

3-21. Determine the effective net area of the $L7 \times 4 \times \frac{1}{2}$ shown in Fig. P3-21. Assume the holes are for 1-in \varnothing bolts.

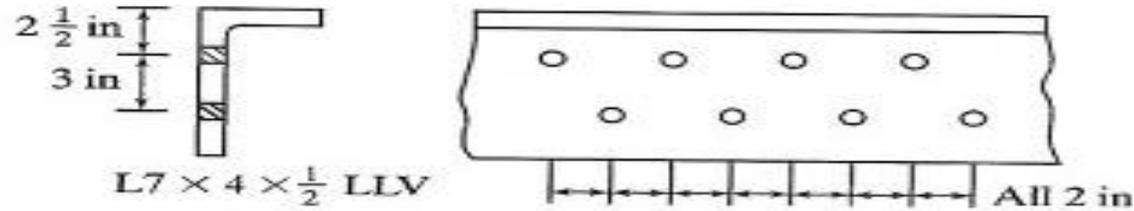


FIGURE P3-21

Aim:
Find U
 A_e

How is L calculated?

L = Length of Connection

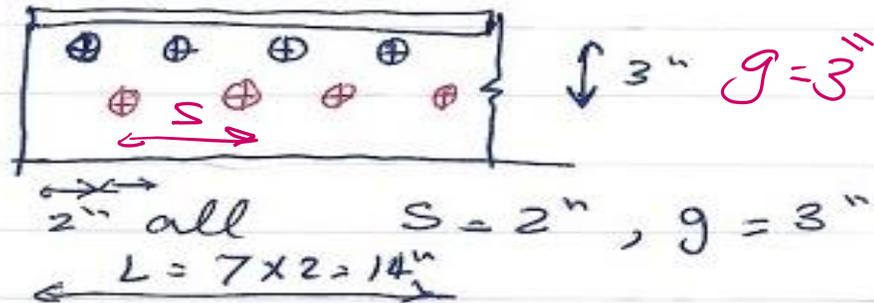
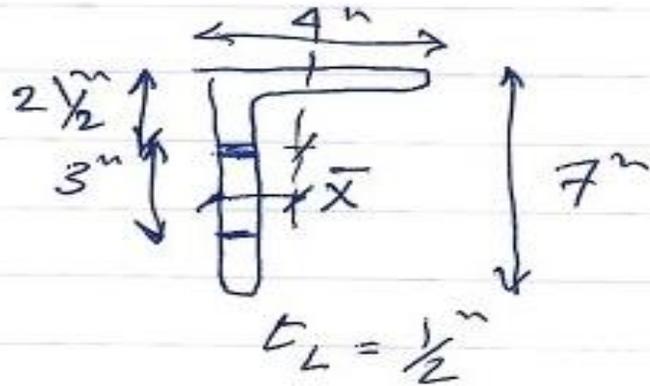
Solution
given

LLV stands for Long Leg Vertical

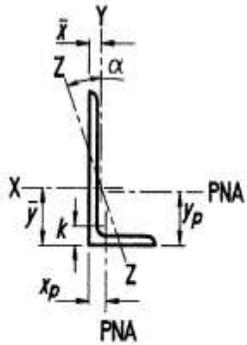
$L 7 \times 4 \times \frac{1}{2} \text{ in} \times d_b = 1 \text{ in}$

$\rightarrow d_h = d_b + \frac{1}{8} = 1 \frac{1}{8} \text{ in}$

it is required to get effective area for staggered bolts



Prepared by Eng. Maged Kamel.



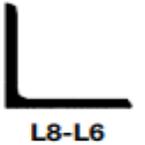
**Table 1-7
Angles
Properties**

$A = 5.26$
 inch^2
Part-1

Shape	k	Wt. lb/ft	Area, A in. ²	Axis X-X						Flexural-Torsional Properties		
				I	S	r	\bar{y}	Z	y_p	J	C_w	\bar{r}_o
				in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ⁶	in.
L7x4x3/4	1/4	26.2	7.74	37.8	8.39	2.21	2.50	14.8	1.84	1.47	3.97	3.31
x5/8	1/8	22.1	6.50	32.4	7.12	2.23	2.45	12.5	1.80	0.868	2.37	3.34
→ x1/2	1	17.9	5.26	26.6	5.79	2.25	2.40	10.2	1.74	0.456	1.25	3.37
x7/16	15/16	15.7	4.63	23.6	5.11	2.26	2.38	9.03	1.71	0.310	0.851	3.38
x3/8	7/8	13.6	4.00	20.5	4.42	2.27	2.35	7.81	1.67	0.198	0.544	3.40

7x4x1/2
Part-2

**Table 1-7 (continued)
Angles
Properties**



Shape	Axis Y-Y						Axis Z-Z				Q_s
	I	S	r	\bar{x}	Z	x_p	I	S	r	Tan α	$F_y = 36$ ksi
	in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ³	in.		
L7x4x3/4	9.00	3.01	1.08	1.00	5.60	0.553	5.63	2.57	0.855	0.324	1.00
x5/8	7.79	2.56	1.10	0.958	4.69	0.464	4.81	2.16	0.860	0.329	1.00
→ x1/2	6.48	2.10	1.11	0.910	3.77	0.376	3.94	1.76	0.866	0.334	0.965
x7/16	5.79	1.86	1.12	0.886	3.31	0.331	3.50	1.55	0.869	0.337	0.912
x3/8	5.06	1.61	1.12	0.861	2.84	0.286	3.04	1.34	0.873	0.339	0.840

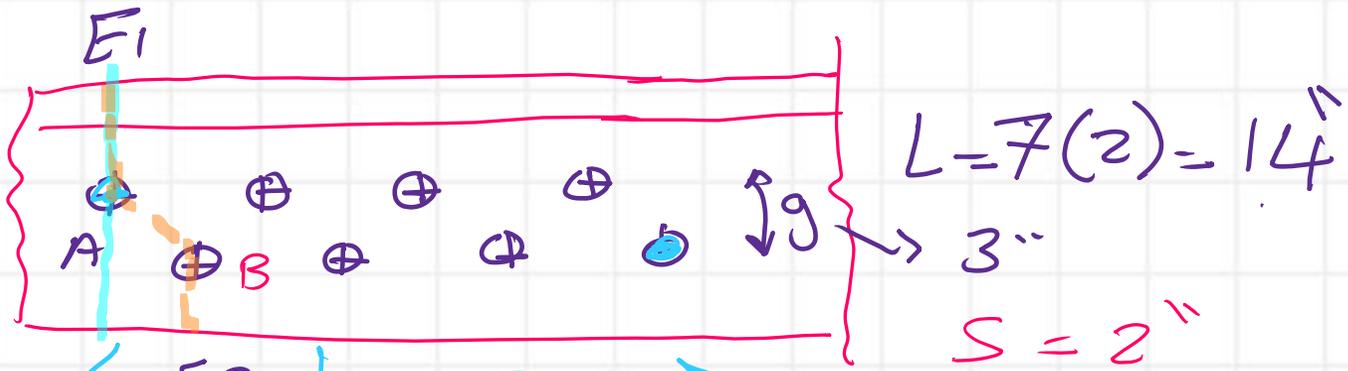
$\bar{x} = 0.91$

L is the distance from first bolt to last bolt

Data for $L 7 \times 4 \times \frac{1}{2}$

$$A = 5.26 \text{ inch}^2$$

$\bar{x} = 0.91$ // to the Unconnected Leg



$$L = 7(2) = 14$$

$$3''$$

$$S = 2''$$

VL Section $E_1 - A - E_2$

$$A_g = 5.26 \text{ inch}^2$$

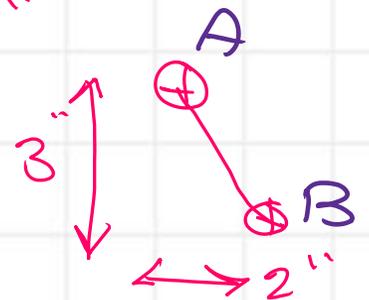
$$A_h = 1 \left(\frac{9}{8} \right) \left(\frac{1}{2} \right) = \frac{9}{16} \text{ inch}^2$$

$$A_n = A_g - A_h = 5.26 - \frac{9}{16} = 4.697 \text{ inch}^2$$

* Section $E_1 - A - B - E_2$ $S = 2''$ $g = 3''$ $n_0 = 2$

$$A_n = A_g - A_h + \frac{S^2}{4g} t = 5.26 - (2) \left(\frac{9}{8} \right) \left(\frac{1}{2} \right) + \frac{(2)^2}{4(3)} \cdot \frac{1}{2} = 4.302 \text{ inch}^2$$

$$A_n = \min(4.697, 4.302) = 4.302 \text{ inch}^2$$

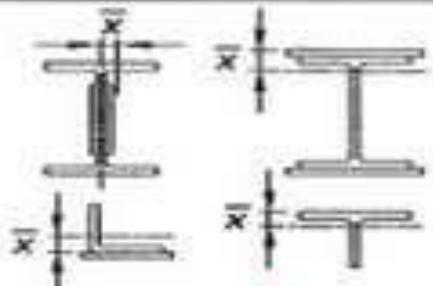
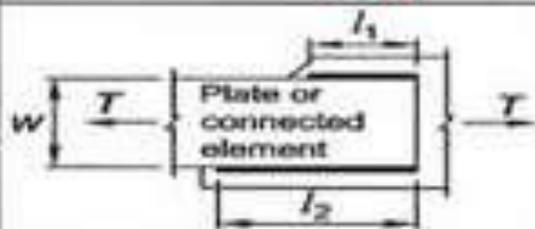


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CA#15 2016 specs

→ same as 2010

TABLE D3.1
Shear Lag Factors for Connections to Tension Members

Case	Description of Element	Shear Lag Factor, U	Example
1	All tension members where the tension load is transmitted directly to each of the cross-sectional elements by fasteners or welds (except as in Cases 4, 5 and 6).	$U = 1.0$	-
2	All tension members, except HSS, where the tension load is transmitted to some but not all of the cross-sectional elements by fasteners or by longitudinal welds in combination with transverse welds. Alternatively, Case 7 is permitted for W, M, S and HP shapes. (For angles, Case 8 is permitted to be used.)	$U = 1 - \frac{\bar{x}}{l}$ Longitudinal + Transverse	
3	All tension members where the tension load is transmitted only by transverse welds to some but not all of the cross-sectional elements.	$U = 1.0$ and $A_n =$ area of the directly connected elements	- <i>low</i>
4[a]	Plates, angles, channels with welds at heels, tees, and W-shapes with connected elements, where the tension load is transmitted by longitudinal welds only. See Case 2 for definition of \bar{x} .	$U = \frac{3l^2}{3l^2 + w^2} \left(1 - \frac{\bar{x}}{l}\right)$ Factor Change	

New item



Plates, angle, channel
WT
W section

CM # 14, CM # 15

TABLE D3.1
Shear Lag Factors for Connections
to Tension Members

Case	Description of Element	Shear Lag Factor, U	Example
8	Single and double angles. (If U is calculated per Case 2, the larger value is permitted to be used.)	with four or more fasteners per line in the direction of loading	$U = 0.80$
		with three fasteners per line in the direction of loading (with fewer than three fasteners per line in the direction of loading, use Case 2)	$U = 0.60$

$U = 0.80$

Four Fasteners
 in a Line

B = overall width of rectangular HSS member, measured 90° to the plane of the connection, in. (mm); D = outside diameter of round HSS, in. (mm); H = overall height of rectangular HSS member, measured in the plane of the connection, in. (mm); d = depth of section, in. (mm); for tees, d = depth of the section from which the tee was cut, in. (mm); l = length of connection, in. (mm); w = width of plate, in. (mm); \bar{x} = eccentricity of connection, in. (mm).

(a) $l = \frac{l_1 + l_2}{2}$, where l_1 and l_2 shall not be less than 4 times the weld size.

Problem 3.21

$$A_n = 4.302 \text{ inch}^2$$

Two cases govern U

$$\text{Case 2 } U = 1 - \frac{\bar{x}}{L}$$

$$\bar{x} = 0.91''$$

$$L = 14''$$

$$U = 1 - \left(\frac{0.91}{14} \right) = 0.935$$

The 2nd case is Case 8

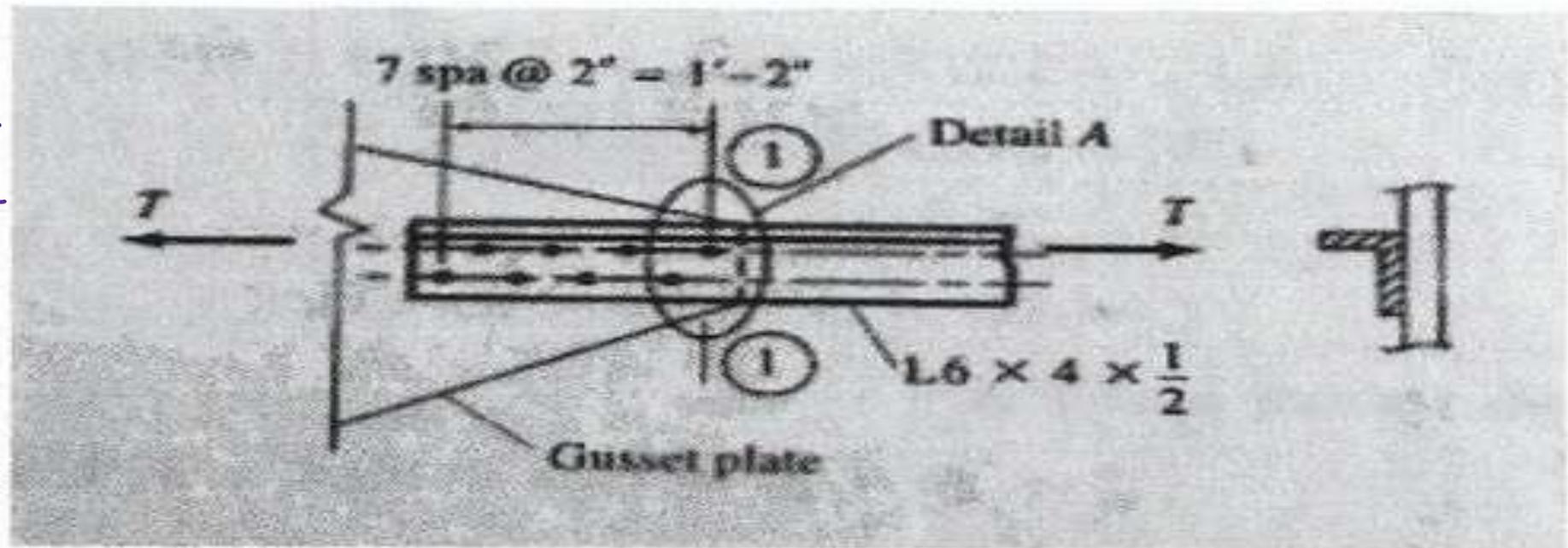
We have Four bolts
in a Line

$$U = 0.80$$

$$U = \max(0.935, 0.8) = 0.935$$

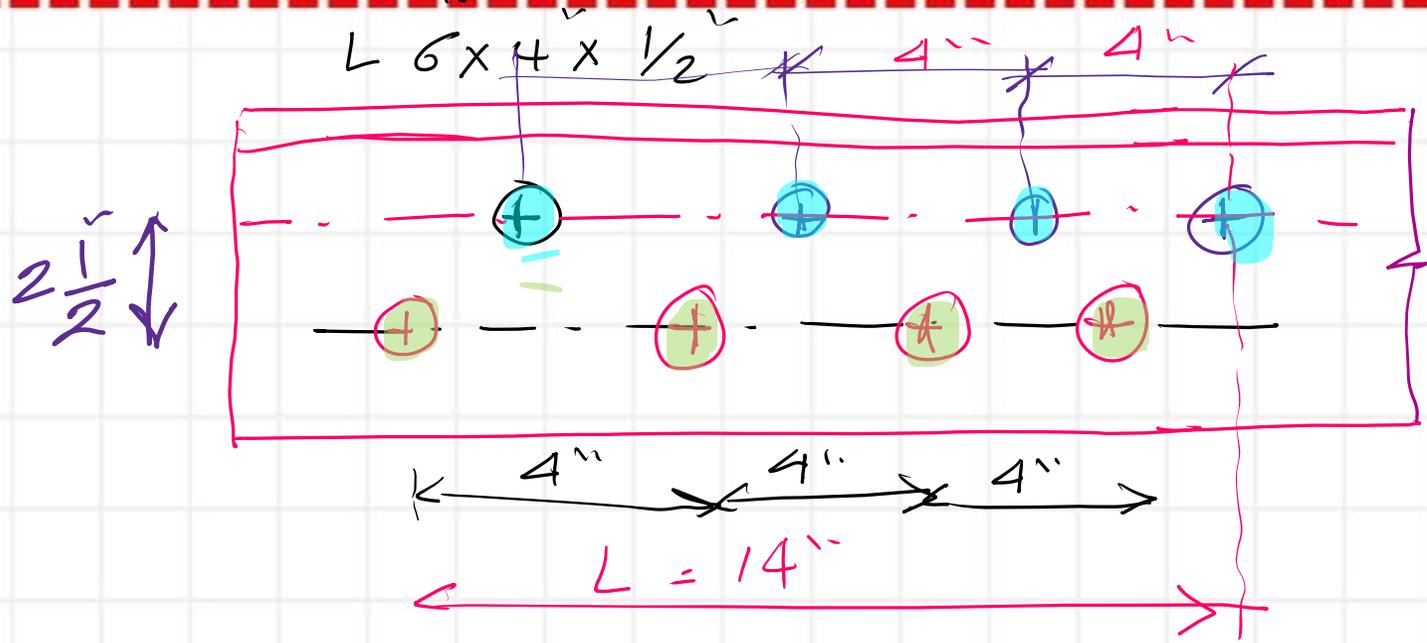
$$A_e = U A_n = 0.935(4.302) = 4.02 \text{ inch}^2$$

Example 3.9.1 Determine the service load capacity in tension for an L 6x 4x1/2 of A572 grade 50 steel connected with 7/8 inch diam bolts in standard holes as shown in fig 3.9.1. Use AISC load and Resistance factor Design and assume the live load to dead load ratio is 3.00.



L \Rightarrow 6x4x $\frac{1}{2}$
First Gauge
with
4 bolts

2nd Gauge
with 4 bolts



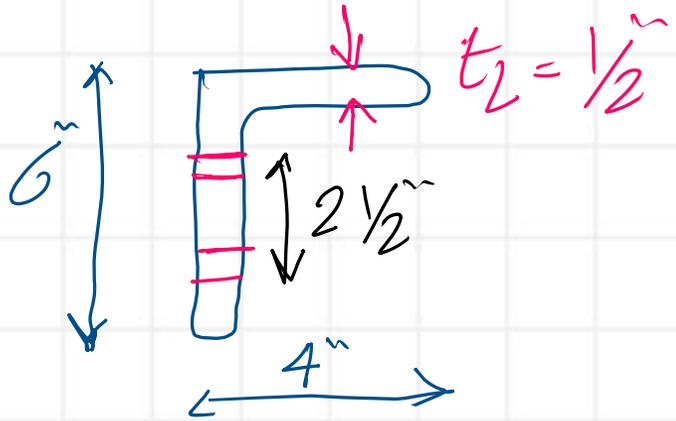
ASTM Grade 50

$d_b = 7/8$
 $d_h = 1$

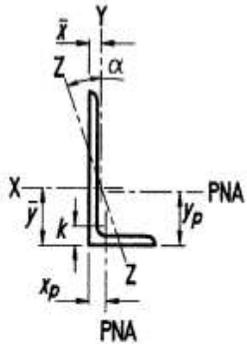
$L/D = 3$

$F_y = 50 \text{ ksi}$
 $F_u = 65 \text{ ksi}$

Area = 4.75 inch²



Prepared by Eng. Maged Kamel.



6x4x1/2

Table 1-7
Angles
Properties

Part-1

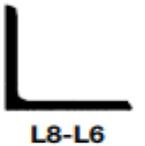
Shape	k	Wt. lb/ft	Area, A in. ²	Axis X-X						Flexural-Torsional Properties		
				I	S	r	ȳ	Z	y _p	J	C _w	r̄ _o
				in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ⁶	in.
L6x4x7/8	13/8	27.2	8.00	27.7	7.13	1.86	2.12	12.7	1.43	2.03	4.04	2.82
x3/4	1 1/4	23.6	6.94	24.5	6.23	1.88	2.07	11.1	1.37	1.31	2.64	2.85
x5/8	1 1/8	20.0	5.86	21.0	5.29	1.89	2.03	9.44	1.31	0.775	1.59	2.88
x9/16	1 1/16	18.1	5.31	19.2	4.81	1.90	2.00	8.59	1.28	0.572	1.18	2.90
x1/2	1	16.2	4.75	17.3	4.31	1.91	1.98	7.71	1.25	0.407	0.843	2.91

$A = 4.75 \text{ inch}^2$

6x4x1/2

Part-2

Table 1-7 (continued)
Angles
Properties

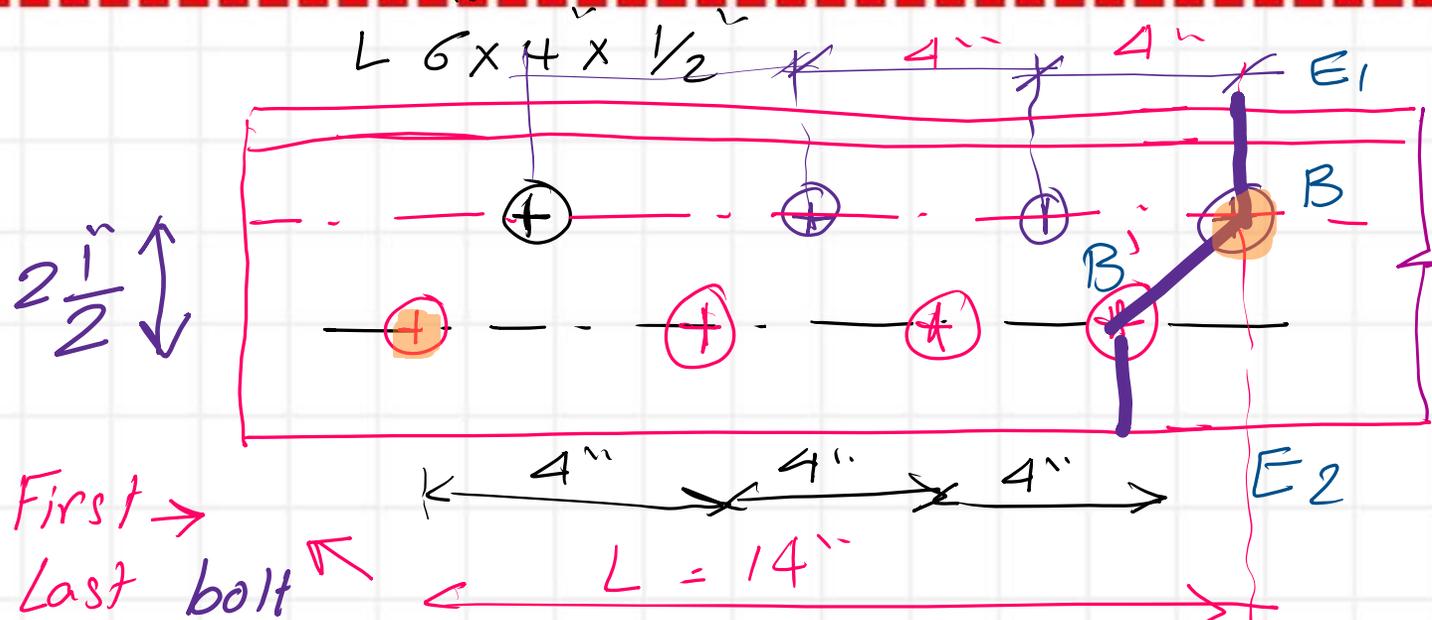


Shape	Axis Y-Y						Axis Z-Z				Q _s F _y = 36 ksi
	I	S	r	ȳ	Z	x _p	I	S	r	Tan α	
	in. ⁴	in. ³	in.	in.	in. ³	in.	in. ⁴	in. ³	in.		
L6x4x7/8	9.70	3.37	1.10	1.12	6.26	0.667	5.82	2.91	0.854	0.421	1.00
x3/4	8.63	2.95	1.12	1.07	5.42	0.578	5.08	2.51	0.856	0.428	1.00
x5/8	7.48	2.52	1.13	1.03	4.56	0.488	4.32	2.12	0.859	0.435	1.00
x9/16	6.86	2.29	1.14	1.00	4.13	0.443	3.93	1.92	0.861	0.438	1.00
x1/2	6.22	2.06	1.14	0.981	3.69	0.396	3.54	1.72	0.864	0.440	1.00

6x4x1/2

$\bar{x} = 0.981 \text{ in}$

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AST72 Grade 50

$$d_b = 7/8$$

$$d_h = 1''$$

$$L/D = 3$$

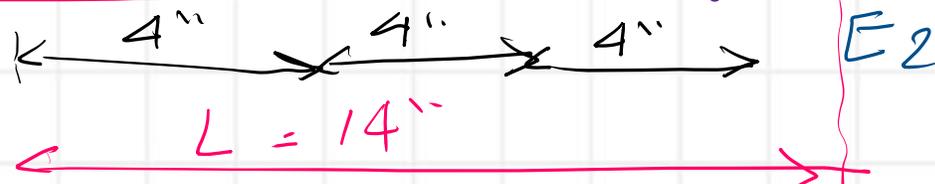
$$\bar{X} = 0.931$$

$$L = 14''$$

$$U \text{ Case 8} = 0.80$$

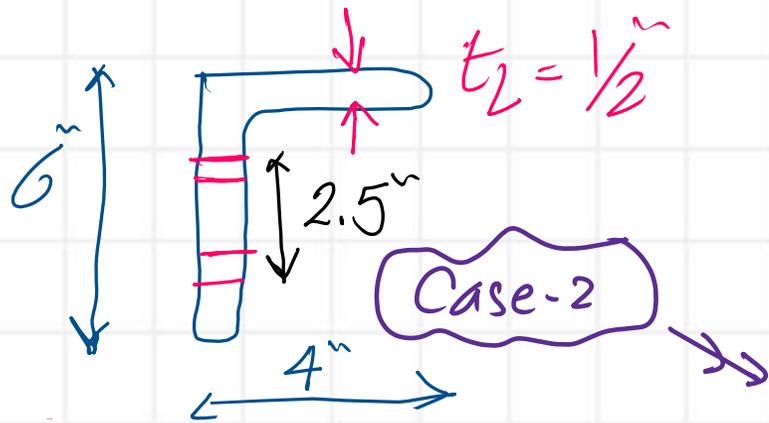
First \rightarrow

Last bolt \leftarrow



First Line $E_1 B B' E_2$
one staggered line

$$\text{Area} = 4.75 \text{ inch}^2$$



$$S = 2''$$

$$g = 2\frac{1}{2}$$

$$A_h = 2(1)\left(\frac{1}{2}\right) = 1.0 \text{ inch}^2$$

$$\sum \frac{S^2 t_L}{4g} = \frac{(2)^2 \frac{1}{2}}{4(2.5)^2} = 0.20 \text{ inch}^2$$

$$A_n = 3.95 \text{ inch}^2$$

$$A_e = 3.95(0.93) = 3.6783 \text{ inch}^2$$

$$U = 1 - \frac{\bar{X}}{L} \Rightarrow 1 - \frac{0.931}{14} = 0.93$$

Prepared by Eng. Maged Kamel.

LRFD

$$L/D = 3$$

$$P_{ult} = 1.2D + 1.6L = D(1.2 + 1.6(3)) = 6D$$

$$A_g = 4.75 \text{ inch}^2$$

$$F_y = 50 \text{ ksi}$$

$$A_e = 3.67 \text{ inch}^2$$

$$F_u = 65 \text{ ksi} \quad \text{yielding}$$

$$\phi = 0.90 \quad \phi P_n = \phi_1 A_g F_y = 0.90 (4.75)(50) = 213.75 \text{ kips}$$

yielding

$$\phi P_n = \phi_2 A_e F_u = 0.75 (3.67)(65) = 179.0 \text{ kips}$$

$\phi = 0.75$
rupture

select $\phi P_n = 179.0 \text{ kips}$

$$P_t \leq \phi P_n$$

$$6D = 179.0 \text{ kips}$$

$$D = 29.80 \text{ kips} \Rightarrow L = 3D = 89.40 \text{ kips}$$

$$D + L = 29.80 + 89.40 = 119.20 \text{ kips}$$

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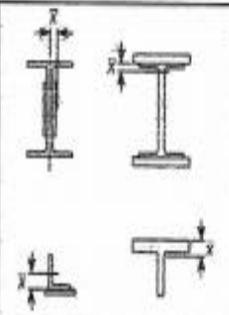
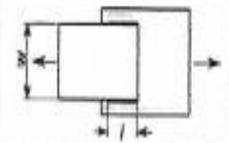
service
Load Capacity

TABLE D3.1
Shear Lag Factors for Connections
to Tension Members

Case	Description of Element	Shear Lag Factor, U	Example
8	Single and double angles (If U is calculated per Case 2, the larger value is permitted to be used.)	with 4 or more fasteners per line in the direction of loading	—
		with 3 fasteners per line in the direction of loading (With fewer than 3 fasteners per line in the direction of loading, use Case 2.)	—

l = length of connection, in. (mm); w = plate width, in. (mm); \bar{x} = eccentricity of connection, in. (mm); B = overall width of rectangular HSS member, measured 90° to the plane of the connection, in. (mm); H = overall height of rectangular HSS member, measured in the plane of the connection, in. (mm)

TABLE D3.1
Shear Lag Factors for Connections
to Tension Members

Case	Description of Element	Shear Lag Factor, U	Example
1	All tension members where the tension load is transmitted directly to each of the cross-sectional elements by fasteners or welds (except as in Cases 4, 5 and 6).	$U = 1.0$	—
2	All tension members, except plates and HSS, where the tension load is transmitted to some but not all of the cross-sectional elements by fasteners or longitudinal welds or by longitudinal welds in combination with transverse welds. (Alternatively, for W, M, S and HP, Case 7 may be used. For angles, Case 8 may be used.)	$U = 1 - \bar{x}/l$	
3	All tension members where the tension load is transmitted only by transverse welds to some but not all of the cross-sectional elements.	$U = 1.0$ and A_n = area of the directly connected elements	—
4	Plates where the tension load is transmitted by longitudinal welds only.	$l \geq 2w \dots U = 1.0$ $2w > l \geq 1.5w \dots U = 0.87$ $1.5w > l \geq w \dots U = 0.75$	

Prepared by Eng.Maged Kamel.