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Analytically computed rates of seepage flow into drains and cavities

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Abstract

The known formulae of Freeze and Cherry, Polubarinova - Kochina, Vedernikov for flow rate during 2-D seepage into horizontal drains and axisymmetric flow into cavities are examined and generalized. The case of an empty drain under ponded soil surface is studied and existence of drain depth providing minimal seepage rate is presented. The depth is found exhibiting maximal difference in rate between a filled and an empty drain. 3-D flow to an empty semi-spherical cavity on an impervious bottom is analysed and the difference in rate as compared with a completely filled cavity is established. Rate values for slot drains in a two-layer aquifer are 'inverted' using the Schulgasser theorem from the Polubarinova-Kochina expressions for corresponding flow rates under a dam. Flow to a point sink modelling a semi-circular drain in a layered aquifer is treated by the Fourier transform method. For unsaturated flow the catchment area of a single drain is established in terms of the quasi-linear model assuming the isobaric boundary condition along the drain contour. Optimal shape design problems for irrigation cavities are addressed in the class of arbitrary contours with seepage rate as a criterion and cavity cross-sectional area as an isoperimetric restriction.

Keywords

Drain, Flow rate, Optimization, Seepage, Tunnel