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RESEARCH SEMINAR SERIES



GOING OFF THE RAILS

By Drs. Salih Kocak, Aneurin Grant, and Gil Fried
University of West Florida

The purpose of this presentation is to:

- Highlight the issue of fan injuries and deaths associated with falling over railing or falling down from malfunctioning railing.
- Examine whether the line of sight exception at 26 inches is safe.
- Analyze the load of force concern associated with fans leaning against railing.
- Offer solutions to railing related concerns.



IN THE NEWS AND IN COURT

There have been a slew of serious injuries associated with fans falling over railing or being injured from collapsing railing

- From 1969-2011, there have been 22 fall-related fatalities at major league ballparks, according to the "Death at the Ballpark" blog compiled by authors David Weeks and Robert Gorman.
- In a 2009 article, the author highlighted in a nine year period from 2000-2009 three deaths and eight serious injuries associated with railing related incidents (Steinbach, 2009).



INCIDENTS CONTINUED

- ESPN highlighted One death at Coors Field in Denver happened in May 2011, one at Turner Field in Atlanta in May 2008, and one at Shea Stadium in New York in April 2008 as examples of railing deaths.
- On April 21, 2009, a St. Louis Cardinal fan fell over a 30-inch rail on the front row of "Casino Queen Party Porch" section of at Busch Stadium. Shortly thereafter, on June 26, 2009, thirty-four-year old Chris Hoffman passed out (from dehydration) and fell over a 30-inch rail on the 4th deck of Busch Stadium.
- On April 25, 2010, Stuart Springstube suffered fatal injuries after he fell 15' over a railing while trying to catch a ball during batting practice at a Milwaukee Brewers game at Miller Park. The same season Tyler Morris fell over a 30" rail at a Texas Rangers baseball game (July 6, 2010).

YET MORE INCIDENTS

- On July 7, 2011, thirty-nine-year-old Shannon Stone fell to his death over a 33-inch rail.
- In 2014, a toddler was hospitalized after tumbling over a railing at the American Airlines Center in Dallas during a performance by the Ringling Brothers Barnum and Bailey Circus.
- In 2016, man was injured after falling over a railing at Oracle Arena following a 2016 NBA Finals game.
- A mother and toddler died when they fell over railing in a picnic bench area at Petco Park in San Diego in 2021.



MR. STONE IN WHITE SHIRT

Reaching for a ball



FALLING OVER THE RAILING



INJURIES ABOUND IN THE STANDS

- The United States Consumer Products Safety Commission (CPSC) issued Guidelines for Retrofitting Bleachers in 2000. The guide highlighted that there was an annual average of 19,100 bleacher-associated injuries treated in emergency rooms. 6,100 of those injuries were the result of falls. Recommendation- the top surface of a bleacher's guardrail should be at least 42 inches above the leading edge.
- Recommendation endorsed by:
 - 2000 National Fire Protection Association (NFPA) 101 Life Safety Code
 - 2000 International Building Code (IBC) of the International Code Council (ICC)
 - 1999 National Building Code (NBC) of the Building Officials and Code Administrators (BOCA)
 - 1997 Uniform Building Code (UBC) of the International Conference of Building Officials (ICBO)
 - 1997 Standard Building Code (SBC) of the Southern Building Code Congress International (SBCCI) (CPSC, 2000).

OTHER CONCERNS

- Litigation
- Major League Baseball warned railings were unsafe before Atlanta fan's fall (Rankin, 2019)
- Railing collapses-
 - Jalen Hurts-2022



HISTORY OF A FALL

ELAPSED TIME IN SECONDS	FREE FALL DISTANCE	SPEED IN MPH	HUMAN RESPONSE	FALL ARREST SYSTEM ACTION
0.0	0"	0	NONE	SLACK
0.1	2"	2	AWARE	SLACK
0.2	8"	5	AWARE	SLACK
0.3	18"	7	REFLEX	SLACK
0.4	31"	9	START MOVEMENT	SLACK
0.5	48"	11	START MOVEMENT	SLACK
0.6	70"	13	SLIGHT MOVEMENT	SLACK
0.61	72"	13.3	IMPACT	SLACK
0.7	95"	16	IMPACT PEAKS	LOAD RISES AND PEAKS
0.8	124"	18	IMPACT DECLINES	LOAD DECLINES
0.9	156"	20	SUSPEND	STATIC LOAD
1.0	193"	22	SUSPEND	STATIC LOAD
2.0	773"	44	SUSPEND	STATIC LOAD

DESIGN CRITERIA

Follow the governing code/local ordinances for the area in which the railing systems are to be constructed and used

- Local codes
- International Building Code (IBC)
- Occupational Safety & Health Administration (OSHA)

* Shall be checked for specific requirements and governing regulations; such as the Americans with Disabilities Act (ADA)

1. **Material Requirements**
2. **Loading Requirements**
3. **Height Requirements**

DESIGN CRITERIA

1. Material Requirements

Most frequently used ones;

- Carbon Steel Pipe- ASTM A53 Type E or F, both Grade B
- Carbon Steel Structural Tubing- ASTM A500 Grade B
- Aluminum 6061-T6 and 6063-T6 Pipe & Tube- ASTM 429
- Stainless Steel Pipe- ASTM A312
- Stainless Steel Tubing- ASTM A554

* Mechanical & physical properties are provided in the National Association of Architectural Metal Manufacturers (NAAMM) –AMP
521-01

DESIGN CRITERIA

1. Material Requirements

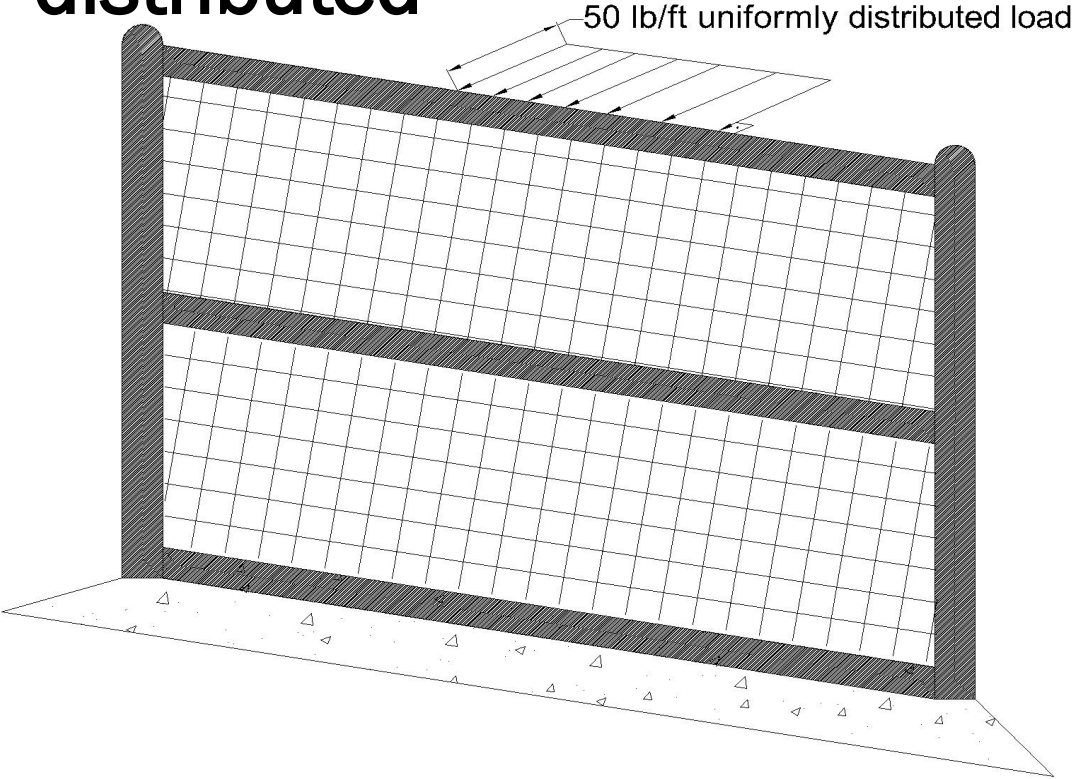
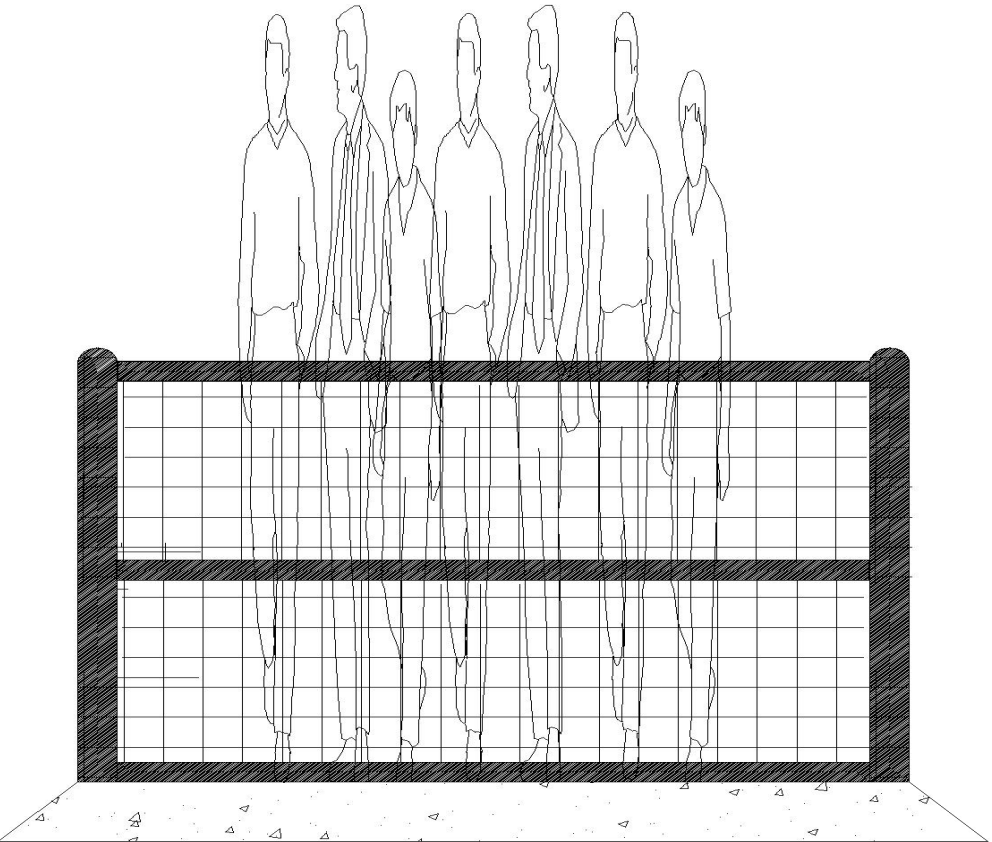
Selection Criteria for Metal Alloys for Guardrail Systems

- Strength
- Corrosion resistance
- Joint Connection (welded or non-welded)
- Cost

* Code requirements, material and labor availability as well as labor and material costs can impact the material selection criteria.

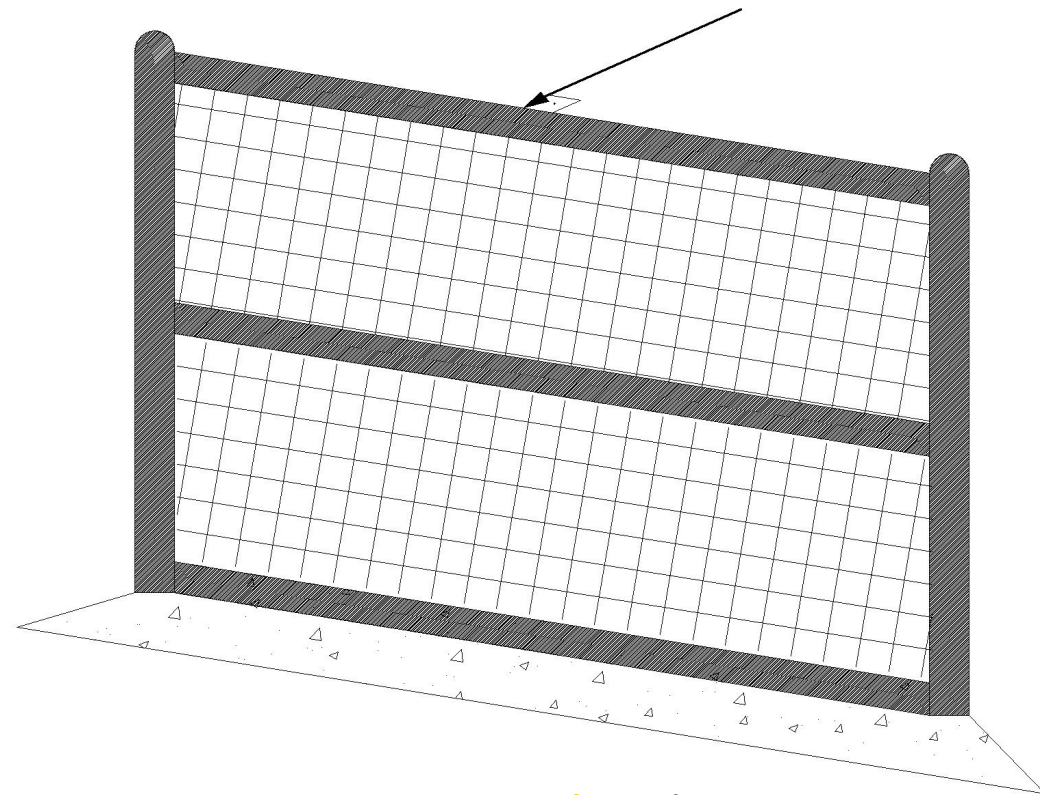
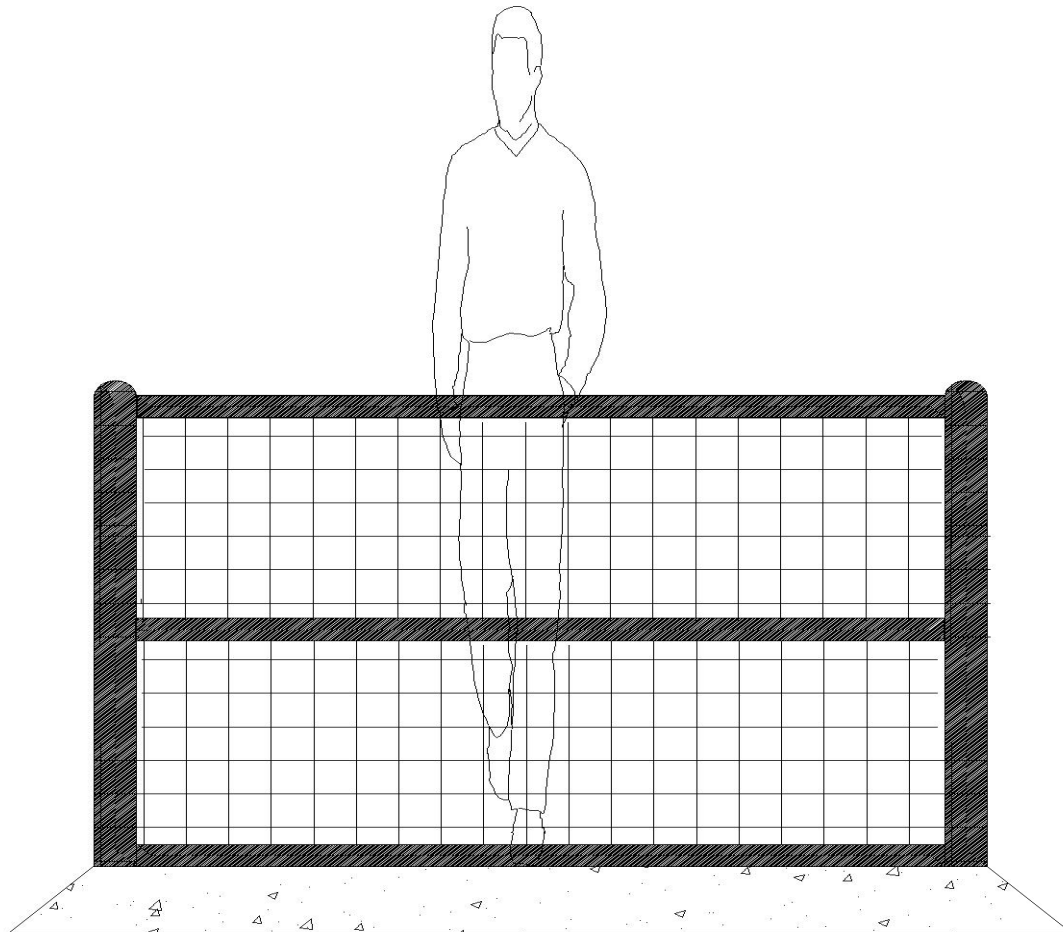
DESIGN CRITERIA

2.1 Loading Requirements- distributed



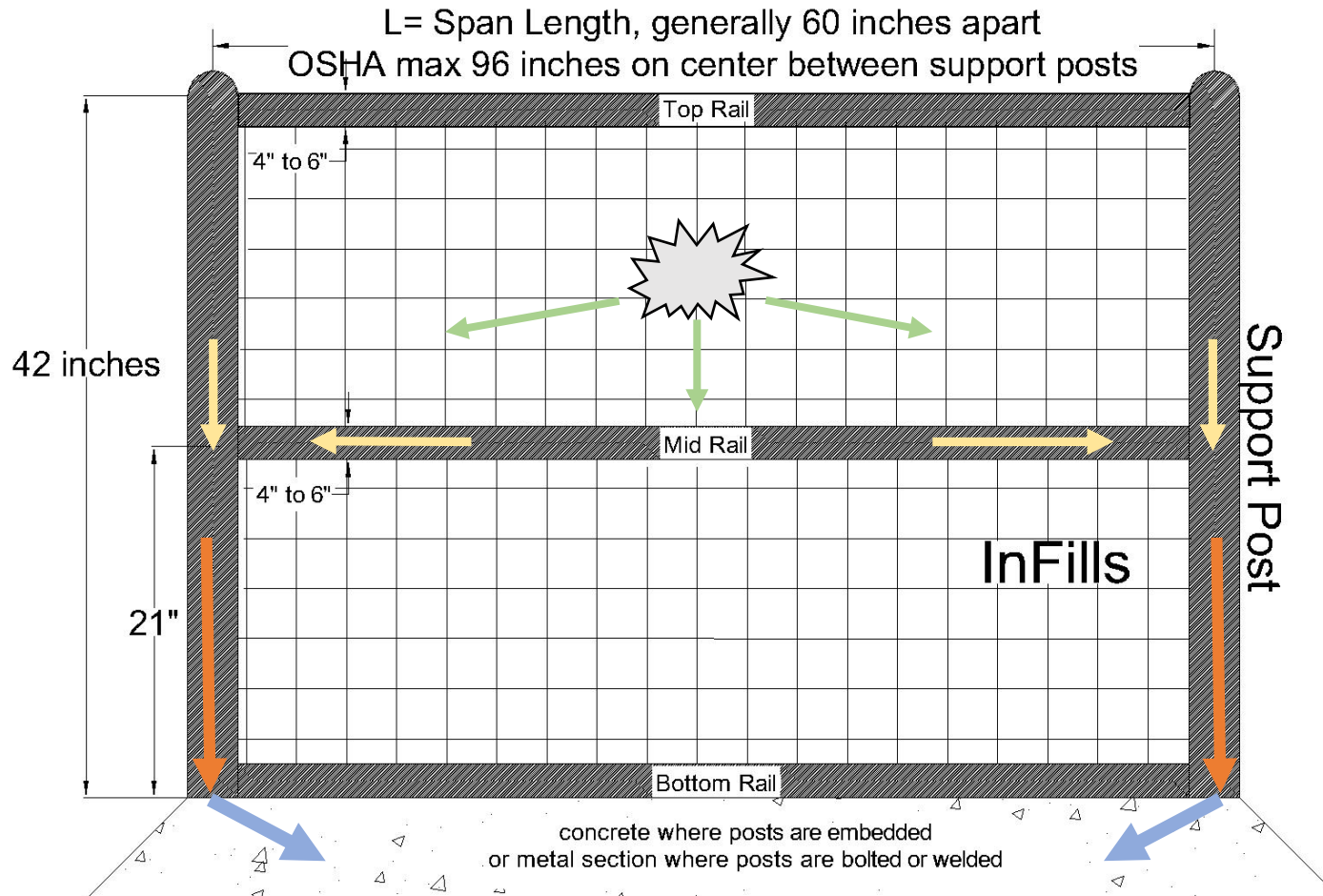
DESIGN CRITERIA

2.2 Loading Requirements- concentrated 200 lb concentrated load



DESIGN CRITERIA

2.3 Loading Requirements- other elements

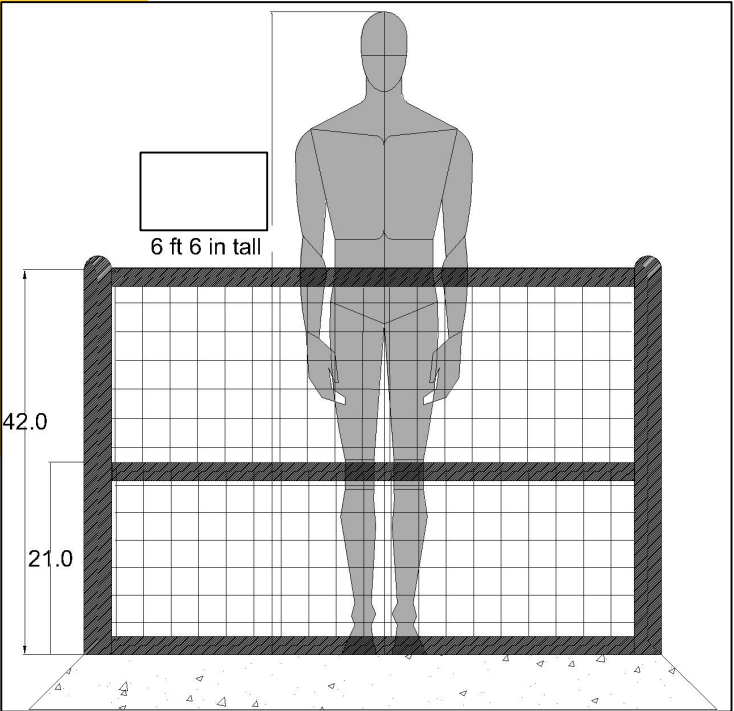


DESIGN CRITERIA

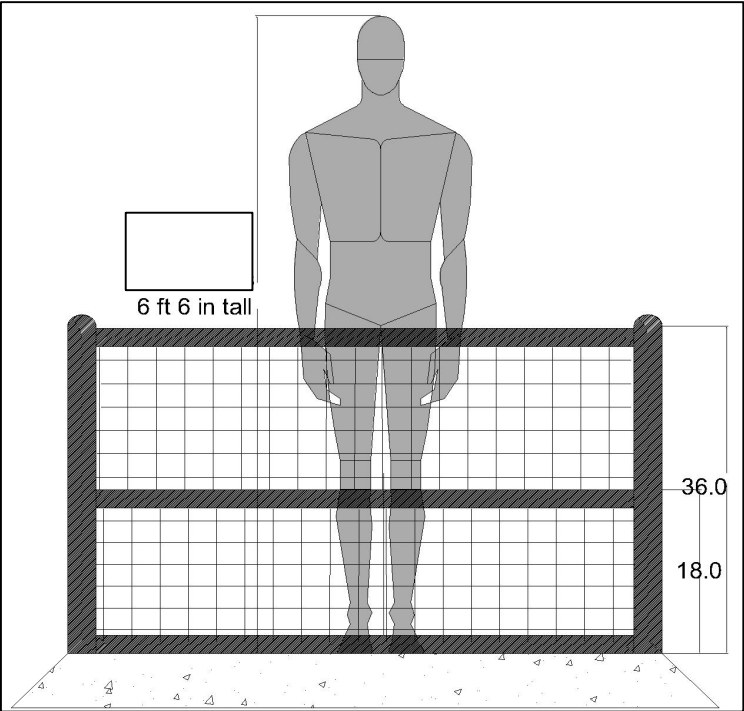
3. Height Requirements

Which one of the following height requirements is the safest for 6.5 ft + tall US population?

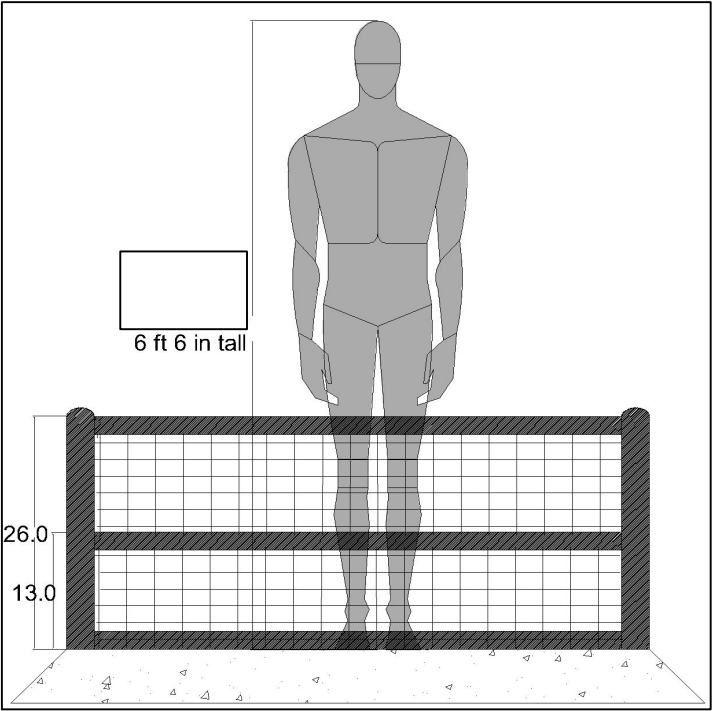
Option A



Option B



Option C



STANDARDS AND REGULATIONS

- OSHA provides specific criteria for protective guardrails in part 1926.502(b) of the 29 CFR 1926 - Construction Industry Regulations and Standards, which states that guardrails shall be 42" +/- 3" high, with the top rail capable of resisting 200 pounds of force both down and out in the direction of the observed fall hazard.
- OSHA also has specific provisions for housekeeping. This promotes safety on a lot of different levels, including the minimization of slips, trips, and falls.
- OSHA specifically references "horseplay" as an unsafe behavior. Many employers will include specific clauses in construction contracts prohibiting horseplay.
- In various public events, people's legs, arms, and behavior would not be tolerated on construction jobsites. Similarly, fan behavior often fits the description of horseplay.



HORSEPLAY

- Horseplay is a common word in our workplaces; it is a term used to describe a fooling and foolish behavior which often result to accident and injury.
- The word horseplay dates back to the 1580's. In the 16th century, "**Horse**" was an adjective describing anything strong, big or coarse. **Horseplay** means a **strong play**. This is shown from the way young horses play together; they chase each other up and down, play-fight, etc., which can often result in unintentional physical harm.

HORSEPLAY

Examples of horseplay

- Playfully splashing an excavator operator water while operating the equipment.
- Using a vehicle to threaten a pedestrian
- Jumping from height to test strength when a safe access has been provided.
- Playing with a cutting machine when the power is on and its operational.
- Playfully throwing a work tool on a fellow worker.
- Playfully trying to recover a sharp object from someone else forcefully.
- Using your hand to stop a rotating ceiling fan.
- Threatening to push someone into a pit
- Competing to jump over an excavation, etc.
- The examples of horseplay are much, as it covers all foolish play which could result to harm



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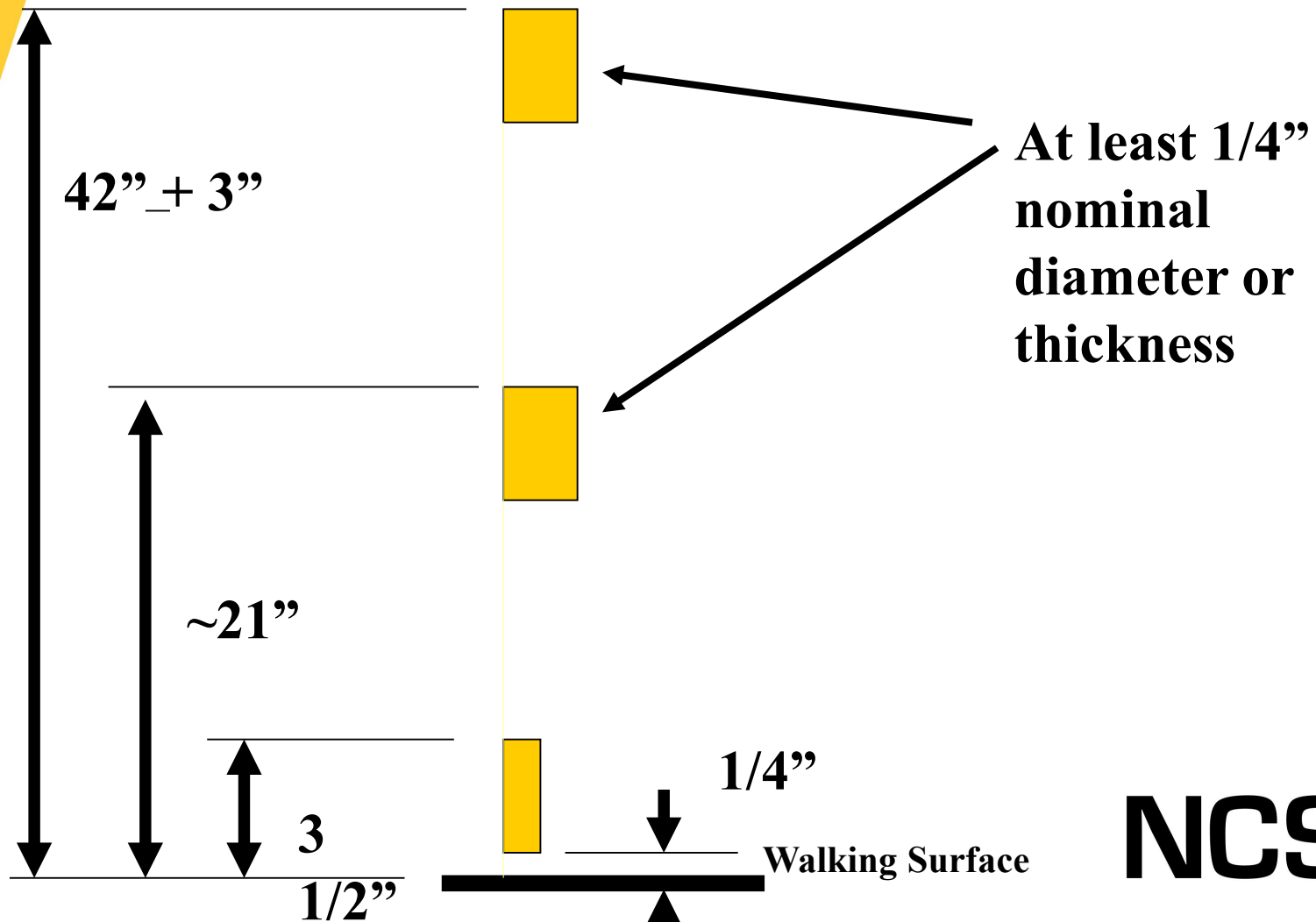
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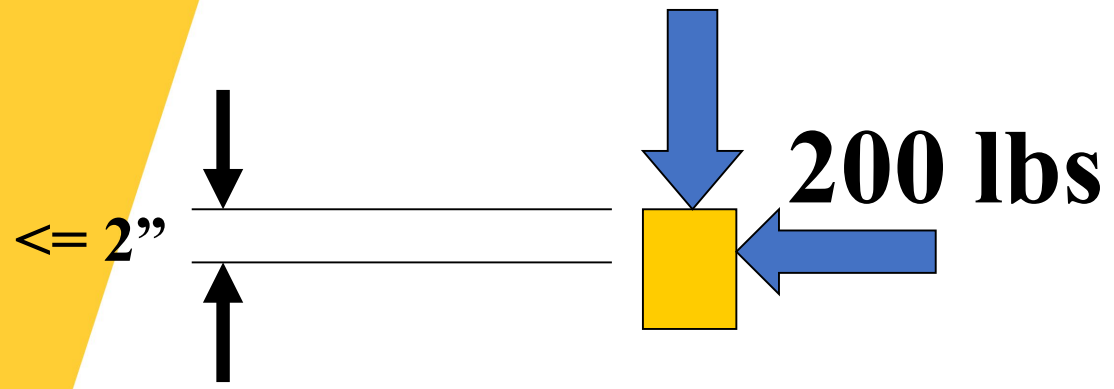


OSHA

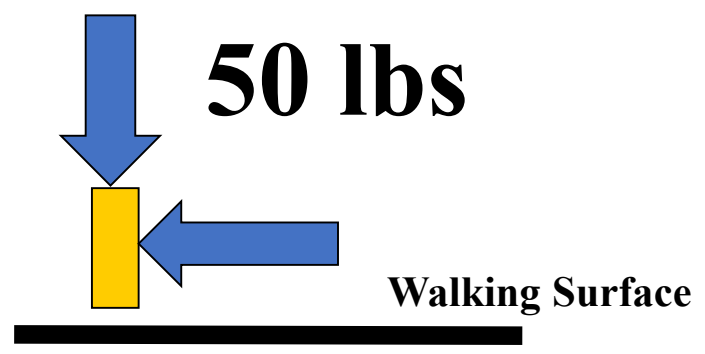
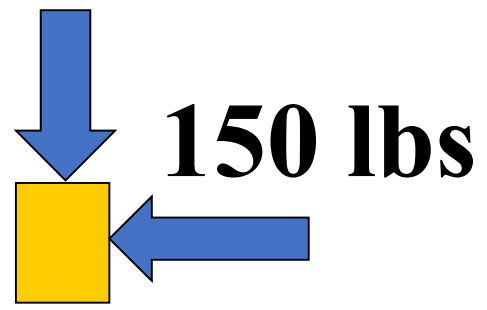
- General Duty Clause – 1970 OSH Act
- Each employer shall furnish to each of his employees employment and a place of employment which are free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees
- The word “employer” appears over and over again in the OSHA standard, with specific language as to their responsibilities.
- Employers are responsible for employee training, communication of hazards to employees, and the overall safety of the site.
- Responsibility and liability is clearly assigned

Guardrails





Guardrails





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CODES

- According to the International Building Code (IBC 2021), guardrail requirements are dependent on the building's occupancy. Assembly occupancy, as follows:
 - Group A-1 – Theaters
 - Group A-3 – Exhibition halls
 - Group A-4 – Arenas
 - Group A-5 – Bleachers, grandstands, and stadiums
- Additionally, per section 1015.3, "required guards shall not be less than 42 inches (1067 mm) high..."

CODES

- In Chapter 16 of the IBC – Structural Design, Section 1607.9.1 Handrails and Guards, loading requirements for guardrails are articulated as needing to resist a “linear load of 50 pounds per linear foot (plf) (0.73kN/m), and a concentrated load of 200 pounds (0.89 kN) (IBC 2021). As with all Building Codes, these are minimum standards.



CODES AND EXCEPTIONS

- Unless subject to the requirements of 1030.17.4, a fascia or railing system in accordance with the guard requirements of section 1015 and having a minimum height of 26 inches (660 mm) shall be provide where the floor or footboard elevation is more than 30 inches (762 mm) above the floor or grade below and the fascia or railing would otherwise interfere with the sightlines of immediately adjacent seating.
- This is called the line of site exception. The 26-inch minimum height for front-row railings dates back to 1929, when it was included in the National Fire Protection Association Building Exits Code and focused on venues such as dinner theaters.
- What are people doing now?
 - Standing, dancing, drinking, jostling, etc.



SOLUTIONS

Higher Railing, Glass/Plastic and Netting

Raised railing

- Increase the height of railing to 42".

Glass

Per Chapter 24 of the IBC – Glass and Glazing, section 2407 – Glass in Handrails and Guards, glass may be used in guardrail assemblies, with specific requirements for lamination, heat strengthening, tempering, and a minimum nominal thickness of ¼" (IBC 2021). Additionally, glass guards must be designed with a factor of safety of 4.

MORE SOLUTIONS

Netting and Construction

Netting

- Increase the height of railing to 42" and/or install netting.
- Netting used in Chicago and Seattle.
- TopGolf uses netting to help catch golfers.

Construction

How to build the best railing system.

CONTACT INFORMATION

Dr. Salih Kocak, Skocak@uwf.edu

Dr. Aneurin Grant, Agrant1@uwf.edu

Dr. Gil Fried, Gfried@uwf.edu



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