SO No.: 115231
Subject: VDOT BRIDGE RATING
BRIDGE NO. 1005 - 1 SPAN TRUSS
TRUSS SPLICE ANALYSIS - U2 CONNECTION
Computed By: DLN Date: 4/3/2009 Checked By: MKB Date: 4/6/2009

J:\DESIGN\VDOT Pilot Project\VDOT Trusses\01005 Gooney Crk\Gusset PL Analysis\[01005 Gusset Chord Splices 040609.xls]Total Splice Plate Capacity

TRUSS MEMBER SPLICE ANALYSIS

For panel points along the top and bottom chord where the truss member is spliced, a reduction to the resulting force in the gusset plate is required which will account for the capacity of the splice plates.

Summary of Truss Member Properties

Note: Since the bottom chord is comprised of 2 angles and has top and side splices, the top leg of the angles was broken out to determine the amount of force distributed separately to the top and side splices.

Tension = (-)
Compression = (+)

MEMBER 4			MEMBER 5		
DL_4 =	*127*	*kips*	DL_5 =	*125*	*kips*
LL_4 =	*100*	*kips*	LL_5 =	*100*	*kips*
P_4 =	227	*kips*	P_5 =	225	*kips*

Free Body Diagram

227 kips ⟶ ● ⟵ 225 kips
PP

P_{Net} = 452 *kips* **NET FORCE AT CONNECTION RESULTS IN A COMPRESSION SPLICE**

Top Plate Properties

t = *0.436* *in.* *(Thickness of the Top Plate)*
W = *2.600* *in.* *(Width of the Top Plate)*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.436 in. x 2.600 in.)
Plate Area = 1.1336 in^2
Total Shape Area = 2.2672 in^2

Top Plate Properties

t = *0.436* *in.*
W = *2.600* *in.*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.436 in. x 2.600 in.)
Plate Area = 1.1336 in^2
Total Shape Area = 2.2672 in^2

Bottom Plate Properties

t = *0.436* *in.* *(Thickness of the Bottom Plate)*
W = *2.600* *in.* *(Width of the Bottom Plate)*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.436 in. x 2.600 in.)
Plate Area = 1.1336 in^2
Total Shape Area = 2.2672 in^2

Bottom Plate Properties

t = *0.436* *in.*
W = *2.600* *in.*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.436 in. x 2.600 in.)
Plate Area = 1.1336 in^2
Total Shape Area = 2.2672 in^2

Side Plate Properties

t = *0.240* *in.* *(Thickness of the Side Plate)*
W = *9.130* *in.* *(Width of the Side Plate)*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.240 in. x 9.130 in.)
Plate Area = 2.1912 in^2
Total Shape Area = 4.3824 in^2

Side Plate Properties

t = *0.240* *in.*
W = *9.130* *in.*
No. of Plates = *2*

Plate Area = *(t x W)*
Plate Area = (0.240 in. x 9.130 in.)
Plate Area = 2.1912 in^2
Total Shape Area = 4.3824 in^2

Total Member Area Transfering Force

8.9168 in^2 (Gross Section)

Total Member Area Transfering Force

8.9168 in^2 (Gross Section)

Controlling Section

Use: MEMBER 4

Top Plate Distribution of Force =	25.4% of the area
Bottom Plate Distribution of Force =	25.4% of the area
Side Channel Distribution of Force =	49.1% of the area

Note: Gross section properties are assumed to be sufficient to determine the distribution of forces to each shape that comprise the truss chord member. The smaller of the two members will controll the force distribution

Summary of Plate Properties

Top Splice Properties

sp_t =	*0.625*	*in.*	*(Thickness of the Splice Plate)*
W =	*16.000*	*in.*	*(Width of the Splice Plate)*
No. of Plates =	*1*		

Splice Area = *(sp_t x W)*
Splice Area = (0.625 in. x 16.000 in.)
Splice Area = 10.0000 in^2
Total Splice Area = 10.0000 in^2

Bottom Splice Properties

sp_t =	*0.625*	*in.*	*(Thickness of the Splice Plate)*
W =	*2.500*	*in.*	*(Width of the Splice Plate)*
No. of Plates =	*2*		

Splice Area = *(sp_t x W)*
Splice Area = (0.625 in. x 2.500 in.)
Splice Area = 1.5625 in^2
Total Splice Area = 3.1250 in^2

Side Splice Properties

sp_t =	*0.000*	*in.*	*(Thickness of the Splice Plate)*
W =	*0.000*	*in.*	*(Width of the Splice Plate)*
No. of Plates =	*0*		

Splice Area = *(sp_t x W)*
Splice Area = (0.000 in. x 0.000 in.)
Splice Area = 0.0000 in^2
Total Splice Area = 0.0000 in^2

Gusset Plate Properties

g_t =	*0.500*	*in.*	*(Thickness of the Gusset Plate)*
Chord Depth =	*10.000*	*in.*	*(Width of the Gusset Plate)*
No. of Plates =	*2*		

Gusset Area = *(g_t x W)*
Gusset Area = (0.500 in. x 10.000 in.)
Gusset Area = 5.0000 in^2
Total Plate Area = 10.0000 in^2

Plate & Force Distribution

Top Splice Distribution = 100% of the force distributed to the Top Plate
Top Splice Force Distribution = 25.4% of Total Member Force

Bottom Splice Distribution = 100% of the force distributed to the Top Plate
Bottom Splice Force Distribution = 25.4% of Total Member Force

Total Area Transfering Force (Sides)= 10.0000 in^2 at the connection

Side Splice Distribution = 0.0% of the area
Side Splice Force Distribution = 0.0% of Total Member Force

Gusset Plate Distribution = 100.0% of the area
Gusset Plate Force Distribution = 49.1% of Total Member Force

Conclusions - Tension Splice

Based on the area of the splice plates and the effective area of the gusset plates, the resulting distribution of truss member forces to the plates is porportional to the ratio of gross effective areas of the truss member shapes and the connecting plates that connect members. Therefore the transfered applied truss member force from one chord member to the next member is:

MEMBER 4		**MEMBER 5**	
Top Splice Plate takes	**25.4%**	**Top Splice Plate takes**	**25.6%**
Bottom Splice Plate takes	**25.4%**	**Bottom Splice Plate takes**	**25.6%**
Side Splice Plates take	**0.0%**	**Side Splice Plates take**	**0.0%**
Gusset Plates take	**49.1%**	**Gusset Plates take**	**49.6%**

FOR INPUT INTO MATHCAD - TENSION SPLICE

Force Transferred by Gusset Plate GP_4 =	NA	Force Transferred by Gusset Plate GP_5 =	NA
Force Transferred by Fasteners BP_4 =	NA	Force Transferred by Fasteners BP_5 =	NA

Buckling Check *(For Compression Splices, not required for Tension Splices)*

AASHTO Guide Specifications for Strength Design of Truss Bridges (Load Factor Design (1985)

Section 1.8 Computation of Member Capacity - Compression Members

$$\frac{P}{0.85 A_{ge} F_{cr}} \leq 1.0$$

Where:

P_{Net} = 452.19 kips (Total Axial Load, DL + LL)
A_{ge} = 10.0000 in^2 (Gross Effective Area - Top Splice Plate)
A_{ge} = 3.1250 in^2 (Gross Effective Area - Bottom Splice Plate)
A_{ge} = 0.0000 in^2 (Gross Effective Area - Side Splice Plate)
F_{cr} = See Below ksi (Critical Load per ALFD 10.54.1.1)

AASHTO 2002 Specifications 17th Edition (Load Factor Design

Section 10.54.1.1 Maximum Capacity - Compression Members

F_y = 30.00 ksi (Yield Stress)
E = 29000.00 ksi (Modulus of Elasticity)
K = 0.75 (Effective length factor in the plane of buckling. For riveted, bolted, or welded end connections) ALFD 10.54.1.2
L_c = 2.50 in. (Length of the member between points of support - Top Splice Plate)
L_c = 2.50 in. (Length of the member between points of support - Bottom Splice Plate)
L_c = 0.00 in. (Length of the member between points of support - Side Splice Plate)
$I_{Top\ Splice}$ = 0.3255 in^4 (Moment of Inertia of the Top Splice Plate)
$I_{Bottom\ Splice}$ = 0.0509 in^4 (Moment of Inertia of the Bottom Splice Plate)
$I_{Side\ Splice}$ = 0.0000 in^4 (Moment of Inertia of the Side Splice Plate)

$$r := \sqrt{\frac{I}{A}}$$

$r_{Top\ Splice}$ = 0.1804 in. (Radius of gyration in the plane of buckling - Top Splice Plate)
$r_{Bottom\ Splice}$ = 0.1276 in. (Radius of gyration in the plane of buckling - Bottom Splice Plate)
$r_{Side\ Splice}$ = 0.0000 in. (Radius of gyration in the plane of buckling - Side Splice Plate)

$\frac{KL_c}{r}$ = 10.39 (Top Splice)

$\frac{KL_c}{r}$ = 14.70 (Bottom Splice) $\sqrt{\frac{2\pi^2 E}{F_y}}$ = 138.13

$\frac{KL_c}{r}$ = 0.00 (Side Splice)

IF $\frac{KL_c}{r} \le \sqrt{\frac{2\pi^2 E}{F_y}}$ **THEN** $F_{cr} := F_y\left[1 - \left(\frac{F_y}{4\pi^2 E}\right)\cdot\left(\frac{K\cdot L_c}{r}\right)^2\right]$ **Equation 1**

IF $\frac{KL_c}{r} > \sqrt{\frac{2\pi^2 E}{F_y}}$ **THEN** $F_{cr} := \left[\frac{\pi^2 E}{\left(\frac{K\cdot L_c}{r}\right)^2}\right]$ **Equation 2**

$F_{cr\ Top\ Splice}$ = 29.92 ksi (Critical Load - Top Splice Plate) Equation 1
$F_{cr\ Bottom\ Splice}$ = 29.83 ksi (Critical Load - Bottom Splice Plate) Equation 1
$F_{cr\ Side\ Splice}$ = NA ksi (Critical Load - Side Splice Plate) Equation 1

Conclusions - Compression Splices

Now, substitute F_{cr} back into the equation to determine if the plate buckles

$$\frac{P}{0.85 A_{ge} F_{cr}} \le 1.0$$

	0.85 A_{ge} x F_{cr}
Top Splice Plate:	254.28 kips
Bottom Splice Plate:	79.24 kips
Side Splice Plate:	0.00 kips
Splice Capacity:	333.51 kips

Determine the % force distribution based on the maximum allowable force at buckling

Member 4

% Member 4 force carried by splice 73.4%

% Member 4 force carried by top & Bottom Splice 73.4%

Member 5

% Member 5 force carried by splice 74.1%

% Member 5 force carried by top & Bottom Splice 74.1%

FOR INPUT INTO MATHCAD - COMPRESSION SPLICE

Force Transferred by Gusset Plate GP_4 =	26.6%	Force Transferred by Gusset Plate GP_5 =	25.9%
Force Transferred by Fasteners BP_4 =	26.6%	Force Transferred by Fasteners BP_5 =	25.9%