TIPPING · MAR + associates
structural engineers

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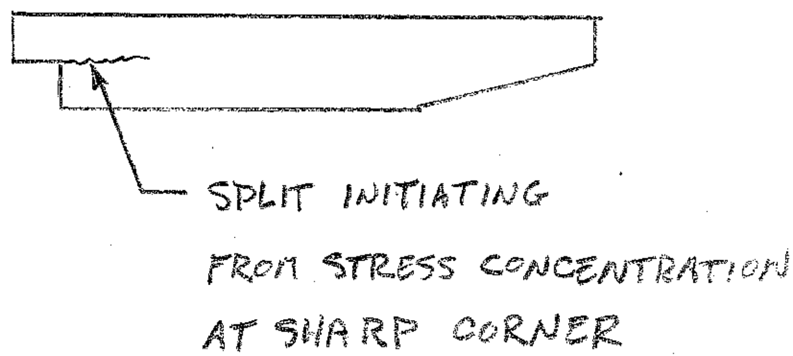
Job No. MT #1
By MBS
Date 9/28/11
Sheet No. 1 of

CE 124

MID TERM #1

Prob. #1



- BEAM WILL HAVE LOWER STRENGTH THAN UN-NOTCHED BEAM. DEGREE OF REDUCTION DEPENDS ON NOTCH DIMENSIONS.

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Job No. MT #1
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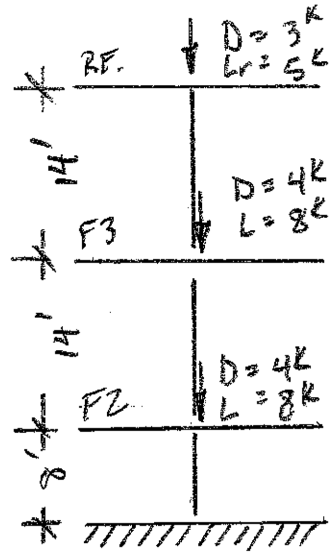
Date 9/28/11
Sheet No. 2 of

Prob. #2a



LC's

1. D + L
2. D + Lr
3. D + 0.75L + 0.75 Lr

(LOADS IN KIPS)

	LC	ROOF	ΣF3	ΣF2
	D	3	7	11
	L	0	8	16
	Lr	5	5	5
$C_D = 1.0$	1	3	15	<u>27</u>
$C_D = 1.25$	2	<u>8</u>	12	16
	3	6.75	<u>16.75</u>	26.75

Col. Section:

- 6x8 DF-L #1
- K = 1.0
- UNBRACED, ALL CONTROLED BY WEAK AXIS (5.5")

BELOW ROOF, F3:

$$\left(\frac{l_e}{d}\right) = \frac{(1.0 \times 14' \times 12)}{5.5''} = \underline{30.55}$$

BELW. F2:

$$\left(\frac{l_e}{d}\right) = \frac{(1.0 \times 8' \times 12)}{5.5} = \underline{17.45}$$

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DETERMINE CRITICAL C_p's:

- At Roof & F_3 Level, both loads controled by L_r Load cases,
  ∴ $C_D = 1.25$
  - They have some slenderness, ∴ only have to check F_3 & F_2

AT F_3:

$F_c = 1{,}000$ psi

$F_c^* = (1.25)(1{,}000) = 1{,}250$ psi

$E_{min} = E'_{min} = 580{,}000$ psi

$$F_{cE} = \frac{0.822\,(580{,}000)}{30.55^2} = 510.8 \text{ psi}$$

$$F_{cE}/F_c^* = \frac{510.8}{1{,}250} = 0.409$$

$c = 0.8$ (sawn lumber)

$$\Rightarrow C_p = \frac{1+.409}{2\times 0.8} - \sqrt{\left[\frac{1+.409}{2\times .8}\right]^2 - \frac{.409}{.8}} = 0.367$$

∴ $F_c' = (.367)(1{,}250) = 458$ psi

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(Col. @ F3):

$$f_c = \frac{16.75^K}{5.5'' \times 7.5''} = 0.406^{ksi} \times 1{,}000 = \underline{406} \text{ psi}$$

$$f_c / F_c' = \frac{406}{458} = \underline{0.89} < 1.0$$

⇒ THE C_P FUNCTION IS <u>NOT</u> VERY SENSITIVE TO C_D - IT DOES NOT SCALE LINEARLY AS, FOR EXAMPLE, BENDING CAPACITY DOES.

∴ THE LC #3 LOAD (16.75^K) IS ENOUGH GREATER THAN LC #1 THAT IT WILL CONTROL, EVEN W/ $C_D = 1.6$:

- CK. D/C FOR LC #1:

$$F_c^* = 1{,}000 \text{ psi} \times 1.0 = 1{,}000 \text{ psi}$$

$$F_{cE} / F_c^* = 0.511 \Rightarrow C_P = 0.44$$

$$F_c' = 1{,}000 \times 0.44 = \underline{440} \text{ psi}$$

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Job No. MT #1
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Date 9/28/11
Sheet No. 4 of

(Col. @ F_3):

$$f_c = \frac{15^K}{5.5'' \times 7.5''} = 0.364 \text{ KSI} = \underline{364} \text{ psi}$$

$$f_c / F_c' = \frac{364}{440} = 0.83 < 0.89^* < 1.0$$

*NOTE THAT LC #3 CONTROLS

∴ Col. BLW. F_3 OK

CK. BLW. F_2: $C_D = 1.0 \Rightarrow F_c^* = \underline{1,000}$ psi

$$F_{cE} = \frac{0.822(580,000)}{17.45^2} = 1,565.7$$

$$F_{cE}/F_c^* = 1,565.7/1,000 = 1.566$$

$$C_p = \frac{2.566}{1.6} - \sqrt{\left[\frac{2.566}{1.6}\right]^2 - \frac{1.566}{.8}} = \underline{0.820}$$

$$F_c' = (.820)(1,000) = \underline{820} \text{ psi}$$

$$f_c = \frac{27^K}{5.5 \times 7.5} = 0.655^{\text{KSI}} = \underline{655} \text{ psi}$$

$$f_c / F_c' = \frac{655}{820} = 0.80 < 1.0 \quad \text{OK}$$

∴ THE COL. STACK IS OK

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Job No. MT #1
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Date 9/29/11
Sheet No. 5 of

Prob. 2b

Highest D/C = 0.89 BLW. F_3

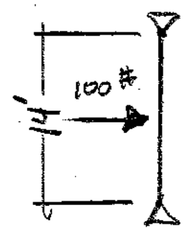
$M = PL/4$

$= \frac{100 \times 14}{4}$

$= 350$ '-lb

$\times$ 12

$4{,}200$ "-lb.



$F_b = 1{,}200$ psi

Timber, Flat Use, #1,

$\therefore C_F = 0.74$

SHORT LOAD, $\therefore C_D = 1.6$

$F_b' = (0.74)(1.6)(1{,}200)$

$= 1421$ psi

$S_y = \frac{(7.5")(5.5")^2}{6}$

$= 37.81$

$f_b = 4{,}200 / 37.81$

$= 111$ psi

(from above): $f_c / F_{cE} = \frac{406 \text{ psi}}{511 \text{ psi}} = 0.795$

CK. INTERACTION:

$(0.89)^2 + \frac{111 \text{ psi}}{(1{,}421)[1 - .795]} = 1.17 > 1.0$ N.G.

$\therefore$ COL. @ F3 FAILS w/ SIDE LOAD

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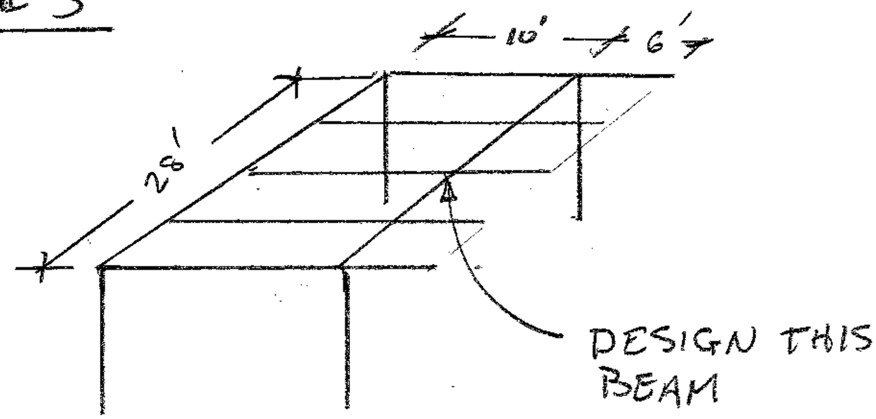
Job No. MT #1
By MBS
Date 9/29/11
Sheet No. 6 of

Prob. # 3

$D = 10$ psf
$L_r = 20$ psf
$C_L = 1.0$

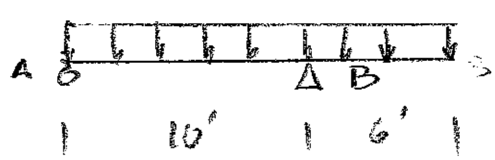


Design GLB 24F-V4 $5\frac{1}{8}$" x ___

For Max. $\Delta_{D+L_r} = 1.25"$

WET SERVICE, ∴ C_M = $F_b = 0.8$
$F_v = 0.875$
$E = 0.833$

LOAD ON BEAM: CONSIDER 1' TRIB. STRIP:



$D + L_r = (10+20) \times 1' = \underline{30}$ plf

Moment About $\underline{A}$ = $\frac{wL^2}{2} = \frac{(30)\ 16^2}{2} = 3{,}840$ ft-lb.

Reaction @ B = 3,840/10' = $\underline{384}$ plf
= LOAD ON $\underline{GLB}$

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Calculate Required I:

$E = 1{,}800{,}000$ psi

$E' = (0.833)E$

$= 1{,}499{,}400$ psi

$$\Delta_{max} = 1.25'' = \frac{5wl^4}{384EI}$$

$$\Rightarrow I_{req} = \frac{5\left(\frac{384 \text{ plf}}{12 \text{ in/ft}}\right)(28' \times 12)^4}{384(1{,}499{,}400)(1.25'')}$$

$$= 2{,}833 \text{ in}^4$$

GLB $5\frac{1}{8} \times 18$: $I_x = 2{,}491$ N.G.

$5\frac{1}{8} \times 19\frac{1}{2}$: $I_x = 3{,}167$ OK

CK. Bending : $S_x = 324.8$ in^3

$$M = \frac{(384)(28)^2}{8} = 37{,}632^{\text{ft-lb}} \times 12 = 451{,}584^{\text{in-lb.}}$$

$$f_b = 451{,}584 / 324.8 = 1{,}390 \text{ psi}$$

$F_b = 2{,}400$ psi $\quad C_D = 1.25 \quad C_M = 0.8$

$$C_V = \left(\frac{21}{28}\right)^{1/10}\left(\frac{12}{19.5}\right)^{1/10}\left(\frac{5.125}{5.125}\right)^{1/10} = 0.93$$

$$F_b' = (1.25)(0.8)(0.93)(2{,}400) = 2{,}232 \text{ psi}$$

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(Prob. 3)

$D/C = \frac{1{,}390 \text{ psi}}{2{,}232 \text{ psi}} = 0.62 < 1.0$ OK

(Long, flexural span: OK to NOT ck. shear, but to illustrate:) $A = 99.94$ #

$F_v' = (1.25)(0.875)(265) = 290$ psi

$V_{max} = (384)\left(\frac{28'}{2}\right) = 5{,}376$ lb.

$f_v = 5{,}376/99.94 = 53.8$ psi

$D/C = 53.8/290 = 0.19 << 1.0$

∴ GLB $5\frac{1}{8} \times 19\frac{1}{2}$ OK

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Prob. #4a

GLB 24F-V4

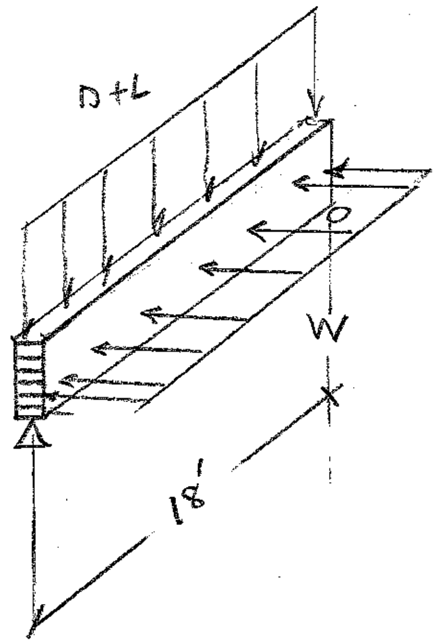
5 1/8" x 12"

$F_{b_x} = 2{,}400$ psi

$E_x = 1{,}800{,}000$ psi

$F_{b_y} = 1{,}450$ psi

$E_y = 1{,}600{,}000$



D = 150 plf

L = 250 plf

W = 13.0 psf

$C_L = C_V = 1.0$

Flat Use:

$C_{fu} = 1.1$

Loads: D+L: $C_D = 1.0$

WIND: $C_D = 1.6$

$F'_{b_x} = 2{,}400 \times 1.0 \times 1.0 = 2{,}400$ psi

$M_x = \frac{(150+250)(18)^2}{8} = 16{,}200^{\text{1-lb}} \times 12 = 194{,}400^{\text{in-lb}}$

$S_x = 123.0 \Rightarrow f_{b_x} = 194{,}400/123 = 1{,}580$ psi

$f_{bx}/F'_{bx} = 1{,}580/2400 = \underline{0.66}$

WIND: $w_{wind} = (\frac{10'}{2})(13.0\text{psf}) = 65.0$ plf

$F'_{b_y} = 1{,}450 \times 1.6 \times 1.1 = 2{,}552$ psi.

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(Prob. 4a)

$$M_y = \frac{(65)(18)^2}{8} = 2{,}633^{'-lb} \times 12 = \underline{31{,}590^{''-lb.}}$$

$S_y = 52.53 \quad f_{by} = 31{,}590 / 52.53 = 601 \text{ psi}$

$$f_{by}/F'_{by} = \frac{601}{2{,}552} = \underline{0.24}$$

$$f_{bx}/F'_{bx} + f_{by}/F'_{by} = 0.66 + 0.24$$

$$= 0.90 < 1.0 \quad \underline{OK}$$

GLB 5 1/8 x12 OK FOR STRESS

Prob. 4b:

$I_x = 738.0 \qquad \Delta_x = \dfrac{5\left(\frac{400}{12}\text{plf}\right)(18\times12)^4}{384\,(1{,}800{,}000)(738)} = 0.71''$

$$L/240 = \frac{18\times12}{240} = 0.9'' > 0.71''$$

$\therefore$ Δ_x OK

$I_y = 134.6 \qquad \Delta_y = \dfrac{5\left(\frac{65}{12}\right)(18\times12)^4}{384(1{,}600{,}000)(134.6)} = 0.71''$

$$L/360 = \frac{18\times12}{360} = 0.6'' < 0.71'' \quad \underline{N.G.}$$

BEAM FAILS Y- DEFLECTION