Architecture 544 Winter 2002 Name: KEY

Wood Framing
Mid-term Exam

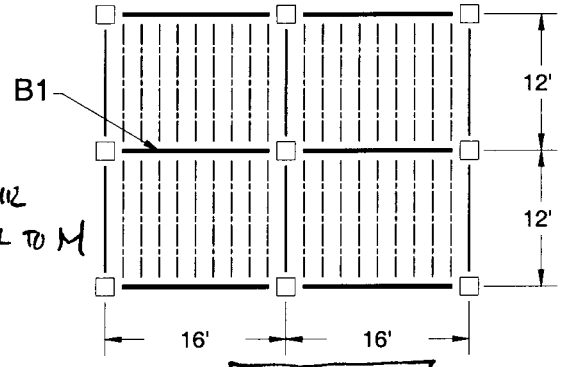
4 pts. 1. The roof framing plan at the right has the follow loadings. Determine the controlling C_D for the applicable combinations on beam B1.

LOADS:

Dead Load (D)	28 PSF
Roof Live Load (L_r)	24 PSF
Snow Load (S)	20 PSF

LOAD COMB.:

1. D
2. D + (L_r or S)



ALL LOADS AFFECT MOMENT & SHEAR IN THE SAME WAY ie $wl^2/8$ & $wl/2$ ∴ PSF IS PROPORTIONAL TO M

1. $28/0.9 = 31.1$

2a. $(28+24)/1.25 = 41.6$

2b. $(28+20)/1.15 = 41.7$ ← CONTROLS ∴ USE $C_D = 1.15$

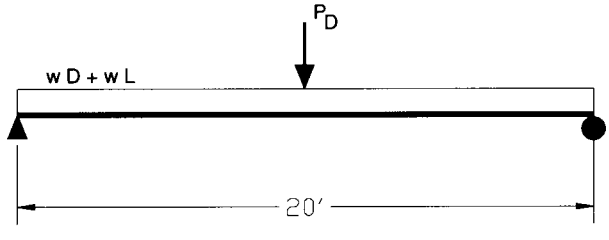
4 pts. 2. For the FLOOR beam loading below, find the controlling C_D.

LOADS:

Dead Load (D)	w=280 ~~PSF~~ PLF
Dead Load (D)	P=1000LBS
Live Load (L)	w=300 ~~PSF~~ PLF

LOAD COMB:

1. D
2. D + L



$M_D = \frac{wl^2}{8} + \frac{Pl}{4} = \frac{280 \cdot 20^2}{8} + \frac{1000 \cdot 20}{4}$

$M_D = 19000$

$M_L = \frac{wl^2}{8} = \frac{300 \cdot 20^2}{8} = 15000$

1. $19000/0.9 = 21111$

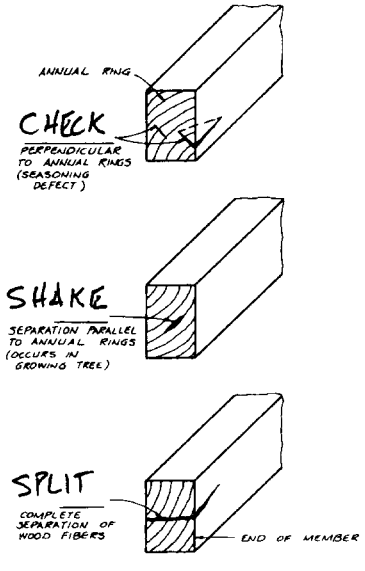
2. $(15000 + 19000)/1.0 = 34000$ ← CONTROLS ∴ $C_D = 1.0$

3 pts. 3. Label the sketches at the right.

Shake

Split

Check



3 pts. 4. Mark each of the following generalizations true (T) or false (F)

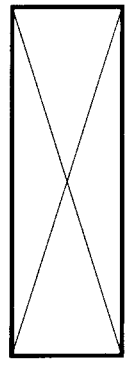
Wood is weak in horizontal shear. T

Wood timbers are more resistant to fire than steel beams. T

Wood as material is stiffer than steel. F

3 pts. 5. Calculate the following bending stress factors for the following simple span beam.

Douglas Fir (North) Grade No.2
M.C. 16% normal interior floor beam
Single member, Dim. 4x12



C_F 1.1
C_{fu} 1.0
C_M 1.0
C_r 1.0
C_t 1.0

3 pts. 6. List the **stress factors** that apply to Dimensioned Sawn Lumber **Shear Stress**.

C_D C_M C_t C_i C_H

4 pts. 7. What is the **weight in PLF** for an Open Grain Redwood 4x12 Dim. Lumber beam (dry).

S.G = 0.37 A_{REA} = 39.38 in^2

DENSITY = 0.37 × 62.428 = 23.1 PCF $\frac{39.38}{144} \times 23.1 =$ **6.32 PLF**

4 pts. 8. What is the longest single span allowed for a 2x12 with two equal concentrated loads and lateral bracing spaced at the 1/3 points?

$R_B = \sqrt{\frac{l_e d}{b^2}} \leq 50$ $l_e = l_u(1.68)$ $d = 11.25$ $b = 1.5$

$R_B = 50 = \sqrt{\frac{l_u(1.68)(11.25)}{1.5^2}}$, $l_u = \frac{50^2(1.5^2)}{1.68(11.25)} = 297.6'' =$ **24.8'**

4 pts. 9. Calculate l_e for a 2x12 with a simple span of 12 FT and a uniform load.

$\frac{144}{11.25} = 12.8 > 7$ $\therefore l_e = 1.63l_u + 3d$

$= 1.63l_u + 3(11.25)$

$= 234.7 + 33.75 =$ **268.47" = 22.37'**

3 pts. 10. What value is to be used for K_{bE} for a grade No. 2 Southern Pine 2x12?

0.439

3 pts. 11. What is C_L for a 2x6 with full depth end blocking , spanning 12'. Assume the floor does NOT provide bracing to the compression edge.

$d/b = 5.5/1.5 = 3.66 \leq 4$ $\therefore C_L = 1.0$

3 pts. 12. What is C_r for roof rafters spaced at 4 FT o.c.?

1.0

3 pts. 13. **Why** is there a "top" side to some Glulam beams ? (not to do with camber). **Where** are the best grade lams located?

BECAUSE ALLOWABLE COMPRESSIVE VALUES ARE HIGHER THAN TENSILE VALUES ∴ TO MORE FULLY OPTIMIZE THE SECTION HIGHER GRADE WOOD IS USED IN THE BOTTOM LAMS THUS PRODUCING A SECTION WITH APROX. EQUAL STRENGTH OR CAPACITY BOTH TOP & BOTTOM.

3 pts. 14. In what ways is **LVL** superior to sawn lumber?

DEFECTS LIKE KNOTS & SPLITS ARE NOT CONTINUOUS BUT LIMITED TO ONE PLY. ALSO, BECAUSE GRAIN IS NOT EXACTLY ALIGNED, SHEAR SPLITS ARE HINDERED.

3 pts. 15. Why is it bad practice to use **dim. sawn lumber** as a rim board with performance rated I-joists?

SAWN LUMBER IS LESS STABLE AND WILL SHRINK MORE AS IT DRIES CAUSING A DIFFERENCE IN HEIGHT.

3 pts. 16. For performance rated I-joists, are the deflection limits **more stringent** or **less stringent** in comparison with dim. lumber ?

MORE STRINGENT eg $\ell/480$

4 pts. 17. Calculate the **deflection** of a 14" PRI-40 I-joist spanning 30' with a uniform load of 35 PLF.

$EI = 482\,000\,000$ psi

$w = 35$

$K = 7280\,000$

$$\Delta = \frac{5w\ell^4}{384EI} + \frac{w\ell^2}{K} = \frac{5(35)30^4(1728)}{(384)482\,000\,000} + \frac{35(30)^2(12)}{7280\,000}$$

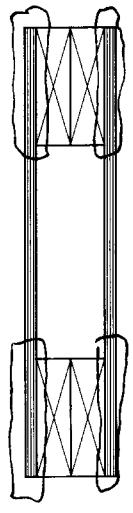
$$= 1.323 + 0.052 = \boxed{1.38"}$$

4 pts. 18. Would the joist described in problem 17. be safe for **flexure** when used in a floor system at 12" o.c. spacing ?

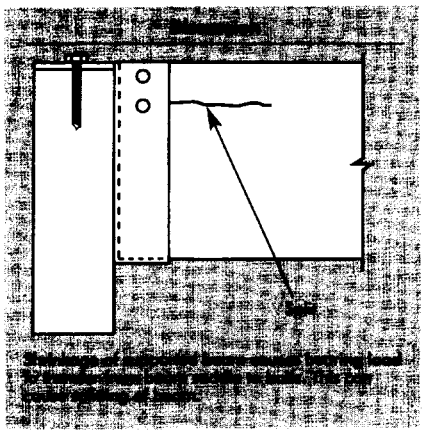
$$M = \frac{w\ell^2}{8} = \frac{35(30)^2}{8} = 3938\ ^{1-\#}$$

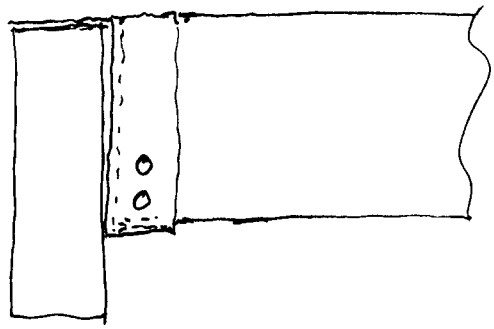
$M_{ALL} = 4130 > 3938 \therefore$ OK

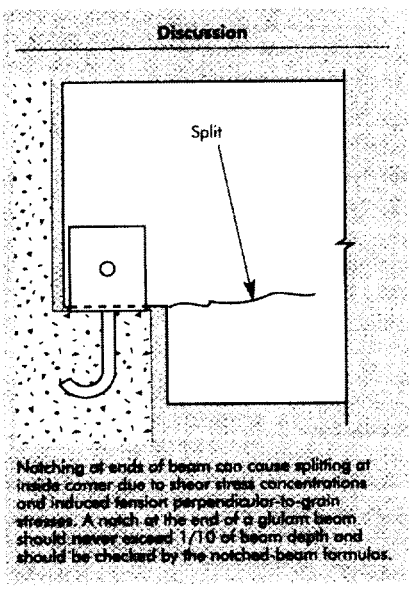
4 pts. 19. For the box beam shown at the right, circle the area subjected to **rolling shear**.

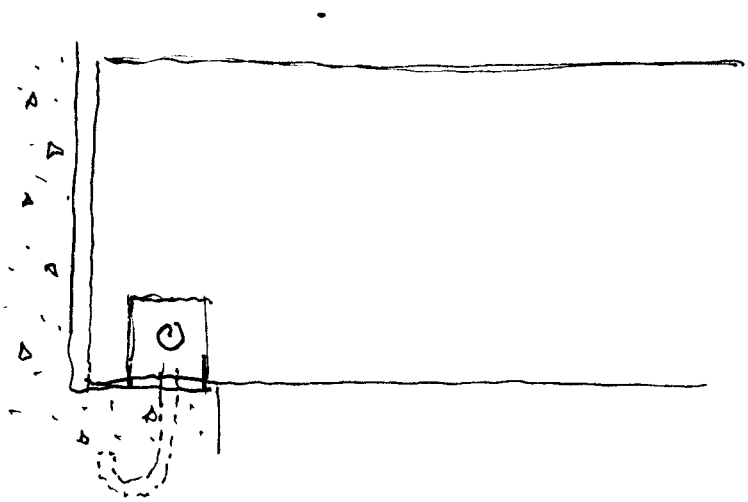


3 pts. 20. Sketch a "corrected" version of the two faulty timber details shown below.









3 pts. 21. Where would it be better to drill holes in the webs of simple span I-joists: at the ends or in the middle?

4 pts. 22. A flitched beam is to be designed as shown using 2x12's and mild steel plate. To maintain strain compatibility, what is the maximum allowable depth of **d** for the steel ?

STEEL:

Fb = 20 ksi

E = 29 000 ksi

$\epsilon_s = \frac{20}{29000}$

$\epsilon_s = .000689$

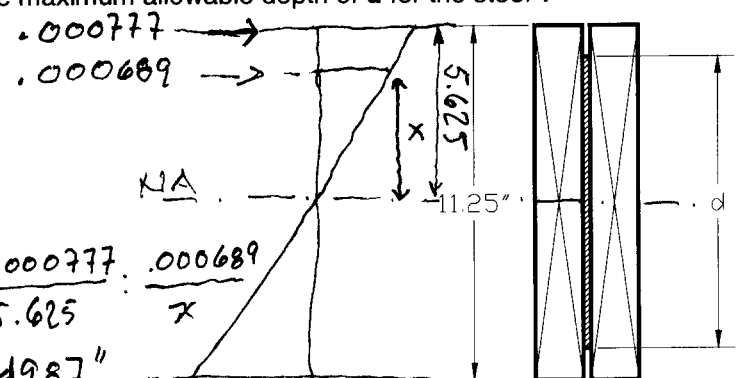
WOOD:

F'b = 1.4 ksi

E' = 1 800 ksi

$\epsilon_w = \frac{1.4}{1800}$

$\epsilon_w = .000777$



$\frac{.000777}{5.625} : \frac{.000689}{x}$

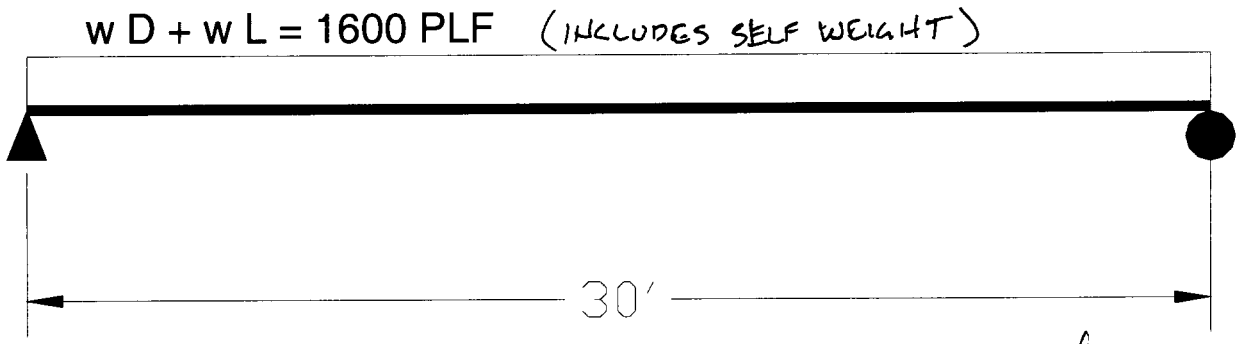
$x = 4.987"$

$d = 2x = \boxed{9.975"}$

25 pts. 23. Design a Glulam section for the following conditions.

20F-V1 Visually Graded Western Species, M.C. < 16% , maximum depth = 30", $C_D = 1.0$, $C_L = 1.0$

Design for both **flexure** and **shear**. Find the minimum **bearing length**. You may omit deflection calcs.



$$M = \frac{wl^2}{8} = \frac{1600(30)^2}{8} = 180000'^{\#} \qquad V = \frac{wl}{2} = \frac{1600 \cdot 30}{2} = 24000$$

$$F_b = 2000 = \frac{M}{S}\ ;\ S = \frac{180000(12)}{2000} = 1080\ in^3$$

TRY $8\frac{3}{4} \times 30$ $S_x = 1313\ in^3$ $A = 262.5\ in^2$

$$C_v = K_L(21/L)^{1/x}(12/d)^{1/x}(5.125/b)^{1/x} \leq 1.0$$

$K_L = 1.0$
$L = 30'$
$x = 10$

$C_v = 0.8346$

$$F'_b = 2000 \cdot 0.8346 = 1669\ psi$$

$$f_b = \frac{M}{S_x} = \frac{180000(12)}{1313} = 1645\ psi < 1669 \quad \checkmark\ OK$$

$$F'_v = 140$$

$$f_v = \frac{3}{2}\frac{V}{A} = \frac{3}{2}\frac{24000}{262.5} = 137 < 140 \quad \checkmark\ OK$$

$$F'_{c\perp} = 650 = \frac{V}{A} = \frac{V}{f_b b} \qquad f_b = \frac{V}{650(8.75)} = 4.22''$$