ME367
Non-Destructive Testing

Module I

- Introduction to NDT, Comparison between destructive and NDT, Importance of NDT, Scope of NDT, difficulties of NDT, future progress in NDT, economics aspects of NDT.
- **Visual Inspection** - tools, applications and limitations - Fundamentals of visual testing: vision, lighting, material attributes, environmental factors. visual perception, direct and indirect methods mirrors, magnifiers, boroscopes, fibro scopes, closed circuit television, light sources special lighting, a systems, computer enhanced system

Non-destructive testing (NDT)

- Non-destructive testing (NDT) is the process of inspecting, testing, or evaluating materials, components or assemblies for discontinuities, or differences in characteristics without destroying the serviceability of the part or system.
- In other words, when the inspection or test is completed the part can still be used.
- The terms **nondestructive examination** (**NDE**), **nondestructive inspection** (**NDI**), and **nondestructive evaluation** (**NDE**) are also commonly used to describe this technology.
- It is a highly valuable technique that can save both money and time in product evaluation, troubleshooting, and research.
- Inspect or measure without doing harm.

NDT - Benefits

- To improve product reliability
- Accident prevention and to reduce costs
- To determine acceptance to a given requirement
- To verify proper assembly
- To inspect for in-service damage
- To give information on repair criteria.

Comparison between destructive and NDT

	Destructive Testing	Non Destructive testing
Purpose	It is carried to find properties and behaviour of specimen under different load	It is used to find properties of material and to find out defects.
Specimen	Specimen is damaged during test	Specimen is not damaged during test
Defects	Defects cannot be found using Destructive testing	Defects are found using NDT
Cost	More Costly	Less Costly
Example	Bending Test, Tensile Testing, Compression Testing, Impact testing e.t.c.	Ultrasonic testing, Liquid die penetrant method, eddy current testing.

Types of NDT

- Visual Inspection
- Liquid Penetrant Inspection
- Magnetic Particle Inspection
- Eddy Current Inspection
- Ultrasonic Inspection
- Radiographic Inspection
- Acoustic Emission

Technique	Capabilities	Limitations
Visual Inspection	Macroscopic surface flaws	Small flaws are difficult to detect, no subsurface flaws.
Microscopy	Small surface flaws	Not applicable to larger structures; no subsurface flaws.
Radiography	Subsurface flaws	Smallest defect detectable is 2% of the thickness; radiation protection. No subsurface flaws not for porous materials
Dye penetrate	Surface flaws	No subsurface flaws not for porous materials
Ultrasonic	Subsurface flaws	Material must be good conductor of sound.
Magnetic Particle	Surface / near surface and layer flaws	Limited subsurface capability, only for ferromagnetic materials.
Eddy Current	Surface and near surface flaws	Difficult to interpret in some applications; only for metals.
Acoustic emission	Can analyze entire structure	Difficult to interpret, expensive equipments.

Importance of NDT

- NDT plays an important role in the quality control of a product. It is used during all the stages of manufacturing of a product. It is used to monitor the quality of the:
  - (a) Raw materials which are used in the construction of the product.
  - (b) Fabrication processes which are used to manufacture the product.
  - (c) Finished product before it is put into service.
- Use of NDT during all stages of manufacturing results in the following benefits:
  - (a) It increases the safety and reliability of the product during operation.
  - (b) It decreases the cost of the product by reducing scrap and conserving materials, labor and energy.
  - (c) It enhances the reputation of the manufacturer as producer of quality goods.

Summary of Importance of NDT

1. NDT increases the safety and reliability of the product during operation.
2. It decreases the cost of the product by reducing scrap and conserving materials, labor and energy.
3. It enhances the reputation of the manufacturer as a producer of quality goods. All of the above factors boost the sales of the product which bring more economical benefits for the manufacturer.
4. NDT is also used widely for routine or periodic determination of quality of the plants and structures during service.
5. This not only increases the safety of operation but also eliminates any forced shut down of the plants.

scope

- The scope of non destructive inspection is to determine if the object being inspected is to be accepted or rejected
- During the inspection, the inspector looks for discontinuities in the object and identifies their nature and size. Then, those discontinuities are evaluated according to an acceptance criterion to determine if they are considered to be defects.
- **Discontinuity**
  - An interruption of the typical structure of a material, Such as lack of homogeneity in its mechanical, metallurgical, or physical characteristics.
  - A discontinuity is not necessarily a defect.
- **Defect**
  - A flaw or flaws by nature or accumulated effect renders a part or product unable to meet minimum applicable acceptance standards or specifications.
  - The term designates reject ability.

Scope of NDT Cont..

NDT is used typically for the following reasons:

Accident prevention and to reduce costs

To improve product reliability

To determine acceptance to a given requirement

To give information on repair criteria.

- Type of discontinuity
- Material manufacturing process
- Accessibility of the component to perform NDT
- Type of equipment availability
- Time available

Selection of NDT methods

Difficulties in NDT

- However lack of skilled operators, an aging workforce and cost conscious users are key challenge faced by Non Destructive testing market.
- Though development in infrastructure and power generation have incrementally increased demand for new operators but shortage of supply and shrinking budget continues to (such as protective equip.) …
- Interference of background noises with the actual signal which are reflected back.
- Difficulties like wrong positioning, orientation and the wrong determination of the defect type will be there.

Future Progress in NDT

3D characterisation

Ultrasound is the ideal vehicle for exploring the local response of a composite structure to stress, and map this across the whole 3D structure

Mechanical Modelling Using NDT Data

Recent developments in X-ray CT and ultrasonic 3D characterisation of composites offer the potential for a greater understanding of the effects on structural integrity of material variations such as in-plane fibre waviness, out-of-plane ply wrinkling, and 3D variations in fibre-volume fraction or porosity

Economic Aspects of NDT

- It is highly Economical compared to other methods.
- Products can be reused if its good.
- Rejection rate is less.