

**INSTITUTO FEDERAL**  
Sul-rio-grandense

Câmpus  
Passo Fundo

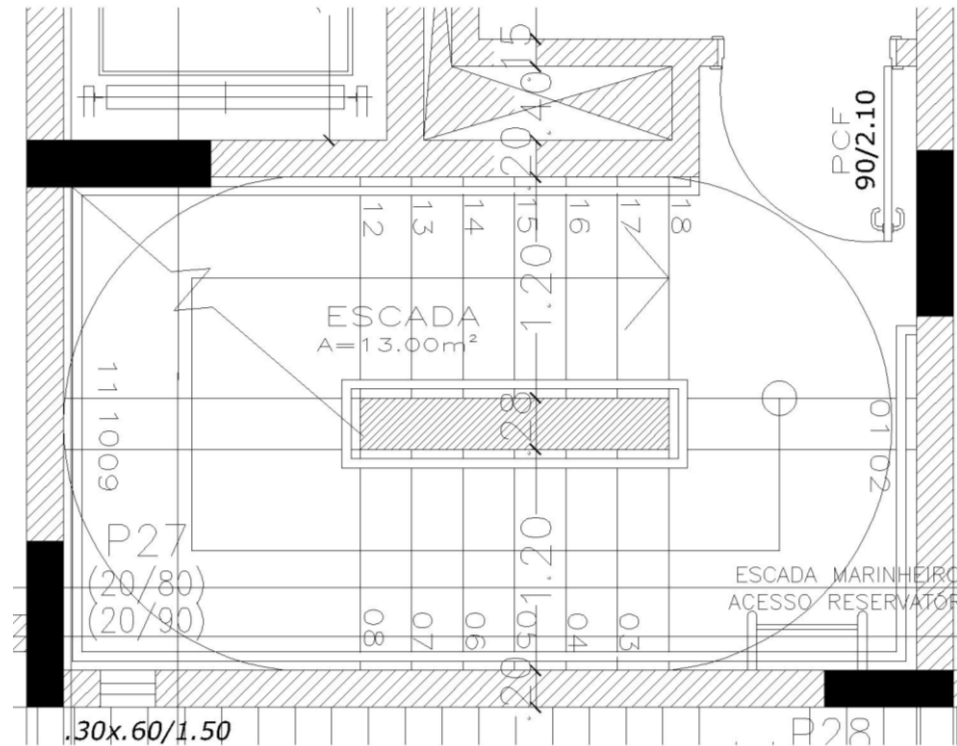
EDUCAÇÃO  
PÚBLICA  
**100%**  
GRATUITA

# Estrutura de Concreto Armado III

## Unidade II - Escadas

Fonte: Araújo, J. M. – Curso de Concreto Armado

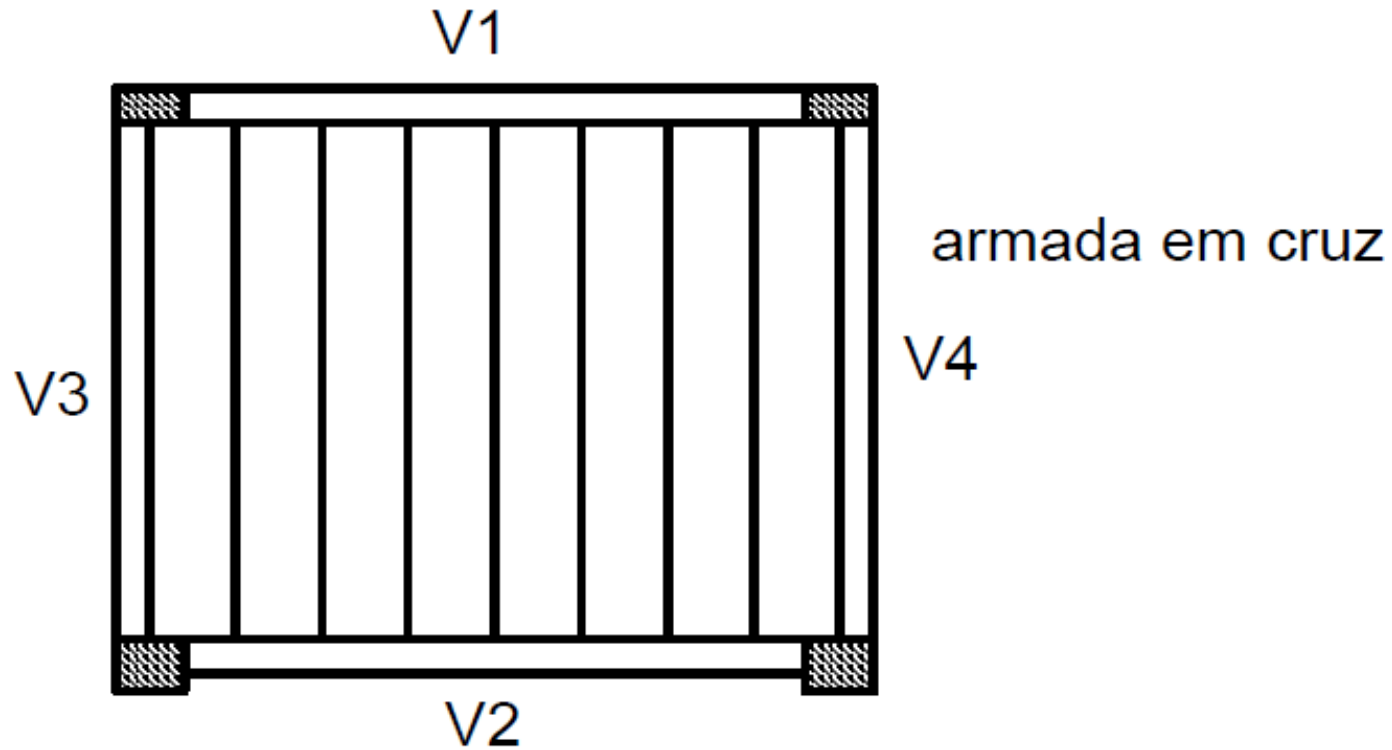
ABNT 9050 – tamanho do degrau



- Como projetar esta escada?
  - Qual é o comportamento estrutural desta escada?
  - Qual é o elemento estrutural mais parecido com uma escada?

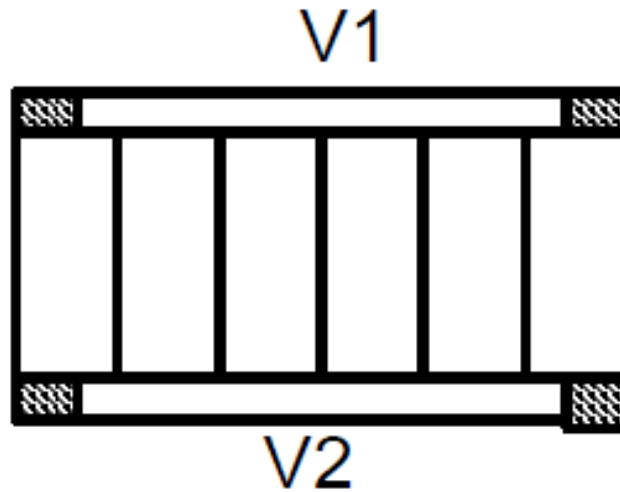


- Analogia com lajes maciças





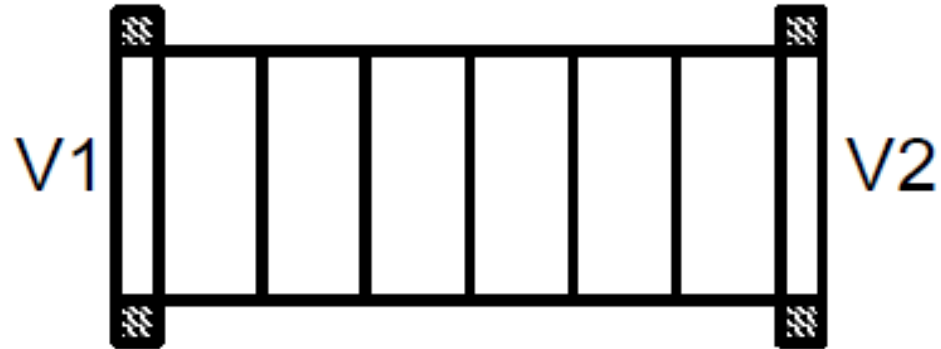
- Analogia com lajes maciças



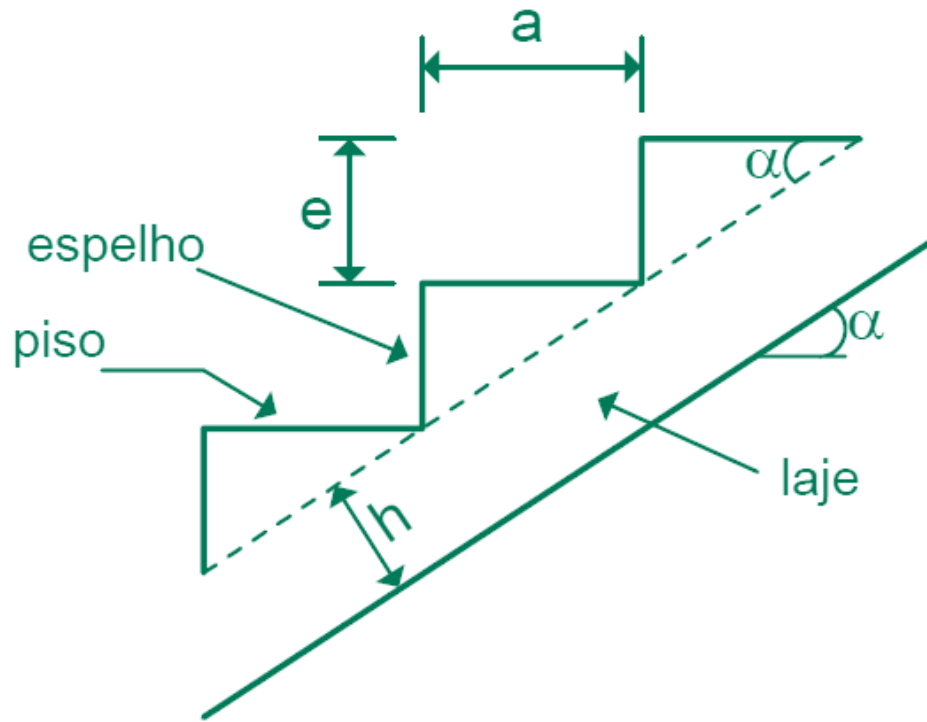
armada transversalmente



- Analogia com lajes maciças



armada longitudinalmente



- Fórmula de Blondel:

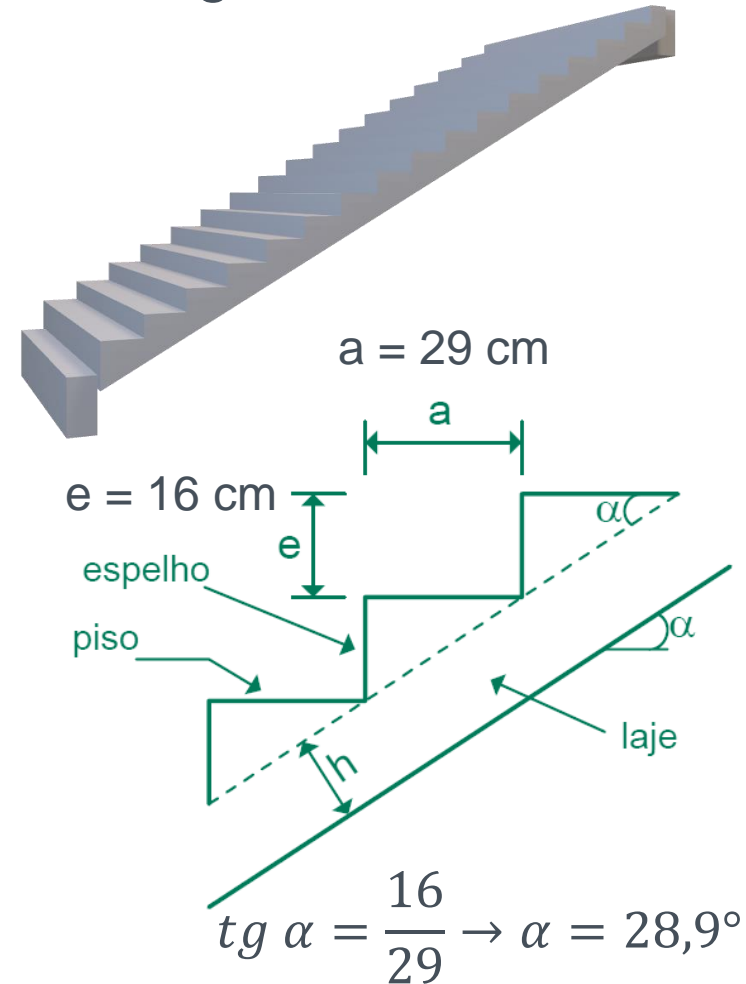
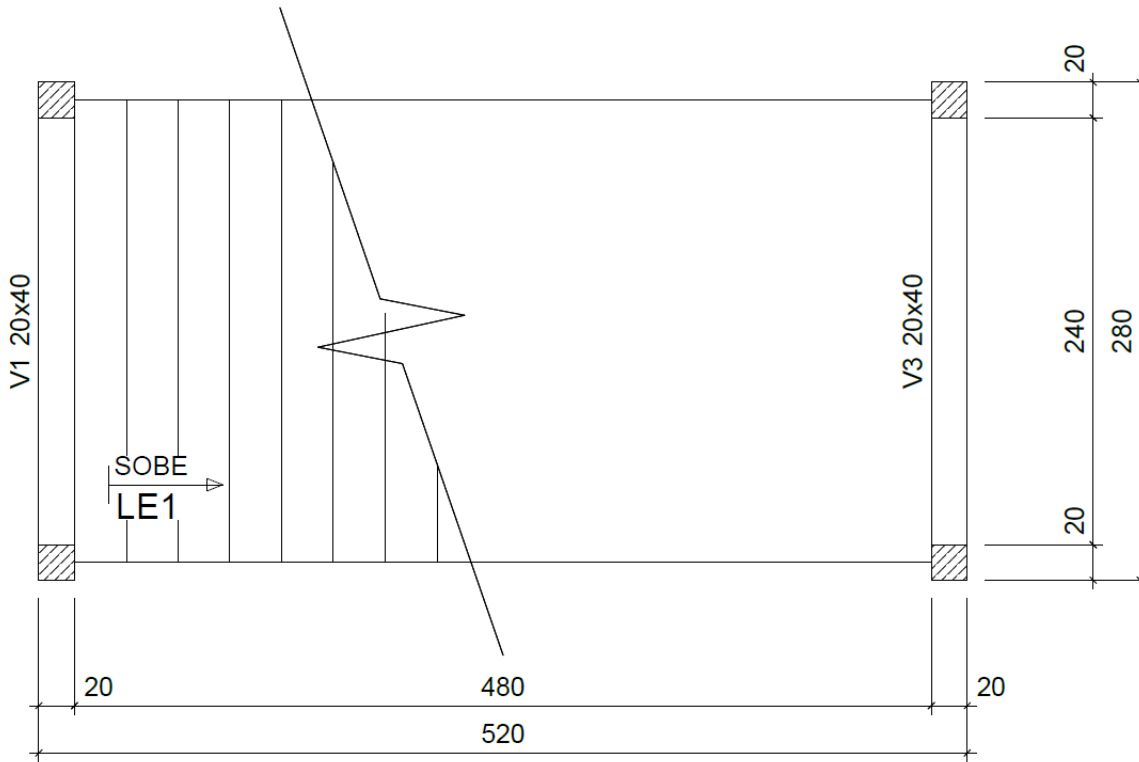
$$a + 2.e = 64 \text{ cm}$$

$$\text{tg } \alpha = \frac{e}{a}$$



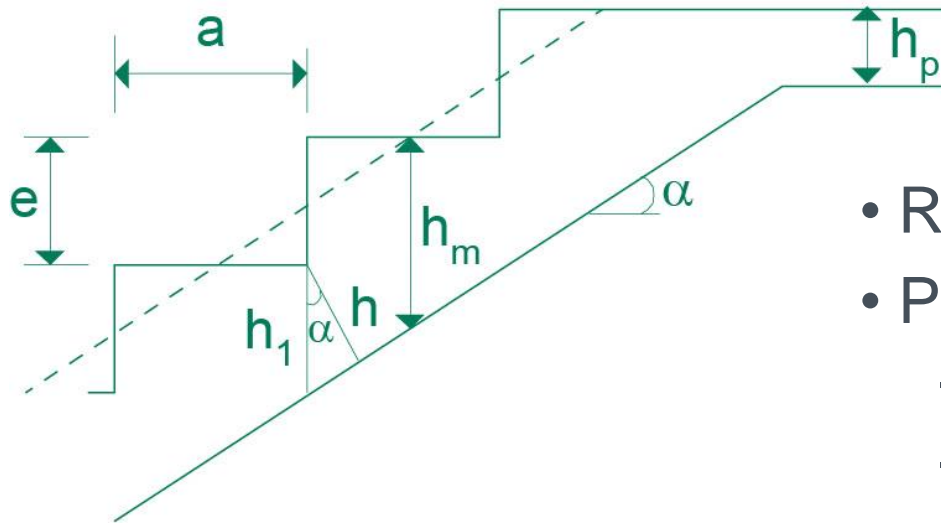
# Exemplo: escada de um lance

- Laje apoiada nas vigas da base e topo → Longitudinal





- Peso próprio: carga vertical  
→ projeção horizontal da escada



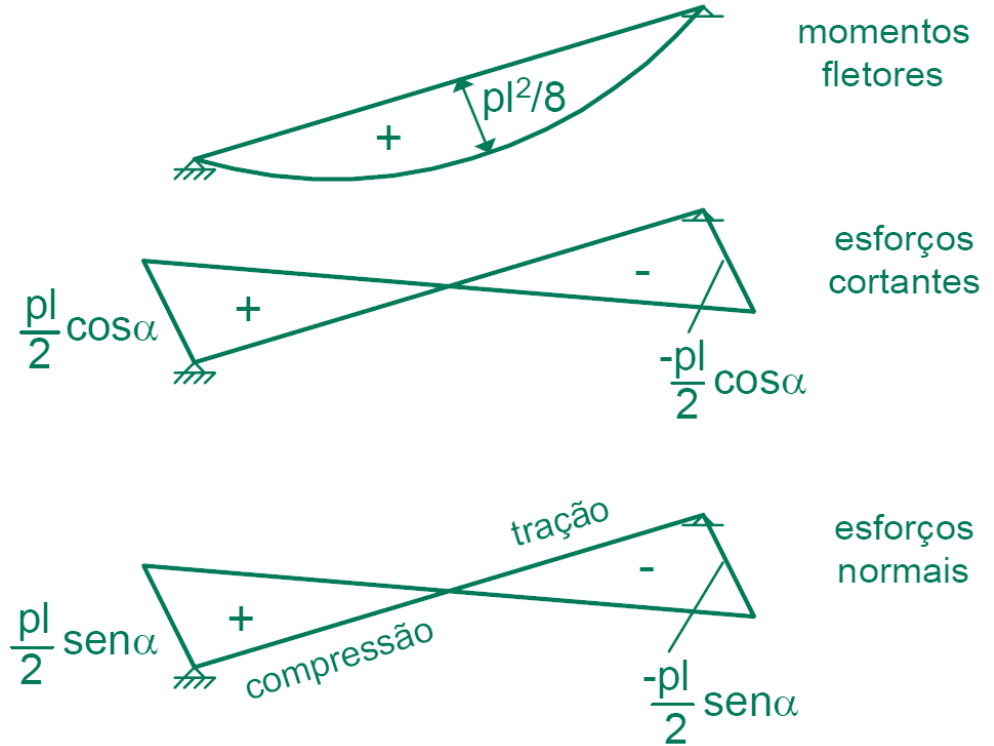
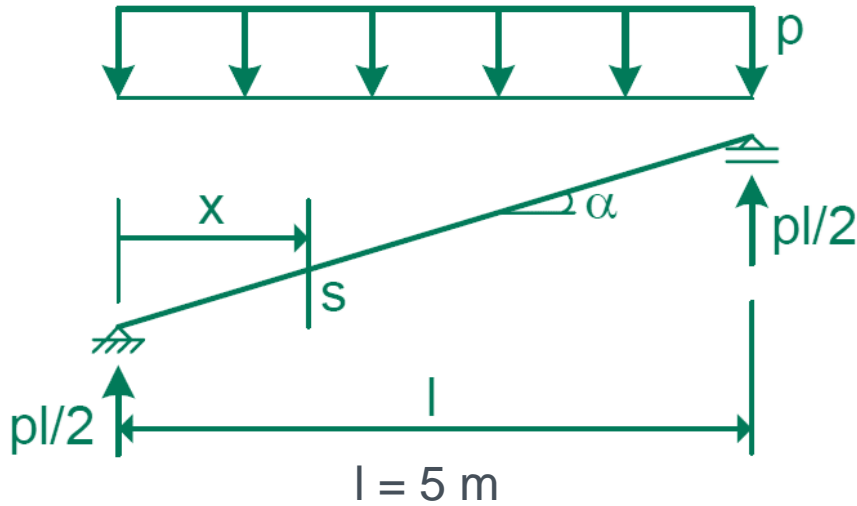
$$h_m = h_1 + \frac{e}{2}$$

- Revestimento (1,0 kN/m<sup>2</sup>)
- Parapeitos
  - Peso próprio
  - Acidental: Horizontal (0,8 kN) + Vertical (2,0 kN)
- Sobrecarga:
  - Sem acesso público: 2,5 kN/m<sup>2</sup>
  - Com acesso público: 3,0 kN/m<sup>2</sup>



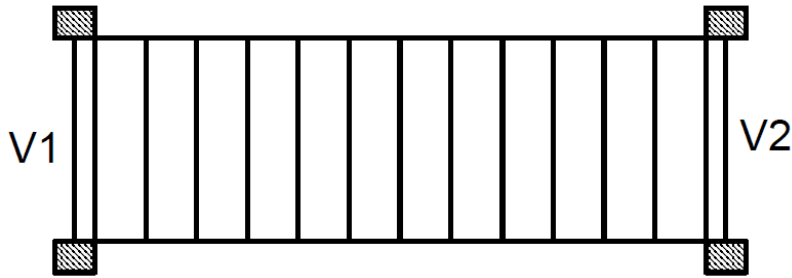


- Viga inclinada

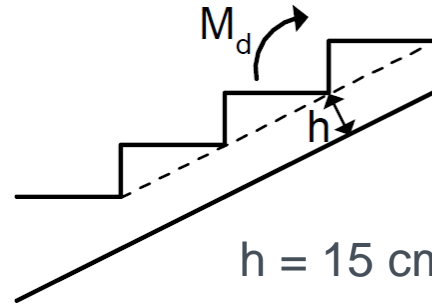




- Laje apoiada nas vigas da base e topo  $\rightarrow$  Longitudinal

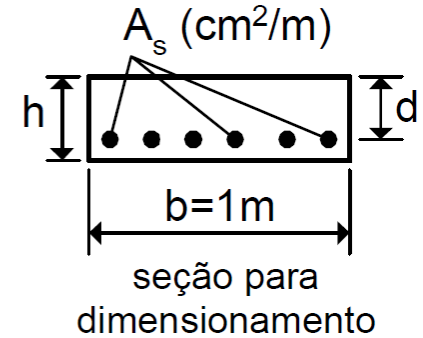


Concreto C-25 e aço CA 50



$h = 15 \text{ cm}$

$d = 13 \text{ cm}$





## Áreas de armadura para lajes

- $A_s / m \rightarrow$  Diâmetro  $\rightarrow$  Área de cada barra  $\rightarrow$  Número de barras
- Número de barras em um metro  $\rightarrow$  Espaçamento

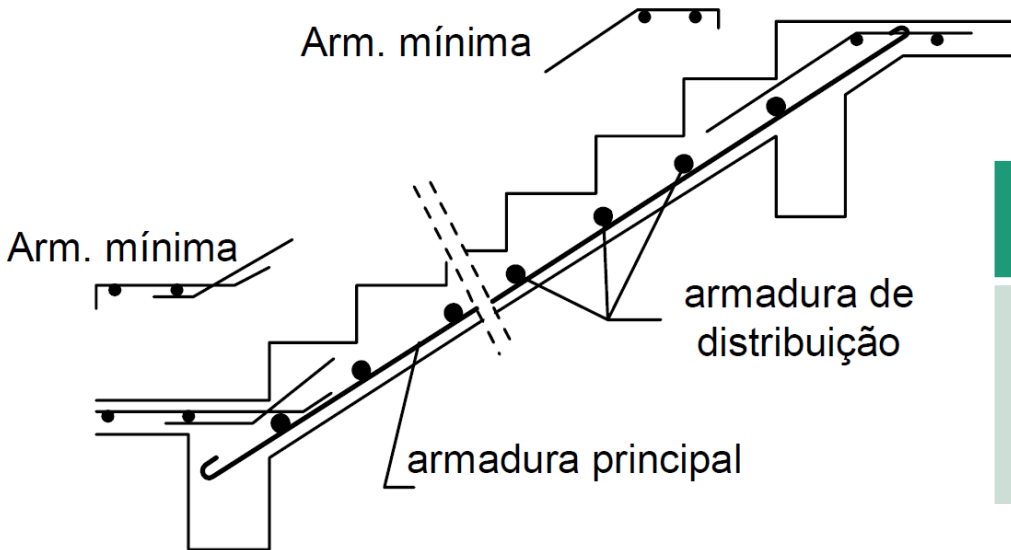
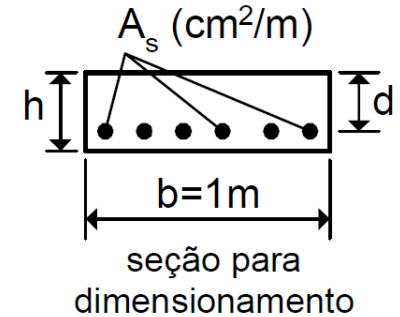
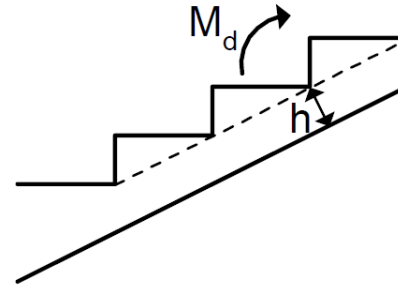
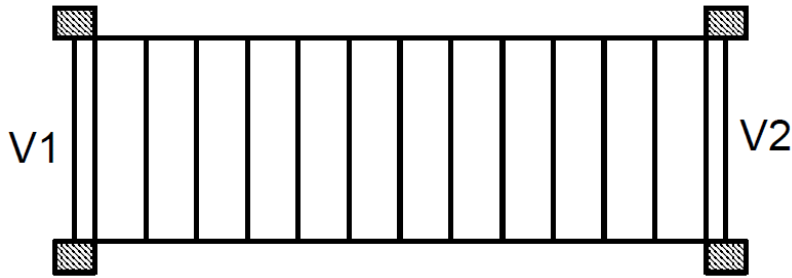
$$\frac{A_s}{m} = \frac{n}{m} \left( \pi \cdot \frac{\phi^2}{4} \right)$$

$$s = \frac{100cm}{n}$$

Lajes - $A_s / s$ (cm <sup>2</sup> /m)													
Diâmetro		Espaçamento (cm)											
Pol	mm	7	8	9	10	12	14	15	16	18	20	25	30
3/16"	5,0	2,80	2,45	2,18	1,96	1,64	1,40	1,31	1,23	1,09	0,98	0,79	0,65
1/4"	6,3	4,45	3,90	3,46	3,12	2,60	2,23	2,08	1,95	1,73	1,56	1,25	1,04
5/16"	8,0	7,18	6,28	5,59	5,03	4,19	3,59	3,35	3,14	2,79	2,51	2,01	1,68
3/8"	10,0	11,22	9,82	8,73	7,85	6,54	5,61	5,24	4,91	4,36	3,93	3,14	2,62
1/2"	12,5	17,53	15,34	13,64	12,27	10,23	8,77	8,18	7,67	6,82	6,14	4,91	4,09
5/8"	16,0	28,72	25,13	22,34	20,11	16,76	14,36	13,40	12,57	11,17	10,05	8,04	6,70



- Laje apoiada nas vigas da base e topo → Longitudinal

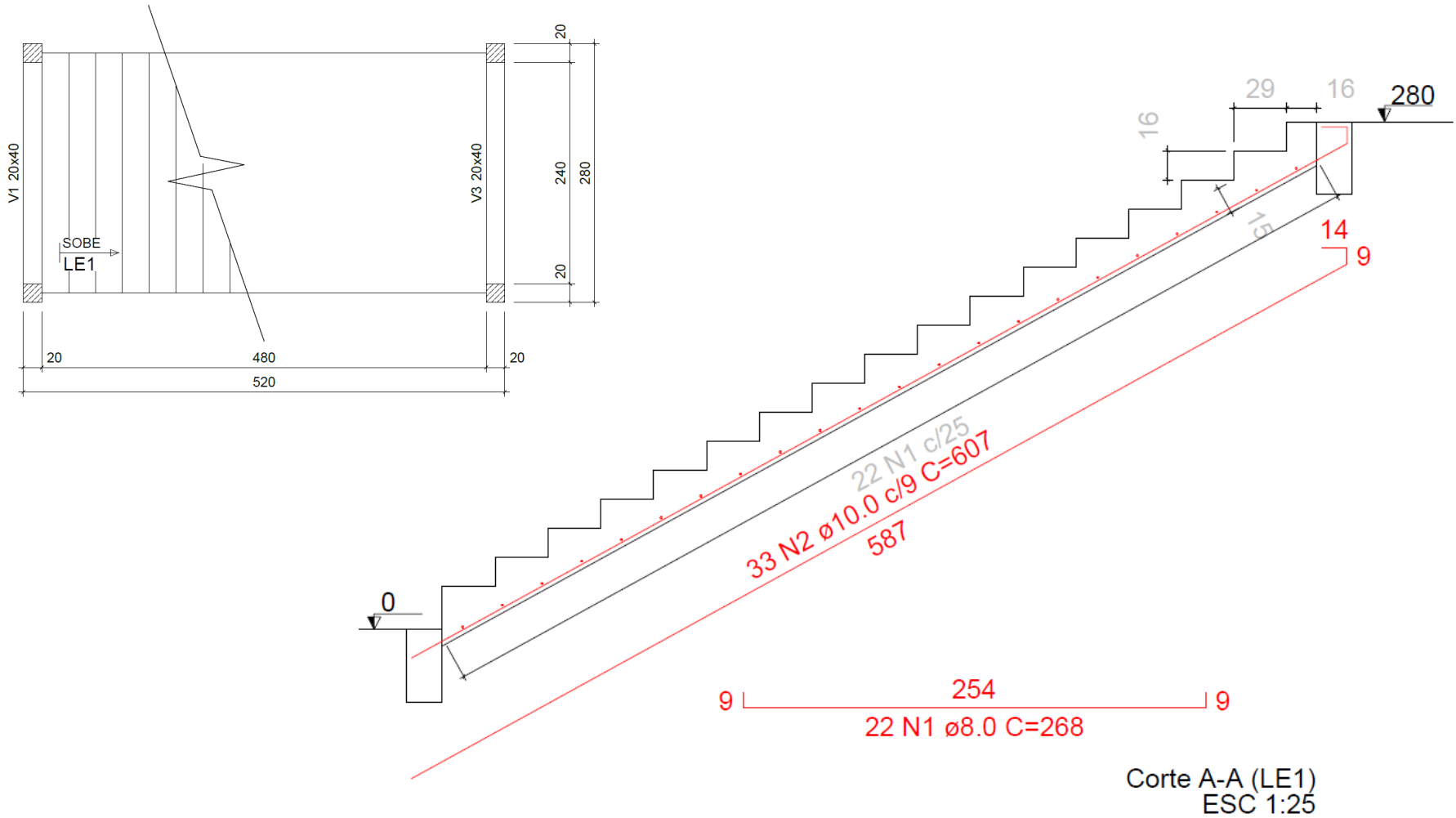


**Disposição das armaduras**

Tipo de Armadura	Mínimo	Espaçamento
Positiva secundária ou de distribuição	20%.As 0,9 cm <sup>2</sup> /m 0,5.ρ <sub>min</sub>	33 cm

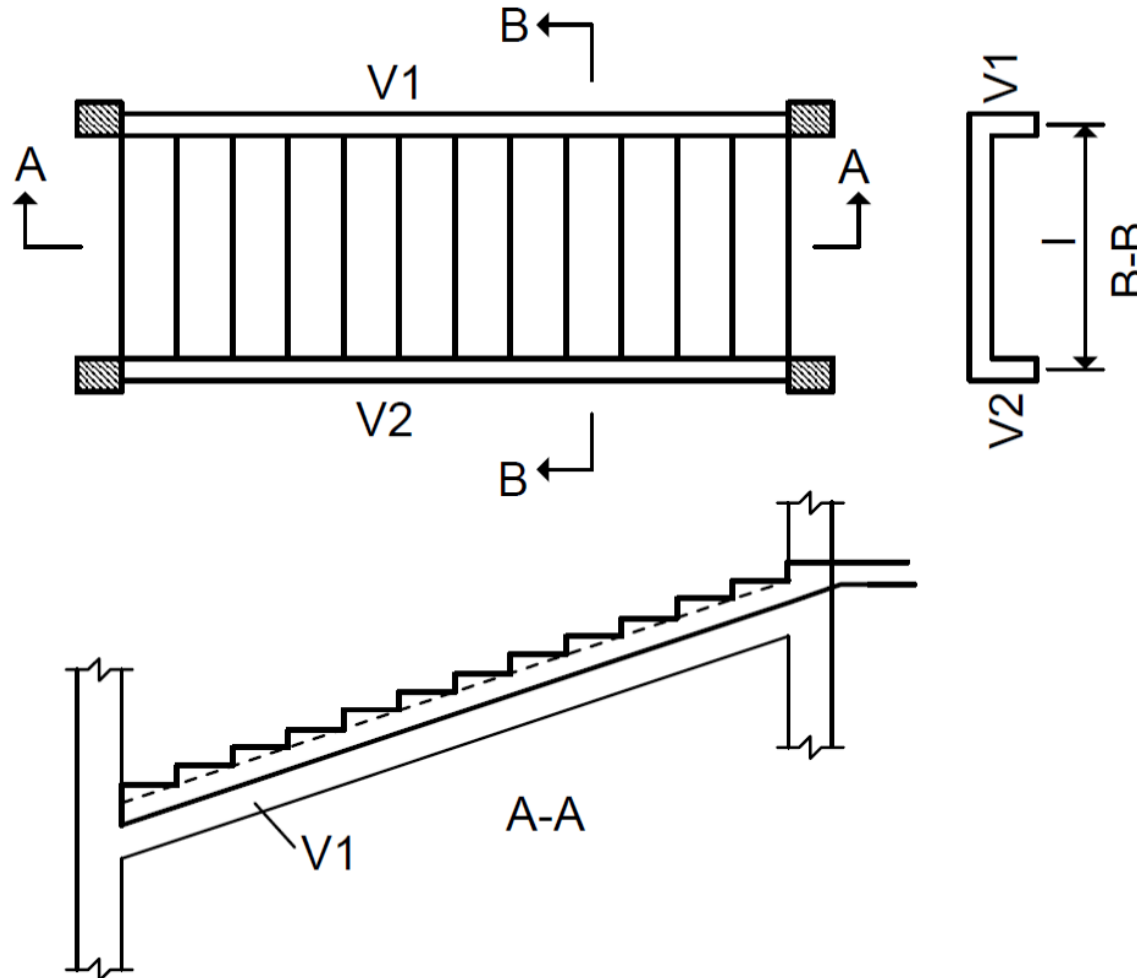


# Exemplo: escada de um lance



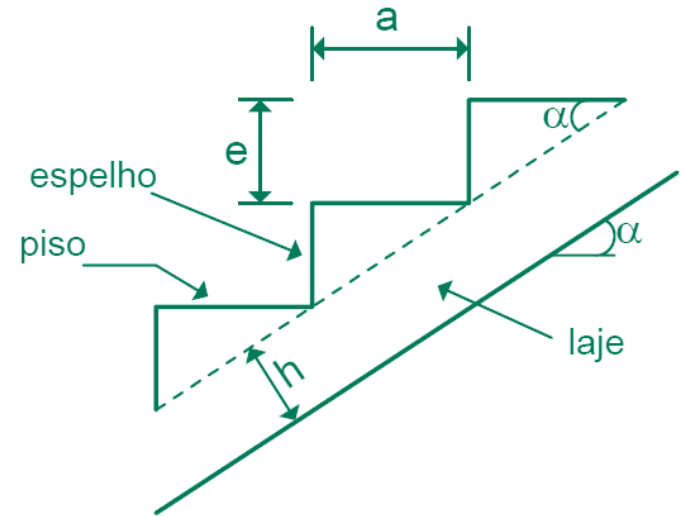
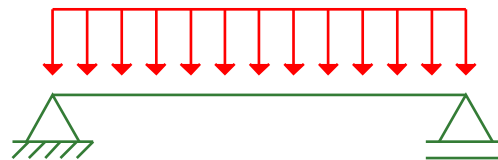
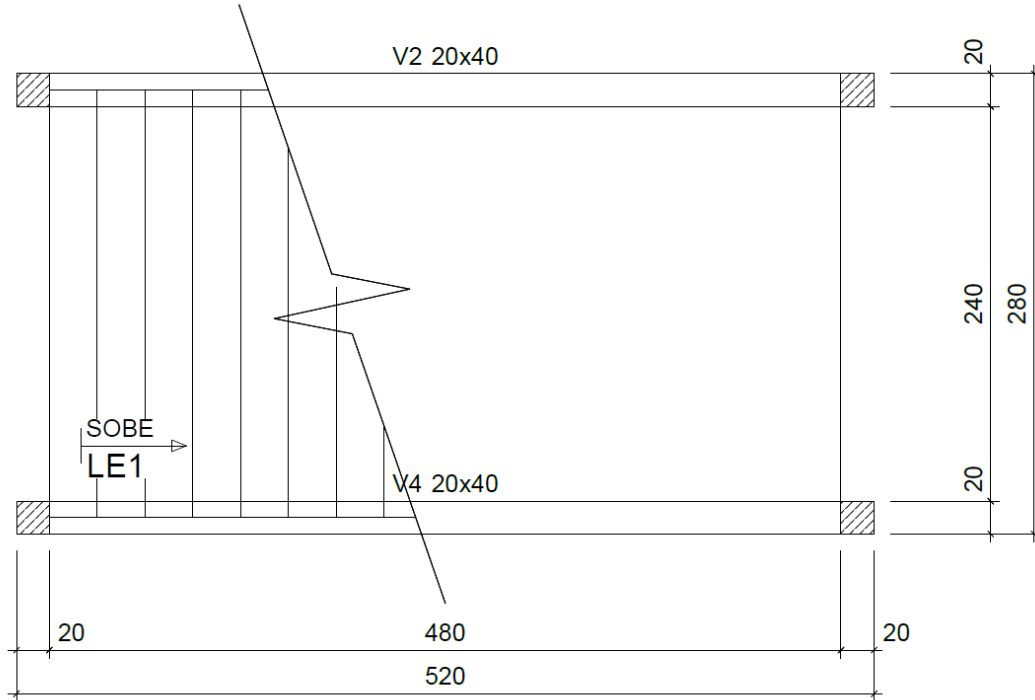


- Laje armada na menor direção





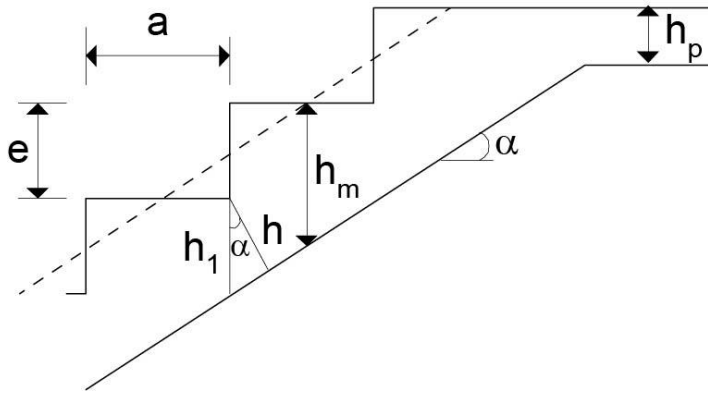
- Laje armada na menor direção



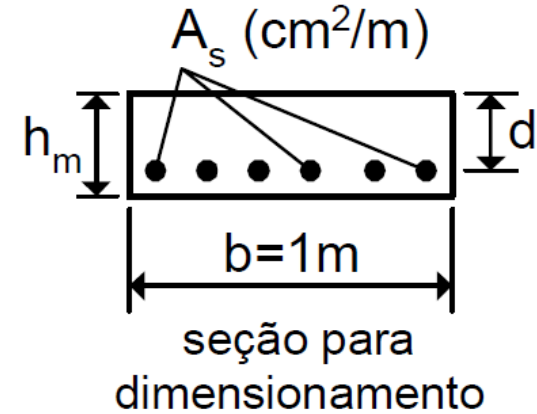
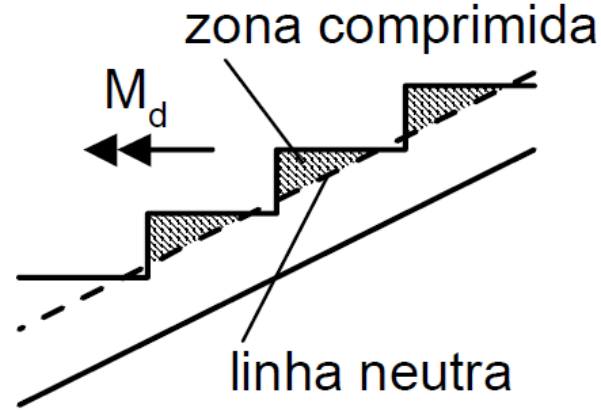


# Exemplo: escada apoiada em vigas laterais

- Laje armada na menor direção



Concreto C-25 e aço CA 50







# Exemplo: escada apoiada em vigas laterais



## Áreas de armadura para lajes

•  $A_s / m \rightarrow$  Diâmetro  $\rightarrow$  Área de cada barra  $\rightarrow$  Número de barras

$$\frac{A_s}{m} = \frac{n}{m} \left( \pi \cdot \frac{\phi^2}{4} \right)$$

• Número de barras em um metro  $\rightarrow$  Espaçamento

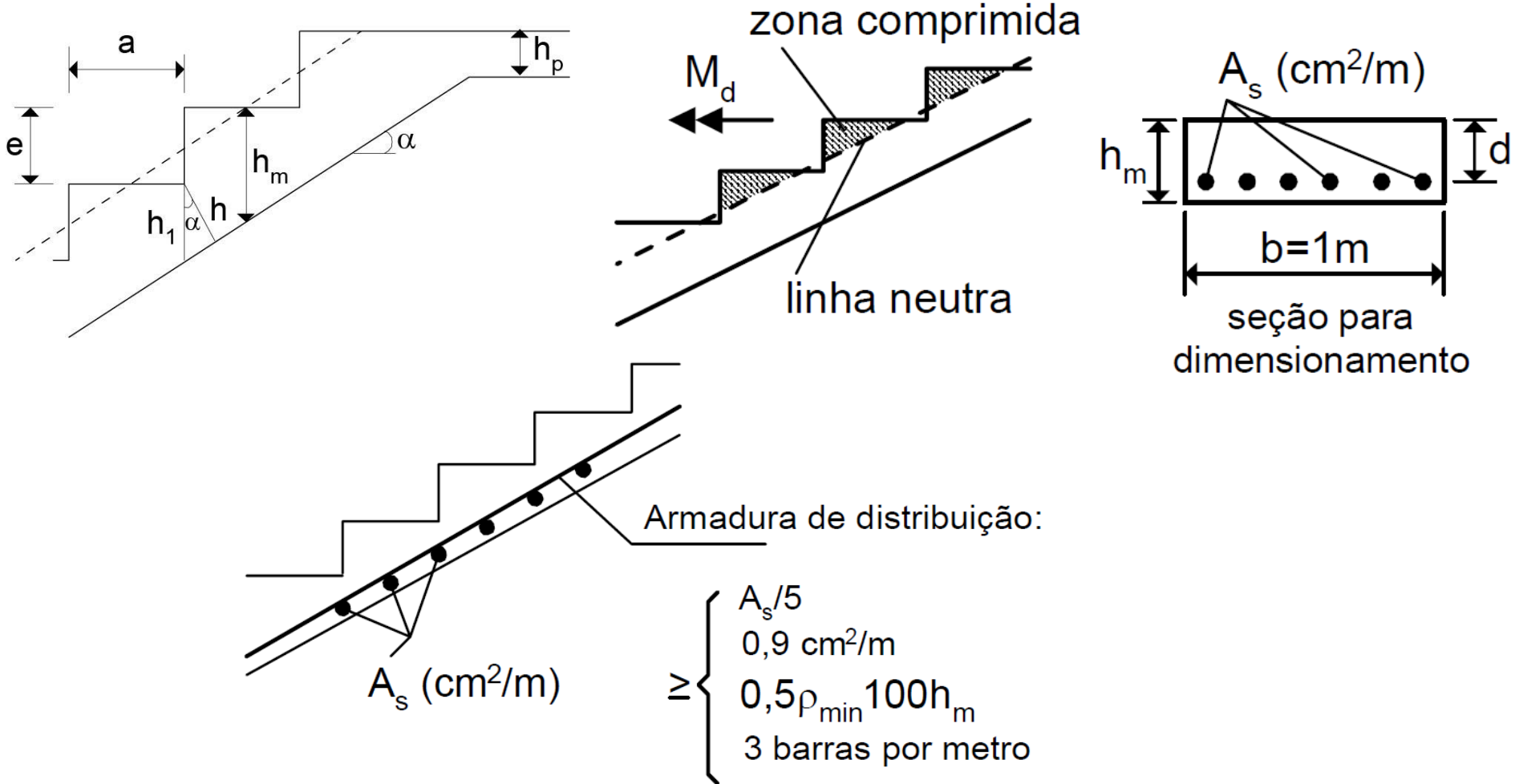
$$s = \frac{100cm}{n}$$

Lajes - $A_s / s$ (cm <sup>2</sup> /m)													
Diâmetro		Espaçamento (cm)											
Pol	mm	7	8	9	10	12	14	15	16	18	20	25	30
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5/16"	8,0	7,18	6,28	5,59	5,03	4,19	3,59	3,35	3,14	2,79	2,51	2,01	1,68
3/8"	10,0	11,22	9,82	8,73	7,85	6,54	5,61	5,24	4,91	4,36	3,93	3,14	2,62
1/2"	12,5	17,53	15,34	13,64	12,27	10,23	8,77	8,18	7,67	6,82	6,14	4,91	4,09
5/8"	16,0	28,72	25,13	22,34	20,11	16,76	14,36	13,40	12,57	11,17	10,05	8,04	6,70



# Exemplo: escada apoiada em vigas laterais

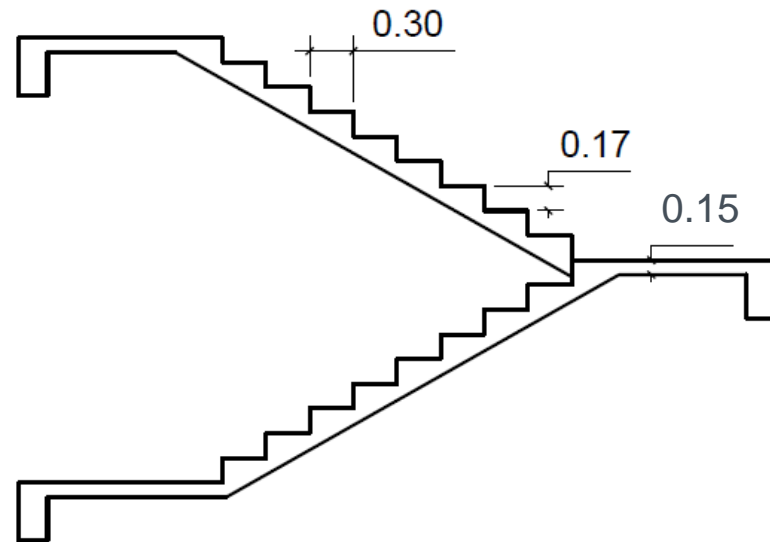
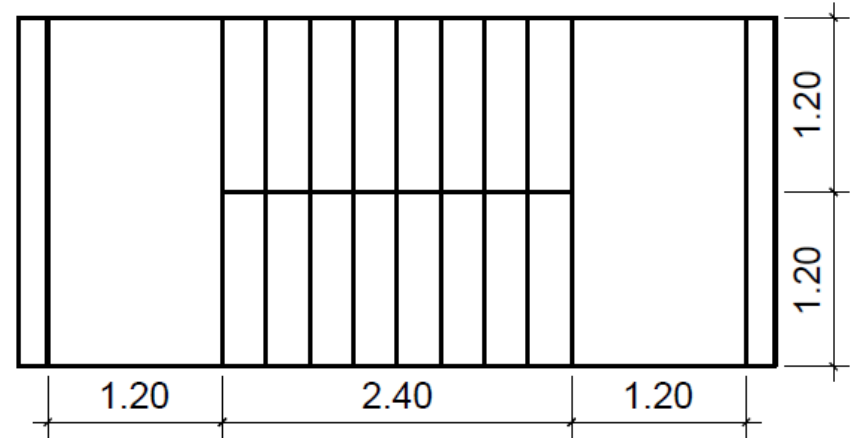
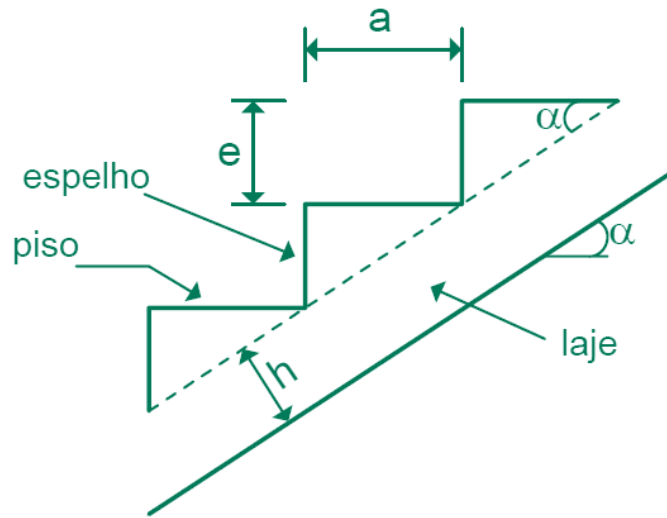
- Laje armada na menor direção





# Exemplo: escada com patamar

- Escada de prédio residencial
- CA-50
- C-25





# Escada com patamar

- Laje apoiada nas vigas da base e topo  $\rightarrow$  Longitudinal

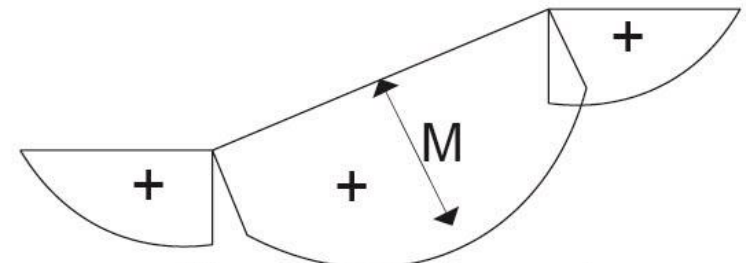
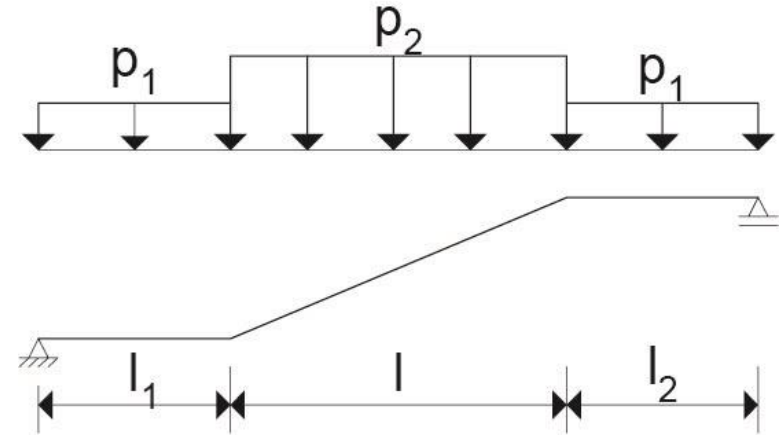
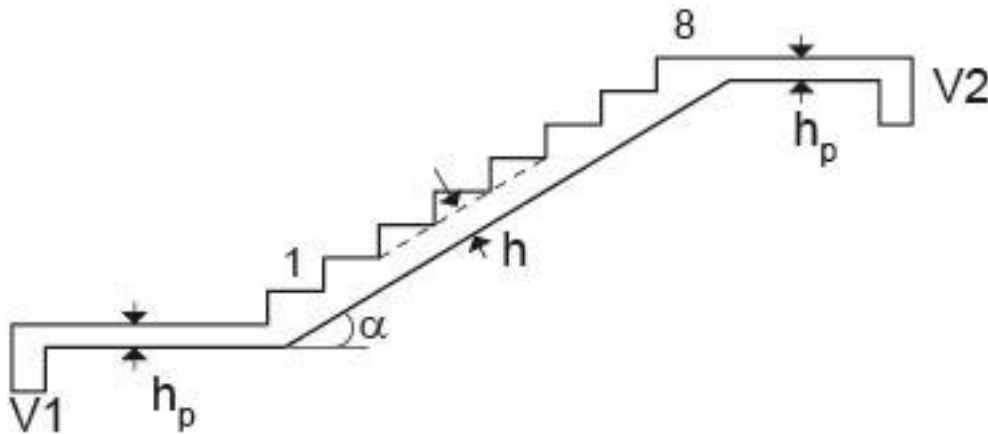
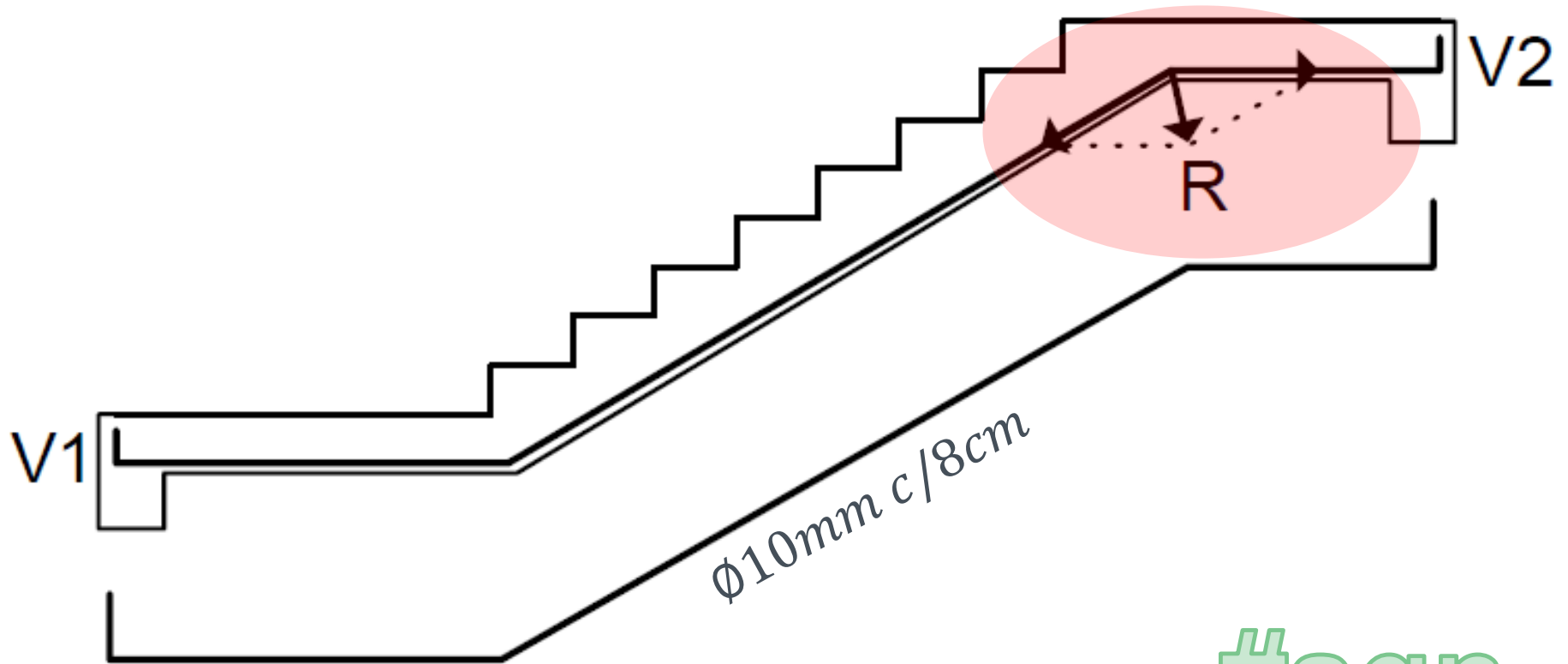


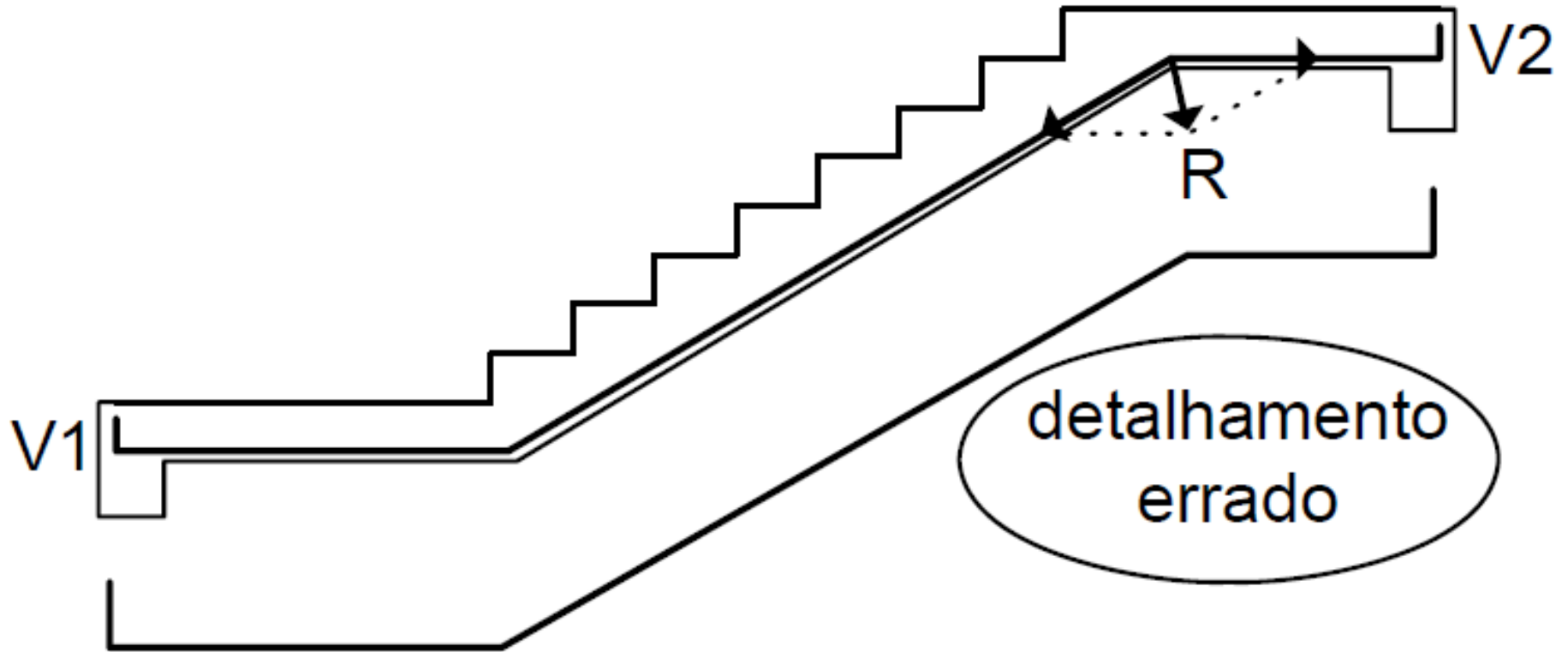
Diagrama de momentos fletores

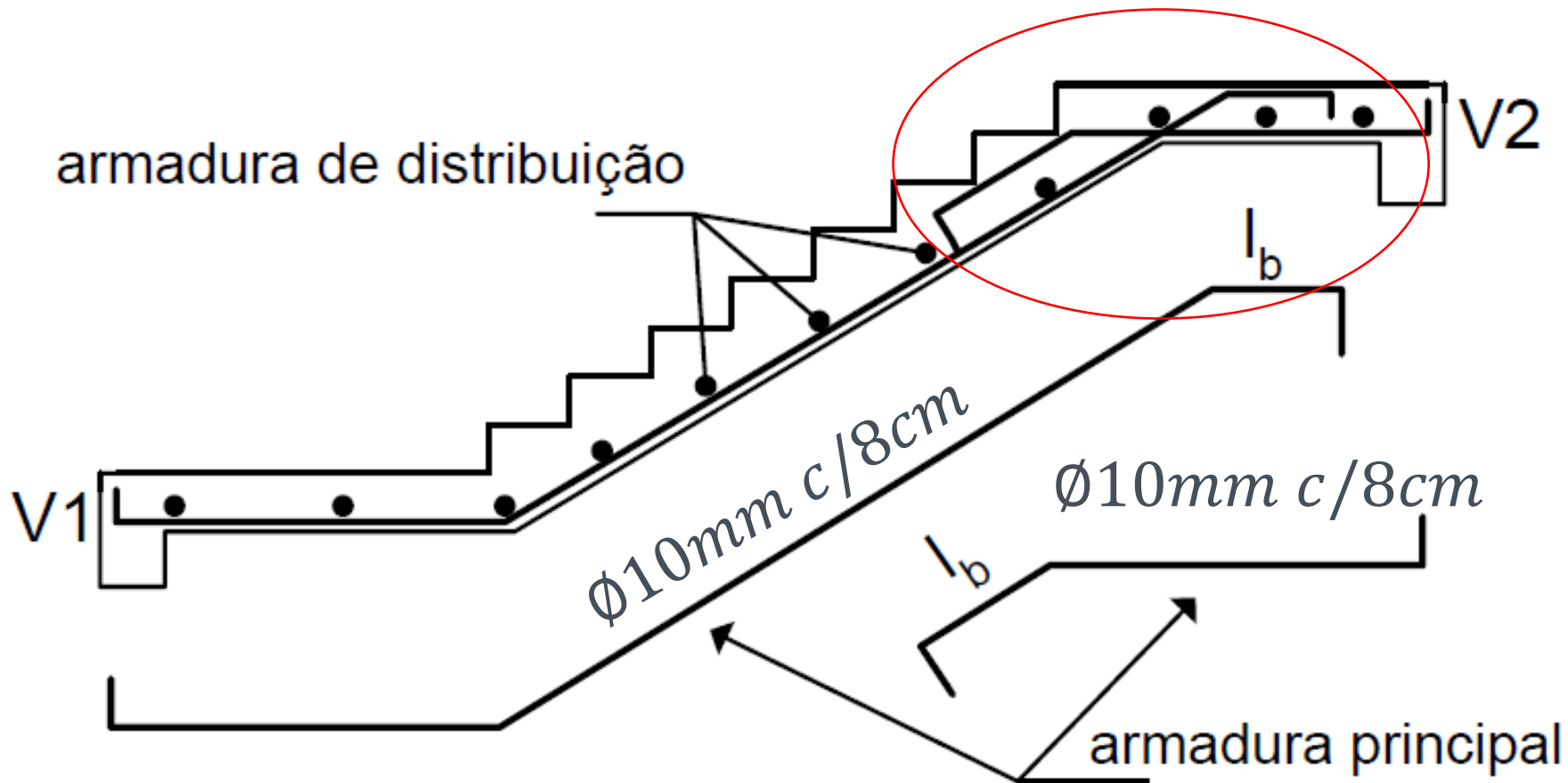


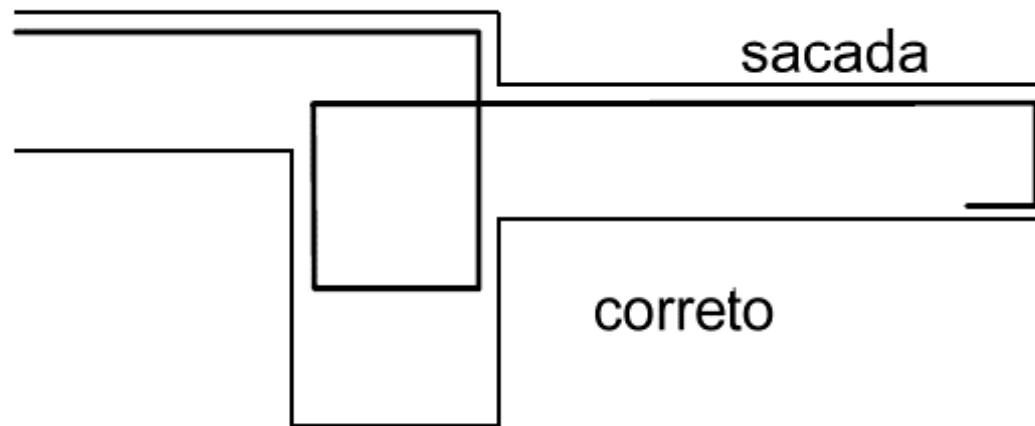
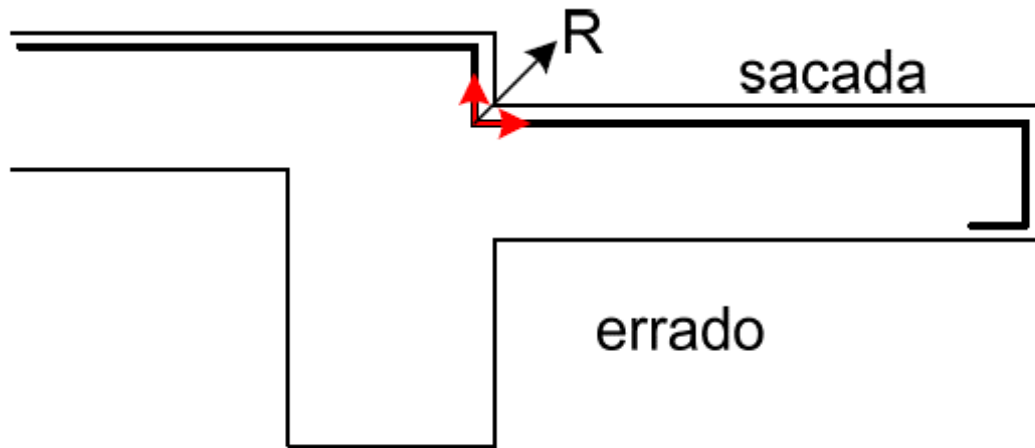
# Exemplo: escada com patamar



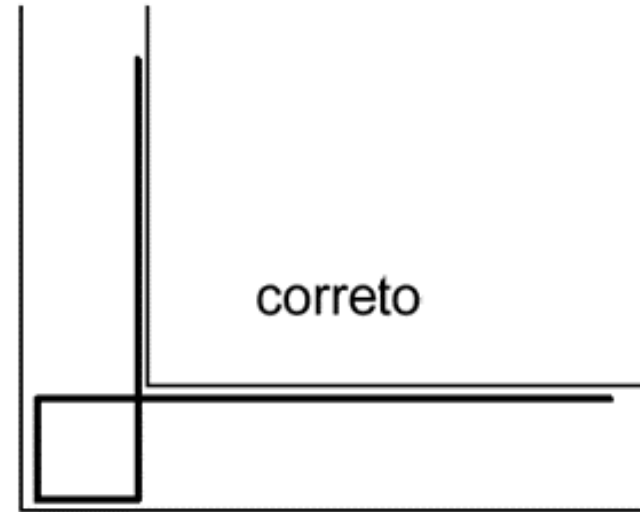
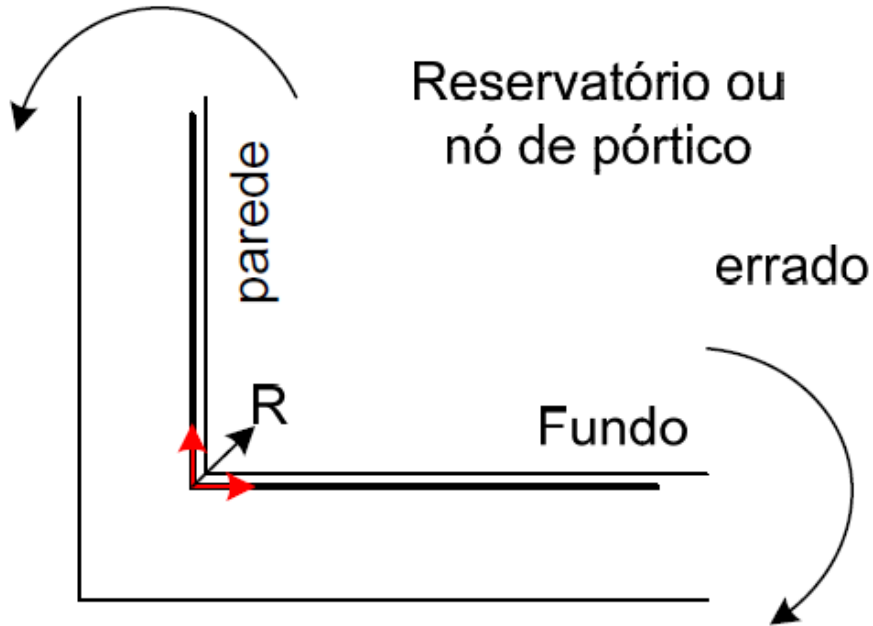
#sqn





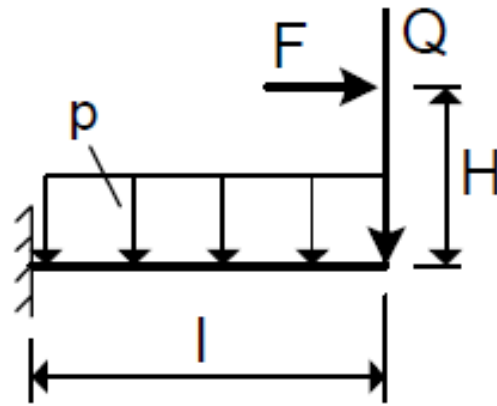
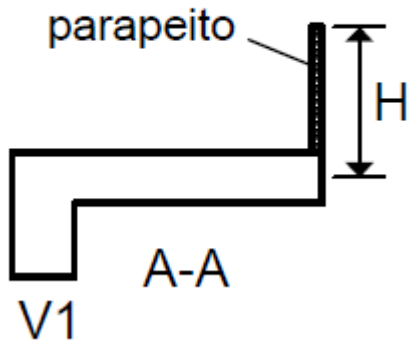
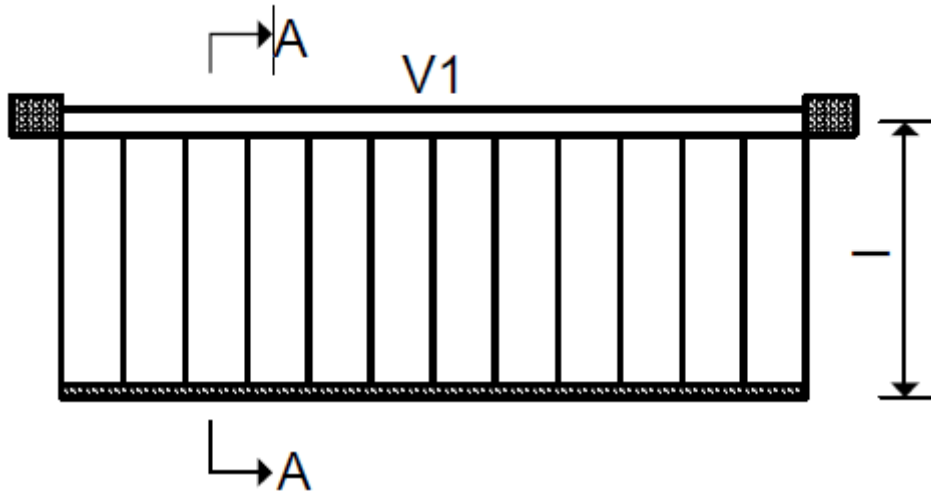








# Exemplo: escada em balanço engastada em viga lateral

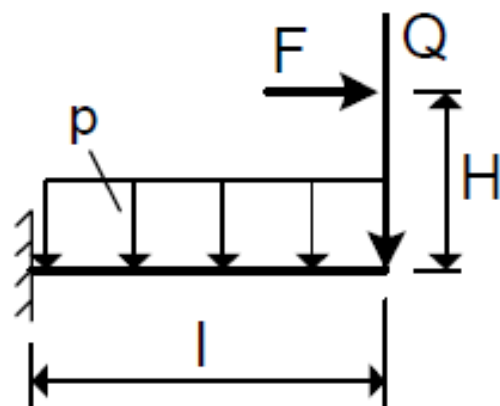


modelo de cálculo

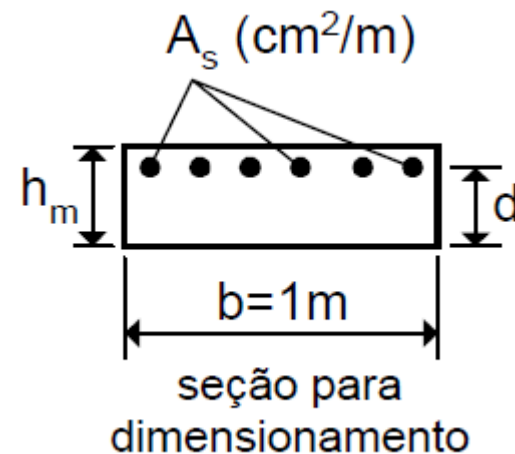
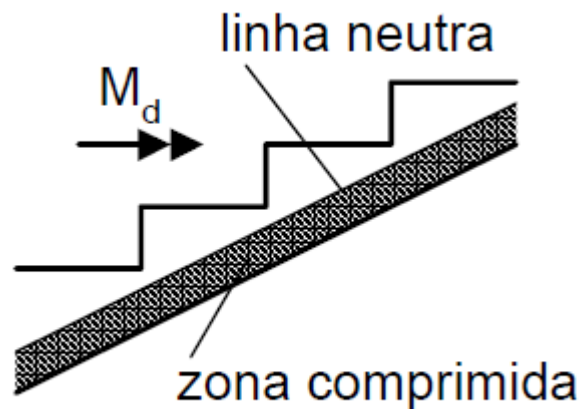
- Peso próprio
- Revestimento
- Parapeitos
  - Peso próprio
  - Acidental:
    - Horizontal (0,8 kN)
    - Vertical (2,0 kN)
- Sobrecarga



# Exemplo: escada em balanço engastada em viga lateral

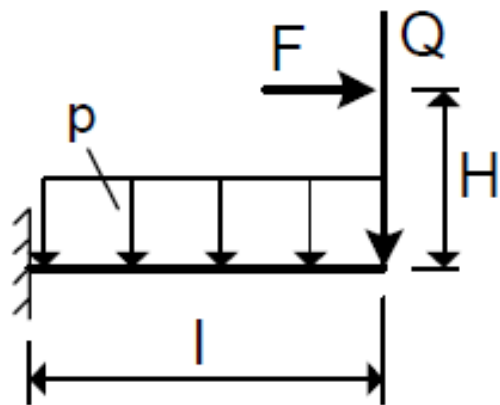


modelo de cálculo

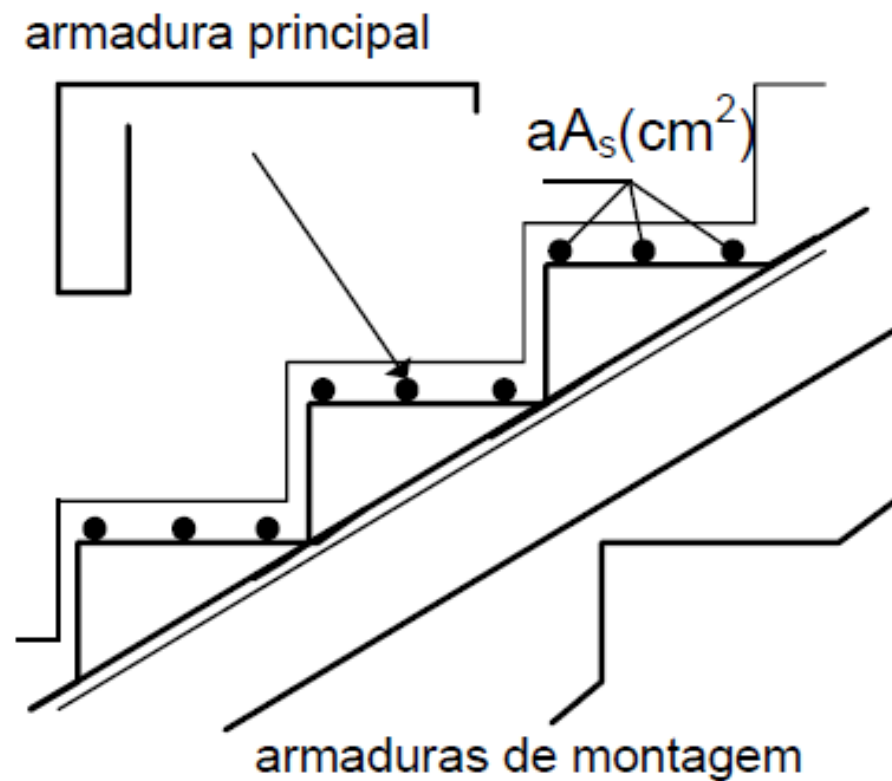
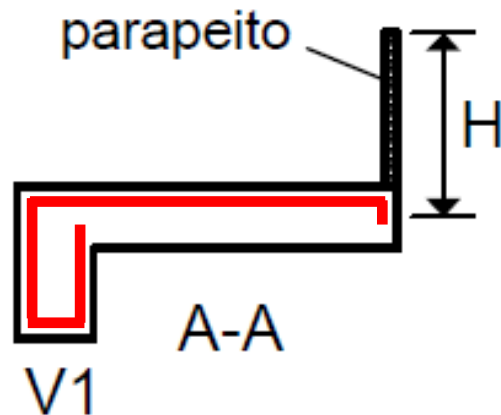




# Exemplo: escada em balanço engastada em viga lateral

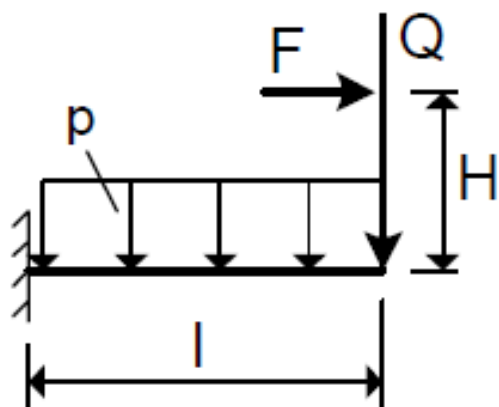


modelo de cálculo

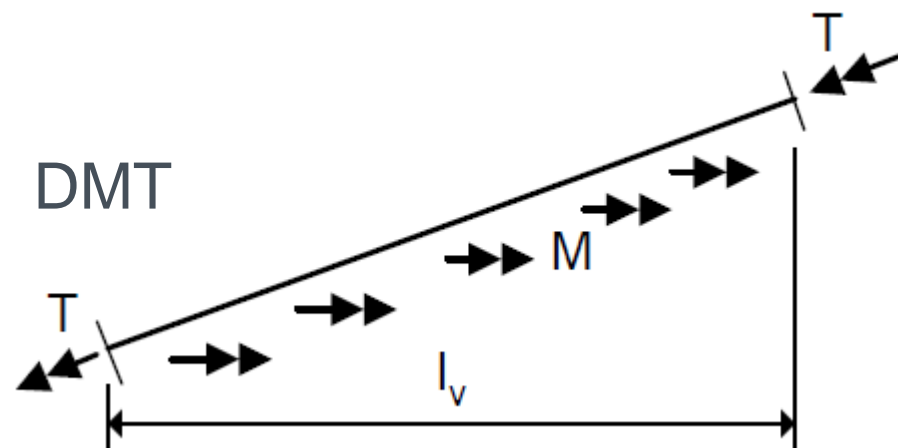
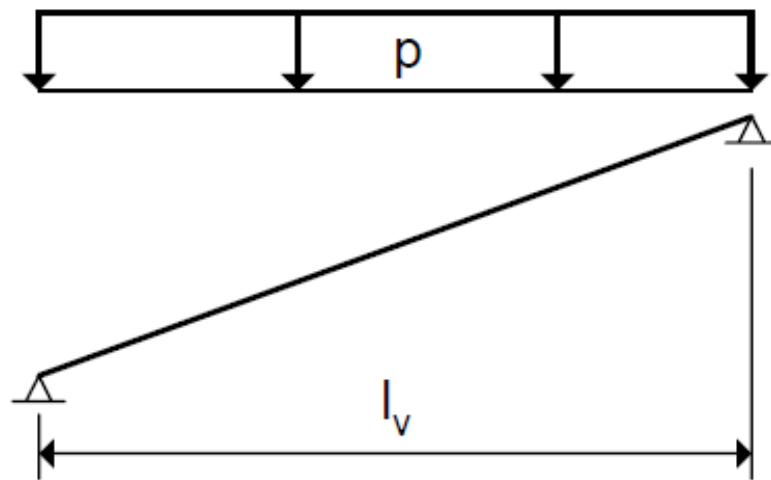




# Exemplo: escada em balanço engastada em viga lateral

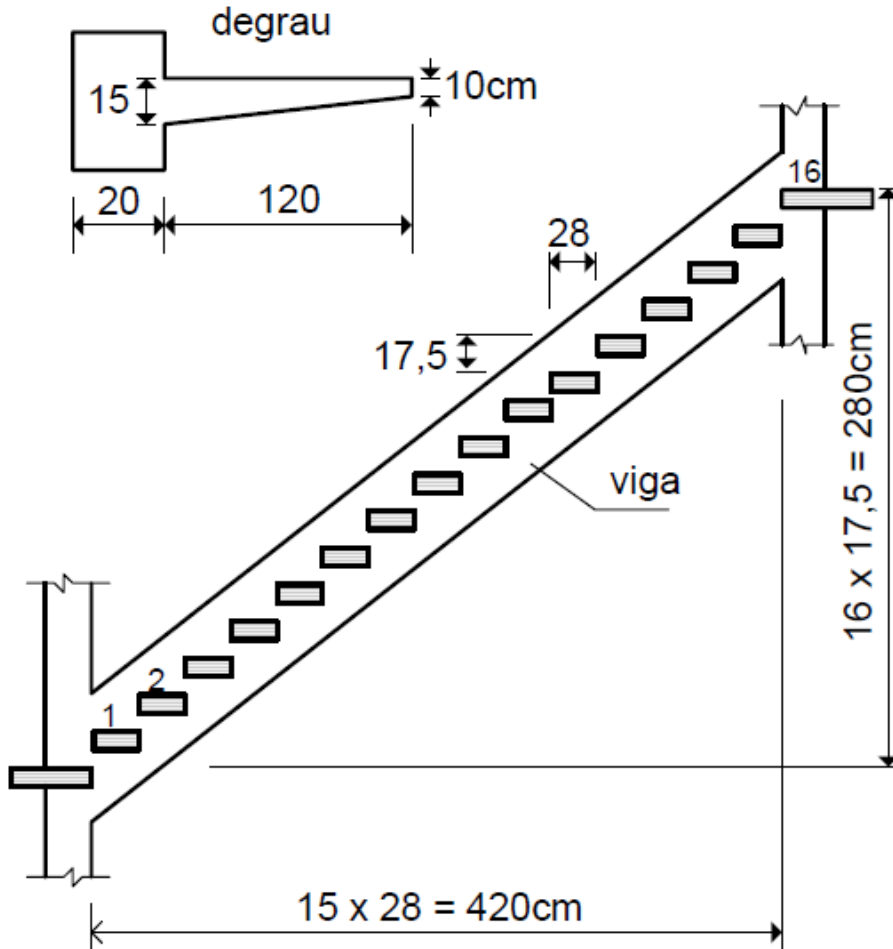


modelo de cálculo





# Exemplo: escada em balanço com degraus isolados



- **Cálculo dos degraus:**
  - Considerar uma carga acidental concentrada de 2,5kN, aplicada na posição mais desfavorável
- **Cálculo da viga lateral:**
  - Considerar a carga acidental uniformemente distribuída sobre toda a superfície da escada (usualmente, uma carga de 2,5kN/m<sup>2</sup>).



# Exemplo: escada em balanço com degraus isolados

