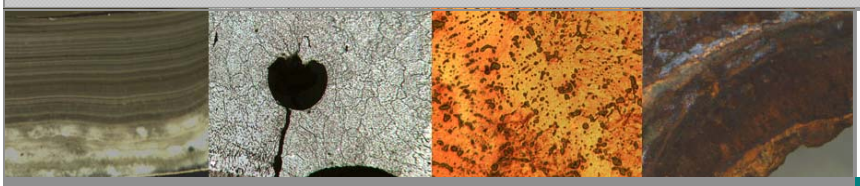
NUTS & BOLTS



MATERIALS FAILURE MODES & STEPS OF FAILURE ANALYSIS

New Hampshire MATERIALS LABORATORY, INC.
Your Problem Solving Partner

Oct. 2010 Supplement Issue

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Welcome to New Hampshire Materials Laboratory

At NHML we determine why failures occur, thereby enabling the customer to take corrective action.

The bullet points below summarize our approach to failure analysis. We begin with a procedure to identify how the failure occurred then move on to determine why the failure occurred.

If you need help in finding the root cause to your failure, please contact us to further discuss.

Tim Kenney
Laboratory Director

Types of Failure Modes

Material failures occur in a wide variety of modes. The purpose of a failure analysis is to determine the root cause in order for corrective action to be taken to prevent similar failure(s). A listing of failure modes are shown below.

- Single overload failures in tension, compression, torsion, or shear
- Fatigue
- Distortion
- Wear and Erosion
- Corrosion
- Embrittlement (Liquid Metal Embrittlement, Hydrogen Embrittlement, and Embrittlement by solid metal environments)
- Elevated Temperatures
- Common combined failure modes include: stress corrosion cracking and corrosion fatigue

Failure Modes

Us road, highways, and bridges are some of the best prime examples of corrosion, wear and erosion, and other failure modes.

Highway signs can be helpful tools to help us get to where we need to go. This past summer, a sign over Interstate I-93 in Concord, NH collapsed. The NHDOT found the bolt to have corroded over the 20 year span. **I-93 Interstate Signage**

A 125 year old bridge built during the time of horse and buggy will need to be eventually over-hauled to accommodate today's cars and modern day traffic needs. It can also lead to frustrations and headaches for those who are in charge of the repairs. A prime example is the North Main Street Bridge in Rochester, NH. Once repair crews were able to examine the bridge, more damage was found than originally anticipated. **North Street Bridge Rochester NH**

Steps of a Failure Analysis

The following steps are common to most failure analyses.

Collection of background information:

- Obtain drawings or prints of the failed component, determine the specified material, and processing (processing information would include heat treatment, case hardening, welding, or plating).
- Determine service history of the part to include time in service, environment prior to failure, and whether any abnormal conditions or events occurred prior to failure.

Initial examination of the failed component:

- Usually performed in the field and includes examination at low magnification, photography, and selection of specimens for laboratory examination.

Non-Destructive testing (if appropriate):

- This work may include radiography, dye penetrant, eddy current, ultrasonic.

Mechanical testing:

- This work includes hardness, tensile tests, fatigue, and toughness testing. All of this work depends upon the availability of sufficient material without compromising the actual fracture or fractures. The analyst must be aware of the limitations of any mechanical tests selected.

Chemical analysis:

- In order to verify a part was fabricated from a specific material, a bulk chemical analysis is performed. A piece of the bulk material is compared to a piece of the failed part. During a chemical analysis additional information can be obtained by looking a the surface deposits, areas of corrosion, and coating.

Macroscopic examination:

- Cleaning and preservation of the fracture surface may include the use of polar or non-polar solvents in an ultrasonic bath. Mild acidic or basic solutions that remove surface deposits but do not attack the base metal may also be used. This stage also includes photographic documentation and location of the fracture origin.

Microscopic examination:

- Scanning Electron Microscopy (SEM) is the most common examination tool.
- The selection, preparation, and examination of polished and etched metallographic specimens is often key in determining the root cause of failure.

The Sara Long and Memorial Bridge connecting Kittery, ME and Portsmouth, NH are two other bridges that are in need of repair. **Two Bridges connecting Portsmouth, NH and Kittery, ME in danger**

Failures can occur anywhere anytime. After the 35W bridge in Minneapolis collapsed on August 1, 2007, the Federal Highway Administration had states inspect bridges with similar construction to avoid another bridge collapsing into the waters. These ongoing inspections are done to avoid future failures.

NHML is here to help. We can provide failure analysis to help solve a piece of the puzzle or materials analysis to verify material used during the construction or re-construction of our bridges and highways to meet the necessary requirements.

Determination of the failure mechanism:

- This is determined based upon the results of the macroscopic and microscopic examination of the fracture and metallographic specimens.
- The failure may be ductile or brittle: A brittle fracture may be transgranular or intergranular. Intergranular fractures are easy to identify although determining the cause may be quite difficult.
- Other failure mechanisms include but are not limited to fatigue, corrosion and stress corrosion cracking, embrittlement, and stress-rupture.

The final step of a failure analysis includes: Gathering of information to formulate a conclusion. The writing of a report to be sent off to the customer.

To view more information about NHML visit our website...NHML Failure Capabilities

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