STEEL DESIGN 14.452 ANA CLARA R. GOUVEIA DUE: 9/30/13
HOMEWORK # 4 CHAPTER 12

PROBLEM 21

GIVEN:

Load Info:											
	D =	35	kips	L =	115	kips	R=	0	kips	S=	65	kips
	I=	0	kips	Lr=	0	kips	W=	0	kips	E=	0	kips
	Pu=	0	kips	Pa=	0	kips						

FIND:
METHOD: 1. Find loads according to AISC p2-10

SOLUTION: **1. Finding loads:**

1.1) LRFD:

	Load Combinations	D	L+I	Lr	S	R	W	E	Sum
					Uniform Load Cases				
1	1.4D	35							35
2	1.2D+1.6L+0.5(Lr or S or R)	42	184	0	32.5	0			258.5
3	1.2D+1.6(Lr or S or R)+(L* or 0.5W)	42	57.5	0	104	0	0		203.5
4	1.2D+1.0W+L*+0.5(Lr or S or R)	42	57.5	0	32.5	0	0		132
5	1.2D+1.0E+L* + 0.2S	42	57.5		13			0	112.5
6	0.9D+1.0W	31.5					0		31.5
7	0.9D+1.0E	31.5						0	31.5

***Note:** *Change Load Factor for 1 for public assembly, live loads in excess of 100 psf and for parking*

The governing factored load for design is equal to: **258.5** kips

1.2.) ASD:

	Load Combinations	D	L+I	Lr	S	R	W	E	Sum
					Uniform Load Cases				
1	D	35							35
2	D+L	35	115						150
3	D+(Lr or S or R)	35		0	65	0			100
4	D+0.75L + 0.75(Lr or S or R)	35	86.25	0	48.75	0			170
5	D+(0.6W OR 0.7E)	35					0	0	35
6 (a)	D+0.75L+0.75(0.6W)+0.75(Lr/S/R)	35	86.25	0	48.75	0	0		170
6 (b)	D+0.75L+0.75(0.7E)+0.75S	35	86.25		48.75			0	170
7	0.6D+0.6W	21					96		117
8	0.6D+0.7E	21						0	21

The governing factored load for design is equal to: **170** kips

Pu= 258.5 kips	Pa= 170 kips

PROBLEM 6

GIVEN:

	Plate		Member		
	PL 5/8 x 12		PL 1 x 12		
Width =	12	in.	12	in.	
Thickness =	0.625	in.	1	in.	
? Gross Area, Ag =	7 1/2	in.	12	in.	
Yield Stress, Fy =	36	ksi.	36	ksi.	Table 2-4
Double Shear or Single?	2				

FIND:

METHOD:

1. General Equations for Yielding

Pn = Fy*Ag — Eq D2--1

2. LRFD yield strength = Pn*ϕ — ϕ = 0.9

3. ASD Yield Strength = Pn/Ω — Ω = 1.67

SOLUTION:

1. Nominal Yield Strength, Pn

A. Plate:	135	kips	*value is divided by 2 if double shear.
B. Member:	432	kips	

2. LRFD Bearing Strength = ϕ*Rn

A. Plate	121.5	Kips
B. Member	388.8	Kips

3. ASD Bearing Strength = Rn/Ω

A. Plate	80.84	Kips
B. Member	258.7	Kips

PROBLEM 6

GIVEN:

		Threads:				
Type of Bolt:	A325	N				
Nominal Bolt Diameter, d1	3/4	in.	No. Bolts	9		REF. AISC 14th ed
Nominal Bolt Hole Diameter, d	0.813	in.				
Effective Hole diameter, de=	0.875	in.				

	Plate		REF.	Member		REF.
	PL 5/8 x 12			PL 1 x 12		
Minimum Edge Distance =	2	in.		2	in.	
Minimum Spacing =	3	in.		3	in.	
Length of Connection, l=	6	in.		6	in.	
distance to centroid, x-bar =	0.313	in.		0.5	in.	
width, b =	12	in.		12	in.	
Thickness, tf =	0.625	in.		1	in.	
Area Gross, Ag =	7.5	in^2		12	in^2.	
Ultimate Stress, Fu =	58	ksi.		58	ksi.	Table 2-4
Double or single shear?	2					

FIND:

METHOD:

1. General Equations for Rupture:
Pn=Fu.Ae — D2-2

2. LRFD yield strength = Rn*ϕ — ϕ = 0.75
3. ASD Yield Strength = Rn/Ω — Ω = 2

A.1 Find Minimum Net Area, An — **An=Ag-holes**

A.2 Find Effective Area, Ae — **Ae=An*U**
A.2.1. Find Shear Lag Factor, U.

B.1 Solve for Rupture Strength (LRFD)
B.2 Solve for Rupture Strength (ASD)

SOLUTION:

A.1. Find minimum net area:

	Ag	Bolts	de	t	An
Plate	7.5	3	0.875	0.625	5.859
Member	12	3	0.875	1	9.375

A.2. Finding Effective Area

	An	U	Ae
Plate	5.859	1	5.859
Member	9.375	1	9.375

Shear Lag U:

		Plate	Member	
Case 2:	U=	0.948	0.917	
Case 1	U=	1	1	all parts connected

2. Nominal Rupture Strength, Pn & Pu and Pa.

	Pn	LRFD	ASD
Plate	339.8	254.9	169.9
Member	543.8	407.8	271.9

PROBLEM 6

GIVEN:

		Threads:			
Type of Bolt:	A325	N			
Nominal Bolt Diameter, d1	3/4	in.	No. Bolts	9	REF. AISC 14th ed
Nominal Bolt Hole Diameter, d	0.813	in.			
Effective Hole diameter, de=	0.875	in.			

	Plate		REF.	Member		REF.
	PL 5/8 x 12			PL 1 x 12		
Minimum Edge Distance =	2	in.		2	in.	
Minimum Spacing =	3	in.		3	in.	
Length of Connection, l=	6	in.		6	in.	
distance to centroid, x-bar =	0.313	in.		0.5	in.	
width, b =	12	in.		12	in.	
Thickness, tf =	0.625	in.		1	in.	
Area Gross, Ag =	7.5	in^2		12	in^2.	
Ultimate Stress, Fu =	58	ksi.		58	ksi.	
Yield Stress, Fy=	36			36		
Double or single shear?	2					

FIND:

METHOD:

1. General Equations for Block Shear:

1.1. Shear + Tensile Rupture:	0.6*Fu*Anv + Ubs*Fu*Ant	CONDITION 1
1.2. Shear Yield + Tensile Rupture:	0.6*Fy*Agv + Ubs*Fu*Ant	CONDITION 2

2. Assume Load is uniform,	Ubs=	1
3. LRFD yield strength = Rn*ϕ	ϕ =	0.75
4. ASD Yield Strength = Rn/Ω	Ω =	2

A.1 Find Net Tensile Area, Ant
A.2 Find Net Shear Area, Anv
A.3 Find Gross Shear Area, Agv

B.1 Solve for Condition 1
B.2 Solve for Condition 2
B.3 Select minimum nominal strength

B.4 Calculate LRFD/ASD Block shear strengths

SOLUTION:

A.1. Find Net Tensile Area, Ant Ant = [Length - no.bolt holes(eff hole diam)+df]t

Section	Length	s	g	df = s^2/4g	# holes	Eff. Diam	Eff lengt	Plate t	Member t	Plate An	Member An
AB	3	0	1	0	0.5	0.875	2.56	0.63	1	1.6	2.5625
ED	3	0	1	0	0.5	0.875	2.56	0.63	1	1.6	2.5625

Plate	Total Net Area AB+ED	3.203
Member	Total Net Area AB+ED	5.125

A.2. Find Net Shear Area, Anv Anv = [Total Length - no.bolt holes(eff hole diam)]t

Section	Length	# holes	Eff. Diam	Eff length	Plate t	Member t	Plate An	Member An
AB	8	2.5	0.875	5.8125	0.63	1	3.63	5.81
ED	8	2.5	0.875	5.8125	0.63	1	3.63	5.81

Plate	Total Net Area AB+ED	7.266
Member	Total Net Area AB+ED	11.63

A.3. Gross Shear Area Agv=L*t

Section	Length	Plate t	Member t	Plate An	Member An
AB	8	0.625	1	5	8
ED	8	7.5	12	60	96

Plate	Total Gross Area AB+ED	65
Member	Total Gross Area AB+ED	104

	Plate	Member
B.1. Nominal Shear Rupture Strength	252.8	3619
B.1 Nominal Tensile Rupture Strength	185.8	297
Condition 1: Shear Rupture + Tensile:	438.6	3916
B.2. Nominal Shear Yield Strength	1404	2246
Condition 2: Shear Yield + Tensile	1590	2544
B.3 Nominal Block Shear Strength, Pn:	438.6	2544

B.4. LRFD Block Shear Strength:	329	1908
B.4. ASD Block Shear:	219.3	1272

PROBLEM 6

GIVEN:

		Threads:						
Type of Bolt:	A325	N						
Nominal Bolt Diameter, d1	3/4	in.	No. Bolts	9			REF. AISC 14th ed	
Nominal Bolt Hole Diameter, d	0.813	in.						
	Plate		Member					
	PL 5/8 x 12		PL 1 x 12					
Minimum Edge Distance =	2	in.	2	in.			J.3-4	Satisfy
Minimum Spacing =	3	in.	3	in.	Given		J.3-3 (3xd)	code
Thickness =	0.625	in.	1	in.				
? Ultimate Stress, Fu =	58	ksi.	58	ksi.			Table 2-4	
long-slot holes	NO		NO					
Deformation Important	YES		YES					

FIND:

METHOD:

1. General Equations for Bearing: AISC J3.10

1.1 Standard, Oversize, short-slot holes:

a) Rn=1.2Lct.Fu <= 2.4dt.Fu — *Deformation important (<0.25 in)* — Eq. J3.6a

b) Rn=1.5Lct.Fu <= 3dt.Fu — *Deformation not important* — Eq. J3.6b

1.2. Long-slot holes perpendicular to force

a) Rn=1.0Lct.Fu <= 2.0dt.Fu — Eq. J3.6c

2. LRFD yield strength = Rn*ϕ — ϕ = 0.75

3. ASD Yield Strength = Rn/Ω — Ω = 2

SOLUTION:

1. Find minimum clear distance, Lc	Plate	Member	Lc - (space from edge of hole to

A. interior Lc = spacing - hole diam - 1/16 in	2.125	in.	2 1/8	in.	edge of hole)
B. Edge Lc = edge distance - (hole diam + 1/16 in)/2	1.563	in.	1.563	in.	
C. Min Lc	1.563	in.	1.563	in.	

2. Nominal Strength, Rn

A. Plate:	**Tear-out** (kips/bolt)	**Deformation** (kips/bolt)	**Control** (kips/bolt)	
Deformation important	67.97	65.25	65.25	Eq. J3.6a
Deformation not important	84.96	81.56	81.56	Eq. J3.6b
Long-slot holes	56.64	54.38	54.38	Eq. J3.6c
		Control:	65.25	

Nominal Plate Bearing Strength:	587.3	kips

B. Member:	**Tear-out** (kips/bolt)	**Deformation** (kips/bolt)	**Control** (kips/bolt)	
Deformation important	108.8	104.4	104.4	Eq. J3.6a
Deformation not important	135.9	130.5	130.5	Eq. J3.6b
Long-slot holes	90.63	87	87	Eq. J3.6c
		Control:	104.4	

Nominal Member Bearing Strength	939.6	kips

3. LRFD Bearing Strength = ϕ*Rn

A. Plate	440.4	Kips
B. Member	704.7	Kips

3. ASD Bearing Strength = Rn/Ω

A. Plate	293.6	Kips
B. Member	469.8	Kips

PROBLEM 6

GIVEN:

		Threads:			
Type of Bolt:	A325	N			
Nominal Bolt Diameter, d1	3/4	in.	No. Bolts	9	REF. AISC 14th ed
Nominal Bolt Hole Diameter, d	0.813	in.			
Nominal Bolt Area, Ab	0.442	in^2			
Threades Excluded:	1	1-yes 0- no			
Nominal Shear Strength, A325X, Fnv=	68	ksi			Table J3.2
Nominal Shear Strength, A325N, Fnv=	54	ksi.			Table J3.2
Single or Double Shear?	2				

FIND:

METHOD:

1. General Equations for Shear: AISC J3.6

1.1 Rn=Fnv*Ab

2. LRFD yield strength = Rn*ϕ $\phi =$ 0.75

3. ASD Yield Strength = Rn/Ω $\Omega =$ 2

SOLUTION:

1. Nominal Bolt Shear Strength, Rn

A. Threads excluded	30.03	kips/bolt	
B. Threads not excluded	23.84	kips/bolt	
C. Nominal Shear Strength of bolted connection	270.2	kips	Depend if either A/B
	540.5		

3. LRFD Bearing Strength = ϕ*Rn

Shear strength of bolted connection 405.4 Kips

3. ASD Bearing Strength = Rn/Ω

Shear strength of bolted connection 270.2 Kips

PROBLEM 6

GIVEN:

			Threads:				
	Type of Bolt:	A325	N				
	Nominal Bolt Diameter, d1	3/4	in.	No. Bolts	9		REF. AISC 14th ed
	Nominal Bolt Hole Diameter, d	0.813	in.				
	Specified Pretension Force, Du	1.13	in^2				
	Number of Slip Planes/ bolt, ns	1					
	Minimum Bolt Pretension A325, Tb=	28	ksi				Table J3.1
What?	Faying Surfaces?	No.	ksi.				J3.8
What?	Hole Type	-					
	Filler Plate Factor, hf	1	No filler plates added				Eq. J3-4

FIND:

METHOD:

1. Slip Critical Nominal Strength, Rn =μ.Du.hf.Tb.ns Eq J3-4

2. LRFD yield strength = Rn*ϕ	ϕ =	1	Depend 16.1-p126
3. ASD Yield Strength = Rn/Ω	Ω =	2	

SOLUTION:

1. General Equations for Slip Critical Strength, Rn

A. Mean slip coefficient, μ	0.3		J3.8
B. Nominal strength per bolt	9.492	kips/bolt	
C. Nominal Strength of bolted connection	85.43	kips	

3. LRFD Bearing Strength = ϕ*Rn

Shear strength of bolted connection 85.43 Kips

3. ASD Bearing Strength = Rn/Ω

Shear strength of bolted connection	42.71	Kips

PROBLEM 6

GIVEN:

Limit States		**LRFD**	**ASD**
1. Yield	Plate	121.5	80.84
	Member	388.8	258.7
2. Rupture	Plate	254.9	169.9
	Member	407.8	271.9
3. Block Shear	Plate	329	219.3
	Member	1908	1272
4. Bolt Bearing	Plate	440.4	293.6
	Member	704.7	469.8
5. Bolt Shear		405.4	270.2
6. Slip Critical		85.43	42.71

Design Tensile Strength:	388.8	258.7	kips

Thus if, slip critical is not considered, yielding controls.