Practical NDT - Dr. Baldev Raj

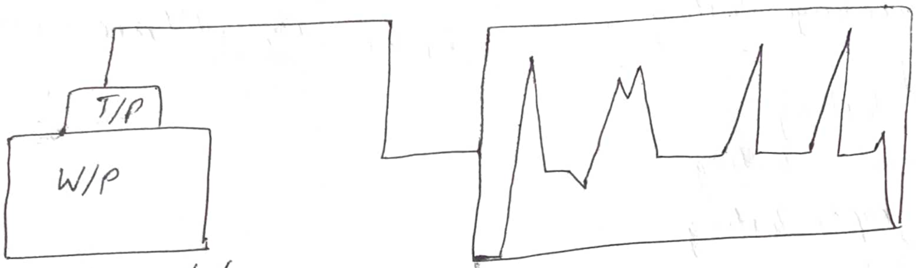
MNDT

Ultrasonic Testing

Detection of internal defects in casting, forging, welding & other finished jobs. Applied to metals, non-metals — plastics, composites.
Specific application in weld testing.
Defect sizing by using DAC (Distance Amplitude Correction)
Another method is DGS (Distance Gain Size)

Basic principle of UT

Fig. 1



- Longitudinal Waves & Shear Waves are mostly used in UT.
- Soundwaves above 20,000 Hz are referred to as ultrasonics.
- They are produced by piezo-electric discs in a probe. Then it is sent through the material to be tested as shown in (fig. 1).
- Then the movement of sound waves is calibrated in a CRO screen
- Echo from both top & bottom of screen. If there is a defect, then echo from defect also.
- In longitudinal waves, oscillation occurs in longitudinal direction (or direction of wave propogation).
- In shear waves, particles oscillate at the right ∠(angle) or transverse direction.
- SW are relatively weaker than LW.

Rayleigh Waves used for surface defects.
Plate Waves also for surface.

Properties of accoustics waves

$$\boxed{\lambda = \frac{v}{f}}$$

λ = wavelength
v = vel
f = frequency

Modern NDT Methods

1. Accoustic Emission Testing
2. Electromagnetic Testing
3. Guided Wave Testing
4. Laser Testing Methods
5. Leak Testing
6. Magnetic Probes Leakage Testing
7. Microwave Testing
8. Liquid Penetrant Testing
9. Magnetic Particulate Testing
10. Neutral Radiography Testing
11. Radiography Testing
12. Thermal IR testing
13. Ultrasonic Testing
14. Vibration Analysis
15. Visual Testing

2, 6, 8, 13, 11, 14 are mostly used

Die penetrant

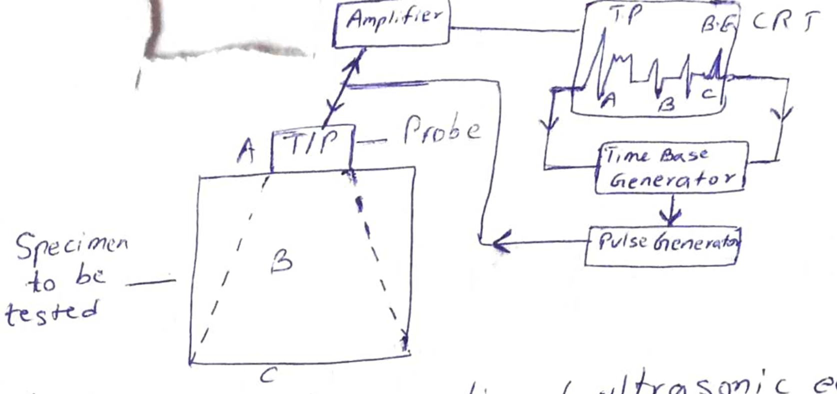
Ultrasonics

Attenuation – In most materials, the ultrasonic ~~velocity~~ intensity is reduced as the wave travels through a material. Due to various mechanisms like reflection, refraction including scattering. The absorption depends markedly on the nature and structure of the material (grain size & grain orientation), and is also a function of the ultrasonic frequency. Many materials are anisotropic so far as absorption is concerned, i.e. the absorption varies with the beam direction. Formally ultrasonic attenuation is described in terms of an attenuation co-efficient. This coefficient is given by α

$$I = I_0 \exp(-\alpha t)$$

I = intensity at a distance t from an initial intensity I_0

Most metals show a pronounced reduction in attenuation if their cast structure is destroyed by cold or hot working (forging, rolling etc) This is because, the large grains are destroyed, resulting in reduced scattering.



Principle of operation of conventional ultrasonic equipment

Wave Velocity - For compressional waves, wave velocity given by

$$V_c = \frac{E(1-\sigma)}{\rho(1+\sigma)(1-2\sigma)}$$

E = Young's modulus
ρ = density
σ = poisson's ratio

V_c for steel ≃ 6400-6500
aluminium ≃ 6300

shear velocity

$$V_s = \left[\frac{E}{2\rho(1+\sigma)}\right]^{1/2}$$

Near Field / Far Field

$$N = \frac{D^2 - \lambda^2}{4\lambda}$$

D = diameter of probe
λ = wavelength

$$= \frac{D^2}{4\lambda} \quad (\lambda << D)$$

For steel, $\lambda = 3mm$
$D = 20\ mm$

$$N = \frac{D^2}{4\lambda} = \frac{20 \times 20}{4 \times 3}\ mm = 33.334mm$$

~~Atten~~