On a toy model for fluid-structure interaction problems with contact

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In this talk, I will present a recent joint work with Boris Muha which concerns a simple model that is used to study contact problem for the interaction between a beam and a fluid. The model consists of a viscoelastic beam described by function η denoting the vertical displacement. The beam is located above an obstacle $y = 0$ and satisfies the equation

$$\partial_{tt}\eta - \partial_{xx}\eta - \partial_{txx}\eta = F_{con} \tag{1}$$

where F_{con} represents the contact force which acts only on the set $\{\eta = 0\}$ and ensures that $\eta \geq 0$. The contact is assumed to be completely inelastic, i.e. the beam loses all kinetic energy upon contact. For this problem, a weak solution is constructed by approximative method – the contact force is approximated with a penalizing term $\frac{1}{\varepsilon}\chi_{\{\eta<0\}}(\partial_t\eta)^-$ which does not depend on the distance from the obstacle. The two main novelties are that the following properties are preserved for the constructed limiting solution as $\varepsilon \to 0$:

1. The dissipation due to contact for the constructed weak solution is a singular measure which only exists when the beam is going down (it is zero on $\mathrm{int}\{\partial_t\eta \geq 0\}$);

2. The velocity after contact is zero in a weak sense.

Some numerical examples are also included which demonstrate certain properties and difficulties considering the contact set $\{\eta = 0\}$ and the contact force F_{con}, and their behavior throughout the convergence $\varepsilon \to 0$.

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