

Parametrization of the drag and turbulent intensities over rough walls

F. Bruno¹, M. De Marchis² and S. Leonardi^{3,*}

¹ Department of Architecture and Engineering, University of Enna "Kore", Enna, Italy.

² Department of Engineering, University of Palermo, Palermo, Italy

³ Department of Mechanical Engineering, University of Texas at Dallas, Richardson, TX, USA.

* stefano.leonardi@utdallas.edu

ABSTRACT

Turbulent flows over rough surfaces can be encountered in a wide range of engineering applications. Despite progress made after several decades of studies, the prediction of the drag and turbulent intensities from the geometrical parameters of the surface remains an open question. In a recent paper, Bruno *et al.* (2024), we performed Direct Numerical Simulations of 15 rough walls with different shapes but similar Effective Slope, skewness, and kurtosis. We found that the drag does not scale well with any of these geometrical parameters. In fact, we observed through flow visualizations that the solid portion of the rough walls should be weighted differently according to its positions. For example, roughness elements in the wake of large pinnacles have negligible contributions to the drag and should not be included in the calculation of geometrical statistics of the surface to predict the drag. To account for this effect, their size and pattern we introduced the Effective Distribution by subtracting to the Effective Slope the contribution of roughness elements located in the wake region and adding the contribution of pinnacles above the crest plane. The Effective Distribution correlates quite well both with the drag and the roughness function for a wide range of cases having different mean roughness

height, skewness and kurtosis. To further validate the ED, and assessing how it can be generalized to real rough wall, an irregular wall made from the superposition of random sinusoidal function was considered. Results were consistent with the correlation here presented. At the conference we will further extend this findings by analyzing the turbulent intensities (Fig.1) and assessing how they scale with the Effective Slope, skewness, and kurtosis and how the new parameter, Effective Distribution correlate well with their maximum intensity.

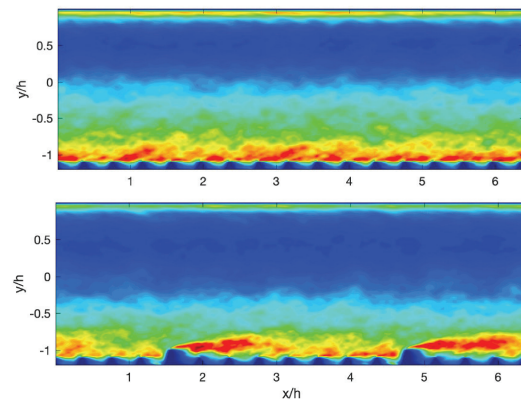


Figure 1: Color contours of the root mean square of the streamwise velocity for two different rough walls.

References

F. Bruno, S. Leonardi and M. De Marchis (2024). Towards a new roughness parametrization through the effective distribution function. *Journal of Fluid Mechanics* **Volume 999**, 25.