Framing Techniques for Builders: Lessons Learned and Best Practices

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Course Description

Today's session is intended improve framing techniques; addressing common commercial and multi-family construction issues. We will review several case studies and discuss the lessons learned so that we avoid similar issues on your own projects.

This is an interactive discussion; questions and comments are welcomed.

Learning Objectives

1. Highlight framing issues and discuss solutions.
2. Discuss proper load path framing techniques.
3. Review lessons learned from different project case studies.
4. Examine construction strategies that result in high-performing structures.

A bit about me

Academics –

- **BSCE - The Ohio State University**
- **MBA – The University of Dayton**

Experience -

- **Consulting Structural Engineer – Columbus, Ohio**
- **Wood Products/Structural Engineering – Trus Joist/Weyerhaeuser**

Registered Professional Engineer/Structural Engineer

Expertise – Design & Analysis, Forensics, Litigation Support

Agenda - Lessons Learned

- **Load Path Resolution**
  - **Vertical & Lateral**
  - **Lateral Stability**
  - **Differential Deflection**
  - **Unique Floor/Fascia Requirements**
- **Moisture Management**
  - **Keep it Dry**
  - **Preservative Treatments**
  - **Protecting Products in Inventory & Jobsites**
- **Vibration**
- **Fire & Sound Design**
- **Roof Anchors**

Load Path Resolution

Simply stated … vertical and lateral loads need to be transferred to the foundation/ground.

Load rationalization =
Joist → Beam → Column → Foundation

- **Proper member selection**
- **Adequate support**
- **Appropriate load transfer details**
- **Foundation adequacy**

Software – 2d analysis; 3d view; review of software operator design

Load Path Resolution

Member Analysis – *"what to watch for?"*

Vertical Loads

- **Increased Dead Loads – lightweight concrete, tile or stone, non-load bearing walls**
- **Concentrated Loads (Fc perp or Fc parallel)**
  - **Beams & Headers**
  - **Girder Truss**
- **Construction Loading**
- **Wall and Post Load transfer**
- **Differential loading conditions**

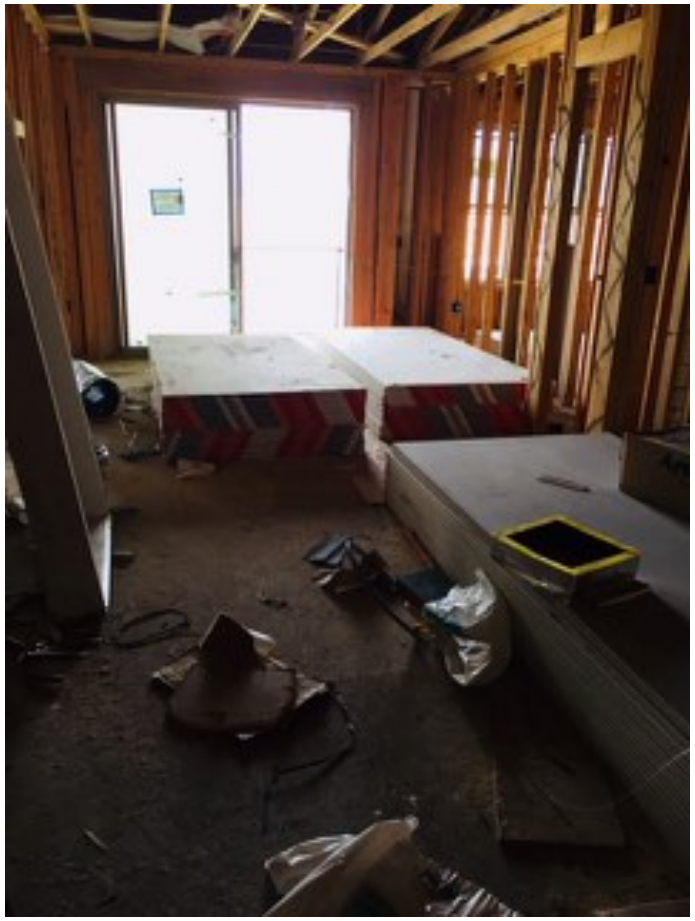
Lateral Loads

- **Location of Shear Walls – connection design; manufacturer's limitations (fastener o/c spacing)**
- **Blocking**
- **Screws vs. Nails**

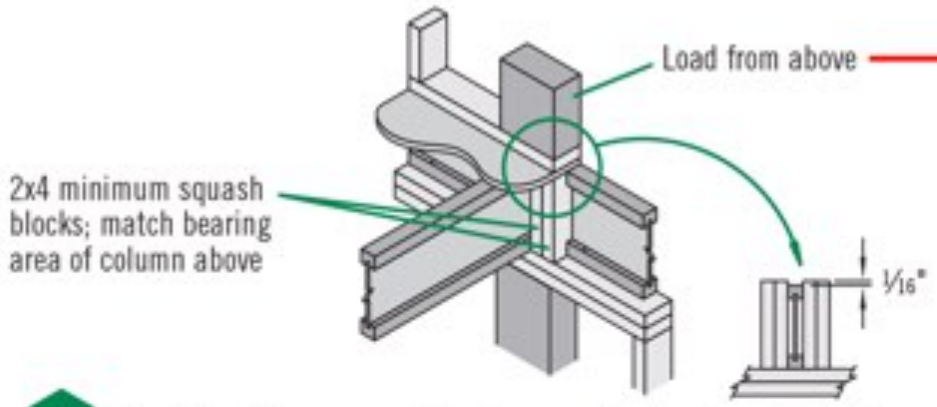
Installation Review

In other words - Sequence the Framing

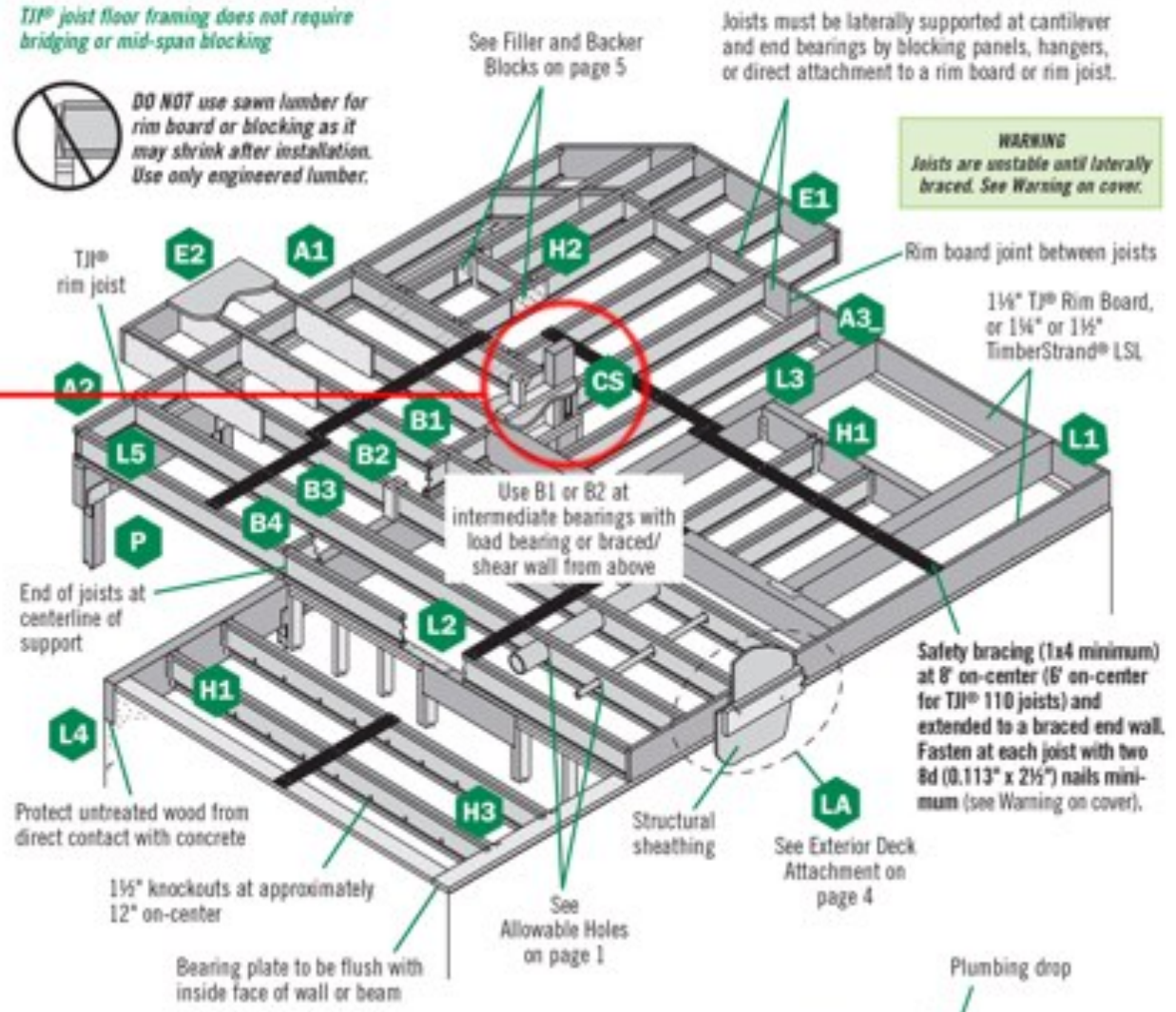
Construction Loads – The Unforeseen



Wall and Post Load Transfer

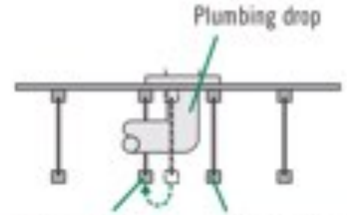


CS ***Use 2x4 minimum squash blocks to transfer load around TJI® joist***



INSTALLATION TIPS

- Subfloor adhesive will improve floor performance, but may not be required.
- Squash blocks and blocking panels carry stacked vertical loads (details B1 and B2). Packing out the web of a TJI® joist (with web stiffeners) is not a substitute for squash blocks or blocking panels.
- When joists are doubled at non-load bearing parallel partitions, space joists apart the width of the wall for plumbing or HVAC.
- Additional joist at plumbing drop (see detail at right).



Inadequate Load Transfer

Student Apartments
Complaint – Floor Levelness, Water Leaks
Construction Issue – Load Transfer (rim not bearing on masonry wall)
Squash Blocks added to Stabilize
Floor Jacked to Level

What could the EOR/AOR have done better? – Load Transfer detailing
What could the suppliers have done better? – 'Protocol' communications

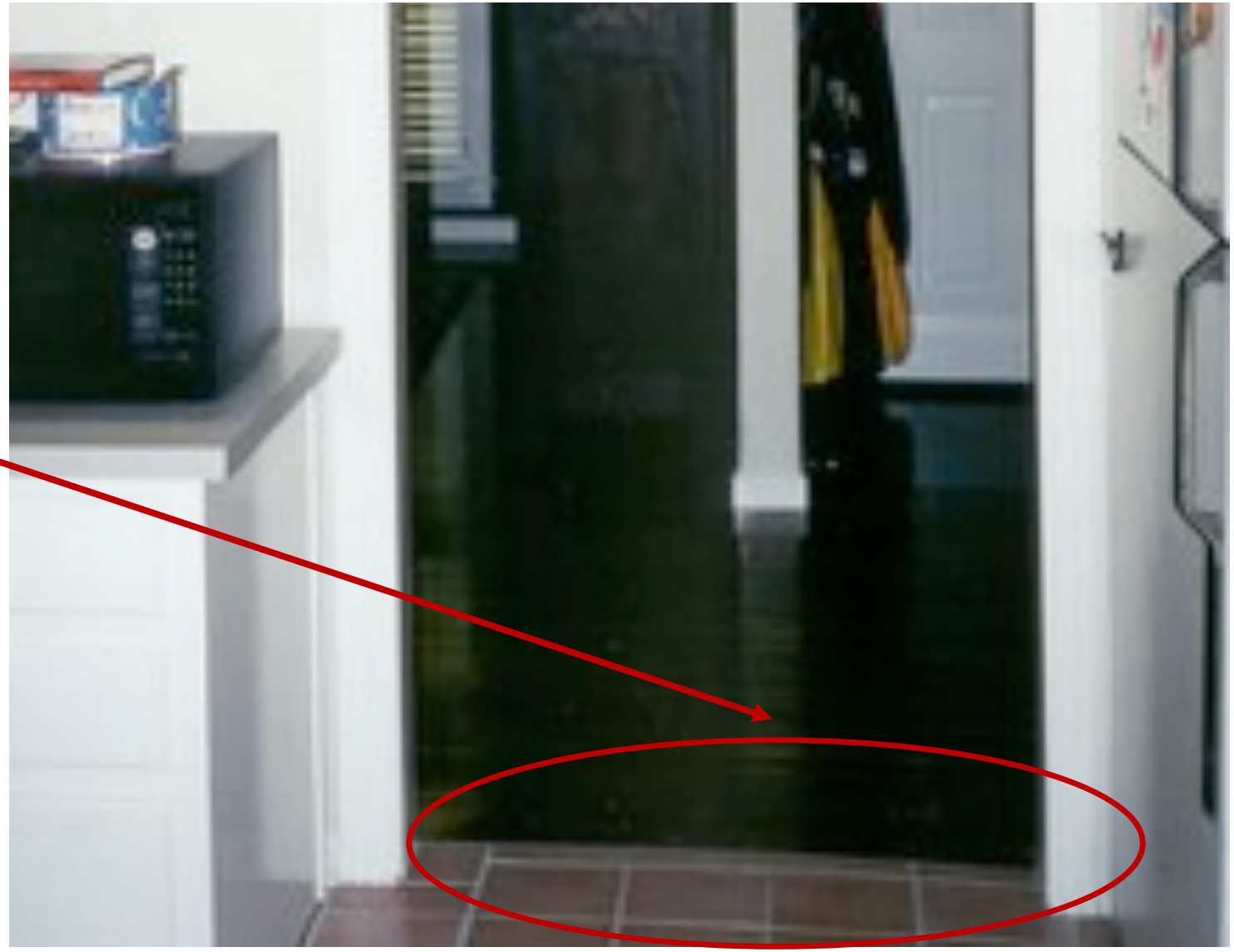
Differential Deflection

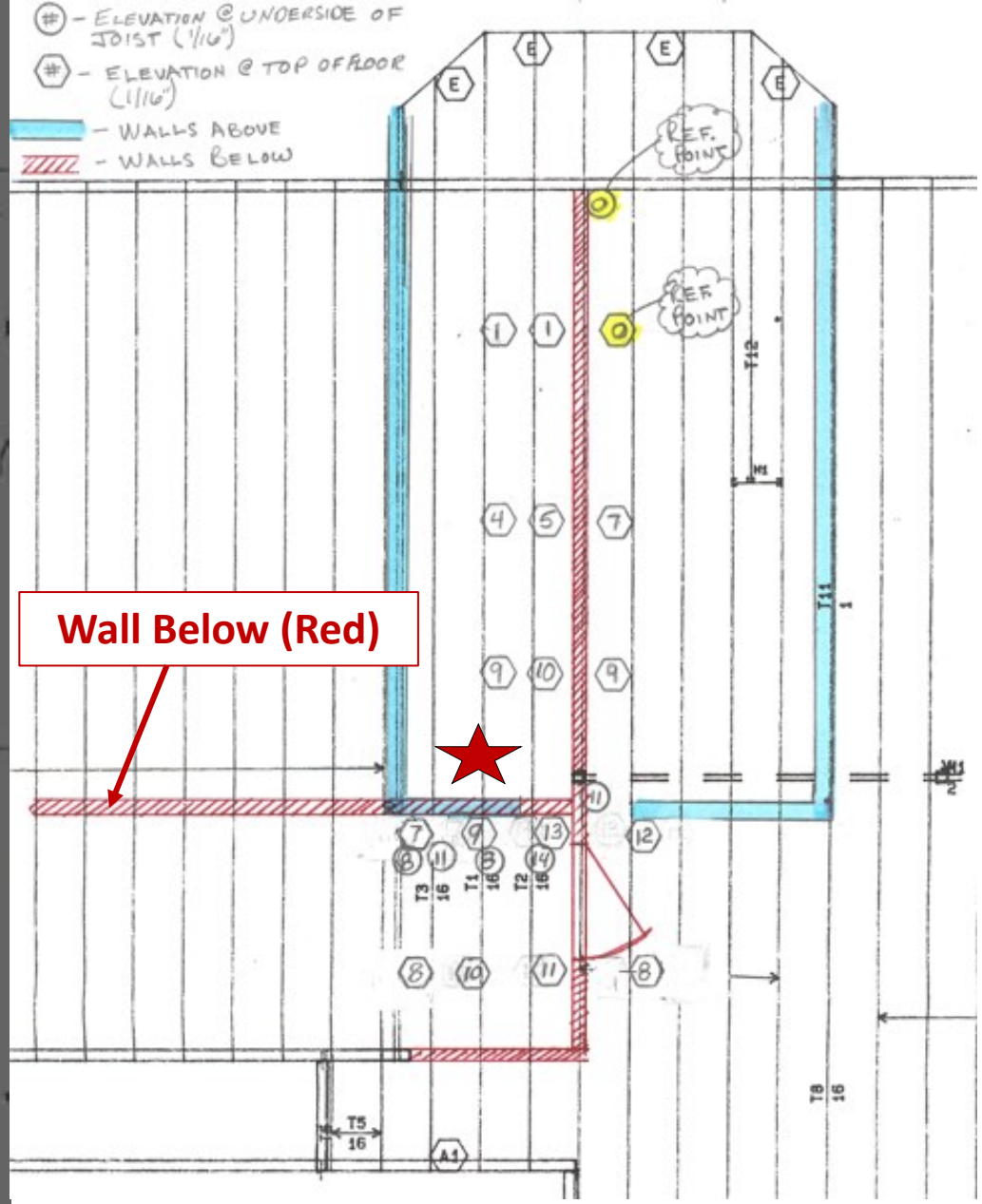
Complaint –

Tile Cracking

Excessive Deflection

‘dropping’ 5/8“ over 4’



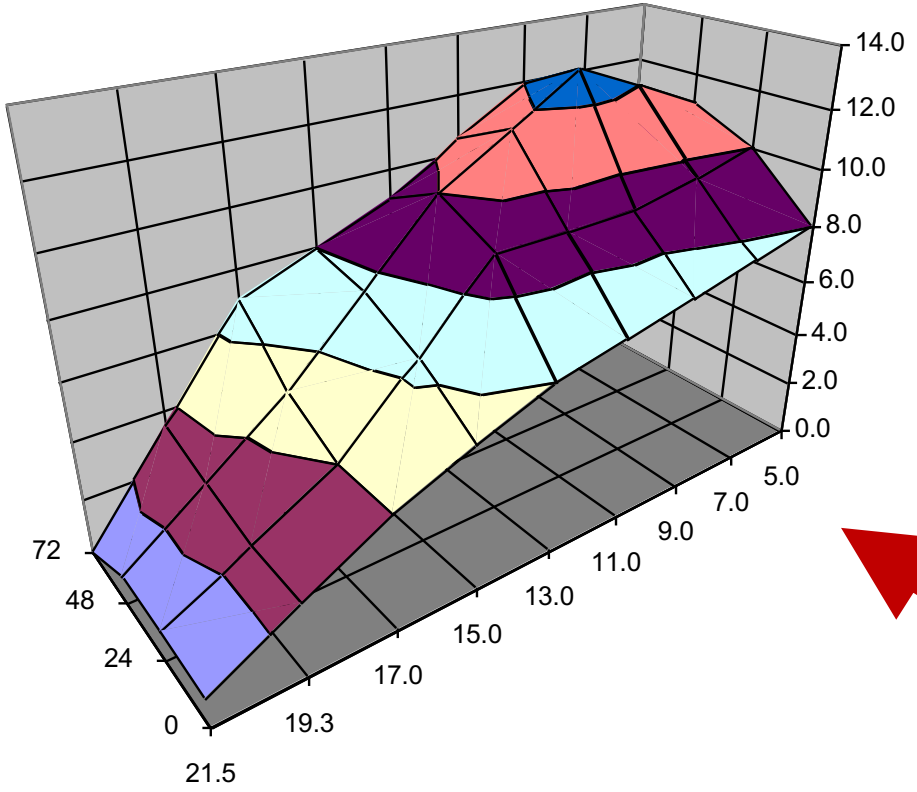


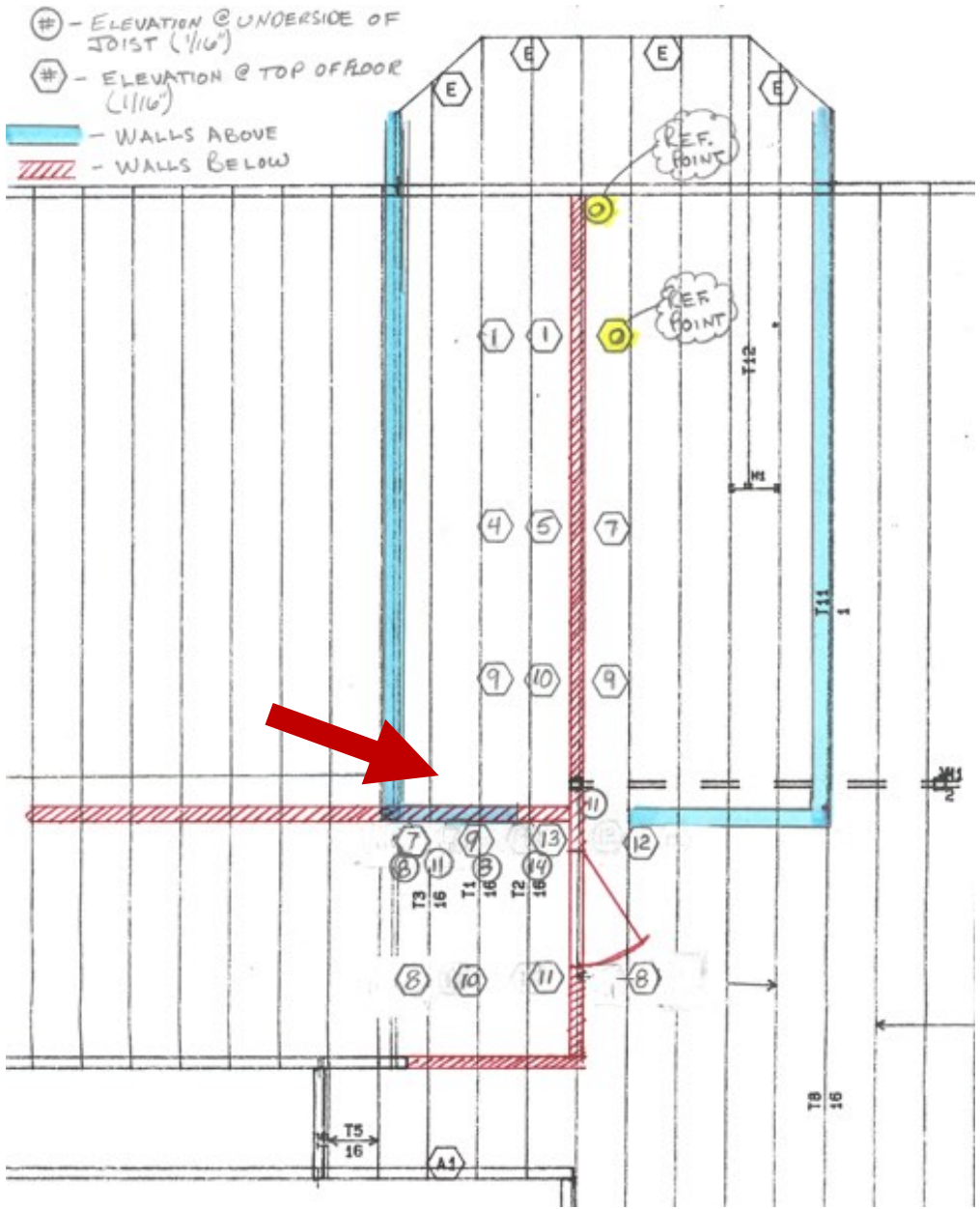
Differential Deflection

Field Investigation Results

Transit Floor Readings

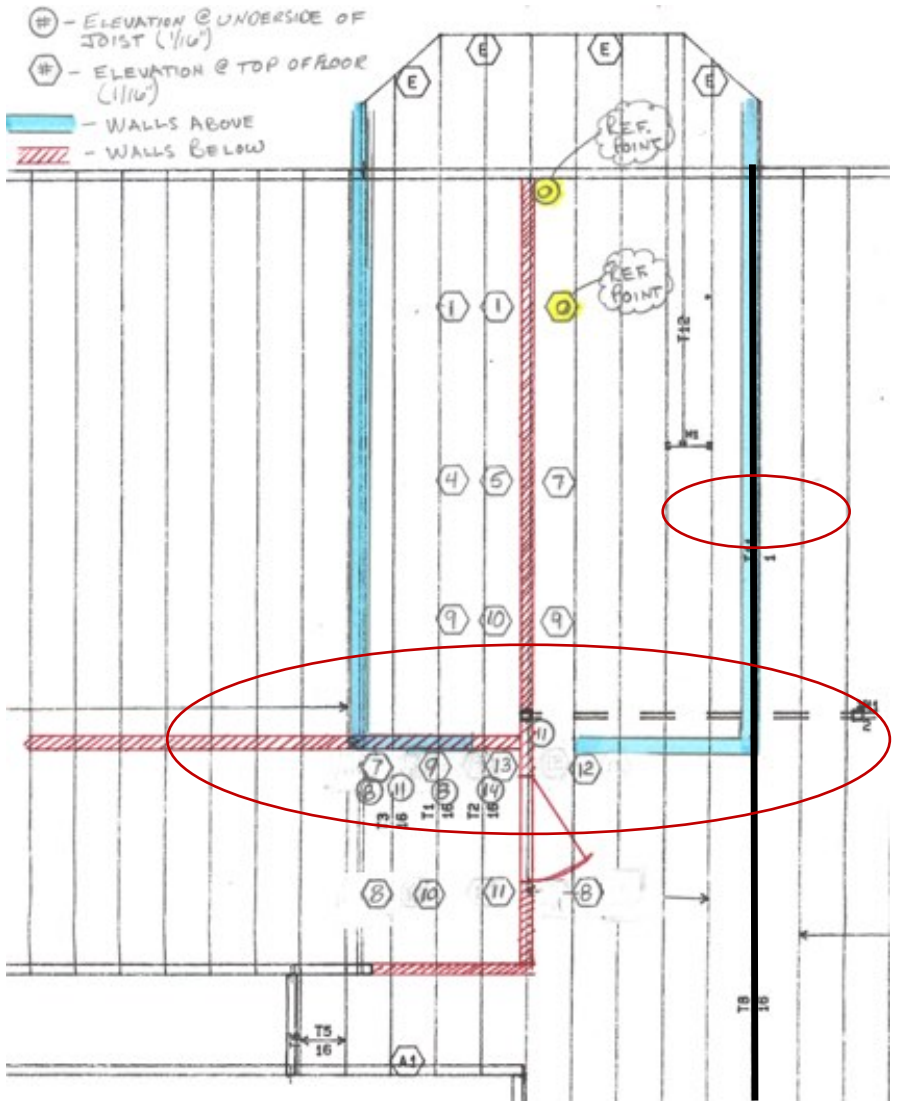
- Potential for Differential Deflection
- Beam set too high!





Best Practices - Differential Deflection

1. Anticipate different span and loading conditions
2. ‘Feather framing’ - simple vs. continuous span
3. Match deflection performance – beam vs adjacent joists
4. Acknowledge different support conditions (wall vs. beam)



Best Practices - Assumptions Follow-up

EXPECTATIONS OF THE CONTRACTOR

- **OFA Review**
- **Framing for correctness**
- **Notes and deviations**
- **Notes are acceptable unless noted otherwise**

EXPECTATIONS OF THE SUPPLIER

- **Highlight deviations**
- **Load rationalization**
- **Value design – professional protocol**
- **Framing details**

Moisture Management

Simple stated … keep it dry or use preservative treated wood

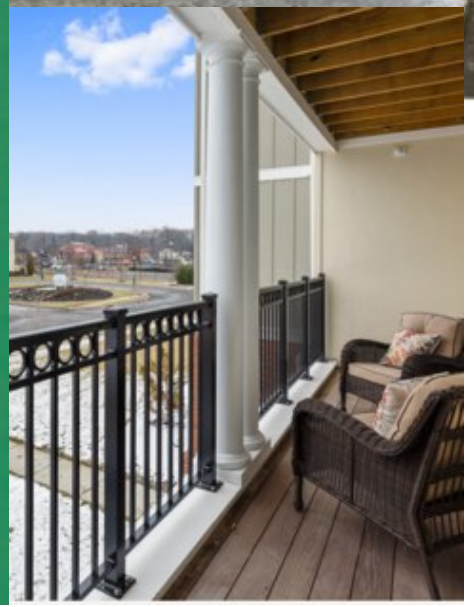
Guiding Principles

- **Dry Usage is classified as < 16%**
- **Reasonable construction rainfall is OK**
- **Service Life - Keep it Dry**
- **When in doubt – Preservative Treated or Naturally Durable Wood**

Dry Use Conditions - "*what to watch for?*"

Balcony/Deck Conditions

- **Flashing, connections, detailing, etc. → waterproofing**
- **Allow for wicking – don't encapsulate**
- **Installation Review**
- **Maintenance Program**



Apartments – Cherry Hill, NJ

Waterproofing Untreated Wood Framing

Moisture Management

Untreated wood products are intended for dry-use applications only. When used for exterior applications, the construction must maintain dry-use over the entire service life of the structure.

Best Practices

- **Positive drainage**
- **Adequate separation for ventilation/condensation control**
- **Wrap dry products only**

HDH Complex – Frisco, TX

Waterproof Membrane

Perforated Vinyl

Moisture Management

Waterproof Deck Membrane
Alberta, Canada
150^{o} F differential

Waterproof Roof Membrane
Santa Rosa, California
Closed Roof/Floor Cavity

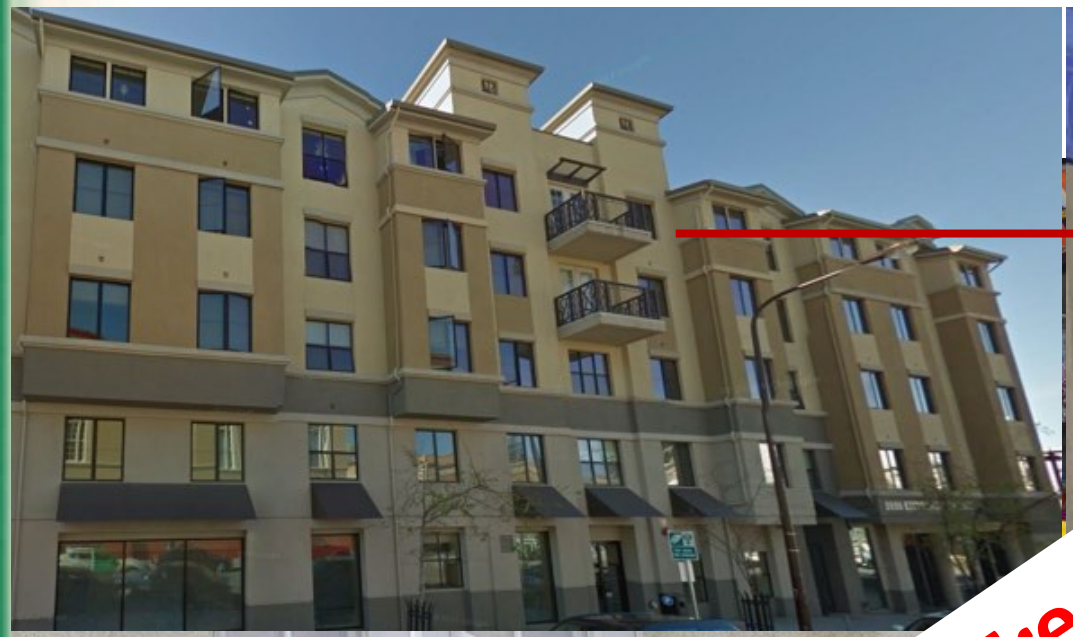
Moisture Management

Condos – La Jolla, CA
Balcony Framing

Partial Roof Watershed

Moisture Intrusion into the Building Envelop ('Wicking')

Moisture Management



Preservative Treated Wood Lumber

Berkley, CA
Balcony Deck Collapse
2015

Moisture Management
Selecting the Correct Preservative Treatment
Exposure 4A

Phillip Merrill Center, MD
Exposed Heavy Timber
CuAz Treated

Vibration – Factors Affecting Floor Performance

FREQUENCY

Frequency is the number of waves per second created when you step on the floor. Generally, low frequencies are uncomfortable. The less stiff the joist, the lower the frequency.

DAMPING

Damping is the ability of the floor sytem to "absorb" the wave that is introduced. The faster the wave is absorbed, the more solid the floor will feel.

PERCEPTION

How a floor feels is highly variable from one person to another.

- **Basic Stiffness** is a combination of joist depths and span.
- **Composite Action**—Careful nailing in conjunction with construction adhesives increases basic stiffness.
- **Continuity**—Continuous joists over several supports generally perform better than simple spans. Care must be taken if the joists continue into another occupancy.
- **Joist Spacing and Deck Stiffness**—Reduced spacing or increased deck thickness generally improves floor performance.
- **Ceilings** directly applied to the bottom edge of the floor members, or equivalent 1x or 2x strapping, is a performance enhancement.
- **Beams**—Floor systems supported by steel or wood beams tend to feel less stiff than those supported by solid bearing walls.
- **Bridging or Blocking** can be a contributor to improved floor performance.
- **Non-bearing Partition Walls** dampen vibration and improve floor performance when installed transverse to the floor joists.
- **Mass** reduces damping in a floor system, causing a decrease in floor performance. This impact is more noticeable as span lengths increase.

Vibration Design

$$f = 1.57\sqrt{\frac{386EI}{WL^3}}$$

Fundamental Frequency – f (Hz)

E – MOE (psi)

I - moment of inertia (in^4)

W – true dead load (lbs.)

L - joist span (in)

Virginia Tech Guidelines

Quick Rules of Thumb

Floor covering/floor membranes

Shorten the span

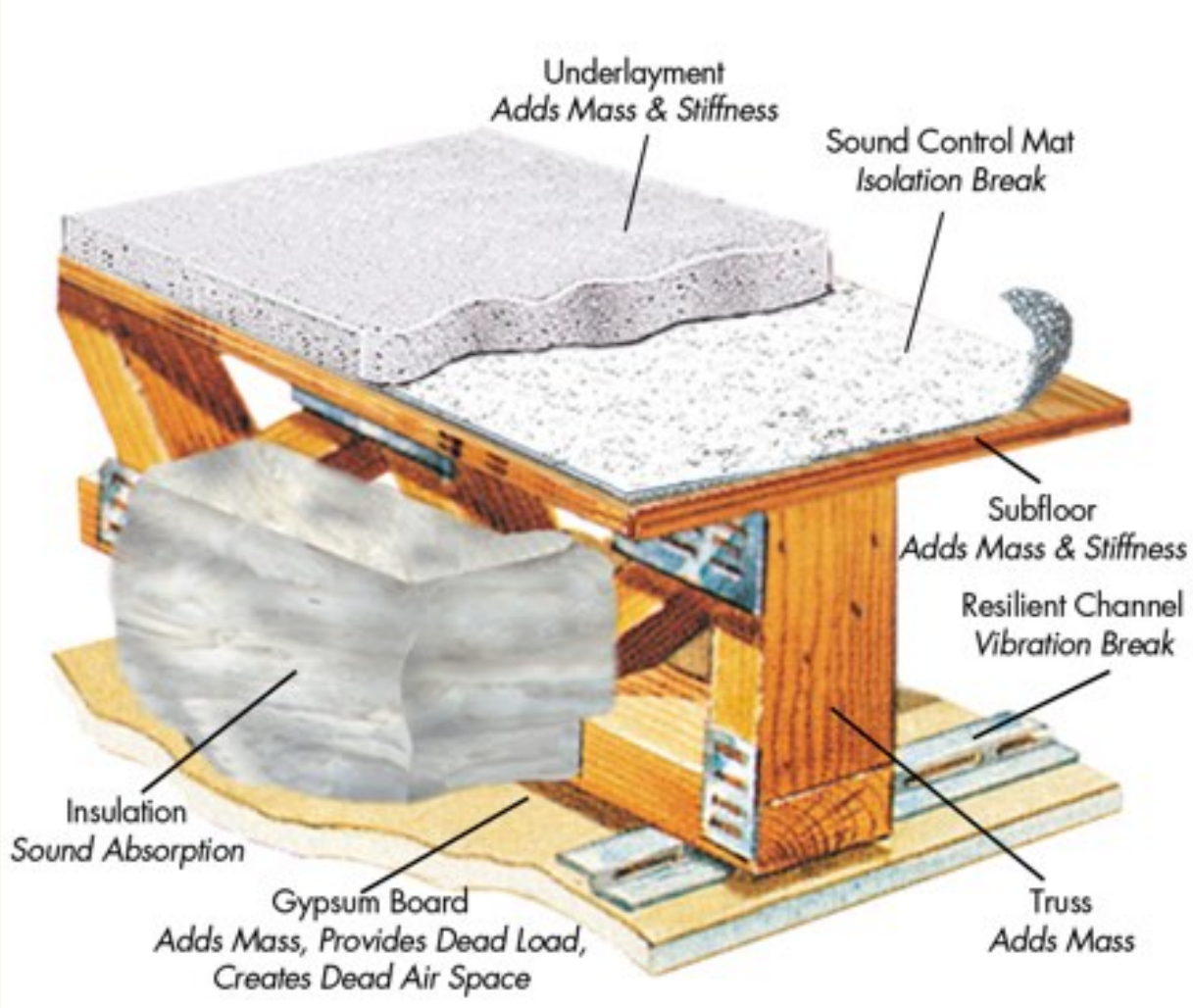
Increase the joist depth

L/480 +

Glued/Screwed floor decking

Bridging/Ceiling – tied to a support wall

Fire & Sound Design



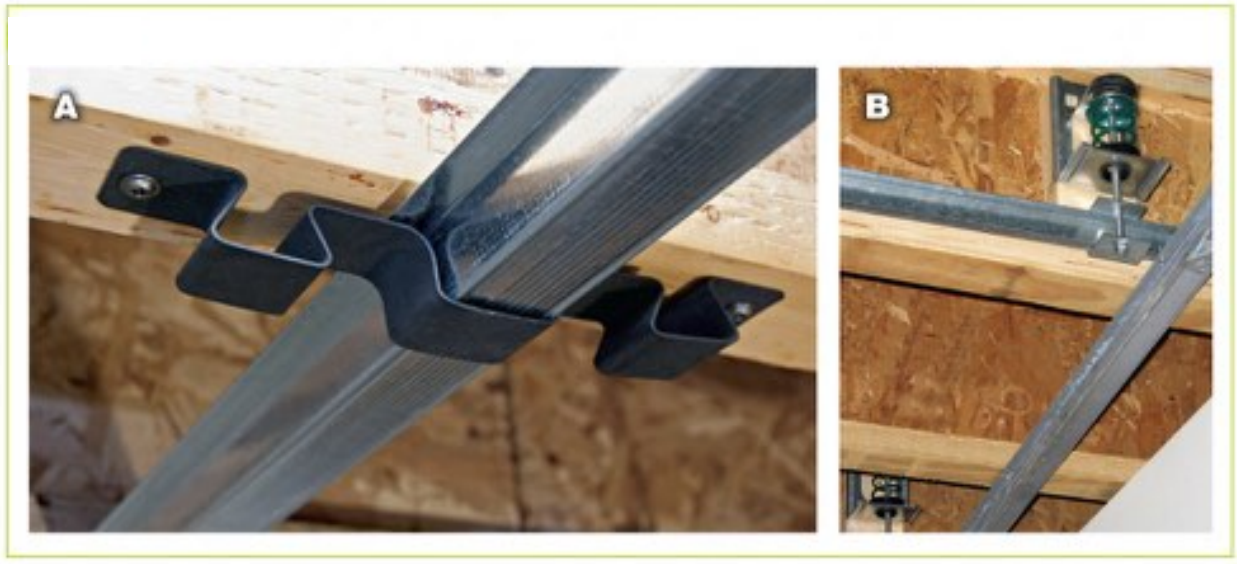
Product Application Assurance

Specification

- **Prescribed Code vs ‘Preferred’ Standards (apartments to condos)**
- **Full Floor Specification (including varied finished floor coverings)**
- **Sound Control Mats**
- **Isolation**

Installation

- **Matching Specification**
- **Manufacturer’s Recommendation**
- **Isolation/De-Couple**



Fire & Sound Design – Frisco, TX

Park Place; Fountain Hills, AZ

Fire & Sound Design

Type 3 Construction Requires FRT Wood Framing

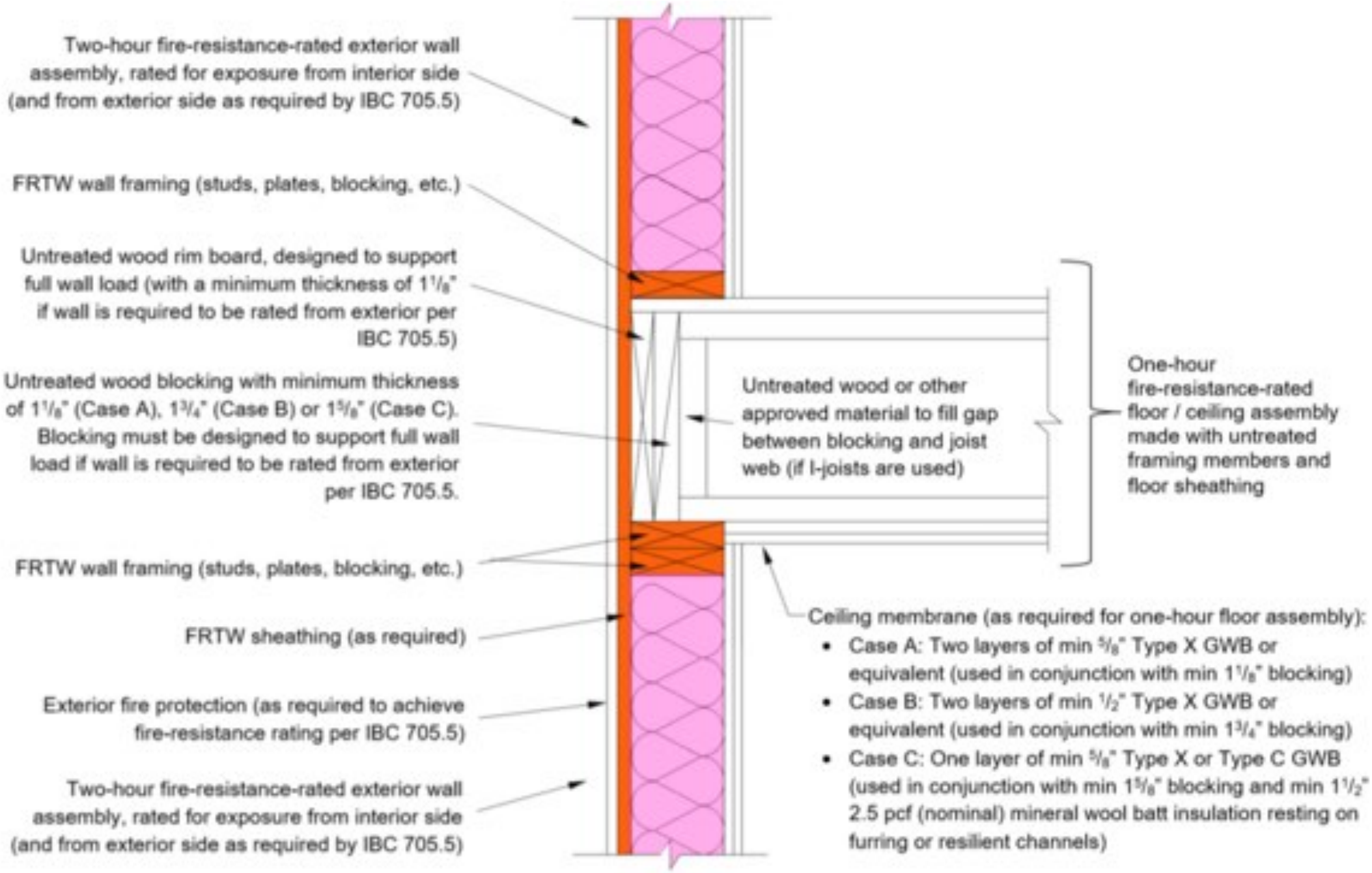
(Type A Flamespread ≠ FRTW)

- **Fire-Retardant-Treated Wood Must be Impregnated with Chemicals**

  (2018 International Building Code)

- **FRTW in accordance with ASTM E84 or UL723.**
- **Field Applied Coatings ≠ Manufactured FRT Products**

  Quality Control, plant vs. field environments, etc.)


Two-hour fire-resistance-rated exterior wall assembly, rated for exposure from interior side (and from exterior side as required by IBC 705.5)
FRTW wall framing (studs, plates, blocking, etc.)
Untreated wood rim board, designed to support full wall load (with a minimum thickness of 1 1/8" if wall is required to be rated from exterior per IBC 705.5)
Untreated wood blocking with minimum thickness of 1 1/8" (Case A), 1 3/4" (Case B) or 1 5/8" (Case C). Blocking must be designed to support full wall load if wall is required to be rated from exterior per IBC 705.5.
FRTW wall framing (studs, plates, blocking, etc.)
FRTW sheathing (as required)
Exterior fire protection (as required to achieve fire-resistance rating per IBC 705.5)
Two-hour fire-resistance-rated exterior wall assembly, rated for exposure from interior side (and from exterior side as required by IBC 705.5)
Untreated wood or other approved material to fill gap between blocking and joist web (if I-joists are used)
One-hour fire-resistance-rated floor / ceiling assembly made with untreated framing members and floor sheathing
Ceiling membrane (as required for one-hour floor assembly):
• Case A: Two layers of min 5/8" Type X GWB or equivalent (used in conjunction with min 1 1/8" blocking)
• Case B: Two layers of min 1/2" Type X GWB or equivalent (used in conjunction with min 1 3/4" blocking)
• Case C: One layer of min 5/8" Type X or Type C GWB (used in conjunction with min 1 5/8" blocking and min 1 1/2" 2.5 pcf (nominal) mineral wool batt insulation resting on furring or resilient channels)

Type 3 Construction
Addison, Texas

Code Approved FRTW – Field Issue

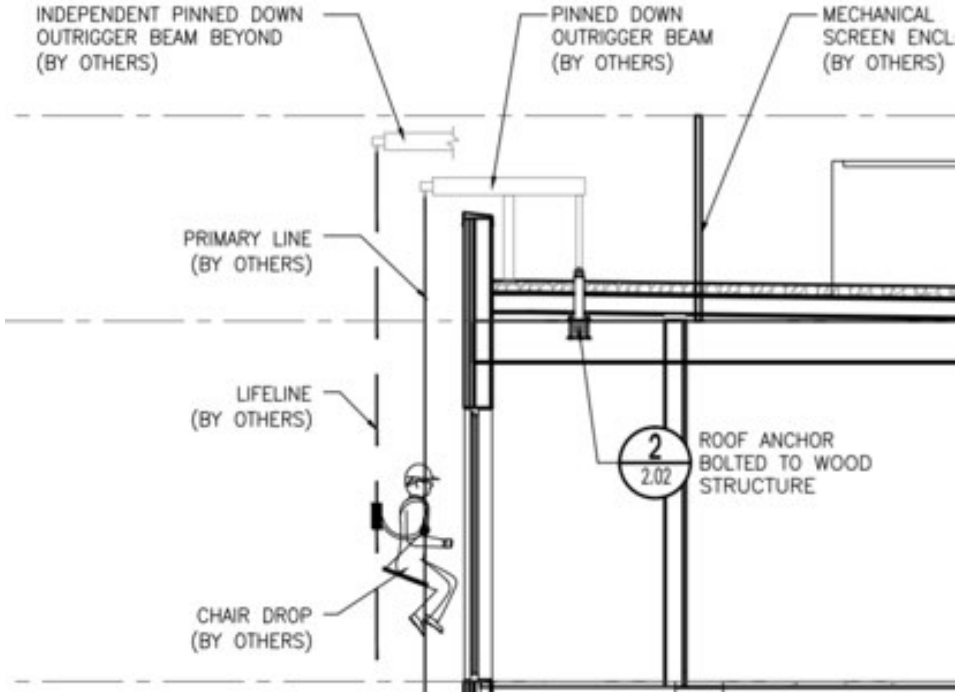
Apartment projects in Minneapolis — non-code approved FRT requires replacement (2x6 and 2x8 perimeter framing)

"On Big-D's watch, lumber that was not approved or code-compliant was used on the Hello Apartments project and Golden Villas will not tolerate actions that create any risk for future tenants," **Golden Villas Chief Manager Traci Tomas said in a news release.**

Professional Protocol Approval Process

Roof Anchors
(window wash/maintenance)

- Design by EOR or specialty engineer
- Load can act in any direction
- Requires beams
- Coordination with suppliers/contractors



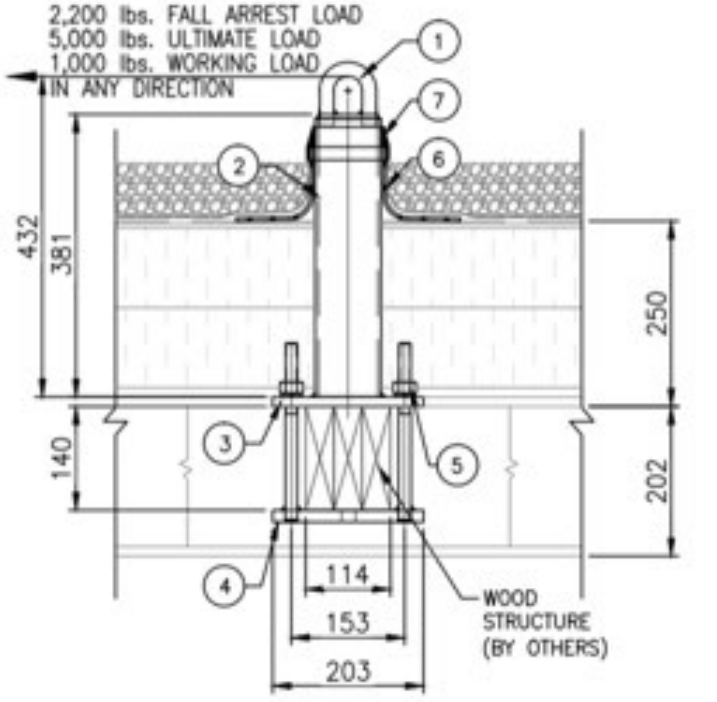
PRO-BEL FULL ASSEMBLY MODEL #206382

1. 3/4"ø STAINLESS STEEL U-BAR.
2. 3 1/2" O.D. GALVANIZED STEEL PIER.
3. TOP PLATE 8" X 8".
4. BOTTOM PLATE 8" X 8".
5. 4- 5/8"ø STAINLESS STEEL THREADED STUDS (15" Lg) c/w HEX NUTS, FLAT AND LOCK WASHERS.

ADDITIONAL PARTS

PART MODEL #CUSTOM
6. 5" TALL CONVENTIONAL FLASHING.

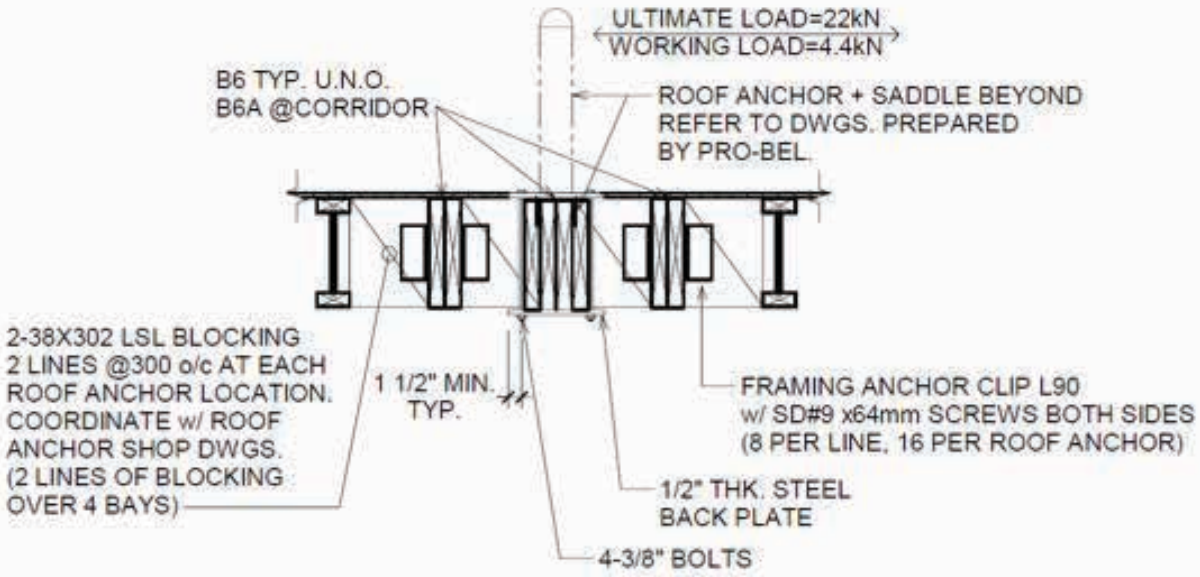
PART MODEL #P-HSM-1
7. HEAT SHRINK c/w MASTIC TAPE.



IMPORTANT NOTE:
STRUCTURE BY OTHERS TO ACCOMMODATE STEEL PIER BASE PLATE. SUPPORTING STRUCTURE MUST FULLY DEVELOP THE ANCHORAGE CONNECTION FOR THE MOMENT, SHEAR AND AXIAL FORCES, WHICH WILL BE PLACED ON THE ANCHOR.

Roof Anchors

example – Toronto (done per plan)



Summarizing - My Personal List
“to allow for caution”

- **Tight Construction Timeline (design/modify as you ‘go’) → frequent communications, documentation**
- **Dimensional Issues/Construction Tolerances (field measurement, pre-cut holes/locations, concentrated load alignment) → design and installation review**
- **Floor Covering – Lightweight Concrete Topping, Tile/Stone Cracking → expansion joints, differential deflection, concentrated loads**
- **Manufacturing Defect → urgency for communication and decision making**
- **Installation Issues → inspection, concurrence of architecturals and framing plans**

Summarizing - My Personal List
“to allow for caution”

- **Deflection – define client/customer expectations → differential deflection, ‘Non-Load’ bearing walls**
- **Assumptions → Architectural Discrepancies, framing irregularities, professional protocol**
- **Floor Performance → define client/customer expectations; floor system parameters**
- **Moisture Design → Dry Use or correct preservative treatment**
- **Load Tracking → rationalize loads to the foundation**

Questions?

This concludes The American Institute of Architects Continuing Education Systems Course

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