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Roughness predictors and their effects on the rating curve

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Water levels during floods are largely influenced by bed roughness in the main channel of the river. However, still a lot is unknown about this roughness. In the present study different roughness predictors and their effects on the rating curve are investigated in a theoretic way.

Distinction is made between fixed and mobile-bed roughness predictors; the latter taking into account the effects of bedforms on the roughness. However, all predictors still assume equilibrium bed form dimensions. Thus, the dynamics of roughness due to the changes in bed forms during floods are not yet considered. In other words: bedforms are assumed to adapt instantaneously to changing flow conditions.
For the analysis a rectangular channel is assumed, with dimensions similar to the main channel of the river Rhine. All roughness predictors are calibrated such that they yield the same water level at a discharge comparable to the yearly-mean discharge of the river Rhine. Next, the effects on the rating curve are investigated for discharges up to the design discharge of the river Rhine. Both steady uniform flow is analysed (analytically), as well as unsteady flow during a flood wave (using Sobek). To that end, the roughness predictor developed by Van Rijn (1984) has been added to the roughness module of Sobek.

The results show that applying different fixed bed roughness predictors leads to small differences in calculated water levels at the maximum discharge. However, for steady uniform flow the mobile-bed roughness predictors yield differences in water level at the maximum discharge of up to 10%, which is comparable to more than a meter in this case. The Van Rijn roughness predictor yields a smaller water level at the design discharge and a smaller hysteresis between the rising stage and the falling stage of the flood wave than the Engelund and Hansen (1967) roughness predictor. In the presentation, detailed results of the analysis will be shown and explanations for the observed behaviour will be given.

References

Engelund, F. and E. Hansen, 1967. A monocurve on sediment transport in alluvial streams. *Tenisk forlag, Copenhagen.*

Van Rijn, L.C., 1984. Sediment transport, part III: bed forms and alluvial roughness. *J. of Hydr. Eng., Vol. 110, No. 12, pp. 1733-1754.*