Midterm 2

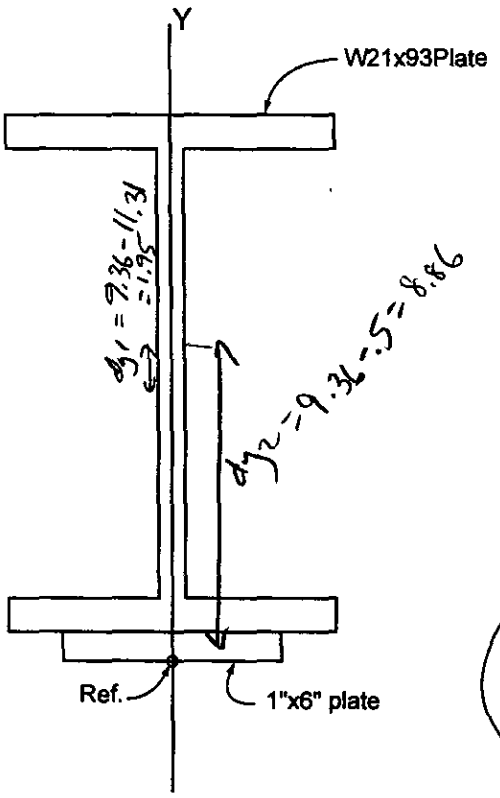
ARCH 321

EXAM 2

(50 PTS)

Instructor:

1. (10 pts)



A built-up steel beam cross section is fabricated using a W21x93 and a 1"x6" plate welded to the bottom flange. Assume that the plate is centered along the y-axis of the wide flange. In an organized fashion, determine the moment of inertia of the composite section about the major x and y axes. (I_x and I_y)

45/50

$I_y = \Sigma I_{yc} + \Sigma A dx^2$ (0)

$= 111 in^4$

Component	A	y	yA	Ixc	dy	Ady^2
	$27.3 in^2$	21.62/2 = 10.81 + 5.0 = 11.81 in	$308.8 in^3$	$2070 in^4$	1.95 in	$103.8 in^4$
6" 1"	$6 in^2$	.5"	$3 in^3$	$\frac{b_1 h^3}{12} = \frac{6(1)^3}{12} = .5 in^4$	9.36 - .5 = 8.86	471.
	$\Sigma A = 33.3 in^2$		$\Sigma y_A A = 311.8 in^3$	$\Sigma I_{xc} = 2070.5$		$574.8 in^4$

$\bar{y} = \frac{\Sigma yA}{\Sigma A} = \frac{311.8 in^3}{33.3 in^2} = 9.36 in$ 9.71in

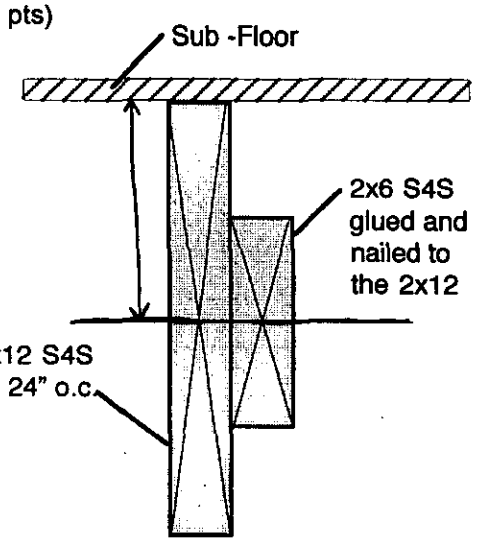
2700in4

$I_x = 2645.3 in^4$

$I_x = \Sigma I_{xc} + \Sigma A dy^2$

6/10

2. (10 pts)



Built-Up Beam Cross Section

Hem-Fir No. 2
DL = 10 psf, LL = 50 psf
60 psf

A wood floor is supported by 2x12 S4S joists @ 24" o.c. but is in need of bolstering since the load condition is increasing due to a change in use in the building. The floor capacity is to be increased by nailing and gluing 2x6 S4S joists to each 2x12 as shown. Determine the critical bending stress of this built-up section.

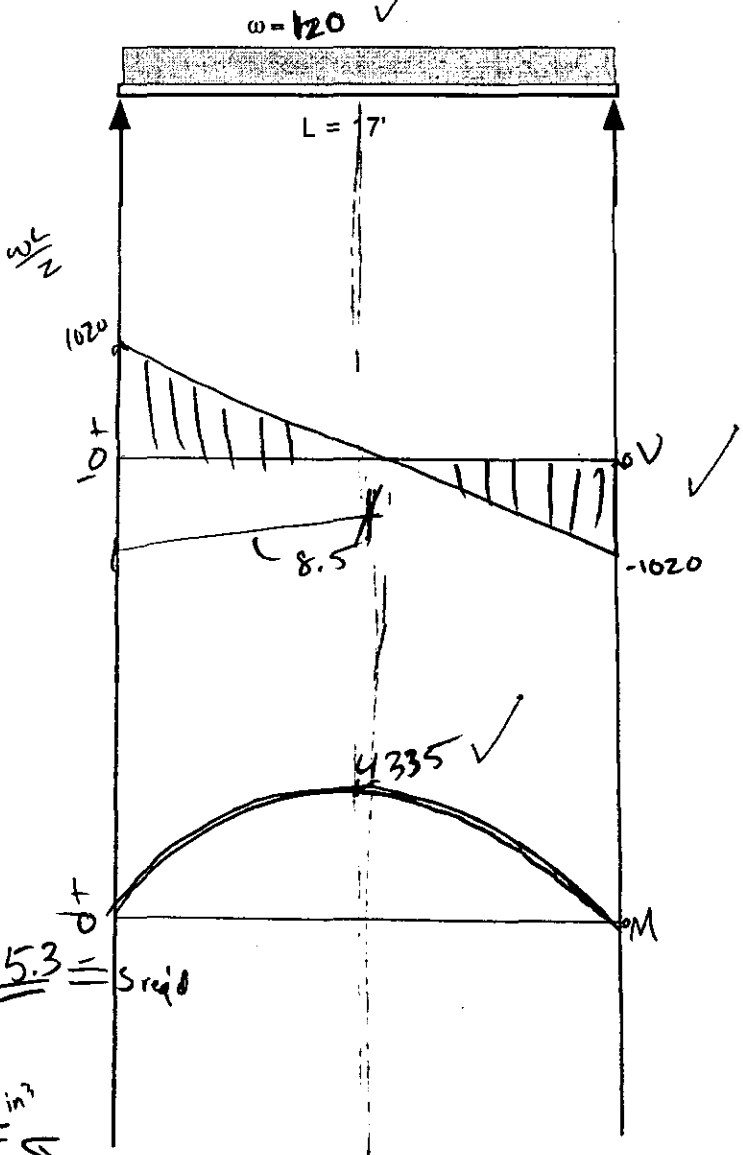
ok? or No?

2x12 = 1.5 x 11.25

11.25 = C

C = 5.625

$(60)\frac{24}{12} = 120\#\text{-ft.}$



$\frac{wL^2}{8} = M_{max}$

$M_{max} = 4335$

$S_{req'd} = \frac{4335(12\text{in/ft})}{Fb} = \frac{52020}{1472.04\text{psi}} = 35.3 = S_{req'd}$

S_x 2x12 = 31.64
S_x 2x6 = 7.56
39.2

$39.2\text{in}^3 > 35.3\text{in}^3$

$I_{2x12} = 177.98$

$I_{xc} = 177.98$

$I_{2x6} = 20.8$

$\frac{20.8}{198.78}$

9/10

Built up beam is ok!

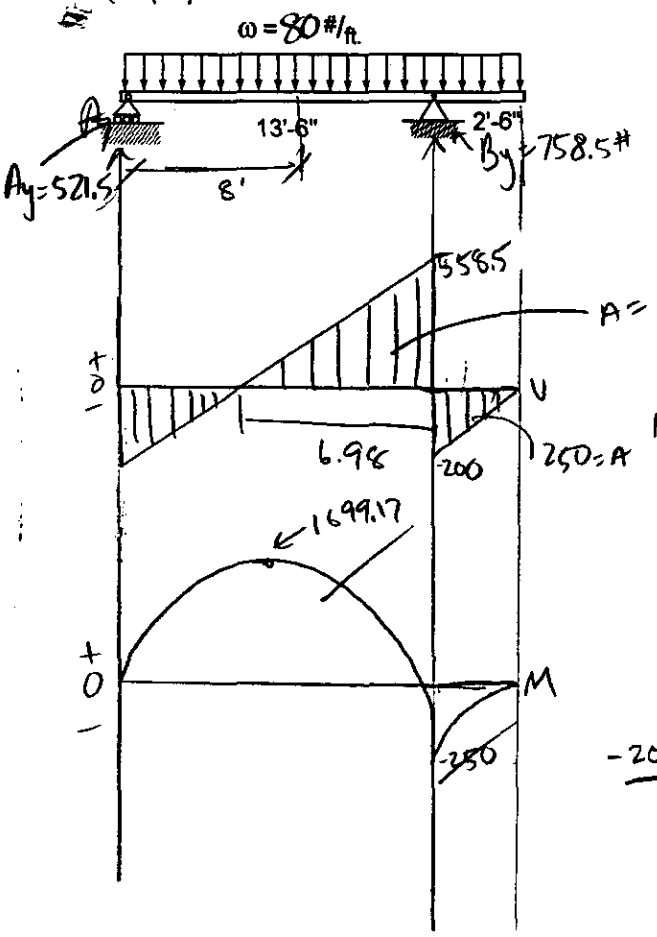
$F_b = 1150\text{psi} < 1472\text{psi}$ overstressed

$f_b = \frac{Mc}{I}$

$f_b = \frac{4335(12\text{in/ft})(5.625")}{(177.98+20.8)} = \frac{292612.5}{198.78} = 1472.04_{psi} = fb$

3. (10 pts)

$2.5 \times 80 = 200^{\#}$



An outdoor deck in a mountainous region is supported by No. 2 grade Hem-Fir.
The joists, spaced at 16" o.c., are cantilevered 2'-6" at one end.
If the snow load is 50psf and the dead load 10psf, determine the joist size necessary to satisfy the bending stress requirement.

Load = 50 + 10 = 60psf

$60 \times \frac{16}{12} = 80\#\text{-ft}$

$13.5 + 2.5 = 16' \times 80\#\text{-ft} = 1280\#$ @ 8'

$\Sigma MA = -1280\#(8') + By(13.5')$

$By = 758.5\#$

$\frac{-200 \times 2.5}{2} = 250$

$\Delta V = w \Delta x$

$558.5 = 80 \Delta x$

$\Delta x = 6.98$

$1699.17 = M_{max}$

$\frac{558.5 \times 6.98}{2} = 1949.165$

$1949.165 - 250 - 1699.17$

$S_{reqd} = \frac{(1699.17)(12\text{ in/ft.})}{fb} = \frac{20390.04}{1,150psi} = 17.7 = S_{reqd}$

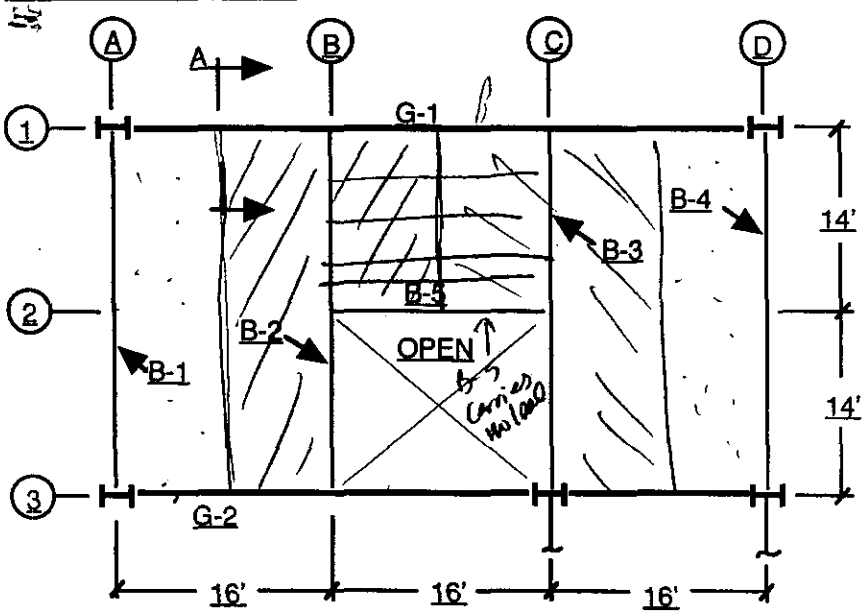
$Fb = 1,150psi$

$2 \times 10 = Sx = 21.39 > 17.7$

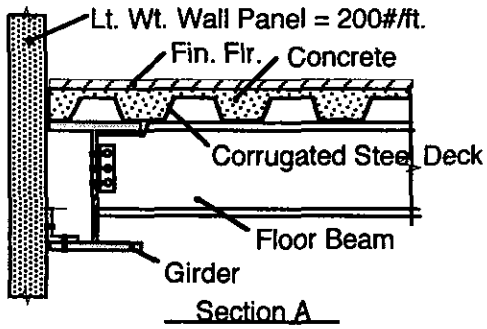
Use 2x10's

10

4. (20) Load Trace - Steel



PARTIAL FLOOR FRAMING PLAN
(Office Building)



Section A

Loads:
LL = 50 psf
DL = 65 psf (concrete)
5 psf (steel deck)
10 psf (Mech/Elec)
3 psf (Finished Floor)
2 psf (Susp. Ceiling)
15 psf (Framing)

Wall panel weight on B-1, G-1, and G-2 = 200 #/ft. ← in addition to beam reactions

Assume A572-Gr. 50 steel

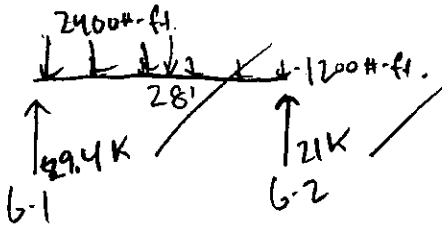
Design the *lightest* 'W' section required for Girders G-1 and G-2. Show all pertinent FBD's in arriving at your solution.

B-1 = 8' x 28' x 150

B-1 total load = 33,600 # = 16800 per Girder

B-2 = 33,600 +

Loads for beams = 150 psf total



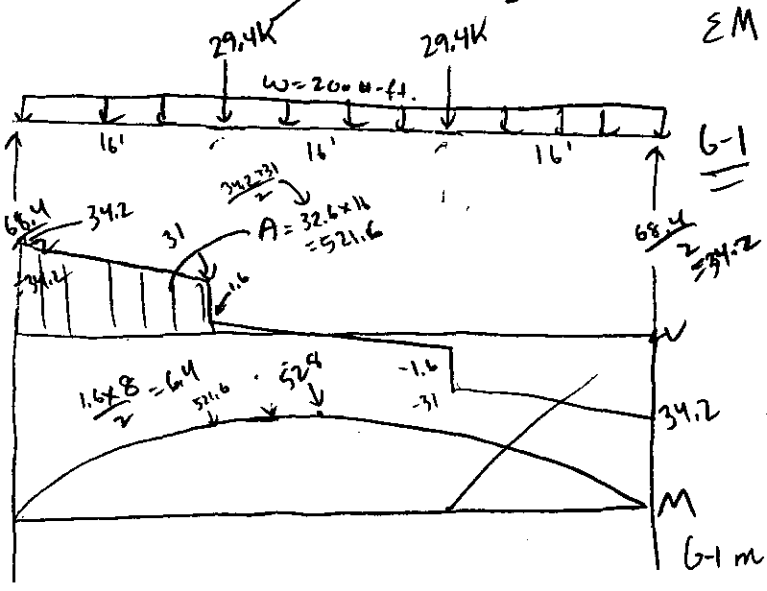
8 x 150 = 1200 #/ft.

2400 x 14 = 33600 @ 7'

1200 x 14 = 16800 @ 21'

20

Girder G-2 on back →



$\Sigma M_{G-1} = -33600(7') - 16800(21') + G\text{-}2(28')$

G-2 y = 21K

G-1 y = 29.4K

(29.4K)2 + (200#)(48') = 68.4K

$S_{req'd} = \frac{528 K\text{-}ft \times 12}{F_b = 30 ksi}$

$S_{req'd} = 211.2$

W27x84 = 213 > 211.2

W27x84 Girder G-1

G-1 $M_{max} = 528 k\text{-}ft$

$21\# + 21 + (200\#)(48') = 57.6K$

$32 \times 200 = 6.4K$

$\Sigma M_A = -21K(16') - 21K(32') - 6.4K(16') + B_y(32') = 0$

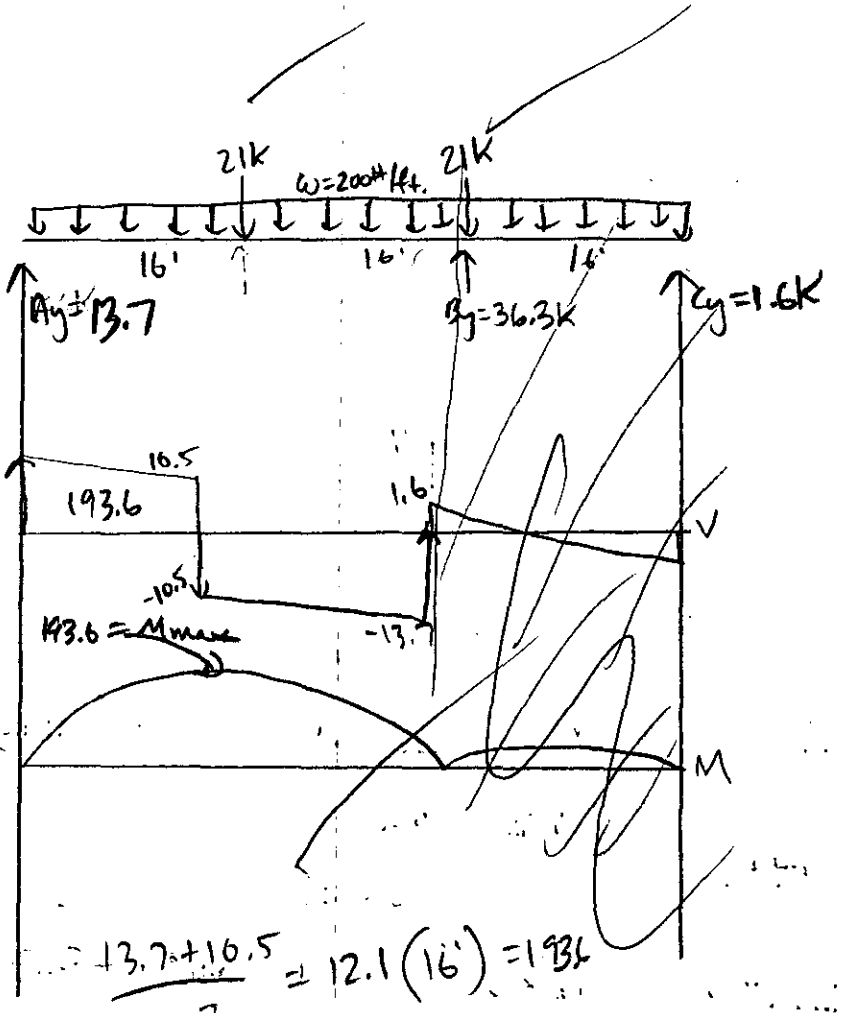
$B_y = \frac{1110.4}{32}$

$B_y = 34.7 + 1.6K = 36.3K$

$\Sigma M_B = 21K(16') + 6.4K(16') - A_y(32') = 0$

$13.7K$

$200 \times 16 = \frac{3.2K}{2} = 1.6K$



$= \frac{13.7 + 16.5}{2} = 12.1(16') = 193.6$

$S_{req'd} = \frac{193.6 \times 12/1}{F_b = 30} = \frac{2323.2}{30} = 77.44$

$F_b = 30 ksi$

$W21 \times 44 = 81.6 > 77.44$

Girder 2

USE W21x44