ANSYS - Semi-monocoque shell - Step 9

Step 9: Validate the results

We checked in the previous step that the BC's have been applied correctly and the deflection looks plausible.

Comparison With Plate Theory

An FEA analyst displays his mettle by going head-to-head with theory. The theoretical solution for a clamped plate subjected to pressure is presented by Timoshenko and Woinowsky-Krieger, page 202. This solution can be modified to account for the presence of stiffeners using the parallel axis theorem. This calculation and the resulting stress and displacement values have been generously provided by Prof. Alan Zehnder and are sumarized in this pdf document. Do take the time to review this document.

The head-to-head comparison of the analytical values with the FEA values from Step 8 at the center of the structure is presented in the following table.

Entity	Location	FEA	Theory
w		3.8 mm	3.6 mm
xx	Bottom	-56 MPa	-50 MPa
xx	Top	312 MPa	350 MPa
yy	Bottom	-28 MPa	-20 MPa
yy	Top	38 MPa	105 MPa

The deflection at the center is about 8% larger than the theoretical value due to shear deformation in the FEA model that is not accounted for in the analytical result. Correlation of stresses in the center is reasonably good. It might improve if solution for anisotropic plate were used. Also, the stiffeners are not at the centerline of the model, while maximum stresses in theory are calculated at the center.

The head-to-head comparison of the *edge* stresses is given in the following table.

Entity	Location	FEA	Theory
xx	Bottom	116 MPa	100 MPa
xx	Top	-653 MPa	-704 MPa
yy	Bottom	77 MPa	78 MPa
yy	Top	-300 MPa	-403 MPa

There is good correlation of the edge stress on the bottom of facesheet but the edge stress at the top of the stiffeners is overestimated by the theory. This is possibly due to the stiffeners not being at the centerline of the model while the maximum stresses in theory are calculated at the center.

Back to Problem Specification

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