"Discussion of Numerical oscillations in Pipe-filling bore predictions by shock-capturing models" by Jose G. Vasconcelos, Steven J. Wright and Philip L. Roe

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The discussers wish to congratulate the authors for an illuminating exposition of numerical oscillations in the problem of pipe-filling bore. The authors presented two techniques for attenuating such numerical oscillations for wavespeeds around 50 m/s.

The discussers wish to point that numerical oscillations in pipe filling bores can be minimized for wavespeeds that are representative of those that can be attained in stormwater systems (e.g., 1000m/s) if the physical processes of bore filling are modeled appropriately. The flow regime on one side of the filling bore is pressurized flow, while the flow on the other side is free surface flow. Therefore, an appropriate approach is to enforce the waterhammer equations in the pressurized region, the saint Venant equations in the free surface region and the jump relations across the filling bore. León et al. (2009a, 2009b) adopted this approach, and a finite volume scheme to solve the waterhammer as well as the Saint-Venant equations and found no unphysical oscillations even when using acoustic wave speeds as large as 1000 m/s.

In order to examine the effect of this conceptual model on numerical oscillations, the model in León et al. (2009a, 2009b), implemented in the Illinois Transient Model (ITM), was applied to the test rig considered in the paper under discussion. In their paper, the authors used a wavespeed of 50m/s. To show the robustness of the ITM approach, the discussers used a wavespeed four times greater than that of the authors (i.e., 200 m/s). As suggested by the first author in a personal communication, a costant water level was imposed at the inflow-box boundary (level of spillage), thus, a sudden raise in the water depth (0.082 m to 0.244 m) at this boundary was assumed at time = 0 s. The pressure head results are presented in Fig. 1. It is clear that the results are free of unphysical oscillations. The fluctuations in the pressure profile that are observed in Figures 1(b) and 1(c) were generated at the inflow-box boundary as a result of the initial water raise and propagated back and forth in the pressurized zone.

In conclusion, the discussers' are of the opinion that oscillations due to inadequate representation of the physics should not be treated by numerical damping. If one is certain that the origin of the oscillations is numerical, then the scheme must be fixed. On the other hand, if inadequate representation of the physics is the reason for the oscillations, then the governing equations need to be modified. We find that the unphysical oscillations that arise in surcharging problems as the wavespeed gets large can be avoided by choosing governing equations that best mimic the physics. In the present case this amount to the waterhammer equations in the surcharged region, the Saint-Venant equations in the free surface region and the shock relations across the filling-bore.

References

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