CDC Workplace Safety and Health

WORKPLACE SOLUTIONS

From the National Institute for Occupational Safety and Health

Ground Fall Injuries in Underground Stone Mines

Summary

Workers in underground stone mines have a high fatality rate caused by falls of ground from the mine roof or rib. NIOSH recommendations to reduce ground fall injuries and deaths address baskets, mechanical scalers, mechanical bolters, drill steel changing, personal protective equipment, and training.

Description of Exposure

An informal National Institute for Occupational Safety and Health (NIOSH) review in 1998 identified approximately 17 new underground limestone operations in various stages of planning; as many as 35 new underground stone mines are expected by 2005. Many of these new underground stone mines will employ new or inexperienced workers with minimal knowledge of the hazardous conditions that exist underground.

Workers in underground stone mines have a fatality rate nearly 20 times that of workers in the manufacturing sector. Three quarters of the fatalities in underground stone mines are caused by falls of ground from the mine roof or rib (Figure 1) [Statistical Abstract of the United States 1985–1999; MSHA 1983–1999]. During 1983–1999, nonfatal ground falls resulted in 140 injuries, or 15% of all underground, lost-time stone mine injuries. These nonfatal ground fall injuries resulted in more than 13,800 lost workdays (one third of all lost workdays). Ground falls generate more disabling injuries and time away from work than any other type of incident.

Figure 1. Large roof fall at underground limestone mine.

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Because of the high ground fall fatality rate and high number of lost workdays from injuries, NIOSH examined the Mine Safety and Health Administration (MSHA) accident and employment databases for worker activity at the time of injury for the period 1983–1999 (mine worker activity codes and accident narratives) [MSHA 1983–1999]. During this period, 156 injuries (both fatal and lost-time) related to ground falls were reported. These incidents included all roof and rib falls listed in the database as well as incidents classified as machinery, for which the source of injury was caving rock. The frequency of ground fall injuries was associated with worker activities as follows: scaling activities, 47%; handling explosives, 24%; other activities, 10%; roof bolting, 8%; drilling face, 6%; and handling supplies, 5%.

Injury and Fatality Review

To identify work practices for improving the safety of miners, the MSHA injury narratives and fatal accident reports noted above were reviewed for each lost-time and fatal ground fall injury (includes mines with bolted and unbolted roofs). The results are summarized by the type of work activity at the time of the ground fall.

- ***Scaling*** was the most common worker activity at the time of a ground fall; almost one half of all ground falls were related to scaling. Nearly a third of the scaling incidents were associated with roof or rib rock falling onto the basket, scaling machine, or outrigger equipment used to reach the remote areas of the mine. The jarring of the basket or scaling machine caused by the falling rock often caused workers to fall from the basket or against the basket rail.

  According to one incident narrative, two miners were hand scaling the roof from a bucket when a large rock dislodged and struck the corner of the bucket. The weight of the rock on the bucket caused the boom of the scaling rig to bend toward the mine floor until the rock fell to the floor. The boom then catapulted upward, throwing the two scalers from the bucket. A second narrative described a worker who was hand scaling while leaning out of a basket. When a massive slab of rock fell and struck the outrigger of the scaling machine, it caused the machine to fall on its side. The worker was thrown from the basket, but a harness apparently prevented the worker from being thrown to the floor or crushed by the machine. The worker suffered a fractured skull.

- ***Handling explosives*** accounted for a high number of lost-work-time injuries from ground falls. Most of these incidents occurred while the worker was loading explosives into the hole. These incidents resulted in injury to the victim's neck, back, or shoulder from small rock pieces that fell from the mine face and roof. Two fatalities from ground falls occurred while a miner was cleaning out bottom holes. According to the MSHA [1983–1999] fatality report, the workers routinely cleaned the bottom holes before entering the basket and going up to check the roof. They relied entirely on visual inspection of roof conditions.

- ***Roof bolting activities*** involving ground fall injuries accounted for more than twice the typical number of days lost per incident for all underground stone mine incidents. Miners working from a basket to install the bolts have more injuries than miners using an automated bolter.

- ***Drilling the face*** accounted for the highest number of days lost per incident of all worker activities. MSHA face drilling operation narratives indicated that in at least 75% of the drilling incidents, the victim was outside the cab. In most instances, the victims were changing drill steel or checking the drill alignment.

- ***Miscellaneous activities*** account for more than 40% of fatal ground fall injuries. The MSHA fatality reports were reviewed to find other causes [MSHA 1986–1996]. Four of the seven recorded fatalities occurred while the victims were entering a recently blasted face area. These fatalities resulted from the fall of roof or face loosened by the recent blast. In two of the cases, MSHA was unable to determine why the victims had entered the blast area.

Controls

The following measures are recommended to reduce ground fall injuries in underground stone mines:

- Minimize scaling injuries that occur from the impact of rock falling onto the basket or lift:
  - — Make sure that safety harnesses and hard hats with chin straps are used correctly during scaling operations.
  - — Fasten harnesses to structurally secure locations on the basket with proper rope length to minimize the momentum of the fall.
  - — Provide proper training in putting on a harness and operating the basket manually in case the hydraulic system is damaged because of a ground fall or malfunction.
- Equip baskets that are used for scaling and roof bolting with padded railings and a canopy or caging to absorb and deflect ground falls. Ensure that canopies are convenient to workers and that they allow easy access to the roof. If possible, use a retractable canopy with a partially removable roof section.
- Use mechanical scalers with protective cabs instead of hand scaling if possible.
- Use personal protective equipment such as a hard hat with a back rim (similar to a fire fighters helmet) to help deflect small rock pieces from hitting the neck and back while loading explosives. In severe conditions, use flack jackets or padding devices worn by athletes for additional protection for the back [Grau and Prosser 1997].
- When roof bolting, use mechanical bolters with a protective cab if possible.
- Move the location for changing the drill steel away from the drilled face to an area where the rib and roof are stable.
- Use hazard training to emphasize the severe ground fall risk associated with a freshly blasted mine face and the proper procedures for entering the area.
- Develop a complete checklist of all critical safety procedures related to ground falls that can be used as a training tool.

Acknowledgments

The principal contributors to this publication were Deno Pappas and Leonard Prosser, Pittsburgh Research Laboratory, National Institute for Occupational Safety and Health.

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For More Information

NIOSH research on ground fall injuries in underground stone mines has been published in a journal:

Pappas DM, Prosser LJ [2001]. An overview of groundfall injuries and worker activity in underground stone mines. Falls Church, VA: Joseph A. Holmes Safety Association Bulletin, August, pp. 8–14.

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DHHS (NIOSH) Publication No. 2004–106
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November 2003

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