Technology News

No. 470 NIOSH February 1998

Analysis of Hangups and Structural Failure in Underground Mine Ore Passes

Objective

Develop field measurement and computer modeling methods to predict the potential for hang-ups and structural failures in underground mine ore passes.

Background

Analysis of Mine Safety and Health Administration (MSHA) accident statistics has identified ore pass hazards as a significant safety problem in underground metal mines in the United States. Recent ore pass failures have underlined the lack of ore pass design methods and standards available to both MSHA and mine engineers. Injury and fatality data for the 20-year period between 1975 and 1995 show that nearly 75% of the injuries were directly or indirectly related to pulling or freeing ore pass chutes, the use of hand tools, falls of broken rock, and structural failures of chutes or gates and ore pass walls.

Risk assessment methods, such as fault tree analysis (FTA), revealed the most probable causes of ore pass failures, assisted in defining research priorities, and allowed analyses of the causes of malfunctioning ore passes. Important *structural design factors* are the static and dynamic loads that ore pass chutes and gates must withstand. *Functional design factors* may involve considerations of malfunctions in material flow, such as hang-ups, piping, and water inundations.

Approach

Static and dynamic loads were measured on an underground ore pass and truck chute (figure 1). The weight of material dumped in the ore pass was in excess of 27,300 kg (60,000 lb); however, a maximum static load of only 6,800 kg (15,000 lb) was measured, which was approximately the weight of the waste material needed to fill the chute itself. The rest of the static load was carried by the ore pass walls and the timbers adjacent to the chute.

A three-dimensional particle flow code was used to predict the static and dynamic loads resulting from the flow and impact of material on the control gate in an ore pass chute. Figure 2 shows total static and dynamic loads normal to the chute gate after a typical dump from a load-haul-dump (LHD) unit. The load response from 14 dumps is shown in figure 3. Analysis of the initial time steps indicated that dynamic loads were a factor on the control gate only during the first few dumps. Dynamic load factors ranged from 1.06 to 1.33 on the chute and gate assembly and were reduced significantly because the chute was offset from the ore pass. The accumulated calculated loads on the control gate after the first 14 loads were compared to results from the actual field test. Total calculated static load exceeded actual load for a full muck chute by about four times, considering just the cross-sectional area exposed to the muck carried by the support bolts.

The combination of numerical modeling, scaled experiments, and full-scale testing have provided a methodology to determine static and dynamic loads involved in ore pass failures. Research is continuing to evaluate methods that will increase awareness of the proper functioning of mine ore passes, warn of potentially dangerous situations, and improve hang-up removal techniques.

Patent Status

An invention report has been filed for a device to determine hang-up location in ore passes.

U.S. Department of Health and Human Services
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health

CDC
CENTERS FOR DISEASE CONTROL AND PREVENTION

For More Information

NIOSH is seeking cooperators to assist in further study of mine ore pass safety issues. Additional information can be obtained by contacting Bill Stewart at (509) 354-8064, Steve Iverson at (509) 354-8089, or Elaine Cullen, technology transfer officer, at 354-8057, Spokane Research Laboratory, Spokane, WA, 99207

Mention of any company name or product does not constitute endorsement by the National Institute for Occupational Safety and Health.

To receive additional information about mining issues or other occupational safety and health problems, call **1-800-35-NIOSH (1-800-356-4674)**, or visit the NIOSH Home Page on the World Wide Web at http://www.cdc.gov/niosh/homepage.html

As of October 1996 the safety and health research functions of the former U.S. Bureau of Mines are now located in the National Institute for Occupational Safety and Health (NIOSH).

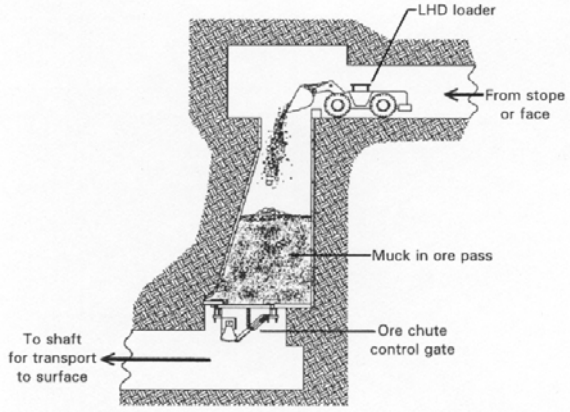

Figure 1.—An ore pass system used for field tests and PFC^{3d} modeling.

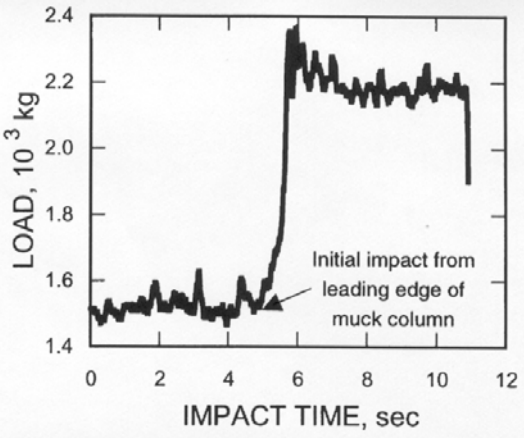

Figure 2.—Plot of normal loads on chute gate from one LHD dump.

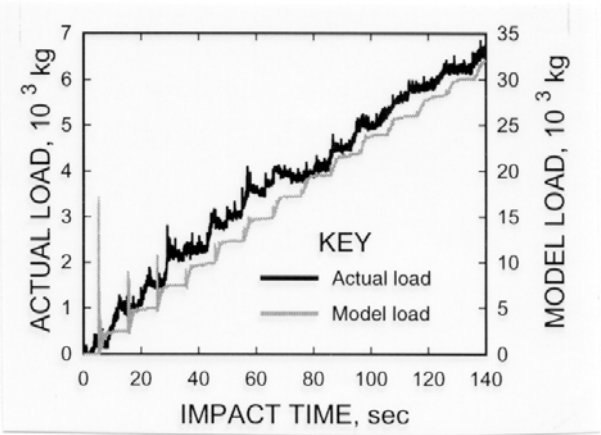

Figure 3.—Plot of calculated and actual loads on chute gate following 14 LHD dumps.