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Rainfall simulations on extreme artificial slopes

Petr Kavka, Martin Neumann, Tomas Laburda, Adam Tejkl, and David Zumr

Czech Technical University in Prague, Faculty of Civil Engineering, Department of Landscape Water Conservation, Prague 6, Czech Republic (petr.kavka@fsv.cvut.cz)

Soil erosion and transportation of the detached soil particles towards the river networks is one of the key environmental problems connected to the intensive land use. The soil erosion is not only a problem initiated by intensive agricultural, but also by the engineering construction such as the slopes along the linear structures (roads, railroads, etc.). Surface erosion prevention of yet non-vegetated slopes is of a high concern due to potential loss of quality topsoil. Therefore, it is becoming a routine practice to protect such slopes shortly after the construction with geosynthetic materials. We present results of a research project studying the behaviour of the protected and unprotected slopes under an artificial extreme rainfall events. The aim is to propose the selection methodology for the effective erosion prevention materials. Both natural and synthetics protection geosynthetics are tested for different slopes and rainfall intensities.

Two types of rainfall simulators (RS) were developed and used for this study. First an innovative laboratory simulator was designed to simulate complicated experimental setups which could be hardly performed in the terrain. The principles of rain generation allow to produce rainfall of various intensity and kinetic energy, maximal rain intensity is 200 mm/h. The simulator combines two types of nozzles (i) flat nozzles (VeeJet) with swiping mechanism; and (ii) fulljet nozzles (WSQ) with interruptions. The soil sample temperature is controlled (-15 to +50 °C) therefore we can simulate erosion processes ranging from permafrost to tropical soils. Dimension of the soil sample can be up to 4 m long and 1 m wide. Maximum plot inclination is 40 %. The automatic monitoring system records surface runoff, soil loss, percolating water, soil water content and soil temperature regime. The second RS type is the outdoor rainfall laboratory with three simple rainfall simulators on different slopes. Three plots with the size of 2 x 4 m with different inclinations (1:1.5, 1:1.75 and 1:2.5) were equipped with a "stable" rainfall simulator. Each plot is splitted longitudinally into two halfs, where one half is always bare soil and the other half is covered with various geosynthetic materials.

Standard values of surface runoff, soil loss, rill generation, soil moisture and surface changing with SfM are analysed for establishing of the effect the protection measures in relation with slope, rain intensity and rainfall kinetic energy. Eight types of technical measures were tested on both devices. Altogether, more than one hundred experiments were carried out and used to determine the suitability of technical measures.

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