Units

$R := \frac{ft^2 \cdot \Delta°F \cdot hr}{BTU}$ R value in archaic US customary units

$R_{SI} := \frac{m^2 \cdot K}{W}$ Metric R value

Constants

Wood

$\kappa := \begin{pmatrix} 0.117 \\ 0.142 \end{pmatrix} \cdot \frac{W}{m \cdot K}$ Range of Thermal conductivity of Wood

$R_{\lambda Wood} := \frac{1}{\kappa} = \begin{pmatrix} 1.23272 \\ 1.01569 \end{pmatrix} \cdot \frac{R}{in}$ Fir Spruce

$R_{\lambda Wood} := 1.227 \frac{R}{in}$ Nominal R value per inch of common framing species

Fiberglass Batts

$R_{\lambda Fiber} := \frac{21}{5.5} \frac{R}{in}$ R value per inch of dense fiberglass batts

Other Construction Materials

$R_{Drywall} := 0.45R$ 1/2" thick gypsum drywall

$R_{OSB} := 0.61R$ OSB sheathing

$R_{Cladding} := 0.1 \cdot R$ Outer cladding

$R_{InteriorAirFilm} := 0.68R$ Internal air boundary layer

$R_{ExteriorAirFilm} := 0.17R$ External air boundary layer

Analysis

Framing Factors

Conventional Framing

16" oc 24" oc

$$FF := \begin{pmatrix} 23\% & 20\% & 19\% & 16\% \end{pmatrix}^T$$

16" oc 24" oc

Advanced Framing

Wall Model

$R_{Framing}(\tau) := R_{\lambda Wood} \cdot \tau$ *τ is the stud width*

$R_{Fiberglass}(\tau) := R_{\lambda Fiber} \cdot \tau$ *τ is the fiberglass thickness*

$$R_{Wall}(\tau, ff) := \frac{1}{\frac{ff}{R_{Framing}(\tau)} + \frac{1 - ff}{R_{Fiberglass}(\tau)}}$$ Composite resistance of the framing with insulated cavity

$$\tau := \begin{pmatrix} 3.5 \\ 5.5 \end{pmatrix} \cdot in$$ 2x4 / 2x6 Two common wall thicknesses

Total R Value

$R_{Total}(\tau, ff) := R_{ExteriorAirFilm} + R_{Cladding} + R_{OSB} + R_{Wall}(\tau, ff) + R_{Drywall} + R_{InteriorAirFilm}$

$R := matrix\left(rows(\tau), rows(FF), f(i, j) \leftarrow R_{Total}\left(\tau_i, FF_j\right)\right)$

$$R = \begin{pmatrix} 11.0 & 11.4 & 11.5 & 12.0 \\ 16.1 & 16.8 & 17.0 & 17.7 \end{pmatrix} \cdot R$$

R Value	Framing Approach			
Stud Size	Conventional (16" oc)	Conventional (24" oc)	Adv.Framing (16" oc)	Adv.Framing (24" oc)
2x4	11.0	11.4	11.5	12.0
2x6	16.1	16.8	17.0	17.7

$$\frac{R}{R}$$

$$R = \begin{pmatrix} 1.9 & 2.0 & 2.0 & 2.1 \\ 2.8 & 3.0 & 3.0 & 3.1 \end{pmatrix} \cdot R_{SI}$$

R Value	Framing Approach			
Stud Size	Conventional (16" oc)	Conventional (24" oc)	Adv.Framing (16" oc)	Adv.Framing (24" oc)
2x4	1.9	2.0	2.0	2.1
2x6	2.8	3.0	3.0	3.1

$$\frac{\mathbf{R}}{R_{SI}}$$