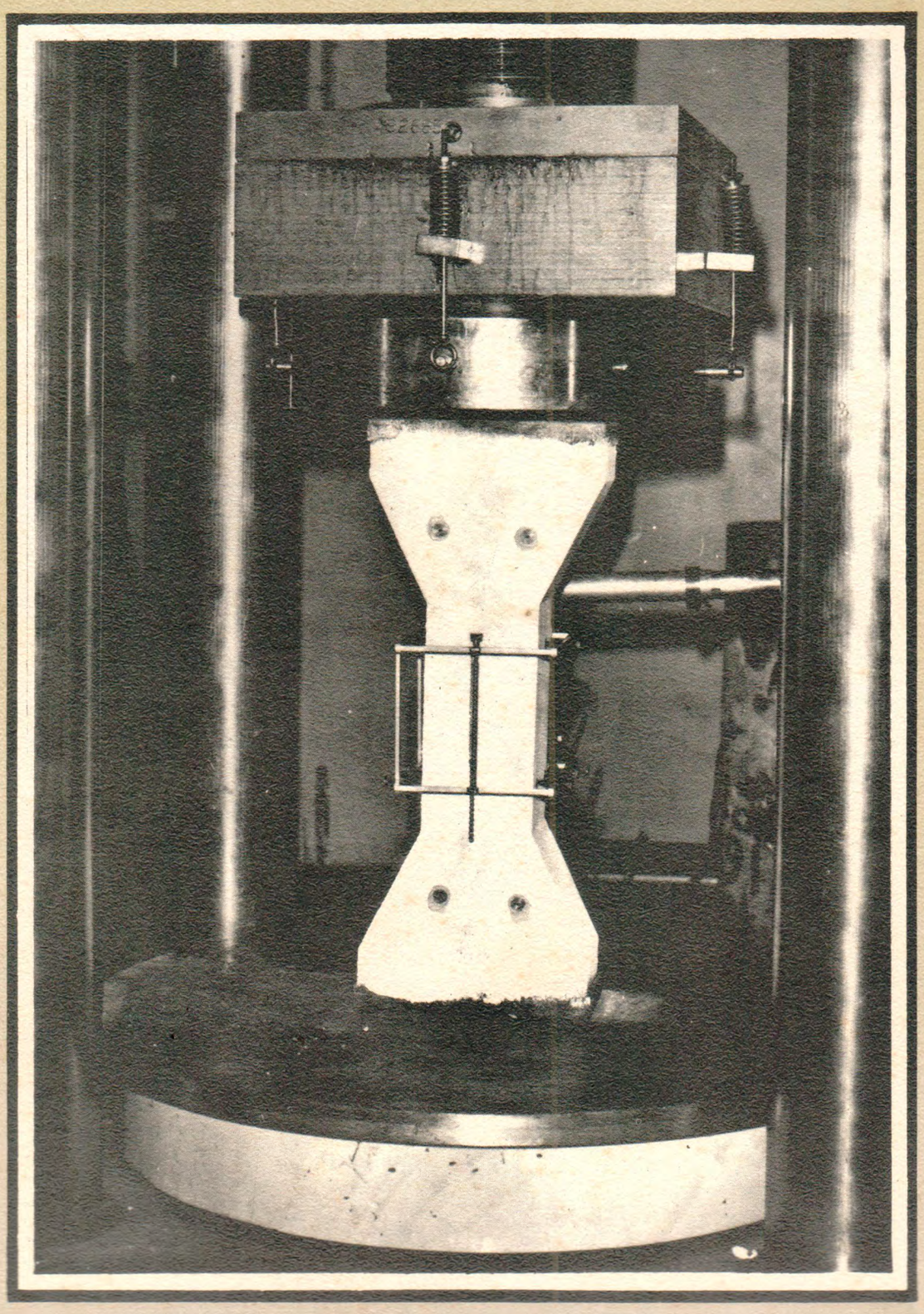
CONCRETO ARMADO

• DIMENSIONAMENTO •



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CONCRETO ARMADO
DIMENSIONAMENTO

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UNIVERSIDADE FEDERAL DE SANTA MARIA

CONCRETO ARMADO
DIMENSIONAMENTO

Segundo NBR 6118/82

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PREFÁCIO

O presente volume resultou da reunião de tabelas desenvolvidas ao longo de nosso tempo como professores das disciplinas de Concreto Armado e Estrutura de Concreto Armado, no Centro de Tecnologia da Universidade Federal de Santa Maria.

Esta iniciativa foi motivada por nossos alunos, no sentido de prover-lhes uma maior simplificação no volume de cálculo de solicitações e de dimensionamento de seções de Concreto Arrnado.

Inicialmente, portanto, objetivou-se atender as necessidades acadêmicas através de uma série de tabelas auxiliares.

Neste tempo, em que estamos envolvidos naquelas disciplinas, muitas alterações de normalização obrigaram a atualizações sistemáticas.

Com a criação da Comissão de Divulgação da Universidade, tornou-se possível reunir em livro o trabalho que, em parte, havia sido publicado esparsamente em alguns números da revista do Centro de Tecnologia.

Embora a intenção primeira desta obra vise o alunado do Curso de Engenharia Civil, poderá ela, de alguma forma, ser útil aos profissionais da área como mais um recurso para o dimensionamento direto de seções de elementos estruturais.

Não podemos deixar de agradecer aos nossos colegas professores, assim como à Comissão de Divulgação da Universidade e seus funcionários pelo incentivo e apoio recebidos.

José Ubirajara Martins Flores
Newton Soares Gomes

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NOTAÇÕES

As notações utilizadas foram baseadas na NBR 6118/82.

1 Letras romanas maiúsculas

A_s - área da seção transversal da armadura longitudinal tracionada.

A_{smin} - área mínima da seção transversal da armadura longitudinal de tração.

A'_s - área da seção transversal da armadura longitudinal comprimida.

$A_{s\omega}$ área da seçao transversal das barras da armadura de cisalhamento.

$A_{s\omega min}$ - área mínima da seção transversal da armadura de cisalhamento.

F - força normal majorada, $F=\gamma_h N$; $F=F_c+F_s$.

F_c - parcela da força normal F resistida pelo concreto;

$F_c = A_c \bar{\sigma} c$.

F_s - parcela da força normal F; $F_s=A_s\sigma_{sd}$ $\sigma_{sd}=\sigma_s$ σ_c, $\bar{\sigma}_s = \sigma_{sd(2‰)}/\gamma_f$; $\bar{\sigma}_c = 0,85\ f_{cd}/\gamma_f$.

M - momento fletor característico (sem majoração).

M_{lim} - momento fletor limite, $\xi = \xi_{yd}$.

M_1 - momento resistido pela armadura longitudinal comprimida.

M_f - momento fletor resistido pelas abas da mesa (b_f-b_ω) de uma seção transversal tê.

$M\omega$ - momento fletor resistido pela alma de uma seção transversal tê.

N - força normal característica (sem majoração)

V - força cortante característica (sem majoração)

V_c - parcela da força cortante absorvida pelo concreto

V_{min} - força cortante resistida pela seção de concreto com armadura transversal mínima de estribos verticais.

K - coeficiente para determinação da posição da linha neutra, (ξ).

K_s - coeficiente para determinar a armadura longitudinal tracionada.

K'_s - coeficiente para determinar a armadura longitudinal comprimida.

K_{s1} - coeficiente para determinar a parcela de armadura longitudinal de tração devido a ação de M_1.

K_{cf} - valor de K_c quando $\xi = h_f/d$.

K_{sf} - valor de K_s correspondente a K_{cf} .

$K_{c\omega}$ valor de K_c correspondente ao momento M_ω

$K_{s\omega}$ - valor de K_s correspondente a $K_{c\omega}$

K_{clim} - valor de K_c quando $\xi = \xi_{yd}$

2 Letras romanas minúsculas

b - largura

$\tilde{b}$ largura das vigas de seção retangular ou da alma das vigas de seção T

b_f - largura da mesa das vigas de seção T.

c - cobrimento

d - distância do ponto de aplicação da resultante das tensões de tração na armadura longitudinal ao ponto de maior encurtamento de uma seção transversal de peça fletida, medida normalmente à linha neutra (altura útil)

d' - distância do ponto de aplicação da resultante das tensões de compressão na armadura longitudinal ao ponto de maior encurtamento de uma seção transversal de peça fletida, medida normalmente à linha neutra.

d_{max} diâmetro máximo do agregado .

e - excentricidade total da força normal

e_a - excentricidade acidental da força normal.

e_c - excentricidade complementar (e_2)

e_v - distância vertical entre duas barras adjacentes .

e_h - distância horizontal entre duas barras adjacentes.

f_{ck} resistência característica do concreto à compressão.

f_{tk} - resistência característica do concreto à tração.

f_{yk} resistência característica do aço à tração.

f_{cd} resistência de cálculo do concreto à compressão.

f_{yd} resistência de cálculo do aço à tração.

$f_{y\omega k}$ - resistência característica do aço da armadura transversal à tração.

$f_{y\omega d}$ - resistência de cálculo do aço da armadura transversal à tração.

h - altura total da seção transversal; espessura.

h_f - espessura da mesa de seção T.

l - comprimento.

l_b - comprimento de ancoragem.

l_e - comprimento de flambagem.

l_x - menor vão de uma laje

l_y - maior vão de uma laje.

s - espaçamento dos estribos verticais.

u - perímetro.

ω - abertura de fissura.

x - distância da linha neutra ao ponto de maior encurtamento, na seção transversal de uma peça fletida.

y - altura da linha neutra fictícia.

3 Letras gregas maiúscula

ϕ - diâmetro da barra da armadura.

ϕ_e - diâmetro da barra do estribo.

4 Letras gregas minúsculas

γ_c - coeficiente de minoração da resistência do concreto.

γ_s - coeficiente de minoração da resistência do aço.

γ_f - coeficiente de majoração das solicitações.

γ_h - coeficiente de majoração da força normal.

ε_c - deformação específica do concreto.

ε_s - deformação específica do aço.

λ - índice de esbeltez

μ - momento fletor reduzido adimensional.

ν - força normal relativa adimensional.

ρ - taxa geométrica de armadura.

ρ_ℓ - menor taxa da armadura longitudinal de tração no trecho de comprimento 2h a partir da face do apoio.

ρ_1 - $100\ \rho_\ell$

σ_{sd} - tensão normal de cálculo na armadura tracionada.

σ'_{sd} - tensão normal de cálculo na armadura comprimida.

$\sigma_{sd(2‰)}$ - tensão normal de cálculo para um encurtamento $\varepsilon = 2‰$

$\sigma_{s\omega d}$ - tensão normal de cálculo na armadura transversal.

τ_ω - tensão convencional de cisalhamento (de referência) na alma da peça

$\tau_{\omega d}$ - tensão τ_ω de cálculo.

Tabela I

ÁREA DA SEÇÃO DE ARMADURA A_s (cm^2)

BITOLA		MASSA LINEAR	μ PERÍMETRO	NÚMERO DE FIOS OU DE BARRAS									
FIOS	BARRAS	Kg/m	(cm)	1	2	3	4	5	6	7	8	9	10
3,2	-	0,063	1,00	0,08	0,16	0,24	0,32	0,40	0,48	0,56	0,64	0,72	0,80
4	-	0,10	1,25	0,125	0,25	0,375	0,50	0,625	0,75	0,875	1,00	1,125	1,25
5	5	0,16	1,60	0,20	0,40	0,60	0,80	1,00	1,20	1,40	1,60	1,80	2,00
6,3	6,3	0,25	2,00	0,315	0,63	0,945	1,26	1,575	1,89	2,205	2,52	2,835	3,15
8	8	0,40	2,50	0,50	1,00	1,50	2,00	2,50	3,00	3,50	4,00	4,50	5,00
10	10	0,63	3,15	0,80	1,60	2,40	3,20	4,00	4,80	5,60	6,40	7,20	8,00
-	12,5	1,00	4,00	1,25	2,50	3,75	5,00	6,25	7,50	8,75	10,00	11,25	12,50
-	16	1,60	5,00	2,00	4,00	6,00	8,00	10,00	12,00	14,00	16,00	18,00	20,00
-	20	2,50	6,30	3,15	6,30	9,45	12,60	15,75	18,90	22,05	25,20	28,35	31,50
-	22,2*	3,05	6,97	3,88	7,76	11,64	15,52	19,40	23,28	27,16	31,04	34,92	38,80
-	25	4,00	8,00	5,00	10,00	15,00	20,00	25,00	30,00	35,00	40,00	45,00	50,00
-	32	6,30	10,00	8,00	16,00	24,00	32,00	40,00	48,00	56,00	64,00	72,00	80,00
-	40	10,00	12,50	12,50	25,50	37,50	50,00	62,50	75,00	87,50	100,00	112,50	125,00

* Bitola intermediária não especificada pela EB - 3/80.

Tabela II

ÁREA DA SEÇÃO DE ARMADURA POR METRO DE LARGURA (cm^2/m)

ESPAÇAMENTO (cm)	BITOLAS PADRONIZADAS (EB - 3/80) BITOLA Ø						
	3,2	4	5	6,3	8	10	12,5
7,0	1,14	1,79	2,86	4,50	7,14	11,43	17,86
7,5	1,07	1,67	2,67	4,20	6,67	10,67	16,67
8,0	1,00	1,56	2,50	3,94	6,25	10,00	15,63
8,5	0,94	1,47	2,35	3,71	5,88	9,41	14,71
9,0	0,89	1,39	2,22	3,50	5,56	8,89	13,89
9,5	0,84	1,32	2,11	3,32	5,26	8,42	13,16
10,0	0,80	1,25	2,00	3,15	5,00	8,00	12,50
11,0	0,73	1,14	1,82	2,86	4,55	7,27	11,36
12,0	0,67	1,04	1,67	2,62	4,17	6,67	10,42
12,5	0,64	1,00	1,60	2,52	4,00	6,40	10,00
13,0	0,62	0,96	1,54	2,42	3,85	6,15	9,62
14,0	0,57	0,89	1,43	2,25	3,57	5,71	8,93
15,0	0,53	0,83	1,33	2,10	3,33	5,33	8,33
16,0	0,50	0,78	1,25	1,97	3,13	5,00	7,81
17,0	0,47	0,74	1,18	1,85	2,94	4,71	7,35
17,5	0,46	0,71	1,14	1,80	2,86	4,57	7,14
18,0	0,44	0,69	1,11	1,75	2,78	4,44	6,94
19,0	0,42	0,66	1,05	1,66	2,63	4,21	6,58
20,0	0,40	0,63	1,00	1,58	2,50	4,00	6,25
21,0	0,38	0,60	0,95	1,50	2,38	3,81	5,95
22,0	0,36	0,57	0,91	1,43	2,27	3,64	5,68
23,0	0,35	0,54	0,87	1,37	2,17	3,48	5,43
24,0	0,33	0,52	0,83	1,31	2,08	3,33	5,21
25,0	0,32	0,50	0,80	1,26	2,00	3,20	5,00
26,0	0,31	0,48	0,77	1,21	1,92	3,08	4,81
27,0	0,30	0,46	0,74	1,17	1,85	2,96	4,63
28,0	0,29	0,45	0,71	1,12	1,79	2,86	4,46
29,0	0,28	0,43	0,69	1,09	1,72	2,76	4,31
30,0	0,27	0,42	0,67	1,05	1,67	2,67	4,17

Tabela III

NÚMERO MÁXIMO DE BARRAS POR CAMADA
DIÂMETRO MÁXIMO DO AGREGADO 19mm

ϕ \ b_ω	10	12	15	17	20	22	25	30
10.0	2	3	3	4	5	6	7	8
12.5	2	2	3	4	5	5	6	7
16.0	2	2	3	3	4	5	5	7
20.0		2	3	3	4	4	5	6
*22.2		2	2	3	4	4	5	6
25.0		2	2	3	3	4	4	5

Tabela IV

NÚMERO MÁXIMO DE BARRAS POR CAMADA
DIÂMETRO MÁXIMO DO AGREGADO 25mm

ϕ \ b_ω	10	12	15	17	20	22	25	30
10.0	2	2	3	3	4	5	5	7
12.5	2	2	3	3	4	4	5	6
16.0		2	3	3	4	4	5	6
20.0		2	2	3	3	4	4	5
*22.2		2	2	3	3	3	4	5
25.0			2	2	3	3	4	5

* Bitola intermediária não especificada pela EB-3/80.

NOTA: Para o cálculo desta tabela foram admitidos

$\phi_t = 6,0$ mm

$e_h \geq \begin{matrix} 2.0 \text{ cm} \\ \phi \\ 1,2\ d_{máx} \end{matrix}$

$c = 1,5$ cm

Tabela V

Comprimento de ancoragem reta (cm) — — CA -50

A 1º coluna corresponde à situação de boa aderência e a 2º à situação de má aderência

ϕ	13,5		15,0		18,0		20,0		22,0		25,0	
6,3	36	54	34	51	30	45	28	42	26	39	24	36
8,0	46	69	43	64	38	57	35	53	33	50	30	46
10,0	57	86	54	80	47	71	44	66	41	62	38	57
12,5	71	107	67	100	59	89	55	83	52	78	48	71
16,0	91	137	86	128	76	114	71	106	66	100	61	91
20,0	114	171	107	161	95	142	88	133	83	124	76	114
22,2	127	190	119	178	105	158	98	147	92	138	85	127
25,0	143	214	134	201	119	178	110	166	104	156	95	143
32,0	183	274	171	257	152	228	141	212	133	199	122	183
40,0	228	343	214	321	190	284	177	265	166	249	152	229

Tabela VI

Comprimento de ancoragem com gancho (cm) — — CA-50

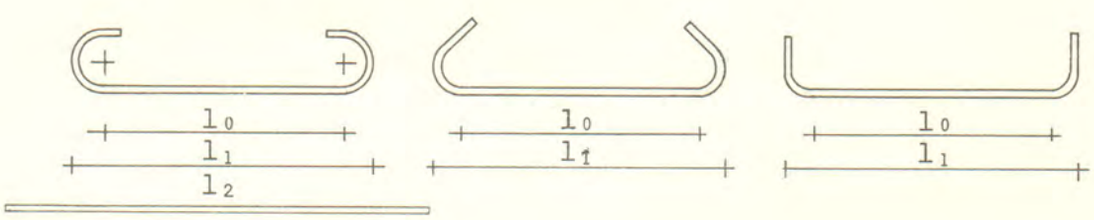
A 1º coluna corresponde à situação de boa aderência e a 2º à situação de má aderência

ϕ	13,5		15,0		18,0		20,0		22,0		25,0	
6,3	30	48	28	45	24	39	22	36	20	33	18	30
8,0	38	61	35	56	30	49	27	45	24	42	22	38
10,0	47	76	44	70	37	61	34	56	31	52	28	47
12,5	59	95	55	88	47	77	43	71	40	66	36	59
16,0	75	121	70	112	60	98	55	90	50	84	45	75
20,0	94	151	87	141	75	132	68	113	63	104	56	94
22,2	105	168	97	156	83	136	76	125	70	116	63	105
25,0	118	189	109	176	94	153	85	141	79	131	70	118
32,0	151	242	139	225	120	196	109	180	101	167	90	151
40,0	188	343	174	281	150	244	137	225	126	209	112	189

Tabela VII

Comprimento de dois ganchos em cm CA - 50

ϕ mm	180º		45º		90º		
	l_2-l_1	l_2-l_0	l_2-l_1	l_2-l_0	l_2-l_1	l_2-l_0	l_1-l_0
5,0	7,9	11,4	7,6	11,1	9,2	12,7	3,5
6,3	10,0	14,4	9,5	13,9	11,6	16,0	4,4
8,0	12,7	18,3	12,1	17,7	14,7	20,3	5,6
10,0	15,8	22,8	15,1	22,1	18,4	25,4	7,0
12,5	19,9	28,6	18,9	27,7	23,0	31,8	8,7
16,0	25,3	36,5	24,2	35,4	29,5	40,7	11,2
20,0	44,5	64,5	38,4	58,4	40,3	60,3	20,0
22,2	49,4	71,6	42,6	64,8	44,7	66,9	22,2
25,0	55,7	80,7	48,0	73,0	50,4	75,4	25,0
32,0	71,3	103,3	61,4	93,4	64,5	96,5	32,0
40,0	89,1	129,1	76,8	116,8	80,6	120,5	40,0



TABELAS DE FLEXÃO RETA DE SEÇÕES RETANGULARES

1 As tabelas foram elaboradas de acordo com a **NBR 6118/82** e servem para cálculo da armadura longitudinal de seções retangulares de concreto armado.

2 As tabelas prevêem 4 valores de f_{ck} e foram feitas para os aços CA 25, CA 50-A, CA 50-B e CA 60-B.

3 Deve-se entrar nas tabelas com o momento característico M (sem majoração).

4 Unidades

Momentos: M; M_{lim}; M_1; M_f; M_ω - KNm

Alturas: h; d; h_f - cm

Áreas: A_s; A'_s cm^2

Tensão: MPa

5 Coeficientes

$\gamma_c=1,4$; $\gamma_f=1,4$; $\gamma_s=1,15$; $\delta'=d'/d=0,08$

6 - Formulação básica

6.1 Seções retangulares com armadura simples

$K_c = d/\sqrt{M/b_\omega}$; $A_s=K_s\ M/d$

6.2 Seções retangulares com armadura dupla

$M_{lim}=d^2 b_\omega/K_{c\,lim}^2$

$M_1 = M-M_{lim}$

$A_s = K_s\ M_{lim}/d + K_{s1}\ M_1/d$

$A'_s = K'_s\ M_1/d$

6.3 Vigas de seção geométrica tê

6.3.1 $K_c = d/\sqrt{M/b_f}$ conduzindo a $\xi < h_f/d$

Viga estaticamente retangular

$A_s = K_s\ M/d$

6.3.2 $K_c = d/\sqrt{M/b_f}$ conduzindo a $\xi \geq h_f/d$

com $\xi = h_f/d$ retirar da tabela $K_c = K_{cf}$

e $K_s = K_{sf}$

$$M_f = \frac{d^2(b_f - b_\omega)}{K_{cf}^2}$$

$M_\omega = M - M_f$

$K_{c\omega} = d/\sqrt{M_\omega/b_\omega}$; $K_s = K_{s\omega}$

Se $K_{c\omega} > K_{clim}$ (Viga tê com armadura simples)

$A_s = K_{s\omega}\, M_\omega/d + K_{sf}\, M_f/d$

Se $K_{c\omega} < K_{clim}$ (Viga tê com armadura dupla)

$M_{lim} = d^2 b_\omega / K_{clim}^2$

$M_1 = M_\omega - M_{lim}$

$A'_s = K'_s\, M_1/d$

$A_s = K_s\, M_{lim}/d + K_{s1}\, M_1/d + K_{sf}\, M_f/d$

7 Exemplos de aplicação

7.1 Seção retangular com armadura simples

M= 94,51 KNm; b_ω=0,20m; d=50 cm; f_{ck}=15 MPa; CA-50-A.

$K_c = d/\sqrt{M/b_\omega} = 50/\sqrt{94,51/0,20} = 2,30$

entrando na tabela na coluna do f_{ck} = 15 MPa temos para o CA-50-A

K_s = 3,94 e K'_s =0 logo

$A_s = K_s\, M/d = 3,94 \times 94,51 / 50 = 7,44\ cm^2$

7.2 Seção retangular com armadura dupla

M=110,20 KNm; b_ω=0,20m; d=50 cm; f_{ck}=15 MPa; CA-50-B.

$K_c = d/\sqrt{M/b_\omega} = 50/\sqrt{110,20/0,20} = 2,13$

entrando na tabela na coluna do

f_{ck} = 15 MPa temos para o aço CA-50-B

K_s=3,98 ; K'_s=3,83; como $K_c < K_{clim}$ temos armadura dupla,

K_{s1} = 3,50.

K_{clim} = 2,26 correspondente a X/d =0,46

$M_{lim} = d^2 b_\omega / K_{clim}^2 = 50^2 \times 0,20/2,26^2 = 97,89$ KNm

$M_1 = M \quad M_{lim} = 110,20 - 97,89 = 12,31$ KNm

$A_s = K_s M_{lim}/d + K_{s1} M_1/d$

$A_s = 3,98 \times 97,89/50 + 3,50 \times 12,31/50 = 8,65 \text{ cm}^2$

$A'_s = K'_s M_1/d$

$A'_s = 3,83 \times 12,31/50 = 0,94 \text{ cm}^2$

7.3 Seção geométrica tê com armadura simples

7.3.1 Viga estaticamente retangular

M = 98,42 ; b_f=1,0 m; b_ω=0,20m; d=50 cm; h_f=8 cm.

f_{ck} = 15 MPa; CA-50-A.

$K_c = d/\sqrt{M/b_f} = 50/\sqrt{98,42/1,0} = 5,04$; K_s = 3,36

conduzindo o ξ=X/d = 0,12 < h_f/d=8/50=0,16

Viga estaticamente retangular

$A_s = K_s M/d$

$A_s = 3,36 \times 98,42/50 = 6,61 \text{ cm}^2$

7.3.2 Viga funcionando como tê

M=222,04 KNm; b_f=1,0m; b_ω=0,20m; d=50 cm; h_f=8 cm.

f_{ck} = 15 MPa; CA-50-A.

$K_c = d/\sqrt{M/b_f} = 50/\sqrt{222,04/1,0} = 3,35$

conduzindo o ξ=X/d = 0,20 > h_f/d=8/50 =0,16

com $\xi = h_f/d$=0,16 retirar da tabela

$K_c = 3,96 = K_{cf}$ e $K_s = 3,42 = K_{sf}$

$M_f = d^2(b_f - b_\omega)/K^2_{cf}$

$M_f = 50^2(1,0-0,20)/3,96^2 = 127,53$ KNm

$M_\omega = M - M_f = 222,04 - 127,53 = 94,51$ KNm

$K_{c\omega} = d/\sqrt{M_\omega/b_\omega} = 50/\sqrt{94,51/0,20} = 2,30$

Para $K_c = 2,30$ temos $K_s = 3,94 = K_{s\omega}$

$K_c > K_{clim}$ (Viga tê com armadura simples)

$A_s = K_{s\omega} M_\omega/d + K_{sf} M_f/d$

$A_s = 3,94 \times 94,51/50 + 3,42 \times 127,53/50 = 16,16\ cm^2$

7.4 Seção geométrica tê com armadura dupla

$M = 237,73$ KNm; $b_f = 1,0$m; $b_\omega = 0,20$m; d=50cm; $h_f = 8,0$cm.

$f_{ck} = 15$ MPa; CA-50-B.

$K_c = d/\sqrt{M/b_f} = 50/\sqrt{237,73/1,0} = 3,24$

conduzindo a um $\xi = 0,215 > \xi = h_f/d = 0,16$

com $\xi = h_f/d$ retirar da tabela

$K_c = 3,96 = K_{cf}$ e $K_s = 3,42 = K_{sf}$

$M_f = d^2(b_f - b_\omega)/k^2_{cf}$

$M_f = 50^2(1,0 - 0,20)/3,96^2 = 127,53$ KNm

$M_\omega = M - M_f = 237,73 - 127,53 = 110,20$ KNm

$K_{c\omega} = d/\sqrt{M_\omega/b_\omega} = 50/\sqrt{110,20/0,20} = 2,13$

entrando na tabela na coluna do

$f_{ck} = 15$MPa temos para o aço CA-50-B

$K_s = 3,98 = K_{s\omega}$; $K'_s = 3,83$, como $K_{c\omega} < K_{clim}$ temos

viga tê com armadura dupla, $K_{s1} = 3,50$.

$K_{c\,lim}$=2,26 correspondente a x/d=0,46

$M_{lim} = d^2 b_\omega / k^2_{c\,lim} = 50^2 \times 0,20/2,26^2 = 97,89 KNm$

$M_1 = M - M_{lim} = 110,20 - 97,89 = 12,31\ KNm$

$A'_s = K'_s\ M_1/d = 3,83 \times 12,31/50 = 0,94\ cm^2$

$A_s = K_s\ M_{lim}/d + K_{s1}\ M_1/d + K_{sf}\ M_f/d$

$A_s = 3,98 \times 97,89/50 + 3,50 \times 12,31/50 + 3,42 \times 127,53/50$

$A_s = 17,37 cm^2$

Tabela I

TABELA DE FLEXÃO RETA DE SEÇÕES RETANGULARES

X/d	ε_c	ε_s	CA-50B		CA-50A		K_c para os f_{ck} em MPa			
			K'_s	K_s	K'_s	K_s	13.5	15	18	20
0.01	0.1	10.0		3.23		3.23	58.75	55.73	50.88	48.27
0.02	0.2	10.0		3.24		3.24	29.53	28.02	25.59	24.27
0.04	0.4	10.0		3.26		3.26	14.94	14.18	12.94	12.28
0.06	0.6	10.0		3.28		3.28	10.10	9.58	8.74	8.29
0.08	0.9	10.0		3.31		3.31	7.69	7.29	6.66	6.31
0.10	1.1	10.0		3.33		3.33	6.25	5.93	5.42	5.14
0.12	1.4	10.0		3.36		3.36	5.31	5.04	4.60	4.37
0.14	1.6	10.0		3.39		3.39	4.66	4.42	4.03	3.83
0.16	1.9	10.0		3.42		3.42	4.18	3.96	3.62	3.43
0.18	2.2	10.0		3.45		3.45	3.83	3.63	3.31	3.14
0.20	2.5	10.0		3.49		3.49	3.55	3.37	3.08	2.92
0.22	2.8	10.0		3.53		3.53	3.34	3.17	2.89	2.74
0.24	3.2	10.0		3.57		3.57	3.16	3.00	2.74	2.60
0.26	3.5	10.0		3.61		3.61	3.02	2.86	2.61	2.48
0.28	3.5	9.0		3.64		3.64	2.92	2.77	2.53	2.40
0.30	3.5	8.2		3.67		3.67	2.83	2.69	2.46	2.33
0.32	3.5	7.4		3.71		3.71	2.76	2.62	2.39	2.27
0.34	3.5	6.8		3.75		3.75	2.69	2.55	2.33	2.21
0.36	3.5	6.2		3.78		3.78	2.63	2.49	2.27	2.16
0.38	3.5	5.7		3.82		3.82	2.57	2.44	2.22	2.11
0.40	3.5	5.3		3.86		3.86	2.52	2.39	2.18	2.07
0.42	3.5	4.8		3.90		3.90	2.47	2.34	2.14	2.03
0.44	3.5	4.5		3.94		3.94	2.42	2.30	2.10	1.99
0.46	3.5	4.1	3.83	3.98		3.98	2.38	2.26	2.06	1.96
0.48	3.5	3.8	3.83	3.98		4.02	2.34	2.22	2.03	1.93
0.50	3.5	3.5	3.83	3.98		4.06	2.31	2.19	2.00	1.90
0.52	3.5	3.2	3.83	3.98		4.10	2.28	2.16	1.97	1.87
0.54	3.5	3.0	3.83	3.98		4.15	2.24	2.13	1.94	1.84
0.56	3.5	2.8	3.83	3.98		4.19	2.22	2.10	1.92	1.82
0.58	3.5	2.5	3.83	3.98		4.24	2.19	2.09	1.90	1.80
0.60	3.5	2.3	3.83	3.98		4.29	2.16	2.05	1.87	1.78
0.62	3.5	2.1	3.83	3.98	3.50	4.33	2.14	2.03	1.85	1.76
	K_{s1}		3.50		3.50					

$K_c = d/\sqrt{M/b_\omega}$

d cm

M KNm

b_ω m

ARM. SIMPLES: $A_s = K_s M/d$ cm^2

ARM. DUPLA : $A'_s = K'_s M_1/d$; $M_1 = M - M_{1lim}$; $M_{1lim} = d^2 b_\omega / K^2_{c\,lim}$

$A_s = K_s M_{1lim}/d + K_{s1} M_1/d$

$\gamma_f = 1.4$; $\gamma_c = 1.4$; $\gamma_s = 1.15$; $d'/d = 0.08$

Tabela II

TABELA DE FLEXÃO RETA DE SEÇÕES RETANGULARES

X/d	ε_c	ε_s	CA-60B		CA-25		K_c para os f_{ck} em MPa			
			K'_s	K_s	K'_s	K_s	13.5	15	18	20
0.01	0.1	10.0		2.69		6.46	58.75	55.73	50.88	48.27
0.02	0.2	10.0		2.70		6.48	29.53	28.02	25.58	24.27
0.04	0.4	10.0		2.72		6.52	14.94	14.18	12.94	12.28
0.06	0.6	10.0		2.73		6.57	10.10	9.58	8.74	8.29
0.08	0.9	10.0		2.76		6.62	7.69	7.29	6.66	6.31
0.10	1.1	10.0		2.78		6.67	6.25	5.93	5.42	5.14
0.12	1.4	10.0		2.80		6.72	5.31	5.04	4.60	4.37
0.14	1.6	10.0		2.82		6.78	4.66	4.42	4.03	3.83
0.16	1.9	10.0		2.85		6.84	4.18	3.96	3.62	3.43
0.18	2.2	10.0		2.88		6.91	3.83	3.63	3.31	3.14
0.20	2.5	10.0		2.91		6.98	3.55	3.37	3.08	2.92
0.22	2.8	10.0		2.94		7.06	3.34	3.17	2.89	2.74
0.24	3.2	10.0		2.97		7.14	3.16	3.00	2.74	2.60
0.26	3.5	10.0		3.00		7.22	3.02	2.86	2.61	2.48
0.28	3.5	9.0		3.03		7.28	2.92	2.77	2.53	2.40
0.30	3.5	8.2		3.06		7.35	2.83	2.69	2.46	2.33
0.32	3.5	7.4		3.09		7.42	2.76	2.62	2.39	2.27
0.34	3.5	6.8		3.12		7.50	2.69	2.55	2.33	2.21
0.36	3.5	6.2		3.15		7.57	2.63	2.49	2.27	2.16
0.38	3.5	5.7		3.18		7.64	2.57	2.44	2.22	2.11
0.40	3.5	5.3		3.21		7.72	2.52	2.39	2.18	2.07
0.42	3.5	4.8		3.25		7.80	2.47	2.34	2.14	2.03
0.43	3.5	4.6	3.33	3.26		7.85	2.44	2.32	2.12	2.01
0.46	3.5	4.1	3.33	3.26		7.96	2.38	2.26	2.06	1.96
0.48	3.5	3.8	3.33	3.26		8.04	2.34	2.22	2.03	1.93
0.50	3.5	3.5	3.33	3.26		8.13	2.31	2.19	2.00	1.90
0.52	3.5	3.2	3.33	3.26		8.21	2.28	2.16	1.97	1.87
0.54	3.5	3.0	3.33	3.26		8.30	2.24	2.13	1.94	1.84
0.56	3.5	2.8	3.33	3.26		8.39	2.22	2.10	1.92	1.82
0.58	3.5	2.5	3.33	3.26		8.48	2.19	2.08	1.90	1.80
0.60	3.5	2.3	3.33	3.26		8.58	2.16	2.05	1.87	1.78
0.62	3.5	2.1	3.33	3.26		8.67	2.14	2.03	1.85	1.76
0.64	3.5	2.0	3.33	3.26		8.77	2.12	2.01	1.84	1.74
0.66	3.5	1.8	3.33	3.26		8.87	2.10	1.99	1.82	1.72
0.68	3.5	1.6	3.33	3.26		8.98	2.08	1.97	1.80	1.71
0.70	3.5	1.5	3.33	3.26		9.08	2.06	1.96	1.79	1.69
0.72	3.5	1.4	3.33	3.26		9.19	2.05	1.94	1.77	1.68
0.74	3.5	1.2	3.33	3.26		9.30	2.03	1.93	1.76	1.67
0.76	3.5	1.1	3.33	3.26		9.41	2.01	1.91	1.74	1.66
0.77	3.5	1.0	3.33	3.26	7.00	9.47	2.00	1.90	1.74	1.65
	K_{s1}		2.91		7.00					

Tabela III

TABELA DE FLEXÃO
DIAGRAMA RETANGULAR
CA – 25

y/d	εsd	εcd	Ks	Ks'	Valores de Kc para fck em MPa					
					13,5	15,0	18,0	20,0	22,0	24,0
0,01	10,0	0,1	6,47		13,10	12,43	11,35	10,76	10,26	9,83
0,02	10,0	0,3	6,51		9,29	8,81	8,04	7,63	7,28	6,97
0,03	10,0	0,4	6,54		7,60	7,21	6,58	6,25	5,96	5,70
0,04	10,0	0,5	6,57		6,60	6,26	5,72	5,42	5,17	4,95
0,05	10,0	0,7	6,61		5,92	5,62	5,13	4,86	4,64	4,44
0,06	10,0	0,8	6,64		5,42	5,14	4,69	4,45	4,24	4,06
0,07	10,0	1,0	6,67	88,16	5,03	4,77	4,35	4,13	3,94	3,77
0,08	10,0	1,1	6,71	32,61	4,72	4,47	4,08	3,87	3,69	3,54
0,09	10,0	1,3	6,74	19,79	4,46	4,23	3,86	3,66	3,49	3,34
0,10	10,0	1,4	6,78	14,09	4,24	4,02	3,67	3,48	3,32	3,18
0,11	10,0	1,6	6,81	10,87	4,05	3,85	3,51	3,33	3,18	3,04
0,12	10,0	1,8	6,85	8,80	3,89	3,69	3,37	3,20	3,05	2,92
0,13	10,0	1,9	6,89	7,36	3,75	3,56	3,25	3,08	2,94	2,81
0,14	10,0	2,1	6,92	7,00	3,62	3,44	3,14	2,98	2,84	2,72
0,15	10,0	2,3	6,96	7,00	3,51	3,33	3,04	2,88	2,75	2,63
0,16	10,0	2,5	7,00	7,00	3,41	3,23	2,95	2,80	2,67	2,55
0,17	10,0	2,7	7,04	7,00	3,31	3,14	2,87	2,72	2,60	2,49
0,18	10,0	2,9	7,08	7,00	3,23	3,06	2,80	2,65	2,53	2,42
0,19	10,0	3,1	7,12	7,00	3,15	2,99	2,73	2,59	2,47	2,36
0,20	10,0	3,3	7,16	7,00	3,08	2,92	2,67	2,53	2,41	2,31
0,21	9,8	3,5	7,20	7,00	3,01	2,86	2,61	2,48	2,36	2,26
0,22	9,2	3,5	7,24	7,00	2,95	2,80	2,56	2,43	2,31	2,22
0,23	8,7	3,5	7,28	7,00	2,90	2,75	2,51	2,38	2,27	2,17
0,24	8,2	3,5	7,32	7,00	2,84	2,70	2,46	2,34	2,23	2,13
0,25	7,7	3,5	7,36	7,00	2,79	2,65	2,42	2,30	2,19	2,10
0,26	7,3	3,5	7,40	7,00	2,75	2,61	2,38	2,26	2,15	2,06
0,27	6,9	3,5	7,45	7,00	2,70	2,57	2,34	2,22	2,12	2,03
0,28	6,5	3,5	7,49	7,00	2,66	2,53	2,31	2,19	2,09	2,00
0,29	6,2	3,5	7,53	7,00	2,62	2,49	2,27	2,16	2,06	1,97
0,30	5,8	3,5	7,58	7,00	2,59	2,46	2,24	2,13	2,03	1,94
0,31	5,5	3,5	7,62	7,00	2,55	2,42	2,21	2,10	2,00	1,92
0,32	5,2	3,5	7,67	7,00	2,52	2,39	2,18	2,07	1,97	1,89
0,33	5,0	3,5	7,71	7,00	2,49	2,36	2,16	2,05	1,95	1,87
0,34	4,7	3,5	7,76	7,00	2,46	2,33	2,13	2,02	1,93	1,85
0,35	4,5	3,5	7,81	7,00	2,43	2,31	2,11	2,00	1,91	1,82
0,36	4,3	3,5	7,85	7,00	2,41	2,28	2,08	1,98	1,88	1,80
0,37	4,1	3,5	7,90	7,00	2,38	2,26	2,06	1,96	1,86	1,78
0,38	3,9	3,5	7,95	7,00	2,36	2,23	2,04	1,94	1,85	1,77
0,39	3,7	3,5	8,00	7,00	2,33	2,21	2,02	1,92	1,83	1,75
0,40	3,5	3,5	8,05	7,00	2,31	2,19	2,00	1,90	1,81	1,73
0,41	3,3	3,5	8,10	7,00	2,29	2,17	1,98	1,88	1,79	1,72
0,42	3,2	3,5	8,15	7,00	2,27	2,15	1,96	1,86	1,78	1,70
0,43	3,0	3,5	8,20	7,00	2,25	2,13	1,95	1,85	1,76	1,69
0,44	2,9	3,5	8,26	7,00	2,23	2,12	1,93	1,83	1,75	1,67
0,45	2,7	3,5	8,31	7,00	2,21	2,10	1,92	1,82	1,73	1,66
0,46	2,6	3,5	8,36	7,00	2,20	2,08	1,90	1,80	1,72	1,65
0,47	2,5	3,5	8,42	7,00	2,18	2,07	1,89	1,79	1,71	1,63
0,48	2,3	3,5	8,47	7,00	2,16	2,05	1,87	1,78	1,70	1,62
0,49	2,2	3,5	8,53	7,00	2,15	2,04	1,86	1,77	1,68	1,61
0,50	2,1	3,5	8,59	7,00	2,13	2,02	1,85	1,75	1,67	1,60
0,51	2,0	3,5	8,64	7,00	2,12	2,01	1,84	1,74	1,66	1,59
0,52	1,9	3,5	8,70	7,00	2,11	2,00	1,82	1,73	1,65	1,58
0,53	1,8	3,5	8,76	7,00	2,09	1,99	1,81	1,72	1,64	1,57
0,54	1,7	3,5	8,82	7,00	2,08	1,97	1,80	1,71	1,63	1,56
0,55	1,6	3,5	8,88	7,00	2,07	1,96	1,79	1,70	1,62	1,55
0,56	1,5	3,5	8,94	7,00	2,06	1,95	1,78	1,69	1,61	1,54
0,57	1,4	3,5	9,01	7,00	2,05	1,94	1,77	1,68	1,60	1,54
0,58	1,3	3,5	9,07	7,00	2,04	1,93	1,76	1,67	1,60	1,53
0,59	1,2	3,5	9,13	7,00	2,03	1,92	1,75	1,66	1,59	1,52
0,60	1,2	3,5	9,20	7,00	2,02	1,91	1,75	1,66	1,58	1,51

Tabela IV

TABELA DE FLEXÃO
DIAGRAMA RETANGULAR
CA – 50A

y/d	ε_{sd}	ε_{cd}	Ks	Ks'	Valores de Kc para fck em MPa					
					13,5	15,0	18,0	20,0	22,0	24,0
0,01	10,0	0,1	3,24		13,10	12,43	11,35	10,76	10,26	9,83
0,02	10,0	0,3	3,25		9,29	8,81	8,04	7,63	7,28	6,97
0,03	10,0	0,4	3,27		7,60	7,21	6,58	6,25	5,96	5,70
0,04	10,0	0,5	3,29		6,60	6,26	5,72	5,42	5,17	4,95
0,05	10,0	0,7	3,30		5,92	5,62	5,13	4,86	4,64	4,44
0,06	10,0	0,8	3,32		5,42	5,14	4,69	4,45	4,24	4,06
0,07	10,0	1,0	3,34	88,16	5,03	4,77	4,35	4,13	3,94	3,77
0,08	10,0	1,1	3,35	32,61	4,72	4,47	4,08	3,87	3,69	3,54
0,09	10,0	1,3	3,37	19,79	4,46	4,23	3,86	3,66	3,49	3,34
0,10	10,0	1,4	3,39	14,09	4,24	4,02	3,67	3,48	3,32	3,18
0,11	10,0	1,6	3,41	10,87	4,05	3,85	3,51	3,33	3,18	3,04
0,12	10,0	1,8	3,43	8,80	3,89	3,69	3,37	3,20	3,05	2,92
0,13	10,0	1,9	3,44	7,36	3,75	3,56	3,25	3,08	2,94	2,81
0,14	10,0	2,1	3,46	6,29	3,62	3,44	3,14	2,98	2,84	2,72
0,15	10,0	2,3	3,48	5,48	3,51	3,33	3,04	2,88	2,75	2,63
0,16	10,0	2,5	3,50	4,83	3,41	3,23	2,95	2,80	2,67	2,55
0,17	10,0	2,7	3,52	4,31	3,31	3,14	2,87	2,72	2,60	2,49
0,18	10,0	2,9	3,54	3,87	3,23	3,06	2,80	2,65	2,53	2,42
0,19	10,0	3,1	3,56	3,51	3,15	2,99	2,73	2,59	2,47	2,36
0,20	10,0	3,3	3,58	3,50	3,08	2,92	2,67	2,53	2,41	2,31
0,21	9,8	3,5	3,60	3,50	3,01	2,86	2,61	2,48	2,36	2,26
0,22	9,2	3,5	3,62	3,50	2,95	2,80	2,56	2,43	2,31	2,22
0,23	8,7	3,5	3,64	3,50	2,90	2,75	2,51	2,38	2,27	2,17
0,24	8,2	3,5	3,66	3,50	2,84	2,70	2,46	2,34	2,23	2,13
0,25	7,7	3,5	3,68	3,50	2,79	2,65	2,42	2,30	2,19	2,10
0,26	7,3	3,5	3,70	3,50	2,75	2,61	2,38	2,26	2,15	2,06
0,27	6,9	3,5	3,72	3,50	2,70	2,57	2,34	2,22	2,12	2,03
0,28	6,5	3,5	3,74	3,50	2,66	2,53	2,31	2,19	2,09	2,00
0,29	6,2	3,5	3,77	3,50	2,62	2,49	2,27	2,16	2,06	1,97
0,30	5,8	3,5	3,79	3,50	2,59	2,46	2,24	2,13	2,03	1,94
0,31	5,5	3,5	3,81	3,50	2,55	2,42	2,21	2,10	2,00	1,92
0,32	5,2	3,5	3,83	3,50	2,52	2,39	2,18	2,07	1,97	1,89
0,33	5,0	3,5	3,86	3,50	2,49	2,36	2,16	2,05	1,95	1,87
0,34	4,7	3,5	3,88	3,50	2,46	2,33	2,13	2,02	1,93	1,85
0,35	4,5	3,5	3,90	3,50	2,43	2,31	2,11	2,00	1,91	1,82
0,36	4,3	3,5	3,93	3,50	2,41	2,28	2,08	1,98	1,88	1,80
0,37	4,1	3,5	3,95	3,50	2,38	2,26	2,06	1,96	1,86	1,78
0,38	3,9	3,5	3,98	3,50	2,36	2,23	2,04	1,94	1,85	1,77
0,39	3,7	3,5	4,00	3,50	2,33	2,21	2,02	1,92	1,83	1,75
0,40	3,5	3,5	4,02	3,50	2,31	2,19	2,00	1,90	1,81	1,73
0,41	3,3	3,5	4,05	3,50	2,29	2,17	1,98	1,88	1,79	1,72
0,42	3,2	3,5	4,08	3,50	2,27	2,15	1,96	1,86	1,78	1,70
0,43	3,0	3,5	4,10	3,50	2,25	2,13	1,95	1,85	1,76	1,69
0,44	2,9	3,5	4,13	3,50	2,23	2,12	1,93	1,83	1,75	1,67
0,45	2,7	3,5	4,15	3,50	2,21	2,10	1,92	1,82	1,73	1,66
0,46	2,6	3,5	4,18	3,50	2,20	2,08	1,90	1,80	1,72	1,65
0,47	2,5	3,5	4,21	3,50	2,18	2,07	1,89	1,79	1,71	1,63
0,48	2,3	3,5	4,24	3,50	2,16	2,05	1,87	1,78	1,70	1,62
0,49	2,2	3,5	4,26	3,50	2,15	2,04	1,86	1,77	1,68	1,61
0,50	2,1	3,5	4,29	3,50	2,13	2,02	1,85	1,75	1,67	1,60

Tabela V

TABELA DE FLEXÃO
DIAGRAMA RETANGULAR
CA – 50 B

y/d	ε_{sd}	ε_{cd}	Ks	Ks'	Valores de Kc para fck em MPa					
					13,5	15,0	18,0	20,0	22,0	24,0
0,01	10,0	0,1	3,24		13,10	12,43	11,35	10,76	10,26	9,83
0,02	10,0	0,3	3,25		9,29	8,81	8,04	7,63	7,28	6,97
0,03	10,0	0,4	3,27		7,60	7,21	6,58	6,25	5,96	5,70
0,04	10,0	0,5	3,29		6,60	6,26	5,72	5,42	5,17	4,95
0,05	10,0	0,7	3,30		5,92	5,62	5,13	4,86	4,64	4,44
0,06	10,0	0,8	3,32		5,42	5,14	4,69	4,45	4,24	4,06
0,07	10,0	1,0	3,34	88,16	5,03	4,77	4,35	4,13	3,94	3,77
0,08	10,0	1,1	3,35	32,61	4,72	4,47	4,08	3,87	3,69	3,54
0,09	10,0	1,3	3,37	19,79	4,46	4,23	3,86	3,66	3,49	3,34
0,10	10,0	1,4	3,39	14,09	4,24	4,02	3,67	3,48	3,32	3,18
0,11	10,0	1,6	3,41	10,87	4,05	3,85	3,51	3,33	3,18	3,04
0,12	10,0	1,8	3,43	8,80	3,89	3,69	3,37	3,20	3,05	2,92
0,13	10,0	1,9	3,44	7,36	3,75	3,56	3,25	3,08	2,94	2,81
0,14	10,0	2,1	3,46	6,29	3,62	3,44	3,14	2,98	2,84	2,72
0,15	10,0	2,3	3,48	5,48	3,51	3,33	3,04	2,88	2,75	2,63
0,16	10,0	2,5	3,50	4,86	3,41	3,23	2,95	2,80	2,67	2,55
0,17	10,0	2,7	3,52	4,57	3,31	3,14	2,87	2,72	2,60	2,49
0,18	10,0	2,9	3,54	4,38	3,23	3,06	2,80	2,65	2,53	2,42
0,19	10,0	3,1	3,56	4,24	3,15	2,99	2,73	2,59	2,47	2,36
0,20	10,0	3,3	3,58	4,11	3,08	2,92	2,67	2,53	2,41	2,31
0,21	9,8	3,5	3,60	4,03	3,01	2,86	2,61	2,48	2,36	2,26
0,22	9,2	3,5	3,62	4,00	2,95	2,80	2,56	2,43	2,31	2,22
0,23	8,7	3,5	3,64	3,98	2,90	2,75	2,51	2,38	2,27	2,17
0,24	8,2	3,5	3,66	3,97	2,84	2,70	2,46	2,34	2,23	2,13
0,25	7,7	3,5	3,68	3,95	2,79	2,65	2,42	2,30	2,19	2,10
0,26	7,3	3,5	3,70	3,94	2,75	2,61	2,38	2,26	2,15	2,06
0,27	6,9	3,5	3,72	3,92	2,70	2,57	2,34	2,22	2,12	2,03
0,28	6,5	3,5	3,74	3,91	2,66	2,53	2,31	2,19	2,09	2,00
0,29	6,2	3,5	3,77	3,90	2,62	2,49	2,27	2,16	2,02	1,97
0,30	5,8	3,5	3,79	3,89	2,59	2,46	2,24	2,13	2,03	1,94
0,31	5,5	3,5	3,81	3,88	2,55	2,42	2,21	2,10	2,00	1,92
0,32	5,2	3,5	3,83	3,87	2,52	2,39	2,18	2,07	1,97	1,89
0,33	5,0	3,5	3,86	3,86	2,49	2,36	2,16	2,05	1,95	1,87
0,34	4,7	3,5	3,88	3,85	2,46	2,33	2,13	2,02	1,93	1,85
0,35	4,5	3,5	3,90	3,85	2,43	2,31	2,11	2,00	1,91	1,82
0,36	4,3	3,5	3,93	3,84	2,41	2,28	2,08	1,98	1,88	1,80

Tabela VI

TABELA DE FLEXÃO
DIAGRAMA RETANGULAR
CA – 60B

y/d	εsd	εcd	Ks	Ks'	Valores de Kc para fck em MPa					
					13,5	15,0	18,0	20,0	22,0	24,0
0,01	10,0	0,1	2,70		13,10	12,45	11,35	10,76	10,26	9,83
0,02	10,0	0,3	2,71		9,29	8,81	8,04	7,63	7,28	6,97
0,03	10,0	0,4	2,72		7,60	7,21	6,58	6,25	5,96	5,70
0,04	10,0	0,5	2,74		6,60	6,26	5,72	5,42	5,17	4,95
0,05	10,0	0,7	2,75		5,92	5,62	5,13	4,86	4,64	4,44
0,06	10,0	0,8	2,77		5,42	5,14	4,69	4,45	4,24	4,06
0,07	10,0	1,0	2,78	88,16	5,03	4,77	4,35	4,13	3,94	3,77
0,08	10,0	1,1	2,80	32,61	4,72	4,47	4,08	3,87	3,69	3,54
0,09	10,0	1,3	2,81	19,79	4,46	4,23	3,86	3,66	3,49	3,34
0,10	10,0	1,4	2,82	14,09	4,24	4,02	3,67	3,48	3,32	3,18
0,11	10,0	1,6	2,84	10,87	4,05	3,85	3,51	3,33	3,18	3,04
0,12	10,0	1,8	2,85	8,80	3,89	3,69	3,37	3,20	3,05	2,92
0,13	10,0	1,9	2,87	7,36	3,75	3,56	3,25	3,08	2,94	2,81
0,14	10,0	2,1	2,89	6,29	3,62	3,44	3,14	2,98	2,84	2,72
0,15	10,0	2,3	2,90	5,48	3,51	3,33	3,04	2,88	2,75	2,63
0,16	10,0	2,5	2,92	4,83	3,41	3,23	2,95	2,80	2,67	2,55
0,17	10,0	2,7	2,93	4,31	3,31	3,14	2,87	2,72	2,60	2,49
0,18	10,0	2,9	2,95	3,95	3,23	3,06	2,80	2,65	2,53	2,42
0,19	10,0	3,1	2,97	3,75	3,15	2,99	2,73	2,59	2,47	2,36
0,20	10,0	3,3	2,98	3,61	3,08	2,92	2,67	2,53	2,41	2,31
0,21	9,8	3,5	3,00	3,52	3,01	2,86	2,61	2,48	2,36	2,26
0,22	9,2	3,5	3,01	3,49	2,95	2,80	2,56	2,43	2,31	2,22
0,23	8,7	3,5	3,03	3,47	2,90	2,75	2,51	2,38	2,27	2,17
0,24	8,2	3,5	3,05	3,45	2,84	2,70	2,46	2,34	2,23	2,13
0,25	7,7	3,5	3,07	3,43	2,79	2,65	2,42	2,30	2,19	2,10
0,26	7,3	3,5	3,08	3,42	2,75	2,61	2,38	2,26	2,15	2,06
0,27	6,9	3,5	3,10	3,41	2,70	2,57	2,34	2,22	2,12	2,03
0,28	6,5	3,5	3,12	3,39	2,66	2,53	2,31	2,19	2,09	2,00
0,29	6,2	3,5	3,14	3,38	2,62	2,49	2,27	2,16	2,06	1,97
0,30	5,8	3,5	3,16	3,37	2,59	2,46	2,24	2,13	2,03	1,94
0,31	5,5	3,5	3,18	3,36	2,55	2,42	2,21	2,10	2,00	1,92
0,32	5,2	3,5	3,19	3,35	2,52	2,39	2,18	2,07	1,97	1,89
0,33	5,0	3,5	3,21	3,35	2,49	2,36	2,16	2,05	1,95	1,87
0,34	4,7	3,5	3,23	3,34	2,46	2,33	2,13	2,02	1,93	1,85
0,35	4,5	3,5	3,25	3,33	2,43	2,31	2,11	2,00	1,91	1,82

TABELAS PARA CÁLCULOS DIRETO DE SEÇÕES RETANGULARES SUBMETIDAS A FLEXÃO RETA

1 As tabelas foram elaboradas de acordo com a NBR 6118/82, e ser vem para o cálculo direto do número de barras em uma seção retangular de concreto armado (diagrama retangular).

2 As tabelas prevêem 4 valores de f_{ck}, e foram feitas para o aço CA-50-A e com b_ω=10; 12; 15; 17; 20; 22; 25 e 30cm respectivamente.

3 Deve-se entrar nas tabelas com o momento característico M (sem majoração)

4 Unidades

Momento M - KNm

Altura total h - cm

Largura b - cm

Diâmetro da armadura ϕ - mm

Resistência característica do concreto f_{ck} - MPa

5 Coeficientes e valores embutidos

γ_f=1,4 ; γ_c=1,4 ; γ_s=1,15

c=1,5cm

ω=0,3mm

$A_{smin} = 0{,}0015\, b_\omega h$

$\phi_e = 6{,}0$mm

5% h

espaçamento entre as barras e_h=3cm, e_v=2cm.

6 Exemplo de aplicação

M = 104,3KNm; b_ω=20cm; h =50 cm

f_{ck} = 15 MPa ; CA-50-A

Entrando na tabela para o f_{ck}=15 MPa e b_ω=20 na coluna correspondente a h=50 tiramos 3ϕ20mm.

A solução obtida na tabela satisfaz a NBR 6118/82 no que concerne a fissuração ($\omega \leq 0,3mm$), $5\%\ h$, A_{smin}.

O centro de gravidade da armadura foi determinado com C=1,5 cm (cobrimento), ϕ_e=6,0 (diâmetro do estribo), $e_h \geq 3cm$ e $e_v \geq 2cm$, $e_v \geq \phi$.

Tabela I

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR $b_\omega = 10$ CA-50A $f_{ck} = 13.5$MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		6.5	8.9	11.3	13.8	16.2	18.7	21.1	23.5	26.0	28.4							
10.0	3					18.4	22.1	25.7	29.4	33.0	36.7	40.4	44.0	47.7	51.3	55.0	58.6	62.3	
10.0	4							31.8	36.7	41.5	46.4	51.3	56.2	61.0	65.9	70.8	75.7	80.6	85.4
10.0	5										54.5	60.5	66.6	72.7	78.8	84.9	91.0	97.1	103.2
10.0	6													83.3	90.6	97.9	105.2	112.5	119.9
10.0	7																117.7	126.3	134.8
12.5	2				15.8	19.6	23.5	27.3	31.1	34.9	38.7	42.5	46.3	50.1	53.9				
12.5	3							35.9	41.6	47.4	53.1	58.8	64.5	70.2	75.9	81.7	87.4	93.1	98.8
12.5	4										65.0	72.6	80.2	87.9	95.5	103.1	110.7	118.3	126.0
12.5	5													101.8	111.3	120.8	130.3	139.9	149.4
12.5	6															136.0	147.5	158.9	170.3
12.5	7																		187.6

Tabela II

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR $b_\omega = 12$ CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		6.8	9.2	11.7	14.1	16.6	19.0	21.4										
10.0	3					19.2	22.8	26.5	30.1	33.8	37.5	41.1	44.8	48.4	52.1				
10.0	4							33.1	38.0	42.9	47.8	52.6	57.5	62.4	67.3	72.2	77.0	81.9	86.8
10.0	5										56.5	62.6	68.7	74.8	80.9	87.0	93.1	99.2	105.3
10.0	6													86.3	93.6	101.0	108.3	115.6	122.9
10.0	7																121.9	130.4	139.0
12.5	2			12.8	16.7	20.5	24.3	28.1	31.9	35.7	39.5	43.3							
12.5	3						32.1	37.8	43.5	49.2	54.9	60.7	66.4	72.1	77.8	83.5	89.2	95.0	100.7
12.5	4								53.1	60.7	68.3	75.9	83.5	91.2	98.8	106.4	114.0	121.7	129.3
12.5	5											87.9	97.4	106.9	116.5	126.0	135.5	145.0	154.6
12.5	6														132.1	143.5	154.9	166.4	177.8
12.5	7																		197.9
16.0	2						35.2	41.5	47.7	54.0	60.2	66.5	72.7	78.9	85.2				
16.0	3										79.7	89.1	98.5	107.8	117.2	126.6	135.9	145.3	154.7
16.0	4														143.7	156.2	168.7	181.1	193.6
16.0	5																	209.2	224.8
20.0	2										83.9	93.7	103.4	113.2	123.0	132.7	142.5	152.2	162.0
20.0	3																189.5	204.1	218.7

Tabela III

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 15 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.1	9.6	12.0	14.5	16.9												
10.0	3		9.7	13.3	17.0	20.7	24.3	28.0	31.6	35.3	39.0	42.6							
10.0	4				20.6	25.5	30.3	35.2	40.1	45.0	49.9	54.7	59.6	64.5	69.4	74.2			
10.0	5					29.6	35.7	41.8	47.9	54.0	60.1	66.2	72.3	78.4	84.5	90.6	96.7	102.8	108.9
10.0	6							47.7	55.0	62.3	69.6	79.6	84.2	91.6	98.9	106.2	113.5	120.8	128.2
10.0	7									69.2	77.7	86.3	94.8	103.4	111.9	120.4	129.0	137.5	146.0
10.0	8											95.0	104.7	114.5	124.2	134.0	143.7	153.5	163.3
10.0	9													124.9	135.9	146.9	157.8	168.8	179.8
10.0	10															158.3	170.5	182.7	194.9
12.5	2		9.9	13.7	17.5	21.3	25.1	28.9	32.7										
12.5	3				23.7	29.5	35.2	40.9	46.6	52.3	58.0	63.8	69.5	75.2	80.9				
12.5	4						42.4	50.0	57.6	65.2	72.8	80.5	88.1	95.7	103.3	111.0	118.6	126.2	133.8
12.5	5								66.9	76.5	86.0	95.5	105.0	114.6	124.1	133.6	143.2	152.7	162.2
12.5	6										97.5	108.9	120.3	131.8	143.2	154.7	166.1	177.5	189.0
12.5	7												132.8	146.1	159.4	172.8	186.1	199.5	212.8
12.5	8													158.8	174.0	189.3	204.5	219.7	235.0
12.5	9															204.1	221.2	238.4	255.5
12.5	10																	254.1	273.2
16.0	2					31.2	37.5	43.7	49.9	56.2	62.4	68.7							
16.0	3								68.3	77.6	87.0	96.3	105.7	115.1	124.4	133.8	143.2	152.5	161.9
16.0	4											117.3	129.8	142.3	154.8	167.3	179.8	192.3	204.8
16.0	5														180.7	196.3	211.9	227.6	243.2
16.0	6																239.7	258.4	277.1
20.0	2								69.8	79.6	89.4	99.1	108.9	118.6	128.4				
20.0	3													157.8	172.4	187.0	201.7	216.3	230.9
20.0	4																	264.1	283.6
25.0	2													165.5	180.8	196.0	211.3	226.5	241.8

Tabela IV

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 17 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.3	9.7	12.2	14.6													
10.0	3		10.0	13.7	17.4	21.0	24.7	28.3	32.0	35.7									
10.0	4				21.2	26.1	31.0	35.9	40.7	45.6	50.5	55.4	60.2	65.1					
10.0	5					30.6	36.7	42.8	48.9	55.0	61.1	67.2	73.3	79.4	85.5	91.6	97.7	103.8	
10.0	6							49.1	56.4	63.7	71.0	78.4	85.7	93.0	100.3	107.6	115.0	122.3	129.6
10.0	7									71.2	79.7	88.2	96.8	105.3	113.8	122.4	130.9	139.5	148.0
10.0	8											97.5	107.3	117.0	126.8	136.5	146.3	156.1	165.8
10.0	9													128.1	139.1	150.1	161.	172.0	183.0
10.0	10															162.3	174.5	186.7	198.9
12.5	2		10.2	14.1	17.9	21.7	25.5	29.3											
12.5	3				24.6	30.3	36.1	41.8	47.5	53.2	58.9	64.6	70.4						
12.5	4					36.3	43.9	51.5	59.2	66.8	74.4	82.0	89.6	97.3	104.9	112.5	120.1		
12.5	5							59.8	69.4	78.9	88.4	98.0	107.5	117.0	126.5	136.1	145.6	155.1	164.6
12.5	6									89.6	101.0	112.4	123.9	135.3	146.7	158.2	169.6	181.0	192.5
12.5	7										110.9	124.2	137.5	150.9	164.2	177.5	190.9	204.2	217.6
12.5	8												149.7	165.0	180.2	195.5	210.7	226.0	241.2
12.5	9														194.8	212.0	229.1	246.3	263.4
12.5	10																	263.8	282.9
16.0	2				26.0	32.2	38.5	44.7	51.0	57.2									
16.0	3							61.2	70.6	80.0	89.3	98.7	108.1	117.4	126.8	136.2			
16.0	4									96.5	109.0	121.5	134.0	146.5	159.0	171.5	184.0	196.4	208.9
16.0	5												156.0	171.6	187.2	202.9	218.5	234.1	249.7
16.0	6														211.6	230.3	249.1	267.8	286.5
16.0	7																	295.3	317.2
20.0	2							62.6	72.4	82.1	91.9	101.7	111.4						
20.0	3											138.1	152.8	167.4	182.0	196.7	211.3	225.9	240.6
20.0	4															239.2	258.7	278.2	297.7
25.0	2											141.3	156.5	171.8	187.0	202.2	217.5		
25.0	3																		329.3

Tabela V

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 20 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.5	9.9	12.4														
10.0	3		10.4	14.1	17.8	21.4	25.1	28.7											
10.0	4		12.9	17.8	22.7	27.5	32.4	37.3	42.2	47.1	51.9	56.8							
10.0	5			20.2	26.3	32.4	38.5	44.6	50.7	56.8	62.9	69.0	75.1	81.2	87.3				
10.0	6					36.8	44.1	51.4	58.8	66.1	73.4	80.7	88.0	95.3	102.7	110.0	117.3	124.6	
10.0	7						49.2	57.7	66.3	74.8	83.4	91.9	100.4	109.0	117.5	126.0	134.6	143.1	151.7
10.0	8							63.5	73.3	83.1	92.8	102.6	112.3	122.1	131.8	141.6	151.4	161.1	170.9
10.0	9									90.1	101.0	112.0	123.0	134.0	144.9	155.9	166.9	177.9	188.8
10.0	10										108.7	120.9	133.1	145.3	157.5	169.7	181.9	194.1	206.3
12.5	2		10.7	14.5	18.3	22.1	25.9												
12.5	3			19.9	25.6	31.3	37.0	42.8	48.5	54.2	59.9								
12.5	4				31.7	39.3	46.9	54.5	62.1	69.8	77.4	85.0	92.6	100.3	107.9				
12.5	5						54.3	63.8	73.3	82.9	92.4	101.9	111.5	121.0	130.5	140.0	149.6	159.1	168.6
12.5	6							71.9	83.3	94.7	106.2	117.6	129.0	140.5	151.9	163.3	174.8	186.2	197.6
12.5	7								92.0	105.4	118.7	132.0	145.4	158.7	172.0	185.4	198.7	212.1	225.4
12.5	8										130.0	145.2	160.5	175.7	191.0	206.2	221.4	236.7	251.9
12.5	9											155.9	173.1	190.2	207.4	224.5	241.7	258.8	276.0
12.5	10													203.5	222.6	241.6	260.7	279.7	298.8
16.0	2			20.9	27.2	33.4	39.7	45.9	52.2										
16.0	3					45.1	54.5	63.9	73.2	82.6	92.0	101.3	110.7	120.1					
16.0	4								91.0	103.5	116.0	128.5	141.0	153.4	165.9	178.4	190.9	203.4	215.9
16.0	5										134.4	150.0	165.6	181.2	196.8	212.5	228.1	243.7	259.3
16.0	6												187.0	205.7	224.4	243.2	261.9	280.6	299.4
16.0	7														248.7	270.5	292.4	314.2	336.1
16.0	8																319.5	344.5	369.5
20.0	2						55.7	65.5	75.3	85.0	94.8								
20.0	3									115.3	130.0	144.6	159.2	173.9	188.5	203.1	217.8		
20.0	4													211.7	231.2	250.7	270.2	289.7	309.2
20.0	5																314.5	338.9	363.3
25.0	2										133.0	148.3	163.5	178.8					
25.0	3															284.1	307.0	329.8	352.7

Tabela VI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 22 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.6	10.0															
10.0	3		10.7	14.3	18.0	21.6	25.3												
10.0	4		13.3	18.2	23.0	27.9	32.8	37.7	42.6	47.4									
10.0	5			21.5	27.6	33.7	39.8	45.9	52.0	58.1	64.2	70.3	76.4						
10.0	6				31.1	38.4	45.7	53.0	60.3	67.6	75.0	82.3	89.6	96.9	104.2	111.5			
10.0	7				34.0	42.5	51.1	59.6	68.2	76.7	85.2	93.8	102.3	110.8	119.4	127.9	136.4	145.0	153.3
10.0	8					46.2	56.0	65.8	75.5	85.3	95.0	104.8	114.5	124.3	134.1	143.8	153.6	163.3	173.1
10.0	9						60.5	71.4	82.4	93.4	104.4	115.3	126.3	137.3	148.3	159.3	170.2	181.2	192.2
10.0	10							76.7	88.9	101.1	113.3	125.4	137.6	149.8	162.0	174.2	186.4	198.6	210.8
12.5	2		10.9	14.7	18.5	22.3													
12.5	3			20.4	26.1	31.8	37.5	43.3	49.0										
12.5	4				32.6	40.2	47.8	55.4	63.0	70.7	78.3	85.9	93.5						
12.5	5					46.2	55.7	65.2	74.8	84.3	93.8	103.3	112.9	122.4	131.9	141.4	151.0		
12.5	6						62.5	73.9	85.3	96.8	108.2	119.6	131.1	142.5	153.9	165.4	176.8	188.2	199.7
12.5	7								94.8	108.1	121.5	134.8	148.1	161.5	174.8	188.1	201.5	214.8	228.2
12.5	8									118.3	133.6	148.8	164.1	179.3	194.6	209.8	225.1	240.3	255.5
12.5	9										143.4	160.5	177.7	194.8	212.0	229.1	246.3	263.4	280.6
12.5	10											171.0	190.1	209.2	228.2	247.3	266.3	285.4	304.4
16.0	2			21.5	27.8	34.0	40.3	46.5											
16.0	3					46.5	55.9	65.2	74.6	84.0	93.3	102.7							
16.0	4							80.9	93.4	105.9	118.4	130.9	143.4	155.9	168.4	180.8	193.3		
16.0	5									122.6	138.2	153.8	169.4	185.0	200.6	216.2	231.8	247.5	263.1
16.0	6											173.7	192.4	211.1	229.9	248.6	267.3	286.1	304.8
16.0	7													234.2	256.1	277.9	299.8	321.7	343.5
16.0	8															304.3	329.2	354.2	379.2
16.0	9																	381.5	409.6
20.0	2					47.5	57.2	67.0	76.7	86.5									
20.0	3								104.0	118.7	133.3	147.9	162.6	177.2	191.8				
20.0	4											182.4	202.0	221.5	241.0	260.5	280.0	299.5	319.0
20.0	5														278.9	303.2	327.6	352.0	376.4
20.0	6																	397.1	426.4
25.0	2									121.4	136.6	151.9							
25.0	3													246.5	269.4	292.2	315.1	338.0	360.8
25.0	4																		437.4

Tabela VII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 25 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.7	10.1															
10.0	3		10.9	14.6	18.2	21.9													
10.0	4		13.7	18.6	23.5	28.4	33.2	38.1	43.0										
10.0	5		16.1	22.2	28.3	34.4	40.5	46.6	52.7	58.8	64.9	71.0							
10.0	6			24.7	32.1	39.4	46.7	54.0	61.3	68.5	76.0	83.3	90.6	97.9					
10.0	7				35.4	43.9	52.4	61.0	69.5	78.0	86.6	95.1	103.7	112.2	120.7	129.3	137.8		
10.0	8					48.0	57.8	67.5	77.3	87.0	96.8	106.6	116.3	126.1	135.8	145.6	155.3	165.1	174.9
10.0	9						62.7	73.7	84.7	95.6	106.6	117.6	128.6	139.5	150.5	161.5	172.5	183.4	194.4
10.0	10							79.4	91.6	103.3	116.0	128.2	140.4	152.6	164.8	177.0	189.2	201.4	213.6
12.5	2		11.2	15.0	18.8														
12.5	3		15.3	21.0	26.7	32.4	38.2	43.9											
12.5	4			26.0	33.6	41.3	48.9	56.5	64.1	71.8	79.4								
12.5	5				39.6	49.1	58.6	68.2	77.7	87.2	96.7	106.3	115.8	125.3	134.8				
12.5	6					54.7	66.1	77.6	89.0	100.4	111.9	123.3	134.7	146.2	157.6	169.0	180.5	191.9	
12.5	7						72.7	86.0	99.3	112.7	126.0	139.3	152.7	166.0	179.4	192.7	206.0	219.4	232.7
12.5	8								108.7	123.9	139.2	154.4	169.6	184.9	200.1	215.4	230.6	245.9	261.1
12.5	9									134.2	151.3	168.5	185.6	202.8	219.9	237.1	254.2	271.4	288.5
12.5	10										162.5	181.5	200.6	219.6	238.7	257.8	276.8	295.9	314.9
16.0	2		16.0	22.3	28.5	34.8	41.0												
16.0	3				38.8	48.1	57.5	66.9	76.2	85.6	95.0								
16.0	4						71.4	83.8	96.3	108.8	121.3	133.8	146.3	158.8	171.3				
16.0	5								113.8	129.4	145.0	160.6	176.2	191.8	207.4	223.0	238.6	254.2	269.9
16.0	6									145.0	163.7	182.5	201.2	219.9	238.7	257.4	276.1	294.9	313.6
16.0	7											201.7	223.5	245.4	267.2	289.1	310.9	332.8	354.7
16.0	8													268.2	293.2	318.1	343.1	368.1	393.1
16.0	9															344.5	372.6	400.7	428.8
16.0	10																399.4	430.7	461.9
20.0	2				39.5	49.2	59.0	68.8											
20.0	3							93.4	108.0	122.6	137.3	151.9	166.5						
20.0	4										170.0	189.5	209.1	228.6	248.1	267.6	287.1	306.6	
20.0	5													265.5	289.9	314.3	338.7	363.1	387.5
20.0	6															354.6	383.8	413.1	442.4
20.0	7																		490.7
25.0	2							95.2	110.5	125.7	141.0								
25.0	3												233.4	256.2	279.1	302.0	324.8		
25.0	4																401.4	431.8	462.3

Tabela VIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 30 CA-50A f_{ck} = 13.5MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.8																
10.0	3		11.2	14.9	18.5														
10.0	4		14.3	19.1	24.0	28.9	33.8												
10.0	5		17.0	23.1	29.2	35.3	41.4	47.5	53.6										
10.0	6		19.4	26.7	34.0	41.3	48.6	56.0	63.3	70.6	77.9	85.2							
10.0	7			29.9	38.5	47.0	55.6	64.1	72.6	81.2	89.7	98.2	106.8	115.3					
10.0	8				41.9	51.7	61.4	71.2	80.9	90.7	100.4	110.2	119.9	129.7	139.5	149.2			
10.0	9				45.0	55.9	66.9	77.9	88.9	99.8	110.8	121.8	132.8	143.8	154.7	165.7	176.7	187.7	
10.0	10					59.9	72.1	84.3	96.5	108.7	120.9	133.1	145.3	157.5	169.7	181.9	194.0	206.2	218.4
12.5	2		11.5	15.3															
12.5	3		16.0	21.7	27.5	33.2	38.9												
12.5	4		19.7	27.3	35.0	42.6	50.2	57.8	65.5										
12.5	5			32.1	41.6	51.2	60.7	70.2	79.7	89.3	98.8	108.3							
12.5	6				47.5	58.9	70.4	81.8	93.2	104.7	116.1	127.5	139.0	150.4	161.8				
12.5	7					64.6	77.9	91.3	104.6	118.0	131.3	144.6	158.0	171.3	184.7	198.0	211.3		
12.5	8						84.7	100.1	115.2	130.4	145.7	160.9	176.2	191.4	206.7	221.9	237.2	252.4	267.6
12.5	9							107.8	124.9	142.1	159.2	176.4	193.5	210.7	227.8	245.0	262.1	279.3	296.4
12.5	10								133.9	152.9	172.0	191.0	210.1	229.1	248.2	267.3	286.3	305.4	324.4
16.0	2		16.9	23.2	29.4														
16.0	3			31.4	40.8	50.1	59.5	68.9	78.2										
16.0	4					62.4	74.9	87.4	99.9	112.4	124.9	137.3							
16.0	5						88.1	103.7	119.3	134.9	150.5	166.1	181.7	197.4	213.0				
16.0	6								136.5	155.2	174.0	192.7	211.4	230.2	248.9	267.6	286.4	305.1	323.8
16.0	7									171.1	192.9	214.8	236.7	258.5	280.4	302.2	324.1	345.9	267.8
16.0	8											234.7	259.7	284.6	309.6	334.6	359.6	384.5	409.5
16.0	9												280.4	308.5	336.6	364.7	392.8	420.9	449.0
16.0	10														361.4	392.7	423.9	455.1	486.3
20.0	2				41.7	51.4	61.2												
20.0	3						83.6	98.3	112.9	127.5	142.2								
20.0	4								139.7	159.2	178.7	198.2	217.7	237.2	256.8				
20.0	5										209.8	234.2	258.6	283.0	307.4	331.8	356.2	380.6	405.0
20.0	6													319.4	348.7	378.0	407.2	436.5	465.8
20.0	7															418.8	452.9	487.1	521.2
20.0	8																	532.2	571.2
25.0	2						85.3	100.5	115.8										
25.0	3										199.5	222.4	245.3	268.1					
25.0	4													331.1	361.5	392.0	422.5	453.0	483.5
25.0	5																495.1	533.2	571.3

Tabela IX

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 10 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		6.7	9.1	11.5	14.0	16.4	18.9	21.3	23.7	26.2								
10.0	3					18.9	22.5	26.2	29.8	33.5	37.2	40.8	44.5	48.1	51.8	55.4	59.1	62.8	
10.0	4							32.6	37.5	42.3	47.2	52.1	57.0	61.9	66.7	71.6	76.5	81.4	86.2
10.0	5										55.6	61.7	67.8	73.9	80.0	86.1	92.2	98.3	104.4
10.0	6													85.1	92.4	99.7	107.1	114.4	121.7
10.0	7																120.2	128.8	137.3
12.5	2				16.3	20.1	23.9	27.8	31.6	35.4	39.2	43.0	46.8	50.6					
12.5	3						31.3	37.0	42.8	48.5	54.2	59.9	65.6	71.3	77.1	82.8	88.5	94.2	99.9
12.5	4									59.4	67.0	74.6	82.2	89.8	97.5	105.1	112.7	120.3	128.0
12.5	5											85.8	95.3	104.9	114.4	123.9	133.4	143.0	152.5
12.5	6														129.1	140.5	151.9	163.4	174.8
12.5	7																		193.7

Tabela X

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 12 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.0	9.4	11.8	14.3	16.7	19.2	21.6										
10.0	3					19.5	23.2	26.9	30.5	34.2	37.8	41.5	45.2	48.8	52.5				
10.0	4							33.8	38.7	43.6	48.4	53.3	58.2	63.1	68.0	72.8	77.7	82.6	87.5
10.0	5										57.5	63.6	69.7	75.8	81.9	88.0	94.1	100.2	106.3
10.0	6													87.8	95.2	102.5	109.8	117.1	124.4
10.0	7																124.0	132.5	141.0
12.5	2			13.3	17.1	20.9	24.7	28.5	32.3	36.1	39.9	43.7							
12.5	3					27.3	33.0	38.7	44.4	50.2	55.9	61.6	67.3	73.0	78.7	84.5	90.2	95.9	
12.5	4								54.7	62.3	70.0	77.6	85.2	92.8	100.4	108.1	115.7	123.3	130.9
12.5	5											90.5	100.0	109.5	119.0	128.6	138.1	147.6	157.2
12.5	6														135.8	147.2	158.6	170.1	181.5
12.5	7																		202.8
16.0	2					30.1	36.3	42.6	48.8	55.1	61.3	67.6	73.8	80.1	86.3				
16.0	3									72.9	82.2	91.6	101.0	110.3	119.7	129.1	138.4	147.8	152.2
16.0	4												123.1	135.6	148.1	160.6	173.1	185.6	198.1
16.0	5																200.5	216.1	231.7
20.0	2									76.9	86.6	96.4	106.2	115.9	125.7	135.4	145.2	154.9	164.7
20.0	3														166.3	180.9	195.6	210.2	224.8

Tabela XI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 15 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.3	9.7	12.1	14.6	17.0												
10.0	3		10.0	13.6	17.3	21.0	24.6	28.3	31.9	35.5	39.3								
10.0	4				21.1	26.0	30.9	35.8	40.6	45.5	50.4	55.3	60.1	65.0	69.9	74.8			
10.0	5					30.4	36.5	42.6	48.7	54.8	60.9	67.0	73.1	79.2	85.3	91.4	97.5	103.6	109.7
10.0	6							48.9	56.2	63.5	70.8	78.2	85.5	92.8	100.1	107.4	114.7	122.1	129.4
10.0	7									70.9	79.4	87.9	96.5	105.0	113.6	122.1	130.6	139.2	147.7
10.0	8											97.1	106.9	116.6	126.4	136.2	145.9	155.7	165.4
10.0	9													127.7	138.6	149.6	160.6	171.6	182.5
10.0	10															161.7	173.9	186.1	198.3
12.5	2		10.2	14.0	17.8	21.6	25.4	29.2	33.1										
12.5	3				24.5	30.2	35.9	41.6	47.4	53.1	58.8	64.5	70.2	75.9					
12.5	4					36.1	43.7	51.3	58.9	66.5	74.2	81.8	89.4	97.0	104.7	112.3	119.9	127.5	135.1
12.5	5							59.5	69.0	78.5	88.1	97.6	107.1	116.6	126.2	135.7	145.2	154.8	164.3
12.5	6									89.0	100.5	111.9	123.3	134.8	146.2	157.6	169.1	180.5	191.9
12.5	7										110.1	123.5	136.8	150.2	163.5	176.8	190.2	203.5	216.8
12.5	8												148.8	164.1	179.3	194.5	209.8	225.0	240.3
12.5	9														193.6	210.8	227.9	245.1	262.2
12.5	10																	262.4	281.4
16.0	2				25.9	32.1	38.3	44.6	50.8	57.1	63.3	69.6							
16.0	3							60.9	70.2	79.6	89.0	98.3	107.7	117.1	126.4	135.8	145.2	154.5	
16.0	4									95.9	108.4	120.9	133.4	145.9	158.4	170.8	183.3	195.8	208.3
16.0	5												155.0	170.7	186.3	201.9	217.5	233.1	248.7
16.0	6															228.9	247.7	266.4	285.1
16.0	7																	293.4	315.3
20.0	2							62.2	72.0	81.8	91.5	101.3	111.0	120.8	130.5				
20.0	3											133.4	148.0	162.6	177.3	191.9	206.6	221.2	235.8
20.0	4															233.8	253.3	272.8	292.3
25.0	2												155.6	170.8	186.1	201.3	216.6	231.8	247.0
25.0	3																		327.2

Tabela XII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_{ω} = 17 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.4	9.9	12.3	14.7													
10.0	3		10.3	14.0	17.6	21.3	24.9	28.6	32.3	35.9									
10.0	4				21.7	26.6	31.5	36.3	41.2	46.1	51.0	55.8	60.7	65.6					
10.0	5					31.3	37.4	43.5	49.6	55.7	61.8	67.9	74.0	80.1	86.2	92.3	98.4	104.5	
10.0	6							50.2	57.5	64.8	72.1	79.4	86.8	94.1	101.4	108.7	116.0	123.3	130.7
10.0	7									72.6	81.2	89.7	98.2	106.8	115.3	123.8	132.4	140.9	149.5
10.0	8											99.4	109.2	118.9	128.7	138.4	148.2	158.0	167.7
10.0	9													130.6	141.5	152.5	163.5	174.5	185.4
10.0	10															165.3	177.5	189.7	201.9
12.5	2		10.5	14.4	18.2	22.0	25.8	29.6											
12.5	3			19.6	25.3	31.0	36.7	42.4	48.1	53.9	59.6	65.3	71.0						
12.5	4					37.5	45.1	52.7	60.3	67.9	75.6	83.2	90.8	98.4	106.1	113.7	121.3		
12.5	5						52.1	61.7	71.2	80.7	90.2	99.8	109.3	118.8	128.4	137.9	147.4	156.9	166.5
12.5	6								80.7	92.2	103.6	115.0	126.5	137.9	149.3	160.8	172.2	183.6	195.1
12.5	7										114.4	127.8	141.1	154.4	167.8	181.1	194.5	207.8	221.1
12.5	8												154.4	169.7	184.9	200.1	215.4	230.6	245.9
12.5	9														200.7	217.9	235.0	252.2	269.3
12.5	10																	271.1	290.2
16.0	2				26.8	33.0	39.3	45.5	51.8	58.0									
16.0	3						53.6	63.0	72.4	81.7	91.1	100.5	109.8	119.2	128.6	137.9			
16.0	4								87.2	99.7	112.2	124.7	137.1	149.6	162.1	174.6	187.1	199.6	212.1
16.0	5											145.3	160.9	176.5	192.1	207.8	223.4	239.0	254.6
16.0	6													199.9	218.6	237.4	256.1	274.8	293.6
16.0	7															261.2	283.1	304.9	326.8
16.0	8																		356.5
20.0	2						54.8	64.5	74.3	84.1	93.8	103.6	113.3						
20.0	3										127.8	142.4	157.1	171.7	186.3	201.0	215.6	230.3	244.9
20.0	4													207.8	227.3	246.9	266.4	285.9	305.4
20.0	5																	332.9	357.3
25.0	2										130.7	145.9	161.2	176.4	191.7	206.9			
25.0	3																294.1	317.0	339.8

Tabela XIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 20 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.6	10.0	12.5														
10.0	3		10.7	14.3	18.0	21.7	25.3	29.0											
10.0	4		13.3	18.2	23.1	28.0	32.8	37.7	42.6	47.5	52.3								
10.0	5			20.9	27.0	33.1	39.2	45.3	51.4	57.5	63.6	69.7	75.8	81.8	87.9				
10.0	6					37.7	45.0	52.4	59.7	67.0	74.3	81.6	88.9	96.3	103.6	110.9	118.2	125.5	
10.0	7						50.5	59.0	67.5	76.1	84.6	93.1	101.7	110.2	118.8	127.3	135.8	144.4	152.9
10.0	8							65.2	74.9	84.7	94.4	104.2	114.0	123.7	133.5	143.2	153.0	162.7	172.5
10.0	9									92.1	103.1	114.1	125.0	136.0	147.0	158.0	169.0	179.9	190.9
10.0	10										111.3	123.5	135.7	147.9	160.1	172.3	184.5	196.7	208.9
12.5	2		10.9	14.7	18.6	22.4													
12.5	3			20.4	26.2	31.9	37.6	43.3	49.0	54.7									
12.5	4				32.6	40.3	47.9	55.5	63.1	70.8	78.4	86.0	93.6	101.2					
12.5	5					46.3	55.8	65.4	74.9	84.4	93.9	103.5	113.0	122.5	132.1	141.6	151.1	160.6	
12.5	6						62.7	74.1	85.5	97.0	108.4	119.8	131.3	142.7	154.1	165.6	177.0	188.4	199.9
12.5	7							81.7	95.1	108.4	121.7	135.1	148.4	161.7	175.1	188.4	201.8	215.1	228.4
12.5	8									118.7	133.9	149.2	164.4	179.7	194.9	210.2	225.4	240.7	255.9
12.5	9										143.8	161.0	178.1	195.3	212.4	229.6	246.7	263.9	281.0
12.5	10											171.6	190.7	209.7	228.8	247.8	266.9	285.9	305.0
16.0	2			21.6	27.8	34.1	40.3	46.6	52.8										
16.0	3					46.6	56.0	65.4	74.7	84.1	93.5	102.8	112.2	121.6					
16.0	4							81.2	93.7	106.2	118.6	131.1	143.6	156.1	168.6	181.1	193.6	206.1	
16.0	5									123.0	138.6	154.2	169.8	185.4	201.0	216.6	232.2	247.8	263.4
16.0	6											174.2	193.0	211.7	230.4	249.1	267.9	286.6	305.3
16.0	7													235.0	256.8	278.7	300.5	322.4	344.2
16.0	8															305.2	330.2	355.2	280.2
16.0	9																	382.7	410.8
20.0	2					47.6	57.4	67.1	76.9	86.6	96.4								
20.0	3								104.3	119.0	133.6	148.3	162.9	177.5	192.2	206.8	221.4		
20.0	4											179.1	198.6	218.2	237.7	257.2	276.7	296.2	315.7
20.0	5														275.9	300.3	324.7	349.0	373.4
20.0	6																	394.6	423.8
25.0	2								106.5	121.8	137.0	152.2	167.5	182.7					
25.0	3													247.3	270.2	293.0	315.9	338.8	361.6
25.0	4																		438.8

Tabela XIV

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 22 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.7	10.1															
10.0	3		10.9	14.5	18.2	21.8	25.5												
10.0	4		13.7	18.5	23.4	28.3	33.2	38.0	42.9	47.8									
10.0	5		16.0	22.1	28.2	34.3	40.4	46.5	52.6	58.7	64.8	70.9	77.0						
10.0	6			24.6	31.9	39.2	46.5	53.8	61.2	68.5	75.8	83.1	90.4	97.7	105.1	112.4			
10.0	7				35.1	43.7	52.2	60.7	69.3	77.8	86.4	94.9	103.4	112.0	120.5	129.0	137.6	146.1	154.7
10.0	8					47.7	57.5	67.2	77.0	86.8	96.5	106.3	116.0	125.8	135.5	145.3	155.0	164.8	174.6
10.0	9						62.3	73.3	84.3	95.3	106.2	117.2	128.2	139.2	150.1	161.1	172.1	183.1	194.1
10.0	10							79.0	91.2	103.4	115.6	127.8	140.0	152.1	164.3	176.5	188.7	200.9	213.1
12.5	2		11.1	14.9	18.8	22.6													
12.5	3		15.2	20.9	26.6	32.3	38.1	43.8	49.5										
12.5	4			25.8	33.5	41.1	48.7	56.3	63.9	71.6	79.2	86.8	94.4						
12.5	5				38.0	47.6	57.1	66.6	76.2	85.7	95.2	104.7	114.3	123.8	133.3	142.9	152.4		
12.5	6						64.5	75.9	87.4	98.8	110.2	121.7	133.1	144.5	156.0	167.4	178.8	190.3	201.7
12.5	7							84.2	97.5	110.9	124.2	137.6	150.9	164.2	177.6	190.9	204.3	217.6	230.9
12.5	8								106.7	121.9	137.2	152.4	167.7	182.9	198.2	213.4	228.7	243.9	259.2
12.5	9										147.9	165.1	182.2	199.4	216.5	233.7	250.8	268.0	285.1
12.5	10											176.7	195.7	214.8	233.9	252.9	272.0	291.0	310.1
16.0	2			22.2	28.4	34.6	40.9	47.1											
16.0	3				38.5	47.9	57.2	66.6	76.0	85.3	94.7	104.1							
16.0	4						70.9	83.4	95.8	108.3	120.8	133.3	145.8	158.3	170.8	183.3	195.8		
16.0	5								110.7	126.4	142.0	157.6	173.2	188.8	204.4	220.0	235.6	251.2	266.9
16.0	6										160.4	179.1	197.9	216.6	235.3	254.1	272.8	291.5	310.3
16.0	7												219.8	241.7	263.5	285.4	307.2	329.1	350.9
16.0	8													264.0	289.0	313.9	338.9	363.9	388.9
16.0	9															337.6	365.7	393.8	421.9
16.0	10																	420.9	452.1
20.0	2					48.9	58.7	68.5	78.2	88.0									
20.0	3							92.7	107.3	122.0	136.6	151.2	165.9	180.5	195.2				
20.0	4										168.8	188.4	207.9	227.4	246.9	266.4	285.9	305.4	325.0
20.0	5													263.7	288.1	312.5	336.9	361.3	285.7
20.0	6																381.2	410.4	439.7
20.0	7																		487.1
25.0	2								109.8	125.0	140.2	155.5							
25.0	3												231.7	254.6	277.5	300.3	323.2	346.1	368.9
25.0	4																390.8	421.3	451.8

Tabela XV

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 25 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.8	10.2															
10.0	3		11.1	14.7	18.4	22.1													
10.0	4		14.0	18.9	23.8	28.7	33.6	38.4	43.3										
10.0	5		16.6	22.7	28.8	34.9	41.0	47.1	53.2	59.3	65.4								
10.0	6			25.5	32.8	40.1	47.4	54.7	62.1	69.4	76.7	84.0	91.3	98.6					
10.0	7				36.4	44.9	53.4	62.0	70.5	79.0	87.6	96.1	104.7	113.2	121.7	130.3	138.8		
10.0	8					49.3	59.1	68.8	78.6	88.3	98.1	107.9	117.6	127.4	137.1	146.9	156.6	166.4	176.2
10.0	9						64.4	75.3	86.3	97.3	108.3	119.2	130.2	141.2	152.2	163.1	174.1	185.1	196.1
10.0	10							81.5	93.7	105.9	118.1	130.3	142.4	154.6	166.8	179.0	191.2	203.4	215.6
12.5	2		11.4	15.2	19.0														
12.5	3		15.7	21.4	27.2	32.9	38.6	44.3											
12.5	4			26.8	34.4	42.1	49.7	57.3	64.9	72.5	80.2								
12.5	5				40.8	50.3	59.9	69.4	78.9	88.4	98.0	107.5	117.0	126.6					
12.5	6					56.5	67.9	79.4	90.8	102.2	113.7	125.1	136.5	148.0	159.4	170.8	182.3	193.7	
12.5	7						75.1	88.4	101.8	115.1	128.4	141.8	155.1	168.5	181.8	195.1	208.5	221.8	235.2
12.5	8							96.6	111.8	127.1	142.3	157.6	172.8	188.1	203.3	218.6	233.8	249.0	264.3
12.5	9								121.0	138.2	155.3	172.5	189.6	206.8	223.9	241.1	258.2	275.4	292.5
12.5	10									148.4	167.4	186.5	205.5	224.6	243.7	262.7	281.8	300.8	319.9
16.0	2		16.6	22.8	29.0	35.3	41.5												
16.0	3				40.0	49.3	58.7	68.1	77.4	86.8	96.2								
16.0	4					61.0	73.5	86.0	98.5	110.9	123.4	135.9	148.4	160.9					
16.0	5							101.5	117.1	132.7	148.3	163.9	179.5	195.1	210.7	226.4	242.0	257.6	
16.0	6								131.1	149.8	168.5	187.3	206.0	224.7	243.5	262.2	280.9	299.6	318.4
16.0	7										186.3	208.2	230.1	251.9	273.8	295.6	317.5	339.3	361.2
16.0	8												251.7	276.7	301.7	326.7	351.6	376.6	401.6
16.0	9													299.1	327.2	355.3	383.4	411.5	439.6
16.0	10															381.5	412.8	444.0	475.2
20.0	2				40.8	50.5	60.3	70.1											
20.0	3						81.7	96.3	110.9	125.6	140.2	154.8	169.5						
20.0	4									155.7	175.2	194.7	214.3	233.8	253.3	272.8	292.3	311.8	
20.0	5											224.9	249.3	273.7	298.1	322.5	346.9	371.2	395.6
20.0	6														337.0	366.3	395.5	424.8	454.1
20.0	7																438.4	472.5	506.7
25.0	2							98.4	113.7	128.9	144.1								
25.0	3										194.8	217.6	240.5	263.4	286.2	309.1	332.0		
25.0	4														353.1	383.6	414.1	444.5	475.0
25.0	5																		550.5

Tabela XVI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w =30 CA-50A f_{ck} = 15MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.9																
10.0	3		11.4	15.0	18.7														
10.0	4		14.5	19.4	24.3	29.2	34.1												
10.0	5		17.4	23.5	29.6	35.7	41.8	47.9	54.0										
10.0	6		20.0	27.3	34.6	41.9	49.2	56.6	63.9	71.2	78.5								
10.0	7			30.8	39.3	47.9	56.4	64.9	73.5	82.0	90.5	99.1	107.6	116.1					
10.0	8			33.2	43.0	52.7	62.5	72.2	82.0	91.8	101.5	111.3	121.0	130.8	140.5	150.3			
10.0	9				46.3	57.3	68.3	79.3	90.2	101.2	112.2	123.2	134.1	145.1	156.1	167.1	178.1	189.0	
10.0	10				49.4	61.6	73.8	86.0	98.2	110.4	122.6	134.8	147.0	159.2	171.4	183.5	195.7	207.9	220.1
12.5	2		11.7	15.5															
12.5	3		16.4	22.1	27.8	33.6													
12.5	4		20.4	28.0	35.6	43.2	50.9	58.5	66.1										
12.5	5			33.1	42.7	52.2	61.7	71.3	80.8	90.5	99.8	109.4							
12.5	6				49.0	60.4	71.8	83.3	94.7	106.1	117.6	129.0	140.4	151.9					
12.5	7					66.6	80.0	93.3	106.6	120.0	133.3	146.7	160.0	173.3	186.7	200.0	213.4		
12.5	8					72.1	87.4	102.6	117.8	133.1	148.3	163.6	178.8	194.1	209.3	224.6	239.8	255.0	270.3
12.5	9						94.0	111.1	128.3	145.4	162.6	179.7	196.9	214.0	231.2	248.3	265.5	282.6	299.8
12.5	10							118.9	138.0	157.1	176.1	195.2	214.2	233.3	252.3	271.4	290.4	309.5	328.6
16.0	2		17.4	23.6	29.8														
16.0	3			32.4	41.8	51.1	60.5	69.9	79.2										
16.0	4				51.7	64.2	76.7	89.2	101.7	114.1	126.6	139.1							
16.0	5					75.2	90.9	106.5	122.1	137.7	153.3	168.9	184.5	200.1	215.7				
16.0	6							121.8	140.5	159.2	178.0	196.7	215.4	234.2	252.9	271.6	290.4	309.1	
16.0	7								154.7	176.5	198.4	220.2	242.1	263.9	285.8	307.7	329.5	351.4	373.2
16.0	8									191.8	216.8	241.8	266.8	291.7	316.7	341.7	366.7	391.6	416.6
16.0	9											261.3	289.4	317.5	345.6	373.7	401.8	429.9	458.0
16.0	10												310.1	341.3	372.5	403.8	435.0	466.2	497.4
20.0	2			33.0	42.7	52.5	62.2												
20.0	3					71.4	86.1	100.7	115.3	130.0	144.6								
20.0	4							124.5	144.0	163.5	183.0	202.5	222.1	241.6	261.1				
20.0	5									192.2	216.6	241.0	265.4	289.8	314.2	338.6	362.9	387.3	411.7
20.0	6											270.7	299.9	329.2	358.5	387.7	417.0	446.3	475.5
20.0	7													363.7	397.9	432.0	466.2	500.3	534.5
20.0	8															471.5	510.5	549.5	588.5
20.0	9																	593.8	637.7
25.0	2					72.7	87.9	103.2	118.4										
25.0	3								159.8	182.6	205.5	228.4	251.2	274.1					
25.0	4												311.2	341.6	372.1	402.6	433.1	463.6	494.1
25.0	5															473.5	511.6	549.7	587.8
25.0	6																		662.1

Tabela XVII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 10 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.0	9.4	11.8	14.3	16.7	19.2	21.6	24.0	26.5								
10.0	3					19.5	23.2	26.9	30.5	34.2	37.8	41.5	45.2	48.8	52.5	56.1	59.8	63.5	
10.0	4							33.8	38.7	43.6	48.4	53.3	58.2	63.1	68.0	72.8	77.7	82.6	87.5
10.0	5										57.5	63.6	69.7	75.8	81.9	88.0	94.1	100.2	106.3
10.0	6													87.8	95.2	102.5	109.8	117.1	124.4
10.0	7																124.0	132.5	141.0
12.5	2			13.3	17.1	20.9	24.7	28.5	32.3	36.1	39.9	43.7	47.6	51.4					
12.5	3					27.3	33.0	38.7	44.4	50.2	55.9	61.6	67.3	73.0	78.7	84.5	90.2	95.9	101.6
12.5	4								54.7	62.3	70.0	77.6	85.2	92.8	100.4	108.1	115.7	123.3	130.9
12.5	5											90.5	100.0	109.5	119.0	128.6	138.1	147.6	157.2
12.5	6														135.8	147.2	158.6	170.1	181.5
12.5	7																		202.8

Tabela XVIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 12 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.2	9.7	12.1	14.5	17.0	19.4	21.9										
10.0	3					20.1	23.8	27.4	31.1	34.8	38.4	42.1	45.7	49.4	53.0				
10.0	4							34.8	39.7	44.6	49.5	54.3	59.2	64.1	69.0	73.8	78.7	83.6	88.5
10.0	5										59.1	65.2	71.3	77.4	83.5	89.6	95.7	101.8	107.9
10.0	6													90.1	97.5	104.8	112.1	119.4	126.7
10.0	7																127.1	135.6	144.2
12.5	2		10.1	13.9	17.7	21.5	25.3	29.1	32.9	36.7	40.6	44.4							
12.5	3					28.7	34.4	40.1	45.8	51.6	57.3	63.0	68.7	74.4	80.1	85.9	91.6	97.3	
12.5	4								57.2	64.8	72.4	80.1	87.7	95.3	102.9	110.5	118.2	125.8	133.4
12.5	5											94.3	103.9	113.4	122.9	132.4	142.0	151.5	161.0
12.5	6														141.4	152.8	164.2	175.7	187.1
12.5	7																		210.4
16.0	2				25.5	31.8	38.0	44.3	50.5	56.7	63.0	69.2	75.5	81.7	88.0				
16.0	3							57.9	67.3	76.6	86.0	95.4	104.7	114.1	123.4	132.8	142.2	151.5	160.9
16.0	4										104.8	117.3	129.8	142.3	154.8	167.3	179.8	192.2	204.7
16.0	5													164.1	179.7	195.3	210.9	226.5	242.1
16.0	6																237.9	256.6	275.4
20.0	2							61.4	71.2	80.9	90.7	100.5	110.2	120.0	129.7	139.5	149.2	159.0	
20.0	3												146.2	160.8	175.5	190.1	204.7	219.4	234.0
20.0	4																250.0	269.5	289.1

Tabela XIX

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 15 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	86	90	95	100
10.0	2		7.5	9.9	12.4	14.8	17.2												
10.0	3		10.4	14.1	17.8	21.4	25.1	28.7	32.4	36.1	39.7								
10.0	4				21.9	26.8	31.7	36.6	41.4	46.3	51.2	56.1	61.0	65.8	70.7	75.6			
10.0	5					31.7	37.8	43.9	50.0	56.1	62.2	68.3	74.4	80.5	86.6	92.7	98.8	104.9	111.0
10.0	6							50.7	58.0	65.3	72.7	80.0	87.3	94.6	101.9	109.2	116.6	123.9	131.2
10.0	7									73.4	81.9	90.4	99.0	107.5	116.0	124.6	133.1	141.7	150.2
10.0	8											100.4	110.1	119.9	129.6	139.4	149.2	158.9	168.7
10.0	9													131.8	142.7	153.7	164.7	175.7	186.7
10.0	10															166.8	179.0	191.2	203.4
12.5	2		10.7	14.5	18.3	22.1	25.9	29.7	33.6										
12.5	3			19.9	25.6	31.3	37.0	42.8	48.5	54.2	59.9	65.6	71.3	77.1					
12.5	4				30.4	38.0	45.7	53.3	60.9	68.5	76.2	83.8	91.4	99.0	106.6	114.3	121.9	129.5	137.1
12.5	5						53.0	62.6	72.1	86.6	91.2	100.7	110.2	119.7	129.3	138.8	148.3	157.9	167.4
12.5	6								82.1	95.3	104.9	116.4	127.8	139.2	150.7	162.1	173.5	185.0	196.4
12.5	7										116.2	129.6	142.9	156.2	169.6	182.9	196.2	209.6	222.9
12.5	8												156.8	172.0	187.2	202.5	217.7	233.0	248.2
12.5	9														203.7	220.8	238.0	255.1	272.3
12.5	10																	274.8	293.8
16.0	2			20.9	27.2	33.4	39.7	45.9	52.2	58.4	64.6	70.9							
16.0	3					45.1	54.5	63.9	73.2	82.6	92.0	101.3	110.7	120.1	129.4	138.8	148.2	157.5	
16.0	4								88.8	101.2	113.7	126.2	138.7	151.2	163.7	176.2	188.7	201.1	213.6
16.0	5										132.2	147.8	163.4	179.0	194.6	210.2	225.8	241.4	257.0
16.0	6												184.7	203.4	222.2	240.9	259.6	278.4	297.1
16.0	7														244.2	266.0	287.9	309.7	331.6
16.0	8																	337.8	362.8
20.0	2						55.7	65.5	75.3	85.0	94.8	104.5	114.3	124.0					
20.0	3									111.4	126.1	140.7	155.3	170.0	184.6	199.2	213.9	228.5	243.1
20.0	4													207.8	227.3	246.8	266.3	285.8	305.3
20.0	5																306.7	331.1	355.5
25.0	2										133.0	148.3	163.5	178.8	194.0	209.2	224.5	239.7	
25.0	3															276.5	299.3	322.2	345.1

Tabela XX

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω =17 CA-50A f_{ck} = 18MPa

ϕ	η	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.6	10.0	12.5	14.9													
10.0	3		10.7	14.4	18.0	21.7	25.3	29.0	32.7	36.3									
10.0	4				22.4	27.3	32.2	37.0	41.9	46.8	51.7	56.6	61.4	66.3					
10.0	5					32.4	38.5	44.6	50.7	56.8	62.9	69.0	75.1	81.2	87.3	93.4	99.5		
10.0	6							51.8	59.1	66.4	73.7	81.1	88.4	95.7	103.0	110.3	117.6	125.0	132.3
10.0	7									74.8	83.4	91.9	100.4	109.0	117.5	126.0	134.6	143.1	151.7
10.0	8											102.3	112.0	121.8	131.6	141.3	151.1	160.8	170.6
10.0	9													134.2	145.2	156.1	167.1	178.1	189.1
10.0	10															169.8	182.0	194.2	206.4
12.5	2		11.0	14.8	18.6	22.4	26.2	30.0											
12.5	3		14.8	20.5	26.3	32.0	37.7	43.4	49.1	54.8	60.6	66.3							
12.5	4				31.6	39.2	46.8	54.5	62.1	69.7	77.3	84.9	92.6	100.2	107.8	115.4	123.1		
12.5	5						54.9	64.4	73.9	83.5	93.0	102.5	112.0	121.6	131.1	140.6	150.1	159.7	169.2
12.5	6								84.7	96.1	107.6	119.0	130.4	141.9	153.3	164.7	176.2	187.6	199.0
12.5	7										119.8	133.1	146.5	159.8	173.1	186.5	199.8	213.2	226.5
12.5	8												161.4	176.7	191.9	207.2	222.4	237.6	252.9
12.5	9														209.6	226.7	243.9	261.0	278.2
12.5	10																	282.1	301.1
16.0	2			21.7	28.0	34.2	40.5	46.7	52.9	59.2									
16.0	3					46.9	56.3	65.6	75.0	84.4	93.7	103.1	112.5	121.8	131.2	140.6			
16.0	4							79.4	91.9	104.4	116.9	129.4	141.8	154.3	166.8	179.3	191.8	204.3	216.8
16.0	5									121.4	137.0	152.7	168.3	183.9	199.5	215.1	230.7	246.3	261.9
16.0	6											173.0	191.8	210.5	229.2	248.0	266.7	285.4	304.2
16.0	7													231.9	253.8	275.6	297.5	319.3	341.2
16.0	8															300.4	325.3	350.3	375.3
16.0	9																	378.4	406.5
20.0	2					47.9	57.7	67.4	77.2	86.9	96.7	106.4	116.2						
20.0	3								105.0	119.6	134.3	148.9	163.5	178.2	192.8	207.4	222.1	236.7	251.3
20.0	4											180.3	199.8	219.3	238.8	258.3	277.8	297.4	316.9
20.0	5														277.7	302.1	326.5	350.8	375.2
20.0	6																	397.2	426.4
25.0	2								107.2	122.5	137.7	152.9	168.2	183.4	198.7	213.9			
25.0	3													241.3	264.1	287.0	309.9	332.7	355.6
25.0	4																		434.0

Tabela XXI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VALORES DE SEÇÃO RETANGULAR b_ω = 20 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.7	10.2	12.6														
10.0	3		11.0	14.7	18.3	22.0	25.7	29.3											
10.0	4		13.9	18.8	23.7	28.6	33.4	38.3	43.2	48.1	53.0								
10.0	5			21.8	27.9	34.0	40.1	46.2	52.3	58.4	64.5	70.6	76.7	82.8	88.9				
10.0	6					39.1	46.4	53.7	61.0	68.4	75.7	83.0	90.3	97.6	105.0	112.3	119.6	126.9	
10.0	7						52.3	60.9	69.4	77.9	86.5	95.0	103.5	112.1	120.6	129.2	137.7	146.2	154.8
10.0	8							67.6	77.4	87.1	96.9	106.6	116.4	126.2	135.9	145.7	155.4	165.2	174.9
10.0	9									95.2	106.2	117.2	128.1	139.1	150.1	161.1	172.0	183.0	194.0
10.0	10										115.1	127.3	139.5	151.7	163.9	176.1	188.3	200.5	212.7
12.5	2		11.3	15.1	18.9	22.7													
12.5	3		15.6	21.3	27.0	32.7	38.4	44.1	49.9	55.6									
12.5	4			26.5	34.1	41.8	49.4	57.0	64.6	72.2	79.9	87.5	95.1	102.7					
12.5	5				39.1	48.6	58.2	67.7	77.2	86.7	96.3	105.8	115.3	124.9	134.4	143.9	153.4	163.0	
12.5	6					54.6	66.0	77.4	88.9	100.3	111.7	123.2	134.6	146.0	157.5	168.9	180.3	191.8	203.2
12.5	7							86.3	99.6	112.9	126.3	139.6	153.0	166.3	179.6	193.0	206.3	219.7	233.0
12.5	8								109.4	124.7	139.9	155.1	170.4	185.6	200.9	216.1	231.4	246.6	261.9
12.5	9										151.3	168.5	185.6	202.8	219.9	237.1	254.2	271.4	288.5
12.5	10											180.9	200.0	219.0	238.1	257.1	276.2	295.2	314.3
16.0	2		16.4	22.6	28.0	35.1	41.3	47.6											
16.0	3				39.5	48.9	58.3	67.6	77.0	86.4	95.7	105.1	114.5						
16.0	4					60.2	72.7	85.2	97.7	110.1	122.6	135.1	147.6	160.1	172.6	185.1	197.6	210.1	
16.0	5							98.0	113.6	129.2	144.8	160.4	176.0	191.6	207.2	222.9	238.5	254.1	269.7
16.0	6									145.7	164.5	183.2	201.9	220.7	239.4	258.1	276.9	295.6	314.3
16.0	7											203.5	225.4	247.2	269.1	290.9	312.8	334.6	356.5
16.0	8												246.3	271.3	296.2	321.2	346.2	371.2	396.1
16.0	9														318.7	346.8	374.8	402.9	431.0
16.0	10																401.0	432.2	463.5
20.0	2				40.3	50.1	59.8	69.6	79.3	89.1									
20.0	3							95.2	109.8	124.5	139.1	153.7	168.4	183.0	197.6	212.3			
20.0	4									149.9	169.4	188.9	208.4	227.9	247.4	266.9	286.5	306.0	325.5
20.0	5												242.3	266.7	291.1	315.5	339.9	364.3	388.7
20.0	6														328.7	358.0	387.2	416.5	445.8
20.0	7																	458.7	492.9
25.0	2							97.2	112.5	127.7	142.9	158.2	173.4						
25.0	3											215.0	237.8	260.7	283.6	306.4	329.3	352.2	375.0
25.0	4															371.2	401.7	432.2	462.6

Tabela XXII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 22 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.8	10.2															
10.0	3		11.2	14.8	18.5	22.1	25.8												
10.0	4		14.2	19.1	24.0	28.8	33.7	38.6	43.5	48.4									
10.0	5		16.9	23.0	29.1	35.2	41.3	47.4	53.5	59.6	65.7	71.8	77.9						
10.0	6			25.8	33.1	40.4	47.8	55.1	62.4	69.7	77.0	84.4	91.7	99.0	106.3	113.6			
10.0	7				36.8	45.4	53.9	62.4	71.0	79.5	88.1	96.6	105.1	113.7	122.2	130.7	139.3	147.8	156.3
10.0	8					49.9	59.7	69.5	79.2	89.0	98.7	108.5	118.2	128.0	137.8	147.5	157.3	167.0	176.8
10.0	9						65.1	76.1	87.1	98.1	109.0	120.0	131.0	142.0	153.0	163.9	174.9	185.9	196.9
10.0	10							82.4	94.6	106.8	119.0	131.2	143.4	155.6	167.8	180.0	192.2	204.4	216.6
12.5	2		11.5	15.5	19.1	22.9													
12.5	3		15.9	21.7	27.4	33.1	38.8	44.5	50.2										
12.5	4			27.2	34.8	42.4	50.1	57.7	65.3	72.9	80.5	88.2	95.8						
12.5	5				40.2	49.7	59.2	68.7	78.3	87.8	97.3	106.9	116.4	125.9	135.4	145.0			
12.5	6					56.1	67.5	79.0	90.4	101.8	113.3	124.7	136.1	147.6	159.0	170.4	181.9	193.3	204.7
12.5	7							88.3	101.7	115.0	128.4	141.7	155.0	168.4	181.7	195.1	208.4	221.7	235.1
12.5	8								112.1	127.4	142.6	157.9	173.1	188.3	203.6	218.8	234.1	249.3	264.6
12.5	9										154.8	171.9	189.1	206.2	223.4	240.5	257.7	274.8	292.0
12.5	10											185.1	204.2	223.3	242.3	261.4	280.4	299.5	318.5
16.0	2		16.8	23.1	29.3	35.5	41.8												
16.0	3			31.2	40.5	49.9	59.3	68.6	78.0	87.4	96.7	106.1							
16.0	4					62.0	74.5	87.0	99.5	112.0	124.5	136.9	149.4	161.9	174.4	186.9			
16.0	5						85.2	100.8	116.4	132.0	147.6	163.3	178.9	194.5	210.1	225.7	241.3	256.9	272.5
16.0	6								131.1	149.8	168.6	187.3	206.0	224.8	243.5	262.2	281.0	299.7	318.4
16.0	7										187.2	209.1	230.9	252.8	274.6	296.5	318.3	240.2	362.0
16.0	8											228.6	253.5	278.5	303.5	328.5	353.5	378.4	403.4
16.0	9													299.7	327.8	355.9	384.0	412.1	440.2
16.0	10														349.9	381.1	412.4	443.6	474.8
20.0	2				41.4	51.2	60.9	70.7	80.4										
20.0	3						83.1	97.7	112.3	127.0	141.6	156.2	170.9	185.5	200.1				
20.0	4								138.7	158.2	177.7	197.2	216.7	236.3	355.8	275.3	294.8	314.3	333.8
20.0	5											228.8	253.2	277.6	302.0	326.3	350.7	375.1	399.5
20.0	6													313.3	342.6	371.9	401.1	430.4	459.7
20.0	7															411.8	446.0	480.1	514.3
20.0	8																		563.3
25.0	2						84.7	99.9	115.2	130.4	145.7	160.9							
25.0	3										198.2	221.1	243.9	266.8	289.7	312.5	335.4	358.3	
25.0	4														351.5	382.0	412.5	443.0	473.5
25.0	5																	514.2	552.3

Tabela XXIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 25 CA-50A f_{ck} = 18MPa

φ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.9	10.3															
10.0	3		11.4	15.0	18.7	22.3													
10.0	4		14.5	19.4	24.3	29.2	34.1	38.9	43.8										
10.0	5		17.4	23.5	29.6	35.7	41.8	47.9	54.0	60.1	66.2								
10.0	6			26.6	33.9	41.2	48.5	55.8	63.1	70.5	77.8	85.1	92.4	99.7					
10.0	7				37.9	46.4	54.9	63.5	72.0	80.5	89.1	97.6	106.1	114.7	123.2	131.8			
10.0	8					51.3	61.0	70.8	80.5	90.3	100.1	109.8	119.6	129.3	139.1	148.8	158.6	168.3	178.1
10.0	9						66.8	77.8	88.8	99.8	110.7	121.7	132.7	143.7	154.6	165.6	176.6	187.6	198.5
10.0	10							84.5	96.7	108.9	121.1	133.3	145.5	157.7	169.9	182.1	194.3	206.5	218.7
12.5	2		11.7	15.5	19.3														
12.5	3		16.4	22.1	27.8	33.6	39.3	45.0											
12.5	4		20.4	28.8	35.6	43.2	50.9	58.5	66.1	73.7	81.4								
12.5	5			33.1	42.7	52.2	61.7	71.3	80.8	90.3	99.8	109.4	118.9	128.4					
12.5	6				47.7	59.2	70.6	82.0	93.5	104.9	116.3	127.8	139.2	150.6	162.1	173.5	184.9		
12.5	7					65.4	78.7	92.1	105.4	118.7	132.1	145.4	158.8	172.1	185.4	198.8	212.1	225.5	238.8
12.5	8						86.1	101.4	116.6	131.8	147.1	162.3	177.6	192.8	208.1	223.3	238.6	253.8	269.1
12.5	9							109.9	127.1	144 .2	161.4	178.5	195.7	212.8	230.0	247.1	264.3	281.4	298.6
12.5	10								136.8	155.8	174.9	193.9	213.9	232.0	251.1	270.2	289.2	208.3	327.3
16.0	2		17.4	23.6	29.8	36.1													
16.0	3			32.4	41.8	51.1	60.5	69.9	79.2	88.6									
16.0	4				51.7	64.2	76.7	89.2	101.7	114.1	126.6	139.1	151.6	164.1					
16.0	5					75.2	90.9	106.5	122.1	137.7	153.3	168.9	184.5	200.1	215.7	231.3	247.0	262.6	
16.0	6							119.5	138.3	157.0	175.7	194.4	213.2	231.9	250.6	269.4	288.1	306.8	325.6
16.0	7								152.4	174.3	196.1	218.0	239.8	261.7	283.6	305.4	327.3	349.1	371.0
16.0	8										214.6	239.5	264.5	289.5	314.5	339.4	364.4	389.4	414.4
16.0	9											259.1	287.2	315.3	343.4	371.5	399.6	427.7	455.8
16.0	10												307.8	339.1	370.3	401.5	432.7	464.0	495.2
20.0	2			33.0	42.7	52.5	62.2	72.0											
20.0	3					71.4	86.1	100.7	115.3	130.0	144.6	159.2	173.9						
20.0	4							124.5	144.0	163.5	183.0	202.5	222.1	241.6	261.1	280.6	300.1	319.6	
20.0	5									188.3	212.7	237.1	261.5	285.9	310.3	334.7	359.0	383.4	407.8
20.0	6											266.8	296.0	325.3	354.6	383.8	413.1	442.4	471.6
20.0	7													359.8	394.0	428.1	462.3	496.4	530.6
20.0	8															467.6	506.6	545.6	584.6
20.0	9																		629.9
25.0	2					72.7	87.9	103.2	118.4	133.7									
25.0	3								159.8	182.6	205.5	228.4	251.2	274.1	297.0	319.8			
25.0	4												311.2	341.6	372.1	402.6	433.1	463.6	494.1
25.0	5															465.9	504.0	542.1	580.2
25.0	6																		654.4

Tabela XXIV

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω =30 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		8.0																
10.0	3		11.6	15.2	18.9														
10.0	4		14.9	19.8	24.7	29.6	34.5												
10.0	5		18.0	24.1	30.2	36.3	42.4	48.5	54.6										
10.0	6		20.9	28.2	35.5	42.8	50.2	57.5	64.8	72.1	79.4								
10.0	7		23.5	32.0	40.6	49.1	57.6	66.2	74.7	83.2	91.8	100.3	108.9						
10.0	8		25.1	34.8	44.6	54.4	64.1	73.9	83.6	93.4	103.1	112.9	122.7	132.4	142.2	151.9			
10.0	9			37.4	48.4	59.4	70.3	81.3	92.3	103.3	114.3	125.2	136.2	147.2	158.2	169.1	180.1	191.1	
10.0	10				51.9	64.1	76.3	88.5	100.7	112.9	125.1	137.3	149.5	161.7	173.9	186.1	198.3	210.5	222.7
12.5	2		11.9	15.7															
12.5	3		17.0	22.7	28.4	34.1													
12.5	4		21.4	29.0	36.6	44.2	51.9	59.5	67.1										
12.5	5		25.2	34.7	44.2	53.7	63.3	72.8	82.3	91.9	101.4	110.9							
12.5	6			39.8	51.2	62.6	74.1	85.5	96.9	108.4	119.8	131.2	142.7	154.1					
12.5	7				56.3	69.7	83.0	96.3	109.7	123.0	136.4	149.7	163.0	176.4	189.7	203.1	216.4		
12.5	8				60.8	76.1	91.3	106.6	121.8	137.1	152.3	167.5	182.8	198.0	213.3	228.5	243.8	259.0	274.3
12.5	9					81.9	99.0	116.2	133.3	150.5	167.6	184.8	201.9	219.1	236.2	253.4	270.5	287.7	304.8
12.5	10						106.1	125.1	144.2	163.3	182.3	201.4	220.4	239.5	258.5	277.6	296.7	315.7	334.8
16.0	2		18.0	24.3	30.5														
16.0	3		24.5	33.9	43.3	52.6	62.0	71.4											
16.0	4			41.9	54.4	66.9	79.3	91.8	104.3	116.8	129.3	141.8							
16.0	5				63.8	79.4	95.0	110.6	126.2	141.8	157.5	173.1	188.7	204.3	219.9				
16.0	6					90.3	109.0	127.8	146.5	165.2	184.0	202.7	221.4	240.2	258.9	277.6	296.4	315.1	
16.0	7							141.0	162.8	184.7	206.5	228.4	250.3	272.1	294.0	315.8	337.7	359.5	381.4
16.0	8								177.5	202.5	227.5	252.4	277.4	302.4	327.4	352.3	377.3	402.3	427.3
16.0	9									218.6	246.7	274.8	302.9	331.0	359.1	387.2	415.3	443.4	471.5
16.0	10										264.3	295.5	326.7	358.0	389.2	420.4	451.6	482.8	514.1
20.0	2			34.6	44.4	54.1	63.9												
20.0	3				60.4	75.1	89.7	104.3	119.0	133.6									
20.0	4						111.5	131.0	150.5	170.0	189.5	209.1	228.6	248.1					
20.0	5							153.6	178.0	202.4	226.8	251.2	275.5	299.9	324.3	348.7	373.1	397.5	
20.0	6									226.7	256.0	285.3	314.6	343.8	373.1	402.4	431.6	460.9	490.2
20.0	7											315.4	349.5	383.7	417.8	451.9	486.1	520.2	554.4
20.0	8													419.4	458.4	497.5	536.5	575.5	614.5
20.0	9														495.0	538.9	582.8	626.7	670.6
20.0	10																625.1	673.9	722.7
25.0	2				61.4	76.7	91.9	107.1											
25.0	3							145.8	168.7	191.6	214.4	237.3	260.2						
25.0	4										266.1	296.5	327.0	357.5	388.0	418.5	449.0	479.5	
25.0	5												384.0	422.1	460.2	498.3	536.4	574.5	612.6
25.0	6															560.6	606.3	652.0	697.8
25.0	7																		773.0

Tabela XXV

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 10 CA-50A f_{ck} = 20MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.1	9.6	12.0	14.4	16.9	19.3	21.8	24.2	26.6								
10.0	3					19.9	23.5	27.2	30.9	34.5	38.2	41.8	45.5	49.2	52.8	56.5	60.1	63.8	
10.0	4							34.4	39.3	44.2	49.1	53.9	58.8	63.7	68.6	73.4	78.3	83.2	88.1
10.0	5										58.5	64.6	70.7	76.8	82.9	89.0	95.1	101.2	107.3
10.0	6													89.2	96.5	103.9	111.2	118.5	125.8
10.0	7																125.8	134.4	142.9
12.5	2			13.6	17.4	21.3	25.1	28.9	32.7	36.5	40.3	44.1	47.9	51.7					
12.5	3					28.1	33.8	39.6	45.3	51.0	56.7	62.4	68.1	73.9	79.6	85.3	91.0	96.7	102.4
12.5	4								56.2	63.8	71.4	79.1	86.7	94.3	101.9	109.6	117.2	124.8	132.4
12.5	5											92.8	102.3	111.8	121.4	130.9	140.4	149.9	159.5
12.5	6														139.1	150.6	162.0	173.4	184.9
12.5	7																		207.3

Tabela XXVI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 12 CA-50A f_{ck} = 20MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.3	9.8	12.2	14.7	17.1	19.5	22.0										
10.0	3					20.4	24.1	27.7	31.4	35.0	38.7	42.4	46.0	49.7					
10.0	4							35.3	40.2	45.1	50.0	54.8	59.7	64.6	69.5	74.4	79.2	84.1	89.0
10.0	5										59.9	66.0	72.1	78.2	84.3	90.4	96.5	102.6	108.7
10.0	6													91.3	98.6	105.9	113.2	120.5	127.9
10.0	7																128.6	137.2	145.7
12.5	2		10.4	14.2	18.0	21.8	25.6	29.4	33.2	37.1	40.9	44.7							
12.5	3					29.4	35.1	40.8	46.5	52.2	58.0	63.7	69.4	75.1	80.8	86.5	92.3	98.0	
12.5	4								58.4	66.0	73.7	81.3	88.9	96.5	104.2	111.8	119.4	127.0	134.7
12.5	5											96.3	105.8	115.3	124.9	134.4	143.9	153.4	163.0
12.5	6														144.2	155.6	167.0	178.5	189.9
12.5	7																		214.2
16.0	2				26.4	32.6	38.8	45.1	51.3	57.6	63.8	70.1	76.3	82.5	88.8				
16.0	3							59.8	69.1	78.5	87.9	97.2	106.6	116.0	125.3	134.7	144.1	153.4	162.8
16.0	4									95.7	108.2	120.6	133.1	145.6	158.1	170.6	183.1	195.6	208.1
16.0	5													169.3	184.9	200.5	216.1	231.7	247.3
16.0	6																245.4	264.1	282.9
20.0	2							63.5	73.2	83.0	92.7	102.5	112.3	122.0	131.8	141.5	151.3	161.0	
20.0	2											136.1	150.8	165.4	180.0	194.7	209.3	223.9	238.6
20.0	3														219.1	238.7	258.2	277.7	297.2
20.0	4																		342.8

Tabela XXVII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 15 CA-50A f_{ck} = 20 MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.6	10.0	12.5	14.9	17.3												
10.0	3		10.7	14.3	18.0	21.7	25.3	29.0	32.6	36.3	39.9								
10.0	4				22.3	27.2	32.1	37.0	41.9	46.7	51.6	56.5	61.4	66.2	71.1	76.0			
10.0	5					32.3	38.4	44.5	50.6	56.7	62.8	68.9	75.0	81.1	87.2	93.3	99.4	105.5	111.6
10.0	6							51.6	58.9	66.3	73.6	80.9	88.2	95.5	102.8	110.2	117.5	124.8	132.1
10.0	7									74.6	83.1	91.7	100.2	108.8	117.3	125.8	134.4	142.9	151.4
10.0	8											102.0	111.8	121.5	131.3	141.0	150.8	160.5	170.3
10.0	9													133.8	144.8	155.8	166.8	177.7	188.7
10.0	10															169.3	181.5	193.7	205.9
12.5	2		10.9	14.7	18.6	22.4	26.2	30.0	33.8										
12.5	3			20.4	26.2	31.9	37.6	43.3	49.0	54.7	60.5	66.2	71.9	77.6					
12.5	4				31.4	39.0	46.7	54.3	61.9	69.5	77.1	84.8	92.4	100.0	107.6	115.3	122.9	130.5	138.1
12.5	5						54.6	64.1	73.7	83.2	92.7	102.2	111.8	121.3	130.8	140.3	149.9	159.4	168.9
12.5	6								84.3	95.7	107.2	118.6	130.0	141.5	152.9	164.3	175.8	187.2	198.6
12.5	7										119.3	132.6	145.9	159.3	172.6	185.9	199.3	212.5	226.0
12.5	8												160.7	176.0	191.2	206.5	221.7	236.9	252.2
12.5	9														208.7	225.8	243.0	260.1	277.3
12.5	10																	281.0	300.0
16.0	2			21.6	27.8	34.1	40.3	46.6	52.8	59.1	65.3								
16.0	3					46.6	56.0	65.4	74.7	84.1	93.5	102.8	112.2	121.6	130.9	140.3	149.7	159.0	
16.0	4							78.9	91.4	103.9	116.4	128.9	141.4	153.9	166.3	178.8	191.3	203.8	216.3
16.0	5									120.7	136.3	151.9	167.5	183.1	198.8	214.4	230.0	245.6	261.2
16.0	6											172.0	190.7	209.4	228.2	246.9	265.6	284.4	303.1
16.0	7													230.5	252.3	274.2	296.0	317.9	339.8
16.0	8															298.5	323.5	348.4	373.4
16.0	9																	376.0	404.1
20.0	2					47.6	57.4	67.1	76.9	86.6	96.4	106.2	115.9	125.7					
20.0	3								100.4	115.1	129.7	144.4	159.0	173.6	188.3	202.9	217.5	232.2	246.8
20.0	4											175.2	194.7	214.3	233.8	253.3	272.8	292.3	311.8
20.0	5															292.5	316.9	341.2	365.6
25.0	2								106.5	121.8	137.0	152.2	167.5	182.7	198.0	213.2	228.5	243.7	
25.0	3													239.7	262.5	285.4	308.3	331.1	354.0
25.0	4																		431.2

Tabela XXVIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 17 CA-50A f_{ck} = 20MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.7	10.1	12.6	15.0													
10.0	3		10.9	14.6	18.2	21.9	25.6	29.2	32.9	36.5									
10.0	4				22.8	27.7	32.5	37.4	42.3	47.2	52.0	56.9	61.8	66.7					
10.0	5					33.0	39.1	45.2	51.3	57.4	63.5	69.6	75.7	81.8	87.5	94.0	100.1		
10.0	6							52.6	59.9	67.2	74.5	81.9	89.2	96.5	103.8	111.1	118.4	125.8	133.1
10.0	7									75.9	84.5	93.0	101.5	110.1	118.5	127.1	135.7	144.2	152.8
10.0	8											103.7	113.5	123.2	133.0	142.8	152.5	162.3	172.0
10.0	9													136.0	147.0	158.0	168.9	179.9	190.9
10.0	10															172.0	184.2	196.4	208.6
12.5	2		11.2	15.0	18.8	22.6	26.4	30.3											
12.5	3		15.3	21.0	26.8	32.5	38.2	43.9	49.6	55.3	61.1	66.8							
12.5	4				32.5	40.1	47.7	55.3	62.9	70.6	78.2	85.8	93.4	101.1	108.7	116.3	123.9		
12.5	5						56.2	65.8	75.3	84.8	94.4	103.9	113.4	122.9	132.5	142.0	151.5	161.0	170.6
12.5	6								86.7	98.1	109.5	121.0	132.4	143.8	155.3	166.7	178.1	189.6	201.0
12.5	7										122.5	135.8	149.1	162.5	175.8	189.2	202.5	215.8	229.2
12.5	8												164.9	180.2	195.4	210.7	225.9	241.1	256.4
12.5	9														214.0	231.2	248.3	265.5	282.6
12.5	10																	287.6	306.6
16.0	2		16.1	22.3	28.6	34.8	41.0	47.3	53.5	59.8									
16.0	3				38.9	48.2	57.6	67.8	76.3	85.7	95.1	104.4	113.8	123.2	132.5	141.9			
16.0	4						69.3	81.7	94.2	106.7	119.2	131.7	144.2	156.7	169.2	181.7	194.1	206.6	219.1
16.0	5								109.5	125.1	140.7	156.3	171.9	187.6	203.2	218.8	234.4	250.0	265.6
16.0	6										159.5	178.3	197.0	215.8	234.5	253.2	272.0	290.7	309.4
16.0	7												217.3	239.1	261.0	282.8	304.7	326.5	348.4
16.0	8														284.8	309.8	334.7	359.7	384.7
16.0	9																362.2	390.3	418.4
20.0	2				39.6	49.3	59.1	68.8	78.6	88.4	98.1	107.9							
20.0	3							93.6	108.2	122.9	137.5	152.1	166.8	181.4	196.0	210.7	225.3	239.9	254.6
20.0	4										166.5	186.0	205.5	225.0	244.6	264.1	283.6	303.1	322.6
20.0	5													262.2	286.6	311.0	335.4	359.8	384.2
20.0	6															351.5	380.8	410.1	439.3
20.0	7																		484.1
25.0	2							95.5	110.7	126.0	141.2	156.4	171.7	186.9	202.2				
25.0	3												226.3	249.1	272.0	294.9	317.7	340.6	363.5
25.0	4																387.0	417.5	448.0

Tabela XXIX

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR $b_w = 20$ CA-50A $f_{ck} = 20MPa$

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.8	10.2	12.7														
10.0	3		11.2	14.8	18.5	22.2	25.8	29.5											
10.0	4		14.2	19.1	24.0	28.9	33.7	38.6	43.5	48.4	53.3								
10.0	5			22.3	28.4	34.5	40.6	46.7	52.8	58.9	65.0	71.1	77.2	83.3					
10.0	6					39.8	47.1	54.4	61.7	69.0	76.4	83.7	91.0	98.3	105.6	113.0	120.3	127.6	
10.0	7						53.3	61.8	70.3	78.9	87.4	95.9	104.5	113.0	121.6	130.1	138.6	147.2	155.7
10.0	8							68.8	78.6	88.3	98.1	107.9	117.6	127.4	137.1	146.9	156.6	166.4	176.2
10.0	9									96.7	107.7	118.7	129.7	140.7	151.6	162.6	173.6	184.6	195.5
10.0	10										117.0	129.2	141.4	153.6	165.8	178.0	190.2	202.4	214.6
12.5	2		11.5	15.3	19.1	22.9													
12.5	3		16.0	21.7	27.4	33.1	38.9	44.6	50.3	56.0									
12.5	4			27.3	34.9	42.5	50.1	57.7	65.4	73.0	80.6	88.2	95.9	103.5					
12.5	5				40.3	49.8	59.3	68.9	78.4	87.9	97.4	107.0	116.5	126.0	135.5	145.1	154.6	164.1	
12.5	6					56.3	67.7	79.1	90.6	102.0	113.4	124.9	136.3	147.7	159.2	170.6	182.0	193.5	204.9
12.5	7							88.6	101.9	115.2	128.6	141.9	155.2	168.6	181.9	195.3	208.6	221.9	235.3
12.5	8								112.4	127.6	142.9	158.1	173.4	188.6	203.9	219.1	234.3	249.6	264.8
12.5	9										155.1	172.3	189.4	206.6	223.7	240.9	258.0	275.2	292.3
12.5	10											185.6	204.6	223.7	242.7	261.8	280.8	299.9	319.0
16.0	2		16.9	23.1	29.3	35.6	41.8	48.1											
16.0	3			31.3	40.7	50.0	59.4	68.7	78.1	87.5	96.8	106.2	115.6						
16.0	4					62.2	74.7	87.2	99.7	112.1	124.6	137.1	149.6	162.1	174.6	187.1	199.6	212.1	
16.0	5						85.5	101.1	116.7	132.3	147.9	163.5	179.1	194.8	210.4	226.0	241.6	257.2	272.8
16.0	6								131.5	150.2	169.0	187.7	206.4	225.2	243.9	262.6	281.4	300.1	318.8
16.0	7									165.9	187.8	209.6	231.5	253.3	275.2	297.0	318.9	340.8	362.6
16.0	8											229.3	254.3	279.2	304.2	329.2	354.2	379.2	404.1
16.0	9												272.6	300.7	328.8	356.9	385.0	413.1	441.2
16.0	10														351.1	382.3	413.5	444.7	475.9
20.0	2				41.5	51.3	61.0	70.8	80.5	90.3									
20.0	3						83.3	97.9	112.6	127.2	141.9	156.5	171.1	185.8	200.4	215.0			
20.0	4								135.2	154.7	174.3	193.8	213.3	232.8	252.3	271.8	291.3	310.8	330.4
20.0	5											225.6	250.0	274.3	298.7	323.1	347.5	371.9	396.3
20.0	6													310.4	339.7	369.0	398.2	427.5	456.8
20.0	7															405.4	439.5	473.7	507.8
20.0	8																		553.4
25.0	2						84.9	100.2	115.4	130.7	145.9	161.2	176.4						
25.0	3										198.8	221.7	244.5	267.4	290.3	313.1	336.0	358.9	381.7
25.0	4													322.1	352.6	383.1	413.6	444.1	474.6
25.0	5																	515.9	554.0

Tabela XXX

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR $b_\omega = 22$ CA-50A $f_{ck} = 20MPa$

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.9	10.3															
10.0	3		11.3	15.0	18.6	22.3	26.0												
10.0	4		14.5	19.4	24.2	29.1	34.0	38.9	43.8	48.6									
10.0	5		17.3	23.4	29.5	35.6	41.7	47.8	53.9	60.0	66.1	72.2	78.3						
10.0	6			26.4	33.8	41.1	48.4	55.7	63.0	70.3	77.7	85.0	92.3	99.6	106.9	114.2			
10.0	7				37.7	46.2	54.8	63.3	71.8	80.4	88.9	97.4	106.0	114.5	123.0	131.6	140.1	148.7	157.2
10.0	8					51.0	60.8	70.6	80.3	90.1	99.8	109.6	119.3	129.1	138.9	148.6	158.4	168.1	177.9
10.0	9						66.5	77.5	88.5	99.5	110.5	121.4	132.4	143.4	154.4	165.3	176.3	187.3	1983.
10.0	10							84.2	96.4	108.6	120.8	133.0	145.1	157.3	169.5	181.7	193.9	206.1	218.3
12.5	2		11.6	15.5	19.3	23.1													
12.5	3		16.3	22.0	27.8	33.5	39.2	44.9	50.6										
12.5	4		20.2	27.9	35.5	43.1	50.7	58.4	66.0	73.6	81.2	88.8	96.5						
12.5	5				41.2	50.7	60.3	69.8	79.3	88.9	98.4	107.9	117.4	127.0	136.5	146.0			
12.5	6					57.6	69.1	80.5	91.9	103.4	114.8	126.2	137.7	149.1	160.5	172.0	183.4	194.8	206.3
12.5	7							90.4	103.8	117.1	130.4	143.8	157.1	170.5	183.8	197.1	210.5	223.8	237.1
12.5	8								114.8	130.1	145.3	160.6	175.8	191.0	206.3	221.5	236.8	252.0	267.3
12.5	9										158.2	175.3	192.5	209.6	226.8	243.9	261.1	278.2	295.4
12.5	10											189.4	208.4	227.5	246.5	265.6	284.6	303.7	322.8
16.0	2		17.3	23.5	29.8	36.0	42.2												
16.0	3			32.2	41.6	50.9	60.3	69.7	79.0	88.4	97.8	107.1							
16.0	4				51.3	63.8	76.3	88.8	101.3	113.8	126.3	138.8	151.2	163.7	176.2	188.7			
16.0	5						88.0	103.7	119.3	134.9	150.5	166.1	181.7	197.3	212.9	228.5	244.1	259.8	275.4
16.0	6							116.5	135.2	153.9	172.6	191.4	210.1	228.8	247.6	266.3	285.0	303.8	322.5
16.0	7									170.9	192.8	214.6	236.5	258.3	280.2	302.0	323.9	345.8	367.6
16.0	8										210.9	235.8	260.8	285.8	310.8	335.7	360.7	385.7	410.7
16.0	9											252.7	280.8	308.9	337.7	365.1	393.2	421.3	449.4
16.0	10													330.1	361.3	392.5	423.7	454.9	486.2
20.0	2			32.8	42.5	52.3	62.0	71.8	81.5										
20.0	3					70.9	85.6	100.2	114.8	129.5	144.1	158.7	173.4	188.0	202.6				
20.0	4							123.6	143.1	162.6	182.2	201.7	221.2	240.7	260.2	279.7	299.2	318.7	338.3
20.0	5									186.9	211.3	235.7	260.1	284.5	308.9	333.3	357.7	382.1	406.4
20.0	6												294.0	323.3	352.6	381.8	411.1	440.4	269.6
20.0	7														391.3	425.4	459.6	493.7	527.9
20.0	8																503.0	542.1	581.1
20.0	9																		625.4
25.0	2						87.4	102.6	117.9	133.1	148.4	163.6							
25.0	3									181.4	204.3	227.1	250.0	272.9	295.7	318.6	341.5	364.3	
25.0	4												301.4	331.9	362.3	392.8	423.3	453.8	484.3
25.0	5															454.9	493.0	531.1	569.2

Tabela XXXI

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 25 CA-50A f_{ck} = 20MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.9	10.4															
10.0	3		11.5	15.2	18.8	22.5													
10.0	4		14.8	19.7	24.5	29.4	34.3	39.2	44.1										
10.0	5		17.8	23.9	30.0	36.1	42.2	48.3	54.4	60.5	66.6								
10.0	6			27.1	34.4	41.7	49.1	56.4	63.7	71.0	78.3	85.7	93.0	100.3					
10.0	7				38.6	47.1	55.7	64.2	72.7	81.3	89.8	98.4	106.9	115.4	124.0	132.5			
10.0	8					52.2	62.0	71.8	81.5	91.3	101.0	110.8	120.5	130.3	140.1	149.8	159.6	169.3	179.1
10.0	9						68.1	79.0	90.0	101.0	112.0	122.9	133.9	144.9	155.9	166.8	177.8	188.8	199.8
10.0	10							86.0	98.2	110.4	122.6	134.8	147.0	159.2	171.4	183.6	195.8	208.0	220.2
12.5	2		11.8	15.6	19.5														
12.5	3		16.7	22.5	28.2	33.9	39.6	45.3											
12.5	4		21.0	28.6	36.2	43.8	51.5	59.1	66.7	74.3	82.0								
12.5	5			34.1	43.6	53.1	62.7	72.2	81.7	91.2	100.8	110.3	119.8	129.4					
12.5	6			37.6	49.1	60.5	71.9	83.4	94.8	106.2	117.7	129.1	140.5	152.0	163.4	174.8	186.3		
12.5	7					67.2	80.6	93.9	107.2	120.6	133.9	147.2	160.6	173.9	187.3	200.6	213.9	227.3	240.6
12.5	8						88.5	103.7	119.0	134.2	149.5	164.7	180.0	195.2	210.5	225.7	240.9	256.2	271.4
12.5	9							112.9	130.1	147.2	164.4	181.5	198.7	215.8	233.0	250.1	267.3	284.4	301.6
12.5	10								140.5	159.5	178.6	197.7	216.7	235.8	254.8	273.9	292.9	312.0	331.0
16.0	2		17.8	24.0	30.2	36.5													
16.0	3			33.3	42.7	52.0	61.4	70.8	80.1	89.5									
16.0	4				53.3	65.8	78.3	90.8	103.3	115.7	128.2	140.7	153.2	165.7					
16.0	5					77.7	93.4	109.0	124.6	140.2	155.8	171.4	187.0	202.6	218.2	233.8	249.5	265.1	
16.0	6						104.4	123.1	141.8	160.6	179.3	198.0	216.8	235.5	254.2	273.0	291.7	310.4	329.2
16.0	7							135.5	157.3	179.2	201.0	222.9	244.7	266.6	288.4	310.3	332.2	354.0	375.9
16.0	8									196.0	221.0	245.9	270.9	295.9	320.9	345.8	370.8	395.8	420.8
16.0	9										239.1	267.2	295.3	323.4	351.5	379.6	407.7	435.8	463.9
16.0	10											286.6	317.8	349.1	380.3	411.5	442.7	473.9	505.2
20.0	2			34.0	43.7	53.5	63.2	73.0											
20.0	3				59.0	73.6	88.2	102.9	117.5	132.2	146.8	161.4	176.1						
20.0	4						108.9	128.4	147.9	167.4	186.9	206.5	226.0	245.5	265.0	284.5	304.0		
20.0	5								170.0	194.4	218.8	243.2	267.6	292.0	316.4	340.8	365.1	489.5	413.9
20.0	6										246.3	275.5	304.8	334.1	363.3	392.6	421.9	451.2	480.4
20.0	7												337.6	371.8	405.9	440.1	474.2	508.4	542.5
20.0	8														444.1	483.2	522.2	561.2	600.2
20.0	9																561.8	605.8	649.7
20.0	10																		694.7
25.0	2					75.1	90.3	105.6	120.8	136.0									
25.0	3								165.1	188.0	210.9	233.7	256.6	279.5	302.3	325.2			
25.0	4										259.7	290.2	320.7	351.2	381.7	412.1	442.6	473.1	503.6
25.0	5													404.5	442.7	480.8	518.9	557.0	595.1
25.0	6																584.4	630.1	675.9

Tabela XXXII — FLEXÃO SIMPLES — VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_w = 30 CA-50A f_{ck} = 20MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		8.0																
10.0	3		11.7	15.4	19.0														
10.0	4		15.1	20.0	24.9	29.8	34.7												
10.0	5		18.4	24.5	30.6	36.7	42.8	48.9	54.9										
10.0	6		21.3	28.7	36.0	43.3	50.6	57.9	65.3	72.6	79.9								
10.0	7		24.1	32.6	41.2	49.7	58.3	66.8	75.3	83.9	92.4	100.9	109.5						
10.0	8		25.9	35.7	45.4	55.2	64.9	74.7	84.4	94.2	104.0	113.7	123.5	133.2	143.0	152.7			
10.0	9			38.4	49.4	60.4	71.4	82.4	93.3	104.3	115.3	126.3	137.2	148.2	159.2	170.2	181.1	192.1	
10.0	10				53.2	65.4	77.6	89.8	102.0	114.2	126.4	138.6	150.8	163.0	175.2	187.4	199.6	211.7	223.9
12.5	2		12.1	15.9															
12.5	3		17.2	23.0	28.7	34.4													
12.5	4		21.9	29.5	37.1	44.7	52.4	60.0	67.6										
12.5	5		25.9	35.5	45.0	54.5	64.1	73.6	83.1	92.6	102.2	111.7							
12.5	6			40.9	52.3	63.8	75.2	86.6	98.1	109.5	120.9	132.4	143.8	155.2					
12.5	7			44.5	57.8	71.2	84.5	97.9	111.2	124.5	137.9	151.2	164.6	177.9	191.2	204.6	217.9		
12.5	8				62.8	78.1	93.3	108.6	123.8	139.0	154.3	169.5	184.8	200.0	215.3	230.5	245.8	261.0	276.2
12.5	9					84.4	101.5	118.7	135.8	153.0	170.1	187.3	204.4	221.6	238.7	255.9	273.0	290.2	307.3
12.5	10						109.2	128.3	147.3	166.4	185.4	204.5	223.5	242.6	261.6	280.7	299.8	318.8	337.9
16.0	2		18.4	24.6	30.8														
16.0	3		25.3	34.7	44.0	53.4	62.8	72.1											
16.0	4			43.2	55.7	68.2	80.7	93.2	105.7	118.1	130.6								
16.0	5				65.9	81.5	97.1	112.7	128.3	143.9	159.5	175.2	190.8	206.4	222.0				
16.0	6					93.3	112.0	130.8	149.5	168.2	187.0	205.7	224.4	243.2	261.9	280.6	299.3	318.1	
16.0	7						123.2	145.1	166.9	188.8	210.6	232.5	254.3	276.2	298.0	319.9	341.7	363.6	385.5
16.0	8							157.9	182.8	207.8	232.8	257.8	282.7	307.7	332.7	357.7	382.6	407.6	432.6
16.0	9								197.3	225.4	253.5	281.6	309.7	337.8	365.9	394.0	422.1	450.1	478.2
16.0	10									241.4	272.6	303.8	335.1	366.3	397.5	428.7	460.0	491.2	522.4
20.0	2			35.4	45.2	54.9													
20.0	3				62.3	76.9	91.5	106.2	120.8	135.4									
20.0	4					95.2	114.7	134.3	153.8	173.3	192.8	212.3	231.8	251.3					
20.0	5							158.7	183.1	207.5	231.8	256.2	280.6	305.0	329.4	353.8	378.2	402.6	
20.0	6								204.8	234.1	263.3	292.6	321.9	351.1	380.4	409.7	439.0	468.2	497.5
20.0	7										291.2	325.3	359.5	393.6	427.8	461.9	496.1	530.2	564.4
20.0	8											354.4	393.4	432.4	471.4	510.5	549.5	588.5	627.6
20.0	9													467.6	511.5	555.4	599.3	643.2	687.1
20.0	10														547.8	596.6	645.4	694.2	743.0
25.0	2				63.4	78.6	93.9	109.1											
25.0	3						127.4	150.3	173.2	196.0	218.9	241.8	264.6						
25.0	4								213.0	243.5	274.0	304.5	335.0	365.5	395.9	426.4	456.9	487.4	
25.0	5											358.3	396.4	434.5	472.6	510.7	548.8	586.9	625.1
25.0	6													487.0	532.7	578.4	624.2	669.9	715.6
25.0	7																690.6	744.0	797.3
25.0	8																		870.0

TABELAS PARA CÁLCULO DIRETO DE ESTRIBOS VERTICAIS

1 As tabelas foram elaboradas de acordo com a NBR 6118/82 e servem para o cálculo do espaçamento dos estribos , em cm, para seções retangulares de concreto armado.

2 As tabelas prevêem 4 valores de f_{ck}, $\sigma_{s\omega d}$=435 MPa e foram feitas para b_ω=10; 12; 15; 17; 20; 22; 25 e 30 cm.

3 Deve-se entrar nas tabelas com o esforço cortante V característico (sem majoração).

4 Unidades

Esforço cortante V ; V_{mim} - KN
Altura útil d - m
Diâmetro dos estribos ϕ_e - mm
Largura b_ω - cm
Tensão $\sigma_{s\omega d}$ = 435 MPa

5 Coeficientes

γ_f=1,4; γ_c=1,4; γ_s=1,15

$\rho_1 = 100\rho_\ell$

ρ_ℓ = menor taxa da armadura longitudinal de tração no trecho de comprimento 2 h a partir da face do apoio.

6 Os espaçamentos tabelados, maiores que 5cm e menores que 30cm, correspondem a relações V/d compreendidas entre $V_{max}/d = 0,25. f_{ck}.b_\omega$ e V_{min}/d, onde V_{min} é a força cortante resistida pela seção de concreto com armadura transversal mínima de estribos verticais.

$V_{min} = fv_{min}. b_\omega.d$; $V \leq V_{min}$ temos $A_{s\omega min}$.

$V_c = f_v \ b_\omega.d$. Parcela absorvida pelo concreto.

7 Exemplo de aplicação

V=75 KN; b_ω=15cm; d=0,50m; f_{ck}=15 MPa

CA-60 ou CA-50

Valor de entrada na tabela

V/d= 75/0,50=150

Se b_ω=15cm ; f_{ck}=15 MPa ; para um valor de $\rho_1 = 100\rho_\ell$ =1,0 e com ϕ_e=6,3mm tiramos da tabela o espaçamento do estribo s=15cm

f_{ck}= 15 MPa; b_ω=15cm

ρ_1	ϕ_e	V/d	150
1,0	6,3	→	15

Tabela I

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 10 V/d = $\tau\ .b_\omega$

		V/d												
ρ_1	ϕ	50	60	70	80	90	100	110	120	130	140	150	160	169
0.15	4.6	23	20	16	14	12	10	9	8	7	7	6	6	5
0.15	5.0	28	24	19	16	14	12	11	10	9	8	7	7	6
0.15	6.0			28	24	20	18	16	14	13	12	11	10	9
0.15	6.3				26	22	20	18	16	14	13	12	11	10
0.15	7.0					28	24	22	20	18	16	15	14	13
0.15	8.0							29	26	23	22	20	18	17
0.15	10.0												29	27
0.50	4.6	23	22	18	15	12	11	10	9	8	7	6	6	6
0.50	5.0	28	26	21	17	15	13	11	10	9	8	8	7	7
0.50	6.0				25	21	19	17	15	13	12	11	10	10
0.50	6.3				28	24	21	18	16	15	14	13	12	11
0.50	7.0					29	26	23	20	18	17	16	14	13
0.50	8.0								27	24	22	20	19	18
0.50	10.0													28
1.00	4.6	23	23	20	16	14	12	10	9	8	7	7	6	6
1.00	5.0	28	28	24	19	16	14	12	11	10	9	8	7	7
1.00	6.0				28	23	20	18	16	14	13	12	11	10
1.00	6.3					26	22	20	17	16	14	13	12	11
1.00	7.0						28	24	22	20	18	16	15	14
1.00	8.0								28	26	23	21	20	18
1.00	10.0													29
1.50	4.6	23	23	23	18	15	13	11	10	9	8	7	7	6
1.50	5.0	28	28	27	22	18	15	13	12	10	9	8	8	7
1.50	6.0					26	22	19	17	15	14	12	11	11
1.50	6.3					29	24	21	19	17	15	14	13	12
1.50	7.0							26	23	21	19	17	16	15
1.50	8.0									27	25	23	21	19
1.50	10.0													

Tabela II

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 12 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	60	72	84	96	108	120	132	144	156	167	180	191	204
0.15	4.6	19	17	14	11	10	8	8	7	6	6	5	5	
0.15	5.0	23	20	16	13	12	10	9	8	7	7	6	6	5
0.15	6.0		29	23	20	17	15	13	12	11	10	9	8	8
0.15	6.3			26	22	19	16	15	13	12	11	10	9	9
0.15	7.0				27	23	20	18	16	15	14	12	12	11
0.15	8.0						27	24	21	19	18	16	15	14
0.15	10.0										28	26	24	23
0.50	4.6	19	18	15	12	10	9	8	7	6	6	5	5	5
0.50	5.0	23	22	17	14	12	11	9	8	8	7	6	6	5
0.50	6.0			25	21	18	16	14	12	11	10	9	9	8
0.50	6.3			28	23	20	17	15	14	12	11	10	10	9
0.50	7.0				29	24	21	19	17	15	14	1.3	12	11
0.50	8.0						28	25	22	20	18	17	16	15
0.50	10.0										29	27	25	23
1.00	4.6	19	19	17	13	11	10	8	7	7	6	6	5	5
1.00	5.0	23	23	20	16	13	11	10	9	8	7	7	6	6
1.00	6.0			29	23	19	17	15	13	12	11	10	9	8
1.00	6.3				26	22	19	16	14	13	12	11	10	9
1.00	7.0					27	23	20	18	16	15	14	12	12
1.00	8.0							27	24	21	19	18	16	15
1.00	10.0											28	26	24
1.50	4.6	19	19	19	15	12	10	9	8	7	6	6	5	5
1.50	5.0	23	23	23	18	15	12	11	10	9	8	7	6	6
1.50	6.0				26	21	18	16	14	12	11	10	9	9
1.50	6.3				29	24	20	17	15	14	12	11	10	10
1.50	7.0					29	25	22	19	17	16	14	13	12
1.50	8.0							29	25	23	20	19	17	16
1.50	10.0											29	27	25

Tabela III

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 15 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	75	90	105	120	135	150	164	179	194	209	225	239	254
0.15	4.6	15	13	11	9	8	7	6	5	5				
0.15	5.0	18	16	13	11	9	8	7	6	6	5	5		
0.15	6.0	26	23	19	16	13	12	10	9	8	8	7	7	6
0.15	6.3	29	25	21	17	15	13	12	10	9	9	8	7	7
0.15	7.0			25	21	18	16	14	13	12	11	10	9	9
0.15	8.0				28	24	21	19	17	15	14	13	12	11
0.15	10.0								27	24	22	21	19	18
0.50	4.6	15	15	12	10	8	7	6	6	5	5			
0.50	5.0	18	17	14	11	10	8	7	7	6	5	5	5	
0.50	6.0	26	25	20	17	14	12	11	10	9	8	7	7	6
0.50	6.3	29	28	22	18	16	14	12	11	10	9	8	8	7
0.50	7.0			28	23	19	17	15	13	12	11	10	9	9
0.50	8.0					26	22	20	18	16	15	13	12	12
0.50	10.0								28	25	23	21	20	18
1.00	4.6	15	15	13	11	9	8	7	6	5	5			
1.00	5.0	18	18	16	13	11	9	8	7	6	6	5	5	
1.00	6.0	26	26	23	18	15	13	12	10	9	8	8	7	7
1.00	6.3	29	29	25	20	17	15	13	11	10	9	9	8	7
1.00	7.0				25	21	18	16	14	13	12	11	10	9
1.00	8.0					28	24	21	19	17	15	14	13	12
1.00	10.0									27	24	22	21	19
1.50	4.6	15	15	15	12	10	8	7	6	6	5	5		
1.50	5.0	18	18	18	14	12	10	9	8	7	6	5	5	5
1.50	6.0	26	26	26	21	17	14	13	11	10	9	8	7	7
1.50	6.3	29	29	29	23	19	16	14	12	11	10	9	8	8
1.50	7.0				28	23	20	17	15	14	12	11	10	10
1.50	8.0						26	23	20	18	16	15	14	13
1.50	10.0									28	26	23	22	20

Tabela IV

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 17 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	85	102	119	136	153	170	186	204	220	237	255	271	288
0.15	4.6	13	12	9	8	7	6	5	5					
0.15	5.0	16	14	11	9	8	7	6	6	5	5			
0.15	6.0	23	20	16	14	12	10	9	8	7	7	6	6	5
0.15	6.3	26	22	18	15	13	11	10	9	8	8	7	6	6
0.15	7.0		28	22	19	16	14	13	11	10	9	9	8	7
0.15	8.0			29	25	21	19	17	15	14	12	11	11	10
0.15	10.0						29	26	24	22	20	18	17	16
0.50	4.6	13	13	10	8	7	6	5	5					
0.50	5.0	16	15	12	10	8	7	6	6	5	5			
0.50	6.0	23	22	18	15	12	11	10	9	8	7	6	6	6
0.50	6.3	26	25	20	16	14	12	11	9	9	8	7	7	6
0.50	7.0			24	20	17	15	13	12	11	10	9	8	8
0.50	8.0				26	23	20	17	16	14	13	12	11	10
0.50	10.0							27	25	22	20	19	17	16
1.00	4.6	13	13	12	9	8	7	6	5	5				
1.00	5.0	16	16	14	11	9	8	7	6	6	5	5		
1.00	6.0	23	23	20	16	14	12	10	9	8	7	7	6	6
1.00	6.3	26	26	22	18	15	13	11	10	9	8	8	7	6
1.00	7.0			27	22	19	16	14	13	11	10	9	9	8
1.00	8.0				29	25	21	19	17	15	14	12	11	11
1.00	10.0							29	26	24	21	20	18	17
1.50	4.6	13	13	13	10	9	8	6	5	5				
1.50	5.0	16	16	16	12	10	9	7	7	6	5	5		
1.50	6.0	23	23	23	18	15	13	11	10	9	8	7	7	6
1.50	6.3	26	26	26	20	17	14	12	11	10	9	8	7	7
1.50	7.0				25	21	17	15	13	12	11	10	9	8
1.50	8.0					27	23	20	18	16	14	13	12	11
1.50	10.0								28	25	23	21	19	18

Tabela V

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 20 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	100	120	140	160	179	200	219	239	259	279	300	319	339
0.15	4.6	11	10	8	7	6	5							
0.15	5.0	14	12	9	8	7	6	5	5					
0.15	6.0	20	17	14	12	10	9	8	7	6	6	5	5	
0.15	6.3	22	19	15	13	11	10	9	8	7	6	6	5	5
0.15	7.0	27	23	19	16	14	12	11	10	9	8	7	7	6
0.15	8.0			25	21	18	16	14	13	11	11	10	9	8
0.15	10.0					28	25	22	20	18	17	15	14	13
0.50	4.6	11	11	9	7	6	5	5						
0.50	5.0	14	13	10	8	7	6	5	5					
0.50	6.0	20	19	15	12	10	9	8	7	6	6	5	5	5
0.50	6.3	22	21	17	14	12	10	9	8	7	7	6	6	5
0.50	7.0	27	26	21	17	14	13	11	10	9	8	8	7	6
0.50	8.0			27	22	19	17	15	13	12	11	10	9	9
0.50	10.0						26	23	21	19	17	16	15	14
1.00	4.6	11	11	10	8	7	6	5						
1.00	5.0	14	14	12	9	8	7	6	5	5				
1.00	6.0	20	20	17	14	11	10	9	8	7	6	6	5	5
1.00	6.3	22	22	19	15	13	11	10	8	8	7	6	6	5
1.00	7.0	27	27	23	19	16	14	12	11	10	9	8	7	7
1.00	8.0				25	21	18	16	14	13	11	10	10	9
1.00	10.0						28	25	22	20	18	17	15	14
1.50	4.6	11	11	11	9	7	6	5	5					
1.50	5.0	14	14	13	11	9	7	6	6	5				
1.50	6.0	20	20	20	15	13	11	9	8	7	7	6	5	5
1.50	6.3	22	22	22	17	14	12	10	9	8	7	7	6	6
1.50	7.0	27	27	27	21	17	15	13	11	10	9	8	8	7
1.50	8.0				28	23	19	17	15	13	12	11	10	9
1.50	10.0							27	24	21	19	17	16	15

Tabela VI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 22 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	110	132	154	176	197	220	241	263	285	307	330	351	373
0.15	4.6	10	9	7	6	5								
0.15	5.0	12	11	9	7	6	5	5						
0.15	6.0	18	15	12	10	9	8	7	6	6	5	5		
0.15	6.3	20	17	14	12	10	9	8	7	6	6	5	5	
0.15	7.0	24	21	17	14	12	11	10	9	8	7	7	6	6
0.15	8.0		28	23	19	16	14	13	11	10	10	9	8	8
0.15	10.0					26	23	20	18	17	15	14	13	12
0.50	4.6	10	10	8	6	5	5							
0.50	5.0	12	12	9	8	6	6	5						
0.50	6.0	18	17	14	11	9	8	7	6	6	5	5		
0.50	6.3	20	19	15	12	11	9	8	7	6	6	5	5	5
0.50	7.0	24	23	19	15	13	11	10	9	8	7	7	6	6
0.50	8.0			24	20	17	15	13	12	11	10	9	8	8
0.50	10.0					27	24	21	19	17	16	14	13	12
1.00	4.6	10	10	9	7	6	5							
1.00	5.0	12	12	11	8	7	6	5	5					
1.00	6.0	18	18	15	12	10	9	8	7	6	6	5	5	
1.00	6.3	20	20	17	14	12	10	9	8	7	6	6	5	5
1.00	7.0	24	24	21	17	14	12	11	10	9	8	7	7	6
1.00	8.0			28	22	19	16	14	13	11	10	9	9	8
1.00	10.0						26	23	20	18	16	15	14	13
1.50	4.6	10	10	10	8	7	5	5						
1.50	5.0	12	12	12	10	8	7	6	5					
1.50	6.0	18	18	18	14	11	10	8	7	7	6	5	5	5
1.50	6.3	20	20	20	15	13	11	9	8	7	7	6	5	5
1.50	7.0	24	24	24	19	16	13	12	10	9	8	8	7	6
1.50	8.0				25	21	18	15	14	12	11	10	9	8
1.50	10.0						28	24	21	19	17	16	15	13

Tabela VII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 25 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	125	150	174	199	224	250	274	299	324	349	375	399	424
0.15	4.6	9	8	6	5									
0.15	5.0	11	9	7	6	5	5							
0.15	6.0	16	14	11	9	8	7	6	5	5				
0.15	6.3	17	15	12	10	9	8	7	6	5	5	5		
0.15	7.0	21	19	15	13	11	9	8	8	7	6	6	5	5
0.15	8.0	28	25	20	17	14	13	11	10	9	8	8	7	7
0.15	10.0				26	23	20	18	16	14	13	12	11	11
0.50	4.6	9	9	7	6	5								
0.50	5.0	11	10	8	7	6	5							
0.50	6.0	16	15	12	10	8	7	6	6	5	5			
0.50	6.3	17	17	13	11	9	8	7	6	6	5	5		
0.50	7.0	21	21	16	13	11	10	9	8	7	6	6	5	5
0.50	8.0	28	27	21	18	15	13	12	10	9	9	8	7	7
0.50	10.0				28	24	21	18	17	15	14	13	12	11
1.00	4.6	9	9	8	6	5								
1.00	5.0	11	11	9	7	6	5	5						
1.00	6.0	16	16	13	11	9	8	7	6	5	5			
1.00	6.3	17	17	15	12	10	9	8	7	6	5	5	5	
1.00	7.0	21	21	19	15	13	11	9	8	8	7	6	6	5
1.00	8.0	28	28	24	20	17	14	12	11	10	9	8	8	7
1.00	10.0					26	23	20	18	16	14	13	12	11
1.50	4.6	9	9	9	7	6	5							
1.50	5.0	11	11	11	8	7	6	5						
1.50	6.0	16	16	16	12	10	8	7	6	6	5	5		
1.50	6.3	17	17	17	14	11	9	8	7	6	6	5	5	
1.50	7.0	21	21	21	17	14	12	10	9	8	7	7	6	6
1.50	8.0	28	28	28	22	18	15	13	12	11	10	9	8	7
1.50	10.0					29	24	21	19	17	15	14	13	12

Tabela VIII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 13.5 MPa $f_{y\,\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 30 V/d = $\tau . b_\omega$

		V/d												
ρ_1	ϕ	150	179	209	239	269	300	329	359	389	419	450	479	509
0.15	4.6	7	6	5										
0.15	5.0	9	8	6	5									
0.15	6.0	13	11	9	8	6	6	5						
0.15	6.3	14	12	10	8	7	6	6	5					
0.15	7.0	18	15	12	10	9	8	7	6	6	5	5		
0.15	8.0	23	20	16	14	12	10	9	8	7	7	6	6	5
0.15	10.0			26	22	19	16	15	13	12	11	10	9	9
0.50	4.6	7	7	6	5									
0.50	5.0	9	8	7	5	5								
0.50	6.0	13	12	10	8	7	6	5	5					
0.50	6.3	14	14	11	9	8	7	6	5	5				
0.50	7.0	18	17	14	11	9	8	7	6	5	5	5		
0.50	8.0	23	22	18	15	13	11	10	9	8	7	6	6	6
0.50	10.0			28	23	20	17	15	14	12	11	10	10	9
1.00	4.6	7	7	6	5									
1.00	5.0	9	9	8	6	5								
1.00	6.0	13	13	11	9	7	6	6	5					
1.00	6.3	14	14	12	10	8	7	6	5	5				
1.00	7.0	18	18	15	12	10	9	8	7	6	6	5	5	
1.00	8.0	23	23	20	16	14	12	10	9	8	7	7	6	6
1.00	10.0				26	22	19	16	15	13	12	11	10	9
1.50	4.6	7	7	7	6	5								
1.50	5.0	9	9	9	7	6	5							
1.50	6.0	13	13	13	10	8	7	6	5	5				
1.50	6.3	14	14	14	11	9	8	7	6	5	5			
1.50	7.0	18	18	18	14	11	10	8	7	7	6	5	5	5
1.50	8.0	23	23	23	18	15	13	11	10	9	8	7	7	6
1.50	10.0				29	24	20	18	16	14	13	11	11	10

Tabela IX

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 10 V/d = $\tau . b_\omega$

		V/d														
ρ_1	ϕ	50	60	70	80	90	100	110	120	130	140	150	160	169	179	189
0.15	4.6	23	21	17	14	12	10	9	8	7	7	6	6	5	5	5
0.15	5.0	28	24	20	16	14	12	11	10	9	8	8	7	6	6	6
0.15	6.0			29	24	21	18	16	14	13	12	11	10	10	9	8
0.15	6.3				26	23	20	18	16	14	13	12	11	11	10	9
0.15	7.0					28	25	22	20	18	16	15	14	13	12	12
0.15	8.0							29	26	24	22	20	19	17	16	15
0.15	10.0												29	27	26	24
0.50	4.6	23	23	18	15	13	11	10	9	8	7	6	6	6	5	5
0.50	5.0	28	27	21	18	15	13	12	10	9	8	8	7	7	6	6
0.50	6.0				26	22	19	17	15	14	12	11	11	10	9	9
0.50	6.3				28	24	21	19	17	15	14	13	12	11	10	10
0.50	7.0						26	23	21	19	17	16	15	14	13	12
0.50	8.0								27	25	22	21	19	18	17	16
0.50	10.0													28	26	25
1.00	4.6	23	23	21	17	14	12	10	9	8	7	7	6	6	5	5
1.00	5.0	28	28	25	20	17	14	12	11	10	9	8	8	7	6	6
1.00	6.0				29	24	21	18	16	14	13	12	11	10	10	9
1.00	6.3					27	23	20	18	16	14	13	12	11	11	10
1.00	7.0						28	25	22	20	18	16	15	14	13	12
1.00	8.0								29	26	24	22	20	19	17	16
1.00	10.0													29	27	26
1.50	4.6	23	23	23	19	15	13	11	10	9	8	7	7	6	6	5
1.50	5.0	28	28	28	22	18	15	13	12	11	9	9	8	7	7	6
1.50	6.0					27	23	20	17	15	14	13	12	11	10	9
1.50	6.3					29	25	22	19	17	15	14	13	12	11	10
1.50	7.0							27	24	21	19	17	16	15	14	13
1.50	8.0									28	25	23	21	19	18	17
1.50	10.0														29	27

Tabela X

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 12 V/d = $\tau . b_\omega$

		V/d														
ρ_1	ϕ	60	72	84	95	108	120	132	144	156	167	180	191	204	216	227
0.15	4.6	19	17	14	11	10	9	8	7	6	6	5	5			
0.15	5.0	23	20	16	14	12	10	9	8	7	7	6	6	5	5	5
0.15	6.0		29	24	20	17	15	13	12	11	10	9	8	8	7	7
0.15	6.3			26	22	19	17	15	13	12	11	10	9	9	8	8
0.15	7.0				27	23	20	18	16	15	14	13	12	11	10	10
0.15	8.0						27	24	22	20	18	17	15	14	13	13
0.15	10.0										28	26	24	23	21	20
0.50	4.6	19	19	15	12	10	9	8	7	6	6	5	5	5		
0.50	4.0	23	23	18	15	12	11	10	8	8	7	6	6	5	5	5
0.50	6.0			26	21	18	16	14	12	11	10	9	9	8	8	7
0.50	6.3			29	24	20	17	15	14	12	11	10	10	9	8	8
0.50	7.0				29	25	22	19	17	15	14	13	12	11	10	10
0.50	8.0						28	25	23	20	19	17	16	15	14	13
0.50	10.0										29	27	25	23	22	21
1.00	4.6	19	19	17	14	12	10	9	8	7	6	6	5	5		
1.00	5.0	23	23	20	16	14	12	10	9	8	7	7	6	6	5	5
1.00	6.0				24	20	17	15	13	12	11	10	9	8	8	7
1.00	6.3				26	22	19	17	15	13	12	11	10	9	9	8
1.00	7.0					27	23	21	18	16	15	14	13	12	11	10
1.00	8.0							27	24	22	20	18	17	15	14	13
1.00	10.0											28	26	24	23	21
1.50	4.6	19	19	19	16	13	11	9	8	7	7	6	5	5	5	
1.50	5.0	23	23	23	19	15	13	11	10	9	8	7	6	6	6	5
1.50	6.0				27	22	19	16	14	13	11	10	10	9	8	8
1.50	6.3					24	21	18	16	14	13	12	11	10	9	8
1.50	7.0						26	22	20	17	16	14	13	12	11	11
1.50	8.0							29	26	23	21	19	17	16	15	14
1.50	10.0												27	25	24	22

Tabela XI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 15 $V/d = \tau . b_\omega$

		V/d														
ρ_1	ϕ	75	90	105	120	135	150	164	179	194	209	225	239	254	269	284
0.15	4.6	15	14	11	9	8	7	6	5	5						
0.15	5.0	18	16	13	11	9	8	7	6	6	5	5				
0.15	6.0	26	23	19	16	14	12	11	9	9	8	7	7	6	6	5
0.15	6.3	29	26	21	17	15	13	12	10	9	9	8	7	7	6	6
0.15	7.0			26	22	19	16	14	13	12	11	10	9	9	8	8
0.15	8.0				28	24	21	19	17	16	14	13	12	11	11	10
0.15	10.0								27	25	23	21	19	18	17	16
0.50	4.6	15	15	12	10	8	7	6	6	5	5					
0.50	5.0	18	18	14	12	10	9	8	7	6	5	5	5			
0.50	6.0	26	26	21	17	14	13	11	10	9	8	7	7	6	6	6
0.50	6.3	29	29	23	19	16	14	12	11	10	9	8	8	7	7	6
0.50	7.0			28	23	20	17	15	14	12	11	10	10	9	8	8
0.50	8.0					26	23	20	18	16	15	14	13	12	11	10
0.50	10.0								28	26	23	22	20	19	17	16
1.00	4.6	15	15	14	11	9	8	7	6	5	5					
1.00	5.0	18	18	16	13	11	9	8	7	6	6	5	5			
1.00	6.0	26	26	24	19	16	14	12	11	9	9	8	7	7	6	6
1.00	6.3	29	29	26	21	18	15	13	12	10	9	9	8	7	7	6
1.00	7.0				26	22	19	16	15	13	12	11	10	9	9	8
1.00	8.0					29	25	21	19	17	16	14	13	12	11	11
1.00	10.0									27	25	23	21	19	18	17
1.50	4.6	15	15	15	12	10	9	7	6	6	5	5				
1.50	5.0	18	18	18	15	12	10	9	8	7	6	6	5	5		
1.50	6.0	26	26	26	21	18	15	13	11	10	9	8	8	7	6	6
1.50	6.3	29	29	29	24	19	16	14	13	11	10	9	8	8	7	7
1.50	7.0				29	24	20	18	16	14	13	11	10	10	9	8
1.50	8.0						27	23	20	18	17	15	14	13	12	11
1.50	10.0									29	26	24	22	20	19	18

Tabela XII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 17 $V/d = \tau . b_\omega$

		V/d														
ρ	ϕ	85	102	119	135	153	170	186	204	220	237	255	271	288	305	322
0.15	4.6	13	12	10	8	7	6	5	5							
0.15	5.0	16	14	11	9	8	7	6	6	5	5					
0.15	6.0	23	21	17	14	12	10	9	8	7	7	6	6	5	5	5
0.15	6.3	26	23	18	15	13	12	10	9	8	8	7	6	6	6	5
0.15	7.0		28	23	19	16	14	13	11	10	9	9	8	8	7	7
0.15	8.0				25	22	19	17	15	14	13	12	11	10	9	9
0.15	10.0							26	24	22	20	18	17	15	15	14
0.50	4.6	13	13	10	9	7	6	5	5							
0.50	5.0	16	16	12	10	9	7	7	6	5	5					
0.50	6.0	23	23	18	15	13	11	10	9	8	7	7	6	6	5	5
0.50	6.3	26	25	20	16	14	12	11	10	9	8	7	7	6	6	5
0.50	7.0			25	20	17	15	13	12	11	10	9	8	8	7	7
0.50	8.0				27	23	20	18	16	14	13	12	11	10	10	9
0.50	10.0							28	25	23	21	19	18	16	15	14
1.00	4.6	13	13	12	10	8	7	6	5	5						
1.00	5.0	16	16	14	11	10	8	7	6	6	5	5				
1.00	6.0	23	23	21	17	14	12	10	9	8	8	7	6	6	5	5
1.00	6.3	26	26	23	18	15	13	12	10	9	8	8	7	6	6	6
1.00	7.0			28	23	19	16	14	13	11	10	9	9	8	8	7
1.00	8.0					25	22	19	17	15	14	13	12	11	10	9
1.00	10.0								27	24	22	20	18	17	16	15
1.50	4.6	13	13	13	11	9	7	6	6	5						
1.50	5.0	16	16	16	13	11	9	8	7	6	5	5				
1.50	6.0	23	23	23	19	15	13	11	10	9	8	7	7	6	6	5
1.50	6.3	26	26	26	21	17	14	12	11	10	9	8	7	7	6	6
1.50	7.0				26	21	18	16	14	12	11	10	9	8	8	7
1.50	8.0					28	24	20	18	16	15	13	12	11	10	10
1.50	10.0								28	25	23	21	19	18	17	15

Tabela XIII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 20 V/d = $\tau . b_\omega$

		V/d														
ρ_1	ϕ	100	120	140	160	179	200	219	239	259	279	300	319	339	359	379
0.15	4.6	11	10	8	7	6	5									
0.15	5.0	14	12	10	8	7	6	5	5							
0.15	6.0	20	17	14	12	10	9	8	7	6	6	5	5	5		
0.15	6.3	22	19	16	13	11	10	9	8	7	6	6	5	5	5	
0.15	7.0	27	24	19	16	14	12	11	10	9	8	7	7	6	6	6
0.15	8.0			25	21	18	16	14	13	12	11	10	9	8	8	7
0.15	10.0					29	25	22	20	18	17	16	14	13	13	12
0.50	4.6	11	11	9	7	6	5	5								
0.50	5.0	14	13	10	9	7	6	5	5							
0.50	6.0	20	19	15	13	11	9	8	7	7	6	5	5	5		
0.50	6.3	22	21	17	14	12	10	9	8	7	7	6	6	5	5	5
0.50	7.0	27	27	21	17	15	13	11	10	9	8	8	7	7	6	6
0.50	8.0			28	23	19	17	15	13	12	11	10	9	9	8	8
0.50	10.0						27	24	21	19	17	16	15	14	13	12
1.00	4.6	11	11	10	8	7	6	5								
1.00	5.0	14	14	12	10	8	7	6	5	5						
1.00	6.0	20	20	18	14	12	10	9	8	7	6	6	5	5	5	
1.00	6.3	22	22	19	16	13	11	10	9	8	7	6	6	5	5	5
1.00	7.0	27	27	24	19	16	14	12	11	10	9	8	7	7	6	6
1.00	8.0				25	21	18	16	14	13	12	11	10	9	8	8
1.00	10.0						29	25	22	20	18	17	16	14	13	13
1.50	4.6	11	11	11	9	7	6	5	5							
1.50	5.0	14	14	14	11	9	7	6	6	5						
1.50	6.0	20	20	20	16	13	11	10	8	7	7	6	6	5	5	
1.50	6.3	22	22	22	18	14	12	11	9	8	7	7	6	6	5	5
1.50	7.0	27	27	27	22	18	15	13	12	10	9	8	8	7	7	6
1.50	8.0				29	24	20	17	15	14	12	11	10	9	9	8
1.50	10.0							27	24	22	19	18	16	15	14	13

Tabela XIV

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 22 $V/d = \tau . b_\omega$

		V/d														
ρ_1	ϕ	110	132	154	176	197	220	241	263	285	307	330	351	373	395	417
0.15	4.6	10	9	7	6	5										
0.15	5.0	12	11	9	7	6	5	5								
0.15	6.0	18	16	13	11	9	8	7	6	5	5					
0.15	6.3	20	17	14	12	10	9	8	7	6	6	5	5	5		
0.15	7.0	24	22	17	15	13	11	10	9	8	7	7	6	6	5	5
0.15	8.0		29	23	19	17	14	13	12	10	10	9	8	8	7	7
0.15	10.0					26	23	20	18	17	15	14	13	12	11	11
0.50	4.6	10	10	8	6	5	5									
0.50	5.0	12	12	9	8	7	6	5								
0.50	6.0	18	18	14	11	10	8	7	7	6	5	5	5			
0.50	6.3	20	19	15	13	11	9	8	7	7	6	5	5	5		
0.50	7.0	24	24	19	16	13	12	10	9	8	7	7	6	6	5	5
0.50	8.0			25	21	18	15	13	12	11	10	9	8	8	7	7
0.50	10.0					28	24	21	19	17	16	15	13	13	12	11
1.00	4.6	10	10	9	7	6	5									
1.00	5.0	12	12	11	9	7	6	5	5							
1.00	6.0	18	18	16	13	11	9	8	7	6	6	5	5			
1.00	6.3	20	20	18	14	12	10	9	8	7	6	6	5	5	5	
1.00	7.0	24	24	22	18	15	13	11	10	9	8	7	7	6	6	5
1.00	8.0			29	23	19	17	14	13	12	10	10	9	8	8	7
1.00	10.0						26	23	20	18	17	15	14	13	12	11
1.50	4.6	10	10	10	8	7	6	5								
1.50	5.0	12	12	12	10	8	7	6	5	5						
1.50	6.0	18	18	18	14	12	10	9	8	7	6	5	5	5		
1.50	6.3	20	20	20	16	13	11	10	8	7	7	6	6	5	5	
1.50	7.0	24	24	24	20	16	14	12	10	9	8	8	7	6	6	6
1.50	8.0				26	21	18	16	14	12	11	10	9	9	8	7
1.50	10.0						29	25	22	20	18	16	15	14	13	12

Tabela XV

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\omega d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 25 V/d = $\tau . b_\omega$

		V/d														
ρ_1	ϕ	125	150	174	199	224	250	274	299	324	439	375	399	424	449	474
0.15	4.6	9	8	6	5											
0.15	5.0	11	9	8	6	5	5									
0.15	6.0	16	14	11	9	8	7	6	5	5						
0.15	6.3	17	15	12	10	9	8	7	6	5	5	5				
0.15	7.0	21	19	15	13	11	10	8	8	7	6	6	5	5	5	
0.15	8.0	28	25	20	17	14	13	11	10	9	8	8	7	7	6	6
0.15	10.0				27	23	20	18	16	15	13	12	11	11	10	9
0.50	4.6	9	9	7	6	5										
0.50	5.0	11	11	8	7	6	5									
0.50	6.0	16	15	12	10	8	7	6	6	5	5					
0.50	6.3	17	17	13	11	9	8	7	6	6	5	5				
0.50	7.0	21	21	17	14	12	10	9	8	7	7	6	6	5	5	
0.50	8.0	28	28	22	18	15	13	12	11	10	9	8	7	7	6	6
0.50	10.0				29	24	21	19	17	15	14	13	12	11	10	10
1.00	4.6	9	9	8	6	5										
1.00	5.0	11	11	10	8	6	5	5								
1.00	6.0	16	16	14	11	9	8	7	6	5	5					
1.00	6.3	17	17	15	12	10	9	8	7	6	5	5	5			
1.00	7.0	21	21	19	15	13	11	10	9	8	7	6	6	5	5	5
1.00	8.0	28	28	25	20	17	15	13	11	10	9	8	8	7	7	6
1.00	10.0					27	23	20	18	16	15	13	12	11	11	10
1.50	4.6	9	9	9	7	6	5									
1.50	5.0	11	11	11	9	7	6	5								
1.50	6.0	16	16	16	13	10	9	8	7	6	5	5				
1.50	6.3	17	17	17	14	11	10	8	7	6	6	5	5			
1.50	7.0	21	21	21	17	14	12	10	9	8	7	7	6	6	5	5
1.50	8.0	28	28	28	23	19	16	14	12	11	10	9	8	7	7	6
1.50	10.0						25	22	19	17	15	14	13	12	11	10

Tabela XVI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

f_{ck} = 15.0 MPa $f_{y\,\omega\,d}$ = 435 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 30 V/d = $\tau . b_\omega$

		V/d														
ρ_1	ϕ	150	179	209	239	269	300	329	359	389	419	450	479	509	539	569
0.15	4.6	7	7	5												
0.15	5.0	9	8	6	5											
0.15	6.0	13	11	9	8	7	6	5								
0.15	6.3	14	13	10	8	7	6	6	5							
0.15	7.0	18	16	13	11	9	8	7	6	6	5	5				
0.15	8.0	23	21	17	14	12	10	9	8	8	7	6	6	5	5	5
0.15	10.0			26	22	19	17	15	13	12	11	10	9	9	8	8
0.50	4.6	7	7	6	5											
0.50	5.0	9	9	7	6	5										
0.50	6.0	13	13	10	8	7	6	5	5							
0.50	6.3	14	14	11	9	8	7	6	5	5						
0.50	7.0	18	18	14	11	10	8	7	7	6	5	5	5			
0.50	8.0	23	23	18	15	13	11	10	9	8	7	7	6	6	5	5
0.50	10.0			29	24	20	18	16	14	13	11	11	10	9	8	8
1.00	4.6	7	7	7	5											
1.00	5.0	9	9	8	6	5										
1.00	6.0	13	13	12	9	8	7	6	5							
1.00	6.3	14	14	13	10	9	7	6	6	5						
1.00	7.0	18	18	16	13	11	9	8	7	6	6	5	5			
1.00	8.0	23	23	21	17	14	12	10	9	8	8	7	6	6	5	5
1.00	10.0				27	22	19	17	15	13	12	11	10	9	9	8
1.50	4.6	7	7	7	6	5										
1.50	5.0	9	9	9	7	6	5									
1.50	6.0	13	13	13	10	9	7	6	5	5						
1.50	6.3	14	14	14	12	9	8	7	6	5	5					
1.50	7.0	18	18	18	14	12	10	9	8	7	6	5	5	5		
1.50	8.0	23	23	23	19	16	13	11	10	9	8	7	7	6	6	5
1.50	10.0					25	21	18	16	14	13	12	11	10	9	9

Tabela XVII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 10 V/d = $\tau . b_\omega$

		V/d																	
ρ_1	ϕ	50	60	70	80	90	100	110	120	130	140	150	160	169	179	189	200	209	219
0.15	4.6	23	21	17	14	12	11	9	8	8	7	6	6	5	5	5.			
0.15	5.0	28	25	20	17	14	13	11	10	9	8	8	7	7	6	6	5	5	5
0.15	6.0				25	21	18	16	15	13	12	11	10	10	9	8	8	8	7
0.15	6.3				27	23	20	18	16	15	13	12	11	11	10	9	9	8	8
0.15	7.0					29	25	22	20	18	17	15	14	13	12	12	11	10	10
0.15	8.0							29	26	24	22	20	19	18	16	15	15	14	13
0.15	10.0													28	26	24	23	22	21
0.50	4.6	23	23	19	15	13	11	10	9	8	7	7	6	6	5	5	5		
0.50	5.0	28	28	22	18	16	13	12	11	9	9	8	7	7	6	6	6	5	5
0.50	6.0				27	23	20	17	15	14	13	12	11	10	9	9	8	8	7
0.50	6.3				29	25	22	19	17	15	14	13	12	11	10	10	9	9	8
0.50	7.0						27	24	21	19	17	16	15	14	13	12	11	11	10
0.50	8.0								28	25	23	21	19	18	17	16	15	14	13
0.50	10.0													29	27	25	24	22	21
1.00	4.6	23	23	22	18	15	12	11	10	9	8	7	6	6	5	5	5		
1.00	5.0	28	28	26	21	17	15	13	11	10	9	8	8	7	7	6	6	5	5
1.00	6.0					25	21	19	17	15	13	12	11	10	10	9	9	8	8
1.00	6.3					28	24	21	18	16	15	14	12	12	11	10	9	9	8
1.00	7.0						29	26	23	20	18	17	16	14	13	13	12	11	10
1.00	8.0									27	24	22	20	19	18	17	16	15	14
1.00	10.0														28	26	25	23	22
1.50	4.6	23	23	23	20	16	14	12	10	9	8	7	7	6	6	5	5	5	
1.50	5.0	28	28	28	24	19	16	14	12	11	10	9	8	7	7	6	6	6	5
1.50	6.0					28	24	20	18	16	14	13	12	11	10	9	9	8	8
1.50	6.3						26	23	20	18	16	14	13	12	11	11	10	9	9
1.50	7.0							28	25	22	20	18	16	15	14	13	12	12	11
1.50	8.0									29	26	24	22	20	18	17	16	15	14
1.50	10.0														29	27	26	24	23

Tabela XVIII

FLEXÃO SIMPLES VALORES DO MOMENTO EM KNm

VIGAS DE SEÇÃO RETANGULAR b_ω = 12 CA-50A f_{ck} = 18MPa

ϕ	n	h	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100
10.0	2		7.2	9.7	12.1	14.5	17.0	19.4	21.9										
10.0	3					20.1	23.8	27.4	31.1	34.8	38.4	42.1	45.7	49.4	53.0				
10.0	4							34.8	39.7	44.6	49.5	54.3	59.2	64.1	69.0	73.8	78.7	83.6	88.5
10.0	5										59.1	65.2	71.3	77.4	83.5	89.6	95.7	101.8	107.9
10.0	6													90.1	97.5	104.8	112.1	119.4	126.7
10.0	7																127.1	135.6	144.2
12.5	2		10.1	13.9	17.7	21.5	25.3	29.1	32.9	36.7	40.6	44.4							
12.5	3					28.7	34.4	40.1	45.8	51.6	57.3	63.0	68.7	74.4	80.1	85.9	91.6	97.3	
12.5	4								57.2	64.8	72.4	80.1	87.7	95.3	102.9	110.5	118.2	125.8	133.4
12.5	5											94.3	103.9	113.4	122.9	132.4	142.0	151.5	161.0
12.5	6														141.4	152.8	164.2	175.7	187.1
12.5	7																		210.4
16.0	2				25.5	31.8	38.0	44.3	50.5	56.7	63.0	69.2	75.5	81.7	88.0				
16.0	3							57.9	67.3	76.6	86.0	95.4	104.7	114.1	123.4	132.8	142.2	151.5	160.9
16.0	4										104.8	117.3	129.8	142.3	154.8	167.3	179.8	192.2	204.7
16.0	5													164.1	179.7	195.3	210.9	226.5	242.1
16.0	6																237.9	256.6	275.4
20.0	2							61.4	71.2	80.9	90.7	100.5	110.2	120.0	129.7	139.5	149.2	159.0	
20.0	3												146.2	160.8	175.5	190.1	204.7	219.4	234.0
20.0	4																250.0	269.5	289.1

Tabela XIX

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 15 $V/d = \tau . b_\omega$

		V/d																
ρ_1	ϕ	75	90	105	120	135	150	164	179	194	209	225	239	254	269	284	300	314	329
0.15	4.6	15	14	11	9	8	7	6	5	5									
0.15	5.0	18	17	13	11	9	8	7	7	6	5	5	5						
0.15	6.0	26	24	20	16	14	12	11	10	9	8	7	7	6	6	5	5	5	5
0.15	6.3	29	27	22	18	15	13	12	11	10	9	8	7	7	6	6	6	5	5
0.15	7.0			27	22	19	17	15	13	12	11	10	9	9	8	8	7	7	6
0.15	8.0				29	25	22	19	17	16	14	13	12	12	11	10	10	9	9
0.15	10.0								28	25	23	21	20	18	17	16	15	14	14
0.50	4.6	15	15	12	10	9	7	6	6	5	5								
0.50	50	18	18	15	12	10	9	8	7	6	6	5	5						
0.50	6.0	26	26	22	18	15	13	11	10	9	8	8	7	6	6	6	5	5	5
0.50	6.3	29	29	24	19	16	14	13	11	10	9	8	8	7	7	6	6	6	5
0.50	7.0			29	24	20	18	16	14	13	11	10	10	9	8	8	7	7	7
0.50	8.0					27	23	20	18	17	15	14	13	12	11	10	19	9	9
0.50	10.0								29	26	24	22	20	19	18	17	16	15	14
1.00	4.6	15	15	15	12	10	8	7	6	6	5	5							
1.00	5.0	18	18	17	14	11	10	8	7	7	6	5	5	5					
1.00	6.0	26	26	25	20	17	14	12	11	10	9	8	7	7	6	6	6	5	5
1.00	6.3	29	29	28	22	18	16	14	12	11	10	9	8	8	7	7	6	6	5
1.00	7.0				27	23	19	17	15	13	12	11	10	9	9	8	8	7	7
1.00	8.0						25	22	20	18	16	15	13	12	12	11	10	10	9
1.00	10.0									28	25	23	21	20	18	17	16	15	14
1.50	4.6	15	15	15	13	11	9	8	7	6	5	5							
1.50	5.0	18	18	18	16	13	11	9	8	7	6	6	5	5					
1.50	6.0	26	26	26	23	19	16	13	12	10	9	9	8	7	7	6	6	5	5
1.50	6.3	29	29	29	26	21	17	15	13	12	10	9	9	8	7	7	6	6	6
1.50	7.0					26	21	18	16	14	13	12	11	10	9	9	8	8	7
1.50	8.0						28	24	21	19	17	16	14	13	12	11	11	10	9
1.50	10.0										27	25	22	21	19	18	17	16	15

Tabela XX

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\omega d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 17 $V/d = \tau . b_\omega$

		V/d																	
ρ_1	ϕ	85	102	119	136	153	170	186	204	220	237	255	271	288	305	322	340	356	373
0.15	4.6	13	12	10	8	7	6	5	5										
0.15	5.0	16	15	12	10	8	7	6	6	5	5								
0.15	6.0	23	21	17	14	12	11	9	8	8	7	6	6	5	5	5			
0.15	6.3	26	24	19	16	13	12	10	9	8	8	7	7	6	6	5	5	5	
0.15	7.0		29	24	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6
0.15	8.0				26	22	19	17	15	14	13	12	11	10	9	9	8	8	7
0.15	10.0							27	24	22	20	19	17	16	15	14	13	13	12
0.50	4.6	13	13	11	9	7	6	6	5										
0.50	5.0	16	16	13	11	9	8	7	6	5	5								
0.50	6.0	23	23	19	15	13	11	10	9	8	7	7	6	6	5	5	5		
0.50	6.3	26	26	21	17	14	12	11	10	9	8	7	7	6	6	5	5	5	5
0.50	7.0			26	21	18	16	14	12	11	10	9	8	8	7	7	6	6	6
0.50	8.0				28	24	20	18	16	15	13	12	11	10	10	9	9	8	8
0.50	10.0							28	25	23	21	19	18	17	15	15	14	13	12
1.00	4.6	13	13	13	10	8	7	6	5	5									
1.00	5.0	16	16	15	12	10	8	7	6	6	5	5							
1.00	6.0	23	23	22	18	15	12	11	10	9	8	7	6	6	6	5	5	5	
1.00	6.3	26	26	24	19	16	14	12	11	9	9	8	7	7	6	6	5	5	5
1.00	7.0				24	20	17	15	13	12	11	10	9	8	8	7	7	6	6
1.00	8.0					26	22	20	17	16	14	13	12	11	10	10	9	8	8
1.00	10.0								27	25	22	20	19	17	16	15	14	13	13
1.50	4.6	13	13	13	12	9	8	7	6	5	5								
1.50	5.0	16	16	16	14	11	9	8	7	6	6	5	5						
1.50	6.0	23	23	23	20	16	14	12	10	9	8	7	7	6	6	5	5	5	
1.50	6.3	26	26	26	22	18	15	13	11	10	9	8	8	7	6	6	6	5	5
1.50	7.0				28	23	19	16	14	13	11	10	9	9	8	7	7	7	5
1.50	8.0						25	21	19	17	15	14	12	12	11	10	9	9	8
1.50	10.0									26	24	22	20	18	17	16	15	14	13

Tabela XXI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 20 V/d = $\tau . b_\omega$

		V/d																	
ρ_1	ϕ	100	120	140	160	179	200	219	239	259	279	300	319	339	359	379	400	419	439
0.15	4.6	11	10	8	7	6	5												
0.15	5.0	14	12	10	8	7	6	5	5										
0.15	6.0	20	18	15	12	10	9	8	7	6	6	5	5	5					
0.15	6.3	22	20	16	13	11	10	9	8	7	6	6	5	5	5				
0.15	7.0	27	25	20	17	14	12	11	10	9	8	7	7	6	6	6	5	5	5
0.15	8.0			26	22	19	16	14	13	12	11	10	9	9	8	7	7	7	6
0.15	10.0					29	26	23	21	19	17	16	15	14	13	12	11	11	10
0.50	4.6	11	11	9	7	6	5	5											
0.50	5.0	14	14	11	9	8	6	6	5										
0.50	6.0	20	20	16	13	11	10	8	7	7	6	6	5	5					
0.50	6.3	22	22	18	14	12	11	9	8	7	7	6	6	5	5	5			
0.50	7.0	27	27	22	18	15	13	12	10	9	8	8	7	7	6	6	5	5	5
0.50	8.0			29	24	20	17	15	14	12	11	10	9	9	8	8	7	7	6
0.50	10.0						27	24	22	19	18	16	15	14	13	12	12	11	10
1.00	4.6	11	11	11	9	7	6	5	5										
1.00	5.0	14	14	13	10	8	7	6	5	5									
1.00	6.0	20	20	19	15	12	10	9	8	7	6	6	5	5	5				
1.00	6.3	22	22	21	16	14	12	10	9	8	7	7	6	6	5	5			
1.00	7.0	27	27	26	20	17	14	13	11	10	9	8	8	7	6	6	6	5	5
1.00	8.0				27	22	19	17	15	13	12	11	10	9	9	8	8	7	7
1.00	10.0							26	23	21	19	17	16	15	14	13	12	11	11
1.50	4.6	11	11	11	10	8	7	6	5										
1.50	5.0	14	14	14	12	9	8	7	6	5	5								
1.50	6.0	20	20	20	17	14	12	10	9	8	7	6	6	5	5				
1.50	6.3	22	22	22	19	15	13	11	10	9	8	7	6	6	5	5	5		
1.50	7.0	27	27	27	24	19	16	14	12	11	10	9	8	7	7	6	6	6	5
1.50	8.0					25	21	18	16	14	13	12	11	10	9	8	8	7	7
1.50	10.0							29	25	22	20	18	17	15	14	13	13	12	11

Tabela XXII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 22 V/d = $\tau . b_\omega$

		V/d																
ρ_1	ϕ	110	132	154	176	197	220	241	263	285	307	330	351	373	395	417	440	461	483
0.15	4.6	10	9	8	6	5	5												
0.15	5.0	12	11	9	7	6	5	5											
0.15	6.0	18	16	13	11	9	8	7	6	6	5	5							
0.15	6.3	20	18	15	12	10	9	8	7	6	6	5	5	5					
0.15	7.0	24	23	18	15	13	11	10	9	8	7	7	6	6	5	5	5		
0.15	8.0			24	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6
0.15	10.0					27	23	21	19	17	15	14	13	12	11	11	10	10	9
0.50	4.6	10	10	8	7	6	5												
0.50	5.0	12	12	10	8	7	6	5	5										
0.50	6.0	18	18	15	12	10	9	8	7	6	5	5	5						
0.50	6.3	20	20	16	13	11	10	8	7	7	6	6	5	5					
0.50	7.0	24	24	20	16	14	12	10	9	8	8	7	6	6	6	5	5	5	
0.50	8.0			26	21	18	16	14	12	11	10	9	9	8	7	7	7	6	6
0.50	10.0					29	25	22	20	18	16	15	14	13	12	11	10	10	9
1.00	4.6	10	10	10	8	6	5	5											
1.00	5.0	12	12	12	9	8	6	6	5										
1.00	6.0	18	18	17	13	11	9	8	7	6	6	5	5						
1.00	6.3	20	20	19	15	12	10	9	8	7	6	6	5	5	5				
1.00	7.0	24	24	23	19	15	13	11	10	9	8	7	7	6	6	5	5	5	
1.00	8.0				24	20	17	15	13	12	11	10	9	8	8	7	7	6	6
1.00	10.0						27	24	21	19	17	16	14	13	12	12	11	10	10
1.50	4.6	10	10	10	9	7	6	5											
1.50	5.0	12	12	12	11	9	7	6	5	5									
1.50	6.0	18	18	18	16	13	11	9	8	7	6	6	5	5					
1.50	6.3	20	20	20	17	14	12	10	9	8	7	6	6	5	5	5			
1.50	7.0	24	24	24	21	17	14	12	11	10	9	8	7	7	6	6	5	5	5
1.50	8.0				28	23	19	16	14	13	11	10	10	9	8	8	7	7	6
1.50	10.0							26	23	20	18	17	15	14	13	12	11	11	10

Tabela XXIII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 25 V/d = $\tau . b_\omega$

		V/d																
ρ_1	ϕ	125	150	174	199	224	250	274	299	324	349	375	399	424	449	474	500	524	549
0.15	4.6	9	8	7	5	5													
0.15	5.0	11	10	8	6	5	5												
0.15	6.0	16	14	12	10	8	7	6	6	5	5								
0.15	6.3	17	16	13	11	9	8	7	6	6	5	5							
0.15	7.0	21	20	16	13	11	10	9	8	7	6	6	5	5	5				
0.15	8.0	28	26	21	17	15	13	11	10	9	8	8	7	7	6	6	6	5	5
0.15	10.0				27	23	20	18	16	15	14	12	12	11	10	9	9	8	8
0.50	4.6	9	9	7	6	5													
0.50	5.0	11	11	9	7	6	5												
0.50	6.0	16	16	13	10	9	8	7	6	5	5								
0.50	6.3	17	17	14	11	10	8	7	6	6	5	5							
0.50	7.0	21	21	17	14	12	10	9	8	7	7	6	6	5	5	5			
0.50	8.0	28	28	23	19	16	14	12	11	10	9	8	7	7	6	6	6	5	5
0.50	10.0					25	22	19	17	15	14	13	12	11	10	10	9	9	8
1.00	4.6	9	9	9	7	6	5												
1.00	5.0	11	11	10	8	7	6	5											
1.00	6.0	16	16	15	12	10	8	7	6	6	5	5							
1.00	6.3	17	17	16	13	11	9	8	7	6	6	5	5						
1.00	7.0	21	21	20	16	13	11	10	9	8	7	6	6	5	5	5			
1.00	8.0	28	28	27	21	18	15	13	12	10	9	9	8	7	7	6	6	6	5
1.00	10.0					28	24	21	18	17	15	14	13	12	11	10	10	9	8
1.50	4.6	9	9	9	8	6	5												
1.50	5.0	11	11	11	9	7	6	5	5										
1.50	6.0	16	16	16	14	11	9	8	7	6	5	5							
1.50	6.3	17	17	17	15	12	10	9	8	7	6	5	5	5					
1.50	7.0	21	21	21	19	15	13	11	10	8	8	7	6	6	5	5	5		
1.50	8.0	28	28	28	25	20	17	14	13	11	10	9	8	8	7	7	6	6	5
1.50	10.0						26	23	20	18	16	15	13	12	11	11	10	9	9

Tabela XXIV

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega d}$ = 435 MPa f_{ck} = 18.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 30 V/d = $\tau . b_\omega$

		V/d																
ρ_1	ϕ	150	179	209	239	269	300	329	359	389	419	450	479	509	539	569	600	629	659
0.15	4.6	7	7	5															
0.15	5.0	9	8	6	5														
0.15	6.0	13	12	10	8	7	6	5	5										
0.15	6.3	14	13	11	9	7	6	6	5	5									
0.15	7.0	18	16	13	11	9	8	7	6	6	5	5							
0.15	8.0	23	22	17	14	12	11	9	8	8	7	6	6	6	5	5	5		
0.15	10.0			27	23	19	17	15	14	12	11	10	10	9	8	8	7	7	7
0.50	4.6	7	7	6	5														
0.50	5.0	9	9	7	6	5													
0.50	6.0	13	13	11	9	7	6	5	5										
0.50	6.3	14	14	12	9	8	7	6	5	5									
0.50	7.0	18	18	14	12	10	9	8	7	6	5	5	5						
0.50	8.0	23	23	19	16	13	11	10	9	8	7	7	6	6	5	5	5		
0.50	10.0				25	21	18	16	14	13	12	11	10	9	9	8	8	7	7
1.00	4.6	7	7	7	6	5													
1.00	5.0	9	9	8	7	5	5												
1.00	6.0	13	13	12	10	8	7	6	5	5									
1.00	6.3	14	14	14	11	9	8	7	6	5	5								
1.00	7.0	18	18	17	13	11	9	8	7	6	6	5	5						
1.00	8.0	23	23	22	18	15	12	11	10	9	8	7	6	6	6	5	5	5	
1.00	10.0				28	23	20	17	15	14	12	11	10	10	9	8	8	7	7
1.50	4.6	7	7	7	6	5													
1.50	5.0	9	9	9	8	6	5												
1.50	6.0	13	13	13	11	9	8	6	6	5									
1.50	6.3	14	14	14	13	10	8	7	6	6	5								
1.50	7.0	18	18	18	16	13	10	9	8	7	6	6	5	5					
1.50	8.0	23	23	23	21	17	14	12	10	9	8	8	7	6	6	5	5	5	
1.50	10.0					26	22	19	17	15	13	12	11	10	9	9	8	8	7

Tabela XXV

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 10 V/d = $\tau . b_\omega$

		V/d																		
ρ_1	ϕ	50	60	70	80	90	100	110	120	130	140	150	160	169	179	189	200	209	219	229	239
0.15	4.6	23	22	18	15	12	11	9	8	8	7	6	6	5	5	5					
0.15	5.0	28	26	21	17	15	13	11	10	9	8	8	7	7	6	6	5	5	5	5	
0.15	6.0				25	21	19	17	15	13	12	11	10	10	9	8	8	8	7	7	6
0.15	6.3				28	24	21	18	16	15	14	12	12	11	10	9	9	8	8	8	7
0.15	7.0					29	26	23	20	18	17	16	14	13	13	12	11	10	10	9	9
0.15	8.0								27	24	22	20	19	18	16	15	15	14	13	12	12
0.15	10.0													28	26	24	23	22	21	20	19
0.50	4.6	23	23	19	16	13	11	10	9	8	7	7	6	6	5	5	5				
0.50	5.0	28	28	23	19	16	14	12	11	10	9	8	7	7	6	6	6	5	5	5	
0.50	6.0				27	23	20	17	15	14	13	12	11	10	9	9	8	8	7	7	7
0.50	6.3					25	22	19	17	16	14	13	12	11	10	10	9	9	8	8	7
0.50	7.0						27	24	21	19	18	16	15	14	13	12	11	11	10	10	9
0.50	8.0								28	25	23	21	20	18	17	16	15	14	13	13	12
0.50	10.0													29	27	25	24	22	21	20	19
1.00	4.6	23	23	23	18	15	13	11	10	9	8	7	7	6	6	5	5	5			
1.00	5.0	28	28	27	22	18	15	13	12	10	9	8	8	7	7	6	6	5	5	5	5
1.00	6.0					26	22	19	17	15	14	12	11	11	10	9	9	8	8	7	7
1.00	6.3					29	24	21	19	17	15	14	13	12	11	10	10	9	8	8	8
1.00	7.0							26	23	21	19	17	16	15	14	13	12	11	11	10	9
1.00	8.0									27	25	23	21	19	18	17	16	15	14	13	13
1.00	10.0														28	26	25	23	22	21	20
1.50	4.6	23	23	23	21	17	14	12	11	9	8	8	7	6	6	5	5	5			
1.50	5.0	28	28	28	25	20	17	14	13	11	10	9	8	8	7	7	6	6	5	5	5
1.50	6.0					29	25	21	18	16	15	13	12	11	10	10	9	8	8	7	7
1.50	6.3						27	23	20	18	16	15	13	12	11	11	10	9	9	8	8
1.50	7.0							29	25	22	20	18	17	15	14	13	12	12	11	10	10
1.50	8.0									29	26	24	22	20	19	17	16	15	14	14	13
1.50	10.0															28	26	24	23	22	21

Tabela XXVI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 12 V/d = $\tau . b_\omega$

		V/d																		
ρ_1	ϕ	60	72	84	96	108	120	132	144	156	167	180	191	204	216	227	240	251	263	275	287
0.15	4.6	19	18	15	12	10	9	8	7	6	6	5	5								
0.15	5.0	23	22	17	14	12	11	9	8	8	7	6	6	5	5	5					
0.15	6.0			25	21	18	15	14	12	11	10	9	9	8	7	7	7	6	6	6	5
0.15	6.3			28	23	20	17	15	14	12	11	10	10	9	8	8	7	7	7	6	6
0.15	7.0				28	24	21	19	17	15	14	13	12	11	10	10	9	9	8	8	7
0.15	8.0						28	25	22	20	18	17	16	15	14	13	12	11	11	10	10
0.15	10.0										29	27	25	23	22	20	19	18	17	16	16
0.50	4.6	19	19	16	13	11	9	8	7	7	6	5	5	5							
0.50	5.0	23	23	19	16	13	11	10	9	8	7	7	6	6	5	5	5				
0.50	6.0			28	23	19	16	14	13	12	11	10	9	8	8	7	7	6	6	6	5
0.50	6.3				25	21	18	16	14	13	12	11	10	9	9	8	8	7	7	6	6
0.50	7.0					26	23	20	18	16	15	13	12	11	11	10	9	9	8	8	8
0.50	8.0							26	23	21	19	18	16	15	14	13	12	12	11	11	10
0.50	10.0											28	26	24	22	21	20	19	18	17	16
1.00	4.6	19	19	19	15	12	10	9	8	7	6	6	5	5	5						
1.00	5.0	23	23	23	18	15	12	11	10	9	8	7	6	6	5	5	5				
1.00	6.0				26	21	18	16	14	12	11	10	9	9	8	8	7	7	6	6	6
1.00	6.3				29	24	20	17	15	14	12	11	10	10	9	8	8	7	7	7	6
1.00	7.0					29	25	22	19	17	16	14	13	12	11	10	10	9	9	8	8
1.00	8.0							28	25	23	20	19	17	16	15	14	13	12	12	11	10
1.00	10.0											29	27	25	23	22	21	19	18	17	16
1.50	4.6	19	19	19	18	14	12	10	9	8	7	6	6	5	5						
1.50	5.0	23	23	23	21	17	14	12	10	9	8	7	7	6	6	5	5	5			
1.50	6.0					24	20	17	16	13	12	11	10	9	9	8	7	7	7	6	6
1.50	6.3					27	22	19	17	15	13	12	11	10	9	9	8	8	7	7	6
1.50	7.0						28	24	21	19	17	15	14	13	12	11	10	10	9	9	8
1.50	8.0								27	24	22	20	18	17	16	14	14	13	12	11	11
1.50	10.0												29	26	25	23	21	20	19	18	17

Tabela XXVII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\omega d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 15 $V/d = \tau . b_\omega$

		V/d																			
ρ_1	ϕ	75	90	105	120	135	150	164	179	194	209	225	239	254	269	284	300	314	329	344	359
0.15	4.6	15	15	12	10	8	7	6	5	5											
0.15	5.0	18	17	14	11	10	8	7	7	6	5	5	5								
0.15	6.0	26	25	20	17	14	12	11	10	9	8	7	7	6	6	5	5	5	5		
0.15	6.3	29	28	22	18	16	14	12	11	10	9	8	8	7	7	6	6	5	5	5	5
0.15	7.0			27	23	19	17	15	13	12	11	10	9	9	8	8	7	7	6	6	6
0.15	8.0					25	22	20	18	16	15	13	12	12	11	10	10	9	9	8	8
0.15	10.0								28	25	23	21	20	18	17	16	15	14	14	13	12
0.50	4.6	15	15	13	10	9	7	7	6	5	5										
0.50	5.0	18	18	15	12	10	9	8	7	6	6	5	5								
0.50	6.0	26	26	22	18	15	13	11	10	9	8	8	7	7	6	6	5	5	5		
0.50	6.3	29	29	24	20	17	14	13	11	10	9	8	8	7	7	6	6	6	5	5	5
0.50	7.0				25	21	18	16	14	13	12	11	10	9	8	8	7	7	7	6	6
0.50	8.0					27	24	21	19	17	15	14	13	12	11	10	10	9	9	8	8
0.50	10.0								29	26	24	22	20	19	18	17	16	15	14	13	13
1.00	4.6	15	15	15	12	10	8	7	6	6	5	5									
1.00	5.0	18	18	18	14	12	10	9	8	7	6	5	5	5							
1.00	6.0	26	26	26	21	17	14	13	11	10	9	8	7	7	6	6	6	5	5	5	
1.00	6.3	29	29	29	23	19	16	14	12	11	10	9	8	8	7	7	6	6	5	5	5
1.00	7.0				28	23	20	17	15	14	12	11	10	10	9	8	8	7	7	7	6
1.00	8.0						26	23	20	18	16	15	14	13	12	11	10	10	9	9	8
1.00	10.0									28	26	23	22	20	19	17	16	15	15	14	13
1.50	4.6	15	15	15	14	11	9	8	7	6	5	5									
1.50	5.0	18	18	18	17	13	11	9	8	7	6	6	5	5	5						
1.50	6.0	26	26	26	24	19	16	14	12	11	10	9	8	7	7	6	6	5	5	5	5
1.50	6.3	29	29	29	27	21	18	15	13	12	11	10	9	8	7	7	6	6	6	5	5
1.50	7.0					27	22	19	17	15	13	12	11	10	9	9	8	8	7	7	6
1.50	8.0						29	25	22	19	17	16	14	13	12	11	11	10	9	9	9
1.50	10.0										27	25	23	21	20	18	17	16	15	14	14

Tabela XXVIII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 17 V/d = $\tau . b_\omega$

		V/d																		
ρ_1	ϕ	85	102	119	136	153	170	186	204	220	237	255	271	288	305	322	340	356	373	390	407
0.15	4.6	13	13	10	8	7	6	5	5												
0.15	5.0	16	15	12	10	8	7	6	6	5	5										
0.15	6.0	23	22	18	15	12	11	10	8	8	7	6	6	5	5	5					
0.15	6.3	26	24	19	16	14	12	11	9	9	8	7	7	6	6	5	5	5			
0.15	7.0			24	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6	5	5
0.15	8.0				26	22	20	17	15	14	13	12	11	10	9	9	8	8	7	7	7
0.15	10.0							27	24	22	20	19	17	16	15	14	13	13	12	11	11
0.50	4.6	13	13	11	9	8	7	6	5	5											
0.50	5.0	16	16	13	11	9	8	7	6	5	5										
0.50	6.0	23	23	19	16	13	11	10	9	8	7	7	6	6	5	5	5				
0.50	6.3	26	26	22	18	15	13	11	10	9	8	7	7	6	6	6	5	5	5		
0.50	7.0			27	22	18	16	14	12	11	10	9	9	8	7	7	6	6	6	5	5
0.50	8.0				29	24	21	18	16	15	13	12	11	11	10	9	9	8	8	7	7
0.50	10.0							29	26	23	21	19	18	17	16	15	14	13	12	12	11
1.00	4.6	13	13	13	10	9	7	6	5	5											
1.00	5.0	16	16	16	12	10	9	7	7	6	5	5									
1.00	6.0	23	23	23	18	15	13	11	10	9	8	7	7	6	6	5	5	5			
1.00	6.3	26	26	26	20	17	14	12	11	10	9	8	7	7	6	6	5	5	5	5	
1.00	7.0				25	21	17	15	13	12	11	10	9	8	8	7	7	6	6	6	5
1.00	8.0					27	23	20	18	16	14	13	12	11	10	10	9	8	8	8	7
1.00	10.0								28	25	23	21	19	18	16	15	14	14	13	12	11
1.50	4.6	13	13	13	12	10	8	7	6	5	5										
1.50	5.0	16	16	16	15	12	10	8	7	6	6	5	5								
1.50	6.0	23	23	23	21	17	14	12	11	9	8	8	7	6	6	5	5	5			
1.50	6.3	26	26	26	24	19	16	13	12	10	9	8	8	7	7	6	6	5	5	5	
1.50	7.0				29	23	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6
1.50	8.0						26	22	19	17	15	14	13	12	11	10	9	9	8	8	7
1.50	10.0									27	24	22	20	19	17	16	15	14	13	13	12

Tabela XXIX

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 20 V/d = τ .b_ω

		V/d																		
ρ_1	ϕ	100	120	140	160	179	200	219	239	259	279	300	319	339	359	379	400	419	439	459	479
0.15	4.6	11	11	9	7	6	5														
0.15	5.0	14	13	10	8	7	6	5	5												
0.15	6.0	20	19	15	12	10	9	8	7	6	6	5	5	5							
0.15	6.3	22	21	16	14	12	10	9	8	7	7	6	6	5	5						
0.15	7.0	27	26	20	17	14	13	11	10	9	8	8	7	6	6	6	5	5	5		
0.15	8.0			27	22	19	17	15	13	12	11	10	9	9	8	7	7	7	6	6	6
0.15	10.0						26	23	21	19	17	16	15	14	13	12	11	11	10	10	9
0.50	4.6	11	11	9	8	6	5	5													
0.50	5.0	14	14	11	9	8	7	6	5	5											
0.50	6.0	20	20	16	13	11	10	8	8	7	6	6	5	5							
0.50	6.3	22	22	18	15	12	11	9	8	8	7	6	6	5	5	5					
0.50	7.0	27	27	23	18	15	13	12	10	9	9	8	7	7	6	6	5	5	5	5	
0.50	8.0				24	20	18	15	14	12	11	10	10	9	8	8	7	7	6	6	6
0.50	10.0						28	24	22	20	18	16	15	14	13	12	12	11	10	10	9
1.00	4.6	11	11	11	9	7	6	5	5												
1.00	5.0	14	14	13	11	9	7	6	6	5											
1.00	6.0	20	20	20	15	13	11	9	8	7	7	6	5	5	5						
1.00	6.3	22	22	22	17	14	12	10	9	8	7	7	6	6	5	5	5				
1.00	7.0	27	27	27	21	17	15	13	11	10	9	8	8	7	7	6	6	5	5	5	
1.00	8.0				28	23	19	17	15	13	12	11	10	9	9	8	8	7	7	6	6
1.00	10.0							27	24	21	19	17	16	15	14	13	12	11	11	10	10
1.50	4.6	11	11	11	10	8	7	6	5												
1.50	5.0	14	14	14	12	10	8	7	6	5	5										
1.50	6.0	20	20	20	18	14	12	10	9	8	7	6	6	5	5	5					
1.50	6.3	22	22	22	20	16	13	11	10	9	8	7	6	6	5	5	5				
1.50	7.0	27	27	27	25	20	17	14	12	11	10	9	8	7	7	6	6	6	5	5	5
1.50	8.0					26	22	19	16	14	13	12	11	10	9	8	8	7	7	7	6
1.50	10.0							29	26	23	20	19	17	16	15	14	13	12	11	11	10

Tabela XXX

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 22 $V/d = \tau . b_\omega$

		V/d																		
ρ_1	ϕ	110	132	154	176	197	220	241	263	285	307	330	351	373	395	417	440	461	483	505	527
0.15	4.6	10	10	8	6	5	5														
0.15	5.0	12	12	9	8	6	6	5													
0.15	6.0	18	17	13	11	9	8	7	6	6	5	5									
0.15	6.3	20	19	15	12	10	9	8	7	6	6	5	5	5							
0.15	7.0	24	23	18	15	13	11	10	9	8	7	7	6	6	5	5	5				
0.15	8.0			24	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6	5	5
0.15	10.0					27	24	21	19	17	16	14	13	12	12	11	10	10	9	9	8
0.50	4.6	10	10	9	7	6	5														
0.50	5.0	12	12	10	8	7	6	5	5												
0.50	6.0	18	18	15	12	10	9	8	7	6	6	5	5								
0.50	6.3	20	20	17	13	11	10	9	8	7	6	6	5	5							
0.50	7.0	24	24	21	17	14	12	11	9	9	8	7	7	6	6	5	5	5			
0.50	8.0			27	22	18	16	14	12	11	10	9	9	8	7	7	7	6	6	6	5
0.50	10.0					29	25	22	20	18	16	15	14	13	12	11	11	10	9	9	8
1.00	4.6	10	10	10	8	7	5	5													
1.00	5.0	12	12	12	10	8	7	6	5												
1.00	6.0	18	18	18	14	11	10	8	7	7	6	5	5	5							
1.00	6.3	20	20	20	15	13	11	9	8	7	7	6	5	5	5						
1.00	7.0	24	24	24	19	16	13	12	10	9	8	8	7	6	6	5	5	5	5		
1.00	8.0				25	21	18	15	14	12	11	10	9	8	8	7	7	6	6	6	5
1.00	10.0						28	24	21	19	17	16	15	13	13	12	11	10	10	9	9
1.50	4.6	10	10	10	9	7	6	5	5												
1.50	5.0	12	12	12	11	9	7	6	5	5											
1.50	6.0	18	18	18	16	13	11	9	8	7	6	6	5	5							
1.50	6.3	20	20	20	18	14	12	10	9	8	7	6	6	5	5	5					
1.50	7.0	24	24	24	22	18	15	13	11	10	9	8	7	7	6	6	5	5	5		
1.50	8.0					24	20	17	15	13	12	11	10	9	8	8	7	7	6	6	6
1.50	10.0							27	23	21	19	17	15	14	13	12	11	11	10	10	9

Tabela XXXI

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega\,d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 25 $V/d = \tau . b_\omega$

		V/d																			
ρ_1	ϕ	125	150	174	199	224	250	274	299	324	349	375	399	424	449	474	500	524	549	574	599
0.15	4.6	9	9	7	6	5															
0.15	5.0	11	10	8	7	6	5														
0.15	6.0	16	15	12	10	8	7	6	6	5	5										
0.15	6.3	17	16	13	11	9	8	7	6	6	5	5									
0.15	7.0	21	20	16	13	11	10	9	8	7	6	6	5	5	5						
0.15	8.0	28	27	21	18	15	13	12	10	9	9	8	7	7	6	6	6	5	5	5	
0.15	10.0				28	24	21	18	16	15	14	13	12	11	10	9	9	8	8	8	7
0.50	4.6	9	9	7	6	5															
0.50	5.0	11	11	9	7	6	5														
0.50	6.0	16	16	13	11	9	8	7	6	5	5										
0.50	6.3	17	17	14	12	10	8	7	7	6	5	5									
0.50	7.0	21	21	18	15	12	11	9	8	7	7	6	6	5	5	5					
0.50	8.0	28	28	24	19	16	14	12	11	10	9	8	8	7	7	6	6	5	5	5	5
0.50	10.0					26	22	19	17	16	14	13	12	11	10	10	9	9	8	8	7
1.00	4.6	9	9	9	7	6	5														
1.00	5.0	11	11	11	8	7	6	5													
1.00	6.0	16	16	16	12	10	8	7	6	6	5	5									
1.00	6.3	17	17	17	14	11	9	8	7	6	6	5	5								
1.00	7.0	21	21	21	17	14	12	10	9	8	7	7	6	6	5	5					
1.00	8.0	28	28	28	22	18	15	13	12	11	10	9	8	7	7	6	6	6	5	5	5
1.00	10.0					29	24	21	19	17	15	14	13	12	11	10	10	9	9	8	8
1.50	4.6	9	9	9	8	7	5	5													
1.50	5.0	11	11	11	10	8	6	5	5												
1.50	6.0	16	16	16	14	11	10	8	7	6	6	5	5								
1.50	6.3	17	17	17	16	13	11	9	8	7	6	6	5	5							
1.50	7.0	21	21	21	20	16	13	11	10	9	8	7	6	6	5	5	5				
1.50	8.0	28	28	28	26	21	17	15	13	11	10	9	8	8	7	7	6	6	5	5	5
1.50	10.0						27	23	20	18	16	15	14	12	12	11	10	9	9	8	8

Tabela XXXII

TABELA DE DIMENSIONAMENTO DO ESFORÇO CORTANTE

$f_{y\,\omega d}$ = 435 MPa f_{ck} = 20.0 MPa γ_f = 1.40 γ_c = 1.40 γ_s = 1.15

VALORES DO S (CM) b_ω = 30 $V/d = \tau . b_\omega$

		V/d																		
ρ_1	ϕ	150	179	209	239	269	300	329	359	389	419	450	479	509	539	569	600	629	659	689	719
0.15	4.6	7	7	6	5																
0.15	5.0	9	8	7	5	5															
0.15	6.0	13	12	10	8	7	6	5	5												
0.15	6.3	14	14	11	9	8	7	6	5	5											
0.15	7.0	18	17	13	11	9	8	7	6	6	5	5									
0.15	8.0	23	22	18	15	12	11	10	9	8	7	6	6	6	5	5	5				
0.15	10.0			28	23	20	17	15	14	12	11	10	10	9	8	8	7	7	7	6	6
0.50	4.6	7	7	6	5																
0.50	5.0	9	9	7	6	5															
0.50	6.0	13	13	11	9	7	6	5	5												
0.50	6.3	14	14	12	10	8	7	6	5	5											
0.50	7.0	18	18	15	12	10	9	8	7	6	6	5	5								
0.50	8.0	23	23	20	16	13	12	10	9	8	7	7	6	6	5	5	5				
0.50	10.0				25	21	18	16	14	13	12	11	10	9	9	8	8	7	7	6	6
1.00	4.6	7	7	7	6	5															
1.00	5.0	9	9	9	7	6	5														
1.00	6.0	13	13	13	10	8	7	6	5	5											
1.00	6.3	14	14	14	11	9	8	7	6	5	5										
1.00	7.0	18	18	18	14	11	10	8	7	7	6	5	5	5							
1.00	8.0	23	23	23	18	15	13	11	10	9	8	7	7	6	6	5	5	5			
1.00	10.0				29	24	20	18	16	14	13	11	11	10	9	8	8	7	7	7	6
1.50	4.6	7	7	7	7	5															
1.50	5.0	9	9	9	8	6	5														
1.50	6.0	13	13	13	12	9	8	7	6	5	5										
1.50	6.3	14	14	14	13	10	9	7	6	6	5	5									
1.50	7.0	18	18	18	16	13	11	9	8	7	6	6	5	5							
1.50	8.0	23	23	23	22	17	14	12	11	9	8	8	7	6	6	5	5	5			
1.50	10.0					27	23	19	17	15	13	12	11	10	10	9	8	8	7	7	7

TABELAS PARA CÁLCULO DIRETO DE PILARES COM SEÇÃO RETANGULAR

1 As tabelas foram elaboradas de acordo com a NBR 6118/82e servem para o cálculo de verificação e dimensionamento de pilares de concreto armado de seção retangular, submetidos a compressão centrada, $\lambda \leq 80$

2 As tabelas prevêem 4 valores de f_{ck} e foram feitas para os aços CA-50-A e CA-50-B.

3 Deve-se entrar nas tabelas com $F=\gamma_h N$, sendo N o valor característico do esforço de compressão (sem majoração).

4 Unidades

Esforços $F=\gamma_h N$; F_c, F_s - KN

5 Coeficientes

$\gamma_f=1,4$; $\gamma_c=1,4$; $\gamma_s=1,15$

$\gamma_h = 1 + \frac{6}{h} \geq 1,10$ com $\lambda < 40$

$\gamma_h = 1 + K\frac{e}{h} \geq 1,10$ com $40 < \lambda < 80$

6 Se F/F_c estiver compreendido entre os valores indicados na tabela temos $0,8\% \leq \rho < 6\%$

7 Exemplo de aplicação

7.1 Verificação

Determinar a carga normal admissível, em serviço, de um pilar curto com seção transversal 25 x 40, f_{ck}=15 MPa, 8ϕ16mm CA-50-B

Para f_{ck} =15 MPa, 25x40 temos F_c=650,51KN

CA-50-B, 8ϕ16mm temos F_s = 397,93 KN

$F=F_c + F_s$ = 1048,44KN

com h=25 temos γ_h=1,24

portanto $N = \frac{F}{\gamma_h} \quad \frac{1048,44}{1,24} = 845,51$ KN

7.2 Dimensionamento, $\lambda \leq 40$

7.2.1. Seção com $0,8\% \leq \rho \leq 6\%$

Determinar a armadura para um pilar curto ($\lambda < 40$) de 25x25, f_{ck}=15 MPa, CA-50-A, N=560,16. Com h=25 temos γ_h=1,24

$F=\gamma_h N$=1,24 x 560,16=694,6 KN

Para f_{ck}=15 MPa, 25x25 temos F_c=406,57KN

F/F_c= 694,60/ 405,6=1,71

$1,36 < F/F_c < 3,70$

$F_s = F - F_c$ = 694,60- 406,57= 288,03KN

com F_s=288,03entramos na tabela do CA-50-A para f_{ck}=15 MPa temos 8 ϕ 12,5 .

7.2.2. Seção com $\rho < 0,8\%$

Sobre um pilar de 25x40 atua uma força de 636,53 KN, f_{ck}=15 MPa, CA-50-B, determinar a armadura

γ_h=1,24 F=1,24x636,53=789,30

Para f_{ck}=15 MPa, 25x40 temos F_c=650,51KN

F/F_c =789,30 / 650,51=1,21 < 1,3 (seção abundante)

F_{cnec}= F/1,3 =789,30/1,3=607,15

F_s = F - F_{cnec}=789,30 - 607,15=182,15KN

Com F_s=182,15entramos na tabela do CA-50-B para f_{ck}=15 MPa temos 6ϕ12,5

7.3 Dimensionamento $40 \leq \lambda \leq 80$; $\nu > 0,7$

Determinar a armadura de um pilar de 25x25, ℓ_e=3,50cm, N=528,91 KN, f_{ck}=15 MPa, CA-50-B.

λ =3,46 x 350/25=48,44 $f_{cd}=f_{ck}/\gamma_c$=15/1,4=10,71 MPa=

= 1,071 KN/cm^2

$$\nu = \frac{Nd}{A_c\ f_{cd}} = \frac{528,91x1,4}{25x25x1,071} = 1,10 > 0,7$$

excentricidade complementar, ℓ_e(m), h(cm)

$$e_c = 5,5\ \frac{\ell_e^2}{h} \times \frac{1}{\nu+0,5} = 5,5 \times \frac{3.50^2}{25} \times \frac{1}{1,1+0,5} = 1,67 \text{ cm}$$

$$e_a \geq \begin{cases} h/30 = 25/30 = 0,83 \\ 2cm \end{cases}$$

$$e = e_c + e_a = 1,67+2,00 = 3,67 \text{ cm}$$

$\gamma_h = 1+K\ e/h \geq 1,1$, tomando K=3 temos

$\gamma_h = 1+3x3,67/25 = 1,44$

$F = \gamma_h \times N = 1,44x528,91 = 761,63$

Para f_{ck}=15MPa, 25x25 temos

$F_c = 406,57$ KN

$F/F_c = 761,63/406,5 = 1,875$

$1,30 \leq F/F_c \leq 3,28$

$F_s = F - F_c = 761,63 - 406,5 = 355,13$

Com F_s=355,13 entramos na tabela CA-50-B para

f_{ck}=15 MPa temos 12 ϕ 12,5

Tabela I

PILARES —

VALORES DE 'Fc' (KN) F_{ck} = 13.5 MPa

$1.40 \leqslant F/Fc \leqslant 4.01$ CA-50A

$1.33 \leqslant F/Fc \leqslant 3.54$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	234.18									11.71	140.51
22	257.60	283.36								12.88	154.56
25	292.72	322.00	365.91							14.64	175.63
30	351.27	386.40	439.09	526.90						17.56	210.76
35	409.81	450.80	512.27	614.72	717.18					20.49	245.89
40	468.36	515.20	585.45	702.54	819.63	936.72				23.42	281.02
45	526.90	579.60	658.63	790.36	922.08	1053.81	1185.54			26.35	316.14
50	585.45	643.99	731.81	878.17	1024.54	1170.90	1317.26	1463.62		29.27	351.27
55	643.99	708.39	804.99	965.99	1126.99	1287.99	1448.99	1609.99	1931.98	32.20	386.40
60	702.54	772.79	878.17	1053.81	1229.44	1405.08	1580.71	1756.35	2107.62	35.13	421.52
65	761.08	837.19	951.36	1141.63	1331.90	1522.17	1712.44	1902.71	2283.25	38.05	456.65
70	819.63	901.59	1024.54	1229.44	1434.35	1639.26	1844.17	2049.07	2458.89	40.98	491.78
75	878.17	965.99	1097.72	1317.26	1536.81	1756.35	1975.89	2195.44	2634.52	43.91	526.90
80	936.72	1030.39	1170.90	1405.08	1639.26	1873.44	2107.62	2341.80	2810.16	46.84	562.03
85	995.26	1094.79	1244.08	1492.90	1741.71	1990.53	2239.35	2488.16	2985.79	49.76	597.16
90	1053.81	1159.19	1317.26	1580.71	1844.17	2107.62	2371.07	2634.52	3161.43	52.69	632.29
95	1112.35	1223.59	1390.44	1668.53	1946.62	2224.71	2502.80	2780.89	3337.06	55.62	667.41
100	1170.90	1287.99	1463.62	1756.35	2049.07	2341.80	2634.52	2927.25	3512.70	58.54	702.54

Tabela II — VALORES DE 'Fs' (KN) CA - 50 - A σ_s (2 ‰) = 420 MPa

n/ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	46.20	72.19	118.28	184.82	227.71	288.78	473.13	739.27
04	92.41	144.39	236.57	369.63	455.43	577.55	946.26	1478.53
06	138.61	216.58	354.85	554.45	683.14	866.33	1419.39	2217.80
08	184.82	288.78	473.13	739.27	910.85	1155.10	1892.52	2957.07
10	231.02	360.97	591.41	924.08	1138.56	1443.88	2365.65	3696.34
12	277.23	433.16	709.70	1108.90	1366.28	1732.66	2838.79	4435.60
14	323.43	505.36	827.98	1293.72	1593.99	2021.43	3311.92	5174.87
16	369.63	577.55	946.26	1478.53	1821.70	2310.21	3785.05	5914.14
18	415.84	649.75	1064.54	1663.35	2049.41	2598.98	4258.18	6653.41
20	462.04	721.94	1182.83	1848.17	2277.13	2887.76	4731.31	7392.67

Tabela III

PILARES –

VALORES DE 'Fc' (KN) f_{ck} = 15.0 MPa

$1.36 \leqslant F/Fc \leqslant 3.70$ CA-50A

$1.30 \leqslant F/Fc \leqslant 3.28$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	260.20									13.01	156.12
22	286.22	314.85								14.31	171.73
25	325.25	357.78	406.57							16.26	195.15
30	390.31	429.34	487.88	585.46						19.52	234.18
35	455.36	500.89	569.20	683.04	796.87					22.77	273.21
40	520.41	572.45	650.51	780.61	910.71	1040.82				26.02	312.24
45	585.46	644.00	731.82	878.19	1024.55	1170.92	1317.28			29.27	351.28
50	650.51	715.56	813.14	975.76	1138.39	1301.02	1463.65	1626.27		32.53	390.31
55	715.56	787.12	894.45	1073.34	1252.23	1431.12	1610.01	1788.90	2146.68	35.78	429.34
60	780.61	858.67	975.76	1170.92	1366.07	1561.22	1756.38	1951.53	2341.84	39.03	468.37
65	845.66	930.23	1057.08	1268.49	1479.91	1691.33	1902.74	2114.16	2536.99	42.28	507.40
70	910.71	1001.79	1138.39	1366.07	1593.75	1821.43	2049.11	2276.78	2732.14	45.54	546.43
75	975.76	1073.34	1219.71	1463.65	1707.59	1951.53	2195.47	2439.41	2927.29	48.79	585.46
80	1040.82	1144.90	1301.02	1561.22	1821.43	2081.63	2341.84	2602.04	3122.45	52.04	624.49
85	1105.87	1216.45	1382.33	1658.80	1935.27	2211.73	2488.20	2764.67	3317.60	55.29	663.52
90	1170.92	1288.01	1463.65	1756.38	2049.11	2341.84	2634.57	2927.29	3512.75	58.55	702.55
95	1235.97	1359.57	1544.96	1853.95	2162.95	2471.94	2780.93	3089.92	3707.91	61.80	741.58
100	1301.02	1431.12	1626.27	1951.53	2276.78	2602.04	2927.29	3252.55	3903.06	65.05	780.61

Tabela IV – VALORES DE 'Fs' (KN) CA-50-A σ_s (2 ‰) = 420 MPa

n/φ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	46.10	72.03	118.02	184.41	227.21	288.14	472.08	737.63
04	92.20	144.07	236.04	368.82	454.42	576.27	944.17	1475.26
06	138.31	216.10	354.06	553.22	681.63	864.41	1416.25	2212.90
08	184.41	288.14	472.08	737.63	908.84	1152.55	1888.34	2950.53
10	230.51	360.17	590.10	922.04	1136.04	1440.69	2360.42	3688.16
12	276.61	432.21	708.13	1106.45	1363.25	1728.82	2832.51	4425.79
14	322.71	504.24	826.15	1290.86	1590.46	2016.96	3304.59	5163.43
16	368.82	576.27	944.17	1475.26	1817.67	2305.10	3776.68	5901.06
18	414.92	648.31	1062.19	1659.67	2044.88	2593.24	4248.76	6638.69
20	461.02	720.34	1180.21	1844.08	2272.09	2881.37	4720.84	7376.32

Tabela V

PILARES —

VALORES DE 'Fc' (KN) f_{ck} = 18.0 MPa

$1.29 \leqslant F/Fc \leqslant 3.24$ CA-50A

$1.25 \leqslant F/Fc \leqslant 2.89$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	312.24									15.61	187.35
22	343.47	377.82								17.17	206.08
25	390.30	429.34	487.88							19.52	234.18
30	468.37	512.20	585.46	702.55						23.42	281.02
35	546.43	601.07	683.03	819.64	956.25					27.32	327.86
40	624.49	686.94	780.61	936.73	1092,85	1248.98				31.22	374.69
45	702.55	772.80	878.19	1052.82	1229.46	1405.10	1580.74			35.13	421.53
50	780.61	858.67	975.76	1170.91	1366.07	1561.22	1756.37	1951.52		39.03	468.37
55	858.67	944.54	1073.34	1288.01	1502.67	1717.34	1932.01	2146.68	2576.01	42.93	515.20
60	936.73	1030.41	1170.91	1405.10	1639.28	1873.46	2107.65	2341.83	2810.20	46.84	562.04
65	1014.79	1116.27	1268.49	1522.19	1775.89	2029.59	2283.28	2536.98	3044.38	50.74	608.88
70	1092.85	1202.14	1366.07	1639.28	1912.49	2185.71	2458.92	2732.13	3278.56	56.64	655.71
75	1170.91	1288.01	1463.64	1756.37	2049.10	2341.83	2634.56	2927.29	3512.74	58.55	702.55
80	1248.98	1373.87	1561.22	1873.46	2185.71	2497.95	2810.20	3122.44	3746.93	62.45	749.39
85	1327.04	1459.74	1658.80	1990.56	2322.31	2654.07	2985.83	3317.59	2981.11	66.35	796.22
90	1405.10	1545.61	1756.37	2107.65	2458.92	2810.20	3161.47	3512.74	4215.29	70.25	843.06
95	1483.16	1631.47	1853.95	2224.74	2595.53	2966.32	3337.11	3707.90	4449.48	74.16	889.90
100	1561.22	1717.34	1951.52	2341.83	2732.13	3122.44	3512.74	3903.05	4683.66	78.06	936.73

Tabela VI — VALORES DE 'Fs' (KN) CA - 50 - A σ_s (2 ‰) = 420 MPa

n/ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	45.90	71.72	117.50	183.59	226.20	286.86	469.99	734.36
04	91.80	143.43	235.00	367.18	452.40	573.72	939.98	1468.73
06	137.69	215.15	352.49	550.77	678.61	860.58	1409.98	2203.09
08	183.59	286.86	469.99	734.36	904.81	1147.44	1879.97	2937.45
10	229.49	358.58	587.49	917.95	1131.01	1434.30	2349.96	3671.81
12	275.39	430.29	704.99	1101.54	1357.21	1721.16	2819.95	4406.18
14	321.28	502.01	822.48	1285.13	1583.41	2008.02	3289.94	5140.54
16	367.18	573.72	939.98	1468.73	1809.61	2294.88	3759.93	5874.90
18	413.08	645.44	1057.48	1652.32	2035.82	2581.74	4229.93	6609.26
20	458.98	717.15	1174.98	1835.91	2262.02	2868.60	4699.92	7343.63

Tabela VII

PILARES –

VALORES DE 'Fc' (KN) f_{ck} = 20.0 MPa

$1.26 \leq F/Fc \leq 3.01$ CA-50A

$1.22 \leq F/Fc \leq 2.69$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	346.92									17.35	208.15
22	381.61	419.77								19.08	228.97
25	433.65	477.01	542.06							21.68	260.19
30	520.38	572.42	650.47	780.57						26.02	312.23
35	607.11	667.82	758.89	910.66	1062.44					30.36	364.27
40	693.84	763.22	867.30	1040.76	1214.22	1387.68				34.69	416.30
45	780.57	858.63	975.71	1170.85	1366.00	1561.14	1756.28			39.03	468.34
50	867.30	954.03	1084.12	1300.95	1517.77	1734.60	1951.42	2168.25		43.36	520.38
55	954.03	1049.43	1192.54	1431.04	1669.55	1908.06	2146.57	2385.07	2862.09	47.70	572.42
60	1040.66	1144.84	1300.95	1561.14	1821.33	2081.52	2341.71	2601.90	3122.28	52.04	624.46
65	1127.49	1240.24	1409.36	1691.23	1973.11	2254.98	2536.85	2818.72	3382.47	56.37	676.49
70	1214.22	1335.64	1517.77	1821.33	2124.88	2428.44	2731.99	3035.55	3642.66	60.71	728.53
75	1300.95	1431.04	1626.19	1951.42	2276.66	2601.90	2927.14	3252.37	3902.85	65.05	780.57
80	1387.68	1526.60	1734.60	2081.52	2428.44	2775.36	3122.28	3469.20	4163.04	69.38	832.61
85	1474.41	1621.85	1843.01	2211.61	2580.22	2948.82	3317.42	3686.02	4423.23	73.72	884.65
90	1561.14	1717.25	1951.42	2341.71	2731.99	3122.28	3512.56	3902.85	4683.42	78.06	936.68
95	1647.87	1812.66	2059.84	2471.80	2883.77	3295.74	3707.71	4119.67	4943.61	82.39	988.72
100	1734.60	1908.06	2168.25	2601.90	3035.55	3469.20	3902.85	4336.50	5203.80	86.73	1040.76

Tabela VIII – VALORES DE 'Fs' (KN) CA - 50 - A σ_s (2 ‰) = 420 MPa

n /ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	45.76	71.50	117.15	183.05	225.53	286.01	468.60	732.18
04	91.52	143.00	234.30	366.09	451.06	572.02	937.19	1464.37
06	137.28	214.51	351.45	549.14	676.59	858.03	1405.79	2196.55
08	183.05	286.01	468.60	732.18	902.12	1144.04	1874.39	2928.73
10	228.81	357.51	585.75	915.23	1127.65	1430.05	2342.99	3660.92
12	274.57	429.01	702.90	1098.28	1353.18	1716.05	2811.58	4394.10
14	320.33	500.52	820.04	1281.32	1578.71	2002.06	3280.18	5125.29
16	366.09	572.02	937.19	1464.37	1804.25	2288.07	3748.78	5857.47
18	411.85	643.52	1054.34	1647.41	2029.78	2574.08	4217.38	6589.65
20	457.61	715.02	1171.49	1830.46	2255.31	2860.09	4685.97	7321.84

Tabela IX

PILARES — VALORES DE 'Fc' (KN) f_{ck} = 13.5 MPa

1.40 ≤ F/Fc ≤ 4.01 CA-50A

1.33 ≤ F/Fc ≤ 3.54 CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	234.18									11.71	140.51
22	257.60	283.36								12.88	154.56
25	292.72	322.00	365.91							14.64	175.63
30	351.27	386.40	439.09	526.90						17.56	210.76
35	409.81	450.80	512.27	614.72	717.18					20.49	245.89
40	468.36	515.20	585.45	702.54	819.63	936.72				23.42	281.02
45	526.90	579.60	658.63	790.36	922.08	1053.81	1185.54			26.35	316.14
50	585.45	643.99	731.81	878.17	1024.54	1170.90	1317.26	1463.62		29.27	351.27
55	643.99	708.39	804.99	965.99	1126.99	1287.99	1448.99	1609.99	1931.98	32.20	386.40
60	702.54	772.79	878.17	1053.81	1229.44	1405.08	1580.71	1756.35	2107.62	35.13	421.52
65	761.08	837.19	951.36	1141.63	1331.90	1522.17	1712.44	1902.71	2283.25	38.05	456.65
70	819.63	901.59	1024.54	1229.44	1434.35	1639.26	1844.17	2049.07	2458.89	40.98	491.78
75	878.17	965.99	1097.72	1317.26	1536.81	1756.35	1975.89	2195.44	2634.52	43.91	526.90
80	936.72	1030.39	1170.90	1405.08	1639.26	1873.44	2107.62	2341.80	2810.16	46.84	562.03
85	995.26	1094.79	1244.08	1492.90	1741.71	1990.53	2239.35	2488.16	2985.79	49.76	597.16
90	1053.81	1159.19	1318.26	1580.71	1844.17	2107.62	2371.07	2634.52	3161.43	52.69	632.29
95	1112.35	1223.59	1390.44	1668.53	1946.62	2224.71	2502.80	2780.89	3337.06	55.62	667.41
100	1170.90	1287.99	1463.62	1756.35	2049.07	2341.80	2634.52	2927.25	3512.70	58.54	702.54

Tabela X — VALORES DE 'Fs' (KN) CA - 50 - B σ_s (2 ‰) = 355.5MPa

n/ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	38.96	60.88	99.74	155.85	192.02	243.52	398.98	623.41
04	77.93	121.76	199.49	311.70	384.05	487.04	797.96	1246.81
06	116.89	182.64	299.23	467.55	576.07	730.55	1196.94	1870.22
08	155.85	243.52	398.98	623.41	768.10	974.07	1595.92	2493.62
10	194.81	304.40	498.72	779.26	960.12	1217.59	1994.90	3117.03
12	233.78	365.28	598.47	935.11	1152.15	1461.11	2393.88	3740.43
14	272.74	426.16	698.21	1090.96	1344.17	1704.62	2792.86	4363.84
16	311.70	487.04	797.96	1246.81	1536.19	1948.14	3191.84	4987.24
18	350.67	547.91	897.70	1402.66	1728.22	2191.66	3590.81	5610.65
20	389.63	608.79	997.45	1558.51	1920.24	2435.18	3989.79	6234.06

Tabela XI

PILARES –

VALORES DE 'Fc' (KN) f_{ck} = 15.0 MPa

$1.36 \leq F/Fc \leq 3.70$ CA-50A

$1.30 \leq F/Fc \leq 3.28$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	260.20									13.01	156.12
22	286.22	314.85								14.31	171.73
25	325.25	357.78	406.57							16.26	195.15
30	390.31	429.34	487.88	585.46						19.52	234.18
35	455.36	500.89	569.20	683.04	796.87					22.77	273.21
40	520.41	572.45	650.51	780.61	910.71	1040.82				26.02	312.24
45	585.46	644.00	731.82	878.19	1024.55	1170.92	1317.28			29.27	351.28
50	650.51	715.56	813.14	975.76	1138.39	1301.02	1463.65	1626.27		32.53	390.31
55	715.56	787.12	894.45	1073.34	1252.23	1431.12	1610.01	1788.90	2146.68	35.78	429.34
60	780.61	858.67	975.76	1070.92	1366.07	1561.22	1756.38	1951.53	2341.84	39.03	468.37
65	845.66	930.23	1057.08	1268.49	1479.91	1691.33	1902.74	2114.16	2536.99	42.28	507.40
70	910.71	1001.79	1138.39	1366.07	1593.75	1821.43	2049.11	2276.78	2732.14	45.54	546.43
75	975.76	1073.34	1219.71	1463.65	1707.59	1951.53	2195.47	2439.41	2927.29	48.79	585.46
80	1040.82	1144.90	1301.02	1561.22	1821.43	2081.63	2341.84	2602.04	3122.45	52.04	624.49
85	1105.87	1216.45	1382.33	1658.80	1935.27	2211.73	2488.20	2764.67	3317.60	55.29	663.52
90	1170.92	1288.01	1463.65	1756.38	2049.11	2341.84	2634.57	2927.29	3512.75	58.55	702.55
95	1235.97	1359.57	1544.96	1853.95	2162.65	2471.94	2780.93	3089.92	3707.91	61.80	741.58
100	1301.02	1431.12	1626.27	1951.53	2276.78	2602.04	2927.29	3252.55	3903.06	65.05	780.61

Tabela XII – VALORES DE 'Fs' (KN) CA - 50 - B σ_s (2 ‰) = 355.5 MPa

n/ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	38.86	60.72	99.48	145.44	191.52	242.88	397.93	621.77
04	77.72	121.44	198.97	310.89	383.04	485.76	795.87	1243.54
06	116.58	182.16	298.45	466.33	574.56	728.64	1193.80	1865.31
08	155.44	242.88	397.93	621.77	766.08	971.52	1591.73	2487.08
10	194.30	303.60	497.42	777.21	957.60	1214.39	1989.66	3108.85
12	233.16	364.32	596.90	932.66	1149.12	1457.27	2387.60	3730.62
14	272.02	425.04	696.38	1088.10	1340.64	1700.15	2785.53	4352.39
16	310.89	485.76	795.87	1243.54	1532.17	1943.03	3183.46	4974.16
18	349.75	546.48	895.35	1398.98	1723.69	2185.91	3581.40	5595.93
20	388.61	607.20	994.83	1554.43	1915.21	2428.79	3979.33	6217.70

Tabela XIII

PILARES – $1.29 \leq F/Fc \leq 3.24$ CA-50A

VALORES DE 'Fc' (KN) f_{ck} = 18.0 MPa $1.25 \leq F/Fc \leq 2.89$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	312.24									15.61	187.35
22	343.47	377.82								17.17	206.08
25	390.30	429.34	487.88							19.52	234.18
30	468.37	515.20	585.46	702.55						23.42	281.02
35	546.43	601.07	683.03	819.64	956.25					27.32	327.86
40	624.49	686.94	780.61	936.73	1092.85	1248.98				31.22	374.69
45	702.55	772.80	878.19	1053.82	1229.46	1405.10	1580.74			35.13	421.53
50	780.61	858.76	975.76	1170.91	1366.07	1561.22	1756.37	1951.52		39.03	468.37
55	858.67	944.54	1073.34	1288.01	1502.67	1717.34	1932.01	2146.68	2776.01	42.93	515.20
60	936.73	1030.41	1170.91	1405.10	1639.28	1873.46	2107.65	2341.83	2810.20	46.84	562.04
65	1014.79	1116.27	1268.49	1522.19	1775.89	2029.59	2283.28	2536.98	3044.38	50.74	608.88
70	1092.85	1202.14	1366.07	1639.28	1912.49	2185.71	2458.92	2732.13	3278.56	54.64	655.71
75	1170.91	1288.01	1463.64	1756.37	2049.10	2341.83	2634.56	2927.29	3512.74	58.55	702.55
80	1248.98	1373.87	1561.22	1873.46	2185.71	2497.95	2810.20	3122.44	3746.93	62.45	749.39
85	1327.04	1459.74	1658.80	1990.56	2322.31	2654.07	2985.83	3317.59	3981.11	66.35	796.22
90	1405.10	1545.61	1756.37	2107.65	2458.92	2810.20	3161.47	3512.74	4215.29	70.25	843.06
95	1483.16	1631.47	1853.95	2224.74	2595.53	2966.32	3337.11	3707.90	4449.48	74.16	889.90
100	1561.22	1717.34	1951.52	2341.83	2732.13	3122.44	3512.74	3903.05	4683.66	78.06	936.73

Tabela XIV – VALORES DE 'Fs' (KN) CA-50-B σ_s (2 ‰) = 355.5 MPa

n/ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	38.66	60.40	98.96	154.63	190.51	241.60	395.84	618.50
04	77.31	120.80	197.92	309.25	381.03	483.20	791.68	1237.00
06	115.97	181.20	296.88	463.88	571.54	724.80	1187.52	1855.50
08	154.63	241.60	395.84	618.50	762.05	966.41	1583.36	2474.00
10	193.28	302.00	494.80	773.13	952.57	1208.01	1979.20	3092.50
12	231.94	362.40	593.76	927.75	1143.08	1449.61	2375.04	3711.00
14	270.59	422.80	692.72	1082.38	1333.59	1691.21	2770.88	4329.50
16	309.25	483.20	791.68	1237.00	1524.11	1932.81	3166.72	4948.01
18	347.91	543.60	890.64	1391.63	1714.62	2174.41	3562.56	5566.51
20	386.56	604.00	989.60	1546.25	1905.14	2416.02	3958.40	6185.01

Tabela XV

PILARES — $1.26 \leq F/Fc \leq 3.01$ CA-50A

VALORES DE 'Fc' (KN) f_{ck} = 20.0 MPa $1.22 \leq F/Fc \leq 2.69$ CA-50B

b/h	20	22	25	30	35	40	45	50	60	1	12
20	346.92									17.35	208.15
22	381.61	419.77								19.08	228.97
25	433.65	477.01	542.06							21.68	260.19
30	520.38	572.42	650.47	780.57						26.02	312.23
35	607.11	667.82	758.89	910.66	1062.44					30.36	364.27
40	693.84	763.22	867.30	1040.76	1214.22	1387.68				34.69	416.30
45	780.57	858.63	975.71	1170.85	1366.00	1561.14	1756.28			39.03	468.34
50	867.30	954.03	1084.12	1300.95	1517.77	1734.60	1951.42	2168.25		43.36	520.38
55	954.03	1049.43	1192.54	1431.04	1669.55	1908.06	2146.57	2385.07	2862.09	47.70	572.42
60	1040.76	1144.84	1300.95	1561.14	1821.33	2081.52	2341.71	2601.90	3122.28	52.04	624.46
65	1127.49	1240.24	1409.36	1691.23	1973.11	2254.98	2536.85	2818.72	3382.47	56.37	676.49
70	1214.22	1335.64	1517.77	1821.33	2124.88	2428.44	2731.99	3035.55	3642.66	60.71	728.53
75	1300.95	1431.04	1626.19	1951.42	2276.66	2601.90	2927.14	3252.37	3902.85	65.05	780.57
80	1387.68	1526.45	1734.60	2085.52	2428.44	2775.36	3122.28	3469.20	4163.04	69.38	832.61
85	1474.41	1621.85	1843.01	2211.61	2580.22	2948.82	3317.42	3686.02	4423.23	73.72	884.65
90	1561.14	1717.25	1951.42	2341.71	2731.99	3122.28	3512.56	3902.85	4683.42	78.06	936.68
95	1647.87	1812.66	2059.84	2471.80	2883.77	3295.74	3707.71	4119.67	4943.61	82.39	988.72
100	1734.60	1908.06	2168.25	2601.90	3035.55	3469.20	3902.85	4336.50	5203.80	86.73	1040.76

Tabela XVI — VALORES DE 'Fs' (KN) CA - 50 - B σ_s (2 ‰) = 355.5 MPa

n /ϕ	10.0	12.5	16.0	20.0	22.2	25.0	32.0	40.0
02	38.52	60.19	98.61	154.08	189.84	240.75	394.45	616.32
04	77.04	120.38	197.22	308.16	379.68	481.50	788.99	1232.64
06	115.56	180.56	295.83	462.24	569.53	722.25	1183.34	1848.97
08	154.08	240.75	394.45	616.32	759.37	963.00	1577.78	2465.29
10	192.60	300.94	493.06	770.40	949.21	1203.75	1972.23	3081.61
12	231.12	361.13	591.67	924.48	1139.05	1444.50	2366.68	3697.93
14	269.64	421.31	690.28	1078.56	1328.90	1685.25	2761.12	4314.25
16	308.16	481.50	788.89	1232.64	1518.74	1926.00	3155.57	4930.58
18	346.68	541.69	887.50	1386.72	1708.58	2166.75	3550.01	5546.90
20	385.20	601.88	986.11	1540.80	1898.42	2407.51	3944.46	6163.22

TABELAS PARA DETERMINAÇÃO DIRETA DE MOMENTOS FLETORES EM LAJES.

1 Generalidades

São consideradas apenas as lajes retangulares apoiadas integralmente ao longo dos bordos. Para cada um dos nove tipos de vinculações admitidos, adotaram-se espessuras variáveis de 8,0 a 12,0 cm, dependendo das dimensões dos vãos.

As tabelas fornecem os valores dos momentos fletores em KNm por metro, para cada uma das direções principais, em função de coordenadas que são os vãos ℓ_x e ℓ_y das lajes ($\ell_x \leq \ell_y$). Os comprimentos dos vãos variam de 2,0 a 6,0 m, com intervalos de 20cm.

As tabelas apresentam a forma de uma matriz triangular superior em que cada elemento é constituído pelo valor dos dois momentos principais; o superior correspondente à menor dimensão da laje e o inferior, à maior dimensão.

O coeficiente de engastamento adotado foi -1,0, com o que os momentos nos apoios contínuos são iguais aos do meio do vão na direção respectiva. Adotou-se o método de ruptura para a determinação dos momentos.

2 Materiais

Concreto: 13,5; 15,0; 18,0 e 20,0 MPa, como valores de f_{ck}

Aço: CA-50

3 Coeficientes de segurança embutidos

$\gamma_f = \gamma_c = 1,4$ $\qquad$ $\gamma_s = 1,15$

4 Verificações feitas

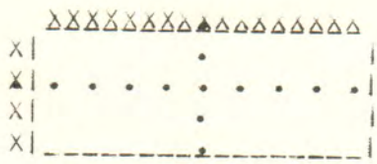
Em virtude da verificação da flecha, as tabelas apresentam faixas para diferentes espessuras. Estas podem variar, dependendo das dimensões da laje bem como das suas vinculações, de 8,0 a 12.0cm

5 Cargas consideradas

Revestimento	reboco :	0,25 KN/m^2
	piso :	0,85 KN/m^2
Peso próprio		0,25 h KN/m^2
Carga acidental		0,15 KN/m^2

6 Exemplos

6.1 f_{ck} = 13,5 MPa Aço: CA-50



Com ℓ_x=3,00m e ℓ_y=4,80m, temos:

h = 8,0 cm

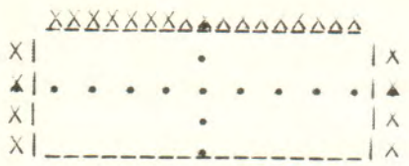
M_x =2,17 KNm/m (tabela VI, pág. 126)

1 ϕ 5,0 c. 18,0 (tabela I, pág. 158)

M_y = 1,09 KNm/m (tabela VI, pág. 126)

1 ϕ 5,0 c. 21,0 (tabela I, pág. 158)

6.2 f_{ck} = 13,5 MPa ; Aço: CA-50



Com ℓ_x=4,0 m e ℓ_y=5,00 m, temos:

h = 8,0 cm

M_x = 2,25 KNm/m (tabela VII, pág. 127)

1 ϕ 5,0 c. 18,0 (tabela I, pág. 158)

M_y = 2,25 KNm/m (tabela VII, pág. 127)

1 ϕ 5,0 c. 18,0 (tabela I, pág. 158)

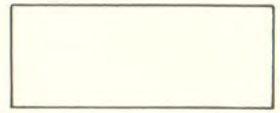
Tabela I

LAJE ARMADA EM CRUZ

VINCULAÇÃO: BORDOS LIVREMENTE APOIADOS

CONCRETO: f_{ck} = 13.5 MPa – AÇO: CA-50

CARGA G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



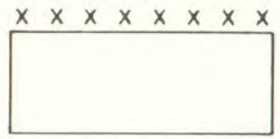
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.77	0.85	0.91	0.98	1.31	1.36	1.41	1.45	1.49	1.68	1.71	1.74	1.76	1.78	1.80	1.82						
	0.77	0.85	0.91	0.98	0.66	0.68	0.70	0.73	0.75	0.50	0.51	0.52	0.53	0.53	0.54	0.55						
2.2		0.93	1.01	1.09	1.16	1.56	1.62	1.67	1.72	1.77	2.00	2.04	2.07	2.10	2.12	2.15	2.17	2.19				
		0.93	0.01	1.09	1.16	0.78	0.81	0.84	0.86	0.88	0.60	0.61	0.62	0.63	0.64	0.64	0.65	0.66				
2.4			1.11	1.20	1.28	1.36	1.83	1.90	1.96	2.02	2.07	2.12	2.39	2.43	2.46	2.49	2.52	2.55	2.57	2.60		h=8
			1.11	1.20	1.28	1.36	0.92	0.95	0.98	1.01	1.03	1.06	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78		
2.6				1.30	1.40	1.49	1.58	1.66	2.20	2.27	2.33	2.39	2.45	2.50	2.96	3.01	3.04	3.08	3.11	3.14	3.17	
				1.30	1.40	1.49	1.58	1.66	1.10	1.13	1.17	1.20	1.22	1.25	0.89	0.90	0.91	0.92	0.93	0.94	0.95	h=9
2.8					1.51	1.61	1.71	1.81	1.90	2.66	2.74	2.81	2.88	2.95	3.01	3.07	3.62	3.67	3.71	3.75	3.79	
					1.51	1.61	1.71	1.81	1.90	1.33	1.37	1.41	1.44	1.47	1.50	1.53	1.09	1.10	1.11	1.13	1.14	h=10
3.0						1.73	1.84	1.95	2.05	2.15	3.02	3.10	3.19	3.43	3.51	3.58	3.65	3.71	4.37	4.42	4.47	
						1.73	1.84	1.95	2.05	2.15	1.51	1.55	1.59	1.72	1.75	1.79	1.82	1.86	1.31	1.33	1.34	
3.2							1.97	2.09	2.20	2.31	2.55	2.66	3.68	3.77	3.86	3.94	4.02	4.30	4.37	4.45	4.98	h=11
							1.97	2.09	2.20	2.31	2.55	2.66	1.84	1.88	1.93	1.97	2.01	2.15	2.19	2.22	1.49	
3.4			h=8					2.22	2.48	2.61	2.73	2.85	2.96	4.31	4.42	4.52	4.62	4.71	4.80	4.88	5.19	
								2.22	2.48	2.61	2.73	2.85	2.96	2.15	2.21	2.26	2.31	2.35	2.40	2.44	2.59	
3.6									2.62	2.77	2.90	3.19	3.33	3.45	4.79	5.14	5.25	5.36	5.47	5.57	5.66	
									2.62	2.77	2.90	3.19	3.33	3.45	2.39	2.57	2.63	2.68	2.73	2.78	2.83	h=12
3.8			h=9							2.92	3.23	3.39	3.53	3.67	4.00	4.14	5.67	5.80				
										2.92	3.23	3.39	3.53	3.67	4.00	4.14	2.84	2.90				
4.0											3.40	3.57	3.73	4.08	4.24	4.39	4.54					
			h=10								3.40	3.57	3.73	4.08	4.24	4.39	4.54					
4.2												3.94	4.12	4.30	4.47	4.86	5.02	5.19				
												3.94	4.12	4.30	4.47	4.86	5.02	5.19				
4.4			h=11										4.32	4.51	4.92	5.11	5.29	5.47				
													4.32	4.51	4.92	5.11	5.29	5.47				
4.6														4.94	5.15	5.36						
														4.94	5.15	5.36						
4.8			h=12												5.38							
															5.38							

LAJE ARMADA EM CRUZ

Tabela II — VINCULAÇÃO: UM BORDO MAIOR ENGASTADO

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



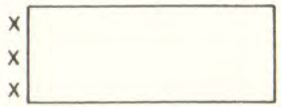
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.63	0.69	0.73	0.78	1.00	1.03	1.06	1.08	1.11	1.22	1.24	1.26	1.27	1.28	1.29	1.30						
	0.63	0.69	0.73	0.78	0.50	0.51	0.53	0.54	0.55	0.37	0.37	0.38	0.38	0.38	0.39	0.39						
2.2		0.76	0.82	0.88	0.93	1.19	1.23	1.26	1.29	1.32	1.46	1.48	1.50	1.52	1.53	1.55	1.56	1.57				
		0.76	0.82	0.88	0.93	0.59	0.61	0.63	0.65	0.66	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47				
2.4			0.91	0.97	1.03	1.09	1.40	1.44	1.48	1.51	1.55	1.58	1.74	1.76	1.78	1.80	1.82	1.83	1.85	1.86		
			0.91	0.97	1.03	1.09	0.70	0.72	0.74	0.76	0.77	0.79	0.52	0.53	0.53	0.54	0.55	0.55	0.55	0.56		
2.6				1.07	1.13	1.20	1.26	1.32	1.67	1.71	1.75	1.79	1.82	1.86	2.05	2.07	2.09	2.11	2.13	2.15	2.16	
				1.07	1.13	1.20	1.26	1.32	0.84	0.86	0.88	0.90	0.91	0.93	0.61	0.62	0.63	0.63	0.64	0.64	0.65	
2.8					1.24	1.31	1.38	1.45	1.51	1.92	1.97	2.01	2.05	2.09	2.13	2.16	2.38	2.40	2.43	2.45	2.47	h=8
					1.24	1.31	1.38	1.45	1.51	0.96	0.98	1.01	1.03	1.05	1.06	1.08	0.71	0.72	0.73	0.73	0.74	
3.0						1.42	1.50	1.57	1.64	1.71	2.18	2.23	2.28	2.33	2.37	2.41	2.45	2.49	2.73	2.91	2.93	
						1.42	1.50	1.57	1.64	1.71	1.09	1.12	1.14	1.16	1.19	1.21	1.23	1.24	0.82	0.87	0.88	
3.2							1.61	1.70	1.78	1.85	1.93	2.00	2.52	2.57	2.62	2.67	2.86	2.91	2.95	2.99	3.28	
							1.61	1.70	1.78	1.85	1.93	2.00	1.26	1.29	1.31	1.34	1.43	1.45	1.47	1.49	0.98	
3.4								1.82	1.91	2.00	2.08	2.16	2.23	2.97	3.04	3.09	3.15	3.20	3.25	3.30	3.34	h=9
								1.82	1.91	2.00	2.08	2.16	2.23	1.49	1.52	1.55	1.57	1.60	1.63	1.65	1.67	
3.6									2.04	2.14	2.23	2.31	2.40	2.48	3.31	3.38	3.62	3.68	3.74	3.80	3.85	
									2.04	2.14	2.23	2.31	2.40	2.48	1.65	1.69	1.81	1.84	1.87	1.90	1.92	
3.8										2.27	2.37	2.47	2.70	2.80	2.89	2.97	3.93	4.00	4.07	4.13	4.19	h=10
			h=8							2.27	2.37	2.47	2.70	2.80	2.89	2.97	1.96	2.00	2.03	2.07	2.10	
4.0											2.65	2.77	2.87	2.98	3.08	3.17	3.26	4.53	4.61	4.69	4.76	
											2.65	2.77	2.87	2.98	3.08	3.17	3.26	2.27	2.31	2.35	2.38	
4.2			h=9									2.92	3.04	3.16	3.43	3.55	3.65	3.75	4.96	5.05	5.13	h=11
												2.92	3.04	3.16	3.43	3.55	3.65	3.75	2.48	2.53	2.57	
4.4													3.37	3.50	3.63	3.75	3.87	3.98	4.29	4.40	5.77	h=12
													3.37	3.50	3.63	3.75	3.87	3.98	4.29	4.40	2.88	
4.6			h=10											3.69	3.82	3,96	4.28	4.41	4.54	4.65	4.77	
														3.69	3.82	3.96	4.28	4.41	4.54	4.65	4.77	
4.8															4.21	4.36	4.51	4.65	4.78	4.91	5.27	
															4.21	4.36	4.51	4.65	4.78	4.91	5.27	
5.0			h=11													4.57	4.72	5.10	5.26	5.40	5.55	
																4.57	4.72	5.10	5.26	5.40	5.55	
5.2																	5.17	5.34	5.51	5.67	5.82	
																	5.17	5.34	5.51	5.67	5.82	
5.4			h=12															5.58	5.75			
																		5.58	5.75			

LAJE ARMADA EM CRUZ

Tabela III — VINCULAÇÃO: UM BORDO MENOR ENGASTADO

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



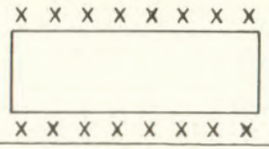
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.63	0.70	0.77	0.83	1.17	1.22	1.27	1.32	1.36	1.57	1.60	1.63	1.66	1.68	1.71	1.73						
	0.63	0.70	0.77	0.83	0.58	0.61	0.64	0.66	0.68	0.47	0.48	0.49	0.50	0.51	0.51	0.52						
2.2		0.76	0.84	0.91	0.98	1.38	1.45	1.50	1.58	1.61	1.87	1.90	1.94	1.97	2.00	2.03	2.05	2.08				
		0.76	0.84	0.91	0.98	0.69	0.72	0.75	0.78	0.80	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.62				
2.4			0.91	0.99	1.07	1.15	1.62	1.69	1.75	1.82	1.87	1.92	2.23	2.27	2.31	2.34	2.37	2.40	2.43	2.46		
			0.91	0.99	1.07	1.15	0.81	0.85	0.88	0.91	0.94	0.96	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74		h=8
2.6				1.07	1.16	1.24	1.33	1.41	1.95	2.02	2.09	2.16	2.22	2.27	2.76	2.81	2.85	2.89	2.93	2.97	3.00	
				1.07	1.16	1.24	1.33	1.41	0.98	1.01	1.05	1.08	1.11	1.14	0.83	0.84	0.86	0.87	0.88	0.89	0.90	h=9
2.8					1.24	1.33	1.43	1.52	1.60	2.23	2.31	2.39	2.46	2.66	2.73	2.79	3.21	3.26	3.48	3.52	3.57	
					1.24	1.33	1.43	1.52	1.60	1.12	1.16	1.19	1.23	1.33	1.36	1.40	0.96	0.98	1.04	1.06	1.07	
3.0						1.42	1.52	1.62	1.72	1.81	2.67	2.76	2.85	2.93	3.01	3.08	3.15	3.38	3.88	3.94	3.99	
						1.42	1.52	1.62	1.72	1.81	1.33	1.38	1.42	1.46	1.50	1.54	1.57	1.69	1.16	1.18	1.20	h=10
3.2							1.61	1.72	1.83	1.94	2.04	2.13	3.10	3.36	3.45	3.54	3.63	3.71	3.79	3.86	4.64	
							1.61	1.72	1.85	1.94	2.04	2.13	1.55	1.68	1.73	1.77	1.81	1.86	1.89	1.93	1.39	
3.4								1.82	1.94	2.05	2.16	2.27	2.51	3.64	3.75	3.85	4.14	4.24	4.33	4.42	4.51	
								1.82	1.94	2.05	2.16	2.27	2.51	1.82	1.87	1.92	2.07	2.12	2.17	2.21	2.25	h=11
3.6			h=8						2.04	2.16	2.29	2.54	2.66	2.77	4.23	4.36	4.47	4.58	4.69	4.79	5.12	
									2.04	2.16	2.29	2.54	2.66	2.77	2.12	2.18	2.24	2.29	2.35	2.40	2.56	
3.8										2.39	2.53	2.67	2.80	2.93	3.21	3.34	5.03	5.16	5.28	5.40	5.52	
										2.39	2.53	2.67	2.80	2.93	3.21	3.34	2.51	2.58	2.64	2.70	2.76	h=12
4.0			h=9								2.65	2.80	3.09	3.24	3.38	3.52	3.66	5.52	5.66			
											2.65	2.80	3.09	3.24	3.38	3.52	3.66	2.76	2.83			
4.2												3.07	3.24	3.40	3.55	3.88	4.04	4.19				
												3.07	3.24	3.40	3.55	3.88	4.04	4.19				
4.4			h=10										3.37	3.54	3.89	4.06	4.23	4.39	4.76	4.93		
													3.37	3.54	3.89	4.06	4.23	4.39	4.76	4.93		
4.6														3.87	4.05	4.24	4.42	4.81	4.98	5.16	5.33	
														3.87	4.05	4.24	4.42	4.81	4.98	5.16	5.33	
4.8			h=11												4.21	4.41	4.81	5.01	5.20	5.39		
															4.21	4.41	4.81	5.01	5.20	5.39		
5.0																4.78	4.99	5.20				
																4.78	4.99	5.20				
5.2			h=12														5.17					
																	5.17					

LAJE ARMADA EM CRUZ

Tabela IV — VINCULAÇÃO: DOIS BORDOS MAIORES ENGASTADOS

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.53	0.56	0.60	0.63	0.78	0.80	0.82	0.84	0.85	0.93	0.94	0.95	0.96	0.97	0.97	0.98					
	0.53	0.56	0.60	0.63	0.39	0.40	0.41	0.42	0.43	0.28	0.28	0.28	0.29	0.29	0.29	0.29					
2.2		0.64	0.68	0.72	0.75	0.93	0.96	0.98	1.00	1.02	1.11	1.12	1.14	1.15	1.16	1.17	1.17	1.18			
		0.64	0.68	0.72	0.75	0.47	0.48	0.49	0.50	0.51	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35			
2.4			0.76	0.80	0.84	0.88	1.10	1.13	1.15	1.17	1.20	1.22	1.32	1.34	1.35	1.36	1.37	1.38	1.39	1.40	
			0.76	0.80	0.84	0.88	0.55	0.56	0.58	0.59	0.60	0.61	0.40	0.40	0.41	0.41	0.41	0.41	0.42	0.42	
2.6				0.89	0.94	0.98	1.03	1.07	1.31	1.34	1.36	1.39	1.41	1.43	1.56	1.57	1.58	1.60	1.61	1.62	1.63
				0.89	0.94	0.98	1.03	1.07	0.65	0.67	0.68	0.69	0.71	0.72	0.47	0.47	0.48	0.48	0.48	0.49	0.49
2.8					1.03	1.08	1.13	1.18	1.22	1.50	1.54	1.57	1.59	1.62	1.64	1.66	1.81	1.82	1.84	1.85	1.86
					1.03	1.08	1.13	1.18	1.22	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.54	0.55	0.55	0.55	0.56
3.0						1.18	1.24	1.29	1.34	1.39	1.71	1.75	1.78	1.81	1.84	1.87	1.89	1.91	2.07	2.09	2.11
						1.18	1.24	1.29	1.34	1.39	0.86	0.87	0.89	0.91	0.92	0.93	0.95	0.96	0.62	0.63	0.63
3.2							1.34	1.40	1.48	1.51	1.57	1.61	1.97	2.01	2.04	2.07	2.10	2.13	2.16	2.18	2.36
							1.34	1.40	1.48	1.51	1.57	1.61	0.99	1.00	1.02	1.04	1.05	1.07	1.08	1.09	0.71
3.4								1.51	1.58	1.64	1.70	1.75	1.81	2.21	2.25	2.29	2.32	2.36	2.39	2.42	2.44
								1.51	1.58	1.64	1.70	1.75	1.81	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.22
3.6									1.69	1.76	1.83	1.89	1.95	2.01	2.46	2.51	2.55	2.58	2.62	2.65	2.69
									1.69	1.76	1.83	1.89	1.95	2.01	1.23	1.25	1.27	1.29	1.31	1.33	1.34
3.8										1.89	1.96	2.03	2.10	2.16	2.22	2.28	2.93	2.97	3.01	3.06	3.09
										1.89	1.96	2.03	2.10	2.16	2.22	2.28	1.46	1.49	1.51	1.53	1.55
4.0											2.09	2.17	2.24	2.31	2.38	2.44	2.51	3.22	3.27	3.32	3.36
			h=8								2.09	2.17	2.24	2.31	2.38	2.44	2.51	1.61	1.64	1.66	1.68
4.2												2.30	3.39	2.46	2.54	2.75	2.82	2.89	3.71	3.77	3.82
												2.30	2.39	2.46	2.54	2.75	2.82	2.89	1.86	1.89	1.91
4.4													2.53	2.76	2.84	2.93	3.00	3.08	3.15	3.22	4.12
													2.53	2.76	2.84	2.93	3.00	3.08	3.15	3.22	2.06
4.6														2.91	3.01	3.10	3.19	3.27	3.52	3.60	3.68
														2.91	3.01	3.10	3.19	3.27	3.52	3.60	3.68
4.8			h=9												3.17	3.44	3.54	3.63	3.73	3.81	3.90
															3.17	3.44	3.54	3.63	3.73	3.81	3.90
5.0																3.62	3.72	3.83	3.93	4.03	4.12
																3.62	3.72	3.83	3.93	4.03	4.12
5.2			h=10														3.91	4.02	4.34	4.45	4.55
																	3.91	4.02	4.34	4.45	4.55
5.4																		4.42	4.55	4.67	4.78
																		4.42	4.55	4.67	4.78
5.6			h=11																4.76	4.88	5.24
																			4.76	4.88	5.24
5.8																				5.34	5.48
																				5.34	5.48
6.0			h=12																		5.71
																					5.71

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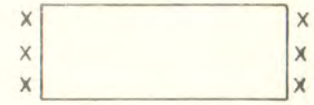
Tabela V — VINCULAÇÃO: DOIS BORDOS MENORES ENGASTADOS

CONCRETO: f_{ck} = 13.5 MPa -- AÇO: CA-50

CARGA : G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.59	0.65	0.71	1.04	1.09	1.15	1.19	1.24	1.47	1.50	1.53	1.56	1.59	1.62	1.64						
	0.53	0.59	0.65	0.71	0.52	0.55	0.57	0.60	0.62	0.44	0.45	0.46	0.47	0.48	0.49	0.49						
2.2		0.64	0.70	0.77	0.84	1.23	1.29	1.35	1.41	1.46	1.74	1.78	1.82	1.85	1.88	1.92	1.94	1.97				
		0.64	0.70	0.77	0.84	0.62	0.65	0.68	0.70	0.73	0.52	0.53	0.54	0.56	0.57	0.57	0.58	0.59				
2.4			0.76	0.83	0.90	0.98	1.44	1.51	1.57	1.64	1.69	1.75	2.07	2.12	2.16	2.20	2.23	2.27	2.30	2.33		h=8
			0.76	0.83	0.90	0.98	0.72	0.75	0.79	0.82	0.85	0.88	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70		
2.6				0.89	0.97	1.05	1.13	1.20	1.74	1.81	1.88	1.95	2.01	2.07	2.44	2.49	2.53	2.72	2.76	2.80	2.83	
				0.89	0.97	1.05	1.13	1.20	0.87	0.91	0.94	0.97	1.00	1.03	0.73	0.75	0.76	0.81	0.83	0.84	0.85	
2.8					1.03	1.11	1.20	1.29	1.37	1.98	2.06	2.14	2.21	2.28	2.35	2.41	2.99	3.05	3.10	3.14	3.19	
					1.03	1.11	1.20	1.29	1.37	0.99	1.03	1.07	1.11	1.14	1.17	1.21	0.90	0.91	0.93	0.94	0.96	h=9
3.0						1.18	1.27	1.37	1.46	1.54	2.24	2.33	2.42	2.63	2.71	2.79	2.86	2.93	3.62	3.68	3.74	
						1.18	1.27	1.37	1.46	1.54	1.12	1.17	1.21	1.32	1.36	1.39	1.43	1.47	1.09	1.10	1.12	h=10
3.2							1.34	1.44	1.54	1.64	1.73	1.82	2.76	2.85	2.95	3.03	3.12	3.36	3.44	3.52	4.33	
							1.34	1.44	1.54	1.64	1.73	1.82	1.38	1.43	1.47	1.52	1.56	1.68	1.72	1.76	1.30	h=11
3.4								1.51	1.62	1.72	1.83	1.93	2.03	3.07	3.34	3.44	3.55	3.64	3.73	3.82	3.91	
								1.51	1.62	1.72	1.83	1.93	2.03	1.54	1.67	1.72	1.77	1.82	1.87	1.91	1.95	
3.6									1.69	1.81	1.92	2.03	2.14	2.24	3.58	3.70	3.81	4.11	4.22	4.33	4.45	
									1.69	1.81	1.92	2.03	2.14	2.24	1.79	1.85	1.90	2.06	2.11	2.16	2.21	
3.8										1.89	2.01	2.12	2.24	2.48	2.60	2.72	4.27	4.40	4.52	4.64	4.75	
										1.89	2.01	2.12	2.24	2.48	2.60	2.72	2.13	2.20	2.26	2.32	2.38	h=11
4.0		h=8									2.09	2.22	2.47	2.60	2.72	2.85	3.12	4.68	5.04	5.18	5.31	
											2.09	2.22	2.47	2.60	2.72	2.85	3.12	2.34	2.52	2.59	2.66	
4.2												2.43	2.57	2.71	2.84	3.13	3.27	3.40	5.34	5.50	5.64	
												2.43	2.57	2.71	2.84	3.13	3.27	3.40	2.67	2.75	2.82	h=12
4.4		h=9											2.66	2.81	3.11	3.26	3.41	3.55	3.87	4.02		
													2.66	2.81	3.11	3.26	3.41	3.55	3.87	4.02		
4.6														3.06	3.22	3.38	3.54	3.88	4.04	4.19	4.35	
														3.06	3.22	3.38	3.54	3.88	4.04	4.19	4.35	
4.8		h=10													3.33	3.50	3.85	4.02	4.19	4.36	4.73	
															3.33	3.50	3.85	4.02	4.19	4.36	4.73	
5.0																3.79	3.98	4.16	4.34	4.73	4.91	
																3.79	3.98	4.16	4.34	4.73	4.91	
5.2		h=11															4.10	4.29	4.69	4.89	5.08	
																	4.10	4.29	4.69	4.89	5.08	
5.4																		4.63	4.84	5.04		
																		4.63	4.84	5.04		
5.6		h=12																	4.98			
																			4.98			

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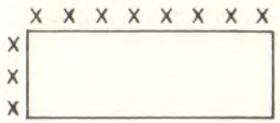
Tabela VI — VINCULAÇÃO: DOIS BORDOS ADJACENTES ENGASTADOS

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



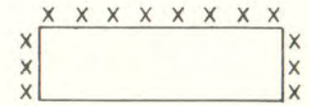
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.58	0.63	0.67	0.90	0.94	0.97	1.00	1.03	1.16	1.18	1.19	1.21	1.22	1.24	1.25						
	0.53	0.58	0.63	0.67	0.45	0.47	0.48	0.50	0.51	0.35	0.35	0.36	0.36	0.37	0.37	0.38						
2.2		0.64	0.70	0.75	0.80	1.07	1.11	1.15	1.18	1.22	1.38	1.40	1.42	1.44	1.46	1.48	1.49	1.51				
		0.64	0.70	0.75	0.80	0.54	0.56	0.58	0.59	0.61	0.41	0.42	0.43	0.43	0.44	0.44	0.45	0.45				
2.4			0.76	0.82	0.88	0.94	1.26	1.31	1.35	1.39	1.42	1.46	1.64	1.67	1.69	1.71	1.73	1.75	1.77	1.78		
			0.76	0.82	0.88	0.94	0.63	0.65	0.67	0.69	0.71	0.73	0.49	0.50	0.51	0.51	0.52	0.52	0.53	0.54		
2.6				0.89	0.96	1.02	1.08	1.14	1.51	1.56	1.60	1.64	1.68	1.72	1.93	1.96	1.98	2.01	2.03	2.05	2.07	
				0.89	0.96	1.02	1.08	1.14	0.76	0.78	0.80	0.82	0.84	0.86	0.58	0.59	0.59	0.60	0.61	0.61	0.62	
2.8					1.04	1.11	1.18	1.24	1.30	1.73	1.78	1.83	1.88	1.92	1.96	2.00	2.24	2.27	2.30	2.32	2.35	
					1.04	1.11	1.18	1.24	1.30	0.87	0.89	0.92	0.94	0.96	0.98	1.00	0.67	0.68	0.69	0.70	0.70	
3.0						1.19	1.27	1.34	1.41	1.48	1.97	2.02	2.08	2.13	2.17	2.22	2.26	2.30	2.58	2.61	2.64	h=8
						1.19	1.27	1.34	1.41	1.48	0.98	1.01	1.04	1.06	1.09	1.11	1.13	1.15	0.77	0.78	0.79	
3.2							1.35	1.43	1.51	1.59	1.66	1.73	2.28	2.34	2.39	2.44	2.49	2.54	2.58	2.62	3.10	
							1.35	1.43	1.51	1.59	1.66	1.73	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.31	0.93	
3.4								1.53	1.61	1.70	1.78	1.86	1.93	2.55	2.61	2.81	2.87	2.93	2.99	3.04	3.09	
								1.53	1.61	1.70	1.78	1.86	1.93	1.27	1.30	1.41	1.44	1.47	1.49	1.52	1.54	
3.6									1.71	1.80	1.89	1.98	2.06	2.14	2.98	3.05	3.12	3.19	3.25	3.31	3.37	h=9
									1.71	1.80	1.89	1.98	2.06	2.14	1.49	1.53	1.56	1.59	1.63	1.66	1.68	
3.8										1.90	2.00	2.10	2.19	2.28	2.36	2.44	3.55	3.63	3.70	3.77	3.84	
										1.90	2.00	2.10	2.19	2.28	2.36	2.44	1.77	1.81	1.85	1.89	1.92	
4.0											2.11	2.21	2.31	2.41	2.64	2.73	2.82	3.90	3.98	4.06	4.14	h=10
											2.11	2.21	2.31	2.41	2.64	2.73	2.82	1.95	1.99	2.03	2.07	
4.2		h=8										2.33	2.57	2.68	2.78	2.89	2.99	3.09	4.47	4.57	4.66	h=11
												2.33	2.57	2.81	2.78	2.89	2.99	3.09	2.24	2.28	2.33	
4.4													2.69	2.81	2.93	3.04	3.15	3.42	3.53	3.63	4.98	
													2.69	2.81	2.93	3.04	3.15	3.42	3.53	3.63	2.49	
4.6		h=9												2.94	3.07	3.35	3.48	3.60	3.71	3.83	3.94	
														2.94	3.07	3.35	3.48	3.60	3.71	3.83	3.94	
4.8															3.37	3.50	3.64	3.77	3.89	4.21	4.34	
															3.37	3.50	3.64	3.77	3.89	4.21	4.34	
5.0		h=10														3.65	3.79	4.13	4.27	4.41	4.54	h=11
																3.65	3.79	4.13	4.27	4.41	4.54	
5.2																	4.14	4.30	4.45	4.60	4.75	
																	4.14	4.30	4.45	4.60	4.75	
5.4		h=11																4.47	4.63	5.01	5.17	
																		4.47	4.63	5.01	5.17	
5.6																			5.03	5.20	5.38	h=12
																			5.03	5.20	5.38	
5.8		h=12																		5.39	5.58	
																				5.39	5.58	

LAJE ARMADA EM CRUZ

Tabela VII — VINCULAÇÃO: UM BORDO MAIOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 13.5 MPa — AÇO : CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



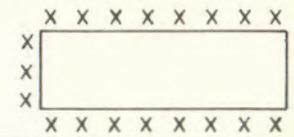
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.45	0.50	0.54	0.59	0.82	0.85	0.89	0.92	0.95	1.09	1.11	1.13	1.15	1.17	1.18	1.20						
	0.45	0.50	0.54	0.59	0.41	0.43	0.44	0.46	0.47	0.33	0.33	0.34	0.35	0.35	0.36	0.36						
2.2		0.54	0.60	0.65	0.70	0.97	1.01	1.05	1.09	1.12	1.30	1.32	1.35	1.37	1.39	1.41	1.42	1.44				
		0.54	0.60	0.65	0.70	0.49	0.51	0.53	0.54	0.56	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.43				
2.4			0.65	0.70	0.76	0.81	1.14	1.18	1.23	1.27	1.31	1.34	1.55	1.58	1.60	1.63	1.65	1.67	1.69	1.71		
			0.65	0.70	0.76	0.81	0.57	0.59	0.61	0.63	0.65	0.67	0.46	0.47	0.48	0.49	0.49	0.50	0.51	0.51		
2.6				0.76	0.82	0.88	0.94	0.99	1.37	1.42	1.46	1.51	1.55	1.59	1.82	1.85	1.88	1.90	1.93	1.95	1.97	
				0.76	0.82	0.88	0.94	0.99	0.68	0.71	0.73	0.75	0.77	0.79	0.55	0.56	0.56	0.57	0.58	0.59	0.59	
2.8					0.88	0.95	1.01	1.07	1.13	1.57	1.62	1.67	1.72	1.76	1.81	1.85	2.12	2.15	2.18	2.21	2.23	
					0.88	0.95	1.01	1.07	1.13	0.78	0.81	0.84	0.86	0.88	0.90	0.92	0.64	0.64	0.65	0.66	0.67	
3.0						1.01	1.08	1.15	1.22	1.28	1.77	1.83	1.89	1.99	1.99	2.04	2.09	2.13	2.43	2.47	2.50	h=8
						1.01	1.08	1.15	1.22	1.28	0.89	0.92	0.95	0.97	1.00	1.02	1.04	1.06	0.73	0.74	0.75	
3.2							1.15	1.22	1.30	1.37	1.44	1.51	2.06	2.12	2.18	2.24	2.29	2.34	2.39	2.43	2.92	
							1.15	1.22	1.30	1.37	1.44	1.51	1.03	1.06	1.09	1.12	1.14	1.17	1.19	1.22	0.88	
3.4								1.29	1.37	1.45	1.53	1.61	1.68	2.30	2.37	2.43	2.49	2.55	2.60	2.80	2.85	
								1.29	1.37	1.45	1.53	1.61	1.68	1.15	1.18	1.22	1.25	1.27	1.30	1.40	1.43	
3.6									1.45	1.54	1.62	1.70	1.78	1.86	2.55	2.77	2.84	2.91	2.97	3.04	3.10	h=9
									1.45	1.54	1.62	1.70	1.78	1.86	1.28	1.38	1.42	1.45	1.49	1.52	1.55	
3.8										1.61	1.71	1.79	1.88	1.97	2.05	2.13	3.05	3.13	3.20	3.27	3.51	
										1.61	1.71	1.79	1.88	1.97	2.05	2.13	1.53	1.56	1.60	1.64	1.76	
4.0											1.79	1.88	1.98	2.07	2.16	2.25	2.33	3.52	3.61	3.69	3.77	
											1.79	1.88	1.98	2.07	2.16	2.25	2.33	1.76	1.80	1.85	1.89	
4.2												1.97	2.07	2.17	2.27	2.36	2.59	2.68	3.85	3.94	4.03	h=10
												1.97	2.07	2.17	2.27	2.36	2.59	2.68	1.92	1.97	2.02	
4.4													2.16	2.27	2.37	2.61	2.71	2.82	2.92	3.01	4.50	h=11
													2.16	2.27	2.37	2.61	2.71	2.82	2.92	3.01	2.25	
4.6				h=8										2.36	2.61	2.72	2.84	2.95	3.05	3.32	3.43	
														2.36	2.61	2.72	2.84	2.95	3.05	3.32	3.43	
4.8															2.71	2.83	2.95	3.07	3.35	3.47	3.59	
															2.71	2.83	2.95	3.07	3.35	3.47	3.59	
5.0				h=9												2.94	3.23	3.36	3.49	3.61	3.74	h=10
																2.94	3.23	3.36	3.49	3.61	3.74	
5.2																	3.34	3.48	3.62	3.76	4.08	
																	3.34	3.48	3.62	3.76	4.08	
5.4				h=10														3.60	3.75	4.08	4.23	
																		3.60	3.75	4.08	4.23	
5.6																			4.07	4.22	4.38	h=11
																			4.07	4.22	4.38	
5.8																				4.36	4.53	
																				4.36	4.53	
6.0				h=12																	4.88	
																					4.88	h=12

LAJE ARMADA EM CRUZ

Tabela VIII — VINCULAÇÃO: UM BORDO MENOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh Q = 1,50 KN/m^2



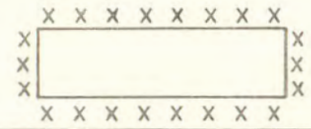
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.45	0.49	0.52	0.56	0.72	0.74	0.76	0.78	0.80	0.89	0.90	0.91	0.92	0.93	0.94	0.95						
	0.45	0.49	0.52	0.56	0.36	0.37	0.38	0.39	0.40	0.27	0.27	0.27	0.28	0.28	0.28	0.28						
2.2		0.54	0.59	0.63	0.66	0.85	0.88	0.91	0.93	0.95	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.14				
		0.54	0.59	0.63	0.66	0.43	0.44	0.45	0.46	0.48	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34				
2.4			0.65	0.69	0.74	0.78	1.00	1.04	1.06	1.09	1.11	1.14	1.26	1.28	1.29	1.30	1.32	1.33	1.34	1.35		
			0.65	0.69	0.74	0.78	0.50	0.52	0.53	0.54	0.56	0.57	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.41		
2.6				0.76	0.81	0.85	0.90	0.94	1.20	1.23	1.26	1.29	1.31	1.34	1.48	1.50	1.51	1.53	1.54	1.56	1.57	
				0.76	0.81	0.85	0.90	0.94	0.60	0.62	0.63	0.64	0.66	0.67	0.44	0.45	0.45	0.46	0.46	0.47	0.47	
2.8					0.88	0.93	0.98	1.03	1.08	1.38	1.41	1.45	1.48	1.51	1.53	1.56	1.72	1.74	1.75	1.77	1.79	
					0.88	0.93	0.98	1.03	1.08	0.69	0.71	0.72	0.74	0.75	0.77	0.78	0.52	0.52	0.53	0.53	0.54	
3.0						1.01	1.07	1.12	1.17	1.22	1.57	1.61	1.64	1.68	1.71	1.74	1.77	1.79	1.98	1.99	2.01	
						1.01	1.07	1.12	1.17	1.22	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.90	0.59	0.60	0.60	
3.2							1.15	1.21	1.27	1.32	1.37	1.42	1.81	1.85	1.89	1.92	1.96	1.99	2.02	2.04	2.25	
							1.15	1.21	1.27	1.32	1.37	1.42	0.90	0.92	0.94	0.96	0.98	0.99	1.01	1.02	0.67	
3.4								1.29	1.36	1.42	1.48	1.54	1.59	2.03	2.07	2.11	2.15	2.19	2.22	2.25	2.28	
								1.29	1.36	1.42	1.48	1.54	1.59	1.01	1.03	1.06	1.07	1.09	1.11	1.13	1.14	
3.6									1.45	1.52	1.58	1.65	1.71	1.77	2.25	2.30	2.34	2.39	2.43	2.46	2.50	h=8
									1.45	1.52	1.58	1.65	1.71	1.77	1.13	1.15	1.17	1.19	1.21	1.23	1.25	
3.8										1.61	1.69	1.76	1.83	1.89	1.95	2.01	2.54	2.59	2.64	2.83	2.87	
										1.61	1.69	1.76	1.83	1.89	1.95	2.01	1.27	1.30	1.32	1.41	1.43	
4.0											1.79	1.86	1.94	2.01	2.08	2.15	2.21	2.95	3.00	3.06	3.11	
											1.79	1.86	1.94	2.01	2.08	2.15	2.21	1.47	1.50	1.53	1.55	
4.2												1.97	2.05	2.13	2.21	2.28	2.35	2.41	3.23	3.29	3.34	
												1.97	2.05	2.13	2.21	2.28	2.35	2.41	1.62	1.64	1.67	h=9
4.4													2.16	2.25	2.33	2.41	2.49	2.70	2.77	2.84	3.77	
													2.16	2.25	2 33	2.41	2.49	2.70	2.77	2.84	1.89	h=10
4.6		h=8												2.36	2.45	2.68	2.76	2.85	2.93	3.01	3.08	
														2.36	2.45	2.68	2.76	2.85	3.93	3.01	3.08	
4.8															2.71	2.81	2.90	3.00	3.09	3.17	3.42	
															2.71	2.81	2.90	3.00	3.09	3.17	3.42	
5.0		h=9														2.94	3.04	3.14	3.41	3.50	3.60	
																2.94	3.04	3.14	3.41	3.50	3.60	
5.2																	3.34	3.46	3.57	3.67	3.77	
																	3.34	3.46	3.57	3.67	3.77	
5.4																		3.60	3.72	3.84	3.95	h=10
																		3.60	3.72	3.84	3.95	
5.6		h=10																	3.88	4.19	4.32	
																			3.88	4.19	4.32	h=11
5.8																				4.36	4.49	
6.0		h=11																		4.36	4.49	
																					4.67	
																					4.67	

LAJE ARMADA EM CRUZ

Tabela IX — VINCULAÇÃO: TODOS OS BORDOS ENGASTADOS

CONCRETO: f_{ck} = 13.5 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.39	0.43	0.46	0.49	0.66	0.68	0.71	0.73	0.75	0.84	0.86	0.87	0.88	0.89	0.90	0.91					
	0.39	0.43	0.46	0.49	0.33	0.34	0.35	0.36	0.37	0.25	0.26	0.26	0.26	0.27	0.27	0.27					
2.2		0.47	0.51	0.55	0.58	0.78	0.81	0.84	0.86	0.89	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.10			
		0.47	0.51	0.55	0.58	0.39	0.41	0.42	0.43	0.44	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33			
2.4			0.56	0.60	0.64	0.68	0.92	0.95	0.98	1.01	1.04	1.06	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.30	
			0.56	0.60	0.64	0.68	0.46	0.48	0.49	0.51	0.52	0.53	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39	
2.6				0.65	0.70	0.75	0.79	0.83	1.10	1.14	1.17	1.20	1.23	1.25	1.41	1.43	1.45	1.46	1.48	1.49	1.51
				0.65	0.70	0.75	0.79	0.83	0.55	0.57	0.58	0.60	0.61	0.63	0.42	0.43	0.43	0.44	0.44	0.45	0.45
2.8					0.76	0.81	0.86	0.91	0.95	1.26	1.30	1.34	1.37	1.40	1.43	1.46	1.64	1.66	1.68	1.69	1.71
					0.76	0.81	0.86	0.91	0.95	0.63	0.65	0.67	0.68	0.70	0.71	0.73	0.49	0.50	0.50	0.51	0.51
3.0						0.87	0.92	0.98	1.03	1.08	1.43	1.48	1.51	1.55	1.59	1.62	1.65	1.68	1.88	1.90	1.92
						0.87	0.92	0.98	1.03	1.08	0.72	0.74	0.76	0.78	0.79	0.81	0.82	0.84	0.56	0.57	0.58
3.2							0.99	1.05	1.10	1.16	1.21	1.26	1.66	1.70	1.74	1.78	1.82	1.85	1.88	1.91	2.14
							0.99	1.05	1.10	1.16	1.21	1.26	0.83	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.64
3.4								1.11	1.18	1.24	1.30	1.35	1.41	1.86	1.90	1.95	1.99	2.03	2.06	2.10	2.13
								1.11	1.18	1.24	1.30	1.35	1.41	0.93	0.95	0.97	0.99	1.01	1.03	1.05	1.07
3.6									1.25	1.31	1.38	1.44	1.50	1.56	2.06	2.11	2.16	2.21	2.25	2.29	2.33
									1.25	1.31	1.38	1.44	1.50	1.56	1.03	1.06	1.08	1.10	1.12	1.14	1.16
3.8										1.39	1.46	1.53	1.60	1.66	1.72	1.78	2.33	2.38	2.43	2.48	2.52
										1.39	1.46	1.53	1.60	1.66	1.72	1.78	1.17	1.19	1.22	1.24	1.26
4.0											1.54	1.61	1.69	1.76	1.82	1.89	1.95	2.56	2.62	2.82	2.87
											1.54	1.61	1.69	1.76	1.82	1.89	1.95	1.28	1.31	1.41	1.43
4.2												1.70	1.77	1.85	1.93	2.00	2.07	2.13	2.96	3.02	3.08
												1.70	1.77	1.85	1.93	2.00	2.07	2.13	1.48	1.51	1.54
4.4													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	3.29
													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	1.64
4.6														2.03	2.12	2.20	2.29	2.37	2.44	2.65	2.73
														2.03	2.12	2.20	2.29	2.37	2.44	2.65	2.73
4.8															2.21	2.30	2.39	2.61	2.70	2.78	2.87
															2.21	2.30	2.39	2.61	2.70	2.78	2.87
5.0		h=8														2.40	2.63	2.73	2.82	2.91	3.00
																2.40	2.63	2.73	2.82	2.91	3.00
5.2																	2.74	2.84	2.94	3.04	3.14
																	2.74	2.84	2.94	3.04	3.14
5.4		h=9																2.95	3.06	3.33	3.43
																		2.95	3.06	3.33	3.43
5.6																			3.34	3.45	3.57
																			3.34	3.45	3.57
5.8																				3.58	3.70
																				3.58	3.70
6.0		h=10																			3.83
																					3.83

LAJE ARMADA EM CRUZ

Tabela X — VINCULAÇÃO: BORDOS LIVREMENTE APOIADOS

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2

lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.77	0.85	0.91	0.98	1.31	1.36	1.41	1.45	1.49	1.68	1.71	1.74	1.76	1.78	1.80	1.82					
	0.77	0.85	0.91	0.98	0.66	0.68	0.70	0.73	0.75	0.50	0.51	0.52	0.53	0.53	0.54	0.55					
2.2		0.93	1.01	1.09	1.16	1.56	1.62	1.67	1.72	1.77	2.00	2.04	2.07	2.10	2.12	2.15	2.17	2.19			
		0.93	1.01	1.09	1.16	0.78	0.81	0.84	0.86	0.88	0.60	0.61	0.62	0.63	0.64	0.64	0.65	0.66			
2.4			1.11	1.20	1.28	1.36	1.83	1.90	1.96	2.02	2.07	2.12	2.39	2.43	2.46	2.49	2.52	2.55	2.57	2.60	
			1.11	1.20	1.28	1.36	0.92	0.95	0.98	1.01	1.03	1.06	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78	
2.6				1.30	1.40	1.49	1.58	1.66	2.20	2.27	2.33	2.39	2.45	2.50	2.96	3.01	3.04	3.08	3.11	3.14	3.17
				1.30	1.40	1.49	1.58	1.66	1.10	1.13	1.17	1.20	1.22	1.25	0.89	0.90	0.91	0.92	0.93	0.94	0.95
2.8					1.51	1.61	1.71	1.81	1.90	2.52	2.60	2.67	2.88	2.95	3.01	3.07	3.44	3.49	3.53	3.57	3.79
					1.51	1.61	1.71	1.81	1.90	1.26	1.30	1.33	1.44	1.47	1.50	1.53	1.03	1.05	1.06	1.07	1.14
3.0						1.73	1.84	1.95	2.05	2.15	3.02	3.10	3.19	3.26	3.34	3.41	3.47	3.71	4.16	4.21	4.26
						1.73	1.84	1.95	2.05	2.15	1.51	1.55	1.59	1.63	1.67	1.70	1.74	1.86	1.25	1.26	1.28
3.2							1.97	2.09	2.20	2.31	2.42	2.52	3.68	3.77	3.86	3.94	4.02	4.10	4.17	4.24	4.98
							1.97	2.09	2.20	2.31	2.42	2.52	1.84	1.88	1.93	1.97	2.01	2.05	2.09	2.12	1.49
3.4		h=8						2.22	2.35	2.47	2.73	2.85	2.96	4.11	4.21	4.52	4.62	4.71	4.80	4.88	4.98
								2.22	2.35	2.47	2.73	2.85	2.96	2.05	2.11	2.26	2.31	2.35	2.40	2.44	2.48
3.6									2.62	2.77	2.90	3.04	3.16	3.45	4.79	4.91	5.02	5.12	5.22	5.57	5.66
									2.62	2.77	2.90	3.04	3.16	3.45	2.39	2.45	2.51	2.56	2.61	2.78	2.83
3.8		h=9								2.92	3.07	3.39	3.53	3.67	3.81	3.94	5.67	5.80	5.92	6.03	6.14
										2.92	3.07	3.39	3.53	3.67	3.81	3.94	2.84	2.90	2.96	3.01	3.07
4.0											3.40	3.57	3.73	3.89	4.04	4.39	4.54	6.23			
											3.40	3.57	3.73	3.89	4.04	4.39	4.54	3.12			
4.2		h=10										3.75	3.93	4.30	4.47	4.64	4.80	4.96			
												3.75	3.93	4.30	4.47	4.64	4.80	4.96			
4.4													4.32	4.51	4.70	4.88	5.29	5.47	5.64	5.81	
													4.32	4.51	4.70	4.88	5.29	5.47	5.64	5.81	
4.6		h=11												4.72	5.15	5.36	5.56	5.75	5.94		
														4.72	5.15	5.36	5.56	5.75	5.94		
4.8		h=12													5.38	5.60	5.82				
															5.38	5.60	5.82				

h=8

h=9

h=10

h=11

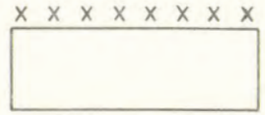
h=12

LAJE ARMADA EM CRUZ

Tabela XI — VINCULAÇÃO: UM BORDO MAIOR ENGASTADO

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



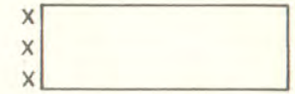
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.63	0.69	0.73	0.78	1.00	1.03	1.06	1.08	1.11	1.22	1.24	1.26	1.27	1.28	1.29	1.30					
	0.63	0.69	0.73	0.78	0.50	0.51	0.53	0.54	0.55	0.37	0.37	0.38	0.38	0.38	0.39	0.39					
2.2		0.76	0.82	0.88	0.93	1.19	1.23	1.26	1.29	1.32	1.46	1.48	1.50	1.52	1.53	1.55	1.56	1.57			
		0.76	0.82	0.88	0.93	0.59	0.61	0.63	0.65	0.66	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47			
2.4			0.91	0.97	1.03	1.09	1.40	1.44	1.48	1.51	1.55	1.58	1.74	1.76	1.78	1.80	1.82	1.83	1.85	1.86	
			0.91	0.97	1.03	1.09	0.70	0.72	0.74	0.76	0.77	0.79	0.52	0.53	0.53	0.54	0.55	0.55	0.55	0.56	
2.6				1.07	1.13	1.20	1.26	1.32	1.67	1.71	1.75	1.79	1.82	1.86	2.05	2.07	2.09	2.11	2.13	2.15	2.16
				1.07	1.13	1.20	1.26	1.32	0.84	0.86	0.88	0.90	0.91	0.93	0.61	0.62	0.63	0.63	0.64	0.64	0.65
2.8					1.24	1.31	1.38	1.45	1.51	1.92	1.97	2.01	2.05	2.09	2.13	2.16	2.38	2.40	2.43	2.45	2.47
					1.24	1.31	1.38	1.45	1.51	0.96	0.98	1.01	1.03	1.05	1.06	1.08	0.71	0.72	0.73	0.73	0.74
3.0						1.42	1.50	1.57	1.64	1.71	2.18	2.23	2.28	2.33	2.37	2.41	2.45	2.49	2.73	2.76	2.78
						1.42	1.50	1.57	1.64	1.71	1.09	1.12	1.14	1.16	1.19	1.21	1.23	1.24	0.82	0.83	0.83
3.2							1.61	1.70	1.78	1.85	1.93	2.00	2.52	2.57	2.62	2.67	2.72	2.76	2.80	2.84	3.28
							1.61	1.70	1.78	1.85	1.93	2.00	1.26	1.29	1.31	1.34	1.36	1.38	1.40	1.42	0.98
3.4								1.82	1.91	2.00	2.08	2.16	2.23	2.82	3.04	3.09	3.15	3.20	3.25	3.30	3.34
								1.82	1.91	2.00	2.08	2.16	2.23	1.41	1.52	1.55	1.57	1.60	1.63	1.65	1.67
3.6									2.04	2.14	2.23	2.31	2.40	2.48	3.31	3.38	3.44	3.50	3.56	3.61	3.66
									2.04	2.14	2.23	2.31	2.40	2.48	1.65	1.69	1.72	1.75	1.78	1.80	1.83
3.8										2.27	2.37	2.47	2.56	2.65	2.89	2.97	3.93	4.00	4.07	4.13	4.19
										2.27	2.37	2.47	2.56	2.65	2.89	2.97	1.96	2.00	2.03	2.07	2.10
4.0		h=8									2.52	2.62	2.87	2.98	3.08	3.17	3.26	4.32	4.40	4.47	4.54
											2.52	2.62	2.87	2.98	3.08	3.17	3.26	2.16	2.20	2.24	2.27
4.2												2.92	3.04	3.16	3.27	3.37	3.47	3.75	4.96	5.05	5.13
												2.92	3.04	3.16	3.27	3.37	3.47	3.75	2.48	2.53	2.57
4.4		h=9											3.21	3.33	3.63	3.75	3.87	3.98	4.09	4.19	5.51
													3.21	3.33	3.63	3.75	3.87	3.98	4.09	4.19	2.75
4.6														3.69	3.82	3.96	4.08	4.21	4.32	4.65	4.77
														3.69	3.82	3.96	4.08	4.21	4.32	4.65	4.77
4.8		h=10													4.01	4.16	4.51	4.65	4.78	4.91	5.04
															4.01	4.16	4.51	4.65	4.78	4.91	5.04
5.0																4.57	4.72	4.88	5.02	5.16	5.30
																4.57	4.72	4.88	5.02	5.16	5.30
5.2		h=11															4.94	5.10	5.51	5.67	5.82
																	4.94	5.10	5.51	5.67	5.82
5.4																		5.58	5.75	5.93	6.09
																		5.58	5.75	5.93	6.09
5.6		h=12																	6.00	6.18	
																			6.00	6.18	

LAJE ARMADA EM CRUZ

Tabela XII — VINCULAÇÃO: EM BORDO MENOR ENGASTADO

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.63	0.70	0.77	0.83	1.17	1.22	1.27	1.32	1.36	1.57	1.60	1.63	1.66	1.68	1.71	1.73					
	0.63	0.70	0.77	0.83	0.58	0.61	0.64	0.66	0.68	0.47	0.48	0.49	0.50	0.51	0.51	0.52					
2.2		0.76	0.84	0.91	0.98	1.38	1.45	1.50	1.56	1.61	1.87	1.90	1.94	1.97	2.00	2.03	2.05	2.08			
		0.76	0.84	0.91	0.98	0.69	0.72	0.75	0.78	0.80	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.62			
2.4			0.91	0.99	1.07	1.15	1.62	1.69	1.75	1.82	1.87	1.92	2.23	2.27	2.31	2.34	2.37	2.40	2.43	2.46	
			0.91	0.99	1.07	1.15	0.81	0.85	0.88	0.91	0.94	0.96	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74	
2.6				1.07	1.16	1.24	1.33	1.41	1.95	2.02	2.09	2.16	2.22	2.27	2.62	2.66	2.70	2.74	2.93	2.97	3.00
				1.07	1.16	1.24	1.33	1.41	0.98	1.01	1.05	1.08	1.11	1.14	0.79	0.80	0.81	0.82	0.88	0.89	0.90
2.8					1.24	1.33	1.43	1.52	1.60	2.23	2.31	2.39	2.46	2.52	2.59	2.65	3.21	3.26	3.31	3.35	3.39
					1.24	1.33	1.43	1.52	1.60	1.12	1.16	1.19	1.23	1.26	1.29	1.32	0.96	0.98	0.99	1.00	1.02
3.0						1.42	1.52	1.62	1.72	1.81	2.53	2.62	2.85	2.93	3.01	3.08	3.15	3.22	3.99	3.94	3.88
						1.42	1.52	1.62	1.72	1.81	1.26	1.31	1.42	1.46	1.50	1.54	1.57	1.61	1.16	1.18	1.20
3.2							1.61	1.72	1.83	1.94	2.04	2.13	3.10	3.19	3.28	3.37	3.63	3.71	3.79	3.86	4.64
							1.61	1.72	1.83	1.94	2.04	2.13	1.55	1.60	1.64	1.69	1.81	1.86	1.89	1.93	1.39
3.4								1.82	1.94	2.05	2.16	2.27	2.38	3.64	3.75	3.85	3.95	4.04	4.13	4.21	4.51
								1.82	1.94	2.05	2.16	2.27	2.38	1.82	1.87	1.92	1.97	2.02	2.06	2.11	2.25
3.6									2.04	2.16	2.29	2.40	2.66	2.77	4.04	4.15	4.47	4.58	4.69	4.79	4.89
									2.04	2.16	2.29	2.40	2.66	2.77	2.02	2.08	2.24	2.29	2.35	2.40	2.44
3.8			h=8							2.27	2.40	2.67	2.80	2.93	3.06	3.18	4.80	4.93	5.05	5.16	5.52
										2.27	2.40	2.67	2.80	2.93	3.06	3.18	2.40	2.46	2.52	2.58	2.76
4.0											2.65	2.80	2.94	3.08	3.38	3.52	3.66	5.52	5.66	5.79	5.92
											2.65	2.80	2.94	3.08	3.38	3.52	3.66	2.76	2.83	2.90	2.96
4.2			h=9									2.92	3.08	3.40	3.55	3.70	3.85	4.19	6.03		
												2.92	3.08	3.40	3.55	3.70	3.85	4.19	3.01		
4.4													3.37	3.54	3.71	3.87	4.23	4.39	4.55	4.71	
													3.37	3.54	3.71	3.87	4.23	4.39	4.55	4.71	
4.6			h=10											3.69	3.86	4.24	4.42	4.59	4.76	5.16	5.33
														3.69	3.86	4.24	4.42	4.59	4.76	5.16	5.33
4.8															4.21	4.41	4.60	5.01	5.20	5.39	5.57
															4.21	4.41	4.60	5.01	5.20	5.39	5.57
5.0			h=11													4.57	4.99	5.20	5.41	5.61	
																4.57	4.99	5.20	5.41	5.61	
5.2																	5.17	5.39	5.61		
																	5.17	5.39	5.61		
5.4			h=12															5.58			
																		5.58			

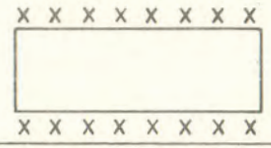
h=8 h=9 h=10 h=11 h=12

LAJE ARMADA EM CRUZ

Tabela XIII — VINCULAÇÃO: DOIS BORDOS MAIORES ENGASTADOS

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



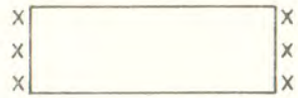
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.56	0.60	0.63	0.78	0.80	0.82	0.84	0.85	0.93	0.94	0.95	0.96	0.97	0.97	0.98						
	0.53	0.56	0.60	0.63	0.39	0.40	0.41	0.42	0.45	0.28	0.28	0.28	0.29	0.29	0.29	0.29						
2.2		0.64	0.68	0.72	0.75	0.93	0.96	0.98	1.00	1.02	1.11	1.12	1.14	1.15	1.16	1.17	1.17	1.18				
		0.64	0.68	0.72	0.75	0.47	0.48	0.49	0.50	0.51	0.33	0.34	0.34	0.34	0.36	0.35	0.35	0.35				
2.4			0.76	0.80	0.84	0.88	1.10	1.13	1.15	1.17	1.20	1.22	1.32	1.34	1.35	1.36	1.37	1.38	1.39	1.40		
			0.76	0.80	0.84	0.88	0.55	0.56	0.58	0.59	0.60	0.61	0.40	0.40	0.41	0.41	0.41	0.41	0.42	0.42		
2.6				0.89	0.94	0.98	1.03	1.07	1.31	1.34	1.36	1.39	1.41	1.43	1.56	1.57	1.58	1.60	1.61	1.62	1.63	
				0.89	0.94	0.98	1.03	1.07	0.65	0.67	0.68	0.69	0.71	0.72	0.47	0.47	0.48	0.48	0.48	0.49	0.49	
2.8					1.03	1.08	1.13	1.18	1.22	1.50	1.54	1.57	1.59	1.62	1.64	1.76	1.81	1.82	1.84	1.85	1.86	
					1.03	1.08	1.13	1.18	1.22	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.54	0.55	0.55	0.55	0.56	
3.0						1.18	1.24	1.29	1.34	1.39	1.71	1.75	1.78	1.81	1.84	1.87	1.89	1.91	2.07	2.09	2.11	
						1.18	1.24	1.29	1.34	1.39	0.86	0.87	0.89	0.91	0.92	0.93	0.95	0.96	0.62	0.63	0.63	
3.2							1.34	1.40	1.46	1.51	1.57	1.61	1.97	2.01	2.04	2.07	2.10	2.13	2.16	2.18	2.36	
							1.34	1.40	1.46	1.51	1.57	1.61	0.99	1.00	1.02	1.04	1.05	1.07	1.08	1.09	0.71	
3.4								1.51	1.58	1.64	1.70	1.75	1.81	2.21	2.25	2.29	2.32	2.36	2.39	2.42	2.44	
								1.51	1.58	1.64	1.70	1.75	1.81	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.22	
3.6									1.69	1.76	1.83	1.89	1.95	2.01	2.46	2.51	2.55	2.58	2.62	2.65	2.69	h=8
									1.69	1.76	1.83	1.89	1.95	2.01	1.23	1.25	1.27	1.29	1.31	1.33	1.34	
3.8										1.89	1.96	2.03	2.10	2.16	2.22	2.28	2.77	2.82	2.86	2.90	3.09	
										1.89	1.96	2.03	2.10	2.16	2.22	2.28	1.39	1.41	1.43	1.45	1.55	
4.0											2.09	2.17	2.24	2.31	2.38	2.44	2.51	3.22	3.27	3.32	3.36	
											2.09	2.17	2.24	2.31	2.38	2.44	2.51	1.61	1.64	1.66	1.68	
4.2												2.30	2.39	2.46	2.54	2.61	2.68	2.74	3.53	3.59	3.64	h=9
												2.30	2.39	2.46	2.54	2.61	2.68	2.74	1.77	1.79	1.82	
4.4		h=8											2.53	2.61	2.70	2.93	3.00	3.08	3.15	3.22	4.12	h=10
													2.53	2.61	2.70	2.93	3.00	3.08	3.15	3.22	2.06	
4.6														2.91	3.01	3.10	3.19	3.27	3.35	3.43	3.50	
														2.91	3.01	3.10	3.19	3.27	3.35	3.43	3.50	
4.8															3.17	3.27	3.36	3.46	3.54	3.81	3.90	
															3.17	3.27	3.36	3.46	3.54	3.81	3.90	
5.0		h=9														3.44	3.72	3.83	3.93	4.03	4.12	
																3.44	3.72	3.83	3.93	4.03	4.12	h=10
5.2																	3.91	4.02	4.13	4.24	4.34	
																	3.91	4.02	4.13	4.24	4.34	
5.4		h=10																4.22	4.33	4.67	4.78	
																		4.22	4.33	4.67	4.78	
5.6																			4.76	4.88	5.01	
																			4.76	4.88	5.01	h=11
5.8		h=11																		5.10	5.23	
																				5.10	5.23	
6.0																					5.71	
		h=12																			5.71	h=12

LAJE ARMADA EM CRUZ

Tabela XIV — VINCULAÇÃO: DOIS BORDOS MENORES ENGASTADOS

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



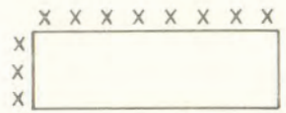
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.59	0.65	0.71	1.04	1.09	1.15	1.19	1.24	1.47	1.50	1.53	1.56	1.59	1.62	1.64						
	0.53	0.59	0.65	0.71	0.52	0.55	0.57	0.60	0.62	0.44	0.45	0.46	0.47	0.48	0.49	0.49						
2.2		0.64	0.70	0.77	0.84	1.23	1.29	1.35	1.41	1.46	1.74	1.78	1.82	1.85	1.88	1.92	1.94	1.97				
		0.64	0.70	0.77	0.84	0.62	0.65	0.68	0.70	0.73	0.52	0.53	0.54	0.56	0.57	0.57	0.58	0.59				
2.4			0.76	0.83	0.90	0.98	1.44	1.51	1.57	1.64	1.69	1.75	2.07	2.12	2.16	2.20	2.23	2.27	2.30	2.33		
			0.76	0.83	0.90	0.98	0.72	0.75	0.79	0.82	0.85	0.88	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70		
2.6				0·89	0.97	1.05	1.13	1.20	1.74	1.81	1.88	1.95	2.01	2.07	2.44	2.49	2.53	2.58	2.62	2.65	2.69	h=8
				0·89	0.97	1.05	1.13	1.20	0.87	0.91	0.94	0.97	1.00	1.03	0.73	0.75	0.76	0.77	0.78	0.80	0.81	
2.8					1.03	1.11	1.20	1.29	1.37	1.98	2.06	2.14	2.21	2.28	2.35	2.41	2.99	3.04	3.10	3.14	3.19	h=9
					1.03	1.11	1.20	1.29	1.37	0.99	1.03	1.07	1.11	1.14	1.17	1.21	0.90	0.91	0.93	0.94	0.96	
3.0						1.18	1.27	1.37	1.46	1.54	2.24	2.33	2.42	2.50	2.57	2.79	2.86	2.93	3.44	3.68	3.74	
						1.18	1.27	1.37	1.46	1.54	1.12	1.17	1.21	1.25	1.29	1.39	1.43	1.47	1.03	1.10	1.12	
3.2							1.34	1.44	1.54	1.64	1.73	1.82	2.76	2.85	2.95	3.03	3.12	3.20	3.28	3.35	4.13	
							1.34	1.44	1.54	1.64	1.73	1.82	1.38	1.43	1.47	1.52	1.56	1.60	1.64	1.67	1.24	
3.4								1.51	1.62	1.72	1.83	1.93	2.03	3.07	3.18	3.28	3.55	3.64	3.73	3.82	3.91	h=10
								1.51	1.62	1.72	1.83	1.93	2.03	1.54	1.59	1.64	1.77	1.82	1.87	1.91	1.95	
3.6									1.69	1.81	1.92	2.03	2.14	2.24	3.58	3.70	3.81	3.92	4.02	4.12	4.43	
									1.69	1.81	1.92	2.03	2.14	2.24	1.79	1.85	1.90	1.96	2.01	2.06	2.21	
3.8										1.89	2.01	2.12	2.24	2.36	2.60	2.72	4.07	4.40	4.52	4.64	4.75	
										1.89	2.01	2.12	2.24	2.36	2.60	2.72	2.03	2.20	2.26	2.32	2.38	
4.0											2.09	2.22	2.34	2.60	2.72	2.85	2.97	4.68	4.82	4.95	5.07	h=11
											2.09	2.22	2.34	2.60	2.72	2.85	2.97	2.34	2.41	2.47	2.54	
4.2		h=8										2.30	2.57	2.71	2.84	2.98	3.11	3.40	5.34	5.50	5.64	
												2.30	2.57	2.71	2.84	2.98	3.11	3.40	2.67	2.75	2.82	h=12
4.4													2.66	2.81	2.96	3.26	3.41	3.55	3.69	3.83	5.97	
													2.66	2.81	2.96	3.26	3.41	3.55	3.69	3.83	2.99	
4.6		h=9												2.91	3.22	3.38	3.54	3.69	3.85	4.19	4.35	
														2.91	3.22	3.38	3.54	3.69	3.85	4.19	4.35	h=11
4.8															3.33	3.50	3.67	4.02	4.19	4.36	4.52	
															3.33	3.50	3.67	4.02	4.19	4.36	4.52	
5.0		h=10														3.62	3.98	4.16	4.34	4.52	4.69	
																3.62	3.98	4.16	4.34	4.52	4.69	
5.2																	4.10	4.29	4.48	4.89	5.08	
																	4.10	4.29	4.48	4.89	5.08	
5.4		h=11																4.42	4.84	5.04	5.25	h=12
																		4.42	4.84	5.04	5.25	
5.6																			4.98	5.19	5.41	
																			4.98	5.19	5.41	
5.8		h=12																		5.34		
																				5.34		

LAJE ARMADA EM CRUZ

Tabela XV — VINCULAÇÃO: DOIS BORDOS ADJACENTES ENGASTADOS

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



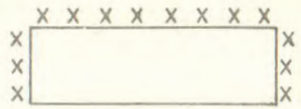
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.58	0.63	0.67	0.90	0.94	0.97	1.00	1.03	1.16	1.18	1.19	1.21	1.22	1.24	1.25						
	0.53	0.58	0.63	0.67	0.45	0.47	0.48	0.50	0.51	0.35	0.35	0.36	0.36	0.37	0.37	0.38						
2.2		0.64	0.70	0.75	0.80	1.07	1.11	1.15	1.18	1.22	1.38	1.40	1.42	1.44	1.46	1.48	1.49	1.51				
		0.64	0.70	0.75	0.80	0.54	0.56	0.58	0.59	0.61	0.41	0.42	0.43	0.43	0.44	0.44	0.45	0.45				
2.4			0.76	0.82	0.88	0.94	1.26	1.31	1.35	1.39	1.42	1.46	1.64	1.67	1.69	1.71	1.73	1.75	1.77	1.78		
			0.76	0.82	0.88	0.94	0.63	0.65	0.67	0.69	0.71	0.73	0.49	0.50	0.51	0.51	0.52	0.52	0.53	0.54		
2.6				0.89	0.96	1.02	1.08	1.14	1.51	1.56	1.60	1.64	1.68	1.72	1.93	1.96	1.98	2.01	2.03	2.05	2.07	
				0.89	0.96	1.02	1.08	1.14	0.76	0.78	0.80	0.82	0.84	0.86	0.58	0.59	0.59	0.60	0.61	0.61	0.62	
2.8					1.04	1.11	1.18	1.24	1.30	1.73	1.78	1.83	1.88	1.92	1.96	2.00	2.24	2.27	2.30	2.32	2.35	
					1.04	1.11	1.18	1.24	1.30	0.87	0.89	0.92	0.94	0.96	0.98	1.00	0.67	0.68	0.69	0.70	0.70	
3.0						1.19	1.27	1.34	1.41	1.48	1.97	2.02	2.08	2.13	2.17	2.22	2.26	2.30	2.58	2.61	2.64	h=8
						1.19	1.27	1.34	1.41	1.48	0.98	1.01	1.04	1.06	1.09	1.11	1.13	1.15	0.77	0.78	0.79	
3.2							1.35	1.43	1.51	1.59	1.66	1.73	2.28	2.34	2.39	2.44	2.49	2.54	2.58	2.62	3.10	
							1.35	1.43	1.51	1.59	1.66	1.73	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.31	0.93	
3.4								1.53	1.61	1.70	1.78	1.86	1.93	2.55	2.61	2.67	2.73	2.78	2.83	3.04	3.09	
								1.53	1.61	1.70	1.78	1.86	1.93	1.27	1.30	1.33	1.36	1.39	1.42	1.52	1.54	
3.6									1.71	1.80	1.89	1.98	2.06	2.14	2.98	3.05	3.12	3.19	3.25	3.31	3.37	h=9
									1.71	1.80	1.89	1.98	2.06	2.14	1.49	1.53	1.56	1.59	1.63	1.66	1.68	
3.8										1.90	2.00	2.10	2.19	2.28	2.36	2.44	3.37	3.45	3.52	3.59	3.84	
										1.90	2.00	2.10	2.19	2.28	2.36	2.44	1.69	1.72	1.76	1.79	1.92	
4.0											2.11	2.21	2.31	2.41	2.50	2.59	2.68	3.90	3.98	4.06	4.14	
											2.11	2.21	2.31	2.41	2.50	2.59	2.68	1.95	1.99	2.03	2.07	
4.2												2.33	2.43	2.54	2.64	2.89	2.99	3.09	4.27	4.35	4.44	h=10
												2.33	2.43	2.54	2.64	2.89	2.99	3.09	2.13	2.18	2.22	
4.4		h=8											2.55	2.81	2.93	3.04	3.15	3.25	3.36	3.63	4.98	h=11
													2.55	2.81	2.93	3.04	3.15	3.25	3.36	3.63	2.49	
4.6														2.94	3.07	3.19	3.31	3.60	3.71	3.83	3.94	
														2.94	3.07	3.19	3.31	3.60	3.71	3.83	3.94	
4.8		h=9													3.20	3.33	3.64	3.77	3.89	4.02	4.14	
															3.20	3.33	3.64	3.77	3.89	4.02	4.14	
5.0																3.65	3.79	3.93	4.07	4.20	4.54	
																3.65	3.79	3.93	4.07	4.20	4.54	
5.2		h=10															3.95	4.10	4.45	4.60	4.75	
																	3.95	4.10	4.45	4.60	4.75	
5.4																		4.47	4.63	4.79	4.94	h=11
																		4.47	4.63	4.79	4.94	
5.6		h=11																	4.80	4.97	5.38	
																			4.80	4.97	5.38	h=12
5.8																				5.39	5.58	
																				5.39	5.58	
6.0		h=12																			5.77	
																					5.77	

LAJE ARMADA EM CRUZ

Tabela XVI — VINCULAÇÃO: UM BORDO MAIOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



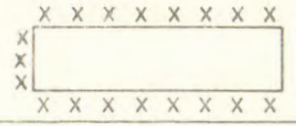
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.45	0.50	0.54	0.59	0.82	0.85	0.89	0.92	0.95	1.09	1.11	1.13	1.15	1.17	1.18	1.20						
	0.45	0.50	0.54	0.59	0.41	0.43	0.44	0.46	0.47	0.33	0.33	0.34	0.35	0.35	0.36	0.36						
2.2		0.54	0.60	0.65	0.70	0.97	1.01	1.05	1.09	1.12	1.30	1.32	1.35	1.37	1.39	1.41	1.42	1.44				
		0.54	0.60	0.65	0.70	0.49	0.51	0.53	0.54	0.56	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.43				
2.4			0.65	0.70	0.76	0.81	1.14	1.18	1.23	1.27	1.31	1.34	1.55	1.58	1.60	1.63	1.65	1.67	1.69	1.71		
			0.65	0.70	0.76	0.81	0.57	0.59	0.61	0.63	0.65	0.67	0.46	0.47	0.48	0.49	0.49	0.50	0.51	0.51		
2.6				0.76	0.82	0.88	0.94	0.99	1.37	1.42	1.46	1.51	1.55	1.59	1.82	1.85	1.88	1.90	1.93	1.95	1.97	
				0.76	0.82	0.88	0.94	0.99	0.68	0.71	0.73	0.75	0.77	0.79	0.55	0.56	0.56	0.57	0.58	0.59	0.59	
2.8					0.88	0.95	1.01	1.07	1.13	1.57	1.62	1.67	1.72	1.76	1.81	1.85	2.12	2.15	2.18	2.21	2.23	
					0.88	0.95	1.01	1.07	1.13	0.78	0.81	0.84	0.86	0.88	0.90	0.92	0.64	0.64	0.65	0.66	0.67	
3.0						1.01	1.08	1.15	1.22	1.28	1.77	1.83	1.89	1.94	1.99	2.04	2.09	2.13	2.43	2.47	2.50	
						1.01	1.08	1.15	1.22	1.28	0.89	0.92	0.95	0.97	1.00	1.02	1.04	1.06	0.73	0.74	0.75	
3.2							1.15	1.22	1.30	1.37	1.44	1.51	2.06	2.12	2.18	2.24	2.29	2.34	2.39	2.43	2.77	
							1.15	1.22	1.30	1.37	1.44	1.51	1.03	1.06	1.09	1.12	1.14	1.17	1.19	1.22	0.83	
3.4								1.29	1.37	1.45	1.53	1.61	1.68	2.30	2.37	2.43	2.49	2.55	2.60	2.65	2.70	h=8
								1.29	1.37	1.45	1.53	1.61	1.68	1.15	1.18	1.22	1.25	1.27	1.30	1.33	1.35	
3.6									1.45	1.54	1.62	1.70	1.78	1.86	2.55	2.62	2.69	2.76	2.97	3.04	3.10	
									1.45	1.54	1.62	1.70	1.78	1.86	1.28	1.31	1.35	1.38	1.49	1.52	1.55	
3.8										1.61	1.71	1.79	1.88	1.97	2.05	2.13	3.05	3.13	3.20	3.27	3.34	
										1.61	1.71	1.79	1.88	1.97	2.05	2.13	1.53	1.56	1.60	1.64	1.67	h=9
4.0											1.79	1.88	1.98	2.07	2.16	2.25	2.33	3.35	3.43	3.51	3.77	
											1.79	1.88	1.98	2.07	2.16	2.25	2.33	1.67	1.72	1.76	1.89	
4.2												1.97	2.07	2.17	2.27	2.36	2.45	2.54	3.85	3.94	4.03	
												1.97	2.07	2.17	2.27	2.36	2.45	2.54	1.92	1.97	2.02	h=10
4.4		h=8											2.16	2.27	2.37	2.47	2.57	2.82	2.92	3.01	4.29	
													2.16	2.27	2.37	2.47	2.57	2.82	2.92	3.01	2.15	
4.6														2.36	2.47	2.72	2.84	2.95	3.05	3.16	3.26	
														2.36	2.47	2.72	2.84	2.95	3.05	3.16	3.26	
4.8															2.71	2.83	2.95	3.07	3.19	3.30	3.59	
															2.71	2.83	2.95	3.07	3.19	3.30	3.59	
5.0																2.94	3.07	3.19	3.49	3.61	3.74	
5.2		h=9														2.94	3.07	3.19	3.49	3.61	3.74	h=10
																	3.18	3.48	3.62	3.76	3.89	
5.4																	3.18	3.48	3.62	3.76	3.89	
																		3.60	3.75	3.89	4.03	
5.6		h=10																3.60	3.75	3.89	4.03	
																			3.88	4.03	4.38	
5.8																			3.88	4.03	4.38	
																				4.36	4.53	h=11
6.0		h=11																		4.36	4.53	
																					4.67	
																					4.67	

LAJE ARMADA EM CRUZ

Tabela XVII — VINCULAÇÃO: UM BORDO MENOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 15.0 MPa – AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



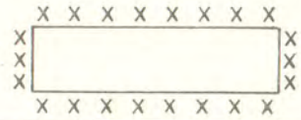
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.45	0.49	0.52	0.56	0.72	0.74	0.76	0.78	0.80	0.89	0.90	0.91	0.92	0.93	0.94	0.95					
	0.45	0.49	0.52	0.56	0.36	0.37	0.38	0.39	0.40	0.27	0.27	0.27	0.28	0.28	0.28	0.28					
2.2		0.54	0.59	0.63	0.66	0.85	0.88	0.91	0.93	0.95	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.14			
		0.54	0.59	0.63	0.66	0.43	0.44	0.45	0.46	0.48	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34			
2.4			0.65	0.69	0.74	0.78	1.00	1.04	1.06	1.09	1.11	1.14	1.26	1.28	1.29	1.30	1.32	1.33	1.34	1.35	
			0.65	0.69	0.74	0.78	0.50	0.52	0.53	0.54	0.56	0.57	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.41	
2.6				0.76	0.81	0.85	0.90	0.94	1.20	1.23	1.26	1.29	1.31	1.34	1.48	1.50	1.51	1.53	1.54	1.56	1.57
				0.76	0.81	0.85	0.90	0.94	0.60	0.62	0.63	0.64	0.66	0.67	0.44	0.45	0.45	0.46	0.46	0.47	0.47
2.8					0.88	0.93	0.98	1.03	1.08	1.38	1.41	1.45	1.48	1.51	1.53	1.56	1.72	1.74	1.75	1.77	1.79
					0.88	0.93	0.98	1.03	1.08	0.69	0.71	0.72	0.74	0.75	0.77	0.78	0.52	0.52	0.53	0.53	0.54
3.0						1.01	1.07	1.12	1.17	1.22	1.57	1.61	1.64	1.68	1.71	1.74	1.77	1.79	1.98	1.99	2.01
						1.01	1.07	1.12	1.17	1.22	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.90	0.59	0.60	0.60
3.2							1.15	1.21	1.27	1.32	1.37	1.42	1.81	1.85	1.89	1.92	1.96	1.99	2.02	2.04	2.25
							1.15	1.21	1.27	1.32	1.37	1.42	0.90	0.92	0.94	0.96	0.98	0.99	1.01	1.02	0.67
3.4								1.29	1.36	1.42	1.48	1.54	1.59	2.03	2.07	2.11	2.15	2.19	2.22	2.25	2.28
								1.29	1.36	1.42	1.48	1.54	1.59	1.01	1.03	1.06	1.07	1.09	1.11	1.13	1.14
3.6									1.45	1.52	1.58	1.65	1.71	1.77	2.25	2.30	2.34	2.39	2.43	2.46	2.50
									1.45	1.52	1.58	1.65	1.71	1.77	1.13	1.15	1.17	1.19	1.21	1.23	1.25
3.8										1.61	1.69	1.76	1.83	1.89	1.95	2.01	2.54	2.59	2.64	2.68	2.72
										1.61	1.69	1.76	1.83	1.89	1.95	2.01	1.27	1.30	1.32	1.34	1.36
4.0											1.79	1.86	1.94	2.01	2.08	2.15	2.21	2.80	2.85	3.06	3.11
											1.79	1.86	1.94	2.01	2.08	2.15	2.21	1.40	1.42	1.53	1.55
4.2												1.97	2.05	2.13	2.21	2.28	2.35	2.41	3.23	3.29	3.34
												1.97	2.05	2.13	2.21	2.28	2.35	2.41	1.62	1.64	1.67
4.4													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	3.59
													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	1.79
4.6														2.36	2.45	2.54	2.62	2.70	2.93	3.01	3.08
														2.36	2.45	2.54	2.62	2.70	2.93	3.01	3.08
4.8			h=8												2.57	2.66	2.90	3.00	3.09	3.17	3.25
															2.57	2.66	2.90	3.00	3.09	3.17	3.25
5.0																2.94	3.04	3.14	3.24	3.33	3.42
																2.94	3.04	3.14	3.24	3.33	3.42
5.2			h=9														3.18	3.29	3.39	3.67	3.77
																	3.18	3.29	3.39	3.67	3.77
5.4																		3.60	3.72	3.84	3.95
																		3.60	3.72	3.84	3.95
5.6																			3.88	4.00	4.12
																			3.88	4.00	4.12
5.8			h=10																	4.16	4.49
																				4.16	4.49
6.0			h=11																		4.67
																					4.67

LAJE ARMADA EM CRUZ

Tabela XVIII VINCULAÇÃO: TODOS OS BORDOS ENGASTADOS

CONCRETO: f_{ck} = 15.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.39	0.43	0.46	0.49	0.66	0.68	0.71	0.73	0.75	0.84	0.86	0.87	0.88	0.89	0.90	0.91						
	0.39	0.43	0.46	0.49	0.33	0.34	0.35	0.36	0.37	0.25	0.26	0.26	0.26	0.27	0.27	0.27						
2.2		0.47	0.51	0.55	0.58	0.78	0.81	0.84	0.86	0.89	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.10				
		0.47	0.51	0.55	0.58	0.39	0.41	0.42	0.43	0.44	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33				
2.4			0.56	0.60	0.64	0.68	0.92	0.95	0.98	1.01	1.04	1.06	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.30		
			0.56	0.60	0.64	0.68	0.46	0.48	0.49	0.51	0.52	0.53	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39		
2.6				0.65	0.70	0.75	0.79	0.83	1.10	1.14	1.17	1.20	1.23	1.25	1.41	1.43	1.45	1.46	1.48	1.49	1.51	
				0.65	0.70	0.75	0.79	0.83	0.55	0.57	0.58	0.60	0.61	0.63	0.42	0.43	0.43	0.44	0.44	0.45	0.45	
2.8					0.76	0.81	0.86	0.91	0.95	1.26	1.30	1.34	1.37	1.40	1.43	1.46	1.64	1.66	1.68	1.69	1.71	
					0.76	0.81	0.86	0.91	0.95	0.63	0.65	0.67	0.68	0.70	0.71	0.73	0.49	0.50	0.50	0.51	0.51	
3.0						0.87	0.92	0.98	1.03	1.08	1.43	1.48	1.51	1.55	1.59	1.62	1.65	1.68	1.88	1.90	1.92	
						0.87	0.92	0.98	1.03	1.08	0.72	0.74	0.76	0.78	0.79	0.81	0.82	0.84	0.56	0.57	0.58	
3.2							0.99	1.05	1.10	1.16	1.21	1.26	1.66	1.70	1.74	1.78	1.82	1.85	1.88	1.91	2.14	
							0.99	1.05	1.10	1.16	1.21	1.26	0.83	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.64	
3.4								1.11	1.18	1.24	1.30	1.35	1.41	1.86	1.90	1.95	1.99	2.03	2.06	2.10	2.13	
								1.11	1.18	1.24	1.30	1.35	1.41	0.93	0.95	0.97	0.99	1.01	1.03	1.05	1.07	
3.6									1.25	1.31	1.38	1.44	1.50	1.56	2.06	2.11	2.16	2.21	2.25	2.29	2.33	
									1.25	1.31	1.38	1.44	1.50	1.56	1.03	1.06	1.08	1.10	1.12	1.14	1.16	
3.8										1.39	1.46	1.53	1.60	1.66	1.72	1.78	2.33	2.38	2.43	2.48	2.52	
										1.39	1.46	1.53	1.60	1.66	1.72	1.78	1.17	1.19	1.22	1.24	1.26	
4.0											1.54	1.61	1.69	1.76	1.82	1.89	1.95	2.56	2.62	2.67	2.72	
											1.54	1.61	1.69	1.76	1.82	1.89	1.95	1.28	1.31	1.34	1.36	h=8
4.2												1.70	1.77	1.85	1.93	2.00	2.07	2.13	2.80	3.02	3.08	
												1.70	1.77	1.85	1.93	2.00	2.07	2.13	1.40	1.51	1.54	
4.4													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	3.29	h=9
4.6													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	1.64	
														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59	
4.8														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59	
															2.21	2.30	2.39	2.48	2.56	2.64	2.87	
5.0															2.21	2.30	2.39	2.48	2.56	2.64	2.87	
																2.40	2.50	2.59	2.82	2.91	3.00	h=9
5.2		h=8														2.40	2.50	2.59	2.82	2.91	3.00	
																	2.60	2.84	2.94	3.04	3.14	
5.4																	2.60	2.84	2.94	3.04	3.14	
																		2.95	3.06	3.16	3.27	
5.6		h=9																2.95	3.06	3.16	3.27	
																			3.17	3.29	3.57	
5.8																			3.17	3.29	3.57	h=10
																				3.58	3.70	
6.0		h=10																		3.58	3.70	
																					3.83	
																					3.83	

LAJE ARMADA EM CRUZ

Tabela XIX — VINCULAÇÃO: BORDOS LIVREMENTE APOIADOS

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2

lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.77	0.85	0.91	0.98	1.31	1.36	1.41	1.45	1.49	1.68	1.71	1.74	1.76	1.78	1.80	1.82						
	0.77	0.85	0.91	0.98	0.66	0.68	0.70	0.73	0.75	0.50	0.51	0.52	0.53	0.53	0.54	0.55						
2.2		0.93	1.01	1.09	1.16	1.56	1.62	1.67	1.72	1.77	2.00	2.04	2.07	2.10	2.12	2.15	2.17	2.19				
		0.93	1.01	1.09	1.16	0.78	0.81	0.84	0.86	0.88	0.60	0.61	0.62	0.63	0.64	0.64	0.65	0.66				
2.4			1.11	1.20	1.28	1.36	1.83	1.90	1.96	2.02	2.07	2.12	2.39	2.43	2.46	2.49	2.52	2.55	2.57	2.60		
			1.11	1.20	1.28	1.36	0.92	0.95	0.98	1.01	1.03	1.06	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78		
2.6				1.30	1.40	1.49	1.58	1.66	2.20	2.27	2.33	2.39	2.45	2.50	2.81	2.85	2.89	2.92	2.95	2.98	3.01	
				1.30	1.40	1.49	1.58	1.66	1.10	1.13	1.17	1.20	1.22	1.25	0.84	0.86	0.87	0.88	0.89	0.89	0.90	h=8
2.8					1.51	1.61	1.71	1.81	1.90	2.52	2.60	2.67	2.73	2.80	2.85	2.91	3.44	3.49	3.53	3.57	3.60	
					1.51	1.61	1.71	1.81	1.90	1.26	1.30	1.33	1.37	1.40	1.43	1.45	1.03	1.05	1.06	1.07	1.08	
3.0						1.73	1.84	1.95	2.05	2.15	2.86	2.95	3.02	3.26	3.34	3.41	3.47	3.53	3.96	4.01	4.05	
						1.73	1.84	1.95	2.05	2.15	1.43	1.47	1.51	1.63	1.67	1.70	1.74	1.77	1.19	1.20	1.22	h=9
3.2							1.97	2.09	2.20	2.31	2.42	2.52	3.50	3.59	3.67	3.75	3.83	3.90	4.17	4.24	2.74	
							1.97	2.09	2.20	2.31	2.42	2.52	1.75	1.79	1.84	1.88	1.91	1.95	2.09	2.12	1.42	
3.4								2.22	2.35	2.47	2.59	2.70	2.81	4.11	4.21	4.31	4.40	4.49	4.57	4.65	4.73	
								2.22	2.35	2.47	2.59	2.70	2.81	2.05	2.11	2.15	2.20	2.24	2.29	2.33	2.36	h=10
3.6									2.49	2.62	2.75	2.88	3.16	3.29	4.57	4.68	4.78	5.12	5.22	5.32	5.41	
									2.49	2.62	2.75	2.88	3.16	3.29	2.28	2.34	2.39	2.56	2.61	2.66	2.70	
3.8		h=8								2.77	3.07	3.22	3.36	3.49	3.62	3.94	5.42	5.54	5.65	5.76	5.86	h=11
										2.77	3.07	3.22	3.36	3.49	3.62	3.94	2.71	2.77	2.83	2.88	2.93	
4.0											3.24	3.40	3.55	3.89	4.04	4.19	4.33	6.23	6.37	6.50	6.62	
											3.24	3.40	3.55	3.89	4.04	4.19	4.33	3.12	3.18	3.25	3.31	
4.2		h=9										3.57	3.93	4.10	4.26	4.42	4.58	4.96	6.82	6.96	7.10	h=12
												3.57	3.93	4.10	4.26	4.42	4.58	4.96	3.41	3.48	3.55	
4.4		h=10											4.12	4.30	4.48	4.88	5.06	5.23	5.39	5.55		
													4.12	4.30	4.48	4.88	5.06	5.23	5.39	5.55		
4.6														4.72	4.92	5.12	5.31	5.50	5.94	6.12	6.30	
														4.72	4.92	5.12	5.31	5.50	5.94	6.12	6.30	
4.8		h=11													5.14	5.35	5.82	6.03	6.23	6.42	6.61	
															5.14	5.35	5.82	6.03	6.23	6.42	6.61	
5.0																5.84	6.07	6.29	6.51			
																5.84	6.07	6.29	6.51			
5.2		h=12															6.31	6.55				
																	6.31	6.55				

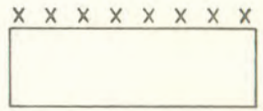
LAJE ARMADA EM CRUZ

Tabela XX

VINCULAÇÃO: UM BORDO MAIOR ENGASTADO

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



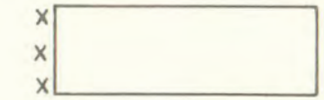
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.63	0.69	0.73	0.78	1.00	1.03	1.06	1.08	1.11	1.22	1.24	1.26	1.27	1.28	1.29	1.30						
	0.63	0.69	0.73	0.78	0.50	0.51	0.53	0.54	0.55	0.37	0.37	0.38	0.38	0.38	0.39	0.39						
2.2		0.76	0.82	0.88	0.93	1.19	1.23	1.26	1.29	1.32	1.46	1.48	1.50	1.52	1.53	1.55	1.56	1.57				
		0.76	0.82	0.88	0.93	0.59	0.61	0.63	0.65	0.66	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47				
2.4			0.91	0.97	1.03	1.09	1.40	1.44	1.48	1.51	1.55	1.58	1.74	1.76	1.78	1.80	1.82	1.83	1.85	1.86		
			0.91	0.97	1.03	1.09	0.70	0.72	0.74	0.76	0.77	0.79	0.52	0.53	0.53	0.54	0.55	0.55	0.55	0.56		
2.6				1.07	1.13	1.20	1.26	1.32	1.67	1.71	1.75	1.79	1.82	1.86	2.05	2.07	2.09	2.11	2.13	2.15	2.16	
				1.07	1.13	1.20	1.26	1.32	0.84	0.86	0.88	0.90	0.91	0.93	0.61	0.62	0.63	0.63	0.64	0.64	0.65	
2.8					1.24	1.31	1.38	1.45	1.51	1.92	1.97	2.01	2.05	2.09	2.13	2.16	2.38	2.40	2.43	2.45	2.47	
					1.24	1.31	1.38	1.45	1.51	0.96	0.98	1.01	1.03	1.05	1.06	1.08	0.71	0.72	0.73	0.73	0.74	
3.0						1.42	1.50	1.57	1.64	1.71	2.18	2.23	2.28	2.33	2.37	2.41	2.45	2.49	2.73	2.76	2.78	
						1.42	1.50	1.57	1.64	1.71	1.09	1.12	1.14	1.16	1.19	1.21	1.23	1.24	0.82	0.83	0.03	
3.2							1.61	1.70	1.78	1.85	1.93	2.00	2.52	2.57	2.62	2.67	2.72	2.76	2.80	2.84	3.11	
							1.61	1.70	1.78	1.85	1.93	2.00	1.26	1.29	1.31	1.34	1.36	1.38	1.40	1.42	0.93	
3.4								1.82	1.91	2.00	2.08	2.16	2.23	2.82	2.88	2.93	2.99	3.04	3.08	3.13	3.17	h=8
								1.82	1.91	2.00	2.08	2.16	2.23	1.41	1.44	1.47	1.49	1.52	1.54	1.56	1.58	
3.6									2.04	2.14	2.23	2.31	2.40	2.48	3.14	3.20	3.44	3.50	3.56	3.61	3.69	
									2.04	2.14	2.23	2.31	2.40	2.48	1.57	1.60	1.72	1.75	1.78	1.80	1.83	
3.8										2.27	2.37	2.47	2.56	2.65	2.74	2.82	3.73	3.80	3.87	3.93	3.99	
										2.27	2.37	2.47	2.56	2.65	2.74	2.82	1.87	1.90	1.93	1.96	1.99	h=9
4.0											2.52	2.62	2.73	2.82	2.92	3.01	3.09	4.11	4.40	4.47	4.54	
											2.52	2.62	2.73	2.82	2.92	3.09	3.09	2.05	2.20	2.24	2.27	
4.2		h=8										2.77	2.89	2.99	3.27	3.37	3.47	3.57	4.73	4.82	4.90	
												2.77	2.89	2.99	3.27	3.37	3.47	3.57	2.37	2.41	2.45	h=10
4.4													3.21	3.33	3.45	3.57	3.68	3.79	3.89	3.99	5.51	h=11
													3.21	3.33	3.45	3.57	3.68	3.79	3.89	3.99	2.75	
4.6														3.51	3.64	3.76	3.88	4.21	4.32	4.44	4.55	
														3.51	3.64	3.76	3.88	4.21	4.32	4.44	4.55	
4.8		h=9													3.82	4.16	4.30	4.43	4.56	4.68	4.80	h=10
															3.82	4.16	4.30	4.43	4.56	4.68	4.80	
5.0																4.35	4.50	4.65	4.79	5.16	5.30	
5.2		h=10														4.35	4.50	4.65	4.79	5.16	5.30	
																	4.71	5.10	5.26	5.41	5.56	h=11
5.4																	4.71	5.10	5.26	5.41	5.56	
																		5.33	5.50	5.66	5.82	
5.6		h=11																5.33	5.50	5.66	5.82	
																			5.73	5.90	6.36	
5.8																			5.73	5.90	6.36	
																				6.43	6.62	h=12
6.0		h=12																		6.43	6.62	
																					6.88	
																					6.88	

LAJE ARMADA EM CRUZ

Tabela XXI — VINCULAÇÃO: UM BORDO MENOR ENGASTADO

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



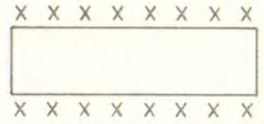
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.63	0.70	0.77	0.83	1.17	1.22	1.27	1.32	1.36	1.57	1.60	1.63	1.66	1.68	1.71	1.73						
	0.63	0.70	0.77	0.83	0.58	0.61	0.64	0.66	0.68	0.47	0.48	0.49	0.50	0.51	0.51	0.52						
2.2		0.76	0.84	0.91	0.98	1.38	1.45	1.50	1.56	1.61	1.87	1.90	1.94	1.97	2.00	2.03	2.05	2.08				
		0.76	0.84	0.91	0.98	0.69	0.72	0.75	0.78	0.80	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.62				
2.4			0.91	0.99	1.07	1.15	1.62	1.69	1.75	1.82	1.87	1.92	2.23	2.27	2.31	2.34	2.37	2.40	2.43	2.46		
			0.91	0.99	1.07	1.15	0.81	0.85	0.88	0.91	0.94	0.96	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74		
2.6				1.07	1.16	1.24	1.33	1.41	1.95	2.02	2.09	2.16	2.22	2.27	2.62	2.66	2.70	2.74	2.78	2.81	2.85	h=8
				1.07	1.16	1.24	1.33	1.41	0.98	1.01	1.05	1.08	1.11	1.14	0.79	0.80	0.81	0.82	0.83	0.84	0.85	
2.8					1.24	1.33	1.43	1.53	1.60	2.23	2.31	2.39	2.46	2.52	2.59	2.65	3.05	3.09	3.14	3.35	3.39	
					1.24	1.33	1.43	1.53	1.60	1.12	1.16	1.19	1.23	1.26	1.29	1.32	0.91	0.93	0.94	1.00	1.02	
3.0						1.42	1.52	1.62	1.72	1.81	2.53	2.62	2.70	2.78	2.85	2.92	2.99	3.05	3.69	3.74	3.79	h=9
						1.42	1.52	1.62	1.72	1.81	1.26	1.31	1.35	1.39	1.43	1.46	1.49	1.53	1.11	1.12	1.14	
3.2							1.61	1.72	1.83	1.94	2.04	2.13	2.94	3.19	3.28	3.37	3.45	3.53	3.60	3.67	4.42	
							1.61	1.72	1.83	1.94	2.04	2.13	1.47	1.60	1.64	1.69	1.73	1.76	1.80	1.84	1.33	
3.4								1.82	1.94	2.05	2.16	2.27	2.38	3.46	3.56	3.66	3.75	3.84	4.13	4.21	4.30	
								1.82	1.94	2.05	2.16	2.27	2.38	1.73	1.78	1.83	1.88	1.92	2.06	2.11	2.15	
3.6									2.04	2.16	2.29	2.40	2.52	2.63	4.04	4.15	4.26	4.37	4.47	4.57	4.66	h=10
									2.04	2.16	2.29	2.40	2.52	2.63	2.02	2.08	2.13	2.18	2.24	2.28	2.33	
3.8										2.27	2.40	2.53	2.66	2.78	3.06	3.18	4.58	4.70	5.05	5.16	5.27	
										2.27	2.40	2.53	2.66	2.78	3.06	3.18	2.29	2.35	2.52	2.58	2.64	
4.0			h=8								2.52	2.66	2.79	3.08	3.22	3.35	3.48	5.27	5.41	5.53	5.56	h=11
											2.52	2.66	2.79	3.08	3.22	3.35	3.48	2.64	2.70	2.77	2.83	
4.2												2.92	3.08	3.23	3.38	3.52	3.85	3.99	5.76	6.18	6.32	h=12
												2.92	3.08	3.23	3.38	3.52	3.85	3.99	2.88	3.09	3.16	
4.4													3.21	3.37	3.53	3.87	4.03	4.19	4.34	4.49	6.72	
													3.21	3.37	3.53	3.87	4.03	4.19	4.34	4.49	3.36	
4.6			h=9											3.51	3.86	4.04	4.21	4.38	4.76	4.93	5.09	
														3.51	3.86	4.04	4.21	4.38	4.78	4.93	5.09	
4.8															4.01	4.20	4.38	4.78	4.97	5.15	5.32	h=11
															4.01	4.20	4.38	4.78	4.97	5.15	5.32	
5.0			h=10													4.35	4.77	4.97	5.17	5.36	5.80	
																4.35	4.77	4.97	5.17	5.36	5.80	
5.2																	4.94	5.15	5.36	5.82	6.03	h=12
																	4.94	5.15	5.36	5.82	6.03	
5.4			h=11															5.33	5.81	6.03	6.25	
																		5.33	5.81	6.03	6.25	
5.6			h=12																6.00	6.23		
																			6.00	6.23		

LAJE ARMADA EM CRUZ

Tabela XXII — VINCULAÇÃO: DOIS BORDOS MAIORES ENGASTADOS

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



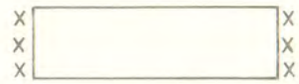
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.53	0.56	0.60	0.63	0.78	0.80	0.82	0.84	0.85	0.93	0.94	0.95	0.96	0.97	0.97	0.98					
	0.53	0.56	0.60	0.63	0.39	0.40	0.41	0.42	0.43	0.28	0.28	0.28	0.29	0.29	0.29	0.29					
2.2		0.64	0.68	0.72	0.75	0.93	0.96	0.98	1.00	1.02	1.11	1.12	1.14	1.15	1.16	1.17	1.17	1.18			
		0.64	0.68	0.72	0.75	0.47	0.48	0.49	0.50	0.51	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35			
2.4			0.76	0.80	0.84	0.88	1.10	1.13	1.15	1.17	1.20	1.22	1.32	1.34	1.35	1.36	1.37	1.38	1.39	1.40	
			0.76	0.80	0.84	0.88	0.55	0.56	0.58	0.59	0.60	0.61	0.40	0.40	0.41	0.41	0.41	0.41	0.42	0.42	
2.6				0.89	0.94	0.98	1.03	1.07	1.31	1.34	1.36	1.39	1.41	1.43	1.56	1.57	1.58	1.60	1.61	1.62	1.63
				0.89	0.94	0.98	1.03	1.07	0.65	0.67	0.68	0.69	0.71	0.72	0.47	0.47	0.48	0.48	0.48	0.49	0.49
2.8					1.03	1.08	1.13	1.18	1.22	1.50	1.54	1.57	1.59	1.62	1.64	1.66	1.81	1.82	1.84	1.85	1.86
					1.03	1.08	1.13	1.18	1.22	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.54	0.55	0.55	0.55	0.56
3.0						1.18	1.24	1.29	1.34	1.39	1.71	1.75	1.78	1.81	1.84	1.87	1.89	1.91	2.07	2.09	2.11
						1.18	1.24	1.29	1.34	1.39	0.86	0.87	0.89	0.91	0.92	0.93	0.95	0.96	0.62	0.63	0.63
3.2							1.34	1.40	1.46	1.51	1.57	1.61	1.97	2.01	2.04	2.07	2.10	2.13	2.16	2.18	2.36
							1.34	1.40	1.46	1.51	1.57	1.61	0.99	1.00	1.02	1.04	1.05	1.07	1.08	1.09	0.71
3.4								1.51	1.56	1.64	1.70	1.75	1.81	2.21	2.25	2.29	2.32	2.36	2.39	2.42	2.44
								1.51	1.56	1.64	1.70	1.75	1.81	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.22
3.6									1.69	1.76	1.83	1.89	1.95	2.01	2.46	2.51	2.55	2.58	2.62	2.65	2.69
									1.69	1.76	1.83	1.89	1.95	2.01	1.23	1.25	1.27	1.29	1.31	1.33	1.34
3.8										1.89	1.96	2.03	2.10	2.16	2.22	2.28	2.77	2.82	2.86	2.90	2.93
										1.89	1.96	2.03	2.10	2.16	2.22	2.28	1.39	1.41	1.43	1.45	1.47
4.0											2.09	2.17	2.24	2.31	2.38	2.44	2.51	3.06	3.10	3.15	3.19
											2.09	2.17	2.24	2.31	2.38	2.44	2.51	1.53	1.55	1.57	1.59
4.2												2.30	2.39	2.46	2.54	2.61	2.68	2.74	3.53	3.59	3.64
												2.30	2.39	2.46	2.54	2.61	2.68	2.74	1.77	1.79	1.82
4.4													2.53	2.61	2.70	2.77	2.85	2.92	2.99	3.06	3.91
													2.53	2.61	2.70	2.77	2.85	2.92	2.99	3.06	1.96
4.6														2.76	2.85	2.94	3.02	3.10	3.35	3.43	3.50
														2.76	2.85	2.94	3.02	3.10	3.35	3.43	3.50
4.8		h=8													3.01	3.10	3.36	3.46	3.54	3.63	3.71
															3.01	3.10	3.36	3.46	3.54	3.63	3.71
5.0																3.44	3.54	3.64	3.74	3.83	3.92
																3.44	3.54	3.64	3.74	3.83	3.92
5.2		h=9															3.72	3.83	3.93	4.24	4.34
																	3.72	3.83	3.93	4.24	4.34
5.4																		4.22	4.33	4.45	4.56
																		4.22	4.33	4.45	4.56
5.6																			4.53	4.66	4.78
																			4.53	4.66	4.78
5.8		h=10																		4.86	5.23
																				4.86	5.23
6.0		h=11																			5.46
																					5.46

LAJE ARMADA EM CRUZ

Tabela XXIII — VINCULAÇÃO: DOIS BORDOS MENORES ENGASTADOS

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



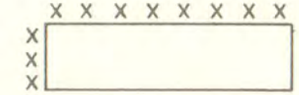
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.59	0.65	0.71	1.04	1.09	1.15	1.19	1.24	1.47	1.50	1.53	1.56	1.59	1.62	1.64						
	0.53	0.59	0.65	0.71	0.52	0.55	0.57	0.60	0.62	0.44	0.45	0.46	0.47	0.48	0.49	0.49						
2.2		0.64	0.70	0.77	0.84	1.23	1.29	1.35	1.41	1.46	1.74	1.78	1.82	1.85	1.88	1.92	1.94	1.97				
		0.64	0.70	0.77	0.84	0.62	0.65	0.68	0.70	0.73	0.52	0.53	0.54	0.56	0.57	0.57	0.58	0.59				
2.4			0.76	0.83	0.90	0.98	1.44	1.51	1.57	1.64	1.69	1.75	2.07	2.12	2.16	2.20	2.23	2.27	2.30	2.33		
			0.76	0.83	0.90	0.98	0.72	0.75	0.79	0.82	0.85	0.88	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70		
2.6				0.89	0.97	1.05	1.13	1.20	1.74	1.81	1.88	1.95	2.01	2.07	2.44	2.49	2.53	2.58	2.62	2.65	2.69	
				0.89	0.97	1.05	1.13	1.20	0.87	0.91	0.94	0.97	1.00	1.03	0.73	0.75	0.76	0.77	0.78	0.80	0.81	
2.8					1.03	1.11	1.20	1.29	1.37	1.98	2.06	2.14	2.21	2.28	2.35	2.41	2.84	2.89	2.94	2.98	3.03	
					1.03	1.11	1.20	1.29	1.37	0.99	1.03	1.07	1.11	1.14	1.17	1.21	0.85	0.87	0.88	0.89	0.91	h=8
3.0						1.18	1.27	1.37	1.46	1.54	2.24	2.33	2.42	2.50	2.57	2.65	2.71	2.78	3.44	3.50	3.55	
						1.18	1.27	1.37	1.46	1.54	1.12	1.17	1.21	1.25	1.29	1.32	1.36	1.39	1.03	1.05	1.07	
3.2							1.34	1.44	1.54	1.64	1.73	1.82	2.61	2.71	2.79	2.88	2.96	3.20	3.28	3.35	3.92	
							1.34	1.44	1.54	1.64	1.73	1.82	1.31	1.35	1.40	1.44	1.48	1.60	1.64	1.67	1.18	
3.4								1.51	1.62	1.72	1.83	1.93	2.03	2.91	3.18	3.28	3.37	3.46	3.55	3.64	3.72	
								1.51	1.62	1.72	1.83	1.93	2.03	1.46	1.59	1.64	1.69	1.73	1.78	1.82	1.86	h=9
3.6									1.69	1.81	1.92	2.03	2.14	2.24	3.40	3.52	3.62	3.73	4.02	4.12	4.22	
									1.69	1.81	1.92	2.03	2.14	2.24	1.70	1.76	1.81	1.86	2.01	2.06	2.11	
3.8										1.89	2.01	2.12	2.24	2.36	2.47	2.58	4.07	4.19	4.31	4.42	4.53	
										1.89	2.01	2.12	2.24	2.36	2.47	2.58	2.03	2.10	2.15	2.21	2.26	h=10
4.0											2.09	2.22	2.34	2.46	2.58	2.70	2.97	4.46	4.59	4.95	5.07	
											2.09	2.22	2.34	2.46	2.58	2.70	2.97	2.23	2.30	2.47	2.54	
4.2												2.30	2.44	2.57	2.70	2.98	3.11	3.24	5.11	5.25	5.39	
												2.30	2.44	2.57	2.70	2.98	3.11	3.24	2.55	2.63	2.70	h=11
4.4			h=8										2.53	2.67	2.96	3.10	3.24	3.38	3.51	3.83	5.97	
													2.53	2.67	2.96	3.10	3.24	3.38	3.51	3.83	2.99	h=12
4.6														2.91	3.07	3.22	3.37	3.51	3.85	4.00	4.14	
														2.91	3.07	3.22	3.37	3.51	3.85	4.00	4.14	
4.8			h=9												3.17	3.33	3.67	3.83	3.99	4.15	4.31	h=10
															3.17	3.33	3.67	3.83	3.99	4.15	4.31	
5.0																3.62	3.79	3.97	4.14	4.31	4.69	
																3.62	3.79	3.97	4.14	4.31	4.69	
5.2																	3.91	4.09	4.27	4.67	4.86	h=11
																	3.91	4.09	4.27	4.67	4.86	
5.4			h=10															4.22	4.62	4.82	5.01	
																		4.22	4.62	4.82	5.01	
5.6																			4.76	4.96	5.17	
																			4.76	4.96	5.17	
5.8			h=11																	5.10	5.56	h=12
																				5.10	5.56	
6.0			h=12																		5.71	
																					5.71	

LAJE ARMADA EM CRUZ

Tabela XXIV — VINCULAÇÃO: DOIS BORDOS ADJACENTES ENGASTADOS

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



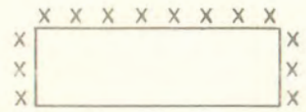
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.58	0.63	0.67	0.90	0.94	0.97	1.00	1.03	1.16	1.18	1.19	1.21	1.22	1.24	1.25						
	0.53	0.58	0.63	0.67	0.45	0.47	0.48	0.50	0.51	0.35	0.35	0.36	0.36	0.37	0.37	0.38						
2.2		0.64	0.70	0.75	0.80	1.07	1.11	1.15	1.18	1.22	1.38	1.40	1.42	1.44	1.46	1.48	1.49	1.51				
		0.64	0.70	0.75	0.80	0.54	0.56	0.58	0.59	0.61	0.41	0.42	0.43	0.43	0.44	0.44	0.45	0.45				
2.4			0.76	0.82	0.88	0.94	1.26	1.31	1.35	1.39	1.42	1.46	1.64	1.67	1.69	1.71	1.73	1.75	1.77	1.78		
			0.76	0.82	0.88	0.94	0.63	0.65	0.67	0.69	0.71	0.73	0.49	0.50	0.51	0.51	0.52	0.52	0.53	0.54		
2.6				0.89	0.96	1.02	1.08	1.14	1.51	1.56	1.60	1.64	1.68	1.72	1.93	1.96	1.98	2.01	2.03	2.05	2.07	
				0.89	0.96	1.02	1.08	1.14	0.76	0.78	0.80	0.82	0.84	0.86	0.58	0.59	0.59	0.60	0.61	0.61	0.62	
2.8					1.04	1.11	1.18	1.24	1.30	1.73	1.78	1.83	1.88	1.92	1.96	2.00	2.24	2.27	2.30	2.32	2.35	
					1.04	1.11	1.18	1.24	1.30	0.87	0.89	0.92	0.94	0.96	0.98	1.00	0.67	0.68	0.69	0.70	0.70	
3.0						1.19	1.27	1.34	1.41	1.48	1.97	2.02	2.08	2.13	2.17	2.22	2.26	2.30	2.58	2.61	2.64	
						1.19	1.27	1.34	1.41	1.48	0.98	1.01	1.04	1.06	1.09	1.11	1.13	1.15	0.77	0.78	0.79	
3.2							1.35	1.43	1.51	1.59	1.66	1.73	2.28	2.34	2.39	2.44	2.49	2.54	2.58	2.62	2.94	
							1.35	1.43	1.51	1.59	1.66	1.73	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.31	0.88	
3.4								1.53	1.61	1.70	1.78	1.86	1.93	2.55	2.61	2.67	2.73	2.78	2.83	2.88	2.93	
								1.53	1.61	1.70	1.78	1.86	1.93	1.27	1.30	1.33	1.36	1.39	1.42	1.44	1.46	
3.6									1.71	1.80	1.89	1.98	2.06	2.14	2.83	2.90	2.96	3.02	3.08	3.14	3.19	
									1.71	1.80	1.89	1.98	2.06	2.14	1.41	1.45	1.48	1.51	1.54	1.57	1.60	h=8
3.8										1.90	2.00	2.10	2.19	2.28	2.36	2.44	3.37	3.45	3.52	3.59	3.65	
										1.90	2.00	2.10	2.19	2.28	2.36	2.44	1.69	1.72	1.76	1.79	1.82	
4.0											2.11	2.21	2.31	2.41	2.50	2.59	2.68	3.71	3.79	3.86	3.94	
											2.11	2.21	2.31	2.41	2.50	2.59	2.68	1.85	1.89	1.93	1.97	h=9
4.2												2.33	2.43	2.54	2.64	2.74	2.83	2.93	4.06	4.35	4.44	
												2.33	2.43	2.54	2.64	2.74	2.83	2.93	2.03	2.18	2.22	h=10
4.4													2.55	2.67	2.78	2.88	2.99	3.25	3.36	3.46	4.74	
													2.55	2.67	2.78	2.88	2.99	3.25	3.36	3.46	2.37	
4.6				h=8										2.79	2.91	3.19	3.31	3.42	3.53	3.64	3.74	
														2.79	2.91	3.19	3.31	3.42	3.53	3.64	3.74	
4.8															3.20	3.33	3.46	3.58	3.70	3.82	4.14	
															3.20	3.33	3.46	3.58	3.70	3.82	4.14	
5.0																3.47	3.61	3.74	4.07	4.20	4.33	h=10
5.2				h=9												3.47	3.61	3.74	4.07	4.20	4.33	
																	3.76	4.10	4.24	4.39	4.52	
5.4																	3.76	4.10	4.24	4.39	4.52	
																		4.26	4.41	4.56	4.71	
5.6				h=10														4.26	4.47	4.56	4.71	
																			4.58	4.97	5.14	
5.8																			4.58	4.97	5.14	
																				5.15	5.33	h=11
6.0				h=11																5.15	5.33	
																					5.51	
																					5.51	

LAJE ARMADA EM CRUZ

Tabela XXV — VINCULAÇÃO: UM BORDO MAIOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



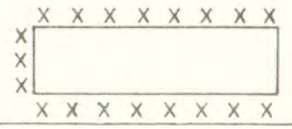
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.45	0.50	0.54	0.59	0.82	0.85	0.89	0.92	0.95	1.09	1.11	1.13	1.15	1.17	1.18	1.20						
	0.45	0.50	0.54	0.59	0.41	0.43	0.44	0.46	0.47	0.33	0.33	0.34	0.35	0.35	0.36	0.36						
2.2		0.54	0.60	0.65	0.70	0.97	1.01	1.05	1.09	1.12	1.30	1.32	1.35	1.37	1.39	1.41	1.42	1.44				
		0.54	0.60	0.65	0.70	0.49	0.51	0.53	0.54	0.56	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.43				
2.4			0.65	0.70	0.76	0.81	1.14	1.18	1.23	1.27	1.31	1.34	1.55	1.58	1.60	1.63	1.65	1.67	1.69	1.71		
			0.65	0.70	0.76	0.81	0.57	0.59	0.61	0.63	0.65	0.67	0.46	0.47	0.48	0.49	0.49	0.50	0.51	0.51		
2.6				0.76	0.82	0.88	0.94	0.99	1.37	1.42	1.46	1.51	1.55	1.59	1.82	1.85	1.88	1.90	1.93	1.95	1.97	
				0.76	0.82	0.88	0.94	0.99	0.68	0.71	0.73	0.75	0.77	0.79	0.55	0.56	0.56	0.57	0.58	0.59	0.59	
2.8					0.88	0.95	1.01	1.07	1.13	1.57	1.62	1.67	1.72	1.76	1.81	1.85	2.12	2.15	2.18	2.21	2.23	
					0.88	0.95	1.01	1.07	1.13	0.78	0.81	0.84	0.86	0.88	0.90	0.92	0.64	0.64	0.65	0.66	0.67	
3.0						1.01	1.08	1.15	1.22	1.28	1.77	1.83	1.89	1.94	1.99	2.04	2.09	2.13	2.43	2.47	2.50	
						1.01	1.08	1.15	1.22	1.28	0.89	0.92	0.95	0.97	1.00	1.02	1.04	1.06	0.73	0.74	0.75	
3.2							1.15	1.22	1.30	1.37	1.44	1.51	2.06	2.12	2.18	2.24	2.29	2.34	2.39	2.43	2.77	
							1.15	1.22	1.30	1.37	1.44	1.51	1.03	1.06	1.09	1.12	1.14	1.17	1.19	1.22	0.83	
3.4								1.29	1.37	1.45	1.53	1.61	1.68	2.30	2.37	2.43	2.49	2.55	2.60	2.65	2.70	
								1.29	1.37	1.45	1.53	1.61	1.68	1.15	1.18	1.22	1.25	1.27	1.30	1.33	1.35	
3.6									1.45	1.54	1.62	1.70	1.78	1.86	2.55	2.62	2.69	2.76	2.82	2.88	2.94	
									1.45	1.54	1.62	1.70	1.78	1.86	1.28	1.31	1.35	1.38	1.41	1.44	1.47	
3.8										1.61	1.71	1.79	1.88	1.97	2.05	2.13	2.89	2.97	3.04	3.11	3.17	
										1.61	1.71	1.79	1.88	1.97	2.05	2.13	1.45	1.48	1.52	1.55	1.59	h=8
4.0											1.79	1.88	1.98	2.07	2.16	2.25	2.33	3.35	3.43	3.51	3.59	
											1.79	1.88	1.98	2.07	2.16	2.25	2.33	1.67	1.72	1.76	1.79	
4.2												1.97	2.07	2.17	2.27	2.36	2.45	2.54	3.66	3.75	3.84	
												1.97	2.07	2.17	2.27	2.36	2.45	2.54	1.83	1.88	1.92	h=9
4.4													2.16	2.27	2.37	2.47	2.57	2.67	2.77	2.86	4.29	
													2.16	2.27	2.37	2.47	2.57	2.67	2.77	2.86	2.15	h=10
4.6														2.36	2.47	2.58	2.69	2.79	2.90	3.16	3.26	
4.8														2.36	2.47	2.58	2.69	2.79	2.90	3.16	3.26	
															2.57	2.69	2.80	2.91	3.19	3.30	3.41	
5.0		h=8													2.57	2.69	2.80	2.91	3.19	3.30	3.41	
																2.79	3.07	3.19	3.32	3.44	3.56	h=9
5.2																2.79	3.07	3.19	3.32	3.44	3.56	
																	3.18	3.31	3.44	3.57	3.70	
5.4		h=9															3.18	3.31	3.44	3.57	3.70	
																		3.43	3.57	3.70	4.03	
5.6																		3.43	3.57	3.70	4.03	h=10
																			3.88	4.03	4.18	
5.8																			3.88	4.03	4.18	
																				4.16	4.31	
6.0		h=10																		4.16	4.31	
																					4.45	
																					4.45	

LAJE ARMADA EM CRUZ

Tabela XXVI — VINCULAÇÃO: UM BORDO MENOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



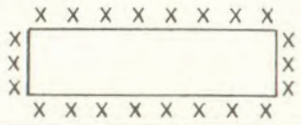
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.45	0.49	0.52	0.56	0.72	0.74	0.76	0.78	0.80	0.89	0.90	0.91	0.92	0.93	0.94	0.95						
	0.45	0.49	0.52	0.56	0.36	0.37	0.38	0.39	0.40	0.27	0.27	0.27	0.28	0.28	0.28	0.28						
2.2		0.54	0.59	0.63	0.66	0.85	0.88	0.91	0.93	0.95	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.14				
		0.54	0.59	0.63	0.66	0.43	0.44	0.45	0.46	0.48	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34				
2.4			0.65	0.69	0.74	0.78	1.00	1.04	1.06	1.09	1.11	1.14	1.26	1.28	1.29	1.30	1.32	1.33	1.34	1.35		
			0.65	0.69	0.74	0.78	0.50	0.52	0.53	0.54	0.56	0.57	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.41		
2.6				0.76	0.81	0.85	0.90	0.94	1.20	1.23	1.26	1.29	1.31	1.34	1.48	1.50	1.51	1.53	1.54	1.56	1.57	
				0.76	0.81	0.85	0.90	0.94	0.60	0.62	0.63	0.64	0.66	0.67	0.44	0.45	0.45	0.46	0.46	0.47	0.47	
2.8					0.88	0.93	0.98	1.03	1.08	1.38	1.41	1.45	1.48	1.51	1.53	1.56	1.72	1.74	1.75	1.77	1.79	
					0.88	0.93	0.98	1.03	1.08	0.69	0.71	0.72	0.74	0.75	0.77	0.78	0.52	0.52	0.53	0.53	0.54	
3.0						1.01	1.07	1.12	1.17	1.22	1.57	1.61	1.64	1.68	1.71	1.74	1.77	1.79	1.98	1.99	2.01	
						1.01	1.07	1.12	1.17	1.22	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.90	0.59	0.60	0.60	
3.2							1.15	1.21	1.27	1.32	1.37	1.42	1.81	1.85	1.89	1.92	1.96	1.99	2.02	2.04	2.25	
							1.15	1.21	1.27	1.32	1.37	1.42	0.90	0.92	0.94	0.96	0.98	0.99	1.01	1.02	0.67	
3.4								1.29	1.36	1.42	1.48	1.54	1.59	2.03	2.07	2.11	2.15	2.19	2.22	2.25	2.28	
								1.29	1.36	1.42	1.48	1.54	1.59	1.01	1.03	1.06	1.07	1.09	1.11	1.13	1.14	
3.6									1.45	1.52	1.58	1.65	1.71	1.77	2.25	2.30	2.34	2.39	2.43	2.46	2.50	
									1.45	1.52	1.58	1.65	1.71	1.77	1.13	1.15	1.17	1.19	1.21	1.23	1.25	
3.8										1.61	1.69	1.76	1.83	1.89	1.95	2.01	2.54	2.59	2.64	2.68	2.72	
										1.61	1.69	1.76	1.83	1.89	1.95	2.01	1.27	1.30	1.32	1.34	1.36	
4.0											1.79	1.86	1.94	2.01	2.08	2.15	2.21	2.80	2.85	2.90	2.95	
											1.79	1.86	1.94	2.01	2.08	2.15	2.21	1.40	1.42	1.45	1.47	
4.2												1.97	2.05	2.13	2.21	2.28	2.35	2.41	3.06	3.12	3.17	h=8
												1.97	2.05	2.13	2.21	2.28	2.35	2.41	1.53	1.56	1.59	
4.4													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	3.59	
													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	1.79	h=9
4.6														2.36	2.45	2.54	2.62	2.70	2.78	2.85	2.93	
														2.36	2.45	2.54	2.62	2.70	2.78	2.85	2.93	
4.8															2.57	2.66	2.76	2.84	2.93	3.01	3.09	
															2.57	2.66	2.76	2.84	2.93	3.01	3.09	
5.0																2.79	2.89	2.98	3.24	3.33	3.42	
5.2		h=8														2.79	2.89	2.98	3.24	3.33	3.42	
																	3.02	3.29	3.39	3.49	3.59	h=9
5.4																	3.02	3.29	3.39	3.49	3.59	
																		3.43	3.54	3.65	3.75	
5.6		h=9																3.43	3.54	3.65	3.75	
																			3.69	3.80	4.12	
5.8																			3.69	3.80	4.12	h=10
																				4.16	4.28	
6.0		h=10																		4.16	4.28	
																					4.45	
																					4.45	

LAJE ARMADA EM CRUZ

Tabela XXVII — VINCULAÇÃO: TODOS OS BORDOS ENGASTADOS

CONCRETO: f_{ck} = 18.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.39	0.43	0.46	0.49	0.66	0.68	0.71	0.73	0.75	0.84	0.86	0.87	0.88	0.89	0.90	0.91					
	0.39	0.43	0.46	0.49	0.33	0.34	0.35	0.36	0.37	0.25	0.26	0.26	0.26	0.27	0.27	0.27					
2.2		0.47	0.51	0.55	0.58	0.78	0.81	0.84	0.86	0.89	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.10			
		0.47	0.51	0.55	0.58	0.39	0.41	0.42	0.43	0.44	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33			
2.4			0.56	0.60	0.64	0.68	0.92	0.95	0.98	1.01	1.04	1.06	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.30	
			0.56	0.60	0.64	0.68	0.46	0.48	0.49	0.51	0.52	0.53	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39	
2.6				0.65	0.70	0.75	0.79	0.83	1.10	1.14	1.17	1.20	1.23	1.25	1.41	1.43	1.45	1.46	1.48	1.49	1.51
				0.65	0.70	0.75	0.79	0.83	0.55	0.57	0.58	0.60	0.61	0.63	0.42	0.43	0.43	0.44	0.44	0.45	0.45
2.8					0.76	0.81	0.86	0.91	0.95	1.26	1.30	1.34	1.37	1.40	1.43	1.46	1.64	1.66	1.68	1.69	1.71
					0.76	0.81	0.86	0.91	0.95	0.63	0.65	0.67	0.68	0.70	0.71	0.73	0.49	0.50	0.50	0.51	0.51
3.0						0.87	0.92	0.98	1.03	1.08	1.43	1.48	1.51	1.55	1.59	1.62	1.65	1.68	1.88	1.90	1.92
						0.87	0.92	0.98	1.03	1.08	0.72	0.74	0.76	0.78	0.79	0.81	0.82	0.84	0.56	0.57	0.58
3.2							0.99	1.05	1.10	1.16	1.21	1.26	1.66	1.70	1.74	1.78	1.82	1.85	1.88	1.91	2.14
							0.99	1.05	1.10	1.16	1.21	1.26	0.83	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.64
3.4								1.11	1.18	1.24	1.30	1.35	1.41	1.86	1.90	1.95	1.99	2.03	2.06	2.10	2.13
								1.11	1.18	1.24	1.30	1.35	1.41	0.93	0.95	0.97	0.99	1.01	1.03	1.05	1.07
3.6									1.25	1.31	1.38	1.44	1.50	1.56	2.06	2.11	2.16	2.21	2.25	2.29	2.33
									1.25	1.31	1.38	1.44	1.50	1.56	1.03	1.06	1.08	1.10	1.12	1.14	1.16
3.8										1.39	1.46	1.53	1.60	1.66	1.72	1.78	2.33	2.38	2.43	2.48	2.52
										1.39	1.46	1.53	1.60	1.66	1.72	1.78	1.17	1.19	1.22	1.24	1.26
4.0											1.54	1.61	1.69	1.76	1.82	1.89	1.95	2.56	2.62	2.67	2.72
											1.54	1.61	1.69	1.76	1.82	1.89	1.95	1.28	1.31	1.34	1.36
4.2												1.70	1.77	1.85	1.93	2.00	2.07	2.13	2.80	2.86	2.92
												1.70	1.77	1.85	1.93	2.00	2.07	2.13	1.40	1.43	1.46
4.4													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	3.12
													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	1.56
4.6														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59
														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59
4.8															2.21	2.30	2.39	2.48	2.56	2.64	2.72
															2.21	2.30	2.39	2.48	2.56	2.64	2.72
5.0																2.40	2.50	2.59	2.68	2.76	2.85
																2.40	2.50	2.59	2.68	2.76	2.85
5.2																	2.60	2.69	2.79	2.88	2.97
																	2.60	2.69	2.79	2.88	2.97
5.4		h=8																2.80	2.90	3.16	3.27
																		2.80	2.90	3.16	3.27
5.6																			3.17	3.29	3.39
																			3.17	3.29	3.39
5.8																				3.40	3.52
																				3.40	3.52
6.0		h=9																			3.64
																					3.64

LAJE ARMADA EM CRUZ

Tabela XXVIII — VINCULAÇÃO: BORDOS LIVREMENTE APOIADOS

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2

lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.77	0.85	0.91	0.98	1.31	1.36	1.41	1.45	1.49	1.68	1.71	1.74	1.76	1.78	1.80	1.82					
	0.77	0.85	0.91	0.98	0.66	0.68	0.70	0.73	0.75	0.50	0.51	0.52	0.53	0.53	0.54	0.55					
2.2		0.93	1.01	1.09	1.16	1.56	1.62	1.67	1.72	1.77	2.00	2.04	2.07	2.10	2.12	2.15	2.17	2.19			
		0.93	1.01	1.09	1.16	0.78	0.81	0.84	0.86	0.88	0.60	0.61	0.62	0.63	0.64	0.64	0.65	0.66			
2.4			1.11	1.20	1.28	1.36	1.83	1.90	1.96	2.02	2.07	2.12	2.39	2.43	2.46	2.49	2.52	2.55	2.57	2.60	
			1.11	1.20	1.28	1.36	0.92	0.95	0.98	1.01	1.03	1.06	0.72	0.73	0.74	0.75	0.76	0.76	0.77	0.78	
2.6				1.30	1.40	1.49	1.58	1.66	2.20	2.27	2.33	2.39	2.45	2.50	2.81	2.85	2.89	2.92	2.95	2.98	3.01
				1.30	1.40	1.49	1.58	1.66	1.10	1.13	1.17	1.20	1.22	1.25	0.84	0.86	0.87	0.88	0.89	0.89	0.90
2.8					1.51	1.61	1.71	1.81	1.90	2.52	2.60	2.67	2.73	2.80	2.85	2.91	3.27	3.31	3.35	3.38	3.42
					1.51	1.61	1.71	1.81	1.90	1.26	1.30	1.33	1.37	1.40	1.43	1.45	0.98	0.99	1.00	1.02	1.03
3.0						1.73	1.84	1.95	2.05	2.15	2.86	2.95	3.02	3.10	3.17	3.23	3.29	3.53	3.96	4.01	4.05
						1.73	1.84	1.95	2.05	2.15	1.43	1.47	1.51	1.55	1.58	1.62	1.65	1.77	1.19	1.20	1.22
3.2							1.97	2.09	2.20	2.31	2.42	2.52	3.50	3.59	3.67	3.75	3.83	3.90	3.97	4.03	4.74
							1.97	2.09	2.20	2.31	2.42	2.52	1.75	1.79	1.84	1.88	1.91	1.95	1.98	2.02	1.42
3.4								2.22	2.35	2.47	2.59	2.70	2.81	3.91	4.01	4.10	4.19	4.49	4.57	4.65	4.73
								2.22	2.35	2.47	2.59	2.70	2.81	1.95	2.00	2.05	2.09	2.24	2.29	2.33	2.36
3.6									2.49	2.62	2.75	2.88	3.00	3.12	4.57	4.68	4.78	4.88	4.98	5.07	5.16
									2.49	2.62	2.75	2.88	3.00	3.12	2.28	2.34	2.39	2.44	2.49	2.53	2.58
3.8		h=8								2.77	2.92	3.05	3.36	3.49	3.62	3.75	5.17	5.54	5.65	5.76	5.86
										2.77	2.92	3.05	3.36	3.49	3.62	3.75	2.58	2.77	2.83	2.88	2.93
4.0											3.24	3.40	3.55	3.70	3.84	3.98	4.33	5.96	6.08	6.21	6.32
											3.24	3.40	3.55	3.70	3.84	3.98	4.33	2.98	3.04	3.10	3.16
4.2		h=9										3.57	3.74	3.90	4.26	4.42	4.58	4.72	6.82	6.96	7.10
												3.57	3.74	3.90	4.26	4.42	4.58	4.72	3.41	3.48	3.55
4.4													4.12	4.30	4.48	4.65	4.82	5.23	5.39	5.55	7.59
													4.12	4.30	4.48	4.65	4.82	5.23	5.39	5.55	3.79
4.6		h=10												4.50	4.69	4.88	5.31	5.50	5.67	5.85	6.02
														4.50	4.69	4.88	5.31	5.50	5.67	5.85	6.02
4.8															5.14	5.35	5.56	5.76	5.95	6.42	6.61
															5.14	5.35	5.56	5.76	5.95	6.42	6.61
5.0		h=11														5.58	5.80	6.29	6.51	6.72	6.93
																5.58	5.80	6.29	6.51	6.72	6.93
5.2																	6.31	6.55	6.79	7.01	
																	6.31	6.55	6.79	7.01	
5.4		h=12																6.81	7.06		
																		6.81	7.06		

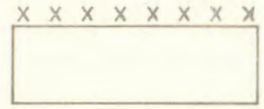
h=8 h=9 h=10 h=11 h=12 h=12

LAJE ARMADA EM CRUZ

Tabela XXIX — VINCULAÇÃO: UM BORDO MAIOR ENGASTADO

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh , Q = 1,50 KN/m^2



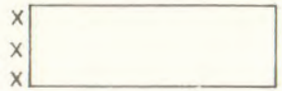
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.63	0.69	0.73	0.78	1.00	1.03	1.06	1.08	1.11	1.22	1.24	1.26	1.27	1.28	1.29	1.30					
	0.63	0.69	0.73	0.78	0.50	0.51	0.53	0.54	0.55	0.37	0.37	0.38	0.38	0.38	0.39	0.39					
2.2		0.76	0.82	0.88	0.93	1.19	1.23	1.26	1.29	1.32	1.46	1.48	1.50	1.52	1.53	1.55	1.56	1.57			
		0.76	0.82	0.88	0.93	0.59	0.61	0.63	0.65	0.66	0.44	0.44	0.45	0.45	0.46	0.46	0.47	0.47			
2.4			0.91	0.97	1.03	1.09	1.40	1.44	1.48	1.51	1.55	1.58	1.74	1.76	1.78	1.80	1.82	1.83	1.85	1.86	
			0.91	0.97	1.03	1.09	0.70	0.72	0.74	0.76	0.77	0.79	0.52	0.53	0.53	0.54	0.55	0.55	0.55	0.56	
2.6				1.07	1.13	1.20	1.26	1.32	1.67	1.71	1.75	1.79	1.82	1.86	2.05	2.07	2.09	2.11	2.13	2.15	2.16
				1.07	1.13	1.20	1.26	1.32	0.84	0.86	0.88	0.90	0.91	0.93	0.61	0.62	0.63	0.63	0.64	0.64	0.65
2.8					1.24	1.31	1.38	1.45	1.51	1.92	1.97	2.01	2.05	2.09	2.13	2.16	2.38	2.40	2.43	2.45	2.47
					1.24	1.31	1.38	1.45	1.51	0.96	0.98	1.01	1.03	1.05	1.06	1.08	0.71	0.72	0.73	0.73	0.74
3.0						1.42	1.50	1.57	1.64	1.71	2.18	2.23	2.28	2.33	2.37	2.41	2.45	2.49	2.73	2.76	2.78
						1.42	1.50	1.57	1.64	1.71	1.09	1.12	1.14	1.16	1.19	1.21	1.23	1.24	0.82	0.83	0.83
3.2							1.61	1.70	1.78	1.85	1.93	2.00	2.52	2.57	2.62	2.67	2.72	2.76	2.80	2.84	3.11
							1.61	1.70	1.78	1.85	1.93	2.00	1.26	1.29	1.31	1.34	1.36	1.38	1.40	1.42	0.93
3.4								1.82	1.91	2.00	2.08	2.16	2.23	2.82	2.88	2.93	2.99	3.04	3.08	3.13	3.17
								1.82	1.91	2.00	2.08	2.16	2.23	1.41	1.44	1.47	1.49	1.52	1.54	1.56	1.58
3.6									2.04	2.14	2.23	2.31	2.40	2.48	3.14	3.20	3.26	3.32	3.37	3.42	3.47
									2.04	2.14	2.23	2.31	2.40	2.48	1.57	1.60	1.63	1.66	1.69	1.71	1.74
3.8										2.27	2.37	2.47	2.56	2.65	2.74	2.82	3.73	3.80	3.87	3.93	3.99
										2.27	2.37	2.47	2.56	2.65	2.74	2.82	1.87	1.90	1.93	1.96	1.99
4.0											2.52	2.62	2.73	2.82	2.92	3.01	3.09	4.11	4.18	4.25	4.32
											2.52	2.62	2.73	2.82	2.92	3.01	3.09	2.05	2.09	2.13	2.16
4.2												2.77	2.89	2.99	3.10	3.20	3.29	3.57	4.73	4.82	4.90
												2.77	2.89	2.99	3.10	3.20	3.29	3.57	2.37	2.41	2.45
4.4		h=8											3.04	3.16	3.28	3.57	3.68	3.79	3.89	3.99	5.25
													3.04	3.16	3.28	3.57	3.68	3.79	3.89	3.99	2.63
4.6														3.51	3.64	3.76	3.88	4.00	4.11	4.22	4.55
														3.51	3.64	3.76	3.88	4.00	4.11	4.22	4.55
4.8															3.82	3.95	4.09	4.21	4.56	4.68	4.80
															3.82	3.95	4.09	4.21	4.56	4.68	4.80
5.0		h=9														4.14	4.50	4.65	4.79	4.92	5.05
																4.14	4.50	4.65	4.79	4.92	5.05
5.2																	4.71	4.87	5.02	5.16	5.56
																	4.71	4.87	5.02	5.16	5.56
5.4		h=10																5.08	5.50	5.66	5.82
																		5.08	5.50	5.66	5.82
5.6																			5.73	5.90	6.08
																			5.73	5.90	6.08
5.8		h=11																		6.14	6.33
																				6.14	6.33
6.0		h=12																			6.88
																					6.88

LAJE ARMADA EM CRUZ

Tabela XXX — VINCULAÇÃO: UM BORDO MENOR ENGASTADO

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



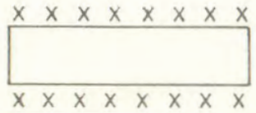
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.63	0.70	0.77	0.83	1.17	1.22	1.27	1.32	1.36	1.57	1.60	1.63	1.66	1.68	1.71	1.73						
	0.63	0.70	0.77	0.83	0.58	0.61	0.64	0.66	0.68	0.47	0.48	0.49	0.50	0.51	0.51	0.52						
2.2		0.76	0.84	0.91	0.98	1.38	1.45	1.50	1.56	1.61	1.87	1.90	1.94	1.97	2.00	2.03	2.05	2.08				
		0.76	0.84	0.91	0.98	0.69	0.72	0.75	0.78	0.80	0.56	0.57	0.58	0.59	0.60	0.61	0.62	0.62				
2.4			0.91	0.99	1.07	1.15	1.62	1.69	1.75	1.82	1.87	1.92	2.23	2.27	2.31	2.34	2.37	2.40	2.43	2.46		
			0.91	0.99	1.07	1.15	0.81	0.85	0.88	0.91	0.94	0.96	0.67	0.68	0.69	0.70	0.71	0.72	0.73	0.74		
2.6				1.07	1.16	1.24	1.33	1.41	1.95	2.02	2.09	2.16	2.22	2.27	2.62	2.66	2.70	2.74	2.78	2.81	2.85	
				1.07	1.16	1.24	1.33	1.41	0.98	1.01	1.05	1.08	1.11	1.14	0.79	0.80	0.81	0.82	0.83	0.84	0.85	
2.8					1.24	1.33	1.43	1.52	1.60	2.23	2.31	2.39	2.46	2.52	2.59	2.65	3.05	3.09	3.14	3.18	3.22	h=8
					1.24	1.33	1.43	1.52	1.60	1.12	1.16	1.19	1.23	1.26	1.29	1.32	0.91	0.93	0.94	0.95	0.96	
3.0						1.42	1.52	1.62	1.72	1.81	2.53	2.62	2.70	2.78	2.85	2.92	2.99	3.05	3.69	3.74	3.79	
						1.42	1.52	1.62	1.72	1.81	1.26	1.31	1.35	1.39	1.43	1.46	1.49	1.53	1.11	1.12	1.14	
3.2							1.61	1.72	1.83	1.94	2.04	2.13	2.94	3.03	3.12	3.20	3.45	3.53	3.60	3.67	4.21	
							1.61	1.72	1.83	1.94	2.04	2.13	1.47	1.52	1.56	1.60	1.73	1.76	1.80	1.84	1.26	
3.4								1.82	1.94	2.05	2.16	2.27	2.38	3.46	3.56	3.66	3.75	3.84	3.93	4.01	4.09	h=9
								1.82	1.94	2.05	2.16	2.27	2.38	1.73	1.78	1.83	1.88	1.92	1.96	2.00	2.04	
3.6									2.04	2.16	2.29	2.40	2.52	2.63	3.84	3.95	4.05	4.37	4.47	4.57	4.66	
									2.04	2.16	2.29	2.40	2.52	2.63	1.92	1.97	2.03	2.18	2.24	2.28	2.33	
3.8										2.27	2.40	2.53	2.66	2.78	2.90	3.01	4.58	4.70	4.81	4.92	5.03	h=10
										2.27	2.40	2.53	2.66	2.78	2.90	3.01	2.29	2.35	2.41	2.46	2.51	
4.0											2.52	2.66	2.79	2.92	3.22	3.35	3.48	5.02	5.41	5.53	5.66	
											2.52	2.66	2.79	2.92	3.22	3.35	3.48	2.51	2.70	2.77	2.83	
4.2		h=8										2.77	2.92	3.23	3.38	3.52	3.66	3.80	5.76	5.90	6.04	h=11
												2.77	2.92	3.23	3.38	3.52	3.66	3.80	2.88	2.95	3.02	
4.4													3.21	3.37	3.53	3.68	3.83	4.19	4.34	4.49	6.72	h=12
													3.21	3.37	3.53	3.68	3.83	4.19	4.34	4.49	3.36	
4.6		h=9												3.51	3.68	4.04	4.21	4.38	4.54	4.70	4.85	
														3.51	3.68	4.04	4.21	4.38	4.54	4.70	4.85	
4.8															4.01	4.20	4.38	4.56	4.74	5.15	5.32	
															4.01	4.20	4.38	4.56	4.74	5.15	5.32	
5.0																4.35	4.55	4.74	5.17	5.36	5.55	h=11
																4.35	4.55	4.74	5.17	5.36	5.55	
5.2		h=10															4.71	5.15	5.36	5.56	5.76	
																	4.71	5.15	5.36	5.56	5.76	
5.4																		5.33	5.55	5.76	6.25	
																		5.33	5.55	5.76	6.25	
5.6		h=11																	5.73	6.23	6.47	h=12
																			5.73	6.23	6.47	
5.8																				6.43	6.68	
																				6.43	6.68	
6.0		h=12																			6.88	
																					6.88	

LAJE ARMADA EM CRUZ

Tabela XXXI — VINCULAÇÃO: DOIS BORDOS MAIORES ENGASTADOS

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.53	0.56	0.60	0.63	0.78	0.80	0.82	0.84	0.85	0.93	0.94	0.95	0.96	0.97	0.97	0.98					
	0.53	0.56	0.60	0.63	0.39	0.40	0.41	0.42	0.43	0.28	0.28	0.28	0.29	0.29	0.29	0.29					
2.2		0.64	0.68	0.72	0.75	0.93	0.96	0.98	1.00	1.02	1.11	1.12	1.14	1.15	1.16	1.17	1.17	1.18			
		0.64	0.68	0.72	0.75	0.47	0.48	0.49	0.50	0.51	0.33	0.34	0.34	0.34	0.35	0.35	0.35	0.35			
2.4			0.76	0.80	0.84	0.88	1.10	1.13	1.15	1.17	1.20	1.22	1.32	1.34	1.35	1.36	1.37	1.38	1.39	1.40	
			0.76	0.80	0.84	0.88	0.55	0.56	0.58	0.59	0.60	0.61	0.40	0.40	0.41	0.41	0.41	0.41	0.42	0.42	
2.6				0.89	0.94	0.98	1.03	1.07	1.31	1.34	1.36	1.39	1.41	1.43	1.56	1.57	1.58	1.60	1.61	1.62	1.63
				0.89	0.94	0.98	1.03	1.07	0.65	0.67	0.68	0.69	0.71	0.72	0.47	0.47	0.48	0.48	0.48	0.49	0.49
2.8					1.03	1.08	1.13	1.18	1.22	1.50	1.54	1.57	1.59	1.62	1.64	1.66	1.81	1.82	1.84	1.85	1.86
					1.03	1.08	1.13	1.18	1.22	0.75	0.77	0.78	0.80	0.81	0.82	0.83	0.54	0.55	0.55	0.55	0.56
3.0						1.18	1.24	1.29	1.34	1.39	1.71	1.75	1.78	1.81	1.84	1.87	1.89	1.91	2.07	2.09	2.11
						1.18	1.24	1.29	1.34	1.39	0.86	0.87	0.89	0.91	0.92	0.93	0.95	0.96	0.62	0.63	0.63
3.2							1.34	1.40	1.46	1.51	1.57	1.61	1.97	2.01	2.04	2.07	2.10	2.13	2.16	2.18	2.36
							1.34	1.40	1.46	1.51	1.57	1.61	0.99	1.00	1.02	1.04	1.05	1.07	1.08	1.09	0.71
3.4								1.51	1.58	1.64	1.70	1.75	1.81	2.21	2.25	2.29	2.32	2.36	2.39	2.42	2.44
								1.51	1.58	1.64	1.70	1.75	1.81	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.22
3.6									1.69	1.76	1.83	1.89	1.95	2.01	2.46	2.51	2.55	2.58	2.62	2.65	2.69
									1.69	1.76	1.83	1.89	1.95	2.01	1.23	1.25	1.27	1.29	1.31	1.33	1.34
3.8										1.89	1.96	2.03	2.10	2.16	2.22	2.28	2.77	2.82	2.86	2.90	2.93
										1.89	1.96	2.03	2.10	2.16	2.22	2.28	1.39	1.41	1.43	1.45	1.47
4.0											2.09	2.17	2.24	2.31	2.38	2.44	2.51	3.06	3.10	3.15	3.19
											2.09	2.17	2.24	2.31	2.38	2.44	2.51	1.53	1.55	1.57	1.59
4.2												2.30	2.39	2.46	2.54	2.61	2.68	2.74	3.35	3.40	3.45
												2.30	2.39	2.46	2.54	2.61	2.68	2.74	1.68	1.70	1.72
4.4													2.53	2.61	2.70	2.77	2.85	2.92	2.99	3.06	3.91
													2.53	2.61	2.70	2.77	2.85	2.92	2.99	3.06	1.96
4.6														2.76	2.85	2.94	3.02	3.10	3.18	3.25	3.32
														2.76	2.85	2.94	3.02	3.10	3.18	3.25	3.32
4.8															3.01	3.10	3.19	3.28	3.36	3.63	3.71
															3.01	3.10	3.19	3.28	3.36	3.63	3.71
5.0		h=8														3.26	3.54	3.64	3.74	3.83	3.92
																3.26	3.54	3.64	3.74	3.83	3.92
5.2																	3.72	3.83	3.93	4.03	4.13
																	3.72	3.83	3.92	4.03	4.13
5.4		h=9																4.01	4.12	4.23	4.56
																		4.01	4.12	4.23	4.56
5.6																			4.53	4.66	4.78
																			4.53	4.66	4.78
6.8																				4.86	4.99
																				4.86	4.99
6.0		h=10																			5.20
																					5.20

h=9

LAJE ARMADA EM CRUZ

Tabela XXXII — VINCULAÇÃO: DOIS BORDOS MENORES ENGASTADOS

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2

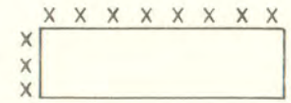
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.59	0.65	0.71	1.04	1.09	1.15	1.19	1.24	1.47	1.50	1.53	1.56	1.59	1.62	1.64						
	0.53	0.59	0.65	0.71	0.52	0.55	0.57	0.60	0.62	0.44	0.45	0.46	0.47	0.48	0.49	0.49						
2.2		0.64	0.70	0.77	0.84	1.23	1.29	1.35	1.41	1.46	1.74	1.78	1.82	1.85	1.88	1.92	1.94	1.97				
		0.64	0.70	0.77	0.84	0.62	0.65	0.68	0.70	0.73	0.52	0.53	0.54	0.56	0.57	0.57	0.58	0.59				
2.4			0.76	0.83	0.90	0.98	1.44	1.51	1.57	1.64	1.69	1.75	2.07	2.12	2.16	2.20	2.23	2.27	2.30	2.33		
			0.76	0.83	0.90	0.98	0.72	0.75	0.79	0.82	0.85	0.88	0.62	0.64	0.65	0.66	0.67	0.68	0.69	0.70		
2.6				0.89	0.97	1.05	1.13	1.20	1.74	1.81	1.88	1.95	2.01	2.07	2.44	2.49	2.53	2.58	2.62	2.65	2.69	
				0.89	0.97	1.05	1.13	1.20	0.87	0.91	0.94	0.97	1.00	1.03	0.73	0.75	0.76	0.77	0.78	0.80	0.81	
2.8					1.03	1.11	1.20	1.29	1.37	1.98	2.06	2.14	2.21	2.28	2.35	2.41	2.84	2.89	2.94	2.98	3.03	
					1.03	1.11	1.20	1.29	1.37	0.99	1.03	1.07	1.11	1.14	1.17	1.21	0.85	0.87	0.88	0.89	0.91	h=8
3.0						1.18	1.27	1.37	1.46	1.54	2.24	2.33	2.42	2.50	2.57	2.65	2.71	2.78	3.27	3.32	3.55	
						1.18	1.27	1.37	1.46	1.54	1.12	1.17	1.21	1.25	1.29	1.32	1.36	1.39	0.98	1.00	1.07	
3.2							1.34	1.44	1.54	1.64	1.73	1.82	2.61	2.71	2.79	2.88	2.96	3.03	3.11	3.18	3.92	
							1.34	1.44	1.54	1.64	1.73	1.82	1.31	1.35	1.40	1.44	1.48	1.52	1.55	1.59	1.18	
3.4								1.51	1.62	1.72	1.83	1.93	2.03	2.91	3.01	3.11	3.20	3.46	3.55	3.64	3.72	
								1.51	1.62	1.72	1.83	1.93	2.03	1.46	1.51	1.55	1.60	1.73	1.78	1.82	1.86	
3.6									1.69	1.81	1.92	2.03	2.14	2.24	3.40	3.52	3.62	3.73	3.83	3.92	4.01	
									1.69	1.81	1.92	2.03	2.14	2.24	1.70	1.76	1.81	1.86	1.91	1.96	2.01	h=9
3.8										1.89	2.01	2.12	2.24	2.36	2.47	2.58	3.87	3.99	4.31	4.42	4.53	
										1.89	2.01	2.12	2.24	2.36	2.47	2.58	1.94	1.99	2.15	2.21	2.26	
4.0											2.09	2.22	2.34	2.46	2.58	2.70	2.82	4.46	4.59	4.72	4.84	
											2.09	2.22	2.34	2.46	2.58	2.70	2.82	2.23	2.30	2.36	2.42	h=10
4.2												2.30	2.44	2.57	2.70	2.82	2.95	3.24	4.87	5.01	5.39	
												2.30	2.44	2.57	2.70	2.82	2.95	3.24	2.43	2.50	2.70	
4.4													2.53	2.67	2.80	2.94	3.24	3.38	3.51	3.65	5.71	h=11
4.6			h=8										2.53	2.67	2.80	2.94	3.24	3.38	3.51	3.65	2.85	
														2.76	2.91	3.22	3.37	3.51	3.66	3.80	4.14	
4.8														2.76	2.91	3.22	3.37	3.51	3.66	3.80	4.14	
															3.17	3.33	3.49	3.65	3.99	4.15	4.31	h=10
5.0			h=9												3.17	3.33	3.49	3.65	3.99	4.15	4.31	
																3.44	3.61	3.97	4.14	4.31	4.47	
5.2																3.44	3.61	3.97	4.14	4.31	4.47	
																	3.91	4.09	4.27	4.45	4.63	
5.4																	3.91	4.09	4.27	4.45	4.63	
																		4.22	4.41	4.59	5.01	
5.6			h=10															4.22	4.41	4.59	5.01	
																			4.53	4.96	5.17	h=11
5.8																			4.53	4.96	5.17	
																				5.10	5.32	
6.0			h=11																	5.10	5.32	
																					5.46	
																					5.46	

LAJE ARMADA EM CRUZ

Tabela XXXIII — VINCULAÇÃO: DOIS BORDOS ADJACENTES ENGASTADOS

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



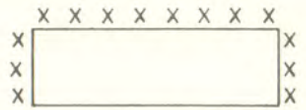
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0	
2.0	0.53	0.58	0.63	0.67	0.90	0.94	0.97	1.00	1.03	1.16	1.18	1.19	1.21	1.22	1.24	1.25						
	0.53	0.58	0.63	0.67	0.45	0.47	0.48	0.50	0.51	0.35	0.35	0.36	0.36	0.37	0.37	0.38						
2.2		0.64	0.70	0.75	0.80	1.07	1.11	1.15	1.18	1.22	1.38	1.40	1.42	1.44	1.46	1.48	1.49	1.51				
		0.64	0.70	0.75	0.80	0.54	0.56	0.58	0.59	0.61	0.41	0.42	0.43	0.43	0.44	0.44	0.45	0.45				
2.4			0.76	0.82	0.88	0.94	1.26	1.31	1.35	1.39	1.42	1.46	1.64	1.67	1.69	1.71	1.73	1.75	1.77	1.78		
			0.76	0.82	0.88	0.94	0.63	0.65	0.67	0.69	0.71	0.73	0.49	0.50	0.51	0.51	0.52	0.52	0.53	0.54		
2.6				0.89	0.96	1.02	1.08	1.14	1.51	1.56	1.60	1.64	1.68	1.72	1.93	1.96	1.98	2.01	2.03	2.05	2.07	
				0.89	0.96	1.02	1.08	1.14	0.76	0.78	0.80	0.82	0.84	0.86	0.58	0.59	0.59	0.60	0.61	0.61	0.62	
2.8					1.04	1.11	1.18	1.24	1.30	1.73	1.78	1.83	1.88	1.92	1.96	2.00	2.24	2.27	2.30	2.32	2.35	
					1.04	1.11	1.18	1.24	1.30	0.87	0.89	0.92	0.94	0.96	0.98	1.00	0.67	0.68	0.69	0.70	0.70	
3.0						1.19	1.27	1.34	1.41	1.48	1.97	2.02	2.08	2.13	2.17	2.22	2.26	2.30	2.58	2.61	2.64	
						1.19	1.27	1.34	1.41	1.48	0.98	1.01	1.04	1.06	1.09	1.11	1.13	1.15	0.77	0.78	0.79	
3.2							1.35	1.43	1.51	1.59	1.66	1.73	2.28	2.34	2.39	2.44	2.49	2.54	2.58	2.62	2.94	
							1.35	1.43	1.51	1.59	1.66	1.73	1.14	1.17	1.20	1.22	1.25	1.27	1.29	1.31	0.88	
3.4								1.53	1.61	1.70	1.78	1.86	1.93	2.55	2.61	2.67	2.73	2.78	2.83	2.88	2.93	
								1.53	1.61	1.70	1.78	1.86	1.93	1.27	1.30	1.33	1.36	1.39	1.42	1.44	1.46	
3.6									1.71	1.80	1.89	1.98	2.06	2.14	2.83	2.90	2.96	3.02	3.08	3.14	3.19	
									1.71	1.80	1.89	1.98	2.06	2.14	1.41	1.45	1.48	1.51	1.54	1.57	1.60	
3.8										1.90	2.00	2.10	2.19	2.28	2.36	2.44	3.20	3.27	3.34	3.40	3.46	
										1.90	2.00	2.10	2.19	2.28	2.36	2.44	1.60	1.64	1.67	1.70	1.73	h=8
4.0											2.11	2.21	2.31	2.41	2.50	2.59	2.68	3.71	3.79	3.86	3.94	
											2.11	2.21	2.31	2.41	2.50	2.59	2.68	1.85	1.89	1.93	1.97	
4.2												2.33	2.43	2.54	2.64	2.74	2.83	2.93	4.06	4.14	4.22	
												2.33	2.43	2.54	2.64	2.74	2.83	2.93	2.03	2.07	2.11	h=9
4.4													2.55	2.67	2.78	2.88	2.99	3.09	3.18	3.28	4.74	
													2.55	2.67	2.78	2.88	2.99	3.09	3.18	3.28	2.37	h=10
4.6														2.79	2.91	3.02	3.14	3.24	3.53	3.64	3.74	
														2.79	2.91	3.02	3.14	3.24	3.53	3.64	3.74	
4.8			h=8												3.04	3.16	3.46	3.58	3.70	3.82	3.93	h=9
															3.04	3.16	3.46	3.58	3.70	3.82	3.93	
5.0																3.47	3.61	3.74	3.87	4.00	4.12	
																3.47	3.61	3.74	3.87	4.00	4.12	
5.2																	3.76	3.90	4.04	4.39	4.52	
																	3.76	3.90	4.04	4.39	4.52	
5.4			h=9															4.05	4.41	4.56	4.71	h=10
																		4.05	4.41	4.56	4.71	
5.6																			4.58	4.74	4.90	
																			4.58	4.74	4.90	
5.8			h=10																	4.91	5.08	
																				4.91	5.08	
6.0			h=11																		5.51	h=11
																					5.51	

LAJE ARMADA EM CRUZ

Tabela XXXIV — VINCULAÇÃO: UM BORDO MAIOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.45	0.50	0.54	0.59	0.82	0.85	0.89	0.92	0.95	1.09	1.11	1.13	1.15	1.17	1.18	1.20					
	0.45	0.50	0.54	0.59	0.41	0.43	0.44	0.46	0.47	0.33	0.33	0.34	0.35	0.35	0.36	0.36					
2.2		0.54	0.60	0.65	0.70	0.97	1.01	1.05	1.09	1.12	1.30	1.32	1.35	1.37	1.39	1.41	1.42	1.44			
		0.54	0.60	0.65	0.70	0.49	0.51	0.53	0.54	0.56	0.39	0.40	0.40	0.41	0.42	0.42	0.43	0.43			
2.4			0.65	0.70	0.76	0.81	1.14	1.18	1.23	1.27	1.31	1.34	1.55	1.58	1.60	1.63	1.65	1.67	1.69	1.71	
			0.65	0.70	0.76	0.81	0.57	0.59	0.61	0.63	0.65	0.67	0.46	0.47	0.48	0.49	0.49	0.50	0.51	0.51	
2.6				0.76	0.82	0.88	0.94	0.99	1.37	1.42	1.46	1.51	1.55	1.59	1.82	1.85	1.88	1.90	1.93	1.95	1.97
				0.76	0.82	0.88	0.94	0.99	0.68	0.71	0.73	0.75	0.77	0.79	0.55	0.56	0.56	0.57	0.58	0.59	0.59
2.8					0.88	0.95	1.01	1.07	1.13	1.57	1.62	1.67	1.72	1.76	1.81	1.85	2.12	2.15	2.18	2.21	2.23
					0.88	0.95	1.01	1.07	1.13	0.78	0.81	0.84	0.86	0.88	0.90	0.92	0.64	0.64	0.65	0.66	0.67
3.0						1.01	1.08	1.15	1.22	1.28	1.77	1.83	1.89	1.94	1.99	2.04	2.09	2.13	2.43	2.47	2.50
						1.01	1.08	1.15	1.22	1.28	0.89	0.92	0.95	0.97	1.00	1.02	1.04	1.06	0.73	0.74	0.75
3.2							1.15	1.22	1.30	1.37	1.44	1.51	2.06	2.12	2.18	2.24	2.29	2.34	2.39	2.43	2.77
							1.15	1.22	1.30	1.37	1.44	1.51	1.03	1.06	1.09	1.12	1.14	1.17	1.19	1.22	0.83
3.4								1.29	1.37	1.45	1.53	1.61	1.68	2.30	2.37	2.43	2.49	2.55	2.60	2.65	2.70
								1.29	1.37	1.45	1.53	1.61	1.68	1.15	1.18	1.22	1.25	1.27	1.30	1.33	1.35
3.6									1.45	1.54	1.62	1.70	1.78	1.86	2.55	2.62	2.69	2.76	2.82	2.88	2.94
									1.45	1.54	1.62	1.70	1.78	1.86	1.28	1.31	1.35	1.38	1.41	1.44	1.47
3.8										1.61	1.71	1.79	1.88	1.97	2.05	2.13	2.89	2.97	3.04	3.11	3.17
										1.61	1.71	1.79	1.88	1.97	2.05	2.13	1.45	1.48	1.52	1.55	1.59
4.0											1.79	1.88	1.98	2.07	2.16	2.25	2.33	3.18	3.26	3.33	3.59
											1.79	1.88	1.98	2.07	2.16	2.25	2.33	1.59	1.63	1.67	1.79
4.2												1.97	2.07	2.17	2.27	2.36	2.45	2.54	3.66	3.75	3.84
												1.97	2.07	2.17	2.27	2.36	2.45	2.54	1.83	1.88	1.92
4.4													2.16	2.27	2.37	2.47	2.57	2.67	2.77	2.86	4.08
													2.16	2.27	2.37	2.47	2.57	2.67	2.77	2.86	2.04
4.6														2.36	2.47	2.58	2.69	2.79	2.90	3.00	3.09
														2.36	2.47	2.58	2.69	2.79	2.90	3.00	3.09
4.8															2.57	2.69	2.80	2.91	3.02	3.13	3.41
															2.57	2.69	2.80	2.91	3.02	3.13	3.41
5.0																2.79	2.91	3.03	3.15	3.44	3.56
																2.79	2.91	3.03	3.15	3.44	3.56
5.2			h=8														3.02	3.31	3.44	3.57	3.70
																	3.02	3.31	3.44	3.57	3.70
5.4																		3.43	3.57	3.70	3.84
																		3.43	3.57	3.70	3.84
5.6																			3.69	3.83	3.97
																			3.69	3.83	3.97
5.8			h=9																	3.95	4.31
																				3.95	4.31
6.0			h=10																		4.45
																					4.45

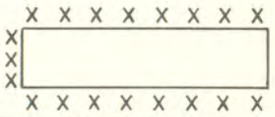
h=9

LAJE ARMADA EM CRUZ

Tabela XXXV — VINCULAÇÃO: UM BORDO MENOR LIVREMENTE APOIADO

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



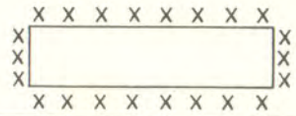
lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.45	0.49	0.52	0.56	0.72	0.74	0.76	0.78	0.80	0.89	0.90	0.91	0.92	0.93	0.94	0.95					
	0.45	0.49	0.52	0.56	0.36	0.37	0.38	0.39	0.40	0.27	0.27	0.27	0.28	0.28	0.28	0.28					
2.2		0.54	0.59	0.63	0.66	0.85	0.88	0.91	0.93	0.95	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.14			
		0.54	0.59	0.63	0.66	0.43	0.44	0.45	0.46	0.48	0.32	0.32	0.33	0.33	0.33	0.34	0.34	0.34			
2.4			0.65	0.69	0.74	0.78	1.00	1.04	1.06	1.09	1.11	1.14	1.26	1.28	1.29	1.30	1.32	1.33	1.34	1.35	
			0.65	0.69	0.74	0.78	0.50	0.52	0.53	0.54	0.56	0.57	0.38	0.38	0.39	0.39	0.40	0.40	0.40	0.41	
2.6				0.76	0.81	0.85	0.90	0.94	1.20	1.23	1.26	1.29	1.31	1.34	1.48	1.50	1.51	1.53	1.54	1.56	1.57
				0.76	0.81	0.85	0.90	0.94	0.60	0.62	0.63	0.64	0.66	0.67	0.44	0.45	0.45	0.46	0.46	0.47	0.47
2.8					0.88	0.93	0.98	1.03	1.08	1.38	1.41	1.45	1.48	1.51	1.53	1.56	1.72	1.74	1.75	1.77	1.79
					0.88	0.93	0.98	1.03	1.08	0.69	0.71	0.72	0.74	0.75	0.77	0.78	0.52	0.52	0.53	0.53	0.54
3.0						1.01	1.07	1.12	1.17	1.22	1.57	1.61	1.64	1.68	1.71	1.74	1.77	1.79	1.98	1.99	2.01
						1.01	1.07	1.12	1.17	1.22	0.78	0.80	0.82	0.84	0.85	0.87	0.88	0.90	0.59	0.60	0.60
3.2							1.15	1.21	1.27	1.32	1.37	1.42	1.81	1.85	1.89	1.92	1.96	1.99	2.02	2.04	2.25
							1.15	1.21	1.27	1.32	1.37	1.42	0.90	0.92	0.94	0.96	0.98	0.99	1.01	1.02	0.67
3.4								1.29	1.36	1.42	1.48	1.54	1.59	2.03	2.07	2.11	2.15	2.19	2.22	2.25	2.28
								1.29	1.36	1.42	1.48	1.54	1.59	1.01	1.03	1.06	1.07	1.09	1.11	1.13	1.14
3.6									1.45	1.52	1.58	1.65	1.71	1.77	2.25	2.30	2.34	2.39	2.43	2.46	2.50
									1.45	1.52	1.58	1.65	1.71	1.77	1.13	1.15	1.17	1.19	1.21	1.23	1.25
3.8										1.61	1.69	1.76	1.83	1.89	1.95	2.01	2.54	2.59	2.64	2.68	2.72
										1.61	1.69	1.76	1.83	1.89	1.95	2.01	1.27	1.30	1.32	1.34	1.36
4.0											1.79	1.86	1.94	2.01	2.08	2.15	2.21	2.80	2.85	2.90	2.95
											1.79	1.86	1.94	2.01	2.08	2.15	2.21	1.40	1.42	1.45	1.47
4.2												1.97	2.05	2.13	2.21	2.28	2.35	2.41	3.06	3.12	3.17
												1.97	2.05	2.13	2.21	2.28	2.35	2.41	1.53	1.56	1.59
4.4													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	3.40
													2.16	2.25	2.33	2.41	2.49	2.56	2.63	2.70	1.70
4.6														2.36	2.45	2.54	2.62	2.70	2.78	2.85	2.93
														2.36	2.45	2.54	2.62	2.70	2.78	2.85	2.93
4.8															2.57	2.66	2.76	2.84	2.93	3.01	3.09
															2.57	2.66	2.76	2.84	2.93	3.01	3.09
5.0																2.79	2.89	2.98	3.07	3.16	3.25
5.2																2.79	2.89	2.98	3.07	3.16	3.25
																	3.02	3.12	3.22	3.49	3.59
5.4		h=8															3.02	3.12	3.22	3.49	3.59
																		3.25	3.54	3.65	3.75
5.6																		3.25	2.54	3.65	3.75
																			3.69	3.80	3.91
5.8		h=9																	3.69	3.80	3.91
																				3.95	4.07
6.0		h=10																		3.95	4.07
																					4.45
																					4.45

LAJE ARMADA EM CRUZ

Tabela XXXVI — VINCULAÇÃO: TODOS OS BORDOS ENGASTADOS

CONCRETO: f_{ck} = 20.0 MPa — AÇO: CA-50

CARGA: G = 1,10 + 0,25 xh, Q = 1,50 KN/m^2



lx/ly	2.0	2.2	2.4	2.6	2.8	3.0	3.2	3.4	3.6	3.8	4.0	4.2	4.4	4.6	4.8	5.0	5.2	5.4	5.6	5.8	6.0
2.0	0.39	0.43	0.46	0.49	0.66	0.68	0.71	0.73	0.75	0.84	0.86	0.87	0.88	0.89	0.90	0.91					
	0.39	0.43	0.46	0.49	0.33	0.34	0.35	0.36	0.37	0.25	0.26	0.26	0.26	0.27	0.27	0.27					
2.2		0.47	0.51	0.55	0.58	0.78	0.81	0.84	0.86	0.89	1.00	1.02	1.04	1.05	1.06	1.08	1.09	1.10			
		0.47	0.51	0.55	0.58	0.39	0.41	0.42	0.43	0.44	0.30	0.31	0.31	0.32	0.32	0.32	0.33	0.33			
2.4			0.56	0.60	0.64	0.68	0.92	0.95	0.98	1.01	1.04	1.06	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.30	
			0.56	0.60	0.64	0.68	0.46	0.48	0.49	0.51	0.52	0.53	0.36	0.36	0.37	0.37	0.38	0.38	0.39	0.39	
2.6				0.65	0.70	0.75	0.79	0.83	1.10	1.14	1.17	1.20	1.23	1.25	1.41	1.43	1.45	1.46	1.48	1.49	1.51
				0.65	0.70	0.75	0.79	0.83	0.55	0.57	0.58	0.60	0.61	0.63	0.42	0.43	0.43	0.44	0.44	0.45	0.46
2.8					0.76	0.81	0.86	0.91	0.95	1.26	1.30	1.34	1.37	1.40	1.43	1.46	1.64	1.66	1.68	1.69	1.71
					0.76	0.81	0.86	0.91	0.95	0.63	0.65	0.67	0.68	0.70	0.71	0.73	0.49	0.50	0.50	0.51	0.51
3.0						0.87	0.92	0.98	1.03	1.08	1.43	1.48	1.51	1.55	1.59	1.62	1.65	1.68	1.88	1.90	1.92
						0.87	0.92	0.98	1.03	1.08	0.72	0.74	0.76	0.78	0.79	0.81	0.82	0.84	0.56	0.57	0.58
3.2							0.99	1.05	1.10	1.16	1.21	1.26	1.66	1.70	1.74	1.78	1.82	1.85	1.88	1.91	2.14
							0.99	1.05	1.10	1.16	1.21	1.26	0.83	0.85	0.87	0.89	0.91	0.93	0.94	0.96	0.64
3.4								1.11	1.18	1.24	1.30	1.35	1.41	1.86	1.90	1.95	1.99	2.03	2.06	2.10	2.13
								1.11	1.18	1.24	1.30	1.35	1.41	0.93	0.95	0.97	0.99	1.01	1.03	1.05	1.07
3.6									1.25	1.31	1.38	1.44	1.50	1.56	2.06	2.11	2.16	2.21	2.25	2.29	2.33
									1.25	1.31	1.38	1.44	1.50	1.56	1.03	1.06	1.08	1.10	1.12	1.14	1.16
3.8										1.39	1.46	1.53	1.60	1.66	1.72	1.78	2.33	2.38	2.43	2.48	2.52
										1.39	1.46	1.53	1.60	1.66	1.72	1.78	1.17	1.19	1.22	1.24	1.26
4.0											1.54	1.61	1.69	1.76	1.82	1.89	1.95	2.56	2.62	2.67	2.72
											1.54	1.61	1.69	1.76	1.82	1.89	1.95	1.28	1.31	1.34	1.36
4.2												1.70	1.77	1.85	1.93	2.00	2.07	2.13	2.80	2.86	2.92
												1.70	1.77	1.85	1.93	2.00	2.07	2.13	1.40	1.43	1.46
4.4													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	3.12
													1.86	1.94	2.02	2.10	2.18	2.25	2.32	2.39	1.56
4.6														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59
														2.03	2.12	2.20	2.29	2.37	2.44	2.52	2.59
4.8															2.21	2.30	2.39	2.48	2.56	2.64	2.72
															2.21	2.30	2.39	2.48	2.56	2.64	2.72
5.0																2.40	2.50	2.59	2.68	2.76	2.85
																2.40	2.50	2.59	2.68	2.76	2.85
5.2																	2.60	2.69	2.79	2.88	2.97
																	2.60	2.69	2.79	2.88	2.97
5.4																		2.80	2.90	3.00	3.10
																		2.80	2.90	3.00	3.10
5.6		h=8																	3.01	3.12	3.39
																			3.01	3.12	3.39
5.8																				3.40	3.52
																				3.40	3.52
6.0		h=9																			3.64
																					3.64

TABELA PARA DIMENSIONAMENTO DE ARMADURA DE LAJES
EM FUNÇÃO DO MOMENTO FLETOR.

1 Unidades

Bitolas: mm

Momentos: KNm/m

Tensões: MPa

Espaçamentos: cm

2 Materiais

Concreto: f_{ck} = 13,5; 15,0; 18,0; 20,0 (MPa)

Aço: CA-50

3 Coeficientes

$\gamma_f = \gamma_c = 1,4$

$\gamma_s = 1,15$

4 Verificações

a) O diâmetro máximo respeita o limite de um décimo de espessura da laje.

b) As colunas para cada bitola, aparecem em branco a partir dos espaçamentos que conduzem à área de seção de armadura inferior a $0,9cm^2/m$.

c) O momento absorvido pela densidade mínima de armadura está plotado na última linha das tabelas.

d) A altura útil considerada corresponde ao plano tangente das armaduras com recobrimento de 0,5cm de concreto.

5 Espessuras

Para cada concreto foram consideradas espessuras compreendidas de 8,0 a 12,0cm.

Tabela I

h = 7 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 6.1	5.0 6.0	6.3 5.9
7.0	3.14	4.58	6.48
8.0	2.77	4.08	5.85
9.0	2.48	3.67	5.33
10.0	2.25	3.34	4.88
11.0	2.06	3.06	4.50
12.0	1.89	2.83	4.18
13.0	1.75	2.63	3.90
14.0		2.45	3.65
15.0		2.30	3.43
16.0		2.16	3.24
17.0		2.04	3.07
18.0		1.93	2.91
19.0		1.84	2.77
20.0		1.75	2.64
21.0		1.67	2.52
22.0			2.42
23.0			2.32
24.0			2.23
25.0			2.15
26.0			2.07
27.0			1.99
28.0			1.93
29.0			1.86
30.0			1.81
MMIN	1.67	1.62	1.55

h = 8 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 7.1	5.0 7.0	6.3 6.9	8.0 6.7
7.0	3.69	5.45	7.87	10.69
8.0	3.26	4.84	7.06	9.82
9.0	2.92	4.35	6.40	9.05
10.0	2.64	3.95	5.85	8.38
11.0	2.41	3.62	5.38	7.79
12.0	2.22	3.34	4.99	7.27
13.0	2.05	3.10	4.64	6.81
14.0		2.89	4.34	6.41
15.0		2.70	4.08	6.05
16.0		2.54	3.84	5.72
17.0		2.40	3.64	5.43
18.0		2.27	3.45	5.17
19.0		2.16	3.28	4.93
20.0		2.05	3.13	4.71
21.0		1.96	2.99	4.51
22.0			2.86	4.32
23.0			2.74	4.15
24.0			2.63	4.00
25.0			2.53	3.85
26.0			2.44	3.71
27.0			2.35	3.59
28.0			2.27	2.47
29.0			2.20	3.36
30.0			2.13	3.26
MMIN	2.26	2.20	2.12	2.01

h = 9 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 8.1	5.0 8.0	6.3 7.9	8.0 7.7
7.0	4.25	6.32	9.25	12.92
8.0	3.75	5.60	8.27	11.77
9.0	3.35	5.03	7.48	10.79
10.0	3.03	4.56	6.82	9.94
11.0	2.77	4.17	6.26	9.21
12.0	2.54	3.84	5.79	8.57
13.0	2.35	3.56	5.39	8.01
14.0		3.32	5.03	7.52
15.0		3.11	4.72	7.09
16.0		2.92	4.45	6.70
17.0		2.76	4.20	6.35
18.0		2.61	3.99	6.04
19.0		2.48	3.79	5.75
20.0		2.36	3.61	5.49
21.0		2.25	3.45	5.25
22.0			3.30	5.03
23.0			3.16	4.83
24.0			3.04	4.65
25.0			2.92	4.48
26.0			2.81	4.32
27.0			2.71	4.17
28.0			2.62	4.03
29.0			2.53	3.90
30.0			2.45	3.78
MMIN	2.94	2.87	2.78	2.66

Tabela II

h = 10 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 9.1	5.0 9.0	6.3 8.9	8.0 8.7
7.0	4.81	7.19	10.63	15.15
8.0	4.24	6.36	9.48	13.72
9.0	3.79	5.71	8.55	12.52
10.0	3.42	5.17	7.79	11.50
11.0	3.12	4.73	7.14	10.63
12.0	2.87	4.35	6.60	9.87
13.0	2.65	4.03	6.13	9.22
14.0		3.76	5.73	8.64
15.0		3.52	5.37	8.13
16.0		3.31	5.05	7.68
17.0		3.12	4.77	7.27
18.0		2.95	4.52	6.90
19.0		2.80	4.30	6.57
20.0		2.66	4.09	6.27
21.0		2.54	3.91	6.00
22.0			3.74	5.74
23.0			3.58	5.51
24.0			3.44	5.30
25.0			3.31	5.10
26.0			3.18	4.92
27.0			3.07	4.74
28.0			2.96	4.58
29.0			2.87	4.44
30.0			2.77	4.30
MMIN	3.71	3.63	3.52	3.39

h = 11 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 10.1	5.0 10.0	6.3 9.9	8.0 9.7
7.0	5.37	8.06	12.02	17.38
8.0	4.72	7.13	10.69	15.68
9.0	4.22	6.38	9.63	14.26
10.0	3.81	5.78	8.75	13.06
11.0	3.48	5.28	8.02	12.05
12.0	3.19	4.86	7.41	11.17
13.0	2.96	4.50	6.88	10.42
14.0		4.19	6.42	9.75
15.0		3.92	6.01	9.17
16.0		3.69	5.66	8.65
17.0		3.48	5.34	8.19
18.0		3.29	5.06	7.77
19.0		3.12	4.81	7.39
20.0		2.97	4.58	7.05
21.0		2.83	4.37	6.74
22.0			4.18	6.45
23.0			4.00	6.19
24.0			3.84	5.95
25.0			3.69	5.72
26.0			3.56	5.52
27.0			3.43	5.32
28.0			3.31	5.14
29.0			3.20	4.97
30.0			3.10	4.82
MMIN	4.57	4.48	4.36	4.21

h = 12 f_{ck} = 13.5 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 11.1	5.0 11.0	6.3 10.9	8.0 10.7
7.0	5.92	8.93	13.40	19.61
8.0	5.21	7.89	11.90	17.63
9.0	4.65	7.06	10.70	15.99
10.0	4.20	6.39	9.72	14.62
11.0	3.83	5.84	8.91	13.46
12.0	3.52	5.37	8.21	12.47
13.0	3.26	4.97	7.62	11.62
14.0		4.63	7.11	10.87
15.0		4.33	6.66	10.21
16.0		4.07	6.26	9.63
17.0		3.84	5.91	9.11
18.0		3.63	5.60	8.64
19.0		3.44	5.32	8.21
20.0		3.27	5.06	7.83
21.0		3.12	4.83	7.48
22.0			4.62	7.16
23.0			4.42	6.87
24.0			4.25	6.60
25.0			4.08	6.35
26.0			3.93	6.12
27.0			3.79	5.90
28.0			3.66	5.70
29.0			3.53	5.51
30.0			3.42	5.34
MMIN	5.52	5.42	5.29	5.13

Tabela III

h = 7 f_{ck} = 15.0 MPa, f_{yk} = 500. MPa

s	ϕ 4.0 d 6.1	5.0 6.0	6.3 5.9
7.0	3.16	4.64	6.65
8.0	2.79	4.13	5.98
9.0	2.50	3.71	5.42
10.0	2.26	3.37	4.96
11.0	2.07	3.09	4.57
12.0	1.90	2.85	4.24
13.0	1.76	2.65	3.95
14.0		2.47	3.69
15.0		2.31	3.47
16.0		2.18	3.27
17.0		2.05	3.09
18.0		1.94	2.93
19.0		1.85	2.79
20.0		1.76	2.66
21.0		1.68	2.54
22.0			2.43
23.0			2.33
24.0			2.24
25.0			2.16
26.0			2.08
27.0			2.01
28.0			1.94
29.0			1.87
30.0			1.81
MMIN	1.68	1.62	1.55

h = 8 f_{ck} = 15.0 MPa, f_{yk} = 500. MPa

s	ϕ 4.0 d 7.1	5.0 7.0	6.3 6.9	8.0 6.7
7.0	3.72	5.51	8.03	11.12
8.0	3.28	4.89	7.19	10.15
9.0	2.93	4.39	6.50	9.31
10.0	2.65	3.98	5.93	8.59
11.0	2.42	3.64	5.45	7.96
12.0	2.23	3.36	5.04	7.42
13.0	2.06	3.11	4.69	6.94
14.0		2.90	4.38	6.52
15.0		2.72	4.11	6.14
16.0		2.56	3.88	5.81
17.0		2.41	3.66	5.50
18.0		2.28	3.47	5.23
19.0		2.17	3.30	4.99
20.0		2.06	3.15	4.76
21.0		1.97	3.00	4.56
22.0			2.87	4.37
23.0			2.76	4.19
24.0			2.65	4.03
25.0			2.55	3.88
26.0			2.45	3.75
27.0			2.36	3.62
28.0			2.28	3.50
29.0			2.21	3.38
30.0			2.14	3.28
MMIN	2.27	2.21	2.12	2.02

h = 9 f_{ck} = 15.0 MPa, f_{yk} = 500. MPa

s	ϕ 4.0 d 8.1	5.0 8.0	6.3 7.9	8.0 7.7
7.0	4.28	6.39	9.41	13.35
8.0	3.77	5.65	8.40	12.10
9.0	3.37	5.07	7.58	11.04
10.0	3.04	4.59	6.90	10.15
11.0	2.78	4.20	6.33	9.38
12.0	2.55	3.87	5.85	8.72
13.0	2.36	3.58	5.43	8.14
14.0		3.34	5.07	7.63
15.0		3.13	4.76	7.18
16.0		2.94	4.48	6.78
17.0		2.77	4.23	6.42
18.0		2.62	4.01	6.10
19.0		2.49	3.81	5.81
20.0		2.37	3.63	5.54
21.0		2.26	3.46	5.30
22.0			3.31	5.08
23.0			3.18	4.87
24.0			3.05	4.68
25.0			2.93	4.51
26.0			2.82	4.35
27.0			2.72	4.19
28.0			2.63	4.05
29.0			2.54	3.92
30.0			2.46	3.80
MMIN	2.95	2.88	2.79	2.67

Tabela IV

h = 10 f_{ck} = 15.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 9.1	5.0 9.0	6.3 8.9	8.0 8.7
7.0	4.83	7.26	10.80	15.58
8.0	4.26	6.41	9.61	14.05
9.0	3.80	5.75	8.65	12.78
10.0	3.43	5.20	7.87	11.71
11.0	3.13	4.75	7.21	10.80
12.0	2.88	4.37	6.66	10.02
13.0	2.66	4.05	6.18	9.34
14.0		3.77	5.77	8.75
15.0		3.53	5.40	8.22
16.0		3.32	5.09	7.76
17.0		3.13	4.80	7.34
18.0		2.96	4.55	6.97
19.0		2.81	4.32	6.63
20.0		2.67	4.11	6.32
21.0		2.55	3.93	6.04
22.0			3.75	5.79
23.0			3.60	5.55
24.0			3.45	5.33
25.0			3.32	5.13
26.0			3.20	4.95
27.0			3.08	4.77
28.0			2.97	4.61
29.0			2.88	4.46
30.0			2.78	4.32
MMIN	3.72	3.64	3.54	3.40

h = 11 f_{ck} = 15.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 10.1	5.0 10.0	6.3 9.9	8.0 9.7
7.0	5.39	8.13	12.18	17.81
8.0	4.74	7.18	10.82	16.00
9.0	4.24	6.42	9.73	14.51
10.0	3.82	5.81	8.83	13.27
11.0	3.49	5.31	8.09	12.22
12.0	3.20	4.88	7.46	11.32
13.0	2.96	4.52	6.92	10.54
14.0		4.21	6.46	9.86
15.0		3.94	6.05	9.26
16.0		3.70	5.69	8.73
17.0		3.49	5.37	8.26
18.0		3.30	5.09	7.83
19.0		3.13	4.83	7.45
20.0		2.98	4.60	7.10
21.0		2.84	4.39	6.79
22.0			4.19	6.50
23.0			4.02	6.23
24.0			3.86	5.98
25.0			3.71	5.76
26.0			3.57	5.55
27.0			3.44	5.35
28.0			3.32	5.17
29.0			3.21	5.00
30.0			3.11	4.84
MMIN	4.59	4.50	4.38	4.23

h = 12 f_{ck} = 15.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 11.1	5.0 11.0	6.3 10.9	8.0 10.7
7.0	5.95	9:00	13.56	20.04
8.0	5.23	7.94	12.03	17.95
9.0	4.67	7.10	10.80	16.25
10.0	4.21	6.42	9.80	14.83
11.0	3.84	5.86	8.97	13.64
12.0	3.53	5.39	8.27	12.62
13.0	3.26	4.99	7.67	11.74
14.0		4.65	7.15	10.98
15.0		4.34	6.70	10.30
16.0		4.08	6.30	9.71
17.0		3.85	5.94	9.18
18.0		3.64	5.62	8.70
19.0		3.45	5.34	8.27
20.0		3.28	5.08	7.88
21.0		3.13	4.85	7.53
22.0			4.63	7.21
23.0			4.44	6.91
24.0			4.26	6.63
25.0			4.09	6.38
26.0			3.94	6.15
27.0			3.80	5.93
28.0			3.67	5.73
29.0			3.54	5.54
30.0			3.43	5.36
MMIN	5.54	5.44	5.31	5.15

Tabela V

h = 7 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 6.1	5.0 6.0	6.3 5.9
7.0	3.20	4.74	6.89
8.0	2.82	4.20	6.17
9.0	2.52	3.77	5.57
10.0	2.28	3.42	5.08
11.0	2.08	3.13	4.67
12.0	1.92	2.88	4.32
13.0	1.77	2.67	4.02
14.0		2.49	3.75
15.0		2.33	3.52
16.0		2.19	3.32
17.0		2.07	3.14
18.0		1.96	2.97
19.0		1.86	2.82
20.0		1.77	2.69
21.0		1.69	2.57
22.0			2.46
23.0			2.36
24.0			2.26
25.0			2.18
26.0			2.10
27.0			2.02
28.0			1.95
29.0			1.89
30.0			1.83
MMIN	1.69	1.63	1.56

h = 8 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 7.1	5.0 7.0	6.3 6.9	8.0 6.7
7.0	3.76	5.61	8.28	11.76
8.0	3.31	4.96	7.38	10.63
9.0	2.96	4.45	6.65	9.69
10.0	2.67	4.03	6.05	8.90
11.0	2.44	3.68	5.55	8.22
12.0	2.24	3.39	5.13	7.63
13.0	2.07	3.14	4.76	7.12
14.0		2.93	4.44	6.67
15.0		2.74	4.17	6.28
16.0		2.57	3.92	5.93
17.0		2.43	3.70	5.61
18.0		2.30	3.51	5.33
19.0		2.18	3.33	5.07
20.0		2.07	3.18	4.84
21.0		1.98	3.03	4.63
22.0			2.90	4.43
23.0			2.78	4.25
24.0			2.67	4.09
25.0			2.56	3.93
26.0			2.47	3.79
27.0			2.38	3.66
28.0			2.30	3.54
29.0			2.22	3.42
30.0			2.15	3.31
MMIN	2.28	2.22	2.14	2.03

h = 9 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 8.1	5.0 8.0	6.3 7.9	8.0 7.7
7.0	4.32	6.48	9.66	13.99
8.0	3.80	5.73	8.59	12.59
9.0	3.39	5.13	7.72	11.43
10.0	3.06	4.64	7.02	10.46
11.0	2.79	4.24	6.43	9.64
12.0	2.57	3.90	5.93	8.93
13.0	2.37	3.61	5.51	8.32
14.0		3.36	5.14	7.79
15.0		3.15	4.81	7.32
16.0		2.96	4.53	6.90
17.0		2.79	4.27	6.53
18.0		2.64	4.05	6.20
19.0		2.50	3.84	5.89
20.0		2.38	3.66	5.62
21.0		2.27	3.49	5.37
22.0			3.34	5.14
23.0			3.20	4.93
24.0			3.07	4.74
25.0			2.95	4.56
26.0			2.84	4.39
27.0			2.74	4.24
28.0			2.64	4.09
29.0			2.56	3.96
30.0			2.47	3.83
MMIN	2.97	2.90	2.80	2.68

Tabela VI

h = 10 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 9.1	5.0 9.0	6.3 8.9	8.0 8.7
7.0	4.87	7.35	11.04	16.22
8.0	4.29	6.49	9.80	15.54
9.0	3.83	5.80	8.80	13.16
10.0	3.45	5.25	7.99	12.02
11.0	3.15	4.79	7.31	11.06
12.0	2.89	4.41	6.74	10.23
13.0	2.67	4.08	6.25	9.52
14.0		3.80	5.83	8.90
15.0		3.55	5.46	8.36
16.0		3.34	5.13	7.88
17.0		3.15	4.84	7.45
18.0		2.98	4.59	7.06
19.0		2.82	4.35	6.72
20.0		2.68	4.14	6.40
21.0		2.56	3.95	6.11
22.0			3.78	5.85
23.0			3.62	5.61
24.0			3.47	5.39
25.0			3.34	5.18
26.0			3.21	4.99
27.0			3.10	4.82
28.0			2.99	4.65
29.0			2.89	4.50
30.0			2.80	4.35
MMIN	3.75	3.67	3.56	3.43

h = 11 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 10.1	5.0 10.0	6.3 9.9	8.0 9.7
7.0	5.43	8.23	12.43	18.45
8.0	4.77	7.25	11.01	16.49
9.0	4.26	6.48	9.88	14.90
10.0	3.84	5.86	8.95	13.58
11.0	3.50	5.35	8.19	12.48
12.0	3.22	4.92	7.55	11.53
13.0	2.97	4.55	6.99	10.72
14.0		4.23	6.52	10.02
15.0		3.96	6.10	9.40
16.0		3.72	5.74	8.85
17.0		3.50	5.41	8.37
18.0		3.31	5.12	7.93
19.0		3.14	4.86	7.54
20.0		2.99	4.63	7.18
21.0		2.85	4.41	6.86
22.0			4.22	6.56
23.0			4.04	6.29
24.0			3.88	6.04
25.0			3.73	5.81
26.0			3.59	5.59
27.0			3.46	5.39
28.0			3.34	5.21
29.0			3.22	5.04
30.0			3.12	4.87
MMIN	4.62	4.52	4.41	4.26

h = 12 f_{ck} = 18.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 11.1	5.0 11.0	6.3 10.9	8.0 10.7
7.0	5.99	9.10	13.81	20.68
8.0	5.26	8.01	12.22	18.44
9.0	4.69	7.16	10.95	16.63
10.0	4.23	6.47	9.92	15.14
11.0	3.86	5.90	9.07	13.89
12.0	3.54	5.42	8.35	12.84
13.0	3.27	5.02	7.74	11.93
14.0		4.67	7.21	11.13
15.0		4.37	6.75	10.44
16.0		4.10	6.34	9.83
17.0		3.86	5.98	9.29
18.0		3.65	5.66	8.80
19.0		3.46	5.37	8.36
20.0		3.29	5.11	7.96
21.0		3.14	4.87	7.60
22.0			4.66	7.27
23.0			4.46	6.97
24.0			4.28	6.69
25.0			4.11	6.43
26.0			3.96	6.19
27.0			3.82	5.97
28.0			3.68	5.77
29.0			3.56	5.57
30.0			3.44	5.39
MMIN	5.57	5.47	5.34	5.18

Tabela VII

h = 7 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 6.1	5.0 6.0	6.3 5.9
7.0	3.22	4.79	7.02
8.0	2.84	4.24	6.26
9.0	2.54	3.80	5.65
10.0	2.29	3.44	5.14
11.0	2.09	3.15	4.72
12.0	1.92	2.90	4.36
13.0	1.78	2.69	4.05
14.0		2.50	3.78
15.0		2.34	3.55
16.0		2.20	3.34
17.0		2.08	3.16
18.0		1.97	2.99
19.0		1.87	2.84
20.0		1.78	2.71
21.0		1.69	2.58
22.0			2.47
23.0			2.37
24.0			2.27
25.0			2.19
26.0			2.11
27.0			2.03
28.0			1.96
29.0			1.90
30.0			1.83
MMIN	1.69	1.64	1.57

h = 8 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 7.1	5.0 7.0	6.3 6.9	8.0 6.7
7.0	3.78	5.66	8.40	12.07
8.0	3.33	5.00	7.47	10.88
9.0	2.97	4.48	6.72	9.89
10.0	2.68	4.05	6.11	9.05
11.0	2.45	3.70	5.60	8.35
12.0	2.25	3.41	5.17	7.74
13.0	2.08	3.16	4.80	7.21
14.0		2.94	4.47	6.75
15.0		2.75	4.19	6.35
16.0		2.58	3.95	5.99
17.0		2.44	3.73	5.67
18.0		2.31	3.53	5.38
19.0		2.19	3.35	5.12
20.0		2.08	3.19	4.88
21.0		1.98	3.04	4.66
22.0			2.91	4.46
23.0			2.79	4.28
24.0			2.68	4.11
25.0			2.57	3.96
26.0			2.48	3.81
27.0			2.39	3.68
28.0			2.31	3.56
29.0			2.23	3.44
30.0			2.16	3.33
MMIN	2.29	2.23	2.14	2.04

h = 9 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 d 8.1	5.0 8.0	6.3 7.9	8.0 7.7
7.0	4.34	6.53	9.78	14.30
8.0	3.81	5.76	8.68	12.83
9.0	3.40	5.16	7.80	11.62
10.0	3.07	4.66	7.08	10.62
11.0	2.80	4.26	6.48	9.77
12.0	2.57	3.92	5.97	9.04
13.0	2.38	3.63	5.54	8.41
14.0		3.38	5.17	7.87
15.0		3.16	4.84	7.39
16.0		2.97	4.55	6.96
17.0		2.80	4.29	6.58
18.0		2.64	4.07	6.24
19.0		2.51	3.86	5.94
20.0		2.39	3.67	5.66
21.0		2.27	3.51	5.41
22.0			3.35	5.17
23.0			3.21	4.96
24.0			3.08	4.76
25.0			2.96	4.58
26.0			2.85	4.42
27.0			2.75	4.26
28.0			2.65	4.11
29.0			2.56	3.98
30.0			2.48	3.85
MMIN	2.98	2.91	2.81	2.69

Tabela VIII

h = 10 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 / d 9.1	5.0 / 9.0	6.3 / 8.9	8.0 / 8.7
7.0	4.89	7.40	11.16	16.53
8.0	4.30	6.53	9.89	14.78
9.0	3.84	5.83	8.87	13.36
10.0	3.46	5.27	8.05	12.18
11.0	3.16	4.81	7.36	11.19
12.0	2.90	4.42	6.78	10.34
13.0	2.68	4.09	6.29	9.62
14.0		3.81	5.86	8.98
15.0		3.56	5.48	8.43
16.0		3.35	5.16	7.94
17.0		3.15	4.86	7.50
18.0		2.98	4.60	7.11
19.0		2.83	4.37	6.76
20.0		2.69	4.16	6.44
21.0		2.56	3.97	6.15
22.0			3.79	5.88
23.0			3.63	5.64
24.0			3.48	5.41
25.0			3.35	5.21
26.0			3.22	5.02
27.0			3.11	4.84
28.0			3.00	4.67
29.0			2.90	4.52
30.0			2.80	4.37
MMIN	3.76	3.68	3.57	3.44

h = 11 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 / d 10.1	5.0 / 10.0	6.3 / 9.9	8.0 / 9.7
7.0	5.45	8.27	12.55	18.76
8.0	4.79	7.29	11.10	16.73
9.0	4.27	6.51	9.95	15.09
10.0	3.85	5.88	9.01	13.74
11.0	3.51	5.37	8.24	12.60
12.0	3.22	4.93	7.59	11.64
13.0	2.98	4.56	7.03	10.82
14.0		4.25	6.55	10.10
15.0		3.97	6.13	9.47
16.0		3.73	5.76	8.92
17.0		3.51	5.43	8.42
18.0		3.32	5.14	7.98
19.0		3.15	4.88	7.58
20.0		3.00	4.64	7.22
21.0		2.86	4.43	6.89
22.0			4.23	6.59
23.0			4.05	6.32
24.0			3.89	6.07
25.0			3.74	5.83
26.0			3.60	5.62
27.0			3.46	5.42
28.0			3.34	5.23
29.0			3.23	5.05
30.0			3.13	4.89
MMIN	4.63	4.54	4.42	4.27

h = 12 f_{ck} = 20.0 MPa f_{yk} = 500. MPa

s	ϕ 4.0 / d 11.1	5.0 / 11.0	6.3 / 10.9	8.0 / 10.7
7.0	6.01	9.14	13.93	20.99
8.0	5.28	8.05	12.31	18.68
9.0	4.70	7.19	11.03	16.82
10.0	4.24	6.49	9.98	15.30
11.0	3.87	5.92	9.12	14.02
12.0	3.55	5.44	8.39	12.94
13.0	3.28	5.03	7.78	12.02
14.0		4.68	7.24	11.21
15.0		4.38	6.78	10.51
16.0		4.11	6.37	9.89
17.0		3.87	6.00	9.34
18.0		3.66	5.68	8.85
19.0		3.47	5.39	8.40
20.0		3.30	5.13	8.00
21.0		3.15	4.89	7.64
22.0			4.67	7.30
23.0			4.47	7.00
24.0			4.29	6.72
25.0			4.12	6.46
26.0			3.97	6.22
27.0			3.82	5.99
28.0			3.69	5.79
29.0			3.56	5.59
30.0			3.45	5.41
MMIN	5.59	5.49	5.36	5.20

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