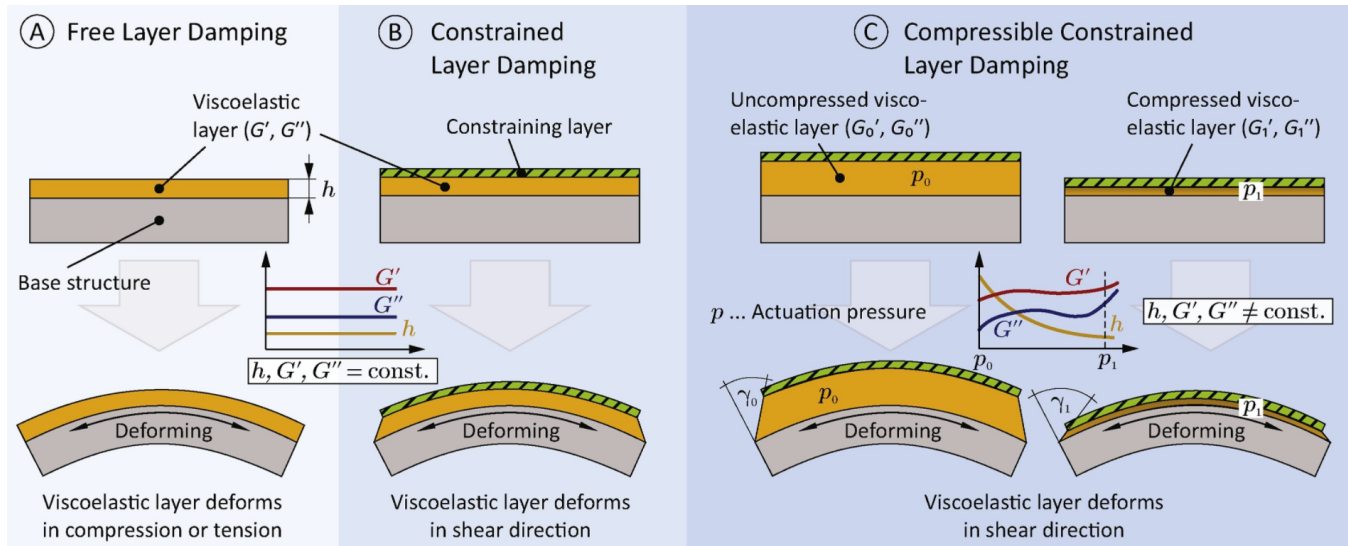


Free/ Constrained layer Damping

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:

Use of Viscoelastic Laminae: Additive Layer Damping using VEM

Layers of Viscoelastic Materials are used often for vibration control. These are of two types:

- ✓ Unconstrained
- ✓ Constrained

For **unconstrained damping**, the V.E. layer is placed over one of the surfaces.

- The **vibrational energy is dissipated** due to the **extensional deformation** of the high damping viscoelastic layer
- If assuming the **base plate to be non-dissipative** and the **extensional stiffness of the viscoelastic layer is much less than that of the base plate**.

Overall loss factor, $\eta \approx \frac{(\eta_{E_2})eh(3+6h+4h^2)}{[1+eh(3+6h+4h^2)]}$

η_{E_2} = loss factor of the viscoelastic layer in longitudinal deformation

$e = \frac{E_2}{E_1}, h = \frac{H_2}{H_1}$

E_1 = Young's modulus of the base layer
 E_2 = Young's modulus of the viscoelastic layer

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

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

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

With H_1, H_2, H_3 as the **thickness** of the base, viscoelastic, constraining layers,

E_1, E_3 as Young's moduli of the base and constraining layer

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

$$g = \left[\frac{G_2}{\left(\frac{4\pi^2}{\lambda^2}\right)H_2} \right] \left[\frac{1}{E_1 H_1} + \frac{1}{E_3 H_3} \right]$$

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

