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Root tensile strength of grey alder and mountain maple grown on a coarse grained eco-engineered slope in the Swiss Alps related to wood anatomical features

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Steep, vegetation free slopes are a common feature in alpine areas. The material covering these slopes is prone to all kind of erosional processes, resulting in a high risk potential for population and infrastructure. This risk potential is likely to increase with the predicted change in the spatiotemporal distribution of precipitation events. A potential increase in extreme precipitation events will also result in a higher magnitude and frequency of erosional processes. In the Swiss Alps as in many other mountainous areas, there is a need to stabilize these slopes to reduce their direct or indirect hazard potential. In this regard, eco-engineering is a very promising and sustainable approach for slope stabilization.

Planting trees and shrubs is a central task in eco-engineering. A developing vegetation cover will on one hand reduce the mechanical effects of rainfall by an increased interception, on the other hand, the root systems cause modifications of soil properties. Roots not only provide anchorage for the plants, they also promote soil aggregation and are able to penetrate possible shear horizons. Overall, anchorage of plants is at the same extend also stabilizing the near subsurface. When rainfall occurs, the saturated soil exerts downhill pressure to a tree or shrub. As long as the root distribution supports anchorage, the respective slope area remains stable. At this point, the tensile strength of the roots is a critical measure, because it is more likely that the supporting roots break than the entire root system being pulled out of the soil completely. As a consequence, root tensile strength is an important parameter in characterizing the soil stabilization potential of trees and shrubs.

It is known that tree roots show a high variability in their anatomical structure depending on their depth below soil surface as well as their distance to the main stem. Therefore, we assume that these structural changes affect the tensile strength of every single root. In order to confirm this assumption and possibly find more important root properties which have an influence on soil stabilization, the root systems of seven trees (three grey alder, four mountain maple) were excavated and analyzed. The study site is a catchment, where shallow landslides are common. It is located in the Prättigau valley in the Eastern Swiss Alps and was eco-engineered in 1997. The substrate is coarse-grained morainic material, mean annual air temperature reaches 4.64°C, average precipitation is 1170 mm, and the altitude is about 1000 m a.s.l..

The root system of each tree was uncovered carefully by hand to keep the roots undamaged, before removal it was photographed in situ to document the root distribution. The root systems were then cut into single root pieces of about 20 cm length and the position of each sample was documented. The root samples were then hierarchically classified in several root classes. The tensile strength of more than 500 samples was determined. In addition, the values for age, diameter, and root moisture were ascertained. Since it was assumed, that the cellular structure of the roots has an influence on the tensile strength, two microscopic thin-sections were prepared from all successfully tested root samples. The microscopic analysis focused on anatomical parameters such as the size and number of vessels, their distribution as well as their conductivity. The results for the final correlation between the anatomical characteristics and the root's tensile strength are presented for both tree species.