STRESS DISTRIBUTION INVESTIGATION AT THE TAPERED SANDWICH ENDINGS

František Löffelmann
Brno University of Technology, Institute of Aerospace Engineering
Technická 896/2, Brno, 616 69, Czech Republic

y126184@stud.fme.vutbr.cz

Abstract: Background - The research is done during author's Erasmus+ internship at KTH where is running cooperation between the university and Saab. The topic, proposed by industry, is focused on the sandwich endings of the common type where sandwich is tapered into a solid laminate. The goal is to suggest suitable geometry and layup of the transition area as a general guideline. The project is not yet finished, but a comparison of different designs is in the process on the stable FE model.

Review of literature

Although sandwich endings need special attention due to stress concentrations, as is usually mentioned in design books, there are not too many publications investigating a behavior of tapered sandwich endings in detail. Analytical approaches points to sharp stress concentrations at both ends of tapering, which are dependent on a tapering angle. At these points facesheet is not loaded only by axial forces, as is typical in sandwiches, but there is localized bending of facesheet and extreme stress in the core tip which was proved experimentally as an initialization of cracks at the core-facesheet interface. One experimental study showed that introducing a radius to the tapered facesheet leads to higher failure load. Also studies investigating core densification (numerically, experimentally and from the production point of view) report higher load capacity.

All the found previous studies deal only with a beam which cannot take into consideration side boundary condition. In a practical design, reinforcing plies are used at a solid laminate and they are sequentially dropped along the core. This was not the point of the most published articles since they deal only with constant thickness facesheets.

Methods

Cross sectional FE model was built in Abaqus. Thus it was easy to modify basic geometry parameters (tapering angle, radii at start and end of the tapering), facesheet layups and ply drop positions. That enabled comparison of facesheet stresses and stresses in the facesheet-core boundary. Since cross sectional model which is practically a 2D case can differ from the cross sections in the real panel due to side boundary conditions, second model was built to compare the first one with a 3D case of a flat panel simply supported on sides.

Results

Radius at the start of the tapering (near solid laminate) partially decrease stresses in the core and facesheets at the fork point. Radius at the end point of the tapering effectively decreases stress peak at that area, which almost disappears in compare to sharp geometry. Comparison of the cross sectional model with a flat panel supported also on the side edge shows significant change in overall displacement. For a large panel displacements of its center part section are comparable to the simple cross sectional model only for bending load case. Displacements for the tension load case are different even in the center section of the full panel.