Light Vehicle Penetration Protection System

BHP Billiton – Cannington Mine

The Problem

Rock bolts and other rigid objects penetrating the floor pans of light vehicles is a hazard across the mining industry. These incidents, which can occur on surface roadways as well as in the underground environment, have the potential to cause serious injury to the occupants of the light vehicle.

In the underground, rock bolts become mixed with the ore when drives are being developed through previously mined sections of the ore body. During transport the loose rock bolts can fall out of loader buckets, from the back of trucks, or off conveyors. A bolt submerged in dirt or water is difficult to detect, and has the potential to flick (with one end firm against the ground) and penetrate the floor pan of any vehicle that runs over it.

At Cannington Mine, rock bolts and scaling bars have on several occasions entered the vehicle cabins of Land Cruiser Utilities and Troop Carriers, as shown in figure 1. More disturbing are the hundreds of reported events of rock bolts located in drives, each with the potential to pierce the floor pan of a tramming vehicle and injure the occupants.

The Solution

The increase in rigid objects penetrating the floor pans of light vehicles on site lead Mechanical Engineer, Adrian Bush, to head a team of site personnel to seek a solution to this hazard.

As Cannington is not currently in a position to eliminate foreign objects on roadways, an engineering solution that reduces the consequence of a rock bolt impacting the floor pan of a vehicle was researched.

Neither previous research nor the Australian Standards had produced a method that evaluated the performance of floor protection in reducing the risk of penetration. Therefore, the initial component of the design was to determine the material most resilient to penetration. Four unique materials, with varying strengths and weaknesses, were chosen for further investigation:

- Plate Steel
- High Density Polyethylene (HDPE)
- Spray on Kevlar Reinforced Liner
- Moulded Composite Sheeting (MCS)

Initial testing deemed MCS the most effective against the forces of an impacting rock bolt and concluded that even if the rock bolt penetrates through several layers, it will slide along the remaining sheets once the normal force is not sufficient to continue penetration.

Testing was completed on a combination of Kevlar sheets up to 8 millimetres thick. The test piece was held horizontally while a short length of rock bolt attached to a 200 kilogram weight was raised approximately 5 metres up inside a casing and released (see figures 2 and 3). This produced an impact speed in excess of 35 kilometres per hour, which is slightly faster than the speed underground vehicles are allowed to travel.

This apparatus impacts the test sheet at ninety degrees—a worst case scenario that minimises the ability of the shortened section of rock bolt to bend. In a real-life situation, it is more likely that the rock bolt will impact the floor pan at an angle.

Internal resources were utilised when researching an engineering solution for initial problem. When developing the system, suitable manufacturers in penetration protection products (Redpath Australia and LSM Composite Products) were engaged. Through one of Cannington's key contractors, an innovative and highly technical organisation able to develop the design to the appropriate specifications, was discovered.

Cannington was not in a position to eliminate the presence of foreign objects on roadways and previously relied on the lowest level of control (PPE) to protect site personnel. With the introduction of the Penetration Protection System, Cannington has engineered a control to prevent penetration hazards on site.

This engineering and installation project, initiated in response to penetration hazards, has resulted in the world-first floor penetration protection system being implemented at Cannington (see figure 4).

Benefits/Effects

Since implementation, the Penetration Protection System has proven to:

- Significantly increase the strength of the floor pans in light vehicles, making them effectively impenetrable.
- Eliminate the potential of a high severity risk incident on site.
- Safeguard personnel driving light vehicles on site.
- Dramatically reduce the risk of floor pan penetration from rigid objects in the path of the light vehicles—compared to a brand new standard steel floor pan, an increase in penetration energy absorption of 13.6 times was demonstrated through testing. Theoretically, 24 millimetre diameter unsharpened rock bolts over the length of 0.57 metres will buckle before penetration of the panel occurs.

A light vehicle's composite panel will outlast the lifetime of that particular vehicle and the panel can easily be transferred to another vehicle—providing further significant value without additional materials costs. Cannington Mine has invested approximately $235, 000 to develop the innovation, including testing and fitment costs, penetration testing and the supply and installation of the panels.

Transferability

The risk of foreign objects penetrating light vehicles is an industry-wide problem that is not confined to one mine site. This solution would be highly beneficial to the industry, as well as very adaptable to any type of working site, surface or underground operation in construction, agriculture or any other operation where there is a risk of rigid objects impaling a vehicle.

Innovation

The penetration protection system significantly reduced a common hazard in the work environment through the development of an innovative, yet simply designed, solution.

There are no other examples of an innovation of this kind in a mining operation; the new floor protection system had to be designed and developed from scratch. With no manual to follow or Safe Working Instruction to adhere to, there was only the motivation to protect Cannington employees from a major hazard to kick-start the improvement.

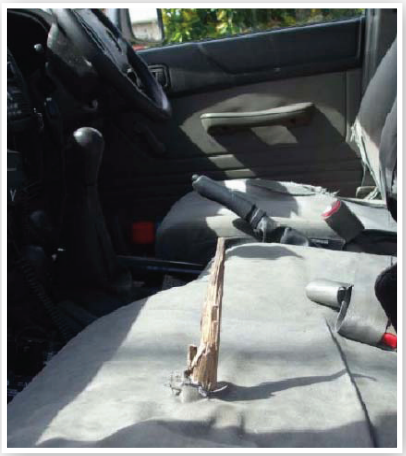

Figure 1: A dead tree branch penetrated the passenger seat of a Cannington exploration vehicle in 2008

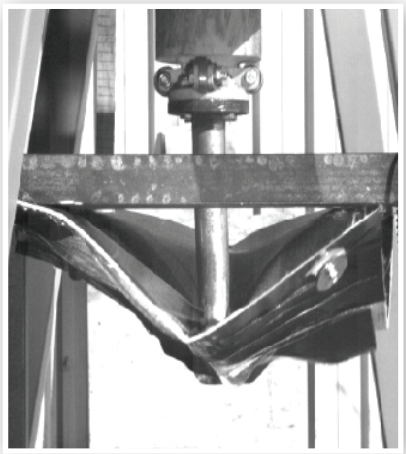

Figure 2: Snap shot from video footage testing 8mm Kevlar against a Split Set

Figure 3: Post testing photos of the Kevlar panel still intact and the bent Split Set

Figure 4: Completed wagon cut down