The myth of the Ladder Effect
and other railing safety issues

Presented by:
The Wagner Companies
R & B Wagner, Inc.

Learning Objectives

- Code Bodies and Standards
  - International Code Council
  - NFPA
  - ADA, ABA & ANSI A117.1
  - OSHA
- Handrail/Guardrail
  - Definition
  - The Ladder Effect
  - Load Requirements

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Code Bodies and Standards

- International Code Council (ICC)
  - International Residential Code (IRC)
  - International Building Code (IBC)
- National Fire Protection Association (NFPA)
  - NFPA 101
  - NFPA 5000
- Accessibility
  - ANSI-A117.1 Accessible and Usable Buildings and Facilities
  - Americans with Disabilities Act (ADA)
  - Architectural Barriers Act (ABA)
- Occupational Safety and Health Administration (OSHA)

International Code Council

- Created one uniform building code by combining:
  - Building Officials Code Administrators International (BOCA) – National Building Code (NBC)
  - Southern Building Code Congress International (SBCCI) – Southern Building Code (SBC)
  - International Conference of Building Officials (ICBO) – Uniform Building Code (UBC)

The “I” Codes

- The International Building Code (IBC) and International Residential Code (IRC)
- First published in 2000 and most recent is 2015
  - 3 year cycle
- The IBC and IRC publish “model” codes that are then adopted or modified by code bodies and local jurisdictions
- Anyone can submit a code change
2018 Changes to IRC

2018 Code Cycle

IRC: R308.4.4.1

Proposed: Christopher Jensen, Town of Canandaigua, NY, representing Town of Canandaigua (cjensen@townofcanandaigua.org)

Cost Impact: Will increase the cost of construction

Reason:

IRC: R312.1.3

2015 International Residential Code

Exceptions:

RB116-16

Proposed: Richard Davidson, representing Self

Cost Impact: Will increase the cost of construction

Reason:

IRC: R312.1.5 (New)

2015 International Residential Code

Proponent:

 Christopher Jensen, Town of Canandaigua, NY, representing Town of Canandaigua (cjensen@townofcanandaigua.org)

RB118-16

Proposed: Richard Davidson, representing Self

Cost Impact: Will not increase the cost of construction

Reason:

IRC: R308.4.4.1

2015 International Residential Code

Proponent:

 Lee Kranz, City of Bellevue, WA, representing Washington Association of Building Officials Technical Code Development Committee (lkranz@bellevuewa.gov)

RB120-16

Proposed: Christopher Jensen, representing Self

IRC: R312.1.5

2015 International Residential Code

Proponent:

 Richard Davidson, representing Self

RB121-16

Proposed: Christopher Jensen, Town of Canandaigua NY, representing Town of Canandaigua (cjensen@townofcanandaigua.org)

IRC: R312.1.5 (New)

Cost Impact: Will increase the cost of construction

Reason:

IRC: R312.1.5

2015 International Residential Code

Proponent:

 Richard Davidson, representing Self

Additional Notes:

The proposed code text is consistent with, but not identical to the IBC text (Section 2407.1.2). However, we believe this more clearly states the requirements, and have submitted a parallel amendment for the IBC.

Richard Davidson, representing Self

This proposal will increase construction costs for portions of guards that previously would have permitted larger openings. This will be stairs and landings.

Christopher Jensen, Town of Canandaigua, NY, representing Town of Canandaigua (cjensen@townofcanandaigua.org)

Guards with structural glass baluster panels shall be installed with an attached top rail or handrail. The top guardrail shall be located along open-sided walking surfaces, including stairs, ramps and landings. The proposed code text is consistent with, but not identical to the IBC text (Section 2407.1.2). However, we believe this more clearly states the requirements, and have submitted a parallel amendment for the IBC.

Richard Davidson, representing Self

This proposal may increase construction costs. The proposed top rail or handrail should be permitted to replace openings. This is to ensure adherence.

Christopher Jensen, Town of Canandaigua, NY, representing Town of Canandaigua (cjensen@townofcanandaigua.org)
National Fire Protection Association

- Known for NFPA 101 and NFPA 1
- Released NFPA 5000 Building Construction and Safety Code
- Fire inspectors, firefighters and government agencies
- NFPA 5000 did not gain general acceptance. However, some elements of NFPA 5000 have been pulled into NFPA101

Occupational Safety and Health Administration (OSHA)

- U.S. Dept. of Labor
- 1910.23 Guarding Floor and Wall Openings and Holes

Guard Railings

- 42 inches – plus or minus 3 inches above walking/working surface
- Required if the “drop” is 48 inches or higher
- Intermediate rail at “about halfway up”
- Openings must be less than 19 inches
- Intermediate balusters are no more than 19 inches apart
- Must have a toe board
- Top Rails and Mid Rails must be at least .25 inches in diameter or thickness.
- Load Requirement: withstand a 200 pound load applied in a downward or outward direction within 2 inches of the top edge of the top rail.

Handrail and Stair Rail Systems

- Handrails are between 30 and 38 inches as measured from the leading edge of the stair tread.
- Stair Rail System:
  - Before Jan. 17, 2017: Not less than 30 inches above the nosing.
  - After Jan. 17, 2017: Not less than 42 inches above the nosing.
- Top Rail may also serve as handrail if height of the system is between 36 and 38 inches.

- The minimum clearance between handrails and other objects is 2.25 inches.
- Handrails have the shape and dimension necessary to grasp firmly.
- Ends of handrail and systems do not present any projection hazards.
- Load Requirement: withstand a 200 pound load applied in a downward or outward direction within 2 inches of the top edge of the top rail.

ANSI A117.1 2009 and ICC

- Accessible and Usable Buildings and Facilities
- Now overseen by ICC
- Published on a five year cycle
- 1986 standard had incorrect handrail dimension – 1-1/4" to 1-1/2" OD with a 1-1/2" clearance between wall and rail.
Americans with Disabilities Act (ADA)

- Signed into law in July 1990
- Civil Rights Law – prohibits discrimination on the basis of disability
- Applies to facilities in the private sector -- places of public accommodation and commercial facilities -- and to state and local government facilities.
- Overseen by the Access Board
- Standards issued by the Department of Justice (DOJ)

2010 ADA Standards for Accessible Design (ADASAD)

- Went into effect on March 15, 2011
  □ Compliance was permitted as of September 15, 2010 but not required until March 15, 2012.
- States can be more stringent
  □ Florida and Texas updated

Americans with Disabilities Act Accessibility Guidelines (ADAAG)

- Created in 1991; revised in 1994; updated in 2004
- Originally based on 1986 ANSI A117 which had incorrect dimensions for handrail
  □ 1¼” to 1½” OD
  □ 1½” absolute between wall and handrail
- Clarification of acceptability of “pipe sizes” (1.66” and 1.90”) published in July 1998.
- New ADA approved July 23, 2010

Architectural Barriers Act (ABA)

- Applies to federally funded facilities.
  □ U.S. Postal Service (USPS) for postal facilities
  □ Department of Defense for military facilities
  □ The Department of Housing (HUD) is in the processing of updating its ABA standards
- The General Services Administration (GSA) updated its ABA standards, which apply to most facilities covered by the ABA.
Accessible Routes

- Accessible routes shall consist of one or more of the following components:
  - Walking surfaces with a running slope not steeper than 1:20
  - Doorways
  - Ramps
  - Curb ramps
  - Elevators
  - Platform lifts

Protruding Objects

- Objects with leading edges more than 27 inches and not more than 80 inches above the finish floor or ground shall protrude 4 inches maximum horizontally into the circulation path.
  - EXCEPTION: Handrails shall be permitted to protrude 4½ inches maximum.

Changes in Level

- Changes in level of ¼ inch high maximum shall be permitted to be vertical.

Ramps

- Ramp runs shall have a running slope not steeper than 1:12.
Ramps

- Clear Width
  - The clear width of a ramp run and, where handrails are provided, the clear width between handrails shall be 36 inches minimum.

- Rise
  - The rise for any ramp run shall be 30 inches maximum.

Curb or Barrier

- A curb or barrier shall be provided that prevents the passage of a 4 inch diameter sphere, where any portion of the sphere is within 4 inches of the finish floor or ground surface.

Handrail

- Placed between 34 inches and 38 inches
  - For children, the 2010 ADASAD recommends a maximum height of 28 inches with a minimum of 9 inches of clearance between the child’s rail and the adult rail (not required).

Handrail Continuity

- Continuous within the full length of each stair flight or ramp run.
- Inside handrails on switchback or dogleg stairs and ramps shall be continuous between flights or runs.
- Not be obstructed along their tops or sides.
- The bottoms of handrail gripping surfaces shall not be obstructed for more than 20 percent of their length.
Handrail Size Limitations

- 1 ¼ inch to 2 inch diameter
- Equivalent graspability
  - Handrail gripping surfaces with a non-circular cross section shall have a perimeter dimension of 4 inches (100 mm) minimum and 6½ inch maximum, and a cross section dimension of 2¼ inch (57mm) maximum.

Type II Definition

- Perimeter greater than 6¼ inch
  - Provide a graspable finger recess on both sides of the profile
  - Added in 2001 IRC and 2009 IBC for multi story residential

Bracket Clearance -- Horizontal

1991 ADAAG

IBC, IRC, ANSI and ADASAD

NFPA and OSHA

Maximum Projection: 4½″

Bracket Clearance -- Vertical

Decrease by 1/8″ for each ½″ of perimeter over 4″

<table>
<thead>
<tr>
<th>Railing Diameter</th>
<th>Clearance from Underside</th>
</tr>
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<tr>
<td>1.25″</td>
<td>1½″</td>
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<tr>
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<td>1¾″</td>
</tr>
<tr>
<td>1.66″</td>
<td>1¾⁄₄″</td>
</tr>
<tr>
<td>1.90″ or 2.00″</td>
<td>1″</td>
</tr>
</tbody>
</table>

Conflicts

- Handrail clearance requirements
  - NFPA 101: 2⅛″ minimum
  - ICC, ANSI and new ADASAD: 1½″ minimum
  - 1991 ADAAG: 1½″ absolute
- Job could have IBC code, NFPA 101 and a state accessibility code applied – which stands?
Rail extensions
- Ramps: handrails extend horizontally above the landing for 12 inches minimum beyond the top and bottom of the ramp runs.
- Stairs, Top Extension: handrails extend horizontally above the landing for 12 inches minimum beginning directly above first riser nosing.
- Stairs, Bottom Extension: handrails extend at the slope of the stair flight for a horizontal distance equal to one tread depth beyond the last riser nosing.

Extensions shall return to a wall, guard or the landing surface or continue to another stair run.

Guard
- Guards are in place to prevent "accidental falls"
- Height of 42" in (IBC) commercial applications and 36" in (IRC) residential applications
- Generally not required unless there is a 30 inch drop
- 4 inch sphere rule

The Ladder Effect
- 2000 IRC:
  "Required guards shall not be constructed with horizontal rails or other ornamental pattern that result in a ladder effect"
- Blocked from the IBC successfully
- First appeared in BOCA's National Building Code 1993
- Decision based on perception not reality
  - No hard evidence ever presented to indicate there was an epidemic of injuries to young children related to climbing.

Removed in 2001
- The "ladder effect" wording was removed from 2001 IRC Supplement
- States that use BOCA's NBC or adopted the 2000 IRC without the 2001 supplement still have the "ladder effect" wording
- Does not appear in the 2003, 2006 or 2009 ICC codes
- However, being applied on a local basis in various parts of the country.

Kidsafe.org
- Child accident prevention group Kidsafe has stated that balconies are a death trap for toddlers.
  - Most of these small balconies usually have a combination of table and chairs, which if left against the safety railing can act as a simple set of steps for toddlers. A toddler can easily climb onto a chair and then onto the top of the table, placing them in a very dangerous situation.
The toddler had climbed up a sofa set placed next to the wall in the balcony of the house on the sixth floor and fell over. There was a chair on the balcony, in fact two chairs. So, you could speculate that the child got up on the chair and was able to get over the railing, said Miami Police Lt. Bill Schwartz.

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4-year-old . . . fell 23 stories to his death . . . (He) lived with his mother, who was reportedly in the shower at the time of the incident . . . the child pushed a chair up to the railing of the balcony, climbed over and fell.
ICC Code Technology Committee

- CTC was given the task in 2004 to determine how to make guards less climbable if necessary.
- Because of conflicting data, in 2007 NOMMA commissioned the NAHB Research Center to review all existing peer reviewed reports and CPSC data.

Final Draft, Oct. 2007:
Includes:
- Critical review of peer-reviewed scientific literature
- Review of Injury data

Peer-Reviewed Studies

- Over 40 peer-reviewed studies were examined for the report covering the areas of children's physical development and their interaction with the built environment. The review of the studies resulted in this set of conclusions:

  - The human child is built to climb and loves to do so! (Readdick and Park, 1998).
  - Climbing is involved in the child's physical, psychological and social development.
  - Climbing skills are often taught and encouraged by parents, especially with boys.
  - Climbing is a part of physical education at school.
  - No evidence of a gender difference in either climbing skill or climbing speed in young children.
  - Difficult barrier designs merely present a greater challenge to the determined child.
  - Studies also generally agree that it is probably impossible and most likely undesirable to render any environment completely "safe" from children's climbing.

NEISS Data Review

- The NAHB Research Center's review went on to analyze Consumer Product Safety Commission (CPSC) data collected by the National Electronic Injury Surveillance System (NEISS). Previous analysis of this data had been unscientific and inconclusive. Following a thorough, scientific analysis, the review of NEISS data resulted in the following conclusions:

Conclusions:

- The results indicate that falls from Porches, Balconies, Open-Side Floors, Floor Openings Handrails, Railings, Banisters among young children aged 18 months to 4 years account for an estimated 0.032 percent of injuries in that population.
- The incident rate is approximately 2.5 per 100,000 children between 18 months and 4 years of age.
- There is much uncertainty in the data to ascribe causality or the physical situation that lead to reported injuries.
CTC Conclusion, Oct. 5, 2007

- The low incidence rate does not warrant the creation of code language.
- Unanimously voted to create a draft conclusion based on the NAHB Research Center report
- Peer Review Completed May 2008

Load Requirements

- For Handrail and Guard
  - 50 lb/ft Uniform Load
  - 200 lbs Concentrated Load
- Infill
  - 50 lb/sqft

Glass Railing Code Requirements

Prior to 2015 IBC

IBC 2407.1.2: Support. Each handrail or guard section shall be supported by a minimum of three glass balusters or shall be supported to remain in place should one baluster panel fail. Glass balusters shall not be installed without an attached handrail or guard.

We would say “no”

- Guard is improperly used in this requirement
  - “Guard” by definition is the full structure not the part that is supported by the glass.
- This “handrail” is not required
  - This is not a stair or ramp
- Handrail is in place due to the ambiguity of the code language.
- Interpretation should have been that a handrail should have an attached handrail and a guard should have an attached handrail or guard.
- Attempts to change this were not welcome as fabricators prefer the ambiguity.

We would say “no”

- IBC clarified this with an exception referring to “top rail” in place of incorrect use of “guard”.
  - 2009
    - Exception: A top rail shall not be required where the glass balusters are laminated glass with two or more glass plies of equal thickness and the same glass type. The panels shall be designed to withstand the loads specified in Section 1607.7.
  - Exception updated in 2015:
    - Exception: A top rail shall not be required when the glass balusters are laminated glass with two or more glass plies of equal thickness of the same glass type when approved by the building official.
- IBC position is that no top rail is required if the glass is laminated or the guard meets the structural load requirements.
Glass Railing Load Requirements

- Glass Railing specific Load Requirement:
  - IBC 2407.1.1 Loads. The panels and their support system shall be designed to withstand the loads specified in section 1607.8. A design factor of four shall be used for safety.
  - All Guard and Handrail Requirements:
    - IBC1607.8.1 Handrails and guards. Handrail assemblies and guards shall be designed to resist a linear load of 50 pounds per linear foot (plf) (0.73 kN/m) in accordance with Section 4.5.1 of ASCE 7.
    - IBC1607.8.1.1 Concentrated Load. Handrails and guards shall be designed to resist a concentrated load of 200 pounds (0.89kN), in accordance with Section 4.5.1 of ASCE 7.
  - ASCE7 notes the load needs to be placed at the “top” of the guard.

Glass Railing Code Requirement and Exception

- Section 2407.1.2
  - Support – Each handrail or guard section shall be supported by a minimum of three glass balusters or shall be otherwise supported to remain in place should one baluster fail. Glass balusters shall not be installed without an attached handrail or guard.
  - Exception – A top rail shall not be required where the glass balusters are laminated glass with two or more glass plies of equal thickness and the same glass type when approved by the building official. The panels shall be designed to withstand the loads specified in Section 1607.8.
  - Do architects and structural engineers want the building official to have the ultimate decision making power?
  - What if we include a post-glass-breakage requirement in the code?

What is Nelophobia?

- Nelophobia is the fear of glass (breakage).

- Nelophobia is also called Hyalophobia and Hyelophobia and related to Crystallophobia (fear of crystal or glass).

Glass Failures in Guards – North America

- Monolithic Tempered Glass was breaking across North America
  - Toronto
  - Austin
  - Houston
  - Seattle
  - New York City
  - Chicago
  - Dallas
  - Cleveland

- Causes:
  - Nickel-Sulfide Inclusions
  - Oil fired vs. gas fired ovens
  - unprotected edges
Laminated Glass

- 2015 IBC now requires laminated glass in all glass railing applications
  - In-Fill Panels
  - Glass Balustrades

Why the Change To Laminated Glass?

- The downside to monolithic tempered glass is glass fall-out after breakage
  - Falling glass can cause injuries to people below

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2018

- R308.4.4.1 Structural glass baluster panels. Guards with structural glass baluster panels shall be installed with an attached top rail or handrail. The top rail or handrail shall be supported by a minimum of three glass baluster panels, or shall be otherwise supported to remain in place should one glass baluster panel fail.
  - Exception: An attached top rail or handrail is not required where the glass baluster panels are laminated glass with two or more glass plies of equal thickness and of the same glass type.

Resources

- wwwintlcode.org
- www.usdoj.gov/crt/ada/adahom1.html
- wwwnomma.org
- Twitter: @wagnercompanies

Thank you for your time

Questions?