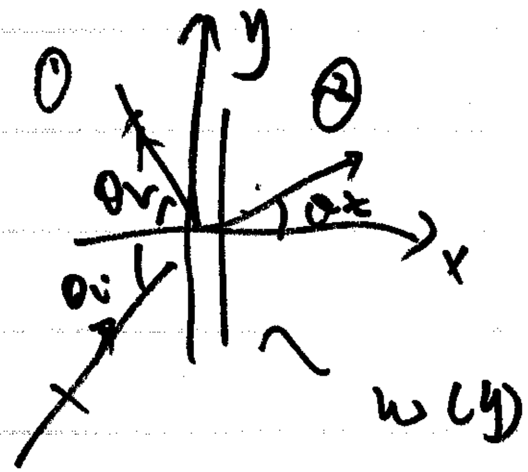
Exam Wed. Oct 23 In class 50 min

- No Text book
- No electronics
- Yes Homework Lecture notes

4.3.2 Reflection and Transmission at a limp Thin panel



$\rho_1 c_1 = \rho_2 c_2$

$w(y)$ - transverse displacement of the panel

m_s = mass per unit area of the panel

- Locally reacting (untensioned string)
  - no shear no bending
  - No free wave propagation

- $\rho_1 c_1 \cdot \rho_2 c_2 \xrightarrow{B.C.} R, T.$

Claim if $\rho_1 c_1 = \rho_2 c_2$
$\theta_i = \theta_r = \theta_t = \theta$ (last wk.)

In Region 1

$$\tilde{p}_1 = p_i e^{-j(k_x x + k_y y)} + p_r e^{-j(k_x x - k_y y)}$$

$$\tilde{u}_{1x} = \frac{p_i}{\rho_0 c} \cos\theta \, e^{-j(k_x x + k_y y)} + \frac{p_r}{\rho_0 c} \cos\theta \, e^{-j(k_x x - k_y y)}$$

$$\theta = \theta_i = \theta_r = \theta_t$$

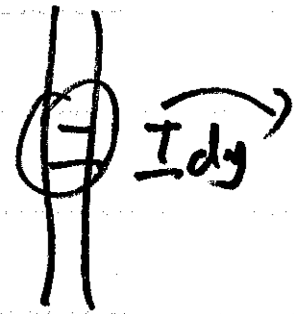
$$k_x = k\cos\theta \qquad k_y = k\sin\theta \qquad k = \frac{\omega}{c}$$

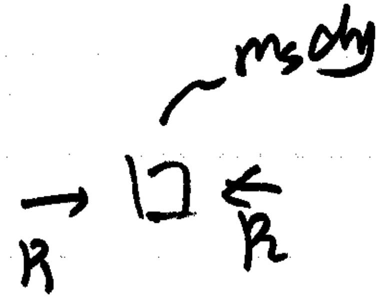
In region 2

$$\tilde{p}_2 = p_t e^{-j(k_x x + k_y y)}$$

$$\tilde{u}_{2x} = \frac{p_t}{\rho_0 c} \cos\theta \, e^{-j(k_x x + k_y y)}$$

E.o.M of panel





Locally reacting

⇒ no shearing, no bending

⇒ Force $= (P_2 - P_1) \cdot dy$

$F = ma$

$$\Rightarrow (P_2 - P_1)\big|_{x=0} dy = \underbrace{m_s dy}_{m} \frac{\partial^2 w}{\partial t^2}$$ – Because of locally reacting

$w(y)$ – displacement of the panel

- Normal velocity is continuous

$$u_{1x}\big|_{x=0} = u_{2x}\big|_{x=0} = \frac{\partial w}{\partial t}$$

B.C. at $x=0$

① $(\tilde{p}_1(0) - \hat{p}_2(0)) = m_s \frac{d^2 w}{dt^2} = m_s \frac{\partial u_{x1}}{\partial t} = m_s \frac{\partial u_{2x}}{\partial t}$

$= j\omega m_s \tilde{u}_{2x}$ — Harmonic

② $\hat{u}_{2x}(0) = \tilde{u}_{1x}(0)$

Sub. assumed solutions to B.C.

① $1+R-T = \left(\dfrac{j\omega m_s}{\rho c}\cos\theta\right)T$

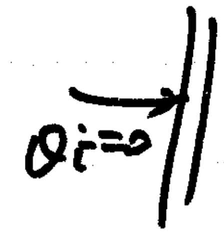
② $1-R = T$

Solve for R, T

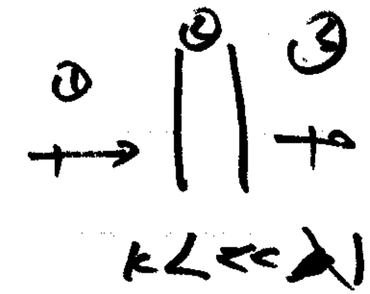
$$\Rightarrow \quad R = \frac{j\omega m_s}{\frac{2\rho c}{\cos\theta} + j\omega m_s} \qquad T = \frac{\frac{2\rho c}{\cos\theta}}{\frac{2\rho c}{\cos\theta} + j\omega m_s}$$

Special cases,

(I) $\theta_i = 0$ _ Normal Incidence



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



- the same result as three fluid layer:

$$\rho_2 \gg \rho_1 \qquad kL \ll 1$$

(II) Light panel $m_s \to 0$

$$R = 0 \qquad T \to 1$$

- panel disappears.

(III) massive panel

$m_s \to \infty$

$R \to 1$ $\qquad T \to \underline{\dfrac{2\rho_0 c}{2\cos\theta} \dfrac{1}{j\omega m_s}}$ "mass law"

$T \propto \dfrac{1}{\omega}$ $\qquad T \propto \dfrac{1}{m_s}$

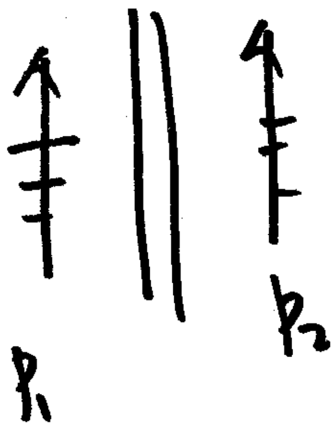
$\omega m_s \gg \dfrac{2\rho_0 c}{\cos\theta}$ – mass law applies

(iv) Grazing Incidence Case

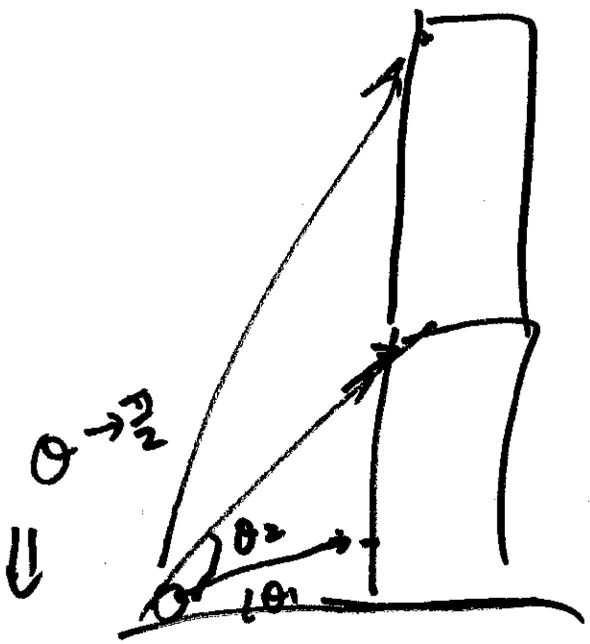
$\theta_i \Rightarrow \frac{\pi}{2}$

$\cos\theta_i \to 0$

$R \to 0$ $T \to 1$



$P_1 = P_2$

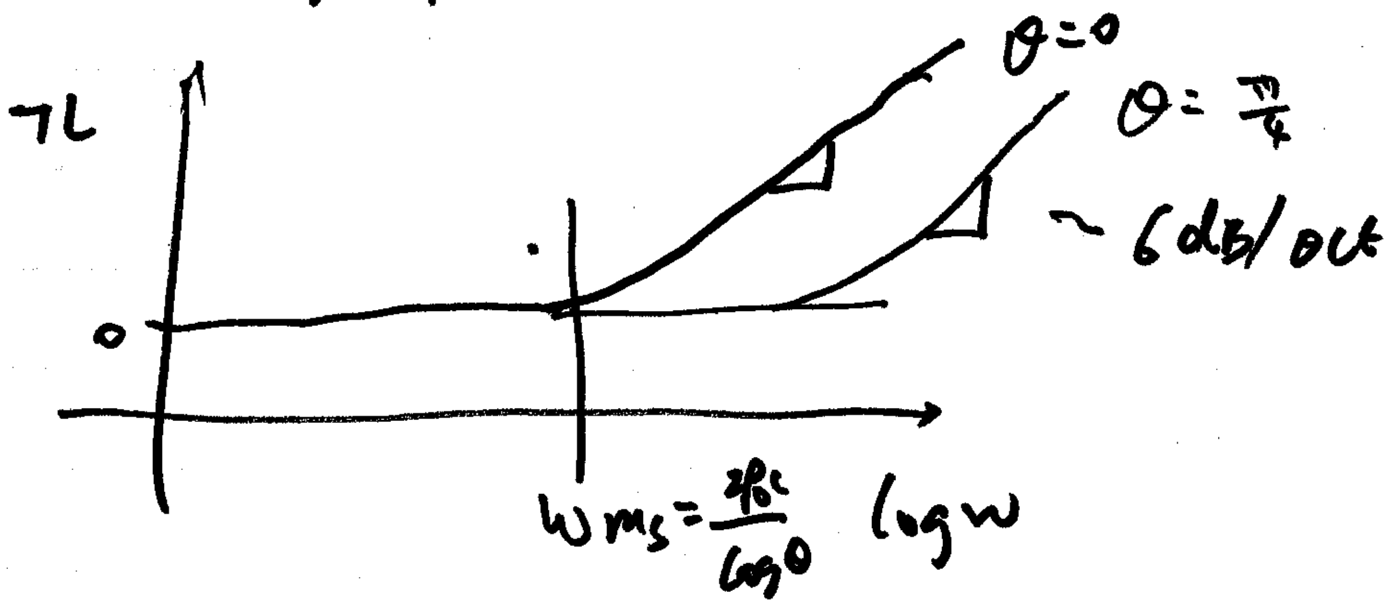


Grazing Incidence

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

(IV) overall behavior of the panel

R.T → TL (θ, ω)



(vi) finite panel with stiffness