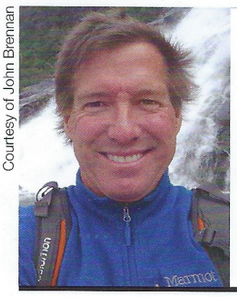
Courtesy of John Brennan

Mitigating the risks of avalanches

By John Brennan

Avalanches can travel extremely fast, averaging in the 120 kilometres per hour range, but they can exceed 250 kilometres per hour. Wind-driven storm snow can weigh 380 kilograms per cubic metre. Avalanches typically entrain more mass as they descend their path. Ballpark estimates for the weight of snow in a large avalanche path can be thousands of tonnes. For mining operations in snowy mountainous regions, avalanches can be devastating. Consider the metaphor of a 50,000-tonne, 200-metre-wide bulldozer freewheeling down a mountainside at 200 kilometres per hour aimed at mining operations' roadways, vehicles, buildings and employees.

It was the 1965 avalanche at the Granduc copper mine in British Columbia, which killed 26 men and destroyed major infrastructure, that marked a turning point for the mining industry to adopt avalanche mitigation technology to protect operation assets and people. Only a few decades earlier, over 100 people were killed when an avalanche crashed through the housing district at the El Teniente copper mine site in Sewell, Chile. This mine has been called the largest underground copper mine in the world, with over 3,000 kilometres of drifts.

The study of snow physics and avalanche forecasting is complicated and specialists have years of field experience and advanced education in numerous areas, including fracture mechanics, weather forecasting and architecture. Modelling software can be used to calculate the dimension of the danger zones beneath avalanche terrain to understand how torrents of avalanching snow and resultant impact pressure can affect the placement and design of structures and travel corridors.

There are numerous ways miners can mitigate avalanche risk to protect their assets and personnel, such as:

Forecasting avalanche risk during storms, then making educated operational decisions: Avalanche specialists will determine when mining roads need to be closed during snow events or when special protocols need to be followed. These specialists will also determine when explosive-mitigation efforts need to take place.

Installing avalanche-retarding devices: Fences, using cable netting, hold the snow cover in place so it is unable to avalanche.

Tunnelling to avoid hazardous terrain: By keeping traffic out of an avalanche path, transportation does not need to be interrupted during hazardous storms.

Adding roofs or sheds over transportation corridors: These structures are engineered to withstand any amount of snow load that Mother Nature can throw at them.

Using explosives to release avalanches on the miner's terms and time frames: Many mountain operations use explosives to release avalanches and there are a number of options for delivering these blasts.

Military artillery has been in the arsenal of the modern-day avalanche tactician from the mid-20th century. Ski areas, railways and highway departments all utilize these military weapons for reducing avalanche hazard. Though concerns over security, shrapnel, aging cannons and munitions, the danger of shooting over inhabited structures and other matters make the use of military artillery limited today.

Helicopters can be used to carry explosives to avalanche paths but only during periods of good visibility and appropriate weather conditions. Remote avalanche-control devices allow 24/7 explosive delivery but again, there can be drawbacks to these systems as well. Concerns over security of remotely stored explosives, the fixed nature of these installations not allowing unlimited targeting options and difficulty with maintenance or restocking materials during storms warrant consideration. While some remote systems rely on traditional bulk explosives, others utilize a blend of propane and oxygen to deliver an explosive punch. With these gas systems, there are no high explosives stored remotely, sometimes an important consideration, but the oxygen and propane stores must be replaced at some point.

In the early 1960s, Avalauncher, a civilian explosive-delivery system, was developed by pioneering avalanche specialist Monty Atwater. He commissioned the developer of the first pneumatic baseball pitching machine to modify the sports device to place an explosive at least 400 metres from its launching point. By the end of that year, the Mark 10 Avalauncher was in production. There have been hundreds of Avalaunchers sold globally since. They currently have the ability to place explosives into remote avalanche terrain thousands of metres from their launch point and almost 700 metres vertically above their gun crews. And, by using azimuth and elevation plates, these machines can vary targeting locations based on what the avalanche-forecasting specialists determine are ideal for any given storm parameters.

Since the tragedies at both the Granduc and the El Teniente mines, Avalaunchers have been used to reduce avalanche hazard. Modern targeting models have since been developed for these machines using full-pressure range studies with high-speed dataloggers and GPS gridding to enable precision-targeting charts. Avalauncher users can set up their devices on preset coordinates and fire accurately without being able see the targets.

Other remote avalanche-control systems available today involve gas-based or explosive-based exploders, which can be placed at the top of avalanche paths and detonated remotely when required, regardless of the time of day, weather and visibility.

It is more and more common to see commercial and residential development in areas capable of generating destructive and deadly avalanches. As technology similarly advances, more and more options will become tools to reduce and mitigate avalanche hazard. Damage to facilities within the industry remains an issue to this day given the preference to locate mine-processing facilities adjacent to the ore body even when on a mountainside. CIM

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