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The Design of a Slope Stabilisation using Plants

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The method of stabilising slopes by means of hardwood cuttings and/or hardwood whips consists in creating a retaining structure by using plant material to reinforce soil. Such retaining structures ensure that steep slopes remain stable. The twigs and branches that act as reinforcement are taken from plants capable of growing adventive roots – usually willows; they do not rot but remain alive due to root development, thus ensuring the durability of the structure. In spring, the parts of the plants growing above ground produce new foliage that not only protects the slope against erosion due to wind and precipitation but also prevents desiccation of the soil.

This method of stabilisation was used successfully in the construction of fortifications as long ago as the 17^{th} century and is now used primarily to stabilise slopes in mountainous areas. By comparison, this very economical and environmentally friendly method of construction is rarely used in lowland areas even though it is an ideal way of stabilising slopes beside canals and rivers. In many cases a slope stabilised by plants is an effective alternative to sheet pile walls or concrete retaining walls which often are not acceptable to the public.

The first approach to taking the role of plants into account in slope stabilisation used Coulomb's friction law to describe how plants reinforce soil. Since then, a number of model tests and test slopes have been carried out to determine the structural performance of plants. These investigations have demonstrated that it is the pull-out resistance of the plants and the strength of the bond between the plants and the soil that govern slope design, not the strength of the plant material. The bond strength between plants and soil prior to root development is determined first and foremost by the soil density. It varies quite considerably owing to the irregular geometry of the plants,

thus masking the influence of the normal stress on it. It is for this reason that the calculation model has been simplified by assuming a constant bond strength instead of applying the friction law originally used. Root development results in a four- to five-fold increase in the bond strength over several years. This increase in the resistance is a useful reserve in case some of the installed plants die in the course of time.

Two calculation models are being investigated: a rigid body failure mechanism with a straight failure surface and a failure mechanism with two sliding wedges. The partial safety factor concept is applied when deriving the design formulae used to determine the required number, length and thickness of the plants to be installed in slope stabilisation. The result is a soil mechanical design method verified by tests that enables the stabilising effect of plants to be taken into account in slope design.