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New features of 3D adaptivity in LS-DYNA

W. Hu LSTC

The 3D remeshing in adaptivity is defined by the keyword *CONTROL_REMESHING, where the two important parameters, RMIN and RMAX, are the minimum and maximum mesh size in the re-meshing. The internal remesher of LS-DYNA uses these two values globally for all adaptive parts. In many applications, users may need more flexibility on defining the mesh size for different parts of the model. This short paper presents two new features: run-time control and *DEFINE_ADAPTIVE_BOX in 3D adaptivity.

By setting IADPFCTRL=1 (*CONTROL_ADAPTIVE, Card4, the 7th flag), users are able to perform run-time control on 3D adaptivity through control files in the following manners:

(1) Trigger additional adaptive step in run time

(2) Setup a special adaptive step with the option of manual remeshing by users

(3) For multiple adaptive parts, define remeshing parameters individually

In the current implementation, there are two control files: adapt.fc1 and adapt.fc2. They can be automatically generated by LS-DYNA if they are not pre-defined.

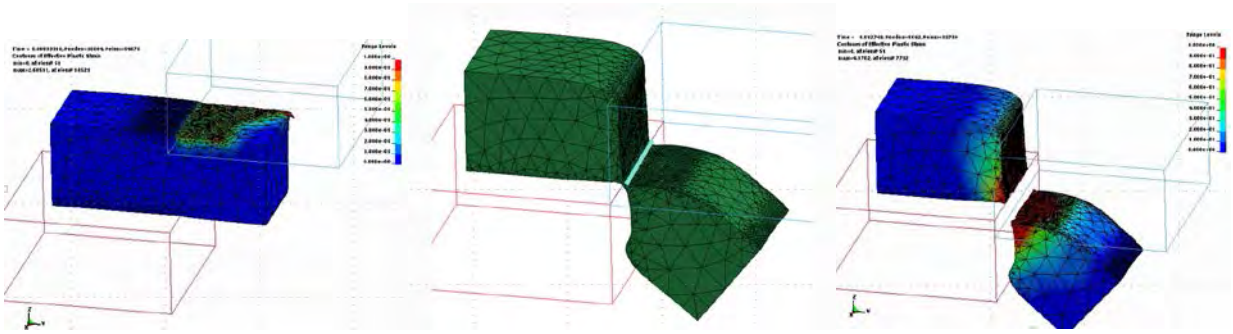
The file adapt.fc1 has three control parameters: C1 is the overall switch for this module; C2 defines the time for the next additional adaptive step; C3 is the switch for manual remeshing. The detail can be found in the following three examples:

(1) 1, 0.0, 0: C1=1 to turn on run-time control; C2=0.0 to start additional adaptivity immediately; C3=0 to turn off manual remeshing

(2) 1, 0.01, 0: C2=0.01 to start additional adaptivity at the time 0.01

(3) 1, 0.01, 3: C3=3 to turn on manual remeshing of the adaptive part 3 in the additional adaptive step at time 0.01

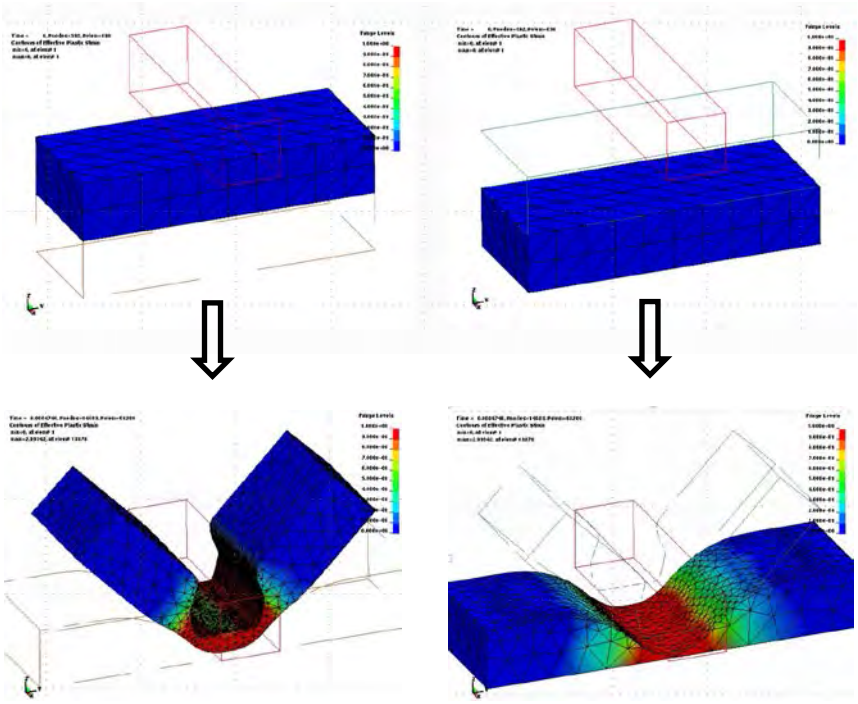
In this case, LS-DYNA is paused and the mesh information of part 3 is output into a keyword file, named user.mesh. Users can either manually change the mesh or use CAD software to generate a new mesh and then save into the same file. LS-DYNA continues the analysis by users setting C1=-1 in adapt.fc1.



In the metal cutting simulation shown above, it can be estimated when the tool front meets the bottom die so that the additional adaptive step can be triggered for users to trim the mesh using CAD software and then continue the analysis in LS-DYNA.

In the control file adapt.fc2, users are able to define the birth and death time of adaptivity (same as TBIRTH and TDEATH in *CONTROL_ADAPTIVE) as well as the mesh size (same as RMIN and RMAX in *CONTROL_REMESHING) for each adaptive part. Here is an example:

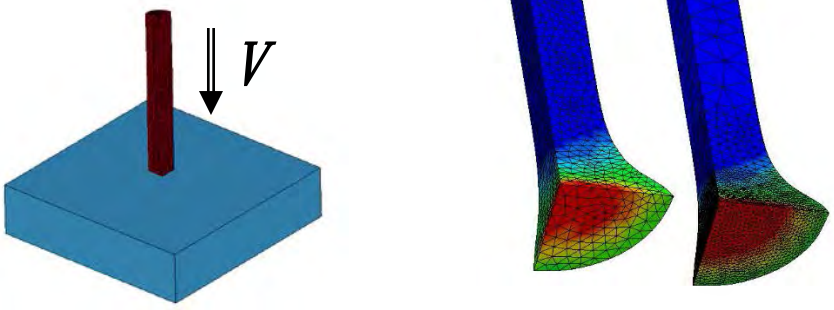
2	Set the parameters for two adaptive parts
2, 0.0, 0.1, 1.0, 4.0	Part 2: TBIRTH=0.0, TDEATH=0.1, RMIN=1.0, RMAX=4.0
3, 0.01, 0.2, 2.0, 4.0	Part 3: TBIRTH=0.01, TDEATH=0.2, RMIN=2.0, RMAX=4.0



In the example shown above, there are adaptive parts: the top one contacts with a very sharp tool so that a smaller mesh size is needed to well represent the contact surface and better simulate the local large deformation; the bottom part has much smoother profile of

material deformation so that the less frequent adaptivity and larger mesh size are used to reduce the overall computational cost. All of these differences in defining adaptivity for different parts can be made in adapt.fc2.

The 3D adaptivity in LS-DYNA has the capability to automatically perform dynamic mesh refinement based on the curvature of contact surfaces. In addition to that, *DEFINE_ADAPTIVE_BOX is now supported for users to define multiple boxes in space with different definitions of remeshing mesh size. In the card 2 of this keyword, users can specify the adaptive part ID (PID), the minimum mesh size (BRMIN) and the maximum mesh size (BRMAX) so that, within the box defined in the card 1, all the mesh from this part is remeshed using BRMIN/BRMAX instead of the global RMIN/RMAX. The following shows a Taylor bar impact simulation using 3D adaptivity (a quarter model), where the standard remeshing is compared to the one with three remeshing boxes defined by *DEFINE_ADAPTIVE_BOX. The results show that the second one is able to capture the high-gradient field with much finer mesh and at the same time achieve the optimal performance with better distribution of mesh size.



* Dr. W. Hu graduated from the department of civil engineering in UCLA in 2007, and joined LSTC in 2009. He has been working on the research and development of adaptivity and meshless methods.

For information please contact Dr. W. Hu through sales@lstc.com Sub. Dr.W. Hu