THE ACOUSTICAL CHALLENGE OF QUARRY DESIGN

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INTRODUCTION

Quarries must be located where there are adequate supplies of the mineral resource (rock). Often they are in very quiet areas where there are no significant noise sources in the environment. However, there are often a scattering of permanent or seasonal residences around the proposed site where the applicable noise guidelines have to be met. The noise mitigation measures not only have to be effective acoustically, they must also meld with the operational design to make extraction economically viable.

NOISE GUIDELINES

In Ontario, the Ministry of Environment and Energy (MOEE) noise guidelines require that the hourly sound exposures (L_{eq} in dBA) produced by the quarry operations not exceed the existing ambient sound environment at neighbouring noise sensitive receptors (although mitigation to below 40 dBA is not required).

We have often found that the ambient sound environment is less than 40 dBA in the vicinity of proposed quarries. The very stringent sound exposure limit of 40 dBA that is triggered can be difficult to achieve at nearby receptors.

BASIC QUARRY OPERATION

A quarry operation is a heavy industrial operation using very large pieces of machinery, many of which have high noise emission levels. The operations typically involve:

- Drilling and blasting of rock;
- Transport of rock from the working face;
- Processing of the rock; and
- Shipping of the product off-site.

Prior to start-up of the quarry operations, some construction activities are needed, such as building of the scale house, storage building, processing plant, noise mitigation measures, internal haul roads, etc. These activities are not part of the chronic daily operations are often need not be considered if their duration is relatively small in relation to the life of the site.

NOISE MITIGATION

Many of the noise sources associated with the activities outlined above can be dealt with fairly easily. Most of the noise sources are located on the quarry floor, well below surrounding grade, taking advantage of the inherent screening provided by the working face. To maximize this screening, the operations can be designed so that the working face progresses towards the receptors and the equipment is located as close to the working face as possible, inherently screened by the embankment. Rock can be transported from the working face to the processing area by electrically powered conveyors, which are very quiet. Conventionally, large off-road trucks are used to carry blasted material from the working face to the primary crusher. Large, noisy pieces of processing equipment (secondary crushers and screens) can be located inside of buildings specially designed to provide appropriate noise attenuation.

Truly mobile crushers are being developed which travel with the working face. They can be loaded directly by an excavator. This method of mining can be very effective acoustically since this equipment can be located very close to the working face, maximizing the inherent screening.

However, the rock drilling operation is the one noise source that is very difficult to mitigate and is often the determining factor in terms of the noise mitigation requirements. The rock drill is always located on top of the working face. If there is very little overburden, the drill is exposed to the surrounding area, at least for the first lift. Large quarries often have to carry out rock drilling continuously even if the actual blasting occurs only once a week. Combine all of this with the fact that the rock drill is often the single most significant noise source and the challenge becomes obvious.

The most commonly used form of noise mitigation is the perimeter berm. The acoustical effectiveness of any barrier is greatest when either the source or the receiver is close to the barrier. For large sites, very high barriers are required since the rock drill would generally be far away from the perimeter berm as would the off-site receptors. If there is little overburden on the site, there may not be adequate resources to construct the perimeter berms.

To reduce the height of the berms, interim berms could be used. These are located fairly close to the operations and would be moved as required. In this way, the effectiveness of the barrier is increased, reducing the height requirements. However, there is the added operational complexity and cost to move the berms from time to time.

A further reduction in the height of the sound barriers can be achieved through the use of a portable barrier placed close to and around the drill. These barriers can be constructed on flat bed trailers fitted with skirts so that there are no holes or gaps. Again, complexity is added since the barrier needs to be moved frequently.

ROCK DRILLS

There are different types of rock drills available, with pneumatic or hydraulic drives. Percussive drill heads are common. Some models have dust collectors. The hammer type drills can be fitted either with an overhead hammer or with a down-the-hole hammer. Our experience has been that all models are relatively noisy, with sound emission levels in excess of 85 dBA at 15 m (some exceed 100 dBA). In some models, the drill head travels down the tower. In others, a down-the-hole head is used. The latter is reputed to be quieter. However, this does not appear to be the case as a result of radiation from the drill tower and above ground portions of the drill rod.

The best solution would be for mitigation to be added to at the manufacturing level to simply produce quieter rock drills. However, there are several difficulties with having this done:

- The major drill manufacturers, even today, are not fully aware that these stringent receptor based guidelines exist in Ontario. Their main noise concern is minimizing the sound level at the operator position.
- The Ontario market is too small to have enough clout with the manufacturers to cause design changes.

CONCLUSIONS

Quarries are often located in very quiet rural areas with a scattering of residential uses located around the proposed site. Currently the applicable noise exposure limit (one hour L_{eq}) can be as low as 40 dBA. Many quarry noise sources are fairly easy to mitigate since they are located on the quarry floor. The pit wall acts as a sound barrier by interrupting the line of sight between the operations and the neighbours, providing inherent screening. Most processing equipment can be enclosed. The rock drill operates on top of the working face and is often exposed to the neighbours. The drill is usually the single most significant noise source, producing in the range of 85 to 100 dBA at 15 m.

Mitigation measures other than the typical perimeter barrier often need to be considered. However, the best solution would be to manufacture quieter drills. To achieve this, quarry operators need to apply pressure and to educate the manufacturers about noise requirements in the province of Ontario.