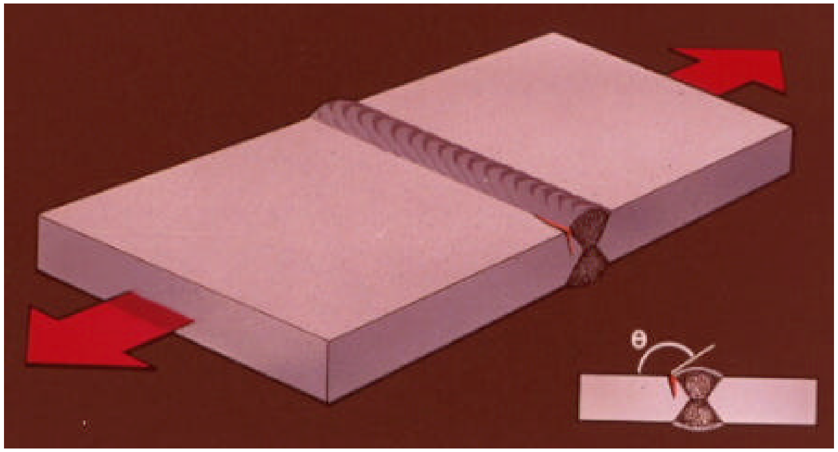
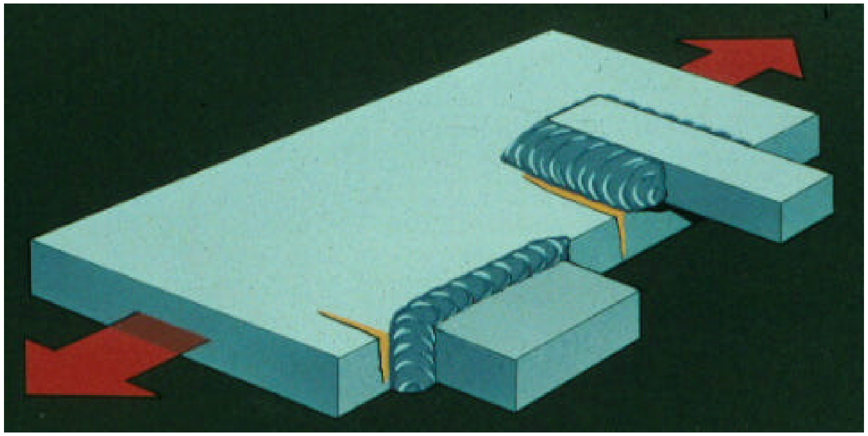
6.2 Classification of weldments



Good

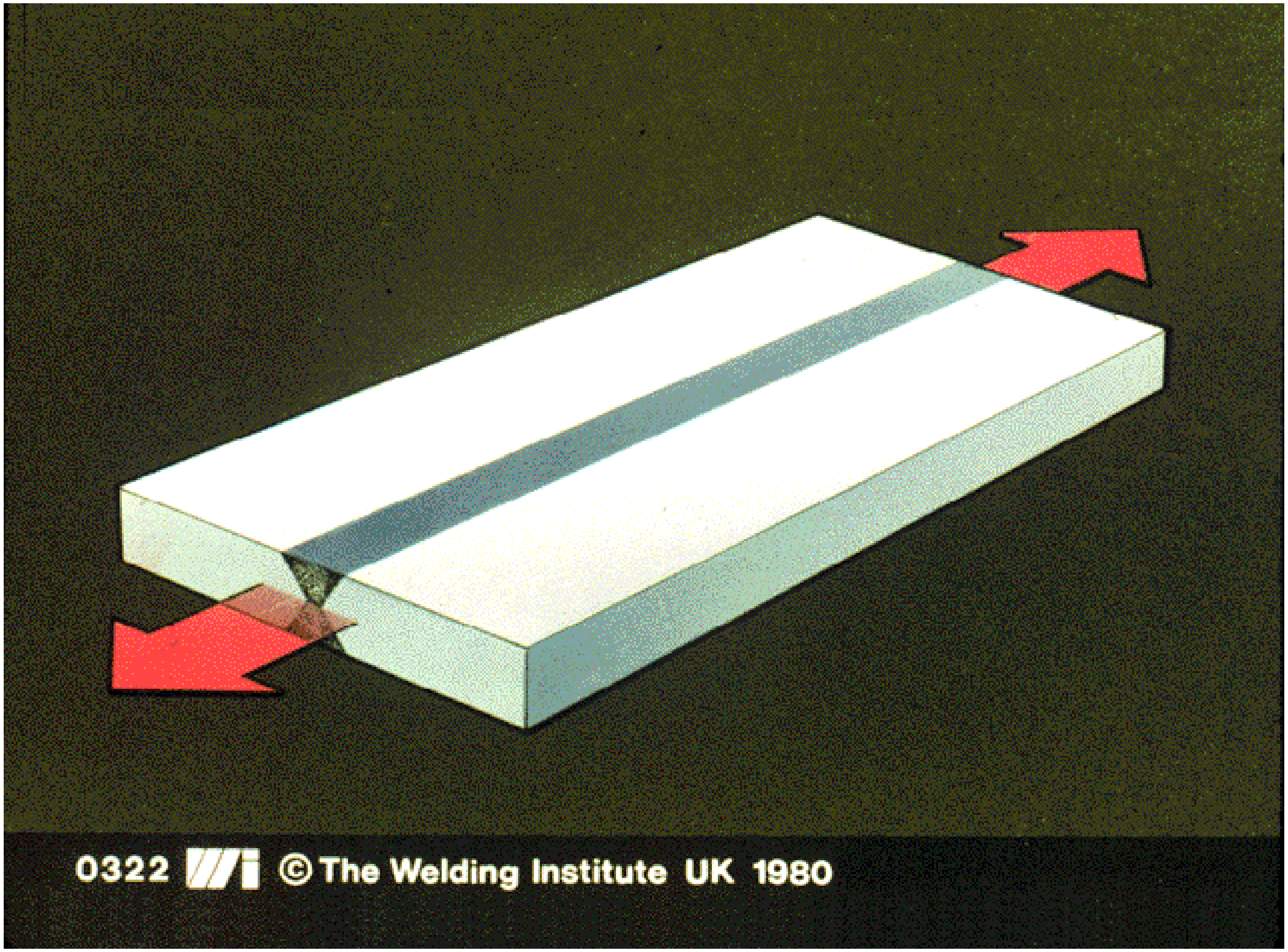


Bad

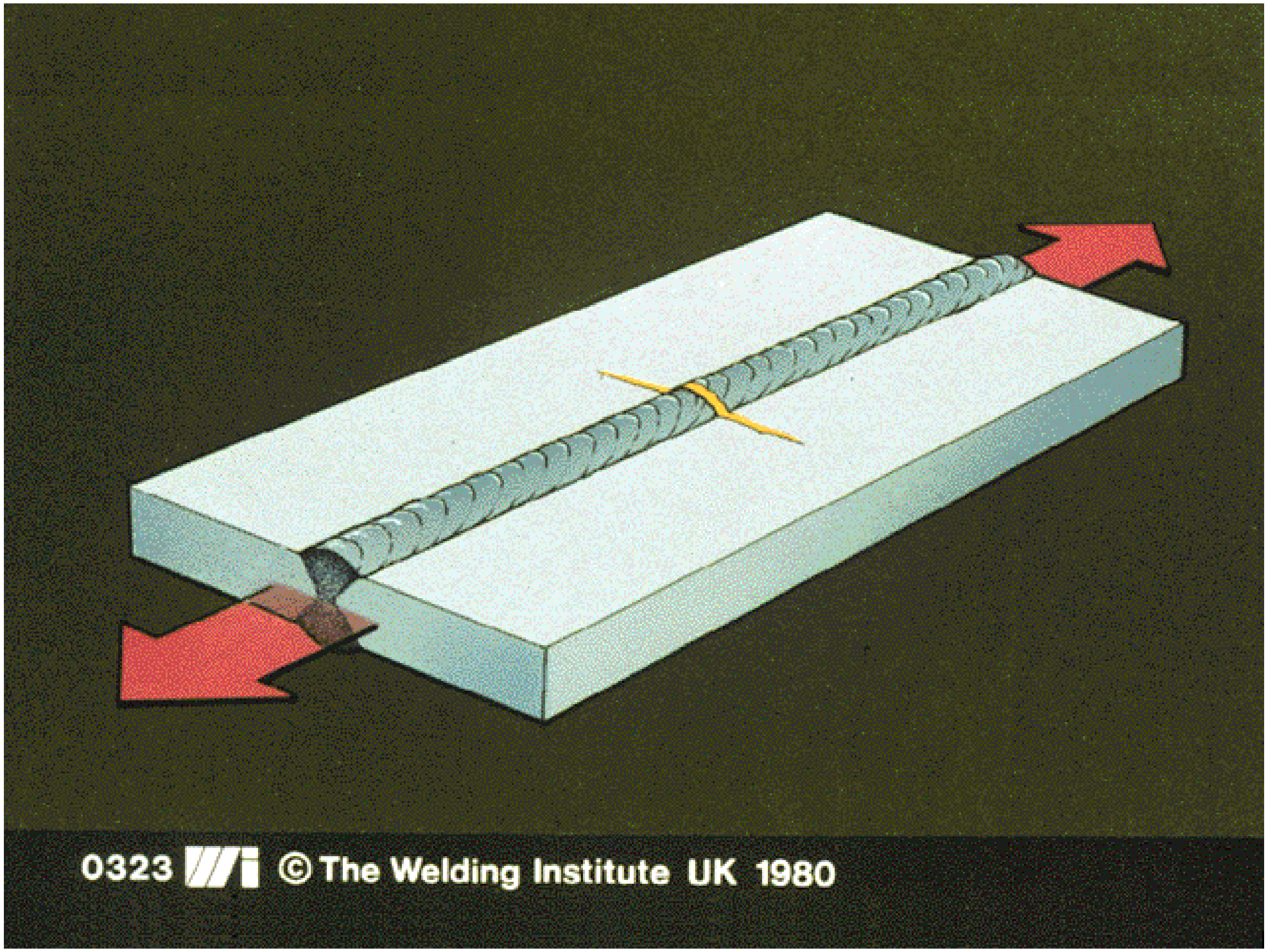
Outline

- **TWI Classification system**
- AISC classification system
- An alternative classification system

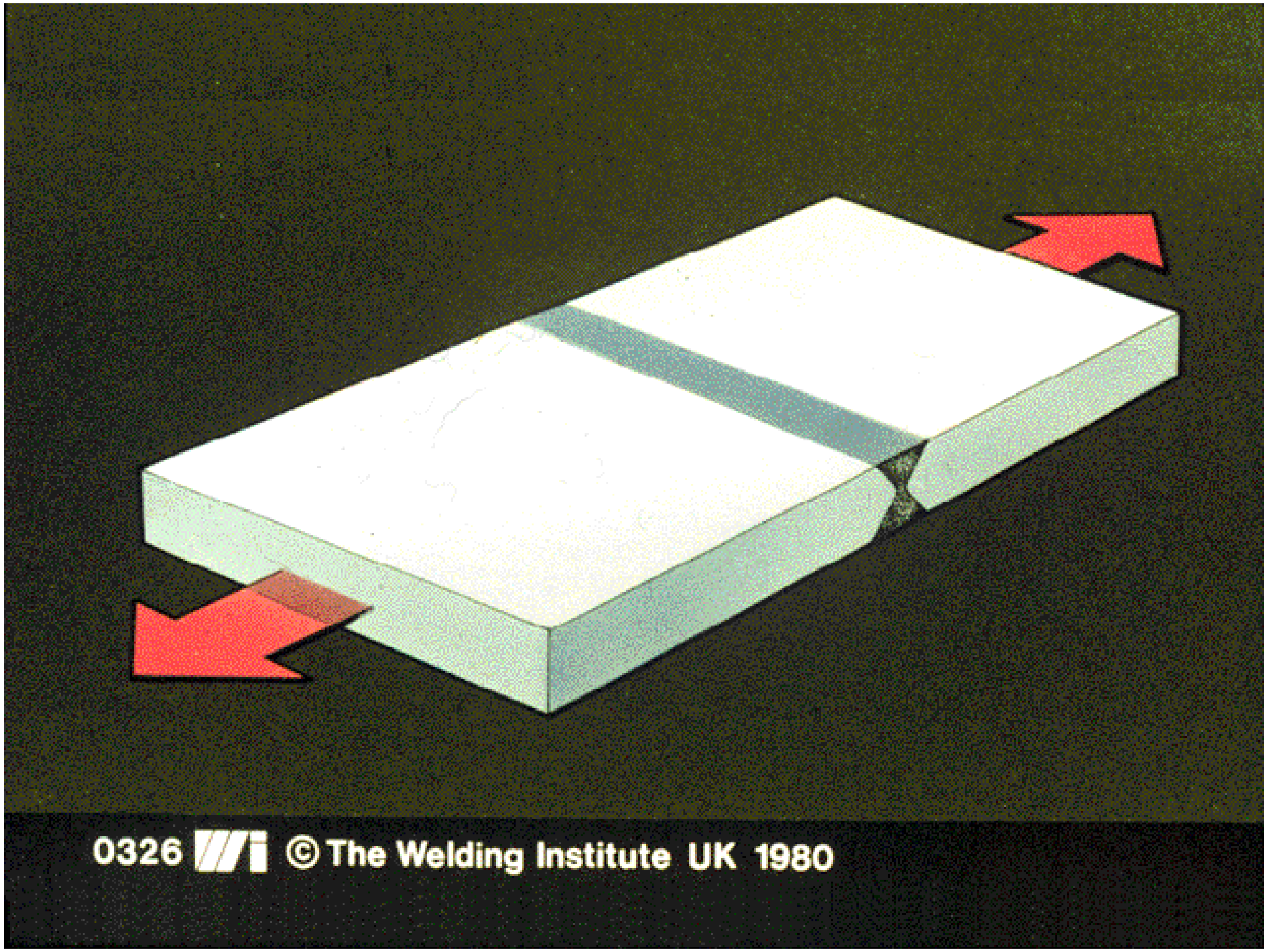
B - Longitudinal butt



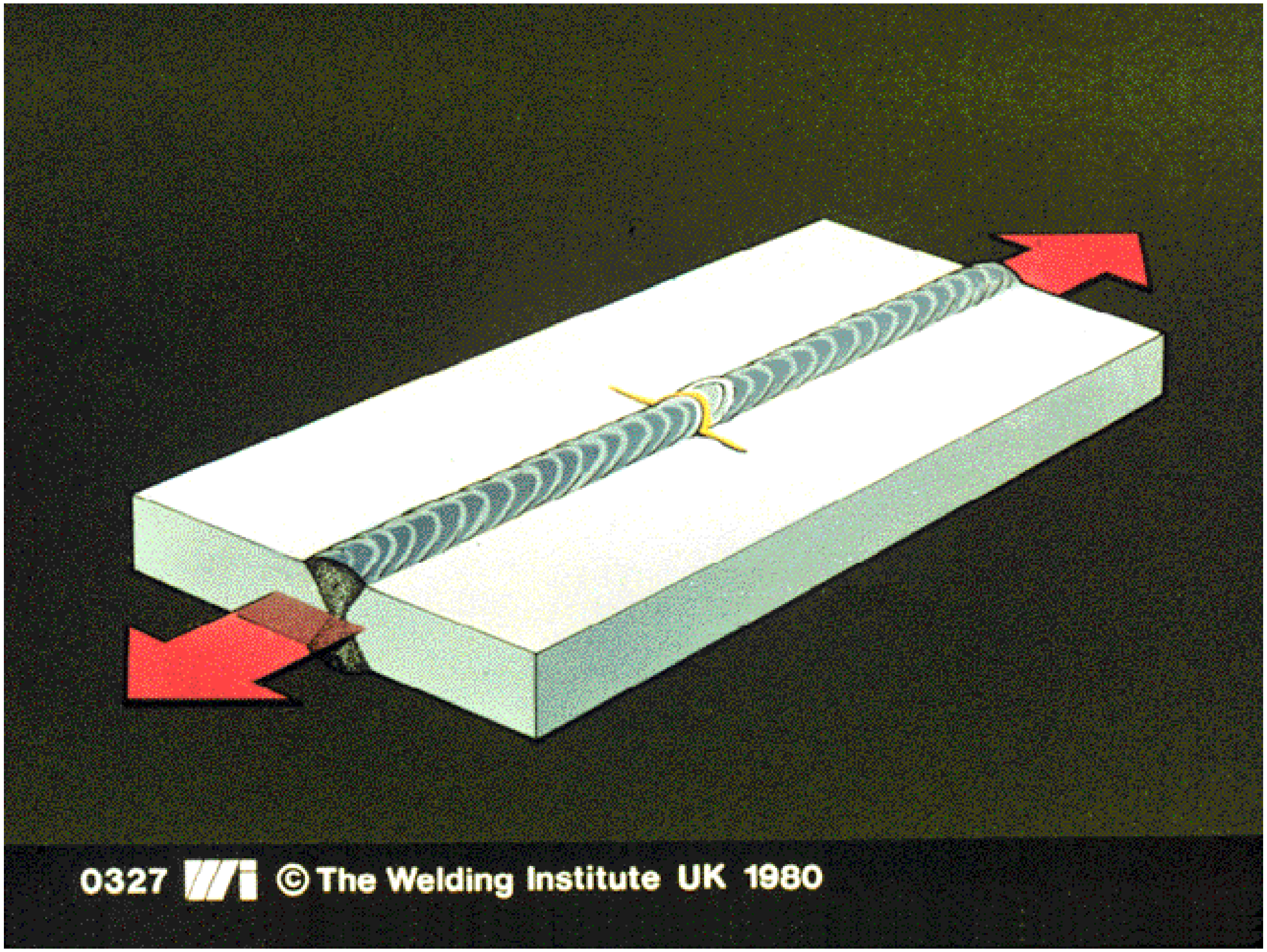
C - longit. Butt w/ Reinforcement



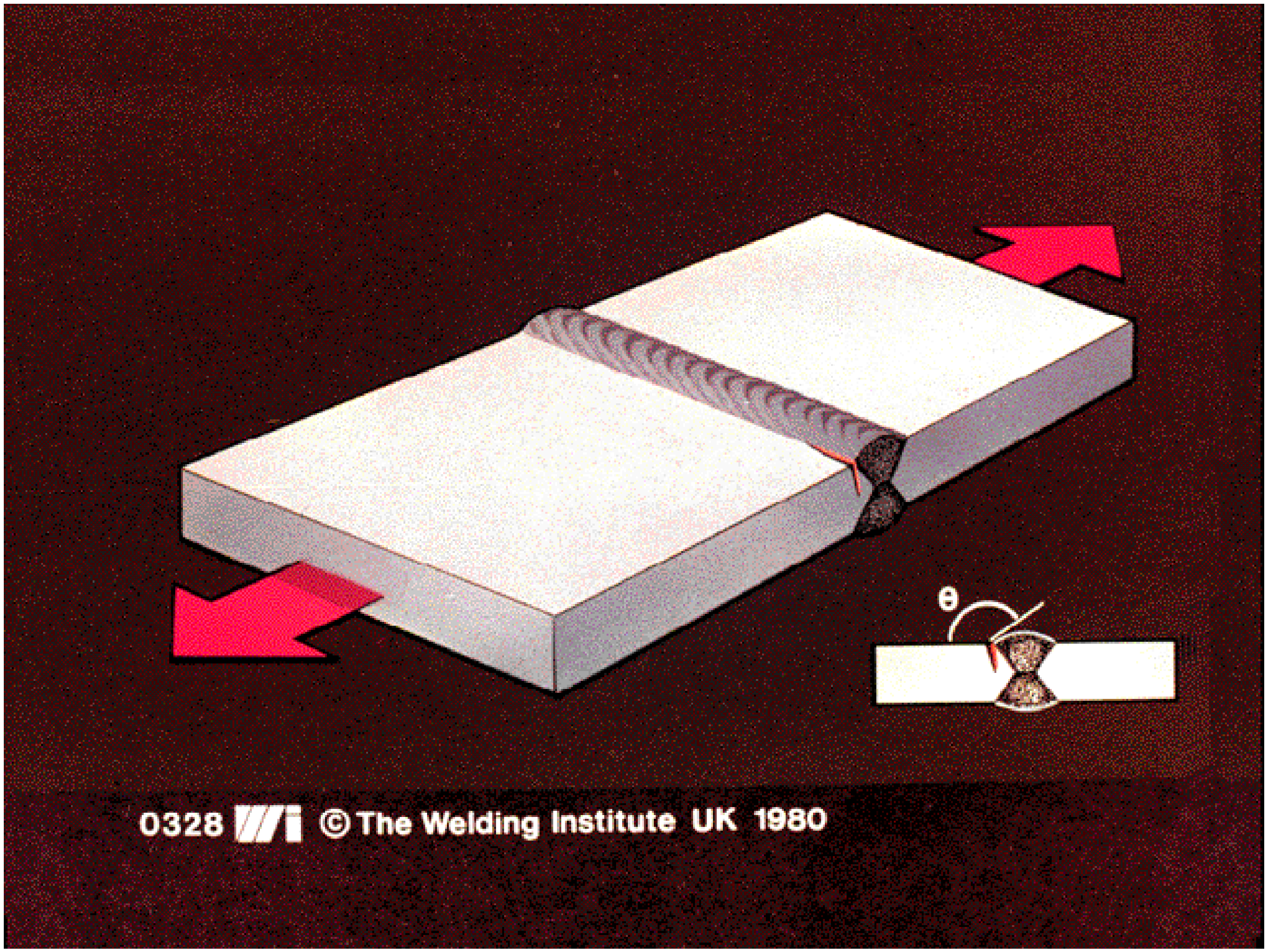
C - Transverse Butt, Machined



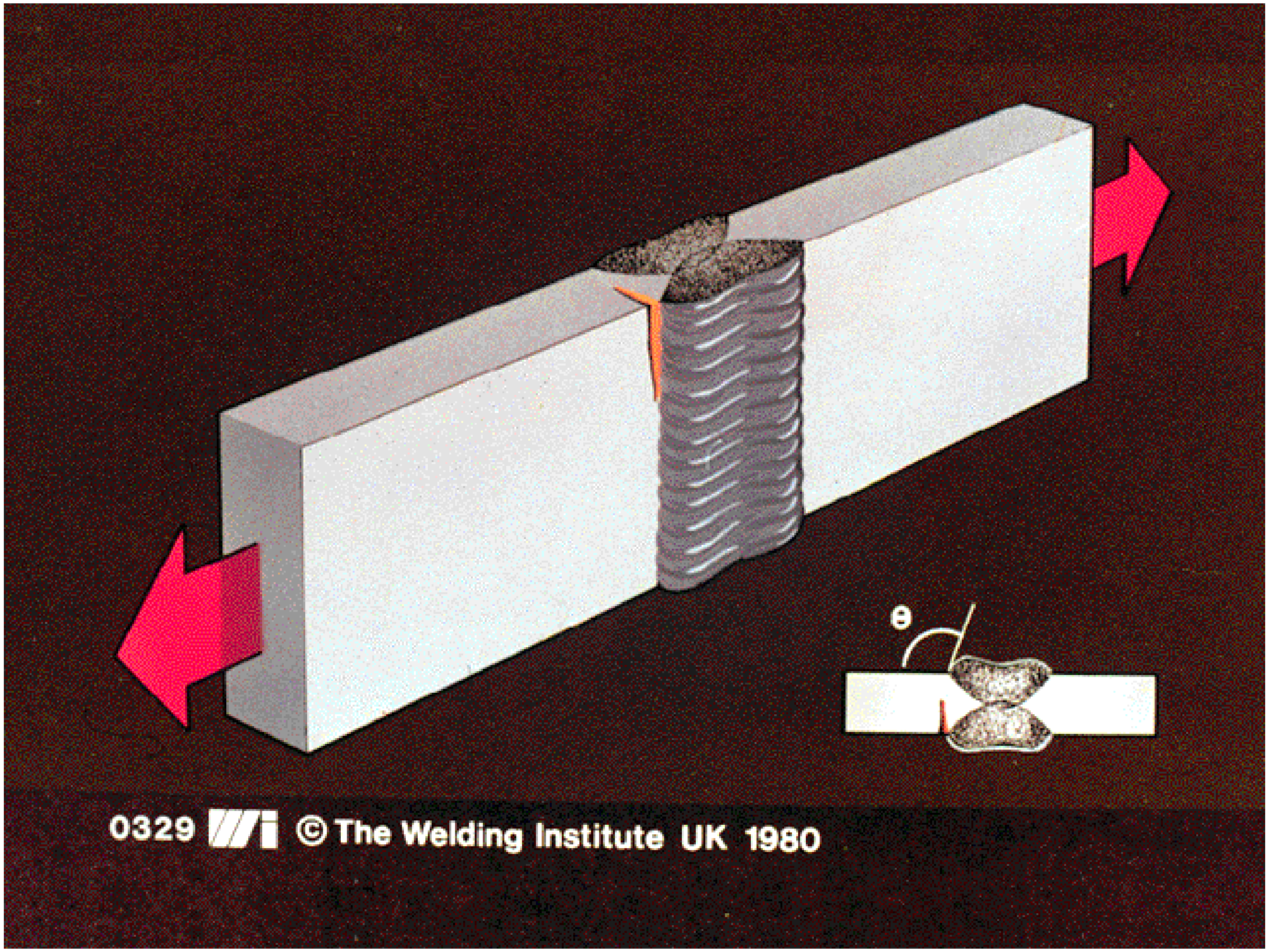
D - Long. Butt w/ Start-stop



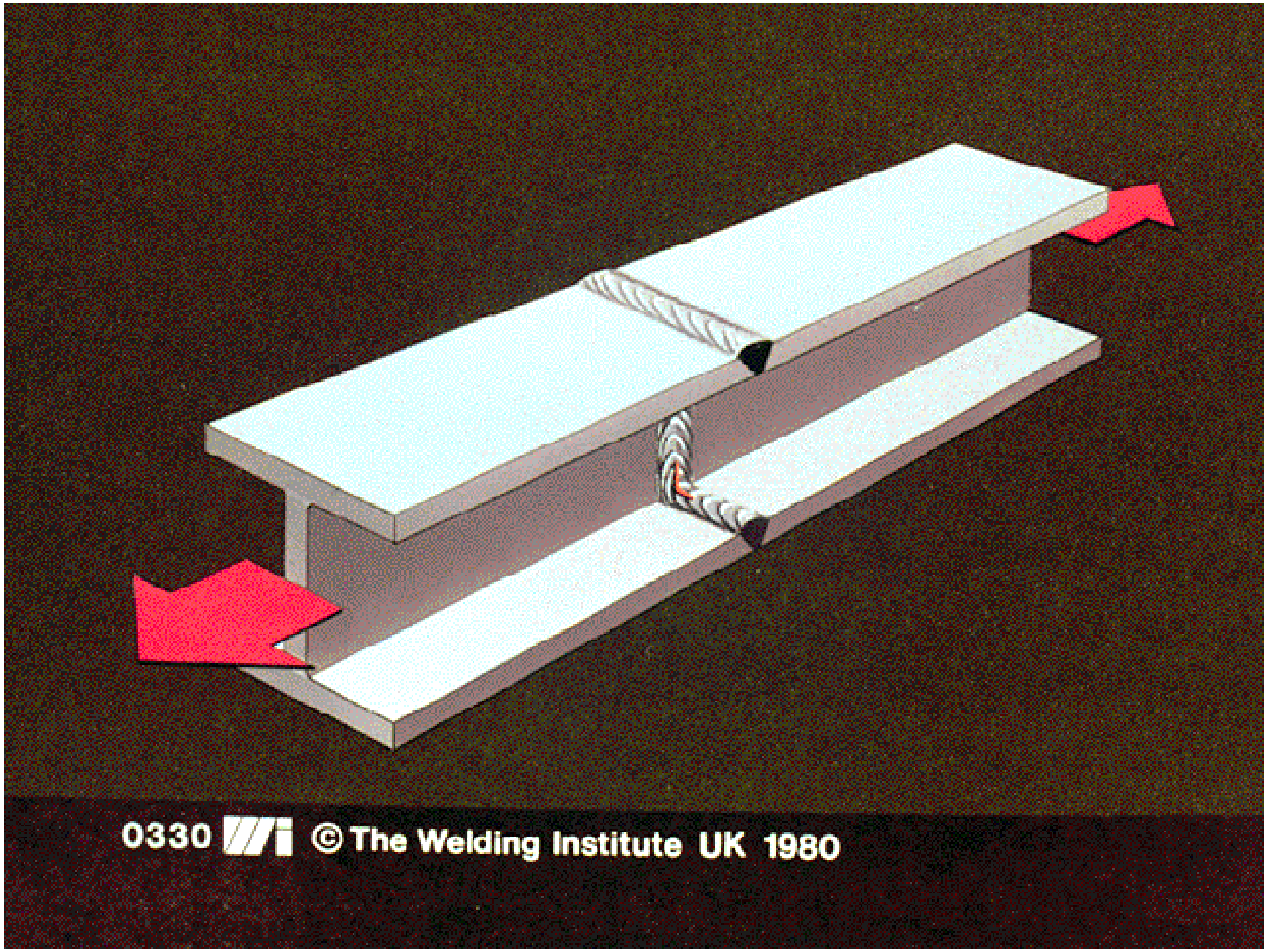
D - Butt weld w/ good toe



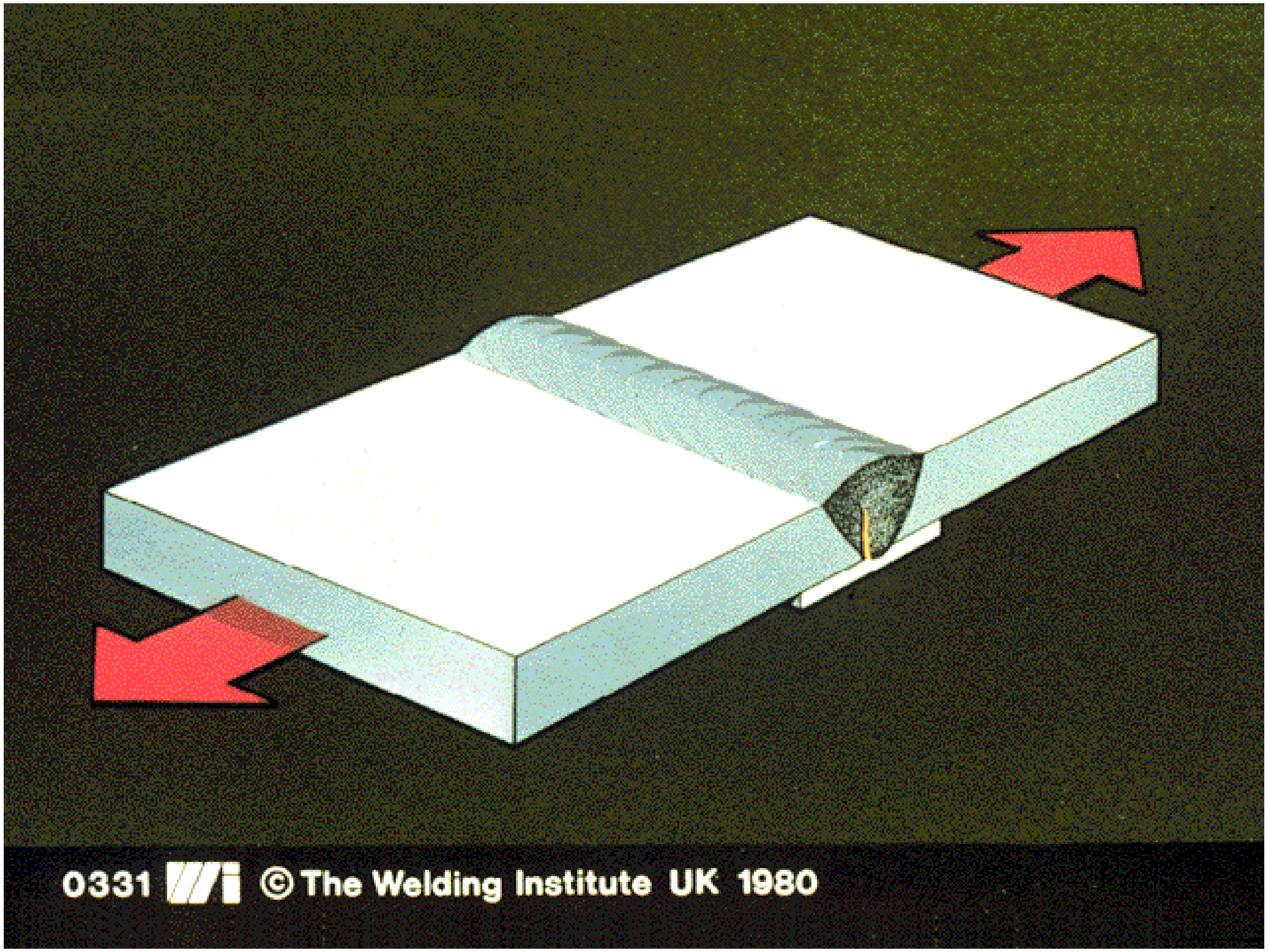
E - Butt weld w/ bad toe



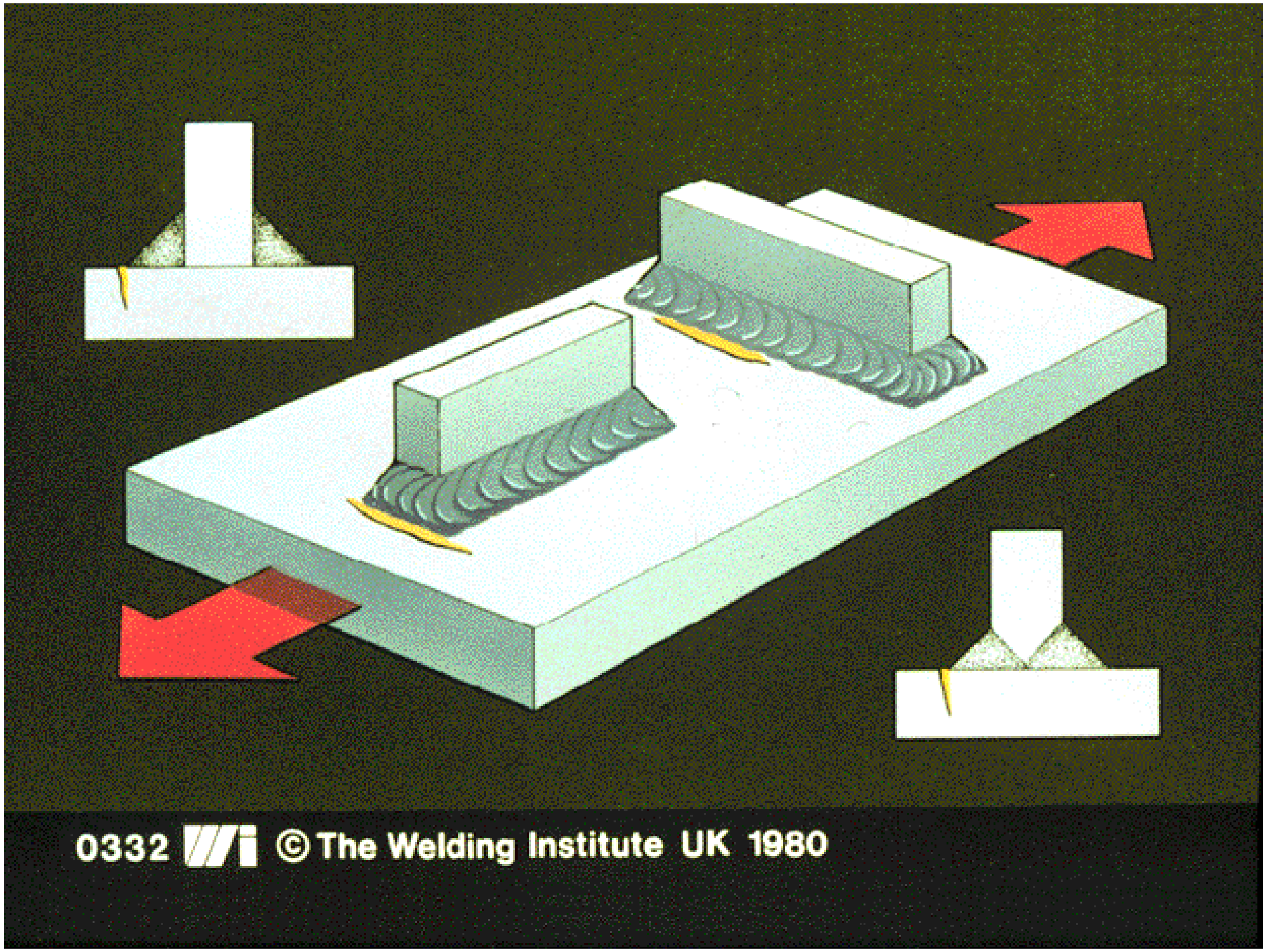
F2 - Trans. butt in rolled section



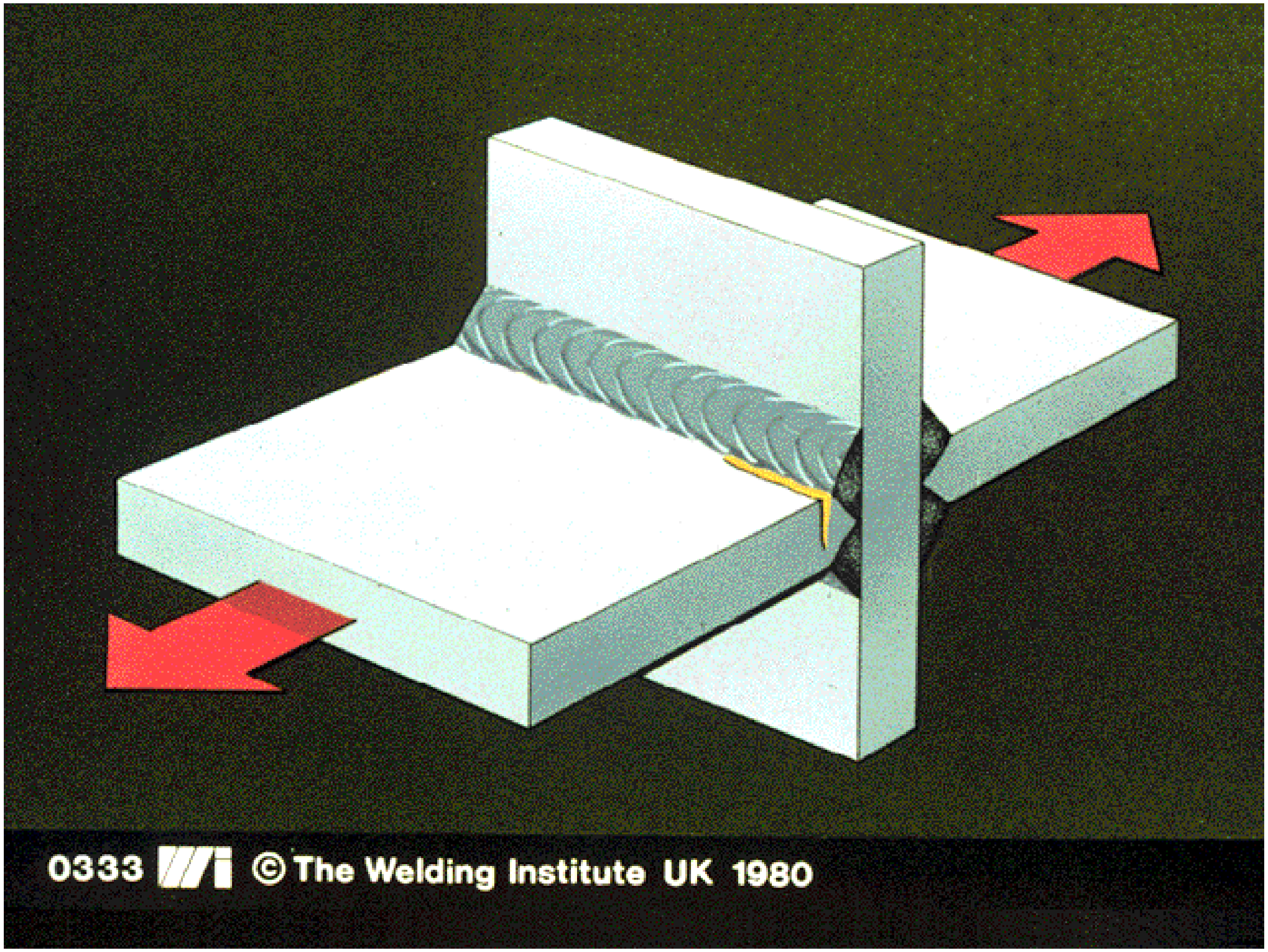
F - Trans. Butt w/ backing strip



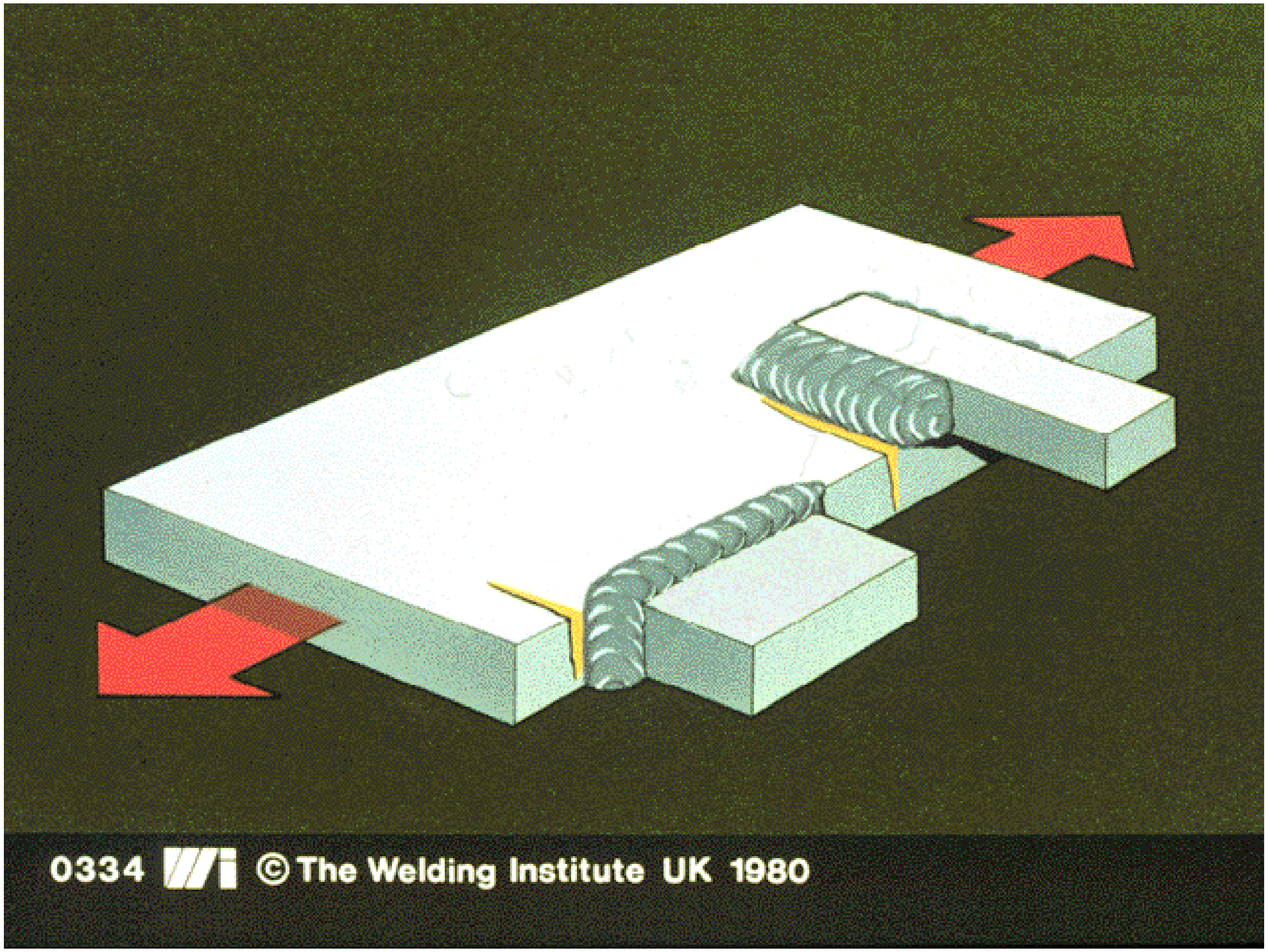
F - Attachments on plate face



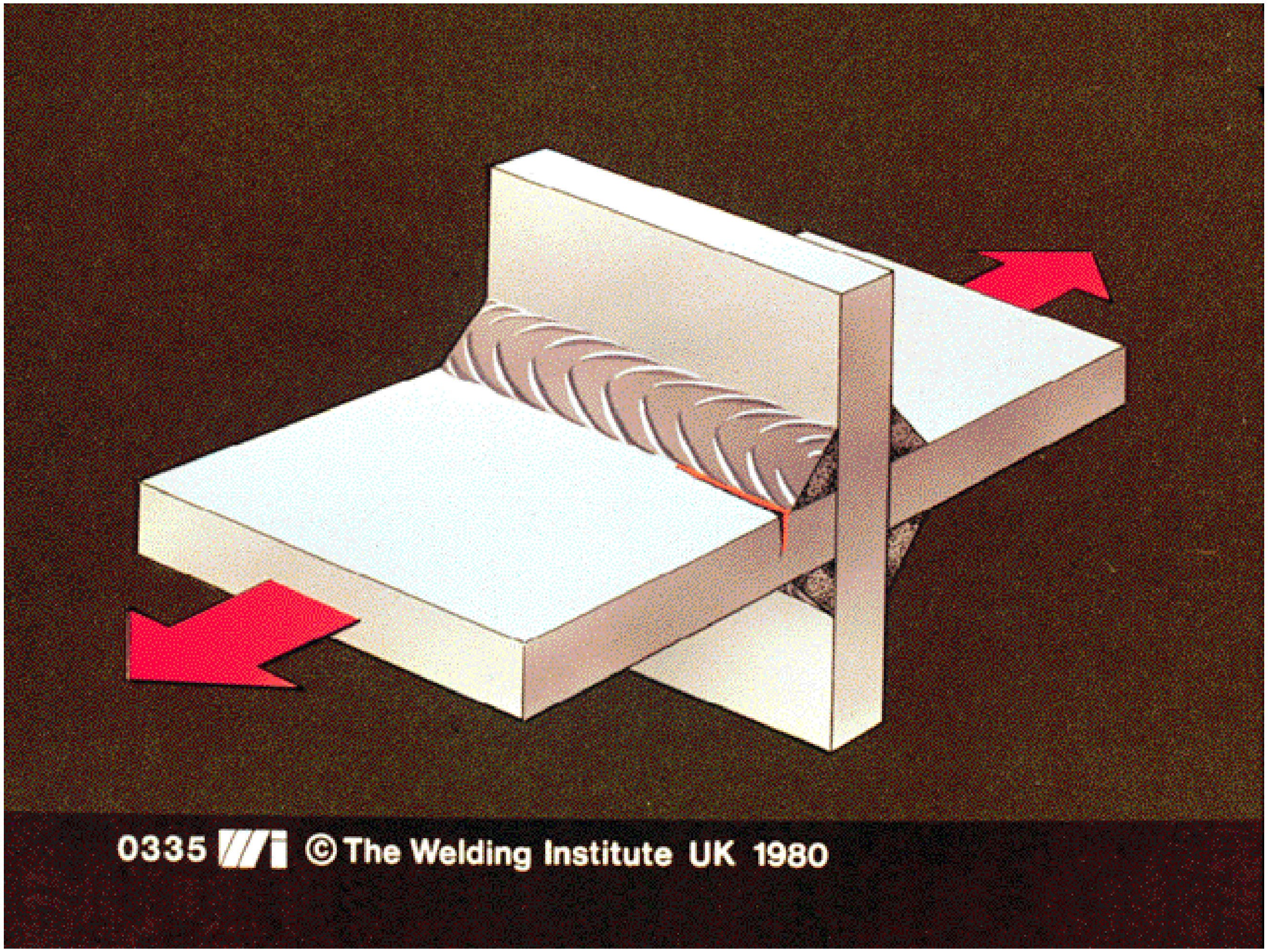
F - Groove welded cruciform



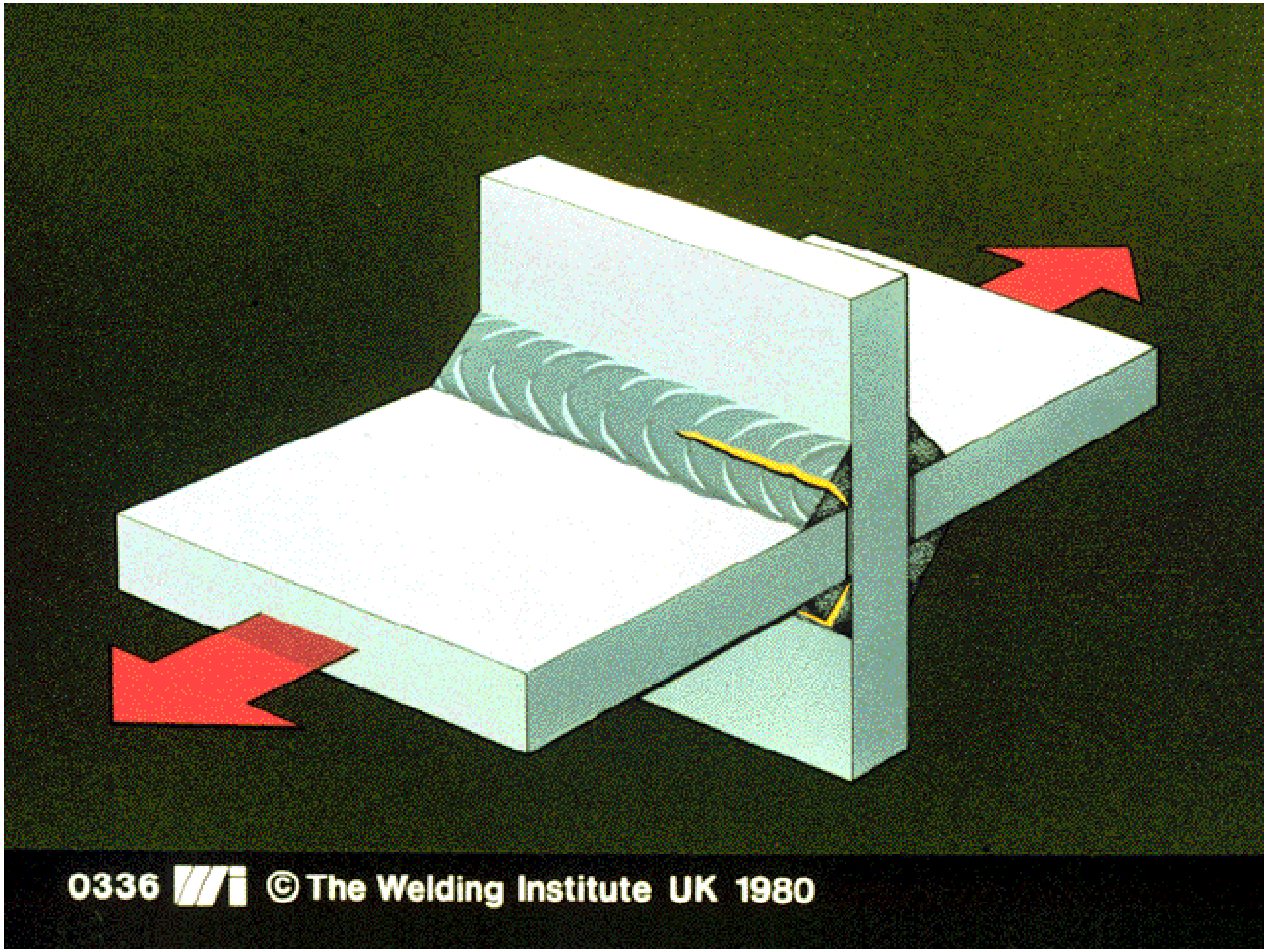
G - Attachments near edge



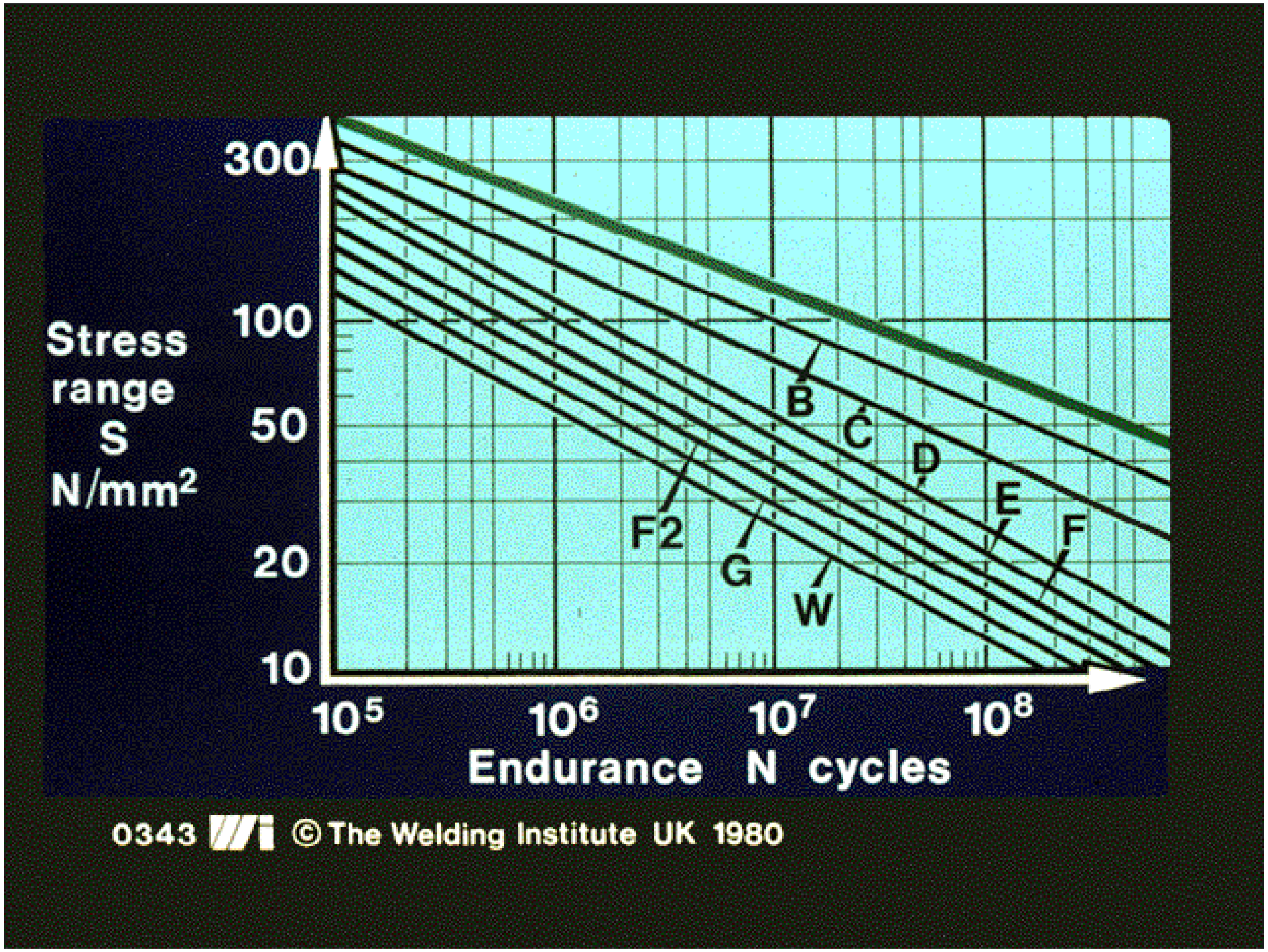
F2 - Load carrying fillet weld



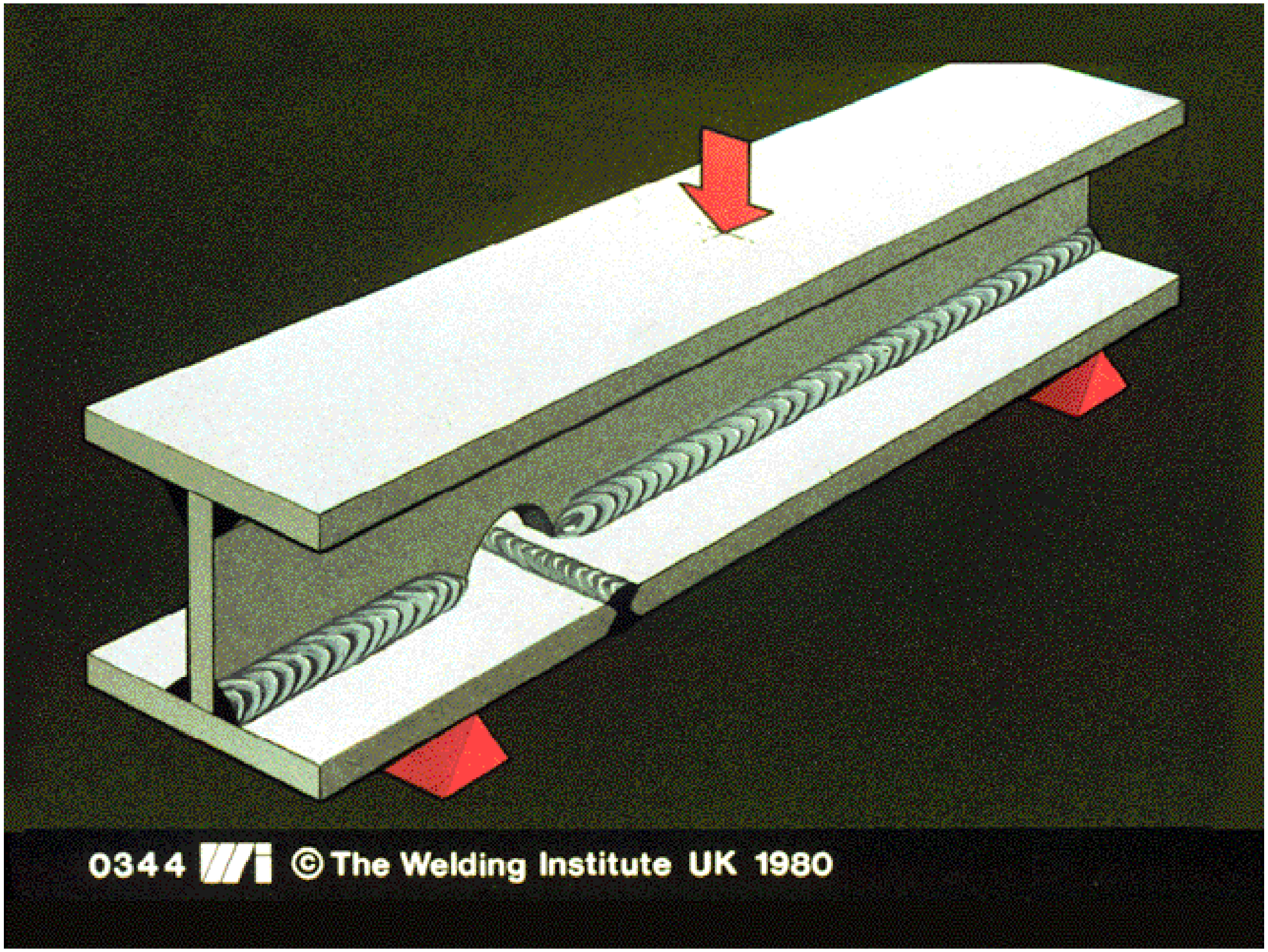
W - Fillet weld metal



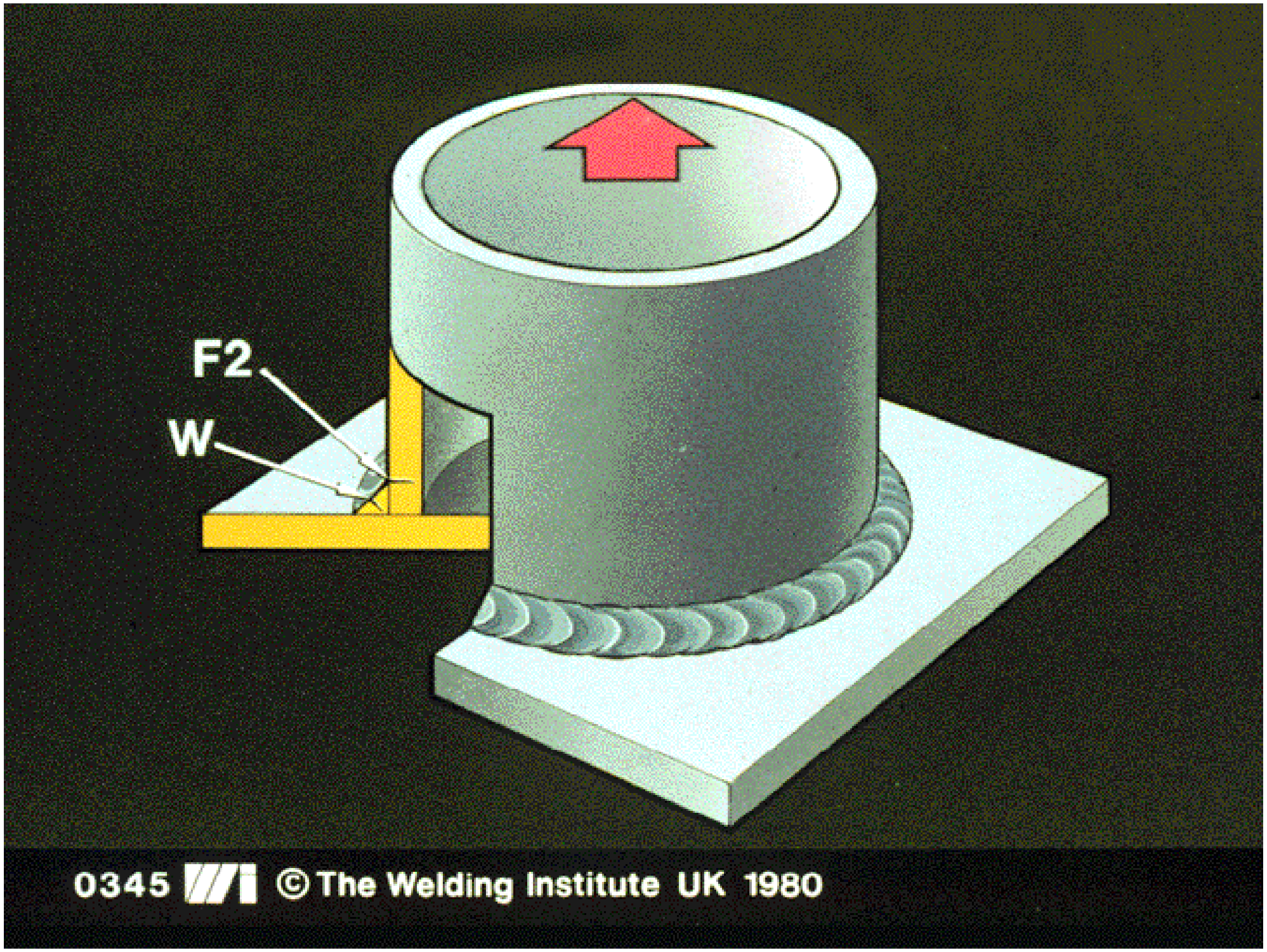
TWI - Classification system



Application of TWI system



Application of TWI system



TWI rules

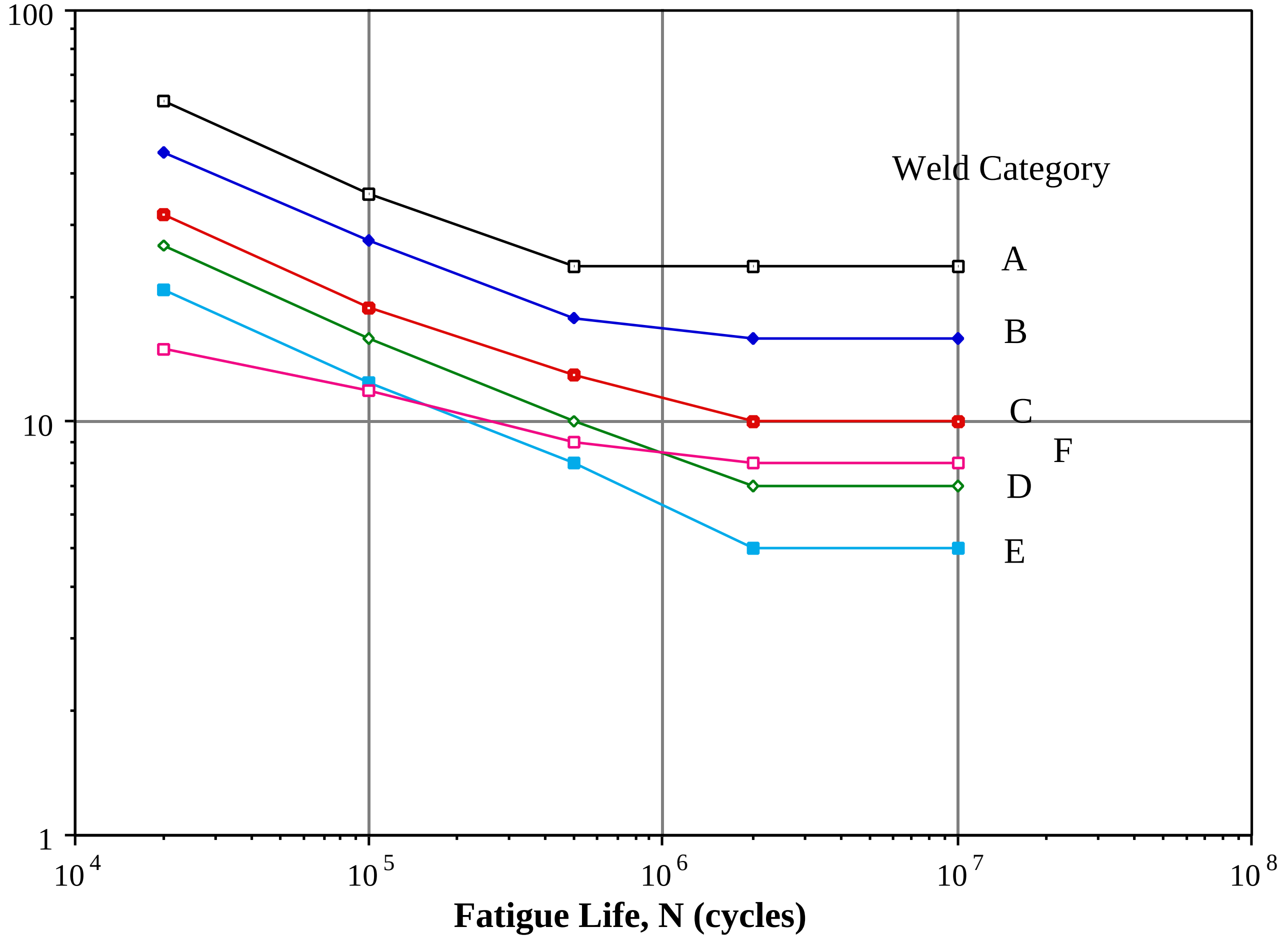
DESIGNING FOR FATIGUE LOADING

1. Use smooth shapes and transitions
2. Put welds in low stress areas if possible
3. Check weld joint classification
4. Check effect of possible weld defects, and if necessary define weld quality
5. Fatigue strength of welded steels does not depend on yield or tensile strengths of the parent metal
6. Improvement techniques can be used
7. Provide for inspection in service for fatigue cracks

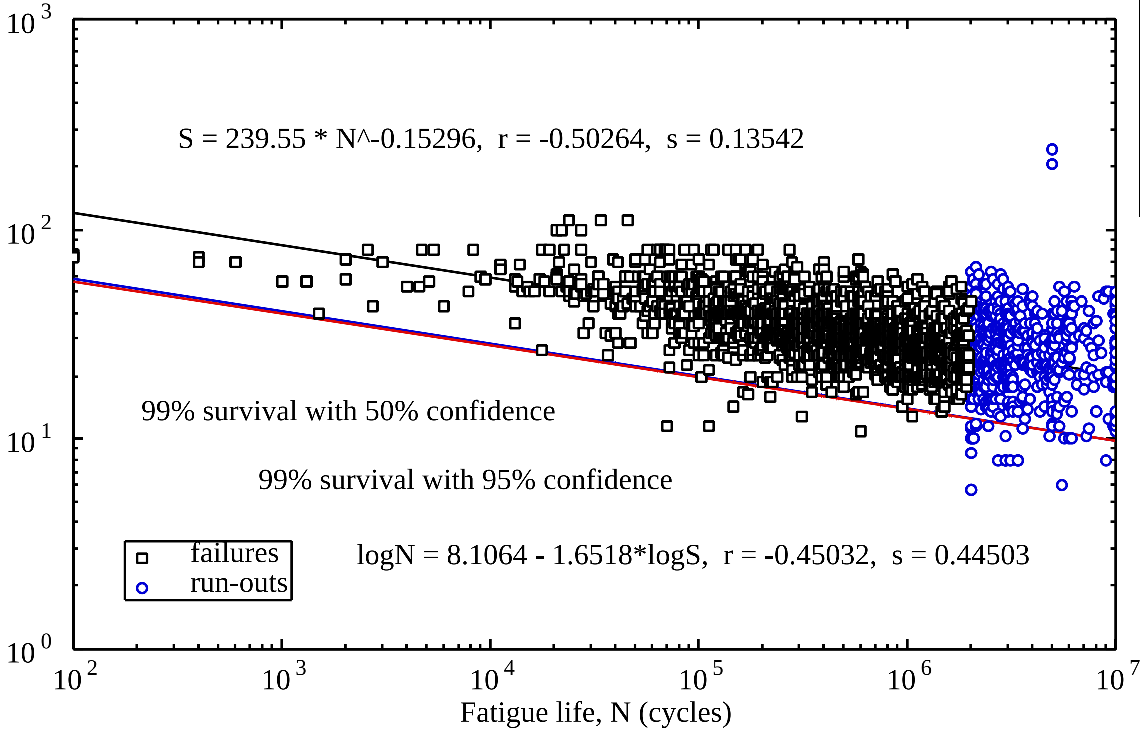
Outline

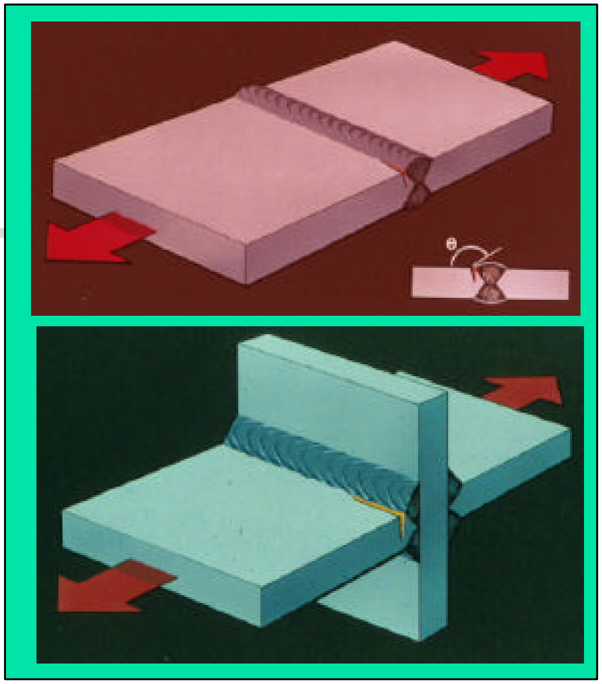
- TWI Classification system
- **AISC classification system**
- An alternative classification system

AISC classification system



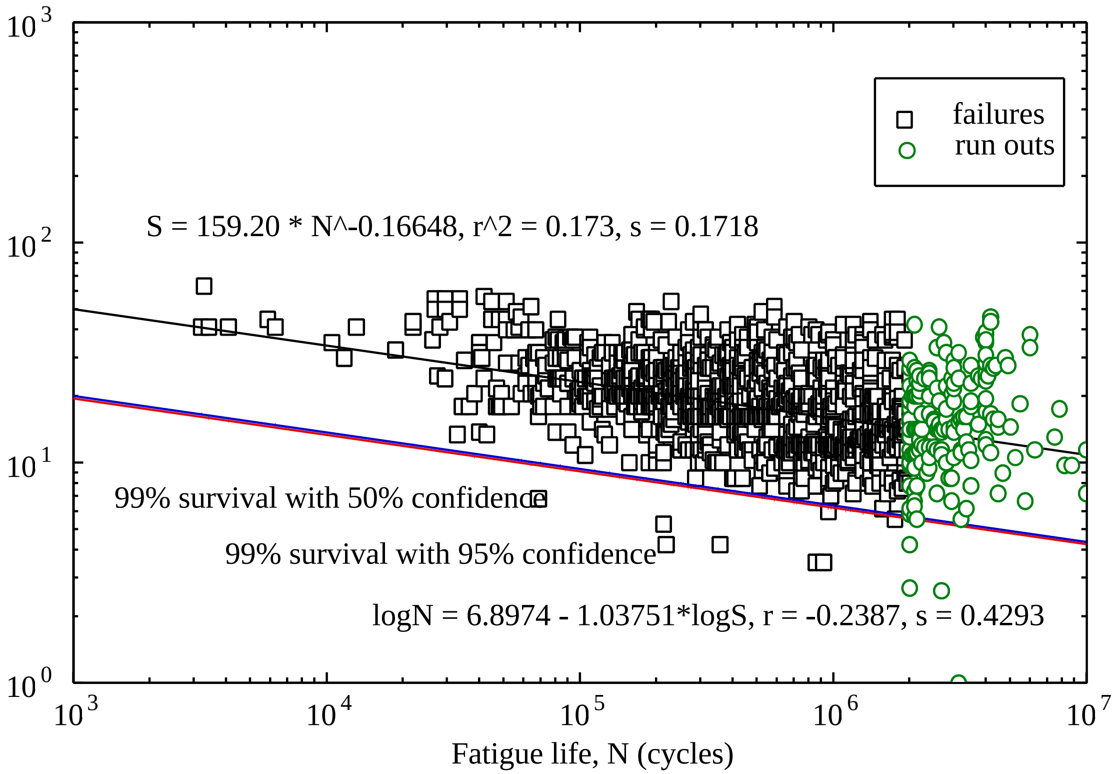
AISC category B and C

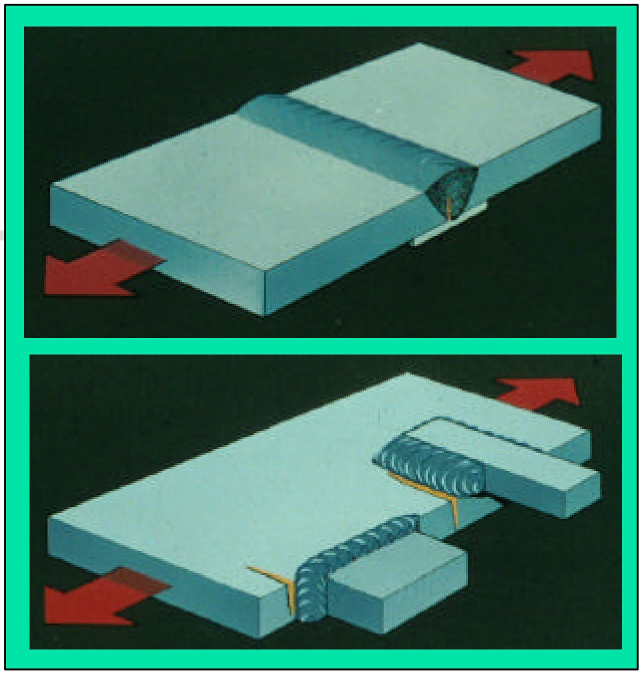




The good welds!

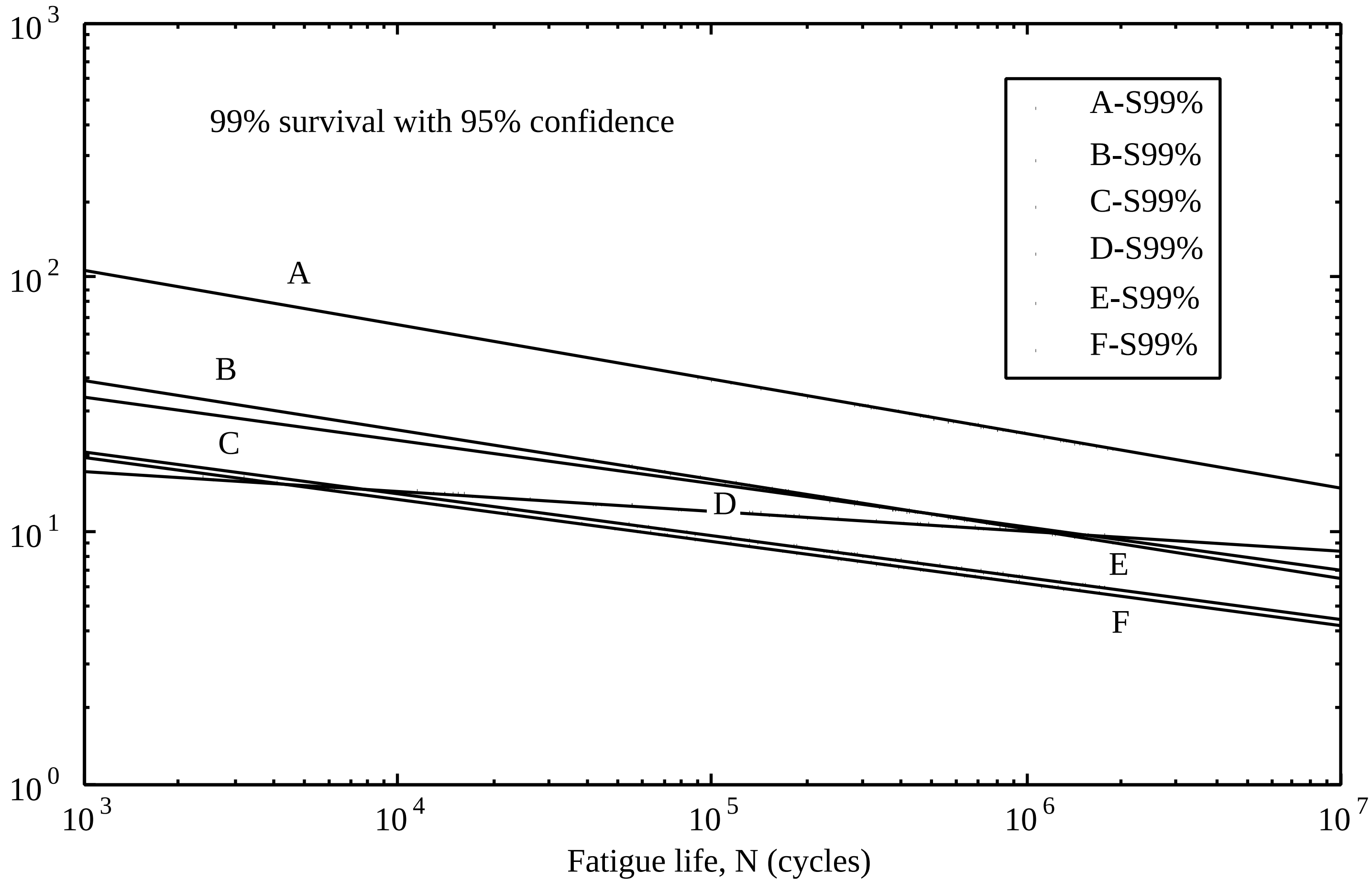
AISC category D and E





The bad welds!

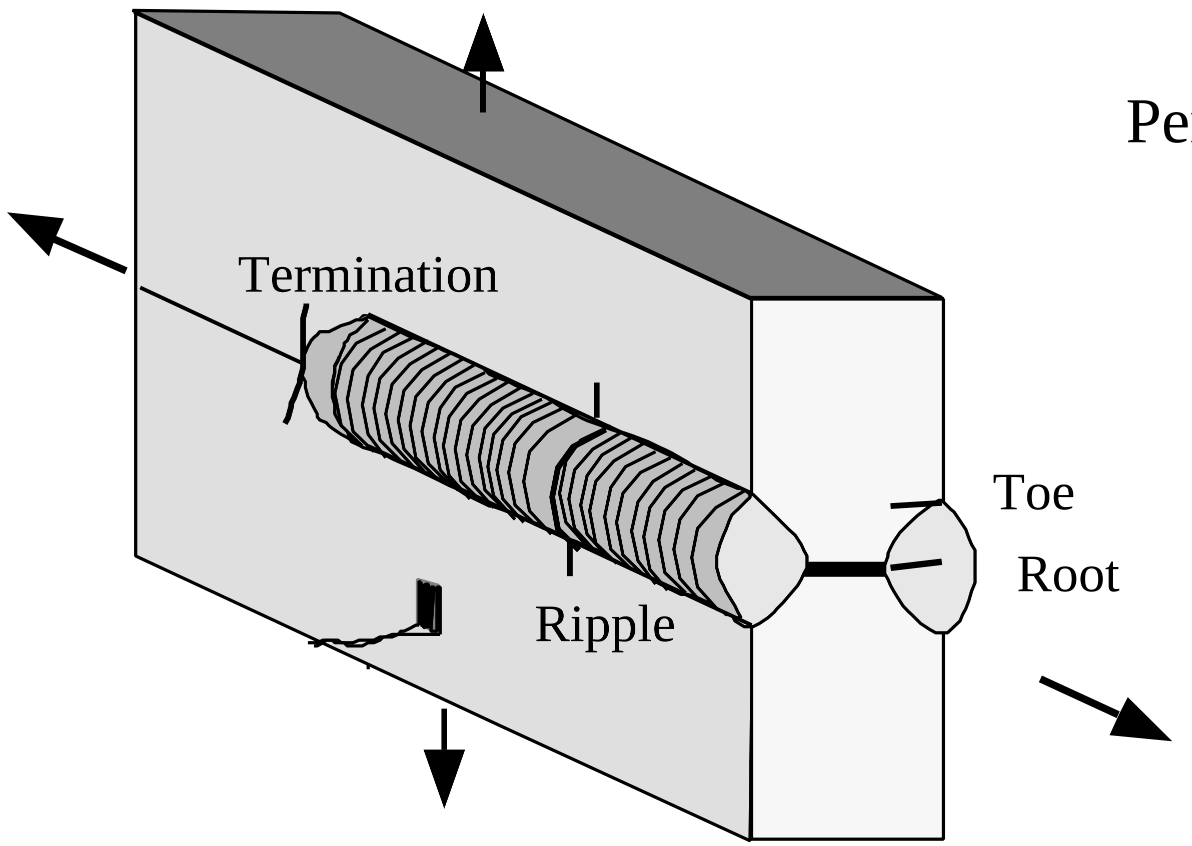
AISC category best fit lines to data



Outline

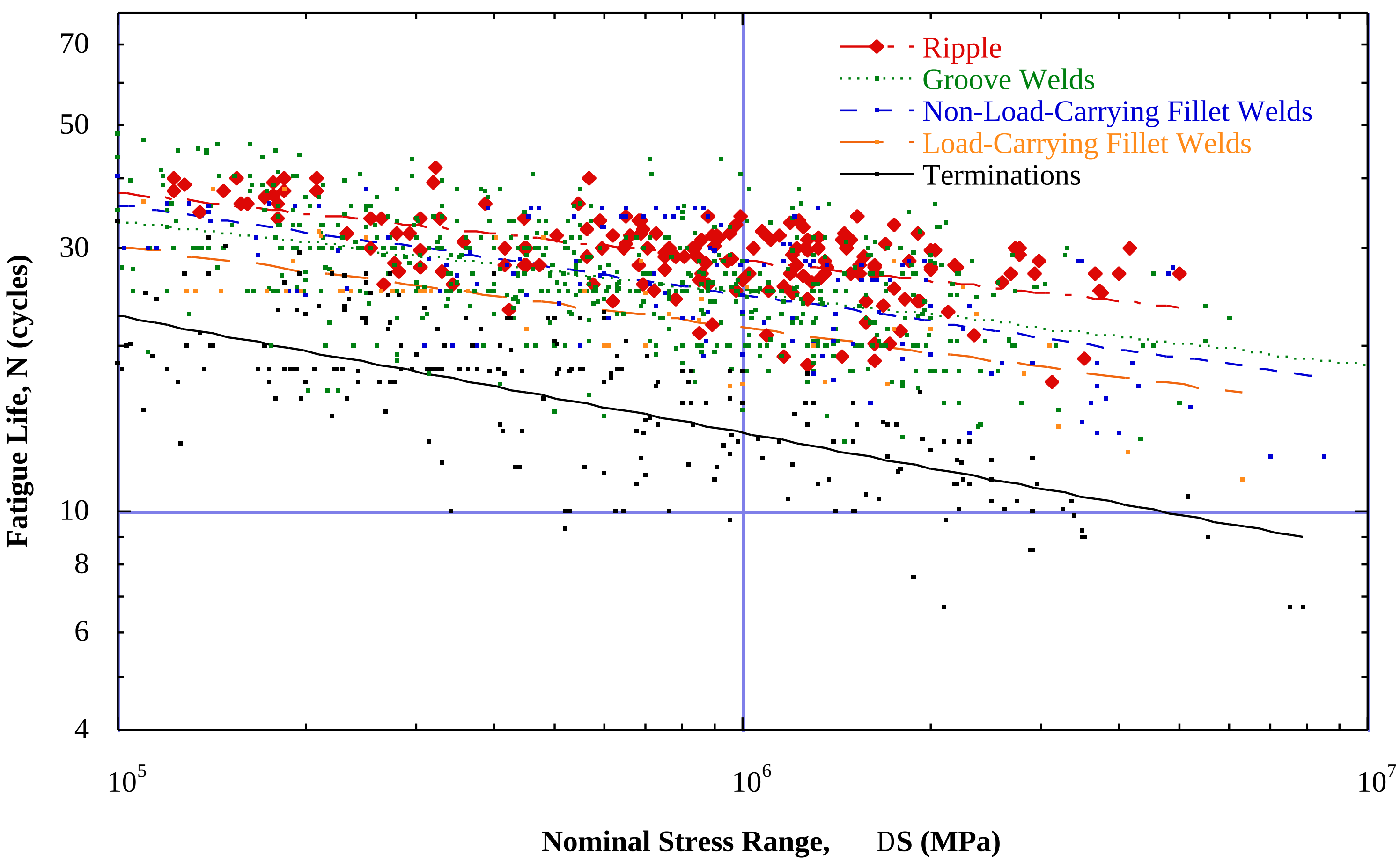
- TWI Classification system
- AISC classification system
- **An alternative classification system**

Weld stress concentrations



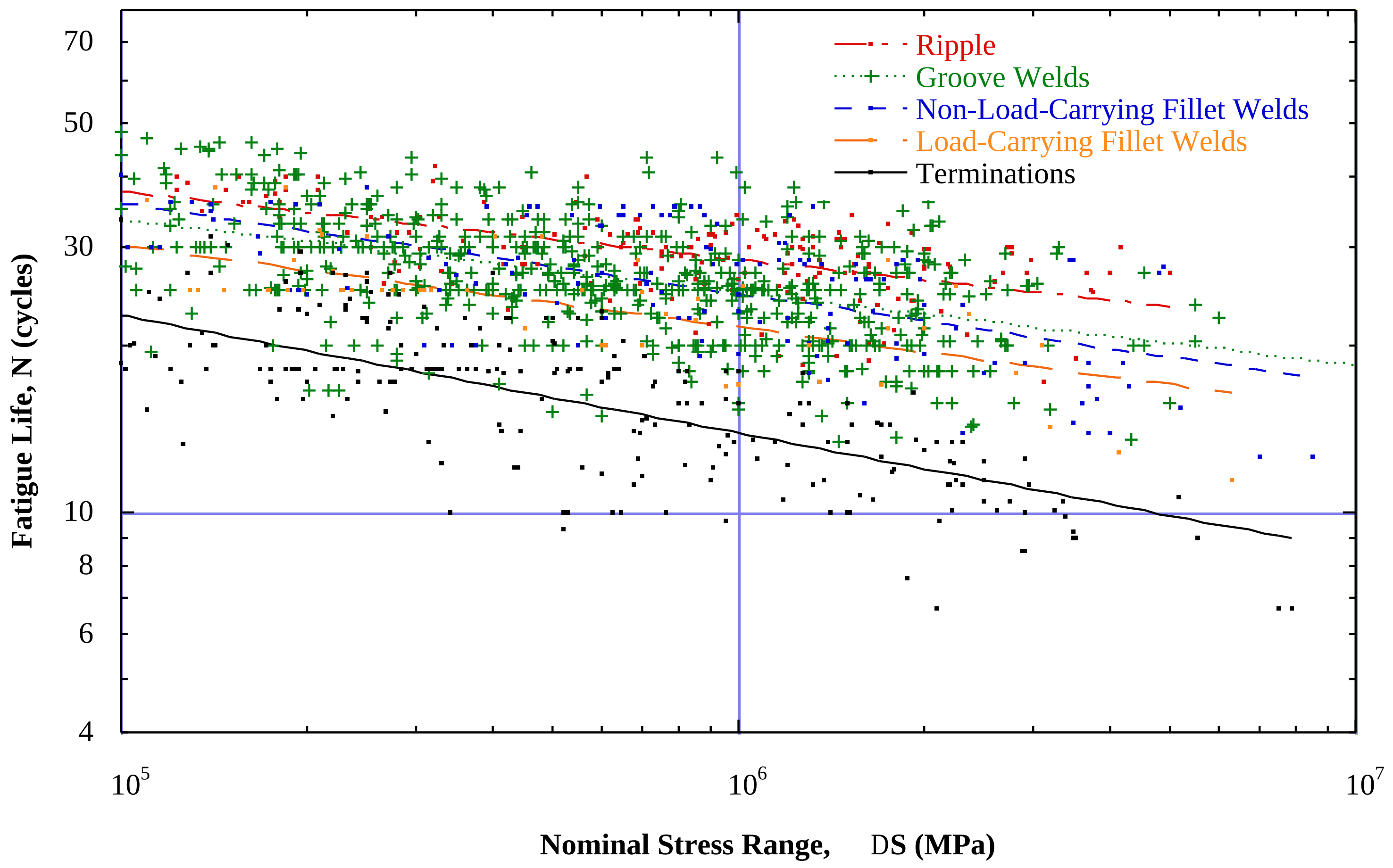
Personal view

Ripple

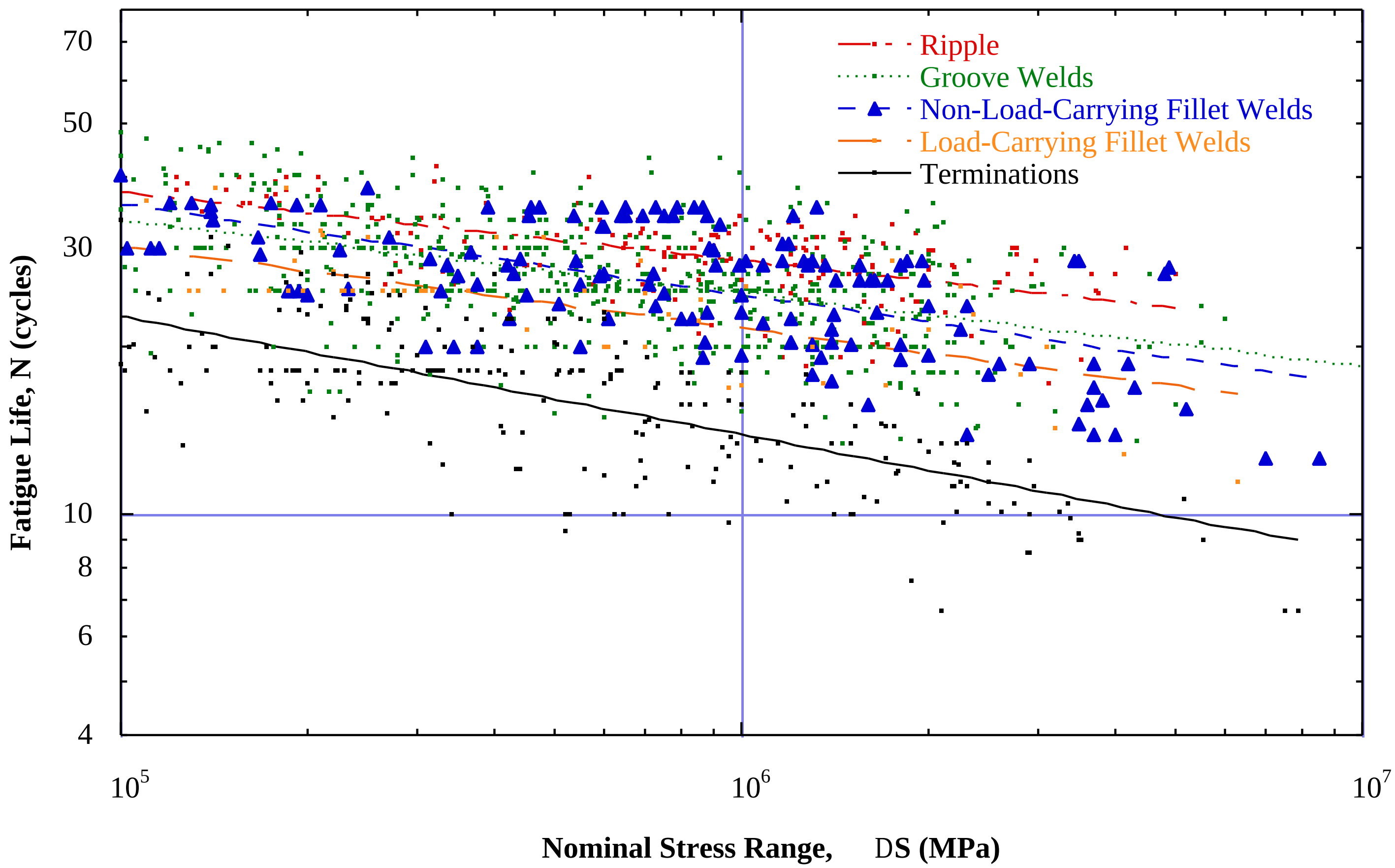


Ripple
Groove Welds
Non-Load-Carrying Fillet Welds
Load-Carrying Fillet Welds
Terminations
70
50
30
10
8
6
4
Fatigue Life, N (cycles)
10^5
10^6
10^7
Nominal Stress Range, DS (MPa)

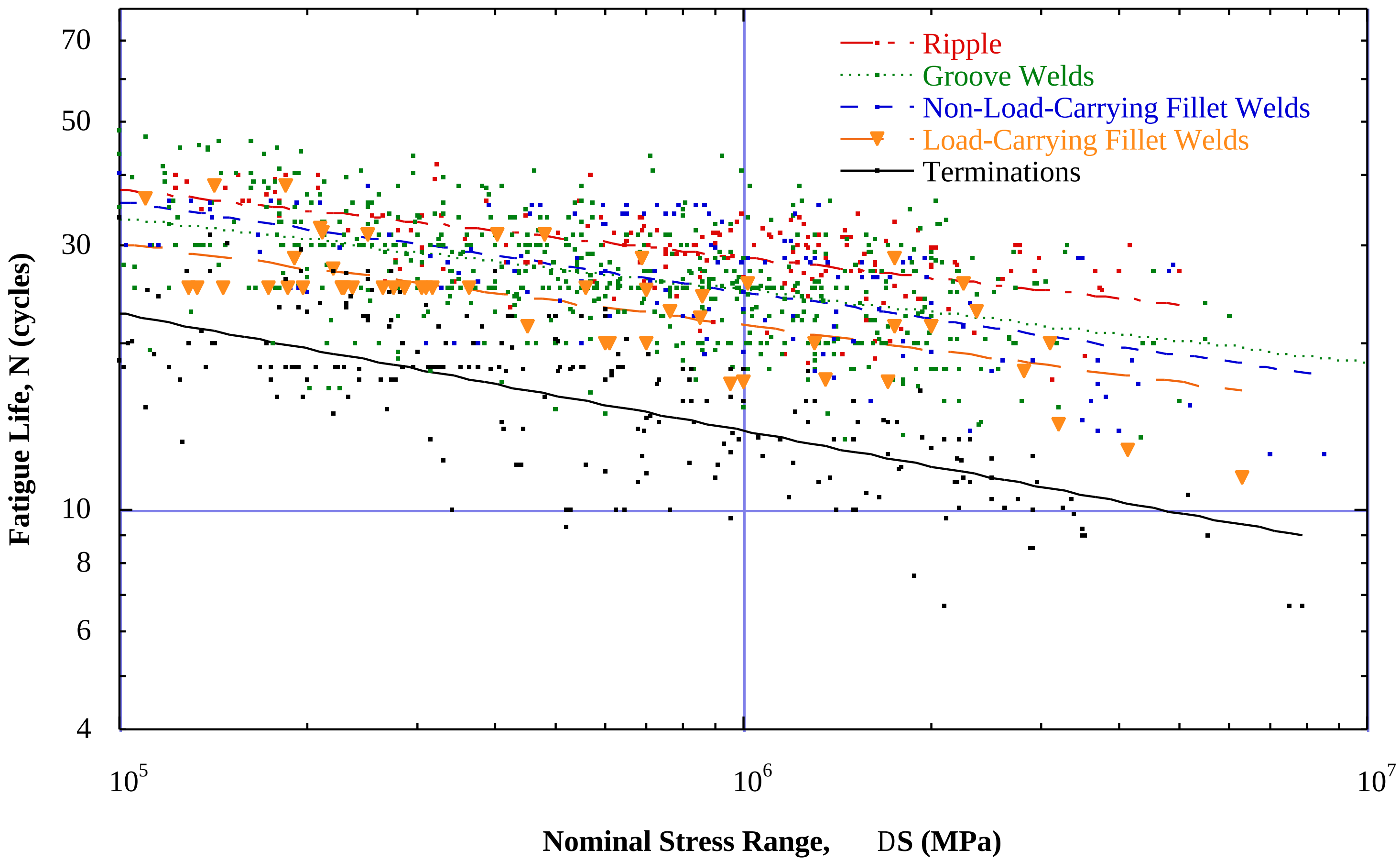
Groove welded butt joints



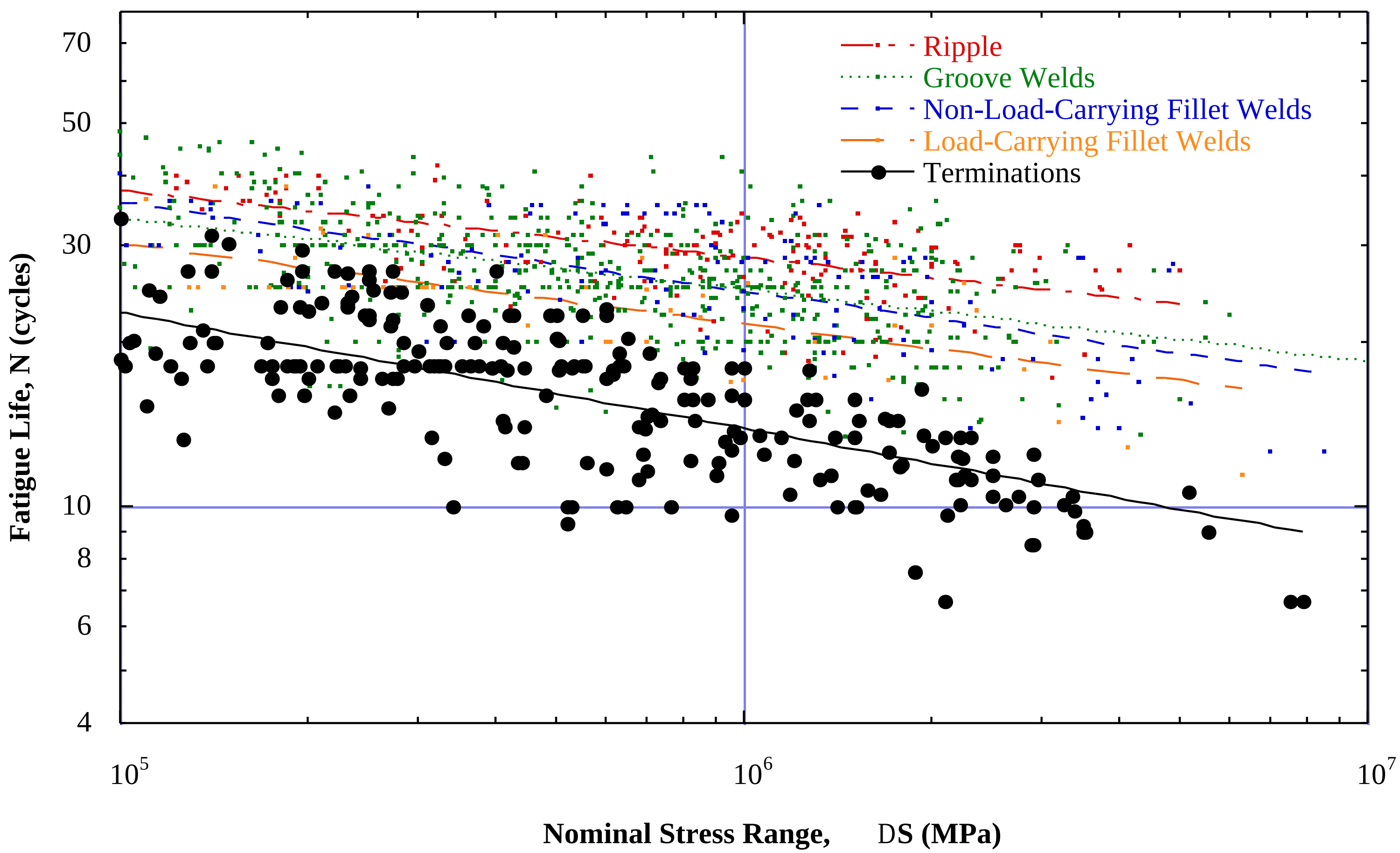
Non-load-carrying fillet welds



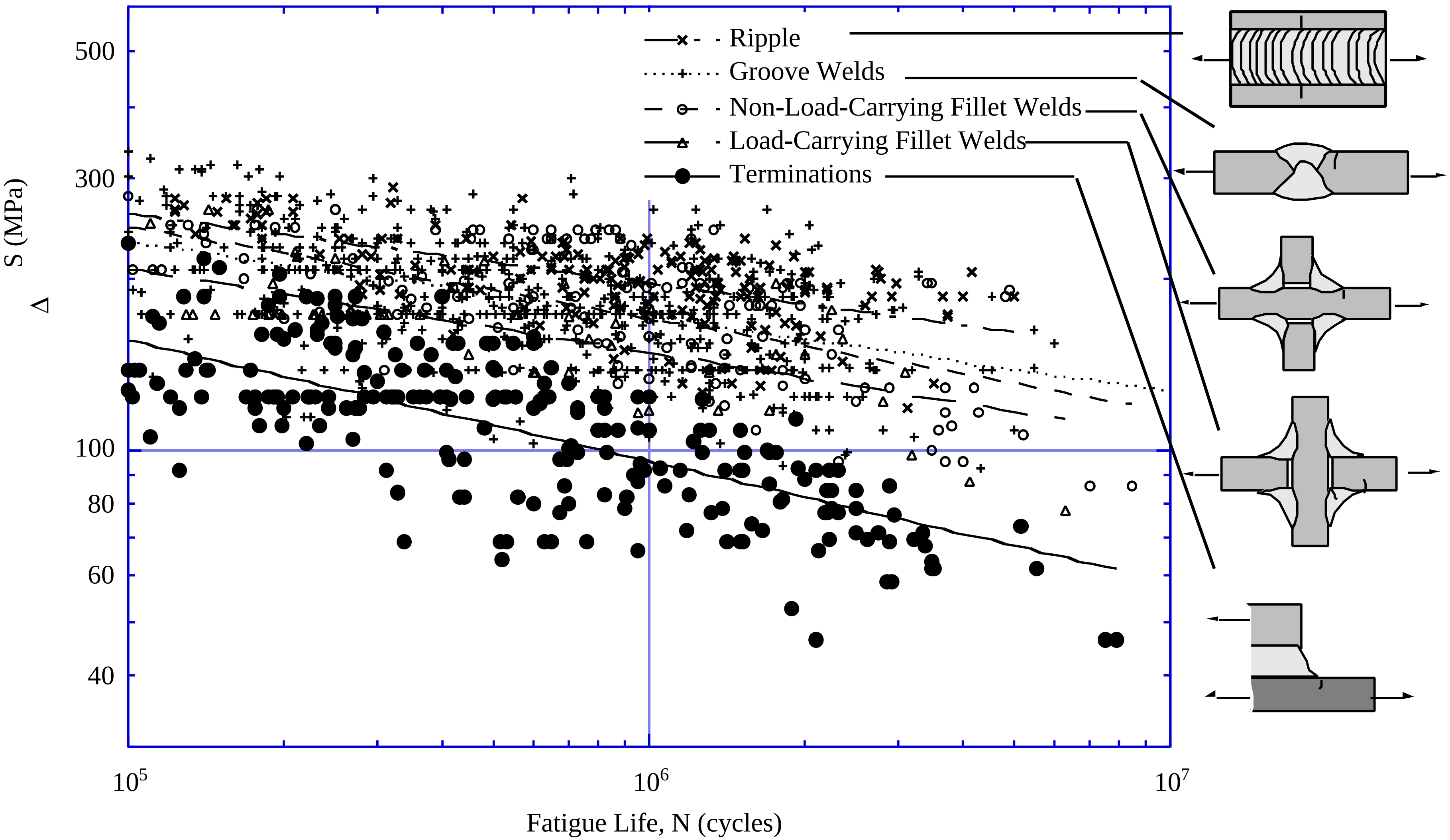
Transverse attachments



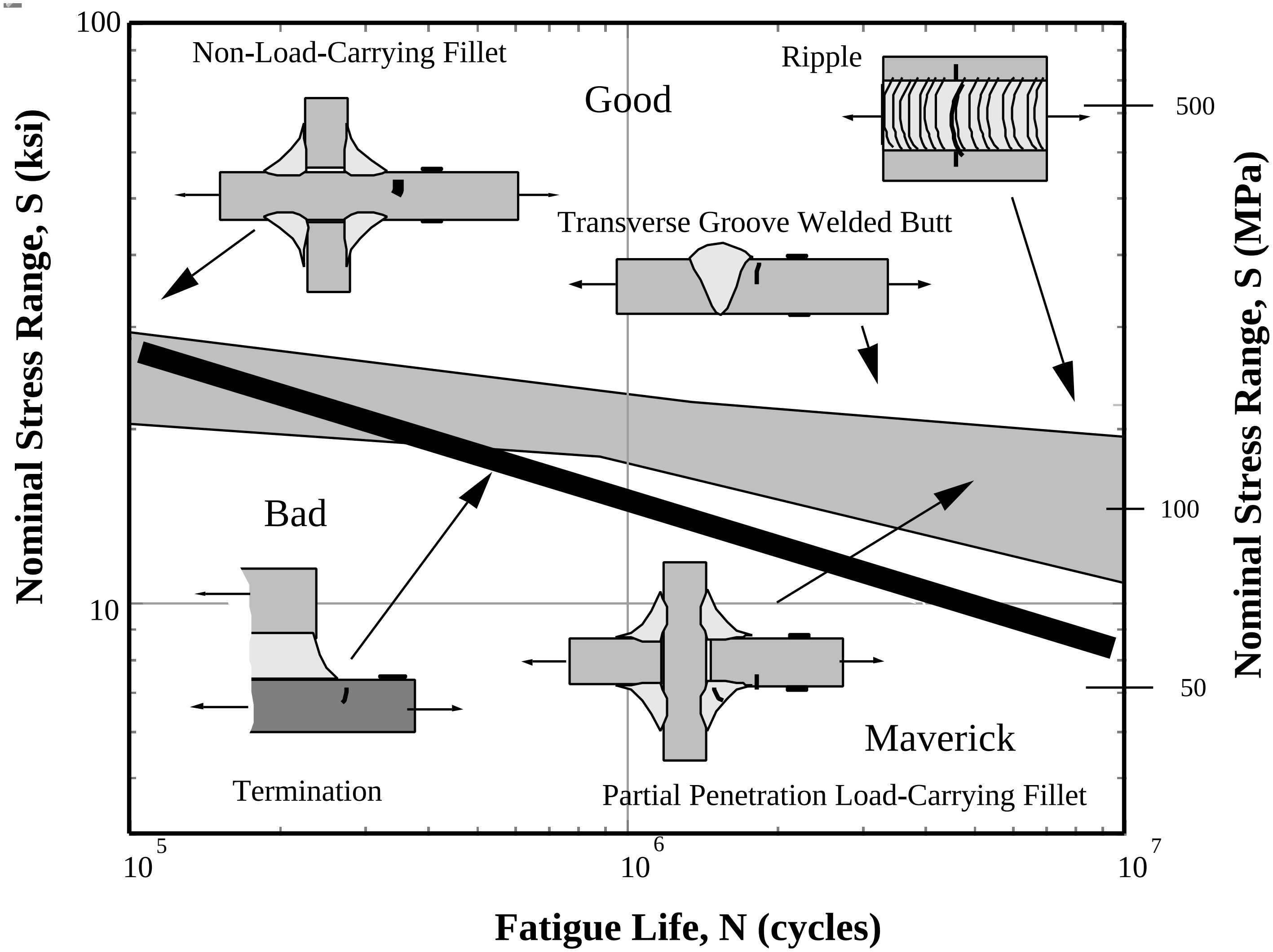
Longitudinal attachments



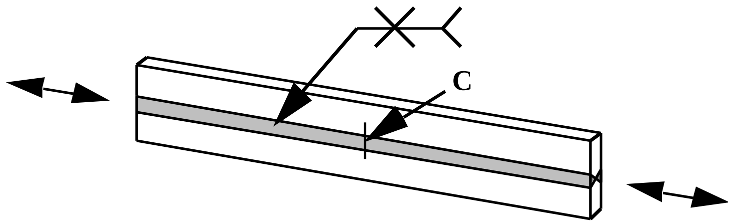
Good, bad, maverick



Good welds, Bad welds, Mavericks



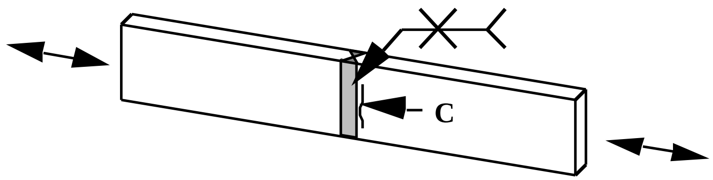
The good welds: weld toe failures



Detail #3

K_f = 1.87

²S design = 27.0 ksi.

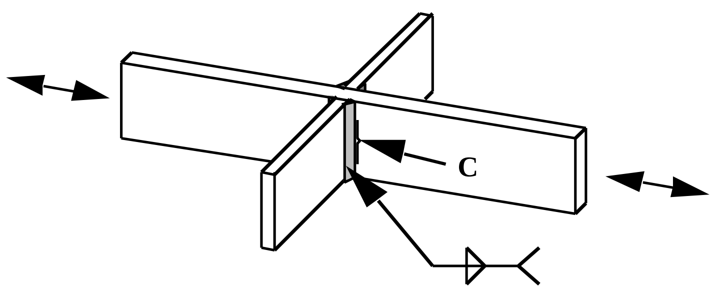


Full-Penetration Groove

Weld: Detail #10

K_f =2.12

²S design = 23.3 ksi.



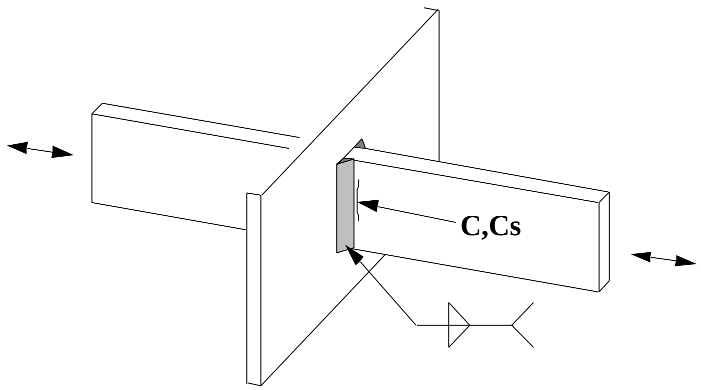
Non-Load Carrying Fillet

Weld: Detail #25

K_f =2.23

²S design = 22.1 ksi.

The bad welds: terminations

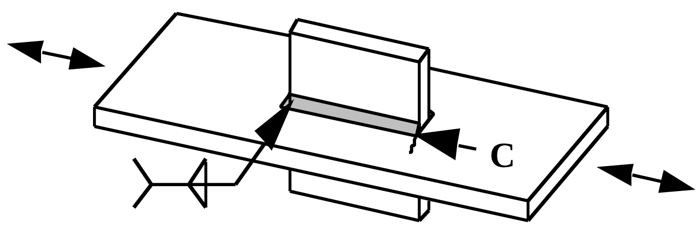


Load Carrying Fillet Weld:

Detail #20

K_f =3.12

$^{2}S_{design}$ = 17.5 ksi.



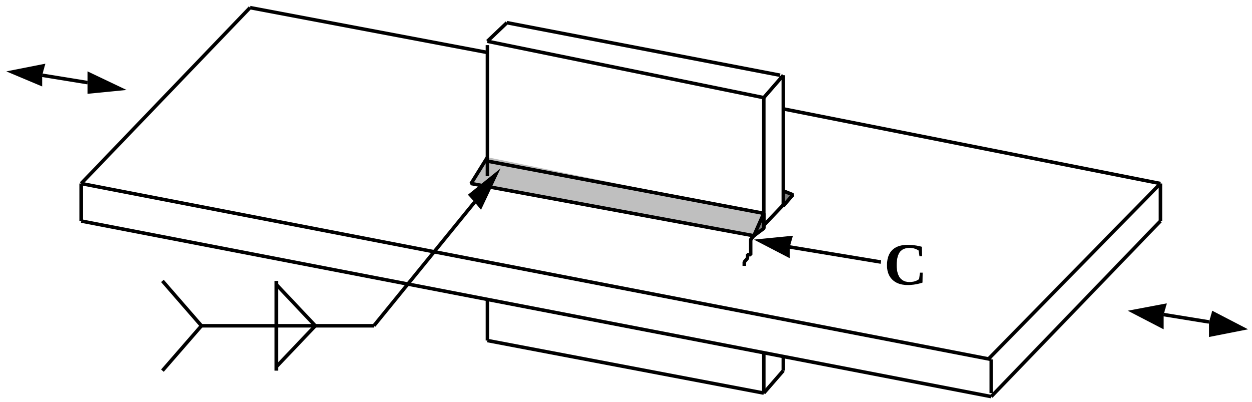
Weld Termination:

Detail #30

K_f =3.27

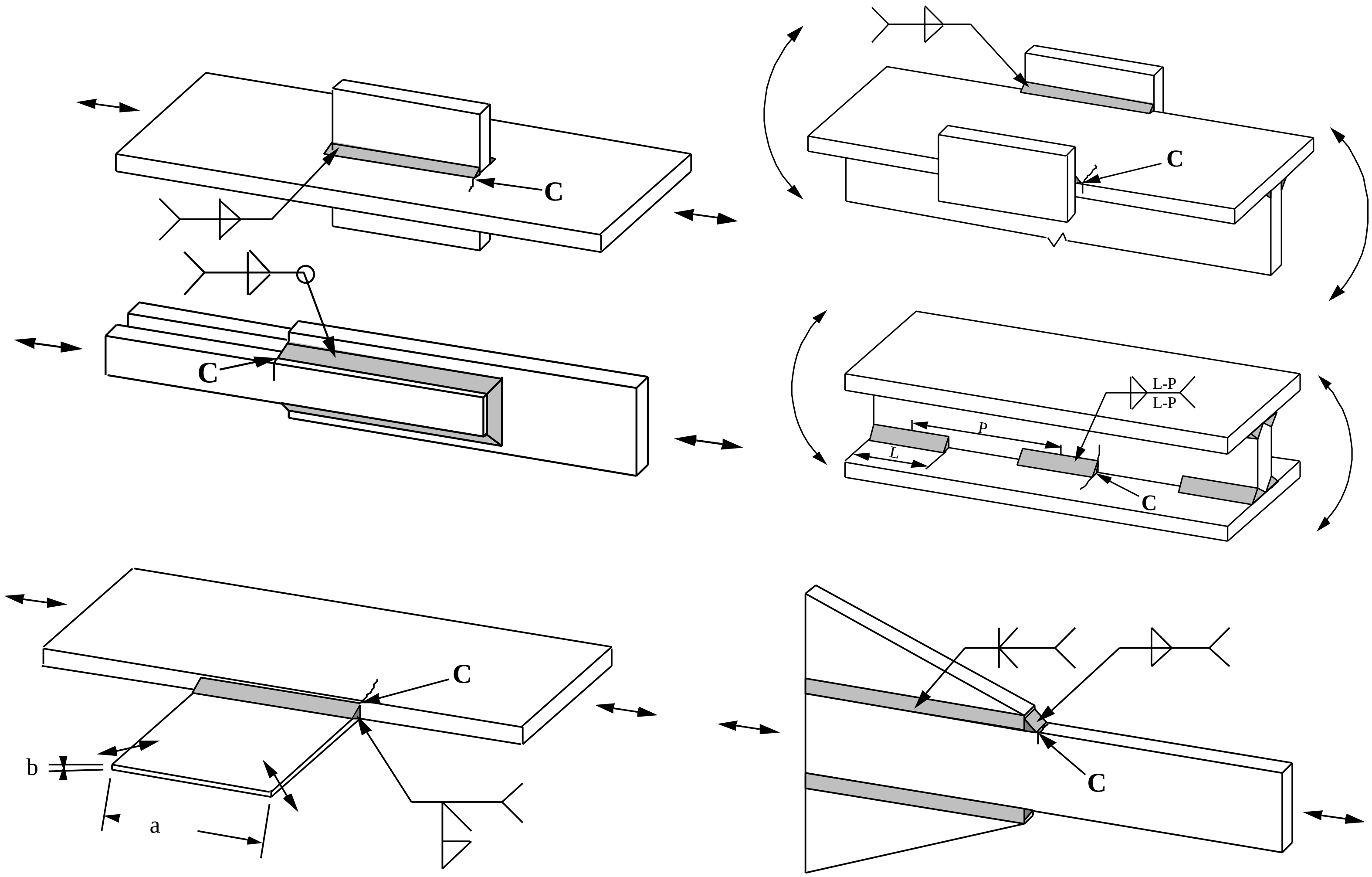
$^{2}S_{design}$ = 14.5 ksi.

Fatigue severity of terminations

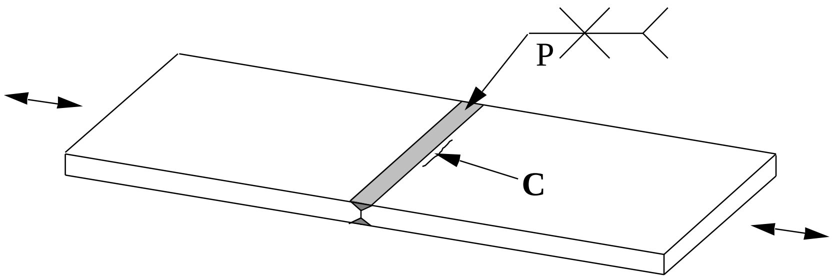


- Starts and stops introduce weld discontinuities.
- Residual stresses very high.
- 3-D stress concentrations effects.

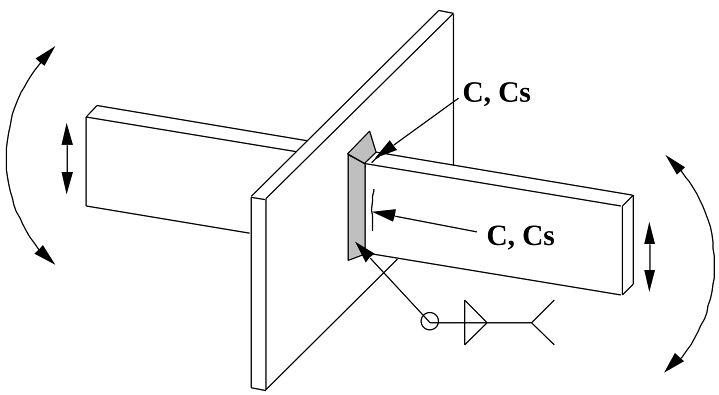
Examples of terminations



The mavericks: something undefined

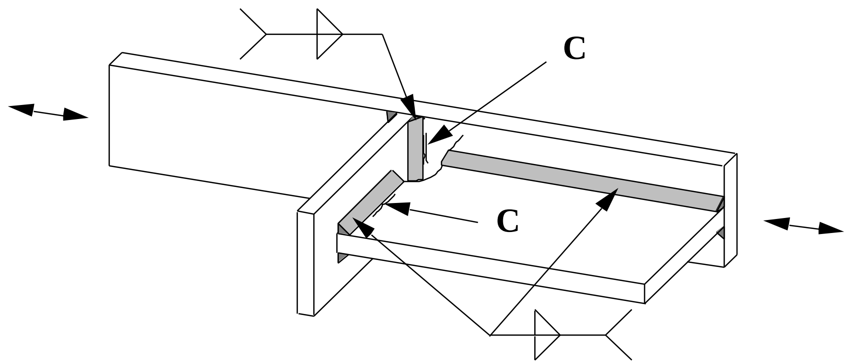


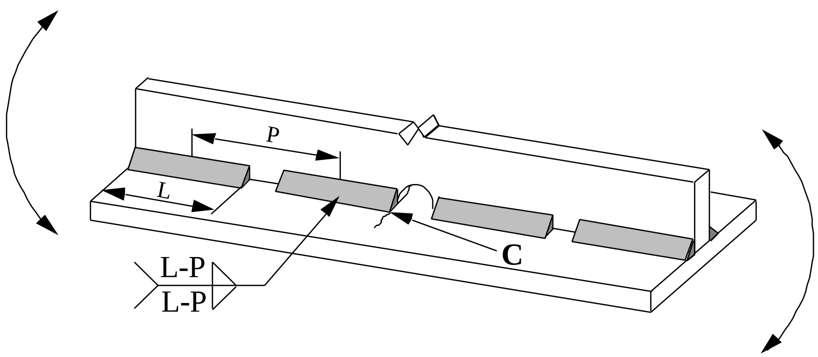
- Partial penetration weldment. The amount of penetration is generally unknown.



- Undercut. Failure occurs at the undercut on wrap-around weld where the arris of the plate is melted. the amount of the undercut is generally unknown.

The mavericks: complex components





- Multiple failure sites. The stress distribution in the joint changes as fatigue cracks initiate and grow at various locations.
- Local stresses uncertain because of structural redundancy

Summary

- Classification systems popular, simple and probably sufficient for many applications.
- However, the actual fatigue resistance of a weldment varies considerably with manner of loading, weldment size, and the state of the mean and residual stresses…..