White Paper
August 2011

Complex Bearing Problem on a Slow Speed Application (96 RPM)

Normally, outer race problems are relatively easy to recognize in a vibration spectrum. This case study shows an example of an outer race problem on a concrete breaker.

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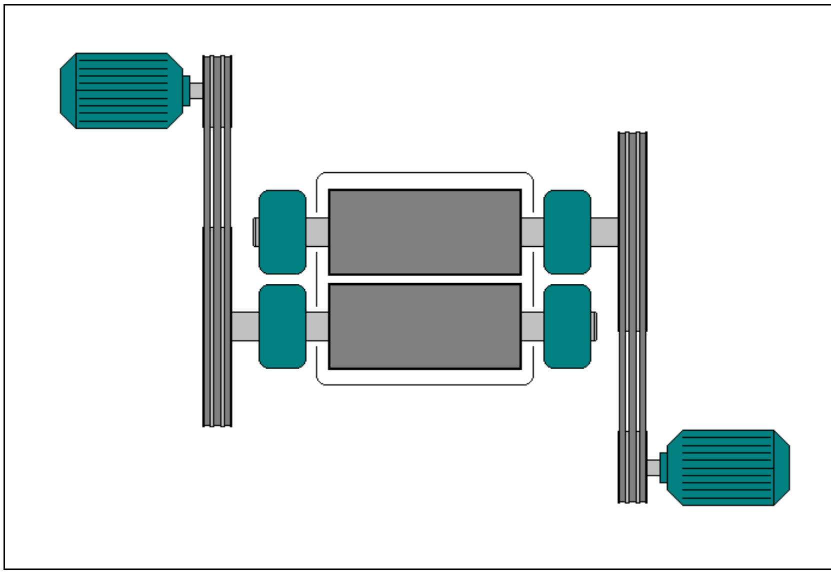
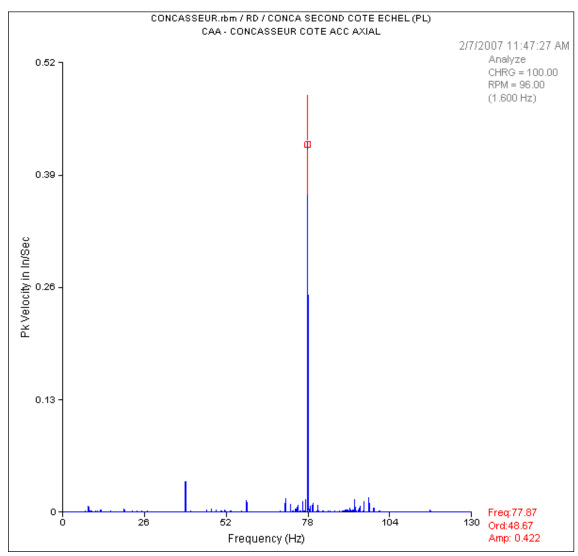
Introduction

In this example, there is a combination of an outer race problem, with a resonance problem and a wrongly-installed bearing. Those 3 problems together give a very special vibration pattern that was difficult to analyze and recognize in the beginning.



The installation is a concrete breaker. 2 motors with a speed of 740 RPM are connected with a belt to roll with a speed of 100 RPM.

On 7 February 2007, a very high frequency was measured at 78 Hz on a rotor in axial direction.



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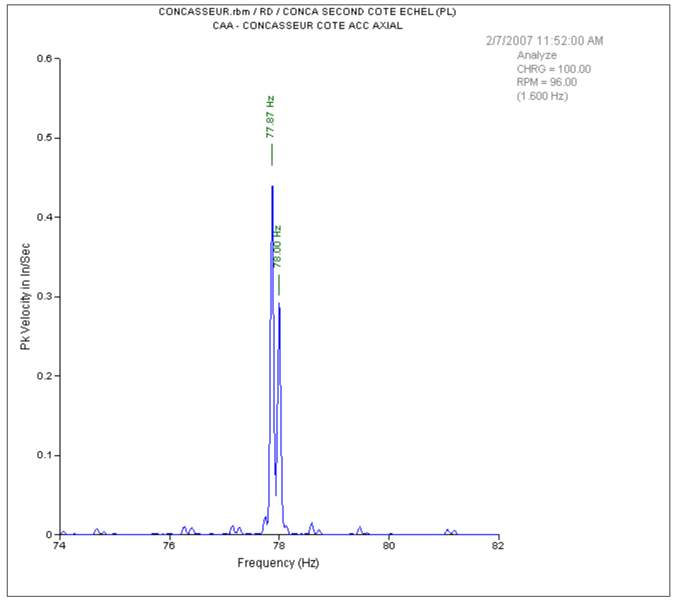
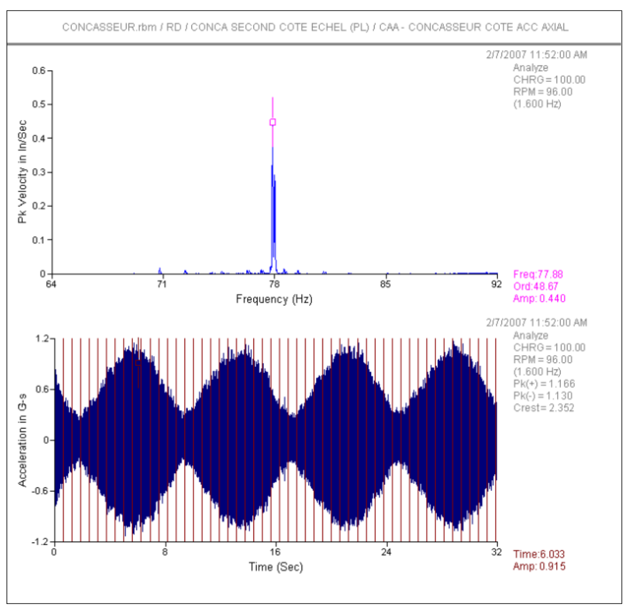
A detail measurement tells us that this frequency, in reality, is the combination of 2 frequencies, very close to each other. 1 peak is at 77.87 Hz and the other is at 78.0 Hz



Those 2 peaks are creating a beat frequency. This is also easy to recognize in the associated waveform.



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Of course, the million dollar question here is: What is the source or reason for this beat frequency at 78 Hz on a concrete breaker bearing?

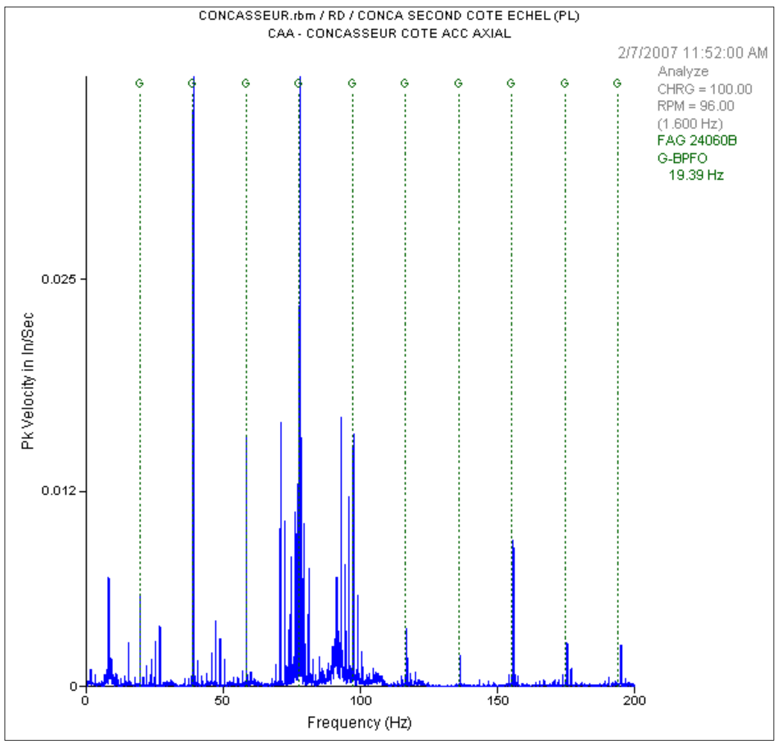
Analyzing the Measurements

First of all, we must explain the peak at 78 Hz.

High resolution measurements show that the peak at 78 Hz is not a standalone peak, but is in fact the 4th harmonic of a family at 19.5 Hz. This is the BPFO frequency of the installed bearing (bearing number is 24060B).

So, we know now that this is an outer race problem. But why is the 4th harmonic so high, and where is the beat frequency coming from?

Let's examine why the 4th harmonic is much higher than all other components.



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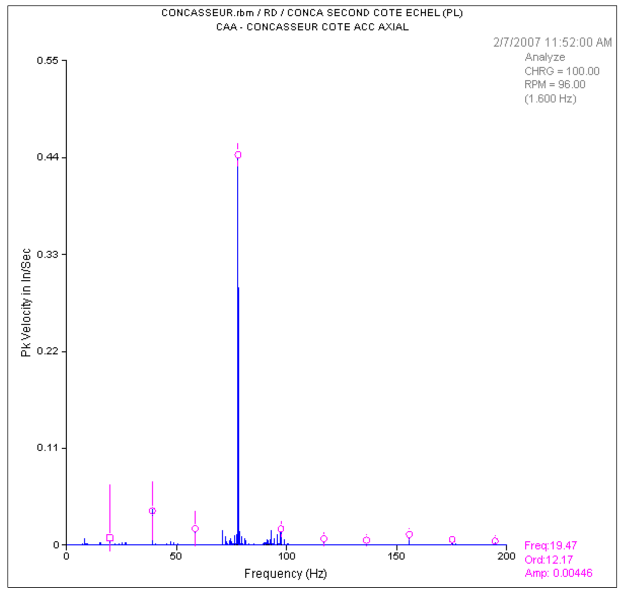
When we take a closer look at the spectrum in the neighborhood of 78 Hz, we see an increased floor level, which can be an indication of a structural resonance frequency. In other words, the 4th harmonic of the outer race problem has such high amplitude because it is amplified with a structural resonance.

But, what about the beat frequency?



A closer look at the spectra shows us that there are 2 harmonic families in the spectrum, one at 19.47 Hz and one at 19.50 Hz. If we want to explain the beat frequency at 77.87 Hz and 78.0 Hz, we have to find an explanation of 19.47 Hz and 19.50 Hz.

The explanation of this can be found when we take a closer look at the type of bearing.

The 24060B bearing is a double row spherical bearing.

When this bearing is installed correctly and loaded, the pitch diameter and contact angle should be the same for both rows.

If there is an axial force on the bearing, the contact angle will be different for both rows.

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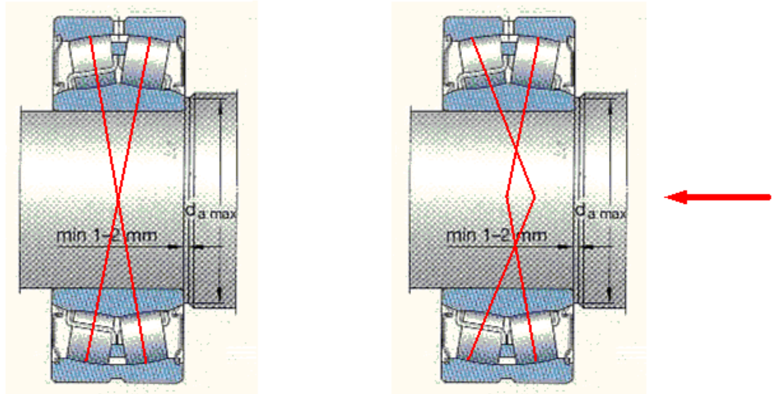
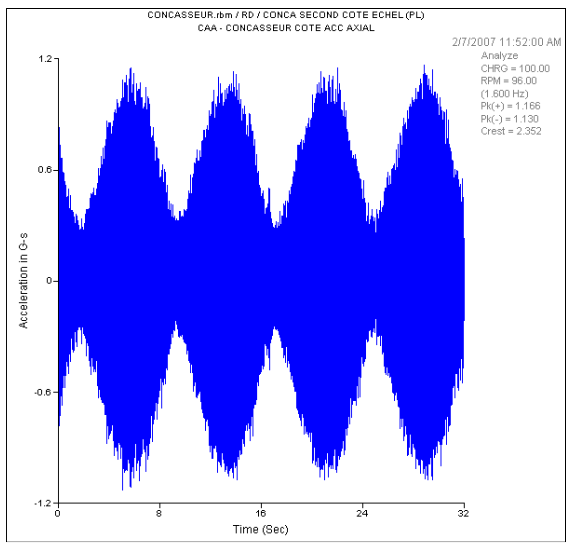


$$BPFO = \frac{N_b}{2} \times \left(1 - \frac{B_d}{P_d} \times \cos\theta\right)$$

And this will create the 2 harmonic families, who are very close to each other.

The combination of a resonance problem with an outer race problem and an installation problem created this extraordinary waveform.



Here is a picture of the damaged bearing.

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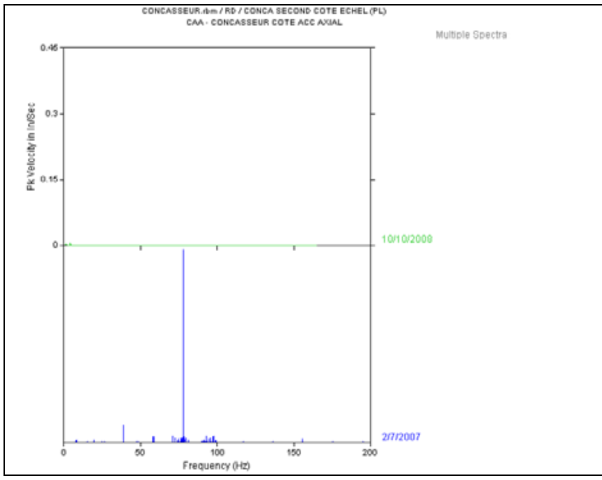

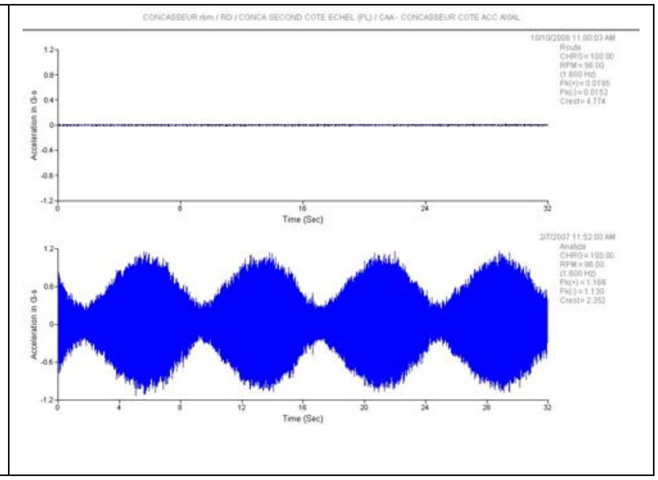

The last pictures show a comparison of the spectra and waveforms before and after the bearing replacement.

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