Overview of Nondestructive Testing

An Online Continuing Education Course for Engineers

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Overview of Nondestructive Testing (NDT)

Introduction

Every person responsibly involved in the manufacture of a quality product worries until he has evidence that its quality is up to snuff. Part of his discontent these days stems from the fact that his product costs so much that the traditional technique of testing a few samples to destruction would soon put him out of business. What he wants is a method of scientifically "thunking," squeezing, smelling, and looking at his melon to see if it's ripe without having to cut it apart to find out.

In what has come to be called nondestructive testing (NDT), he has a family of techniques for doing just this. By exploiting a variety of physical effects, he can evaluate his product at almost any stage of its manufacture to seek evidence of its integrity (or lack of it) without impairing its usefulness in the process.

Whatever his requirement, there is some physically based method of interrogating his "subject." The problem is to choose the right method, apply it with sophistication, and use the results with discrimination.

All branches of Engineering are intimately concerned with materials and products, especially those engineers dealing with the design of structures and machines.

There are many tests for the determination of a material’s soundness. The most desirable test is a nondestructive test

It is important for engineers to have a general understanding of the common methods of nondestructive testing for appraisal and use of the test results and to design for inspectability.

Nondestructive Testing – NDT
Nondestructive Evaluation – NDE
Nondestructive Inspection – NDI

They all mean the same thing. The classic definition of NDT is:

"Testing to detect surface and internal defects in materials, or the physical properties of materials, using techniques that do not damage or destroy the items being tested."

Another way to express NDT is:
The development and application of technical methods to examine materials or components in ways that **do not impair future usefulness and serviceability** in order to detect, locate, measure, and evaluate flaws; to assess integrity, properties, and composition; and to measure geometrical characteristics

Here are some common terms used in NDT

- **Indication** – The response or evidence from a nondestructive examination

- **Discontinuity** – An intentional or unintentional interruption in the physical structure or configuration of a material or component

- **Flaw** – An imperfection or discontinuity that may be detectable by nondestructive testing and is not necessarily rejectable

- **Defect** – One or more flaws whose aggregate size, shape, orientation, location, or properties do not meet specified acceptance criteria and are rejectable. Engineering judgment determines whether a discontinuity is a defect or not. These judgments are usually expressed as Codes or Specifications

Discontinuities affect the soundness of materials. A **discontinuity** is judged to be a **defect** when the decreased soundness interferes with the usefulness of the part.
Engineers make judgments as to how serious a discontinuity must be to become a defect. This judgment is made the same way that design judgments are made – to include some uncertainty in the material properties.

Engineering considerations that allow for the uncertainty of the material properties in the design of a part include a safety factor, proof testing, statistical sampling, and nondestructive testing. The particular design situation will dictate which NDT method or combination of NDT methods is most suitable.

Considerations for the selection of which NDT methods will be used include:

Safety – how reliable the part or system must be.

Economic – what are the incentives based on cost versus reliability improvement are.

Test Constraints – what type of tests can physically be made.

Advantages and Disadvantages – which method will work most effectively for a given material and location.

When NDT tests can be made, they are used to locate, identify, and size discontinuities in the specimen. The engineer then decides on the usefulness of the specimen for the design application.

Engineering judgments are often presented as codes or design specifications.
There are many NDT methods available for obtaining discontinuity information to fulfill code or specification requirements

This course will be concerned with the most widely used and accepted NDT methods. The six most common methods are:

- Visual Testing
- Liquid Penetrant Testing
- Magnetic Particle Testing
- Eddy Current Testing
- Ultrasonic Testing
- Radiographic Testing

Each method has certain applications, advantages, and limitations which will be summarized individually.

NDT methods can be categorized by the location of discontinuities that can be detected, as either: Surface, Surface/Near-Surface, or Volumetric.

Surface methods can only detect discontinuities that are open to the surface. Surface/Near Surface methods are primarily used to detect surface discontinuities but also have the ability to detect discontinuities very close to the surface. Volumetric methods are primarily used to detect subsurface discontinuities but also have the ability to detect discontinuities open to the surface, depending on discontinuity location.

Below are classifications for the six common NDT methods:

Surface

- Visual Examination
- Liquid Penetrant Testing

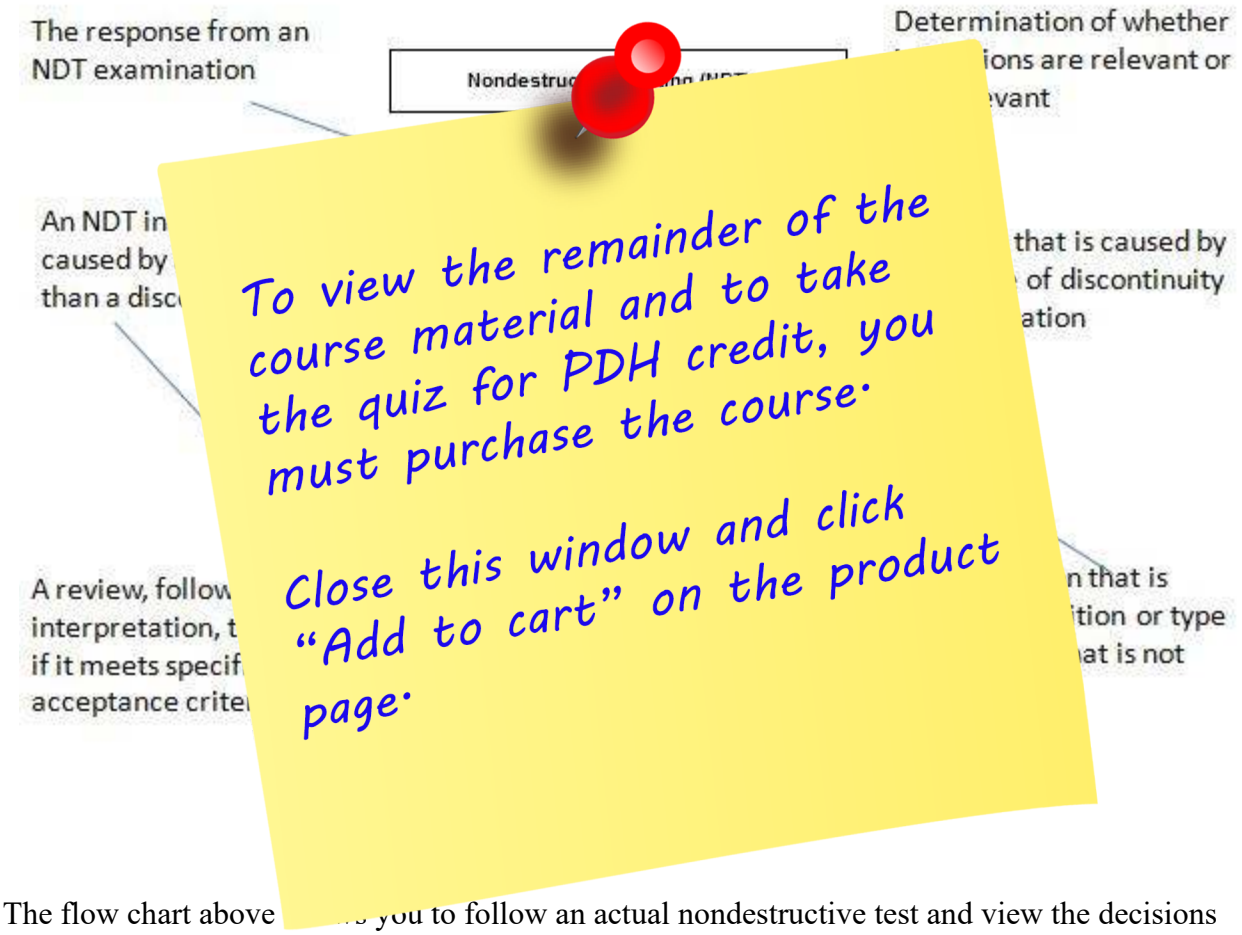
Surface/Near Surface

- Magnetic Particle Testing
- Eddy Current Testing

Volumetric

- Ultrasonic Testing
- Radiographic Testing

Flow Chart for a Nondestructive Test



The flow chart above ...s you to follow an actual nondestructive test and view the decisions that are made to determine whether a material or component is accepted or rejected. This process is used for any of the six methods that will be discussed in greater detail.

When the test is performed, the first evidence observed is always referred to as an "indication." This indication is then "interpreted" to determine if it is a "relevant" indication. If the indication is "false" or "non-relevant," it is either noted for future reference or ignored, depending on the