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MULTIPLE-SCALE ANALYSIS OF WAVE PROPAGATION IN HYDRAULICS

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Method of multiple scales is used in the present paper in order to analyze wave propagation in a circular pipe. Two problems are considered: (1) non-constant cross-sectional area of the pipe and (2) variable friction coefficient. It is not uncommon in hydraulic engineering to assume that the radius of the pipe is not constant. The changes in the radius of the pipe can be caused by many reasons: deformations of the pipe, biofilm build-up on the walls, rough wall. The flow is governed by a one-dimensional linearized water-hammer equation with variable coefficients. An amplitude evolution equation is derived under the assumption that radial irregularities are assumed to be small in comparison with the mean radius of the pipe. Amplitude evolution equation in this case has rather simple form which allows one to evaluate localization distance analytically.

In the second problem we assume that the friction coefficient contains irregular component. An amplitude equation is also derived for this case. Analytical estimates for the localization distance are compared with available data from the numerical solution of two-dimensional water-hammer equations with irregular inhomogeneities. Reasonable agreement between analytical results and numerical computations is found.