CE 124
Fall 2014

Name

Midterm 2

General Notes:

- You are allowed to bring the NDS, the NDS Supplement and one note sheet
- 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; its interaction must be equal to or less than 1.00
- Do not reduce any live loads unless asked to
- Assume $C_m = C_t = C_L = C_{fu} = C_i = 1.0$ unless noted otherwise
- Box, cloud, or highlight final answers
- When making assumptions, clearly state what they are
- Unreasonable or overly conservative assumptions may not receive credit

	Score	Maximum
Problem 1	8	8
Problem 2	8	8
Problem 3	10	10
Problem 4	8	8
Problem 5	8	8
Problem 6	7	8
Totals	49	**50**

Good!

Good luck!

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Midterm #2

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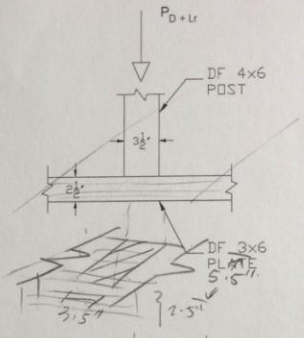
8/8 **Problem 1** (8 pts): Post Bearing

Given:
Load = D + L_r
Post = 4x6 (3.5" x 5.5")
F_c^* = 1,485 psi
C_p = 0.525
$F_{c\perp}$ = 625 psi

a) What is the value of C_b?

b) What is the maximum allowable load P?
What is the limiting condition?



a) assume $l_{end} \geq 3"$ $\quad l_b = 3\frac{1}{2}"$ ✓

4/4 $C_b = \frac{l_b + 3/8"}{l_b} = \frac{3.5" + 3/8"}{3.5"} = \boxed{1.11}$ ✓

b) bearing area = $3.5" \times 5.5" = 19.25\ in^2$

4/4 $F'_{c\perp} = C_m C_t C_i C_b F_{c\perp} = (625\ psi)(1.11) = 694\ psi$ ✓

$F'_c = C_p F_c^* = (0.525)(1485\ psi) = 780\ psi > 694\ psi$ ✓

$F'_{c\perp}$ controls,

$P/A \leq F'_{c\perp} = 694\ psi$ ✓

$\boxed{P \leq 13.36\ kips}$ ✓

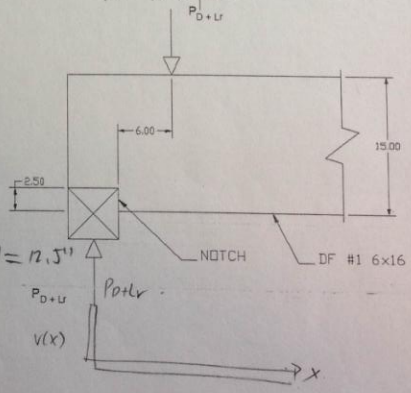
• Limiting condition is bearing failure in 3x6 plate. ✓

8/13 **Problem 2** (8 pts): Shear with Notch and Point Load

Given:
Load = D + L
Beam = 6x16 (5.5" x 15")
F_v' = 170 psi

4/4 a) What is the reduction factor for P?

4/4 b) What is the maximum allowable load P?



a) $\frac{x}{d} = \frac{6}{15} = \boxed{0.4}$ ✓

b) $V_r' = \left[\frac{2}{3} F_v' b d_n\right]\left(\frac{d_n}{d}\right)^2$, $d_n = 15" - 2.5" = 12.5"$

$= \left[\frac{2}{3}(170\ psi)(5.5")(12.5")\right]\left[\frac{12.5"}{15"}\right]^2$

$= 5.41\ kips$ ✓

$V_{max} = 0.4P \leq 5.41\ kips$

$P \leq \boxed{13.53\ kips}$ ✓

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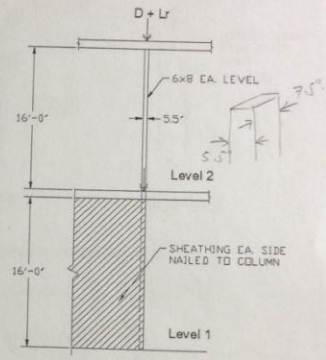
10/10 **Problem 3** (10 pts): Two-Story Column Stack

Given:
Species = DF #1
Column = 6x8 (5.5" x 7.5");
Assume separate pieces at both levels
Ke = 1.0
$F_c^* = 1{,}000$ psi
$E_{min} = 580{,}000$ psi



2/2 a) What is the controlling l_e/d at Level 1?

2/2 b) What is the controlling l_e/d at Level 2?

2/2 c) Assume the controlling load at Level 2 is (D + L_r) = 20,000 lbs. and $C_p = 0.289$. What is the column D/C ratio at Level 2?

2/2 d) What is the value of F_{ce} at Level 2 for the load case (D+L_r)?

2/2 e) Assume the column is continuous over the two stories, giving Ke = 0.80. Now what is the value of F_{ce} at Level 2 for the load case (D+L_r)? How will this affect the final D/C ratio for this column?

a) $K_e = 1.0$ (due to sheathing in y-axis. b) $K_e = 1.0$ (no sheathing.)

$\frac{l_e}{d} = \frac{(16)(12")}{7.5"} = \boxed{25.6}$ ✓ $\quad \frac{l_e}{d} = \frac{(16')(12)}{5.5"} = \boxed{34.9}$ ✓

c) $F_c' = C_p F_c^* = (0.289)(1000\ psi) = 289\ psi$

$A = (5.5")(7.5") = 41.25\ in^2$

$f_c = \frac{P}{A} = \frac{20000\ lb}{41.25\ in^2} = 485\ psi$

$\frac{D}{C} = \frac{485\ psi}{289\ psi} = \boxed{1.68} > 1.0$ N.G ✓

d) $F_{cE} = \frac{0.822\ E_{min}}{\left(\frac{l_e}{d}\right)^2} = \frac{(0.822)(580000\ psi)}{(34.9)^2} = \boxed{391.4\ psi}$ ✓

e) $\frac{l_e}{d} = \frac{(0.8)(16')(12)}{5.5"} = 27.9$

$F_{cE} = \frac{0.822\ E_{min}}{\left(\frac{l_e}{d}\right)^2} = \frac{(0.822)(580000\ psi)}{(27.9)^2} = \boxed{612\ psi}$ ✓

this will increase the value of C_p and therefore F_c'. D/C will decrease as a result. ✓

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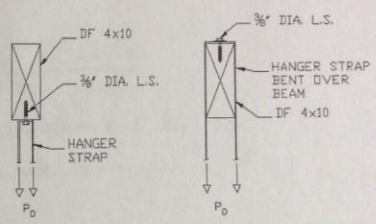
Problem 4 (8 pts): Hanger Strap (8)

Given:
Species = DF #1 (G = 0.50)
Hanger tension load = Dead only
Lag Screw = 3/8" x 6"
Thread len. T = 3.5"
Tip len. E = 0.25"



VERSION I VERSION II

a) For Version I, what is the allowable P_D for this connection?

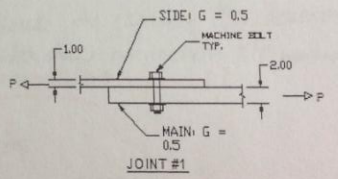
b) What is the difference between Versions 1 & 2 in terms of their effect on the supporting beam? Which is preferable?

a) W from NDS for G=0.5, ϕ = 3/8" lag screw = 305 lb/in.
l_p = T - E = 3.5" - 0.25" = 3.25" ✓
W' = W ($C_D C_M C_t C_{eg} C_{tn}$) = (305 lb/in)(0.9) = 275 lb/in ✓
W' = (275 lb/in)(3.25") = 892 lb. ✓
∴ $P_D \leq$ 892 lb

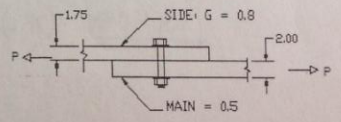
⇒ b).

Problem 5 (8 pts) Yield Limit Equations & Dowel Bearing (8)

Mode I_s = dowel bearing yield in side member
Mode I_m = dowel bearing yield in main member
Mode II = rigid body rotation of fastener

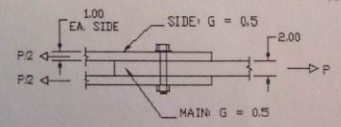


JOINT #1



JOINT #2

⇒ a, b, c, d



JOINT #3

a) For which joints will the Mode I_s capacity be greater than the Mode I_m capacity?

b) For which joints must Mode II be checked?

c) Which joint will have the greatest capacity? Why?

d) Given fastener diameter D = 0.75" and G = 0.80, calculate $F_{e\parallel}$ and $F_{e\perp}$

Problem 4

b) version II distributes the force better along the beam's cross-section and is therefore more preferable. Version I may cause stress concentration at the lag screw.

Problem 5

a) Im $Z = \frac{D l_m F_{em}}{R_d}$ Is: $Z = \frac{D l_s F_{es}}{R_d}$

Since D, Rd the same, only variation are l_i, Fe.

For joint # 1, 3, $l_s \leq l_m$ while $G_m = G_s$, so $Z_s \leq Z_m$

For joint # 2, although $l_s < l_m$, $F_{es} > F_{em}$ since $G_s = .08$ and $G_m = .05$.

If $\phi \leq 0.125"$, $F_e = 16600 G^{1.84}$, $\left(\frac{G_s}{G_m}\right)^{1.84} = 2.37 > \frac{2"}{1.75"}$

If $\phi \leq 0.25"$, $F_{e\parallel} = 11200 G$, $\frac{G_s}{G_m} = 1.6 > \frac{2"}{1.75"}$

So for joint #2, Is mode will have greater capacity.

b) mode II (rigid rotation) should be checked for single shear connections #1 and #2.

c) joint #3 will have the greatest capacity since the capacity Z is determined by the weakest yield mode. Because it is a double shear connection, its weakest yield mode will be stronger than the rest of connections. Good!

d) $D = 0.75" > 0.25"$, $G = 0.80$

$F_{e\parallel} = 11200 G = (11200)(0.80) = 5960$ psi

$F_{e\perp} = 6100 G^{1.45} (D)^{-0.5} = 6100 (0.8)^{1.45} (0.75)^{-0.5} = 5097$ psi

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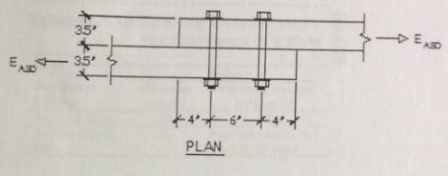
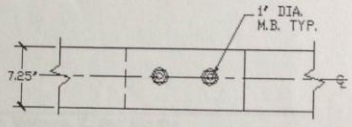
Problem 6 (8 pts) Truss Chord Splice (7)

Given:

Species = DF #1
Chord = 4x8 (3.5" x 7.25")
Type = softwood
Tension load = Seismic
F_t = 675 psi
C_f (tension) = 1.2



PLAN



ELEVATION

a) What is the value of C_Δ for this connection?

b) Using the value of C_Δ calculated above, what is the allowable tension load for this connection?

c) If the allowable connection load is taken as 7,250 lbs., what is the D/C ratio for the chord members?

a) end distance requirement:
actual = 4"
required for $C_\Delta = 1.0$ = 7D = (7)(1") = 7".
$C_\Delta = \frac{4"}{7"} = 0.57$ ✓
$\therefore C_\Delta = \boxed{0.57}$

Spacing requirement:
only 1 row, $C_\Delta = 1.0$
for parallel loading to grain

(-1) Spacing Along Row: $\frac{C}{1} = 6D > 4D$

b) Z value for ϕ = 1" bolts, DF ($G = 0.50$), $Z_\parallel = 2260$ lb., $Z_\perp = 720$ lb
force is parallel to grain → use $Z_\parallel$
$Z' = Z(C_D C_M C_t C_g C_\Delta C_{eg} C_{di} C_{tn}) = (2260\text{lb})(1.6)(0.57) = 2061$ lb.
There are 2 bolts → $P_{allowable} \le (2061\text{lb})(2) = \boxed{4122\text{lb}}$ ✓

c) $A_g = (3.5")(7.25") = 25.4\ in^2$ | $A_n = A_g - (d + 1/16")t = 25.4in^2 - (1\frac{3}{16}")(3.5") = 21.68\ in^2$ ✓
$f_t = \frac{P}{A} = \frac{7250\text{lb}}{21.68in^2} = 334.4\ psi$
$F_t' = F_t(C_D C_M C_t C_i) = (675\ psi)(1.6)(1.2) = 1296\ psi$ Good
$\frac{D}{C} = \frac{f_t}{F_t} = \frac{334}{1296} = \boxed{0.26} < 1.0$ ok