Summary for the Content of post 7a

Solved problem 12-1 From Prof. McCormac

Determine design strength for a given Bearing Connection

(a) Use Table J3-2 to determine shear strength for bolts

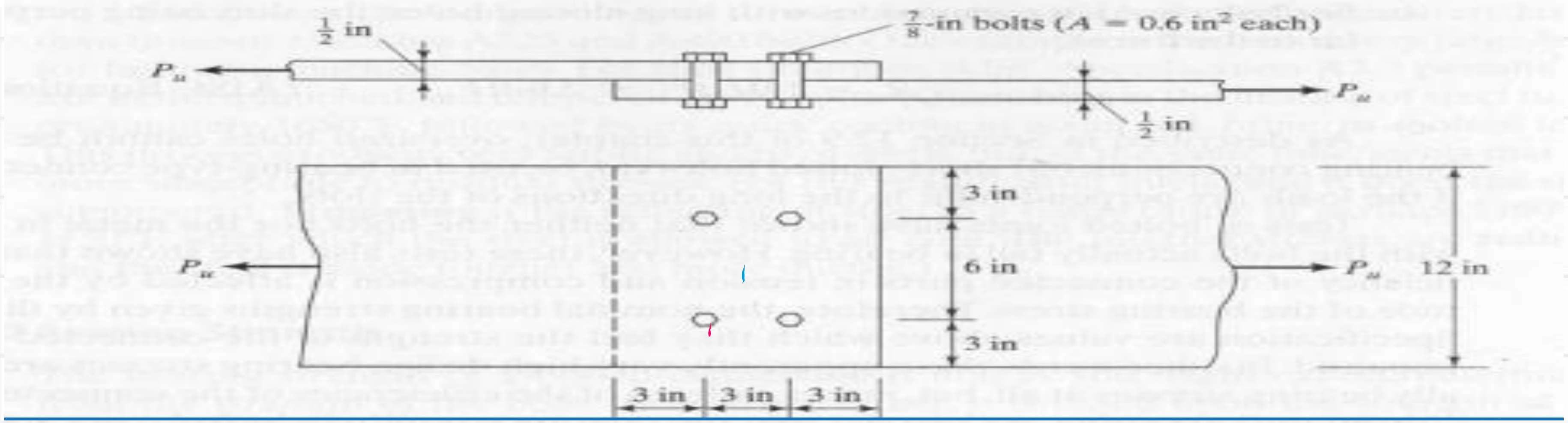
(b) Use Table 7-1 For shear strength

(c) Use Table 7-4 For Bearing Strength for inner bolts

Prof. McCormac

Example 12-1

Determine the design strength $\phi_c P_n$ and the allowable strength $\frac{P_n}{\Omega}$ for the bearing-type connection shown in Fig. 12.5. The steel is A36(F_y = 36 ksi and F_u = 58 ksi), the bolts



are 7/8-in A325, the holes are standard sizes, and the threads are excluded from the shear plane. Assume that deformations at bolt holes are a design consideration.

A325 bolts $\quad d_b = 7/8"$ $\quad A_b = \frac{\pi}{4} d_b^2 = \frac{3.14159}{4}(7/8)^2$

$A_b = 0.601$ inch²

single shear

Prepared by Eng.Maged Kamel.

X-Type

TABLE J3.2
Nominal Strength of Fasteners and Threaded Parts, ksi (MPa)

$A_b = 0.601\ inch^2$

Description of Fasteners	Nominal Tensile Strength, F_{nt}, ksi (MPa)[a]	Nominal Shear Strength in Bearing-Type Connections, F_{nv}, ksi (MPa)[b]
A307 bolts	45 (310)[c]	27 (186)[c] [d]
Group A (e.g., A325) bolts, when threads are not excluded from shear planes	90 (620)	54 (372)
Group A (e.g., A325) bolts, when threads are excluded from shear planes	90 (620)	68 (469)
Group B (e.g., A490) bolts, when threads are not excluded from shear planes	113 (780)	68 (469)
Group B (e.g., A490) bolts, when threads are excluded from shear planes	113 (780)	84 (579)

A 325 bolts $d = 7/8''$ x_ Type $F_{nv} = 68$ ksi

No. $N = 4$ bolts $R_{nv} = F_{nv} \cdot N \cdot A_b$ $\boxed{S.S}$

$\phi = 0.75$ $\rightarrow R_{nv} = 68(4)(0.601) = 163.472$ kips

$\phi R_{nv} = 0.75(163.472) = 122.60$ kips

$\frac{1}{2} R_{nv} = \frac{1}{2}(163.472) = 81.736$ kips

Use Table 7-1

S. shear

Group A _ X-Type

$d = 7/8''$

$\phi r_{nv} = 30.70$ kips for one bolt

For $N = 4$ bolts

Final ϕR_{nv}

$30.7(4) = 122.8$ kips

slight difference 122.60 kips From J3.2

Table 7-1
Available Shear Strength of Bolts, kips

7/8"

Nominal Bolt Diameter, d, in.					5/8		3/4		7/8		1	
Nominal Bolt Area, in.^{2}					0.307		0.442		0.601		0.785	
ASTM Desig.	Thread Cond.	F_{nv}/Ω (ksi) ASD	ϕF_{nv} (ksi) LRFD	Loading	r_n/Ω ASD	ϕr_n LRFD	r_n/Ω ASD	ϕr_n LRFD	r_n/Ω ASD	ϕr_n LRFD	r_n/Ω ASD	ϕr_n LRFD
Group A	N	27.0	40.5	S	8.29	12.4	11.9	17.9	16.2	24.3	21.2	31.8
				D	16.6	24.9	23.9	35.8	32.5	48.7	42.4	63.6
	X	34.0	51.0	S	10.4	15.7	15.0	22.5	20.4	30.7	26.7	40.0
				D	20.9	31.3	30.1	45.1	40.9	61.3	53.4	80.1

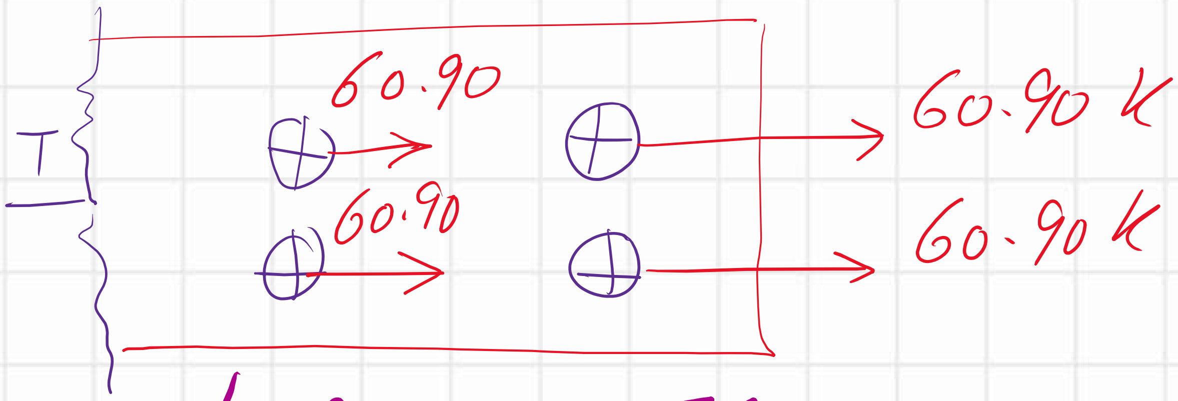
$\frac{r_{nv}}{\Omega} = 20.40$ kips $\Rightarrow$ $\frac{R_{nv}}{\Omega} = 4(20.4$

$= 81.6$ kips

S. shear

81.74 kips

From First part Bearing Values



$R_{n_b} = 4(60.90) = 243.60$ kips

Bearing

$\phi R_{n_b} = 0.75 \Rightarrow 0.75(243.60) = 182.70$ kips

$\frac{R_{n_b}}{\Omega} = 2.0 \Rightarrow \frac{1}{2}(243.60) = 121.80$ kips

We Can Use Table 7-4 For Bearing For inner bolts & Table 7-5 For Tear-out Values → LRFD & ASD Values

But we will get $\frac{\phi r_n}{inch}$ & $\left(\frac{r_n}{\Omega}\right)/inch$

$t_p = 1/2''$

Table 7-4
Available Bearing Strength at Bolt Holes Based on Bolt Spacing
kips/in. thickness

$F_{ult} = 58$ ksi

$d = \frac{7}{8}''$

Hole Type	Bolt Spacing, s, in.	F_u, ksi	Nominal Bolt Diameter, d, in.							
			5/8		3/4		7/8		1	
			r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n	r_n/Ω	ϕr_n
			ASD	LRFD	ASD	LRFD	ASD	LRFD	ASD	LRFD
STD SSLT	$2^2/_3\ d_b$	58	34.1	51.1	41.3	62.0	48.6	72.9	55.8	83.7
		65	38.2	57.3	46.3	69.5	54.4	81.7	62.6	93.8
	3 in.	58	43.5	65.3	52.2	78.3	60.9	91.4	67.4	101
		65	48.8	73.1	58.5	87.8	68.3	102	75.6	113

Spacing for full bearing strength s_{full}[a], in.		5/8	3/4	7/8	1
	STD, SSLT, LSLT	$1^{15}/_{16}$	$2^5/_{16}$	$2^{11}/_{16}$	$3^1/_{16}$
	OVS	$2^1/_{16}$	$2^7/_{16}$	$2^{13}/_{16}$	$3^1/_4$
	SSLP	$2^1/_8$	$2^1/_2$	$2^7/_8$	$3^5/_{16}$
	LSLP	$2^{13}/_{16}$	$3^3/_8$	$3^{15}/_{16}$	$4^1/_2$
Minimum Spacing[a] $= 2^2/_3 d$, in.		$1^{11}/_{16}$	2	$2^5/_{16}$	$2^{11}/_{16}$

STD = standard hole
SSLT = short-slotted hole oriented transverse to the line of force
SSLP = short-slotted hole oriented parallel to the line of force
OVS = oversized hole
LSLP = long-slotted hole oriented parallel to the line of force
LSLT = long-slotted hole oriented transverse to the line of force

$\phi r_n = 91.40\ k/\text{inch of Plate}$

$\frac{r_n}{\Omega} = 60.90 k/\text{inch}$

ASD	LRFD
$\Omega = 2.00$	$\phi = 0.75$

Note: Spacing indicated is from the center of the hole or slot to the center of the adjacent hole or slot in the line of force. Hole deformation is considered. When hole deformation is not considered, see AISC *Specification* Section J3.10.

[a] Decimal value has been rounded to the nearest sixteenth of an inch.

From Table - 7-4 $\quad t_{pl} = \frac{1}{2}''$

$$\phi r_n = 91.40 \ \frac{kip}{inch}$$

$$\frac{r_n}{\Omega} = 60.90 \ \frac{kip}{inch}$$

$$\phi R_{n\,\text{one bolt}} = 91.40\left(\frac{1}{2}\right) = 45.70 \ \text{kips}$$

$$\frac{R_n}{\Omega} = \frac{60.90}{2}(1) = 30.45 \ \text{kips}$$

Table 7-5

For this example, No provision for $l_e = 3''$

ϕR_n, $\frac{R_n}{\Omega}$ For Four bolts $= 4(45.70) = 182.8$ kips

$4(30.45) = 121.8$ kips

We will Review all strength values $\boxed{LRFD}$

① From Tensile yielding $\Rightarrow R_n = 216$ kips $\Rightarrow \phi_t = 0.90$

② From Tensile Rupture $\Rightarrow R_n = 290$ kips $\Rightarrow \phi = 0.75$

③ From Shear strength $\Rightarrow R_{nv} = 163.47$ kips $\Rightarrow \phi = 0.75$

④ From Bearing strength $\Rightarrow R_{nv} = 243.60$ kips $\phi = 0.75$

$0.9(216) = 194.40$ kips

$0.75(290) = 217.50$ kips

$0.75(163.47) = 122.55$ kips $\Longrightarrow$ min value $= 122.55$ kips shear

$0.75(243.60) = 182.70$ kips

We will Review all strength values $\boxed{ASD}$

① From Tensile yielding $\Rightarrow R_n = 216$ kips $\Rightarrow \frac{1}{\Omega} = 0.60$

② From Tensile Rupture $\Rightarrow R_n = 290$ kips $\Rightarrow \frac{1}{\Omega} = 0.50$

③ From Shear strength $\Rightarrow R_{nv} = 163.47$ kips $\Rightarrow \frac{1}{\Omega} = 0.50$

④ From Bearing strength $\Rightarrow R_{nv} = 243.60$ kips $\Rightarrow \frac{1}{\Omega} = 0.50$

$0.60\,(216) = 129.60$ kips

$0.50\,(290) = 145.0$ kips

$0.5\,(163.47) = 81.70$ kips $\Rightarrow \min = 81.70$ kips

$0.50\,(243.60) = 121.80$ kips

Shear