Visualizing beam outputs with actual beam cross-section representation for contact

This example provides perspective on visualizing different types of Abaqus/Standard solution results on beams.

This page discusses:

Products: Abaqus/Standard

Application description

By default, in Abaqus/Standard contact edges representing beam elements have a circular cross-section, regardless of the actual cross-section of the element. An alternative contact surface representation is available for beam elements with a noncircular cross-section (see Contact Surface Representation for Beams).

This example demonstrates the visualization of different output variables when actual beam cross-section representation for noncircular beams is enabled in Abaqus/Standard general contact analyses.

Abaqus modeling approaches and simulation techniques

Mesh design

The model is meshed with second-order shear deformable beam elements of type B32.

Interactions

The simulation involves contact between two beams with trapezoidal and hexagonal cross-sections, respectively. Figure 1 shows the initial and final configurations for the simulation from two view angles. The top-right portion of Figure 1 shows that the beams originally lie in parallel planes. The top-left portion of Figure 1 shows that one of the beams is originally L-shaped and the other beam is originally curved. Figure 2 shows an oblique, translucent view of the original configuration, with nodes represented as circles.

A method to represent the beam surface geometry for contact calculations accurately (see Contact Surface Representation for Beams) is used for this simulation. With this method, Abaqus/Standard automatically generates meshes of quadrilateral surface elements to represent the beam contact surfaces. Motion of the internally generated nodes associated with the beam surface meshes is driven by the motion of the user-defined beam nodes. Different visualization options for these beams are discussed below.

Analysis steps

Symbols representing the boundary conditions in Figure 1 and Figure 2 show that one end of the L-shaped beam is clamped and the other end is constrained to move only along the beam axis. The continuously curved beam segment moves downward driven by a displacement boundary condition at one of its ends. The boundary conditions are expected to cause contact between the beams. The simulation uses a general static procedure.

Discussion of results and comparison of cases

Figure 3 shows four options for representing the beam geometry in the vicinity of contact for this simulation:

- The surface-element representation shown in the upper-left corner of Figure 3 will likely appear by default for most postprocessors. Postprocessors typically do not render beam element profiles by default but will represent the automatically generated surface elements by default.
- The upper-right corner of Figure 3 has beam element rendering active during postprocessing, and the surface-element representation remains active in the display group. In this case, some interference occurs between the two types of representations, with the rendered beam representation primarily showing through.
- The bottom-right corner of Figure 3 has beam element rendering active during postprocessing, with surface elements removed from the display group. In this case, only the beam element rendering appears.
- The bottom-left corner of Figure 3 has beam element rendering inactive and surface elements removed from the display group. In this case, only references lines of the beam elements are displayed the beam cross-section is not apparent in this view.

The first and third options listed above are best for viewing the beam configurations. Figure 4 compares the surface element representation (first option) and the beam element rendering (third option) near the corner of the L-shaped beam. The surface element representation provides more detail at the corners, whereas the beam element rendering is approximate. Surface element representations are less detailed at junctions of three or more beam elements.

Figure 5 and Figure 6 show contour plots of the displacement magnitude and rotation magnitude, respectively, for the same four options of representing beams as discussed above. Three of these options provide similar plots, but the bottom-left plots in the respective figures do not show the beam cross-section. The maximum displacement magnitude in Figure 6 is greater in the top two plots with surface elements in the display group. These plots consider displacement values for nodes on the exterior surface of the beam, which can be larger than displacements along the reference line of the beam, due to rotational effects.

Figure 7 shows Mises stress contour plots for the same four options of representing beams. Element results associated with beam elements are not known to surface elements; therefore, the Mises results are not apparent in the upper-left corner of Figure 7 associated with surface elements. Stress, strain, and other elements results fundamentally associated with beam elements should be viewed on a beam element representation.

Figure 8 shows contact pressure contour plots for the same four options of representing beams. Contact results for this simulation are best viewed on the surface element representation without beam element rendering (top-left plot of Figure 8). Beam element rendering in the top-right plot mostly obscures CPRESS plotted on the surface elements in the top-right of Figure 8. The two bottom cases in Figure 8 without surface elements in the display group lead to diagnostic messages regarding the selected variable not being available for any elements in the current display group.

Input files

std_gc_beamRealCross_beamBeam.inp

Model with actual beam cross-section representation in an Abaqus/Standard general contact analysis.

Figures

Figure 1. Simple contact model involving two beams.

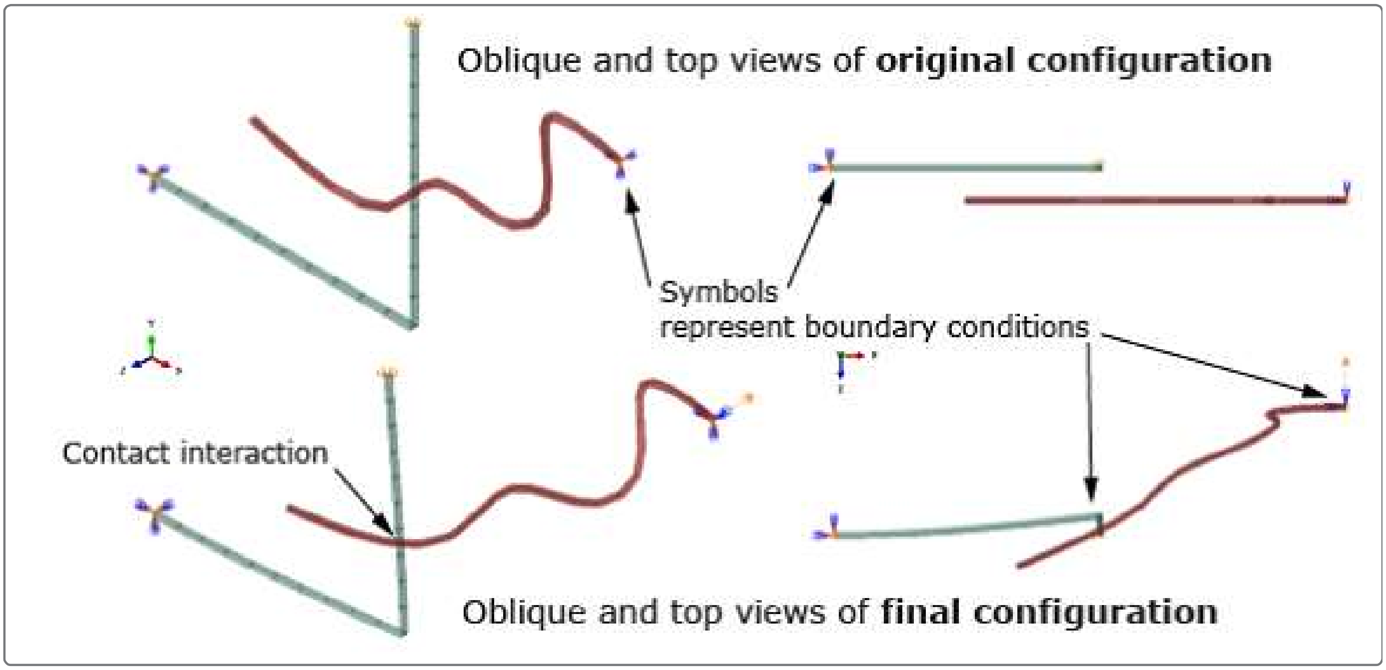


Figure 2. Original configuration showing nodal positions for a contact model involving two beams.

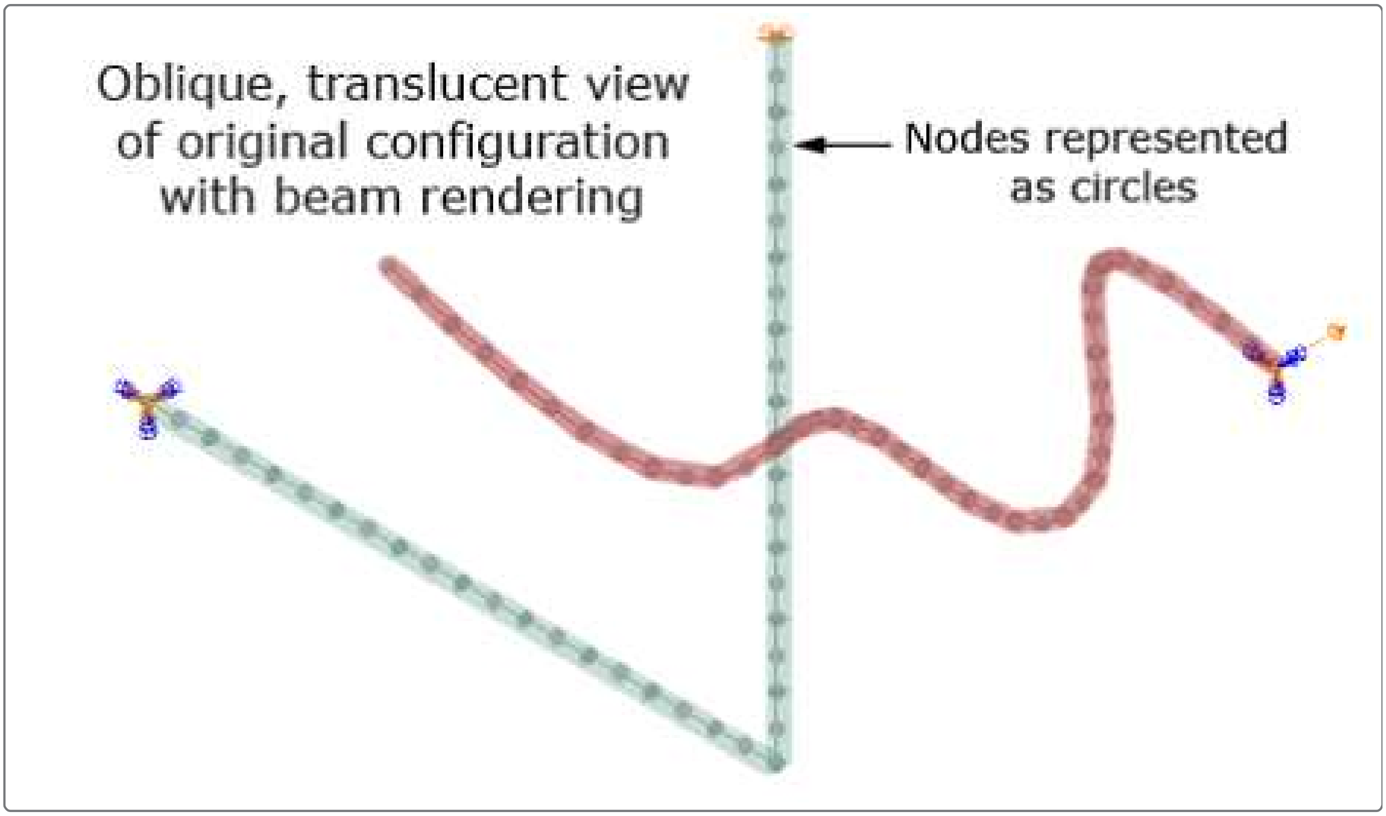


Figure 3. Comparison of four representations of the deformed configuration for the same simulation involving two beams in contact.

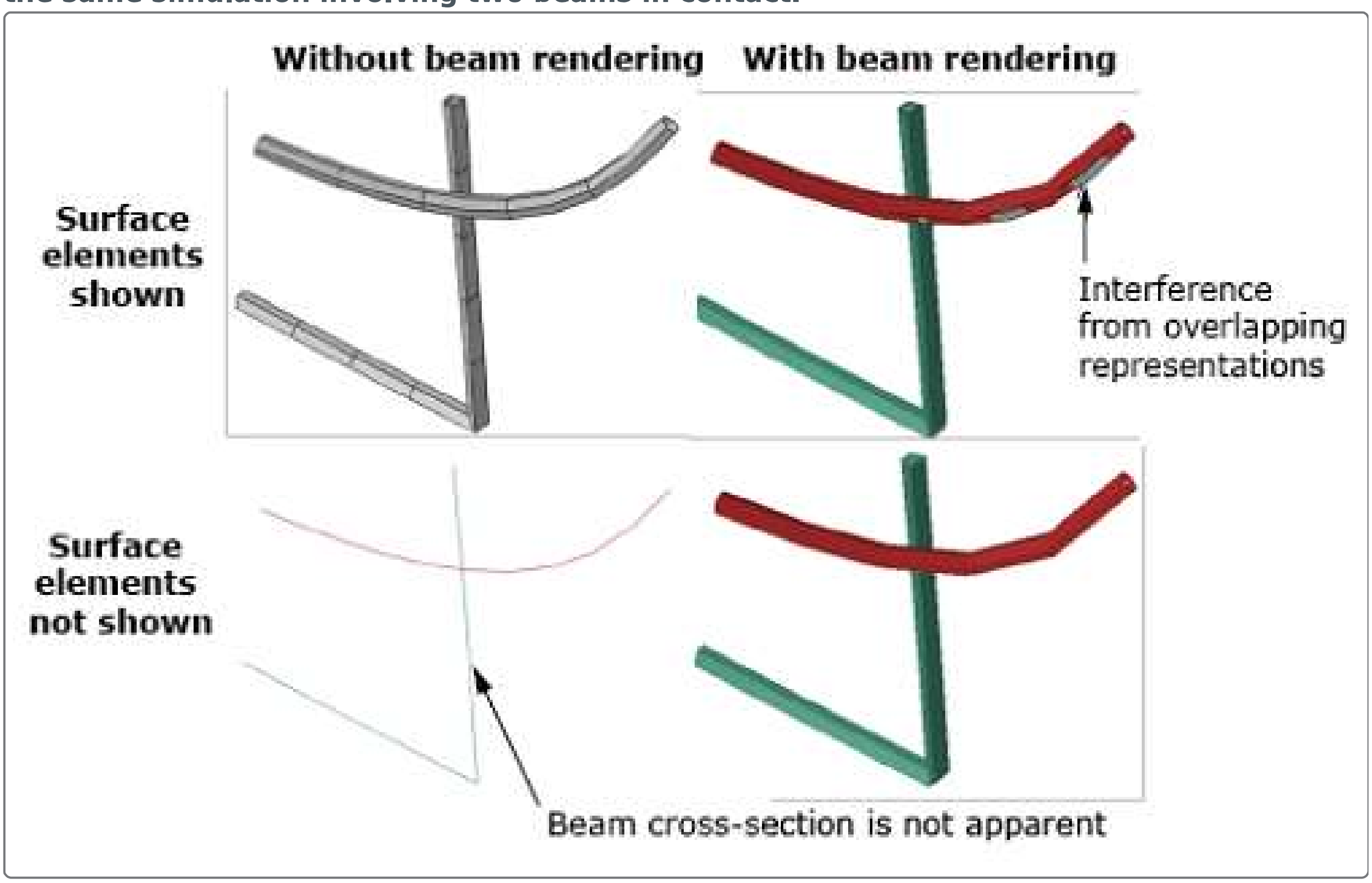


Figure 4. Close-up views of two representations of the deformed configuration for the same simulation involving two beams in contact.

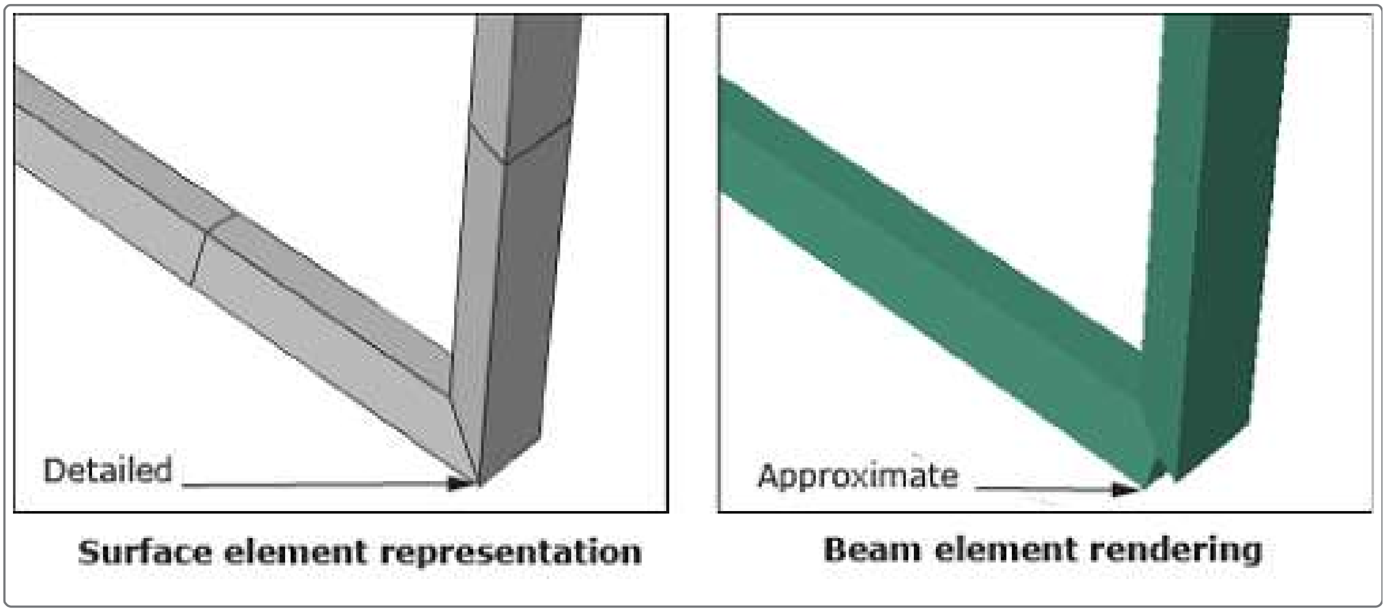


Figure 5. Comparison of four representations of displacement magnitude contour plots for the same simulation involving two beams in contact.

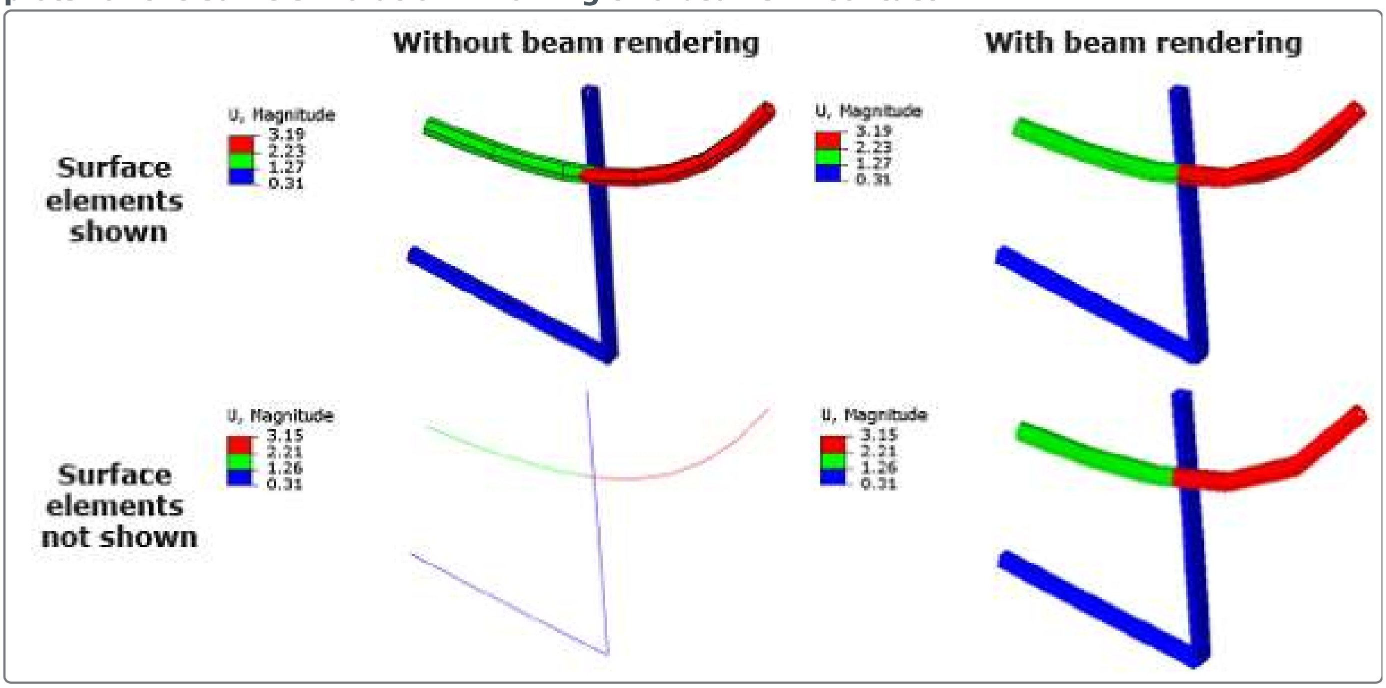


Figure 6. Comparison of four representations of rotation magnitude contour plots for the same simulation involving two beams in contact.

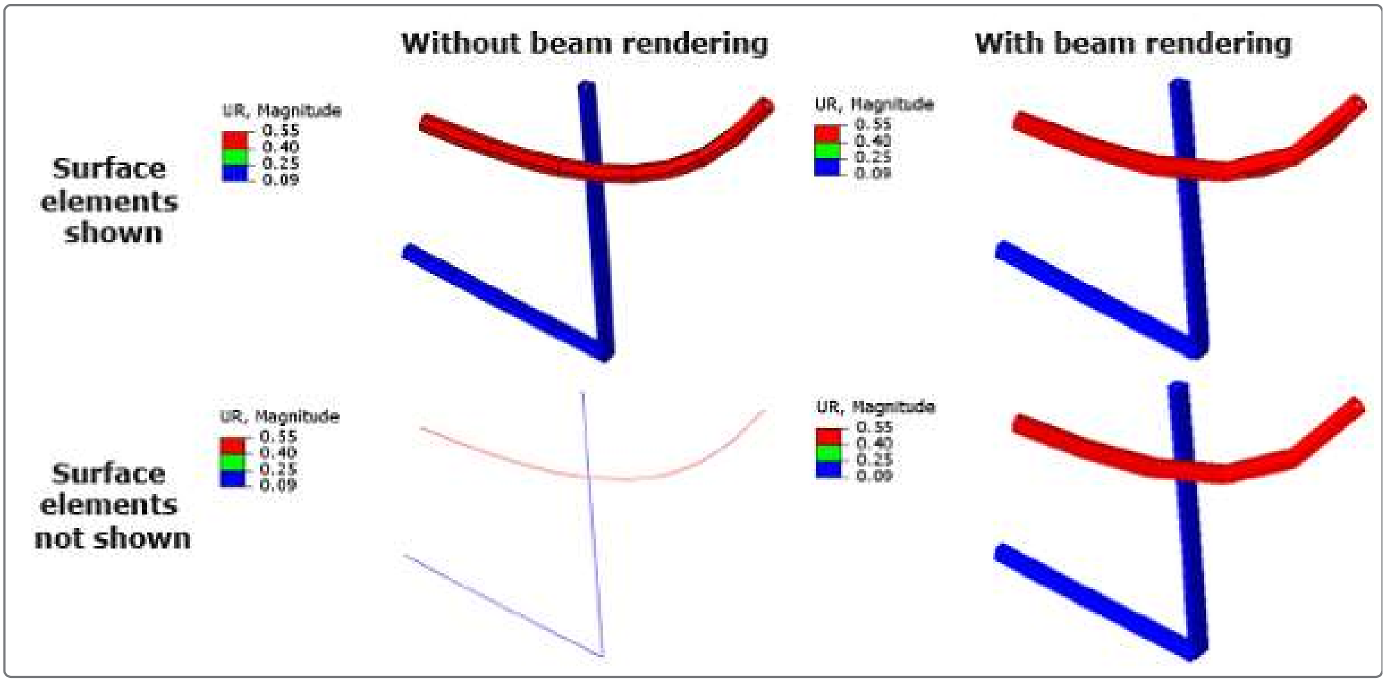


Figure 7. Comparison of four representations of Mises stress contour plots for the same simulation involving two beams in contact.

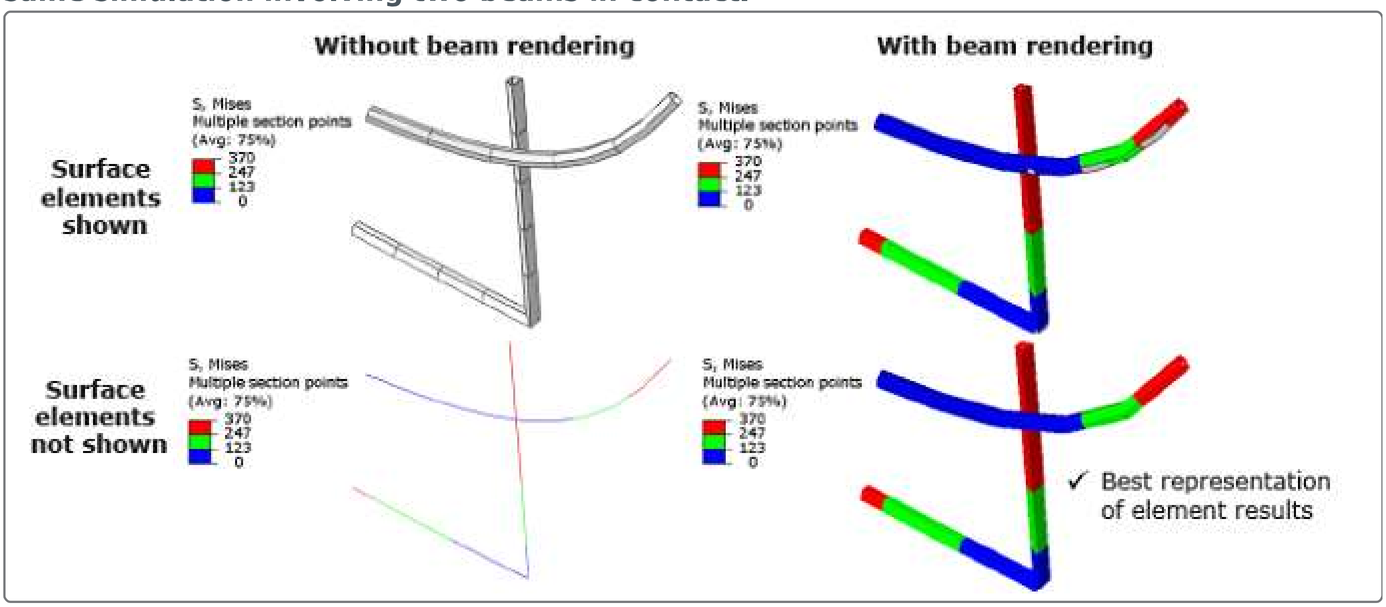
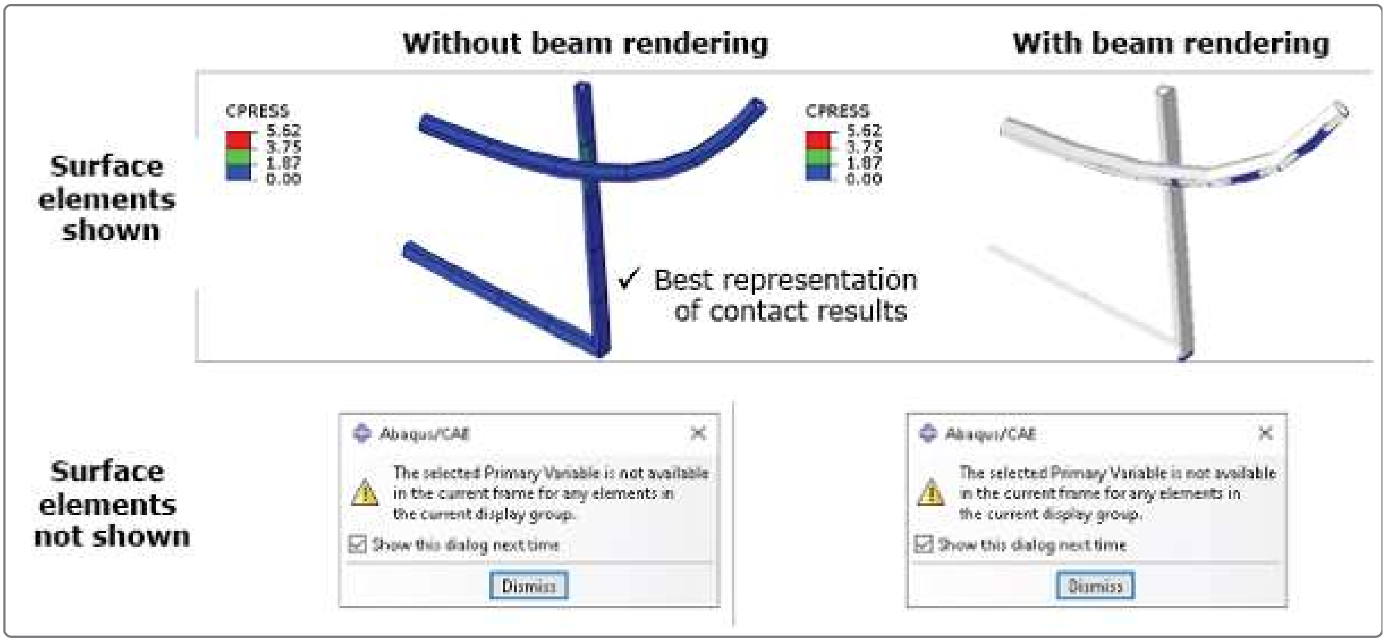


Figure 8. Comparison of four representations of contact pressure contour plots for the same simulation involving two beams in contact.


Without beam rendering
With beam rendering
Surface elements shown
CPRESS
5.62
3.75
1.87
0.00
CPRESS
5.62
3.75
1.87
0.00
✓ Best representation of contact results
Surface elements not shown
Abaqus/CAE
The selected Primary Variable is not available in the current frame for any elements in the current display group.
Show this dialog next time
Dismiss
Abaqus/CAE
The selected Primary Variable is not available in the current frame for any elements in the current display group.
Show this dialog next time
Dismiss