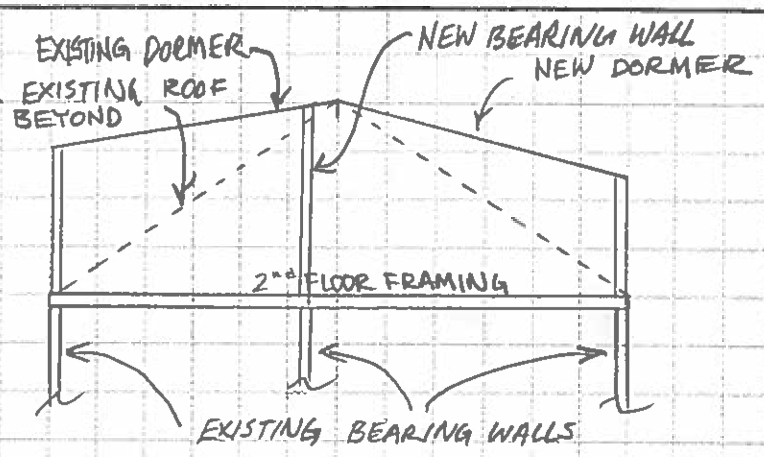
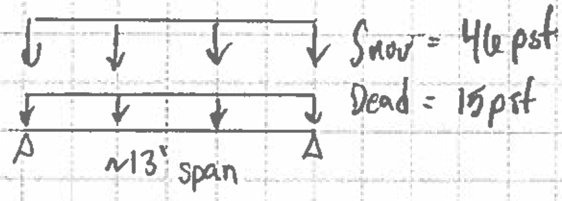
Dormer Addition Structural Design
28 Harvey Street
Portland, Maine



SECTION THRU DORMERS

NEW DORMER RAFTER DESIGN



ASSUME 16" O.C. RAFTER SPACING

TOTAL LOAD: $16/12'' \cdot (46psf + 15psf) = 81\ plf$

DETERMINE FORCES:

$M = \frac{w\ell^2}{8} = 81plf(13')^2/8 = 1.7\ kft$

$V = \frac{w\ell}{2} = 81plf(13')/2 = 530\#$

DETERMINE REQ'D MEMBER SIZE:

ASSUME NO. 2 SPF FRAMING

$F_b = 875\ psi$

$F_v = 135\ psi$

$E = 1{,}400{,}000\ psi$

BENDING WILL LIKELY CONTROL

$F'_b = F_b C_D C_M C_t C_L C_F C_{fu} C_i C_r$

$C_D = 1.15$ (D+S will control)

$C_M = 1.0$ (Dry conditions)

$C_t = 1.0$ (temp < 100°F)

$C_L = 1.0$ (use 1.0 and assume adequately braced – will check later)

$C_F = 1.0$ (assume 1.0 for size factor – will check later)

$C_{fu} = 1.0$ (not flat use)

$C_i = 1.0$ (not incised)

$C_r = 1.15$ (repetitive member)

$F'_b = (875psi)(1.15)(1.0)(1.0)(1.0)(1.0)(1.0)(1.0)(1.15) = 1157\ psi$

CRITERIUM ENGINEERS
22 Monument Square
Portland, ME 04101
Tel (800) 242-1969
Fax (207) 775-4405
www.criterium-engineers.com

Sketch Title: Calculations
Project
Drawn by
Checked by
No.

No.
Date 2/12/2016
Date

NEW DORMER RAFTER DESIGN (CONT.)

MEMBER SIZE FOR BENDING:

$M/S = f_b \therefore S_{REQ'D} = M/F_b' = \frac{(1.7\ k\text{-}ft \cdot 12''/ft)}{1157\ psi} = 17.6\ in^3$

$2\times10 - S = 21.39\ in^3 > 17.6\ in^3$ ✓ OK

$f_b = \frac{1.7\ k\text{-}ft\ (12''/ft)}{21.39\ in^3} = 954\ psi$ ✓ OK

CHECK SHEAR ON 2X10:

$f_v = \frac{3V}{2bd} = \frac{3(530^{\#})}{2(1.5'')(9.25'')} = 57.3\ psi$

$F_v' = F_v C_D C_M C_t C_i = 135\ psi\ (1.15)(1.0)(1.0)(1.0)(1.0) = 155\ psi > 57.3\ psi$

✓ OK FOR SHEAR

CHECK DEFLECTION:

$\Delta = 5w\ell^4 / 384\ EI = \frac{(5)(81\ plf)(1ft/12'')(13' \cdot 12''/ft)^4}{384\ (1,400,000)(98.93\ in^4)} = 0.376'' = L/414$ OK

CHECK ASSUMPTIONS:

BEAM STABILITY FACTOR $C_i = 1.0$
- INSTALL MID-SPAN BRIDGING OR BLOCKING
- COMPRESSION EDGE HELD BY SHEATHING
- POINTS OF BEARING HELD TO PREVENT ROTATION

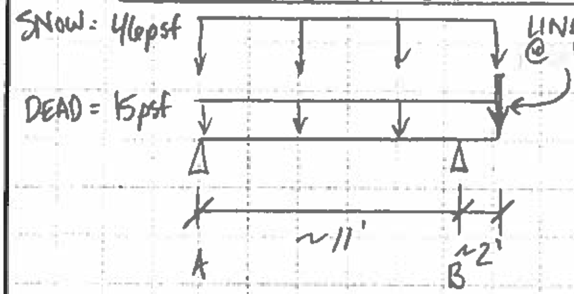
THESE CONDITIONS WILL BE MET.

SIZE FACTOR $C_F = 1.0$ – USED, BUT PER TABLES USE 1.1 FOR 2x10. THEREFORE DESIGN IS CONSERVITIVE

USE 2X10 @ 16" O.C. W/ MID-SPAN BRIDGING AT NEW DORMER RAFTERS

Dormer Addition Structural Design
28 Harvey Street
Portland, Maine

CANTILEVERED RAFTER DESIGN



LINE LOAD @ RIDGE $= 61\,psf \cdot 6.5' = 400^{\#}$

LOOK AT LOADING PER 1'-0" TRIB WIDTH

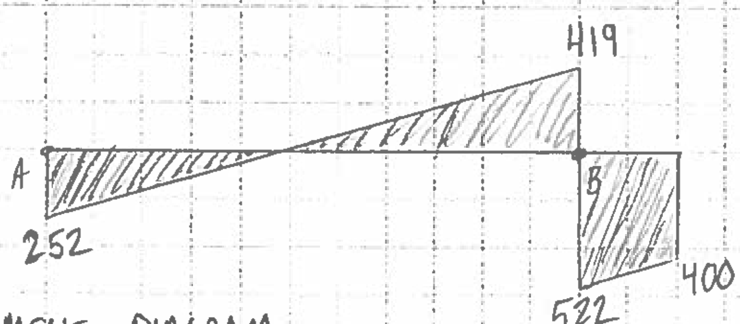
$$\Sigma M_B = R_A \cdot 11' + 400^{\#} \cdot 2' - (13')(61\,plf)(4.5') = 0$$

$$R_A = \frac{(13)(61\,plf)(4.5') - 400^{\#} \cdot 2'}{11'} = 252^{\#}$$

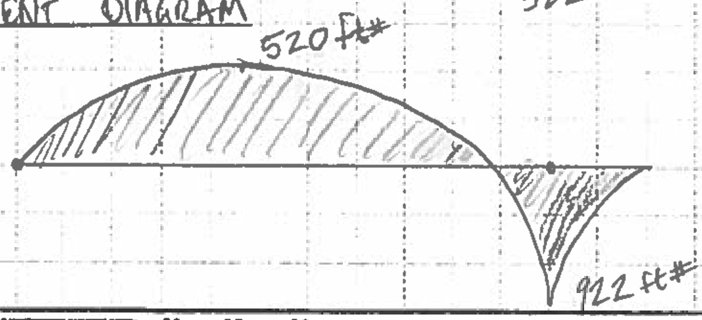
$$\Sigma F = R_A - 13'(61\,plf) + R_B - 400^{\#} = 0$$

$$R_B = 400^{\#} + 13'(61\,plf) - \underset{(252^{\#})}{R_A} = 941^{\#}$$

SHEAR DIAGRAM



MOMENT DIAGRAM



VERIFIED USING RISA 2D

CRITERIUM ENGINEERS
22 Monument Square
Portland, ME 04101
Tel (800) 242-1969
Fax (207) 775-4405
www.criterium-engineers.com

Sketch Title: Calculations
Project:
Drawn by:
Checked by:
No.
Sheet 3 of 9
No.
Date 2/12/2016
Date

Dormer Addition Structural Design
28 Harvey Street
Portland, Maine

CANTILEVERED RAFTER DESIGN (CONT.)

DESIGN MOMENT = 922 ft# }
DESIGN SHEAR = 941 # } PER FOOT OF TRIB (SEE PREVIOUS PAGE)

DETERMINE REQ'D SECTION PROPERTIES

ASSUME NO. 2 SPF FRAMING
$F'_b = 1157$ psi }
$F'_v = 155$ psi } SEE PREVIOUS PAGES

$$S_{REQ'D} = M/F'_b = \frac{922 ft\# \cdot 12''/ft}{1157 psi} = 9.6 in^3$$

$$A_{REQ'D} = \frac{3V}{2(F_v)} = \frac{3(941\#)}{2(155 psi)} = 9.1 in^2$$

TRY (2) 2x6's @ 12" O.C.

$$S = 2(7.563 in^3) = 15.13 in^3$$

$$f_b = M/S = \frac{922 ft\#(12''/ft)}{15.13 in^3} = 731 psi < 1157 psi \checkmark$$

$$A = 2(8.25 in^2) = 16.5 in^2$$

$$f_v = \frac{3V}{2bd} = \frac{3(941\#)}{2(3'')(5.5'')} = 86 psi < 155 psi \checkmark$$

CHECK DEFLECTION
TIP ONLY W/ POINT LOAD

$$\Delta = \frac{Pa^2}{3EI}(l+a) = \frac{400\#(24'')^2}{3(1,400,000)(111.6 in^4)}(156'') =$$

$$\Delta = 0.206'' = 2L/233 \quad \cdot 2L/240 = 0.2'' \text{ ONLY } 3\%$$

OVER & LOAD ON BACK SPAN WILL REDUCE TIP DEFLECTION

BACK SPAN W/O POINT LOAD @ TIP

$$\Delta = 5wl^4/384EI = 0.345'' = L/383 \checkmark \text{ OK}$$

USE (2) 2X6 @ 12" O.C. (NO. 2 SPF OR BETTER)
W/ MID-SPAN BRIDGING @ EXISTING DORMER RAFTERS

Project:
Job#:
Designer:
Date:

Timber Wall Stud Design with combined axial and bending forces

Location Reference: 2nd FLOOR BEARING WALL CHECK

Roof Load: wr =	941	plf
Snow =	yes	
Axial Load Due to Roof Loading: Pr =	1255	lbs
Floor Load: wf =	0	plf
Axial Load Due to Floor Loading: Pf =	0	lbs
Stud Total Axial Load: Pt =	1255	lbs
Eccentricity: e =	0	in
Lateral Pressure: p =	5	psf
Wind or Seismic =	yes	
Lateral Load: wl =	7	plf
Bending Moment: M =	640	in-lbs
Stud Height =	8	ft
Stud Spacing: s =	16	in
Stud Width: b =	1.5	in
Stud Thickness: d =	3.5	in
Allowable Compression Stress: Fc =	1150	psi
Allowable Bending Stress: Fb =	875	psi
Adjusted Compression Stress: F*c =	1521	psi
Column Area: A =	5.25	in^2
Section Modulus: S =	3.06	
Modulus of elasticity: E =	1.4 E+06	psi
E'_{min} =	5.1 E+05	psi
Effective length: Le =	8	ft
Le/d =	27	
Fce =	557	psi
Studs OK		
Fce (Le/d=33) =	1057	psi
Rated Wall Req's Don't Control		
Fce/F*c =	0.37	
c =	0.8	
Cp =	0.33	
Adjusted Allow. Compression Stress: Fc =	507	psi
Actual Compression Stress: fc =	239	psi
Adjusted Allowable Bending Stress: Fb =	1509	psi
Actual Bending Stress: fb =	209	psi

IBC Load Combination

D+L+S

Stud Type:	SPF #1/#2	*Studs OK*
Rated Wall:	no	

Available Stud Types:	
Spruce-Pine-Fir	
Select Structural	SPF SS
#1 / #2	SPF #1/#2
#3	SPF #3
STUD	SPF STUD

Compression Load duration factor: Cd =	1.15
Repetitive member factor: Cr =	1.15
Bending Load Duration Factor: Cd =	1.00
Compression Size factor: Cf =	1.15
Bending Size factor: Cf =	1.50
Rated Wall Factor =	1.00
Bearing Area Factor: C_b =	1.25

Deflection: Δ = 0.08 in
L/ 1172

DEFLECTION OK

Sill Plate: Fc(perp) = 531 psi
Therefore: *fc<F'c(perp)*

NO SILL PLATE CRUSHING

Unity Value:	***0.46***	***Studs OK***

USE 2X4 NO.2 SPF STUDS @ 16" O.C

Calculations 28 Harvey St. Dormer

2/12/2016

Dormer Addition Structural Design
28 Harvey Street
Portland, Maine

TYPICAL HEADER DESIGN (AT NEW INTERIOR BEARING WALL)

USE MAX. LOADING: 941 plf

$M = wl^2/8 = \frac{941\,plf(3'\text{-}6")^2}{8} = 1441\ ft\#$

$V = wl/2 = \frac{941\,plf(3'\text{-}6")}{2} = 1.6\ K$

$S_{REQ'D} = M/F'_b = 1441\,ft\#/1006\,psi = 17.2\ in^3$

$A_{REQ'D} = 3V/2(F'_v) = \frac{3(1.6K)}{2(155psi)} = 16\ in^2$

(2) 2x8 — $A = 10.88\,in^2 \times 2 = 21.8\,in^2 \therefore f_v = 113\,psi$ ✓ OK

$S = 13.14\,in^3 \times 2 = 26.3\,in^3 \therefore f_b = 657\,psi$ ✓ OK

$\Delta = \frac{5(941plf)(3.5')(42")^3}{384(1,400000)(95.3in^4)} = 0.024" = l/1763$ ✓ OK

USE (2) 2X8 NO. 2 SPF
AT HEADER IN INTERIOR BEARING WALL

HEADER @ EXTERIOR WALL

$61psf \times 6.5'\ TRIB = 400\ \#/ft$

$M = wl^2/8 = 400\,\#/ft(3.5')^2/8 = 613\ ft\#$

$V = wl/2 = 400\,\#/ft \cdot 3.5'/2 = 700\ \#$

$S_{REQD} = 613\,ft\#/1006psi = 7.3\ in^3$

$A_{REQD} = (3)700\#/(2)(155psi) = 6.8\ in^2$

(2) 2x6 NO. 2 SPF OK BY INSPECTION

$S_{2x6} = 7.563\,in^3 \times 2 = 15.1\,in^3$

$A_{2x6} = 8.25\,in^2 \times 2 = 16.5\,in^2$ ✓ OK

CRITERIUM ENGINEERS
22 Monument Square
Portland, ME 04101
Tel (800) 242-1969
Fax (207) 775-4405
www.criterium-engineers.com

Sketch Title: Calculations
Project No.:
Drawn by:
Checked by:
No.

Date: 2/12/2016
Date:

Dormer Addition: Structural Design
28 Harvey Street
Portland, Maine

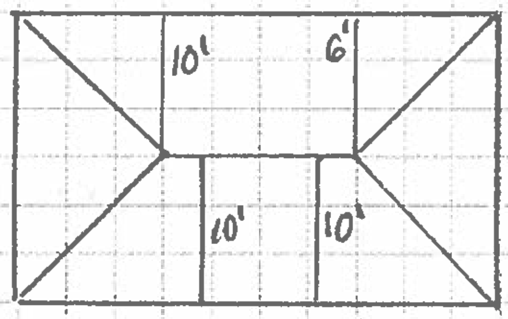
REVIEW: LATERAL LOADING FROM WIND:

PROJECTED AREA (MAX) = 8' x 18' = 144 sf

WIND LOAD = 25 psf

TOTAL LOAD = 144 sf · 25 psf = 3600 #

WALL LAYOUT:



TOTAL WALL LENGTH ~ 36'

∴ LOAD TO WALLS = 3600#/36' = ~ 100#/ft (FLEXIBLE DIAPHRAGMS)

SHEAR WALL CAPACITY = 100 plf FOR SHEARWALLS SHEATHED W/ 1/2" GYPSUM BOARD, UNBLOCKED, 16" STUD SPACING & 7" FASTENER SPACING (SHEATHED ONE SIDE)
(SEE ATTACHED

ADDITIONALLY, MOST WALLS WILL BE SHEATHED BOTH SIDES & W/ MORE RESILIENT MATERIALS.

THEREFORE, LATERAL CAPACITY IS ADEQUATE.

	5/8	15/8	10d	200	305	395	520

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.
a. Values are not permitted in Seismic Design Category D, E or F.
b. Galvanized nails shall be hot-dipped or tumbled.

2306.6 Fiberboard shear walls. Fiberboard shear walls shall be designed and constructed in accordance with AF&PA SDPWS. Fiberboard shear walls are permitted to resist horizontal forces using the allowable shear capacities set forth in Table 2306.6. Allowable capacities in Table 2306.6 are permitted to be increased 40 percent for wind design. Fiberboard shall not be used to resist seismic forces in structures assigned to *Seismic Design Category* D, E or F.

TABLE 2306.6
ALLOWABLE SHEAR VALUES (plf) FOR WIND OR SEISMIC LOADING ON
SHEAR WALLS OF FIBERBOARD SHEATHING BOARD CONSTRUCTION FOR TYPE V CONSTRUCTION ONLY[a, b, c, d, e]

THICKNESS AND GRADE	FASTENER SIZE	ALLOWABLE SHEAR VALUE (pounds per linear foot) NAIL SPACING AT PANEL EDGES (inches)[a]		
		4	3	2
1/2" or 25/32" Structural	No. 11 gage galvanized roofing nail 1 1/2" long for 25/32" with 3/8" head	170	230	260
	No. 11 gage galvanized staple, 7/16" crown[f]	150	200	225
	No. 11 gage galvanized staple, 1" crown[f]	220	290	325

For SI: 1 inch = 25.4 mm, 1 pound per foot = 14.5939 N/m.
a. Fiberboard sheathing shall not be used to brace concrete or masonry walls.
b. Panel edges shall be backed with 2-inch or wider framing of Douglas fir-larch or Southern pine. For framing of other species: (1) Find specific gravity for species of framing lumber in AF&PA NDS. (2) For staples, multiply the shear value from the table above by 0.82 for species with specific gravity of 0.42 or greater, or 0.65 for all other species. (3) For nails, multiply the shear value from the table above by the following adjustment factor: specific gravity adjustment factor = [1-(0.5-SG)], where SG = Specific gravity of the framing lumber.
c. Values shown are for fiberboard sheathing on one side only with long panel dimension either parallel or perpendicular to studs.
d. Fastener shall be spaced 6 inches on center along intermediate framing members.
e. Values are not permitted in Seismic Design Category D, E or F.
f. Staple length shall not be less than 1 1/2 inches for 25/32-inch sheathing or 1 1/4 inches for 1/2-inch sheathing.

2306.7 Shear walls sheathed with other materials. Shear walls sheathed with portland cement plaster, gypsum lath, gypsum sheathing or gypsum board shall be designed and constructed in accordance with AF&PA SDPWS. Shear walls sheathed with these materials are permitted to resist horizontal forces using the allowable shear capacities set forth in Table 2306.7. Shear walls sheathed with portland cement plaster, gypsum lath, gypsum sheathing or gypsum board shall not be used to resist seismic forces in structures assigned to *Seismic Design Category* E or F.

TABLE 2306.7
ALLOWABLE SHEAR FOR WIND OR SEISMIC FORCES FOR SHEAR WALLS OF LATH AND PLASTER OR GYPSUM BOARD WOOD FRAMED WALL ASSEMBLIES

TYPE OF MATERIAL	THICKNESS OF MATERIAL	WALL CONSTRUCTION	FASTENER SPACING[b] MAXIMUM (inches)	SHEAR VALUE[a, e] (plf)	MINIMUM FASTENER SIZE[c, d, j, k]
1. Expanded metal or woven wire lath and portland cement plaster	7/8"	Unblocked	6	180	No. 11 gage 1 1/2" long, 7/16" head No. 16 gage galv. staple, 7/8" legs
2. Gypsum lath, plain or perforated with vertical joints staggered	3/8" lath and 1/2" plaster	Unblocked	5	180	No. 13 gage galv. 1 1/8" long, 19/64" head, plasterboard nail
3. Gypsum lath, plain or perforated	3/8" lath and 1/2" plaster	Unblocked	5	100	No. 16 gage galv. staple, 1 1/8" long, 0.120" nail, min. 3/8" head, 1 1/4" long
4. Gypsum board, gypsum veneer base	1/2"	Unblocked[f]	7	75	5d cooler (1 5/8" × 0.086") or wallboard 0.120" nail, min. 3/8" head, 1 1/2" long No. 16 gage galv. staple, 1 1/2" long
		Unblocked[f]	4	110	
		Unblocked	7	100	
		Unblocked	4	125	
		Blocked[g]	7	125	
		Blocked[g]	4	150	
		Unblocked	8/12[h]	60	No. 6—1 1/4" screws[i]
		Blocked[g]	4/16[h]	160	
		Blocked[f, g]	4/12[h]	155	
		Blocked[g]	8/12[h]	70	
		Blocked[g]	6/12[h]	90	
		Unblocked[f]	7	115	6d cooler (1 7/8" × 0.092") or wallboard 0.120" nail, min. 3/8"
			4	145	

16" STUD SPACING

Calculations 28 Havey Dormer 8 of 9 2/12/16

or water-resistant gypsum backing board		Blocked[g]	7	145	head, 1 3/4" long No. 16 gage galv. staple, 1 1/2" legs, 1 5/8" long
			4	175	
	5/8"	Blocked[g] Two-ply	Base ply: 9 Face ply: 7	250	Base ply-6d cooler (1 7/8" × 0.092") or wallboard 1 3/4" × 0.120" nail, min. 3/8" head 1 5/8" 16 gage galv. staple 1 5/8" 16 gage galv. staple Face ply-8d cooler (2 3/8" × 0.113") or wallboard 0.120" nail, min. 3/8" head, 2 3/8" long No. 15 gage galv. staple, 2 1/4" long
		Unblocked	8/12[h]	70	No. 6—1 1/4" screws[i]
		Blocked[g]	8/12[h]	90	

For SI: 1 inch = 25.4 mm, 1 foot = 304.8 mm, 1 pound per foot = 14.5939 N/m.

a. These shear walls shall not be used to resist loads imposed by masonry or concrete walls (see Section 4.1.5 of AF & PA SDPWS). Values shown are for short-term loading due to wind or seismic loading. Walls resisting seismic loads shall be subject to the limitations in Section 12.2.1 of ASCE 7. Values shown shall be reduced 25 percent for normal loading.

b. Applies to fastening at studs, top and bottom plates and blocking.

c. Alternate fasteners are permitted to be used if their dimensions are not less than the specified dimensions. Drywall screws are permitted to substitute for the 5d (1 5/8" × 0.086"), and 6d (1 7/8" × 0.092")(cooler) nails listed above, and No. 6 1 1/4 inch Type S or W screws for 6d (1 7/8" × 0.092) (cooler) nails.

d. For properties of cooler nails, see ASTM C 514.

e. Except as noted, shear values are based on a maximum framing spacing of 16 inches on center.

f. Maximum framing spacing of 24 inches on center.

g. All edges are blocked, and edge fastening is provided at all supports and all panel edges.

h. First number denotes fastener spacing at the edges; second number denotes fastener spacing at intermediate framing members.

i. Screws are Type W or S.

j. Staples shall have a minimum crown width of 7/16 inch, measured outside the legs, and shall be installed with their crowns parallel to the long dimension of the framing members.

k. Staples for the attachment of gypsum lath and woven-wire lath shall have a minimum crown width of 3/4 inch, measured outside the legs.

« Section 2305: General Design Requirements for Lateral-force-resisting Systems - Section 2307: Load and Resistance Factor Design »

Calculations
28 Harvey St
Dormer

9 of 9
2/12/2016