Colorado Asphalt Pavement Association

# Road Construction Work Zone Safety

Protecting workers on road and highway construction sites

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## Safety in Road Construction Work Zones

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## What this presentation covers

- Road construction hazards
- Roadway worker fatalities
- Traffic control measures
- Construction vehicle blind spots
- How to protect roadway workers
- AI in asphalt construction
- Resources

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Workers in construction, utilities, or public works jobs on both highways or city streets are at risk of fatal or serious debilitating injuries.

The work is in congested areas with exposure to high traffic volumes and speeds, as well as under conditions of low lighting, low visibility, and inclement weather.

The work is routinely near both moving construction vehicles and passing motor vehicle traffic.

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## How are roadway workers exposed or at risk?

Workers in temporary traffic control work zones are exposed to risk of injury from construction vehicles and motorized equipment:

- Operating in and around the active work zone(s)
- Operating in traffic control or secondary areas that support the work zone ( ex. - temporary batch plants)
- Entering and leaving the work zone

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## How are roadway workers at risk?

Workers in the roadway are at risk of injury from a variety of general traffic vehicles entering the work zone:

- Drunk drivers
- Sleepy or impaired drivers
- Impatient, reckless drivers
- Drivers using cell phones; other inattentive drivers
- Law enforcement and emergency vehicles
- Disabled vehicles pulling in and parking
- Lost drivers looking for directions

This attenuator truck was rear ended at 63 mph by an inattentive driver, despite workers' attempts to get the driver's attention.

Two workers were hurt and the driver received minor injuries.

The driver pled guilty to reckless endangerment of a road-way worker.

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## How are workers on foot at risk?

Flaggers and other Workers On Foot* are exposed to the risk of being struck if they are not visible to motorists or equipment operators.

Driver's view passing by a work zone under overcast/rainy conditions...

Do you see the flagger?

* Workers On Foot refers to any pedestrian worker on the ground in the work zone

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## How are equipment operators at risk?

Workers who operate construction vehicles or motorized equipment risk injury due to rollovers, collisions, being caught between or struck by operating equipment.


Paver run into by passing motorist

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## How bad is the problem of road construction workers fatalities in the United States?

WORKER DEATHS in roadway work zones from 1995-2002 (over 100/year avg.)

Statistical data regarding roadway construction-related worker deaths indicates that while fatalities fluctuate, they remain a significant safety concern, with hundreds of worker-pedestrians killed in work zones annually, and a specific sector averaging over 100 deaths yearly between 2003 and 2020

**2021-2022:** Highway worker occupational fatalities in road construction sites were 108 in 2021 and 94 in 2022.

**2023:** 88 fatal injuries occurred in the Highway, Street, and Bridge (HSB) sector.

**2024:** Fatal injuries in the HSB sector fell to 84.

91% of these were related to motor vehicle traffic or construction equipment, or both

Source: National Safety Council

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## Worker Fatalities in Roadway Work Zones (continued)

Emergency vehicles at accident scene

- The trend in worker deaths showed an increase...
  - 90 deaths/yr average between 1992-1997
  - 120 deaths/yr average between 1995-2002
- Construction vehicle related accidents are responsible for the increase in worker deaths
- Construction equipment accidents accounted for as many "worker on foot" deaths as traffic vehicles

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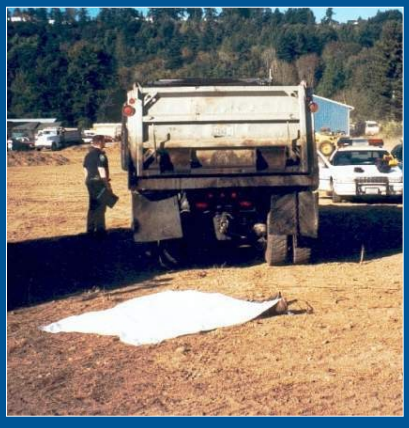
## Worker Fatalities in Roadway Work Zones
(continued)

Dump trucks were responsible for 41% of the "worker on foot" related deaths

52% of these involved dump trucks backing up!



Victim (under sheet) who was backed over by the Dump Truck

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## Traffic Control Around the Work Zone

Flaggers and other workers assigned traffic control responsibilities work very close to motor vehicles and are at risk of getting struck or run over by them.

Flaggers:

- must be trained in traffic control techniques
- Required to attend TCS Training?
- Must have a valid Traffic Control Flagger card from that training?

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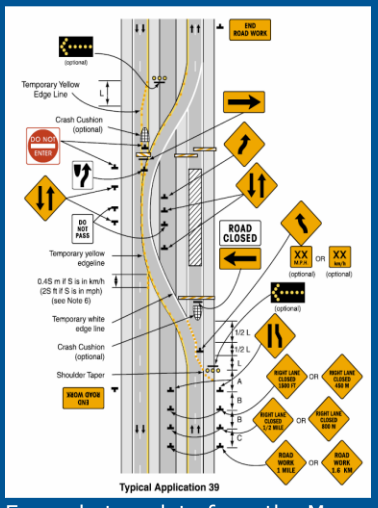
# Traffic Control Around the Work Zone

## Site-specific Temporary Traffic Control Plans

A Traffic Control Plan helps move motorist traffic safely through or around roadway work zones to protect the public and workers.

- It makes use of traffic control devices, standard signage, and buffer and transition zones.




Example template from the Manual on Uniform Traffic Control Devices

Click link to see more on the *Manual on Uniform Traffic Control Devices*

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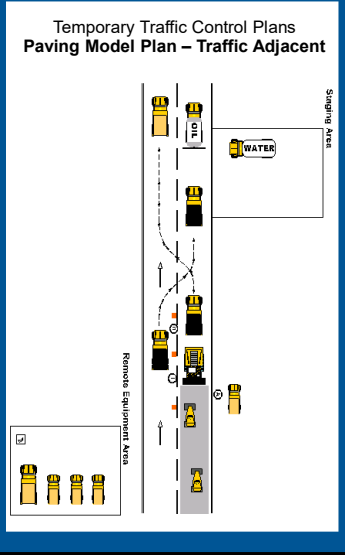
# Safety within the Work Zone: Temporary Traffic Control Plan

Example:




In the Temporary Traffic Control zone, construction vehicles and equipment moving inside create a risk to workers on foot requiring additional protection planning and policies to minimize backing-up maneuvers in the "activity area"

The Temporary Traffic Control "Activity Area" is the section of the highway where the work activity takes place. It is comprised of the work space, the traffic space, and the buffer space.

The "work space" is that portion of the road closed and set aside for equipment, workers, and material.

Work spaces are usually delineated apart from the traffic space, to exclude vehicles and pedestrians, by channelizing devices or temporary barriers and signs.

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## Safety within the Work Zone: Temporary Traffic Control Plan

-- Restrict personnel access points into work areas and define/designate "no backing zones" and "pedestrian-free zones"

-- Design into the Temporary Traffic Control Plan flow paths for equipment and vehicle traffic to minimize backing maneuvers where possible as well as buffer spaces to protect pedestrian workers from straying traffic vehicles and/or work zone equipment

-- Establish procedures for entering and exiting work zone

-- Train all employees on the Temporary Traffic Control Plan and its precautionary measures

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## Working at Night

Visibility is greatly reduced at night.

Your risk of getting injured or killed increases in the dark.

Drivers may be more tired, sleepy, and less attentive.

Hazards & Problems:

- poor visibility
- glare off lights
- adverse weather conditions
- tired drivers
- inattentive workers

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## Working at Night

Protect yourself when you must work at night by:

- being aware of your surroundings at ALL TIMES
- wearing High Visibility Apparel
- arranging good work area lighting
- setting up proper traffic controls
- knowing the traffic flow plan/pattern

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## Working Around Vehicles/Heavy Equipment

Vehicle and Heavy Equipment Blind Spots

A blind spot (or blind area) is the area around a vehicle or piece of construction equipment that is not visible to the operator, either by direct line-of-sight or indirectly by use of internal and external mirrors.

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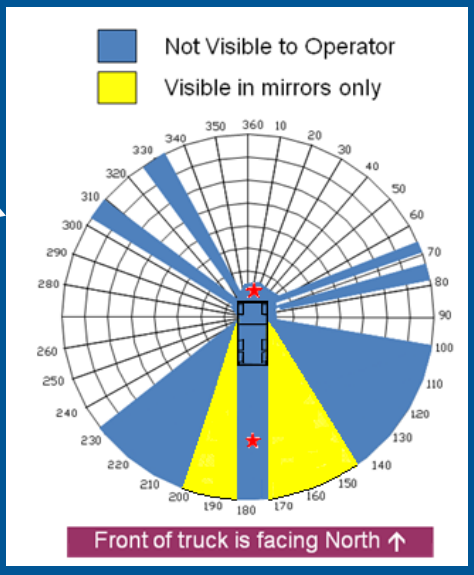
# Blind Spots or Areas

Example: this mapping diagram shows the blind areas around a Ford F-800 dump truck.




- 8 ft in front and 16 ft in rear are the most hazardous areas.

The driver side door area is the only zone within 8 feet of the dump truck that is safely visible.

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# Blind Areas: Getting struck or run over

DRIVER'S and OPERATORS

What happens when you can't see around you?

HAZARDS:

- Running over or striking pedestrians
- Smashing site materials and tools
- Striking other equipment or vehicles
- Rollover on steep slopes
- Contact with utilities

"Roadway Construction Worker Dies From Crushing Injuries When Backed Over by a Dump Truck"

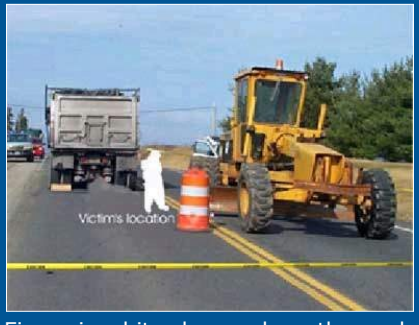


Figure in white shows where the worker was standing when he was run over. The driver did not see the victim.

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## Vehicle Blind Spots

The problem is that pedestrian or ground workers Often need to be near moving equipment and vehicles to perform their work.

Operator's view from inside a motor grader cab

Construction equipment is typically large and has an enclosed cab, which can make the blind areas around this equipment very large and hard to see.

The bigger the equipment the larger the blind spots or hazardous areas for pedestrians and ground workers.

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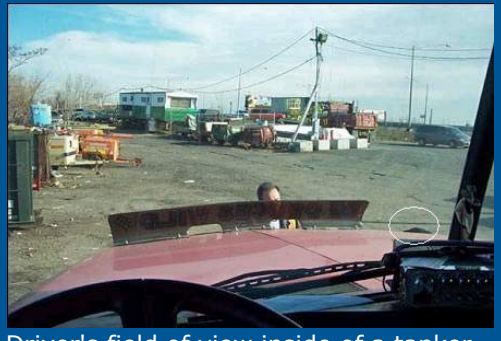
## Vehicle Blind Spots

Truck drivers and equipment operators sit high above the ground and cannot see pedestrian workers crossing close to front of them.



Driver's field of view inside of a tanker truck. Can you see the workers in front of and directly to the right of bug shield? (circle)

Obstructions in a driver's LINE of SIGHT might be:

- Mirrors
- Cab arrangements
- Door and window post
- Stacks and air cleaners
- Bug shield or other ornamentations
- Box, tank, and other equipment configurations

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# Vehicle Blind Spots

Tools/Attachments on vehicles can create greater blind spots, reduce visibility, or swings that increases the risk to workers being struck or pinned.

Know equipment swing radius
(how far can it reach, move or rotate)

Watch out for heavy equipment moving with raised buckets

Be ready for possible sudden movements of booms or changes in direction of equipment operation

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# Vehicle Blind Spots:

## How can you protect yourself when working near heavy equipment?

*Courtesy of Construction Safety Association of Ontario*

- Do not cross directly in front of or immediately behind large heavy equipment or trucks where the operator sits higher in the vehicle.
- Communicate with an operator (verbally and/or by eye contact) before entering any area near heavy equipment or large trucks.
- If you have to stand near parked equipment or trucks, stand in front or on operator side so if equipment comes into use, the operator can see you and you can see them.

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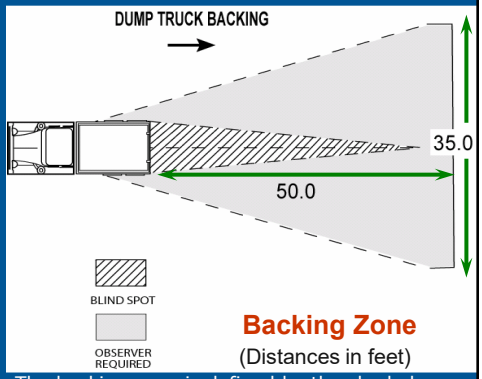
# Operating Dump Trucks in Reverse

Before backing a dump truck the driver must determine that no one is currently in the backing zone and it is reasonable to expect that no employee will enter the backing zone while operating the dump truck in reverse.

If employees are in the backing zone or it is reasonable to expect that an employee will enter the backing zone, you must make sure the truck is backed up only when:

- An observer signals that it is safe to back; or
- An operable mechanical device that provides the driver a full view behind the dump truck is used, such as a video camera.




The backing zone is defined by the shaded area. The driver cannot see anything in the blind spot, either directly or by using mirrors.

Because of the significant number of deaths caused by backing dump trucks, Washington adopted this rule directed at their operation.

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# Operating Dump Trucks in Reverse

If employees are in the backing zone or it is reasonable to expect that employees will enter the backing zone behind a dump truck, then ensure that:

The vehicle has an operable *automatic reverse signal alarm*

- which is audible above surrounding noise level; and
- Is audible at least fifteen feet from the rear of the vehicle

AND

An observer who signals when it is SAFE to back up or stop

OR

the vehicle has an operable device installed which provides the driver a FULL VIEW of the area behind the dump truck

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## Operating Dump Trucks in Reverse

An "operable mechanical device" that provides the driver with a full view behind the dump truck can be a video camera.

The left photo show a camera mounted on the rear of the vehicle - the monitor is mounted in the cab of the truck.

**Exemption to Rule**

Workers are considered protected when they are on the opposite side of a fixed barrier such as a jersey barrier or a six-inch concrete curb or heavy equipment like a paving machine.

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## How do you protect workers in roadway work zones?

Employers must have...

- A comprehensive Site-specific Safety Program (APP)
- A Temporary Traffic Control Plan in place for the project site
- Conducted crew meetings and trained all workers on work zone safety; discussing potential hazards, equipment blind spots, movement precautions in the activity area

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## How do you protect workers in Roadway Work Zones?

Workers must:

-- Wear high-visibility safety apparel (vest & head gear in photos)

-- Be alert for construction vehicles and equipment as well as general traffic

-- Check surroundings often for hazards

-- Know the plan for traffic flow

-- Keep a safe distance from traffic

-- Communicate with other workers, especially when there are changes in procedures, locations, or traffic flow pattern

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## More Roadway Work Zones protective measures

Pedestrian Workers

- Keep in eye contact with operators when working near moving equipment
- Remember equipment blind spots and limited visual areas

Equipment/Vehicle Operators

- Keep windows and mirrors clean
- Watch for workers on foot; know where they are
- Remember equipment blind spots and limited visual areas

Can you see the parked vehicles through this window?

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## How else can workers protect themselves in Roadway Work Zones?

- Stay behind protective barriers where possible
- Do not linger or cross into areas around moving equipment if you have no reason to be there
- Use extra precautions and additional safety apparel at night and during poor weather conditions

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## Speed Cameras Are Coming to a Colorado Highway Construction Zone Near You

- The Colorado legislature in 2024 passed a law allowing for the implementation of automated speed cameras on roadways, initially focusing on construction zones, following new legislative support. This decision comes after recent legislation explicitly granted CDOT, Local Agencies, the Colorado State Patrol and Local Police and Sheriffs departments the authority to use these cameras on state highways, excluding toll roads, and local roadways. This law aims to enhance safety for both workers and drivers, noting the historical fatalities among its workers. A pilot program in construction zones will precede broader implementation, targeting high-crash areas. The legislation, which caps fines at $75, allocates revenue to safety projects, particularly benefiting vulnerable road users. The bill also sets declining targets for road user injuries and simplifies the use of cameras to enforce bus-only lanes.

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## AI in Construction and Infrastructure

- Global AI trends
- Transferable applications

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## Key Drivers of AI Adoption

- Safety
- Cost
- Workforce
- Sustainability

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## AI in Design & Planning

- Predictive modeling
- Simulation
- Optimization

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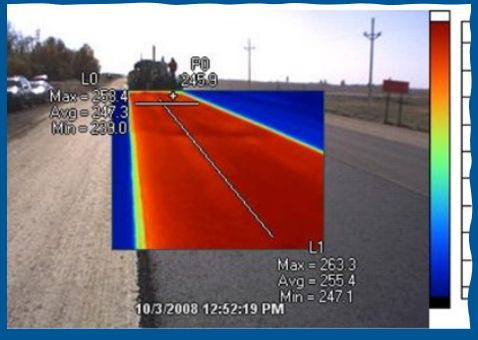
## AI in Paving Operations




- **Smart pavers**
- **Thermal profiling**
- **AI compaction analysis**

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**how is AI being used to determine the compaction of Asphalt being placed?**

- AI is used to determine asphalt compaction by processing data from on-board sensors on vibratory rollers, enabling real-time quality monitoring and control. These "Intelligent Compaction" (IC) systems use machine learning models, particularly artificial neural networks (ANNs), to analyze vibration patterns and other parameters to predict the mat's density and stiffness

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## What other ways is AI used in road construction?

- In addition to measuring asphalt quantities, AI is revolutionizing road construction across several other areas, including safety, quality control, project management, and planning. By providing real-time analysis and predictive capabilities, AI technologies are making the entire process more efficient, safer, and more cost-effective

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- Wearables
- Hazard detection
- Automated traffic management

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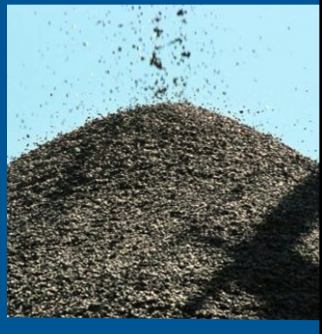

## Environmental Opportunities

Emissions reduction

Material efficiency

RAP optimization

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## AI in Training & Workforce Development


- Virtual training
- Skill gap reduction
- Upskilling

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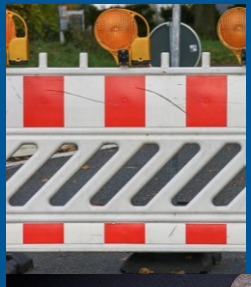
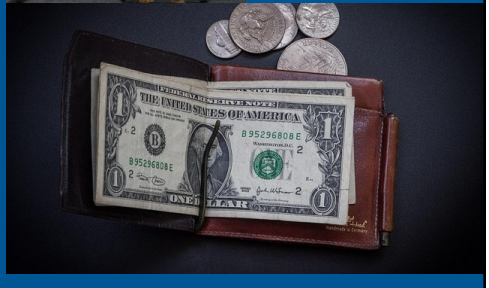
## Barriers & Challenges

- Costs
- Data management
- Workforce resistance
- Regula





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# Case Studies

- European AI compaction
- U.S. predictive maintenance

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## The Future of AI in Asphalt Construction

- Autonomous vehicle integration
- Digital twins
- Fully Integrated Supply Chain

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# Opportunities for the Asphalt Industry

- Competitive advantage
- Sustainability
- Safety
- Savings

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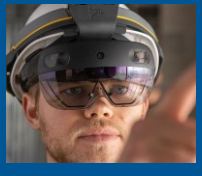
# AI-Driven Wearable Safety Monitors

- Technical Implementation:
  - Smart helmets
  - Vests
  - exoskeletons track worker health
  - Smart Glasses
  - Smart Clothing
  - Heat Stress Patches
- Biometric sensors detect fatigue and hydration.
- Industry Examples:
  - Guardhat's AI helmets monitor PPE compliance.
  - The HMT-1 a Wearable Computer
  - Smart Helmet from Excellent Web World
  - XR10 w/ Hololens 2 from Trimble and Microsoft
- Future Potential:
  - AI-powered exoskeletons reduce strain injuries.

**Guardhat Communicator helmet**

**Guardio's new Armet Pro 'smart' helmet (Image: Guardio)**

The HMT-1 from RealWear



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# AI-Based Fatigue Monitoring

**Technical Implementation:**

- AI tracks blinking rate, eye closure, and head nodding for drivers a operators.
- Wearable EEG sensors monitor brain activity.
- Industry Examples:
  - Amazon's AI safety cameras track worker fatigue.

**Future Potential:**

- AI-driven break schedule optimization enhances safety.

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# Enhanced Work Zone Safety

- **Technical Implementation:**
  - AI-powered geofencing uses GPS and RFID tracking
    - Asset tracking
    - Employee monitoring
    - Security management
    - Retail analytics
    - Logistics optimization
  - Haptic feedback wearables warn of unsafe zones.
- **Benefits of using AI with geofencing:**
  - Enhanced accuracy
  - Automated decision-making
  - Predictive

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## Smart Traffic Control Systems

- Technical Implementation:
  - AI-enhanced adaptive signals adjust based on traffic flow
  - AI optimizes lane closures using digital twin simulations.
- Industry Examples:
  - Tesla's AI traffic prediction improves road safety.
- Future Potential:
  - AI-powered traffic directors manage work zones autonomously


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## AI-Assisted Road Condition Analysis

Technical Implementation:

AI-driven drones scan roads for defects.

Deep learning models analyze asphalt integrity.

Industry Examples:

RoadBotics' AI prioritizes infrastructure repairs.

Future Potential:

AI robotic repair units autonomously seal cracks and potholes.

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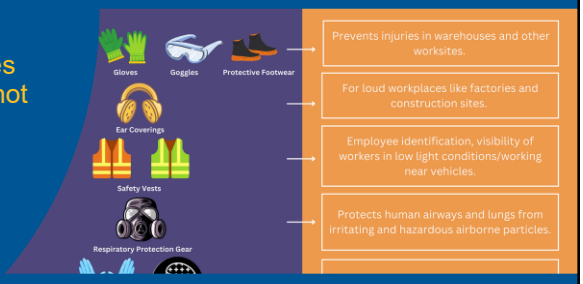
## Smart PPE Compliance Monitoring

- Technical Implementation:
- AI-powered video analytics verify PPE compliance.
- RFID tags ensure workers are fully equipped.
- Industry Examples:
- DeepVision AI monitors PPE compliance.
- Future Potential:
  - AI auto-locks site gates if PPE compliance is not met.

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## Intelligent Equipment Proximity Alerts

- Technical Implementation:
- AI-driven sensors detect workers in machine blind spots.
- AI braking assist systems prevent collisions.
- Future Potential:
- AI-controlled 'smart boots' alert workers near active


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## Question?

- Who is responsible for Job Site Safety?

- **ANSWER: EVERYBODY!**

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## More Information & Resources

- Federal Highway Administration – work zone mobility & safety program: FHWA Work Zone
- OSHA – Compactor Rollover Hazard - Compactor Rollover Hazard
- NIOSH – Highway Work Zone Safety: NIOSH Topic: Highway Work Zone Safety | CDC/NIOSH
- American Traffic Safety Services Association: http://www.atssa.com/workzonesafetygrant/app

Google Play store
Apple

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