ADVANCED INSPECTION OF STEEL ELEMENTS

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Methods of Inspection

- Level II inspection in steel elements is made if cracks or potential for cracks or faults is present

Visual

- Important for detecting degradation
- Logical and systematic procedures
- Used to establish non-destructive testing (NDT) techniques

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Methods of Inspection

Non-Destructive Testing

- To supplement visual inspection
- To define the extent of faults

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Non-Destructive Test Methods

Dye Penetrant Inspection

- Surface requires mechanical cleaning
- Low viscosity, high capillary fluid containing red dye is sprayed and allowed to penetrate the cracks and surface defects
- Excess fluid is wiped from the surface after a penetration time
- Surface sprayed with a developer
- Cracks and faults will be apparent by drawn red dye on a surrounding white background

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Non-Destructive Test Methods

Dye Penetrant Inspection

- Advantages: Low cost, requires minimal skills, portable, not time consuming, can identify extent of surface cracks
- Disadvantages: Limited to surface defects

Non-Destructive Test Methods

Magnetic Particle Inspection

- Yoke is used to produce a magnetic field in the steel
- Fine iron powder is sprayed on the surface
- Field is distorted by surface or near surface discontinuities causing concentrations of magnetic lines
- Iron powder is drawn to these lines

Non-Destructive Test Methods

Magnetic Particle Inspection

- Advantages: portable, requires minimal skills and can define tight cracks
- Disadvantages: limited to the inspection of cracks and surface defects near the surface. Depth of cracks cannot be determined and element may become magnetized

Non-Destructive Test Methods

Hardness Testing

- Used to determine if mechanical properties have changed. System can be used for determining degradation after fire damage
- Telebrineller system principle is comparing hardness of a known test bar to the bridge element hardness
- Equipment: Anvil, steel impression bar, microscope, hammer

Non-Destructive Test Methods

Hardness Testing

- Anvil is placed on the element and struck. Impact is transmitted to the test bar and the specimen element
- Steel ball makes an impression in the test bar and the element
- Diameters are measured and read through a microscope to within 0.05 mm

Non-Destructive Test Methods

Hardness Testing

$$\left(\frac{\text{Dia of Impression In Bar}}{\text{Dia of Impression In Metal}}\right)^2 \times \text{BHN of Test Bar} = \text{BHN of Specimen Material}$$

- BHN has a correlation to the tensile strength of steel
- Advantages: equipment is light weight, portable, reasonably accurate and requires no special training

Non-Destructive Test Methods

Eddy Current

- Similar to MPI, except defect is detected by disturbances in electrical field
- Technique involves the use of a coil carrying an alternating current, which produces an eddy current in the part being examined
- Eddy current creates an impedance in the exiting coil
- Impedance depends on the nature of the part being tested and the exiting coil, magnitude and frequency of the current and the presence of discontinuities in the part
- Change is read from a meter

Non-Destructive Test Methods

Eddy Current

- Advantages: size and depth of defects can be estimated reasonably and surface conditions such as paint do not affect scanning
- Disadvantages: changes in geometry affect the impedance and recalibration is required
- Limited use but has potential

Non-Destructive Test Methods

Radiography

- Used to detect macroscopic defects and discontinuities
- Testing is based on the ability of radiation such as gamma rays to penetrate metal and other opaque materials to produce an image on sensitive film
- Gamma rays are produced by the disintegration of radioisotopes or radium of which cobalt or iridium are common sources

Non-Destructive Test Methods

Radiography

- Source housed in a lead capsule to avoid radiation danger when not in use
- Amount of radiation getting through section being tested depends on section and density
- Defects result in less steel to pass through and more radiation gets on to the film placed behind the section
- Defect size and shape shows up as a dark area on the film

Non-Destructive Test Methods

Radiography

- Planar defects are only detectable if they are parallel to the source axis due to radiation absorption
- Accuracy is dependent on the section and location of the crack
- Fatigue cracks to 2% of thickness can be detected

Non-Destructive Test Methods

Radiography

- Advantages: permanent record and size and shape are determined
- Disadvantages: cannot detect planar defects and depth of cracks, hazardous and government licensing is required

Non-Destructive Test Methods

Ultrasonics

- Uses high frequency sound waves to detect flaws
- Discontinuities act as a reflector for high frequency vibrations
- Sound waves are produced by a wave generator and receiving pulses are displayed on a cathode ray oscilloscope
- Ultrasonic frequency is 2 MHz or approximately 9500 ft/sec.

Non-Destructive Test Methods

Ultrasonics

- Sound waves are transmitted by contact through a crystal and an intervening couplant
- Depth, size and nature of the defects are determined from the return signal on the oscilloscope
- Signal corresponds to elapsed time between transmission and reception

Non-Destructive Test Methods

Ultrasonics

- Time can be converted to distance because the angle and velocity are known
- Sensitivity is influenced by the sound frequency, design of the unit, instrumentation processing of the return signal on the oscilloscope and operator skill

Non-Destructive Test Methods

Ultrasonics

- Advantages: portability, sensitivity, ability to detect locations and depth of defects
- Disadvantages: influenced by operator ability, no permanent record of the display and it can be too sensitive displaying very minor defects

Non-Destructive Test Methods

Sound reflection from fatigue crack at toe weld.

Sound reflection from rollover in fillet weld.

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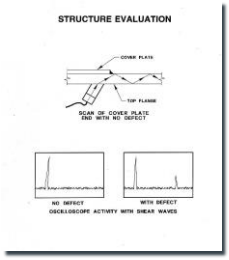
Non-Destructive Test Methods



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Methods of Inspection

- It is important for the inspector to evaluate the damage and recognize the potential faults
- The visual assessment can be used to establish non-destructive testing (NDT) techniques to supplement the visual inspection and define the extent of faults or damage
- Assess the significance of damage on the load carrying capacity

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Questions?

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