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5.6 ACOUSTIC EMISSION

5.6.1 Introduction

Noises occurring in nature are accompanied by, and are probably the result of, an energy release of some kind. Fatigue cracks, weld discontinuities, and many other failure causing mechanisms also produce sound energy. Although a portion of the sound produced by materials under stress may exist as audible sound, most is low energy and inaudible. This depends on deformation magnitude and type, and upon flaw growth or failure. An example of the audible stress release occurred at the Mianus River Bridge in Greenwich, CT, where various newspapers reported loud noises being heard by residents days before the actual collapse occurred. This was also the case at the Hoan Bridge in Milwaukee, where witnesses reported a loud noise at the time of the brittle fracture of the steel girders.

For the purposes of this discussion, an Acoustic Emission (AE) is defined as inaudible sound energy released within a material undergoing deformation or flaw growth. An AE test is described as a method used to detect this sound energy. This is a "passive" method. The inspector or a system of transducers simply listens for any sounds emanating from the source location.

To detect acoustic emissions, one or more "listening" transducers are attached to the test object. Positioning of AE transducers in the path of anticipated sound propagation enables detection. The detected signals are then electronically processed to derive information or the location and severity of growing flaws. It should be noted that "guard" transducers are also used in conjunction with the "listening" transducers to differentiate the flaws from just normal bridge noises. Refer to Figure 5.6.1-1 for a schematic of a basic acoustic emission test.

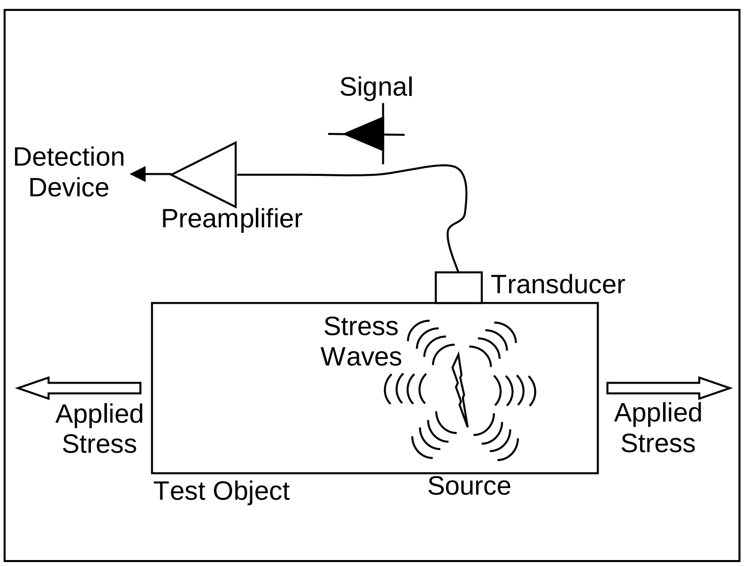

Figure 5.6.1-1: Acoustic Emission Test Configuration (Guard Transducers are Not Shown for Clarity).

AE testing differs significantly from the other nondestructive evaluation (NDE) methods discussed in Part 5. Perhaps the most notable differences are:

1. The detected signal is produced by the test material itself, not by an external source. The AE transducers need only act as receivers;

2. AE tests detect movement, where most other methods typically only detect existing geometrical discontinuities; and

3. An applied stress is required to cause flaw growth, and hence, the acoustic emission. The applied stress can be the result of the components service and dead loads or an induced load used specifically for the AE test. In many tests, a combination of the two is necessary.

Various American Society for Testing and Materials (ASTM) Standards cover AE testing and are dependent on the material and type of structural component being tested.

5.6.2 Applications

AE testing is used to detect cracks, corrosion, weld defects, and material embrittlement. This method can be used on a wide variety of materials, such as metal, timber, concrete, fiberglass, composites, and ceramic. However, it is most extensively used in steel structures, particularly on retrofitted connections and previously noted cracked members.

An entire structure can be monitored with AE testing from a few locations, reducing the amount of access required. AE testing can also be conducted while the structure is in-service. Furthermore the structure can be inspected remotely. That is, the inspector can obtain the data from the web rather than at the site.

AE testing is a real-time NDE method. In other words, it is monitoring the actual condition of the component during the test. The AE test method can also be used to record an accumulation of damage occurring within a structure. The data obtained can be used as history for a structure, and possibly to predict failure.

5.6.3 Limitations

A primary limitation of AE testing of structures, such as bridges, is the requirement to differentiate the sound energy released by a growing flaw from that which is called background noise. Many background noise generators such as bolts, joint friction, traffic, and others can mimic or mask the sound energy released from growing cracks. Some AE test methods avoid this problem by isolating areas known to contain possible background noise generators.

When a global AE inspection is conducted to determine areas where structural problems exist, it will not provide the inspector with the type or size of the defect. Additional NDE or partially destructive evaluation (PDE) methods may be required to identify the exact nature of the emission source defect.

Due to the necessity of listening to the flaw grow, AE systems are typically set up and run 24/7, which can be very costly depending on the size of the structure, the number of transducers on the structure, and the amount of data the inspector must analyze.

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