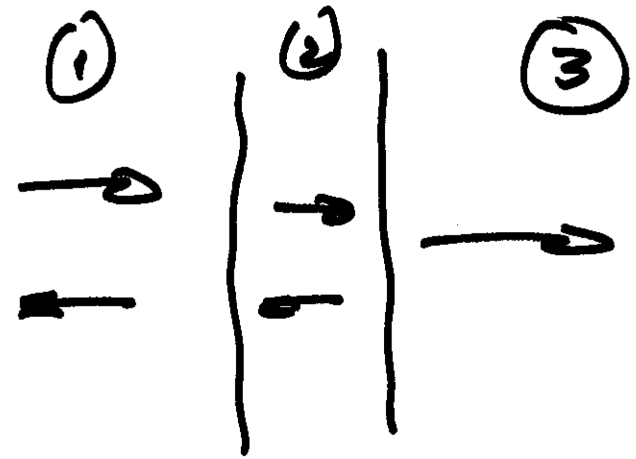


Note correction on page 8

$\rho_1 c_1 = \rho_3 c_3$ $\qquad L = n \dfrac{\lambda_2}{2}$

Sonar

Thin heavy, barrier

$k_2 L << 1 \qquad \rho_2 c_2 >> \rho_1 c_1 \qquad \rho_0 c \,\|\, \rho_0 c$

$$\rho_1 c_1 = \rho_3 c_3$$

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

m_s: mass/unit area

when $\omega m_s \gg 2\rho_0 c$

$$T \propto \frac{2\rho_0 c}{\omega m_s}$$ **mass law**

Transmission Loss

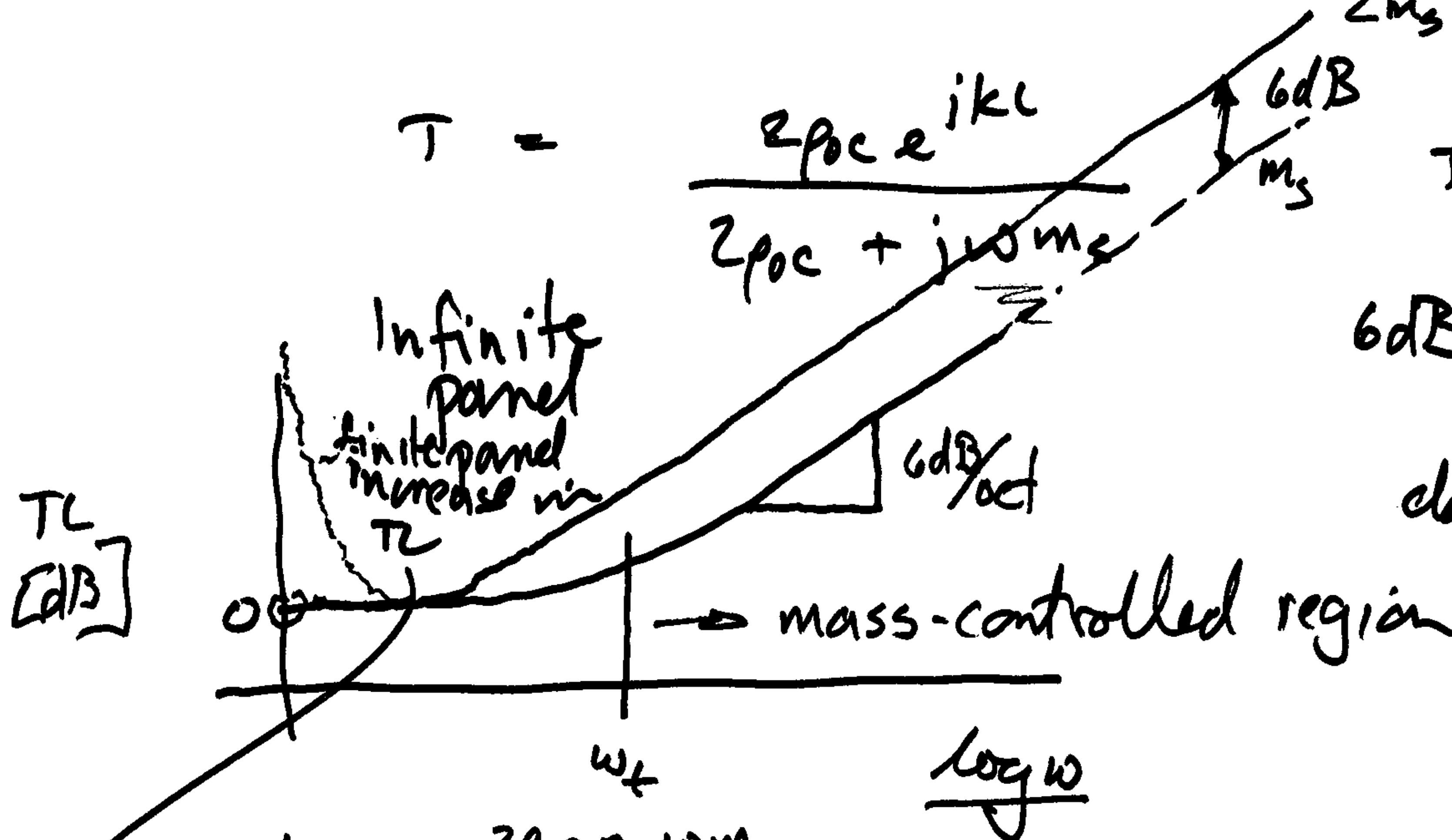
$|T|^2 \downarrow \quad TL \uparrow$

$$\underline{TL} = 10 \log \frac{1}{|T|^2} \quad dB$$

True - when the same medium is on both sides of the panel.

$$T = \frac{2\rho c\, e^{ikl}}{2\rho c + j\omega m_s}$$

$$TL = 10 \log \frac{1}{|T|^2}$$

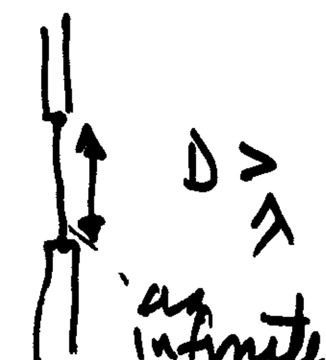


6dB increase in TL for each doubling of mass or frequency.

due to stiffness of panel & edge-constraints

$2\rho c \approx \omega m_s$

$\omega_t \approx \frac{2\rho c}{m_s}$

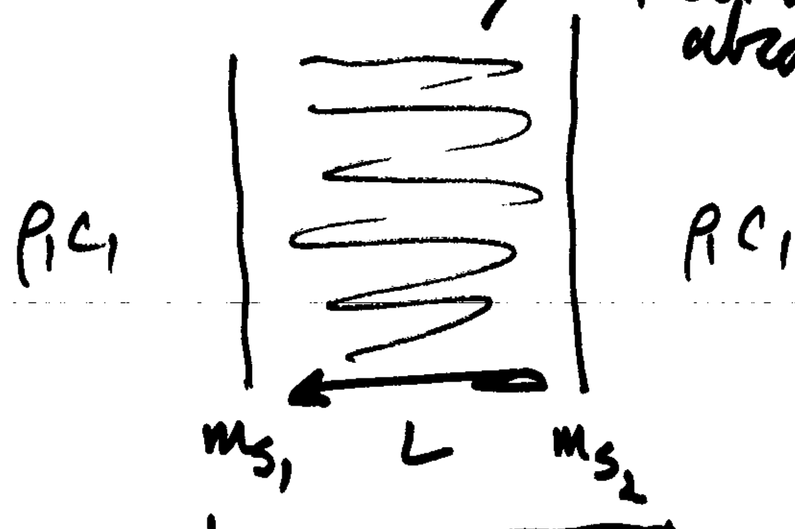


mass controlled region

doubling of mass $\rightarrow$ 6 dB increase in TL

fill with absorbing material

$TL \propto TL_1 + TL_2 + 6\text{ dB}$



single panel

30 dB TL at 1 kHz

double the m_s

$TL \rightarrow 36\text{ dB}$

Double panel system

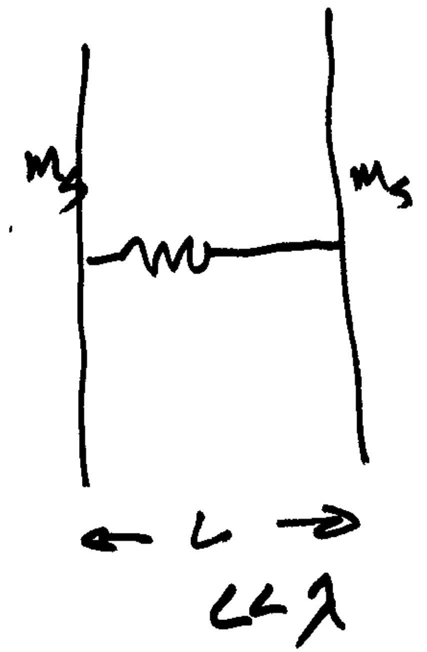
Two identical panels $2m_{s_1}$

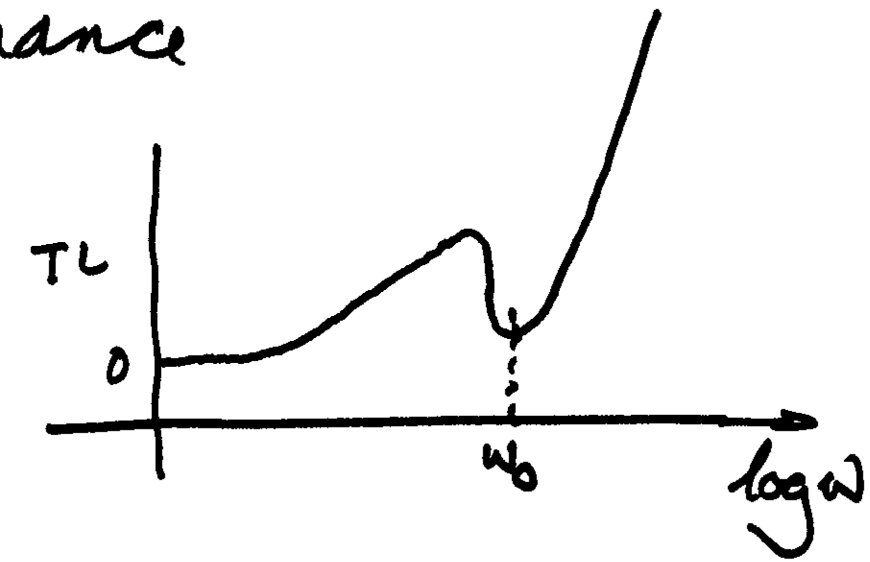
$TL \simeq 66\text{ dB}$

same total m_s

Double Panel System

mass-air-mass resonance





4.2.3 Relation to Acoustic Intensity

→ Freely propagating plane wave

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

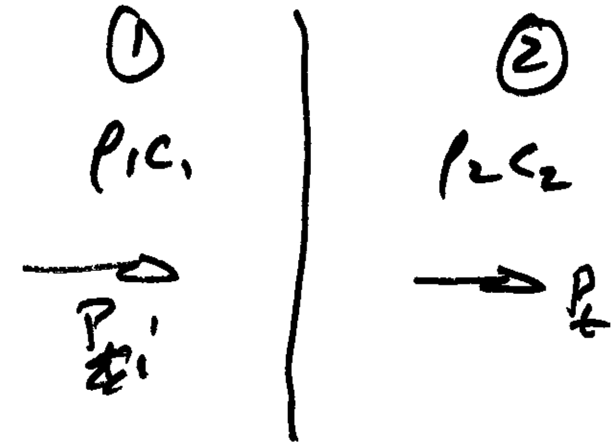
Pressure Coefficients

$$R = \frac{p_r}{p_i} \qquad T = \frac{p_t}{p_i}$$

Intensity (Power) Coefficients

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

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



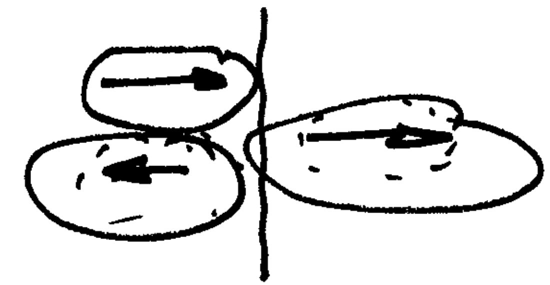
$$= \frac{\rho_1 c_1}{\rho_2 c_2} \underbrace{\left(\frac{p_{t\,rms}^2}{p_{i\,rms}^2}\right)}_{|T|^2}$$

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

$$T_I = \frac{\rho_1 c_1}{\rho_2 c_2} |T|^2 \qquad \zeta_{21} = \frac{\rho_2 c_2}{\rho_1 c_1}$$

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

Two fluid case (normal incidence)



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

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

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

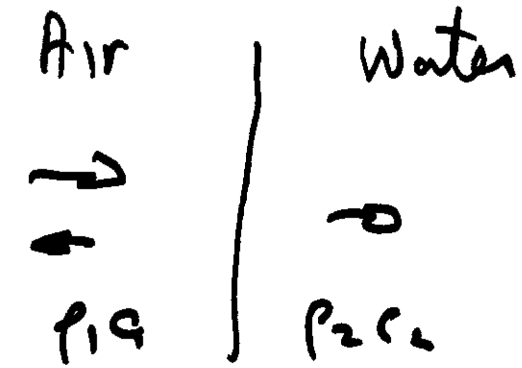
Note:

1. $T_I + \cancel{2} R_I = 1$ true

statement of energy conservation

while generally $T + R \neq 1$

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



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

$T_I \to 0$ $\qquad T = 2$

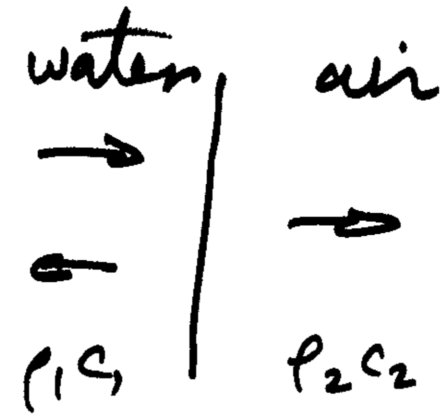
$R_I \to 1$ $\qquad R = 1$

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

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

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

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



pressure release boundary

4.3 Oblique Incidence Reflection & Transmission