# SAE Weld Challenge
# Fatigue Life Prediction

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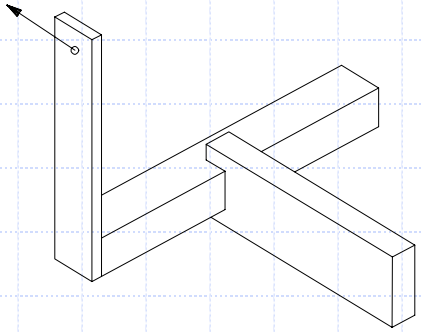

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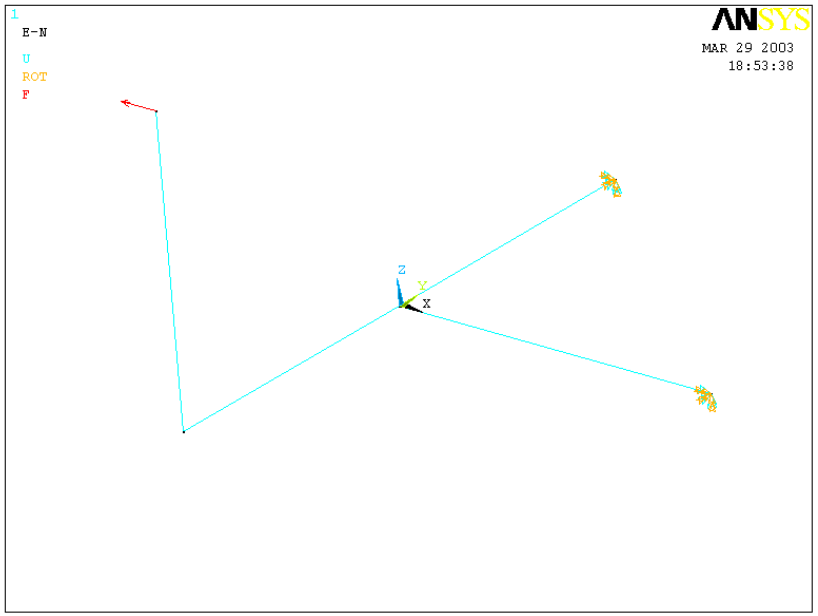
# Weld Loading Analysis

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

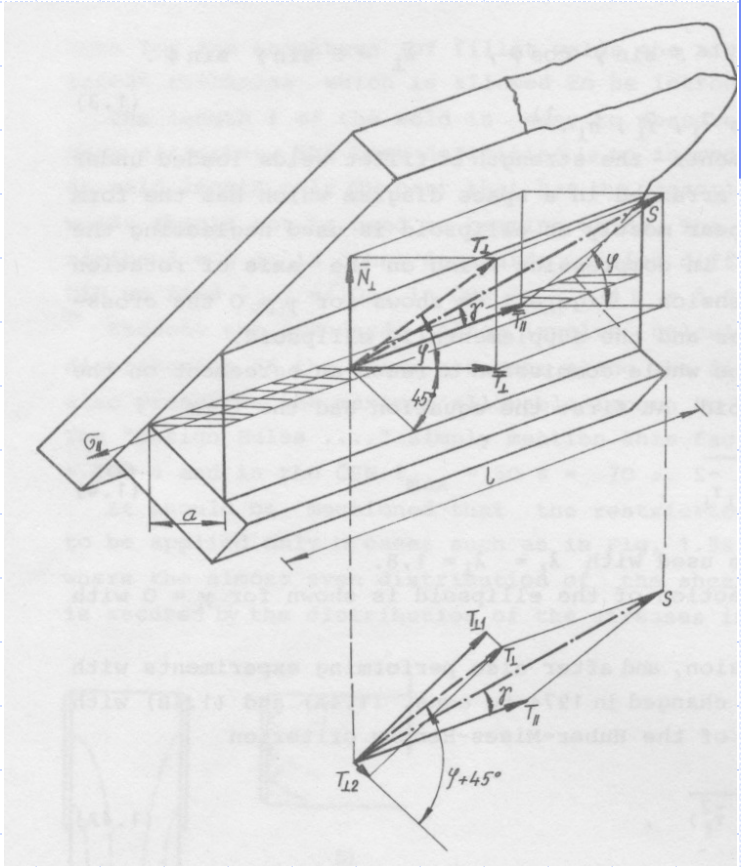


# Resulting Loads at Junction

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

# Stress Analysis

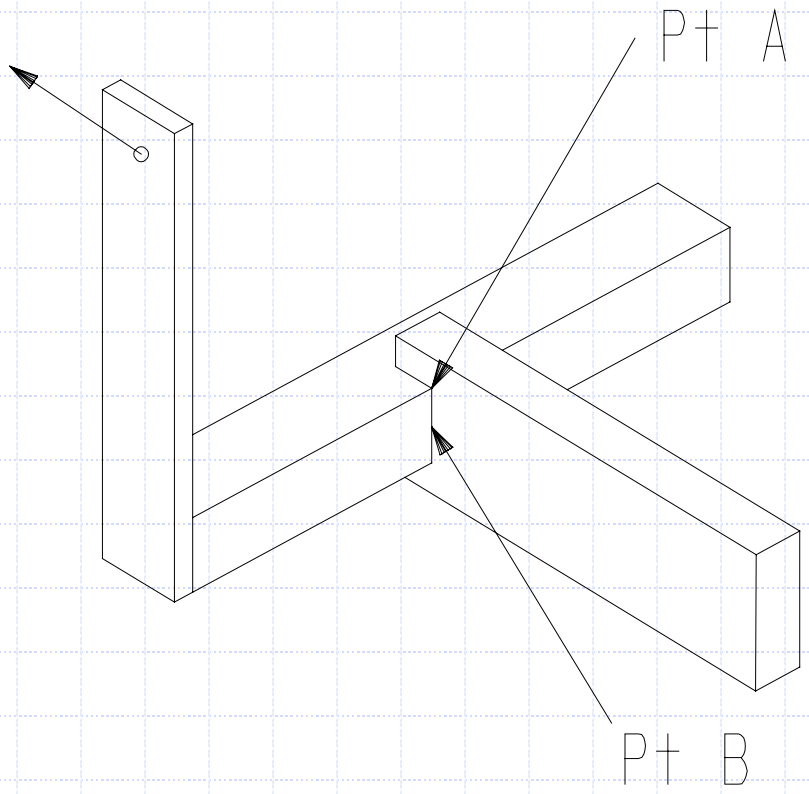
- Stresses in the structural components were determined using simple mechanics.
- Multiaxial forces on the welds were resolved into their normal and shear stress components with respect to the minimum throat area.
- Methods for weld stress analysis are based on the International Institute of Welding's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




Fatus, F. Joints with Fillet Welds. Elsevier Science Publishers, 1986, pg. .24

# 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 |

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