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Testing of Welded and Machined A36 Steel T-Joint Configuration Specimens

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Testing of Welded and Machined A36 Steel T-Joint Configuration Specimens Co-Authors

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Agenda

- Test/Analysis Effort
- Specimen Geometry/Design
- Test Rig
- Load Histories
- Results
- Summary
- Contributors

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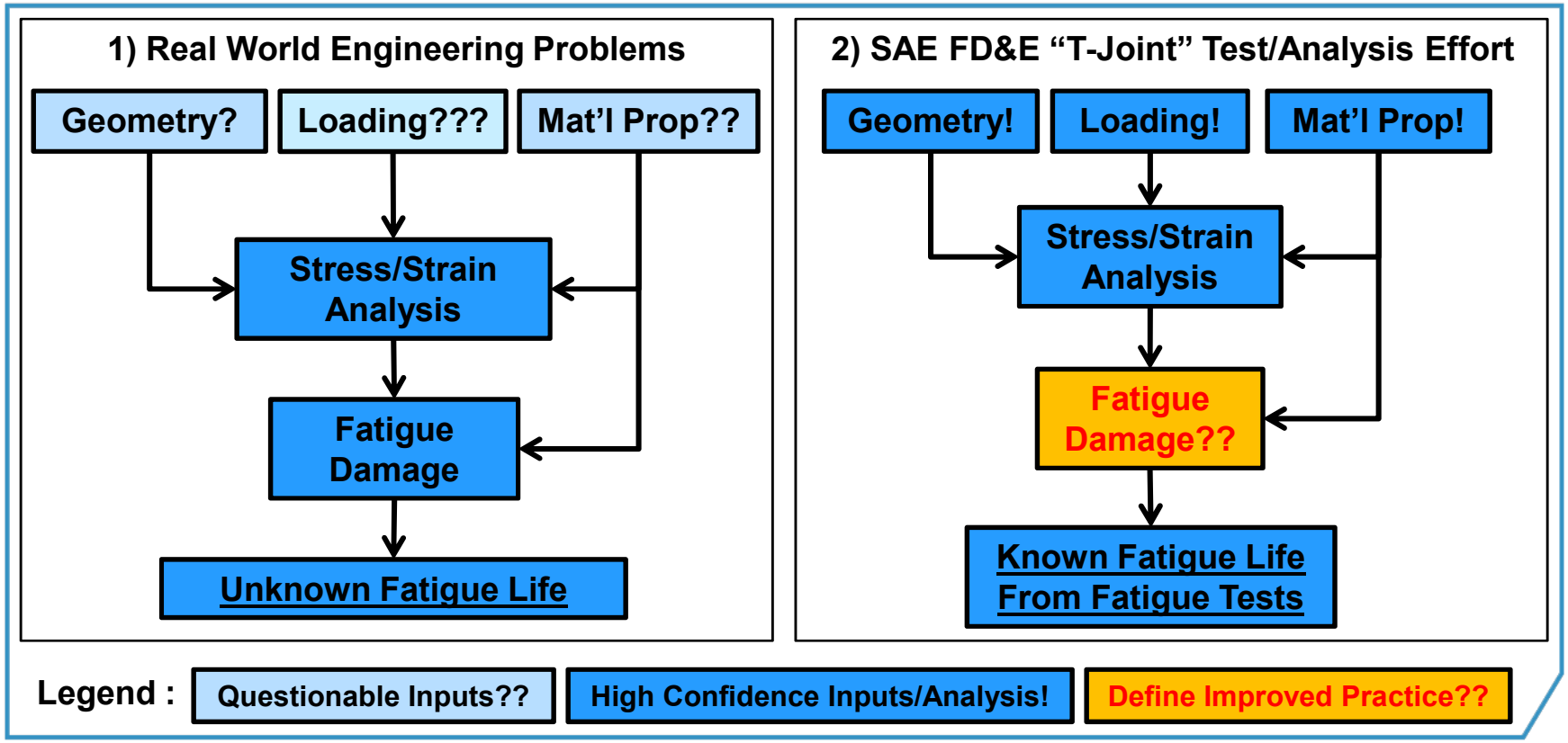
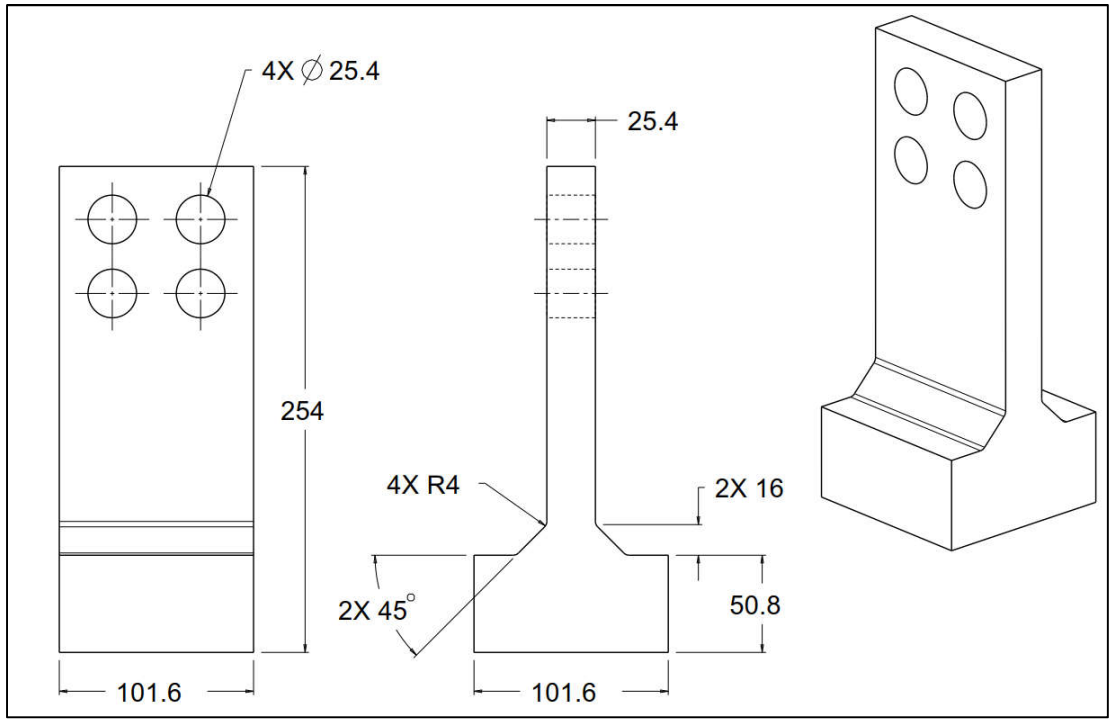
Total Life Methodology – Test/Analysis Effort

Using Defined/Controlled Inputs to Evaluate Methodology

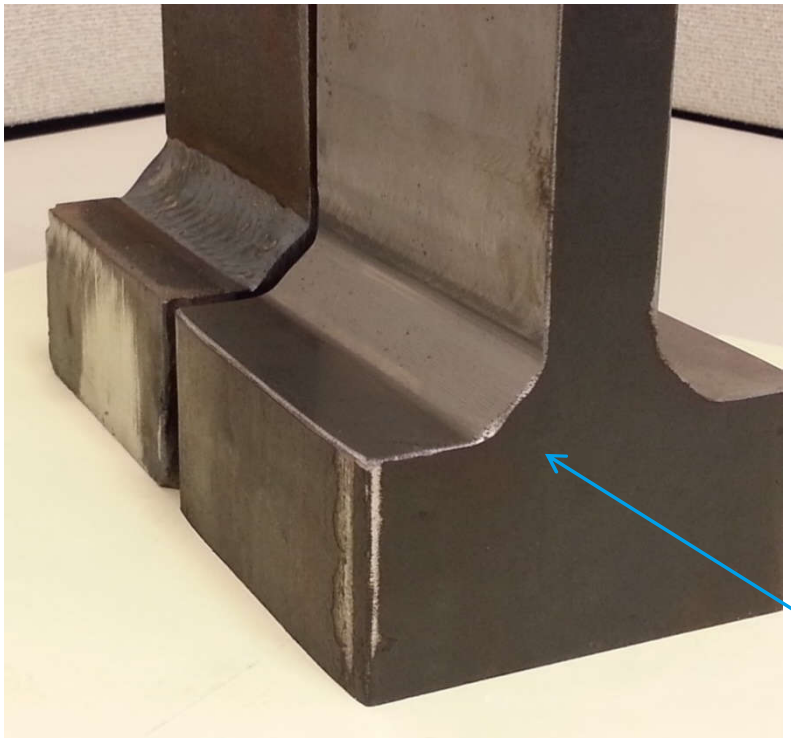


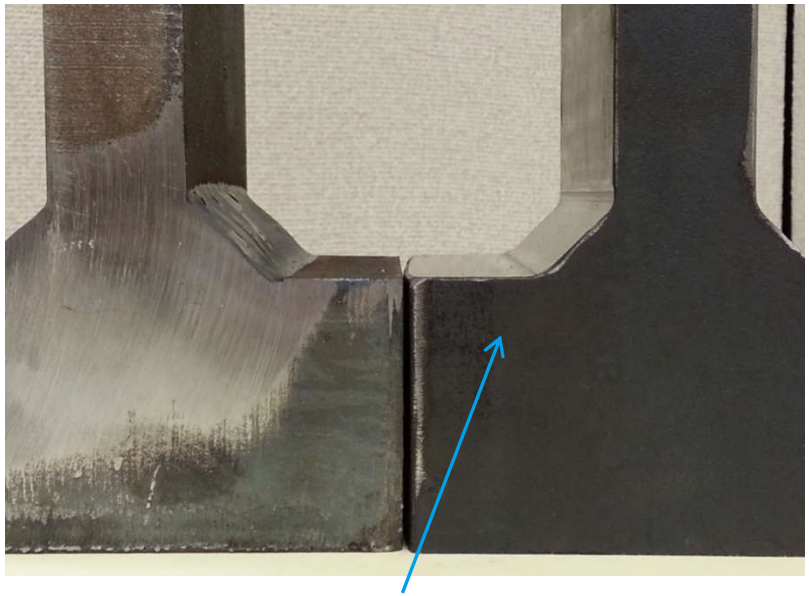
Specimen Geometry -
T-Joint Specimen Design

- Dimensions in mm
- Loaded in bending
- Mode I crack growth
- Max bending stress at weld toe



Specimen Design -
Welded and Machined Specimens

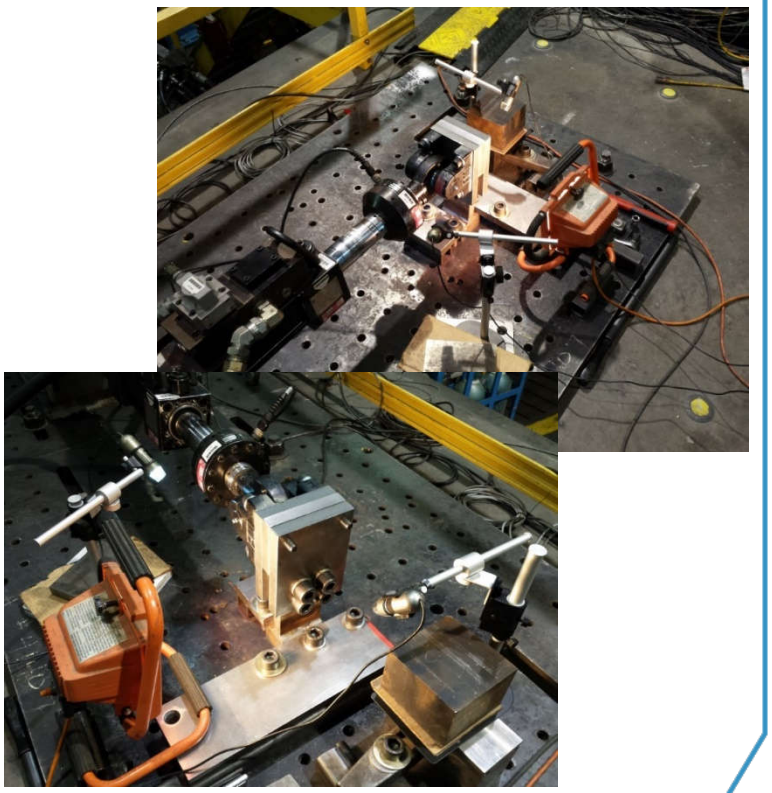




Machined T-Bar Replicates
Welded Specimen Geometry
Does Method Work For Both?

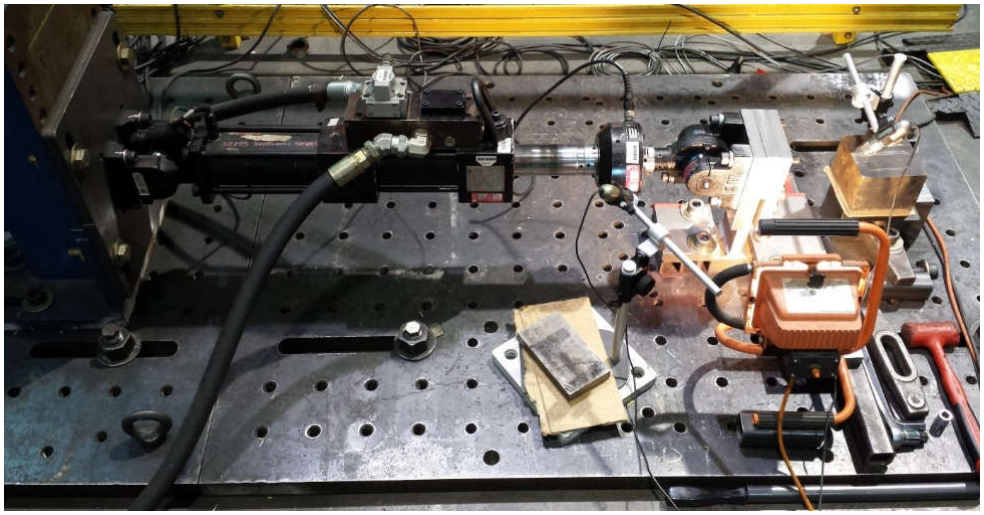
Test Rig -
Loading Mechanism/Fixture

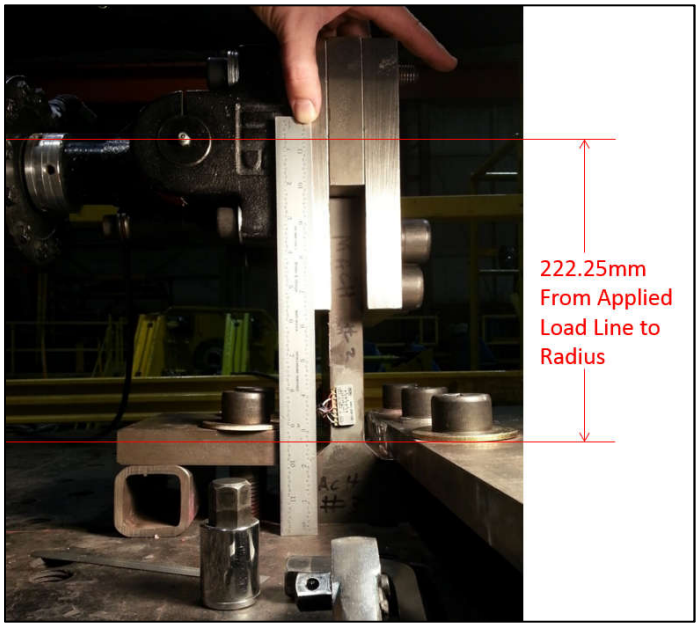
- MTS FlexTest IIm Controller
  - Load Control
- MTS 793 Series Software
  - Basic Testware (constant amplitude)
  - MultiPurpose Testware (block loading)
  - RPC Pro (variable amplitude loading)
- MTS 244 Series Hydraulic Actuator
  - Dual Stage Servo Valve, Load Cell, LVDT



Test Rig -
Loading Mechanism/Fixture

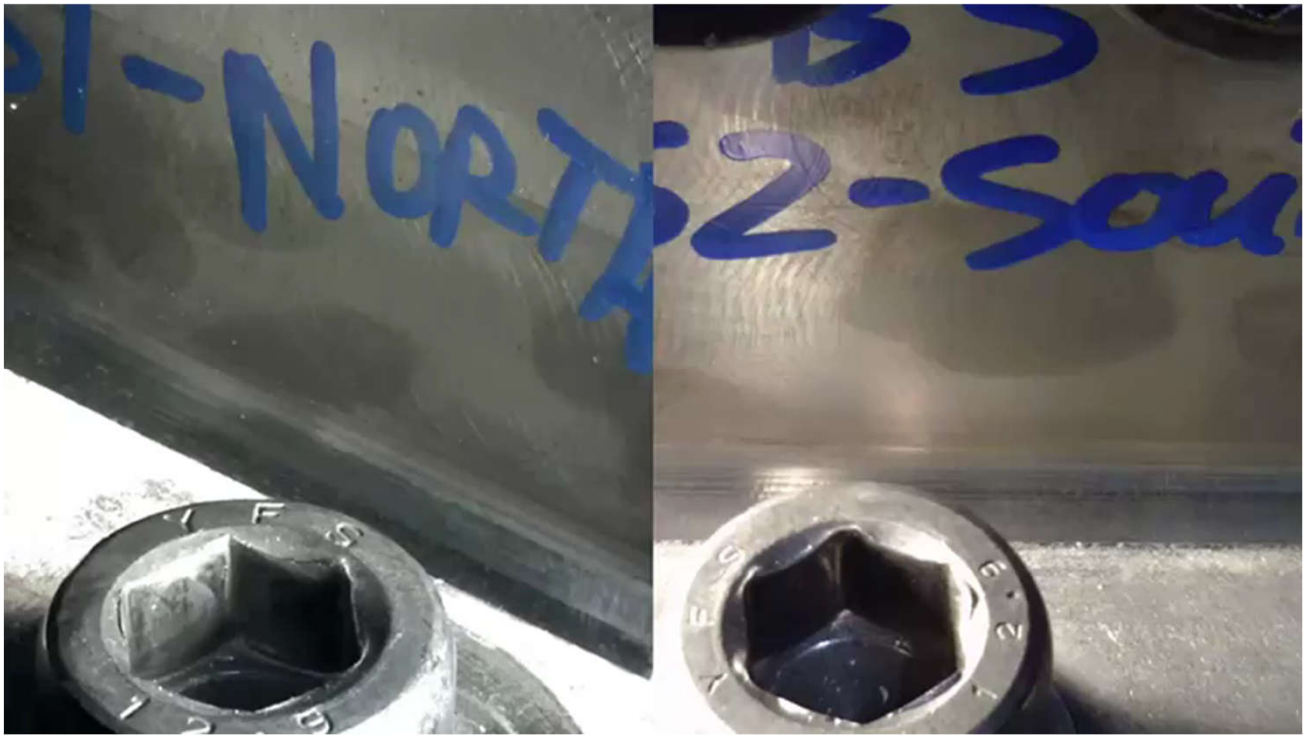
- HBM eDAQ Lite
- Dino-Lite USB Cameras / Laptop



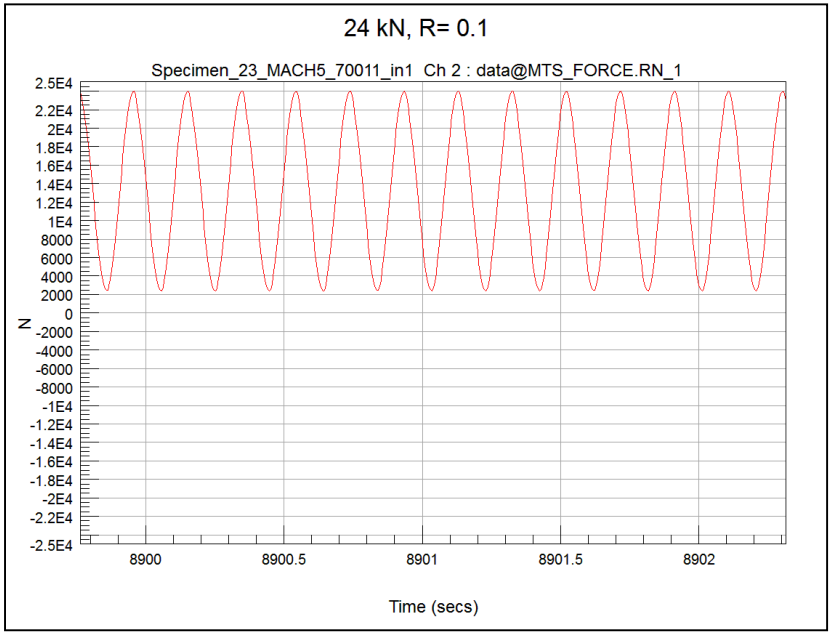


Test Rig -
Video of Test Setup

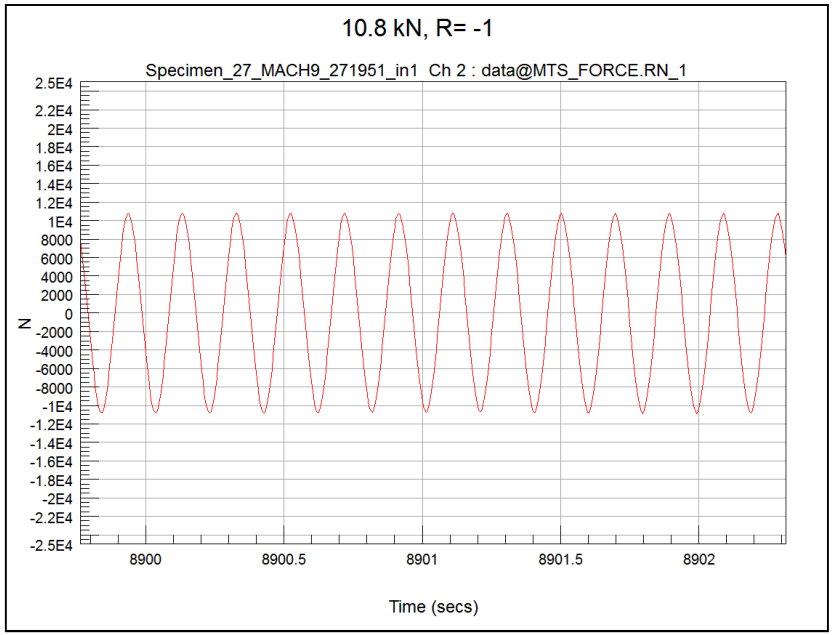
Test Rig -
Video of Test Specimen

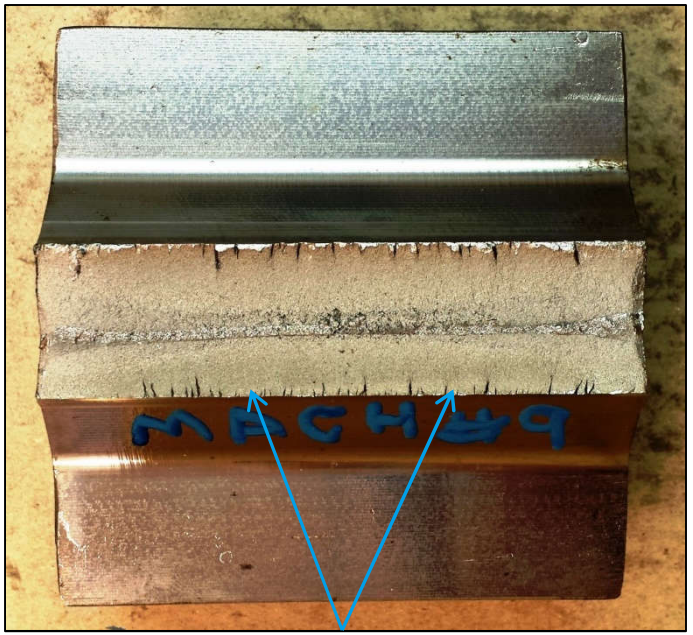


Load Histories -
24 kN, R= 0.1



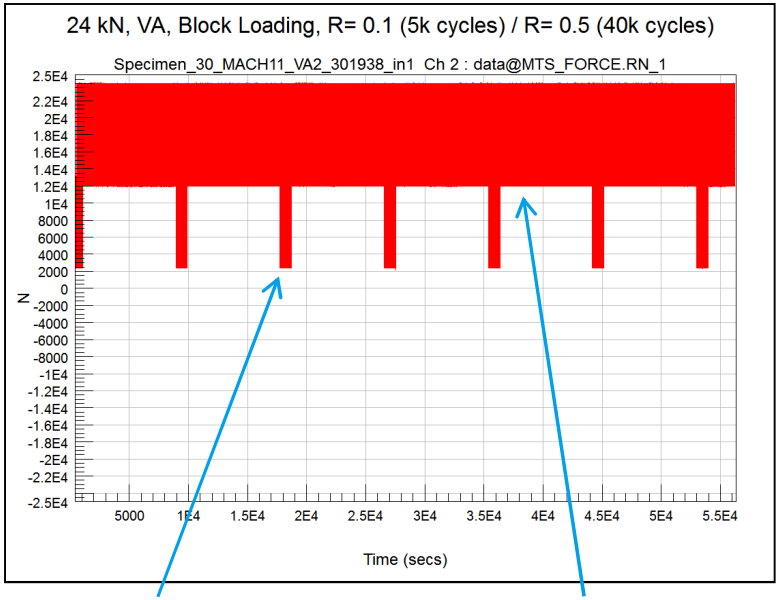
Load Histories -
10.8 kN, R= -1

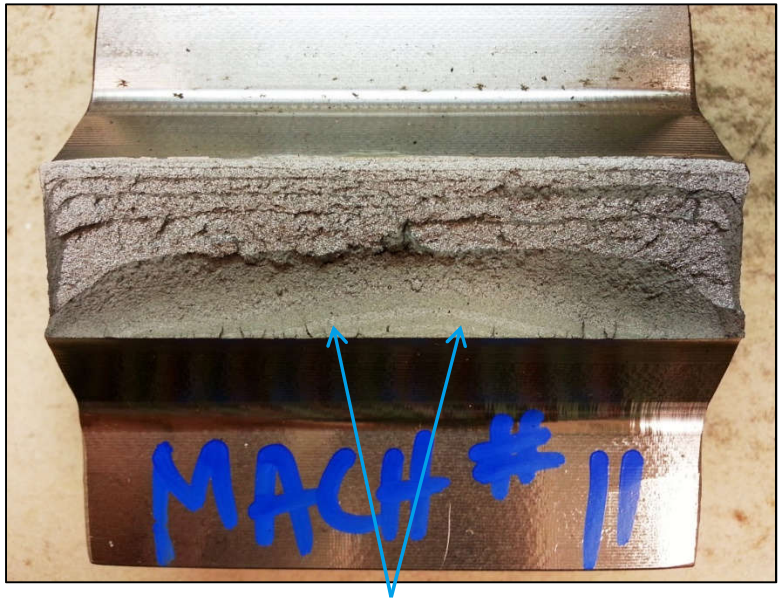




Multiple Initiation Locations
Grow Into One Main Crack

Load Histories -
24 kN, VA, Block Loading, R= 0.1 (5k cycles) / R=0.5 (40k cycles)





5,000 Cycles
24 kN, R= 0.1

40,000 Cycles
24 kN, R= 0.5

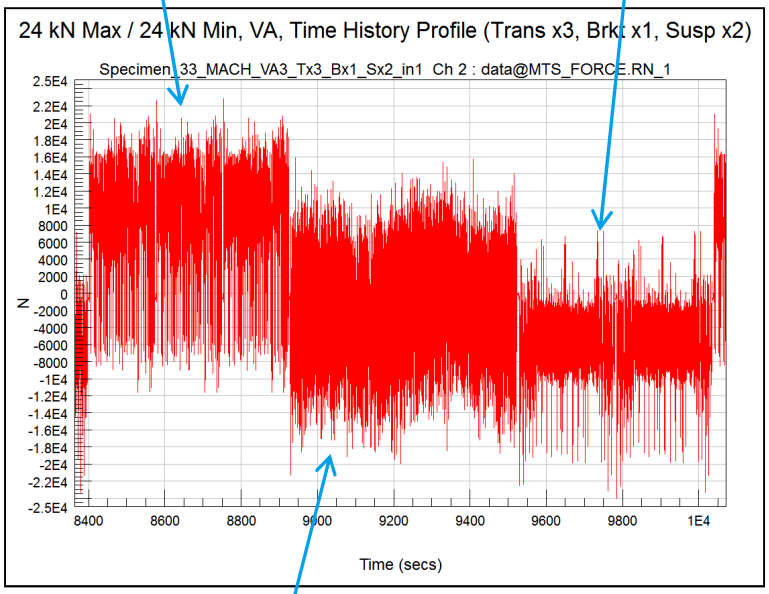
Marker Bands
(Blocks of Striations at a Load Level)

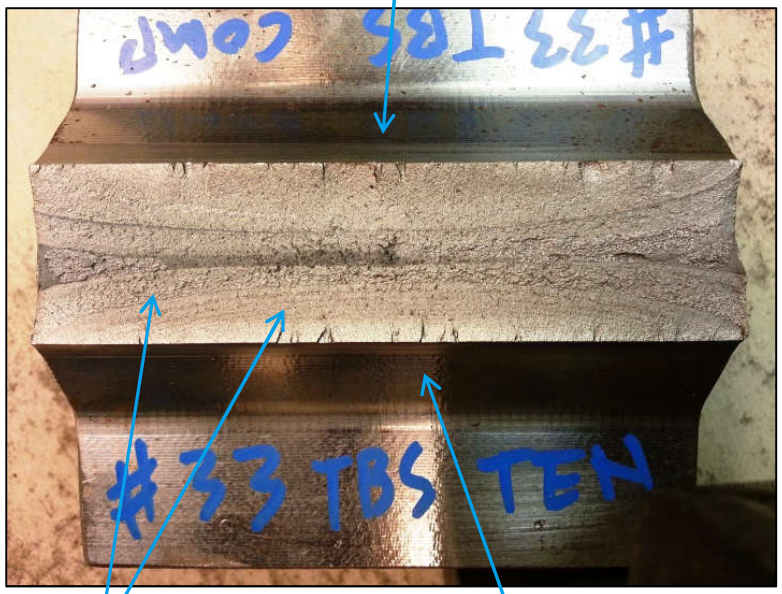
Load Histories -
24 kN Max / 24 kN Min, VA, Time History Profile (Tx3,Bx1,Sx2)

Transmission

Suspension

Side of First Cycle In Compression





Bracket

Marker Bands

Side of First Cycle In Tension

Results -
Welded and Machined Specimens

Welded Specimens (17)		
Max Load (kN)	R Ratio Dimensionless	Experimental Test Cycles
24	0.1	36,895
24	0.1	48,160
24	0.1	62,047
14	0.1	325,579
14	0.1	375,813
14	0.1	494,456
24	0.3	105,522
14	0.3	922,658
24	0.5	262,628
24	0.5	349,002
24	0.5	503,441
20	0.5	592,250
17***	0.5	4,901,846
24	*Block Load: 0.1/0.5	138,421
24	*Block Load: 0.1/0.5	174,069
24	**Var Amplitude	168,504
24	**Var Amplitude	168,504

Note: *5k 24kN R=0.1 Cycles followed by 40k 24kN R=0.5 Cycles
**3xSAE Transmission+1xBracket+2Suspension PV File
***Run out

Machined Specimens (13)		
Max Load (kN)	R Ratio Dimensionless	Experimental Test Life Cycles
24***	0.5	2,471,943
24****	0.3	266,012
24	0.3	218,671
24	0.3	200,464
24	0.1	58,481
24	0.1	70,011
18*****	0.1	424,431
18	0.1	411,745
14***	0.1	3,495,011
10.8	-1	214,765
10.8	-1	271,951
24	*Block Load: 0.1/0.5	326,135
24	*Block Load: 0.1/0.5	301,938
24	**Var Amplitude	224,672
24	**Var Amplitude	232,696

Note: *5k 24kN R=0.1 Cycles followed by 40k 24kN R=0.5 Cycles
**3xSAE Transmission+1xBracket+2Suspension PV File
***Run out
****Tested after R=0.5 run out
*****Tested after R=0.1 run out

Summary/Conclusions

- Successful Fatigue Tests
  - Correlating fatigue prediction methodologies to fatigue life data
  - Unique data set comparing welded to machined specimens
  - Residual stresses have a significant effect on high cycle fatigue

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SAE FD&E Total Life Project Contributors

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<u>And any other participants and contributors:</u> who may have been inadvertently overlooked in the preceding list.

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Following papers document Total Life Project

- Accounting For Geometry And Residual Stresses In Weld Fatigue: A Strain Energy Density Approach To Total Life Of Welded T-specimens
- FD&E Total Life T-sample Residual Stress Analytical Predictions And Measured Results
- Testing Of Welded And Machined A36 Steel T-joint Configuration Specimens
- A Finite Element Based Methodology For Combined Crack Initiation And Crack Growth Prediction In Welded Structures
- Comparison of Total Fatigue Life Predictions of Welded and Machined A36 Steel T-Joints
- Crack Initiation and Propagation Fatigue Life Prediction for an A36 Steel Welded Plate Specimen

The End -

Thank You

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