Masonry Institute of America

Reinforced Masonry Engineering Handbook, 8th ed.
Errata
Issued Update July 19, 2021

Page 6

1.2.2.1 CONCRETE BRICK

Concrete brick is available ~~in Grade N and Grade S. Grade N is~~ for use in architectural veneer and as facing units in exterior walls. ~~It is suitable for applications where high strength, or where resistance to moisture penetration and severe frost action is required. Grade S is~~ Concrete brick is suitable for general use, where moderate strength or resistance to moisture penetration and frost action is required.

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FIGURE 1.23 High lift grouting concrete masonry wall. - Revision in Red

Types of Grouting				Self-Consolidating Grout
Limitations				• ~~Grout slump between 10 and 11 inches~~ • Grout spread (flow) between 24 and 30 in.

Page 37 – Table revision in Red

TABLE 2.2B Compressive Strength of Masonry Based on the Compressive Strength of Concrete Masonry Units and Type of Mortar Used in Construction (TMS 602 Article 1.4 B.2 Table 2)

Net Area Compressive Strength of Concrete Masonry[1], psi (MPa)	Net Area Compressive Strength of ~~Clay~~ Concrete Masonry Units, psi (MPa)	
	Type M or S Mortar	Type N Mortar
1,700 (11.72)	—	1,900 (13.10)
1,900 (13.10)	1,900 (13.10)	2,350 (16.20)
2,000 (13.79)	2,000 (13.79)	2,650 (18.27)
2,250 (15.51)	2,600 (17.93)	3,400 (23.44)
2,500 (17.24)	3,250 (22.41)	4,350 (29.99)
2,750 (18.96)	3,900 (26.89)	—
3,000 (20.69)	4,500 (31.03)	—

1. For units less than 4 in. (102 mm) nominal height, use 85 percent of the values listed.

Errata Continued on Next Page

Page 64 – Change in Red

When snow loads act on a slope of a roof which is more than 5 degrees, the roof snow load is calculated by Section 7.4 of ASCE 7. This requires that a roof slope factor, C_s, be determined. The values for C_s are determined for warm roofs, cold roofs, curved roofs, and multiple roofs in accordance with Sections 7.4.1 through 7.4.4 of ASCE 7. The factor C_t given in Table ~~3.6~~ 3.4 determines if a roof is considered warm or cold.

Page 71 - Table revision in Red

TABLE 3.10 Steps to Determine C&C Wind Loads Enclosed Building with *h* ≤ 160 ft (Adapted from ASCE 7 Table 30.7-1)

Step 3:	Determine wind load parameters: Exposure Category B, C or D, see Section 3.8.1.3.1.

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5th Bulleted paragraph – …maps found on ~~IBC~~ Figures 22-12 through 22-16 - <u>should read</u> "…maps found on ASCE 7 Figures 22-12 through 22-16."

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Revision based on 2010 Edition of ASCE 7 – Supplement No. 1 (Errata) – Effective: March 31, 2013

~~$C_w = \frac{100}{A_B}\sum_{i=1}^{x}\left(\frac{h_n}{h_i}\right)^2\left[\frac{A_i}{1+0.83\left(\frac{h_i}{D_i}\right)^2}\right]$~~

$$C_w = \frac{100}{A_B}\sum_{i=1}^{x}\frac{A_i}{\left[1+0.83\left(\frac{h_n}{D_i}\right)^2\right]}$$

ASCE Eq 12.8-10

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~~h_i = Height of shear wall "i" in ft~~

Errata Continued on Next Page

Page 92 – Revisions in Red

Revision based on 2010 Edition of ASCE 7 – Supplement No. 1 (Errata) – Effective: March 31, 2013

TABLE 3.19 Coefficients for Architectural Components (Excerpted from ASCE 7 Table 13.5-1)

Architectural Component	a_p[1]	R_p	Ω_0[3]
Interior Nonstructural Walls and Partitions[2]			
Plain (unreinforced) masonry walls	1	$1^1/_2$	$1^1/_2$
All other walls and partitions	1	$2^1/_2$	2
Cantilever Elements (Unbraced or braced to structural frame below its center of mass)			
Parapets and cantilever interior nonstructural walls	$2^1/_2$	$2^1/_2$	2
Chimneys where laterally braced or supported by the structural frame	$2^1/_2$	$2^1/_2$	2
Cantilever Elements (Braced to structural frame above its center of mass)			
Parapets	1	$2^1/_2$	2
Chimneys	1	$2^1/_2$	2
Exterior Nonstructural Walls[2]	1[2]	$2^1/_2$	2
Exterior Nonstructural Wall Elements and Connections[2]			
Wall Element	1	$2^1/_2$	NA
Body of wall panel connections	1	$2^1/_2$	NA
Fasteners of the connecting system	$1^1/_4$	1	1
Veneer			
Limited deformability elements and attachments	1	$2^1/_2$	2
Low deformability elements and attachments	1	$1^1/_2$	2

1 A lower value for a_p shall not be used unless justified by detailed dynamic analysis. The value for a_p shall not be less than 1. The value of a_p = 1 is for rigid components and rigidly attached components. The value of $a_p = 2^1/_2$ is for flexible components and flexibly attached components. See ASCE 7 Section 11.2 for definitions of rigid and flexible.

2 Where flexible diaphragms provide lateral support for concrete or masonry walls and partitions, the design forces for anchorage to the diaphragm shall be as specified in ASCE 7 Section 12.11.2.

3 Overstrength where required for nonductile anchorage to concrete and masonry. See ASCE Section 12.4.3 for seismic load effects including overstrength.

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TABLE 4.2 Example 4-C – Rigidity of 8 Story Wall at the Fourth Floor

~~Floor Level~~	~~h~~	~~Σh_{above}~~	~~d~~	~~h/d~~	~~$\Delta_{top\ of\ wall}$ due to transition of this level~~	~~$\Delta_{top\ of\ wall}$ due to rotation of this level~~	~~Total $\Delta_{top\ of\ wall}$ due to this level~~	~~Correction~~	~~Actual $\Delta_{top\ of\ wall}$ due to this level~~
~~4~~	~~10~~		~~30~~	~~0.333~~	~~0.115~~	~~0.000~~	~~0.115~~	~~0.0971~~	~~0.011~~
~~3~~	~~10~~	~~10~~	~~30~~	~~0.333~~	~~0.137~~	~~0.006~~	~~0.143~~	~~0.0461~~	~~0.007~~
~~2~~	~~10~~	~~20~~	~~30~~	~~0.333~~	~~0.159~~	~~0.019~~	~~0.178~~	~~0.0461~~	~~0.008~~
~~1~~	~~14~~	~~30~~	~~30~~	~~0.467~~	~~0.311~~	~~0.058~~	~~0.369~~	~~0.0461~~	~~0.017~~

~~$\Delta_{top\ of\ wall}$ = 0.043~~

$$R_{DEF} = \frac{1}{\Delta_T} = \frac{1}{0.043} = 23.26$$

Errata Continued on Next Page

Page 101 – Table 4.2 Example 4-C – Rigidity of 8 Story Wall at the Fourth Floor

Replace with

Floor Level	*h*	Σh_{above}	*d*	*h/d*	$\Delta_{top\ of\ wall}$ due to transition of this level	$\Delta_{top\ of\ wall}$ due to rotation of this level	Total $\Delta_{top\ of\ wall}$ due to this level	Correction	Actual $\Delta_{top\ of\ wall}$ due to this level
4	10		30	0.333	0.115	0.000	0.115	0.0971	0.011
3	10	10	30	0.333	0.137	0.067	0.204	0.0461	0.009
2	10	20	30	0.333	0.159	0.222	0.381	0.0461	0.018
1	14	30	30	0.467	0.311	0.691	1.002	0.0461	0.046

$\Delta_{top\ of\ wall}$ **= 0.084**

$$R_{DEF} = \frac{1}{\Delta_T} = \frac{1}{0.084} = 11.90$$

TABLE 4.3 Example 4-C – Rigidity of 8 Story Wall at the Roof

Floor Level	*h*	Σh_{above}	*d*	*h/d*	$\Delta_{top\ of\ wall}$ due to transition of this level	$\Delta_{top\ of\ wall}$ due to rotation of this level	Total $\Delta_{top\ of\ wall}$ due to this level	Correction	Actual $\Delta_{top\ of\ wall}$ due to this level
~~8~~	~~10~~		~~30~~	~~0.333~~	~~0.115~~	~~0.000~~	~~0.115~~	~~0.1512~~	~~0.017~~
~~7~~	~~10~~	~~10~~	~~30~~	~~0.333~~	~~0.137~~	~~0.006~~	~~0.143~~	~~0.1512~~	~~0.022~~
~~6~~	~~10~~	~~20~~	~~30~~	~~0.333~~	~~0.159~~	~~0.016~~	~~0.178~~	~~0.0971~~	~~0.017~~
~~5~~	~~10~~	~~30~~	~~30~~	~~0.333~~	~~0.181~~	~~0.039~~	~~0.220~~	~~0.0971~~	~~0.021~~
~~4~~	~~10~~	~~40~~	~~30~~	~~0.333~~	~~0.204~~	~~0.067~~	~~0.270~~	~~0.0971~~	~~0.026~~
~~3~~	~~10~~	~~50~~	~~30~~	~~0.333~~	~~0.226~~	~~0.102~~	~~0.328~~	~~0.0461~~	~~0.015~~
~~2~~	~~10~~	~~60~~	~~30~~	~~0.333~~	~~0.248~~	~~0.144~~	~~0.393~~	~~0.0461~~	~~0.018~~
~~1~~	~~14~~	~~70~~	~~30~~	~~0.467~~	~~0.486~~	~~0.279~~	~~0.765~~	~~0.0461~~	~~0.035~~

~~$\Delta_{top\ of\ wall}$ **= 0.172**~~

~~$$R_{DEF} = \frac{1}{\Delta_T} = \frac{1}{0.172} = 5.81$$~~

Replace with

Floor Level	*h*	Σh_{above}	*d*	*h/d*	$\Delta_{top\ of\ wall}$ due to transition of this level	$\Delta_{top\ of\ wall}$ due to rotation of this level	Total $\Delta_{top\ of\ wall}$ due to this level	Correction	Actual $\Delta_{top\ of\ wall}$ due to this level
8	10		30	0.333	0.115	0.000	0.115	0.1512	0.017
7	10	10	30	0.333	0.137	0.067	0.204	0.1512	0.031
6	10	20	30	0.333	0.159	0.222	0.381	0.0971	0.037
5	10	30	30	0.333	0.181	0.467	0.648	0.0971	0.063
4	10	40	30	0.333	0.204	0.800	1.004	0.0971	0.097
3	10	50	30	0.333	0.226	1.222	1.448	0.0461	0.067
2	10	60	30	0.333	0.248	1.733	1.981	0.0461	0.091
1	14	70	30	0.467	0.486	3.354	3.839	0.0461	0.177

$\Delta_{top\ of\ wall}$ **= 0.581**

$$R_{DEF} = \frac{1}{\Delta_T} = \frac{1}{0.581} = 1.72$$

Errata Continued on Next Page

Page 117 – Change in Red

Inertial forces are determined using two sources. The first source is the story forces determined from the vertical distribution of lateral forces. The second source is the diaphragm inertial forces determined from ASCE 7 Equation 12.10-1, subject to a minimum value of $0.2S_{DS}I_e w_{px}$ and a maximum value of $0.4S_{DS}I_e w_{px}$, where w_{px} represents the weight of the diaphragm and attached components.

Page 122 – Bottom of page – Change in Red

~~ΣR_x~~ $= \overline{13.7}$ should be $\Sigma R_y = \overline{13.7}$

Page 128 – Revision in Red

Revision based on 2010 Edition of ASCE 7 – Supplement No. 1 (Errata) – Effective: March 31, 2013

ASCE 7 Table 12.3-1 Horizontal Structural Irregularities			
Type	**Description**	**Reference Section**	**Seismic Design Category Application**
1b.	**Extreme Torsional Irregularity:** Extreme torsional irregularity is defined to exist where the maximum story drift, computed including accidental torsion with $A_x = 1.0$, at one end of the structure transverse to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Extreme torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.	12.3.3.1 12.3.3.4 12.7.3 12.8.4.3 12.12.1 Table 12.6-1 Sec. 16.2.2 Sec. 12.3.4.2	E and F D B, C and D C and D C and D D B, C and D D

Page 129 – Revision in Red

Revision based on 2010 Edition of ASCE 7 – Supplement No. 1 (Errata) – Effective: March 31, 2013

ASCE 7 Table 12.3-2 Vertical Structural Irregularities			
Type	**Description**	**Reference Section**	**Seismic Design Category Application**
4.	**In-Plane Discontinuity in Vertical Lateral Force-Resisting Element Irregularity:** In-plane discontinuity in vertical lateral force-resisting element irregularity is defined to exist where there is an in-plane offset of a vertical seismic force-resisting element resulting in overturning demands on ~~a~~ supporting ~~beam, column, truss, or slab~~ structural elements.	12.3.3.3 12.3.3.4 Table 12.6-1	B, C, D, E, and F D, E, and F D, E, and F

Page 140 – Revision in Red

Next, use *nρj* to determine the required *nρ* if the section is limited by ~~compression~~ tension stress in the ~~masonry~~ steel:

Page 141 – Solution 5-B

3. Calculate the neutral axis depth, *kd*

~~$k = \sqrt{(n\rho)^2 + 2n\rho - n\rho}$~~ Revise to: $k = \sqrt{(n\rho)^2 + 2n\rho} - n\rho$

Page 173 – Bottom of page – first column

Equation ~~$M_{3,s} = P_{3,s}\left(\frac{h}{2} - d_1\right) = 3.4\left(2.5 \frac{15.625}{2}\right)$~~ should be $M_{3,s} = -P_{3,s}\left(\frac{h}{2} - d_1\right) = -3.4\left(\frac{15.625}{2} - 2.5\right)$

$= -1.5$ k - ft

Page 185 – Top of page

$B_{as} = 0.6(0.196)(\cancel{60}\ 36) = 4{,}240$

Page 194 – Solution 5-V

2. ~~$V = \frac{wl}{2} + \frac{P}{2} = \frac{1{,}200(14.67)}{2} + \frac{40}{2} = 28.8$ kips~~

$V = \frac{wl}{2} + \frac{P}{2} = \frac{1.2(14.67)}{2} + \frac{40}{2} = 28.8$ kips

5. Determine whether shear reinforcement is required:

$f_v = \frac{V}{A_{nv}} = \frac{28.8}{(9)(144)} = 22.2$ psi

~~$\frac{M}{Vd_v} = \frac{97.1}{(28.8)(6.97)} = 0.48$~~

Using Tables ASD-4 and ASD-6, find:

$F_{v,max}$ = ~~120 psi > 22.2~~ psi OK

F_{vm} = ~~71 psi > 22.2~~ psi OK. No shear reinforcement is required.

Determine whether shear reinforcement is required:

$f_v = \frac{V}{A_{nv}} = \frac{28.8}{(9)(144)} = 22.2$ psi

$\frac{M}{Vd_v} = \frac{97.1}{(28.8)(12)} = 0.28$

Using Tables ASD-4 and ASD-6, find:

$F_{v,max}$ = 132 psi > 22.2 psi OK

F_{vm} = 74 psi > 22.2 psi OK. No shear reinforcement is required.

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$$A_{st} = \left(\frac{0.65F_s}{0.25f'_m} - 1\right)A_s$$

$$= \left(\frac{0.65(32)}{0.25(2)} - 1\right)(1.76) \not> 71.4\ \text{in.}^2$$

Change in Red

$$A_{st} = \left(\frac{0.65F_s}{0.25f'_m} - 1\right)A_s$$

$$= \left(\frac{0.65(32)}{0.25(2)} - 1\right)(1.76) = 71.4\ \text{in.}^2$$

Page 219 – Change in Red

$$k = \frac{-2{,}245 + \sqrt{2{,}245^2 - 4(2{,}688)(-501)}}{2\ (2{,}688)} = 0.183$$

Page 237 – Change in Red

Determine ϕM_n:

= 1,940 k-in. = 162 k-ft

Errata Continued on Next Page

Page 239

Section 6.3 Shear – Modify TMS 402, Equation 9-21 to read: $V_n = (V_{nm} + V_{ns})\gamma_g$

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Table 6.5 Modulus of Rupture (f_r) for Clay and Concrete Masonry

Parallel to bed joints in running bond				
Solid units		200 (1,379)		
Hollow units				
Ungrouted and partially grouted		127 ~~(655)~~ (873)		
Fully grouted		200 (1,379)		

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2. Determine loads on center span.

Equation $M_u^+ = \frac{w_u l^2}{8} \neq \frac{P_u l}{4} - M_u^-$ *Revise to:* $M_u^+ = \frac{w_u l^2}{8} + \frac{P_u l}{4} - M_u^-$

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4. Determine whether shear reinforcement is required

Using Tables SD-26 and SD-27, find

ϕv_{nm} = 0.8 (129) = 103 psi > 67.4 psi OK.

Page 286 – Revise Equation

$\Delta = 14.97 \frac{30{,}700}{100{,}000} \frac{1{,}000{,}000}{1{,}800{,}000} \frac{1}{7.63} \neq 2(3.5) = 2.34$ in. Revise to: $\Delta = 14.97 \frac{30{,}700}{100{,}000} \frac{1{,}000{,}000}{1{,}800{,}000} \frac{1}{7.63} 2(3.5) = 2.34$ in.

$DR = \frac{\cancel{2.28}}{288} = 0.0081 = 0.81\%$ **Revise to**: $DR = \frac{2.34}{288} = 0.0081 = 0.81\%$

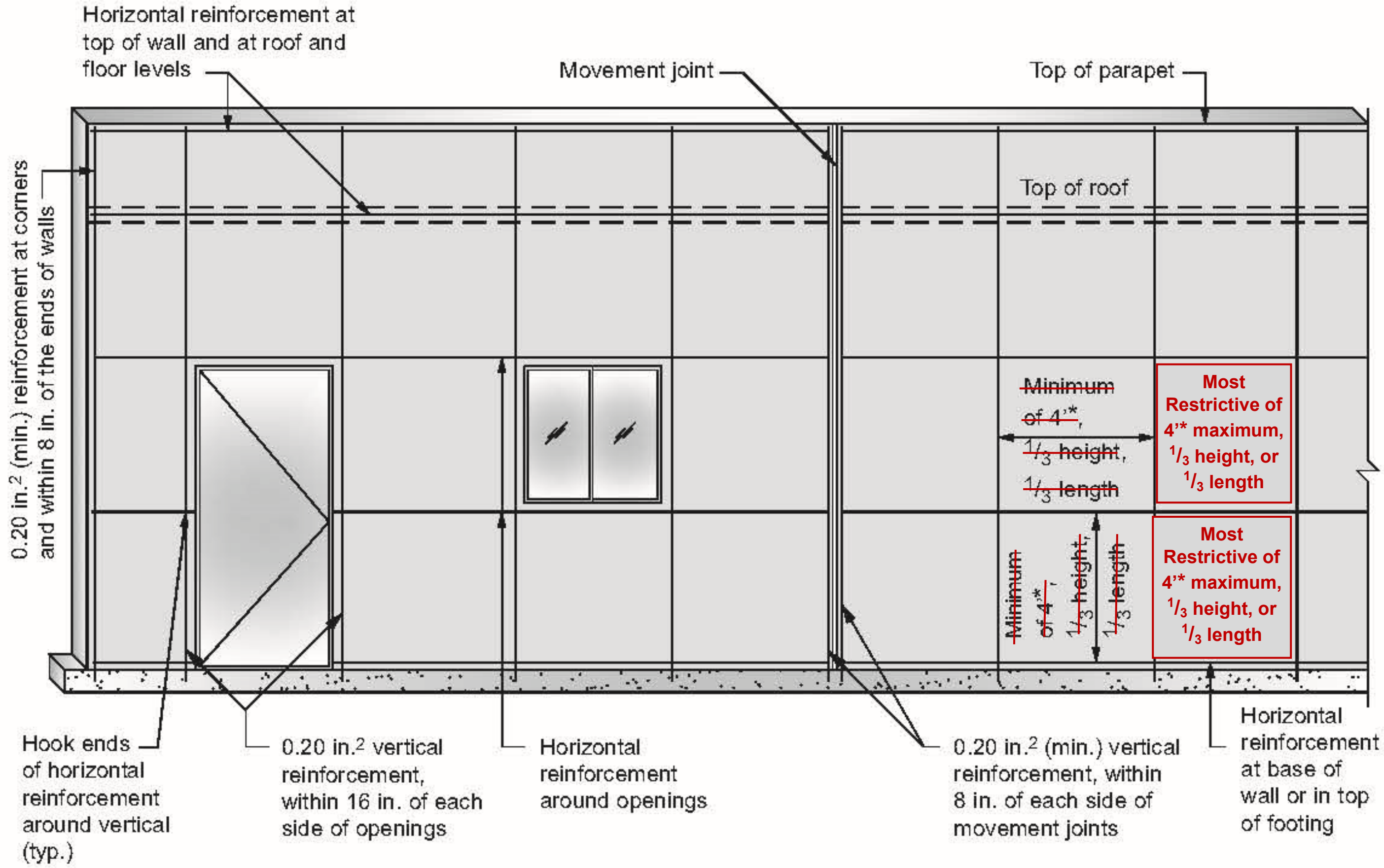
Page 294 – Revision in Red

Since $\frac{M_u}{V_u d_v} > 1.0$ use 1.0

$$= \phi \left[[4.0 - 1.75(1.0)](7.63)(88)\frac{\sqrt{2{,}000}}{1{,}000} + 0.25(26.4) \right]$$

Errata Continued on Next Page

Page 354-Correct Callout in Figure 7.37



*Reduced to 24 in. for reinforcement not laid in running bond

Note: Horizontal reinforcement shall consist of at least two longitudinal wires of W1.7 joint reinforcement spaced at 16 in. on center maximum or 0.2 in.^{2} of bond beam reinforcement spaced at 120 in. on center maximum.

FIGURE 7.37 Minimum reinforcement for special reinforced masonry shear walls.

Page 372 – Revise

k_t = 0.000004, in./in./°F (mm/mm/°C)

Pages 538 through 561

Tables ASD-74a through ASD-79b were updated to reflect changed K_f values for compression reinforcement. The values for tension reinforcement, which is most common, remain the same. Associated Diagrams were also updated to reflect revised K_f values for compression reinforcement.

Errata Continued on Next Page

TABLE ASD-74a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 1500 psi, F_s = 32,000 psi, and n = 27.6

DESIGN DATA

f'_m = 1500 psi $\quad$ f_y = 60,000 psi

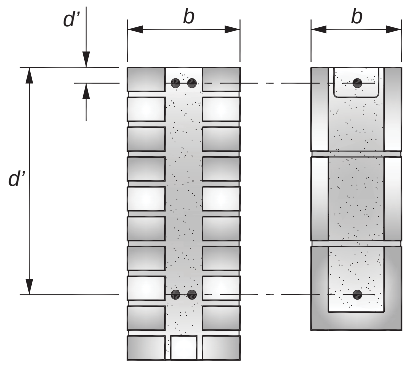
f_b = 675 psi $\quad$ F_s = 32,000 psi

E_m = 1,050,000 psi

E_s = 29,000,000 psi

n = 27.6 $\quad$ k = 0.368

K_{fb} = 109.0 $\quad$ ρ_b = 0.0039



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right] 2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	109.0	115	120	125	130	135	140	145	150	155
0.02	ρ'	—	0.0004	0.0007	0.0010	0.0013	0.0016	0.0019	0.0022	0.0025	0.0028
	ρ	0.0039	0.0041	0.0043	0.0044	0.0046	0.0047	0.0049	0.0050	0.0052	0.0054
0.04	ρ'	—	0.0004	0.0007	0.0010	0.0014	0.0017	0.0020	0.0023	0.0027	0.0030
	ρ	0.0039	0.0041	0.0043	0.0044	0.0046	0.0047	0.0049	0.0051	0.0052	0.0054
0.06	ρ'	—	0.0004	0.0008	0.0011	0.0015	0.0018	0.0022	0.0025	0.0029	0.0033
	ρ	0.0039	0.0041	0.0043	0.0044	0.0046	0.0048	0.0049	0.0051	0.0053	0.0054
0.08	ρ'	—	0.0005	0.0009	0.0012	0.0016	0.0020	0.0024	0.0028	0.0032	0.0036
	ρ	0.0039	0.0041	0.0043	0.0044	0.0046	0.0048	0.0050	0.0051	0.0053	0.0055
0.10	ρ'	—	0.0005	0.0009	0.0014	0.0018	0.0022	0.0026	0.0031	0.0035	0.0039
	ρ	0.0039	0.0041	0.0043	0.0045	0.0046	0.0048	0.0050	0.0052	0.0053	0.0055
0.12	ρ'	—	0.0006	0.0010	0.0015	0.0020	0.0024	0.0029	0.0034	0.0039	0.0043
	ρ	0.0039	0.0041	0.0043	0.0045	0.0046	0.0048	0.0050	0.0052	0.0054	0.0055
0.14	ρ'	—	0.0006	0.0011	0.0017	0.0022	0.0027	0.0032	0.0038	0.0043	0.0048
	ρ	0.0039	0.0041	0.0043	0.0045	0.0047	0.0048	0.0050	0.0052	0.0054	0.0056
0.16	ρ'	—	0.0007	0.0013	0.0019	0.0025	0.0030	0.0036	0.0042	0.0048	0.0054
	ρ	0.0039	0.0041	0.0043	0.0045	0.0047	0.0049	0.0051	0.0052	0.0054	0.0056
0.18	ρ'	—	0.0008	0.0015	0.0021	0.0028	0.0035	0.0041	0.0048	0.0055	0.0061
	ρ	0.0039	0.0041	0.0043	0.0045	0.0047	0.0049	0.0051	0.0053	0.0055	0.0057
0.20	ρ'	—	0.0009	0.0017	0.0024	0.0032	0.0040	0.0047	0.0055	0.0063	0.0070
	ρ	0.0039	0.0041	0.0043	0.0045	0.0047	0.0049	0.0051	0.0053	0.0055	0.0057
0.22	ρ'	—	0.0011	0.0020	0.0028	0.0037	0.0046	0.0055	0.0064	0.0073	0.0082
	ρ	0.0039	0.0041	0.0043	0.0045	0.0047	0.0049	0.0051	0.0053	0.0055	0.0057
0.24	ρ'	—	0.0013	0.0023	0.0034	0.0044	0.0055	0.0065	0.0076	0.0086	0.0097
	ρ	0.0039	0.0041	0.0044	0.0046	0.0048	0.0050	0.0052	0.0054	0.0056	0.0058
0.26	ρ'	—	0.0015	0.0028	0.0041	0.0054	0.0067	0.0080	0.0092	0.0105	0.0118
	ρ	0.0039	0.0042	0.0044	0.0046	0.0048	0.0050	0.0052	0.0054	0.0056	0.0058
0.28	ρ'	—	0.0019	0.0036	0.0052	0.0068	0.0084	0.0100	0.0116	0.0133	0.0149
	ρ	0.0039	0.0042	0.0044	0.0046	0.0048	0.0050	0.0052	0.0055	0.0057	0.0059
0.30	ρ'	—	0.0026	0.0047	0.0069	0.0090	0.0112	0.0133	0.0155	0.0177	0.0198
	ρ	0.0039	0.0042	0.0044	0.0046	0.0048	0.0051	0.0053	0.0055	0.0057	0.0060

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-74a Steel Ratio ρ and ρ' Versus K_f for f'_m = 1500 psi, (Clay Masonry)

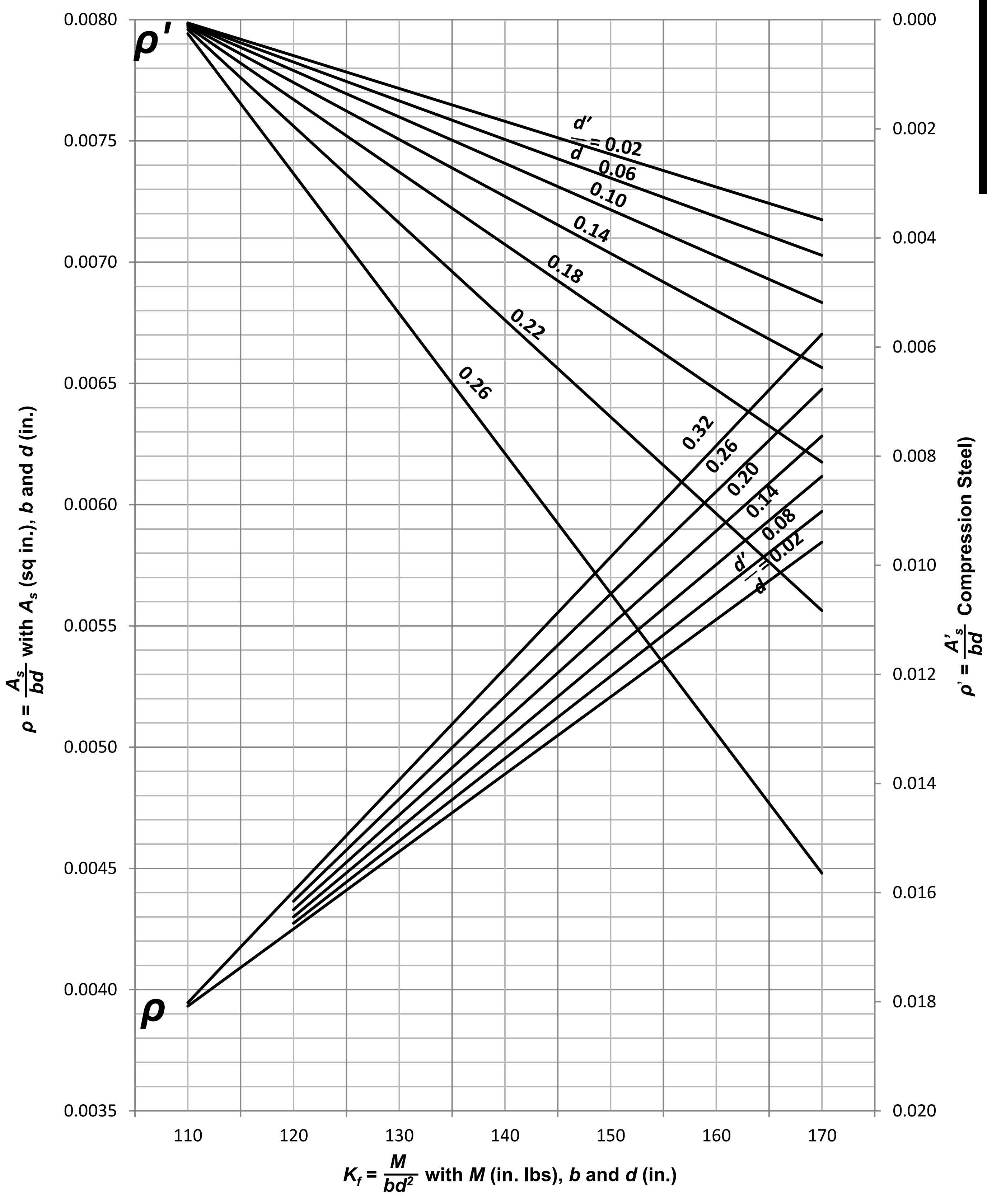


TABLE ASD-74b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 1750 psi, F_s = 32,000 psi, and n = 18.4

DESIGN DATA

f'_m = 1750 psi f_y = 60,000 psi

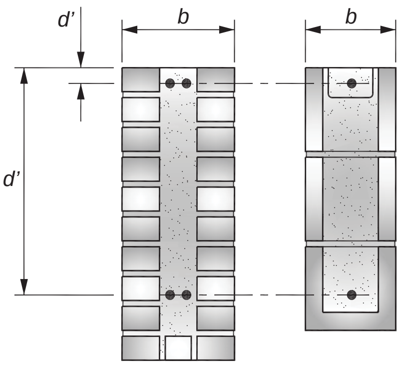
f_b = 788 psi F_s = 32,000 psi

E_m = 1,575,000 psi

E_s = 29,000,000 psi

n = 18.4 k = 0.312

K_{fb} = 110.1 ρ_b = 0.0038



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	110.1	115	120	125	130	135	140	145	150	155
0.02	ρ'	—	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024	0.0028	0.0032	0.0036
	ρ	**0.0038**	**0.0040**	**0.0041**	**0.0043**	**0.0044**	**0.0046**	**0.0048**	**0.0049**	**0.0051**	**0.0052**
0.04	ρ'	—	0.0004	0.0009	0.0013	0.0017	0.0022	0.0026	0.0030	0.0035	0.0039
	ρ	**0.0038**	**0.0040**	**0.0041**	**0.0043**	**0.0044**	**0.0046**	**0.0048**	**0.0049**	**0.0051**	**0.0053**
0.06	ρ'	—	0.0005	0.0010	0.0014	0.0019	0.0024	0.0029	0.0034	0.0038	0.0043
	ρ	**0.0038**	**0.0040**	**0.0041**	**0.0043**	**0.0045**	**0.0046**	**0.0048**	**0.0050**	**0.0051**	**0.0053**
0.08	ρ'	—	0.0005	0.0011	0.0016	0.0021	0.0027	0.0032	0.0037	0.0043	0.0048
	ρ	**0.0038**	**0.0040**	**0.0041**	**0.0043**	**0.0045**	**0.0046**	**0.0048**	**0.0050**	**0.0052**	**0.0053**
0.10	ρ'	—	0.0006	0.0012	0.0018	0.0024	0.0030	0.0036	0.0042	0.0048	0.0054
	ρ	**0.0038**	**0.0040**	**0.0041**	**0.0043**	**0.0045**	**0.0047**	**0.0048**	**0.0050**	**0.0052**	**0.0054**
0.12	ρ'	—	0.0007	0.0013	0.0020	0.0027	0.0034	0.0040	0.0047	0.0054	0.0060
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0043**	**0.0045**	**0.0047**	**0.0049**	**0.0050**	**0.0052**	**0.0054**
0.14	ρ'	—	0.0008	0.0015	0.0023	0.0031	0.0038	0.0046	0.0054	0.0061	0.0069
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0043**	**0.0045**	**0.0047**	**0.0049**	**0.0051**	**0.0052**	**0.0054**
0.16	ρ'	—	0.0009	0.0018	0.0027	0.0035	0.0044	0.0053	0.0062	0.0071	0.0080
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0045**	**0.0047**	**0.0049**	**0.0051**	**0.0053**	**0.0055**
0.18	ρ'	—	0.0010	0.0021	0.0031	0.0042	0.0052	0.0063	0.0073	0.0084	0.0094
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0046**	**0.0047**	**0.0049**	**0.0051**	**0.0053**	**0.0055**
0.20	ρ'	—	0.0012	0.0025	0.0038	0.0051	0.0063	0.0076	0.0089	0.0101	0.0114
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0046**	**0.0048**	**0.0050**	**0.0052**	**0.0054**	**0.0056**
0.22	ρ'	—	0.0016	0.0031	0.0047	0.0063	0.0079	0.0095	0.0111	0.0127	0.0142
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0046**	**0.0048**	**0.0050**	**0.0052**	**0.0054**	**0.0056**
0.24	ρ'	—	0.0020	0.0041	0.0062	0.0083	0.0104	0.0124	0.0145	0.0166	0.0187
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0046**	**0.0048**	**0.0050**	**0.0052**	**0.0054**	**0.0056**
0.26	ρ'	—	0.0029	0.0059	0.0088	0.0118	0.0147	0.0177	0.0206	0.0236	0.0265
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0046**	**0.0049**	**0.0051**	**0.0053**	**0.0055**	**0.0057**
0.28	ρ'	—	0.0048	0.0098	0.0147	0.0197	0.0246	0.0295	0.0345	0.0394	0.0443
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0044**	**0.0047**	**0.0049**	**0.0051**	**0.0053**	**0.0055**	**0.0057**
0.30	ρ'	—	0.0133	0.0268	0.0404	0.0539	0.0674	0.0810	0.0945	0.1081	0.1216
	ρ	**0.0038**	**0.0040**	**0.0042**	**0.0045**	**0.0047**	**0.0049**	**0.0051**	**0.0054**	**0.0056**	**0.0058**

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-74b Steel Ratio ρ and ρ' Versus K_f for f'_m = 1750 psi, (Concrete Masonry)

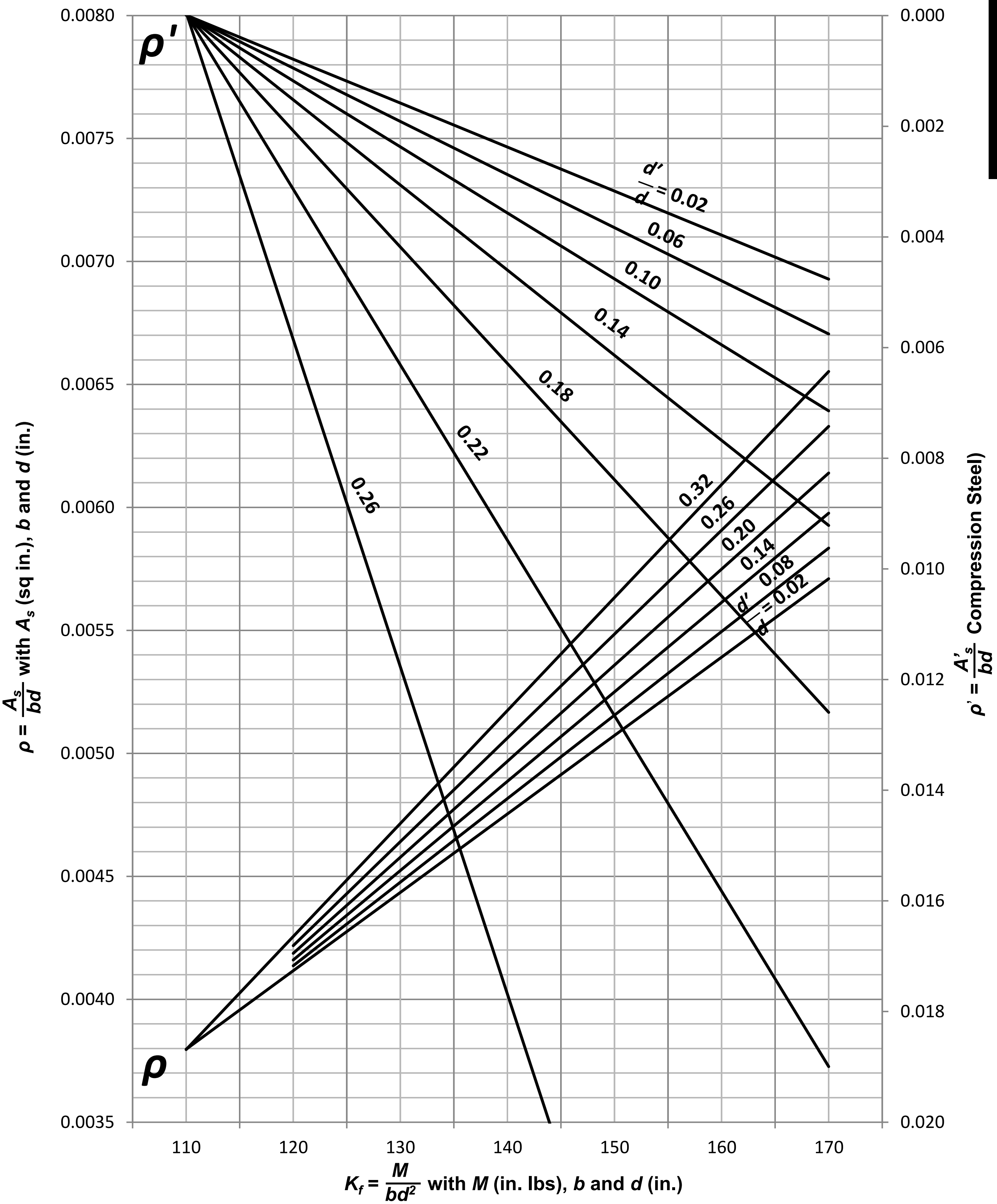


TABLE ASD-75a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 2000 psi, F_s = 32,000 psi, and n = 20.7

DESIGN DATA

f'_m = 2000 psi f_y = 60,000 psi

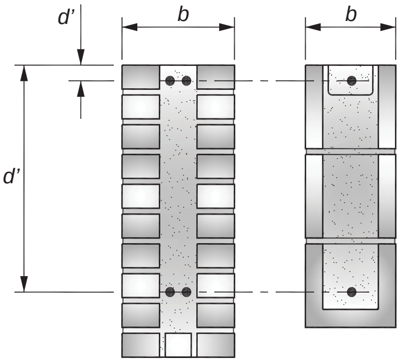
f_b = 900 psi F_s = 32,000 psi

E_m = 1,400,000 psi

E_s = 29,000,000 psi

n = 20.7 k = 0.368

K_{fb} = 145.3 ρ_b = 0.0052



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	145.3	150	155	160	165	170	175	180	185	190
0.02	ρ'	—	0.0003	0.0006	0.0009	0.0012	0.0015	0.0018	0.0021	0.0024	0.0027
	ρ	0.0052	0.0053	0.0055	0.0057	0.0058	0.0060	0.0061	0.0063	0.0065	0.0066
0.04	ρ'	—	0.0003	0.0006	0.0010	0.0013	0.0016	0.0020	0.0023	0.0026	0.0029
	ρ	0.0052	0.0054	0.0055	0.0057	0.0058	0.0060	0.0062	0.0063	0.0065	0.0067
0.06	ρ'	—	0.0003	0.0007	0.0011	0.0014	0.0018	0.0021	0.0025	0.0028	0.0032
	ρ	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062	0.0064	0.0065	0.0067
0.08	ρ'	—	0.0004	0.0008	0.0012	0.0015	0.0019	0.0023	0.0027	0.0031	0.0035
	ρ	0.0052	0.0054	0.0055	0.0057	0.0059	0.0060	0.0062	0.0064	0.0065	0.0067
0.10	ρ'	—	0.0004	0.0008	0.0013	0.0017	0.0021	0.0026	0.0030	0.0034	0.0038
	ρ	0.0052	0.0054	0.0055	0.0057	0.0059	0.0061	0.0062	0.0064	0.0066	0.0068
0.12	ρ'	—	0.0004	0.0009	0.0014	0.0019	0.0023	0.0028	0.0033	0.0038	0.0043
	ρ	0.0052	0.0054	0.0055	0.0057	0.0059	0.0061	0.0063	0.0064	0.0066	0.0068
0.14	ρ'	—	0.0005	0.0010	0.0016	0.0021	0.0026	0.0031	0.0037	0.0042	0.0047
	ρ	0.0052	0.0054	0.0056	0.0057	0.0059	0.0061	0.0063	0.0065	0.0066	0.0068
0.16	ρ'	—	0.0006	0.0012	0.0017	0.0023	0.0029	0.0035	0.0041	0.0047	0.0053
	ρ	0.0052	0.0054	0.0056	0.0057	0.0059	0.0061	0.0063	0.0065	0.0067	0.0069
0.18	ρ'	—	0.0006	0.0013	0.0020	0.0027	0.0033	0.0040	0.0047	0.0053	0.0060
	ρ	0.0052	0.0054	0.0056	0.0058	0.0060	0.0061	0.0063	0.0065	0.0067	0.0069
0.20	ρ'	—	0.0007	0.0015	0.0023	0.0030	0.0038	0.0046	0.0054	0.0061	0.0069
	ρ	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0069
0.22	ρ'	—	0.0008	0.0017	0.0026	0.0035	0.0044	0.0053	0.0062	0.0071	0.0080
	ρ	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0070
0.24	ρ'	—	0.0010	0.0021	0.0031	0.0042	0.0053	0.0063	0.0074	0.0085	0.0095
	ρ	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0070
0.26	ρ'	—	0.0012	0.0025	0.0038	0.0051	0.0064	0.0077	0.0090	0.0103	0.0116
	ρ	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062	0.0065	0.0067	0.0069	0.0071
0.28	ρ'	—	0.0015	0.0032	0.0048	0.0065	0.0081	0.0097	0.0114	0.0130	0.0146
	ρ	0.0052	0.0054	0.0056	0.0058	0.0061	0.0063	0.0065	0.0067	0.0069	0.0071
0.30	ρ'	—	0.0020	0.0042	0.0064	0.0086	0.0108	0.0130	0.0151	0.0173	0.0195
	ρ	0.0052	0.0054	0.0056	0.0059	0.0061	0.0063	0.0065	0.0067	0.0070	0.0072

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-75a Steel Ratio ρ and ρ' Versus K_f for f'_m = 2000 psi, (Clay Masonry)

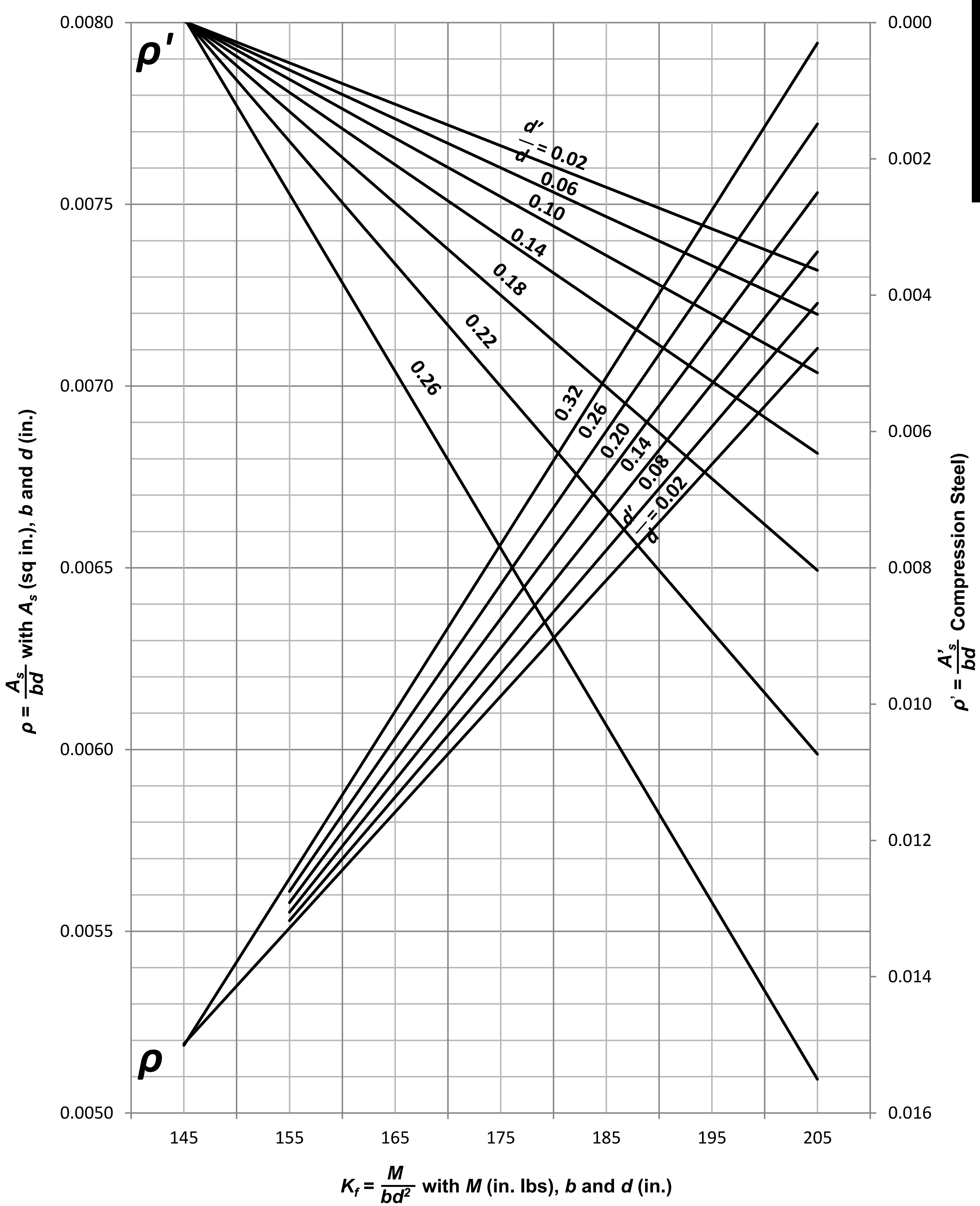


TABLE ASD-75b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 2000 psi, F_s = 32,000 psi, and n = 16.1

DESIGN DATA

f'_m = 2000 psi f_y = 60,000 psi

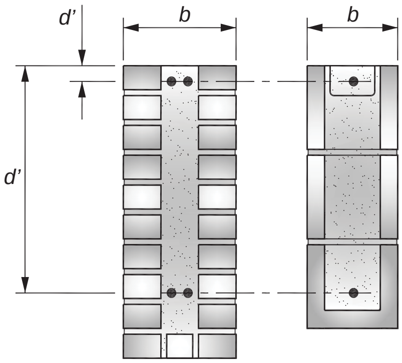
f_b = 900 psi F_s = 32,000 psi

E_m = 1,800,000 psi

E_s = 29,000,000 psi

n = 16.1 k = 0.312

K_{fb} = 125.7 ρ_b = 0.0044



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	125.7	130	135	140	145	150	155	160	165	170
0.02	ρ'	—	0.0003	0.0007	0.0011	0.0015	0.0019	0.0024	0.0028	0.0032	0.0036
	ρ	0.0044	0.0045	0.0047	0.0049	0.0050	0.0052	0.0053	0.0055	0.0057	0.0058
0.04	ρ'	—	0.0004	0.0008	0.0013	0.0017	0.0021	0.0026	0.0030	0.0035	0.0039
	ρ	0.0044	0.0045	0.0047	0.0049	0.0050	0.0052	0.0054	0.0055	0.0057	0.0058
0.06	ρ'	—	0.0004	0.0009	0.0014	0.0019	0.0024	0.0028	0.0033	0.0038	0.0043
	ρ	0.0044	0.0045	0.0047	0.0049	0.0050	0.0052	0.0054	0.0055	0.0057	0.0059
0.08	ρ'	—	0.0005	0.0010	0.0015	0.0021	0.0026	0.0032	0.0037	0.0042	0.0048
	ρ	0.0044	0.0045	0.0047	0.0049	0.0051	0.0052	0.0054	0.0056	0.0057	0.0059
0.10	ρ'	—	0.0005	0.0011	0.0017	0.0023	0.0029	0.0035	0.0041	0.0047	0.0053
	ρ	0.0044	0.0045	0.0047	0.0049	0.0051	0.0052	0.0054	0.0056	0.0058	0.0059
0.12	ρ'	—	0.0006	0.0013	0.0019	0.0026	0.0033	0.0040	0.0047	0.0053	0.0060
	ρ	0.0044	0.0046	0.0047	0.0049	0.0051	0.0053	0.0054	0.0056	0.0058	0.0060
0.14	ρ'	—	0.0007	0.0014	0.0022	0.0030	0.0038	0.0045	0.0053	0.0061	0.0069
	ρ	0.0044	0.0046	0.0047	0.0049	0.0051	0.0053	0.0055	0.0056	0.0058	0.0060
0.16	ρ'	—	0.0008	0.0017	0.0026	0.0035	0.0044	0.0053	0.0062	0.0071	0.0080
	ρ	0.0044	0.0046	0.0047	0.0049	0.0051	0.0053	0.0055	0.0057	0.0059	0.0060
0.18	ρ'	—	0.0009	0.0020	0.0030	0.0041	0.0052	0.0062	0.0073	0.0083	0.0094
	ρ	0.0044	0.0046	0.0048	0.0049	0.0051	0.0053	0.0055	0.0057	0.0059	0.0061
0.20	ρ'	—	0.0011	0.0024	0.0037	0.0049	0.0062	0.0075	0.0088	0.0101	0.0114
	ρ	0.0044	0.0046	0.0048	0.0050	0.0052	0.0053	0.0055	0.0057	0.0059	0.0061
0.22	ρ'	—	0.0014	0.0030	0.0046	0.0062	0.0078	0.0094	0.0110	0.0126	0.0142
	ρ	0.0044	0.0046	0.0048	0.0050	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062
0.24	ρ'	—	0.0018	0.0039	0.0060	0.0081	0.0102	0.0123	0.0144	0.0165	0.0186
	ρ	0.0044	0.0046	0.0048	0.0050	0.0052	0.0054	0.0056	0.0058	0.0060	0.0062
0.26	ρ'	—	0.0026	0.0055	0.0085	0.0115	0.0145	0.0175	0.0205	0.0234	0.0264
	ρ	0.0044	0.0046	0.0048	0.0050	0.0052	0.0054	0.0056	0.0058	0.0061	0.0063
0.28	ρ'	—	0.0043	0.0093	0.0142	0.0192	0.0242	0.0292	0.0342	0.0392	0.0441
	ρ	0.0044	0.0046	0.0048	0.0050	0.0052	0.0055	0.0057	0.0059	0.0061	0.0063
0.30	ρ'	—	0.0118	0.0254	0.0391	0.0527	0.0664	0.0801	0.0937	0.1074	0.1211
	ρ	0.0044	0.0046	0.0048	0.0050	0.0053	0.0055	0.0057	0.0059	0.0062	0.0064

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-75b Steel Ratio ρ and ρ' Versus K_f for f'_m = 2000 psi, (Concrete Masonry)

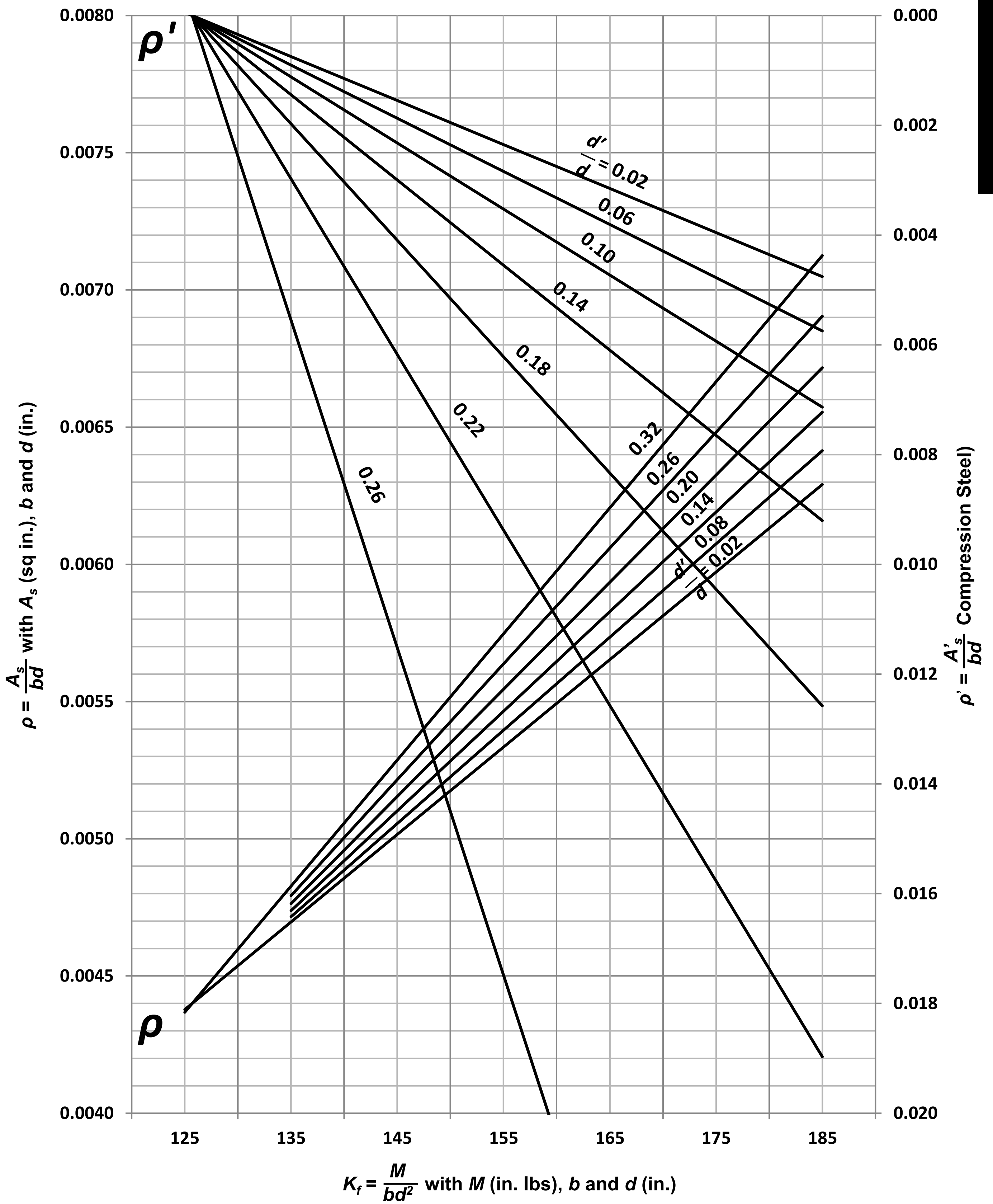


TABLE ASD-76a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 2500 psi, F_s = 32,000 psi, and n = 16.6

DESIGN DATA

f'_m = 2500 psi f_y = 60,000 psi

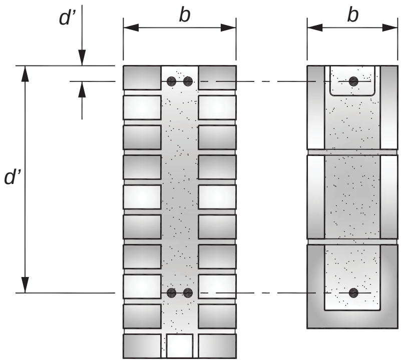
f_b = 1125 psi F_s = 32,000 psi

E_m = 1,750,000 psi

E_s = 29,000,000 psi

n = 16.6 k = 0.368

K_{fb} = 181.7 ρ_b = 0.0065



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	181.7	185	190	195	200	205	210	215	220	225
0.02	ρ'	—	0.0002	0.0005	0.0008	0.0011	0.0014	0.0017	0.0020	0.0024	0.0027
	ρ	0.0065	0.0066	0.0068	0.0069	0.0071	0.0072	0.0074	0.0076	0.0077	0.0079
0.04	ρ'	—	0.0002	0.0006	0.0009	0.0012	0.0016	0.0019	0.0022	0.0026	0.0029
	ρ	0.0065	0.0066	0.0068	0.0069	0.0071	0.0073	0.0074	0.0076	0.0077	0.0079
0.06	ρ'	—	0.0002	0.0006	0.0010	0.0013	0.0017	0.0020	0.0024	0.0028	0.0031
	ρ	0.0065	0.0066	0.0068	0.0069	0.0071	0.0073	0.0074	0.0076	0.0078	0.0079
0.08	ρ'	—	0.0003	0.0007	0.0011	0.0014	0.0018	0.0022	0.0026	0.0030	0.0034
	ρ	0.0065	0.0066	0.0068	0.0070	0.0071	0.0073	0.0075	0.0076	0.0078	0.0080
0.10	ρ'	—	0.0003	0.0007	0.0012	0.0016	0.0020	0.0025	0.0029	0.0033	0.0038
	ρ	0.0065	0.0066	0.0068	0.0070	0.0071	0.0073	0.0075	0.0077	0.0078	0.0080
0.12	ρ'	—	0.0003	0.0008	0.0013	0.0018	0.0022	0.0027	0.0032	0.0037	0.0042
	ρ	0.0065	0.0066	0.0068	0.0070	0.0071	0.0073	0.0075	0.0077	0.0079	0.0080
0.14	ρ'	—	0.0004	0.0009	0.0014	0.0020	0.0025	0.0030	0.0036	0.0041	0.0046
	ρ	0.0065	0.0066	0.0068	0.0070	0.0072	0.0073	0.0075	0.0077	0.0079	0.0081
0.16	ρ'	—	0.0004	0.0010	0.0016	0.0022	0.0028	0.0034	0.0040	0.0046	0.0052
	ρ	0.0065	0.0066	0.0068	0.0070	0.0072	0.0074	0.0076	0.0077	0.0079	0.0081
0.18	ρ'	—	0.0004	0.0011	0.0018	0.0025	0.0032	0.0038	0.0045	0.0052	0.0059
	ρ	0.0065	0.0066	0.0068	0.0070	0.0072	0.0074	0.0076	0.0078	0.0080	0.0082
0.20	ρ'	—	0.0005	0.0013	0.0021	0.0029	0.0036	0.0044	0.0052	0.0060	0.0068
	ρ	0.0065	0.0066	0.0068	0.0070	0.0072	0.0074	0.0076	0.0078	0.0080	0.0082
0.22	ρ'	—	0.0006	0.0015	0.0024	0.0033	0.0042	0.0051	0.0060	0.0070	0.0079
	ρ	0.0065	0.0066	0.0068	0.0070	0.0072	0.0074	0.0076	0.0078	0.0080	0.0082
0.24	ρ'	—	0.0007	0.0018	0.0029	0.0039	0.0050	0.0061	0.0072	0.0083	0.0093
	ρ	0.0065	0.0066	0.0068	0.0070	0.0073	0.0075	0.0077	0.0079	0.0081	0.0083
0.26	ρ'	—	0.0009	0.0022	0.0035	0.0048	0.0061	0.0074	0.0087	0.0100	0.0114
	ρ	0.0065	0.0066	0.0069	0.0071	0.0073	0.0075	0.0077	0.0079	0.0081	0.0083
0.28	ρ'	—	0.0011	0.0027	0.0044	0.0061	0.0077	0.0094	0.0110	0.0127	0.0143
	ρ	0.0065	0.0066	0.0069	0.0071	0.0073	0.0075	0.0077	0.0079	0.0082	0.0084
0.30	ρ'	—	0.0015	0.0037	0.0059	0.0081	0.0103	0.0125	0.0147	0.0169	0.0191
	ρ	0.0065	0.0066	0.0069	0.0071	0.0073	0.0075	0.0078	0.0080	0.0082	0.0084

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-76a Steel Ratio ρ and ρ' Versus K_f for f'_m = 2500 psi, (Clay Masonry)

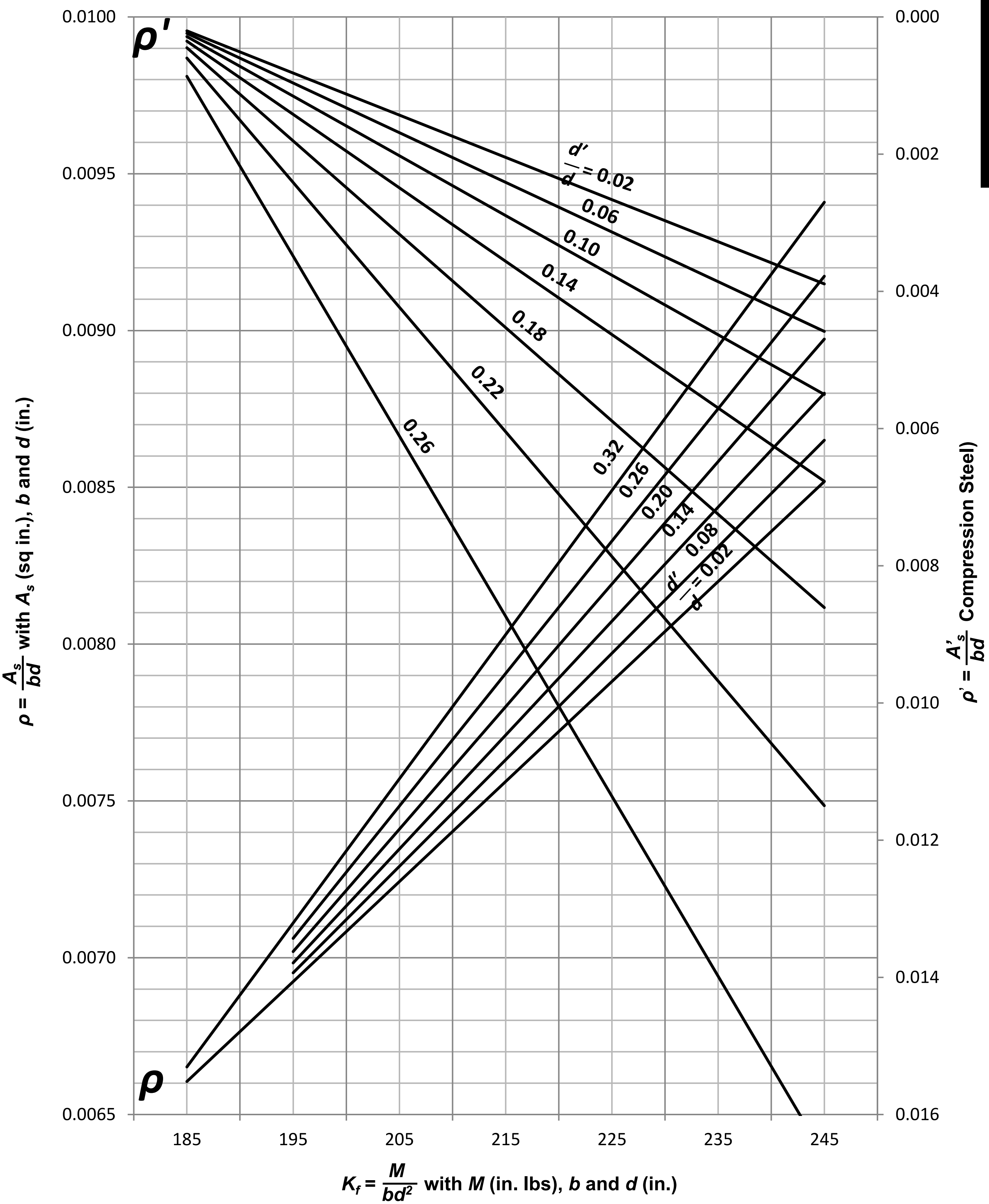


TABLE ASD-76b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 2500 psi, F_s = 32,000 psi, and n = 12.9

DESIGN DATA

f'_m = 2500 psi f_y = 60,000 psi

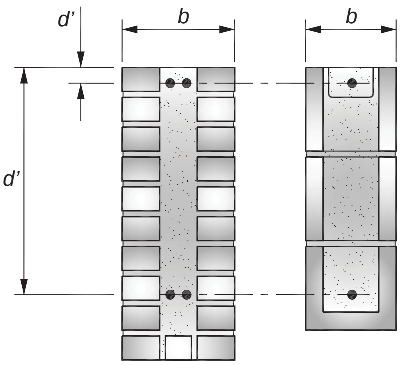
f_b = 1125 psi F_s = 32,000 psi

E_m = 2,250,000 psi

E_s = 29,000,000 psi

n = 12.9 k = 0.312

K_{fb} = 157.2 ρ_b = 0.0055



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	157.2	160	165	170	175	180	185	190	195	200
0.02	ρ'	—	0.0002	0.0006	0.0010	0.0014	0.0019	0.0023	0.0027	0.0031	0.0035
	ρ	0.0055	0.0056	0.0057	0.0059	0.0061	0.0062	0.0064	0.0065	0.0067	0.0069
0.04	ρ'	—	0.0002	0.0007	0.0011	0.0016	0.0020	0.0025	0.0029	0.0034	0.0038
	ρ	0.0055	0.0056	0.0058	0.0059	0.0061	0.0062	0.0064	0.0066	0.0067	0.0069
0.06	ρ'	—	0.0003	0.0008	0.0013	0.0018	0.0022	0.0027	0.0032	0.0037	0.0042
	ρ	0.0055	0.0056	0.0058	0.0059	0.0061	0.0063	0.0064	0.0066	0.0068	0.0069
0.08	ρ'	—	0.0003	0.0009	0.0014	0.0019	0.0025	0.0030	0.0036	0.0041	0.0047
	ρ	0.0055	0.0056	0.0058	0.0059	0.0061	0.0063	0.0064	0.0066	0.0068	0.0070
0.10	ρ'	—	0.0003	0.0010	0.0016	0.0022	0.0028	0.0034	0.0040	0.0046	0.0052
	ρ	0.0055	0.0056	0.0058	0.0059	0.0061	0.0063	0.0065	0.0066	0.0068	0.0070
0.12	ρ'	—	0.0004	0.0011	0.0018	0.0025	0.0031	0.0038	0.0045	0.0052	0.0059
	ρ	0.0055	0.0056	0.0058	0.0060	0.0061	0.0063	0.0065	0.0067	0.0068	0.0070
0.14	ρ'	—	0.0004	0.0012	0.0020	0.0028	0.0036	0.0044	0.0052	0.0060	0.0067
	ρ	0.0055	0.0056	0.0058	0.0060	0.0061	0.0063	0.0065	0.0067	0.0069	0.0071
0.16	ρ'	—	0.0005	0.0014	0.0023	0.0032	0.0042	0.0051	0.0060	0.0069	0.0078
	ρ	0.0055	0.0056	0.0058	0.0060	0.0062	0.0063	0.0065	0.0067	0.0069	0.0071
0.18	ρ'	—	0.0006	0.0017	0.0028	0.0038	0.0049	0.0060	0.0071	0.0081	0.0092
	ρ	0.0055	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0069	0.0071
0.20	ρ'	—	0.0007	0.0020	0.0033	0.0046	0.0059	0.0072	0.0085	0.0098	0.0111
	ρ	0.0055	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0070	0.0072
0.22	ρ'	—	0.0009	0.0025	0.0042	0.0058	0.0074	0.0090	0.0107	0.0123	0.0139
	ρ	0.0055	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0070	0.0072
0.24	ρ'	—	0.0012	0.0033	0.0055	0.0076	0.0097	0.0118	0.0140	0.0161	0.0182
	ρ	0.0055	0.0056	0.0058	0.0060	0.0062	0.0064	0.0066	0.0068	0.0071	0.0073
0.26	ρ'	—	0.0017	0.0047	0.0078	0.0108	0.0138	0.0168	0.0199	0.0229	0.0259
	ρ	0.0055	0.0056	0.0058	0.0060	0.0063	0.0065	0.0067	0.0069	0.0071	0.0073
0.28	ρ'	—	0.0028	0.0079	0.0129	0.0180	0.0231	0.0281	0.0332	0.0382	0.0433
	ρ	0.0055	0.0056	0.0058	0.0061	0.0063	0.0065	0.0067	0.0069	0.0071	0.0074
0.30	ρ'	—	0.0078	0.0216	0.0355	0.0494	0.0633	0.0771	0.0910	0.1049	0.1187
	ρ	0.0055	0.0056	0.0058	0.0061	0.0063	0.0065	0.0067	0.0070	0.0072	0.0074

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-76b Steel Ratio ρ and ρ' Versus K_f for f'_m = 2500 psi, (Concrete Masonry)

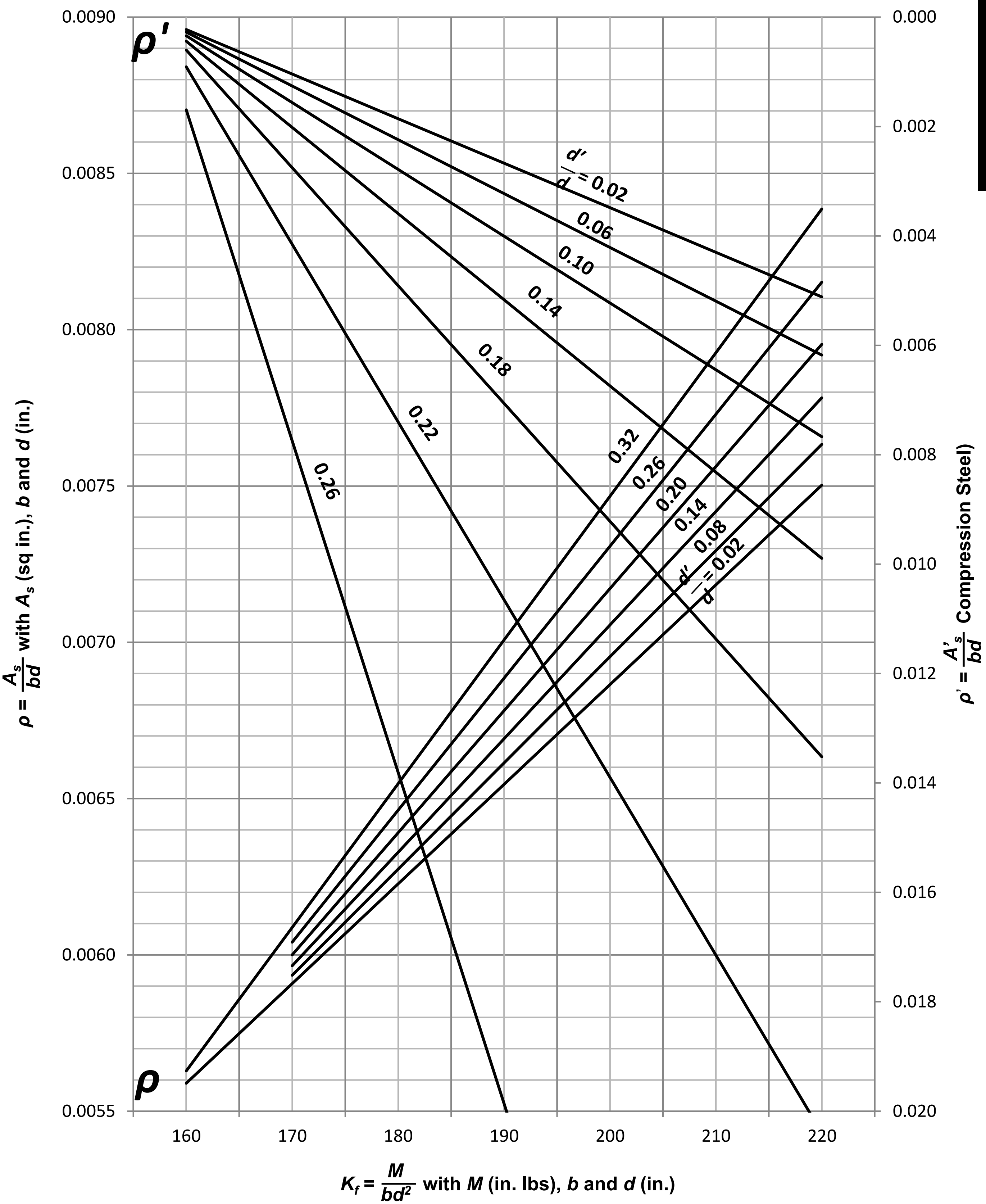


TABLE ASD-77a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 3000 psi, F_s = 32,000 psi, and n = 13.8

DESIGN DATA

f'_m = 3000 psi f_y = 60,000 psi

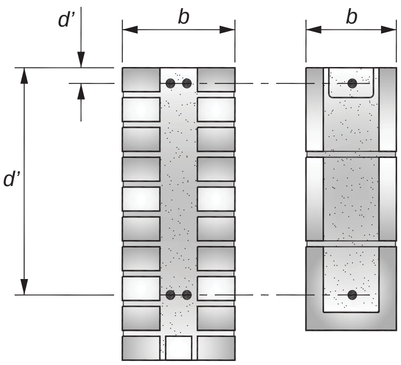
f_b = 1350 psi F_s = 32,000 psi

E_m = 2,100,000 psi

E_s = 29,000,000 psi

n = 13.8 k = 0.368

K_{fb} = 218.0 ρ_b = 0.0078



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	218.0	225	230	235	240	245	250	255	260	265
0.02	ρ'	—	0.0004	0.0007	0.0011	0.0014	0.0017	0.0020	0.0023	0.0026	0.0029
	ρ	0.0078	0.0080	0.0082	0.0083	0.0085	0.0087	0.0088	0.0090	0.0091	0.0093
0.04	ρ'	—	0.0005	0.0008	0.0011	0.0015	0.0018	0.0022	0.0025	0.0028	0.0032
	ρ	0.0078	0.0080	0.0082	0.0084	0.0085	0.0087	0.0088	0.0090	0.0092	0.0093
0.06	ρ'	—	0.0005	0.0009	0.0013	0.0016	0.0020	0.0024	0.0027	0.0031	0.0035
	ρ	0.0078	0.0080	0.0082	0.0084	0.0085	0.0087	0.0089	0.0090	0.0092	0.0094
0.08	ρ'	—	0.0006	0.0010	0.0014	0.0018	0.0022	0.0026	0.0030	0.0034	0.0038
	ρ	0.0078	0.0080	0.0082	0.0084	0.0085	0.0087	0.0089	0.0091	0.0092	0.0094
0.10	ρ'	—	0.0006	0.0011	0.0015	0.0019	0.0024	0.0028	0.0033	0.0037	0.0041
	ρ	0.0078	0.0080	0.0082	0.0084	0.0086	0.0087	0.0089	0.0091	0.0093	0.0094
0.12	ρ'	—	0.0007	0.0012	0.0017	0.0021	0.0026	0.0031	0.0036	0.0041	0.0046
	ρ	0.0078	0.0080	0.0082	0.0084	0.0086	0.0088	0.0089	0.0091	0.0093	0.0095
0.14	ρ'	—	0.0008	0.0013	0.0018	0.0024	0.0029	0.0035	0.0040	0.0046	0.0051
	ρ	0.0078	0.0081	0.0082	0.0084	0.0086	0.0088	0.0090	0.0091	0.0093	0.0095
0.16	ρ'	—	0.0009	0.0015	0.0021	0.0027	0.0033	0.0039	0.0045	0.0051	0.0057
	ρ	0.0078	0.0081	0.0082	0.0084	0.0086	0.0088	0.0090	0.0092	0.0094	0.0095
0.18	ρ'	—	0.0010	0.0017	0.0023	0.0030	0.0037	0.0044	0.0051	0.0058	0.0065
	ρ	0.0078	0.0081	0.0083	0.0084	0.0086	0.0088	0.0090	0.0092	0.0094	0.0096
0.20	ρ'	—	0.0011	0.0019	0.0027	0.0035	0.0043	0.0051	0.0059	0.0067	0.0074
	ρ	0.0078	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0092	0.0094	0.0096
0.22	ρ'	—	0.0013	0.0022	0.0031	0.0041	0.0050	0.0059	0.0068	0.0077	0.0087
	ρ	0.0078	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0093	0.0095	0.0097
0.24	ρ'	—	0.0015	0.0026	0.0037	0.0048	0.0059	0.0070	0.0081	0.0092	0.0103
	ρ	0.0078	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0093	0.0095	0.0097
0.26	ρ'	—	0.0019	0.0032	0.0045	0.0059	0.0072	0.0085	0.0099	0.0112	0.0125
	ρ	0.0078	0.0081	0.0083	0.0085	0.0087	0.0089	0.0092	0.0094	0.0096	0.0098
0.28	ρ'	—	0.0024	0.0040	0.0057	0.0074	0.0091	0.0108	0.0124	0.0141	0.0158
	ρ	0.0078	0.0081	0.0083	0.0085	0.0088	0.0090	0.0092	0.0094	0.0096	0.0098
0.30	ρ'	—	0.0031	0.0054	0.0076	0.0098	0.0121	0.0143	0.0166	0.0188	0.0210
	ρ	0.0078	0.0081	0.0083	0.0086	0.0088	0.0090	0.0092	0.0095	0.0097	0.0099

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-77a Steel Ratio ρ and ρ' Versus K_f for f'_m = 3000 psi, (Clay Masonry)

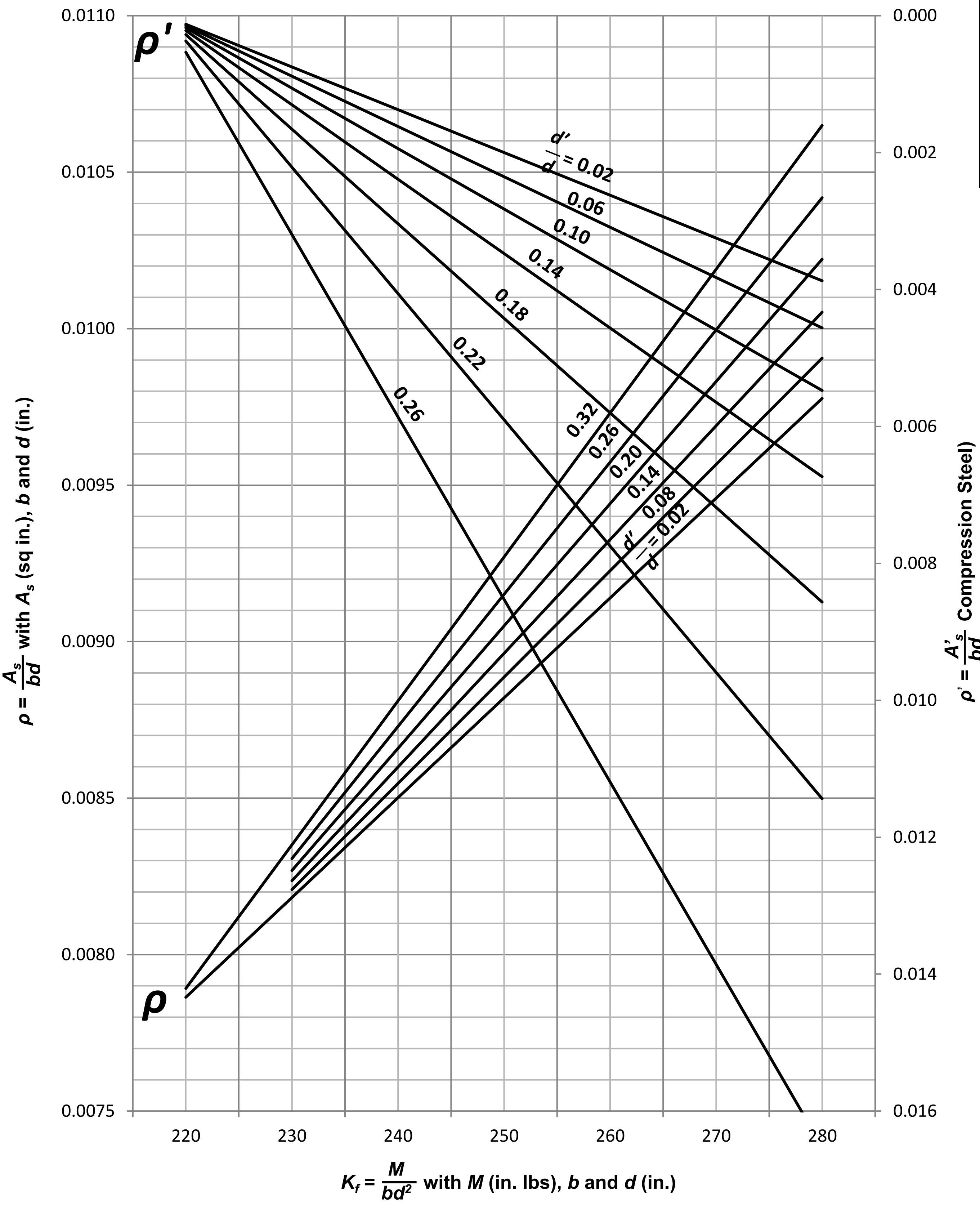


TABLE ASD-77b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 3000 psi, F_s = 32,000 psi, and n = 10.7

DESIGN DATA

f'_m = 3000 psi $\quad f_y$ = 60,000 psi

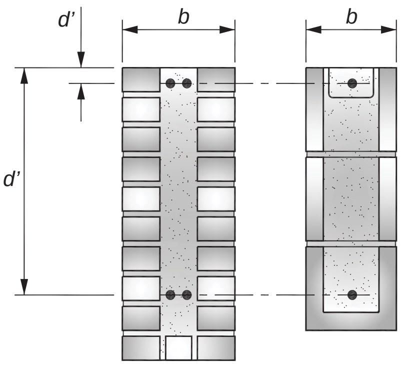
f_b = 1350 psi $\quad F_s$ = 32,000 psi

E_m = 2,700,000 psi

E_s = 29,000,000 psi

n = 10.7 $\quad k$ = 0.312

K_{fb} = 188.6 $\quad \rho_b$ = 0.0066



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	188.6	195	200	205	210	215	220	225	230	235
0.02	ρ'	—	0.0005	0.0009	0.0014	0.0018	0.0022	0.0026	0.0030	0.0034	0.0039
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0071**	**0.0073**	**0.0074**	**0.0076**	**0.0078**	**0.0079**	**0.0081**
0.04	ρ'	—	0.0006	0.0010	0.0015	0.0020	0.0024	0.0029	0.0033	0.0038	0.0042
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0071**	**0.0073**	**0.0075**	**0.0076**	**0.0078**	**0.0079**	**0.0081**
0.06	ρ'	—	0.0006	0.0011	0.0016	0.0022	0.0027	0.0032	0.0037	0.0042	0.0047
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0071**	**0.0073**	**0.0075**	**0.0076**	**0.0078**	**0.0080**	**0.0081**
0.08	ρ'	—	0.0007	0.0013	0.0018	0.0024	0.0029	0.0035	0.0041	0.0046	0.0052
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0073**	**0.0075**	**0.0077**	**0.0078**	**0.0080**	**0.0082**
0.10	ρ'	—	0.0008	0.0014	0.0020	0.0027	0.0033	0.0039	0.0045	0.0052	0.0058
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0073**	**0.0075**	**0.0077**	**0.0079**	**0.0080**	**0.0082**
0.12	ρ'	—	0.0009	0.0016	0.0023	0.0030	0.0037	0.0044	0.0051	0.0058	0.0065
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0074**	**0.0075**	**0.0077**	**0.0079**	**0.0081**	**0.0082**
0.14	ρ'	—	0.0010	0.0018	0.0026	0.0034	0.0043	0.0051	0.0059	0.0067	0.0075
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0074**	**0.0076**	**0.0077**	**0.0079**	**0.0081**	**0.0083**
0.16	ρ'	—	0.0012	0.0021	0.0031	0.0040	0.0049	0.0059	0.0068	0.0077	0.0087
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0074**	**0.0076**	**0.0078**	**0.0080**	**0.0081**	**0.0083**
0.18	ρ'	—	0.0014	0.0025	0.0036	0.0047	0.0058	0.0069	0.0080	0.0091	0.0102
	ρ	**0.0066**	**0.0068**	**0.0070**	**0.0072**	**0.0074**	**0.0076**	**0.0078**	**0.0080**	**0.0082**	**0.0084**
0.20	ρ'	—	0.0017	0.0030	0.0044	0.0057	0.0070	0.0083	0.0097	0.0110	0.0123
	ρ	**0.0066**	**0.0069**	**0.0070**	**0.0072**	**0.0074**	**0.0076**	**0.0078**	**0.0080**	**0.0082**	**0.0084**
0.22	ρ'	—	0.0021	0.0038	0.0054	0.0071	0.0088	0.0104	0.0121	0.0137	0.0154
	ρ	**0.0066**	**0.0069**	**0.0071**	**0.0073**	**0.0075**	**0.0077**	**0.0079**	**0.0081**	**0.0083**	**0.0085**
0.24	ρ'	—	0.0028	0.0050	0.0071	0.0093	0.0115	0.0137	0.0158	0.0180	0.0202
	ρ	**0.0066**	**0.0069**	**0.0071**	**0.0073**	**0.0075**	**0.0077**	**0.0079**	**0.0081**	**0.0083**	**0.0085**
0.26	ρ'	—	0.0040	0.0071	0.0102	0.0133	0.0163	0.0194	0.0225	0.0256	0.0287
	ρ	**0.0066**	**0.0069**	**0.0071**	**0.0073**	**0.0075**	**0.0077**	**0.0079**	**0.0081**	**0.0083**	**0.0086**
0.28	ρ'	—	0.0066	0.0118	0.0170	0.0221	0.0273	0.0325	0.0376	0.0428	0.0480
	ρ	**0.0066**	**0.0069**	**0.0071**	**0.0073**	**0.0075**	**0.0077**	**0.0080**	**0.0082**	**0.0084**	**0.0086**
0.30	ρ'	—	0.0182	0.0323	0.0465	0.0607	0.0749	0.0891	0.1032	0.1174	0.1316
	ρ	**0.0066**	**0.0069**	**0.0071**	**0.0073**	**0.0076**	**0.0078**	**0.0080**	**0.0082**	**0.0084**	**0.0087**

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-77b Steel Ratio ρ and ρ' Versus K_f for f'_m = 3000 psi, (Concrete Masonry)

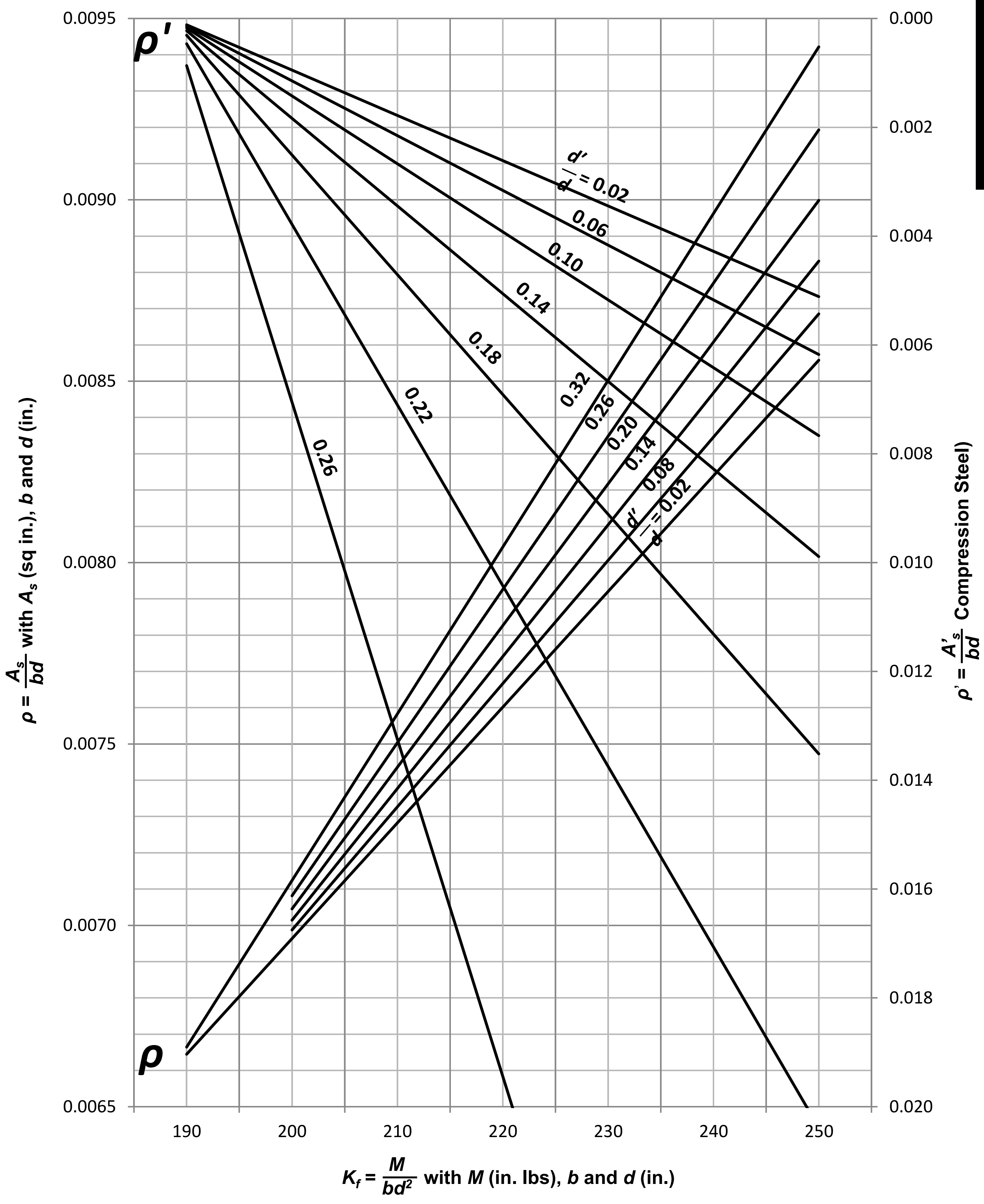


TABLE ASD-78a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 3500 psi, F_s = 32,000 psi, and n = 11.8

DESIGN DATA

f'_m = 3500 psi F_y = 60,000 psi

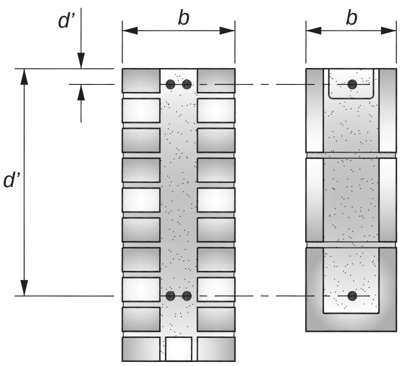
f_b = 1575 psi F_s = 32,000 psi

E_m = 2,450,000 psi

E_s = 29,000,000 psi

n = 11.8 k = 0.368

K_{fb} = 254.3 ρ_b = 0.0091



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right] 2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	254.3	260	265	270	275	280	285	290	295	300
0.02	ρ'	—	0.0004	0.0007	0.0010	0.0013	0.0016	0.0019	0.0023	0.0026	0.0029
	ρ	0.0091	0.0093	0.0094	0.0096	0.0098	0.0099	0.0101	0.0102	0.0104	0.0106
0.04	ρ'	—	0.0004	0.0007	0.0011	0.0014	0.0018	0.0021	0.0025	0.0028	0.0031
	ρ	0.0091	0.0093	0.0094	0.0096	0.0098	0.0099	0.0101	0.0103	0.0104	0.0106
0.06	ρ'	—	0.0004	0.0008	0.0012	0.0015	0.0019	0.0023	0.0027	0.0030	0.0034
	ρ	0.0091	0.0093	0.0095	0.0096	0.0098	0.0100	0.0101	0.0103	0.0105	0.0106
0.08	ρ'	—	0.0005	0.0009	0.0013	0.0017	0.0021	0.0025	0.0029	0.0033	0.0037
	ρ	0.0091	0.0093	0.0095	0.0096	0.0098	0.0100	0.0101	0.0103	0.0105	0.0107
0.10	ρ'	—	0.0005	0.0010	0.0014	0.0019	0.0023	0.0028	0.0032	0.0037	0.0041
	ρ	0.0091	0.0093	0.0095	0.0096	0.0098	0.0100	0.0102	0.0103	0.0105	0.0107
0.12	ρ'	—	0.0006	0.0011	0.0016	0.0021	0.0025	0.0030	0.0035	0.0040	0.0045
	ρ	0.0091	0.0093	0.0095	0.0097	0.0098	0.0100	0.0102	0.0104	0.0105	0.0107
0.14	ρ'	—	0.0006	0.0012	0.0017	0.0023	0.0028	0.0034	0.0039	0.0045	0.0050
	ρ	0.0091	0.0093	0.0095	0.0097	0.0099	0.0100	0.0102	0.0104	0.0106	0.0108
0.16	ρ'	—	0.0007	0.0013	0.0019	0.0026	0.0032	0.0038	0.0044	0.0050	0.0057
	ρ	0.0091	0.0093	0.0095	0.0097	0.0099	0.0101	0.0102	0.0104	0.0106	0.0108
0.18	ρ'	—	0.0008	0.0015	0.0022	0.0029	0.0036	0.0043	0.0050	0.0057	0.0064
	ρ	0.0091	0.0093	0.0095	0.0097	0.0099	0.0101	0.0103	0.0105	0.0107	0.0108
0.20	ρ'	—	0.0009	0.0017	0.0025	0.0033	0.0041	0.0049	0.0057	0.0066	0.0074
	ρ	0.0091	0.0093	0.0095	0.0097	0.0099	0.0101	0.0103	0.0105	0.0107	0.0109
0.22	ρ'	—	0.0011	0.0020	0.0029	0.0039	0.0048	0.0058	0.0067	0.0076	0.0086
	ρ	0.0091	0.0093	0.0095	0.0097	0.0099	0.0101	0.0103	0.0105	0.0107	0.0109
0.24	ρ'	—	0.0013	0.0024	0.0035	0.0046	0.0057	0.0068	0.0079	0.0091	0.0102
	ρ	0.0091	0.0093	0.0095	0.0097	0.0100	0.0102	0.0104	0.0106	0.0108	0.0110
0.26	ρ'	—	0.0015	0.0029	0.0042	0.0056	0.0070	0.0083	0.0097	0.0110	0.0124
	ρ	0.0091	0.0093	0.0096	0.0098	0.0100	0.0102	0.0104	0.0106	0.0108	0.0110
0.28	ρ'	—	0.0019	0.0037	0.0054	0.0071	0.0088	0.0105	0.0122	0.0139	0.0156
	ρ	0.0091	0.0093	0.0096	0.0098	0.0100	0.0102	0.0104	0.0106	0.0109	0.0111
0.30	ρ'	—	0.0026	0.0049	0.0071	0.0094	0.0117	0.0140	0.0162	0.0185	0.0208
	ρ	0.0091	0.0094	0.0096	0.0098	0.0100	0.0102	0.0105	0.0107	0.0109	0.0111

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-78a Steel Ratio ρ and ρ' Versus K_f for f'_m = 3500 psi, (Clay Masonry)

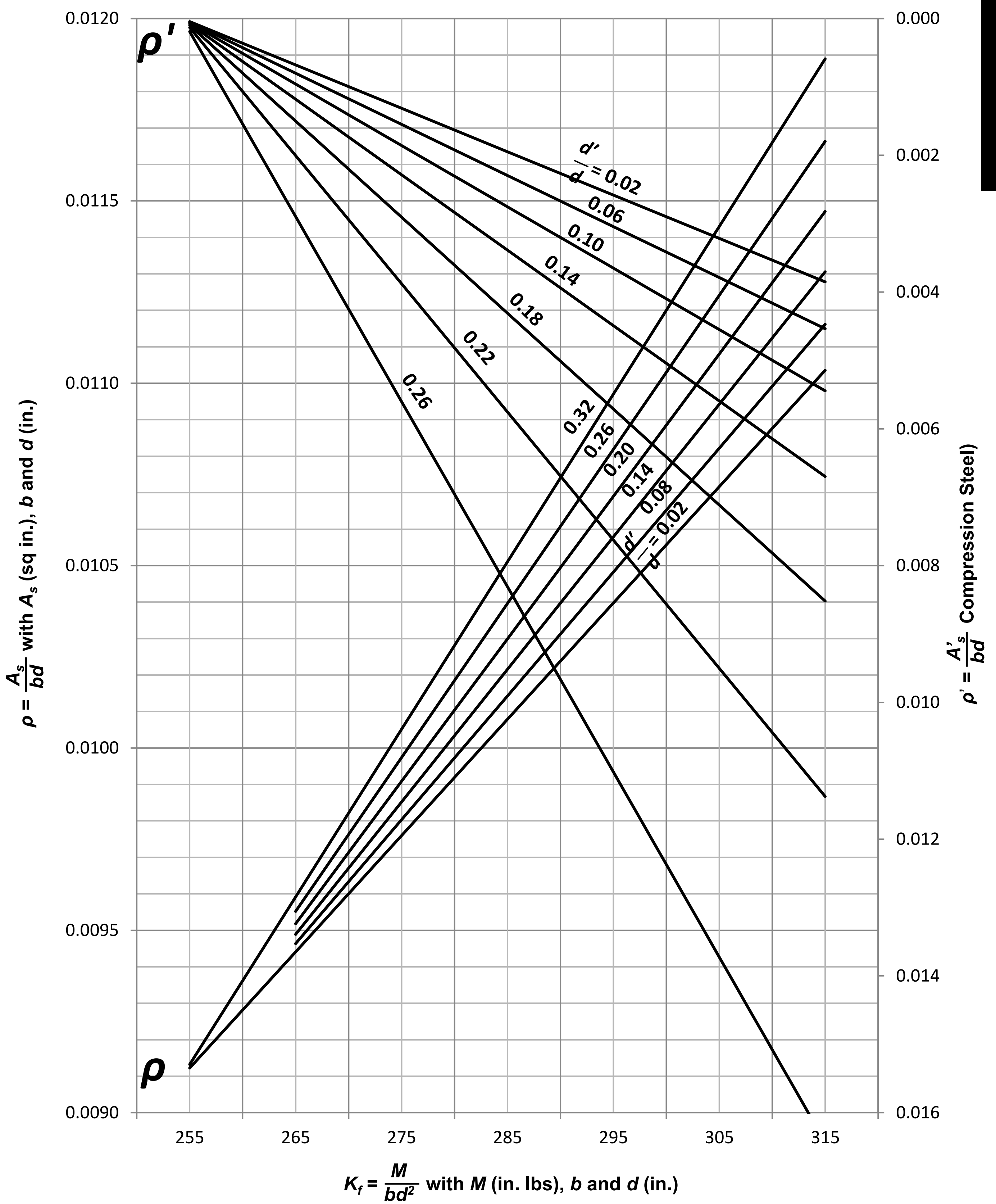


TABLE ASD-78b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 3500 psi, F_s = 32,000 psi, and n = 9.2

DESIGN DATA

f'_m = 3500 psi f_y = 60,000 psi

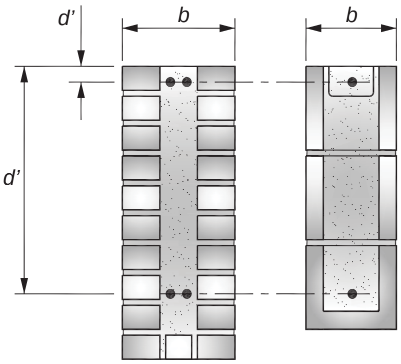
f_b = 1575 psi F_s = 32,000 psi

E_m = 3,150,000 psi

E_s = 29,000,000 psi

n = 9.2 k = 0.312

K_{fb} = 220.0 ρ_b = 0.0077



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - d'/d\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - d'/d}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d[a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	220.0	225	230	235	240	245	250	255	260	265
0.02	ρ'	—	0.0004	0.0008	0.0013	0.0017	0.0021	0.0025	0.0030	0.0034	0.0038
	ρ	0.0077	0.0079	0.0080	0.0082	0.0083	0.0085	0.0087	0.0088	0.0090	0.0091
0.04	ρ'	—	0.0005	0.0009	0.0014	0.0019	0.0023	0.0028	0.0032	0.0037	0.0042
	ρ	0.0077	0.0079	0.0080	0.0082	0.0084	0.0085	0.0087	0.0088	0.0090	0.0092
0.06	ρ'	—	0.0005	0.0010	0.0015	0.0020	0.0025	0.0031	0.0036	0.0041	0.0046
	ρ	0.0077	0.0079	0.0080	0.0082	0.0084	0.0085	0.0087	0.0089	0.0090	0.0092
0.08	ρ'	—	0.0006	0.0011	0.0017	0.0023	0.0028	0.0034	0.0040	0.0045	0.0051
	ρ	0.0077	0.0079	0.0080	0.0082	0.0084	0.0085	0.0087	0.0089	0.0091	0.0092
0.10	ρ'	—	0.0006	0.0013	0.0019	0.0025	0.0032	0.0038	0.0044	0.0051	0.0057
	ρ	0.0077	0.0079	0.0080	0.0082	0.0084	0.0086	0.0087	0.0089	0.0091	0.0093
0.12	ρ'	—	0.0007	0.0014	0.0021	0.0029	0.0036	0.0043	0.0050	0.0057	0.0064
	ρ	0.0077	0.0079	0.0081	0.0082	0.0084	0.0086	0.0088	0.0089	0.0091	0.0093
0.14	ρ'	—	0.0008	0.0016	0.0024	0.0033	0.0041	0.0049	0.0057	0.0065	0.0073
	ρ	0.0077	0.0079	0.0081	0.0082	0.0084	0.0086	0.0088	0.0090	0.0092	0.0093
0.16	ρ'	—	0.0009	0.0019	0.0028	0.0038	0.0047	0.0057	0.0066	0.0076	0.0085
	ρ	0.0077	0.0079	0.0081	0.0083	0.0084	0.0086	0.0088	0.0090	0.0092	0.0094
0.18	ρ'	—	0.0011	0.0022	0.0033	0.0045	0.0056	0.0067	0.0078	0.0089	0.0100
	ρ	0.0077	0.0079	0.0081	0.0083	0.0085	0.0087	0.0088	0.0090	0.0092	0.0094
0.20	ρ'	—	0.0013	0.0027	0.0040	0.0054	0.0067	0.0081	0.0094	0.0108	0.0121
	ρ	0.0077	0.0079	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0093	0.0095
0.22	ρ'	—	0.0017	0.0034	0.0050	0.0067	0.0084	0.0101	0.0118	0.0135	0.0151
	ρ	0.0077	0.0079	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0093	0.0095
0.24	ρ'	—	0.0022	0.0044	0.0066	0.0088	0.0110	0.0132	0.0155	0.0177	0.0199
	ρ	0.0077	0.0079	0.0081	0.0083	0.0085	0.0087	0.0089	0.0091	0.0093	0.0096
0.26	ρ'	—	0.0031	0.0063	0.0094	0.0126	0.0157	0.0188	0.0220	0.0251	0.0283
	ρ	0.0077	0.0079	0.0081	0.0083	0.0085	0.0088	0.0090	0.0092	0.0094	0.0096
0.28	ρ'	—	0.0052	0.0105	0.0157	0.0210	0.0262	0.0315	0.0367	0.0419	0.0472
	ρ	0.0077	0.0079	0.0081	0.0084	0.0086	0.0088	0.0090	0.0092	0.0094	0.0097
0.30	ρ'	—	0.0144	0.0288	0.0431	0.0575	0.0719	0.0863	0.1007	0.1150	0.1294
	ρ	0.0077	0.0079	0.0081	0.0084	0.0086	0.0088	0.0090	0.0093	0.0095	0.0097

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-78b Steel Ratio ρ and ρ' Versus K_f for f'_m = 3500 psi, (Concrete Masonry)

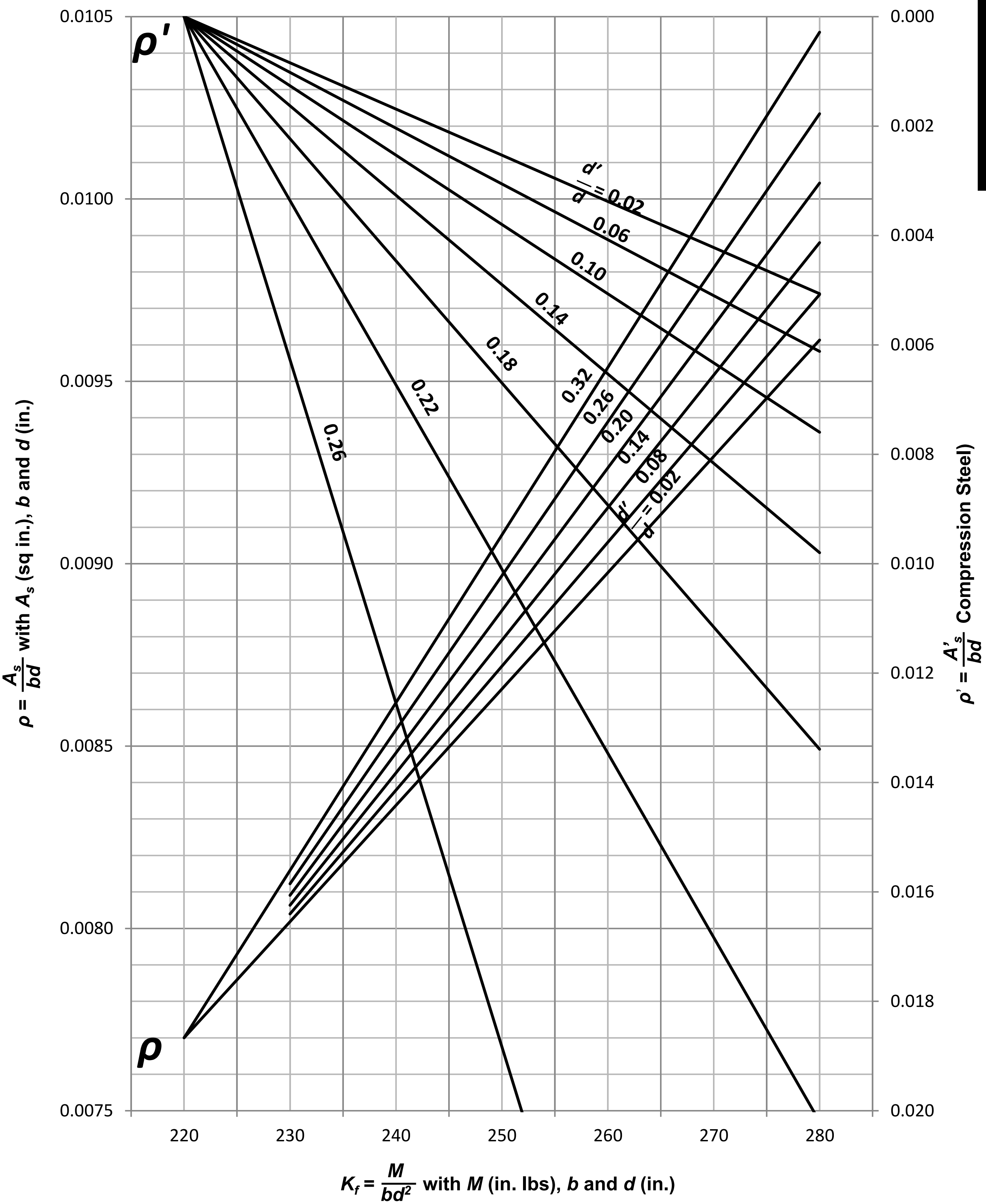


TABLE ASD-79a Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Clay Masonry) f'_m = 4000 psi, F_s = 32,000 psi, and n = 10.4

DESIGN DATA

f'_m = 4000 psi f_y = 60,000 psi

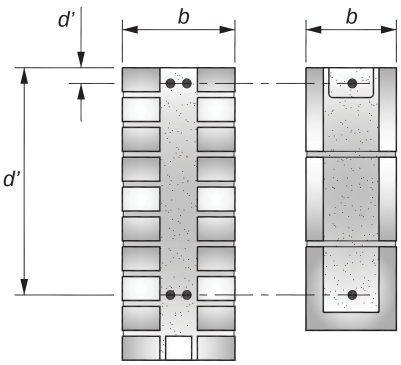
f_b = 1800 psi F_s = 32,000 psi

E_m = 2,800,000 psi

E_s = 29,000,000 psi

n = 10.4 k = 0.368

K_{fb} = 290.7 ρ_b = 0.0104



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	290.7	295	300	305	310	315	320	325	330	335
0.02	ρ'	—	0.0003	0.0006	0.0009	0.0012	0.0015	0.0019	0.0022	0.0025	0.0028
	ρ	0.0104	0.0105	0.0107	0.0109	0.0110	0.0112	0.0113	0.0115	0.0117	0.0118
0.04	ρ'	—	0.0003	0.0006	0.0010	0.0013	0.0017	0.0020	0.0024	0.0027	0.0031
	ρ	0.0104	0.0105	0.0107	0.0109	0.0110	0.0112	0.0114	0.0115	0.0117	0.0118
0.06	ρ'	—	0.0003	0.0007	0.0011	0.0014	0.0018	0.0022	0.0026	0.0030	0.0033
	ρ	0.0104	0.0105	0.0107	0.0109	0.0110	0.0112	0.0114	0.0115	0.0117	0.0119
0.08	ρ'	—	0.0004	0.0008	0.0012	0.0016	0.0020	0.0024	0.0028	0.0032	0.0036
	ρ	0.0104	0.0105	0.0107	0.0109	0.0111	0.0112	0.0114	0.0116	0.0117	0.0119
0.10	ρ'	—	0.0004	0.0008	0.0013	0.0017	0.0022	0.0026	0.0031	0.0035	0.0040
	ρ	0.0104	0.0105	0.0107	0.0109	0.0111	0.0112	0.0114	0.0116	0.0118	0.0119
0.12	ρ'	—	0.0004	0.0009	0.0014	0.0019	0.0024	0.0029	0.0034	0.0039	0.0044
	ρ	0.0104	0.0106	0.0107	0.0109	0.0111	0.0113	0.0114	0.0116	0.0118	0.0120
0.14	ρ'	—	0.0005	0.0010	0.0016	0.0021	0.0027	0.0032	0.0038	0.0044	0.0049
	ρ	0.0104	0.0106	0.0107	0.0109	0.0111	0.0113	0.0115	0.0116	0.0118	0.0120
0.16	ρ'	—	0.0005	0.0012	0.0018	0.0024	0.0030	0.0036	0.0043	0.0049	0.0055
	ρ	0.0104	0.0106	0.0107	0.0109	0.0111	0.0113	0.0115	0.0117	0.0119	0.0120
0.18	ρ'	—	0.0006	0.0013	0.0020	0.0027	0.0034	0.0041	0.0048	0.0055	0.0062
	ρ	0.0104	0.0106	0.0108	0.0109	0.0111	0.0113	0.0115	0.0117	0.0119	0.0121
0.20	ρ'	—	0.0007	0.0015	0.0023	0.0031	0.0039	0.0047	0.0056	0.0064	0.0072
	ρ	0.0104	0.0106	0.0108	0.0110	0.0112	0.0113	0.0115	0.0117	0.0119	0.0121
0.22	ρ'	—	0.0008	0.0018	0.0027	0.0036	0.0046	0.0055	0.0065	0.0074	0.0083
	ρ	0.0104	0.0106	0.0108	0.0110	0.0112	0.0114	0.0116	0.0118	0.0120	0.0122
0.24	ρ'	—	0.0010	0.0021	0.0032	0.0043	0.0054	0.0066	0.0077	0.0088	0.0099
	ρ	0.0104	0.0106	0.0108	0.0110	0.0112	0.0114	0.0116	0.0118	0.0120	0.0122
0.26	ρ'	—	0.0012	0.0025	0.0039	0.0053	0.0066	0.0080	0.0093	0.0107	0.0121
	ρ	0.0104	0.0106	0.0108	0.0110	0.0112	0.0114	0.0116	0.0118	0.0121	0.0123
0.28	ρ'	—	0.0015	0.0032	0.0049	0.0066	0.0083	0.0101	0.0118	0.0135	0.0152
	ρ	0.0104	0.0106	0.0108	0.0110	0.0112	0.0115	0.0117	0.0119	0.0121	0.0123
0.30	ρ'	—	0.0020	0.0042	0.0065	0.0088	0.0111	0.0134	0.0157	0.0180	0.0202
	ρ	0.0104	0.0106	0.0108	0.0110	0.0113	0.0115	0.0117	0.0119	0.0122	0.0124

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-79a Steel Ratio ρ and ρ' Versus K_f for f'_m = 4000 psi, (Clay Masonry)

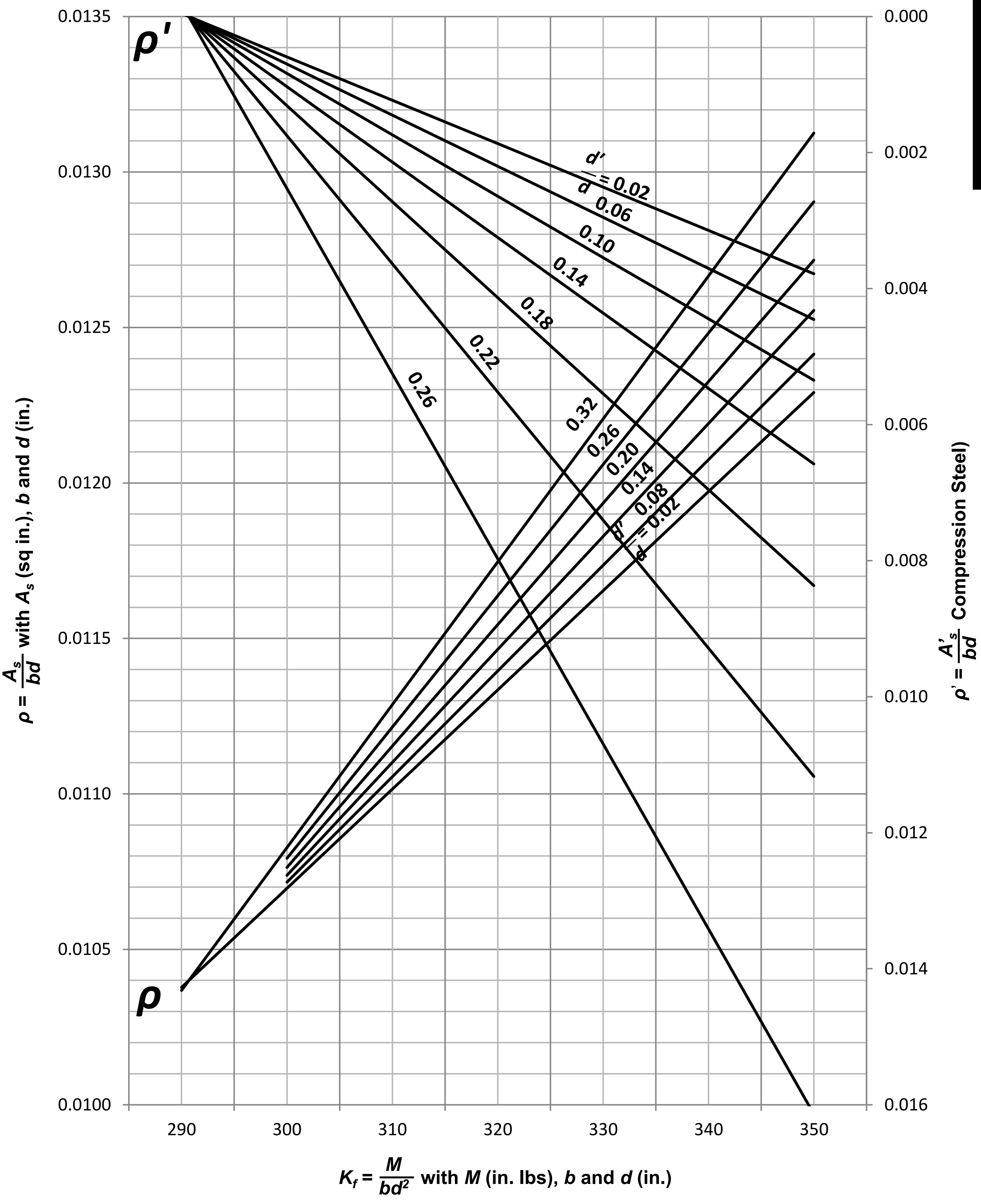


TABLE ASD-79b Coefficients ρ and ρ' for Tension and Compression Steel in a Flexural Member (Concrete Masonry) f'_m = 4000 psi, F_s = 32,000 psi, and n = 8.1

DESIGN DATA

f'_m = 4000 psi f_y = 60,000 psi

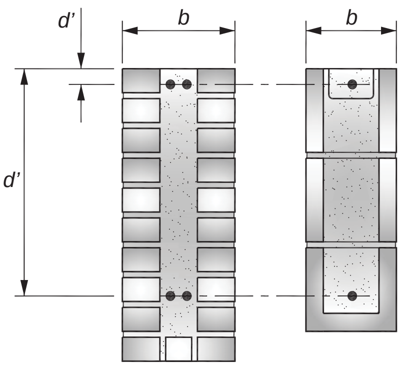
f_b = 1800 psi F_s = 32,000 psi

E_m = 3,600,000 psi

E_s = 29,000,000 psi

n = 8.1 k = 0.312

K_{fb} = 251.5 ρ_b = 0.0088



DESIGN EQUATIONS

$$K_f = \frac{M}{F} = \frac{M\,(\text{ft kips})}{bd^2/12{,}000} \text{ or } \frac{M\ (\text{in. lbs})}{bd^2}$$

$$\rho = \rho_b + \frac{K_f - K_{fb}}{F_s\left(1 - {d'}/{d}\right)}$$

$$\rho' = \frac{K_f - K_{fb}}{(n-1)\left[\frac{k - {d'}/{d}}{k}\right]\left[1 - \frac{d'}{d}\right]2F_b}$$

d'/d [a]	Steel Ratio	K_{fb}	K_f								
	ρ', ρ	251.5	255	260	265	270	275	280	285	290	295
0.02	ρ'	—	0.0003	0.0007	0.0012	0.0016	0.0020	0.0024	0.0029	0.0033	0.0037
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0092**	**0.0094**	**0.0095**	**0.0097**	**0.0099**	**0.0100**	**0.0102**
0.04	ρ'	—	0.0003	0.0008	0.0013	0.0017	0.0022	0.0027	0.0031	0.0036	0.0041
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0092**	**0.0094**	**0.0096**	**0.0097**	**0.0099**	**0.0101**	**0.0102**
0.06	ρ'	—	0.0004	0.0009	0.0014	0.0019	0.0024	0.0029	0.0035	0.0040	0.0045
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0092**	**0.0094**	**0.0096**	**0.0097**	**0.0099**	**0.0101**	**0.0102**
0.08	ρ'	—	0.0004	0.0010	0.0015	0.0021	0.0027	0.0033	0.0038	0.0044	0.0050
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0094**	**0.0096**	**0.0098**	**0.0099**	**0.0101**	**0.0103**
0.10	ρ'	—	0.0004	0.0011	0.0017	0.0024	0.0030	0.0036	0.0043	0.0049	0.0056
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0094**	**0.0096**	**0.0098**	**0.0100**	**0.0101**	**0.0103**
0.12	ρ'	—	0.0005	0.0012	0.0020	0.0027	0.0034	0.0041	0.0048	0.0056	0.0063
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0096**	**0.0098**	**0.0100**	**0.0102**	**0.0103**
0.14	ρ'	—	0.0006	0.0014	0.0022	0.0031	0.0039	0.0047	0.0055	0.0064	0.0072
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0097**	**0.0098**	**0.0100**	**0.0102**	**0.0104**
0.16	ρ'	—	0.0007	0.0016	0.0026	0.0035	0.0045	0.0054	0.0064	0.0074	0.0083
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0097**	**0.0099**	**0.0100**	**0.0102**	**0.0104**
0.18	ρ'	—	0.0008	0.0019	0.0030	0.0042	0.0053	0.0064	0.0076	0.0087	0.0098
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0097**	**0.0099**	**0.0101**	**0.0103**	**0.0105**
0.20	ρ'	—	0.0010	0.0023	0.0037	0.0050	0.0064	0.0078	0.0091	0.0105	0.0119
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0097**	**0.0099**	**0.0101**	**0.0103**	**0.0105**
0.22	ρ'	—	0.0012	0.0029	0.0046	0.0063	0.0080	0.0097	0.0114	0.0131	0.0148
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0093**	**0.0095**	**0.0097**	**0.0099**	**0.0101**	**0.0103**	**0.0105**
0.24	ρ'	—	0.0016	0.0038	0.0060	0.0083	0.0105	0.0127	0.0149	0.0172	0.0194
	ρ	**0.0088**	**0.0089**	**0.0091**	**0.0094**	**0.0096**	**0.0098**	**0.0100**	**0.0102**	**0.0104**	**0.0106**
0.26	ρ'	—	0.0022	0.0054	0.0086	0.0117	0.0149	0.0181	0.0213	0.0244	0.0276
	ρ	**0.0088**	**0.0089**	**0.0092**	**0.0094**	**0.0096**	**0.0098**	**0.0100**	**0.0102**	**0.0104**	**0.0106**
0.28	ρ'	—	0.0037	0.0090	0.0143	0.0196	0.0249	0.0302	0.0355	0.0408	0.0461
	ρ	**0.0088**	**0.0090**	**0.0092**	**0.0094**	**0.0096**	**0.0098**	**0.0100**	**0.0103**	**0.0105**	**0.0107**
0.30	ρ'	—	0.0102	0.0247	0.0392	0.0538	0.0683	0.0828	0.0974	0.1119	0.1264
	ρ	**0.0088**	**0.0090**	**0.0092**	**0.0094**	**0.0096**	**0.0098**	**0.0101**	**0.0103**	**0.0105**	**0.0107**

[a] For d'/d values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-79b Steel Ratio ρ and ρ' Versus K_f for f'_m = 4000 psi, (Concrete Masonry)