8th. World Congress on Computational Mechanics (WCCM8)
5th. European Congress on Computational Methods in Applied Sciences and Engineering (ECCOMAS 2008)
June 30 – July 5, 2008
Venice, Italy

EVOLUTION OF A FLUID WITH COLLISIONS AND UNILATERAL CONTACT : THE P-ALE APPROACH.

***Eric Dimnet[1], Raul Gormaz[2]**

[1] Laboratoire Central des Ponts et Chaussées,
58, Boulevard Lefebvre
75732 Paris cedex 15
France
dimnet@lcpc.fr

[2] Departamento de Ingenieria Matematica,
Facultad de Ciencias Fisicas y Mathematicas
Universidad de Chile,
Blanco Encalada 2120, Casilla : 170-3 C3
Santiago de Chile
Chile
rgormaz@dim.uchile.cl

Key Words: *Collisions, Fluid, Unilateral contact, Computational Methods.*

ABSTRACT

At first, the collision of a rigid solid with a fluid is investigated. When both bodies get colliding, it is no longer possible to solve the classical smooth equation of motion (velocities are not derivable): the application of the principle of virtual work in association with appropriate constitutive laws relating internal stress and velocities, allows to obtain a set of equations of motion, valid both for smooth and for non-smooth evolutions. Il the first part, we focus on the collision time and the corresponding time-discontinuity of the velocities.
The approach that we propose, is based on the theory of instantaneous collisions [2;5] and the description of the internal percussions.
Equations of motion that are valid at the time of the collision are obtained by the application of the principle of virtual work. The constitutive laws that are used to complete the model respect the geometrical constrains (non interpenetration) as well as the thermo-dynamic. From a mathematical point of view, the constitutive laws respect the duality in the sense of the work of the internal effort [3].

Then, the question of the evolution of a fluid with unilateral contact is investigated. The specificity of such an evolution is that the boundary of the fluid is sometimes free and sometimes in unilateral contact with an obstacle. An other important propriety of such an evolution, is that the fluid collides when its boundary contacts the obstacles. This kind of collisions is described by the theory of instantaneous collisions developed for collision of a solid with a fluid.
To solve the problem resulting from the presence of unilateral contact, a computational method has been developed, based on the ALE approach. This method is based on the use of a succession of percussions to approximate time-continuous forces and stresses, as usual in the Percussion Method (PM) and the formulation of the contact problems only involves the velocities.
The proposed method is therefore called P-ALE (Percussive ALE).

Numerical simulations using the P-ALE method will be presented.

REFERENCES

[1] Dimnet, E., Frémond, M., Gormaz, R., San Martin, J., (2001). Collisions involving solids and fluids, *Novel approaches in civil ingeneering*, Springer Verlag Heidelberg.

[2] Dimnet, E. (2002). *Mouvement et collisions de solides rigides ou déformables*. Thèse de l'Ecole Nationale des Ponts et Chaussées, Paris.

[3] Dimnet, E., (2004). Collision in an incompressible fluid. *WCCM VI in conjunction with APCOM'04, Sept. 5-10, 2004, Beijing, China.*

[4] Dimnet, E., Frémond, M., Gormaz, R., San Martin, J., (2003). Collisions of rigid bodies, deformable bodies and fluids. *Second M. I. T. Conference on Computational Fluid and Solid Mechanics*, Boston.

[5] Frémond, M. (1995). Rigid bodies collisions, *Physics Letters A*, 204, pp 33-41.

[6] Frémond, M., Gormaz, R., San Martin, J., (2003).Collisions of a solid with an incompressible fluid, *Theoretical and Computational Fluid Dynamics*, vol 16, 405-420.

[7] Moreau, J.-J. (1966). Fonctionnelles convexes, Séminaire sur les équations aux dérivées partielles, Collège de France, Paris.

[8] Pfeiffer.,F. (2001). *Non smooth mechanics. P. T. R. S.* London 2001; A359:2305–2644.