



Optimized thick-apex unstiffened equivalent ellipsoidal shell with inward normal concentrated load_y

PA= 0.0; PB= 0.0; 410 finite elements are used

step 37 displacement w contours at zero PB (after unloading)

nonlinear w; inward normal concentrated load is normal pressure on element 1 of Unit 4
subroutine usrfab.plastic.src is used with NGCP = 1

Θ x 0.00
Θ y 90.00
Θ z 0.00

9.900E+00

x z

Fig. 167 Elastic-plastic analysis of the **optimized unstiffened equivalent ellipsoidal shell with thick apex, $t(\text{apex})=0.4$ inch; $W_{\text{imp}}=0.2$ inch; the optimum design is listed in Table 78.** This figure shows the end of the **second phase**, the unloading phase, of a STAGS run the objective of which is to produce a **residual dent** with depth fairly close to 0.2 inch, which is the amplitude of the axisymmetric buckling modal imperfection, $W_{\text{imp}}=0.2$ inch, that was used during optimization of the shell. In this case the residual dent is produced in Load Set B (load factor, PB) by application of normal inward-directed pressure over a **single finite element** in the STAGS model. Displayed here is the **residual dent** remaining after the concentrated load, PB, has been removed and before the dented shell has been loaded by the uniform external pressure, PA. The user-written SUBROUTINE USRFAB is employed, not the user-written SUBROUTINE WALL. Here the depth of the residual dent, 0.248 inch, is greater than the depth of the linear axisymmetric buckling modal imperfection, $W_{\text{imp}} = 0.2$ inch, in the presence of which the optimum design of this shell was obtained.