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5.8 EDDY CURRENT

5.8.1 Introduction

The Eddy Current (EC) test is used for testing ferromagnetic and conductive materials. EC is used to confirm and detect cracking or near-surface defects. EC is highly effective at detecting cracking and is commonly employed to detect and map out fatigue cracking on structural members. EC is also used to determine the thicknesses of coatings, such as galvanizing or thin materials.

The Eddy Current test works off the theory of mutual inductance. That is a moving electric field will induce a magnetic field within a nearby conductive material and a moving magnetic field will induce an electric field in a nearby conductive material. In Eddy Current testing a probe is pressed to the surface of the test material. The probe is typically a coiled wire with an electric current running through it. The electric current has an associated magnetic field wrapped around it. At the tip of the probe, this magnetic field induces a circular electric current on the surface of the test material. When the current comes into contact with a discontinuity (crack), the eddy current is disrupted and a characteristic signal is displayed. The circulating current (named eddy currents after similar observed fluid dynamic behavior in streams) has an associated magnetic field which opposes the magnetic field of the probe. This is what is refered to as mutual inductance. Any change in the eddy currents in the test material will affect the resulting impedance of the coil.

Because the magnetic field surround the probe, direct contact with the test material is not essential. However, the magnetic fields attenuate rapidly in the air so the probe must be near the test specimen. Because the “lift-off” distance does not need to be zero and dielectric or non-conductive materials have little effect on the magnetic fields, Eddy Current testing can be performed through coatings.

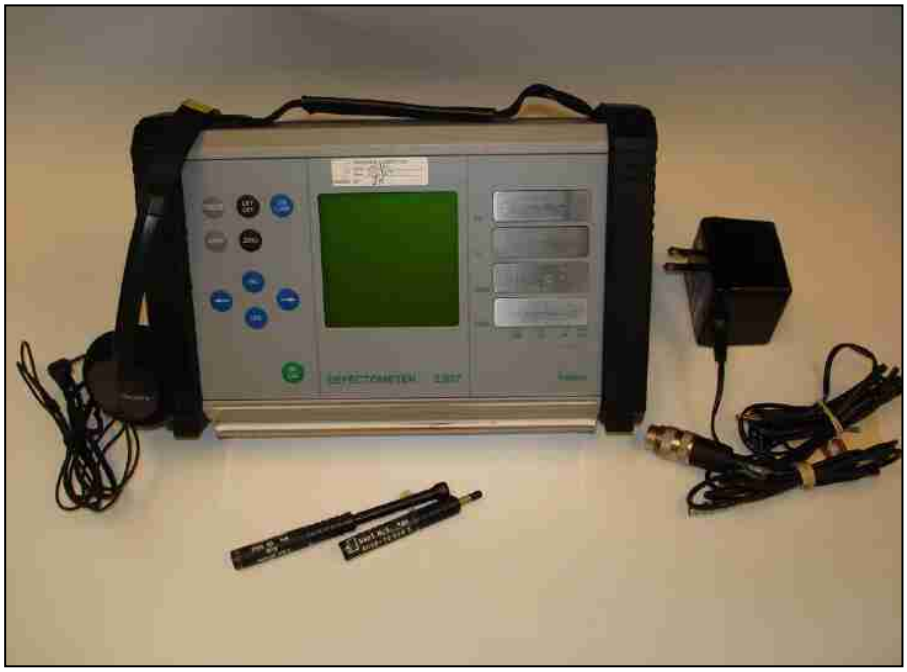

Figure 5.8.1-1: Image of Eddy Current testing device with pencil probe in the foreground.

Field-testing of bridges and related structures use portable units. Commercial units offer a variety of display options and are available in analog or digital. Needle devices (analog) are "go, no-go" devices, meaning the device simply shows if a discontinuity is present. Refer to figure 5.7.1-2 for an image of a needle eddy current unit. The more common display used in bridge inspection is the digital display which typically set up as time vs. signal amplitude. This allows the inspector to more readily pin point the ends of cracks, for example. Refer to Figure 5.8.1-3 for an image of a digital eddy current device.

This testing method is covered in American Society for Testing and Materials (ASTM) Test E709, "Standard Guide for Magnetic Particle Examination."

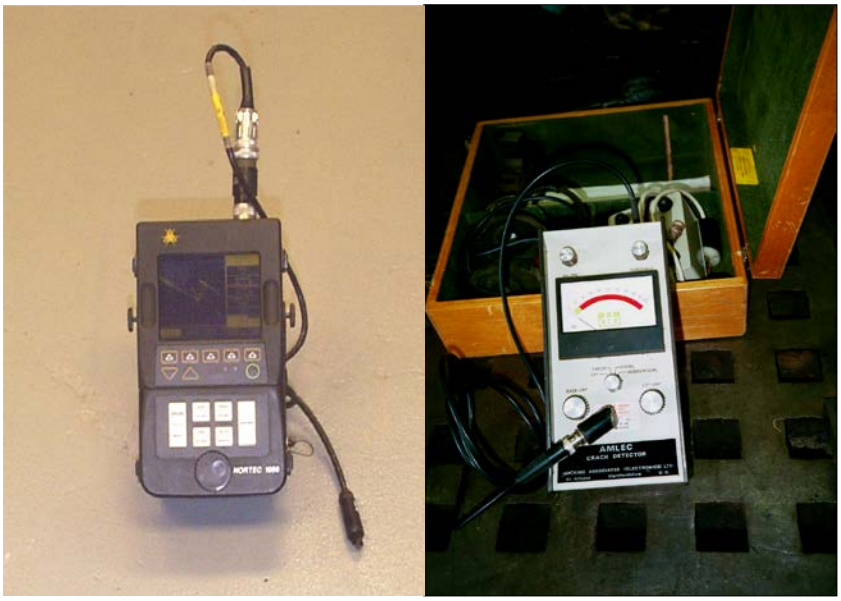

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Figure 5.8.1-2: Magnetic Particle Inspection Kit

5.8.2 Applications

Eddy Current devices are available with testing frequencies ranging from 10Hz to 10Mhz depending on the material, probe type, probe geometry and particular testing need.

The test is suitable for any conductive material and is a highly sensitive means of locating cracking on or near the surface of a member. It is used often on testing fatigue prone details at welds and bolt holes.

Eddy Current testing is also a method for testing coating thickness, such as galvanizing. The device can detect coating thicknesses up to 0.2-1.0 mils. It can also be used to detect the thicknesses of thin conductive members from <25 microns – 3 mm.

This method is reasonably fast, inexpensive especially compared to some other nondestructive evaluation (NDE) methods, and the equipment is very portable. There is also little or no limitation due to size or shape of the part being inspected.

5.8.3 Limitations

Eddy Current testing does have some limitations. This test will work only on conductive material and the discontinuity or defect must be perpendicular to the plane of the induced eddy currents. Subsurface defects may be detected by eddy current testing but the depth of the defect is extremely limited. Furthermore, EC will not afford the inspector with the depth of a crack if detected.

While Eddy Current testing is used to determine the thicknesses of galvanizing coating, the test will not detect defects below the coating due to its conductive characteristics. Any changes to the test materials magnetic characteristics will greatly affect the results of EC.

While EC is an effective and fast test, it does require training and inspector interpretation due to all the factors that can affect test results. Changes in a materials geometry or properties can create complex signals or background noise that an experienced inspector must be able to filter out.