SPH Formulations: New Developments in LS-DYNA

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Summary:

"Standard" SPH methods are based on an Eulerian kernel. In most cases, the support remains constant and the neighbors search is carried out at each time step. This allows to deal with large deformation problems. However, this technique may suffer from instabilities (such as the so-called tensile instability [Xiao 05]).
In the case of a Lagrangian kernel, the neighbors' list remains constant throughout the calculation. This formulation overpasses the tensile instability problems but the treatment of large deformations becomes limited [Xiao 05]. In order to solve this problem, Vidal et al. [Vidal 07] proposed a very interesting approach based on a formulation with updated Lagrangian kernel. They showed that the reference state update and the neighbor list update allow large deformations modeling. Nevertheless, when this reference state is too frequently actualized, numerical instabilities can appear.

Recent developments based on Eulerian and Lagrangian kernel SPH coupling have been introduced in ls-DYNA version 971.
First, we present a coupling between Lagrangian kernel particles and Eulerian kernel particles. Then, an impact of a rigid projectile on a composite material modeled with a lagrangian kernel is showed in order to visualize the advantages of this new element technology.

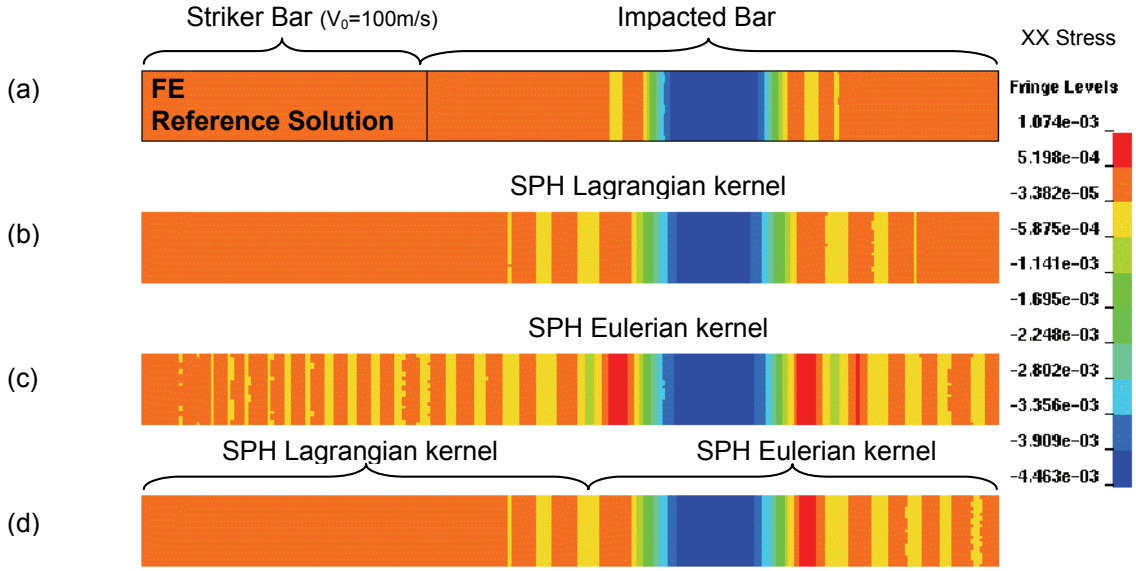

Figure 1. Lagrangian and Eulerian kernel coupling validation : bar impact test case

References

[Xiao 05] S. P. Xiao, T. Belytschko. Material stability analysis of particle methods. Adv. Comput. Math., 171-190, 2005
[Vidal 07] Y. Vidal, J. Bonet, Huerta. A Stabilized updated Lagrangian corrected SPH for explicit dynamic problems. Int. J. Num. Meth. in Engineering, 2687-2710, 2007