CAMICON
CÁMARA DE LA INDUSTRIA DE LA CONSTRUCCIÓN

9º Congreso Internacional Construcción de Infraestructura y Vivienda

REFORZAMIENTO DE PILARES DE HORMIGÓN ARMADO

"do Laboratório de Pesquisa aos Canteiros de Obras"

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Definición

Brasil → ABNT NBR 6118:2014

"14.4.1.2 Pilares

Elementos lineales de eje recto, usualmente dispuestos en la vertical, en que las fuerzas normales de compresión son preponderantes."

Definición

USA → ACI 318 - 14

"2.3 Terminolgy

Column – member, usually vertical or predominantly vertical, used primarily to support axial compresive load, but that can also resist moment, shear, or torsion."

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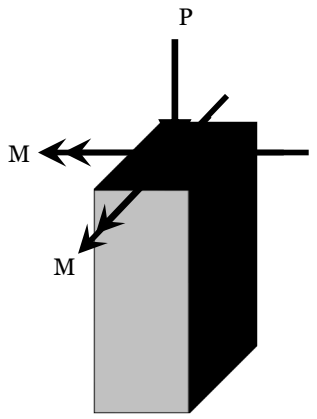
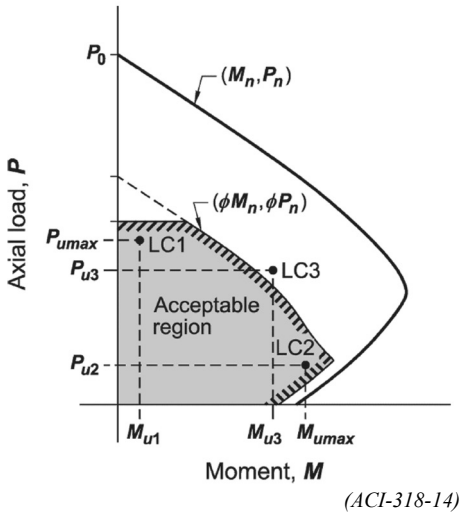
Esfuerzos





(ACI-318-14)

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(Créditos: TQS Informática)

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(Créditos: TQS Informática)

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(Créditos: TQS Informática)

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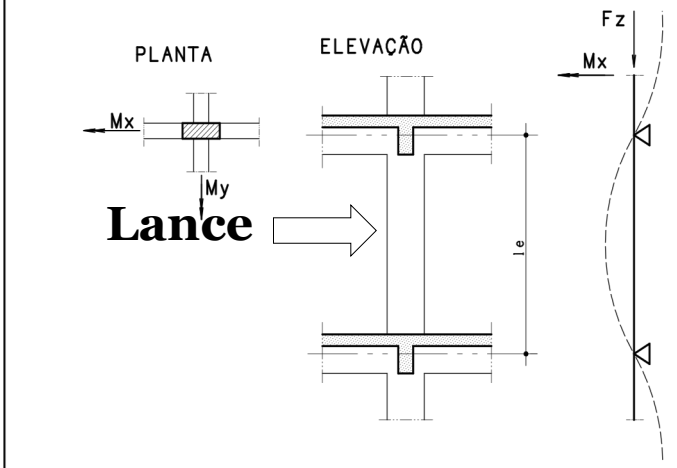
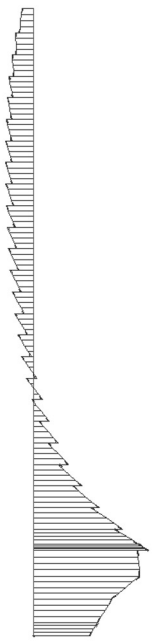
Pilares



9

Pilares

Diagramas de esfuerzos



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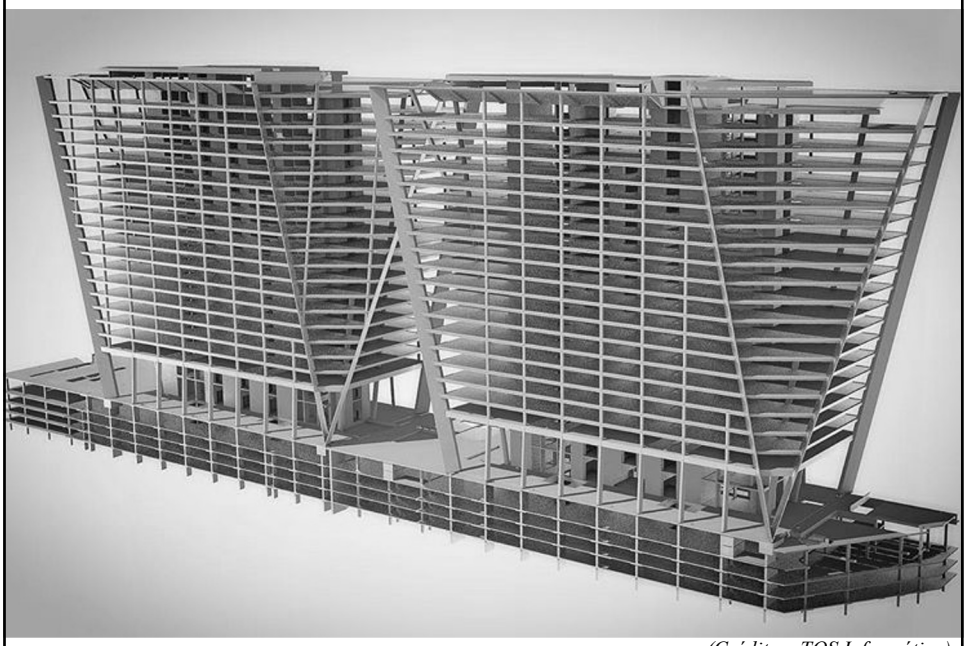

(Créditos: TQS Informática)

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Tipología típicas de pilares

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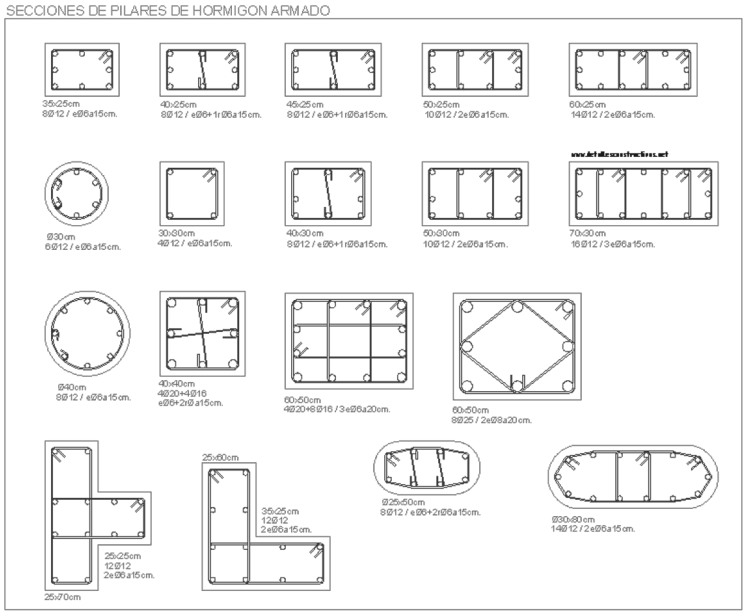
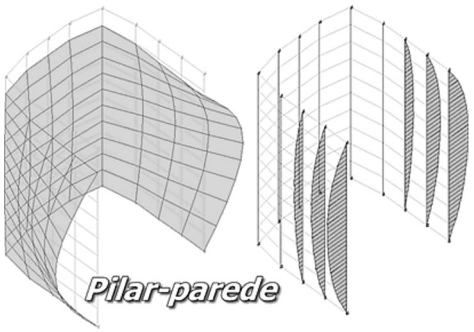
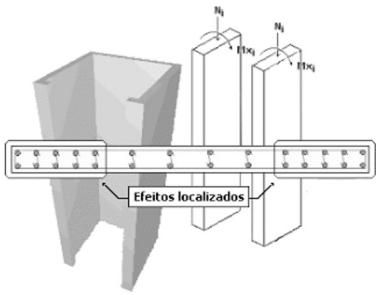
Rectangular y circulares

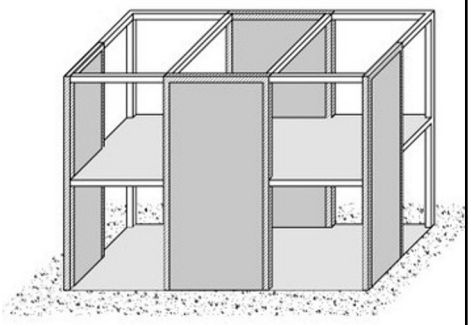


20

Shear wall







21

Algunos factores de influencia

- ***Esbeltez (efectos de 2ª orden);***
- ***Estabilidad global de la estructura;***
- ***Sismos;***
- ***Cuantidad de acero;***
- ***Deformación específica;***
- ***etc.***

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Refuerzo → Aumento de la capacidad de carga.

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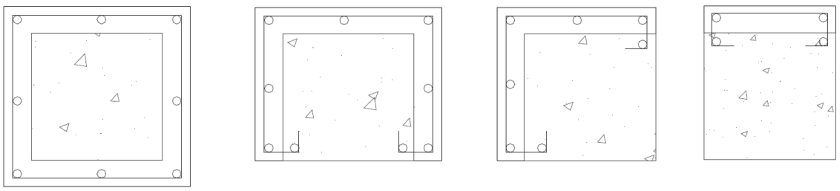
Tipos más comunes de Refuerzos de Pilares

1 – Refuerzo com el uso de hormigón

Concrete Jacketing (Total y Parcial)



(Takeuti, 1999)

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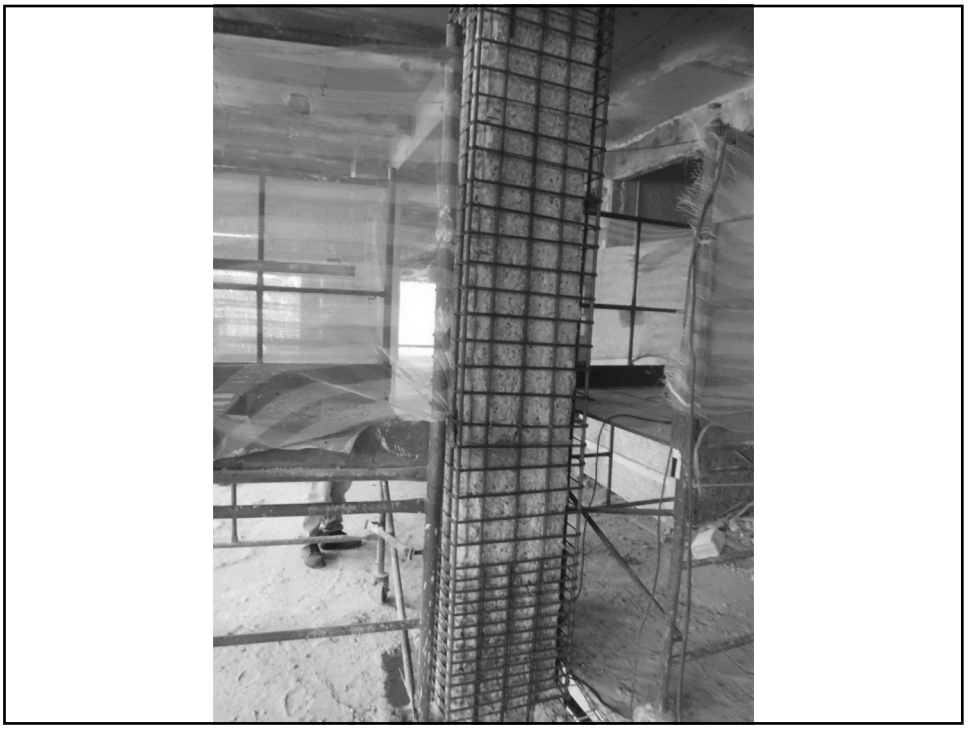

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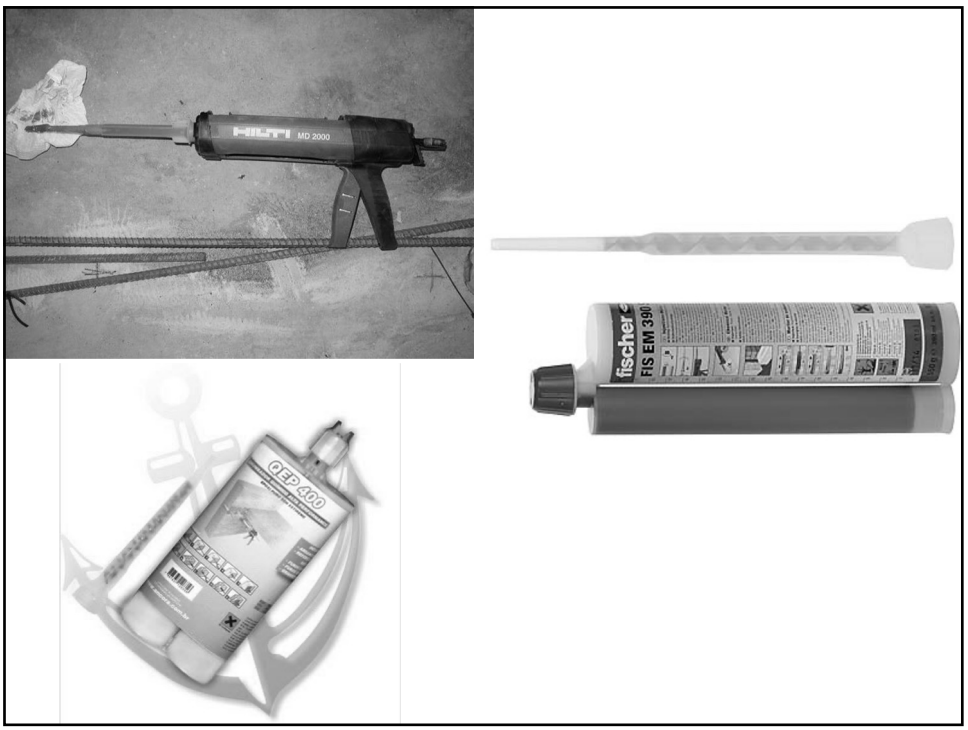

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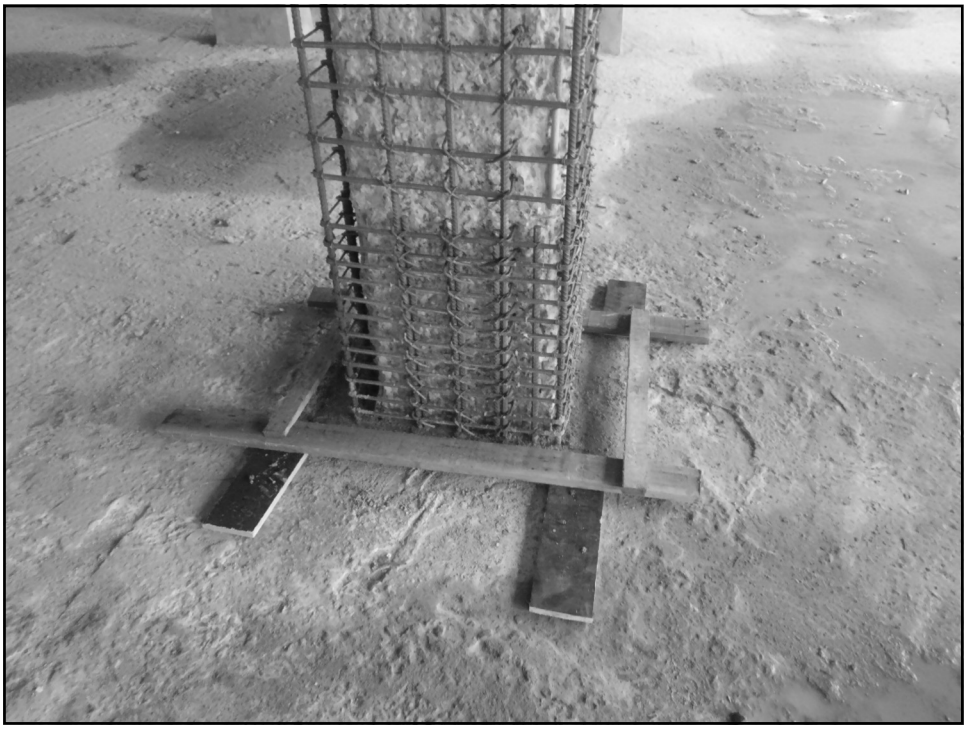

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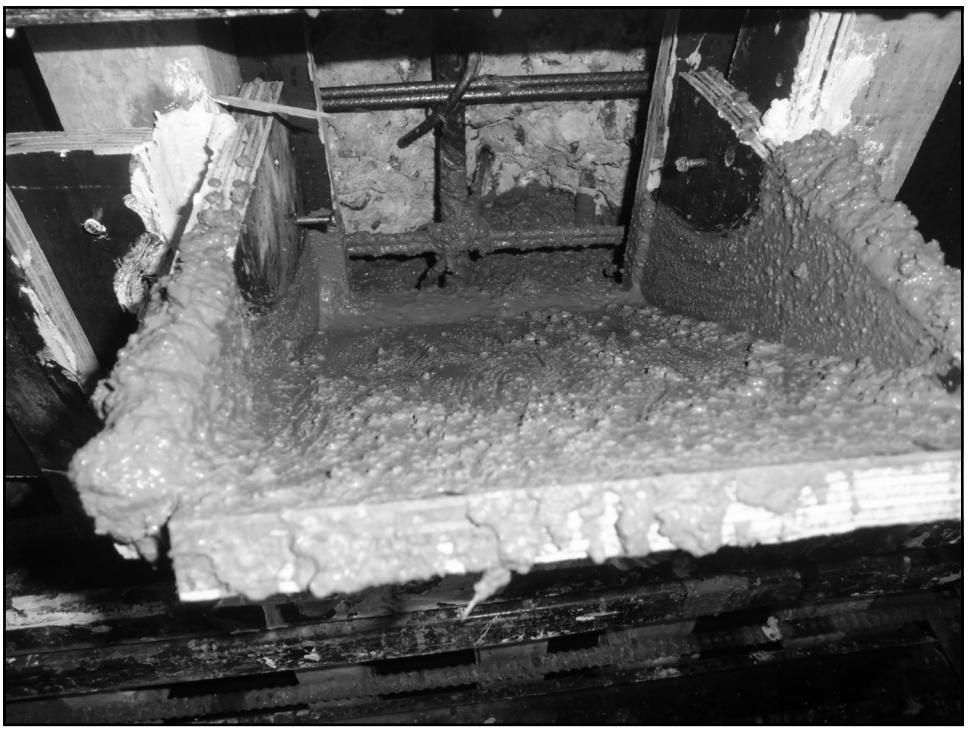

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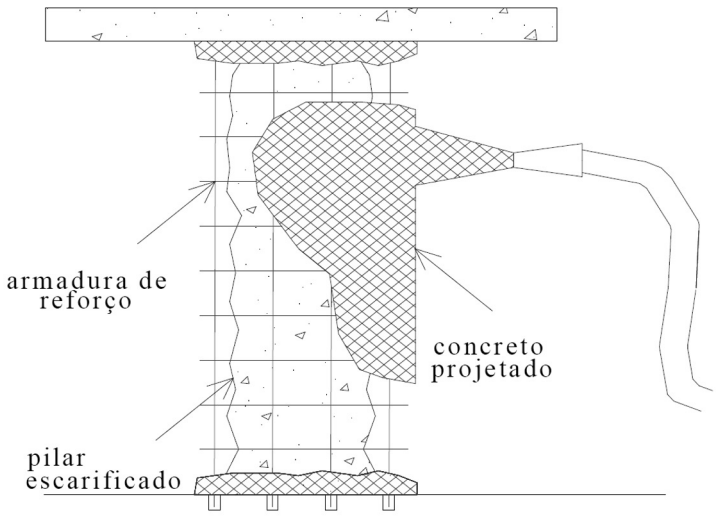
Hormigón proyectado



(Helene, 1992; Takeuti, 1999)

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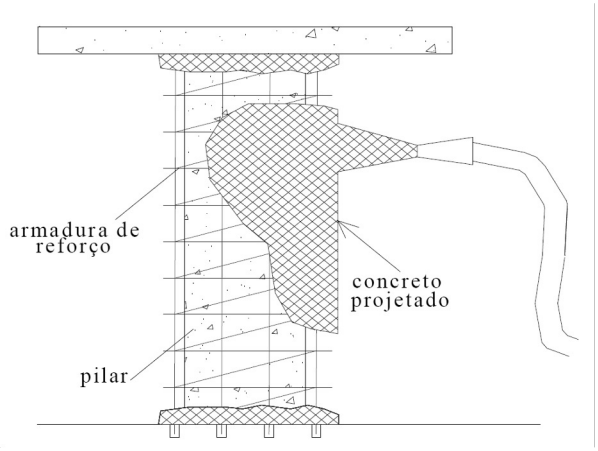
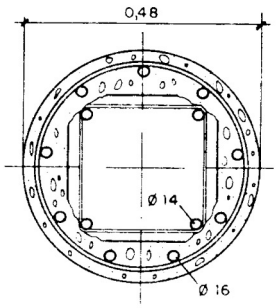
Confinamiento (Espiral)



(Helene, 1992; Takeuti, 1999)

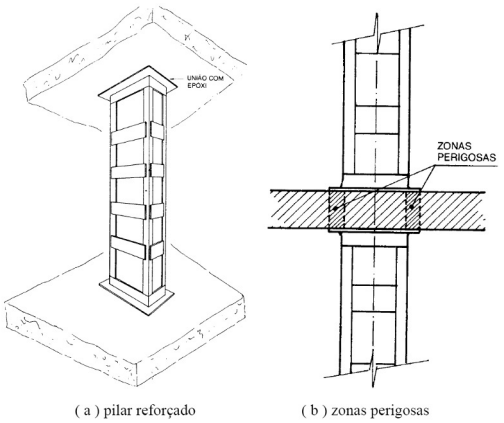


(Cánovas, 1988)

43

Tipos más comunes de Refuerzos de Pilares

2 – Refuerzo con el uso de placas metálicas



(a) pilar reforçado (b) zonas perigosas

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Tipos más comunes de Refuerzos de Pilares

3 – Refuerzo com el uso de Fibras de Carbono

(Créditos das imagens: S&P Reinforcement)

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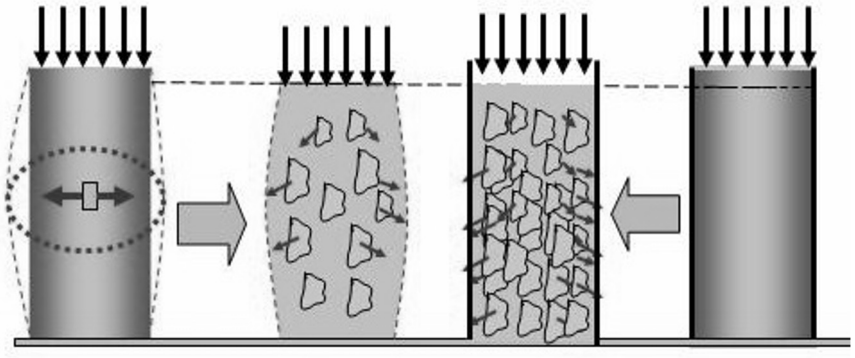
Confinamiento



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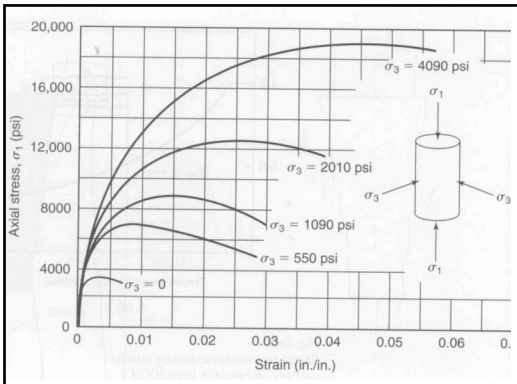
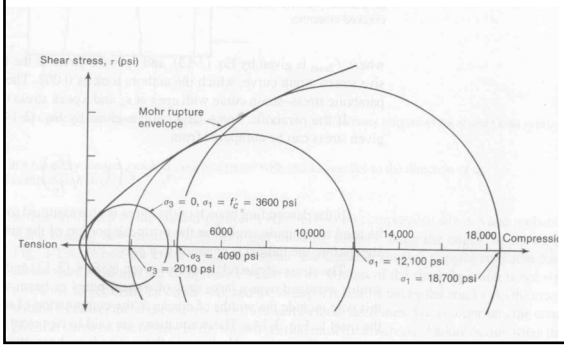
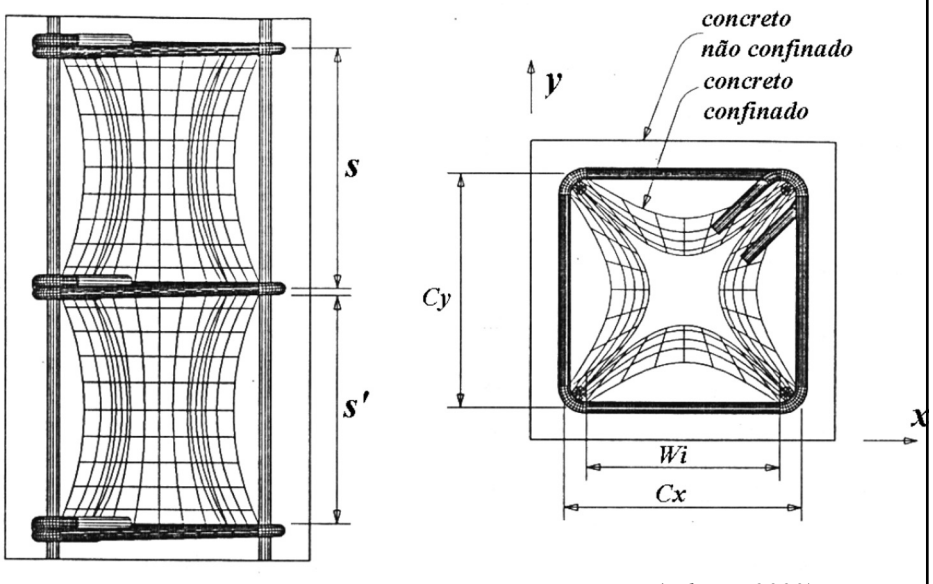


$$\sigma_1 = f'_c + 4.1\sigma_3$$



(Wight & MacGregor, 2012)

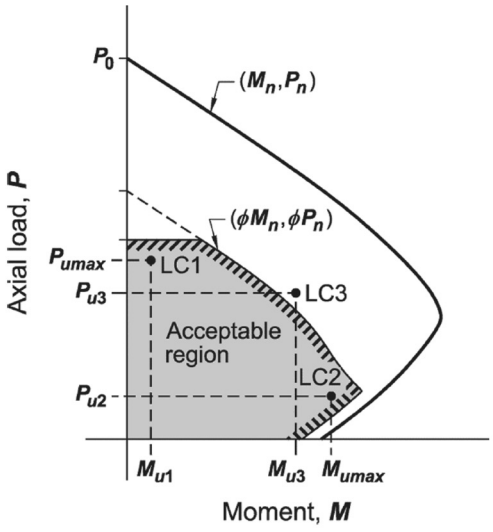
48

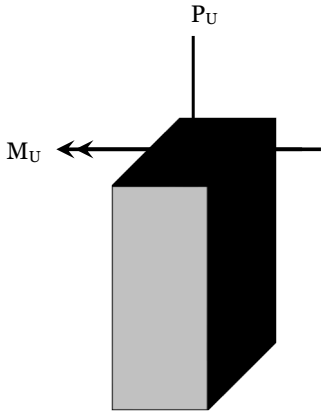


(Takeuti, 2003)

49

Refuerzo de pilares



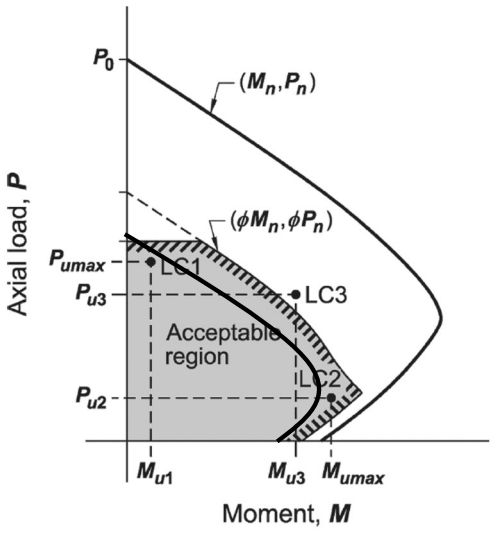


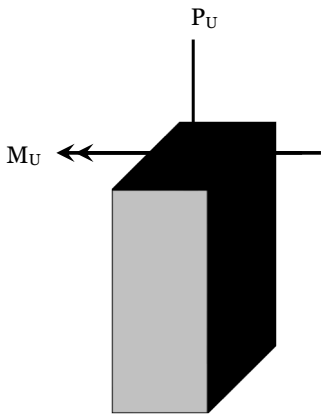
Fuerza normal equivalente para calcular por compresión centrada (Seción plana y con deformación uniforme $\varepsilon_c=\varepsilon_{c2}$)

(Hipótesis de Navier)

50

Refuerzo de pilares



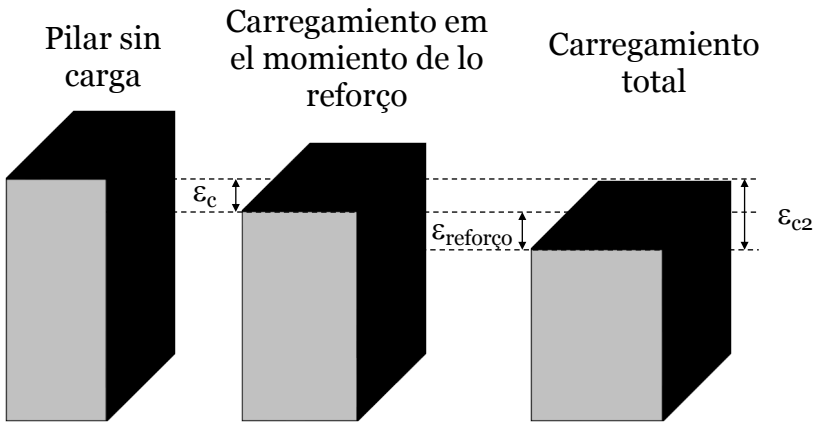


Fuerza normal equivalente para calcular por compresión centrada (Seción plana y con deformación uniforme $\varepsilon_c=\varepsilon_{c2}$)

(Hipótesis de Navier)

51

Control de las deformaciones



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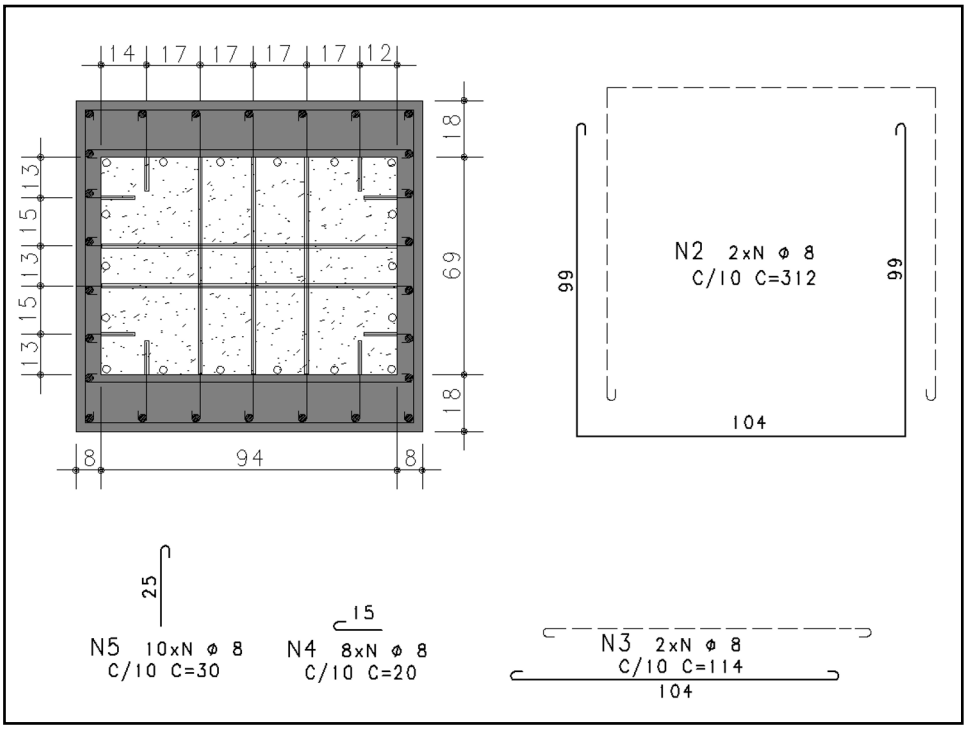
14 17 17 17 17 12
18
13 15 13 15 13
69
18
8 94 8
N2 2xN ⌀ 8
C/10 C=312
99
99
104
25
N5 10xN ⌀ 8
C/10 C=30
15
N4 8xN ⌀ 8
C/10 C=20
N3 2xN ⌀ 8
C/10 C=114
104

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54

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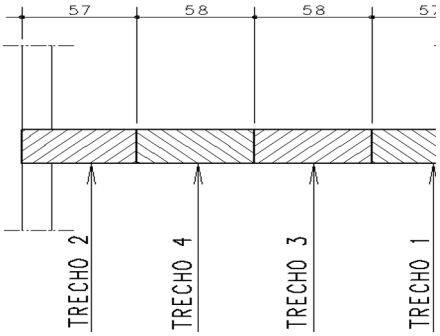
Y cuando no se puede aumentar el pilar???

56

Sustitución del hormigón



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Sustitución del hormigón

58

Sustitución del hormigón

- ***Número de pasos (plazo);***
- ***Necesidad de costosos sistemas de apuntalamiento.***

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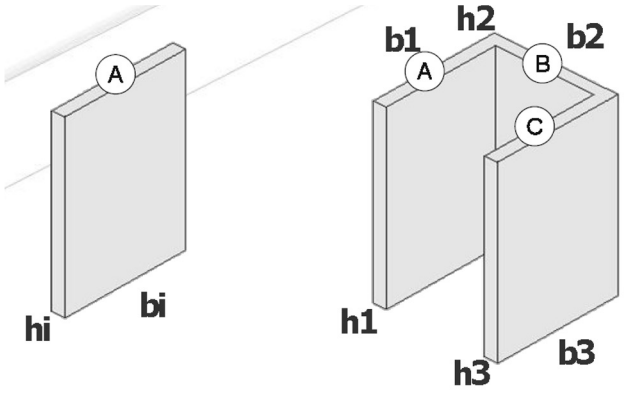
Método alternativo para pilares parede (Shear Walls)

60

Pilar Parede

Elemento de superfície, dispuesto em la vertical sometido a esfuerzos axiales y momentos fletores.

$$h_i < b_i/5$$



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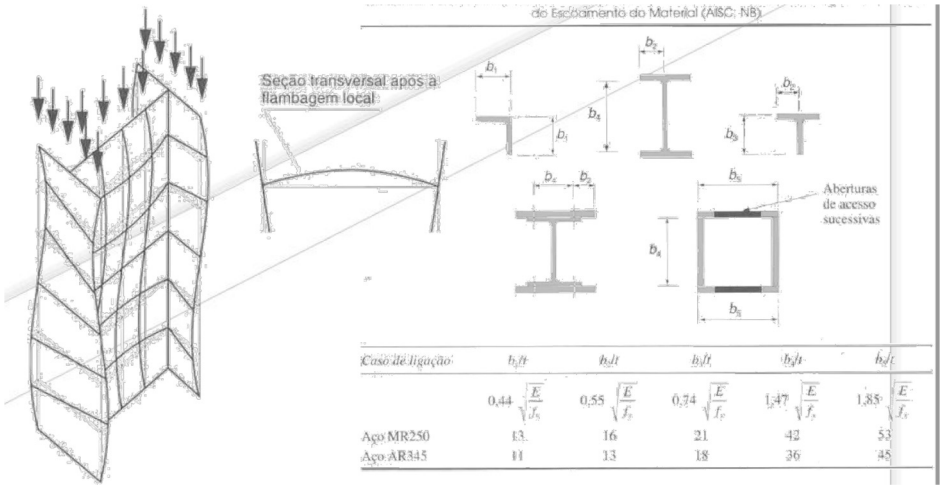

(Pfeil, 2012)

62

Pilar Parede

Efectos locales y localizados de 2ª orden son importantes y deben ser verificados. (pandeo)

La obtención de los esfuerzos debe ser a partir del modelo global, a fin de evaluar todos los esfuerzos que el pilar recebe.

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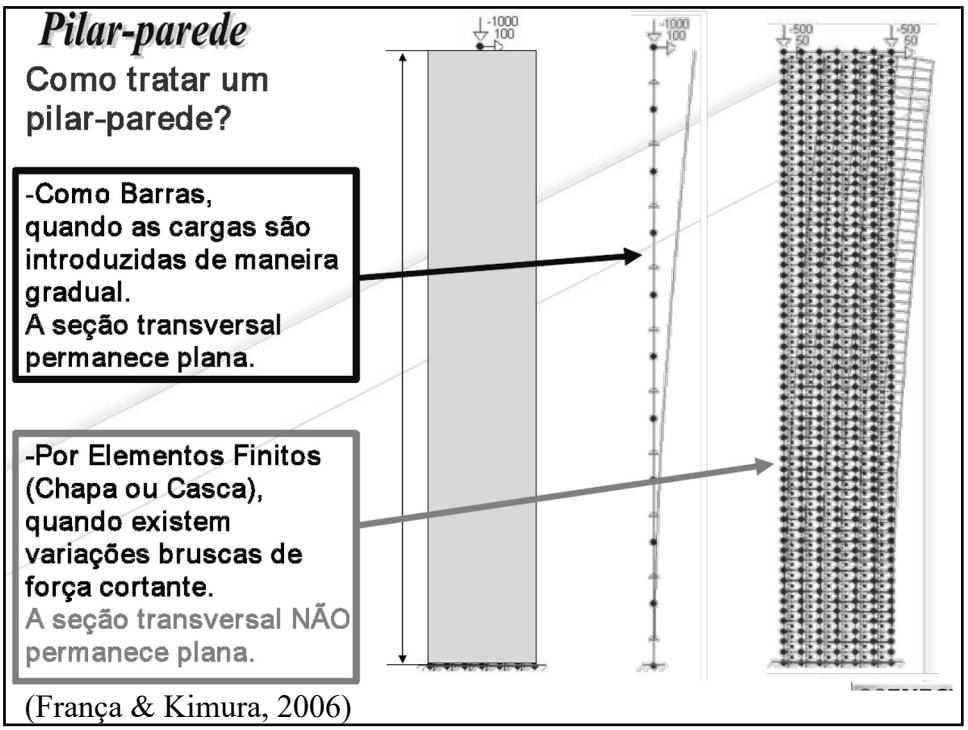
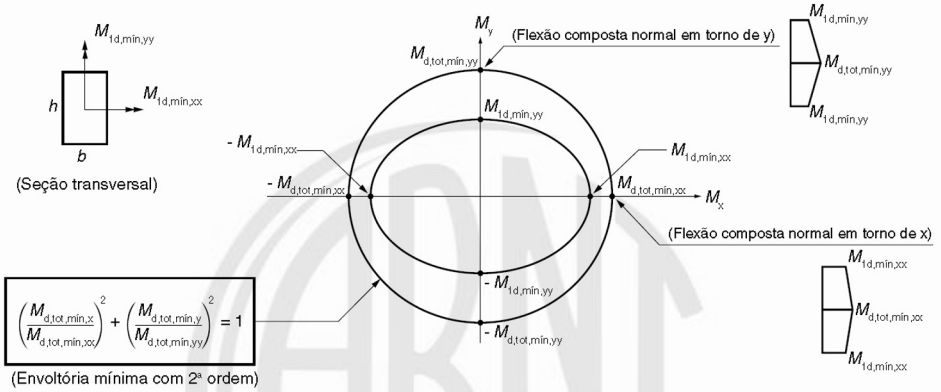


(França & Kimura, 2006)

64

ABNT NBR 6118:2014



Sendo: $M_{d,tot,min,xx}$ e $M_{d,tot,min,yy}$ as componentes em flexão composta normal e

$M_{d,tot,min,x}$ e $M_{d,tot,min,y}$ as componentes em flexão composta oblíqua

Figura 15.2 – Envoltória mínima com 2ª ordem

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ABNT NBR 6118:2014

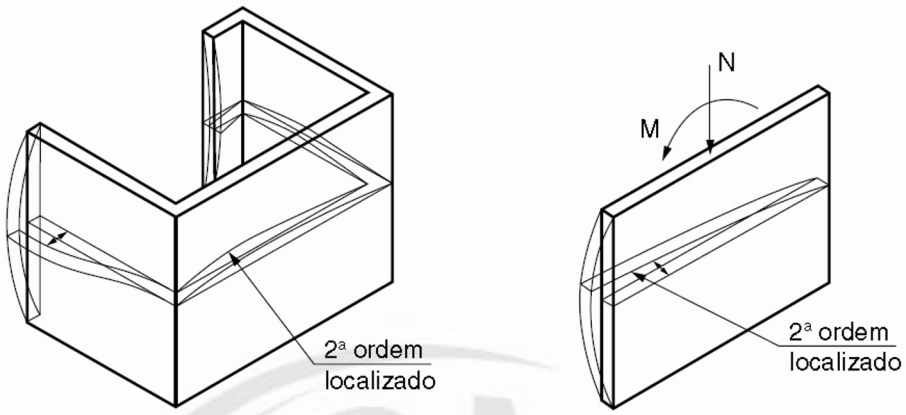
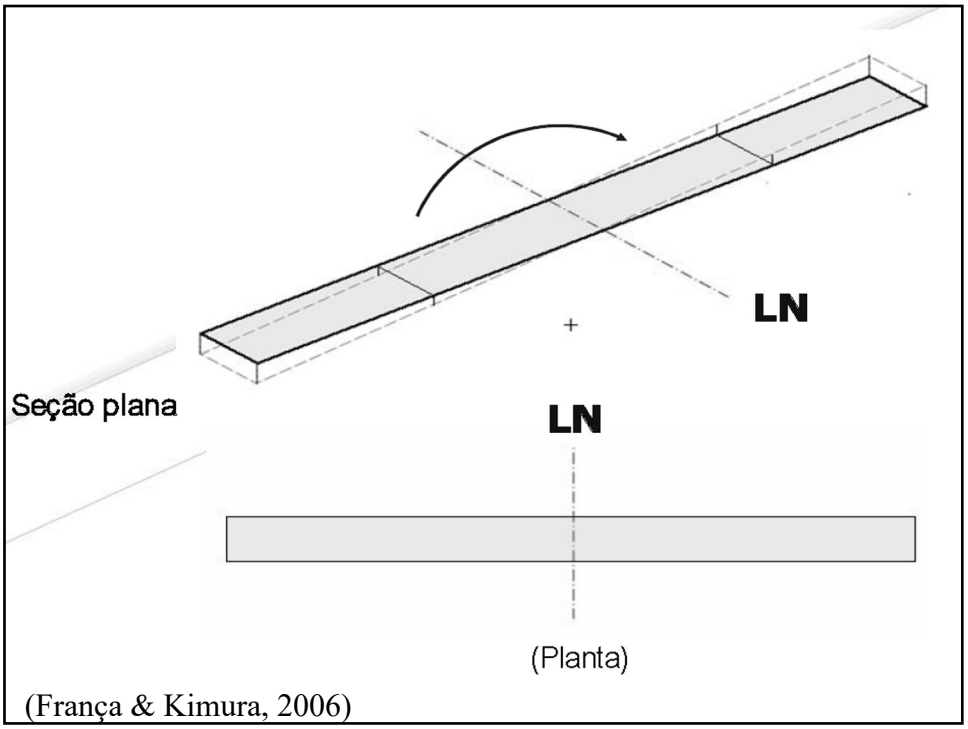


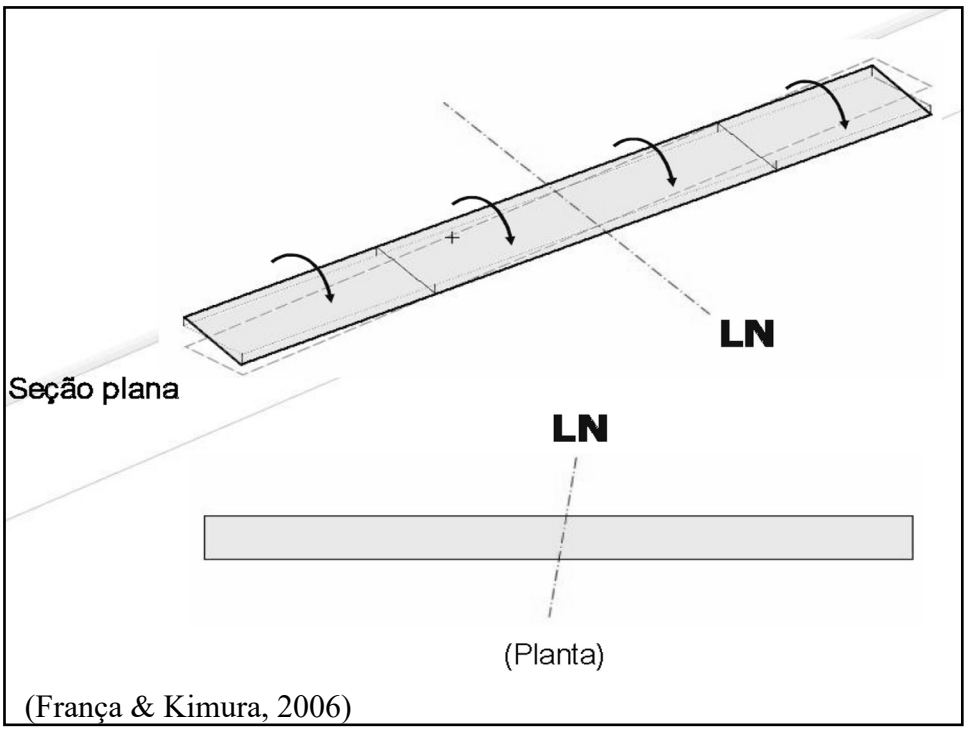
Figura 15.3 – Efeitos de 2ª ordem localizados

66



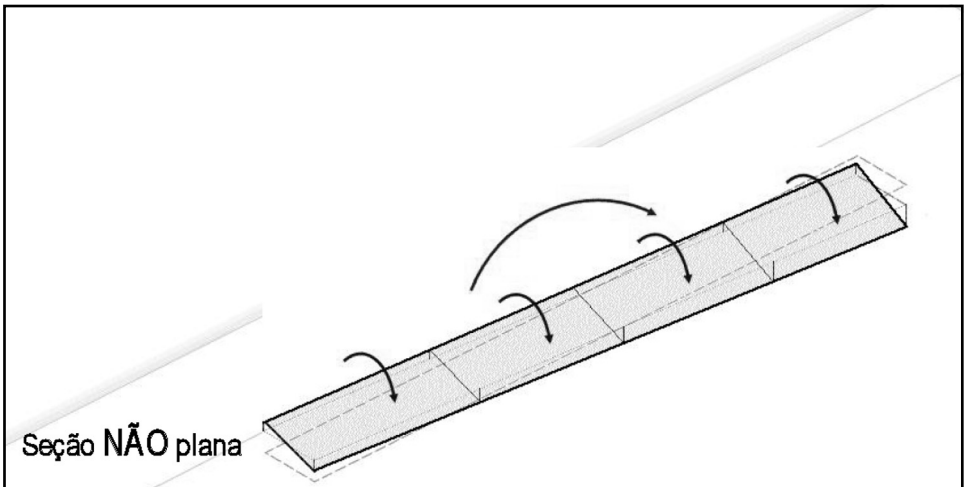
(França & Kimura, 2006)

67



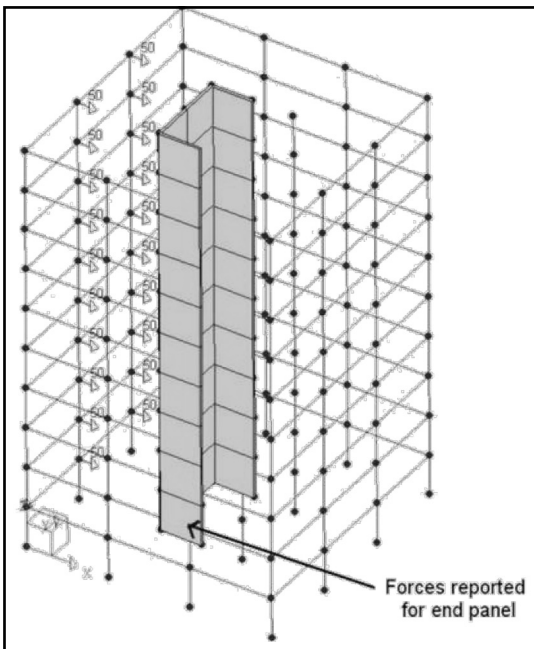
(França & Kimura, 2006)

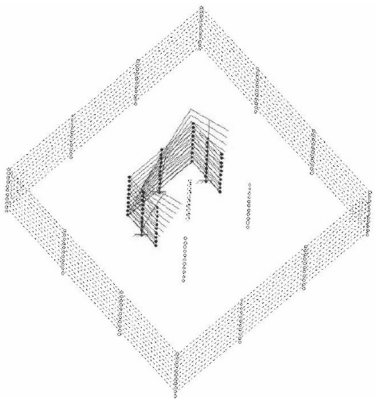
68



(França & Kimura, 2006)

69





- Evitar soluções estruturais onde seja necessária resistência a torção de Pilares-Parede.

(França & Kimura, 2006)

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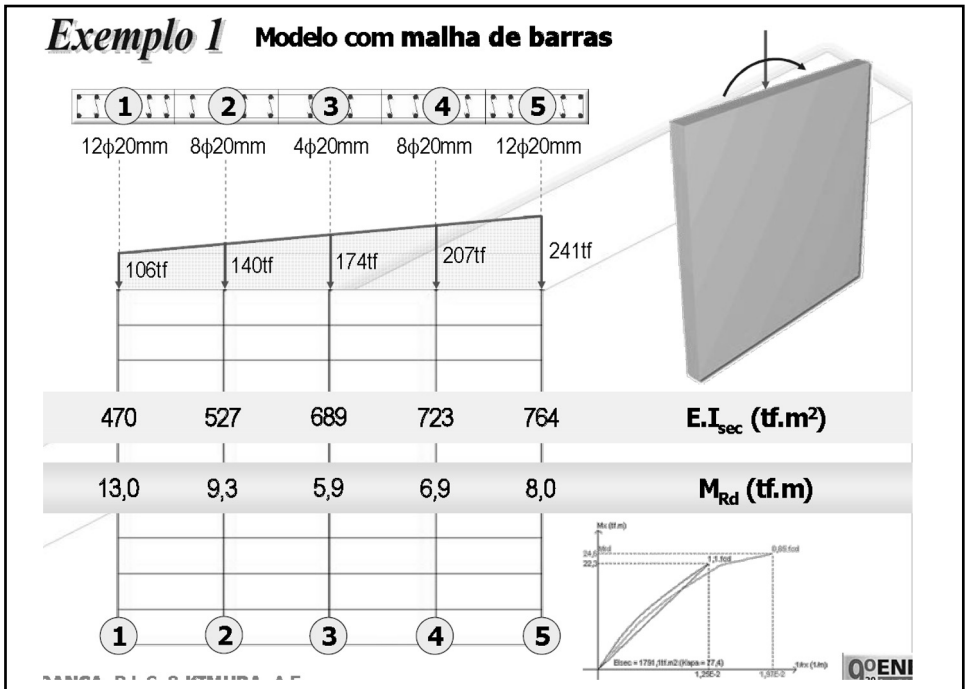
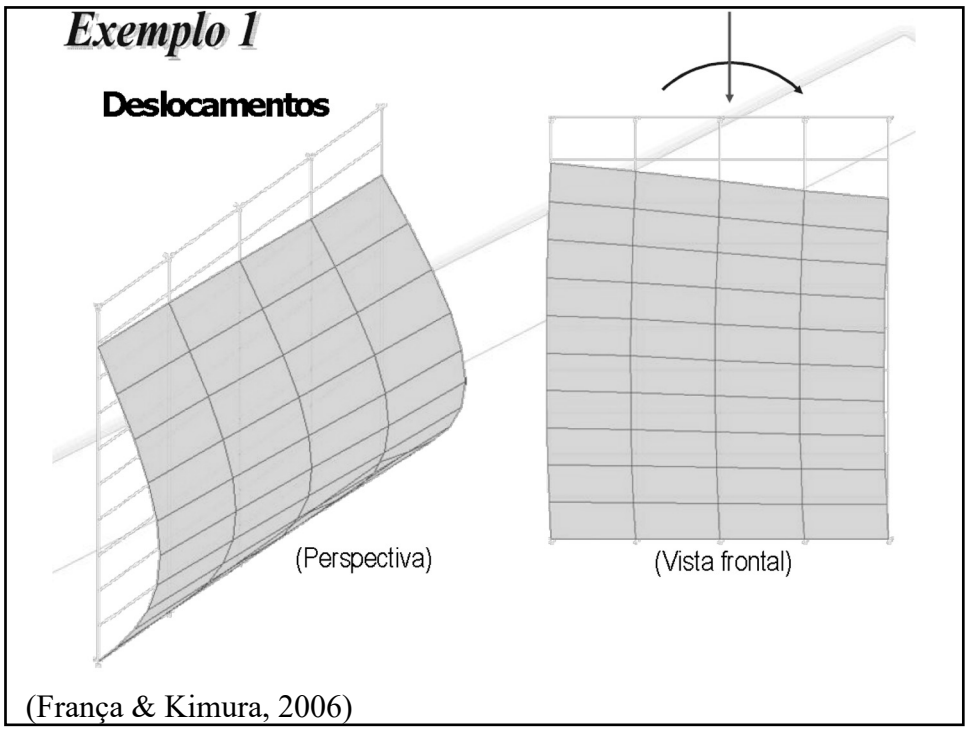


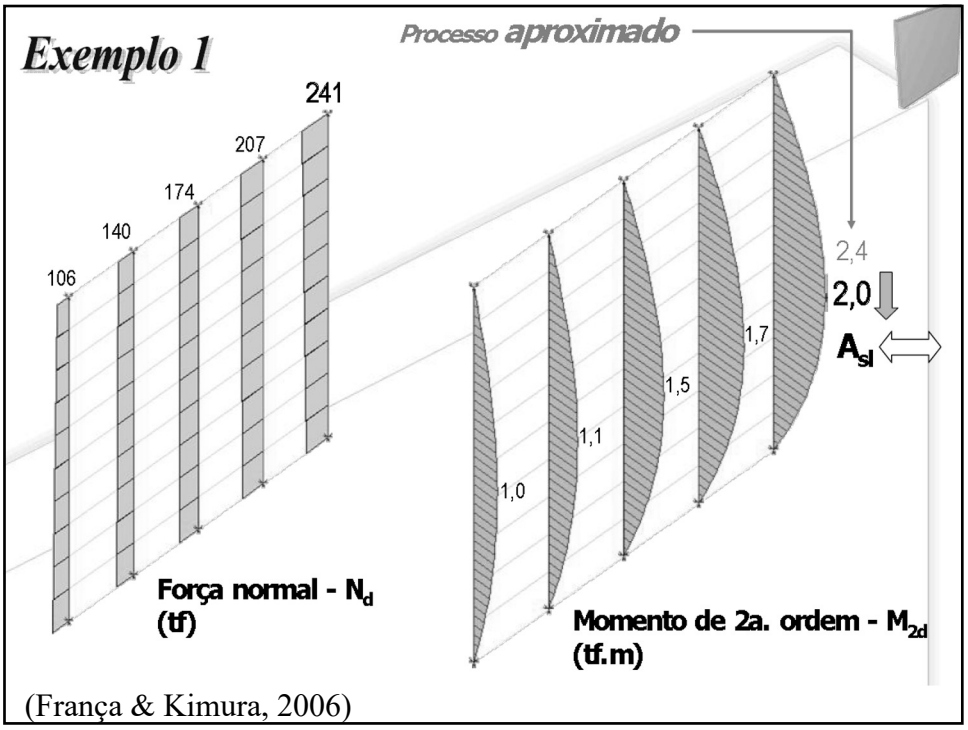
(França & Kimura, 2006)

71



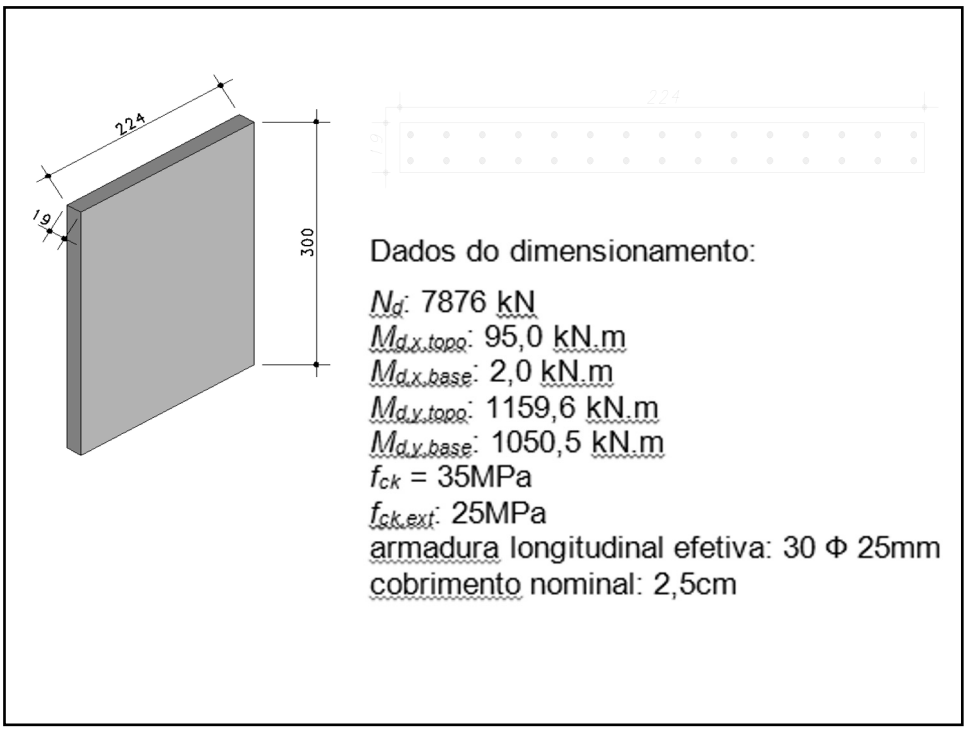
(França & Kimura, 2006)

72



(França & Kimura, 2006)

73



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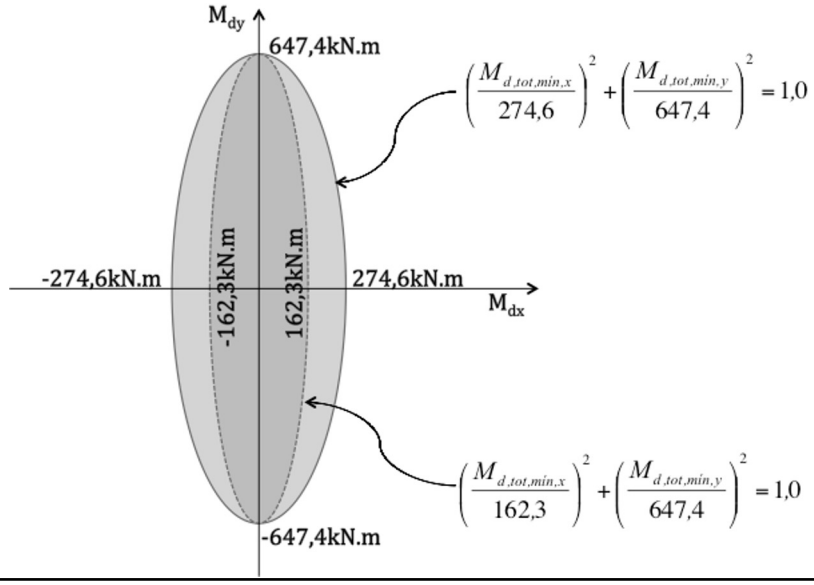
Envoltórias mínimas de 1ª e 2ª ordem



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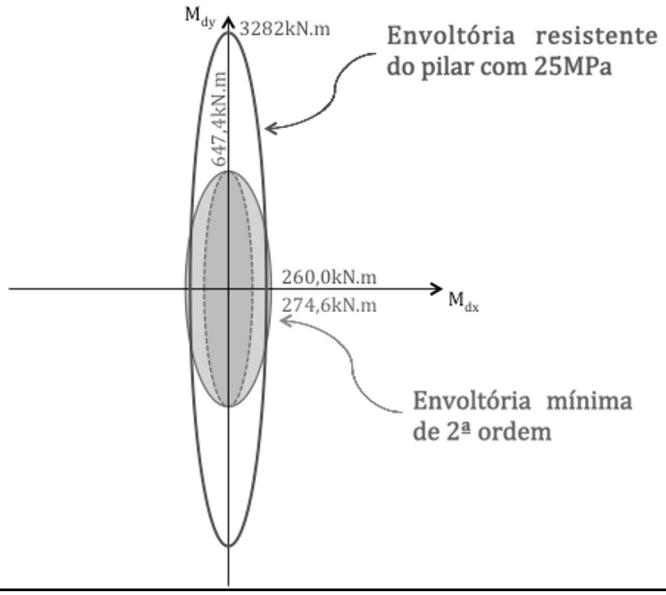
Envoltória mínima X Envoltória resistente



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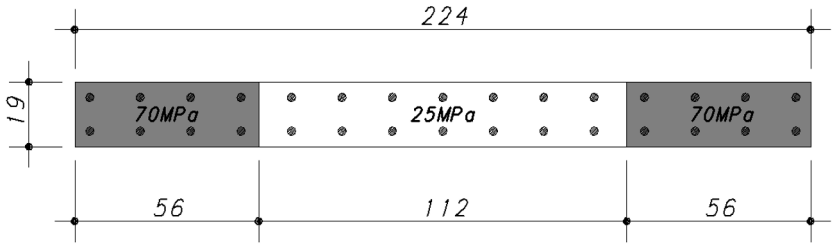
Primeira tentativa



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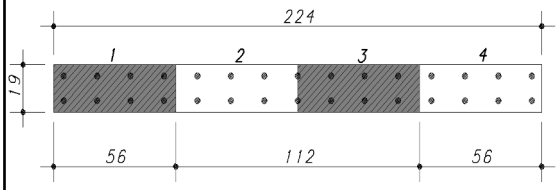
Primeira tentativa



Esforços solicitantes por faixa:

Faixas 1 e 4

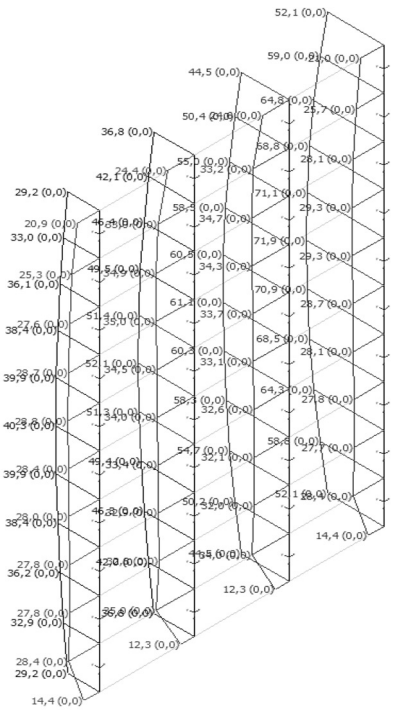
$N_{d,faixa}$ = 2518kN

$M_{dx,faixa}$ = 24kN·m

Faixas 2 e 3

$N_{d,faixa}$ = 2148kN

$M_{dx,faixa}$ = 24kN·m



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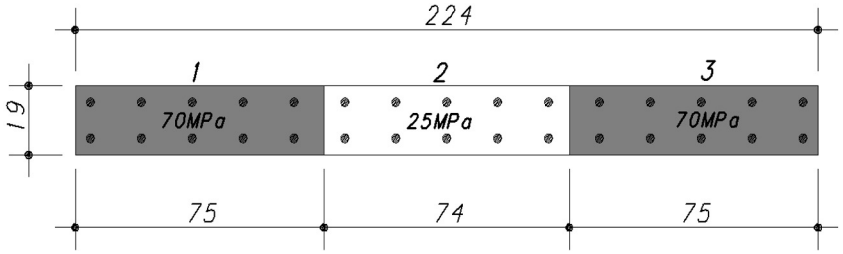
Segunda tentativa



Esforços solicitantes por faixa:

Faixas 1 e 3

$N_{d,faixa}$ = 3289kN

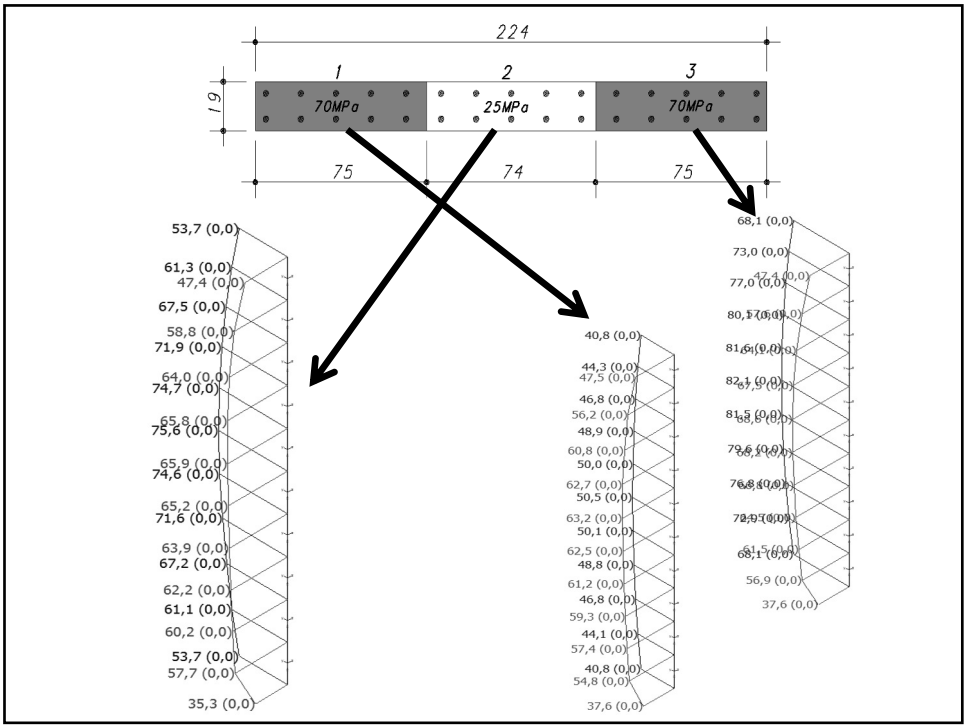
$M_{dx,faixa}$ = 31,8kN·m

Faixas 2

$N_{d,faixa}$ = 2595kN

$M_{dx,faixa}$ = 31,4kN·m

79



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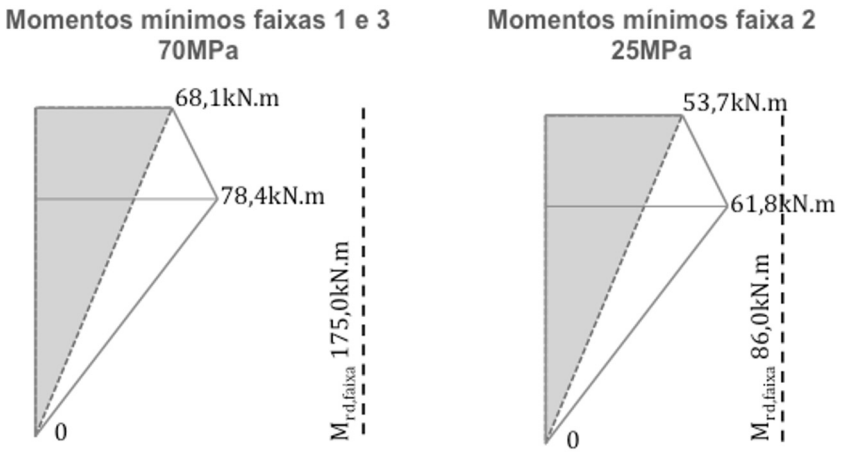
Segunda tentativa
Verificação de momentos mínimos



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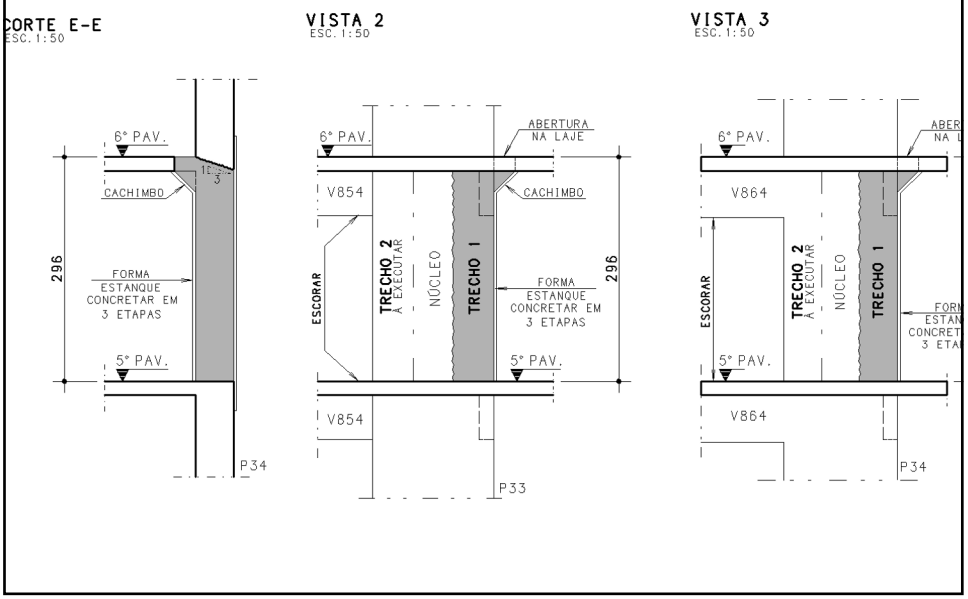

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Processo executivo

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IMPORTANTE!

Verificar la carga que actua en el pilar en el momento de la demolición.

Freccionar la demolición y/o dimensionar lo apuntalado adecuado si la seción demolida es insuficiente.

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IMPORTANTE!

Verificar los factores de seguridad durante la fase de demolición.

Se puede usar factores reduzidos durante este proceso.

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Casos prácticos

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Pilar antes del refuerzo

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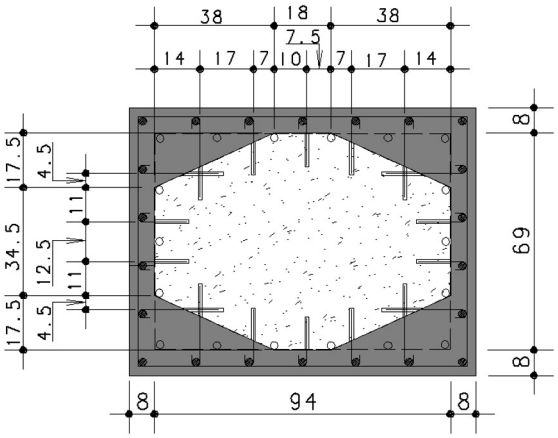
Diseño inicial del refuerzo



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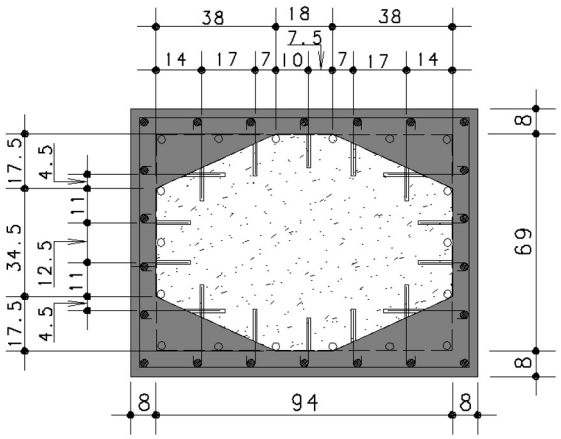
Diseño inicial del refuerzo



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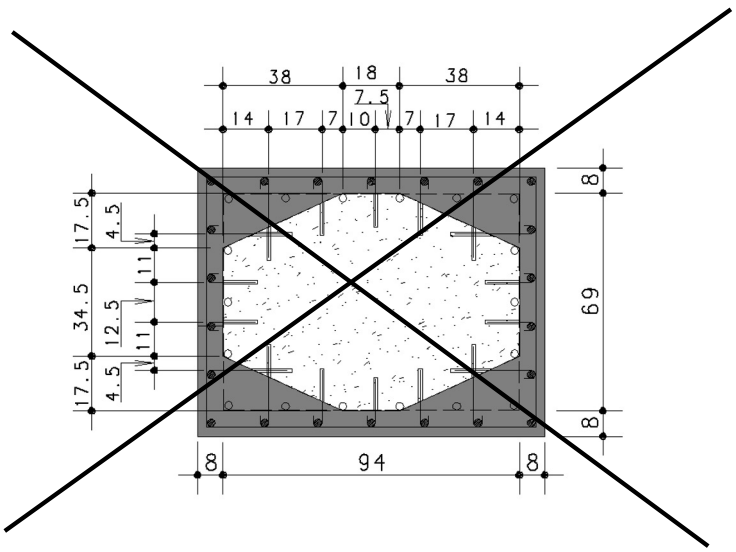
Diseño inicial del refuerzo



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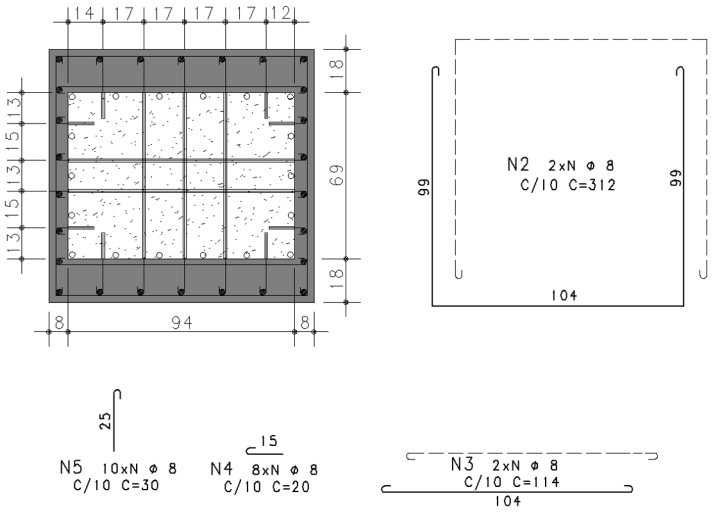
Revisión del diseño del refuerzo



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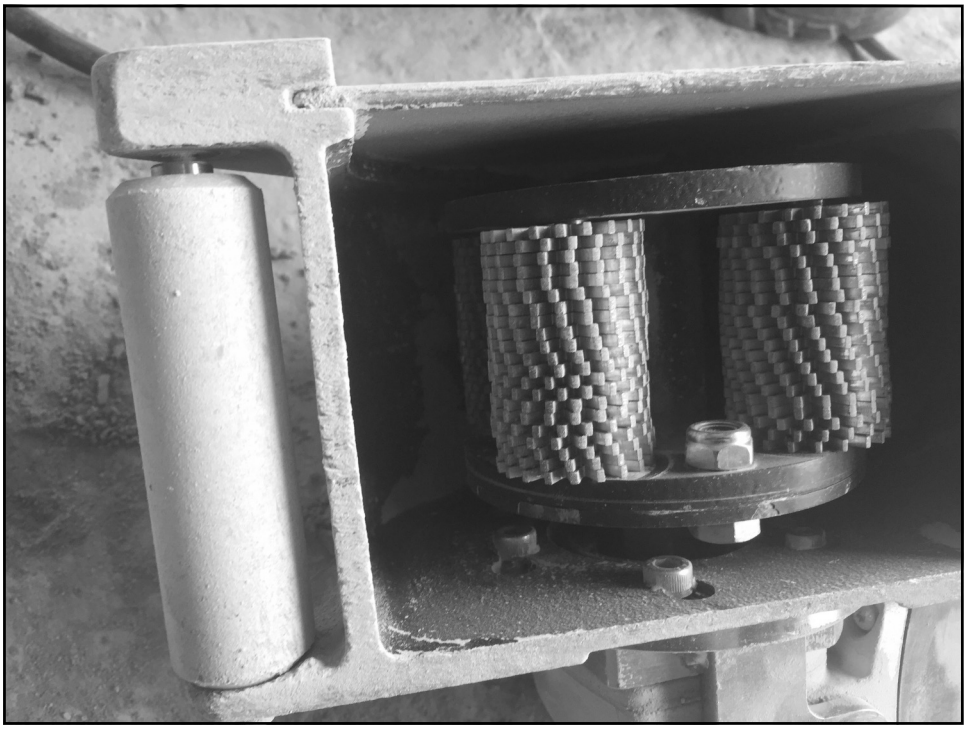

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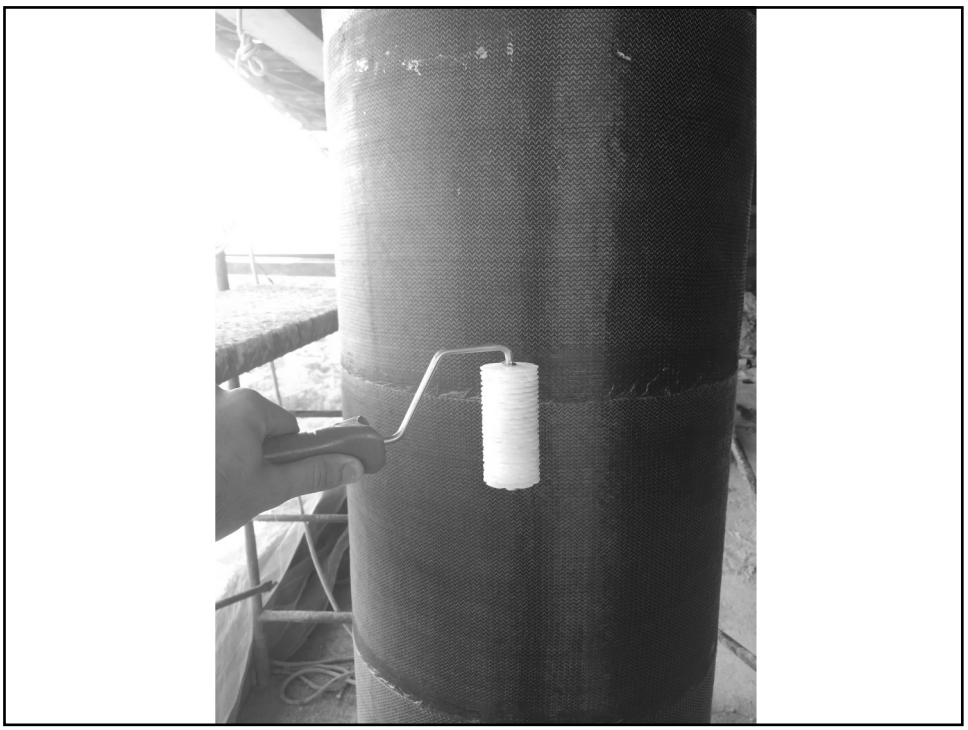

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¡GRACIAS!

OBRIGADO!

THANK YOU!

PhD Engenharia

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