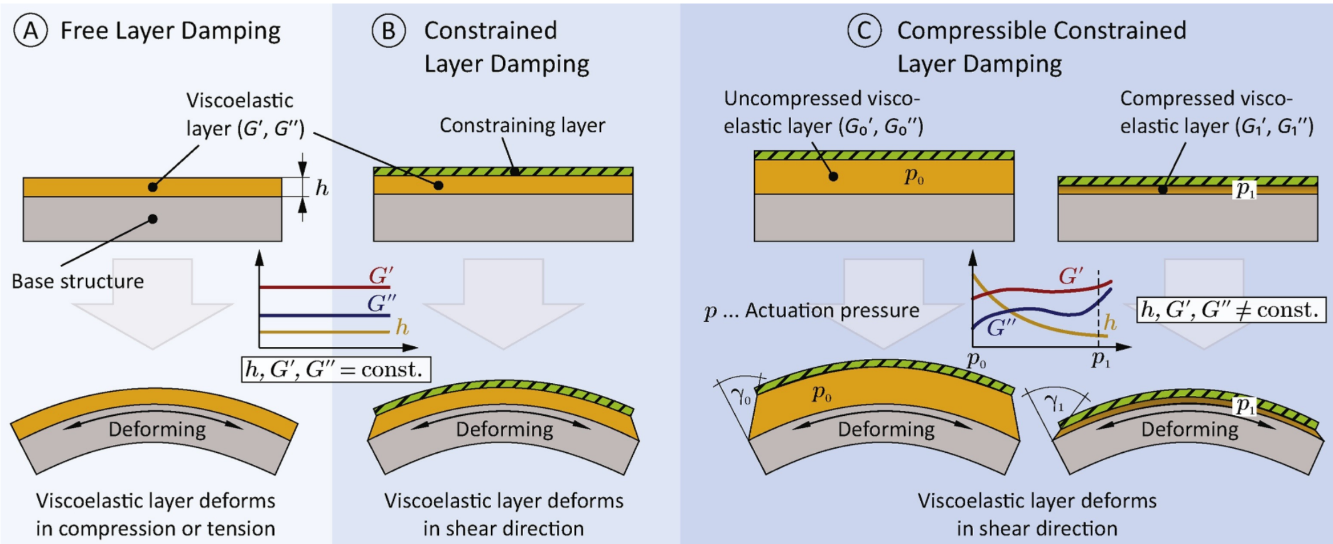
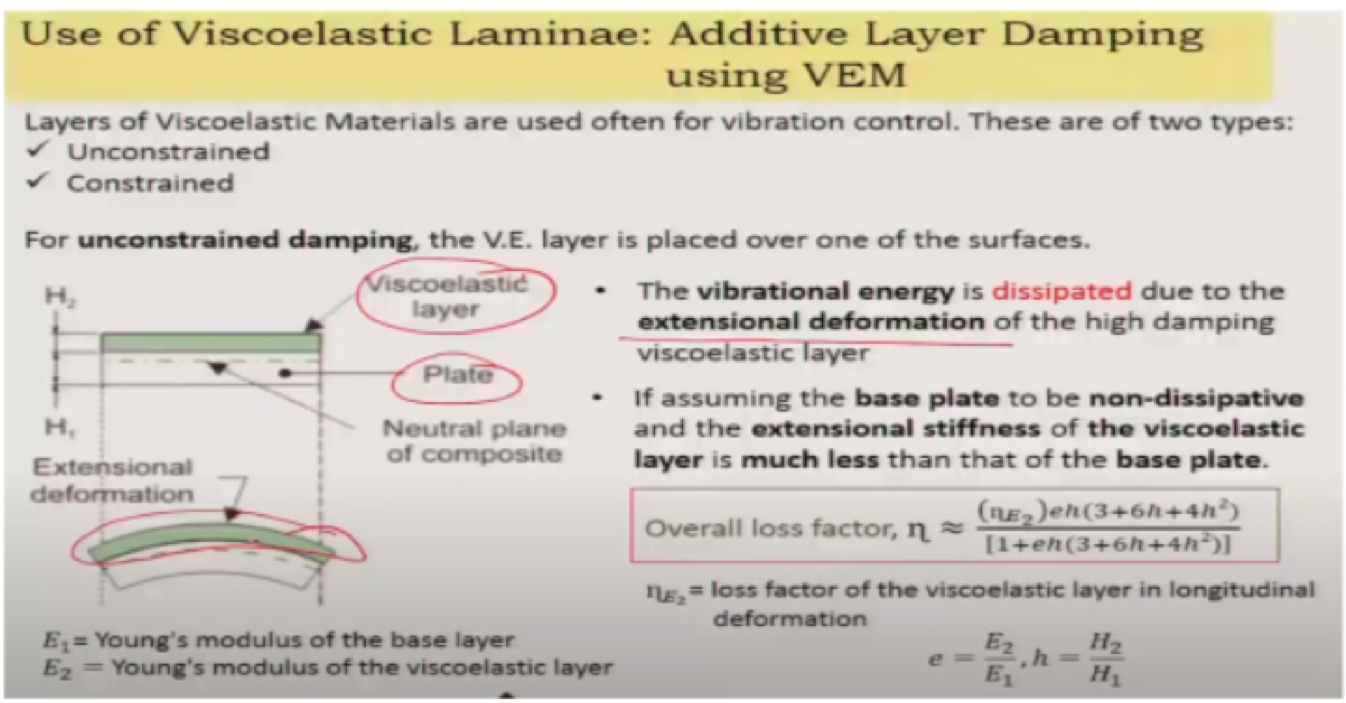
Free/ Constrained layer Damping

Unconstrained layer damping involves gluing proprietary high damping material to thin metal panels. As the panel vibrates, it bends, stretching the damping material and some vibration energy is dissipated as heat.

Constrained-layer damping is a mechanical engineering technique for suppression of vibration. Typically a viscoelastic or other damping material, is sandwiched between two sheets of stiff materials that lack sufficient damping by themselves. The ending result is, any vibration made on either side of the constraining materials (the two stiffer materials on the sides) are trapped and evidently dissipated in the viscoelastic or middle layer.



Hand calculations for calculating the overall loss factor of FLD:



Hand calculations for calculating the overall loss factor of CLD:

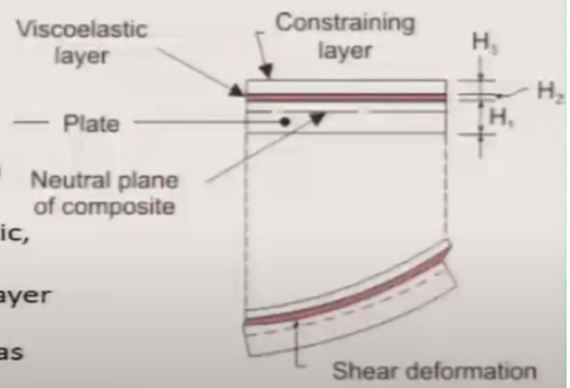
If the **extensional stiffness** of the viscoelastic layer is **negligible** as compared to the **stiffnesses of the bottom and top layers** (as is usually the case in **real life**), then the **overall loss factor**, neglecting the **extensional damping**, is given by

$$\text{Overall loss factor, } \eta \approx \frac{(\eta_{G_2} Y g)}{[1+(2+Y)g+(1+Y)(1+\{\eta_{G_2}\}^2)g^2]}$$

η_{G_2} = loss factor of the viscoelastic material in shear

- The parameter Y, called the **stiffness parameter** is given by

$$Y = \frac{12ehH^2}{[(1+eh)(1+eh^3)]}$$



$$e = \frac{E_3}{E_1}, \boldsymbol{h} = \boldsymbol{H_3} = \boldsymbol{H_1}, H = \frac{1}{2} + \frac{H_2}{H_1} + H_3 = (2H_1)$$

With $\mathbf{H_1}$, $\mathbf{H_2}$, $\mathbf{H_3}$ as the **thickness** of the base, viscoelastic, constraining layers,
$\mathbf{E_1}$, $\mathbf{E_3}$ as Young's moduli of the base and constraining layer

The parameter g, called the **shear factor** is expressed as

$$g = \left[\frac{G_2}{(\frac{4\pi^2}{\lambda^2})H_2}\right]\left[\frac{1}{E_1H_1} + \frac{1}{E_3H_3}\right]$$

G_2 = Storage shear modulus of VEM
λ = wavelength of flexural vibration