Sieve curve analysis to estimate K in fine grained mass movement and moraine material – a critical review

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Grain size analysis is commonly used to estimate hydraulic conductivity of unconsolidated debris or sediments when hydraulic tests are not available. However, this approach is bound on some crucial assumptions and is representative for a very limited scale. Properties of rock mass deposits precluding most grain size approaches comprise (1) wide range of grain sizes, especially high fines content (2) irregular grain shapes promoting large grain contact areas (3) strong scale dependency of grain properties (4) considerable volume of voids non-participating in the flow process (5) significant scale dependency of rock mass deposit properties beyond the sample scale. These properties violate the underlying assumptions of purely empirical formulae such as Hazen, Beyer, Seelheim, USBR, Kaubisch and Fischer, Alyamani and Șen, Krumbein and Monk, Boadu. Hydraulic characterization of mass movement debris and moraine material with high fines content is challenging as their properties are inappropriate for most of the empirical and semi-empirical formulae. As such the applicability of estimating K of existing common formulae was tested on mass movement debris and moraine material with high fines content taken from drillings near Freibach, Carinthia. The empirical methods and the below mentioned semi-empirical approaches were applied within this study to quantify and demonstrate the error by the application of a wrong method. Investigation of the theoretical background of widely used semi-empirical formulae (Slichter-Terzaghi, Kozeny-Carman) reveals that assumptions accepted to derive these formulae are violated by the same class of deposits. The greatest impact on the resulting uncertainty stems from the difficulty to assess geometrical properties of the rock mass deposit, as porosity and specific surface, in a reasonable way. As a result, obtained values of hydraulic conductivity scatter over several orders of magnitude depending on the chosen method. Besides the difficulty to derive appropriate formulae for these conditions, their calibration and verification are especially difficult in these cases. These difficulties arise from the susceptibility of respective samples to internal erosion, thereby complicating the evaluation of permeameter tests. The study results illustrate the strong dependency of computed values on the choice of method and estimation of parameters, rather than on properties of the aquifer.