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Universitat Politècnica de Catalunya, Barcelona, April 15–19, 2013

Numerical Simulation of Fast Transient Dynamic Phenomena in Fluid-Structure Systems

Questions/Exercises on Part III

Note: some questions may admit more than one answer. You may mark all answers you think are appropriate, and eventually add some comments of your own.

1. In fast transient dynamics (explosions, shocks, impacts) FSI usually plays an important role in the presence of:
    a. Incompressible or nearly incompressible fluids
    b. Highly compressible fluids and very stiff structures
    c. Highly compressible fluids and very deformable structures
2. The presence of a fluid free surface or of a Lagrangian interface between two fluids usually:
    a. Leads to non-permanent FSI
    b. Leads to permanent FSI
    c. Has no effect on the type of FSI
3. In the chosen FSI formulation, the contact pressure acts along:
    a. The tangent to the FSI interface
    b. The direction of the relative velocity
    c. The normal to the FSI interface
4. The governing equation of the chosen FSI model is the so-called (material) velocity compatibility condition, which involves:
    a. The particles velocity
    b. The mesh velocity
    c. The relative velocity
5. In the ALE formulation for FSI, the mesh velocitiy of fluid nodes on the F-S interface:
    a. Is arbitrary, as always in ALE methods
    b. Must be equal in all components to the mesh velocity of the structure
    c. Must be equal to the mesh velocity of the structure only along the normal to the interface
    d. Is set to zero
6. The most delicate ingredient of the proposed FSI model is:
    a. Finding the "true" normal(s) to the continuous F-S interface
    b. Writing down the velocity compatibility condition
    c. Finding the normal(s) to the discrete F-S interface

7. In the chosen approach, the resulting FSI coupling conditions are typically:
    a. Solved together with any other boundary conditions via Lagrange multipliers
    b. Treated separately from other boundary conditions because of their special nature
    c. Solved explicitly because they always lead to an uncoupled set of equations
8. Geometric FSI methods such as the FSA/FSR algorithm are based upon:
    a. The conservation of fluid, i.e. zero net flux across the F-S interface at fluid nodes
    b. The balance between forces in the fluid and forces in the structure
    c. The geometric shape of the structure interface near the node considered
    d. The geometric shape of the fluid interface near the node considered
9. Which of the following statements about the FSA/FSR algorithm are correct?
    a. It yields one discrete normal per node
    b. It may lead to spurious velocities in 3D when the FSI interface is warped
    c. It works well at submerged structural edges (shells, plates without a topological thickness)
10. Which of the following statements about the equilibrium-based UP algorithm are correct?
    a. It yields (at most) one discrete normal per node
    b. It may lead to spurious velocities in 3D when the FSI interface is warped
    c. It works well at submerged structural edges (shells, plates without a topological thickness)
11. In the code input, the various FSI coupling conditions must be applied to:
    a. Fluid nodes along the F-S interface
    b. Fluid elements along the F-S interface
    c. Structure nodes along the F-S interface
    d. Both fluid an structure nodes along the F-S interface
12. In a FSI problem involving only rigid (fixed) structures one would normally:
    a. Discretize only the fluid domain and use the FSR algorithm to impose conditions along the F-S interface
    b. Discretize only the fluid domain and simply block all nodes along the F-S interface
    c. Discretize both the fluid and the structure, block the structure nodes and use the FSR algorithm on fluid nodes along the F-S interface
13. In the code, fluid nodes subjected to FSI for which the number of distinct normals found is equal to the space dimension (2 in 2-D, 3 in 3-D) are:
    a. Automatically blocked in all directions
    b. Automatically coupled with the structure along all directions
    c. Automatically declared as Lagrangian and coupled with the structure along all directions
14. The FSI models presented so far (FSA, FSR, UP) are in principle applicable only to:
    a. Permanent FSI
    b. Non-permanent FSI
    c. Both permanent and non-permanent FSI
15. The FSI models presented so far (FSA, FSR, UP) assume:
    a. Distinct but coincident (superposed) structure and fluid nodes along the F-S interface (conforming interface)
    b. Distinct and arbitrarily located structure and fluid nodes along the F-S interface (non-conforming interface)
    c. The same node (but with distinct degrees of freedom) to represent both the structure and the fluid

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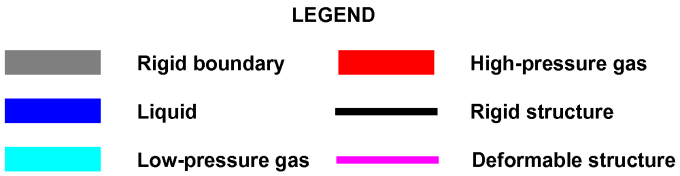
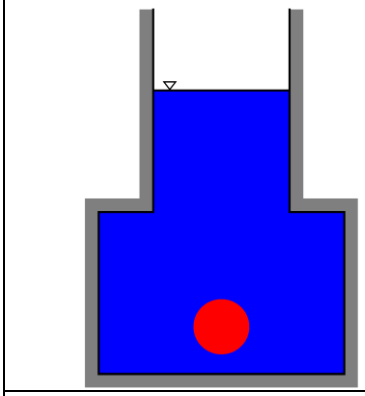
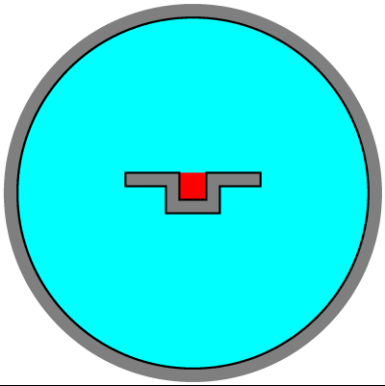
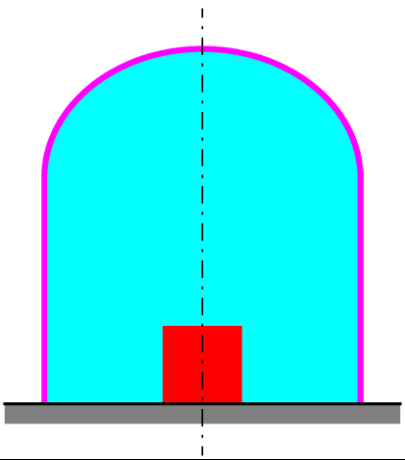
Exercise 1

For each of the following applications, indicate the most appropriate FSI model(s) among those presented in the Course:

Blockage of global fluid dofs, **FSA,** **FSR,**
FSCR, **FLSR.**

Motivate your choices. In some cases more than one model is applicable, or different models are appropriate for different regions of the mesh.



Problem	FSI modeling
	
	
	

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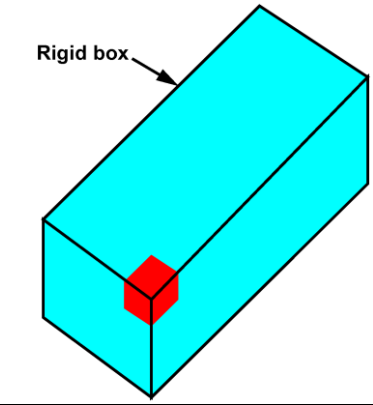	
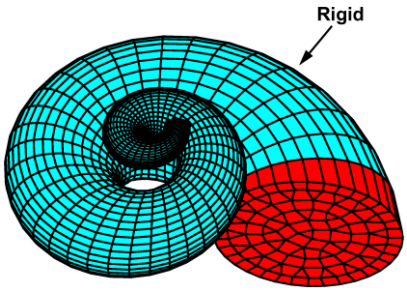	
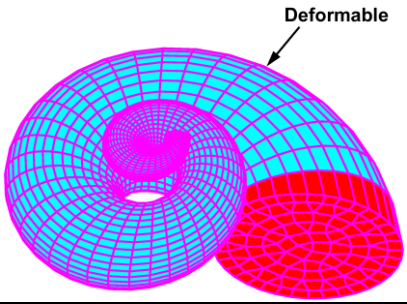	
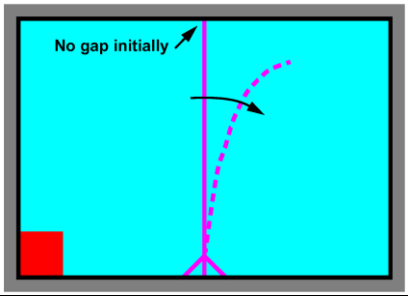	

Additional comments/observations:

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Exercise 2 (optional)

Sketch a fluid-structure interaction problem of your choice. Qualitatively discuss (at least) the following aspects:

- Type of global formulation adopted (Lagrangian, Eulerian, ALE)
- (In case of ALE formulation) The type of grid motion adopted for the various zones of the mesh
- The FSI model(s) adopted and the corresponding mesh zone(s)

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