Structural Analysis Due to Wind Pressure

Tributary Areas

$h_1 := 25ft$

$h_2 := 5ft$

Line Loads

Diaphragm

$line\_load_{ground} := h_2 \cdot Pressure$

$line\_load_{ceiling} := h_1 \cdot Pressure$

$$line\_load_{ground} = \begin{pmatrix} 46.967 & 75.355 \\ 76.95 & 77.793 \\ 79.214 & 108.654 \\ 110.332 & 154.462 \\ 156.461 & 0 \end{pmatrix} \frac{lbf}{ft} \qquad line\_load_{ceiling} = \begin{pmatrix} 234.833 & 376.776 \\ 384.75 & 388.967 \\ 396.071 & 543.268 \\ 551.658 & 772.308 \\ 782.305 & 0 \end{pmatrix} \frac{lbf}{ft}$$

Reaction at Shear Wall

$$reaction_{ground} := \frac{width}{2} \cdot line\_load_{ground} \qquad reaction_{ceiling} := \frac{width}{2} \cdot line\_load_{ceiling}$$

$$reaction_{ground} = \begin{pmatrix} 1.569 & 2.517 \\ 2.57 & 2.599 \\ 2.646 & 3.629 \\ 3.685 & 5.159 \\ 5.226 & 0 \end{pmatrix} kip \qquad reaction_{ceiling} = \begin{pmatrix} 7.844 & 12.585 \\ 12.852 & 12.993 \\ 13.23 & 18.147 \\ 18.427 & 25.797 \\ 26.131 & 0 \end{pmatrix} kip$$

$length = 36\,ft$

$$unit_{shear\_ground} := 2\,\frac{reaction_{ground}}{length} \qquad unit_{shear\_ceiling} := 2 \cdot \frac{reaction_{ceiling}}{length}$$

$$unit_{shear\_ground} = \begin{pmatrix} 87.156 & 139.837 \\ 142.797 & 144.362 \\ 146.999 & 201.629 \\ 204.743 & 286.636 \\ 290.346 & 0 \end{pmatrix} \frac{lbf}{ft} \qquad unit_{shear\_ceiling} = \begin{pmatrix} 435.782 & 699.187 \\ 713.985 & 721.809 \\ 734.993 & 1008.147 \\ 1023.717 & 1433.179 \\ 1451.732 & 0 \end{pmatrix} \frac{lbf}{ft}$$

Select Sheathing and determine nailing schedule for the Diaphragms

blocking of the sheathing is required

Category 1:

Use Structural I sheathing using a 6d common nail; minimum fastner penetration in framing is 1-1/4". Minimum nominal Panel thickness of 5/16" and minimum nominal framing width of 3". Nail spacing at panel edges is 6".

Category 2:

Use Structural I sheathing using a 6d common nail; minimum fastner penetration in framing is 1-1/4". Minimum nominal Panel thickness of 5/16" and minimum nominal framing width of 3". Nail spacing at panel edges is 6".

Category 3:

Use Structural I sheathing using a 6d common nail; minimum fastner penetration in framing is 1-1/4". Minimum nominal Panel thickness of 5/16" and minimum nominal framing width of 2". Nail spacing at panel edges is 4".

Category 4:

Use Structural I sheathing using a 8d common nail; minimum fastner penetration in framing is 1-3/8". Minimum nominal Panel thickness of 3/8" and minimum nominal framing width of 2". Nail spacing at panel edges is 4".

Category 5:

Use Structural I sheathing using a 10d common nail; minimum fastner penetration in framing is 1-1/2". Minimum nominal Panel thickness of 15/32" and minimum nominal framing width of 2". Nail spacing at panel edges is 3".

*note: maximum shear provided by sheathing is 2295 lb/ft

Design of Tension Chord

Wood is Southern Pine, Select Structural

Material properties

$F_t := 1600psi$

$F_c := 2100psi$

Adjustment Factors

$C_D := 1.6$	Load Duration Factor
$C_M := 1$	Wet Service Factor
$C_t := 1$	Temperature Factor
$C_F := 1$	Size Factor
$C_i := 1$	Incising Factor

Calculate the axial force in the chord

$$force\_axial_{ground} := line\_load_{ground} \cdot \frac{width^2}{8 \cdot length} \qquad force\_axial_{ceiling} := line\_load_{ceiling} \cdot \frac{width^2}{8 \cdot length}$$

$$force\_axial_{ground} = \begin{pmatrix} 0.728 & 1.168 \\ 1.192 & 1.206 \\ 1.228 & 1.684 \\ 1.71 & 2.394 \\ 2.425 & 0 \end{pmatrix} kip \qquad force\_axial_{ceiling} = \begin{pmatrix} 3.639 & 5.839 \\ 5.962 & 6.028 \\ 6.138 & 8.419 \\ 8.549 & 11.968 \\ 12.123 & 0 \end{pmatrix} kip$$

Calculate Tensile Capacity

$$F_{t\_prime} := F_t \cdot C_D \cdot C_M \cdot C_t \cdot C_F \cdot C_i$$

$$F_{t\_prime} = 2560\,psi$$

Determine Required area of the chord

$$area\_reqd_{ground} := \frac{force\_axial_{ground}}{F_{t\_prime}} \qquad area\_reqd_{ceiling} := \frac{force\_axial_{ceiling}}{F_{t\_prime}}$$

$$area\_reqd_{ground} = \begin{pmatrix} 0.284 & 0.456 \\ 0.466 & 0.471 \\ 0.48 & 0.658 \\ 0.668 & 0.935 \\ 0.947 & 0 \end{pmatrix} in^2 \qquad area\_reqd_{ceiling} = \begin{pmatrix} 1.422 & 2.281 \\ 2.329 & 2.355 \\ 2.398 & 3.289 \\ 3.339 & 4.675 \\ 4.736 & 0 \end{pmatrix} in^2$$

$$Minimum_{area} := 2 \cdot 1.5in \cdot 3.5in \qquad Minimum_{area} = 10.5\,in^2$$

The chord force is not going to limit the design

Determine Shear sheathing and nailing pattern

$$window\_length := 9\,ft$$

$$wall\_length := length - window\_length \qquad wall\_length = 27\,ft$$

$$Unit\_shear_{ground} := 2\,\frac{reaction_{ground}}{wall\_length} \qquad Unit\_shear_{ceiling} := 2\,\frac{reaction_{ceiling}}{wall\_length}$$

$$Unit\_shear_{ground} = \begin{pmatrix} 116.208 & 186.45 \\ 190.396 & 192.482 \\ 195.998 & 268.839 \\ 272.991 & 382.181 \\ 387.128 & 0 \end{pmatrix} \frac{lbf}{ft} \qquad Unit\_shear_{ceiling} = \begin{pmatrix} 581.042 & 932.25 \\ 951.979 & 962.412 \\ 979.99 & 1344.196 \\ 1364.955 & 1910.906 \\ 1935.642 & 0 \end{pmatrix} \frac{lbf}{ft}$$

Values from the NDS Wind and Seismic Provisions

Max Shear Resistance

If your house is located in:

Category 1:

Use 15/32" Wood Structural Panels - Structural I; minimimum fastener penetration of 1-1/2" using 10d common nail with a panel edge fastener spacing of 6 in

Category 2:

Use 3/8" Wood Structural Panels - Structural I; minimimum fastener penetration of 1-3/8" using 8d common nail with a panel edge fastener spacing of 4 in

Category 3:

Use 15/32" Wood Structural Panels - Structural I; minimimum fastener penetration of 1-1/2" using 10d common nail with a panel edge fastener spacing of 4 in

Category 4:

Use 15/32" Wood Structural Panels - Structural I; minimimum fastener penetration of 1-3/8" using 8d common nail with a panel edge fastener spacing of 2 in

Category 5:

Use 15/32" Wood Structural Panels - Structural I; minimimum fastener penetration of 1-1/2" using 10d common nail with a panel edge fastener spacing of 2 in

*note: sheathing can only resist a unit shear up to 2435 lb/ft