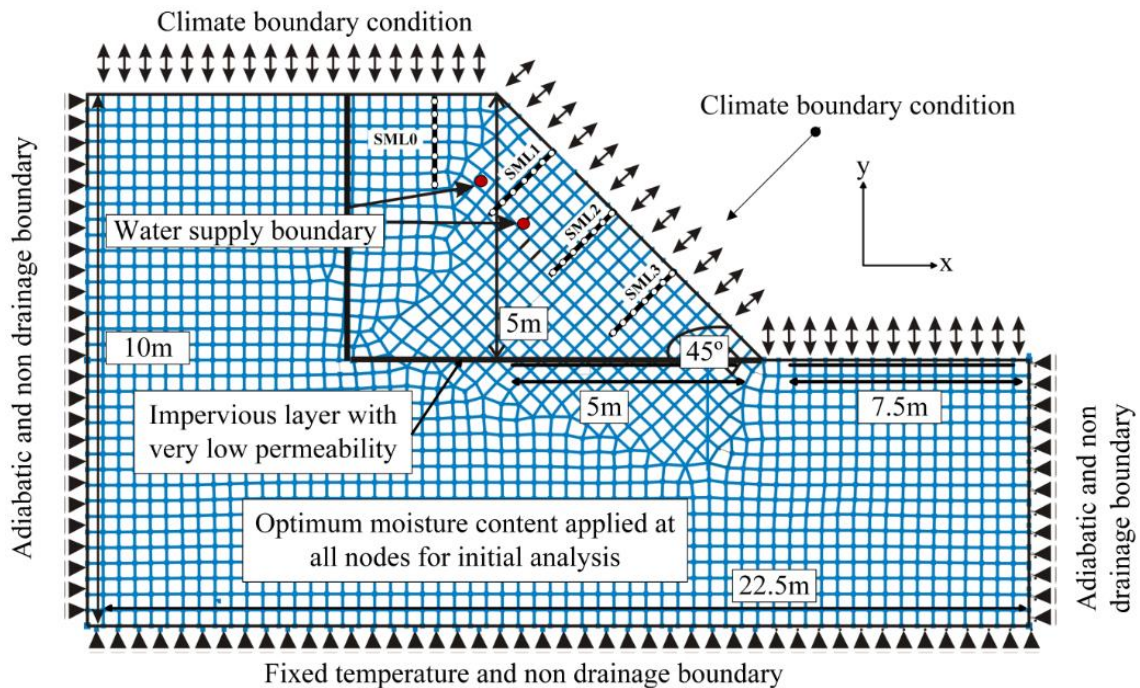


Fig. 4. Two dimensional numerical model with applied boundary conditions and FEM mesh

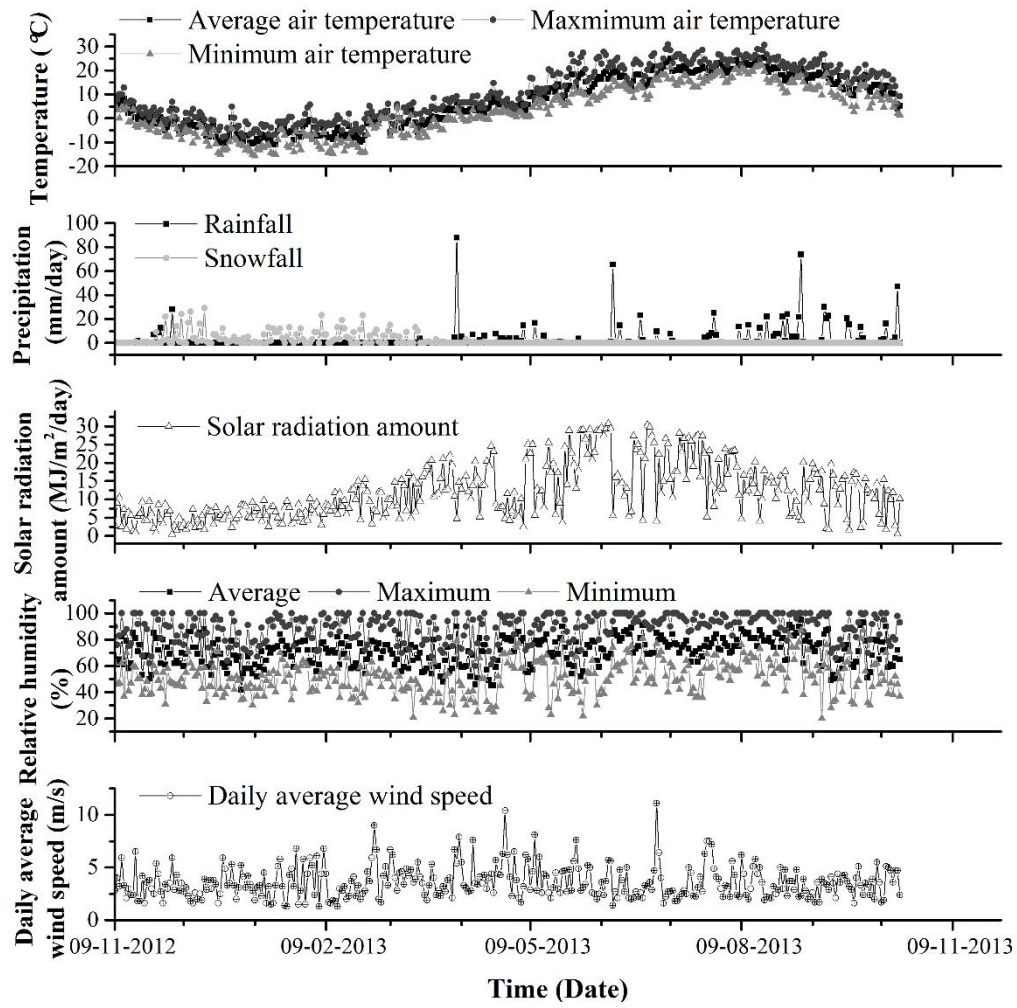
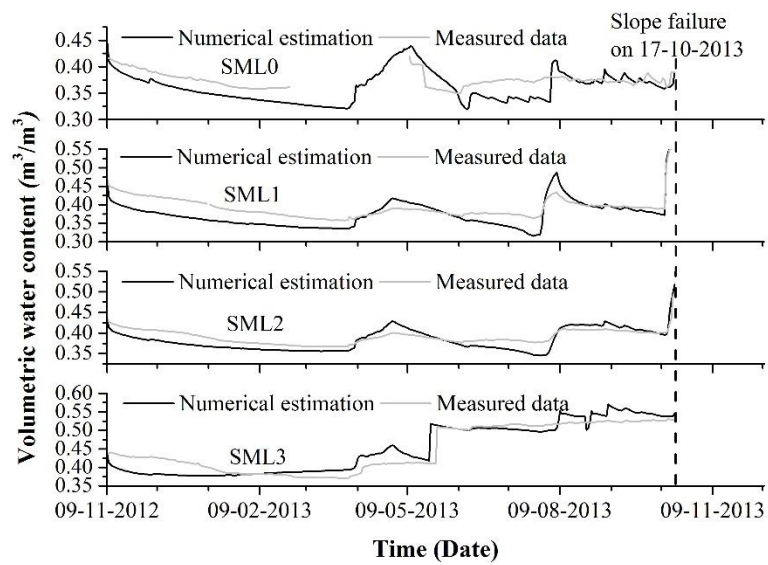


Fig. 5. Climate data used for the numerical simulation of embankment slope



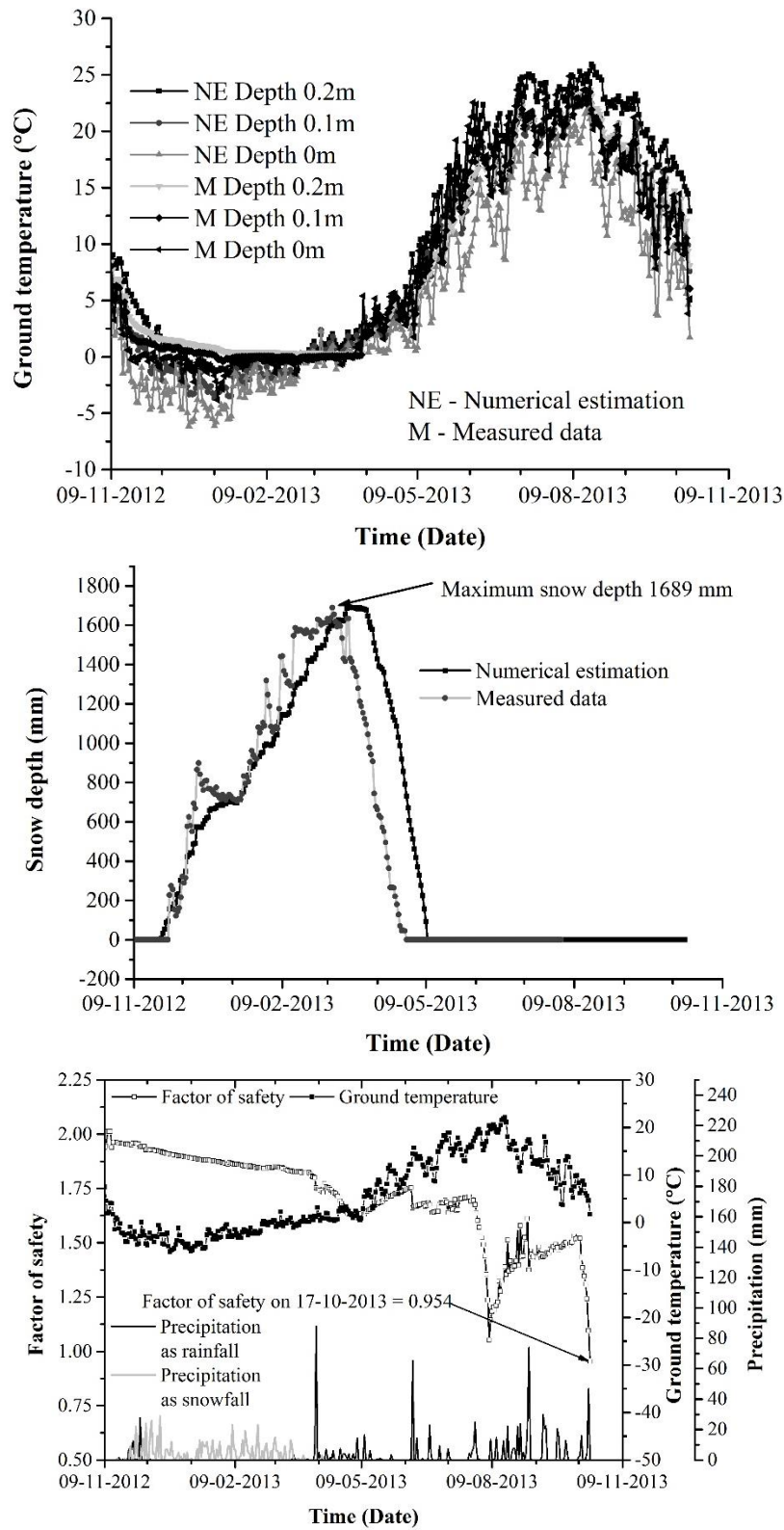


Fig. 6. (a) Comparison of estimated volumetric water content and measured volumetric water content at locations SML0, SML1, SML2 and SML3, (b) Comparison of estimated ground temperature and

measured temperature and (c) estimated snow depth and measured snow depth (d) Stability of soil slope
from the day of slope construction until failure

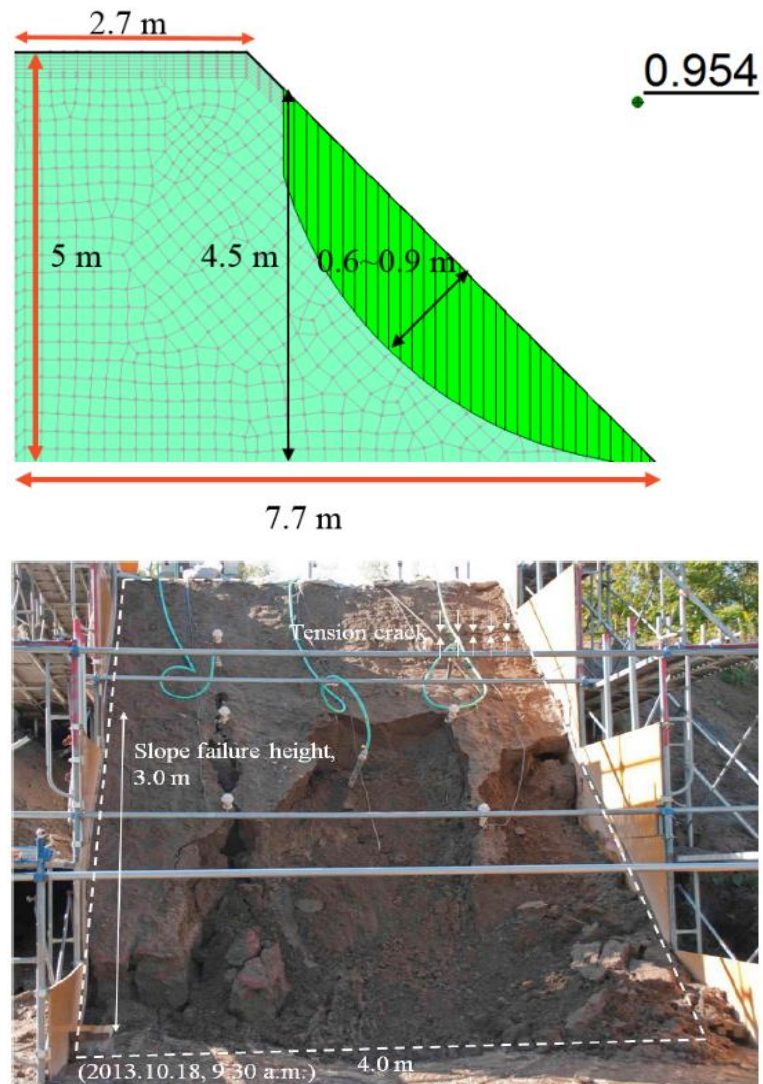


Fig. 7. Comparison between (a) estimated limit equilibrium slip surface with (b) actual slope failure

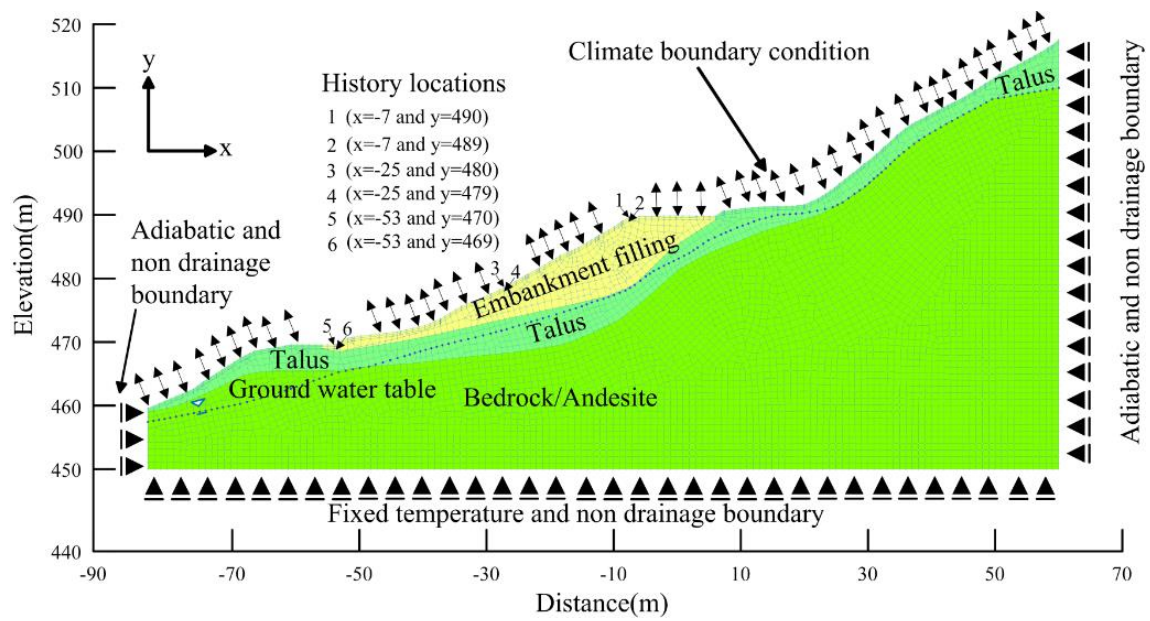


Fig.8. Two-dimensional numerical model for highway slope with boundary conditions

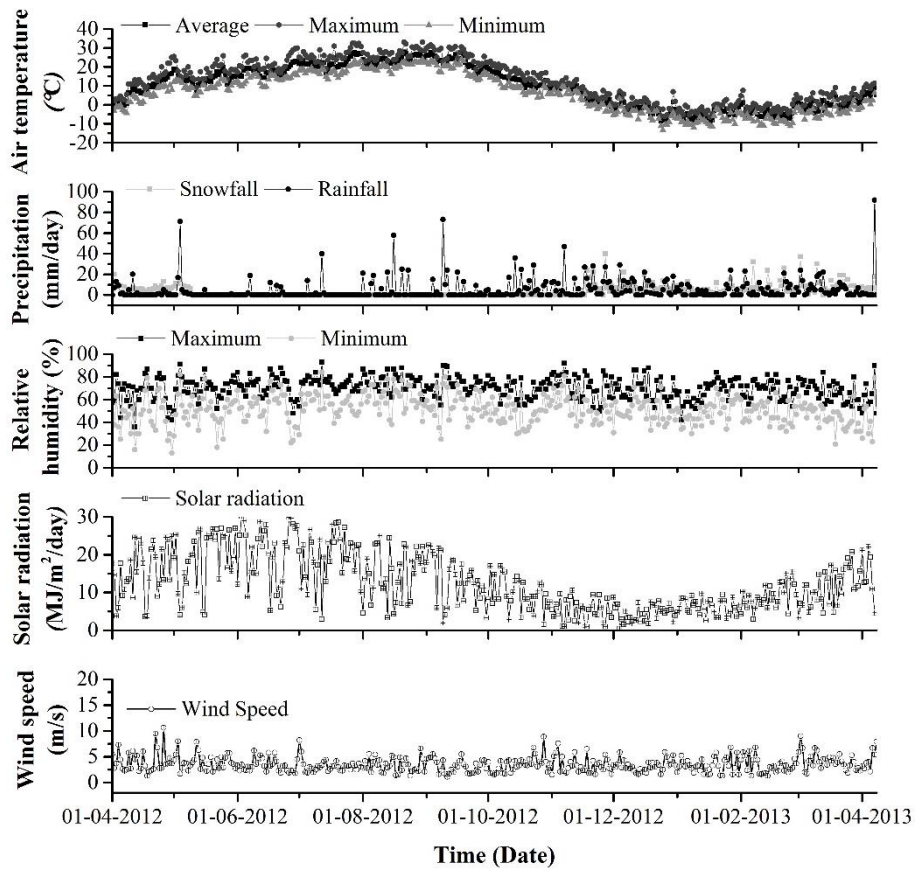
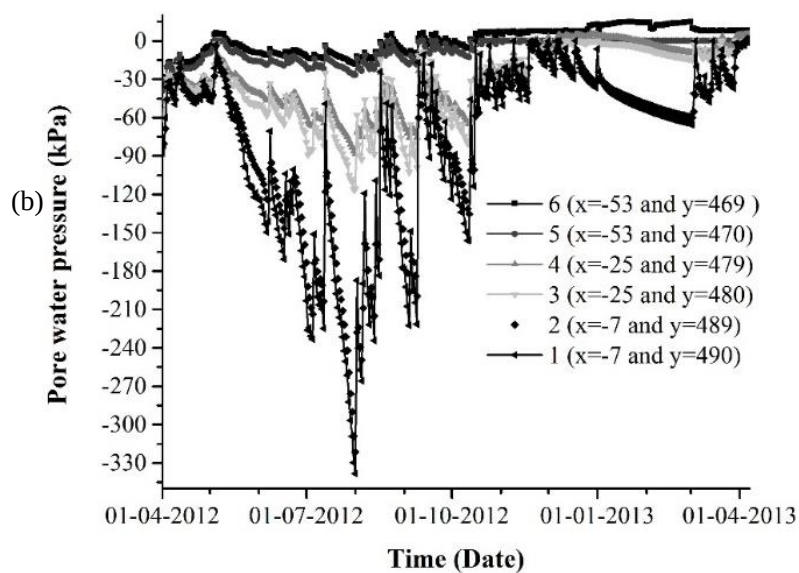
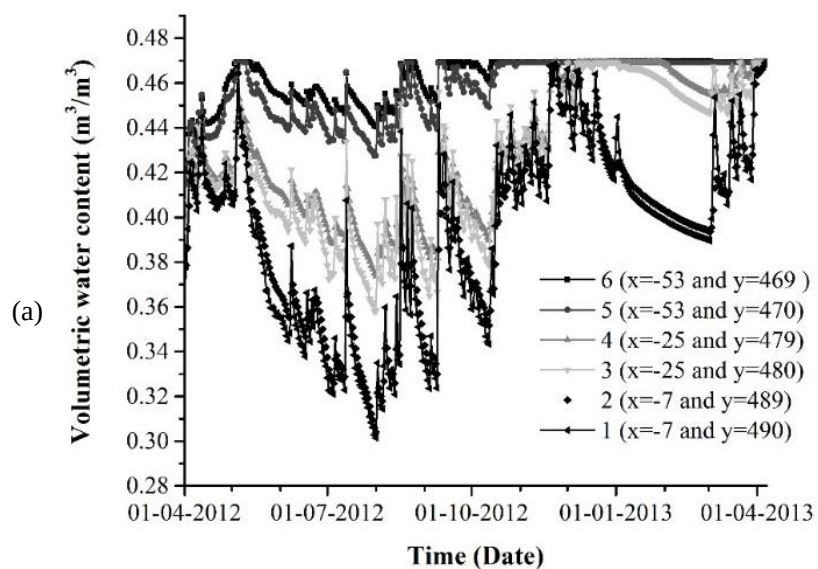


Fig. 9. Climate data used for the simulation of highway slope



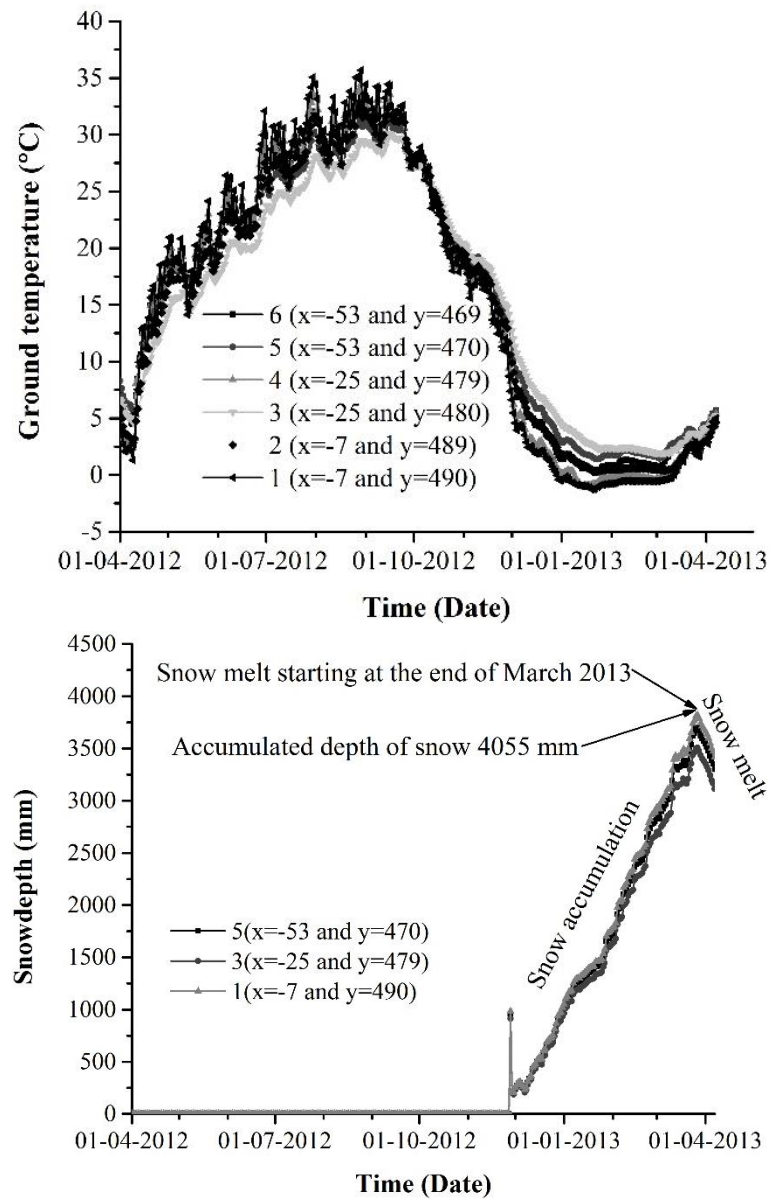


Fig. 10. (a) Variation in volumetric water content, (b) Variation in pore water pressure (c) Variation in ground temperature and (d) accumulation of snow depth

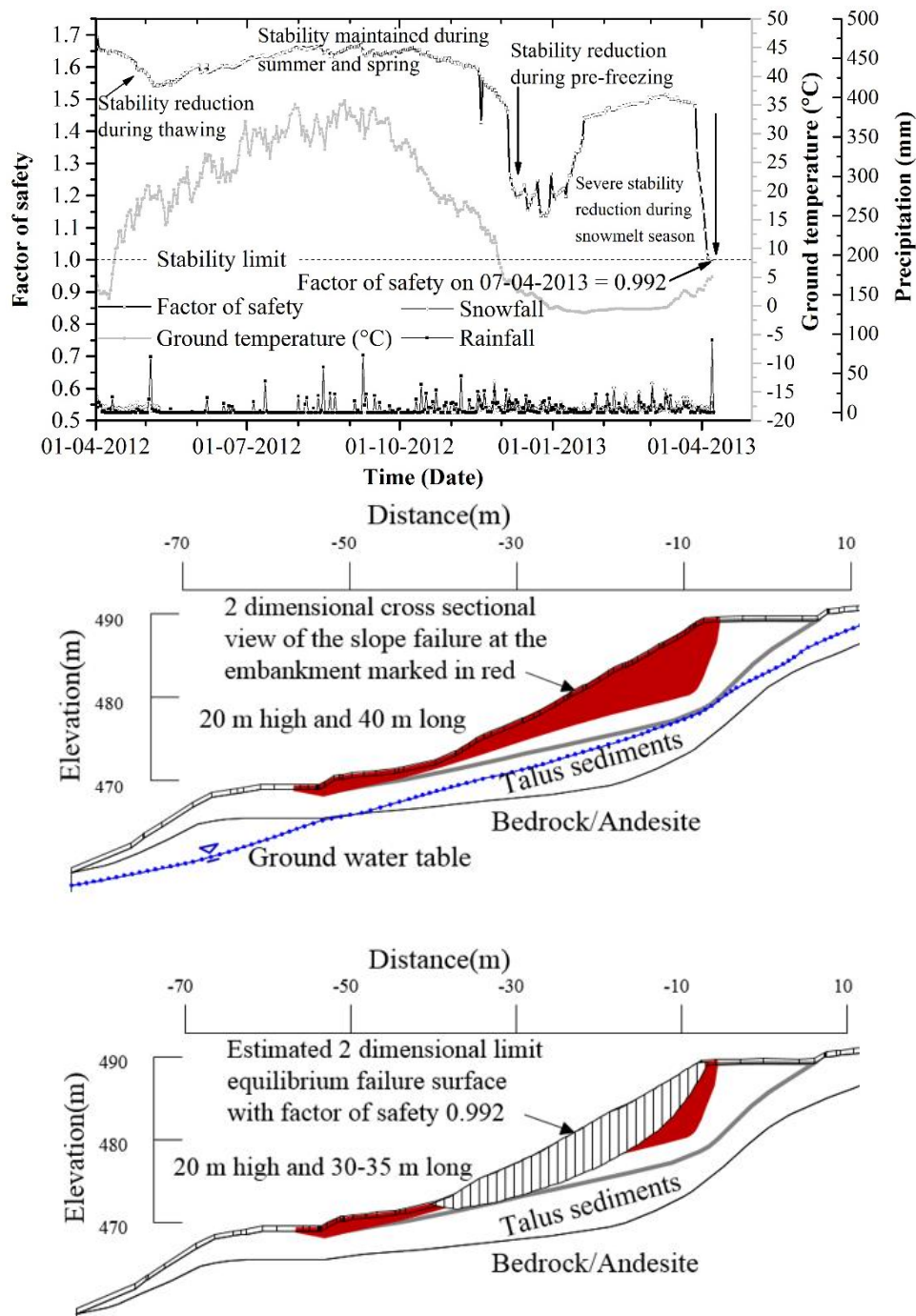


Fig. 11. (a) Stability of slope expressed as factor of safety along with ground temperature and precipitation (b) Two-dimensional geological cross section showing the slope failure area compared with numerically estimated two-dimensional failure surface with factor of safety

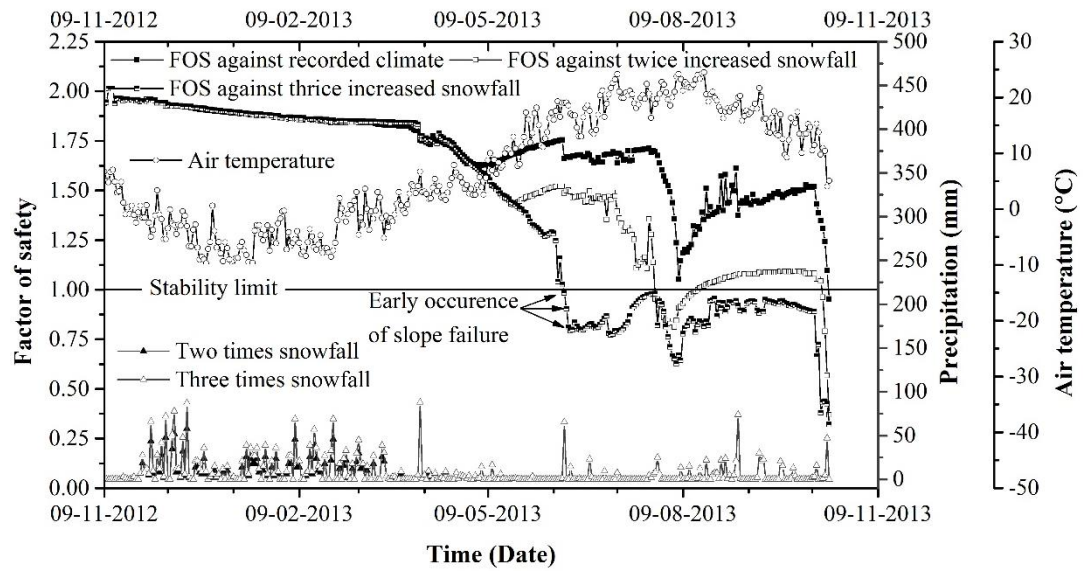
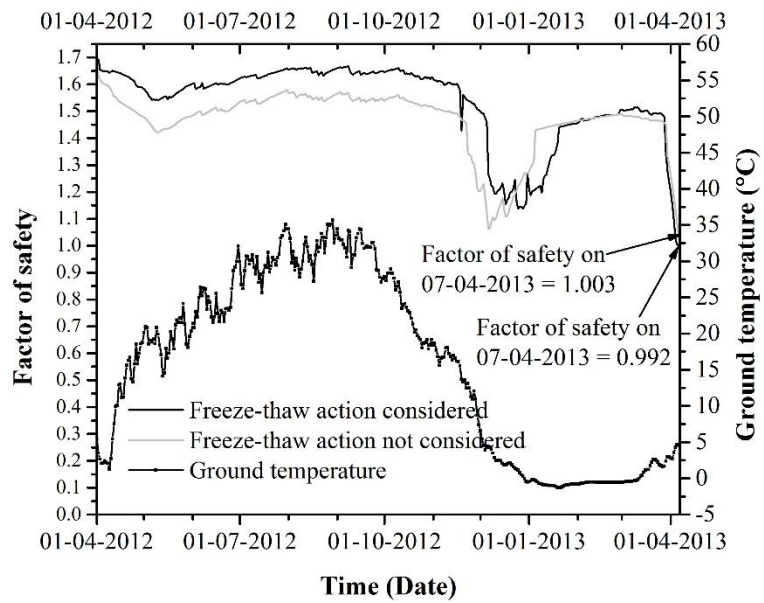
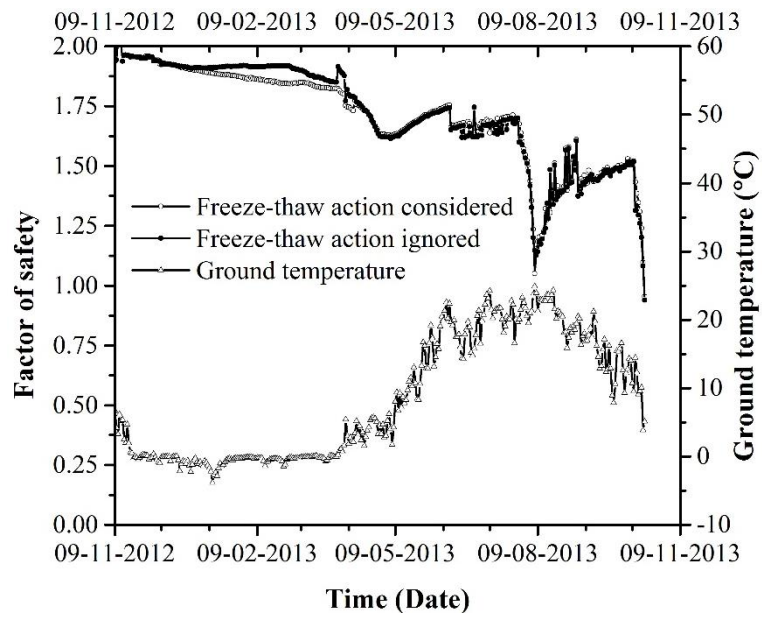


Fig. 12. Influence of increased magnitudes of snowfall on soil slope stability



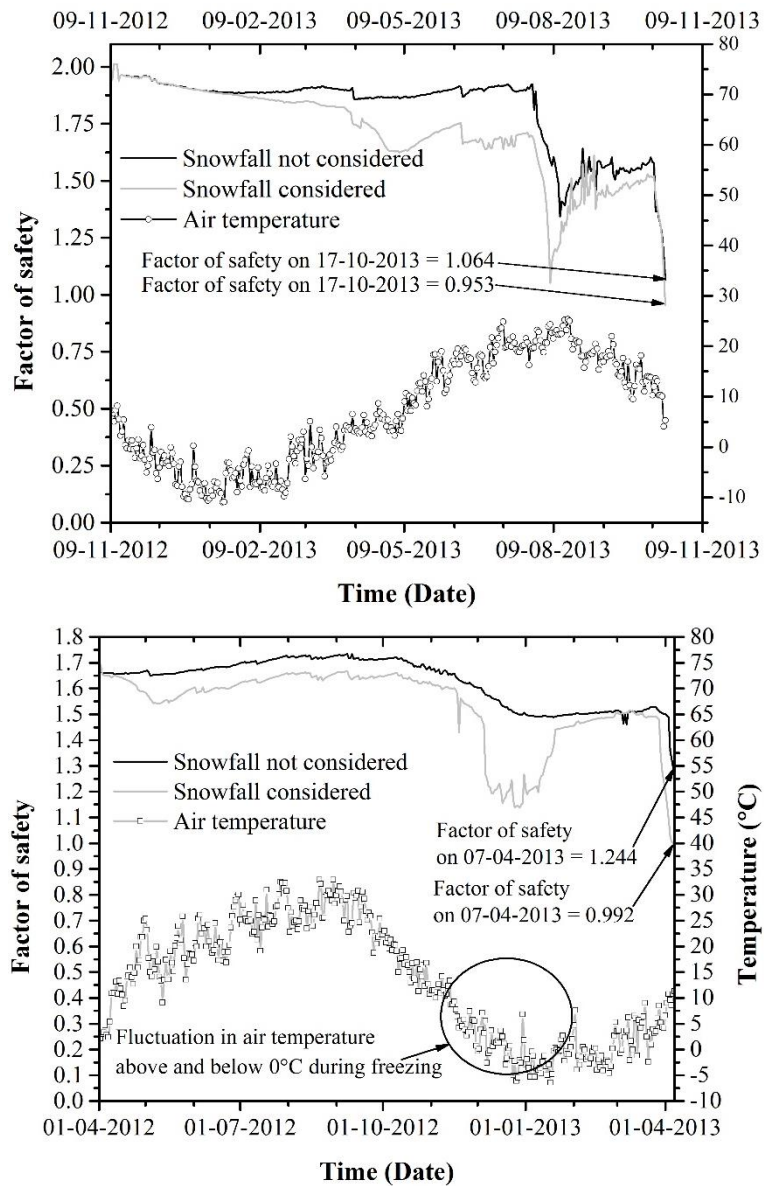
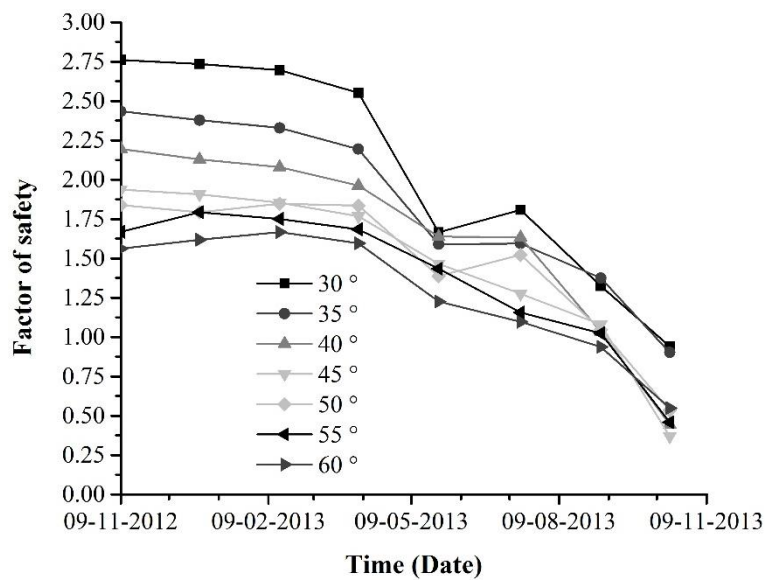
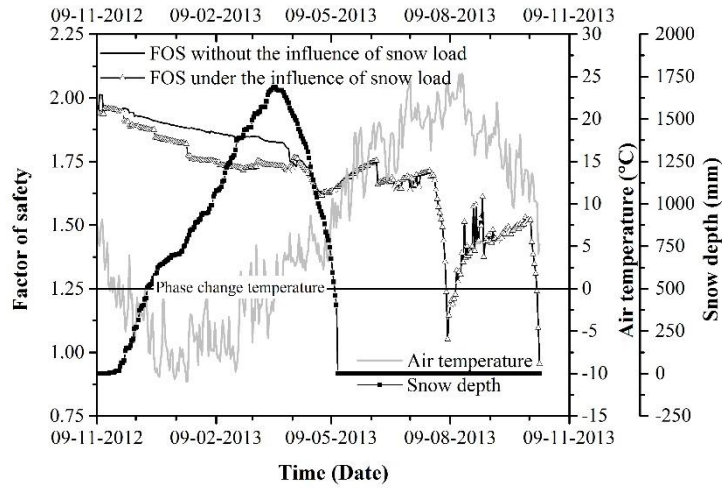
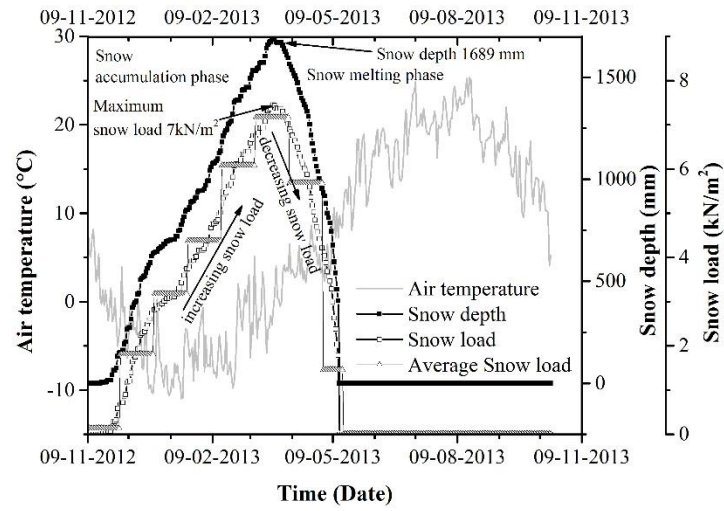


Fig. 13. (a) Variation in factor of safety with and without considering freeze-thaw action for embankment slope (b) Variation in factor of safety with and without considering freeze-thaw action for highway slope, (c) Variation in factor of safety with and without considering snowfall for embankment slope (d) Variation in factor of safety with and without considering snowfall for highway slope



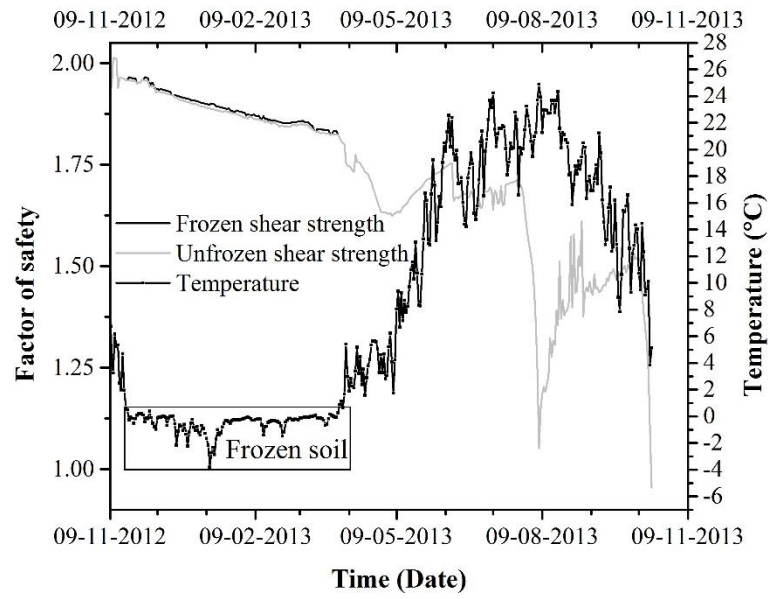


Fig. 14. (a) Accumulated snow depth and calculated average snow load for every 25 days, (b) Effect of snow load on soil slope stability (c) Safety factor of various inclinations of slope (d) Effect of frozen soil shear strength