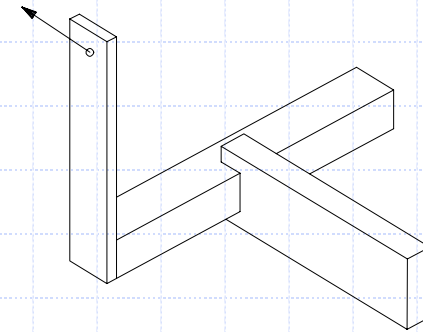


# SAE Weld Challenge

## Fatigue Life Prediction



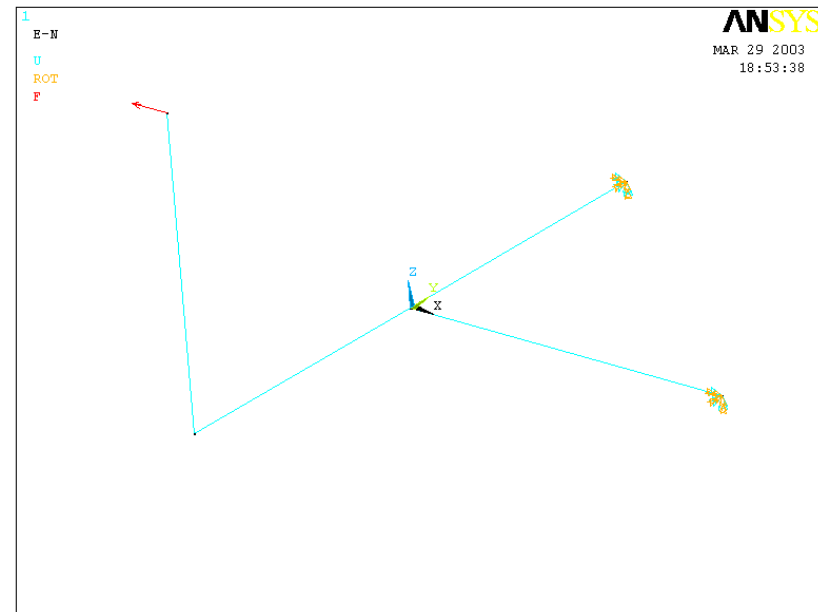
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April 2003

# Weld Loading Analysis

- ◆ Ansys employed to solve statically indeterminate loading
- ◆ Model generated using truss elements
- ◆ Nodal loads used for weld loading

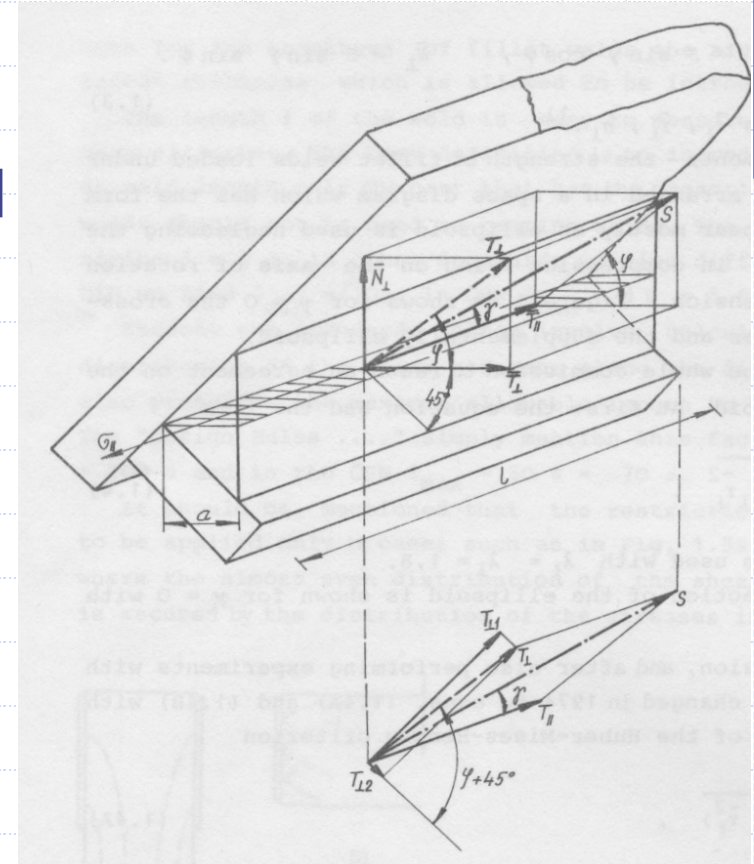


# Resulting Loads at Junction

	<b>4x4 Tube</b>	<b>2x6 Tube</b>
<b>Fx (kips)</b>	-4	5.8
<b>Fy (kips)</b>	0	3.1
<b>Fz (kips)</b>	0	-2.2
<b>Mx (in-kips)</b>	0	-5.3
<b>My (in-kips)</b>	-50	23.8
<b>Mz (in-kips)</b>	-48	31.3

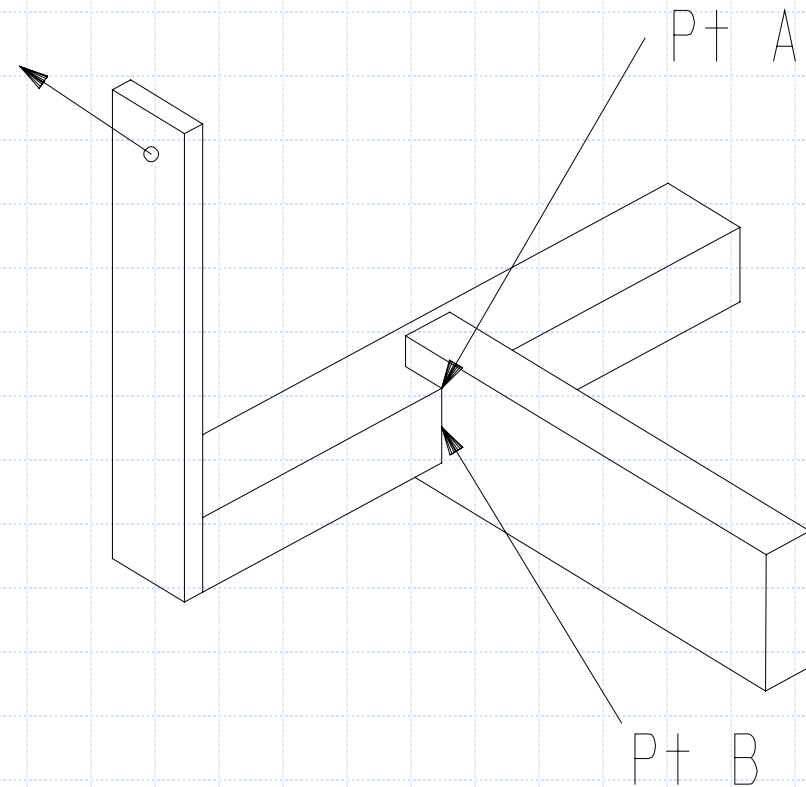
# Stress Analysis

- ◆ Stresses in the structural components were determined using simple mechanics.
- ◆ Multiaxial forces on the welds were resolved into their normal and shear stress components with respect to the minimum throat area.
- ◆ Methods for weld stress analysis are based on the International Institute of Welding's (IIW) methodology.



# Stress Analysis (Cont'd)

- ◆ Stresses were calculated at two points. (A and B)
- ◆ Stresses were then resolved into their principle directions. (for use in BS7608)



# Resulting Principle Stresses

	4x4 Tube		2x6 Tube		Weld	
	Pt A	Pt B	Pt A	Pt B	Pt A	Pt B
$\sigma_1$ (ksi)	11.3	11.3	14.9	12.3	18.6	13.0
$\sigma_2$ (ksi)	-2.2	-2.2	0	0	-7.2	-5.0
$\tau_{\max}$ (ksi)	6.7	6.7	7.5	6.1	13.0	9.0
$\sigma_m$ (ksi)	4.6	4.6	7.5	6.1	5.8	4.0

$\sigma_y^{\text{Base Metal}} \sim 70 \text{ ksi}$        $\sigma_u^{\text{Base Metal}} \sim 90 \text{ ksi}$

Max @ Point A (Also failure location)

# Fatigue Analysis

- ◆ BS 7608
- ◆ Allowance for residual stress and inherent stress concentrations from the weld are built into the BS 7608 S-N curves.
- ◆ Since geometry deviates from standard mockups, Class W was used due to the load bearing weld. Cover all category, resulting in conservative design.
- ◆ BS 7608 life governed by highest principle stress.
- ◆ Reliability of 50% ( $d=0$ ) selected to compare with experimental results.

# Failure Prediction

	Point A		Point B	
Loading	Class W	Class G	Class W	Class G
R=-1	21,800	33,529	63,900	98,300
R=0	174,000	267,620	511,000	786,000

Life is limited by Point A



# Conclusions

- ◆ No additional stress concentration factors were incorporated.
- ◆ Use of Class W in BS7608 results in a fairly conservative approach. Actual life is expected to exceed predicted life.
- ◆ Use of Class G results in a factor of 1.5 in life. Results are still the same relative order of magnitude.
- ◆ Operator patience coupled with desire for results leads us to believe estimates are reasonable!