

Introducing *BOUNDARY_SPC_SYMMETRY_PLANE (SET)

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This keyword constrains nodes that are within some distances (a tolerance) of a defined plane to have no motion orthogonal to that plane. This keyword is used for a geometric symmetry plane, so that the full geometry does not have to be modeled.

As shown in Figure 1, a symmetric plane's position is defined using a point's coordinates X, Y and Z, and its orientation is defined by a vector component VX, VY and VZ. All nodes within a specified tolerance with the variable TOL will be constrained in motion orthogonal to the plane.

Originally designed for metal forming simulation only, the feature has garnered many interests from the users to the point where many of the initial limitations are removed so it can be applied in many other simulation fields. Two of the eliminated restrictions are:

- 1) Only two such (symmetry plane) definitions can be used when the symmetry planes are not parallel to the global XY, YZ, or ZX planes, and,
- 2) For multiple symmetry planes, position coordinates defined by the variables X, Y, and Z on all symmetry planes must have the same values for these fields.

Starting from Dev Revision 124122, multiple symmetric planes can be defined even if they are not aligned with the global coordinate systems. Each symmetric plane can also be defined with distinctive point coordinates.

As shown in Figure 2, a draw model is situated in a fashion with all four sides of the blank not aligned with any of the global axis. Three sides of the blank are defined as symmetric planes, with X, Y, Z coordinates of the three separate node IDs 41770, 41778 and 41786, and with their respective vector components [VX, VY, VZ] indicating the plane's normal direction. The tolerance is 0.1, which should be less than the minimum element edge length near the planes. In Figure 3, the original flat blank and formed blank are overlaid together in the isometric view, showing no movements of the blank edge nodes in any of the three symmetric planes. The effect of the constraints may be even clearer in the top view, Figure 4, where the three edges of the original blank exactly overlap with the formed blank on the three symmetric planes.

The keyword input for this small example is listed as follows:

```
*BOUNDARY_SPC_SYMMETRY_PLANE
$   IDSP      PID      X          Y          Z          VX          VY          VZ
    1  &blk1pid  -88.59   -12.59     0.38  -5.732094   5.73208    0.0
$   TOL
    0.10
    2  &blk1pid -101.173  -25.1730   0.38  -0.707108  -0.707106   0.0
    0.10
    3  &blk1pid  -76.00     0.0       0.38  -0.707108  -0.707106   0.0
    0.10
```

The feature has now been used in all areas, in addition to the originally intended area of metal forming.

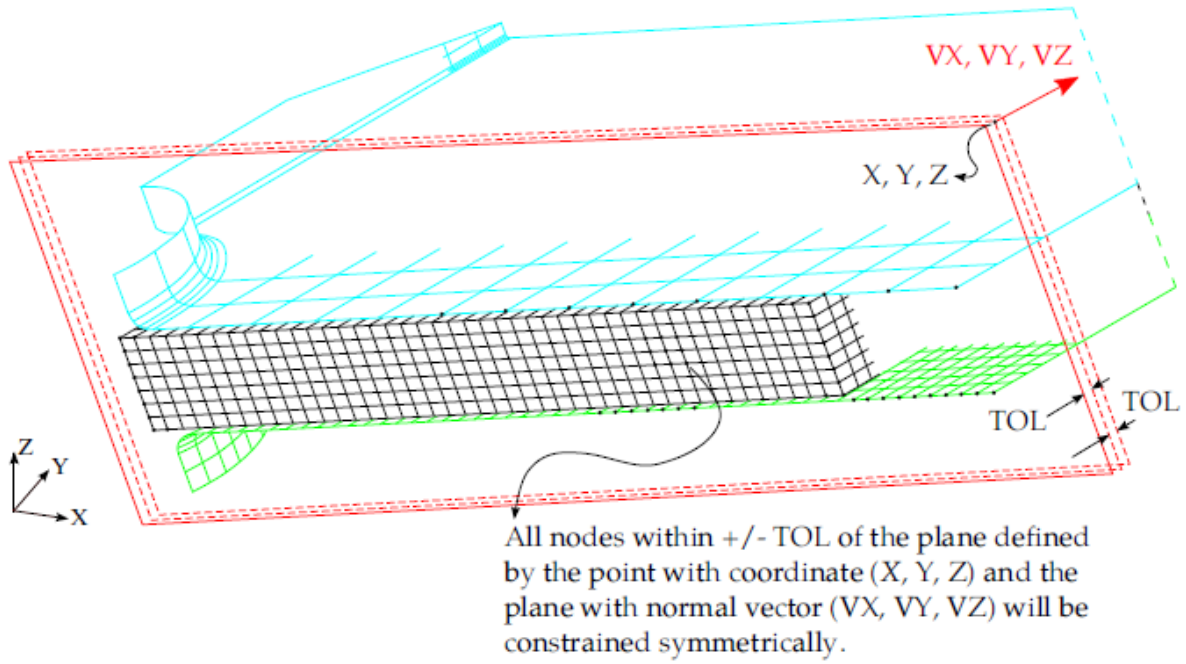


Figure 1 Defining *BOUNDARY_SPC_SYMMETRY_PLANE_SET

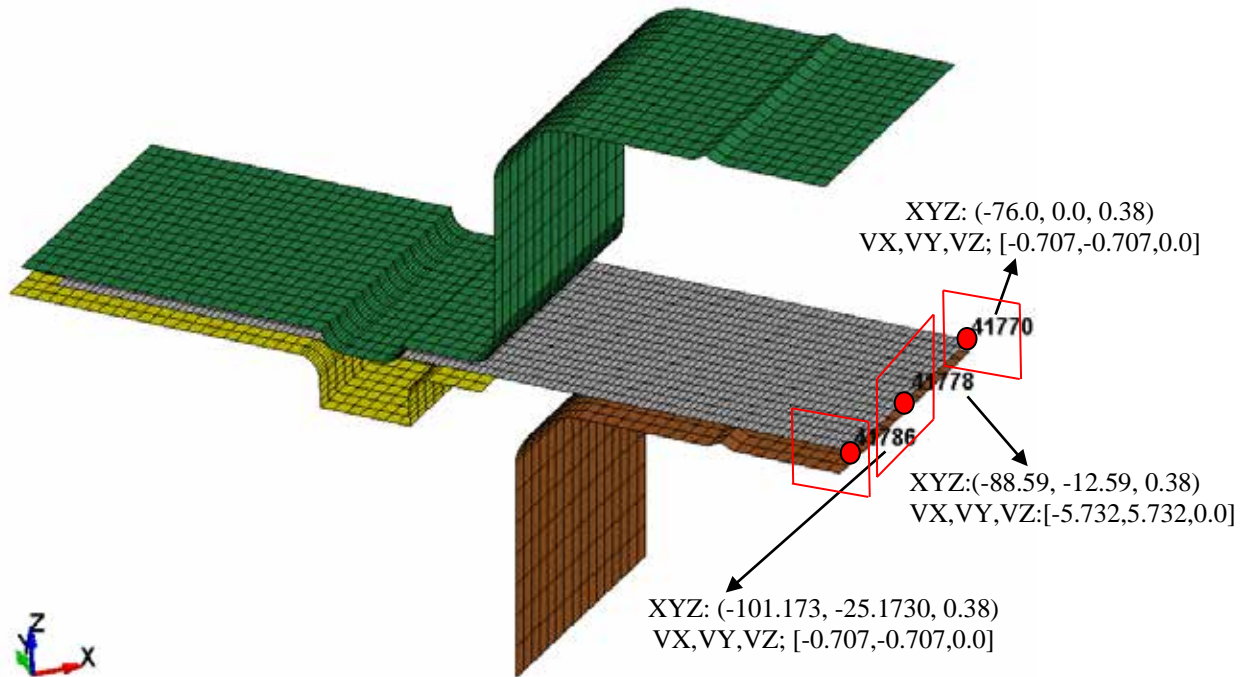


Figure 2 A draw model with three symmetric planes.

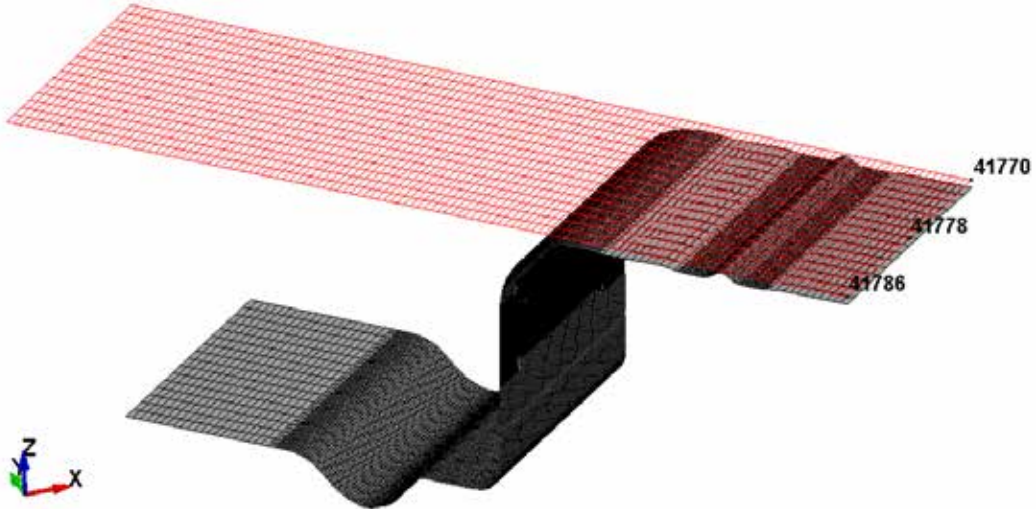


Figure 3 Overlay of original and formed parts in the isometric view, indicating no orthogonal motions exist in the symmetric planes defined.

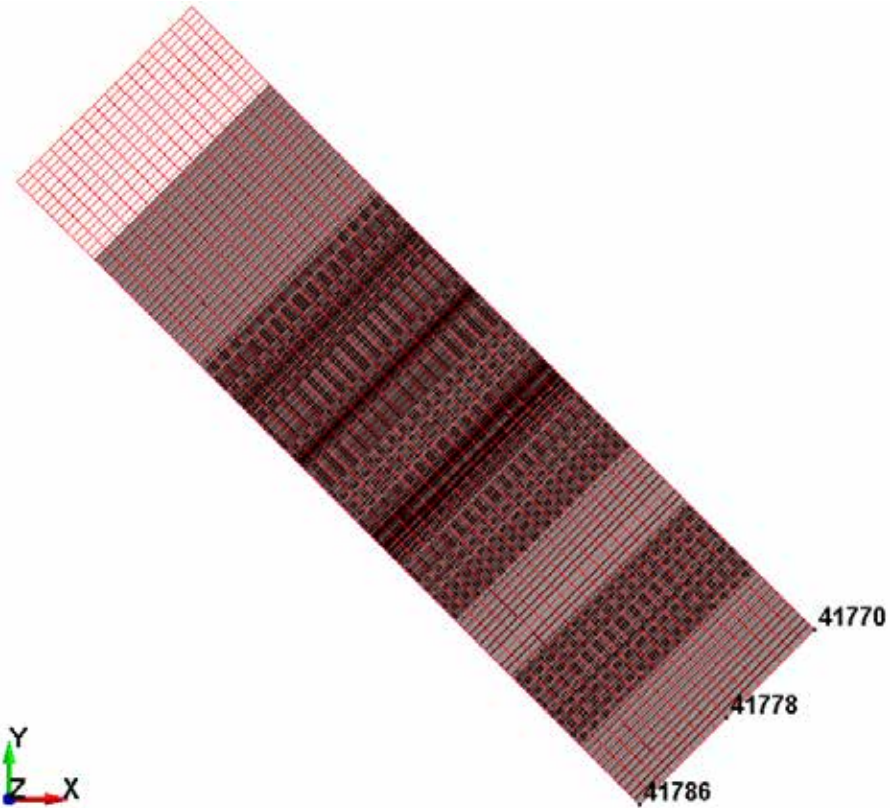


Figure 4 Overlay of original and formed parts in the top view, indicating no orthogonal motions exist in the three symmetric planes defined.

REFERENCE:

- 1) LS-DYNA User's Manual (draft).