Smooth operation or an accident waiting to happen?

Roads and workshops are two aspects of the mining layout that are often overlooked and sometimes neglected. Here's why the planning of road maintenance goes hand in hand with logistics such as material handling, storage and workshops.

It goes without saying that good quality roads and well located, well equipped workshops are as important to the modern miner as the orebody itself. Yet there are still numerous examples of where both have been seriously underestimated.

Many mines still have roads that are not fit for purpose. They are often under-dimensioned and badly maintained, which impacts on their ability to carry traffic efficiently and safely. In general, a road that has been allowed to fall into disrepair at a mine site is an accident waiting to happen.

In many cases, it is a matter of upgrading. The roads should not only be well maintained, but also continually upgraded in order to accommodate increasingly large and heavier vehicles and to prevent other vehicles such as cars, which are not purpose built, from breaking down as a result of poor road conditions. Good, strong roads enable safe and quick transportation which, in turn, saves time and money and benefits productivity.

So, what constitutes a "good" mine road? Basically, it is a road that is built from the bottom up, from coarse to fine material. It is also a road with a surface that is well compacted and designed to drain off water as water filled pot-holes and blasted rock ruins tires. The road should also have a drainage ditch, at least along one side, and water tubes beneath the road to carry off any water ingress from the mine roof.

Heavy water infiltration from the roof should be funnelled to the drainage ditch instead of allowed to fall directly on the road, which can erode the surface. In addition, fine waste rock and ore dust combined with water can make tarmac roads slippery and dangerous.

Roads for mechanised haulage

One of the main differences between the haulage methods used in underground mining, from roads and conveyors to rail and hoists, is the amount of space these installations occupy in the mining environment and the type of maintenance required in each case.

Although electric rail is a common and useful method of transport, a shift toward LHD loaders (Load Haul Dump) equipment has intensified since the 1970s. Today, mine trucks that carry payloads of 85 tonnes can safely navigate in constricted spaces, along narrow openings and up and down steep ramps due to articulated design features.

This rapid evolution of engineering technology has meant that an interconnected network of roads and ramps between the mine's horizontal levels can be planned much more efficiently compared with just a few years ago.

By adapting the layout of haul roads to a chosen equipment fleet with modern capabilities, the transportation cycle and overall costs become far more predictable. To achieve this, the gradient of roads and angle of ramps must be carefully calculated since they impact on fuel consumption, speed of transportation, emergency breaking and wear and tear of machinery components.

Typically, road gradients of up to 12 are regarded as safe and functional. However, some equipment will operate on more severe levels where a 15–20 % road gradient is not uncommon, without putting operators or machinery at risk. It should be remembered, however, that steep ramps generally mean higher operating and maintenance costs. This is because fully loaded vehicles travel slower going upwards and use more fuel, while vehicles traveling downwards have to apply more pressure to their brakes, which increases wear.

As a result, the use of modern equipment for the transportation of ore, waste rock, backfill and other material via a road network has increased the need for high quality roads. However, it has also put greater demands on the skill of mine planners to balance the cost and benefits of a road network design.

Modern mine vehicles are capable of severe road grades, although a maximum of 12% is recommended to avoid high maintenance costs. Well maintained roads can also significantly reduce the cost of tire replacements.

No shortcuts

There are no shortcuts to achieving the optimal layout solution for roads and workshops; the answer is proactive planning at the design stage. It is important that road maintenance is seen as a normal part of the entire operation with grading work carried out at least once a week per dirt road, or more often if the road is heavily used. In addition, tarmac and asphalt roads have to be monitored and swept to clear them of rock fragments that fall from heavy trucks and that ruin the road surface, and also to get rid of mud that makes the surfaces slippery.

Mine conditions such as temperature, water flow and wind, along with the type and frequency of traffic, largely determine the life expectancy of underground haul roads. For example, due to high intensity and stress at Chile's vast copper mine El Teniente, the roads usually only last six months to a year before they need to be resurfaced. For this reason, all modern mines should be staffed with a dedicated road maintenance team equipped with material transport vehicles, compactors and graders.

Haul roads should be constructed using four main layers: subgrade, subbase, base course and surface/wearing course. These layers contain various materials that normally include:

- Crushed stone
- Compacted gravel
- Stabilised earth
- Roller compacted concrete (RCC)
- Asphalt concrete

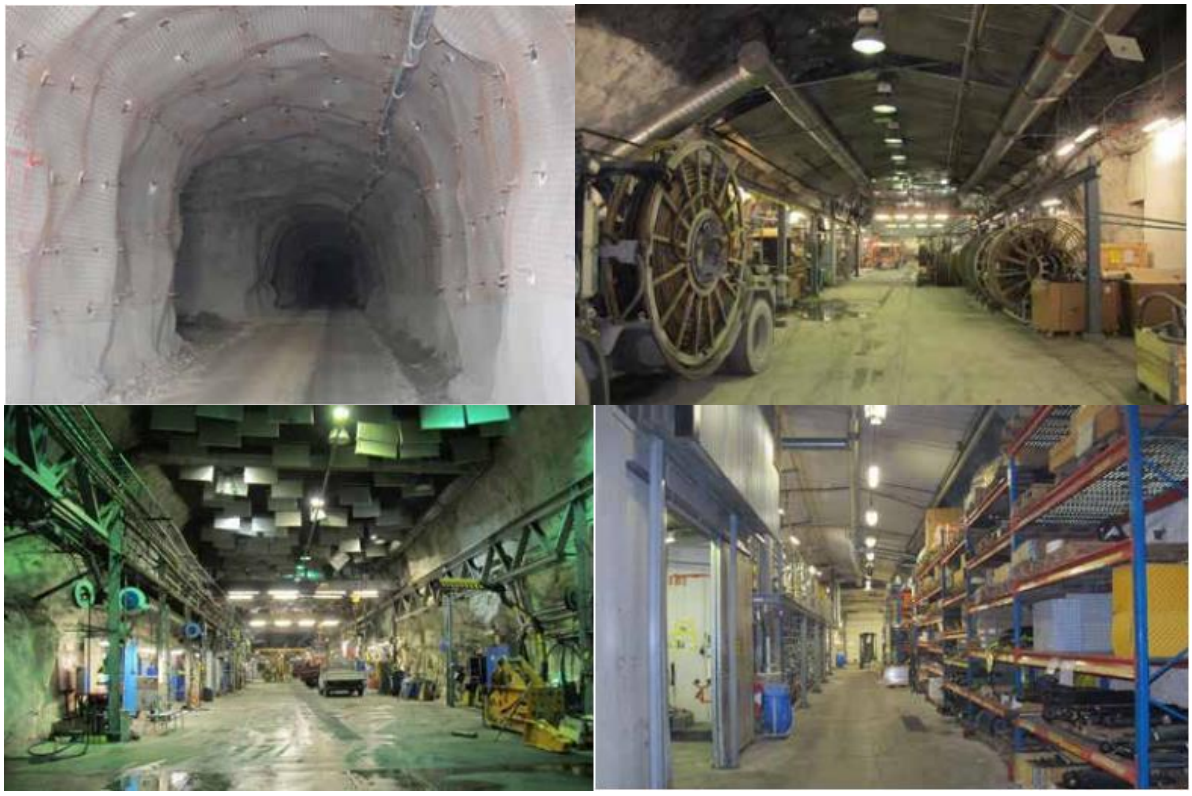
These materials will determine the desired traction to match the specific conditions of the mine, where equipment adhesion and rolling resistance are two main concerns for safety and productivity.

Deterioration as the result of stress is not the only problem when it comes to haul roads. Another common challenge is the dust that is stirred up by the machines, which can become hazardous for operators and the environment. Water is used to minimize dust, but it is crucial that haul roads feature a "sealed" surface consisting of fines that are used as binders for larger particles.

Placement of workshops

In the same way that a systematic approach toward road maintenance is highly recommended, the strategic location of workshops is required in order to optimize a mine's production cycle. As every hour counts and downtime is always costly, larger mines may employ a system that combines field maintenance with main and secondary workshops, which drastically reduces distances and service/repair time.

By definition, the main workshop is under ground, situated some distance away but strategically placed in relation to all mining areas. All preventive maintenance is done here, as well as all major repairs. For major overhauls of large components, the main underground workshop will often send these up to a surface workshop. When they are completed, they are returned to the main workshop to carry out the replacement work on the machines.



Secondary workshops are smaller and located closer to the mining area, often in close proximity to personnel rest areas. These secondary facilities are equipped with some smaller spare parts, fluids etc, and located in well drained or dry areas. Field maintenance is carried out by dedicated crews with well equipped vehicles.

Where possible, it is advisable that both main and secondary workshops are designed with independent access routes so as not to disturb the production and daily flow of haulage traffic. They should also be located in dry areas where there is no water ingress from the rock that could potentially damage electronics and create slippery surfaces. This also means that facilities needed for cleaning equipment should be kept separate from the workshops.

The same strategy should apply to the location of the workshop's loading bays. Shop materials such as tires, fuel and oils can pose a fire risk and need to be carefully stored. Like all mining operations, road maintenance and workshops naturally come with a price tag, but the cost usually represents just a small percentage of the total cost of the overall operation. On the other hand, the cost of choosing to overlook or deliberately neglect these aspects of the operation could end up costing a great deal more.

In northern Finland, the Kemi chromite mine serves as a good example of how proactive planning for roads and workshops leads to a safer working environment, while enabling continuous expansion. Using an advanced layout of ramps and drifts for rail haulage and large payload trucks, maintenance facilities are located close to the excavation area at a depth of 500 m. Due to smooth operation which is extending deeper in the mine, a low accident rate and low outage time, the annual production of 2.5 M tonnes of chromite ore is set to double in the next few years.