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Numerical Solution of Manning's Equation in Rectangular Channels

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Abstract : When the Manning equation is used, a unique value of normal depth in the uniform flow exists for a given channel geometry, discharge, roughness, and slope. Depending on the value of normal depth relative to the critical depth, the flow type (supercritical or subcritical) for a given characteristic of channel conditions is determined whether or not flow is uniform. There is no general solution of Manning's equation for determining the flow depth for a given flow rate, because the area of cross section and the hydraulic radius produce a complicated function of depth. The familiar solution of normal depth for a rectangular channel involves 1) a trial-and-error solution; 2) constructing a non-dimensional graph; 3) preparing tables involving non-dimensional parameters. Author in this paper has derived semi-analytical solution to Manning's equation for determining the flow depth given the flow rate in rectangular open channel. The solution was derived by expressing Manning's equation in non-dimensional form, then expanding this form using Maclaurin's series. In order to simplify the solution, terms containing power up to 4 have been considered. The resulted equation is a quartic equation with a standard form, where its solution was obtained by resolving this into two quadratic factors. The proposed solution for Manning's equation is valid over a large range of parameters, and its maximum error is within -1.586%.

Keywords : channel design, civil engineering, hydraulic engineering, open channel flow, Manning's equation, normal depth, uniform flow
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