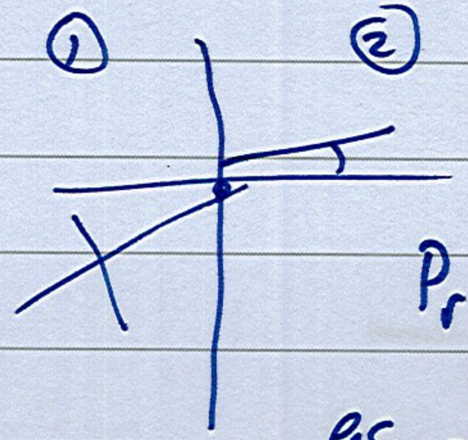
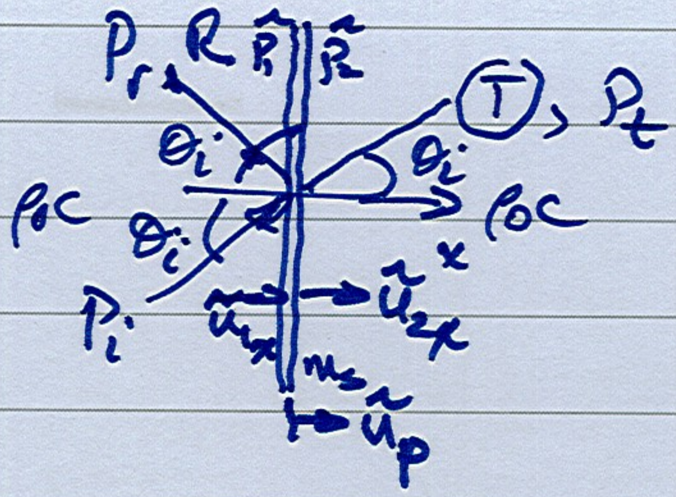
ME 513 Session 28 10/25/19

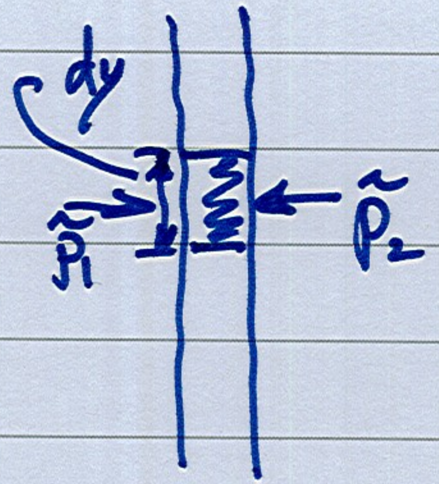




B.C.'s

① $\tilde{u}_{1x} = \tilde{u}_{2x} = \tilde{u}_p$ at $x = 0$

B.C. ② EOM of the panel



$F = ma$

$(\tilde{p}_1 - \tilde{p}_2)\big|_{x=0} dy$

$$(\tilde{p}_1 - \tilde{p}_2)\big|_{x=0} dy = m_s dy \frac{\partial \tilde{u}_p}{\partial t}$$

$$\text{assumed sol'n} = m_s \frac{\partial \tilde{u}_{1x}}{\partial t}\Big|_{x=0}$$

sub into B.C.

$$(\tilde{p}_1 - \tilde{p}_2)\big|_{x=0} = j\omega m_s \tilde{u}_{1x}\big|_{x=0}$$

From B.C. ①

$$P_i - P_r = P_t$$

From B.C. ②

$$P_i + P_r - P_t = j\frac{\omega m_s}{\rho_0 c}\cos\theta \, P_t$$

$\div P_i$ normalize wrt incident wave

$$R = \frac{P_r}{P_i} = \frac{j\omega m_s}{\frac{2\rho_0 c}{\cos\theta} + j\omega m_s}$$

$$T = \frac{P_t}{P_i} = \frac{\frac{2\rho_0 c}{\cos\theta}}{\frac{2\rho_0 c}{\cos\theta} + j\omega m_s}$$

special Cases:

(i) $\theta \to 0$ normal incidence

$$R \to \frac{j\omega m_s}{2\rho_0 c + j\omega m_s} \qquad T \to \frac{2\rho_0 c}{2\rho_0 c + j\omega m_s}$$

Exactly the same as

3 medium $k_2 L \ll 1$

$\rho_2 c_2 \gg \rho_1 c_1$

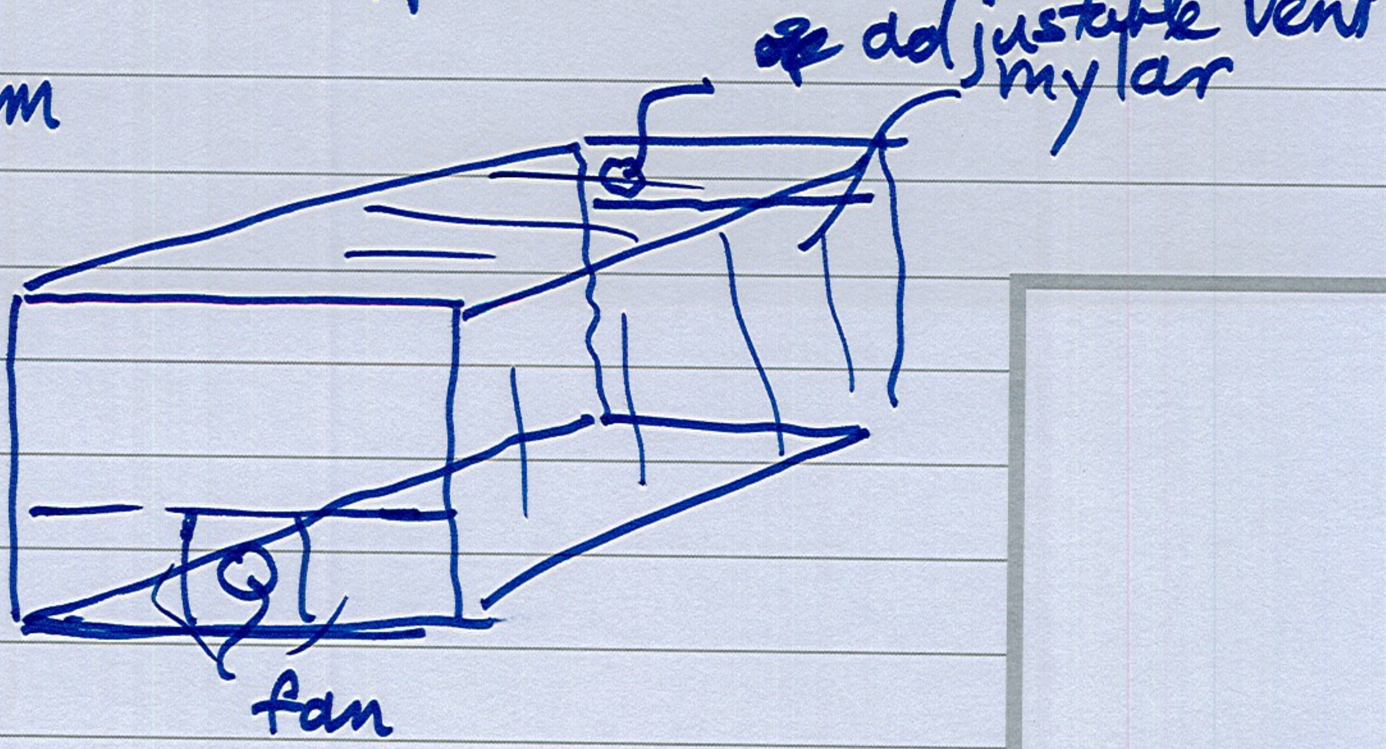
$\gg \rho_3 c_3$

(ii) $m_s \rightarrow 0$ light panel

$R \rightarrow 0$ $T \rightarrow 1$

panel disappears

Fan plenum



(iii) m_s = large <u>massive panel</u>

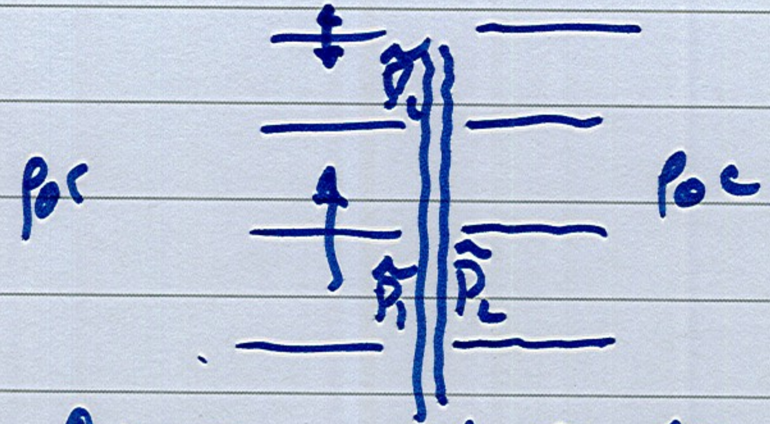
$R \to 1 \qquad T \to \frac{2\rho_0 c}{\cos\theta} \frac{1}{j\omega m_s}$

$\qquad\qquad\qquad\qquad\qquad\qquad\qquad Z_2$

$T \propto \frac{1}{m_s} \propto \frac{1}{\omega}$ "mass law"

massive $\omega . m_s \gg \frac{2\rho_0 c}{\cos\theta}$

(iv) Grazing Incidence



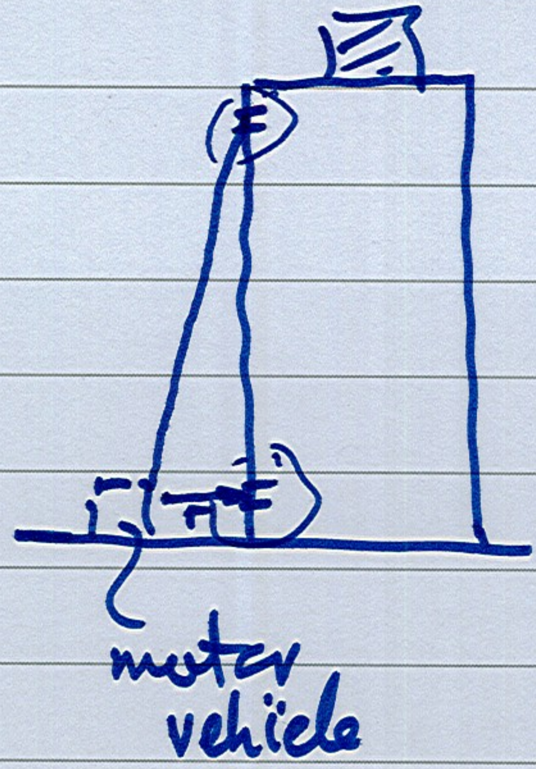
$$T = \frac{\left[\frac{2\rho_0 c}{\cos\theta}\right]}{\frac{2\rho_0 c}{\cos\theta} + j\omega m_s}$$

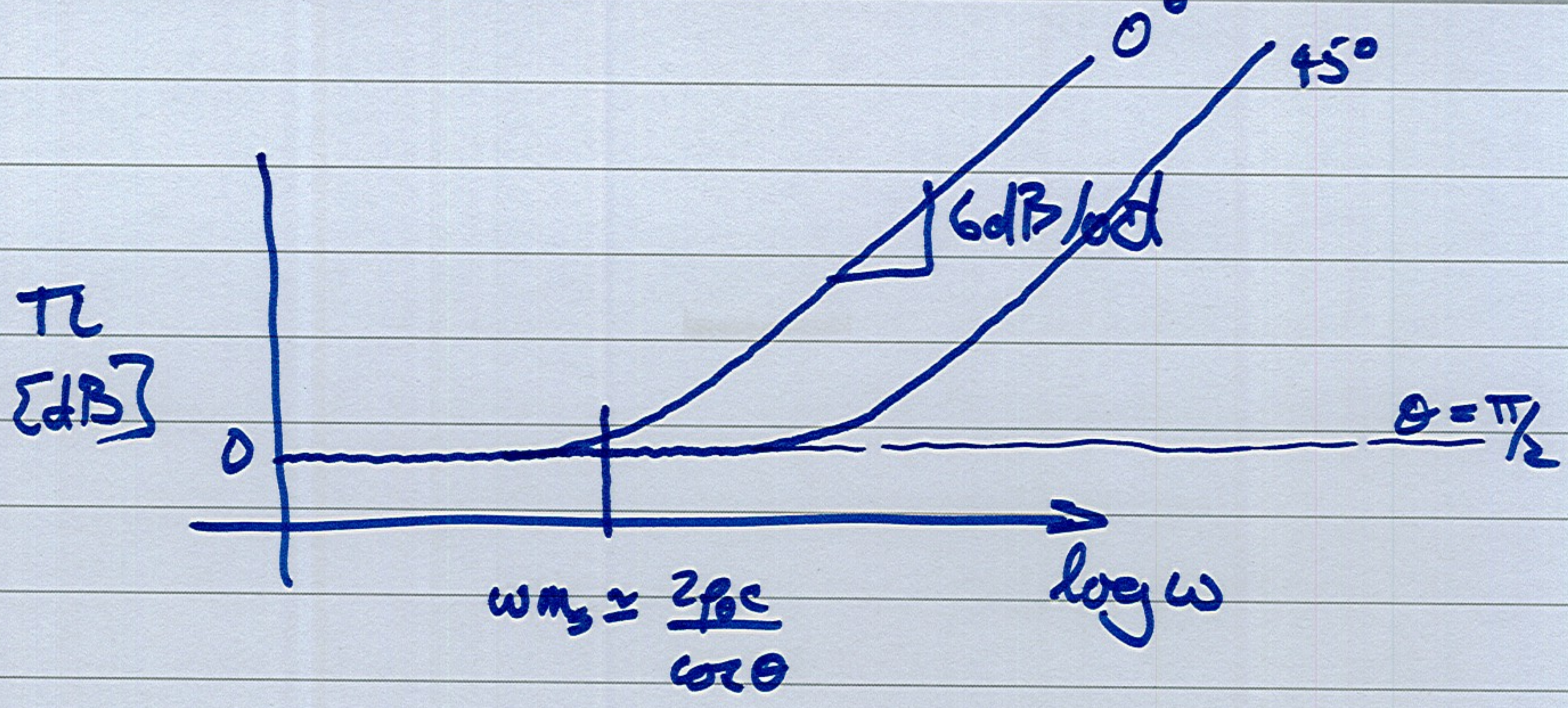
$\theta_i = \frac{\pi}{2}$ if $\tilde{p}_2 = \tilde{p}_1$ no panel motion

$T \rightarrow 1$

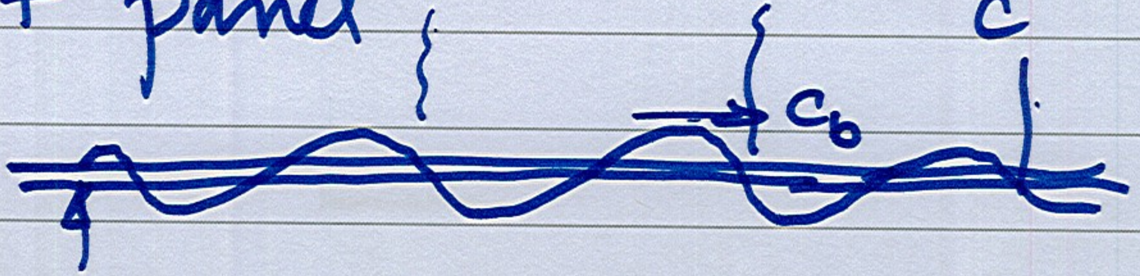
$R \rightarrow 0$

Transmission near grazing approaches unity as a limiting case

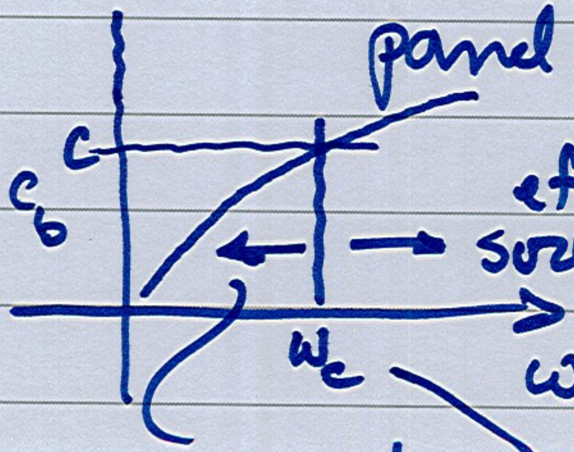

motor
vehicle



transition shifts to higher freqs as angle increases flexurally stiff panel



panel can radiate if $c_b \geq c$.



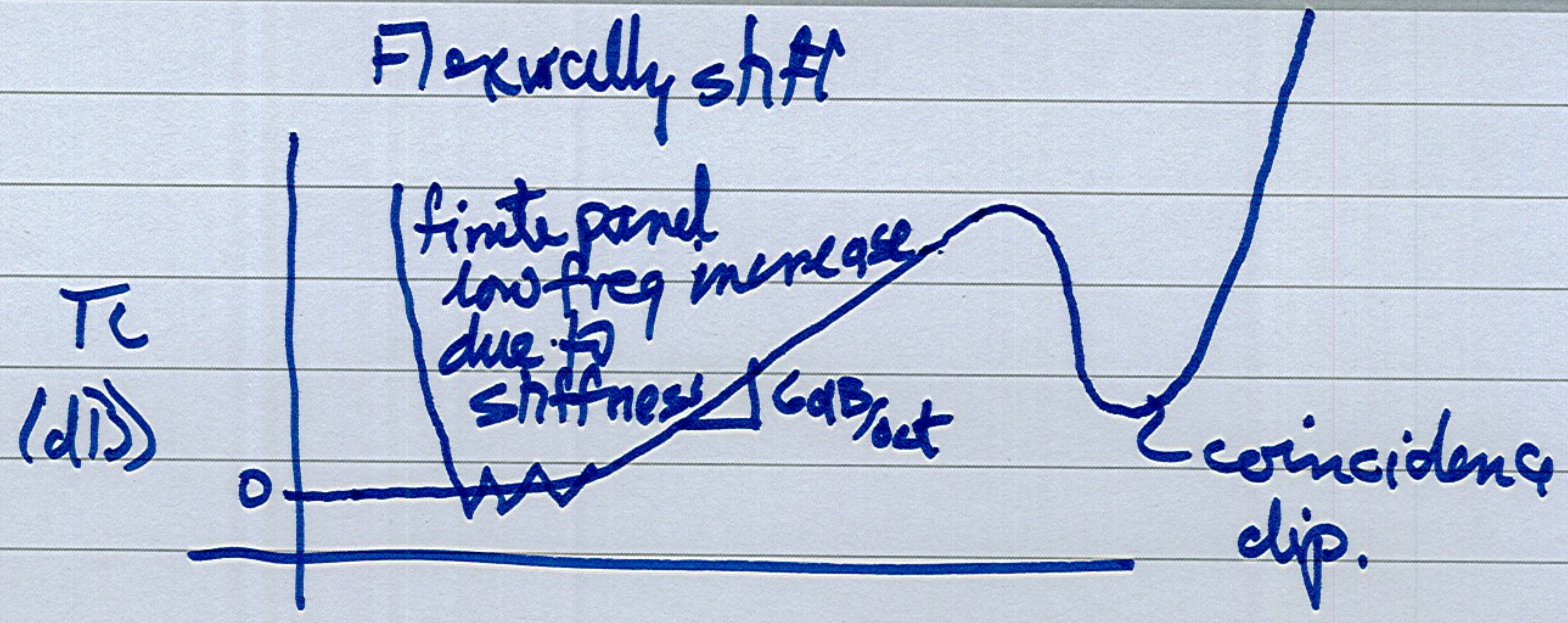
ambient sound speed

no sound radiation from sub-sonic waves

ω_c = critical frequency

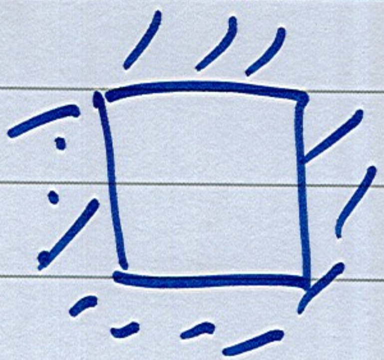
sound transmission at the critical frequency $T \to 1$

Flexurally stiff



This is why we prefer low stiffness barriers

2 critical freqs
That are very high

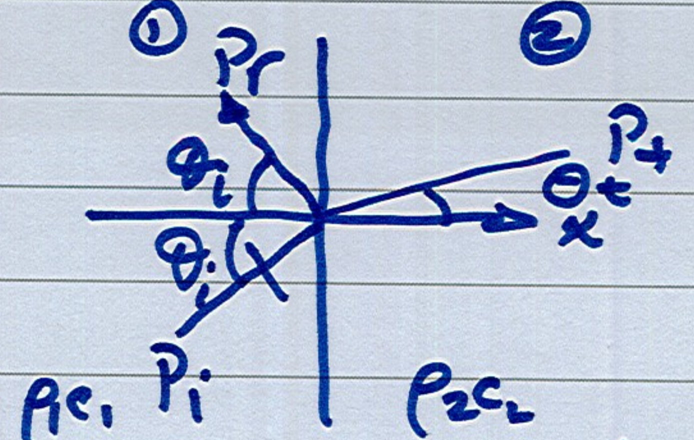


finite
panel

4.4 Reflection coefficient calculations by using surface normal impedances

- when not concerned with sound transmission

Recall the two-fluid case



- assume soln's
- two b.c.'s
  - velocity
  - pressure

⇓ R, T

at $x = 0$ $\quad \dfrac{\hat{p}_1}{\hat{u}_{1x}} = \dfrac{\hat{p}_2}{\hat{u}_{2x}}$ Impedance is continuous at the interface

Define: $\left.\dfrac{\tilde{P}_1}{\tilde{u}_{1x}}\right|_{x=0} = z_n$ specific surface normal impedance

$= z_{2n} = \left.\dfrac{\tilde{P}_2}{\tilde{u}_{2x}}\right|_{x=0}$

$\dfrac{\tilde{P}_1}{\tilde{u}_{1x}} = \tilde{z}_{2n}$ assume this is known

Impedance B.C.

→ can use to calculate R