Subject: Steel Design College
Class: 4th Year
Lecturer: Dr. Wasan Qasim Fayyadh
Lecture: 3

University of Thi-Qar
College of Engineering
Civil Engineering Department

Method of designs

Limit States in Tension

gross-section yield

net-section fracture

block shear fracture

AISC Manual:

- Chapter B: Gross and Net Areas
- Chapter D: Tension Member Strength
- Chapter J: Block Shear
- Part 5: Design Charts and Tables

Sect. J3.] BOLTS AND THREADED PARTS 105

TABLE J3.3
Nominal Hole Dimensions, in.

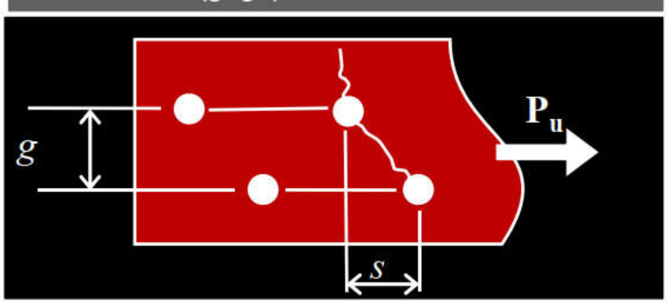
Bolt Diameter	Hole Dimensions			
	Standard (Dia.)	Oversize (Dia.)	Short-Slot (Width × Length)	Long-slot (Width × Length)
1/2	9/16	5/8	9/16 × 11/16	9/16 × 1 1/4
5/8	11/16	13/16	11/16 × 7/8	11/16 × 1 9/16
3/4	13/16	15/16	13/16 × 1	13/16 × 1 7/8
7/8	15/16	1 1/16	15/16 × 1 1/8	15/16 × 2 3/16
1	1 1/16	1 1/4	1 1/16 × 1 5/16	1 1/16 × 2 1/2
≥1 1/8	d + 1/16	d + 5/16	(d + 1/16) × (d + 3/8)	(d + 1/16) × (2.5 × d)

Rupture on Effective Net Area

Staggered holes

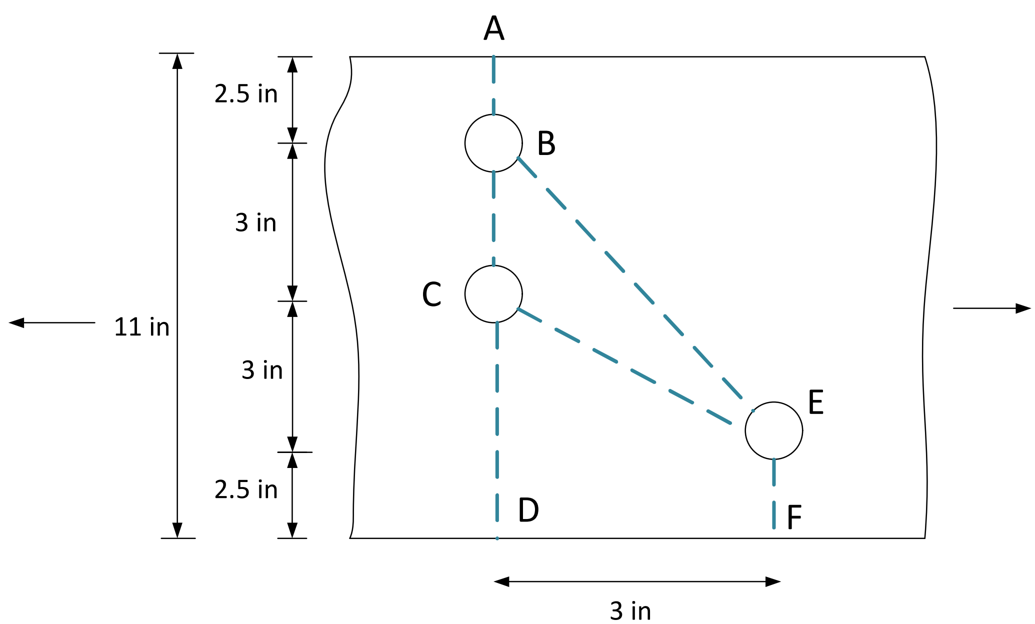
Diagonal hole pattern:
Net Width = Gross Width + $\Sigma s^2/4g$ – width of all holes
Section B4.3b.

s = longitudinal center-to-center spacing of holes (pitch)
g = transverse center-to-center spacing between fastener lines (gage)



Example:

Determine the critical net area of the ½ in thick plate as shown, using the AISC Specification (Section B4.3b).
The holes are punched for ¾ in bolts.



Effective Area

A_e = Effective Net Area
Modify net area (A_n) to account for shear lag.

$A_e = A_n U$ Equation D3-1

$$U = 1 - \frac{\bar{x}}{l}$$

Or value per Table D3.1

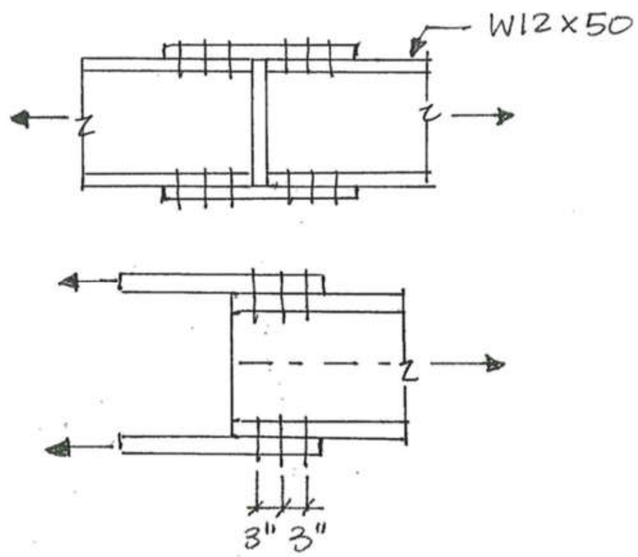
U = shear lag factor reduction

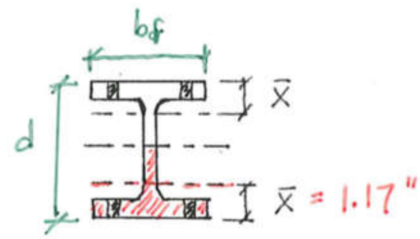
$\bar{x}$ = eccentricity of connection

l = length where force transfer occurs (distance parallel to applied tension force along bolts or weld)

Example

Calculate U for a spliced W-shape tension member





based on AISC Fig. C-D3.1
treat as two WTs
(WT6×25)
$\bar{x} = \bar{y} = 1.17''$
Table 1-8

Case 2

$$U = 1 - \frac{\bar{X}}{l} = 1 - \frac{1.17''}{6''} = \underline{0.81}$$

Case 7 (Alternative)

✓ At flange,
3 or more fasteners per line in direction of loading

$b_f \geq 2/3\, d \rightarrow U = 0.90$

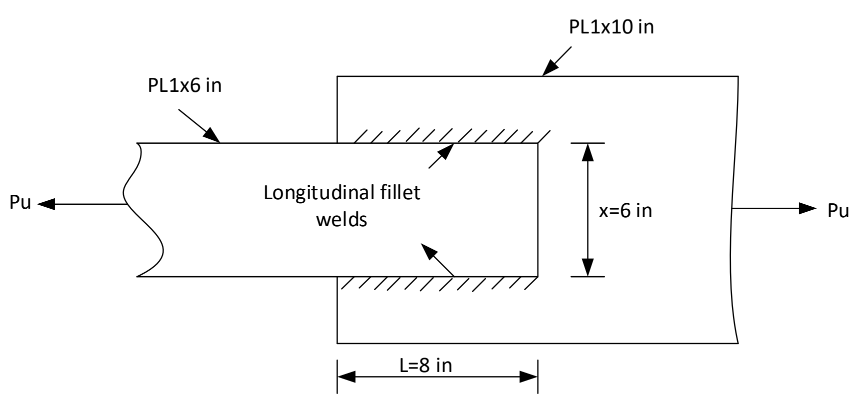
$b_f < 2/3\, d \rightarrow U = 0.85$

Table 1-1 (W12 x 50) $\frac{b_f}{d} = \frac{8.08''}{12.2''} = 0.66 \quad \therefore U = \underline{0.85}$

Larger of Case 2 or Case 7 permitted $\therefore \underline{U = 0.85}$

Example

The 1X6 in plate shown in the figure below is connected to a 1X10 in plate with longitudinal fillet welds to transfer a tensile load. Determine the LRFD design tensile strength and the ASD allowable tensile strength of the member if Fy=50 ksi and Fu=65ksi.



Block Shear

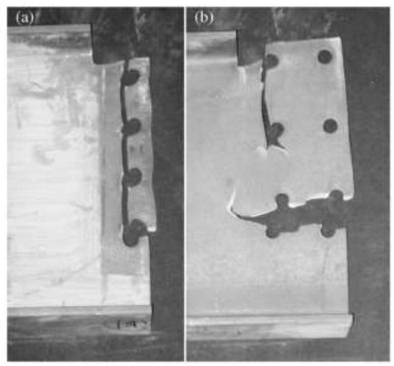
Block Shear Rupture Strength (Equation J4-5),

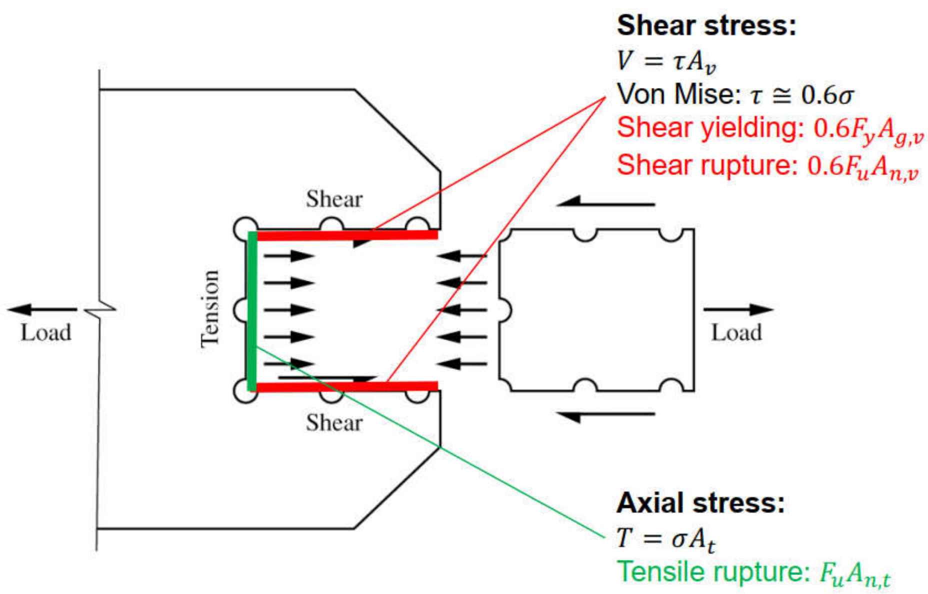
$$R_n = 0.6F_uA_{nv} + U_{bs}F_uA_{nt} \leq 0.6F_yA_{gv} + U_{bs}F_uA_{nt}$$

Smaller of two values will control

$\phi = 0.75\ (\Omega = 2.00)$

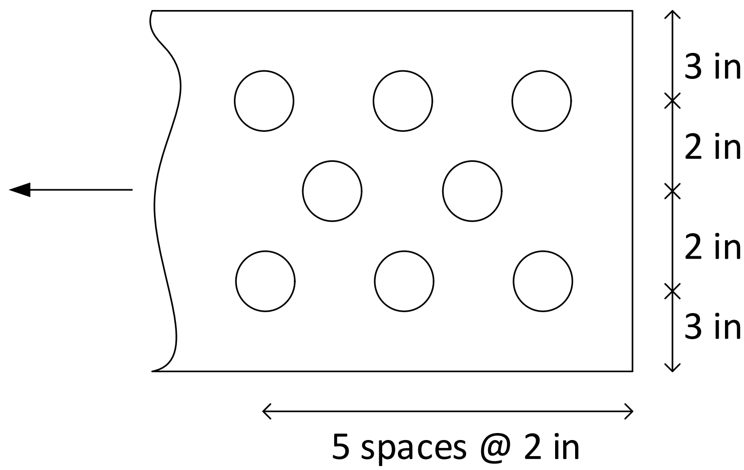
A_{gv} = gross area subject to shear
A_{nv} = net area subject to shear
A_{nt} = net area subject to tension
U_{bs} = 1 or 0.5 (1 for most tension members, see Figure C-J4.2)





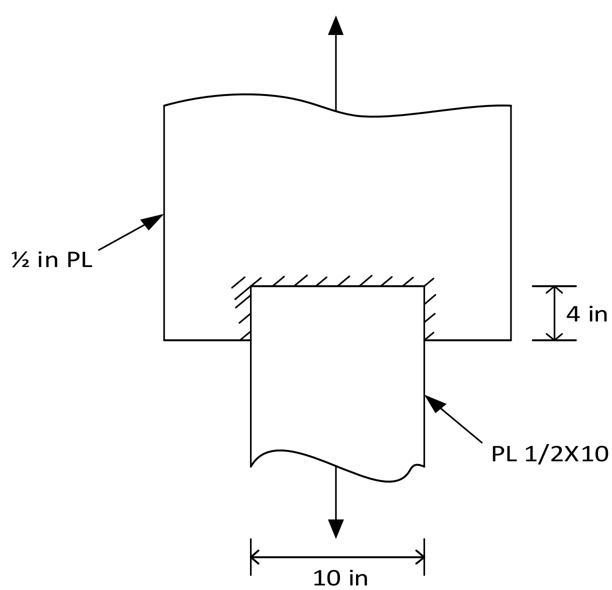
Tensile strength:
T_n = tensile strength + shear strength

What are possible block shear paths?



Example:

Determine the LRFD design strength and the ASD allowable strength of the A36 (Fy=36 ksi, Fu=58 ksi) plates shown. Include block shear strength in the calculations.



Example:

Determine the LRFD tensile design strength and the ASD tensile strength of the w12x30 (Fy=50 ksi, Fu= 65 ksi) shown below, if 7/8 in bolts are used in the connection. Include block shear calculations for the flanges.