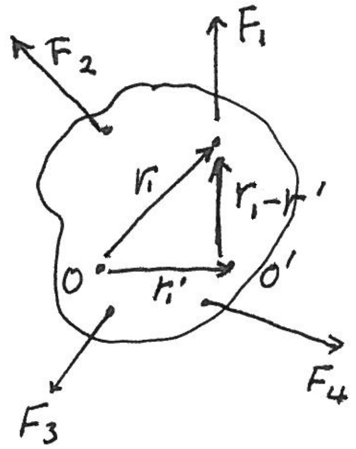
Chap 12.

Static Equilibrium and Elasticity

12.1 The Condition for equilibrium

1) for rotational motion · the net torque about any axis must be zero · $\sum \tau = 0$

2) for translation $\sum F = 0$



if $\sum \tau_0 = 0$ and $\sum F = 0$

$$\sum \tau_0 = r_1 \times F_1 + r_2 \times F_2 + r_3 \times F_3 + \cdots$$

$$\sum \tau_{0'} = (r_1 - r') \times F_1 + (r_2 - r') \times F_2 + (r_3 - r') \times F_3 + \cdots$$

Fig 12-4

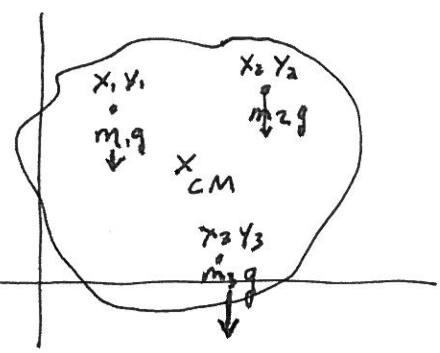
$$= \underbrace{r_1 \times F_1 + r_2 \times F_2 \cdots}_{=0} + \cdots - r' \times \underbrace{(F_1 + F_2 + F_3 + \cdots)}_{=0}$$

$$= 0$$

∴ If an object is in translation equilibrium, and the net torque is zero about one axis, then the net torque is zero about any other axis

12.2 Center of mass and Center of gravity

$$X_{CM} = \frac{m_1 x_1 + m_2 x_2 + \cdots}{m_1 + m_2 + \cdots} = \frac{\sum_i x_i m_i}{\sum_i m_i}$$



from the point of view of gravity

$$(m_1 g_1 + m_2 g_2 + \cdots) X_{CG} = m_1 g_1 x_1 + m_2 g_2 x_2 + \cdots$$

if g can vary

$$x_{CG} = \frac{m_1 g_1 x_1 + m_2 g_2 x_2 + \cdots + m_n g_n x_n}{m_1 g_1 + m_2 g_2 + \cdots + m_n g_n}$$

$$= \frac{m_1 x_1 + m_2 x_2 + \cdots + m_n x_n}{m_1 + m_2 + m_2 + \cdots + m_n}$$

if $g_i = g$

That is if g is uniform

12.4 Elastic properties of Solid

Stress : A quantity that cause the deformation

Strain : The result of a stress

Strain ∝ Stress

Stress = Elastic Modulus · ~~Stress~~ Strain

1) Young's Modulus $Y \equiv \frac{\text{tensile stress}}{\text{tensile strain}} = \frac{F/A}{\Delta L/L_i}$

Check the table 2.1, P 374

2) Shear Modulus $S \equiv \frac{\text{Shear stress}}{\text{Shear strain}} = \frac{F/A}{\Delta x/h}$

3) Bulk Modulus $B \equiv \frac{\text{Volume stress}}{\text{Volume strain}} = \frac{-\Delta F/A}{\Delta V/V_i} = \frac{-\Delta P}{\Delta V/V}$

Note the negative sign.