

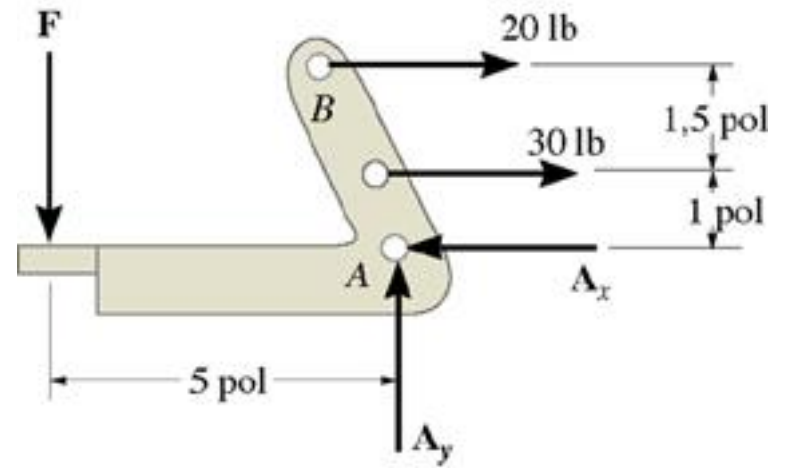
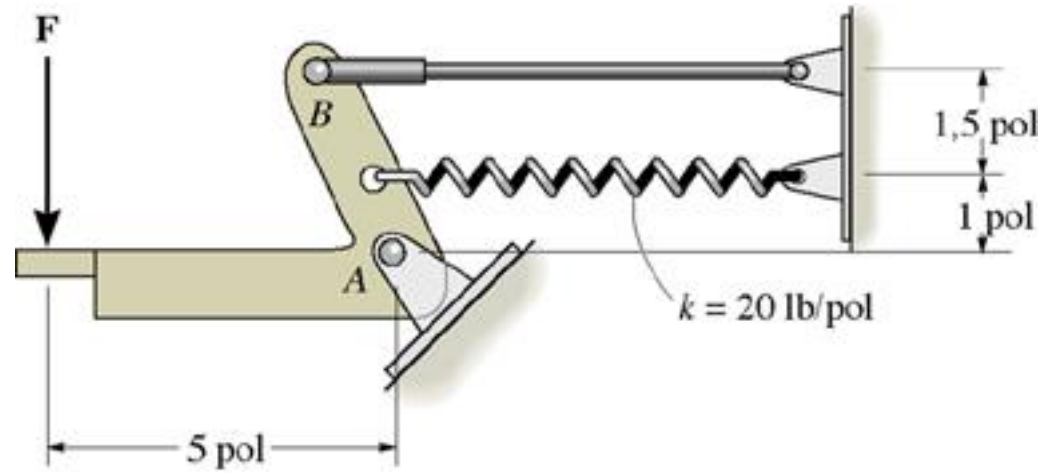
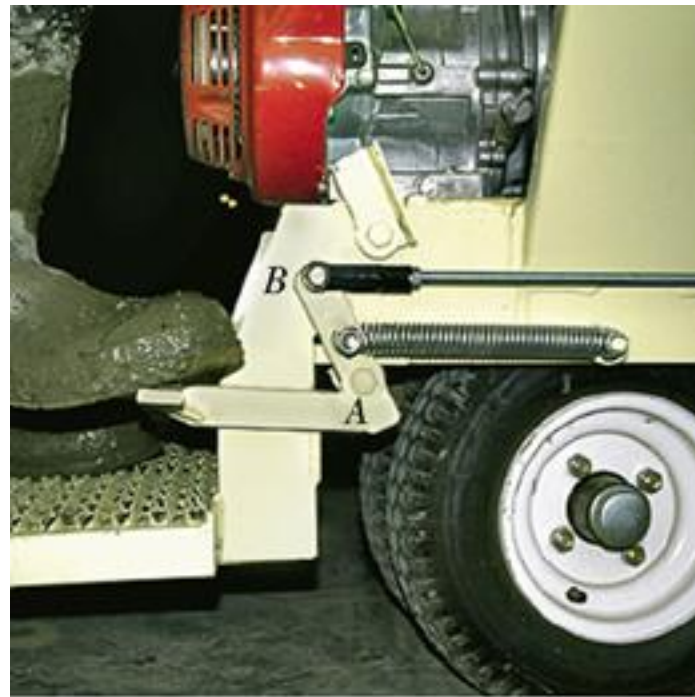
PEF 3200

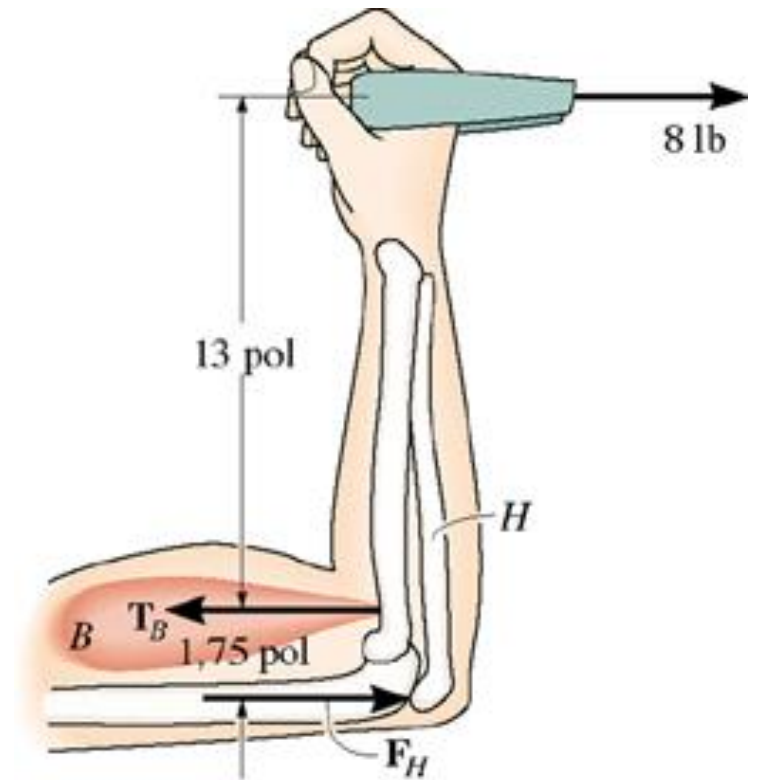
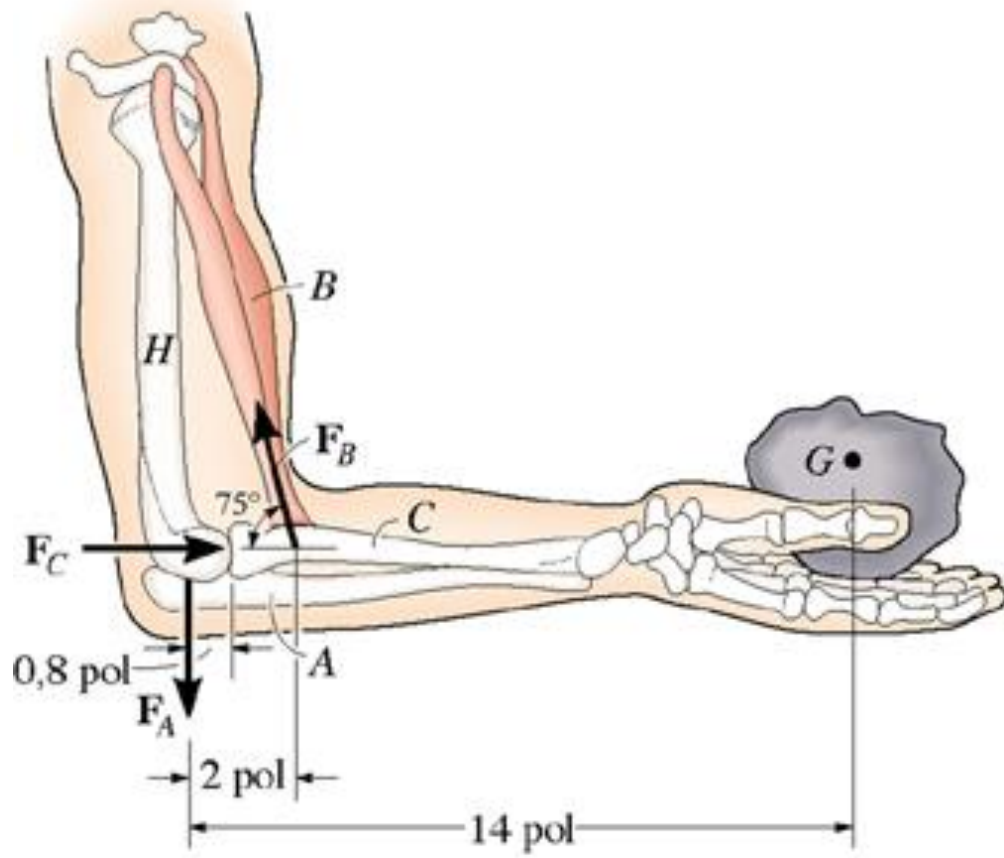
Aula do dia 27/2/2019 turma 2

PROF. OSVALDO NAKAO

Projeto, construção:

- 1) Arquitetura define os espaços
- 2) Estrutura para que o espaço exista: dimensões, materiais,
- 3) Memória de cálculo: documento
- 4) Segurança: 10^{-6} ; 10^{-7}
- 5) TRABALHA-SE COM MODELOS:
Ciência para resolver problemas práticos
Comportamento (funcionamento da estrutura)
Deformações (como?, medidas)
Não se medem esforços
Resultados aproximados
- 6) A melhor maneira de estudar é por meio de como se deforma





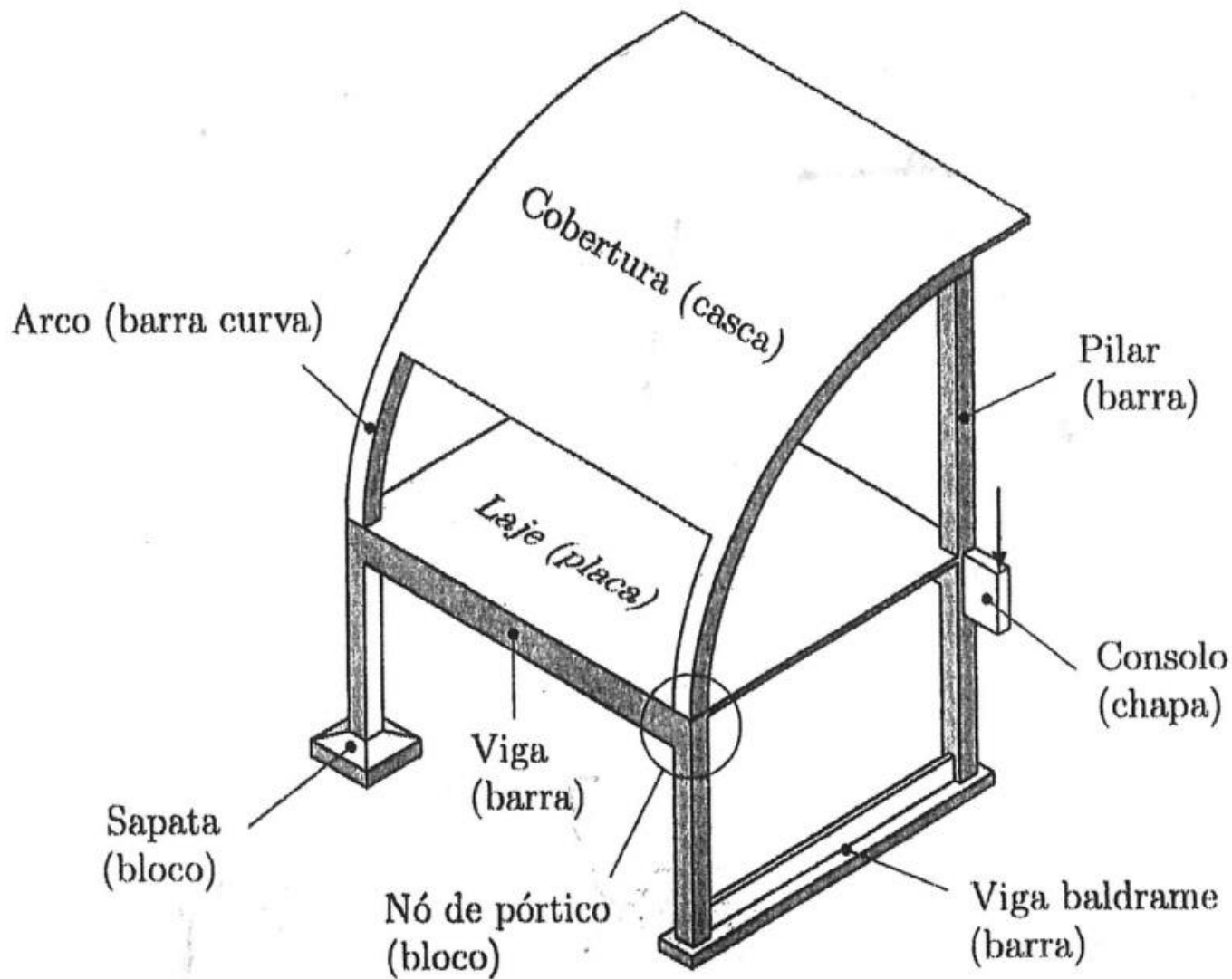
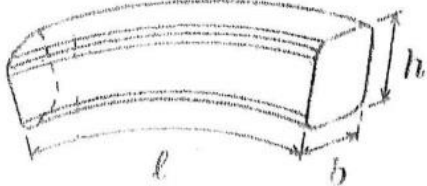


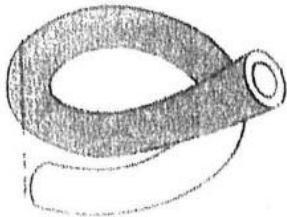
Fig. 1: Elementos estruturais de uma edificação.

Classificação dos elementos estruturais quanto à geometria

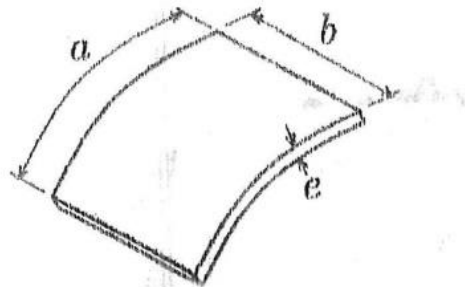
(a) Barra



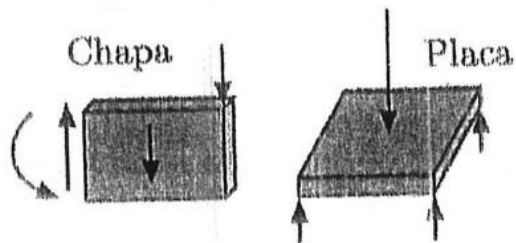
$$b, h \ll l$$



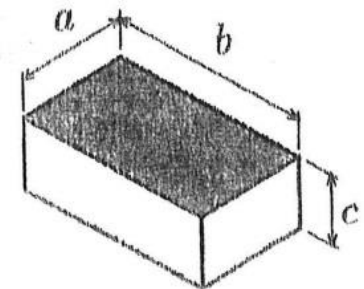
(b) Folha



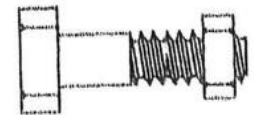
$$e \ll a, b$$

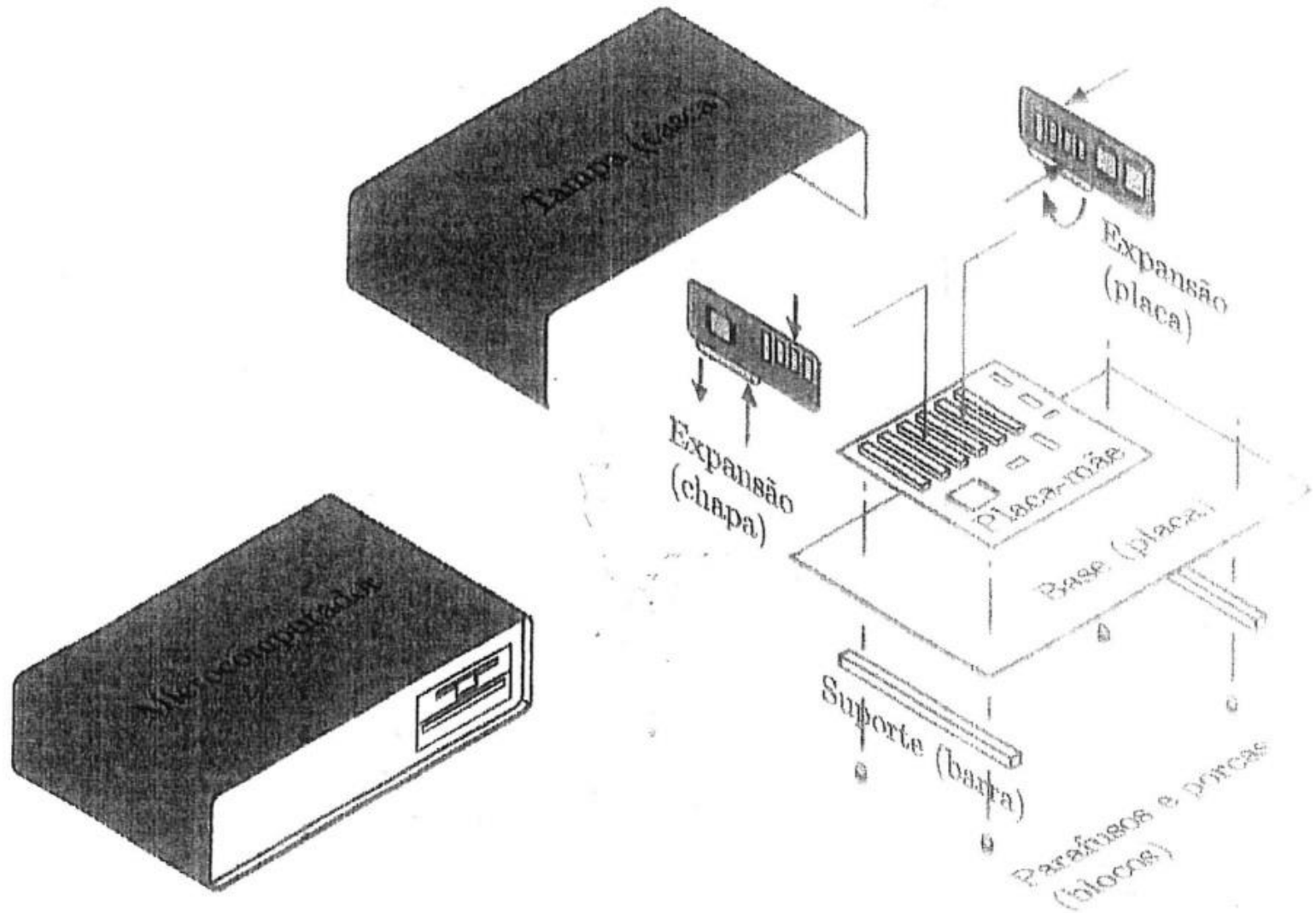


(c) Bloco

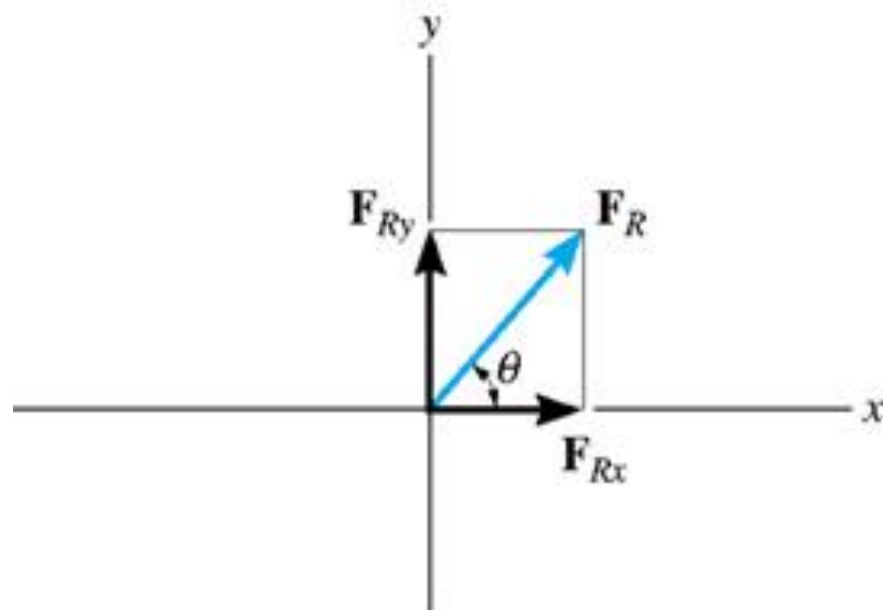
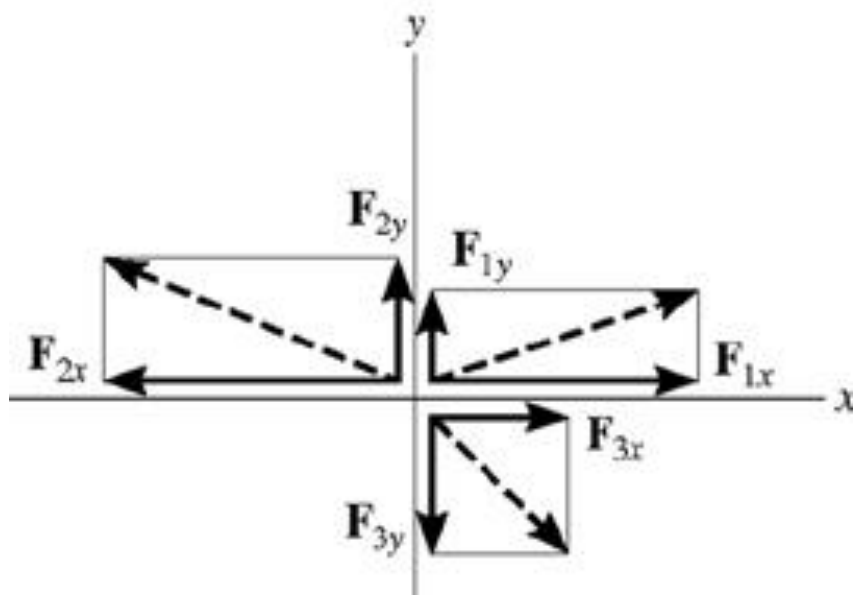
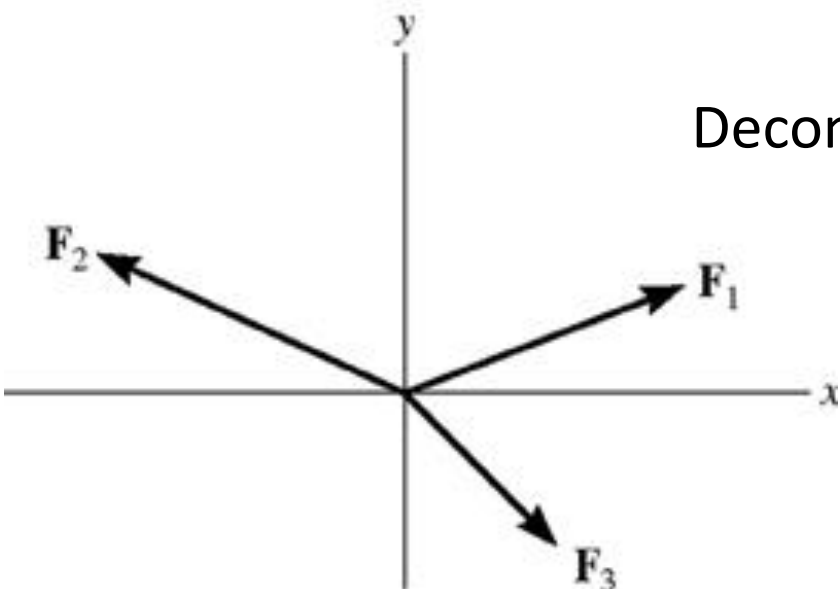


$$a \approx b \approx c$$



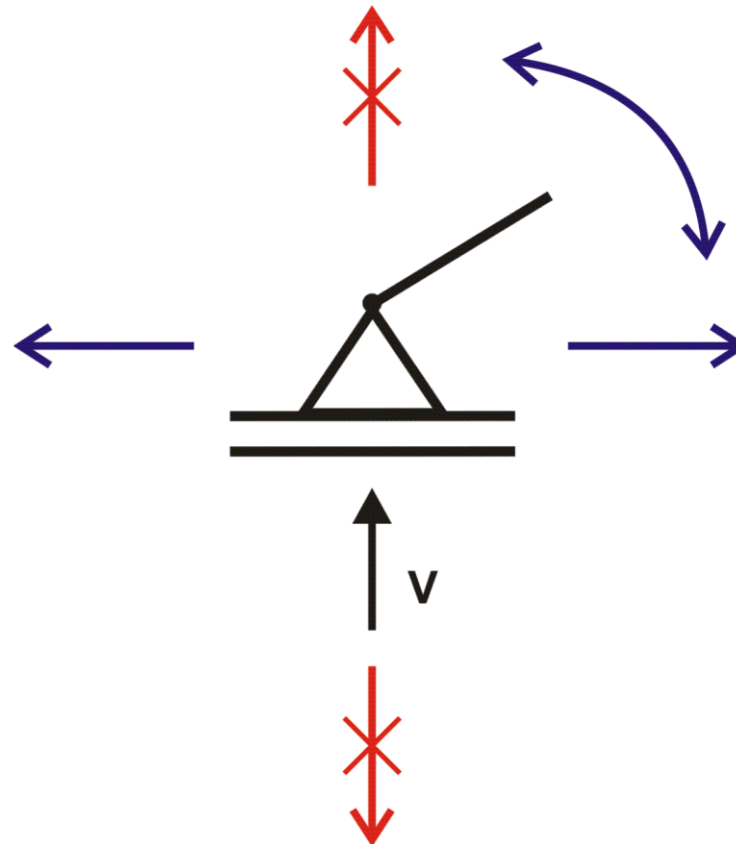
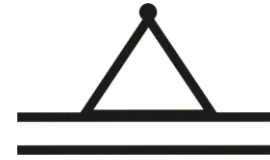


Decomposição de forças



APOIOS DE ESTRUTURAS

- Articulação móvel (estrutura plana)





Ponte D. Pedro II, sobre o rio Paraguaçu, ligando Cachoeira a São Félix, na Bahia, 1885



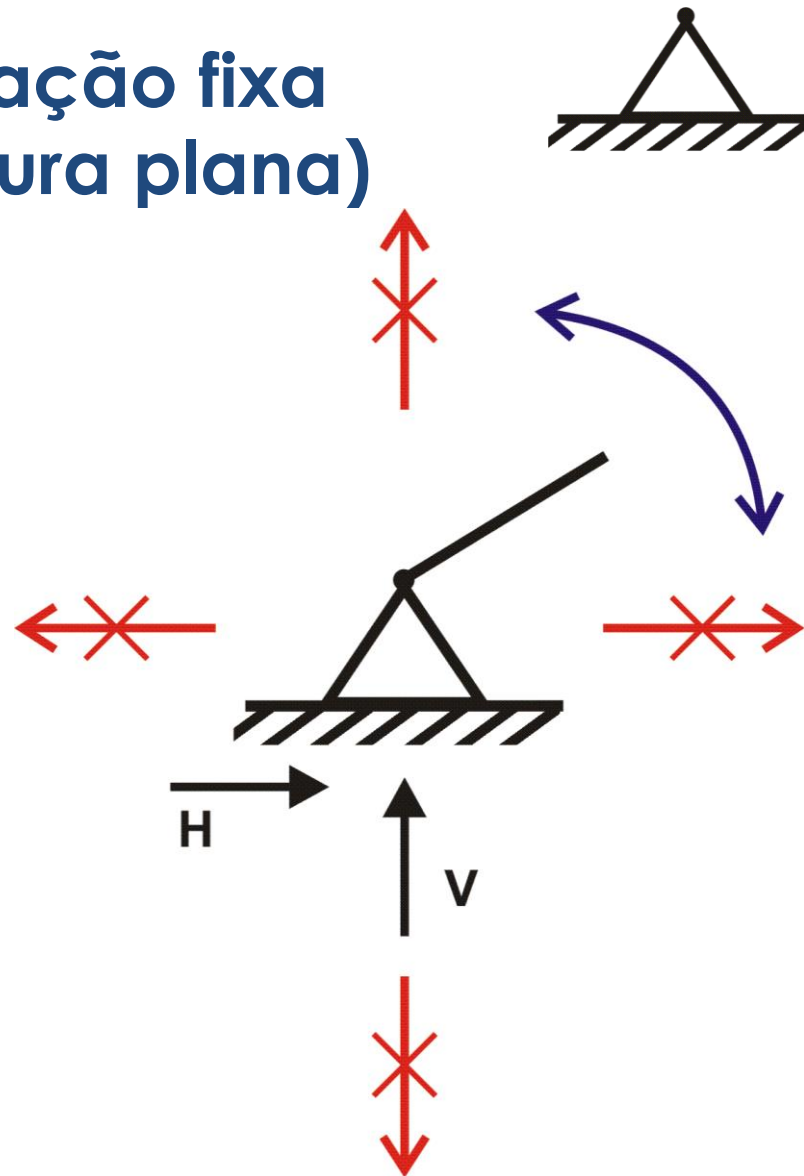




Ponte ferroviária Zarate Brazo Largo I sobre o rio Paraná de las Palmas, na Argentina, 1978



- Articulação fixa (estrutura plana)





Ponte ferroviária Zarate Brazo Largo I sobre o rio Paraná de las Palmas, na Argentina, 1978

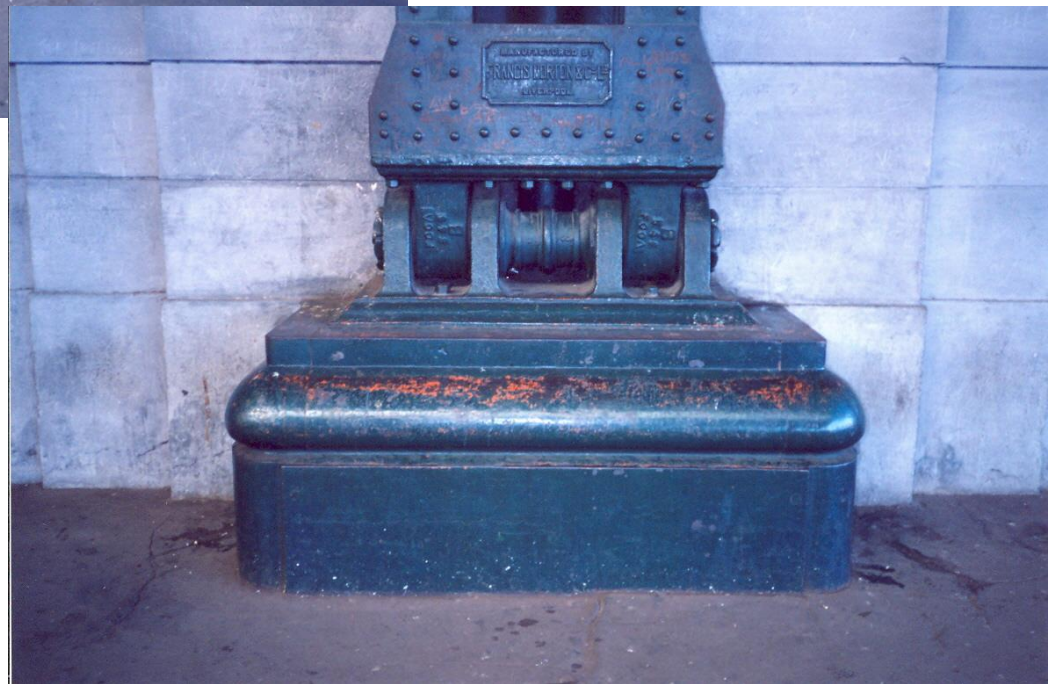


Estação Mapocho, hoje um centro cultural, em Santiago, Chile, 1912



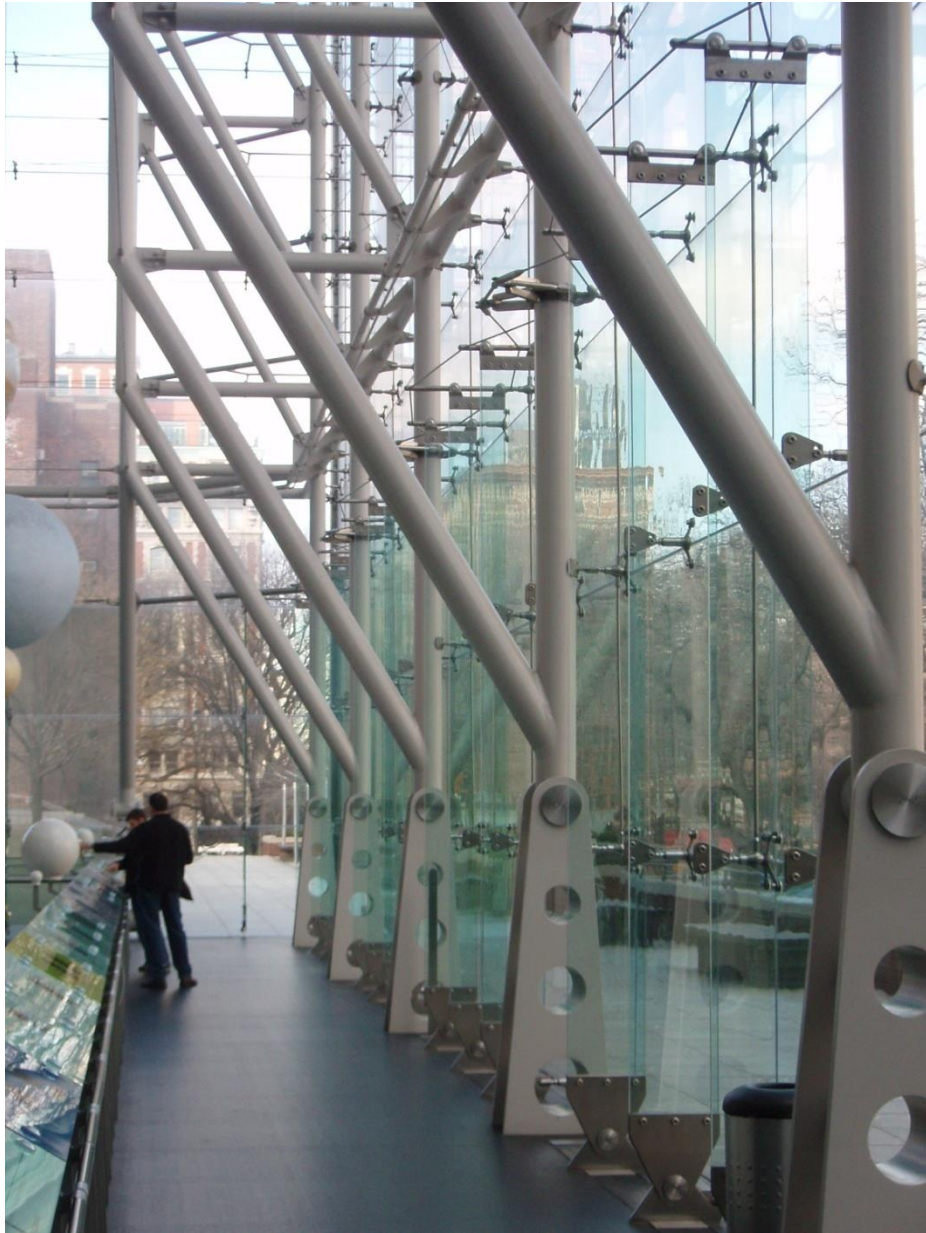


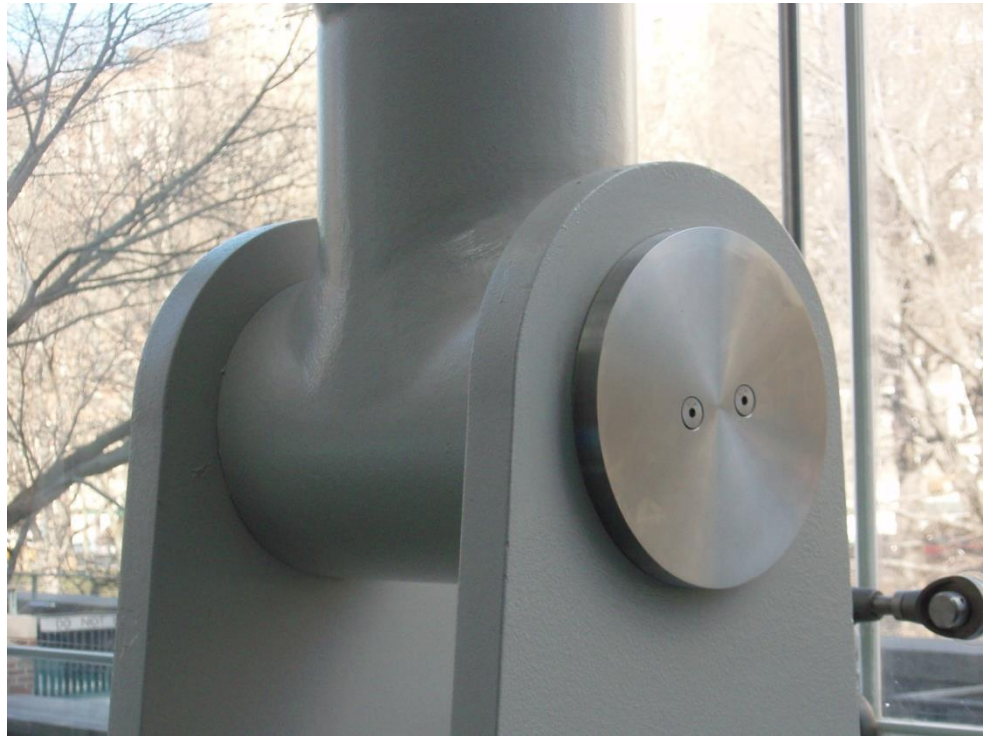
Estação Retiro, em Buenos Aires, 1915





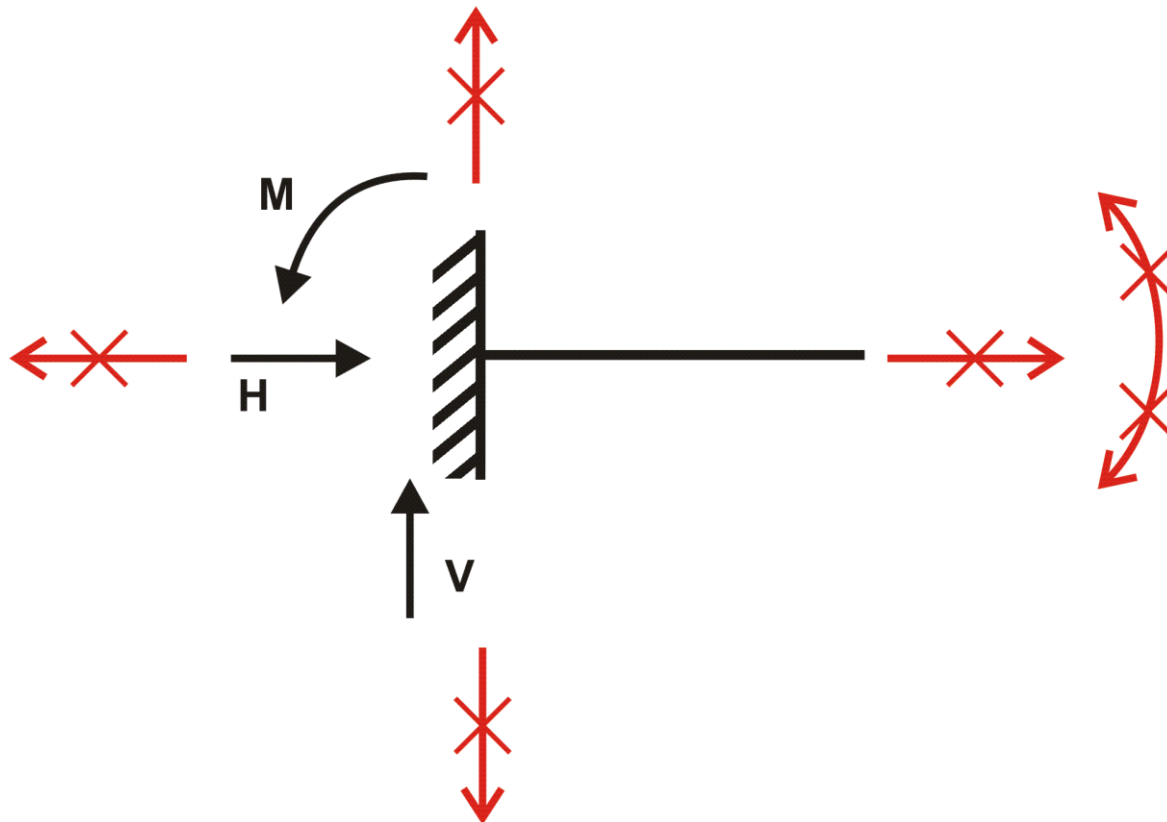
Hayden Planetarium, em Nova York, 2000







- Engastamento
(estrutura plana)







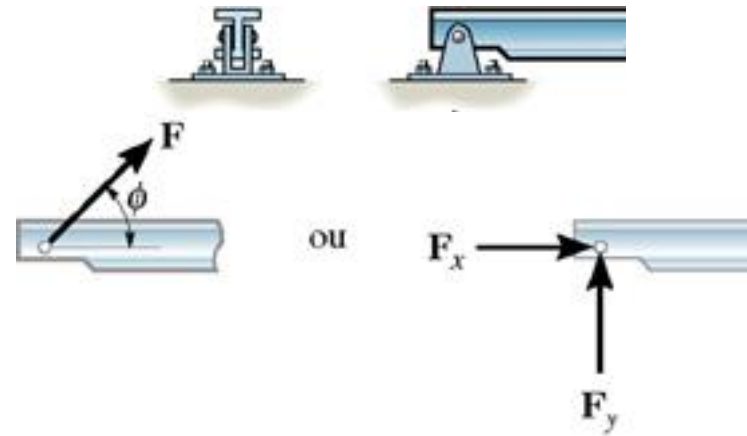
CN Tower, em Toronto, no Canadá, inaugurada em 1976; possui 553 m de altura

APOIOS NO PLANO

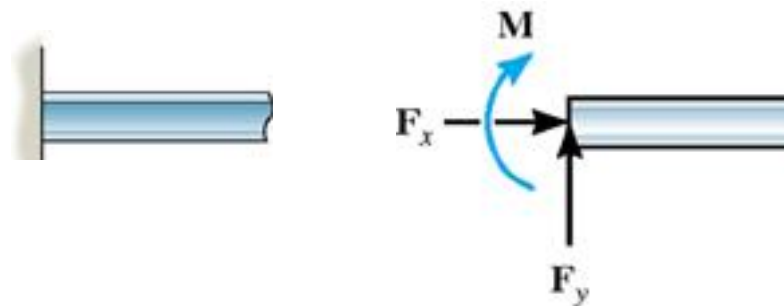
ARTICULAÇÃO MÓVEL:



ARTICULAÇÃO FIXA:



ENGASTAMENTO:









Para um corpo em repouso em relação a um sistema inercial, as leis de Euler³ fornecem:

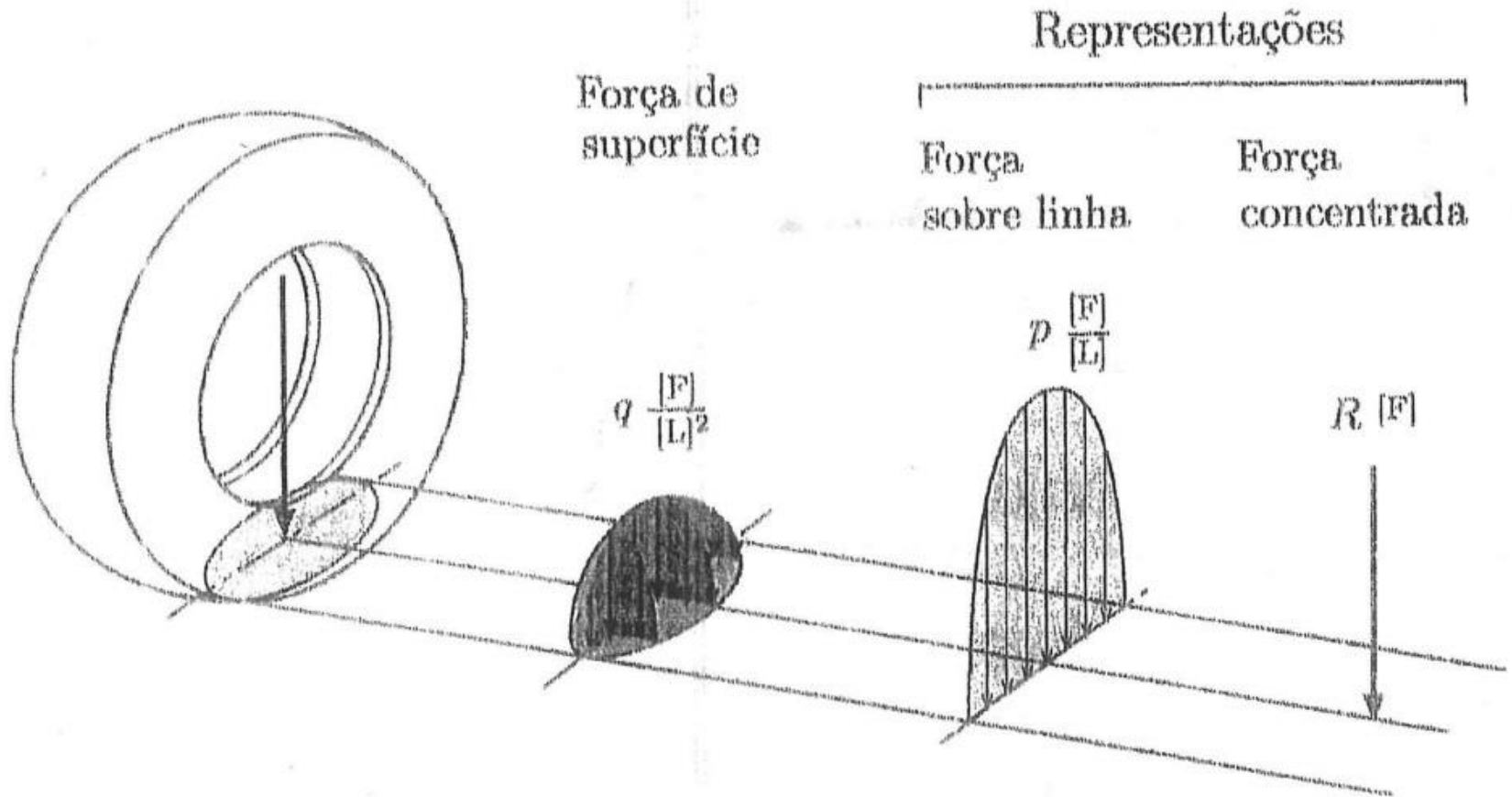
$$\sum_{i=1}^{n_F} \mathbf{F}_i = \mathbf{0}, \quad \sum_{j=1}^{n_M} \mathbf{M}_{Oj} = \mathbf{0}, \quad (2.1)$$

correspondendo ao equilíbrio de n_F forças \mathbf{F}_i e n_M momentos \mathbf{M}_j em relação a um polo arbitrário O. Reescrevendo a equação acima empregando as componentes de força e momento em relação a três eixos ortogonais x , y e z passando por O, obtemos

$$\begin{aligned} \sum F_x &= 0, & \sum M_{Ox} &= 0, \\ \sum F_y &= 0, & \sum M_{Oy} &= 0, \\ \sum F_z &= 0, & \sum M_{Oz} &= 0, \end{aligned} \quad (2.2)$$

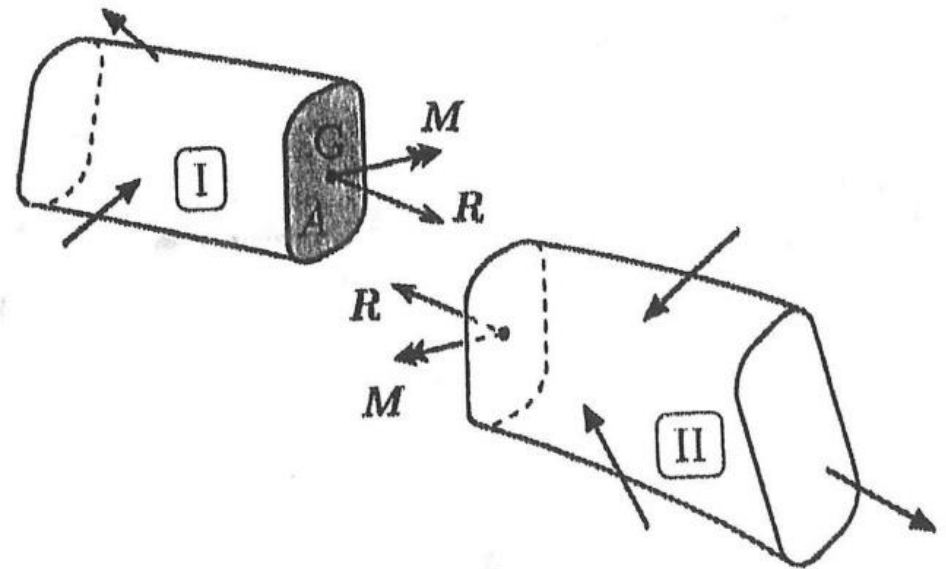
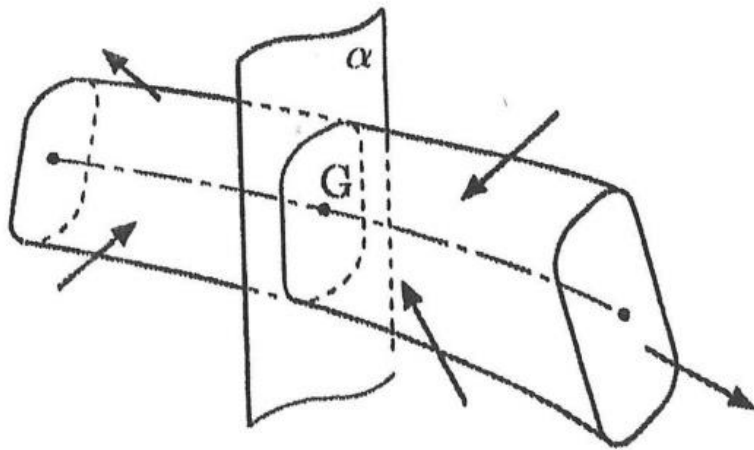
onde os índices foram omitidos. Para um sistema de forças coplanares em que as forças e momentos atuam no plano definido pelos eixos x e y , restam apenas três equações não-identicamente nulas:

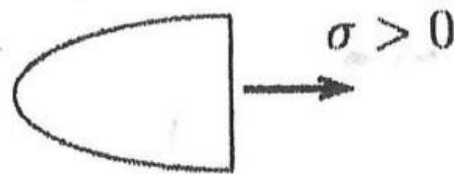
$$\begin{aligned} \sum F_x &= 0, & \sum M_{Oz} &= 0. \\ \sum F_y &= 0, \end{aligned} \quad (2.3)$$



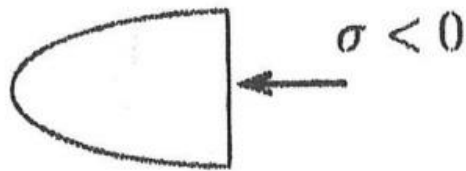
Teorema fundamental da Resistência dos materiais

Teorema do corte

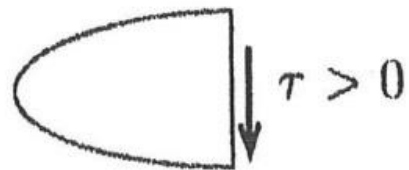
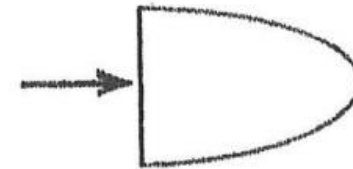




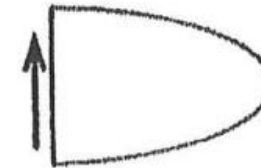
Tração



Compressão



Sentido horário



$$dN = \sigma dA,$$

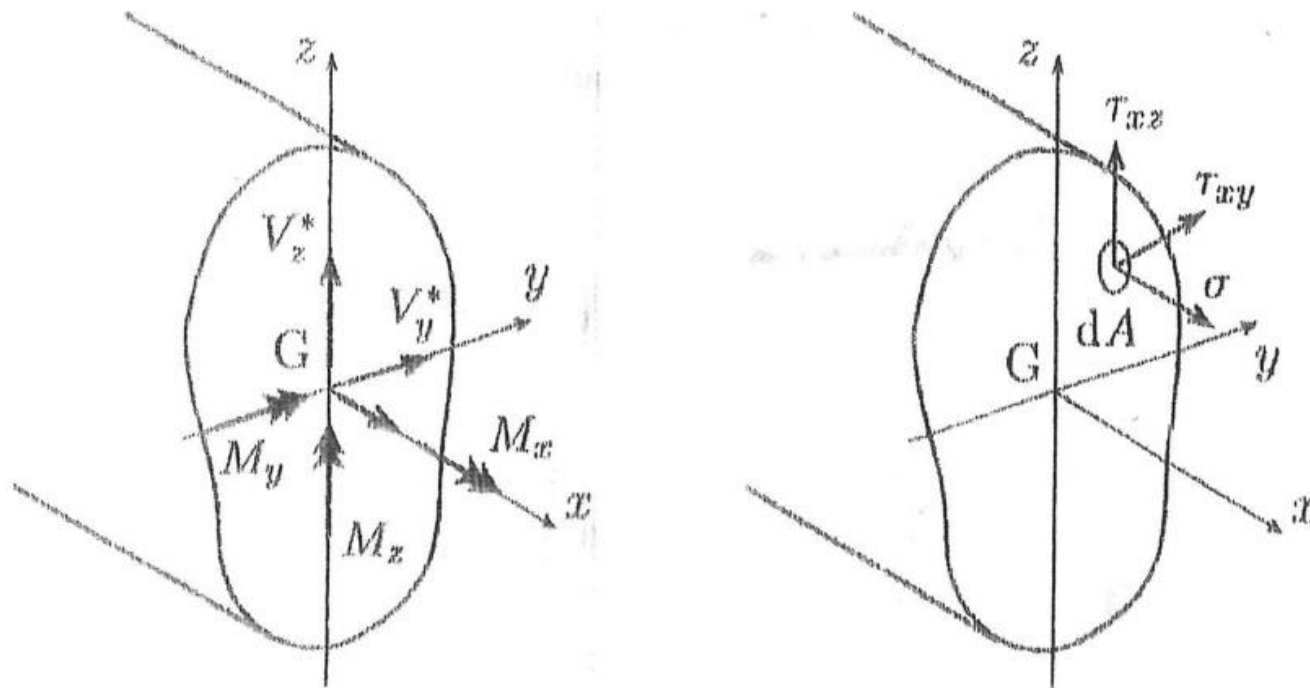
$$dV_y^* = \tau_{xy} dA,$$

$$dV_z^* = \tau_{xz} dA,$$

$$dM_y = \sigma z dA,$$

$$dM_z = -\sigma y dA,$$

$$dM_x = (\tau_{xz} y - \tau_{xy} z) dA$$



Esforços solicitantes e componentes de tensão na seção transversal.

$$dN = \sigma dA,$$

$$dV_y^* = \tau_{xy} dA,$$

$$dV_z^* = \tau_{xz} dA,$$

$$N = \int_A \sigma dA,$$

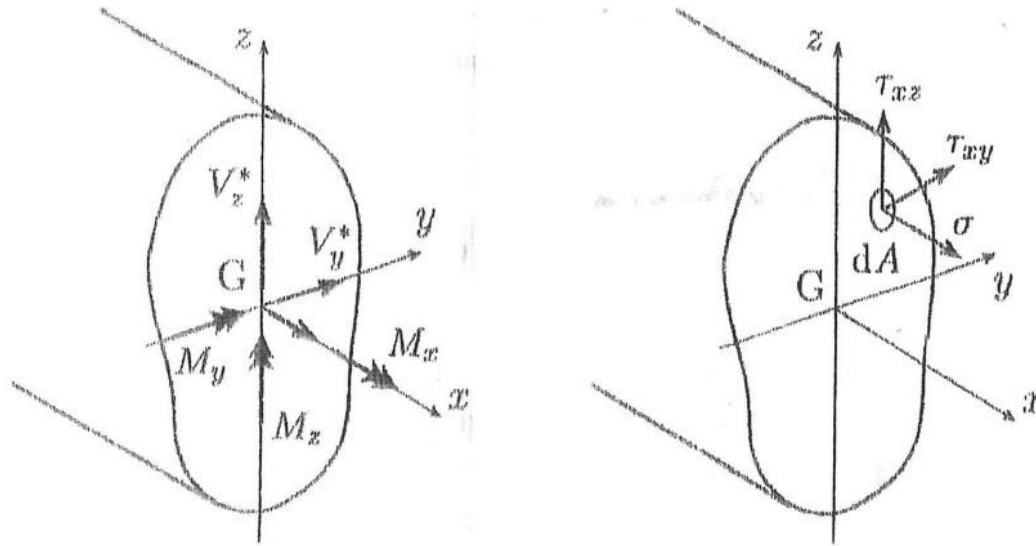
$$V_y^* = \int_A \tau_{xy} dA,$$

$$V_z^* = \int_A \tau_{xz} dA,$$

$$M_y = \int_A \sigma z dA,$$

$$M_z = - \int_A \sigma y dA,$$

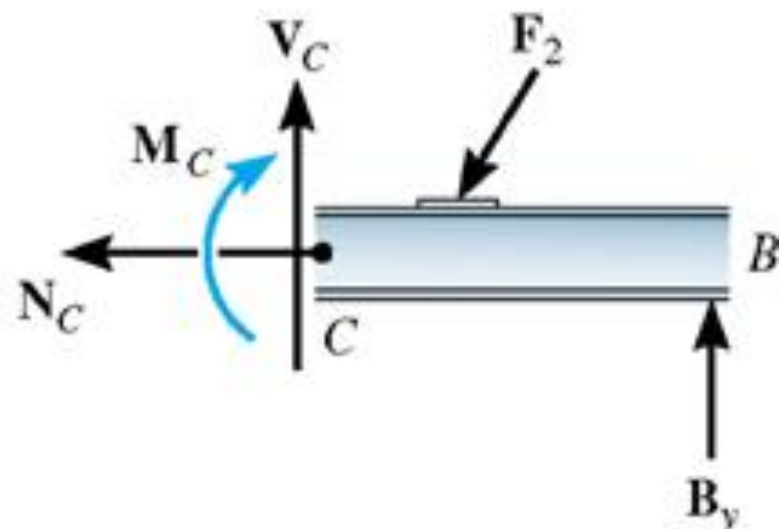
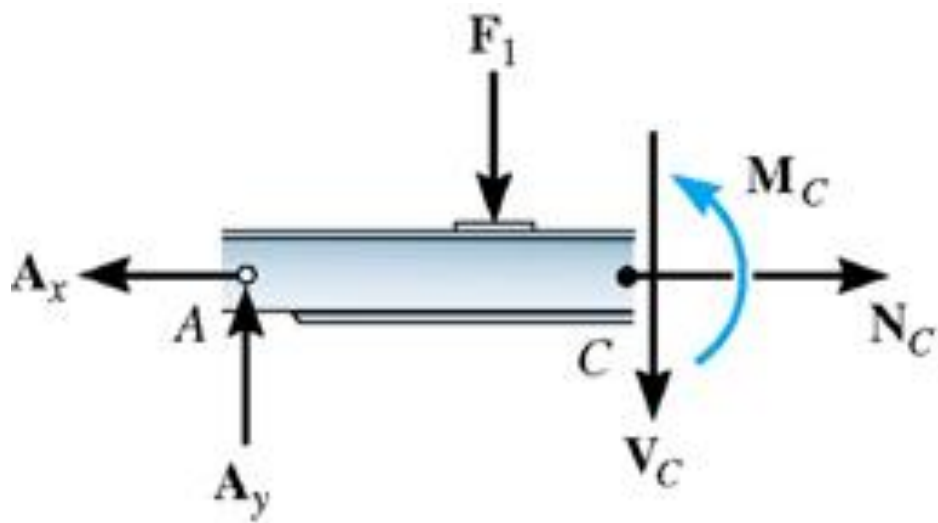
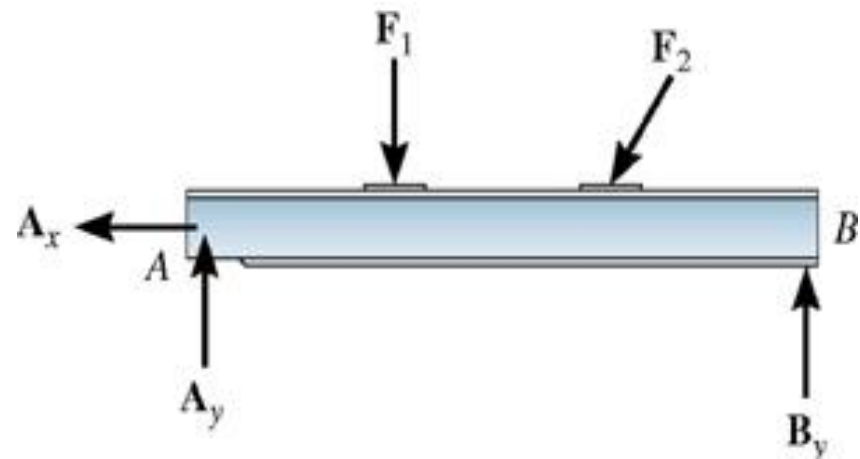
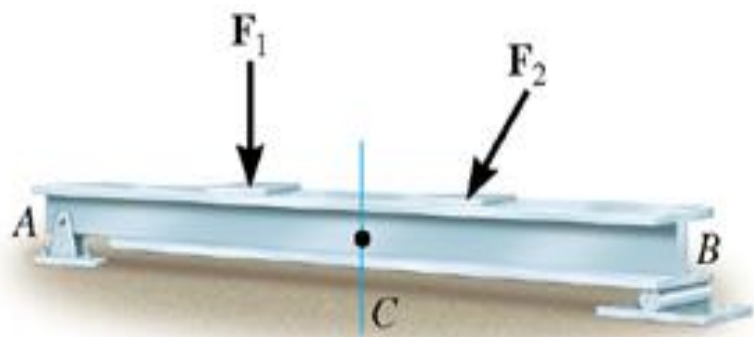
$$M_x = \int_A (\tau_{xz} y - \tau_{xy} z) dA.$$

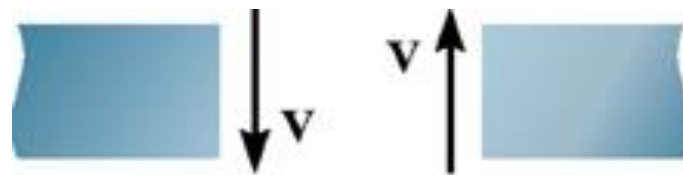


Esforços solicitantes e componentes de tensão na seção transversal.

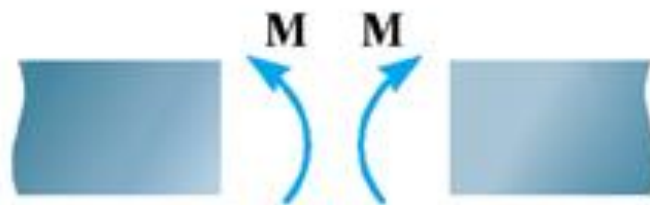
$$N = \int_A \sigma \, dA, \quad V_y^* = \int_A \tau_{xy} \, dA, \quad V_z^* = \int_A \tau_{xz} \, dA,$$

$$M_y = \int_A \sigma z \, dA, \quad M_z = - \int_A \sigma y \, dA, \quad M_x = \int_A (\tau_{xz} y - \tau_{xy} z) \, dA.$$





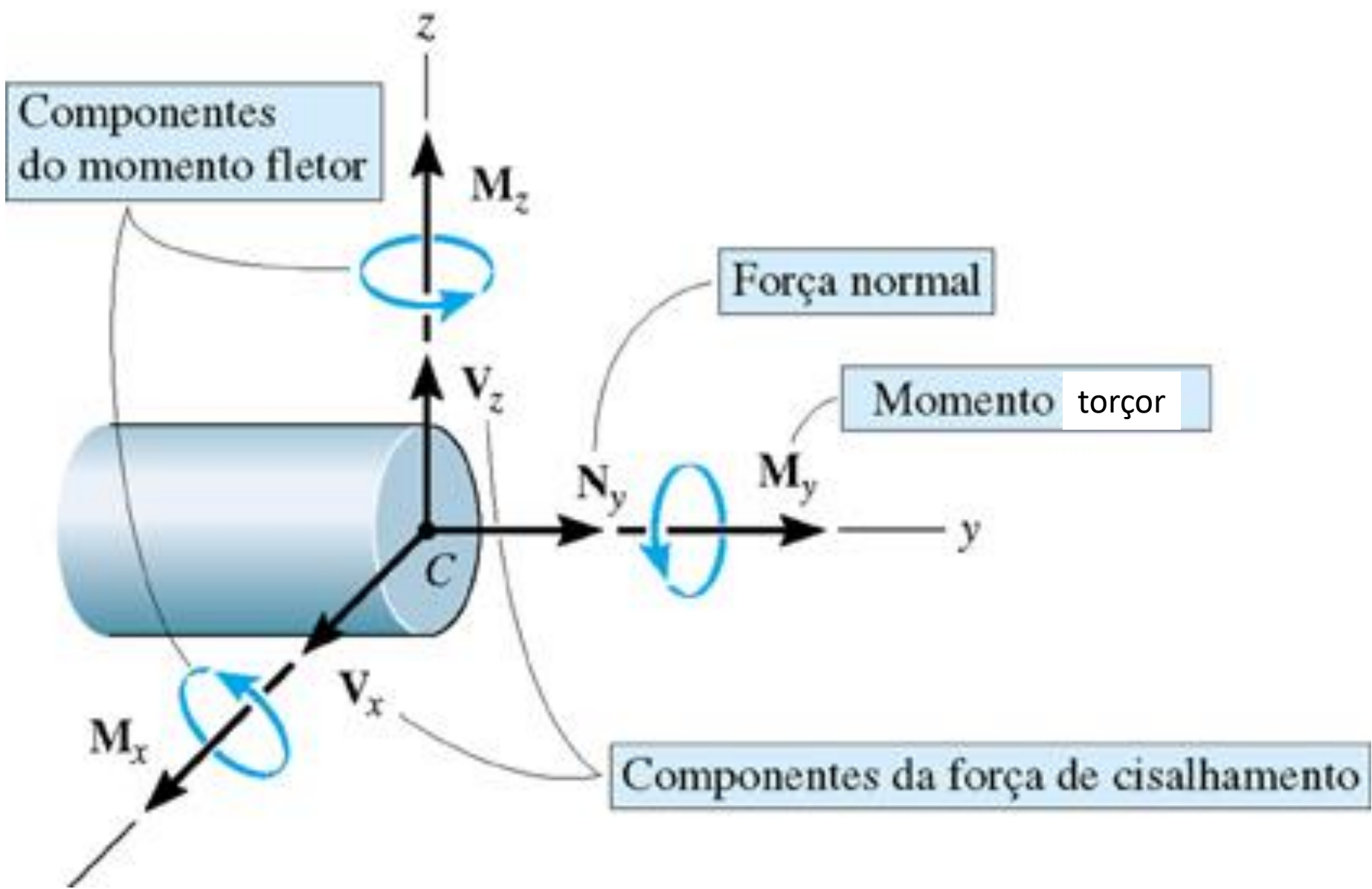
Força de cisalhamento positiva

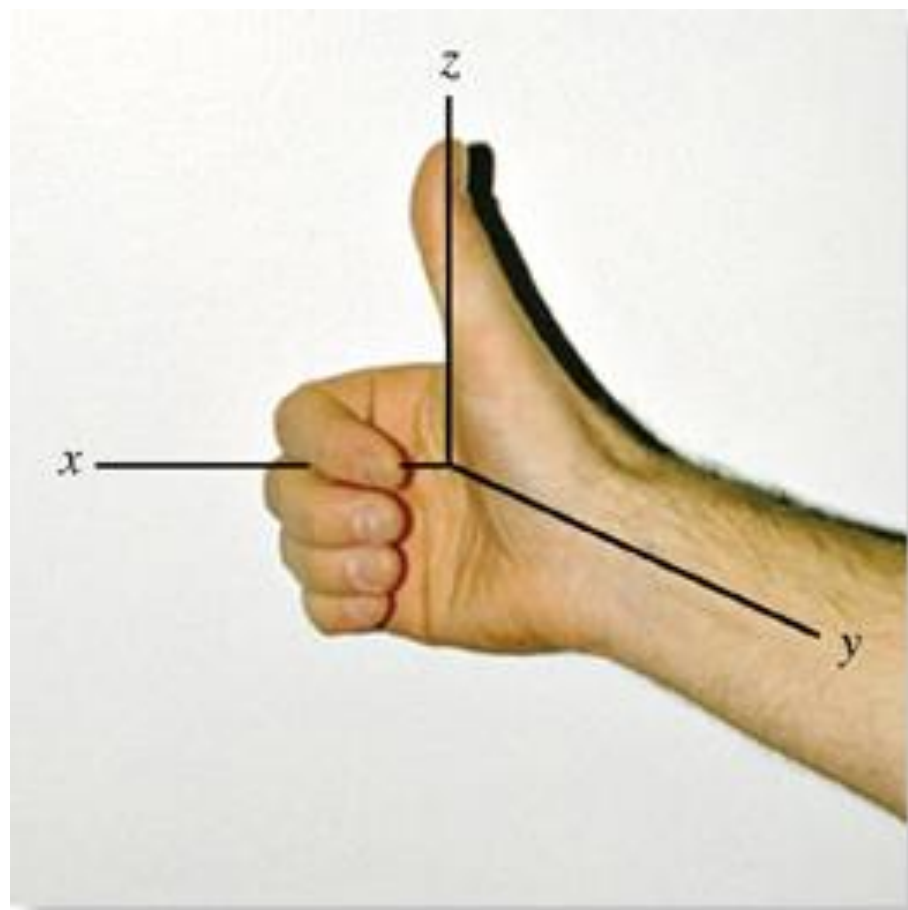


Momento fletor positivo

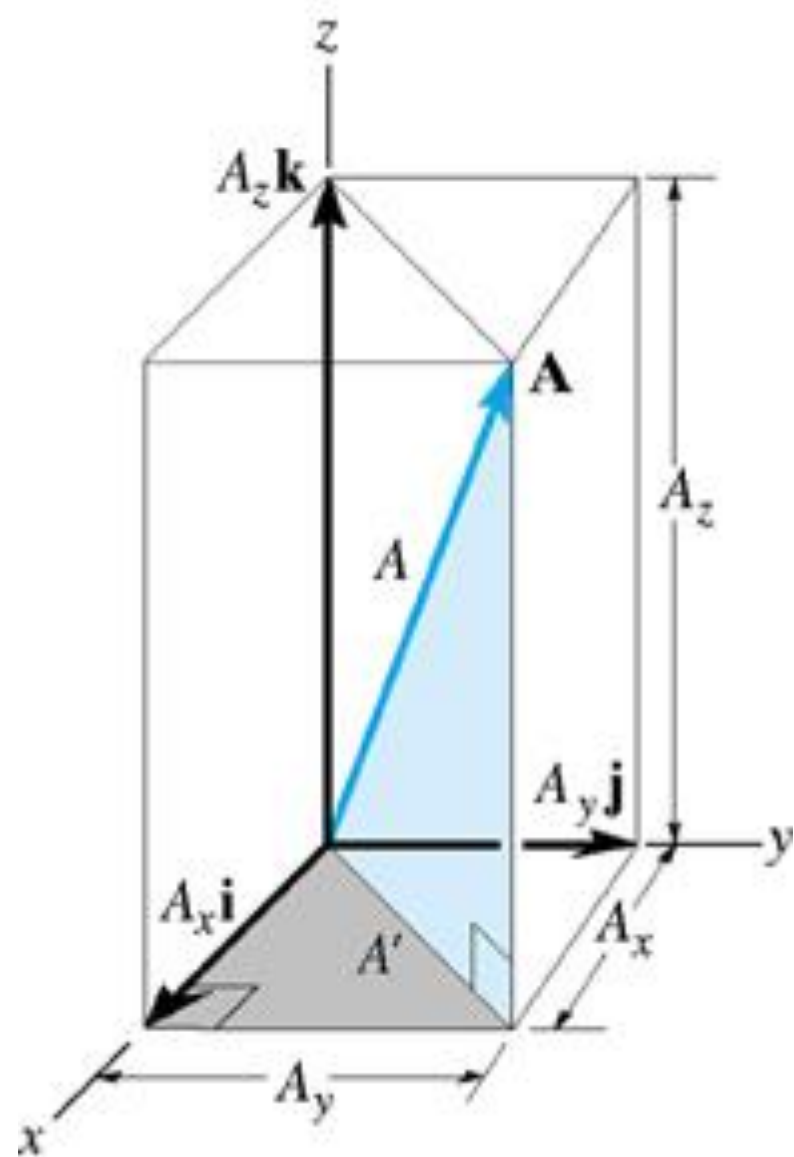


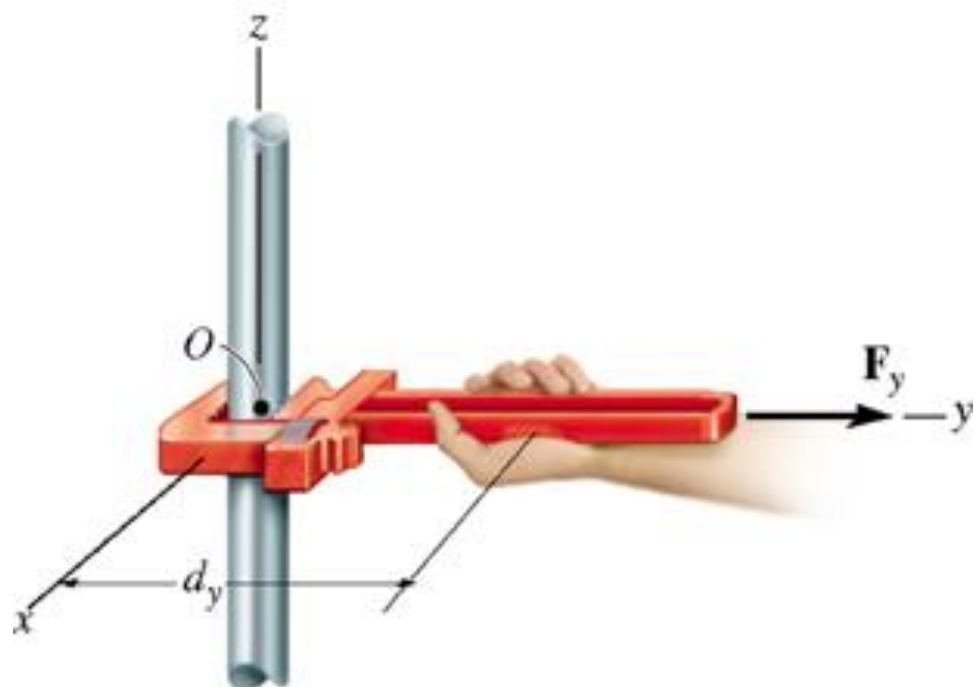
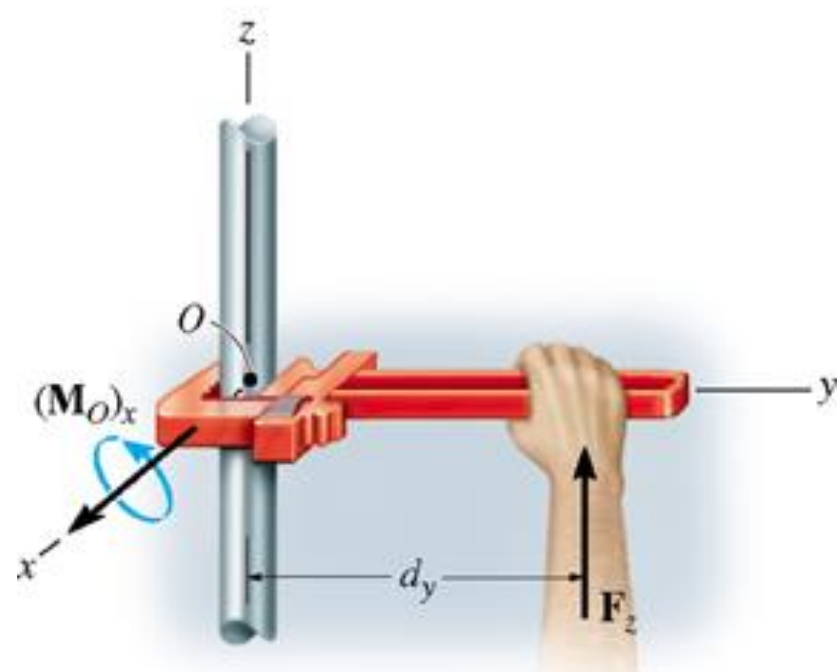
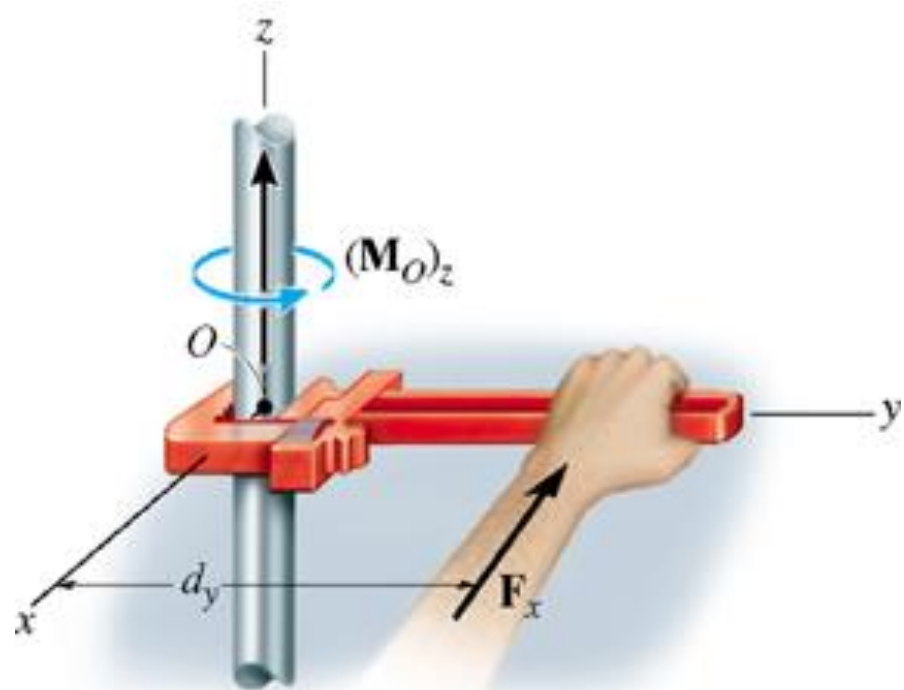
Convenção de sinais para a viga



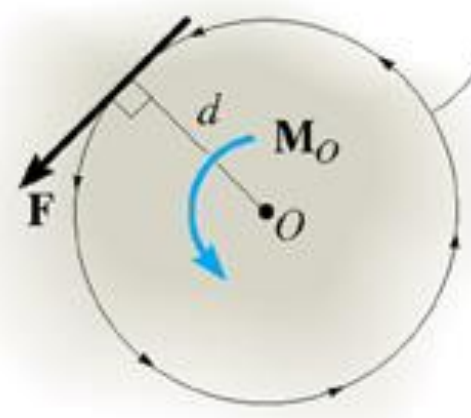
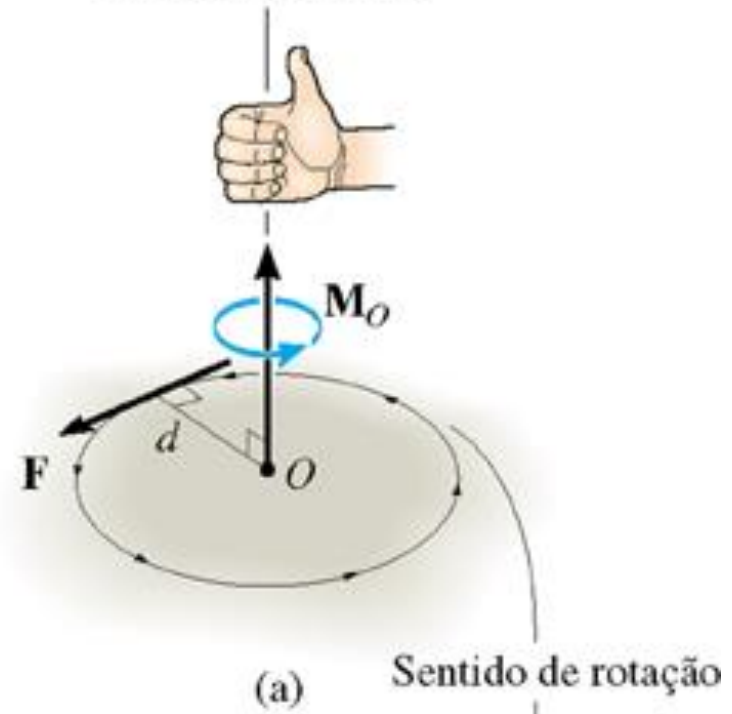


Sistema de coordenadas da mão direita

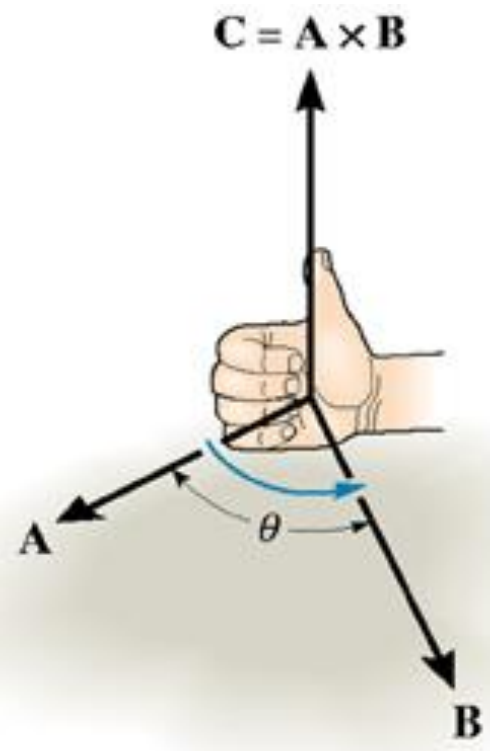


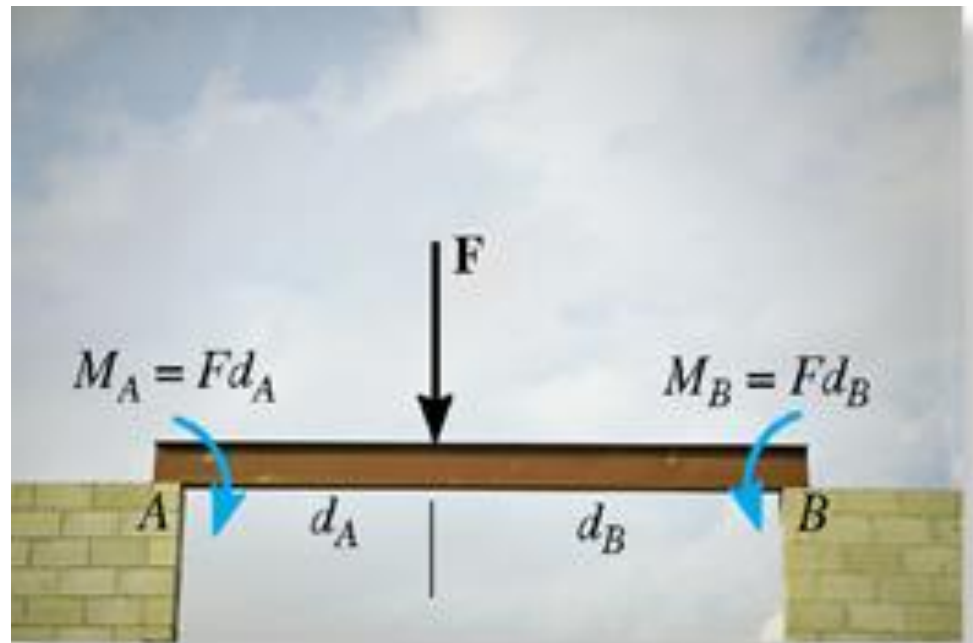
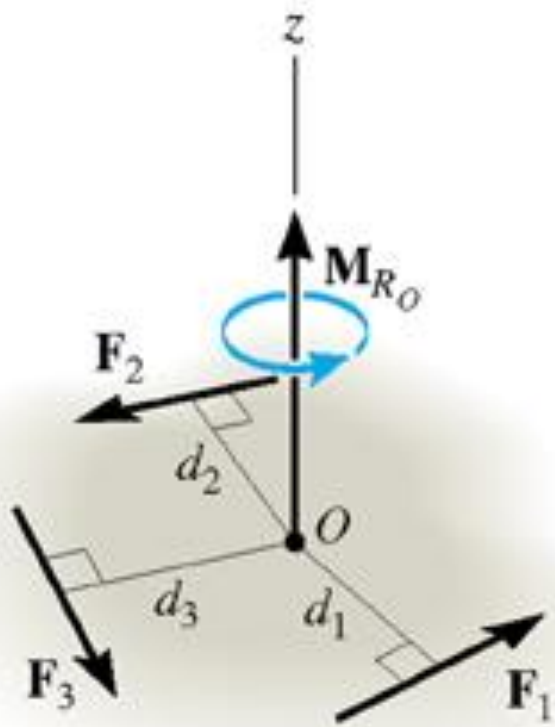


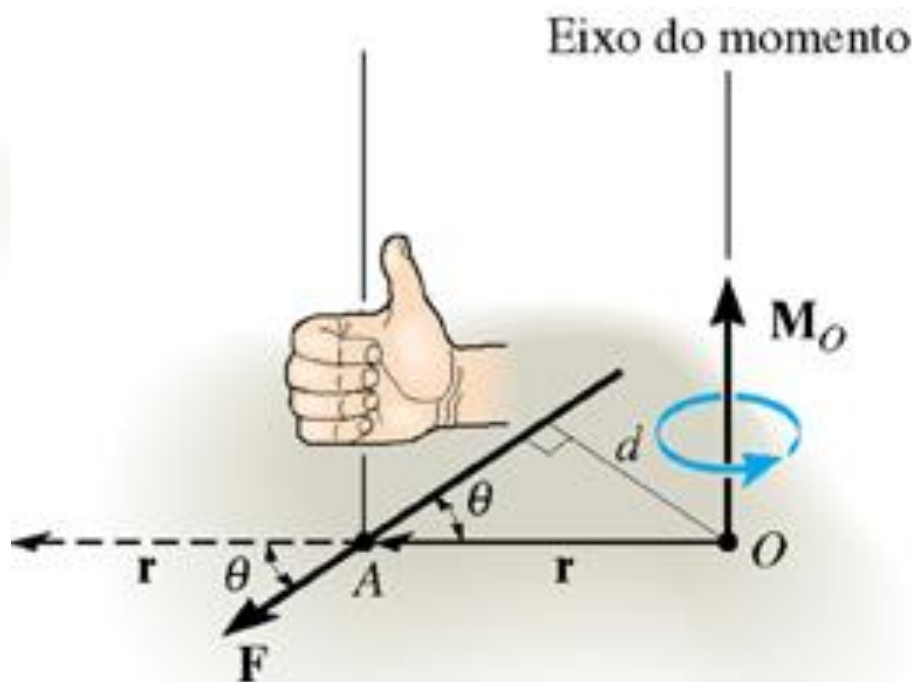
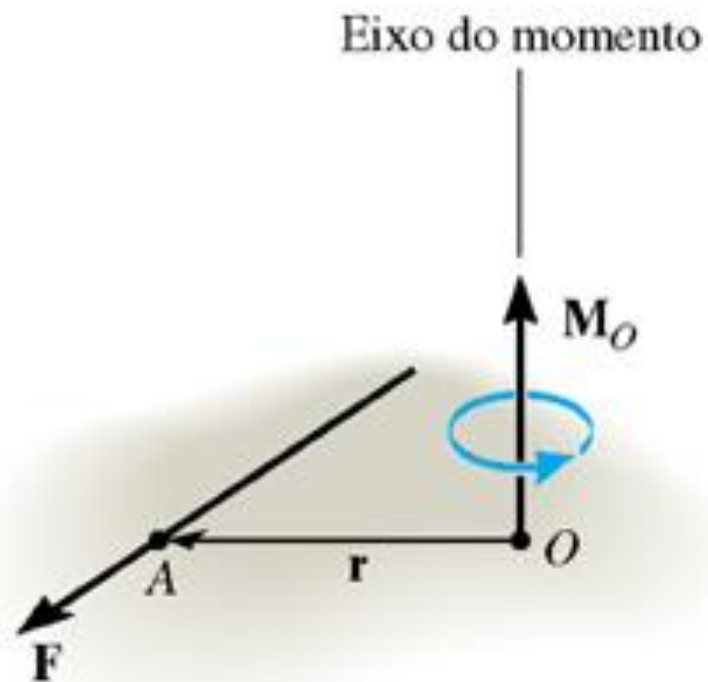
Eixo do momento

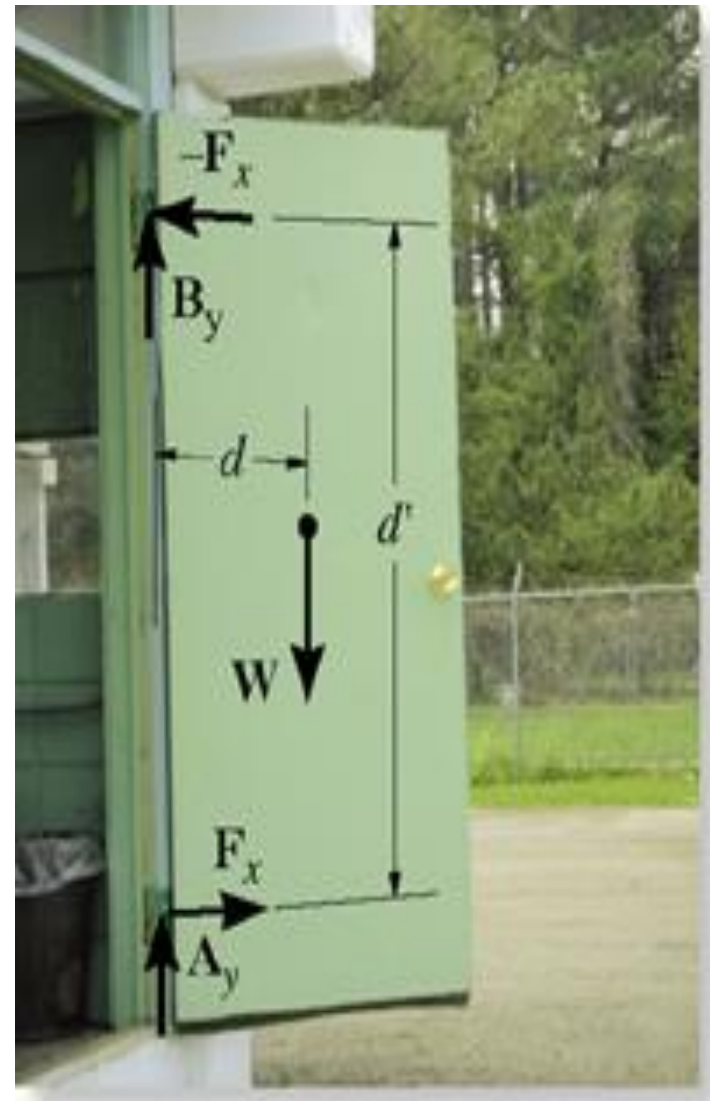
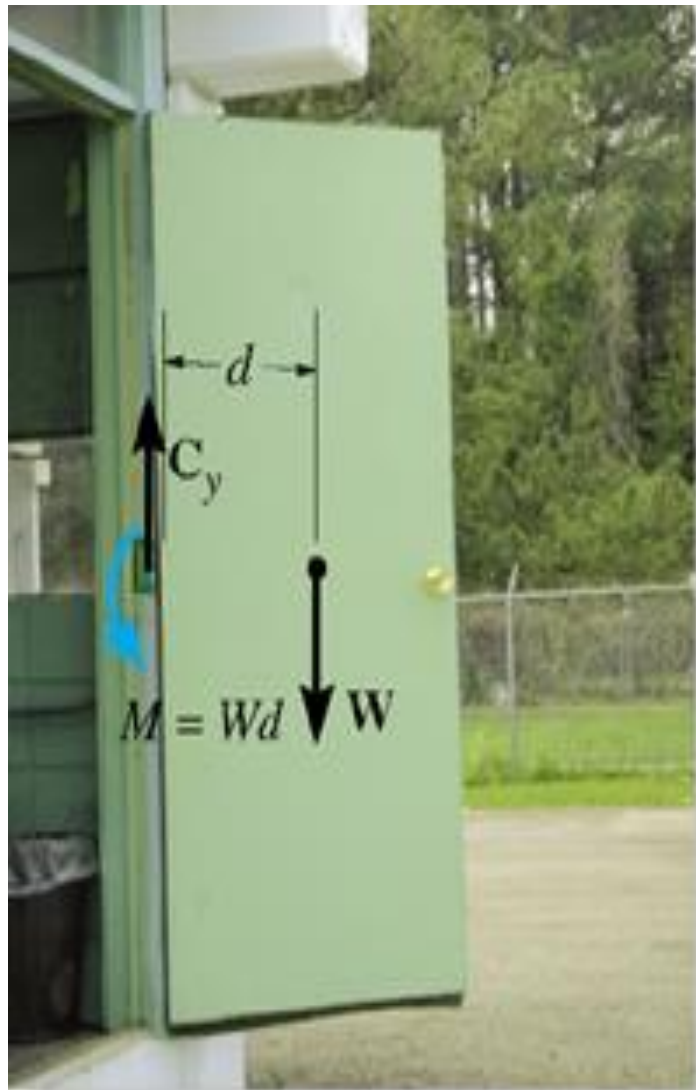


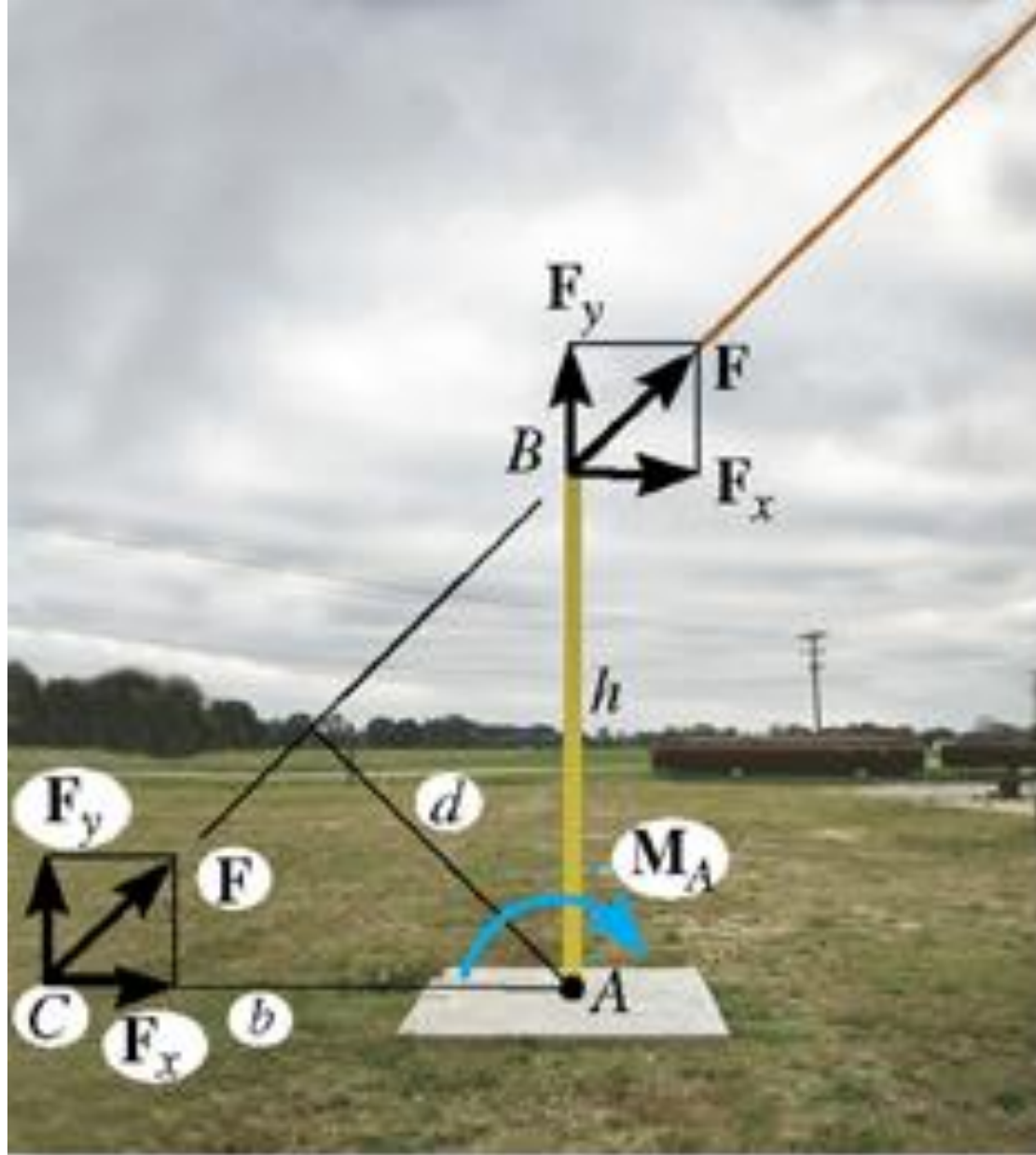
(b)



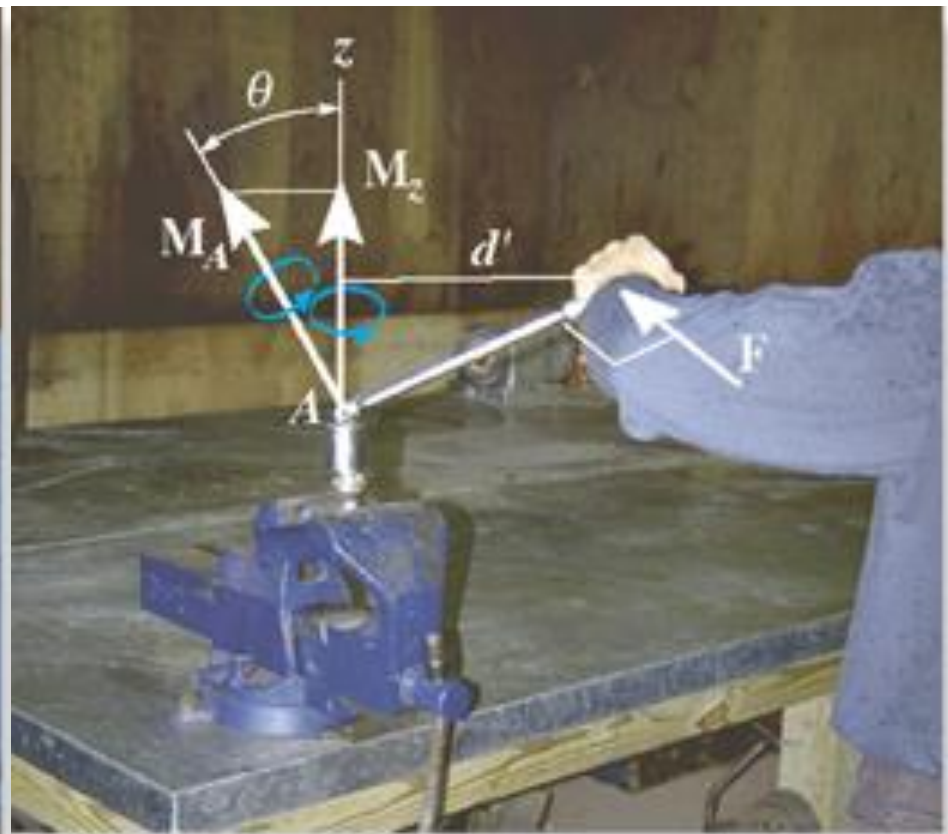


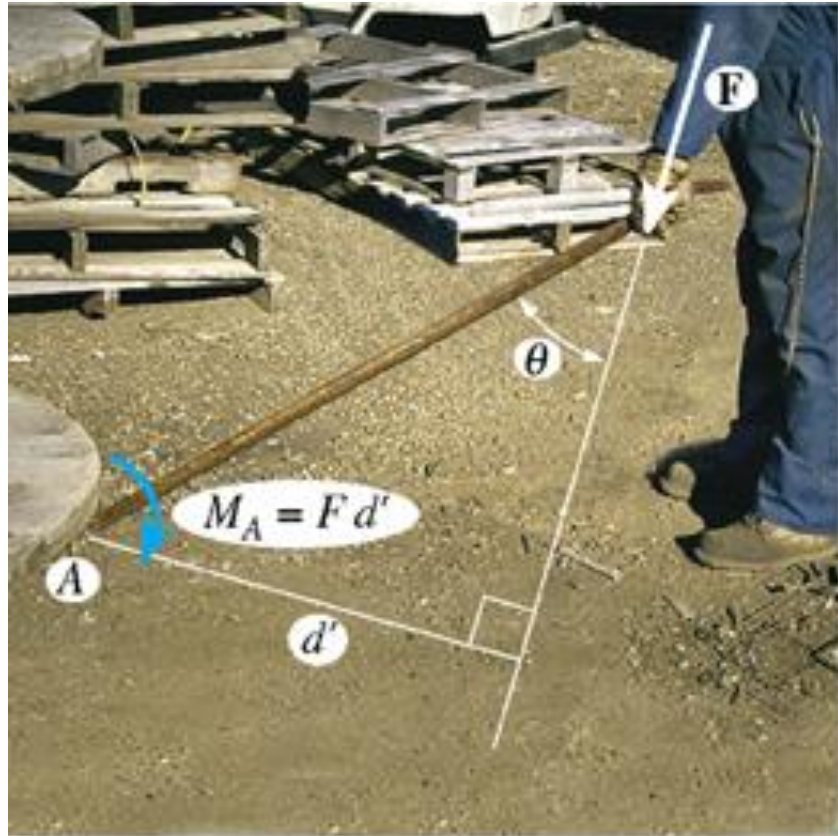


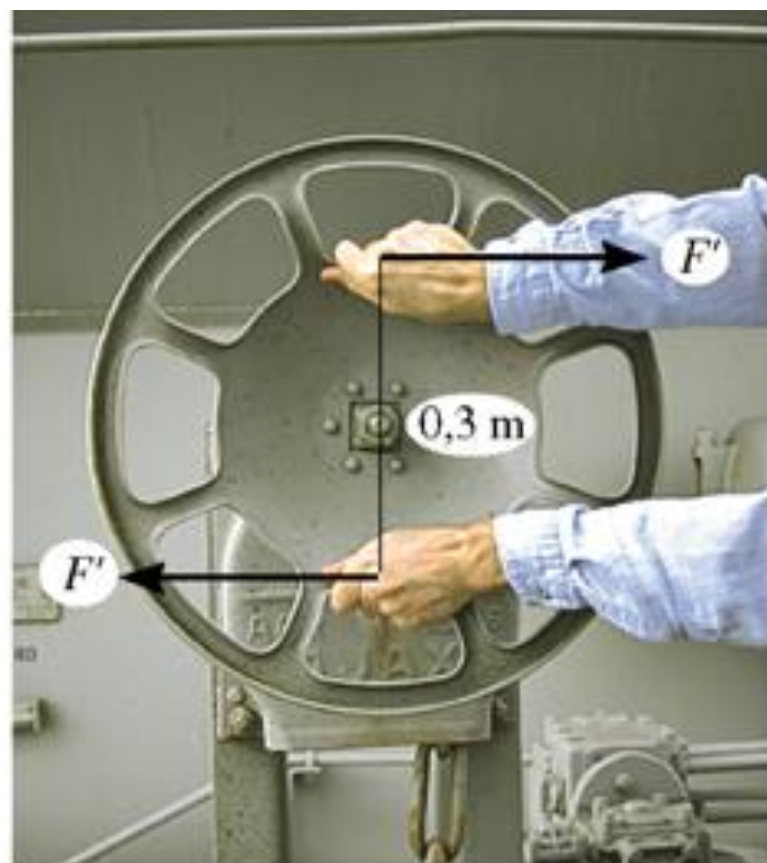
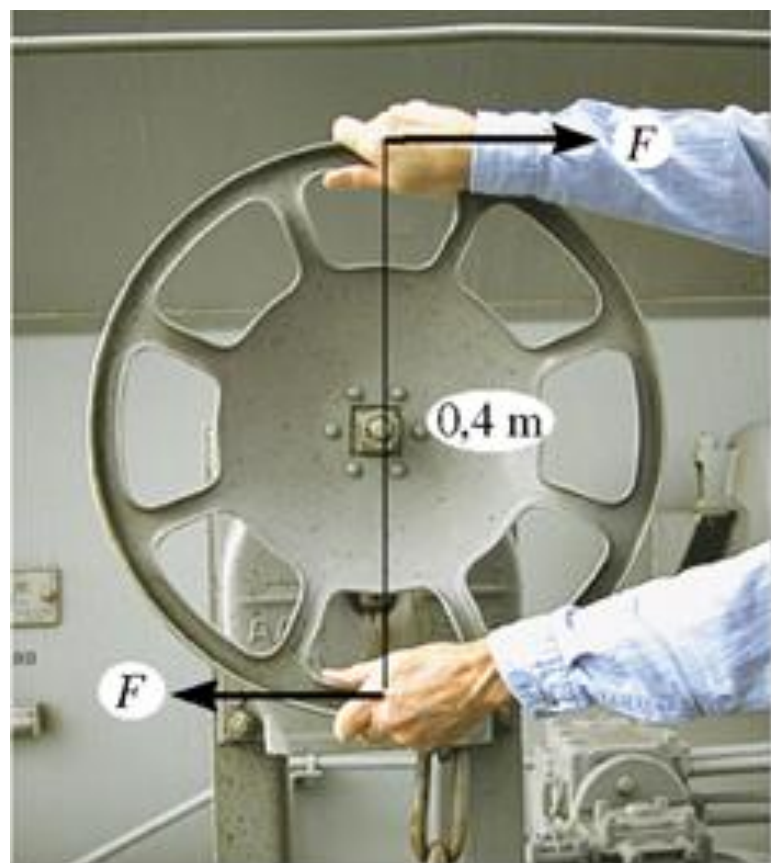


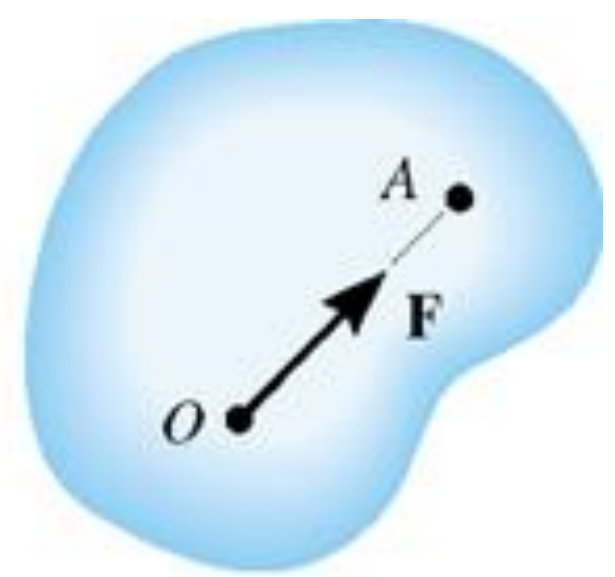
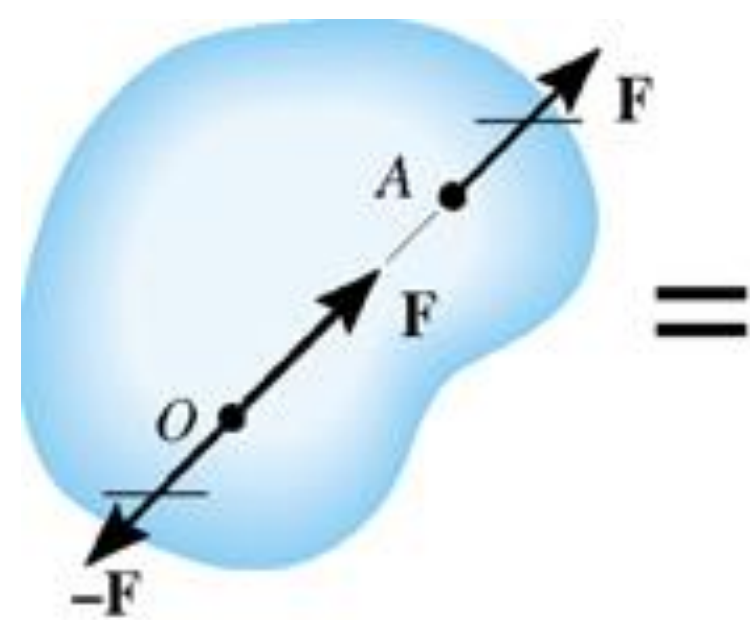
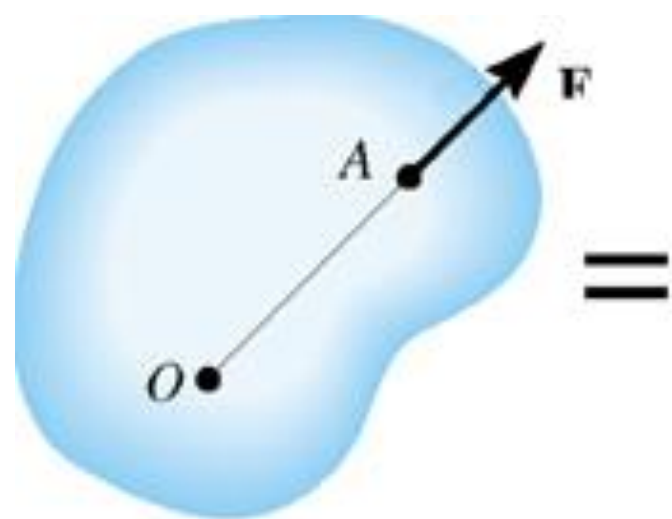


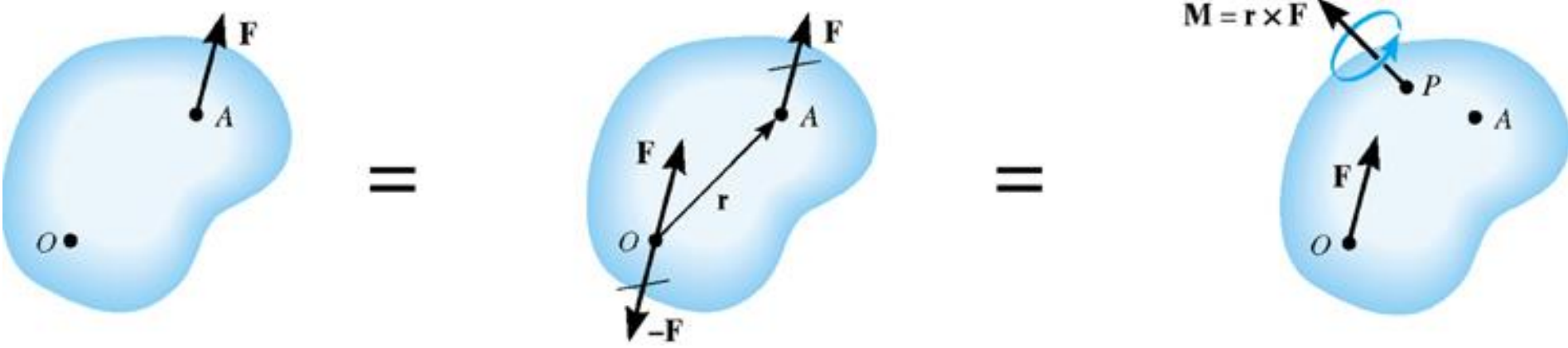
$$M_A = F \cdot d = F_x \cdot h = F_y \cdot b$$

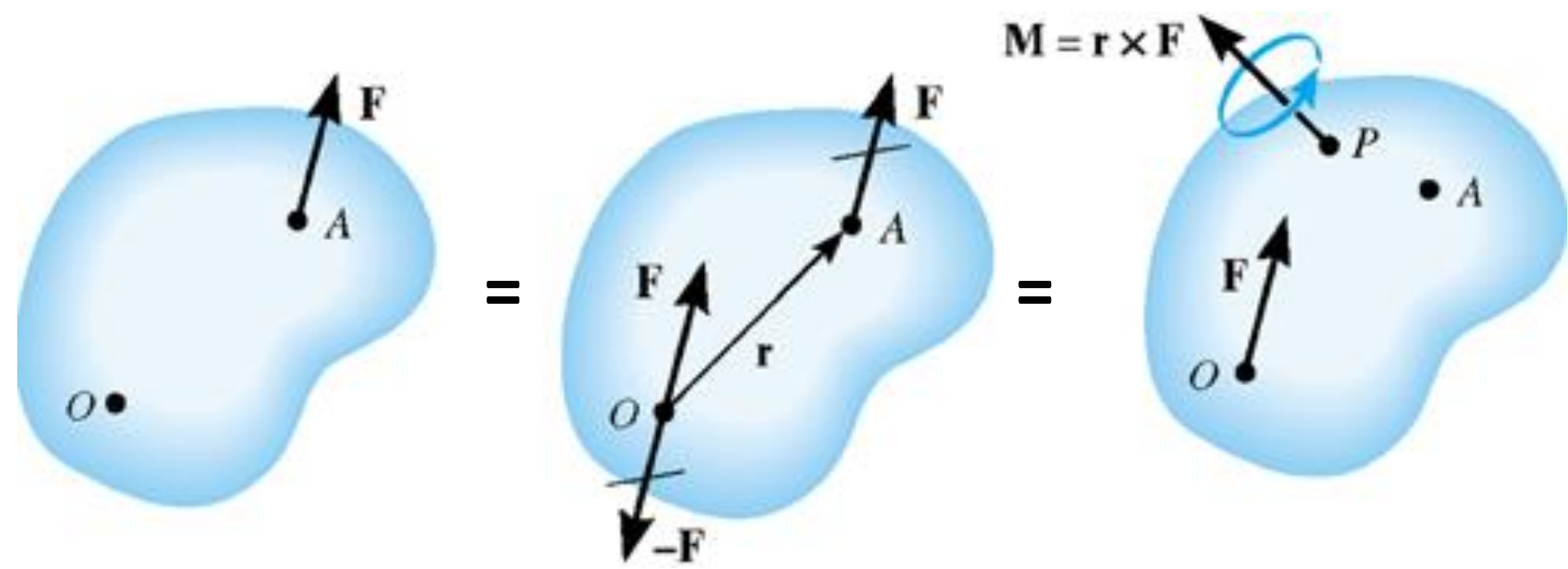










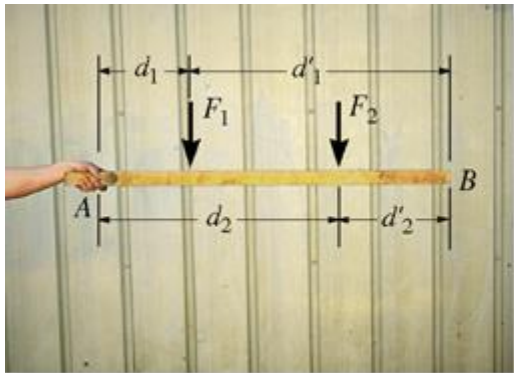
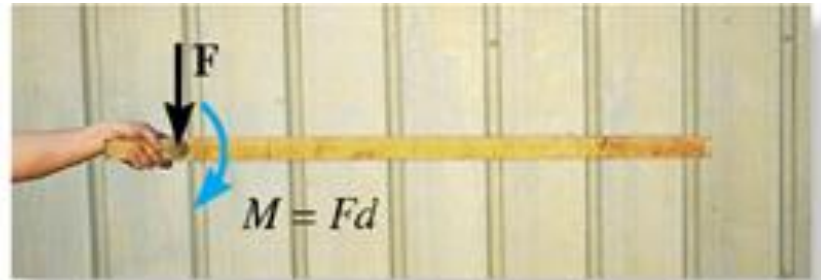




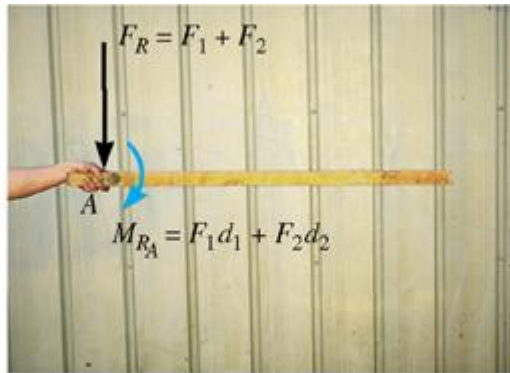
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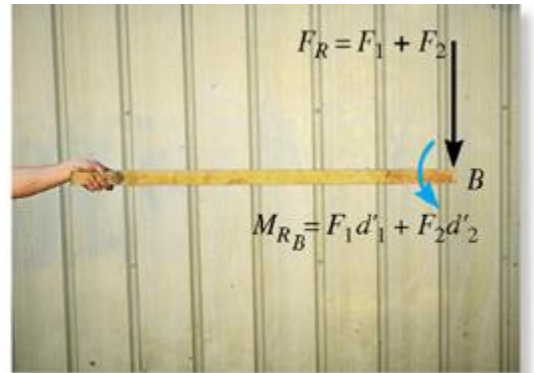
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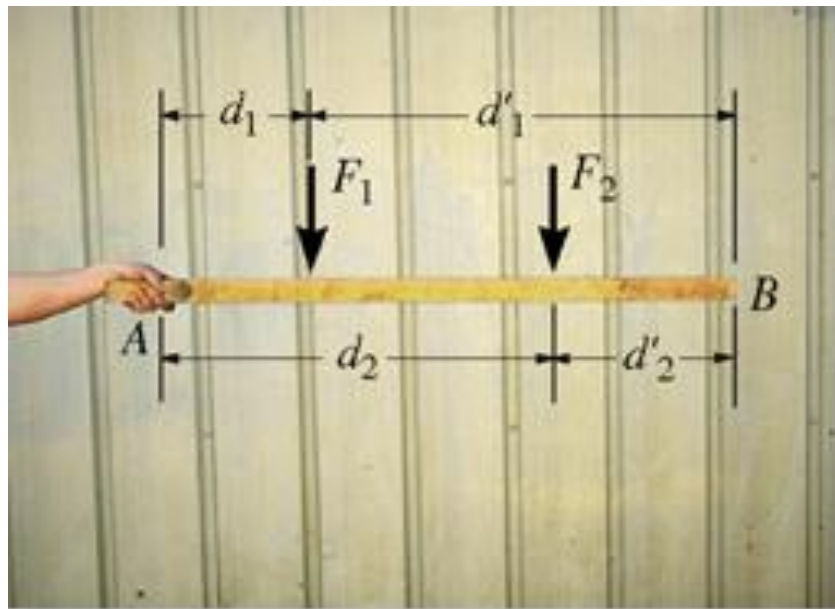


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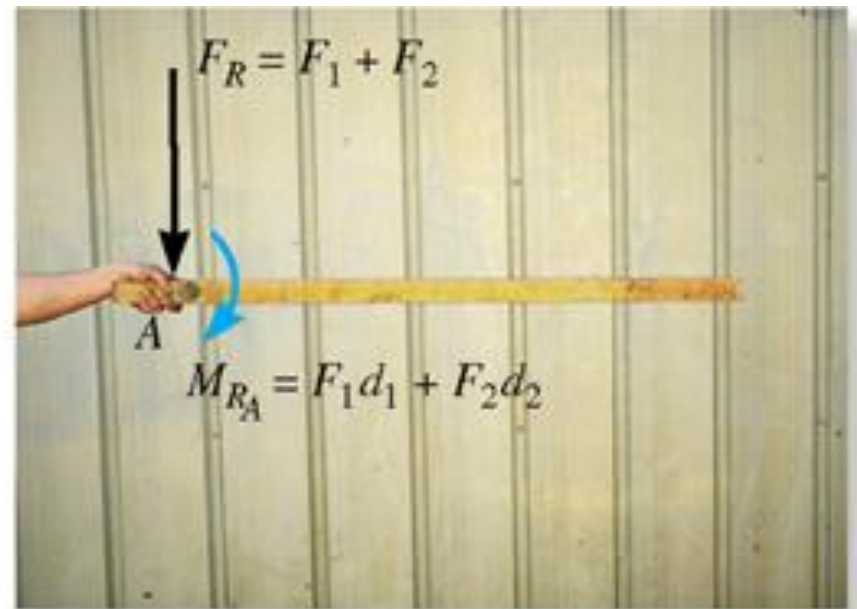


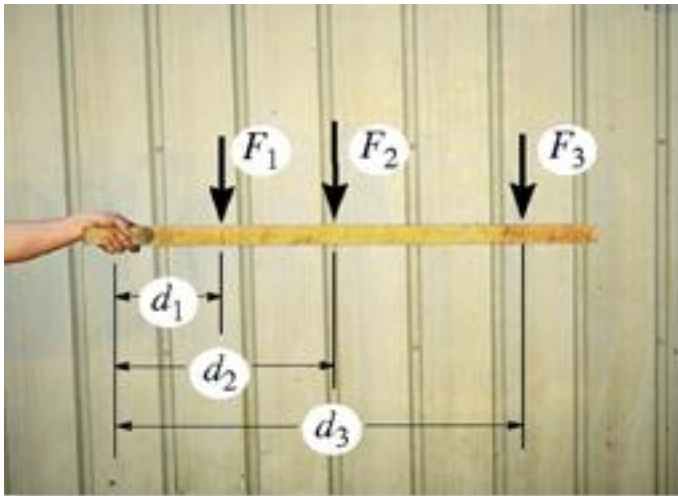
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