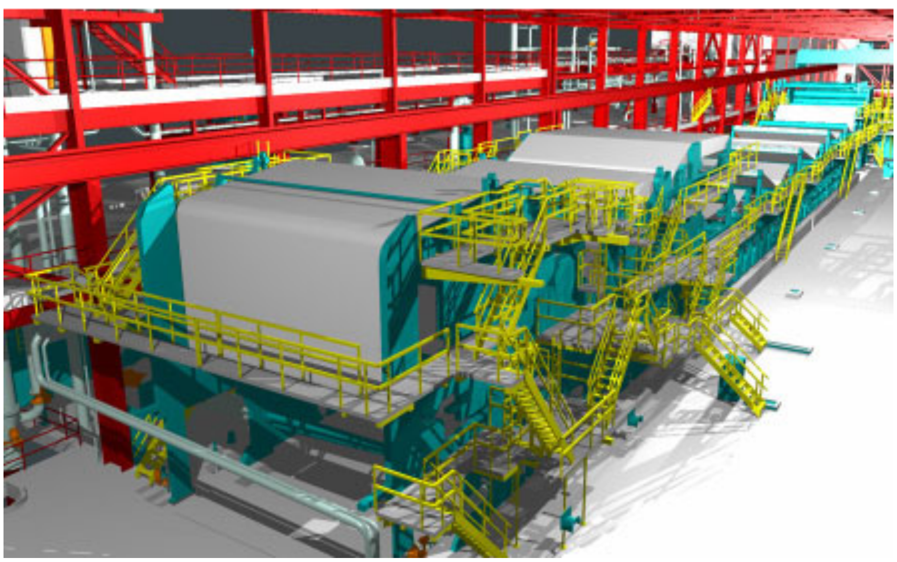
Monitoring Aperiodic Damage Events

SWAN™ technology as an effective instrumentation

Stress Wave Analysis (SWAN) technology is a highly effective instrumentation technique to detect periodic damage events. Recent testing on paper mill roller bearings presented a particularly challenging assignment for the demonstration of Stress Wave Analysis Technology due to the special nature of the customer's problem. The bearings under analysis were cylindrical roller bearings with inner races which were shrink fitted onto the journal of the dryer rolls in the dryer section of a paper machine. (The dryer journal was also hollow and had steam passing through it, to provide heat for drying the paper as it passes over the roll).



There had been a recent series of bearing failures due to through-the-part cracks in the bearing's inner race. This crack released the inner race hoop stress (from shrink fitting) and allowed the race to intermittently rotate in a "stick-slip" fashion on the dryer roll journal. This "stick-slip" phenomenon then "machined" material from the dryer roll journal. This machining debris moved through the race crack and into the bearing, were it was ground up between the rollers and races, causing further damage, and eventual catastrophic failure.

Objectives of Diagnostic Task

Replacement of all suspect bearings was not feasible due to a limited inventory of, and long lead time for, new bearings. Therefore, the diagnostic task had the following objectives:

- Identify which bearings were good and which were failing.
- Of the discrepant bearings, identify those with through-the-part inner race cracks as opposed to pitting or spalling, and...
- Of those bearings with inner race cracks, identify those which had progressed to serious

To accomplish all of these tasks; fault detection, failure mode definition, and damage quantification, the Stress Wave Pulse Train (SWPT) was analyzed three ways:

- Computation of Stress Wave Energy (SWE)
- Spectral Analysis to identify bearings with friction and shock events occurring at the rolling element passage frequency over a point on the inner race, and...
- Recording a time history to identify bearings with high amplitude, aperiodic stress wave

Data was first obtained from a new, undamaged bearing, before surveying the rest of the suspect population.

The survey found two defective bearings; one with a "new" inner race crack, but relatively little secondary damage, and one with an "old: inner race crack plus surface damage due to ingested metallic debris. Instrument sensitivity was set so that the new bearing had a SWE reading of zero (0). The bearing with the "new" inner race crack read SWE=3-4, and the bearing with advanced damage read 75-76. A comparison of the time history data showed a small background pulse amplitude of both the new bearing and the bearing with the "new" inner race crack, but a much larger background amplitude from the bearing with an "old" crack and ingested metallic debris.

This time domain data also showed large, randomly occurring, pulses from both bearing with race cracks. The frequency domain data showed a spectral line at the inner race roller passage frequency only on the bearing with the "new" inner race crack. The reason the bearing with the "old" race crack did not exhibit this spectral line, is that the stress wave pulses from ingested debris and debris damage are randomly occurring and higher in amplitude than the periodic pulses that occur due to rollers crossing over the race crack.

This is an example of the inability of traditional Spectrum Analysis to detect advanced levels of damage that can be both identified and quantified by the analysis of Stress Wave Energy.

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