

Assessment of Structural Integrity of Titanium Weldments for U.S. Navy Applications

REC2010

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Weldments for Applications

- U.S. Navy applications
- Structural integrity for long-term service
- Titanium



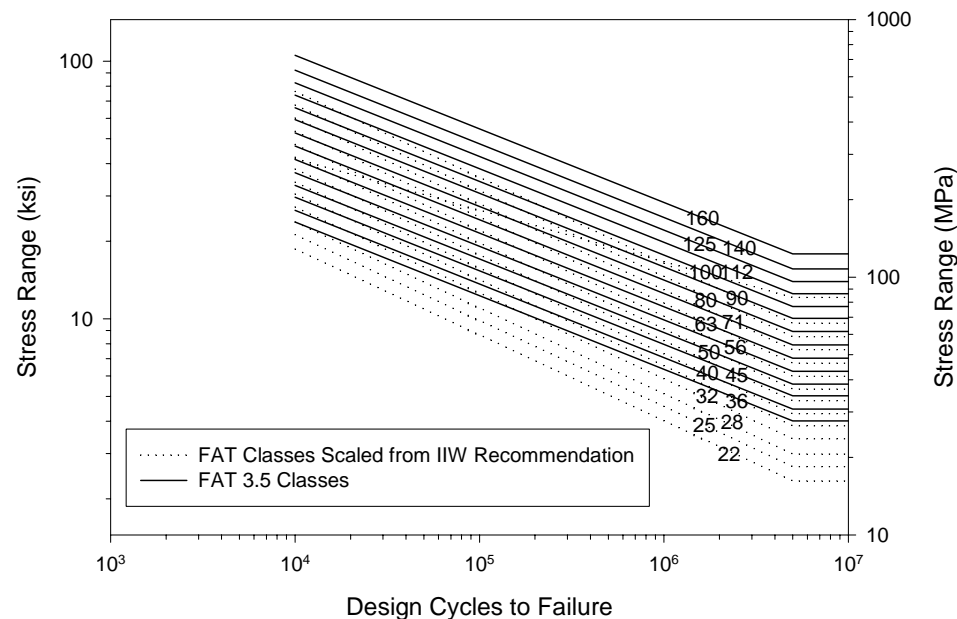
Weld Strength

- Indirect requirements set strength
 - Matching weld chemistry of Ti alloy
 - Some range to what is “matching”
- Sometimes welds are below base metal in strength
- AWS D1.9 assumes weld strength 90% of base metal requirement
 - Conservative for low strength base metals
- Different from Steel and Aluminum
 - Steel weld usually “over-match”
 - Al welds almost always greatly “under-match”



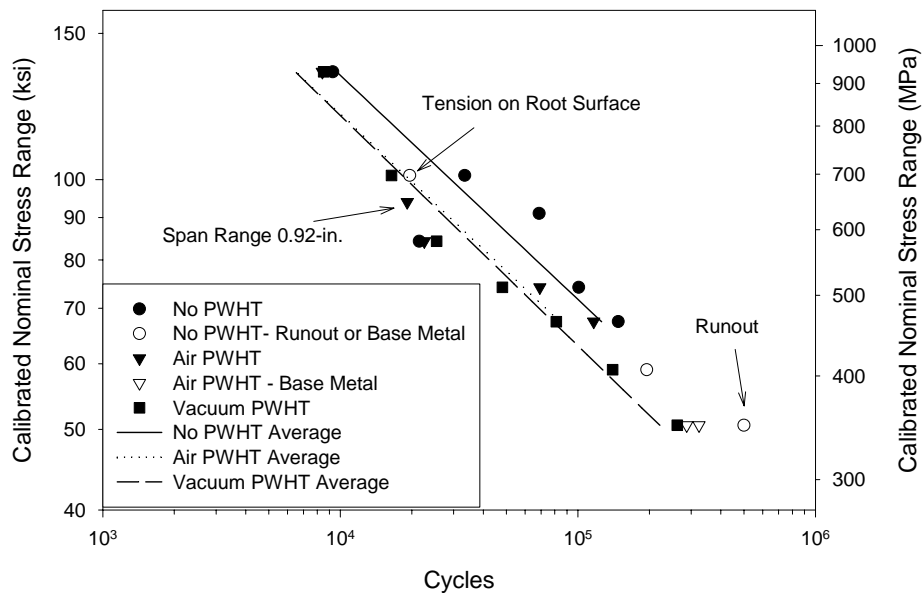
Weld Fatigue

- Available standard methods for fatigue assessment for steel and aluminum
- Slope change to 1/3.5, based on crack growth rate data



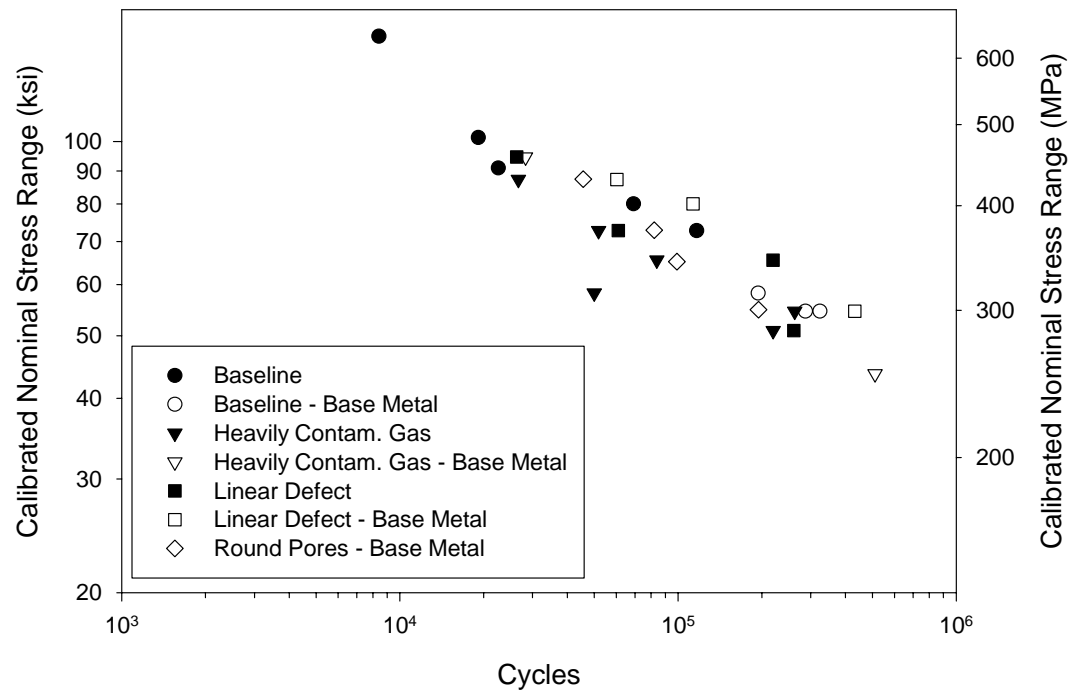
Butt Welds

- Tests in bending with differing heat treatment
- Other tests showing PWHT advantage not confirmed



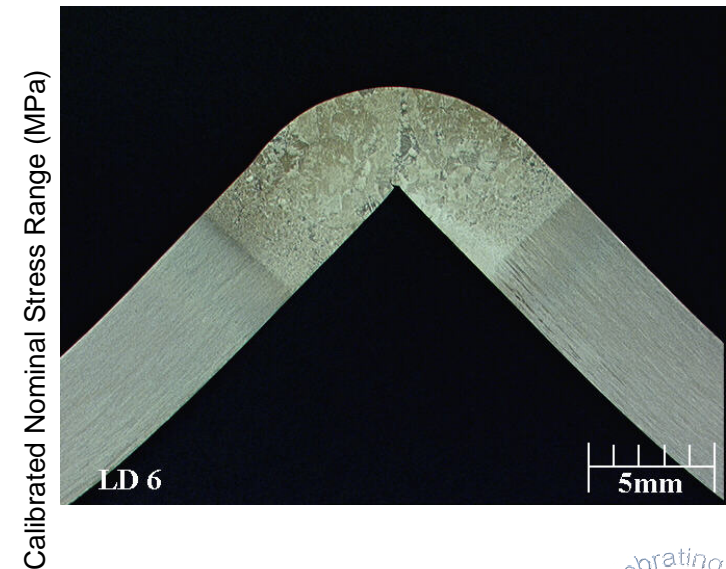
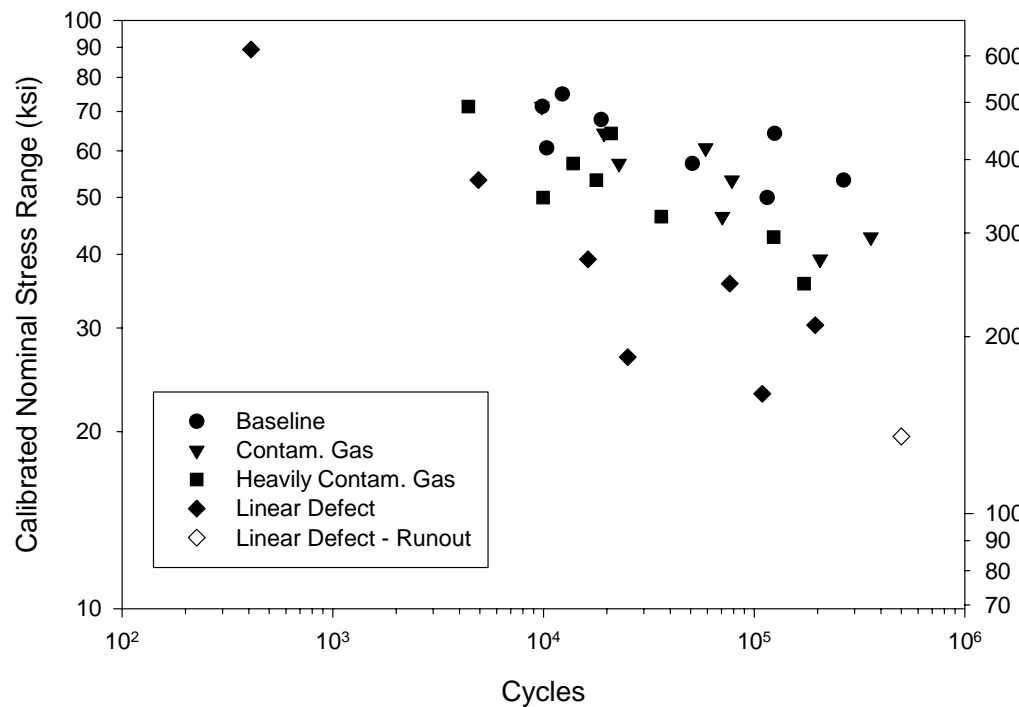
Butt Welds

- 4-Point Bending
- Minor effect of weld defects



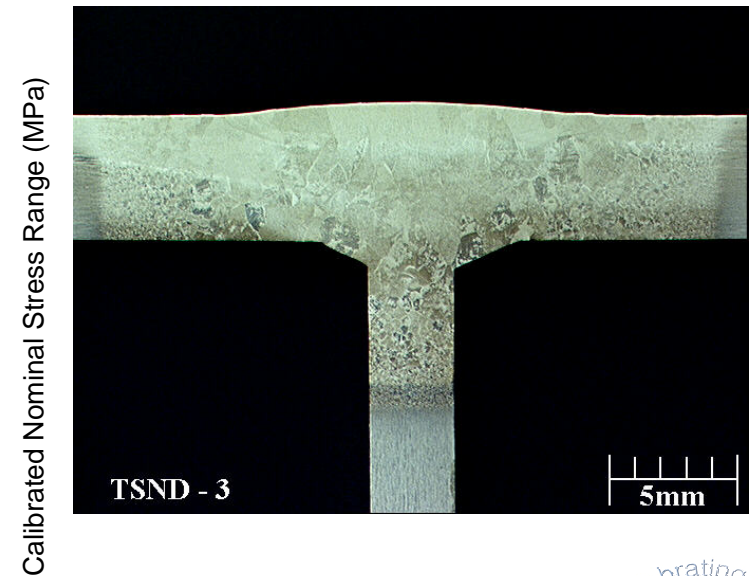
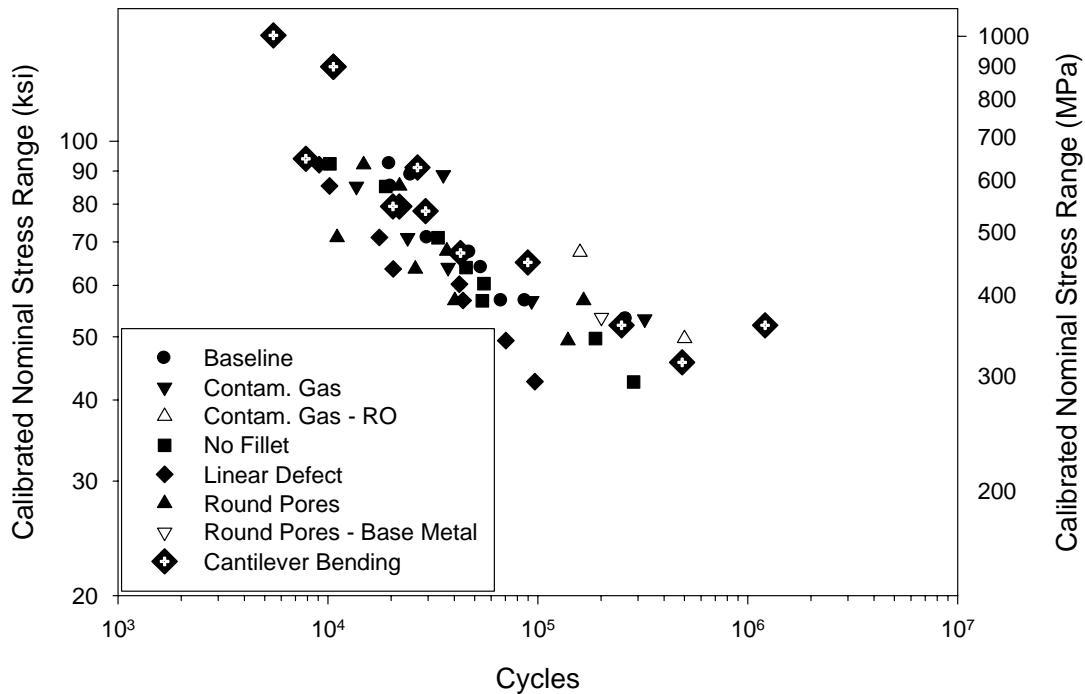
Corner Joints

- 4-Point Bending
- Stronger effect of root linear defects



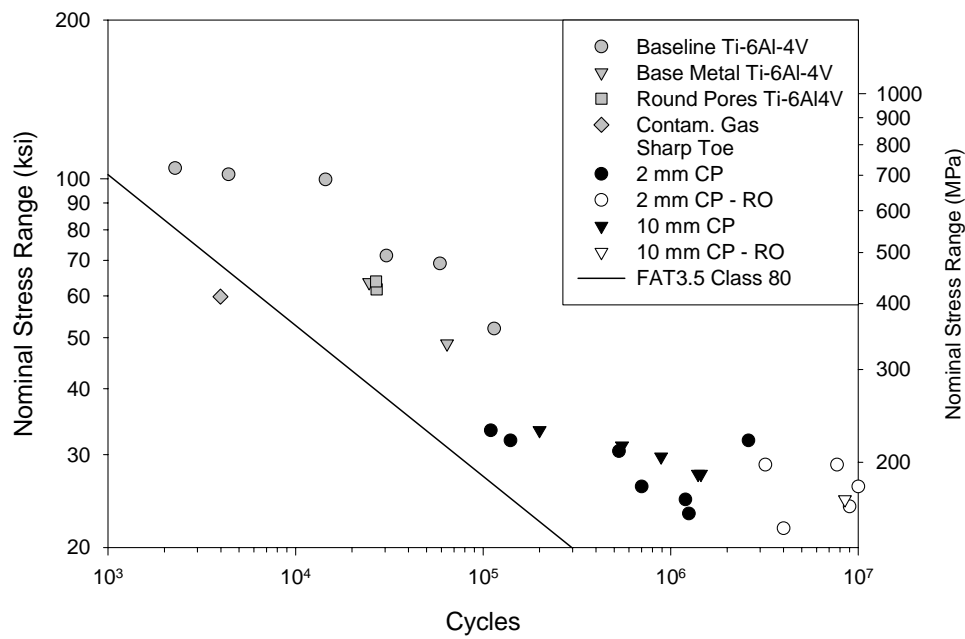
Tang and Slot Models

- Attachment weld models
- Minor effect of imperfections



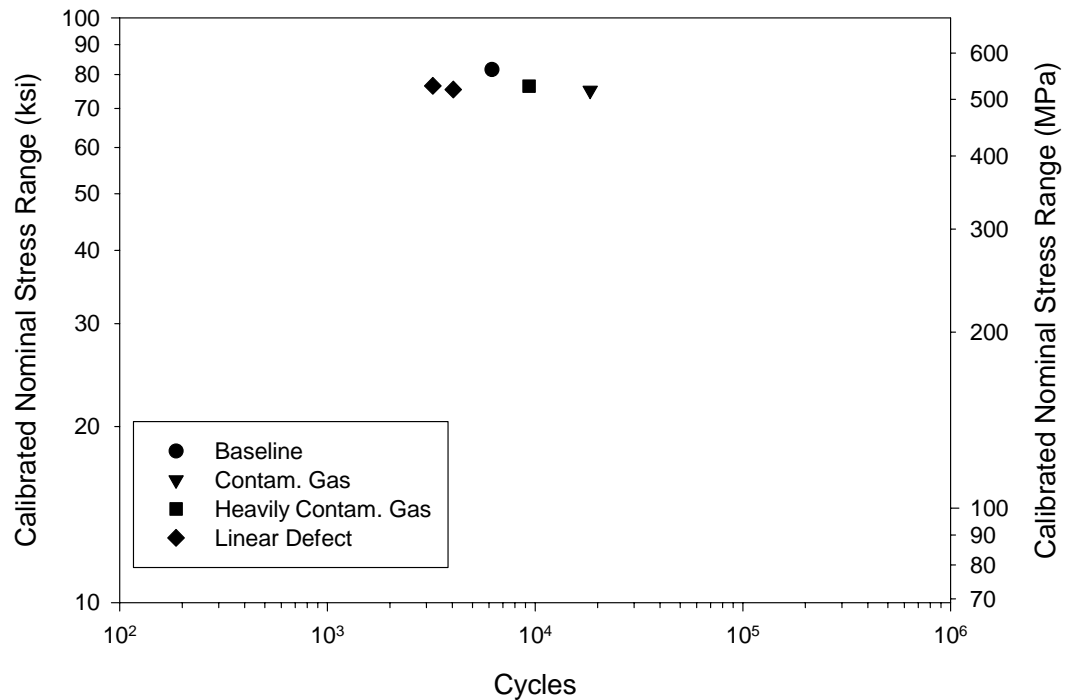
Butt Welds

- Tension testing
- 2 programs, 2 alloys, 3 thicknesses
- Big effect of sharp weld toe



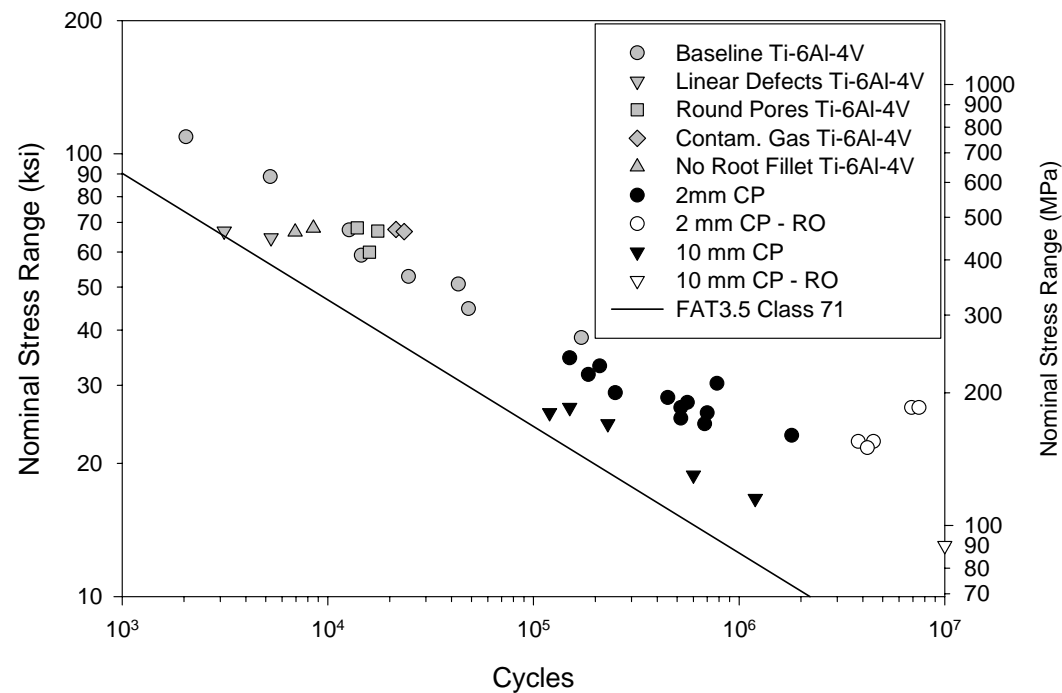
Corner Joints

- Overall tension, but local bending
- Performance similar to 4-point bending



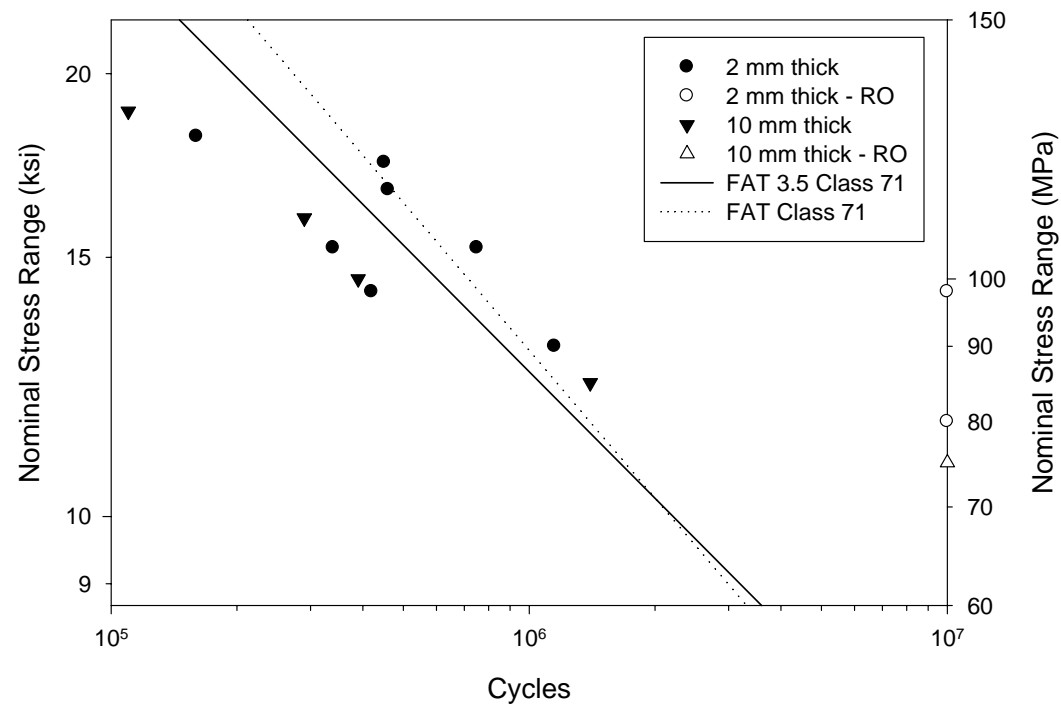
Attachments

- Tension tests
- 2 programs, 2 alloys, 3 materials



Longitudinal Attachments

- Iwata data on CP titanium
- Lower performance than correlated for steel and aluminum



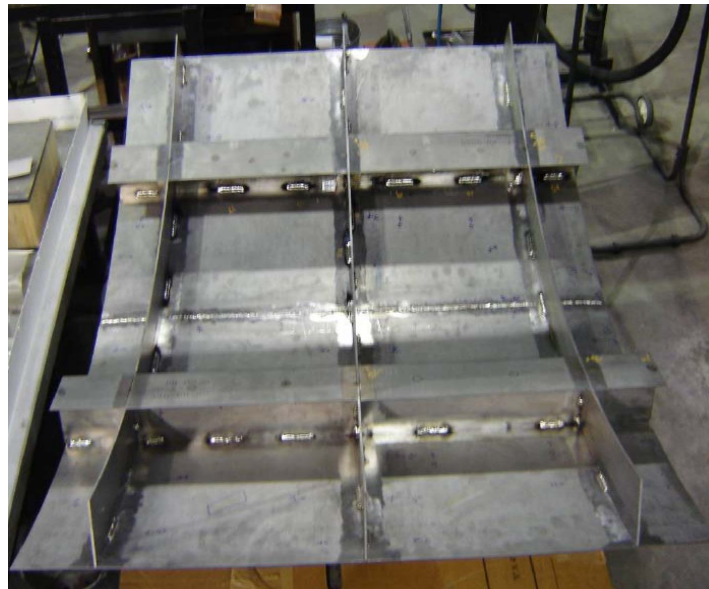
Application to Howitzer

- AWS Standard developed for welding acceptability along with howitzer development
- Additional areas of study
 - Inserts for reducing total weld metal
 - Welding on cast material



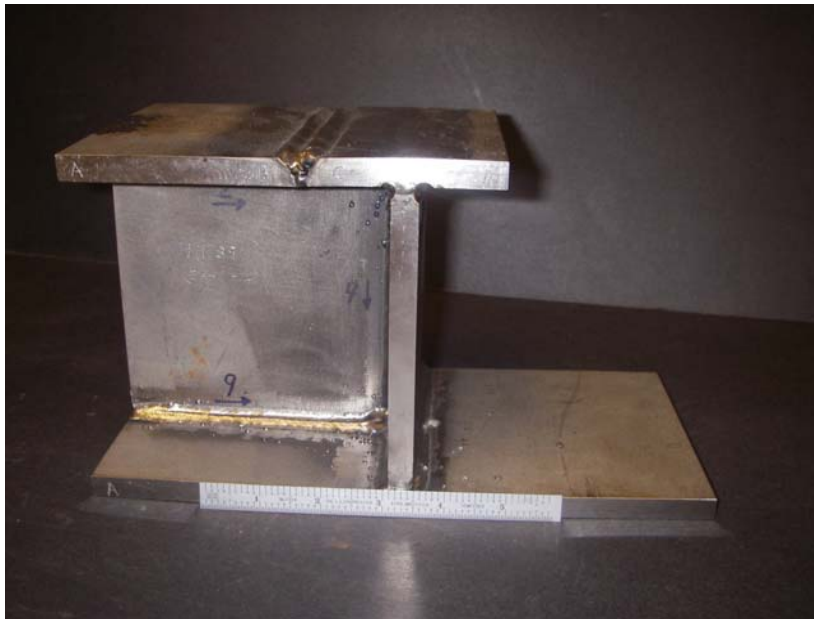
Application to Thin Structure

- Mock-up with gas shielding demonstration
- AWS Code does not cover minimum thickness, so use NAVSEA 248
- Pulse welding (GMAW) with 100% helium



Application to Large Door

- GMAW design mock-up
- Spatter indicates need for improved weld procedures and shielding
- Need for Navy application ballistic testing



Knowing Enough

- Transferability from steel and aluminum to titanium
- Transferability from one alloy to another
- Transferability from one weld geometry to another
- Transferability of weld acceptance criteria
- Transferability from GTAW to GMAW
- Transferability from one thickness to another





Questions?

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