Haul Road Design and Road Safety

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Abstract

Incidents occur on mine sites at locations where the road is deficient in design. The investigation of these incidents identifies improvements at the location of the incident but usually the issues go deeper. The haul road design and maintenance guidelines need to reflect what a safe road should look like; too often they are generic and do not give sufficient information to build a safe road.

The public road network is designed to Australian Standards; there is no mine haul road standard. Haul road design and maintenance of haul roads are critical functions of the mine and the haul roads should be designed and maintained to the safest possible standard.

The incidence of truck rollover or vehicle- to-vehicle collisions or near misses is ever present on a mine site due to the mix of vehicles-haul trucks, road trains and watering trucks together with cranes, excavators and contractor vehicles all operating on the mine haul roads.

The mines have an opportunity to improve their mine haul roads using demonstrated road safety techniques and reduce the likelihood of incidents and crashes if they build and maintain them to a high standard with safety as a focus.

Introduction

Within the mining sector, there a few road builders or traffic and safety engineers; this contributes to substandard roads and intersections. There is usually little understanding or planning of the road hierarchy in the mine and roads are built and maintained with limited resources and equipment.

When assessing mining assets, roads are not recognised for high levels of expenditure as it is not easy to put a value on the roads as they are not seen as a resource such as coal or iron ore.

The public road network uses Australian Standards and Austroads Guidelines to ensure the road is built and maintained to a high standard. Signage and delineation is provided to guide drivers, intersections are signed in advance with warning signs and directional signs so drivers can traverse the road network easily. Speed limits are set and managed in accordance with the road hierarchy and function.

Most Australian mine sites operate under Australian road rules and expect drivers to comply with the speed and regulatory signs installed. However, there is no consistent intersection design or signage to conform to. All too often there are many posted speed limits ranging from 5 km/h to 100 km/h. The drivers could be forgiven for making mistakes in this environment. We should therefore look to provide the same road environment as on the public road network with consistent signage, delineation, simple intersection design and layout. Mine operations should post speed limits that match the design and layout of the road. This requires an understanding of who the road users are and providing pedestrian-friendly areas when required around workshops and administration areas.

Basic Guidelines

To assist mine operations with making the road network more user-friendly and ultimately safer, mines should follow some simple rules:

- Provide training for design/planning personnel in elements of traffic engineering.
- Design roads that are fit for purpose, with adequate road width, drainage and good running surface.
- Design and build T- intersections at 90 degrees to the through road.
- Conduct design audits, considering road safety principles.
- Provide adequate sight distance through curves and crests.
- Post realistic and consistent speed limits.
- Only use Australian Standard signs.
- Provide delineation of all roads using guideposts with reflective tape.

Once the road network is establishes it is important to review the signage, delineation, and speed limits regularly. Every 6 months should be sufficient. Have a maintenance crew to maintain and replace the signs and guideposts as required. Have a sign register and keep spare signs and guideposts on site in case they are damaged and require replacing.

Every 2 years or if there is going to be a major change to the road network have an external road safety audit carried out to see how the roads are performing. This will assist in improving the roads and ensuring consistency with best practice and conformity to standards.

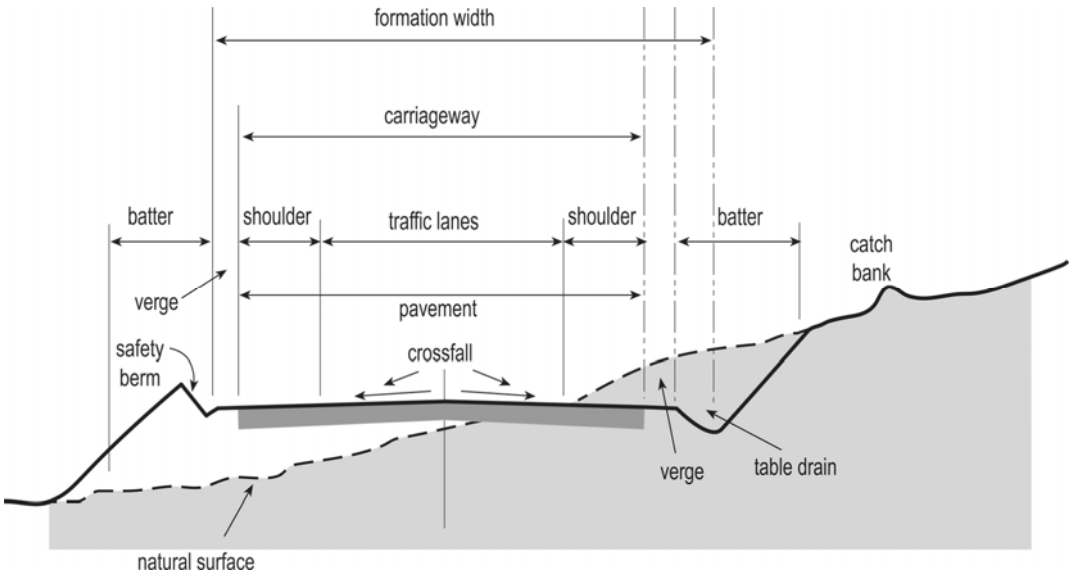
Managing road safety by providing a safe road system

Adopting a Safe System approach to road safety on mine haul roads recognises that humans, as road users, are fallible and will continue to make mistakes, and that road users should not be penalised with death or serious injury when they do make mistakes. Safer road user behaviour, safer speeds, safer roads and safer vehicles are the four key elements that make a Safe System. In a Safe System, therefore, roads and vehicles should be designed to reduce the incidence and severity of crashes when they do occur. This can be achieved by:

- designing, constructing and maintaining a road system (roads, vehicles and operating requirements) so that forces on the human body generated in crashes are generally less than those resulting in fatal or debilitating injury
- improving roads and roadsides to reduce the risk of crashes and minimise harm: measures for high speed roads include dividing traffic, designing “forgiving” roadsides, and providing clear driver guidance. In areas with large numbers of vulnerable road users or where there is substantial collision risk, speed management supplemented by road and roadside treatments is a key strategy for limiting crash forces
- advising, educating and encouraging road users to obey road rules and to be unimpaired, alert and responsive to potentially high-risk situations.

What should a good road look like?

Mine haul roads are generally designed to 3.5 times the largest vehicle width; this allows vehicles to pass safely. The cross-section of a road illistrated below shows a good representation of a mine haul road; note the crossfall for drainage and the safety berms installed to improve safety.

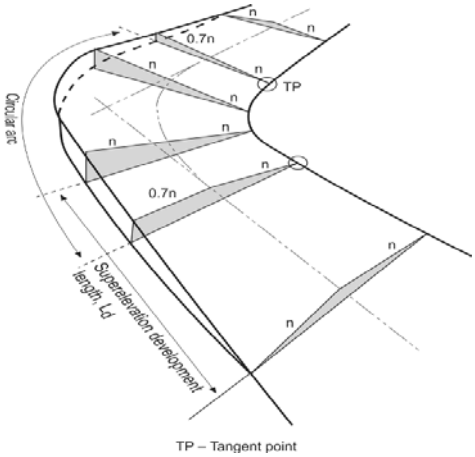


Vehicles using the haul road

Consideration should be given to the interaction of heavy and light vehicles on haul roads. Where possible, roads should be provided for light vehicles to create separation; interaction between vehicle classes can lead to an increased likelihood of incidents.

Crossfall and superelevation

Poor crossfall or superelevation may result in the build-up of loose material on the outside of the curve, creating a potential safety hazard. Good superelevation will assist driver comfort and safety in travelling around curves, and will minimise the build-up of loose material.



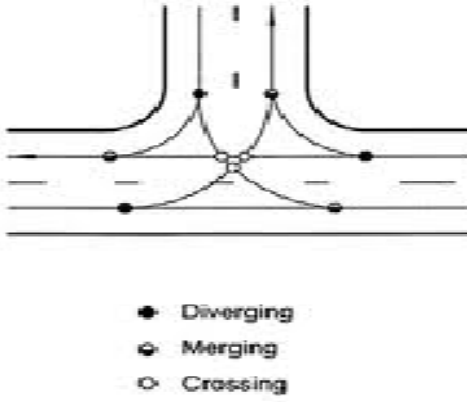
Drainage

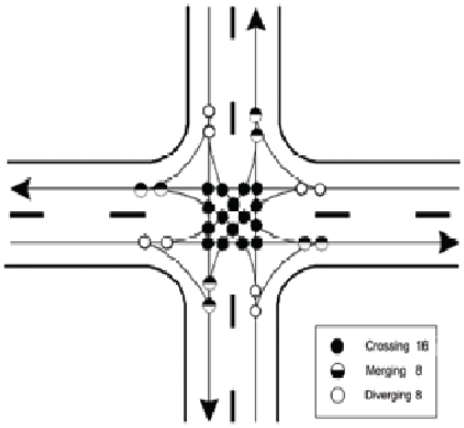
Without good drainage the haul road will start to degrade very quickly; where possible, table or V drains should be constructed to remove the run-off water from the edge of the road.

Intersections on haul roads

Intersections should be kept simple in design. There is a need to understand what an intersection is designed to achieve on the site. Intersections can be

considered in terms of conflict points. A simple T- intersection has half the conflict points of a 4-way intersection, as can be seen in the following diagrams. Conflicts are caused as vehicles turn across each other's path, these conflict points are areas of increased risk and their management is critical to minimise the risks.





Intersection location

When designing locations for intersecting roads, curves and crests should be avoided as these can restrict visibility for drivers entering the through road. The windrows at the intersection should be lowered to avoid masking of light vehicles. A separation island in the side road results in channalisation at the intersection and avoids the cutting of the corners through the intersection.

Y- Intersections

Y- Intersections should be removed as they allow for high- speed movement through intersections with limited visibility.

Y- intersections should be modified as shown below. A single intersection should be changed to a simple T-intersection at 90 degrees to the through road and a crossroad should be modified to a staggered T-intersection also bringing the side road to a 90 degree approach to the through road.

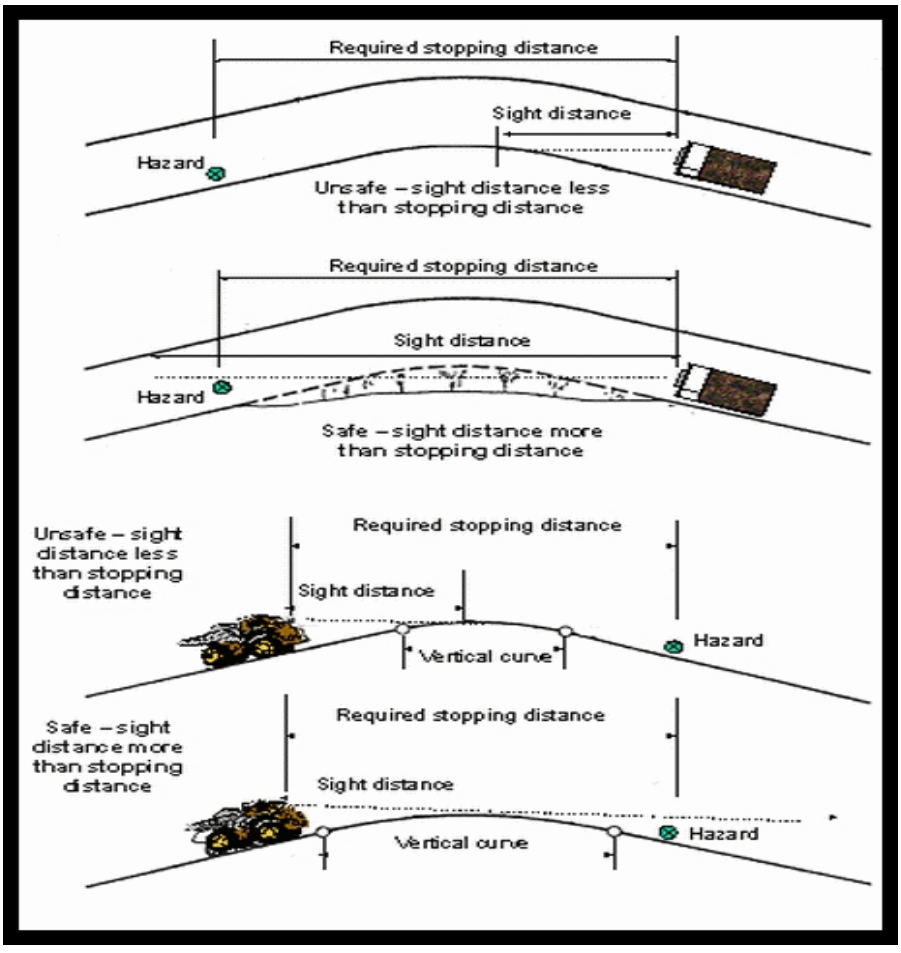
Number of intersections

Over time, roads are built to gain access to various locations on the site. This often leads to too many intersections, increasing the risk of incidents. Roads should be closed off once they are not required operationally; earth bunds are an effective way of doing this.

Horizontal and vertical alignment

It is important to provide adequate stopping sight distance so that drivers can see oncoming vehicles in time to take avoidance action.

This is particularly important at critical locations such as at tight curves and intersections. Sight distance is influenced by road geometry and vegetation on the roadside. Safe stopping sight distances for mine haul roads are longer than those for sealed roads. It is important to take this into account when considering sight distance requirements for unsealed roads.



Consistent speed limits

It is important to post realistic and consistent speed limits on mine haul roads and not to have too many speed limits. Usually three or four are sufficient comprising 10 km/h for pedestrian areas, 40 km/h for narrow roads for light vehicles, 60 km/h for haul roads, and 80 km/h for long hauls.

Signage

It is important that road signs are used appropriately when required to warn motorists of potential hazards. Road signs are low-cost items and should be placed to remove potential 'surprise' situations. Standard road signs can be used to alert drivers to changing road features or roadworks ahead, to help them drive to conditions. All signage on site should conform to the relevant Australian Standard, (for road signs that is AS1742), to create a consistent road environment that informs the driver. Intersection signage should be consistent in its application, Stop or Give Way signs installed at all intersections, keep left signs installed on earth berms, information signs installed where required, and warning signs installed at the correct locations. Signs should be the correct size and retro reflectivity. It is much more effective to install the correct sign rather than multiple signs that convey the same message.

Delineation

Delineators in the form of guideposts should be installed on all roads on the mine site. Guideposts should be spaced consistently with red reflectors on the left-hand side and white reflectors on the right-hand side.

Haul road maintenance

It is good practice to have a dedicated road crew on all mine sites, with access to graders, rollers and good road-building materials. Road maintenance competes with mine activities for resources and equipment. Signs and delineators should be cleaned regularly and should be replaced if damaged. The crossfall should be maintained by grading regularly.

Maintaining mine haul roads to a good standard will reduce the rolling resistance along the roads and reduce maintenance costs for vehicles.

Conclusion

Building and maintaining mine haul roads to a consistent standard will reduce the overall risk and improve safety. The application of key road design elements and consistent road signs and delineation will make this a reality. It is now becoming widely recognised that roads are an important asset to the mine and without them the business is not as profitable or efficient. Following the guidance outlined in the paper will lead to a simpler and safer mine road network for all road users. This in turn will lead to fewer incidents, increased efficiency and profitability of the mine operation.