Appendix H

Specimen TCBF-B-1 to TCBF-B-4 Design Calculation Sheets
**Building height =** 2 stories

**Typical floor height =** 9 ft

**F1, max =** 300 kip

**F2, max =** 600 kip

**SR =** 4 -

**ratio =** 0.8 -

<table>
<thead>
<tr>
<th>Items</th>
<th>values</th>
<th>units</th>
<th>Items</th>
<th>values</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>240</td>
<td>kip</td>
<td>V1</td>
<td>720</td>
<td>kip</td>
</tr>
<tr>
<td>F2</td>
<td>480</td>
<td>kip</td>
<td>V2</td>
<td>480</td>
<td>kip</td>
</tr>
<tr>
<td>h1</td>
<td>9</td>
<td>ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h2</td>
<td>18</td>
<td>ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>span</td>
<td>20 (beam span)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h</td>
<td>9 (typical floor height)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mbase</td>
<td>13500</td>
<td>kip-ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pcolumn</td>
<td>675</td>
<td>kip</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lbracket</td>
<td>13.45 ft</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Es</td>
<td>29000</td>
<td>ksi</td>
<td></td>
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</table>

**Notes**

: input value

**Materials**

<table>
<thead>
<tr>
<th>Members</th>
<th>Material Type</th>
<th>Fy (ksi)</th>
<th>Fu (ksi)</th>
<th>Ry</th>
<th>Rt</th>
<th>(Ref: Table I-6-1)</th>
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<tbody>
<tr>
<td>Columns</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
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<tr>
<td>Beams</td>
<td>ASTM A992</td>
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<td>65</td>
<td>1.1</td>
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<tr>
<td>Braces</td>
<td>ASTM A500B</td>
<td>46</td>
<td>58</td>
<td>1.4</td>
<td>1.3</td>
<td>(HSS-Square)</td>
</tr>
<tr>
<td>Plates 1</td>
<td>ASTM A36</td>
<td>36</td>
<td>58</td>
<td>1.3</td>
<td>1.2</td>
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<tr>
<td>Plates 2</td>
<td>ASTM A572 Gr.50</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.2</td>
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</table>

**Load Combinations**

Per ASCE-7-2005

**Basic Reference Codes**

AISC Specification for Structural Steel Buildings (March 9, 2005)
AISC Seismic Provisions for Structural Steel Buildings (March 9, 2005)
Pu = 131.72 kip (compression)

L brace = 8.1 ft

k = 1.0

Try section HSS5x5x5/16 (HSS-Square)

As = 5.26 in²

Iₓ = 19.00 in⁴

Zₓ = 9.16 in³

Iᵧ = 19.00 in⁴

b = 5.00 in

h = 5.00 in

t nom = 0.31 in

t des = 0.291 in

rₓ = 1.90 in

rᵧ = 1.90 in

Fᵧ (brace) = 46 ksi

Es = 29000 ksi

Kl/r = 51.05 - Limit = 100.43 OK

Fe = 109.81 ksi

0.44 Fᵧ = 20.24 ksi

φ = 0.90

Φ Pn = 182.74 kip (compression) Check OK

Check Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)

λ ps = 16.07 - b/t = 14.20 OK

(Table I-8-1)

h/t = 14.20 OK

Φ = 0.90

Φ Pn = 217.76 kip (tension) Check OK
<table>
<thead>
<tr>
<th>Parameter</th>
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<tbody>
<tr>
<td>( P_u )</td>
<td>249.37 kip</td>
</tr>
<tr>
<td>( L_{br} )</td>
<td>9 ft</td>
</tr>
<tr>
<td>( k )</td>
<td>1.0</td>
</tr>
<tr>
<td>Try section</td>
<td>HSS6x6x3/8</td>
</tr>
<tr>
<td>( A_s )</td>
<td>7.58 in²</td>
</tr>
<tr>
<td>( Z_x )</td>
<td>15.80 in³</td>
</tr>
<tr>
<td>( b )</td>
<td>6.00 in</td>
</tr>
<tr>
<td>( t_{nom} )</td>
<td>0.38 in</td>
</tr>
<tr>
<td>( r_x )</td>
<td>2.28 in</td>
</tr>
<tr>
<td>( r_y )</td>
<td>2.28 in</td>
</tr>
<tr>
<td>( kL/r )</td>
<td>47.37</td>
</tr>
<tr>
<td>( F_c )</td>
<td>127.55 ksi</td>
</tr>
<tr>
<td>( \phi )</td>
<td>0.90</td>
</tr>
<tr>
<td>( \phi P_n )</td>
<td>269.85 kip</td>
</tr>
<tr>
<td>( F_y ) (brace)</td>
<td>46 ksi</td>
</tr>
<tr>
<td>( E_s )</td>
<td>29000 ksi</td>
</tr>
<tr>
<td>( \lambda_{ps} )</td>
<td>16.07</td>
</tr>
<tr>
<td>( b/t )</td>
<td>14.20</td>
</tr>
<tr>
<td>( h/t )</td>
<td>14.20</td>
</tr>
<tr>
<td>( \phi )</td>
<td>0.90</td>
</tr>
<tr>
<td>( \phi P_n )</td>
<td>313.81 kip</td>
</tr>
</tbody>
</table>

**Check Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)**

- \( KI/r \leq 4\sqrt{E/F_y} \)
- \( \lambda_{ps} \geq 16.07 \)
- \( b/t \geq 14.20 \)
- \( h/t \geq 14.20 \)

**Check Seismic Provisions Limits**

- \( F_c \) = 127.55 ksi
- \( F_y \) = 46 ksi

**Check Tension Force**

- \( \phi P_n = 313.81 \) kip
- **Check OK**
<table>
<thead>
<tr>
<th>Brace to Gusset Plate Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brace</strong></td>
</tr>
<tr>
<td><strong>HSS5x5x5/16</strong></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brace Block Shear</th>
<th>Brace to Gusset Plate Weld</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R_yF_yA_g =</strong> 338.74 kip (T_u)</td>
<td></td>
</tr>
<tr>
<td><strong>F_uA_g =</strong> 305.08 kip (P_u)</td>
<td></td>
</tr>
<tr>
<td><strong>T_u/P_u =</strong> 1.11</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brace</th>
<th>Gusset Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>R_yF_y =</strong> 64.4 ksi</td>
<td></td>
</tr>
<tr>
<td><strong>R_yF_u =</strong> 75.4 ksi</td>
<td></td>
</tr>
<tr>
<td><strong>U =</strong> 0.9</td>
<td></td>
</tr>
<tr>
<td><strong>φ_t =</strong> 0.75 (tensile rupture in net section)</td>
<td></td>
</tr>
<tr>
<td><strong>A_y/A_g =</strong> 1.27 (Net section reinforcement required!)</td>
<td></td>
</tr>
<tr>
<td><strong>φ_t =</strong> 0.90 (tensile yield in gross section)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gusset Plate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>t_gusset =</strong> 0.75 in (estimated)</td>
</tr>
<tr>
<td><strong>t_g =</strong> 0.75 in (use)</td>
</tr>
<tr>
<td><strong>F_y =</strong> 50 ksi</td>
</tr>
<tr>
<td><strong>F_u =</strong> 65 ksi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reinforcement Plates</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A_cut =</strong> 0.51 in²</td>
</tr>
<tr>
<td><strong>A_net =</strong> 4.75 in²</td>
</tr>
<tr>
<td><strong>A_e =</strong> 5.99 in² (Reinforcement required!)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1 = 12 in</th>
<th>B = 5 in</th>
<th>H = 5 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>x_bar = 1.875 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>U =</strong> 0.84 -</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A_e,req =</strong> 5.99 in²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A_net,req =</strong> 7.10 in²</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A_reinf =</strong> 1.17 in² (both sides)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>b_reinf =</strong> 2 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>t_req =</strong> 0.59 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>t_use =</strong> 0.625 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L_plate =</strong> 14 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F_y,plate =</strong> 50 ksi</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>R_yF_yA_g =</strong> 68.75 kip</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>L_weld =</strong> 6 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>weld =</strong> 5 x 1/16 in (fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>φR_n =</strong> 83.51 kip</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Brace Block Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>t_brace =</strong> 0.291 in</td>
</tr>
<tr>
<td><strong>L_req =</strong> 11.15 in</td>
</tr>
<tr>
<td><strong>L_use =</strong> 12 in</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Brace to Gusset Plate Weld</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>L_weld =</strong> 12 in</td>
</tr>
<tr>
<td><strong>weld =</strong> 6 x 1/16 in (fillet)</td>
</tr>
<tr>
<td><strong>φ_b =</strong> 0.75 -</td>
</tr>
</tbody>
</table>
\[ F_{exx} = 70 \text{ ksi} \]
\[ F_w = 42 \text{ ksi} \]
\[ \phi_b \sigma_n = 400.87 \text{ kip OK} \]

### Gusset Plate Block Shear

\[ A_{gv} = 18 \text{ in}^2 \]
\[ A_{nt} = 4.31 \text{ in}^2 \]
\[ U_{bs} = 1 \text{ -} \]
\[ \phi = 0.75 \text{ -} \]
\[ \phi \sigma_n = 615.23 \text{ kip OK} \]

### Whitmore Effective Width

\[ L_{\text{whitmore}} = 20.59 \text{ in (theoretical width)} \]
\[ \phi = 0.90 \text{ -} \]
\[ \phi \sigma_n = 694.86 \text{ kip OK (check gross yield)} \]
<table>
<thead>
<tr>
<th>Brace</th>
<th>HSS6x6x3/8</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_y F_y A_g = 488.152$ kip ($T_u$)</td>
<td></td>
</tr>
<tr>
<td>$F_u A_g = 439.64$ kip ($P_u$)</td>
<td>$T_u/P_u = 1.11$</td>
</tr>
<tr>
<td>$R_y F_y = 64.4$ ksi</td>
<td></td>
</tr>
<tr>
<td>$R_t F_u = 75.4$ ksi</td>
<td></td>
</tr>
<tr>
<td>$U = 0.9$</td>
<td>-</td>
</tr>
<tr>
<td>$\phi_t = 0.75$ (tensile rupture in net section)</td>
<td></td>
</tr>
<tr>
<td>$A_y/A_g = 1.27$ (Net section reinforcement required!)</td>
<td></td>
</tr>
<tr>
<td>$\phi_t = 0.90$ (tensile yield in gross section)</td>
<td></td>
</tr>
<tr>
<td>$t_{gusset} = 0.90$ in (estimated)</td>
<td>$F_y = 50$ ksi</td>
</tr>
<tr>
<td>$t_g = 0.75$ in (use)</td>
<td>$F_u = 65$ ksi</td>
</tr>
<tr>
<td>$A_{cut} = 0.61$ in$^2$</td>
<td></td>
</tr>
<tr>
<td>$A_{net} = 6.97$ in$^2$</td>
<td></td>
</tr>
<tr>
<td>$A_e = 8.63$ in$^2$ (reinforcement required)</td>
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</tr>
</tbody>
</table>

### Reinforcement Plates

<table>
<thead>
<tr>
<th>1</th>
<th>14 in</th>
<th>$A_e, req = 8.63$ in$^2$</th>
<th>$A_{net, req} = 10.29$ in$^2$</th>
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</thead>
<tbody>
<tr>
<td>$x_{bar} = 2.25$ in</td>
<td>$U = 0.84$</td>
<td>(both sides)</td>
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</tr>
<tr>
<td>$A_{reinf} = 1.66$ in$^2$</td>
<td>$b_{reinf} = 3$ in</td>
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</tr>
<tr>
<td>$t_{req} = 0.55$ in</td>
<td>$t_{use} = 0.625$ in</td>
<td>$L_{plate} = 16$ in</td>
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</tr>
<tr>
<td>$F_{y, plate} = 50$ ksi</td>
<td>$R_y F_y A_g = 103.13$ kip</td>
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</tr>
<tr>
<td>$L_{weld} = 7$ in</td>
<td>weld = 6 x 1/16 in (fillet)</td>
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</tr>
<tr>
<td>$\phi R_n = 116.92$ kip</td>
<td>OK</td>
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### Brace Block Shear

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$t_{brace} = 0.349$ in</td>
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</tr>
<tr>
<td>$L_{req} = 13.40$ in</td>
<td>OK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{use} = 14$ in</td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

### Brace to Gusset Plate Weld

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{weld} = 14$ in</td>
<td>weld = 7 x 1/16 in (fillet)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi_b = 0.75$</td>
<td>-</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------</td>
<td>-----</td>
<td>-----</td>
<td></td>
</tr>
<tr>
<td>$F_{exx}$</td>
<td>70</td>
<td>ksi</td>
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</tr>
<tr>
<td>$F_w$</td>
<td>42</td>
<td>ksi</td>
<td></td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>545.63</td>
<td>kip</td>
<td></td>
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<tr>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Gusset Plate Block Shear</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_{gv}$</td>
<td>21</td>
<td>in²</td>
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</tr>
<tr>
<td>$A_{nt}$</td>
<td>5.16</td>
<td>in²</td>
<td></td>
</tr>
<tr>
<td>$U_{bs}$</td>
<td>1</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>723.87</td>
<td>kip</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Whitmore Effective Width</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{whitmore}$</td>
<td>23.90</td>
<td>in</td>
<td></td>
</tr>
<tr>
<td>(theoretical width)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>806.55</td>
<td>kip</td>
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</tr>
<tr>
<td>(check gross yield)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Try

\[ R_y F_y A_g = 338.74 \text{kip} \]
\[ 0.3 P_n = 60.91 \text{kip} \]
\[ V = 185.86 \text{kip} \]
\[ H = 297.06 \text{kip} \]
\[ P_u = 600.00 \text{kip} \] (conservatively)
\[ M_u = 100.97 \text{kip-ft} \] (revised from structural analysis)

\[ \theta = 0.73 \text{(rad) 42.0 (deg)} \]
\[ \sin(\theta) = 0.67 \]
\[ \cos(\theta) = 0.74 \]

\[ V = 185.86 \text{kip} \]
\[ H = 297.06 \text{kip} \]
\[ P_u = 600.00 \text{kip} \] (conservatively)
\[ M_u = 100.97 \text{kip-ft} \] (revised from structural analysis)

\[ \lambda_{p1} = 9.15 \]
\[ \lambda_{p2} = 90.55 \]
\[ L_p = 10.38 \text{ft} \]
\[ c = 1 \]
\[ C_w = 40800 \text{in}^6 \]
\[ S_x = 291 \text{in}^3 \]
\[ L_r = 29.90 \text{ft} \]
\[ L_b = 10 \text{ft} \]
\[ M_p = 1362.5 \text{kip-ft} \]
\[ \phi_{b} = 0.90 \]
\[ \phi_{b} P_n = 1370.46 \text{kip} \]

\[ P_u/\phi_{b} P_n = 0.44 \text{ use (H1-1a)} \]

Check 0.51 OK
<table>
<thead>
<tr>
<th>Title</th>
<th>Lower Beam Design Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>August 16, 2008</td>
</tr>
<tr>
<td>1F</td>
<td></td>
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</table>

### Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_{y}F_{y}A_{g}$</td>
<td>488.15 kip</td>
<td>(1F)</td>
</tr>
<tr>
<td>$R_{y}F_{y}A_{g}$</td>
<td>338.74 kip</td>
<td>(2F)</td>
</tr>
<tr>
<td>$0.3 P_{n}$</td>
<td>89.95 kip</td>
<td>(1F)</td>
</tr>
<tr>
<td>$0.3 P_{n}$</td>
<td>60.91 kip</td>
<td>(2F)</td>
</tr>
<tr>
<td>$V$</td>
<td>285.81 kip</td>
<td></td>
</tr>
<tr>
<td>$H$</td>
<td>317.56 kip</td>
<td></td>
</tr>
<tr>
<td>$P_{u}$</td>
<td>317.56 kip</td>
<td>(conservatively)</td>
</tr>
<tr>
<td>$M_{u}$</td>
<td>170.85 kip-ft</td>
<td>(revised from structural analysis)</td>
</tr>
</tbody>
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### Material Properties

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\theta$</td>
<td>0.73 (rad)</td>
<td>42.0 (deg)</td>
</tr>
<tr>
<td>$V = \sin(\theta)$</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>$H = \cos(\theta)$</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>$V = 285.81$ kip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$H = 317.56$ kip</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$P_{u} = 317.56$ kip</td>
<td>(conservatively)</td>
<td></td>
</tr>
<tr>
<td>$M_{u} = 170.85$ kip-ft</td>
<td>(revised from structural analysis)</td>
<td></td>
</tr>
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### Section Properties

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Description</th>
</tr>
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<tbody>
<tr>
<td>$A_{g}$</td>
<td>20.1 in²</td>
<td></td>
</tr>
<tr>
<td>$I_{x}$</td>
<td>1830 in⁴</td>
<td></td>
</tr>
<tr>
<td>$I_{y}$</td>
<td>70.4 in⁴</td>
<td></td>
</tr>
<tr>
<td>$r_{x}$</td>
<td>9.55 in</td>
<td></td>
</tr>
<tr>
<td>$r_{y}$</td>
<td>1.87 in</td>
<td></td>
</tr>
<tr>
<td>$F_{y}$</td>
<td>50 ksi</td>
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### Stability Analysis

<table>
<thead>
<tr>
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<tr>
<td>$\lambda_{p1}$</td>
<td>9.15</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{p2}$</td>
<td>90.55</td>
<td></td>
</tr>
<tr>
<td>$Z_{x}$</td>
<td>177 in³</td>
<td></td>
</tr>
<tr>
<td>$J$</td>
<td>1.87 in⁴</td>
<td></td>
</tr>
<tr>
<td>$h_{b}$</td>
<td>23.12 in</td>
<td></td>
</tr>
<tr>
<td>$r_{bs}$</td>
<td>2.30 in</td>
<td></td>
</tr>
<tr>
<td>$L_{p}$</td>
<td>6.61 ft</td>
<td></td>
</tr>
<tr>
<td>$c$</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>$w_{24x68}$ (revised from structural analysis)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{b}$</td>
<td>10 ft</td>
<td></td>
</tr>
<tr>
<td>$M_{p}$</td>
<td>737.5 kip-ft</td>
<td></td>
</tr>
<tr>
<td>$F_{cr}$</td>
<td>110.86 ksi</td>
<td></td>
</tr>
<tr>
<td>$M_{n}$</td>
<td>656.87 kip-ft</td>
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### Check

<table>
<thead>
<tr>
<th>Parameter</th>
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<th>Description</th>
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<tbody>
<tr>
<td>$P_{u}/\phi_{c}P_{n}$</td>
<td>0.47</td>
<td>use (H1-1a)</td>
</tr>
<tr>
<td>Check</td>
<td>0.73</td>
<td>OK</td>
</tr>
<tr>
<td>Pu</td>
<td>Mu</td>
<td>L_{\text{column}}</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
<td>-------------------</td>
</tr>
</tbody>
</table>
| 42.58 kip | 126.56 kip-ft | 9 ft | \begin{align*} A_g &= 28.2 \text{ in}^2 \\
I_x &= 833 \text{ in}^4 \\
I_y &= 270 \text{ in}^4 \\
r_x &= 5.44 \text{ in} \\
r_y &= 3.09 \text{ in} \\
F_y &= 50 \text{ ksi} \\
\lambda_{p1} &= 7.22 - b/t = 6.78 \text{ Compact} \\
\lambda_{p2} &= 71.71 - h/tw = 19.82 \text{ Compact} \\
L_p &= 10.91 \text{ ft} \\
c &= 1 \\
C_w &= 9410 \text{ in}^6 \\
S_x &= 131 \text{ in}^3 \\
L_r &= 40.86 \text{ ft} \\
L_b &= 9 \text{ ft} \\
M_p &= 612.5 \text{ kip-ft} \\
\phi_b &= 0.90 \\
\phi_{M_n} &= 551.25 \text{ kip-ft} \\
kl/r &= 34.95 \\
F_c &= 234.28 \text{ ksi} \\
\phi_c &= 0.90 \\
\phi_{P_n} &= 1160.56 \text{ kip} \\
\frac{P_u}{\phi_c P_n} &= 0.04 \text{ use (H1-1b)} \\
\text{Check} &= 0.25 \text{ OK} |
### Column Design Check

\begin{align*}
P_u &= 484.19 \text{ kip (revised from structural analysis)} \\
M_u &= 274.18 \text{ kip-ft (revised from structural analysis)} \\
L_{\text{column}} &= 9 \text{ ft}
\end{align*}

**Try**  
\begin{align*}
A_e &= 28.2 \text{ in}^2 \\
I_x &= 833 \text{ in}^4 \\
I_y &= 270 \text{ in}^4 \\
r_x &= 5.44 \text{ in} \\
r_y &= 3.09 \text{ in}
\end{align*}

\begin{align*}
\lambda_{p1} &= 7.22 \quad \text{Compact} \\
\lambda_{p2} &= 52.56 \quad \text{Compact} \\
L_p &= 10.91 \text{ ft} \\
c &= 1 \\
C_w &= 9410 \text{ in}^6 \\
S_x &= 131 \text{ in}^3 \\
L_r &= 40.86 \text{ ft} \\
L_b &= 9 \text{ ft} \\
M_p &= 612.5 \text{ kip-ft} \\
\phi_b &= 0.90 \\
\phi_b M_n &= 551.25 \text{ kip-ft}
\end{align*}

\begin{align*}
\phi c &= 0.90 \\
\phi c P_n &= 1160.56 \text{ kip} \\
F_e &= 234.28 \text{ ksi} \\
F_y &= 22 \text{ ksi} \\
\phi c &= 0.90 \\
P_u/\phi c P_n &= 0.42 \quad \text{use (H1-1a)}
\end{align*}

Check 0.86 OK
<table>
<thead>
<tr>
<th>Check Column Web Shear Stress</th>
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<tr>
<td>$M_p = 7350$ kip-in</td>
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<tr>
<td>$L = 96.15$ in</td>
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<tr>
<td>$V = 152.89$ kip</td>
</tr>
<tr>
<td>$A_s = 6.99$ in$^2$</td>
</tr>
<tr>
<td>$A_s = d \times tw$</td>
</tr>
<tr>
<td>$S_v = 21.89$ ksi</td>
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<tr>
<td>$S_{v, yield} = 29.00$ ksi</td>
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<td>Elastic</td>
</tr>
<tr>
<td>Type</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>H</td>
</tr>
<tr>
<td>V</td>
</tr>
<tr>
<td>M</td>
</tr>
<tr>
<td>$R_u$</td>
</tr>
<tr>
<td>$d_b$</td>
</tr>
<tr>
<td>$A_b$</td>
</tr>
<tr>
<td>$N_b$</td>
</tr>
<tr>
<td>$R_n$</td>
</tr>
<tr>
<td>$\phi$</td>
</tr>
<tr>
<td>$\phi R_n$</td>
</tr>
<tr>
<td>$L_{c,ex}$</td>
</tr>
<tr>
<td>$L_{c,in}$</td>
</tr>
<tr>
<td>$R_n1$</td>
</tr>
<tr>
<td>$R_n2$</td>
</tr>
<tr>
<td>$L_{c,1}$</td>
</tr>
<tr>
<td>$L_{c,2}$</td>
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<tr>
<td>$t$</td>
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<tr>
<td>$R_n$</td>
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<tr>
<td>$\phi$</td>
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<tr>
<td>$\phi R_n$</td>
</tr>
<tr>
<td>$L_{tab}$</td>
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<tr>
<td>$w_{tab}$</td>
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<tr>
<td>$w$</td>
</tr>
<tr>
<td>$L_{weld}$</td>
</tr>
<tr>
<td>$b_f$</td>
</tr>
<tr>
<td>$t_f$</td>
</tr>
<tr>
<td>d</td>
</tr>
<tr>
<td>$t_w$</td>
</tr>
<tr>
<td>$F_{exx}$</td>
</tr>
<tr>
<td>$F_{w}$</td>
</tr>
<tr>
<td>$w$</td>
</tr>
<tr>
<td>$b_f$</td>
</tr>
<tr>
<td>$t_f$</td>
</tr>
<tr>
<td>d</td>
</tr>
<tr>
<td>$t_w$</td>
</tr>
<tr>
<td>$F_{y,tm}$</td>
</tr>
<tr>
<td>$P_{nt}$</td>
</tr>
<tr>
<td>$P_{nv}$</td>
</tr>
<tr>
<td>$R_n$</td>
</tr>
<tr>
<td>$R_n$</td>
</tr>
<tr>
<td>$R_n$</td>
</tr>
<tr>
<td>$F_{y,bm}$</td>
</tr>
<tr>
<td>$M_n$</td>
</tr>
</tbody>
</table>

**Weld Fillet**

- **Fexx**: 70 ksi
- **Fw**: 42 ksi

**Weld CJP**

- **bt**: 12.8 in
- **tf**: 0.85 in
- **d**: 24.3 in
- **tw**: 0.55 in

---

**Beam-Column Connection**

- **H-14**

---

**August 16, 2008**

---

**Title**: TCBF-B-1 Specimen Design Calculation Sheet

**Date**: August 16, 2008

**Page**: 10

---

**Title**: PEER Report 2013/20

**H-14**
<table>
<thead>
<tr>
<th>Check</th>
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<table>
<thead>
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<th>Check Block Shear</th>
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<table>
<thead>
<tr>
<th>Beam w24x117</th>
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</thead>
<tbody>
<tr>
<td>( A_{gv} = 9.9 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{gt} = 1.925 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{nv} = 6.6 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{nt} = 1.65 \text{ in}^2 )</td>
</tr>
<tr>
<td>( U_{bs} = 0.5 )</td>
</tr>
<tr>
<td>( \phi = 0.75 )</td>
</tr>
<tr>
<td>( F_y = 50 \text{ ksi} )</td>
</tr>
<tr>
<td>( F_u = 65 \text{ ksi} )</td>
</tr>
<tr>
<td>( \phi R_n = 233.27 \text{ kip} \text{ OK} )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Shear Tab</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_{gv} = 8.25 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{gt} = 1.5 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{nv} = 5.5 \text{ in}^2 )</td>
</tr>
<tr>
<td>( A_{nt} = 1.25 \text{ in}^2 )</td>
</tr>
<tr>
<td>( U_{bs} = 0.5 )</td>
</tr>
<tr>
<td>( \phi = 0.75 )</td>
</tr>
<tr>
<td>( F_y = 50 \text{ ksi} )</td>
</tr>
<tr>
<td>( F_u = 65 \text{ ksi} )</td>
</tr>
<tr>
<td>( \phi R_n = 191.34 \text{ kip} \text{ OK} )</td>
</tr>
<tr>
<td>Title</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>2F Braces to Beam Connection</td>
</tr>
</tbody>
</table>

Braces

- **T** = 338.74 kip, \( \sin(\theta) = 0.669 \)
- **C** = 312.69 kip, \( \cos(\theta) = 0.743 \)
- **e** = 12.15 in
- **Shear** = 484.21 kip
- **Tension** = 169.56 kip
- **Moment** = 490.26 kip-ft

\[ t_{\text{gusset}} = 0.75 \text{ in} \]
\[ L = 60 \text{ in} \]
\[ s_v = 10.76 \text{ ksi} \]
\[ s_A = 3.77 \text{ ksi} \]
\[ s_M = 13.07 \text{ ksi} \]
\[ \phi = 0.9 \]

**Fy, gusset** = 50 ksi

**Ratio** = 0.56 OK

\[ L_{\text{whitmore}} = 20.59 \text{ in} \]
\[ L_v = 16 \text{ in} \]

\[ w_{\text{up}} = 10.29 \text{ in} \]
\[ w_{\text{low}} = 20.92 \text{ in} \]

**Whitmeff** = 20.59 in

**\( \phi R_n \)** = 694.86 kip

\( e = 0.5 d \)

**Gusset Plate to Beam Flange**

**Weld Fillet**

- \( F_{\text{exx}} = 70 \text{ ksi} \)
- \( F_w = 42 \text{ ksi} \)
- \( w = 8 \text{ in} \)
- \( L_{\text{weld}} = 60 \text{ in} \)
- \( \phi = 0.75 \)

**Ratio** = 0.77 OK

**Check Beam Web**

- **width** = 60 in

---

**PEER Report 2013/20**

**H-16**
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
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<td>$R_u$</td>
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<tr>
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</tr>
<tr>
<td>$t_w$</td>
<td>0.55 in</td>
</tr>
<tr>
<td>$N$</td>
<td>30 in</td>
</tr>
<tr>
<td>$t_f$</td>
<td>0.85 in</td>
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<tr>
<td>$F_{y,web}$</td>
<td>50 ksi</td>
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<tr>
<td>(\phi)</td>
<td>0.75</td>
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<tr>
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<td>1060.63 kip</td>
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<tr>
<td>(\phi R_n)</td>
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<td>$k_{des}$</td>
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<tr>
<td>(\phi R_n)</td>
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<tr>
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</tr>
<tr>
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</tr>
<tr>
<td>$0.44 F_y$</td>
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<tr>
<td>$L_{c1}$</td>
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<tr>
<td>$L_{ave}$</td>
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</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
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<tr>
<td>$L_c$</td>
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<td>$kL/r$</td>
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<td>$L_{tip}$</td>
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<td>$L_{tip}$</td>
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<tr>
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</tr>
<tr>
<td>$kL/r$</td>
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<td>$L_c$</td>
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<td>$L_{tip}$</td>
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<td>14.13 in</td>
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<tr>
<td>$kL/r$</td>
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<tr>
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<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
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<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
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<tr>
<td>$L_{max}$</td>
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</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
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<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
</tbody>
</table>
Big Gusset Plate for Upper Floor Bracing and Lower Floor Bracing

<table>
<thead>
<tr>
<th>Sway to Right</th>
<th>Sway to Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{U2R} = 338.74 \text{ kip} )</td>
<td>( F_{L2L} = 312.69 \text{ kip} )</td>
</tr>
<tr>
<td>( F_{L2R} = 461.74 \text{ kip} )</td>
<td>( F_{L2R} = 488.15 \text{ kip} )</td>
</tr>
</tbody>
</table>

Beam:
- \( w_{24x68} \)
- \( d = 23.7 \text{ in} \)
- \( L_{c, \text{min}} = 56.77 \text{ in} \)

Column:
- \( w_{12x96} \)
- \( e_c = 6.35 \text{ in} \)
- \( R_{beam} = 22.51 \text{ kip} \) (downward)
- \( L_{b, \text{min}} = 15.99 \text{ in} \)
- \( L_{cu, \text{min}} = 15.30 \text{ in} \)
- \( L_{cl, \text{min}} = 17.76 \text{ in} \)
- \( t_u = 0.75 \text{ in} \)
- \( L_{cu} = 18 \text{ in} \) (use)
- \( L_{cl} = 18 \text{ in} \) (use)
- \( L_c = 59.7 \text{ in} \) (use)
- \( L_b = 23 \text{ in} \) (use)

<table>
<thead>
<tr>
<th>Sway to the Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{U2R} = 226.61 \text{ kip} ) (upward)</td>
</tr>
<tr>
<td>( H_{U2R} = 251.79 \text{ kip} ) (rightward)</td>
</tr>
<tr>
<td>( V_{L2R} = 308.89 \text{ kip} ) (upward)</td>
</tr>
<tr>
<td>( H_{L2R} = 343.21 \text{ kip} ) (leftward)</td>
</tr>
<tr>
<td>( V_{\text{total}} = 512.98 \text{ kip} ) (upward)</td>
</tr>
<tr>
<td>( M = 271.45 \text{ kip-ft} ) (counter-clockwise)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Column-Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>( V_{cu} = 154.67 \text{ kip} ) (downward)</td>
</tr>
<tr>
<td>( f_1 = 5.48 \text{ kip/in} ) (leftward)</td>
</tr>
<tr>
<td>( f_2 = 2.18 \text{ kip/in} ) (leftward)</td>
</tr>
<tr>
<td>( H_{cu} = 68.95 \text{ kip} ) (leftward)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Beam-Side</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H_{bu} = 182.84 \text{ kip} ) (leftward)</td>
</tr>
<tr>
<td>( V_{bu} = 71.94 \text{ kip} ) (downward)</td>
</tr>
<tr>
<td>( M_{cu} = 7.44 \text{ kip-ft} ) (counter-clockwise)</td>
</tr>
<tr>
<td>Parameter</td>
</tr>
<tr>
<td>-----------</td>
</tr>
<tr>
<td>M_{bd}</td>
</tr>
<tr>
<td>Ratio</td>
</tr>
<tr>
<td>V_{cl}</td>
</tr>
<tr>
<td>f_1</td>
</tr>
<tr>
<td>f_2</td>
</tr>
<tr>
<td>H_{cl}</td>
</tr>
<tr>
<td>H_{bl}</td>
</tr>
<tr>
<td>M_{bl}</td>
</tr>
<tr>
<td>M_{cl}</td>
</tr>
<tr>
<td>Ratio</td>
</tr>
<tr>
<td>V_{mid}</td>
</tr>
<tr>
<td>M_{mid}</td>
</tr>
<tr>
<td>H_{mid}</td>
</tr>
<tr>
<td>Ratio</td>
</tr>
</tbody>
</table>

**Weld Size**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>f_v</td>
<td>8.59</td>
<td>kip/in</td>
</tr>
<tr>
<td>f_a</td>
<td>4.98</td>
<td>kip/in (averaged)</td>
</tr>
<tr>
<td>f_b</td>
<td>5.48</td>
<td>kip/in</td>
</tr>
<tr>
<td>f_peak</td>
<td>13.54</td>
<td>kip/in</td>
</tr>
<tr>
<td>f_avg</td>
<td>11.07</td>
<td>kip/in</td>
</tr>
<tr>
<td>f_r</td>
<td>13.84</td>
<td>kip/in 13.84342</td>
</tr>
<tr>
<td>D</td>
<td>4.97</td>
<td>x 1/16 (weld size)</td>
</tr>
<tr>
<td>Use</td>
<td>6</td>
<td>x 1/16 (weld size)</td>
</tr>
</tbody>
</table>
## Fillet Welds with Web Plates

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( P_u )</td>
<td>317.56 kip</td>
</tr>
<tr>
<td>( t_r )</td>
<td>0.59 in</td>
</tr>
<tr>
<td>( b )</td>
<td>8.97 in</td>
</tr>
<tr>
<td>( A_s )</td>
<td>5.25 in²</td>
</tr>
<tr>
<td>( 2A_sF_y )</td>
<td>524.75 kip</td>
</tr>
</tbody>
</table>

\( R_{beam} = 22.51 \) kip (Gravity)

\( L_{tab} = 20.375 \) in | \( t = 0.5 \) in
\( w_{tab} = 8 \) in

### Weld (shear tab)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{exx} )</td>
<td>70 ksi</td>
</tr>
<tr>
<td>( F_w )</td>
<td>42 ksi</td>
</tr>
<tr>
<td>( w )</td>
<td>6 x 1/16 inch</td>
</tr>
<tr>
<td>( \phi_b )</td>
<td>0.75</td>
</tr>
<tr>
<td>( \phi_b R_n )</td>
<td>236.97 kip</td>
</tr>
</tbody>
</table>

\( L_{weld} = 28.375 \) in | \( \text{side} = 1 \) sides

## Shim Plate

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L )</td>
<td>20 in</td>
</tr>
<tr>
<td>( w )</td>
<td>4 in</td>
</tr>
</tbody>
</table>

### Weld (shear tab)

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{exx} )</td>
<td>70 ksi</td>
</tr>
<tr>
<td>( F_w )</td>
<td>42 ksi</td>
</tr>
<tr>
<td>( w )</td>
<td>2.68 x 1/16 inch</td>
</tr>
<tr>
<td>( \phi_b )</td>
<td>0.75</td>
</tr>
<tr>
<td>( \phi_b R_n )</td>
<td>104.45 kip</td>
</tr>
</tbody>
</table>

\( L_{weld} = 28 \) in | \( \text{side} = 1 \) sides (3 sides)
<table>
<thead>
<tr>
<th>Braces to Floor Beam Connection</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Braces</strong></td>
<td><strong>HSS6x6x3/8</strong></td>
</tr>
<tr>
<td>( T = 488.15 ) kip</td>
<td>( \sin(\theta) = 0.669 )</td>
</tr>
<tr>
<td>( C = 461.74 ) kip</td>
<td>( \cos(\theta) = 0.743 )</td>
</tr>
<tr>
<td>( e = 0 ) in</td>
<td>( )</td>
</tr>
<tr>
<td><strong>Shear</strong></td>
<td><strong>706.05 kip</strong></td>
</tr>
<tr>
<td><strong>Tension</strong></td>
<td><strong>242.31 kip</strong></td>
</tr>
<tr>
<td><strong>Moment</strong></td>
<td><strong>0.00 kip-ft</strong></td>
</tr>
<tr>
<td>( t_{\text{gusset}} = 0.75 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( L = 46 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( s_V = 20.47 ) ksi</td>
<td>( )</td>
</tr>
<tr>
<td>( s_M = 0.00 ) ksi</td>
<td>( )</td>
</tr>
<tr>
<td>( \phi = 0.9 )</td>
<td>( )</td>
</tr>
<tr>
<td>( F_{Y, \text{gusset}} = 50 ) ksi</td>
<td>( )</td>
</tr>
<tr>
<td><strong>Ratio</strong></td>
<td><strong>0.80 OK</strong></td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( whitmo = 23.90 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( L_v = 19 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( w_{up} = 11.95 ) in</td>
<td>( A_v = 14.25 ) in2</td>
</tr>
<tr>
<td>( w_{low} = 14.12 ) in</td>
<td>( P_u = 326.56 ) kip</td>
</tr>
<tr>
<td>( whit_{\text{eff}} = 23.90 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( \phi R_n = 806.55 ) kip</td>
<td>( )</td>
</tr>
<tr>
<td><strong>Weld Fillet</strong></td>
<td><strong>(Gusset to beam flange)</strong></td>
</tr>
<tr>
<td>( F_{exx} = 70 ) ksi</td>
<td>( )</td>
</tr>
<tr>
<td>( F_w = 42 ) ksi</td>
<td>( )</td>
</tr>
<tr>
<td>( w = 11 \times \frac{1}{16} ) inch</td>
<td>( s_V = 15.79 ) ksi</td>
</tr>
<tr>
<td>( L_{\text{weld}} = 46 ) in</td>
<td>( s_M = 0.00 ) ksi</td>
</tr>
<tr>
<td>( )</td>
<td>( s_A = 5.42 ) ksi</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( t_{\text{eff}} = 0.486 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( \phi = 0.75 )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>Ratio</strong></td>
<td><strong>0.89 OK</strong></td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td><strong>Check Beam Web</strong></td>
<td><strong>w30x391</strong></td>
</tr>
<tr>
<td>( width = 46 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>( )</td>
<td>( )</td>
</tr>
<tr>
<td>( R_u = 0.00 ) kip</td>
<td>( d = 33.2 ) in</td>
</tr>
<tr>
<td>( t_w = 1.36 ) in</td>
<td>( )</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>(N)</td>
<td>23 in</td>
</tr>
<tr>
<td>(t_f)</td>
<td>2.44 in</td>
</tr>
<tr>
<td>(F_{y,\text{web}})</td>
<td>50 ksi</td>
</tr>
<tr>
<td>(\phi)</td>
<td>0.75</td>
</tr>
<tr>
<td>(R_n)</td>
<td>4450.60 kip</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>3337.95 kip</td>
</tr>
<tr>
<td>(k_{\text{des}})</td>
<td>3.23 in</td>
</tr>
<tr>
<td>(\phi)</td>
<td>1.00</td>
</tr>
<tr>
<td>(R_n)</td>
<td>2662.20 kip</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>2662.20 kip</td>
</tr>
<tr>
<td>(k_{\text{des}})</td>
<td>3.23 in</td>
</tr>
<tr>
<td>(\phi)</td>
<td>1.00</td>
</tr>
<tr>
<td>(R_n)</td>
<td>2662.20 kip</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>2662.20 kip</td>
</tr>
<tr>
<td>(k_{\text{des}})</td>
<td>3.23 in</td>
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</table>

### Check Gusset Plate Buckling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_{eb})</td>
<td>14.84 in</td>
<td></td>
</tr>
<tr>
<td>(k)</td>
<td>1.2</td>
<td>-</td>
</tr>
<tr>
<td>(F_e)</td>
<td>42.32 ksi</td>
<td></td>
</tr>
<tr>
<td>(r)</td>
<td>0.217 in</td>
<td></td>
</tr>
<tr>
<td>(A_g)</td>
<td>17.92 in²</td>
<td></td>
</tr>
<tr>
<td>(\phi)</td>
<td>0.9</td>
<td>-</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>491.88 kip</td>
<td></td>
</tr>
<tr>
<td>(L_{c})</td>
<td>15.88 in</td>
<td></td>
</tr>
<tr>
<td>(L_{c1})</td>
<td>18.06 in</td>
<td></td>
</tr>
<tr>
<td>(L_{c2})</td>
<td>12.56 in</td>
<td></td>
</tr>
<tr>
<td>(L_{\text{max}})</td>
<td>18.56 in</td>
<td></td>
</tr>
<tr>
<td>(L_{\text{ave}})</td>
<td>9.13 in</td>
<td></td>
</tr>
<tr>
<td>(L_{\text{ave}})</td>
<td>14.84 in</td>
<td></td>
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</tbody>
</table>

### Free Edge Buckling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(L_v)</td>
<td>17.88 in</td>
<td></td>
</tr>
<tr>
<td>(L_v/t_e)</td>
<td>23.83</td>
<td>-</td>
</tr>
<tr>
<td>(\text{Limit})</td>
<td>18.06</td>
<td>-</td>
</tr>
<tr>
<td>(\text{Edge stiffener required!})</td>
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<td></td>
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</tbody>
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### Lateral Stability of Beam

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M_r)</td>
<td>6645.83 kip·ft</td>
<td></td>
</tr>
<tr>
<td>(C_d)</td>
<td>1</td>
<td>(Nodal)</td>
</tr>
<tr>
<td>(Z)</td>
<td>1450 in³</td>
<td></td>
</tr>
<tr>
<td>(h_o)</td>
<td>30.76 in</td>
<td>(Nodal)</td>
</tr>
<tr>
<td>(P_{br})</td>
<td>51.85 kip</td>
<td>(Nodal)</td>
</tr>
<tr>
<td>(\beta_{br})</td>
<td>288.07 kip/in</td>
<td>OK</td>
</tr>
<tr>
<td>(L_{pb})</td>
<td>17.05 ft</td>
<td></td>
</tr>
<tr>
<td>(n)</td>
<td>1</td>
<td>OK</td>
</tr>
<tr>
<td>(I_y)</td>
<td>1550 in⁴</td>
<td></td>
</tr>
<tr>
<td>(M_{br})</td>
<td>79.75 kip·ft</td>
<td></td>
</tr>
<tr>
<td>(P_{br})</td>
<td>31.11 kip</td>
<td>(torsional)</td>
</tr>
<tr>
<td>(\beta_{T})</td>
<td>108666 kip-in/rad</td>
<td>(\beta) sec not included</td>
</tr>
<tr>
<td>(\beta_{br})</td>
<td>114.85 kip/in</td>
<td>(torsional)</td>
</tr>
<tr>
<td>(\Delta)</td>
<td>0.27 in</td>
<td></td>
</tr>
</tbody>
</table>
## Column Base Plate Design Check

### Calculation Results

- **$Z_x = 147 \text{ in}^3$**
- **$L = 96.15 \text{ in}$**
- **$F_y = 50 \text{ ksi}$**
- **$V_{M_p} = 152.89 \text{ kip}$**
- **$M_p = 7350 \text{ kip-in}$**
- **$P_u = 484.19 \text{ kip}$**
- **$M_u = 3290.12 \text{ kip-in}$**
- **$N = 31.25 \text{ in}$**
- **$f_{p, \text{max}} = 36 \text{ ksi}$**
- **$B = 28 \text{ in}$**
- **$e = 6.80 \text{ in}$**
- **$q_{\text{max}} = 1008 \text{ kip/in}$**
- **$e_{cr} = 15.38 \text{ in}$** (Small Moment)
- **$Y = 17.66 \text{ in}$**
- **$q = 27.42 \text{ kip/in}$** OK
- **$m = 9.59 \text{ in}$**
- **$f_p = 0.98 \text{ ksi}$**
- **$t_{p, \text{req}} = 2.01 \text{ in}$** eq 3.3.14a (LRFD)
- **$\text{use} = 2.00 \text{ in}$**

### All-thread-rods

- **Type**: ASTM A193 B7
- **$d_{\text{bolt}} = 1.125 \text{ in}$**
- **$F_u = 125 \text{ ksi}$**
- **$F_y = 105 \text{ ksi}$**
- **$F_{at} = 93.75 \text{ ksi}$**
- **$F_{nv} = 50 \text{ ksi}$**
- **$A_b = 0.99 \text{ in}^2$**
- **$\phi = 0.75$**
- **$\phi R_n = 69.89 \text{ kip}$** (tension)
- **$\phi R_n = 37.28 \text{ kip}$** (shear)
- **$F_{PT} = 86.98 \text{ kip}$** (minimum required pretension)
- **$V_u = 152.89 \text{ kip}$** (very conservative assumption)
- **$M_u = 7350 \text{ kip-in}$** (very conservative assumption)
- **$P_u = 600 \text{ kip}$** (very conservative assumption)
- **$\mu = 0.35$** - (class A surface)
- **$SF = 2$** - (safety factor for not having enough bolt pretension force)
<table>
<thead>
<tr>
<th>N_V</th>
<th>10 bolts (for friction shear)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N_M</td>
<td>17 bolts (for bending)</td>
</tr>
<tr>
<td>N_T</td>
<td>9 bolts (for uplifting)</td>
</tr>
<tr>
<td>N_{req,total}</td>
<td>35 bolts</td>
</tr>
<tr>
<td>use</td>
<td>34 bolts</td>
</tr>
<tr>
<td>Title</td>
<td>TCBF-B-1 Specimen Design Calculation Sheet</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>2F</td>
<td>Stub Beam</td>
</tr>
<tr>
<td>F1 =</td>
<td>300 kip</td>
</tr>
<tr>
<td>F2 =</td>
<td>600 kip</td>
</tr>
<tr>
<td>L_{stub} =</td>
<td>19 in</td>
</tr>
<tr>
<td>Beam</td>
<td>w24x117</td>
</tr>
</tbody>
</table>

**Column Dimension List**

- w12x96
- Column:
  - $A_g = 28.2$ in²
  - $I_x = 833$ in⁴
  - $I_y = 270$ in⁴
  - $r_x = 5.44$ in
  - $r_y = 3.09$ in
  - $k_{des} = 1.5$ in
  - $E_s = 29000$ ksi

**Column Web Local Yielding**

- $N = 24.00$ in
- $R_n = 866.25$ kip
- $\phi = 1.00$
- $\phi R_n = 866.25$ kip OK

**Column Web Crippling**

- $R_n = 1382.366$ kip
- $\phi = 0.75$
- $\phi R_n = 1036.77$ kip OK

**Column Flange Local Bending**

- $R_n = 253.13$ kip
- $\phi = 0.90$
- $\phi R_n = 227.81$ kip
- $A_{web} = 12.43$ in²
- $A_s = 34.19$ in²
- $A_{flange} = 21.76$ in²
- $F_{1,flange} = 190.93$ kip
- $F_{2,flange} = 381.87$ kip Continue Plate Required!

**Stub Beam Gross Yielding**

- $A_s (beam) = 34.4$ in²
- $P_y = 1720$ kip OK
### Column Dimension List

**Stub Beam**:
- $F_1 = 300 \text{ kip}$
- $d = 23.7 \text{ in}$
- $L_{\text{stub}} = 19 \text{ in}$
- $F_2 = 600 \text{ kip}$
- $t_w = 0.415 \text{ in}$
- $b = 8.97 \text{ in}$
- $t_f = 0.585 \text{ in}$

**Column**:
- $w24\times68$
- $t_r = 0.585 \text{ in}$

### Column Web Local Yielding

- $N = 24.00 \text{ in}$
- $R_n = 866.25 \text{ kip}$
- $\phi = 1.00$
- $\phi R_n = 866.25 \text{ kip}$  
  **OK**

### Column Web Crippling

- $R_n = 1382.366 \text{ kip}$
- $\phi = 0.75$
- $\phi R_n = 1036.77 \text{ kip}$  
  **OK**

### Column Flange Local Bending

- $R_n = 253.13 \text{ kip}$
- $\phi = 0.90$
- $\phi R_n = 227.81 \text{ kip}$  
  - $A_{\text{web}} = 9.35 \text{ in}^2$
  - $A_s = 19.84 \text{ in}^2$
  - $A_{\text{flange}} = 10.49 \text{ in}^2$
  - $F_{1\text{flange}} = 158.65 \text{ kip}$
  - $F_{2\text{flange}} = 317.31 \text{ kip}$  
  **OK**

### Stub Beam Gross Yielding

- $A_s (\text{beam}) = 20.1 \text{ in}^2$
- $P_y = 1005 \text{ kip}$  
  **OK**
**Title**
TCBF-B-2 Specimen Design Calculation Sheet

**General**

Building height = 2 stories
Typical floor height = 9 ft

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_1_{\text{max}}$</td>
<td>300 kip</td>
<td></td>
</tr>
<tr>
<td>$F_2_{\text{max}}$</td>
<td>600 kip</td>
<td></td>
</tr>
<tr>
<td>SR</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>ratio</td>
<td>0.8</td>
<td></td>
</tr>
</tbody>
</table>

**Calculation Initialize**

<table>
<thead>
<tr>
<th>Items</th>
<th>Values</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_1$</td>
<td>240 kip</td>
<td></td>
</tr>
<tr>
<td>$F_2$</td>
<td>480 kip</td>
<td></td>
</tr>
<tr>
<td>$h_1$</td>
<td>9 ft</td>
<td></td>
</tr>
<tr>
<td>$h_2$</td>
<td>18 ft</td>
<td></td>
</tr>
<tr>
<td>span</td>
<td>20 ft</td>
<td>(beam span)</td>
</tr>
<tr>
<td>$h$</td>
<td>9 ft</td>
<td>(typical floor height)</td>
</tr>
<tr>
<td>$M_{\text{base}}$</td>
<td>13500 kip-ft</td>
<td></td>
</tr>
<tr>
<td>$P_{\text{column}}$</td>
<td>675 kip</td>
<td></td>
</tr>
<tr>
<td>$L_{\text{brace}}$</td>
<td>13.45 ft</td>
<td>(work point to work point)</td>
</tr>
<tr>
<td>$E_s$</td>
<td>29000 ksi</td>
<td></td>
</tr>
</tbody>
</table>

**Notes**

: input value

**Materials**

<table>
<thead>
<tr>
<th>Members</th>
<th>Material Type</th>
<th>$F_y$ (ksi)</th>
<th>$F_u$ (ksi)</th>
<th>$R_y$</th>
<th>$R_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columns</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Beams</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Braces</td>
<td>ASTM A500B</td>
<td>42</td>
<td>58</td>
<td>1.4</td>
<td>1.3</td>
</tr>
<tr>
<td>Plates 1</td>
<td>ASTM A36</td>
<td>36</td>
<td>58</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Bolts</td>
<td>A490</td>
<td>130</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Welds</td>
<td>E70XX</td>
<td>-</td>
<td>70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates 2</td>
<td>ASTM A572 Gr.50</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

(Ref: Table I-6-1)

(HSS-Round)

**Load Combinations**

Per ASCE-7-2005

**Basic Reference Codes**

AISC Specification for Structural Steel Buildings (March 9, 2005)
AISC Seismic Provisions for Structural Steel Buildings (March 9, 2005)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_u$</td>
<td>144.00 kip (compression)</td>
</tr>
<tr>
<td>$L_{brake}$</td>
<td>8.1 ft</td>
</tr>
<tr>
<td>$k$</td>
<td>1.0</td>
</tr>
<tr>
<td>Try section</td>
<td>HSS5x.500 (HSS-Square)</td>
</tr>
<tr>
<td>$A_s$</td>
<td>6.62 in$^2$</td>
</tr>
<tr>
<td>$Z_x$</td>
<td>9.60 in$^3$</td>
</tr>
<tr>
<td>$OD$</td>
<td>5.00 in</td>
</tr>
<tr>
<td>$t_{nom}$</td>
<td>0.50 in</td>
</tr>
<tr>
<td>$r_x$</td>
<td>1.61 in</td>
</tr>
<tr>
<td>$r_y$</td>
<td>1.61 in</td>
</tr>
<tr>
<td>$F_y$ (brace)</td>
<td>42 ksi</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>60.25</td>
</tr>
<tr>
<td>$F_c$</td>
<td>78.85 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90</td>
</tr>
<tr>
<td>$\phi P_n$</td>
<td>200.23 kip (compression) Check OK</td>
</tr>
</tbody>
</table>

Check Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_{ps}$</td>
<td>16.82</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90</td>
</tr>
<tr>
<td>$\phi P_n$</td>
<td>250.24 kip (tension) Check OK</td>
</tr>
</tbody>
</table>

The given design calculations follow the AISC Seismic Provisions 2005 guidelines, ensuring structural integrity under seismic loads.
**TCBF-B-2 Specimen Design Calculation Sheet**

<table>
<thead>
<tr>
<th>Title</th>
<th>1F-Brace</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pu (kip)</td>
<td>252.07</td>
</tr>
<tr>
<td>Lbrace (ft)</td>
<td>9</td>
</tr>
<tr>
<td>k</td>
<td>1.0</td>
</tr>
<tr>
<td>Try section</td>
<td>HSS6x.500</td>
</tr>
</tbody>
</table>

### Structural Properties

- \(A_s = 8.09 \text{ in}^2\)
- \(Z_x = 14.30 \text{ in}^3\)
- \(O_D = 6.00 \text{ in}\)
- \(t_{nom} = 0.50 \text{ in}\)
- \(r_x = 1.96 \text{ in}\)
- \(r_y = 1.96 \text{ in}\)
- \(F_y (brace) = 42 \text{ ksi}\)
- \(kL/r = 55.10\)
- \(F_e = 94.26 \text{ ksi}\)
- \(\phi = 0.90\)
- \(\phi P_n = 253.77 \text{ kip (compression)}\)

**Check Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)**

- \(\lambda_{ps} = 16.82\)
- \(b/t = 0.00\)
- \(h/t = 0.00\)

\[Kl/r \leq 4\sqrt{E/F_y}\]

### Check

- \(\phi P_n = 305.80 \text{ kip (tension)}\)
- \(\phi = 0.90\)
- \(\phi P_n = 253.77 \text{ kip (compression)}\)

**Check**: OK
<table>
<thead>
<tr>
<th>Brace to Gusset Plate Connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brace Block Shear</td>
</tr>
<tr>
<td>Brace to Gusset Plate Weld</td>
</tr>
</tbody>
</table>

**Title:** TCBF-B-2 Specimen Design Calculation Sheet  
**Date:** May 27, 2009  
**Page:** 4

### Brace

**Brace:** HSS5x.500

\[
\begin{align*}
  R_y F_y A_g &= 389.26 \text{ kip} \quad (T_u) \\
  F_u A_g &= 383.96 \text{ kip} \quad (P_u) \\
  T_u / P_u &= 1.01 \\
  R_y F_y &= 58.8 \text{ ksi} \\
  R_y F_u &= 75.4 \text{ ksi} \\
  U &= 0.9 \\
  \phi_t &= 0.75 \quad (\text{tensile rupture in net section}) \\
  A_g / A_g &= 1.16 \quad (\text{Net section reinforcement required!}) \\
  \phi_t &= 0.90 \quad (\text{tensile yield in gross section}) \\
  t_{\text{gusset}} &= 0.87 \text{ in} \quad (\text{estimated}) \\
  t_g &= 0.75 \text{ in} \quad (\text{use}) \\
  A_{\text{cut}} &= 0.81 \text{ in}^2 \\
  A_{\text{net}} &= 5.81 \text{ in}^2 \\
  A_e &= 6.88 \text{ in}^2 \quad (\text{Reinforcement required!})
\end{align*}
\]

#### Reinforcement Plates

<table>
<thead>
<tr>
<th>1</th>
<th>12</th>
<th>in</th>
<th>Section</th>
<th>HSS6x.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>x_{\text{bar}}</td>
<td>1.909859</td>
<td>in</td>
<td>OD</td>
<td>6</td>
</tr>
<tr>
<td>ID</td>
<td>5</td>
<td>in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>0.84</td>
<td>-</td>
<td>Ae,req</td>
<td>6.88</td>
</tr>
<tr>
<td>Ae,req</td>
<td>6.88</td>
<td>in$^2$</td>
<td>A_{\text{net,req}}</td>
<td>8.19</td>
</tr>
<tr>
<td>A_{\text{reinf}}</td>
<td>1.19</td>
<td>in$^2$</td>
<td>(both sides)</td>
<td></td>
</tr>
<tr>
<td>b_{\text{reinf}}</td>
<td>2.38</td>
<td>in</td>
<td>c_{\text{reinf}}</td>
<td>2.32</td>
</tr>
<tr>
<td>t_{\text{req}}</td>
<td>0.50</td>
<td>in</td>
<td>b_{\text{use}}</td>
<td>2.5</td>
</tr>
<tr>
<td>L_{\text{plate}}</td>
<td>14</td>
<td>in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F_{y,\text{plate}}</td>
<td>42</td>
<td>ksi</td>
<td>R_y F_y A_g</td>
<td>73.50</td>
</tr>
<tr>
<td>L_{\text{weld}}</td>
<td>6</td>
<td>in</td>
<td>weld</td>
<td>5</td>
</tr>
<tr>
<td>\phi R_n</td>
<td>83.51</td>
<td>kip</td>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

#### Brace Block Shear

| t_{\text{brace}} | 0.465 | in |
| L_{\text{req}} | 8.02 | in | OK |
| L_{\text{use}} | 12 | in |

#### Brace to Gusset Plate Weld

<p>| L_{\text{weld}} | 12 | in |
| weld | 6 | x 1/16 in |
| \phi_b | 0.75 | - |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{exx}$</td>
<td>70 ksi</td>
<td></td>
</tr>
<tr>
<td>$F_w$</td>
<td>42 ksi</td>
<td></td>
</tr>
<tr>
<td>$\phi_bR_n$</td>
<td>400.87 kip</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Gusset Plate Block Shear**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv}$</td>
<td>18 in$^2$</td>
<td></td>
</tr>
<tr>
<td>$A_{nt}$</td>
<td>4.31 in$^2$</td>
<td></td>
</tr>
<tr>
<td>$U_{bs}$</td>
<td>1 -</td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75 -</td>
<td></td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>615.23 kip</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Whitmore Effective Width**

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{whitmore}$</td>
<td>21.59 in (theoretical width)</td>
<td></td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90 -</td>
<td></td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>728.61 kip</td>
<td>OK (check gross yield)</td>
</tr>
<tr>
<td>Brace Block Shear</td>
<td>Brace to Gusset Plate Weld</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>----------------------------</td>
<td></td>
</tr>
<tr>
<td>$R_yF_yA_g = 475.692 \text{ kip (T_y)}$</td>
<td>$L_{weld} = 14 \text{ in}$</td>
<td></td>
</tr>
<tr>
<td>$F_u A_g = 469.22 \text{ kip (P_y)}$</td>
<td>$L_{weld} = 7 \text{ in} \times 1/16 \text{ in} \text{ (fillet)}$</td>
<td></td>
</tr>
<tr>
<td>$T_y/P_u = 1.01$</td>
<td>$\phi_b = 0.75 \text{ -}$</td>
<td></td>
</tr>
<tr>
<td>$R_y F_y = 58.8 \text{ ksi}$</td>
<td>$\phi_b = 0.75 \text{ (tensile rupture in net section)}$</td>
<td></td>
</tr>
<tr>
<td>$R_y F_u = 75.4 \text{ ksi}$</td>
<td>$A_g/A_g = 1.16 \text{ (Net section reinforcement required!)}$</td>
<td></td>
</tr>
<tr>
<td>$U = 0.9$</td>
<td>$\phi_t = 0.90 \text{ (tensile yield in gross section)}$</td>
<td></td>
</tr>
<tr>
<td>$\phi_t = 0.75$</td>
<td>$t_{gusset} = 0.88 \text{ in (estimated)}$</td>
<td></td>
</tr>
<tr>
<td>$A_g/A_g = 1.16$</td>
<td>$F_y = 50 \text{ ksi}$</td>
<td></td>
</tr>
<tr>
<td>$\phi_t = 0.90$</td>
<td>$t_g = 0.75 \text{ in (use)}$</td>
<td></td>
</tr>
<tr>
<td>$F_u = 65 \text{ ksi}$</td>
<td>$(\text{gusset plate})$</td>
<td></td>
</tr>
<tr>
<td>$A_{cut} = 0.81 \text{ in}^2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_{net} = 7.28 \text{ in}^2$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_e = 8.41 \text{ in}^2 \text{ (reinforcement required)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reinforcement Plates</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$l = 14 \text{ in \ Section \ HSS7x.500}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x_{bar} = 2.23 \text{ in \ OD = 7 \ in \ ID = 6 \ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$U = 0.84$</td>
<td>$A_{req, \text{req}} = 8.41 \text{ in}^2$</td>
<td></td>
</tr>
<tr>
<td>$A = 1.36 \text{ in}^2 \text{ (both sides)}$</td>
<td>$A_{net, \text{req}} = 10.00 \text{ in}^2$</td>
<td></td>
</tr>
<tr>
<td>$b_{reinf} = 2.73 \text{ in \ c_{reinf} = 2.66 \ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{req} = 0.50 \text{ in \ t_{use} = 2.75 \ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{req} = 0.50 \text{ in}$</td>
<td>$L_{plate} = 16 \text{ in}$</td>
<td></td>
</tr>
<tr>
<td>$F_y, \text{plate} = 42 \text{ ksi \ R_yF_yA_g = 80.85 \ kip}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{weld} = 7 \text{ in \ weld = 5 \ x \ 1/16 \ in \ (fillet)}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\phi \text{R}_n = 97.43 \text{ kip \ OK}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brace to Gusset Plate Weld</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$t_{brace} = 0.465 \text{ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{req} = 9.80 \text{ in \ OK}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{use} = 14 \text{ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$L_{weld} = 14 \text{ in}$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td>--------</td>
<td></td>
</tr>
<tr>
<td>$F_{exx}$</td>
<td>70 ksi</td>
<td></td>
</tr>
<tr>
<td>$F_w$</td>
<td>42 ksi</td>
<td></td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>545.63 kip OK</td>
<td></td>
</tr>
</tbody>
</table>

**Gusset Plate Block Shear**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv}$</td>
<td>21 in²</td>
</tr>
<tr>
<td>$A_{nt}$</td>
<td>5.16 in²</td>
</tr>
<tr>
<td>$U_{bs}$</td>
<td>1 -</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75 -</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>723.87 kip OK</td>
</tr>
</tbody>
</table>

**Whitmore Effective Width**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{whitmore}$</td>
<td>24.90 in (theoretical width)</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90 -</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>840.30 kip OK (check gross yield)</td>
</tr>
<tr>
<td>Title</td>
<td>TCBF-B-2 Specimen Design Calculation Sheet</td>
</tr>
<tr>
<td>---------------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>2F</td>
<td>Roof Beam Design Check</td>
</tr>
</tbody>
</table>

R_y F_y A_g = 389.26 kip  \quad \theta = 0.73 \quad \text{(rad)}  \quad 42.0 \quad \text{(deg)}

0.3 P_n = 66.74 kip  \quad \sin(\theta) = 0.67

\cos(\theta) = 0.74

V = 215.75 kip

H = 338.94 kip

P_u = 600.00 kip \quad \text{(conservatively)}

M_u = 88.57 kip-ft \quad \text{(revised from structural analysis)}

Try  \quad \text{w24x117}

A_g = 34.4 \quad \text{in}^2  \quad b_f = 12.8 \quad \text{in}

I_x = 3540 \quad \text{in}^4  \quad t_f = 0.85 \quad \text{in}

I_y = 297 \quad \text{in}^4  \quad d = 24.3 \quad \text{in}

r_x = 10.1 \quad \text{in}  \quad t_w = 0.55 \quad \text{in}

r_y = 2.94 \quad \text{in}  \quad F_y = 50 \quad \text{ksi}

\lambda_{p1} = 9.15  \quad \text{Compact}

\lambda_{p2} = 90.55  \quad \text{Compact}

L_p = 10.38 \quad \text{ft}  \quad Z_x = 327 \quad \text{in}^3

c = 1  \quad \text{-}  \quad J = 6.72 \quad \text{in}^4

C_w = 40800 \quad \text{in}^6  \quad h_c = 23.45 \quad \text{in}

S_x = 291 \quad \text{in}^3  \quad r_{tk} = 3.46 \quad \text{in}

L_r = 29.90 \quad \text{ft}  \quad \text{Brace PT} = 2 \quad \text{-}

L_b = 10 \quad \text{ft}  \quad C_b = 1.0  \quad \text{(Conservatively)}

M_p = 1362.5 \quad \text{kip-ft}  \quad F_{cr} = 248.50 \quad \text{ksi}

\phi_b = 0.90  \quad \text{-}  \quad M_n = 1362.50 \quad \text{kip-ft} \quad \text{(Need Check)}

\phi_b M_n = 1226.25 \quad \text{kip-ft}

k_l/r = 40.82  \quad \text{-}  \quad k = 1.0  \quad \text{-}

F_c = 171.79 \quad \text{ksi}  \quad 0.44 F_y = 22 \quad \text{ksi}

\phi_c = 0.90  \quad \text{-}

\phi_c P_n = 1370.46 \quad \text{kip}

P_u/\phi_c P_n = 0.44 \quad \text{use (H1-1a)}

Check 0.50 \quad \text{OK}
<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-2 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 27, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F</td>
<td>Lower Beam Design Check</td>
<td>Page</td>
<td>7</td>
</tr>
<tr>
<td>$R_y F_y A_g$</td>
<td>kip</td>
<td>(1F)</td>
<td></td>
</tr>
<tr>
<td>$R_y F_y A_g$</td>
<td>kip</td>
<td>(2F)</td>
<td>$\theta = 0.73$ (rad) $\sin(\theta) = 0.67$</td>
</tr>
<tr>
<td>$0.3 P_n$</td>
<td>kip</td>
<td>(1F)</td>
<td>$V = 273.57$ kip</td>
</tr>
<tr>
<td>$0.3 P_n$</td>
<td>kip</td>
<td>(2F)</td>
<td>$H = 303.97$ kip</td>
</tr>
<tr>
<td>$P_u$</td>
<td>kip</td>
<td>(conservatively)</td>
<td></td>
</tr>
<tr>
<td>$M_u$</td>
<td>kip-ft</td>
<td>(revised from structural analysis)</td>
<td></td>
</tr>
</tbody>
</table>

Try

| $A_g$         | in$^2$                                   | $b_t = 8.97$ in |
| $I_x$         | in$^4$                                   | $t_r = 0.585$ in |
| $I_y$         | in$^4$                                   | $d = 23.7$ in |
| $r_x$         | in                                      | $t_w = 0.415$ in |
| $r_y$         | in                                      | $F_y = 50$ ksi |

| $\lambda_{p1}$ | 9.15 | $b/t = 7.67$ Compact |
| $\lambda_{p2}$ | 90.55 | $h/tw = 54.29$ Compact |
| $L_p$          | ft  | $Z_x = 177$ in$^3$ |
| $c$            | -   | $J = 1.87$ in$^4$ |
| $C_w$          | in$^6$ | $h_b = 23.12$ in |
| $S_x$          | in$^3$ | $r_b = 2.30$ in |
| $L_r$          | ft  | Brace PT = 2 |
| $L_b$          | ft  | $C_b = 1.0$ (Conservatively) |
| $M_p$          | kip-ft | $F_{cr} = 110.86$ ksi |
| $\phi_b$      | 0.90 | $M_u = 656.87$ kip-ft OK |
| $\phi_b M_n$  | 591.18 | kip-ft |

| $k l/r$        | 64.17 | $k = 1.0$ |
| $F_c$          | ksi | 0.44 $F_y = 22$ ksi |
| $\phi_c$      | 0.90 | - |
| $\phi_c P_n$  | 669.33 | kip |

$P_u/\phi_c P_n = 0.45$ use (H1-1a)

Check $0.69$ OK
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_u$</td>
<td>43.94</td>
<td>kip</td>
</tr>
<tr>
<td>$M_u$</td>
<td>110.65</td>
<td>kip-ft</td>
</tr>
<tr>
<td>$L_{\text{column}}$</td>
<td>9</td>
<td>ft</td>
</tr>
</tbody>
</table>

Try: \( w_{12x96} \)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_g$</td>
<td>28.2</td>
<td>in$^2$</td>
</tr>
<tr>
<td>$I_x$</td>
<td>833</td>
<td>in$^4$</td>
</tr>
<tr>
<td>$I_y$</td>
<td>270</td>
<td>in$^4$</td>
</tr>
<tr>
<td>$r_x$</td>
<td>5.44</td>
<td>in</td>
</tr>
<tr>
<td>$r_y$</td>
<td>3.09</td>
<td>in</td>
</tr>
<tr>
<td>$F_y$</td>
<td>50</td>
<td>ksi</td>
</tr>
</tbody>
</table>

\[
\lambda_{p1} = 7.22 \quad \lambda_{p2} = 71.59 \quad \text{Compact}
\]

\[
\lambda_{p1} = 71.59 \quad \lambda_{p2} = 19.82 \quad \text{Compact}
\]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_p$</td>
<td>10.91</td>
<td>ft</td>
</tr>
<tr>
<td>$c$</td>
<td>1</td>
<td>ft</td>
</tr>
<tr>
<td>$C_w$</td>
<td>9410</td>
<td>in$^6$</td>
</tr>
<tr>
<td>$S_x$</td>
<td>131</td>
<td>in$^3$</td>
</tr>
<tr>
<td>$L_r$</td>
<td>40.86</td>
<td>ft</td>
</tr>
</tbody>
</table>

Brace: PT = 0

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_b$</td>
<td>9</td>
<td>ft</td>
</tr>
<tr>
<td>$M_p$</td>
<td>612.5</td>
<td>kip-ft</td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.90</td>
<td>-</td>
</tr>
<tr>
<td>$\phi_bM_n$</td>
<td>551.25</td>
<td>kip-ft</td>
</tr>
</tbody>
</table>

\[
\phi_c = 0.90 \quad \phi_bM_n = 612.50 \quad \text{Need Check}
\]

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$k$</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>$F_c$</td>
<td>234.28</td>
<td>ksi</td>
</tr>
<tr>
<td>$\phi_c$</td>
<td>0.90</td>
<td>-</td>
</tr>
</tbody>
</table>

$P_d/\phi_cP_n = 0.04$ use (H1-1b)

Check: $0.22$ OK
TCBF-B-2 Specimen Design Calculation Sheet

Column Design Check

| \( P_u \) | 493.82 kip | (revised from structural analysis) |
| \( M_u \) | 263.05 kip-ft | (revised from structural analysis) |
| \( L_{\text{column}} \) | 9 ft |

Try \( \text{w12x96} \)

\[
\begin{align*}
A_g &= 28.2 \text{ in}^2 \quad & b_l &= 12.2 \text{ in} \\
I_x &= 833 \text{ in}^4 \\
I_y &= 270 \text{ in}^4 \quad & d &= 12.7 \text{ in} \\
I_x &= 5.44 \text{ in} \\
I_y &= 3.09 \text{ in} \quad & F_y &= 50 \text{ ksi} \\
\lambda_{p1} &= 7.22 \quad & b/t &= 6.78 \quad \text{Compact} \\
\lambda_{p2} &= 52.35 \quad & h/tw &= 19.82 \quad \text{Compact} \\
L_p &= 10.91 \text{ ft} \quad & Z_x &= 147 \text{ in}^3 \\
c &= 1 \quad & J &= 6.85 \text{ in}^4 \\
C_w &= 9410 \text{ in}^6 \quad & h_o &= 11.80 \text{ in} \\
S_x &= 131 \text{ in}^3 \quad & r_{ts} &= 3.49 \text{ in} \\
L_r &= 40.86 \text{ ft} \quad & \text{Brace PT} &= 0 \quad \text{(Conservatively)} \\
L_b &= 9 \text{ ft} \quad & C_b &= 1.0 \\
M_p &= 612.5 \text{ kip-ft} \quad & F_{cr} &= 344.49 \text{ ksi} \\
\phi_b &= 0.90 \quad & M_n &= 612.50 \text{ kip-ft} \quad \text{(Need Check)} \\
\phi_b M_n &= 551.25 \text{ kip-ft} \quad & C_n &= 0.39 \quad - \\
\lambda_p &= 7.22 \quad & b/t &= 6.78 \quad \text{Compact} \\
\lambda = 7.22 \quad & b/t &= 6.78 \quad \text{Compact} \\
L_p &= 10.91 \text{ ft} \quad & Z_x &= 147 \text{ in}^3 \\
c &= 1 \quad & J &= 6.85 \text{ in}^4 \\
C_w &= 9410 \text{ in}^6 \quad & h_o &= 11.80 \text{ in} \\
S_x &= 131 \text{ in}^3 \quad & r_{ts} &= 3.49 \text{ in} \\
L_r &= 40.86 \text{ ft} \quad & \text{Brace PT} &= 0 \quad \text{(Conservatively)} \\
L_b &= 9 \text{ ft} \quad & C_b &= 1.0 \\
M_p &= 612.5 \text{ kip-ft} \quad & F_{cr} &= 344.49 \text{ ksi} \\
\phi_b &= 0.90 \quad & M_n &= 612.50 \text{ kip-ft} \quad \text{(Need Check)} \\
\phi_b M_n &= 551.25 \text{ kip-ft} \quad & C_n &= 0.39 \quad - \\
kl/r &= 34.95 \quad - \quad & k &= 1.0 \quad - \\
F_c &= 234.28 \text{ ksi} \quad & 0.44 F_y &= 22 \text{ ksi} \\
\phi_c &= 0.90 \quad - \\
\phi_c P_n &= 1160.56 \text{ kip} \\
\frac{P_u}{\phi_c P_n} &= 0.43 \quad \text{use (H1-1a)} \\
\text{Check} &= 0.85 \quad \text{OK}
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(M_p)</td>
<td>7350</td>
<td>kip-in</td>
</tr>
<tr>
<td>(L)</td>
<td>96.15</td>
<td>in</td>
</tr>
<tr>
<td>(V)</td>
<td>152.89</td>
<td>kip</td>
</tr>
<tr>
<td>(A_s)</td>
<td>6.99</td>
<td>in(^2)</td>
</tr>
<tr>
<td>(S_y)</td>
<td>21.89</td>
<td>ksi</td>
</tr>
<tr>
<td>(S_{y,yield})</td>
<td>29.00</td>
<td>ksi</td>
</tr>
</tbody>
</table>

### Check Column Web Shear Stress
Title | TCBF-B-2 Specimen Design Calculation Sheet | Date | May 27, 2009
---|---|---|---
2F | Beam-Column Connection | Page | 10

Type Bolted (WUF-B)

H = 169.47 kip
V = 107.88 kip
M = 88.57 kip-ft (revised from structural analysis)

\[ R_u = 200.89 \text{ kip} \]

Try \( d_b = 0.88 \text{ in} \) \( F_u = 150 \text{ ksi} \)

\[ A_b = 0.60 \text{ in}^2 \]
\[ F_{nv} = 75 \text{ ksi} \] (threads excluded)

\[ N_b = 6 \text{ bolts} \] (in one row)

\[ R_n = 270.59 \text{ kip} \] (bolt shear)
\[ L_{c_{\text{ex}}} = 1.5 \text{ in} \]

\[ \phi_b = 0.75 \]
\[ L_{c_{\text{in}}} = 3 \text{ in} \]

\[ \phi_b R_n = 202.94 \text{ kip} \] OK

\[ L_{c1} = 1.03 \text{ in} \] (edge clear distance)
\[ R_{n1} = 46.41 \text{ kip} \]

\[ L_{c2} = 2.06 \text{ in} \] (clear distance)
\[ R_{n2} = 236.25 \text{ kip} \]

\[ t = 0.50 \text{ in} \] (shear tab thickness)

\[ R_n = 1227.66 \text{ kip} \] (combined bolt bearing)

\[ \phi_b = 0.75 \]

\[ \phi_b R_n = 920.74 \text{ kip} \] OK

\[ L_{\text{tab}} = 18 \text{ in} \]
\[ w_{\text{tab}} = 4.5 \text{ in} \]
\[ A_{s_{\text{tab}}} = 9 \text{ in}^2 \]
\[ F_{y_{\text{tab}}} = 50 \text{ ksi} \]
\[ F_{v_{\text{tab}}} = 30.0 \text{ ksi} \]
\[ P_{nt} = 450.00 \text{ kip} \]
\[ P_{nv} = 270.00 \text{ kip} \] OK

Weld Fillet (shear tab)

\[ F_{exx} = 70 \text{ ksi} \]
\[ F_{w} = 42 \text{ ksi} \]
\[ w = 5 \times \frac{1}{16} \text{ inch} \]
\[ \phi_b R_n = 250.54 \text{ kip} \] OK

Weld CJP (top, bottom flanges)

\[ b_f = 12.8 \text{ in} \]
\[ t_f = 0.85 \text{ in} \]
\[ d = 24.3 \text{ in} \]
\[ t_w = 0.55 \text{ in} \]

PEER Report 2013/20

H-39
<table>
<thead>
<tr>
<th>Check Block Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Beam</strong></td>
</tr>
<tr>
<td>w24x117</td>
</tr>
<tr>
<td>$A_{gv}$ = 9.9 in²</td>
</tr>
<tr>
<td>$A_{gt}$ = 1.925 in²</td>
</tr>
<tr>
<td>$A_{nv}$ = 6.6 in²</td>
</tr>
<tr>
<td>$A_{nt}$ = 1.65 in²</td>
</tr>
<tr>
<td>$U_{bs}$ = 0.5</td>
</tr>
<tr>
<td>$\phi$ = 0.75</td>
</tr>
<tr>
<td>$F_y$ = 50 ksi</td>
</tr>
<tr>
<td>$F_u$ = 65 ksi</td>
</tr>
<tr>
<td>$\phi R_n$ = 233.27 kip OK</td>
</tr>
</tbody>
</table>

<p>| <strong>Shear Tab</strong> |
| $A_{gv}$ = 8.25 in² |
| $A_{gt}$ = 1.5 in² |
| $A_{nv}$ = 5.5 in² |
| $A_{nt}$ = 1.25 in² |
| $U_{bs}$ = 0.5 |
| $\phi$ = 0.75 |
| $F_y$ = 50 ksi |
| $F_u$ = 65 ksi |
| $\phi R_n$ = 191.34 kip NG! |</p>
<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-2 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 27, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F</td>
<td>Braces to Beam Connection</td>
<td>Page</td>
<td>11</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Braces</th>
<th>HSS5x.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>( T = 389.26 ) kip</td>
<td>( \sin(\theta) = 0.669 )</td>
</tr>
<tr>
<td>( C = 342.61 ) kip</td>
<td>( \cos(\theta) = 0.743 )</td>
</tr>
<tr>
<td>( e = 12.15 ) in</td>
<td></td>
</tr>
<tr>
<td>Shear = 543.99 kip</td>
<td></td>
</tr>
<tr>
<td>Tension = 197.89 kip</td>
<td></td>
</tr>
<tr>
<td>Moment = 550.79 kip-ft</td>
<td></td>
</tr>
<tr>
<td>( t_{gusset} = 0.75 ) in</td>
<td></td>
</tr>
<tr>
<td>( L = 60 ) in</td>
<td></td>
</tr>
<tr>
<td>( s_V = 12.09 ) ksi</td>
<td></td>
</tr>
<tr>
<td>( s_A = 4.40 ) ksi</td>
<td></td>
</tr>
<tr>
<td>( s_M = 14.69 ) ksi</td>
<td></td>
</tr>
<tr>
<td>( \phi = 0.9 )</td>
<td></td>
</tr>
<tr>
<td>( F_{y, gusset} = 50 ) ksi</td>
<td></td>
</tr>
<tr>
<td>Ratio = 0.63 OK</td>
<td></td>
</tr>
</tbody>
</table>

\[ L_{\text{Whitmore}} = 21.59 \text{ in} \quad \text{in} \quad L_{\text{min}} = 59.27 \text{ in} \quad \text{(geometry limit)} \quad \text{OK} \]

\[ L_v = 16 \text{ in} \quad \text{in} \quad L_{v, \text{min}} = 16.05 \text{ in} \quad \text{(geometry limit)} \quad \text{NG!} \]

\[ w_{up} = 10.79 \text{ in} \quad A_v = 12 \text{ in}^2 \]

\[ w_{low} = 20.92 \text{ in} \quad P_u = 260.40 \text{ kip} \]

\[ \text{Whitmeff} = 21.59 \text{ in} \quad \phi R_n = 324 \text{ kip} \quad \text{OK} \]

\[ \phi R_n = 728.61 \text{ kip} \quad \text{OK} \]

---

**Gusset Plate to Beam Flange**

<table>
<thead>
<tr>
<th>Weld</th>
<th>Fillet</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_{exx} = 70 ) ksi</td>
<td></td>
</tr>
<tr>
<td>( F_w = 42 ) ksi</td>
<td>( s_V = 12.82 ) ksi</td>
</tr>
<tr>
<td>( w = 8 \times ) 1/16 inch</td>
<td>( s_M = 15.58 ) ksi</td>
</tr>
<tr>
<td>( L_{\text{weld}} = 60 ) in</td>
<td>( s_A = 4.67 ) ksi</td>
</tr>
<tr>
<td>( \text{side} = 2 ) sides</td>
<td>( f_{\text{peak}} = 23.97 ) ksi</td>
</tr>
<tr>
<td>( t_{\text{eff}} = 0.354 ) in</td>
<td>( f_{\text{avg}} = 20.40 ) ksi</td>
</tr>
<tr>
<td>( \phi = 0.75 ) -</td>
<td>( f_r = 25.50 ) ksi</td>
</tr>
<tr>
<td>Ratio = 0.86 OK</td>
<td>Ratio = 0.81 OK</td>
</tr>
</tbody>
</table>

---

**Check Beam Web**

| width = 60 in |

Beam | \( w24x117 \)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_u$</td>
<td>220.32 kip</td>
</tr>
<tr>
<td>$d$</td>
<td>24.3 in</td>
</tr>
<tr>
<td>$t_w$</td>
<td>0.55 in</td>
</tr>
<tr>
<td>$N$</td>
<td>30 in</td>
</tr>
<tr>
<td>$t_f$</td>
<td>0.85 in</td>
</tr>
<tr>
<td>$F_{y,web}$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$R_n$</td>
<td>1060.63 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>795.47 kip</td>
</tr>
<tr>
<td>$k_{des}$</td>
<td>1.35 in</td>
</tr>
<tr>
<td>$R_n$</td>
<td>1010.63 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>1010.63 kip</td>
</tr>
<tr>
<td>$L_{gb}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$F_c$</td>
<td>29.82 ksi</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$r$</td>
<td>0.217 in</td>
</tr>
<tr>
<td>$A_g$</td>
<td>16.19 in²</td>
</tr>
<tr>
<td>$R_n$</td>
<td>401.31 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>361.18 kip</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{c1}$</td>
<td>11.38 in</td>
</tr>
<tr>
<td>$L_{c2}$</td>
<td>16.94 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$Le$</td>
<td>15.63 in</td>
</tr>
<tr>
<td>$Le/tg$</td>
<td>20.83 -</td>
</tr>
<tr>
<td>Limit</td>
<td>18.06 -</td>
</tr>
<tr>
<td>$M_r$</td>
<td>1498.75 kip-ft</td>
</tr>
<tr>
<td>$Z$</td>
<td>327 in³</td>
</tr>
<tr>
<td>$L_b$</td>
<td>10 ft</td>
</tr>
<tr>
<td>$C_d$</td>
<td>1</td>
</tr>
<tr>
<td>$h_o$</td>
<td>23.45 in</td>
</tr>
<tr>
<td>$L_{pd}$</td>
<td>17.05 ft</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>15.34 kip</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>85.22 kip/in</td>
</tr>
<tr>
<td>$C_b$</td>
<td>1</td>
</tr>
<tr>
<td>$M_{br}$</td>
<td>17.985 kip-ft</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>9.20 kip</td>
</tr>
<tr>
<td>$\beta_T$</td>
<td>28842 kip-in/rad</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>52.45 kip/in</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>0.18 in</td>
</tr>
<tr>
<td>$k_{axial}$</td>
<td>2006.8 kip/in</td>
</tr>
<tr>
<td>$k$</td>
<td>1419 kip/in</td>
</tr>
</tbody>
</table>

**Check Gusset Plate Buckling**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{gb}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>98.0</td>
</tr>
<tr>
<td>$F_c$</td>
<td>29.82 ksi</td>
</tr>
<tr>
<td>$L_c$</td>
<td>14.13 in</td>
</tr>
<tr>
<td>$r$</td>
<td>0.217 in</td>
</tr>
<tr>
<td>$A_g$</td>
<td>16.19 in²</td>
</tr>
<tr>
<td>$R_n$</td>
<td>401.31 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>361.18 kip</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{c1}$</td>
<td>11.38 in</td>
</tr>
<tr>
<td>$L_{c2}$</td>
<td>16.94 in</td>
</tr>
<tr>
<td>$L_{max}$</td>
<td>24.06 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$Le$</td>
<td>15.63 in</td>
</tr>
<tr>
<td>$Le/tg$</td>
<td>20.83 -</td>
</tr>
<tr>
<td>Limit</td>
<td>18.06 -</td>
</tr>
<tr>
<td>$M_r$</td>
<td>1498.75 kip-ft</td>
</tr>
<tr>
<td>$Z$</td>
<td>327 in³</td>
</tr>
<tr>
<td>$L_b$</td>
<td>10 ft</td>
</tr>
<tr>
<td>$C_d$</td>
<td>1</td>
</tr>
<tr>
<td>$h_o$</td>
<td>23.45 in</td>
</tr>
<tr>
<td>$L_{pd}$</td>
<td>17.05 ft</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>15.34 kip</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>85.22 kip/in</td>
</tr>
<tr>
<td>$C_b$</td>
<td>1</td>
</tr>
<tr>
<td>$M_{br}$</td>
<td>17.985 kip-ft</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>9.20 kip</td>
</tr>
<tr>
<td>$\beta_T$</td>
<td>28842 kip-in/rad</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>52.45 kip/in</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>0.18 in</td>
</tr>
<tr>
<td>$k_{axial}$</td>
<td>2006.8 kip/in</td>
</tr>
<tr>
<td>$k$</td>
<td>1419 kip/in</td>
</tr>
</tbody>
</table>

**Free Edge Buckling**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{c1}$</td>
<td>11.38 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$L_{tip}$</td>
<td>21.88 in</td>
</tr>
<tr>
<td>$L_{ave}$</td>
<td>17.68 in</td>
</tr>
</tbody>
</table>

**Lateral Stability of Beam**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_{br}$</td>
<td>17.985 kip-ft</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>9.20 kip</td>
</tr>
<tr>
<td>$\beta_T$</td>
<td>28842 kip-in/rad</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>52.45 kip/in</td>
</tr>
<tr>
<td>$\Delta$</td>
<td>0.18 in</td>
</tr>
</tbody>
</table>

**Kicker**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_g$</td>
<td>1.73 in²</td>
</tr>
<tr>
<td>$L$</td>
<td>25 in</td>
</tr>
<tr>
<td>$k_{axial}$</td>
<td>2006.8 kip/in</td>
</tr>
<tr>
<td>$k$</td>
<td>1419 kip/in</td>
</tr>
</tbody>
</table>
### Big Gusset Plate for Upper Floor Bracing and Lower Floor Bracing

#### Sway to Right
- \( F_{U2R} = 389.26 \text{ kip} \)
- \( F_{L2R} = 434.24 \text{ kip} \)
- \( \cos(\theta_U) = 0.743 \)
- \( \cos(\theta_L) = 0.743 \)

#### Sway to Left
- \( F_{U2L} = 342.61 \text{ kip} \)
- \( F_{L2L} = 475.69 \text{ kip} \)

### Beam
- \( d = 23.7 \text{ in} \)
- \( L_{c,\text{min}} = 58.25 \text{ in} \)

### Column
- \( e_c = 6.35 \text{ in} \)
- \( R_{\text{beam}} = 21.32 \text{ kip} \) (downward)
- \( L_{b,\text{min}} = 16.66 \text{ in} \)
- \( L_{cu,\text{min}} = 16.05 \text{ in} \)
- \( L_{cl,\text{min}} = 18.51 \text{ in} \)
- \( t_g = 0.75 \text{ in} \)
- \( L_{cu} = 18 \text{ in} \) (use)
- \( L_{cl} = 18 \text{ in} \) (use)
- \( L_c = 59.7 \text{ in} \) (use)
- \( L_b = 23 \text{ in} \) (use)
- \( F_y, \text{gusset} = 50 \text{ ksi} \)

### Sway to the Right
- \( V_{U2R} = 260.40 \text{ kip} \) (upward)
- \( H_{U2R} = 289.33 \text{ kip} \) (rightward)
- \( V_{L2R} = 290.49 \text{ kip} \) (upward)
- \( H_{L2R} = 322.77 \text{ kip} \) (leftward)
- \( V_{\text{total}} = 529.57 \text{ kip} \) (upward)
- \( M = 280.23 \text{ kip-ft} \) (counter-clockwise)
- \( V_{cu} = 159.67 \text{ kip} \) (downward)
- \( f_1 = 5.66 \text{ kip/in} \) (leftward)
- \( f_2 = 2.25 \text{ kip/in} \) (leftward)
- \( H_{cu} = 71.18 \text{ kip} \) (leftward)
- \( H_{bu} = 218.16 \text{ kip} \) (leftward)
- \( V_{bu} = 100.73 \text{ kip} \) (downward)
- \( M_{cu} = 7.68 \text{ kip-ft} \) (counter-clockwise)

### Column-Side
- \( s_A = 5.27 \text{ ksi} \)
- \( s_V = 11.83 \text{ ksi} \)
- \( s_M = 2.28 \text{ ksi} \)
- \( s_A = 5.84 \text{ ksi} \)
- \( s_V = 12.65 \text{ ksi} \)

### Beam-Side
- \( s_A = 0.75 \text{ ksi} \)
- \( s_V = 11.83 \text{ ksi} \)
- \( s_M = 7.55 \text{ ksi} \)
- \( s_A = 0.75 \text{ ksi} \)
- \( s_V = 12.65 \text{ ksi} \)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Direction</th>
<th>Unit</th>
<th>Ratio</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_{bs}$</td>
<td>-112.45 kip-ft</td>
<td>clockwise</td>
<td></td>
<td>Ratio = 0.58</td>
<td>OK</td>
</tr>
<tr>
<td>$V_{cl}$</td>
<td>159.67 kip</td>
<td>downward</td>
<td></td>
<td>$s_A = 5.27$ ksi</td>
<td></td>
</tr>
<tr>
<td>$f_1$</td>
<td>5.66 kip/in</td>
<td>rightward</td>
<td></td>
<td>$s_V = 11.83$ ksi</td>
<td></td>
</tr>
<tr>
<td>$f_2$</td>
<td>2.25 kip/in</td>
<td>rightward</td>
<td></td>
<td>$s_M = 2.28$ ksi</td>
<td></td>
</tr>
<tr>
<td>$H_{cl}$</td>
<td>71.18 kip</td>
<td>rightward</td>
<td></td>
<td>Ratio = 0.49</td>
<td>OK</td>
</tr>
<tr>
<td>$H_{bl}$</td>
<td>251.59 kip</td>
<td>rightward</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$V_{bl}$</td>
<td>130.82 kip</td>
<td>downward</td>
<td></td>
<td>$s_A = 7.58$ ksi</td>
<td></td>
</tr>
<tr>
<td>$M_{bs}$</td>
<td>100.71 kip-ft</td>
<td>clockwise</td>
<td></td>
<td>$s_V = 14.58$ ksi</td>
<td></td>
</tr>
<tr>
<td>$M_{cl}$</td>
<td>7.68 kip-ft</td>
<td>counter-clockwise</td>
<td></td>
<td>$s_M = 18.28$ ksi</td>
<td></td>
</tr>
<tr>
<td>$H_{mid}$</td>
<td>0.00 kip</td>
<td>leftward</td>
<td></td>
<td>Ratio = 0.35</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Weld Size**

- $f_v = 8.87$ kip/in
- $f_a = 5.13$ kip/in (averaged)
- $f_b = 5.66$ kip/in
- $f_{peak} = 13.97$ kip/in
- $f_{avg} = 11.43$ kip/in
- $f_r = 14.28$ kip/in

D >= 5.13 x 1/16 (weld size)

Use 6 x 1/16 (weld size)
<table>
<thead>
<tr>
<th>Web</th>
<th>Fillet welds with web plates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flange</td>
<td>CJP weld (T &amp; B)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pu</th>
<th>303.97 kip</th>
</tr>
</thead>
<tbody>
<tr>
<td>tr</td>
<td>0.59 in</td>
</tr>
<tr>
<td>b</td>
<td>8.97 in</td>
</tr>
<tr>
<td>As</td>
<td>5.25 in²</td>
</tr>
</tbody>
</table>

\[ 2*As*F_y = 524.75 \text{ kip} \quad \text{OK} \]

<table>
<thead>
<tr>
<th>R_{beam}</th>
<th>21.32 kip (Gravity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{tab}</td>
<td>20.375 in</td>
</tr>
<tr>
<td>( w_{tab} )</td>
<td>8 in</td>
</tr>
<tr>
<td>Weld</td>
<td>Fillet (shear tab)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F_{exx}</th>
<th>70 ksi</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_{w}</td>
<td>42 ksi</td>
</tr>
<tr>
<td>w</td>
<td>6 in x 1/16 inch</td>
</tr>
</tbody>
</table>

\[ \phi_b R_n = 236.97 \text{ kip} \quad \text{OK} \]

L_{weld} = 28.375 in
side = 1 sides

Shim Plate

<table>
<thead>
<tr>
<th>L</th>
<th>20 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>w</td>
<td>4 in</td>
</tr>
<tr>
<td>Weld</td>
<td>Fillet (shear tab)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F_{exx}</th>
<th>70 ksi</th>
</tr>
</thead>
<tbody>
<tr>
<td>F_{w}</td>
<td>42 ksi</td>
</tr>
<tr>
<td>w</td>
<td>2.68 in x 1/16 inch</td>
</tr>
</tbody>
</table>

\[ \phi_b R_n = 104.45 \text{ kip} \quad \text{OK} \]

L_{weld} = 28 in (3 sides)
side = 1 sides
Braces  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>475.69 kip</td>
</tr>
<tr>
<td>C</td>
<td>434.24 kip</td>
</tr>
<tr>
<td>e</td>
<td>0 in</td>
</tr>
<tr>
<td>Shear</td>
<td>676.34 kip</td>
</tr>
<tr>
<td>Tension</td>
<td>239.00 kip</td>
</tr>
<tr>
<td>Moment</td>
<td>0.00 kip-ft</td>
</tr>
</tbody>
</table>

| t<sub>gusset</sub> | 0.75 in |
| L               | 46 in   |
| s<sub>V</sub>   | 19.60 ksi |
| s<sub>M</sub>   | 0.00 ksi |
| φ              | 0.9 |
| F<sub>y, gusset</sub> | 50 ksi |
| Ratio          | 0.77 OK |

Shear: 676.34 kip  
Tension: 239.00 kip  
Moment: 0.00 kip-ft  

Gusset to beam flange  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>s&lt;sub&gt;V&lt;/sub&gt;</td>
<td>15.12 ksi</td>
</tr>
<tr>
<td>s&lt;sub&gt;M&lt;/sub&gt;</td>
<td>0.00 ksi</td>
</tr>
<tr>
<td>s&lt;sub&gt;A&lt;/sub&gt;</td>
<td>5.34 ksi</td>
</tr>
</tbody>
</table>

L<sub>weld</sub> = 46 in  

<table>
<thead>
<tr>
<th>Weld</th>
<th>Fillet (Gusset to beam flange)</th>
</tr>
</thead>
<tbody>
<tr>
<td>F&lt;sub&gt;exx&lt;/sub&gt;</td>
<td>70 ksi</td>
</tr>
<tr>
<td>F&lt;sub&gt;w&lt;/sub&gt;</td>
<td>42 ksi</td>
</tr>
<tr>
<td>w</td>
<td>11 x 1/16 inch</td>
</tr>
<tr>
<td>L&lt;sub&gt;weld&lt;/sub&gt;</td>
<td>46 in</td>
</tr>
<tr>
<td>side</td>
<td>2 sides</td>
</tr>
<tr>
<td>t&lt;sub&gt;eff&lt;/sub&gt;</td>
<td>0.486 in</td>
</tr>
<tr>
<td>φ</td>
<td>0.75 -</td>
</tr>
<tr>
<td>Ratio</td>
<td>0.85 OK</td>
</tr>
</tbody>
</table>

Check Beam Web  

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>width</td>
<td>46 in</td>
</tr>
<tr>
<td>R&lt;sub&gt;u&lt;/sub&gt;</td>
<td>0.00 kip</td>
</tr>
<tr>
<td>d</td>
<td>33.2 in</td>
</tr>
<tr>
<td>t&lt;sub&gt;w&lt;/sub&gt;</td>
<td>1.36 in</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>N = 23 in</td>
<td>t_i = 2.44 in</td>
</tr>
<tr>
<td>φ = 0.75</td>
<td>R_n = 4450.60 kip</td>
</tr>
<tr>
<td>k_{des} = 3.23 in</td>
<td>(web crippling)</td>
</tr>
<tr>
<td>φ = 1.00</td>
<td>R_n = 2662.20 kip</td>
</tr>
<tr>
<td>L_{gb} = 14.84 in</td>
<td>kL/r = 82.2</td>
</tr>
<tr>
<td>k = 1.2</td>
<td>F_e = 42.32 ksi</td>
</tr>
<tr>
<td>r = 0.217 in</td>
<td>0.44 F_y = 22 ksi</td>
</tr>
<tr>
<td>A_g = 18.67 in^2</td>
<td>R_n = 569.41 kip</td>
</tr>
<tr>
<td>φ = 0.9</td>
<td>φR_n = 512.47 kip</td>
</tr>
<tr>
<td>L_{ave} = 14.84 in</td>
<td>OK</td>
</tr>
</tbody>
</table>

**Check Gusset Plate Buckling**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>L_{ave} = 17.88 in</td>
<td>L_{ave} = 14.84 in</td>
</tr>
<tr>
<td>L_{ave}/t_g = 23.83</td>
<td>-</td>
</tr>
<tr>
<td>Limit = 18.06</td>
<td>Edge stiffener required!</td>
</tr>
</tbody>
</table>

**Free Edge Buckling**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>M_r = 6645.83 kip-ft</td>
<td>Z = 1450 in^3</td>
</tr>
<tr>
<td>C_d = 1</td>
<td>h_o = 30.76 in</td>
</tr>
<tr>
<td>P_{br} = 51.85 kip</td>
<td>β_{br} = 288.07 kip/in</td>
</tr>
<tr>
<td>(Nodal)</td>
<td>(Nodal)</td>
</tr>
<tr>
<td>M_{br} = 79.75 kip-ft</td>
<td>I_y = 1550 in^4</td>
</tr>
<tr>
<td>P_{br} = 31.11 kip</td>
<td>(torsional)</td>
</tr>
<tr>
<td>β_T = 108666 kip-in/rad</td>
<td>β_{sec} not included</td>
</tr>
<tr>
<td>β_{br} = 114.85 kip/in</td>
<td>(torsional)</td>
</tr>
<tr>
<td>Δ = 0.27 in</td>
<td>-</td>
</tr>
</tbody>
</table>
### Column Base Plate Design Check

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Z_x$</td>
<td>147</td>
<td>in³</td>
</tr>
<tr>
<td>$F_y$</td>
<td>50</td>
<td>ksi</td>
</tr>
<tr>
<td>$M_p$</td>
<td>7350</td>
<td>kip-in</td>
</tr>
<tr>
<td>$P_u$</td>
<td>493.82</td>
<td>kip</td>
</tr>
<tr>
<td>$M_u$</td>
<td>3156.6</td>
<td>kip-in</td>
</tr>
<tr>
<td>$N$</td>
<td>31.25</td>
<td>in</td>
</tr>
<tr>
<td>$B$</td>
<td>28</td>
<td>in</td>
</tr>
<tr>
<td>$e$</td>
<td>6.39</td>
<td>in</td>
</tr>
<tr>
<td>$e_{cr}$</td>
<td>15.38</td>
<td>in</td>
</tr>
<tr>
<td>$a$</td>
<td>9.59</td>
<td>in</td>
</tr>
<tr>
<td>$q_{max}$</td>
<td>1008</td>
<td>kip/in</td>
</tr>
<tr>
<td>$f_{p, max}$</td>
<td>36</td>
<td>ksi</td>
</tr>
<tr>
<td>$q_{p, req}$</td>
<td>1.99</td>
<td>in</td>
</tr>
<tr>
<td>$tp, use$</td>
<td>2.00</td>
<td>in</td>
</tr>
</tbody>
</table>

### All-thread-rods

- **Type**: ASTM A193 B7
- **$d_{bolt}$**: 1.125 in
- **$F_u$**: 125 ksi
- **$F_y$**: 105 ksi
- **$F_{at}$**: 93.75 ksi
- **$F_{nv}$**: 50 ksi
- **$A_b$**: 0.99 in²
- **$\phi$**: 0.75
- **$\phi R_n$**: 69.89 kip (tension)
- **$\phi R_n$**: 37.28 kip (shear)
- **$F_{PT}$**: 86.98 kip (minimum required pretension)
- **$V_u$**: 152.89 kip (very conservative assumption)
- **$M_u$**: 7350 kip-in (very conservative assumption)
- **$P_u$**: 600 kip (very conservative assumption)
- **$\mu$**: 0.35 (class A surface)
- **SF**: 2 (safety factor for not having enough bolt pretension force)
<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$N_V$</td>
<td>10</td>
<td>bolts (for friction shear)</td>
</tr>
<tr>
<td>$N_M$</td>
<td>17</td>
<td>bolts (for bending)</td>
</tr>
<tr>
<td>$N_T$</td>
<td>9</td>
<td>bolts (for uplifting)</td>
</tr>
<tr>
<td>$N_{req,\ total}$</td>
<td>35</td>
<td>bolts</td>
</tr>
<tr>
<td>$use$</td>
<td>34</td>
<td>bolts</td>
</tr>
</tbody>
</table>
### TCBF-B-2 Specimen Design Calculation Sheet

<table>
<thead>
<tr>
<th>Title</th>
<th>Date</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F</td>
<td>May 27, 2009</td>
<td>16</td>
</tr>
</tbody>
</table>

#### Stub Beam

- $F_1 = 300$ kip, $d = 24.3$ in
- $F_2 = 600$ kip, $t_w = 0.55$ in
- $L_{stub} = 19$ in, $b = 12.8$ in
- Beam: $w_{24\times117}$, $t_f = 0.85$ in

#### Column Dimension List

- **Column**: $w_{12\times96}$
  - $A_g = 28.2$ in$^2$, $b_f = 12.2$ in
  - $I_x = 833$ in$^4$, $t_f = 0.9$ in
  - $I_y = 270$ in$^4$, $d = 12.7$ in
  - $r_x = 5.44$ in, $t_w = 0.55$ in
  - $r_y = 3.09$ in, $F_y = 50$ ksi
  - $k_{des} = 1.5$ in, $E_s = 29000$ ksi

#### Column Web Local Yielding

- $N = 24.00$ in
- $R_n = 866.25$ kip
- $\phi = 1.00$ -
- $\phi R_n = 866.25$ kip, **OK**

#### Column Web Crippling

- $R_n = 1382.366$ kip
- $\phi = 0.75$ -
- $\phi R_n = 1036.77$ kip, **OK**

#### Column Flange Local Bending

- $R_n = 253.13$ kip
- $\phi = 0.90$ -
- $\phi R_n = 227.81$ kip
- $A_{web} = 12.43$ in$^2$, $A_s = 34.19$ in$^2$
- $A_{flange} = 21.76$ in$^2$
- $F_{1_{flange}} = 190.93$ kip
- $F_{2_{flange}} = 381.87$ kip
- **Continue Plate Required!**

#### Stub Beam Gross Yielding

- $A_{s\, (beam)} = 34.4$ in$^2$
- $P_y = 1720$ kip, **OK**
<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-2 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 27, 2009</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>IF</th>
<th>Stub Beam</th>
<th>Page</th>
<th>17</th>
</tr>
</thead>
<tbody>
<tr>
<td>F₁ = 300 kip</td>
<td>d = 23.7 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F₂ = 600 kip</td>
<td>tₚ = 0.415 in</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lstub = 19 in</td>
<td>b = 8.97 in</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Column Dimension List

<table>
<thead>
<tr>
<th>Column</th>
<th>w₁₂x₉₆</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₉ = 28.2 in²</td>
<td>bₙ = 12.2 in</td>
</tr>
<tr>
<td>Iₓ = 833 in⁴</td>
<td>tₙ = 0.9 in</td>
</tr>
<tr>
<td>Iᵧ = 270 in⁴</td>
<td>d = 12.7 in</td>
</tr>
<tr>
<td>rₓ = 5.44 in</td>
<td>tₓ = 0.55 in</td>
</tr>
<tr>
<td>rᵧ = 3.09 in</td>
<td>Fᵧ = 50 ksi</td>
</tr>
<tr>
<td>kₖₑₙ = 1.5 in</td>
<td>Eₛ = 29000 ksi</td>
</tr>
</tbody>
</table>

### Column Web Local Yielding

| N = 24.00 in | Rₙ = 866.25 kip |
| φ = 1.00 | φRₙ = 866.25 kip OK |

### Column Web Crippling

| Rₙ = 1382.366 kip | φ = 0.75 |
| φRₙ = 1036.77 kip | OK |

### Column Flange Local Bending

| Rₙ = 253.13 kip | Aₛ (beam) = 19.84 in² |
| φ = 0.90 | Aₛ (flange) = 10.49 in² |
| φRₙ = 227.81 kip | F₁ (flange) = 158.65 kip |
| F₂ (flange) = 317.31 kip | OK |

### Stub Beam Gross Yielding

| Aₛ (beam) = 20.1 in² | Pₛ = 1005 kip |
| OK |
Building height = 2 stories
Typical floor height = 9 ft

F1, max = 300 kip
F2, max = 600 kip
SR = 4
ratio = 0.8

<table>
<thead>
<tr>
<th>Items</th>
<th>values</th>
<th>units</th>
</tr>
</thead>
<tbody>
<tr>
<td>F1</td>
<td>240</td>
<td>kip</td>
</tr>
<tr>
<td>F2</td>
<td>480</td>
<td>kip</td>
</tr>
<tr>
<td>h1</td>
<td>9</td>
<td>ft</td>
</tr>
<tr>
<td>h2</td>
<td>18</td>
<td>ft</td>
</tr>
<tr>
<td>span</td>
<td>20</td>
<td>ft</td>
</tr>
<tr>
<td>h</td>
<td>9</td>
<td>ft</td>
</tr>
<tr>
<td>M_base</td>
<td>13500</td>
<td>kip-ft</td>
</tr>
<tr>
<td>P_column</td>
<td>675</td>
<td>kip</td>
</tr>
<tr>
<td>L_brace</td>
<td>13.45</td>
<td>ft</td>
</tr>
<tr>
<td>E_s</td>
<td>29000</td>
<td>ksi</td>
</tr>
</tbody>
</table>

Notes: input value

Materials

<table>
<thead>
<tr>
<th>Members</th>
<th>Material Type</th>
<th>Fy (ksi)</th>
<th>Fu (ksi)</th>
<th>Ry</th>
<th>Rt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Columns</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Beams</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Braces</td>
<td>ASTM A992</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.1</td>
</tr>
<tr>
<td>Plates 1</td>
<td>ASTM A36</td>
<td>36</td>
<td>58</td>
<td>1.3</td>
<td>1.2</td>
</tr>
<tr>
<td>Bolts</td>
<td>A490</td>
<td>130</td>
<td>150</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Welds</td>
<td>E70XX</td>
<td>-</td>
<td>70</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Plates 2</td>
<td>ASTM A572 Gr.50</td>
<td>50</td>
<td>65</td>
<td>1.1</td>
<td>1.2</td>
</tr>
</tbody>
</table>

Load Combinations

Per ASCE-7-2005

Basic Reference Codes

AISC Specification for Structural Steel Buildings (March 9, 2005)
AISC Seismic Provisions for Structural Steel Buildings (March 9, 2005)
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_u$</td>
<td>139.67 kip</td>
</tr>
<tr>
<td>$L_{brace}$</td>
<td>8.1 ft</td>
</tr>
<tr>
<td>$k$</td>
<td>1.0</td>
</tr>
<tr>
<td>Try section</td>
<td>W8x21</td>
</tr>
<tr>
<td>$A_s$</td>
<td>6.16 in$^2$</td>
</tr>
<tr>
<td>$I_x$</td>
<td>75.30 in$^4$</td>
</tr>
<tr>
<td>$Z_x$</td>
<td>20.40 in$^3$</td>
</tr>
<tr>
<td>$b_f$</td>
<td>5.27 in</td>
</tr>
<tr>
<td>$t_f$</td>
<td>0.40 in</td>
</tr>
<tr>
<td>$d$</td>
<td>8.28 in</td>
</tr>
<tr>
<td>$t_w$</td>
<td>0.250 in</td>
</tr>
<tr>
<td>$r_x$</td>
<td>3.49 in</td>
</tr>
<tr>
<td>$r_y$</td>
<td>1.26 in</td>
</tr>
<tr>
<td>$F_y$ (brace)</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$E_s$</td>
<td>29000 ksi</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>76.98</td>
</tr>
<tr>
<td>$F_e$</td>
<td>48.29 ksi</td>
</tr>
<tr>
<td>$0.44 F_y$</td>
<td>22 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.90</td>
</tr>
<tr>
<td>$\phi P_n$</td>
<td>179.72 kip</td>
</tr>
</tbody>
</table>

**Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda_{ps}$</td>
<td>7.22</td>
</tr>
<tr>
<td>$Ca$</td>
<td>0.50</td>
</tr>
<tr>
<td>$\lambda_{ps}$</td>
<td>35.88</td>
</tr>
<tr>
<td>$b_f/2t$</td>
<td>6.59</td>
</tr>
<tr>
<td>$h/t_w$</td>
<td>27.50</td>
</tr>
</tbody>
</table>

**Check Compactness**

- $Kl/r = 4\sqrt{E_s/F_y}$

**Tension**

<p>| $\phi$         | 0.90        |
| $\phi P_n$      | 277.20 kip  |</p>
<table>
<thead>
<tr>
<th>P&lt;sub&gt;u&lt;/sub&gt; = 254.24 kip (compression)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L&lt;sub&gt;brace&lt;/sub&gt; = 9 ft</td>
</tr>
<tr>
<td>k = 1.0</td>
</tr>
<tr>
<td>Try section W8x28 (HSS-Square)</td>
</tr>
</tbody>
</table>

| A<sub>s</sub> = 8.24 in<sup>2</sup> | I<sub>x</sub> = 98.00 in<sup>4</sup> |
| Z<sub>x</sub> = 27.20 in<sup>3</sup> | I<sub>y</sub> = 98.00 in<sup>4</sup> |
| b = 6.54 in | t<sub>f</sub> = 0.47 in |
| d = 8.06 in | t<sub>w</sub> = 0.285 in |
| r<sub>x</sub> = 3.45 in | |
| r<sub>y</sub> = 1.62 in |

F<sub>y</sub> (brace) = 50 ksi | E<sub>s</sub> = 29000 ksi | \[ \frac{kL}{r} \leq 4\sqrt{\frac{E}{F_y}} \]  
| Fe = 64.40 ksi | 0.44 F<sub>y</sub> = 22 ksi |
| \( \phi = 0.90 \) |
| \( \phi P_n = 267.92 \) kip (compression) | Check OK |

Check Compactness Seismically (AISC Seismic Provisions 2005, Sec 8.2b)

| \( \lambda_{ps} = 7.22 \) | \( b_f / 2t = 7.03 \) OK |
| Ca = 0.69 | | \( \lambda_{ps} = 35.88 \) | \( h / t_w = 22.30 \) OK |

<p>| ( \phi = 0.90 ) |
| ( \phi P_n = 370.80 ) kip (tension) | Check OK |</p>
<table>
<thead>
<tr>
<th>Brace to Gusset Plate Connection</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Brace Block Shear</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Brace to Gusset Plate Weld</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-3 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 28, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brace</td>
<td>W8x21</td>
<td>Page</td>
<td>4</td>
</tr>
</tbody>
</table>

\[
R_yF_yA_g = 338.80 \text{ kip (T_d)} \\
F_uA_g = 400.40 \text{ kip (P_d)} \\
T_u/P_u = 0.85 -
\]

\[
R_yF_y = 55 \text{ ksi} \\
R_yF_u = 71.5 \text{ ksi} \\
U = 0.9 - \\
\phi_t = 0.75 \text{ (tensile yield in gross section)} \\
A_p/A_g = 1.14 \text{ (Net section reinforcement required!)} \\
\phi_t = 0.90 \text{ (tensile yield in gross section)} \\
t_{gusset} = 0.71 \text{ in (estimated)} \\
t_g = 0.75 \text{ in (use)} \\
F_y = 50 \text{ ksi (gusset plate)} \\
F_u = 65 \text{ ksi}
\]

\[
A_{cut} = 2.57 \text{ in}^2 \\
A_{net} = 3.59 \text{ in}^2 \\
A_e = 6.32 \text{ in}^2 \text{ (Reinforcement required!)}
\]

<table>
<thead>
<tr>
<th>Reinforcement Plates</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>l = 12 \text{ in} &amp; d = 8.28 \text{ in}</th>
</tr>
</thead>
</table>

\[
U = 1.00 - \quad A_{e, req} = 6.32 \text{ in}^2 \quad A_{net, req} = 6.32 \text{ in}^2 \\
A_{reinf} = 1.36 \text{ in}^2 \text{ (both sides)} \\
b_{reinf} = 4 \text{ in} \\
t_{req} = 0.47 \text{ in} \\
t_{use} = 0.5 \text{ in} \\
L_{plate} = 14 \text{ in} \\
F_y, plate = 36 \text{ ksi} \\
R_yF_yA_g = 93.60 \text{ kip} \\
L_{weld} = 6 \text{ in} \\
weld = 6 \times \frac{1}{16} \text{ in (fillet)} \\
\phi R_n = 100.22 \text{ kip} \quad OK
\]

<table>
<thead>
<tr>
<th>Brace Block Shear</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Brace to Gusset Plate Weld</th>
</tr>
</thead>
</table>

| L_{weld} = 12 \text{ in} \\
weld = 6 \times \frac{1}{16} \text{ in (fillet)} \\
\phi_b = 0.75 - |
<table>
<thead>
<tr>
<th></th>
<th>Gusset Plate Block Shear</th>
<th>Whitmore Effective Width</th>
<th>Brace Web Block Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_{exx} = 70$ ksi</td>
<td>$A_{gv} = 18$ in$^2$</td>
<td>$L_{whitmore} = 23.87$ in</td>
<td>$A_{gv} = 3$ in$^2$</td>
</tr>
<tr>
<td>$F_w = 42$ ksi</td>
<td>$A_{nt} = 6.77$ in$^2$</td>
<td></td>
<td>$A_{nt} = 1.19$ in$^2$</td>
</tr>
<tr>
<td>$\phi_{bRn} = 400.87$ kip OK</td>
<td>$U_{bs} = 1$ -</td>
<td></td>
<td>$U_{bs} = 1$ -</td>
</tr>
<tr>
<td></td>
<td>$\phi = 0.75$ -</td>
<td></td>
<td>$\phi = 0.75$ -</td>
</tr>
<tr>
<td></td>
<td>$\phi R_{n} = 735.16$ kip OK</td>
<td></td>
<td>$\phi R_{n} = 125.39$ kip OK</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brace Block Shear</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_y F_y A_{g} = 453.2$ kip (T$_u$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$F_u A_{g} = 535.6$ kip (P$_u$)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$T_u/P_u = 0.85$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R_y F_y = 55$ ksi</td>
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</tr>
<tr>
<td>$R_y F_u = 71.5$ ksi</td>
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</tr>
<tr>
<td>$U = 0.9$</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$\phi_t = 0.75$ (tensile rupture in net section)</td>
<td></td>
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</tr>
<tr>
<td>$A_p/A_g = 1.14$ (Net section reinforcement required!)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$\phi_t = 0.90$ (tensile yield in gross section)</td>
<td></td>
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</tr>
<tr>
<td>$t_{gusset} = 0.77$ in (estimated)</td>
<td></td>
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</tr>
<tr>
<td>$t_g = 0.75$ in (use)</td>
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</tr>
<tr>
<td>$F_y = 50$ ksi</td>
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</tr>
<tr>
<td>$F_u = 65$ ksi</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>$A_{cut} = 2.85$ in$^2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$A_{net} = 5.39$ in$^2$</td>
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</tr>
<tr>
<td>$A_e = 8.45$ in$^2$ (reinforcement required)</td>
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</tr>
<tr>
<td>Reinforcement Plates</td>
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<tr>
<td>------------------</td>
<td></td>
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</tr>
<tr>
<td>$l = 14$ in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$d = 8.06$ in</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$U = 1.00$</td>
<td></td>
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</tr>
<tr>
<td>$A_{reinf} = 1.53$ in$^2$</td>
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</tr>
<tr>
<td>$b_{reinf} = 4$ in</td>
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</tr>
<tr>
<td>$t_{req} = 0.53$ in</td>
<td></td>
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</tr>
<tr>
<td>$t_{use} = 0.625$ in</td>
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<tr>
<td>$L_{plate} = 16$ in</td>
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<tr>
<td>$F_{y, plate} = 36$ ksi</td>
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<tr>
<td>$R_y F_y A_{g} = 99.00$ kip</td>
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</tr>
<tr>
<td>$L_{weld} = 7$ in</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$weld = 6$ x 1/16 in (fillet)</td>
<td></td>
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</tr>
<tr>
<td>$\phi R_n = 116.92$ kip</td>
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</tr>
<tr>
<td>$OK$</td>
<td></td>
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</tr>
<tr>
<td>Brace to Gusset Plate Weld</td>
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<tr>
<td>------------------</td>
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</tr>
<tr>
<td>$L_{weld} = 14$ in</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$weld = 7$ x 1/16 in (fillet)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>$\phi_b = 0.75$</td>
<td></td>
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<td></td>
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</tbody>
</table>

TCBF-B-3 Specimen Design Calculation Sheet

May 28, 2009
<table>
<thead>
<tr>
<th>Gusset Plate Block Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv} = 21 \text{ in}^2$</td>
</tr>
<tr>
<td>$A_{nt} = 6.70 \text{ in}^2$</td>
</tr>
<tr>
<td>$U_{bs} = 1$</td>
</tr>
<tr>
<td>$\phi = 0.75$</td>
</tr>
<tr>
<td>$\phi R_n = 799.19 \text{ kip} \quad \text{OK}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Whitmore Effective Width</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{whitmore} = 25.96 \text{ in}$ (theoretical width)</td>
</tr>
<tr>
<td>$\phi = 0.90$</td>
</tr>
<tr>
<td>$\phi R_n = 876.08 \text{ kip} \quad \text{OK} \quad \text{(check gross yield)}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Brace Web Block Shear</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv} = 3.99 \text{ in}^2$</td>
</tr>
<tr>
<td>$A_{nt} = 1.35 \text{ in}^2$</td>
</tr>
<tr>
<td>$U_{bs} = 1$</td>
</tr>
<tr>
<td>$\phi = 0.75$</td>
</tr>
<tr>
<td>$\phi R_n = 155.77 \text{ kip} \quad \text{OK}$</td>
</tr>
</tbody>
</table>
### Roof Beam Design Check

#### Calculation Sheet

<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-3 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>Page</th>
<th>May 28, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F</td>
<td></td>
<td></td>
<td></td>
<td>6</td>
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</table>

<table>
<thead>
<tr>
<th>R_y F_y A_g</th>
<th>338.80 kip</th>
<th>θ = 0.73 (rad) 42.0 (deg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.3 P_n</td>
<td>59.91 kip</td>
<td>sin(θ) = 0.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>cos(θ) = 0.74</td>
</tr>
<tr>
<td>V</td>
<td>186.57 kip</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>296.36 kip</td>
<td></td>
</tr>
<tr>
<td>P_u</td>
<td>600.00 kip (conservatively)</td>
<td></td>
</tr>
<tr>
<td>M_u</td>
<td>92.46 kip-ft (revised from structural analysis)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Try</th>
<th>w24x117</th>
</tr>
</thead>
<tbody>
<tr>
<td>A_s</td>
<td>34.4 in²</td>
</tr>
<tr>
<td>I_x</td>
<td>3540 in⁴</td>
</tr>
<tr>
<td>I_y</td>
<td>297 in⁴</td>
</tr>
<tr>
<td>r_x</td>
<td>10.1 in</td>
</tr>
<tr>
<td>r_y</td>
<td>2.94 in</td>
</tr>
</tbody>
</table>

| λ_p1 | 9.15 | b/t = 7.53 Compact |
| λ_p2 | 90.55 | h/tw = 41.09 Compact |
| L_p | 10.38 ft | Z_x = 327 in³ |
| c | 1 | J = 6.72 in⁴ |
| C_w | 40800 in⁶ | h_b = 23.45 in |
| S_x | 291 in³ | r_k = 3.46 in |
| L_r | 29.90 ft | Brace PT= 2 |
| L_b | 10 ft | C_b = 1.0 (Conservatively) |
| M_p | 1362.5 kip-ft | F_cr = 248.50 ksi |
| φ_b | 0.90 | M_n = 1362.50 kip-ft (Need Check) |
| φ_b M_n | 1226.25 kip-ft | |

| kl/r | 40.82 | k = 1.0 |
| F_c | 171.79 ksi | 0.44 F_y = 22 ksi |
| φ_c | 0.90 | |
| φ_c P_n | 1370.46 kip |

| P_u/φ_c P_n | 0.44 | use (H1-1a) |

Check 0.50 OK
<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-3 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 28, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>1F</td>
<td>Lower Beam Design Check</td>
<td>Page</td>
<td>7</td>
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</table>

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>$R_y F_y A_g$</td>
<td>453.20 kip</td>
<td>(1F)</td>
</tr>
<tr>
<td>$R_y F_y A_g$</td>
<td>338.80 kip</td>
<td>(2F)</td>
</tr>
<tr>
<td>$\theta$</td>
<td>0.73 radians (rad)</td>
<td></td>
</tr>
<tr>
<td>$\theta$</td>
<td>42.0 degrees (deg)</td>
<td></td>
</tr>
<tr>
<td>$0.3 P_n$</td>
<td>89.31 kip</td>
<td>(1F)</td>
</tr>
<tr>
<td>$\sin(\theta)$</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td>$0.3 P_n$</td>
<td>59.91 kip</td>
<td>(2F)</td>
</tr>
<tr>
<td>$\cos(\theta)$</td>
<td>0.74</td>
<td></td>
</tr>
<tr>
<td>$V$</td>
<td>263.10 kip</td>
<td></td>
</tr>
<tr>
<td>$H$</td>
<td>292.33 kip</td>
<td></td>
</tr>
<tr>
<td>$P_u$</td>
<td>300.00 kip (conservatively)</td>
<td></td>
</tr>
<tr>
<td>$M_u$</td>
<td>160.72 kip-ft (revised from structural analysis)</td>
<td></td>
</tr>
</tbody>
</table>

**Try w24x68**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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</thead>
<tbody>
<tr>
<td>$A_g$</td>
<td>20.1 in$^2$</td>
<td></td>
</tr>
<tr>
<td>$I_x$</td>
<td>1830 in$^4$</td>
<td></td>
</tr>
<tr>
<td>$I_y$</td>
<td>70.4 in$^4$</td>
<td></td>
</tr>
<tr>
<td>$r_x$</td>
<td>9.55 in</td>
<td></td>
</tr>
<tr>
<td>$r_y$</td>
<td>1.87 in</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{p1}$</td>
<td>9.15</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{p2}$</td>
<td>90.55</td>
<td></td>
</tr>
<tr>
<td>$L_p$</td>
<td>6.61 ft</td>
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</tr>
<tr>
<td>$Z_x$</td>
<td>177 in$^3$</td>
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</tr>
<tr>
<td>$h/tw$</td>
<td>54.29</td>
<td></td>
</tr>
<tr>
<td>$C_w$</td>
<td>9430 in$^6$</td>
<td></td>
</tr>
<tr>
<td>$S_x$</td>
<td>154 in$^3$</td>
<td></td>
</tr>
<tr>
<td>$r_{bs}$</td>
<td>2.30 in</td>
<td></td>
</tr>
<tr>
<td>$L_t$</td>
<td>18.74 ft</td>
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</tr>
<tr>
<td>$L_b$</td>
<td>10 ft</td>
<td></td>
</tr>
<tr>
<td>$M_p$</td>
<td>737.5 kip-ft (Conservatively)</td>
<td></td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>$M_n$</td>
<td>656.87 kip-ft</td>
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</tr>
<tr>
<td>$F_e$</td>
<td>69.50 ksi</td>
<td></td>
</tr>
<tr>
<td>$F_{cr}$</td>
<td>110.86 kpsi</td>
<td></td>
</tr>
<tr>
<td>$k$</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>$\phi_c$</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>$\phi_c M_n$</td>
<td>669.33 kip-ft</td>
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</tr>
<tr>
<td>$P_u/\phi_c P_n$</td>
<td>0.45</td>
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</tr>
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<td>Check</td>
<td>0.69 OK</td>
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PEER Report 2013/20

H-60
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>( P_u )</td>
<td>43.55</td>
<td>kip</td>
</tr>
<tr>
<td>( M_u )</td>
<td>115.54</td>
<td>kip-ft</td>
</tr>
<tr>
<td>( L_{\text{column}} )</td>
<td>9</td>
<td>ft</td>
</tr>
<tr>
<td>( A_g )</td>
<td>28.2</td>
<td>in²</td>
</tr>
<tr>
<td>( I_x )</td>
<td>833</td>
<td>in⁴</td>
</tr>
<tr>
<td>( I_y )</td>
<td>270</td>
<td>in⁴</td>
</tr>
<tr>
<td>( r_x )</td>
<td>5.44</td>
<td>in</td>
</tr>
<tr>
<td>( r_y )</td>
<td>3.09</td>
<td>in</td>
</tr>
<tr>
<td>( F_y )</td>
<td>50</td>
<td>ksi</td>
</tr>
<tr>
<td>( \lambda_{p1} )</td>
<td>7.22</td>
<td>-</td>
</tr>
<tr>
<td>( \lambda_{p2} )</td>
<td>71.62</td>
<td>-</td>
</tr>
<tr>
<td>( c )</td>
<td>10.91</td>
<td>ft</td>
</tr>
<tr>
<td>( C_w )</td>
<td>9410</td>
<td>in⁶</td>
</tr>
<tr>
<td>( S_x )</td>
<td>131</td>
<td>in³</td>
</tr>
<tr>
<td>( L_r )</td>
<td>40.86</td>
<td>ft</td>
</tr>
<tr>
<td>( L_b )</td>
<td>9</td>
<td>ft</td>
</tr>
<tr>
<td>( M_b )</td>
<td>612.5</td>
<td>kip-ft</td>
</tr>
<tr>
<td>( \phi_b )</td>
<td>0.90</td>
<td>-</td>
</tr>
<tr>
<td>( \phi_{c}M_n )</td>
<td>551.25</td>
<td>kip-ft</td>
</tr>
<tr>
<td>( k )</td>
<td>1.0</td>
<td>-</td>
</tr>
<tr>
<td>( F_c )</td>
<td>234.28</td>
<td>ksi</td>
</tr>
<tr>
<td>( \phi_{c}P_n )</td>
<td>1160.56</td>
<td>kip</td>
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</tbody>
</table>

Check: \( P_u / \phi_{c}P_n = 0.04 \) use (H1-1b)  
Check: 0.23 OK
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Unit</th>
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<tbody>
<tr>
<td>$P_u$</td>
<td>492.31 kip</td>
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<tr>
<td>$M_u$</td>
<td>259.53 kip-ft</td>
<td></td>
</tr>
<tr>
<td>$L_{column}$</td>
<td>9 ft</td>
<td></td>
</tr>
<tr>
<td>$A_g$</td>
<td>28.2 in$^2$</td>
<td></td>
</tr>
<tr>
<td>$I_x$</td>
<td>833 in$^4$</td>
<td></td>
</tr>
<tr>
<td>$I_y$</td>
<td>270 in$^4$</td>
<td></td>
</tr>
<tr>
<td>$r_x$</td>
<td>5.44 in</td>
<td></td>
</tr>
<tr>
<td>$r_y$</td>
<td>3.09 in</td>
<td></td>
</tr>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{p1}$</td>
<td>7.22</td>
<td></td>
</tr>
<tr>
<td>$\lambda_{p2}$</td>
<td>52.38</td>
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</tr>
<tr>
<td>$L_p$</td>
<td>10.91 ft</td>
<td></td>
</tr>
<tr>
<td>$C_w$</td>
<td>9410 in$^6$</td>
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</tr>
<tr>
<td>$S_x$</td>
<td>131 in$^3$</td>
<td></td>
</tr>
<tr>
<td>$L_r$</td>
<td>40.86 ft</td>
<td></td>
</tr>
<tr>
<td>$L_b$</td>
<td>9 ft</td>
<td></td>
</tr>
<tr>
<td>$M_p$</td>
<td>612.5 kip-ft</td>
<td></td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>$\phi_bM_n$</td>
<td>551.25 kip-ft</td>
<td></td>
</tr>
<tr>
<td>$F_c$</td>
<td>234.28 ksi</td>
<td></td>
</tr>
<tr>
<td>$\phi_c$</td>
<td>0.90</td>
<td></td>
</tr>
<tr>
<td>$\phi_cP_n$</td>
<td>1160.56 kip</td>
<td></td>
</tr>
<tr>
<td>$P_u/\phi_cP_n$</td>
<td>0.42</td>
<td></td>
</tr>
<tr>
<td>Check</td>
<td>0.84</td>
<td>OK</td>
</tr>
</tbody>
</table>

(revised from structural analysis)
Check Column Web Shear Stress

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$M_p$</td>
<td>7350 kip-in</td>
</tr>
<tr>
<td>$L$</td>
<td>96.15 in</td>
</tr>
<tr>
<td>$V$</td>
<td>152.89 kip</td>
</tr>
<tr>
<td>$A_s$</td>
<td>6.99 in$^2$</td>
</tr>
<tr>
<td>$S_y$</td>
<td>21.89 ksi</td>
</tr>
<tr>
<td>$S_{y,\text{yield}}$</td>
<td>29.00 ksi</td>
</tr>
</tbody>
</table>

$A_s = d \times tw$

Elastic
<table>
<thead>
<tr>
<th>Type</th>
<th>Bolted (WUF-B)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>148.18 kip</td>
</tr>
<tr>
<td>V</td>
<td>93.29 kip</td>
</tr>
<tr>
<td>M</td>
<td>92.46 kip-ft (revised from structural analysis)</td>
</tr>
<tr>
<td>$R_u$</td>
<td>175.10 kip</td>
</tr>
<tr>
<td>$d_b$</td>
<td>0.88 in</td>
</tr>
<tr>
<td>$F_u$</td>
<td>150 ksi</td>
</tr>
<tr>
<td>$A_b$</td>
<td>0.60 in$^2$</td>
</tr>
<tr>
<td>$F_{nv}$</td>
<td>75 ksi (threads excluded)</td>
</tr>
<tr>
<td>$N_b$</td>
<td>6 bolts (in one row)</td>
</tr>
<tr>
<td>$R_n$</td>
<td>270.59 kip (bolt shear)</td>
</tr>
<tr>
<td>$L_{c,ex}$</td>
<td>1.5 in</td>
</tr>
<tr>
<td>$L_{c,in}$</td>
<td>3 in</td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.75</td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>202.94 kip OK</td>
</tr>
<tr>
<td>$L_{c1}$</td>
<td>1.03 in (edge clear distance)</td>
</tr>
<tr>
<td>$R_{n1}$</td>
<td>46.41 kip</td>
</tr>
<tr>
<td>$L_{c2}$</td>
<td>2.06 in (clear distance)</td>
</tr>
<tr>
<td>$R_{n2}$</td>
<td>236.25 kip</td>
</tr>
<tr>
<td>$t$</td>
<td>0.50 in (shear tab thickness)</td>
</tr>
<tr>
<td>$R_n$</td>
<td>1227.66 kip (combined bolt bearing)</td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.75</td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>920.74 kip OK</td>
</tr>
<tr>
<td>$L_{tab}$</td>
<td>18 in</td>
</tr>
<tr>
<td>$A_{s,tab}$</td>
<td>9 in$^2$</td>
</tr>
<tr>
<td>$R_n$</td>
<td>524.79 kip</td>
</tr>
<tr>
<td>$F_{exx}$</td>
<td>70 ksi</td>
</tr>
<tr>
<td>$F_{w}$</td>
<td>42 ksi</td>
</tr>
<tr>
<td>$F_{w}$</td>
<td>$0.75$</td>
</tr>
<tr>
<td>$w$</td>
<td>5 x 1/16 inch</td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>250.54 kip OK</td>
</tr>
<tr>
<td>$L_{weld}$</td>
<td>18 in</td>
</tr>
<tr>
<td>side</td>
<td>2 sides</td>
</tr>
<tr>
<td>Weld Fillet</td>
<td>(shear tab)</td>
</tr>
<tr>
<td>Fexx</td>
<td>70 ksi</td>
</tr>
<tr>
<td>Rw</td>
<td>42 ksi</td>
</tr>
<tr>
<td>$\phi_b$</td>
<td>0.75</td>
</tr>
<tr>
<td>$w$</td>
<td>5 x 1/16 inch</td>
</tr>
<tr>
<td>$\phi_b R_n$</td>
<td>250.54 kip OK</td>
</tr>
<tr>
<td>Weld CJP</td>
<td>(top, bottom flanges)</td>
</tr>
<tr>
<td>$b_f$</td>
<td>12.8 in</td>
</tr>
<tr>
<td>$F_{y, bm}$</td>
<td>50 ksi (base metal)</td>
</tr>
<tr>
<td>$t_f$</td>
<td>0.85 in</td>
</tr>
<tr>
<td>$M_n$</td>
<td>1063.07 kip-ft OK</td>
</tr>
<tr>
<td>$d$</td>
<td>24.3 in</td>
</tr>
<tr>
<td>$t_w$</td>
<td>0.55 in</td>
</tr>
<tr>
<td>Check Block Shear</td>
<td></td>
</tr>
<tr>
<td>------------------</td>
<td></td>
</tr>
</tbody>
</table>

**Beam**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv}$</td>
<td>9.9 in$^2$</td>
</tr>
<tr>
<td>$A_{gt}$</td>
<td>1.925 in$^2$</td>
</tr>
<tr>
<td>$A_{nv}$</td>
<td>6.6 in$^2$</td>
</tr>
<tr>
<td>$A_{nt}$</td>
<td>1.65 in$^2$</td>
</tr>
<tr>
<td>$U_{bs}$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>65 ksi</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>233.27 kip OK</td>
</tr>
</tbody>
</table>

**Shear Tab**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_{gv}$</td>
<td>8.25 in$^2$</td>
</tr>
<tr>
<td>$A_{gt}$</td>
<td>1.5 in$^2$</td>
</tr>
<tr>
<td>$A_{nv}$</td>
<td>5.5 in$^2$</td>
</tr>
<tr>
<td>$A_{nt}$</td>
<td>1.25 in$^2$</td>
</tr>
<tr>
<td>$U_{bs}$</td>
<td>0.5</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>65 ksi</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>191.34 kip OK</td>
</tr>
</tbody>
</table>
**Braces to Beam Connection**

<table>
<thead>
<tr>
<th>Title</th>
<th>TCBF-B-3 Specimen Design Calculation Sheet</th>
<th>Date</th>
<th>May 28, 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>2F</td>
<td>Braces to Beam Connection</td>
<td>Page</td>
<td>11</td>
</tr>
</tbody>
</table>

- **Braces**
  - \( T = 338.80 \) kip
  - \( \sin(\theta) = 0.669 \)
  - \( C = 241.62 \) kip
  - \( \cos(\theta) = 0.743 \)
  - \( e = 12.15 \) in
  - **Shear** = 431.42 kip
  - **Tension** = 182.56 kip
  - **Moment** = 436.81 kip-ft

- \( t_{\text{gusset}} = 0.75 \) in
- \( L = 60 \) in
- \( s_V = 9.59 \) ksi
- \( s_A = 4.06 \) ksi
- \( s_M = 11.65 \) ksi
- \( \phi = 0.9 \)
- \( F_{y, \text{gusset}} = 50 \) ksi
- **Ratio** = 0.51 OK

- **L_{\text{whitmore}}** = 23.87 in
- **L_{\nu}** = 16 in
- **L_{\nu, \text{min}}** = 17.74 in

- **L_{\nu}** = 16 in
- **L_{\nu, \text{min}}** = 17.74 in

- **w_{up}** = 11.93 in
- **A_{\nu}** = 12 in²
- **w_{low}** = 20.92 in
- **P_u** = 226.65 kip
- **Whitm_{eff}** = 23.87 in
- \( \phi R_n = 805.56 \) kip

- **Gusset Plate to Beam Flange**

- **Weld**
  - \( F_{exx} = 70 \) ksi
  - \( F_w = 42 \) ksi
  - \( w = 8 \times \frac{1}{16} \) inch
  - \( L_{\text{weld}} = 60 \) in
  - \( s_V = 10.17 \) ksi
  - \( s_M = 12.36 \) ksi
  - \( s_A = 4.30 \) ksi
  - **Side** = 2 sides
  - \( f_{\text{peak}} = 19.52 \) ksi
  - \( f_{\text{avg}} = 16.25 \) ksi
  - \( f_{\nu} = 20.31 \) ksi
  - **Ratio** = 0.68 OK

- **Check Beam Web**
  - **width** = 60 in

---

PEER Report 2013/20

H-66
### Check Gusset Plate Buckling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{gb}$</td>
<td>17.68 in</td>
</tr>
<tr>
<td>$k$</td>
<td>1.2</td>
</tr>
<tr>
<td>$r$</td>
<td>0.217 in</td>
</tr>
<tr>
<td>$A_g$</td>
<td>17.90 in$^2$</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.9</td>
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</tbody>
</table>

### Free Edge Buckling

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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</thead>
<tbody>
<tr>
<td>$L_e$</td>
<td>15.63 in</td>
</tr>
<tr>
<td>$L_{A_e}$</td>
<td>20.83</td>
</tr>
<tr>
<td>Limit</td>
<td>18.06</td>
</tr>
</tbody>
</table>

### Lateral Stability of Beam

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M_t$</td>
<td>1498.75 kip-ft</td>
</tr>
<tr>
<td>$C_d$</td>
<td>1</td>
</tr>
<tr>
<td>$P_{br}$</td>
<td>15.34 kip</td>
</tr>
<tr>
<td>$\beta_{br}$</td>
<td>85.22 kip/in</td>
</tr>
</tbody>
</table>

### Kicker

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_g$</td>
<td>1.73 in$^2$</td>
</tr>
<tr>
<td>$L$</td>
<td>25 in</td>
</tr>
</tbody>
</table>

### Miscellaneous

- Edge stiffener required!
Big Gusset Plate for Upper Floor Bracing and Lower Floor Bracing

Sway to Right

\[ F_{U2R} = 338.80 \text{ kip} \quad \cos(\theta_U) = 0.743 \]
\[ F_{L2R} = 360.20 \text{ kip} \quad \cos(\theta_L) = 0.743 \]

Sway to Left

\[ F_{U2L} = 241.62 \text{ kip} \]
\[ F_{L2L} = 453.20 \text{ kip} \]

Beam

- \[ w_{24x68} \]
- \[ d = 23.7 \text{ in} \]
- \[ L_{c, \text{min}} = 60.74 \text{ in} \]

Column

- \[ w_{12x96} \]
- \[ e_c = 6.35 \text{ in} \]
- \[ R_{\text{beam}} = 21.45 \text{ kip} \text{ (downward)} \]
- \[ L_{t, \text{min}} = 17.36 \text{ in} \]
- \[ L_{cu, \text{min}} = 17.74 \text{ in} \]
- \[ L_{cl, \text{min}} = 19.29 \text{ in} \]
- \[ t_e = 0.75 \text{ in} \]
- \[ L_{cu} = 18 \text{ in} \text{ (use)} \]
- \[ L_{cl} = 18 \text{ in} \text{ (use)} \]
- \[ L_c = 59.7 \text{ in} \text{ (use)} \]
- \[ L_b = 23 \text{ in} \text{ (use)} \]

V_{total} = 446.16 \text{ kip} \text{ (upward)}

M = 236.09 \text{ kip-ft} \text{ (counter-clockwise)}

Sway to the Right

\[ V_{U2R} = 226.65 \text{ kip} \text{ (upward)} \quad s_V = 9.96 \text{ ksi} \]
\[ H_{U2R} = 251.83 \text{ kip} \text{ (rightward)} \quad s_M = 6.36 \text{ ksi} \]
\[ V_{L2R} = 240.96 \text{ kip} \text{ (upward)} \quad s_A = 0.36 \text{ ksi} \]
\[ H_{L2R} = 267.73 \text{ kip} \text{ (leftward)} \quad \text{Ratio} = 0.41 \text{ - OK} \]
\[ V_{\text{total}} = 446.16 \text{ kip} \text{ (upward)} \]
\[ M = 236.09 \text{ kip-ft} \text{ (counter-clockwise)} \]

Column-Side

\[ V_{cu} = 134.52 \text{ kip} \text{ (downward)} \quad s_A = 4.44 \text{ ksi} \]
\[ f_1 = 4.77 \text{ kip/in} \text{ (leftward)} \quad s_V = 9.96 \text{ ksi} \]
\[ f_2 = 1.89 \text{ kip/in} \text{ (leftward)} \quad s_M = 1.92 \text{ ksi} \]
\[ H_{cu} = 59.96 \text{ kip} \text{ (leftward)} \quad \text{Ratio} = 0.41 \text{ - OK} \]
\[ H_{bu} = 191.86 \text{ kip} \text{ (leftward)} \]

Beam-Side

\[ V_{bu} = 92.13 \text{ kip} \text{ (downward)} \quad s_A = 5.34 \text{ ksi} \]
\[ M_{cu} = 6.47 \text{ kip-ft} \text{ (counter-clockwise)} \quad s_V = 11.12 \text{ ksi} \]
<table>
<thead>
<tr>
<th></th>
<th>M_{bd}</th>
<th>kip-ft</th>
<th>(clockwise)</th>
<th>s_{M}</th>
<th>-16.68</th>
<th>ksi</th>
<th>Ratio</th>
<th>0.50</th>
<th>-</th>
<th>OK</th>
</tr>
</thead>
<tbody>
<tr>
<td>V_{cl}</td>
<td>134.52</td>
<td>kip</td>
<td>(downward)</td>
<td>s_{A}</td>
<td>4.44</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f_{1}</td>
<td>4.77</td>
<td>kip/in</td>
<td>(rightward)</td>
<td>s_{V}</td>
<td>9.96</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f_{2}</td>
<td>1.89</td>
<td>kip/in</td>
<td>(rightward)</td>
<td>s_{M}</td>
<td>1.92</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H_{cl}</td>
<td>59.96</td>
<td>kip</td>
<td>(rightward)</td>
<td>Ratio</td>
<td>0.41</td>
<td>-</td>
<td>OK</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H_{bl}</td>
<td>207.77</td>
<td>kip</td>
<td>(rightward)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{bl}</td>
<td>106.44</td>
<td>kip</td>
<td>(downward)</td>
<td>s_{A}</td>
<td>6.17</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_{bl}</td>
<td>86.32</td>
<td>kip-ft</td>
<td>(clockwise)</td>
<td>s_{V}</td>
<td>12.04</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_{cl}</td>
<td>6.47</td>
<td>kip-ft</td>
<td>(counter-clockwise)</td>
<td>s_{M}</td>
<td>15.66</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V_{mid}</td>
<td>136.01</td>
<td>kip</td>
<td>(downward)</td>
<td>s_{A}</td>
<td>0.00</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M_{mid}</td>
<td>8.71</td>
<td>kip-ft</td>
<td>(counter-clockwise)</td>
<td>s_{V}</td>
<td>7.65</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H_{mid}</td>
<td>0.00</td>
<td>kip</td>
<td>(leftward)</td>
<td>s_{M}</td>
<td>1.49</td>
<td>ksi</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratio</td>
<td>0.30</td>
<td>-</td>
<td>OK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Weld Size

- \( f_v = 7.47 \) kip/in
- \( f_s = 4.35 \) kip/in (averaged)
- \( f_b = 4.77 \) kip/in
- \( f_{peak} = 11.79 \) kip/in
- \( f_{avg} = 9.64 \) kip/in
- \( f_t = 12.05 \) kip/in

\( D \geq 4.33 \times 1/16 \) (weld size)

**Use** \( 6 \times 1/16 \) (weld size)
Web Flange
Fillet welds with web plates at one end and bolted to gusset plate (T & B) free (no weld)

\[ P_u = 300.00 \text{ kip} \]
\[ R_{beam} = 21.45 \text{ kip} \] (Gravity)

**Fillet Weld at Beam Side**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( L )</td>
<td>16 in</td>
</tr>
<tr>
<td>( w )</td>
<td>7 in</td>
</tr>
<tr>
<td>( L_{\text{weld}} )</td>
<td>30 in</td>
</tr>
<tr>
<td>( t_{\text{shim}} )</td>
<td>0.168 in</td>
</tr>
<tr>
<td>( t_{\text{splice}} )</td>
<td>0.500 in</td>
</tr>
<tr>
<td>( F_{\text{exx}} )</td>
<td>70 ksi</td>
</tr>
<tr>
<td>( F_w )</td>
<td>42 ksi</td>
</tr>
<tr>
<td>( w )</td>
<td>7 in x 1/16 inch</td>
</tr>
<tr>
<td>( \phi_b )</td>
<td>0.75</td>
</tr>
<tr>
<td>( \phi_b R_n )</td>
<td>584.60 kip</td>
</tr>
<tr>
<td>( R_n )</td>
<td>779.47 kip</td>
</tr>
</tbody>
</table>

OK
### Block Shear in Splice Plate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_y$</td>
<td>36 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>58 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$A_{gv}$</td>
<td>7 in$^2$</td>
</tr>
<tr>
<td>$A_{nf}$</td>
<td>8 in$^2$</td>
</tr>
<tr>
<td>side</td>
<td>2 sides</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>1061.40 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Block Shear in Lower Beam Web

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>65 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$A_{gv}$</td>
<td>5.81 in$^2$</td>
</tr>
<tr>
<td>$A_{nf}$</td>
<td>6.64 in$^2$</td>
</tr>
<tr>
<td>side</td>
<td>1 sides</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>493.64 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Bolt Strength Check

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$L_{slot}$</td>
<td>1.125 in (short slot)</td>
</tr>
<tr>
<td>$d_{bolt}$</td>
<td>0.875 in (TC bolts)</td>
</tr>
<tr>
<td>$w_{slot}$</td>
<td>0.9375 in (short slot)</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>21.6 kip / per bolt (LRFD)</td>
</tr>
<tr>
<td>$N_{bolt}$</td>
<td>15 bolts</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>324 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Block Shear in Gusset Plate

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>65 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$A_{gv}$</td>
<td>12.38 in$^2$</td>
</tr>
<tr>
<td>$A_{nf}$</td>
<td>6.19 in$^2$</td>
</tr>
<tr>
<td>$A_{av}$</td>
<td>8.16 in$^2$</td>
</tr>
<tr>
<td>side</td>
<td>1 sides</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>540.21 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>OK</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
</tr>
<tr>
<td>$F_y$</td>
<td>36 ksi</td>
</tr>
<tr>
<td>$F_u$</td>
<td>58 ksi</td>
</tr>
<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$A_{gt}$</td>
<td>8 in$^2$</td>
</tr>
<tr>
<td>$A_{nt}$</td>
<td>5.66 in$^2$</td>
</tr>
<tr>
<td>side</td>
<td>2 sides</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>576.00 kip</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>492.09 kip</td>
</tr>
<tr>
<td>Parameter</td>
<td>Value</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>T</td>
<td>453.20 kip</td>
</tr>
<tr>
<td>( \sin(\theta) )</td>
<td>0.669</td>
</tr>
<tr>
<td>C</td>
<td>360.20 kip</td>
</tr>
<tr>
<td>( \cos(\theta) )</td>
<td>0.743</td>
</tr>
<tr>
<td>e</td>
<td>0 in</td>
</tr>
<tr>
<td>Shear</td>
<td>604.60 kip</td>
</tr>
<tr>
<td>Tension</td>
<td>237.46 kip</td>
</tr>
<tr>
<td>Moment</td>
<td>0.00 kip-ft</td>
</tr>
<tr>
<td>( t_{\text{gusset}} )</td>
<td>0.75 in</td>
</tr>
<tr>
<td>L</td>
<td>46 in</td>
</tr>
<tr>
<td>( s_V )</td>
<td>17.52 ksi</td>
</tr>
<tr>
<td>( s_M )</td>
<td>0.00 ksi</td>
</tr>
<tr>
<td>( \phi )</td>
<td>0.9 -</td>
</tr>
<tr>
<td>( F_{Y, \text{gusset}} )</td>
<td>50 ksi</td>
</tr>
<tr>
<td>Ratio</td>
<td>0.69 OK</td>
</tr>
<tr>
<td>whitmo</td>
<td>25.96 in</td>
</tr>
<tr>
<td>L_v</td>
<td>19 in</td>
</tr>
<tr>
<td>( L_{\text{min}} )</td>
<td>38.80 in</td>
</tr>
<tr>
<td>( L_{\text{v, min}} )</td>
<td>19.29 in</td>
</tr>
<tr>
<td>( w_{\text{up}} )</td>
<td>12.98 in</td>
</tr>
<tr>
<td>( A_v )</td>
<td>14.25 in²</td>
</tr>
<tr>
<td>( w_{\text{low}} )</td>
<td>14.12 in</td>
</tr>
<tr>
<td>( P_u )</td>
<td>303.17 kip</td>
</tr>
<tr>
<td>whit_{\text{eff}}</td>
<td>25.96 in</td>
</tr>
<tr>
<td>( \phi R_n )</td>
<td>384.75 kip</td>
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<tr>
<td>( \phi R_n )</td>
<td>876.08 kip</td>
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**Weld**  
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>( F_{exx} )</td>
<td>70 ksi</td>
</tr>
<tr>
<td>( F_w )</td>
<td>42 ksi</td>
</tr>
<tr>
<td>( w )</td>
<td>11 x 1/16 inch</td>
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<tr>
<td>( s_V )</td>
<td>13.52 ksi</td>
</tr>
<tr>
<td>( s_M )</td>
<td>0.00 ksi</td>
</tr>
<tr>
<td>( s_A )</td>
<td>5.31 ksi</td>
</tr>
<tr>
<td>( t_{\text{eff}} )</td>
<td>0.486 in</td>
</tr>
<tr>
<td>( \phi )</td>
<td>0.75 -</td>
</tr>
<tr>
<td>Ratio</td>
<td>0.76 OK</td>
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</table>

**Check Beam Web**  
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>width</td>
<td>46 in</td>
</tr>
<tr>
<td>( R_u )</td>
<td>0.00 kip</td>
</tr>
<tr>
<td>d</td>
<td>33.2 in</td>
</tr>
<tr>
<td>( t_w )</td>
<td>1.36 in</td>
</tr>
<tr>
<td>Symbol</td>
<td>Value</td>
</tr>
<tr>
<td>--------</td>
<td>-------</td>
</tr>
<tr>
<td>N</td>
<td>23</td>
</tr>
<tr>
<td>$t_f$</td>
<td>2.44</td>
</tr>
<tr>
<td>$F_{y,web}$</td>
<td>50</td>
</tr>
<tr>
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<td>0.75</td>
</tr>
<tr>
<td>$R_n$</td>
<td>4450.60</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>3337.95</td>
</tr>
<tr>
<td>$k_{des}$</td>
<td>3.23</td>
</tr>
<tr>
<td>$\phi$</td>
<td>1.00</td>
</tr>
<tr>
<td>$R_n$</td>
<td>2662.20</td>
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<tr>
<td>$\phi R_n$</td>
<td>2662.20</td>
</tr>
<tr>
<td>$L_{gb}$</td>
<td>14.84</td>
</tr>
<tr>
<td>$kL/r$</td>
<td>82.2</td>
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<tr>
<td>$L_c$</td>
<td>15.88</td>
</tr>
<tr>
<td>$F_e$</td>
<td>42.32</td>
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<tr>
<td>$L_{c1}$</td>
<td>18.06</td>
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<tr>
<td>$k$</td>
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<tr>
<td>$r$</td>
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<td>$F_y$</td>
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<td>$L_{c2}$</td>
<td>12.56</td>
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<td>19.47</td>
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<td>593.65</td>
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<tr>
<td>$\phi R_n$</td>
<td>534.29</td>
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<tr>
<td>$\phi$</td>
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<td>$L_{tip}$</td>
<td>9.13</td>
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<tr>
<td>$L_{ave}$</td>
<td>14.84</td>
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<tr>
<td>$L_{e}$</td>
<td>17.88</td>
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<td>$L_{e}/t_g$</td>
<td>23.83</td>
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<tr>
<td>Limit</td>
<td>18.06</td>
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<tr>
<td>$M_r$</td>
<td>6645.83</td>
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<td>$Z$</td>
<td>1450</td>
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<tr>
<td>$L_b$</td>
<td>10</td>
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<tr>
<td>$C_d$</td>
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<tr>
<td>$h_o$</td>
<td>30.76</td>
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<tr>
<td>$L_{pd}$</td>
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<tr>
<td>$P_{br}$</td>
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<tr>
<td>$\beta_{br}$</td>
<td>288.07</td>
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<td>$n$</td>
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<tr>
<td>$\Delta$</td>
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<tr>
<td>$M_{br}$</td>
<td>79.75</td>
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<tr>
<td>$I_y$</td>
<td>1550</td>
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<tr>
<td>$P_{br}$</td>
<td>31.11</td>
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<tr>
<td>$\beta_{br}$</td>
<td>108666</td>
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<tr>
<td>$\beta_{sec}$</td>
<td>not included</td>
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<td>$\Delta$</td>
<td>0.27</td>
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### Column Base Plate Design Check

<table>
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<th>Parameter</th>
<th>Value</th>
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<tbody>
<tr>
<td>$Z_x$</td>
<td>147 in$^3$</td>
</tr>
<tr>
<td>$F_y$</td>
<td>50 ksi</td>
</tr>
<tr>
<td>$M_p$</td>
<td>7350 kip-in</td>
</tr>
<tr>
<td>$P_u$</td>
<td>492.31 kip</td>
</tr>
<tr>
<td>$M_u$</td>
<td>3114.35 kip-in</td>
</tr>
<tr>
<td>$N$</td>
<td>31.25 in</td>
</tr>
<tr>
<td>$B$</td>
<td>28 in</td>
</tr>
<tr>
<td>$e$</td>
<td>6.33 in</td>
</tr>
<tr>
<td>$e_{cr}$</td>
<td>15.38 in</td>
</tr>
<tr>
<td>$Q = 26.47$ kip/in</td>
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</tr>
<tr>
<td>$m$</td>
<td>9.59 in</td>
</tr>
<tr>
<td>$f_p$</td>
<td>0.95 ksi</td>
</tr>
<tr>
<td>$t_{p,req}$</td>
<td>1.98 in</td>
</tr>
<tr>
<td>$use$</td>
<td>2.00 in</td>
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### All-thread-rods

<table>
<thead>
<tr>
<th>Type</th>
<th>ASTM A193 B7</th>
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<tbody>
<tr>
<td>$d_{bolt}$</td>
<td>1.125 in</td>
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<tr>
<td>$F_u$</td>
<td>125 ksi</td>
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<td>$F_y$</td>
<td>105 ksi</td>
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<tr>
<td>$F_{at}$</td>
<td>93.75 ksi</td>
</tr>
<tr>
<td>$F_{nv}$</td>
<td>50 ksi</td>
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<tr>
<td>$A_b$</td>
<td>0.99 in$^2$</td>
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<tr>
<td>$\phi$</td>
<td>0.75</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>69.89 kip (tension)</td>
</tr>
<tr>
<td>$\phi R_n$</td>
<td>37.28 kip (shear)</td>
</tr>
<tr>
<td>$F_{PT}$</td>
<td>86.98 kip (minimum required pretension)</td>
</tr>
<tr>
<td>$V_u$</td>
<td>152.89 kip (very conservative assumption)</td>
</tr>
<tr>
<td>$M_u$</td>
<td>7350 kip-in (very conservative assumption)</td>
</tr>
<tr>
<td>$P_u$</td>
<td>600 kip (very conservative assumption)</td>
</tr>
<tr>
<td>$\mu$</td>
<td>0.35 (class A surface)</td>
</tr>
<tr>
<td>SF</td>
<td>2 (safety factor for not having enough bolt pretension force)</td>
</tr>
<tr>
<td>NV</td>
<td>10</td>
</tr>
<tr>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>NM</td>
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</tr>
<tr>
<td>NT</td>
<td>9</td>
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<tr>
<td>N_{req, total}</td>
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<td>use</td>
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<td></td>
<td>TCBF-B-3 Specimen Design Calculation Sheet</td>
</tr>
<tr>
<td>----------</td>
<td>-------------------------------------------</td>
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<tr>
<td><strong>2F</strong></td>
<td>Stub Beam</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
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**Column Dimension List**

<table>
<thead>
<tr>
<th>Column</th>
<th>w12x96</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A_g)</td>
<td>(28.2) in(^2)</td>
</tr>
<tr>
<td>(I_x)</td>
<td>(833) in(^4)</td>
</tr>
<tr>
<td>(I_y)</td>
<td>(270) in(^4)</td>
</tr>
<tr>
<td>(r_x)</td>
<td>(5.44) in</td>
</tr>
<tr>
<td>(r_y)</td>
<td>(3.09) in</td>
</tr>
<tr>
<td>(k_{des})</td>
<td>(1.5) in</td>
</tr>
<tr>
<td>(E_s)</td>
<td>(29000) ksi</td>
</tr>
</tbody>
</table>

**Column Web Local Yielding**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(N)</td>
<td>(24.00) in</td>
</tr>
<tr>
<td>(R_n)</td>
<td>(866.25) kip</td>
</tr>
<tr>
<td>(\phi)</td>
<td>(1.00) -</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>(866.25) kip OK</td>
</tr>
</tbody>
</table>

**Column Web Crippling**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_n)</td>
<td>(1382.366) kip</td>
</tr>
<tr>
<td>(\phi)</td>
<td>(0.75) -</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>(1036.77) kip OK</td>
</tr>
</tbody>
</table>

**Column Flange Local Bending**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(R_n)</td>
<td>(253.13) kip</td>
</tr>
<tr>
<td>(\phi)</td>
<td>(0.90) -</td>
</tr>
<tr>
<td>(\phi R_n)</td>
<td>(227.81) kip</td>
</tr>
<tr>
<td>(F_{1flange})</td>
<td>(190.93) kip</td>
</tr>
<tr>
<td>(F_{2flange})</td>
<td>(381.87) kip</td>
</tr>
<tr>
<td></td>
<td>Continue Plate Required!</td>
</tr>
</tbody>
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**Stub Beam Gross Yielding**

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>(A_{s (beam)})</td>
<td>(34.4) in(^2)</td>
</tr>
<tr>
<td>(P_y)</td>
<td>(1720) kip</td>
</tr>
<tr>
<td></td>
<td>OK</td>
</tr>
<tr>
<td>Title</td>
<td>TCBF-B-3 Specimen Design Calculation Sheet</td>
</tr>
<tr>
<td>-------</td>
<td>------------------------------------------</td>
</tr>
<tr>
<td>1F</td>
<td>Stub Beam</td>
</tr>
<tr>
<td>$F_1$ = 300 kip</td>
<td>d = 23.7 in</td>
</tr>
<tr>
<td>$F_2$ = 600 kip</td>
<td>t_w = 0.415 in</td>
</tr>
<tr>
<td>$L_{stub}$ = 19 in</td>
<td>b = 8.97 in</td>
</tr>
<tr>
<td>Beam</td>
<td>w24x68</td>
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</table>

### Column Dimension List

<table>
<thead>
<tr>
<th>Column</th>
<th>w12x96</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A_g$ = 28.2 in$^2$</td>
<td>$b_f$ = 12.2 in</td>
</tr>
<tr>
<td>$I_x$ = 833 in$^4$</td>
<td>$t_f$ = 0.9 in</td>
</tr>
<tr>
<td>$I_y$ = 270 in$^4$</td>
<td>$d$ = 12.7 in</td>
</tr>
<tr>
<td>$r_x$ = 5.44 in</td>
<td>$t_w$ = 0.55 in</td>
</tr>
<tr>
<td>$r_y$ = 3.09 in</td>
<td>$F_y$ = 50 ksi</td>
</tr>
<tr>
<td>$k_{des}$ = 1.5 in</td>
<td>$E_s$ = 29000 ksi</td>
</tr>
</tbody>
</table>

### Column Web Local Yielding

<table>
<thead>
<tr>
<th>N = 24.00 in</th>
<th>$R_n$ = 866.25 kip</th>
<th>$\phi$ = 1.00 -</th>
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</thead>
<tbody>
<tr>
<td>$\phi R_n$ = 866.25 kip</td>
<td>OK</td>
<td></td>
</tr>
</tbody>
</table>

### Column Web Crippling

<table>
<thead>
<tr>
<th>$R_n$ = 1382.366 kip</th>
<th>$\phi$ = 0.75 -</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi R_n$ = 1036.77 kip</td>
<td>OK</td>
</tr>
</tbody>
</table>

### Column Flange Local Bending

<table>
<thead>
<tr>
<th>$R_n$ = 253.13 kip</th>
<th>$A_{web}$ = 9.35 in$^2$</th>
<th>$A_s$ = 19.84 in$^2$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$ = 0.90 -</td>
<td>$A_{flange}$ = 10.49 in$^2$</td>
<td>$F_{1,flange}$ = 158.65 kip</td>
</tr>
<tr>
<td>$\phi R_n$ = 227.81 kip</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>$F_{2,flange}$ = 317.31 kip</td>
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### Stub Beam Gross Yielding

<table>
<thead>
<tr>
<th>$A_{s \text{(beam)}}$ = 20.1 in$^2$</th>
<th>$P_y$ = 1005 kip</th>
<th>OK</th>
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</table>