Problem 10.2

a) ¼ in. minimum sheathing thickness (IBC Table 2306.4.1) Note that while ¼ in. is permitted, 3/8 in. is common minimum thickness due to ease of handling and to obtain flat wall surface. When shear wall sheathing also serves as exposed exterior siding, 3/8 in. minimum is recommended per footnote c.

b) Wind: $R_W = w_L(b)/2$ = (250 lb/ft)(75 ft)/2 = 9375 lb; $v_W = R_W/b_1$ = (9375 lb)/25 ft = 375 lb/ft

c) IBC Table 2306.4.1 (wind): 6d common nails spaced 4 in. o.c. at edges, 12 in. o.c. in field; blocking required; v_{allow} = 1.4(300 lb/ft) = 420 lb/ft > 375 lb/ft OK

$h/b_{segment}$ = 12 ft/25 ft = 0.48 < 3.5

d) $T_{gross} = v_W(h)$ = 375 lb/ft (12 ft) = 4500 lb conservative estimate

Two 2x6: $A_g = 2\ bd$ = 2 (1.5 in.)(5.5 in.) = 16.5 in^2

$A_n = A_g - 2b(d_{hole})$ = 16.5 in^2 – 2 (1.5 in.)($^3/_4$ in. + $^1/_{16}$ in.) = 14.1 in^2

No.2 DF-L: F_t = 575 psi; C_D = 1.6; C_F = 1.3

F_t' = 575 (1.6)(1.3) = 1196 psi

T' = F_t' A_n = 1196 psi (14.1 in^2) = 16,800 lb > 4500 lb OK

Compression force includes dead loads (see Part e):

Load combination from page 2.77: D + W (EQ16-12)

$C_{gross} = v_W(h) + D_{roof}$ (5 ft)(b_1/2) + D_{wall} (h)(b_1/2)

= 375 lb/ft (12 ft) + 10 psf (5 ft)(25 ft/2) + 15 psf (12 ft)(25 ft/2) = 7375 lb

F_c = 1350 psi; C_D = 1.6; C_F = 1.1

F_c^* = 1350 (1.6)(1.1) = 2376 psi

E_{min}' = E_{min} = 580,000 psi ; K_e = 1; c = 0.8

Assume 2x6 roof joists (conservative): $l_e = l_u$ = 144 in – 5.5 in. – 3(1.5 in.) = 134 in.

l_e/d = 134/5.5 = 24.4

$$F_{cE} = \frac{0.822E'_{min}}{\left(l_e/d\right)^2} = \frac{0.822(580{,}000)}{(24.4)^2} = 800 \text{ psi}$$

$$C_P = \frac{1+\left(F_{cE}/F_c^*\right)}{2c} - \sqrt{\left(\frac{1+\left(F_{cE}/F_c^*\right)}{2c}\right)^2 - \frac{\left(F_{cE}/F_c^*\right)}{c}} = 0.310$$

F_c' = F_c^* (C_P) = 2376 (0.310) = 737 psi

P' = F_c' A_g = 737 psi (16.5 in^2) = 12,160 lb > 7375 lb OK

[Check: $F_c^* A_n$ = 2376 psi (14.1 in^2) = 33,400 lb > 7375 lb OK]
[Check $F_{cperp} A_g$ = 625 psi (16.5 in2) = 10310 lb > 7375 lb OK]
e) Load combination from page 2.77: 0.6D + W (EQ16-14)

T_{gross} = 4500 lb

$T_{net} = T_{gross} - 0.6 [D_{roof} (5 \text{ ft})(b_1/2) + D_{wall} (h)(b_1/2)]$

$= 4500 \text{ lb} - 0.6 [10 \text{ psf} (5 \text{ ft})(25 \text{ ft}/2) + 15 \text{ psf} (12 \text{ ft})(25 \text{ ft}/2)]$

$= 2775 \text{ lb}$

Problem 10.10

a) 2nd floor: $v_{2nd} = R_R/b_{wall}$ = 2100 lb/8 ft = 263 lb/ft
IBC Table 2306.4.1(wind): 15/32 STR I 8d common or galvanized box nails spaced 6 in. o.c. at edges, 12 in. o.c. in field, all edges nailed and blocked; v_{allow} = 1.4(280 lb/ft) = 392 lb/ft > 263 lb/ft OK
1st floor: $v_{1st} = (R_R + R_2)/b_{wall}$ = (2100 lb + 2600 lb)/8 ft = 588 lb/ft
IBC Table 2306.4.1(wind): 8d common or galvanized box nails spaced 4 in. o.c. at edges, 12 in. o.c. in field, all edges nailed and blocked; v_{allow} = 1.4(430 lb/ft) = 602 lb/ft > 588 lb/ft OK

b) Roof strut: $v_R = R_R/b$ = 2100 lb/40 ft = 52.5 lb/ft
$T_A = v_R$ (24 ft) = (52.5 lb/ft)(24 ft) = 1260 lb; $T_B = v_R$ (32 ft) = (52.5 lb/ft)(32 ft) = 1680 lb
2nd floor strut: $v_2 = R_2/b$ = 2600 lb/40 ft = 65 lb/ft
$T_C = v_2$ (24 ft) = (65 lb/ft)(24 ft) = 1560 lb; $T_D = v_2$ (32 ft) = (65 lb/ft)(32 ft) = 2080 lb

c) Load combination p. 2.77: 0.6D + W
At 2nd floor: $OM_{gross} = R_R(h_2)$ = (2100 lb)(9 ft) = 18,900 ft-lb
$T_{gross} = OM_{gross}/b_{wall}$ = 18,900 ft-lb/8 ft = 2360 lb
$OM_{net} = OM_{gross} - 0.6(D_{roof})(b_{wall})(b_{wall}/2)$
= 18,900 ft-lb – (0.6)(155 lb/ft)(8 ft)(8 ft/2) = 15,900 ft-lb
$T_{net} = OM_{net}/b_{wall}$ = 15,900 ft-lb/8 ft = 1990 lb
At foundation: $OM_{gross} = R_R(h_1 + h_2) + R_2(h_1)$ = (2100 lb)(19 ft) + (2600 lb)(10 ft) = 65,900 ft-lb
$T_{gross} = OM_{gross}/b_{wall}$ = 65,900 ft-lb/8 ft = 8240 lb
$OM_{net} = OM_{gross} - 0.6(D_{roof} + D_{floor})(b_{wall})(b_{wall}/2)$
= 65,900 ft-lb – (0.6)(155 lb/ft + 250 lb/ft)(8 ft)(8 ft/2) = 58,100 ft-lb
$T_{net} = OM_{net}/b_{wall}$ = 58,100 ft-lb/8 ft = 7270 lb

d) Load combination p. 2.77: D + 0.75W + 0.75 L + 0.75L_r
2nd floor; D + 0.75(L_r + W) is governing load combination:
155 lb/ft (8 ft) + 0.75[(200 lb/ft)(8 ft) + (2100 lb)(9 ft/8 ft)] = 4210 lb
Foundation: D + 0.75(L + L_r + W) is governing load combination:
(155+250 lb/ft)(8 ft) + 0.75[(200+500 lb/ft)(8 ft) + 2100 lb(19 ft/8 ft) + 2600 lb(10 ft/8 ft)]
= 13,600 lb

e) $N_{bolts} \geq (R_R + R_2)/V_{allow}$ = (2100 lb + 2600 lb)/1500 lb = 3.13
Use 4 bolts @ 8 ft/4 bolts = 96 in./4 bolts = 24 in. o.c.

Problem 10.11

a) $v = R/b_{wall}$ = 3600 lb/8 ft = 450 lb/ft; h/b_{wall} = 10 ft/8 ft = 1.25 < 3.5 OK
IBC Table 2306.4.1(wind) for 15/32 sheathing that is not STR I: 8d common or galvanized box nails spaced 4 in. o.c. at edges, 12 in. o.c. in field; v_{allow} = 1.4(380 lb/ft) = 532 lb/ft > 450 lb/ft OK

b) Uplift at A: $T_{gross} = R(h/b_{wall})$ = 3600 lb (10 ft/8 ft) = 4500 lb
$T_{net} = T_{gross} - 0.6(P_D/2)$ = 4500 lb – 0.6(4000 lb/2) = 3300 lb

c) Compressive force at B: D + 0.75(L_r + W) is critical load combination
$C_{gross} = [P_D + P_D/2] + 0.75[P_{Lr} + P_{Lr}/2 + R(h/b_{wall})]$
= [4000 lb + 4000 lb/2] + 0.75[4000 lb + 4000 lb/2 + 4500 lb] = 13,900 lb

d) $N_{bolts} \geq R / V_{allow}$ = 3600 lb /1000 lb = 3.6
Use 4 bolts @ 8 ft/4 bolts = 96 in./4 bolts = 24 in. o.c.