Text: Jack C. McCormac, Stephen F. Csernak; Structural Steel Design – Fifth Edition, Pearson International Education

In all of the following problems, F_y = 2400 daN/ cm² and F_u = 3700 daN/cm², unless noted otherwise.

All answers are to be provided in Iranian customary units (tons, Kgf or daN, m, cm, etc.) using steel sections available in Iran (IPE, IPB, L, U, etc.). Derive metric properties of steel and use 1MPa≈10daN/cm², unless noted otherwise. Also, if necessary, convert the US customary units to metric units:

1 yd = 3 ft	1 ft = 12 in	1 in ≈ 2.5 cm	1 kip ≈ 454 daN	1 ksi ≈ 70 daN/cm²
	1 ft ≈ 30 cm	1 kip/ft=1488 kgf/m		1 psf ≈ 4.9 daN/m²

Homework Set #5

Problem Number	Comments
Use only LRFD method to solve the following questions.	
12.27	Bolt size=M20, plates are 25x1.2 cm, convert other dimensions to cm.
12.37	Bolt size=M22, use IPB500, longitudinal center to center spacing of bolts=7.5cm, longitudinal center to edge spacing of bolts=3.8 cm, transverse center to center spacing of bolts=14 cm, use plate 35x1.9 cm, F_y = 3600 daN/ cm² and F_u = 5200 daN/cm².
13.6	P_u=30ton, convert dimensions to cm.
13.9	Bolt size=M20, plate thickness=1.6 cm, convert other dimensions to cm.
13.16	Bolt size=M20.
13.17	Bolt size=M20, use L12x8x1.2 cm, plate thickness=2 cm, L_c=2.5 cm, P_u=80 ton, take F_y = 3600 daN/ cm² and F_u = 5200 daN/cm², use IPE450.

12-26. For an external shear V_u of 600 k, determine by LRFD the spacing required for 1-in A325 web bolts (threads excluded) in a bearing-type connection for the built-up section shown in the accompanying illustration. Assume that $l_c = 1.5$ in and A36 steel.

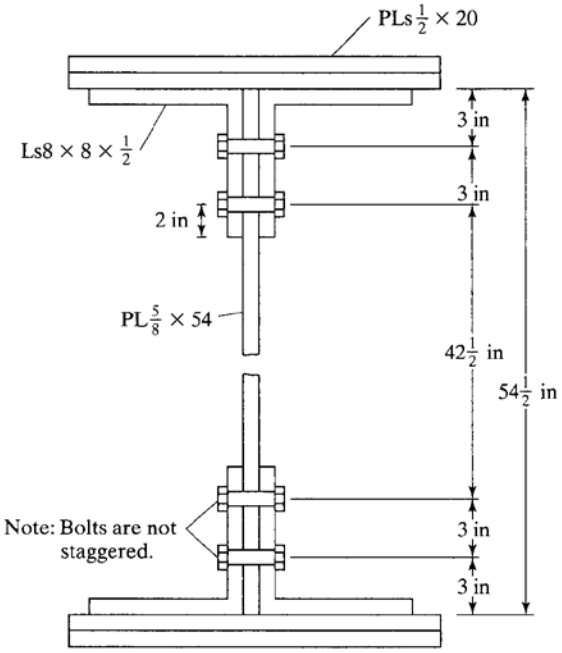

FIGURE P12-26

12-27. Determine the design strength P_u and the allowable strength P_a for the connection shown if $\frac{7}{8}$-in A325 bolts (threads excluded) are used in a slip-critical connection with a factor for fillers, $h_f = 1.0$. Assume A36 steel and Class B faying surface and standard size holes. (*Ans.* 132.2 k, 88.1 k)

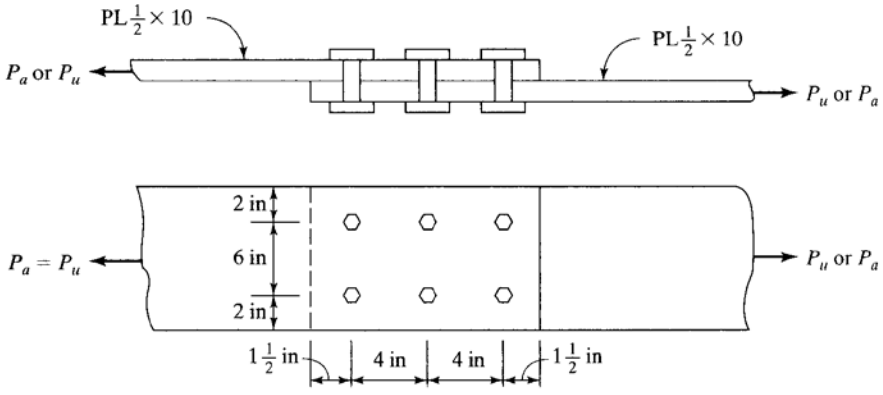

FIGURE P12-27

12-28 to 12-33. *Repeat these problems, using the loads given and determine the number of bolts required for a slip-critical connection. Assume Class A surfaces, standard-size holes,* $h_f = 1.00$, *and* l_c *values of 1.50 in*, UNO.

12-28. Prob. 12-6. $P_D = 100$ k, $P_L = 150$ k

12-29. Prob. 12-11. $P_D = 50$ k, $P_L = 100$ k (*Ans.* 24 both LRFD, ASD)

12-30. Prob. 12-13. $P_D = 75$ k, $P_L = 160$ k

12-31. Prob. 12-14. $P_D = 120$ k, $P_L = 150$ k (*Ans.* 16 both LRFD, ASD)

12-32. Prob. 12-16. $P_D = 40$ k, $P_L = 100$ k

12-33. Prob. 12-20. (*Ans.* 11 LRFD, 12 ASD)

12-34 and 12-35. *Using the bearing-type connection from each problem given, determine the number of 1-in A490 bolts required, by LRFD and ASD, for a slip-critical connection. Assume long-slotted holes in the direction of the load, Class A faying surfaces,* $h_f = 1.00$, *and* $l_c = 1.25$ *in.*

12-34. Prob. 12-12.

12-35. Prob. 12-15. (*Ans.* 11 or 12 LRFD, 12 ASD)

12-36. Determine the design tensile strength P_u and the allowable tensile strength P_a of the connection shown if eight $\frac{7}{8}$-in A325 bearing-type bolts (threads excluded from shear plane) are used in each flange. Include block shear in your calculations. A36 steel is used.

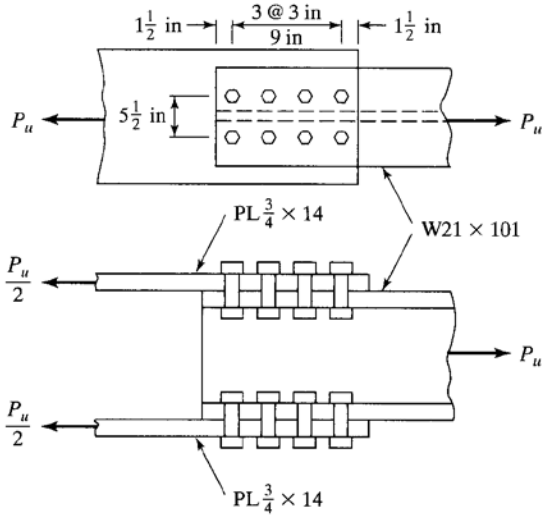

FIGURE P12-36

12-37. Repeat Prob. 12-36, using $\frac{7}{8}$-in A490 bearing-type bolts. $F_y = 50$ ksi and $F_u = 65$ ksi (*Ans.* 604.8 k, 403.2 k)

13.9 PROBLEMS FOR SOLUTION

For each of the problems listed, the following information is to be used, unless otherwise indicated: (a) A36 steel; (b) standard-size holes; (c) threads of bolts excluded from shear plane.

13-1 to 13-7. *Determine the resultant load on the most stressed bolt in the eccentrically loaded connections shown, using the elastic method.*

13-1. (*Ans.* 23.26 k)

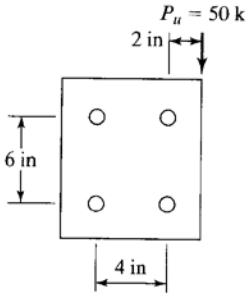

FIGURE P13-1

13-2.

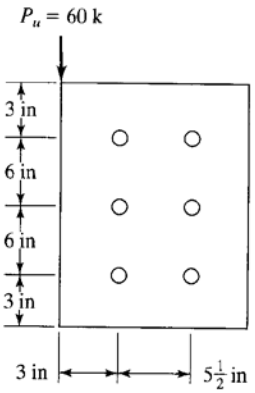

FIGURE P13-2

13-3. (*Ans.* 16.49 k)

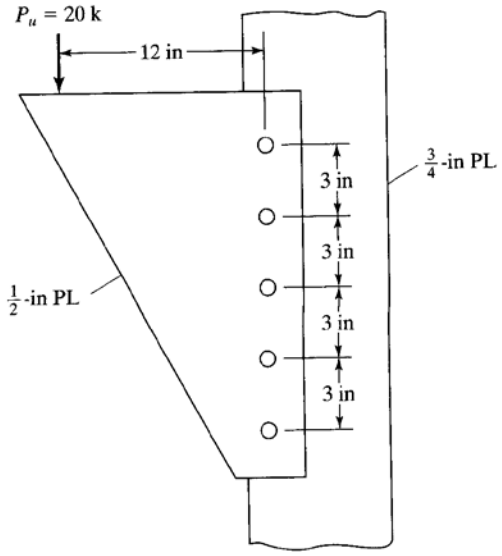

FIGURE P13-3

13-4.

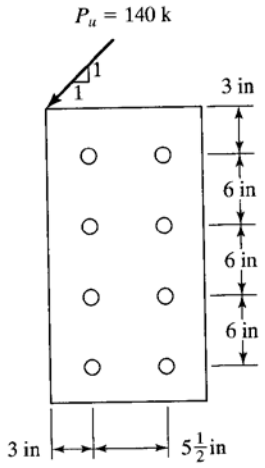

FIGURE P13-4

13-5. (*Ans.* 21.87 k)

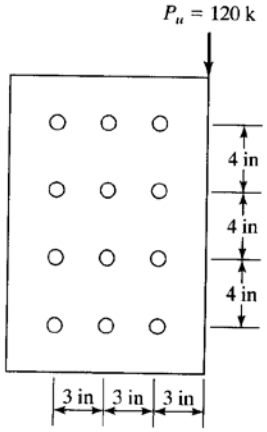

FIGURE P13-5

13-6.

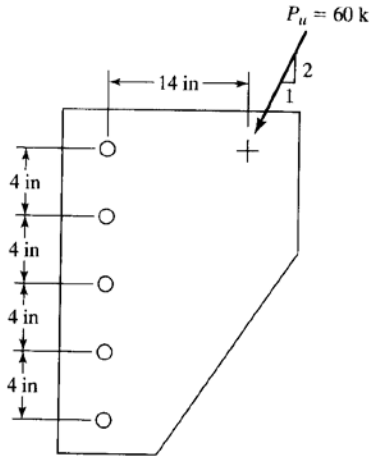

FIGURE P13-6

13-7. (*Ans.* 33.75 k)

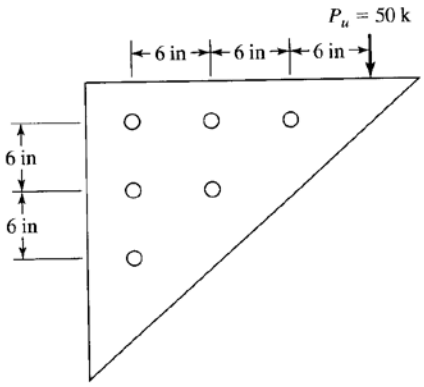

FIGURE P13-7

13-8. Repeat Prob. 13-2, using the reduced eccentricity method given in Section 13.1.2

13-9. Using the elastic method, determine the LRFD design strength and the ASD allowable strength of the bearing-type connection shown. The bolts are 3/4 in A325 and are in single shear and bearing on 5/8 in. The holes are standard sizes and the bolt threads are excluded from the shear plane.(*Ans.* 58.0 k LRFD, 38.7 k ASD)

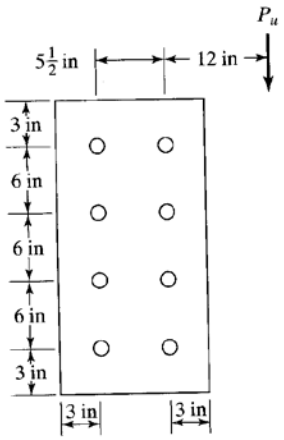

FIGURE P13-9

13-10. Using the elastic method, determine the ASD allowable strength P_n/Ω and the LRFD design strength, ϕP_n for the slip-critical connection shown. The 7/8-in A325 bolts are in "double shear." All plates are 1/2-in thick. Surfaces are Class A. Holes are standard sizes and $h_f = 1.0$.

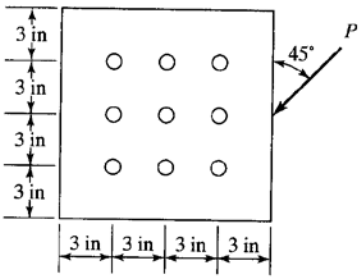

FIGURE P13-10

13-11. Repeat Prob. 13-9, using the ultimate strength tables entitled "Coefficients C for Eccentrically Loaded Bolt Groups" in Part 7 of the AISC Manual. (*Ans.* 73.6 k)

13-12. Repeat Prob. 13-10, using the ultimate strength tables entitled "Coefficients C for Eccentrically Loaded Bolt Groups" in Part 7 of the AISC Manual.

13-13. Is the bearing-type connection shown in the accompanying illustration sufficient to resist the 200 k load that passes through the center of gravity of the bolt group, according to the LRFD and ASD specifications? (*Ans.* $\phi F'_{nt} = 54.7$ ksi, $F'_{nt}/\Omega = 37.8$ ksi. Therefore connection is satisfactory.)

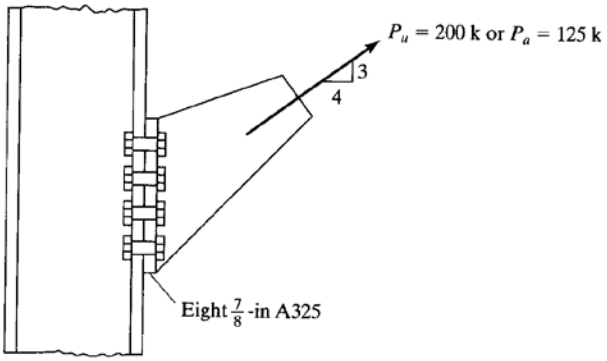

FIGURE P13-13

13-14. Repeat Prob. 13-13 if slip-critical bolts for the required strength level are used and if surfaces are Class A, $h_f = 1.00$ and standard size holes are used.

13-15. If the load shown in the accompanying bearing-type illustration passes through the center of gravity of the bolt group, how large can it be, according to both the LRFD and ASD specifications? Bolt threads are excluded from the shear planes. (*Ans.* 148.7 k LRFD, 99.2 k ASD)

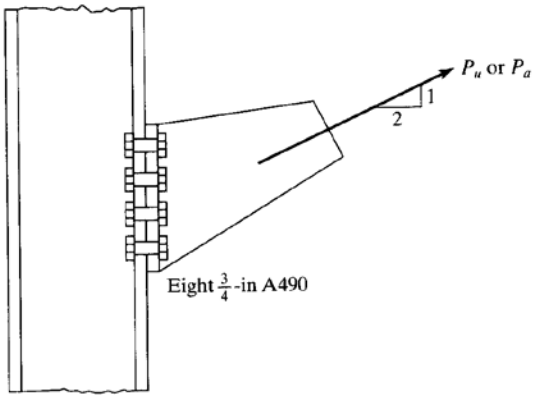

FIGURE P13-15

13-16. Repeat Prob. 13-15 if bolts are A325.

13-17 to 13-24. *Solve these problems by both the LRFD and ASD methods.*

13-17. Determine the number of 3/4-in A325 bolts required in the angles and in the flange of the W shape shown in the accompanying illustration if a bearing-type (snug-tight) connection is used. Use 50 ksi steel, $F_u = 65$ ksi, $L_c = 1.0$ in. Deformation around the bolt holes is a design consideration. (*Ans.* 4 in angle, both LRFD & ASD; 8 in W section, both LRFD & ASD)

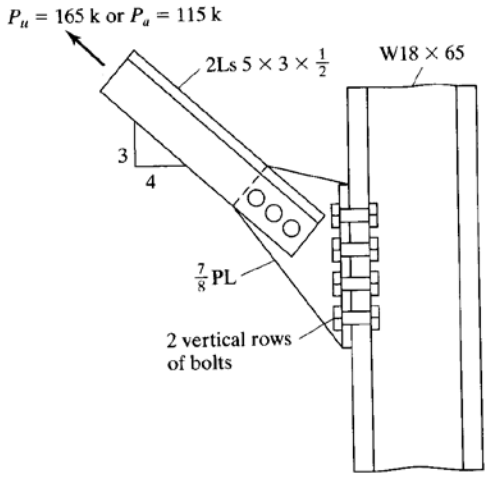

FIGURE P13-17

13-18. Determine the design strength ϕP_n and the allowable strength P_n/Ω of the connection shown if 3/4-in A502, Grade 1 rivets and A36 steel are used. Assume $F_v = 25$ ksi and threads excluded from shear planes.

