1 2nd Year Civil Engineering

NDT – Lecture 3

2 Surface and Near-Surface Defects

- Potentially visible with naked eye
  - If defect is fully surface breaking
  - Often **difficult** to detect visually
- Can be introduced during **manufacture**
  - e.g. quench cracks, cracks induced by grinding, etc.,
- Can be introduced during **use**
  - e.g. fatigue cracks
- Small defects can grow over time
- Can eventually lead to catastrophic failure

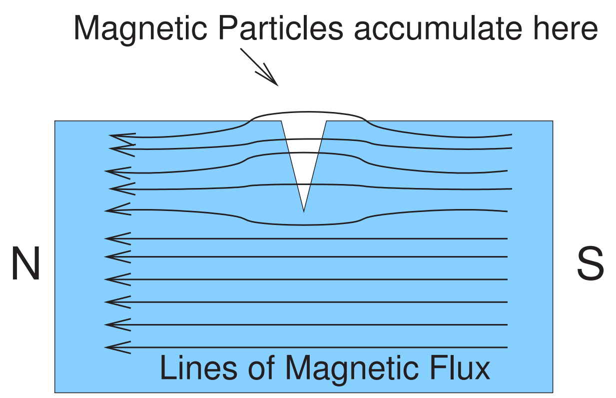
3 Surface Defects

3.1 Nondestructive Testing

- Necessary to highlight defects
- Two techniques will be discussed here
  - Dye Penetrant Inspection
  - Magnetic Particle Inspection

4 Magnetic Particle Inspection

4.1 Basic Principles



5 Magnetic Particle Inspection

5.1 Basic Principles

- Component to be tested is **magnetised**
  - Component must be **ferromagnetic**
- If there is a crack in the surface of the component (or near the surface) the magnetic flux will leak at that point
- Magnetic Poles are formed, these attract magnetic particles (e.g. Iron filings)
- By looking at the patterns formed by the iron filings, we can find irregularities in the magnetic field
- Irregularities in the magnetic field point to irregularities in the material, such as defects.
- Can only detect defects which "cut" the field. i.e. defects at right angles to the magnetic field

6 Magnetic Particle Inspection

6.1 Magnetic Particles

- Particles can be dry powder, or in a liquid suspension
- Material is ferromagnetic with high permeability and low retentivity
- Particles may be coloured to aid visibility
- Flourescent particles can be used too (UV light required)
- Mechanical agitation helps particle mobility
  - Especially important for rougher surfaces

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7 Magnetic Particle Inspection

7.1 Magnetisation

1. Pass electric current directly through all or part of the specimen
2. Pass electric current through a conductor surrounding or in contact with the specimen
3. Use magnets

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8 Magnetic Particle Inspection

8.1 Magnetisation using testpiece as a conductor

- Must be careful not to overheat/burn specimen when using current
  - Use large contact area with electrodes
  - Avoid arcing
  - Current is high (600–2000A, so low voltages must be used)
- Magnetic field is at right angles to the current
  - Only defects of certain orientations detectable
  - Repeating with current direction at right angles will find other defects

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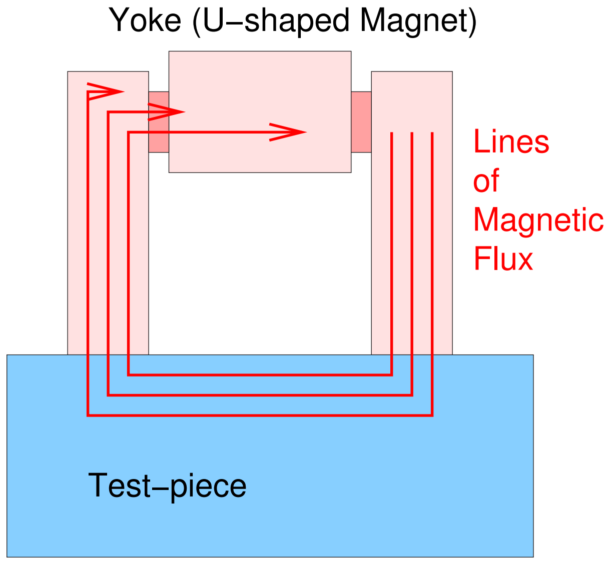
9 Magnetic Particle Inspection

9.1 Magnetisation using another conductor

- Specimens can be placed inside a solenoid, producing longitudinal magnetic field
- Hollow specimens can have a conductor placed inside: produces circumferential magnetic field.
  - Only defects of certain orientations detectable (right angles to field)
  - The combination of these two techniques allows most defect orientations to be detected.
  - Knowledge of expected defects can help in setting up test

10 Magnetic Particle Inspection

10.1 Magnetisation using magnets



11 Magnetic Particle Inspection

11.1 De-Magnetisation

- It is sometimes important to demagnetise the testpiece
  - e.g. to avoid problems with navigation systems in aircraft
- Demagnetisation can be accomplised as follows
  - Magnetise the testpiece with an alternating magnetic field
  - Magnetic field in the testpice will periodically reverse completely
  - Gradually reduce the amplitude of the field towards zero

12 Dye Penetrant

12.1 Basic Principles

- Used to detect **fully** surface breaking defects
- Essentially an extension of visual inspection
- Surface is cleaned
- A **Penetrant** (a liquid) is applied to the surface
- The penetrant soaks into cracks by capillary action
- Excess penetrant is removed, leaving residual in cracks
- Developer is applied to make penetrant easier to see, indicating the locations and sizes of surface defects

13 Dye Penetrant

13.1 Considerations

- Testpiece aterial must be **nonporous**
- Suitable for a wide range of materials
  - Ferrous Alloys
  - Non-ferrous Alloys
  - Ceramics
- **Only** surface breaking defects can be found
- Orientation of defect not so significant
- Test can be very quick, and can cover a large area
  - Examination and interpretation of results will take time and skill, however.

14 Dye Penetrant

14.1 Technique – Cleaning

- Surface must be very clean
- Openings to cracks must be open and clear
- Avoid operations such as sand-blasting or buffing which can tend to close over small openings

14.2 Technique – Applying Penetrant

- Can be done by
  - Brushing
  - Immersion/Dip
  - Spraying
- Penetrant must be allowed time to penetrate defects (3 min. up to 30 min.)

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15 Dye Penetrant

15.1 Technique – Removing Excess Penetrant

- All traces of penetrant on surface are removed using whatever technique/chemicals are recommended by the penetrant supplier/manufacturer.
- Must remove all excess, without compromising penetrant in defects
- Must dry component afterwards

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16 Dye Penetrant

16.1 Technique – Applying the Developer

- Developer is usually finely divided powder (e.g. talc).
- Developer draws penetrant from defect, and spreads it a little way on the surface.
- Has effect of magnifying small defects .
- Heat or mechanical agitation/vibration can accelerate process.
- Blotted penetrant is visible due to different colour, or can be flourescent (requires UV lighting).

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17 Dye Penetrant

17.1 Technique – Inspection and Interpretation

- Most important step in whole procedure.
- Patterns visible must be interpreted in order to identify defects
  - Line of penetrant: Crack or Cold Shut
  - Dots of penetrant: Porosity
  - Series of dots: Tight crack, cols-shut, partially welded lap.
- Wider markings indicate deeper defects, though interpretation requires expertise and experience