Vibration Modelling and Analysis Underpins Feasibility Study Accuracy

Project Summary

VIBRATION MODELLING TO ENABLE ACCURATE MINE PLANNING AND SUPPORT THE FEASIBILITY STUDY FOR AN AFRICAN DEPOSIT

DynoConsult were commissioned to conduct desktop vibration modelling for an African mining project. This work would form an essential part of the mine planning aspect in the final feasibility study.

The analysis was required to predict the expected vibration levels at power lines situated in close proximity to each of the extraction pits at the mine. A range of site constants were employed for vibration prediction, giving best, worst and average case results for a number of blast design scenarios with a view to mitigating vibration issues.

The results of this analysis provided an indication of whether nearby power lines were at risk from future blasting activities and any mitigation measures required in terms of mine scheduling and design for each geological condition present at the mine.

Background

CLOSE PROXIMITY TO ESSENTIAL INFRASTRUCTURE

The project is proposed to be mined as a series of open pits over a 10 year period. The proposed pits sit between 1500m and 100m from a major power line that is the sole supply to the region's capital city.

Having previously worked with DynoConsult on feasibility work for projects in Australia, the mining consultant was confident that a prompt and concise response would be provided for this project. A detailed proposal was prepared for the work including options for desktop modelling through to site measurement and signature hole analysis work.

Project Goals

ESTABLISH BLAST INDUCED VIBRATION IMPACT ON ADJACENT POWER LINES

To complete a feasibility study with an acceptable level of accuracy it was important to understand the effects that blast induced vibration may have on the power lines. Along with predicted levels of vibration, mitigation options were also required to enable the feasibility study to reflect the cost of mining at each pit location.

This study also provided a starting point in terms of the blast design parameters necessary to maintain vibration at an acceptable level prior to any on-site measurements and further analysis taking place.

Technology Applied

VIBRATION ANALYSIS AND PREDICTION

The maximum vibration level, or Peak Particle Velocity (PPV), can be predicted from a relationship between the charge weight of the explosive, W, the distance from the explosive, D, and two site constants, K and b, as shown in the PPV equation below.

$$PPV = K\left(\frac{D}{\sqrt{W}}\right)^{-b}$$

By plotting the Scaled Distance ($D/\sqrt{W}$) against field measured vibration on a Log/Log graph, the two site specific constants (K & b) can be determined.

As there was no site data available, a desktop study of site constants, K & b, was carried out to determine the appropriate range of values to base the vibration prediction modelling on. These collected values were plotted, see figure below, to show the variation across mining operations and differing resource sectors.

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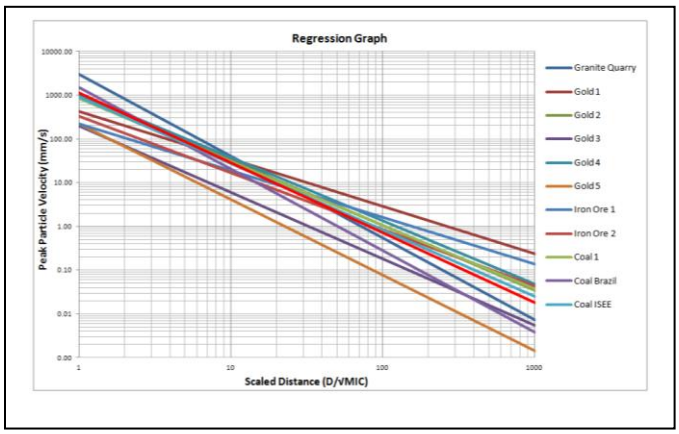

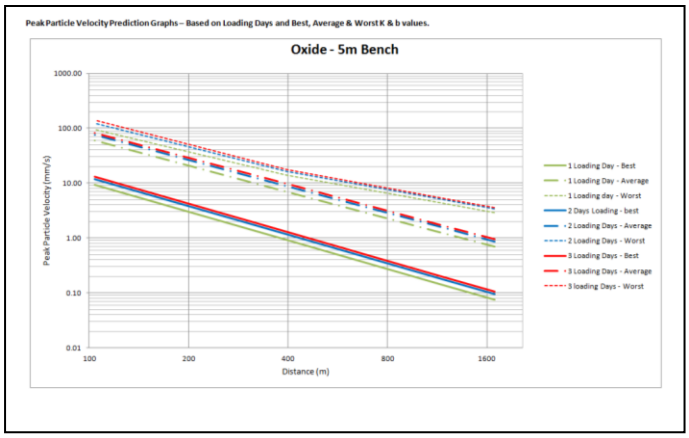

For modelling purposes best, average and worst case site constants were determined from the chart, these values were also subdivided between an upper and lower Scaled Distance range.

Following the selection of the site constants, it was necessary to determine what the Maximum Instantaneous Charge (MIC) would be for the different blasts that were necessary to achieve annual production rates. A number of assumptions based on the information supplied for the feasibility study and accepted "Rules of Thumb" for blasting were used to calculate blast sizes and dimensions for each geological region. Appropriate timing was then determined via a Monte Carlo timing simulation to minimise MIC.

Value Added

IMPROVED FEASIBILITY STUDY ACCURACY

The predicted Peak Particle Velocities (PPV) at the various power line distances from the respective pits, based on worst, average and best case site constants were calculated. The results from one scenario are presented in the next figure.

Key conclusions and recommendations achieved from this vibration modelling work include:

- Where blasting will take place at distances greater than 1100m from the power lines, PPVs should remain within safe levels for all scenarios modelled
- Bench height and blast size will need consideration when blasting in the pit located 400m from the power lines
- Where blasting is required 100m from the power lines, additional controls will need to be implemented to reduce the PPV, including electronic detonators and Signature Hole Analysis

An early indication on the mitigation measures required to combat the effects of blast induced vibration on any proposed critical infrastructure can allow planning optimisation to take place prior to the commencement of mining. This study ultimately resulted in an overall improvement to the accuracy of the feasibility study through the availability of improved mine planning information.

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