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ACOUSTIC EMISSION TESTING OF STRUCTURES EXHIBITING HIGH LEVEL VIBRATION AND AIRBORNE NOISE

INTRODUCTION

Most of you are aware from past newsletters that we have been involved with a client for more than a year in monitoring of a railroad bridge in Colorado utilizing our AESMART 2000 multiple channel acoustic emission instrumentation. I will describe to you some of the problems encountered in this program, along with fixes we have made to both the sensors and instrumentation to solve these problems. We faced the same problems as those encountered with the railroad bridge while monitoring the support structure for a roller coaster, therefore the fixes herein described should also apply to this application.

<u>RAILROAD BRIDGE MONITORING</u>

Acoustic emission testing of a railroad bridge is presently being conducted at the Transportation Technology Center in Pueblo Colorado. The bridge is located in a test loop called Facility for Accelerated Service Testing (F.A.S.T.). The train used in the testing has 68 cars weighing greater than 125 tons each. During our initial tests we placed SE9125-MI sensors near several known crack locations. The train moved slowly back and forth over the bridge and on request would stop on the bridge. We were very encouraged with these initial tests due to the fact that the Modal Ratio filtering utilized by the AESMART 2000 instrument eliminated the noise due to movement of the train in real time while still allowing us to quantify the difference in crack growth rates from specific locations. Very loud audible squeaks and groans were present during the monitoring and these noise signals were propagated throughout the structure but were effectively filtered out in real time by our modal ratio filtering concepts.

Our optimism from these preliminary tests was crushed when the heavy train began its normal test velocity of 40 miles per hour. The squeaks and groans observed during the very slow speeds suddenly became a roar with the train traveling at the faster speeds. Both high amplitude signals due to vibration and high frequency air borne signals were produced at the higher velocities. Both the low frequency and high frequency signals from the SE9125-MI transducer increased dramatically in amplitude and density. A pulser was used on the edge of one of the flanges to insert in-plane crack like signals at a rate of one pulse per second. Although the ratio filter eliminated the high noise background, the noise density was so high that we could not consistently detect the signal from the pulser. We therefore concluded from these results that signals due to crack growth could also not be detected consistently under these conditions.

The piezoelectric element in the SE9125-MI sensor used for the tests is partially mass loaded. Therefore low frequency high amplitude vibration in the bridge produces high amplitude signals from the transducer due to acceleration effects. This transducer also has poor isolation between the active element and the transducer case. Therefore high frequency airborne acoustic waves can directly produce high frequency signals in the transducer. This effect can negate the modal ratio filtering capability of the instrument

the following reason. Out-of-plane
OP) high frequency airborne noise
ident on a plate produces a low fre-
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filtered out with modal ratio filtering.
his same airborne signal hits the
nsducer with poor acoustic isolation
ween the active element and the case,
roduces a high HF/LF ratio and
refore can be interpreted as a signal
to crack growth. The solution to this
blem was to replace the SE9125-MI
nsducer with the SE650-PI transducer
shown in the photograph. This sensor has a small aperture (0.125 in. dia.) , higher frequency response, is not mass loaded, and has 20dB of acoustic isolation between the active element and case of the transducer. The diameter of the transducer is 0.500 in. and is provided with an integral low noise cable and integral 20dB preamplifier. We believe it to be the smallest integral preamplifier AE transducer in the world.

In addition to changing transducers for the testing, several modifications were made in the software and hardware of the system. Details of these modifications can be found by downloading and printing the AESMART 2000 brochure on our web page.

CONCLUSIONS

In order for modal ratio filtering to be effective when conducting acoustic emission tests on structures exhibiting high amounts of vibration and airborne noise, the following precautions should be taken:

1. Do not use AE transducers where the active element is mass loaded.
2. Use an AE transducer with good acoustic isolation between active element and case.
3. Use a small aperture transducer to better resolve plate wave frequency components.
4. Utilize at least 5 pole filters in the instrumentation.

The above 4 factors were implemented in our test equipment used for monitoring the F.A.S.T. railroad bridge. We now can successfully detect fatigue crack growth in the bridge members and filter out the high level noise produced by the heavy trains- all in real time.