2D Beam - Verification & Validation

Authors: Rajesh Bhaskaran and Vincent Prantil

Verification & Validation

"Verification and validation" can be thought of as a formal process for checking results. We previously performed some sanity checks on the deformed shape. A further basic check is how the results change on refining the mesh. The following video shows how to recalculate the results on a refined mesh.

Summary of steps in the above video:

1. Easily investigate the change of deformed shape and max deformation of the beam with mesh refinement. Make a copy of the model:
    a. In Project Schematic, right click on Model.
    b. Select Duplicate.
    c. Rename the copied project “2D Beam (refined mesh)".
2. Refine the mesh in the copied project:
    a. Double click on Setup in the copied version of the project to launch Mechanical.
    b. In the Project Tree, click on Mesh > Face Sizing.
    c. Change Element Size to 0.8in.
    d. Click Update.
3. To redo the solution on the refined mesh:
    a. Click Solve.

We see from the above video that at least one more level of mesh refinement is necessary. Please carry that out. Note that we also need to closely interrogate the comparison with Euler-Bernoulli beam theory as part of the "Verification and validation" process.

To save and exit when you are done, select "File > Save" and "File > Exit" in the project view (yellow icon in taskbar). When transferring the project to another location, you need to transfer the "2d_beam.wbpj" file as well as the "2d_beam_files" folder. The project cannot be read into ANSYS without both these entities.

Discussion

The analyst can proceed to simulate the beam using a variety of elements: one- dimensional beam elements, plane strain triangles, plane strain quadrilaterals, plane stress triangles, plane stress quadrilaterals, and three-dimensional brick elements (using what the analyst believes to be suciently relaxed end constraints, as per the previous example). The results for maximum transverse deection are reported in Fig. 4.12. All results are reported in dimensionless form, normalized by the characteristic deection defined in the Problem Specification Section earlier.

According to these results, and still believing that Euler-Bernoulli beam theory is correct, the analyst would see that the maximum converged transverse deflection predicted by plane stress conditions underestimates the deection predicted by Euler-Bernoulli beam theory by nearly 50%; by comparison, the maximum converged transverse deection predicted by plane strain conditions overestimate the prediction of Euler-Bernoulli theory by 40%. The analyst also realizes that the converged results from the three-dimensional brick elements appear to be in agreement with the con- verged plane stress results, but that a coarse mesh instance of the plane strain model seems to agree well with the expected Euler-Bernoulli beam theory. How does the analyst sort out these mixed messages?

The consequences of getting this analysis wrong, in this case, can be far reaching. The analyst who insists on sticking with the Euler-Bernoulli beam theory not only will persist with that error, but as a consequence might make other poor judgements, such as believing, as is apparent in this case, that a relatively coarse mesh under plane strain conditions is also generally correct! This could, in turn, lead to the analyst to not performing sufficient mesh renement studies in other problems, and to accept other erroneous solutions based on erroneous two-dimensional approximations.

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