

How to Have Fun in Class

- Conversation, not monologue
- Only dumb question is one not asked
- So much to discuss; so little time
- Darwinian decks

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What Could Go Wrong?

Photo Courtesy Shannon Cory



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This Could Go Wrong!

Photo Courtesy Shannon Cory



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Really?





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Gene Pool Contributors?



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Agenda

- Deck risks
- Deck inspection standard of practice
- Deck flashing
- Deck ledgers
- Deck stairs
- Guards and handrails

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WHY SPECIAL DECK INSPECTIONS?

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Scary Statistics

Estimated Total Injuries Involving Decks 2003 – 2007

Decks	Railings	Stairs
178,800	26,640	19,300

Estimated Injuries Involving Deck Structural Failures 2003 – 2007

Decks	Railings	Stairs
20,200	11,120	1,950

Decks cause more injury and loss of life than any other part of the home's structure

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Are You Sure You're Not Scared?



- Some estimate that as many as 20,000,000 decks were not code compliant when they were built
- Research & testing has resulted in significant changes to deck building codes in the last few IRC code cycles
- Deck service life between 15 – 25 years
- Bottom line: most decks have defects

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Deck Demons



8. Flooring
7. Posts and footings
6. Framing installation (beams, joists, hardware, bracing)
5. Deterioration
4. Guards and handrails
3. Stairways
2. Deck ledger attachment to building
1. Flashing

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DECK INSPECTION STANDARD OF PRACTICE

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Why a Deck Inspection Standard?

- Deck inspection time available
  - Limited time during a home inspection
  - As much time as needed during a deck inspection
- Measurements during inspection
  - Home inspections are visual
  - Deck inspections are mostly visual
  - No measurements during a home inspection
  - Measurements necessary during a deck inspection

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Why a Deck Inspection Standard?

- Defect reporting
  - Home inspection: subjective, inspector's judgment
  - Deck inspection: objective, compliance with guideline

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Why a Deck Inspection Standard?

You are not required to perform a Deck Standard inspection during a home inspection

Says so on the first page of the standard!

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Deck Inspection Standard

- Deck inspection stated objectives
  - Determine if inspected decks substantially conforms to *deck construction guideline(s)* selected by the inspector
    - Objective standards
  - Identify deck components that are unsafe or are near the end of their expected service lives
    - Inspector's professional judgment

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Deck Inspection Standard

Deck inspection unstated, but equally important, objective

Provide clients with information they can use to make decisions

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Deck Inspection Standard

Deck construction guideline: A **written** and **recognized authoritative reference** that describes recognized and generally accepted deck construction practices

- Does not include parts of the reference identified as Appendix, Commentary, and similar material
- Does not include references to external documents and standards such as NDS and ASTM

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Deck Inspection Standard

- Inspector selects deck construction guideline(s)
  - – You may use more than one for an inspection
- Recommended guidelines, most current version
  1. DCA 6
  2. International Residential Code
  3. Local building code
- Be prepared to defend your selection if you select a guideline other than these recommended guidelines

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Recommended Deck Construction Guideline



http://www.awc.org/codes-standards/publications/dca6

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Deck Inspection Standard

Reasonable to apply current guidelines to old decks?

YES!

Old decks often built under guidelines that were weak, poorly enforced, or non-existent

Old guidelines usually not based on engineering calculations and testing

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Deck Inspection Standard

Reasonable to apply current guidelines to old decks?

Clients want to know the current condition of their deck, not whether it complied with guidelines when built

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Deck Inspection Standard

Reasonable to apply national guideline to decks that comply with local codes?

Model codes usually slow to adopt new techniques

Jurisdictions usually slow to adopt new code versions, local jurisdiction could be several versions behind current model code

Codes are political documents

Local amendments sometimes based on reasons other than engineering principles and safety

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Deck Inspection Standard

Technically Exhaustive: An investigation that involves the use of advanced techniques, instruments, testing, calculations, engineering, or other means

- – Most of us are not engineers
- – Even if you are, you are not required (and are not being paid) to use those skills
  - But you may do so if you wish

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Deck Inspection Standard

Unsafe: A condition in a …component that is judged by the inspector to be a **significant** risk of **serious bodily injury** during **normal day-to-day use**…

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Deck Inspection Standard

Unsafe: ...the risk may be due to…change in accepted residential construction practices

Residential construction practices ≠ code

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Deck Inspection Standard

- **Unsafe:** examples of possible unsafe conditions
  - Improper ledger attachment
    - Especially by nails
  - Improper stringer attachment
  - Loose and poorly attached handrails or guards
  - Improper handrail grip size
  - Wide guard fill-in spacing
  - Uneven risers and treads

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Unsafe?



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Unsafe: The Bottom Line

No grandfathering of safety deficiencies



- Significant risk
- Serious bodily injury
- Normal day-to-day use

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Deck Inspection Standard

Residential deck: A wood-framed structure that is located outside of the building. A *residential deck* may include structures such as a balcony, deck, landing, stairway, and porch. A *residential deck* may be attached to the building, or it may be free-standing.

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What's in a Name?

- It doesn't matter what you call the structure
  - Deck
  - Balcony
  - Porch
    - Deck guidelines do not apply to structures with a roof
  - Landing with stairs to an exterior door
  - Patio

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What's in a Name?



- If it looks like a deck and acts like a deck, then it's a deck and the deck rules apply

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Is That a Deck?





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Deck Inspection Standard

- Important inspection limitations and exclusions
  - Manufacturer's installation instructions
    - But be very familiar with instructions for common joist hangers and connectors
  - Components not part of the deck
    - This is not a home inspection
  - Type or level of preservative treatment, unless clearly visible
    - Usually not visible unless tag is still attached

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Deck Inspection Standard

- Important limitations and exclusions
  - Preservative treatment of wood cuts
  - Type or level of corrosion resistance, unless clearly visible
    - Usually is visible on hangers and connectors
  - Type, thickness, length of fasteners, unless clearly visible
    - Usually concealed

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Deck Inspection Standard

- Important limitations and exclusions
  - Compliance with past requirements
  - Digging, dismantling, moving belongings or other materials
  - Putting yourself or others at risk

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Deck Inspection Limitations

Photo courtesy Joe Moore

- Guidelines apply to single level decks
  - Multiple levels may be okay if built as single level decks, but look for concentrated loads such as stairs

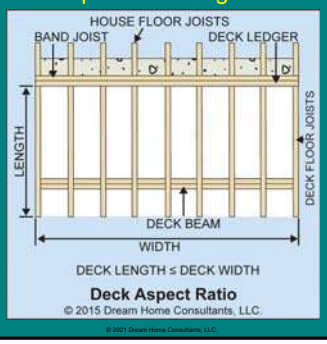


Recommend engineer evaluation, then run like the wind

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Deck Inspection Limitations

Deck aspect ratio length ≤ width



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Deck Inspection Limitations

- No roof loads (e. g., screen porches)
  - Disclaim beams, posts, footings, bracing, and recommend engineer evaluation of these components if client wants assurance about condition of these components
  - Okay to inspect other components

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Deck Inspection Limitations

- No concentrated loads (e. g., hot tubs)
  - Report presence, disclaim inspection of load, recommend engineer evaluation
  - Okay to inspect other components
  - A do not use warning is prudent

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Deck Inspection Limitations

- Does the deck standard apply to residential balconies?
  - **Yes**, if the balcony is built like a deck and the structural components are visible
  - **Maybe**, if the balcony is cantilevered and the structural components are visible
    - Often not the case
    - Select the deck construction guideline carefully
  - **No**, if the balcony is cantilevered and if the structural components are concealed

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FLASHING

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Deck Flashing Importance

Absent and improperly installed flashing is a major contributor to deck failures. Water also damages other components and contributes to fungal growth

Bolts and screws won't work in rotted wood

A little rot can significantly decrease wood strength

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What Happens If Bad Flashing



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What Happens If Bad Flashing



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What Happens If Bad Flashing

Photo Courtesy Shannon Cory



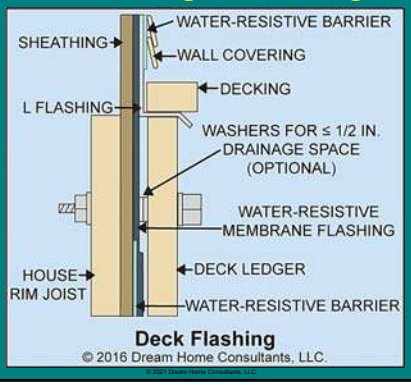
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Deck Flashing Guidelines

- DCA 6 and IRC do not provide good flashing details
- Possible deck construction guidelines for flashing
  - Water Management Guide, Joseph Lstiburek
    - Recommended
  - Journal of Light Construction Field Guide

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Deck Ledger Flashing



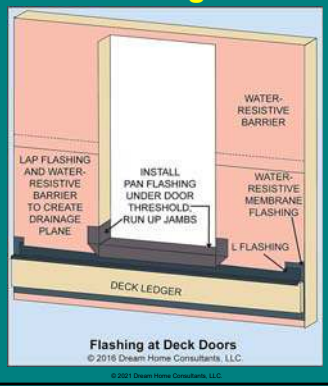
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Deck Flashing at Doors

- In the perfect world
  - Threshold and jamb flashing integrated with water-resistant barrier
  - You use your X-ray vision to see it
- In the real world
  - Flashing installed under the threshold (if lucky), but
  - Threshold corners left vulnerable
    - Caulk at threshold corners may indicate past leaks

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Deck Flashing at Doors



Flashing at Deck Doors

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Deck Flashing Defect



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Inspecting Deck Flashing

- Look carefully for signs of water intrusion inside
  - Look for water at band joist and floor sheathing in basement and crawlspace
  - Move band insulation, especially at fasteners if necessary (not required)
  - Minor looking cracks & blisters in finish materials may be significant

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Inspecting Deck Flashing

- Deck components (guards, handrails, posts) penetrating or attached to wall cladding or water resistant balcony floors are always suspect
  - Report them (deficiency?)
  - Recommend monitoring, at least
- Sealants are not flashing
  - Excessive sealant may indicate attempt to repair problem

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Deck Flashing Defect?



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Inspecting Balcony Flashing

- Inspect balconies with visible floor joists like decks
- Report balconies with concealed floor joists with great care
  - Especially cantilevered balconies
  - Flashing and deterioration, if any, is usually concealed
  - Disclaim inspection and recommend that access from underneath be installed for inspection and ventilation

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Inspecting Balcony Flashing



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Inspecting Balcony Flashing

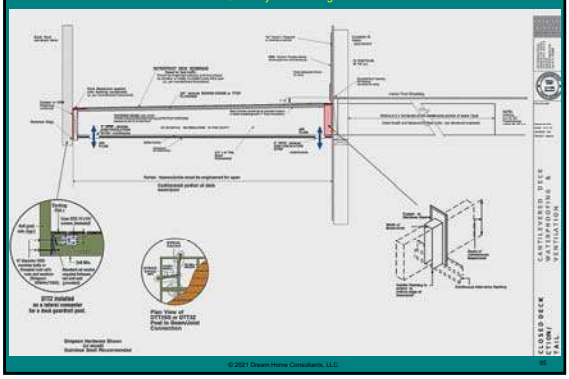




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Balcony Flashing Detail

Courtesy Patrick Burger



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Reporting Deck Flashing

- Report visible flashing that does not comply with the deck flashing construction guideline you select
  - You may not be able to see the damage, yet
  - **Explain risks, and recommend action**
- Critical flashing details are usually concealed
  - Report limitation, warn there may be hidden damage, and recommend evaluation if client wishes additional assurance about condition
  - Destructive evaluation will probably be necessary, but impractical

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Reporting Deck Flashing

We observed absent, deteriorated, or improperly installed flashing between deck, balconies, or exterior stairs and the house. Lack of proper flashing is a well known and frequent reason for moisture intrusion into the structure. Moisture intrusion can damage materials and create conditions for fungal growth. Damaged materials can contribute to structure collapse causing injury.

We recommend that a qualified contractor install flashing according to best practices such as those described in "Water Management Guide" by Joseph W. Lstiburek, Ph. D and other authoritative publications such as the "Journal of Light Construction."

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Reporting Deck Flashing

We were unable to fully observe the deck flashing, if any. Much of the flashing is covered by other materials and is not visible. Flashing that is not properly installed and properly integrated with other flashing such as door flashing can leak. Such leaks can go undetected and damage can occur. Damaged materials can contribute to structure collapse causing injury. We recommend evaluation by a qualified contractor if you wish additional information about the condition of the deck flashing. Destructive evaluation will probably be required.

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DECK LEDGER ATTACHMENT

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Deck Ledger Attachment Importance

Catastrophic failure of attached decks often starts when the deck ledger pulls away from the house

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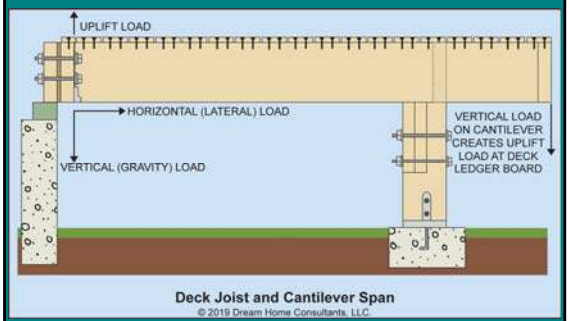
What Happens to Poorly Attached Decks

Photo Courtesy Welmoed Sisson



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Forces Acting on a Deck



Deck Joist and Cantilever Span

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Forces Acting on a Deck

- Gravity loads pull the deck down
- Lateral loads pull the deck away from the house
- Ledger attachment must resist both loads
  - Bolts and screws are primarily for gravity loads
  - Lateral load connectors are for lateral loads

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Forces Acting on a Deck

- **Both types** must be installed
  - Could be expressed more clearly in IRC and DCA 6
- Uplift load resistance may also be necessary
  - Especially for decks with cantilevered joists

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Deck Construction Guideline

- **IRC 2018 R507.8** Where supported by attachment to an exterior wall, decks shall be positively anchored to the primary structure and designed for **both vertical and lateral loads** (emphasis added)
  - Similar requirement since at least IRC 2000
- **IRC 2018 R507.9.2** Where lateral load connection is provided in accordance with Figure R507.9.2(1)… Figure R507.9.2(2)…

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Deck Ledger Gravity Load Attachment

- Band joists/rim boards to which a deck ledger **may** be attached (DCA 6-15)
  - Dimensional lumber band joist
  - Engineered rim board (1"+)
  - Metal plate-connected wood truss
  - Concrete or fully grouted CMU foundation wall
- IRC 2018 does not include trusses and concrete and CMU foundations

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Deck Ledger Gravity Load Attachment

- Materials and components to and through which a deck ledger **may not** be fastened
  - I-joist
  - Sheathing (through ½ in. sheathing ok)
  - Hollow CMU (allowed by past DCA 6)
  - Wall coverings (must be removed)
  - Cantilevered framing
- Report and disclaim such ledgers and recommend engineer evaluation

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Deck Ledger Gravity Load Attachment

- Band joist (rim board) specifications
  - Dimensional lumber band joist (≥ 2x10)
    - 2x8 may be used, but fastener locations change
  - Minimum 1+ inch by 9 ½ inch engineered wood rim board
  - Band joist/rim board depth ≥ deck ledger depth
  - Band joist/rim board bears on foundation, or on wall that bears on foundation

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Deck Ledger Gravity Load Attachment

- Sheathing specifications **(IRC 2018)**
  - Sheathing thickness ≤ 1/2 in. for screws and bolts into approved band joists (rim boards)
  - Sheathing thickness ≤ 1 in. for bolts into approved band joists (rim boards)
    - No provision for stacked washers
- DCA 6 is similar
  - Sheathing limited to ≤ 1/2 in.

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Deck Ledger Gravity Load Attachment

- Deck ledger specifications
  - Preservative-treated or naturally durable ≥ 2x8, #2 grade
  - Ledger depth ≥ deck joist depth

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Deck Ledger Gravity Load Attachment

- Ledger fastener and hardware specifications
  - Fasteners and hardware should be **hot-dipped** galvanized steel (≥ G185) or stainless steel
    - Stainless steel required ≤ 300 feet to salt water
    - Stainless steel highly recommended near salt water
    - Grade 316 (recommended) v. Grade 304 (allowed)
  - Not practical to visually determine galvanization level or application method of most fasteners
    - Limitation statement is prudent

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Deck Ledger Gravity Load Attachment

- Ledger fastener and hardware specifications
  - Report and recommend evaluation of fasteners and hardware not G185 galvanized steel or stainless steel, if visually determined
    - Copper and bronze acceptable in some cases
  - Screws and bolts should be ½ inch diameter
    - Larger fasteners okay, but fastener spacing is different when larger fasteners are used

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Deck Ledger Gravity Load Attachment

- Ledger fastener and hardware specifications
  - Machine bolts, not carriage bolts
  - Washer on both ends of bolts and head end of screws

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Deck Ledger Attachment Defect



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Deck Ledger Gravity Load Attachment

- Deck ledger fastener spacing based on
  - Fastener type: screw or bolt
  - Sheathing thickness and type
  - Band joist/rim joist thickness and type
  - Deck joist span

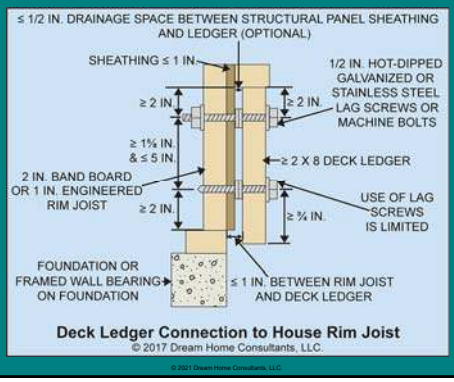
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Deck Ledger Gravity Load Attachment

- Sheathing and band joist/rim board may not be fully visible
  - Use most conservative spacing values and include limitation statement
- Deck construction guidelines, fastener spacing
  - DCA 6-15 Table 5 and Figure 19
  - IRC 2018 Tables R507.9.1.3(1) & R507.9.1.3(2) and related figures

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Deck Ledger Gravity Load Attachment

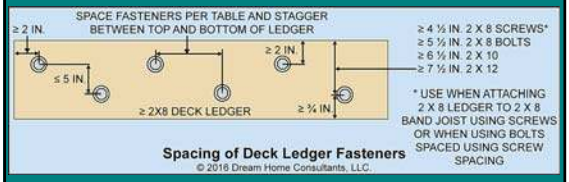


Deck Ledger Connection to House Rim Joist

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Deck Ledger Gravity Load Attachment



Spacing of Deck Ledger Fasteners

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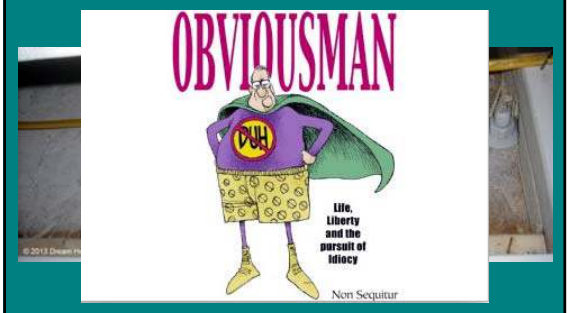
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Deck Ledger Gravity Load Attachment



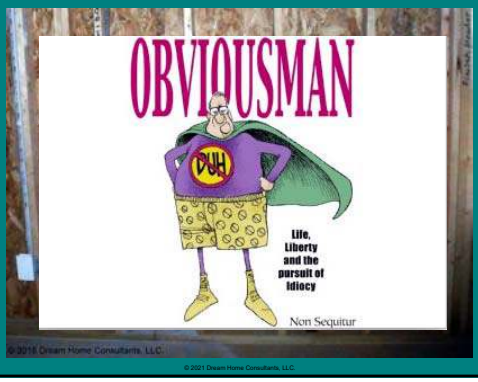
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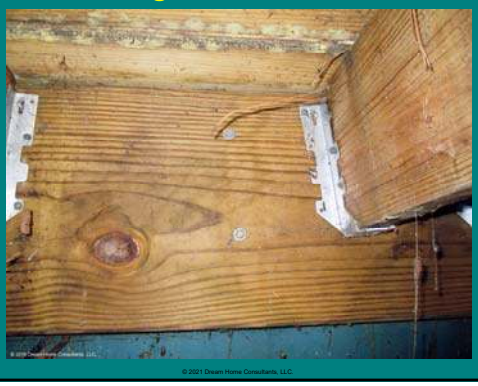
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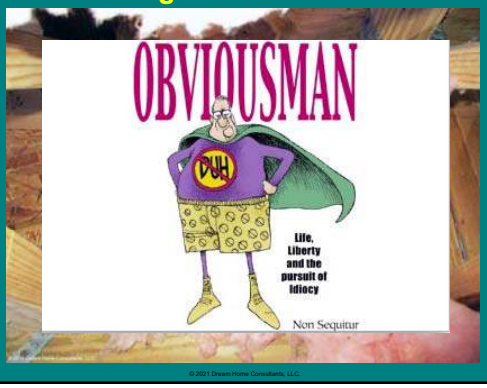
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Deck Ledger Attachment Defect



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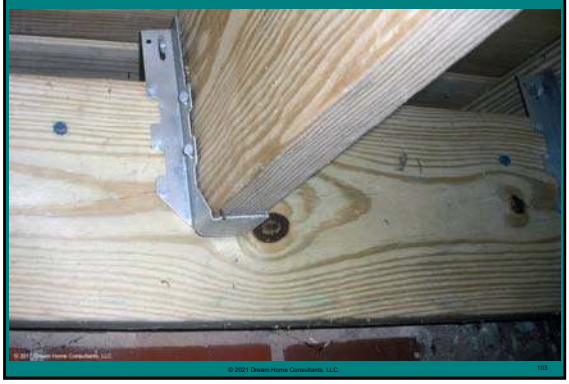
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Deck Ledger Attachment Defect



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Deck Ledger Gravity Load Attachment



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Deck Ledger Gravity Load Attachment

Photo courtesy Welmoed Sisson



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Deck Ledger Gravity Load Attachment

- Alternatives to ½ inch bolts and screws
  - Simpson SDWS and SDWH **timber** screws
    - SDWS **framing** screws are different
  - Simpson SDS **heavy duty** connector screws
    - SD connector screws are different
  - LedgerLOK screws
  - Other listed fasteners

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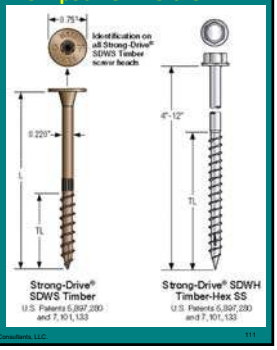
Deck Ledger Gravity Load Attachment

Pictures/illustrations courtesy LedgerLoc and Simpson Strong-Tie

LedgerLOK



Simpson SDWS & SDWH

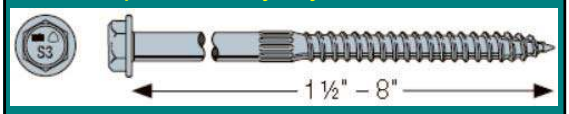


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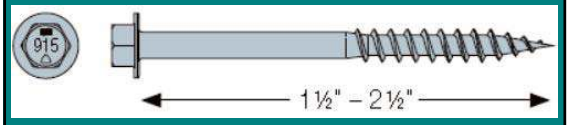
Deck Ledger Gravity Load Attachment

Pictures courtesy Simpson Strong-Tie

Simpson SDS Heavy Duty Connector Screw



Simpson SD Connector Screw



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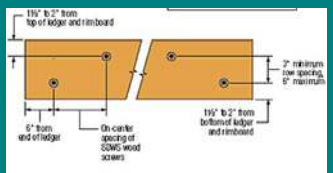
Deck Ledger Gravity Load Attachment



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Deck Ledger Gravity Load Attachment

Material courtesy Simpson Strong-Tie



SDWS Timber Screw Spacing Detail for Ledgers

SDWS Timber Screw – 2012 and 2015 IRC Compliant Spacing for a Sawn Lumber Deck Ledger to Rim Board

Loading Condition	Nominal Ledger Size (in.)	Model No.	Rim Board Material and Minimum Size	Maximum Deck Joist Span: Up to 6 ft.	Up to 8 ft.	Up to 10 ft.	Up to 12 ft.	Up to 14 ft.	Up to 16 ft.	Up to 18 ft.
				Maximum On-Center Spacing of Fasteners (in.)						
40 psf Live 10 psf Dead	2x	SDWS22400DB	1" OSB	14	10	8	7	6	5	5
			1" DFL							
			1⅛" OSB	16	12	10	8	7	6	5
			1⅛" DFL							
			1¼" LSL							
			2x SP, DF – 2x SPF, HF	22	16	13	11	9	8	7

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Deck Ledger Gravity Load Attachment

- Alternatives to ½ inch bolts and screws
  - Installation, location, spacing per manufacturer's instructions
    - Not required to confirm installation per manufacturer's instructions, but
    - If you do, be sure to use the instructions for the product installed
    - If you don't, disclaim and recommend evaluation

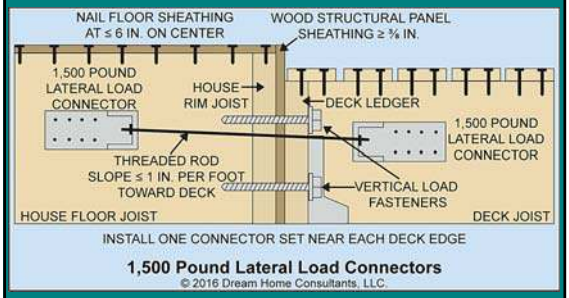
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Deck Ledger Lateral Load Attachment

- Bolts and screws may not provide adequate lateral load connection
  - Confirmation requires engineering analysis
- Lateral load connectors usually should be used to provide lateral load connection
  - Total lateral load resistance ≥ 3,000#
  - Examples: Simpson DTT2 (1,500#), DTT1 (750#)

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Deck Ledger Lateral Load Attachment



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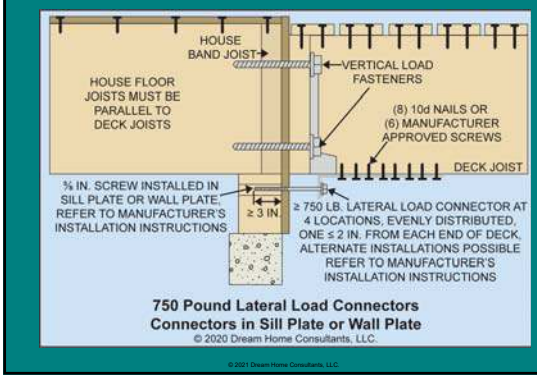
Deck Ledger Lateral Load Attachment

Photos courtesy Dutton Smith



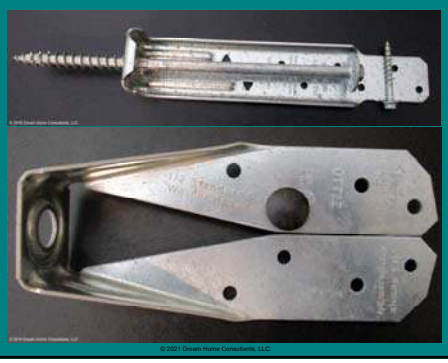
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Deck Ledger Lateral Load Attachment



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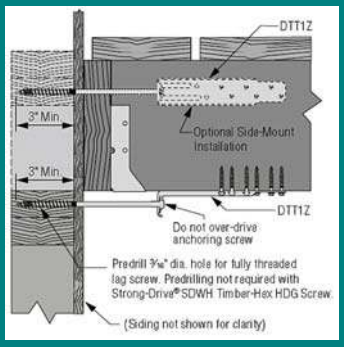
Deck Ledger Lateral Load Attachment



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Deck Ledger Lateral Load Attachment

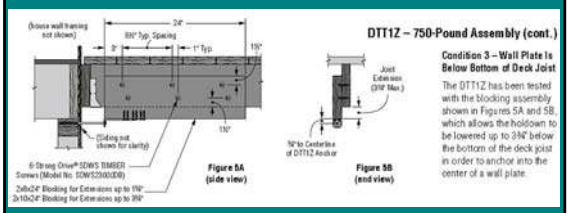
Illustration courtesy Simpson Strong-tie



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Deck Ledger Lateral Load Attachment

Illustration courtesy Simpson Strong-tie



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Deck Ledger Gravity Load Attachment Metal Plate Wood Trusses



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Deck Ledger Gravity Load Attachment Metal Plate Wood Trusses

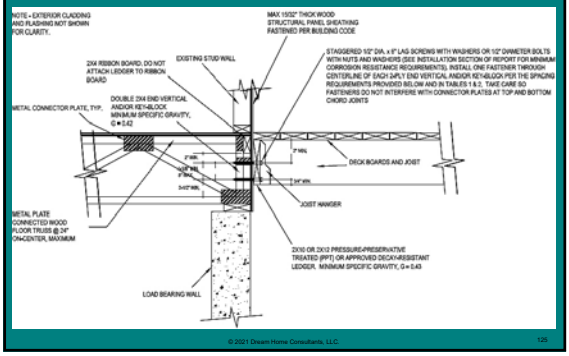
Perpendicular to Band

- Recommended ledger attachment
  - – Gravity loads
    - Ledger bolted or screwed to truss per SBCA
    - See https://www.sbcindustry.com/deck-ledger-attachmentLateral loads
  - – Lateral loads
    - DTT1 (or equivalent) connectors

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Metal Plate Wood Trusses

Perpendicular to Band



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Metal Plate Wood Trusses

Perpendicular to Band



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Metal Plate Wood Trusses
Perpendicular to Band



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Metal Plate Wood Trusses
Perpendicular to Band



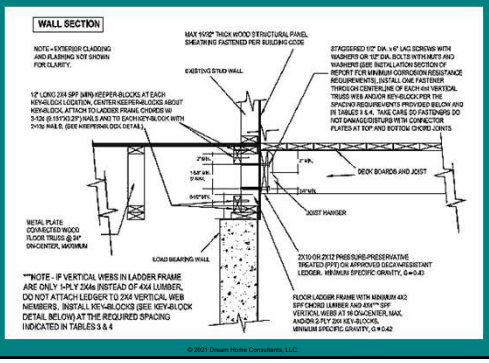
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Deck Ledger Gravity Load Attachment
Metal Plate Wood Trusses
Parallel to Band

- Recommended ledger attachment
  - – Gravity loads
    - Ledger bolted or screwed to truss per SBCA
    - See https://www.sbcindustry.com/deck-ledger-attachment
  - – Lateral loads
    - DTT1 (or equivalent) connectors

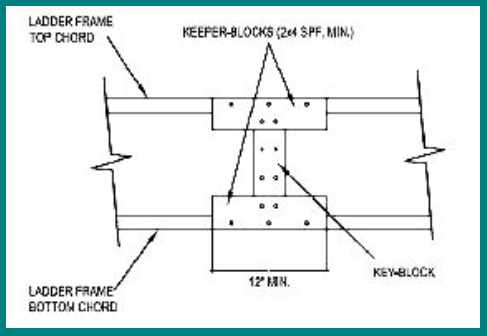
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Metal Plate Wood Trusses
Parallel to Band



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Metal Plate Wood Trusses
Parallel to Band



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Metal Plate Wood Trusses
Parallel to Band



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Metal Plate Wood Trusses
Parallel to Band



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Metal Plate Wood Trusses
Parallel to Band

Photo courtesy John Cauthen



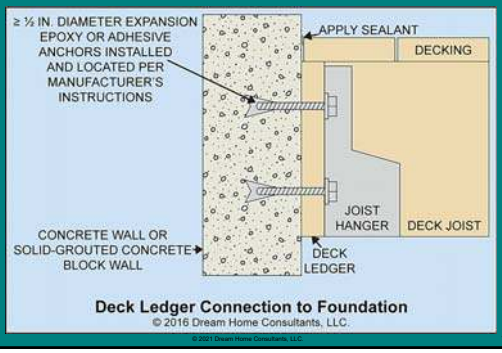
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Deck Ledger Gravity Load Attachment
Concrete and Masonry Foundation Walls

- Yes, directly to solid walls with approved anchors
- No, hollow CMU walls (DCA 6 change)
- Check condition of wall around anchors
  - Cracks?
- Report inability to confirm that anchors are properly installed
- Lateral load connectors are required

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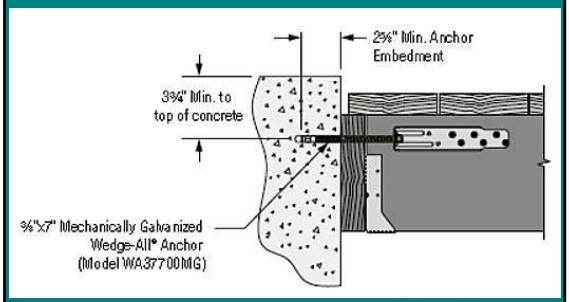
Deck Ledger Gravity Load Attachment
Concrete and Masonry Foundation Walls



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Deck Ledger Lateral Load Attachment
Concrete and Masonry Foundation Walls

Illustration courtesy Simpson Strong-tie



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Deck Ledger Attachment Defect



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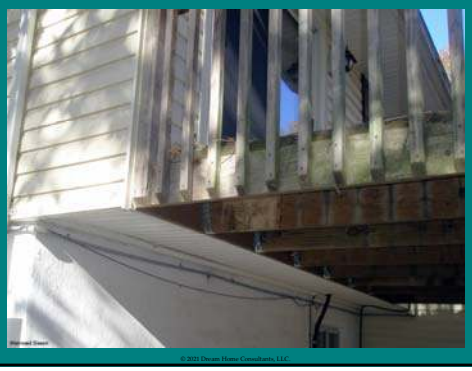
Deck Ledger Attachment Defect



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Deck Ledger Attachment Defect

Photo Courtesy Welmoed Sisson



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Deck Ledger Attachment Defect



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Deck Ledger Attachment Defect



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Deck Ledger Attachment Defect



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Deck Ledger Attachment Defect



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Deck Framing
Framing Around Projections

- DCA 6-15, Figure 35, provides detail for framing around a cantilevered structure
  - – Cantilever width ≤ 6 ft., depth ≤ 3 ft.
  - – > 6 feet wide: engineered design or support beam with posts and footings as required
  - – Triple trimmers required if
    - Joists 12 or 16 inches OC
    - Joist span ≥ 8 ½ feet

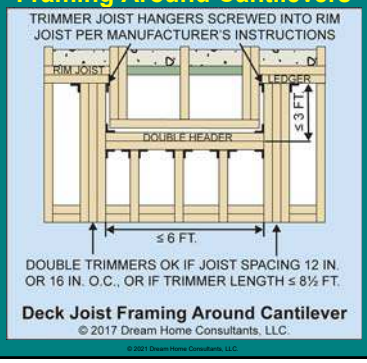
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Deck Framing
Framing Around Projections

- DCA 6-15, Figure 35, provides detail for framing around a cantilevered structure
  - – Special hanger required
    - **No nailed hangers**
  - – Example: Simpson HUCQ with SDS screws
    - Screw tips should be visible in band joist
    - Screw length on Simpson and USP screw heads
  - – No beam attachment directly to ledger
    - Applies to all beams

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Deck Framing
Framing Around Cantilevers



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Deck Framing
Framing Around Projections



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Deck Framing
Framing Around Projections



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Inspecting Deck Ledger Attachment

- Visually inspect band joist/rim board, sheathing, and deck ledger
  - – Determine types, dimensions, condition of ledger, band joist/rim board, fasteners
- Visually inspect deck ledger fasteners
  - – Inspect both inside and outside
  - – Determine fastener type
  - – Measure fastener location and spacing
  - – Measure deck joist span

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Reporting Deck Ledger Attachment

- Compare findings to deck construction guideline
- Report if deck ledger attachment does not conform to deck construction guideline, or if deteriorated or unsafe
  - Degree of deficiency will vary
  - **Report it and explain risks**
  - Deficiency statement will vary depending on deficiency

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Reporting Deck Ledger Attachment

Consider do not use deck warning for deck ledgers attached using only nails and for decks with significantly deteriorated (rusted) fasteners

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Reporting Deck Ledger Attachment

We observed that the methods and materials used to attach deck, balcony, stair, porch, or landing ledgers to the house do not comply with current accepted guidelines. Simply installing fasteners may not be enough to ensure a structurally sound connection. Fasteners should be properly spaced and should be attached to an approved band joist or rim joist in addition to other requirements. Improper attachment could result in a structure collapse causing injury. We recommend evaluation by a qualified contractor based on DCA 6 guidelines and action as recommended by the contractor based on those guidelines. The attachment details requiring attention include. but are not limited to: Picture(s), if any, are examples.

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Reporting Deck Ledger Attachment

- Report if deck ledger attachment details are concealed (common)
  - **Report limitation, warn there may be hidden deficiencies, and recommend evaluation if client wishes additional assurance about condition**
  - Evaluation may not be practical, and destructive examination will probably be required

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DECK STAIRS

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Deck Stair Importance

Accidents involving stairs are one of the most common causes of serious injury in a house. All stairs are potentially dangerous, and deck stairs especially so because they are often poorly constructed and are exposed to the elements.

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What Happens to Poorly Attached Stairs



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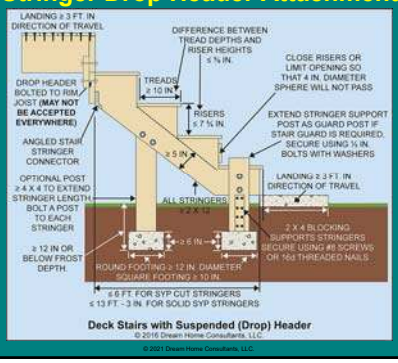
Deck Stairs
Stair Stringer Cut v. Solid





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Deck Stairs
Stringer Drop Header Attachment



Deck Stairs with Suspended (Drop) Header

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Deck Stairs
Stringer Attachment to Rim Joist

- Stringer attachment to rim joist usually a weak connection
  - Almost always attached using nails
- Stringer connectors are specified in DCA 6
  - Good luck finding them!

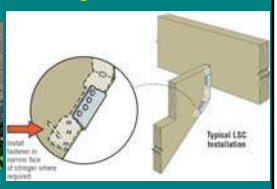
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Deck Stairs
Stringer Attachment to Rim Joist

Picture and illustration courtesy Simpson Strong-tie

Simpson LSC – listed as a stringer connector





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Stair Stringer Attachment Defect



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Deck Stairs
Stringer Attachment to Rim Joist

- Nailed stringers (the real world)
  - – Nails (especially toe nails) may be subject to withdrawal
  - – Small plumb (vertical) cut or small bearing point does not provide good attachment surface

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Deck Stairs
Stringer Attachment to Rim Joist

- Nailed stringers (the real world)
  - – Nailed drop headers are wrong
    - Bolted is better, but still does not comply with DCA 6
  - – A small, , (e.g., 2x8) long rim joist may deflect causing fastener failure
    - Rim joist supporting stringers should be at least 2 x 10

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Stair Stringer Attachment Defect



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Stair Stringer Attachment Defect



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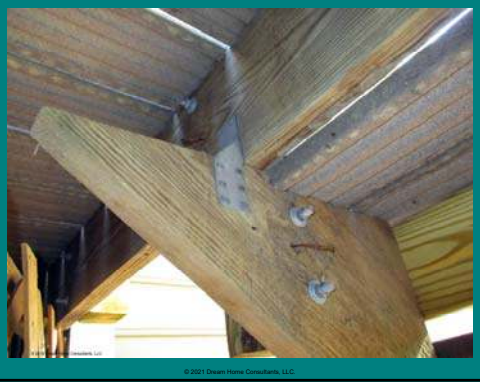
Stair Stringer Attachment Defect

Photo courtesy Welmoed Sisson



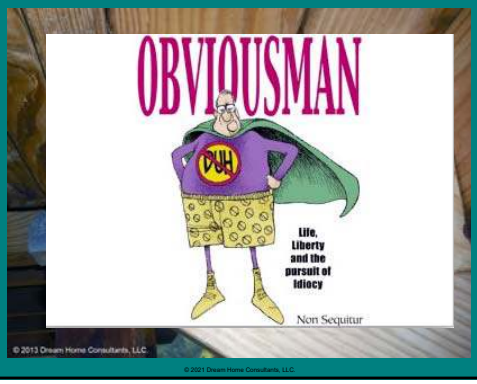
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Stair Stringer Attachment Defect



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Stair Stringer Attachment Defect



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Stair Stringer Attachment Defect



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Stair Stringer Attachment Defect



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Stair Stringer Attachment Defect



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Deck Stairs

Reporting Nailed Stringer Attachment to Rim Joist

- Nailed stringers do not comply with DCA 6
  - Report and explain risk
  - Recommendation depends on stringer attachment condition and on other stringer construction details (e. g., stringer not secured against lateral movement)
- Can nailed stringers work (real world)?
  - Yes, thousands are doing so

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Deck Stairs
Reporting Nailed Stringer Attachment to Rim Joist

- Nailed stringers are most likely to work when
  - Threaded-type nails are used
  - Stringers are restrained against lateral movement
  - Full plumb cut bears on 2 x 10 or larger, well-supported rim joist
  - Enough, but not too many, nails are installed
  - Stringers are not over-spanned
  - Stringers are well-supported at the bottom

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Deck Stairs
Reporting Nailed Stringer Attachment to Rim Joist

We observed that stair stringers are attached to the supports using nails or screws. This could result in a stair collapse causing injury. Current accepted standards recommend using stringer connectors to attach stringers to the supports; however, alternative attachment methods can function adequately if the stairs are restrained against lateral movement. We recommend monitoring the stairs for indications of failure such as fastener withdrawal, stringer movement, splitting wood, and deflection.

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Deck Stairs
Reporting Nailed Stringer Attachment to Rim Joist

We observed that stair stringers are poorly attached to the deck. This could result in a stair collapse causing injury. Current accepted standards recommend using stringer connectors to attach stringers to the supports. Current accepted standards also recommend that the attachment point be securely attached to the deck including full plumb cut bearing on the supporting structure. We recommend evaluation by a qualified contractor based on DCA 6 guidelines and action as recommended by the contractor based on those guidelines. The stairs requiring attention include: . Picture(s), if any, are examples.

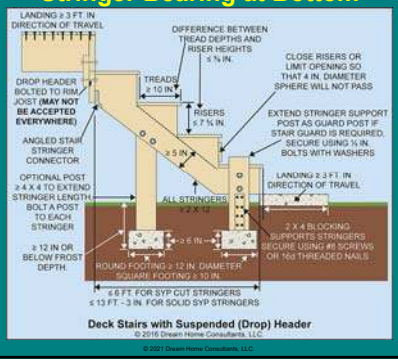
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Deck Stairs
Stringer Bearing at Bottom

- DCA 6, Figure 34, calls for footings and 2 x 4 bearing blocks to support stringers
  - Real world: not going to happen
- No specific prescriptive guidance in IRC
  - General rule: ≥ 3 in. of seat cut heel bearing on concrete/masonry

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Deck Stairs
Stringer Bearing at Bottom



Deck Stairs with Suspended (Drop) Header

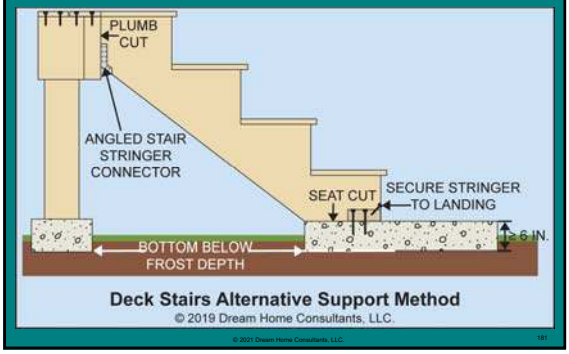
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Deck Stairs
Stringer Bearing at Bottom

- A practical alternative
  - ≥ 3 in. of stringer seat cut heel bearing on solid landing
  - Concrete bottom landing with bottom of concrete below frost depth
  - Stringers restrained against lateral movement

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Deck Stairs
Stringer Bearing at Bottom



Deck Stairs Alternative Support Method

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Stringer Bottom Bearing Defect



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Stringer Bottom Bearing Defect



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Stringer Bottom Bearing Defect



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Deck Stairs
Reporting Poor Stringer Bering at Bottom

- Very unlikely to see DCA 6 detail
  - Nonetheless, report non-compliance
  - Recommending action unnecessary if stringer is properly bearing on a solid landing
- Report actual poor bearing defects and recommend action

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Deck Stairs
Reporting Poor Stringer Bearing at Bottom

We observed that stair stringers are not properly bearing on supporting components. This could result in a stair collapse causing injury. Stringer plumb (top) cuts should fully bear on the supporting deck structure. Stringer seat (bottom) cuts have sufficient bearing on support to reduce wood splitting and to reduce stringer pulling away from the deck. We recommend evaluation by a qualified contractor based on DCA 6 guidelines and action as recommended by the contractor based on those guidelines. The stairs requiring attention include: stringer seat cuts are bearing on notched toes. Picture(s), if any, are examples.

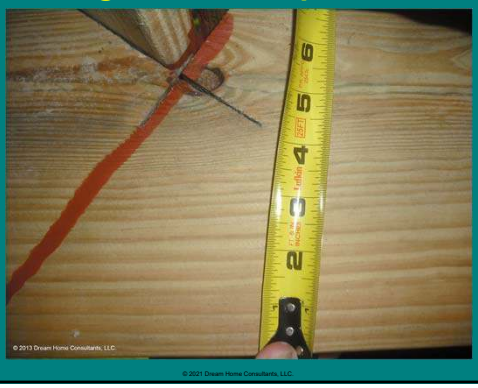
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Deck Stairs
Stringer Throat Depth

- DCA 6-15, Figure 28, calls for 2 x 12 stringers with ≥ 5 in. throat depth
  - Real world: lots of old decks will not comply

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Stringer Throat Depth Defect



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Stringer Throat Depth Defect



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Deck Stairs
Reporting Stringer Throat Depth

- Stringers with a throat depth < 5 in. do not comply with DCA 6
  - Report, explain risk, recommend action

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Deck Stairs
Stringer Unsupported Length

- DCA 6-15, Figure 28, calls for 2 x 12 stringers
  - 6 ft. span for cut stringers
  - 13 ft. – 3 in. span for solid stringers
  - 7 and 16 feet in older DCA 6 editions
  - Real world: lots of old decks will not comply

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Stringer Unsupported Length Defect
(Guard Support too)



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Stringer Unsupported Length Defect
(Guard Support too)



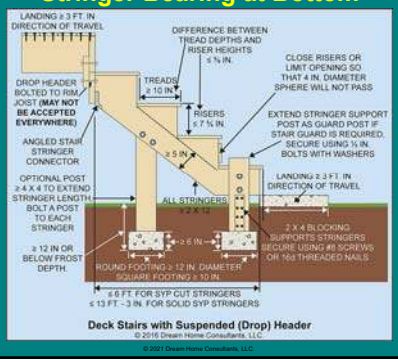
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Deck Stairs
Stringer Support Posts

- DCA 6-15 calls for a 4 x 4 support post under each over-spanned stringer (prescriptive method)
  - – Notch 4 x 4 and bolt to each stringer as a beam
  - – Support post on footing
  - – Real world: other details more likely

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Deck Stairs
Stringer Bearing at Bottom



Deck Stairs with Suspended (Drop) Header

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Deck Stairs
Stringer Support Posts

- Reporting non-compliance
  - – Report and explain risk
  - – Judgment call about recommendation
    - Depends on support structure and condition

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Deck Stairs
Reporting Stringer Unsupported Length

- Stringers that are longer than specified do not comply with DCA 6-15
  - – Report, explain risk, recommend action

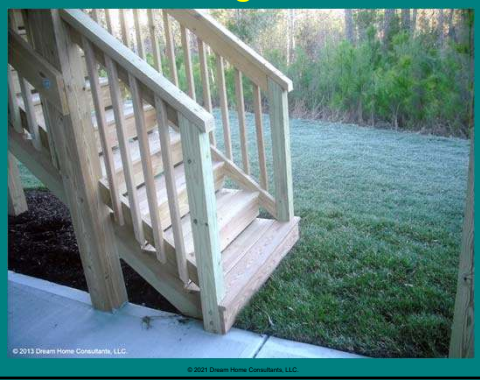
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Deck Stairs
Landings

- DCA 6 cites IRC for landing requirement
  - – Same requirements as interior stairs
  - – Landing at top and bottom of each flight of stairs
    - Flight of stairs is risers and treads between a landing
  - – Landing width ≥ stair width and ≥ 36 in. deep in direction of travel
  - – Intermediate landing required if stair vertical rise > 12 ft.

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Landing Defect



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Deck Stairs
Reporting Stair Landings

- Landing rules are mostly to facilitate emergency egress
  - – Report non-compliance, explain risk
  - – Recommend caution using stairs for minor discrepancies
  - – Recommend action for absent landings and major discrepancies
    - Local requirement will vary, especially for bottom landing

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Deck Stairs
Reporting Stair Landings

We observed stair landings are absent, are not the recommended size, or are not at the recommended locations. This is a fall safety hazard, especially for children and those with reduced mobility. Current accepted standards recommend that there shall be a floor or landing at the top and bottom of each stairway. The width of each landing shall not be less than the stairway served. Every landing shall have a minimum dimension of 36 inches measured in the direction of travel. Standards for stair construction have changed over the years and this deck may have been built under different standards. We recommend appropriate safety precautions when using stairs.

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Deck Stairs
Stairway Width, Riser Height, Tread Depth

- DCA 6-15 cites IRC for these requirements
  - – Same requirements as interior stairs
  - – Stairway width ≥ 36 in.
  - – Riser height ≤ 7 ¾ in.

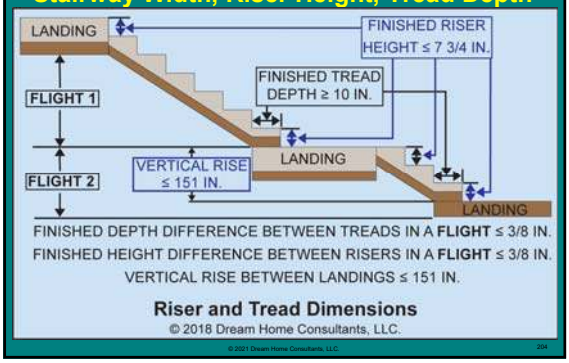
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Deck Stairs
Stairway Width, Riser Height, Tread Depth

- DCA 6-15 cites IRC for these requirements
  - – Tread depth ≥ 10 in. measured from leading edge of adjacent treads
  - – Variance between treads and risers in flight of stairs ≤ ⅜ in.
  - – Local requirements vary
  - – Requirements have changed over time

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Deck Stairs
Stairway Width, Riser Height, Tread Depth



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Deck Stairs
Reporting Stairway Width, Riser Height, Tread Depth

- Stairway width rules are mostly to facilitate emergency egress
  - Report non-compliance, explain risk, recommend caution using stairs for most discrepancies

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Deck Stairs
Reporting Stairway Width, Riser Height, Tread Depth

- Riser height and tread depth non-compliance is a safety concern, but
  - Not a big deal if consistent and close to required measurements, or are accepted locally
  - Report non-compliance, explain risk, recommend caution using stairs for minor discrepancies

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Deck Stairs
Reporting Stairway Width, Riser Height, Tread Depth

- Riser height and tread depth **differences** are a more significant safety concern
  - Fall hazard
  - Report non-compliance, explain risk, recommend action
    - May require new stairs

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Deck Stairs
Reporting Stairway Width, Riser Height, Tread Depth

We observed that stair risers are too tall or are not uniform in height. This is a fall safety hazard, especially for children and those with reduced mobility. Current accepted standards in North Carolina recommend that the maximum riser height shall be 8 1/4 inches. The greatest riser height within any flight of stairs shall not exceed the smallest by more than 3/8 inch, except for top and bottom risers which are allowed a 3/4 inch difference. We recommend action by a qualified contractor. The risers requiring attention include: Picture(s), if any, are examples.

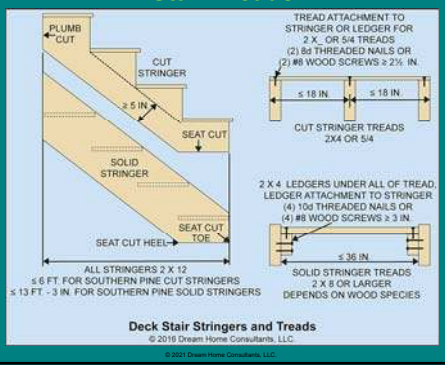
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Deck Stairs
Stair Treads

- DCA 6-15 Figure 29 and Table 6 call for
  - Unsupported stairway tread ≤ 18 inches for cut stringer
    - Use at least 2 x 4 or 5/4 treads for cut stringers
  - Unsupported stairway tread ≤ 36 inches for solid stringer
    - Use 2 x 8 or larger for solid stringer treads depending on tread species
    - 2 x 8 & larger wood tends to cup with age
- Spans for composite products may be less

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Deck Stairs
Stair Treads



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Stair Tread Defect



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Stair Tread Defect



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Deck Stairs
Reporting Stair Treads

- Treads with greater than specified spans or improper support do not comply with DCA 6
  - Report, explain risk, recommend action
- No prescriptive guidance in IRC
  - Use DCA 6 or make a judgment call about how to report

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Deck Stairs
Stairway Nosing

- IRC R311.7 is the source for these requirements
  - Same requirements as interior stairs
  - Nosing not required if treads ≥ 11 in. deep
  - Nosing depth ≥ ¾ in. and ≤ 1 ¼ in.
  - Variance between nosing depth ≤ ⅜ in. over entire stairway
  - Local requirements may vary

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Deck Stairs
Stairway Nosing



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Deck Stairs
Stairway Nosing Defect



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DECK GUARDS

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Guard and Handrail Importance

Guard failures are one of the most common reasons for deck-related injuries.

Lack of a graspable handrail at deck stairs is a nearly universal defect. It is difficult to know how this relates directly to deck-related injuries, but there is a likely correlation.

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Deck Guards

- DCA 6, Figure 24, provides details for typical horizontal deck guards with 2 x 2 wood balusters
- DCA 6, Figures 25 and 26, provide details for attachment of horizontal deck guard posts
  - Also applies to stair guard top posts
- DCA 6, Figure 30, provides details for stair guards

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Deck Guards

- DCA 6, Figure 34, provides details for securing a stair guard bottom post to a footing
  - Stair guard post needs more moment resistance than obtained by securing the post to the stringer
- DCA 6-15 provides no prescriptive guidance for attaching intermediate stair guard posts
- Real world: many decks will not comply with guard post attachment details

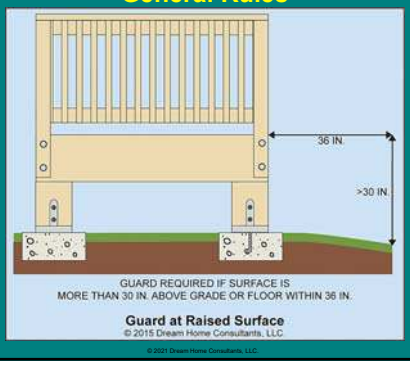
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Deck Guards

- DCA 6-15 cites IRC for opening size in and under guards
  - Same as interior guards
  - 4 in. diameter sphere should not pass through or under horizontal guard openings
  - 4⅜ in. diameter sphere should not pass through stair guard openings
  - 6 in. diameter sphere should not pass under stair guard openings

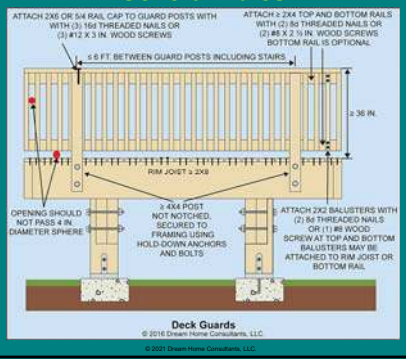
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Deck Guards - Horizontal
General Rules



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Deck Guards
General Rules



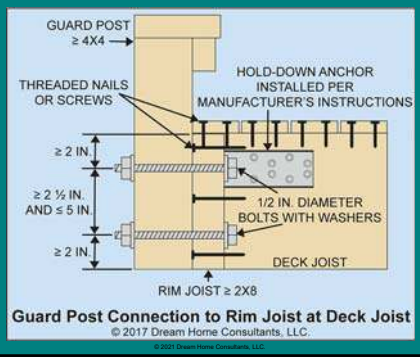
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Guard Height Defect?



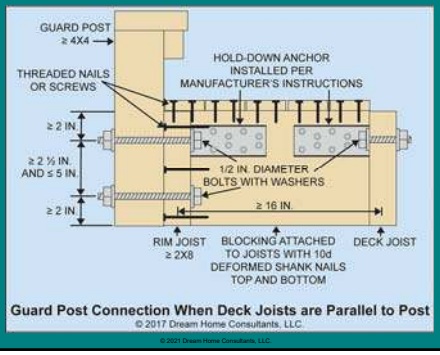
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Deck Guard Post
Recommended Attachment Method



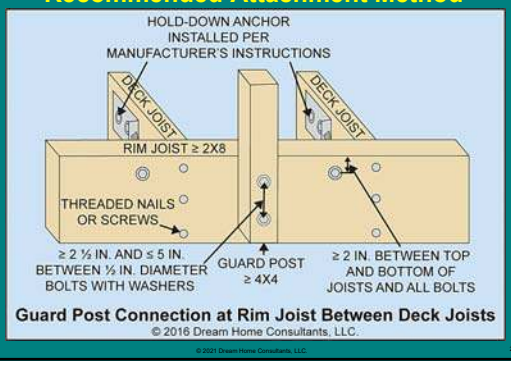
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Deck Guard Post
Recommended Attachment Method



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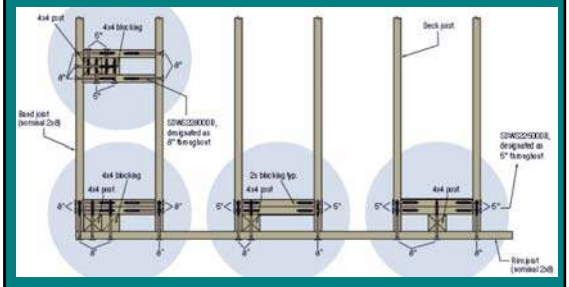
Deck Guard Post
Recommended Attachment Method



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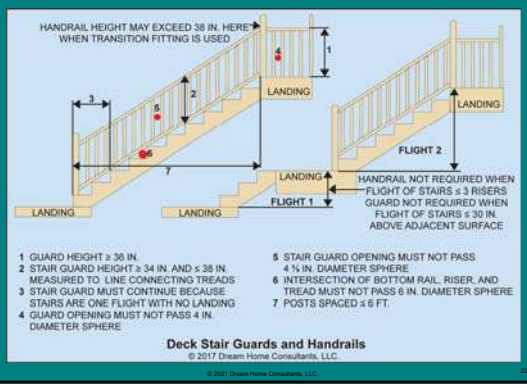
Deck Guard Post
Alternative Attachment Method

Illustration courtesy Simpson Strong-Tie



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Deck Stair Guards



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Guard Post Attachment Defect





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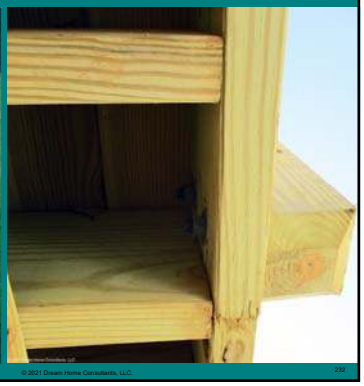
Guard Post Attachment Defect



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Guard Post Attachment Defect





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Guard Post Attachment Defect





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Guard Post Attachment Defect



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Guard Post Spacing Defect



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Baluster Attachment Defect



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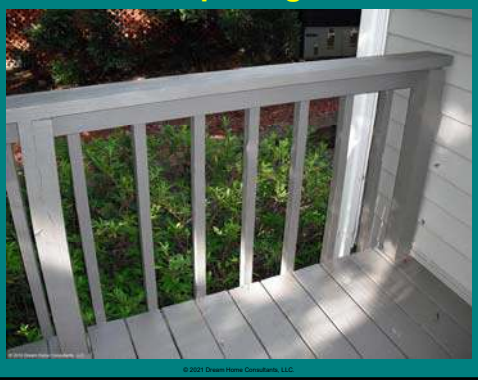
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Baluster Attachment Defect



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Guard Opening Defect



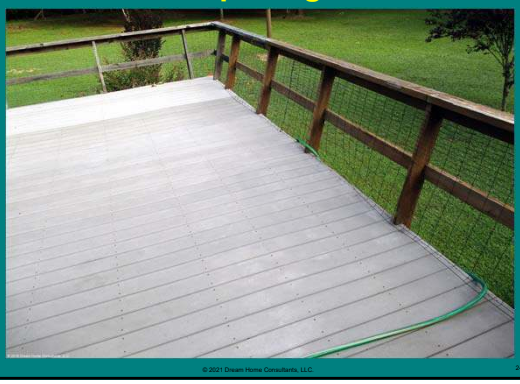
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Guard Opening Defect



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Guard Opening Defect



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Guard Opening Defect



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Guard Opening Defect



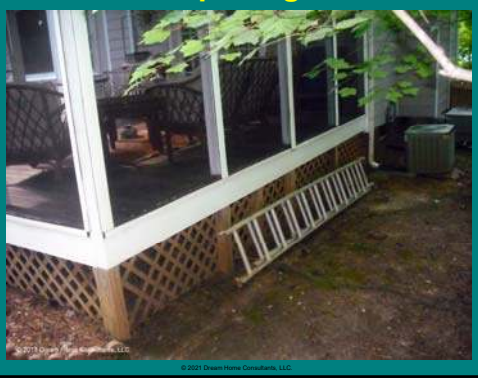
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Guard Opening Defect



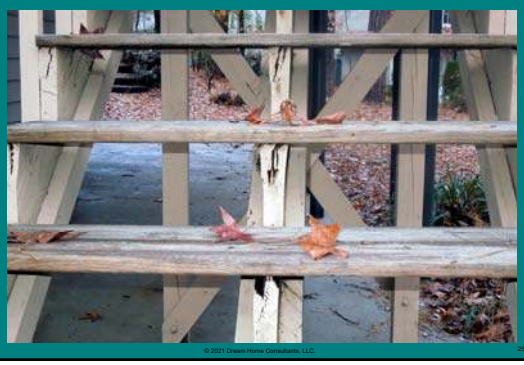
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Guard Opening Defect



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Stair Opening Defect



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Guard Fill-in Defect?



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Deck Guards

- Wire cables as fill-in components
  - Must be taut enough so cannot move beyond 4 inch sphere opening size
  - Look for tubes in posts to reduce wood wear
  - Climbability may be an issue in some jurisdictions
- Glazing as fill-in components
  - Must be safety glazing
  - Must comply with 50 pound load rule

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Deck Guards



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Deck Guards



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Deck Guards



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Deck Guards

- Check at and under penetration by guard (and other) posts at decks and balconies over finished areas
  - Major water leak points
- Check guard height near house on decks with sloping floors (for water drainage)
  - Guard height may be short at house

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Deck Guards
Reporting Deck Guards

- Deck guards not installed as indicated in the previous illustrations do not comply with DCA 6
  - Report, explain risk, recommend action
  - Alternative post attachment details are possible, if installed per manufacturer's instructions

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Deck Guards
Reporting Deck Guards

- We observed that a guard does not appear adequately secured to the deck or similar structure. This could result in a guard collapse causing injury. Current accepted standards recommend that guards be capable of withstanding a single concentrated 200 pound load applied in any direction along the top. The recommended method for complying with this standard is using properly installed 4x4 posts and attachment hardware. While the current installation method is common practice in North Carolina, it is not recommended by national authoritative references and has not been tested for structural stability. The method is unlikely to comply with the load requirement, especially as the structure ages. We recommend evaluation by a qualified contractor based on DCA 6 guidelines and action as recommended by the contractor based on those guidelines. The guards requiring attention include: Picture(s), if any, are examples.

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DECK HANDRAILS

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Deck Stair Handrails

- DCA 6 cites IRC for deck stair handrail requirements (and all exterior stairs)
  - Same as interior stairs
  - Required if 4 or more risers
  - Height 34 in. – 38 in. above tread nosing

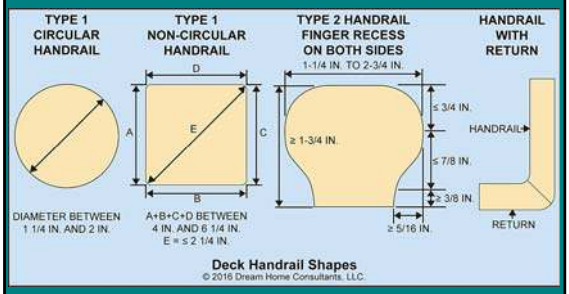
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Deck Stair Handrails

- DCA 6 cites IRC for deck stair handrail requirements (and all exterior stairs)
  - Continuous from top riser to bottom tread nosing
  - Graspable profile, specific dimensions
  - Return or post at each end
- Real world: few deck handrails comply

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Deck Stair Handrails



Deck Handrail Shapes
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Deck Stair Handrail Defect





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Deck Stair Handrail Defect





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Deck Stair Handrail Defect

Photo courtesy Joe Moore



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Deck Guards
Reporting Deck Handrails

- Deck handrails not installed as indicated in the previous illustrations do not comply with DCA 6 and the IRC
  - Report, explain risk, recommend action

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DECK FRAMING

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Deck Framing

- Most everything not already discussed
  - Joist installation including hangers and connectors
  - Beams
  - Posts and footings
  - Bracing
  - Corrosion and deterioration
  - Flooring (decking)

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Deck Framing Importance

Deck framing is not a common direct cause of deck collapse and injury, but it can be a contributing factor. Framing should be carefully inspected.

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Deck Framing
Joist Attachment to Beam and Ledger

- DCA 6-15, Figures 5 and 6, provide details for deck joist attachment to the ledger and beam
  - Joist hangers are specified
  - Nailed angle brackets are expressly forbidden by DCA 6
    - But were allowed by manufacturer's instructions until recently
    - New heavy duty angle brackets attached using screws are available

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Deck Framing
Joist Attachment to Beam and Ledger

- Ledger strips are common, but not recommended
  - (3) 16d nails in ledger under each joist, (4) 16d gun nails
- IRC 2018 no longer allows ledger strips (R507.6.2)
  - DCA 6 never has allowed them
- Recommend monitoring ledger strips, at least

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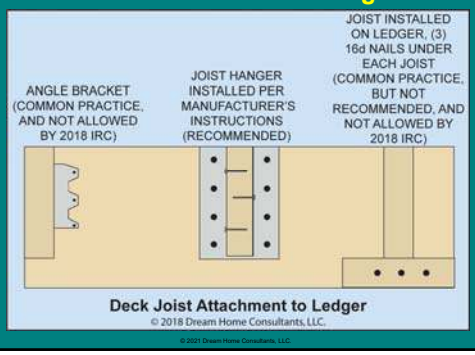
Deck Framing
Why Not Ledger Strips

Photos courtesy Frank Woeste and Joe Loferski, Virginia Tech



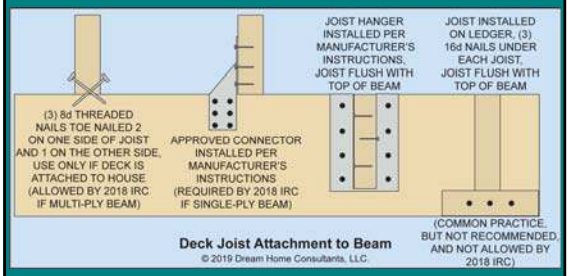
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Deck Framing
Joist Attachment to Ledger



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Deck Framing
Joist Attachment to Beam



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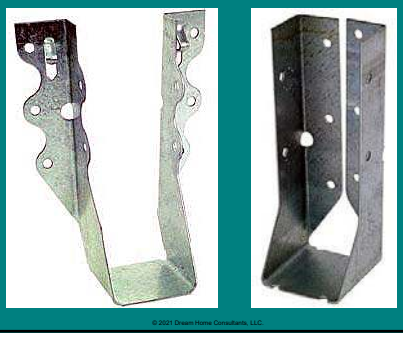
Deck Framing
Joist Hanger Selection

- Minimum vertical load capacity 500 lb. for 2 x 8
  - Simpson LUS26Z, LUC26Z (16d nails), LUS28Z (10d nails)
- Minimum vertical load capacity 600 lb. for 2 x 10
  - Simpson LUS28Z, LUS210Z (10d nails) LUC210Z (16d nails)
- Nailed joist hangers should not support beam on the deck ledger
  - Hanger should be screwed into band joist/rim board

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Deck Framing
Joist Hangers

Photos courtesy Simpson Strong-Tie



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Joist Hanger Defect



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Joist Attachment Defect



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Joist Attachment Defect



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Joist Attachment Defect





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Joist Attachment Defect



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Deck Framing
Hangers & Connectors (Simpson)

- Install per manufacturer's instructions
- Manufacturers have free download instructions, PDF and phone apps
- Following based on Simpson instructions

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Deck Framing
Hangers & Connectors (Simpson)

- Hole filling
  - Round: fill it
  - Oblong: fill it
  - Hexagonal: fill it when attaching directly to concrete or masonry
  - Triangle: fill it when increased strength is required by engineer
  - Diamond: no fill requirement (temporary)

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Deck Framing
Hangers & Connectors (Simpson)

- Fasteners
  - No screws unless manufacturer's product and allowed by product installation instructions
    - No wood screws, deck screws, or drywall screws
    - Do not combine screws and nails to secure the same connector

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Deck Framing
Hangers & Connectors (Simpson)

- Fasteners
  - Hand-driven nails or manufacturer-supplied gun nails usually specified
    - 16d **common** (0.162 x 3 ½ inches) for double hangers
    - 10d **common** (0.148 x 3 inches) for single hangers
    - Other nails reduce load values, or not allowed
    - Common nails have rounded flat head
    - Sinker nails have smaller tapered head with waffle pattern

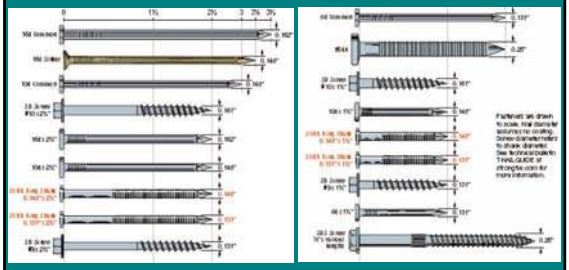
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Deck Framing
Hangers & Connectors (Simpson)

- Fasteners
  - Framing gun nails
    - Most are 0.131 or smaller (8d thickness)
    - No clip head nails
    - Usually not ok for hangers
    - Probably ok for uplift connectors

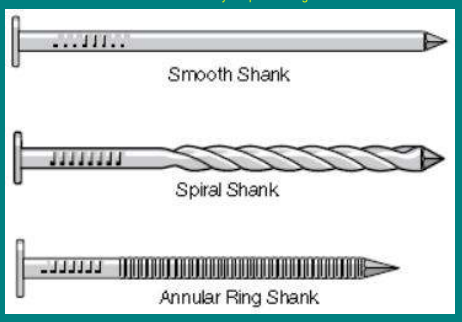
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Deck Framing
Hangers & Connectors (Simpson)
Illustrations courtesy Simpson Strong-Tie



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Deck Framing
Hangers & Connectors (Simpson)
Illustration courtesy Simpson Strong-Tie



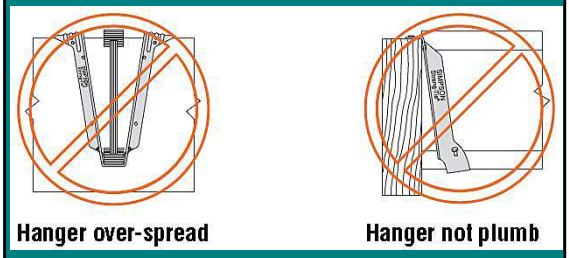
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Deck Framing
Hangers & Connectors (Simpson)

- Installation
  - – No field alterations
    - No additional holes
    - No bending beyond design parameters, only one bend
    - Most not designed to be bent
  - – No damage including over driven fasteners
  - – Hanger depth ≥ 60 % of joist depth
  - – Gap between joist in hanger and support (ledger or beam) ≤ ⅛ inch

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Deck Framing
Hangers & Connectors (Simpson)



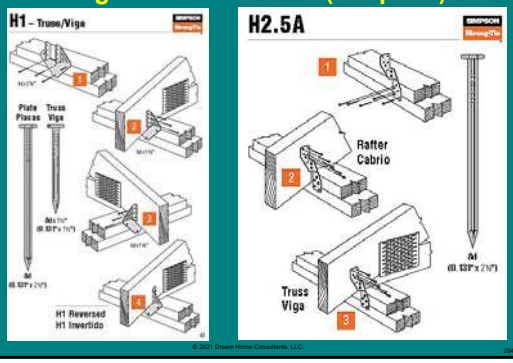
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Deck Framing
Hangers & Connectors (Simpson)



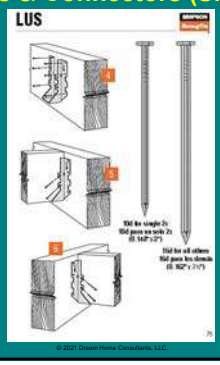
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Deck Framing
Hangers & Connectors (Simpson)



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Deck Framing
Hangers & Connectors (Simpson)



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Hanger & Connector Defect

Right photo courtesy Mike Casey





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Hanger & Connector Defect





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Hanger & Connector Defect





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Hanger & Connector Defect

Photo courtesy Welmoed Sisson



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Hanger & Connector Defect





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Hanger & Connector Defect



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Deck Framing
Reporting Joist Attachment

- Joist hangers are required by DCA 6 and the 2018 IRC if joists run into the side of a beam or ledger
  - Report, explain risk, recommend action
  - Ledger strips were allowed (an still are locally), recommend monitoring at least

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Deck Framing
Reporting Joist Attachment

- Deck joists not attached to the top of a deck beam as indicated in the previous illustration do not comply with DCA 6 and the IRC
  - Report, explain risk, recommend action

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Deck Framing
Reporting Joist Attachment

- Report hangers and connectors that are damaged, corroded, or improperly installed
  - Explain risk
  - Recommend action
- Report cantilevered joists supported by 2 x 2 ledger strip on deck ledger
  - Explain risk
  - Recommend installation of joist hangers or engineer evaluation

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Corrosion
Joist Hangers, Connectors, Fasteners

- Almost all deck hardware is steel
- All steel exposed to moisture eventually corrodes
  - Galvanized and stainless steel just corrodes more slowly
- A little corrosion can significantly weaken the hardware
- Visible corrosion can mean worse corrosion where not visible

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Corrosion
Joist Hangers, Connectors, Fasteners

- Galvanization coats steel with zinc
  - More zinc is better (≥ G185)
  - Zinc wears away to protect the steel
  - Once zinc wears away, steel rusts

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Corrosion
Joist Hangers, Connectors, Fasteners

- "White rust"
  - Zinc is wearing away
  - Report and recommend monitor for replacement
- Significant red rust
  - Hardware is compromised
  - Report and recommend evaluation

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Corrosion Defect
Photo courtesy Frank Woeste



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Corrosion Defect
Photo courtesy John Cranor



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Corrosion Defect





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Corrosion Defect





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Corrosion Defect



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Deck Framing
Joist and Cantilever Span

- DCA 6 Table 2 and IRC 2015 Table R507.5 provide joist maximum clear span and cantilever distance
  - Tables based on joist size, lumber species
  - Wet service conditions assumed
    - Do not use interior span tables

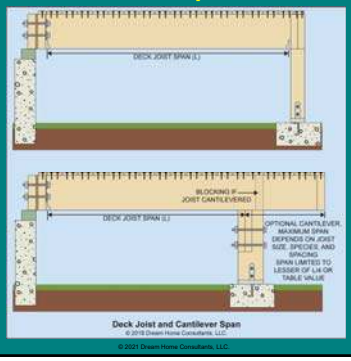
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Deck Framing
Joist and Cantilever Span

- DCA 6 and IRC tables are different
  - DCA 6 limits cantilever distance
  - IRC reduces joist span, allows L/4 cantilever
  - May need to consult both
- DCA 6-15 calls for blocking of cantilevered joists above beam

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Deck Framing
Joist Span



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Joist Cantilever



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Joist Cantilever



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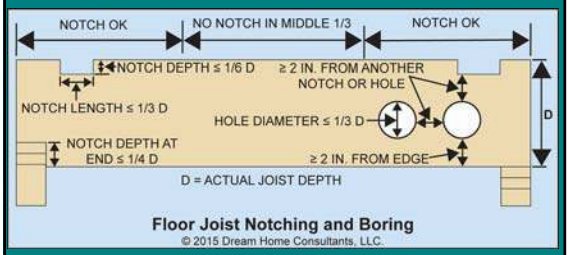
Joist Cantilever

Photo courtesy John Guy



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Deck Framing
Joist Notches and Holes



Floor Joist Notching and Boring

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Joist Notch and Hole Defect





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Deck Framing
Reporting Improperly Installed or Improperly Modified Deck Joists

- Report joists that are over-spanned, excessively cantilevered, or improperly notched or bored, explain risk, recommend replacement or action

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Deck Framing
Beam Span and Construction

- DCA 6-15, Table 3A, and IRC 2018, Table R507.5, provide beam maximum clear span distances
  - Tables based on beam size, lumber species, and deck joist span
  - Joists assumed from one side only
  - Beam may cantilever past post

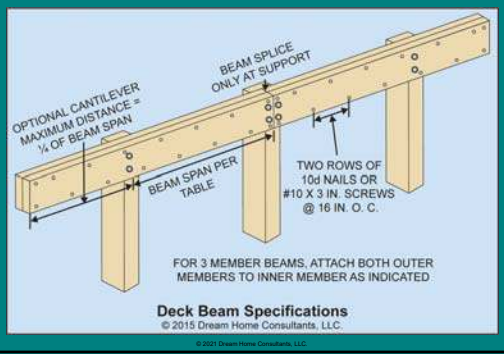
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Deck Framing
Beam Span and Construction

- DCA 6 and IRC tables are different
  - Pick one, but use either DCA 6 or IRC for all beam and joist spans

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Deck Framing
Beam Span and Construction



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Beam Span Defect



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Beam Construction and Support Defect



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Beam Construction and Support Defect



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Beam Construction Defect



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Deck Framing
Beam Attachment and Support

- DCA 6-15, Figures 8A and 8B, and IRC 2015, Figure R507.5.1(1) and (2), illustrate approved beam bearing on post and beam attachment to post
  - Split-post beams, side-saddle beams, and other methods not involving beam bearing on a post do not comply with DCA 6 and the IRC

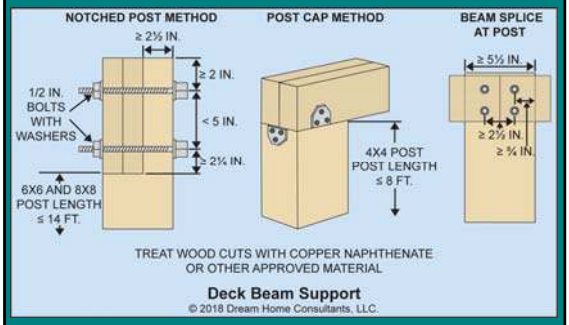
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Deck Framing
Beam Attachment and Support

- Post should support one beam or member
  - Support rim joist (including double) on post-supported beam using joist hanger

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Deck Framing
Beam Attachment and Support



Deck Beam Support

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Beam Support Defect



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Beam Support Defect

Photos courtesy Frank Fletcher-Broucek





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Thank You!

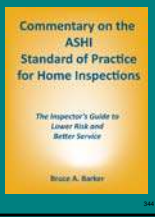
Comments and Questions

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