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Analysis of root reinforcement of vegetated riprap

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Riprap is a traditional engineering solution used to protect riverbanks against erosion on developed riparian corridors. However, the traditional riprap does not provide adequate fish and wildlife habitat within the riparian zone, which is normally provided by naturally vegetated stream banks. An innovative approach, which mitigates this issue and at the same time provides stream bank erosion control, is the vegetated riprap technique. This solution, which combines rocks and native vegetation in the form of live cuttings, has been designed and implemented by Terra Erosion Control Ltd for the past 7 years.

The aim of this work was to study the effect of the vegetation, in particular the root system, on the stability of the riprap. This analysis was carried out in the late spring of 2013 on the vegetated riprap installation located along the Columbia River riverbank, adjacent to the Teck Metals Ltd. smelter in Trail, British Columbia, Canada. An excavation perpendicular to the river was performed in order to investigate the root system development within the vegetated riprap structure. This excavation exposed one of the Salix bebbiana cuttings installed in 2006. The cutting was 2.3 m long and was set with an inclination of 35° with respect to the horizontal plane: the first 0.3 m was exposed, 1 m was buried within the riprap rocks (which had an average diameter of 30 cm) and the remaining 1.0 m was in the soil matrix below the rocks. The diameter of the roots growing along the cutting were measured in order to obtain the root density at various depths and tensile strength tests were carried out on the Salix bebbiana roots with diameters of up to 9 mm. The aim was to quantitatively estimate the additional cohesion given by the roots.

The additional root cohesion was more effective in the deeper soil layer where the soil matrix predominates. In the upper soil layer, where the particle size is significantly higher, roots do not increase the cohesion but act as a network which ties the rocks of the riprap structure together. The uprooting resistance was also tested with a pullout test, which demonstrated that the force necessary to uproot a Salix bebianna cutting, grown in the riprap along the riverbank, was higher if compared with the same species grown in a natural environment.