

**Masonry Institute of America**  
Reinforced Masonry Engineering Handbook, 8<sup>th</sup> ed.  
Errata  
Issue Date: July 31, 2017  
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### 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       |  |  |  | <ul style="list-style-type: none"> <li>Grout slump between 10 and 11 inches</li> <li>Grout spread (flow) between 24 and 30 in.</li> </ul> |

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 <b>Concrete</b> Masonry <sup>1</sup> , (psi) | Net Area Compressive Strength of <del>Clay</del> <b>Concrete</b> Masonry Units (psi) |               |
|---|--|---------------|
|   | 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.

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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.

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

|                |  |
|----------------|--|
| <b>Step 3:</b> | Determine wind load parameters:<br><br>Exposure Category B, C or D, see<br><b>Section 3.8.1.3.1.</b> |
|----------------|--|

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

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$$C_w = \frac{100}{A_B} \sum_{i=1}^x \left( \frac{h_n}{h_i} \right)^2 \left[ \frac{A_i}{1 + 0.83 \left( \frac{h_i}{D_i} \right)^2} \right] \quad C_w = \frac{100}{A_B} \sum_{i=1}^x \frac{A_i}{\left[ 1 + 0.83 \left( \frac{h_n}{D_i} \right)^2 \right]} \quad \text{ASCE Eq 12.8-10}$$

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

Errata Continued on Next Page

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

| Architectural Component   | $a_p^1$ | $R_p$ | $\Omega_0^3$ |
|---|---------|-------|--------------|
| Interior Nonstructural Walls and Partitions <sup>2</sup>                              |         |       |              |
| Plain (unreinforced) masonry walls  | 1       | 1½    | 1½           |
| All other walls and partitions  | 1       | 2½    | 2            |
| Cantilever Elements (Unbraced or braced to structural frame below its center of mass) |         |       |              |
| Parapets and cantilever interior nonstructural walls                                  | 2½      | 2½    | 2            |
| Chimneys where laterally braced or supported by the structural frame                  | 2½      | 2½    | 2            |
| Cantilever Elements (Braced to structural frame above its center of mass)             |         |       |              |
| Parapets  | 1       | 2½    | 2            |
| Chimneys  | 1       | 2½    | 2            |
| Exterior Nonstructural Walls <sup>2</sup>   | 1²      | 2½    | 2            |
| Exterior Nonstructural Wall Elements and Connections <sup>2</sup>                     |         |       |              |
| Wall Element  | 1       | 2½    | NA           |
| Body of wall panel connections  | 1       | 2½    | NA           |
| Fasteners of the connecting system  | 1¼      | 1     | 1            |
| Veneer  |         |       |              |
| Limited deformability elements and attachments  | 1       | 2½    | 2            |
| Low deformability elements and attachments  | 1       | 1½    | 2            |

<sup>1</sup> 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  $a_p = 2½$  is for flexible components and flexibly attached components. See ASCE 7 Section 11.2 for definitions of rigid and flexible.

<sup>2</sup> 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.

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

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

| Floor Level | $h$ | $\Sigma h_{above}$ | $d$ | $h/d$ | $\Delta_{top-of-wall}$<br>due to<br>transition of<br>this level | $\Delta_{top-of-wall}$<br>due to<br>rotation of<br>this level | Total<br>$\Delta_{top-of-wall}$<br>due to this<br>level | Correction | Actual<br>$\Delta_{top-of-wall}$<br>due to this<br>level |
|-------------|-----|--------------------|-----|-------|---|---|---|------------|--|
| 4           | 10  |                    | 30  | 0.333 | 0.115   | 0.000   | 0.115   | 0.0971     | 0.014  |
| 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  |

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

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

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

Replace with

| Floor Level | $h$ | $\Sigma h_{above}$ | $d$ | $h/d$ | $\Delta_{top\ of\ wall\ due\ to\ transition\ of\ this\ level}$ | $\Delta_{top\ of\ wall\ due\ to\ rotation\ of\ this\ level}$ | 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 | $h$ | $\Sigma h_{above}$ | $d$ | $h/d$ | $\Delta_{top\ of\ wall\ due\ to\ transition\ of\ this\ level}$ | $\Delta_{top\ of\ wall\ due\ to\ rotation\ of\ this\ level}$ | 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 | $h$ | $\Sigma h_{above}$ | $d$ | $h/d$ | $\Delta_{top\ of\ wall\ due\ to\ transition\ of\ this\ level}$ | $\Delta_{top\ of\ wall\ due\ to\ rotation\ of\ this\ level}$ | 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   |

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

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

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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  $0.2S_{DS}I_eW_{px}$  and a maximum value of  $0.4S_{DS}I_eW_{px}$ , where  $w_{px}$  represents the weight of the diaphragm and attached components.

Page 122 – Bottom of page – Change in Red

$$\Sigma R_x = 13.7 \text{ should be } \Sigma R_y = 13.7$$

Page 128 – Revision in Red

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| ASCE 7 Table 12.3-1 Horizontal Structural Irregularities |   |  |   |
|--|---|--|---|
| Type   | Description   | Reference Section  | Seismic Design Category Application   |
| 1b.  | <b>Extreme Torsional Irregularity:</b> 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<br>12.3.3.4<br>12.7.3<br>12.8.4.3<br>12.12.1<br>Table 12.6-1<br>Sec. 16.2.2<br><b>Sec. 12.3.4.2</b> | E and F<br>D<br>B, C and D<br>C and D<br>C and D<br>D<br>B, C and D<br><b>D</b> |

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| ASCE 7 Table 12.3-2 Vertical Structural Irregularities |  |                                      |   |
|--|--|--------------------------------------|---|
| Type   | Description  | Reference Section                    | Seismic Design Category Application             |
| 4.   | <b>In-Plane Discontinuity in Vertical Lateral Force-Resisting Element Irregularity:</b> 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 <b>structural elements</b> . | 12.3.3.3<br>12.3.3.4<br>Table 12.6-1 | B, C, D, E, and F<br>D, E, and F<br>D, E, and F |

Page 173 – Bottom of page – first column

$$\text{Equation } \cancel{M_{3,s} = P_{3,s} \left( \frac{h}{2} - d_1 \right) = 3.4 \left( 2.5 \frac{15.625}{2} \right)} \quad \text{should be } M_{3,s} = -P_{3,s} \left( \frac{h}{2} - d_1 \right) = -3.4 \left( \frac{15.625}{2} - 2.5 \right) = -1.5 \text{ k - ft}$$

Page 185 – Top of page

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

Page 194 – Solution 5-V

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

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

5. Determine whether shear reinforcement is required:

Determine whether shear reinforcement is required:

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

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

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

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

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

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

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

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

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

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

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

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

*Change in Red*

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

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

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

*Errata Continued on Next Page*

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

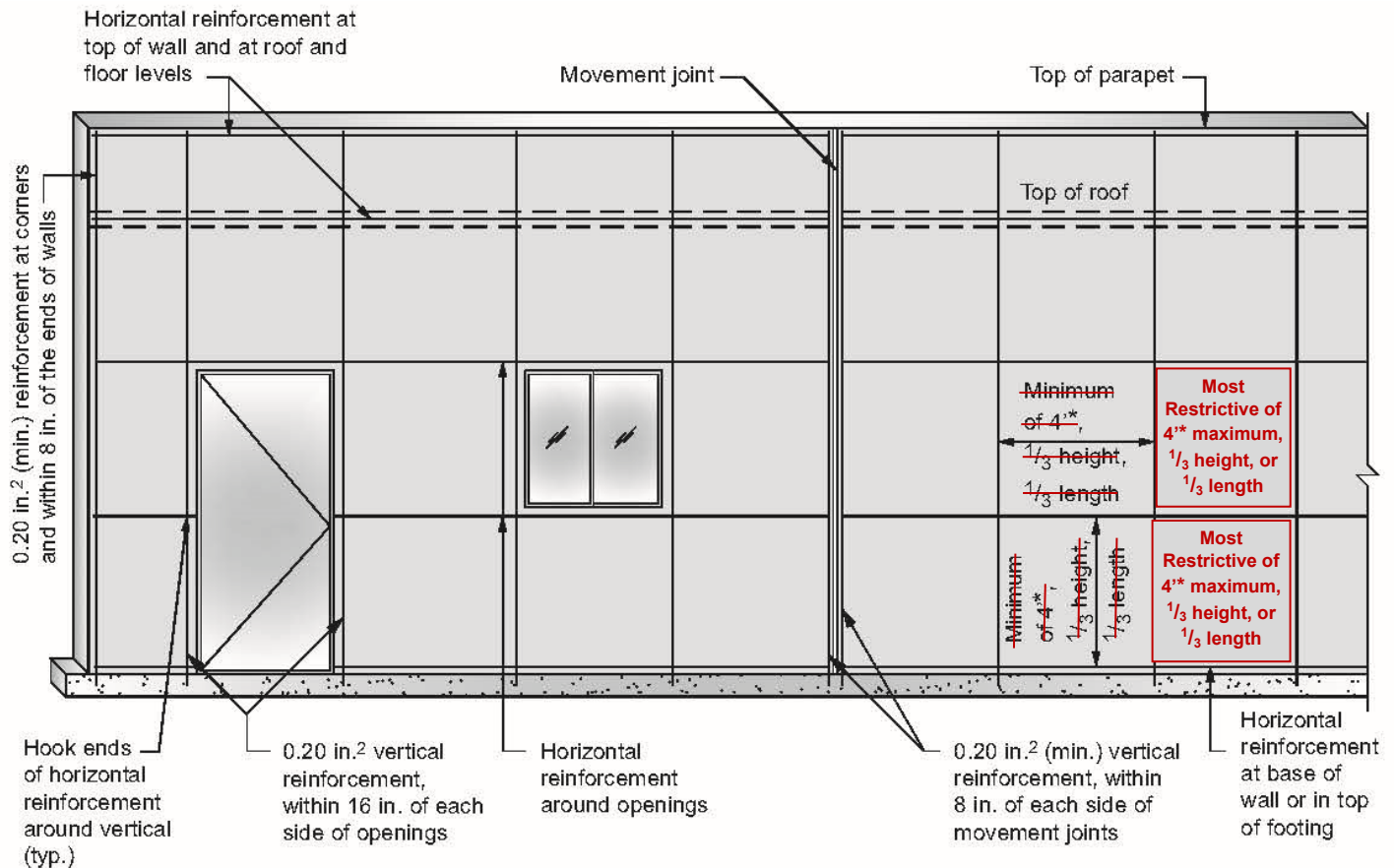
|  |  |                              |  |  |
|--|--|------------------------------|--|--|
| Parallel to bed joints in running bond |  |                              |  |  |
| Solid units                            |  | 200 (1,379)                  |  |  |
| Hollow units                           |  |                              |  |  |
| UngROUTED and partially grouted        |  | 127 ( <del>655</del> ) (873) |  |  |
| Fully grouted                          |  | 200 (1,379)                  |  |  |

#### 4. Determine whether shear reinforcement is required

Using Tables SD-26 and SD-27, find

$$\phi V_{nm} = 0.8 (129) = 103 \text{ psi} > 67.4 \text{ psi OK.}$$

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.<sup>2</sup> of bond beam reinforcement spaced at 120 in. on center maximum.

**FIGURE 7.37** Minimum reinforcement for special reinforced masonry shear walls.

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*Page 372 – Revise*

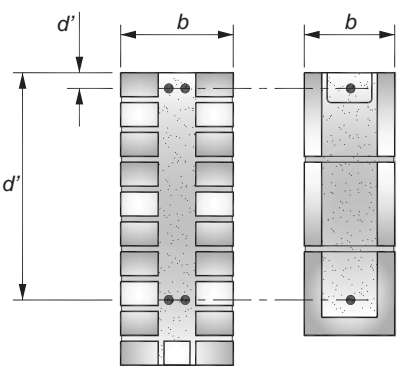
$$k_t = 0.000004, \text{ in./in./}^\circ\text{F (mm/mm/}^\circ\text{C)}$$

*Pages 538 through 561*

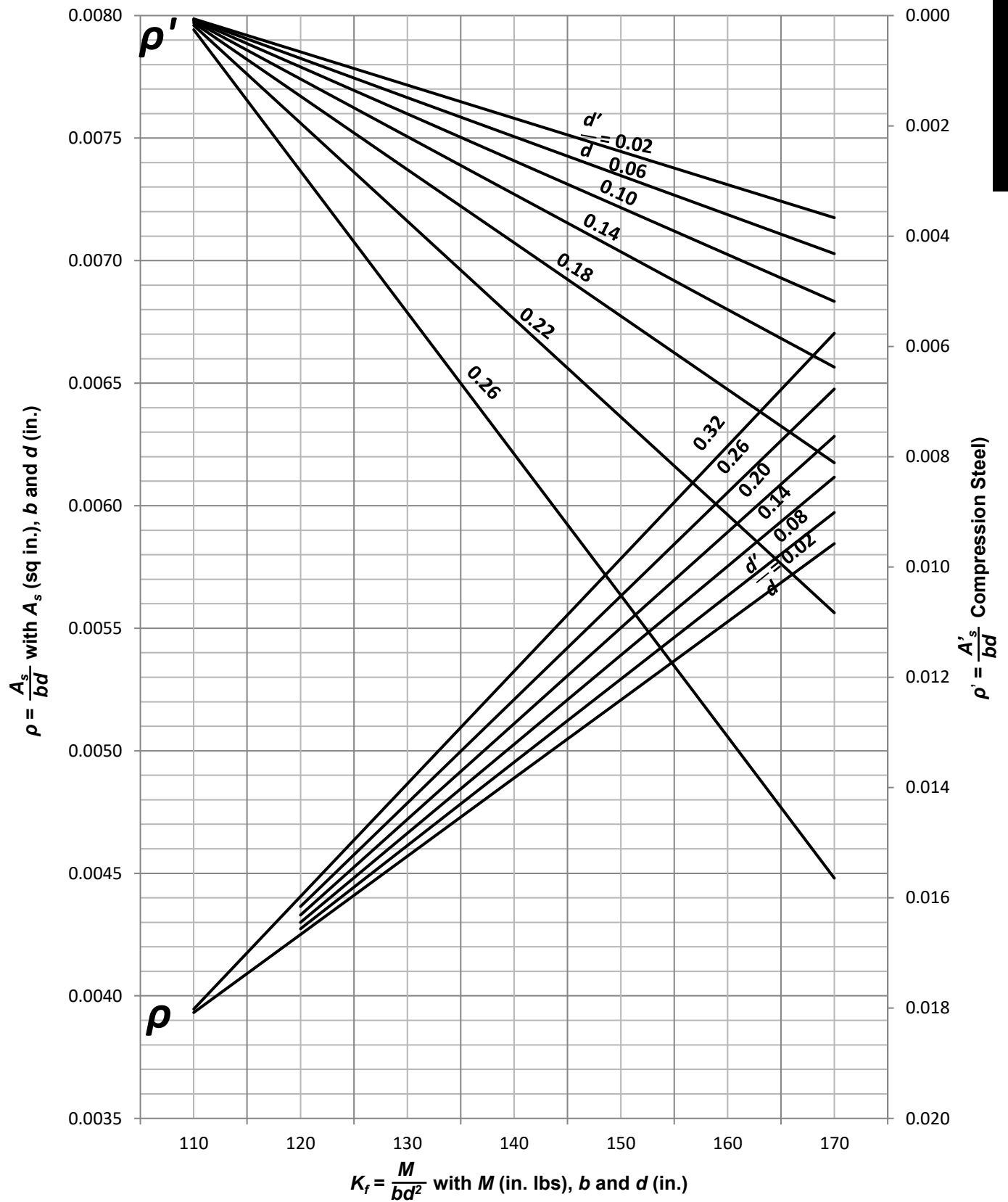
*Tables ASD-74a through ASD-79b were updated to reflect changed  $K_f$  values for compression reinforcement. The values for tension reinforcement, which is most common, remain the same. Associated Diagrams were also updated to reflect revised  $K_f$  values for compression reinforcement.*

***Errata Continued on Next Page***

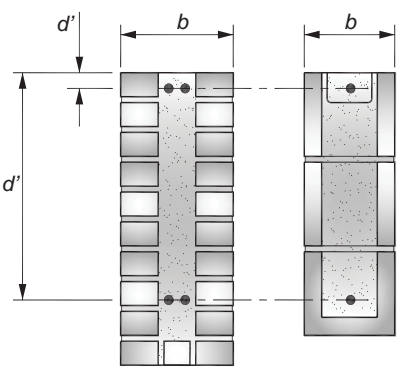
**TABLE ASD-74a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 1500$  psi,  $F_s = 32,000$  psi, and  $n = 27.6$** 

| DESIGN DATA   |               |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|---|---------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 1500$ psi $f_y = 60,000$ psi<br>$f_b = 675$ psi $F_s = 32,000$ psi<br>$E_m = 1,050,000$ psi<br>$E_s = 29,000,000$ psi<br>$n = 27.6$ $k = 0.368$<br>$K_{fb} = 109.0$ $\rho_b = 0.0039$ |               |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $d'/d^a$  | Steel Ratio   | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|   | $\rho', \rho$ | 109.0    | 115   | 120    | 125    | 130    | 135    | 140    | 145    | 150    | 155    |
| 0.02  | $\rho'$       | —        | 0.0004  | 0.0007 | 0.0010 | 0.0013 | 0.0016 | 0.0019 | 0.0022 | 0.0025 | 0.0028 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0044 | 0.0046 | 0.0047 | 0.0049 | 0.0050 | 0.0052 | 0.0054 |
| 0.04  | $\rho'$       | —        | 0.0004  | 0.0007 | 0.0010 | 0.0014 | 0.0017 | 0.0020 | 0.0023 | 0.0027 | 0.0030 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0044 | 0.0046 | 0.0047 | 0.0049 | 0.0051 | 0.0052 | 0.0054 |
| 0.06  | $\rho'$       | —        | 0.0004  | 0.0008 | 0.0011 | 0.0015 | 0.0018 | 0.0022 | 0.0025 | 0.0029 | 0.0033 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0044 | 0.0046 | 0.0048 | 0.0049 | 0.0051 | 0.0053 | 0.0054 |
| 0.08  | $\rho'$       | —        | 0.0005  | 0.0009 | 0.0012 | 0.0016 | 0.0020 | 0.0024 | 0.0028 | 0.0032 | 0.0036 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0051 | 0.0053 | 0.0055 |
| 0.10  | $\rho'$       | —        | 0.0005  | 0.0009 | 0.0014 | 0.0018 | 0.0022 | 0.0026 | 0.0031 | 0.0035 | 0.0039 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0053 | 0.0055 |
| 0.12  | $\rho'$       | —        | 0.0006  | 0.0010 | 0.0015 | 0.0020 | 0.0024 | 0.0029 | 0.0034 | 0.0039 | 0.0043 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0055 |
| 0.14  | $\rho'$       | —        | 0.0006  | 0.0011 | 0.0017 | 0.0022 | 0.0027 | 0.0032 | 0.0038 | 0.0043 | 0.0048 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0047 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 |
| 0.16  | $\rho'$       | —        | 0.0007  | 0.0013 | 0.0019 | 0.0025 | 0.0030 | 0.0036 | 0.0042 | 0.0048 | 0.0054 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0052 | 0.0054 | 0.0056 |
| 0.18  | $\rho'$       | —        | 0.0008  | 0.0015 | 0.0021 | 0.0028 | 0.0035 | 0.0041 | 0.0048 | 0.0055 | 0.0061 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 |
| 0.20  | $\rho'$       | —        | 0.0009  | 0.0017 | 0.0024 | 0.0032 | 0.0040 | 0.0047 | 0.0055 | 0.0063 | 0.0070 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 |
| 0.22  | $\rho'$       | —        | 0.0011  | 0.0020 | 0.0028 | 0.0037 | 0.0046 | 0.0055 | 0.0064 | 0.0073 | 0.0082 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 |
| 0.24  | $\rho'$       | —        | 0.0013  | 0.0023 | 0.0034 | 0.0044 | 0.0055 | 0.0065 | 0.0076 | 0.0086 | 0.0097 |
|   | $\rho$        | 0.0039   | 0.0041  | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 | 0.0058 |
| 0.26  | $\rho'$       | —        | 0.0015  | 0.0028 | 0.0041 | 0.0054 | 0.0067 | 0.0080 | 0.0092 | 0.0105 | 0.0118 |
|   | $\rho$        | 0.0039   | 0.0042  | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 | 0.0058 |
| 0.28  | $\rho'$       | —        | 0.0019  | 0.0036 | 0.0052 | 0.0068 | 0.0084 | 0.0100 | 0.0116 | 0.0133 | 0.0149 |
|   | $\rho$        | 0.0039   | 0.0042  | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0055 | 0.0057 | 0.0059 |
| 0.30  | $\rho'$       | —        | 0.0026  | 0.0047 | 0.0069 | 0.0090 | 0.0112 | 0.0133 | 0.0155 | 0.0177 | 0.0198 |
|   | $\rho$        | 0.0039   | 0.0042  | 0.0044 | 0.0046 | 0.0048 | 0.0051 | 0.0053 | 0.0055 | 0.0057 | 0.0060 |

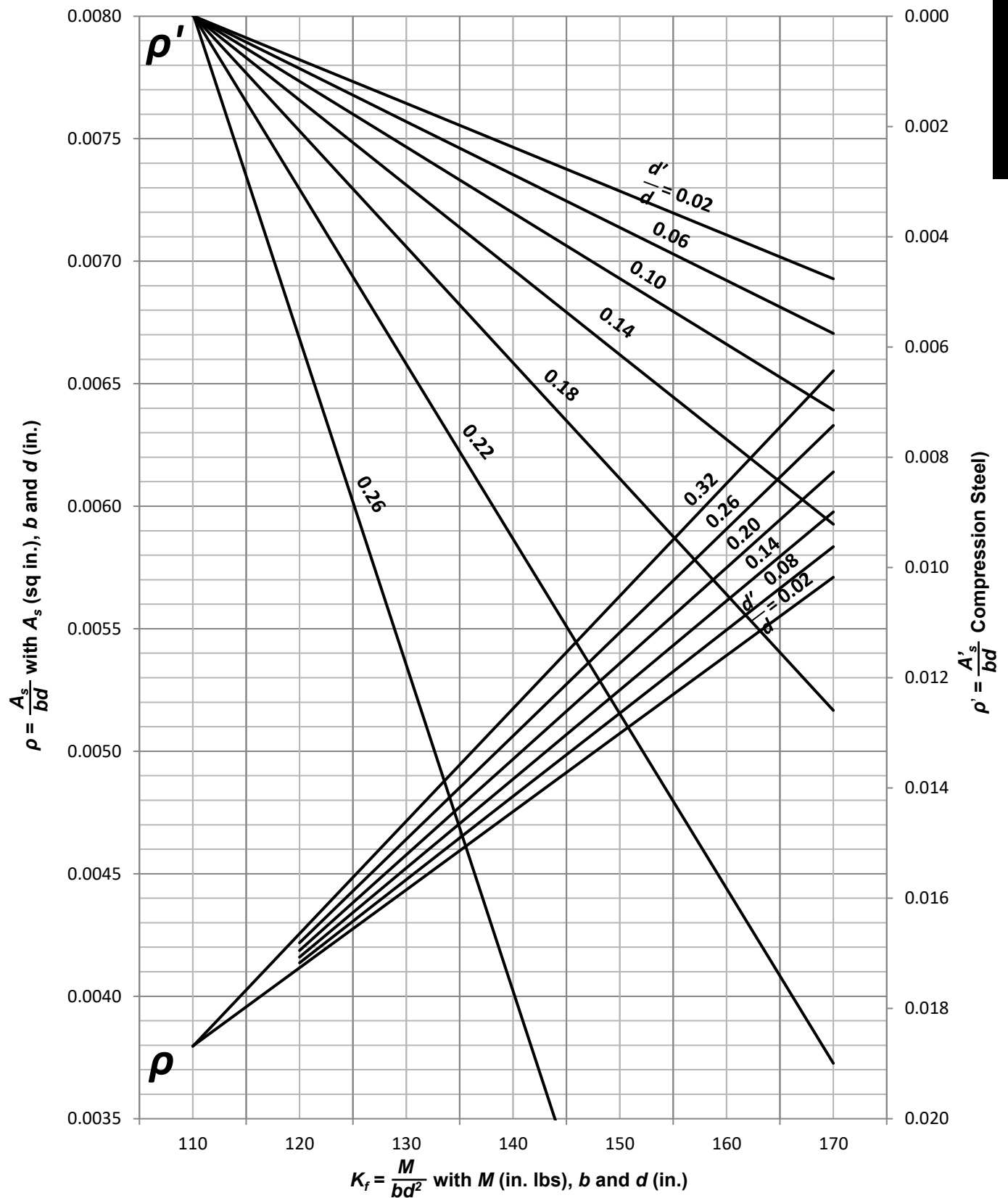
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

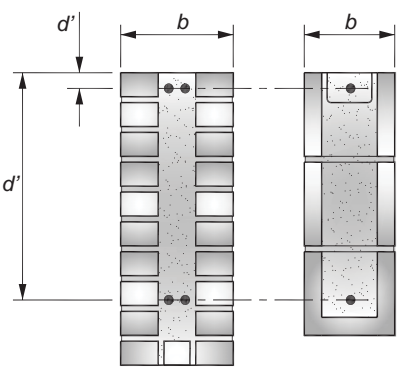
**TABLE ASD-74b Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Concrete Masonry)  $f'_m = 1750$  psi,  $F_s = 32,000$  psi, and  $n = 18.4$** 

| DESIGN DATA   |               |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|---|---------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 1750$ psi $f_y = 60,000$ psi<br>$f_b = 788$ psi $F_s = 32,000$ psi<br>$E_m = 1,575,000$ psi<br>$E_s = 29,000,000$ psi<br>$n = 18.4$ $k = 0.312$<br>$K_{fb} = 110.1$ $\rho_b = 0.0038$ |               |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n-1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $d'/d^a$  | Steel Ratio   | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|   | $\rho', \rho$ | 110.1    | 115   | 120    | 125    | 130    | 135    | 140    | 145    | 150    | 155    |
| 0.02  | $\rho'$       | —        | 0.0004  | 0.0008 | 0.0012 | 0.0016 | 0.0020 | 0.0024 | 0.0028 | 0.0032 | 0.0036 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0041 | 0.0043 | 0.0044 | 0.0046 | 0.0048 | 0.0049 | 0.0051 | 0.0052 |
| 0.04  | $\rho'$       | —        | 0.0004  | 0.0009 | 0.0013 | 0.0017 | 0.0022 | 0.0026 | 0.0030 | 0.0035 | 0.0039 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0041 | 0.0043 | 0.0044 | 0.0046 | 0.0048 | 0.0049 | 0.0051 | 0.0053 |
| 0.06  | $\rho'$       | —        | 0.0005  | 0.0010 | 0.0014 | 0.0019 | 0.0024 | 0.0029 | 0.0034 | 0.0038 | 0.0043 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0041 | 0.0043 | 0.0045 | 0.0046 | 0.0048 | 0.0050 | 0.0051 | 0.0053 |
| 0.08  | $\rho'$       | —        | 0.0005  | 0.0011 | 0.0016 | 0.0021 | 0.0027 | 0.0032 | 0.0037 | 0.0043 | 0.0048 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0041 | 0.0043 | 0.0045 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0053 |
| 0.10  | $\rho'$       | —        | 0.0006  | 0.0012 | 0.0018 | 0.0024 | 0.0030 | 0.0036 | 0.0042 | 0.0048 | 0.0054 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0041 | 0.0043 | 0.0045 | 0.0047 | 0.0048 | 0.0050 | 0.0052 | 0.0054 |
| 0.12  | $\rho'$       | —        | 0.0007  | 0.0013 | 0.0020 | 0.0027 | 0.0034 | 0.0040 | 0.0047 | 0.0054 | 0.0060 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0050 | 0.0052 | 0.0054 |
| 0.14  | $\rho'$       | —        | 0.0008  | 0.0015 | 0.0023 | 0.0031 | 0.0038 | 0.0046 | 0.0054 | 0.0061 | 0.0069 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0043 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0052 | 0.0054 |
| 0.16  | $\rho'$       | —        | 0.0009  | 0.0018 | 0.0027 | 0.0035 | 0.0044 | 0.0053 | 0.0062 | 0.0071 | 0.0080 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 |
| 0.18  | $\rho'$       | —        | 0.0010  | 0.0021 | 0.0031 | 0.0042 | 0.0052 | 0.0063 | 0.0073 | 0.0084 | 0.0094 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0046 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 |
| 0.20  | $\rho'$       | —        | 0.0012  | 0.0025 | 0.0038 | 0.0051 | 0.0063 | 0.0076 | 0.0089 | 0.0101 | 0.0114 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 |
| 0.22  | $\rho'$       | —        | 0.0016  | 0.0031 | 0.0047 | 0.0063 | 0.0079 | 0.0095 | 0.0111 | 0.0127 | 0.0142 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 |
| 0.24  | $\rho'$       | —        | 0.0020  | 0.0041 | 0.0062 | 0.0083 | 0.0104 | 0.0124 | 0.0145 | 0.0166 | 0.0187 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0046 | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 |
| 0.26  | $\rho'$       | —        | 0.0029  | 0.0059 | 0.0088 | 0.0118 | 0.0147 | 0.0177 | 0.0206 | 0.0236 | 0.0265 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0046 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 |
| 0.28  | $\rho'$       | —        | 0.0048  | 0.0098 | 0.0147 | 0.0197 | 0.0246 | 0.0295 | 0.0345 | 0.0394 | 0.0443 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0044 | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 |
| 0.30  | $\rho'$       | —        | 0.0133  | 0.0268 | 0.0404 | 0.0539 | 0.0674 | 0.0810 | 0.0945 | 0.1081 | 0.1216 |
|   | $\rho$        | 0.0038   | 0.0040  | 0.0042 | 0.0045 | 0.0047 | 0.0049 | 0.0051 | 0.0054 | 0.0056 | 0.0058 |

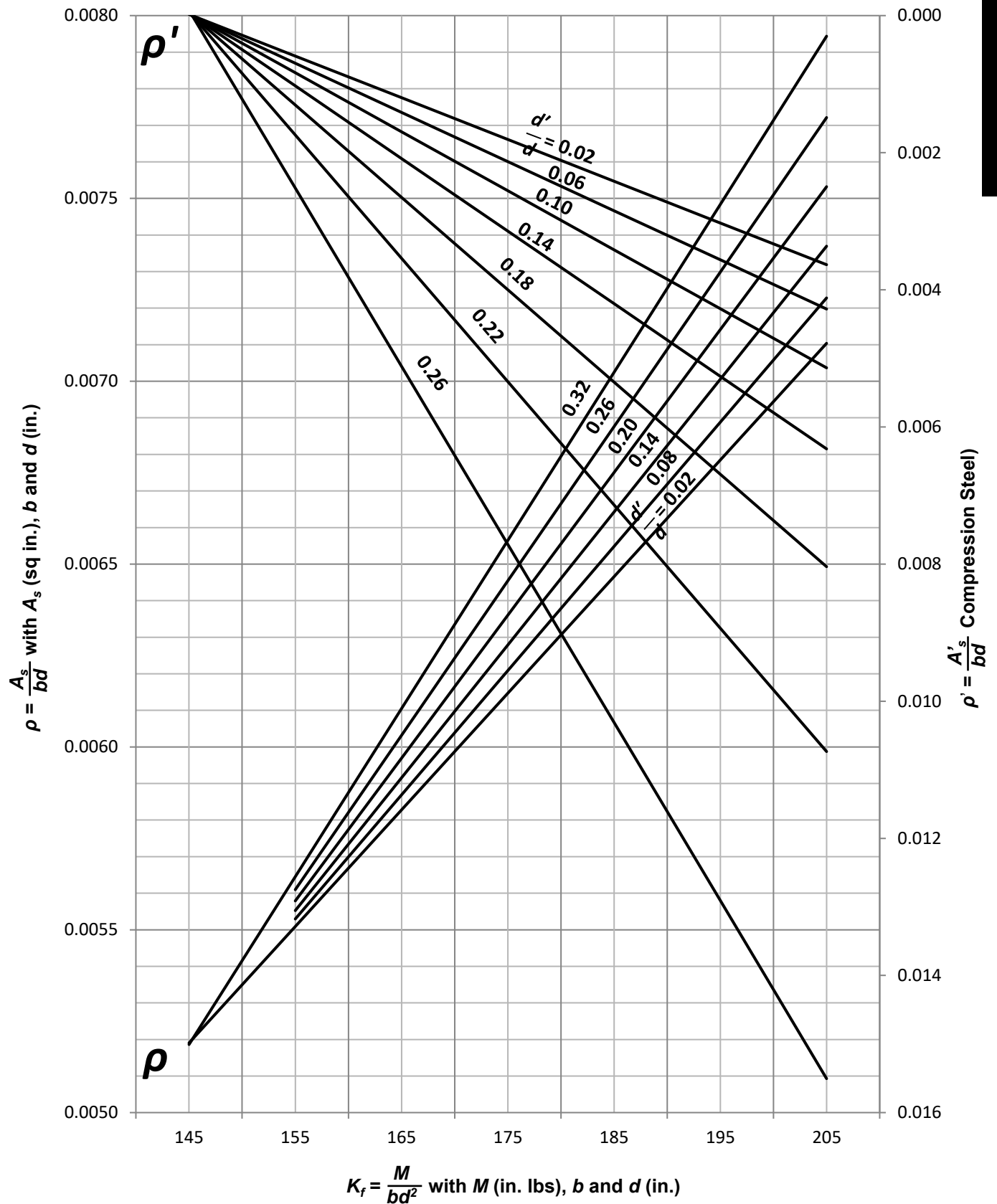
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-74b Steel Ratio  $\rho$  and  $\rho'$  Versus  $K_r$  for  $f'_m = 1750$  psi, (Concrete Masonry)

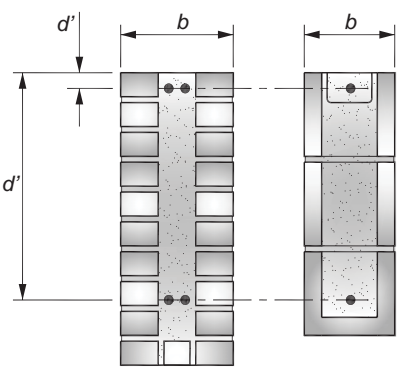
**TABLE ASD-75a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 2000$  psi,  $F_s = 32,000$  psi, and  $n = 20.7$** 

| DESIGN DATA   |               |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|---|---------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 2000$ psi $f_y = 60,000$ psi<br>$f_b = 900$ psi $F_s = 32,000$ psi<br>$E_m = 1,400,000$ psi<br>$E_s = 29,000,000$ psi<br>$n = 20.7$ $k = 0.368$<br>$K_{fb} = 145.3$ $\rho_b = 0.0052$ |               |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n-1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $d'/d^a$  | Steel Ratio   | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|   | $\rho', \rho$ | 145.3    | 150   | 155    | 160    | 165    | 170    | 175    | 180    | 185    | 190    |
| 0.02  | $\rho'$       | —        | 0.0003  | 0.0006 | 0.0009 | 0.0012 | 0.0015 | 0.0018 | 0.0021 | 0.0024 | 0.0027 |
|   | $\rho$        | 0.0052   | 0.0053  | 0.0055 | 0.0057 | 0.0058 | 0.0060 | 0.0061 | 0.0063 | 0.0065 | 0.0066 |
| 0.04  | $\rho'$       | —        | 0.0003  | 0.0006 | 0.0010 | 0.0013 | 0.0016 | 0.0020 | 0.0023 | 0.0026 | 0.0029 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0055 | 0.0057 | 0.0058 | 0.0060 | 0.0062 | 0.0063 | 0.0065 | 0.0067 |
| 0.06  | $\rho'$       | —        | 0.0003  | 0.0007 | 0.0011 | 0.0014 | 0.0018 | 0.0021 | 0.0025 | 0.0028 | 0.0032 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0055 | 0.0057 | 0.0059 | 0.0060 | 0.0062 | 0.0064 | 0.0065 | 0.0067 |
| 0.08  | $\rho'$       | —        | 0.0004  | 0.0008 | 0.0012 | 0.0015 | 0.0019 | 0.0023 | 0.0027 | 0.0031 | 0.0035 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0055 | 0.0057 | 0.0059 | 0.0060 | 0.0062 | 0.0064 | 0.0065 | 0.0067 |
| 0.10  | $\rho'$       | —        | 0.0004  | 0.0008 | 0.0013 | 0.0017 | 0.0021 | 0.0026 | 0.0030 | 0.0034 | 0.0038 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0055 | 0.0057 | 0.0059 | 0.0061 | 0.0062 | 0.0064 | 0.0066 | 0.0068 |
| 0.12  | $\rho'$       | —        | 0.0004  | 0.0009 | 0.0014 | 0.0019 | 0.0023 | 0.0028 | 0.0033 | 0.0038 | 0.0043 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0055 | 0.0057 | 0.0059 | 0.0061 | 0.0063 | 0.0064 | 0.0066 | 0.0068 |
| 0.14  | $\rho'$       | —        | 0.0005  | 0.0010 | 0.0016 | 0.0021 | 0.0026 | 0.0031 | 0.0037 | 0.0042 | 0.0047 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0057 | 0.0059 | 0.0061 | 0.0063 | 0.0065 | 0.0066 | 0.0068 |
| 0.16  | $\rho'$       | —        | 0.0006  | 0.0012 | 0.0017 | 0.0023 | 0.0029 | 0.0035 | 0.0041 | 0.0047 | 0.0053 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0057 | 0.0059 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0069 |
| 0.18  | $\rho'$       | —        | 0.0006  | 0.0013 | 0.0020 | 0.0027 | 0.0033 | 0.0040 | 0.0047 | 0.0053 | 0.0060 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0060 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0069 |
| 0.20  | $\rho'$       | —        | 0.0007  | 0.0015 | 0.0023 | 0.0030 | 0.0038 | 0.0046 | 0.0054 | 0.0061 | 0.0069 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0069 |
| 0.22  | $\rho'$       | —        | 0.0008  | 0.0017 | 0.0026 | 0.0035 | 0.0044 | 0.0053 | 0.0062 | 0.0071 | 0.0080 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0070 |
| 0.24  | $\rho'$       | —        | 0.0010  | 0.0021 | 0.0031 | 0.0042 | 0.0053 | 0.0063 | 0.0074 | 0.0085 | 0.0095 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0070 |
| 0.26  | $\rho'$       | —        | 0.0012  | 0.0025 | 0.0038 | 0.0051 | 0.0064 | 0.0077 | 0.0090 | 0.0103 | 0.0116 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0060 | 0.0062 | 0.0065 | 0.0067 | 0.0069 | 0.0071 |
| 0.28  | $\rho'$       | —        | 0.0015  | 0.0032 | 0.0048 | 0.0065 | 0.0081 | 0.0097 | 0.0114 | 0.0130 | 0.0146 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0058 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0069 | 0.0071 |
| 0.30  | $\rho'$       | —        | 0.0020  | 0.0042 | 0.0064 | 0.0086 | 0.0108 | 0.0130 | 0.0151 | 0.0173 | 0.0195 |
|   | $\rho$        | 0.0052   | 0.0054  | 0.0056 | 0.0059 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0070 | 0.0072 |

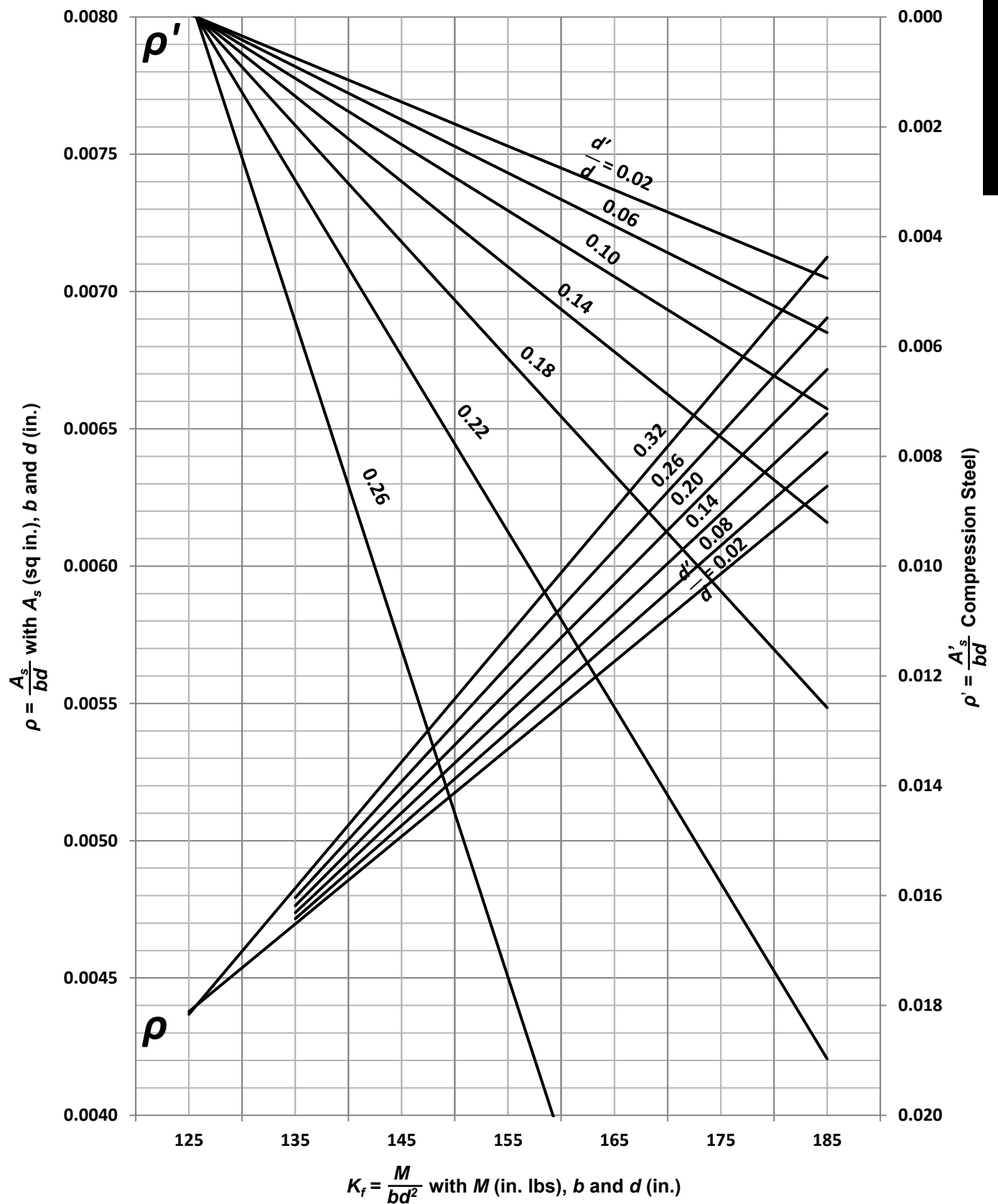
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-75a Steel Ratio  $\rho$  and  $\rho'$  Versus  $K_r$  for  $f'_m = 2000$  psi, (Clay Masonry)

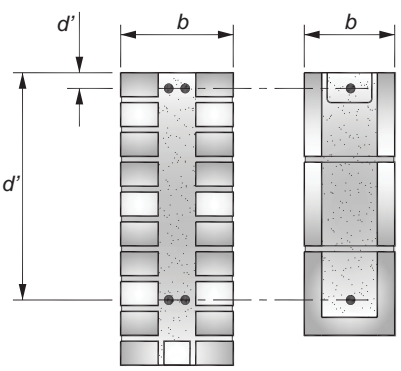
**TABLE ASD-75b Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Concrete Masonry)  $f'_m = 2000$  psi,  $F_s = 32,000$  psi, and  $n = 16.1$** 

| DESIGN DATA            |                    |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 2000$ psi      | $f_y = 60,000$ psi |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $f_b = 900$ psi        | $F_s = 32,000$ psi |          |   |        |        |        |        |        |        |        |        |
| $E_m = 1,800,000$ psi  |                    |          |   |        |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |        |        |        |        |        |        |        |        |
| $n = 16.1$             | $k = 0.312$        |          |   |        |        |        |        |        |        |        |        |
| $K_{fb} = 125.7$       | $\rho_b = 0.0044$  |          |   |        |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 125.7    | 130   | 135    | 140    | 145    | 150    | 155    | 160    | 165    | 170    |
| 0.02                   | $\rho'$            | —        | 0.0003  | 0.0007 | 0.0011 | 0.0015 | 0.0019 | 0.0024 | 0.0028 | 0.0032 | 0.0036 |
|                        | $\rho$             | 0.0044   | 0.0045  | 0.0047 | 0.0049 | 0.0050 | 0.0052 | 0.0053 | 0.0055 | 0.0057 | 0.0058 |
| 0.04                   | $\rho'$            | —        | 0.0004  | 0.0008 | 0.0013 | 0.0017 | 0.0021 | 0.0026 | 0.0030 | 0.0035 | 0.0039 |
|                        | $\rho$             | 0.0044   | 0.0045  | 0.0047 | 0.0049 | 0.0050 | 0.0052 | 0.0054 | 0.0055 | 0.0057 | 0.0058 |
| 0.06                   | $\rho'$            | —        | 0.0004  | 0.0009 | 0.0014 | 0.0019 | 0.0024 | 0.0028 | 0.0033 | 0.0038 | 0.0043 |
|                        | $\rho$             | 0.0044   | 0.0045  | 0.0047 | 0.0049 | 0.0050 | 0.0052 | 0.0054 | 0.0055 | 0.0057 | 0.0059 |
| 0.08                   | $\rho'$            | —        | 0.0005  | 0.0010 | 0.0015 | 0.0021 | 0.0026 | 0.0032 | 0.0037 | 0.0042 | 0.0048 |
|                        | $\rho$             | 0.0044   | 0.0045  | 0.0047 | 0.0049 | 0.0051 | 0.0052 | 0.0054 | 0.0056 | 0.0057 | 0.0059 |
| 0.10                   | $\rho'$            | —        | 0.0005  | 0.0011 | 0.0017 | 0.0023 | 0.0029 | 0.0035 | 0.0041 | 0.0047 | 0.0053 |
|                        | $\rho$             | 0.0044   | 0.0045  | 0.0047 | 0.0049 | 0.0051 | 0.0052 | 0.0054 | 0.0056 | 0.0058 | 0.0059 |
| 0.12                   | $\rho'$            | —        | 0.0006  | 0.0013 | 0.0019 | 0.0026 | 0.0033 | 0.0040 | 0.0047 | 0.0053 | 0.0060 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0054 | 0.0056 | 0.0058 | 0.0060 |
| 0.14                   | $\rho'$            | —        | 0.0007  | 0.0014 | 0.0022 | 0.0030 | 0.0038 | 0.0045 | 0.0053 | 0.0061 | 0.0069 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0056 | 0.0058 | 0.0060 |
| 0.16                   | $\rho'$            | —        | 0.0008  | 0.0017 | 0.0026 | 0.0035 | 0.0044 | 0.0053 | 0.0062 | 0.0071 | 0.0080 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0047 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 | 0.0059 | 0.0060 |
| 0.18                   | $\rho'$            | —        | 0.0009  | 0.0020 | 0.0030 | 0.0041 | 0.0052 | 0.0062 | 0.0073 | 0.0083 | 0.0094 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0049 | 0.0051 | 0.0053 | 0.0055 | 0.0057 | 0.0059 | 0.0061 |
| 0.20                   | $\rho'$            | —        | 0.0011  | 0.0024 | 0.0037 | 0.0049 | 0.0062 | 0.0075 | 0.0088 | 0.0101 | 0.0114 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0052 | 0.0053 | 0.0055 | 0.0057 | 0.0059 | 0.0061 |
| 0.22                   | $\rho'$            | —        | 0.0014  | 0.0030 | 0.0046 | 0.0062 | 0.0078 | 0.0094 | 0.0110 | 0.0126 | 0.0142 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 | 0.0058 | 0.0060 | 0.0062 |
| 0.24                   | $\rho'$            | —        | 0.0018  | 0.0039 | 0.0060 | 0.0081 | 0.0102 | 0.0123 | 0.0144 | 0.0165 | 0.0186 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 | 0.0058 | 0.0060 | 0.0062 |
| 0.26                   | $\rho'$            | —        | 0.0026  | 0.0055 | 0.0085 | 0.0115 | 0.0145 | 0.0175 | 0.0205 | 0.0234 | 0.0264 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0052 | 0.0054 | 0.0056 | 0.0058 | 0.0061 | 0.0063 |
| 0.28                   | $\rho'$            | —        | 0.0043  | 0.0093 | 0.0142 | 0.0192 | 0.0242 | 0.0292 | 0.0342 | 0.0392 | 0.0441 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0052 | 0.0055 | 0.0057 | 0.0059 | 0.0061 | 0.0063 |
| 0.30                   | $\rho'$            | —        | 0.0118  | 0.0254 | 0.0391 | 0.0527 | 0.0664 | 0.0801 | 0.0937 | 0.1074 | 0.1211 |
|                        | $\rho$             | 0.0044   | 0.0046  | 0.0048 | 0.0050 | 0.0053 | 0.0055 | 0.0057 | 0.0059 | 0.0062 | 0.0064 |

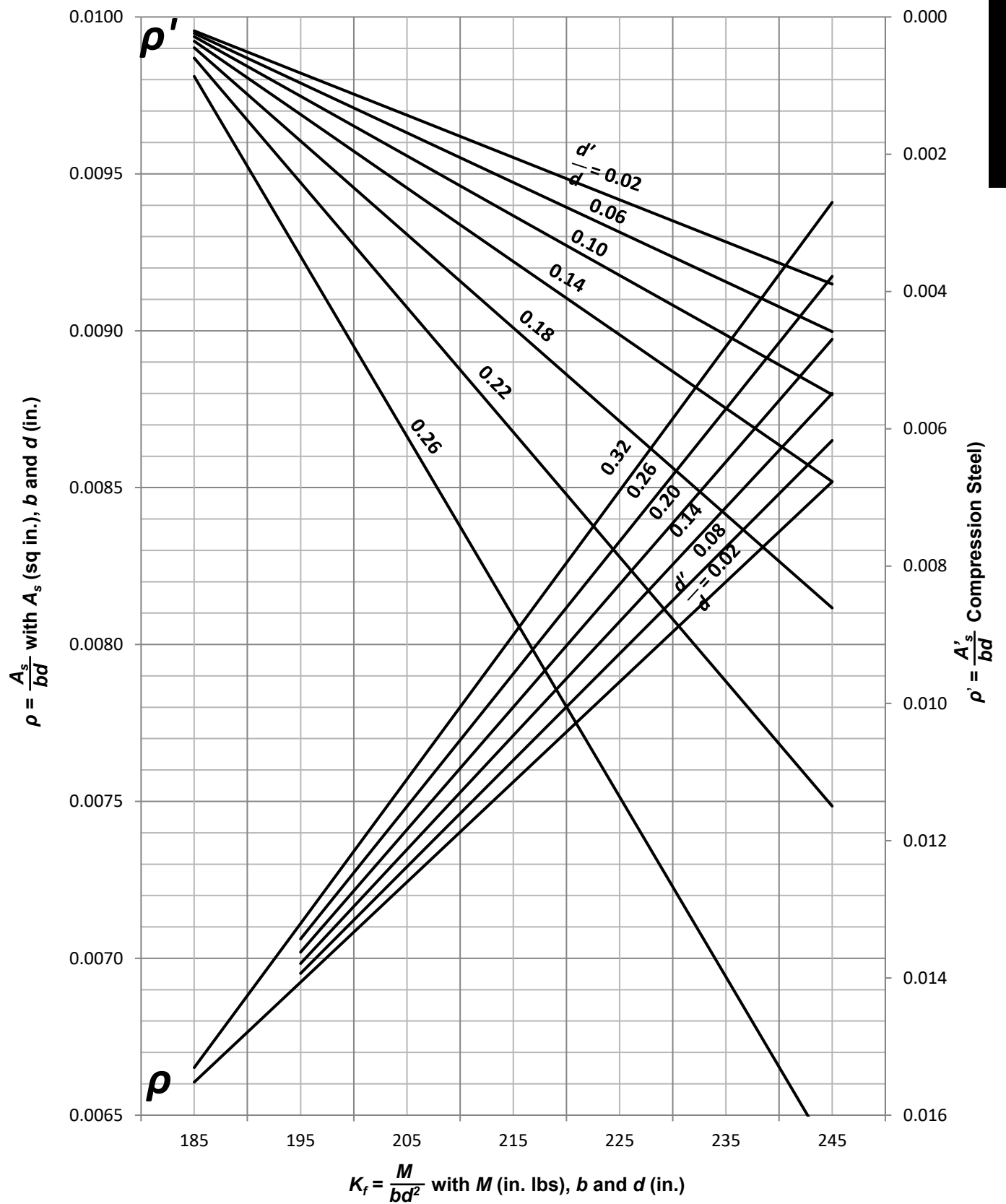
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

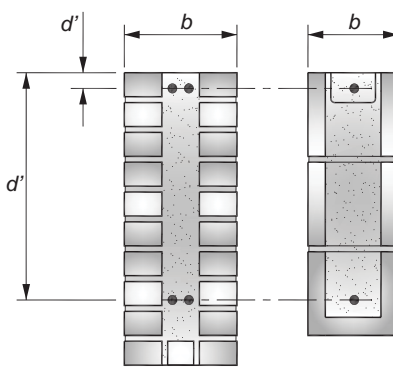
**TABLE ASD-76a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 2500$  psi,  $F_s = 32,000$  psi, and  $n = 16.6$**

| DESIGN DATA            |                    |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 2500$ psi      | $f_y = 60,000$ psi |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n-1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $f_b = 1125$ psi       | $F_s = 32,000$ psi |          |   |        |        |        |        |        |        |        |        |
| $E_m = 1,750,000$ psi  |                    |          |   |        |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |        |        |        |        |        |        |        |        |
| $n = 16.6$             | $k = 0.368$        |          |   |        |        |        |        |        |        |        |        |
| $K_{fb} = 181.7$       | $\rho_b = 0.0065$  |          |   |        |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 181.7    | 185   | 190    | 195    | 200    | 205    | 210    | 215    | 220    | 225    |
| 0.02                   | $\rho'$            | —        | 0.0002  | 0.0005 | 0.0008 | 0.0011 | 0.0014 | 0.0017 | 0.0020 | 0.0024 | 0.0027 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0069 | 0.0071 | 0.0072 | 0.0074 | 0.0076 | 0.0077 | 0.0079 |
| 0.04                   | $\rho'$            | —        | 0.0002  | 0.0006 | 0.0009 | 0.0012 | 0.0016 | 0.0019 | 0.0022 | 0.0026 | 0.0029 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0069 | 0.0071 | 0.0073 | 0.0074 | 0.0076 | 0.0077 | 0.0079 |
| 0.06                   | $\rho'$            | —        | 0.0002  | 0.0006 | 0.0010 | 0.0013 | 0.0017 | 0.0020 | 0.0024 | 0.0028 | 0.0031 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0069 | 0.0071 | 0.0073 | 0.0074 | 0.0076 | 0.0078 | 0.0079 |
| 0.08                   | $\rho'$            | —        | 0.0003  | 0.0007 | 0.0011 | 0.0014 | 0.0018 | 0.0022 | 0.0026 | 0.0030 | 0.0034 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0071 | 0.0073 | 0.0075 | 0.0076 | 0.0078 | 0.0080 |
| 0.10                   | $\rho'$            | —        | 0.0003  | 0.0007 | 0.0012 | 0.0016 | 0.0020 | 0.0025 | 0.0029 | 0.0033 | 0.0038 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0078 | 0.0080 |
| 0.12                   | $\rho'$            | —        | 0.0003  | 0.0008 | 0.0013 | 0.0018 | 0.0022 | 0.0027 | 0.0032 | 0.0037 | 0.0042 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0080 |
| 0.14                   | $\rho'$            | —        | 0.0004  | 0.0009 | 0.0014 | 0.0020 | 0.0025 | 0.0030 | 0.0036 | 0.0041 | 0.0046 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0072 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 |
| 0.16                   | $\rho'$            | —        | 0.0004  | 0.0010 | 0.0016 | 0.0022 | 0.0028 | 0.0034 | 0.0040 | 0.0046 | 0.0052 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0077 | 0.0079 | 0.0081 |
| 0.18                   | $\rho'$            | —        | 0.0004  | 0.0011 | 0.0018 | 0.0025 | 0.0032 | 0.0038 | 0.0045 | 0.0052 | 0.0059 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0082 |
| 0.20                   | $\rho'$            | —        | 0.0005  | 0.0013 | 0.0021 | 0.0029 | 0.0036 | 0.0044 | 0.0052 | 0.0060 | 0.0068 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0082 |
| 0.22                   | $\rho'$            | —        | 0.0006  | 0.0015 | 0.0024 | 0.0033 | 0.0042 | 0.0051 | 0.0060 | 0.0070 | 0.0079 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0082 |
| 0.24                   | $\rho'$            | —        | 0.0007  | 0.0018 | 0.0029 | 0.0039 | 0.0050 | 0.0061 | 0.0072 | 0.0083 | 0.0093 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0068 | 0.0070 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0083 |
| 0.26                   | $\rho'$            | —        | 0.0009  | 0.0022 | 0.0035 | 0.0048 | 0.0061 | 0.0074 | 0.0087 | 0.0100 | 0.0114 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0069 | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0083 |
| 0.28                   | $\rho'$            | —        | 0.0011  | 0.0027 | 0.0044 | 0.0061 | 0.0077 | 0.0094 | 0.0110 | 0.0127 | 0.0143 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0069 | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0082 | 0.0084 |
| 0.30                   | $\rho'$            | —        | 0.0015  | 0.0037 | 0.0059 | 0.0081 | 0.0103 | 0.0125 | 0.0147 | 0.0169 | 0.0191 |
|                        | $\rho$             | 0.0065   | 0.0066  | 0.0069 | 0.0071 | 0.0073 | 0.0075 | 0.0078 | 0.0080 | 0.0082 | 0.0084 |

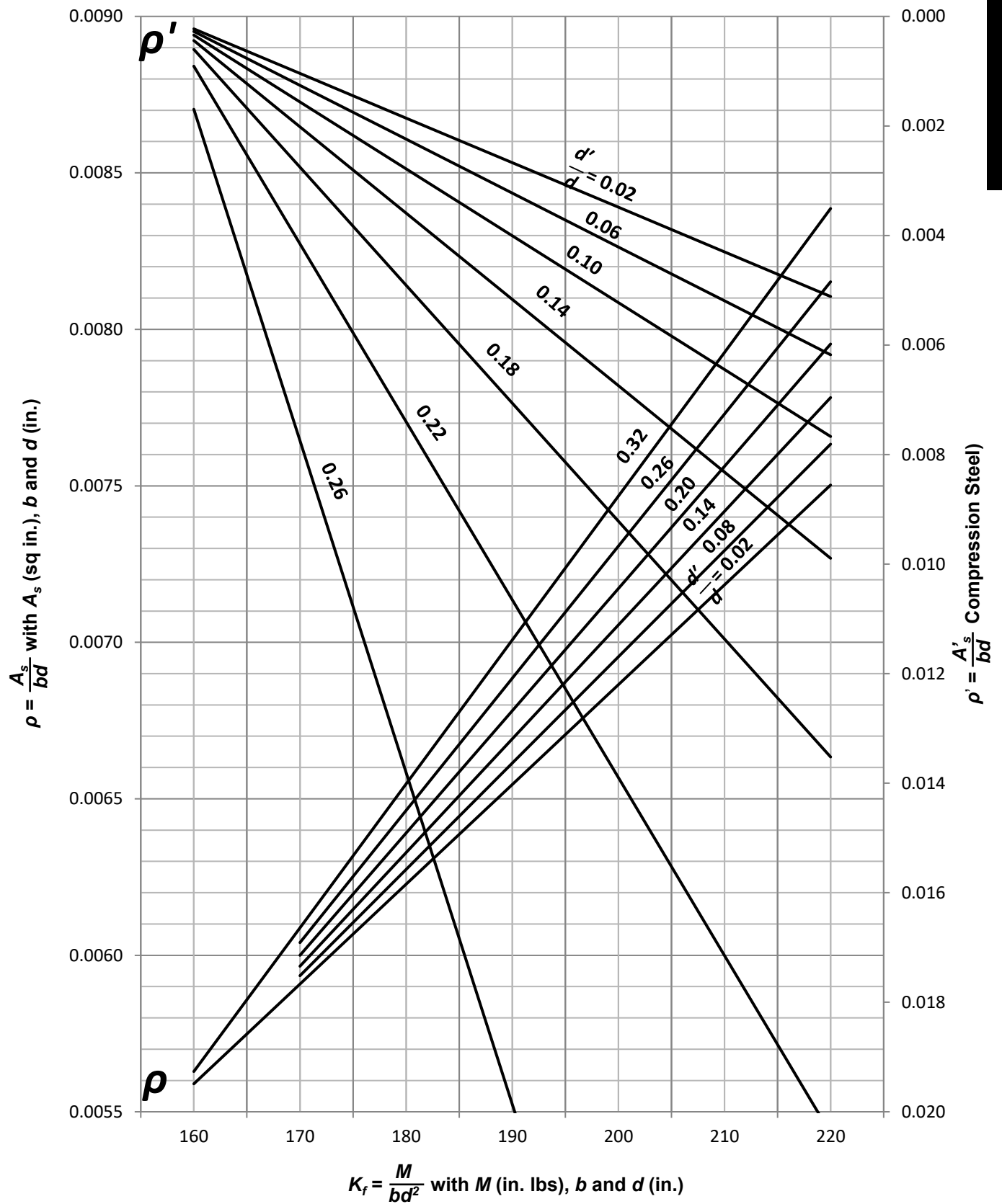
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

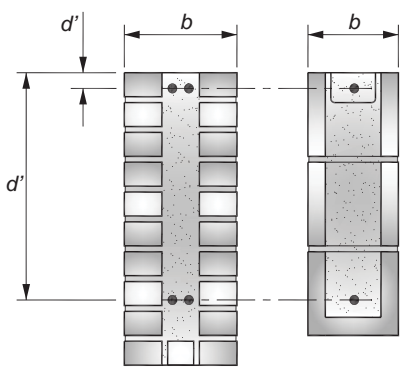
**TABLE ASD-76b Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Concrete Masonry)  $f'_m = 2500$  psi,  $F_s = 32,000$  psi, and  $n = 12.9$** 

| DESIGN DATA            |                    |          | DESIGN EQUATIONS  |   |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|---|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 2500$ psi      | $f_y = 60,000$ psi |          |  | $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$        |        |        |        |        |        |        |        |
| $f_b = 1125$ psi       | $F_s = 32,000$ psi |          |   | $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$  |        |        |        |        |        |        |        |
| $E_m = 2,250,000$ psi  |                    |          |   | $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |   |        |        |        |        |        |        |        |
| $n = 12.9$             | $k = 0.312$        |          |   |   |        |        |        |        |        |        |        |
| $K_{fb} = 157.2$       | $\rho_b = 0.0055$  |          |   |   |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |   |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 157.2    | 160   | 165   | 170    | 175    | 180    | 185    | 190    | 195    | 200    |
| 0.02                   | $\rho'$            | —        | 0.0002  | 0.0006  | 0.0010 | 0.0014 | 0.0019 | 0.0023 | 0.0027 | 0.0031 | 0.0035 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0057  | 0.0059 | 0.0061 | 0.0062 | 0.0064 | 0.0065 | 0.0067 | 0.0069 |
| 0.04                   | $\rho'$            | —        | 0.0002  | 0.0007  | 0.0011 | 0.0016 | 0.0020 | 0.0025 | 0.0029 | 0.0034 | 0.0038 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0059 | 0.0061 | 0.0062 | 0.0064 | 0.0066 | 0.0067 | 0.0069 |
| 0.06                   | $\rho'$            | —        | 0.0003  | 0.0008  | 0.0013 | 0.0018 | 0.0022 | 0.0027 | 0.0032 | 0.0037 | 0.0042 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0059 | 0.0061 | 0.0063 | 0.0064 | 0.0066 | 0.0068 | 0.0069 |
| 0.08                   | $\rho'$            | —        | 0.0003  | 0.0009  | 0.0014 | 0.0019 | 0.0025 | 0.0030 | 0.0036 | 0.0041 | 0.0047 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0059 | 0.0061 | 0.0063 | 0.0064 | 0.0066 | 0.0068 | 0.0070 |
| 0.10                   | $\rho'$            | —        | 0.0003  | 0.0010  | 0.0016 | 0.0022 | 0.0028 | 0.0034 | 0.0040 | 0.0046 | 0.0052 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0059 | 0.0061 | 0.0063 | 0.0065 | 0.0066 | 0.0068 | 0.0070 |
| 0.12                   | $\rho'$            | —        | 0.0004  | 0.0011  | 0.0018 | 0.0025 | 0.0031 | 0.0038 | 0.0045 | 0.0052 | 0.0059 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0068 | 0.0070 |
| 0.14                   | $\rho'$            | —        | 0.0004  | 0.0012  | 0.0020 | 0.0028 | 0.0036 | 0.0044 | 0.0052 | 0.0060 | 0.0067 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0069 | 0.0071 |
| 0.16                   | $\rho'$            | —        | 0.0005  | 0.0014  | 0.0023 | 0.0032 | 0.0042 | 0.0051 | 0.0060 | 0.0069 | 0.0078 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0062 | 0.0063 | 0.0065 | 0.0067 | 0.0069 | 0.0071 |
| 0.18                   | $\rho'$            | —        | 0.0006  | 0.0017  | 0.0028 | 0.0038 | 0.0049 | 0.0060 | 0.0071 | 0.0081 | 0.0092 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0069 | 0.0071 |
| 0.20                   | $\rho'$            | —        | 0.0007  | 0.0020  | 0.0033 | 0.0046 | 0.0059 | 0.0072 | 0.0085 | 0.0098 | 0.0111 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0070 | 0.0072 |
| 0.22                   | $\rho'$            | —        | 0.0009  | 0.0025  | 0.0042 | 0.0058 | 0.0074 | 0.0090 | 0.0107 | 0.0123 | 0.0139 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0070 | 0.0072 |
| 0.24                   | $\rho'$            | —        | 0.0012  | 0.0033  | 0.0055 | 0.0076 | 0.0097 | 0.0118 | 0.0140 | 0.0161 | 0.0182 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0062 | 0.0064 | 0.0066 | 0.0068 | 0.0071 | 0.0073 |
| 0.26                   | $\rho'$            | —        | 0.0017  | 0.0047  | 0.0078 | 0.0108 | 0.0138 | 0.0168 | 0.0199 | 0.0229 | 0.0259 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0060 | 0.0063 | 0.0065 | 0.0067 | 0.0069 | 0.0071 | 0.0073 |
| 0.28                   | $\rho'$            | —        | 0.0028  | 0.0079  | 0.0129 | 0.0180 | 0.0231 | 0.0281 | 0.0332 | 0.0382 | 0.0433 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0069 | 0.0071 | 0.0074 |
| 0.30                   | $\rho'$            | —        | 0.0078  | 0.0216  | 0.0355 | 0.0494 | 0.0633 | 0.0771 | 0.0910 | 0.1049 | 0.1187 |
|                        | $\rho$             | 0.0055   | 0.0056  | 0.0058  | 0.0061 | 0.0063 | 0.0065 | 0.0067 | 0.0070 | 0.0072 | 0.0074 |

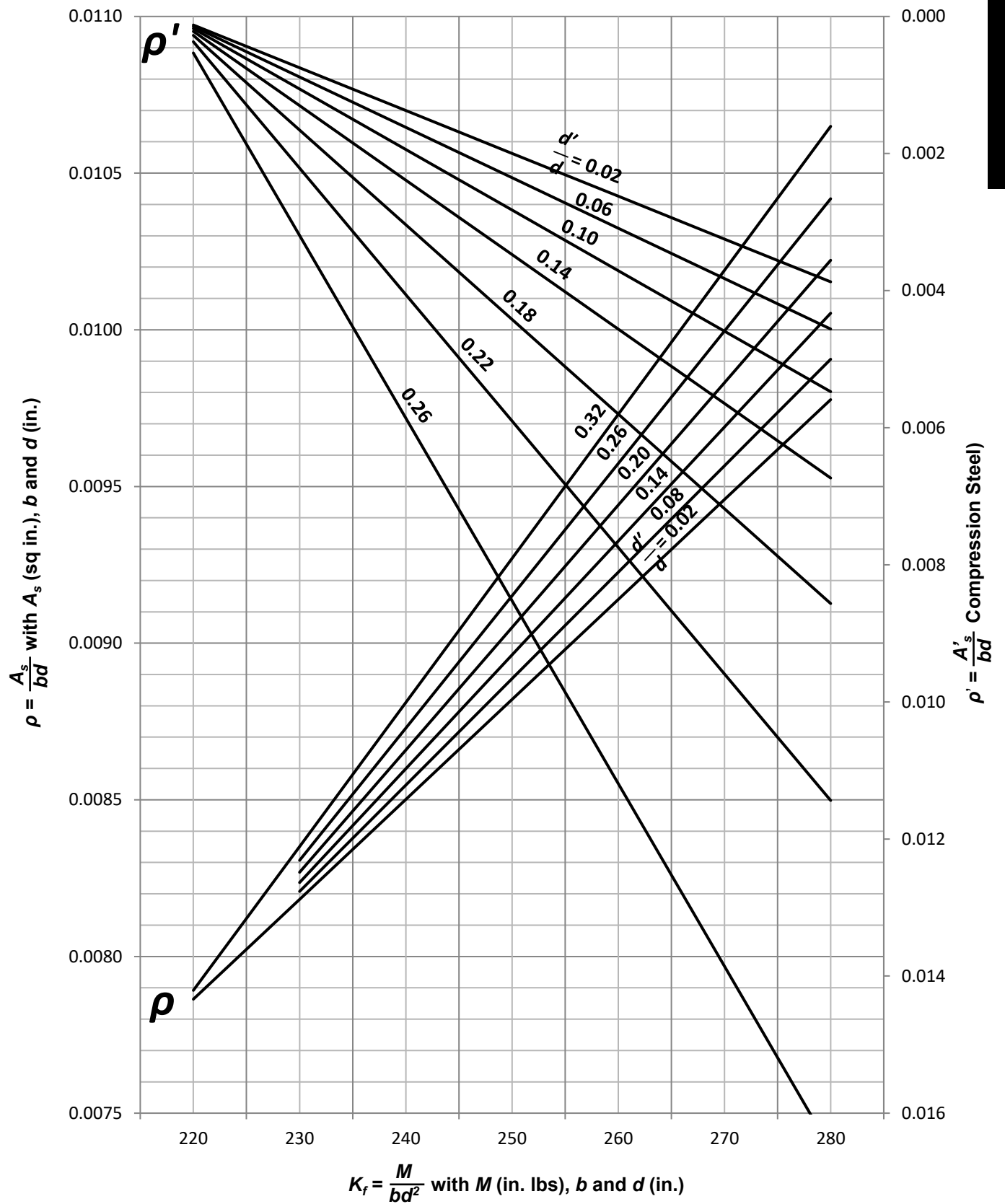
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

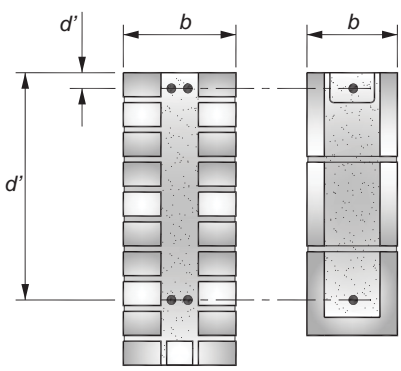
**TABLE ASD-77a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 3000$  psi,  $F_s = 32,000$  psi, and  $n = 13.8$** 

| DESIGN DATA            |                    |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 3000$ psi      | $f_y = 60,000$ psi |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $f_b = 1350$ psi       | $F_s = 32,000$ psi |          |   |        |        |        |        |        |        |        |        |
| $E_m = 2,100,000$ psi  |                    |          |   |        |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |        |        |        |        |        |        |        |        |
| $n = 13.8$             | $k = 0.368$        |          |   |        |        |        |        |        |        |        |        |
| $K_{fb} = 218.0$       | $\rho_b = 0.0078$  |          |   |        |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 218.0    | 225   | 230    | 235    | 240    | 245    | 250    | 255    | 260    | 265    |
| 0.02                   | $\rho'$            | —        | 0.0004  | 0.0007 | 0.0011 | 0.0014 | 0.0017 | 0.0020 | 0.0023 | 0.0026 | 0.0029 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0083 | 0.0085 | 0.0087 | 0.0088 | 0.0090 | 0.0091 | 0.0093 |
| 0.04                   | $\rho'$            | —        | 0.0005  | 0.0008 | 0.0011 | 0.0015 | 0.0018 | 0.0022 | 0.0025 | 0.0028 | 0.0032 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0088 | 0.0090 | 0.0092 | 0.0093 |
| 0.06                   | $\rho'$            | —        | 0.0005  | 0.0009 | 0.0013 | 0.0016 | 0.0020 | 0.0024 | 0.0027 | 0.0031 | 0.0035 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0089 | 0.0090 | 0.0092 | 0.0094 |
| 0.08                   | $\rho'$            | —        | 0.0006  | 0.0010 | 0.0014 | 0.0018 | 0.0022 | 0.0026 | 0.0030 | 0.0034 | 0.0038 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0092 | 0.0094 |
| 0.10                   | $\rho'$            | —        | 0.0006  | 0.0011 | 0.0015 | 0.0019 | 0.0024 | 0.0028 | 0.0033 | 0.0037 | 0.0041 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0084 | 0.0086 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0094 |
| 0.12                   | $\rho'$            | —        | 0.0007  | 0.0012 | 0.0017 | 0.0021 | 0.0026 | 0.0031 | 0.0036 | 0.0041 | 0.0046 |
|                        | $\rho$             | 0.0078   | 0.0080  | 0.0082 | 0.0084 | 0.0086 | 0.0088 | 0.0089 | 0.0091 | 0.0093 | 0.0095 |
| 0.14                   | $\rho'$            | —        | 0.0008  | 0.0013 | 0.0018 | 0.0024 | 0.0029 | 0.0035 | 0.0040 | 0.0046 | 0.0051 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0082 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0091 | 0.0093 | 0.0095 |
| 0.16                   | $\rho'$            | —        | 0.0009  | 0.0015 | 0.0021 | 0.0027 | 0.0033 | 0.0039 | 0.0045 | 0.0051 | 0.0057 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0082 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0094 | 0.0095 |
| 0.18                   | $\rho'$            | —        | 0.0010  | 0.0017 | 0.0023 | 0.0030 | 0.0037 | 0.0044 | 0.0051 | 0.0058 | 0.0065 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0094 | 0.0096 |
| 0.20                   | $\rho'$            | —        | 0.0011  | 0.0019 | 0.0027 | 0.0035 | 0.0043 | 0.0051 | 0.0059 | 0.0067 | 0.0074 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0092 | 0.0094 | 0.0096 |
| 0.22                   | $\rho'$            | —        | 0.0013  | 0.0022 | 0.0031 | 0.0041 | 0.0050 | 0.0059 | 0.0068 | 0.0077 | 0.0087 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0095 | 0.0097 |
| 0.24                   | $\rho'$            | —        | 0.0015  | 0.0026 | 0.0037 | 0.0048 | 0.0059 | 0.0070 | 0.0081 | 0.0092 | 0.0103 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0095 | 0.0097 |
| 0.26                   | $\rho'$            | —        | 0.0019  | 0.0032 | 0.0045 | 0.0059 | 0.0072 | 0.0085 | 0.0099 | 0.0112 | 0.0125 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0092 | 0.0094 | 0.0096 | 0.0098 |
| 0.28                   | $\rho'$            | —        | 0.0024  | 0.0040 | 0.0057 | 0.0074 | 0.0091 | 0.0108 | 0.0124 | 0.0141 | 0.0158 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0085 | 0.0088 | 0.0090 | 0.0092 | 0.0094 | 0.0096 | 0.0098 |
| 0.30                   | $\rho'$            | —        | 0.0031  | 0.0054 | 0.0076 | 0.0098 | 0.0121 | 0.0143 | 0.0166 | 0.0188 | 0.0210 |
|                        | $\rho$             | 0.0078   | 0.0081  | 0.0083 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0095 | 0.0097 | 0.0099 |

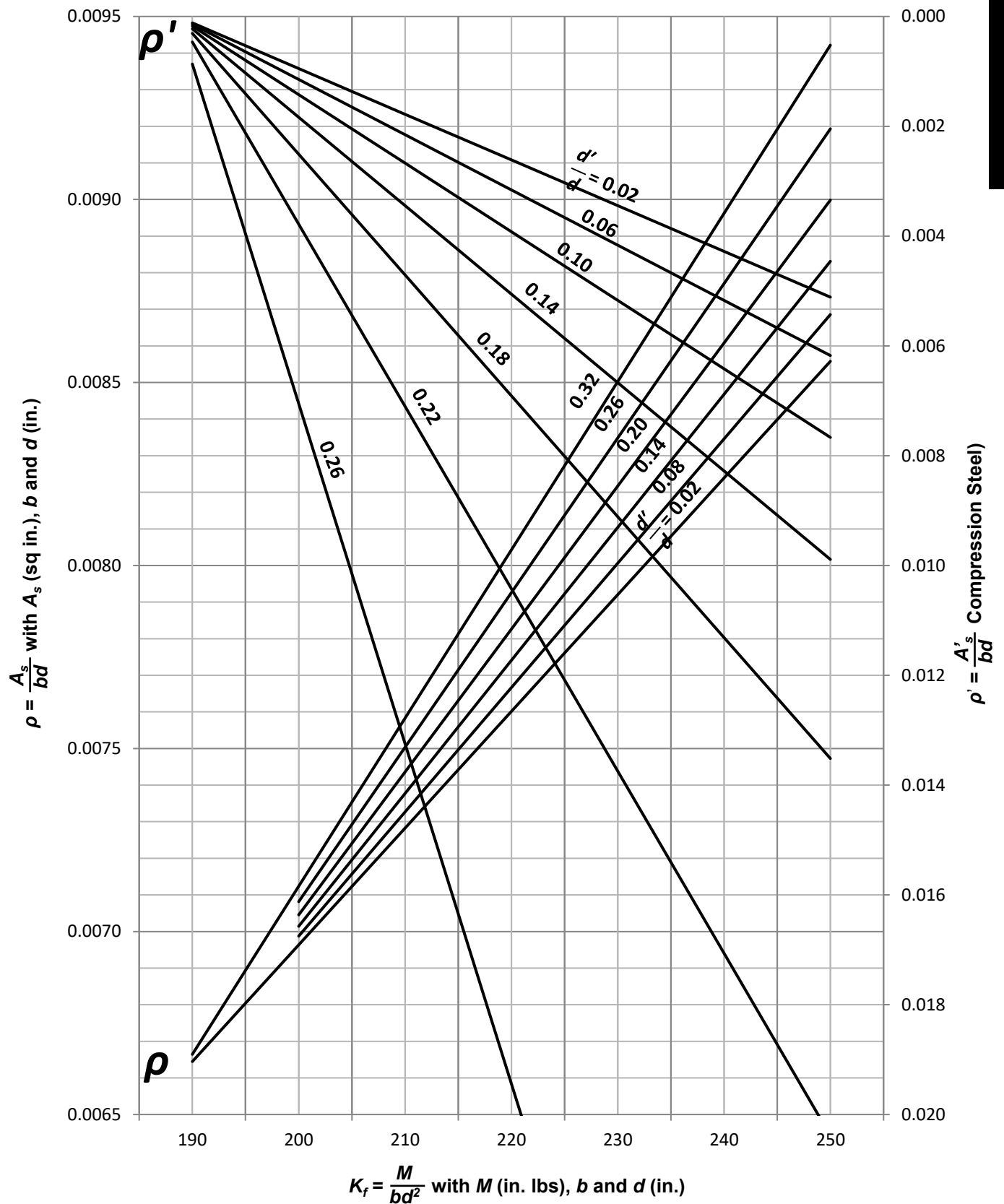
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

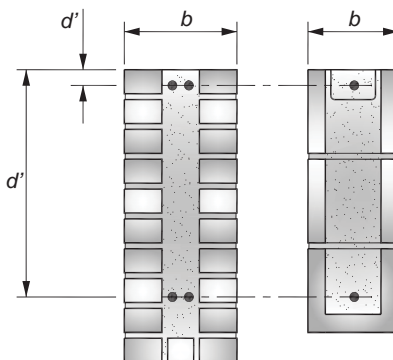
**TABLE ASD-77b Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Concrete Masonry)  $f'_m = 3000$  psi,  $F_s = 32,000$  psi, and  $n = 10.7$** 

| DESIGN DATA            |                    |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 3000$ psi      | $f_y = 60,000$ psi |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n-1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $f_b = 1350$ psi       | $F_s = 32,000$ psi |          |   |        |        |        |        |        |        |        |        |
| $E_m = 2,700,000$ psi  |                    |          |   |        |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |        |        |        |        |        |        |        |        |
| $n = 10.7$             | $k = 0.312$        |          |   |        |        |        |        |        |        |        |        |
| $K_{fb} = 188.6$       | $\rho_b = 0.0066$  |          |   |        |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 188.6    | 195   | 200    | 205    | 210    | 215    | 220    | 225    | 230    | 235    |
| 0.02                   | $\rho'$            | —        | 0.0005  | 0.0009 | 0.0014 | 0.0018 | 0.0022 | 0.0026 | 0.0030 | 0.0034 | 0.0039 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0071 | 0.0073 | 0.0074 | 0.0076 | 0.0078 | 0.0079 | 0.0081 |
| 0.04                   | $\rho'$            | —        | 0.0006  | 0.0010 | 0.0015 | 0.0020 | 0.0024 | 0.0029 | 0.0033 | 0.0038 | 0.0042 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0071 | 0.0073 | 0.0075 | 0.0076 | 0.0078 | 0.0079 | 0.0081 |
| 0.06                   | $\rho'$            | —        | 0.0006  | 0.0011 | 0.0016 | 0.0022 | 0.0027 | 0.0032 | 0.0037 | 0.0042 | 0.0047 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0071 | 0.0073 | 0.0075 | 0.0076 | 0.0078 | 0.0080 | 0.0081 |
| 0.08                   | $\rho'$            | —        | 0.0007  | 0.0013 | 0.0018 | 0.0024 | 0.0029 | 0.0035 | 0.0041 | 0.0046 | 0.0052 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0073 | 0.0075 | 0.0077 | 0.0078 | 0.0080 | 0.0082 |
| 0.10                   | $\rho'$            | —        | 0.0008  | 0.0014 | 0.0020 | 0.0027 | 0.0033 | 0.0039 | 0.0045 | 0.0052 | 0.0058 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0080 | 0.0082 |
| 0.12                   | $\rho'$            | —        | 0.0009  | 0.0016 | 0.0023 | 0.0030 | 0.0037 | 0.0044 | 0.0051 | 0.0058 | 0.0065 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0074 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0082 |
| 0.14                   | $\rho'$            | —        | 0.0010  | 0.0018 | 0.0026 | 0.0034 | 0.0043 | 0.0051 | 0.0059 | 0.0067 | 0.0075 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0077 | 0.0079 | 0.0081 | 0.0083 |
| 0.16                   | $\rho'$            | —        | 0.0012  | 0.0021 | 0.0031 | 0.0040 | 0.0049 | 0.0059 | 0.0068 | 0.0077 | 0.0087 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0081 | 0.0083 |
| 0.18                   | $\rho'$            | —        | 0.0014  | 0.0025 | 0.0036 | 0.0047 | 0.0058 | 0.0069 | 0.0080 | 0.0091 | 0.0102 |
|                        | $\rho$             | 0.0066   | 0.0068  | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0082 | 0.0084 |
| 0.20                   | $\rho'$            | —        | 0.0017  | 0.0030 | 0.0044 | 0.0057 | 0.0070 | 0.0083 | 0.0097 | 0.0110 | 0.0123 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0070 | 0.0072 | 0.0074 | 0.0076 | 0.0078 | 0.0080 | 0.0082 | 0.0084 |
| 0.22                   | $\rho'$            | —        | 0.0021  | 0.0038 | 0.0054 | 0.0071 | 0.0088 | 0.0104 | 0.0121 | 0.0137 | 0.0154 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0083 | 0.0085 |
| 0.24                   | $\rho'$            | —        | 0.0028  | 0.0050 | 0.0071 | 0.0093 | 0.0115 | 0.0137 | 0.0158 | 0.0180 | 0.0202 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0083 | 0.0085 |
| 0.26                   | $\rho'$            | —        | 0.0040  | 0.0071 | 0.0102 | 0.0133 | 0.0163 | 0.0194 | 0.0225 | 0.0256 | 0.0287 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0079 | 0.0081 | 0.0083 | 0.0086 |
| 0.28                   | $\rho'$            | —        | 0.0066  | 0.0118 | 0.0170 | 0.0221 | 0.0273 | 0.0325 | 0.0376 | 0.0428 | 0.0480 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0071 | 0.0073 | 0.0075 | 0.0077 | 0.0080 | 0.0082 | 0.0084 | 0.0086 |
| 0.30                   | $\rho'$            | —        | 0.0182  | 0.0323 | 0.0465 | 0.0607 | 0.0749 | 0.0891 | 0.1032 | 0.1174 | 0.1316 |
|                        | $\rho$             | 0.0066   | 0.0069  | 0.0071 | 0.0073 | 0.0076 | 0.0078 | 0.0080 | 0.0082 | 0.0084 | 0.0087 |

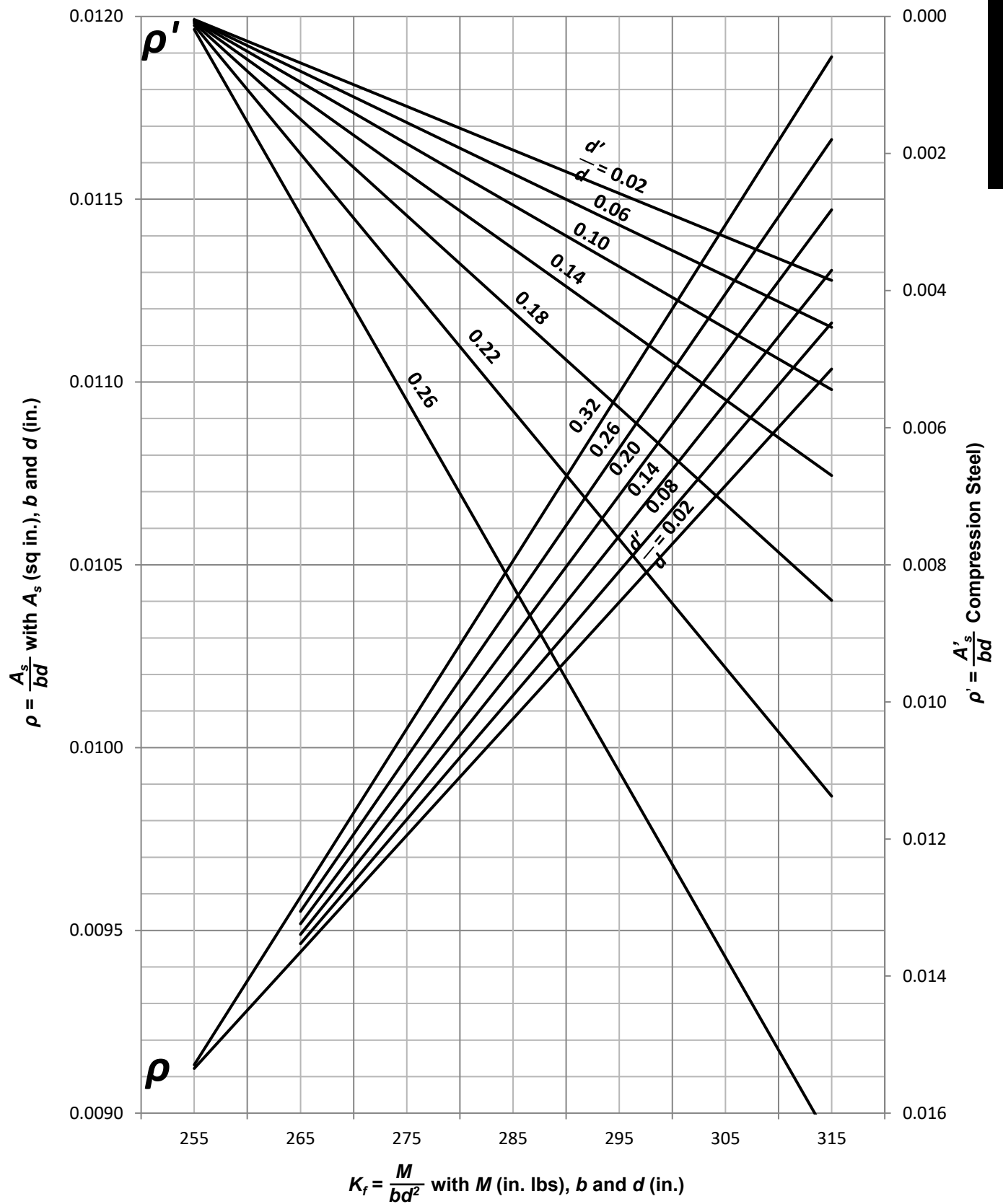
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

DIAGRAM ASD-77b Steel Ratio  $\rho$  and  $\rho'$  Versus  $K_r$  for  $f'_m = 3000$  psi, (Concrete Masonry)

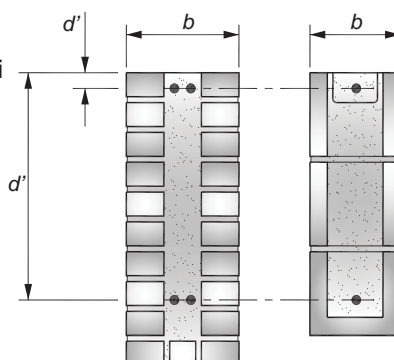
**TABLE ASD-78a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 3500$  psi,  $F_y = 32,000$  psi, and  $n = 11.8$**

| DESIGN DATA  |               |          | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|--|---------------|----------|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 3500$ psi $F_y = 60,000$ psi<br>$f_b = 1575$ psi $F_s = 32,000$ psi<br>$E_m = 2,450,000$ psi<br>$E_s = 29,000,000$ psi<br>$n = 11.8$ $k = 0.368$<br>$K_{fb} = 254.3$ $\rho_b = 0.0091$ |               |          |  $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$ $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ $\rho' = \frac{K_f - K_{fb}}{(n-1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $d'/d^a$   | Steel Ratio   | $K_{fb}$ | $K_f$   |        |        |        |        |        |        |        |        |
|  | $\rho', \rho$ | 254.3    | 260   | 265    | 270    | 275    | 280    | 285    | 290    | 295    | 300    |
| 0.02   | $\rho'$       | —        | 0.0004  | 0.0007 | 0.0010 | 0.0013 | 0.0016 | 0.0019 | 0.0023 | 0.0026 | 0.0029 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0094 | 0.0096 | 0.0098 | 0.0099 | 0.0101 | 0.0102 | 0.0104 | 0.0106 |
| 0.04   | $\rho'$       | —        | 0.0004  | 0.0007 | 0.0011 | 0.0014 | 0.0018 | 0.0021 | 0.0025 | 0.0028 | 0.0031 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0094 | 0.0096 | 0.0098 | 0.0099 | 0.0101 | 0.0103 | 0.0104 | 0.0106 |
| 0.06   | $\rho'$       | —        | 0.0004  | 0.0008 | 0.0012 | 0.0015 | 0.0019 | 0.0023 | 0.0027 | 0.0030 | 0.0034 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0096 | 0.0098 | 0.0100 | 0.0101 | 0.0103 | 0.0105 | 0.0106 |
| 0.08   | $\rho'$       | —        | 0.0005  | 0.0009 | 0.0013 | 0.0017 | 0.0021 | 0.0025 | 0.0029 | 0.0033 | 0.0037 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0096 | 0.0098 | 0.0100 | 0.0101 | 0.0103 | 0.0105 | 0.0107 |
| 0.10   | $\rho'$       | —        | 0.0005  | 0.0010 | 0.0014 | 0.0019 | 0.0023 | 0.0028 | 0.0032 | 0.0037 | 0.0041 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0096 | 0.0098 | 0.0100 | 0.0102 | 0.0103 | 0.0105 | 0.0107 |
| 0.12   | $\rho'$       | —        | 0.0006  | 0.0011 | 0.0016 | 0.0021 | 0.0025 | 0.0030 | 0.0035 | 0.0040 | 0.0045 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0098 | 0.0100 | 0.0102 | 0.0104 | 0.0105 | 0.0107 |
| 0.14   | $\rho'$       | —        | 0.0006  | 0.0012 | 0.0017 | 0.0023 | 0.0028 | 0.0034 | 0.0039 | 0.0045 | 0.0050 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0099 | 0.0100 | 0.0102 | 0.0104 | 0.0106 | 0.0108 |
| 0.16   | $\rho'$       | —        | 0.0007  | 0.0013 | 0.0019 | 0.0026 | 0.0032 | 0.0038 | 0.0044 | 0.0050 | 0.0057 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0099 | 0.0101 | 0.0102 | 0.0104 | 0.0106 | 0.0108 |
| 0.18   | $\rho'$       | —        | 0.0008  | 0.0015 | 0.0022 | 0.0029 | 0.0036 | 0.0043 | 0.0050 | 0.0057 | 0.0064 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0099 | 0.0101 | 0.0103 | 0.0105 | 0.0107 | 0.0108 |
| 0.20   | $\rho'$       | —        | 0.0009  | 0.0017 | 0.0025 | 0.0033 | 0.0041 | 0.0049 | 0.0057 | 0.0066 | 0.0074 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0099 | 0.0101 | 0.0103 | 0.0105 | 0.0107 | 0.0109 |
| 0.22   | $\rho'$       | —        | 0.0011  | 0.0020 | 0.0029 | 0.0039 | 0.0048 | 0.0058 | 0.0067 | 0.0076 | 0.0086 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0099 | 0.0101 | 0.0103 | 0.0105 | 0.0107 | 0.0109 |
| 0.24   | $\rho'$       | —        | 0.0013  | 0.0024 | 0.0035 | 0.0046 | 0.0057 | 0.0068 | 0.0079 | 0.0091 | 0.0102 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0095 | 0.0097 | 0.0100 | 0.0102 | 0.0104 | 0.0106 | 0.0108 | 0.0110 |
| 0.26   | $\rho'$       | —        | 0.0015  | 0.0029 | 0.0042 | 0.0056 | 0.0070 | 0.0083 | 0.0097 | 0.0110 | 0.0124 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0096 | 0.0098 | 0.0100 | 0.0102 | 0.0104 | 0.0106 | 0.0108 | 0.0110 |
| 0.28   | $\rho'$       | —        | 0.0019  | 0.0037 | 0.0054 | 0.0071 | 0.0088 | 0.0105 | 0.0122 | 0.0139 | 0.0156 |
|  | $\rho$        | 0.0091   | 0.0093  | 0.0096 | 0.0098 | 0.0100 | 0.0102 | 0.0104 | 0.0106 | 0.0109 | 0.0111 |
| 0.30   | $\rho'$       | —        | 0.0026  | 0.0049 | 0.0071 | 0.0094 | 0.0117 | 0.0140 | 0.0162 | 0.0185 | 0.0208 |
|  | $\rho$        | 0.0091   | 0.0094  | 0.0096 | 0.0098 | 0.0100 | 0.0102 | 0.0105 | 0.0107 | 0.0109 | 0.0111 |

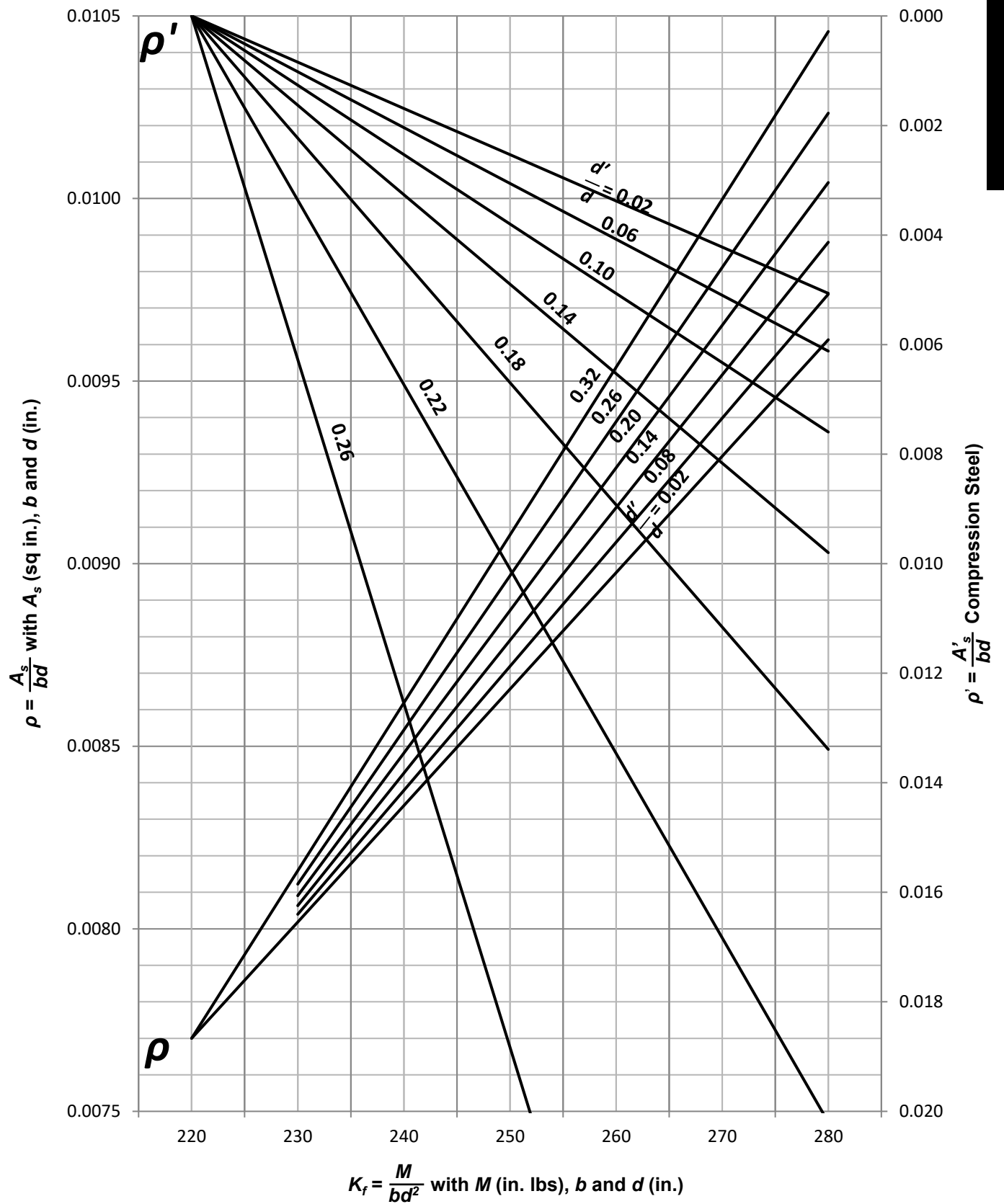
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

**TABLE ASD-78b Coefficients  $\rho$  and  $\rho'$  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            |                    |   | DESIGN EQUATIONS  |        |        |        |        |        |        |        |        |
|------------------------|--------------------|---|---|--------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 3500$ psi      | $f_y = 60,000$ psi |  | $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$        |        |        |        |        |        |        |        |        |
| $f_b = 1575$ psi       | $F_s = 32,000$ psi |   | $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$  |        |        |        |        |        |        |        |        |
| $E_m = 3,150,000$ psi  |                    |   | $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |   |   |        |        |        |        |        |        |        |        |
| $n = 9.2$              | $k = 0.312$        |   |   |        |        |        |        |        |        |        |        |
| $K_{fb} = 220.0$       | $\rho_b = 0.0077$  |   |   |        |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$  | $K_f$   |        |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 220.0   | 225   | 230    | 235    | 240    | 245    | 250    | 255    | 260    | 265    |
| 0.02                   | $\rho'$            | —   | 0.0004  | 0.0008 | 0.0013 | 0.0017 | 0.0021 | 0.0025 | 0.0030 | 0.0034 | 0.0038 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0080 | 0.0082 | 0.0083 | 0.0085 | 0.0087 | 0.0088 | 0.0090 | 0.0091 |
| 0.04                   | $\rho'$            | —   | 0.0005  | 0.0009 | 0.0014 | 0.0019 | 0.0023 | 0.0028 | 0.0032 | 0.0037 | 0.0042 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0080 | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0088 | 0.0090 | 0.0092 |
| 0.06                   | $\rho'$            | —   | 0.0005  | 0.0010 | 0.0015 | 0.0020 | 0.0025 | 0.0031 | 0.0036 | 0.0041 | 0.0046 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0080 | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0089 | 0.0090 | 0.0092 |
| 0.08                   | $\rho'$            | —   | 0.0006  | 0.0011 | 0.0017 | 0.0023 | 0.0028 | 0.0034 | 0.0040 | 0.0045 | 0.0051 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0080 | 0.0082 | 0.0084 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0092 |
| 0.10                   | $\rho'$            | —   | 0.0006  | 0.0013 | 0.0019 | 0.0025 | 0.0032 | 0.0038 | 0.0044 | 0.0051 | 0.0057 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0080 | 0.0082 | 0.0084 | 0.0086 | 0.0087 | 0.0089 | 0.0091 | 0.0093 |
| 0.12                   | $\rho'$            | —   | 0.0007  | 0.0014 | 0.0021 | 0.0029 | 0.0036 | 0.0043 | 0.0050 | 0.0057 | 0.0064 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0082 | 0.0084 | 0.0086 | 0.0088 | 0.0089 | 0.0091 | 0.0093 |
| 0.14                   | $\rho'$            | —   | 0.0008  | 0.0016 | 0.0024 | 0.0033 | 0.0041 | 0.0049 | 0.0057 | 0.0065 | 0.0073 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0082 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0093 |
| 0.16                   | $\rho'$            | —   | 0.0009  | 0.0019 | 0.0028 | 0.0038 | 0.0047 | 0.0057 | 0.0066 | 0.0076 | 0.0085 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0094 |
| 0.18                   | $\rho'$            | —   | 0.0011  | 0.0022 | 0.0033 | 0.0045 | 0.0056 | 0.0067 | 0.0078 | 0.0089 | 0.0100 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0085 | 0.0087 | 0.0088 | 0.0090 | 0.0092 | 0.0094 |
| 0.20                   | $\rho'$            | —   | 0.0013  | 0.0027 | 0.0040 | 0.0054 | 0.0067 | 0.0081 | 0.0094 | 0.0108 | 0.0121 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0095 |
| 0.22                   | $\rho'$            | —   | 0.0017  | 0.0034 | 0.0050 | 0.0067 | 0.0084 | 0.0101 | 0.0118 | 0.0135 | 0.0151 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0095 |
| 0.24                   | $\rho'$            | —   | 0.0022  | 0.0044 | 0.0066 | 0.0088 | 0.0110 | 0.0132 | 0.0155 | 0.0177 | 0.0199 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0085 | 0.0087 | 0.0089 | 0.0091 | 0.0093 | 0.0096 |
| 0.26                   | $\rho'$            | —   | 0.0031  | 0.0063 | 0.0094 | 0.0126 | 0.0157 | 0.0188 | 0.0220 | 0.0251 | 0.0283 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0083 | 0.0085 | 0.0088 | 0.0090 | 0.0092 | 0.0094 | 0.0096 |
| 0.28                   | $\rho'$            | —   | 0.0052  | 0.0105 | 0.0157 | 0.0210 | 0.0262 | 0.0315 | 0.0367 | 0.0419 | 0.0472 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0092 | 0.0094 | 0.0097 |
| 0.30                   | $\rho'$            | —   | 0.0144  | 0.0288 | 0.0431 | 0.0575 | 0.0719 | 0.0863 | 0.1007 | 0.1150 | 0.1294 |
|                        | $\rho$             | 0.0077  | 0.0079  | 0.0081 | 0.0084 | 0.0086 | 0.0088 | 0.0090 | 0.0093 | 0.0095 | 0.0097 |

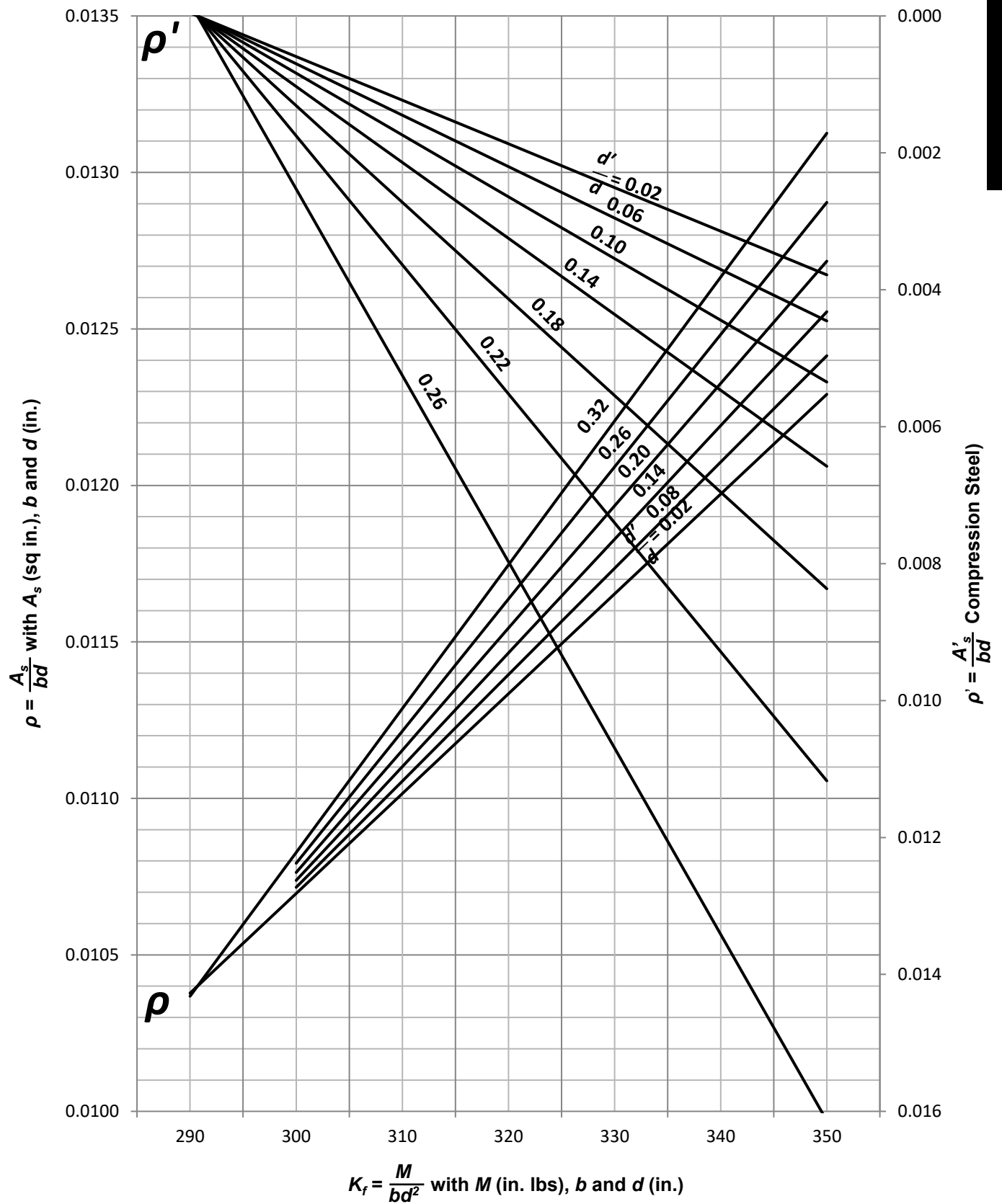
<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

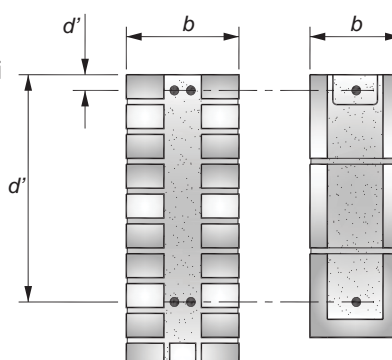
**TABLE ASD-79a Coefficients  $\rho$  and  $\rho'$  for Tension and Compression Steel in a Flexural Member (Clay Masonry)  $f'_m = 4000$  psi,  $F_s = 32,000$  psi, and  $n = 10.4$** 

| DESIGN DATA            |                    |          |   | DESIGN EQUATIONS |        |        |        |        |        |        |        |
|------------------------|--------------------|----------|---|------------------|--------|--------|--------|--------|--------|--------|--------|
| $f'_m = 4000$ psi      | $f_y = 60,000$ psi |          | $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000} \text{ or } \frac{M(\text{in. lbs})}{bd^2}$        |                  |        |        |        |        |        |        |        |
| $f_b = 1800$ psi       | $F_s = 32,000$ psi |          | $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$  |                  |        |        |        |        |        |        |        |
| $E_m = 2,800,000$ psi  |                    |          | $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |                  |        |        |        |        |        |        |        |
| $E_s = 29,000,000$ psi |                    |          |   |                  |        |        |        |        |        |        |        |
| $n = 10.4$             | $k = 0.368$        |          |   |                  |        |        |        |        |        |        |        |
| $K_{fb} = 290.7$       | $\rho_b = 0.0104$  |          |   |                  |        |        |        |        |        |        |        |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$ | $K_f$   |                  |        |        |        |        |        |        |        |
|                        | $\rho', \rho$      | 290.7    | 295   | 300              | 305    | 310    | 315    | 320    | 325    | 330    | 335    |
| 0.02                   | $\rho'$            | —        | 0.0003  | 0.0006           | 0.0009 | 0.0012 | 0.0015 | 0.0019 | 0.0022 | 0.0025 | 0.0028 |
|                        | $\rho$             | 0.0104   | 0.0105  | 0.0107           | 0.0109 | 0.0110 | 0.0112 | 0.0113 | 0.0115 | 0.0117 | 0.0118 |
| 0.04                   | $\rho'$            | —        | 0.0003  | 0.0006           | 0.0010 | 0.0013 | 0.0017 | 0.0020 | 0.0024 | 0.0027 | 0.0031 |
|                        | $\rho$             | 0.0104   | 0.0105  | 0.0107           | 0.0109 | 0.0110 | 0.0112 | 0.0114 | 0.0115 | 0.0117 | 0.0118 |
| 0.06                   | $\rho'$            | —        | 0.0003  | 0.0007           | 0.0011 | 0.0014 | 0.0018 | 0.0022 | 0.0026 | 0.0030 | 0.0033 |
|                        | $\rho$             | 0.0104   | 0.0105  | 0.0107           | 0.0109 | 0.0110 | 0.0112 | 0.0114 | 0.0115 | 0.0117 | 0.0119 |
| 0.08                   | $\rho'$            | —        | 0.0004  | 0.0008           | 0.0012 | 0.0016 | 0.0020 | 0.0024 | 0.0028 | 0.0032 | 0.0036 |
|                        | $\rho$             | 0.0104   | 0.0105  | 0.0107           | 0.0109 | 0.0111 | 0.0112 | 0.0114 | 0.0116 | 0.0117 | 0.0119 |
| 0.10                   | $\rho'$            | —        | 0.0004  | 0.0008           | 0.0013 | 0.0017 | 0.0022 | 0.0026 | 0.0031 | 0.0035 | 0.0040 |
|                        | $\rho$             | 0.0104   | 0.0105  | 0.0107           | 0.0109 | 0.0111 | 0.0112 | 0.0114 | 0.0116 | 0.0118 | 0.0119 |
| 0.12                   | $\rho'$            | —        | 0.0004  | 0.0009           | 0.0014 | 0.0019 | 0.0024 | 0.0029 | 0.0034 | 0.0039 | 0.0044 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0107           | 0.0109 | 0.0111 | 0.0113 | 0.0114 | 0.0116 | 0.0118 | 0.0120 |
| 0.14                   | $\rho'$            | —        | 0.0005  | 0.0010           | 0.0016 | 0.0021 | 0.0027 | 0.0032 | 0.0038 | 0.0044 | 0.0049 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0107           | 0.0109 | 0.0111 | 0.0113 | 0.0115 | 0.0116 | 0.0118 | 0.0120 |
| 0.16                   | $\rho'$            | —        | 0.0005  | 0.0012           | 0.0018 | 0.0024 | 0.0030 | 0.0036 | 0.0043 | 0.0049 | 0.0055 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0107           | 0.0109 | 0.0111 | 0.0113 | 0.0115 | 0.0117 | 0.0119 | 0.0120 |
| 0.18                   | $\rho'$            | —        | 0.0006  | 0.0013           | 0.0020 | 0.0027 | 0.0034 | 0.0041 | 0.0048 | 0.0055 | 0.0062 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0109 | 0.0111 | 0.0113 | 0.0115 | 0.0117 | 0.0119 | 0.0121 |
| 0.20                   | $\rho'$            | —        | 0.0007  | 0.0015           | 0.0023 | 0.0031 | 0.0039 | 0.0047 | 0.0056 | 0.0064 | 0.0072 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0112 | 0.0113 | 0.0115 | 0.0117 | 0.0119 | 0.0121 |
| 0.22                   | $\rho'$            | —        | 0.0008  | 0.0018           | 0.0027 | 0.0036 | 0.0046 | 0.0055 | 0.0065 | 0.0074 | 0.0083 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0112 | 0.0114 | 0.0116 | 0.0118 | 0.0120 | 0.0122 |
| 0.24                   | $\rho'$            | —        | 0.0010  | 0.0021           | 0.0032 | 0.0043 | 0.0054 | 0.0066 | 0.0077 | 0.0088 | 0.0099 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0112 | 0.0114 | 0.0116 | 0.0118 | 0.0120 | 0.0122 |
| 0.26                   | $\rho'$            | —        | 0.0012  | 0.0025           | 0.0039 | 0.0053 | 0.0066 | 0.0080 | 0.0093 | 0.0107 | 0.0121 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0112 | 0.0114 | 0.0116 | 0.0118 | 0.0121 | 0.0123 |
| 0.28                   | $\rho'$            | —        | 0.0015  | 0.0032           | 0.0049 | 0.0066 | 0.0083 | 0.0101 | 0.0118 | 0.0135 | 0.0152 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0112 | 0.0115 | 0.0117 | 0.0119 | 0.0121 | 0.0123 |
| 0.30                   | $\rho'$            | —        | 0.0020  | 0.0042           | 0.0065 | 0.0088 | 0.0111 | 0.0134 | 0.0157 | 0.0180 | 0.0202 |
|                        | $\rho$             | 0.0104   | 0.0106  | 0.0108           | 0.0110 | 0.0113 | 0.0115 | 0.0117 | 0.0119 | 0.0122 | 0.0124 |

<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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

**TABLE ASD-79b Coefficients  $\rho$  and  $\rho'$  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            |                    |   |   | DESIGN EQUATIONS |  |        |        |   |        |        |        |  |
|------------------------|--------------------|---|---|------------------|--|--------|--------|---|--------|--------|--------|--|
| $f'_m = 4000$ psi      | $f_y = 60,000$ psi |  | $K_f = \frac{M}{F} = \frac{M(\text{ft kips})}{bd^2/12,000}$ or $\frac{M(\text{in. lbs})}{bd^2}$ |                  | $\rho = \rho_b + \frac{K_f - K_{fb}}{F_s \left(1 - d'/d\right)}$ |        |        | $\rho' = \frac{K_f - K_{fb}}{(n - 1) \left[ \frac{k - d'/d}{k} \right] \left[ 1 - \frac{d'}{d} \right] 2F_b}$ |        |        |        |  |
| $f_b = 1800$ psi       | $F_s = 32,000$ psi |   |   |                  |  |        |        |   |        |        |        |  |
| $E_m = 3,600,000$ psi  |                    |   |   |                  |  |        |        |   |        |        |        |  |
| $E_s = 29,000,000$ psi |                    |   |   |                  |  |        |        |   |        |        |        |  |
| $n = 8.1$              | $k = 0.312$        |   |   |                  |  |        |        |   |        |        |        |  |
| $K_{fb} = 251.5$       | $\rho_b = 0.0088$  |   |   |                  |  |        |        |   |        |        |        |  |
| $d'/d^a$               | Steel Ratio        | $K_{fb}$  | $K_f$   |                  |  |        |        |   |        |        |        |  |
|                        | $\rho', \rho$      | 251.5   | 255   | 260              | 265  | 270    | 275    | 280   | 285    | 290    | 295    |  |
| 0.02                   | $\rho'$            | —   | 0.0003  | 0.0007           | 0.0012   | 0.0016 | 0.0020 | 0.0024  | 0.0029 | 0.0033 | 0.0037 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0092   | 0.0094 | 0.0095 | 0.0097  | 0.0099 | 0.0100 | 0.0102 |  |
| 0.04                   | $\rho'$            | —   | 0.0003  | 0.0008           | 0.0013   | 0.0017 | 0.0022 | 0.0027  | 0.0031 | 0.0036 | 0.0041 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0092   | 0.0094 | 0.0096 | 0.0097  | 0.0099 | 0.0101 | 0.0102 |  |
| 0.06                   | $\rho'$            | —   | 0.0004  | 0.0009           | 0.0014   | 0.0019 | 0.0024 | 0.0029  | 0.0035 | 0.0040 | 0.0045 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0092   | 0.0094 | 0.0096 | 0.0097  | 0.0099 | 0.0101 | 0.0102 |  |
| 0.08                   | $\rho'$            | —   | 0.0004  | 0.0010           | 0.0015   | 0.0021 | 0.0027 | 0.0033  | 0.0038 | 0.0044 | 0.0050 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0094 | 0.0096 | 0.0098  | 0.0099 | 0.0101 | 0.0103 |  |
| 0.10                   | $\rho'$            | —   | 0.0004  | 0.0011           | 0.0017   | 0.0024 | 0.0030 | 0.0036  | 0.0043 | 0.0049 | 0.0056 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0094 | 0.0096 | 0.0098  | 0.0100 | 0.0101 | 0.0103 |  |
| 0.12                   | $\rho'$            | —   | 0.0005  | 0.0012           | 0.0020   | 0.0027 | 0.0034 | 0.0041  | 0.0048 | 0.0056 | 0.0063 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0096 | 0.0098  | 0.0100 | 0.0102 | 0.0103 |  |
| 0.14                   | $\rho'$            | —   | 0.0006  | 0.0014           | 0.0022   | 0.0031 | 0.0039 | 0.0047  | 0.0055 | 0.0064 | 0.0072 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0097 | 0.0098  | 0.0100 | 0.0102 | 0.0104 |  |
| 0.16                   | $\rho'$            | —   | 0.0007  | 0.0016           | 0.0026   | 0.0035 | 0.0045 | 0.0054  | 0.0064 | 0.0074 | 0.0083 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0097 | 0.0099  | 0.0100 | 0.0102 | 0.0104 |  |
| 0.18                   | $\rho'$            | —   | 0.0008  | 0.0019           | 0.0030   | 0.0042 | 0.0053 | 0.0064  | 0.0076 | 0.0087 | 0.0098 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0097 | 0.0099  | 0.0101 | 0.0103 | 0.0105 |  |
| 0.20                   | $\rho'$            | —   | 0.0010  | 0.0023           | 0.0037   | 0.0050 | 0.0064 | 0.0078  | 0.0091 | 0.0105 | 0.0119 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0097 | 0.0099  | 0.0101 | 0.0103 | 0.0105 |  |
| 0.22                   | $\rho'$            | —   | 0.0012  | 0.0029           | 0.0046   | 0.0063 | 0.0080 | 0.0097  | 0.0114 | 0.0131 | 0.0148 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0093   | 0.0095 | 0.0097 | 0.0099  | 0.0101 | 0.0103 | 0.0105 |  |
| 0.24                   | $\rho'$            | —   | 0.0016  | 0.0038           | 0.0060   | 0.0083 | 0.0105 | 0.0127  | 0.0149 | 0.0172 | 0.0194 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0091           | 0.0094   | 0.0096 | 0.0098 | 0.0100  | 0.0102 | 0.0104 | 0.0106 |  |
| 0.26                   | $\rho'$            | —   | 0.0022  | 0.0054           | 0.0086   | 0.0117 | 0.0149 | 0.0181  | 0.0213 | 0.0244 | 0.0276 |  |
|                        | $\rho$             | 0.0088  | 0.0089  | 0.0092           | 0.0094   | 0.0096 | 0.0098 | 0.0100  | 0.0102 | 0.0104 | 0.0106 |  |
| 0.28                   | $\rho'$            | —   | 0.0037  | 0.0090           | 0.0143   | 0.0196 | 0.0249 | 0.0302  | 0.0355 | 0.0408 | 0.0461 |  |
|                        | $\rho$             | 0.0088  | 0.0090  | 0.0092           | 0.0094   | 0.0096 | 0.0098 | 0.0100  | 0.0103 | 0.0105 | 0.0107 |  |
| 0.30                   | $\rho'$            | —   | 0.0102  | 0.0247           | 0.0392   | 0.0538 | 0.0683 | 0.0828  | 0.0974 | 0.1119 | 0.1264 |  |
|                        | $\rho$             | 0.0088  | 0.0090  | 0.0092           | 0.0094   | 0.0096 | 0.0098 | 0.0101  | 0.0103 | 0.0105 | 0.0107 |  |

<sup>a</sup> For  $d'/d$  values greater than 0.24, the effect of compression reinforcement becomes increasingly negligible.

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