# Personal Fall Arrest Systems
# Nets

*As a Last Resort*

# Primary Concerns

- Impact Force to the Body Less Than 1800# (with a harness)
- Maximum 6’ Free Fall Distance
- May Not Hit Structures Below
- Maximum Weight of Individual w/Tools of 310#

# Impact Force

- Minimize Fall Distance
  - Tie off at or above D-ring height wherever possible
- Use Shock Absorbers
- Choose appropriate harnesses, and wear them properly

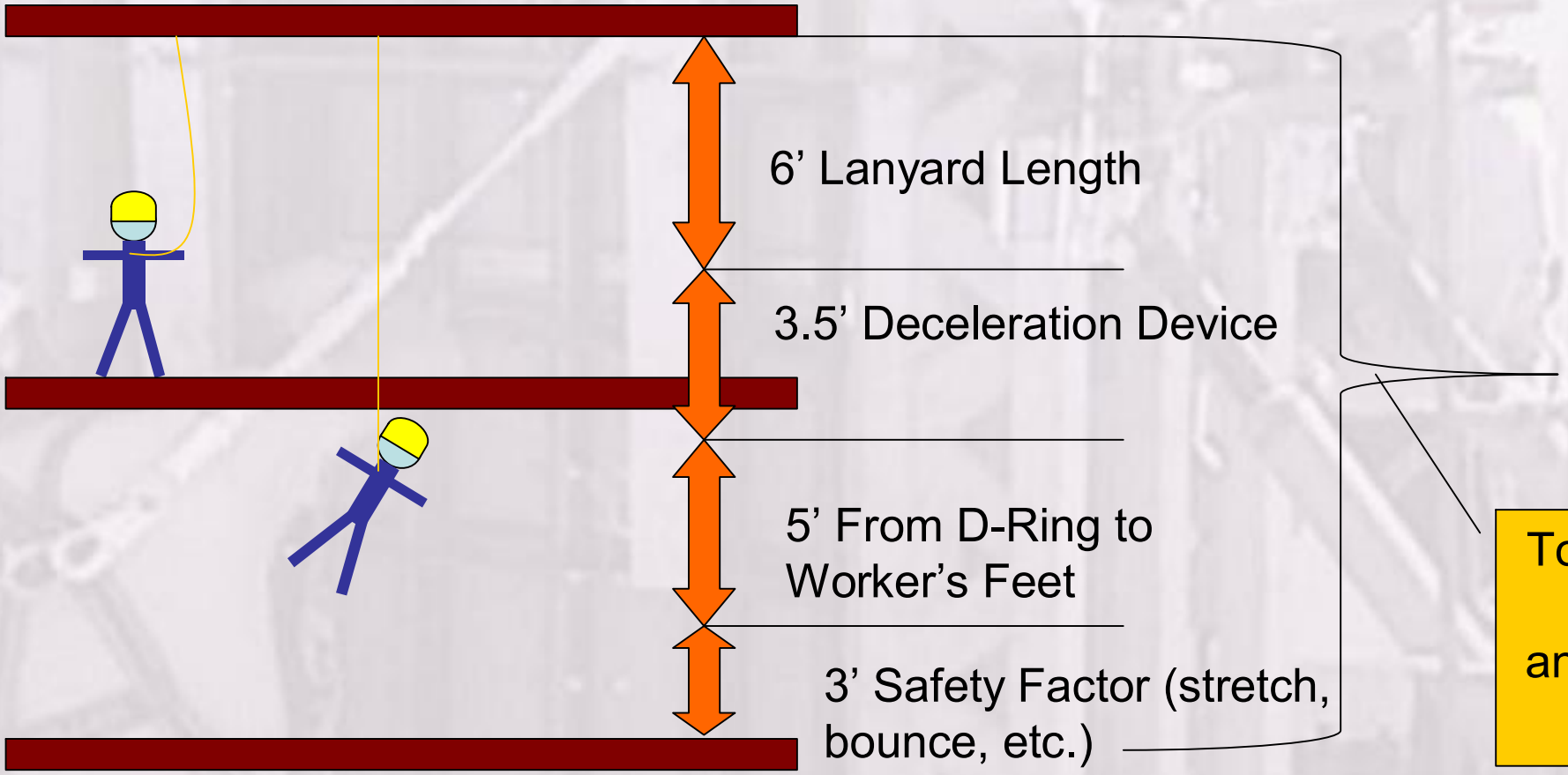
# Fall Distances

- Total Fall Distance
- Free Fall Distance

# Impacting Structures Below (Total Fall Distance)

- Consider:
  - anchorage point location in relation to D-ring height
  - lanyard length,
  - harness elongation,
  - shock absorber opening length,
  - body below D-ring
  - body viscosity (soft tissue injuries!)

# Impacting Structures Below (Total Fall Distance)

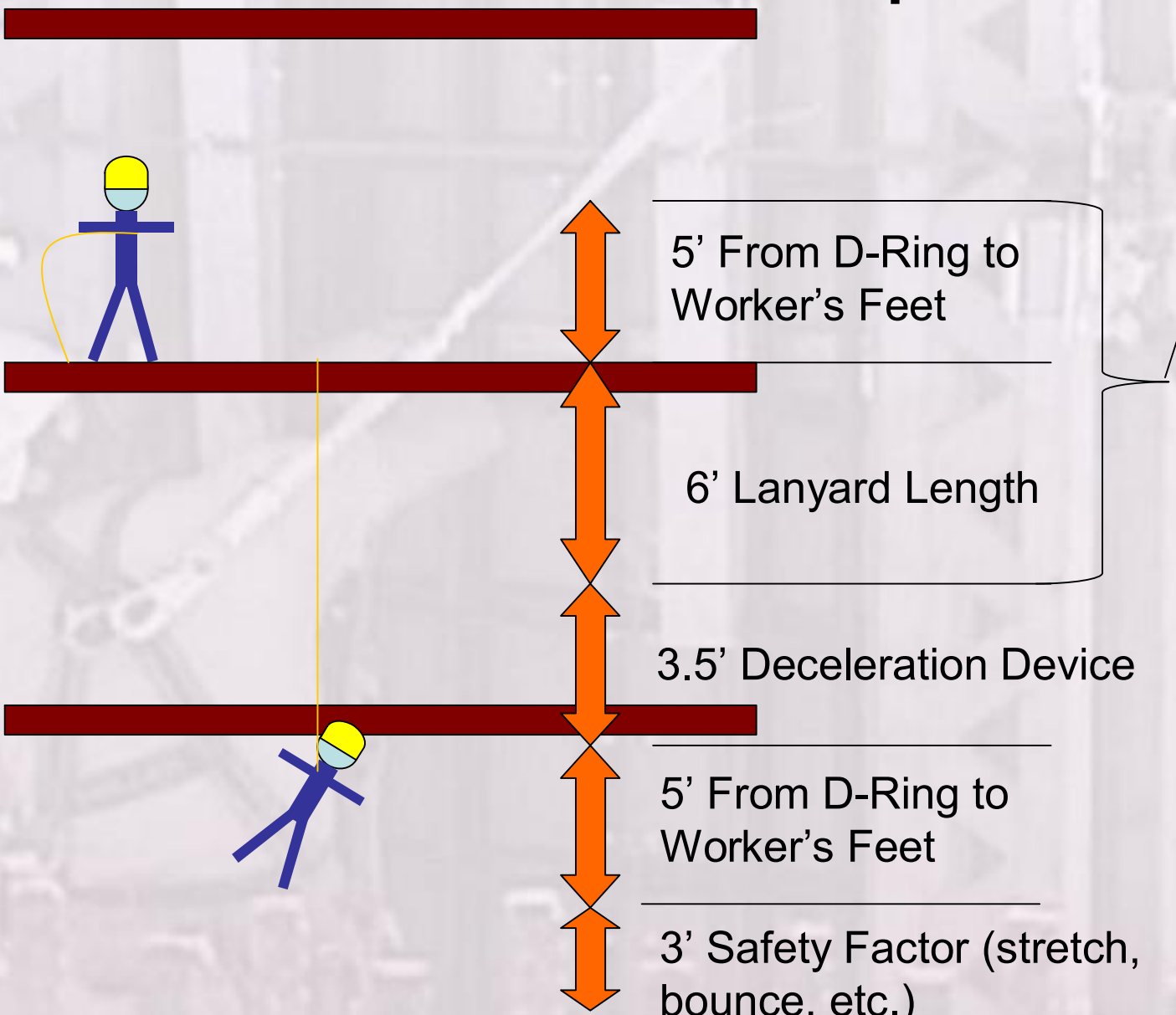



*All distances are approximate, and shown for illustration only. This is why it is critical to maintain the safety factor distance!*

# Free Fall Distance

- How far a worker falls before shock absorbing or deceleration equipment begins to take effect
  - Affects both impact forces and total fall distance
- Anchorage point location in relation to D-ring height
  - Below the D-ring allows excessive falls
  - Above the D-ring minimizes free fall to less than 6’

# Free Fall Distance or "Vertical Displacement"




Total 11' travel distance of d-ring before fall arrest takes effect. This potential impact force exceeds many lanyard capacities (and OSHA standards).

When added to "total fall distance", anchoring at the feet can become problematic

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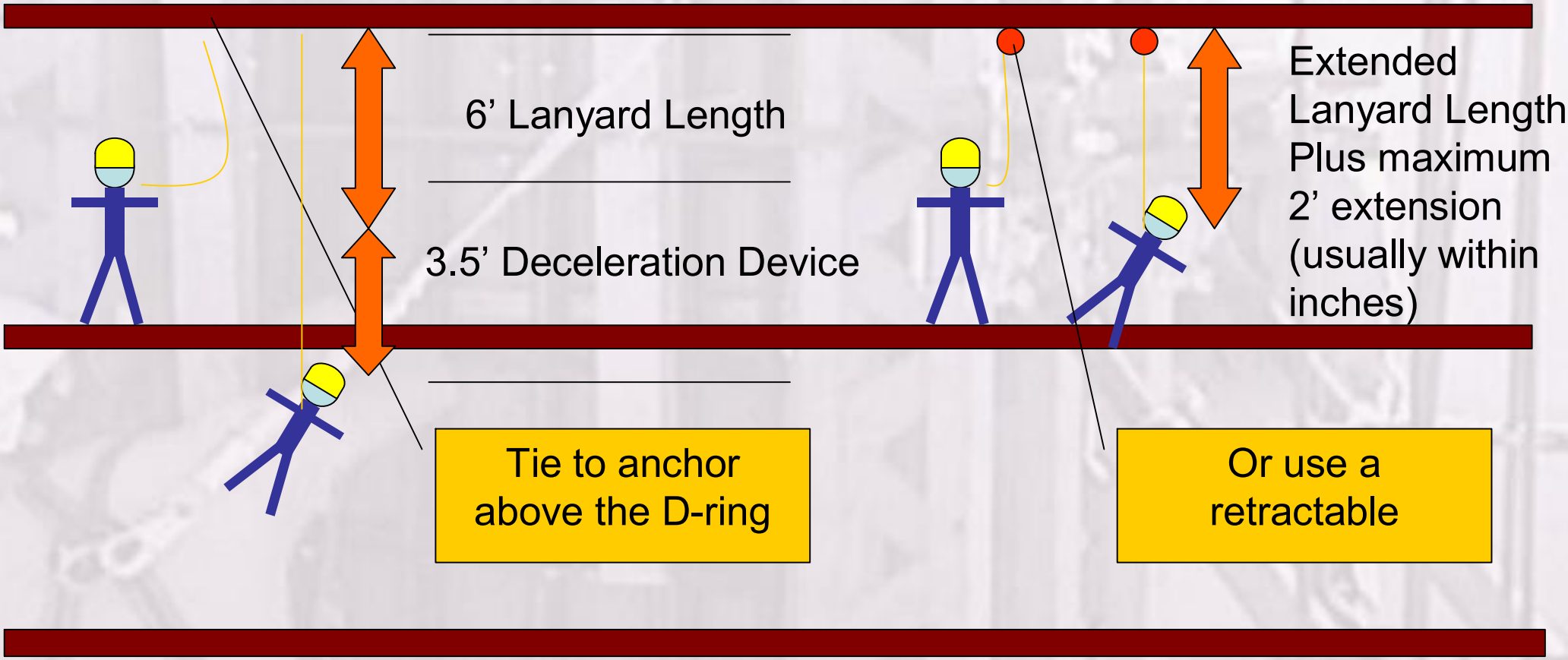
# Minimizing Free Fall Distance or "Vertical Displacement"




Using an anchorage above the D-ring and a standard lanyard may still allow an employee to fall a distance that may be difficult to rescue from. Using a retractable minimizes forces on the body, and may make rescue easier (and therefore more timely)

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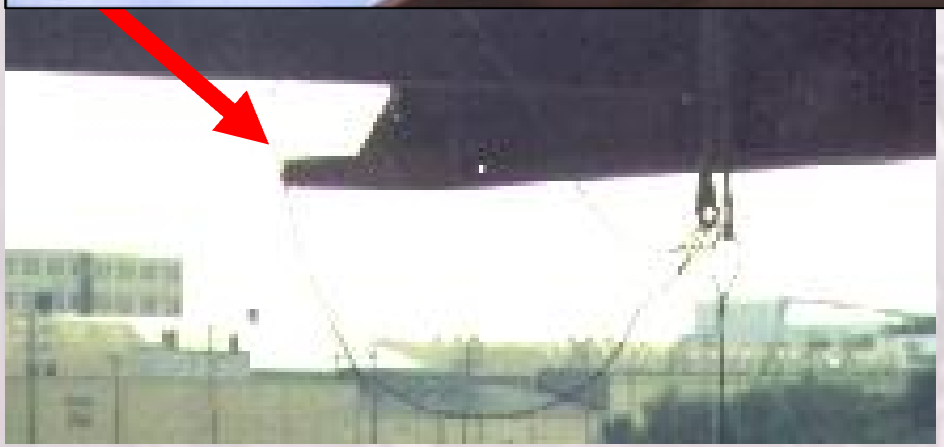
# Practical Implications of Total & Free Fall Distance Added Together

- These workers are tied to the beams they are standing on with choker slings.
- How far will they fall?



# Watch Swing Falls

- This worker is tied off using a retractable lifeline.
- There is a major swing fall potential if he fell to either side.

# Personal Fall Arrest Systems

- Anchorage
- Body
- Connector

Harnesses

Caribiners

Beam Wraps

Rope Grabs

Lanyards

Positioning

# Anchorages

- Must support 5000# per employee attached,
  - Or as part of a complete personal fall arrest system which maintains a safety factor of at least two
  - Or 3000# when using fall restraint or a Self-Retracting Lifeline (SRL, Retractable, or “yo-yo”) which limits free fall distance to 2 feet
- Should always be at or above D-ring height

# Roof & Deck Anchors

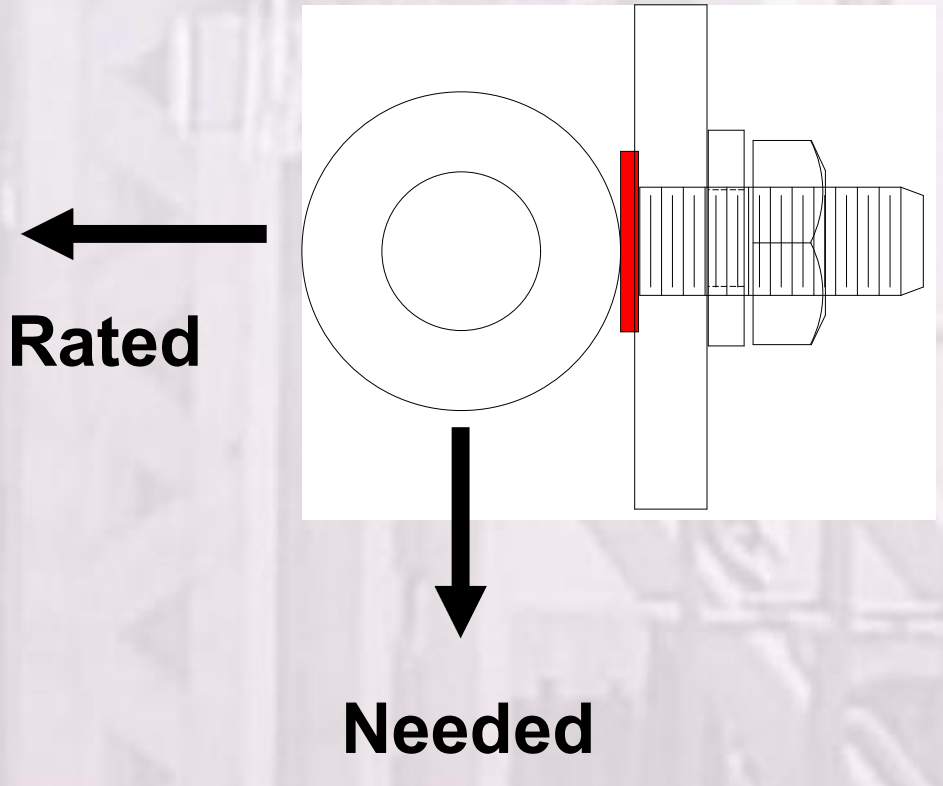
**Permanent Anchors**

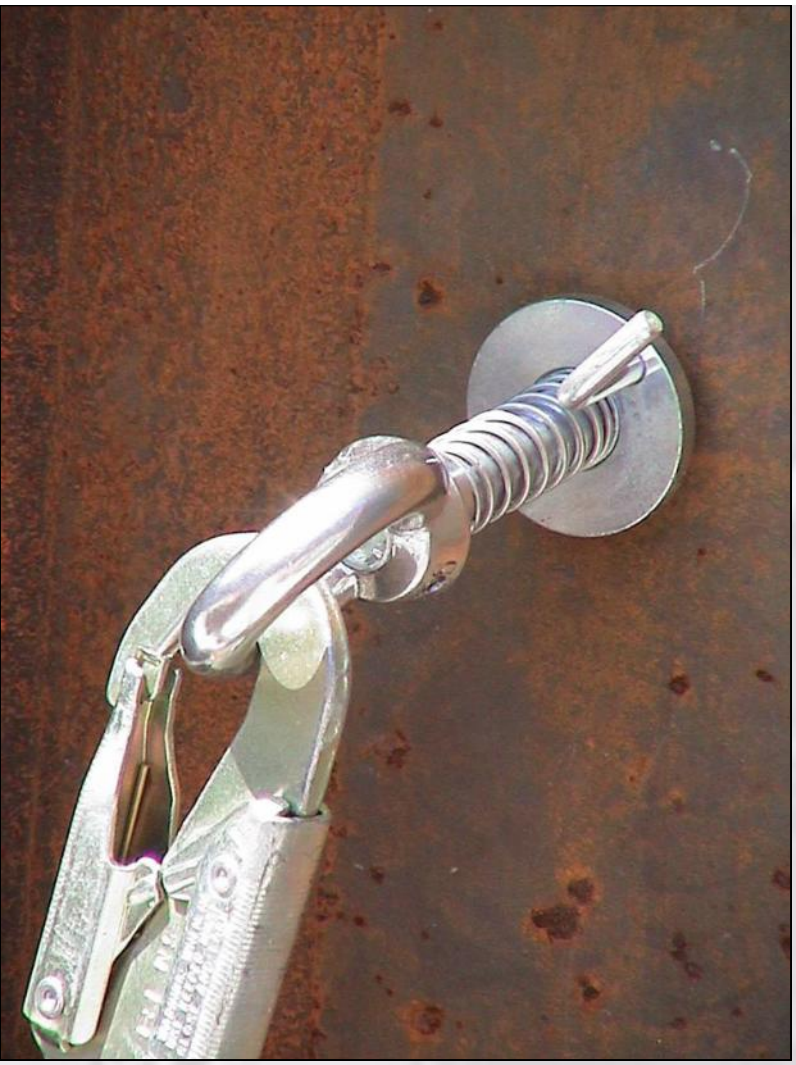
**Wood Roof Anchor**

**Metal Roof Anchor**

# Use of Eye Bolts

- Rated for loading parallel to the bolt axis.
- If wall mounted, the rating perpendicular to the axis must be good for 5,000 lbs. per employee



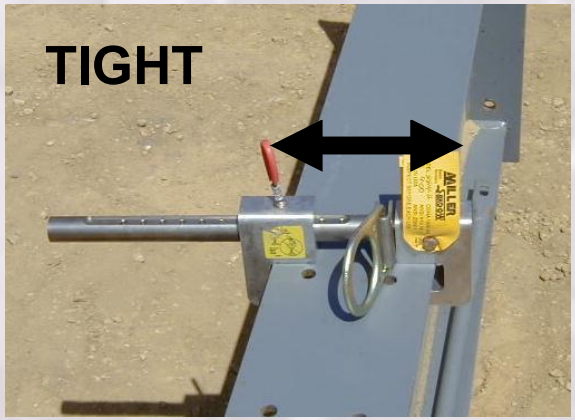


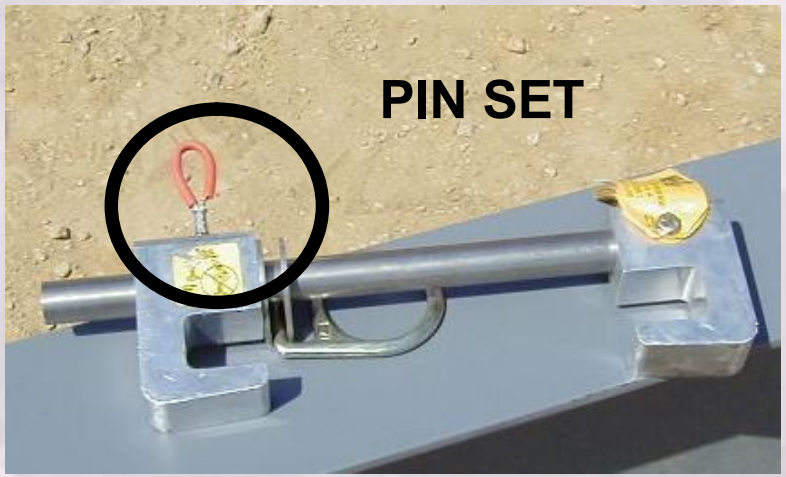
# Girder Grip Anchorage Rings

- These attachments can be mounted through bolt holes on steel members.
- They are rated at 5,000 lbs. in all directions

# Beam Clamps

**Beam clamps can make an effective anchorage when used properly, and with the correct lanyard**





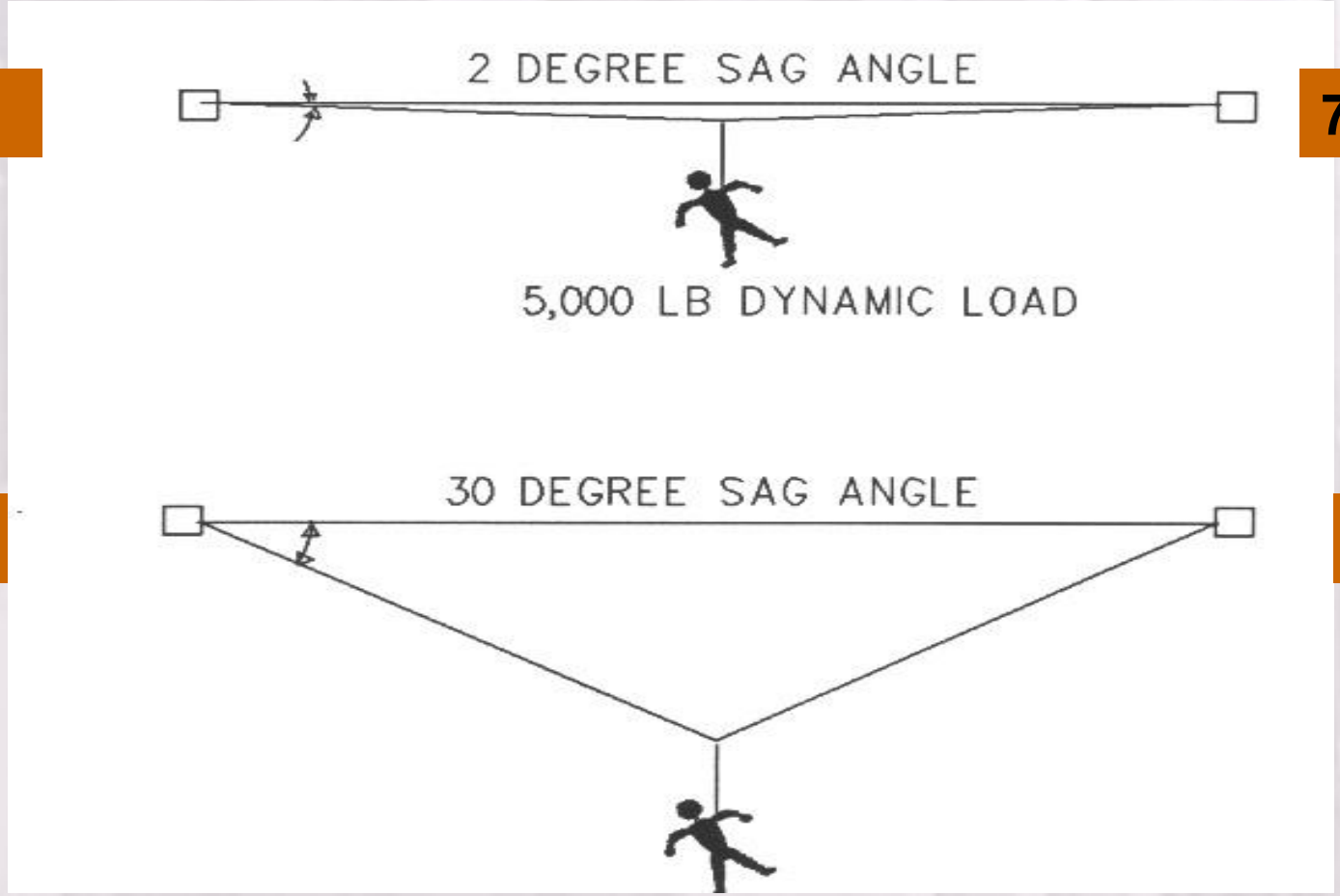
**Be sure pin is inserted full length and clamp is tight.**


Beware of potential for pulling off of coped ends
on filler beams!

# Horizontal Life Lines

- **Provide maneuverability.**
- **Must be designed, installed and used under the guidance of a qualified person**
  - **This could be interpreted as requiring the use of manufactured systems, which is *recommended***

# Horizontal Line Engineering




**72,000 lb**

**72,000 lb**

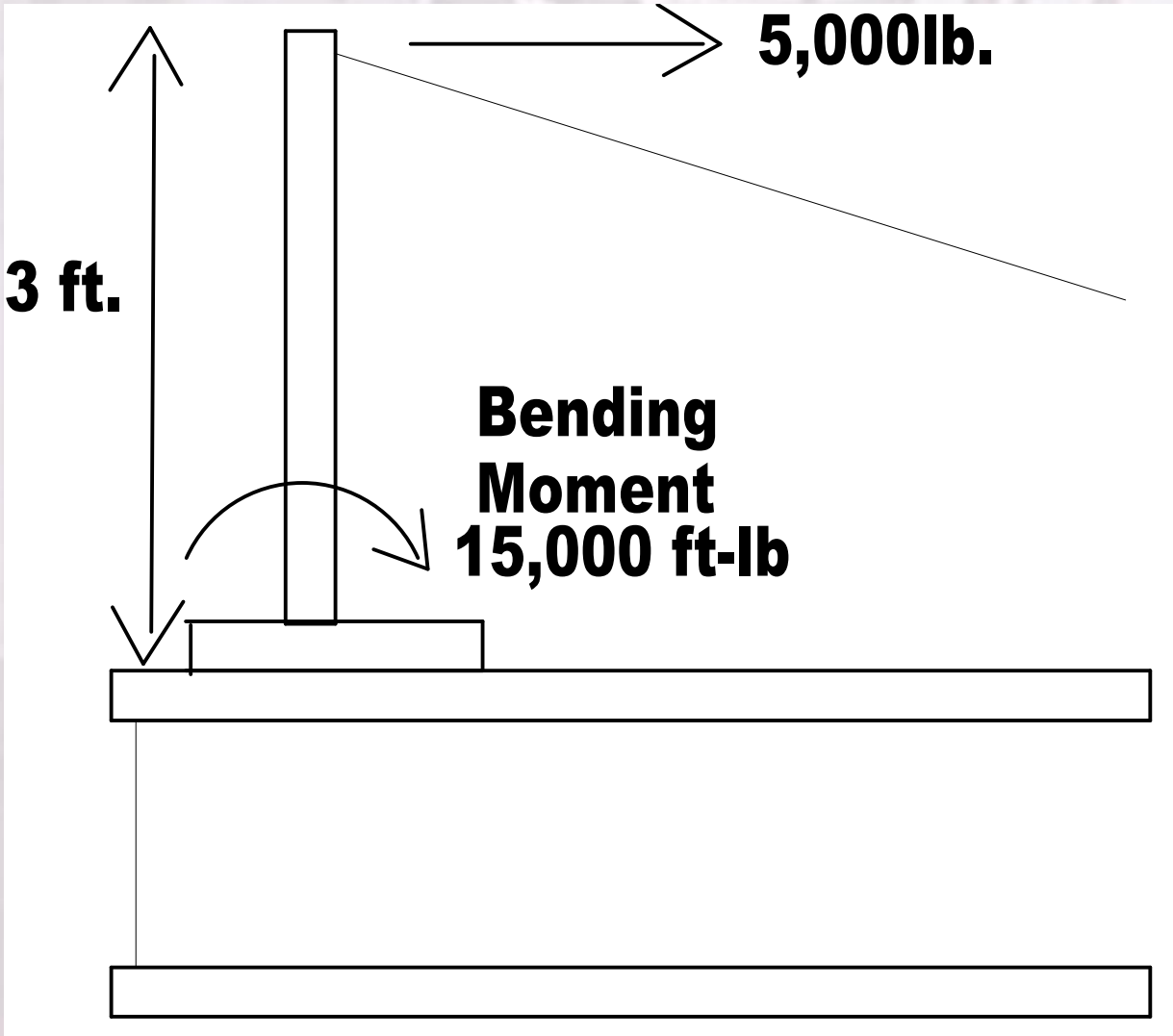
**5,000 lb**

**5,000 lb**

**Anchor stress depends on the sag angle of the line.**

# Line Stanchions

- The connection of the line stanchion to the flange must support the bending moment applied to the base.



# Body (Harnesses)

- Need to be inspected frequently (daily before use by the worker, at least monthly by a Competent Person)
- Should never be modified
- Should be taken out of service immediately if defective or exposed to an impact

# Harness Fitting

Chest strap tightened at mid chest

Proper snugness shoulder to hips

Leg straps snug but not binding

"D" ring between shoulder blades

Butt strap supports the load

- Harness must be sized for the worker

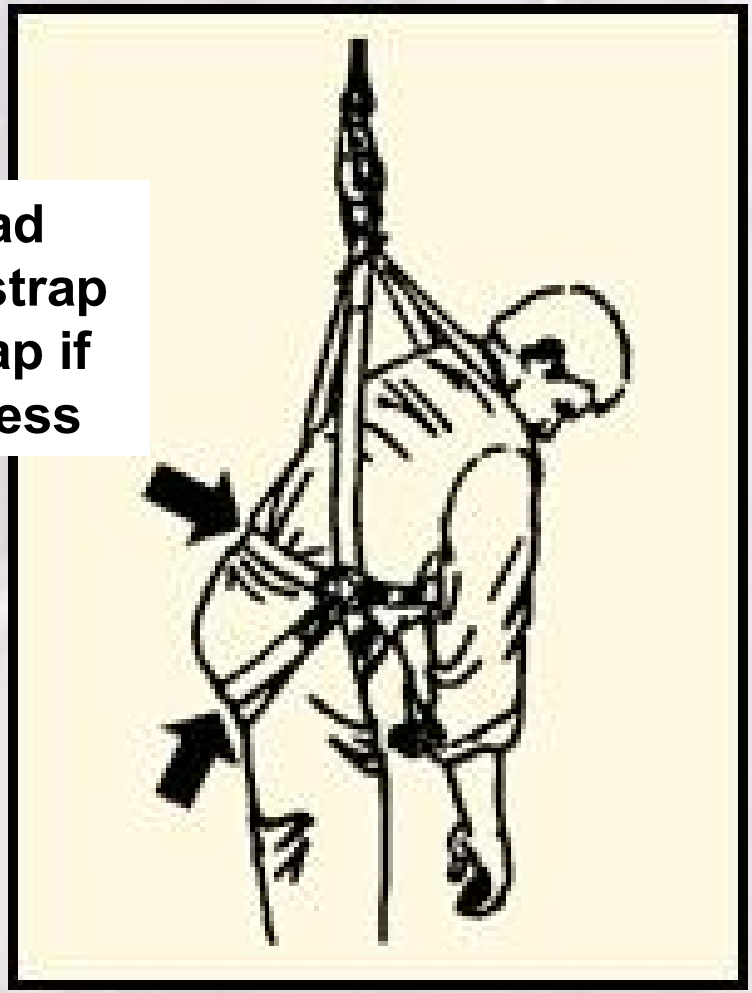
# Proper Adjustment Is Key

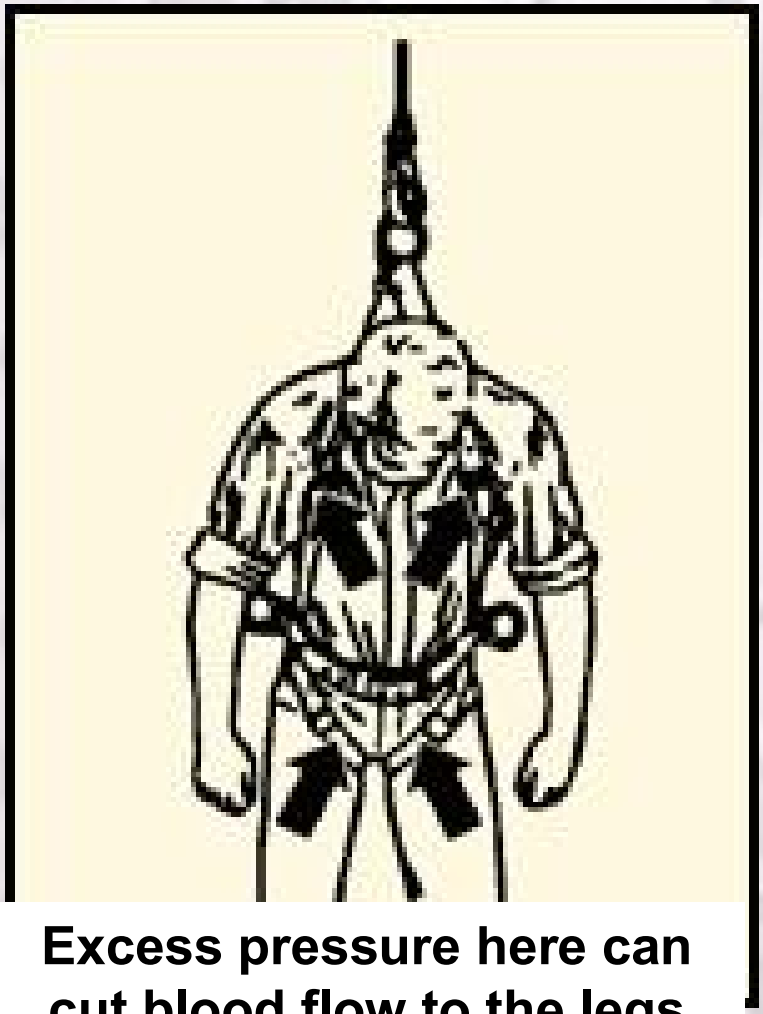
**“Rules of Thumb”**

- Be able to reach your D-ring with your thumb
- Maximum Four (flat) Fingers of Slack at the legs, straps as high as comfortably possible
- Ensure chest strap is across the chest/breastbone
- Have a buddy double check for twists, etc…

# Harness Pressure Points

**Spread load across butt strap and belt strap if on the harness**



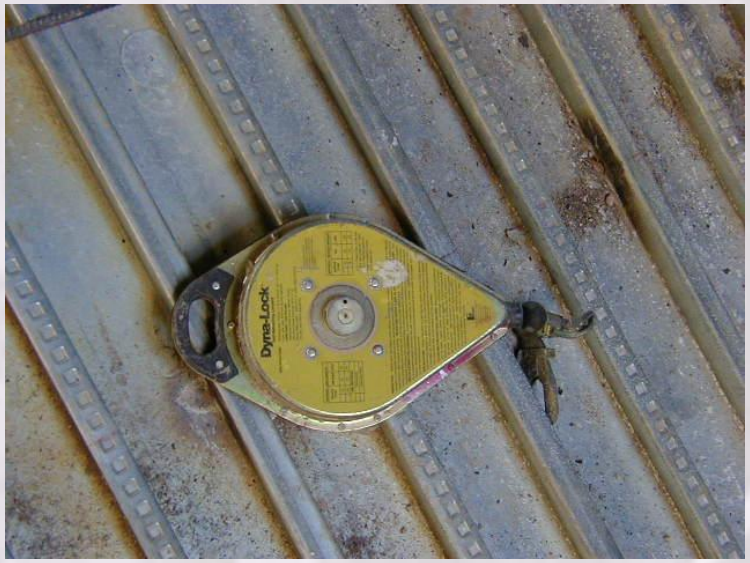


**Excess pressure here can cut blood flow to the legs**

***Some studies have indicated permanent damage to the lower extremities when the worker hangs for more than twenty (20) minutes***

# Connectors (Lanyards)

- Should be inspected before each use
- Should not be tied back to themselves (unless specifically designed for such use)
- Should be worn with the impact absorber/shock pack at the d-ring
- Should have the appropriate clip for the intended anchorage points
  - Do not use large climbing/rebar/ladder hooks with “beamers”




# Retractable Lifelines

- Very effective for vertical applications.
- Will normally lock up in 1 –2 feet, minimizing total fall distance and impact forces on the worker's body

# Do Not Hook Lanyards to Retractables!

- This worker is hooked to a retractable lifeline with his lanyard.
- This can cause hook failures and affect the locking capability of the retractable.
- The retractable should be attached directly to the “D” ring.

# Positioning Systems

- Positioning Devices Provide Hands-free Work
  - Additional Fall Protection (tie-off) may be required to move or access

# Positioning

# Restraint Devices

- Provide Access but Prevent the Fall
- Limit anchorage requirement to 3000#
- May be more suitable for loading areas, scaffold erection and dismantling
- Should be installed and used under the supervision of a Competent Person

# Fall Restraint


- **Fall restraint assumes the employee cannot reach the edge.**
- **He is basically on a short leash.**
- **If the employee could reach to the edge and fall over the edge, he must be in fall arrest.**

# Use of Restraint Cables

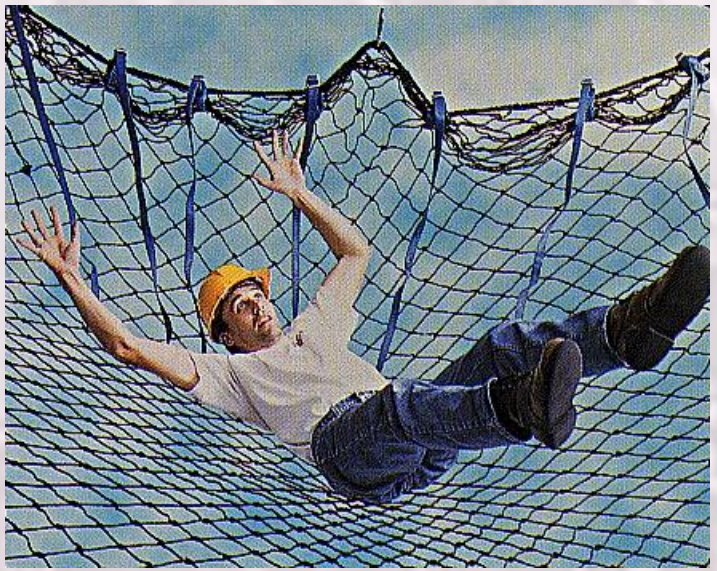
Example of restraint cables used during deck anchoring.

RESTRAINT CABLE

# Will This Work?

# Use of Safety Nets

- Assumes the fall will occur
- Assumes adequacy of the system (or requires testing)



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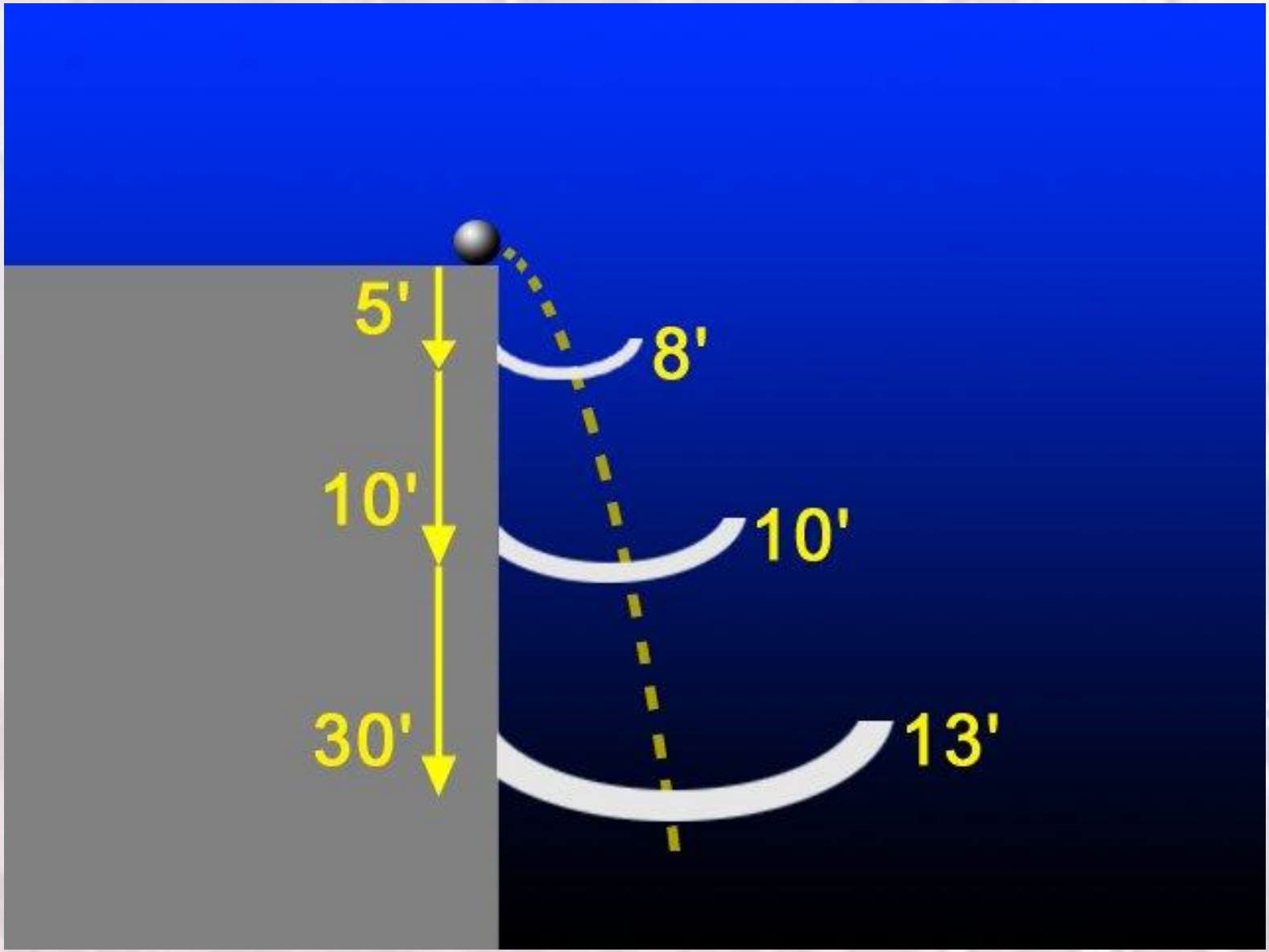
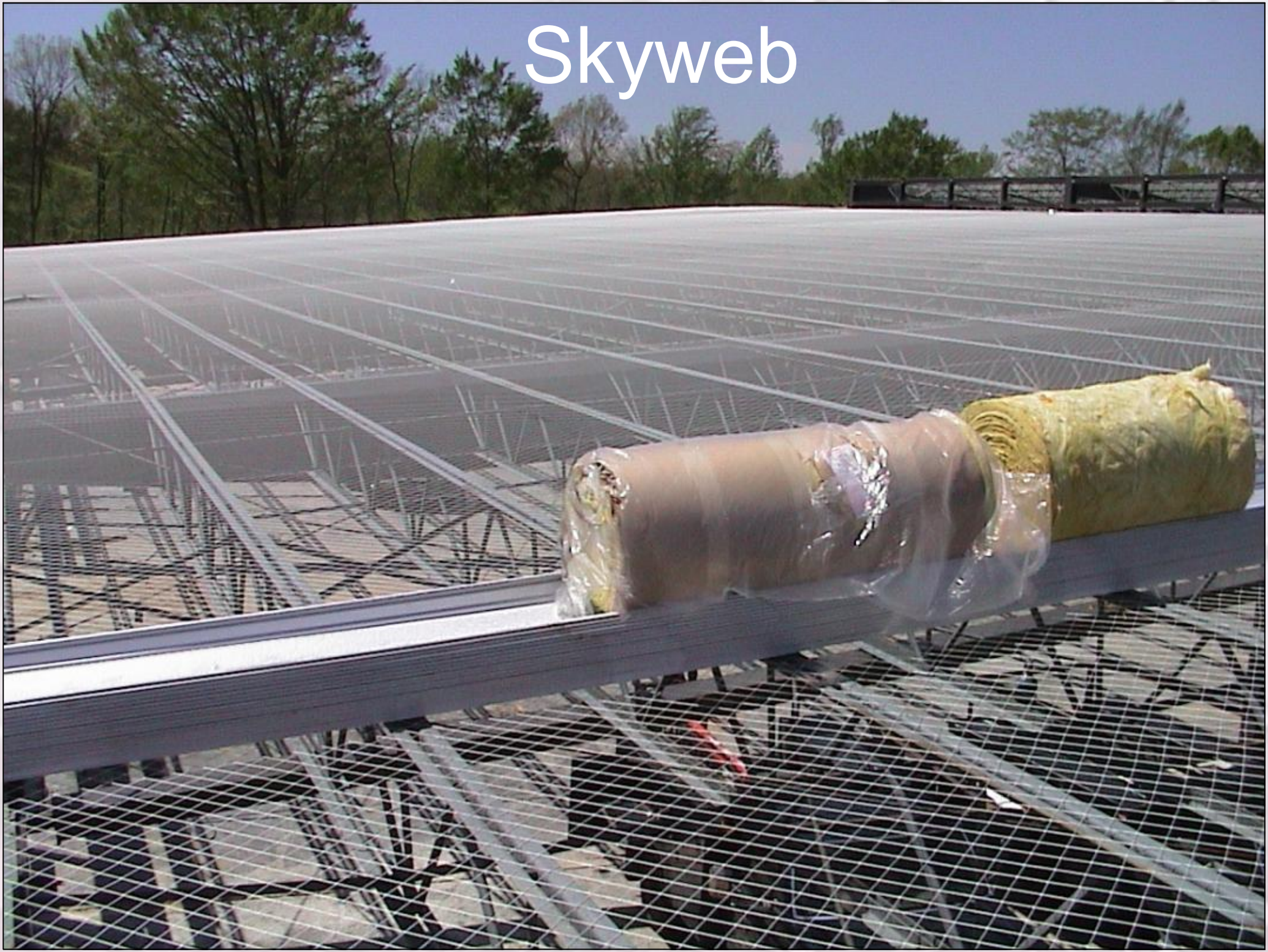


# Skyweb



# Planning For Rescue

Worst-case Scenario?

# When All Works!

# Rescue Plan Put Into Motion

# Safe

# On The Ground And Still Alive!

# Training

Define “Adequate”

# Training

- By a “qualified” or “competent” person
- The nature of hazards
- Appropriate systems and use
- Limitations
- Evaluated
- Re-training
- Documentation/Certification?

# Classroom

# Hands-on

# Site Specific

# Planning for Fall Protection

- Best practice dictates that fall protection becomes an integral part of the project planning process, from constructability, to systems installation, to use and maintenance
- A project cannot be truly safe unless fall protection is incorporated into every phase of the construction process
- Planning will keep workers safe and minimize liability for all parties involved