INFLUENCE OF HYDRAULIC GEOMETRY RATIOS ON THE ENTROPY PARAMETER IN OPEN CHANNEL FLOW

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The knowledge of flow velocity distribution is an essential requirement in dealing with stage–discharge relationships, sediments transport processes and prediction of morphological behaviour in alluvial streams, design of stable channels, flood control works and mathematical and physical modelling of flows. Due to the limitations of classical hydraulic methods, Chiu (1987) derived the velocity distribution law basing on the concept of informational entropy introduced by Shannon (1948) and Tsallis (1988). Such velocity profile has been widely employed in many different flow cases and improved by relevant and meaningful both theoretical and applied contributions derived from robust experimental knowledge. Main aspect of such model is related to the need of one parameter M said as entropy parameter. Such parameter is depending on the ratio between the mean cross section velocity over maximum velocity, Φ(M).

The way to evaluate the entropy parameter M through the ratio Φ(M), still represents a relevant issue nourishing a reach discussion among researchers mainly addressed to the reasonable ground about the invariance of Φ(M) for sections along the same river only at high flow while for low stage the ratio Φ(M) can be affected by the influence of roughness, through the relative submergence, the ratio between water depth and roughness height (D/d) as well as by the aspect ratio related to the cross section geometry, the ratio between flow width and flow depth (B/D). Therefore M should be assumed as a peculiar characteristic not only of the monitored site but also of the river reach where sites are located and the observed flow stage. Moving from these bases, using laboratory and field data, the classical hydraulic relationships on entropy velocity profile, the uniform flow and regime theory, a predictor for entropy parameter is proposed for open channel flow. The work proposes a general logarithmic relationship existing between the parameter Φ(M), the relative submergence and the aspect ratio of the flow.

The [Φ(M)-(D/d)-(B/D)] relationships have been applied to a set of experimental velocity data collected both in laboratory and in field, showing a good response of the theoretical model but selecting different behaviour depending on the roughness scale. In fact, Φ(M) is strongly depending on the ratio depth/roughness for values of D/d less than 4 when large and intermediate roughness scale occurs, while it might be assumed almost constant to 0.66 for small roughness scale (D/d>4) according to literature for high flow stage. On the other hand, the relationship among Φ(M) and B/D seems to be depending on whether or not the flow is confined, like artificial channel, instead of natural cross section.
The comparison between the two set of data, laboratory versus field, enlighten the effect of the aspect ratio which is strongly related to $\Phi(M)$ for flume velocity data while it results not depending on $\Phi(M)$ for river measurements. Further, even this last issue enforce the difference between the $\Phi(M)$ ratio behaviours for high roughness flow and low roughness one, remaking the value of $D/d=4$ as operative threshold.