MACRO-ROUGHNESS FLOW RESISTANCE: A NEW EXPERIMENTAL FORMULA

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Since flow resistance estimation holds a fundamental role in river management, many studies have been proposed around this topic (e.g.: Strickler, 1923; Keulegan, 1938, among the others). Most of the investigations have focused on flow with small-scale roughness, while flows over macro-scale roughness have received much less attention. In case of micro-scale roughness the flow resistance is mainly function of the relative submergence only, while in case of macro-scale roughness various Authors (Bathurst et al., 1981; Bathurst, 1985; Baiamonte et al., 1995; Ferro, 1999) suggest that, in addition to the relative submergence, further additional parameters related to the 'geometry of the roughness' (shape, pattern and spacing of the protruding material from the bed) need to be introduced in order to quantify flow resistance.

In this work the influence of macro-scale roughness arrangement on flow resistance has been investigated by means of laboratory experiments. Results have highlighted the existence of an optimal macro-roughness spatial density, ranging around 40%, maximising flow resistance. Laboratory results have been analysed in order to obtain an interpolating equation able to predict observed values. Relative submergence Y/D_{90}, spatial density Γ and slope S have been demonstrated to play a fundamental role to determine flow resistance in case of macro-roughness presence. Following these findings a predicting equation for dimensionless Chezy is proposed as follows:

$$C = fn_1\left(\frac{Y}{D_{90}}\right)\cdot\left[fn_2(S)\cdot fn_3(\Gamma)\right]^{D/Y}\cdot\left(\frac{D_{50}}{D_{90}}\right) \qquad (1)$$

Functional relationships between the quantities involved in eq. (1) have been found performing a statistical analysis of laboratory results. A good predicting capability of eq. (1) has been shown comparing measured and predicted C values in case of laboratory data and field data (figure 1) A further comparison with some others predicting equations for the evaluation of flow resistance in case of macro-roughness (Graf, 1987; Ferro, 1999) confirms the prediction reliability of eq. (1).

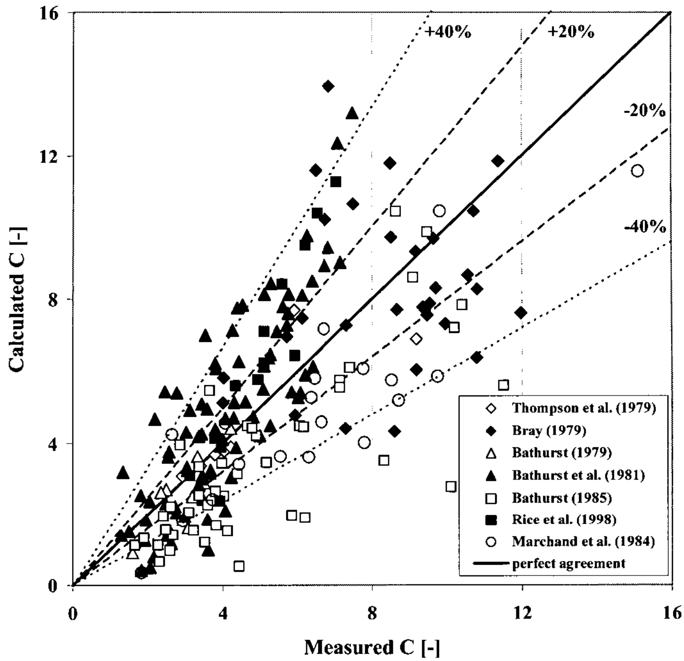

Fig. 1 Comparison between measured and predicted values of *C* for field data.

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