Elective I

ME 367

Non-Destructive Testing

Module I

Asst. Prof. Vishnu Sankar
Department of Mechanical Engineering
Rajagiri School of Engineering & Technology (RSET)

What is NDT?

- It refers to a method of detecting internal flaws in engineering materials without breaking them.
- NDT, NDE, NDI
- Detect and assess the inhomogeneties and harmful defects without damaging the usefullness of materials.
- A highly valuable technique that can save both ***money*** and ***time***.

Importance of NDT

- Reliability – trouble free service given by products.
- Reliability of a machine/assembly depends on individual reliability factors of components.
- Reliability comes through improving the quality level of the components.
- Quality – design, material properties and fabrication techniques.
- Quality is related to presence of defects and imperfections in finished products which lower the performance level.

Importance of NDT contd…

- NDT plays a critical role in assuring that structural components and systems perform their function in a reliable and cost effective fashion.
- Locate and characterize material conditions and flaws that might otherwise cause serious accidents.
- Planes to crash, reactors to fail, trains to derail, pipelines to burst
- As it allows inspection without interfering with a product's final use, NDT provides an excellent balance between ***quality control*** and ***cost effectiveness.***

NDT/NDE

- Technically, NDE is used to describe measurements that are more quantitative in nature.
- NDE method would not only locate a defect, but it would also be used to measure something about that defect such as its size, shape, and orientation
- NDE - determine material properties such as fracture toughness, ductility, conductivity and other physical characteristics.

Uses of NDT/NDE

- Flaw Detection and Evaluation
- Leak Detection
- Location Determination
- Dimensional Measurements
- Structure and Microstructure Characterization
- Estimation of Mechanical and Physical Properties
- Stress (Strain) and Dynamic Response Measurements
- Material Sorting and Chemical Composition Determination

When are NDT Methods Used?

There are NDE application at almost any stage in the production or life cycle of a component.

- To assist in product development
- To screen or sort incoming materials
- To monitor, improve or control manufacturing processes
- To verify proper processing such as heat treating
- To verify proper assembly
- To inspect for in-service damage

Destructive methods of Testing

Properties like ductility, elasticity, hardness, toughness etc are evaluated.

- i) Tensile test: generally performed on UTM
- Stress strain curves
- ii) Compression test – UTM – Uni axial comp load
- iii) Shear and bending test: bending and shear stress
- 3 point system and 4 point system

- iv) Torsion test: shear stress, shear strain, angle of twist
- v) Impact test: assess shock absorbing capability

Comparison of Destructive and Non Destructive Testing methods

Destructive Tests
Advantages

1. Measurements are direct and reliable
2. Quantitative measurements
3. Correlation between test measurements and material properties is direct

Non Destructive Testing
Limitations

1. Measurements are indirect, hence reliability is to be verified.
2. Usually qualitative measurements
3. Skilled judgement and experience are required to interpret indications

Comparison of Destructive and Non Destructive Testing methods

Destructive Tests Limitations

1. Tests are not done directly on the objects
2. A single test measure only one or a few properties
3. Inservice testing is not possible
4. Preparation of specimen is costly
5. Time requirements are generally high

Non Destructive Testing Advantages

1. Direct testing.
2. Many NDT methods can be applied on the same part.
3. Inservice testing possible
4. Very little preparation
5. Most of the tests are rapid

Visual Inspection

- Most widely used NDT method.
- Simple, easy to apply, quickly carried out and cheap in cost.
- Visual inspection before applying other NDT techniques.
- Simple visual test reveal gross surface defects – rejection of component – save time and money
- Advent of microscopes and computers – reliable and cheap visual inspection.

Basic principle

- Illumination of the test specimen with light
- Examination with eye or by light sensitive devices like photocells
- Equipment required is extremely simple
- Cleaning before inspection
- Mirrors, magnifiers, boroscopes, fibroscopes, CCTV, etc.

The eye

- Most valuable NDT tool.
- The eye has excellent visual perception.
- Sensitivity varies for light with different wavelengths.
- Under ordinary conditions eye is most sensitive to yellow green light.
- For visual inspection, adequate lighting (800-1000 lux) is of importance
- Not more than 2 hours on continuous basis.

Optical aids used for visual inspection

- Functions of optical aids

a. Magnify defects that can't be detected by unaided eye.

b. Permits visual checks of areas not accessible to the unaided eye.

- Mirrors, magnifiers, boroscopes, fibroscopes

Defects that can be detected by unaided Visual Inspection

a. The general condition of the component.
b. Presence or absence of oxide film or corrosive products.
c. Presence or absence of cracks, orientation and position of cracks.
d. Surface porosity, unfilled craters, contour of the weld beads, etc.
e. Potential sources of mechanical weakness such as sharp notches, misalignment.

Microscope

- Combination of lenses used to magnify the image of a small object.
- Object is placed close to the lens to obtain higher magnification.

Boroscope / Borescope

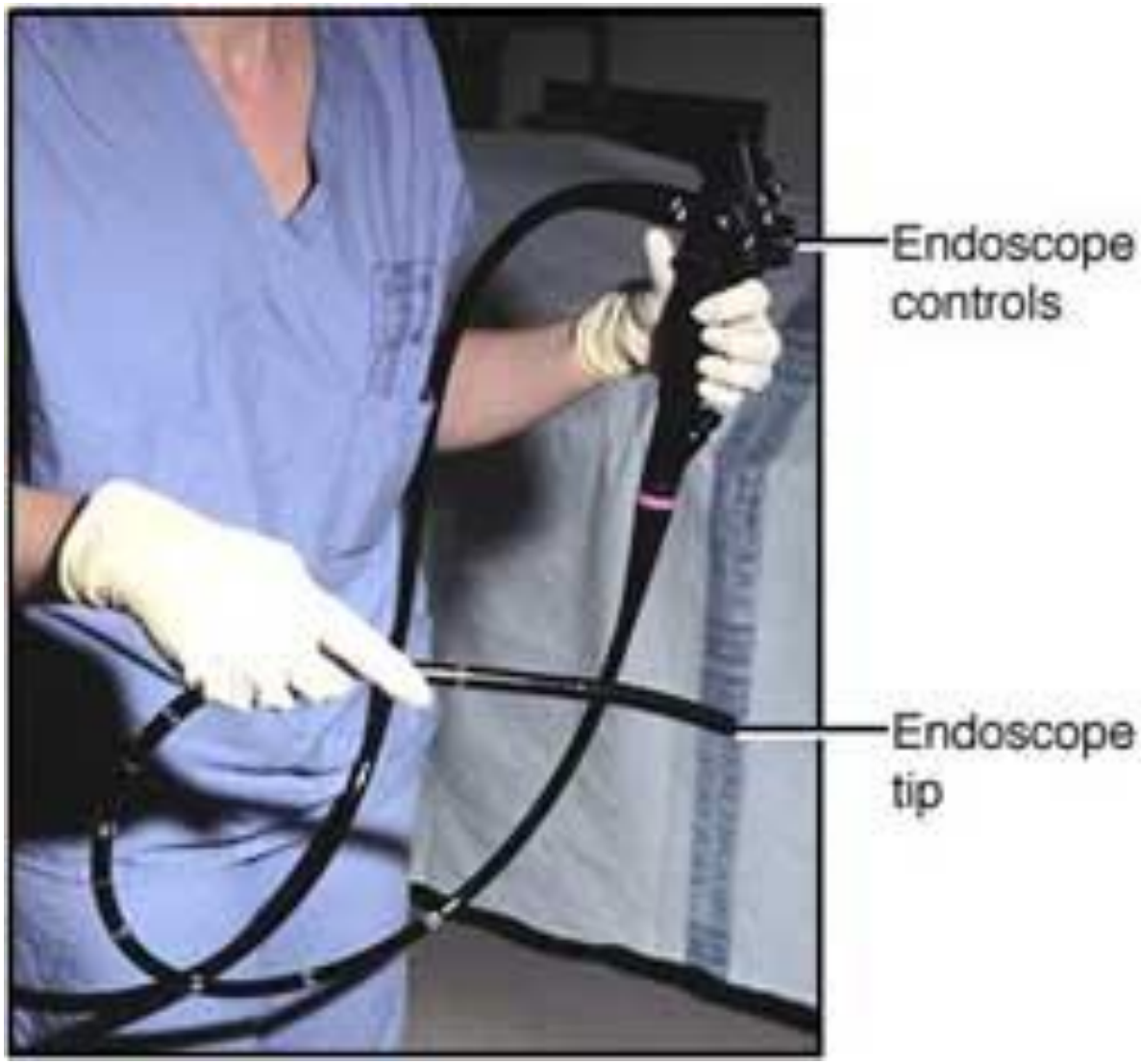
- An instrument designed to enable an observer to inspect the inside of a narrow tube, bore, or chamber.
- Consists of precision built in illumination system with prisms and plain lenses through which light is passed to the observer.


Beechcraft

- As the length increased the image becomes less bright.
- Available in 2.5 to 19mm in diameter and a few metres in length.
- Diameter depends on the diameter of hole or bore to be inspected.
- Length is governed by distance between available access and distance to inspection area.

Endoscope

- Much like a borescope, except that it has a superior optical system and high intensity light source.
- Various viewing angles can be used.
- Objects are constantly in focus from about 4mm to infinity.
- When tip is about 4mm from object a magnification factor of 10X is achieved.
- ‘No focussing’ feature makes it easier to use.
- Available in diameters down to 1.7 mm and length 100 to 1500mm.


Endoscope controls
Endoscope tip

Flexible Fibre-optic Borescope (Fibroscope)

- Permit manipulation of the instrument around corners and through passages with several directional changes.
- Designed to provide sharp and clear images of parts normally impossible to inspect.
- The end tip can be deflected by using a rotating control mechanism mounted on the handle.
- The working lengths are 60 to 365 cm, with diameters from 3 to 12.5mm.

Telescope

- Used to obtain magnified images of objects at considerable distance from the eye.
- Visual examination of surface which is otherwise inaccessible.
- Consists, essentially two lenses: objective and eyepiece.

Applications

- Inspection of plant systems/ component for any leakage, abnormal operation etc.
- Misalignment of parts in equipments
- Corrosion, erosion, cracks, fracture etc
- Defects in weldments: surface cracks, lack of penetration, tear cracks, excess reinforcements, porosity etc
- Minute discontinuities with the help of optical aids in pumps, compressors, turbogenerator parts, etc