

1 / 12 · Review of Ultrasonic Techniques

Longitudinal wave: how do the particles move?

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Shear wave: how do the particles move, and where can it not travel?

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Surface (Rayleigh) wave: motion, depth and speed?

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Worked (invented numbers): a 5 MHz shear wave in steel at 3.24 mm/ μ s. Wavelength?

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Acoustic impedance is the product of which two things?

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At a boundary met square on, what decides how much sound reflects?

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Side to side, across the direction of travel. It needs a solid, so it does not pass through liquids or air.

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Back and forth along the direction of travel. It travels in solids, liquids and gases.

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Wavelength = velocity / frequency = $3.24 / 5$
= 0.65 mm.

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Elliptical motion within about one wavelength of the surface, a little slower than shear. Used for surface-breaking cracks.

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How different the two impedances are. Very different: nearly all reflects. Similar: most passes through.

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Density and sound velocity.

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Snell's law for ultrasound?

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First and second critical angles: what does each remove?

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**Worked (invented numbers):
wedge 2.73 mm/ μ s, steel
shear 3.24 mm/ μ s, wanted
shear angle 45 degrees.
Incident angle?**

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**Near-field length of a
circular probe, and what
changes it?**

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**What makes beam spread
wider?**

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**Attenuation: two causes,
and how frequency affects
it?**

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At the first, the refracted longitudinal wave reaches 90 degrees. At the second, the shear wave does. Between them only shear enters: the working range for angle-beam probes.

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$\sin(\text{angle } 1) / \text{velocity } 1 = \sin(\text{angle } 2) / \text{velocity } 2$, with both angles measured from the normal.

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$N = D^2 \times f / (4 \times v)$. Doubling the diameter multiplies N by four; doubling the frequency doubles it.

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$\sin(i) = (2.73 / 3.24) \times \sin 45 = 0.843 \times 0.707 = 0.596$, so about 36.6 degrees.

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Scattering at grain boundaries and absorption into heat. It climbs steeply with frequency, so coarse grain needs a lower frequency.

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A lower frequency or a smaller element. A higher frequency or larger element narrows it.

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