

Excerpts from NCMA TEK Manual for Concrete Masonry Design and Construction

Section Properties (14-1B 2007)

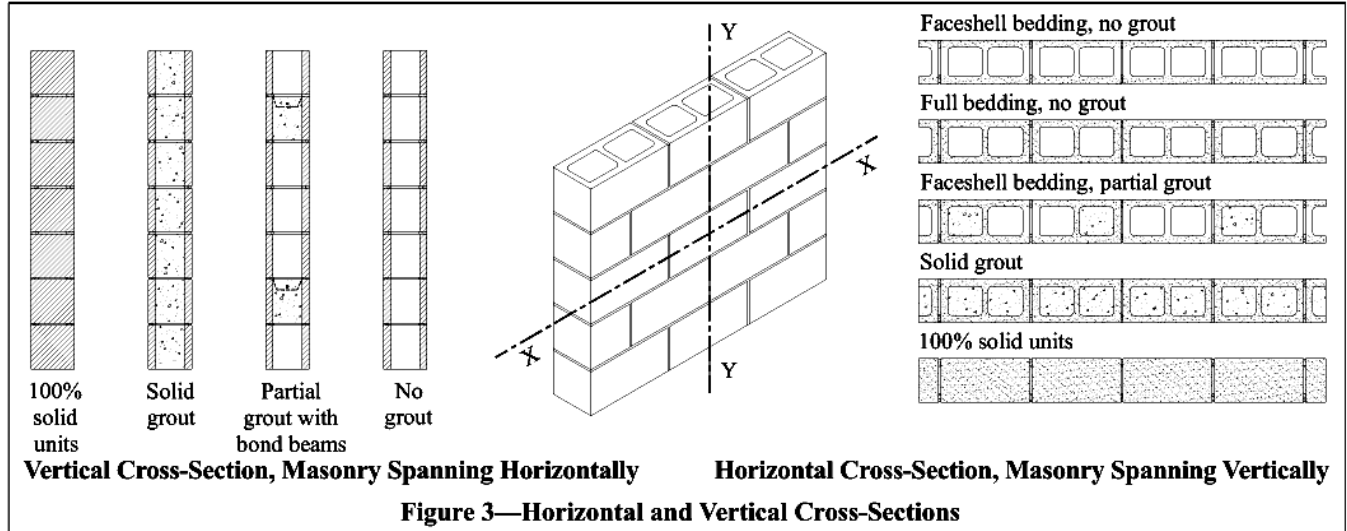


Table for Horizontal Cross Sections (net)

Units	Grouted Spacing	Mortar Bedding	A in ² /ft (10 ³ mm ² /m)	I _x in ⁴ /ft (10 ⁶ mm ⁴ /m)	S _x in ³ /ft (10 ⁶ mm ³ /m)	r in (mm)
4 Inch Single Wythe Walls, 3/4 in. Face Shells (standard)						
Hollow	No grout	Faceshell	18.0 (38.1)	38.0 (51.9)	21.0 (1.13)	1.45 (36.9)
Hollow	No grout	Full	21.6 (45.7)	39.4 (53.8)	21.7 (1.17)	1.35 (34.3)
100 % solid/grouted		Full	43.5 (92.1)	47.4 (64.7)	26.3 (1.41)	1.04 (26.5)
6 Inch Single Wythe Walls, 1 in. Face Shells (standard)						
Hollow	No grout	Faceshell	24.0 (50.8)	130.3 (178)	46.3 (2.49)	2.33 (59.2)
Hollow	None	Full	32.2 (68.1)	139.3 (190)	49.5 (2.66)	2.08 (52.9)
100% Solid/grouted		Full	67.5 (143)	176.9 (242)	63.3 (3.40)	1.62 (41.1)
Hollow	16" o. c.	Faceshell	46.6 (98.6)	158.1 (216)	55.1 (2.96)	1.79 (45.5)
Hollow	24" o. c.	Faceshell	39.1 (82.7)	151.8 (207)	52.2 (2.81)	1.87 (47.4)
Hollow	32" o. c.	Faceshell	35.3 (74.7)	148.7 (203)	50.7 (2.73)	1.91 (48.5)
Hollow	40" o. c.	Faceshell	33.0 (69.9)	146.8 (200)	49.9 (2.68)	1.94 (49.3)
Hollow	48" o. c.	Faceshell	31.5 (66.7)	145.5 (199)	49.3 (2.65)	1.96 (49.8)
Hollow	72" o. c.	Faceshell	29.0 (61.45)	143.5 (196)	51.0 (2.74)	2.00 (50.8)
Hollow	96" o. c.	Faceshell	27.8 (58.8)	142.4 (194)	50.6 (2.72)	2.02 (51.3)
Hollow	122" o. c.	Faceshell	27.0 (57.1)	141.8 (194)	50.4 (2.71)	2.03 (51.5)
8 Inch Single Wythe Walls, 1 1/4 in. Face Shells (standard)						
Hollow	No grout	Faceshell	30.0 (63.5)	308.7 (422)	81.0 (4.35)	3.21 (81.5)
Hollow	No grout	Full	41.5 (87.9)	334.0 (456)	87.6 (4.71)	2.84 (72.0)
100% solid/grouted		Full	91.5 (194)	440.2 (601)	116.3 (6.25)	2.19 (55.7)
Hollow	16" o. c.	Faceshell	62.0 (131)	387.1 (529)	99.3 (5.34)	2.43 (61.6)
Hollow	24" o. c.	Faceshell	51.3 (109)	369.4 (504)	93.2 (5.01)	2.53 (64.3)
Hollow	32" o. c.	Faceshell	46.0 (97.3)	360.5 (492)	90.1 (4.85)	2.59 (65.8)
Hollow	40" o. c.	Faceshell	42.8 (90.6)	355.2 (485)	88.3 (4.75)	2.63 (66.9)
Hollow	48" o. c.	Faceshell	40.7 (86.0)	351.7 (480)	87.1 (4.68)	2.66 (67.6)
Hollow	72" o. c.	Faceshell	37.1 (78.5)	345.8 (472)	85.0 (4.57)	2.71 (69.0)
Hollow	92" o. c.	Faceshell	35.3 (74.7)	342.8 (468)	89.9 (4.83)	2.74 (69.6)
Hollow	120" o. c.	Faceshell	34.3 (72.6)	341.0 (466)	89.5 (4.81)	2.76 (70.1)

Units	Grouted Cores	Mortar Bedding	A in ² /ft (10 ³ mm ² /m)	I _x in ⁴ /ft (10 ⁶ mm ⁴ /m)	S _x in ³ /ft (10 ⁶ mm ³ /m)	r in (mm)
10 Inch Single Wythe Walls, 1 ¼ in. Face Shells (standard)						
Hollow	No grout	Faceshell	30.0 (63.5)	530.0 (724)	110.1 (5.92)	4.20 (107)
Hollow	No grout	Full	48.0 (102)	606.3 (828)	126.0 (6.77)	3.55 (90.2)
100% solid/grouted		Full	115.5 (244)	891.7 (1218)	185.3 (9.96)	2.78 (70.6)
Hollow	16" o. c.	Faceshell	74.8 (158)	744.7 (1017)	154.7 (8.32)	3.04 (77.2)
Hollow	24" o. c.	Faceshell	59.8 (127)	698.6 (954)	145.2 (7.81)	3.16 (80.3)
Hollow	32" o. c.	Faceshell	52.4 (111)	675.5 (923)	140.4 (7.55)	3.24 (82.3)
Hollow	40" o. c.	Faceshell	47.9 (101)	661.6 (904)	137.5 (7.39)	3.29 (83.6)
Hollow	48" o. c.	Faceshell	44.9 (95.0)	652.4 (891)	135.6 (7.29)	3.33 (84.6)
Hollow	72" o. c.	Faceshell	39.9 (84.5)	637.0 (870)	132.4 (7.12)	3.39 (86.1)
Hollow	96" o. c.	Faceshell	37.5 (79.4)	629.3 (859)	130.8 (7.03)	3.43 (87.1)
Hollow	120" o. c.	Faceshell	36.0 (76.2)	624.7 (853)	129.8 (6.98)	3.45 (87.6)
12 Inch Single Wythe Walls, 1 ¼ in. Face Shells (standard)						
Hollow	No grout	Faceshell	30.0 (63.5)	811.2 (1108)	139.6 (7.50)	5.20 (132)
Hollow	No grout	Full	53.1 (112)	971.5 (1327)	167.1 (8.98)	4.28 (109)
100% solid/grouted		Full	139.5 (295)	1571.0 (2145)	270.3 (14.5)	3.36 (85.3)
Hollow	16" o. c.	Faceshell	87.3 (185)	1262.3 (1724)	217.2(11.7)	3.64 (92.5)
Hollow	24" o. c.	Faceshell	68.2 (144)	1165.4 (1591)	200.5 (10.7)	3.79 (96.3)
Hollow	32" o. c.	Faceshell	58.7 (124)	1116.9 (1525)	192.2 (10.3)	3.88 (98.6)
Hollow	40" o. c.	Faceshell	52.9 (112)	1087.8 (1486)	187.2 (10.1)	3.95 (100)
Hollow	48" o. c.	Faceshell	49.1 (104)	1068.4 (1459)	183.8 (9.88)	3.99 (101)
Hollow	72" o. c.	Faceshell	42.7 (90.4)	1036.1 (1415)	178.3 (9.59)	4.07 (103)
Hollow	96" o. c.	Faceshell	39.6 (83.8)	1020.0 (1393)	175.5 (9.44)	4.12 (105)
Hollow	120" o. c.	Faceshell	37.6 (79.6)	1010.3 (1380)	173.8 (9.34)	4.15 (105)
14 Inch Single Wythe Walls, 1 ¼ in. Face Shells (standard)						
Hollow	No grout	Faceshell	30.0 (63.5)	1152.5 (1574)	169.2 (9.09)	6.20 (157)
Hollow	No grout	Full	58.2 (123)	1442.9 (1970)	211.8 (11.4)	4.98 (126)
100% solid/grouted		Full	163.5 (346)	2529.4 (3454)	371.3 (20.0)	3.93 (99.8)
Hollow	16" o. c.	Faceshell	99.9 (211)	1970.0 (2690)	289.2(15.5)	4.25 (108)
Hollow	24" o. c.	Faceshell	76.6 (162)	1794.3 (2450)	263.4 (14.2)	4.41 (112)
Hollow	32" o. c.	Faceshell	64.9 (137)	1706.4 (2330)	250.5 (13.5)	4.51 (115)
Hollow	40" o. c.	Faceshell	58.0 (123)	1653.7 (2258)	242.8 (13.0)	4.59 (117)
Hollow	48" o. c.	Faceshell	53.3 (113)	1618.6 (2210)	237.6 (12.8)	4.64 (118)
Hollow	72" o. c.	Faceshell	45.5 (96.3)	1560.0 (2130)	229.0 (12.3)	4.74 (120)
Hollow	96" o. c.	Faceshell	41.6 (88.1)	1530.7 (2090)	224.7 (12.1)	4.79 (122)
Hollow	120" o. c.	Faceshell	39.3 (83.2)	1513.2 (2067)	221.1 (11.9)	4.83 (123)
16 Inch Single Wythe Walls, 1 ¼ in. Face Shells (standard)						
Hollow	No grout	Faceshell	30.0 (63.5)	1553.7 (2122)	198.9 (10.2)	7.20 (183)
Hollow	No grout	Full	63.2 (134)	2030.6 (2773)	259.9 (13.9)	5.67 (144)
100% solid/grouted		Full	187.5 (397)	3814.7 (5209)	488.3 (26.3)	4.51 (115)
Hollow	16" o. c.	Faceshell	112.4 (238)	2896.2 (3955)	370.7(19.9)	4.84 (123)
Hollow	24" o. c.	Faceshell	85.0 (180)	2607.7 (3561)	333.8 (17.9)	5.02 (127)
Hollow	32" o. c.	Faceshell	71.2 (151)	2463.4 (3364)	315.3 (17.0)	5.14 (131)
Hollow	40" o. c.	Faceshell	63.0 (133)	2376.9 (3246)	304.2 (16.4)	5.22 (133)
Hollow	48" o. c.	Faceshell	57.5 (122)	2319.1 (3167)	296.9 (16.0)	5.28 (134)
Hollow	72" o. c.	Faceshell	48.3 (102)	2223.0 (3036)	284.5 (15.3)	5.39 (137)
Hollow	96" o. c.	Faceshell	43.7 (92.5)	2174.9 (3970)	278.4 (15.0)	5.45 (138)
Hollow	120" o. c.	Faceshell	41.0 (86.8)	2146.0 (2931)	274.7 (14.8)	5.49 (139)

Allowable Stresses for Unreinforced Concrete Masonry (14-7C 2012)

Compression

Axial..... $F_a = 1/4 f'_m [1 - (h/140r)^2]$, where $h/r \geq 99$
 $F_a = 1/4 f'_m (70r/h)^2$, where $h/r > 99$
 Flexural..... $F_b = 1/3 f'_m$

Shear

where $f_v = \frac{VQ}{I_n b}$
 $1.5 \sqrt{f'_m} \leq 120$ psi

Table 1—Allowable Flexural Tensile Stresses, psi (kPa) (ref. 1a)

Direction of flexural tensile stress and masonry type	Mortar types			
	Portland cement/ lime or mortar cement		Masonry cement or air-entrained portland cement/lime	
	M or S	N	M or S	N
Normal to bed joints:				
Solid units	53 (366)	40 (276)	32 (221)	20 (138)
Hollow units ^A				
UngROUTed	33 (228)	25 (172)	20 (138)	12 (83)
Fully grouted	86 (593)	84 (579)	81 (559)	77 (531)
Parallel to bed joints in running bond:				
Solid units	106 (731)	80 (552)	64 (441)	40 (276)
Hollow units				
UngROUTed & partially grouted	66 (455)	50 (345)	40 (276)	25 (172)
Fully grouted	106 (731)	80 (552)	64 (441)	40 (276)
Parallel to bed joints in masonry not laid in running bond:				
Continuous grout section parallel to bed joints	133 (917)	133 (917)	133 (917)	133 (917)
Other	0 (0)	0 (0)	0 (0)	0 (0)

^A For partially grouted masonry, allowable stresses are determined on the basis of linear interpolation between fully grouted hollow units and ungrouted hollow units based on amount (percentage) of grouting.

Allowable Stresses for Reinforced Concrete Masonry (14-7C 2012)

Compression

Axial..... $P_a = [0.25 f'_m A_n + 0.65 A_{st} F_s] \left[1 - \left(\frac{h}{140r} \right)^2 \right]$, where $h/r \geq 99$
 $P_a = [0.25 f'_m A_n + 0.65 A_{st} F_s] \left(\frac{70r}{h} \right)^2$, where $h/r > 99$
 Flexural..... $F_b = 0.45 f'_m$

Shear

where $f_v = \frac{V}{A_{nv}}$ and $F_v = F_{vm} + F_{vs}$

$$M/Vd \leq 0.25 \dots\dots\dots F_v = 3 \sqrt{f'_m}$$

$$M/Vd \geq 1.0 \dots\dots\dots F_v = 2 \sqrt{f'_m}$$

M/Vd falls between may be linearly interpolated

and

$$F_{vm} = \frac{1}{2} \left[\left(4.0 - 1.75 \left(\frac{M}{Vd} \right) \right) \sqrt{f'_m} \right] + 0.25 \frac{P}{A_n}$$

$$F_{vs} = 0.5 \left(\frac{A_v F_s d}{A_n s} \right)$$

Steel Reinforcement

Tension

Grade 40 $F_s = 20,000$ psi (137.9 MPa)

Grade 60 $F_s = 32,000$ psi (220.7 MPa)

Joint reinforcement $F_s = 30,000$ psi (206.9 MPa)

NOTATIONS

A_n net cross-sectional area of masonry, in.² (mm²)

A_{nv} net shear area, in.² (mm²)

A_v cross-sectional area of shear reinforcement, in.² (mm²)

b width of section, in. (mm)

d distance from extreme compression fiber to centroid of tension reinforcement, in. (mm)

F_a allowable compressive stress due to axial load only, psi (MPa)

F_b allowable compressive stress due to flexure only, psi (MPa)

F_s allowable tensile or compressive stress in reinforcement, psi (MPa)

F_v allowable shear stress in masonry, psi (MPa)

F_{vm} allowable shear resisted by the masonry, psi (MPa)

F_{vx} allowable shear resisted by the shear reinforcement, psi (MPa)

f'_m specified compressive strength of masonry, psi (MPa)

f_s calculated shear stress in the masonry, psi (MPa)

h effective height of column, wall, or pilaster, in. (mm)

I_n moment of inertia of net cross-sectional area of a member, in.⁴ (mm⁴)

M maximum moment occurring simultaneously with design shear force, V , at section under consideration, in.-lb (N.m)

P axial compression load, lb (N)

P_a allowable axial compressive force in a reinforced member, lb (N)

Q first moment of inertia about the neutral axis of an area between the extreme fiber and the plane at which the shear stress is being calculated, in.³ (mm³)

r radius of gyration, in. (mm)

s spacing of shear reinforcement, in. (mm)

V design shear force, lb (N)