[TODAY'S TOPIC]

common challenges in light wood-frame gravity structural design

schaefer

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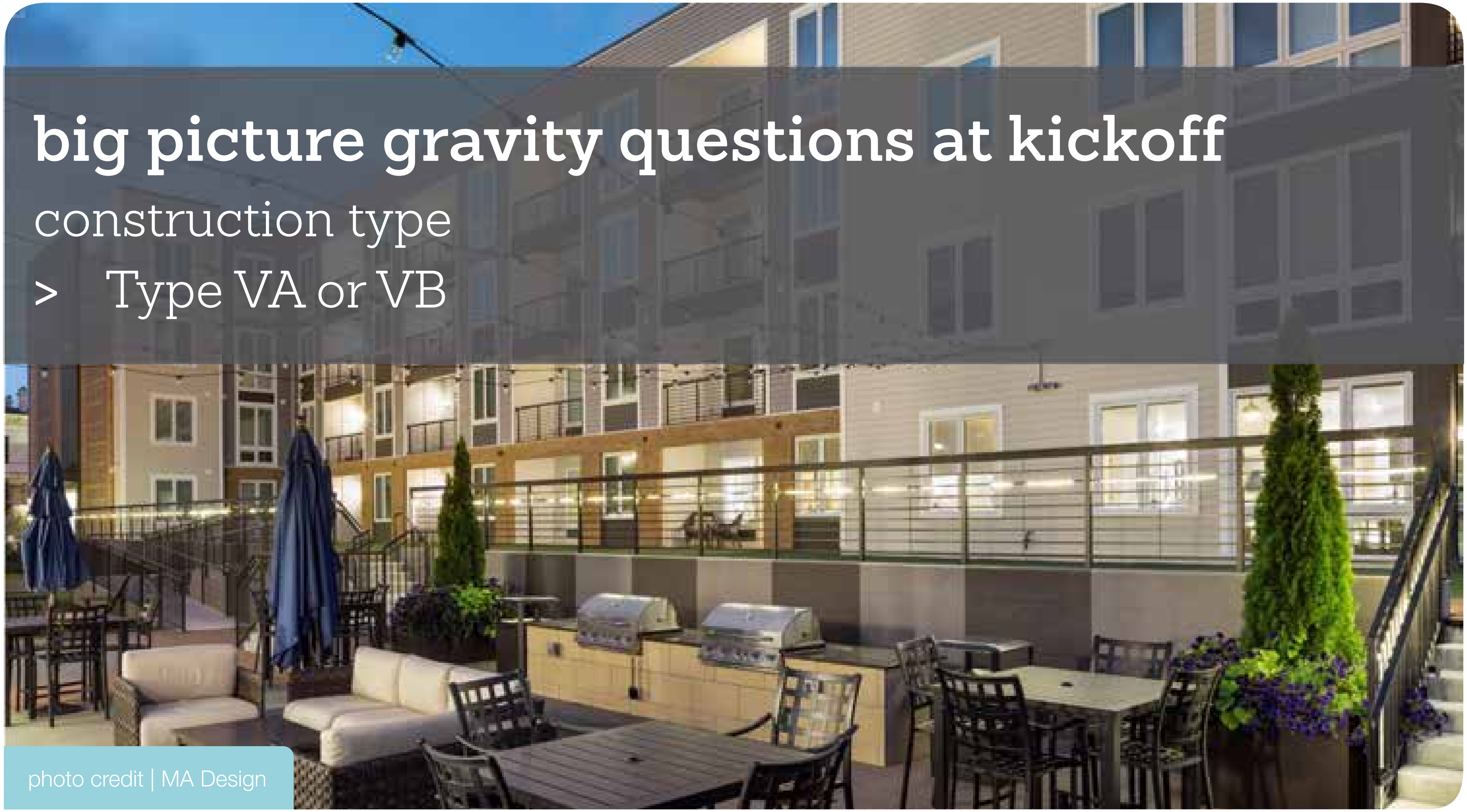
big picture gravity questions at kickoff

construction type

> Type VA or VB



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big picture gravity questions at kickoff

construction type

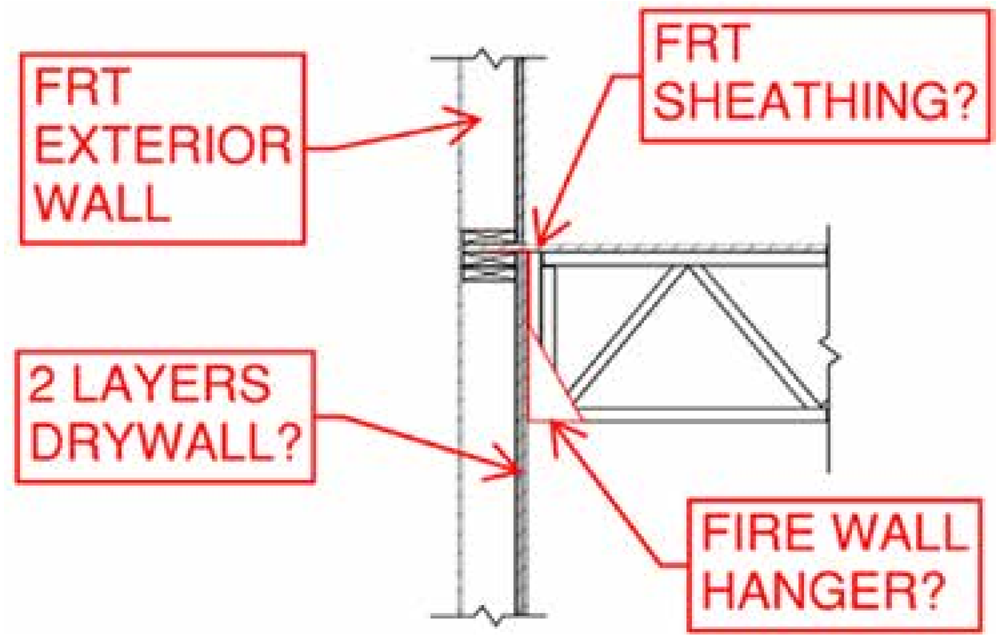
> Type IIIA or IIIB
  - Exterior walls are non-combustible (FRT)

> How to cantilever for decks or canopies through exterior walls?
  - No FRT/PT options yet
  - Steel or aluminum?
  - Or is PT cantilevering through the walls an option?

big picture gravity questions at kickoff

construction type

> Type IIIA or IIIB
> Non-Combustible Exterior Walls (FRT)
> 2-Hour Rated Load Bearing Walls



big picture gravity questions at kickoff

- AWC's DCA3 provides floor to wall intersection detailing options
- Addresses both continuity provisions + requirements for FRT elements in exterior wall plane


Design for Code Acceptance 3

Fire-Resistance-Rated Wood-Frame Wall and Floor/Ceiling Assemblies

Building Code Requirements

Fire Tested Assemblies

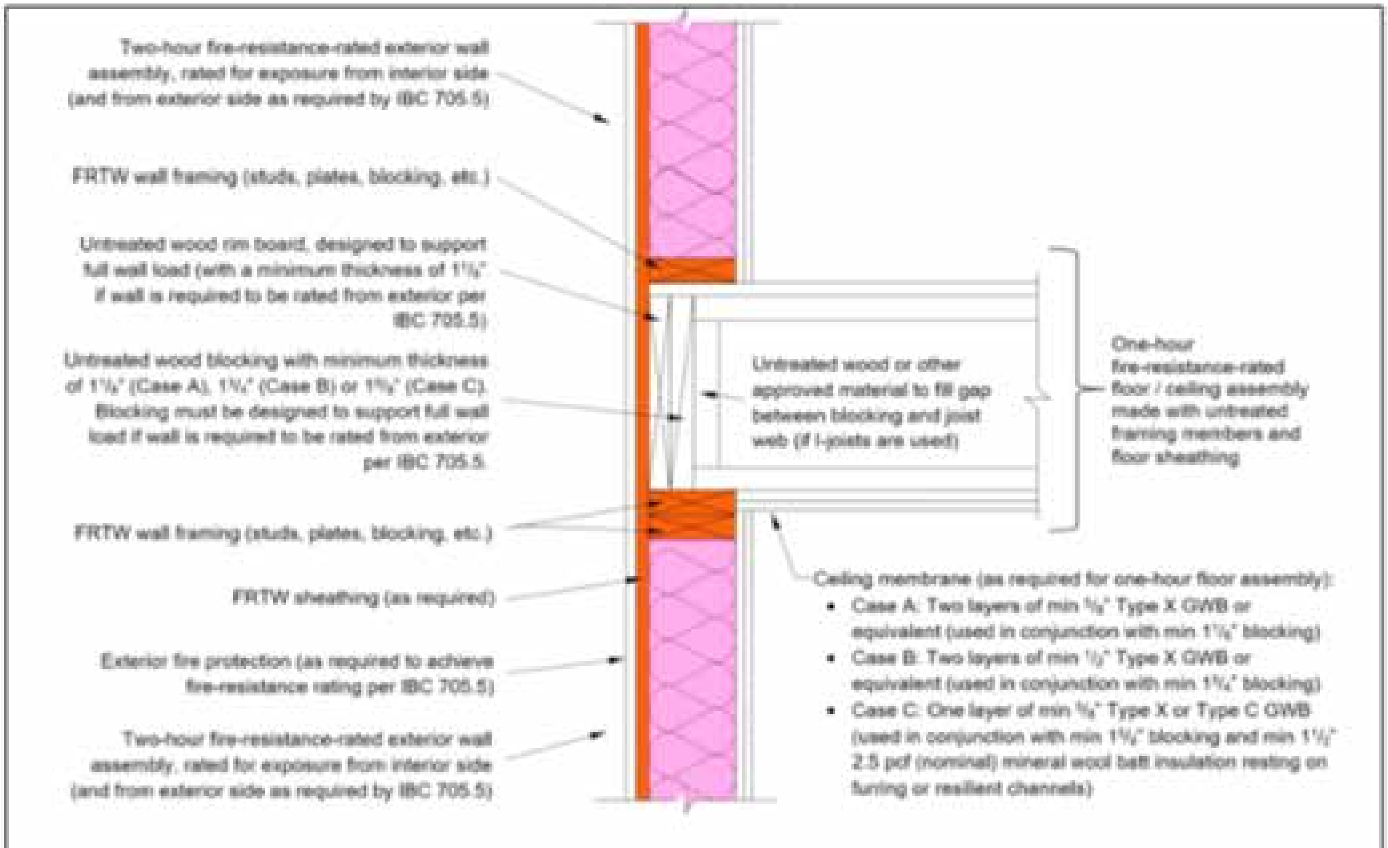


Figure 1A: Example detail for Type III-A exterior wall–floor intersection with rim board and blocking

Type IIIA Exterior Wall Assembly DCA3 | intersecting floors

IBC 2024 Changes | floor-to-wall intersections

> Two key changes:
- Clarification of fire resistance continuity requirements for exterior walls

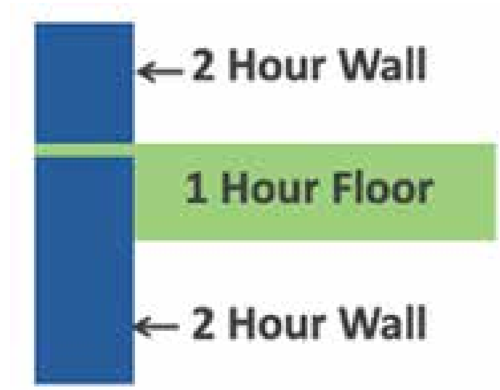
2021 International Building Code

705.6 Continuity . The fire-resistance rating of exterior walls shall extend from the top of the foundation or floor/ceiling assembly below to one of the following:

1. The underside of the floor or roof sheathing, deck or slab above.
2. The underside of a ~~one-hour fire-resistance rated~~ floor/ceiling or roof/ceiling ~~assembly.~~ assembly having a fire-resistance rating equal to or greater than the exterior wall and the fire separation distance is greater than 10 feet .

IBC 2024 Changes | floor-to-wall intersections

Example: Type IIIA Construction, Group R-2, 2 hour exterior wall, 1 hour floor



Since FRR of exterior wall is greater than FRR of floor, the exterior wall's FRR must extend to the underside of the floor sheathing. This doesn't mean that the wall needs to fully bypass the floor, but we do need to demonstrate the wall's 2 hour FRR through the depth of the floor.

IBC 2024 Changes | floor-to-wall intersections

> Code Change #2:

- Clarifies material requirements for floor construction at exterior wall intersections
  - i.e.) Does floor sheathing, joists, rim board at exterior walls in Type III Construction need to be FRTW?

IBC 2024 Changes | floor-to-wall intersections

705.6.1 ~~Supporting construction~~ Floor Assemblies in Type III Construction . ~~Construction that~~ In Type III construction where a floor assembly supports gravity loads from ~~fire-resistance-rated exterior walls shall have a fire-resistance rating that is equal to or greater than the required fire resistance rating of the supported wall. For achieving the required fire resistance rating for exposure from the interior of the building, ceiling materials shall be permitted to contribute to the required fire-resistance of the supporting construction.~~ an exterior wall, the fire-resistance rating of the portion of the floor assembly that supports the exterior wall shall not be less than the fire-resistance rating required for the exterior wall in Table 601. The fire-resistance rating provided by the portion of the floor assembly supporting and within the plane of the exterior wall shall be permitted to include the contribution of the ceiling membrane when considering exposure to fire from the inside. Where a floor assembly supports gravity loads from an exterior wall, the building elements of the floor construction within the plane of the exterior wall, including but not limited to, rim joists, rim boards, and blocking, shall be in accordance with the requirements for interior building elements of Type III Construction.

Where a floor assembly supports gravity loads from an exterior wall, the building elements of the floor construction within the plane of the exterior wall, including but not limited to rim joists, rim boards, and blocking shall be in accordance with the requirements for interior building elements of Type III Construction.

Interior building elements (floor construction) in Type III is not required to be FRTW

big picture gravity questions at kickoff

construction type

> Is there a podium?

big picture gravity questions at kickoff

construction type

> Is there a podium
> Type I Construction
> Podium thickness typically governed by deflection
  - What deflection criteria to use?

podiums below light framed residential

ACI 318-14

Table 8.3.1.1—Minimum thickness of nonprestressed two-way slabs without interior beams (in.)[1]

f_y, psi[2]	Without drop panels[3]			With drop panels[3]		
	Exterior panels		Interior panels	Exterior panels		Interior panels
	Without edge beams	With edge beams[4]		Without edge beams	With edge beams[4]	
40,000	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$	$\ell_n/36$	$\ell_n/40$	$\ell_n/40$
60,000	$\ell_n/30$	$\ell_n/33$	$\ell_n/33$	$\ell_n/33$	$\ell_n/36$	$\ell_n/36$
75,000	$\ell_n/28$	$\ell_n/31$	$\ell_n/31$	$\ell_n/31$	$\ell_n/34$	$\ell_n/34$

podiums below light framed residential

ACI 318-14

> For a 30-foot bay, minimum thickness is approximately 11-inches
  - Some stop here and move on

podiums below light framed residential

ACI 318-14

Table 24.2.2—Maximum permissible calculated deflections

Member	Condition		Deflection to be considered	Deflection limitation
Flat roofs	Not supporting or attached to nonstructural elements likely to be damaged by large deflections		Immediate deflection due to maximum of L_r, S, and R	$\ell/180$[1]
Floors			Immediate deflection due to L	$\ell/360$
Roof or floors	Supporting or attached to nonstructural elements	Likely to be damaged by large deflections	That part of the total deflection occurring after attachment of nonstructural elements, which is the sum of the time-dependent deflection due to all sustained loads and the immediate deflection due to any additional live load[2]	$\ell/480$[3]
		Not likely to be damaged by large deflections		$\ell/240$[4]

[1]Limit not intended to safeguard against ponding. Ponding shall be checked by calculations of deflection, including added deflections due to ponded water, and considering time-dependent effects of sustained loads, camber, construction tolerances, and reliability of provisions for drainage.

[2]Time-dependent deflection shall be calculated in accordance with 24.2.4, but shall be permitted to be reduced by amount of deflection calculated to occur before attachment of nonstructural elements. This amount shall be calculated on basis of accepted engineering data relating to time-deflection characteristics of members similar to those being considered.

[3]Limit shall be permitted to be exceeded if measures are taken to prevent damage to supported or attached elements.

[4]Limit shall not exceed tolerance provided for nonstructural elements.

big picture Gravity questions at kickoff

> Podium thickness typically governed by deflection
- L/480 long term DL +LL at light Framed Wood Above
  - For a 30'x30' grid, $\Delta \approx$ 1-inch
- L/600 where supporting Masonry Veneer per BIA recommendations

podiums below light framed residential

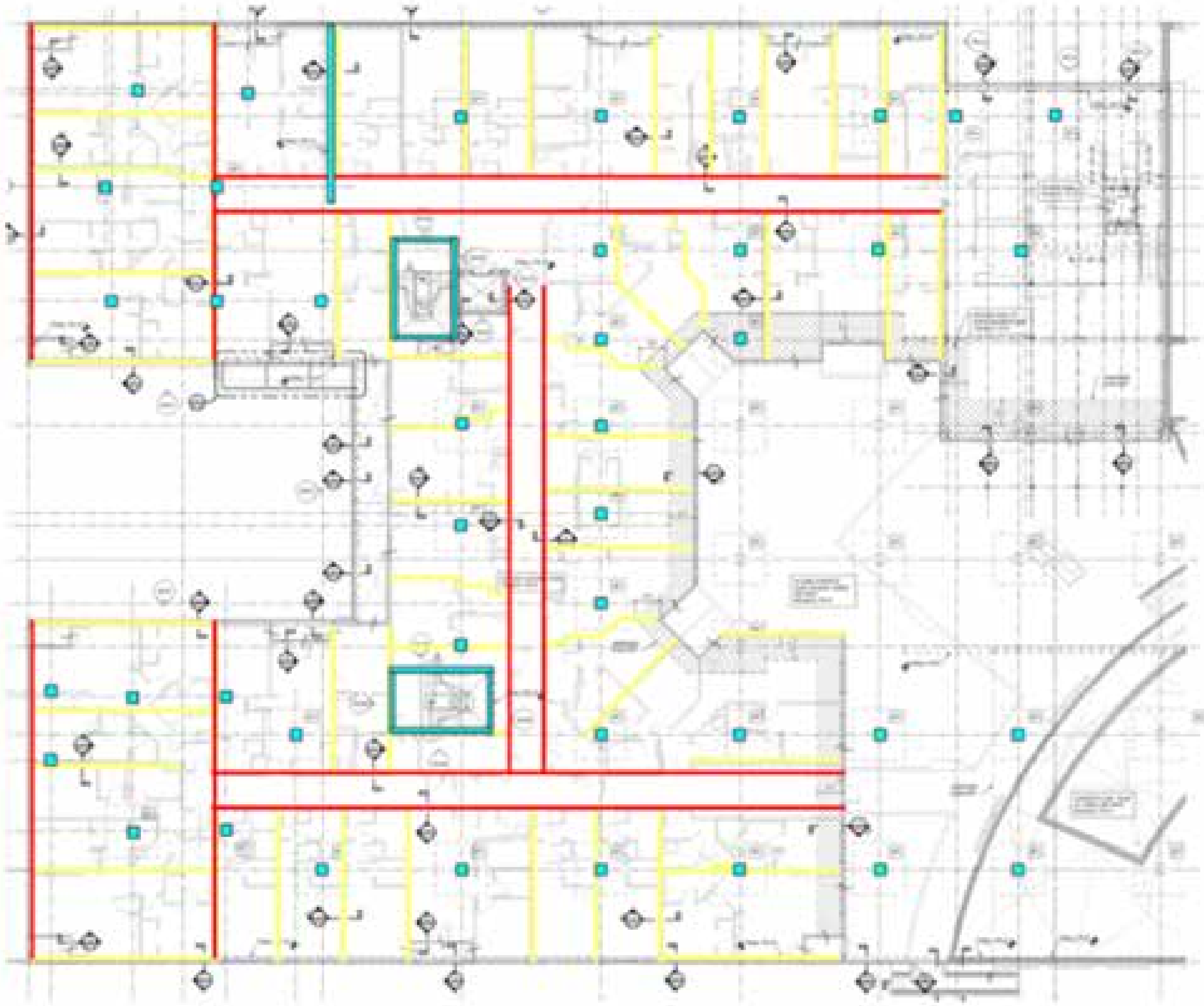
light-framed wood framing direction implications

> Framing Corridor-to-Exterior

- Two heavy line loads adjacent to each other
- Often located over a drive aisle

> Framing Demising-to-Demising

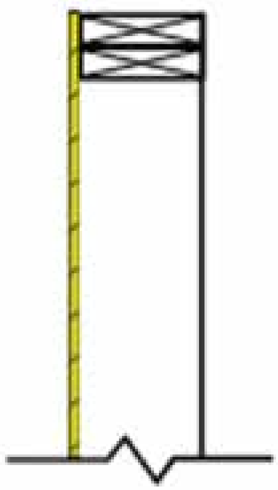
- Line loads are spread out more
- Typically save 2”-4” in podium thickness



load bearing wall design

what's required to brace a stud?

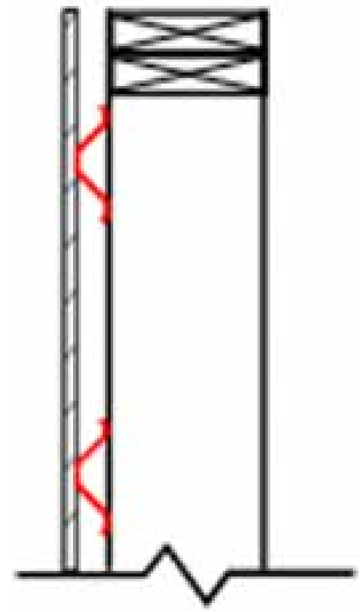
- Per NDS Appendix A.11.3 –
  "Adequately sheathed on one side"
- Industry standard would include drywall



load bearing wall design

what's required to brace a stud?

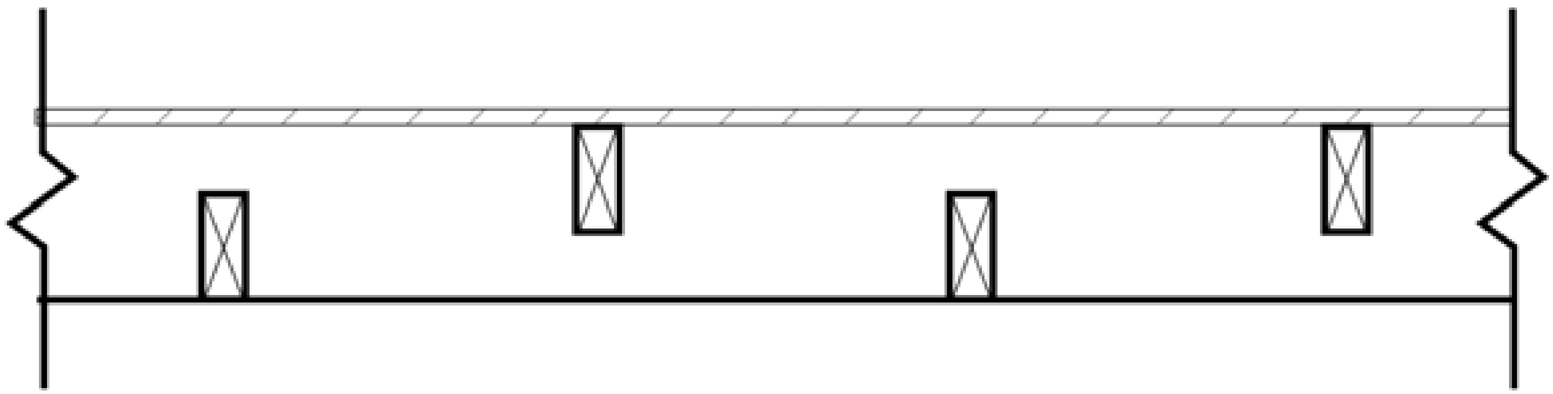
- What about resilient channel directly applied to one face?
  - Probably not



load bearing wall design

what's required to brace a stud?

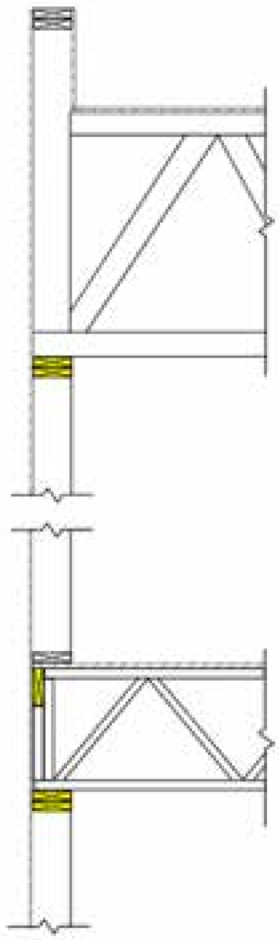
- > Staggered studs?
- > Shear wall – blocking



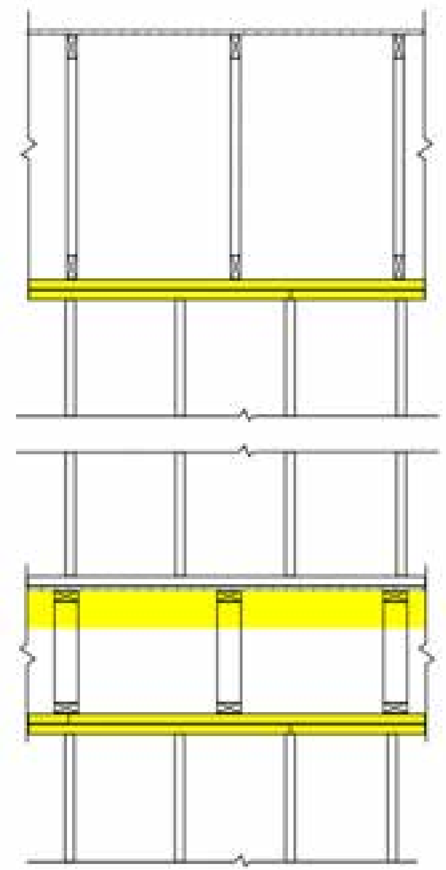
load bearing wall design

to align or not to align bearing studs?

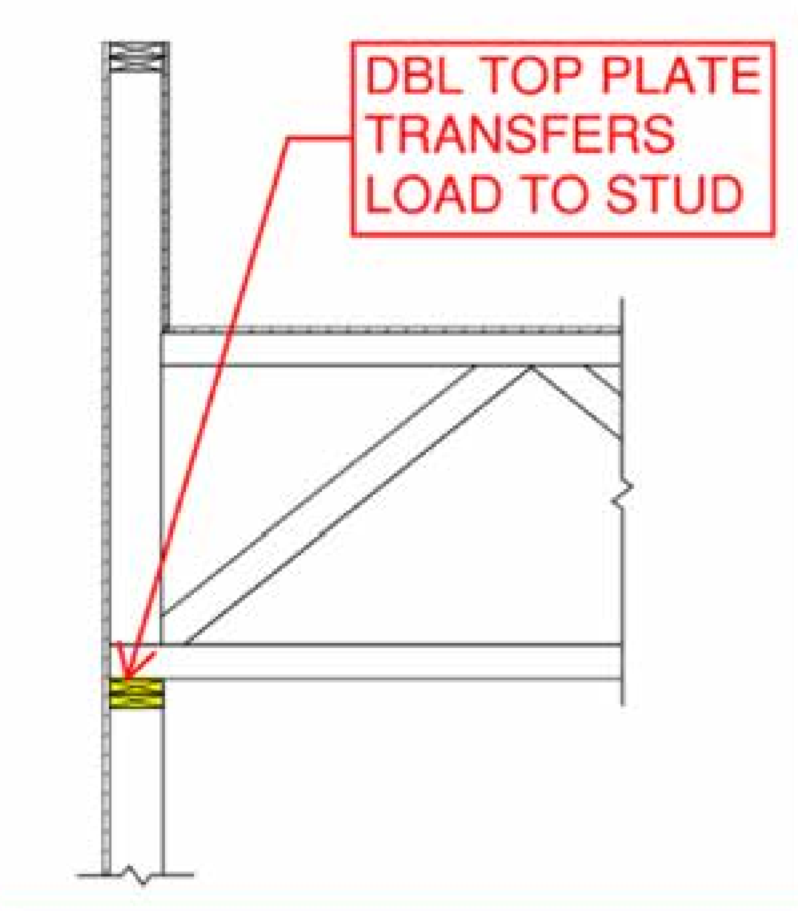
- Pros + cons
- How to avoid aligning studs
- How to align studs



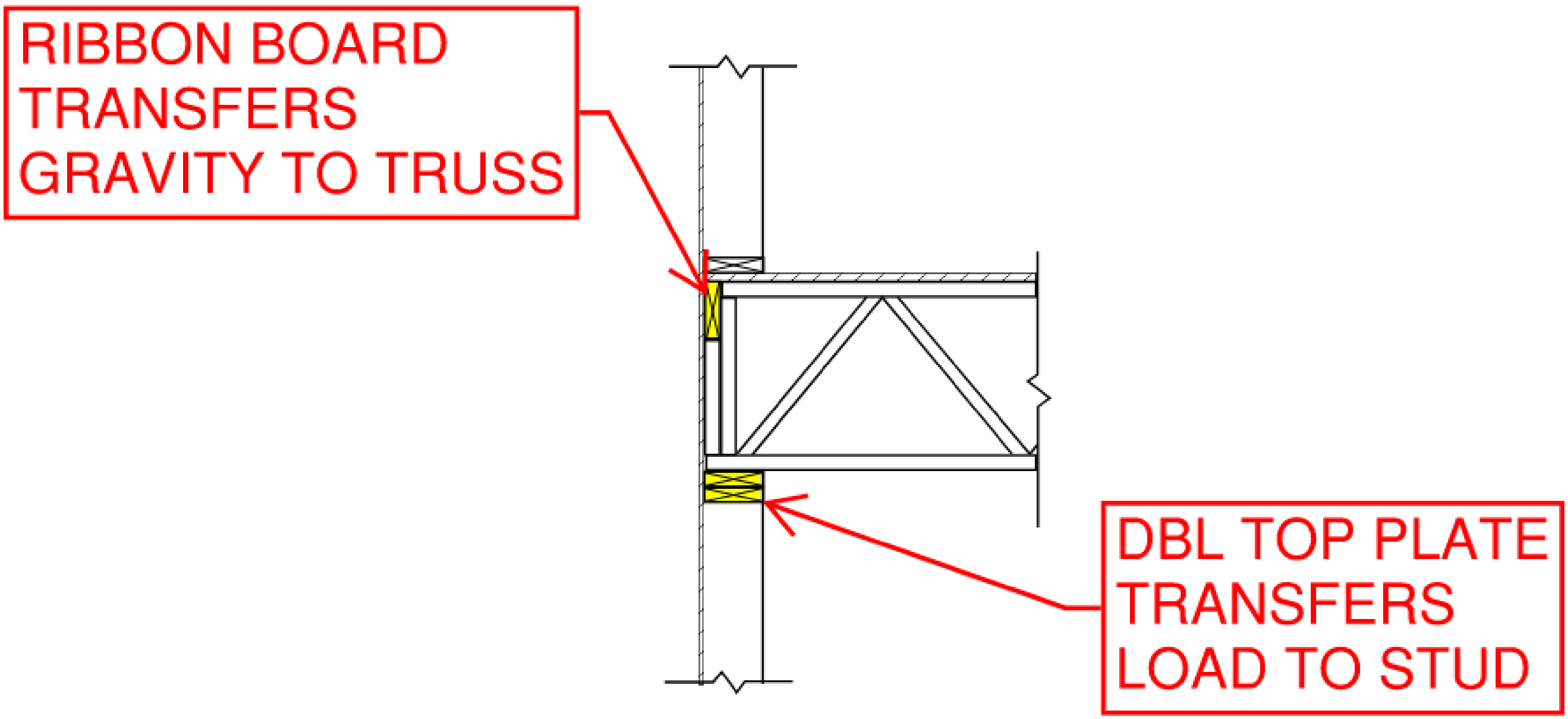
Load Path,
Load Path,
Load Path.

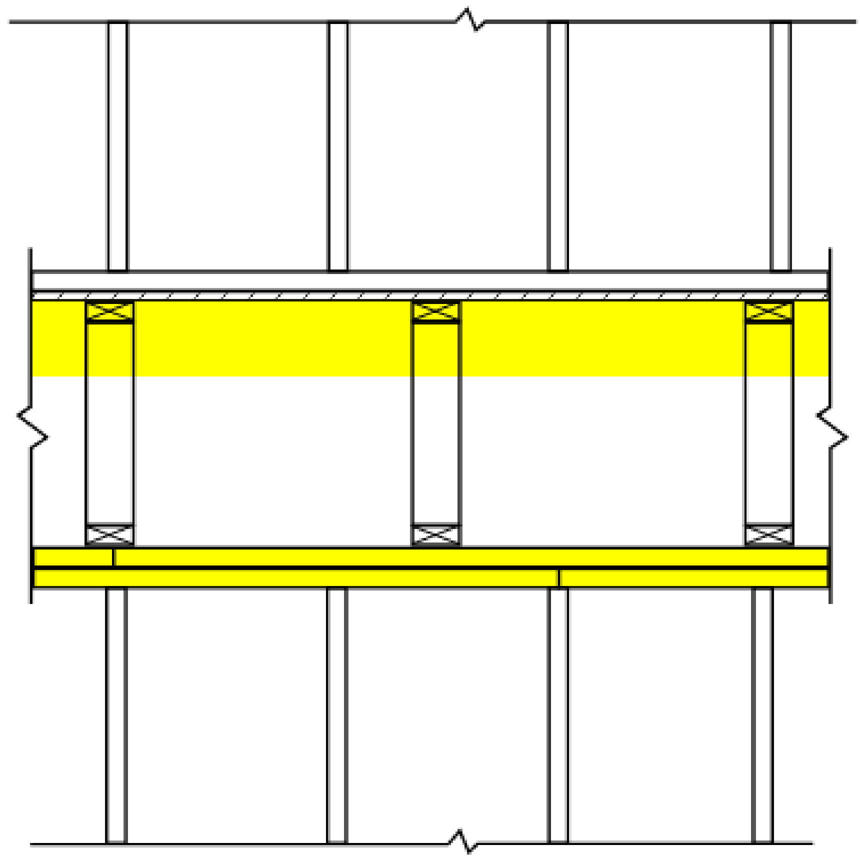


why does it matter?



load bearing wall design | misaligned bearing studs


RIBBON BOARD TRANSFERS GRAVITY TO TRUSS
DBL TOP PLATE TRANSFERS LOAD TO STUD

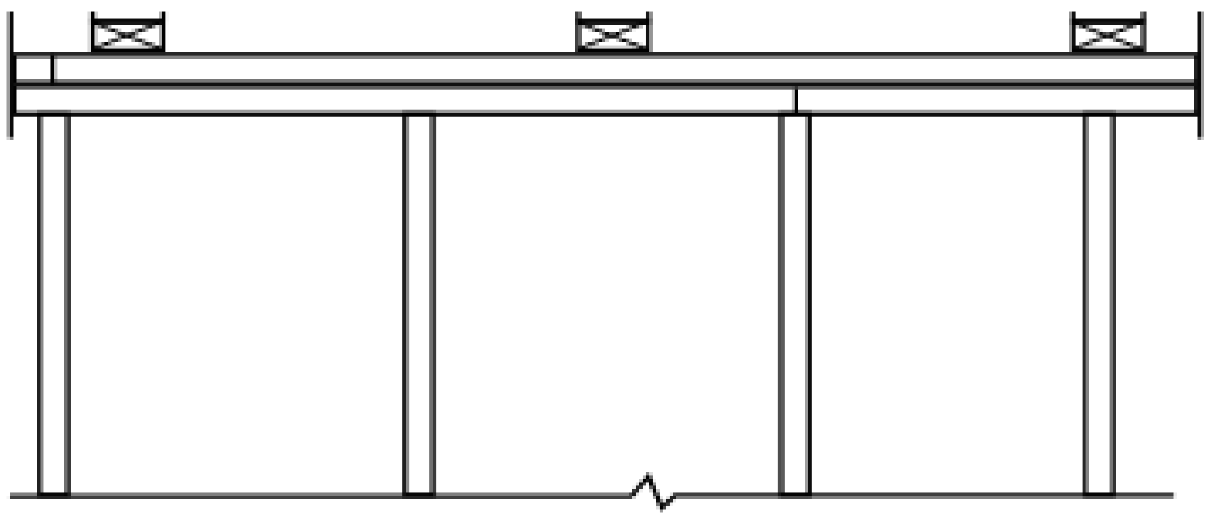


load bearing wall design | misaligned bearing studs

double top plate capacity

If analyzed as continuous

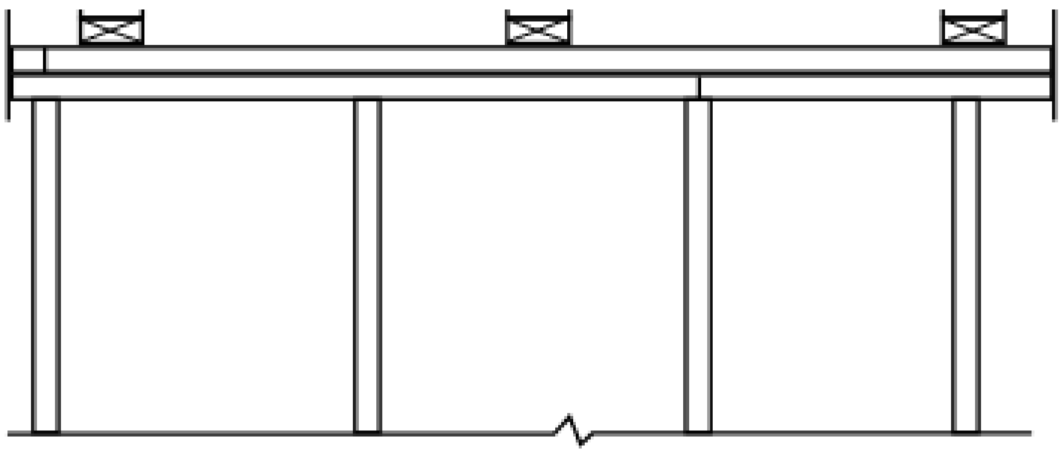
> Increases calculated shear demand and reduces bending moment



double top plate capacity

If analyzed as (2) individual members rather than (1) composite shape

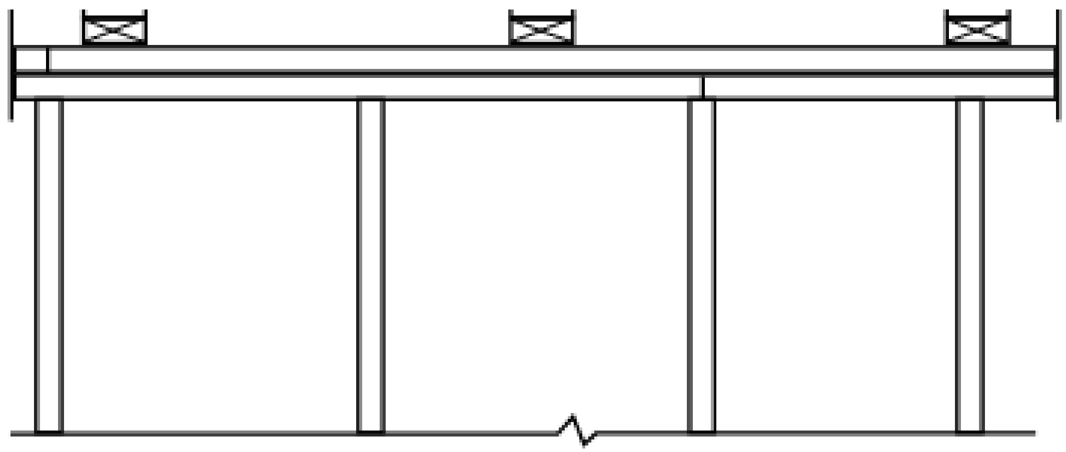
- Composite action would help moment capacity, but not shear capacity
- Fasteners will slip
- Unreasonable number of fasteners required
- Shear capacity would govern with very little benefit realized



double top plate capacity

Takeaways:

> Capacity varies based on stud spacing and species
> Can often justify (2)2x plate transferring one truss/joist reaction
> Unlikely to justify larger capacity than one level at typical truss spans



pros + cons

don’t align studs

PROS

- Easier to economize stud spacing to meet demand/capacity ratio
- Less up-front coordination with GC

CONS

- May require rim board or other detailing to maintain load path

align studs

PROS

- Direct load path
- Reduce/eliminate gravity transfer members
- Easier plumbing stack coordination

CONS

- Up-front coordination with GC
- Added studs where 16”oc required

misaligned bearing studs | alternate details

full-depth rim board

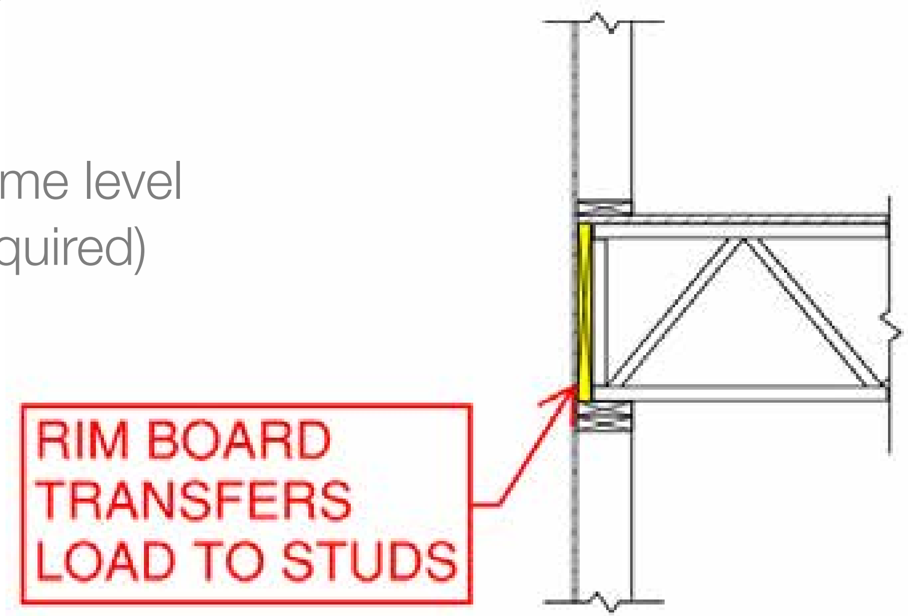
- Stud load transfers through bottom plate and floor sheathing into full-depth rim board
- Rim board spans to mis-aligned stud below

PROS

- Can distribute heavy truss reactions at same level
- Use as header (add plies + hangers as required)

CONS

- LVL/LSL required
- Expensive, availability



misaligned bearing studs | alternate details

partial-depth rim board with notched truss bearing

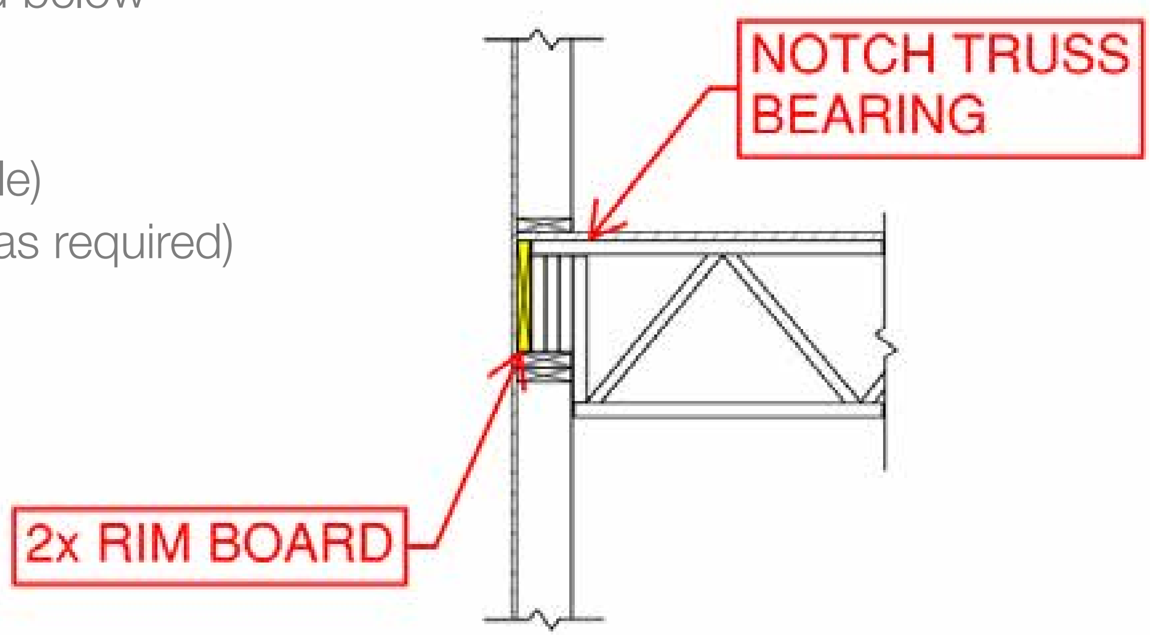
- Stud load transfers through bottom plate and floor sheathing into 2x rim board
- Rim board spans to mis-aligned stud below

PROS

- 2x material (lower cost, more available)
- Use as header (add plies + hangers as required)
- Accommodates higher headers

CONS

- Non-standard truss
- Taller studs



misaligned bearing studs | alternate details

rim truss

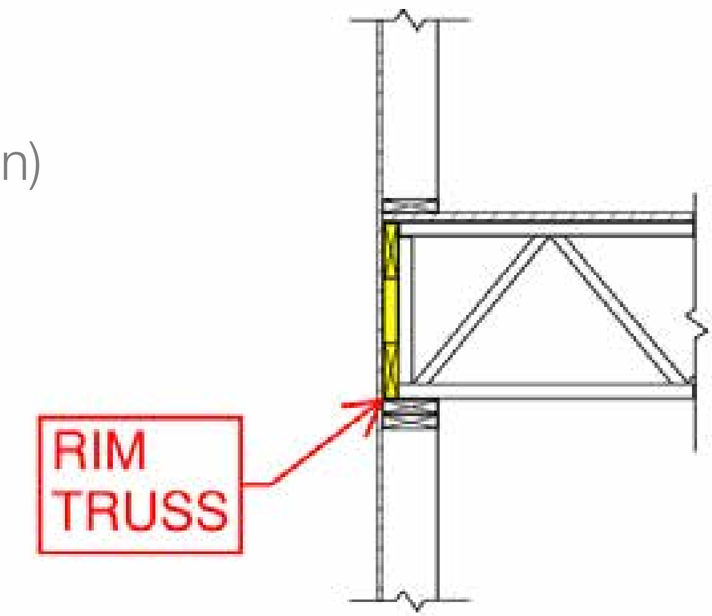
> Stud load transfers through bottom plate and floor sheathing into rim truss
> Rim truss spans to misaligned studs below

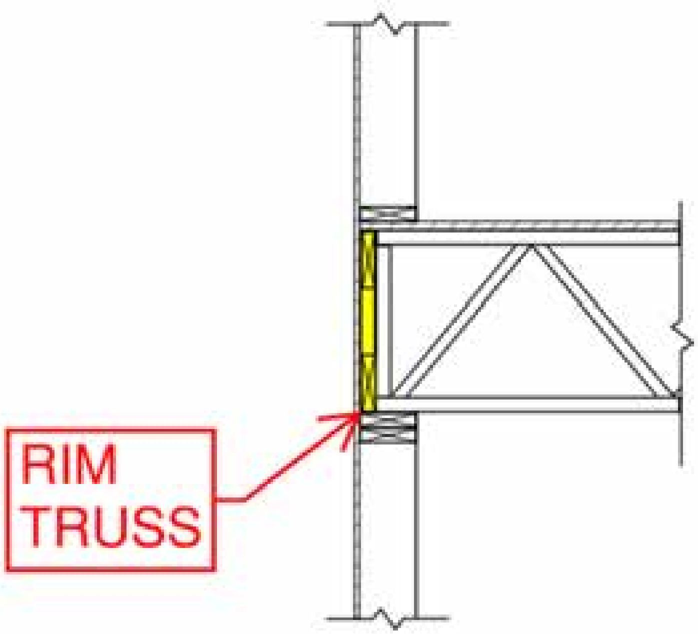
PROS

> Part of the truss package (economy + coordination)

CONS

> Coordinate mechanical penetrations, loads + vertical web spacing with truss designer
> Note: does not provide fire blocking



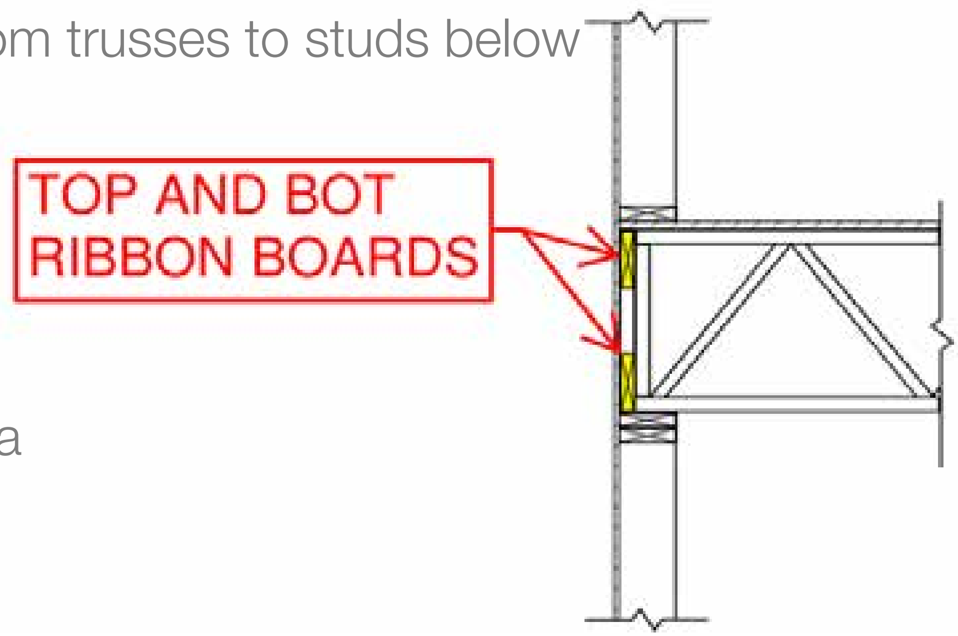


misaligned bearing studs | alternate details

misaligned bearing studs | alternate details

top + bottom ribbon boards

- Load transfers through bottom plate and floor sheathing into top ribbon board
- Top ribbon board spans to trusses
- Bottom ribbon board distributes loads from trusses to studs below



PROS

- 2x framing economy

CONS

- Review with architect for assembly criteria
- Does not transfer lateral load

misaligned bearing studs | alternate details

larger solid top plate member

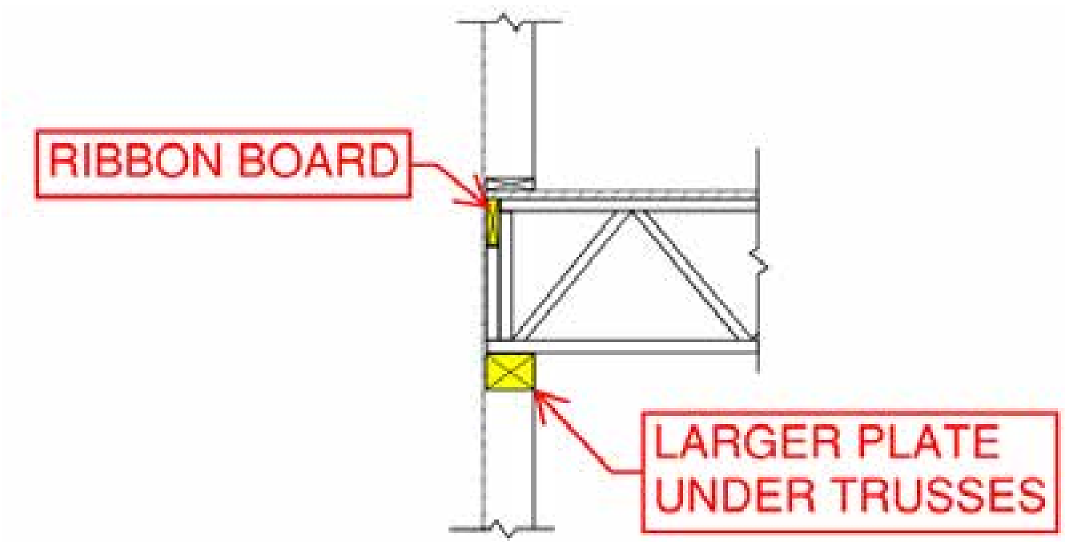
> Load transfers through bottom plate and floor sheathing into ribbon board
> Ribbon board spans to trusses
> Larger top plate spans distributes load to misaligned studs below

PROS

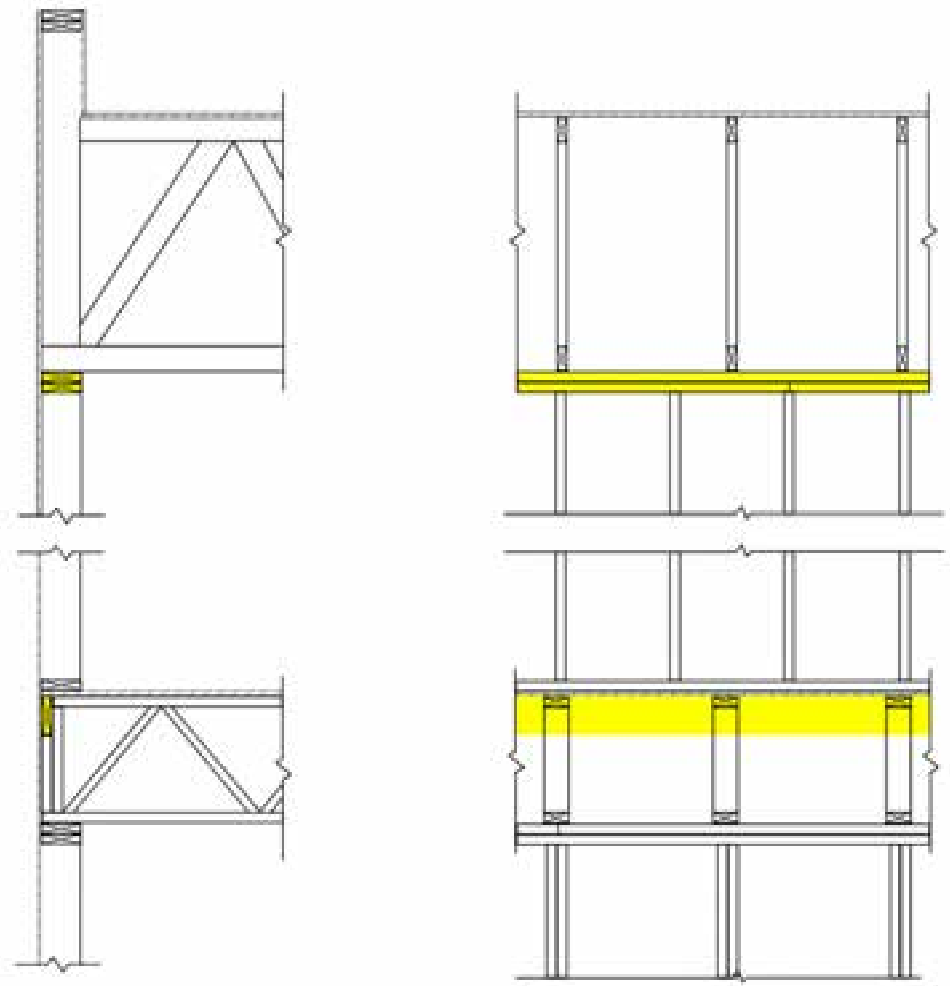
> 2x framing economy

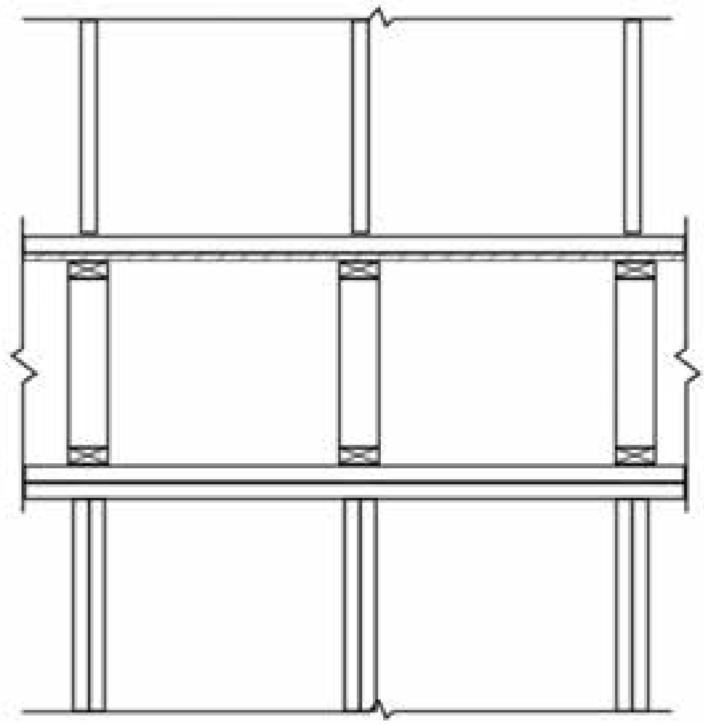
CONS

> Limited gains
> Cost + availability of solid 4x+ section
> Does not transfer lateral load



load bearing wall design | aligned bearing studs





load bearing wall design | aligned bearing studs

load bearing wall design | aligned bearing studs

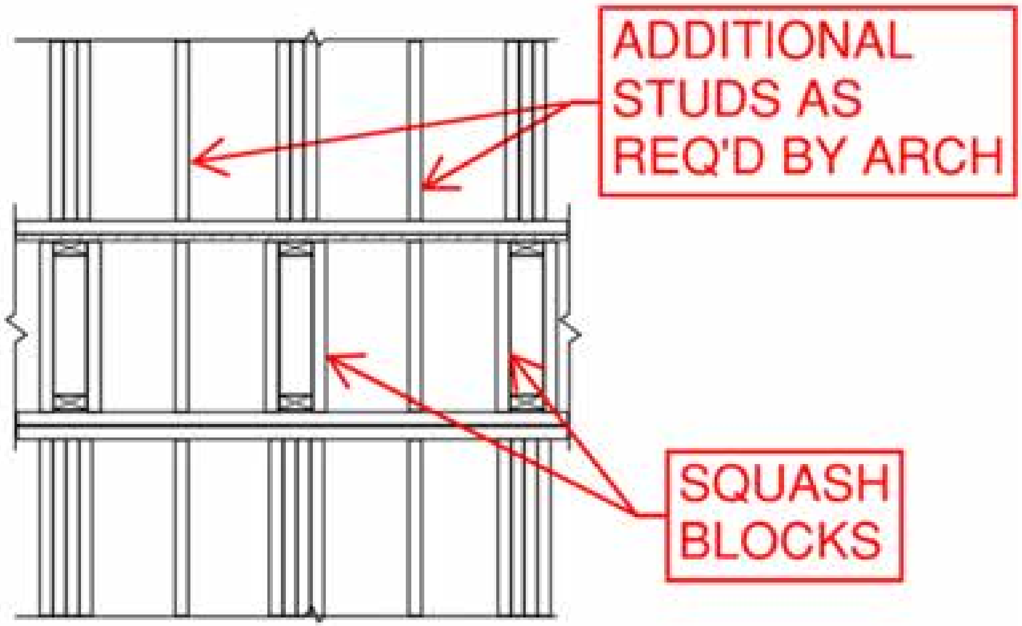
Keep in mind when aligning studs + trusses:

> Truss/joist spacing is often 24”oc

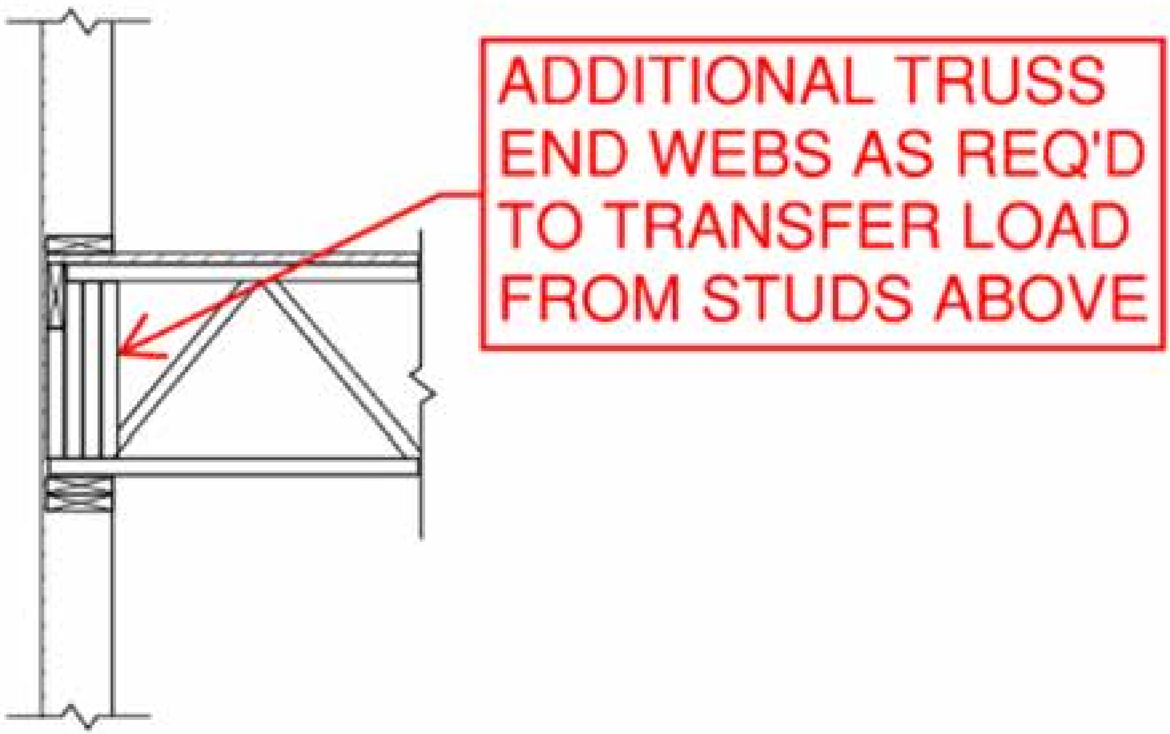
> Stud spacing often will be tighter for fire ratings or architectural finishes

> Squash blocks may be required if stud packs are wider than the floor truss/joist

> Trusses may require additional vertical truss webs at bearing for full width of stud

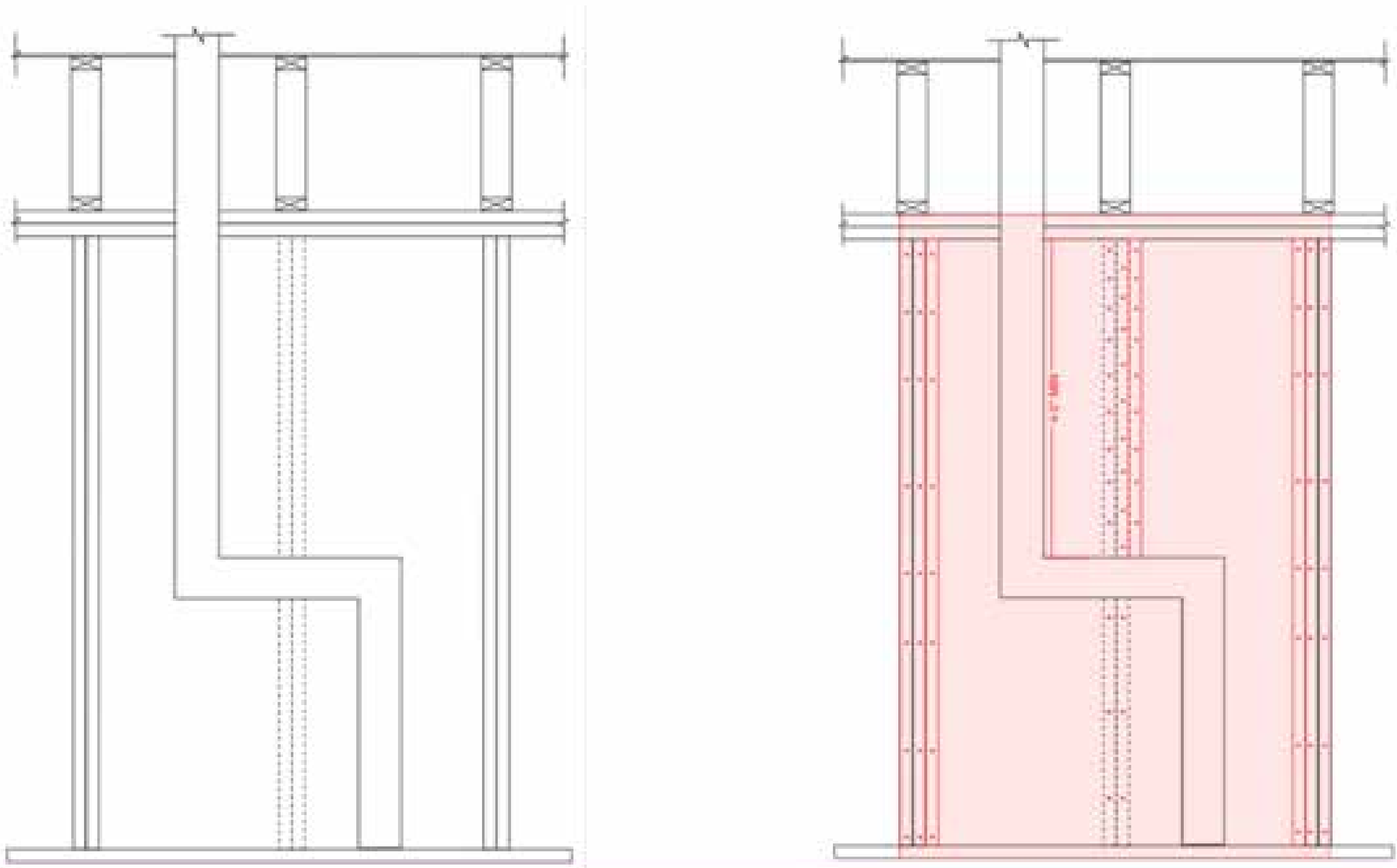


load bearing wall design | aligned bearing studs



load bearing wall design | aligned bearing studs

load bearing wall design | plumbing stack conflicts



load bearing wall design | plumbing stack conflicts

shrinkage |

> See WoodWorks article:
  "Accommodating Shrinkage in Multi-Story Wood-Frame Structures"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questions?

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