

# ARCH 2331

## BUILDING TECHNOLOGY II

## **Class Overview:**

- R value modeling
- Module C development
- Desk crits, open questions

## **Upcoming:**

- Final Examination- **Class 30 Dec 19, 2023**
- Module C final submission;  
Sketchbook/notes 4of4 final; and
- Resubmit of Module B (optional, if you've added drawings)  
**Last Day of Classes Dec. 20, 2023 midnight**

# Ekotrope | Free R Value Calculator — Ekotrope

<https://www.ekotrope.com/r-value-calculator/>

**HERS® Index Score:**  
**0** Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit [www.hersindex.com](http://www.hersindex.com)

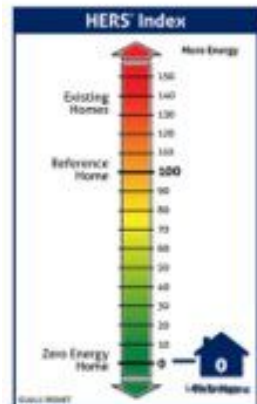
**Annual Savings\***  
**\$3,805**  
 \*Relative to an average U.S. home

**HERS® Index Score:**  
**1** Your home's HERS score is a relative performance score. The lower the number, the more energy efficient the home. To learn more, visit [www.hersindex.com](http://www.hersindex.com)

**Annual Savings\***  
**\$3,795**  
 \*Relative to an average U.S. home

## Your Home's Estimated Energy Use:

	Use (MBtu)	Annual Cost
Heating	3.7	\$142
Cooling	0.1	\$5
Hot Water	0.0	\$0
Lights/Appliances	23.6	\$899
Service Charges		\$0
Generation (e.g. Solar)	27.2	-\$1,037
<b>Total:</b>	<b>27.4</b>	<b>\$9</b>

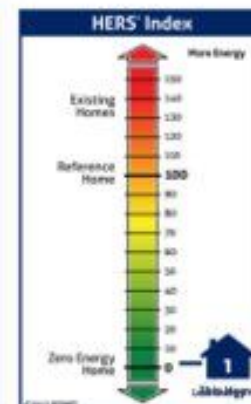


## Home Feature Summary:

Home Type:	Duplex, whole building
Model:	N/A
Community:	N/A
Conditioned Floor Area:	2,623 ft <sup>2</sup>
Number of Bedrooms:	4
Primary Heating System:	Ground Source Heat Pump • Electric • 4.1 COP
Primary Cooling System:	Ground Source Heat Pump • Electric • 15.2086 EER
Primary Water Heating:	Solar Water Heater • Electric • 1 Energy Factor
House Tightness:	3.7 ACH50
Ventilation:	61.448 CFM • 61.45 Watts (Default)
Duct Leakage to Outside:	Radiant
Above Grade Walls:	R-33
Ceiling:	Vaulted Roof, R-77
Window Type:	U-Value: 0.12, SHGC: 0.3
Foundation Walls:	N/A

## Your Home's Estimated Energy Use:

	Use (MBtu)	Annual Cost
Heating	4.0	\$153
Cooling	0.1	\$4
Hot Water	0.0	\$0
Lights/Appliances	23.6	\$899
Service Charges		\$0
Generation (e.g. Solar)	27.2	-\$1,037
<b>Total:</b>	<b>27.7</b>	<b>\$19</b>



## Home Feature Summary:

Home Type:	Duplex, whole building
Model:	N/A
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Foundation Walls:	N/A



Kaizen House / Rama Estudio" [Casa Kaizen / Rama Estudio] 01 Dec 2021. ArchDaily. Accessed 8 Dec 2021.  
<<https://www.archdaily.com/972768/kaizen-house-rama-estudio>> ISSN 0719-8884

# R-value Defined

R-value is the measurement of a building material's capacity to **Resist heat flow**. In simple terms, R-value measures how well it blocks the transmission of heat.

Materials with higher R-values are more effective insulators.

R-values are additive.                      If you have a material with an R-value of  $12$   
attached to another material with an R-value of  $\underline{3}$   
then the combined materials have an R-value of  $15$



# U-value vs. R-value

## U-Value vs. R-Value

The rate of heat transfer (or flow) is measured as U-value, and resistance to heat transfer (or flow) is measured by its reciprocal, R-value.

**U-value = rate of heat transfer**

**R-value = resistance to heat transfer**

R-value and U-value (also known as U-factor) are mathematical reciprocals.

$$\mathbf{U = 1/R}$$

$$\mathbf{R = 1/U}$$

U-factor equals the number of BTUs (British Thermal Unit) of energy passing through one square foot of material, over an 60 minute period, per degree difference in temperature (in Fahrenheit). The formula is expressed like this:

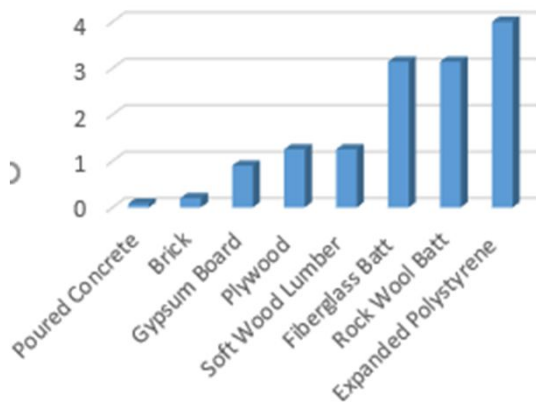
$$\mathbf{U = BTU / \text{feet}^2 \times \text{hour } ^\circ\text{F}}$$

## So why do we use R AND U values?

U-value is used for assemblies (combination of materials, like a window unit) and R-value is used for a building material (brick, gypsum board, wood stud, etc.)

# Typical R-values

Material	R/ Inch	R/ Thick- nessInsulation
Air Films		0.17
Concrete Block 4 inch		0.8
Concrete Block 8 inch		1.11
Expanded Polystyrene	4	
Fiberglass Batt	3.14	
Gypsum Board (5/8 inch)		0.56
Gypsum Board (drywall 1/2 inch)		0.45
Plywood	1.25	
5/8 inch		0.77
Rock Wool Batt	3.14	
Roofing Asphalt Shingles		0.44
Roofing Wood Shingles		0.97
Soft Wood Lumber	1.25	
2 inch nominal (1 1/2 inch)		1.88
2 x 4 (3 1/2 inch)		4.38
2 x 6 (5 1/2 inch)		6.88



## WALL CALCULATION

**Assembly Properties**

**R 61.97      \$8.41/ft<sup>2</sup>**

Exterior  
+

+

Interior

- HouseWrap (Water Barrier): R: 0.1 / D: 0.1"
- Cellulose Dense Pack: R: 3.7 / D: 15.75
- HouseWrap (Air Barrier): R: 0.1 / D: 0.1"
- OSB Sheathing: R: 0.08 / D: 0.71
- Cellulose Dense Pack: R: 3.7 / D: 3.94"
- Gypsum board: R: 0.45 / D: 0.49"

**Layer Edit**

Name: Plywood/OSB Layer

Description:  Continuous  Stud/Cavity

---

Material: Cellulose Dens

Depth in: 15.75

Insulation Grade: I

Per Inch:  Total:

R / inch: 3.7

\$ / board-foot: 0.35

Stud/Cavity

Stud Type: Wood

Depth in: 15.75

Width in: 6.75

Spacing in: 24

Framing Fraction: 0.10921667

Override Framing Fraction:

\$ / s.f.: 0

## FLOOR CALCULATION

**Assembly Properties**

High Mass

**R 24.751      \$3.85/ft<sup>2</sup>**

Interior  
+

+

Exterior

- OSB Sheathing: R: 0.79 / D: 0.79"
- Concrete Slab: R: 0.15 / D: 7.87"
- Cellulose Dense Pack: R: 3.7 / D: 5.9"
- HouseWrap (Heavy Duty Plastic sheet): R: 0.1 / D: 0.1"

**Layer Edit**

Name: Plywood/OSB Layer

Description:  Continuous  Stud/Cavity

---

Material: Plywood/OSB

Depth in: 0.79

Per Inch:  Total:

R: 0.79

Cost [\$/sf]: 0.5

## ROOF CALCULATION

**Assembly Properties**

**R 58.278      \$6.95/ft<sup>2</sup>**

Exterior  
+

+

Interior

- HouseWrap (Water Barrier): R: 0.1 / D: 0.1"
- Cellulose Dense Pack: R: 3.7 / D: 12.99
- HouseWrap (Air Barrier): R: 0.1 / D: 0.1"
- Cellulose Dense Pack: R: 3.7 / D: 3.94"
- Gypsum board: R: 0.45 / D: 0.49"

**Layer Edit**

Name: Plywood/OSB Layer

Description:  Continuous  Stud/Cavity

---

Material: Cellulose Dens

Depth in: 12.99

Insulation Grade: I

Per Inch:  Total:

R / inch: 3.7

\$ / board-foot: 0.35

Stud/Cavity

Stud Type: Wood

Depth in: 12.99

Width in: 6.75

Spacing in: 24

Framing Fraction: 0.09041667

Override Framing Fraction:

\$ / s.f.: 0



# WALL CALCULATION

**Assembly Properties**

**R 61.97      \$8.41/ft<sup>2</sup>**

**Exterior**  
+

HouseWrap (Water Barrier): R: 0.1 / D: 0.1"

Cellulose Dense Pack: R: 3.7 / D: 15.75

HouseWrap (Air Barrier): R: 0.1 / D: 0.1"

OSB Sheathing: R: 0.68 / D: 0.71

Cellulose Dense Pack: R: 3.7 / D: 3.94"

Gypsum board: R: 0.45 / D: 0.49"

**Interior**  
+

**Layer Edit**

Name: Plywood/OSB Layer

Description:

Continuous       Stud/Cavity

---

**Material** Cellulose Dens

Depth in. 15.75

Insulation Grade 1

Per Inch  Total

R / inch 3.7

\$ / board-foot 0.35

---

**Stud/Cavity**

Stud Type Wood

Depth in. 15.75

Width in. 0.79

Spacing in. 24

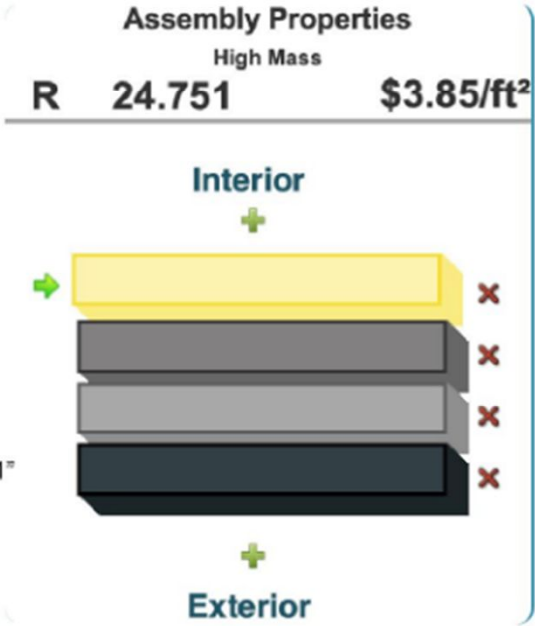
Framing Fraction 0.16921667

Override Framing Fraction

\$ / s.f. 0

# FLOOR CALCULATION

- OSB Sheating: R: 0.79" / D: 0.79"
- Concrete Slab: R: 0.15 / D: 7.87"
- Cellulose Dense Pack: R: 3.7 / D: 5.9"
- HouseWrap (Heavy Duty Plastic sheet): R: 0.1 / D: 0.1"



## Layer Edit

Name:

Description:

Continuous       Stud/Cavity

Material:

Depth in.:

Per Inch       Total

R:

Cost [\$/sf]:



# ROOF CALCULATION

### Assembly Properties

**R 58.278      \$6.95/ft<sup>2</sup>**

**Exterior**

+

**Interior**

+

HouseWrap (Water Barrier): R: 0.1 / D: 0.1"		
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HouseWrap (Air Barrier): R: 0.1 / D: 0.1"		
Cellulose Dense Pack: R: 3.7 / D: 3.94"		
Gypsum board: R: 0.45 / D: 0.49"		

### Layer Edit

Name:

Description:

Continuous     
  Stud/Cavity

---

Material:

Depth in.:

Insulation Grade:

Per Inch     
  Total

R / inch:

\$ / board-foot:

+

Stud/Cavity

Stud Type:

Depth in.:

Width in.:

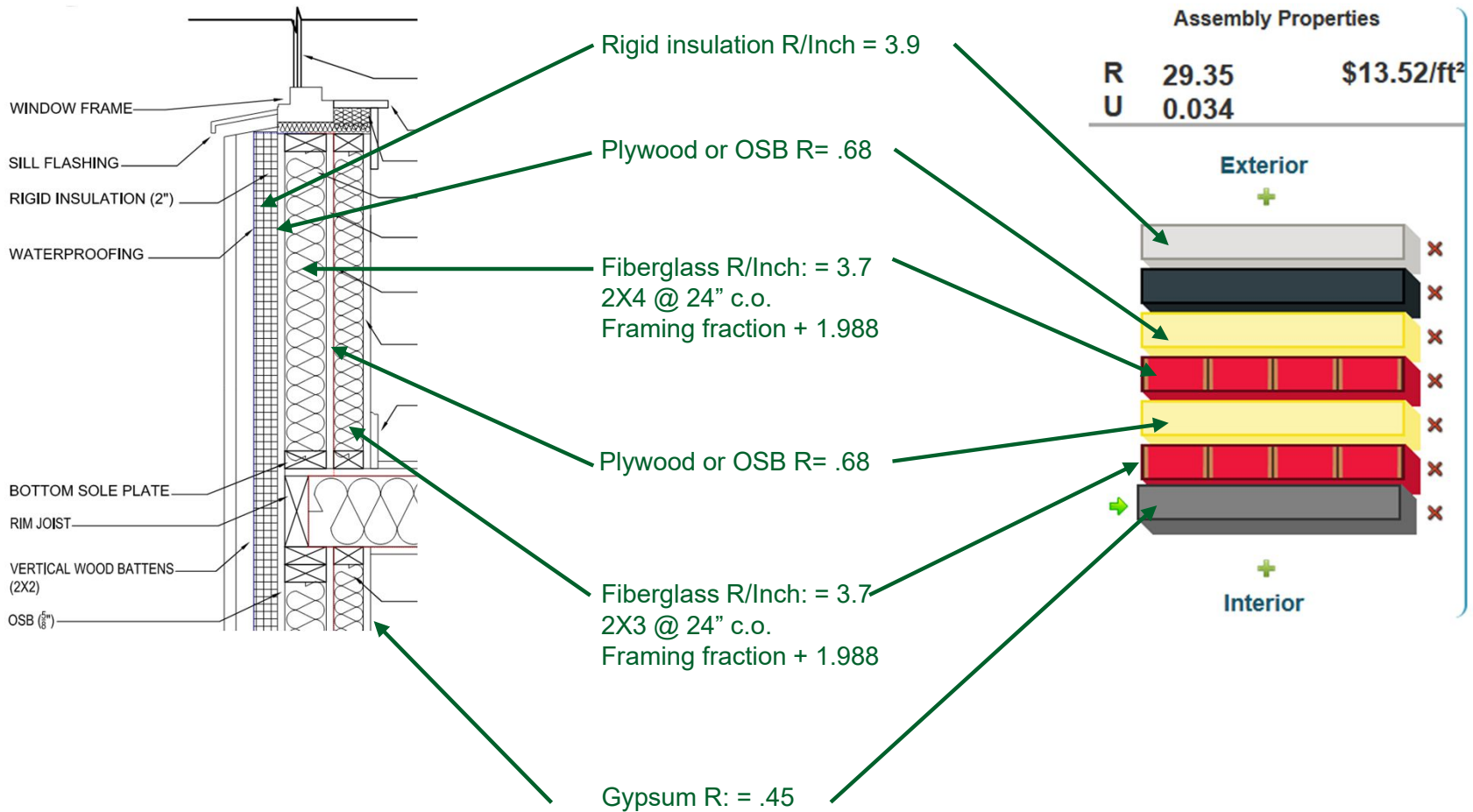
Spacing in.:

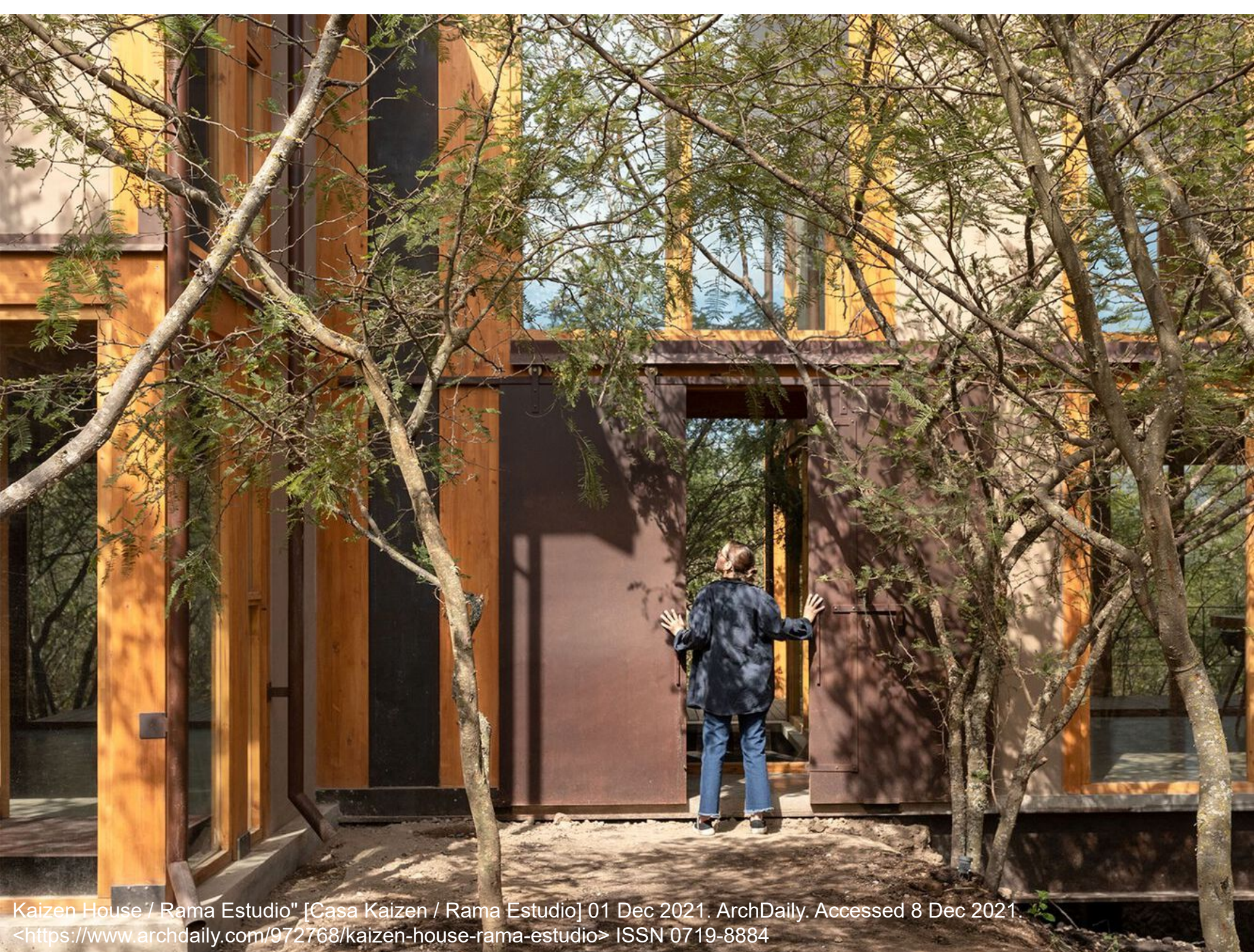
Framing Fraction:

Override Framing Fraction

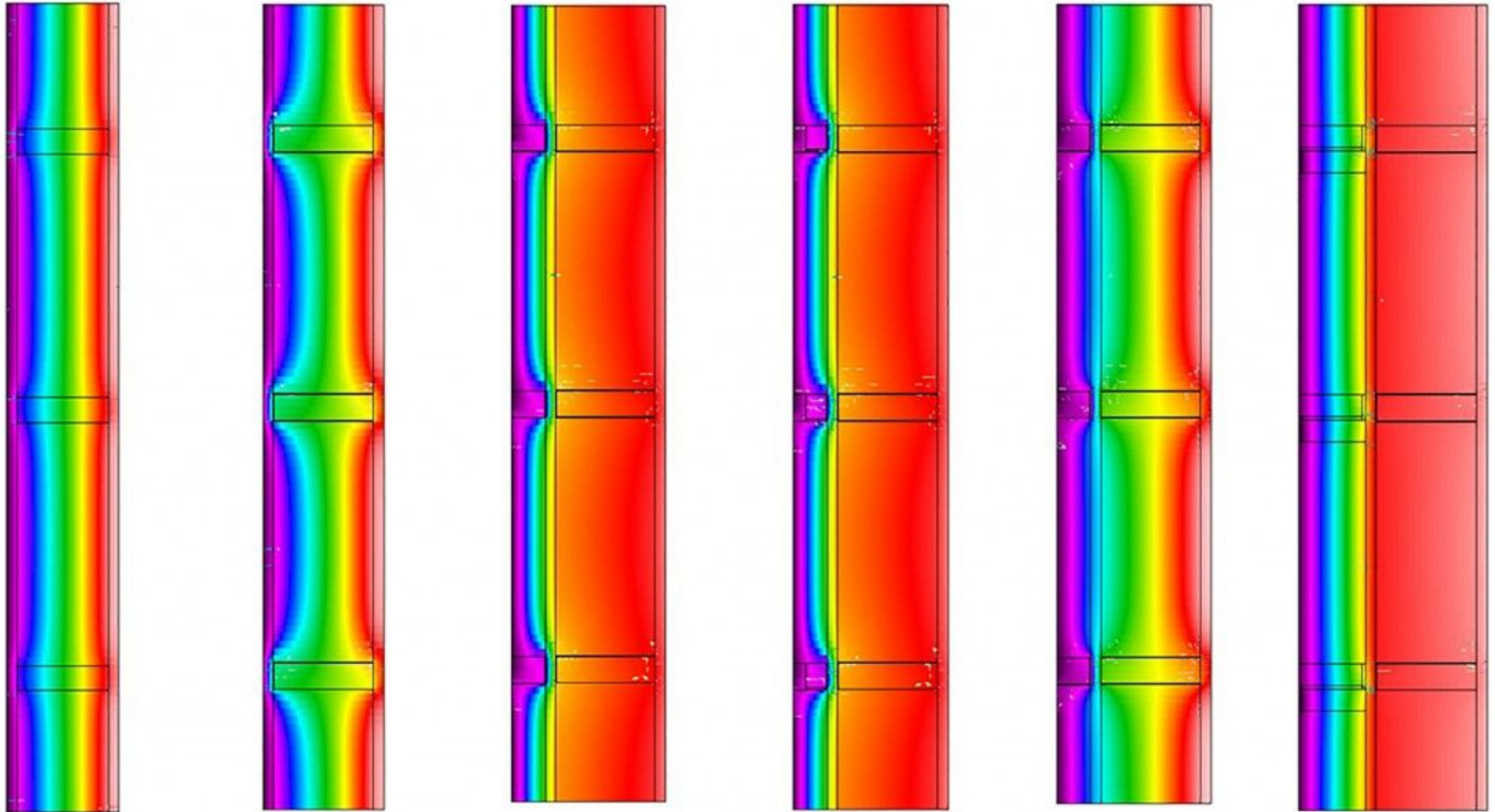
\$ / s.f.:

# Delivery format





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**1**  
Wood Frame  
R19.7

**2**  
Steel Frame  
R 14.7

**3**  
Exterior  
Insulation  
R 12.3

**4**  
Thermally  
Broken Steel  
R 12.6

**5**  
Hybrid Wall  
R 19.7

**6**  
Non-Conductive  
Spacer  
R-23.8



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