Transient wall shear stress measurements and estimates at high Reynolds numbers

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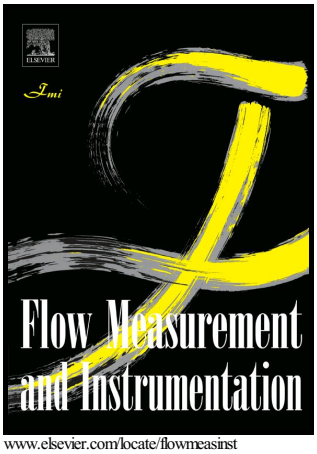

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PII: S0955-5986(17)30244-3
DOI: https://doi.org/10.1016/j.flowmeasinst.2017.10.003
Reference: JFMI1369

To appear in: *Flow Measurement and Instrumentation*

Received date: 5 June 2017
Revised date: 3 October 2017
Accepted date: 5 October 2017

Cite this article as: L.R. Joel Sundstrom and Michel J. Cervantes, Transient wall shear stress measurements and estimates at high Reynolds numbers, *Flow Measurement and Instrumentation,* https://doi.org/10.1016/j.flowmeasinst.2017.10.003

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Abstract

Transient wall shear stress measurements using hot-film anemometry have been performed in a large-scale laboratory setup at high Reynolds numbers. Starting from Reynolds numbers 1.7×10^6 and 0.7×10^6, the flow was brought to a complete rest by closing a knife gate thus replicating a pressure-time (also know as Gibson) flow rate measurement in a hydropower plant. Ensemble-averaged mean wall shear stresses obtained from 22 repeated runs have been compared with estimates obtained using the pressure-time method. The objective of the work has been to assess the accuracy of the frictional formulation entering the pressure-time integral. It is shown that both the standard method, a quasi-steady approach as well as the recently introduced unsteady method all reproduce the measured wall shear stresses quantitatively during most of the transient. The last phase, following the complete closure of the gate, which is characterized by a slow decay towards zero shear stress at the wall is, however, not captured by the available methods. In general, the unsteady formulation produces the smallest flow rate estimation error, which in turn, implies the best modeling of the frictional losses.

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