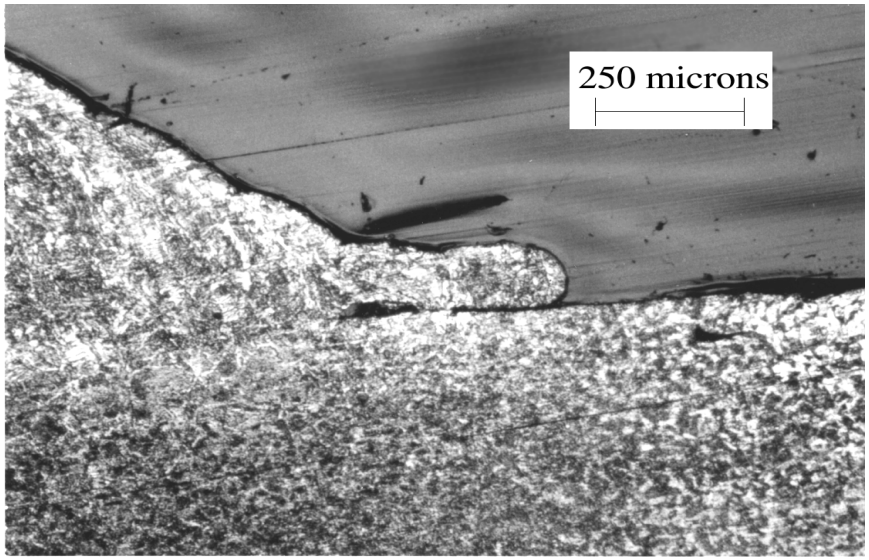
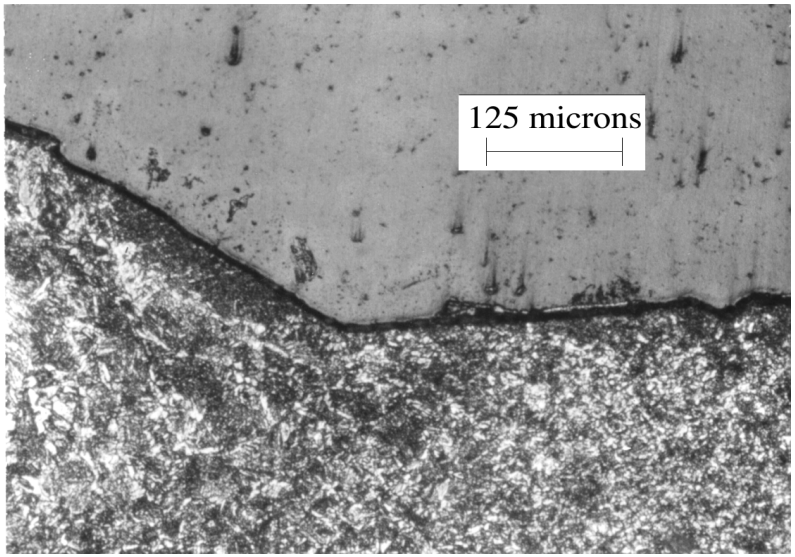
6.3 Improving the fatigue life of weldments

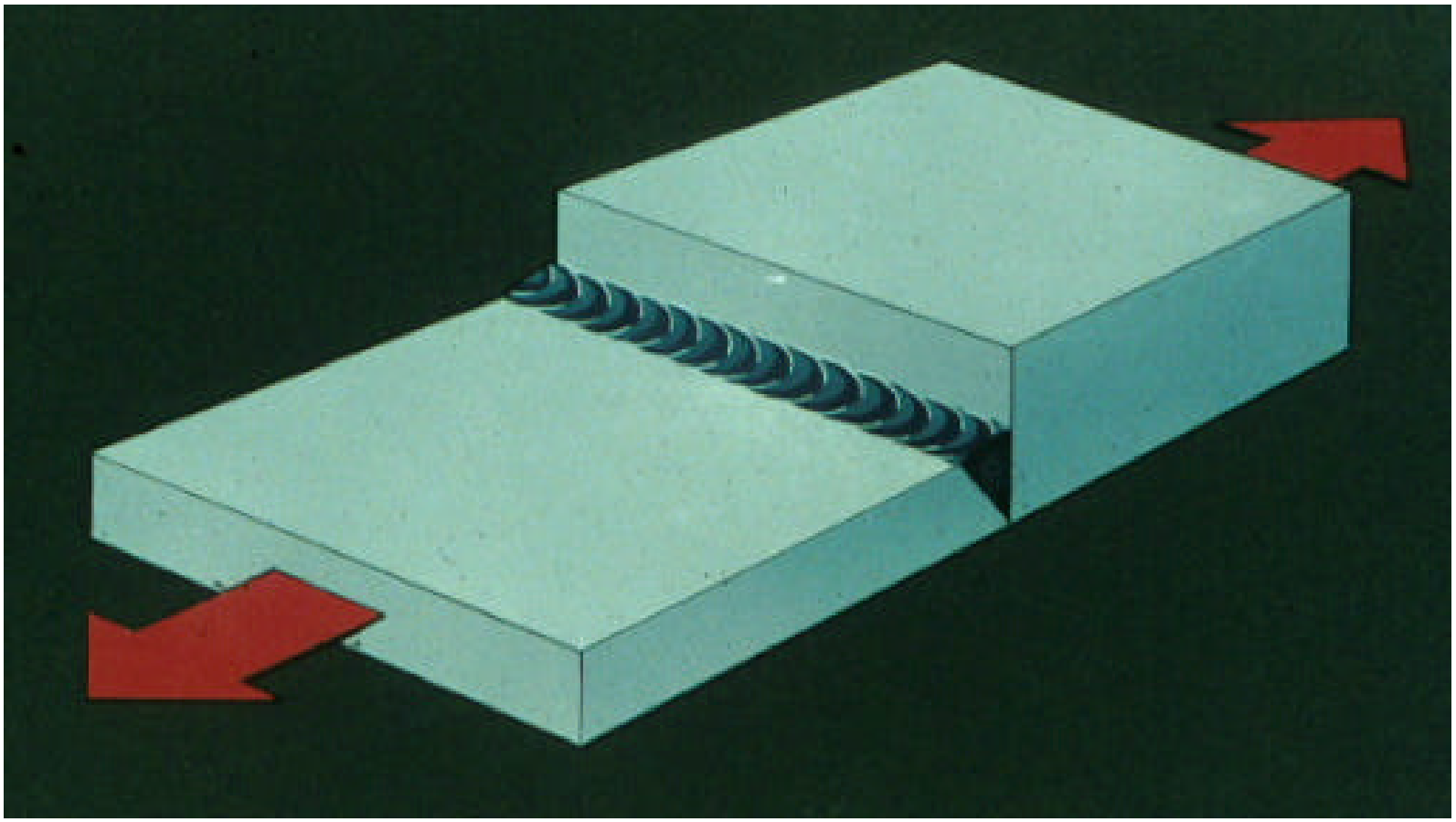




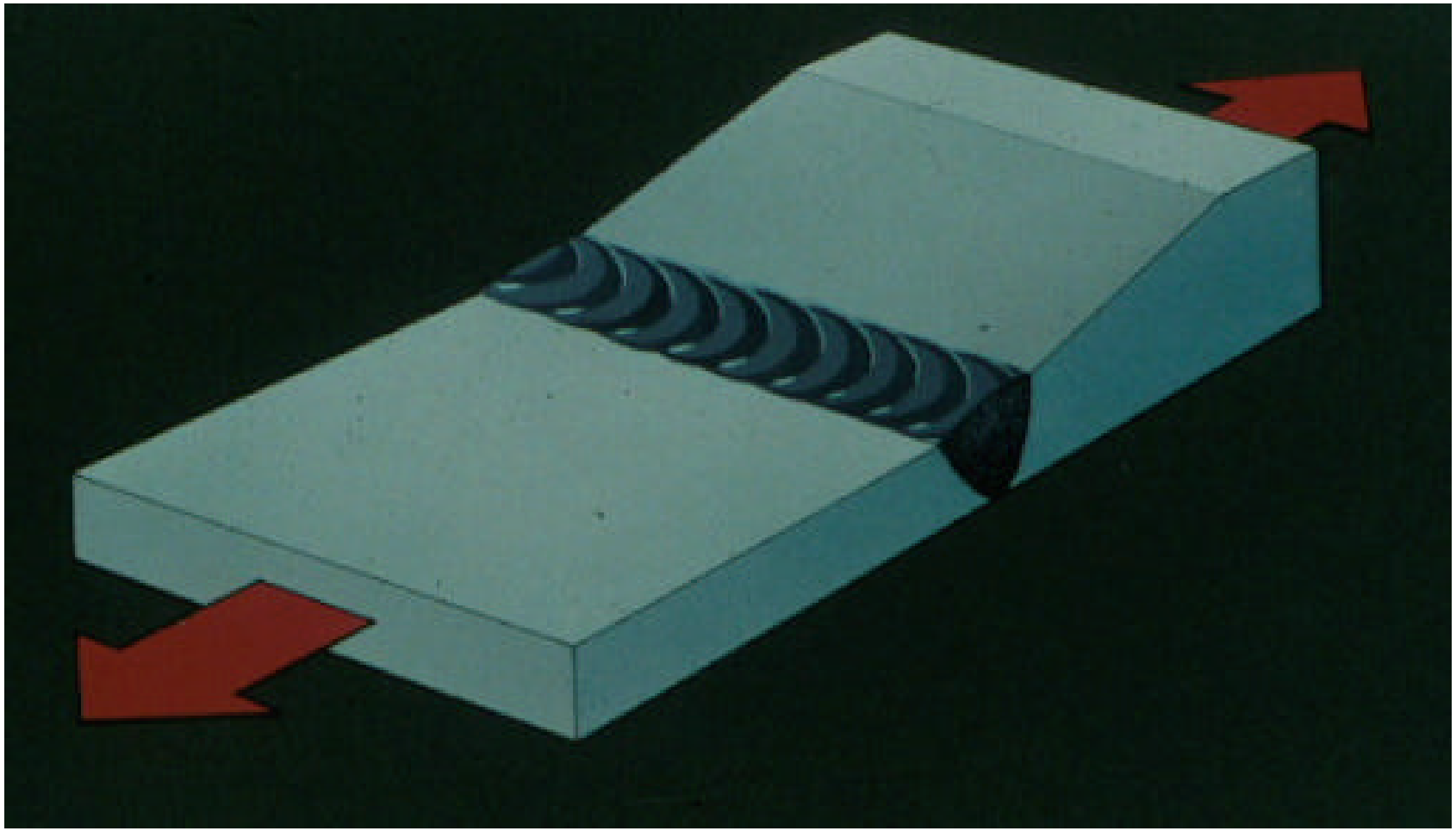
Outline

- **Avoid crudities**
- Improving “good” weldments
- Improving “bad” weldments

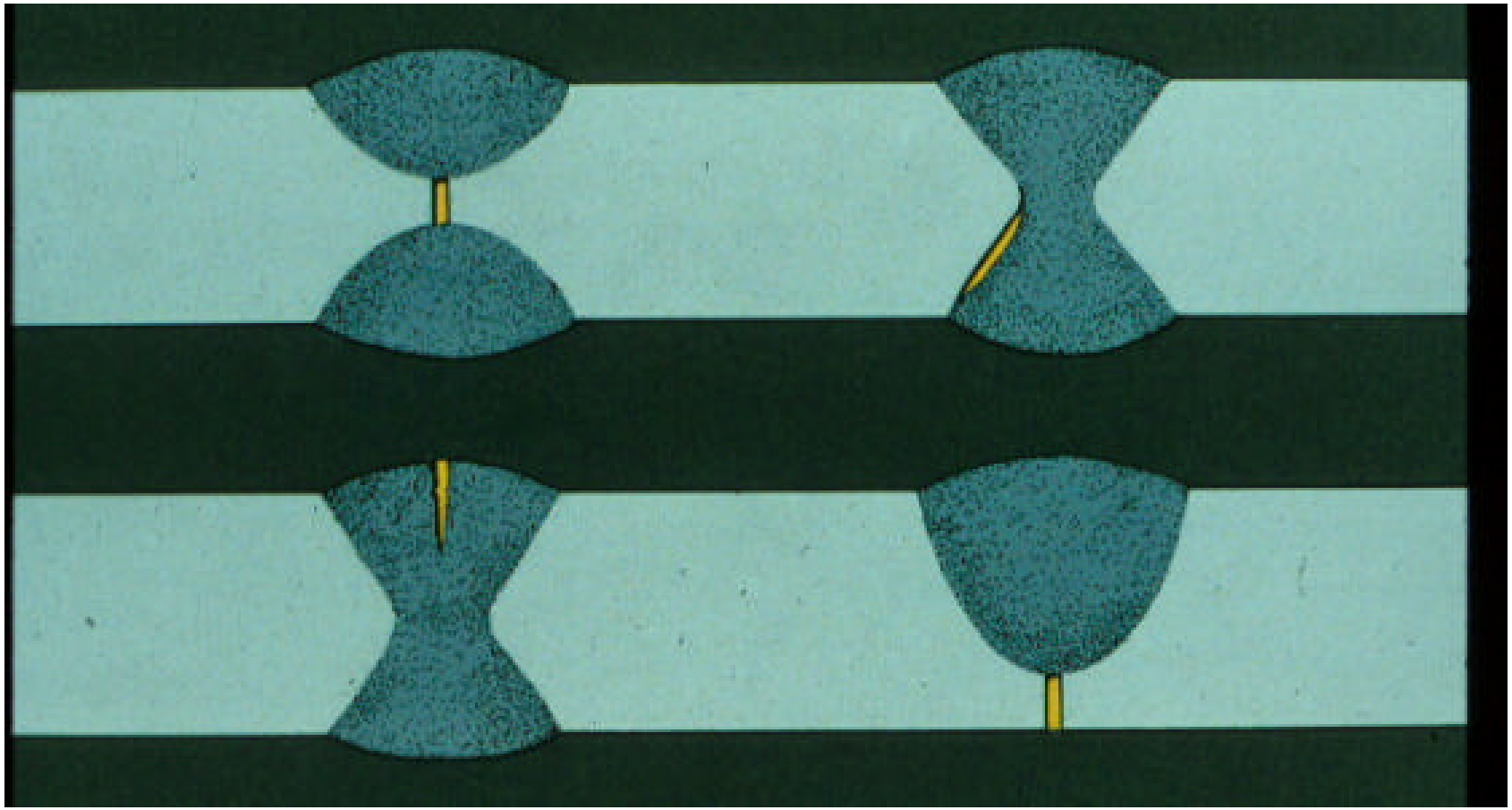
Crude! (bad)



Better



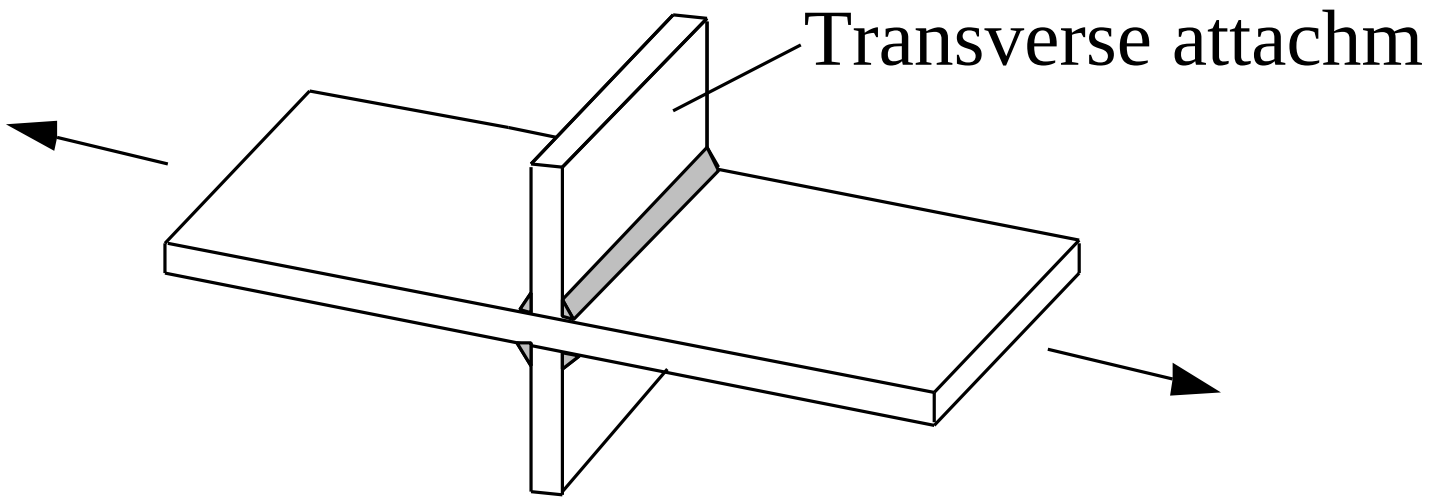
Bad - planar weld discontinuities



Outline

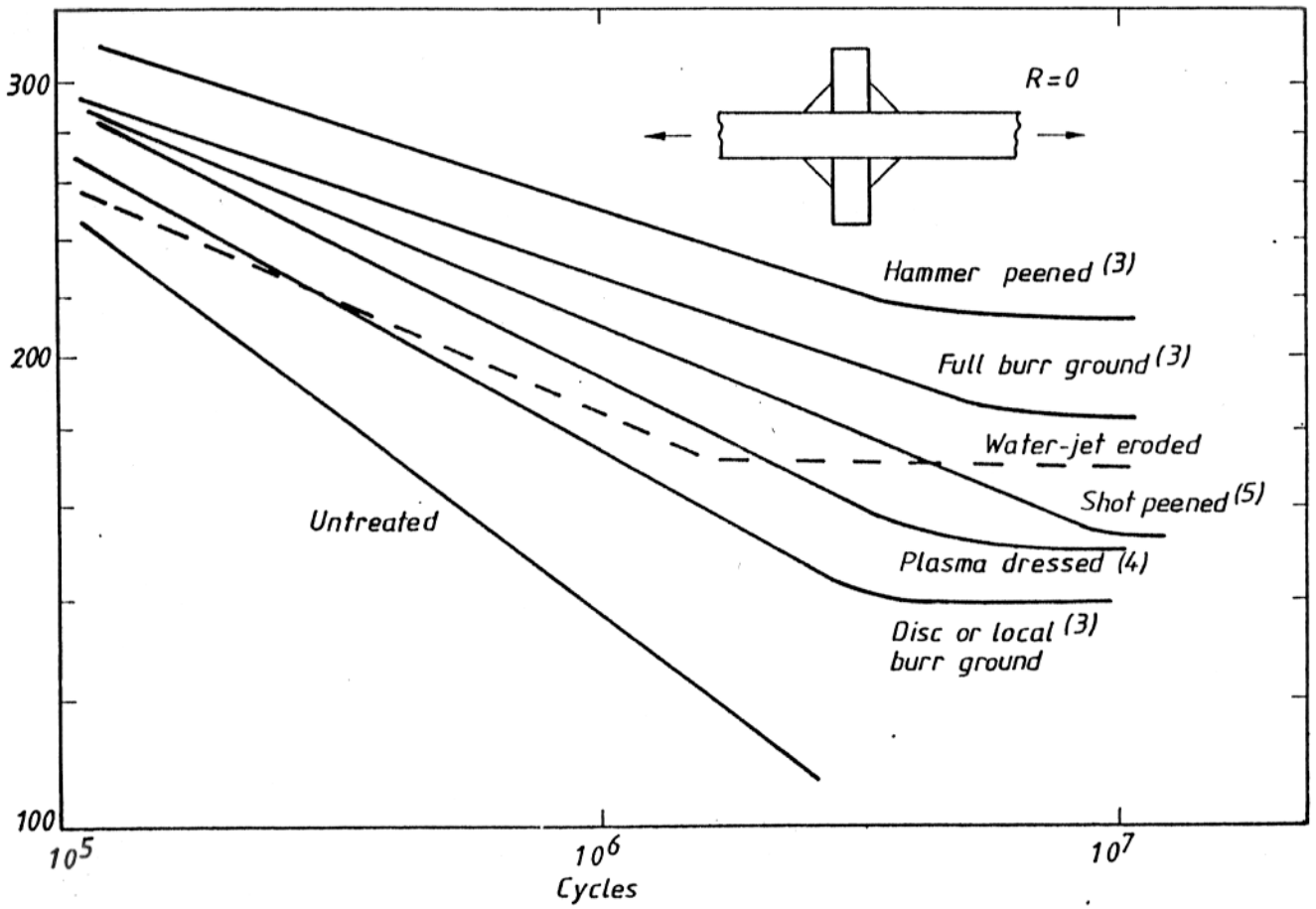
- Avoiding crudities
- **Improving “good” weldments**
- Improving “bad” weldments

A “good” weld



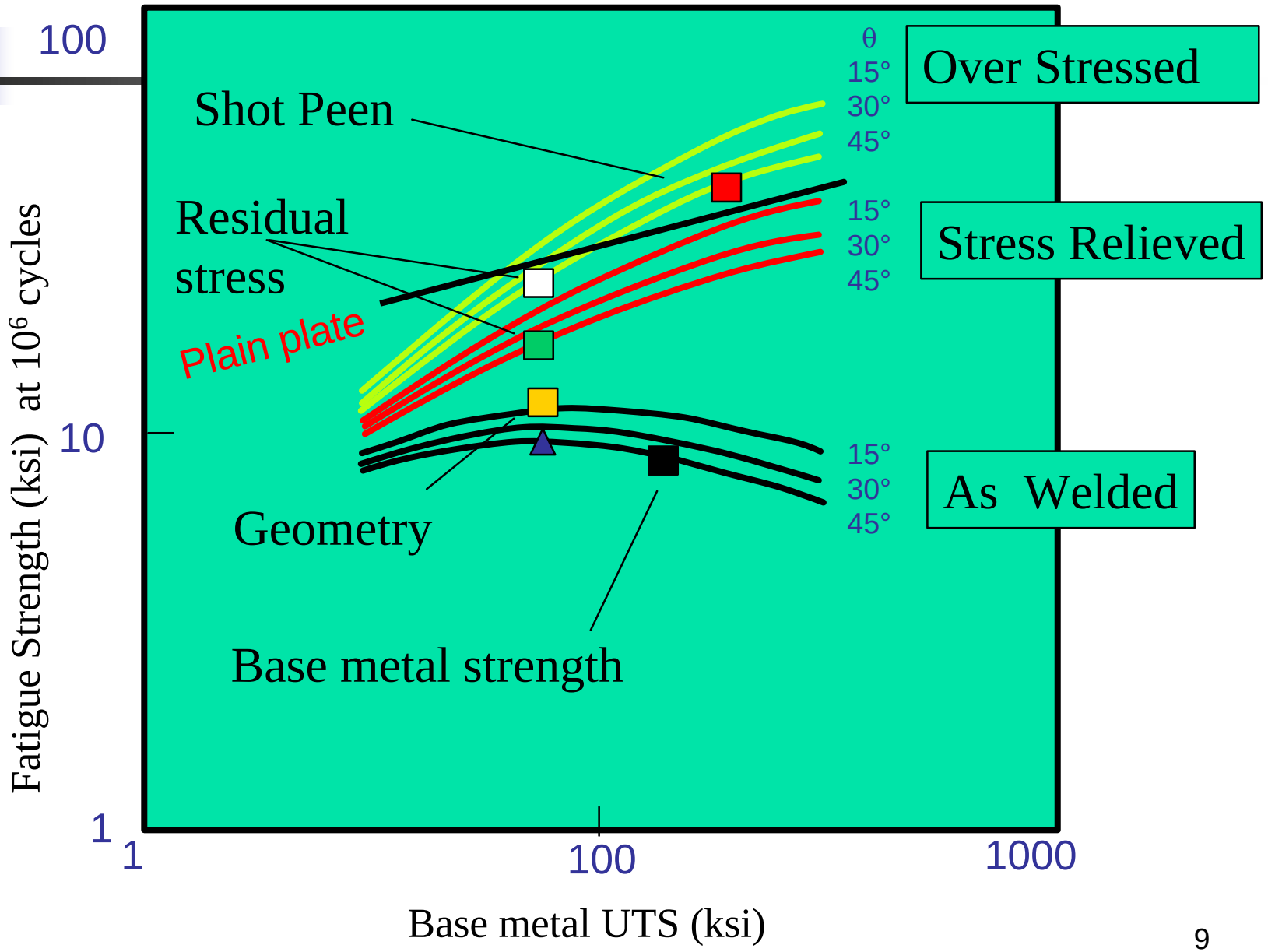
Weldment with a transverse attachment

Options



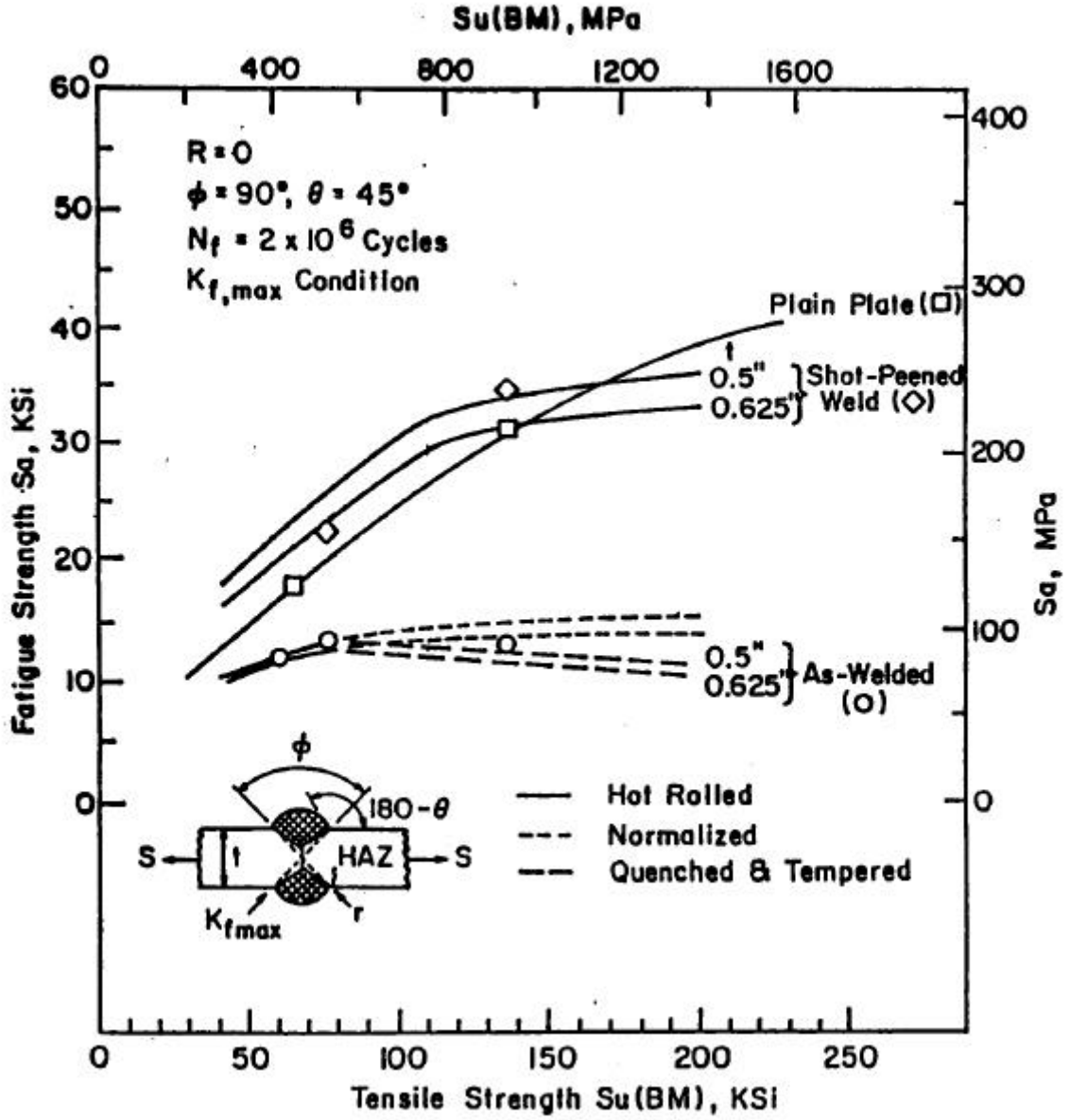
TWI suggestions as to weld improvement procedures

Improvement strategies

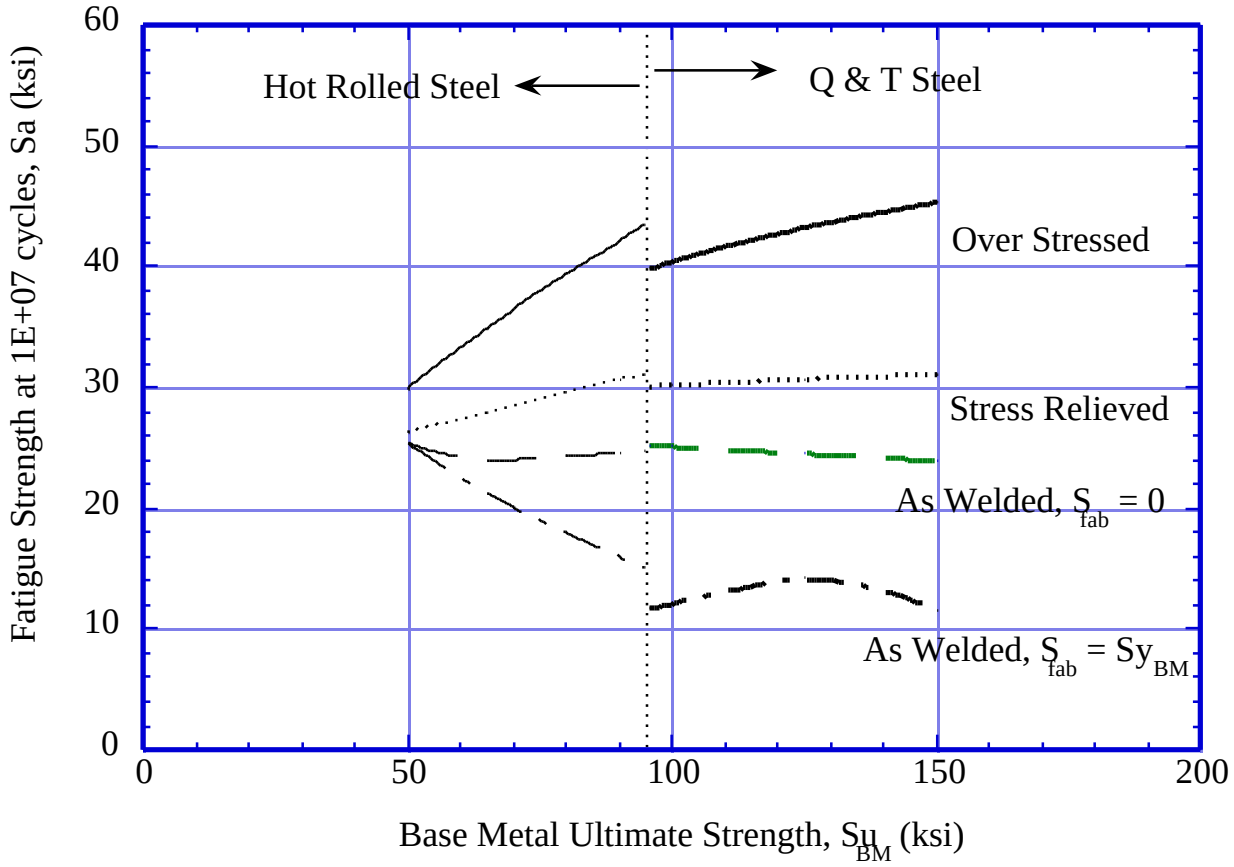


Example

Model predictions and experimental data.



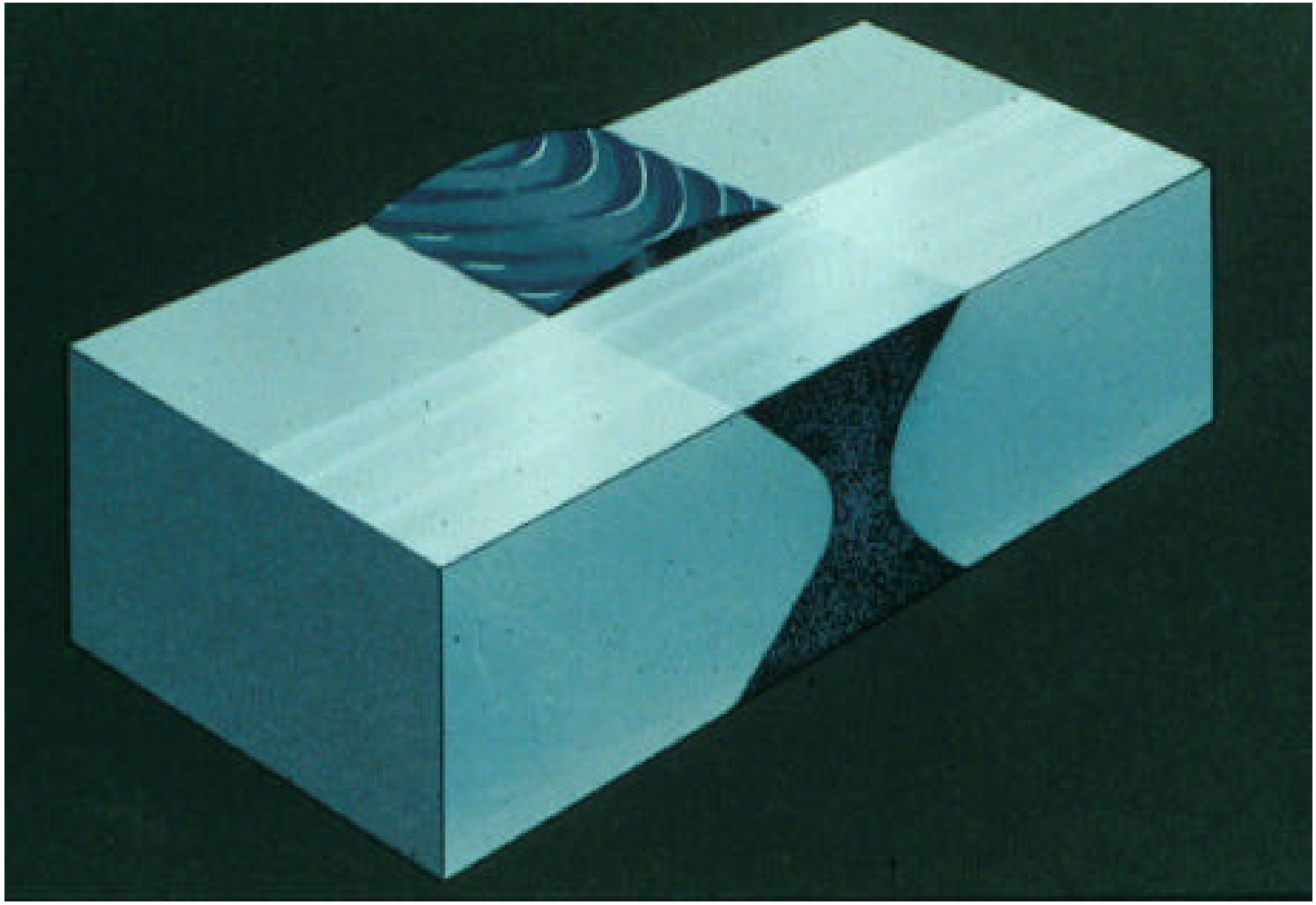
Predicted effect of S_{uBM}



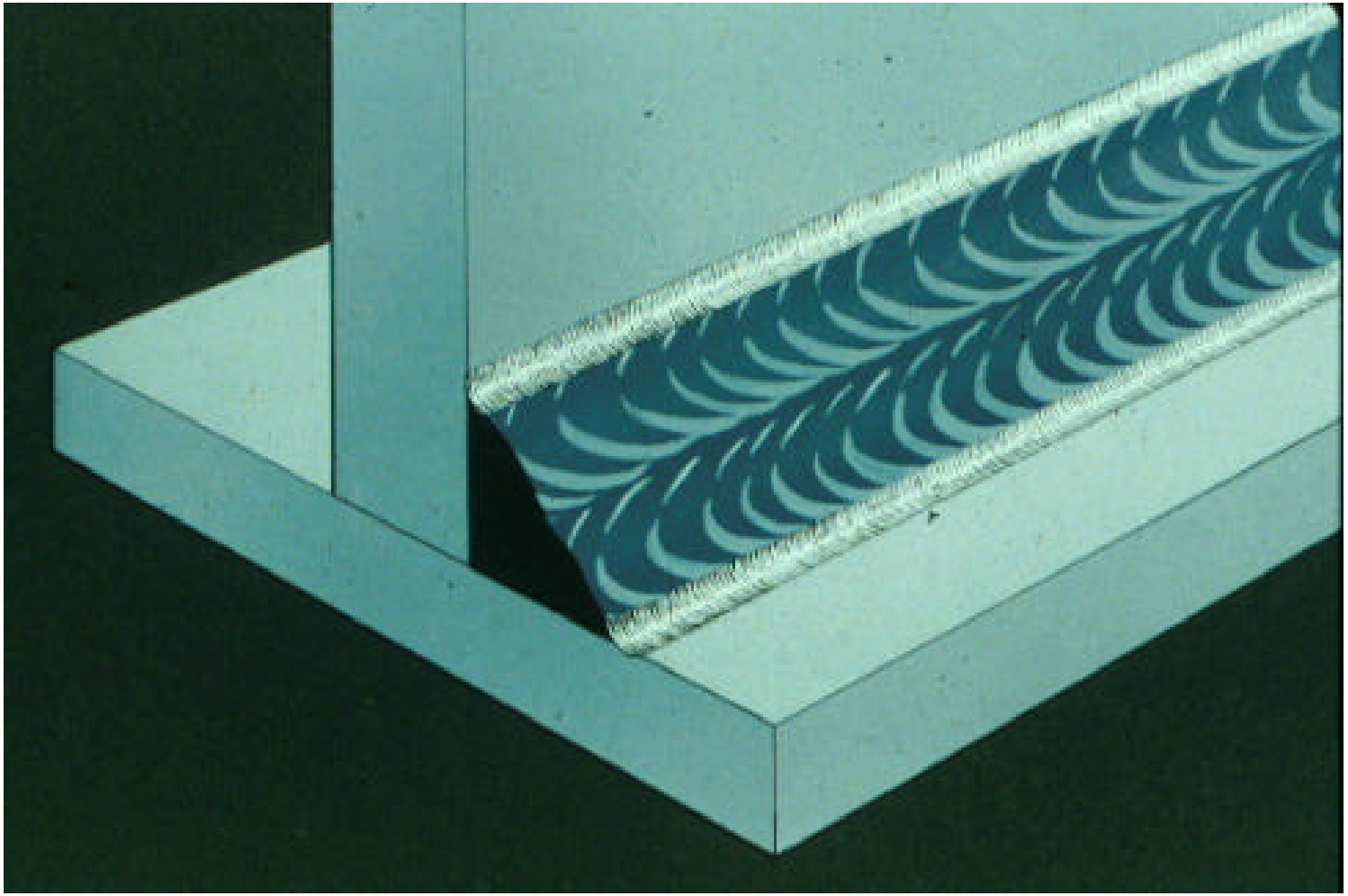
Trends in "Ideal" 1.0-in plate thickness, non-load carrying cruciform weldments fatigue strength.

- R = 0
- Welding residual stresses = 50% of S_{YBM}
- S_{fab} ~ S_{YBM}

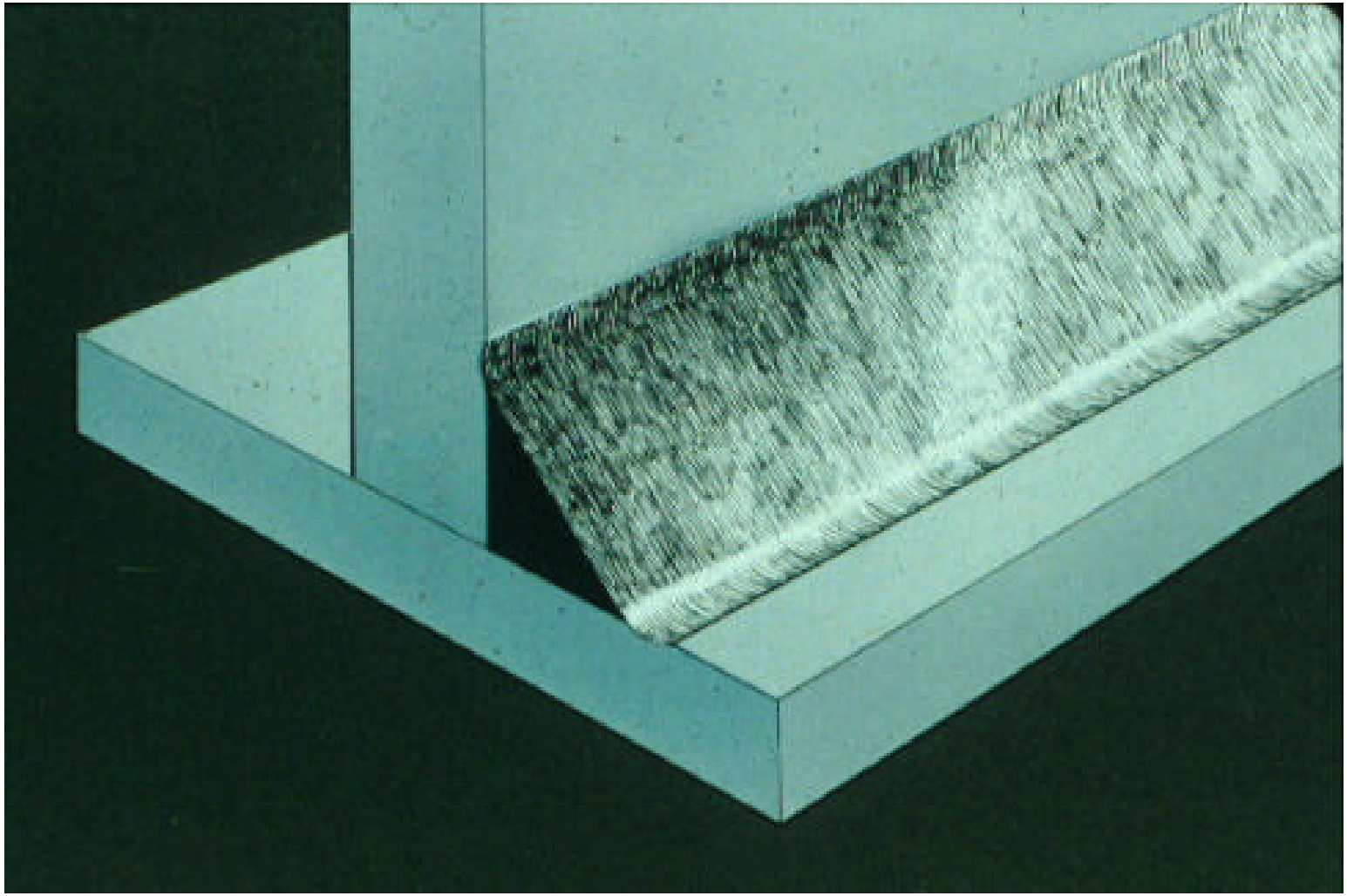
Good - grind off reinforcement



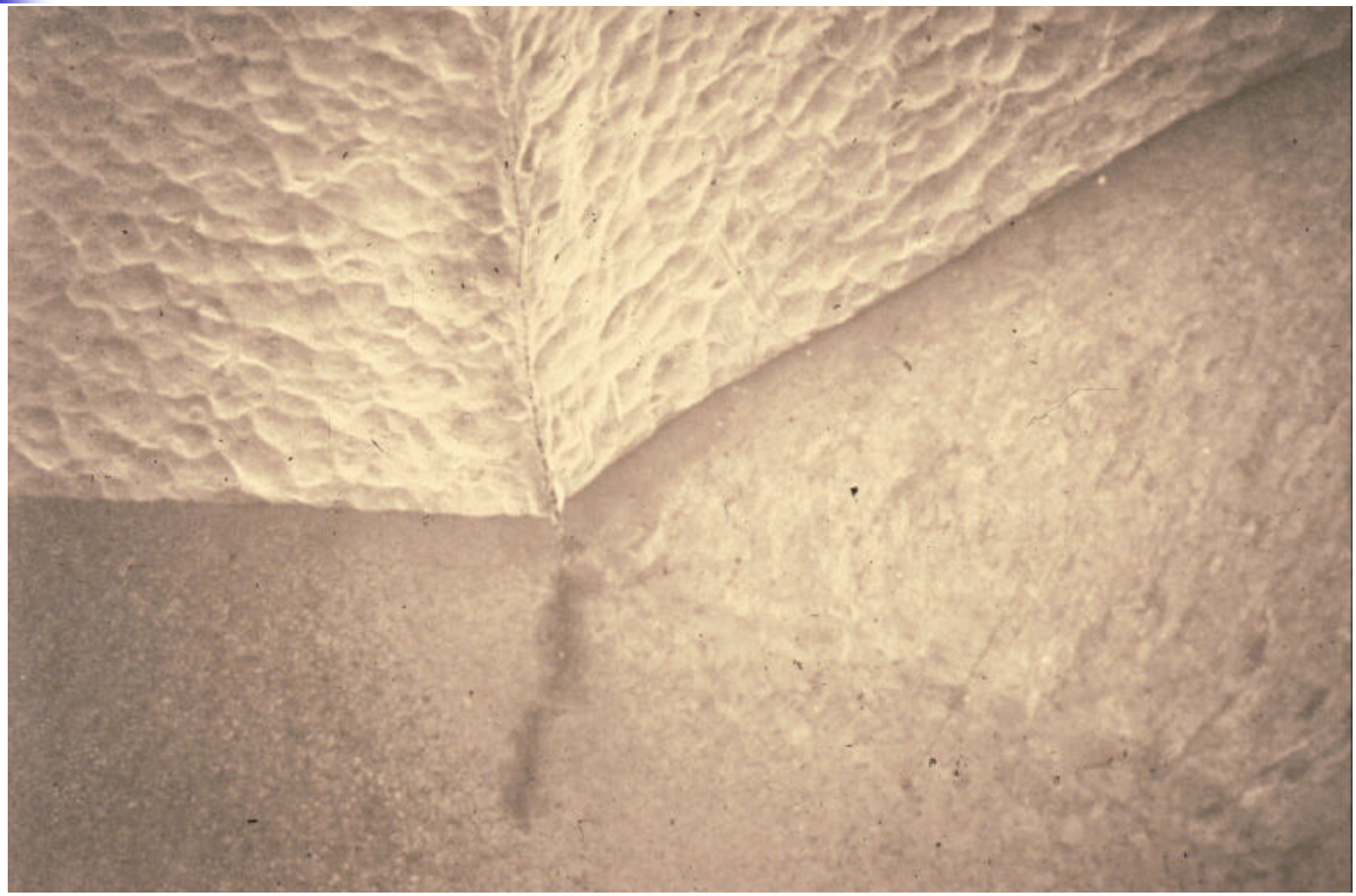
Good - burr grind weld toe



Very good - full face grinding

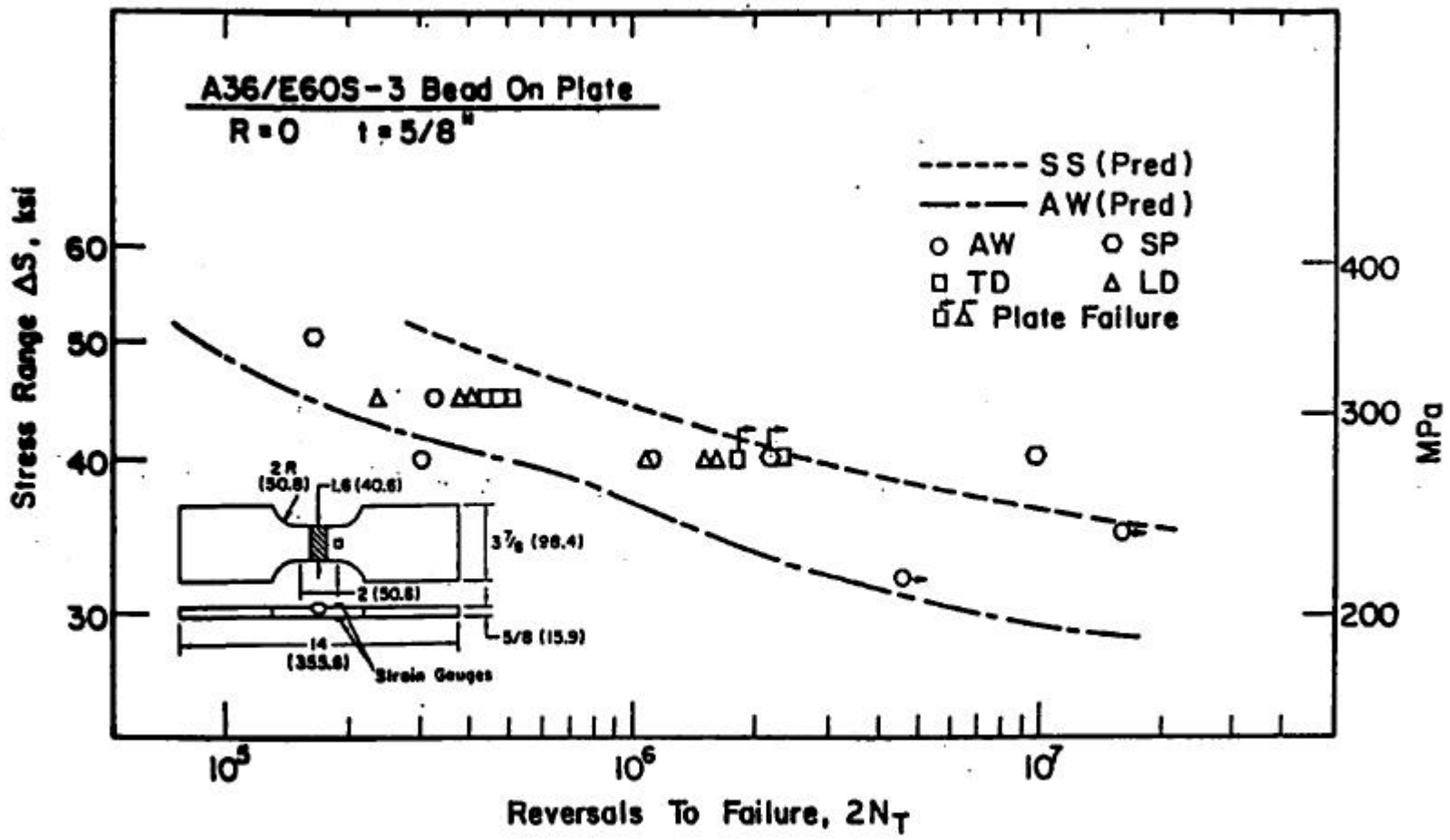


Shot peened weld toe

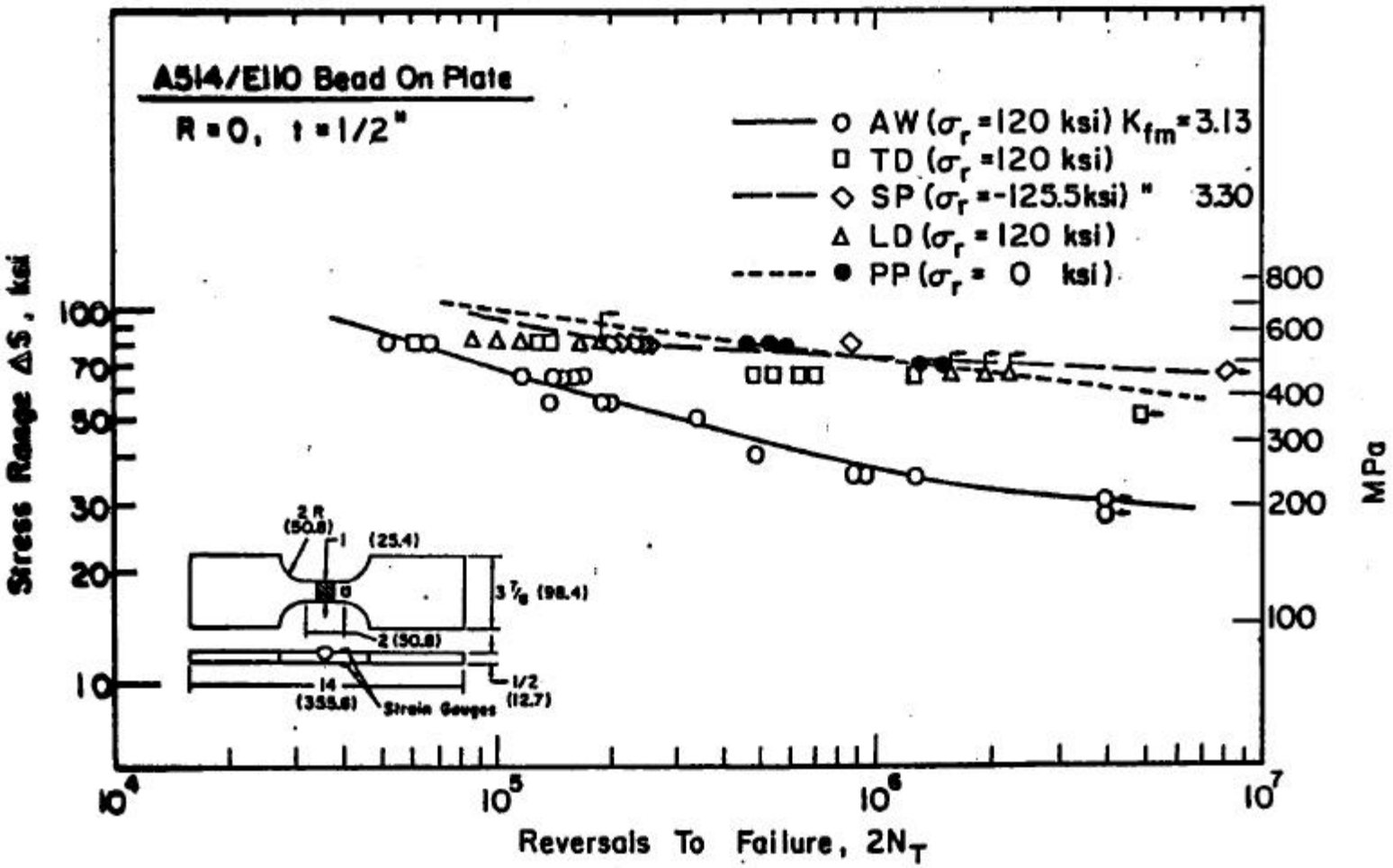


Remelted weld toe (laser)

ASTM A 36 butt weldment



ASTM A 514 butt weldment

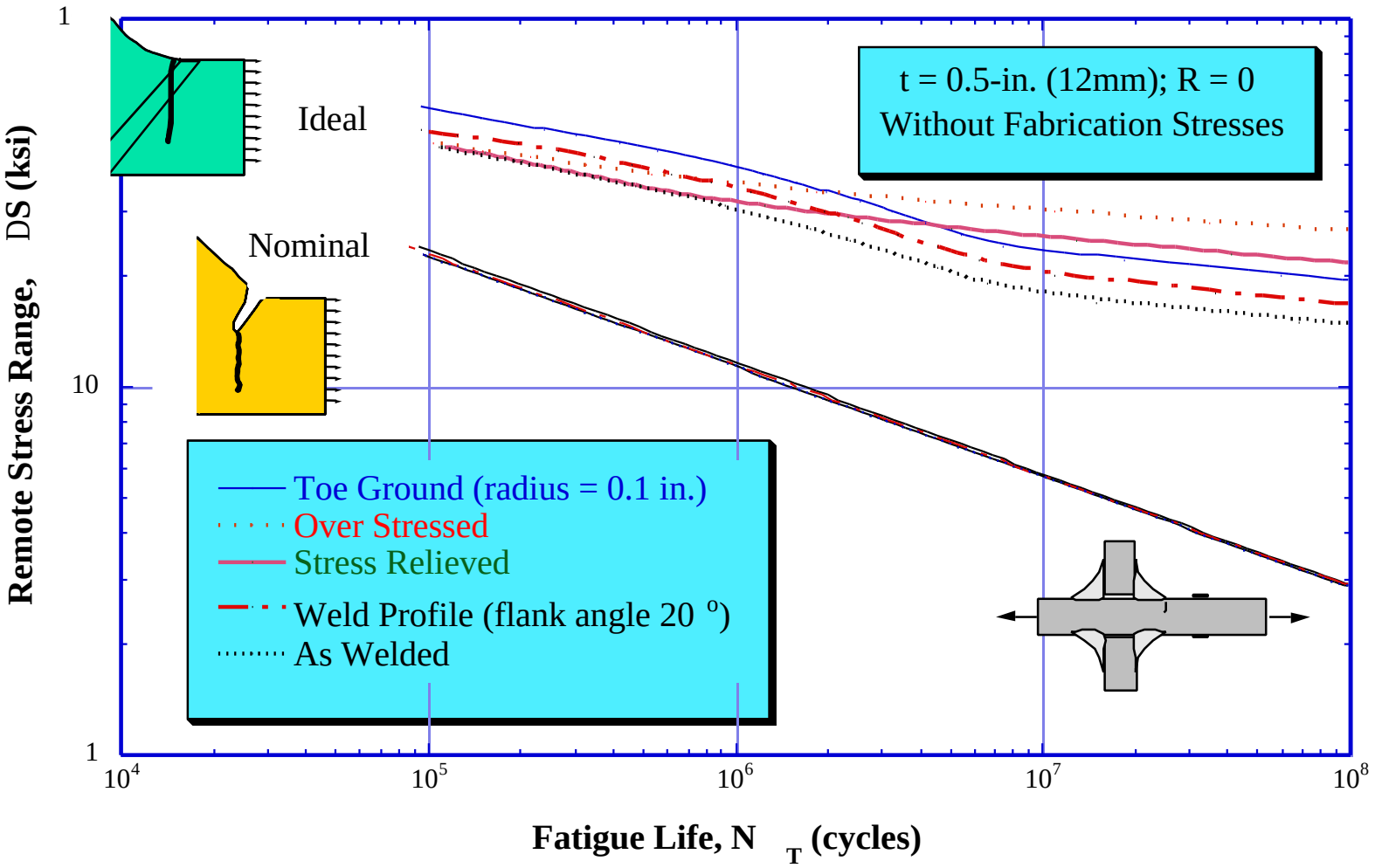


Light, heavy industry weldments

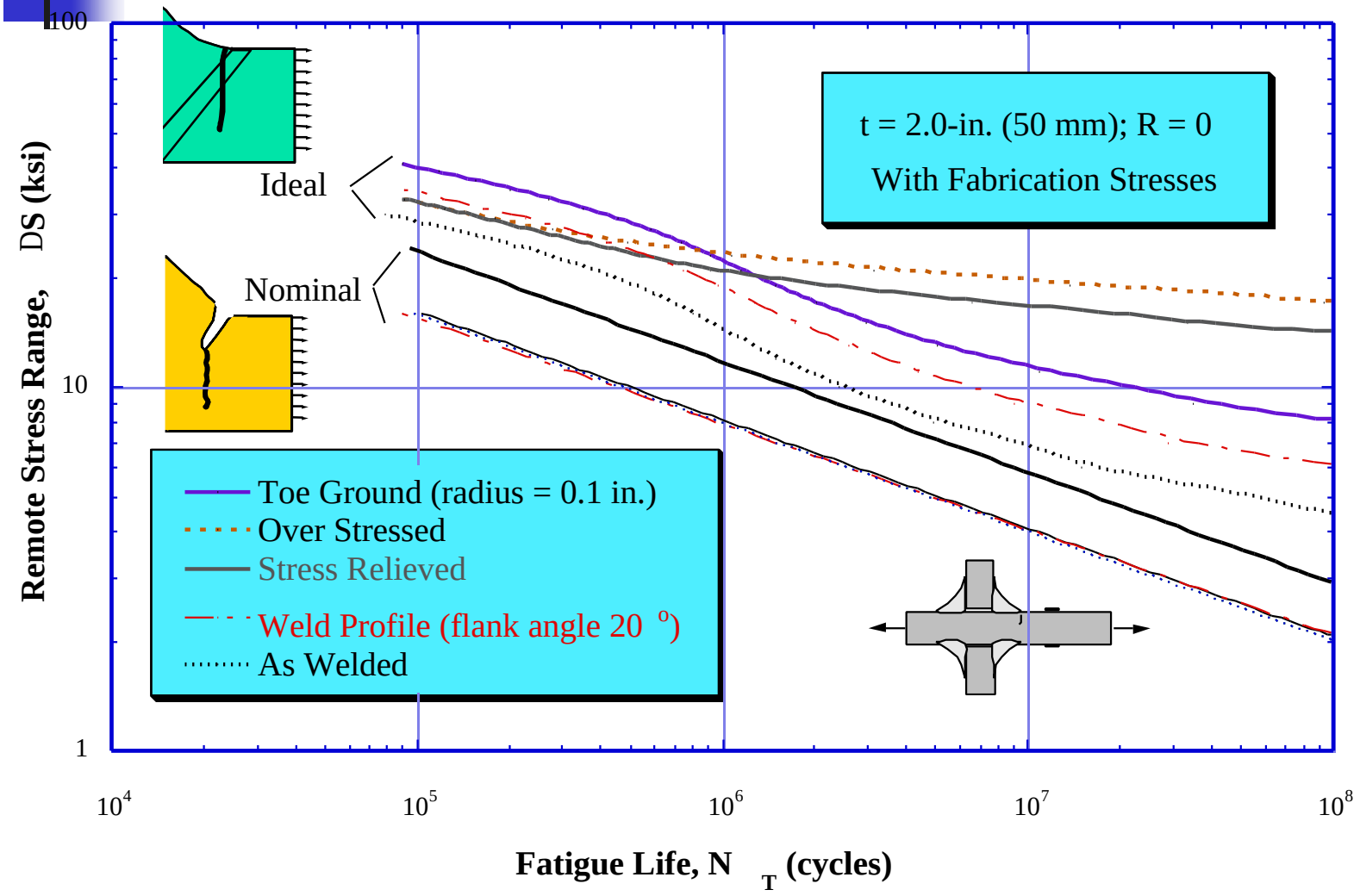
- Light industry weldments are presumed to be fabricated from 1/2” or smaller plate and not to have large fabrication stresses.

- Heavy industry weldments are presumed to be fabricated from larger than 1” thick plates and to possess large fabrication stresses.

Light industry weldments



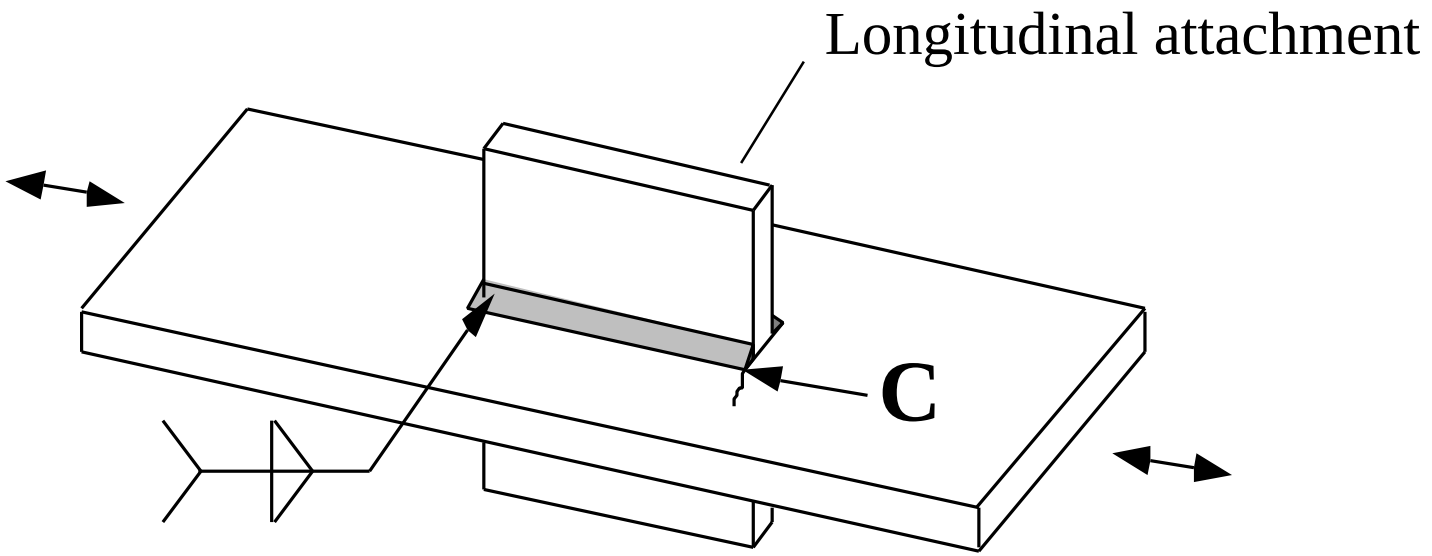
Heavy industry weldments



Outline

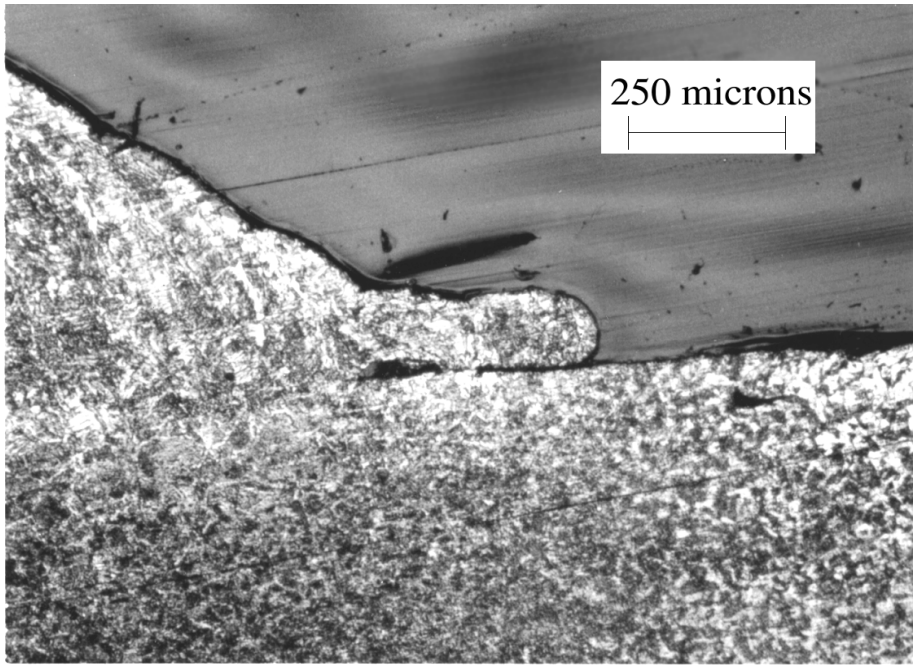
- Avoid crudities
- Improving “good” weldments
- **Improving “bad” weldments**

Bad weldment

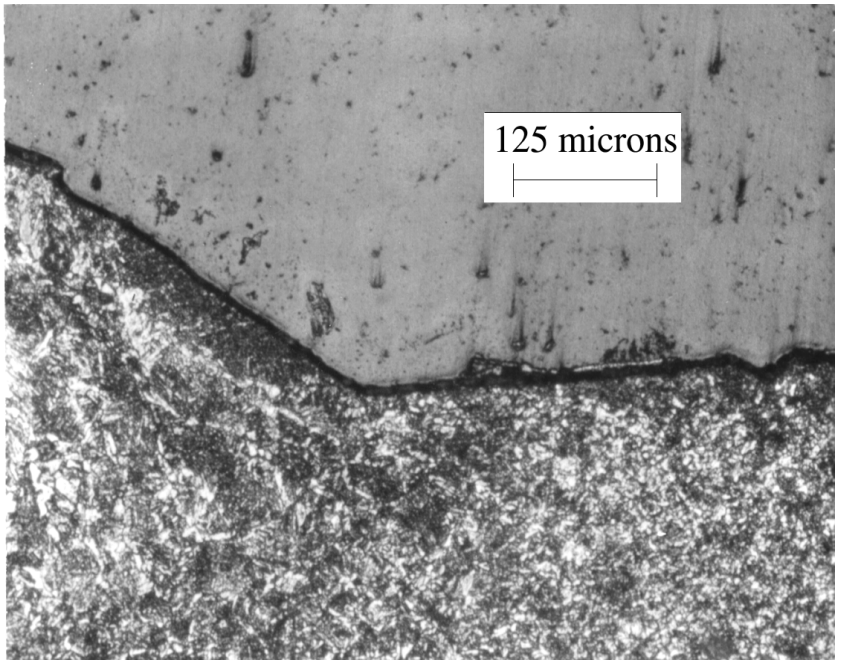


Weldments with longitudinal attachments have a low fatigue resistance because of the presence of weld terminations. Starts and stops introduce weld discontinuities. Residual stresses very high. 3-D stress concentrations effects

Cold lap defects at weld toe

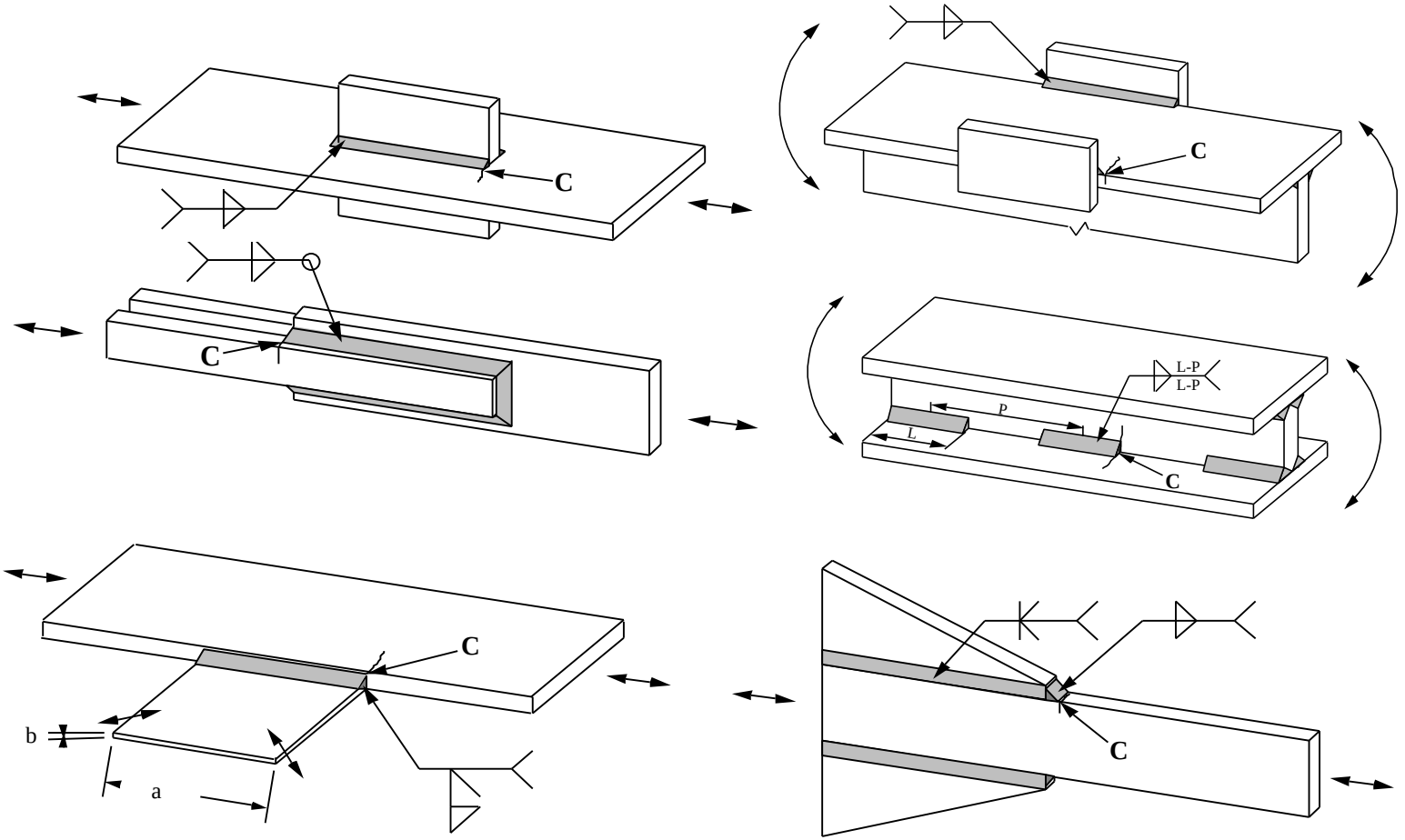


Series 1 and 2

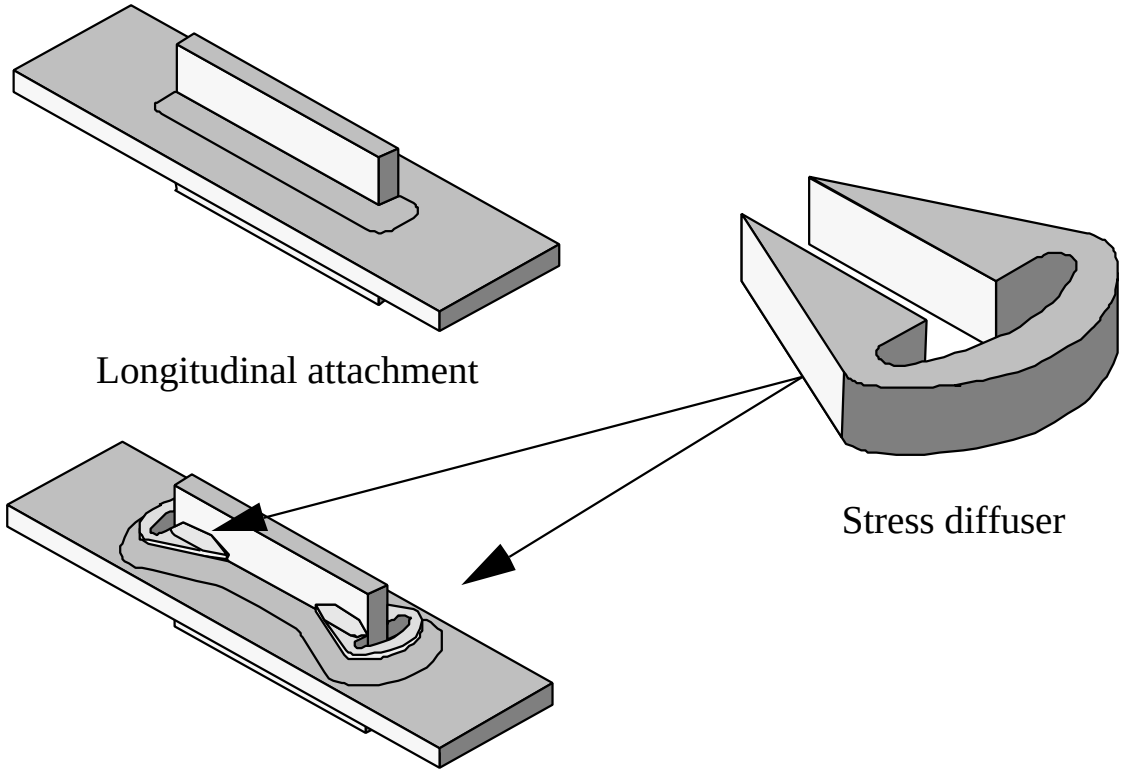


Series 3

Examples of terminations



Placement of stress diffuser

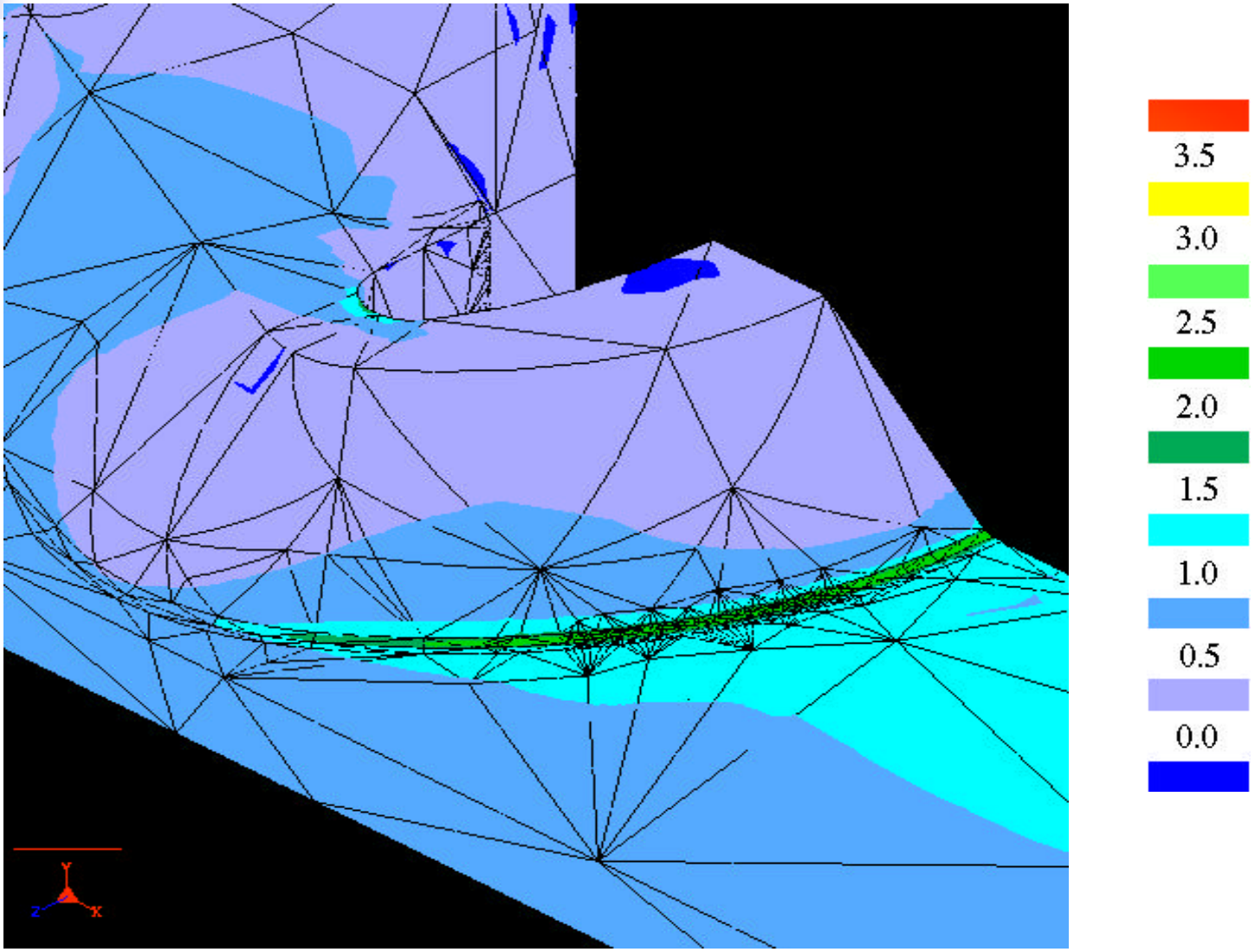


Longitudinal attachment

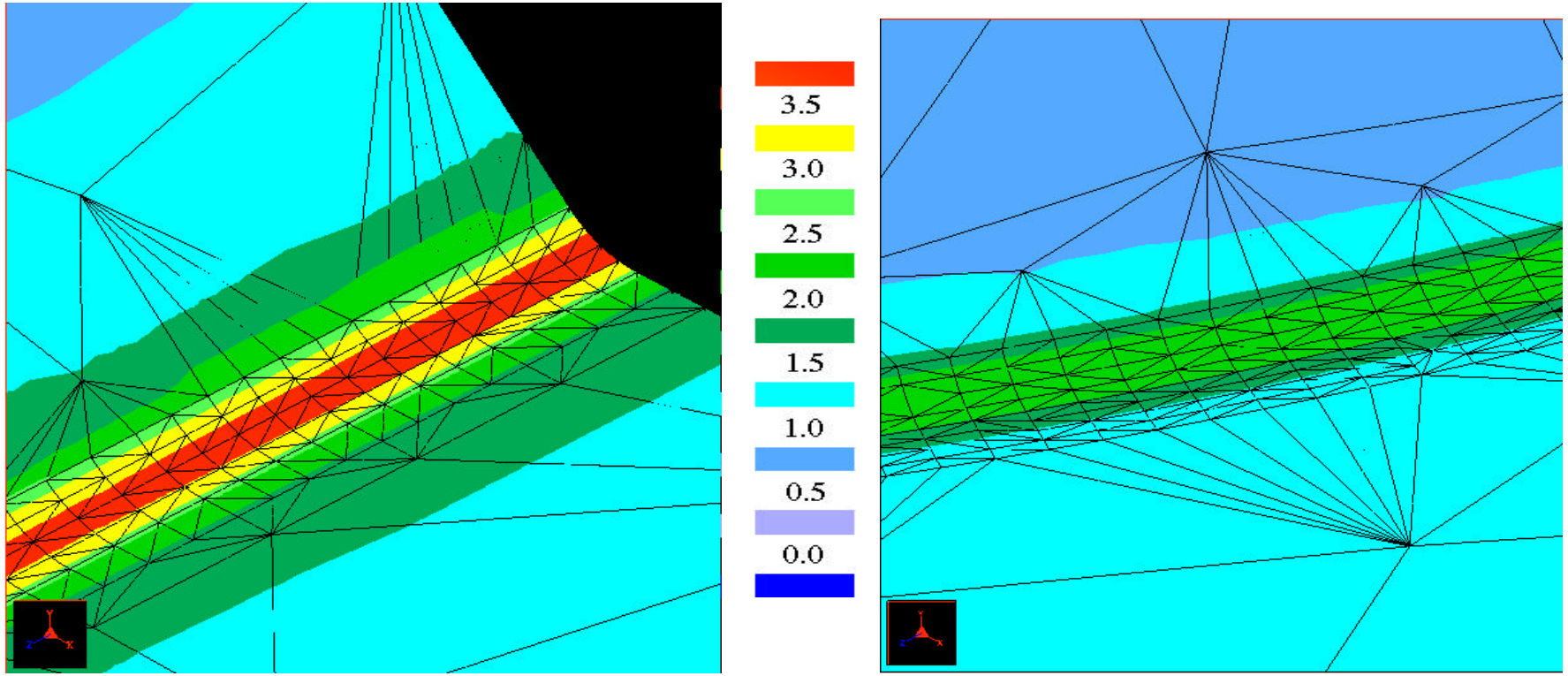
Stress diffuser

Longitudinal attachment with stress diffusers

3-D FEM modeling



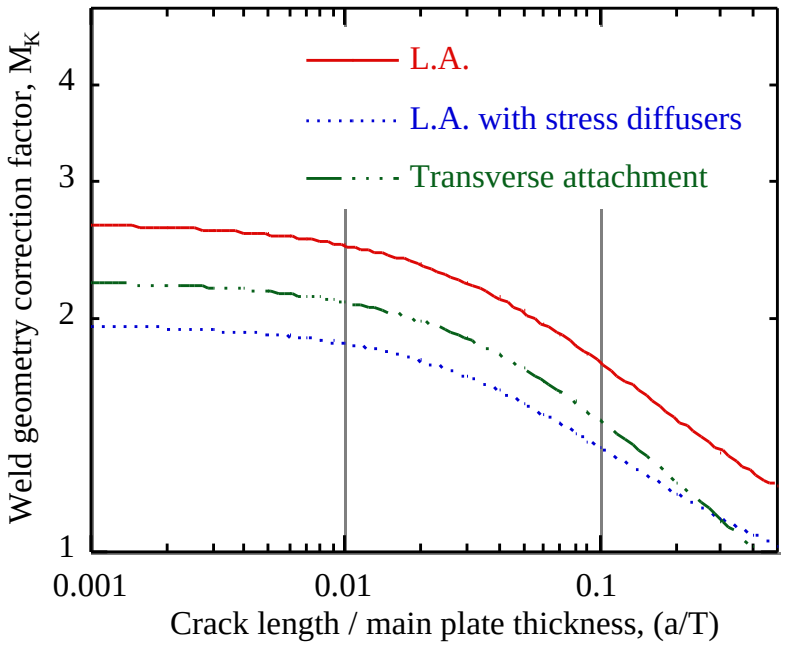
Effectiveness of a stress diffuser

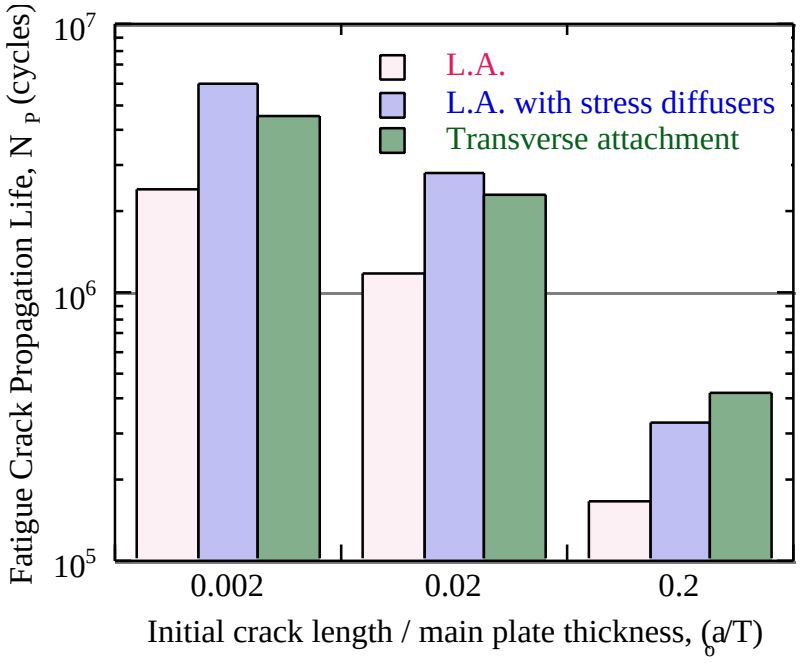


Longitudinal attachment

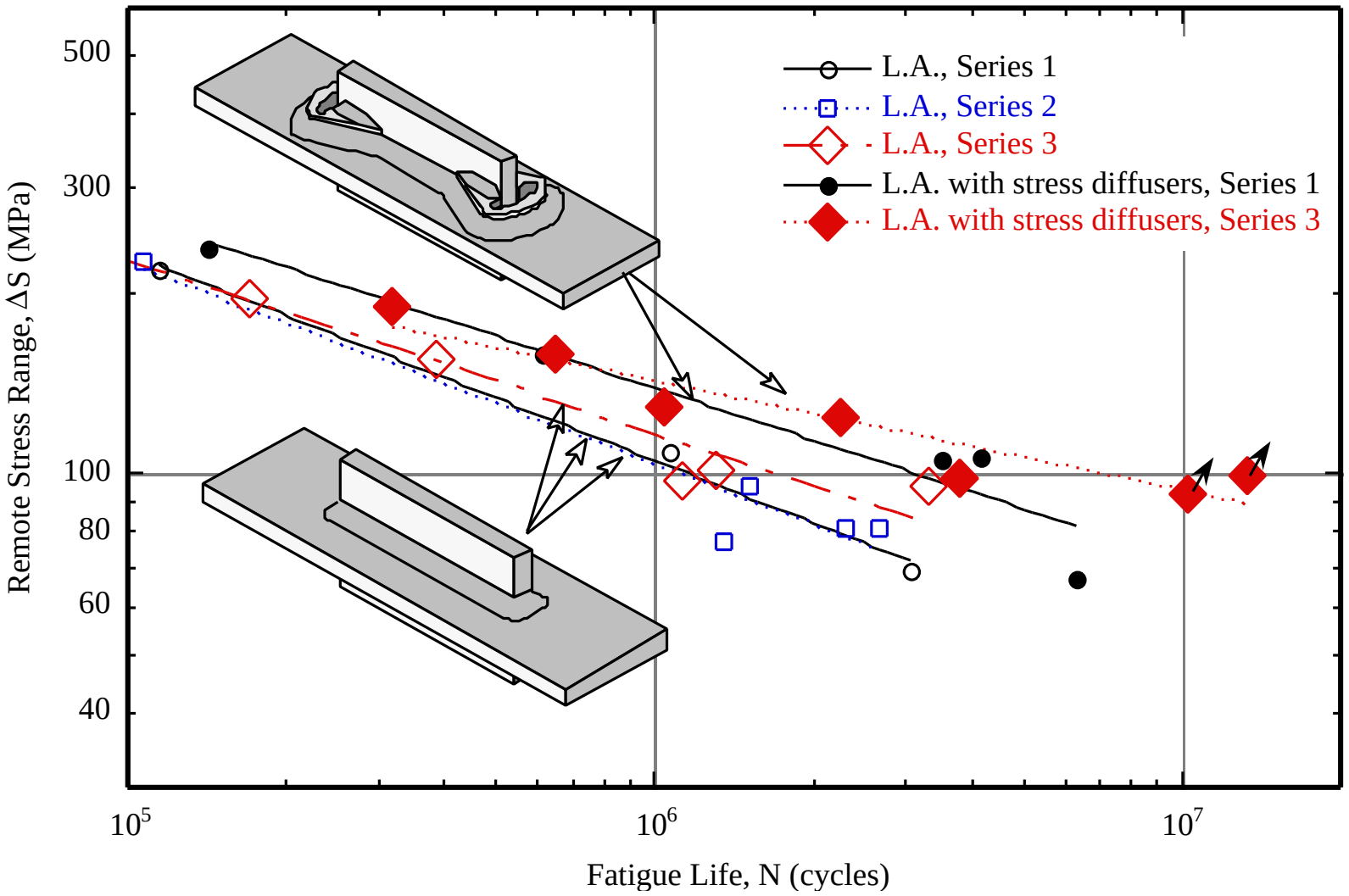
Longitudinal attachment with stress diffuser

Effect on M_K and N_P

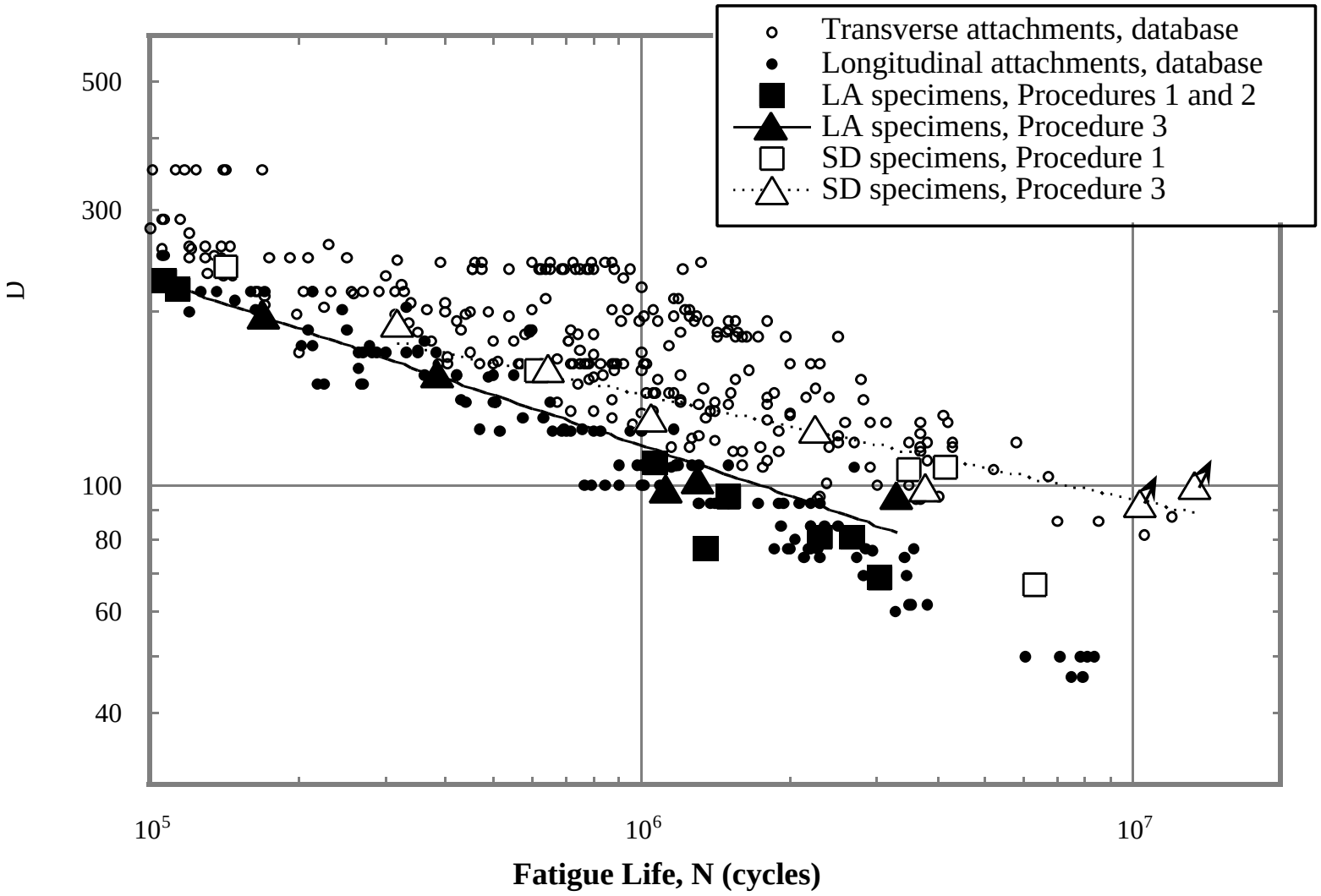




Fatigue test results



Fatigue test results



Summary

- The fatigue strength of “Ideal” weldments can be much improved; whereas, the fatigue strength of “Nominal” weldments cannot.
- Weld toe grinding or weld profile control works best for “Ideal” weldments at short lives. Beware of corrosion pitting.
- Smaller “Ideal” weldments are more susceptible to improvement than larger weldments.
- Fabrication stresses are critically important.

Summary

- The behaviors of light and heavy industry weldments are dissimilar.
- Stress relief annealing and over-stressing works best for “Ideal” weldment at long lives. Beware of compressive overloads.
- Fatigue behavior of weldments and effective life improvement methods depends upon weldment size and weld quality
- Stress-diffuser can substantially improve the fatigue life of terminations without post-weld processing.