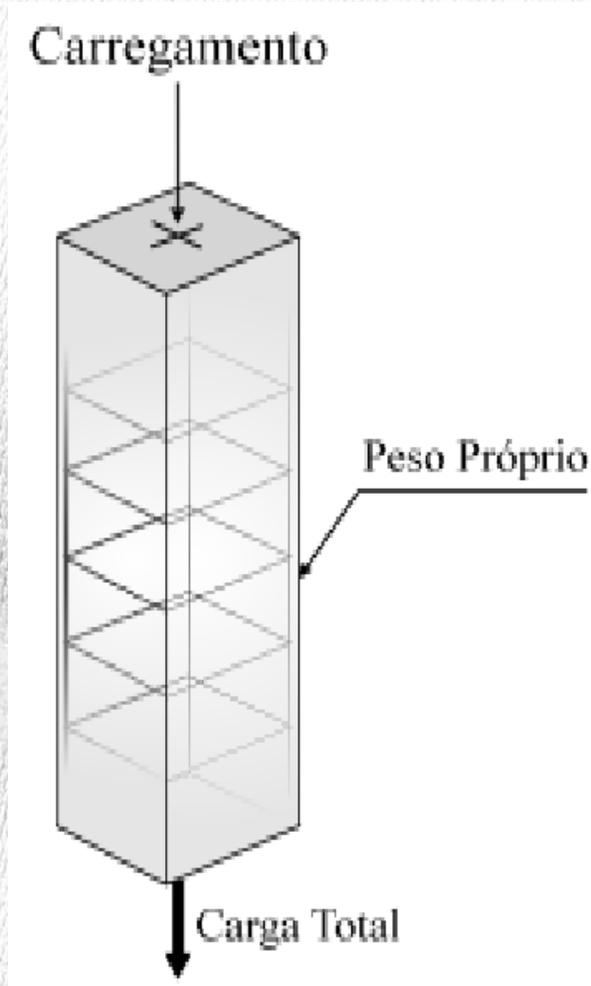
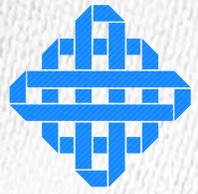


# Princípios Gerais do Projeto e Execução de Lajes Trelaçadas

Dr. Artur Lenz Sartorti



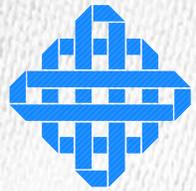
**KÜSTER & SARTORTI**  
ENGENHARIA ESTRUTURAL  
[www.kustersartorti.com.br](http://www.kustersartorti.com.br)



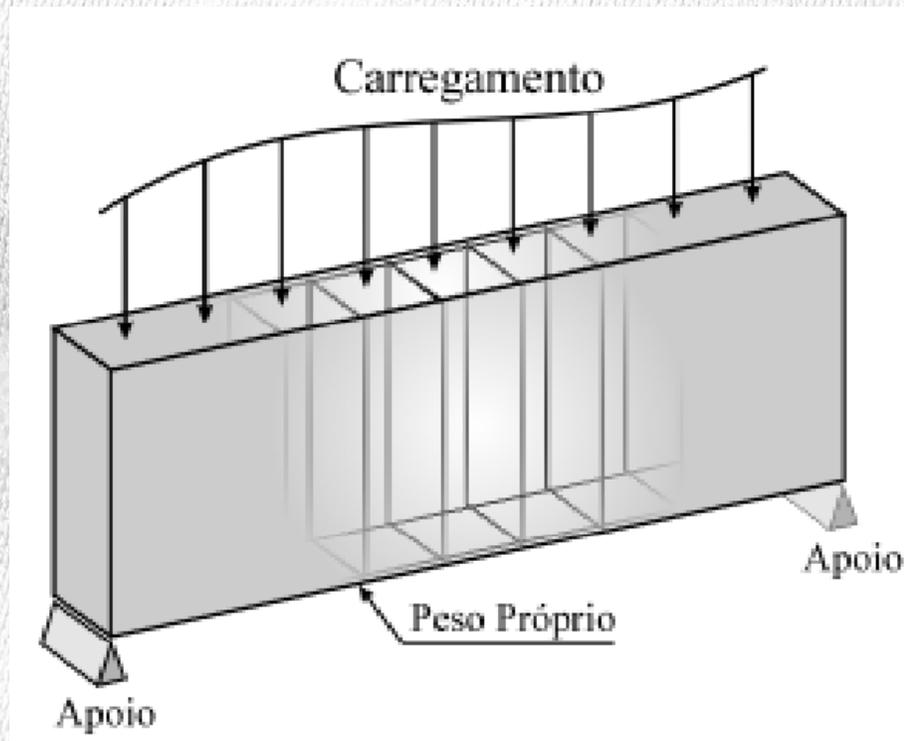
## Pilares

$$E \cong (150 \text{ a } 300) \times \text{Peso Próprio}$$

$$\text{Eficiência (E)} = \frac{\text{Carregamento}}{\text{Peso Próprio}}$$

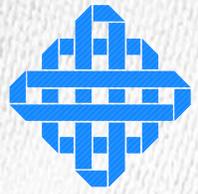


## Vigas



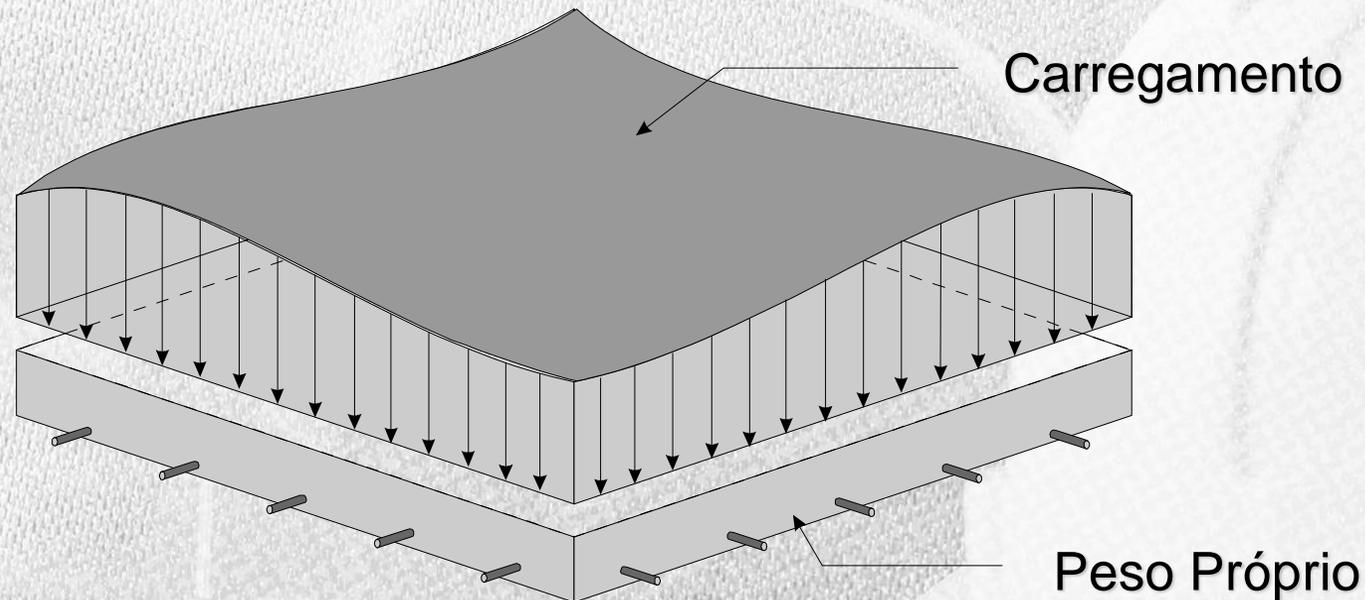
$$E \cong (8 \text{ a } 12) \times \text{Peso Próprio}$$

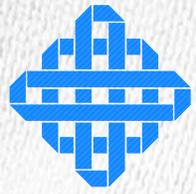
$$\text{Eficiência (E)} = \frac{\text{Carga Total}}{\text{Peso Próprio}}$$



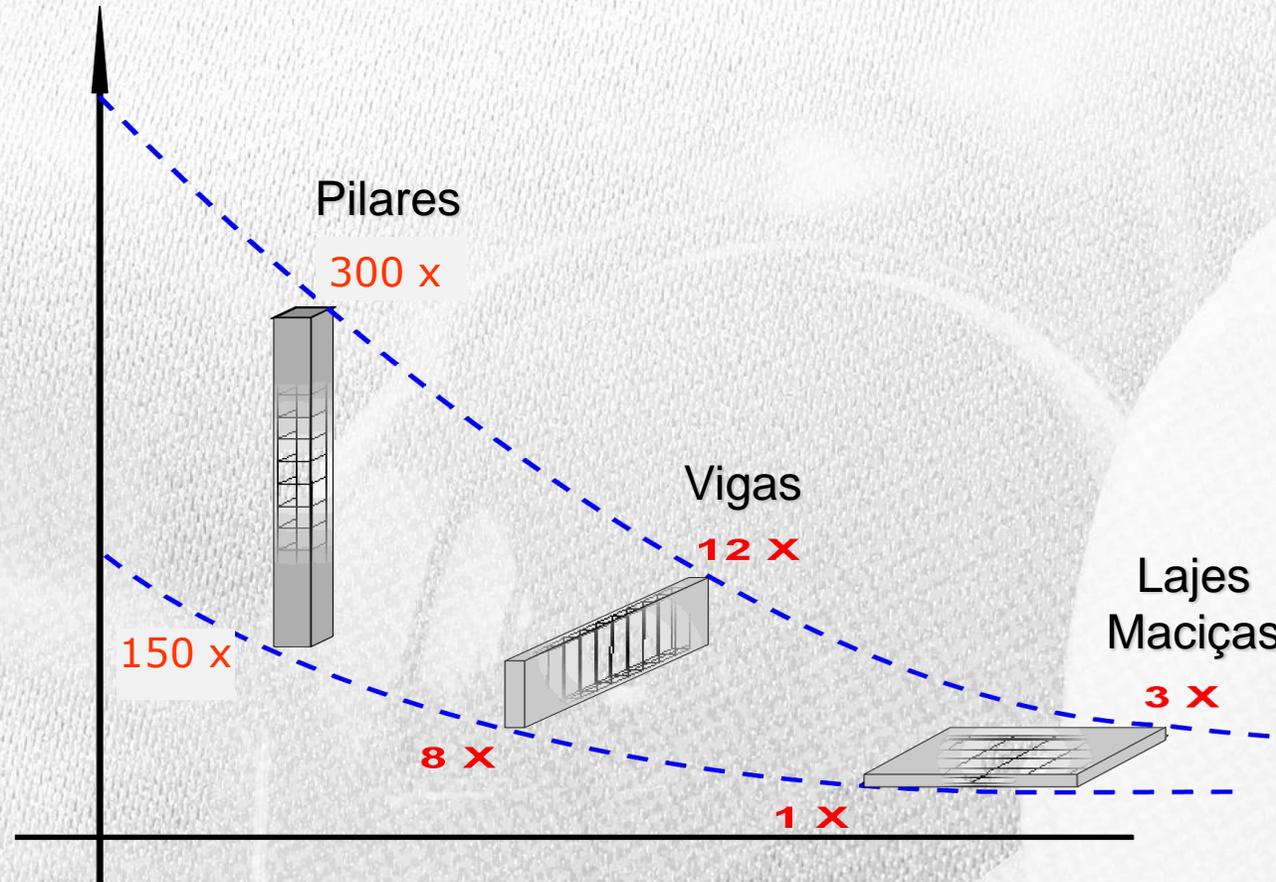
## Lajes Maciças

$$E \cong (1 \text{ a } 3) \times \text{Peso Próprio} \quad \text{Eficiência (E)} = \frac{\text{Carga Total}}{\text{Peso Próprio}}$$

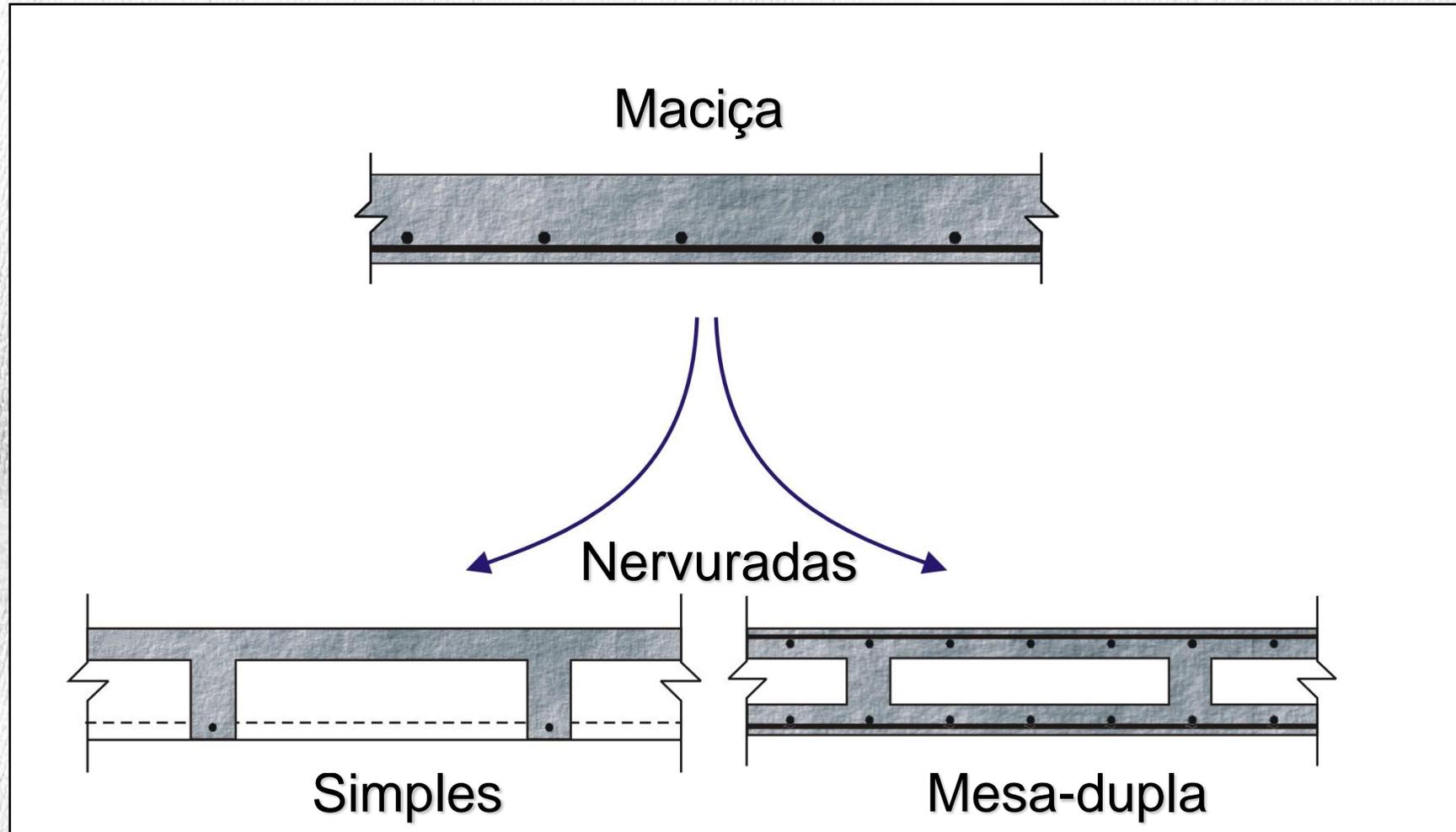
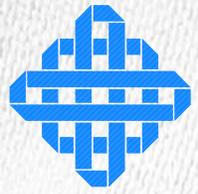


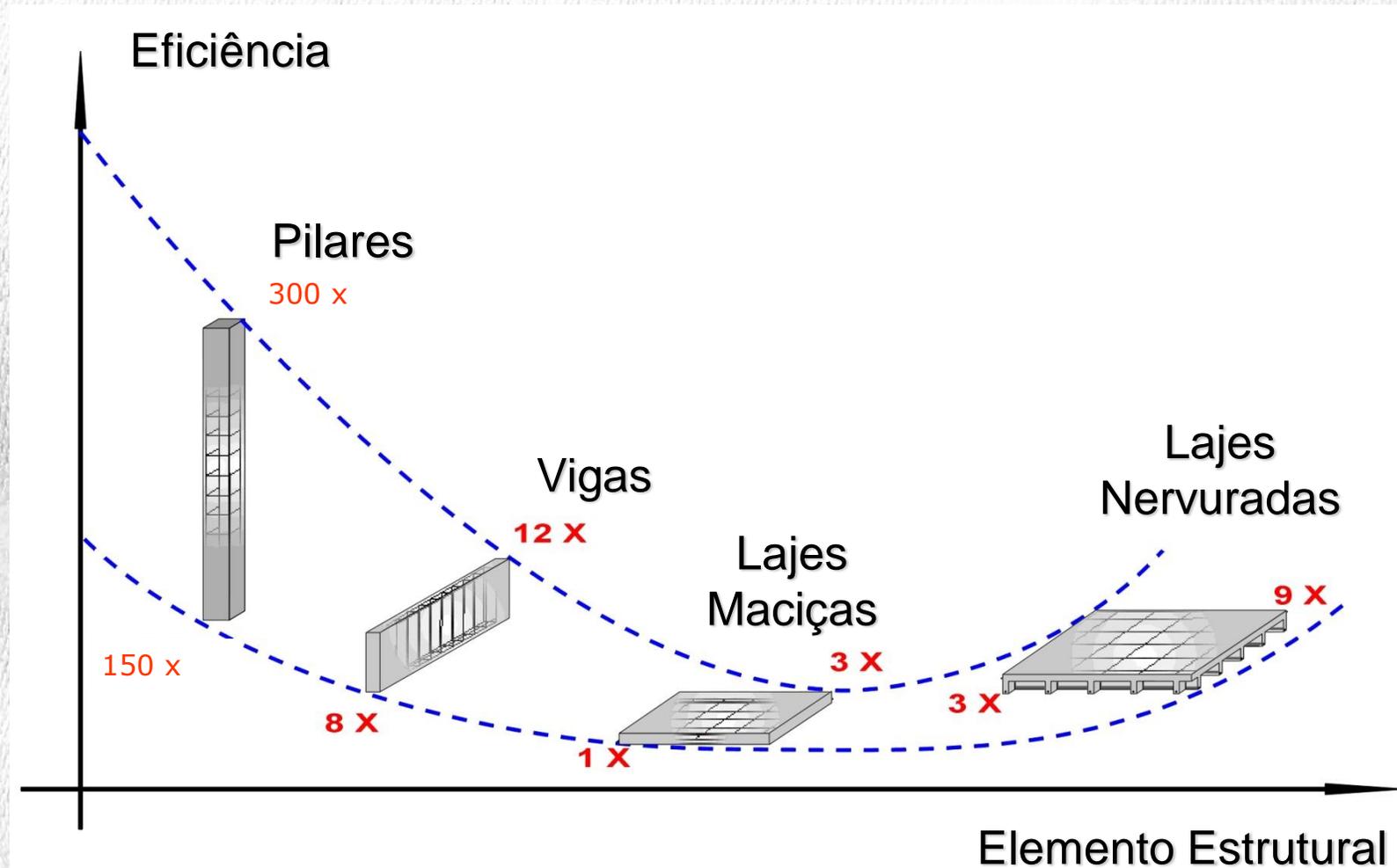
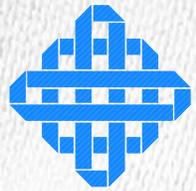


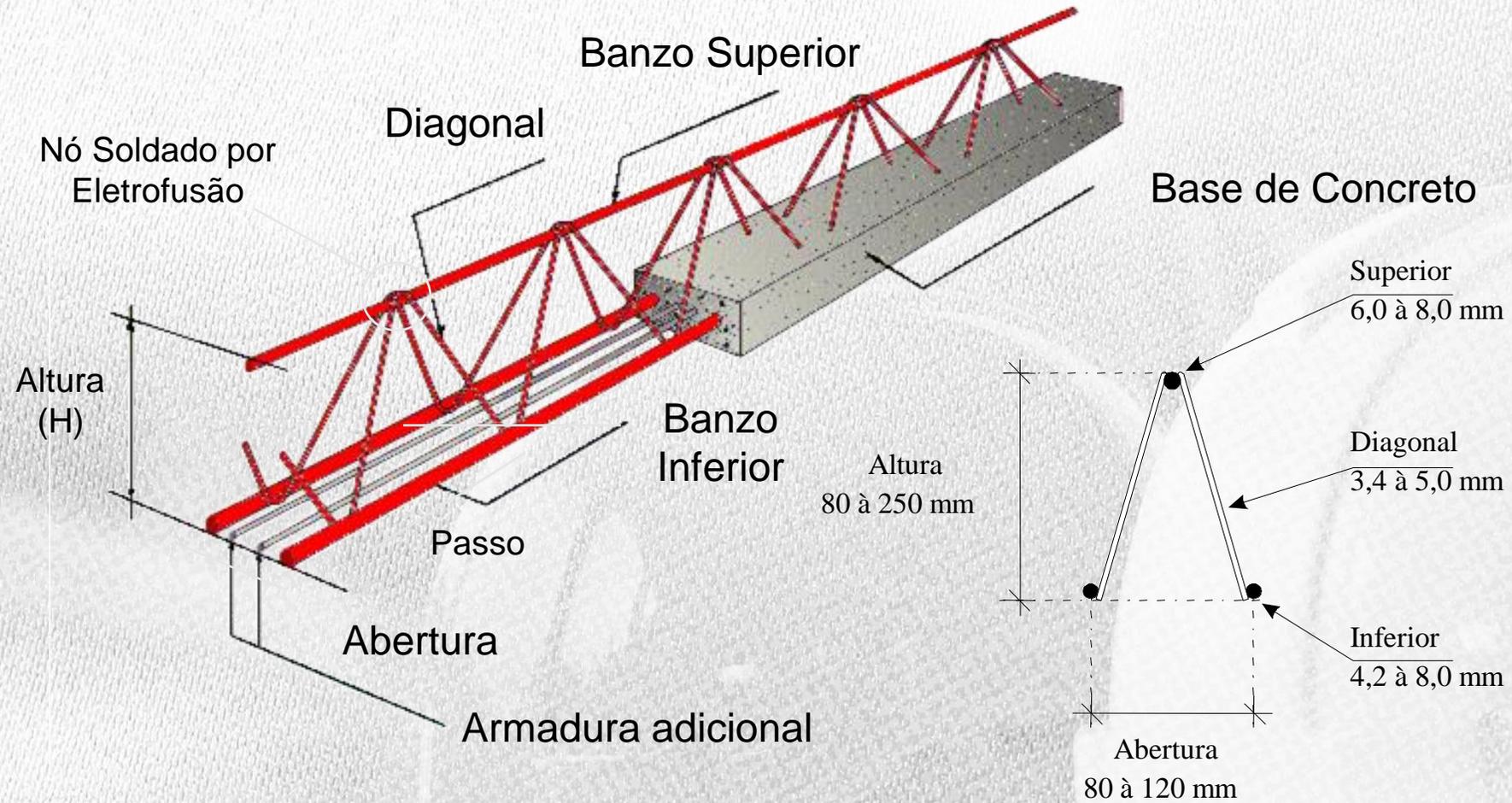
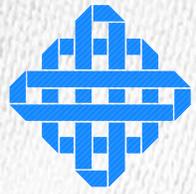
Eficiência

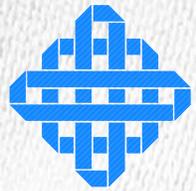


Elemento Estrutural









## Designação NBR 14859-3

# TR08645

Treliça

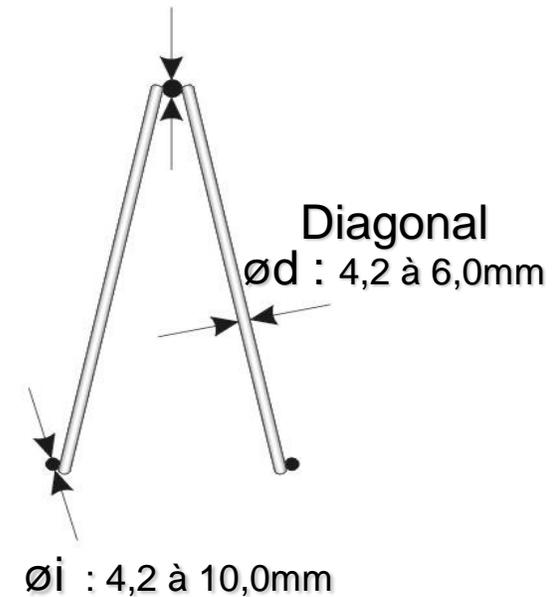
Altura (cm)

Banzo Superior (mm)

Diagonal (sinusóide)

Banzo Inferior

Banzo Superior  
 $\varnothing S : 6,0 \text{ à } 10,0\text{mm}$



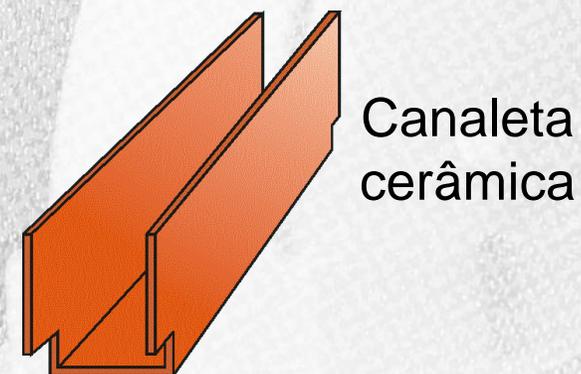
$\varnothing i : 4,2 \text{ à } 10,0\text{mm}$   
Banzo Inferior

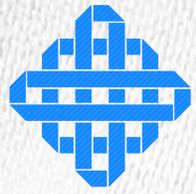


- Geometria diversificada

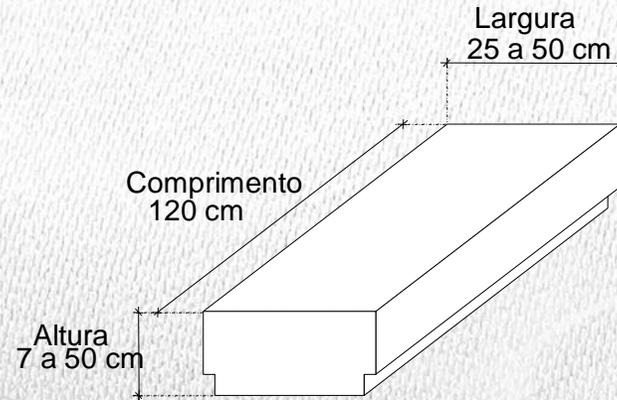


- Peso específico aparente - > 600 a 800kg/m<sup>3</sup>
- Grande absorção de água
- Aderência natural ao revestimento
- Peças indeformáveis
- Material não combustível
- Abundante em todo território nacional

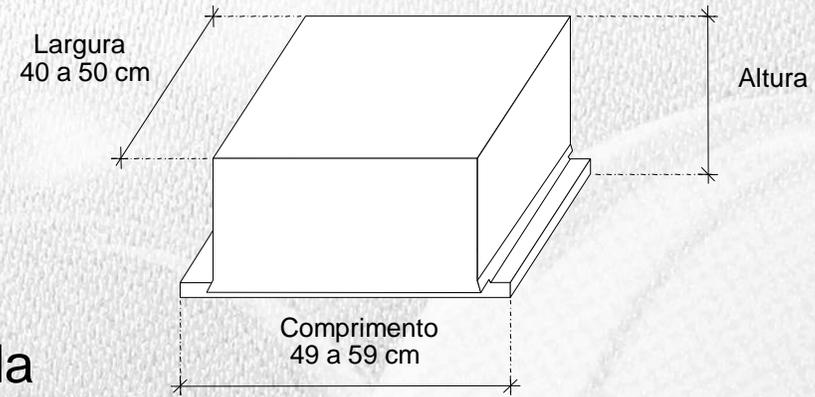




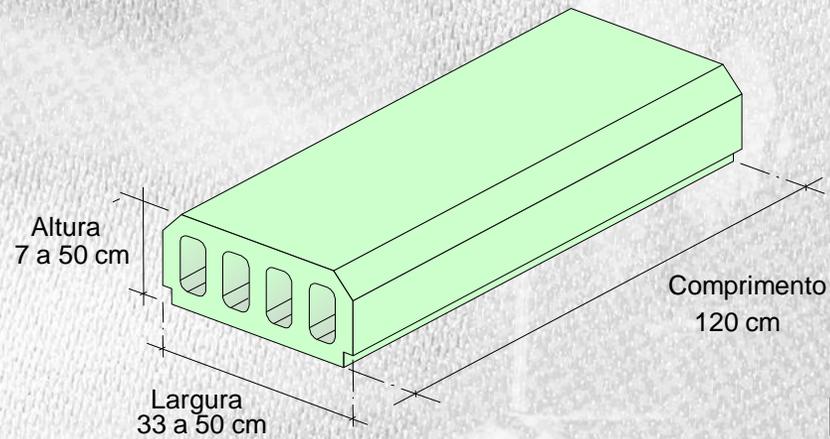
## Unidirecional



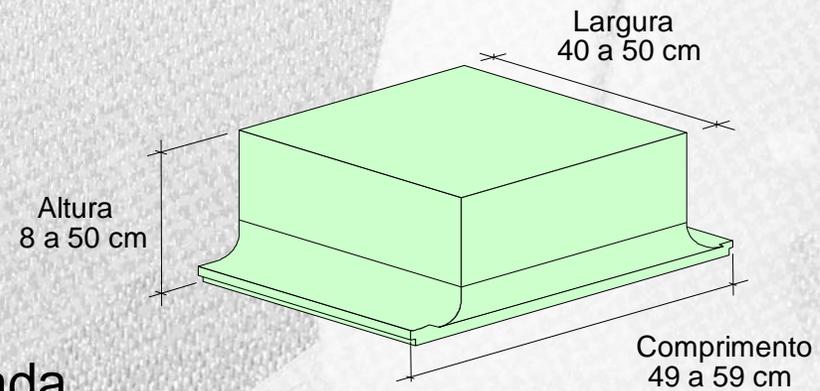
## Bidirecional

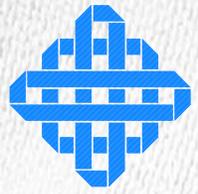


## Recortada

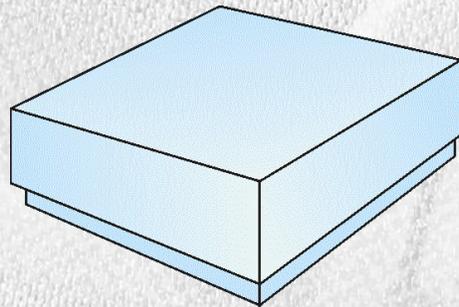


## Moldada

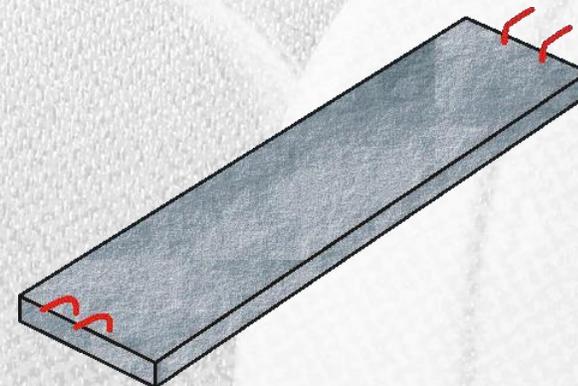


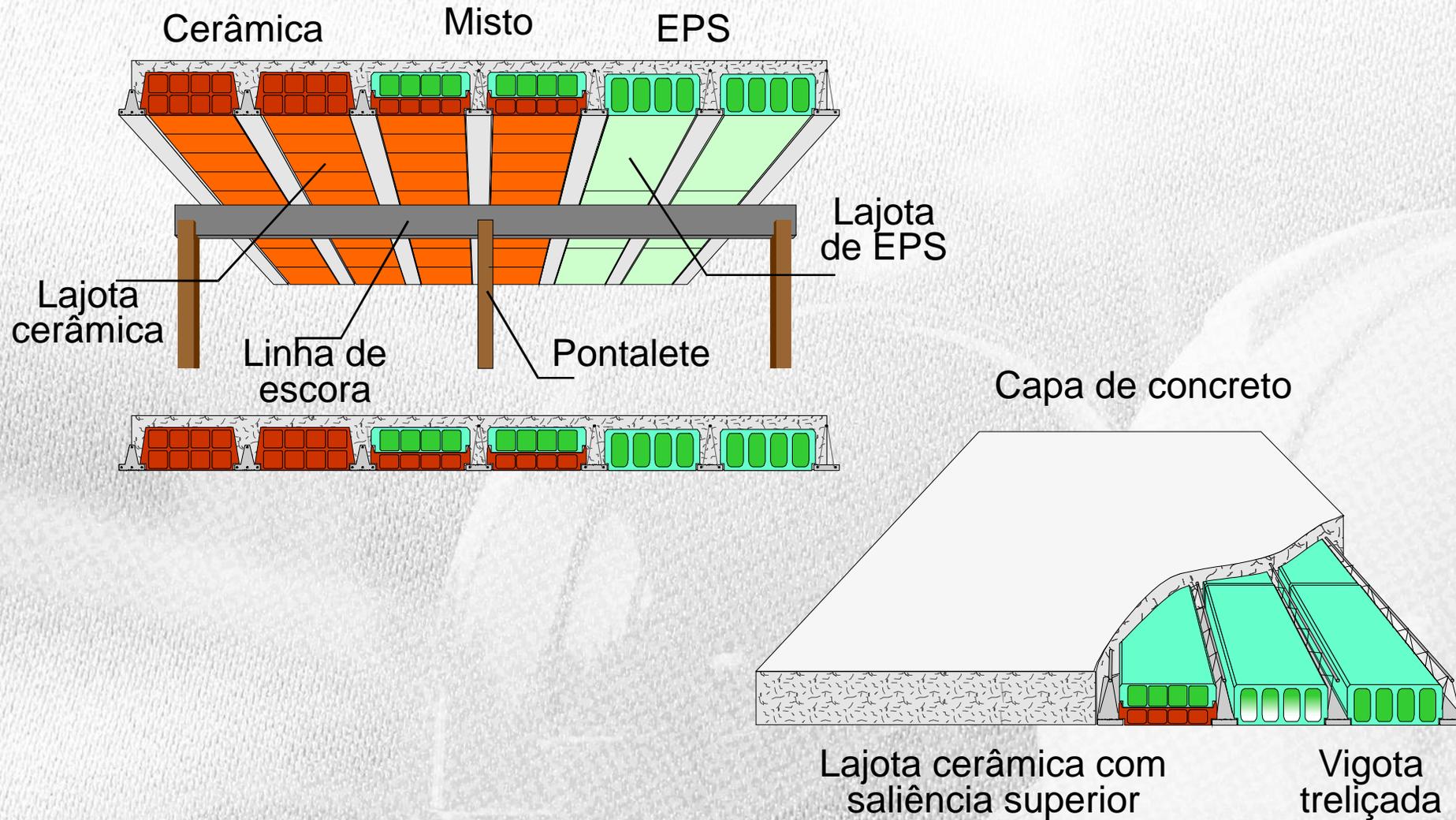


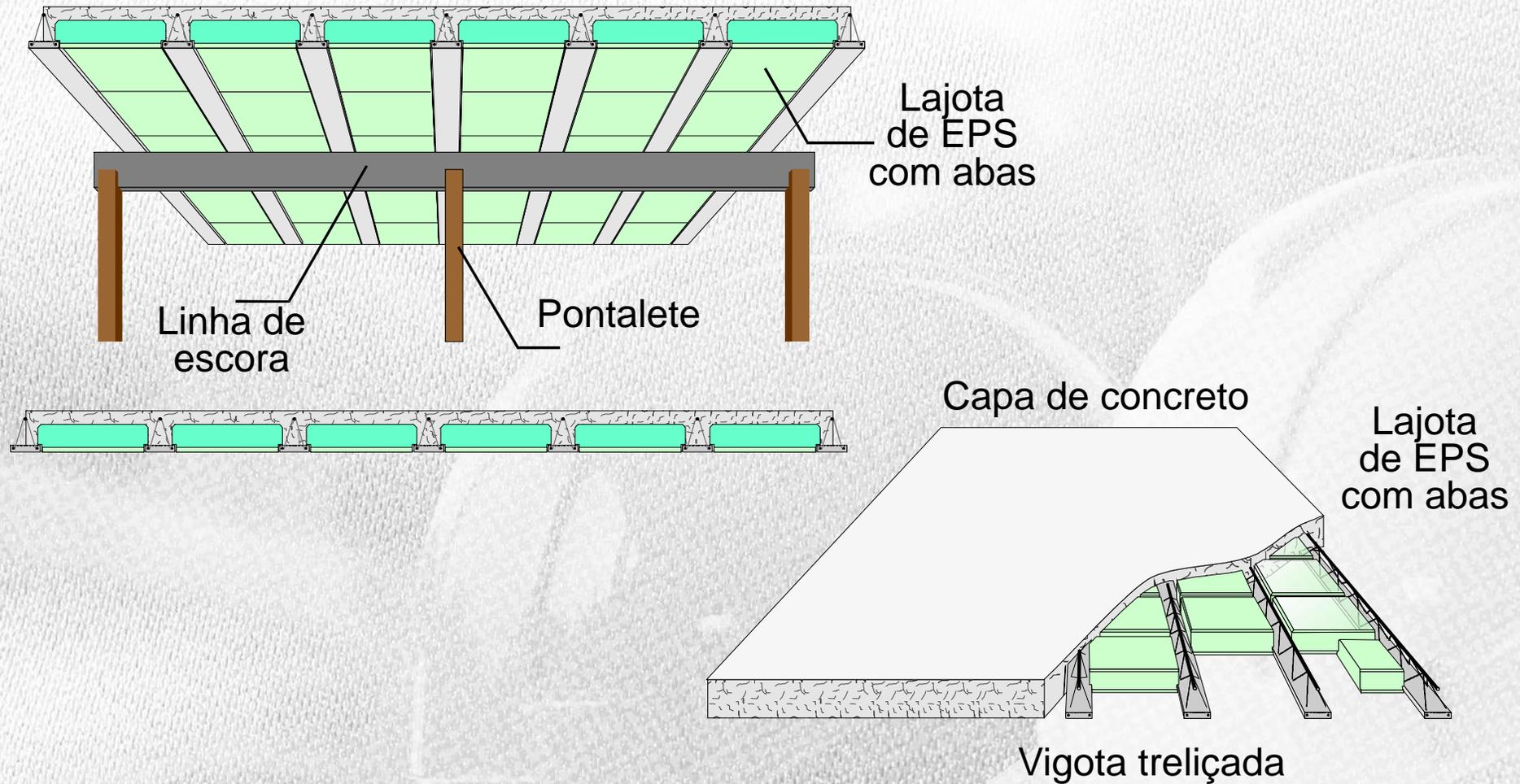
EPS com encaixe para  
apoio nos quatro lados

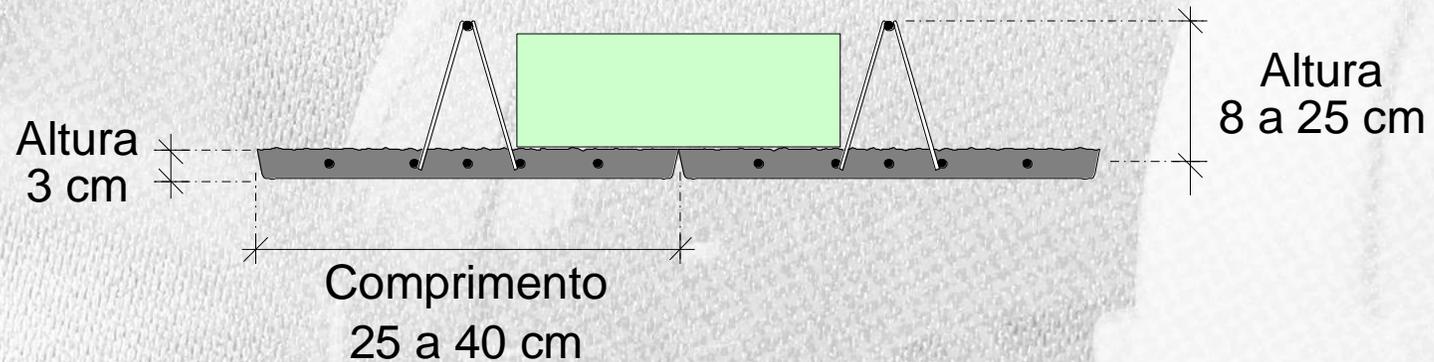
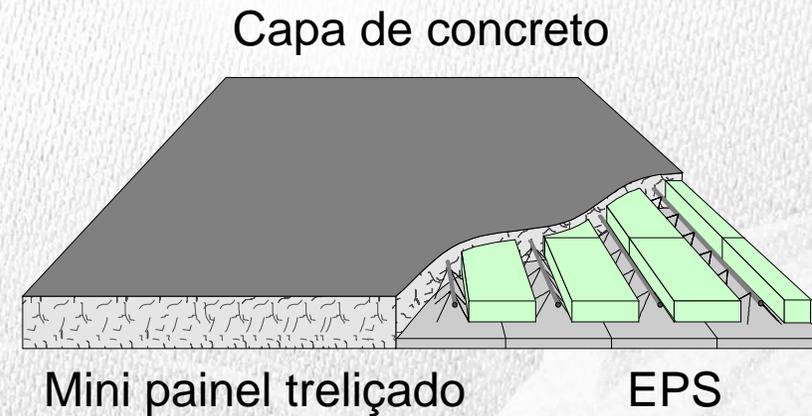


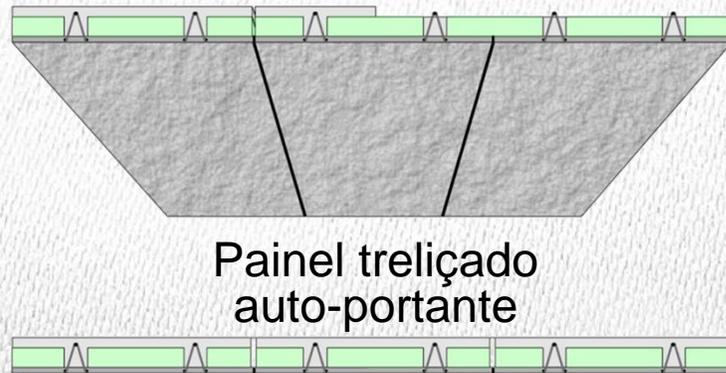
Plaqueta  
“Sistema Franca”



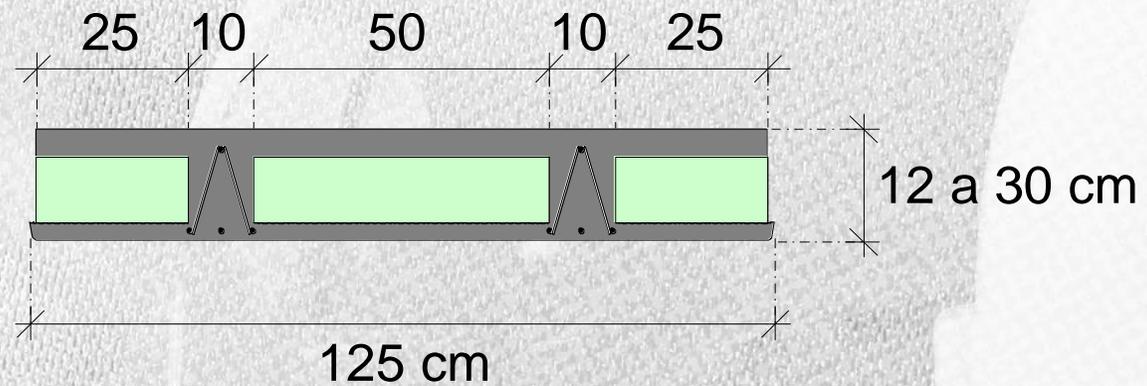
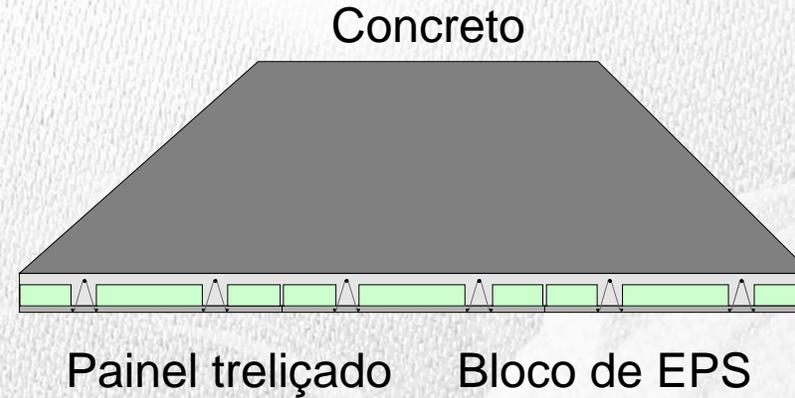


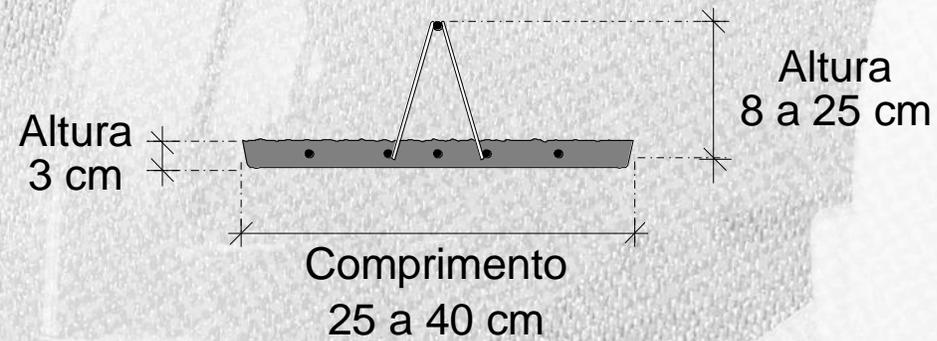
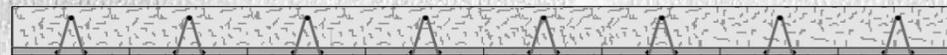
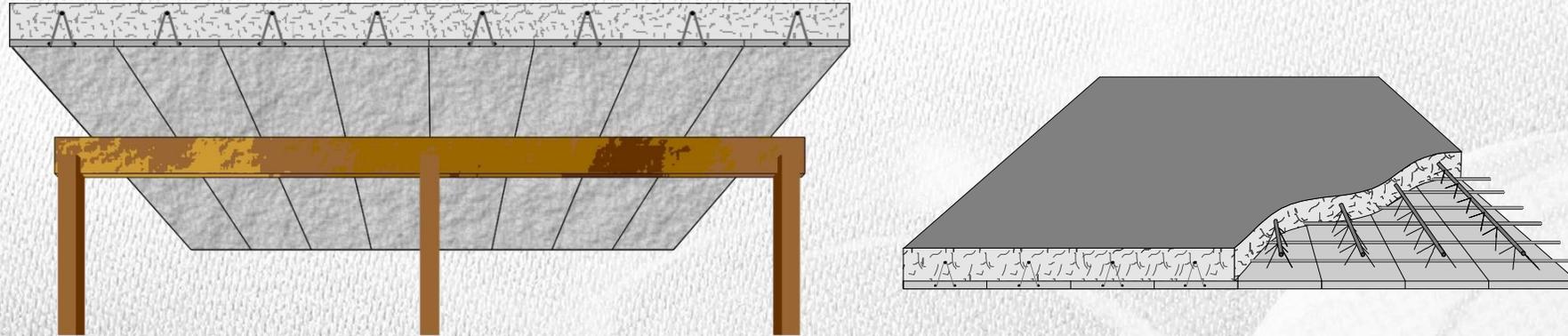
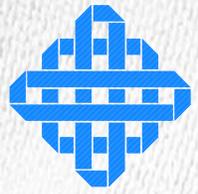


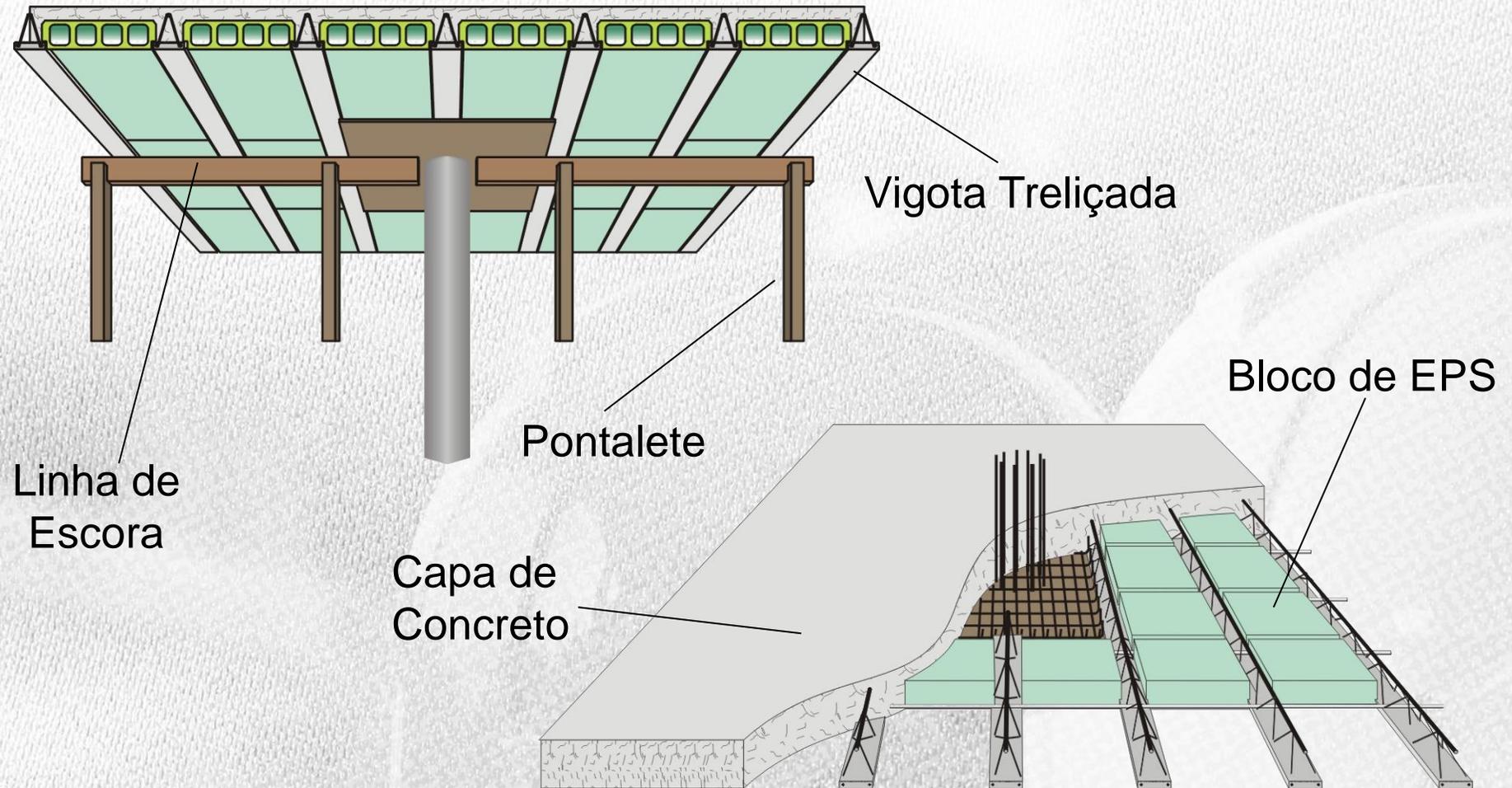


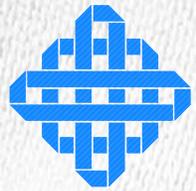


Painel treliçado  
auto-portante









- DEFINIÇÃO DOS MATERIAIS;
- AÇÕES CONSIDERADAS NO CÁLCULO DAS LAJES TRELIÇADAS;
- COMBINAÇÕES DAS AÇÕES;
- CONCEITOS GERAIS, GEOMETRIA E ANALISE ESTRUTURAL;
- PROCEDIMENTOS PARA OS DIMENSIONAMENTOS NOS ESTADOS LIMITES ÚLTIMOS;
- PROCEDIMENTOS PARA AS VERIFICAÇÕES NOS ESTADOS LIMITES DE SERVIÇO.

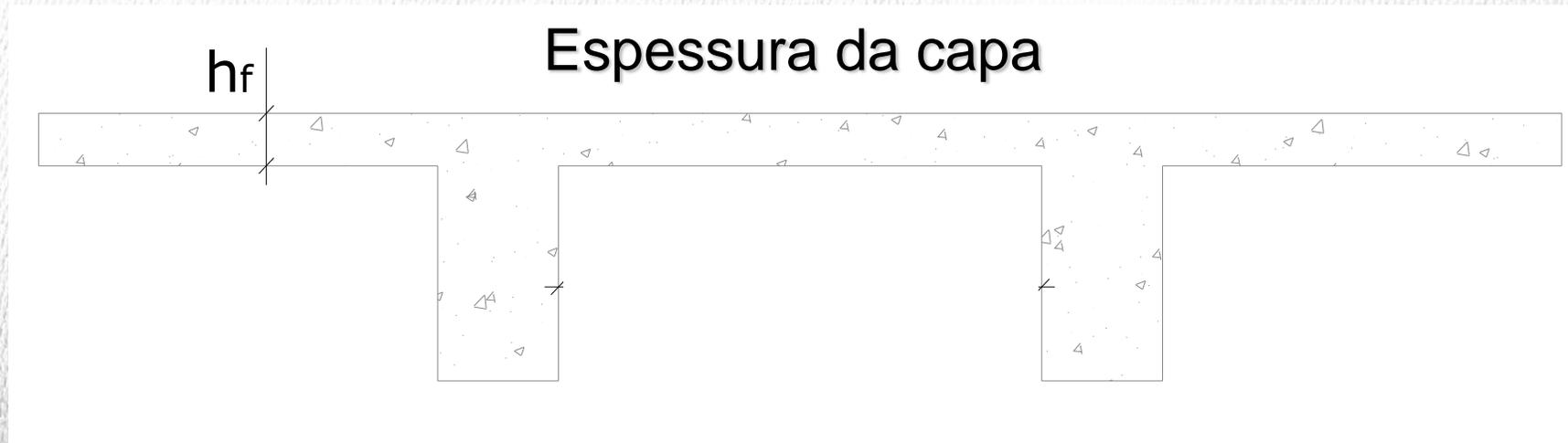
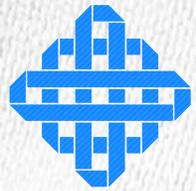




## Espessuras Mínimas

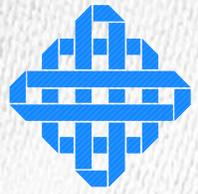
- 7 cm para lajes de cobertura não em balanço;
- 8 cm para lajes de piso não em balanço;
- 10 cm para lajes em balanço (tanto de cobertura como de piso);
- 10 cm para lajes que suportem veículos de peso total menor ou igual a 30 kN;
- 12 cm para lajes que suportem veículos de peso total maior que 30 kN;
- 15 cm para lajes com protensão apoiadas em vigas, com o mínimo de  $l_x/42$  para lajes de piso biapoiadas e  $l_x/50$  para lajes de piso contínuas;
- 16 cm para lajes lisas e 14 cm para lajes-cogumelo, fora do capital.



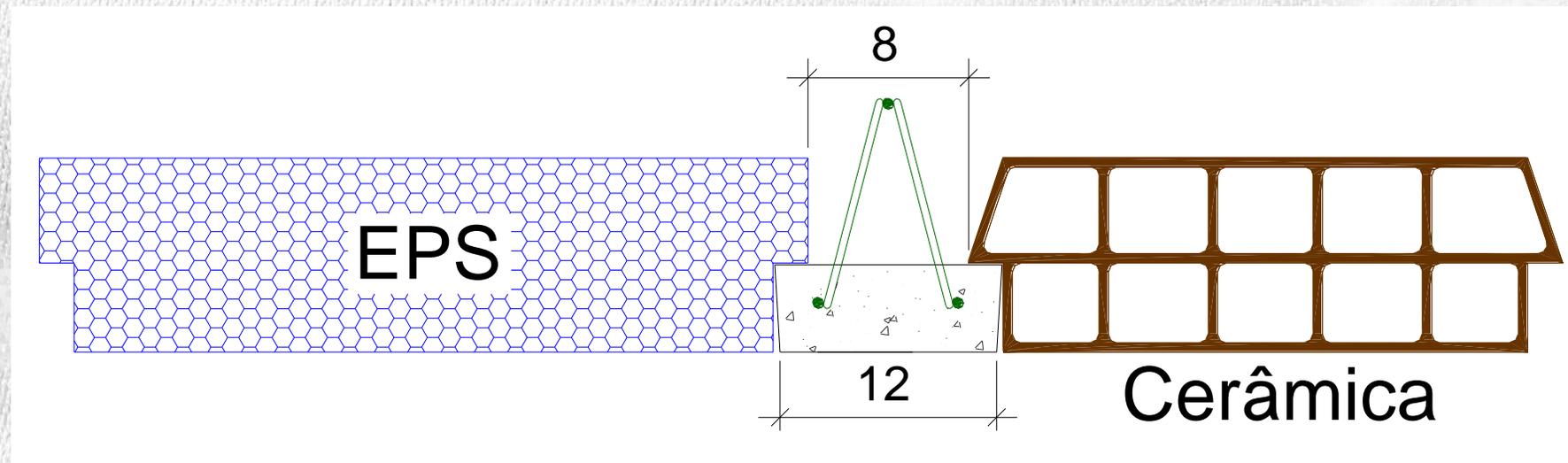


<b>hf (cm)</b>	<b>Diâmetro das tubulações</b>
4	Não há
5	$\leq 10$ mm
$4 + \varnothing$	$> 10$ mm





## Espessura da nervura





## Espaçamento das nervuras

Inter-eixo  $\leq 65$  cm,

(M, N e Q) = Lajes maciças

Dispensa estribos quando o concreto simples for suficiente para suportar as tensões de cisalhamento e/ou punção oriundos da força cortante.





## Espaçamento das nervuras

$65 \text{ cm} < \text{Inter-eixo} \leq 110 \text{ cm},$

(M, N e Q)

Para M, N e Q .... lajes maciças,

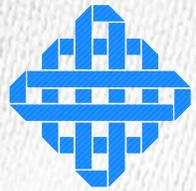
As nervuras devem ser armadas como vigas.

Mesa de concreto:

Verificações a Flexão e

Ligação Mesa-nervura.





## Espaçamento das nervuras

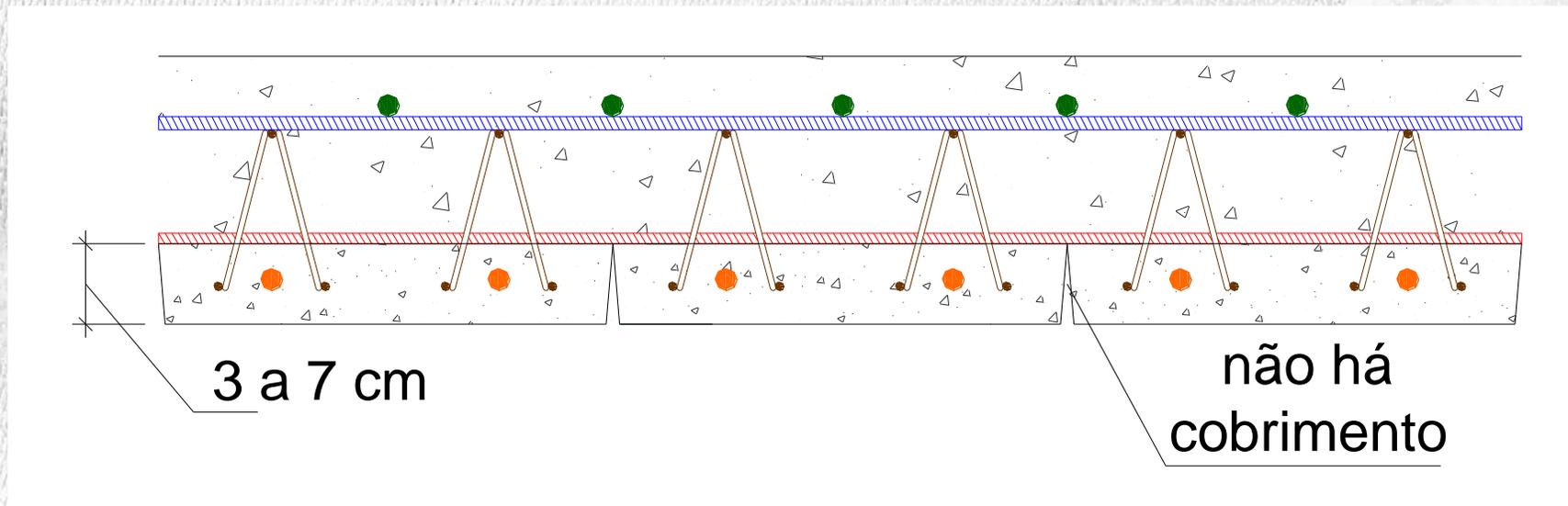
Inter-eixos > 110 cm

Método das grelhas de vigas  
sobre as quais as lajes maciças  
são apoiadas.



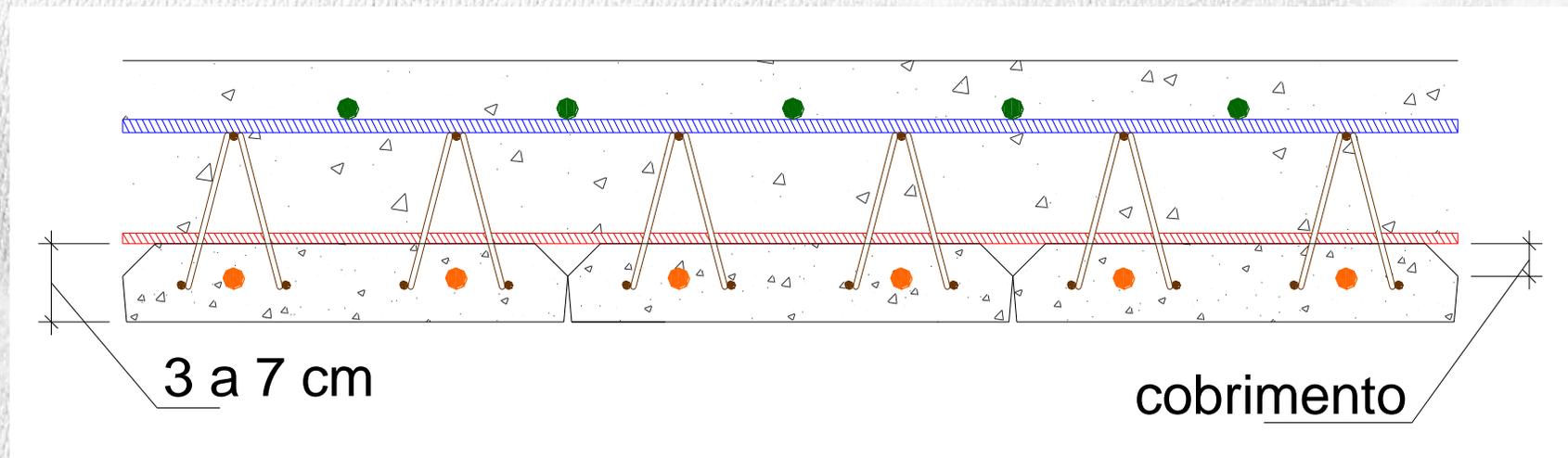


## Detalhes de Cobrimento nas Lajes Trelaçadas



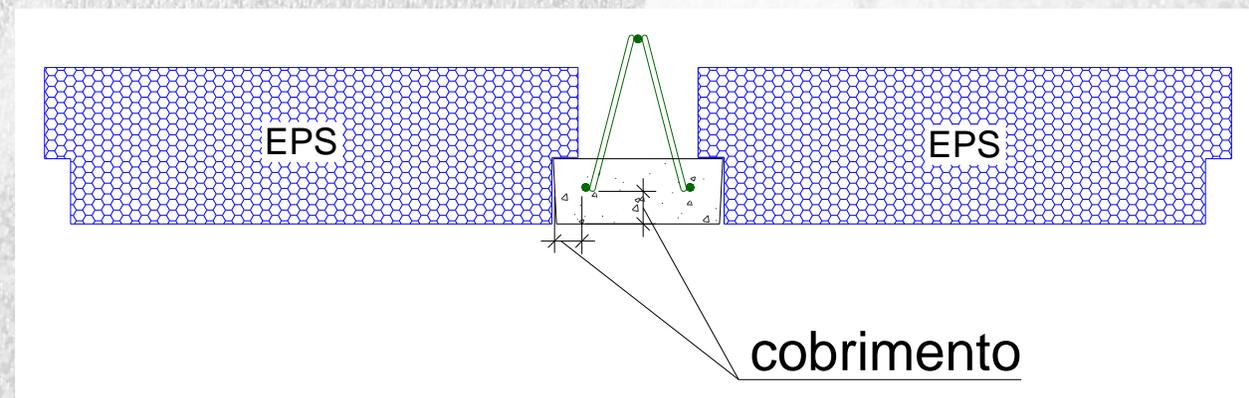
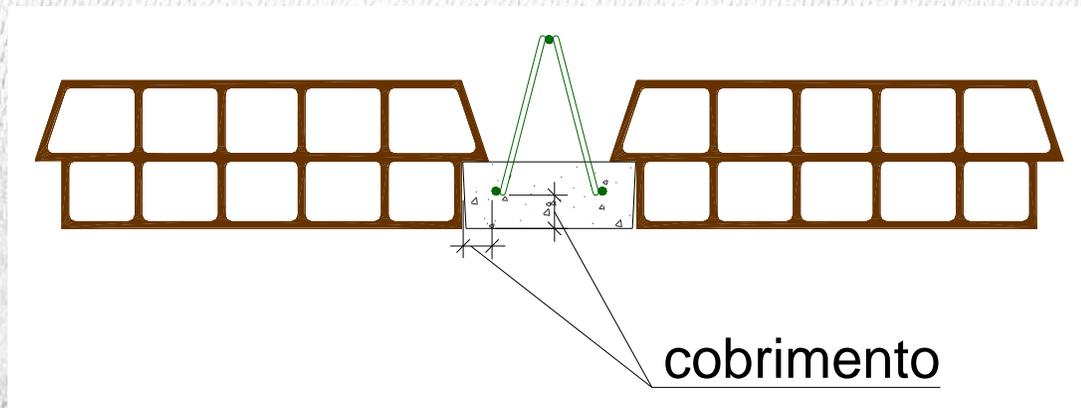


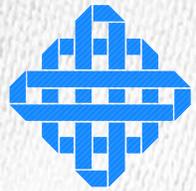
## Detalhes de Cobrimento nas Lajes Trelaçadas



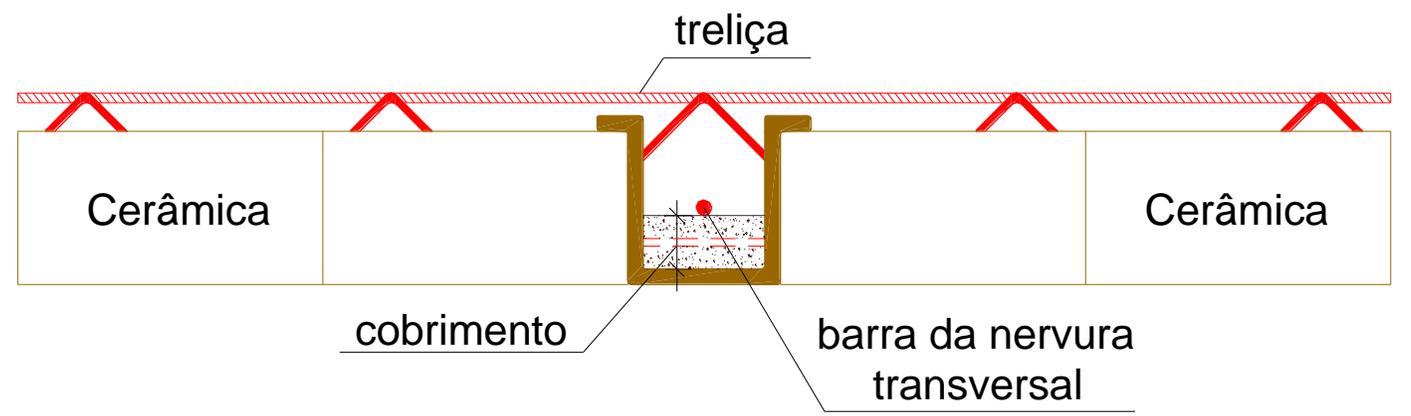
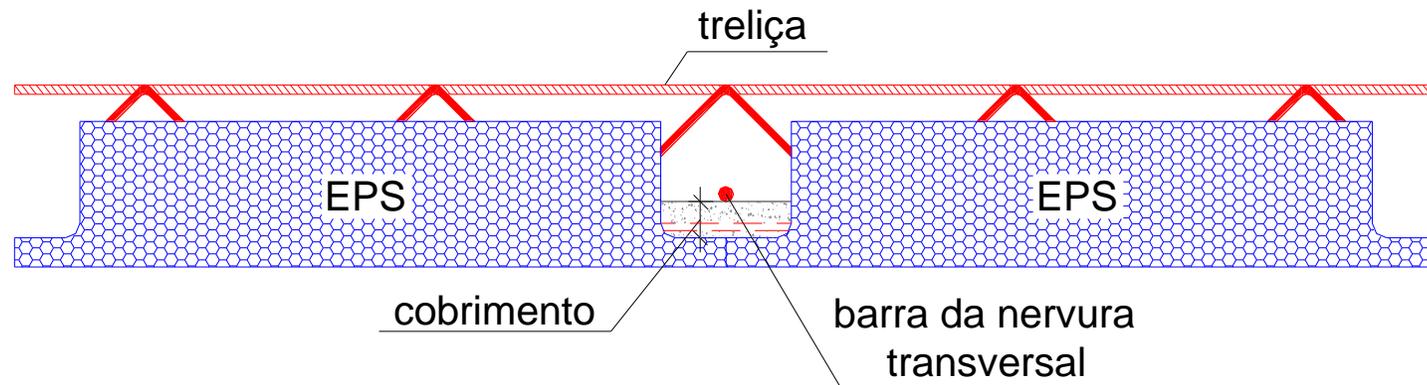


## Detalhes de Cobrimento nas Lajes Trelaçadas



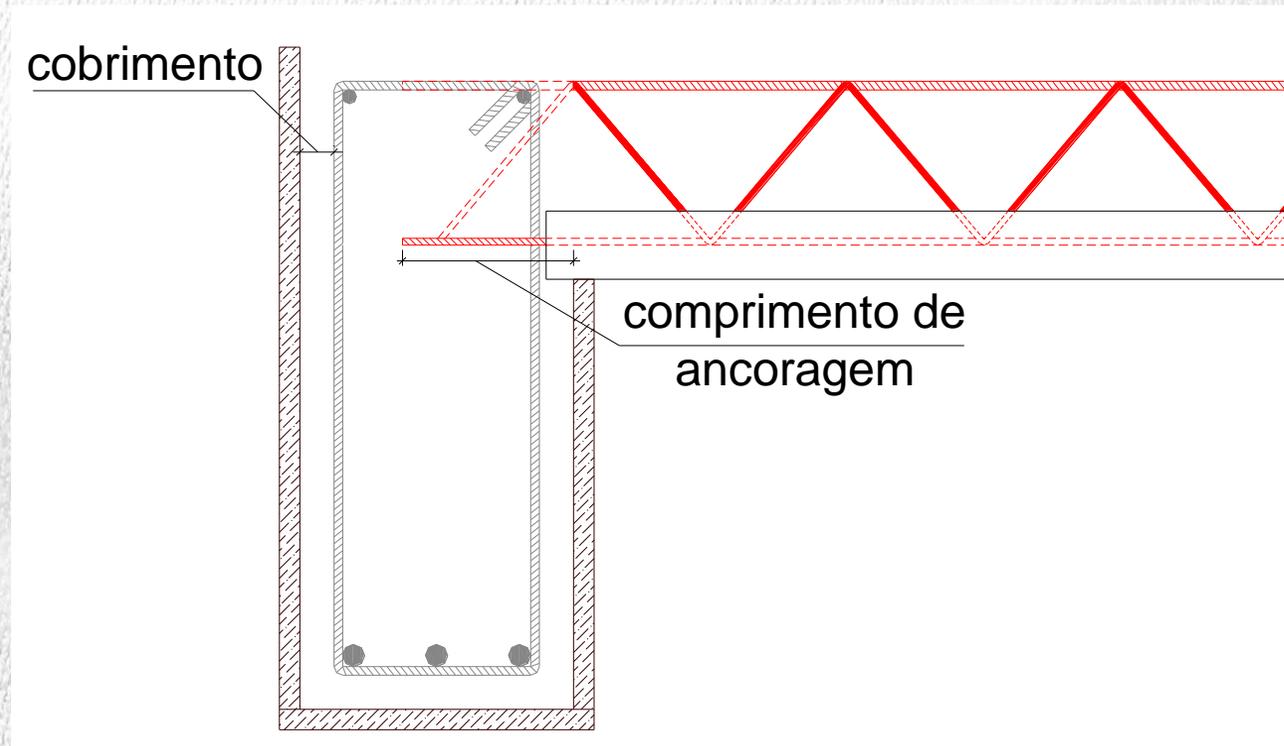


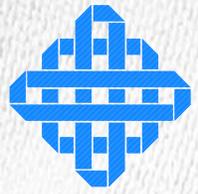
## Detalhes de Cobrimento nas Lajes Trelaçadas



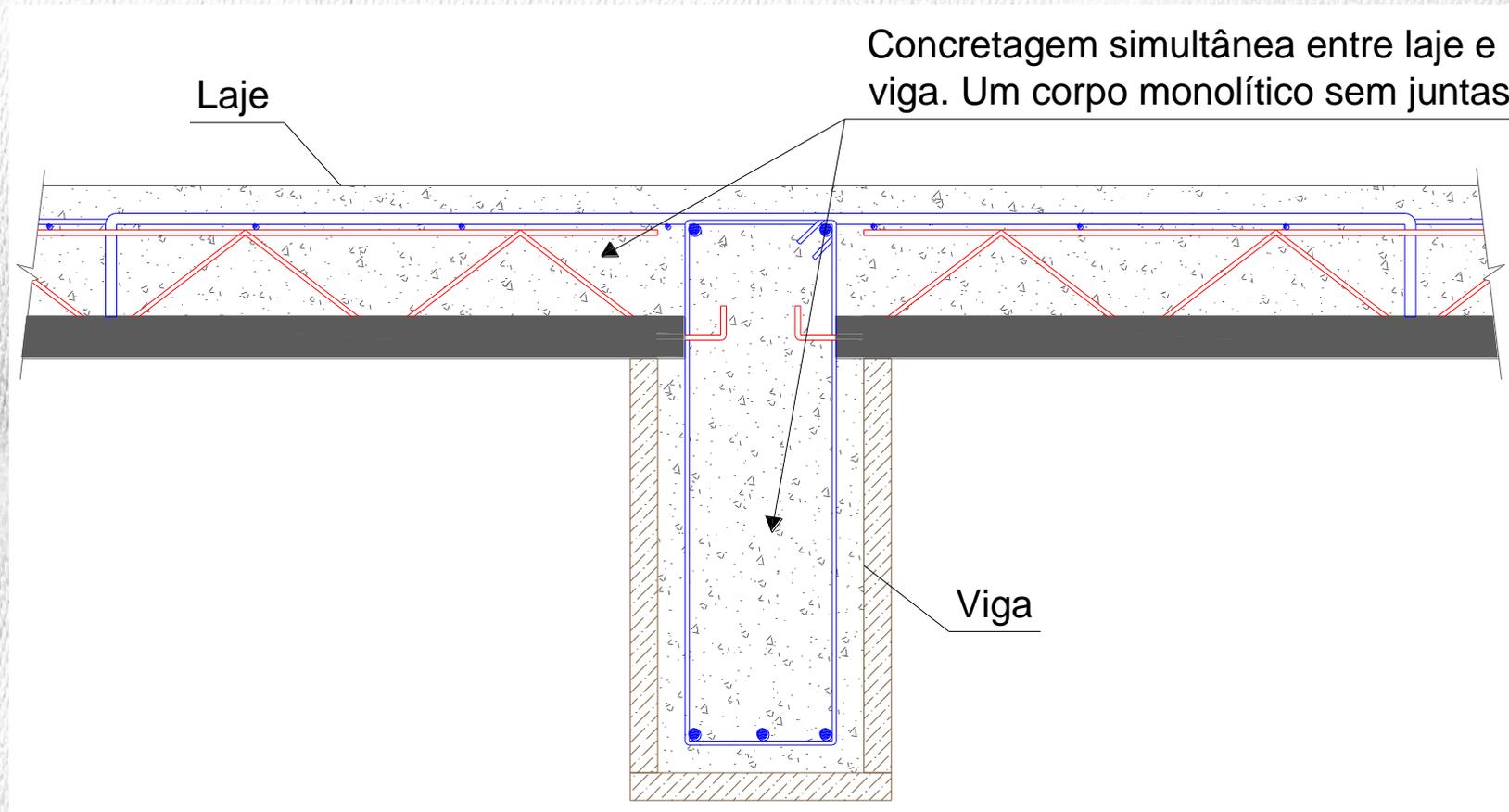


## Detalhes de Cobrimento nas Lajes Trelaçadas



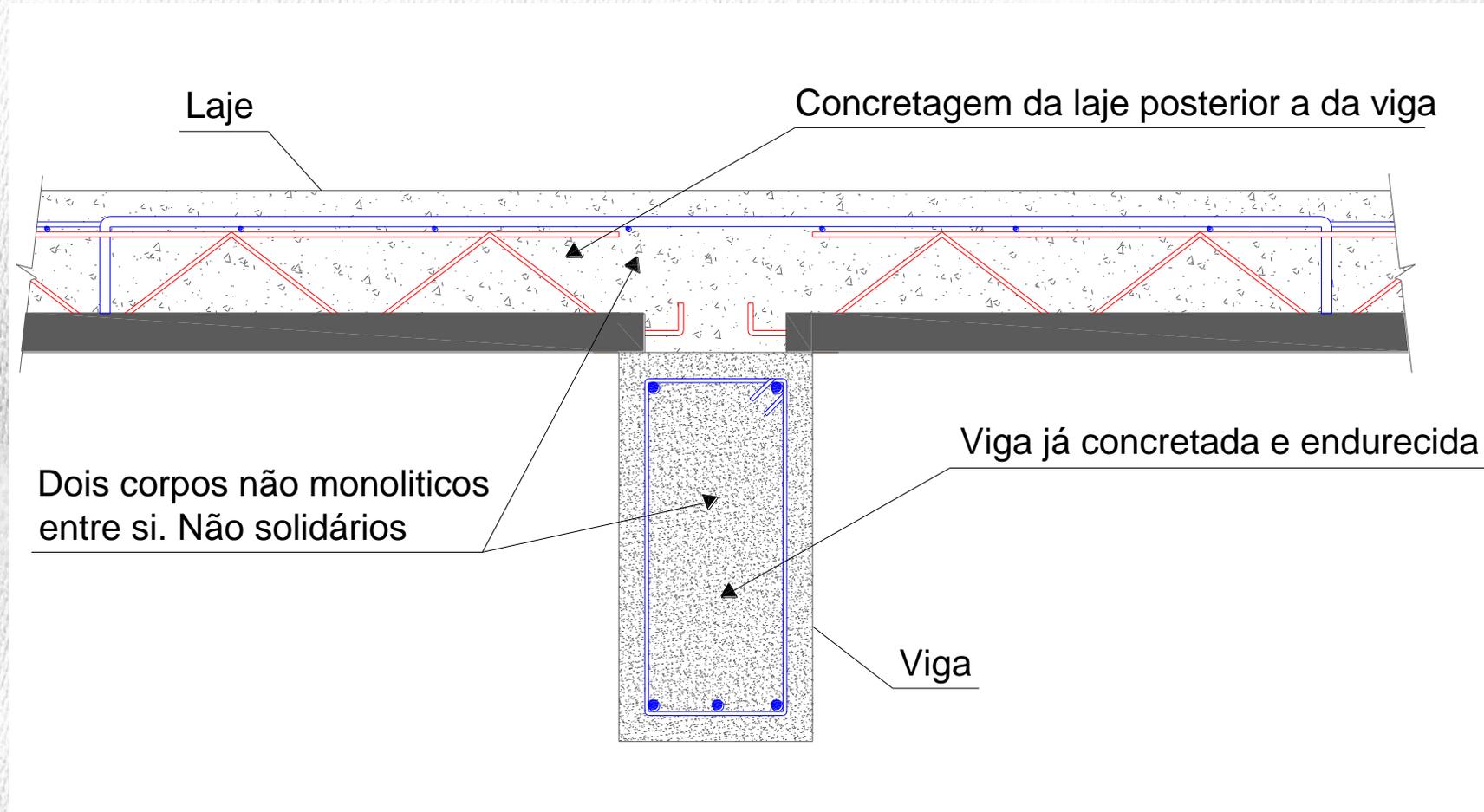


## Condições de apoio





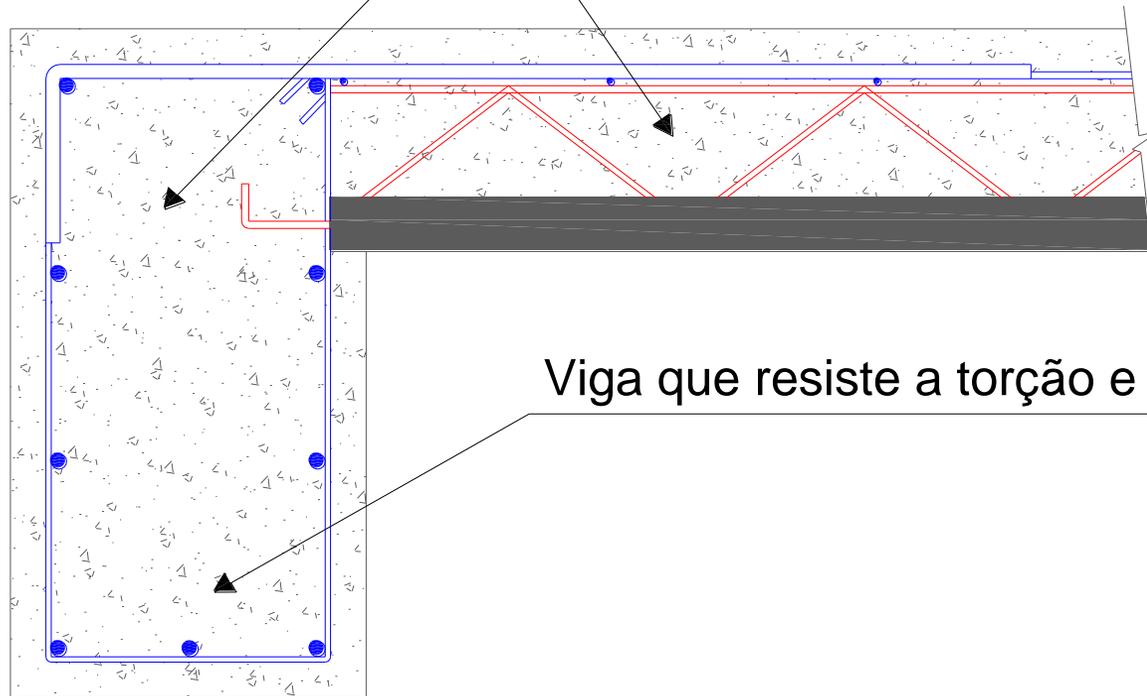
## Condições de apoio





## Condições de apoio

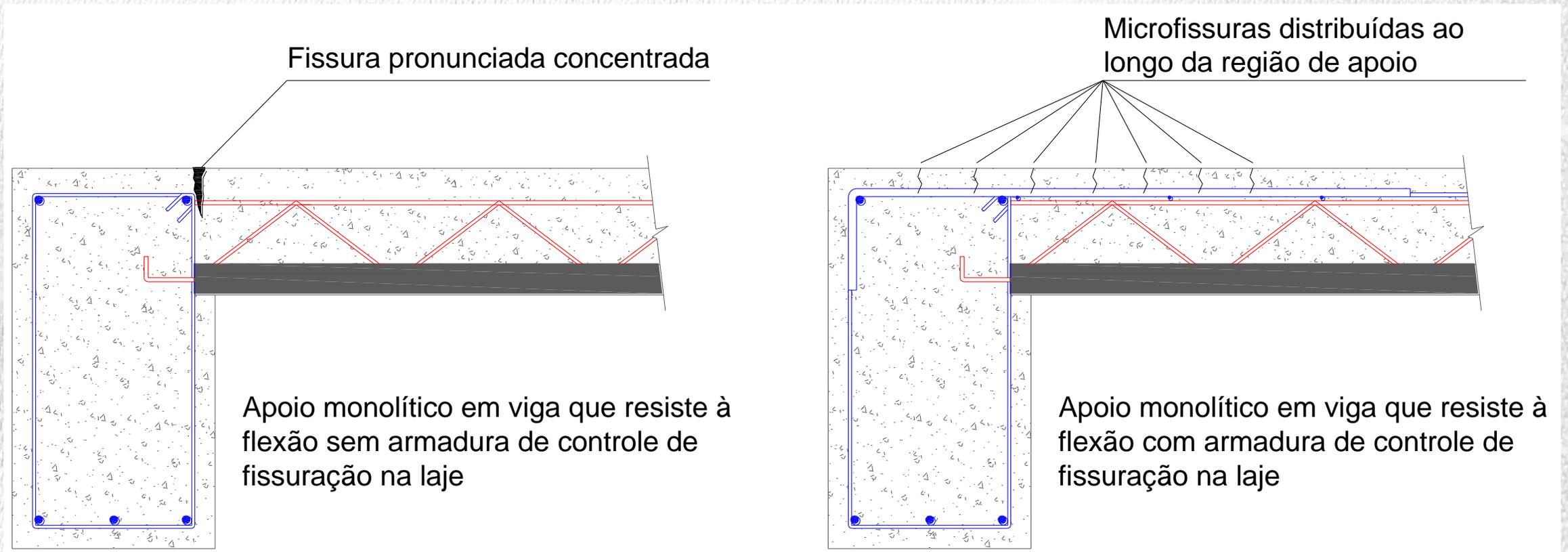
O engastamento se estabelece no equilíbrio entre laje e viga resistente a torção



Viga que resiste a torção e a flexão

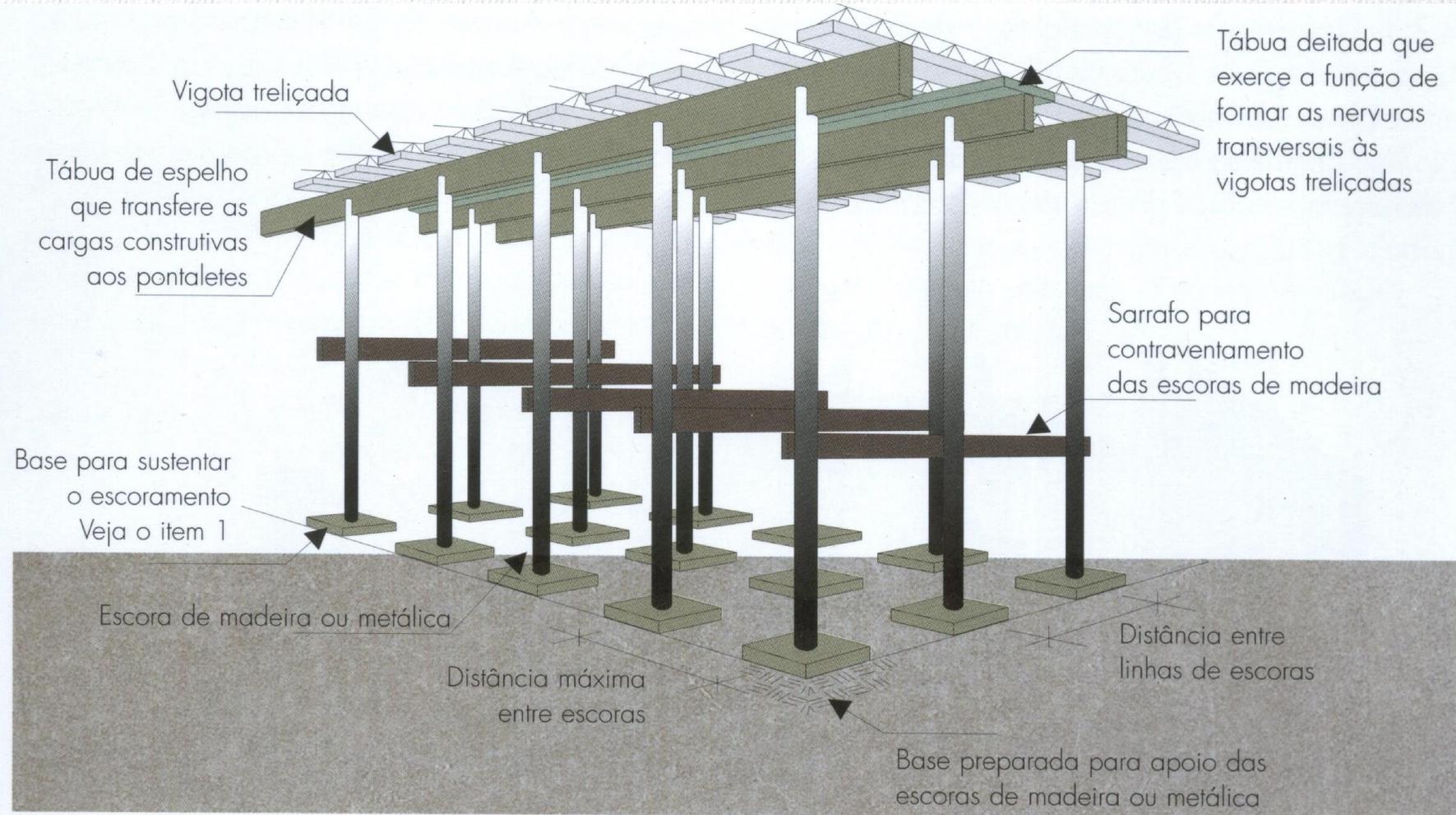


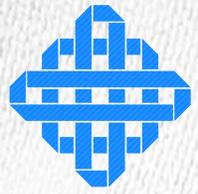
## Armadura para Redistribuição de Fissuras



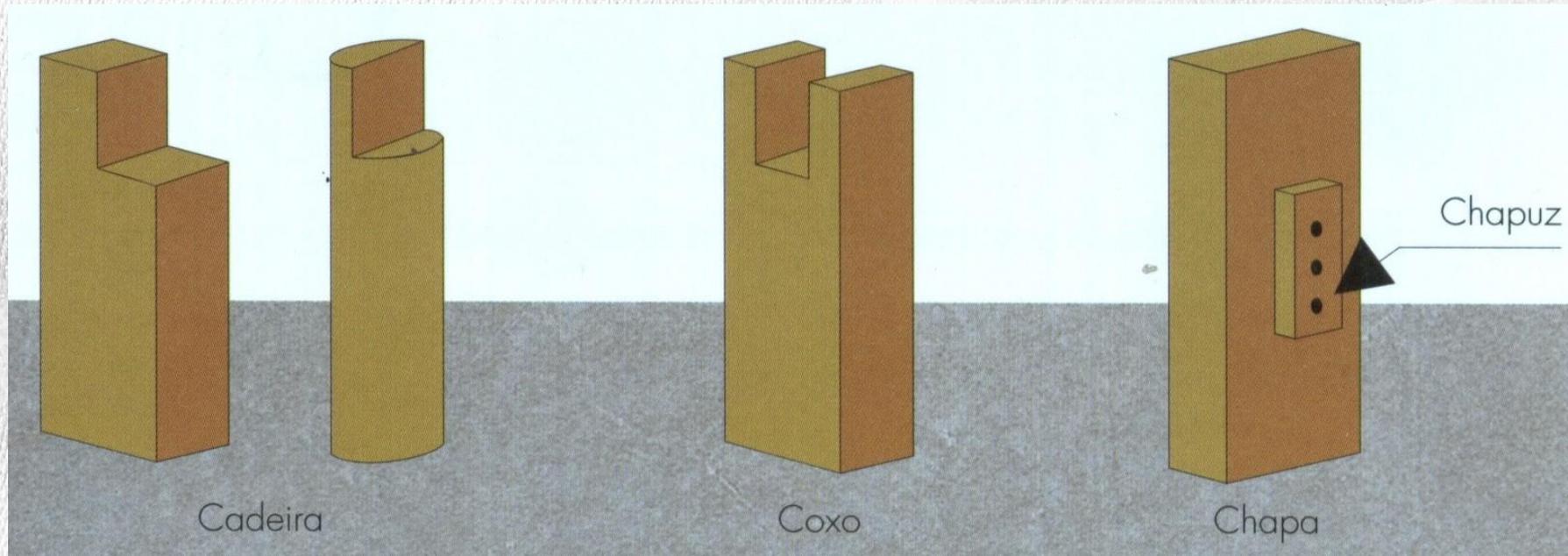


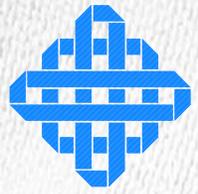
## Escoramento



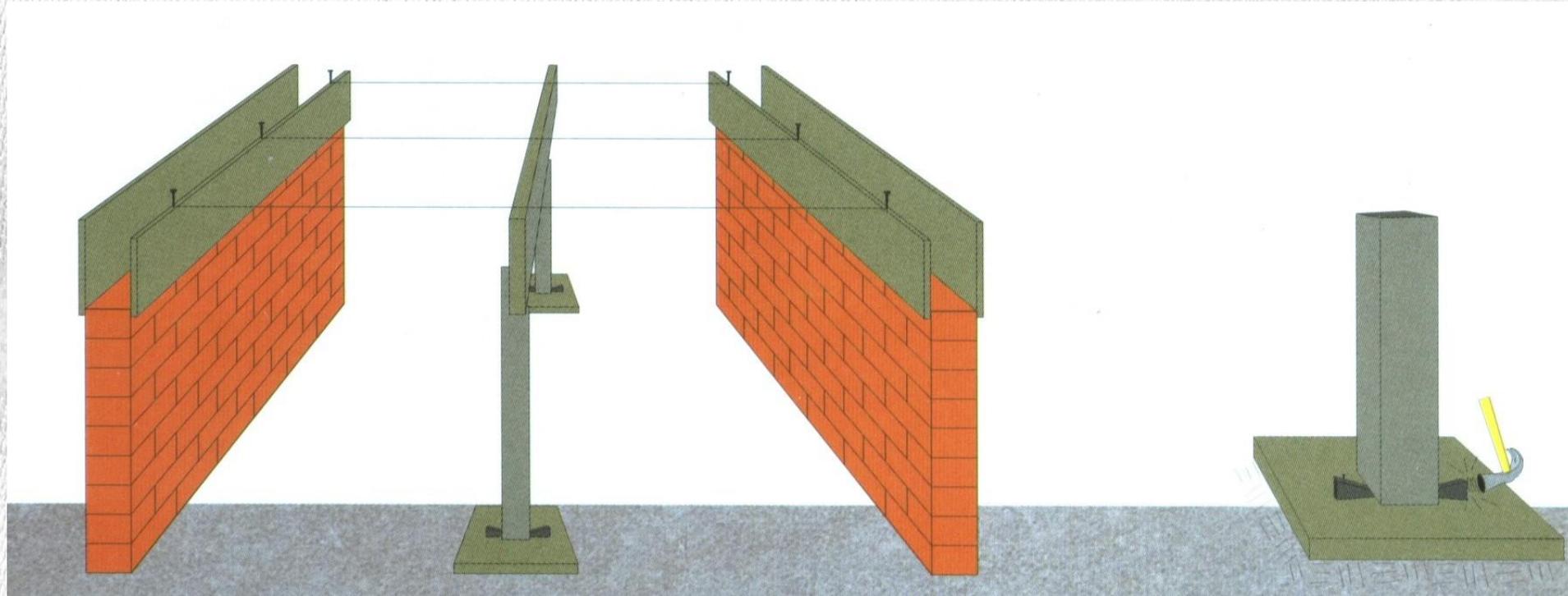


## Escoramento



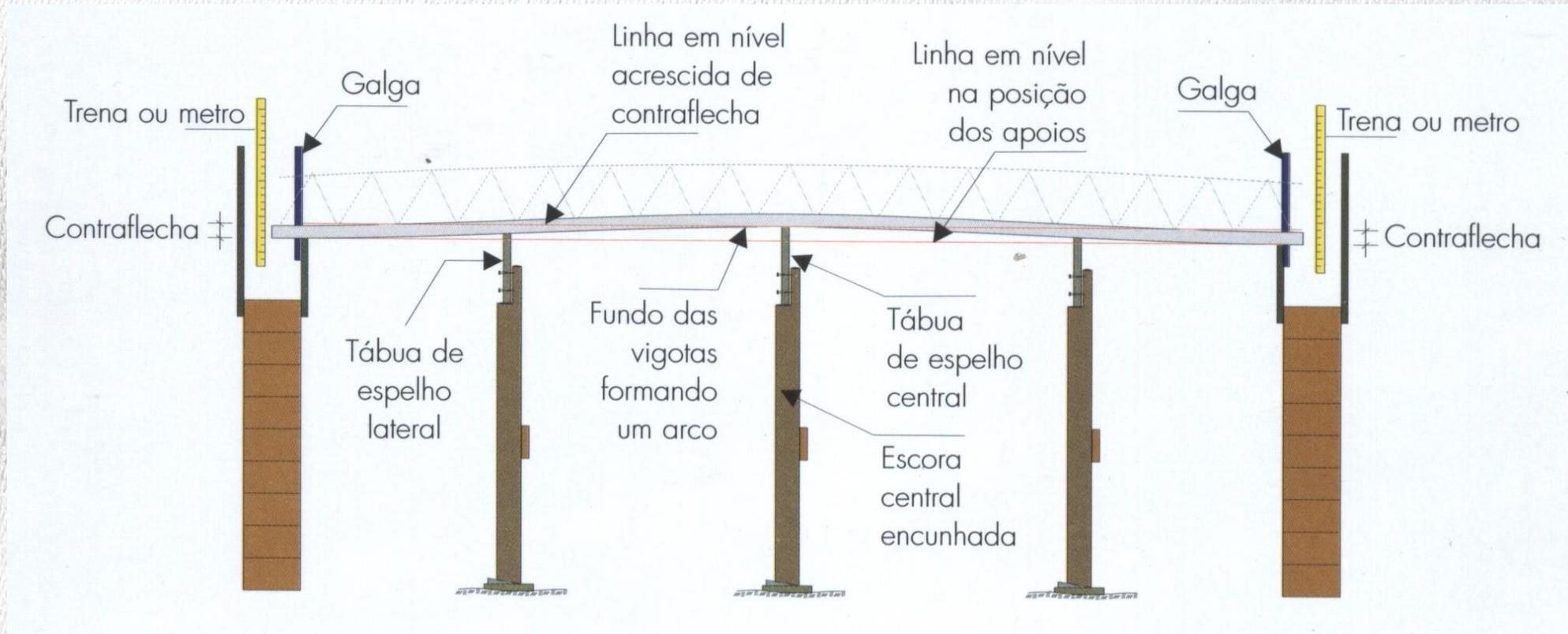


## Escoramento



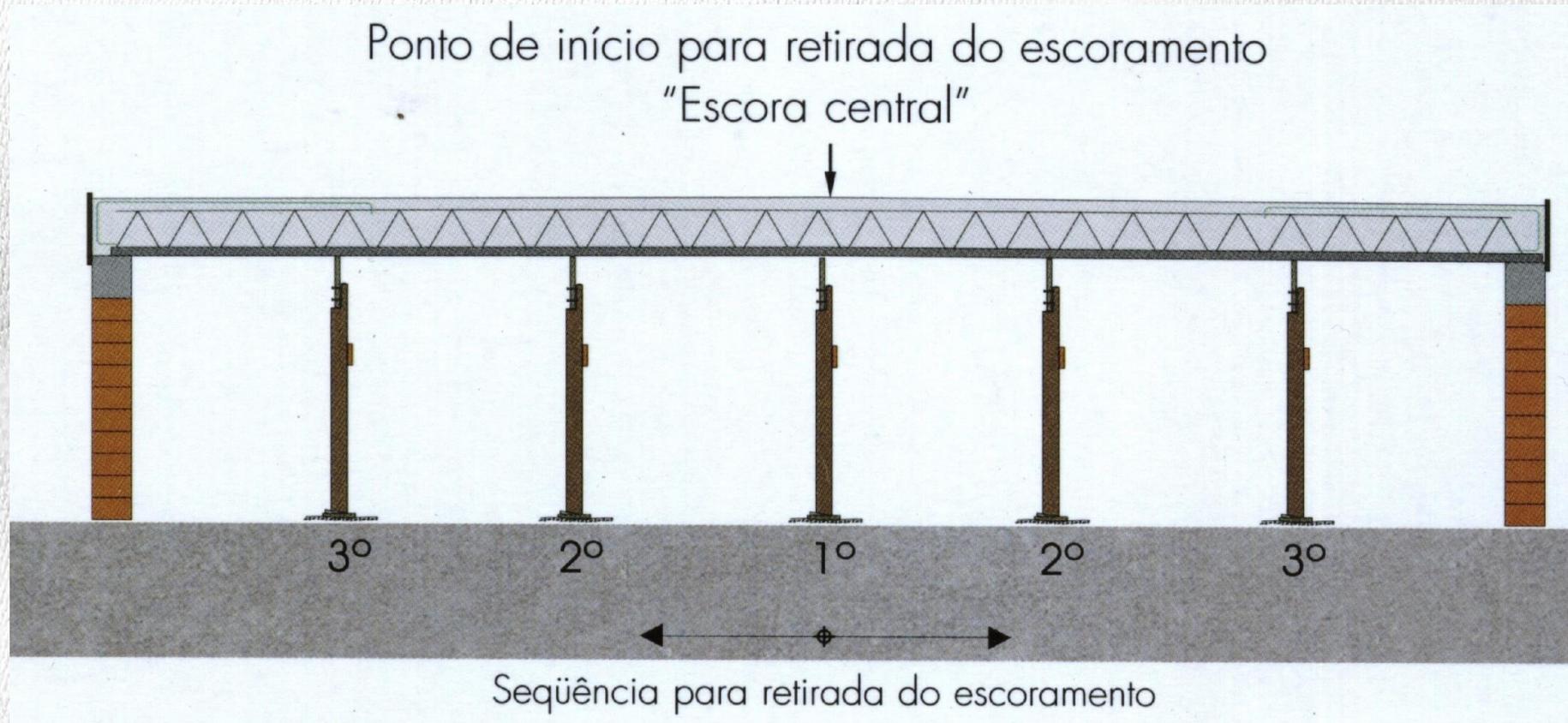


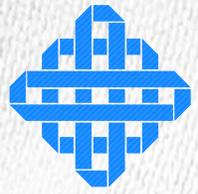
## Escoramento – Aplicação de Contra-flecha



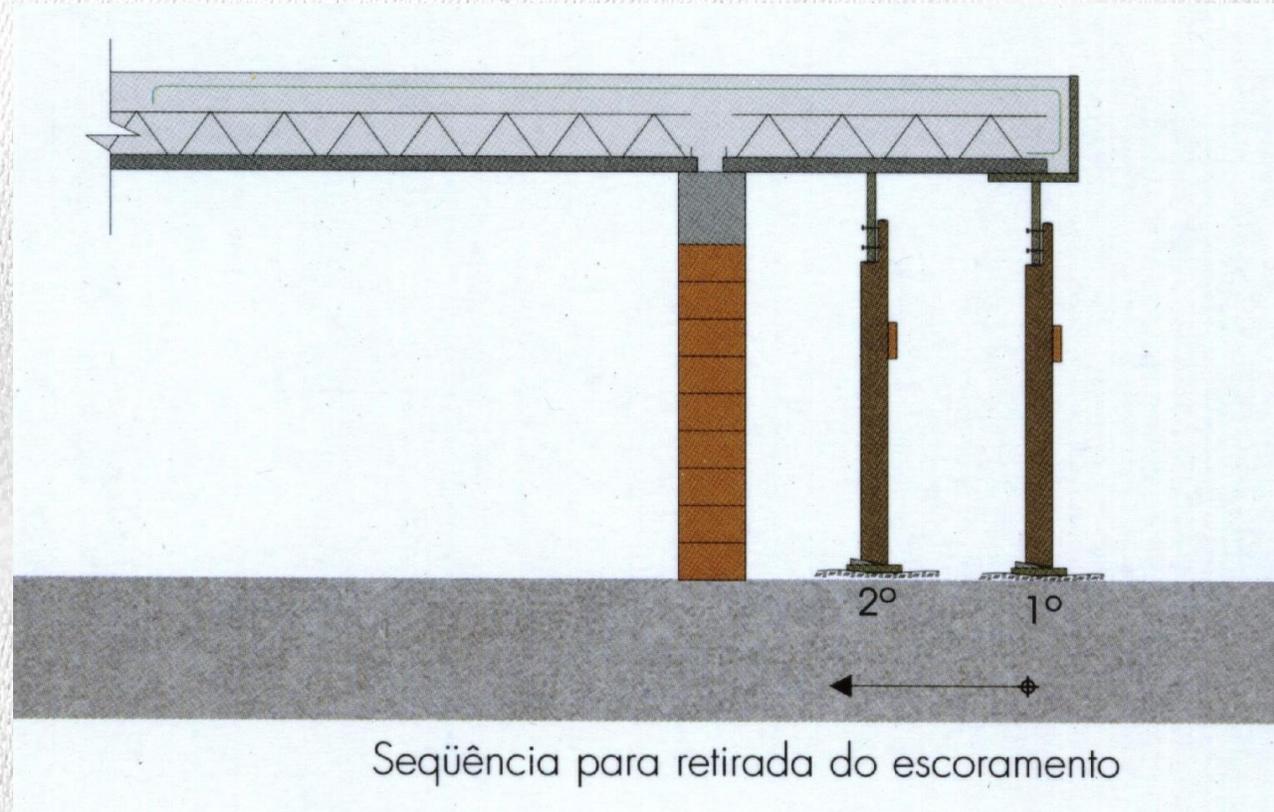


## Escoramento – Retirada das Escoras



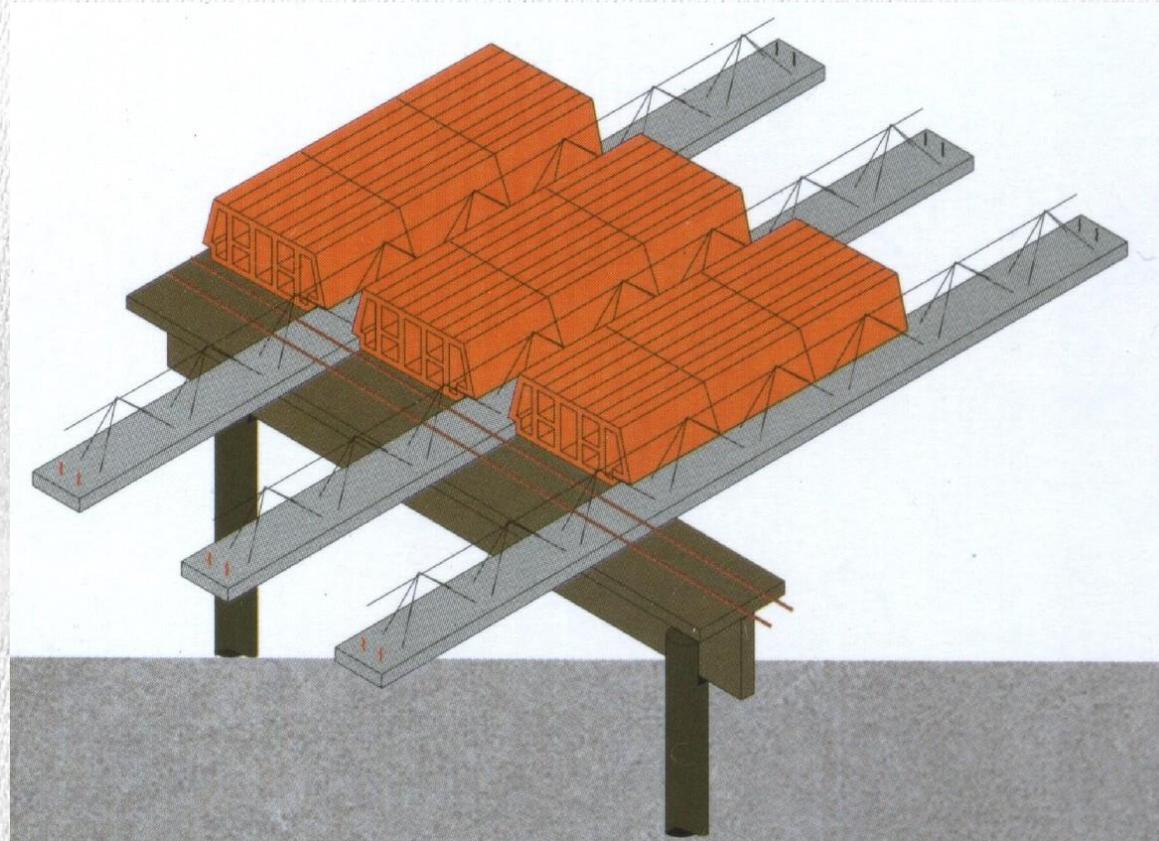


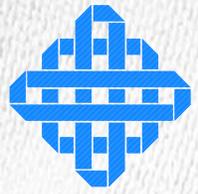
## Escoramento – Retirada das Escoras



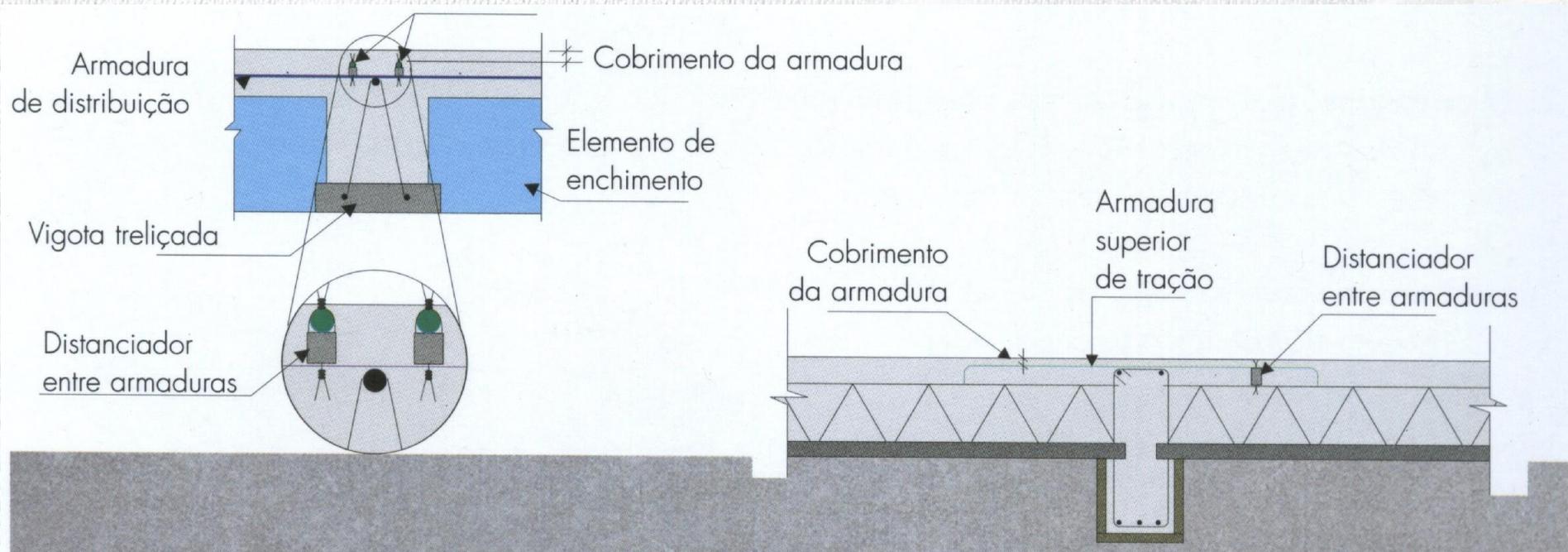


## Armaduras – Nervura Transversal de Travamento



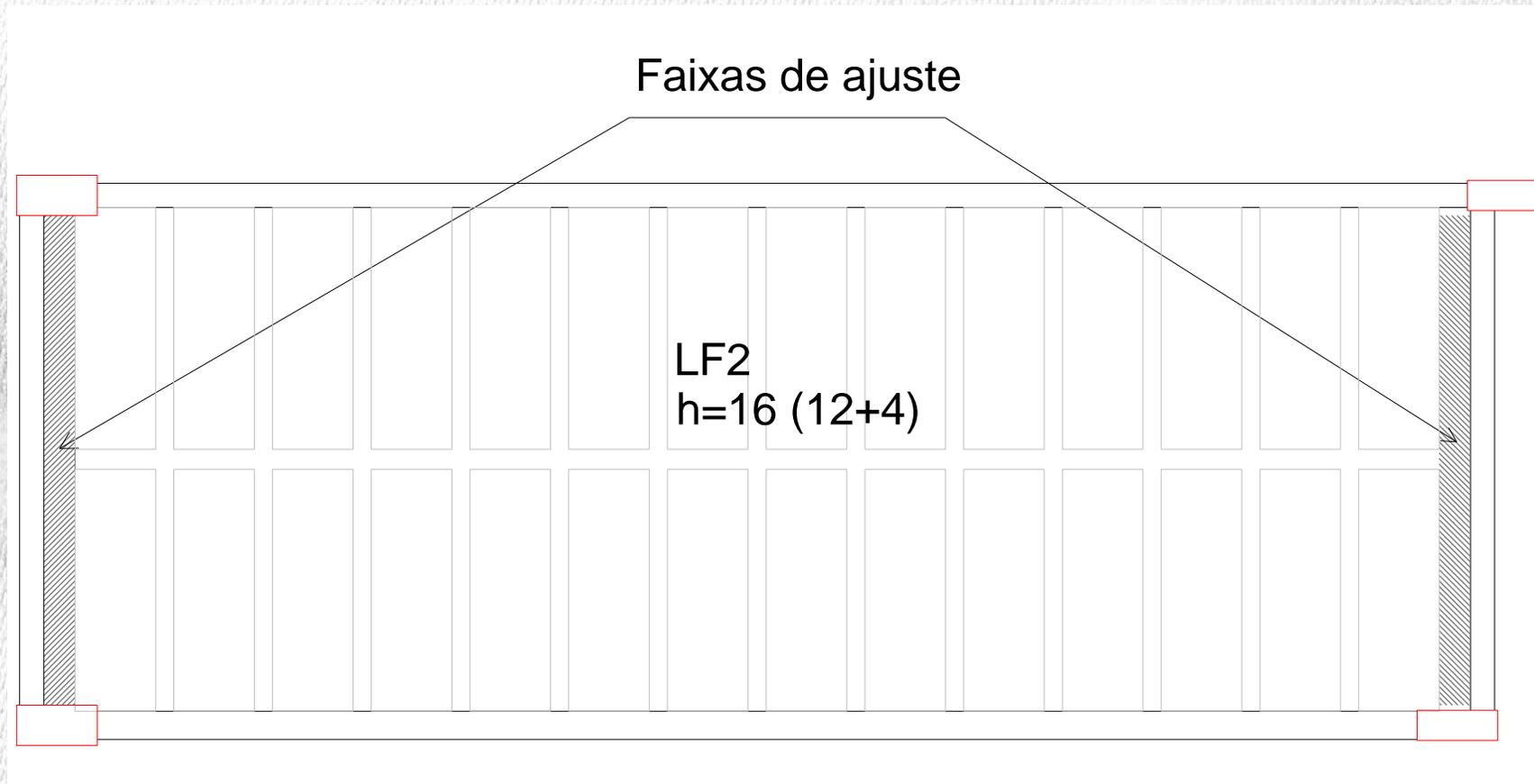


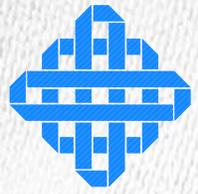
## Armaduras – Armadura Negativa



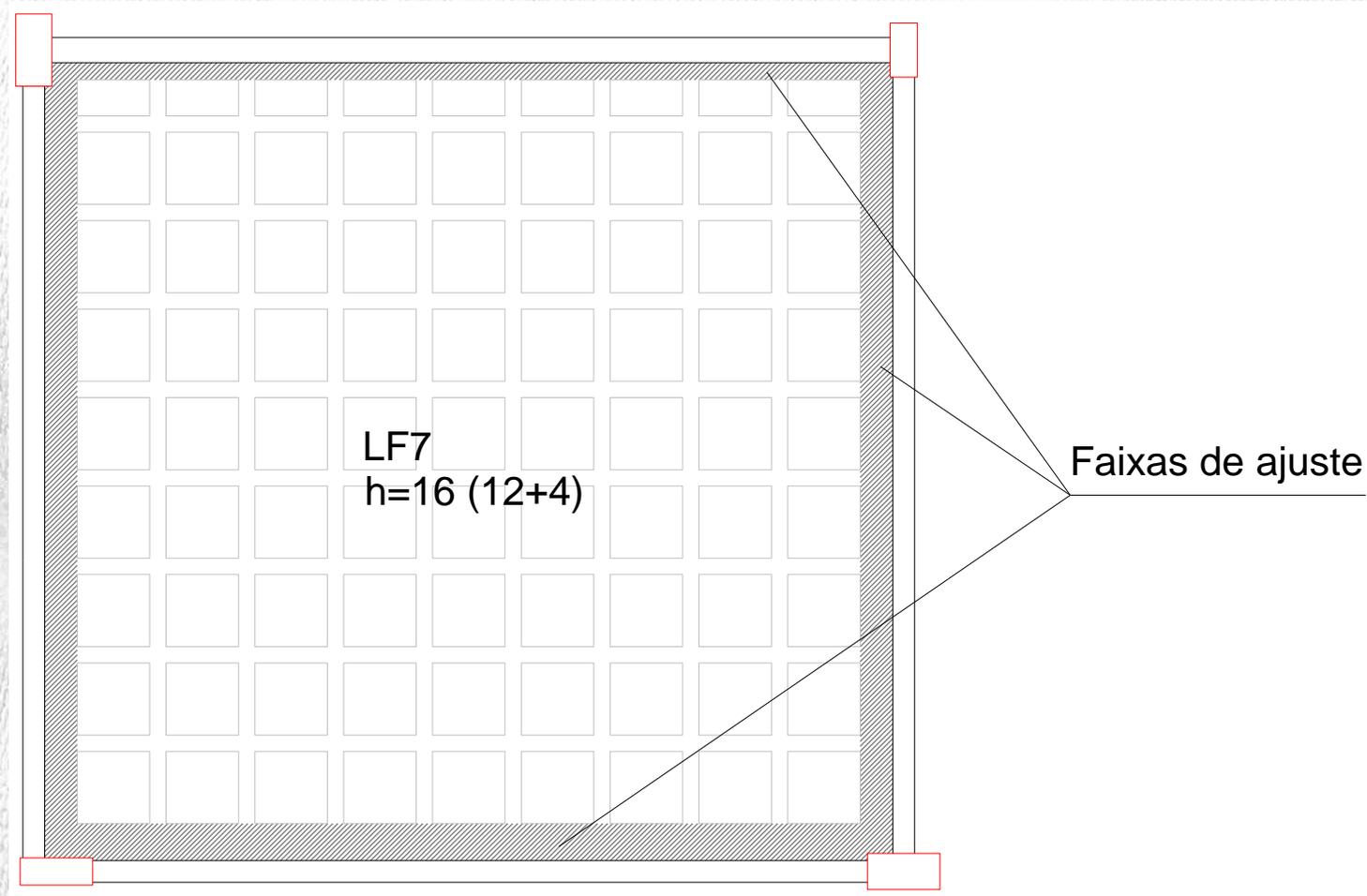


## Faixas de Ajuste Lateral



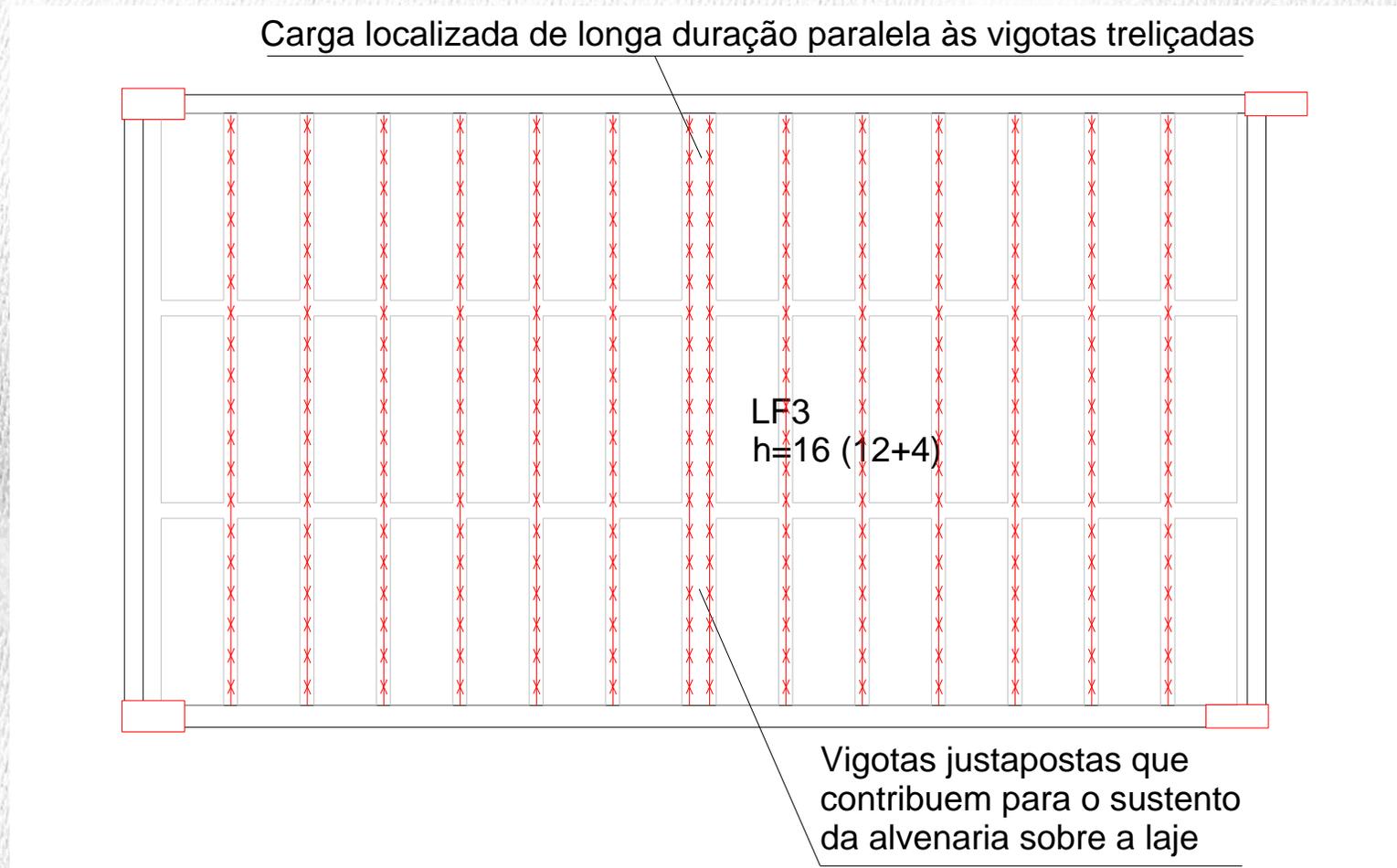


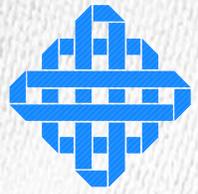
## Faixas de Ajuste Lateral



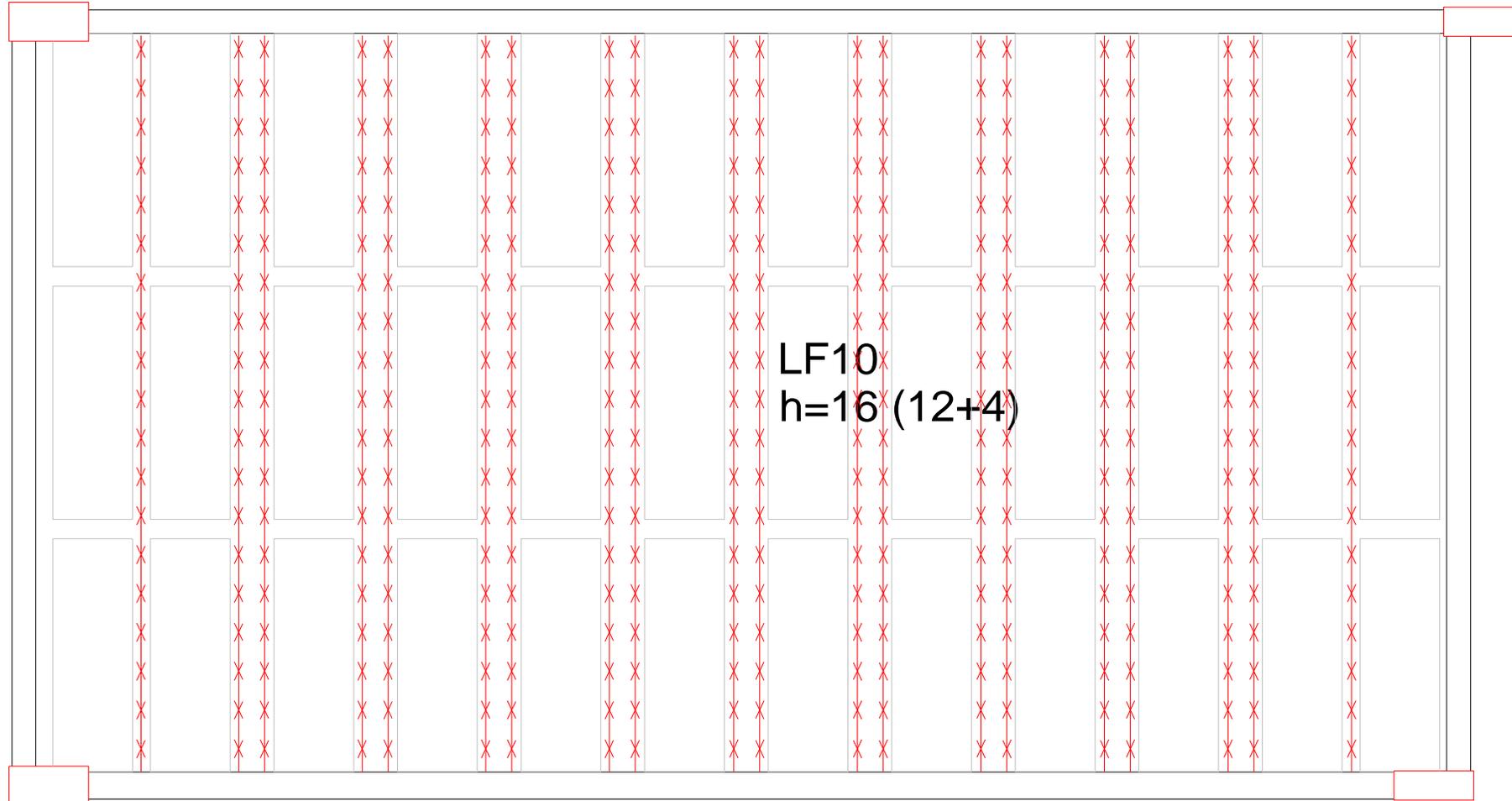


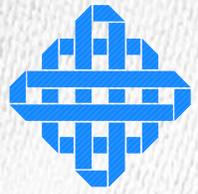
## Vigotas Justapostas



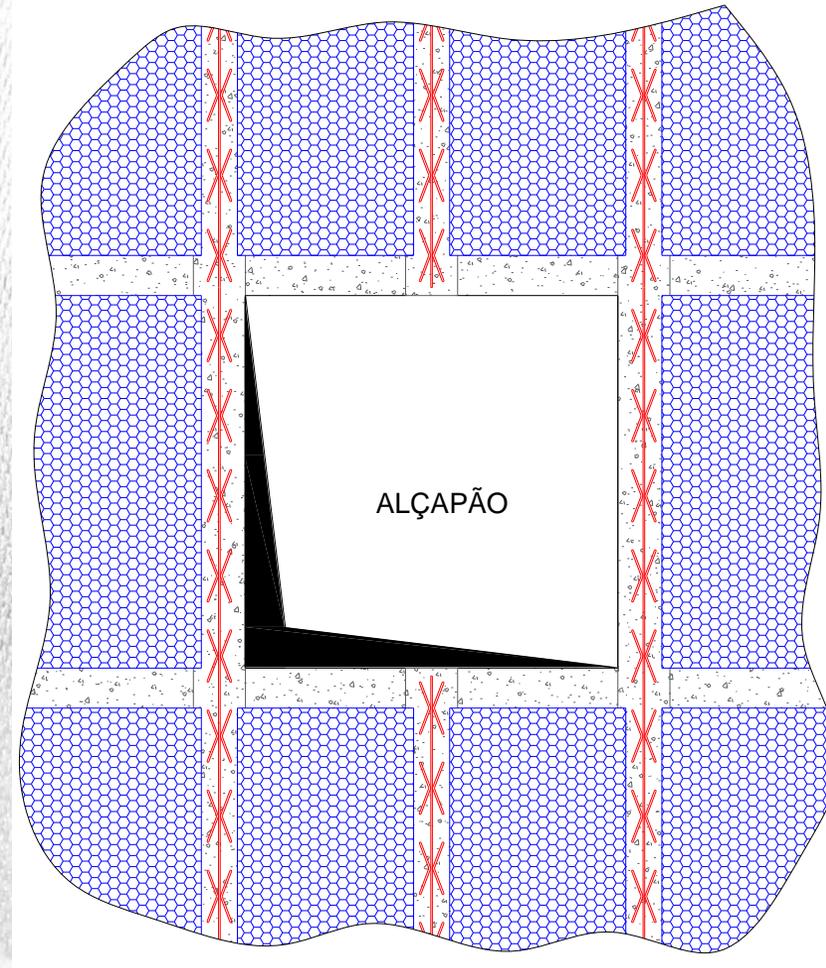


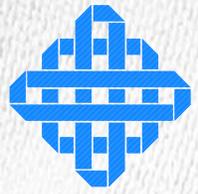
## Vigotas Justapostas



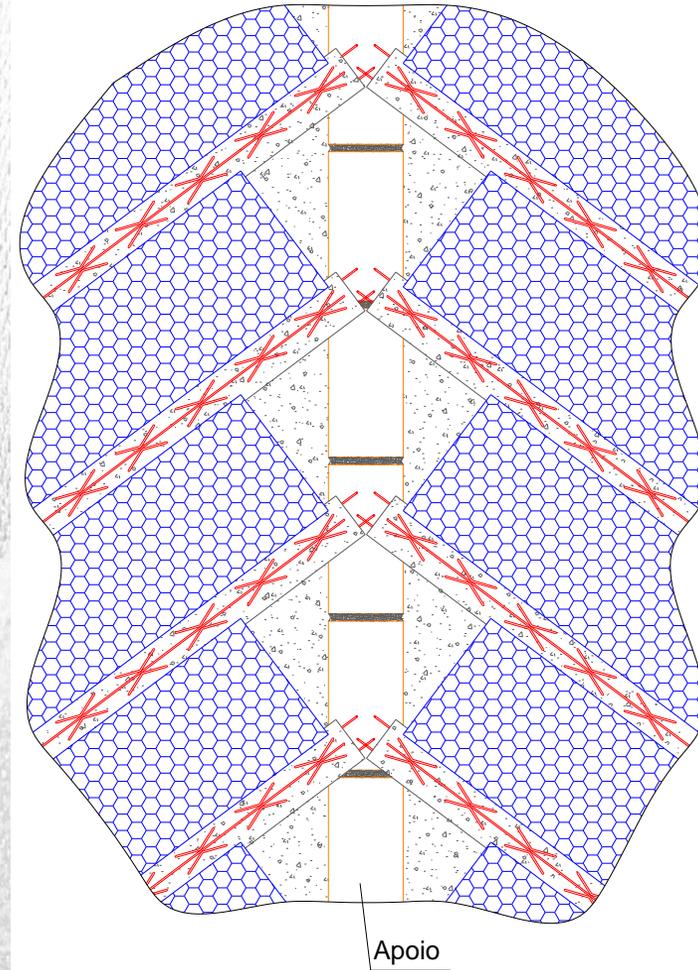


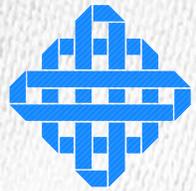
## Aberturas em Lajes Trelaçadas



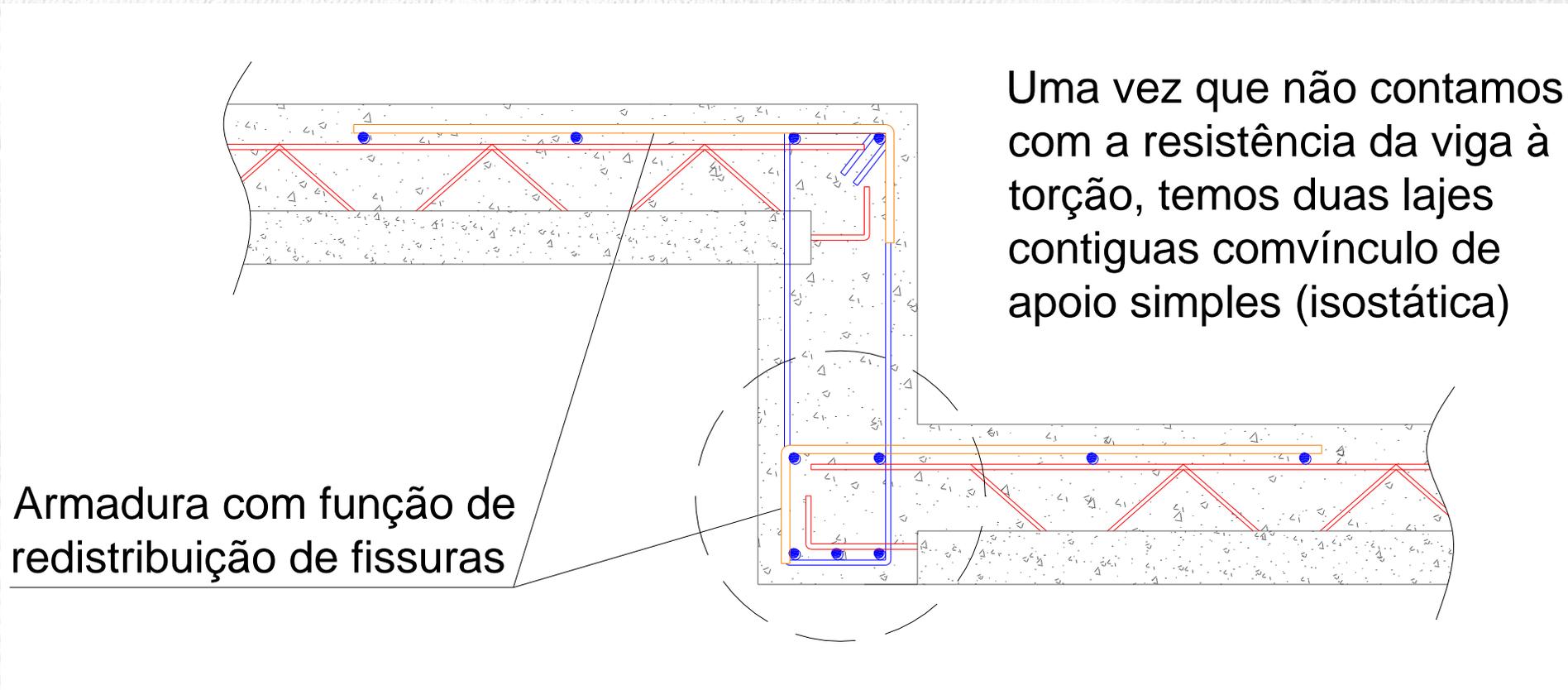


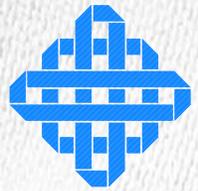
## Contiguidade entre Lajes



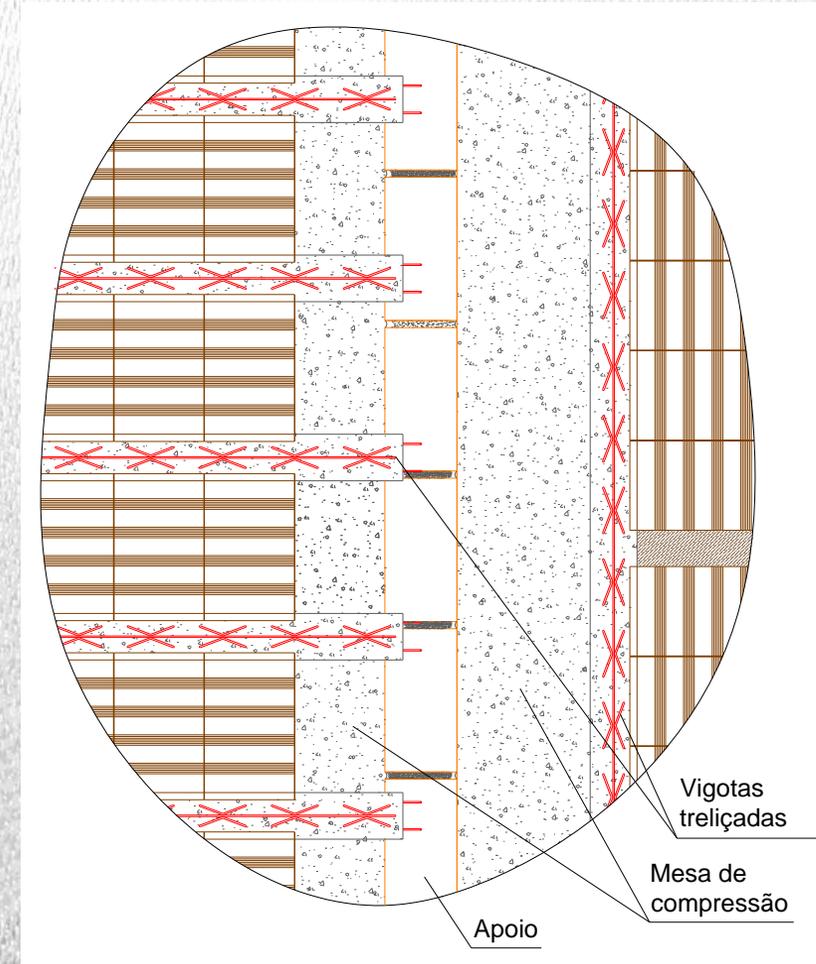
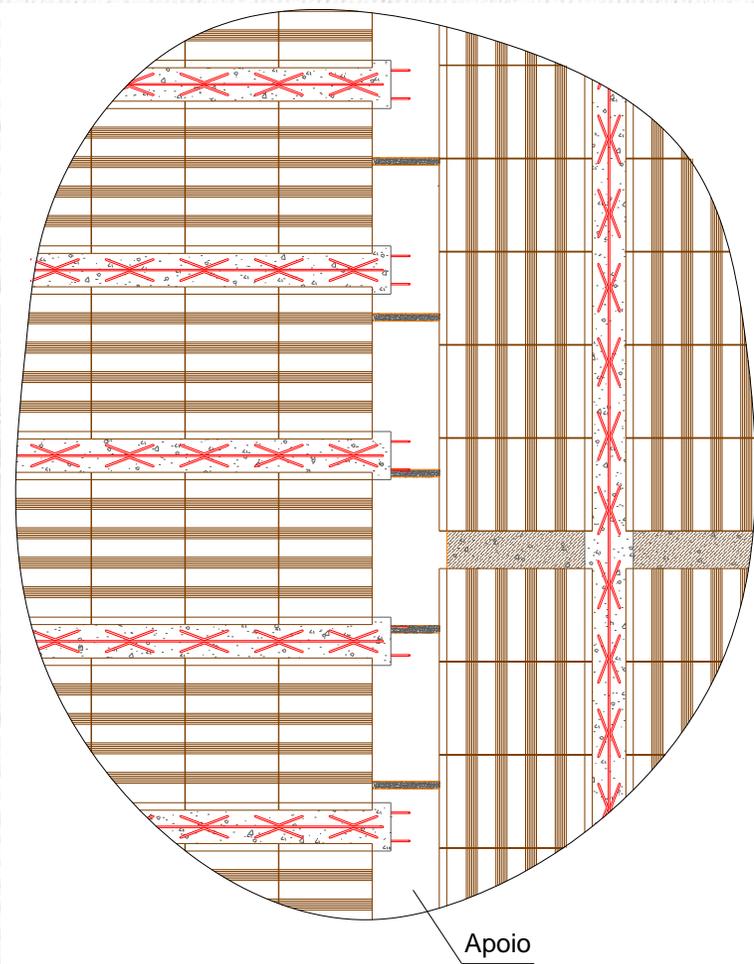


## Contiguidade entre Lajes



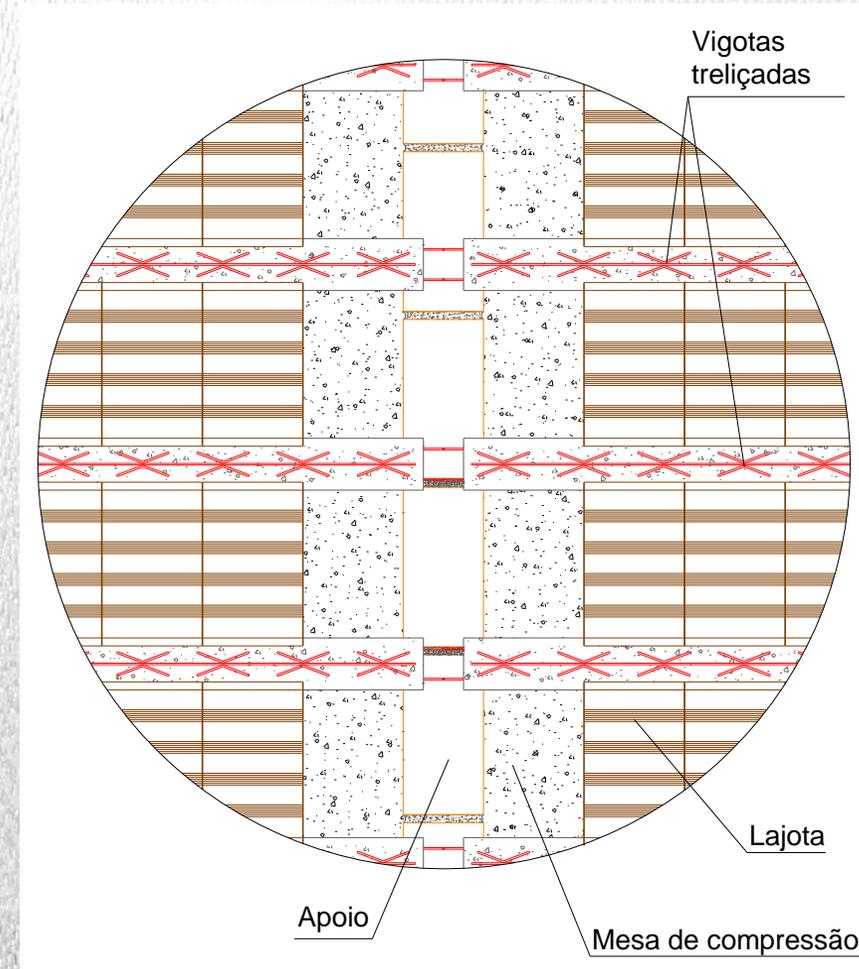
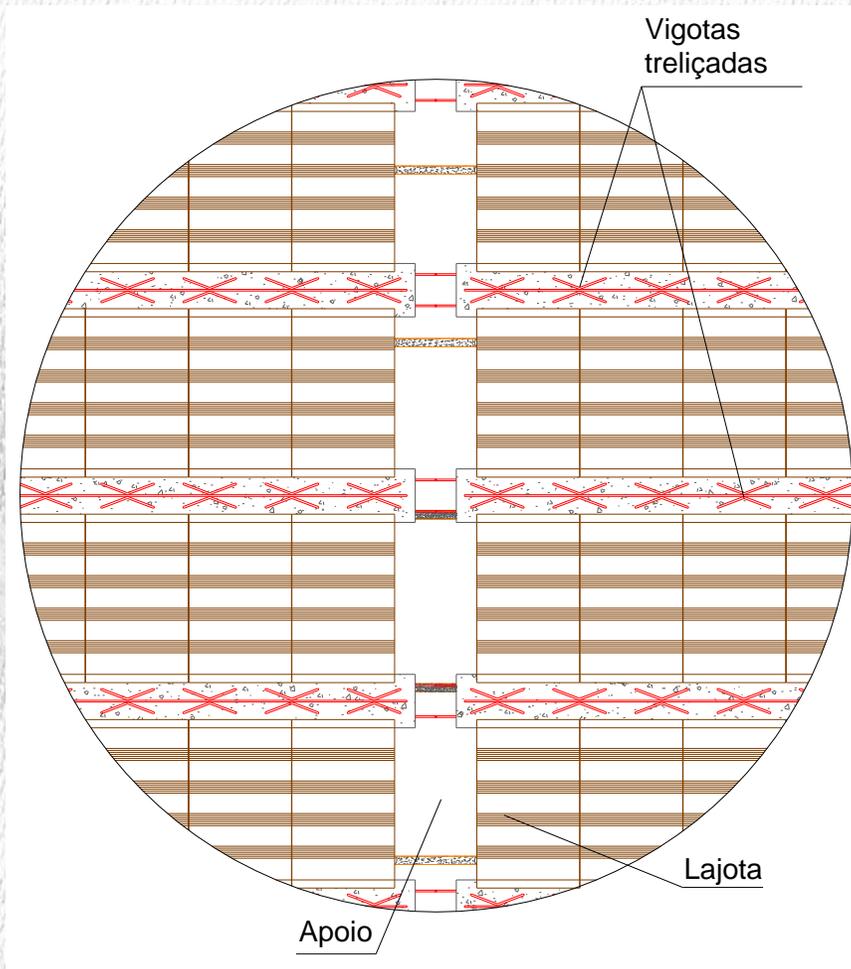


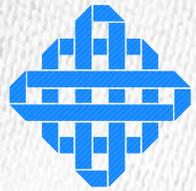
## Contiguidade entre Lajes



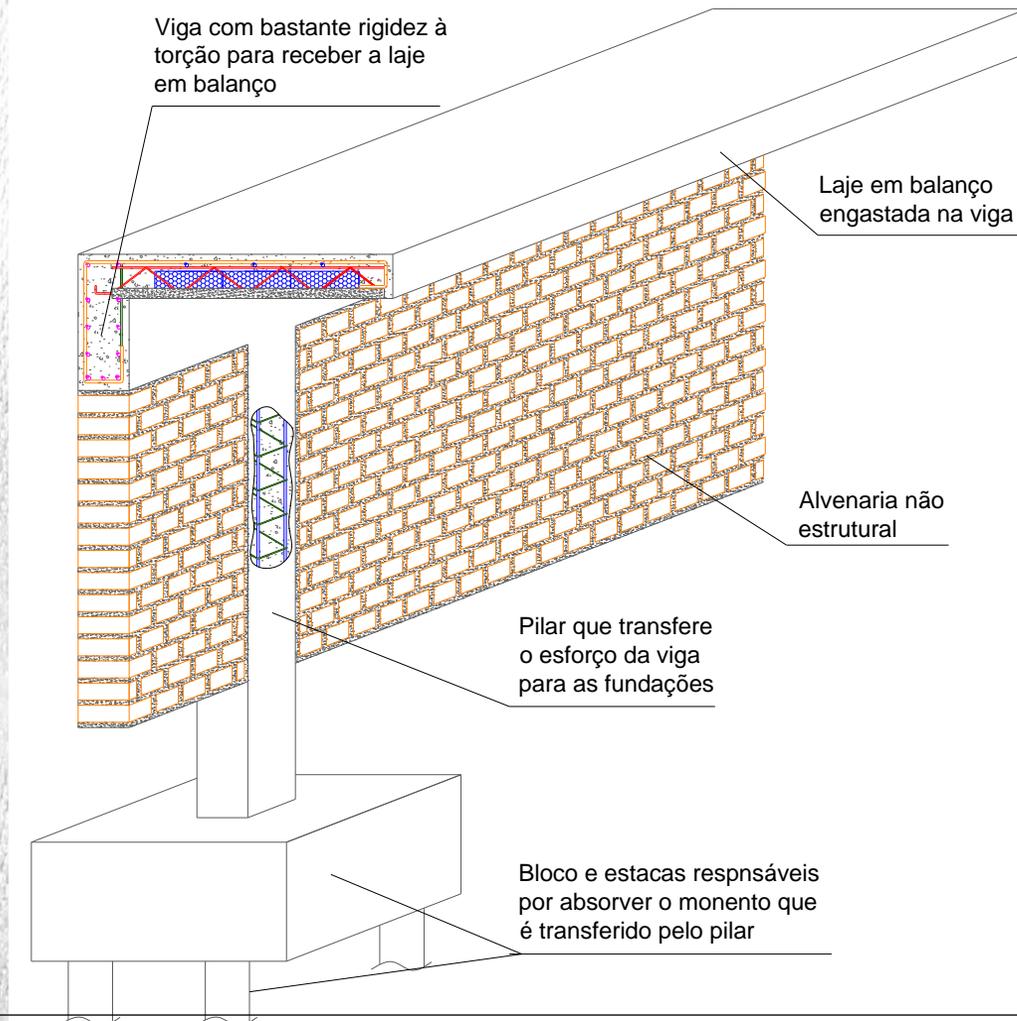


## Contiguidade entre Lajes



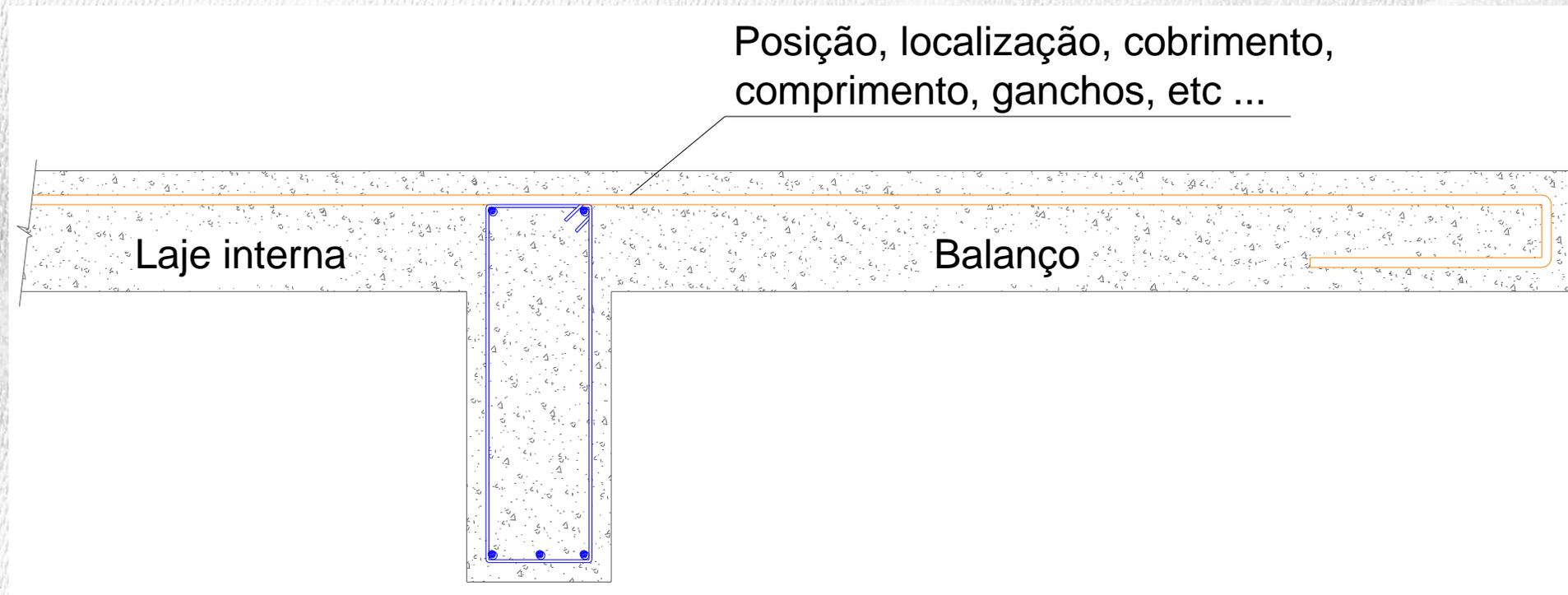


## Balanço em Lajes Treliçadas



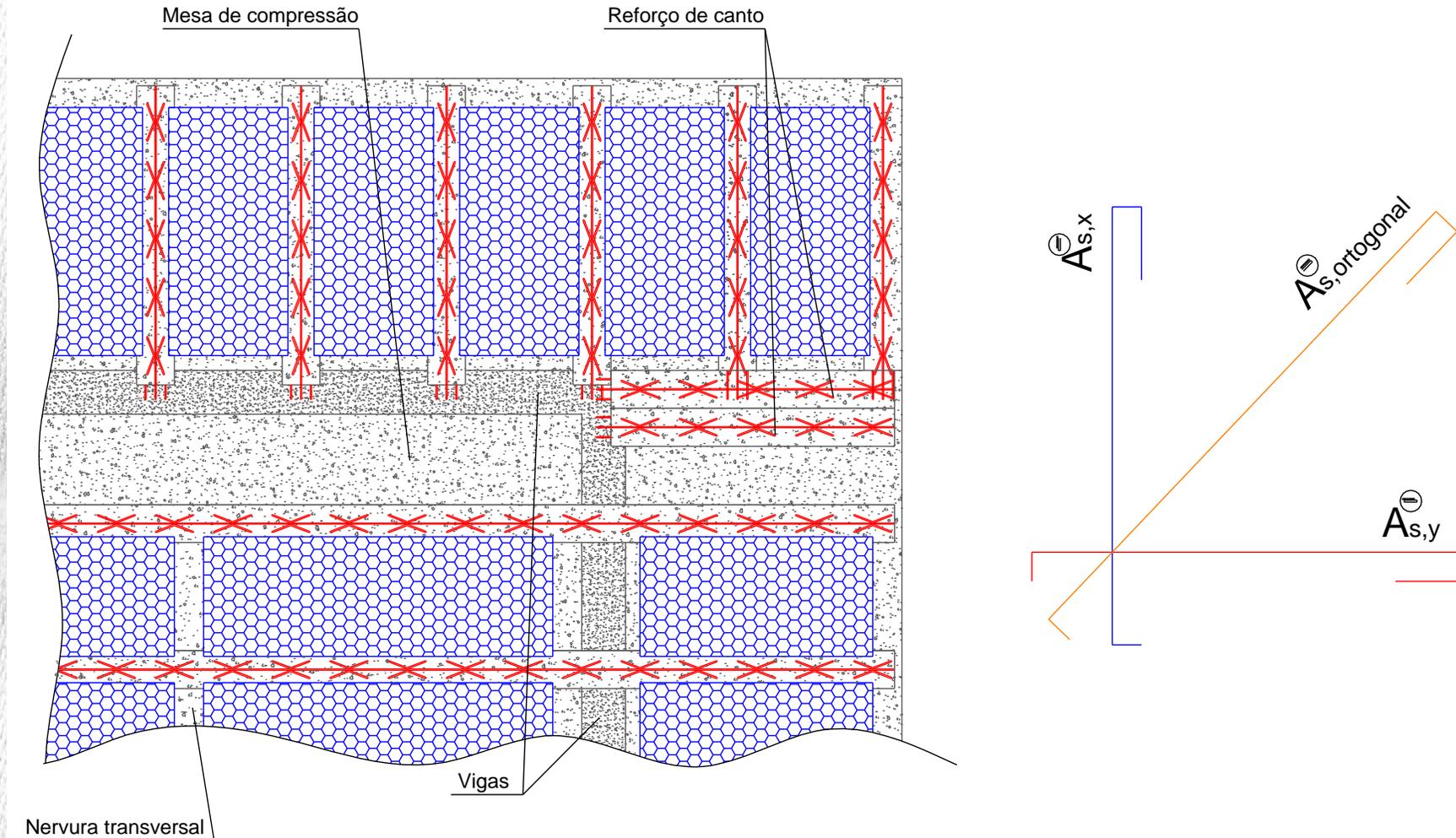


## Balanço em Lajes Trelaçadas



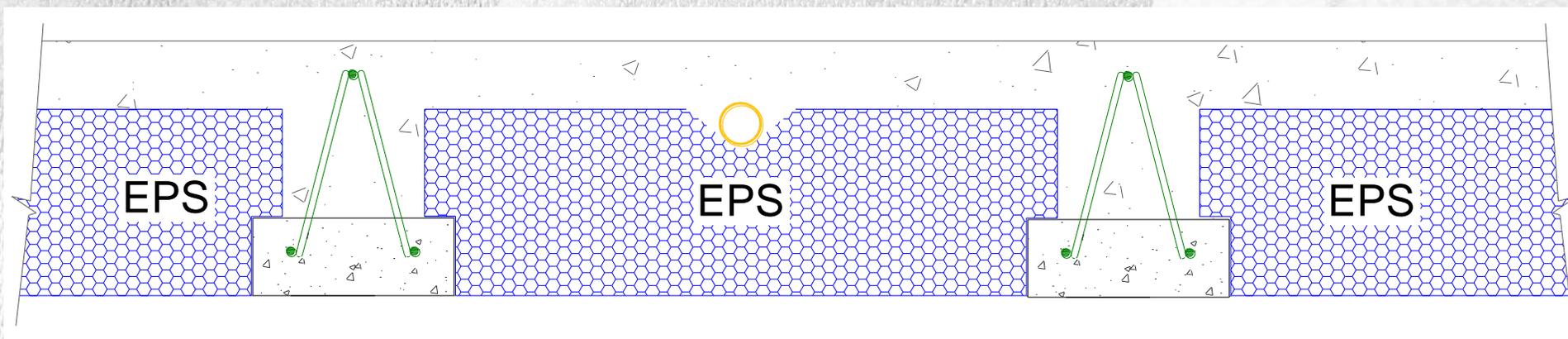
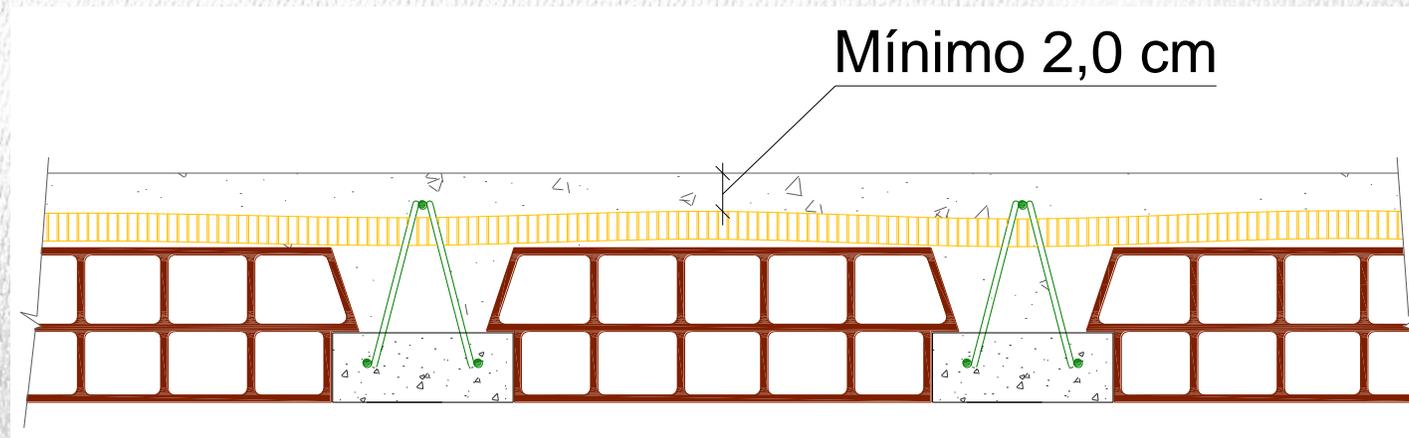


## Balanço em Lajes Trelaçadas



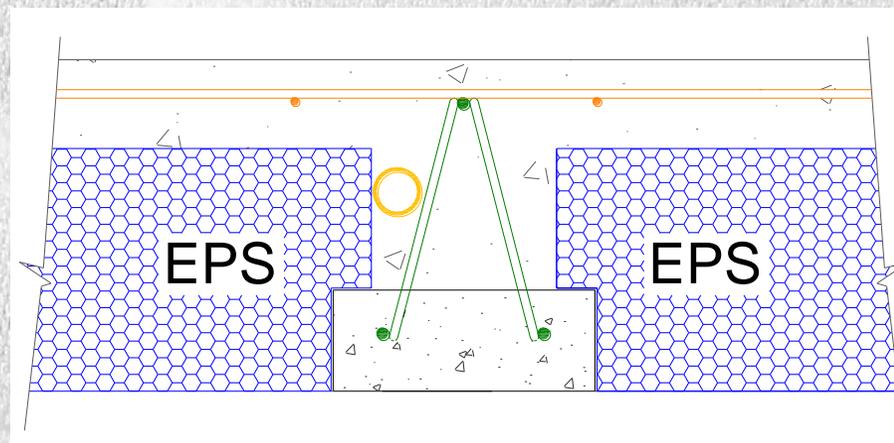
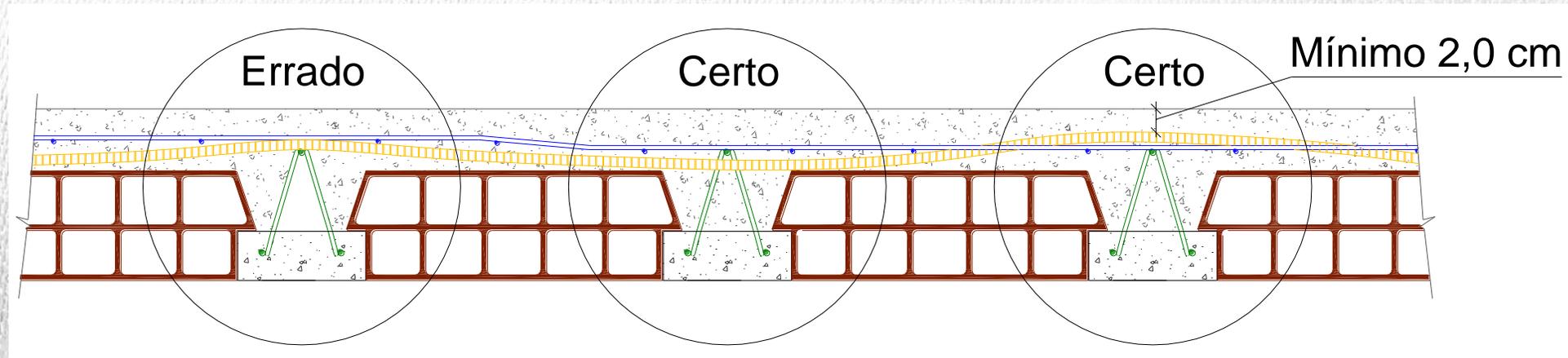


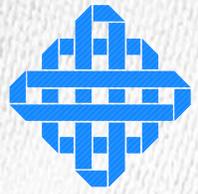
## Instalações Elétricas e Lajes Trelaçadas



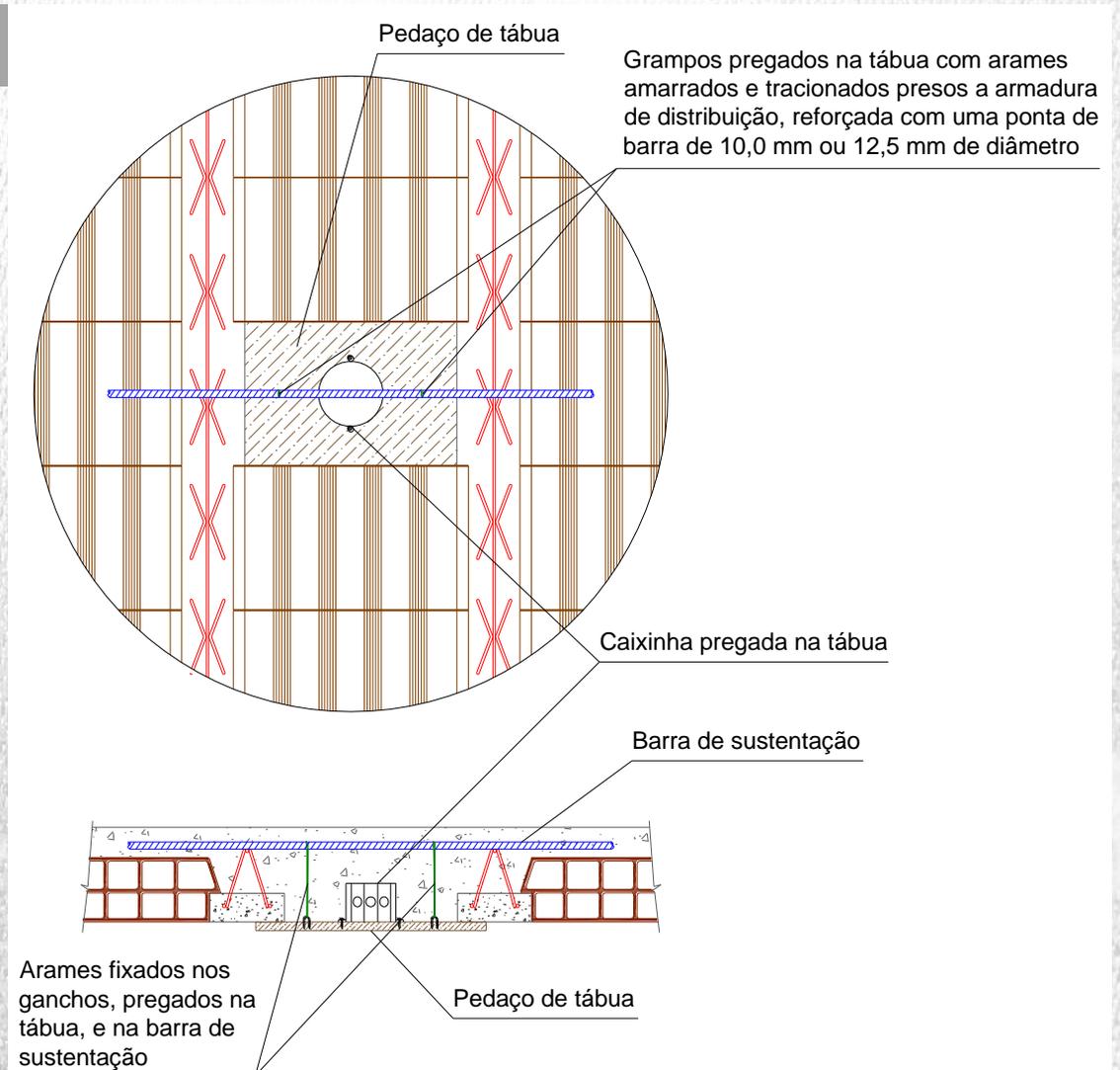


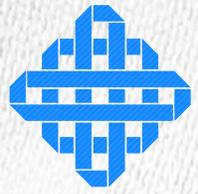
## Instalações Elétricas e Lajes Trelaçadas



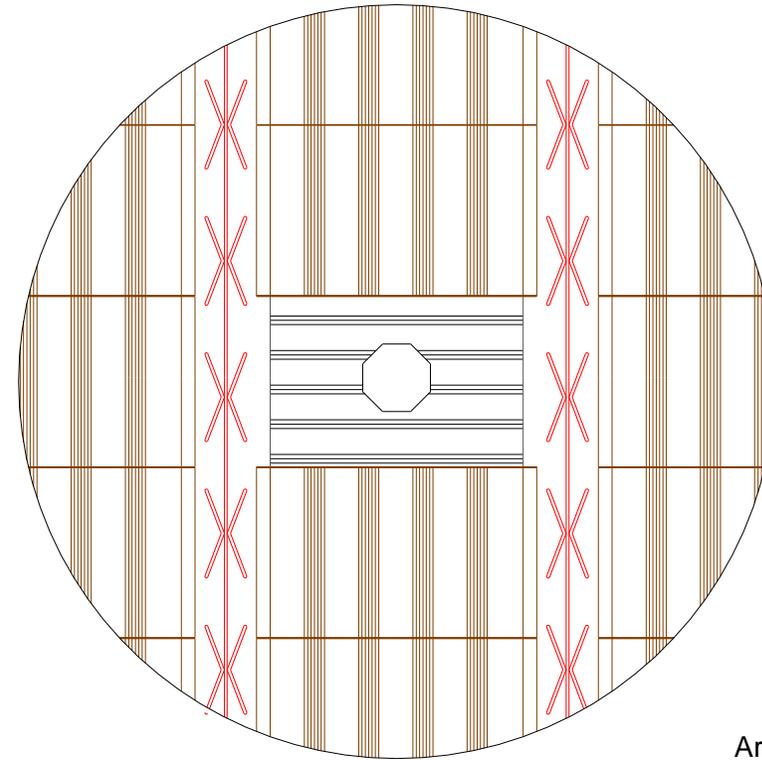


## Instalações Elétricas e Lajes Treliçadas

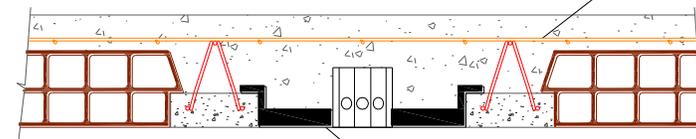




## Instalações Elétricas e Lajes Treliçadas



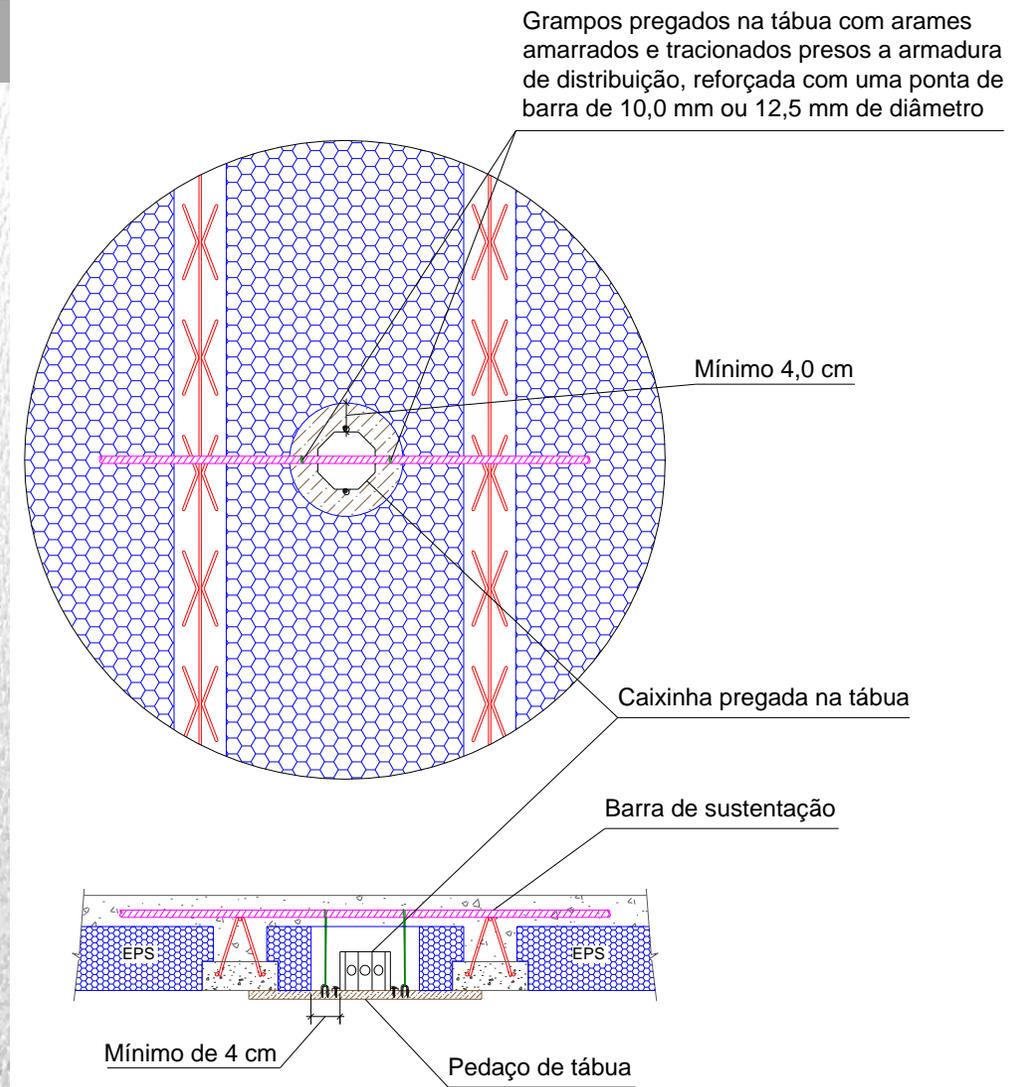
Armadura de distribuição

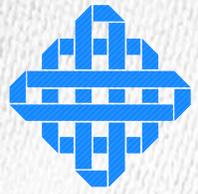


Peça plástica ou similar



## Instalações Elétricas e Lajes Treliçadas



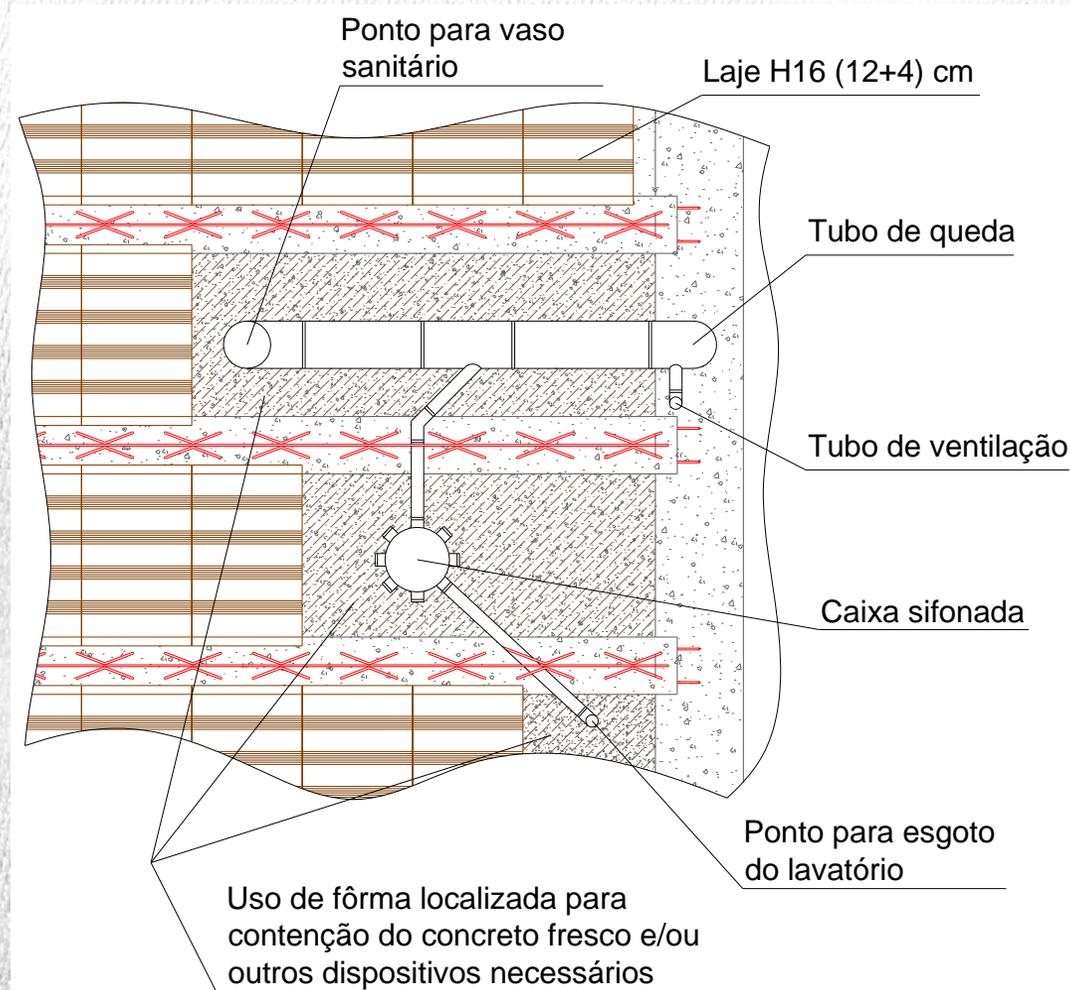


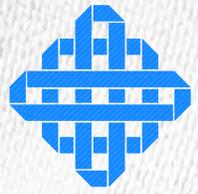
## Instalações Elétricas e Lajes Trelaçadas



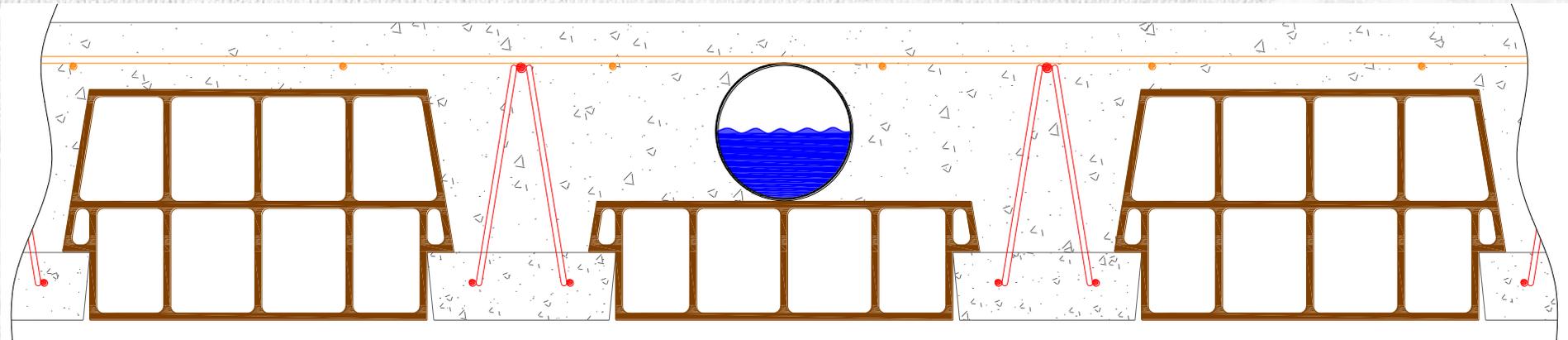


## Instalações Hidráulico Sanitárias e Lajes Trelaçadas



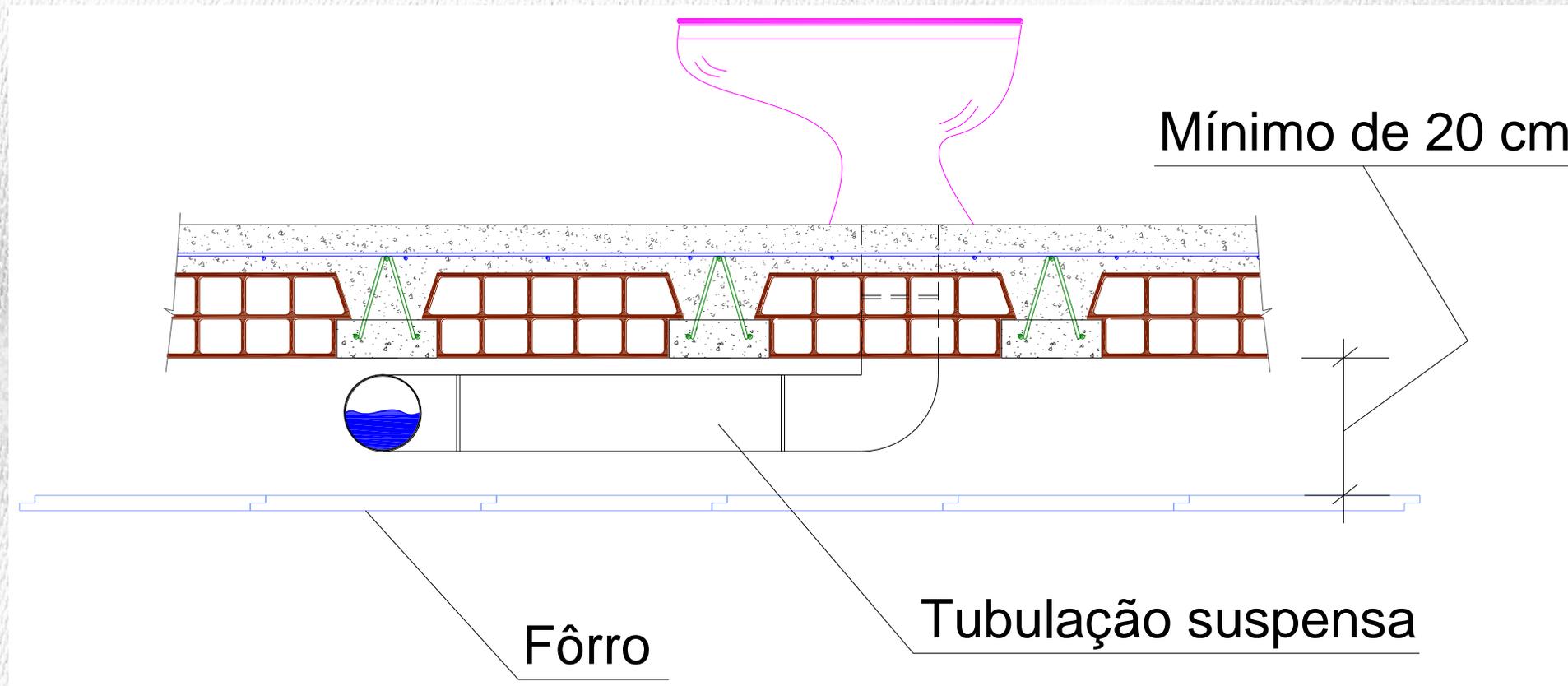


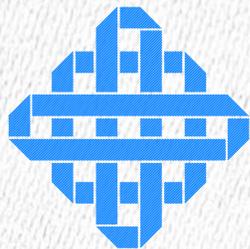
## Instalações Hidráulico Sanitárias e Lajes Trelaçadas





## Instalações Hidráulico Sanitárias e Lajes Trelaçadas





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PROJETO E EXECUÇÃO DE  
**LAJES TRELIÇADAS**