NCHRP Project 10-70: 
Cost-Effective Connection Details for Highway Sign, Luminaire and Traffic Signal Structures 
Recommended Specification – Application Examples

Sougata Roy, Richard Sause, John W. Fisher, Yeun Chul Park, Eric J. Kaufmann
Project Summary (2006-11)

- 80 full scale specimens
  - Rational experiment design to establish infinite life
  - Multiple details and geometric combinations
  - 158 tests including re-runs (approx. 2000 million cycles)
    • Approximately 330 details tested (cumulative 5000 million cycles)

- Parametric FEA using 30,000+ models
  - Extended experimental results over a broad range of structure sizes and geometric combinations

- Specification for cost-effective fatigue design

- Final Report (in the process of publication)
NCHRP Project 10-70 @ Lehigh

- Analytical and experimental evaluation
- 80 full size specimens, 158 tests
- Revisions to the AASHTO Specification
- 2006-11
Critical Details

- Tube-to-transverse plate connections
  - Mast arm-to-transverse plate
  - Pole-to-base plate
- Handhole
  - Reinforced
  - Unreinforced
- Mast arm-to-pole connection
  - Gusseted box
  - Ring stiffened
- Mast arm-to-pole pass-through connection
Tube-to-Transverse Plate Connections

Fillet-welded or Socket

Full-penetration Groove-welded

Stiffened Socket
Tube-to-Transverse Plate Connection

- Displacement Induced Fatigue
  - Relative stiffness of components important

- Fatigue resistance of connections depends on
  - Member cross section
    - Round vs. Multisided
  - Connection Geometry
    - Tube diameter and thickness (relative to plate)
    - Plate thickness (*use minimum 2 in*)
    - Number of fasteners and bolt circle ratio
    - Opening in end plate (groove welded connections only)
    - Stiffened vs. Unstiffened
  - Detail Configuration
    - Fillet (socket), Groove welded etc.
  - Weld Geometry
    - Weld shape and size (*Weld termination angle*)
Geometric Parameters

- $D_T$
- $t_T$
- $t_{TP}$
- $D_{BC}$
- $D_{OP}$
- $N_B$
Specification - What’s New

- 2 level specification
  - Nominal stress-based design for most cases
  - Local stress-based and experiment-based design for special cases (Appendix D)

- Proposed for both finite and infinite life
  - Infinite life: new design
  - Finite life: assessment

- Format similar to *AASHTO LRFD Bridge Design Specification* (2009 Interim)

- Fatigue resistance defined as function of geometric parameters
Stress Concentration Factors - $K_F, K_I$

- Base equations for round section geometries
  - Geometric SCF (finite life - $K_F$)
  - Socket and groove welded connections have different equations
- Modification multiplier for infinite life ($K_I$)
- For multisided cross sections modify SCF equations for round section
- For stiffened connections modify SCF equations for unstiffened connections
Nominal Stress Calculation (1)

- Fillet-welded (socket) connection
  - Section at fillet weld toe on tube wall

- Stiffened connections
  - Section at stiffener top weld toe on tube wall
  - Section at fillet weld toe on tube wall
    - Ignore stiffener section (Implicitly considered in SCF equations in Table 11-1 and in Table C11-1)
Nominal Stress Calculation (2)

- Groove-welded connections with backing ring not welded at top
  - Section at groove weld toe on tube wall
  - Ignore backing ring section

- Groove-welded connection with backing ring welded at top
  - Section at groove weld toe on tube wall
  - Section at toe of backing ring top weld on tube wall
Mandatory Requirements

- Thickness of transverse plate $\geq$ 2 in
- Unstiffened tube-to-transverse plate connections
  - Fillet welds and weld reinforcements shall be unequal leg welds (approximately $30^\circ$ on tube side)
  - Backing ring
    - height $\leq$ 2 in
    - thickness $\leq$ $\frac{1}{4}$ in
    - *Backing ring can be welded to tube only when quality of weld can be ensured (recommended $D_T \leq 16$ in)
Design Example 1: Sign/Signal Structure

- Fatigue critical details
  - Mast-arm-to-transverse plate connection
  - Column-to-transverse plate connection
  - Mast-arm-to-pole connection
  - Handholes
  - Anchor rods
Mast-arm/Pole-to-Transverse Plate Connection

- **Design criteria**
  - \((\Delta f)_n \leq (\Delta F)_n\)

- **Nominal stress range at mast-arm base**
  - \((\Delta f)_n : \text{depends on tube section property } (D_T, t_T)\)

- **Nominal fatigue resistance**
  - \((\Delta F)_n : \text{depends on connection geometry } (D_T, t_T, t_{TP}, D_{OP}, \text{etc...})\)

- **Fatigue design load (due to galloping)**
  - \(P_G = 21 \overline{f}_F\)
Fatigue Resistance in Proposed Spec.

- Three choices
  - Use Table C11-1
    • Tested details in NCHRP 10-70 for infinite life
  - Use Table 11-2 and equations for tubular structures
  - Appendix D
    • Only for *innovative* details
### Choice 1: Table C11-1

<table>
<thead>
<tr>
<th>Description</th>
<th>Identification of Parameters</th>
<th>Tube Configuration</th>
<th>Detail Parameters</th>
<th>Finite Life Constant, $A \times 10^8$ (ksi)</th>
<th>Threshold, $A F_{TH}$ (ksi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full penetration groove-welded tubes and reverse plate connections with backing ring attached to the plate with a full penetration groove weld, filling the groove with a continuous fillet-weld around the interior face of the backing ring, and the backing ring not welded to the tube</td>
<td></td>
<td>Round</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$M_G = 215$ k-in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_T = 0.239$ in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$D_T = 13$ in</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$(\Delta f)_n = 7.2$ ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Option 1**
- $t_{TP} = 2.0$ in
- $D_{OP} = 4$ in

**Option 2**
- $t_{TP} = 2.5$ in
- $D_{OP} = 7$ in

$(\Delta F)_n = (\Delta F)_{TH} = 10.0$ ksi (Category C)

\[ (\Delta f)_n < (\Delta F)_n \rightarrow \text{infinite life (OK!)} \]
## Choice 2: Table 11-2 / Equations

### Round Full-penetration Groove-welded Tube-to-Transverse Plate Connection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Moment</td>
<td>$M$</td>
<td>215 k-in</td>
</tr>
<tr>
<td>Transverse Plate Thickness</td>
<td>$t_{TP}$</td>
<td>2.0 in</td>
</tr>
<tr>
<td>Tube Thickness</td>
<td>$t_T$</td>
<td>0.239 in</td>
</tr>
<tr>
<td>Tube Diameter</td>
<td>$D_T$</td>
<td>13.0 in</td>
</tr>
<tr>
<td>Number of Fasteners</td>
<td>$N_B$</td>
<td>4</td>
</tr>
<tr>
<td>Bolt Circle Diameter</td>
<td>$D_{BC}$</td>
<td>23.3 in</td>
</tr>
<tr>
<td>Transverse Plate Opening</td>
<td>$D_{OP}$</td>
<td>4 in</td>
</tr>
<tr>
<td>Applied Nominal Stress</td>
<td>$(\Delta f)_n$</td>
<td>7.2 ksi</td>
</tr>
<tr>
<td>Stress Concentration Factor</td>
<td>$K_F$</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>$K_I$</td>
<td>2.9</td>
</tr>
<tr>
<td>Constant Amplitude Fatigue Threshold</td>
<td>$(\Delta F)_{TH}$</td>
<td>10 ksi</td>
</tr>
</tbody>
</table>

OK
Note: Groove-welded Connections

- Existing specification: Category E

- Proposed specification:
  - depending on connection geometry ($t_T$, $D_T$, $t_{TP}$, $D_{BC}$, $D_{OP}$, and $N_B$)
    - Category E, D or C
### Table 11-2

<table>
<thead>
<tr>
<th>Description</th>
<th>Finite Life Constant, $A \times 10^9$ (MPa$^3$ (ksi$^3$))</th>
<th>Threshold, $(\Delta F)^{th}$ (MPa (ksi))</th>
<th>Potential Crack Location</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SECTION 1 — GROOVE-WELDED CONNECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>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.</td>
<td>$K_F \leq 1.6 : 3750$ (11.0)</td>
<td>$K_F \leq 3.2 : 69$ (10.0)</td>
<td>In tube wall along groove-weld toe.</td>
<td>Column-to-base-plate connections. Mast-arm-to-flange-plate connections.</td>
</tr>
<tr>
<td></td>
<td>$1.6 &lt; K_F \leq 2.3 : 1330$ (3.9)</td>
<td>$3.2 &lt; K_F \leq 5.1 : 48$ (7.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$2.3 &lt; K_F \leq 3.0 : 70$ (4.5)</td>
<td>$5.1 &lt; K_F \leq 7.2 : 31$ (4.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SECTION 2 — FILLET-WELDED CONNECTIONS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4 Fillet-welded tube-to-transverse plate connections</td>
<td>$K_F \leq 3.0 : 1330$ (3.9)</td>
<td>$K_F \leq 3.0 : 48$ (7.0)</td>
<td>In tube wall along fillet-weld toe.</td>
<td>Column-to-base-plate or mast-arm-to-flange-plate socket connections.</td>
</tr>
<tr>
<td></td>
<td>$3.0 &lt; K_F \leq 5.7 : 31$ (4.5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>$5.7 &lt; K_F \leq 7.2 : 18$ (2.6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SECTION 3 — ATTACHMENTS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 Tube-to-transverse plate connections stiffened by longitudinal attachments with partial- or full penetration groove-welds, or fillet-welds in which the tube is subjected to longitudinal loading and the welds are wrapped around the attachment termination.</td>
<td>$K_F \leq 2.5 : 3750$ (11.0)</td>
<td>$K_F \leq 5.5 : 48$ (7.0)</td>
<td>In tube wall at the toe of the attachment to tube weld at the termination of attachment.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(See detail 5.4)</td>
<td>(See detail 5.4)</td>
<td>In tube wall at the toe of tube-to-transverse plate weld.</td>
<td></td>
</tr>
</tbody>
</table>
Equation: Groove-weld Connection

\[ K_F = 1.35 + \left( 0.982 - \frac{C_{BC}}{N_B^{0.0029}} \right) \times (1.0 + 17.3 \times t_T) \times \left( 2.60 - \frac{D_T^{1.12}}{2.24} \right) \times \left( \frac{1.0}{C_{OP}^{-0.689} - 0.764} \right) \times t_{TP}^{-1.95} \]

GSCF: Geometric Stress Concentration Factor

2940 Geometric Combinations (FEA Models)
Significance of Geometric Parameters

- $N_B$ neglected
- $C_{BC}$ neglected
- $C_{OP}$ neglected
- $t_T$ neglected
- $D_T$ neglected
Simplified Equations (Unstiffened)...

- **Round Fillet-welded connections**

\[ K_F = 2.16 + \left( 0.908 - 0.924 \frac{C_{BC}}{N_B^{0.0474}} \right) \times \left( 4.54 + 52.1 \times t_T \right) \times (14.6 - 1.17 \times D_T^{1.15}) \times t_{TP}^{-2.36} \]

- **Round Groove-welded connections**

\[ K_F = 2.2 + 4.6 \times (1 - C_{BC}^{0.03}) \times (2 + 15 \times t_T) \times \left( 10 - D_T^{1.2} \right) \times t_{TP}^{-2.5} \]

\[ K_F = 1.35 + \left( 0.982 - \frac{C_{BC}^{0.0674}}{N_B^{0.0029}} \right) \times (1.0 + 17.3 \times t_T) \times \frac{2.60 - \frac{D_T^{1.12}}{2.24}}{C_{GP}^{-0.689} - 0.764} \times t_{TP}^{-1.95} \]

\[ K_F = 1.35 - 16 \times (1 + 15 \times t_T) \times (5 - D_T) \times \left( \frac{C_{BC}^{0.02} - 1}{4 \times C_{OP}^{-0.7} - 3} \right) \times t_{TP}^{-2} \]
Simplified Equations (Stiffened) ...

- Stiffened connections at stiffener termination

\[
K_F = \left( \frac{4.36}{t_T^{0.334}} \frac{t_ST}{t_T^{0.707}} - 1.0 \right) \times \left( \frac{0.160 + 0.864 \times h_{ST}}{1.0 + 1.12 \times h_{ST}} \right) \times \left( 0.519 + 0.257 \frac{D_T}{N_{ST}^{1.42}} \frac{1.60}{t_T^{0.797}} + 0.0293 \frac{0.870}{t_ST^{2.01}} \right)
\]

\[
K_F = \left[ 0.3 + \frac{t_ST^{0.4}}{t_T^{0.7}} \right] \times \left[ 0.9 + 0.4 \frac{D_T^{0.8}}{N_{ST}^{1.2}} \right]
\]

- Stiffened connections at fillet-weld toe on tube wall

\[
K_F = \left[ 9.84 - \frac{D_T}{1.82} + 4.89 \frac{D_T^{1.03}}{N_{ST}^{0.914}} \right] \times \left( \frac{0.129}{h_{ST} + 6.56} \right) \times \left( 0.859 + \frac{2.79}{t_ST^{0.631}} \right) \times \left( 0.802 + \frac{t_{TP}}{12.9} \right)
\]

\[
K_F = \left[ 1.0 + 130 \frac{D_T^{0.15}}{N_{ST}^{1.5}} \right] \times \left( \frac{0.13}{h_{ST} + 7} \right) \times \left[ -1 + \frac{6.5}{t_{ST}^{0.5}} \right] \times \times K_F \text{ of unstiffened}
\]
…… But Comes with a Cost

Proposed Equation

\[ K_F = 1.35 + \left(0.982 - \frac{C_{BC}}{N_B^{0.0029}}\right) \times (1.0 + 17.3 \times t_T) \]

\[ \times \left(2.60 - \frac{D_T^{1.12}}{2.24}\right) \times \left(\frac{1.0}{C_{OP}^{-0.689}} - 0.764\right) \times t_{TP}^{-1.95} \]

Simplified Proposed Equation

\[ K_F = 1.35 - 16 \times (1 + 15 \times t_T) \times (5 - D_T) \times \left(\frac{C_{BC}^{0.02} - 1}{4 \times C_{OP}^{-0.7} - 3}\right) \times t_{TP}^{-2} \]

groove-welded connections
Infinite Life Stress Concentration Factor

- Includes local notch effect

\[ \frac{K_I}{K_F} = (1.76 + 1.83t_T) - 4.76 \times 0.22^K_F \]
## Alternative Design Chart (Groove)

<table>
<thead>
<tr>
<th>Category</th>
<th>COP</th>
<th>CBIC</th>
<th>kT</th>
<th>90%</th>
<th>60%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>4</td>
<td>10</td>
<td>13</td>
<td>18</td>
<td>24</td>
<td>30</td>
</tr>
<tr>
<td>t1</td>
<td>0.125</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.1875</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.25</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.3125</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.375</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.5</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
<tr>
<td></td>
<td>0.625</td>
<td>1.25</td>
<td>1.5</td>
<td>1.75</td>
<td>2</td>
<td>2.25</td>
</tr>
</tbody>
</table>

- **COP**: Critical Operating Parameter
- **CBIC**: Critical Bending Moment Index Category
- **kT**: Critical Torque Index
- **90%**, **60%**, **30%**: Design Values

### Categories
- **Category C**: Normal
- **Category D**: Reduced
- **Category E**: Extreme
- **Combination cannot be used**: For combinations outside the chart"
Effect of Simplification (Groove)
Solution Using Simplified Design Chart

<table>
<thead>
<tr>
<th>CDT</th>
<th>90%</th>
<th>60%</th>
<th>30%</th>
</tr>
</thead>
<tbody>
<tr>
<td>tr</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.125</td>
<td>22.7 ksi</td>
<td>13.3 ksi</td>
<td>C</td>
</tr>
<tr>
<td>0.1875</td>
<td>15.4 ksi</td>
<td>9.0 ksi</td>
<td>C</td>
</tr>
<tr>
<td>0.25</td>
<td>11.8 ksi</td>
<td>6.9 ksi</td>
<td>D</td>
</tr>
<tr>
<td>0.3125</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>0.375</td>
<td>D</td>
<td>D</td>
<td>D</td>
</tr>
<tr>
<td>0.5</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
<tr>
<td>0.625</td>
<td>E</td>
<td>E</td>
<td>E</td>
</tr>
</tbody>
</table>

\( M_G = 215 \, \text{k-in} \)

\( (\Delta f)_n = 9.0 \, \text{ksi} \)

\( (\Delta F)_n = (\Delta F)_\text{TH} = 10.0 \, \text{ksi} \) (C)

or

\( (\Delta f)_n = 6.9 \, \text{ksi} \)

\( (\Delta F)_n = (\Delta F)_\text{TH} = 7.0 \, \text{ksi} \) (D)

\( \therefore (\Delta f)_n < (\Delta F)_n \): Category C

\( \text{or} \)

\( \text{or} \)

\( \therefore (\Delta f)_n < (\Delta F)_n \): Category D

or

\( \therefore (\Delta f)_n < (\Delta F)_n \): Category E

\( \therefore (\Delta f)_n < (\Delta F)_n \): Combination cannot be used
## Summary of Design

<table>
<thead>
<tr>
<th></th>
<th>Groove</th>
<th>Fillet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Table C11-1</td>
<td>Table 11-2 / Equation</td>
</tr>
<tr>
<td></td>
<td>Option 1</td>
<td>Option 2</td>
</tr>
<tr>
<td>$t_{TP}$ (in)</td>
<td>2.0</td>
<td>2.5</td>
</tr>
<tr>
<td>$t_T$ (in)</td>
<td>0.239</td>
<td>0.239</td>
</tr>
<tr>
<td>$D_T$ (in)</td>
<td>13</td>
<td>13</td>
</tr>
<tr>
<td>$D_{BC}$ (in)</td>
<td>23.3</td>
<td>23.3</td>
</tr>
<tr>
<td>$D_{OP}$ (in)</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>$(\Delta f)_n$ (ksi)</td>
<td>7.2</td>
<td>7.2</td>
</tr>
<tr>
<td>$(\Delta F)_n$ (ksi)</td>
<td>10.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Mast-arm-to-column Connection
Design Example 2: Highmast Luminaires

- Fatigue critical detail
  - Pole-to-transverse plate connection
## Option 1: Stiffened Connection

### Stiffened Tube-to-transverse Plate Connection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Moment $M$</td>
<td>4235 k-in</td>
</tr>
<tr>
<td>Transverse Plate Thickness $t_{TP}$</td>
<td>2.0 in</td>
</tr>
<tr>
<td>Tube Thickness $t_T$</td>
<td>0.5 in</td>
</tr>
<tr>
<td>Tube Diameter $D_T$</td>
<td>42.0 in</td>
</tr>
<tr>
<td>Number of Fasteners $N_B$</td>
<td>12</td>
</tr>
<tr>
<td>Bolt Circle Diameter $D_{BC}$</td>
<td>50.0 in</td>
</tr>
<tr>
<td>Number of Stiffeners $N_{ST}$</td>
<td>12</td>
</tr>
<tr>
<td>Height of Stiffeners $h_{ST}$</td>
<td>12.0 in</td>
</tr>
<tr>
<td>Thickness of Stiffeners $t_{ST}$</td>
<td>0.625 in</td>
</tr>
</tbody>
</table>

### Applied Nominal Stress $(\Delta f)_n$

- **Value**: 6.3 ksi

### Stiffener Termination

- **Factor $K_F$**: 2.1
- **Factor $K_I$**: 5.1

### Constant Amplitude Fatigue Threshold $(\Delta F)_{TH}$

- **Value**: 7 ksi
- **OK**

### Fillet-weld on Tube Wall

- **Factor $K_F$**: 1.7
- **Factor $K_I$**: 4.0

### Constant Amplitude Fatigue Threshold $(\Delta F)_{TH}$

- **Value**: 4.5 ksi
- **NOT SAFE**
Option 2 : Groove-weld Connection

### Round Full-penetration Groove-welded Tube-to-Transverse Plate Connection

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied Moment</td>
<td>$M$</td>
</tr>
<tr>
<td>Transverse Plate Thickness, $t_{TP}$</td>
<td>3.5 in</td>
</tr>
<tr>
<td>Tube Thickness, $t_T$</td>
<td>0.5 in</td>
</tr>
<tr>
<td>Tube Diameter, $D_T$</td>
<td>42.0 in</td>
</tr>
<tr>
<td>Number of Fasteners, $N_B$</td>
<td>12</td>
</tr>
<tr>
<td>Bolt Circle Diameter, $D_{BC}$</td>
<td>50.0 in</td>
</tr>
<tr>
<td>Transverse Plate Opening, $D_{OP}$</td>
<td>30 in</td>
</tr>
<tr>
<td>Applied Nominal Stress, $(\Delta f)_n$</td>
<td>6.3 ksi</td>
</tr>
<tr>
<td>Stress Concentration Factor, $K_F$</td>
<td>2.0</td>
</tr>
<tr>
<td>$K_I$</td>
<td>5.0</td>
</tr>
<tr>
<td>Constant Amplitude Fatigue Threshold, $(\Delta F)_{TH}$</td>
<td>7 ksi OK</td>
</tr>
</tbody>
</table>
Note: Stiffened Connections

- Existing specification: E'
- Proposed specification:
  - depending on connection geometry \((N_{ST}, h_{ST}, t_{ST}, D_T, t_T)\)
    - Category D
Choice 3 : Appendix D

- Methodology for assessing fatigue performance of innovative connection details
  - Analytical Protocols
  - Experimental Protocols
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Thank You