ADA, Building Codes, and Standards Relating to Handrails and Guards

WAG 101

Presented by The Wagner Companies

AIA Continuing Education Provider

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Course Description

This seminar session will discuss the differences between handrails and guardrails, and the building codes related to the design and installation of such rails.

You will also be made aware of some available resources to answer code-related questions.

Learning Objectives

At the end of this course, participants will be able to:

- Explain the difference between handrails and guardrails.
- Discuss the International Code Council ‘s I-Codes — they relate to handrails and guardrails.
- Recognize building codes related to the design and installation of guardrails and handrails.
- Explain the Americans With Disabilities Act (ADA) and Accessible and Usable Buildings and Facilities (ICC A117.1) as it relates to guardrails and handrails.

Agenda

- Code Bodies and Standards
  - International Code Council (ICC)
  - NFPA
  - ADA, ABA and ICC 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
  - ICC-A117.1 Accessible and Usable Buildings and Facilities
  - Americans with Disabilities Act (ADA)
  - Architectural Barriers Art (ABA)
- Occupational Safety and Health Administration (OSHA)

International Code Council

Prior to 1999 there were multiple Model code bodies across the country, they included:

- 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)

In 1999 these three code groups combined to create the International Code Council (ICC).

The I-Codes

The International Code Council publishes what are known as the “I” Codes

- The International Building Code (IBC) and the International Residential Code (IRC)
- The IRC code applies to 1 & 2 family dwellings, while the IBC code applies to commercial properties & multifamily residential dwellings.

- First “I” codes were published in 2000 and are updated on a three-year cycle with the most recent being in 2018.
- The IBC and IRC publish “model” codes which are then adopted or modified by code bodies and local jurisdictions.
- Always check with your local authority having jurisdiction (AHJ).
- The “I” Codes are considered a minimum standard for safety.
- Anyone can submit a code change.

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 NFPA 101.

Occupational Safety and Health Administration (OSHA)

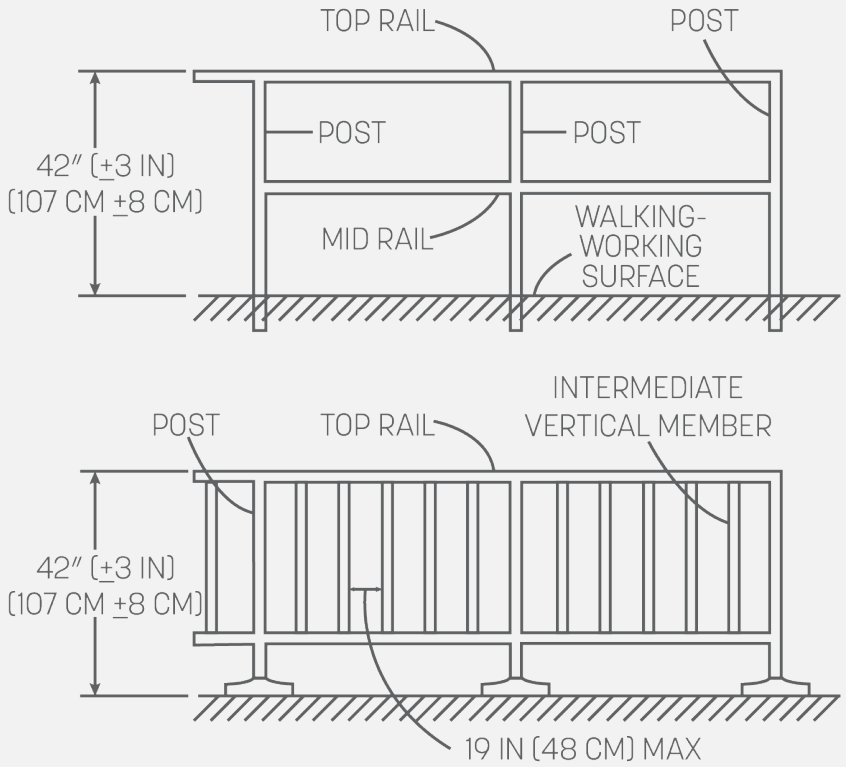
OSHA regulates areas not generally open to the public such as warehouses, manufacturing facilities, or waste water treatment plants.

OSHA is overseen by the U.S. Dept. of Labor

- Railing requirements are located in 1910.29 Fall Protection Systems and Falling Object Projection–Criteria and Practices
- Updated in January of 2017

Guardrailings

- 42”–plus or minus 3” above walking/working surface
- Required if the “drop” is 48” or higher
- Intermediate rail at “about halfway up”
  - Openings must be less than 19”
- Intermediate balusters are no more than 19” apart
- Must have a toe board – minimum 3-1/2” above walking surface
- Top rails and mid rails must be at least .25” in diameter or thickness.
- Load requirement: withstand a 200-lb load applied in a downward or outward direction within 2” of the top edge of the top rail.

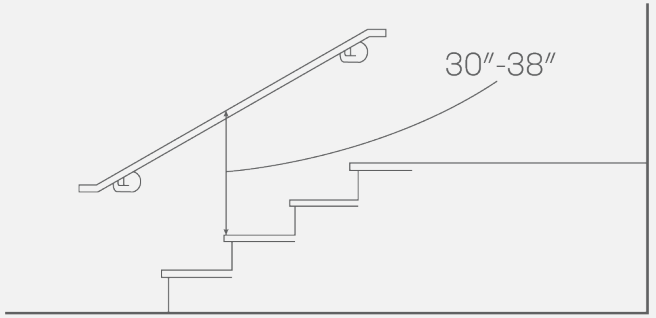


Stair Rail Systems

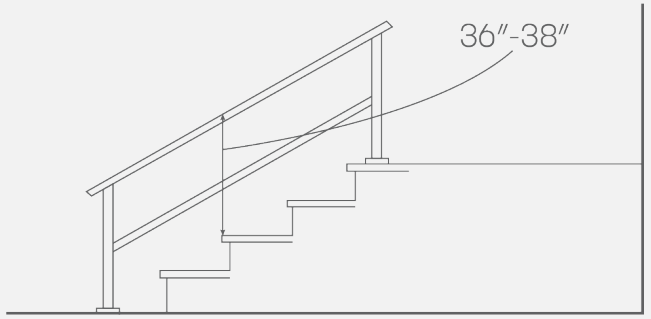
- If a stair has a minimum of four risers, a handrail is required.
- Handrails must be between 30” and 38” as measured from the leading edge of the stair tread.

Stair Rail System:

- Top Rail may also serve as handrail if height of the system is between 36” and 38”.
  - Before Jan. 17, 2017: Not less than 30” above the nosing.
  - After Jan. 17, 2017: Not less than 42” above the nosing.



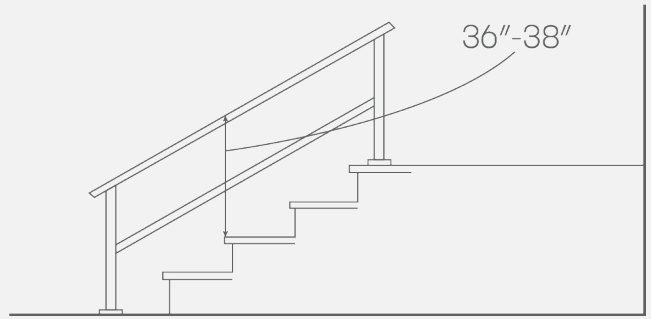
Before January 17, 2017



After January 17, 2017

Stair Rail Systems

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

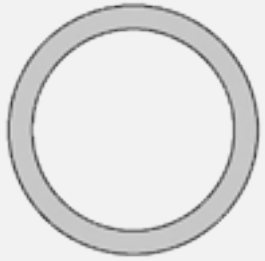


ANSI A117.1 2017

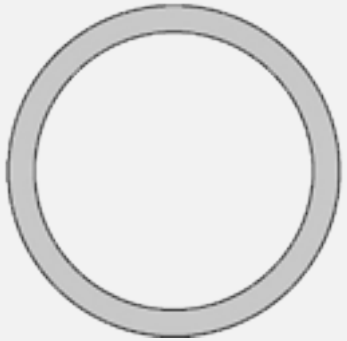
- *Accessible and Usable Buildings and Facilities*
- Now overseen be ICC
- ANSI A117.1 is still used for reference for projects not covered under the ADA
- 1986 standard had incorrect handrail dimension – 1.25” to 1.5” OD with a 1.5” clearance between wall and rail

Pipe vs Tube

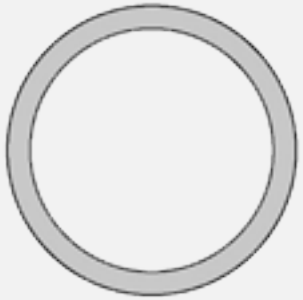
- The dimensions noted were for tube sizes while the railing industry generally used pipe for railing.
- Tube is designated by outside diameter such that a 1¼ inch round tube has an actual diameter of 1¼ inches.
- Pipe uses a nominal inside diameter. 1¼ inch pipe has an actual outside diameter of 1.66 inches. 1½ inch pipe has an actual outside diameter of 1.90 inches.



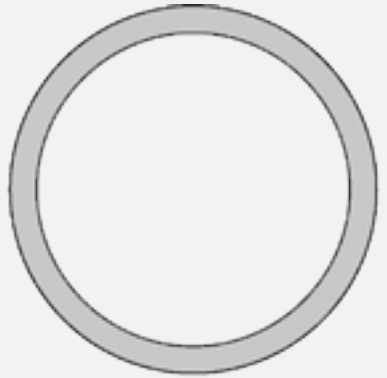
1-1/4” (32mm Tube)
1/8” Wall



1-1/4” pipe size (1.66” [43mm]) OD
Schedule 40 (.140” [3.6mm]) Wall



1-1/2” (39mm Tube)
1/8” Wall



1-1/2” pipe size (1.90” [48mm]) OD
Schedule 40 (.145” [3.7mm]) Wall

Accessible and Usable Buildings and Facilities

- The council of American Building officials was contacted.
- The error was admitted and acknowledged 1-1/4 inch to 1-1/2 inch pipe size was acceptable for handrails.
- Correction published in the 1990 update

Americans with Disabilities Act (ADA)

- Signed into law in July of 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
- You cannot be “grandfathered” under the ADA and it is not optional.
- The ADA does not apply to residential properties (Be aware though that some jurisdictions require the residential property to be “visit-able.”).
- A residential property is “visit-able” when it meets 3 basic requirements.
  - One zero-step entrance
  - Doors with 32 inches of clear passage
  - One bathroom on the main floor accessible with a wheelchair

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
  - 1-1/4” to 1-1/2” OD
  - 1-1/2” *absolute* between wall and handrail
- Clarification of acceptability of “pipe sizes” (1.66” and 1.90”) published in July of 1998
- New ADA approved July 23, 2010

2010 ADA Standards for Accessible Design (ADASAD)

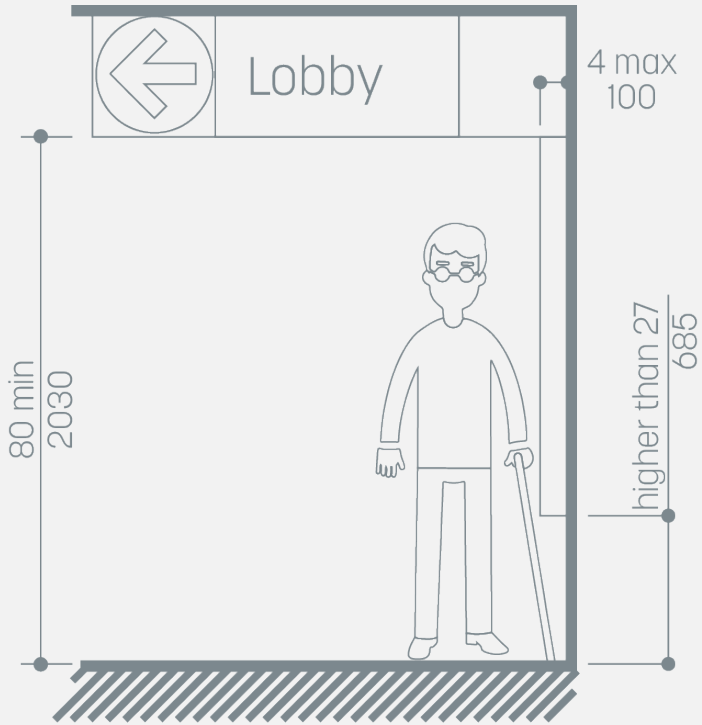
- Went into effect on March 15, 2011
  - Compliance was permitted as of September 15, 2010 but not required until March 15, 2012
- States can be more stringent
  - Florida and Texas updated

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 process of updating its ABA standards
- The General Services Administration (GSA) updated its ABA standards, which apply to the most facilities covered by the ABA.
- Like the ADA, the ABA uses the ADASAD. The difference was that while the ADA required congressional approval before implementation, the ABA was implemented soon after its completion in 2004.

Protruding Objects

- Objects with leading edges more than 27” and not more than 80” above the finish floor or ground shall protrude 4” maximum horizontally into the circulation path
  - Exception: handrails shall be permitted to protrude 4.5” maximum

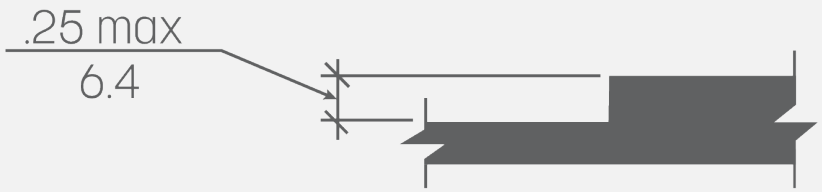


Accessible Routes

- Accessible routes shall consist of one or more of the following components:
  - Walking surfaces with a running slope no steeper than 1:20
  - Doorways
  - Ramps
  - Curb ramps
  - Elevators
  - Platform Lifts

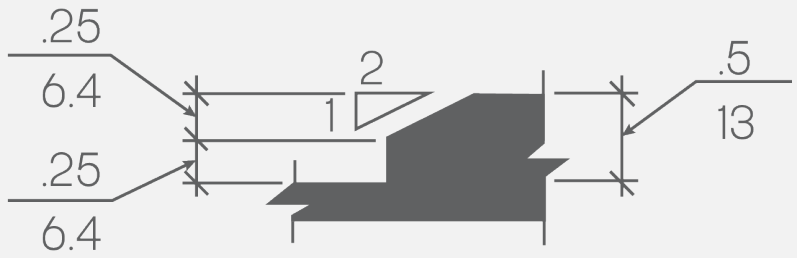
Changes in Level

- Changes in level of .25” 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.



Ramps

- Ramp runs shall have a running slope no steeper than 1:12
- Clear width
  - The clear width of a ramp run, and where handrails are provided, the clear width between handrails shall be 36” minimum
- Rise
  - The rise for any ramp run shall be 30” maximum

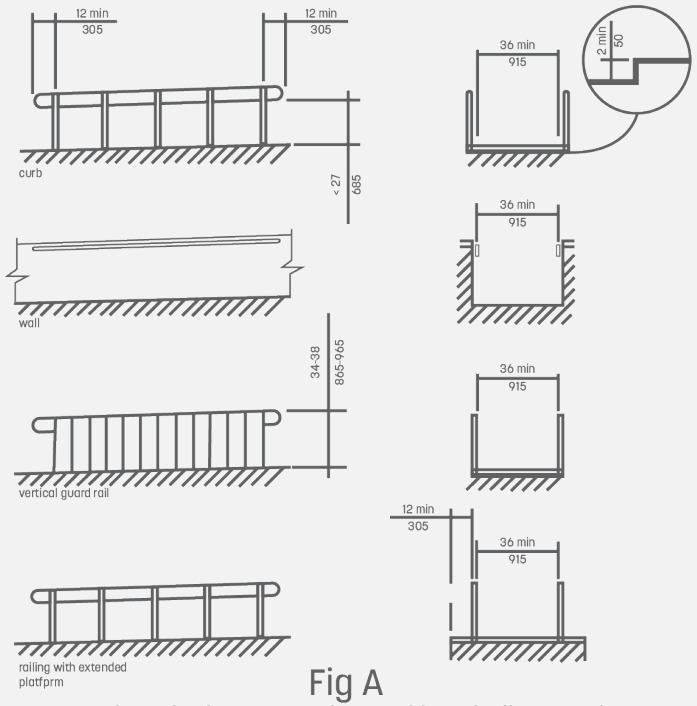
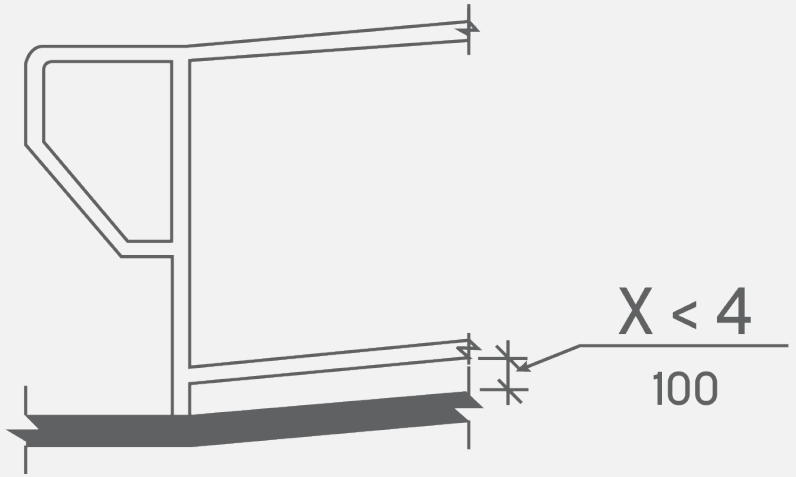


Fig A
Examples of edge protection and handrail extensions

Curb or Barrier

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

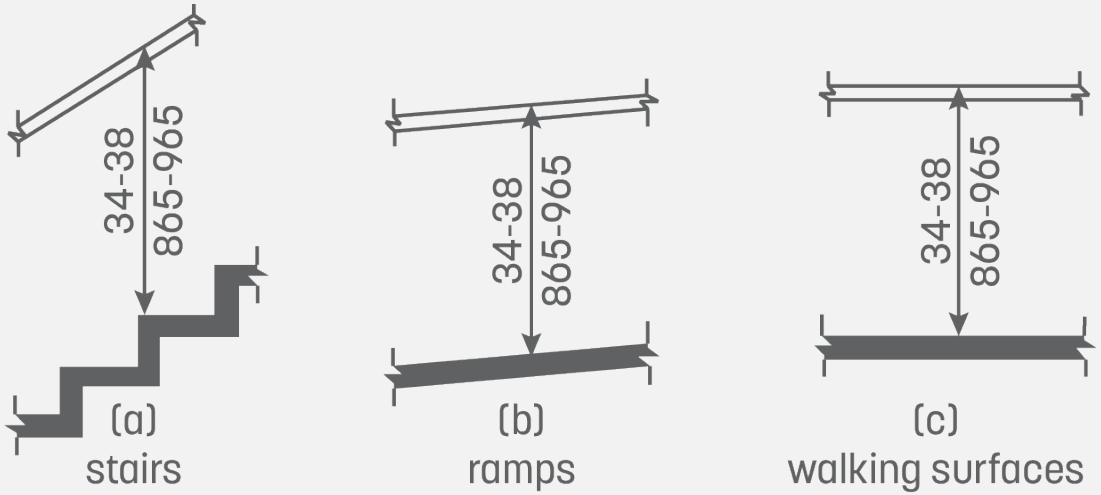


Handrail

- To provide guidance
- Required on stairs with 2 or more risers and ADA ramps with a rise of 6”
  - Handrails are NOT required on walking surfaces with running slopes less than 1:20
- On both sides of stairs and ramps
- If you choose to place a handrail in another area, such as a corridor, it must meet the handrail requirements.
- Intermediate rails:
  - All portions of an egress path must be within 30” of a handrail

Handrail

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

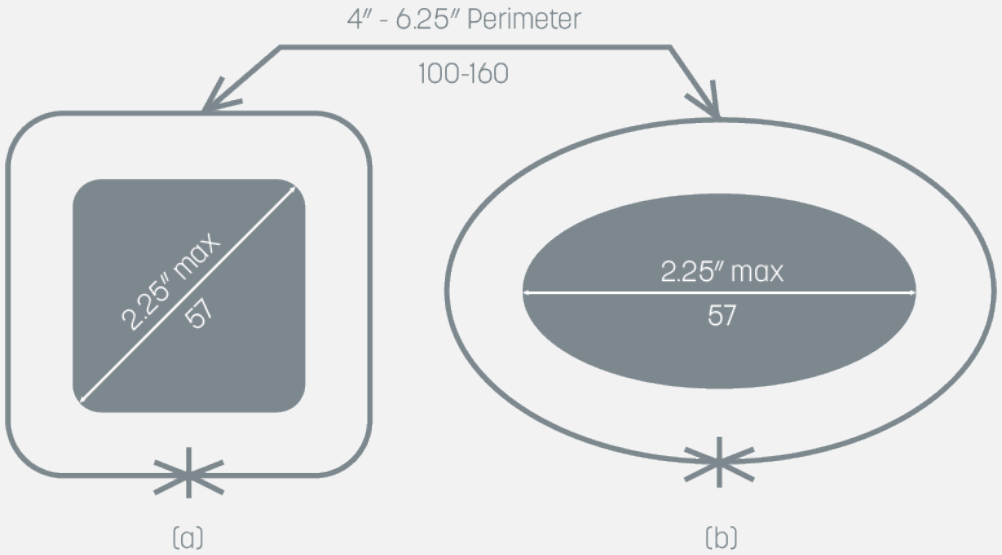


Handrail Continuity

- 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
- Should not be obstructed along their tops or sides

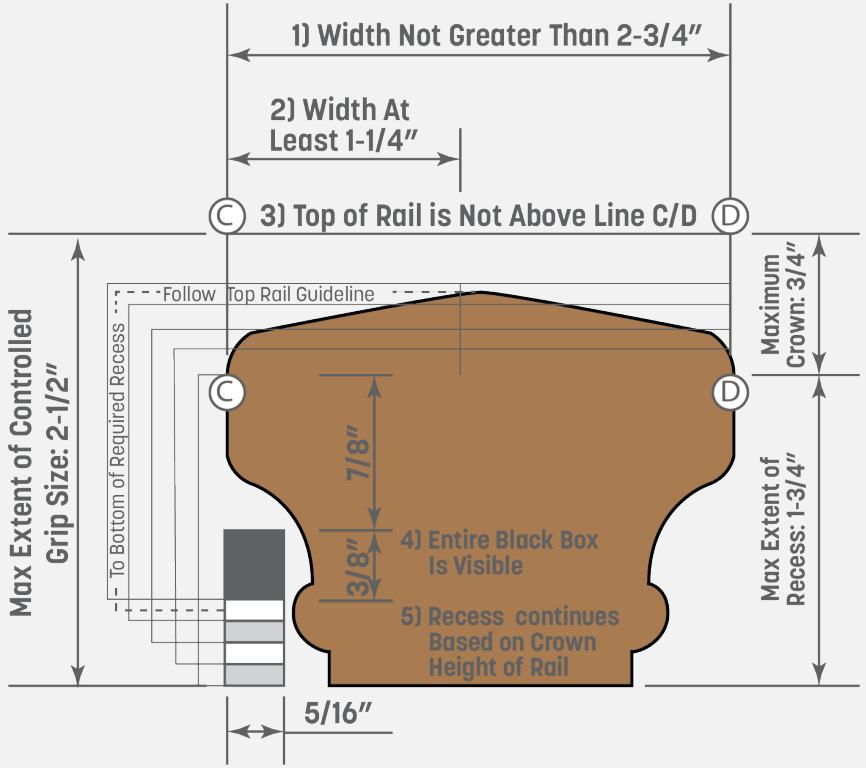
Handrail Size Limitations

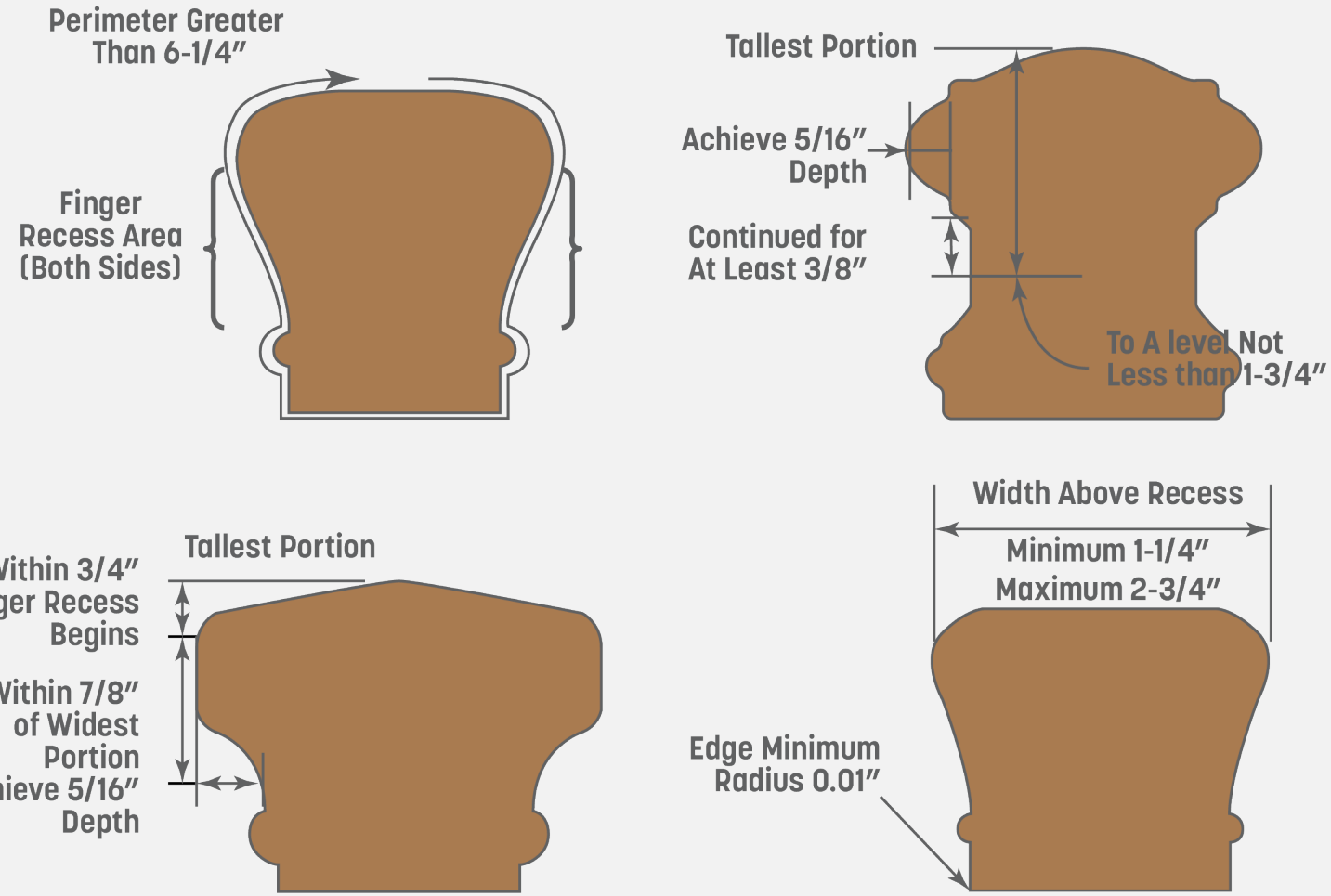
- 1.25” to 2” diameter
- Equivalent “graspability”
  - Handrail gripping surfaces with a non-circular cross section shall have a perimeter dimension of 4” (100mm) minimum and 6.25” maximum, and a cross section dimension of 2.25” (57mm) maximum



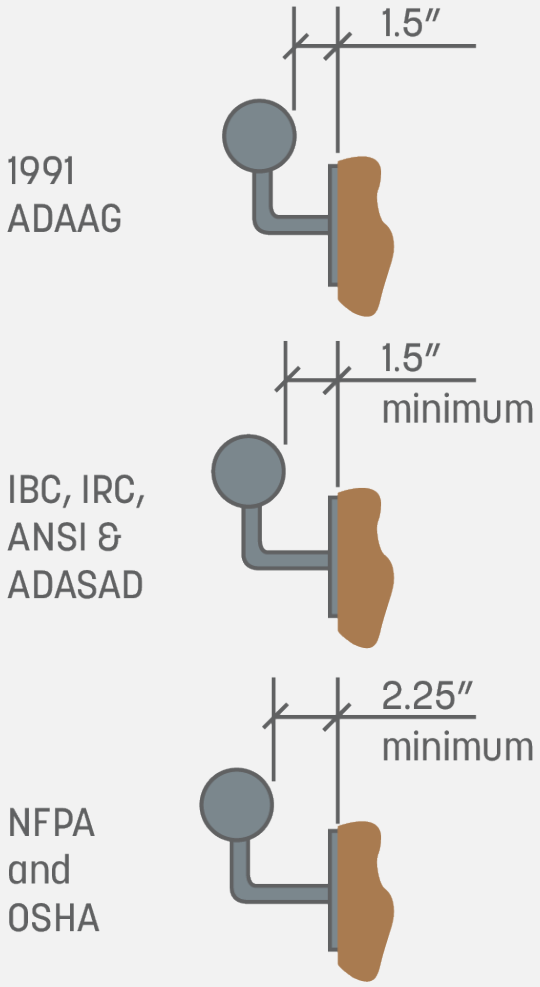
Type II Definition

- Handrails used in residential construction tended to be larger than this. The Stair Manufacturer's Association funded a study which determined that a pinch grip could provide graspable handrail.
- Perimeter greater than 6.25"
  - Provide a graspable finger recess on both sides of the profile
  - Added in 2001 IRC and 2009 IBC for multistory residential



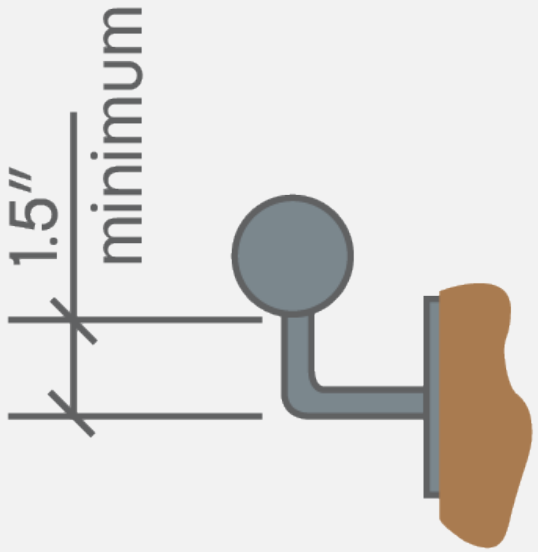

Perimeter Greater Than 6-1/4″
Finger Recess Area (Both Sides)
Tallest Portion
Achieve 5/16″ Depth
Continued for At Least 3/8″
To A level Not Less than 1-3/4″
Tallest Portion
Within 3/4″ Finger Recess Begins
Within 7/8″ of Widest Portion Achieve 5/16″ Depth
Width Above Recess
Minimum 1-1/4″
Maximum 2-3/4″
Edge Minimum Radius 0.01″

Bracket Clearance - Horizontal



Maximum Projection: 4.5″

Bracket Clearance - Vertical

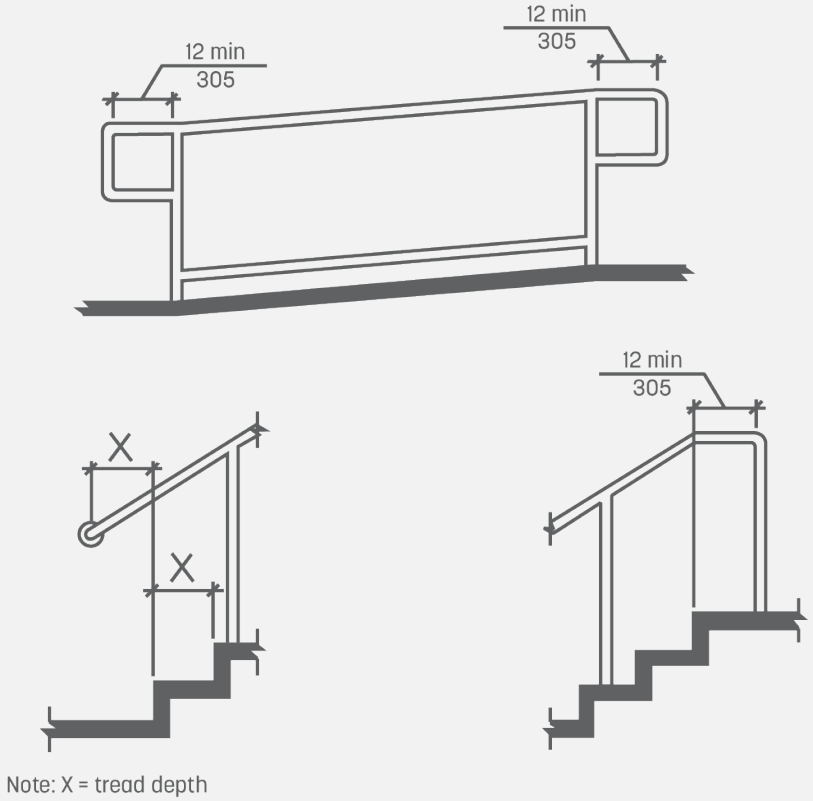


Decrease by .125” for each .5” of perimeter over 4”

Railing Diameter	Clearance from Underside
1.25”	1.55”
1.50”	1.375”
1.66”	1.25”
1.90” or 2”	1”

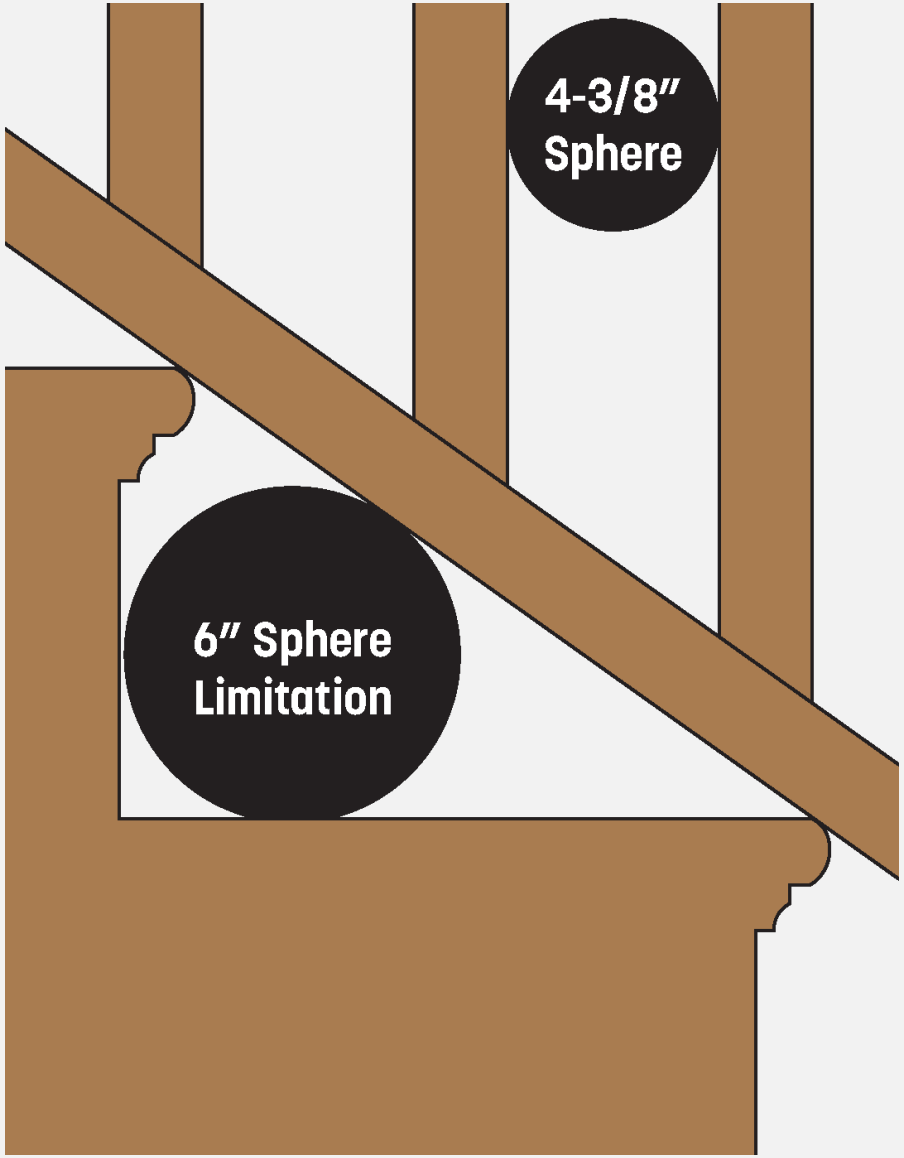
Rail Extensions

- Ramps: handrails extend horizontally above the landing for 12” minimum beyond the top and bottom of the ramp runs
- Stairs, Top Extension: handrails extend horizontally above the landing for 12” 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” drop
- 4” sphere rule



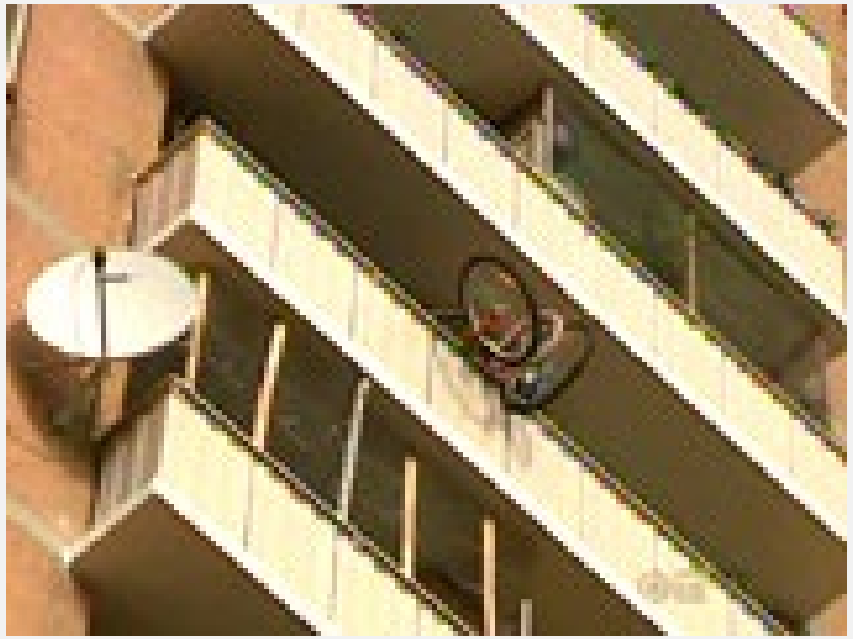
The 4-3/8” opening allowance on the stairs is for residential construction only.

The Ladder Effect

- First appeared in BOCA's National Building Code 1993. There was no similar restriction in either SBCCI or ICBO.
- 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 the 2001 IRC Supplement.
- It has not appeared in any updates since then, but it’s being applied on a local basis in various parts of the country.

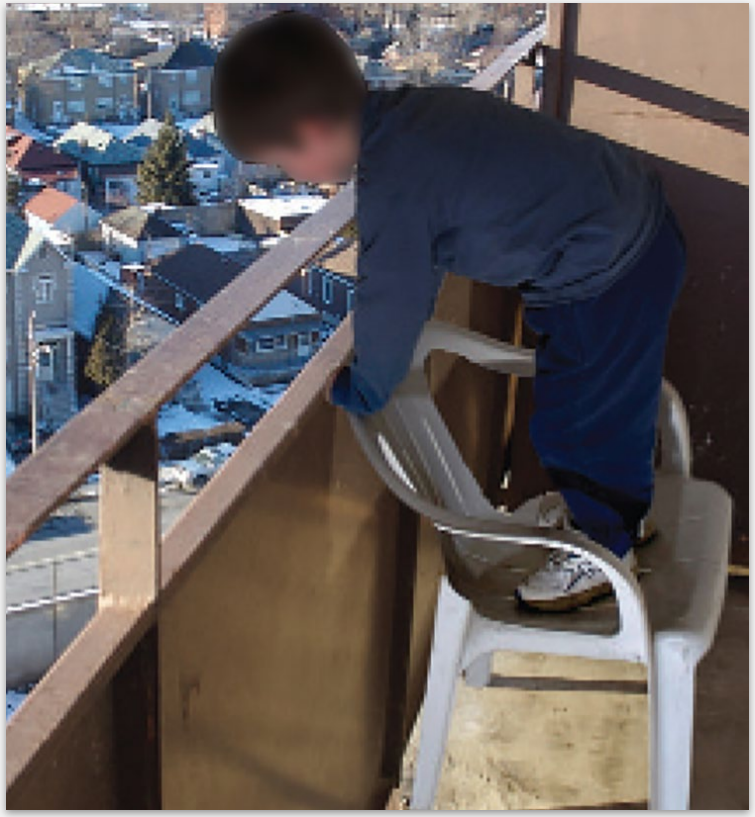






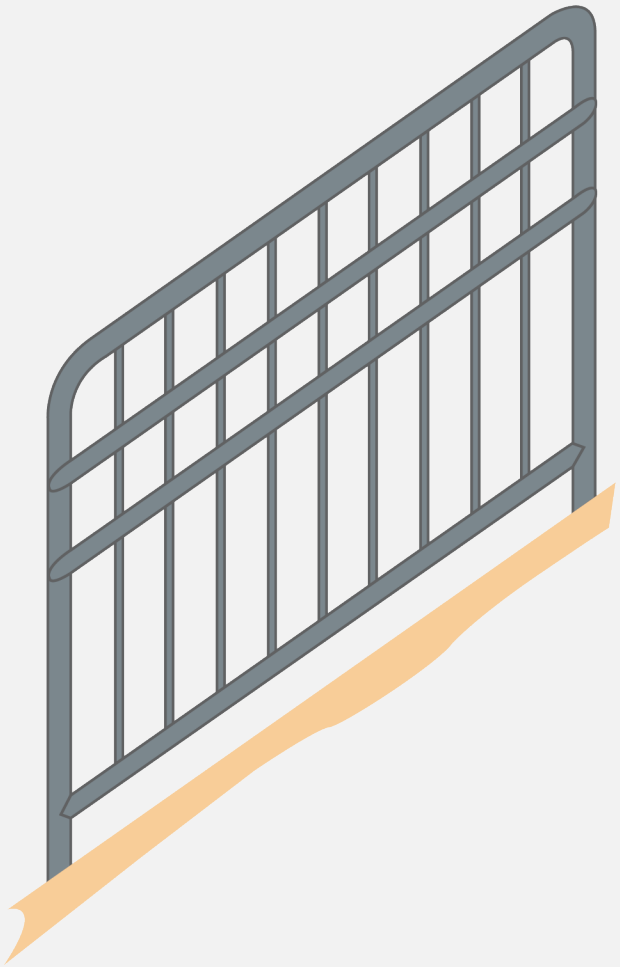

Kidsafe.com.au

- 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 on the top of the table, placing them in a very dangerous situation.



Guardrail with Secondary Handrail for Children

- 2010 ADASAD Advisory 505.4: Height
  - When children are the principal 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”



Pool Barriers

- Pool barriers are not in the model codes but in the Appendix.
- They are optional.
- 48” height minimum
- 2” maximum between the ground and bottom of the barrier
- Multiple other limitations depending on structure of barrier

The Ladder Effect

- In 2004, the ICC Code Technology Committee (C.T.C.) was given the task to determine how to make guards less climbable “if necessary.”
- In 2007, the National Ornamental & Miscellaneous Metals Association (NOMMA) commissioned the National Association of Home Builders (NAHB) Research Center to review all existing peer reviewed reports and CPSC data.

The Ladder Effect

- The report was assembled by the National Association of Home Builders' Research Center and was issued in Oct. 2007. It was called the "Review of Fall Safety of Children Between the Ages of 18 Months and 4 Years in Relation to Guards and Climbing in the Built Environment."
- The researchers felt that those who were younger than 18 months did not have the strength to climb a guard and those older than 4 years would be able to climb just about anything.
- The report included:
  - Critical review of peer-reviewed scientific literature relating to the reasons why children climb.
  - Review of injury data.

The Ladder Effect - 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.

National Home Builders Association - Review

- The National Home Builders Association (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.

NAHB- Conclusions

- The results indicate that falls from Porches, Balconies, Open-Side Floors, Floor Openings, Handrails, Railings, and 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.
- The CPSC noted there was too much uncertainty in the data to ascribe causality of the reported injuries to the physical situation.
- The CPSC felt the number was already so small that it was not an area of concern for them.

NAHB- Peer Review

- The peer review of NAHB report was completed in May 2008.
- The CTC determined the low incidence rate does not warrant the creation of specific code language.
- Attempts to return “the Ladder Effect” to the model codes have since been unsuccessful.
- Remember, however, that some local jurisdictions have maintained “climbability” restrictions in their codes.
- Confirm with your local authority having jurisdiction (AHJ) prior to specifying a guard.

Load Requirements

- For Handrail and Guard
  - 50 lb/ft uniform load
  - 200 lb concentrated load
- Infill
  - 50 lb/sq. ft.

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.*
- **Glass balusters shall not be installed without an attached handrail or guard.**

Question: Does this guard with .5” monolithic tempered glass meet IBC 2407.1?

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 1 baluster panel fail. Glass balusters shall not be installed without an attached handrail or guard.

Why 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.

Why 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’s 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:**
  - ***IBC 1607.8.1 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.*
  - ***IBC 1607.8.1.1 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.*

This is the top of the guard.

- .5” monolithic glass
- Must meet a 200 lb. concentrated load by a design factor of 4

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

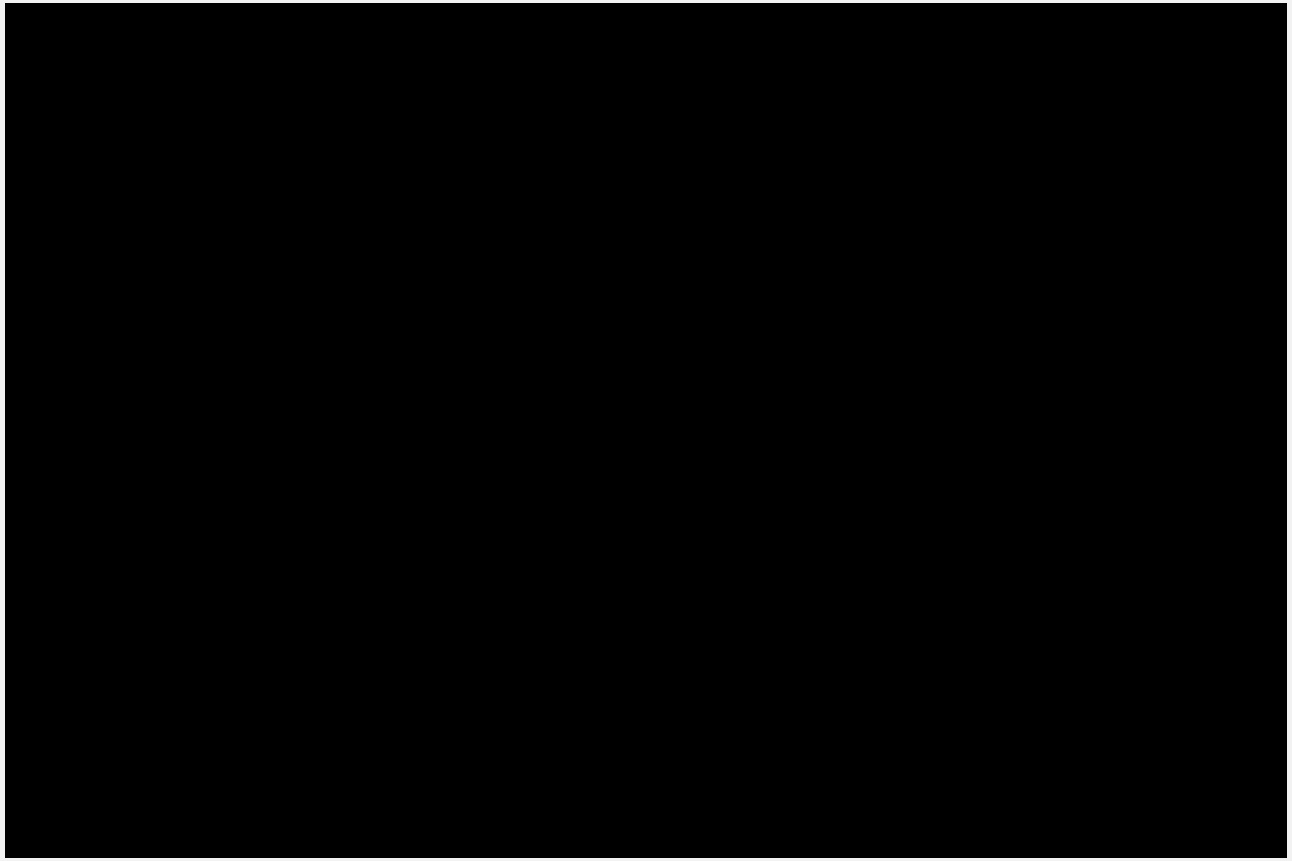
- Monolithic tempered glass was breaking across North America
  - Toronto
  - Austin
  - Houston
  - Seattle
  - New York City
  - Chicago
  - Dallas
  - Cleveland
- Causes:
  - Nickel-sulfide inclusions
    - Oil fired vs. Gas fired ovens
  - Unprotected edges

Laminated Glass

- In response to the issue of glass breakage across North America, the 2015 IBC now requires laminated glass in all glass railing applications.
- This applies to for example
  - Infill Panels
  - Glass Balustrades

Glass Rail Pushed to Failure

PVB vs Lonoplast Rigid Interlayer



Glass Rail Deflection

For More Information

For more information on building codes, go to www.iccsafe.org. Since they do sell the code books, you will not be able to view all the building codes. However, they will allow you to view individual sections of the code.

Additional Resources

https://codes.iccsafe.org/public/collections/I-Codes

www.usdoj.gov/crt/ada/adahom1.html

www.nomma.org

References

1. International Code Council (ICC): https://shop.iccsafe.org/media/wysiwyg/material/7101S18-Sample.pdf
2. OSHA 1910.29-Fall protection systems and falling object protection-criteria and practices: https://www.osha.gov/laws-regs/regulations/standardnumber/1910/1910.29
3. ICC A117.1-2017: https://shop.iccsafe.org/icc-a117-1-2017-standard-and-commentary-accessible-and-usable-buildings-and-facilities-1.html
4. United States Access Board: https://www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-ada-standards/ada-standards
5. NOMMA Guard Climbability study: https://www.nomma.org/page/6

This concludes The American Institute of Architects Continuing Education Systems Course.

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