



Optimized thick-apex unstiffened equivalent ellipsoidal shell with inward  $\cos(\theta)$  line load from  $\theta=0$  to  $90^\circ$ .  
 PA= 0.0; PB= 0.0; 480 finite elements are used; crude model  
 step 50 outer fiber residual plastic strains, epx, layer 2 (shell skin)  
 residual dent in the shell;  $\cos(\theta)$  point loads at junction between Shell Segments 3 and 4 (see Fig. 2)  
 subroutine usrfab.soccerball.plastic.src is used with NGCP = 1

$\Theta x$  -0.00  
 $\Theta y$  0.00  
 $\Theta z$  -0.00

9.900E+00

Fig. 187 Elastic-plastic analysis of the **optimized unstiffened equivalent ellipsoidal shell with the thick apex with  $t(\text{apex}) = 0.4$  inch; Wimp=0.2 inch; the optimum design is listed in Table 78.** State of the shell at load set B (PB) step no. 50 at the end of Run 8. (See Fig. 180). This is the residual **outer fiber** meridional plastic strain, epx, in layer 2 of the shell, which in the STAGS model is the shell skin. This plastic strain remains in the shell after load set B has been removed, that is, when both PA and PB are zero. Compare with Fig. 199, for which the loading that produces the residual dent is by “ $\cos(\theta)$ ” imposed normal inward displacements rather than by “ $\cos(\theta)$ ” imposed normal inward-directed concentrated loads, as is the case here. Also, compare with Fig. 172 for which the dent is produced by a single concentrated load in the form of normal inward-directed pressure applied to a single finite element.