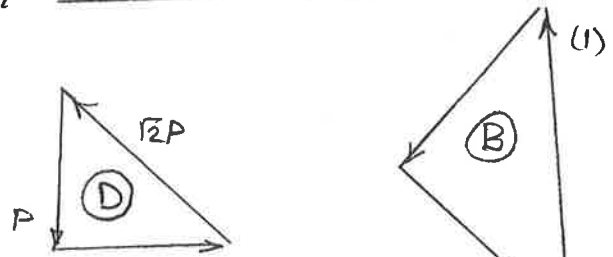
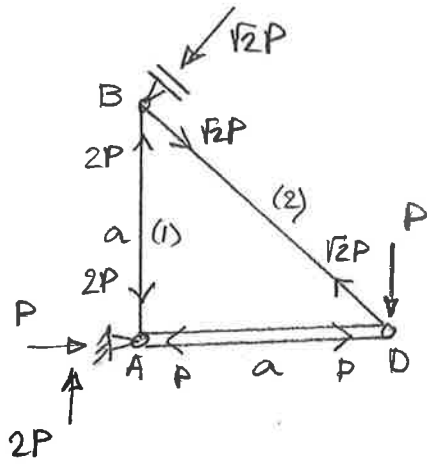
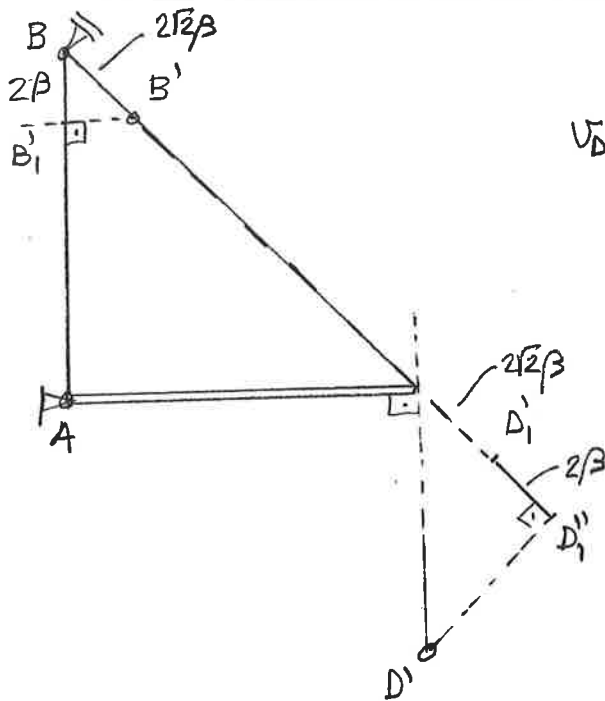


a) Estrutura isostática



$$N_1 = -2P \Rightarrow \Delta_1 = \frac{-2Pa}{EA} = -2\beta \sqrt{2}P$$

$$N_2 = \sqrt{2}P \Rightarrow \Delta_2 = \frac{\sqrt{2}P \sqrt{2}a}{EA} = \frac{2Pa}{EA} = 2\beta$$

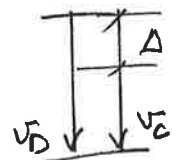


$$v_D = 2(2\sqrt{2}\beta + 2\beta) \frac{1}{\sqrt{2}} = (4 + 2\sqrt{2}) \frac{Pa}{EA}$$

cálculo de θ_0 : $v_D = \Delta$

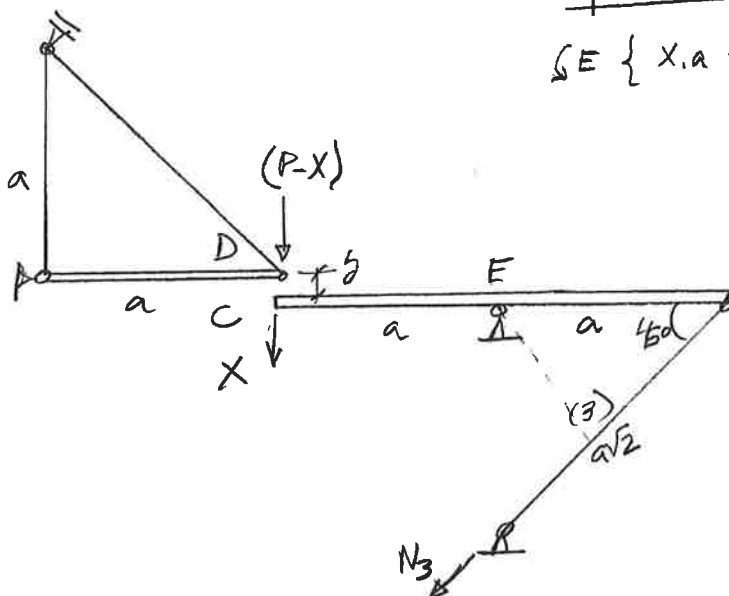
$$\theta_0 = \frac{1}{4 + 2\sqrt{2}} \frac{EA}{a} \Delta$$

b) Estrutura hiperestática (IGH), $v_D = \Delta + v_C$



• Equilíbrio:

$$\sum E \left\{ X \cdot a - N_3 \cdot \frac{a}{\sqrt{2}} = 0 \Rightarrow N_3 = \sqrt{2}X \right.$$



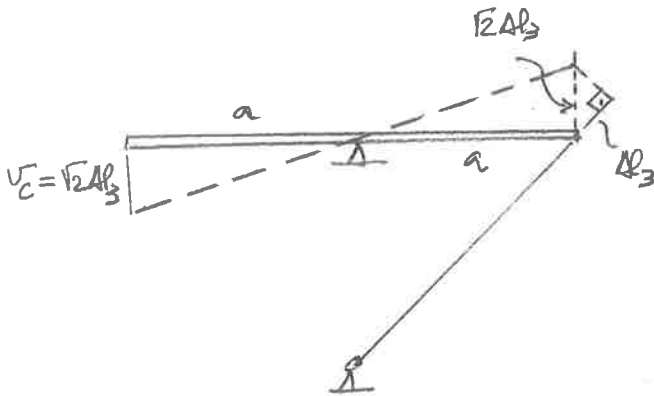
• Eqn. Constitutivas

$$\Delta_1 = \frac{-2(P-X)a}{EA}$$

$$\Delta_2 = \frac{2(P-X)a}{EA}$$

$$\Delta_3 = \frac{\sqrt{2}X \sqrt{2}a}{EA} = \frac{2Xa}{EA}$$

• Eq. de compatibilidade



$$v_D = \Delta + v_C$$

$$(4+2\sqrt{2}) \frac{(P-X)a}{EA} = \Delta + \frac{2\sqrt{2}Xa}{EA}$$

$$(4+2\sqrt{2})P - (4+2\sqrt{2}+2\sqrt{2})X = \frac{EA}{a} \Delta$$

$$4(1+\sqrt{2})X = (4+2\sqrt{2})P - \frac{EA}{a} \Delta$$

$$X = \frac{4+2\sqrt{2}}{4(1+\sqrt{2})} P - \frac{1}{4(1+\sqrt{2})} \frac{EA}{a} \Delta$$

(verif) $\underline{P = P_0} \Rightarrow X^I = \frac{4+2\sqrt{2}}{4(1+\sqrt{2})} \times \frac{1}{4+2\sqrt{2}} \frac{EA}{a} \Delta - \frac{1}{4(1+\sqrt{2})} \frac{EA}{a} \Delta = 0$

$\underline{P = 2P_0} \Rightarrow X^{II} = \frac{1}{4(1+\sqrt{2})} \frac{EA}{a} \Delta$

$$v_D^{II} = \Delta + v_C = \Delta + \frac{2\sqrt{2}}{4(1+\sqrt{2})} \Delta = \frac{4+4\sqrt{2}+2\sqrt{2}}{4(1+\sqrt{2})} \Delta = \frac{2+3\sqrt{2}}{2(1+\sqrt{2})} \Delta$$

ou $v_D = \frac{2+3\sqrt{2}}{2(1+\sqrt{2})} \times \frac{(1-\sqrt{2})}{(1-\sqrt{2})} \Delta = \frac{4-\sqrt{2}}{2} \Delta = 1,293 \Delta$

Expressões em função de P ($P > P_0$)

$$X(P) = \frac{4+2\sqrt{2}}{4(1+\sqrt{2})} P - \frac{1}{4(1+\sqrt{2})} \frac{EA}{a} \times \frac{4+2\sqrt{2}}{EA} P_0 \times a = \frac{4+2\sqrt{2}}{4(1+\sqrt{2})} (P-P_0) = \frac{\sqrt{2}}{2} (P-P_0)$$

$$\begin{aligned} v_D(P) &= \Delta + \frac{2\sqrt{2}Xa}{EA} = (4+2\sqrt{2}) \frac{P_0 a}{EA} + 2\sqrt{2} \frac{\sqrt{2}}{2} (P-P_0) \frac{a}{EA} \\ &= (4+2\sqrt{2}) \frac{P_0 a}{EA} + \frac{2P_0 a}{EA} - \frac{2P_0 a}{EA} = 2[(1+\sqrt{2})P_0 + P] \frac{a}{EA} \end{aligned}$$