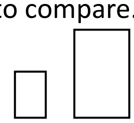
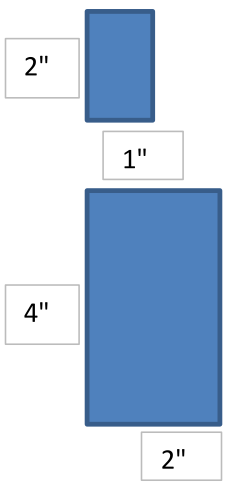
HW 4 SOLN

Reading:
Read AISC 14th Ed Spec Section F, G and H
Read AISC 14th Ed Design Examples - Spec Ch F

Problem 1
What is the ASD bending moment capacity of a solid square bar 1" wide x 2" deep? What is the relative increase in bending capacity if the cross-sectional dimensions are doubled (so 2" x 4")? Assume A36 steel and you will need to find the plastic modulus first to compare.



ASD Moment Capacity = Z Fy/1.67 = 1 x 36ksi/1.67= 21.56 k-in



b	1	in
d	2	in
Area = A	2	in^2
Zx	1.0000	Z = b d^2 / 4
	21.56	k-in

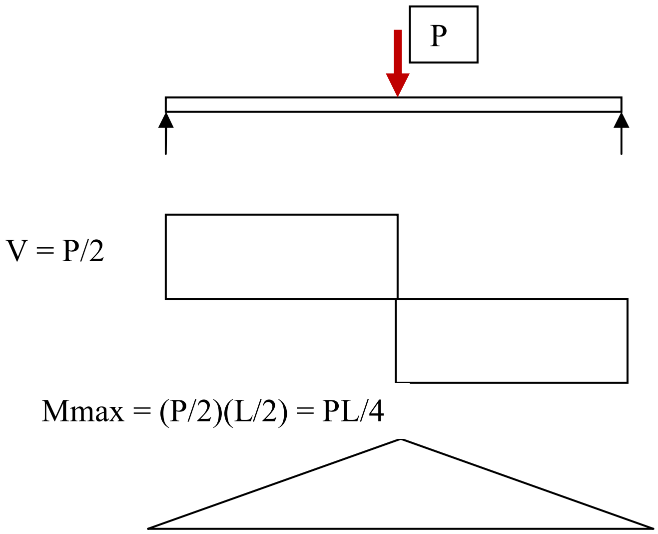
b	2	in
d	4	in
Area = A	8	in^2
Zx	8.0000	Z = b d^2 / 4

Z/ Z	8.0

8 times as much bending strength!

Problem 2

From you answer in problem #1, related to the solid square rod 1" x 2", how long can this rod span assuming it is supporting a person weighing 300 pounds in the center?



Moment Capacity of Rod = 1 x 36ksi /1.67 = 21.56 k-in

Setting Moment Capacity = Moment Demand
21.56 k-in = (0.300k)L/4 and solve for L, L = 287"

This assumes load was ASD, if you did it without the 1.67 factor (or used LRFD) that is OK.

Problem 3

What is a LRFD moment capacity of a W12x50 beam in the strong axis (use Zx)? If this beam was 30 ft long, how much load can it support in pounds per linear foot? See Example F.1-1B to help.

Zx = 71.9 in^3

Moment Capacity = 0.9 FyZ = 0.9 x 50ksi x 71.9 in^3 = 3235 k-in or **269 k-ft**

M = w L^2/8 = 269 k-ft

Rearrange equation above and Solve for w...

w = 8 x 269 k-ft / (30^2) **= 2.4 klf**

Problem 4

Design simple span 20ft long steel beam 'B-2' below using the following loads…

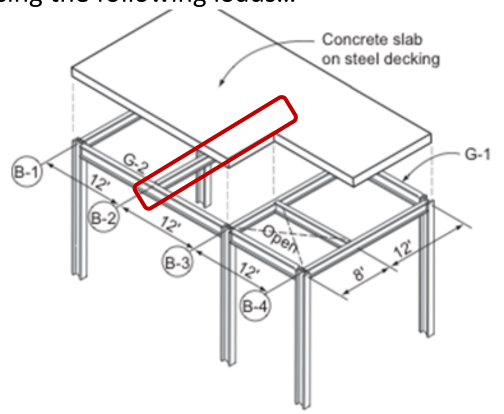
Live Load	= 50 psf
Dead Loads:	
Concrete	= 150 #/ft.^{3}
Steel decking	= 5 psf
Mechanical equipment	= 10 psf
Suspended ceiling	= 5 psf
Steel beams	= 25 #/ft.
Steel girders	= 35 #/ft.

Loads:

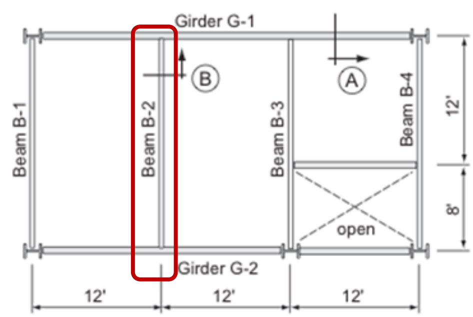
$$\text{Slab load} = \left(\frac{4\text{ in.}}{12\ {}^{\text{in}}/_{\text{ft.}}}\right) \times \left(150\ {}^{\text{lb}}/_{\text{ft.}^3}\right) = 50\ {}^{\text{lb}}/_{\text{ft.}^2}$$

Dead loads:	= 50 psf (slab)
	+ 5 psf (decking)
	+ 10 psf (mech. equip.)
	+ 5 psf (ceiling)
Total DL	= 70 psf

Dead Load + Live Load = 70 psf + 50 psf = 120 psf



) Isometric view of partial steel framing arrangement



L = 20ft

ASD w = 120psf x 12ft = 1.44klf

Try using ASD (but LRFD fine too)

Ma = w L^2/8 = 72k-ft

Moment Capacity = Mn/Omega= FyZ/1.67 > 72k-ft

Z = 1.67 x 72k-ft (12"/ft)/ (50ksi) = 28.8in^3

Pick any wide flange with plastic modulus Zx bigger than 28.8in^3

W12x22
W8x31
W10x26
W14x22

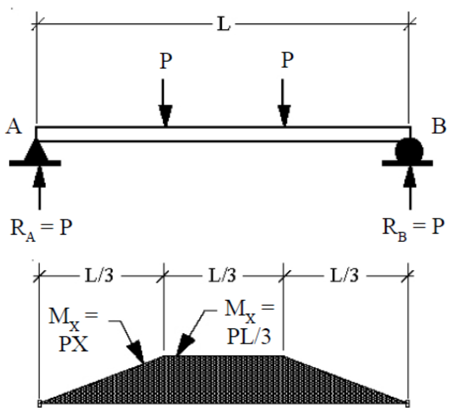
Problem 5

With respect to bending moment considerations only, draw a sketch of the shape variation present in a beam carrying two equal concentrated loads located at third points in the structure such that a constant bending-stress level is maintained on the top and bottom surfaces of the member. Draw one sketch assuming the width of the beam is held constant and the depth varies (see below solution), and another assuming the depth of the beam is held constant and the width allowed to vary (try your best).

Step 1: Find the reactions.

$R_{Ax} = R_{Bx} = P$ (symmetry)

Step 2: Draw the moment diagram.



When $0 \leqq X \leqq L/3$:

$M_X = PX$

When $L/3 \leqq X \leqq 2L/3$:

$M_X = PX - P(X - L/3)$

$M_X = PX - PX + PL/3$

$M_X = PL/3$

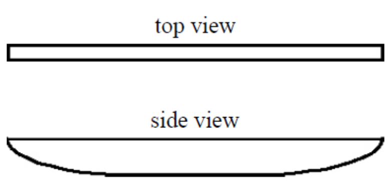
When $2L/3 \leqq X \leqq L$:

$M_X = PX - P(X - L/3) - P(X - 2L/3)$

$M_X = PX - PX + PL/3 - PX + 2PL/3$

$M_X = PL - PX$

Step 3: Assume the width is constant and the depth varies.



$S_X = bd^2/6$

$S_X = M/F_b$

$bd^2/6 = M/F_b$

$d^2 = 6M/bF_b$

$d^2 = 6PX/bF_b$

If P, b, F_b are all constant:

d x $X^{1/2}$

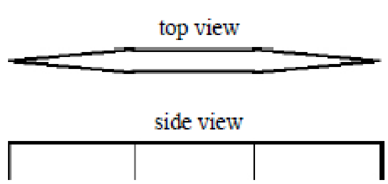
Suppose L = 12 ft:

When X = 0, d = 0

When X = 2 ft, d = 1.4

When X = 4 ft, d = 2

Step 4: Assume the depth is constant and the width varies.



$bd^2/6 = M/F_b$

$b = 6M/d^2F_b$

$b = 6PX/d^2F_b$

If P, d, F_b are all constant:

b x X

Suppose L = 12 ft:

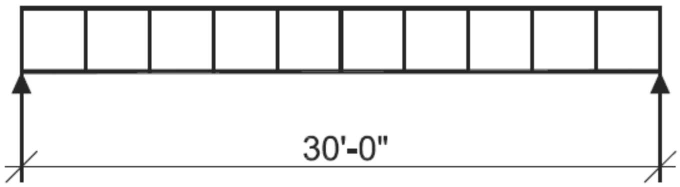
When X = 0, d = 0

When X = 2 ft, d = 2

When X = 4 ft, d = 4

Problem 6

Select an ASTM A992 W-shape flexural member by the moment of inertia, to limit the live load deflection to 1in. The span length is 30 ft. The loads are a uniform dead load of 0.80 kip/ft and a uniform live load of 3 kip/ft. The beam is continuously braced. See Exampled problem F.4 for help (I just changed the live load).



Beam Loading & Bracing Diagram
(*full lateral support*)

The maximum live load deflection, Δ_{max}, occurs at midspan and is calculated as:

$$\Delta_{max} = \frac{5 w_L l^4}{384 EI} \text{ from AISC } \textit{Manual} \text{ Table 3-23 case 1}$$

Rearranging and substituting Δ_{max} = 1.00 in., Since L/360 = 30ft x 12"/306 = 1"

$$I_{min} = \frac{5(3 \text{ kips/ft})(30.0 \text{ ft})^4 (12 \text{ in./ft})^3}{384(29{,}000 \text{ ksi})(1.00 \text{ in.})}$$

= 1885 in ^{4} now look for a WF with that Ix or higher

A W24x76 works for deflection (need to check strength later)
There are many other solutions.