# 340+ Dixwell, New Haven, CT

80% Affordable (60% AMI or less) and 20% Market

A Mass Timber & Passive House Integrated Design with Photovoltaics

69 Units Total

# 340+ Dixwell Project Team:

## Architect of Record /Passive House Consultant:

Schadler Selnau Associates, PC
5 Waterville Road Farmington, CT 06032
Paul Selnau, AIA, CPHC ©
***Presenter***

## Owners:

David Cleghorn – H.E.L.P. Development Corp.
Darrell Brooks – Beulah Land Development Corporation
Jeff Spiritos – Spiritos Properties LLC
***Presenter***

## Design Architect + Mass Timber Consultant:

Gray Organschi Architecture
35 Crown Street New Haven, CT 06510

## Mechanical & Electrical Engineer:

Acorn Consulting Engineers Inc.
244 Farms Village Road, West Simsbury, CT 06092

## Structural Engineer:

Odeh Engineers
1223 Mineral Spring Avenue, North Providence, RI 02904

## Civil Engineer:

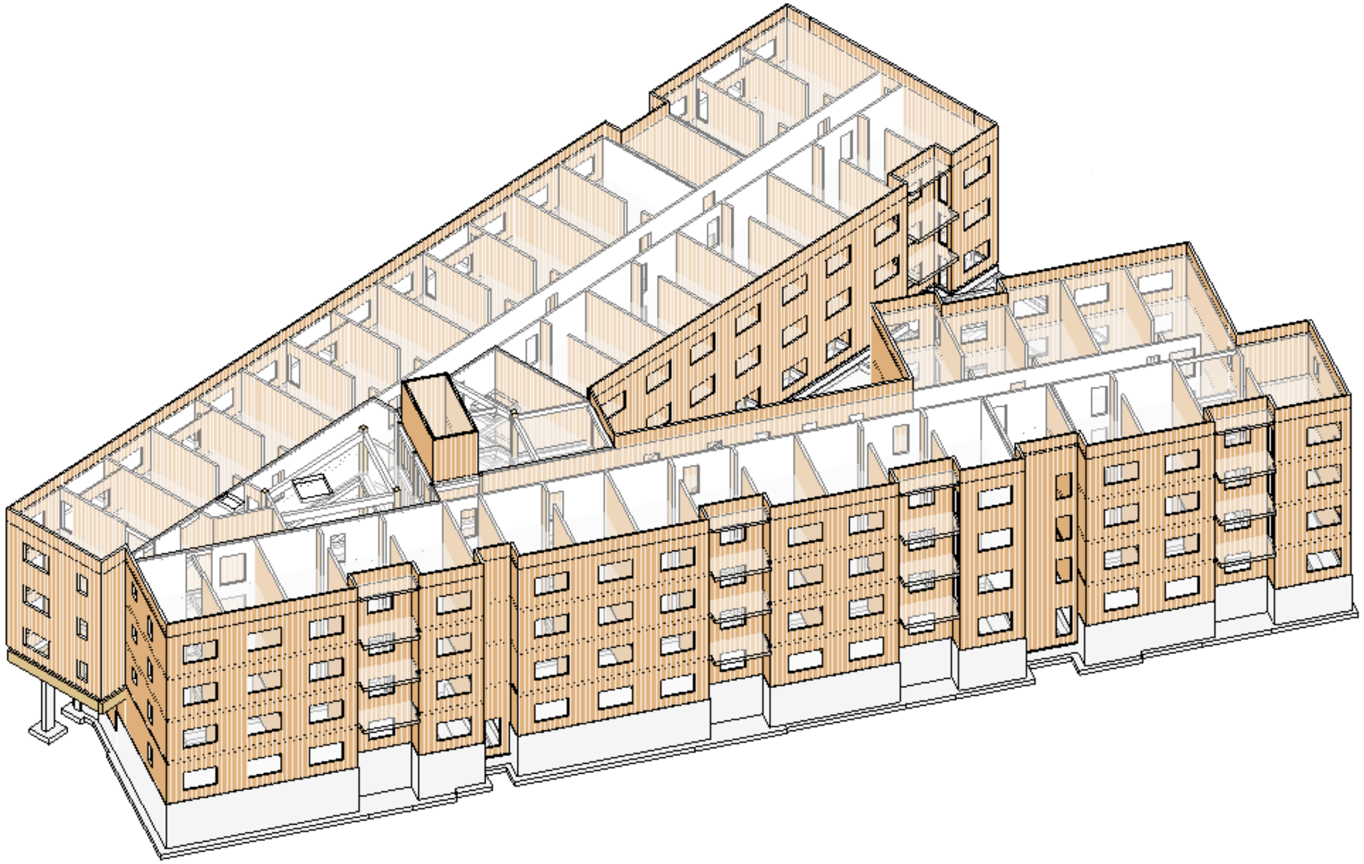
John Paul Garcia & Associates, P.C.
190 Fairwood Road, Bethany, CT 06524

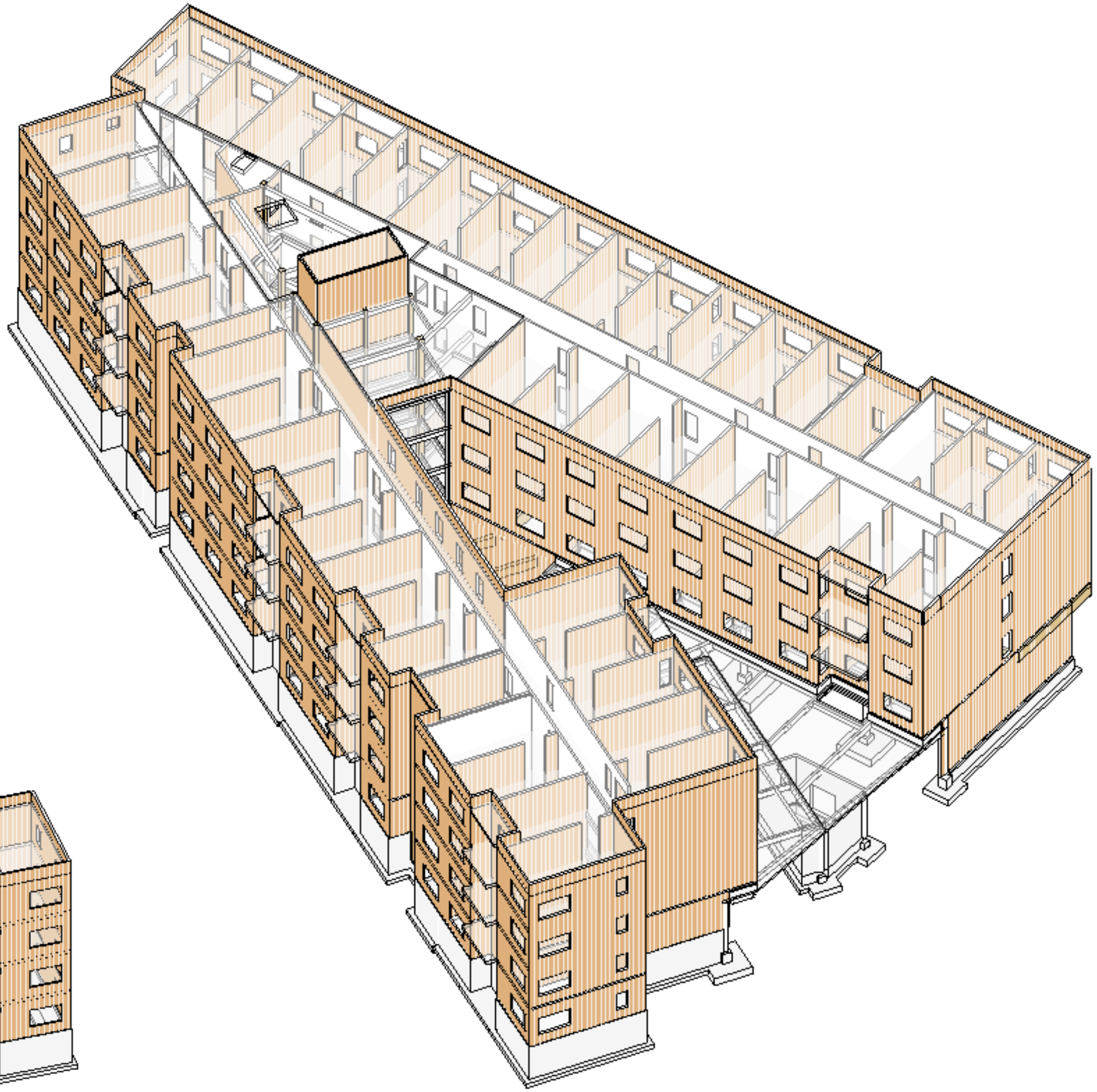
US Forest Service through 2018 Wood Innovation Grant (WIG)

Low Income Housing Tax Credit Project through CHFA, DOH and City of New Haven, CT.
Covid related shortfall impedes closing and construction start


SHELTON AVENUE
MUNSON STREET
DIXWELL AVENUE
340 DIXWELL
316 DIXWELL
ORCHARD STREET

# Structural Strategy





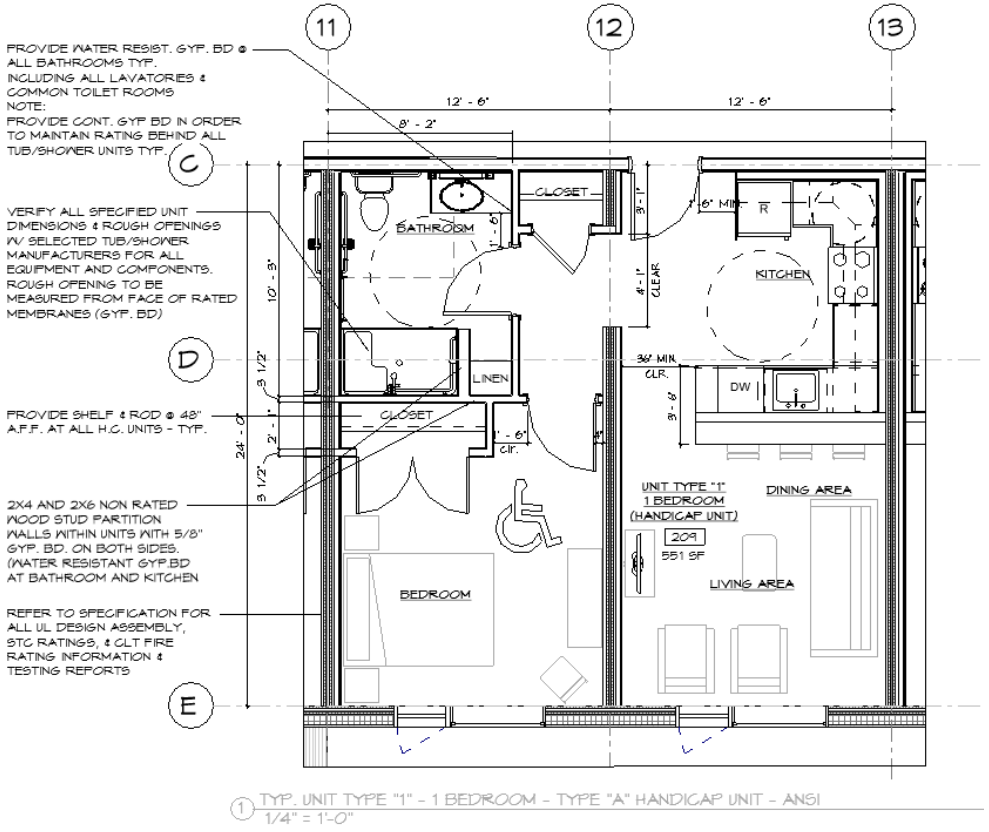
# Interior Renderings

*Typical unit interior rendering*

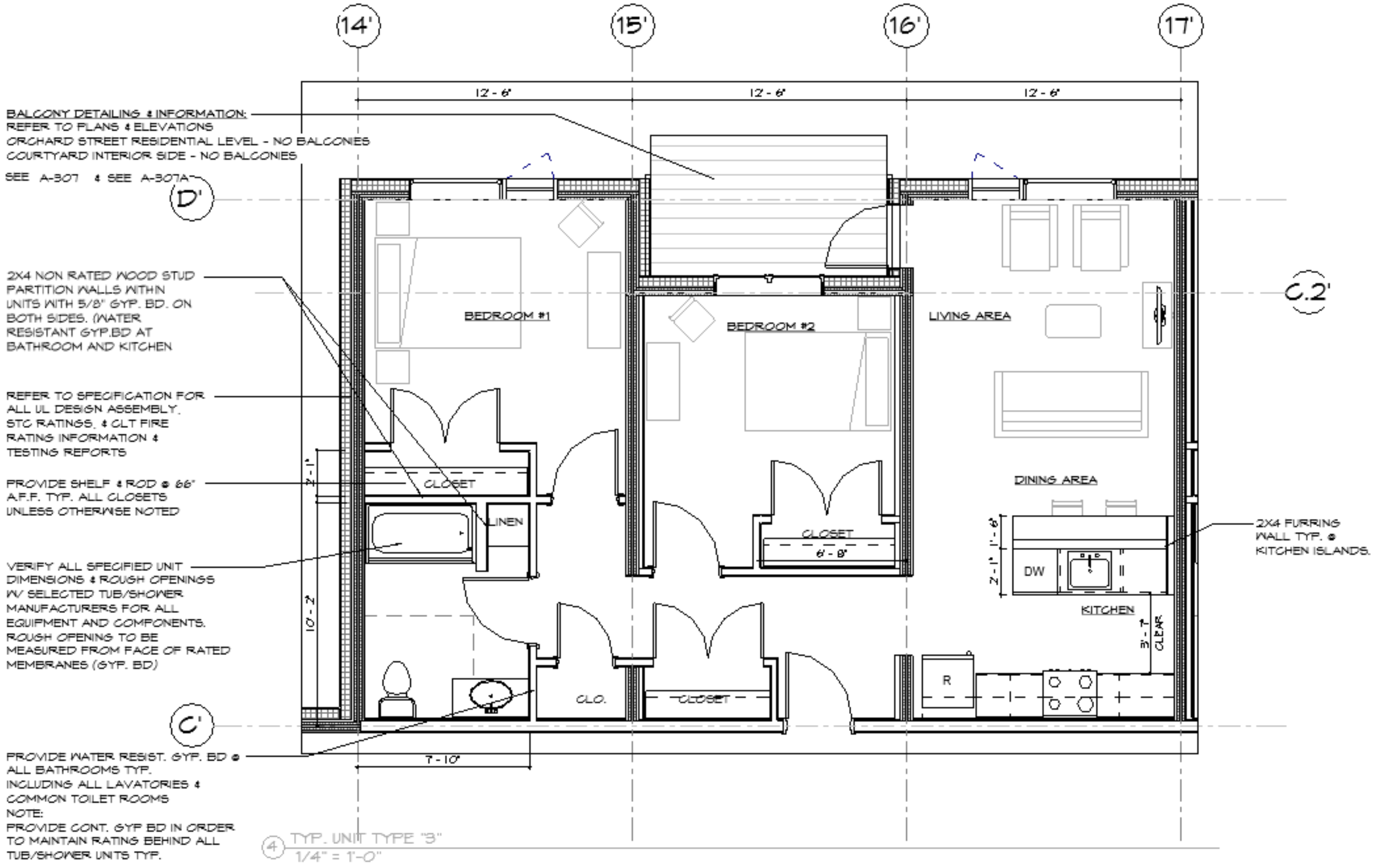
*Main lobby interior rendering*

# Typical Unit Layouts

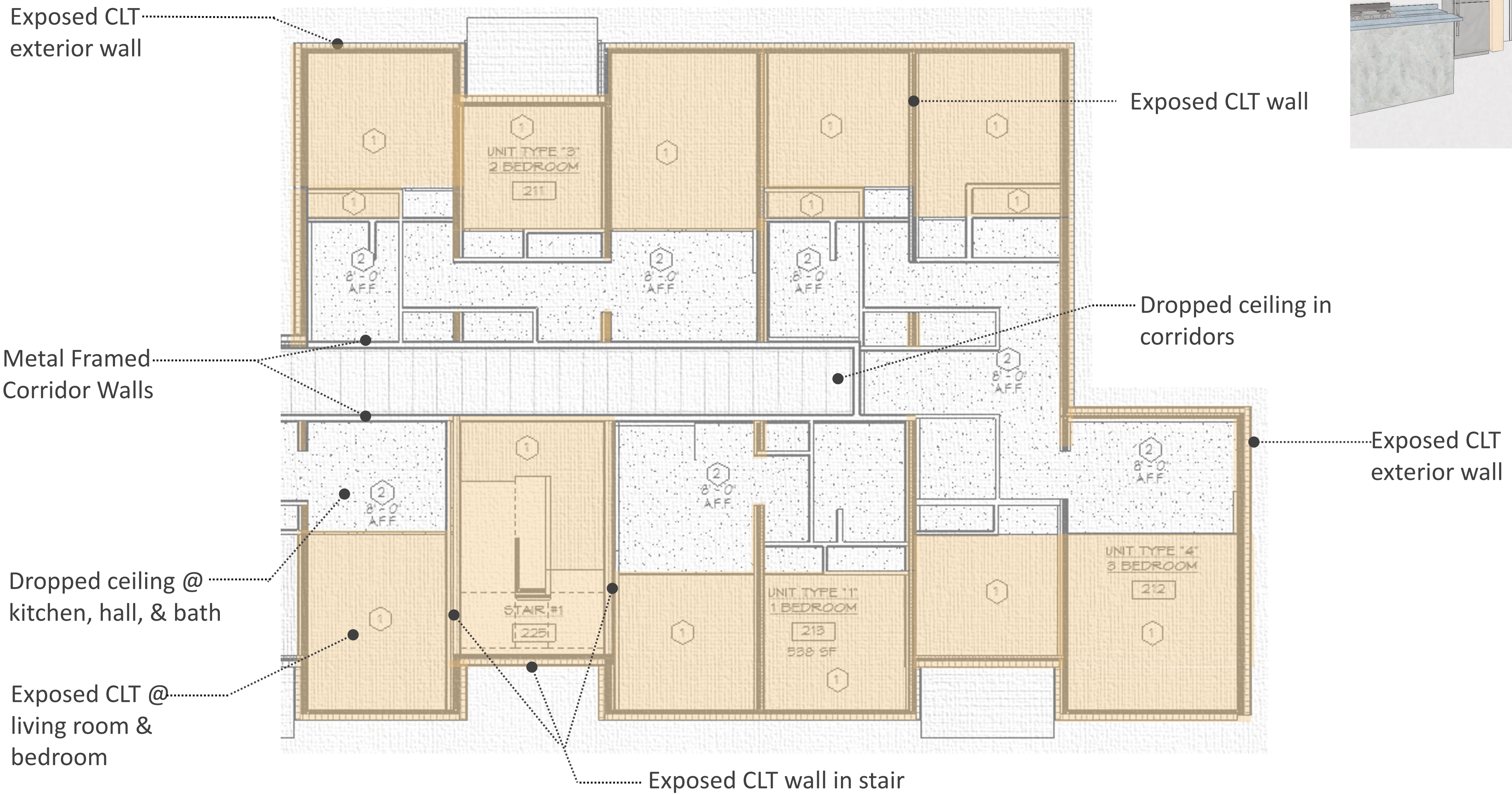
*Typical one bedroom unit*



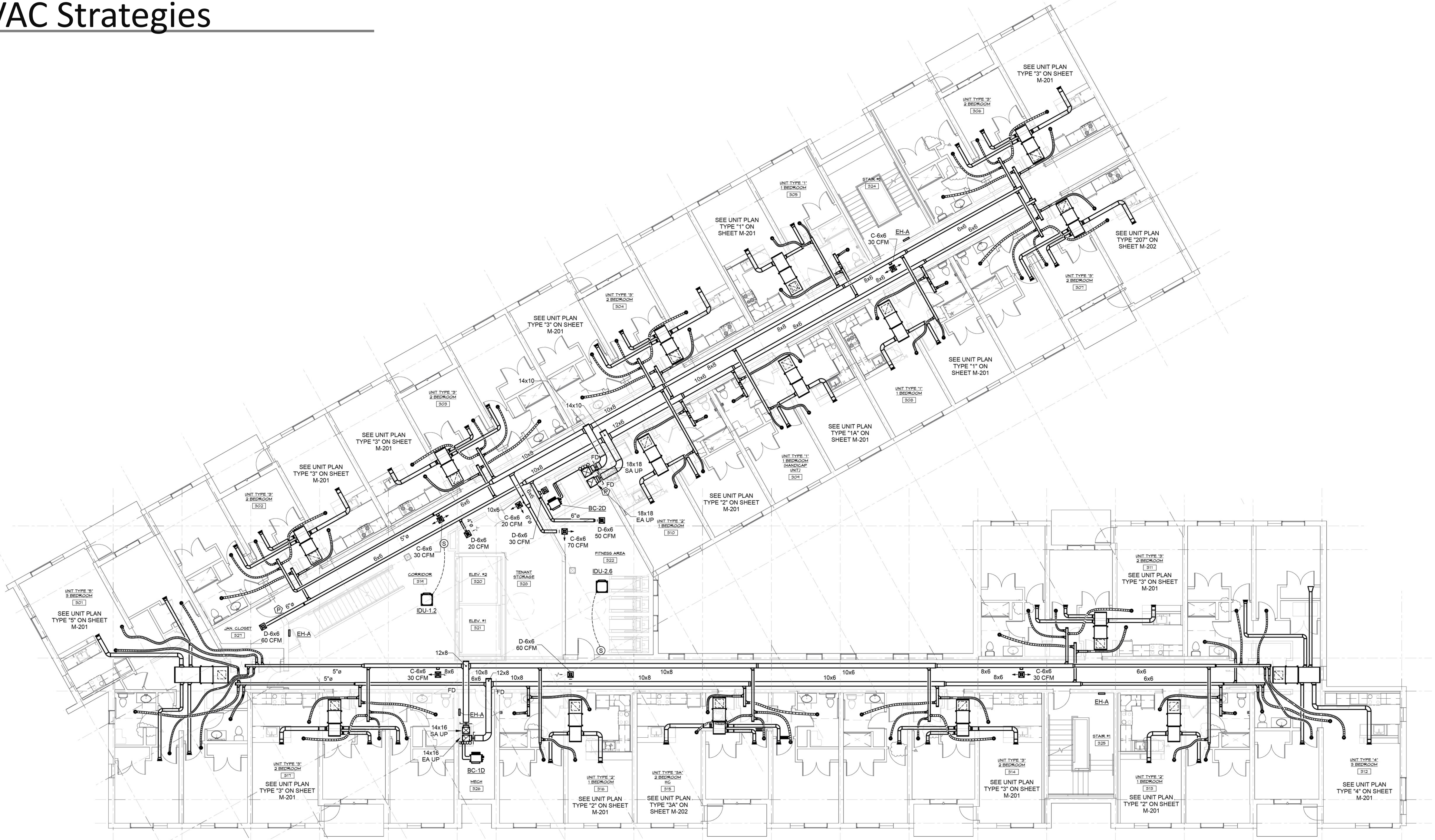

*Typical two bedroom unit*



# Wall, Ceiling Strategies



# HVAC Strategies



# Incremental benefits for mass timber vs light frame

1. Parts and pieces – with light frame, there are many more elements to gather and put together
2. Height– Light frame can be a maximum of 5 floors over a concrete or steel podium
3. Site impact - more deliveries, traffic, trade parking needed with light frame
4. Crew size – 20-30 people compared to 6 or so with mass timber
5. Labor challenges – greater and greater shortages of labor challenge progress and pricing
6. Elevator and stair core walls – typically done in concrete or concrete block
7. Waste and clutter– cutting lumber, sheathing, TJI's on site, blocking, and bracing all take space and create safety concerns with waste
8. Eliminate the steel or concrete podiums, which are the carbon emitting technologies – not structurally required
9. Speed – a) erecting walls, shear walls, bearing walls, ceiling joists, connections take longer than placing glulam/CLT panels
   b) need to wait till roof is on to start insulation and gypsum due to water infiltration concerns
10. Quality – dimensional lumber is less dimensionally stable
11. Thermal performance – wood studs are thermal breaks in an outer wall that diminish wall R value
12. Safety – fall and trip hazards, and walking on installed joists are a skill
13. Fire risk during construction – Dimensional lumber more susceptible
14. Insurance costs – May be higher with light frame due to construction risks (safety and fire) during placement
15. Durability – light frame structures are subject to more movement and weather impact
16. Natural environment – Light frame buildings require covering all wood with artificial surfaces
17. Healthfulness – exposed wood shown to reduce asthma and stress, lowers heart rate and blood pressure, improve concentration

# 340+ Dixwell Mass Timber VS Light Frame Cost Comparison

NOTE - GENERAL CONTRACTOR ADD ONS - GC, INSURANCE, BOND, FEE ARE REFLECTED PROPORTIONATELY
NOTE - COST DIFFERENCES IN THE 0% PERCENTAGE COLUMN ARE DUE TO ROUNDING

BUILDING GROSS SF 86,807

| CATEGORY | MASS TIMBER (MT) ($) | LIGHT FRAME (LF) ($) | MT PERCENTAGE OF LF (%) |
|---|---|---|---|
| GENERAL REQUIREMENTS | 678,927 | 720,541 | -5.78% |
| SITEWORK | 885,870 | 894,752 | 0% |
| FOUNDATION | 627,196 | 633,450 | 0% |
| MASONRY | 124,375 | 401,891 | -69.05% |
| METALS | 380,692 | 599,767 | -36.53% |
| WOOD STRUCTURE & PLASTICS | 4,592,849 | 2,384,866 | 92.58% |
| THERMAL & MOSITURE | 2,390,586 | 2,108,925 | 0% |
| DOORS & WINDOWS | 983,251 | 993,056 | 0% |
| FINISHES | 1,370,747 | 1,861,678 | 73.63% |
| SPECIALTIES | 78,395 | 79,180 | 0% |
| EQUIPMENT | 237,577 | 239,948 | 0% |
| FURNISHINGS | 308,454 | 311,529 | 0% |
| CONVEYING SYSTEMS | 502,332 | 507,341 | 0% |
| FIRE PROTECTION | 467,385 | 472,045 | 0% |
| PLUMBING | 1,037,884 | 1,048,232 | 0% |
| HVAC | 1,546,477 | 1,561,897 | 0% |
| ELECTRICAL | 1,631,961 | 1,648,233 | 0% |
| **SUBTOTAL** | **17,844,958** | **16,467,331** | **108.37%** |
| | | | |
| CONSTRUCTION PERIOD INTEREST (2 MO) | -80,000 | | -80,000 |
| NET RENT COLLECTION (2 MO) | -20,000 | | -20,000 |
| **SUBTOTAL COST OFFSET** | **-100,000** | | **-100,000** |
| | | | |
| TOTAL COST WITH OFFSET | 17,744,958 | | |
| **COST/SF** | **205.57** | **189.70** | **15.87** |
| OFFSETTING NET REVENUE | -1.15 | | -1.15 |
| **TOTAL COST/SF** | **204.42** | **189.70** | **14.72** |

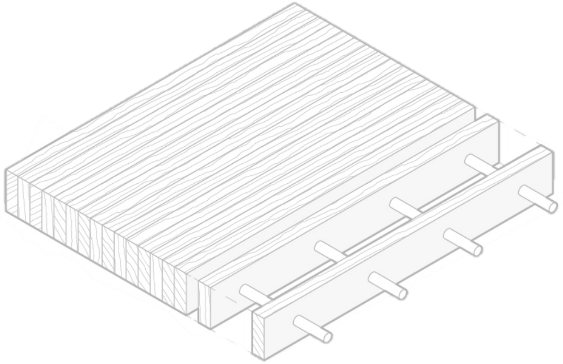
# 340+ Dixwell

# 340+ Dixwell Project Overview

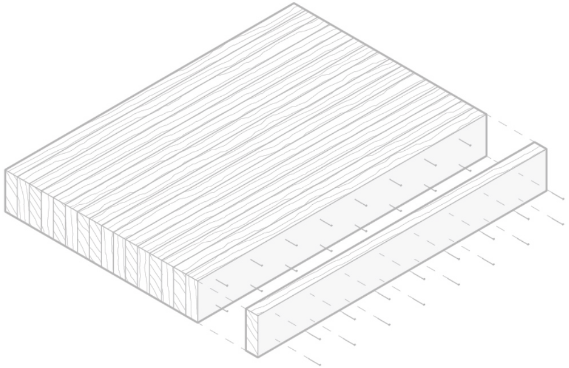
| | |
|---|---|
| Project Location | 340 Dixwell Avenue,<br>New Haven, CT |
| Project Type | Residential Multi-family |
| Construction | Cross-laminated timber (CLT) |
| Total Units | 57 (Bldg. 340)<br>12 (Bldg. 316) |
| Overall SF | 65,766 sf (Bldg. 340)<br>14,047 sf (Bldg. 316) |
| Number of Stories | 4 (Bldg. 340)<br>4 (Bldg. 316) & Rooftop Terrace |
| Exterior Wall Insulation Material | Rockwool Comfortboard 80<br>4” (Bldg. 340)<br>6” (Bldg. 316) |
| Slab Insulation | 2” Con’t EPS (Bldg. 340)<br>6” Con’t EPS (Bldg. 316) |

# Building Layout & Design

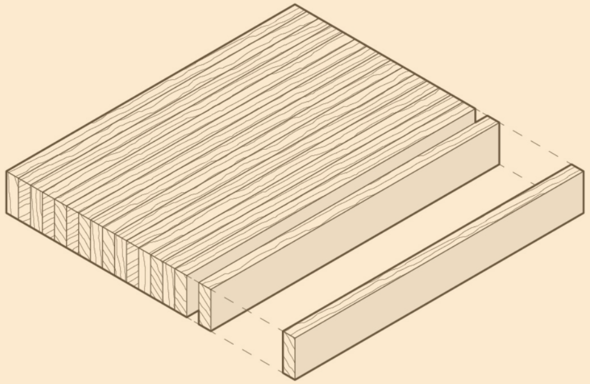
# Mass Timber Systems



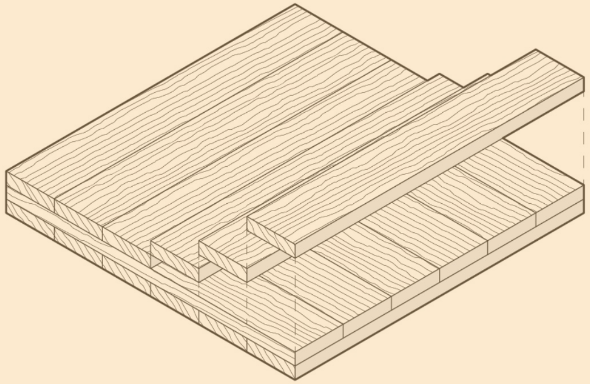
DLT
*dowel-laminated timber*



NLT
*nail-laminated timber*

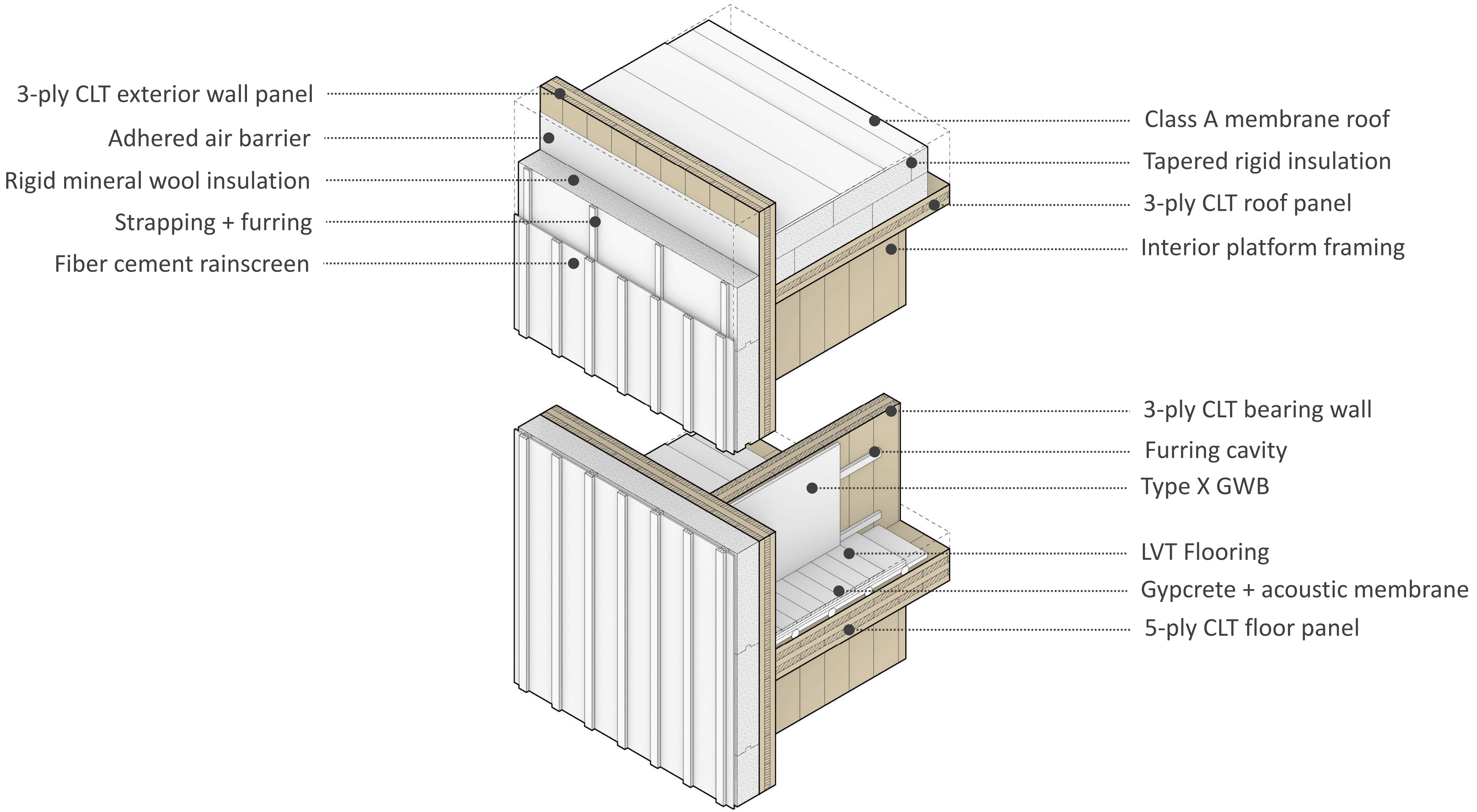


GLT
*glue-laminated timber*



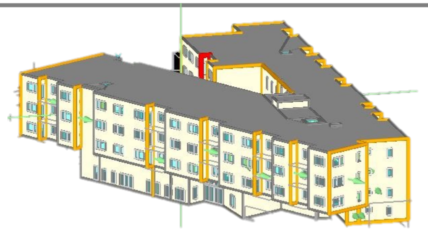
CLT
*cross-laminated timber*

# Mass Timber Building Assembly



# Wufi Modeling:

## 340 Dixwell



**R-value**

Name

4" Conc Slab -2" EPS

Thermal resistance [hr ft² °F/Btu]: 9.62 / 9.62 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | EPS (heat cond.: 0.04 W/mK - density: 1 | | 0.0181 | 2 | 9.2 |
| 2 | Concrete | | 0.7933 | 4 | 0.42 |

9. 62
Slab

5 ply clt Roof -12" Polyiscoyanurate (Average)

Thermal resistance [hr ft² °F/Btu]: 77.792 / 77.792 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | Polyisocyanurate Insulation | | 0.0139 | 12 | 72.114 |
| 2 | 5-ply cross-laminated panel | | 0.0693 | 4.724 | 5.678 |

77.792
Roof

3 ply CLT Wall - 4" Rockwool Confortboard 80

Thermal resistance [hr ft² °F/Btu]: 18.835 / 18.835 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | (de-Valued) Rockwool Confortboard 80 | | 0.0236 | 4 | 14.1 |
| 2 | INTELLO (according to German approva | | 1.3867 | 0.039 | 0.002 |
| 3 | 3-ply cross-laminated panel | | 0.0693 | 3.937 | 4.732 |

18.835
3 Ply
Ext. Wall

5 ply CLT Wall - 4" Rockwool Confortboard 80

Thermal resistance [hr ft² °F/Btu]: 18.835 / 18.835 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | (de-Valued) Rockwool Confortboard 80 | | 0.0236 | 4 | 14.1 |
| 2 | INTELLO (according to German approva | | 1.3867 | 0.039 | 0.002 |
| 3 | 5-ply cross-laminated panel | | 0.0693 | 3.937 | 4.732 |

18.835
5 Ply
Ext. Wall

## 316 Dixwell

**R-value**

4" Conc Slab -6" EPS

Thermal resistance [hr ft² °F/Btu]: 28.045 / 28.045 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | EPS (heat cond.: 0.04 W/mK - density: 1 | | 0.0181 | 6 | 27.624 |
| 2 | Concrete | | 0.7933 | 4 | 0.42 |

28.045
Slab

5 ply clt Roof -12" Polyiscoyanurate (Average)

Thermal resistance [hr ft² °F/Btu]: 77.792 / 77.792 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | Polyisocyanurate Insulation | | 0.0139 | 12 | 72.114 |
| 2 | 5-ply cross-laminated panel | | 0.0693 | 4.724 | 5.678 |

77.792
Roof

3 ply CLT Wall - 6" Rockwool Confortboard 80

Thermal resistance [hr ft² °F/Btu]: 26.093 / 26.093 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | (de-Valued) Rockwool Confortboard 80 | | 0.02341 | 6 | 21.358 |
| 2 | INTELLO (according to German approva | | 1.3867 | 3.9E-2 | 0.002 |
| 3 | 3-ply cross-laminated panel | | 0.0693 | 3.937 | 4.732 |

26.093
3 Ply
Ext. Wall

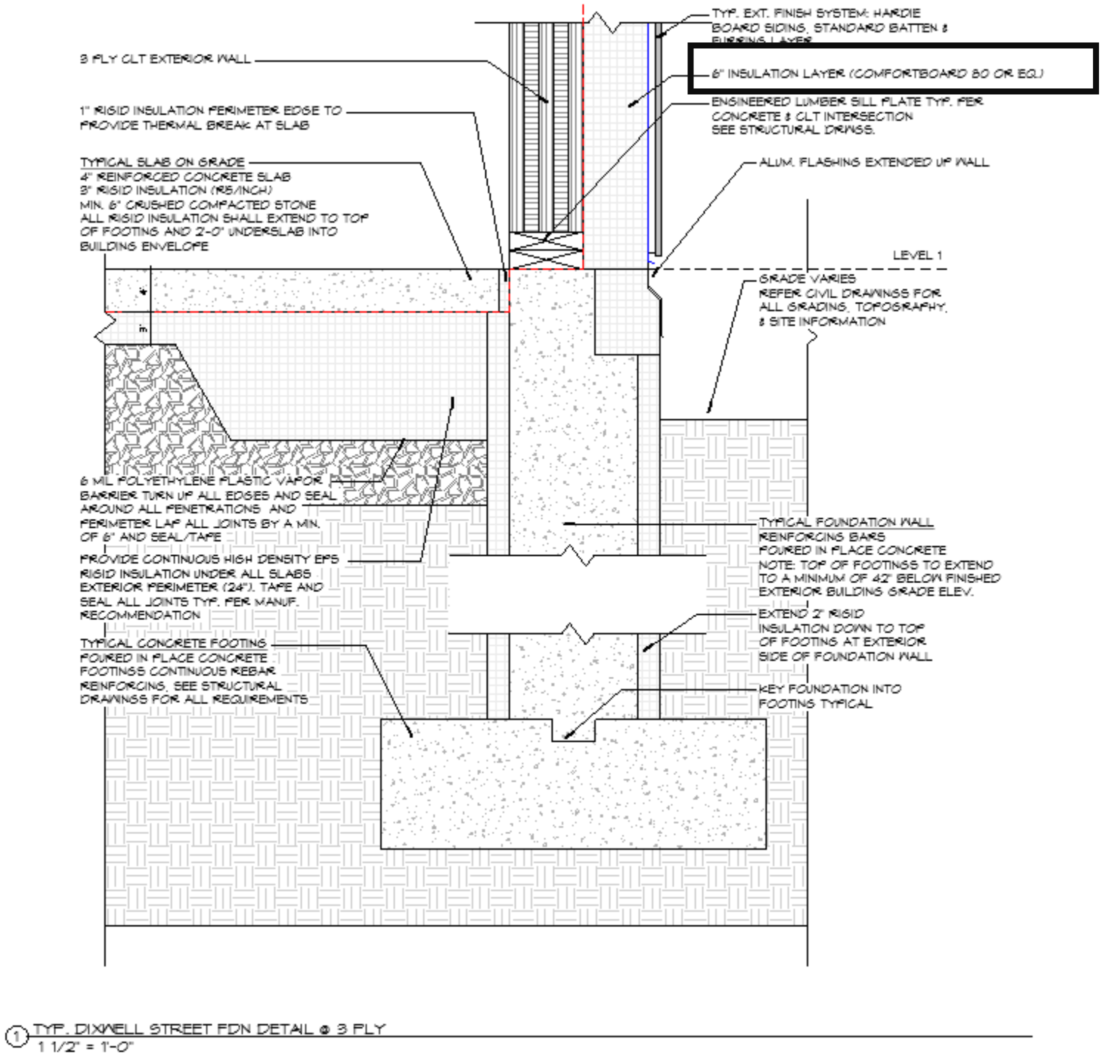
5 ply CLT Wall - 6" Rockwool Confortboard 80

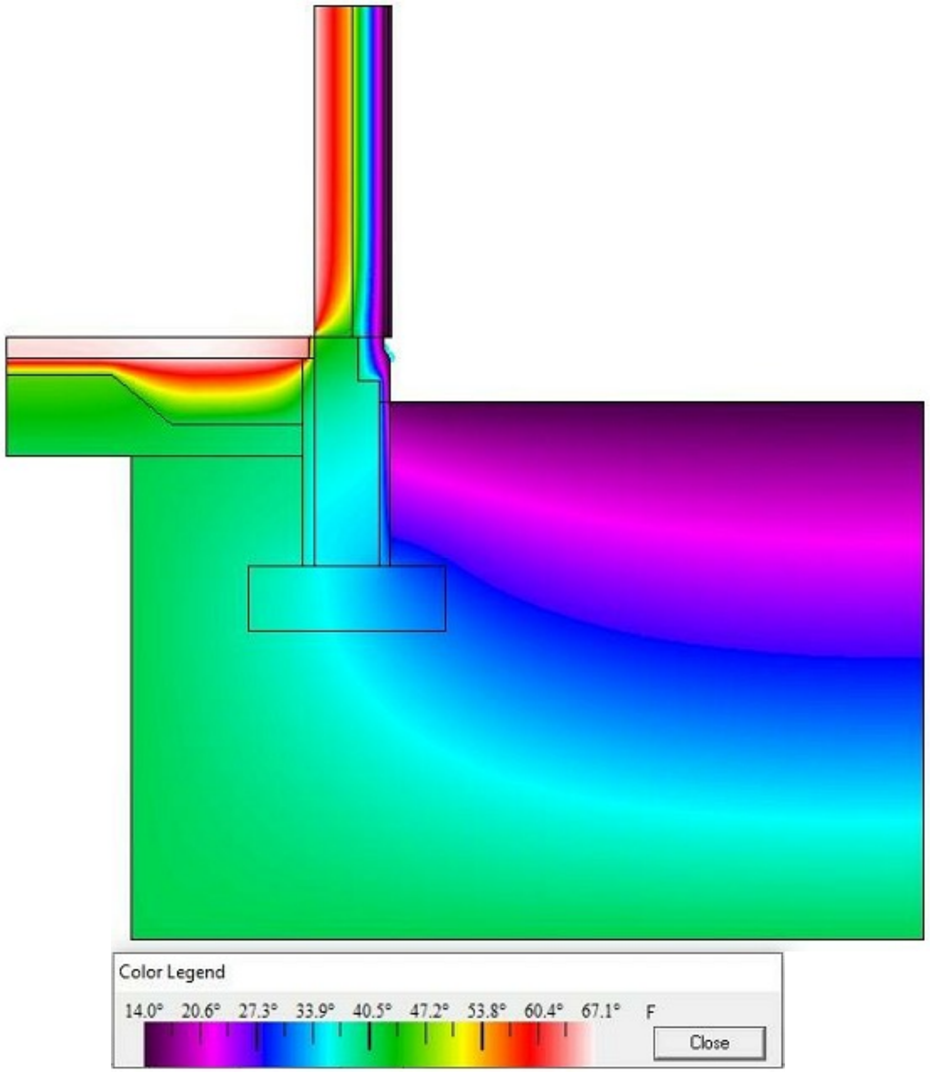
Thermal resistance [hr ft² °F/Btu]: 26.093 / 26.093 (EN ISO 6946 / homogenous layers)

| Nr. | Material / Layer (from outside to inside) | Color | λ [Btu/hr ft °F] | Thickness [in] | R [hr ft² °F/Btu] |
|---|---|---|---|---|---|
| 1 | (de-Valued) Rockwool Confortboard 80 | | 0.02341 | 6 | 21.358 |
| 2 | INTELLO (according to German approva | | 1.3867 | 3.9E-2 | 0.002 |
| 3 | 5-ply cross-laminated panel | | 0.0693 | 3.937 | 4.732 |

26.093
5 Ply
Ext. Wall

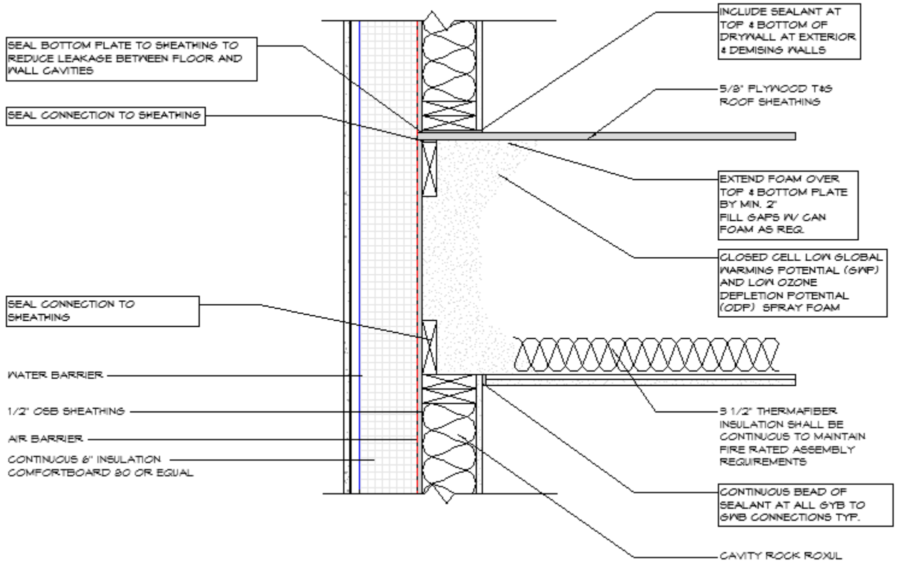
# 316 Dixwell: Foundation & Slab Detail

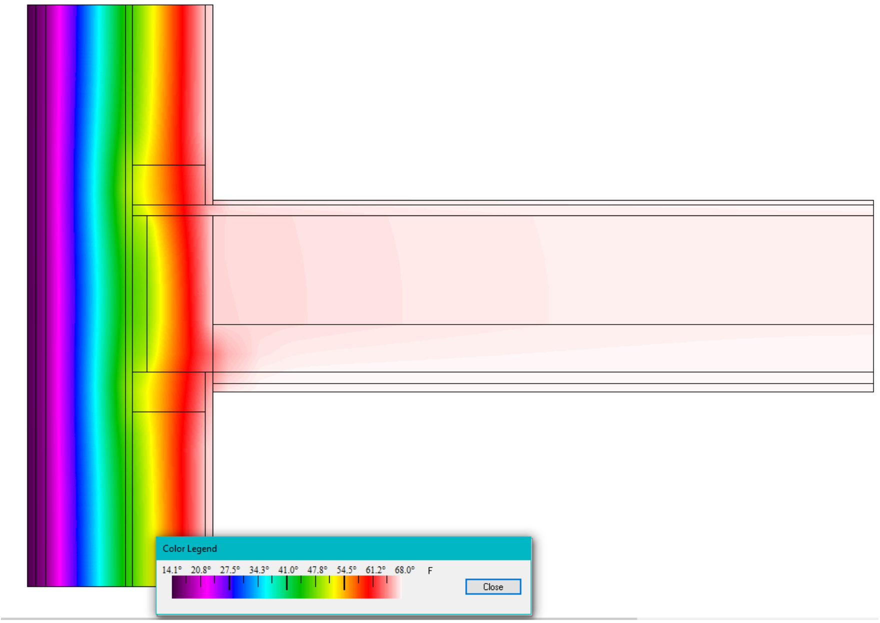


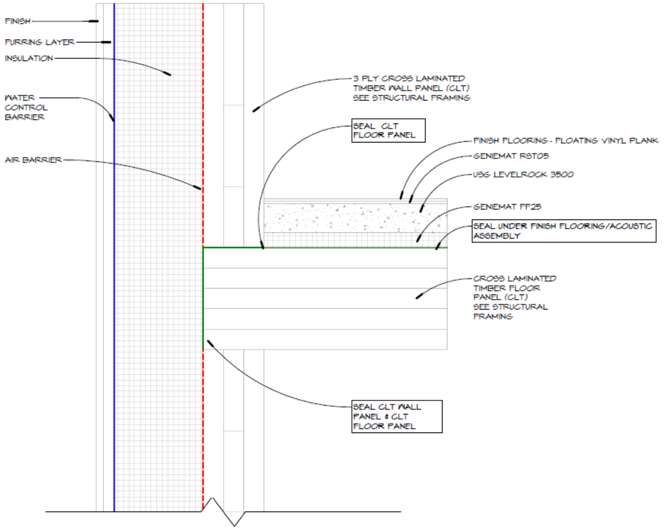
# Wood Framed PH vs CLT Framed PH: Exterior Wall & Floor Detail

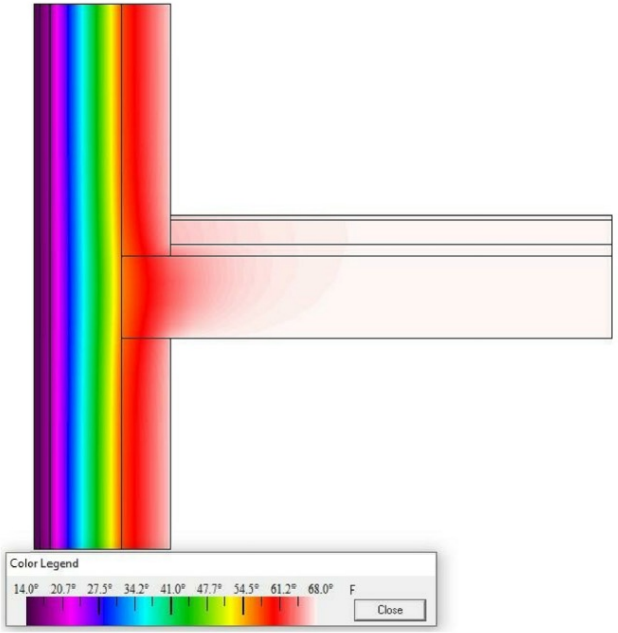
*wood framed construction- passive house*



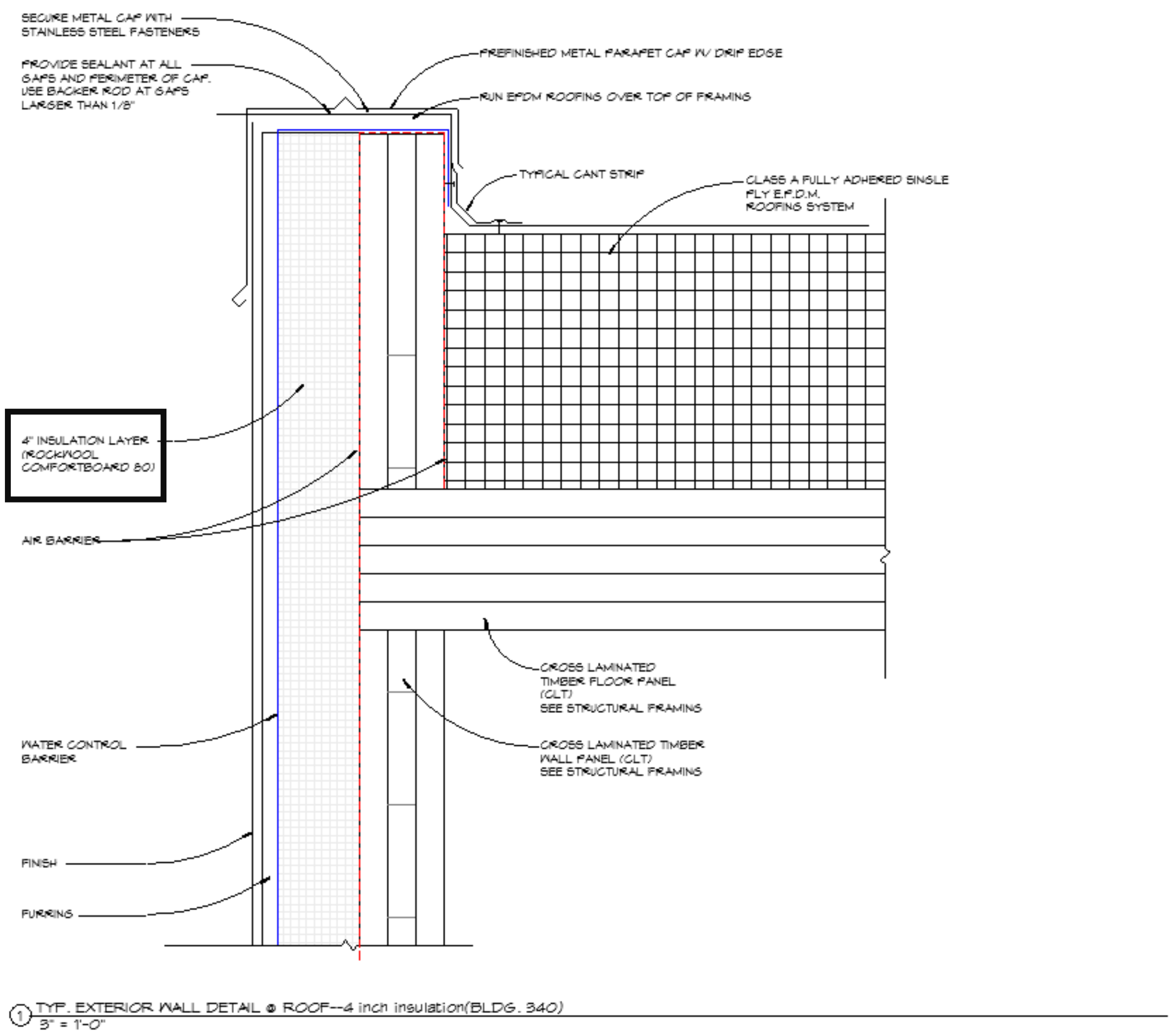



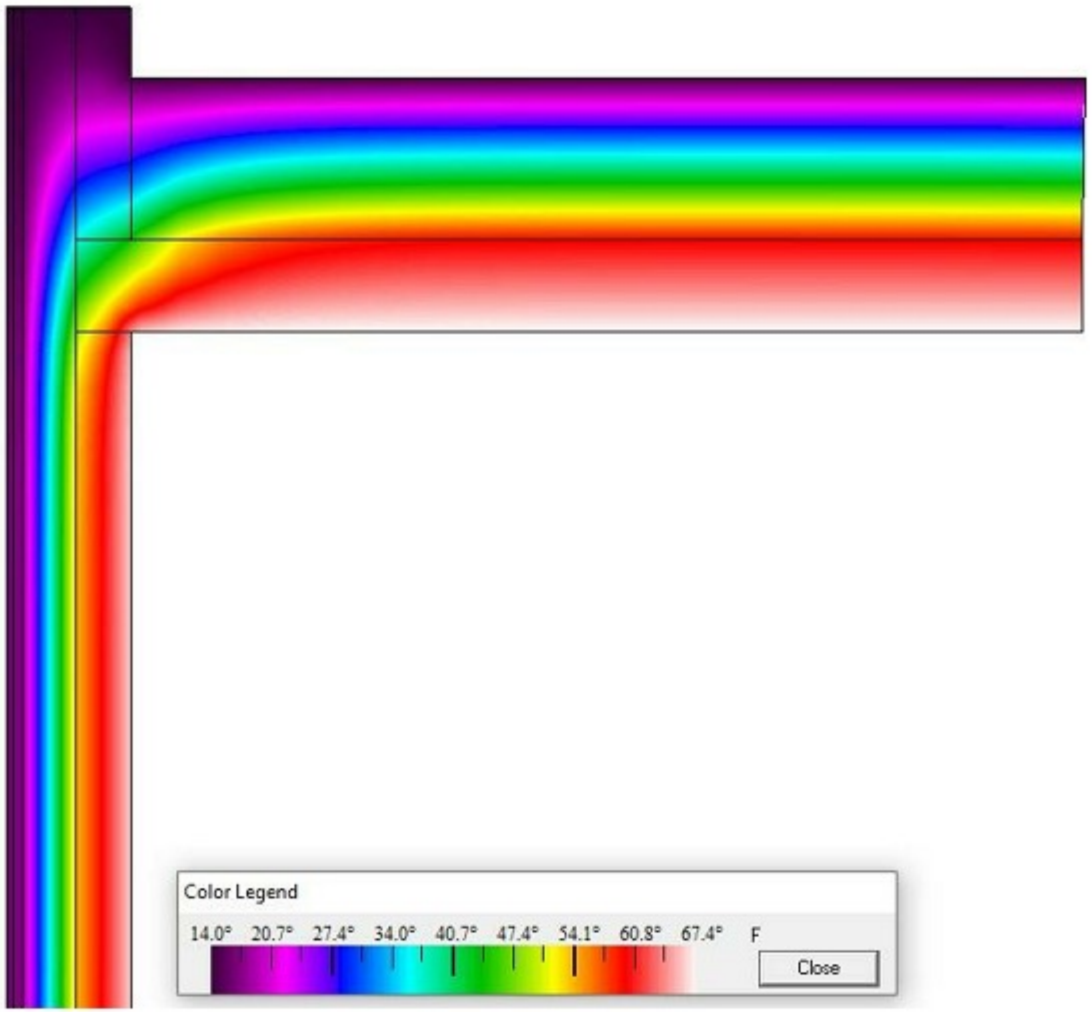

*cross laminated timber construction- passive house*



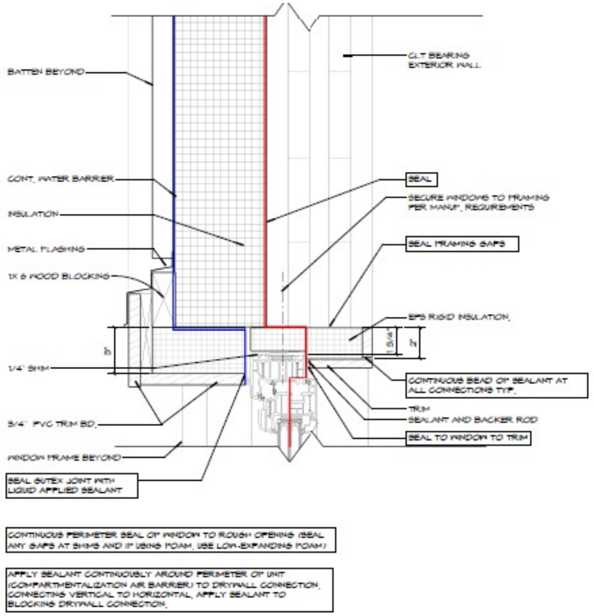



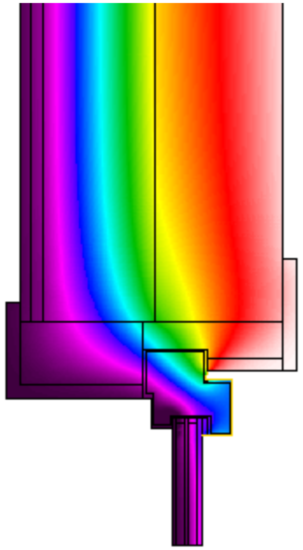
# 340 Dixwell: Roof Detail

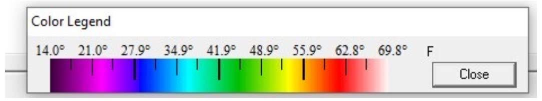


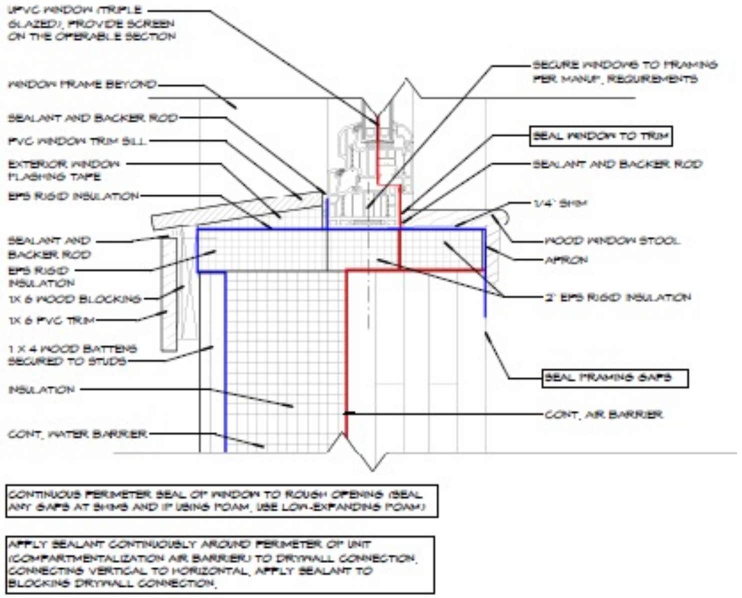



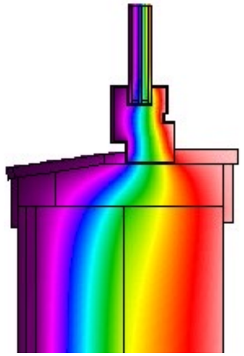
# Typical Window Details



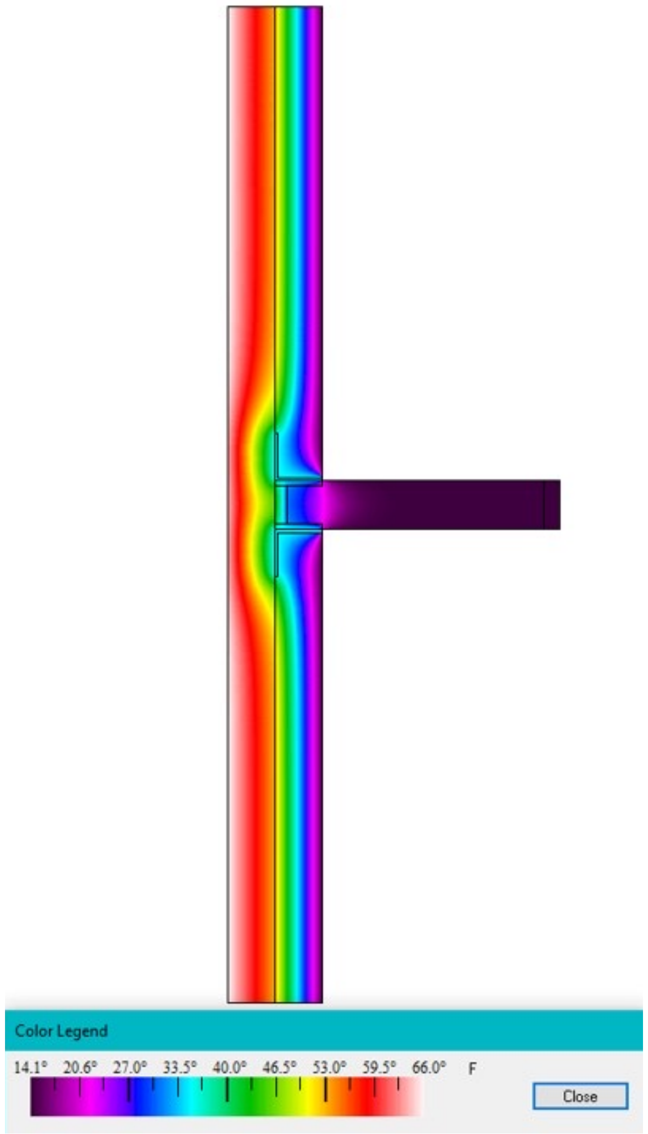





# Exterior Detailing for thermal bridges: North Facade




**North Cowl Thermal Bridge Calculation:**

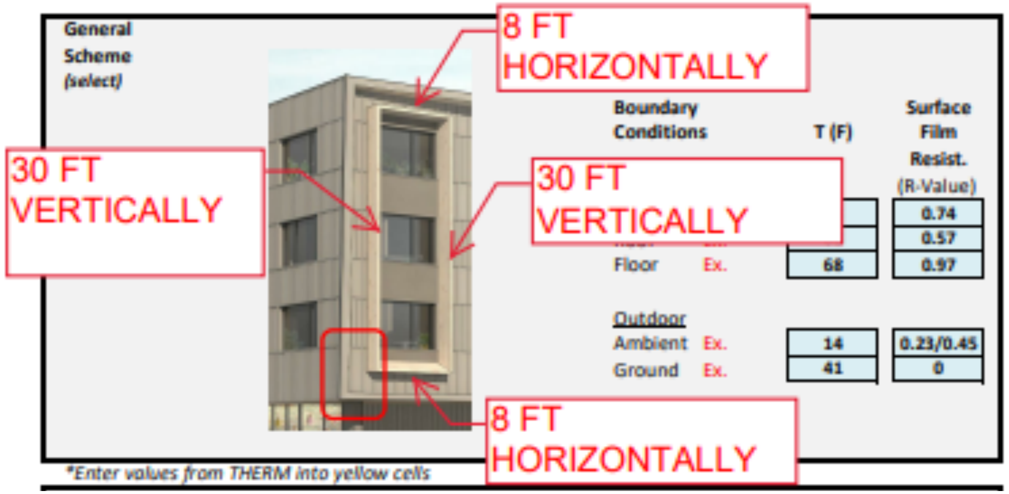
30 FT Vertical
(2 Sides)
8 FT Horizontal
(2 Sides)

Total = 76 FT

912(.072) = 65.664

Linear thermal bridges

| Nr | Name | Linear thermal transmittance [Btu/hr ft °F] | Length [ft] | Attachment |
|---|---|---|---|---|
| 1 | Apt above parking: #1 on A011 | 0.198 | 126.324 | Ambient |
| 2 | North Facade Part Plan 1: #1/ A-307A | 0.072 | 76 | Ambient |
| 3 | North Facade Section @ Soffit: #10 /A307A | 0.008 | 333.25 | Ambient |
| 4 | Entry Door Sill Detail: A002 #1 | 0.261 | 27 | Ambient |
| 5 | Grid C at Mech Rm: #1 / A006 | 0.16 | 47.74 | Ambient |

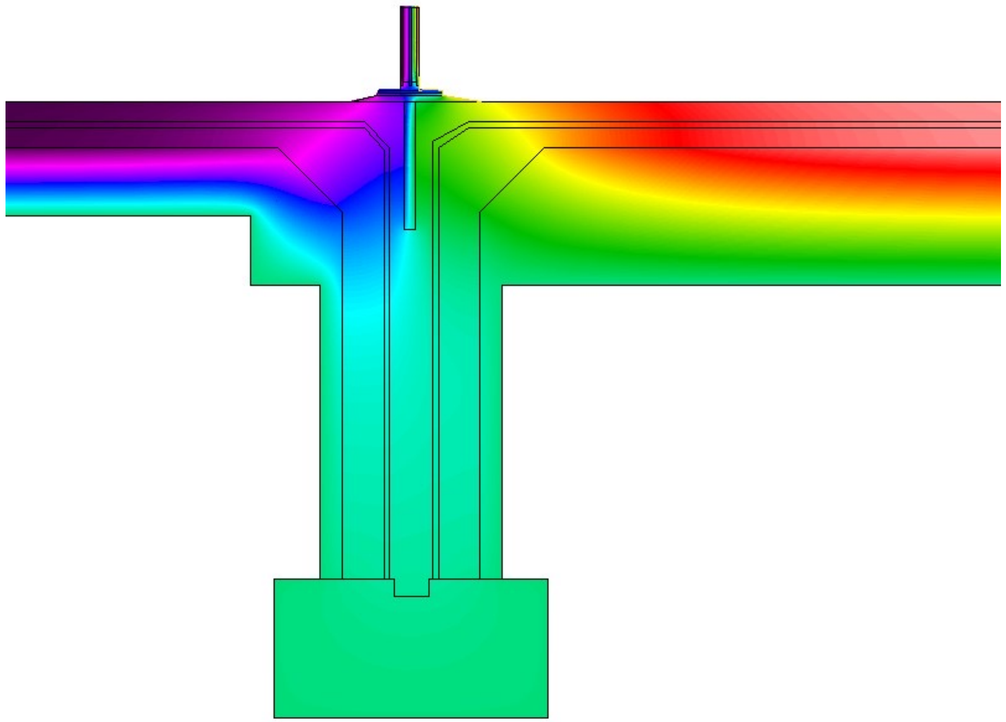


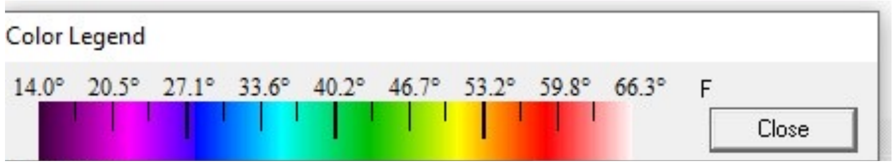

| 2D model | | U (btu/hr.sf.F) | dT (F) | L (in) | ULdT (btu/hr.ft) | error (%) |
|---|---|---|---|---|---|---|
| | Interior | 0.0593 | 54 | 84.13 | 22.45 | 4.78% |
| | Exterior | 0.0415 | 54 | 120.05 | 22.42 | 4.78% |

| Component | | U (btu/hr.sf.F) | dT (F) | L (in) | ULdT (btu/hr.ft) | error (%) |
|---|---|---|---|---|---|---|
| Component A | Interior | 0.0490 | 54 | 84.13 | 18.55 | 0.00% |
| WALL-4INCH, 100 mm | Exterior | 0.049 | 54.00 | 84.13 | 18.55 | 0.00% |
| Component B | Interior | | | | 0.00 | 0.00% |
| N/A | Exterior | 0.0000 | 0.00 | 0.00 | 0.00 | 0.00% |

| Psi | PsidT (btu/hr.ft) | dT (F) | Psi (btu/hr.ft.F) | Psi for WUFI (btu/hr.ft.F) |
|---|---|---|---|---|
| Interior | 3.90 | 54.00 | 0.072 | 0.072 |
| Exterior | 3.87 | 54.00 | 0.072 | |

# Exterior Detailing for thermal bridges: Typical door at grade



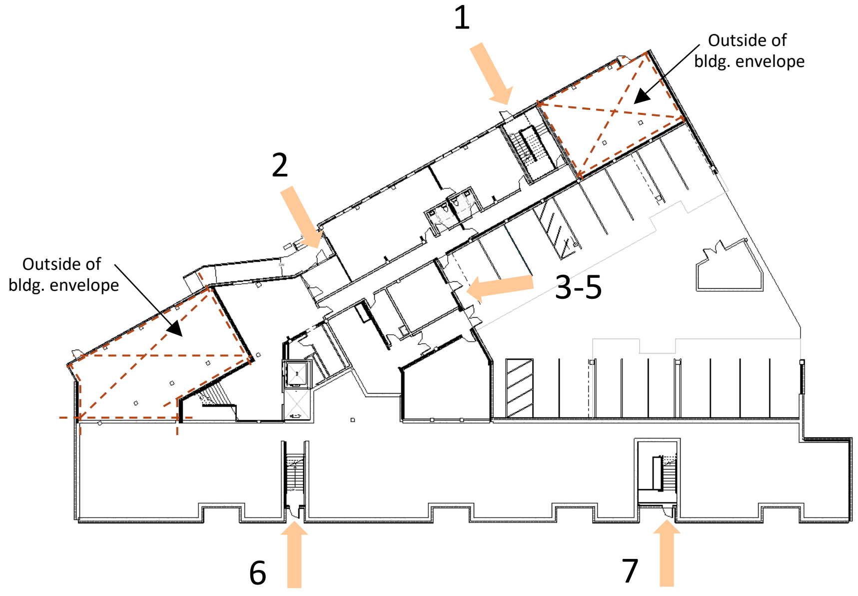



## Entry Door Thermal Bridge Calculation:

7 total exterior doors
(Bldg. 340)

Total Length= 27 feet

324(.261) = 84.564

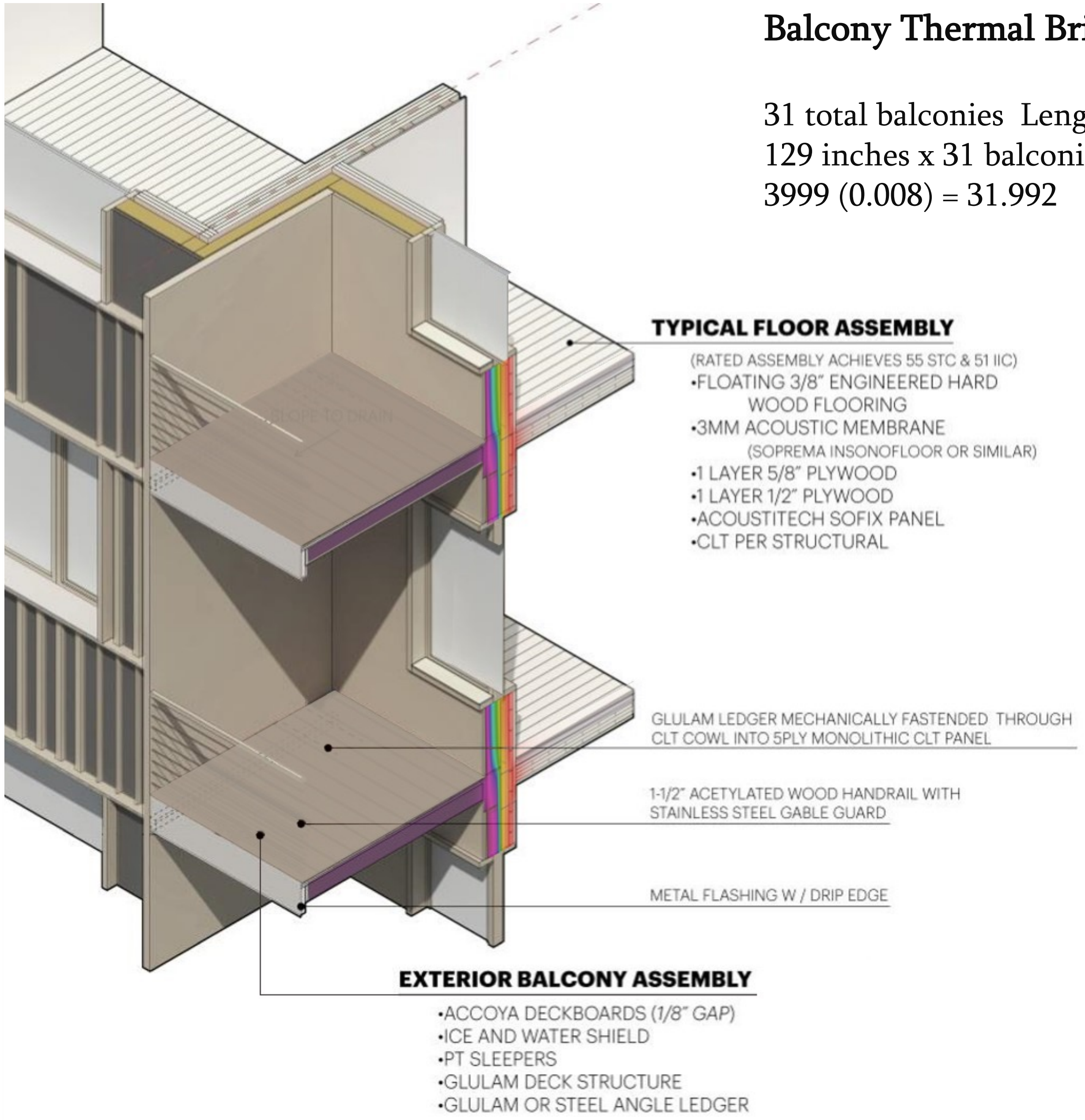



| 2D model | | U (btu/hr.sf.F) | dT (F) | L (in) | ULdT (btu/hr.ft) | error (%) |
|---|---|---|---|---|---|---|
| | Interior | 0.1038 | 54 | 75.19 | 35.12 | 4.97% |
| | Exterior | 0.0164 | 54 | 476.83 | 35.19 | 4.97% |

| Component | | U (btu/hr.sf.F) | dT (F) | L (in) | ULdT (btu/hr.ft) | error (%) |
|---|---|---|---|---|---|---|
| Component A | Interior | 0.1419 | 54 | 11.98 | 7.65 | 0.00% |
| Glass Door | Exterior | 0.142 | 54.00 | 11.98 | 7.65 | 0.00% |
| Component B | Interior | 0.0609 | 27 | 72 | 9.87 | 0.00% |
| Slab | Exterior | 0.0609 | 27.00 | 72.00 | 9.87 | 0.00% |
| Component C | Exterior | 0.0491 | 54 | 16.00 | 3.54 | 0.00% |
| WALL-4INCH | Exterior | 0.049 | 54.00 | 16.00 | 3.54 | 0.00% |

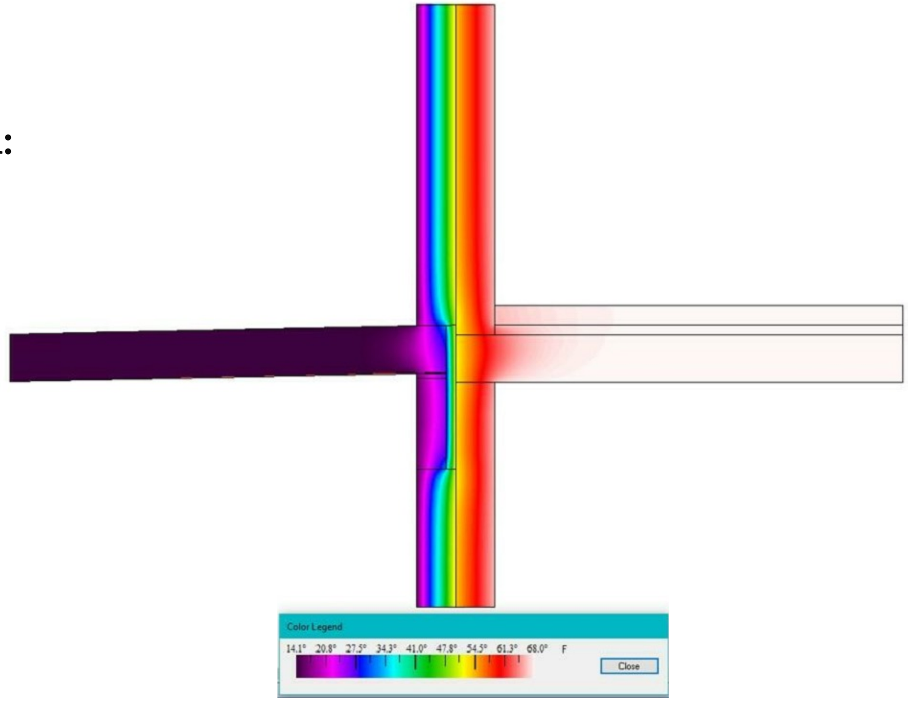
| Psi | PsidT (btu/hr.ft) | dT (F) | Psi (btu/hr.ft.F) | Psi for WUFI (btu/hr.ft.F) |
|---|---|---|---|---|
| Interior | 14.07 | 54.00 | 0.261 | 0.261 |
| Exterior | 14.14 | 54.00 | 0.262 | |

# Exterior Detailing for thermal bridges: Balcony detail




## Balcony Thermal Bridge Calculation:

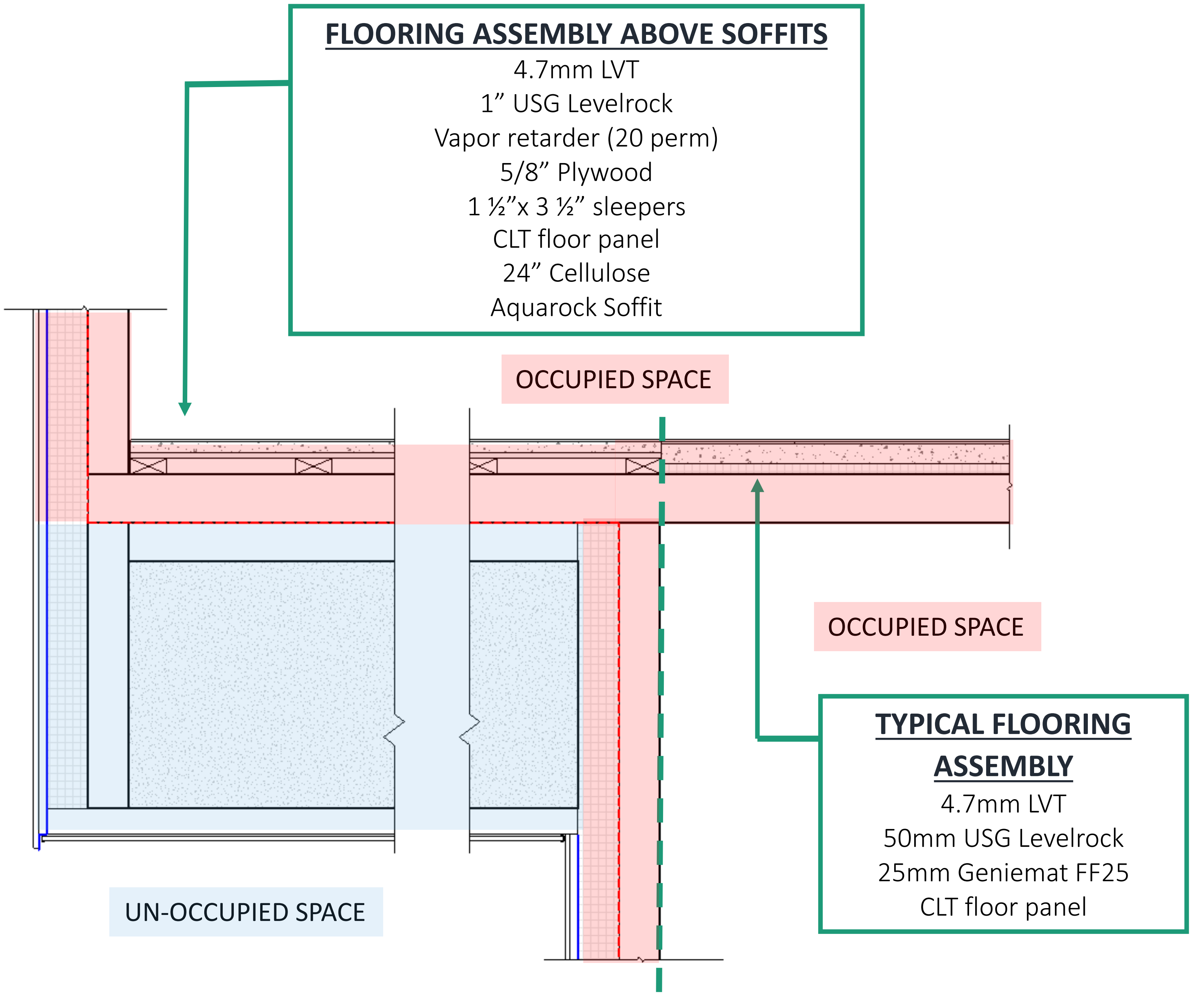
31 total balconies Length 10 ft 9 in
129 inches x 31 balconies = 3999
3999 (0.008) = 31.992

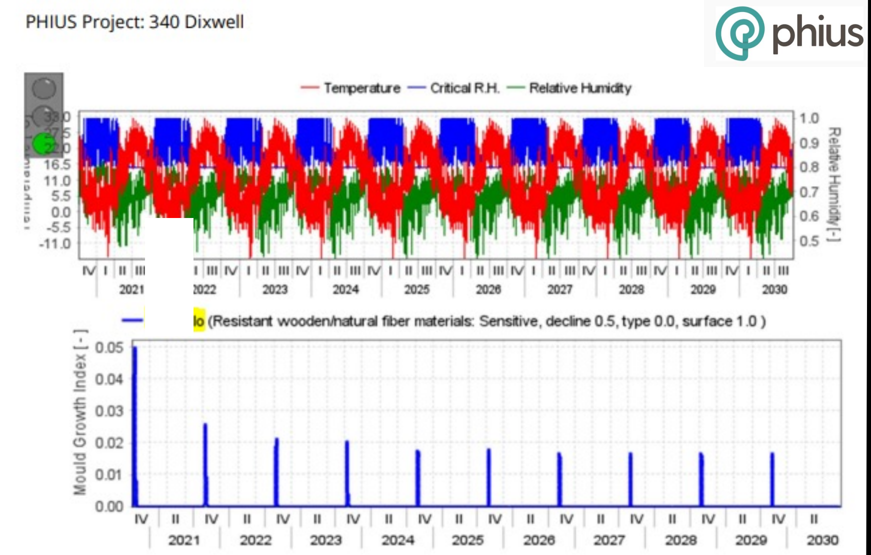


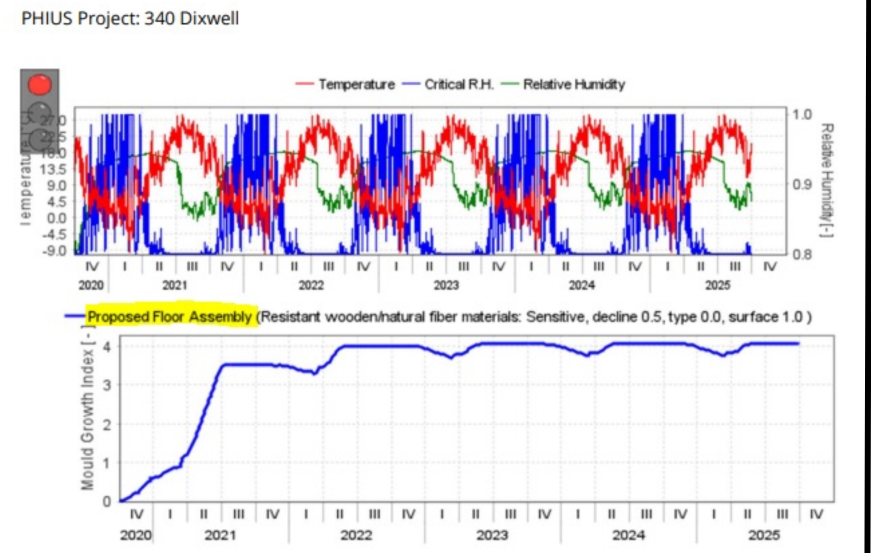

| 2D model | | U (btu/hr.sf.F) | dT (F) | L (in) | ULdT (btu/hr.ft) | error (%) |
|---|---|---|---|---|---|---|
| | Interior | 0.0224 | 54 | 135.67 | 13.68 | 3.42% |
| | Exterior | 0.022 | 54 | 138.25 | 13.69 | 3.42% |
| **Component** | | **U** (btu/hr.sf.F) | **dT** (F) | **L** (in) | **ULdT** (btu/hr.ft) | **error** (%) |
| Component A | Interior | 0.0483 | 54 | 60.99 | 13.26 | 0.00% |
| WALL-4INCH, 100 mm | Exterior | 0.048 | 54.00 | 60.99 | 13.26 | 0.00% |
| Component B | Interior | | | | 0.00 | 0.00% |
| N/A | Exterior | 0.0000 | 0.00 | 0.00 | 0.00 | 0.00% |

| Psi | | PsidT (btu/hr.ft) | dT (F) | Psi (btu/hr.ft.F) | Psi for WUFI (btu/hr.ft.F) |
|---|---|---|---|---|---|
| | Interior | 0.42 | 54.00 | 0.008 | 0.008 |
| | Exterior | 0.43 | 54.00 | 0.008 | |

# Flooring Assembly Analysis At Soffit




| Case | Mold Criterion | Rot Criterion | Initial Dry Out Time |
|---|---|---|---|
| Case 1:Proposed Floor Assembly | Fail | Pass, dry out issues in plywood though | Fail |
| Case 9: Gyp Screed | Pass | Pass, dry out issues in ply | Fail |
| Case 10: No Intello | Pass | Pass | Pass |

# Ventilation/Mechanical Systems

**Swegon ERV**
ERV-1
1885 CFM
ERV-2
2380 CFM

Rinnai
SENSEI

**Tankless Water Heater**
Super High Efficiency (Condensing)
Rinnai -CU199i
Up to 97% thermal efficiency
Certifications: AHRI, ANSI Z21.10.3, CSA 4.3, and Energy Star®

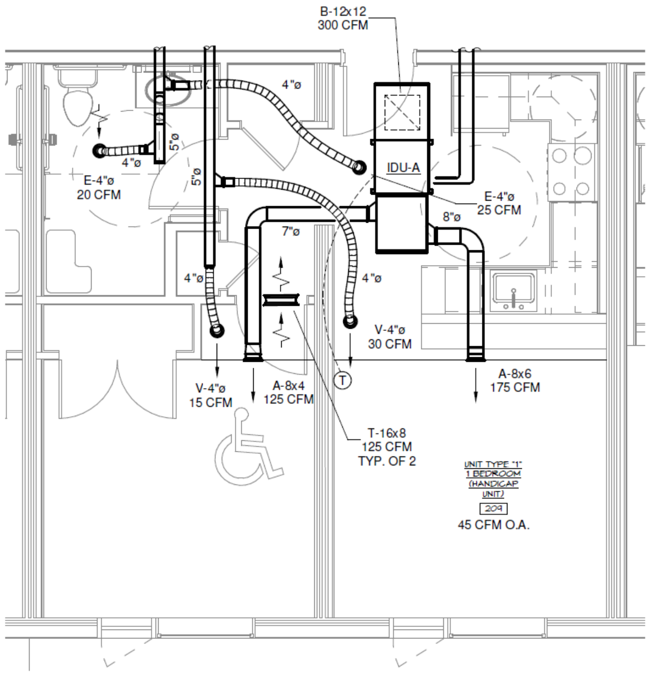
**Variable Refrigerant Flow**
VRF-1A
25.7/11.55 (IEER/EER)
VRF-1B
22.3/11.15 (IEER/EER)
VRF-2A
26.9/12.3 (IEER/EER)
VRF-2B
22.3/11.15 (IEER/EER)

**Fujitsu**
Airstage VR-II
EER (95F): 10.90
IEER: 19.60
SCHE: 25.20

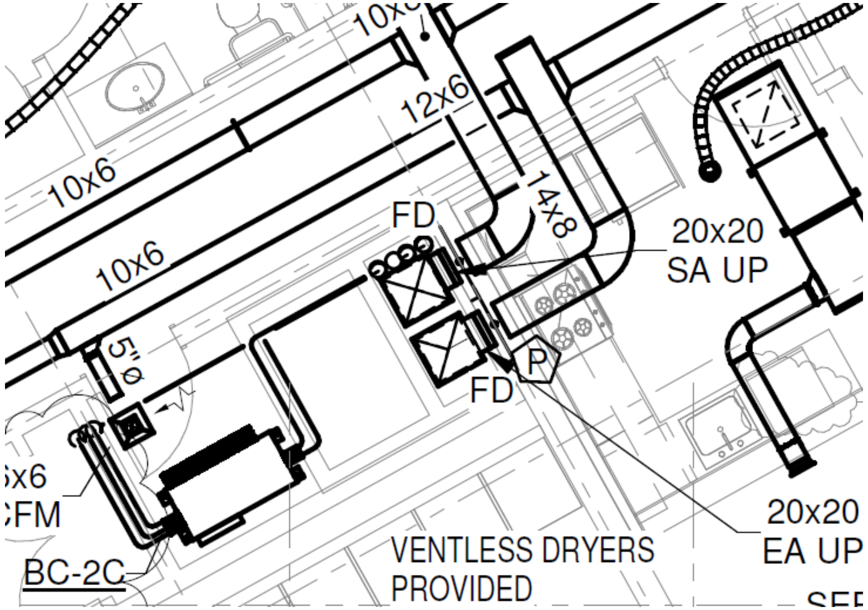

**Quest 70 Dehumidifier**
150 CFM
120 Volts

# Typical Apartment Building: Ventilation/Mechanical Systems

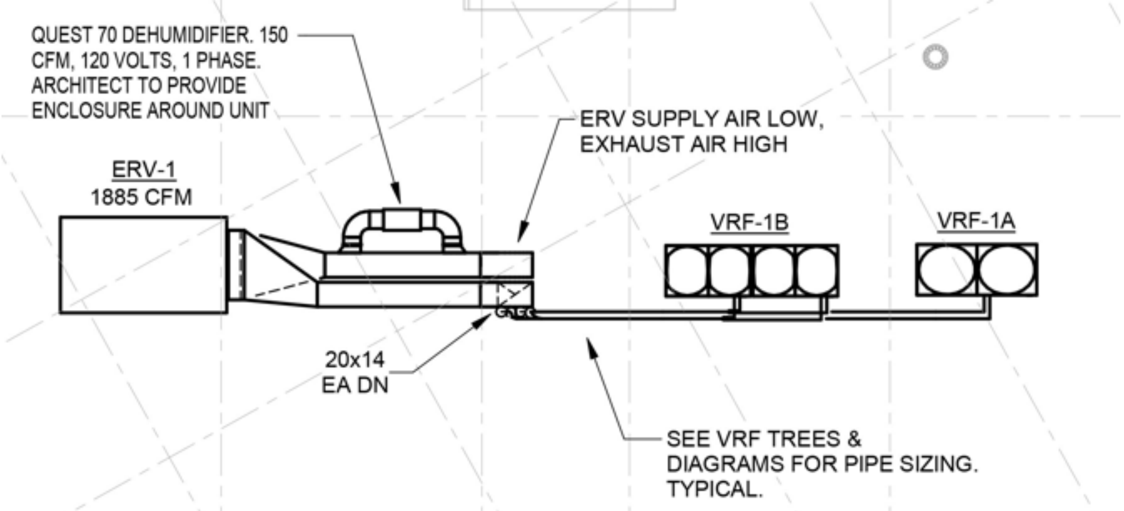
Typical Unit
Mechanical Plan




Mechanical Partial Upper Plan
On demand central water heating



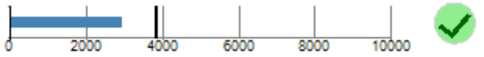

Mechanical
Partial Roof Plan 1



# Renewable Energy

**Source energy**

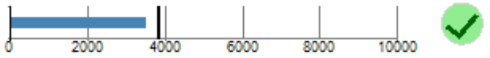
| | | |
|---|---|---|
| total: | 95,972.5 | kWh/yr |
| specific: | 2,908 | kWh/Person yr |
| target: | 3,840 | kWh/Person yr |
| total: | 327,439.45 | kBtu/yr |
| specific: | 23.31 | kBtu/ft²yr |



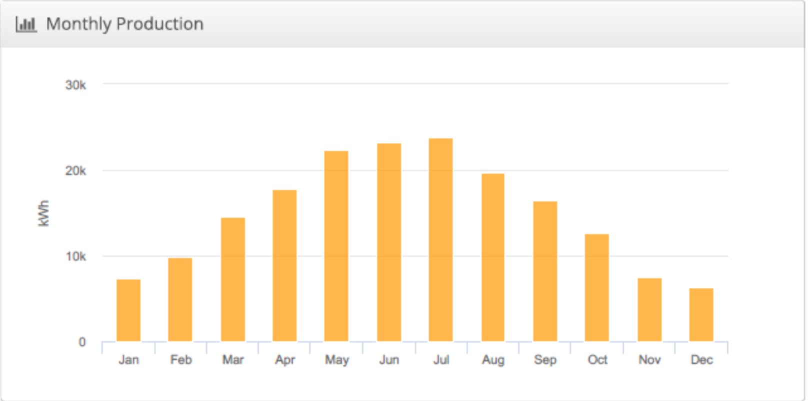

**35,000 kWh/yr Onsite Utilization from PV energy covering 36.46% of building electric usage**

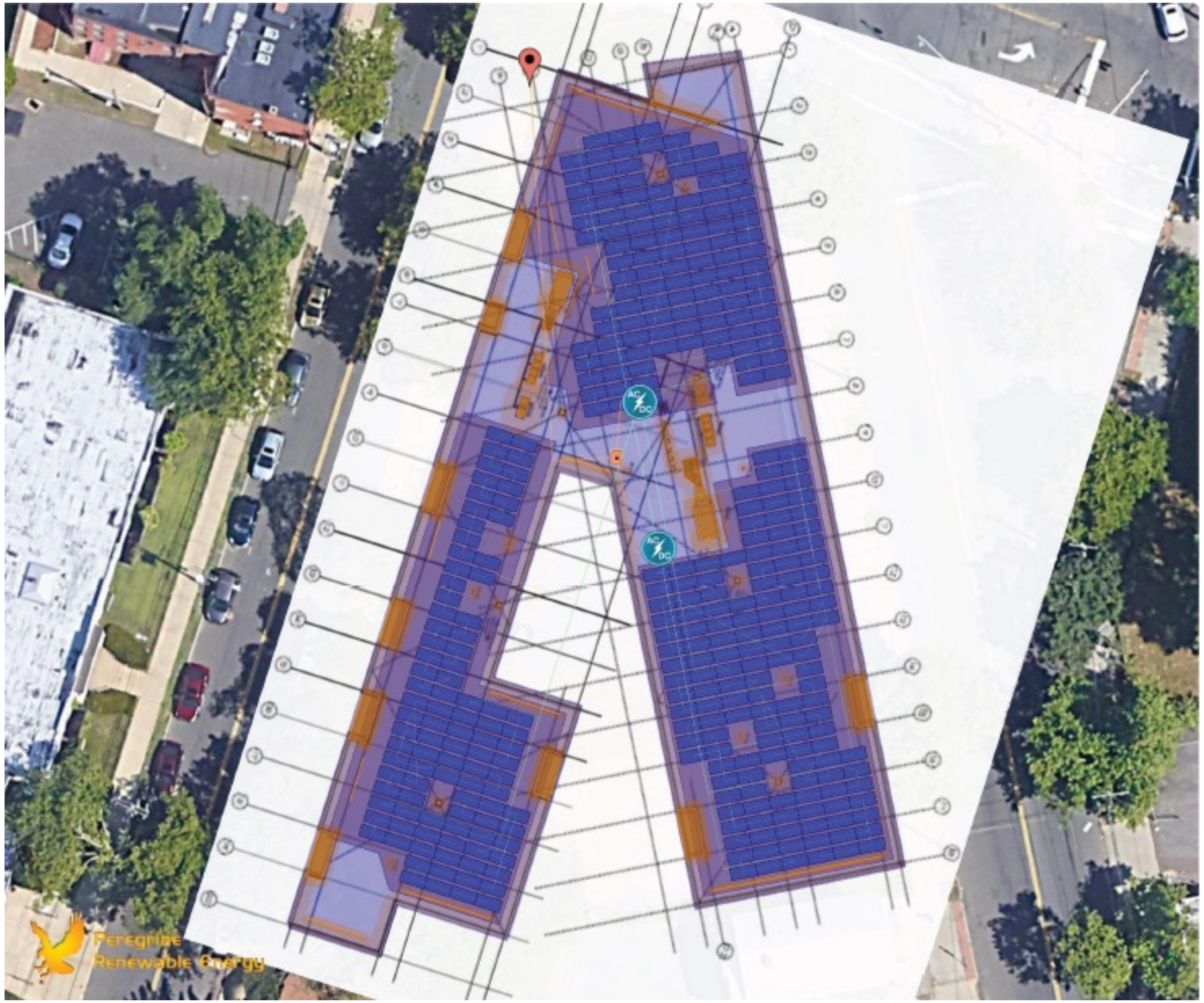
**Source energy**

| | | |
|---|---|---|
| total: | 554,106.54 | kWh/yr |
| specific: | 3,507 | kWh/Person yr |
| target: | 3,840 | kWh/Person yr |
| total: | 1,890,503.37 | kBtu/yr |
| specific: | 28.75 | kBtu/ft²yr |




**145,000 kWh/yr Onsite Utilization from PV energy covering 26.16% of building electric usage**




180,000 kWh/yr Onsite Utilization from PV energy covering 27.68% of Total electric usage

# Carbon Emissions for 340+ Dixwell Project

Volume of wood products used:
2,468 cubic meters (87,156 cubic feet)

Avoided greenhouse gas emissions:
738 metric tons of carbon dioxide

Carbon stored in wood:
1906 metric tons of carbon dioxide

Total potential carbon benefit:
2644 metric tons of carbon dioxide

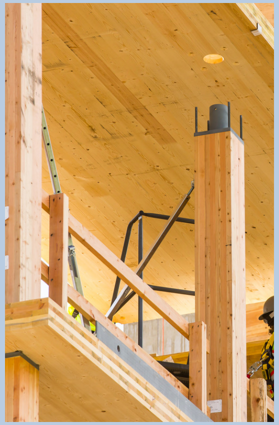
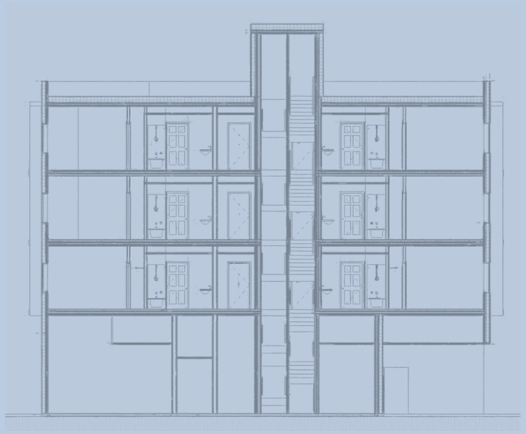
U.S. and Canadian forests grow this much wood in:
7 minutes

## Equivalent to:

559 cars off the road for a year

Energy to operate 279 homes for a year

# In conclusion...

Key Points:

1. Increasing **popularity in CLT incorporating** net-zero design strategies and embodied carbon. Used in a range of **affordable multifamily** housing projects because of its structural diversity.

2. Both traditional and CLT wood-frame structures meet the performance and net-zero goals for the affordable multifamily type, but in different ways.

3. Each construction type has its own unique challenge when designing to highly energy efficient structures.

4. Innovations in wood framing design techniques and products enhancing the energy efficiency in affordable multifamily projects

**Thank you!**

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Schadler Selnau Associates, P.C.

Jeff Spiritos
SPIRITOS PROPERTIES LLC