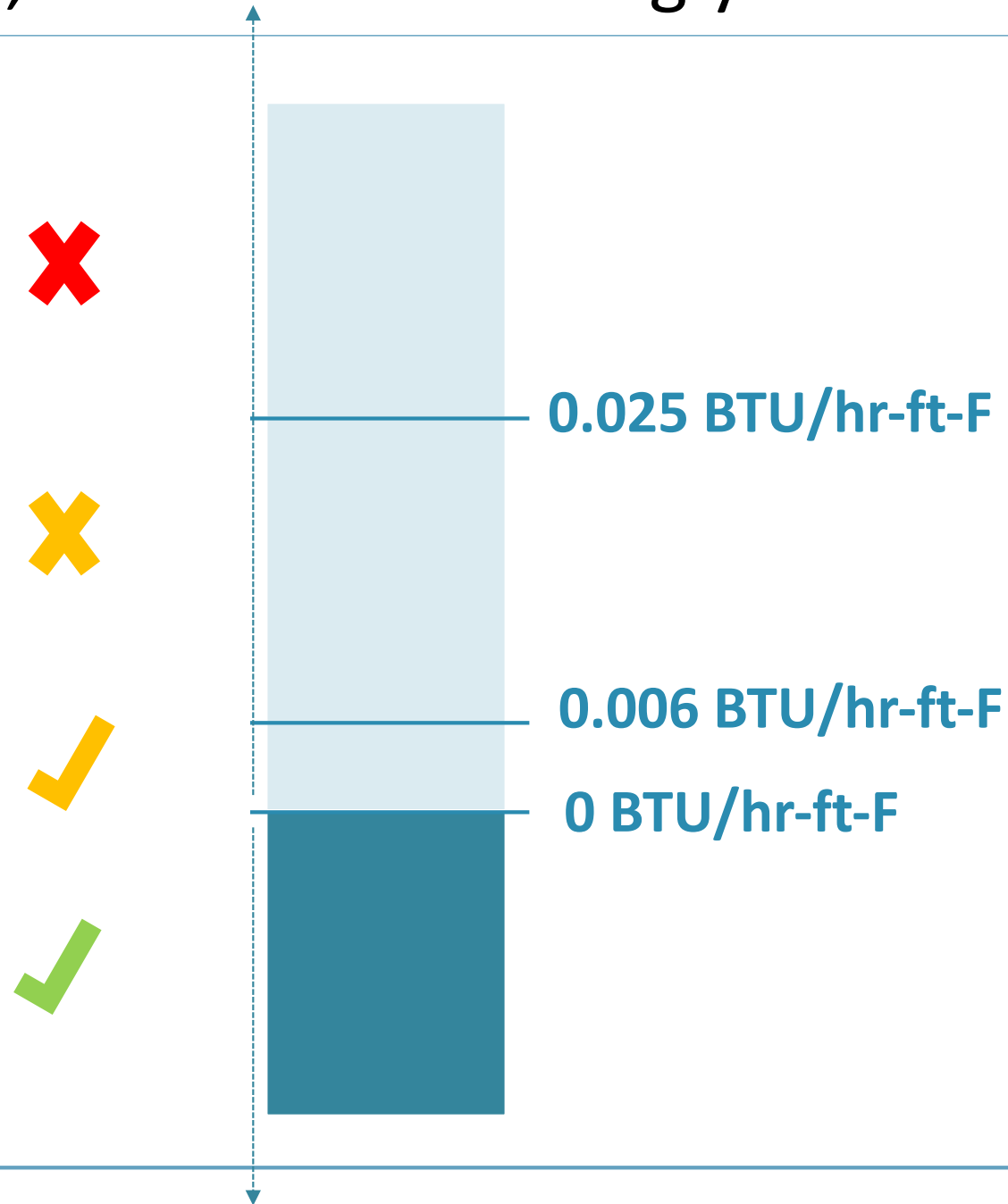


The Good, the Bad and the Ugly



Quantifying Thermal Bridging

How can you quantify the amount thermal bridging?

1. Inspection

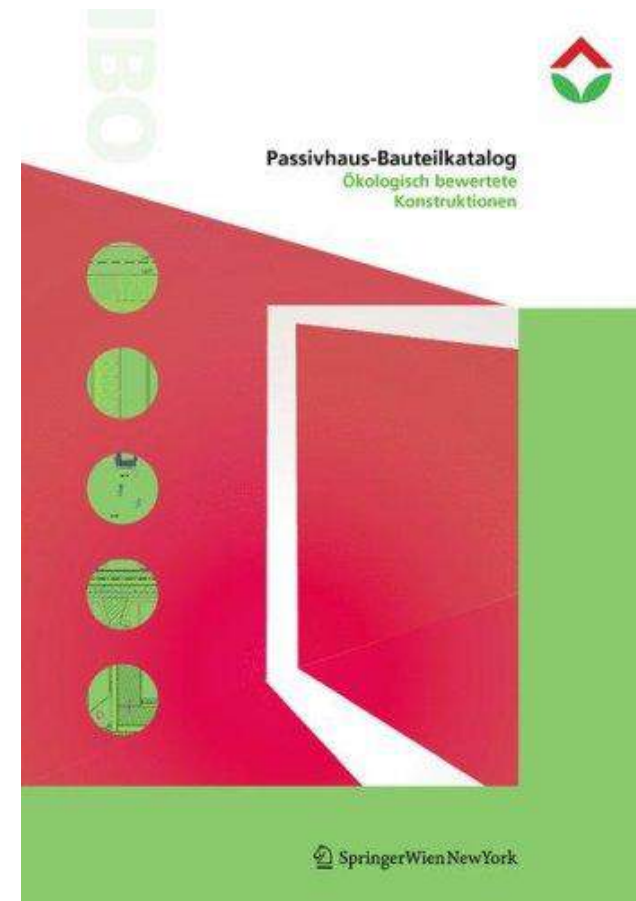
- Continuous insulation
- Amount of bridging material
- Conductivity of bridging material
- inverted junctions will always be +ve

2. Comparison to reference detail

Psi-value resources

Passive House Details, IBO

- Full description of detail
- Step by step instructions for construction
- Psi-values
- Suitability



Psi-value resources

- <http://www.ponts-thermiques.be/fr/galery/>
- <http://www.isover-construction.com/>
- Informationsdienst Holz
- Wärmebrückenkatalog, BFE
- Details für Anwender, GDI (masonry)
- Provided in Resources folder

PASSIVHAUS

DETAILS
FÜR
ANWENDER



Quantifying Thermal Bridging

How can you quantify the amount thermal bridging?

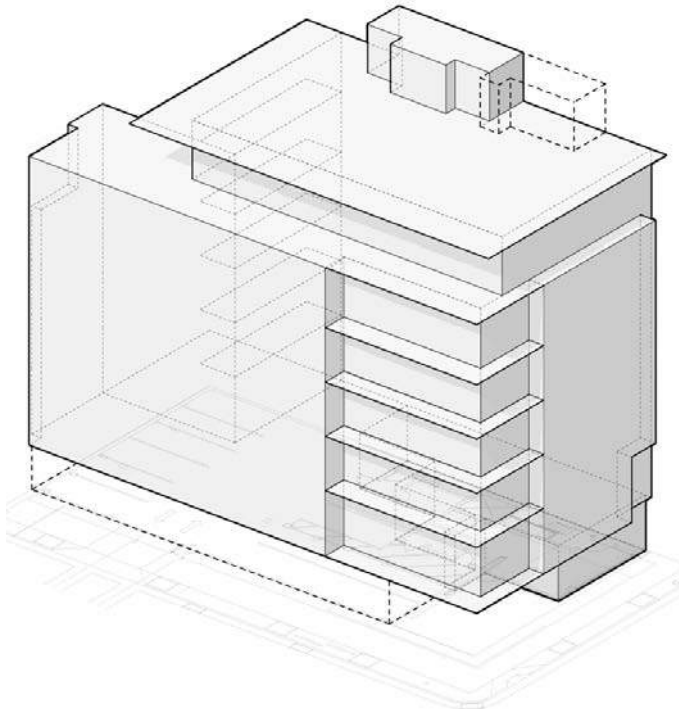
1. Inspection

- Continuous insulation
- Amount of bridging material
- Conductivity of bridging material
- inverted junctions will always be +ve

2. Comparison to reference detail

3. Calculation

Psi Values and heat loss



Total transmission losses through opaque surfaces: 54,055 kWh/a

Total thermal bridge Losses: 5,828 kWh/a (+10%)

# / Sheet	Detail	Detail	PSI Value		Length		Heat Loss: Actual
			Btu/hr-lf-F	W/m-K	(ft)	(m)	kWh/a
			0.012			1121	5828.9
Wall Corner Details							403.4
01/A531	WL-1	SW Outside Corner	0.012	0.021	69.3	21.1	31.1
02/A531	WL-2	Vertical Seam @ Typ. Res Wall-to-Stair-Core Wall	0.012	0.021	138.6	42.2	62.3
03/A531	WL-3	NW Outside Corner	0.012	0.021	69.3	21.1	31.1
05/A531	WL-4	North Wall Jog out @ NW Corner	0.012	0.021	57.6	17.6	25.9
01/A532	WL-5	North Wall Jog @ Balcony	0.012	0.021	57.6	17.6	25.9
04/A532	WL-6	NE Outside Corner	0.012	0.021	57.6	17.6	25.9
02/A532	WL-7	Inside Corner @ East Balconies	0.012	0.021	57.6	17.6	25.9
03/A532	WL-8	Outside Corner @ East Side	0.012	0.021	115.2	35.1	51.8
01/A535	WL-9	Outside Corner @ South Party Wall (SE Lower)	0.012	0.021	45.6	13.9	20.5
06/A535	WL-10	Outside Corner @ South Party Wall (SE Upper)	0.012	0.021	12.0	3.7	5.4
05/A535	WL-11	Outside Corner @ South Party Wall (Jog Upper)	0.012	0.021	12.0	3.7	5.4
02/A535	WL-12	Outside Corner @ South Party Wall (SW Lower)	0.012	0.021	45.6	13.9	20.5
04/A535	WL-13	Outside Corner @ South Party Wall (SW Upper)	0.012	0.021	12.0	3.7	5.4
04/A531	WL-14	Inside Corner @ South Terrace	0.012	0.021	57.6	17.6	25.9
02/A533	WL-15	Outside Corner @ Bulkhead, Stair Core	0.012	0.021	20.0	6.1	9.0
	WL-16	Bulkhead to Boiler Room Intersection	0.012	0.021	20.0	6.1	9.0
03/A533	WL-17	Inside Corner @ Shaftwall	0.012	0.021	20.0	6.1	9.0
05/A533	WL-18	Outside Corners @ Shaftwall	0.012	0.021	30.0	9.1	13.5
Floors							1,882.3
02/A539	FLR-1	Wall-to-Garage Ceiling @ South Terrace	0.258	0.447	59.9	18.3	578.8
01/A538	FLR-2	Wall-to-Garage Ceiling @ East Balcony	0.072	0.125	53.2	16.2	143.3
01/A536	FLR-3	Wall-to-Garage Ceiling @ Typ.	0.027	0.047	106.0	32.3	107.2
02/A536	FLR-4	Wall-to-Garage Floor @ South Party Wall	0.125	0.216	20.0	6.1	93.6
02/A537	FLR-5	Wall-to-Intermediate Floor @ West EIFS-over-Conc wall	0.012	0.021	268.5	81.8	120.7
	FLR-6	Wall-to-Intermediate Floor @ West EIFS-over-Stud wall	0.012	0.021	152.0	46.3	68.3
01/A537	FLR-7	Wall-to-Intermediate Floor @ Typ.	0.008	0.014	584.3	178.1	175.1
02/A536	FLR-8	Wall-to-Intermediate Floor @ South Party Wall	0.136	0.235	80.0	24.4	407.5
02/A521	FLR-9	Wall-to-Floor @ Penthouse Roof-Deck	0.014	0.024	113.6	34.6	59.6
05/A534	FLR-10	Wall-to-Floor @ Bulkhead, Stair Core	0.011	0.019	40.8	12.4	16.8
03/A534	FLR-11	Wall-to-Floor @ Bulkhead, Btwn Elevator Core and Boiler Rm.	0.216	0.374	9.5	2.9	76.5
01/A534	FLR-12	Wall-to-Floor @ Bulkhead, Boiler Rm.	0.028	0.048	33.3	10.1	34.9
Roof & Overhangs							1,104.4
06/A534	RF-1	Wall-to-Roof @ Bulkhead, Stair Core	0.012	0.021	66.9	20.4	30.1
04/A534	RF-2	Wall-to-Roof @ Bulkhead, Btwn Elevator Core and Boiler Rm.	0.052	0.090	9.5	2.9	18.4
	RF-3	EIFS-over-Stud Wall-to-Roof	0.012	0.021	25.3	7.7	11.4
01/A522	RF-4	Typical MW Wall-to-Roof	0.015	0.026	96.8	29.5	54.4
02/A521	RF-5	Wall-to-Roof @ Penthouse Overhang	0.139	0.241	154.2	47.0	802.6
02/A521	RF-6	Wall-to-Roof @ East Balcony Overhang	0.080	0.138	53.2	16.2	159.3
03/A535	RF-7	Wall-to-Roof at South Party Wall	0.057	0.099	13.2	4.0	28.2
Balconies							2,033.5
01/A538	BAL-1	East Balcony-to-Wall	0.135	0.234	212.6	64.8	1,074.9
01/A539	BAL-2	South Balcony-to-Wall	0.135	0.234	189.6	57.8	958.6

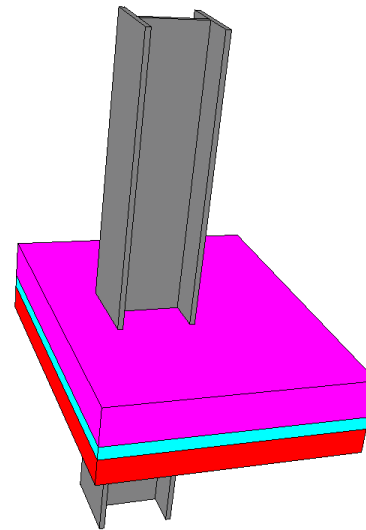
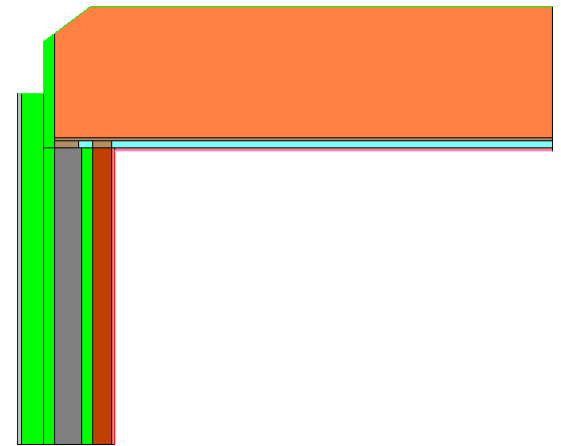
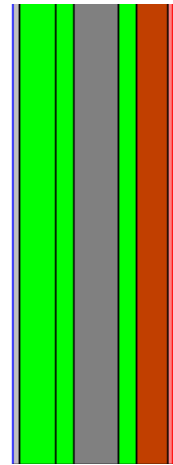
Software Tools

Types of Programs

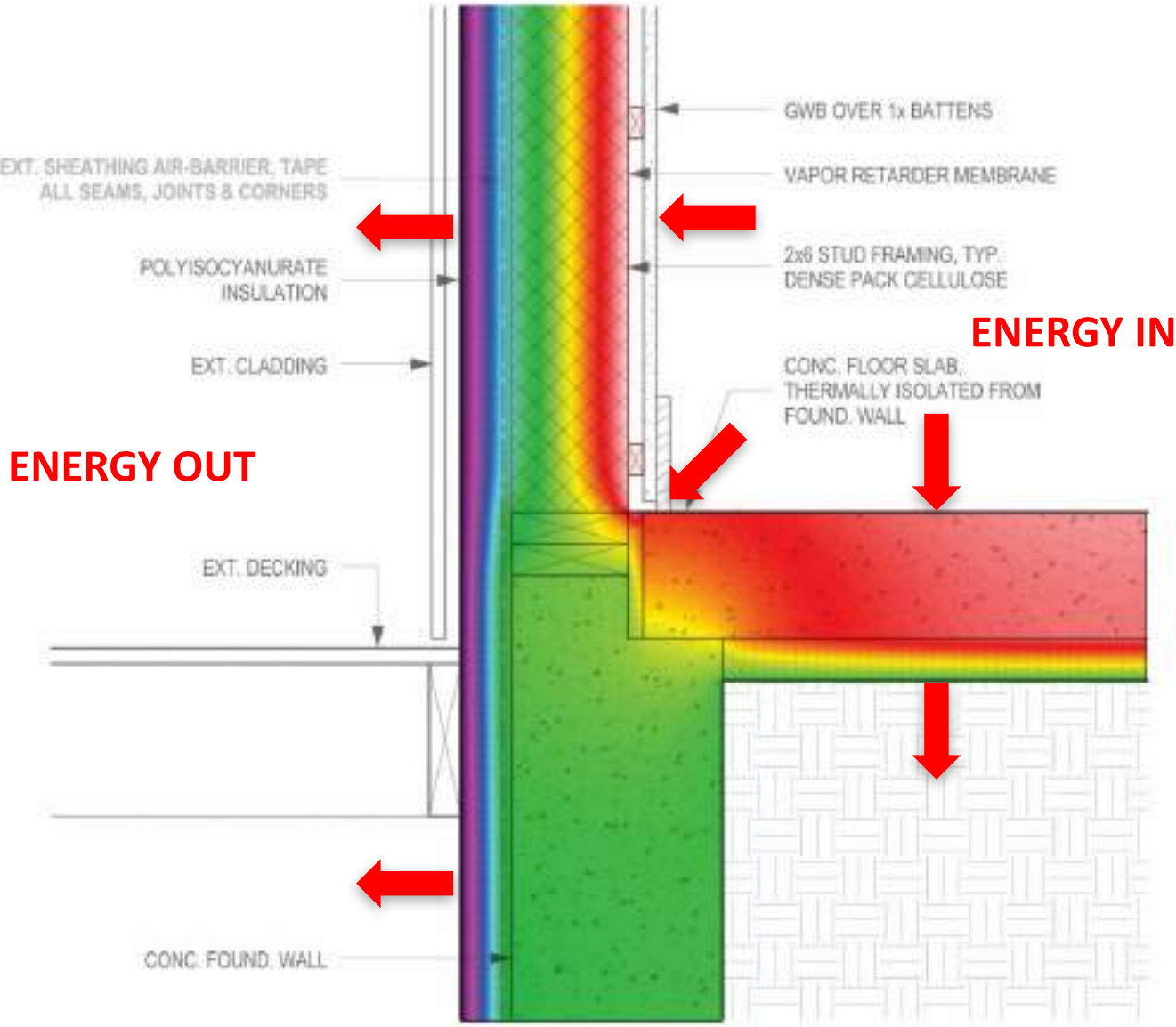
- 2D
- 3D

Types of calculations

- U-values
- Linear thermal bridge
- Point thermal bridges
- Windows and doors
- Surface Temperature



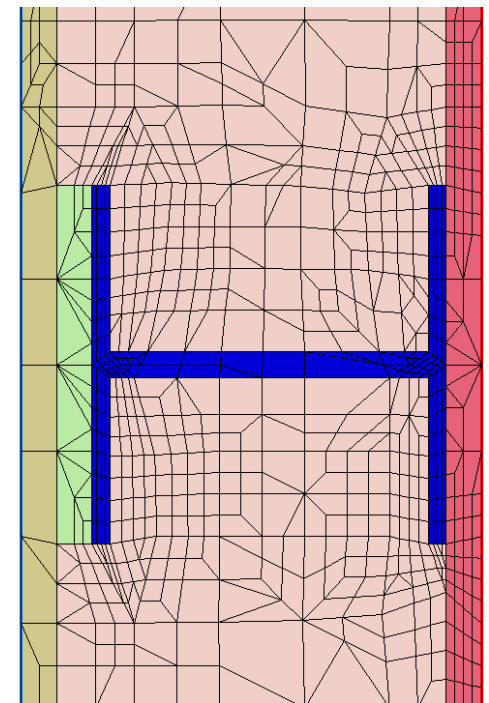
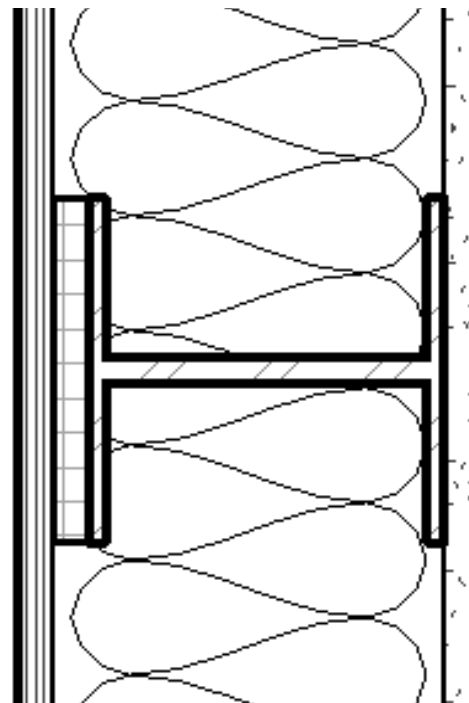
Simulating Thermal Bridges



Thermal Bridge Model

A **model** is made of the construction assembly and the **conductivities / resistances** are added for the relevant materials

The model is overlaid in a mesh and all elements are calculated. The thermal behavior of the construction elements can be calculated according to the 'grain' or scale of the mesh.



ISO Reference Standards

ISO 10211

- Thermal bridges in building construction.
- Heat flows and surface temperatures.
- Detailed calculations

ISO 13370

- Thermal performance of buildings.
- Heat transfer via the ground.
- Calculation methods

ISO 13788

- Hygrothermal performance of building components and building elements
- Internal surface temperature to avoid critical surface humidity and interstitial condensation
- Calculation methods

ISO 10456

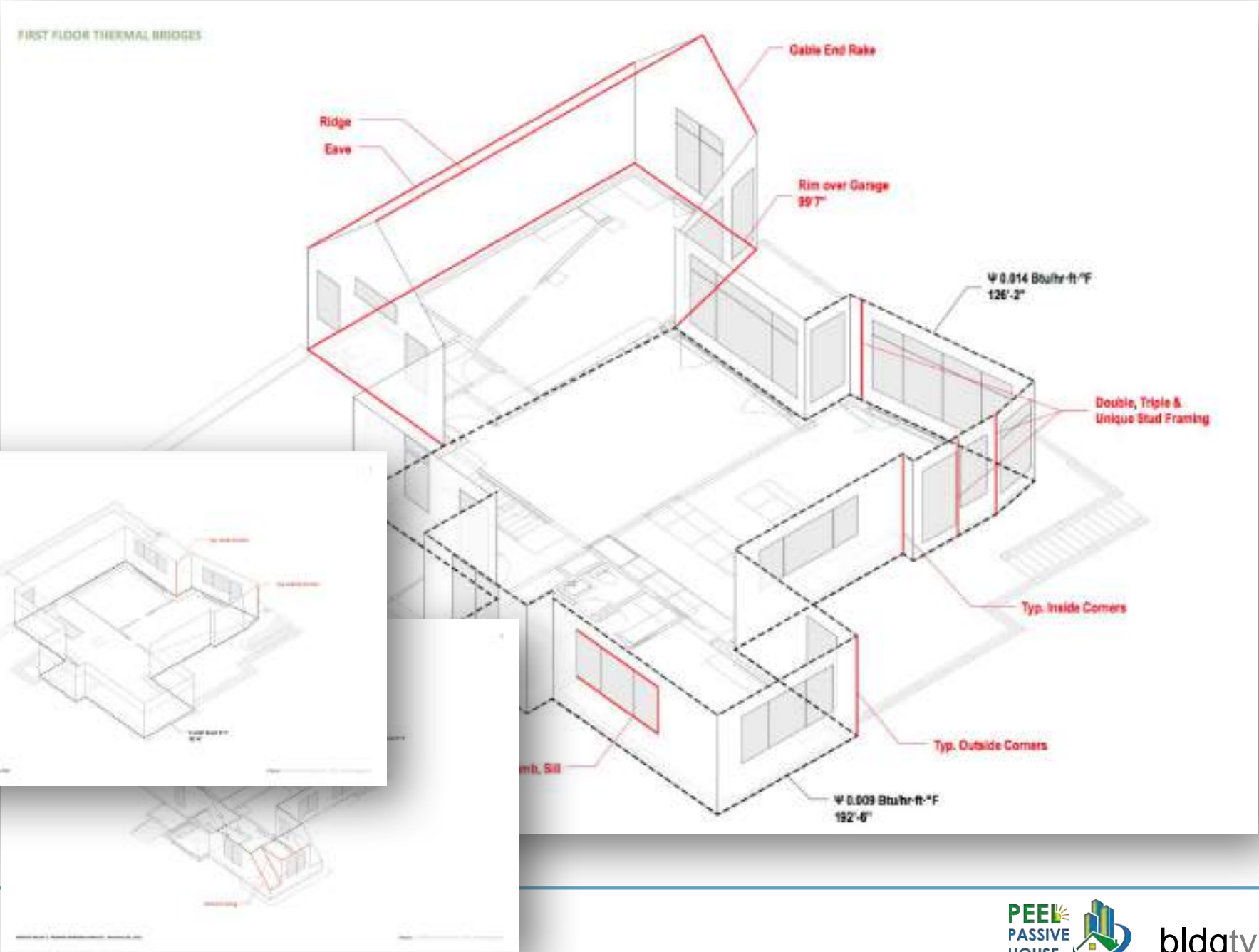
- Building Materials and Products
- Hygrothermal Properties
- Tabulated design values and procedures for determining declared and design thermal values

ISO 6046

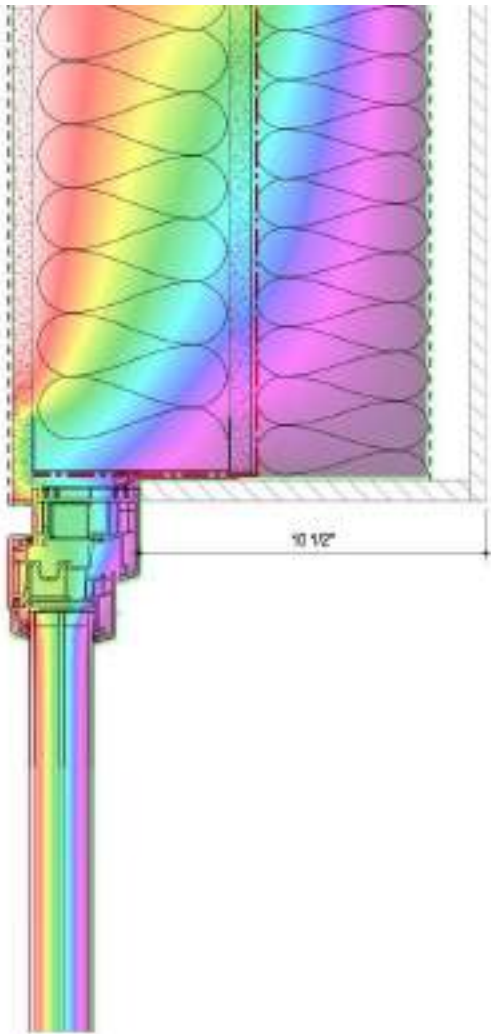
- Building components and building elements
- Thermal resistance and thermal transmittance
- Calculation method

Managing Thermal Bridges

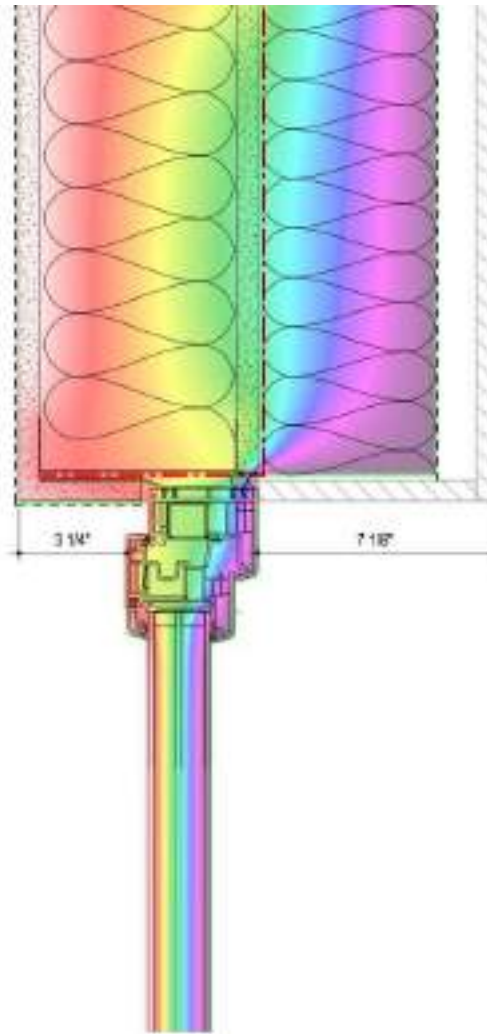
Complete thermal bridge 'catalog'



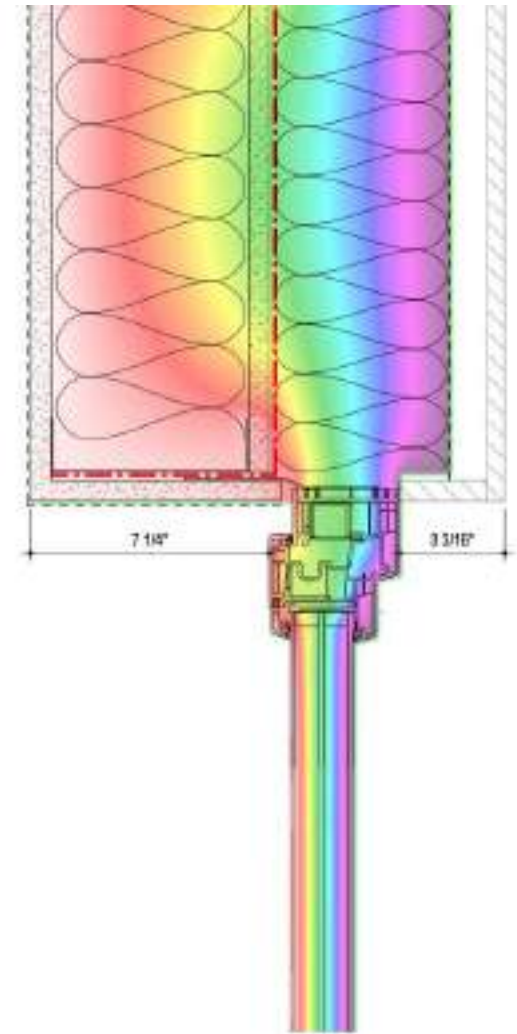
Test design alternatives



INTERIOR POSITION - PSE: +0.1175 Btu/hr-LF-F
(20 x the P_T recommended value)

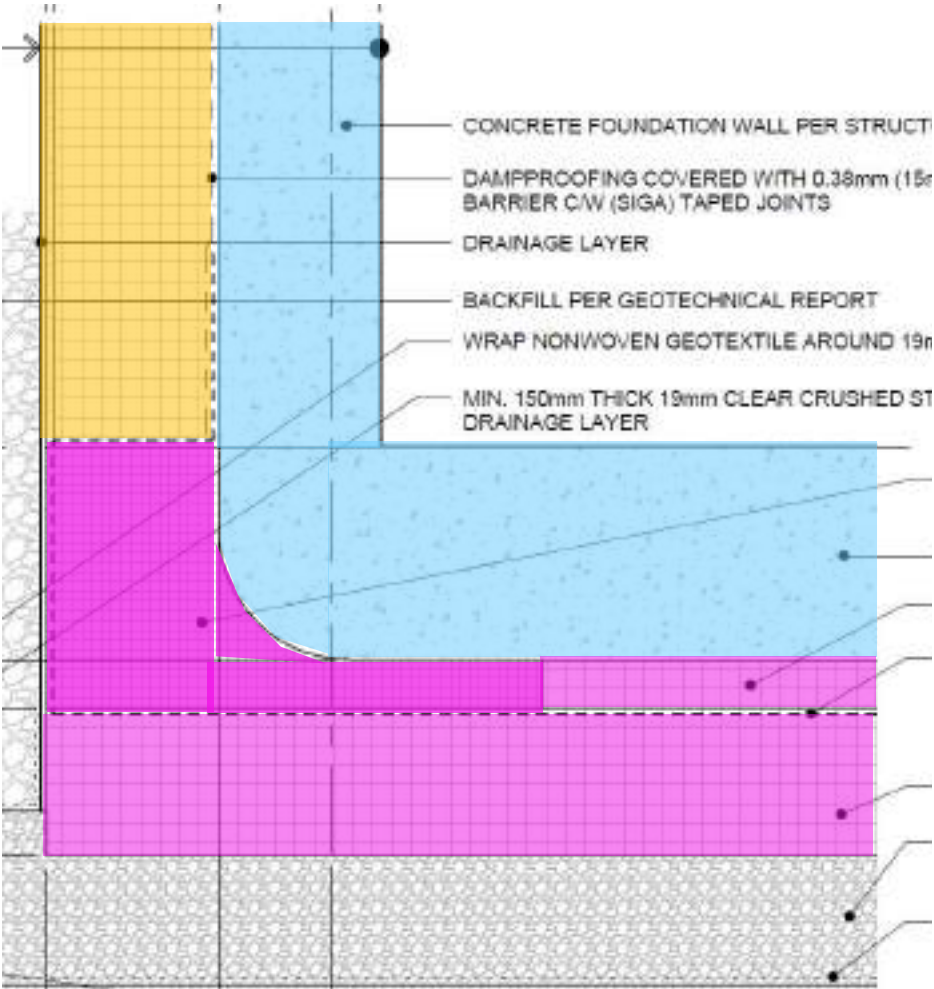


MIDDLE POSITION - PSE: +0.0509 Btu/hr-LF-F
(3 x the P_T recommended value)



EXTERIOR POSITION - PSE: +0.0217 Btu/hr-LF-F
(4 x the P_T recommended value)

Insulated Raft Slabs



Continuous Exterior Insulation

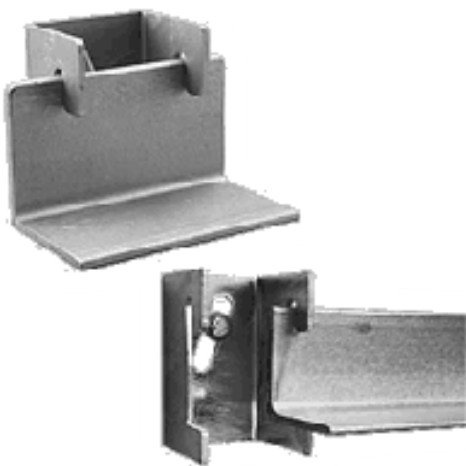
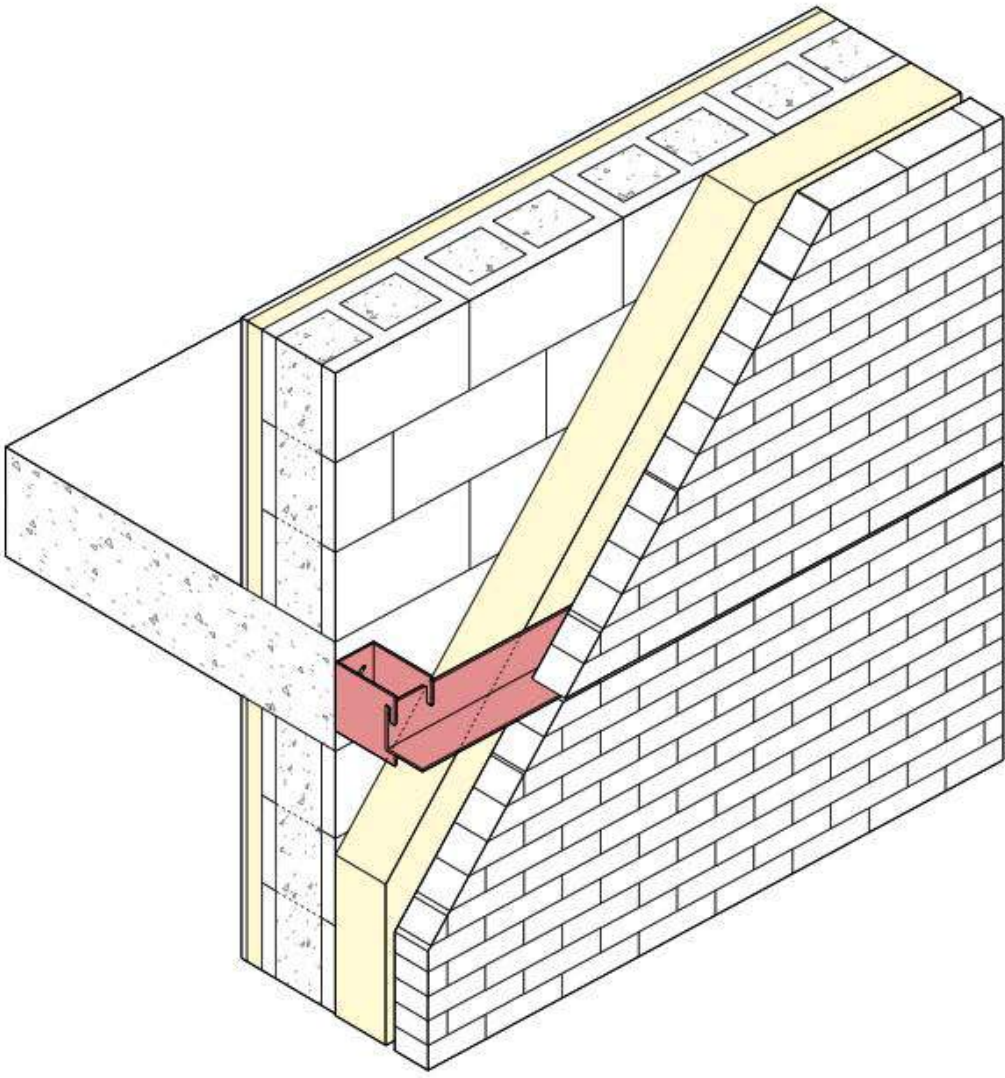


Oops..

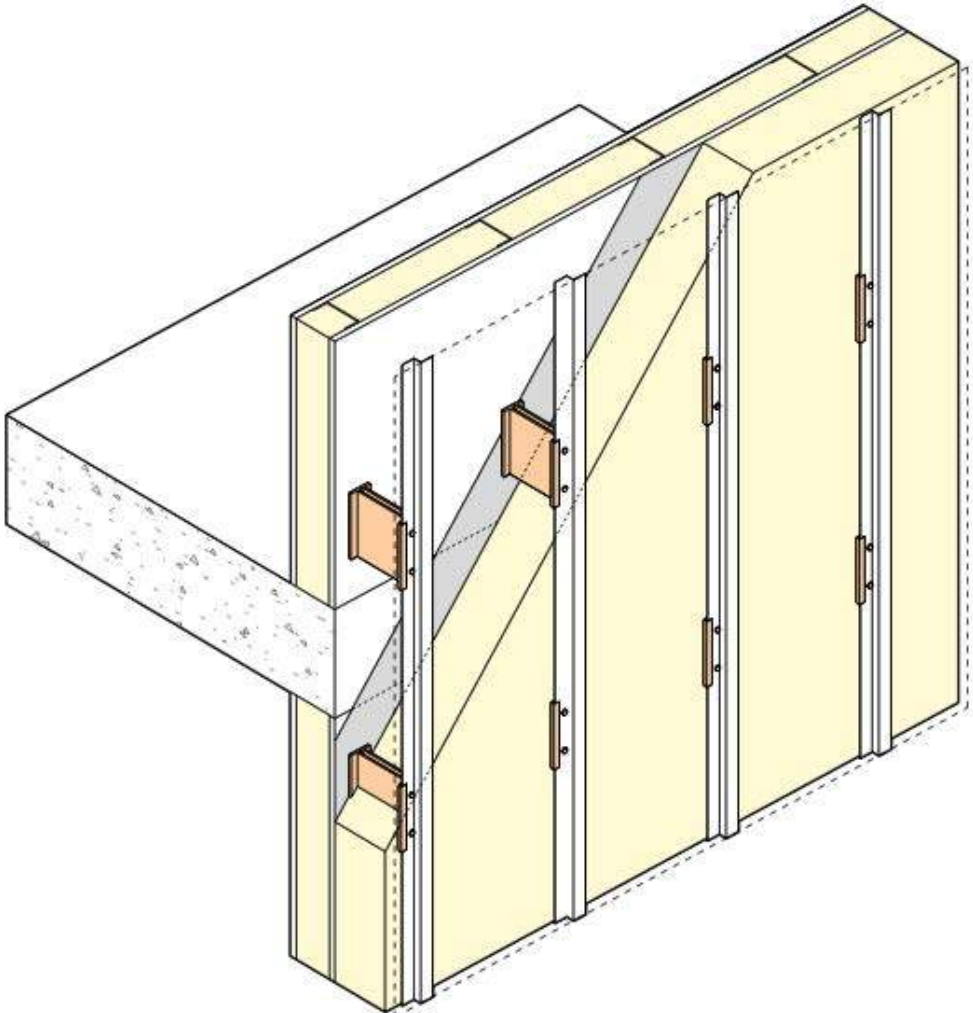


...not the end of the world

Masonry outriggers



Low-Conductivity Façade supports



Balcony thermal isolators



Image: Westerleigh Retirement Residences (Vancouver, Canada), Schock USA, Inc.

Structural Thermal Isolators

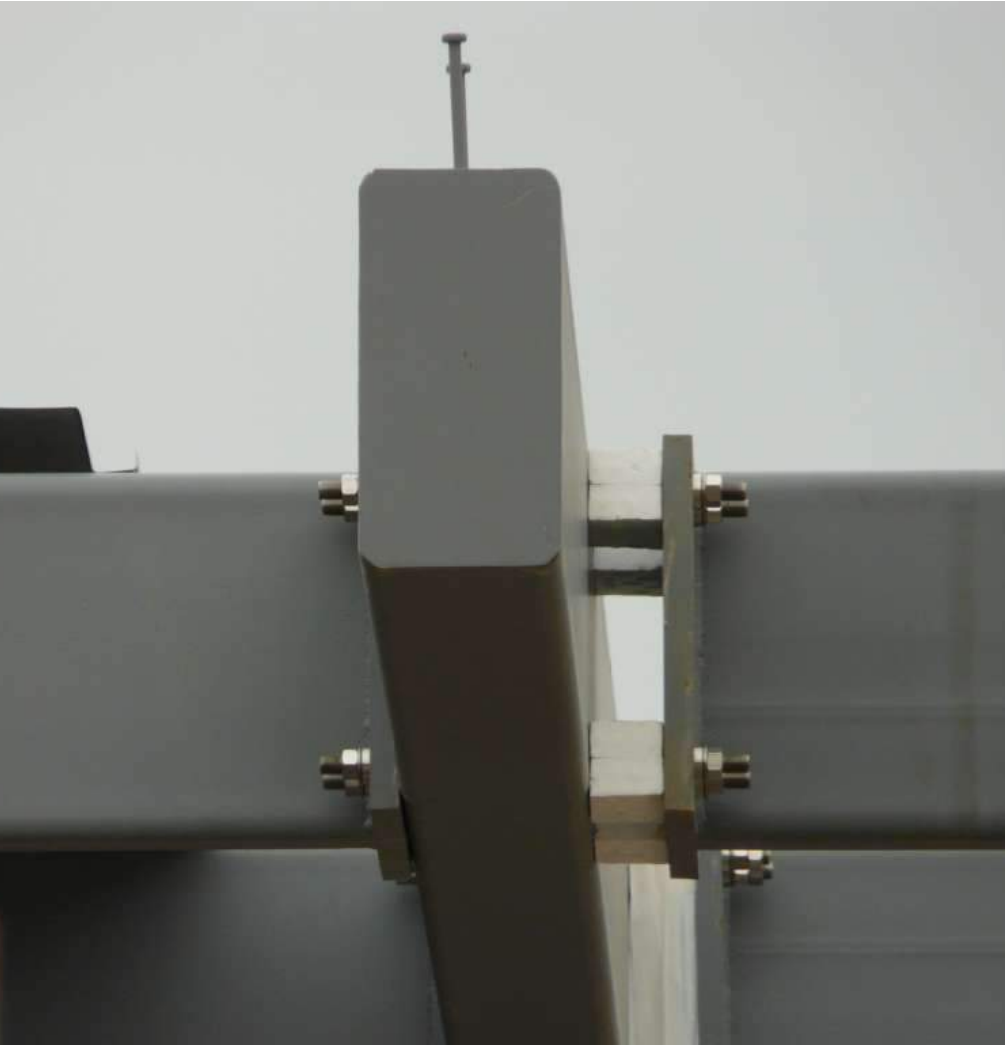


Image: Leutner Hall Cleveland, Case Western University, Schock USA, Inc.

Structural Thermal Isolators



Image: Life Science Laboratory, UMass Amherst, Schock USA, Inc.

Low-Conductivity Masonry



Demonstrating thermal bridge simulations