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Stream function of a perched water table in a sloping gradually layered soil: effect of the soil anisotropy on the flow patterns

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Perched water tables in the upper soil layers are an important landslides triggering mechanism and the knowledge of their properties is relevant in view of slope stability analyses. During long lasting infiltration processes at low rate, after the imbibition transitories vanished, an important role on the formation of a perched water table is played by the profile of the hydraulic conductivity at saturation K_s.

In this paper, as a part of a wider theoretical investigation which aims at describing the effect of gradually decreasing K_s with depth on the steady soil–water flow, the flow field taking place within a perched water table lying on a sloping capillary barrier is described and the corresponding Lagrange stream function is presented. The investigated soil is considered a priori anisotropic. At the bottom of the domain, for the sake of continuity of the total hydraulic head, saturation conditions are assumed. The analytical solution of the flow field was derived with the hypothesis of uniform flow along the slope.

The flow patterns revealed that the water infiltrating at the upper surface of the perched water table rapidly leaks toward the underlying soil. The length of the paths is sensitive to the decrease of the conductivity at saturation and it increases with the soil anisotropy. Anyway it still remains limited so that, if the slope is long enough, the uniform flow hypothesis can be considered a reliable approximation of the water flow within a long central branch of the slope.