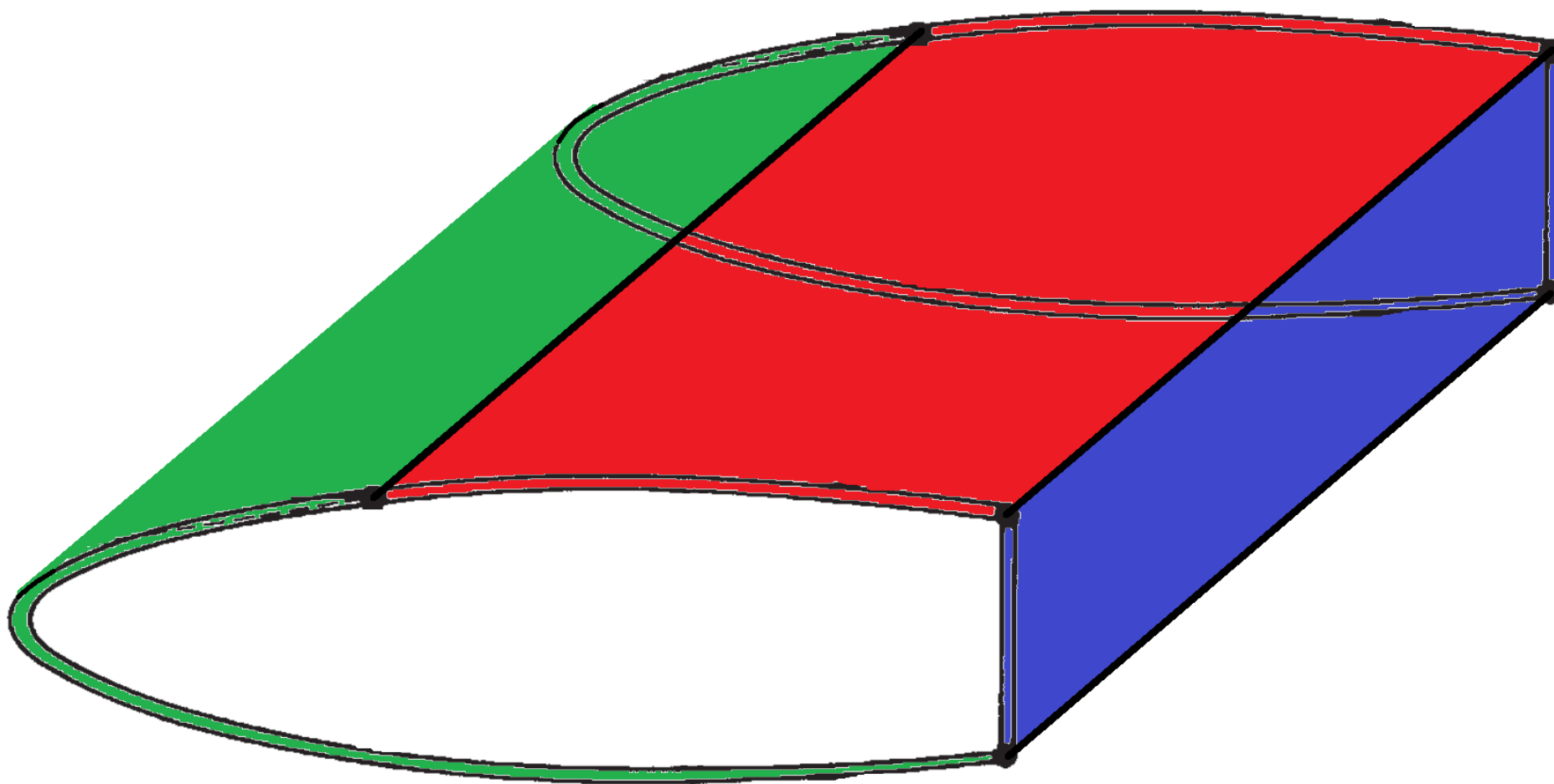


Análises Antigas



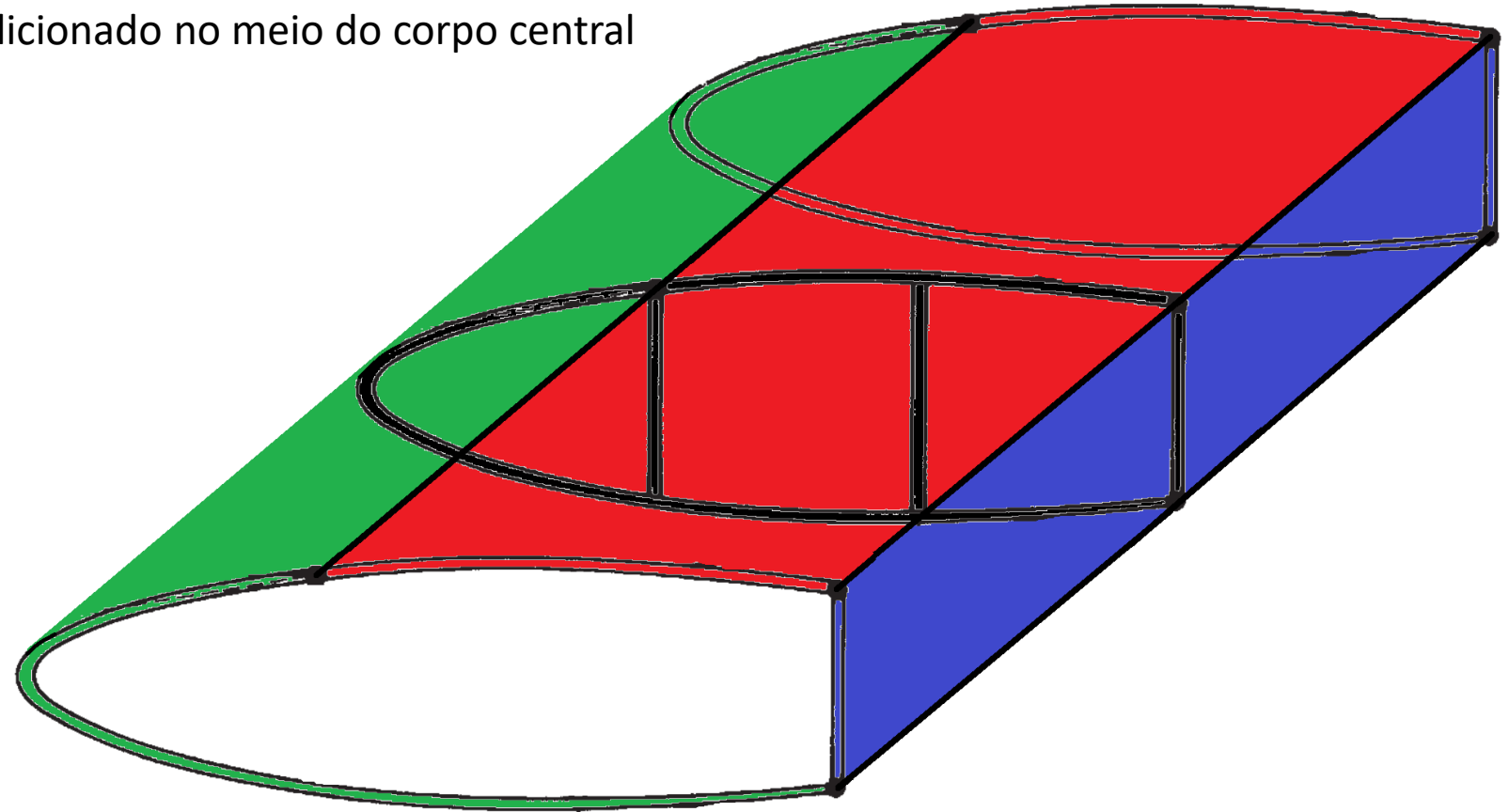
Nervuras de Asas

Nervura de Asa:

Elemento estruturante adicionado no meio do corpo central

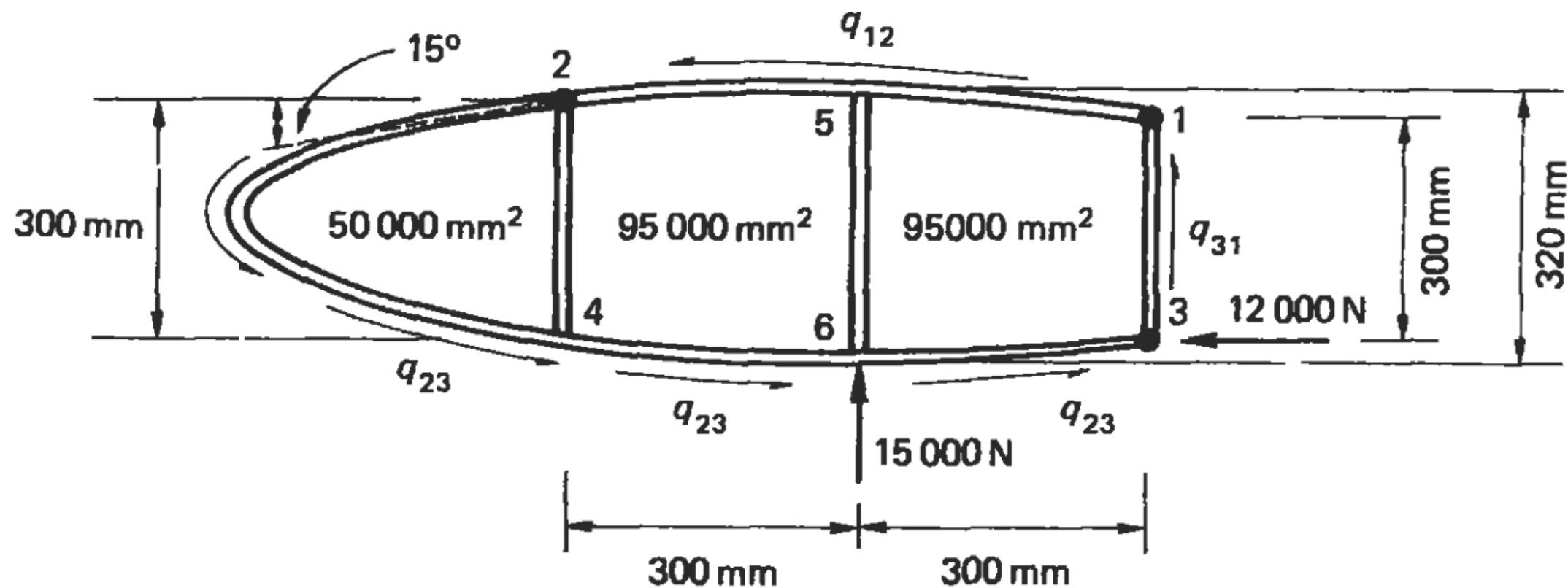
Quais carregamentos ele suporta:

- Cisalhamento
- Torção



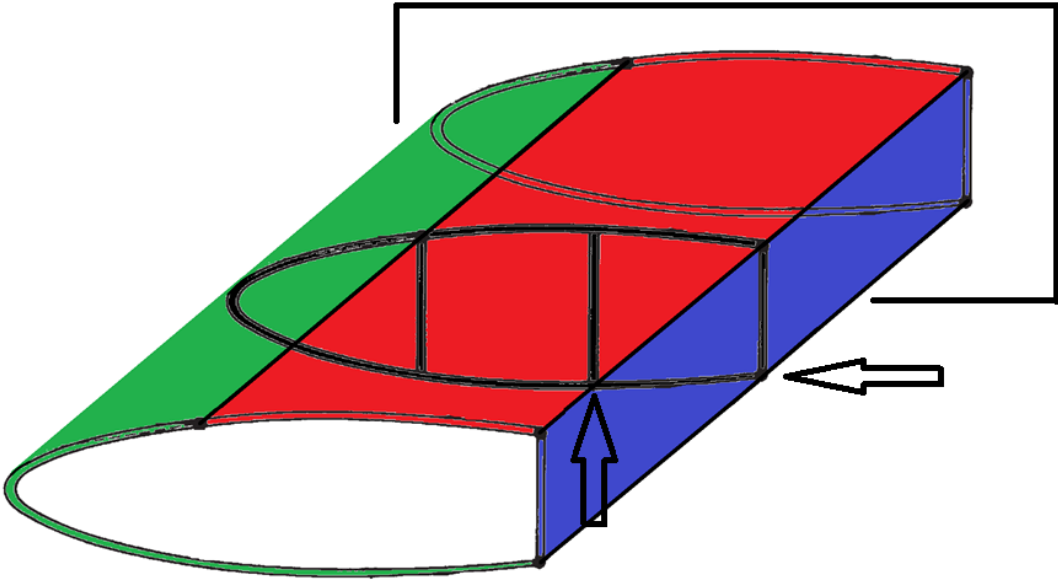
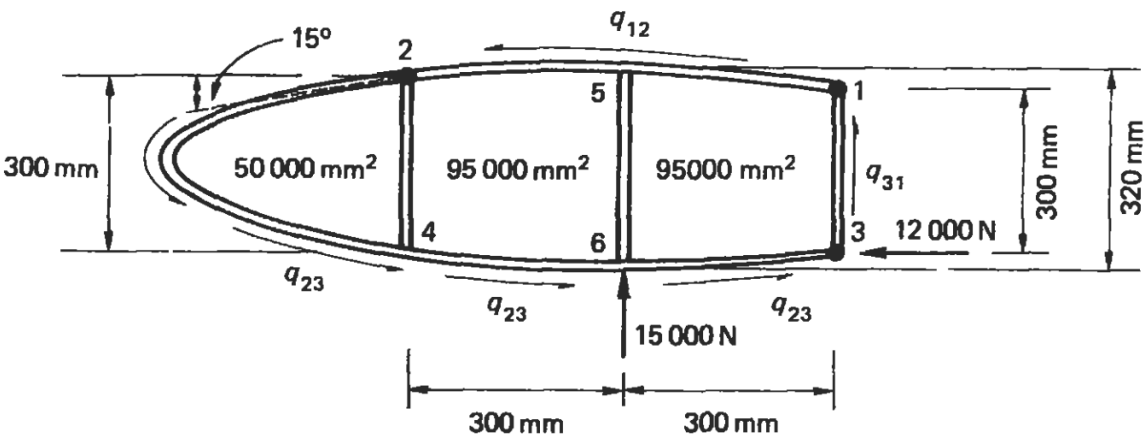
Example 10.14

Calculate the shear flows in the web panels and the axial loads in the flanges of the wing rib shown in Fig. 10.48. Assume that the web of the rib is effective only in shear while the resistance of the wing to bending moments is provided entirely by the three flanges 1, 2 and 3.

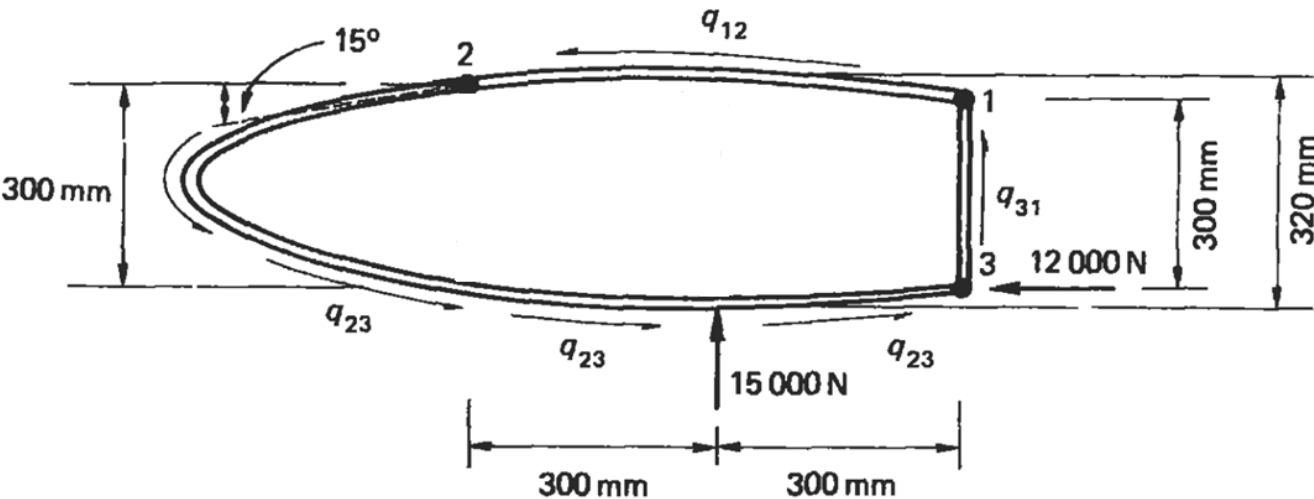


Example 10.14

Calculate the shear flows in the web panels and the axial loads in the flanges of the wing rib shown in Fig. 10.48. Assume that the web of the rib is effective only in shear while the resistance of the wing to bending moments is provided entirely by the three flanges 1, 2 and 3.



Análise da Seção (Não Nervura)



$$\left\{ \begin{array}{l} q_{31} \times 300 - q_{23} \times 300 = 15000 \\ q_{12} \times 600 - q_{23} \times 600 = 12000 \\ 2 \times q_{12} \times 95000 + 2 \times q_{23} \times 145000 = -15000 \times 300 \end{array} \right.$$

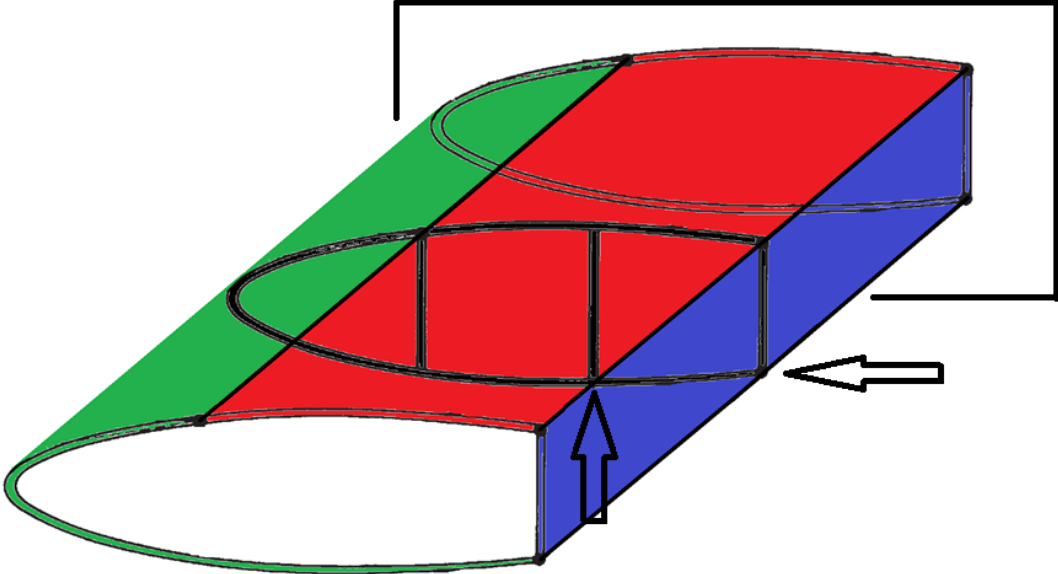
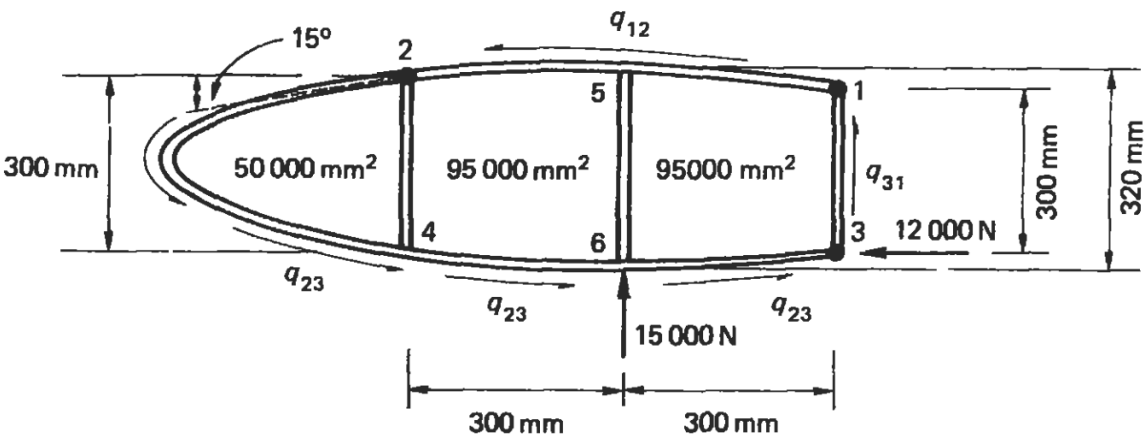
$$\left\{ \begin{array}{l} q_{31} - q_{23} = 50 \\ q_{12} - q_{23} = 20 \\ q_{12} \times 19 + q_{23} \times 29 = -750 \end{array} \right.$$

$$\left\{ \begin{array}{l} q_{12} = -3.54 \text{ N/mm} \\ q_{23} = -23.54 \text{ N/mm} \\ q_{31} = 26.46 \text{ N/mm} \end{array} \right.$$

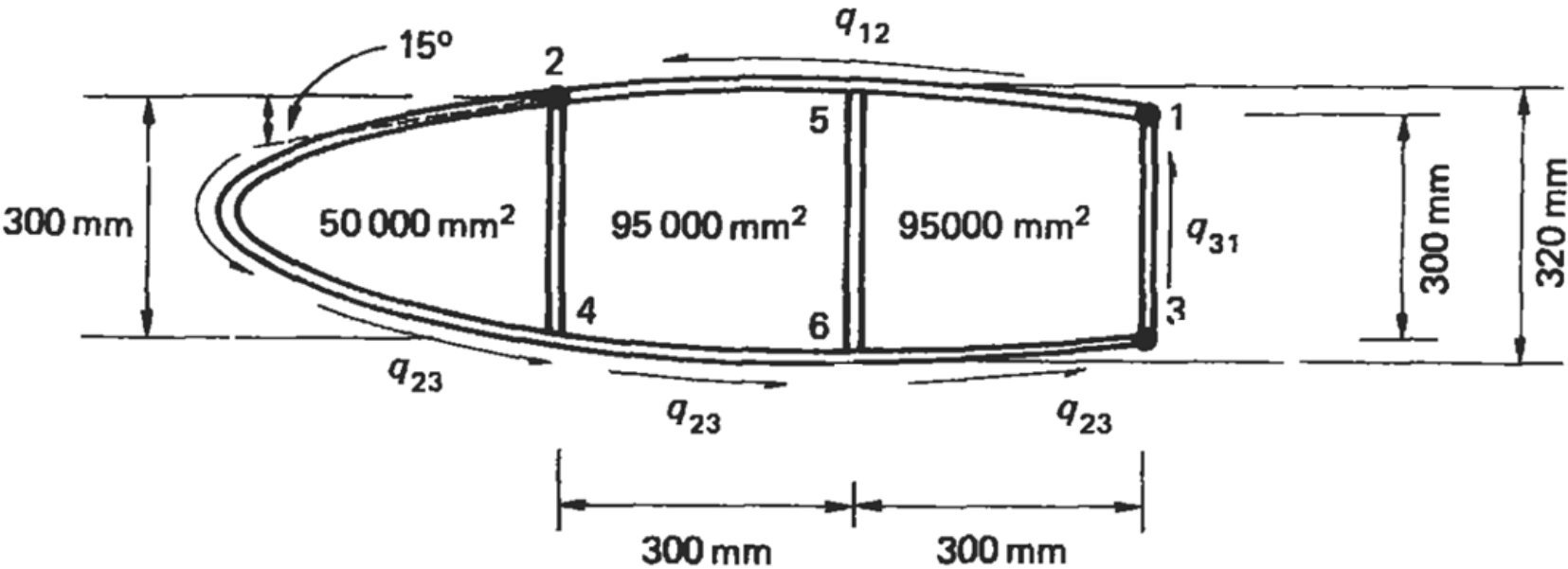
A torção provocada pelo fluxo DEVE SER IGUAL a torção provocada pelo carregamento que gerou o fluxo

Example 10.14

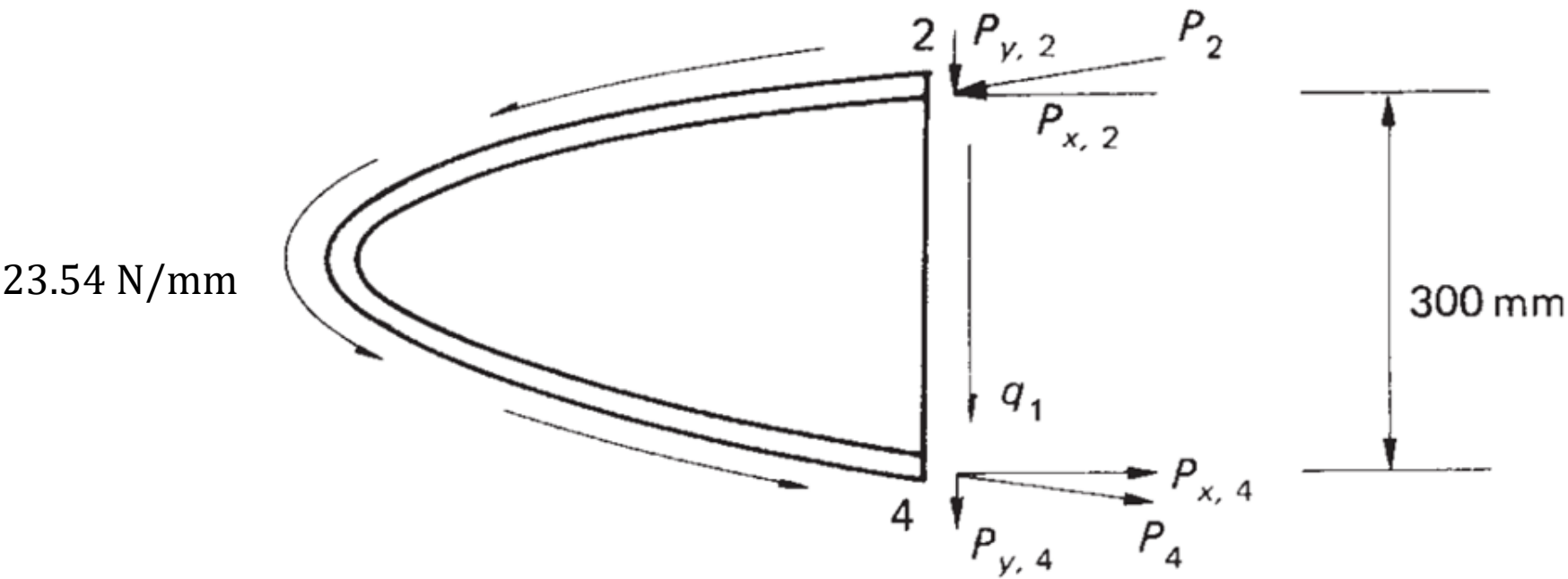
Calculate the shear flows in the web panels and the axial loads in the flanges of the wing rib shown in Fig. 10.48. Assume that the web of the rib is effective only in shear while the resistance of the wing to bending moments is provided entirely by the three flanges 1, 2 and 3.



Análise da Seção (Nervura)



Análise da Seção (Nervura): Primeiro Painel



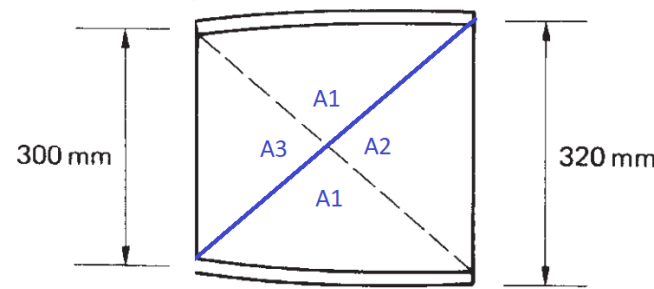
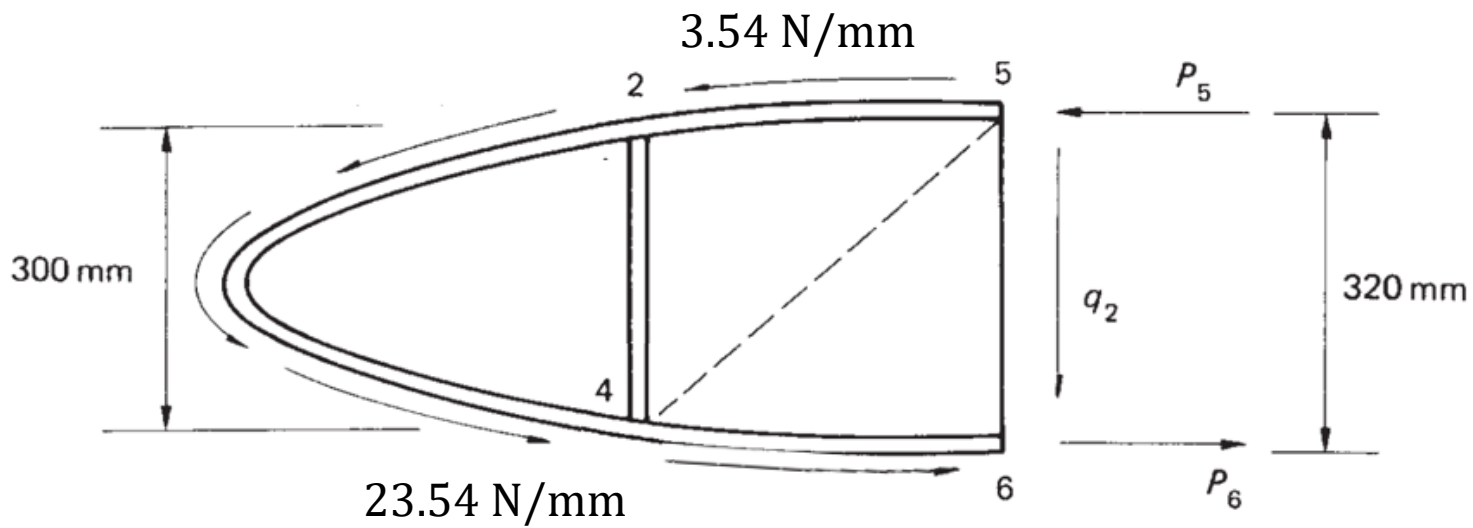
Hipóteses assumidas:

- Fluxo em um segmento do painel é constante
- Estruturas reforçantes só suportam cargas perpendiculares a sua seção

$$\begin{cases} P_{x,2} = P_{x,4} = P_x \\ -23.54 \times 300 - q_1 \times 300 - P_{y,2} - P_{y,4} = 0 \\ 23.54 \times 50000 \times 2 + 300 \times P_x = 0 \end{cases} \rightarrow \begin{cases} P_x = -7846.7 \text{ N} \\ -23.54 \times 300 - q_1 \times 300 - 2 \times P_x \tan 15^\circ = 0 \end{cases} \rightarrow \begin{cases} P_x = -7846.7 \text{ N} \\ q_1 = -9.52 \text{ N/mm} \end{cases}$$

$$\rightarrow \begin{cases} P_2 = P_4 = -8123.5 \text{ N} \\ q_1 = -9.52 \text{ N/mm} \end{cases}$$

Análise da Seção (Nervura): Segundo Painel



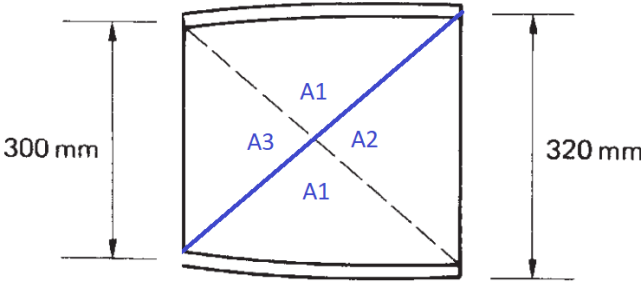
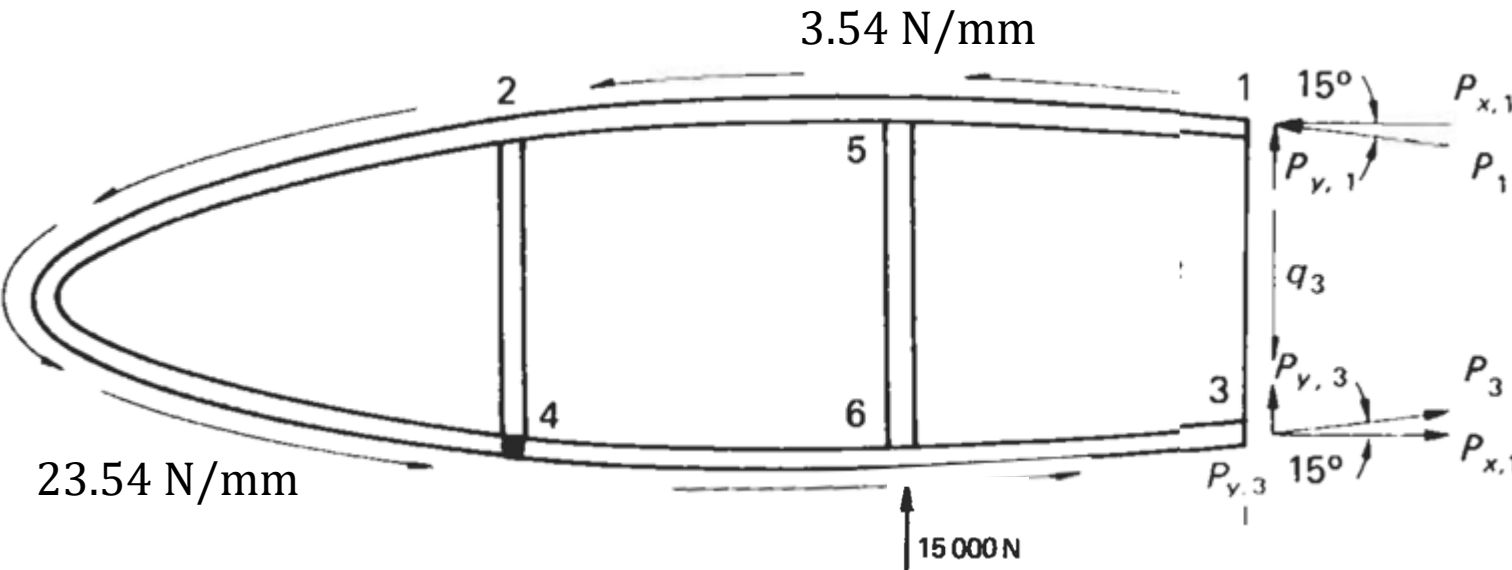
$$\begin{cases} \frac{h_3}{h_2} = \frac{300}{320} \rightarrow h_3 = 0.9375h_2 \\ h_3 + h_2 = 300 \rightarrow h_2 = 154.84 \text{ mm} \end{cases} \rightarrow \begin{cases} A_2 = 24774.4 \text{ mm}^2 \\ A_3 = 21774.4 \text{ mm}^2 \end{cases} \rightarrow 2x + 3000 = 95000$$
$$\rightarrow \begin{cases} A_1 + A_3 = 46000 \text{ mm}^2 \\ A_1 + A_2 = 49000 \text{ mm}^2 \end{cases}$$

Hipóteses assumidas:

- Fluxo em um segmento do painel é constante
- Estruturas reforçantes só suportam cargas perpendiculares a sua seção

$$\begin{cases} -23.54 \times 300 + 3.54 \times 300 + P_5 - P_6 = 0 \\ -23.54 \times 310 - 3.54 \times 10 - q_2 \times 320 = 0 \\ P_5 \times 320 + 23.54 \times 96000 \times 2 + 3.54 \times 49000 \times 2 = 0 \end{cases} \rightarrow \begin{cases} q_2 = -22.91 \text{ N/mm} \\ P_5 = -15208.1 \text{ N} \\ P_6 = -21208.1 \text{ N} \end{cases}$$

Análise da Seção (Nervura): Terceiro Pannel



Hipóteses assumidas:

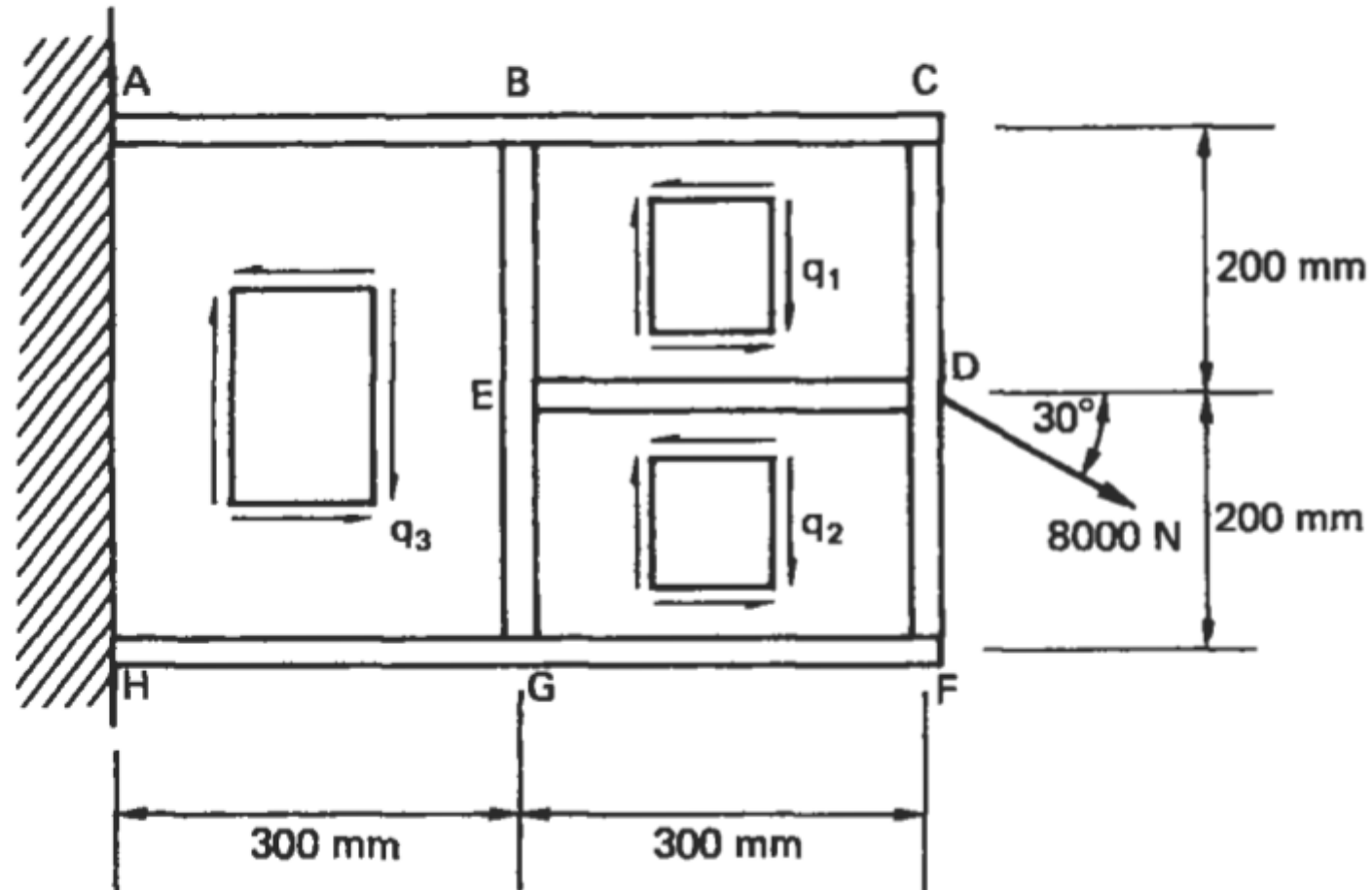
- Fluxo em um segmento do painel é constante
- Estruturas reforçantes só suportam cargas perpendiculares a sua seção

$$\begin{cases} \frac{h_3}{h_2} = \frac{300}{320} \rightarrow h_3 = 0.9375h_2 \\ h_3 + h_2 = 300 \rightarrow h_2 = 154.84 \text{ mm} \end{cases} \rightarrow \begin{cases} A_2 = 24774.4 \text{ mm}^2 \\ A_3 = 21774.4 \text{ mm}^2 \end{cases} \rightarrow 2x + 3000 = 95000$$

$$\rightarrow \begin{cases} A_1 + A_3 = 46000 \text{ mm}^2 \\ A_1 + A_2 = 49000 \text{ mm}^2 \end{cases}$$

$$\begin{cases} -23.54 \times 300 - q_3 \times 300 + P_1 \sin 15 + P_3 \sin 15 + 15000 = 0 \\ -23.54 \times 600 + 3.54 \times 600 + P_1 \cos 15 - P_3 \cos 15 = 0 \\ -23.54 \times 145000 \times 2 - 3.54 \times 95000 \times 2 - P_1 \cos 15 \times 300 + 15000 \times 300 = 0 \end{cases} \rightarrow \begin{cases} q_3 = -2.12 \text{ N/mm} \\ P_1 = -10350 \text{ N} \\ P_3 = -22773.3 \text{ N} \end{cases}$$

P.10.17 Calculate the shear flows in the web panels and direct load in the flanges and stiffeners of the beam shown in Fig. P.10.17 if the web panels resist shear stresses only.



P.10.17 Calculate the shear flows in the web panels and direct load in the flanges and stiffeners of the beam shown in Fig. P.10.17 if the web panels resist shear stresses only.

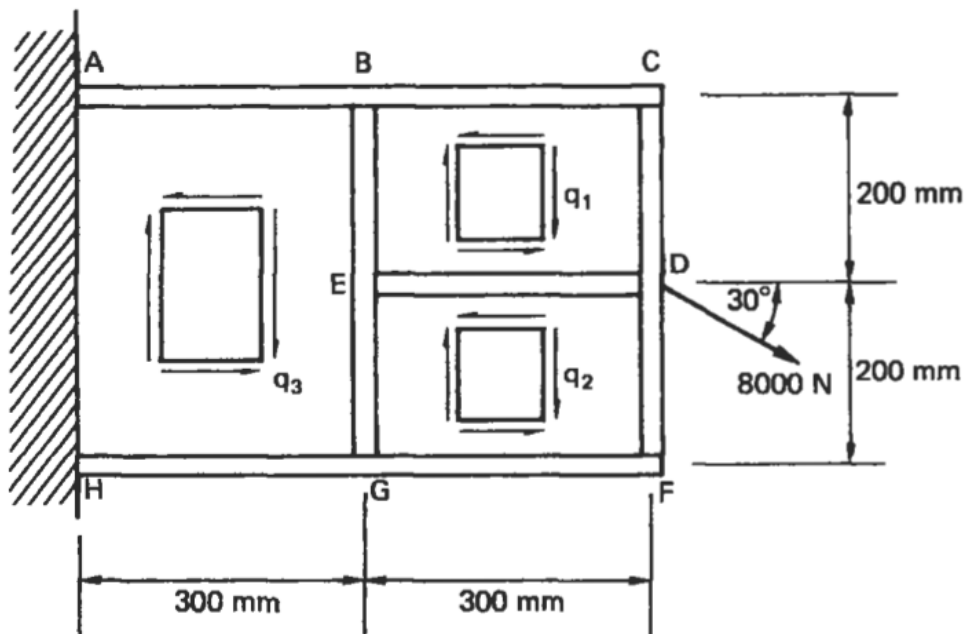
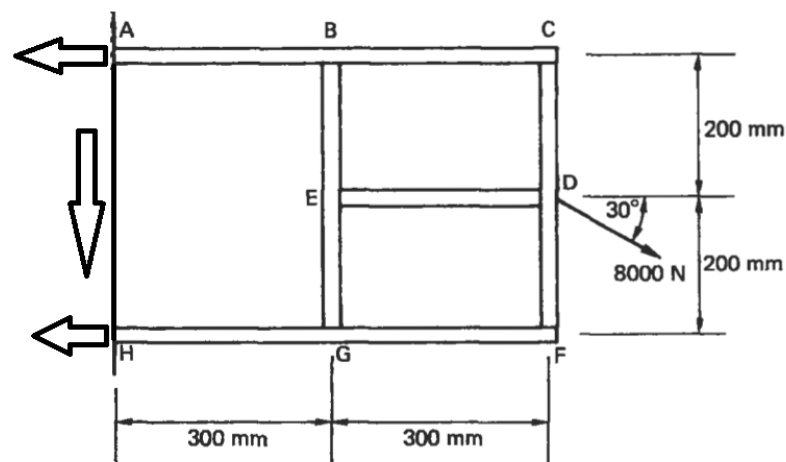
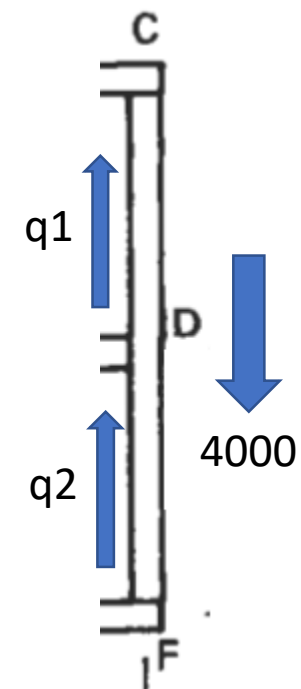
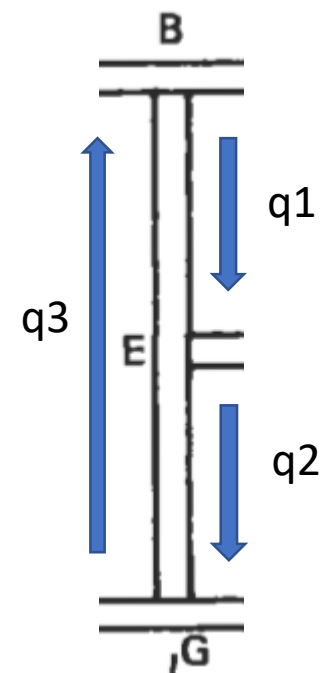
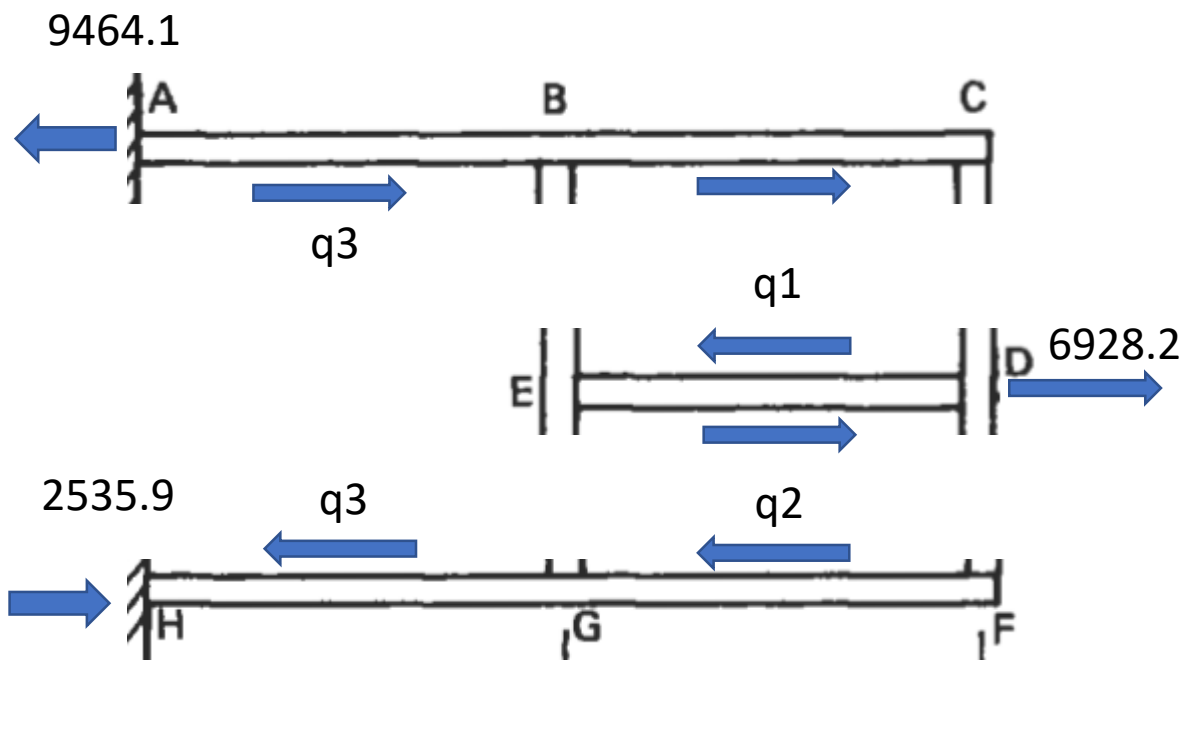


Diagrama de Corpo Livre



$$\begin{cases} P_a + P_h = 6928.2 \\ P_a \times 400 = 6928.2 \times 200 + 4000 \times 600 \rightarrow \\ V = -4000 \\ \begin{cases} P_h = -2535.9 \text{ N} \\ P_a = 9464.1 \text{ N} \\ V = -4000 \text{ N} \end{cases} \end{cases}$$

Análise Segmento a Segmento



$$\begin{cases} (q_1 + q_2) \times 200 = 4000 \\ (q_1 + q_2) \times 200 = q_3 \times 400 \\ (q_1 - q_2) \times 300 = 6928.2 \\ q_1 \times 300 + q_3 \times 300 = 9464.1 \\ q_2 \times 300 + q_3 \times 300 = 2535.9 \end{cases} \rightarrow \begin{cases} q_1 = 21.547 \text{ N/mm} \\ q_2 = -1.547 \text{ N/mm} \\ q_3 = 10 \text{ N/mm} \end{cases}$$