

OVERCOMING COMMON SLIP, TRIP & FALL HAZARDS

Proactive measures based on National Institute for Occupational Safety & Health research to help your operation avoid serious incidents

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Slips, trips and falls are a common problem in the surface mining industry.

In fact, Mine Safety & Health Administration (MSHA) injury and illness data from 2015 to 2017 indicates that slips, trips and falls are the second-leading cause of nonfatal incidents for crushed stone, sand and gravel operators. In addition, slips, trips and falls produced an average of 446 incidents per year.

Falls contribute to about 11 percent of fatalities in the mining industry. On average, each nonfatal slip without a fall has a direct cost of \$33,500. A fall to the same level has a direct cost of \$35,300, and a fall to the lower level has a direct cost of \$50,000.

The high prevalence of slip, trip and fall incidents and the costs associated with these injuries prompted researchers from the National Institute for Occupational Safety & Health (NIOSH) to take a closer look at slip, trip and fall hazards

in the mining industry. Their goal is to eliminate slips, trips and falls altogether.

NIOSH'S HAZARDS ASSESSMENT

To quantify the number of times slip, trip and fall hazards were encountered at surface mines, NIOSH conducted a field assessment during which researchers shadowed mine workers.

In this field study, the goal was to examine the slip, trip and fall hazards that mine workers encounter as part of their daily duties. Researchers concentrated on identifying slip, trip and fall hazards on walkways, stairs and ladders.

A prior investigation determined that mobile equipment operators were the most common occupation involved in slip, trip and fall incidents, followed by mechanics and then laborers.

For the current analysis, NIOSH focused on mechanics and laborers because they are more likely to move around the mine and work in different areas as compared to mobile equipment operators.

ANALYSIS OF MSHA NONFATAL INJURY NARRATIVES

To help corroborate the findings of the hazard assessment and identify specific types of slip, trip and fall hazards that contribute to workplace incidents, NIOSH analyzed one year of narrative



An example of solid and liquid contaminants observed during the shadowing period.

SAFETY HAZARDS

Rocks and stones on unpaved surfaces and material accumulation on paved surfaces are frequently encountered hazards.

descriptions of nonfatal slip, trip and fall incidents reported to MSHA in 2017 by mine operators from stone, sand and gravel operations.

A researcher examined all 431 injury and illness narratives reported to MSHA in 2017 related to slips, trips and falls. The narratives were analyzed for specific event details (i.e., did the person slip; did equipment move) and any contaminants on the surface and other hazards that may have contributed to the slip, trip or fall.

NIOSH'S FINDINGS

Researchers shadowed a total of eight mine workers from one sand mine and three crushed stone mines in western Pennsylvania and Virginia for nearly 36 hours, with workers from all three shifts represented.

Weather conditions included dry and sunny or cloudy (70 percent of the time), rain (11 percent of the time), and snow (19 percent of the time). The ambient temperature ranged from 32 degrees to 74 degrees with an average of 52 degrees.

Primary tasks performed by the shadowed mine workers included inspection of conveyors, screen decks and crushers, and hosing out debris under screen decks and crushers.

Other tasks observed were greasing conveyors, removing debris from grated metal walkways along conveyors, replacing screens, fixing and reassembling pumps, reassembling a cone crusher torn down for maintenance, fixing a water line, hosing out hoppers, replacing equipment sensors, de-icing hoses, and

clearing snow from conveyors, tail pulleys and take-up pulleys.

When asked, mine workers said that the tasks and environmental conditions were representative of what they commonly encountered.

For this analysis, walkways were defined as any surface mine workers had to traverse or work on as part of their daily duties. These could include paved and unpaved surfaces both indoors and outdoors.

NIOSH also studied the number of times and how often, on average, specific walkway hazards were encountered during the 36 hours of shadowing. Solid debris included rocks and stones on unpaved surfaces and material accumulation on paved surfaces – these were the most frequently encountered hazards.

Liquid contaminants were second and primarily included pooled water, but they also included oil and other liquids.

Changes to the level of the walking surface of more than one-half inch were third. Such changes were due to heaving ground and transitions from unpaved to paved surfaces. Trip hazards and snow/ice were also in the top five hazards encountered.

OTHER FINDINGS

During the 36 hours of shadowing, 185 stairways and 28 ladders were encountered. About 30 percent of the stairways had some tread-related issues, including bent or damaged treads, inconsistent tread spacing, or a bottom or top tread that was not level with the landing.

Solid debris, including rocks and material accumulation, were encountered on 25 percent of the stairways. Liquid contaminants, including pooled water and other liquids such as oil, were encountered on 12 percent of the stairways.

Compromised transitions were encountered on 71 percent of the ladders. Compromised transitions onto ladders were defined as ladders where the ground was not level; where debris or liquid were

present at the base or top of the ladder; or where ladders had broken, bent or damaged top or bottom rungs.

The high proportion of ladders with compromised transitions was primarily due to ladders with unpaved ground, as landings that were either eroded had material accumulation or pooled water.

Ladder rung issues, including bent rungs in the middle of the ladder, were observed on 7 percent of the ladders encountered.

ANALYSIS OF MSHA NONFATAL INJURY NARRATIVES

NIOSH's analysis of the slip, trip and fall injury and illness narratives reported to MSHA in 2017 provided additional insight into the event. The analysis also included the details of events from the MSHA narratives.

As anticipated, slips were the most common event, followed by trips. Step on, movement, and failure were other events reported. Movement was most often due to unexpected movement of equipment such as tools, conveyors and mobile equipment. Failure was most often associated with unexpected failure of tools, doors and guards.

Other events included jumping, fainting and pushed/pulled/hit.

There were a high number of narratives categorized as unknown, with unknown outcomes that did not provide much detail and only described the event in terms of the outcome such as "the employee's knee popped," "employee felt pain" or "employee sprained ankle."

Events were also classified as unknown when no information on the event was provided other than that they often led to falls.

Not all events resulted in falls, with MSHA reporting that about 65 percent of events led to actual falls in 2017. NIOSH's analysis of the narratives found similar results, with 60 percent of the slip, trip and fall narratives explicitly reporting

SAFETY HAZARDS

that the employee fell.

Specific contaminants and hazards were only reported in 30 percent of the narratives. Rocks, ice/snow, uneven ground, water, hoses, mud, and loose/unstable material were the most common contaminants and hazards.

For slip events, ice/snow, water, mud, rocks, and loose/unstable material were the most common contaminants.

For trip events, hoses, cables and wires were the leading hazards, followed by items on the ground such as pallets, boxes or rocks.

Step-on events led to injuries most often due to uneven ground, rocks, holes and material accumulation. Carrying/holding items in the hand, inadequate illumination and wind were some of the other contributors to slip, trip and fall incidents.

CONCLUSIONS

Based on NIOSH's findings from both the hazard assessment and the analysis of MSHA nonfatal injury narratives, it is evident that a finite set of hazards in the surface stone, sand and gravel mining environment contribute to slip, trip and fall incidents.

Common walkway and working surface hazards include rocks, mud and material accumulation that cause the surface to be uneven or unstable. Pooled water on the walkway could pose a hazard, along with snow/ice that is not cleared promptly.

Hoses, wires, cables and pallets pose a trip hazard to mine workers. Stairways that are worn and have bent treads were identified as hazards, and material accumulation on stairs also pose a slip, trip and fall hazard.

Transitions from the ground to a ladder, and vice versa, can pose a slip, trip and fall hazard, especially due to uneven and unpaved landings at the bottom of ladders.

Given these findings, mine managers should take proactive steps to help remediate slip, trip and fall hazards, such as:

- Regularly grading unpaved surfaces
- Removing large rocks and ruts from walkways and working surfaces
- Installing designated walkways as needed
- Fixing or replacing bent, broken or damaged stair treads
- Providing level, even and stable landings at the base of ladders **P&Q**

The authors are with the Pittsburgh Mining Research Division of the National Institute for Occupational Safety & Health.

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CONTENTS

VOLUME 112 DECEMBER 2019 NO. 6



PERMITTING & ZONING

Southwest Washington is on the verge of an aggregate supply crisis as communities and government regulations tighten around producers.

PAGE 66

60 CONVEYING & MATERIAL HANDLING

Elevating safety around conveying equipment

A veteran conveyor component supplier shares his experience working with aggregate producers

62 HAUL TRUCKS

The latest equipment and technology to improve your fleet

P&Q BUSINESS

64 BUSINESS UPDATE

The outlook for cement, Knife River to open a quarry, and producer stock prices

66 PERMITTING & ZONING

Crisis on the horizon
Southwest Washington aggregate producers face mounting challenges from their communities and local governments – challenges that severely threaten the future supply of construction materials in the region

BY JOE MCCARTHY

SAFETY

74 SAFETY UPDATE

Operations exhibit Pattern of Violations progress, plus Cemex wins an award

76 HAZARDS

Overcoming common slip, trip & fall hazards
Proactive measures based on National Institute for Occupational Safety & Health research to help your operation avoid serious incidents

IN THE BACK

108 P&Q PROFILE

Steve Arney
A conversation with the safety director of StonePoint Materials

113 QUARRY FACES

Snapshots from around the aggregate industry

114 A LOOK BACK

Historical images from Wingra Stone

CLASSIFIEDS & AD INDEX

109 CLASSIFIED ADS

112 ADVERTISER INDEX

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