On the Geometric Nonlinearity Effects of Polymeric Plates on Structural Performance

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Abstract

Polymer sheets are widely used for glazing and roofing structural applications. The primary design requirements of these polymeric sheets are to resist uniformly distributed wind loading. Conventional building materials such as steel and glass plates are relative stiffer compared to polymeric sheets. The deflection of high stiff plates is about an order lower than polymeric plates. Polymeric plates can undergo large deformation. Design leveraging geometric nonlinear effects of polymeric sheets will increase the efficient use of these materials. Further, the practical boundary conditions used for these polymeric sheets are somewhere in between the fixed and simply supported theoretical conditions. Simple and elegant analytical solution is available for liner plates [1]. The availability of simple analytical solution for larger deformation analysis of plates is limited. Hence, numerical structural analysis methods are preferred. In this paper, the Structural Mechanics Module of COMSOL Multiphysics® software is used to investigate the aspect ratio and boundary condition effects on the deflection performance of the sheets for given width, load and thickness of the plate. The simulation results shows that the deflection for the given width, load and thickness can range significantly. The linear plate performance results for analytical and COMSOL Multiphysics® model will be shown. The comparison of linear vs. nonlinear performance will also be shown. The effect of boundary condition on the overall performance will be investigated. The importance of the practical installation of these sheets will be investigation. Design guidelines for polymeric sheets to large deflection capability will be detailed. A typical simulation contour plot of deflection and stress are shown in Figure 1 and 2, respectively. Figure 3 shows typical deflection results as a function of aspect ratio and boundary conditions. The details of mobile phone apps tool for material selection developed, leveraging COMSOL Multiphysics® parametric modeling capability will also be presented.

Reference

1. S.P. Timoshenko and S. Woinowsky-Kreieger 1984, Theory of plate and shells, International Students edition, Mc-Graw Hill, New York, 1984.

Figures used in the abstract

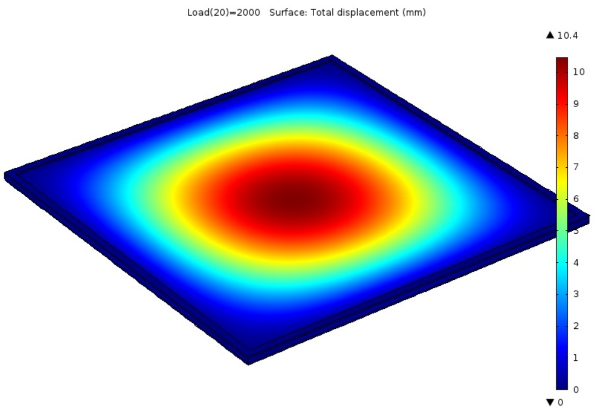

Figure 1: Typical deflection contour plots.

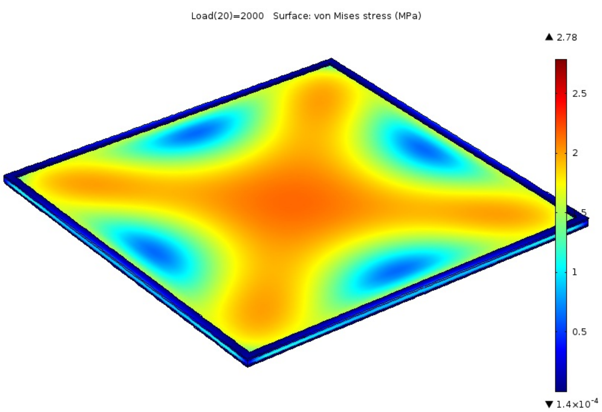

Figure 2: Typical Von misses stress contour plots.

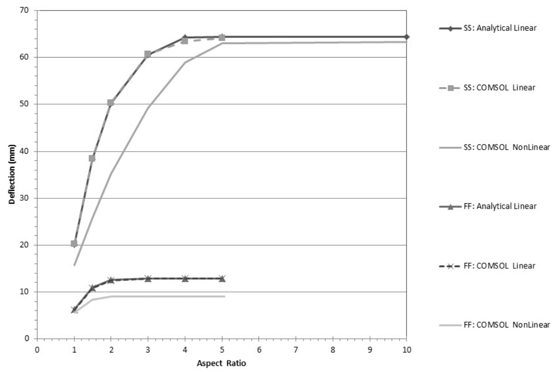

Figure 3: Typical deflection results as a function of aspect ratio and boundary conditions.