"Slide lines in Lagrangian hydrocodes"

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In realistic physical simulations, people often face problem of shear flow at material interfaces. If the materials move along each other but are tied to a single computational mesh without any sliding treatment, severe distortions appear which can eventually cause the failure of the simulation. A typical example is the motion of a laser produced plasma in a deforming channel [1], or a shear flows in a high-velocity impact problem [2]. One option how to resolve this problem is the introduction of sliding line environment into the Lagrangian code. There exist two approaches describing this topic, [3, 4], however, none of them is simple to read, understand, and implement, and we believe that more recipe-like paper is needed for broader audience [5].

One possibility how to treat sliding lines in a compatible staggered Lagrangian code is a special type of boundary condition for nodal forces and velocities. Suppose that there exist two different meshes interacting with each other through a common sliding line, one of them is specified as the master side defining the slide line shape, while the other – slave – side follows the slide line.

We keep the main idea of [4] and incorporate the contact forces for the nodes on the slide line, representing the forces due to the pressure gradient across the interface. The second main ingredient of the sliding line treatment is the correction of the slave side nodal velocity to prevent the inter-penetration of two sides. This projection basically results in neglecting the velocity component normal to the sliding line direction. We discuss this issue in the form described in [4], where just one-by-one interaction is employed, tying the slave node to one particular node (the closest one) from the master side. We extend this definition by the closest-edge concept, which generally provides the interaction of the slave node with two different master nodes using the piece-wise linear velocity approximation.

This approach has been further extended to treat more than two materials sliding on each others in a format of so-called T-junction. Details of this extension will be provided. In this talk, we also present our implementation of the sliding-line approach from [4] and its possible modifications. The differences due to the modifications are demonstrated on a selected numerical example. We also discuss the issues related to implementation into an existing 2D compatible staggered code in such a way that the rest of the code is modified as little as possible.

References

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