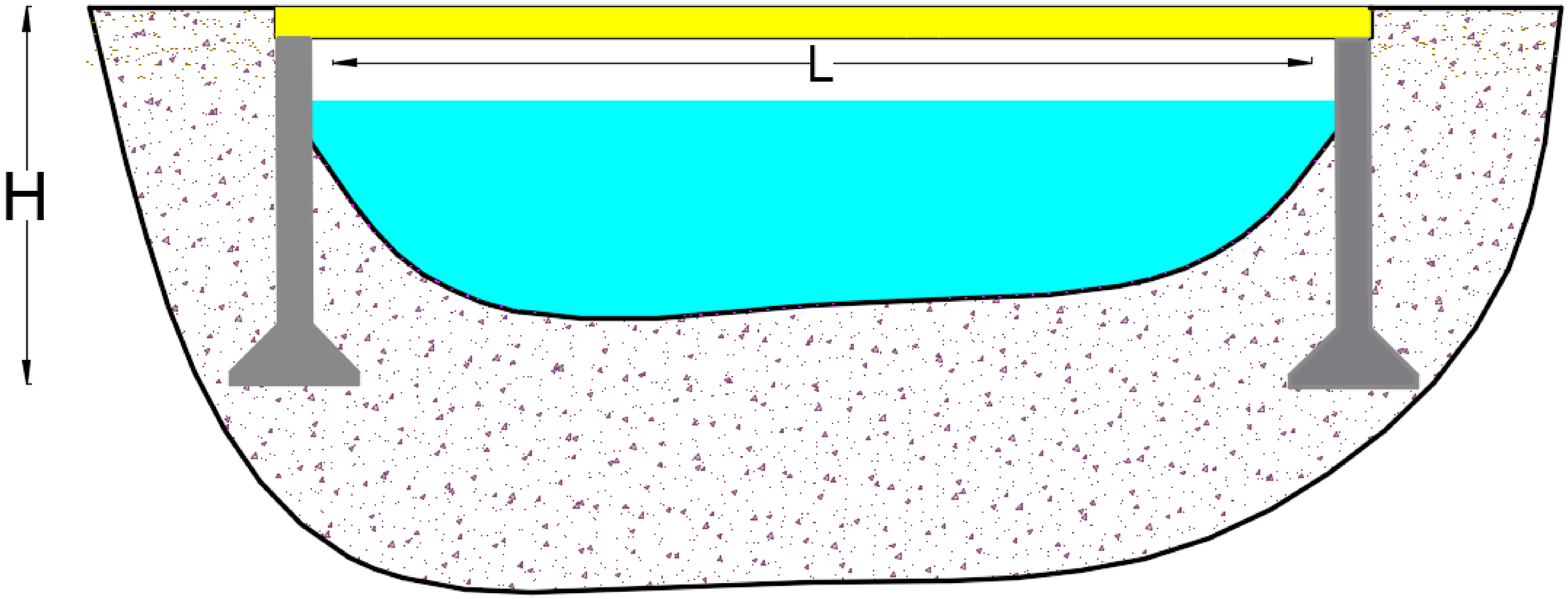
Pórtico Triarticulados

Valério S. Almeida

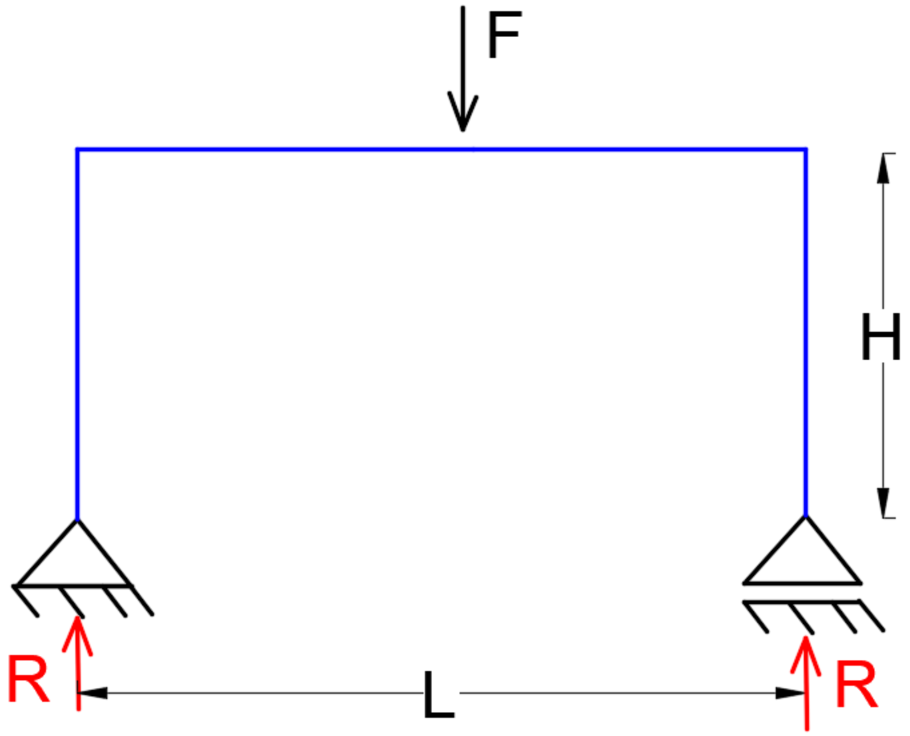
Junho/2023

Capítulo 8 da apostila do Lindenberg pgs. 122 a 153

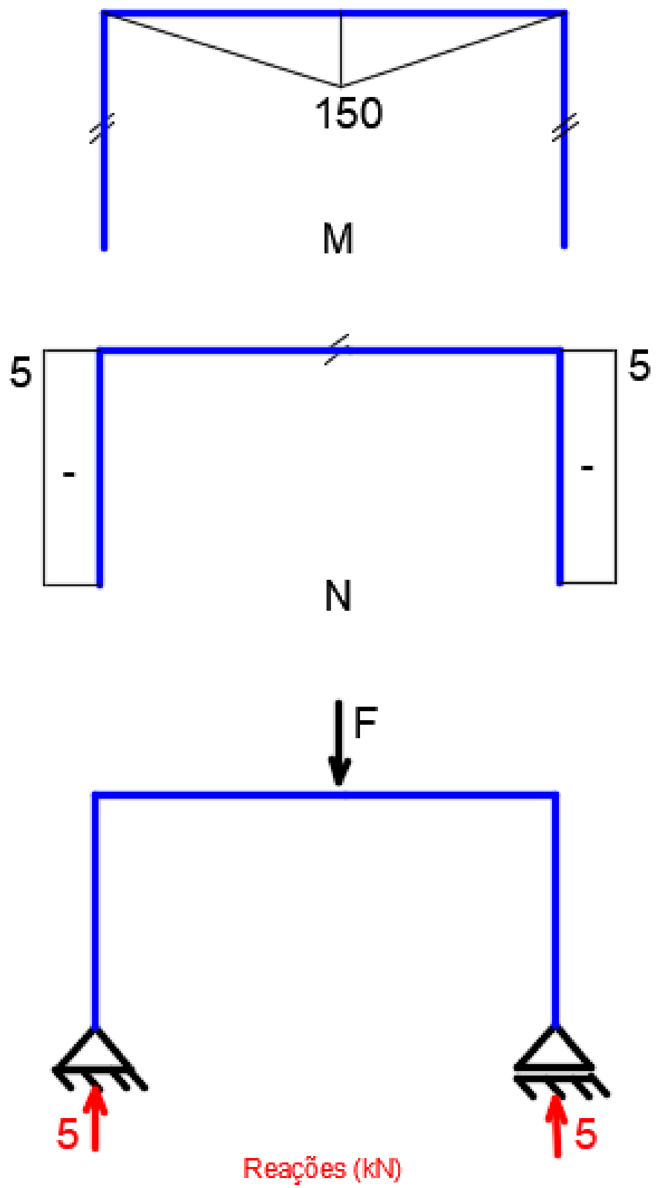
Suponha que você tenha que transpor o rio com a ponte de grande vão L

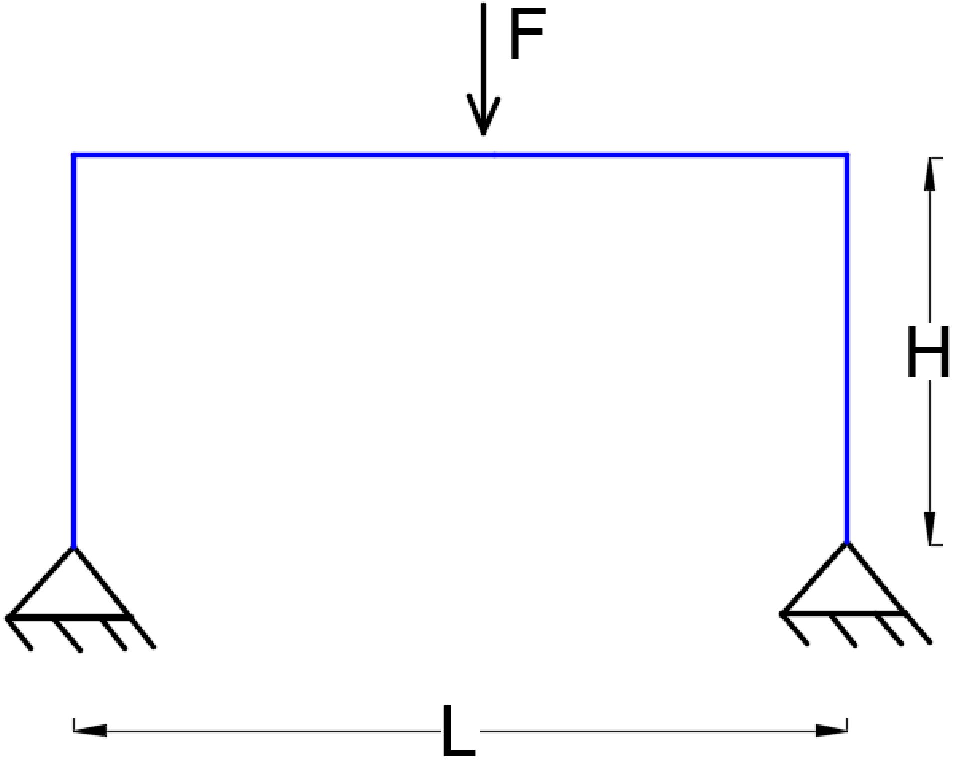


Considere F = 10 kN, L = 60 m e H = 6 m

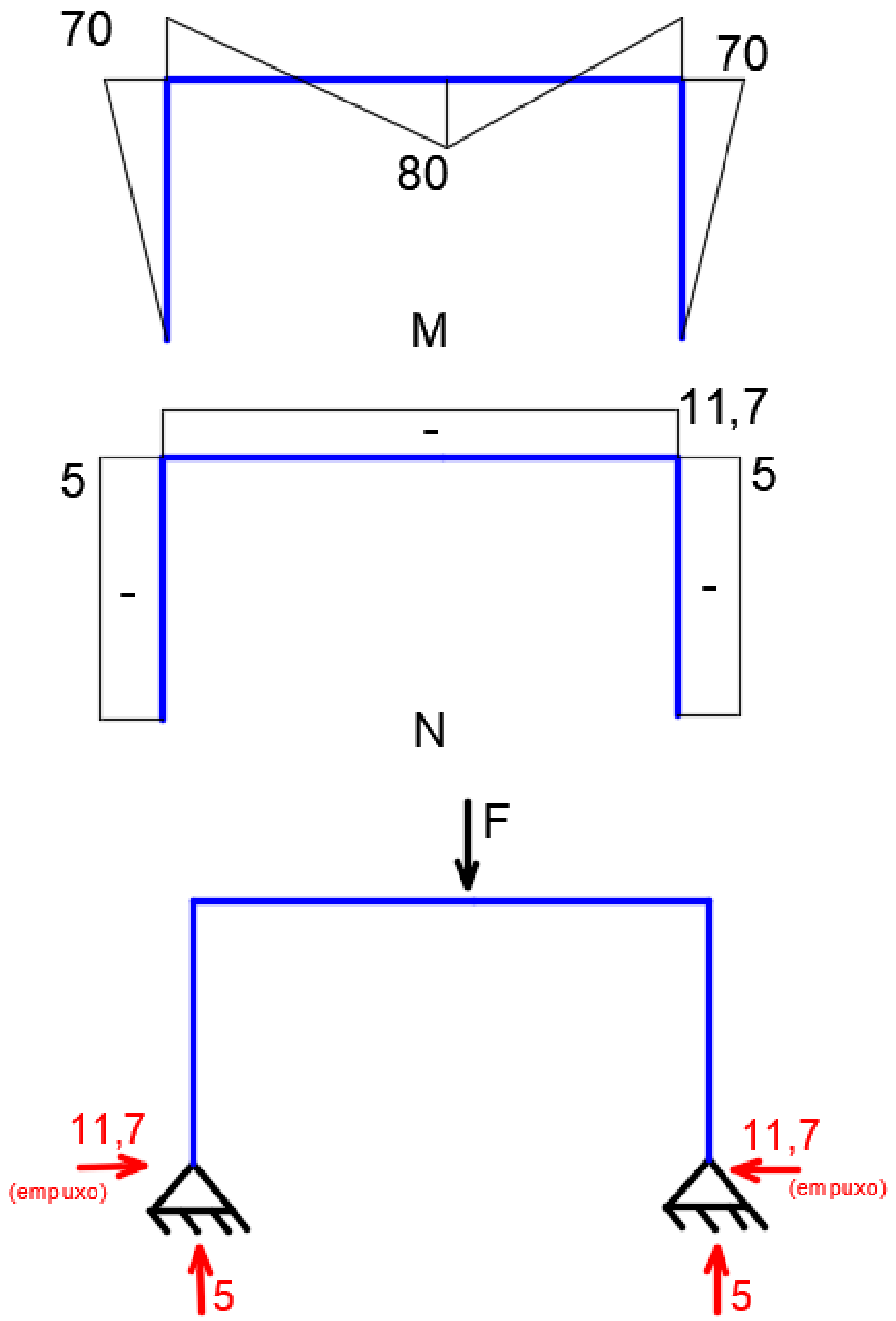


Viga Poligonal (isostático)

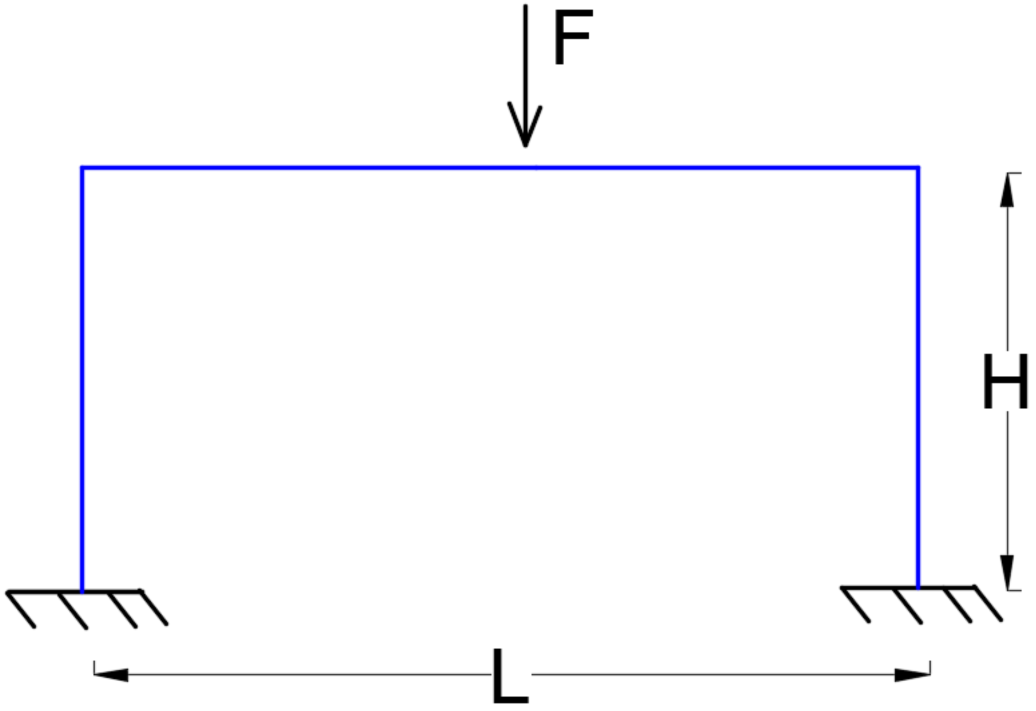




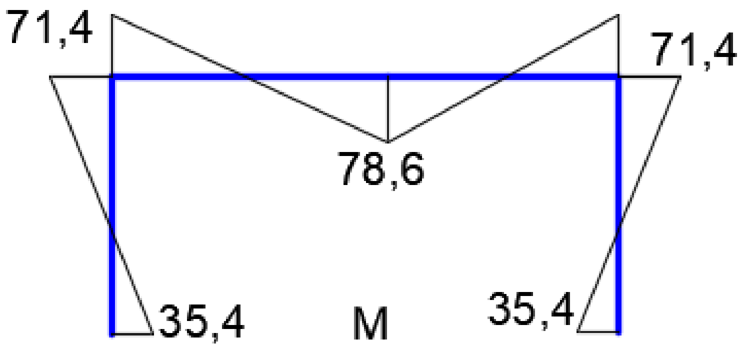
Pórtico Biarticulado (hiperestático)

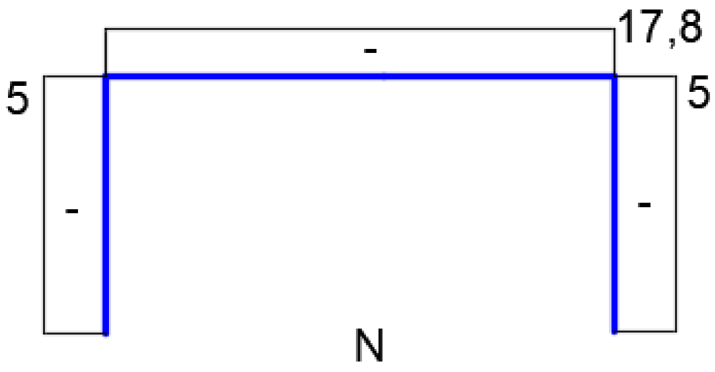


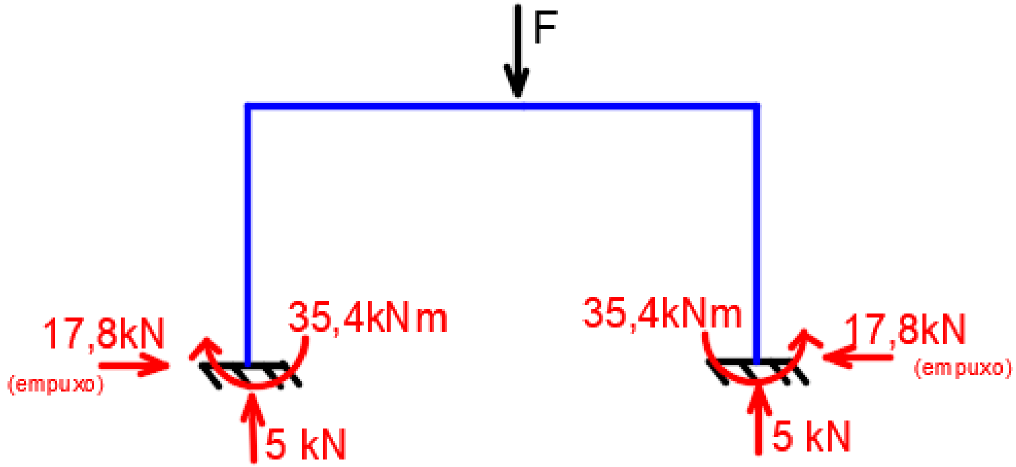
Reações (kN)



Pórtico Biengastado (hiperestático)





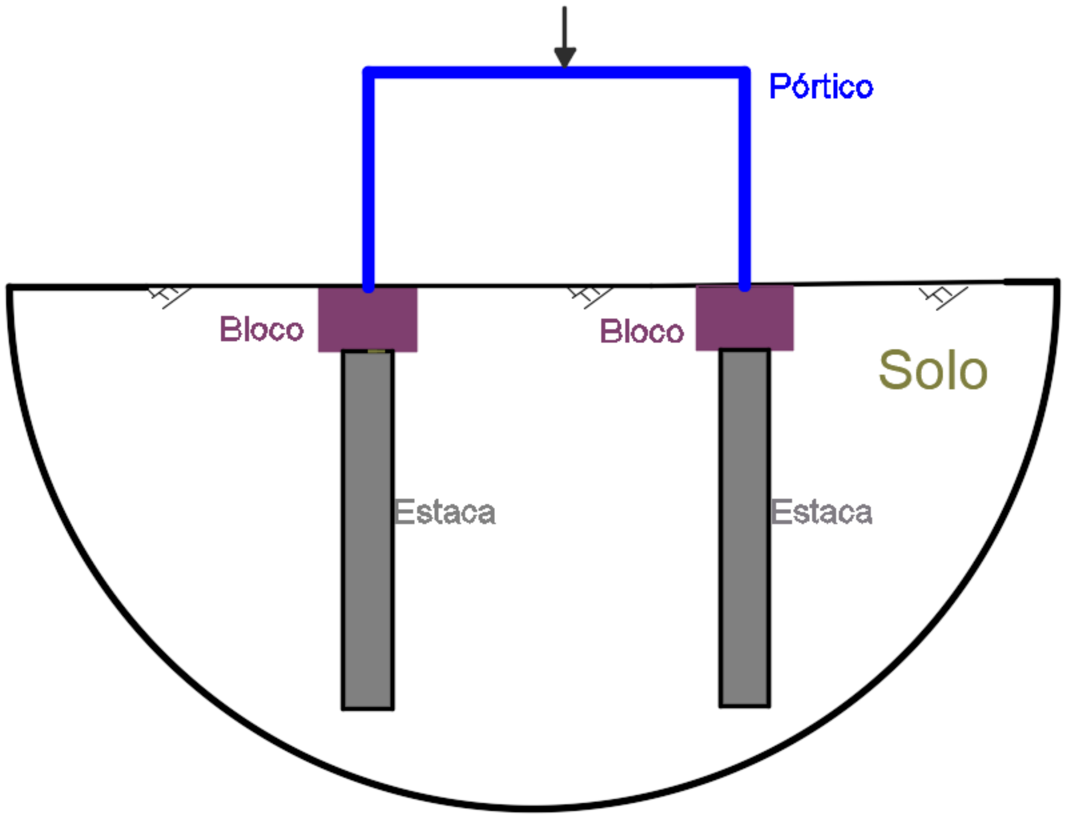


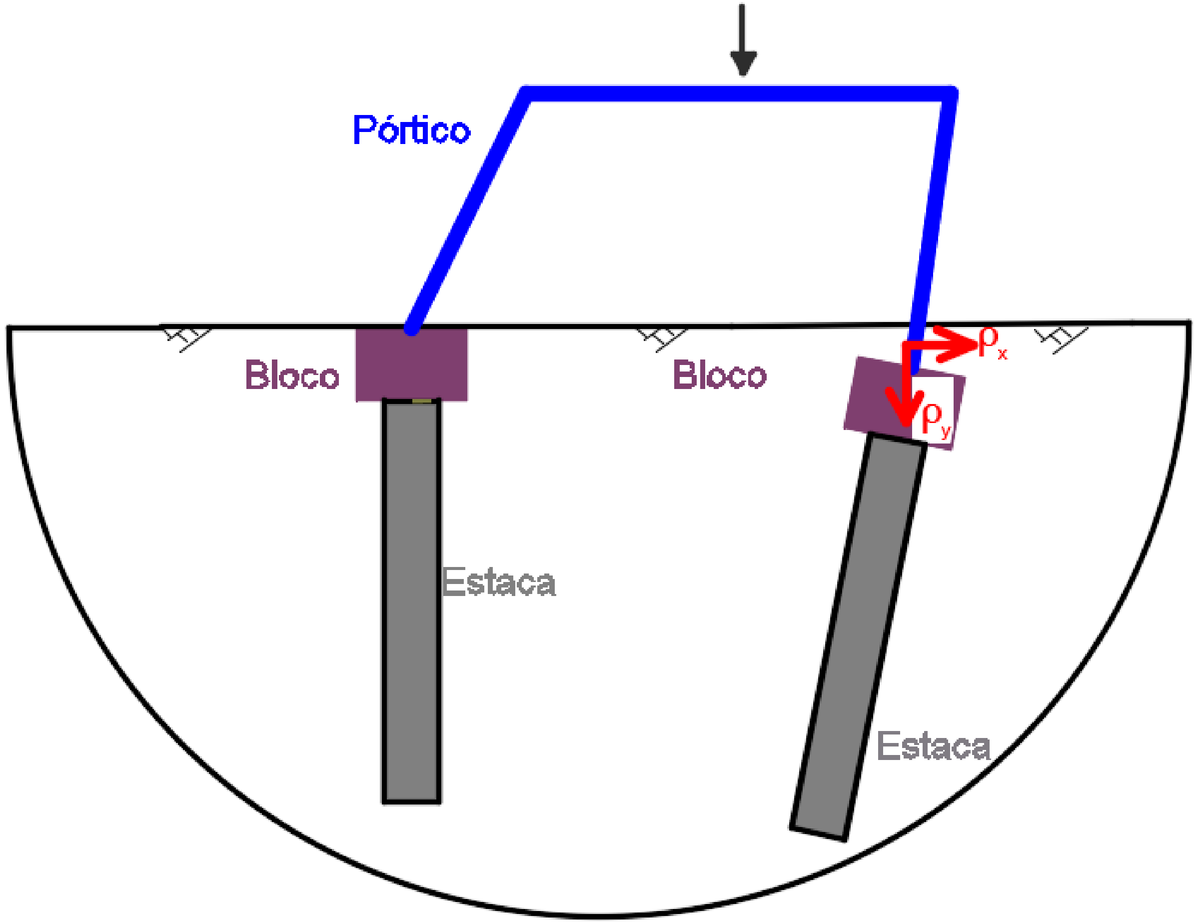
Reações

Uso desses pórticos biarticulados e biengastados levam a menores esforços, entretanto são estruturas hiperestáticas, e são suscetíveis a variação dos esforços devido a:

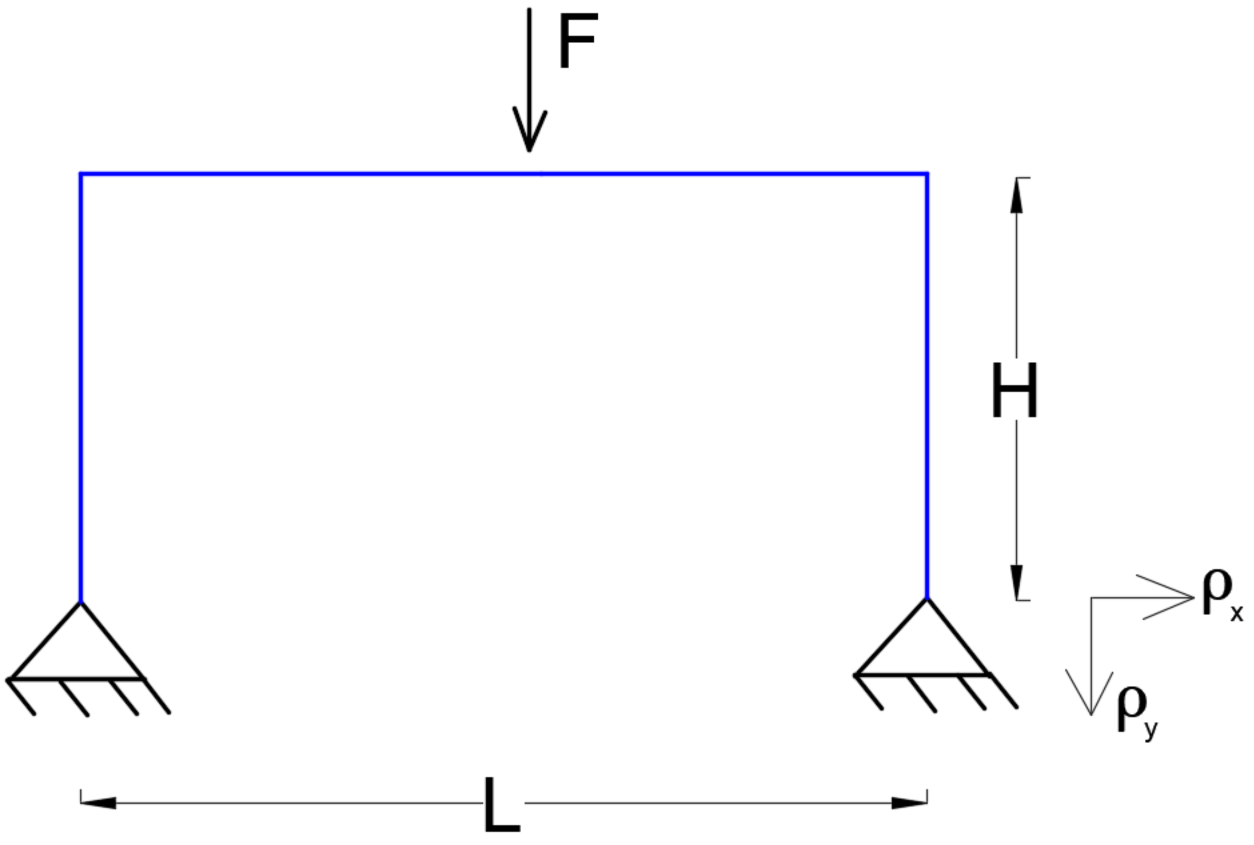
- **Recalque de apoios**
- **Variação de temperatura**
- **Erro de montagem**

Recalque de apoio

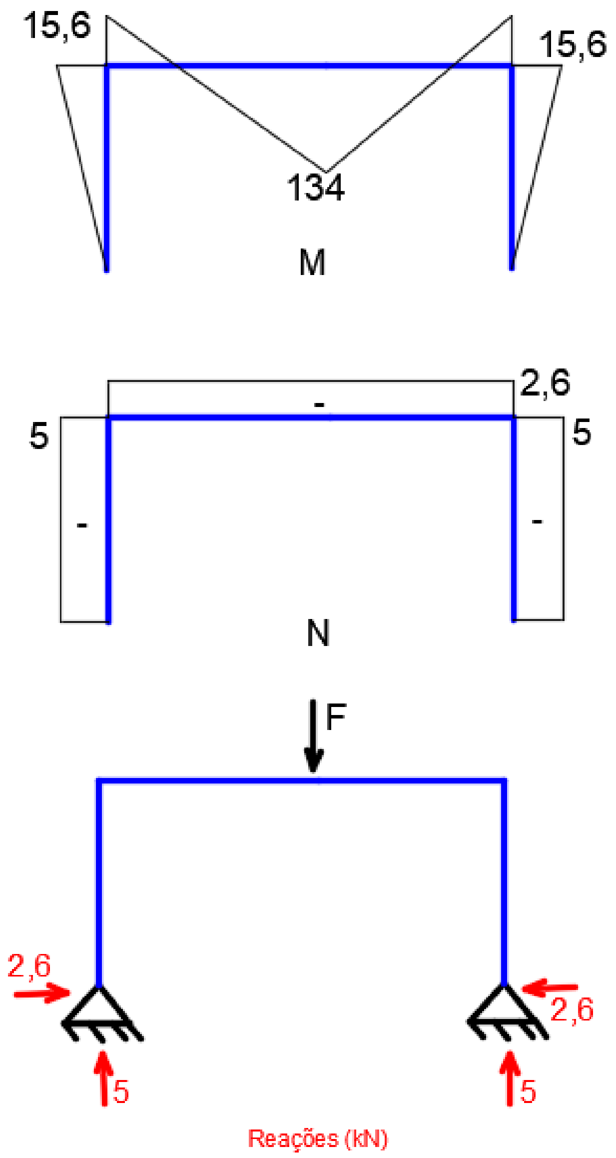


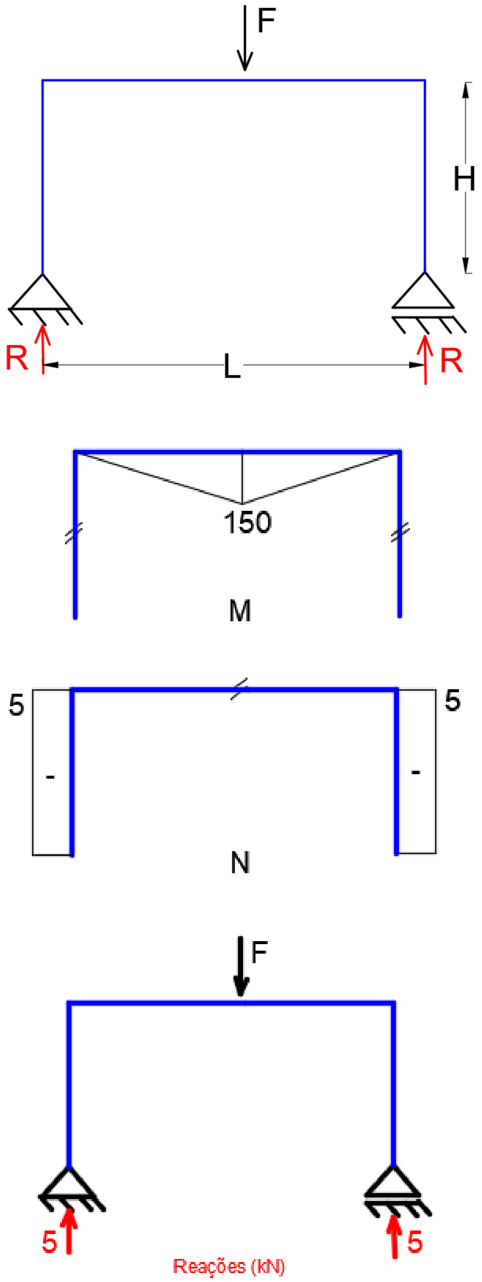


Considere F = 10 kN, L = 60 m, H = 6 m, ρ_x = 5 cm, ρ_y = 5 cm, E = 210 GPa, seção de 19 cm x 50 cm

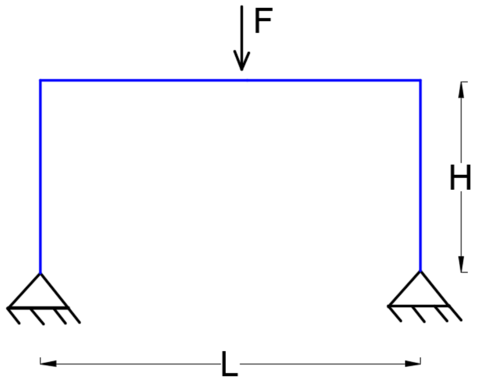


Pórtico Biarticulado (hiperestático)

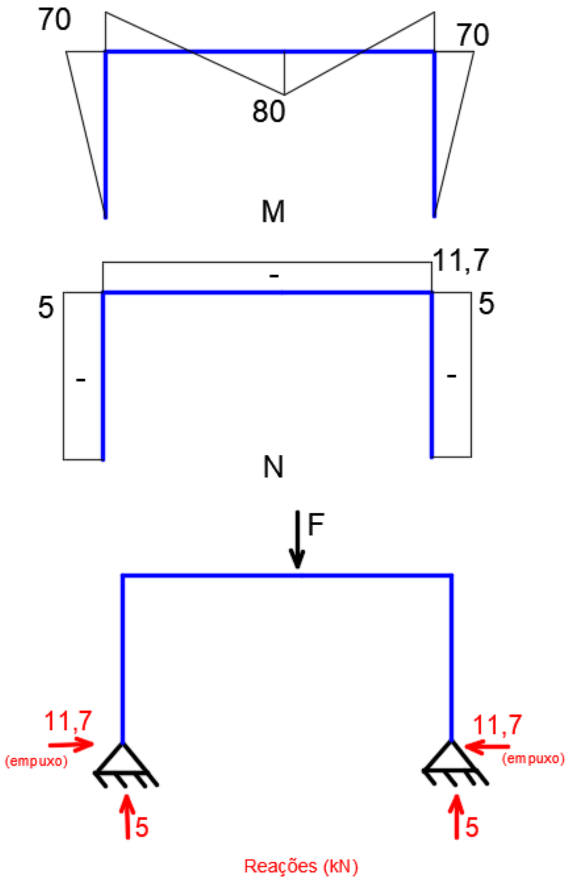


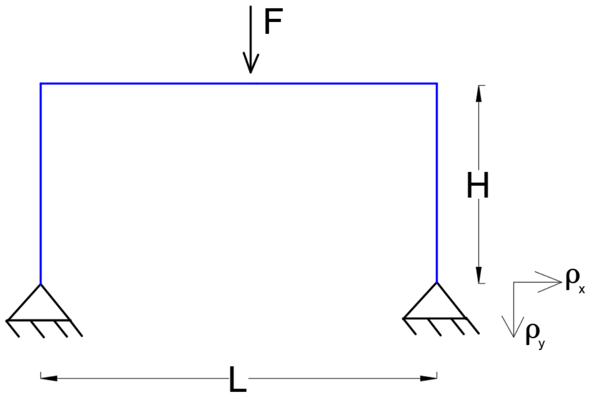


Estrutura isostática não sofre influência de deslocamentos de apoios, var. de temp.

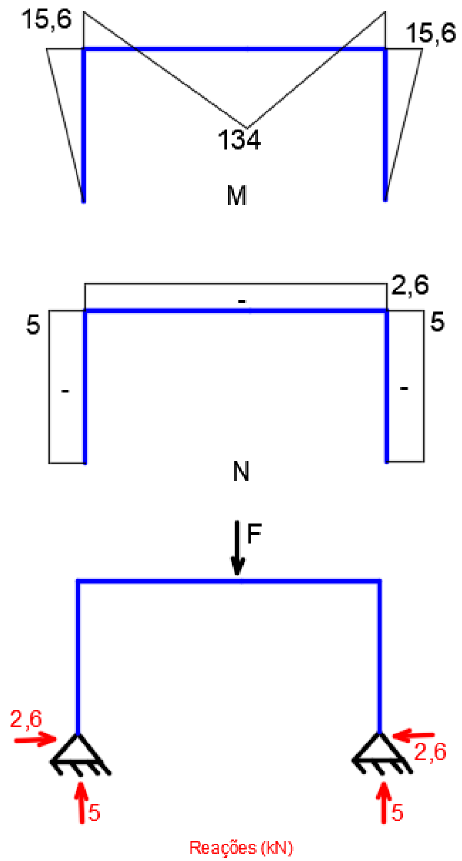


Pórtico Biarticulado (hiperestático)

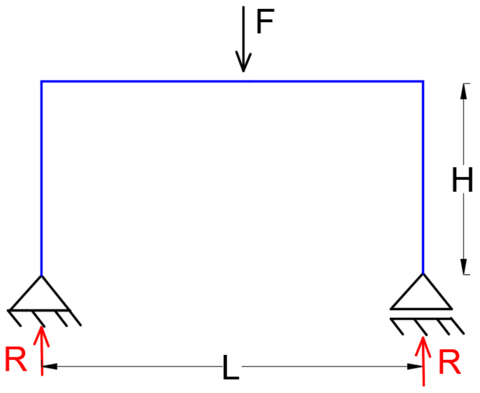




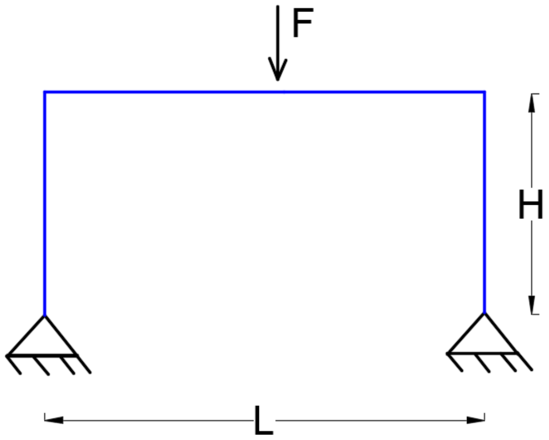
Pórtico Biarticulado (hiperestático)



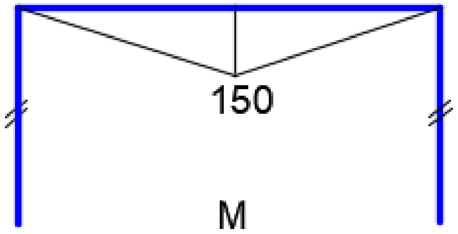
Essa viga poligonal gera momento fletor elevado que depende do vão

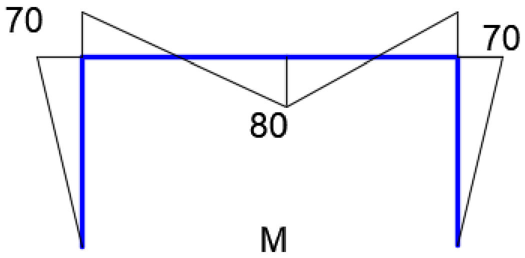


Viga Poligonal (isostático)



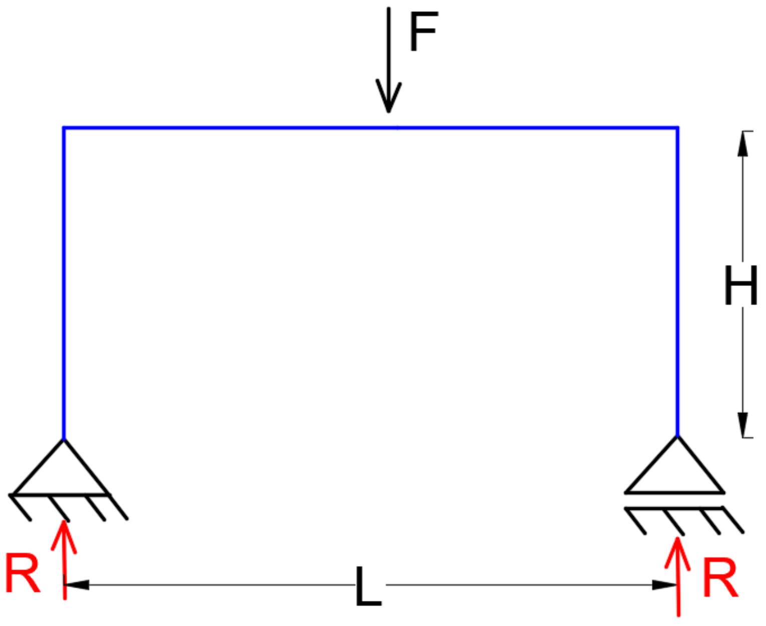
Pórtico Biarticulado (hiperestático)





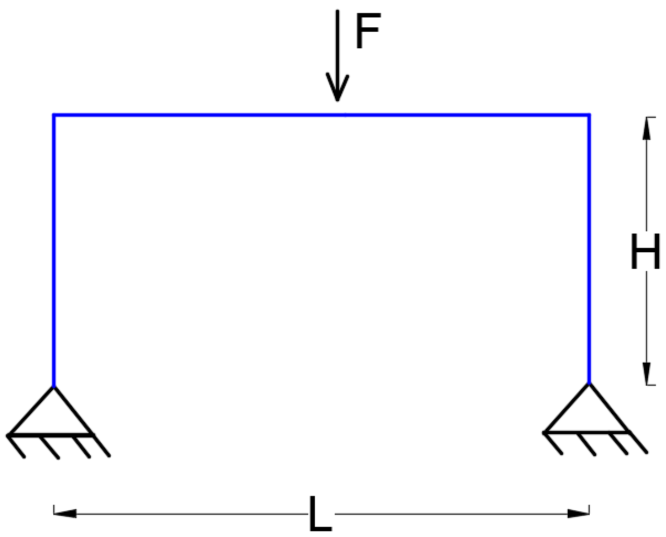
Momentos fletores menores mais suscetível a variação de recalque, temperatura etc..

Viga poligonal: algum deslocamento da base é possível

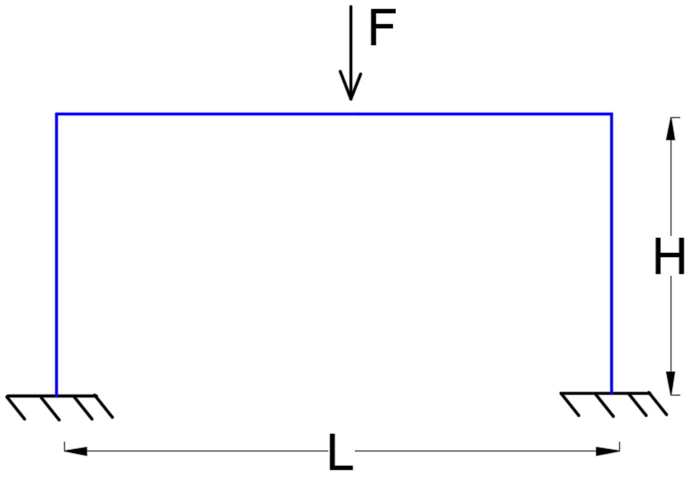


Viga Poligonal (isostático)

Pórtico: deslocamentos da base são restritos pela fundação

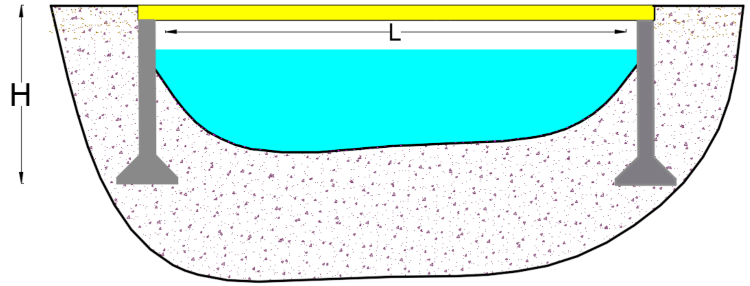


Pórtico Biarticulado (hiperestático)

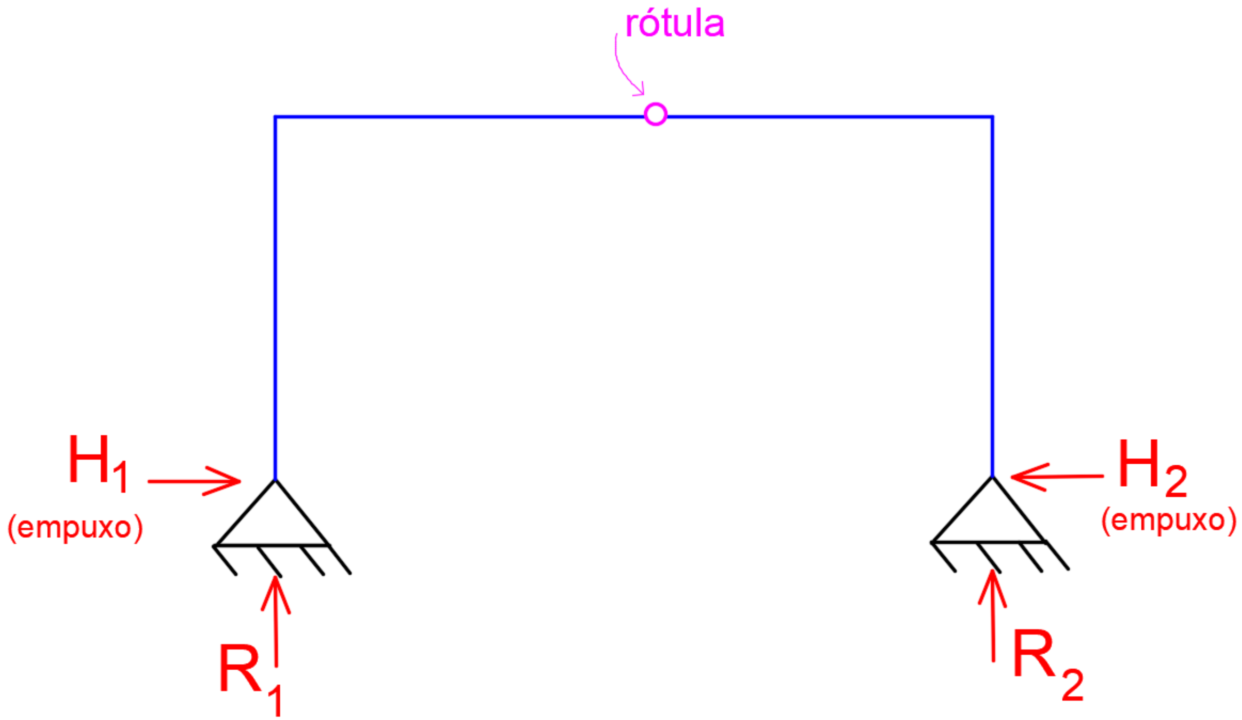


Pórtico Biengastado (hiperestático)

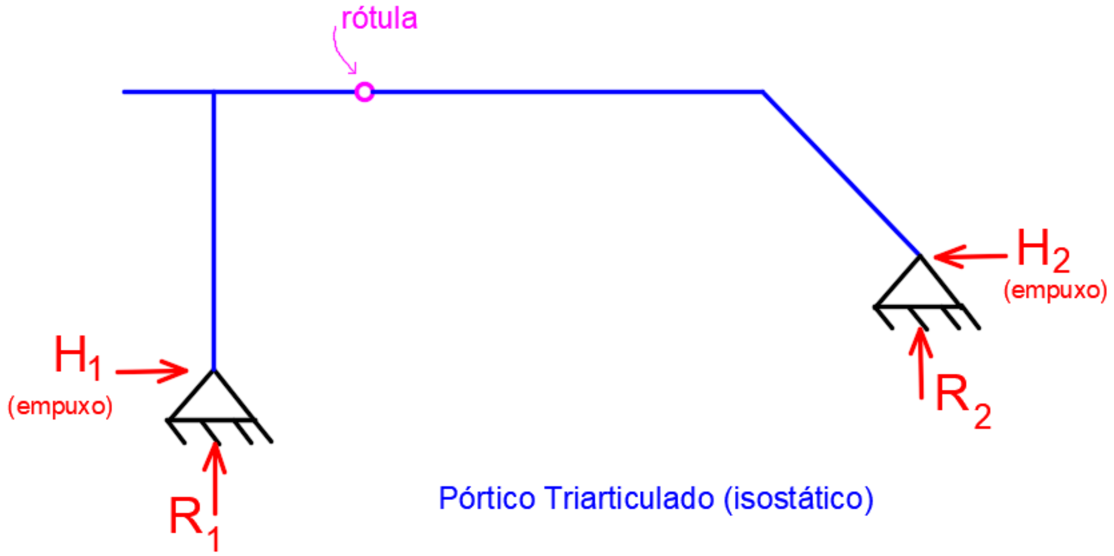
Sistema Estrutural: Pórtico Triarticulado



- Estrutura isostática
- Interessante para vencer grandes vãos com eficiência

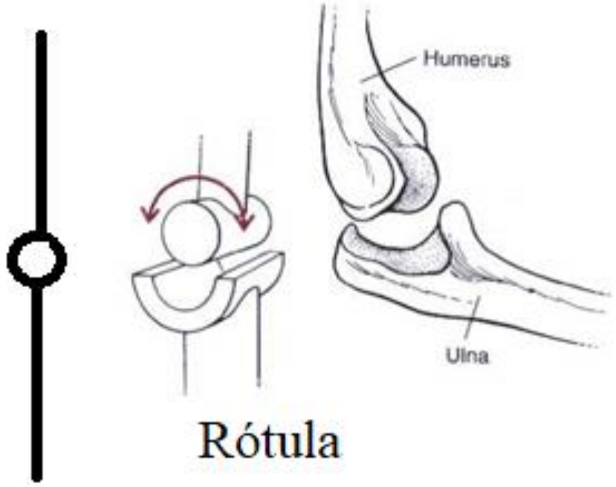


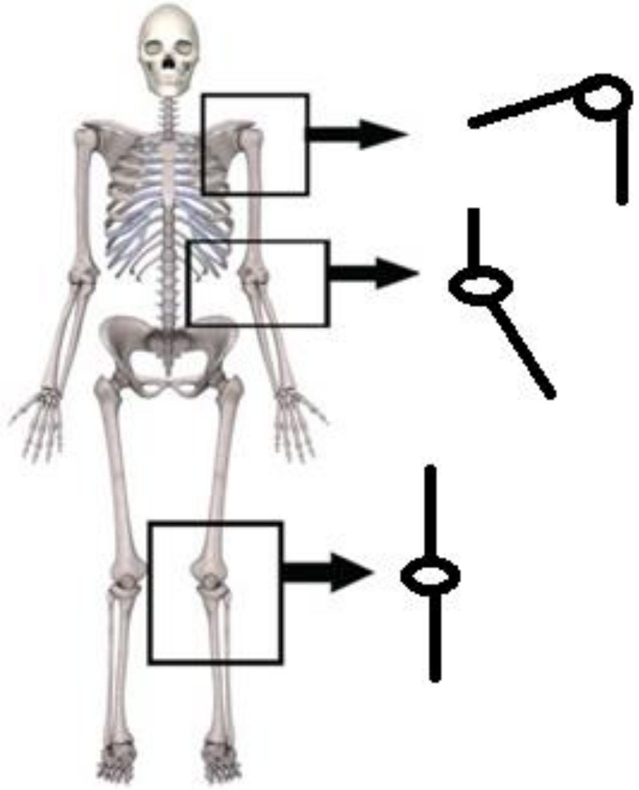
Pórtico Triarticulado (isostático)



Pórtico Triarticulado (isostático)

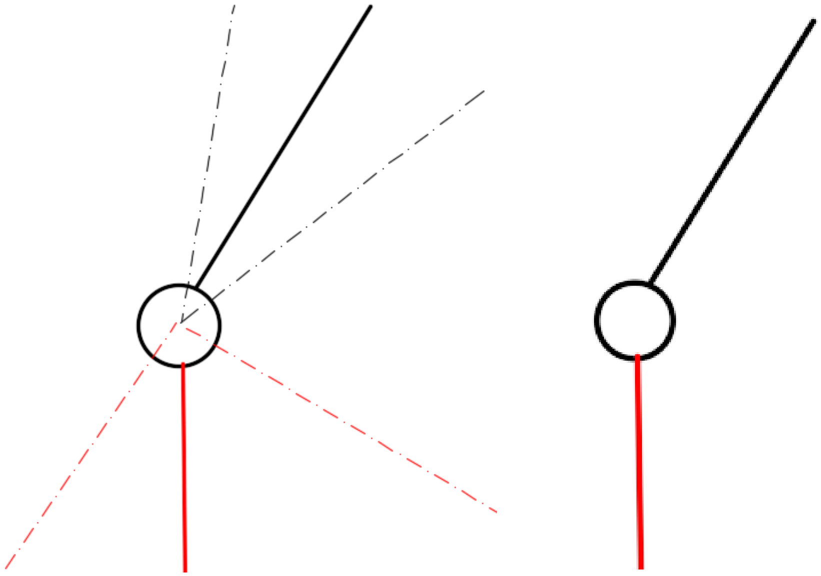
RÓTULAS



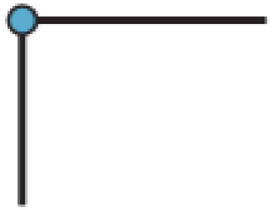


Conecta barras
Permite giro livre das barras

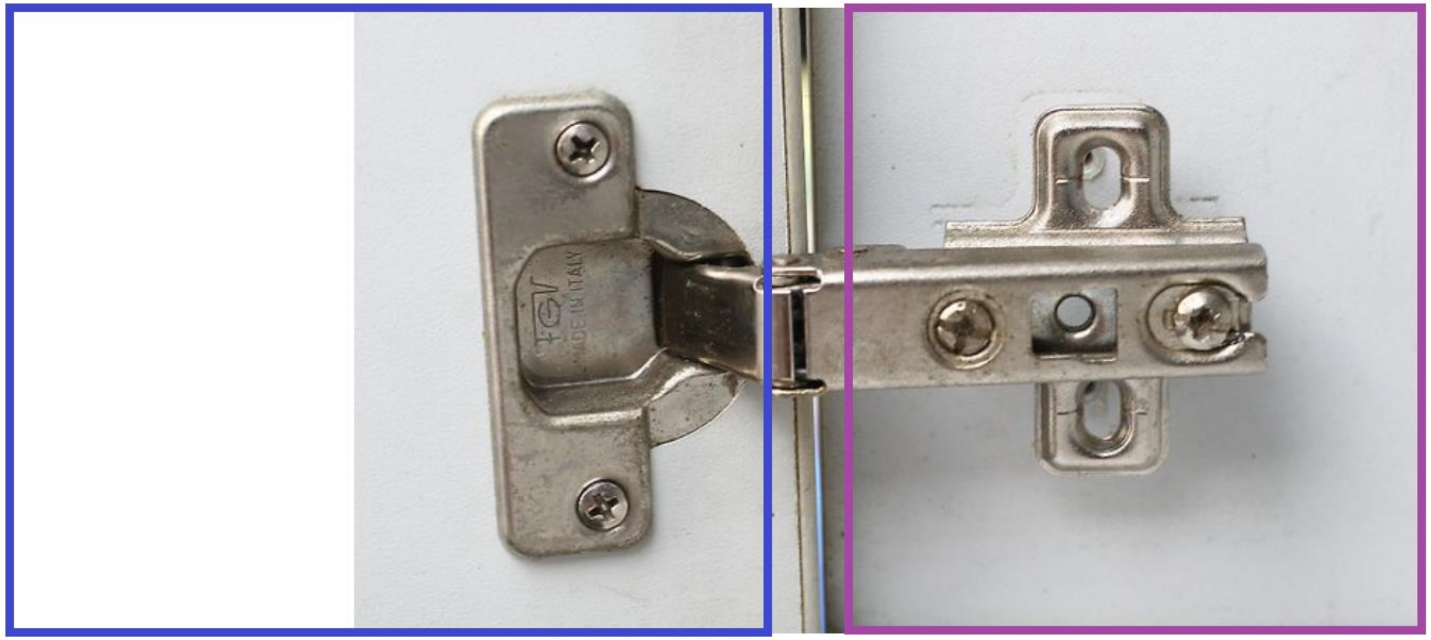
Rótulas

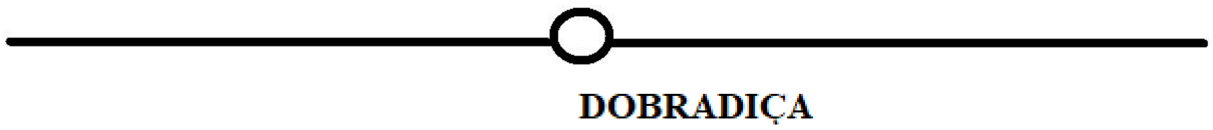


Conecta barras
Permite giro livre das barras

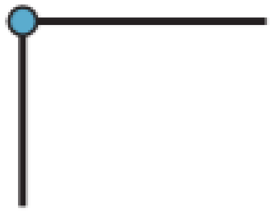


Rótulas





Conecta barras
Permite giro livre das barras

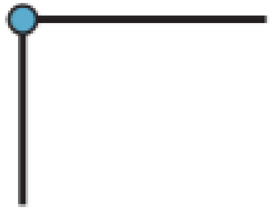


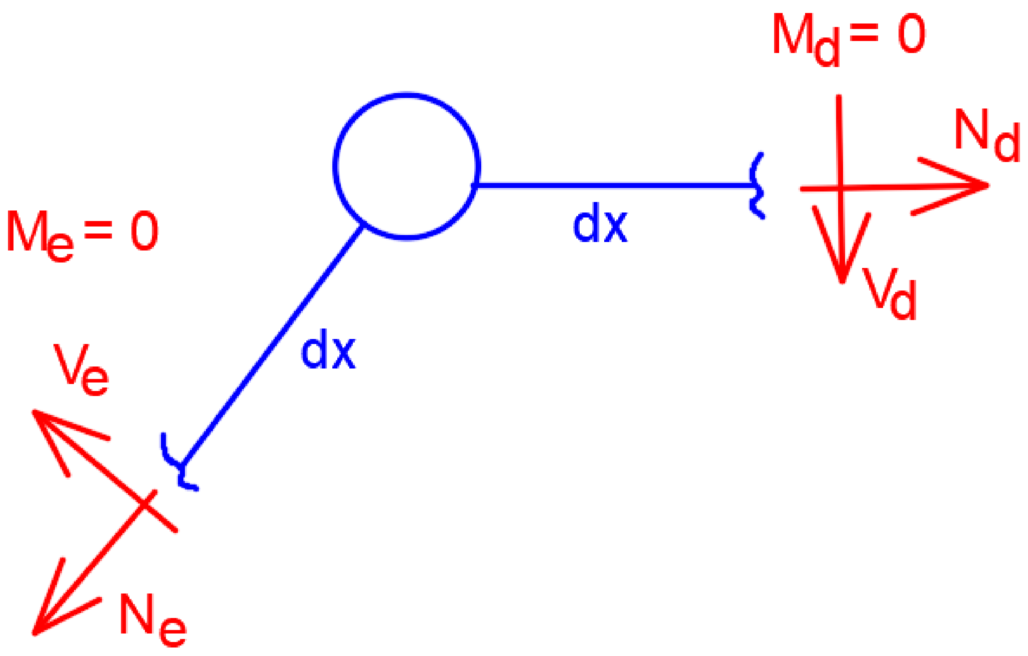
Rótulas

Conecta barras

Permite giro livre das barras

Não há momento fletor junto a seção que liga à rotula

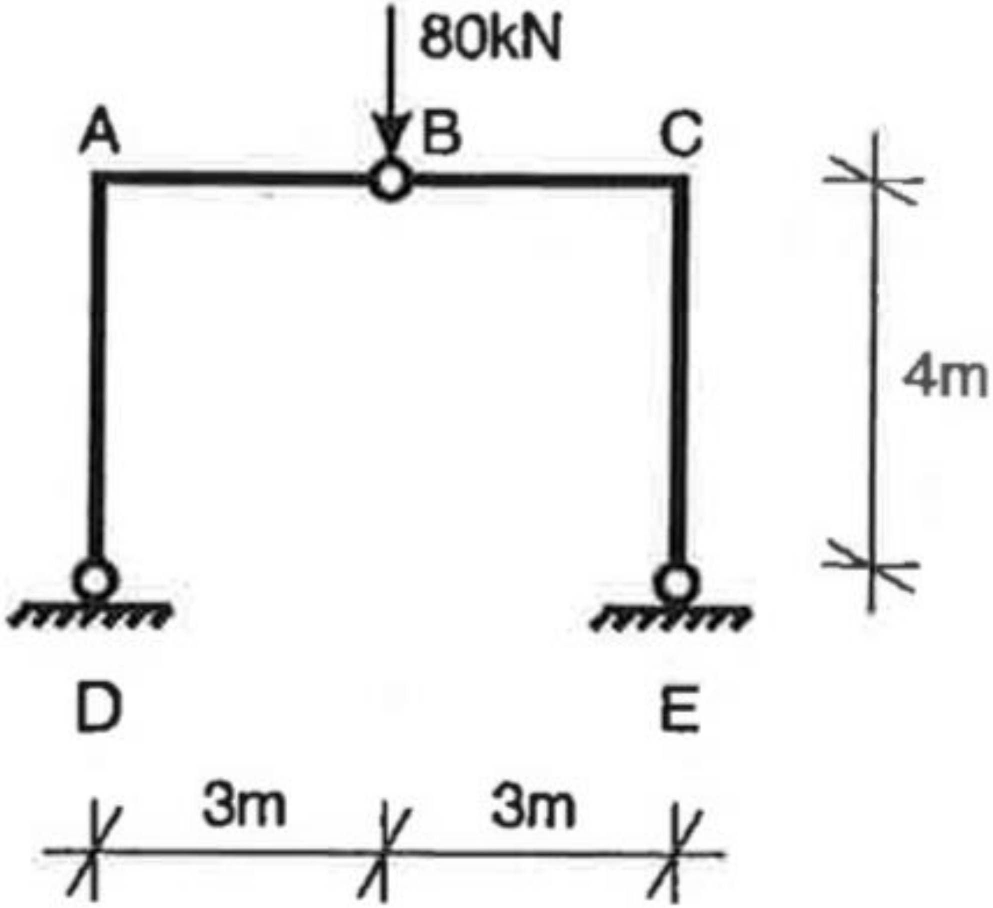


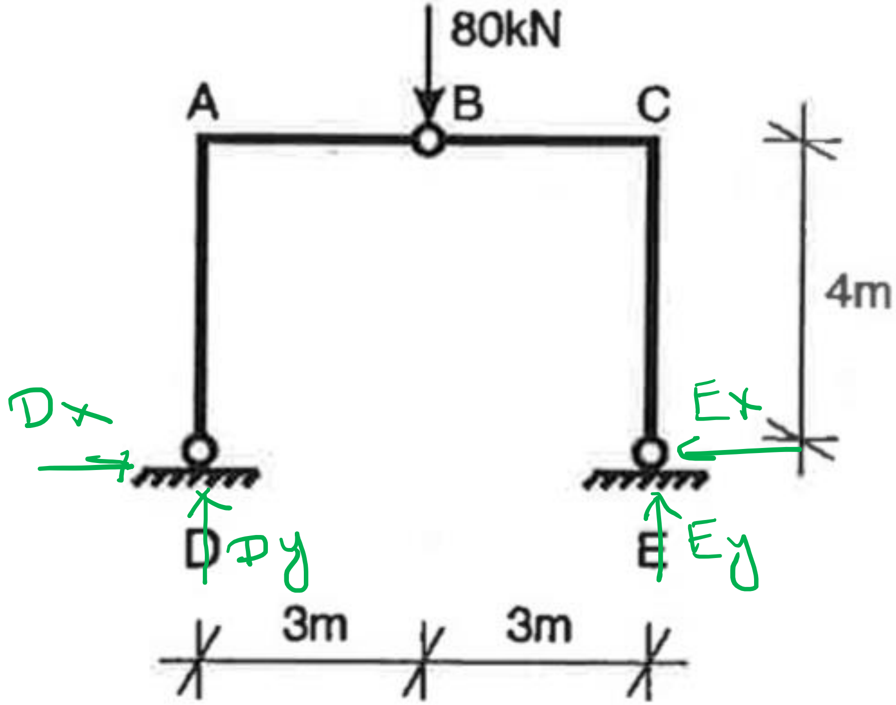


Corta-se a estrutura e usa-se a equação adicional, momento fletor nulo:

$$M_{rótula} = 0$$

Exemplo 1





4 incógnitas: Dx, Dy, Ex e Ey

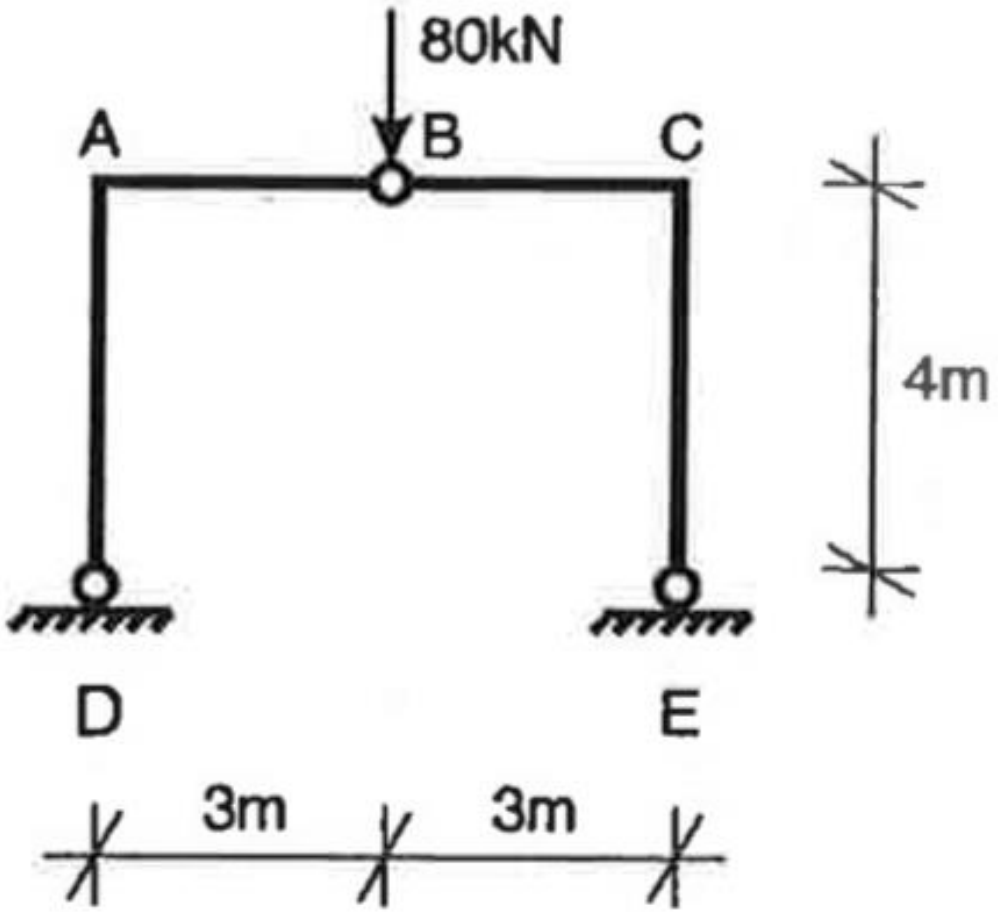
3 eq. da estática

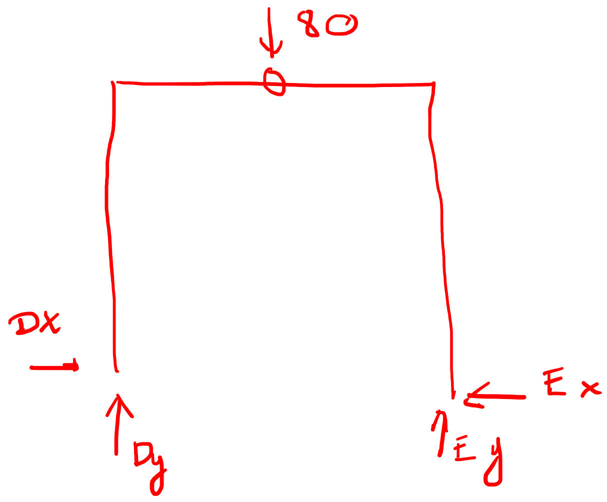
\+

1 eq. de momento fletor na rótula é nulo

} 4 eq.

Exemplo 1





$\Sigma M_D = 0$: (1)

$E_y \cdot 6 = 80 \cdot 3$

$E_y = 40$ kN

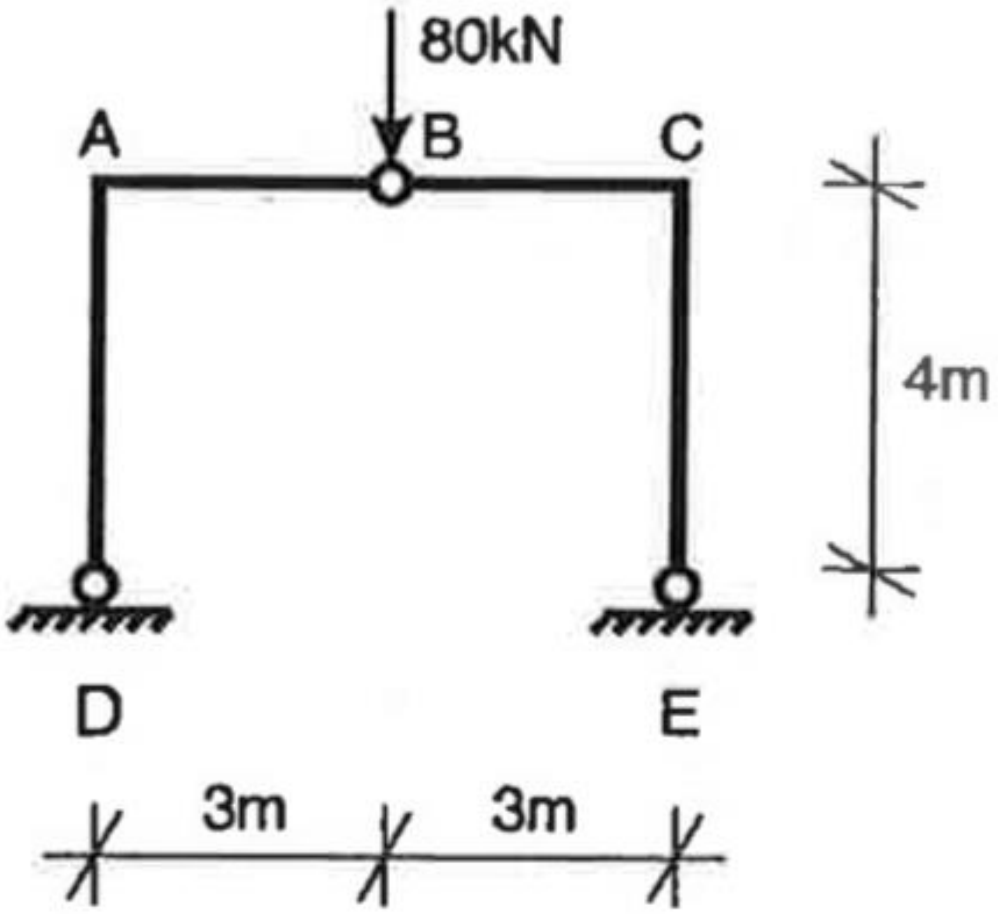
$\Sigma F_y = 0$ (2)

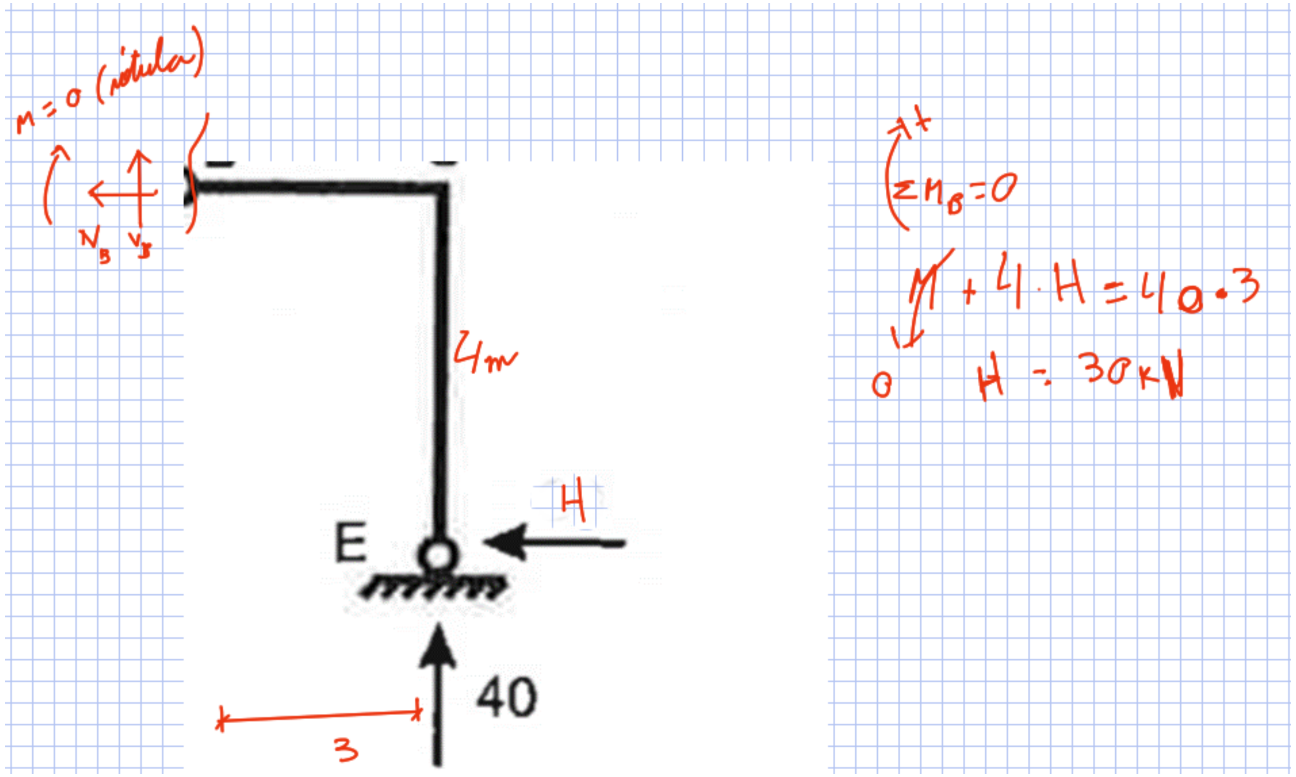
$D_y = 40$ kN

$\Sigma F_x = 0$: $D_x - E_x = 0$ (3)

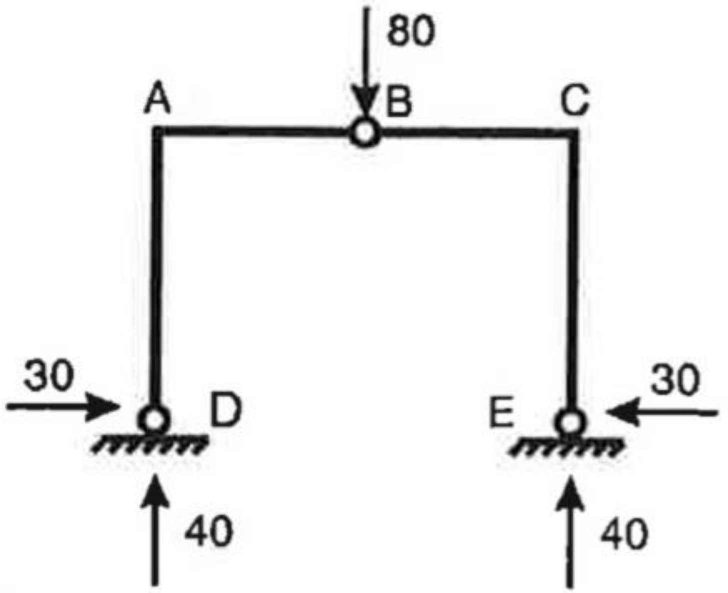
Equação adicional. Cortar na rótula, separar e aplicar eq. de $\Sigma M_{rótula} = 0$, sabe-se que $M_{rótula} = 0$

Exemplo 1

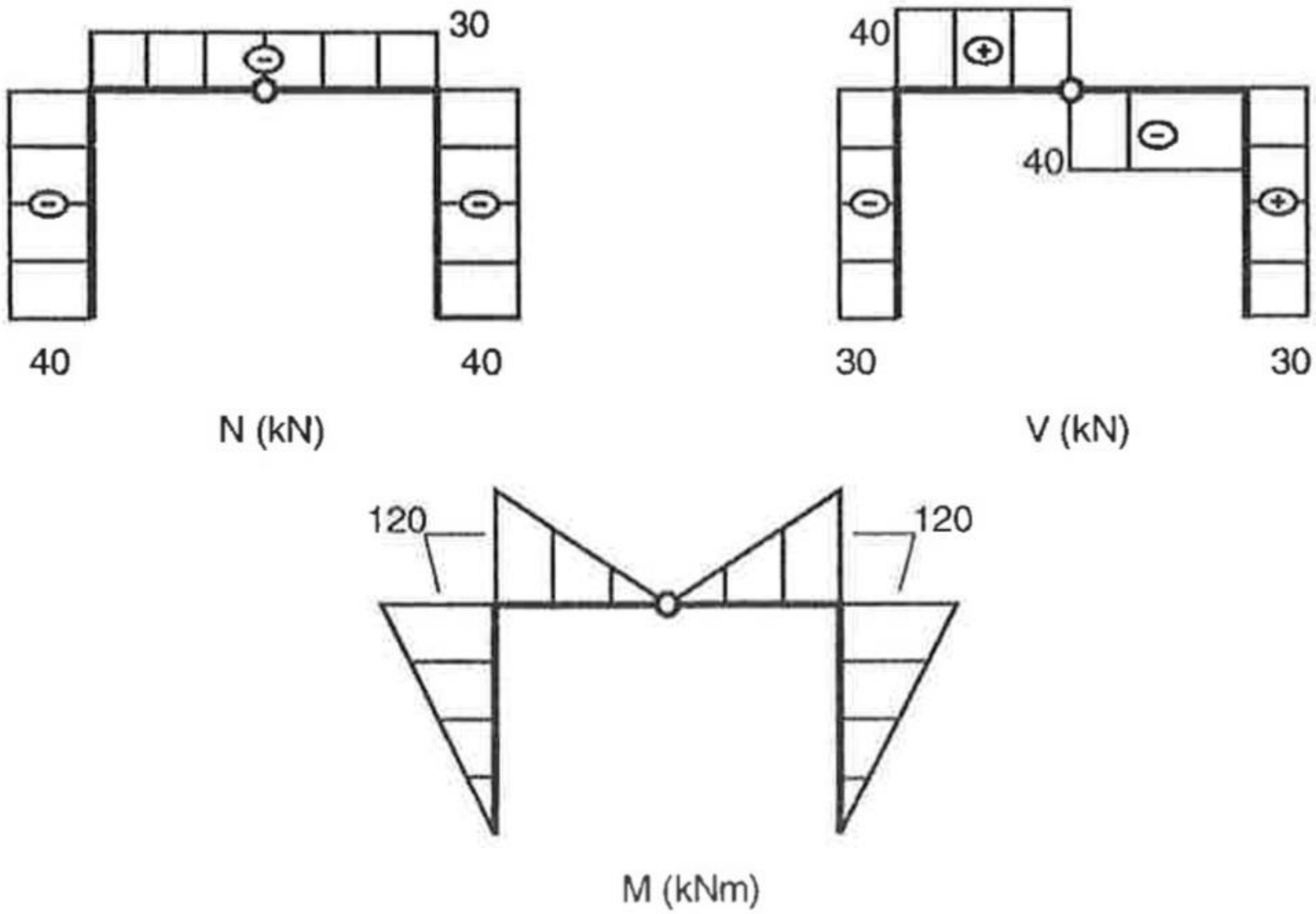




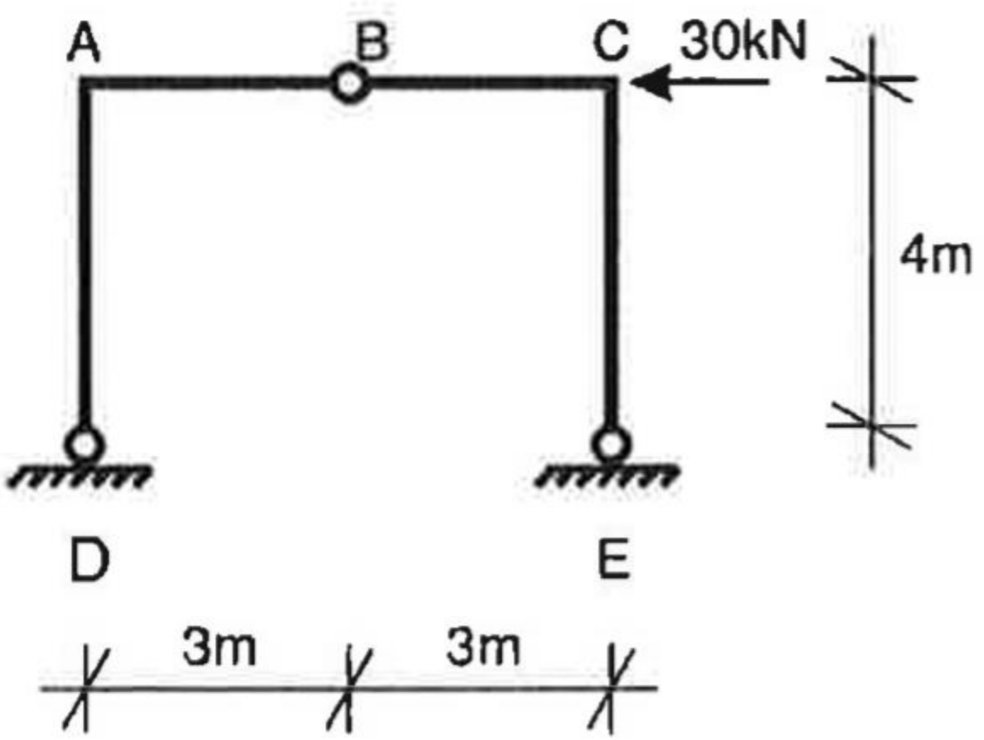
Exemplo 1



Diagramas:



Exemplo 2



$$\sum X = 0 \qquad X_D - 30 + X_E = 0$$

$$\sum Y = 0 \qquad Y_D + Y_E = 0$$

$$\sum M_D = 0 \qquad 30 \cdot 4 + Y_E \cdot 6 = 0$$

$$M_{fletor\ em\ B} = 0 \qquad -X_D \cdot 4 + Y_D \cdot 3 = 0$$

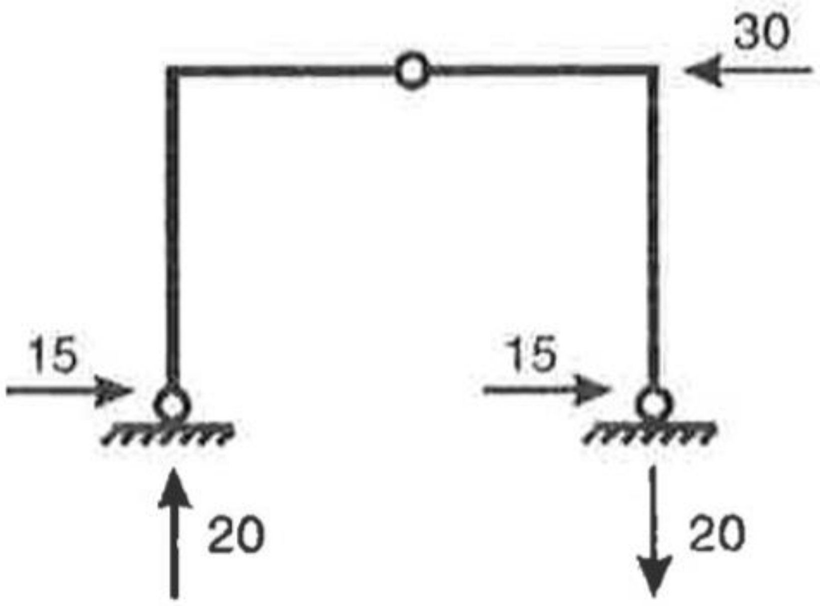
$$X_D = 15\ kN$$

$$Y_D = 20\ kN$$

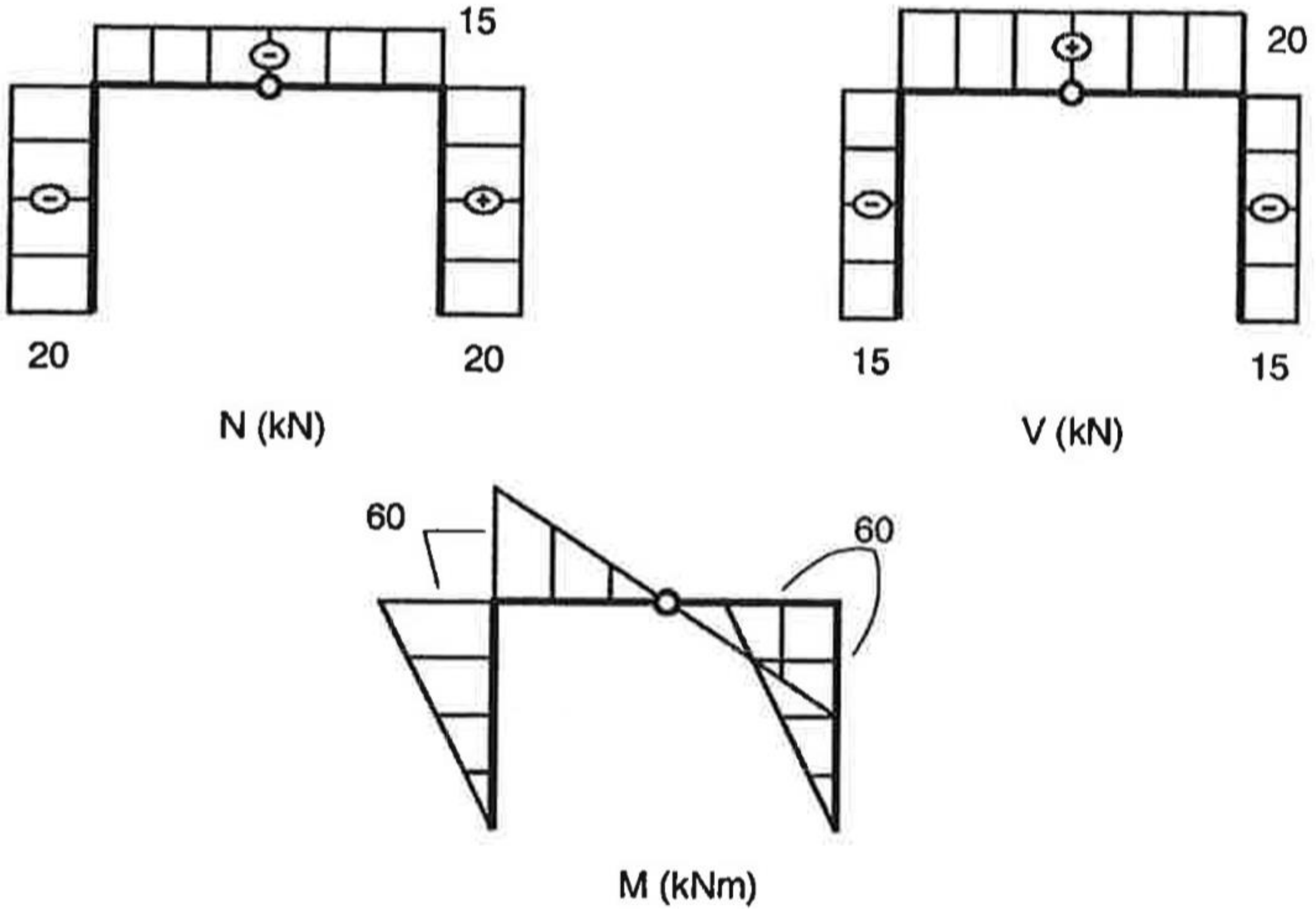
$$X_E = 15\ kN$$

$$Y_E = -20\ kN$$

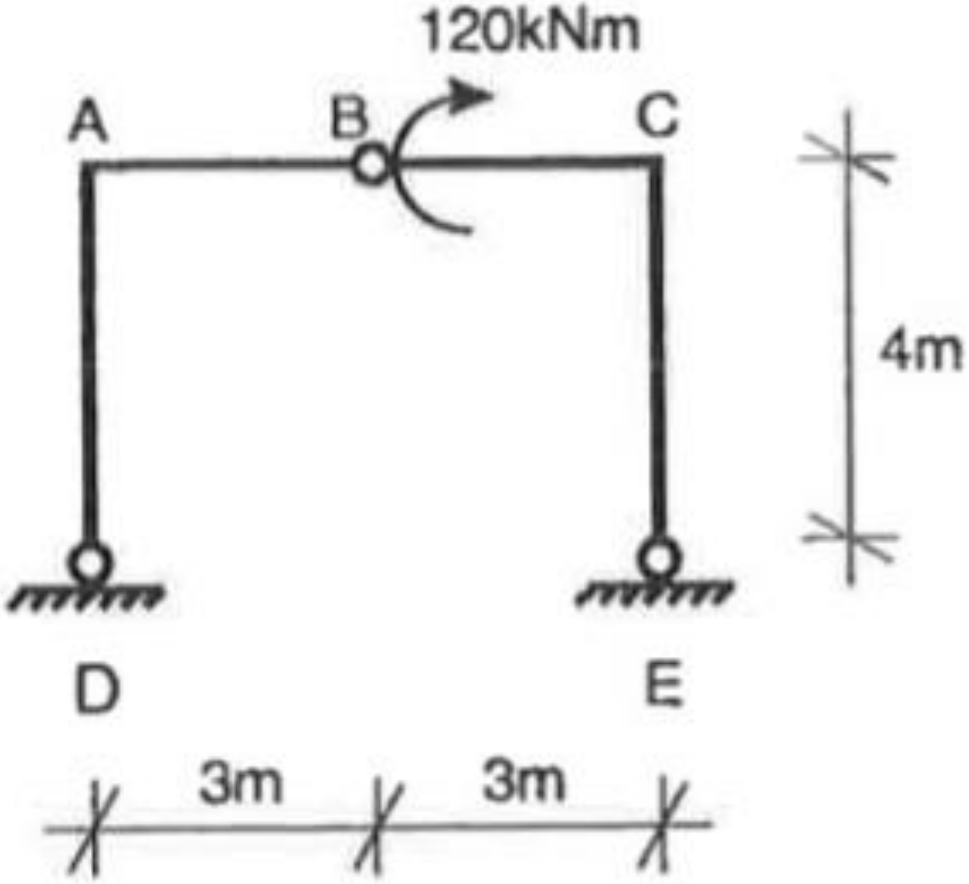
Exemplo 2

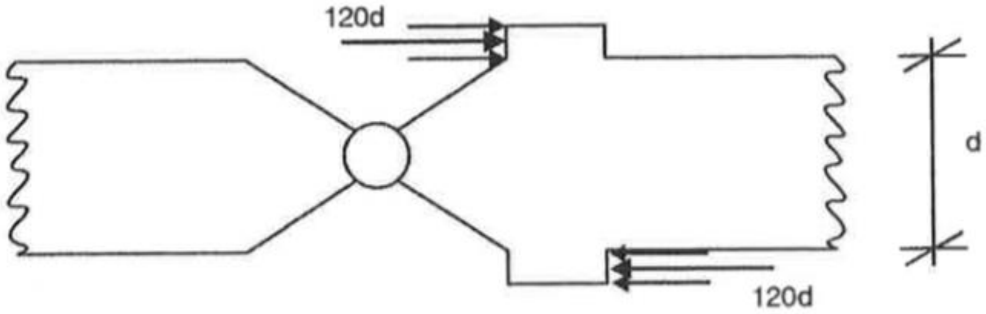


Diagramas:

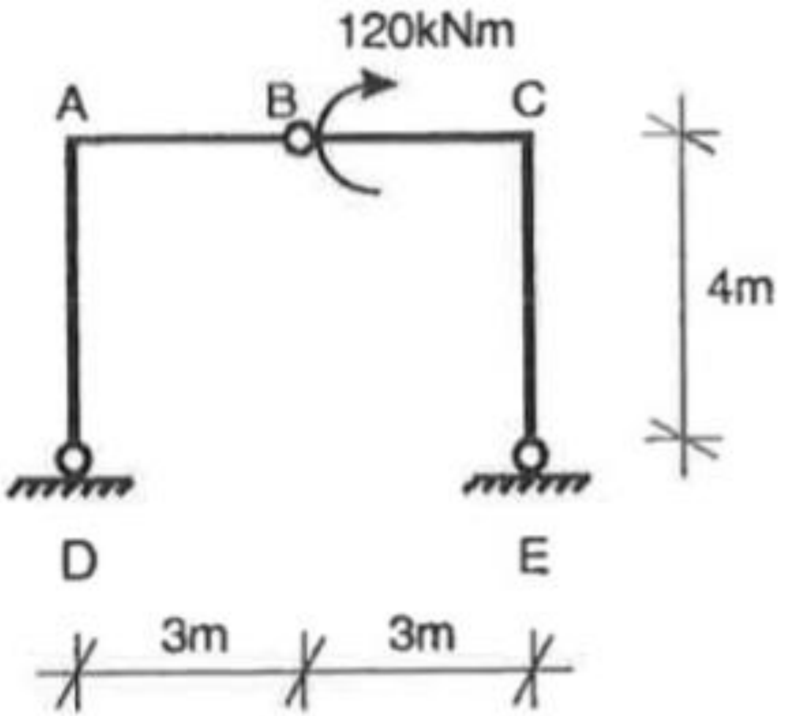


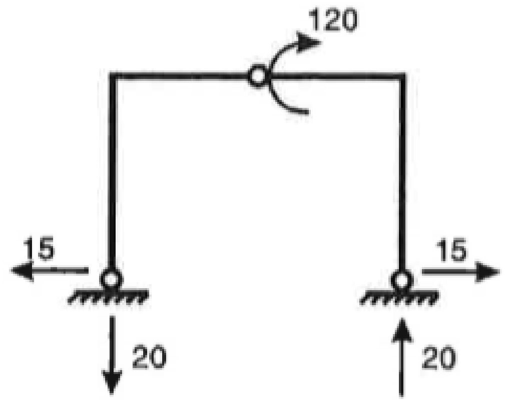
Exemplo 3



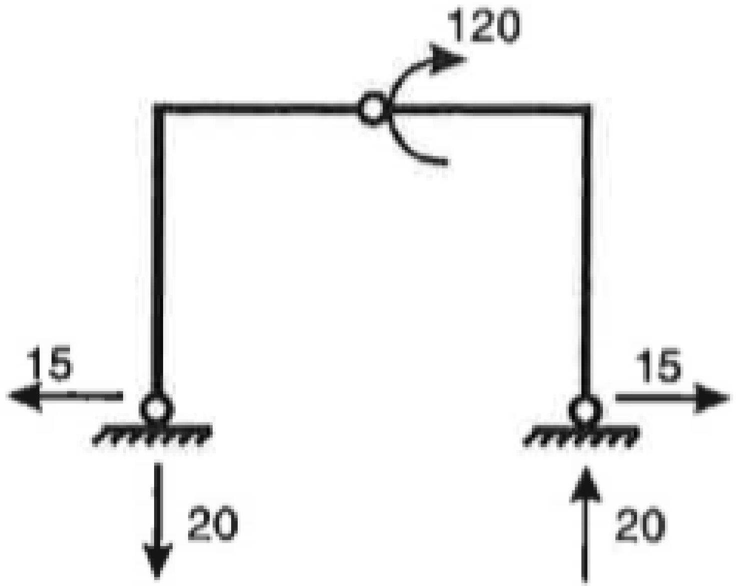


Exemplo 3

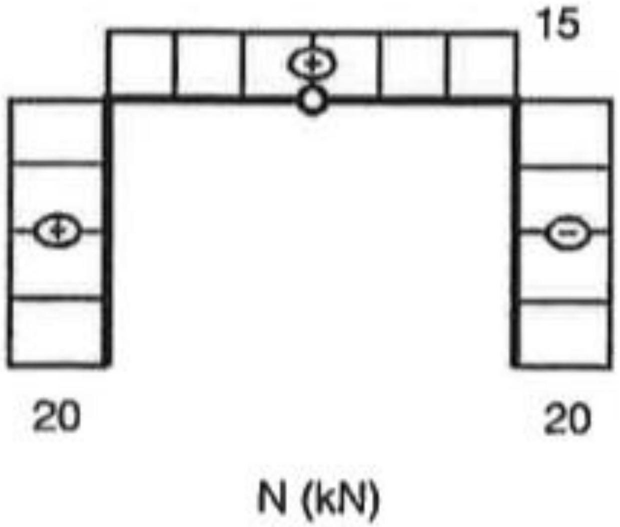


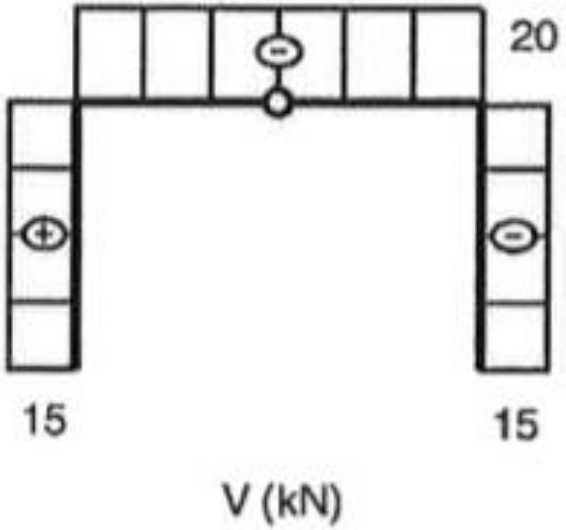


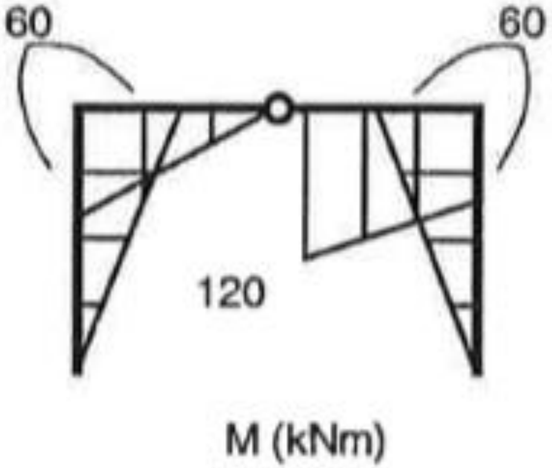
Exemplo 3



Diagramas:







Exemplo 4: Pórtico triarticulado - Galpão

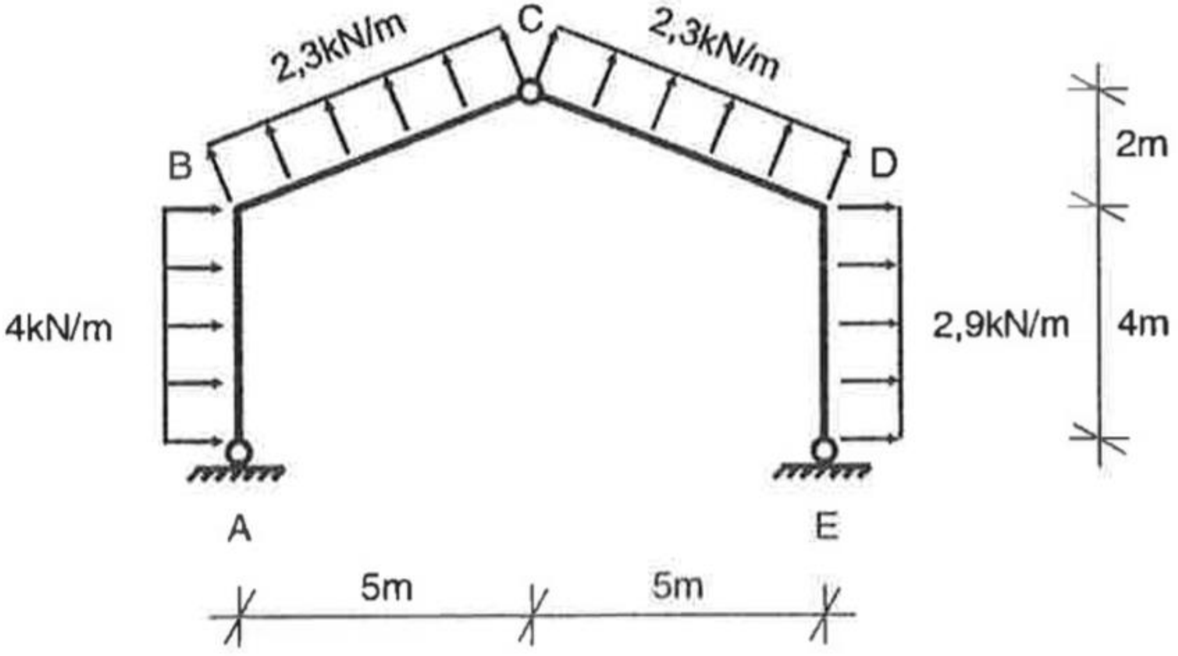
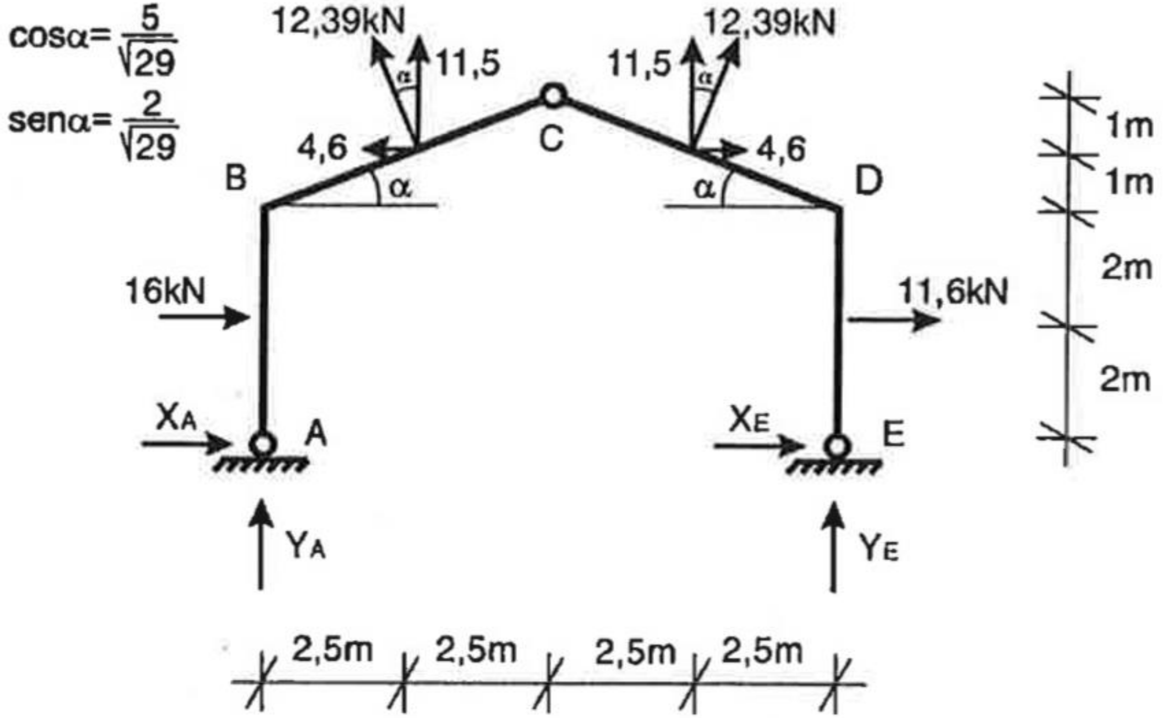


Figura 8.39



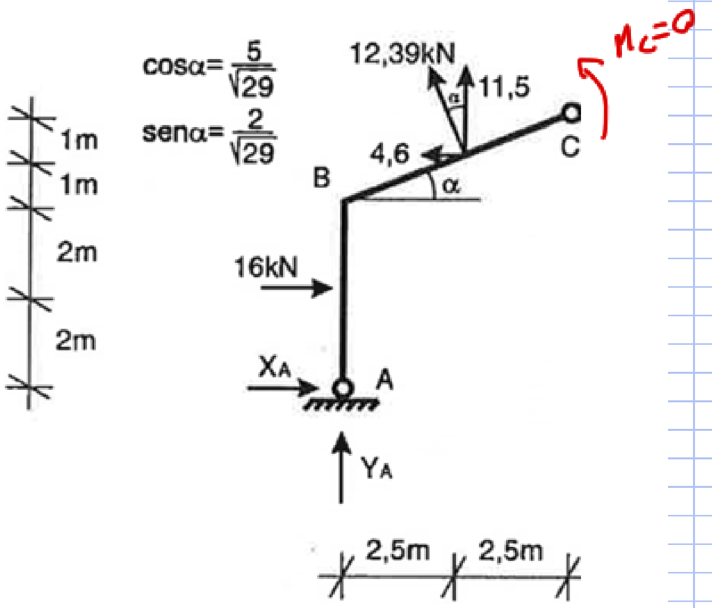
Exemplo: Pórtico triarticulado

$\sum X = 0 \qquad X_A + 16{,}0 - 4{,}6 + 4{,}6 + 11{,}6 + X_E = 0$

$\sum Y = 0 \qquad Y_A + 11{,}5 + 11{,}5 + Y_E = 0$

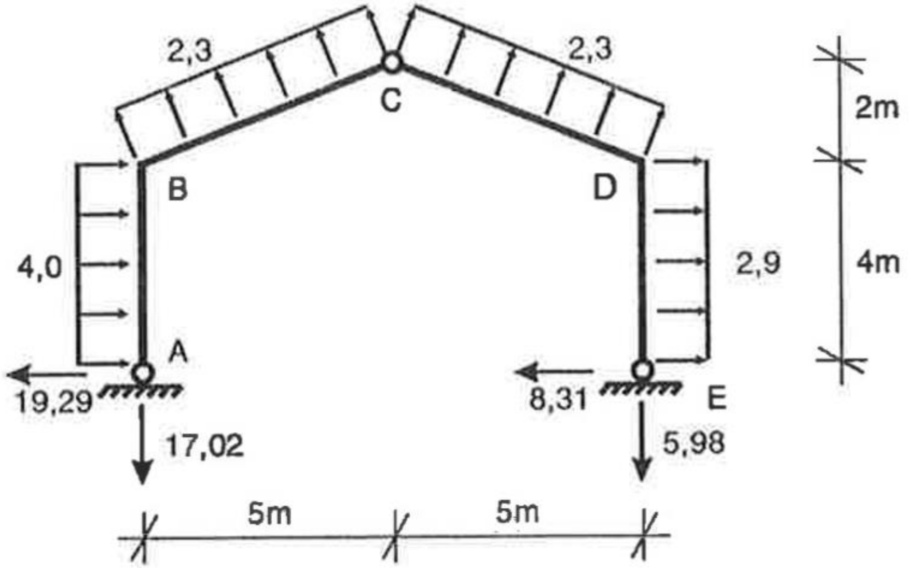
$\sum M_A = 0 \qquad -16{,}0 \cdot 2{,}0 + 4{,}6 \cdot 5{,}0 + 11{,}5 \cdot 2{,}5 + 11{,}5 \cdot 7{,}5 - 4{,}6 \cdot 5{,}0 -$
$-11{,}6 \cdot 2{,}0 + Y_E \cdot 10{,}0 = 0$

$M_{fletor\ em\ C} = 0 \quad -X_A \cdot 6{,}0 + Y_A \cdot 5{,}0 - 16{,}0 \cdot 4{,}0 + 4{,}6 \cdot 1{,}0 + 11{,}5 \cdot 2{,}5 = 0$

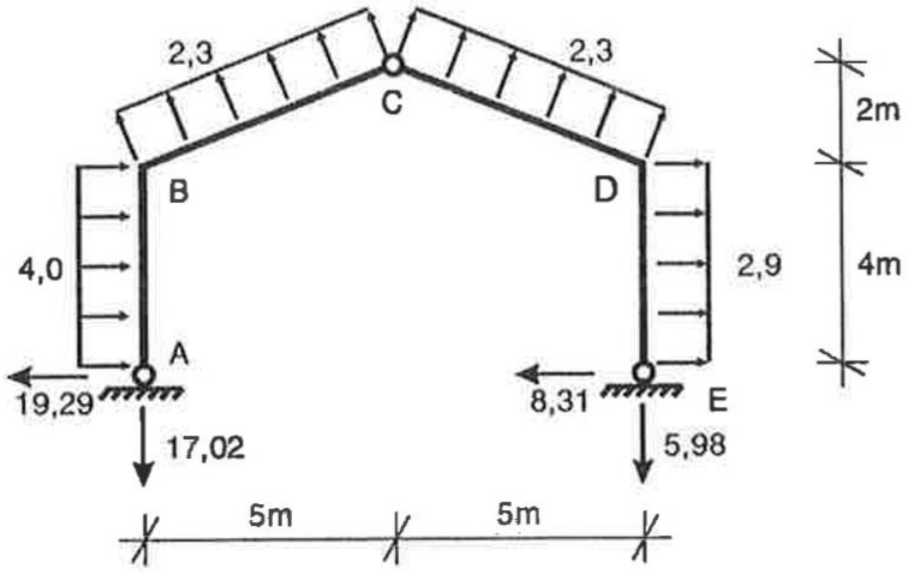


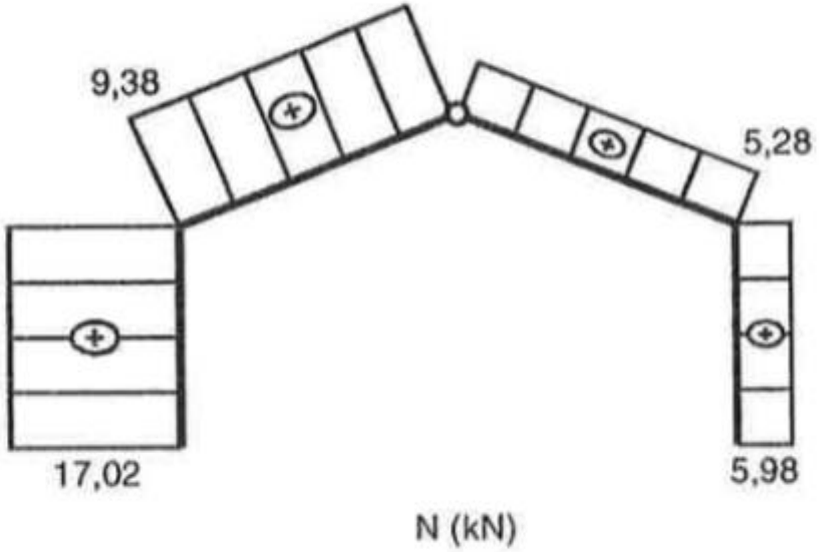
$$+\circlearrowleft \sum M_C = 0$$

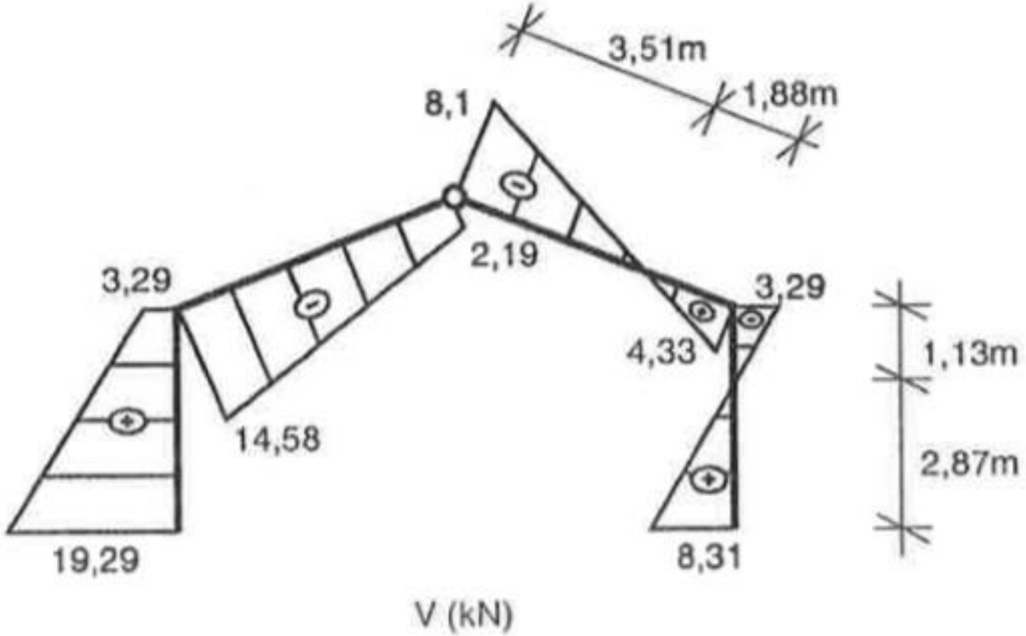
$$Y_A \cdot 5 + 11{,}5 \cdot 2{,}5 + 4{,}6 \cdot 1 - 16 \cdot 4 - X_A \cdot 6 = 0$$



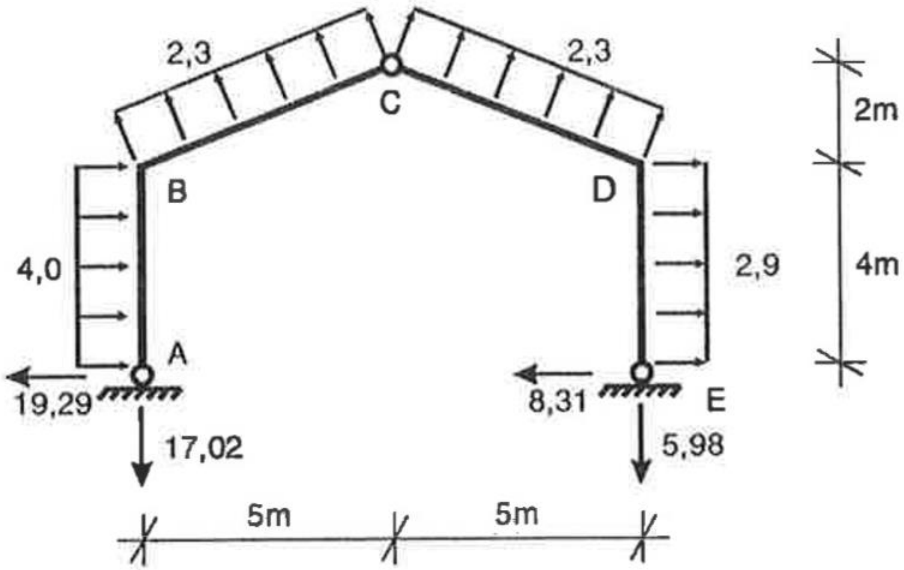
Diagramas:

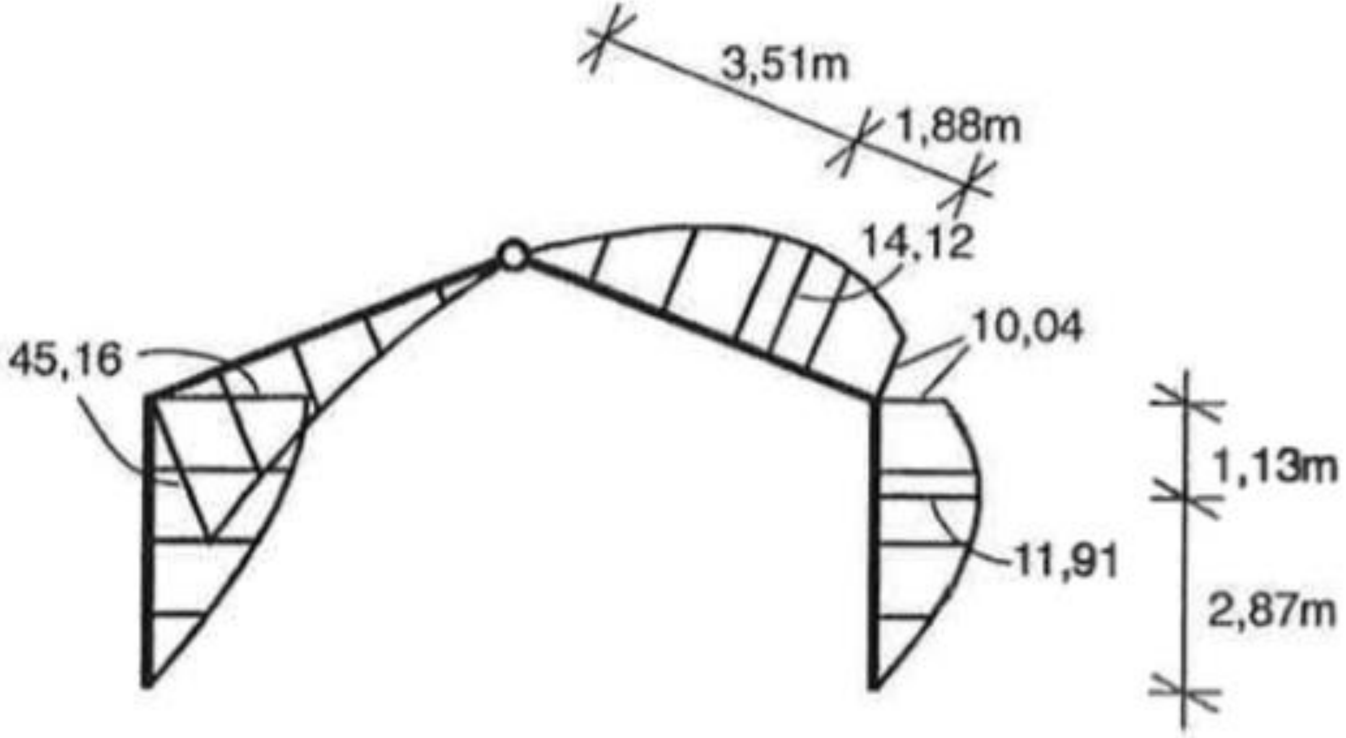

2,3
2,3
C
B
D
4,0
2,9
A
E
19,29
8,31
17,02
5,98
5m
5m
2m
4m


9,38
5,28
17,02
5,98
N (kN)


3,51m
1,88m
8,1
2,19
3,29
3,29
4,33
14,58
1,13m
2,87m
19,29
8,31
V (kN)

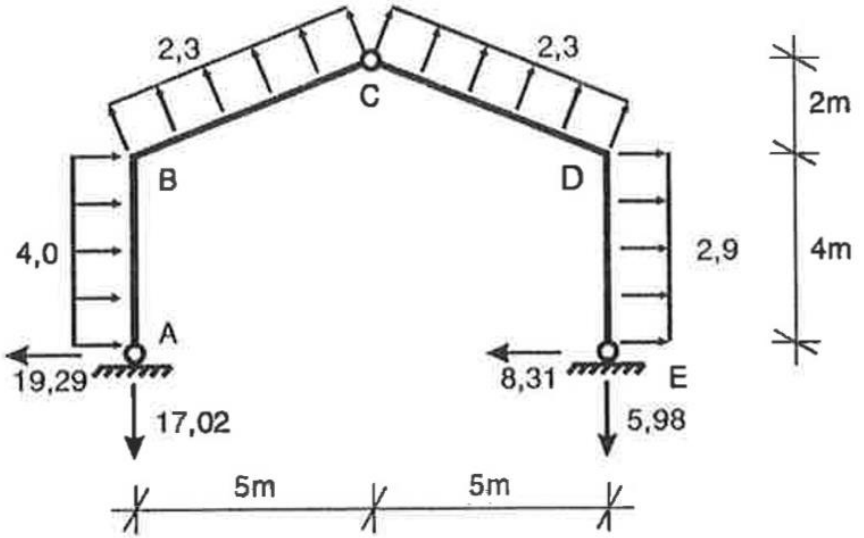
Diagramas:

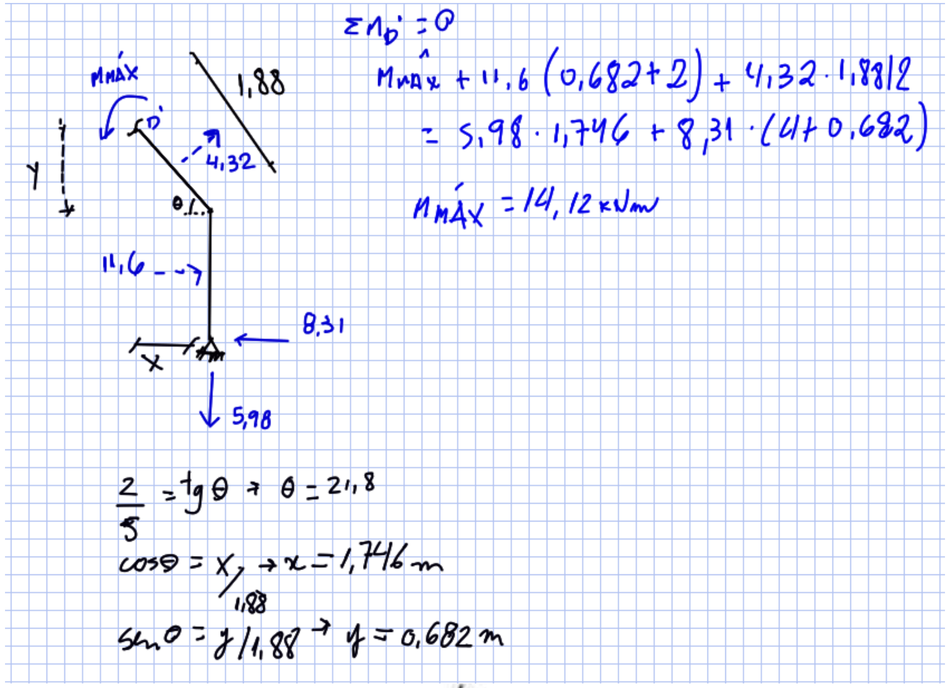


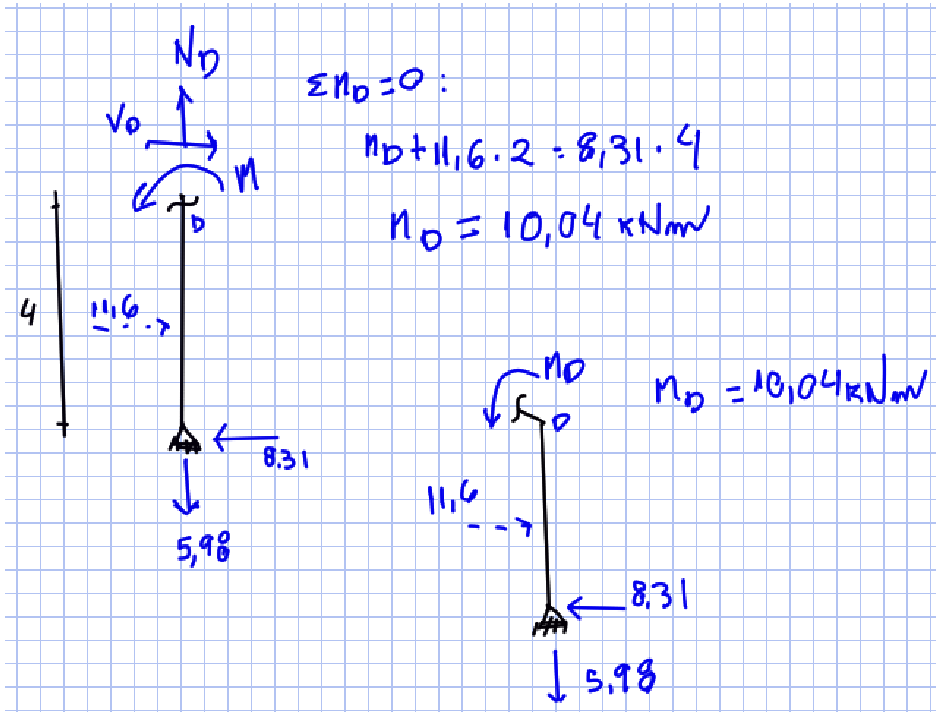


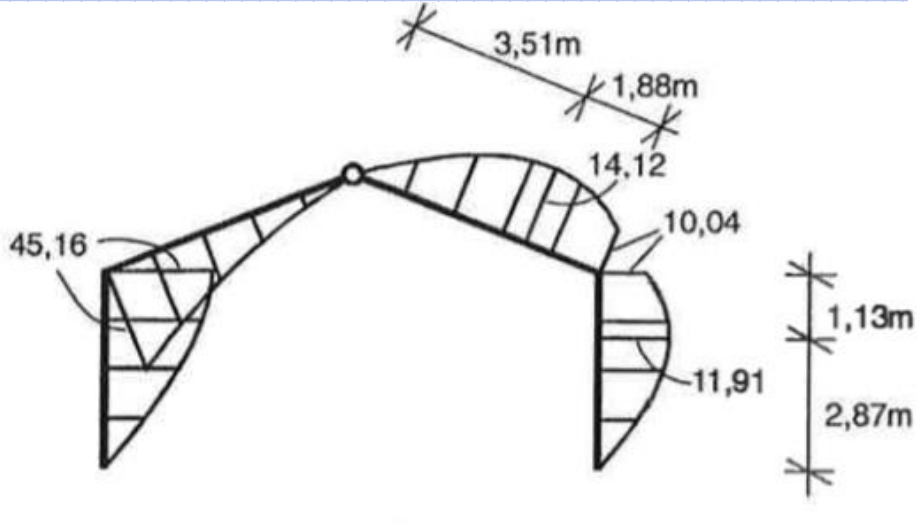
M (kNm)

Exemplo: Pórtico triarticulado



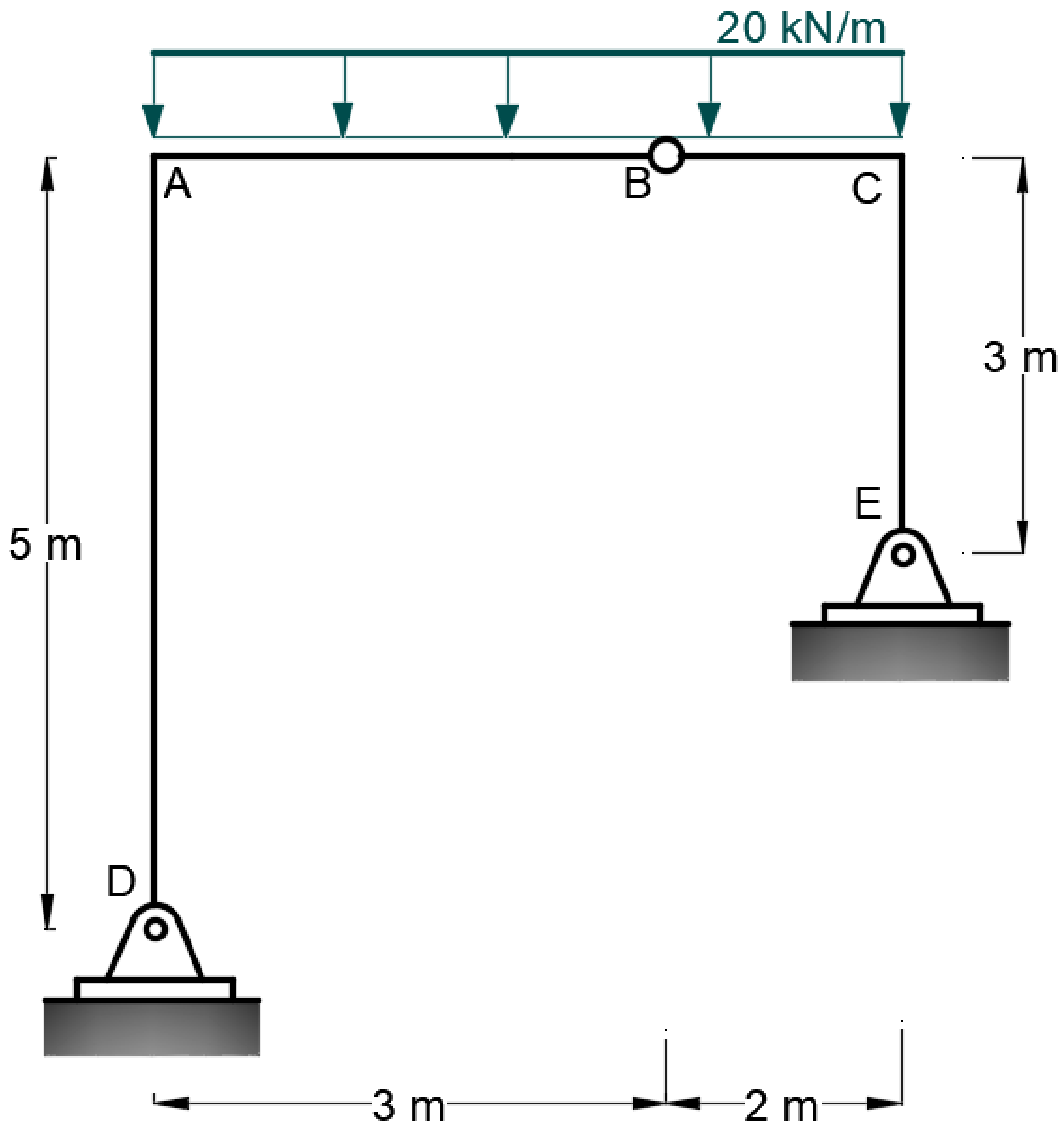






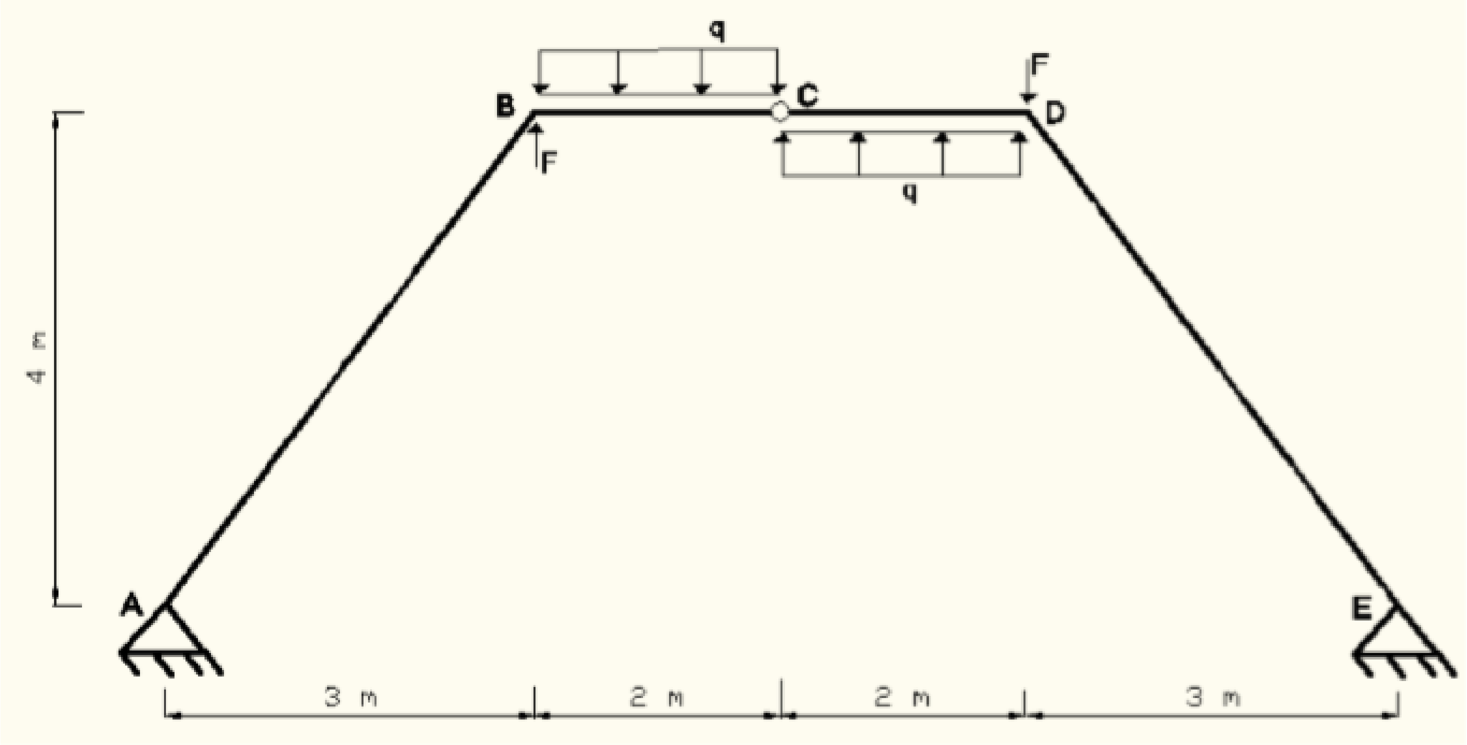
M (kNm)

Exemplo 5: Apoios em níveis distintos

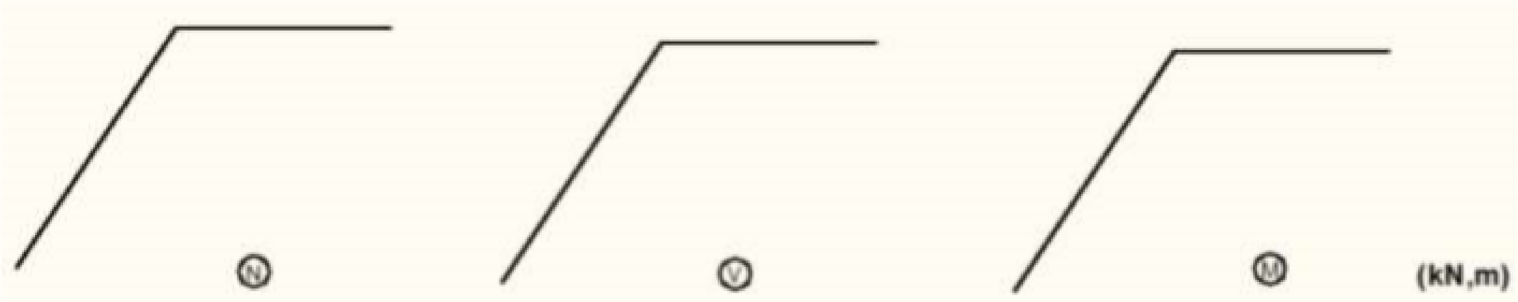


Exemplo 6:
Barras inclinadas

2ª Questão (pontos) Determinar os esforços solicitantes (M, V e N) no pórtico triarticulado **somente nos trechos ABCD**, sob a ações das cargas indicadas. Adote q = 30 kN/m e F = 50 kN. Indique explicitamente os valores e os pontos de momentos extremos. Apresente os diagramas nos desenhos indicados na resposta.

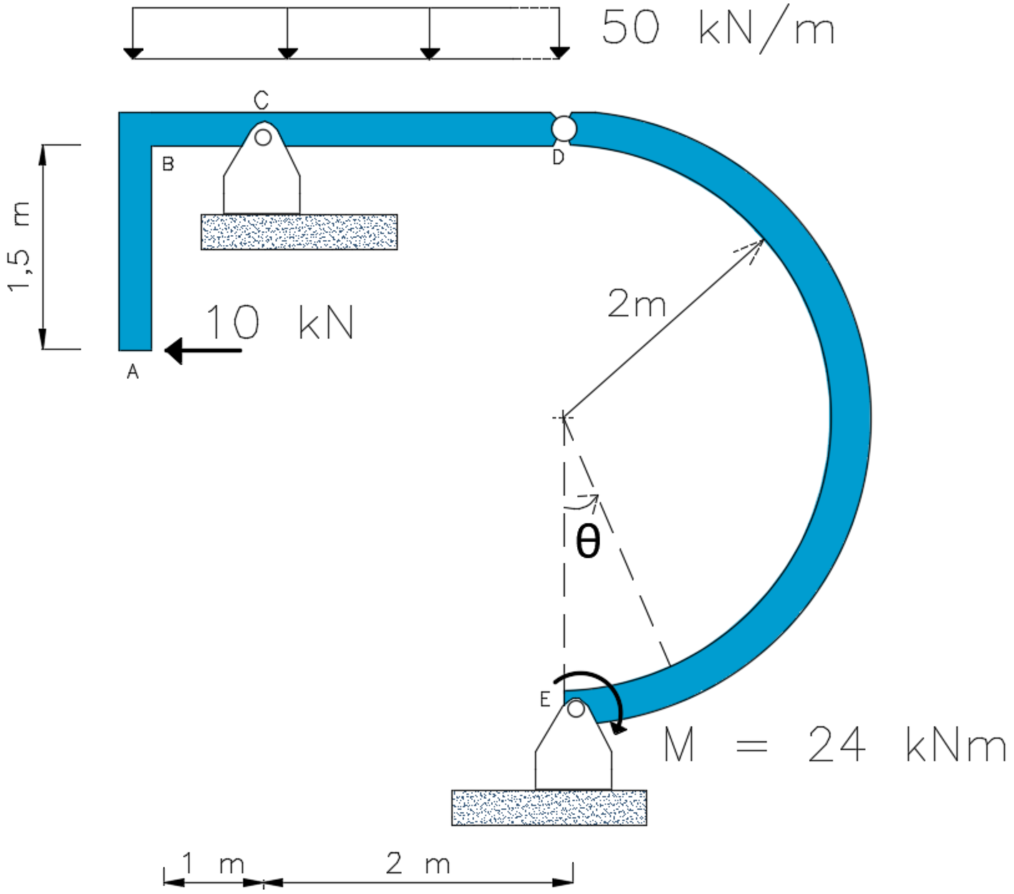


Respostas



3ª Questão (3,0 ptos)/2021:** A figura a seguir representa uma estrutura articulada (rotulada) em D e apoios fixos em C e E. Sob os carregamentos indicados, carga distribuída constante no trecho BD, força concentrada em A (10 kN) e momento concentrado (M = 24 kNm) em E, obtenha:

a) Diagramas dos esforços solicitantes para os trechos ABCD;
b) Para o trecho circular DE, obtenha o valor de momento fletor em kNm na seção em θ = 30°.
Explicite todas as passagens dos cálculos empregados na resolução, para melhor avaliação.



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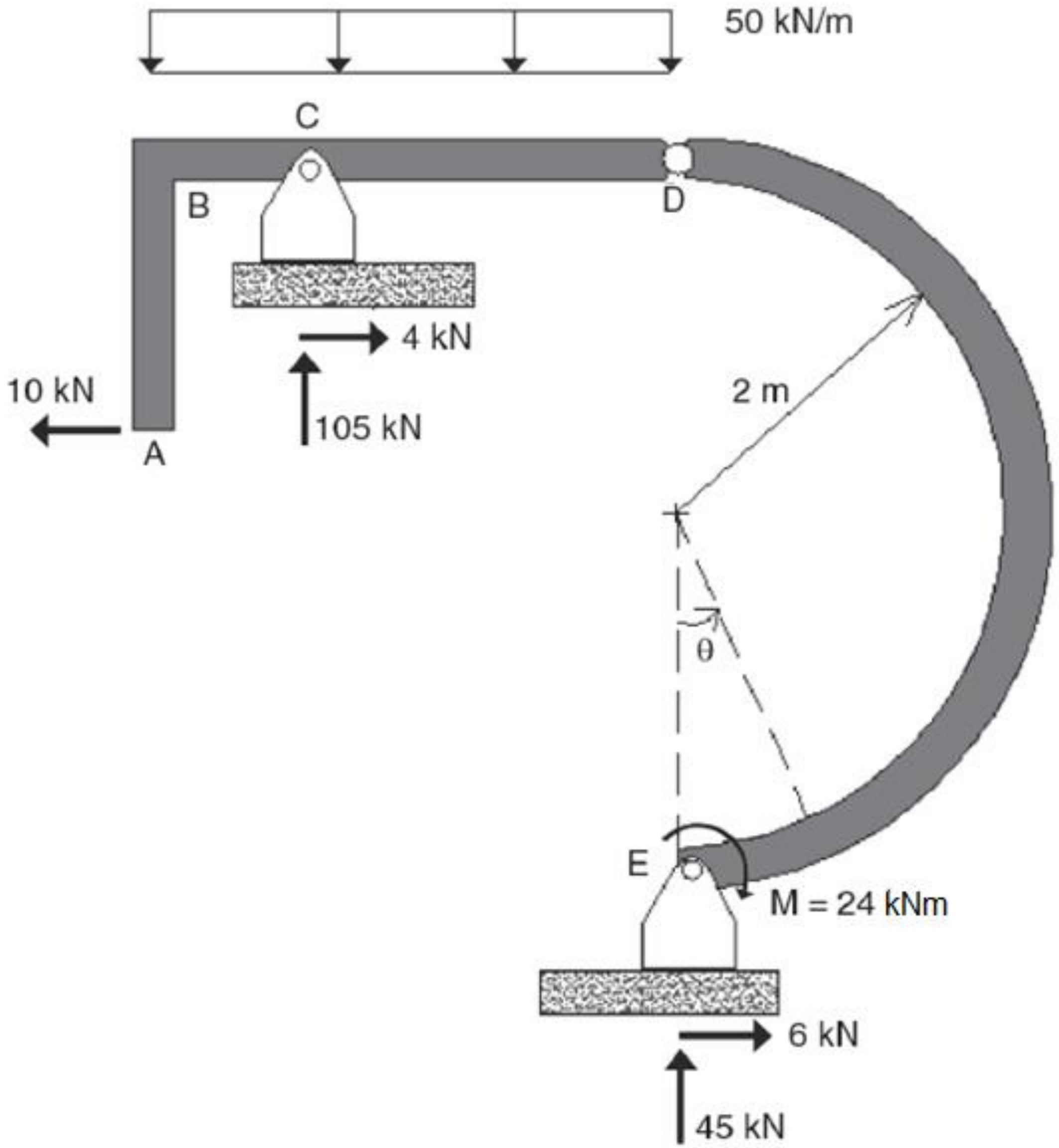
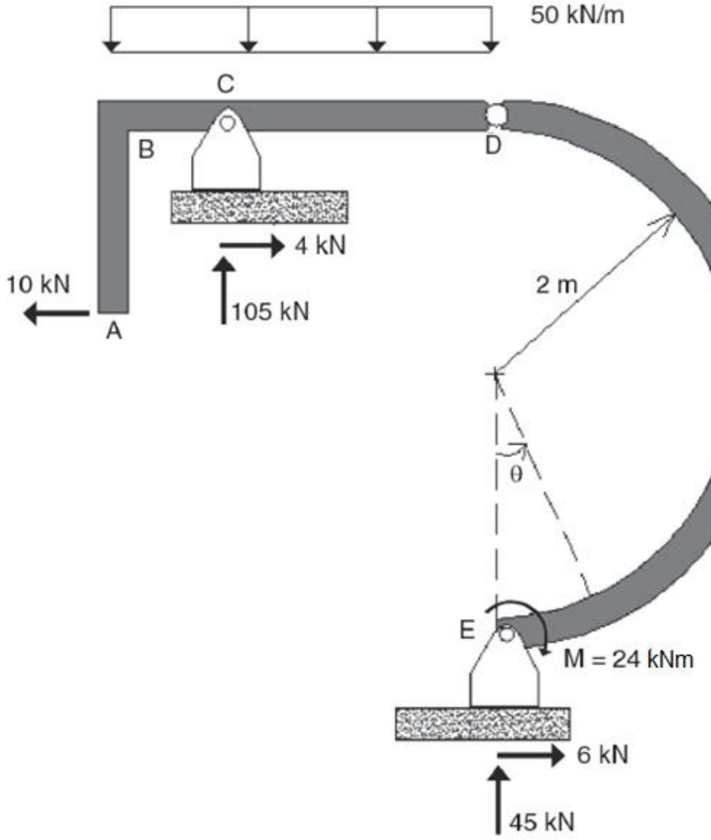


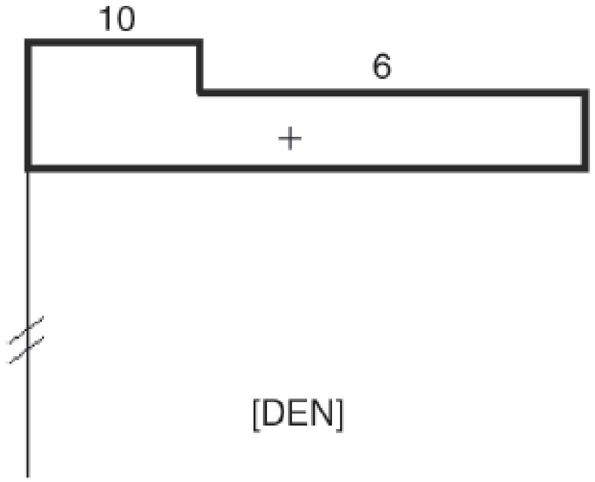
$$\sum M_D = 0 : \rightarrow 4 \cdot E_x = 24 \rightarrow E_x = 6 \text{ kN } (\rightarrow)$$

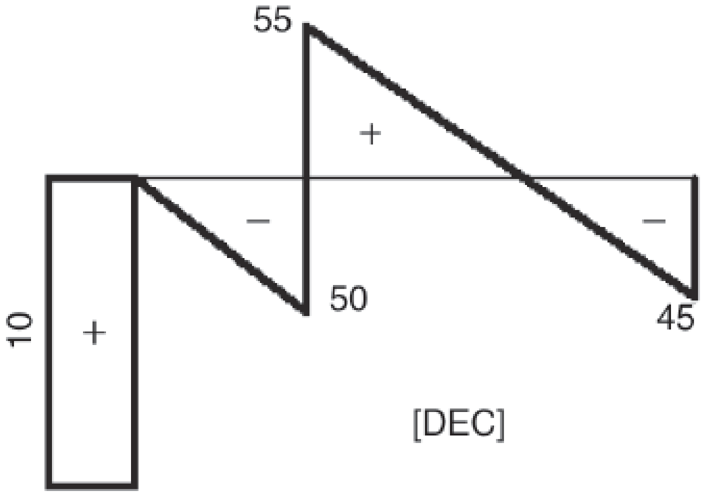
$$\sum F_X = 0 : \rightarrow E_x + C_x = 10 \rightarrow C_x = 4 \text{ kN } (\rightarrow)$$

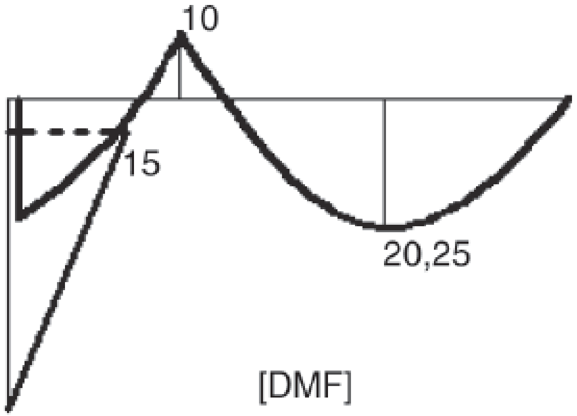
$$\sum M_E = 0 : \rightarrow 2 \cdot C_y + 4 \cdot C_x + 24 = 50 \cdot 3 \cdot 1{,}5 + 10 \cdot 2{,}5 \rightarrow C_y = 105 \text{ kN } (\uparrow)$$

$$\sum F_y = 0 : \rightarrow C_y + E_y = 50 \cdot 3 \rightarrow E_y = 45 \text{ kN } (\uparrow)$$


50 kN/m
C
B
D
4 kN
10 kN
105 kN
A
2 m
θ
E
M = 24 kNm
6 kN
45 kN


10
6
+
[DEN]


55
+
−
−
50
45
10
+
[DEC]


10
15
20,25
[DMF]

(kN, m)

Para o trecho CD são obtidas as equações em termos do ângulo θ, conforme a Figura 1.59D: $N(\theta) = -[6 \cdot \cos(\theta) + 45 \cdot \text{sen}(\theta)]$; $V(\theta) = -6 \cdot \text{sen}(\theta) + 45 \cdot \cos(\theta)$

$M(\theta) = 12 + 90 \cdot \text{sen}(\theta) + 12 \cdot \cos(\theta)$