Deck Inspection--Focusing on Life Safety Issues

by Frank Woeste, P.E.

- Ranking of life safety issues and resources is experience-based with input from peers.

No. 1: Primary Structural Elements of a Multi-Level Deck

Example: Deck ledger connection to structure.

- *2003 Chicago Porch Collapse*, 13 deaths and 57 injured. https://www.cbsnews.com/news/without-warning-chaos/
- 5-ft piece of ledger with one 3/8” lag-screw
- Lag-shield installed in structural brick

- What is the load rating for a 2x_ S. Pine deck ledger, 3/8” lag screw installed in lag-shield, structural brick?

By Mónica De Anda, Sunday, February 16, 2025

SILVER LAKE, LOS ANGELES (KABC) -- Four people and a dog were standing on a balcony…

https://abc7.com/amp/post/balcony-collapses-underneath-4-people-silver-lake/15915933/

Takeaway: Extreme risk-exposure for stacked decks or balconies.

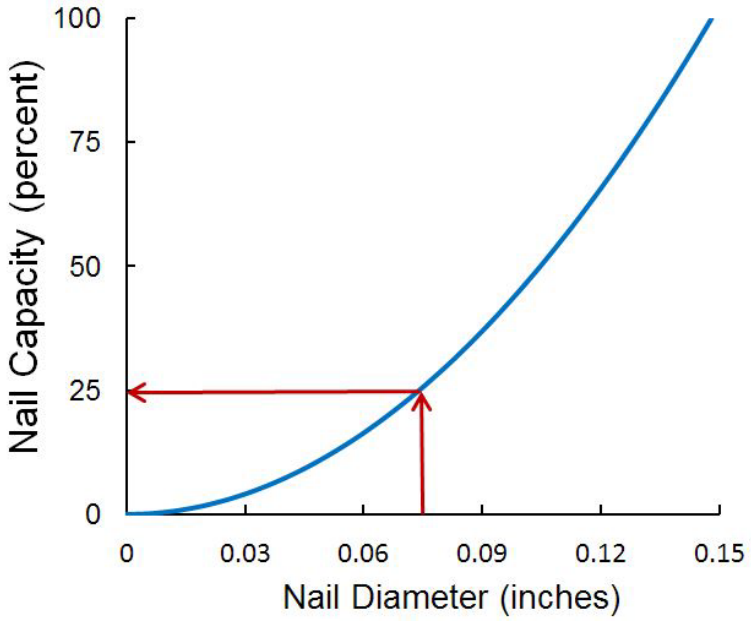
No. 2a: Guard Top-Rail Connection to Support Post

Examples of Coastal Saltwater Corrosion

Top-rail connection to guard post…

- Coastal red-rust is “common”…and a Life Safety warning.

Impact of 50% Reduction in Nail Shank Diameter



(10d Common, 0.148”)

Example Inspection Methodology

For top-rail connections to support posts:

a) Remove a sample of nails or screws,
b) Sample direct and indirect exposure to saltwater body, and
c) examine the head, shank, and condition of ***shank*** at ***shear plane*** for corrosion.

Red-Rust in Shear-Plane Repair Option

- For Coastal Saltwater Exposure, install requisite number of stainless steel (SS) fasteners of the proper size and length in **all** top rail connections.

- Other repair ideas…?

No. 2b: Guard Post Connection to Floor Framing

Inspection Challenges

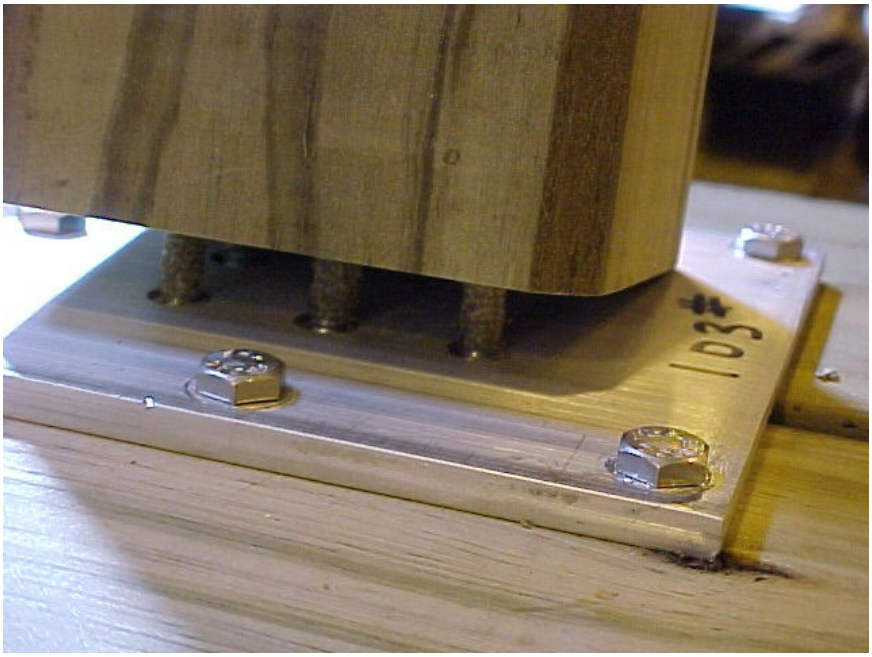
From the 2024 IRC:

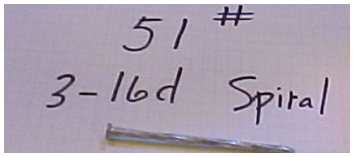
- Requirements only, construction details not given.
- “Pushing” on guard post *not reliable* measure of “strength”…

Photo: https://www.finehomebuilding.com

Structural Testing at **VT Brooks Forest Products Center** 2004

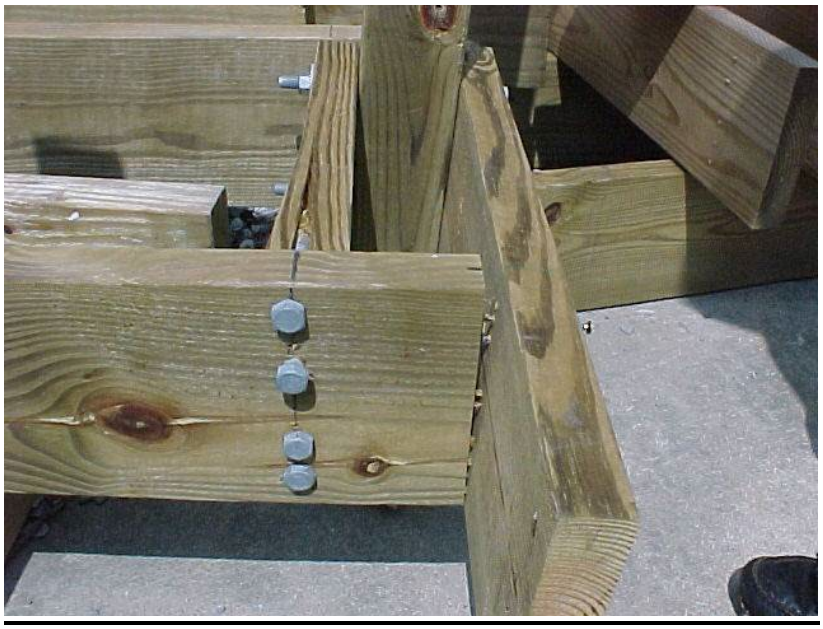
Test Load = 2.5 x 200 lbs. = 500 lbs. (Ref. 1996 BOCA 1710.3.1)



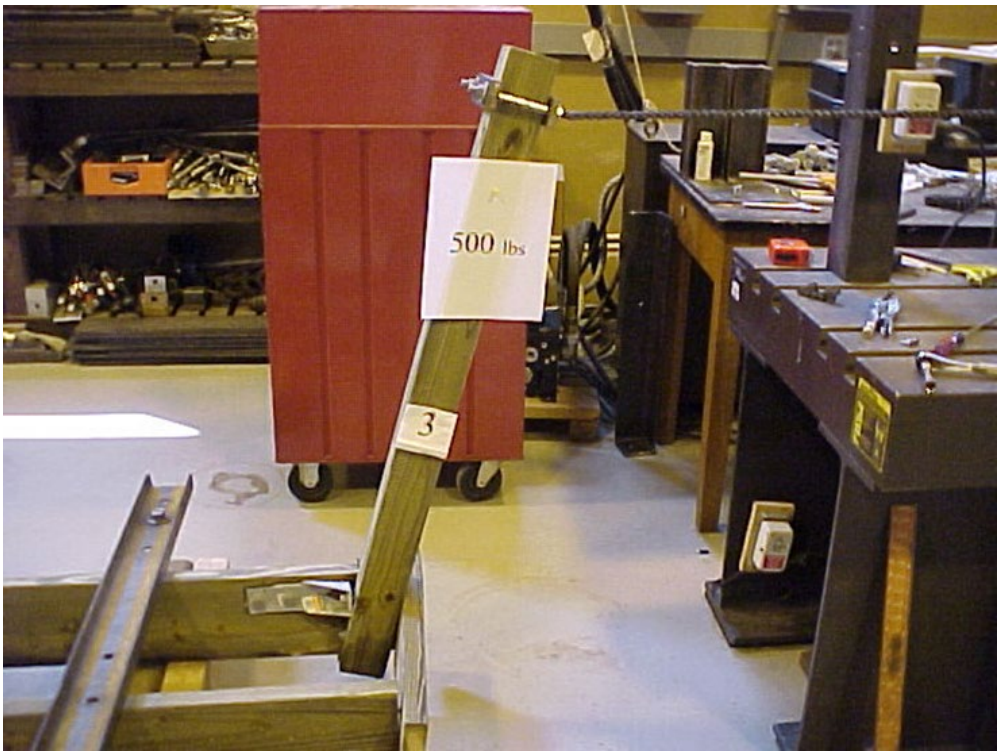


Two ½” x 4” Lag Screws

(“Perfect” laboratory test specimen.)

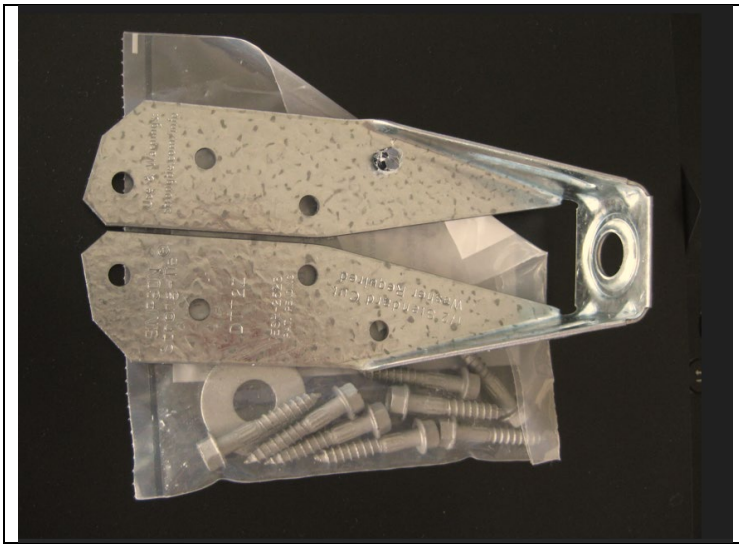


After a couple months of testing, last test before finding a solution…



Test stopped at 650 lbs…

Dr. Dolan's "leftover" shear-wall test connector (HD2A)…



SST DTT2Z

DeckLok

2024 IRC Addresses Guard Post Connections (In General)

R502.11 Floor framing supporting guards. The framing at the open edge of a floor supporting a required guard assembly shall be constructed in accordance with Sections R502.11.1 or R502.11.2 for guard assemblies not exceeding 44 inches (1118 mm) in height or shall be designed in accordance with accepted engineering practice to support the guard assembly. Where trusses and I-joists are used as edge framing members supporting guards, the effects of the guard loads shall be considered in the design of the edge member.

R502.11.1 Conventional edge framing.

R502.11.2 Timber edge framing.

R502.11.3 Roll bracing.

and "Exterior Guards" in Section 2024 IRC R507.10.

R507.10 Exterior guards. *Guards* shall be constructed to meet the requirements of Sections R301.5 and R321, and this section.

R507.10.1 Support of guards. Where *guards* are supported on deck framing, *guard* loads shall be transferred to the deck framing with a continuous load path to the deck joists.

R507.10.1.1 Guards supported by side of deck framing. Where *guards* are connected to the interior or exterior side of a deck joist or beam, the joist or beam shall be connected to the adjacent joists to prevent rotation of the joist or beam. Connections relying only on fasteners in end grain withdrawal are not permitted.

R507.10.1.2 Guards supported on top of deck framing. Where *guards* are mounted on top of the decking, the *guards* shall be connected to the deck framing or blocking and installed in accordance with manufacturer's instructions to transfer the *guard* loads to the adjacent joists.

R507.10.2 Wood posts at deck guards. Where 4-inch by 4-inch (102 mm by 102 mm) wood posts support guard loads applied to the top of the *guard*, such posts shall not be notched at the connection to the supporting structure.

R507.10.3 Plastic composite guards. *Plastic composite guards* shall comply with the provisions of Section R507.2.2.

R507.10.4 Other guards. Other *guards* shall be in accordance with either manufacturer's instructions or accepted engineering principles.

MiTek 2024 August CMA publication, pp. 110-114:
https://componentadvertiser.com/Portals/0/EasyDNNnews/Uploads/1562/24-08_Advertiser-MiTek.pdf

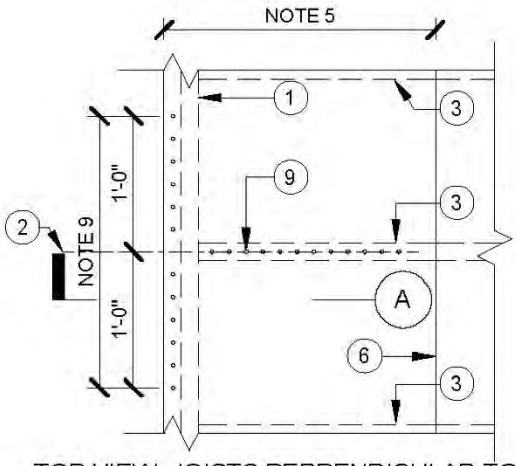
Next Pages

Details from MiTek 2024 Aug. CMA

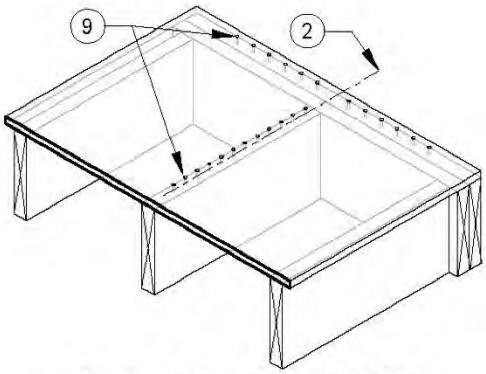
The details of the IRC 2024 code commentary are as shown in these images from the Early Adoption Handout, "Correcting a Serious Deficit to Building Safety," courtesy of the Stairbuilders and Manufacturers Association (SMA).

FLOOR EDGE ROLL BRACING

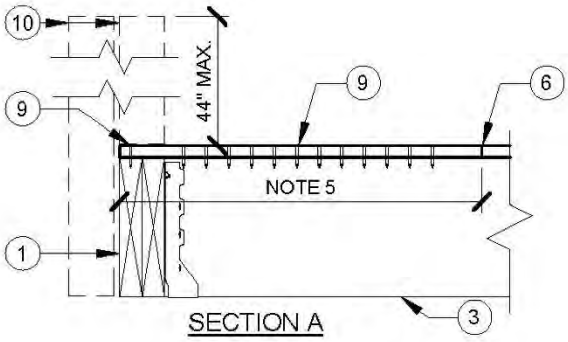
JOISTS PERPENDICULAR TO EDGE



TOP VIEW: JOISTS PERPENDICULAR TO EDGE, GUARD POST ALIGNED WITH JOIST



AXON: JOISTS PERP. TO EDGE, GUARD POST ALIGNED WITH JOIST



SECTION A

NOTES:
1. EDGE MEMBER WITH MIN. 3" NET WIDTH, MIN. 9-1/4" HEIGHT.
2. CENTER LINE OF TOP- OR SIDE-MOUNTED GUARD POST WITH 44" MAX HEIGHT.
3. TYPICAL JOIST (NOMINAL OR ENGINEERED LUMBER) WITH MIN. 9-1/4" HEIGHT.
4. FULL DEPTH BLOCKING WITH MIN. 9-1/4" HEIGHT.
5. FLOOR SHEATHING TO BE CONTINUOUS FOR A MIN. OF 2'-0" FROM EDGE, TYP.
6. JOINT IN FLOOR SHEATHING.
7. 6 - 16d COMMON (3 1/2" x 0.162") TOENAILS, STAGGERED, TYP.
8. 6 - 16d COMMON (3 1/2" x 0.162") NAILS, TYP.
9. 12 - 10d COMMON (3" x 0.148") NAILS BETWEEN FLOOR SHEATHING AND EDGE BEAM, JOIST OR BLOCKING, TYP.
10. TOP- OR SIDE-MOUNTED GUARD POST.

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FLOOR EDGE ROLL BRACING

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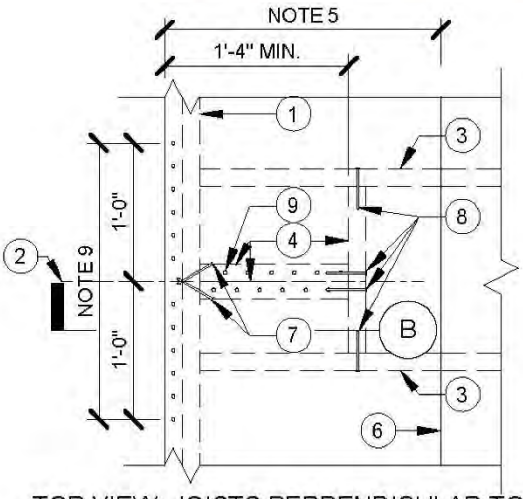
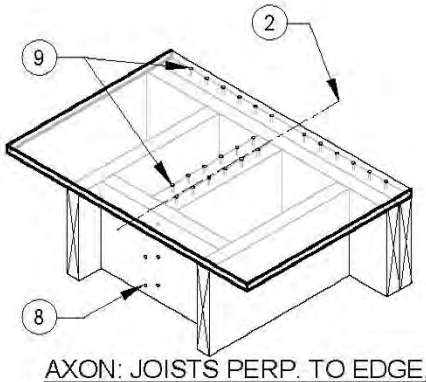


TOP VIEW: JOISTS PERPENDICULAR TO EDGE, GUARD POST OFFSET FROM JOISTS



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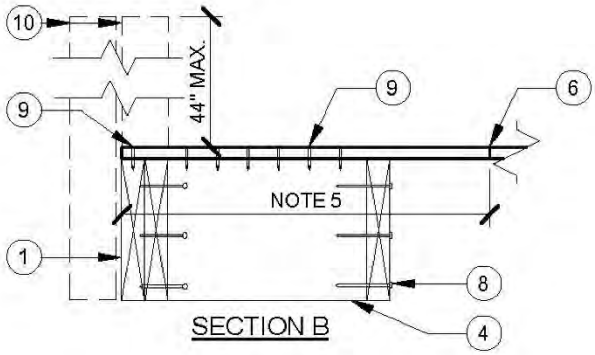

SECTION B

NOTES:

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Image courtesy of SMA

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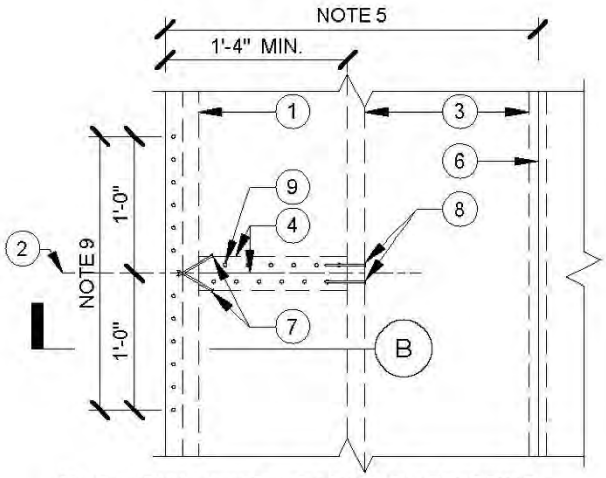
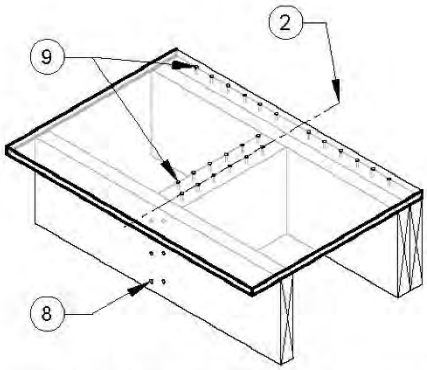
FLOOR EDGE ROLL BRACING

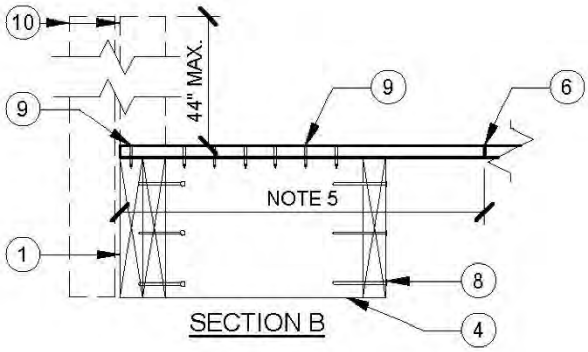
JOISTS PARALLEL TO EDGE



TOP VIEW: JOISTS PARALLEL TO EDGE



AXON: JOISTS PARALLEL TO EDGE



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10. TOP- OR SIDE-MOUNTED GUARD POST.

For additional information or if you have any questions, please visit the Stairbuilders and Manufacturers Association website at https://stairways.org/.

Inspection, Reporting, and Repair Ideas

Absent a guard-post connection that:

a) Meets 2024 IRC R502.11 and R507.10, or
b) Tested guard-post connection,

what are reasonable repair options for a design professional?

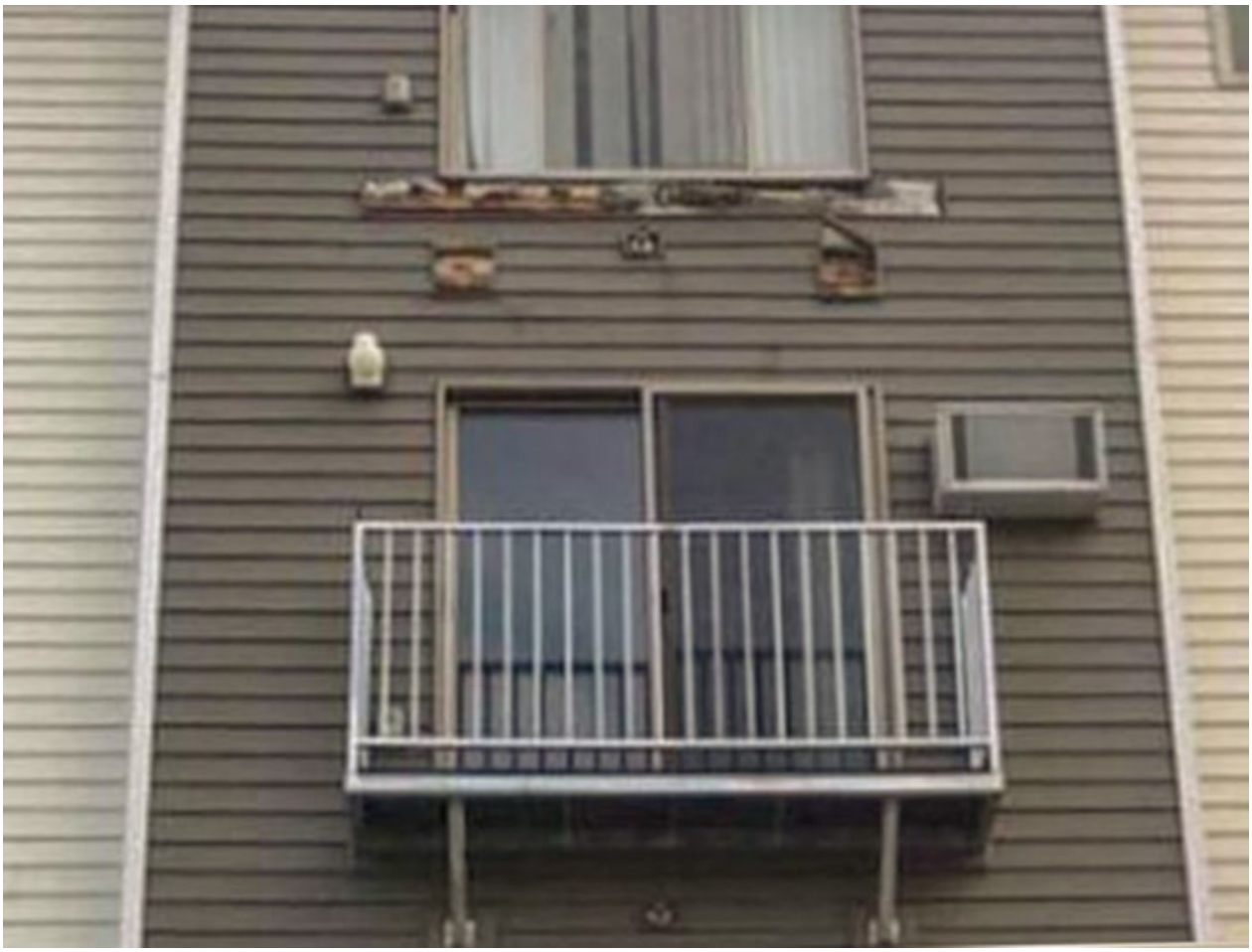
1. Add tested connectors to all guard posts?
2. Professional design and details consistent with **Reinforcement of Floor Systems Supporting Guards** by **Stairbuilders and Manufacturers Association (SMA)**
   https://sma-new.s3.us-east-1.amazonaws.com/EarlyAdoptionHandout-FINALr.pdf
3.

Single & Multi-family concern—Guard Connected to Concealed Decay

No. 3a: Deck or Balcony Ledger w/Angled Supports

- If C in Support, then T in Joist and Fasteners in Withdrawal

Angled Supports ⇨ Tension in Joist ⇨ Tension on Ledger
⇨ Tension on Fasteners
⇨ Fasteners in Withdrawal



Angled Supports: 5 individuals on 4th floor balcony.

Takeway: Gravity load only can collapse a balcony or deck.

No. 3b: Deck Ledger Connections

Nailed **Only** Deck Ledger

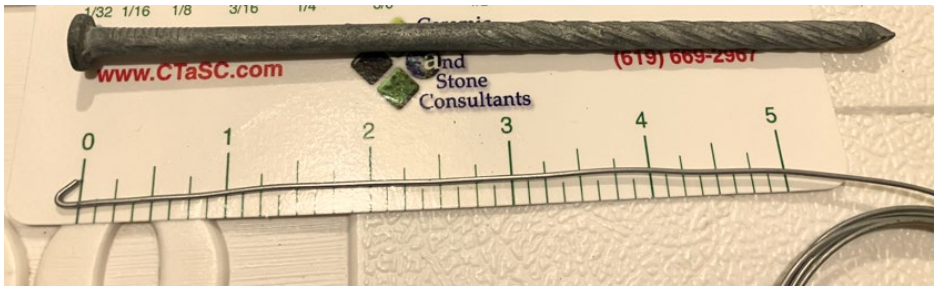
Dangerous connection and prohibited by the IRC since 2000 (R502.2.1)

<u>Framing Not Accessible</u>

1. ½” diameter but what length?

2. Remove fastener and examine condition of shank.

3. Verify band-joist **thickness** using 60d nail or wire



Framing Accessible

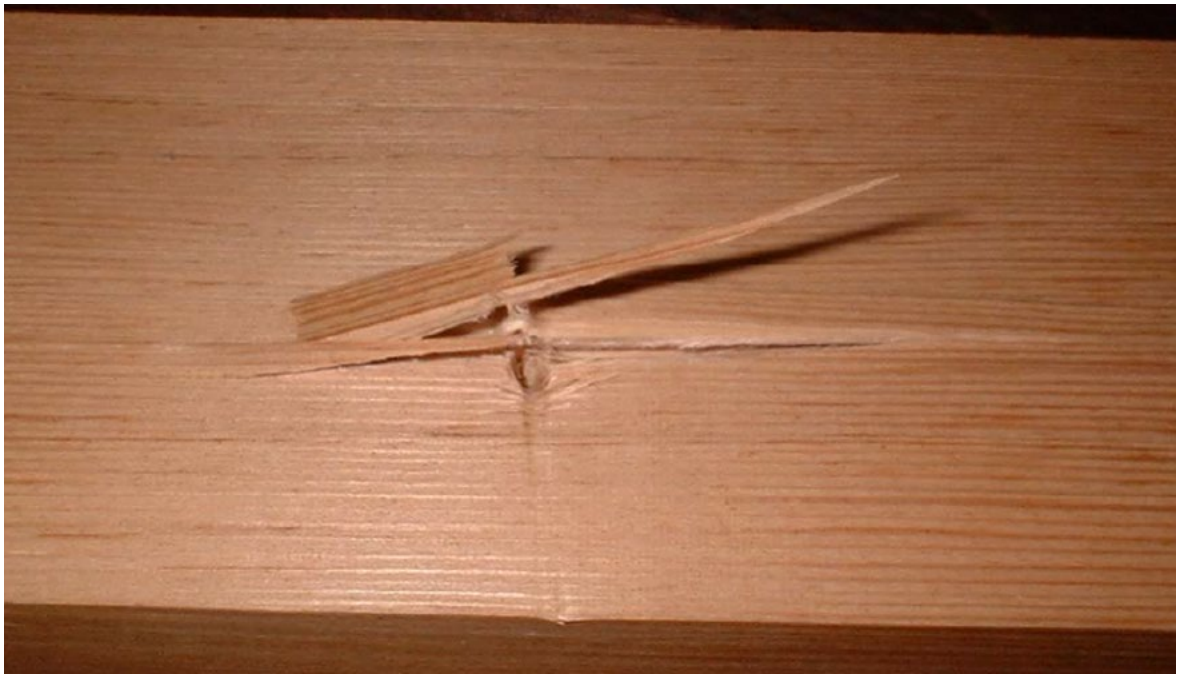
Example: Deck Ledger Screws through Sheathing

2024 IRC R507.9.1.3(1) Connection table anticipates no tip inside band.

Footnote d. The tip of the lag screw shall *fully extend beyond the inside face of the band joist*. Lag screws shall be full-body diameter screws.

Assess Condition of Framing and Solid-Wood Components

Pick Test



- Sound wood (DF) should splinter…

- 50-year-old DF purlin "looked sound"
- Decay is indicated by a brittle cross-grain clean-break directly above the pick, referred to as a "brash failure."

Early Decay

- **Wood and Fiber**, 9(4), 1978
  "Although decay may be detected **microscopically** in wood with *less than* 5% weight loss, …, one cannot have too much confidence in the results obtained at this level of decay…"

From Al DeBonis, **Wood Design Focus**, Spring 1999

Table 1.—Estimated strength loss in softwoods caused by brown-rot fungi during early stages of decay (Wilcox 1978).

Approximate weight loss	Impact bending	Modulus of rupture	Modulus of elasticity	Compression parallel to grain	Tension parallel to grain
			(%)		
2	20–50	13–50	4–55	10	23–40
6	62–72	61	66	25	60
10	85	70	--*	45	--*

* data not available.

and Wilcox, FPJ (Feb. 1983):

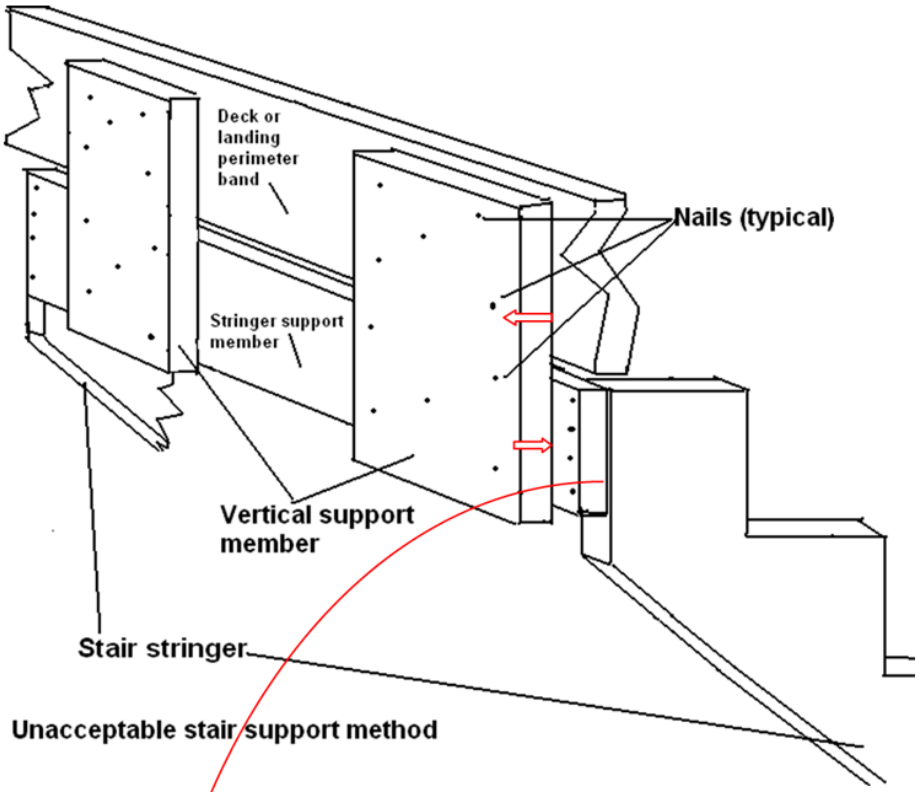
- …the Pick Test is capable of detecting decay as early as 5-10% weight loss.

From **ASTM D245-06**, Section 7.5.1:

- *No allowable stress* can be assigned with assurance to timber containing decay.
- If decay is detected in or near highly stressed areas, the member should be replaced.

No. 4 Stairway Issues

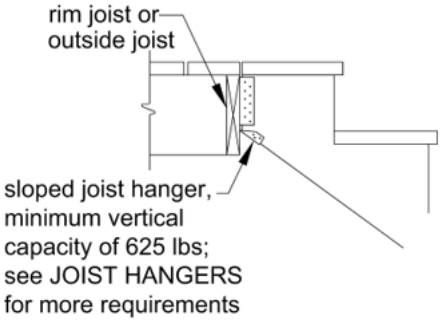
<u>Dangerous stair stringer connection to deck</u>



(Drawing by Roger Robertson, Former Chesterfield County Bldg. Official)

- Nails in Deck Landing or Perimeter Band in <u>Withdrawal</u>
- C_M =0.25 for smooth shank nail, Wet Service Use
- DCA6-2015 (Min, 625-lb. Capacity)

Figure 31. Stair Stringer Attachment Detail.



ATTACHMENT WITH HANGERS

Guards and *Graspable* Handrail per current IRC

(Fall hazard)

Stairway Treads, Size, Supports and Condition

(Fall hazard)

Stairway Illumination per current IRC

(Fall hazard)

Stringer Installation and Condition

(Fall hazard)

No. 5: Deck Ledger Connection to Cantilever

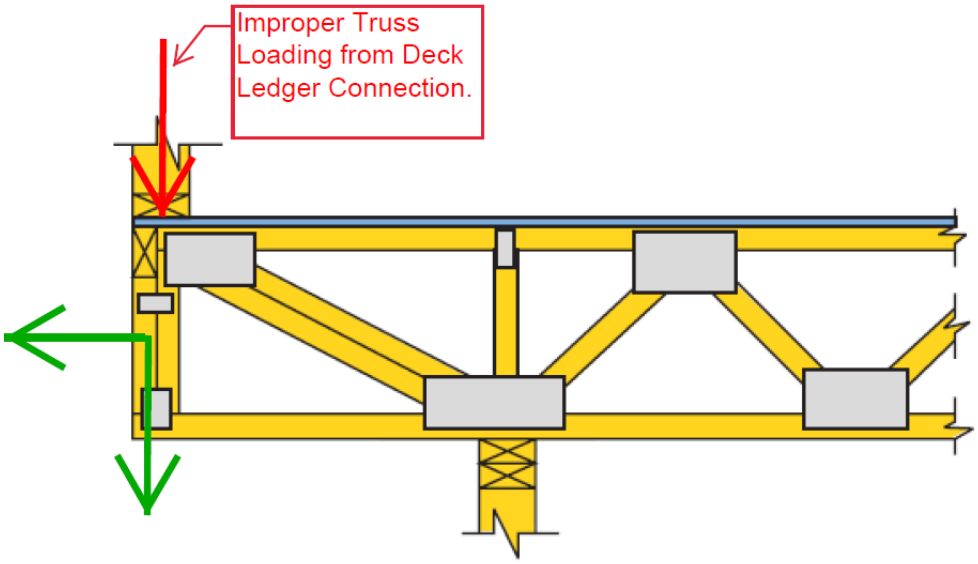
Figure 18. No Attachment to House Overhang with Ledger.

- Not permitted per DCA6-2015.
- Not recognized by MPC Wood Truss and EWP trade associations.
- Not recognized by Fastener Manufacturers.
- 2021 IRC: "**R507.9.1.2 Band joist details.** Band joists supporting…Band joists shall bear fully on the primary structure capable of supporting all required loads."

Detail from the field…

“Deck Ledger Loading” of Truss (or Joist) Cantilever

- Ledger loads 2x4 block, not top chord panel point.



Cantilever with an exterior wall on the end.

Deck Ledgers and Cantilevered Floor Trusses (PDB Sept-Oct, 2023)
https://www.jlconline.com/deck-builder/deck-ledgers-and-cantilevered-floor-trusses_o

No 6: Wood Decking

Decay

(Fall Hazard, Leg Injury)

- Multiple boards should be tested for “stiffness”, especially in shaded areas of the deck.
- Physical damage and signs of decay
- Two-span condition
- Maximum decking span per DCA6-2015, p.3:

“All decking material shall be composed of dimension lumber (2" nominal thickness) or span rated decking in accordance with the American Lumber Standard Committee *Policy for Evaluation of Recommended Spans for Span Rated Decking Products (November 5, 2004)*.”

- Recommended decking spans per ALSC (Nov. 2020):

  ALSC Policy for Evaluation of Recommended Spans for Span Rated Decking Products
  https://alsc.org/lumber-recommended-spans-for-decking/

  ALSC 2020 Policy includes:
  “Point load – 300 lb point load applied at the mid-point of one span of the recommended span, assuming a two-span continuous beam condition.”

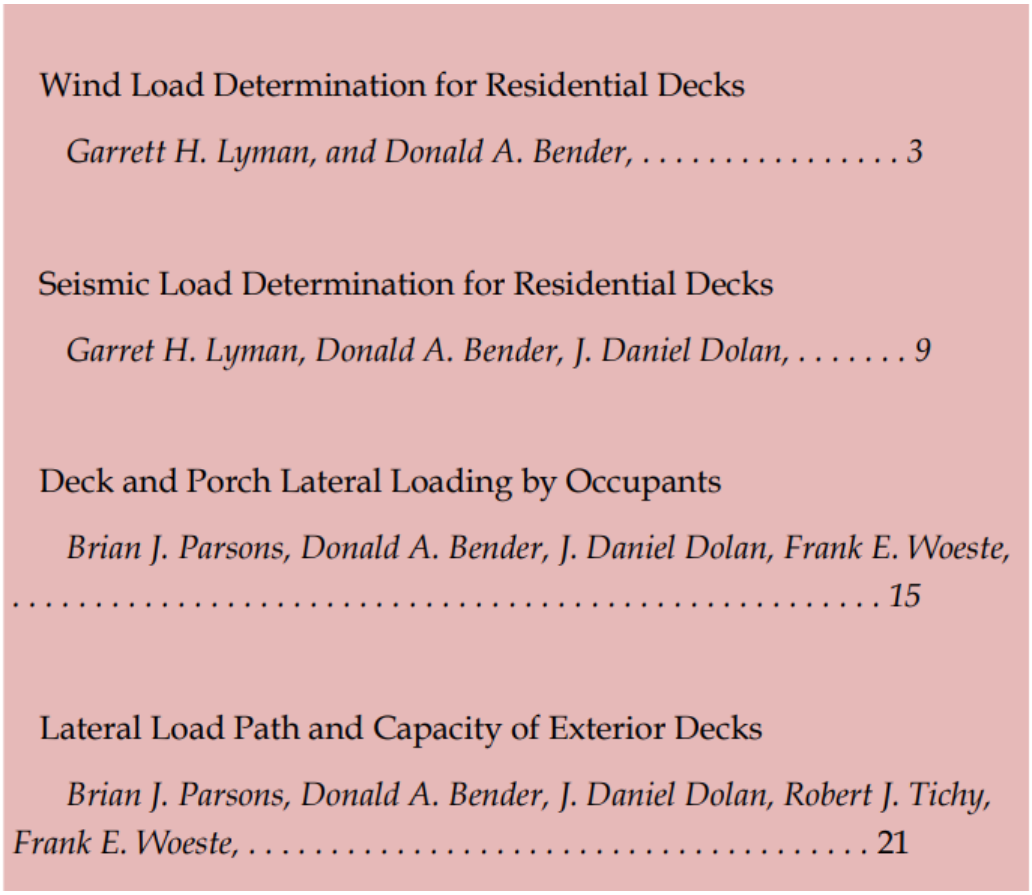
No. 7: Additional IRC and DCA6-2015 Requirements

Next Page—Deck Resources

Deck Resources

Existing Deck Inspection—A Must for Springtime Celebrations
by Woeste and Loferski (**CMA**, 2025, March).
https://componentadvertiser.com/Portals/0/EasyDNNnews/Uploads/1696/25-03_Advertiser-AllThingsWood.pdf

WSU Research on Lateral Loading of Decks
Wood Desingn Focus, Summer 2013
Visit http://wdf.forestprod.org/Archive/23_2.pdf



Wind Load Determination for Residential Decks
Garrett H. Lyman, and Donald A. Bender, ... 3

Seismic Load Determination for Residential Decks
Garret H. Lyman, Donald A. Bender, J. Daniel Dolan, ... 9

Deck and Porch Lateral Loading by Occupants
Brian J. Parsons, Donald A. Bender, J. Daniel Dolan, Frank E. Woeste, ... 15

Lateral Load Path and Capacity of Exterior Decks
Brian J. Parsons, Donald A. Bender, J. Daniel Dolan, Robert J. Tichy, Frank E. Woeste, ... 21

Attachment of Residential Deck Ledger to Metal Plate Connected Wood Truss Floor Systems, SRR No. 1408-01
https://sbcindustry.com/system/files/sbca/research-report/node/924/srr140801deckledger.pdf

Deck Codes + Standards, 2nd Edition (2024) by Bruce Barker
https://www.amazon.com/Black-Decker-Deck-Codes-Standards/dp/0760388164

Preventing Early Deck Framing Decay Ideas (**JLC**, October 2024)

https://www.jlconline.com/deck-builder/preventing-early-deck-framing-failures_o

Thank you!