Fundamentals of ultrasonic measurement in structural materials

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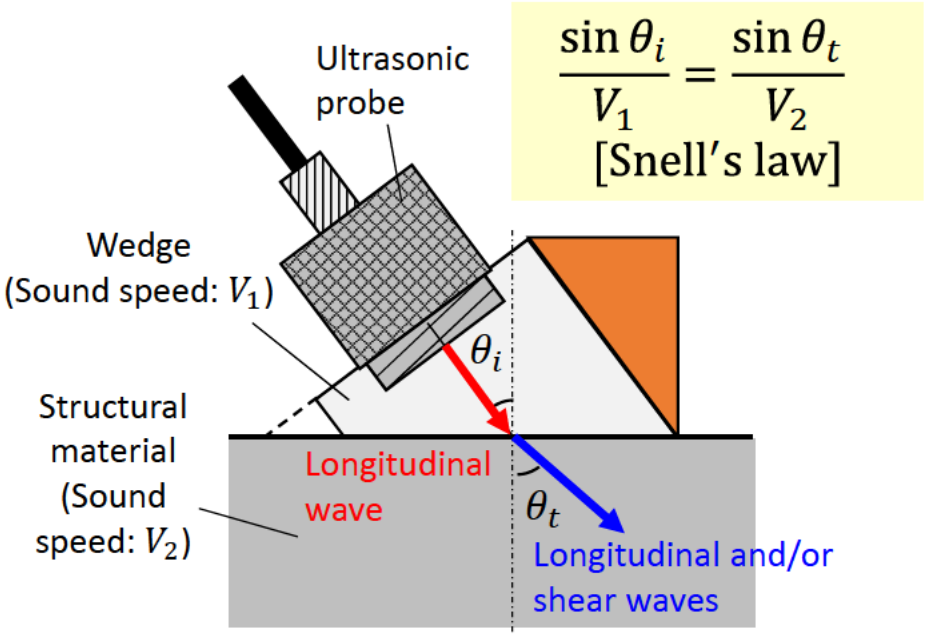
Ultrasound, an inaudible high-frequency sound, is used for safety inspection of structural materials. It propagates like a beam and is reflected by voids and inclusions where elastic modulus and density change. In this seminar, you will learn Snell's law and related formulae such as transmittance coefficient as the fundamentals of the beam control, using numerical calculation software MATLAB ®. The goal of this seminar is to design a wedge for ultrasonic nondestructive inspection.



$$\frac{\sin\theta_i}{V_1} = \frac{\sin\theta_t}{V_2}$$
[Snell's law]

Ultrasonic nondestructive inspection (angle beam method)

Sound speed (1: incident side, 2: transmission side)

```
c1_L = 2700; % Acryl longitudinal wave (m/s)
c2_L = 5900; % Mild steel longitudinal wave
c2_S = 3200; % Mild Steel longitudinal wave
```

Incident angles

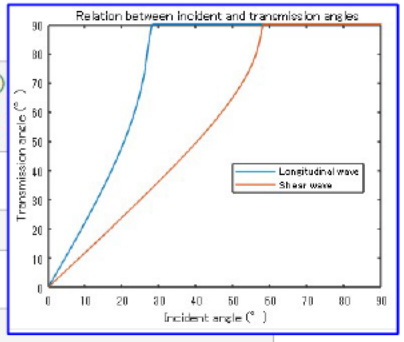
```
theta_i = (0.0:1.0:90)';
```

Refraction (transmission) angles

```
% longitudinal-wave transmission angle (°)
theta_t_L = rad2deg(asin((c2_L/c1_L) * sin(deg2rad(theta_i))));
% transversal-wave transmission angle (°)
theta_t_S = rad2deg(asin((c2_S/c1_L) * sin(deg2rad(theta_i))));
```

Plot of the relation between the incident and the transmission angles

```
plot(theta_i,real(theta_t_L),theta_i,real(theta_t_S));
title(" Relation between incident and transmission angles");
xlabel("Incident angle (°)");
xlim([0,90]);
ylabel("Transmission angle (°)");
ylim([0,90]);
legend("Longitudinal wave","Shear wave",Location="best");
```



Example of calculation with MATLAB®