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Evaluation of water regime of the experimental bioretention cell

Petra Hečková (1,2), Michal Sněhota (1,2), David Stránský (2), and Vojtěch Bareš (2)

(1) UCEEB in Prague, University Centre for Energy Efficient Buildings of Technical University in Prague (petra.heckova@cvut.cz), (2) CTU in Prague, Czech Technical University in Prague

The aim of this study is to investigate the long-term performance of bioretention cells. Bioretention cells are built surface depressions that collect and infiltrate stormwater. Bioretention cells accumulate, filter and partially evaporate the collected rainwater. Two identical experimental bioretention cells were established. The first bioretention cell collects water from a 38 m2 roof, while the second bioretention cell is supplied with water from a tank. In the latter bioretention cell, we can simulate a diverse range of rainfall episodes.
Each rectangular bioretention cell is 4.0 m long and 2.4 m wide. 5 cm thick layer of coarse gravel of a particle size range 16–32 mm covers the surface of the filter layer. The 30 cm thick filter layer is a mixture consisting of 50 % sand, 30 % compost and 20 % topsoil. There is a 10 cm thick sand layer (particle size range 0–4 mm) below the filter layer. Underneath the sand, separated by a geotextile, is 27 cm thick gravel layer (particle size range 16–32 mm). Perforated pipe drains water from the drainage layer to an underground chamber. Bioretention cells are isolated from the surrounding soil by a waterproof membrane. Four species of perennial plants were planted in each bioretention.
Both bioretention cells are instrumented by an identical system of sensors. Four time-domain reflectometry probes monitor soil water contents 20 cm below the surface. Five tensiometers record the water potential in a filter layer. Two water potential meters were installed at a depth of 10 cm below the surface. The amount of a discharge from each bioretention cell is determined by a tipping bucket flowmeter. A ponding depth is recorded by an ultrasonic sensor. The amount of runoff the roof connected to the first bioretention cell is determined from rain gauge located at the experimental site. Two experiments simulating 15 minute and 120 minute rainfalls, each done in three replicated events, were conducted on second bioretention cell. The 15 minute simulated rainfall produced average inflow rates of 3.47, 3.42 and 3.47 m3/h in each repeated event respectively. The 120 minute simulated rainfall delivered water at average flow rates of 0.748, 0.708 and 0.706 m3/h.
The results of the 15 minute simulated rainfall experiment show the outflow peak values of 1.56, 1.34 and 1.34 m3/h respectively. The peaks were detected 16, 17 and 16 minutes after the beginning of the simulated rainfall. Peak outflow rates for 120 minute simulated rainfall were 0.620, 0.620 and 0.583 m3/h. The peaks were reached 35, 63 and 64 minutes after the beginning of the simulated rainfall. Values of the runoff coefficient for the 15 minute simulated rainfall were 0.54, 0.70 and 0.70 while for the 120 minute simulated rainfall were 0.93, 0.96 and 0.97. Natural rainfall episodes that occurred during the first year of bioretention operation were also evaluated in order to determine the runoff coefficients. The detailed data on water contents and pressure heads will be interpreted by a numerical modeling of the water regime of experimental bioretention cells.