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Cost Control for an Uncertain Economy

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Abstract

Controlling costs has been and always will be of paramount importance to the mining industry. The design and condition of the mine haul roads can greatly influence the costs of haulage, Operation & Maintenance (O&M) costs as well as safety. Safety must be the number one consideration when designing haul routes. Technological improvements have been introduced to the industry to improve subgrade performance and reduce costs related to the construction of haul roads. One of the biggest areas affecting haulage economics is tire performance. Prolonging the life of tires is one of the easiest ways to reduce haulage costs. Haul road design considerations are discussed herein to improve the performance of haul roads.

Introduction

Controlling costs has been and always will be of paramount importance to the mining industry. In an uncertain economy this principle becomes even more important. Profits in this industry are made or lost based on small differences in price for multiple units. One area that can have a large influence on profits is in haulage costs. The design and condition of the mine haul roads have major impact on the costs of haulage, Operation & Maintenance (O&M) costs as well as safety.

The principal design elements discussed are not new or unique to Texas but have been promoted by the Mining Industry as well as Federal and State agencies having regulatory responsibilities for many years. Because of the uncertain economy, this industry has a double-edged incentive to provide well designed, well built and well maintained haul roads.

This paper is based on the design of haul roads in Texas. Texas is a big state, most of the mining occurs along the lignite belt running northeast to southwest parallel to the Texas Coast. The climate ranges from subhumid in the northeast to semi-arid in the southwest. Historically, most of the mine roads in Texas were designed using the *U.S. Department of Interior, Bureau of Mines Information Circular No.8758, Design Guidelines for the design of Surface Mine Haulage Roads, 1977*. This guideline was developed to “provide those involved with surface mine haulage road design with a complete manual of recommended practices that, if implemented, will promote safer, more efficient haulage routes”. In recent years, technologic improvements have been introduced to the industry to improve subgrade performance and reduce costs related to the construction of haul roads.

Safety First

Safety must be the number one consideration when designing haul routes. One accident can potentially erase years of profits and in some cases, destroy the company. The Mine Safety and Health Administration (MSHA) reported that of 442 fatal accidents that occurred during a five-year period, 27% of them involved surface haulage equipment. These accidents were categorized into four main types:

- Trucks going over dump points
- Vehicles/persons being run over by large trucks
- Miners getting caught in conveyors
- Haul trucks going out of control

Design Elements Affecting Safety

Three of the four types of accidents identified by MSHA involved haul trucks and, by association, the design, operation and maintenance of haul roads. It also must be pointed out that human error can undue the best design. The need for training truck operators is of the utmost importance. The major design elements affecting safety are:

- Grade and Brake Relationships:
  - Grade and Brake relationships must be considered in design of the alignment and road profile. Grades must be designed to accommodate the breaking capabilities of the equipment using the road. In Texas, this is a major consideration only in the design of ramps into the pit area. Generally, once a truck is out of the pit area, grades are fairly mild.

- Minimize Steep Grades
  - Provide "Runaway Truck" measures including berms and escape ramps.
  - Verify that trucks are operated within the manufacturer's recommendations.

- Sight Distance and Stopping Distance Relationships:
  - The minimum sight distance is tied to the minimum stopping distance. The driver must be able to see a hazard on the road and have time to react and safely stop the vehicle.
  - Consideration must be given to all sizes of vehicles that use the road. A smaller vehicle may not be able to see over a hill or berm that a large truck can.

- Haul road Alignment:
  - Primary consideration must also be given to sight distance around curves and over hills. Consideration also must be given to correct width, radius and superelevation.

Design Elements Affecting Cost of Haulage

One of the biggest areas affecting haulage economics is tire performance. Because of the worldwide demand for tires, manufacturers have not been able to keep up with the demand for tires, and replacement costs have risen substantially. Prolonging the life of tires is one of the easiest ways to reduce haulage costs. As Mr. Mark Sprouls of Caterpillar Global Mining stated in his article in *World Coal* in February 2007, "…what's good for tyres is good for trucks and profits." The number one thing that's good for tires is a well designed, well built and well maintained haul road.

Design considerations for improvement of tire life:

- Rolling Resistance: Rolling resistance may be minimized by reducing grades, maximizing curve radius, providing superelevation in curves, proper compaction, drainage and maintenance.

- Cross Slope: It is primarily for drainage but also has the effect of separating traffic. Properly drained roads reduce slippery conditions and minimize rolling resistance. Cross slopes that are too steep may result in vehicles sliding across the slope during wet conditions.

- Curve radius: This should be made as large as possible to minimize the side forces on tires. Curves should be of constant radius to avoid steering corrections.

- Superelevation: It is used to counteract the centrifugal force that places a side force on the truck and tires. The transition from the normal cross-slope to the superelevated section is referred to as runout. One-third of the runout should be placed in the curve and two-thirds in the tangent.

- Compaction: A stable road is one of the most fundamental principles of good road design. Construction of a road over material that cannot support the weight of the traffic will result in excessive rutting and deterioration of the roadway. Tools to strengthen subgrades include: lime stabilization, cement stabilization, geofabrics and geogrids.

The Texas Experience

In the late 1970s and early 1980s several new mines were opened up in the lignite belt in Texas. Typical surface and subsurface soils were composed of heavy clays with a California Bearing Ratio (CBR) of approximately 5. A typical road cross section consisted of 6 inches of lime stabilized sub-grade, 20 inches of select material with a PI of less than 15 (sandy material), followed by a surface course of 18 inches of limestone flex base material. This road served the mine very well and lasted about 27 years before a major reconstruction of the road was required. It needs to be noted that neither the select material nor the limestone flex base was locally available and had to be hauled in. While there were local sources for the select material, the closest source for the flex base is approximately 100 miles from the quarry to the job site. When the mine first opened, flex base could be obtained for approximately $10 per cubic yard. Last year, it cost approximately $50 per cubic yard due primarily to the high cost of fuel.

In the early 1990s, this road was extended southward to a new area. The typical cross section consisted of 20 inches of compacted subgrade (clay) and 12 inches of flex base surface material from a local quarry. The road had a 2% crown to provide surface drainage off the road. A problem with the material quickly became apparent during the first rain shower. As the haul trucks ran down the road, a thin film of fatty clay came to the surface and made the road super slick. The loaded haul trucks began sliding toward the edge of the road but stopped short of sliding off the road. Needless to say, no lignite was hauled that day. The solution to the problem was to place a layer of limestone flex base on top of the existing road surface. It became quickly apparent that the quarry material required testing before using it as a construction material.

In the mid-1990s the main haul road was extended northward across regraded spoil into a new area. The typical section consisted of a 16 inch lime stabilized subgrade and 12 inches of limestone flexbase, and this road also has served well. The lime stabilized subgrade required considerable time to construct due to the curing time required. In 2000 and again in 2005, the road was extended again over regraded spoil. The construction time was considered critical and did not allow adequate time for lime stabilization. However, the road was extended over an area that had been used as a temporary haul road using 12 inches of parting material over the clay subgrade. When tested, the parting material consisted of clayey material with a small percentage of carbon in it. Unlike the clay in the spoil, the parting material had a characteristic that it would not become slick when wet. This parting material was left in place and a 16 inch layer of compacted clay subgrade was placed over it. In order to reduce construction time, instead of stabilizing subgrade material with quicklime, a geogrid was placed over the subgrade material and a 16 inch layer of limestone flex base was placed over that as a surface course. This section of road also has held up well. Some settlement of the spoil has affected the road finished grade, causing a limited amount of slumping of the edges, which has been easily repaired by adding flex base to the surface.

In 2008 the haul road was again extended; however, fuel prices had risen dramatically increasing the cost of flexbase substantially. In order to hold down construction costs, an effort was made to locate local materials to be used in the surface course. Several local gravel pits were identified but these materials either had too much fatty clay mixed in with the gravel or the gravel portion was too soft to withstand the wheel loads associated with the coal haul trucks. In order to use the local material, the surface course was split so that the road section was 10 inches plus of compacted subgrade overlain with geogrid, overlain with 8 inches of local gravel pit, overlain with 8 inches of limestone flexbase. It's too soon to critique the road but it has held up well so far. The geogrid has been functioning well and seems to be adequately stabilizing the subgrade.

Conclusion

Acceptance of new technologies does not always come easily. It is easier to say that the 'tried and true' is the best way. However, we must remain open to technological advances. Vendors who would sell their products need to be open about testing methods to support their claims. It's difficult to recommend a black box to a client unless there is some proof of concept and use.

As costs for materials have, technological advances have been used to offset some of the costs of road building by reducing the time it takes to construct them and the amount of required offsite materials used. Overall, these can be achieved while maintaining safety and performance, and ultimately the cost, of haulage.