Designing Highly Insulated Envelopes for Multi-Family Buildings

BuildEnergy NYC, October 4, 2018

NESEA

NORTHEAST SUSTAINABLE ENERGY ASSOCIATION

Ed May | Partner, Building-Type, LLC

(architect, passive house consultant, teacher)

Outline (25 mins)

- Challenges in some large high-performance buildings
- High-R Wall Assemblies for Multi-Family buildings
- Partywalls

Candela Lofts (In Construction)

Rendering: Nastasi Architects

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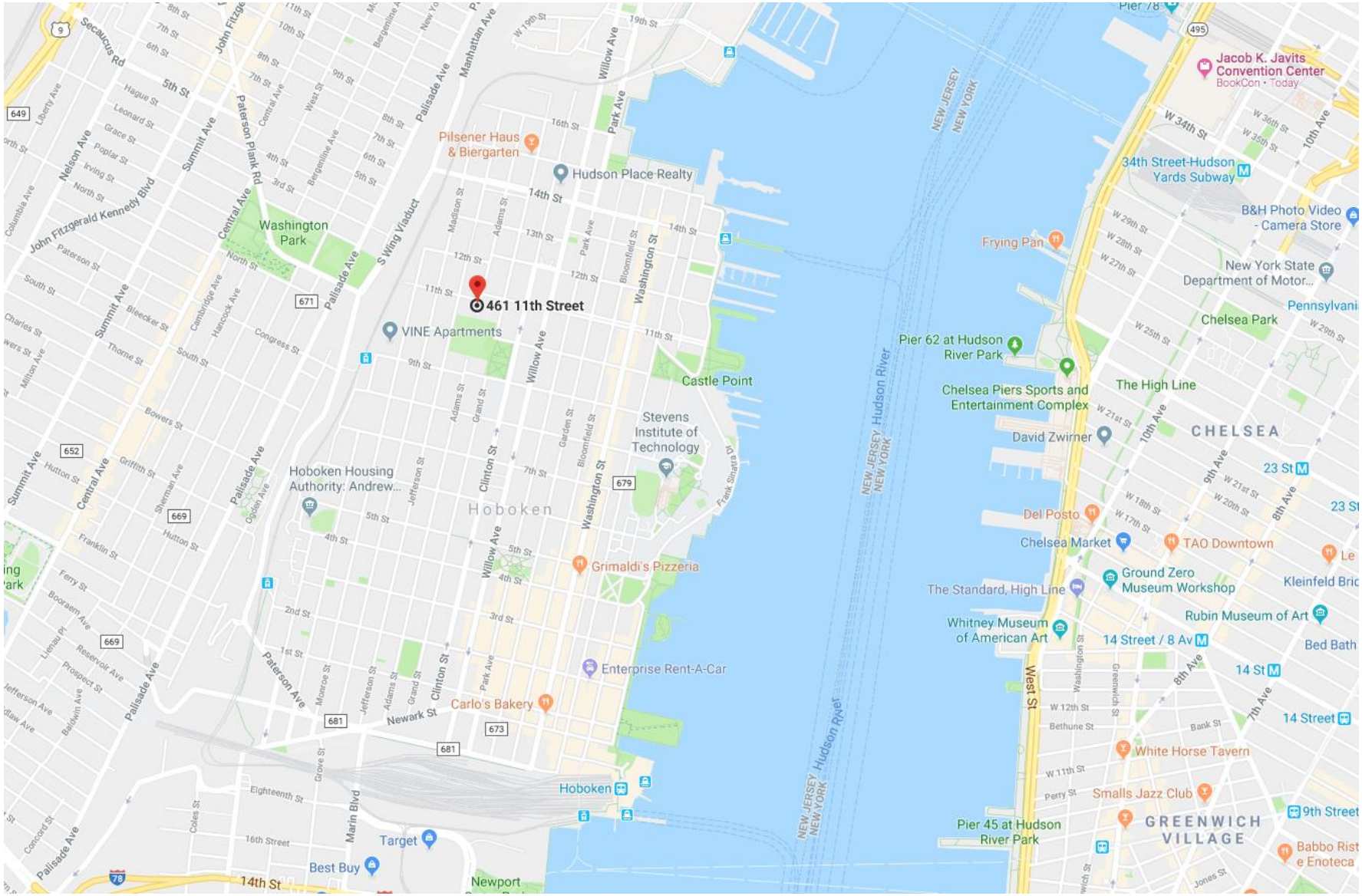
Challenge #1: Orientation + Site



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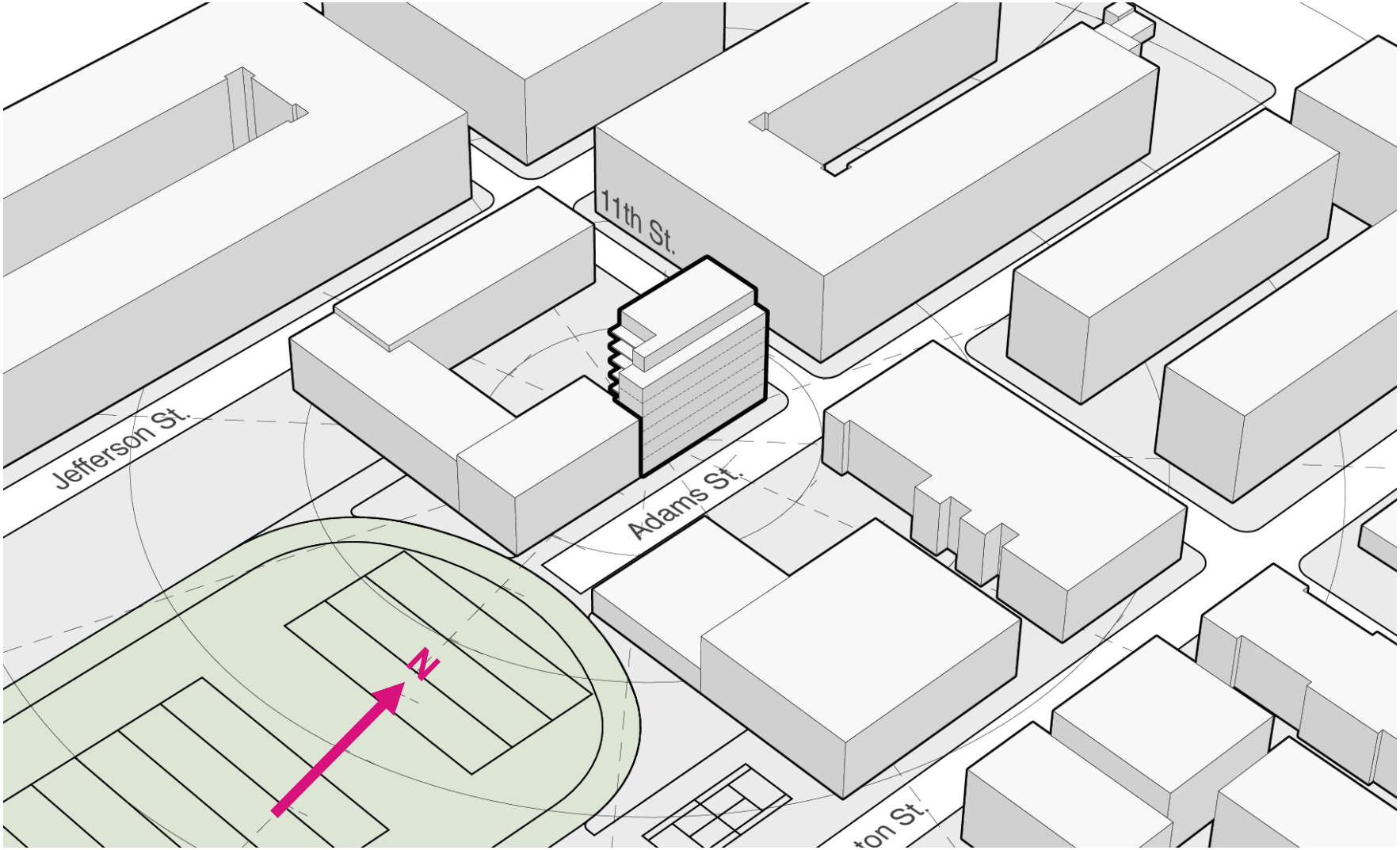
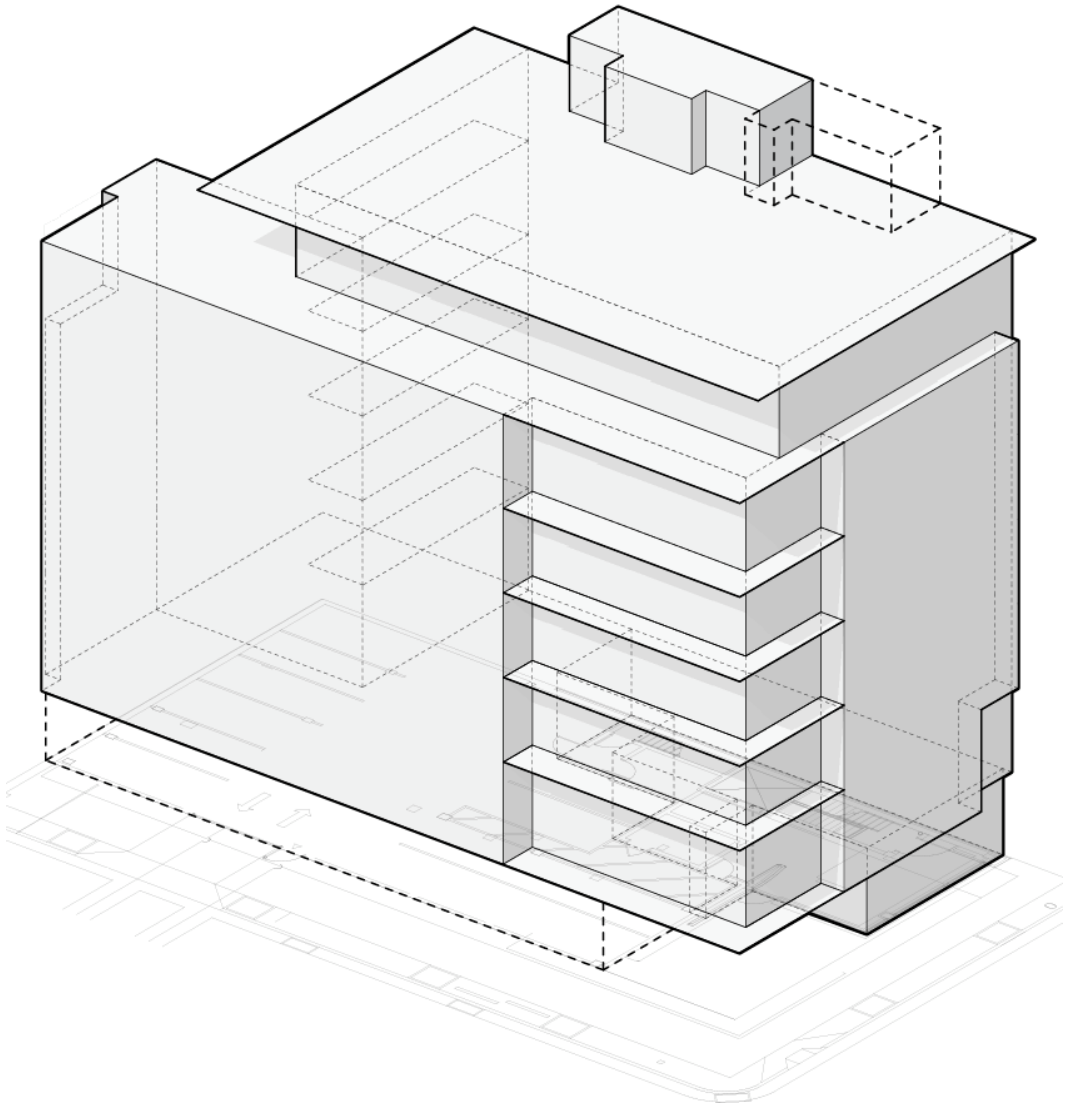
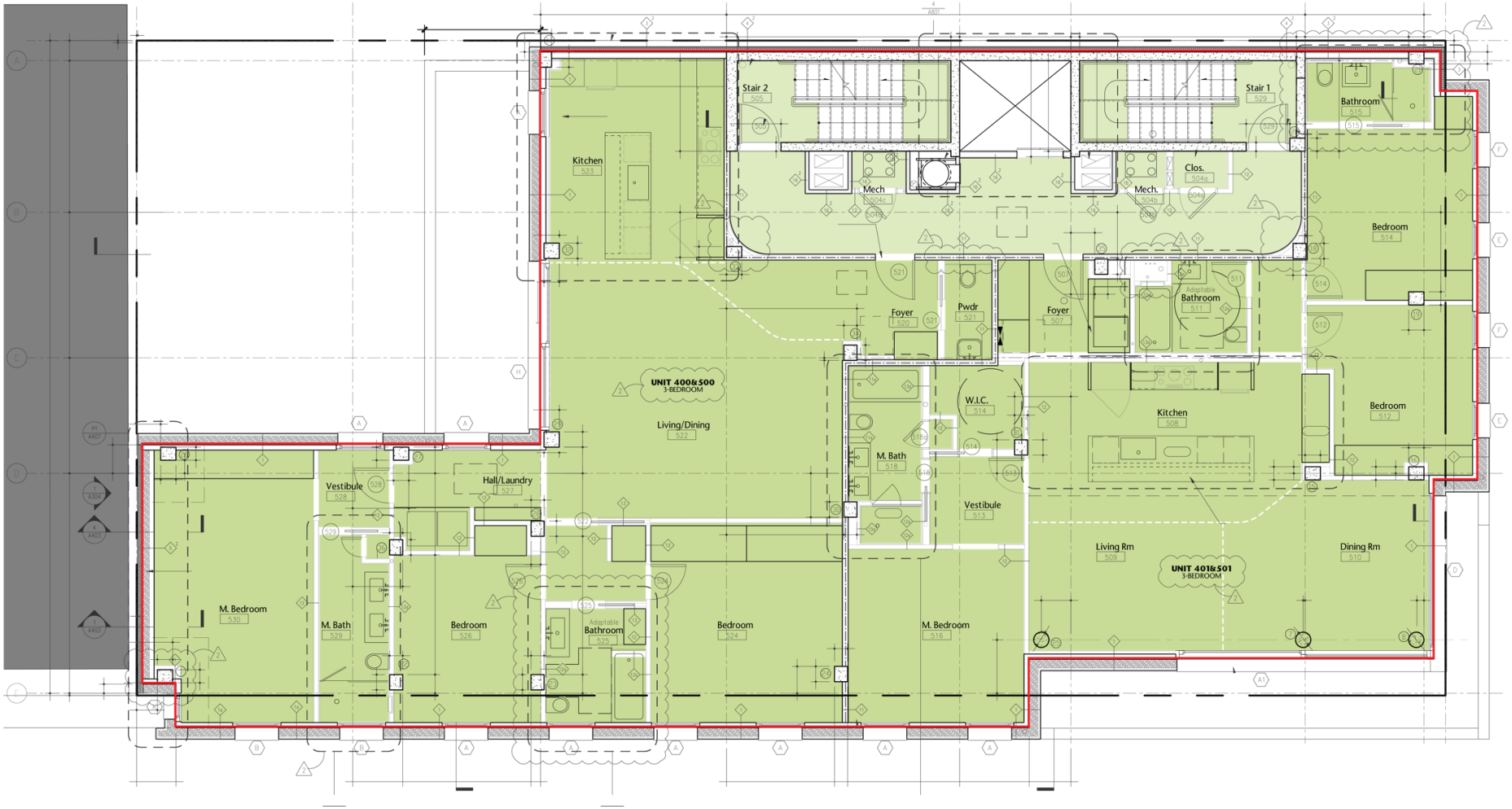
Challenge #1: Orientation + Site



Challenge #2: Massing



Challenge #2: Massing



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Challenge #3: Construction

# / 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**
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				
01/A522	RF-4	Typical MW Wall-to-Roof	0.015				
02/A521	RF-5	Wall-to-Roof @ Penthouse Overhang	0.139				
02/A521	RF-6	Wall-to-Roof @ East Balcony Overhang	0.080				
03/A535	RF-7	Wall-to-Roof at South Party Wall	0.057				
Balconies							
01/A538	BAL-1	East Balcony-to-Wall	0.135				
01/A539	BAL-2	South Balcony-to-Wall	0.135				

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

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

Source: BLDGtyp, LLC

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Specific building characteristics with reference to the treated floor area

				Criteria	Alternative criteria	Fullfilled?[2]
	Treated floor area m²	1734.8				
Space heating	Heating demand kWh/(m²a)	14.67	≤	15.0	-	yes
	Heating load W/m²	14.73	≤	-	10.0	
Space cooling	Cooling & dehum. demand kWh/(m²a)	16.16	≤	17.0	17.0	yes
	Cooling load W/m²	15.14	≤	-	10	
	Frequency of overheating (> 25 °C) %	-	≤	-		-
	Frequency of excessively high humidity (> 12 g/kg) %	3	≤	10		yes
Airtightness	Pressurization test result n_{50} 1/h	0.6	≤	0.6		yes
Non-renewable Primary Energy (PE)	PE demand kWh/(m²a)	102	≤	120		yes
Primary Energy Renewable (PER)	PER demand kWh/(m²a)	75	≤	-	-	-
	Generation of renewable energy (in relation to pro-jected building footprint area) kWh/(m²a)	10	≥	-	-	

[2] Empty field: Data missing; '-': No requirement

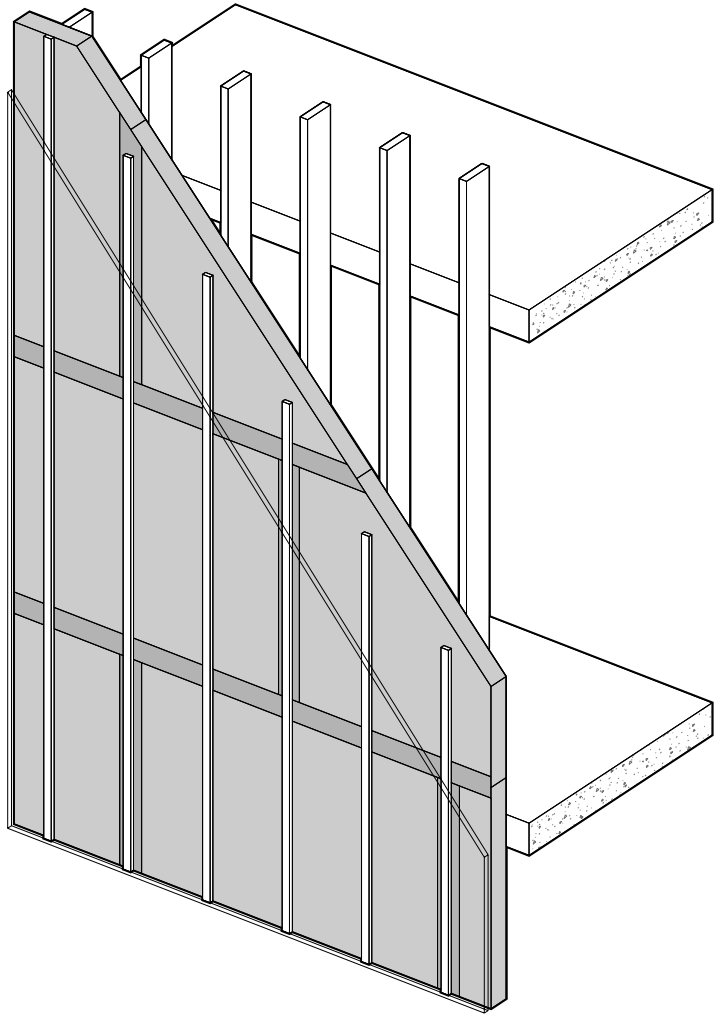
With:

Typ Walls: R-40.3 hr-ft^2-F/Btu (0.141 W/m^2-k)

Typ Roof: R-52.3 hr-ft^2-F/Btu (0.108 W/m^2-k)

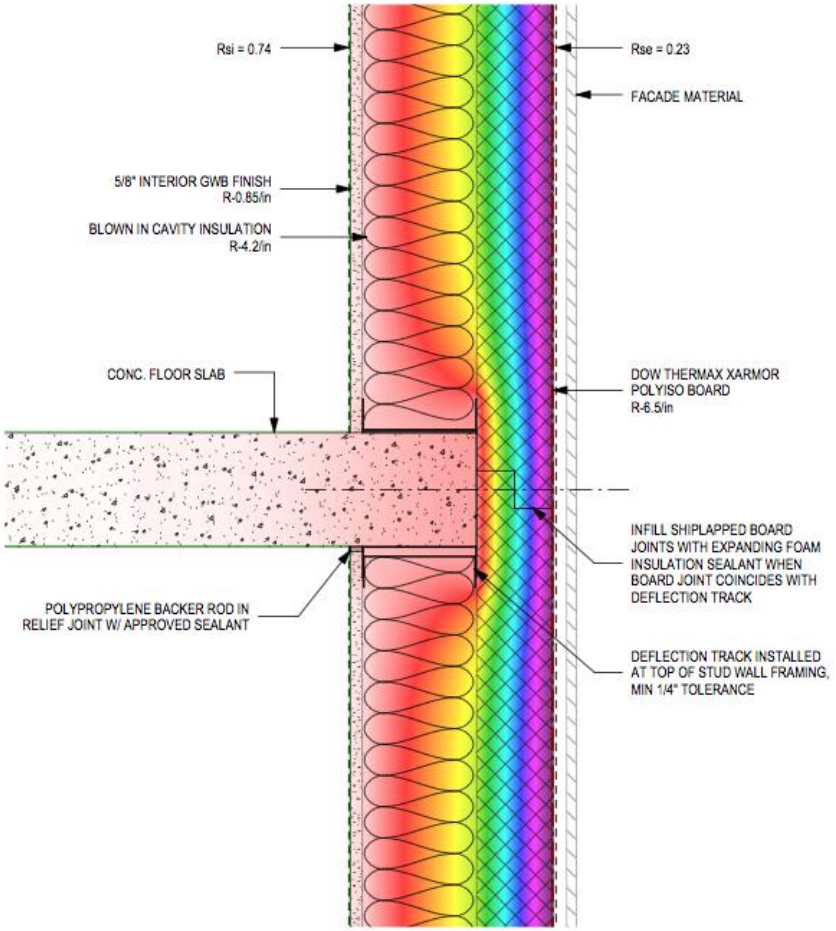
Typ Floor (Over Garage): R-39.4 hr-ft^2-F/Btu (0.144 W/m^2-k)

Insulated Sheathing + Rainscreen Cladding



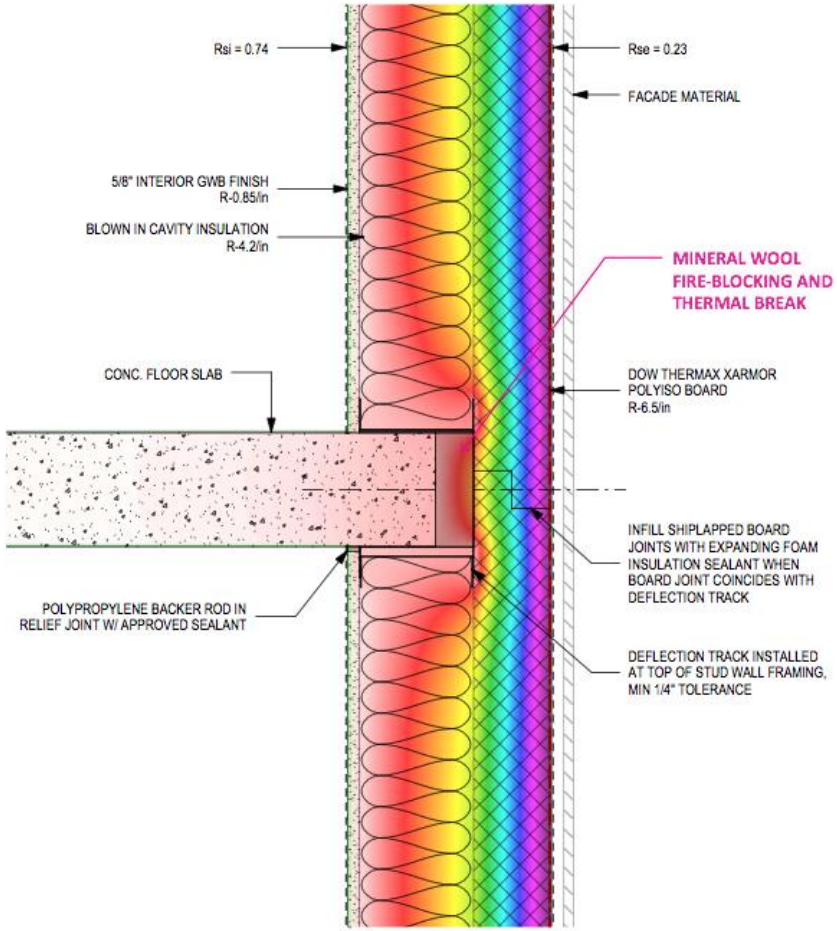
Images by: BLDGtyp

Envelope Evaluation



VERSION 1 PSI: +0.1638 Btu/hr-LF-°F

27 x the PH recommended value



VERSION 2 PSI: +0.1326 Btu/hr-LF-°F

22 x the PH recommended value

19% Less Heat Loss / Foot

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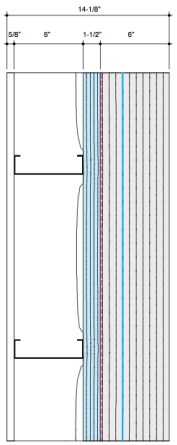
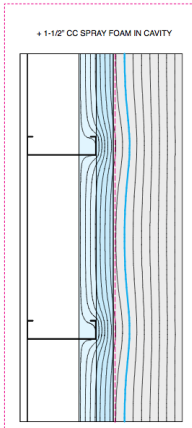
Envelope Evaluation

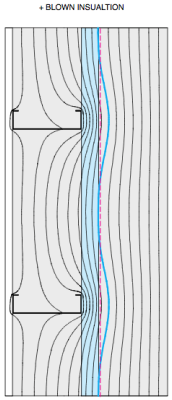


R-33.84

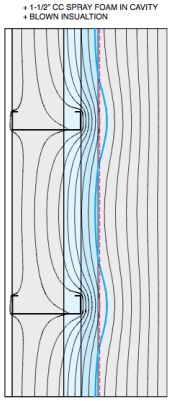


R-40.35

PREFERRED ASSEMBLY
Low material usage (highest R/in to meet R-40)
Good drying / vapor profile
Fastener engineering required



R-46.62



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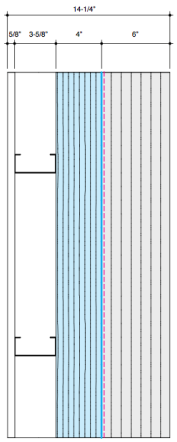
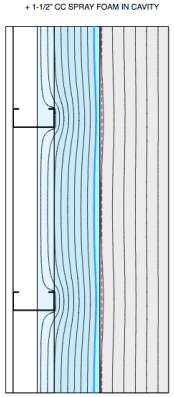
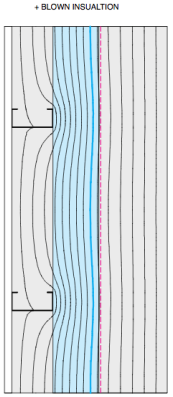


R-50.02



R-56.60



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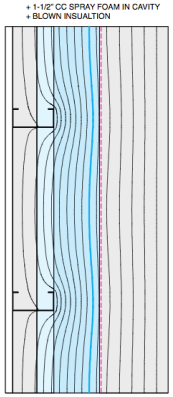

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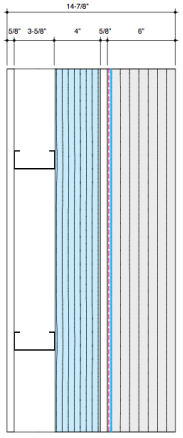

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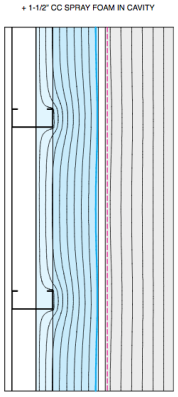
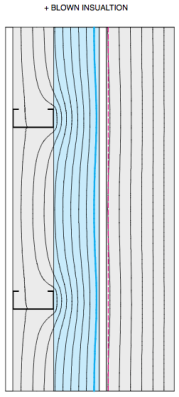


R-53.62



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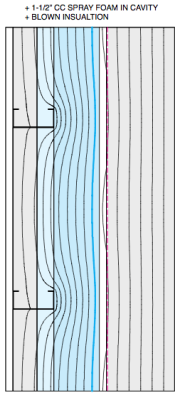

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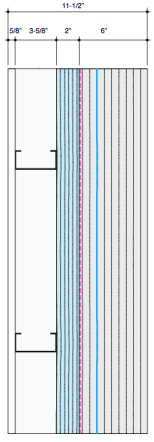

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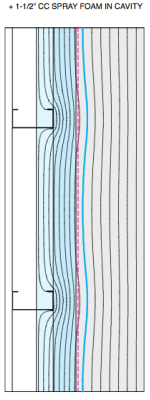

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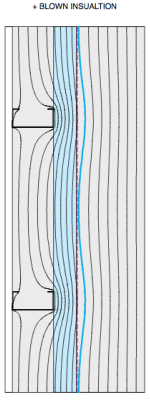

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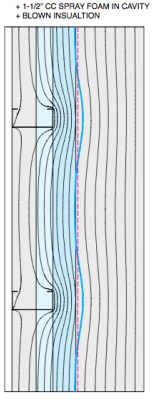

R-48.07

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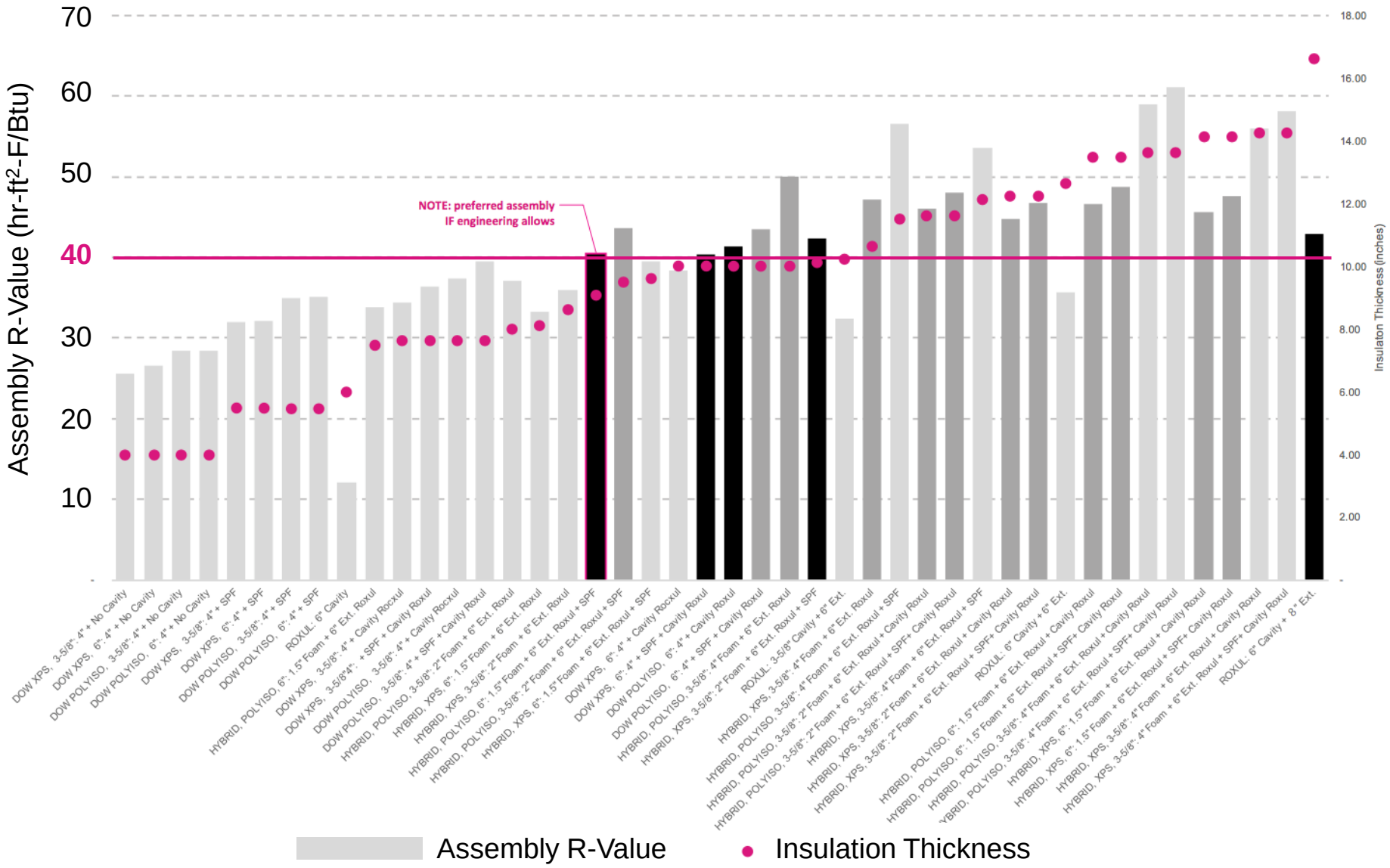
Envelope Evaluation



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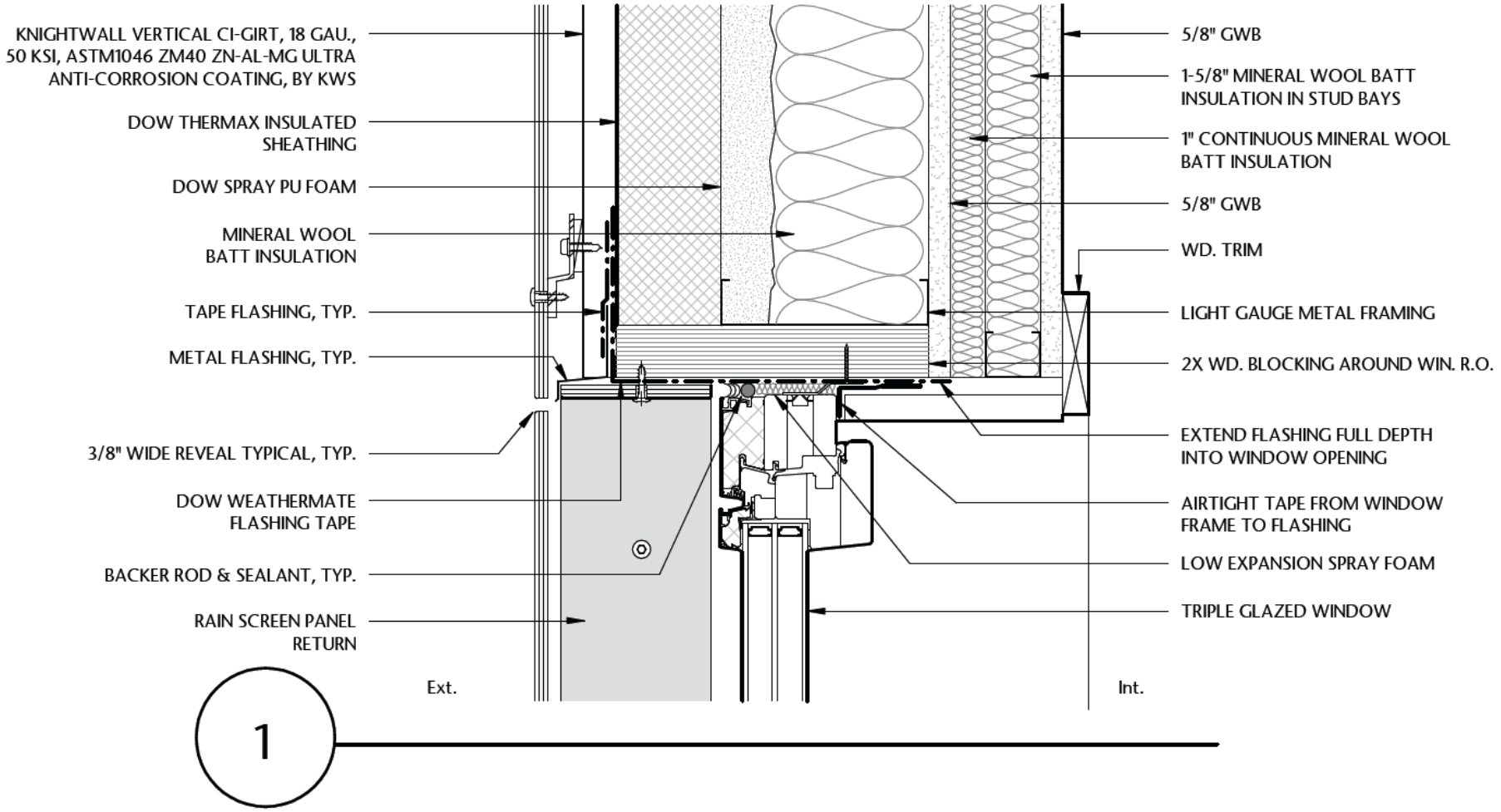
Hybrid Insulated Sheathing + Interior Batt



Challenge #4: NFPA-285

COMBUSTIBLE WRB?

IBC 1403.5 Vertical and Lateral Flame Propagation.

Exterior Walls on buildings Type I, II, III, or IV construction that are greater than 40 feet in height above grade plane and contain a combustible water-resistive barrier shall be tested in accordance with and comply with the acceptance criteria of NFPA 285.

COMBUSTIBLE CLADDING?

IBC 1406.2.1 Combustible Exterior Wall Coverings | Type I, II, III, IV Construction

On buildings of Type I, II, III and IV construction, exterior wall coverings (Metal Composite Material, High-Pressure Laminates, etc..) shall be permitted to be constructed of combustible materials, complying with the following limitations….

COMBUSTIBLE INSULATION?

IBC 2603.5.5 Foam Plastic Insulation | Vertical and Lateral Fire Propagation.

The exterior wall assembly shall be testing in accordance with and comply with the acceptance criteria of NFPA 285.

NFPA 285 is an **ASSEMBLY** test, not a component test. Substitutions and changes are NOT allowed. Consult manufacturer's ESR reports for allowable assemblies and thicknesses.

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ESR-1659

Reissued 04/2018
This report is subject to renewal 04/2020.

DIVISION: 07 00 00—THERMAL AN
SECTION: 07 21 00—THER
SECTION: 07 22 00—ROOF AN
SECTION: 07 25 00—WATER-RESISTIVE B
SECTION: 07 27 00—A

REPORT HOL

THE DOW CHEMICA

4.1.1 Application: THERMAX™ insulation boards, at a maximum thickness of $4^{1}/_{4}$ inches (108 mm), may be used as nonstructural insulating material without a thermal barrier on any or all surfaces (wall or floor/ceiling assembly) in any type of structure. For exterior wall applications, the insulation boards must be attached with fasteners spaced a maximum of 16 inches (406 mm) on center in the field and 12 inches (305 mm) on center on the perimeter. For cementitious exterior wall coating applications, fasteners for insulation boards thicker than $1^{1}/_{2}$ inches (38 mm) must be considered for lateral resistance to ensure support for the exterior wall coatings. For interior applications, the insulation boards must be attached with fasteners spaced a maximum of 24 inches (610 mm) on center along the width of the board and a maximum of 48 inches (1219 mm) on center along the length of the board.

NFPA-285 + Fire Resistance Rating

TABLE 4—ASSEMBLIES FOR USE IN TYPES I THROUGH IV CONSTRUCTION

FRAMING MEMBERS[5,8]			INTERIOR SHEATHING[1,7] (TYPE X GYPSUM)		EXTERIOR SHEATHING (TYPE X GYPSUM)		MAX. INSULATION BOARD THICKNESS, (inches)
Metal		Max. Spacing (inches)	Min. Thickness (inch)	Max. Fastener Spacing (inches)	Min. Thickness (inch)	Max. Fastener Spacing (inches)	
Min. Depth (inches)	Min. Gage						
3 1/2	18	16	1/2	8 at perimeter 12 in field[2]	1/2	6 at perimeter 8 in field[3]	12
3 1/2	18	16[6]	1/2	6[4]	5/8	6 at perimeter 8 in field[3]	12
6¼	20	16	5/8	8[4]	5/8	8[4]	12
3 1/2	18	16					
3 1/2	18	16					

NFPA-285 compliant

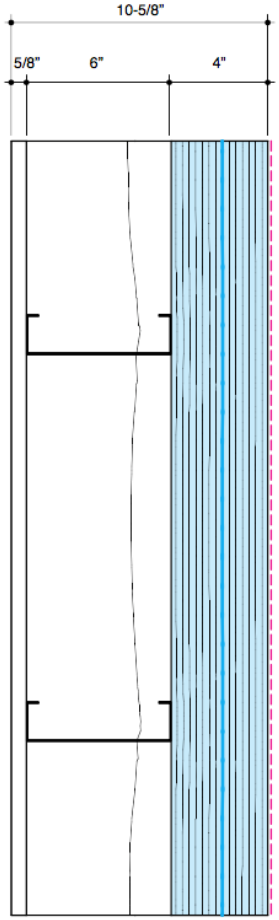
NFPA-285 AND Fire Rated

TABLE 5—FIRE-RESISTANCE-RATED ASSEMBLIES[1,2]

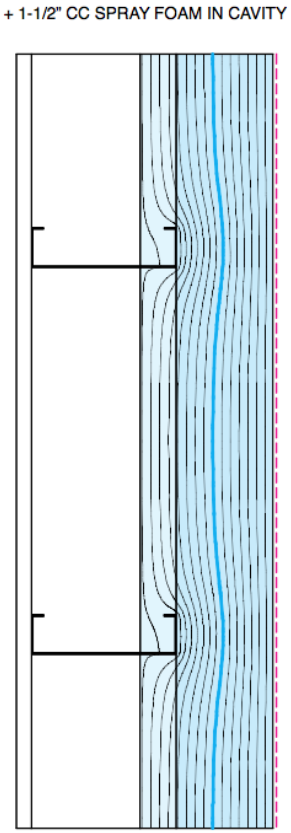
FIRE-RESISTANCE RATING (hrs)	FRAMING MEMBERS			INTERIOR SHEATHING			EXTERIOR SHEATHING			MAXIMUM EPS INSULATION BOARD THICKNESS (inches)
	Min. Depth (inches)	Min. Gage	Max. Spacing (inches)	Type	Min. Thickness (inch)	Max. Fastener Spacing (inches)	Type	Min. Thickness (inch)	Max. Fastener Spacing[5] (inches)	
1	3 1/2	18	16	Type X gypsum[5]	5/8	8 o.c. on perimeter 12 o.c. in field[3]	Type X gypsum	5/8	6 at perimeter 8 in field[4]	4
2	3 1/2	18	16	Two layers of Type X gypsum[5]	5/8	Base layer at 24 o.c. Face layer at 8 o.c.[6]	Two layers of Type X gypsum	5/8	Base layer at 24 o.c. Face layer at 8 o.c.[6]	4

From: ICC-ES Evaluation Report ESR-1748: STOTHERM ci

NFPA 285 Compliant Wall Assemblies

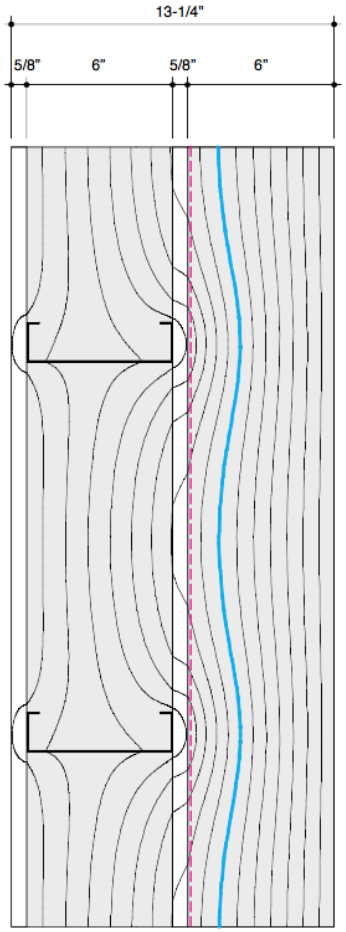


R-28.48

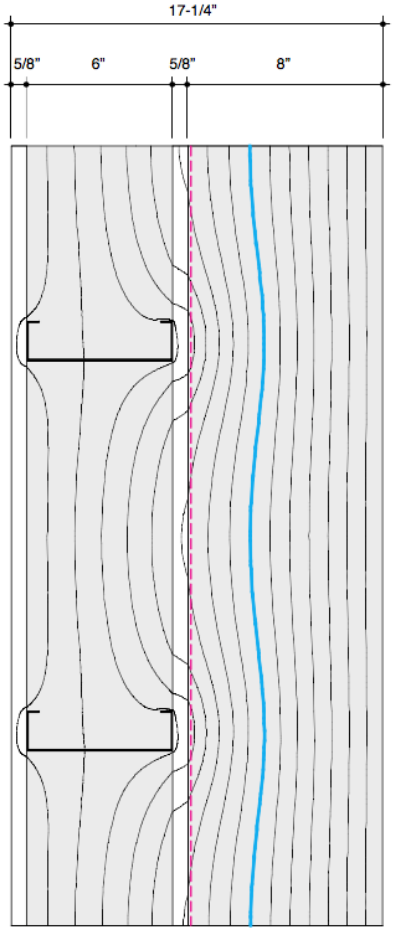


R-35.04

PolyIso + ccSPF



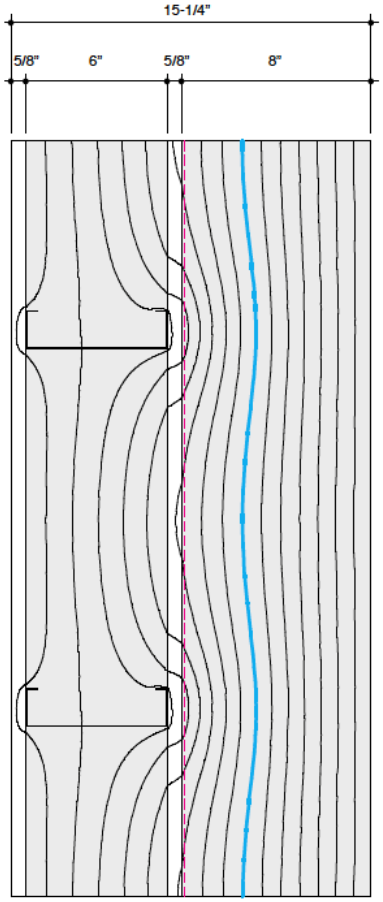
R-35.70



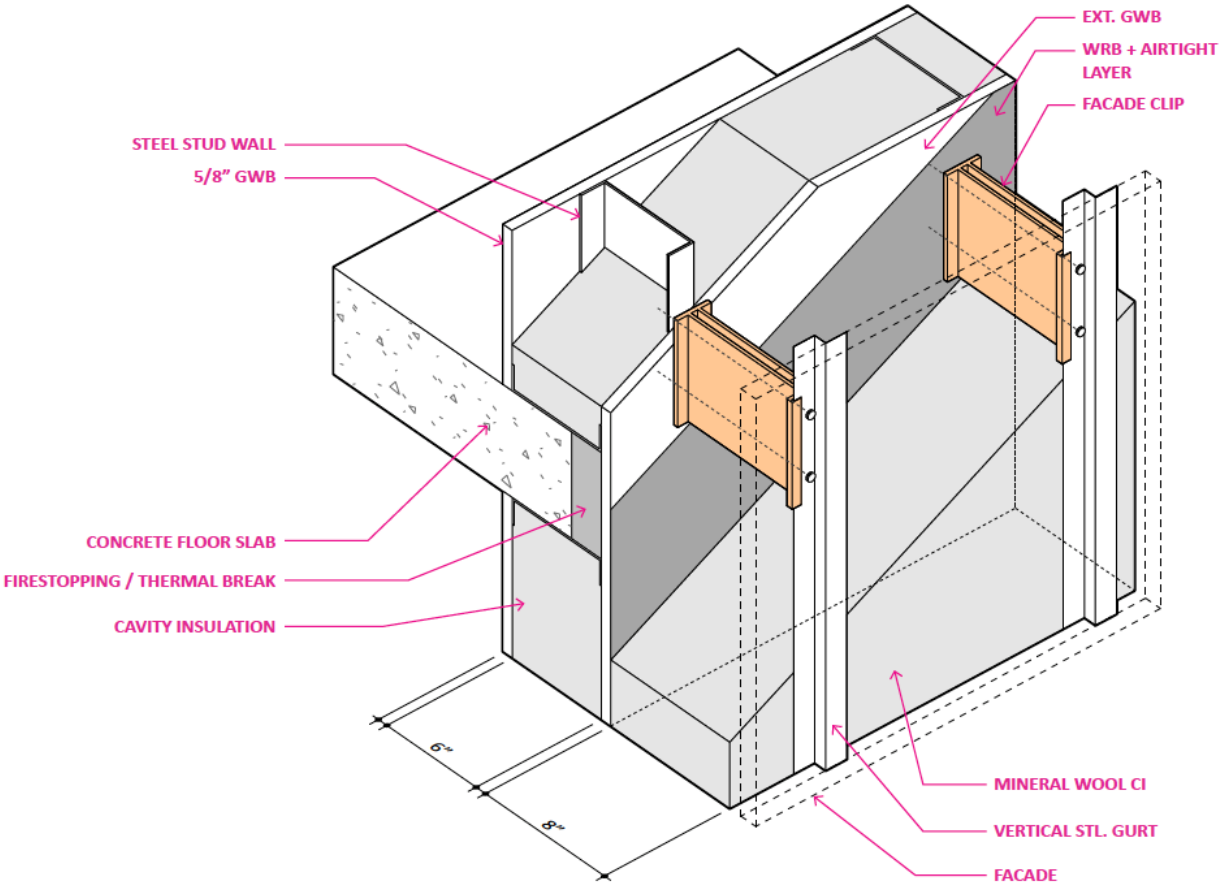
R-42.91

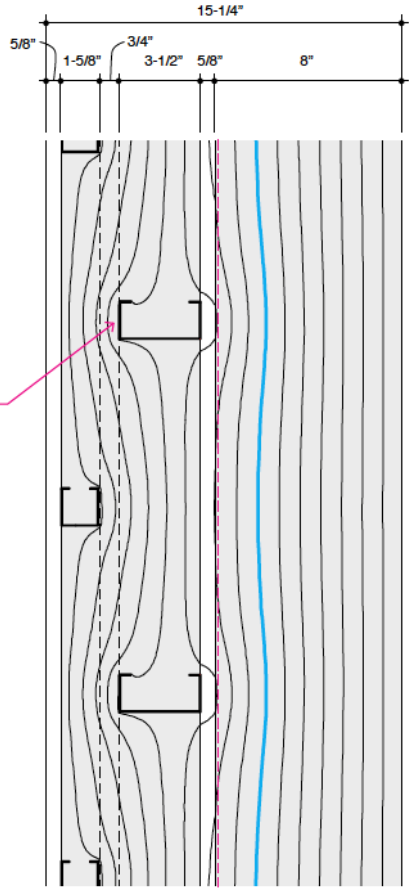
Mineral Wool

bldgtyp


15-1/4"
5/8"
6"
5/8"
8"

R-42.91

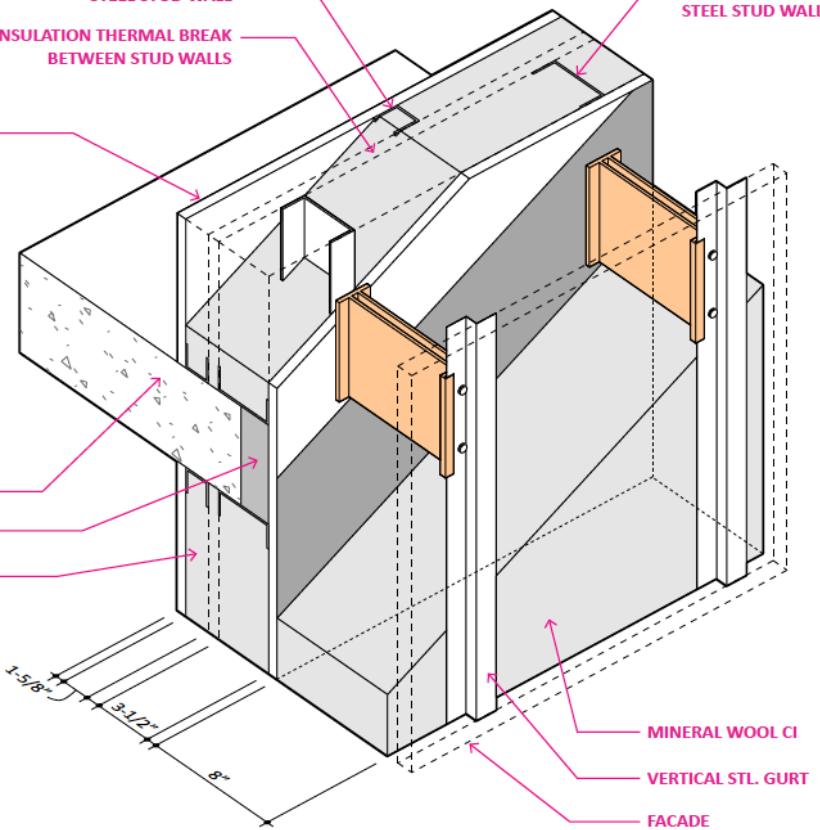

EXT. GWB
WRB + AIRTIGHT LAYER
FACADE CLIP
STEEL STUD WALL
5/8" GWB
CONCRETE FLOOR SLAB
FIRESTOPPING / THERMAL BREAK
CAVITY INSULATION
6"
8"
MINERAL WOOL CI
VERTICAL STL. GURT
FACADE



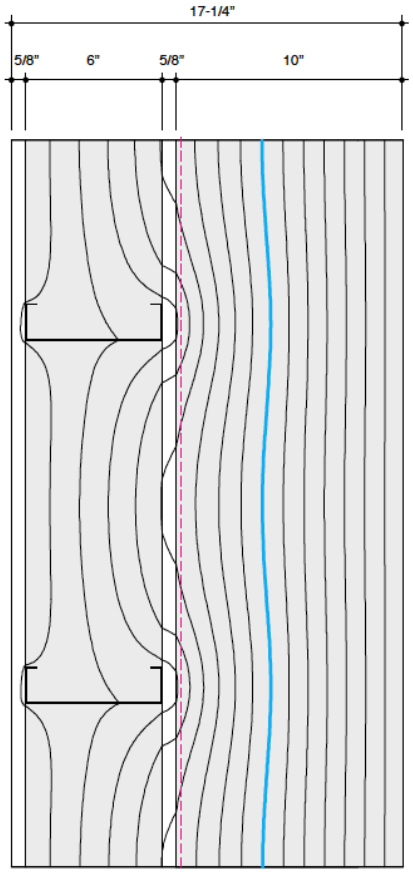
BREAK INTERIOR STUD FRAMING INTO TWO LAYERS. STAGER STUDS TO REDUCE THERMAL BRIDGING

R-50.55

Double stud leads to 18% improvement in performance within the same wall thickness

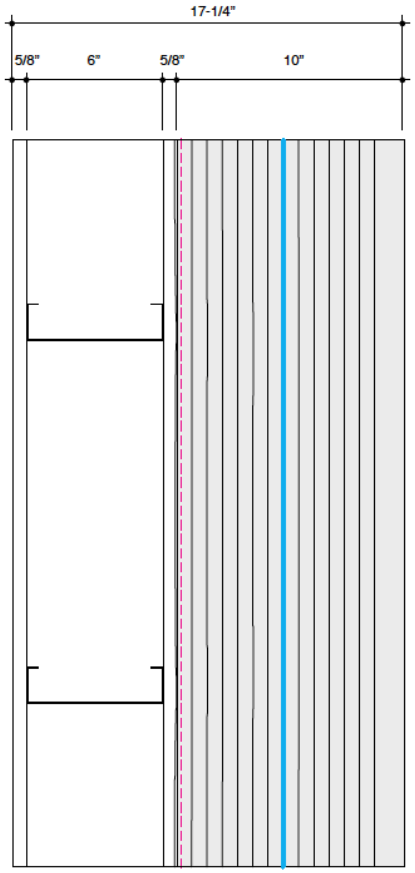


bldgtyp



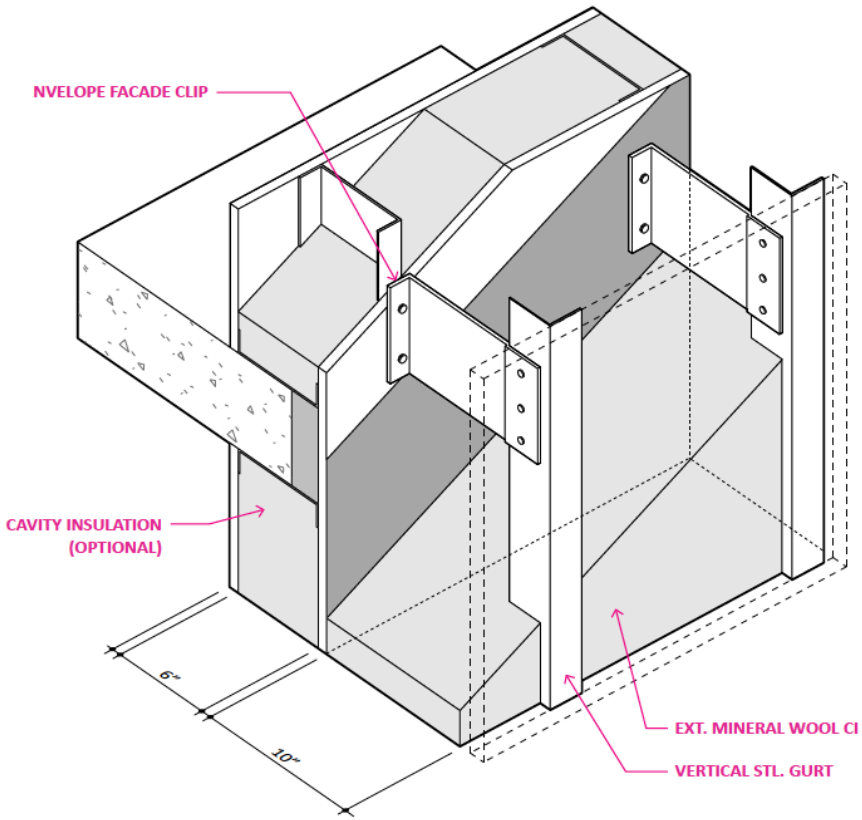
R-50.10

WITH CAVITY INSULATION



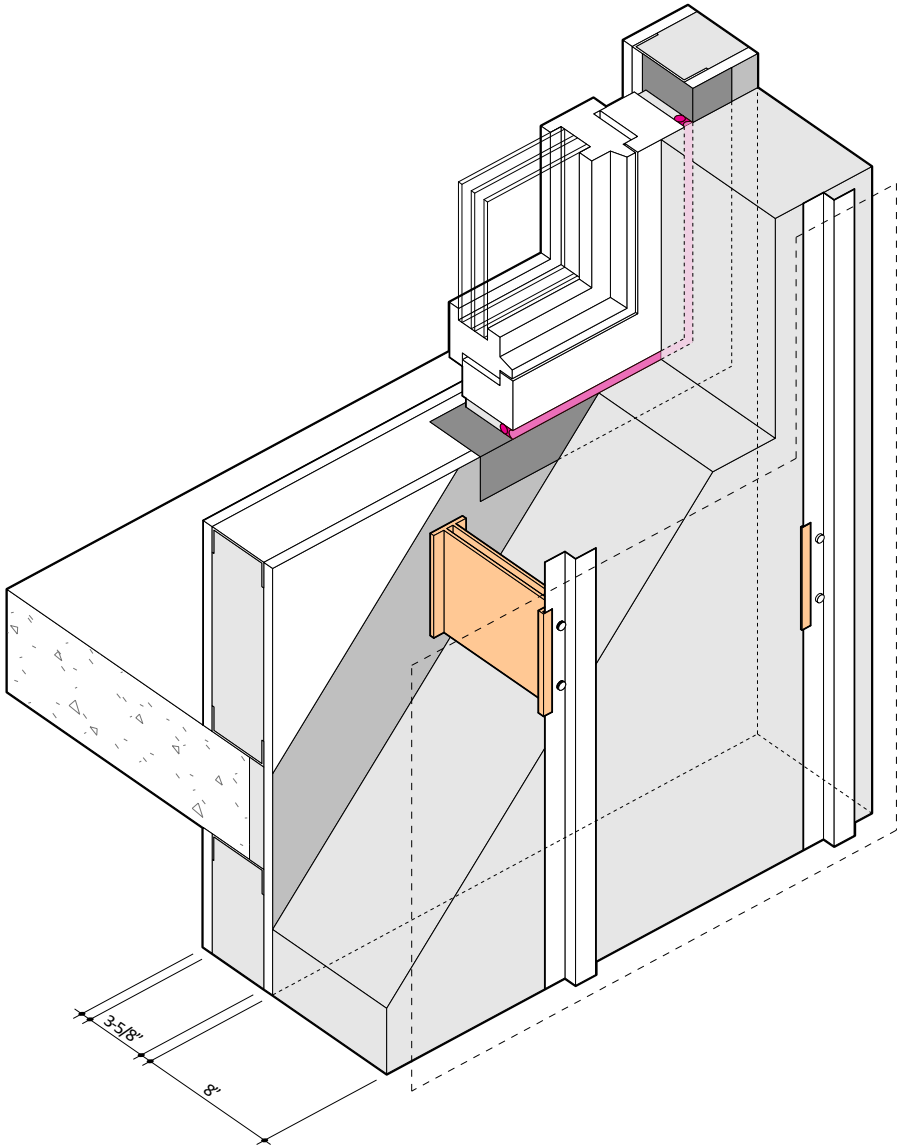
R-38.79

WITHOUT CAVITY INSULATION



bldgtyp

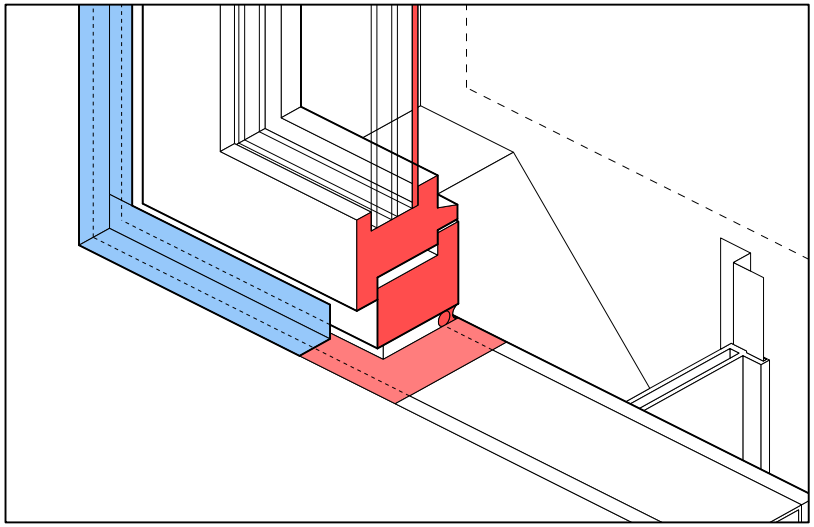
Typical Wall Assembly

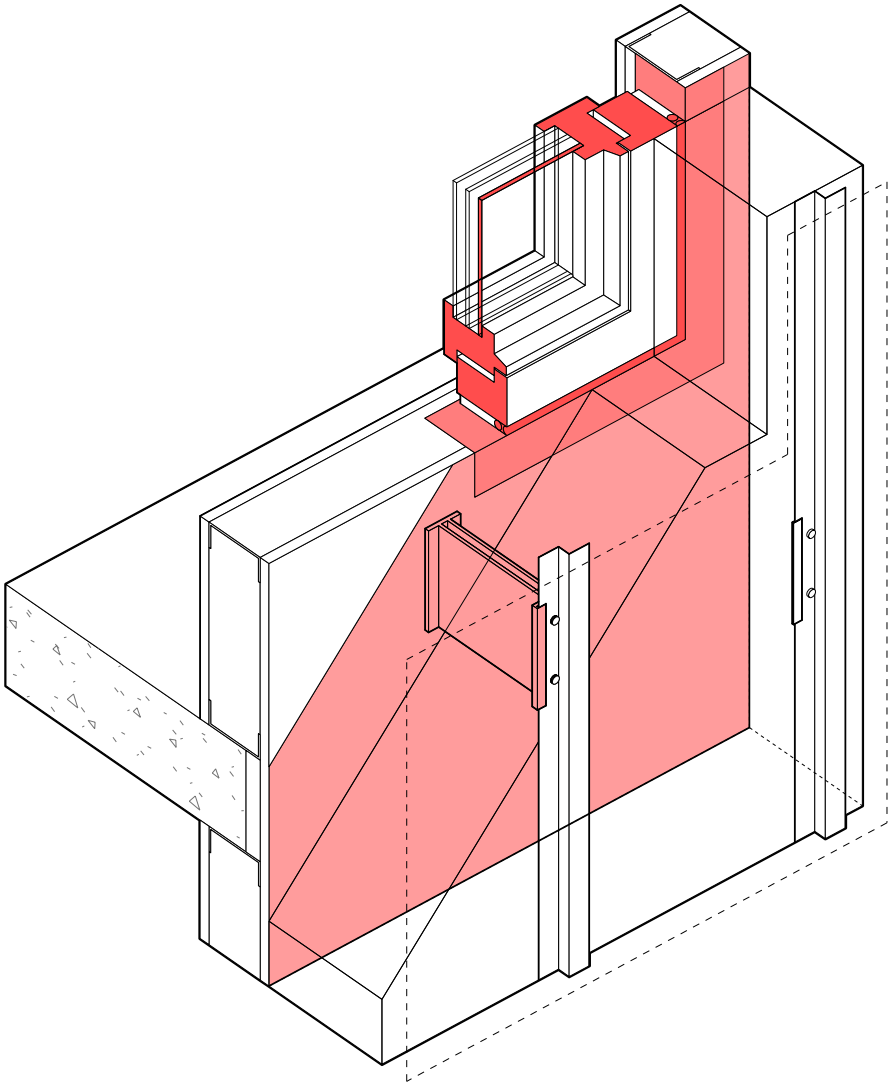


Source: BLDGtyp, LLC

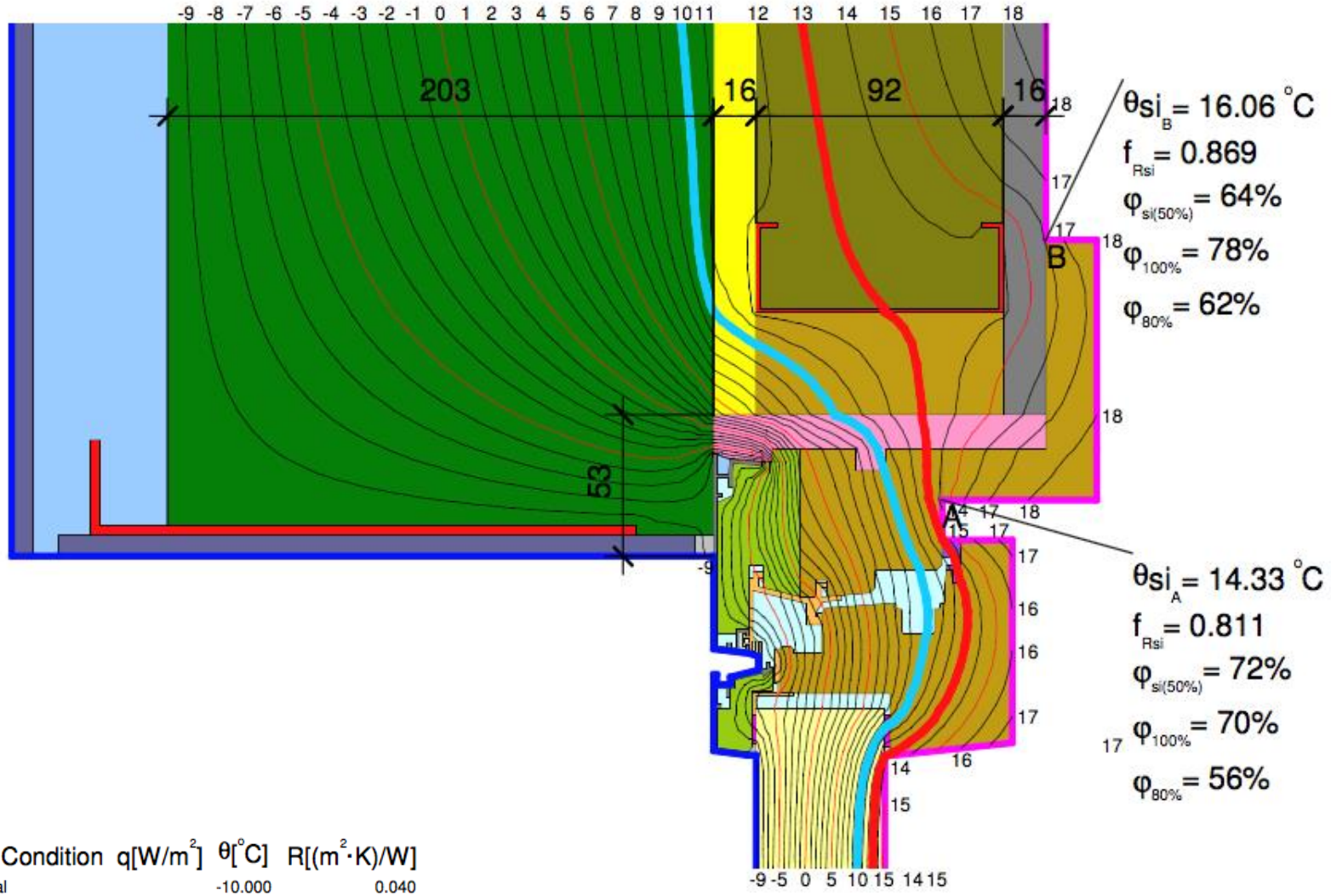
bldgtyp

Typical Wall Assembly: Airtightness





Windows: Thermal Bridging



Boundary Condition	q[W/m²]	θ[°C]	R[(m²·K)/W]
Exterior, normal		-10.000	0.040
Interior, without window/door		20.000	0.250
Symmetry/Model section	0.000		

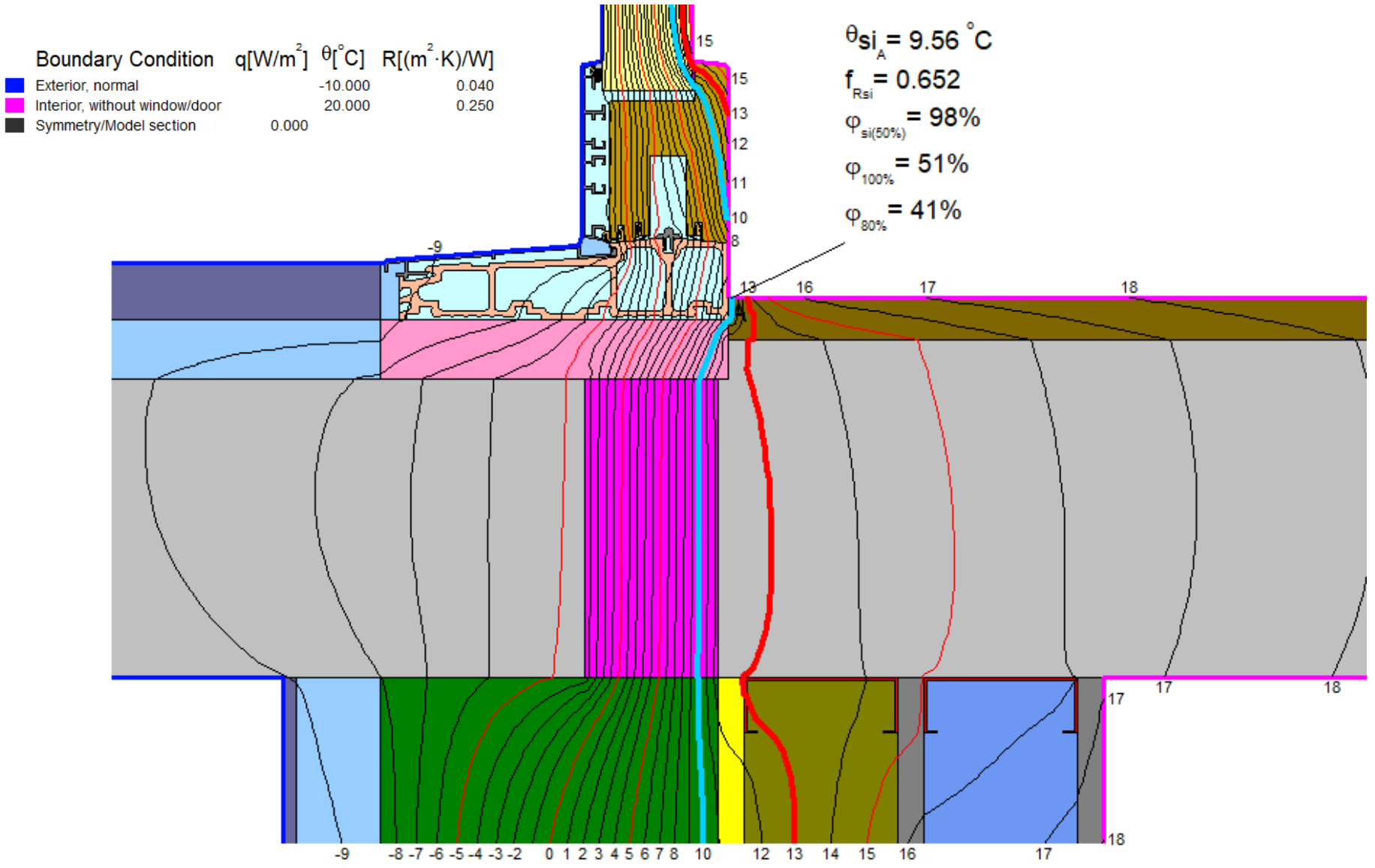
+0.043 W/mk

bldgtyp

Window RO Preparation & Sealing

Window Sealing (outside and in)

Balcony Thermal Breaks



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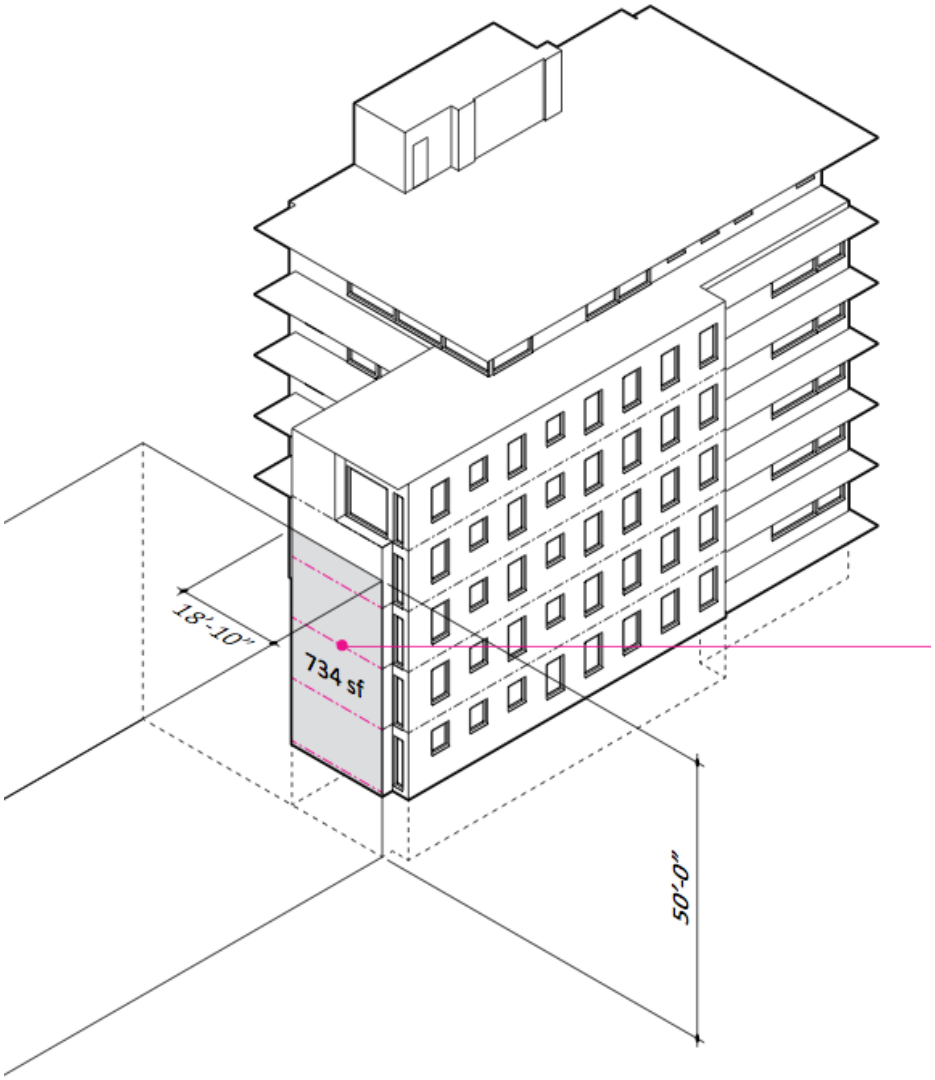
Partywall Seismic Gap



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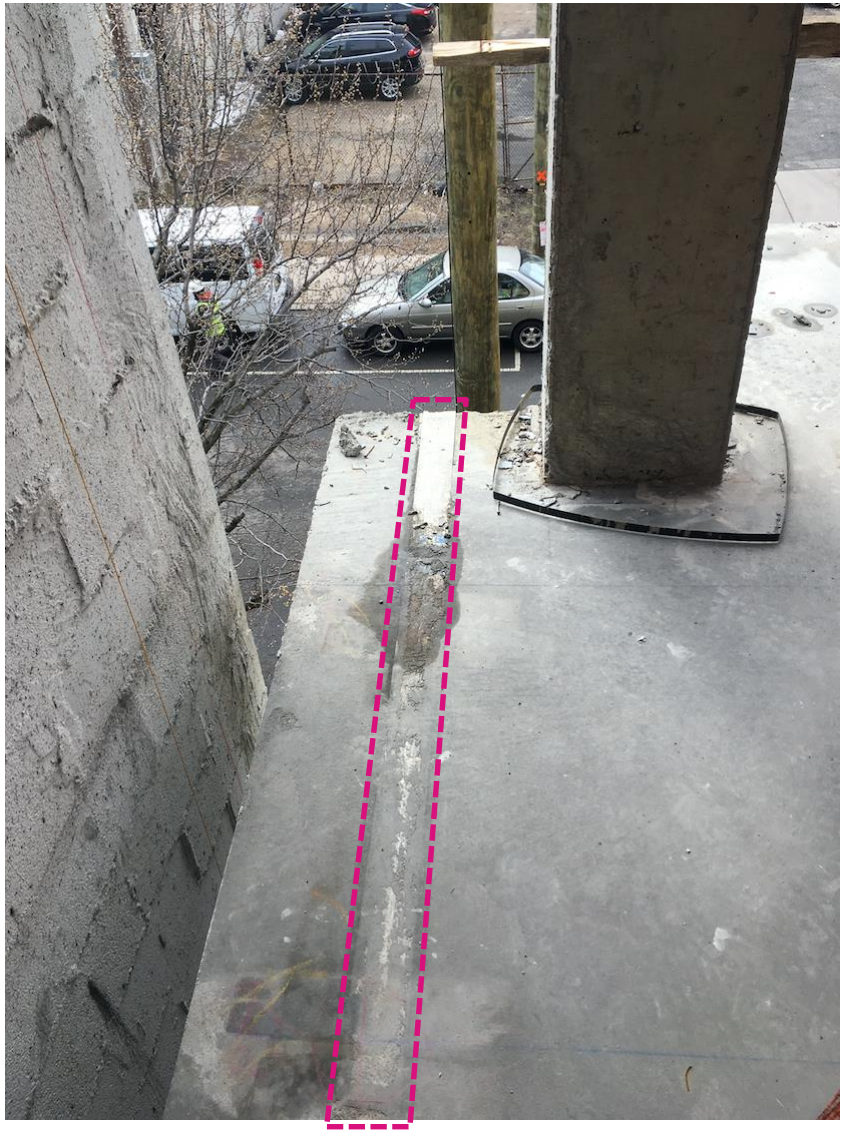
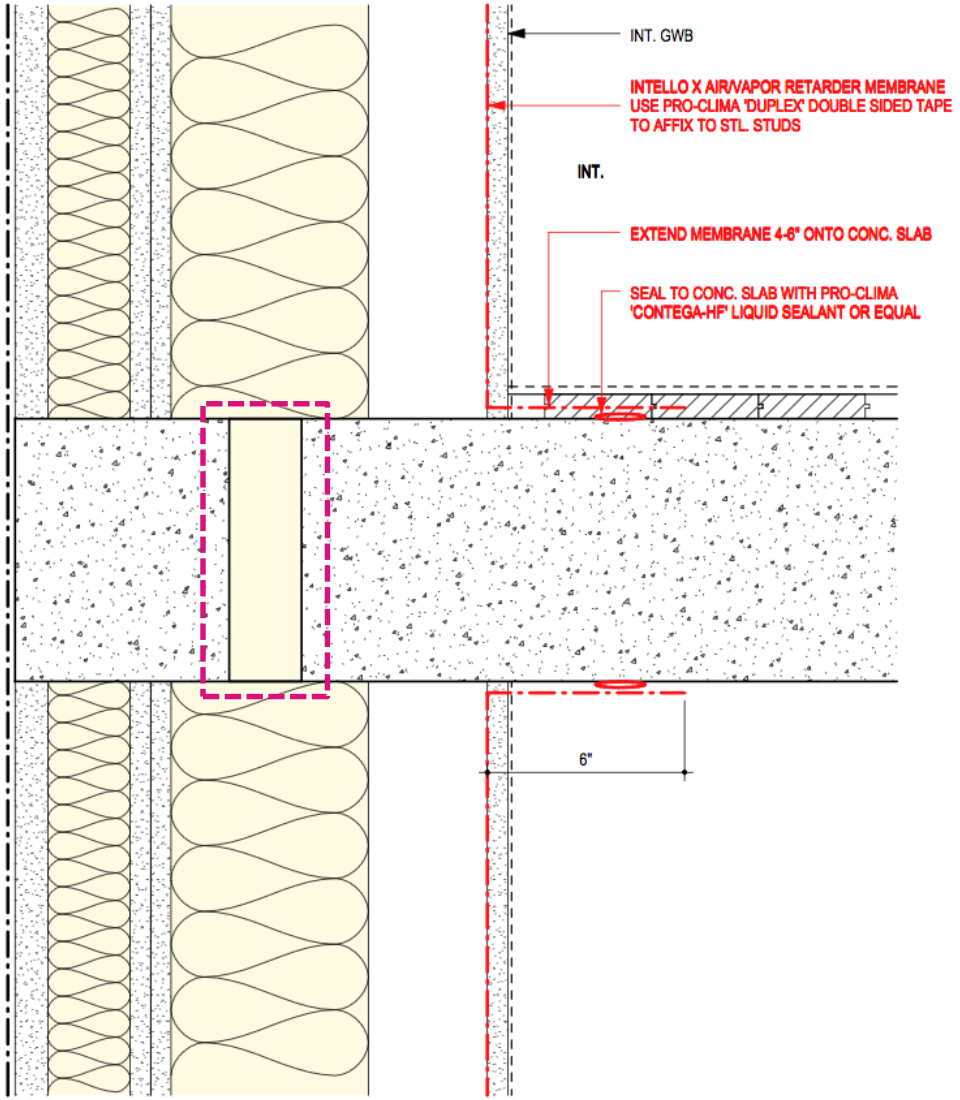
Schöck DF-FS Slab Edge





Rendering: Nastasi Architects

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