



TCM 2430 – Construction Safety

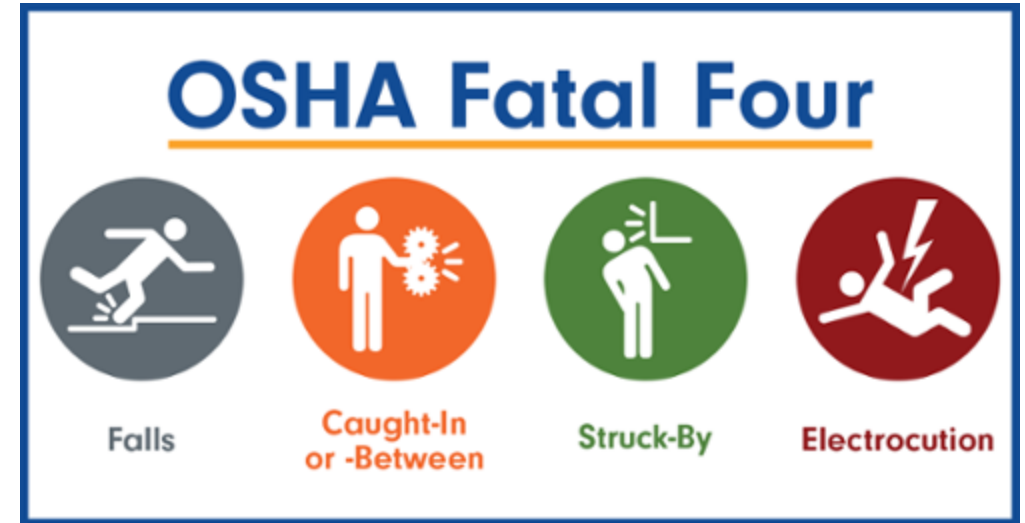
Week 7 – Protection against Falls and Struck-by-Objects



Dr. Tommy Tafazzoli

What do we mean by construction fatal fours?

- Falling
- Electrocution
- Hit-by-object
- Caught-in/between



The above fatal four are, according to OSHA, the leading causes of worker deaths at construction sites.

These **Fatal Fours** are responsible for **more than half** of the construction **deaths**.

Job site accident terminology

Accident

- An accident is an unplanned event that has **inconvenient or undesirable consequences**, other times being inconsequential.

Incident

- An incident denotes an unintended event that possibly **doesn't result in a loss**.

Hazard

- Anything that can **potentially hurt or harm** you through contact.

Exposure

- How **susceptible** you are to an injury or illness because of being **near** a hazardous substance or material.

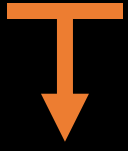


Video ACCIDENT VS INCIDENT | The difference explained

https://www.youtube.com/watch?v=iecEJPLLQDo&ab_channel=AllySafety



Click here in full screen mode to open the video link



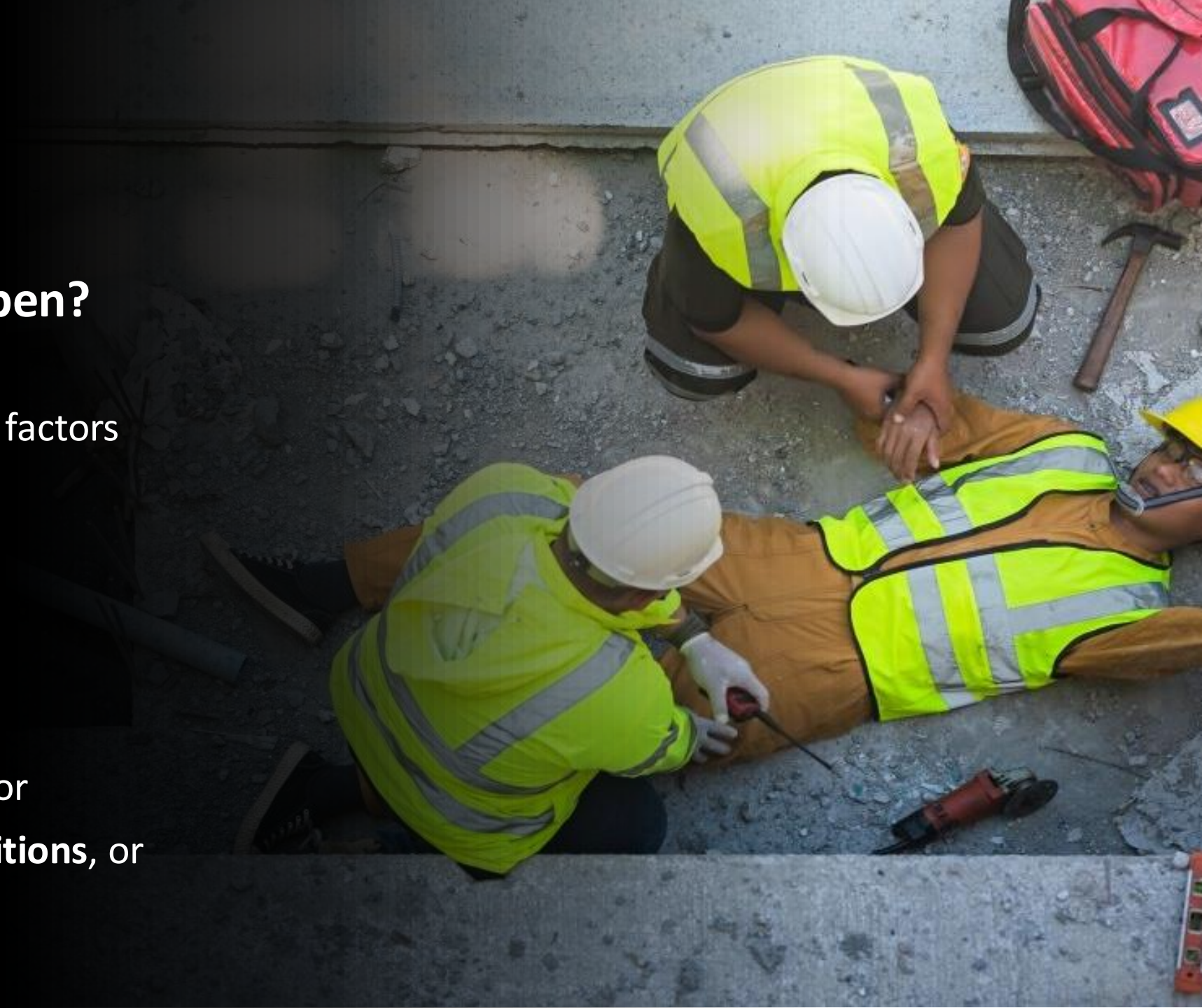
When do accidents happen?

For an accident to happen, two factors should be present:

1. **hazard**
2. **exposure** to the hazard.

Accidents may result from:

1. an **unsafe act** by a worker or
2. from **unsafe working conditions**, or both.



What are the main four theories about the occurrence of accidents?

Theory	Explanation
Single Factor Theory	One event is solely responsible for an accident, akin to the “pilot error syndrome”
Domino Theory	Change of sequential events trigger each other to cause an accident, removing a factor prevents the chain reaction
Multiple Factor Theory	Analyzes 3 phases, precontact, contact, post contact, and influencers like management, machines, and workers
Human Factor Theory	Analyzes factors that lead to human error such as overload and inappropriate activities and responses
Swiss Cheese Theory	Breakdown of components of a complete system creates holes that line up creating an accident condition

Video

Swiss Cheese Model

- https://www.youtube.com/watch?v=ByQRDuXOgl8&ab_channel=EnergyInstitute



Click here in full screen mode to open the video link



Are most accidents caused by unsafe conditions or unsafe behavior?

Research into why construction accidents occur has shown that about **90% of accidents** on construction sites are due to **unsafe behavior**, and about 10% are due to unsafe worksite conditions.

What are the 11 causes of unsafe behavior on the job site?

Lack of Training

Inadequate
Supervision or
Vague Guidance

Poor condition
of physical
environment

Rushed Work
and mental
stress

Fatigue or
Overtime work

Multi-Tasking or
Overnight work

Inadequate
Communication

Peer Pressure,
interruptions
and distractions

Inadequate Risk
Assessment

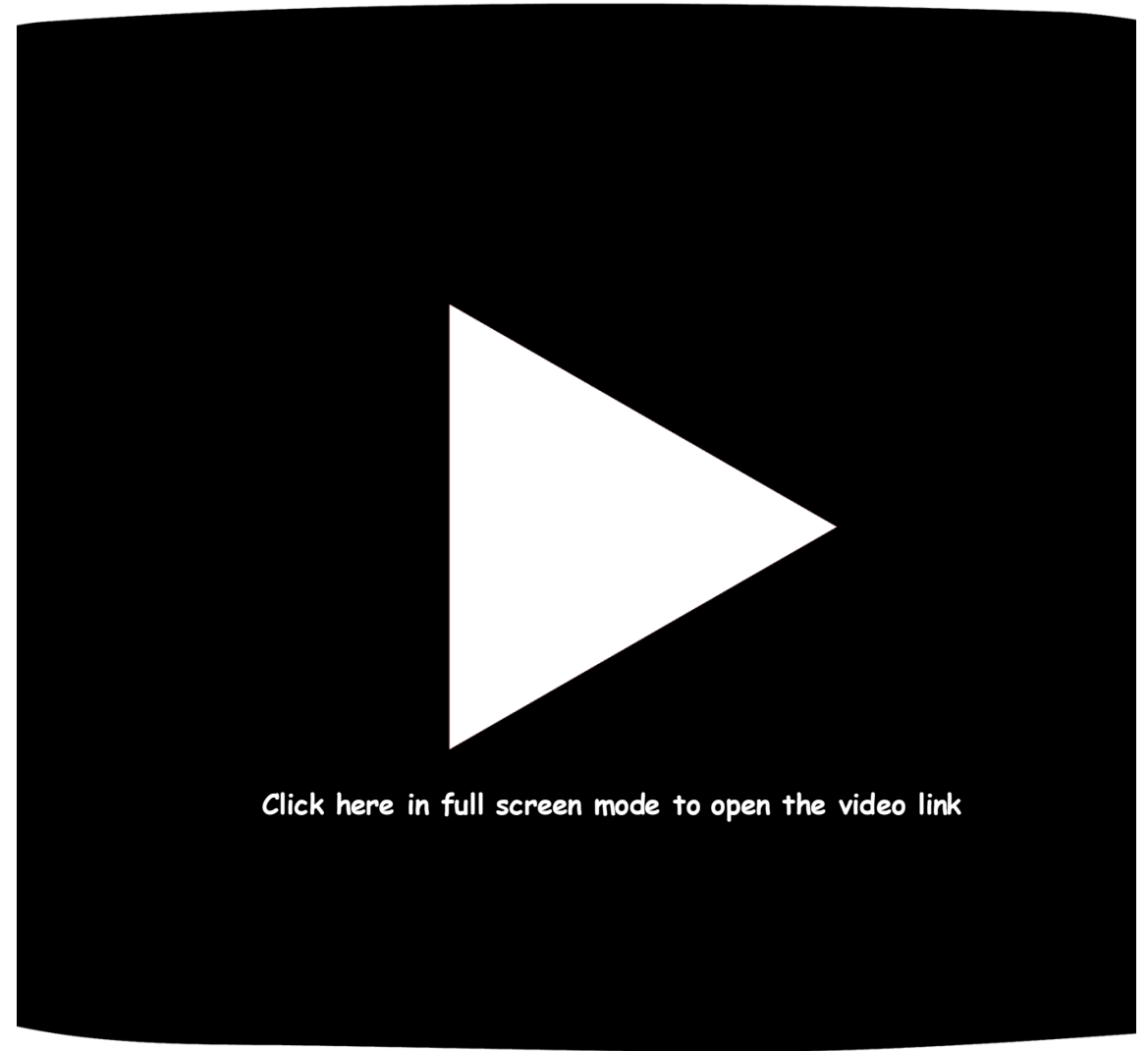
Overconfidence

Lack of Safety
Culture or
Ignoring it

Video

A quick guide for working on steep roofs

- <https://www.youtube.com/watch?v=A-rLmUwB2ck>





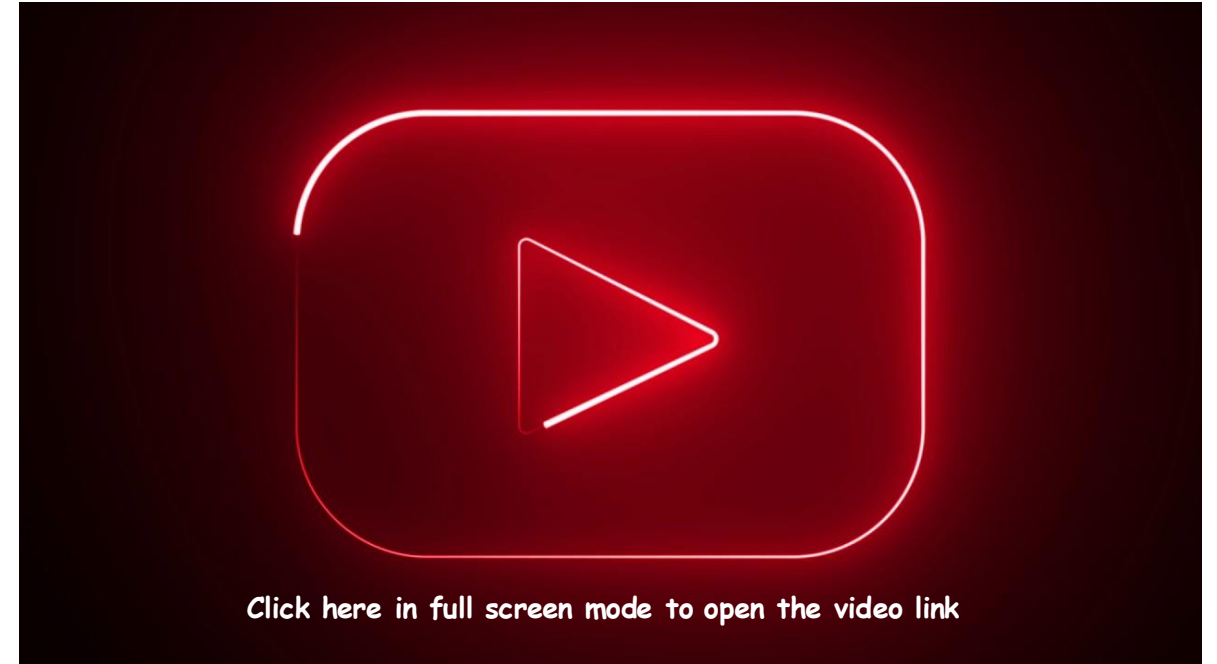
What do we mean by direct and indirect costs of accidents?

- Direct costs of accidents are those costs covered by insurance.
- Indirect cost is not paid by insurance and thus is unrecoverable.

Video

The Direct and Indirect Costs of Workplace Injuries

- https://www.youtube.com/watch?v=G51pFkCL2Ss&ab_channel=CloudApperAI



What are some examples of direct costs of accidents?

- Physical therapy
- Medical expenses
- Repair fees for damaged equipment
- Continuation of pay
- Compensatory damages
- Workers' compensation insurance premium cost
- Liability insurance premium cost
- Equipment liability insurance premium cost
- Legal expenses associated with claim resolution

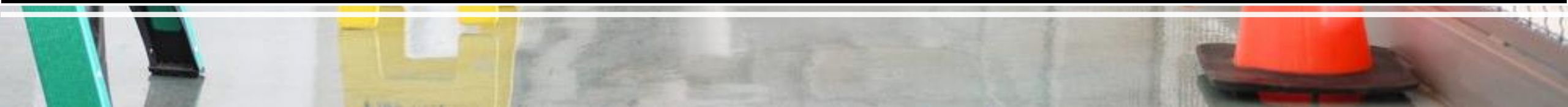


What are some examples of indirect costs of accidents?

- First-aid expenses
- Damage or destruction of materials
- Cleanup and repair cost
- Idle construction machinery cost
- Unproductive labor time
- Construction schedule delays
- Loss of trained manpower
- Work slowdown
- Administrative and legal expenses
- Lowered employee morale
- Third-party lawsuits
- Cleanup, preparation, and replacement cost of damaged materials, machinery, and property
- Wages paid to injured workers for absences not covered by workers' compensation
- Lost wages and work stoppage associated with the worker injury
- Overtime due to the accident
- Administrative costs and time spent by safety personnel, clerical workers, and other employees after the injury
- Training for replacement workers
- Lost productivity due to the work unit separation from the injury
- Accommodation of the injured employee within the organization



Fatal Fours: FALLS



Physics of fall

- There are more than 100,000 injuries and deaths per year due to work-related falls.
- A body in free fall can travel 4 feet in 0.5 seconds.
- A body in free fall can travel 16 feet in 1 second.
- A body in free fall can travel 64 feet in 2 seconds.





YouTube

Click here in full screen mode to open the video link

Video
FALL PROTECTION
BASICS | ABCD's,
Demonstration, PFAS,
Fall Restraint vs. Fall
Arrest, and more!

- https://www.youtube.com/watch?v=TEf1Tsx_3MA&ab_channel=AllySafety

How can I prevent falls on a job site?

Install Guardrails
and Barriers

Use Safety Nets

Require Personal
Fall Arrest
Systems (PFAS)

Erect and Inspect
Scaffolds
Properly

Train Workers on
Ladder Use

Cover or Guard
Floor Openings

Implement Roof
Fall Protection

Regularly Inspect
Equipment

Provide
Comprehensive
Training

Develop a Fall
Protection Plan

Prioritize Fall
Prevention

Ensure Adequate
Lighting

Promote Safe
Work Practices

Foster a Safety
Culture

Conduct Regular
Safety Meetings

Establish
Emergency
Response
Procedures

Ensure
Regulatory
Compliance

What areas are required to have fall protection?

Unprotected sides and edges	Leading edges	Hoist areas	Holes	Formwork and reinforcing steel
Ramps, runways, and other walkways	Excavations	Dangerous equipment	Overhand bricklaying and related work	Roofing work on low-slope roofs
Roofs	Precast concrete erection	Residential construction	Wall openings	Walking/working surfaces not otherwise addressed

Professionals' advice on fall protection

- Fall protection is generally required when one or more employees have exposure to falls of 6 feet or greater to the lower level.
- Surfaces must be inspected before the work begins.
- Employees are only permitted to be on surfaces that are strong enough to support them.
- Employers are expected to assess the workplace in order to decide if the walking/working surfaces on which employees are to work have the strength and structural integrity to safely support workers.
- Employees are not allowed to work on these surfaces until it has been determined that the surfaces have the necessary strength and structural integrity to support workers.

What are the main tools to protect against falls on a construction jobsite? *(Slide 1 of 4)*

- **Personal Fall Arrest Systems (PFAS):** These systems typically consist of a full-body harness, lanyard, and anchor point. Workers wear the harness, and the lanyard is attached to the harness and secured to a suitable anchor point. In the event of a fall, the PFAS prevents the worker from hitting the ground.
- **Guardrails:** Guardrails are physical barriers placed around open edges of elevated work areas, such as scaffolds, platforms, and roofs. They prevent workers from accidentally falling.
- **Safety Nets:** Safety nets are installed beneath elevated work areas to catch falling workers or objects, reducing the risk of injury or damage.

Personal Fall Arrest Systems (PFAS)

A Personal Fall Arrest System
Consists of 3 Main Components:

1. Full Body Harness
2. Connecting Device
3. Anchorage

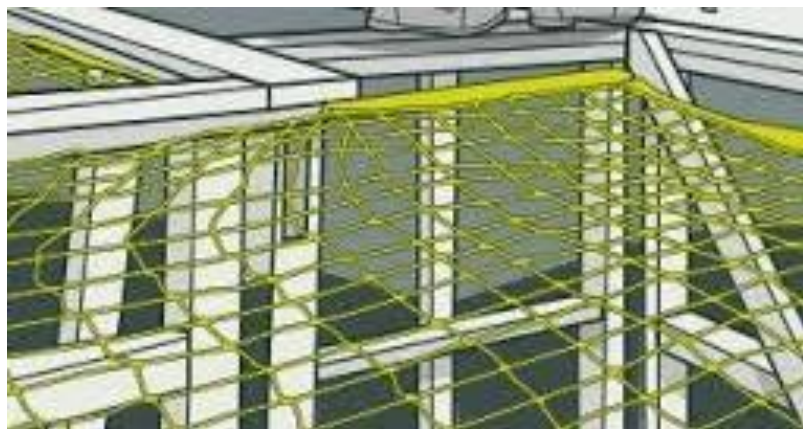


Personal Fall Arrest System

THE EXPERTS
Robson Forensic

Guardrails





Safety Nets

What are the main tools to protect against falls on a construction jobsite? *(Slide 2 of 4)*

- **Safety Harnesses:** Workers wear safety harnesses as part of a personal fall arrest system. These harnesses distribute the force of a fall across the body, reducing the risk of injury.
- **Lanyards and Lifelines:** Lanyards are used to connect a worker's harness to an anchor point, while lifelines are used for horizontal movement on elevated surfaces. They are crucial components of personal fall arrest systems.
- **Anchorage Points:** Anchorage points are secure attachment points for lanyards and lifelines. They can be fixed, such as anchor bolts, or temporary, like anchor straps.



Safety Harnesses



FALL PROTECTION SAFETY GEAR GUIDE



[CertifyMeOnline.net](https://www.certifymeonline.net)

Hard hat



Safety glasses



Work shirt



Construction vest



Work pants



Gloves



Leather boots



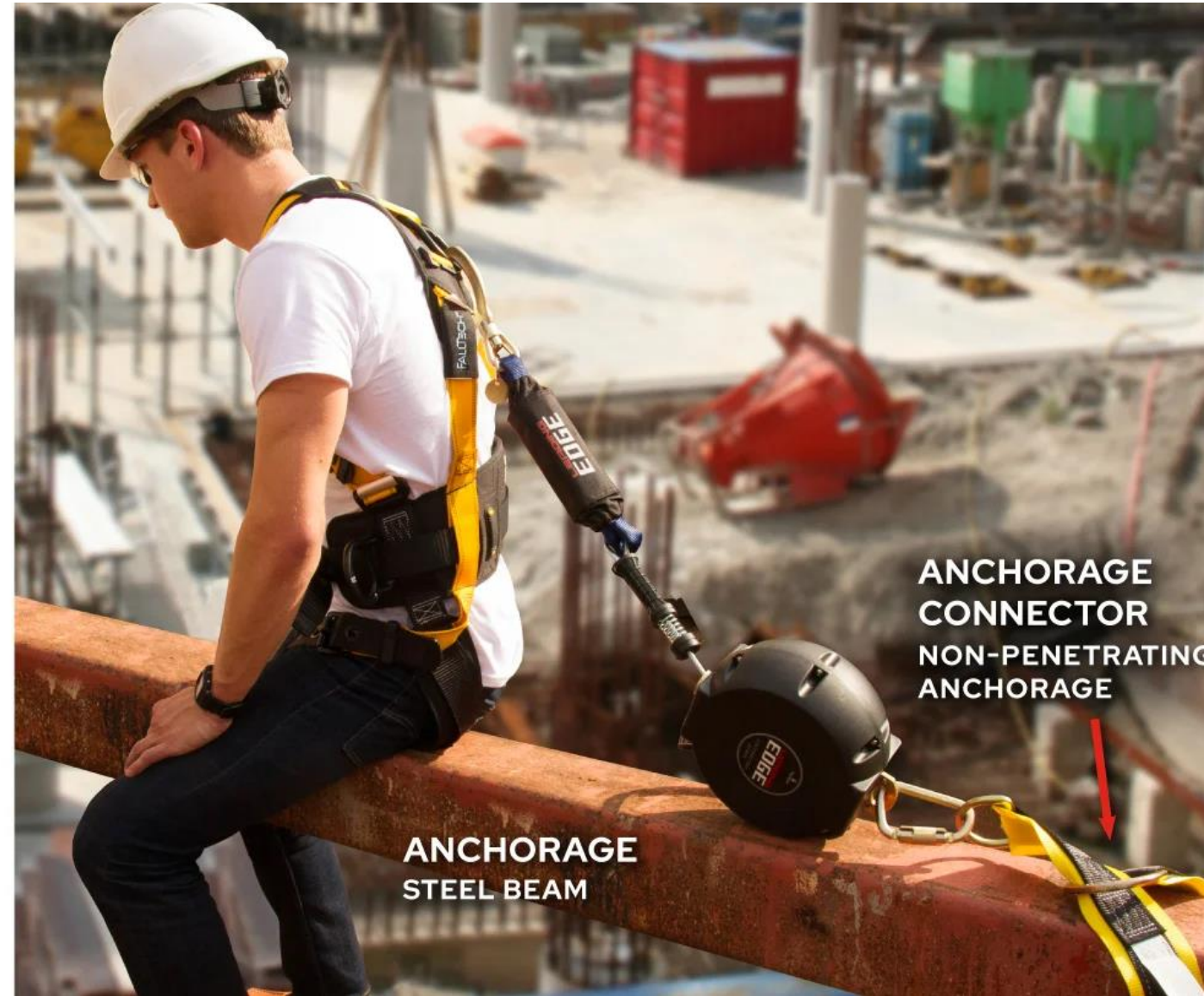
Fall protection



Lanyards and Lifelines



Anchorage Points



What are the main tools to protect against falls on a construction jobsite? *(Slide 3 of 4)*

- **Scaffolding:** Properly constructed scaffolding with guardrails and toe boards provides a safe working platform at elevated heights.
- **Ladder Safety Devices:** These devices, such as ladder cages or ladder safety gates, enhance ladder safety and prevent falls.
- **Safety Barricades:** Temporary barricades are used to create exclusion zones and keep unauthorized personnel away from potential falling object hazards.

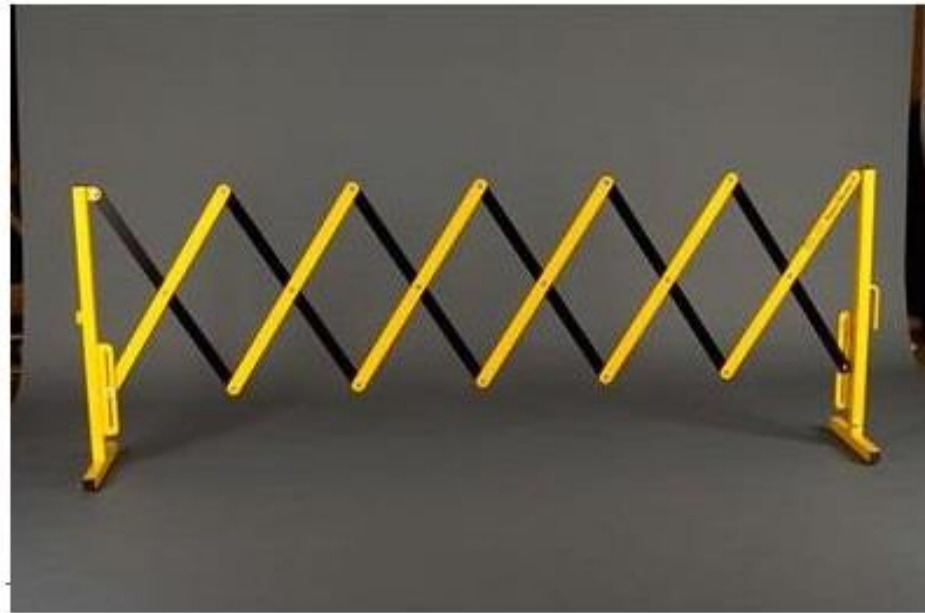
Scaffolding



Ladder Safety Devices



Safety Barricades



What are the main tools to protect against falls on a construction jobsite? *(Slide 4 of 4)*

- **Safety Warning Signs:** Signs indicating potential fall hazards and safety rules are essential for communication and hazard awareness.
- **Safety Training and Education:** Training programs and educational materials help workers understand the importance of fall protection and how to use safety equipment properly.
- **Regular Equipment Inspection:** Inspections of all fall protection equipment, including harnesses, lanyards, and anchors, are necessary to ensure they are in good condition and safe to use.
- **Rescue Equipment:** Having rescue equipment readily available, such as fall arrest retrieval systems or rope access gear, is essential for quickly rescuing a worker in the event of a fall.
- **Fall Protection Plan:** A well-defined fall protection plan specific to the job site ensures that all necessary precautions are taken to prevent falls and respond to incidents effectively.

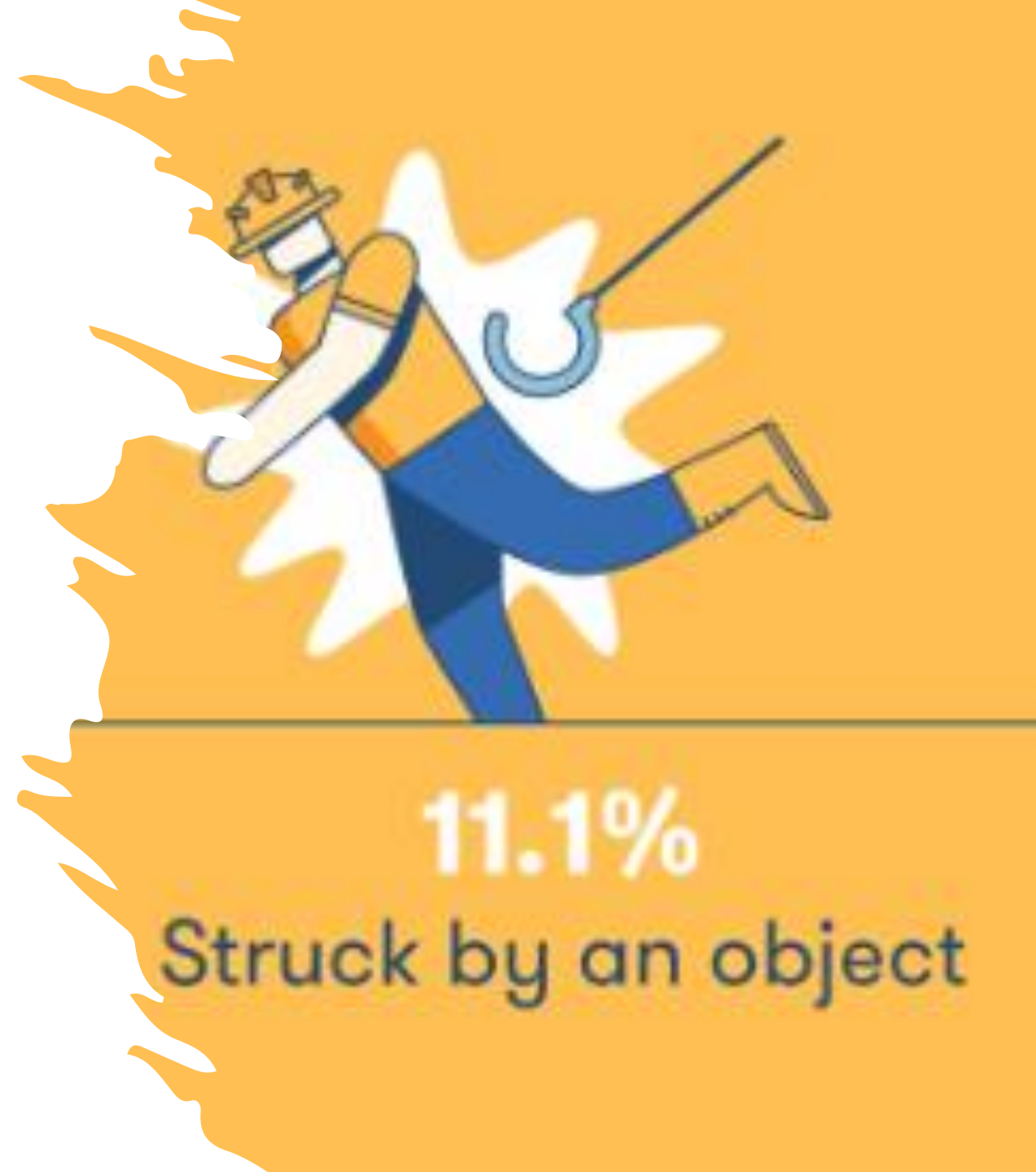
These tools and equipment, along with proper training and adherence to safety procedures, are critical for safeguarding workers and minimizing the risk of falls on construction job sites.



Fatal Fours: Struck (Hit)-by-Objects

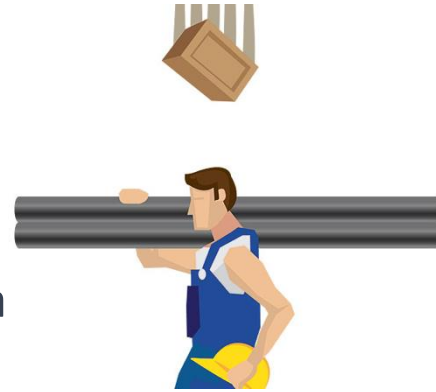
What do we mean by struck-by-object accidents?

- These accidents include objects that are falling (suspended load coming loose), flying (thrown tools or debris), swinging (load swaying), or rolling (vehicle or heavy equipment in motion).
- In these scenarios, employees are sometimes caught off guard and don't have enough time to respond and move out of the way.
- Only falls rank higher and is the number one cause of death in the construction industry.
- OSHA estimates that 75% of struck-by fatalities involve heavy equipment like trucks or cranes.



How Do we prepare against being struck by objects?

1. **Hard Hat Usage:** Require all workers to wear hard hats at all times to protect their heads from falling objects.
2. **Exclusion Zones:** Establish exclusion zones around overhead work areas where there's a risk of falling objects. Ensure that only authorized personnel enter these zones.
3. **Tool Tethering:** Use tool tethering systems to secure tools and equipment at heights. This prevents them from falling.
4. **Barricades and Warning Signs:** Use barricades, cones, and warning signs to mark off hazardous areas and inform workers and visitors of potential risks.
5. **Safety Netting:** Install safety netting or toe boards on scaffolds and elevated work area to catch falling objects.
6. **Debris Nets:** Use debris nets or screens to contain and prevent construction debris from falling to lower levels.
7. **Secure Materials:** Ensure that construction materials are properly stored and secured to prevent them from rolling or falling.
8. **PPE:** In addition to hard hats, provide appropriate personal protective equipment (PPE) such as safety glasses, high-visibility vests, and steel-toed boots to reduce injury risk.
9. **Equipment Inspection:** Regularly inspect heavy equipment, cranes, and lifting devices to ensure they are in good working condition and won't drop loads unexpectedly.
10. **Worker Training:** Train workers on safe work practices and the importance of staying alert and aware of their surroundings to avoid potential hazards.



Mote Safety tips to prevent struck-by-object accidents *(slide 1 of 2):*

- Always install, use, and maintain vehicle backup alarms.
- Station flaggers behind vehicles that have obstructed rear views.
- Keep nonessential workers away from areas of vehicle use.
- Keep workers away from temporary overhead activities.
- Place barriers and warning signs around hazardous operations and public roadways.
- Never put yourself between moving or fixed objects.
- Always wear bright, highly visible clothing when working near equipment and vehicles.



Mote Safety tips to prevent struck-by-object accidents *(slide 2 of 2):*

- Use manufacturer-approved safety restraints unless the vehicle is not designed for them.
- Never allow workers to drive equipment in reverse without an alarm or flagger.
- Enforce a limited access zone before dumping or lowering buckets.
- Properly turn off and block all equipment, including accessories.
- Set parking brakes and use chock wheels if parked on an incline.
- Install cab shields on hauling vehicles to protect against struck-by and rollover injuries.
- Never exceed the vehicle's rated lift capacity or carry unauthorized personnel.
- Use signs, barricades, and flaggers to protect workers near roadways.
- Use proper lighting and reflective clothing/vests at night.



When do we need to get prepared for struck-by-object incidents ?

- Protection from struck-by-object incidents should be an ongoing priority on construction sites.
- It is relevant at all stages of a construction project, from planning and pre-construction to active construction and even during demolition and site cleanup.



What are examples of falling objects?

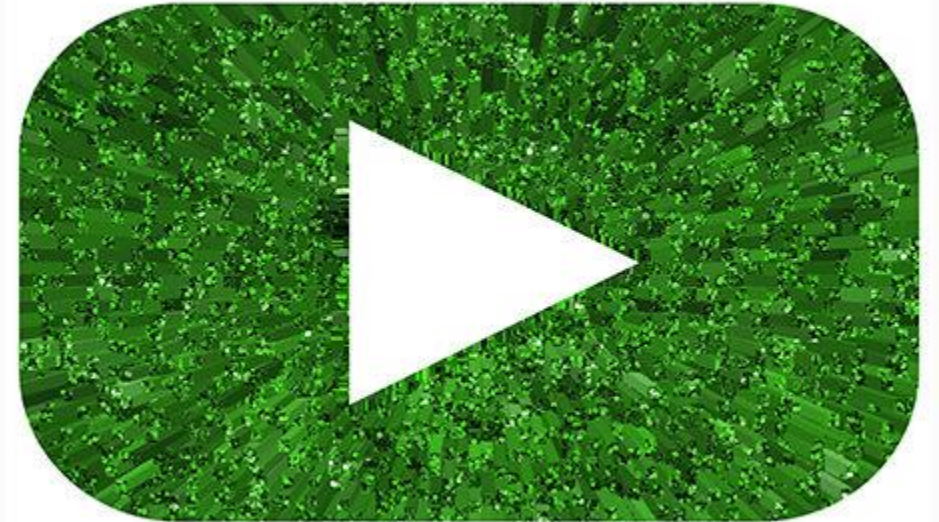
Falling objects can include:
tools,
materials,
debris,
equipment,
and they pose a significant hazard due to
the force and potential for serious harm.



Video

The Dropped Object Experiment Black & Veatch Safety Awareness

- https://www.youtube.com/watch?v=6wQKUDX7D94&ab_channel=Black%26Veatch



Click here in full screen mode to open the video link

Why is protection against falling objects a must?

- 1.Safety:** Falling objects can cause severe injuries, including head trauma, fractures, and even fatalities. Protecting against falling objects is a fundamental aspect of ensuring construction site safety.
- 2.Legal Requirements:** Many occupational safety regulations mandate protection against falling objects on construction sites. Failure to comply can result in fines and legal consequences.
- 3.Productivity:** A safer work environment contributes to higher worker morale and productivity, as workers can focus on their tasks without the fear of falling objects.



A close-up photograph of a construction worker wearing an orange hard hat. The worker's face is partially visible, showing blue eyes and a concerned expression as they look upwards. Above the worker's head, a wooden beam is suspended in the air, suggesting a potential falling object hazard. The background is a plain, light-colored wall.

When is protection against falling objects needed:

- **During All Construction Phases:** Protection against falling objects is necessary throughout all construction phases, from initial site preparation to demolition and cleanup.
- **Whenever Work is Conducted Above Ground:** Any work performed at elevations where objects can fall, such as scaffolding, elevated platforms, or work on upper levels of structures, requires protection against falling objects.
- **When There's Activity Above or Below:** Even when workers are not directly above the ground, objects can fall from heights or be dislodged from work areas above or below.

How can I protect my workers against falling objects?

- Make Them Wear Appropriate PPE
- Install Safety Nets and Catch Platforms
- Use Toe Boards and Guardrails
- Secure Tools and Equipment
- Establish Barricades and Exclusion Zones
- Conduct Regular Inspections
- Store Materials and Tools Securely
- Ensure Clear Communication
- Provide Training
- Supervise and Enforce Safety Measures
- Establish Emergency Response Procedures



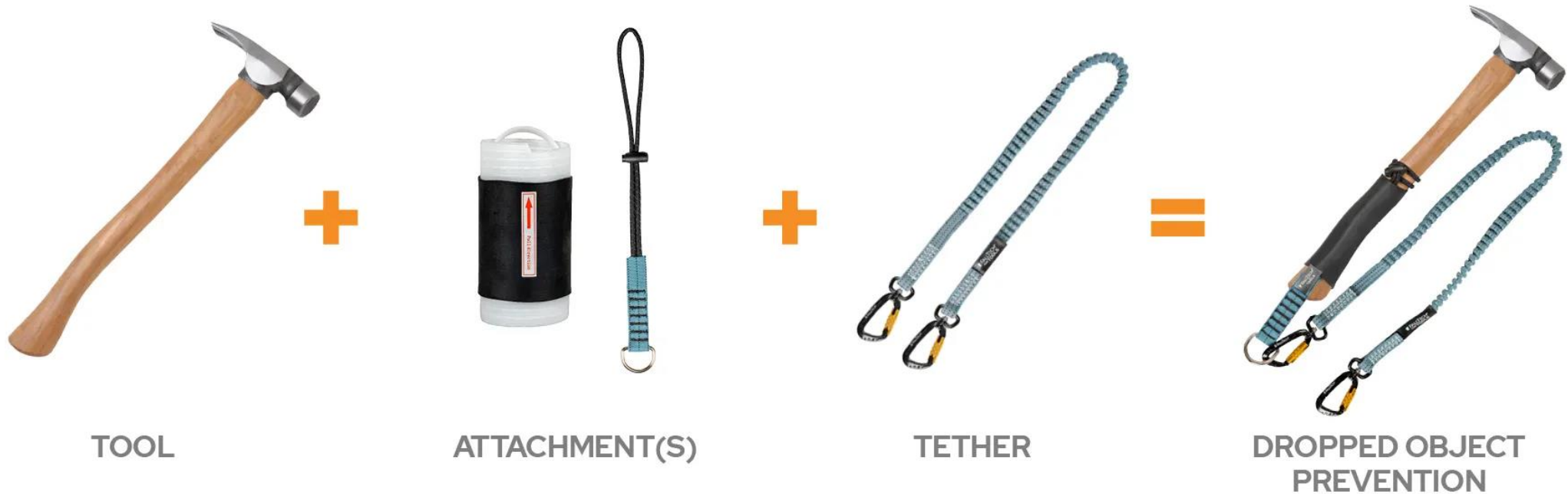
Selection of fall protection systems based on site conditions

Site Conditions	Selection
There is a hoisting area without guardrails	Personal fall arrest system
Workers are working 4 feet above paving equipment	Equipment guards
An 8-foot deep hole is hidden by overgrown grasses	Fences
Roofers are working on low-slope roofs with unprotected sides	Warning line and safety monitoring systems
Workers may be hit by falling tools and materials	Hardhats and barricades
Falling tools and materials	Toe boards
Work on a roof with an unprotected edge	Warning line system
Workers working on a 12-foot high wall	Positioning device system
Workers on a roof with large holes	Covers



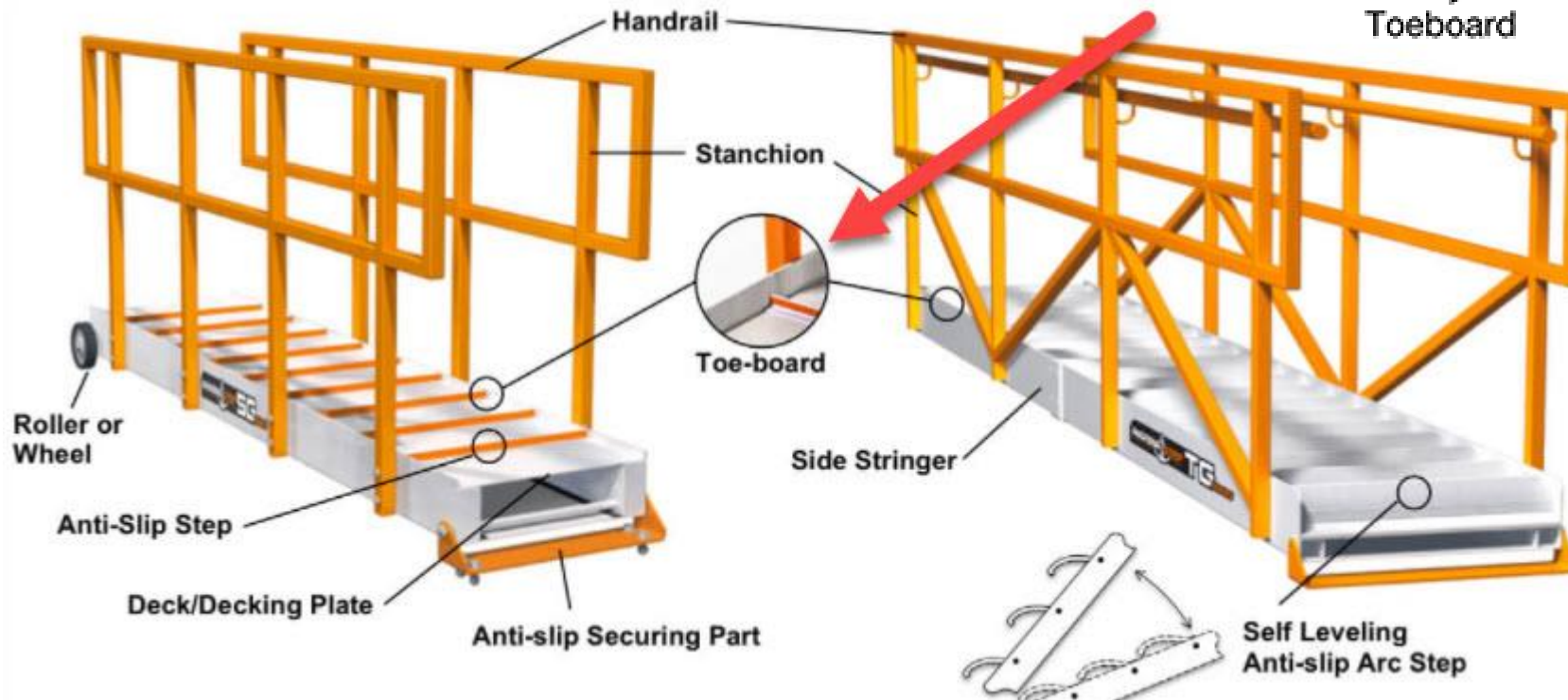
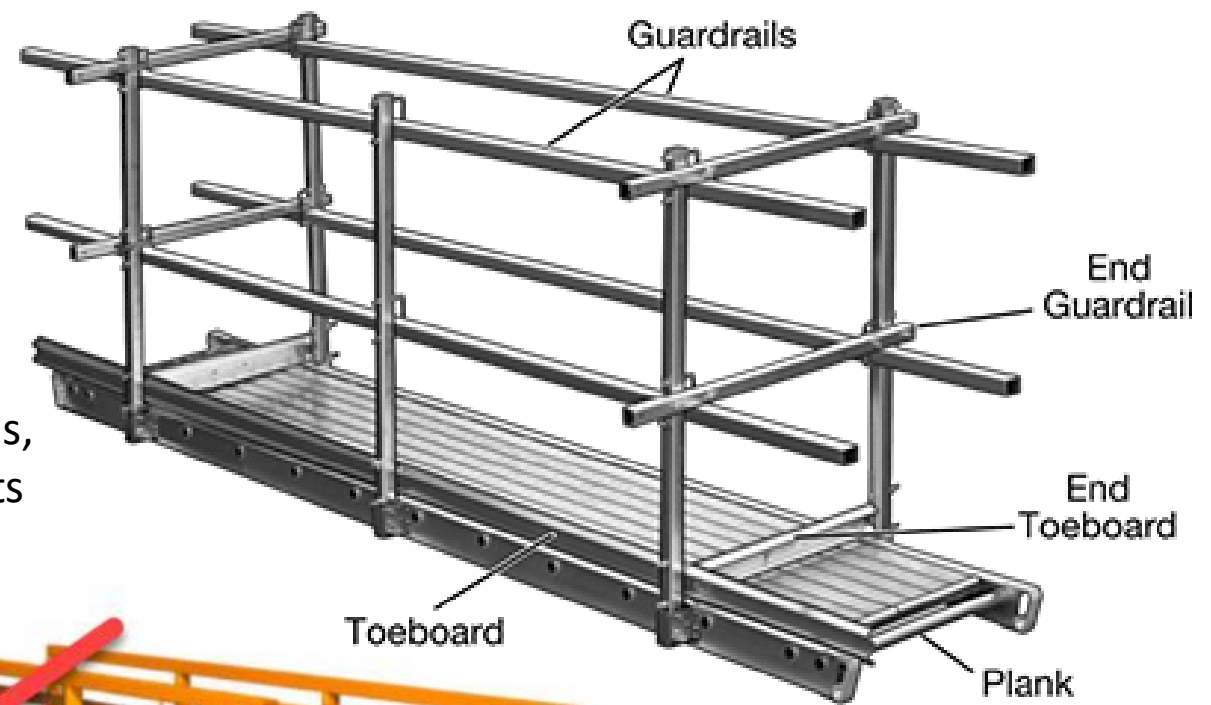
Tool Tethers and Lanyards

These are used to secure tools and equipment to prevent them from falling when workers are at heights. Tool lanyards can be attached to a worker's belt or harness.



Toe Boards

Toe Boards: Toe boards are used along the edges of scaffolds, elevated platforms, and other open edges to prevent objects from falling over the side.

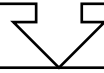


Hard Hats: Workers should wear hard hats to protect against head injuries from falling objects.

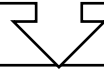


What are the steps to create a fall protection plan?

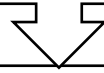
Step 1. Develop a written fall protection plan and train employees in fall protection.



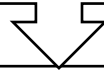
Step 2. Assess potential fall hazards prior to each project.



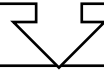
Step 3. Use administrative controls to eliminate hazards by changing or rescheduling tasks.



Step 4. Inspect fall protection equipment to ensure its condition and appropriateness.



Step 5. Before starting work, remind employees of specific fall hazards that are present on the jobsite.



Step 6. Once work has begun, observe workers to ensure that fall protection is being used properly.