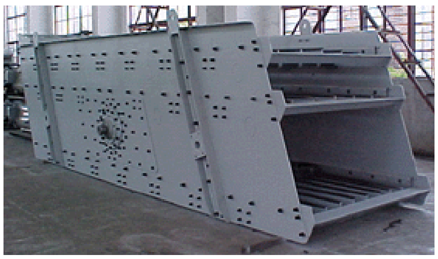
CASE STUDY

ACHIEVING EXCELLENCE IN ENGINEERING

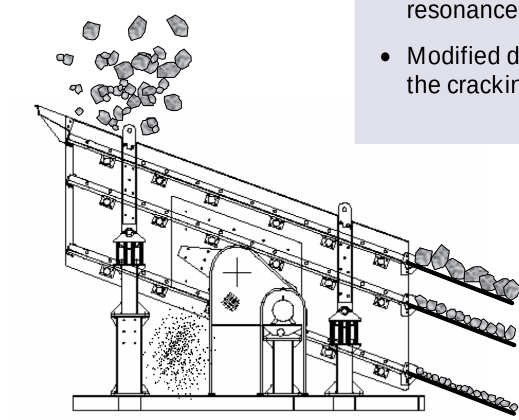
Failure Analysis of a Quarry Screen

The Problem

Quarry screens are used to grade crushed rock into different size ranges. They



work by feeding the unsorted material into the upper end onto a mat with holes sized for the largest range. By vibrating the mat, material too large to pass through the holes moves down to the end and is collected in one bin. Rock that is small enough to pass through the holes falls onto a second mat with smaller holes and is likewise sorted. There may be a third mat as well. The mats are all supported in an open box-like structure, known as a screen, and the whole assembly suspended on soft springs to isolate the vibration from the screen-house building. A set of rotating out-of-balance masses provide the forces to cause the screen motion and by selective positioning, the screen can be forced into linear or circular orbits.



In this case study, the screen was set up to move in a circular orbit. After a short time of operation, cracks began to appear in the side plates of the box. The cracks were welded, but returned later giving concern that catastrophic failure would occur. Some approach was required to identify the cause of the cracking and to suggest the most effective remedial action to take.

Special points of Interest:

- Cracking failure of a quarry screen
- Acceleration measurements used to determine rigid body motion of screen plus deformation component
- Established torsional resonance of screen
- Finite element modelling optimised modifications to avoid resonance
- Modified design cured the cracking problem

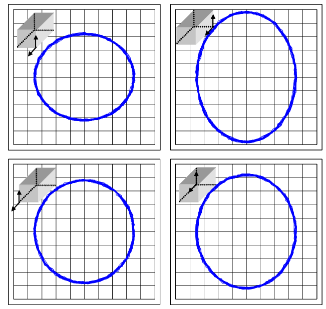
The Approach

Cracking is generally caused by excessive stresses cycling as the structure deforms under imposed forces. The first step in this investigation was to establish the global deformations during running conditions. A pair of accelerometers was used with a high speed data logger to record the motion at the corners in two orthogonal directions.

Suitable processing converted the accelerations into displacements and by monitoring combinations of corners and directions, the overall motion of the screen could be deduced. Most of the motion of the screen would be as a rigid body, vibrating on its spring supports. The objective of the measurements was to determine if there was significant motion involving deformation and hence give rise to damaging levels of stress. With measured deformations, a finite element model could give the expected stress distribution and assess changes to improve the design before implementation.

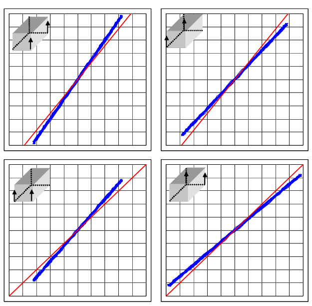
The Results

By plotting the orbits of the four corners, it is possible to check if the screen was operating as intended. While it is acceptable to have differences between front and back and maintain rigid body motion, the patterns of displacements suggest that the screen was also distorting.



Corner orbits of screen

By cross-plotting motions between corners, the nature of the deformation can be understood. These graphs show that the screen had a significant twisting deformation in addition to the rigid body motion. This strongly suggests the presence of a torsional natural mode of vibration of the screen.



Relative motion between corners

A finite element model confirmed the torsional mode at the running speed of the screen. The model was then used to optimise the design changes.

The Outcome

Using this combination of testing and analysis gave a clear understanding of the motion and deformation of the screen and of the cause of the cracking failure. The finite element analysis was able to determine an optimum design change that would raise the frequency of the torsional mode high enough to avoid resonance while being straightforward to implement without compromise to the operational requirements of the screen. Following the modifications, the screen no longer exhibited cracking problems.

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