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# Finite Element Analysis of Membrane Test Panels

FEMCI Workshop 2003

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# Background

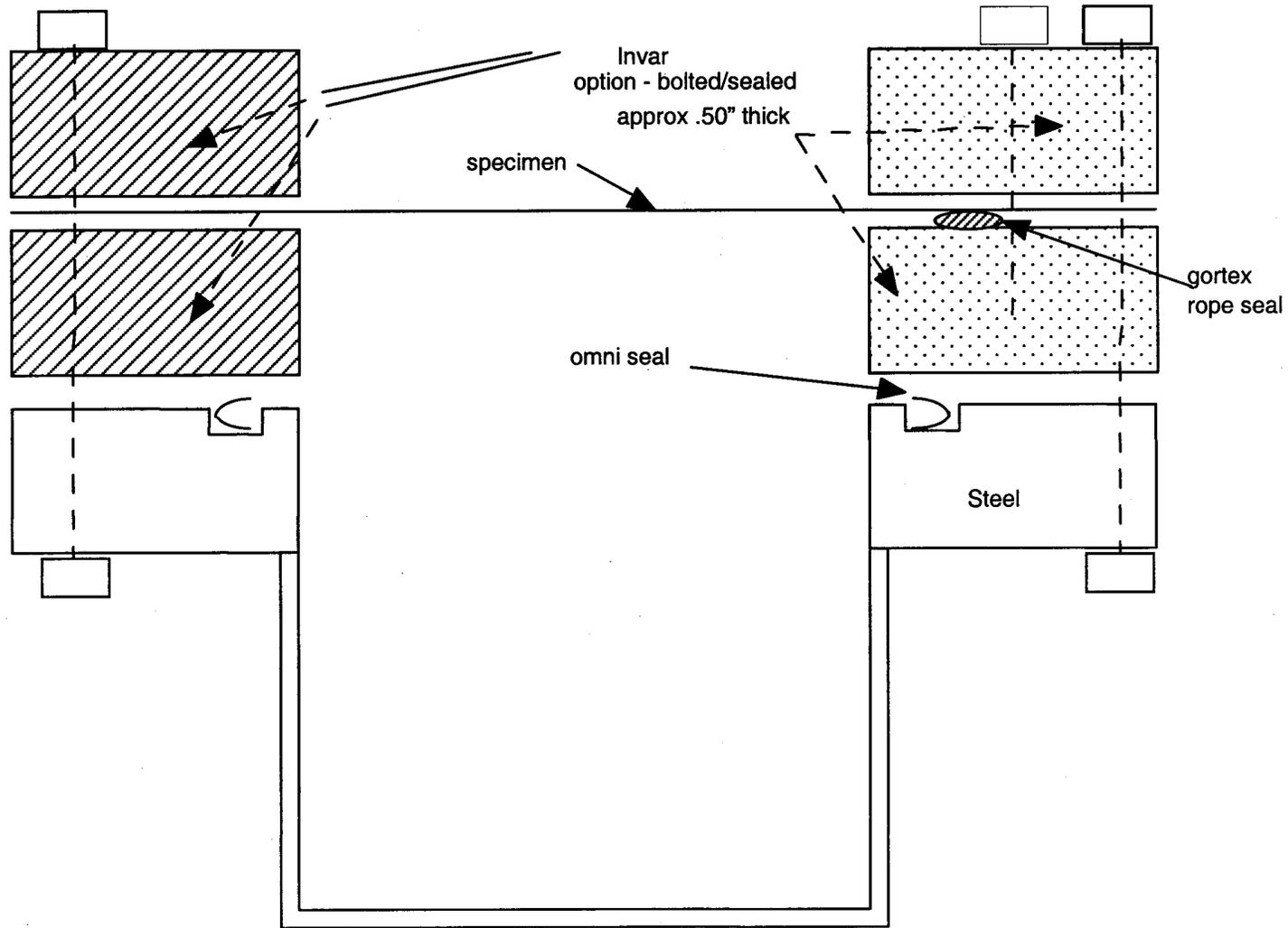
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- The Microwave Lightcraft proposal uses 0.25 mm thick SiC/SiC as the primary structure.
- Estimates of structural properties are stiffness of 840 GPa (10x better specific stiffness than titanium) and strength of 2.1 GPa (3x better specific strength than titanium).
- Test facility available for pressure testing large (~60 cm) diaphragm specimens at MSFC.
- Funding was obtained for testing 0.25 mm SiC/SiC panels.



# Test Set-Up





# Finite Element Analysis

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- Analysis needed prior to testing to determine dimensions of ring fixture and expected pressure.
- Problem is axisymmetric with large deflections and contact.
- Solved with ABAQUS 6.2.1 using panel (not membrane) elements.
- Analytical loads must be applied to the model carefully, or the solution becomes unstable.



# Load Cases for Original Design

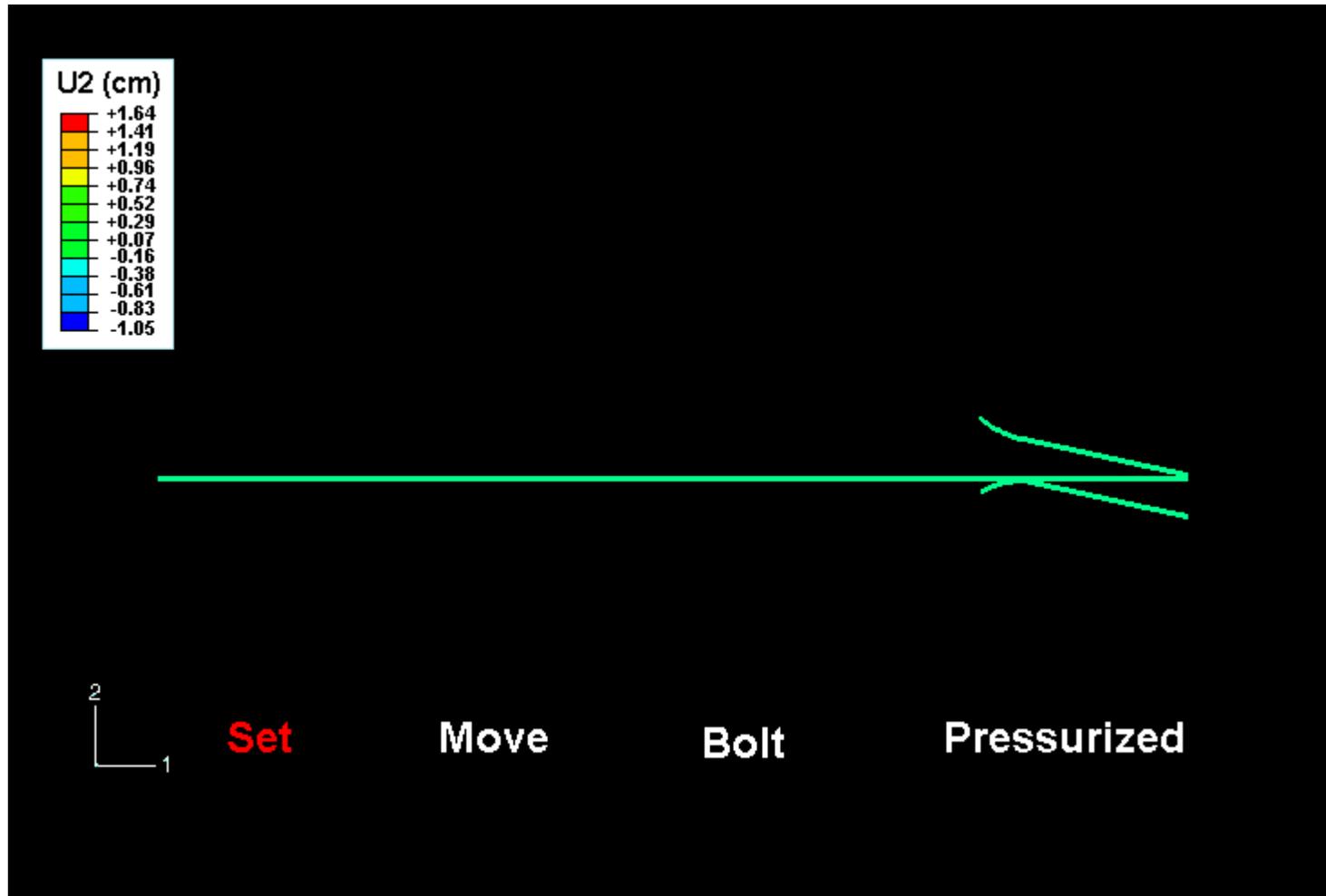


- Existing ring fixture has  $12^\circ$  angle at bonded surface. Model loaded as follows.

Case	Load	Radial BC	Damping
Set	0.1 MPa	Fixed	On
Move	2 mm	Free	Off
Bolt	20 kN	Free	Off
Press	0.5 MPa	Fixed	Off



# Animation for Original Design





# Results of Original Design



- Final results of the original ring fixture show unacceptable stress at the boundary.

Applied Pressure (atm)	Center Stress (GPa)	Center Deflection (cm)	Edge Stress (GPa)
5	2.5	1.6	3.5



# Load Cases for Flat Design

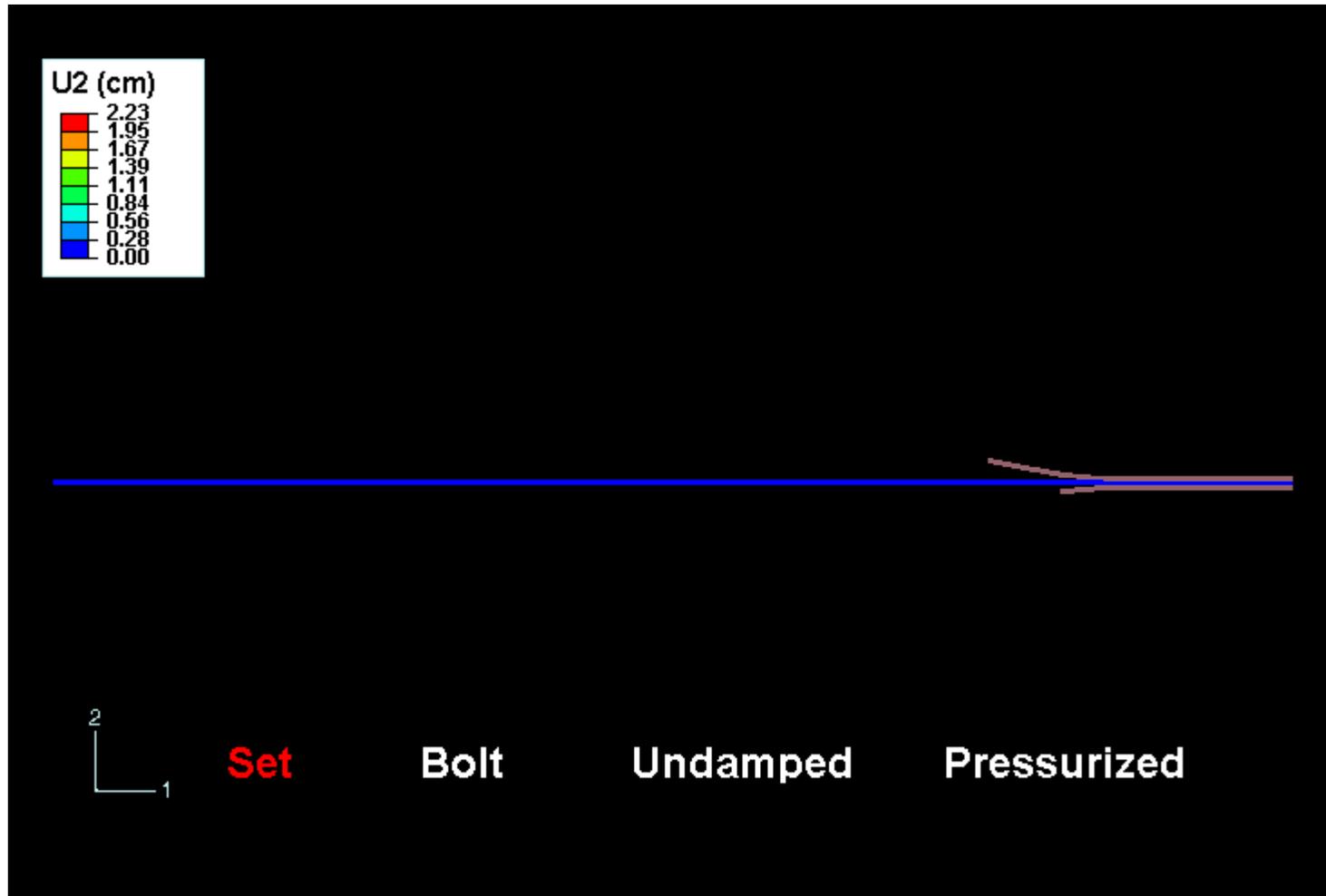


- New design is flat with larger (15 cm radius) corner curvature. Model loaded as follows.

Case	Load	Radial BC	Damping
Set	0.1 MPa	Fixed	On
Bolt	20 kN	Free	On
Undamped	20 kN	Free	Off
Press	1.2 MPa	Fixed	Off



# Animation for Flat Design





# Results of Flat Design



- Results of the original ring fixture show acceptable stress at the boundary.

Applied Pressure (atm)	Center Stress (GPa)	Center Deflection (cm)	Edge Stress (GPa)
1	0.9	1.0	1.4
5	2.6	1.6	2.5
11	4.3	2.2	3.7



# Concluding Remarks

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- Stability of the model is sensitive to these parameters:
  - Damping
  - Contact Property
  - Characteristic Element Size
- Future Work:
  - Compare Results with 3-D analysis
  - Compare Results with test data