COLLECTOR CHANNEL DESIGN APP

DEFINITION

This App applies to open channels of rectangular cross-section with a lateral inflow uniformly spread over the channel length and with a free discharge at the channel outlet. The user may select a channel of circular length profile, such as used as outflow launders on circular clarifiers, or a straight channel as used as outflow launders on rectangular clarifiers. The analysis assumes that circular collector channels slope symmetrically from a high point at mid-channel length to discharge into a common outlet sump.

BASIS OF ANALYSIS

The water surface vertical profile dy/dx in a collector channel with a uniformly distributed lateral inflow is quantified by the following expression:

$$\frac{dy}{dx} = \frac{S_0 - S_f - \frac{2Qq_L}{gA^2}}{\left(1 - \frac{Q^2 W}{gA^3}\right)} \qquad (1)$$

where

S_o = channel bottom slope
S_f = friction slope or energy gradient
Q = channel flow rate (varies linearly over channel length)
q_L = lateral inflow per unit length
W = channel width
A = water cross-sectional area

The collector channels used in water and wastewater engineering practice generally have a moderate gradient and a free discharge at the outlet end. In such circumstances, the outflow depth may be assumed to be the critical depth y_c. Alternatively, the outflow depth may be greater than the critical depth in circumstances where determined by the prevailing water level in the receiving sump. Where the channel slope is steep, the transition to critical depth may be at some point along the channel rather than at the outflow end. However, this is unlikely to be the case in the channel slope range normally employed in water and wastewater treatment plant collector channel design practice.

The Collector Channel App coding solves equation (1) using a fourth order Runge-Kutta numerical computational scheme (Chapra and Canale, 1985) in which the flow depth change ($y_{i+1} - y_i$), over a channel length Δx, is calculated in a step-wise fashion, starting from the defined depth at the outlet end (free discharge) and working upstream to the point of maximum flow depth.

OUTPUT

The user interface includes a Copy command that copies the input data and the calculated maximum flow depth to the clipboard to enable pasting to written record file.

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Reference

Chapra, S. C. and Canale, R. P. (1985) Numerical Methods for Engineers, McGraw-Hill Book Company, New York.