Designing Durable Balconies: Weather, Fire, Structure

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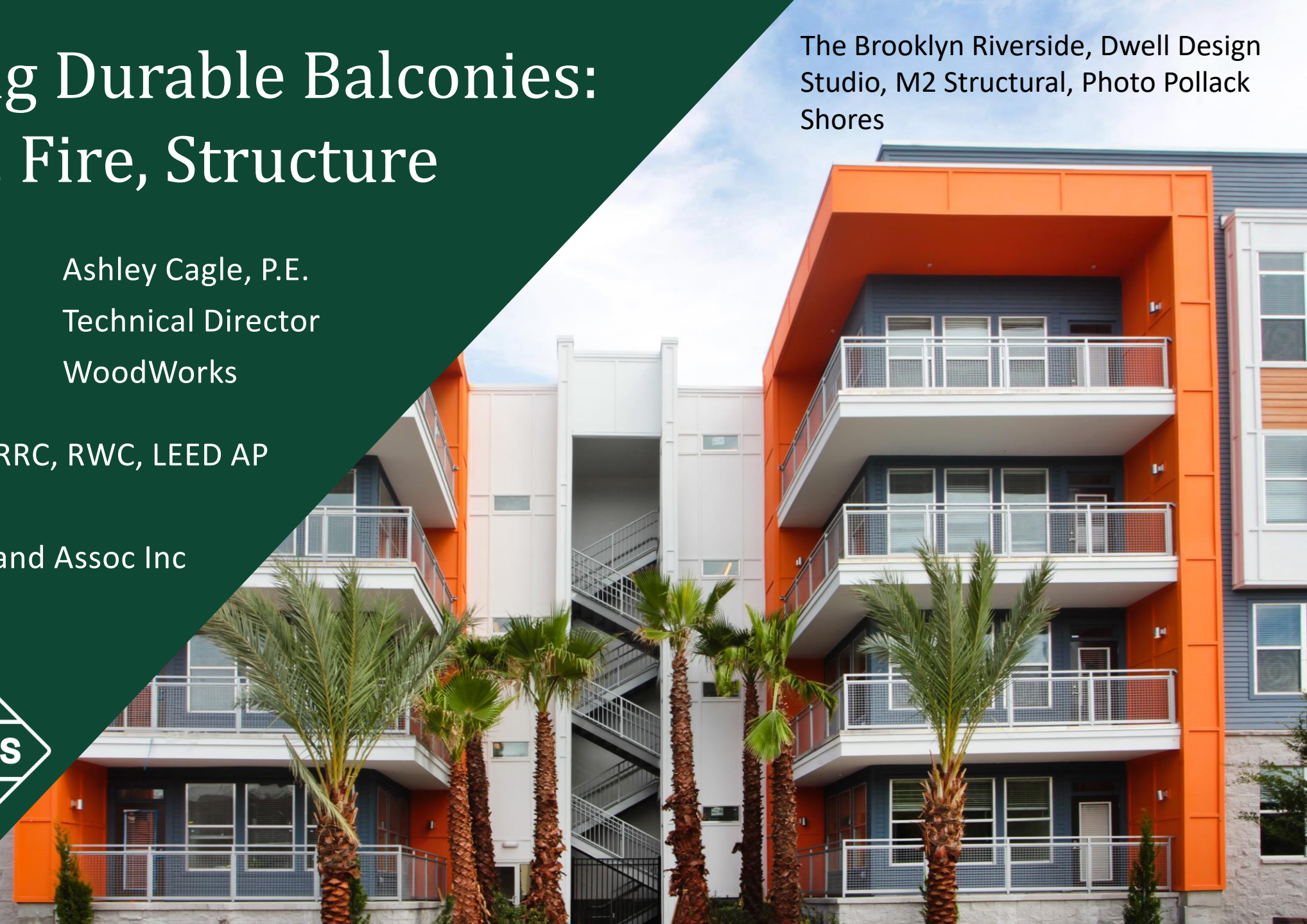

The Brooklyn Riverside, Dwell Design Studio, M2 Structural, Photo Pollack Shores

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Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

AIA Approved Continuing Education

Course Description

Balcony design in mixed-use and multi-family projects can be a challenge. Cantilevered balconies may be the most vulnerable element of the building in that they are exposed to weather and have limited structural redundancy. Not only do they require careful design and detailing to ensure safety and durability, they must also be verified to ensure that construction meets the requirements in the design documents. Adding complexity, fire-resistance requirements of balconies are often misunderstood. In this presentation, we'll discuss balcony detailing practices for greater resilience, as well as code requirements that address fire, structure, and protection from moisture.

Learning Objectives

1. Discuss changes made to the 2018 IBC as a result of the balcony collapse in Berkeley, California.
2. Highlight detailing options and best practices to maximize the long-term durability of balcony construction.
3. Review structural design considerations for balconies and discuss how to increase redundancy.
4. Explain the fire-rating requirements for balconies in common building types.

Agenda

Balconies:

- 2018 IBC Code Changes
- Fire Ratings
- Structural Framing
- Guardrails
- Waterproofing Design
- Waterproofing Construction

1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

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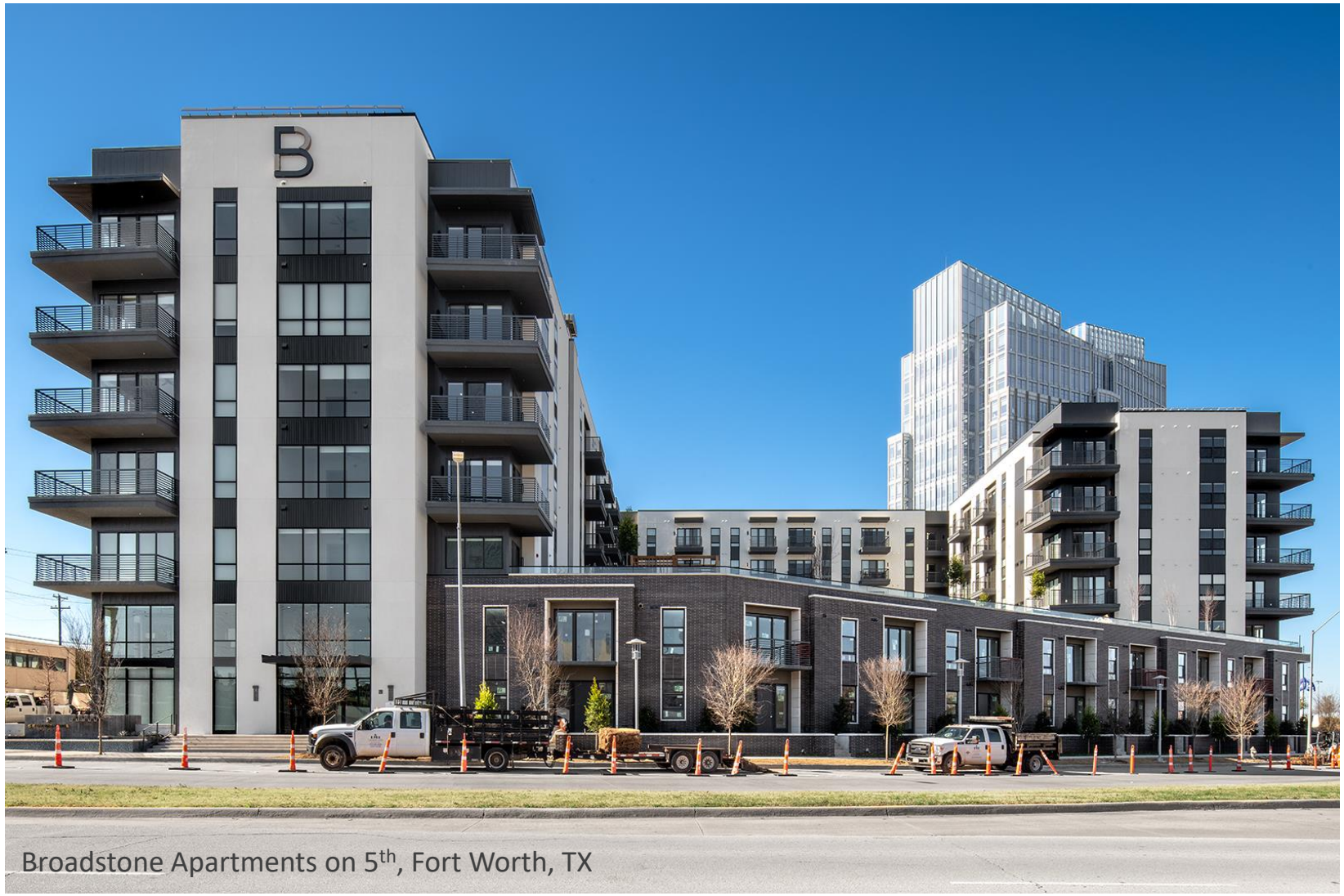
2018 IBC Balcony Code Changes



Broadstone Apartments on 5th, Fort Worth, TX

2018 IBC Balcony Code Changes

As a result of the Berkeley balcony collapse in 2015, several code changes were implemented in the 2018 IBC relative to balcony durability, inspections, ventilation and moisture protection

Changes Included:

Impervious moisture barrier system changes:

- Thorough documentation on construction documents
- Inspections
- Positive drainage
- Ventilation requirements

Broadstone Apartments on 5th, Fort Worth, TX

2018 IBC Balcony Code Changes

Documentation of impervious moisture barrier system on the construction documents, IBC 107.2.5 (new section)

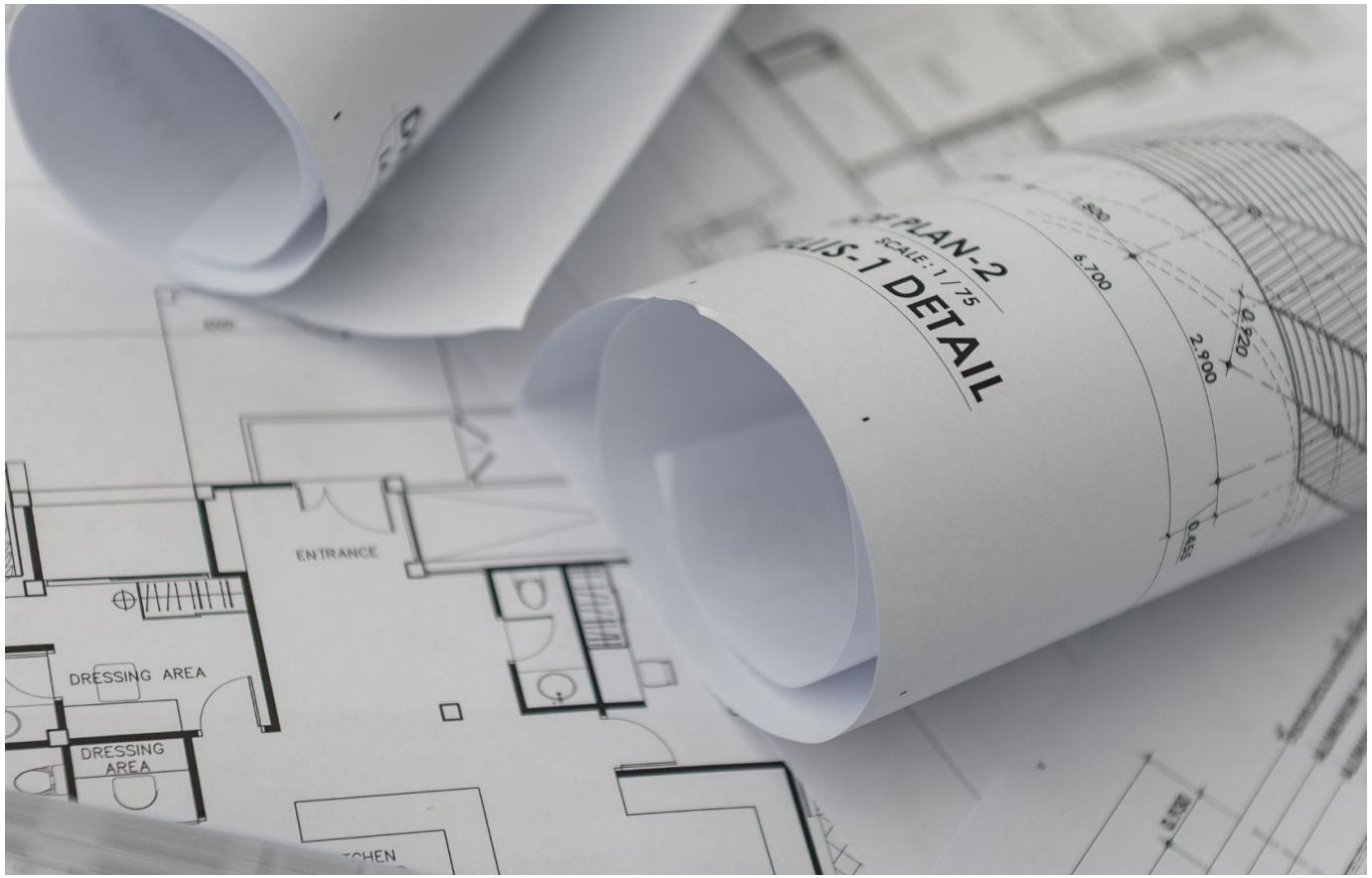
IBC 107.2.5 Exterior balcony and elevated walking surfaces. Where balcony or other elevated walking surfaces are exposed to water from direct or blowing rain, snow, or irrigation, and the structural framing is protected by an impervious moisture barrier, the construction documents shall include details for all elements of the impervious moisture barrier system. The construction documents shall include manufacturer's installation instructions.

Credit: Larry Harwell

2018 IBC Balcony Code Changes

Documentation of impervious moisture barrier system on the construction documents, IBC 107.2.5 (new section)

Purpose: ensure that all installation details and system components are fully documented to enable proper installation techniques and material use



2018 IBC Balcony Code Changes

Required inspection of impervious moisture barrier system, IBC 110.3.6 (new section)

IBC 110.3.6 Weather exposed balcony and walking surface waterproofing. Where balcony or other elevated walking surfaces are exposed to water from direct or blowing rain, snow, or irrigation, and the structural framing is protected by an impervious moisture barrier, all elements of the impervious moisture barrier system shall be not be concealed until inspected and approved.

Exception: Where special inspections are provided in accordance with Section 1705.1.1, Item 3.

2018 IBC Balcony Code Changes

Required inspection of impervious moisture barrier system, IBC 110.3.6 (new section)

Purpose: ensure that an inspection of the impervious moisture barrier system takes place prior to enclosing the space.

A further step toward ensuring that systems are installed in the intended manner with the ability to function as designed

2018 IBC Balcony Code Changes

Positive drainage for impervious moisture barrier systems, IBC 2304.12.2.5 (added language underlined)

IBC 2304.12.2.5 Supporting members for permeable floors and roofs. Wood structural members that support moisture-permeable floors or roofs that are exposed to the weather, such as concrete or masonry slabs, shall be of naturally durable or preservative treated wood unless separated from such floors or roofs by an impervious moisture barrier. <u>The impervious moisture barrier system protecting the structure supporting floors shall provide positive drainage of water that infiltrates the moisture-permeable floor topping</u>.

2018 IBC Balcony Code Changes

So what are the options?

When wood balcony framing is covered with a moisture permeable topping such as a concrete slab, the wood framing must meet one of the following criteria:

- Be preservative-treated or naturally decay resistant wood

or

- Be covered with an impervious moisture barrier system **with positive drainage**

2018 IBC Balcony Code Changes

If the impervious moisture barrier system does not have positive drainage, water that infiltrates the topping can remain stagnant over the impervious moisture barrier system, creating hydrostatic pressure

Positive drainage components commonly include a drainage mat above a waterproof membrane

<u>Some feel that using both PT wood and an impervious moisture barrier system with positive drainage is the best approach, even though it exceeds ‘code minimums’</u>

Walter Huntington Apartments

Preservative-treated and naturally durable wood

2304.12.2.3 Supporting member for permanent appurtenances. Naturally durable or *preservative-treated wood* shall be utilized for those portions of wood members that form the structural supports of buildings, balconies, porches or similar permanent building appurtenances where such members are exposed to the weather without adequate protection from a roof, eave, overhang or other covering to prevent moisture or water accumulation on the surface or at joints between members.

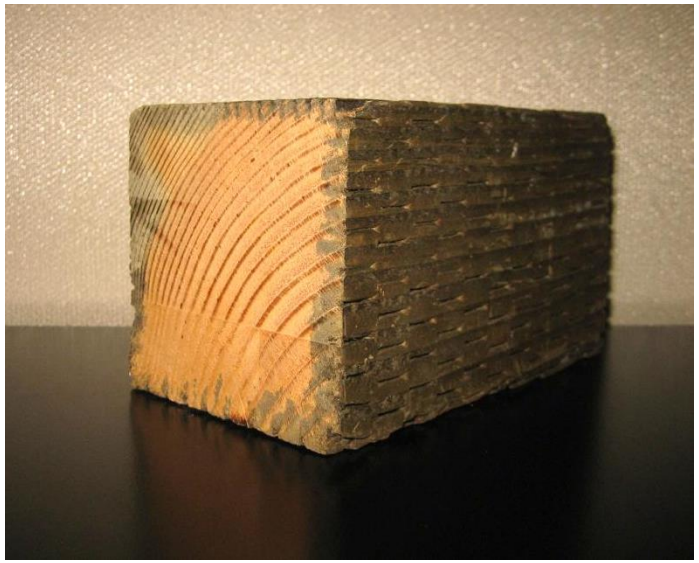
[BS] NATURALLY DURABLE WOOD. The heartwood of the following species except for the occasional piece with corner sapwood, provided 90 percent or more of the width of each side on which it occurs is heartwood.

- Because of their natural ability to resist deterioration, the harder portions of some species of wood are considered to be naturally durable. The code specifies that "occasional" sapwood is permitted, provided that heartwood constitutes 90 percent of each side.

Decay resistant. Redwood, cedar, black locust and black walnut.

Preservative Treated – Incising

Pressure-treated Douglas-fir



Pressure-treated Southern Pine

Photo from University of Tennessee Forest Products Extension

2018 IBC Balcony Code Changes

Enclosed balconies must be ventilated, IBC 2304.12.2.6 (new section)

IBC 2304.12.2.6 Ventilation required beneath balcony or elevated walking surfaces. Enclosed framing in exterior balconies and elevated walking surfaces that are exposed to rain, snow, or drainage from irrigation, shall be provided with openings that provide a net free cross ventilation area not less than 1 /150 of the area of each separate space.

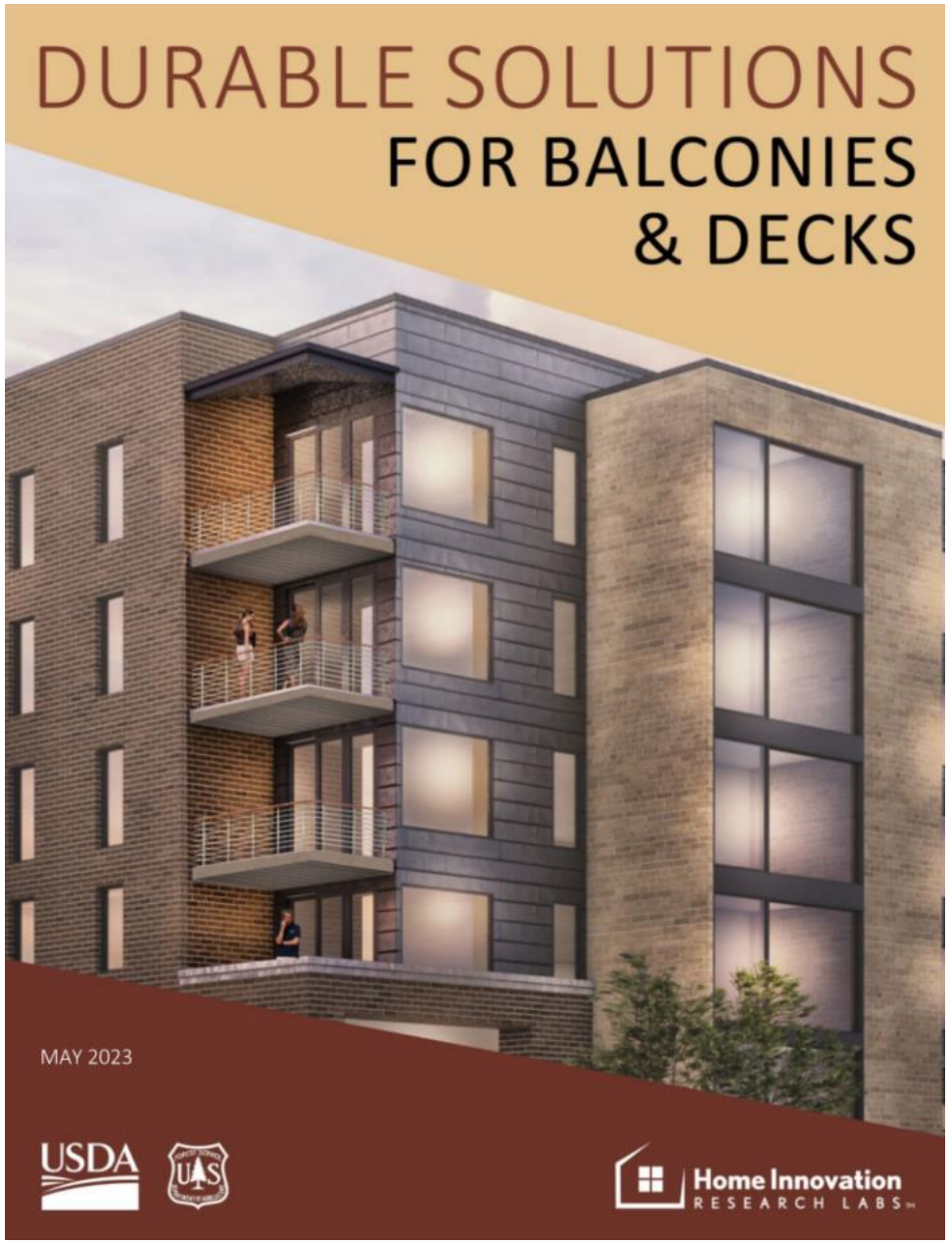
2018 IBC Balcony Code Changes

What's the purpose of ventilating enclosed balcony framing spaces?

No matter how well detailed and installed the balcony moisture protection system is, moisture may still find its way into enclosed spaces. There needs to be a way for this moisture to exit – the ventilation strategy aims to solve that

Credit: Balcony Inspection Vents

2018 IBC Balcony Code Changes



https://www.homeinnovation.com/trends_and_reports/featured_reports/durable-solutions-for-balconies-and-decks

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Balconies – IBC 705.2.3.1

705.2.3.1 Balconies and similar projections. Balconies and similar projections of combustible construction other than fire-retardant-treated wood shall be fire-resistance rated where required by Table 601 for floor construction or shall be of heavy timber construction in accordance with Section 2304.11. The aggregate length of the projections shall not exceed 50 percent of the building's perimeter on each floor.

Exceptions:

1. On buildings of Types I and II construction, three stories or less above grade plane, fire-retardant-treated wood shall be permitted for balconies, porches, decks and exterior stairways not used as required exits.
2. Untreated wood and plastic composites that comply with ASTM D7032 and Section 2612 are permitted for pickets, rails and similar guard components that are limited to 42 inches (1067 mm) in height.
3. Balconies and similar projections on buildings of Types III, IV and V construction shall be permitted to be of Type V construction and shall not be required to have a *fire-resistance rating* where sprinkler protection is extended to these areas.
4. Where sprinkler protection is extended to the balcony areas, the aggregate length of the balcony on each floor shall not be limited.

Balconies – IBC 705.2.3.1

So….

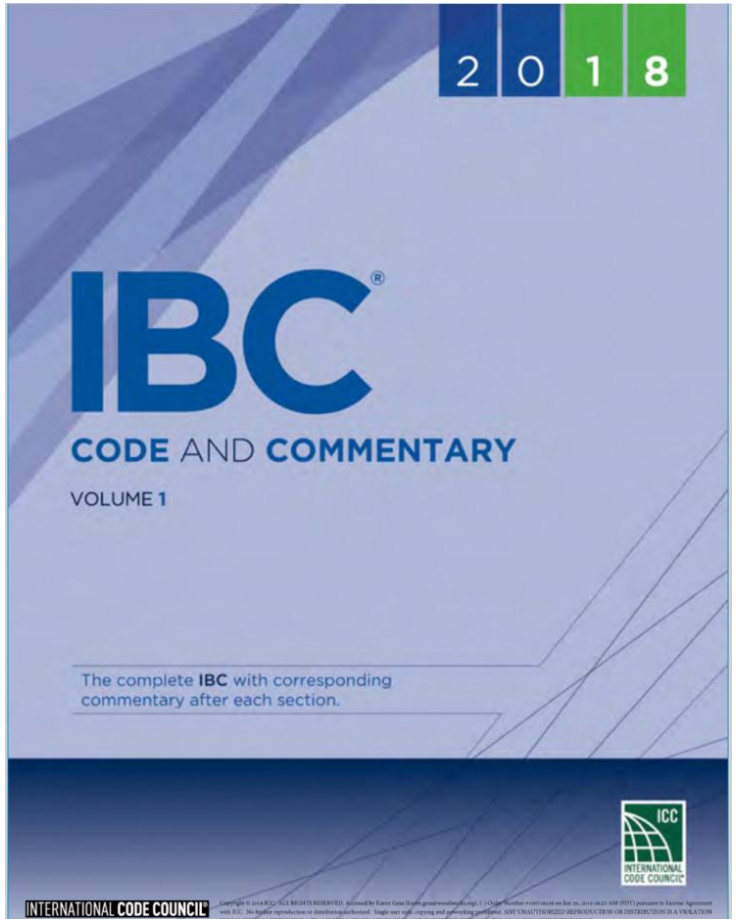
For Type III or V balcony options are:

1. **Non-combustible**: no sprinklers, no fire rating
2. **FRT**: no fire sprinklers, no fire rating
3. **Type IV**: no fire sprinklers, no fire rating
4. Non-FRT: **with fire sprinkler**, no fire rating
5. Non-FRT: no sprinkler, **fire rated per 601 & 602**

Disclaimer: These options are allowed by code for meeting construction type and fire-resistance rating requirements. They do not address durability considerations. Other code requirements may apply.

FRT definition

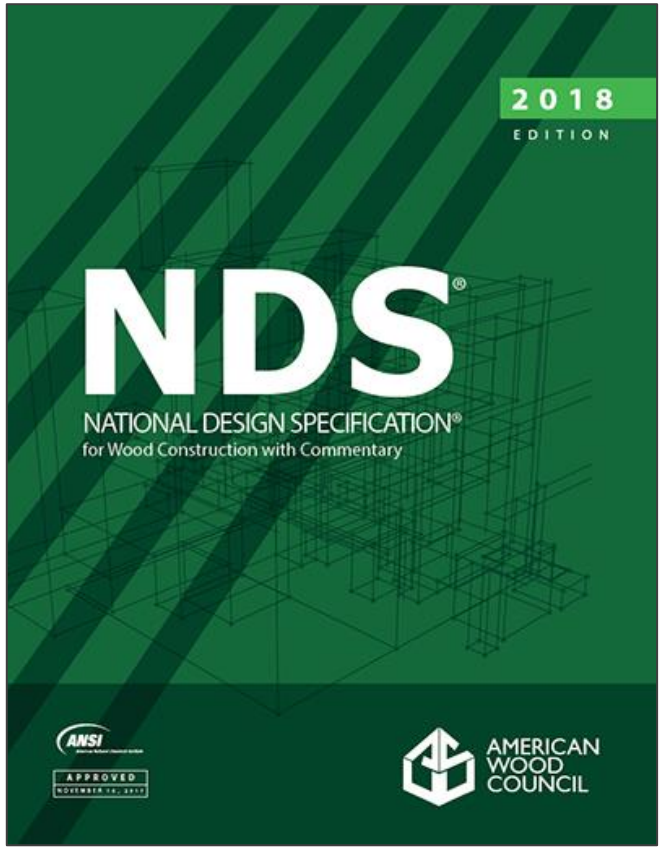
2303.2 Fire-retardant-treated wood. *Fire-retardant-treated wood* is any wood product that, when impregnated with chemicals by a pressure process or other means during manufacture, shall have, when tested in accordance with ASTM E84 or UL 723, a *listed* flame spread index of 25 or less and show no evidence of significant progressive combustion when the test is continued for an additional 20-minute period. Additionally, the flame front shall not progress more than $10^1/_2$ feet (3200 mm) beyond the centerline of the burners at any time during the test.



FRT Wood Design Values

NDS 2.3.4 Fire Retardant Treatment

The effects of fire-retardant chemical treatment on strength shall be accounted for in the design. Adjusted design values, including adjusted connection design values, for lumber and structural glued laminated timber pressure-treated with fire retardant chemicals shall be obtained from the company providing the treatment and redrying service.



FRT Wood Design Values

FRT manufacturers provide reduction values in literature, ICC ESR's, etc.

Sample FRT manufacturer's ESR reduction values:

TABLE 2—DESIGN VALUE ADJUSTMENT FACTORS FOR TREATED LUMBER

PROPERTY	WALL/FLOOR SERVICE TEMPERATURE TO 100°F/38°C			ROOF FRAMING, SERVICE TEMPERATURE TO 150° F/66° C,					
				Douglas fir			Southern pine		
				Climate Zone			Climate Zone		
	Douglas fir	Southern pine	Other species	1A	1B	2	1A	1B	2
Extreme fiber stress in bending, F_b	0.97	0.91	0.88	0.90	0.93	0.96	0.80	0.85	0.89
Tension parallel to grain F_t	0.95	0.88	0.83	0.80	0.87	0.93	0.80	0.84	0.88
Compression parallel to grain, F_c	1.00	0.94	0.94	0.94	0.98	1.00	0.94	0.94	0.94
Horizontal shear F_v	0.96	0.95	0.93	0.95	0.95	0.96	0.92	0.93	0.94
Modulus of elasticity, E	0.96	0.95	0.94	0.96	0.96	0.96	0.95	0.95	0.95
Compression perp. to grain F_{cz}	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Fasteners/connectors	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90

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Balconies vs Decks

IBC 2006 & ASCE 7-05:

BALCONY, EXTERIOR. An exterior floor projecting from and supported by a structure without additional independent supports.

DECK. An exterior floor supported on at least two opposing sides by an adjacent structure, and/or posts, piers or other independent supports.

- Different load requirements

Since then (IBC 2009 & ASCE 7-10):

- No distinction between “balconies” and “decks”

Uniform Live Load

IBC	2012	2015	2018	2021	2024
Balconies & Decks	same as area served	same as area served	1.5x area served, ≤ 100 psf	1.5x area served, ≤ 100 psf	1.5x area served, ≤ 100 psf
ASCE 7	**10**		**16**		**22**
Balconies & Decks	1.5x area served, ≤ 100 psf		1.5x area served, ≤ 100 psf		1.5x area served, ≤ 100 psf

For typical residential, LL = 40 psf

→ Balconies & decks, **LL = 60 psf**

Handrails & Guards

2018 & 2021 IBC refer to ASCE 7-16:

Top Rail:

- **200 lb point load** in any direction, at any point on top rail
- **50 plf line load** in any direction

Intermediate Rails:

- **50 lb point load** on a 12”x12” area

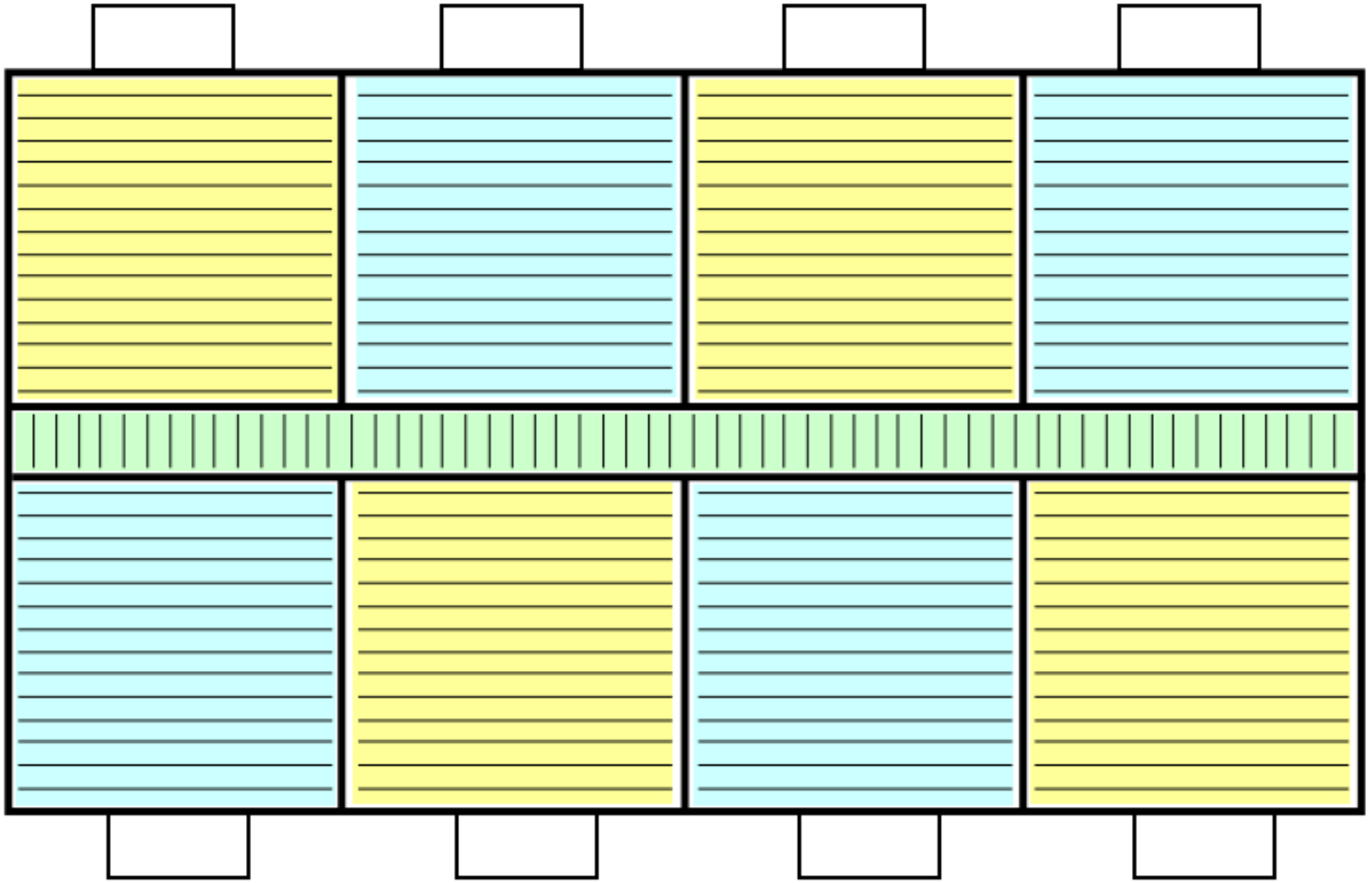
Balcony Details

Please note that the following details are examples of what we have seen used on projects and do not necessarily represent details that will be accepted and applicable in all jurisdictions and to all projects.

These details are not intended as recommendations for universally accepted details. Local product availability and manufacturer specifications should also be considered for each project.

The Architect of Record and Engineer of Record should verify acceptance of the details used on their project with all provisions of the building code, including local amendments, with the local Authority Having Jurisdiction.

Detail Examples



Detail Examples

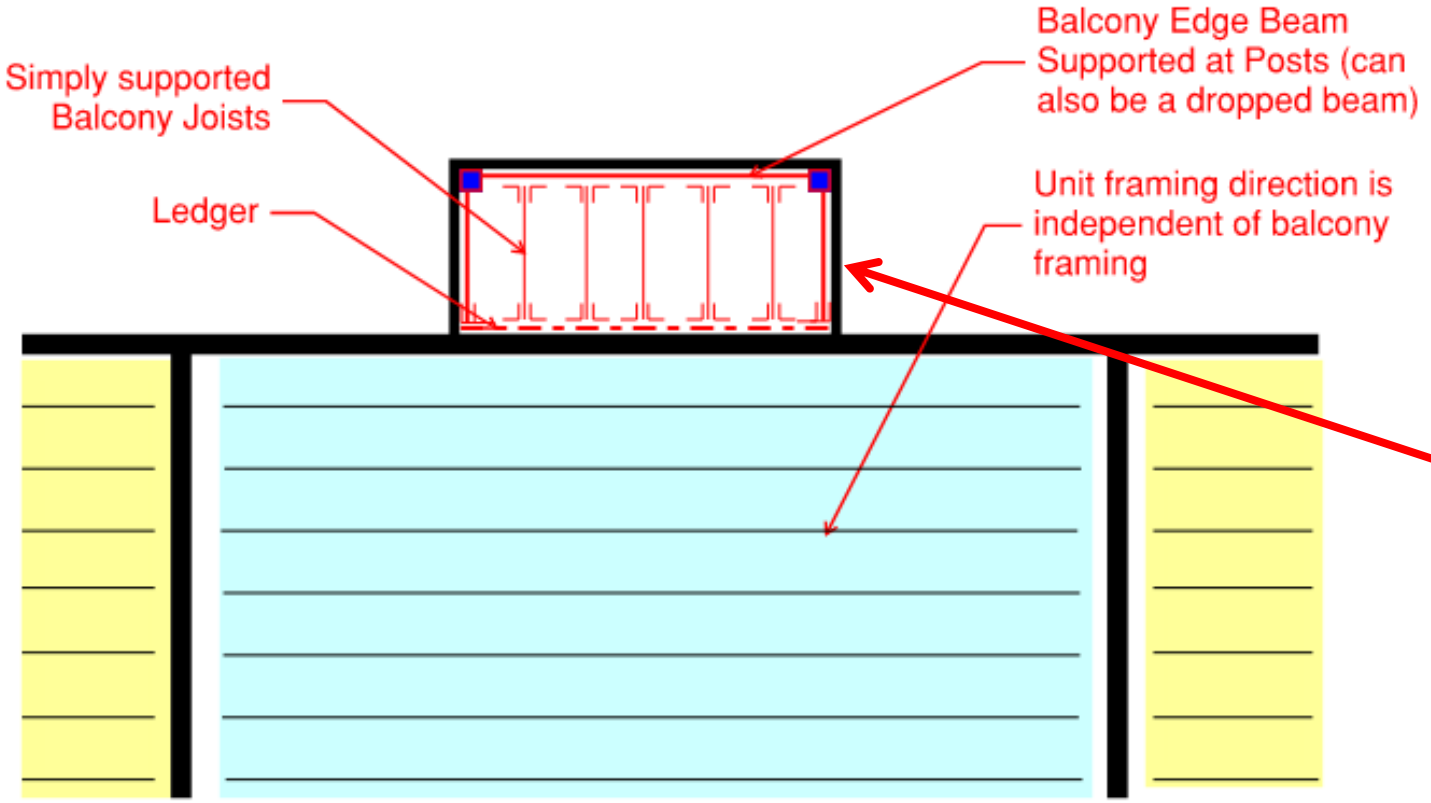
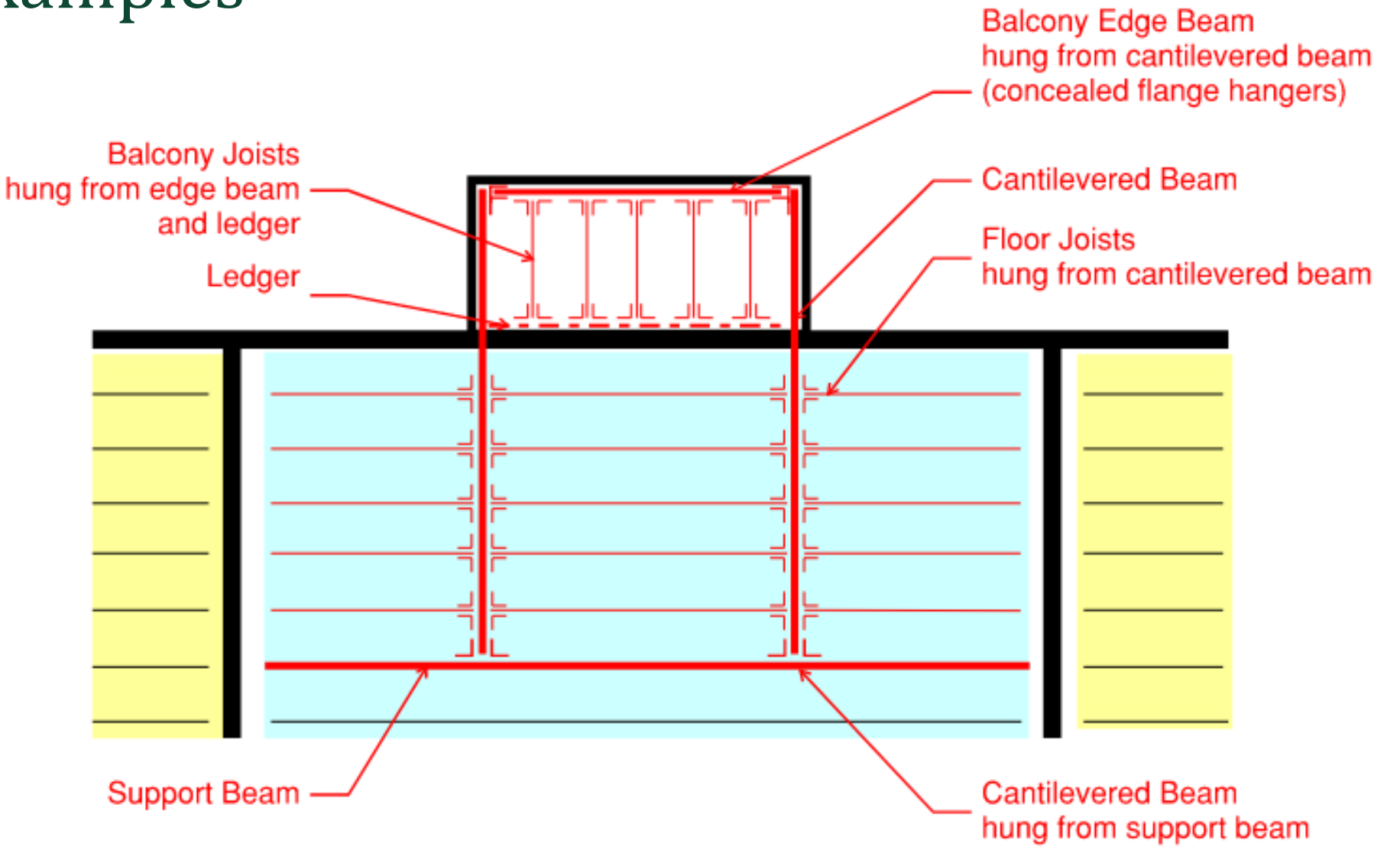
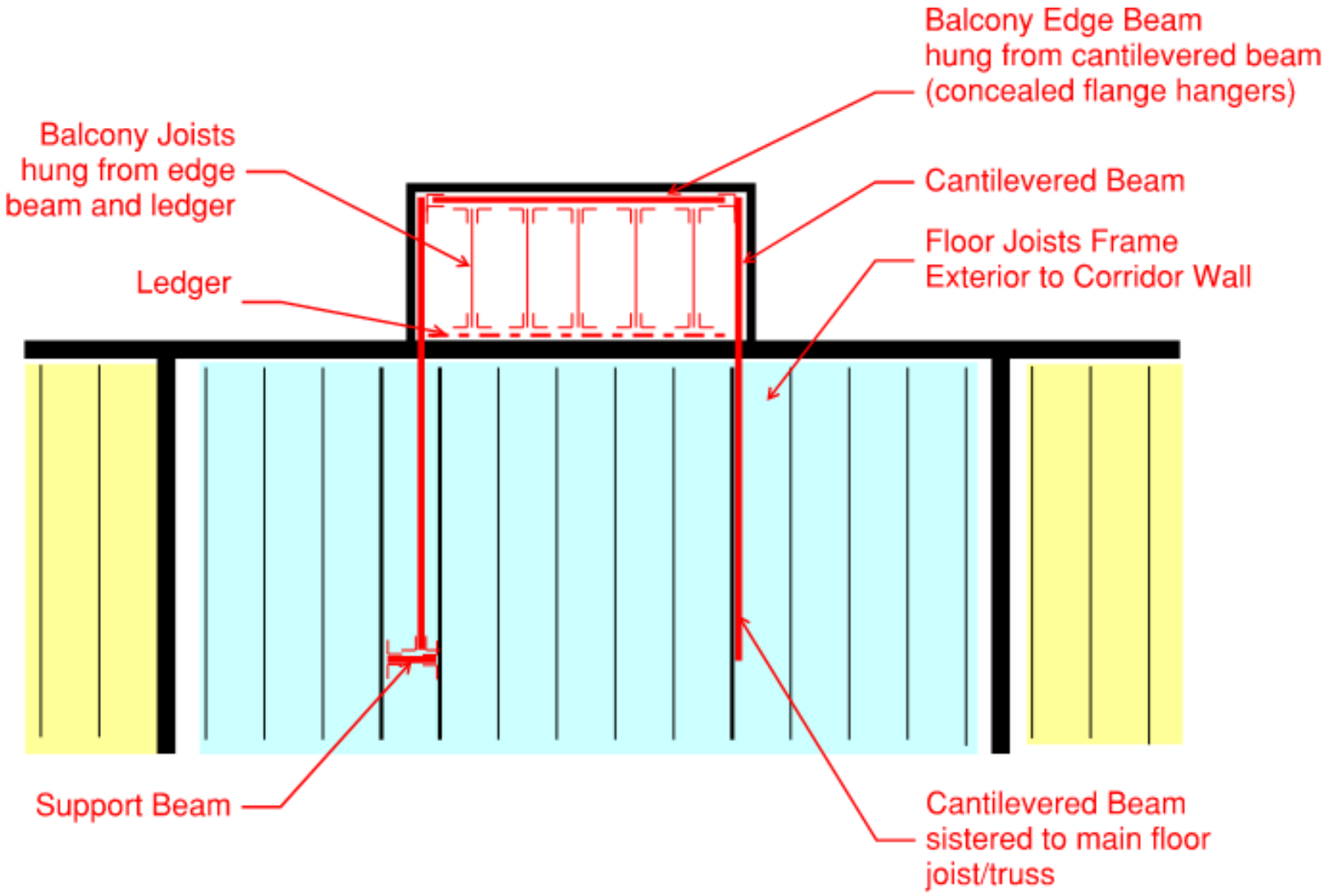


Photo: Patrick Schneider

Detail Examples



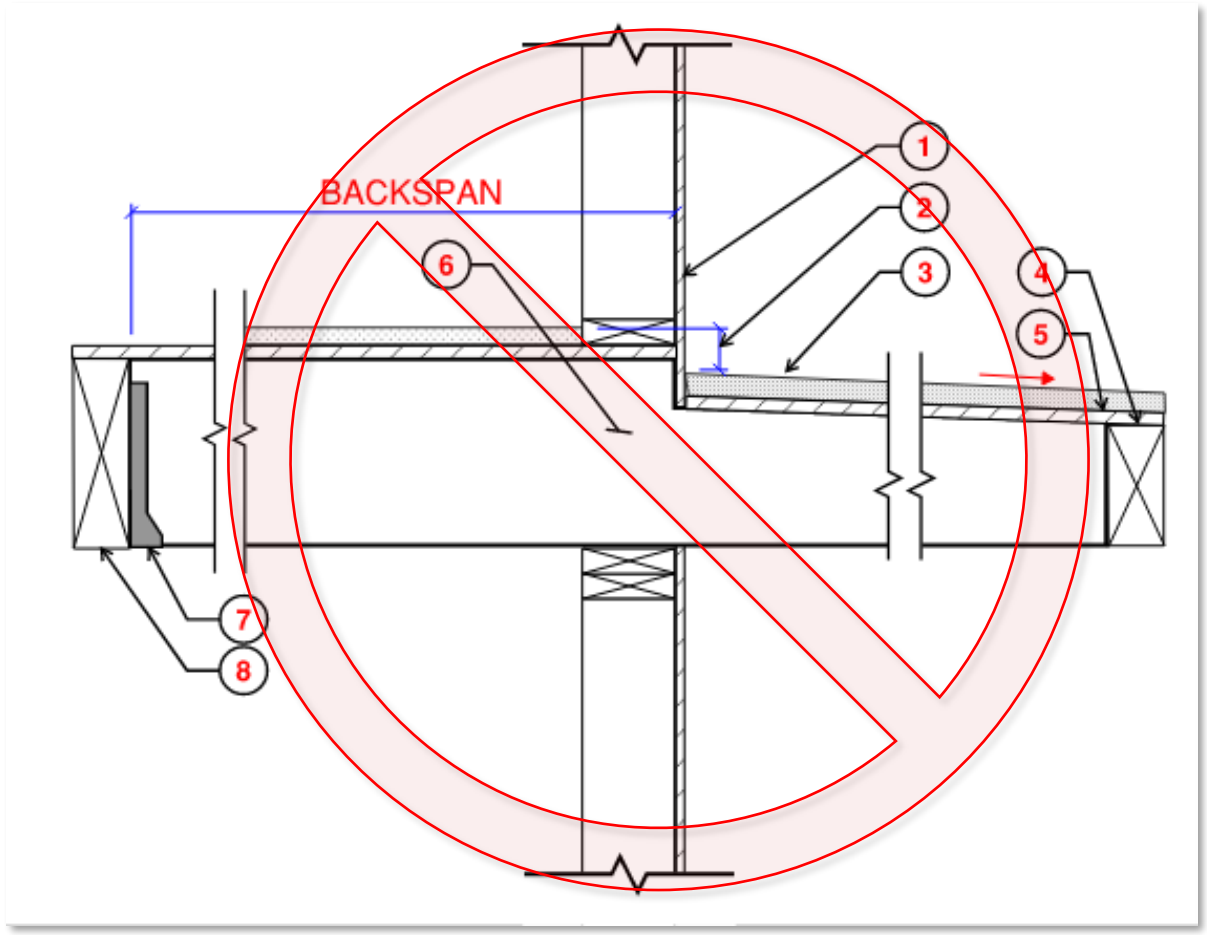
Detail Examples



Detail Examples

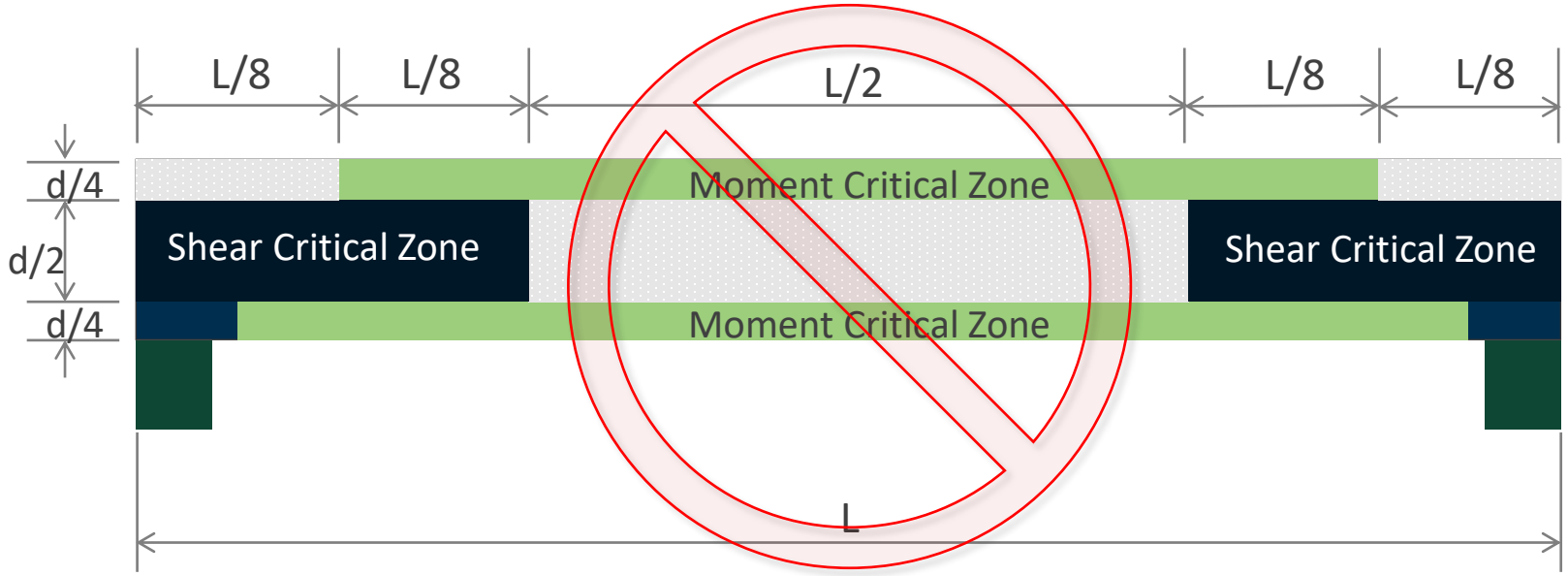
KEYNOTES

1. **Wall sheathing** – interrupted at beam
2. **Step down** – coordinate with architect
3. **Topping** – uniform thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Notched and tapered beam**
7. **Joist hanger**
8. **Girder –** supporting end of balcony outrigger beam



Limits on Notching

- IBC Section 2308: Conventional Light-Frame Construction
- NDS Section 4.4.3 (see also 3.1.2 and 3.4.3)
- APA S560: Field Notching and Drilling of Glued Laminated Timber Beams
- Structural Composite Lumber (SCL): See manufacturer guidance
- Consider where stress concentrations occur: different for cantilevers!



Limits on Ripping Lumber

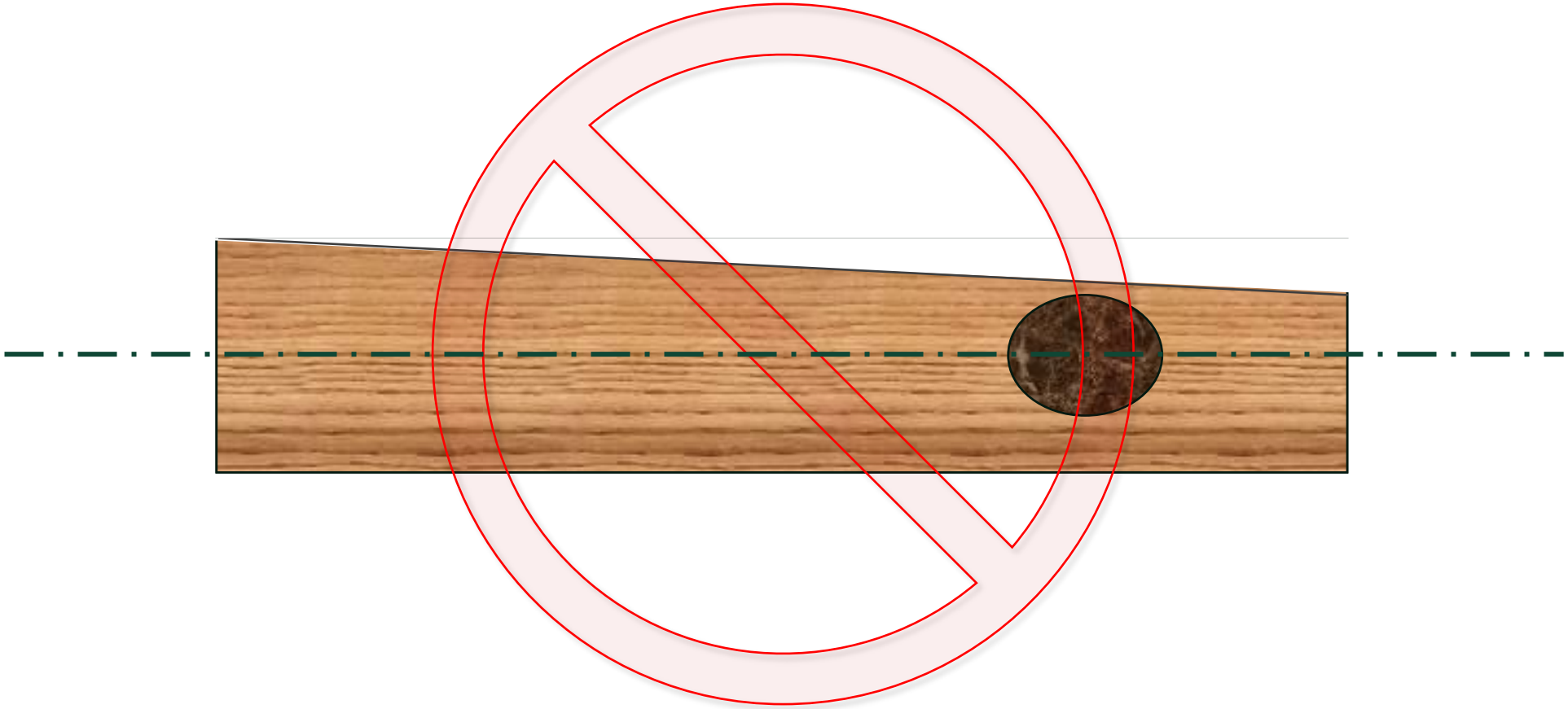
DOC PS 20: American Softwood Lumber Standard
(a referenced standard within the IBC):

> **7.3.7** Remanufacture (ripping, resawing or surfacing) of graded or grade marked lumber negates the grade or grade mark and the design values of the original product and the original grade mark shall be removed, by any appropriate means.

- DOC PS 20 governs grading rules for sawn lumber.

Why this limit?

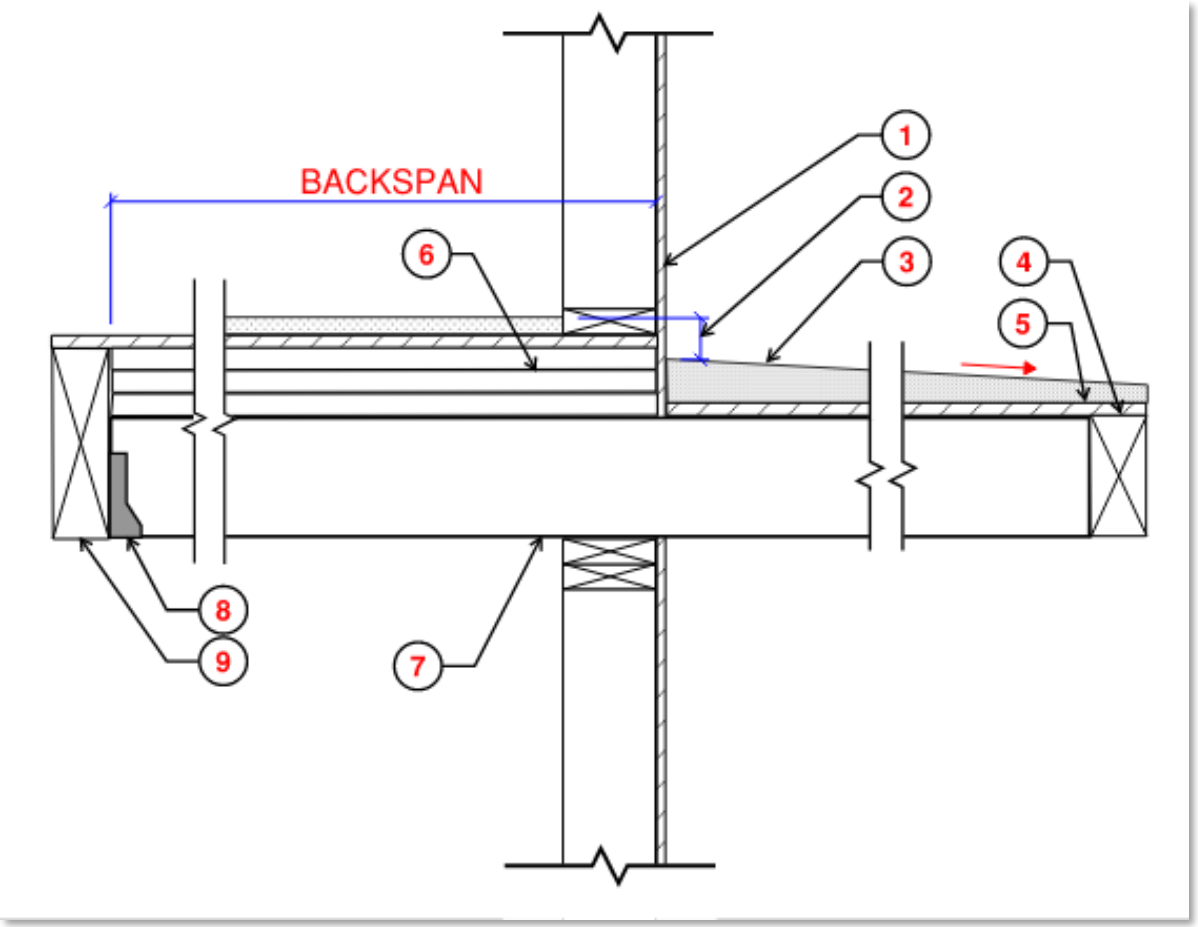
Why this limit?



Detail Examples

KEYNOTES

1. **Wall sheathing** – interrupted at outrigger beam
2. **Step down** – coordinate with architect
3. **Sloped topping** – coordinate min thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Built-up framing** – to match floor framing depth
7. **Outrigger beam** – coordinate treatment requirements (PT, FRT)
8. **Joist hanger** – corrosion protection as required
9. **Girder**

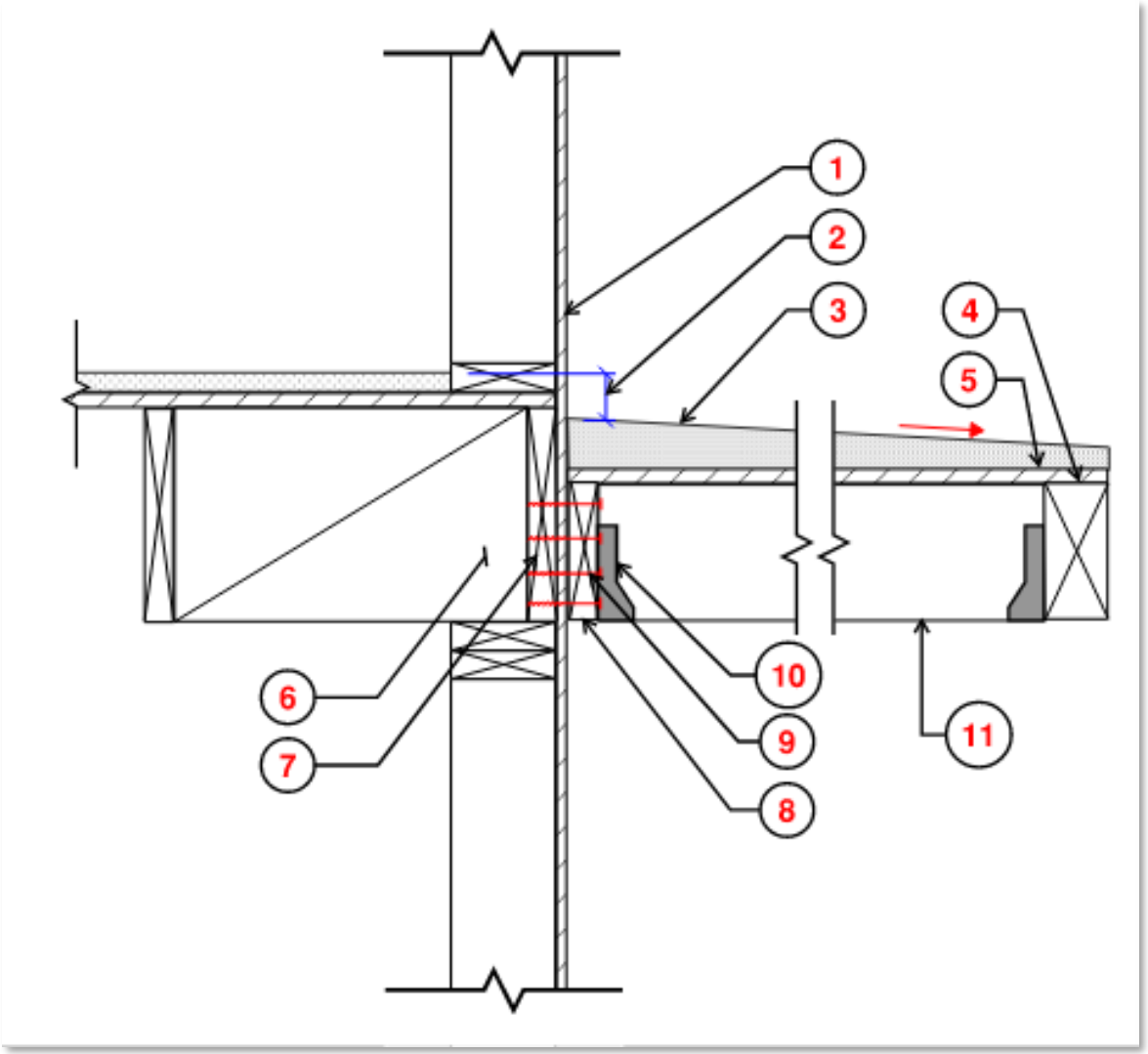


Typical framing connections not shown for clarity.

Detail Examples

KEYNOTES

1. **Wall sheathing**
2. **Step down** – coordinate with architect
3. **Sloped topping** – coordinate min thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Blocking/wall bracing**
7. **Continuous rim**
8. **Ledger** – coordinate treatment requirements (PT, FRT)
9. **Ledger attachment** – corrosion protection as required
10. **Joist hanger** – corrosion protection as required
11. **Balcony joist** – coordinate treatment requirements (PT, FRT)

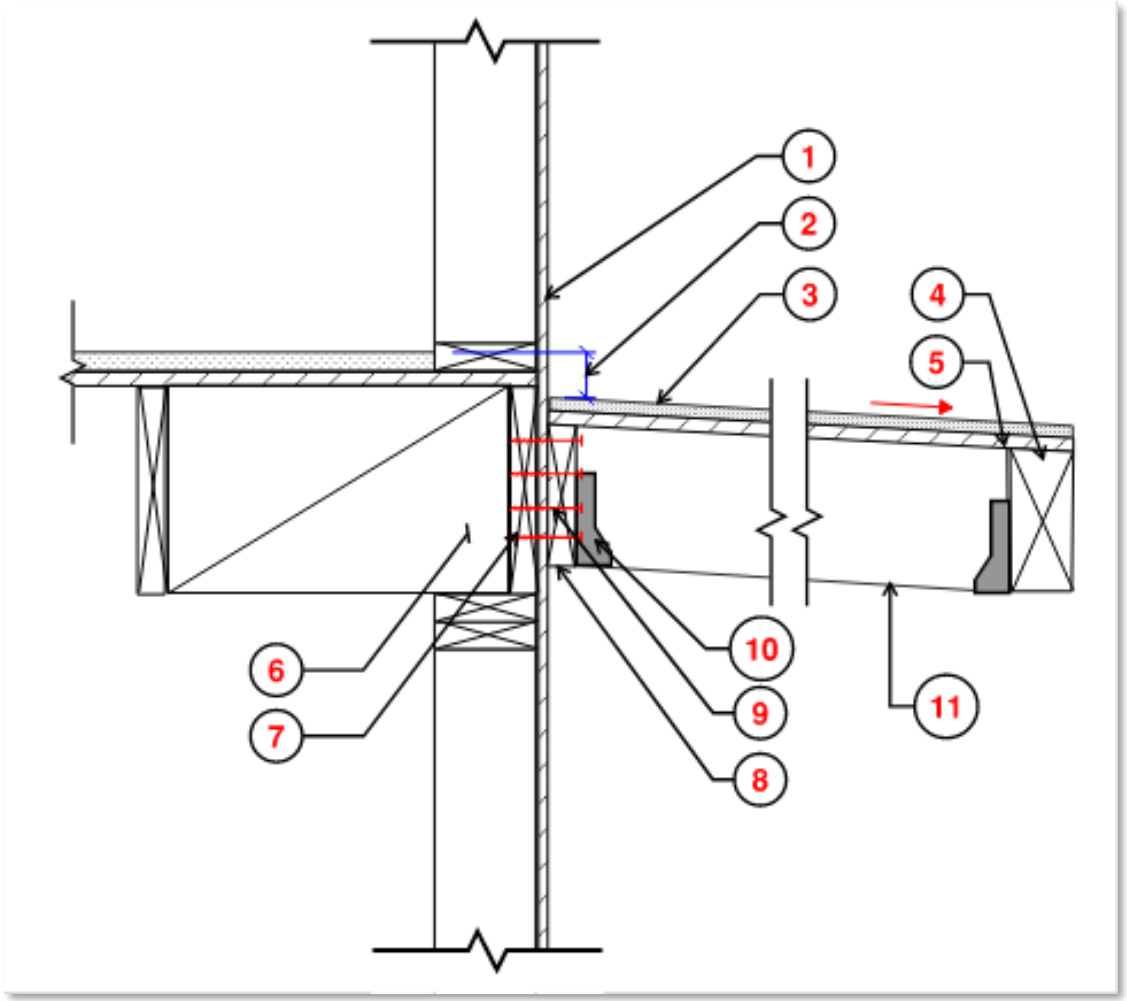


Typical framing connections not shown for clarity.

Detail Examples

KEYNOTES

1. **Wall sheathing**
2. **Step down** – coordinate with architect
3. **Topping** – uniform thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Blocking/wall bracing**
7. **Continuous rim**
8. **Ledger** – coordinate treatment requirements (PT, FRT)
9. **Ledger attachment** – corrosion protection as required
10. **Sloped Joist Hanger** – corrosion protection as required
11. **Sloped Balcony joist** – coordinate treatment requirements (PT, FRT)



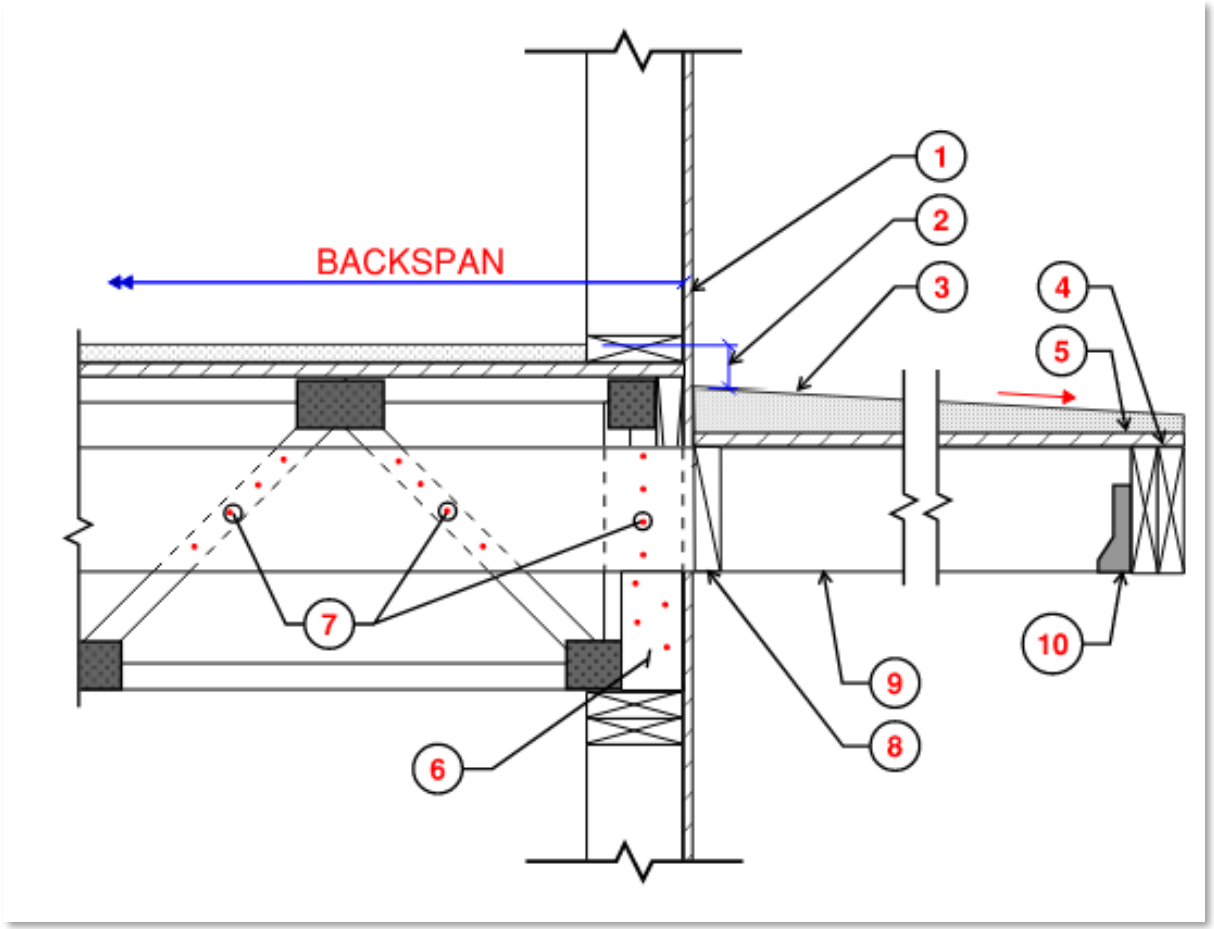
Typical framing connections not shown for clarity.

Detail Examples

KEYNOTES

1. **Wall sheathing** – interrupted at outriggers
2. **Step down** – coordinate with architect
3. **Sloped topping** – coordinate min thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Bearing block**
7. **Scab nailing**
8. **Blocking**
9. **Outrigger framing –** coordinate treatment requirements (PT, FRT)
10. **Joist hanger** – corrosion protection as required

****Detail must be coordinated with truss manufacturer**



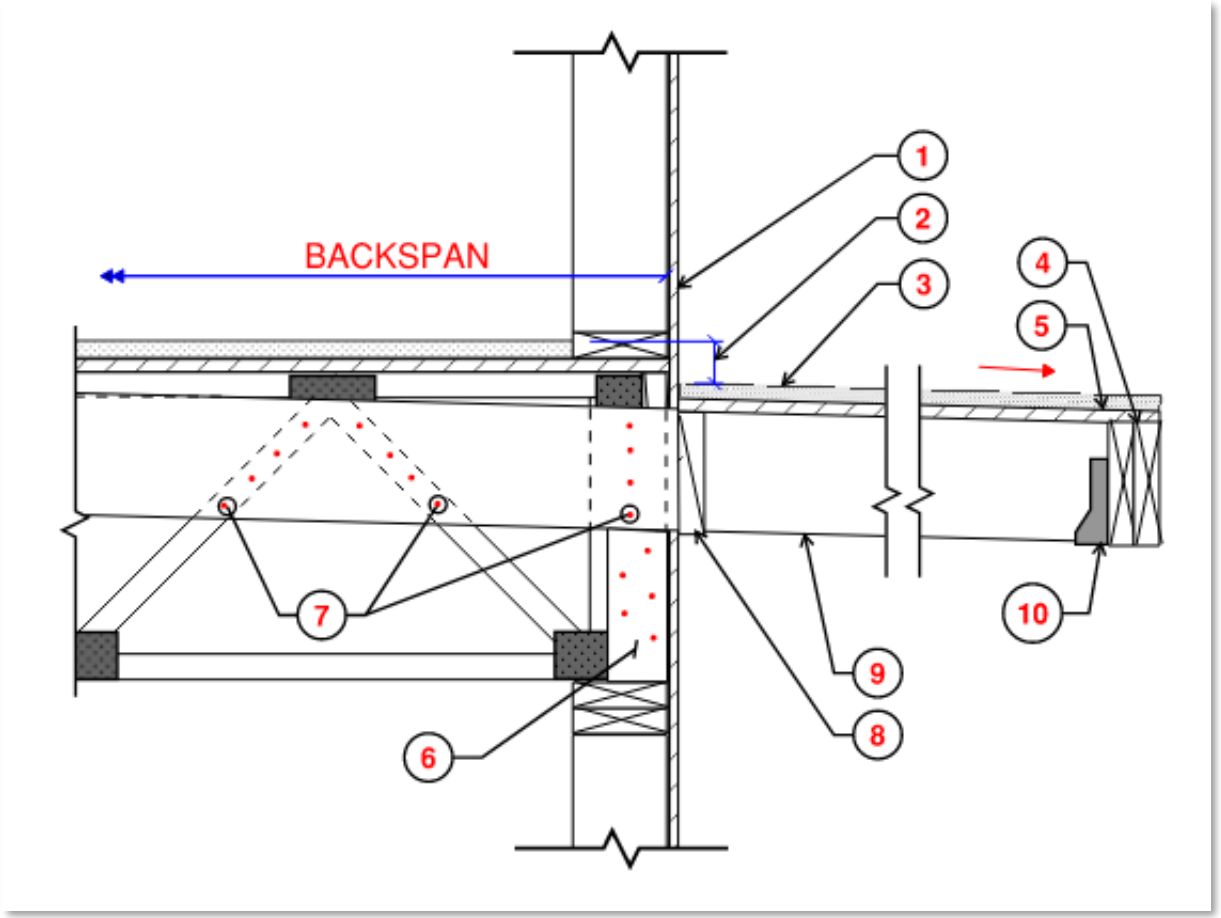
Typical framing connections not shown for clarity.

Detail Examples

KEYNOTES

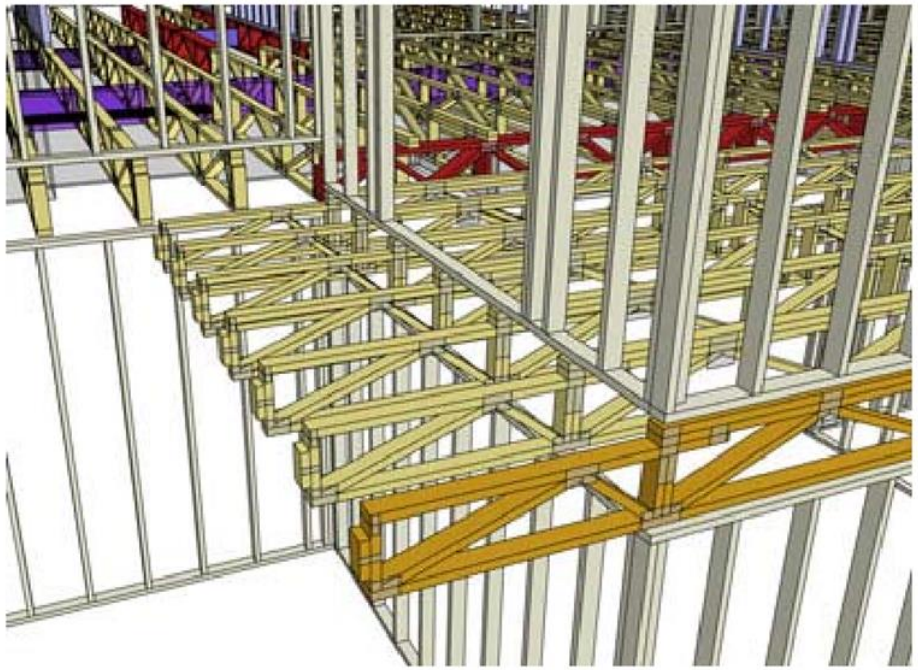
1. **Wall sheathing** – interrupted at outriggers
2. **Step down** – coordinate with architect
3. **Topping** – uniform thickness
4. **Perimeter beam** – coordinate treatment requirements (PT, FRT)
5. **Balcony floor sheathing**
6. **Bearing block**
7. **Scab nailing**
8. **Blocking**
9. **Pitched outrigger framing –** coordinate treatment requirements (PT, FRT)
10. **Joist hanger** – corrosion protection as required

****Detail must be coordinated with truss manufacturer**

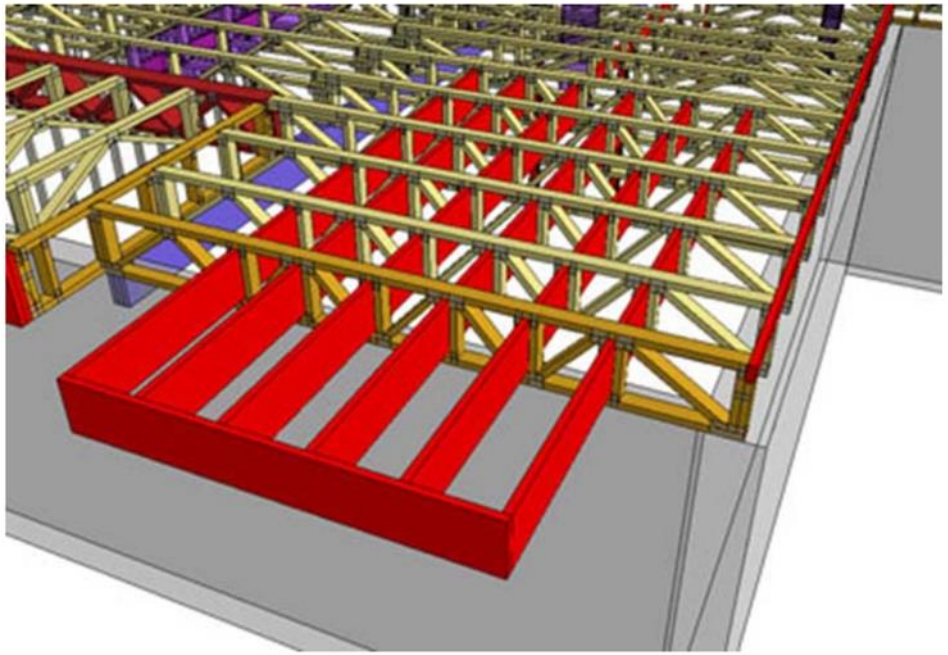


Typical framing connections not shown for clarity.

Detail Examples



Option to incorporate balcony into truss design



Option to coordinate outrigger framing with truss webs

Images: MiTek

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Guardrail Loading per ASCE 7-10

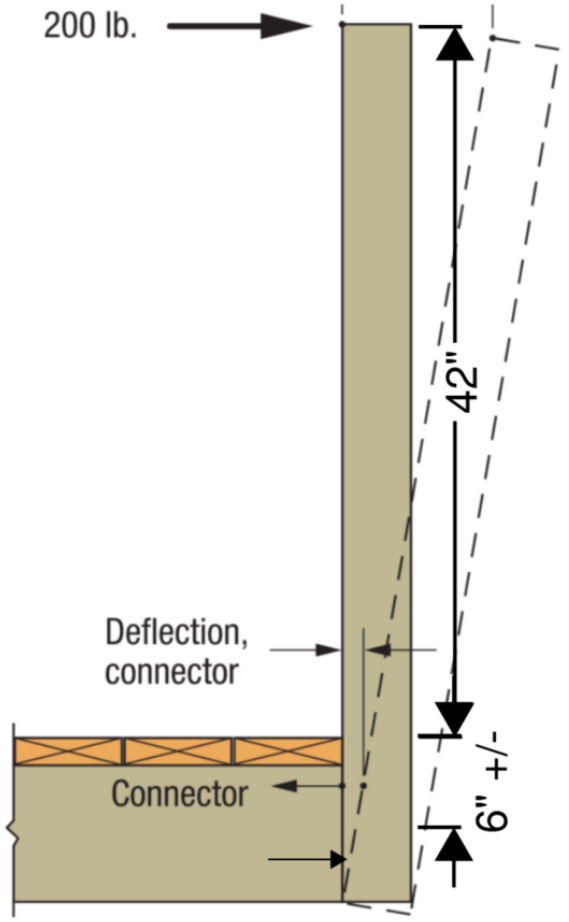
4.5 LOADS ON HANDRAIL, GUARDRAIL, GRAB BAR AND VEHICLE BARRIER SYSTEMS, AND FIXED LADDERS

4.5.1 Loads on Handrail and Guardrail Systems. All handrail and guardrail systems shall be designed to resist a single concentrated load of 200 lb (0.89 kN) applied in any direction at any point on the handrail or top rail to produce the maximum load effect on the element being considered and to transfer this load through the supports to the structure.

Further, all handrail and guardrail systems shall be designed to resist a load of 50 lb/ft (pound-force per linear foot) (0.73 kN/m) applied in any direction along the handrail or top rail. This load need not be assumed to act concurrently with the load specified in the preceding paragraph, and this load need not be considered for the following occupancies:

1. one- and two-family dwellings, and
2. factory, industrial, and storage occupancies, in areas that are not accessible to the public and that serve an occupant load not greater than 50.

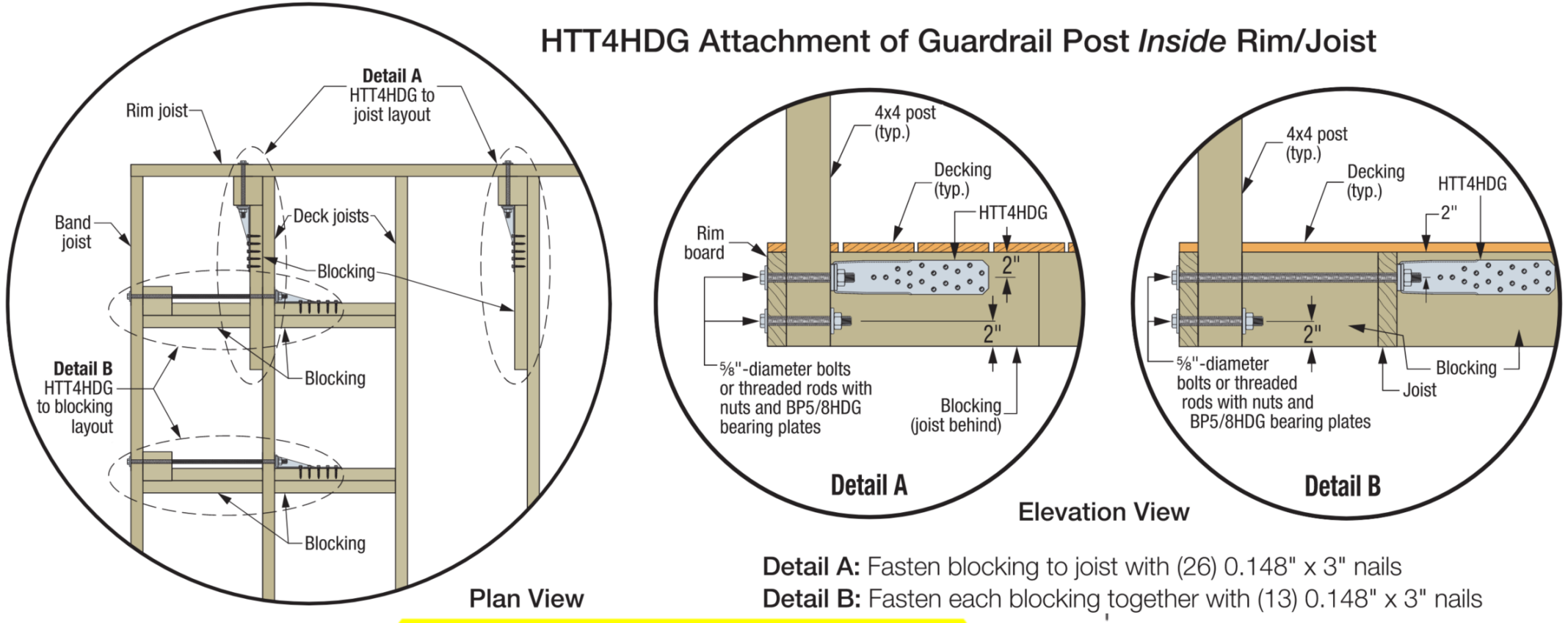
Guardrail Loading per ASCE 7-10



Moment = 9,600 inch-lbs
Connection force = 2,400 lbs

Image by Simpson Strong-tie

Guardrail Loading per ASCE 7-10

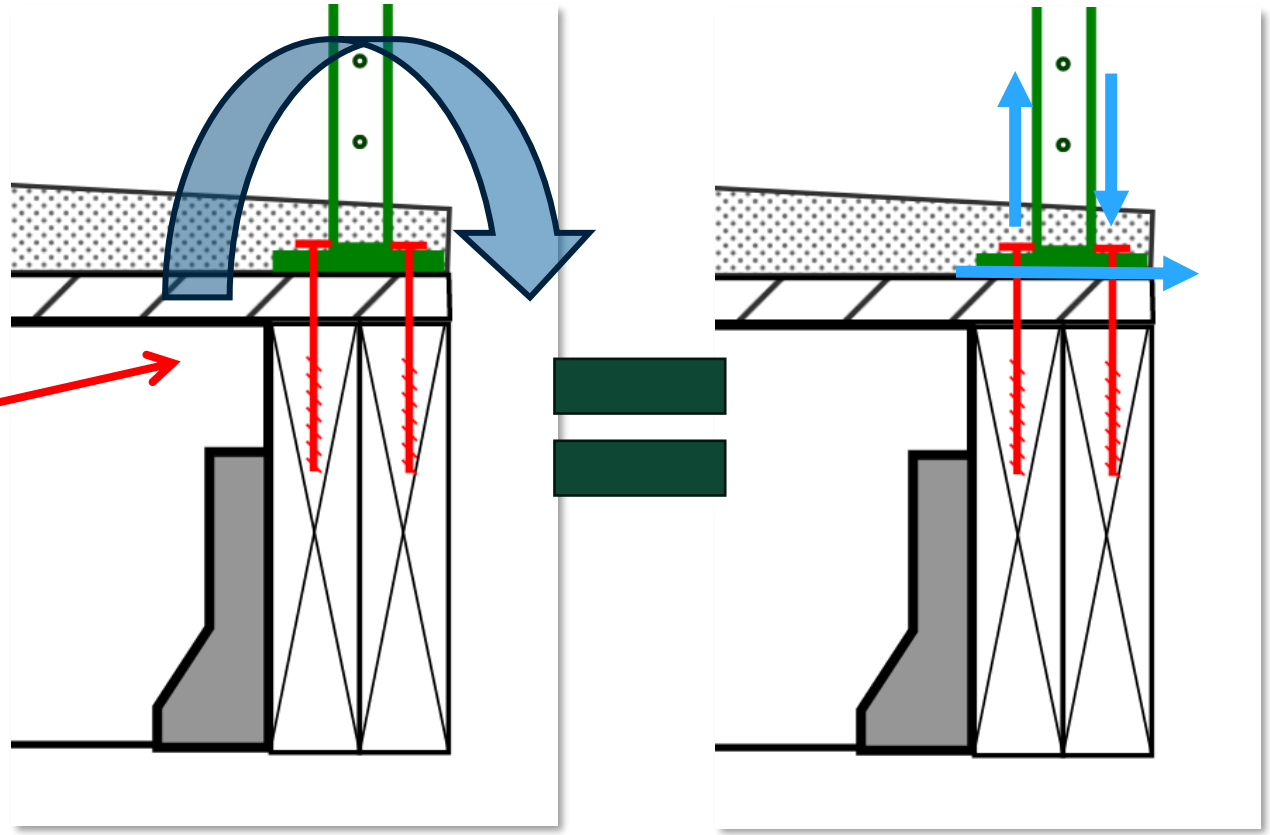


The details in this technical bulletin address an outward force on the guardrail. An additional connector can be installed on the lower bolt to resist an inward force.

Images by Simpson Strong-tie: Technical Bulletin on Code-Compliant Post Connections

Guardrail Considerations

Photo: Lawrence Anderson/Esto



Guardrail Considerations

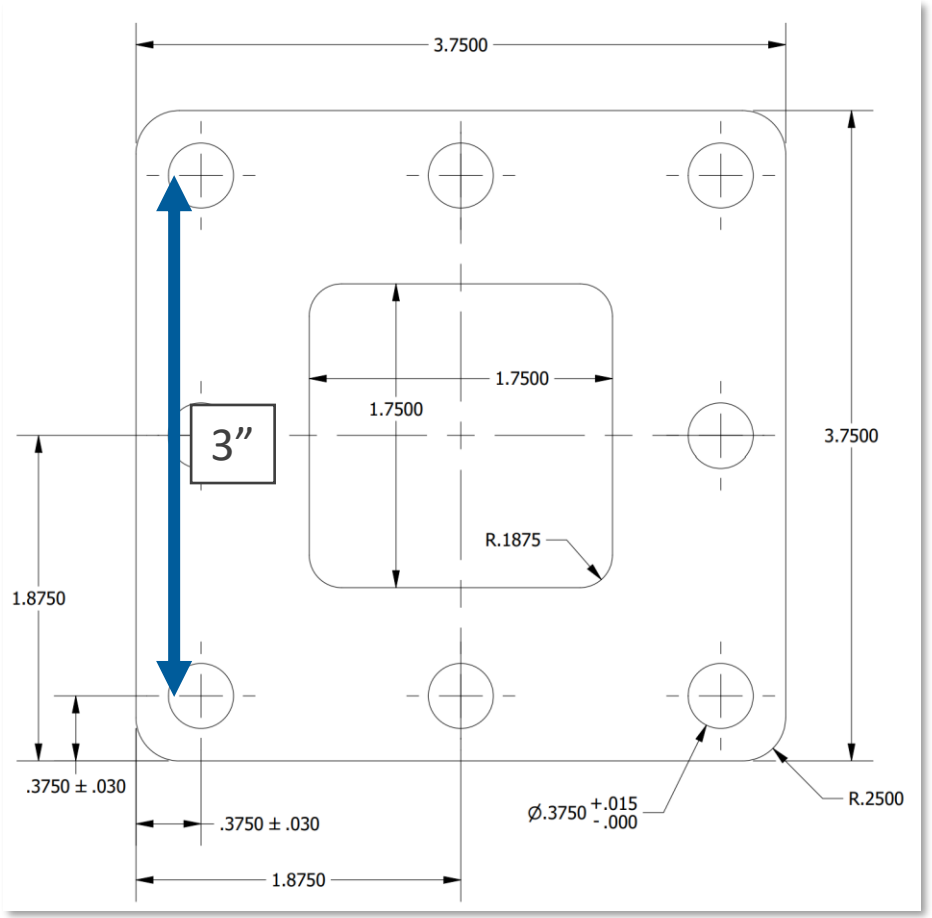
<u>200lbs load @ 42” rail height:</u>

Moment = 200lbs*42” = 8400 in-lbs

Force couple (T=C) = M/d = 8400 in-lbs/3” = 2800lbs

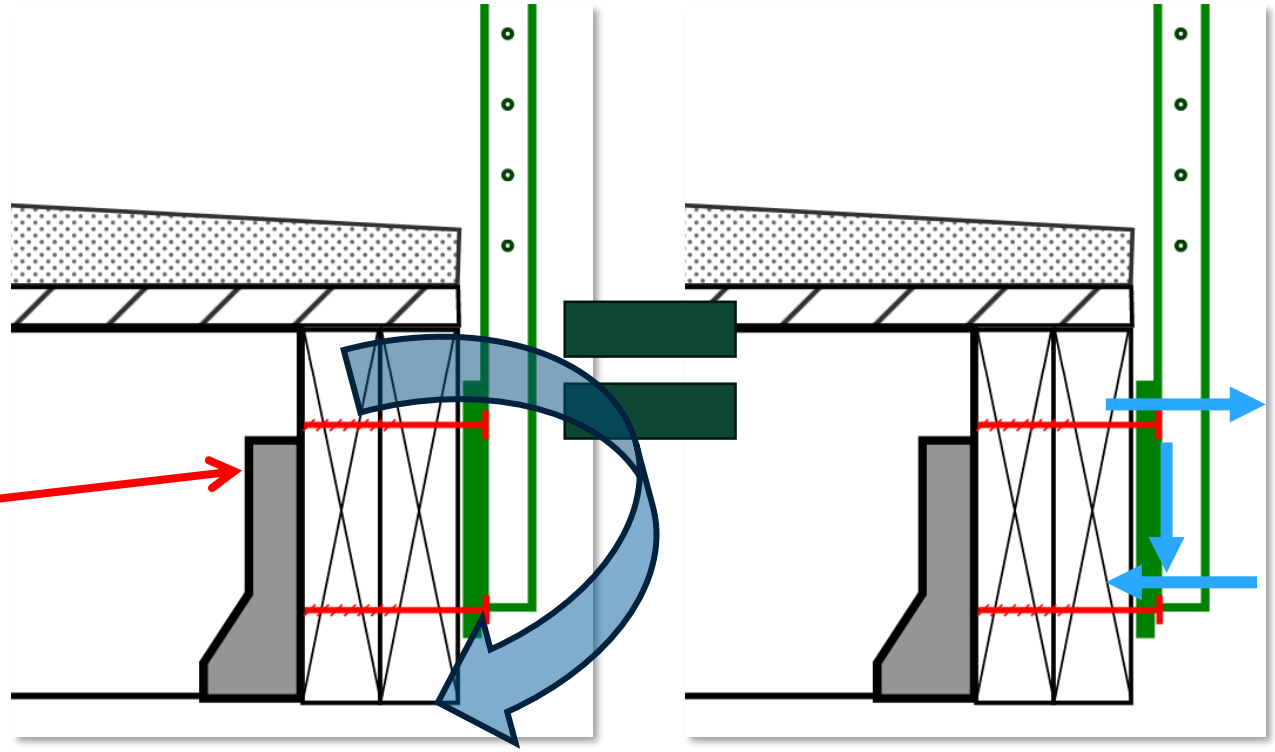
2800lbs/3 screws = 933lbs/screw

**Need to consider screw diameter and edge distances for perimeter beam



Guardrail Considerations

Photo: Ankrom Moisan Architects



Guardrail Considerations

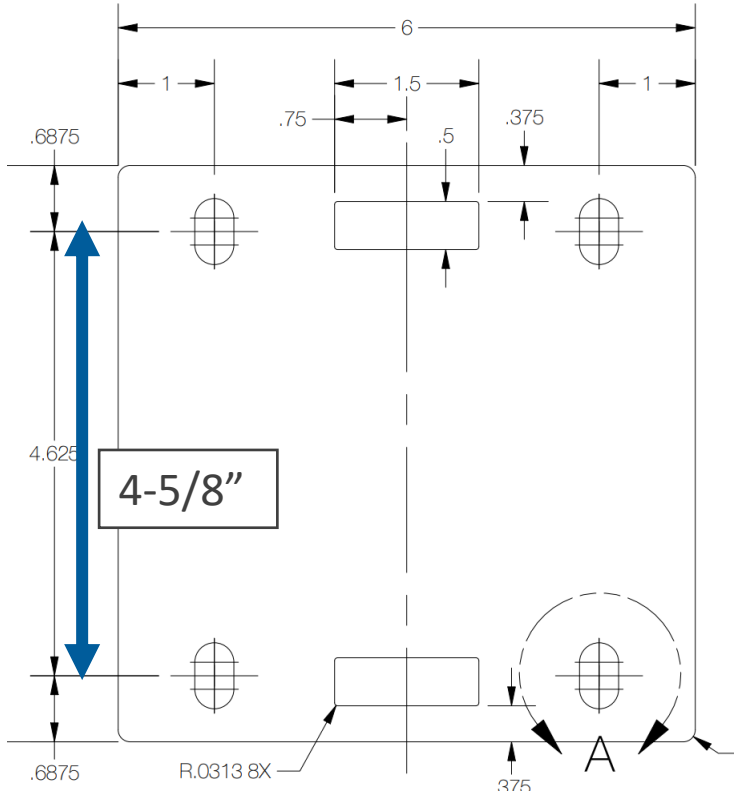
<u>200lbs load @ 42” rail height:</u>

Moment = 200lbs*46” = 9200 in-lbs

Force couple (T=C) = M/d = 9200 in-lbs/4.625” = 1989lbs

1989lbs/2 screws = 995lbs/screw

**Need to consider screw diameter and edge distances for perimeter beam



For perspective – lag screw capacity

Table 12.2A Lag Screw Reference Withdrawal Values, W[1]

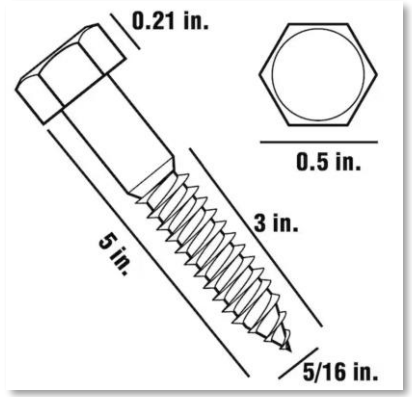
Tabulated withdrawal design values (W) are in pounds per inch of thread penetration into side grain of wood member. Length of thread penetration in main member shall not include the length of the tapered tip (see 12.2.1.1).

Specific Gravity, G[2]	Lag Screw Diameter, D										
	1/4"	5/16"	3/8"	7/16"	1/2"	5/8"	3/4"	7/8"	1"	1-1/8"	1-1/4"
0.73	397	469	538	604	668	789	905	1016	1123	1226	1327
0.71	381	450	516	579	640	757	868	974	1077	1176	1273
0.68	357	422	484	543	600	709	813	913	1009	1103	1193
0.67	349	413	473	531	587	694	796	893	987	1078	1167
0.58	281	332	381	428	473	559	641	719	795	869	940
0.55	260	307	352	395	437	516	592	664	734	802	868
0.51	232	274	314								
0.50	225	266	305								
0.49	218	258	296								
0.47	205	242	278								
0.46	199	235	269								
0.44	186	220	252								
0.43	179	212	243								
0.42	173	205	235								

Table 2.3.2 Frequently Used Load Duration Factors, C_D[1]

Load Duration	C_D	Typical Design Loads
Permanent	0.9	Dead Load
Ten years	1.0	Occupancy Live Load
Two months	1.15	Snow Load
Seven days	1.25	Construction Load
Ten minutes	1.6	Wind/Earthquake Load
Impact[2]	2.0	Impact Load

1. Load duration factors shall not apply to reference modulus of elasticity, E, reference modulus of elasticity for beam and column stability, E_{min}, nor to reference compression perpendicular to grain design values, $F_{c\perp}$, based on a deformation limit.
2. Load duration factors greater than 1.6 shall not be used in the design of structural members pressure-treated with water-borne preservatives (see Reference 30), or fire retardant chemicals. Load duration factors greater than 1.6 shall not be used in the design of connections or wood structural panels.



5/16” x 5” std lag screw

Thread penetration 2-13/16” (NDS Table L2)

266 lbs * 2-13/16” = 748 lbs = W

C_D= 1.6, C_M= 0.7, C_{tn}= 1.0, C_{eg}= 1.0

W’ = 838 lbs NG

3/8” x 5” std lag screw

Thread penetration 2-25/32” (NDS Table L2)

305 lbs * 2-25/32” = 848 lbs = W

C_D= 1.6, C_M= 0.7, C_{tn}= 1.0, C_{eg}= 1.0

W’ = 950 lbs OK

Proprietary Railing Systems

1. Check that there is a ESR report for the proposed railing system
2. Verify the ESR has been tested with the corresponding code for your project
3. Verify the base connection is included in the report
   a) Some reports will not the attachment as something that is “outside the scope of the report”

The post base plate must be fastened to the supporting wood substrate with a minimum specific gravity of 0.50 using either four – $^{3}/_{8}$-inch x 6-inch long (9.5 mm x 152.4 mm) [redacted] wood screws or using four – $^{5}/_{16}$-inch x 6 inch-long (7.9 mm x 152.4 mm) wood screws. When the supporting substrate is concrete having a minimum compressive strength of 3700 psi (25.5 MPa), each post base plate must be fastened to the supporting concrete substrate using four ¼-inch x 3 inch-long (6.35 mm by 76.2 mm) corrosion resistant coated concrete anchor bolts.

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2018, 2015, 2012, 2009, and 2006 *International Building Code*® (IBC)
- 2018, 2015, 2012, 2009, and 2006 *International Residential Code*® (IRC)

4.1 Design:

The [redacted] is satisfactory to resist loads specified Section 1607.8.1 for the 2018, 2015 and 2012 IBC (Section 1607.7.1 for the 2009 and 2006 IBC) and IRC Table R301.5 when installed at the maximum clear distance between the posts as noted in Table 1. When the railing is supported on one or both ends by the supporting structure, the maximum clear distance between the post and the supporting structure or between the supporting structures must comply with the spans noted in Table 1.

4.2.2 Posts: The posts are attached to the building substrate with project specific fasteners or are embedded into concrete. The design of this attachment is outside of the scope of this report.

Agenda

Balconies:

- 2018 IBC Code Changes
- Fire Ratings
- Structural Framing
- Guardrails
- Waterproofing Design
- Waterproofing Construction

1430 Q, The HR Group Architects, Buehler Engineering, Greg Folkins Photography

Balcony Deck Waterproofing – Building Enclosure Design for Multi-Family Buildings WoodWorks

David T. Ford, P.E., RRC, RWC, LEED AP
Senior Principal/Managing Director – Kansas City Diagnostics
Practice Director – Enclosure Diagnostics
Walter P Moore and Associates, Inc.

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Outline

- The Importance of Waterproofing Balconies
- 2015 Berkeley Balcony Collapse
- Balcony Deck Distress Examples
- Balcony Structures and Materials
- Balcony Deck Waterproofing Basics
- Design Development
- Construction Administration
- Summary

The Importance of Balcony Waterproofing

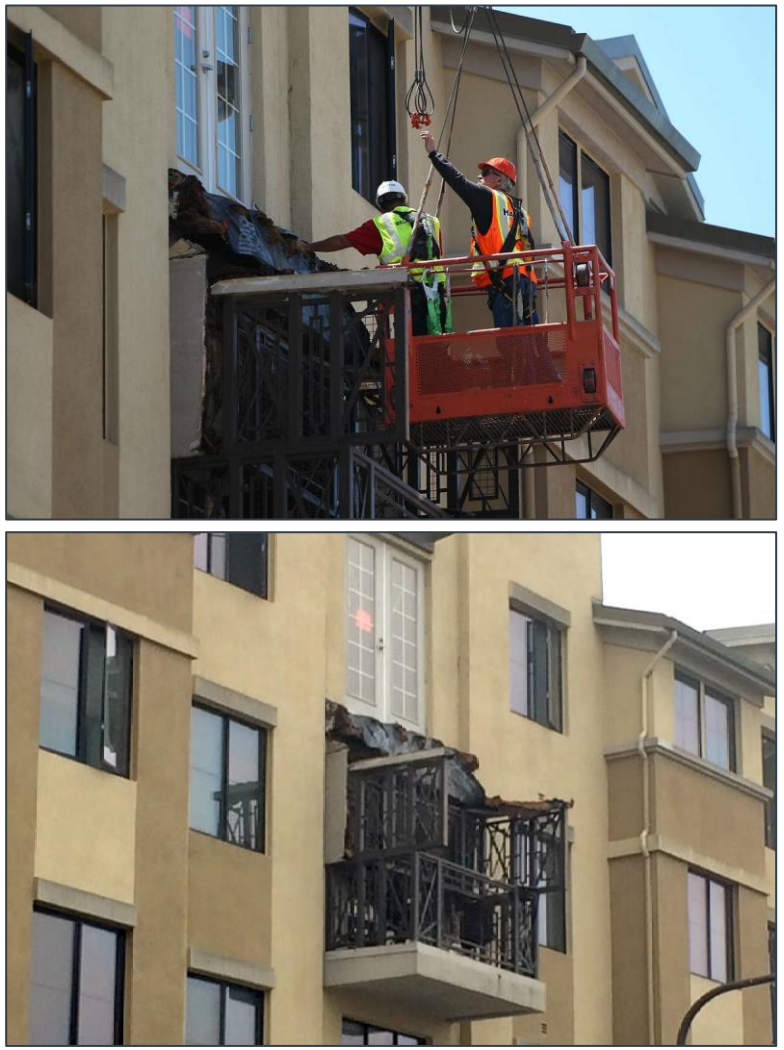
- Balconies are a critical enclosure hot spot for durability within mid-rise residential buildings.
- Balconies bring unique challenges as they are exposed to the elements.
- Drainage and waterproofing are essential to providing safety to residents and long-term protection to exposed materials and structural elements.

Mid-rise residential wood-framed balconies -WPM

2015 Berkeley, CA Balcony Collapse

2015 Berkeley, CA Balcony Collapse

- Constructed circa 2006, Library Gardens is a mid-rise wood framed residential complex located in Berkeley, CA.
- On June 16, 2015, Unit 405's balcony collapsed onto Unit 305's balcony, killing six and severely injuring seven students.
- Lessons learned resulted in a comprehensive review of code and inspection protocols – 2018 International Building Code.



Aftermath photographs of the collapsed balcony – Emily Dugdale & San Francisco Chronicle

Investigation Findings

- Failure mechanism that resulted in the collapse was found to be dry rot damage that had occurred along the top of the cantilever balcony deck joists.

Photographs of dry rot and moisture intrusion experienced by wooden cantilevered deck joists at Units 305 and 405 – California Contractors State License Board

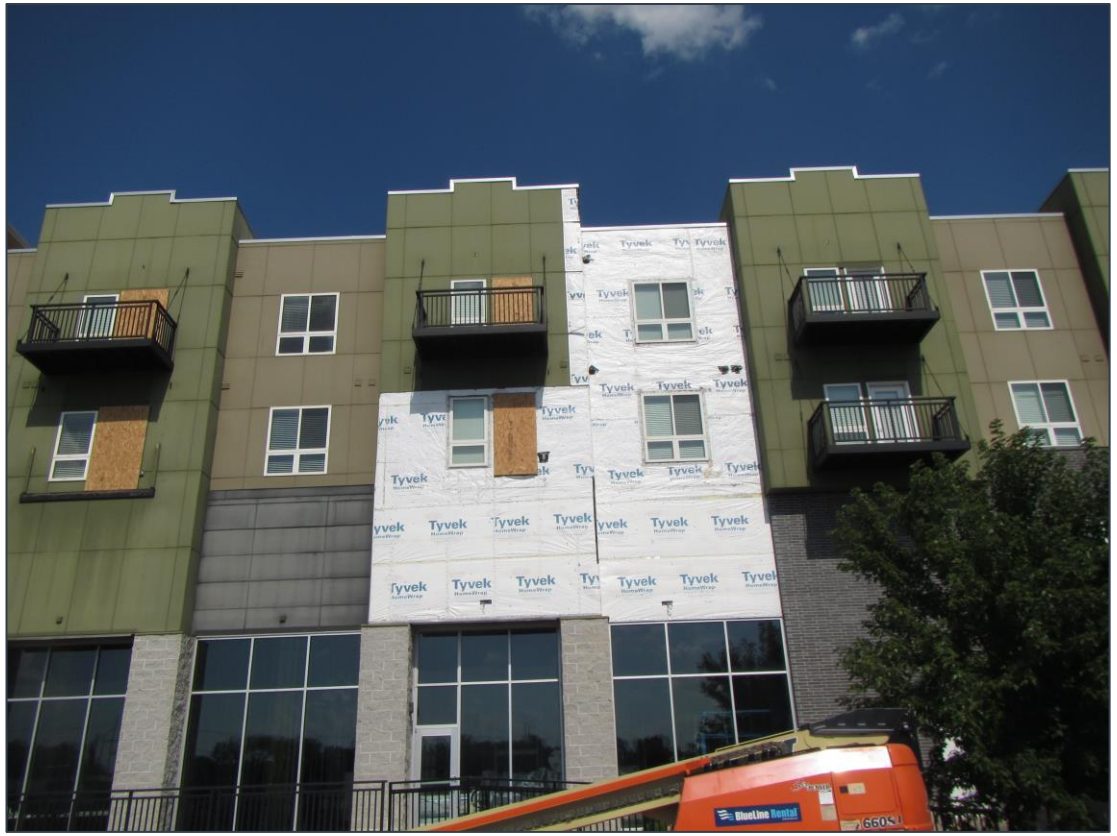
Investigation Conclusions

- The (3) layers of (+/-2”) OSB that were in direct contact with cantilevered joist had sustained high levels of moisture saturation.
- Specified sacrificial waterproofing membrane noted in the details had not been installed over the OSB sheathing prior to additional waterproofing application.
- Additional locations of water damage and dry rot were discovered at the face of the deck joists along the deck to wall transition.
- At Units 305 & 405, the balcony deck to wall prefabricated sheet metal flashing had not been lapped over any membrane at the outside face of the joist framing.
- Guardrail stanchion base plates were not set over the correct waterproofing membrane, creating incompatibility issues between products from different manufacturers.

Balcony Deck Distress Examples

Balcony Waterproofing Related Distress Examples

- Here are some additional examples that illustrate the effects of poorly designed, installed, and maintained balcony waterproofing systems.



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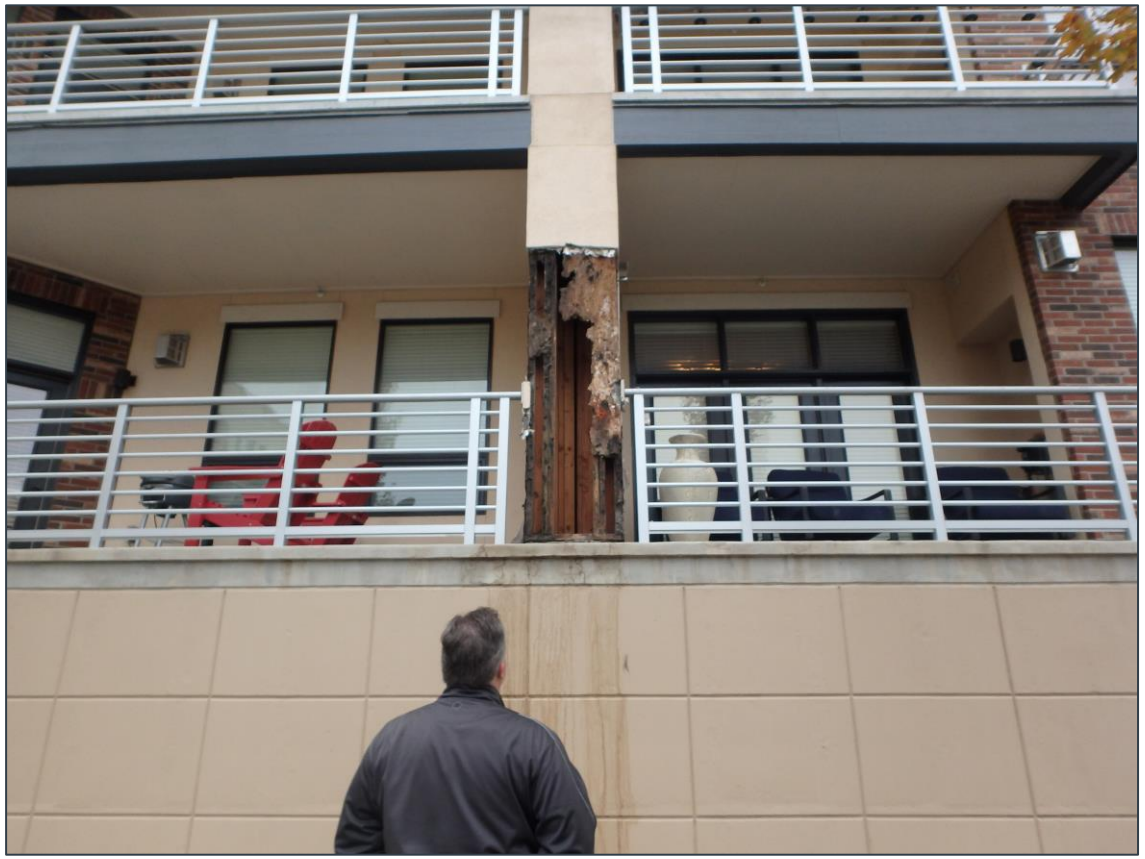
Balcony Waterproofing Related Distress Examples



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Balcony Waterproofing Related Distress Examples

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Balcony Waterproofing Related Distress Examples

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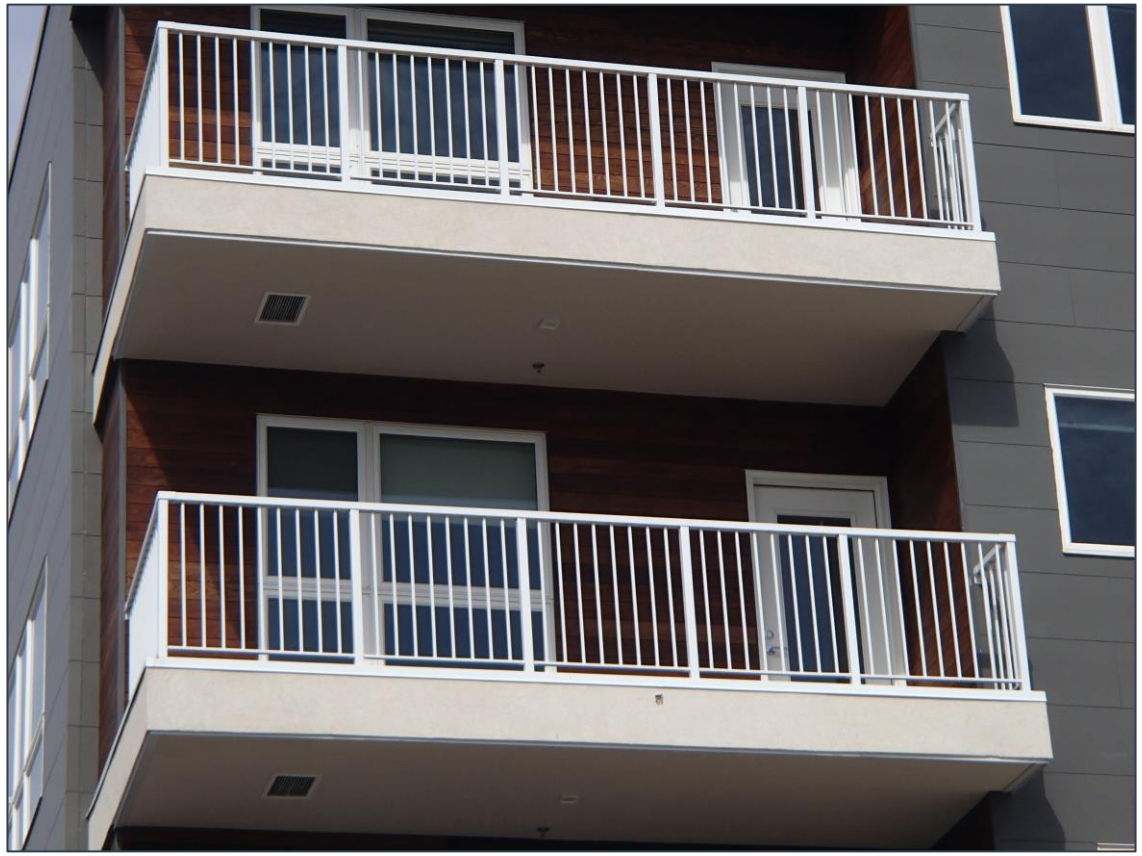
Balcony Structures and Materials

Balcony Designs Used in Mid-Rise Residential

- **Cantilever** – Clear span space without columns or braces.



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Balcony Designs Used in Mid-Rise Residential

- **Stacked** – Feature vertical support posts/columns.

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Balcony Designs Used in Mid-Rise Residential

- **Bolt-on/Hung Self-Supporting** – Bolted onto building and self-supporting.

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Typical Balcony Structural Systems

- **Wood** – Dimensional lumber attached to floor rim joist
- Pros: Less initial construction costs compared to concrete deck systems.
- Cons: Need for waterproofing, ongoing maintenance costs, wood destroying organisms
- **Termite Protection -** IBC 2018 2304.12.4. Naturally durable species or preservative treated in accordance with AWPA U1.

Wood joists with Oriented Strand Board (OSB) layers above - WPM

Typical Balcony Structural Systems

- **Concrete** – Utilized in structural slabs or topping slabs.
- Pros: High impact resistance, subsurface waterproofing
- Cons: Hidden waterproofing, high initial expenses compared to wood decking systems.

Concrete topping slab above OSB substrate and wood joists - WPM

Typical Balcony Structural Systems

- **Steel** – Variety of methods to connect steel to buildings.
- Pros: Durable if maintained from rust or corrosion, typically prefabricated.
- Cons: Waterprooofing required, requires frequent repainting of protective layer, possibility of rust staining on exterior surfaces

Prefabricated steel balcony bolted onto rainscreen building façade - WPM

Typical Balcony Structural Systems

- **Aluminum** – Prefabricated units typically bolted/anchored onto façade.
- Pros: Less weight = less anchor connections required, reduced maintenance costs, deck waterproofing not required
- Cons: Most expensive initial price.

Prefabricated aluminum balcony – WPM

Decking Materials

- **Plywood** – Perpendicular layers of long thin wood veneers glued together by pressure and heat.
- Pros: Swells evenly in comparison to OSB, easily returns to original shape.
- Cons: Surface waterproofing required, higher cost than OSB

Plywood sheets set above wooden structural beams and joists - WPM

Decking Materials

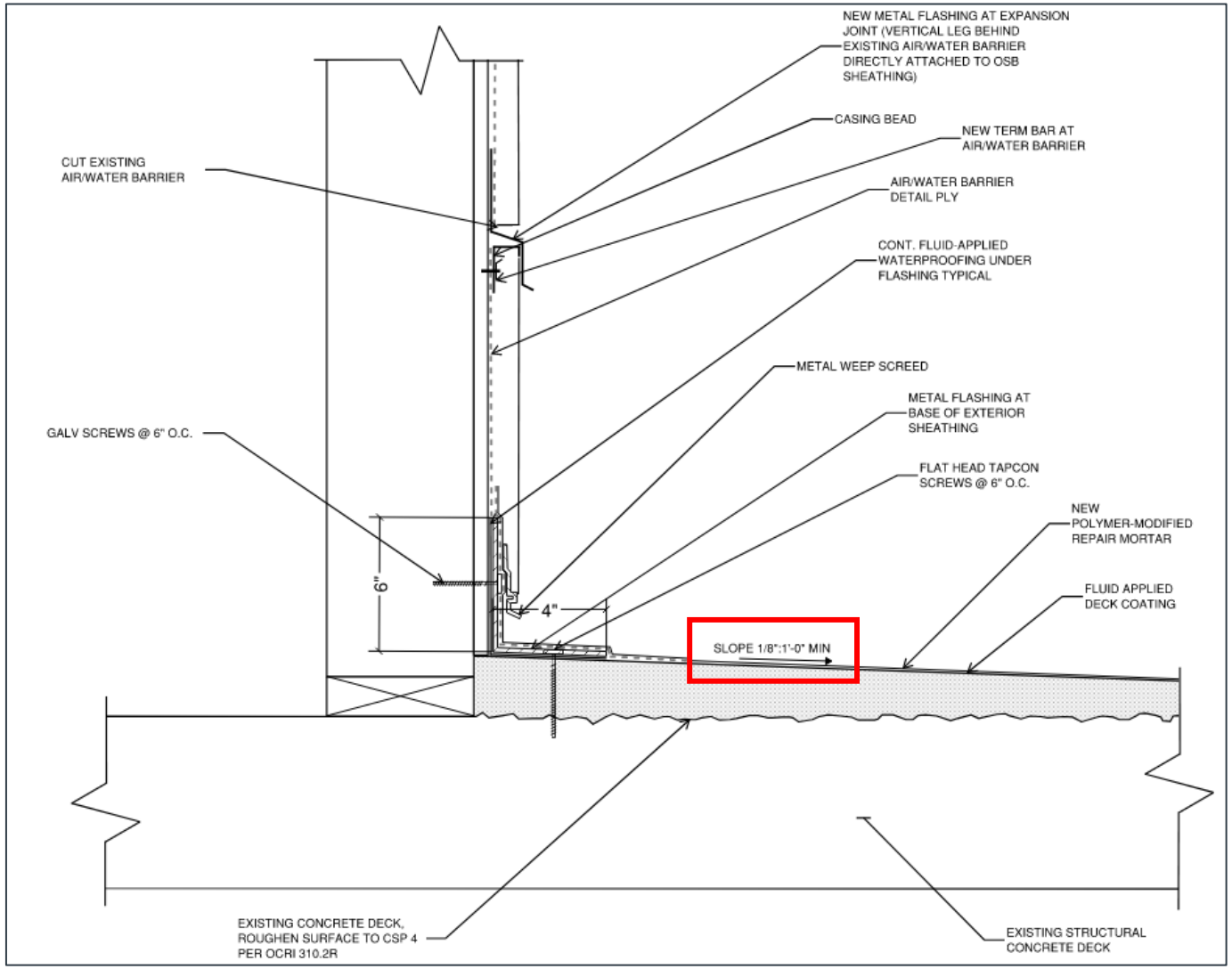
- **Oriented Strand Board** – Wood broken down into layers of small chips oriented perpendicular to the last.
- Pros: High shear capacity, lower cost than plywood.
- Cons: Surface waterproofing required, holds water from saturation

OSB sheets set above wooden structural beams and joists - WPM

Balcony Deck Waterproofing Basics

Slope

- Limit the time water interacts with the building.
- **2018 IBC 1010.1.5** - Floor Elevation. Exterior landings are permitted to have a slope not to exceed 0.25 unit vertical in 12 units horizontal (1-2% slope).



Drainage and Water Management

- Eliminate the risk of ponding and the risk of moisture build up within balcony assembly.
- Consider how waterproofing will run off at edges
- Consider use of gutters, downspouts, scuppers, drains

Traffic Deck Coatings

- **Urethanes** – Seamless and liquid applied waterproofing system. Installed as base, intermediate, and top coat.

Advantages	Disadvantages
Excellent crack-bridging capability	Low chemical resistance
Simple installations	Maintenance required with heavy traffic
Expanded product line	Limited color selection

Construction Waterproofing Handbook 2nd ed., Michael T. Kubal (2008)

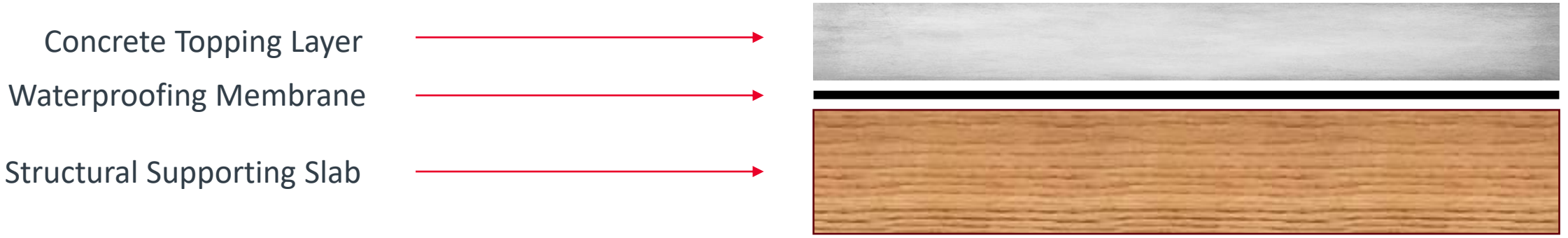
Traffic Deck Coatings

- **PMMA (Polyurethane-Methacrylate)** – Seamless and liquid applied waterproofing system. Installed as base and top coat.

Advantages	Disadvantages
Great versatility and easily incorporated into complicated details and penetrations	Low impact strength
Extreme durability	Expensive material cost
Fast curing times and cold-resistance.	

Split Slab Waterproofing

- **Split Slab** (Sandwich Slab) – Deck comprised of a structural supporting slab (wood/concrete) that features a topping slab (concrete) installed to handle direct traffic contact and weathering.
- Waterproofing membrane is directly applied between and any water that passes through cracks, cold joints, and construction joints is managed.



Deck Membranes With Concrete Topping

- **Sheet Systems** – Commonly applied to wood substrates as it can effectively hide substrate imperfections.

Advantages	Disadvantages
Applicable over wood substrates	Water can travel under sheet systems
Uniformity of material application	Difficult applications in small areas, corners, and transitions
Forgiving of substrate flaws	Difficult to repair

Construction Waterproofing Handbook 2nd ed., Michael T. Kubal (2008)

Sheet waterproofing membrane system fitted around existing balcony column and over plywood decking - WPM

Deck Membranes With Concrete Topping

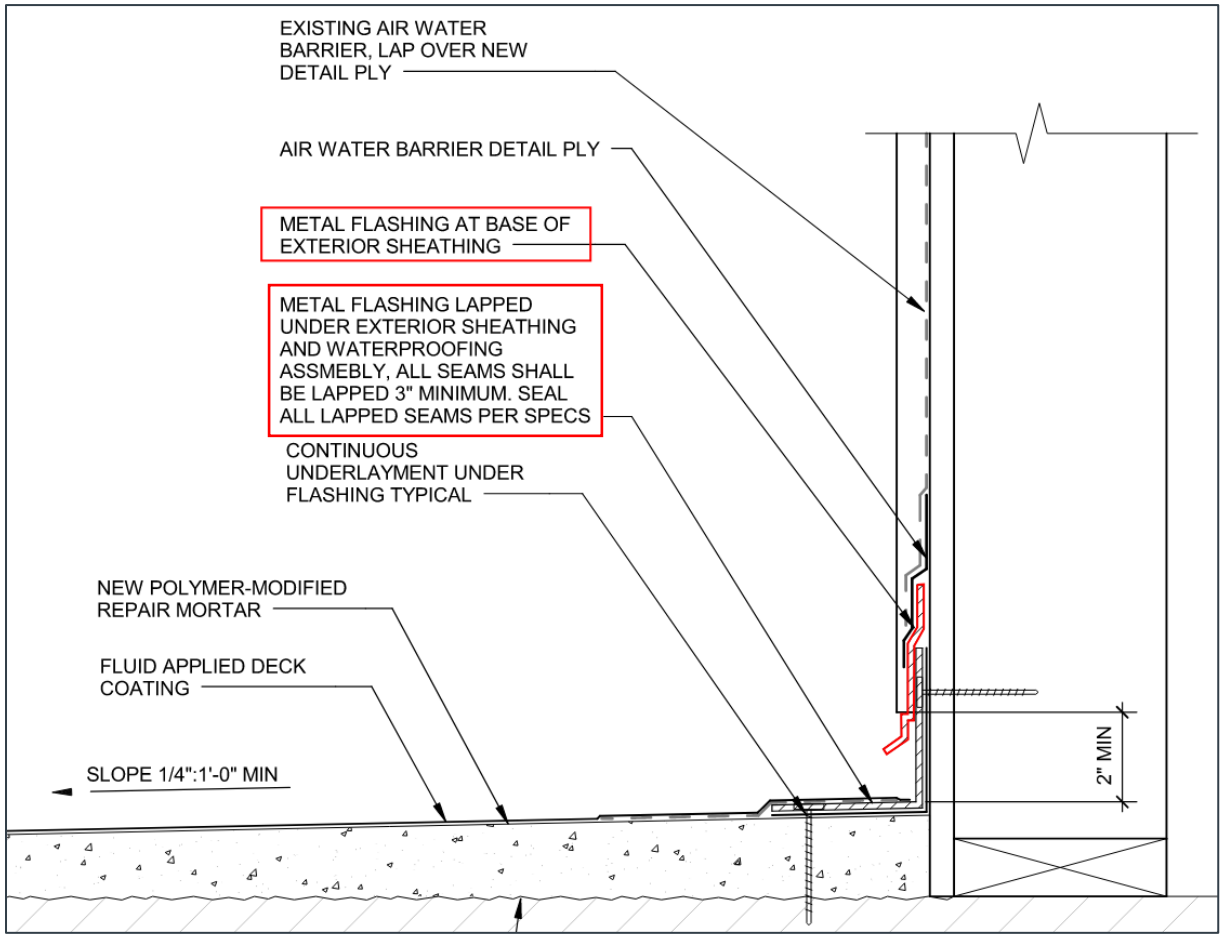
- **Hot-Applied Rubberized Membrane** – Fluid applied, hot rubberized asphalt, monolithic (seamless) membrane.
- Hot-mopped fluid systems including a fleece reinforcement layer and protection board.

- **Cold-Applied Rubberized Membrane** – Brushed, rolled, or sprayed onto surface needed to be protected.
- One/two layers required after primer added.

Application of hot rubberized asphalt membrane

Transition Materials - Flashing

- Through-Wall Flashing (TWF) – Used to divert moisture from sheathing layers.
  - –Stainless Steel
  - –Galvanized Metal
- Counter Flashing – Surface mounted at deck to wall transition.
  - –Apply PMMA at transitions



Ventilation

- **2018 IBC 2304.12.2.6** - Ventilation required beneath balcony. Net free cross ventilation area not less than 1/150 of the balcony surface area.

Grill Installed at Balcony Ceiling with Perforations Greater 1/150 of Balcony Deck Surface Area

Design Development

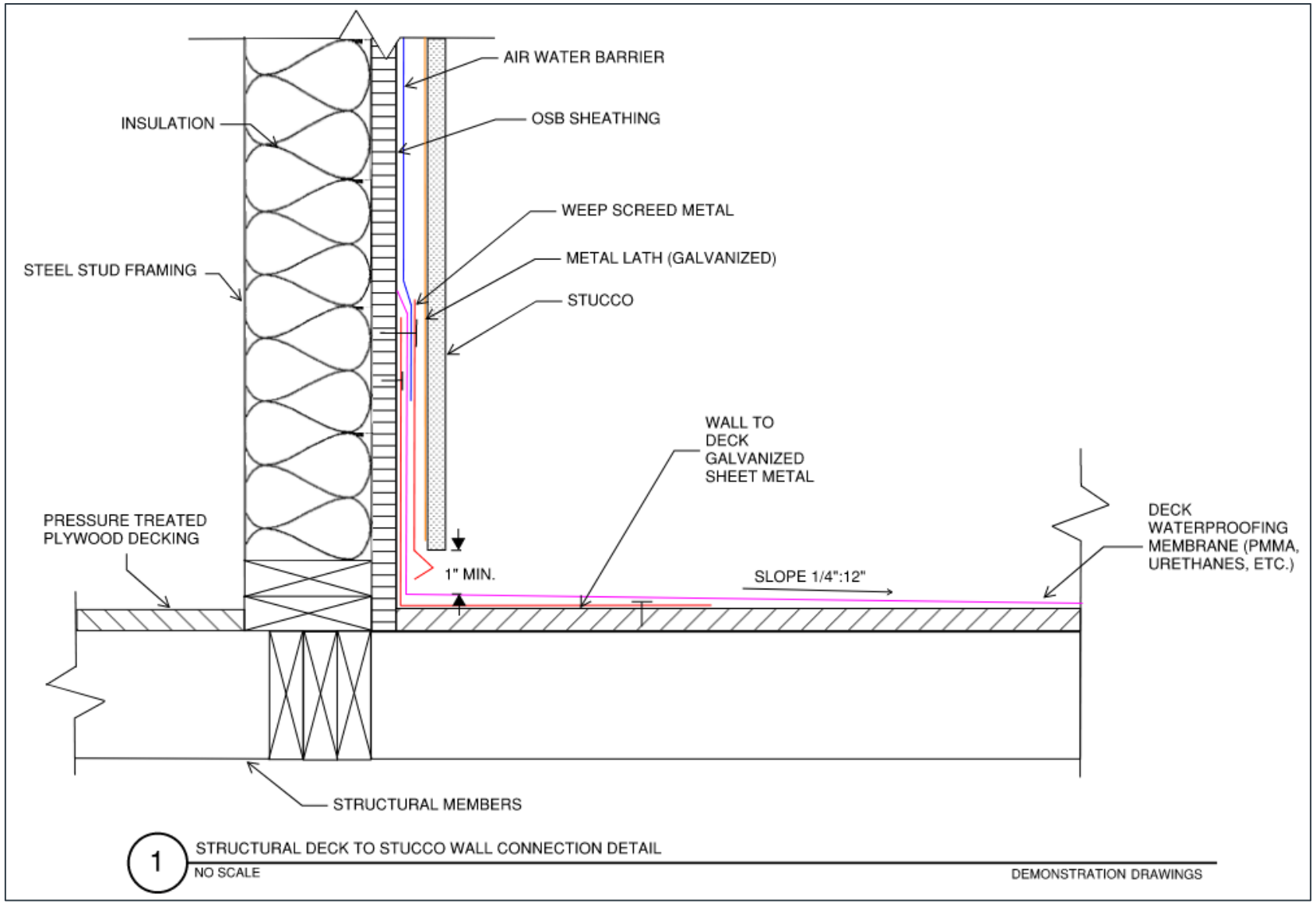
Design Development

- Discipline Coordination
  - Architect
  - Waterproofing Consultant
  - Structural Engineer
  - MEP Engineer
  - Civil/Site Drainage Engineer
  - Fire Protection Engineer
  - BECx Consultant
  - Sustainability Consultant

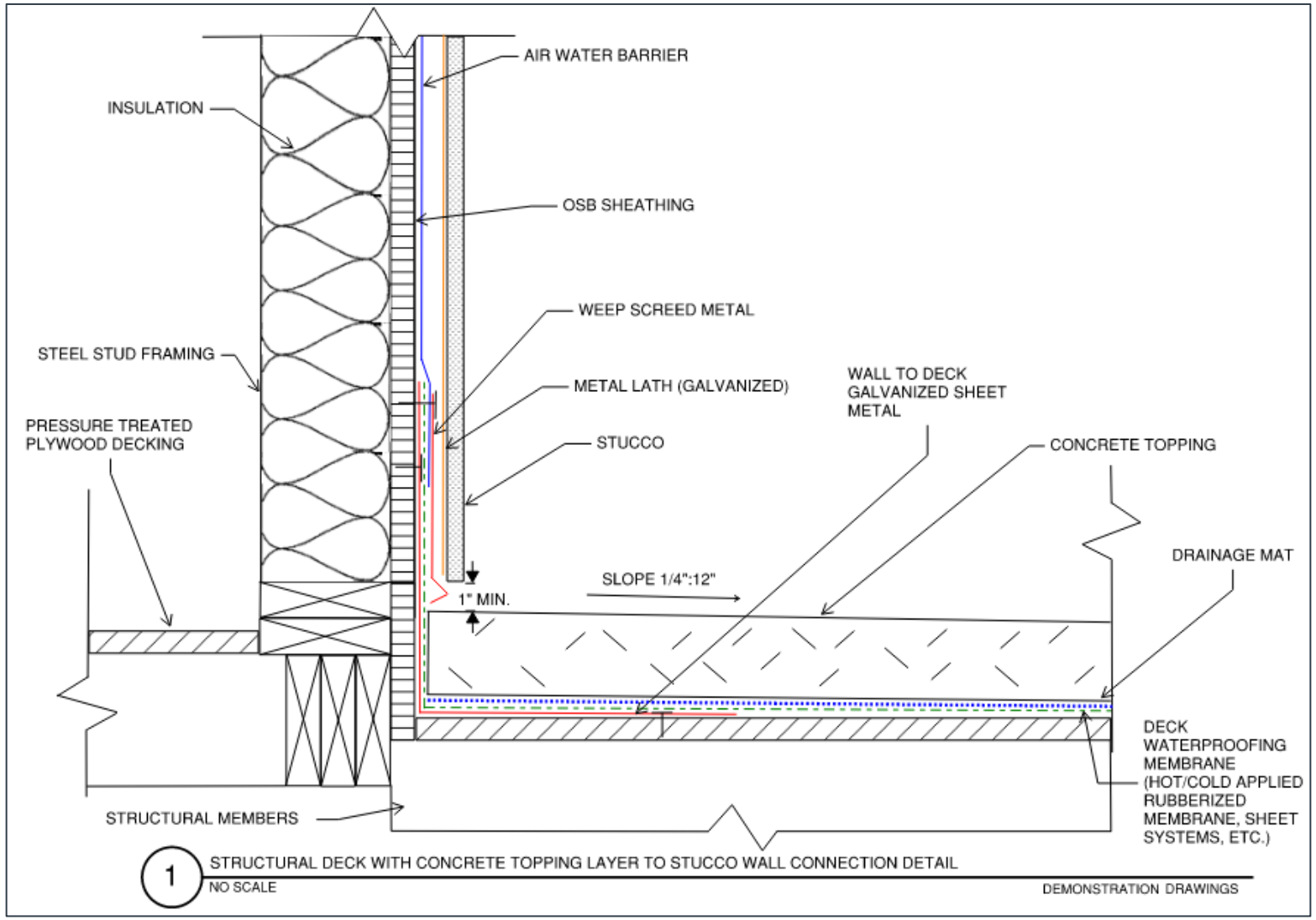
Design Challenges

- **Back Slope to Walls** – Build up of water at decking to wall transition.

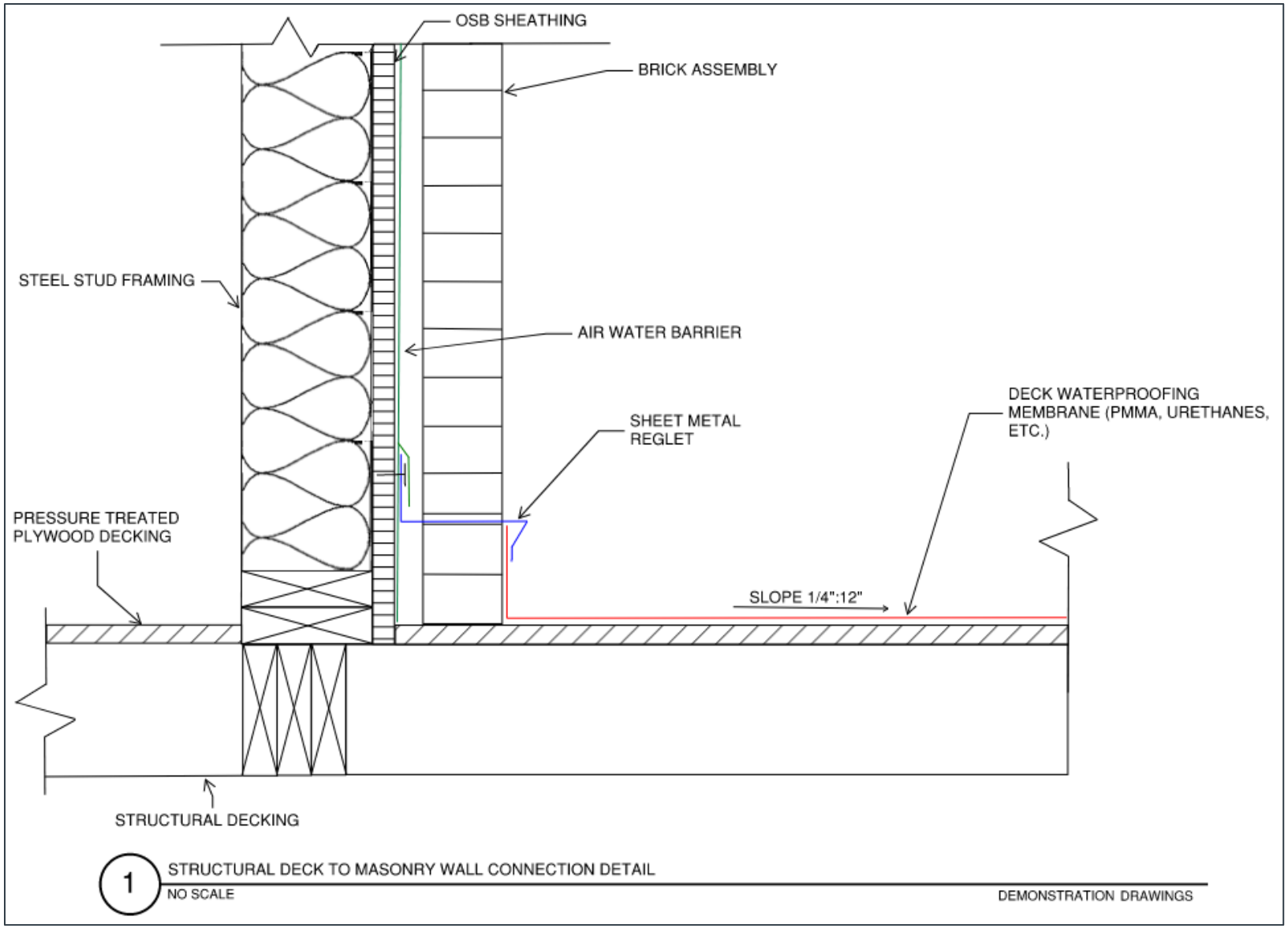
Deck to Stucco Wall Transition



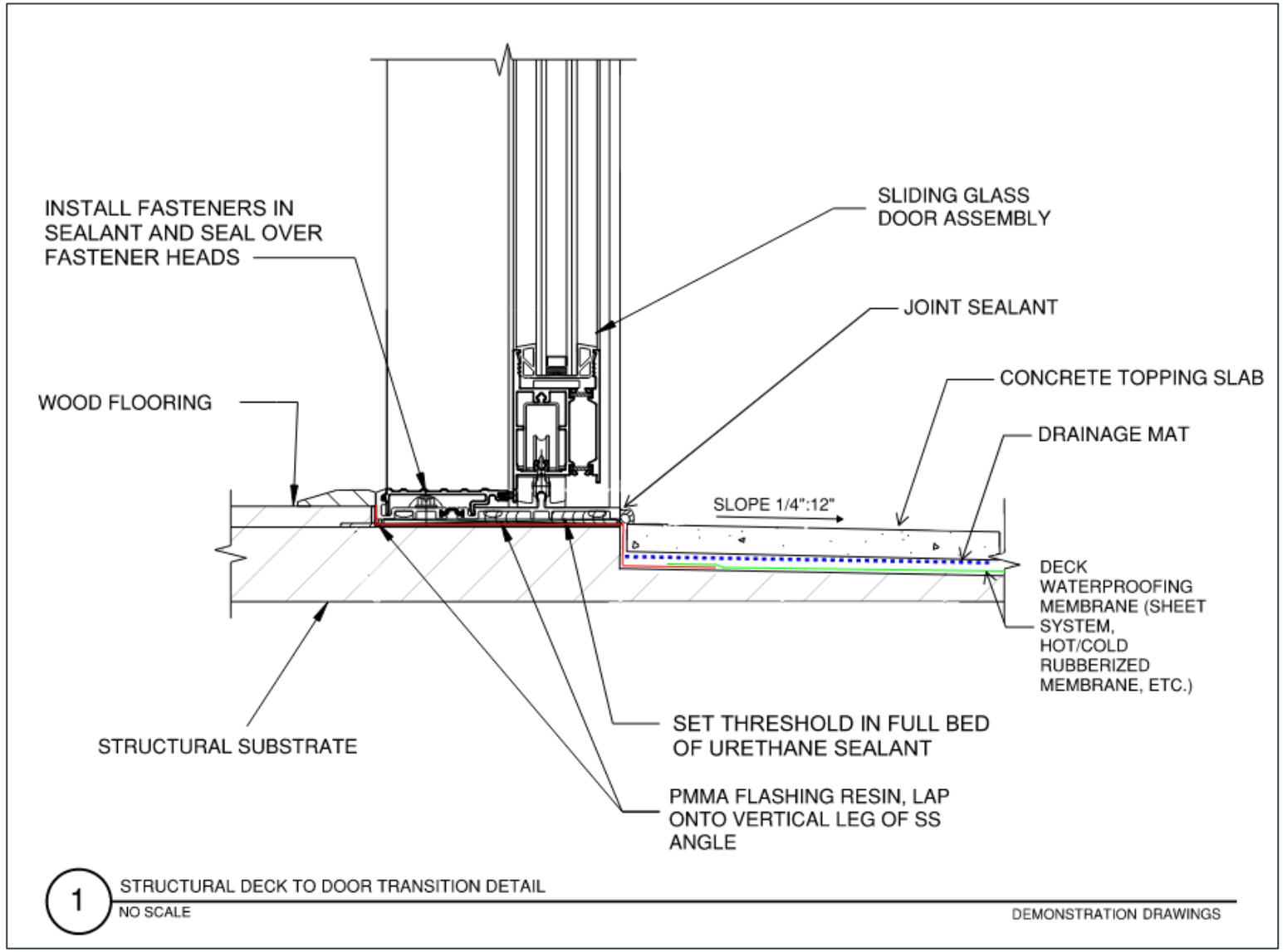
Deck to Stucco Wall Transition at Split Slab



Deck to Masonry Wall Transition



Deck to Door Transition

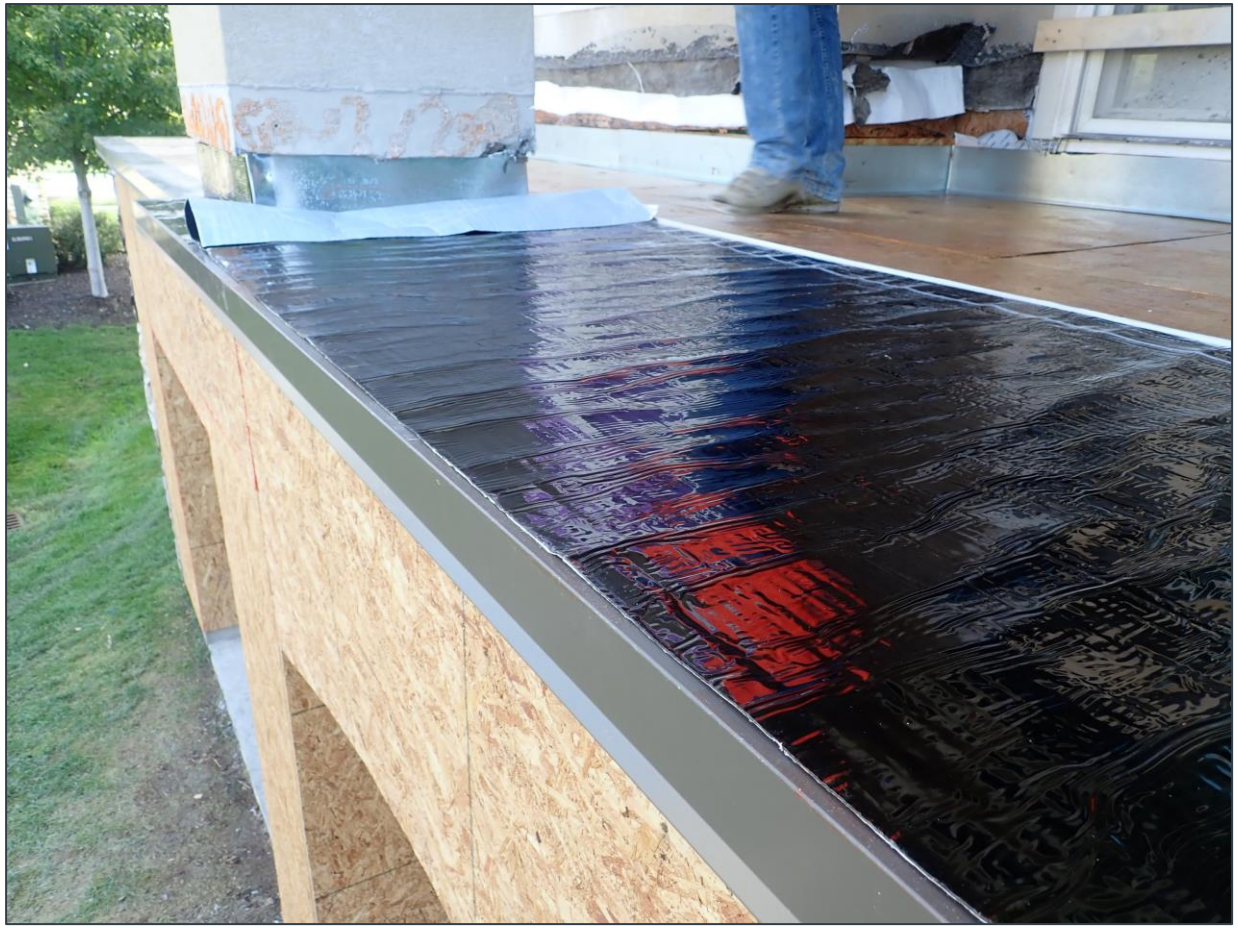


Design Challenges

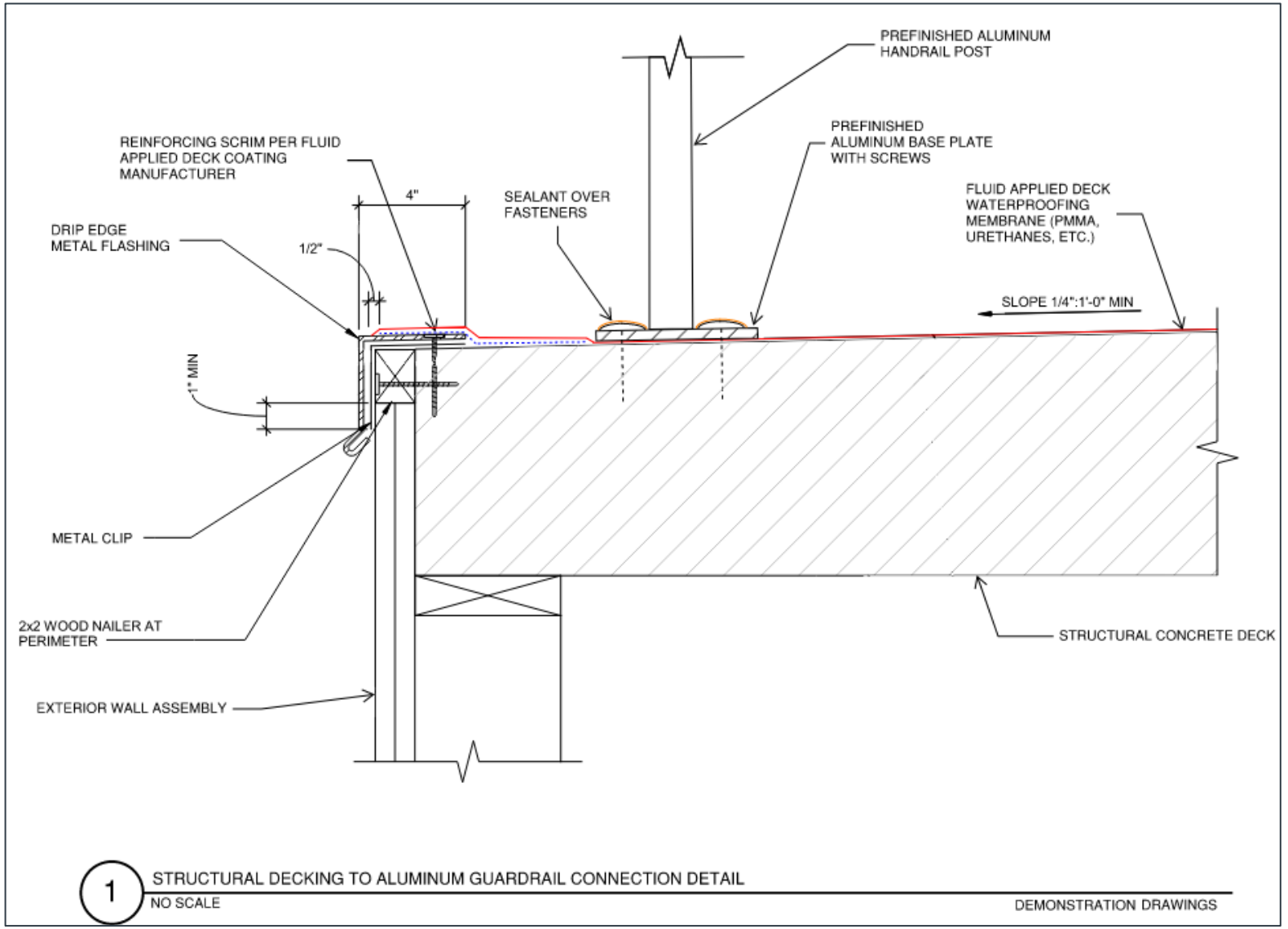
- **Unsealed Penetrations** – Penetrations should sufficiently keep water from balcony assembly.

Design Challenges

- **Incorrect Traffic Coating** – Different traffic coatings for different balcony assemblies.

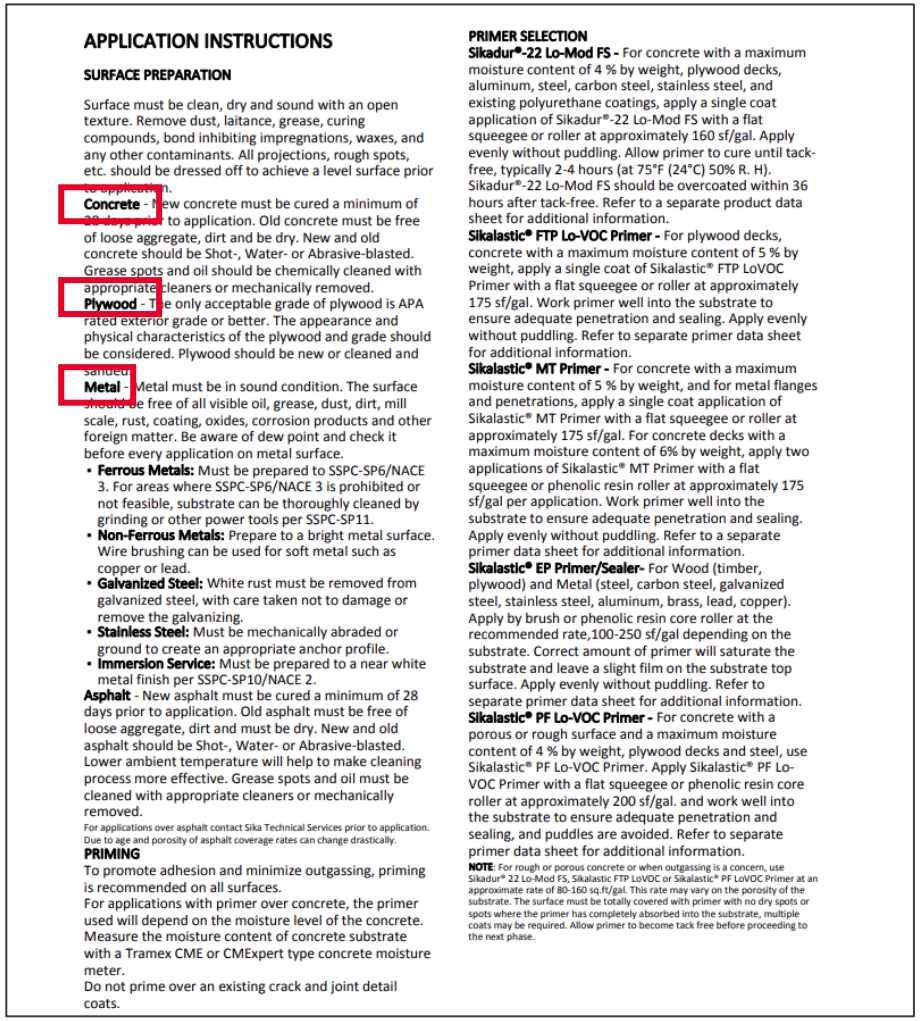


Deck Edge to Handrail Transition



Design Challenges

- **Product Incompatibility** – No individual product will suit all purposes (Product Data Sheets)



APPLICATION INSTRUCTIONS

SURFACE PREPARATION

Surface must be clean, dry and sound with an open texture. Remove dust, laitance, grease, curing compounds, bond inhibiting impregnations, waxes, and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to application.

Concrete - New concrete must be cured a minimum of 28 days prior to application. Old concrete must be free of loose aggregate, dirt and be dry. New and old concrete should be Shot-, Water- or Abrasive-blasted. Grease spots and oil should be chemically cleaned with appropriate cleaners or mechanically removed.

Plywood - The only acceptable grade of plywood is APA rated exterior grade or better. The appearance and physical characteristics of the plywood and grade should be considered. Plywood should be new or cleaned and sanded.

Metal - Metal must be in sound condition. The surface should be free of all visible oil, grease, dust, dirt, mill scale, rust, coating, oxides, corrosion products and other foreign matter. Be aware of dew point and check it before every application on metal surface.

- **Ferrous Metals:** Must be prepared to SSPC-SP6/NACE 3. For areas where SSPC-SP6/NACE 3 is prohibited or not feasible, substrate can be thoroughly cleaned by grinding or other power tools per SSPC-SP11.
- **Non-Ferrous Metals:** Prepare to a bright metal surface. Wire brushing can be used for soft metal such as copper or lead.
- **Galvanized Steel:** White rust must be removed from galvanized steel, with care taken not to damage or remove the galvanizing.
- **Stainless Steel:** Must be mechanically abraded or ground to create an appropriate anchor profile.
- **Immersion Service:** Must be prepared to a near white metal finish per SSPC-SP10/NACE 2.

Asphalt - New asphalt must be cured a minimum of 28 days prior to application. Old asphalt must be free of loose aggregate, dirt and must be dry. New and old asphalt should be Shot-, Water- or Abrasive-blasted. Lower ambient temperature will help to make cleaning process more effective. Grease spots and oil must be cleaned with appropriate cleaners or mechanically removed.

For applications over asphalt contact Sika Technical Services prior to application. Due to age and porosity of asphalt coverage rates can change drastically.

PRIMING

To promote adhesion and minimize outgassing, priming is recommended on all surfaces.

For applications with primer over concrete, the primer used will depend on the moisture level of the concrete. Measure the moisture content of concrete substrate with a Tramex CME or CMExpert type concrete moisture meter.

Do not prime over an existing crack and joint detail coats.

PRIMER SELECTION

Sikadur®-22 Lo-Mod FS - For concrete with a maximum moisture content of 4 % by weight, plywood decks, aluminum, steel, carbon steel, stainless steel, and existing polyurethane coatings, apply a single coat application of Sikadur®-22 Lo-Mod FS with a flat squeegee or roller at approximately 160 sf/gal. Apply evenly without puddling. Allow primer to cure until tack-free, typically 2-4 hours (at 75°F (24°C) 50% R. H). Sikadur®-22 Lo-Mod FS should be overcoated within 36 hours after tack-free. Refer to a separate product data sheet for additional information.

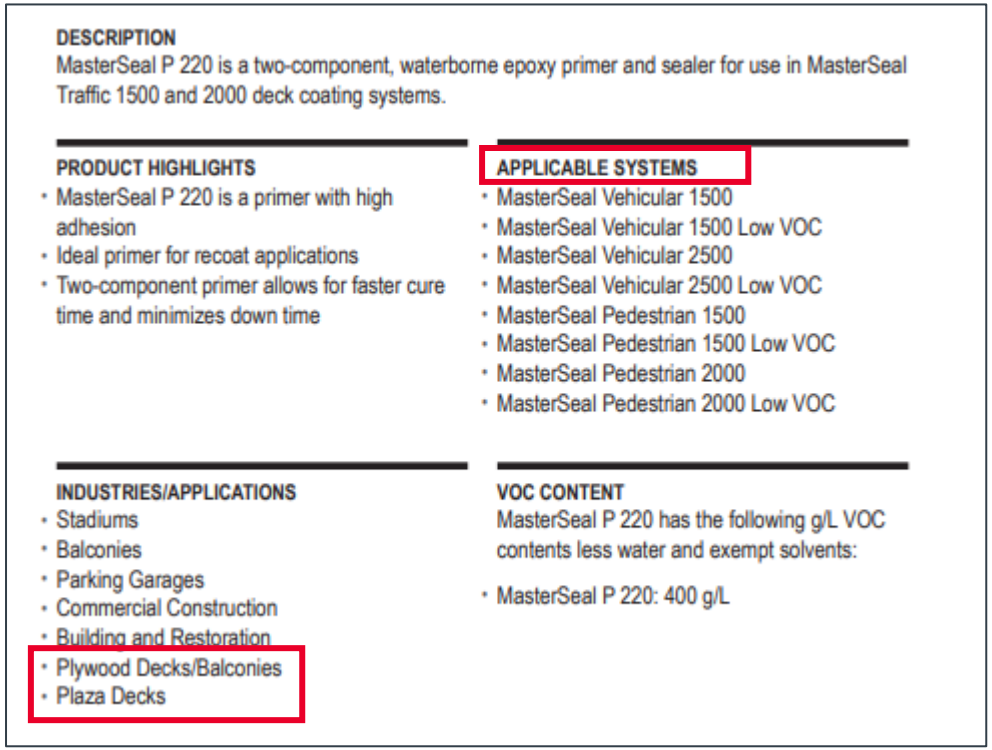
Sikalastic® FTP Lo-VOC Primer - For plywood decks, concrete with a maximum moisture content of 5 % by weight, apply a single coat of Sikalastic® FTP LoVOC Primer with a flat squeegee or roller at approximately 175 sf/gal. Work primer well into the substrate to ensure adequate penetration and sealing. Apply evenly without puddling. Refer to separate primer data sheet for additional information.

Sikalastic® MT Primer - For concrete with a maximum moisture content of 5 % by weight, and for metal flanges and penetrations, apply a single coat application of Sikalastic® MT Primer with a flat squeegee or roller at approximately 175 sf/gal. For concrete decks with a maximum moisture content of 6% by weight, apply two applications of Sikalastic® MT Primer with a flat squeegee or phenolic resin roller at approximately 175 sf/gal per application. Work primer well into the substrate to ensure adequate penetration and sealing. Apply evenly without puddling. Refer to a separate primer data sheet for additional information.

Sikalastic® EP Primer/Sealer- For Wood (timber, plywood) and Metal (steel, carbon steel, galvanized steel, stainless steel, aluminum, brass, lead, copper). Apply by brush or phenolic resin core roller at the recommended rate,100-250 sf/gal depending on the substrate. Correct amount of primer will saturate the substrate and leave a slight film on the substrate top surface. Apply evenly without puddling. Refer to separate primer data sheet for additional information.

Sikalastic® PF Lo-VOC Primer - For concrete with a porous or rough surface and a maximum moisture content of 4 % by weight, plywood decks and steel, use Sikalastic® PF Lo-VOC Primer. Apply Sikalastic® PF Lo-VOC Primer with a flat squeegee or phenolic resin core roller at approximately 200 sf/gal. and work well into the substrate to ensure adequate penetration and sealing, and puddles are avoided. Refer to separate primer data sheet for additional information.

NOTE: For rough or porous concrete or when outgassing is a concern, use Sikadur® 22 Lo-Mod FS, Sikalastic FTP LoVOC or Sikalastic® PF LoVOC Primer at an approximate rate of 80-160 sq.ft/gal. This rate may vary on the porosity of the substrate. The surface must be totally covered with primer with no dry spots or spots where the primer has completely absorbed into the substrate, multiple coats may be required. Allow primer to become tack free before proceeding to the next phase.



DESCRIPTION

MasterSeal P 220 is a two-component, waterborne epoxy primer and sealer for use in MasterSeal Traffic 1500 and 2000 deck coating systems.

PRODUCT HIGHLIGHTS

- MasterSeal P 220 is a primer with high adhesion
- Ideal primer for recoat applications
- Two-component primer allows for faster cure time and minimizes down time

APPLICABLE SYSTEMS

- MasterSeal Vehicular 1500
- MasterSeal Vehicular 1500 Low VOC
- MasterSeal Vehicular 2500
- MasterSeal Vehicular 2500 Low VOC
- MasterSeal Pedestrian 1500
- MasterSeal Pedestrian 1500 Low VOC
- MasterSeal Pedestrian 2000
- MasterSeal Pedestrian 2000 Low VOC

INDUSTRIES/APPLICATIONS

- Stadiums
- Balconies
- Parking Garages
- Commercial Construction
- Building and Restoration
- Plywood Decks/Balconies
- Plaza Decks

VOC CONTENT

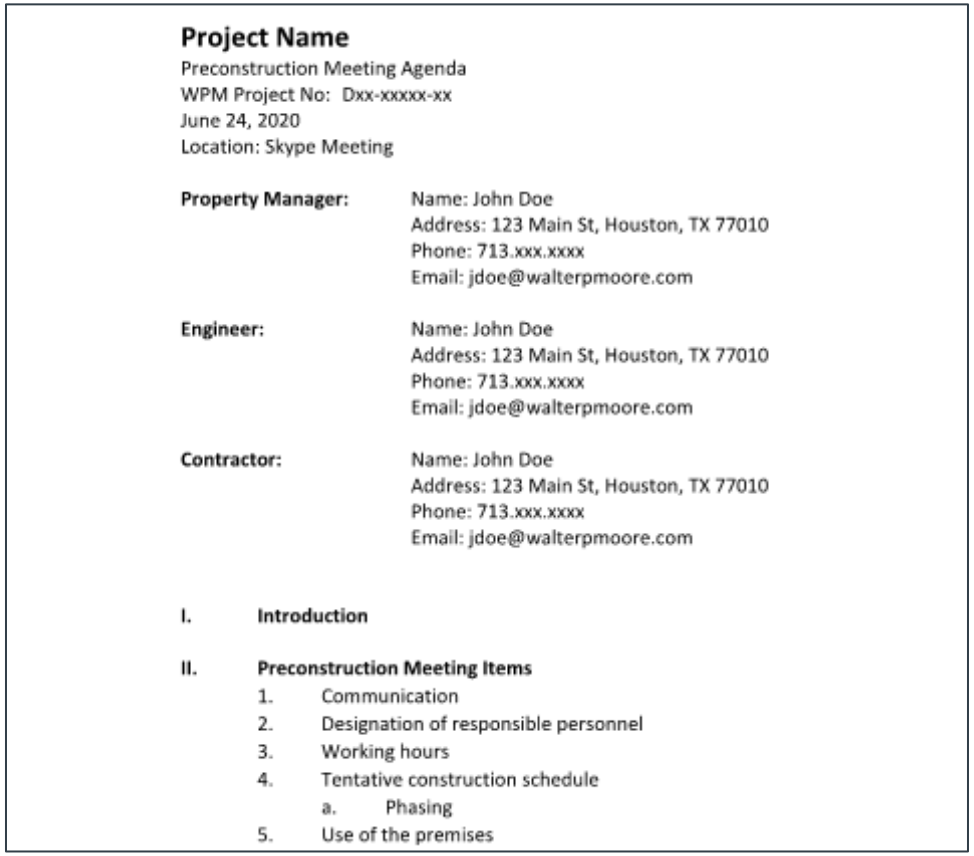
MasterSeal P 220 has the following g/L VOC contents less water and exempt solvents:

- MasterSeal P 220: 400 g/L

Construction Administration

Communication and Coordination

- Critical Meetings
  - Pre-Construction Meetings
  - Pre-Installation Meetings
  - Mockup Reviews
  - Witness Testing Meetings
  - OAC Meetings
  - Ensure details are properly installed.



Project Name
Preconstruction Meeting Agenda
WPM Project No: Dxx-xxxxx-xx
June 24, 2020
Location: Skype Meeting

Property Manager: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

Engineer: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

Contractor: Name: John Doe
Address: 123 Main St, Houston, TX 77010
Phone: 713.xxx.xxxx
Email: jdoe@walterpmoore.com

I. **Introduction**

II. **Preconstruction Meeting Items**
1. Communication
2. Designation of responsible personnel
3. Working hours
4. Tentative construction schedule
   a. Phasing
5. Use of the premises

Detail Clarification

- Submittals and Shop Drawings

SUBMITTAL TRANSMITTAL FORM
Submittal No. 071326-007.00

To:	Looney Ricks Kiss 150 Turtle Creek Blvd, Suite 104D Dallas, TX 75207	Project:	Park Place R3 Multifa
		MWB Job #	1003
		Date:	05/21/2019
Attn:	Reem Najjar	Section:	071326
Via:	Electronic		Self-Adhering Sheet Waterproc

Item No.		Submittal Type	No Copies	Spec. Para. No.	Plan Sheet No.
1	Exterior Decks	Product Data	1		

☑ Reviewed ☐ Revise and Resubmit
☐ Correct as Noted ☐ Rejected

MW Builders has satisfied Contractor's obligations under the Contract Documents with respect to Contractor's review. Contractor's review does not relieve subcontractor and/or supplier of quantities, dimensions, and installation compatibility of materials, for coordination with other trades; or, for full compliance with the contract documents.

BY: Sarah Wallace

DATE: 05/21/2019

WALTER P MOORE

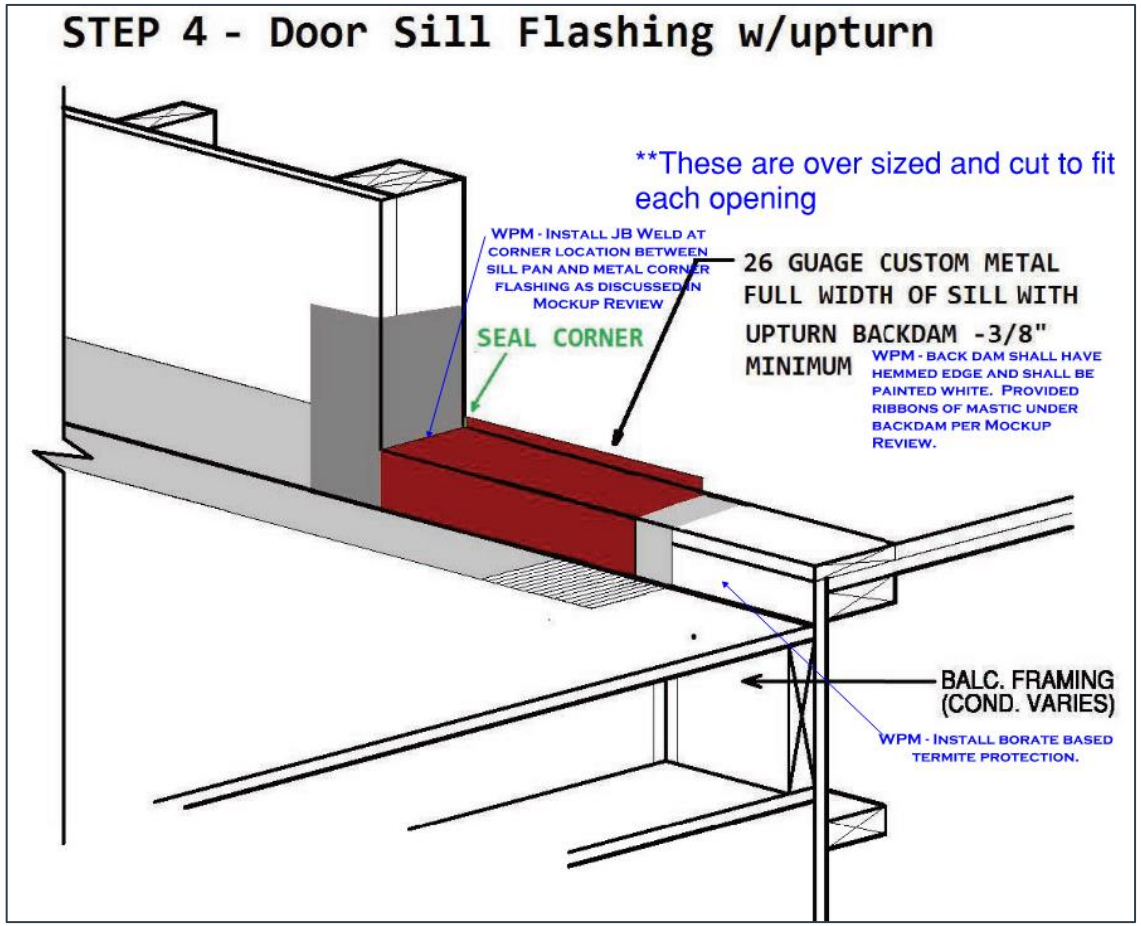
SUBMITTAL REVIEWED AS RELATED TO PERFORMANCE OF THE BUILDING ENCLOSURE (RAINWATER MANAGEMENT, AIR LEAKAGE CONTROL, VAPOR DIFFUSION, DIFFERENTIAL THERMAL MOVEMENTS). COMMENTS ARE ADVISORY IN NATURE AND ARE INTENDED FOR CONSIDERATION BY THE DESIGNER OF RECORD IN EVALUATING THE BUILDING ENCLOSURE SYSTEMS ON THE BUILDING(S). COMMENTS ARE NOT INTENDED TO PROVIDE DIRECTIVE TO THE CONTRACTOR OR SUBCONTRACTORS REGARDING ACTION DURING CONSTRUCTION, INCLUDING REJECTION OR ACCEPTANCE OF THE SUBMITTAL. FINAL DECISION REGARDING THE SUBMITTAL STATUS IS THE RESPONSIBILITY OF THE DESIGNER OF RECORD.

WE RECOMMEND THE FOLLOWING SUBMITTAL STATUS BASED ON OUR REVIEW:

☐ NO EXCEPTIONS TAKEN ☐ REVISE AND RESUBMIT
■ EXCEPTIONS NOTED ☐ SUBMIT SPECIFIED ITEM(S)

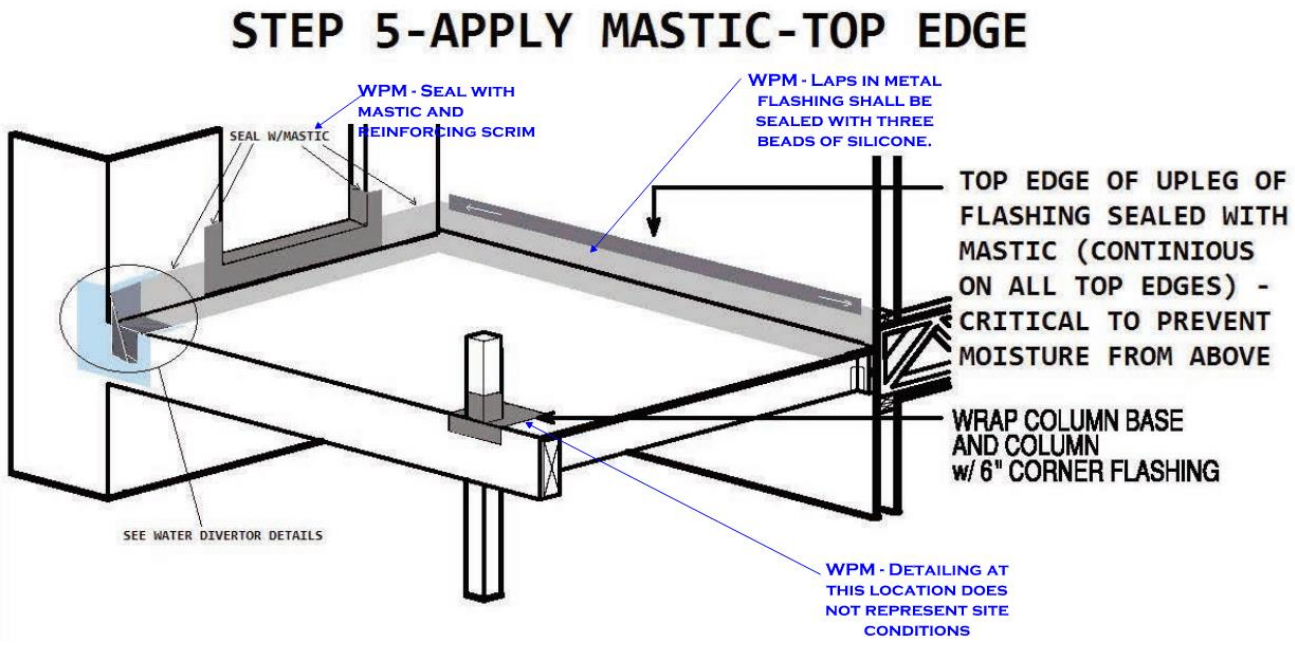
REVIEWED BY: LW
REVIEW DATE: 05/22/2019

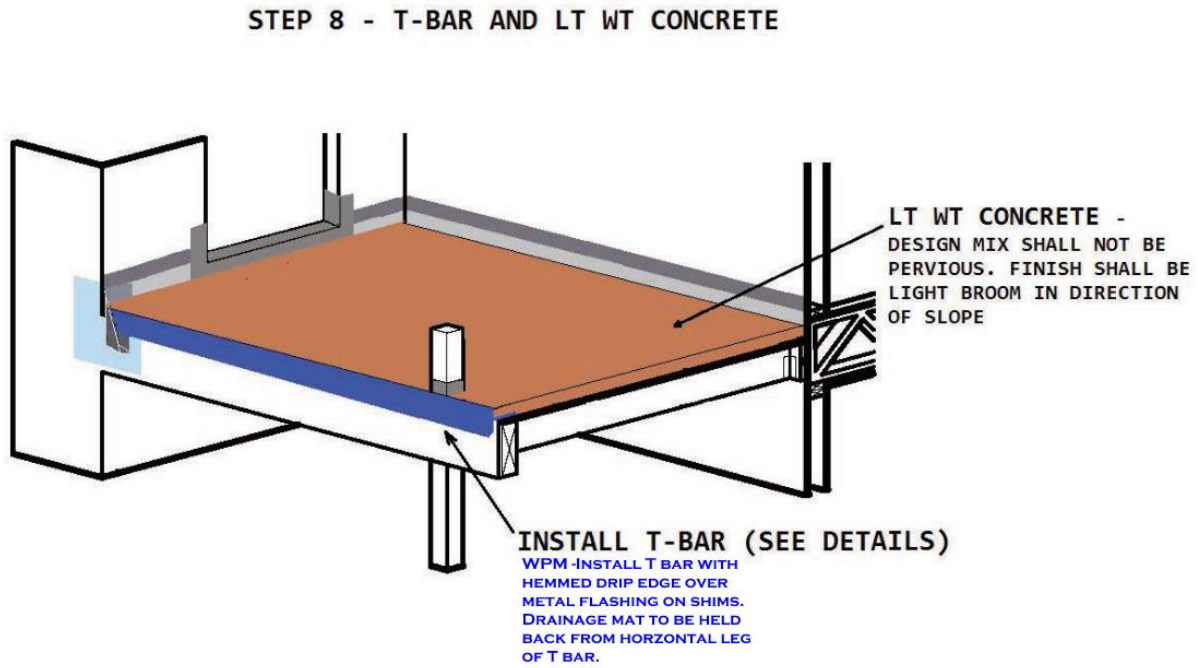
MW Builders | Architect/Engineers Record Stamp



Detail Clarification

- Submittals and Shop Drawings





Field Mockups

- Architect, owner, contractor, and subcontractor work together to successfully complete field mock-up testing before construction to identify and resolve any waterproofing related design flaws.

Pre-construction testing and inspection of handrail connection field mockup - WPM

Field Mockups

Pre-construction testing and inspection of deck waterproofing system field mockup - WPM

Non-Destructive Field Testing – Water Testing

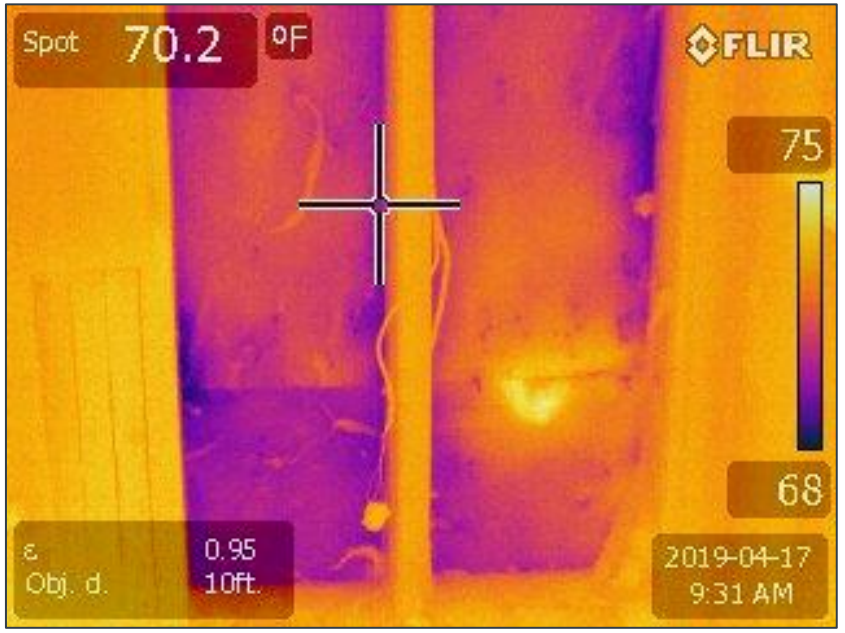
- ASTM D5957-98(2021) – Standard Guide for Flood Testing Horizontal Waterproofing Installations
- ASTM D7877-14 Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes

Water testing to determine possible areas of water intrusion at deck to wall transition - WPM

Non-Destructive Field Testing – Moisture and Infrared Imaging

- Using technology to identify moisture and thermal anomalies in locations with suspected moisture intrusion through moisture imaging meters and infrared cameras.

Imaging moisture meter - WPM

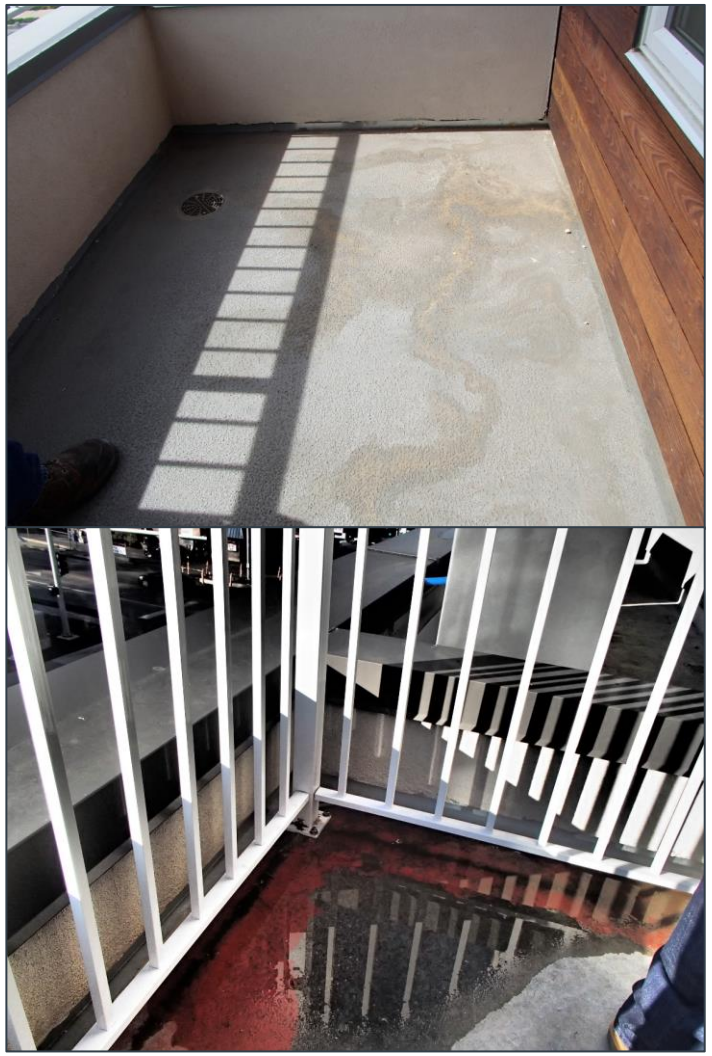


Infrared camera to detect thermal anomalies and locate moisture- WPM

Digital moisture meter- WPM

Maintenance and Inspections

- Inspection and documentation recommended for every 5 years but, never more than 10 years.
- Attention to expansion/control joints, deck-to-wall transitions, handrails, and other protrusions.
- **2018 IBC 110.3.8.1** – Weather exposed balcony and walking surface waterproofing. No moisture barrier system elements to be concealed until inspection and approval.



Evidence of ponding water at deck surface - WPM

Summary

- Balconies are a critical feature of wood-framed buildings that require waterproofing and durable materials to maintain the health, welfare, and safety of users
- A variety of balcony waterproofing systems and materials are available. Design development is critical to select products and systems that can perform with the architecture of the building.
- Special attention should be placed at deck transitions (deck-to-wall, deck-to-door, etc.), and penetrations (connections of railings, etc.) to maintain durability.
- Construction administration is essential to ensure conformance of construction to design.
- Water management and general maintenance are key to maintaining structural integrity of balcony and enclosure.

This concludes The American Institute of Architects Continuing Education Systems Course

QUESTIONS?

This concludes The American Institute of Architects Continuing Education Systems Course

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