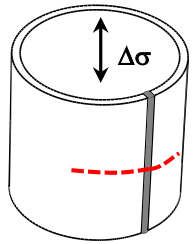
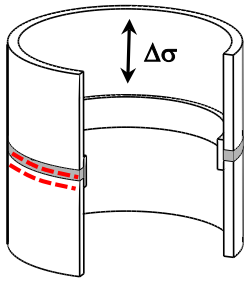
Appendix E – Comparison of Fatigue Detail Resistance

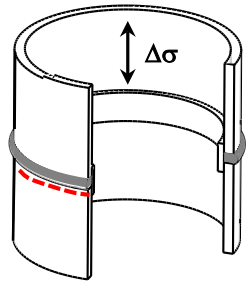
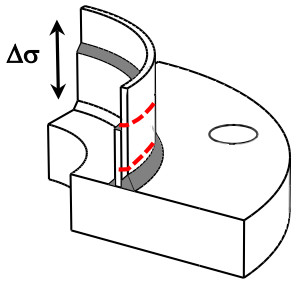
During the course of NCHRP Project 10-80, there were two independent studies conducted that addressed fatigue resistance of several typical connection details. One project was conducted at Lehigh University by Roy et al (2011) under the sponsorship of NCHRP Project 10-70, and the second was conducted at the University of Texas (UT) at Austin by Frank et al (Stam et al 2011) under the sponsorship of a FHWA pooled fund study.

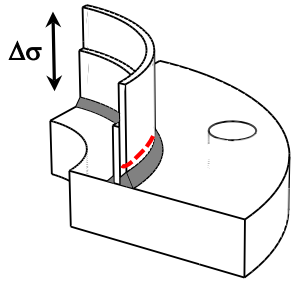
These two works are compared in Table E-1, which is based upon work by Roy et al, and is the based for the resistances outlined in LTS-6, Table 11.2. The red italic text illustrates work at UT and the regular text from the Lehigh work.

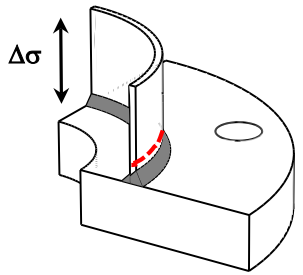
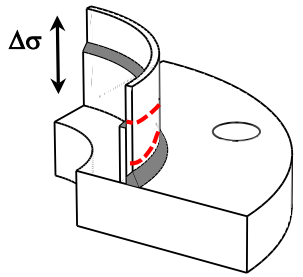
Note that UT takes a difference approach, i.e., specification of geometric restrictions, ultrasonic inspection, etc. If these criteria are met, then the threshold stress range is set. NCHRP Project 10-70 uses an equation-based approach. The two methods could likely be shown to be consistent, i.e., use UT geometry with 10-70 equations to determine the values. Below it is determined where the two methods agreed and might possibly agree depending upon specific requirements.

Table E-1. Comparison for Fatigue Details

Description	Finite Life Constant $Ax10^8$ [MPa^3 (ksi^3)]	Threshold $(\Delta F)_{TH}$ [MPa (ksi)]	Potential Crack Location	Example
4.1 Tubes with continuous full- or partial penetration groove-welds parallel to the direction of the applied stress	20800 (61.0)	83 (12.0) *UT: Detail 8* *Stress Cat: B'* *Threshold: 12 ksi* ***No difference***	In the weld away from the weld termination.	Longitudinal seam welds. 
4.2 Full-penetration groove-welded splices with welds ground to provide a smooth transition between members (with or without backing ring removed).	7500 (22.0)	48 (7.0) *UT: Detail 9* *Stress Cat: D* *Threshold: 7 ksi* ***No difference***	In weld through the throat or along the fusion boundary.	Column or mast-arm butt-splices. 

4.3 Full-penetration groove-welded splices with weld reinforcement not removed (with or without backing ring removed).	3750 (11.0)	31 (4.5) *UT: Detail 10* *Stress Cat: E* *Threshold: 4.5 ksi* ***No difference***	In tube wall along weld toe.	Column or mast-arm butt-splices. 
4.4 Full-penetration groove-welded tube-to-transverse plate connections with backing ring attached to the plate with a full penetration weld, or with a continuous fillet-weld around interior face of backing ring, and the backing ring welded to the tube with a continuous fillet-weld at top face of backing ring.	$K_F \leq 1.6$: 3750 (11.0) $1.6 < K_F \leq 2.3$: 1330 (3.9)	$K_l \leq 3.2$: 69 (10.0) $3.2 < K_l \leq 5.1$: 48 (7.0) $5.1 < K_l \leq 7.2$: 31 (4.5) *UT: Detail 14* *Stress Cat: C* *Threshold: 10 ksi* *UT, geometric restrictions, 12 bolts, etc.* ***Difference approaches are used.***	In tube wall along groove-weld toe or backing ring top weld toe.	Column-to-base plate connections. Mast-arm-to-flange-plate connections. 

4.5 Full-penetration groove-welded tube-to-transverse plate connections with backing ring attached to the plate with a full penetration weld, or with a continuous fillet-weld around interior face of backing ring, and the backing ring not welded to the tube.	$K_F \leq 1.6$: 3750 (11.0) $1.6 < K_F \leq 2.3$: 1330 (3.9)	$K_I \leq 3.2$: 69 (10.0) $3.2 < K_I \leq 5.1$: 48 (7.0) $5.1 < K_I \leq 7.2$: 31 (4.5) *UT: Detail 13* *Stress Cat: C* *Threshold: 10 ksi* *30 degree weld, specific thicknesses, UT, hold limitation, plate thickness:* *D <= 8, t = 1.5in* *8 < D < 12, t = 2 in* *D>= 12, t = 3 in* ***Difference approaches are used***	In tube wall along groove-weld toe.	Column-to-base-plate connections. Mast-arm-to-flange-plate connections. 

4.6 Full penetration groove-welded tube-to-transverse plate connections welded from both sides with back-gouging (without backing ring).	$K_F \leq 1.6$: 3750 (11.0) $1.6 < K_F \leq 2.3$: 1330 (3.9)	$K_I \leq 3.2$: 69 (10.0) $3.2 < K_I \leq 5.1$: 48 (7.0) $5.1 < K_I \leq 7.2$: 31 (4.5) *UT: Detail 12* *Stress Cat: E'* *Threshold: 2.6 ksi* ***Difference approaches are used.***	In tube wall along groove-weld toe.	Column-to-base-plate connections. Mast-arm-to-flange-plate connections. 
4.7 Full-penetration groove-welded tube-to-transverse plate connections with the backing ring not attached to the plate, and the backing ring welded to the tube with a continuous fillet-weld at top face of backing ring.	$K_F \leq 1.6$: 3750 (11.0) $1.6 < K_F \leq 2.3$: 1330 (3.9)	$K_I \leq 3.2$: 69 (10.0) $3.2 < K_I \leq 5.1$: 48 (7.0) $5.1 < K_I \leq 7.2$: 31 (4.5) *UT: Detail 14* *Stress Cat: C* *Threshold: 10 ksi* *UT, several geometric restrictions* ***Difference approaches are used.***	In tube wall along groove-weld toe or backing ring top weld toe.	Column-to-base-plate connections. Mast-arm-to-flange-plate connections. 

The following figure that was developed by Stam et al 2011 and did not get included in the 10-70 work for fatigue resistance. This detail might be considered in the future by T-12.