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INTEGRAL FLOW PARAMETERS FOR EVALUATING THE LAW OF THE WALL IN PIPE AND CHANNEL FACILITIES

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The law of the wall in wall-bounded (pipe, channel and flat plate) turbulent flows is an active area of research since the formulation of the boundary layer theory by Prandtl in 1904. Many challenges, however, remain concerning its physical interpretation, scaling, experimental facilities and resolution of techniques utilized in evaluating its behavior and constants. The present piece of work reports on observations made by the present authors, highlighting and raising few issues about the law of the wall, in particular, within the so-called inertial sublayer. Along the inertial sublayer, it is commonly believed that a logarithmic behavior for the law of the wall is superior and the accuracy of estimating its constants has big potential for evaluating, for instance, the wall skin friction. Estimating the constants of the logarithmic law of the wall either from detailed velocity profile measurements or via direct measurements of the mean velocity gradient is subjected to imperfections. One is always caught between inadequate spatial resolution and errors in measuring small velocity differences between closely-spaced points in flow field. It is therefore; highly desirable to find a high fidelity approach that minimizes the uncertainty in evaluating the logarithmic law of the wall. The basic idea is summarized that permits a reliable methodology based on the integral flow parameters; such as mean pressure gradient (dp/dx), dimensionless bulk (U_b /u_τ) and centerline (U_c /u_τ) for evaluating the constants in the logarithmic relation of the law of the wall. For sufficiently high Reynolds number, a revisited analytical approach by[1] for the functional relationship of the law of the wall is proposed. Additionally, experimental results of fully developed flows in both the CoLaPipe Facility at LAS (Brandenbug University of Technology CottbusSenftenberg) and channel at LSTM-Erlangen (Fredrich Alexander University) for a wide range of Reynolds number up to 10^6 based on the bulk flow velocity are reported verifying the approach adopted.

References

[1] Long, C. E., Wiberg, P. L., and Nowel, A. R. M., (1993), Evaluation of von Karman's Constant from Integral Flow Parameters, J. Hydraulic Engineering **119**, 10, pp. 1182-1190.