

Control over landsliding at Eco-friendly Forest Park at Bansara Gali Murree by Improvising Surface / Subsurface Drainage

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Abstract

A green eco-friendly state-of-the-art surface car parking facility, using natural materials, was recently designed and constructed on two terraces located on sloping ground, at Bansara Gali, Murree. The terraces were rendered more regular in shape with an increase in the car parking capacity, by constructing Mechanically Stabilized Earth (MSE) walls using M/s Freyssinet's green-faced Terratrel T-2 system, along parts of their edges. A total of 85 cars can be parked on the two terraces, with most modern parking sensors, surveillance & ticketing systems.

About nine months after the construction of MSE walls, a part of the mountain slope below one of the terraces but outside the limit of the terrace, manifested movements accompanied by sliding down of boulders and soil mass. Four months later, when the terrace had already stood stable for more than one year, a part of the terrace and the entire lower slope showed signs of global movements.

Although adequate surface as well as subsurface drainage measures had already been provided, it was decided to immediately further augment the surface and subsurface drainage system in the upslope as well as downslope areas. This entailed installation of horizontal / vertical drainage wells, cascade drains, opening of culverts, weep holes etc.

Simultaneous with the onset of movements in the lower slopes, surface settlement markers were also installed at about seventy locations to daily monitor the movements. It was observed that as soon as the drainage system was put into operation, the slope movements started reducing; the lower parts stopping first, followed by almost stoppage of the upper parts. It took about two months to the slope movements to come to a halt, though monitoring continued for at least five more months afterwards.

The parallel slope stability analysis carried out using appropriate geotechnical parameters, for before drainage and after drainage conditions, also validated the effectiveness of the drainage measures. The settlement plateau measured in about seven months of slope observations has indicated that no hard measures for slope stability are required except draining the slopes of the hill after proper hydrological and drainage studies and growing vegetation on upslope as well as downslope areas, for increased stability in the long-term.

The successful experience of stabilization of unstable slopes at Bansara Gali by simple augmentation of drainage measures has open vistas for adopting such simple measures in similar conditions in the mountainous areas.