

The myth of the *Ladder Effect* and other railing safety issues

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Learning Objectives

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



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: Luc Kiani, City of Bellevue, WA, representing Washington Association of Building Officials Technical Code Development Committee (kiani@bellevuewa.gov)

- **Add new text as follows:**
- **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.
 - **Reason:** This proposal will clarify and align the IRC and IBC requirements for glass panels that are used as a structural component in a guard. Imperfections in glass can cause it to fail at loads that are well below its nominal resistance value. We believe the intent of the IRC requirements is to have something in top rail or a handrail at stairs to provide some additional fall protection for a person leaning on the guard, should a glass panel fail. Having a handrail attached to at least 3 panels also provides some backup support if a panel fails while someone is grabbing the handrail to prevent a fall. However, there is an expectation that glass-only guards (without an attached top rail or handrail) if the balusters are laminated glass. The laminated glass provides some backup against total panel failure, but note that the entire glass baluster still has to be designed to be able to support the full loads for guards, as specified in Table R301.5, including using a factor of safety of 4.0 and in footnote 17.
 - We believe the IRC should also have these critical safety requirements, which it currently does not.
 - The proposed code text is consistent with, but not identical to, the IBC and Section 2407.1.2, show over, we believe this more clearly states the requirements, and have submitted a parallel amendment for the IBC.
 - **Cost Impact:** Will not increase the cost of construction.
 - This change creates consistency with the IBC for glass guards only and allows for more safety and flexibility in design. There should be no increase in the cost.

RB116-16

- **Proposed:** Richard Davidson, representing Self
- **2015 International Residential Code**

- **Revise as follows:**
 - **R312.1.1 Where required,** Guards shall be located along open-sided walking surfaces, including stairs, ramps and landings, that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) ~~6 feet~~ horizontally to the edge of the open side. Insect screening shall not be considered as a guard.
 - **Reason:** Momentum plays a role in a person falling from an elevated walk way. That momentum can vary depending on whether the person missteps on the edge of a walking surface, is pushed, or is walking. The greater the momentum of the person when they start their fall the further from the walking surface they will land. Additionally, center of gravity of the person comes into play. If a person is cut off easily, 36 inches from the edge of a walking surface 30 inches high, the momentum of a fall and the center of gravity of the person would likely carry them over the edge of the fall. 36 inches is not sufficient to allow someone to maintain their balance as they fall from an elevated surface and they are at likely to tumble further and over the cliff. Therefore, 36 inches is insufficient to maintain a momentum level of safety. Testimony given in the code as it was changed to require the height measurement of the walking surface be measured at other than the base of the walking surface contained comments about walking surfaces that had elevation changes in the hundreds of feet just inches from the walking surface. As an experiment, stand distributed on the edge of your dining room table. Have someone push you from the table such that you are not able to anticipate the fall. Can you contain yourself to an area within 36 inches of the base of the walking surface? Likely not. And if the elevation change beyond 36 inches is significant, the potential for serious injury or death exists. Therefore, given the current measurement that requires the guard requirement does not provide a minimum degree of safety, this proposal extends that distance to a more reliable measurement of safety, that being 6 feet.
 - **Cost Impact:** Will increase the cost of construction.
 - This proposal will increase costs because it will require guards for some locations that were previously exempt.

RB118-16

- **Proposed:** Thayne Richardson, NHBQA, representing New Hampshire Building Officials Association (thaynerd@nhbqa.org)
- **IRC: R312.1.1.**
- **2015 International Residential Code**

- **Revise as follows:**
 - **R312.1.1 Where required,** Guards shall be located along open-sided walking surfaces, including stairs, ramps and landings, that are located more than 30 inches (762 mm) measured vertically to the floor or grade below at any point within 36 inches (914 mm) horizontally to the edge of the open side. Insect screening shall not be considered as a guard. **Guard system support posts shall comply with Section R407.3.**
 - **Reason:** Currently IRC does not contain prescriptive specifications for guardrail post support for guard systems other than the requirement of being with able to withstand a 200 pound load applied in any direction along the top. For an inspector and the code user this language does not provide clear direction as when a report evaluation may be found by someone if a particular proposed design will meet the requirement. It is frequently based upon common practice or sometimes a structural evaluation may be provided. The first method is not fact based and carries a significant liability for code enforcement and the builder. The second method, while prescriptive, is not fully available for either cost. Based upon code options there are required from IRC one must use section R407.3 Structural requirements for columns as being the action that is most applicable presuming one views the posts as a column. This proposal is being submitted to provide clear direction to the end user for correct project coding and clearly providing a prescriptive method for code compliance.
 - **Cost Impact:** Will not increase the cost of construction.
 - This change is only to make the code more user friendly and provides clear concise direction to the requirements. It should not increase the costs since these requirements are being enforced currently.
 - **R407.3. "Wood columns shall not be less in nominal size than 4 inches by 4 inches (102 mm by 102 mm). Steel columns shall not be less than 3-inch-diameter (76 mm) Schedule 40 pipe. . ."**

RB120-16

- **Proposed:** Richard Davidson, representing Self
- **IRC: R312.1.3.**

- **Revise as follows:**
 - **R312.1.3 Opening limitations.** Required guards, including the triangular openings at the open sides of stairs formed by the riser, tread, and bottom rail of a guard and guards on the open sides of stairs, shall not have openings from the walking surface to the required guard height that allow passage of a sphere 4 inches (102 mm) in diameter.
 - **Exception:**
 - 1. The triangular openings at the open side of stairs formed by the riser, tread and bottom rail of a guard, shall not allow passage of a sphere 4 inches (102 mm) in diameter.
 - 2. Guards on the open side of stairs shall not have openings that allow passage of a sphere 4.3 inches (111 mm) in diameter.
 - **Reason:** I have had my last discussion with a homeowner or contractor why there are three different safety limits to prevent children from falling from a stair, landing, floor, or other walking surface. All three of the current opening limitations can occur in 100 inches of each other. Try to explain to a homeowner why that inconsistency exists. Some have said that children don't play on stairs and that justifies the difference. Two problems with that idea. First, if ever you were a child, had children or grandchildren, or watched someone else's children, you know that children love to investigate and play on stairs from the time they are able to crawl. Second, I've seen how children playing in stairs why have any opening requirement at all or at least expect it to 12 inch? Let's have some sensible consistency in the code. This proposal standardizes the opening requirements so they are all the same. Having three different standards that are all expected to connect the same set of circumstances is absolutely idiotic.
 - **Cost Impact:** Will increase the cost of construction.
 - This proposal may increase construction costs for portions of guards that previously would have permitted larger openings. This will be stairs and landings.

RB121-16

- **Proposed:** Christopher Jensen, Town of Canandaigua, NY, representing Town of Canandaigua (jensen@townofcanandaigua.gov)
- **IRC: R312.1.5 (New).**

- **Add new text as follows:**
 - **R312.1.5 Cable guards.** Cable guard rail systems shall have not less than one-eighth inch diameter cables spaced at not more than three inches on center. Required guard openings shall be in accordance with Section R312.1.3 under inspection loading. Inspection loading shall consist of supporting a 50 pound weight from a cable at the central point between support structures. Supporting structures shall not deflect during inspection or inspection load testing. The cables shall have a tensioning system that allows for tension to be applied to cables.
 - **Reason:** Cable rail system use has increased due to home owner's desire to minimize the visual impact of a rail system from their decks and porches. Existing Section R312.1.3, Opening Limitations, does not detail load being placed on the sphere during inspection. A 4" sphere can easily pass through an under tensioned cable rail system. The intent of the 4" sphere test was to approximate the size of a child's head and to prevent entrapment and suffocation. Adding this section provides for a standard means to perform an inspection of these systems.
 - **Cost Impact:** Will increase the cost of construction.
 - Currently, cable rail systems are permitted to have cable spacing and cable size which do not allow the passage of a 4" sphere (under no loading or pressure) per Section R312.1.3, Opening Limitations. Under loading these existing cable systems can deflect to allow for passage of a 4" sphere. With approval of the new code section, the rail systems may require additional cables, tensioning cables, and additional support structures.

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)

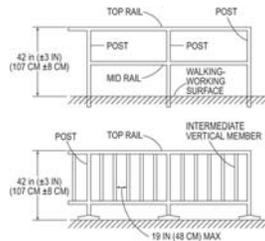
- U.S. Dept. of Labor
- 1910.23 *Guarding Floor and Wall Openings and Holes*



Guard Railings



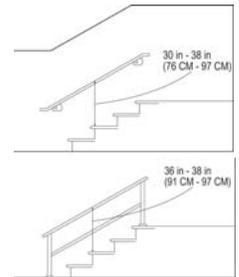
- 42 inches – plus or minus 3 inches above walking/working surface
- Required if the "drop" is 48 inches or higher
- Intermediate rail at "about halfway up"
 - Openings must be less than 19 inches
- Intermediate balusters are no more than 19 inches apart
- Must have a toe board
- Top Rails and Mid Rails 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



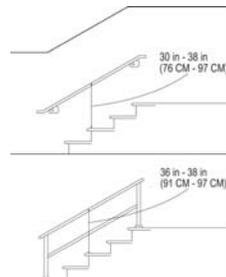
- Handrails are between 30 and 38 inches as measured from the leading edge of the stair tread.
- Stair Rail System:
 - Before Jan. 17, 2017: Not less than 30 inches above the nosing.
 - After Jan. 17, 2017: Not less than 42 inches above the nosing.
 - Top Rail may also serve as handrail if height of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



Handrail and Stair Rail Systems

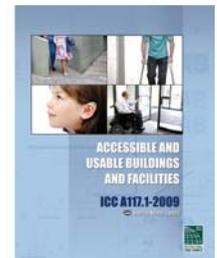


- The minimum clearance between handrails and other objects is 2.25 inches.
- Handrails have the shape and dimension necessary to grasp firmly.
- Ends of handrail and systems do not present any projection hazards.
- Load Requirement: withstand a 200 pound load applied in a downward or outward direction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



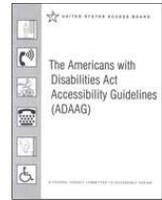
Americans with Disabilities Act (ADA)

- 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)



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



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 (ADA)

	Places of Public Accommodation and Commercial Facilities (private sector)	DOJ's ADA Standards
	State and Local Government Facilities (except transportation facilities)	DOJ's ADA Standards or Uniform Federal Accessibility Standards (UFAS) <i>DOJ's title II regulation (28 CFR Part 35) allows use of the original ADA standards (with some exceptions) or the UFAS</i>
	Transportation Facilities	DOT's ADA Standards for Transportation Facilities (updated)

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.



Architectural Barriers Act (ABA)

	Postal Facilities	USPS's ABA Accessibility Standard (updated) <i>Effective October 1, 2005</i>
	Military Facilities	DOD's ABA Accessibility Standard (updated) <i>Effective October 31, 2008</i>
	Housing	Uniform Federal Accessibility Standards (UFAS)
	Other Federal Facilities	GSA's ABA Accessibility Standard (updated) <i>Effective May 8, 2006 (February 6, 2007 for leased facilities)</i>

Accessible Routes

- Accessible routes shall consist of one or more of the following components:

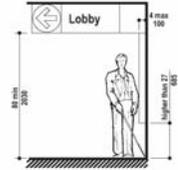
- Walking surfaces with a running slope not steeper than 1:20
- Doorways
- Ramps
- Curb ramps
- Elevators
- Platform lifts



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.



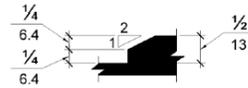
Changes in Level

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



Changes in Level

- Changes in level between ¼ inch high minimum and ½ inch high maximum shall be beveled with a slope not steeper than 1:2.



Changes in level greater than ½ inch high shall be ramped.

Ramps

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



Ramps

- In existing sites, buildings, and facilities, ramps shall be permitted to have running slopes steeper than 1:12 where such slopes are necessary due to space limitations.

- Steeper than 1:10 but not steeper than 1:8
 - 3 inches max rise
- Steeper than 1:12 but not steeper than 1:10
 - 6 inches max rise



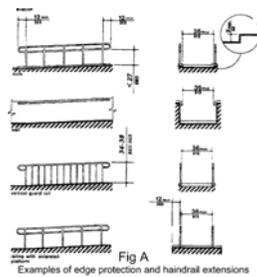
Ramps

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

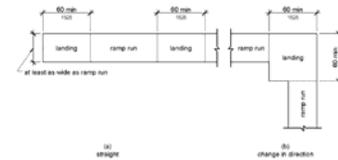
- The rise for any ramp run shall be 30 inches maximum.



Ramps

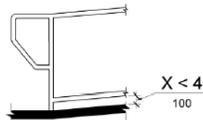
Landings

- Ramps shall have landings at the top and the bottom of each ramp run.



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.



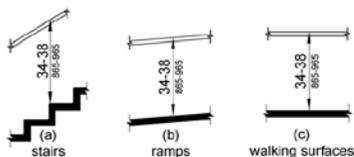
Handrail

- To provide guidance
- Required on stairs with 2 or more risers and ADA ramps with a rise of 6 inches
 - Handrails are not required on walking surfaces with running slopes less than 1:20
- Intermediate Rails:
 - All portions of an egress path must be within 30 inches of a handrail
- On both sides of stairs and ramps.



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.



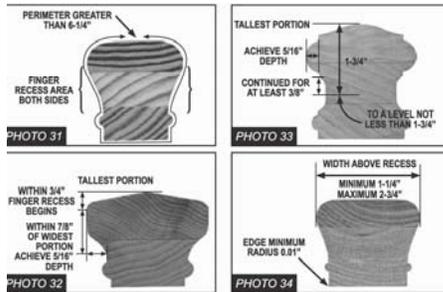
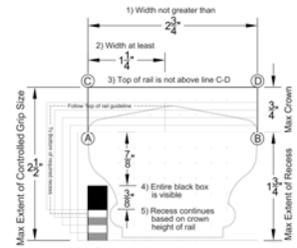
Handrail Size Limitations

- 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 6 ¼ inch maximum, and a cross section dimension of 2 ¼ inch (57mm) maximum.

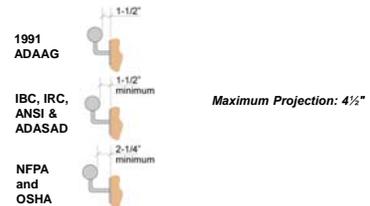


Type II Definition

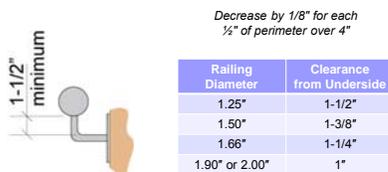
- Perimeter greater than 6 ¼ inch
 - Provide a graspable finger recess on both sides of the profile
 - Added in 2001 IRC and 2009 IBC for multi story residential



Bracket Clearance -- Horizontal



Bracket Clearance -- Vertical

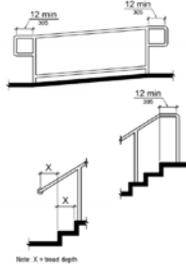


Conflicts

- Handrail clearance requirements
 - NFPA 101: 2 ¼" minimum
 - ICC, ANSI and new ADASAD: 1 ½" minimum
 - 1991 ADAAG: 1 ½" absolute
- Job could have IBC code, NFPA 101 and a state accessibility code applied – which stands?

Rail extensions

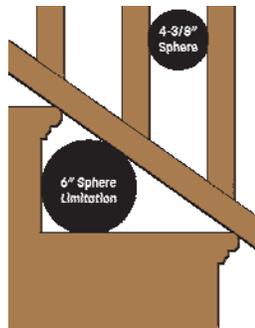
- Ramps: handrails extend horizontally above the landing for 12 inches minimum beyond the top and bottom of the ramp runs.
- Stairs, Top Extension: handrails extend horizontally above the landing for 12 inches minimum beginning directly above first riser nosing.
- Stairs, Bottom Extension: handrails 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.*





... toddler wandered out, climbed onto a chair and fell over the railing."



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.



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.

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.

Guardrail with Vertical Pickets

- Guardrail at 42"
- Pickets spaced with opening less than 4"
- Bottom rail to capture pickets



Guardrail with Handrail

Handrail added at between 34 and 38 inches



Guardrail with Secondary Handrail for Children

2010 ADASAD Advisory 505.4 Height. When children are the principle users in a building or facility (e.g., elementary schools), a second set of handrails at an appropriate height can assist them and aid in preventing accidents. A maximum height of 28 inches. . .



Pool Barriers

- In the Appendix – not in the model codes
- 48" height minimum
- 2" maximum between the ground and bottom of barrier
- Multiple other limitations depending on structure of barrier

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:

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 *top rail*
- Attempts to change this were not welcome as fabricators prefer the ambiguity.



Does this 1/2" monolithic glass guard meet this requirement?

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"

- 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 and 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.



Does this 1/2" monolithic glass guard meet this requirement?

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.

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?



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



Murano Condominiums, Toronto, Canada

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

- www.intlcode.org
- www.usdoj.gov/crt/ada/adahom1.html
- www.nomma.org
- Twitter: @wagnercompanies

Thank you for your time

Questions?

www.wagnercompanies.com