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Mean velocity of a free fully-developed turbulent boundary layer

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A novel model equation for describing the profiles of the mean axial velocity of a free fully developed turbulent boundary layer over a smooth solid wall at zero pressure gradient is developed. The model uses the Reynolds-average equation for the mean axial speed and a modified Prandtl's mixing-length curve for the turbulent stress. This model is used to integrate the mean velocity profiles and compute the wall friction coefficient along the wall. The computed results of the velocity profiles and the friction coefficient show a remarkable agreement with much measured data and results from direct numerical computations for a wide range of Re_x between 10 and 100 million, except for the transition region. Moreover, the present analysis demonstrates the four main regions that govern the flow and sheds new light on the structure of the boundary layer.

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