# VII Improving the fatigue life of weldments



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## Outline

- Obvious things to do
- Problems the weld toe
- Fatigue life Improvement Strategies
- Light and heavy industry weldments
- Improving the "bad" weldments









### Bad - planar weld discontinuities





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#### Weld toe is a stress concentration



#### Slag entrapments at toe?



Virtually eliminates fatigue crack initiation life NI

## Cold-lap defects at weld toe



Cold laps virtually eliminate the fatigue crack initiation life (NI)

Such weldments may have an appreciable fatigue crack initiation life (NI)

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## Effect of cold lap depth







## Effect of cold root radius



## Recent study on rail welds



## **Geometric Parameters**



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## Weld with a Fin and a Cold Lap







## Nominal Weld Geometry







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## Fins and Cold Laps



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#### Predicted effect of S<sub>uBM</sub>



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<sub>fab</sub> ~ S<sub>YBM</sub>

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#### Good - grind off reinforcement



#### Good - burr grind weld toe



#### Very good - full face grinding





#### Remelted weld toe (laser)



#### **Improvement Strategies**



TWI suggestions as to weld improvement procedures

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#### ASTM A 36 butt weldment



#### ASTM A 514 butt weldment



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#### 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.





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Weldment with a transverse attachment



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 AM 11/03 39



## Placement of stress diffuser



Longitudinal attachment with stress diffusers



#### Effectiveness of a stress diffuser

![](_page_42_Picture_1.jpeg)

Longitudinal attachment

Longitudinal attachment with stress diffuser

Effect on  $M_{K}$  and  $N_{P}$ 

![](_page_43_Figure_1.jpeg)

![](_page_44_Figure_0.jpeg)

![](_page_45_Figure_0.jpeg)

![](_page_46_Picture_0.jpeg)

- 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.

![](_page_47_Picture_0.jpeg)

- 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.