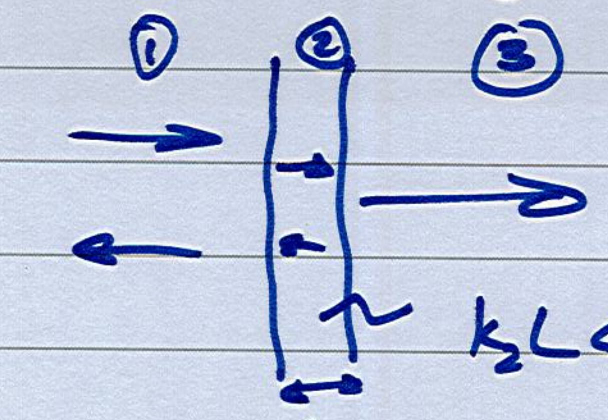
ME 513 Session 24 10/21/15

Yangfan Liu -

Tomorrow Night AES/ASA

7:30 <u>ARMS B071</u>

November 6 - midterm



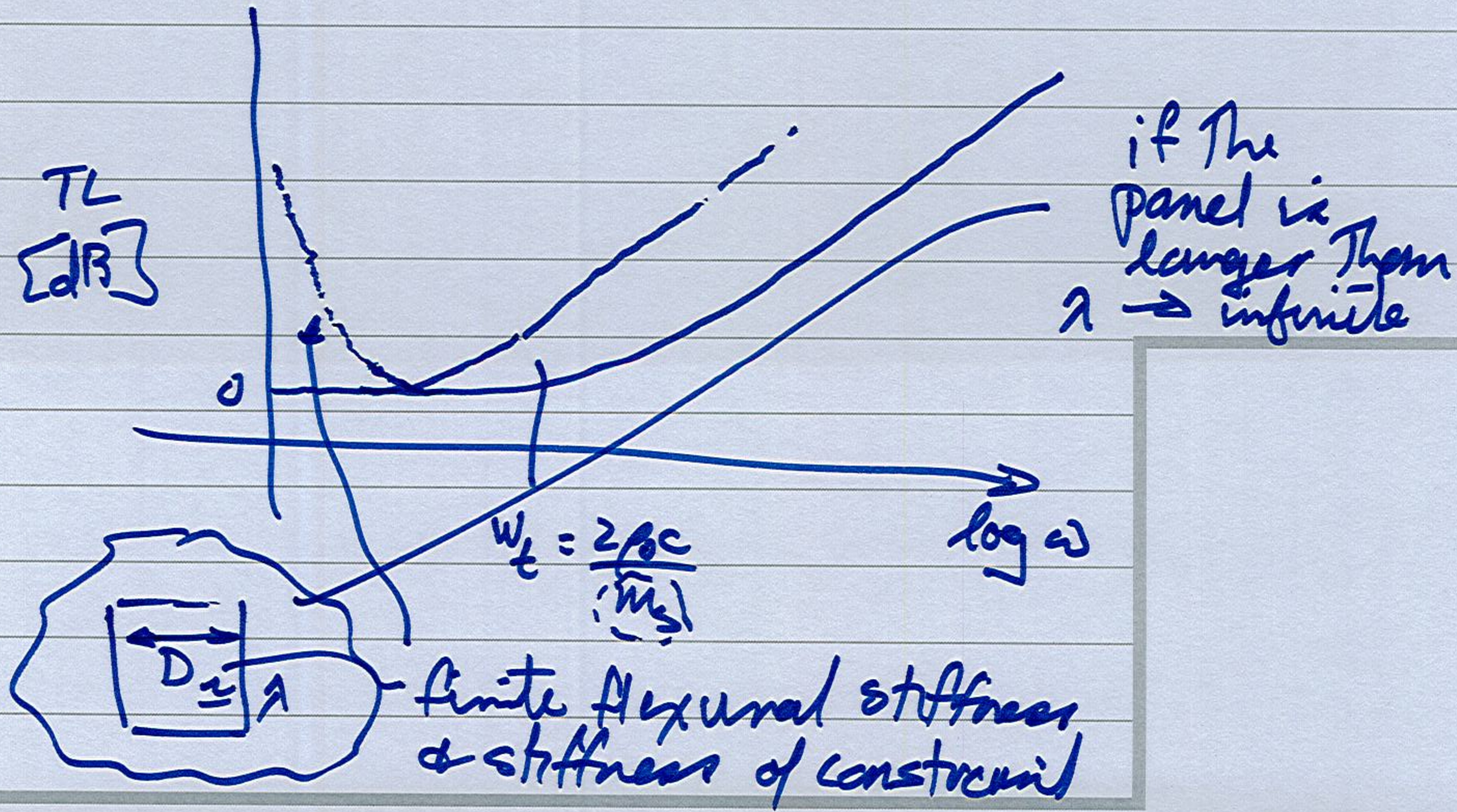
Thin, heavy, limp barrier

$k_2 L \ll 1$

$\rho_2 c_2 \gg \left.\begin{matrix}\rho_1 c_1 \\ \rho_3 c_3\end{matrix}\right] \rho_0 c$

$$T = \frac{2\rho_0 c\, e^{jkL}}{2\rho_0 c + j\underline{\omega} m_s}$$

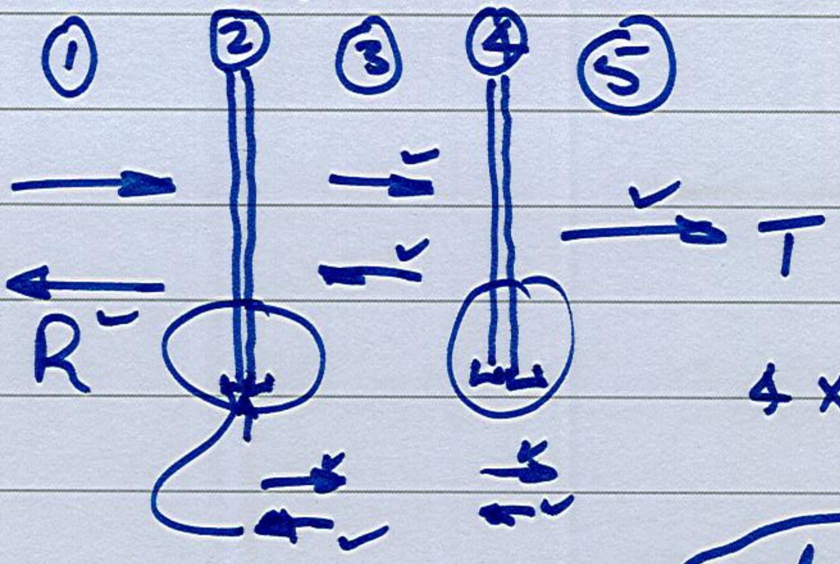
<u>mass law</u>



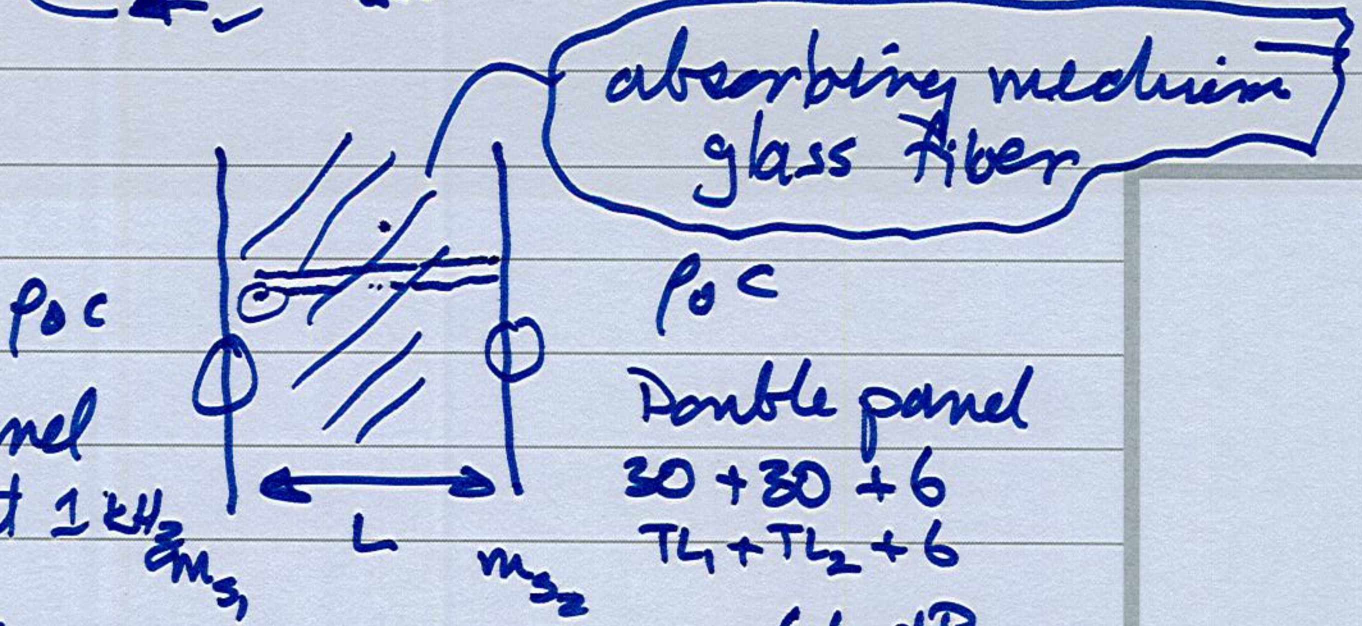
if The panel is langer Than λ → infinite

finite flexural stiffness & stiffness of constraint

Double panels



4 × 2 B.C.'s



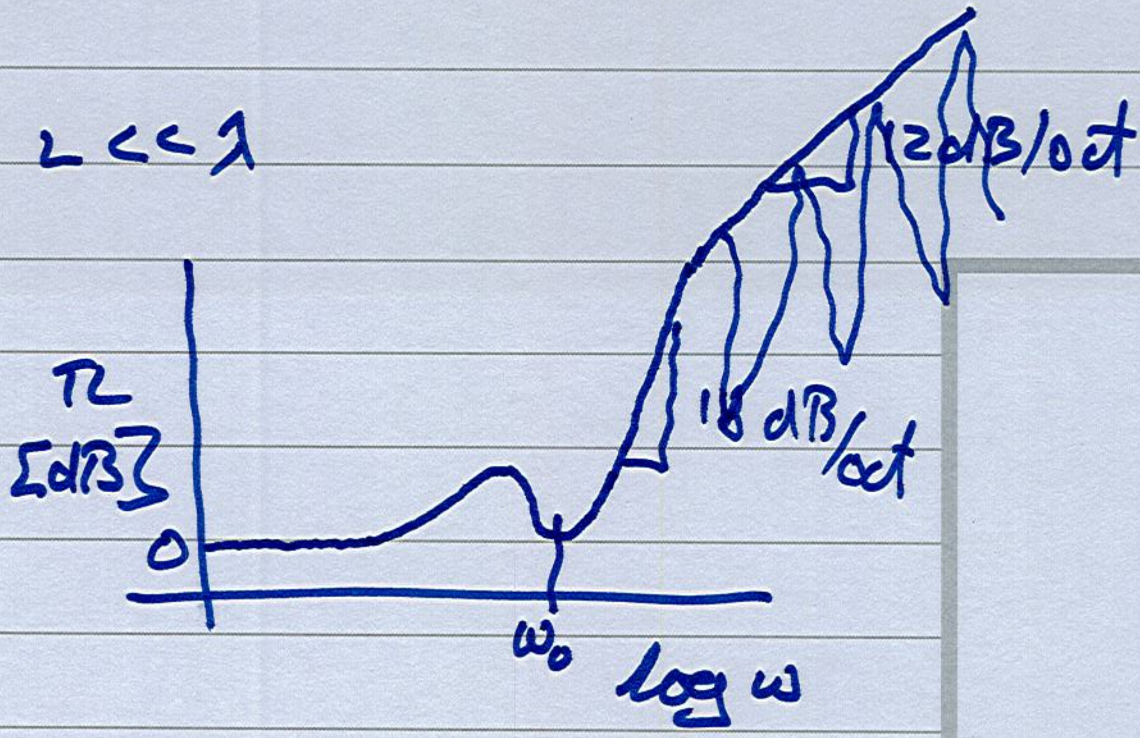
single panel
30 dB at 1 kHz
double the
mass → 36 dB TL

Double panel
30 + 30 + 6
$TL_1 + TL_2 + 6$
66 dB

Double Panel System

- Mass-Air-Mass resonance

$L << \lambda$



4.2.3 Relation to Acoustic Intensity

Pressure Coefficients

$$R = \frac{P_r}{P_i} \qquad T = \frac{P_t}{P_i}$$

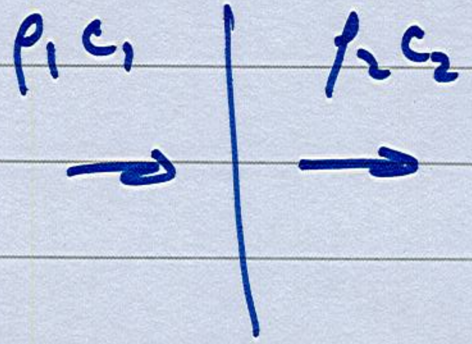
Freely propagating plane wave

$$I = \frac{P_{rms}^2}{\rho_0 c}$$

Intensity (Power) Coefficients

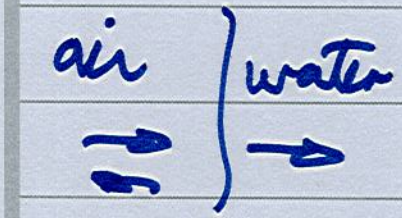
$$R_I = \frac{I_r}{I_i} \qquad T_I = \frac{I_t}{I_i}$$

$$T_I = \frac{I_t}{I_i} = \frac{\left(\frac{p_{t\,rms}^2}{\rho_2 c_2}\right)}{\left(\frac{p_{i\,rms}^2}{\rho_1 c_1}\right)}$$



$$= \frac{\rho_1 c}{\rho_2 c_2}\underbrace{\left(\frac{p_{t\,rms}^2}{p_{i\,rms}^2}\right)}_{|T|^2}$$

$$p_{t\,rms}^2 = \frac{p_t\, p_t^*}{2}$$



$$= \frac{1}{\zeta_{21}} |T|^2$$

$$\zeta_{21} = \frac{\rho_2 c_2}{\rho_1 c_1}$$

$\rho_2 c_2 \underline{\gg \not\approx} \rho_1 c_1$

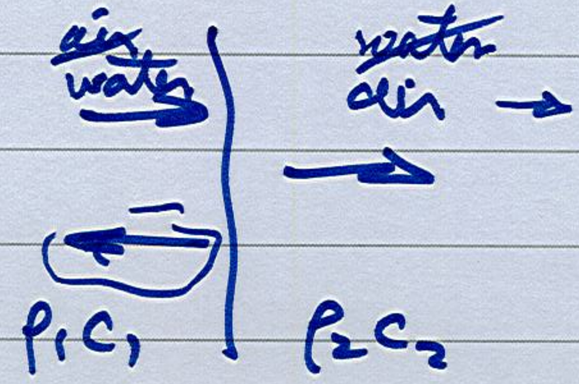
$T \rightarrow 2$

$T_I \rightarrow 0$

power transmission coefficient affected by change in medium

Two Fluid Case (normal incidence)

$$T_I = \frac{1}{\zeta_{21}} |T|^2$$



→ $\zeta_{21} << 1$

$T_I \to 0$

$$= \frac{4\,\zeta_{21}}{(\zeta_{21}+1)^2}$$

$$\underline{R_I} = |R|^2 = \frac{(\zeta_{21}-1)^2}{(\zeta_{21}+1)^2}$$

hard to transmit energy across an interface when the impedance difference is large.

Notes:

1. Always true that

$$\left.\begin{array}{l}\underset{\sim}{T_I} + \underset{\sim}{R_I} = 1\end{array}\right]$$ statement of conservation of energy.

while generally

$$T + R \neq 1$$

2. $\zeta_{21} >> 1$

Air | water

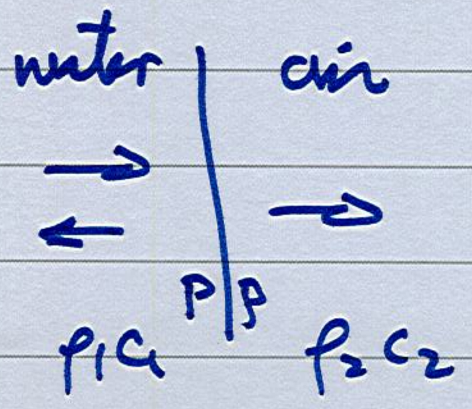
$\rho_1 c_1$ | $\rho_2 c_2$

$$T_I = \frac{4\zeta_{21}}{(\zeta_{21}+1)^2}$$

$T_I \rightarrow 0$ $\quad T \rightarrow 2$

$R_I \rightarrow 1$ $\quad R \rightarrow 1$

3. $\zeta_{21} << 1$

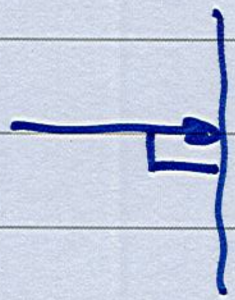


pressure
release
boundary

$$T_I = \frac{4\,\zeta_{21}}{(\zeta_{21}+1)^2}$$

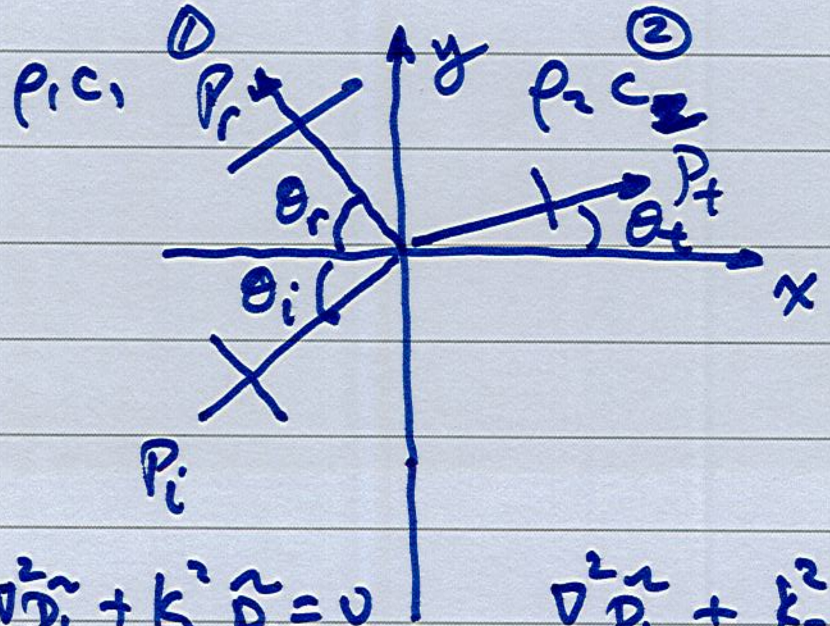
$T_I \to 0 \qquad T \to 0$

$R_I \to 1 \qquad R \to -1$



4.3 Oblique Incidence Reflection + Transmission

4.3.1 Two Fluid Problem



2-D problem
- no prop in z-direction

$$\nabla^2 \tilde{p}_1 + k_1^2 \tilde{p}_1 = 0 \qquad \nabla^2 \tilde{p}_2 + k_2^2 \tilde{p}_2 = 0$$

$$k_1 = \frac{\omega}{c_1} \qquad k_2 = \frac{\omega}{c_2}$$

$$\tilde{p}_1 = \tilde{p}_i + \tilde{p}_r$$

$$= P_i e^{-i(k_{ix}x + k_{iy}y)} + P_r e^{+i(k_{rx}x - k_{ry}y)}$$

$k_{ix} = k_1 \cos\theta_i$ $\quad$ $k_{iy} = k_1 \sin\theta_i$

$k_{rx} = k_1 \cos\theta_r$ $\quad$ $k_{ry} = k_1 \sin\theta_r$

$k_z\text{'s} = 0$

$k_{ix}^2 + k_{iy}^2 = k_{\cancel{z}1}^2$ $\quad$ $k_{rx}^2 + k_{ry}^2 = k_1^2$