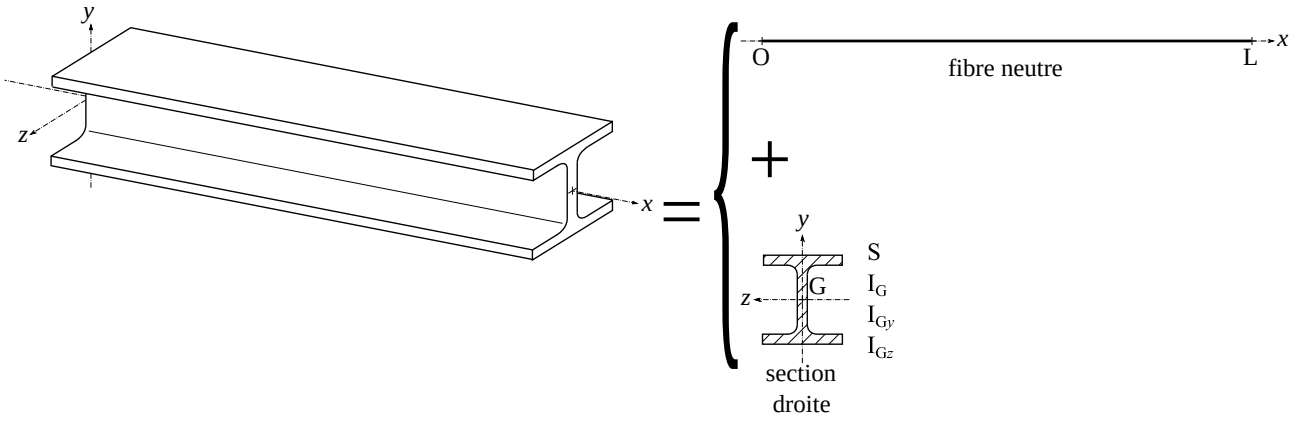
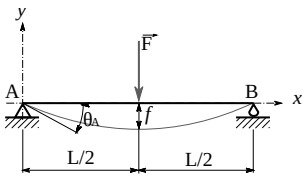
Théorie des poutres : flexion pure (d'après Wikipédia).



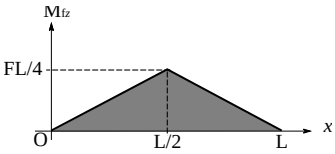
État limite en service (ELS)

$$\left.\begin{array}{l} \gamma = \dfrac{M_{fz}}{E \cdot I_{Gz}} \\ \gamma \approx \dfrac{\partial^2 u}{\partial x^2} \end{array}\right\} \quad E\,I_{Gz}\dfrac{\partial^2 u}{\partial x^2} = M_{fz} \quad \text{a.k.a.} \quad E\,I_{Gz}\cdot y'' = M_{fz}$$

Appui double et force au centre



$$M_{fz} = \frac{F}{2}x \;\Rightarrow\; f = \frac{F \cdot L^3}{48\,E \cdot I_{Gz}}$$

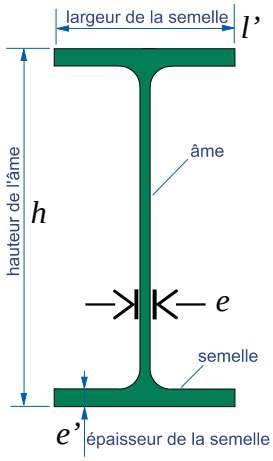


Appui double et force répartie (q N/m)

$$M_{fz} = \frac{q}{2}\left(Lx - x^2\right) \;\Rightarrow\; f = \frac{5\,q\,L^4}{384\,E \cdot I_{Gz}}$$

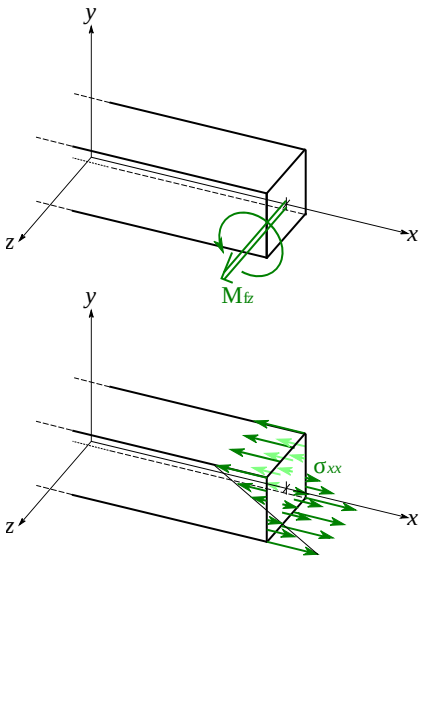
Moment quadratique

- section rectangulaire : $I_{Gz} = \dfrac{b h^3}{12} \qquad q = \rho\, b\, h\, g$
- poutre en I :
  - Huygens : $I_{Gz} = \dfrac{e\left(h-2e'\right)^3}{12} + 2\left(\dfrac{l'e'^3}{12} + \left(l'e'\right)\cdot\left(\dfrac{h}{2} - \dfrac{e'}{2}\right)^2\right)$
  - ou soustraction du vide : $I_{Gz} = \dfrac{l'h^3}{12} - \dfrac{\left(l'-e\right)\left(h-2e'\right)^3}{12}$



État limite ultime (ELU)

$$\sigma_{xx} = -\frac{M_{fz}}{I_{Gz}} \cdot y \text{ et rupture si } \sigma_{xxMax} > R_e$$



Acier

- ρ = 7 850 kg/m^3
- E = 210 GPa
- R_e = 235 (S235) à 355 (S355) MPa