ABSTRACT

Experiences from recent earthquake records all over the world suggest that reinforced soil slopes provide better resistance to the seismic forces and possess higher yield accelerations compared to unreinforced slopes. While the design and practice of geosynthetic reinforced soil slopes has reached a level where the basics are well established and the procedures are standardized, the seismic designs still lack complete understanding of concepts and principles that alter the performance of the slope during seismic episodes. This thesis presents results from shaking table tests on geosynthetic reinforced soil slopes subjected to cyclic base shaking to understand the influence of various parameters that govern the performance of these slopes during seismic events.

A uniaxial shaking table was used in the study and reduced scale model slopes were built in a laminar box and were subjected to sinusoidal base shaking, varying the frequency and acceleration of base shaking in different tests. Various series of shaking table tests were carried out to study the effects of shaking acceleration, frequency of shaking, fines content in soil, type and quantity of reinforcement and slope inclination on the response of model slopes in terms of acceleration amplifications and horizontal displacements. Acceleration of shaking was varied between 0.1g - 0.3g and frequency was varied between 1Hz - 16Hz in different tests. The frequency of testing was much below the natural frequency of the slopes. Two soils, a clayey sand with 44% fines content and a poorly graded sand with no fines were used to study the effect of fines content on the slope response. A geotextile and a biaxial geogrid were used to study the effect of type of reinforcement and reinforcement was placed in single, two and three layers in different tests to study the effect of quantity of reinforcement. Slope inclination was varied as 45°, 60° and 75°.

While understanding the influence of reinforcement parameters, soil gradation and slope angle, tests were carried out at different accelerations and frequencies, to investigate the influence of these parameters under different ground shaking conditions.

Results from shaking table tests revealed that among all the parameters studied, soil gradation has greater influence on the seismic response of the unreinforced as well as reinforced soil slopes. Slopes made of sand without fines showed highest acceleration amplifications and displacements. While the slopes made of clayey sand showed higher displacements at higher frequency levels, exhibiting progressive failure, slopes built with cohesionless sand showed higher seismic response at low-frequency high-amplitude motions, exhibiting sudden flowslide type of failure. Inclusion of reinforcement did not have significant influence on the acceleration amplifications, but the displacements were drastically reduced by reinforcing the slopes, the beneficial effect more pronounced in case of slopes made of sand without fines. Among the two types of geosynthetics used in the study, both were equally effective in reducing the deformations, the different being not significant. Results showed that reinforcement saturation occurred in the models at 2 layers, beyond which further increase in reinforcement did not influence the response of the slope. The catastrophic flowslide occurred in unreinforced slope at low frequency shaking in case of sand without fines is completely arrested by reinforcing the slope with three layers of geotextile and the deformations were reduced by about 92% for that case, indicating the importance of soil reinforcement in mitigating seismic hazards. Increase in slope angle resulted in increase in deformations but the acceleration amplifications remained unaffected. Steeper slopes benefitted more by the inclusion of reinforcing layers. Displacements computed using Newmark's sliding block method agreed reasonably well with the experimental measurements.