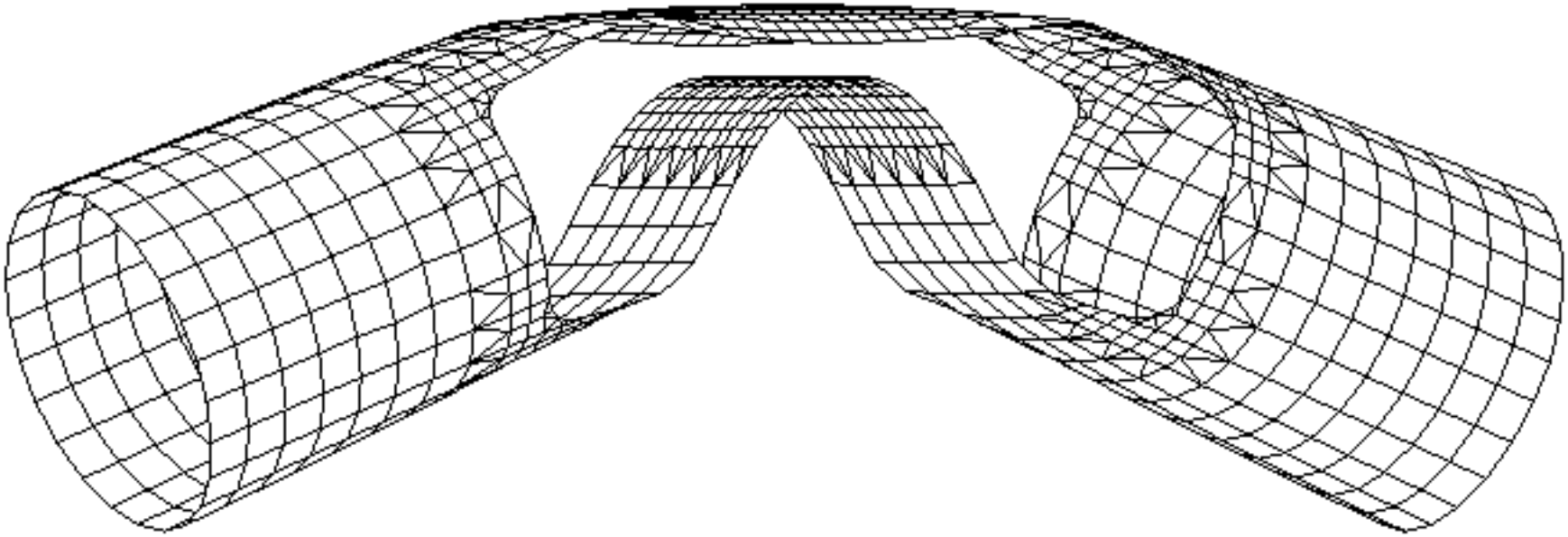
Snapthru Buckling of a Composite Magnetometer Boom



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ST5 Magnetometer Boom

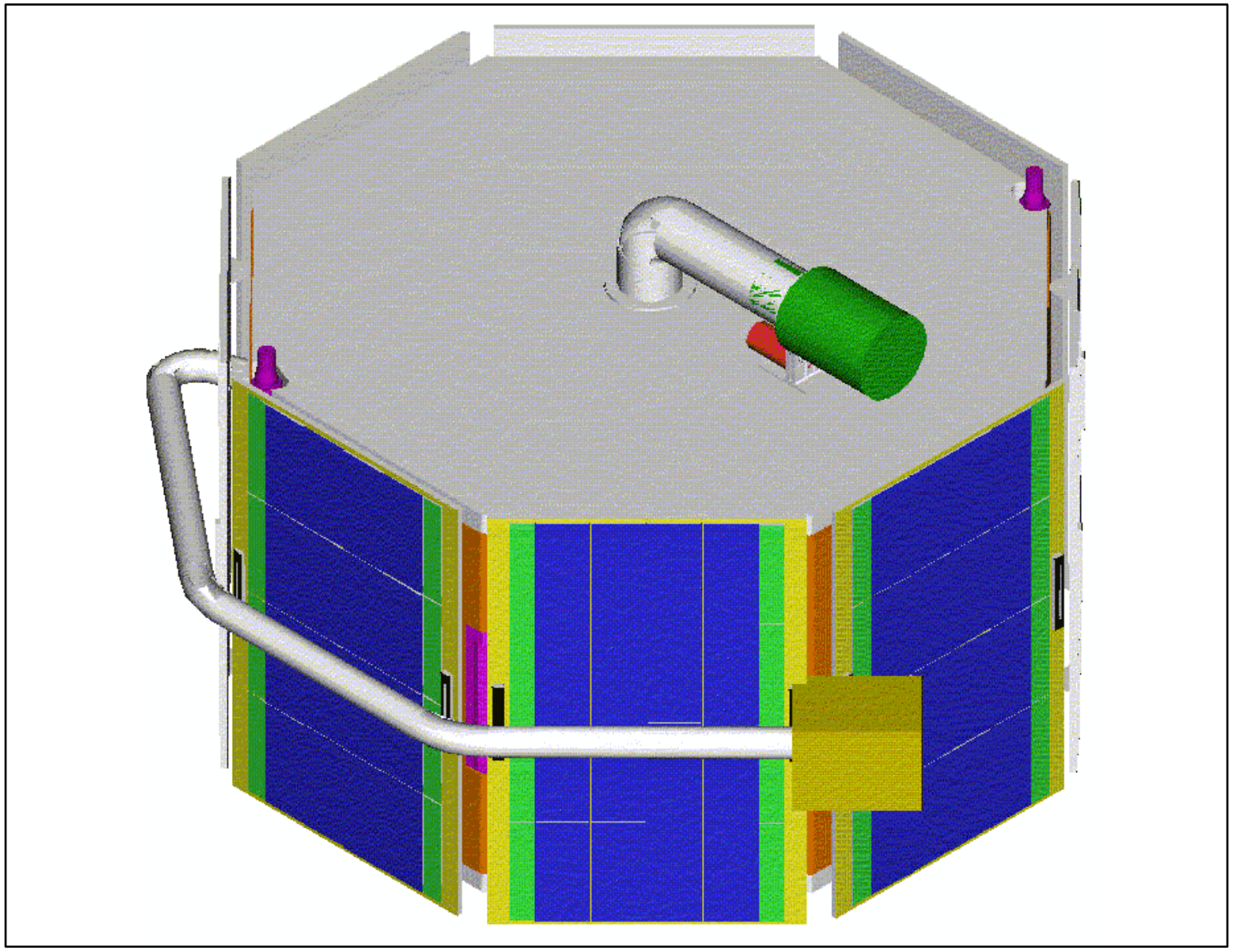
* Dimensions
  - Length of ~ 28 in, diameter of 0.75 in

* Construction
  - Single 0.005" thick T300/977−6 ply
  - Windows cut out at 3 places along length to form "tape spring hinges"

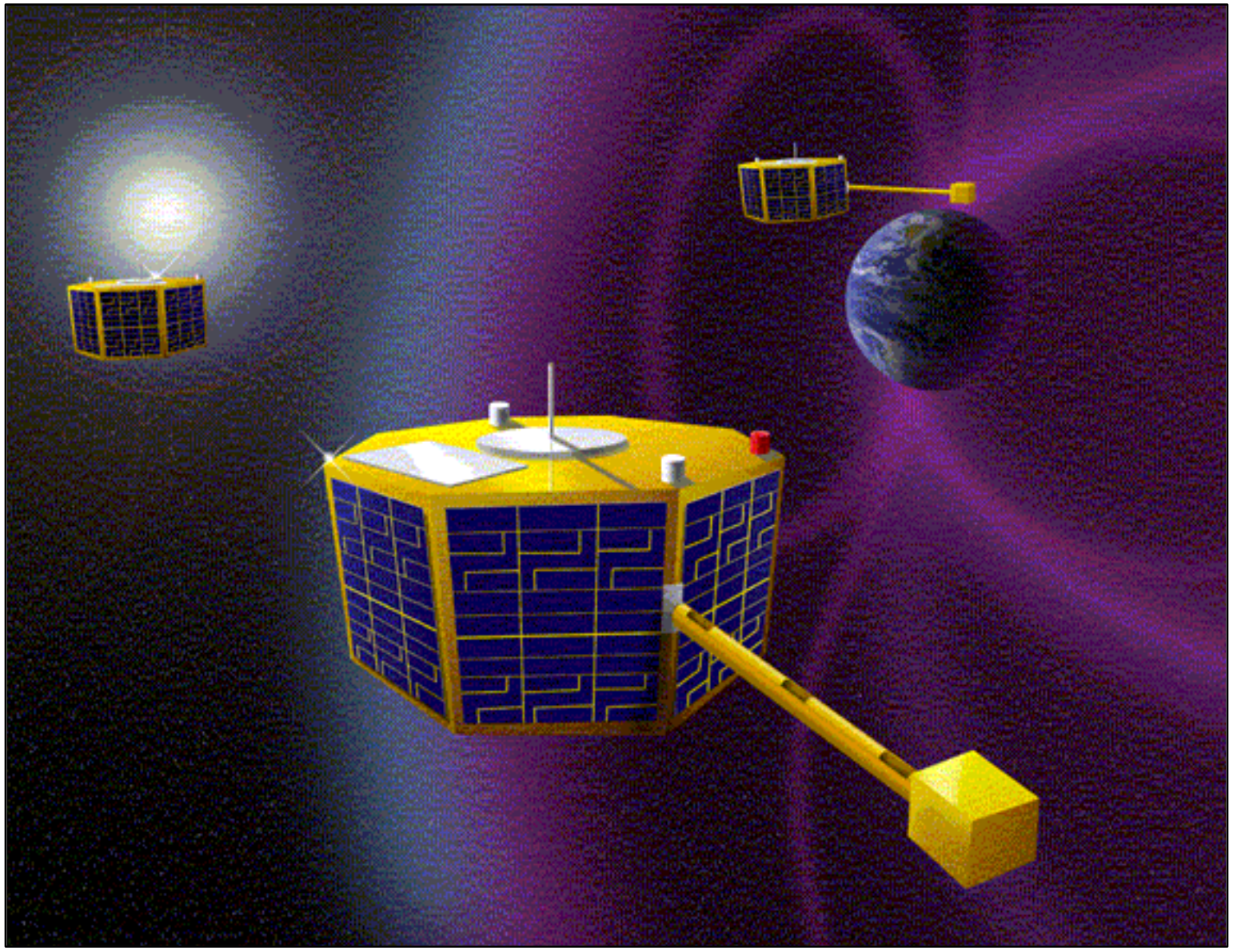
* Snapthru buckling at each hinge location when boom is stowed; each hinge straightens out when deployed

* Primary areas of interest are stresses in composite when stowed and during deployment
  - Assembly, handling, and testing show that booms are quite fragile

ST5 Magnetometer Boom (Stowed)



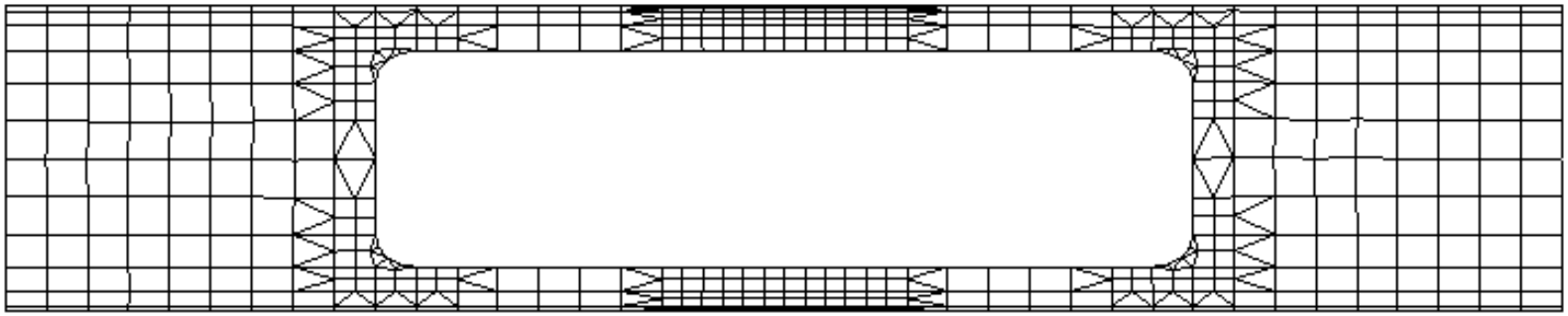
ST5 Magnetometer Boom (Deployed)



Analysis Procedures

* Because of snapthru and postbuckling behavior, regular linear statics solution sequences not adequate

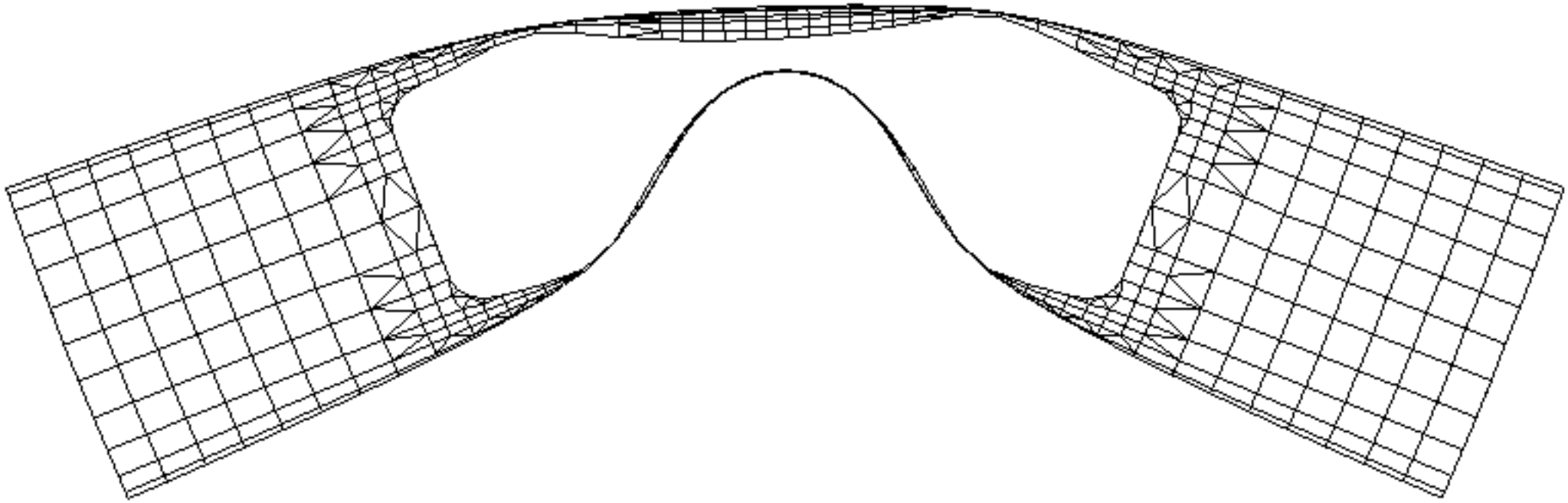
* For simplicity modeled one hinge location



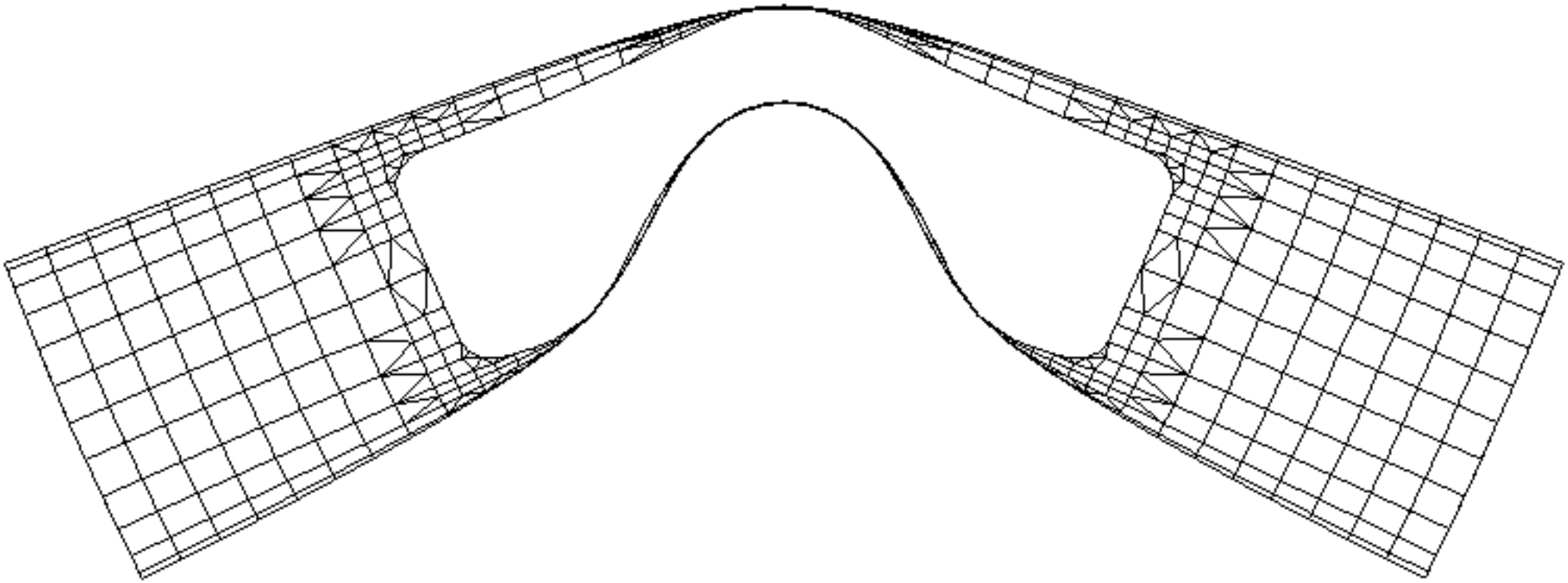
* Initially attempted nonlinear analysis with MSC/NASTRAN, then tried ANSYS, then went back to MSC/NASTRAN

* After much trial and error able to model physical behavior of boom segment by enforcing rotations at ends

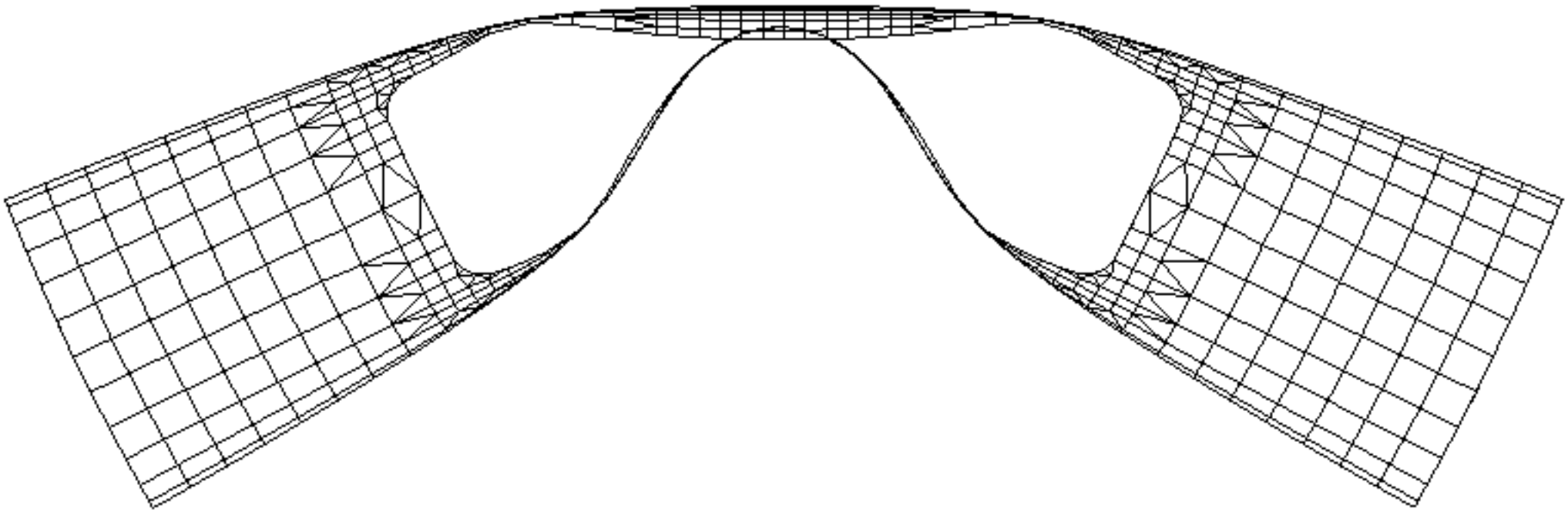
Analysis Results − Enforced Rotation of 22.50° at Ends (Deformed Shape)



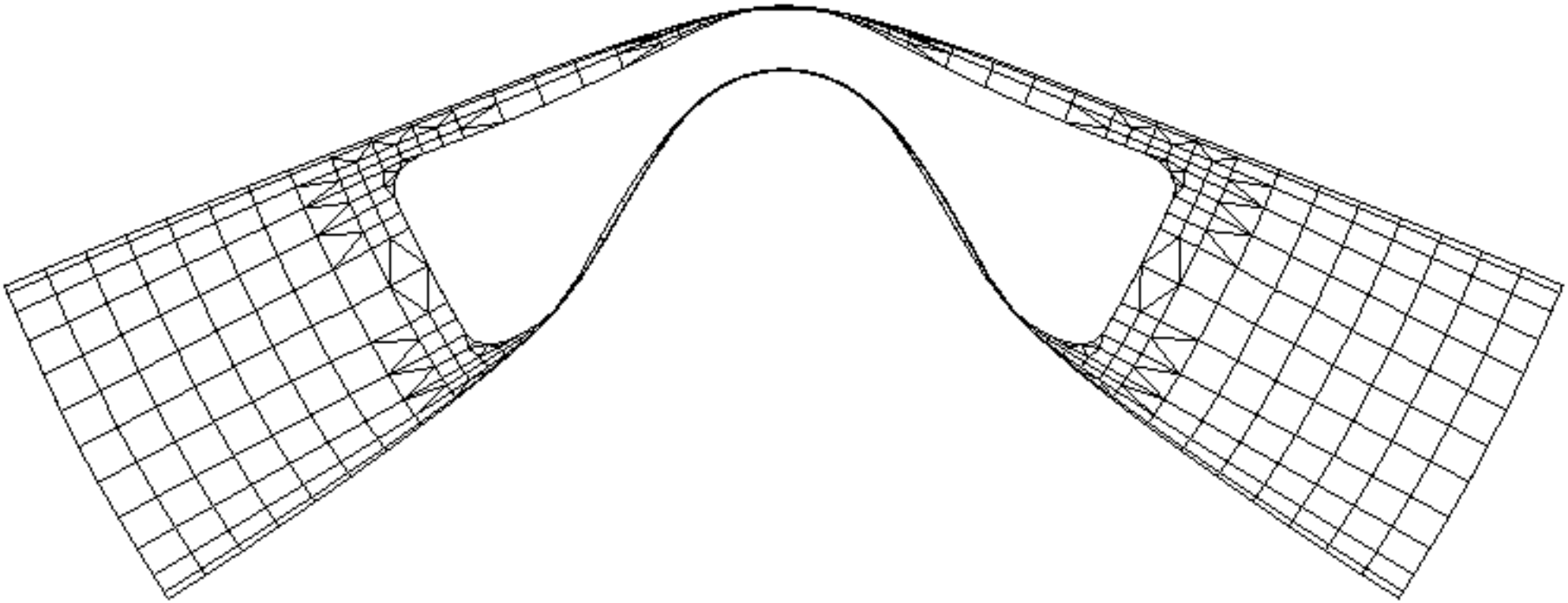
Analysis Results − Enforced Rotation of 25.00° at Ends (Deformed Shape)



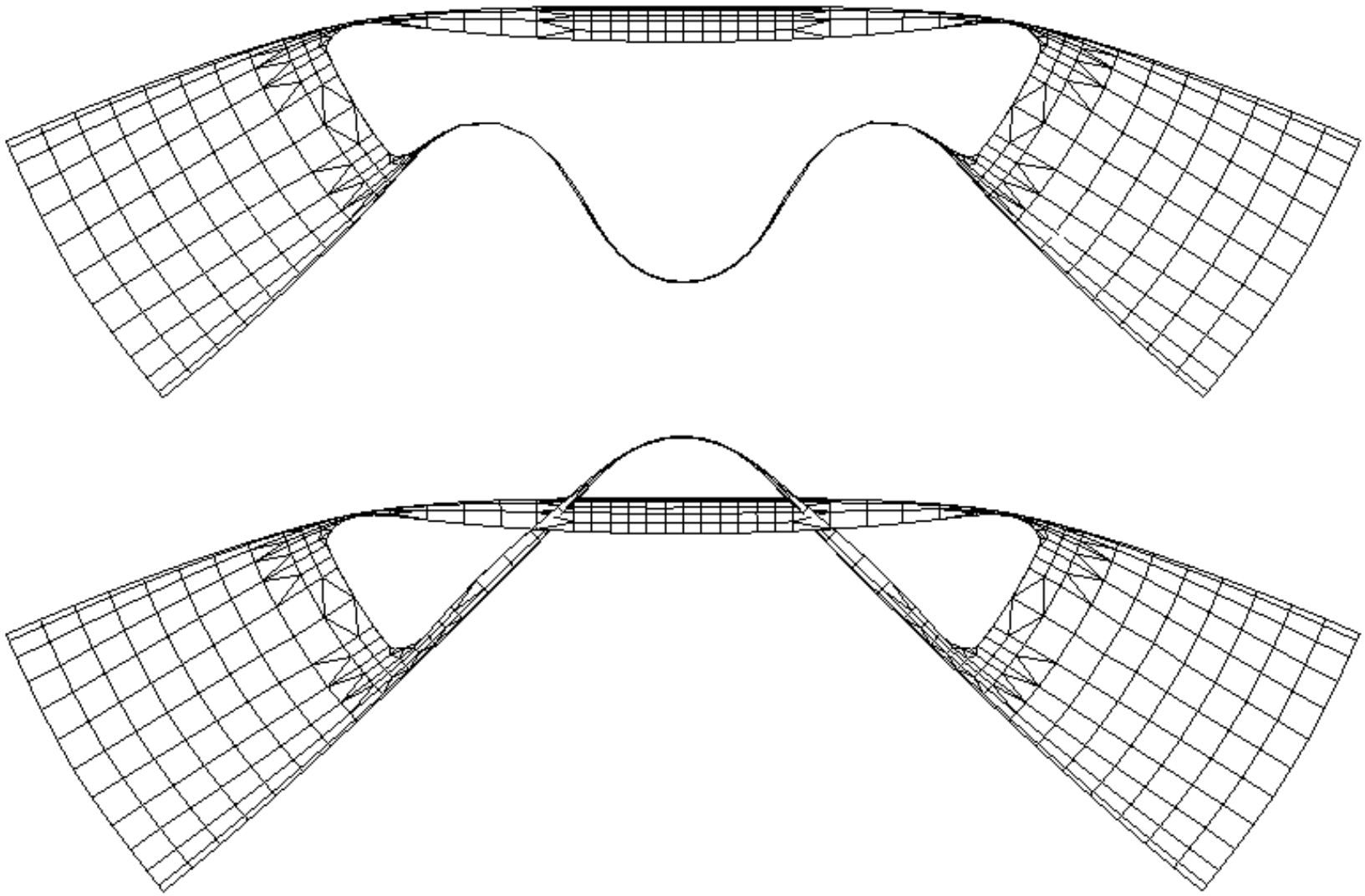
Analysis Results − Enforced Rotation of 27.50° at Ends (Deformed Shape)



Analysis Results − Enforced Rotation of 30.00° at Ends (Deformed Shape)

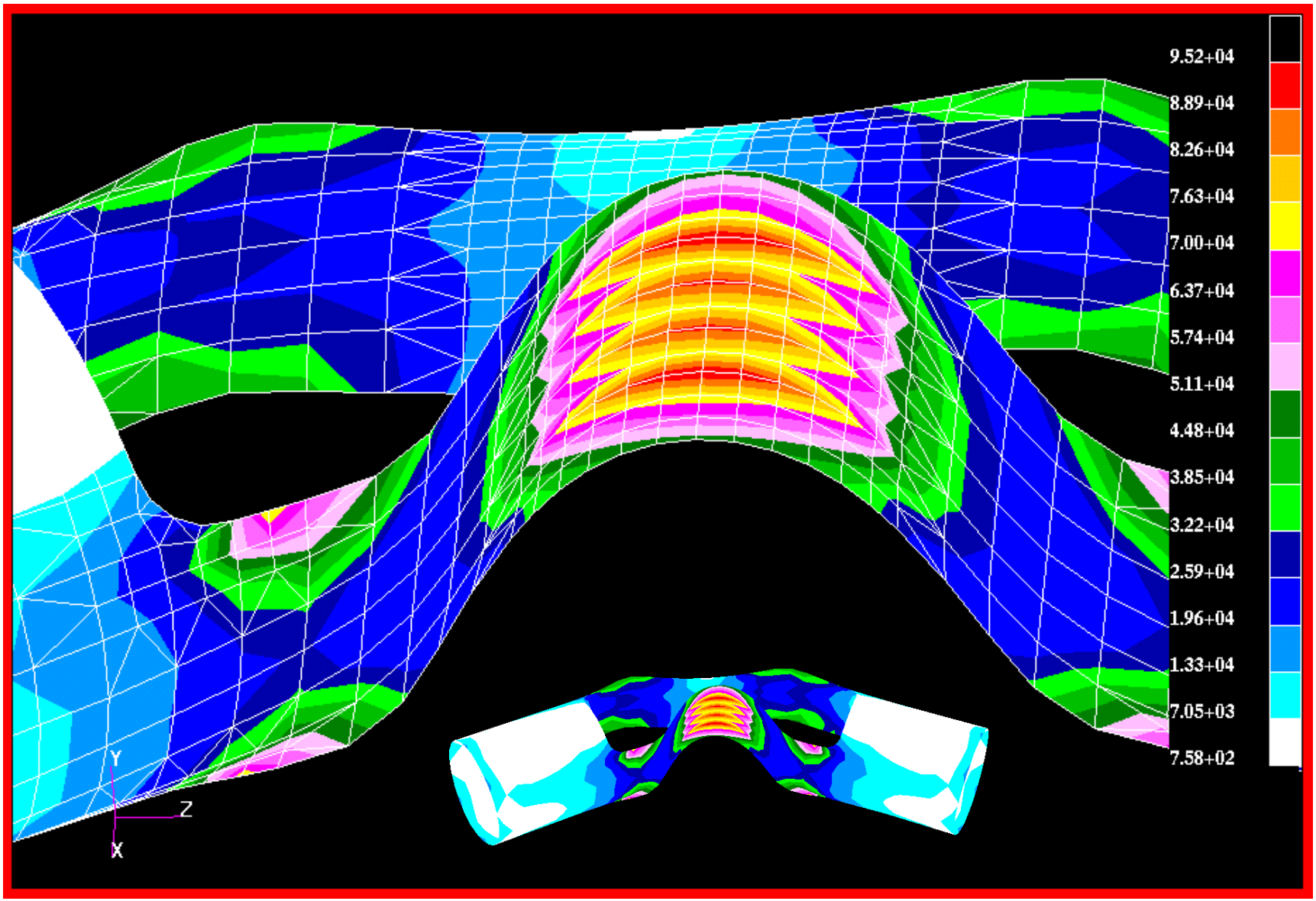


Analysis Results − Enforced Rotation of 35.00° at Ends (Unrealistic Deformed Shapes)



Analysis Results − Enforced Rotation of 22.50° at Ends (von Mises Stresses)

* Stress distribution under investigation



Summary

* Continuing to learn different nonlinear analysis codes and techniques
* Primary goal is to be able to perform and have confidence in nonlinear stress analyses
* Testing of boom coupon segments planned to supplement analysis