Midterm 1

General Notes:

- You are allowed to bring in one sheet of notes
- All loading combinations should follow ASD
- For a member to be acceptable, its demand/capacity ratio must be equal to or less than 1.00 and it must meet any stated deflection criteria
- Do not reduce any live loads unless asked to
- Box, cloud, or highlight final answers
- When making assumptions, clearly state what they are

		Maximum
Problem 1	10	10
Problem 2	10	10
Problem 3	15	15
Problem 4	15	15
Total	50	50

V. Good!

Good luck!

Problem 1 (10 pts)

10

Match the definitions to the appropriate terms:

Def. #	Definition	Term	Def. #
1. ✓	Lumber from 2"-4" (nominal) thick by min. 2" wide	Cal	12
2. ✓	Structure and orientation of wood fibers in a member	Stanford	11
3. ✓	Horizontal distributed framing member; typically loaded in bending	Mud Sill	9
4. ✓	Vertical distributed framing member; typically loaded both axially and in bending	Grain	2
5. ✓	Solid-sawn member larger than 5x5	Header	10
6. ✓	Horizontal, flat member framing the top and bottom of wall panels	King Stud	7
7. ✓	Full-height stud adjacent to opening	Nominal Size	8
8. ✓	Designated member size; actual (dressed) dimensions are smaller	Dimensional Lumber	1
9. ✓	Sill connected to foundation; typically pressure-treated for decay	Timber	5
10. ✓	Beam framed over opening	Plate	6
11. ✓	Over-rated, elitist engineering ~~school.~~ community college.	Joist	3
12. ✓	The best engineering program with the brightest students.	Stud	4

10

Problem 2 (10 pts)

Find F_b', F_v' and E' for the following members:

a) 2x4, Doug Fir-Larch #2; D+L+0.6W

b) 2x10 Doug Fir-Larch #1; D+L; Joists spaced at 16" o.c. & sheathed for load sharing

c) 6x12 Alaska Cedar Select Structural; D+Lr; Wet service (MC > 19%);

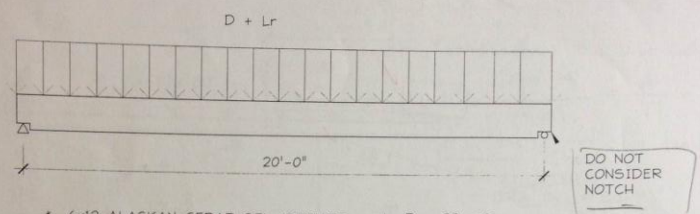
a). Dimension lumber.
DFL #2 from Table 4A:
$F_b = 900$ psi, $F_v = 180$ psi, $E = 1.6 \times 10^6$ psi
$C_D = 1.6$, $C_F = 1.5$ all other factors are 1.0
$F_b' = (F_b)(1.6)(1.5) = \boxed{2160 \text{ psi}}$ ✓
$F_v' = (F_v)(1.6) = \boxed{288 \text{ psi}}$ ✓
$E' = E = \boxed{1.6 \times 10^6 \text{ psi}}$ ✓

b). Dimension lumber.
DFL #1 from table 4A:
$F_b = 1000$ psi, $F_v = 180$ psi, $E = 1.7 \times 10^6$ psi
$C_D = 1.0$, $C_r = 1.15$, $C_F = 1.1$. all other factors are zero ✓
$F_b' = (F_b)(1.0)(1.15)(1.1) = \boxed{1265 \text{ psi}}$ ✓
$F_v' = (F_v)(1.0) = \boxed{180 \text{ psi}}$ ✓
$E' = E = \boxed{1.7 \times 10^6 \text{ psi}}$

c) Timber, $(d-b) \geq 2"$ → beams and stringer
Alaska Cedar Select Structural from table 4D:
$F_b = 1400$ psi, $F_v = 155$ psi, $E = 1.2 \times 10^6$ psi
$C_D = 1.25$, $C_m = 1.0$ for F_b, F_v, E, $C_F = 1.0$ ✓ since $d \leq 12$.
$F_b' = (1400 \text{ psi})(1.25)(1.0)(1.0) = \boxed{1750 \text{ psi}}$ ✓
3
$F_v' = (155 \text{ psi})(1.25)(1.0) = \boxed{194 \text{ psi}}$ ✓
$E' = (1.2 \times 10^6 \text{ psi})(1.0) = \boxed{1.2 \times 10^6 \text{ psi}}$ ✓

15

Problem 3 (15 pts)



- 6x12 ALASKAN CEDAR SEL. STRUCT.
- Cm = Ct = CL = 1.0
- TRIBUTARY WIDTH = 8.0 ft.
- D = 22 psf
- Lr = 20 psf
- L/Δ ≥ 180, D+Lr

Based on the diagram above, find the following:

a) Find the demand-capacity ratio for bending, $D/C = f_b/F'_b$

b) Using the full beam depth, find the demand-capacity ratio for shear, $D/C = f_v/F'_v$

c) Find the (D + Lr) deflection ratio, L/Δ

d) Is the beam adequate? What controls the design?

a). Fb' was determined in problem 2 c) as 1750 psi.

$A_t = 8' \times 20' = 160 ft^2 < 200 ft^2 \Rightarrow R_1 = 0$

$F = 0 \Rightarrow R_2 = 0$.

$L_r = 20$ psf. (no reduction).

Load case: $D+L_r = 22 psf + 20 psf = 42$ psf (w-total)

linear w: $(42 psf)(8 ft) = 336$ plf

$M_{max} = \frac{wl^2}{8} = \frac{(336 plf)(20')^2}{8} = 16800$ lb-ft

$S_{xx} = 121.2 in^3$ from table 1B

$f_b = \frac{M}{S} = \frac{(16800 lb ft)(12 in/1 ft)}{121.2 in^3} = 1664$ psi

$\frac{D}{C} = \frac{1664 psi}{1750 psi} = \boxed{0.95} \rightarrow$ ok

⇒ part b), c), d)

b) F_v' was determined in part c) of problem 2 to be 194 psi

$$V_{max} = \frac{wl}{2} = \frac{(336\ plf)(20')}{2} = 3360\ lb$$

$$f_v = \frac{3}{2}\frac{V}{A}, \quad \text{where } A = 63.25\ in^2 \text{ from table 1B.}$$

$$f_v = \frac{3}{2}\frac{3360\ lb}{63.25\ in^2} = 79.7\ psi$$

notches are not considered, thus:

$$\frac{P}{C} = \frac{f_v}{F_v'} = \frac{79.7\ psi}{194\ psi} = \boxed{0.41} \rightarrow \underline{ok}$$

c) $$\Delta_{allow} = \frac{L}{180} = \frac{(20')(12)}{180} = 1.33''$$

$$\Delta_{D+Lr} = \frac{5wl^4}{384E'I}, \quad E' = 1.2\times10^6\ psi \text{ as in part c) of problem 2}, \quad I_{xx} = 697.1\ in^4 \text{ per table 1B}$$

$$\Delta_{D+Lr} = \frac{(5)(336\ plf)(1\ ft/12\ inches)(20'\times12)^4}{(384)(1.2\times10^6\ psi)(697.1\ in^4)}$$

$$= 1.45''$$

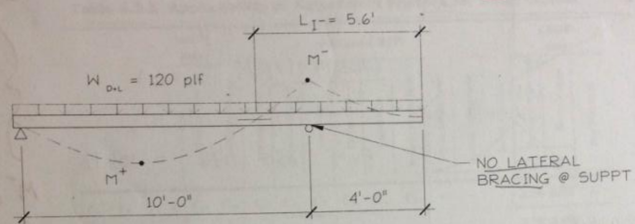
$$\frac{L}{\Delta_{D+Lr}} = \frac{(20')(12)}{1.45''} = \boxed{166} < 180 \quad \text{Not good!} \qquad \frac{P}{C} = \frac{180}{166} = 1.09$$

d) According to the results from part a) - c), the beam is inadequate as it fails to achieve allowable deflection. The controlling criteria is the one with the highest P/C ratio, which is the deflection (due to D+Lr)

Good

(15)

Problem 4 (15 pts)



- 2x10 DF-L #1 → actual dimension is 1.5" x 9.25" per table 1B.
- Cd = Cm = Ct = 1.0
- Cr = 1.15

Based on the diagram above, find the following:

a) What is the effective cantilever length le?

b) What is the slenderness ratio R_B for the cantilever?

c) Given $C_L = 0.94$, what is F'_b for the cantilever?

d) Find the demand-capacity ratio for cantilever bending, $D/C = f_b/F'_b$

e) Sketch the load pattern giving the highest value of M^+ for the back span.

$F_{bE} = \frac{1.2(620000)}{19.05^2} = 2050$

1.579

$C_L = 0.94$ ✓

a) $l_u = 5.6'$ for the cantilever

$\frac{l_u}{d} = \frac{(5.6')(12)}{9.25''} = 7.26 \geq 7.$

The cantilever is loaded uniformly across its span, thus

$l_e = 0.9 l_u + 3d$

$= (0.9)(5.6') + (3)(9.25'')/12 = \boxed{7.3525'}$

b) $R_B = \sqrt{\frac{l_e d}{b^2}} = \sqrt{\frac{(7.3525')(12)(9.25'')}{(1.5'')^2}} = \boxed{19.05} \leq 50$ ok

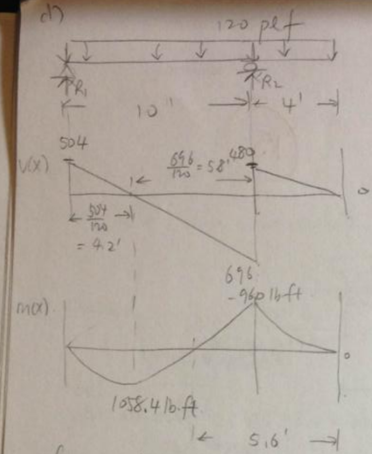
⇒ parts d), e).

c) DF-L #1 from table 4A $F_b = 1000$ psi

$C_F = 1.1$, $C_r = 1.15$, $C_L = 0.94$, all other factors $= 1.0$

$F_b' = (1000\text{ psi})(1.1)(1.15)(0.94) = \boxed{1189\text{ psi}}$

d)



Reactions:

$\sum F_y = 0$

$R_1 + R_2 = (120\ plf)(14')$

$R_1 + R_2 = 1680\ lb.$

$\sum M_1 = 0.$

$\frac{wl^2}{2} = (R_2)(10)$

$\frac{(120plf)(14')^2}{2} = R_2(10)$

$R_2 = 1176\ lb$

$R_1 = 1680 - 1176 = 504\ lb.$

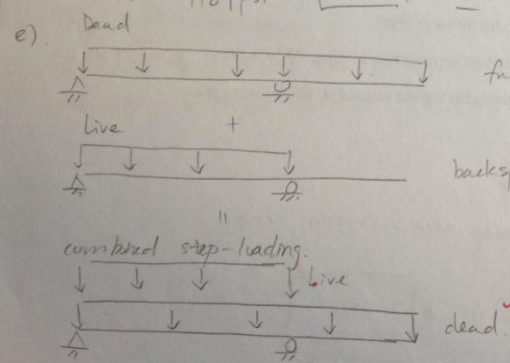
Not REQ'D - only M^- asked for...

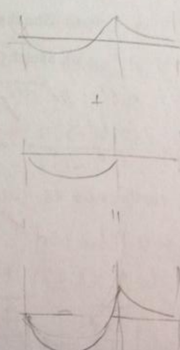
for cantilever we use $M_{max} = M^- = 960\ lb\cdot ft$ ✓ , $S_{xx} = 21.39\ in^3$ from table 1B

$f_b = \frac{(960\ lb\cdot ft)(12)}{21.39\ in^3} = 539\ psi$ ✓

$\frac{D}{C} = \frac{f_b}{F_b'} = \frac{539\ psi}{1189\ psi} = \boxed{0.45} \rightarrow$ ok ✓

e)





✓

Excellent