Structural Design of Insulating Concrete Form Walls in Residential Construction

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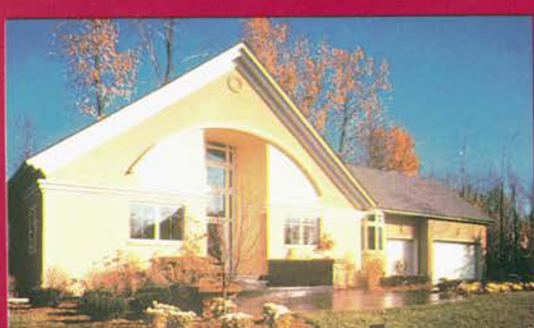

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Disclaimer

Foreword

Insulating concrete forms are hollow blocks, planks, or panels that can be constructed of rigid foam plastic insulation, a composite of cement and foam insulation, a composite of cement and wood chips, or other suitable insulating material that has the ability to act as forms for cast-in-place concrete walls. The forms typically remain in place after the concrete is cured to provide added insulation and are not considered to add to the structural capacity of the wall.

Although insulating concrete forms (ICFs) have been used successfully and extensively in Europe for over 60 years, it is only in the last five years that the system has become more widely used in the United States. The resistance to ICFs in the United States is waning as builders and homeowners become more familiar with the product and its capabilities. Some of the capabilities include the inherent strength of concrete construction in resisting high winds from hurricanes and tornadoes, the energy efficiency provided by insulating forms, the ability to reduce outside noise providing a quiet home, and the natural resistance to damage caused by termites. All of these attributes lead to a more durable form of construction. Recent unpredictable fluctuations in lumber prices and problems cited with the quality of lumber have also provided a major stimulus for the increased use of ICFs in light residential and commercial construction.

Even though ICFs have existed in the United States for almost 20 years, much of the resistance to ICFs in the United States is due to a lack of efficient design guidelines for residential structural concrete. *Structural Design of Insulating Concrete Form Walls in Residential Construction* presents a cost-effective and practical design procedure for residential buildings that reduces the cost of construction without sacrificing reliability, energy efficiency, or durability.

Acknowledgments

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The preparation of this document required the talents of many dedicated professionals. The principal authors are Andrea Vrankar, R.A., of the NAHB Research Center, Inc. and Lionel Lemay, P.E., of the Portland Cement Association, with review by Jay Crandell, P.E., of the NAHB Research Center, Inc. Graphics, figures, and illustrations were produced by Geoffrey Gilg of the NAHB Research Center, Inc., and Barbara Vrankar Karim. Clerical support was provided by Lynda Marchman of the NAHB Research Center, Inc.

Appreciation is also extended to LifeStyle HomeDesign Services of Urbandale, Iowa, for providing the home construction drawings on which the design example is based and to the many ICF manufacturers for their input and cooperation.

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Introduction

Structural Design of Insulating Concrete Form Walls in Residential Construction was developed as a guideline for the design of single- and multi-unit residential structures using insulating concrete form (ICF) wall systems. The objective of this design guide is to employ the technology efficiently by assisting designers, code officials, and others with limited exposure to concrete design. It provides a step-by-step method to design homes using insulating concrete form wall systems and demonstrates the design procedure in a comprehensive design example. Design aids in the form of graphs, charts, and tables are provided to assist designers.

All ICF systems are typically categorized with respect to the form of the ICF unit itself and the resulting form of the concrete wall once it has cured. There are three types of ICF forms: (1) *panel*, (2) *plank*, and (3) *block*. The differences among the ICF form types are their size and attachment requirements. The different form types exist mainly for ease of installation based on use, available resources, and builder preferences and do not necessarily affect the structural capacity of the wall.

There are also three categories of ICF systems based on the resulting form of the concrete wall. From a structural design standpoint, it is only the shape of the concrete inside the form, not the type of the ICF form, that is of importance. The shape of the concrete wall may be better understood by visualizing the form stripped away from the concrete, thereby exposing it to view. The three categories of ICF wall types are (1) *flat*, (2) *grid*, and (3) *post-and-beam*. The *grid* wall type is further categorized into (2a) *waffle-grid* and (2b) *screen-grid* wall systems.[1] Refer to Figure I-1 for a classification of currently available ICF manufacturers' wall systems and Figure I-2 for graphical representations of the ICF wall system types based on the definitions below. These definitions are provided solely to ensure that the design procedure in this document is applied to the ICF wall systems as the authors intended.

A *flat* ICF wall system is a solid concrete wall of uniform thickness.

The *waffle-grid* ICF wall system is a concrete wall composed of closely spaced vertical (maximum 12 inches (305 mm) on center) and horizontal (maximum 16 inches (406 mm) on center) concrete members with concrete webs (approximately 2 inches (51 mm) thick) in between the members. The

[1]In some publications and manufacturers' literature, the waffle-grid may be referred to as an uninterrupted-grid and the screen-grid may be referred to as an interrupted-grid or post-and-beam system.

thicker vertical and horizontal concrete members and the thinner concrete webs create the appearance of a breakfast waffle made of concrete "batter".

The *screen-grid* ICF wall system is similar to a waffle-grid ICF wall system without concrete webs in between the vertical and horizontal members. The thicker vertical and horizontal concrete members and the voids in between create the appearance of a window screen made of thick concrete "wire". For the design procedures described herein, screen-grid ICF wall systems have horizontal and vertical cores spaced a maximum of 12 inches (305 mm) on center. There are some screen-grid ICF wall systems with cores spaced farther than 12 inches (305 mm) on center that may be analyzed in a similar manner; however, this document does not address these systems.

The *post-and-beam* ICF wall system has vertical and/or horizontal concrete members spaced farther than 12 inches (305 mm) on center; therefore, the post-and-beam ICF wall system resembles a concrete frame rather than a monolithic concrete construction (i.e. flat or grid wall). Given that post-and-beam ICF wall systems require a different engineering analysis than flat and grid systems per ACI 318-95, the design method for post-and-beam systems is not included in this design guide.

Manufacturer	ICF Wall Systems			
	Flat	Waffle-Grid	Screen-Grid	Post-and-Beam
3-10 Insulated Forms		*Reward*		
AAB Building Systems	*Bluemaxx*			
AFM Insulated Building Systems	*Diamond Snap-Form*			
American Conform Industries	*SmartBlock VWF*		*SmartBlock SFIO*	
American Polysteel Forms		*Polysteel*		
Amhome USA, Inc.				*Amhome*
ConsulWal		*Consulwal*		
Ener-Grid Building Systems, Inc.				*Ener-Grid*
Energy Lock, Inc.				*Energy Lock*
Featherlite, Inc.				*Featherlite*
Foam Form Systems, LLC	*Foam Form*			
GreenBlock Worldwide Corp.	*GreenBlock*			
ICE Block Building Systems		*ICE Block*		
K-X Industries			*FasWall*	
K & B Associates, Inc.	*Vari-Form*		*E-Z Form*	
Keeva Associates, Inc.				*Keeva*

Manufacturer	ICF Wall Systems			
	Flat	Waffle-Grid	Screen-Grid	Post-and-Beam
Lite-Form, Inc.	*Fold-Form & Lite-Form*			
PermaForm, Inc.			*PermaForm*	
Polycrete Industries, Inc.	*Polycrete*			
Poly-Forms LLC			*Poly-Form*	
Quad-Lock Building Systems	*Quad-Lock*			
RASTRA/ Environmental Building				*Rastra*
Reddi-Form, Inc.			*Reddi-Form*	
R-Forms, Inc.	*R-Form*			
Structura Technologies	*PermaForm*			
Tech Systems	*Tech System*			
ThermoBlock				*ThermoBlock*
Therm-O-Wall		*Therm-O-Wall*		
ThermoFormed Block Corp.	*T-Solid*			*ThermoFormed*
Wall Technologies	*Straight-Block*			
Western Insulform, Inc.				*Insulform*

***Figure I-1 ICF Wall System Classification*[2,3]**

[2]Due to the rapid growth in the ICF industry, ICF manufacturers may exist that do not appear in Figure I-1. There is no intention to preclude any ICF manufacturer. ICF manufacturers that do not appear in Figure I-1 may be classified according to the given ICF system definitions.

[3]There are some post-and-beam ICF wall manufacturers that can vary the spacing of the vertical and horizontal concrete members rather easily. When the spacing of these systems is altered to coincide with the definition of the screen-grid ICF wall system, these systems may be designed in accordance with the screen-grid ICF wall system design provisions herein.

Much of the design procedure described herein is based on the American Concrete Institute's *Building Code Requirements for Structural Concrete (ACI 318-95).* References made to requirements from ACI 318-95 are presented by stating the document and section in a compatible format (e.g. ACI 10.12.1).

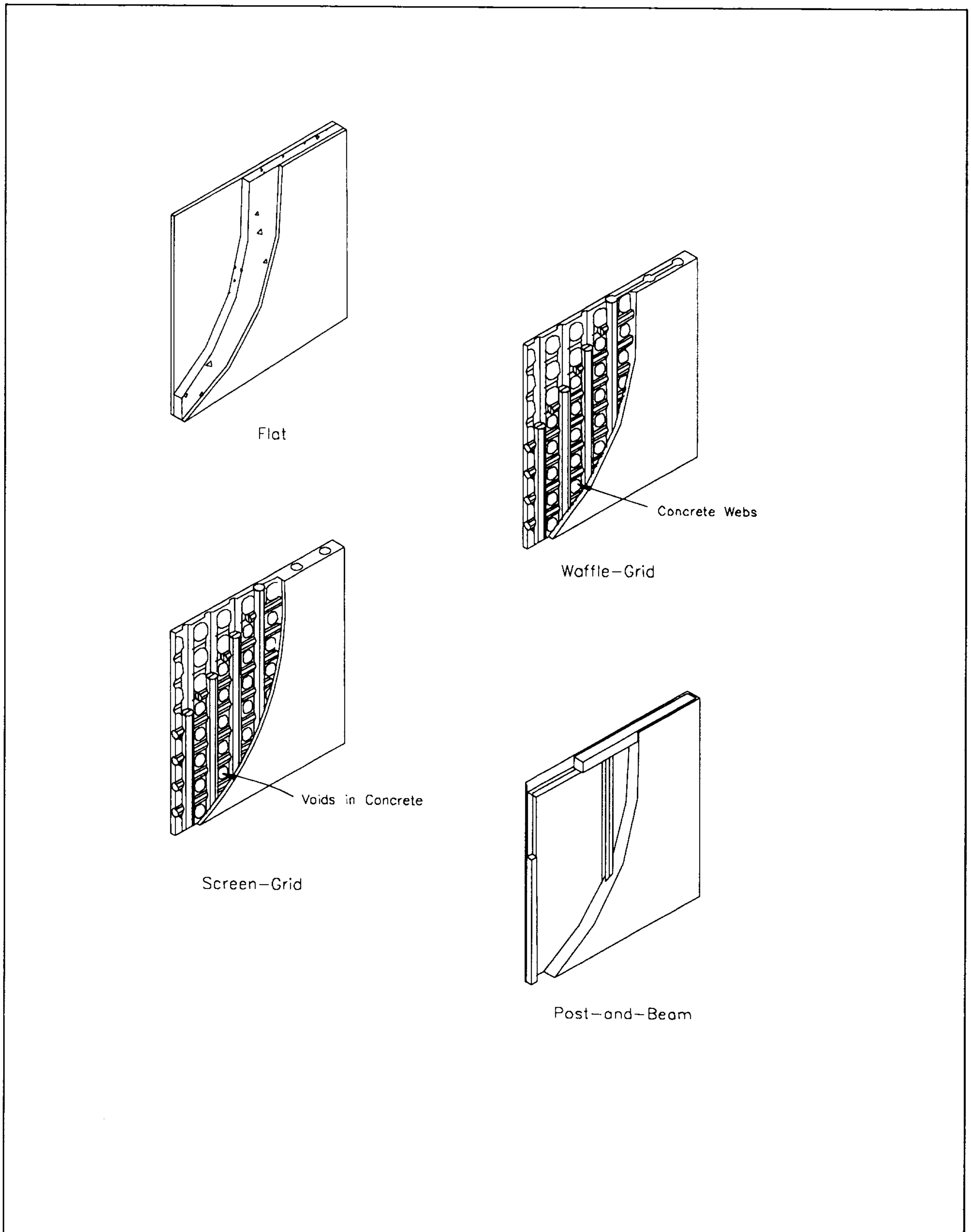

Figure I-2 ICF Wall System Types

Chapter 1

ICF Design Procedure

1.1 APPLICATION AND LIMITATIONS

The design procedure presented in this publication addresses the design of flat, waffle-grid, and screen-grid ICF wall systems used specifically in single- and multi-unit residential construction. The differences among the ICF wall types affect their structural capacity and the methods with which they are structurally analyzed.

Prior to implementing the recommended design procedures described herein, care must be taken to accurately define and analyze the ICF wall system according to the definitions and categories described in the introduction. These definitions are provided solely to ensure that the design procedure in this document is applied to the ICF wall systems as the authors intended. Refer to Figure I-1 for a classification of currently available ICF manufacturers' wall systems based on the definitions in the introduction.

This publication assumes that the user is familiar with load analysis on residential structures, strength-based design procedures, the ACI 318 code, and basic engineering mechanics. This publication also assumes that a user in high seismic regions is very familiar with any special detailing requirements in high seismic regions; therefore, the simplified design procedure presented in this publication does not include any special detailing required for concrete construction in high seismic regions. *The simplified design procedure presented in this publication is not intended to substitute in any way for the recommendations of any ICF manufacturer or accepted engineering practice in general. The manufacturer's recommendations and accepted engineering practices always take precedence over any material presented herein.*

1.2 STRUCTURAL REINFORCED CONCRETE WALLS

The design of structural reinforced concrete walls is governed by ACI 318 Chapter 14, "Walls". ICF wall geometry and loading conditions often do not satisfy the limitations of the empirical design method specified in ACI 14.5; therefore, the design procedure below provides a more flexible approach by which walls are designed as compression members in accordance with ACI 14.4. Although not discussed in detail here, walls may be designed in accordance with ACI 14.5 using the empirical design method if the following limiting conditions are satisfied:

- The wall cross-section is solid.
- The resultant of all axial loads acts within the middle one-third of the wall thickness.
- The wall thickness is not less than 4 inches (102 mm) for above-grade walls or 7.5 inches (191 mm) for basement walls.
- The wall thickness is not less than 1/25 of the supporting wall height or length of the wall, whichever is smaller.

The required minimum horizontal and vertical reinforcement ratio specified in ACI 14.3 for structural reinforced concrete walls has been relaxed in the following design approach based on test data[4] under the provision of ACI 14.2.7, which states

> "Quantity of reinforcement and limits of thickness required by 14.3 and 14.5 shall be permitted to be waived where structural analysis shows adequate strength and stability."

In addition, there is evidence to show that the minimum wall thickness requirements, particularly for basement walls, may be conservative for many residential design conditions. The *One- and Two-Family Dwelling Code* permits basement walls of 5.5 inch (140 mm) thickness when the height of unbalanced fill is less than a prescribed maximum. Analysis will confirm this practice depending on the lateral soil loads present.

1.2.1 Select Trial Wall Section and Properties

Select an ICF wall system type (flat, waffle-grid, or screen-grid), a trial wall thickness for each story, and a trial vertical reinforcement and spacing. In addition, select a trial compressive strength for the concrete and a yield strength for the steel reinforcement. The selection of a particular ICF wall system type may be an issue of personal preference, cost, availability, and other concerns.

1.2.2 Determine Nominal and Factored Loads

Determine the loads acting on all structural concrete walls in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering

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[4]John Roller, *Design Criteria for Insulating Concrete Form Wall Systems (RP 116)*, Portland Cement Association, Skokie, Illinois, 1996.

mechanics. Determine the critical factored axial load and moment for each applicable ACI load case listed in ACI 9.2.

For above-grade walls, applicable ACI load cases are generally

(1) 1.4 Dead + 1.7 Live
(2) 0.75 (1.4 Dead + 1.7 Live + 1.7 Wind)
(3) 0.9 Dead + 1.3 Wind
(4) 0.75 (1.4 Dead + 1.7 Live + 1.87 Seismic)
(5) 0.9 Dead + 1.43 Seismic

For below-grade walls, applicable ACI load cases are generally

(1) 1.4 Dead + 1.7 Live
(2) 0.75 (1.4 Dead + 1.7 Live + 1.7 Earth)
(3) 0.9 Dead + 1.7 Earth

ACI Load Case (1) rarely governs design, and ACI Load Cases (4) and (5) rarely govern design unless the structure is situated in regions of high seismic risk. To simplify calculations further, each wall story may be conservatively assumed to act as a simple span with each end pinned. Appendix A contains basic load diagrams and equations to assist in calculating typical loading conditions encountered in residential design. Refer to Chapter 2, "ICF Design Example" for examples on how to calculate loads.

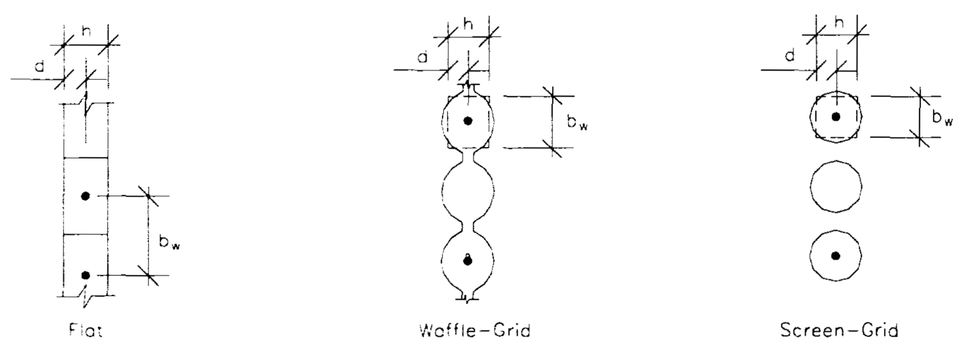

Figure 1-1 Design Variables Defined for Perpendicular Shear Calculations for Structural Reinforced Concrete Walls

1.2.3 Check Perpendicular Shear

The following equations are taken from ACI 11.10 to check perpendicular wall shear. Even though unreinforced vertical cores and webs are often neglected when calculating perpendicular shear, perpendicular shear rarely governs in residential concrete wall design. Dimensions are often simplified for waffle- and screen-grid wall systems that have complex cross-sectional geometries.

Refer to Figure 1-1 for the design variables used in determining perpendicular shear for various ICF wall types. Although shear reinforcement is permitted in ACI 11.5, the use of stirrups in thin ICF walls is difficult to install and should be avoided. If greater shear capacity is required, increasing the thickness of the wall, increasing the compressive strength of the concrete, or using vertical reinforcement to resist shear forces by the shear-friction method (ACI 11.7) is suggested in lieu of using stirrups.

$$V_u \le \phi V_n$$
$$V_n = V_c + V_s$$
$$V_c = 2\sqrt{f_c'}b_w d$$
$$V_s = \frac{A_v f_y d}{s} \le 8\sqrt{f_c'}b_w d \quad when \; V_u > \phi V_c$$
$$A_v = \frac{(V_u - \phi V_c)s}{\phi f_y d} \ge \frac{50 b_w s}{f_y} \quad for\ vertical\ stirrups$$
$$s \le minimum\ of \begin{Bmatrix} d/2 \\ 24" \end{Bmatrix}$$
$$s \le minimum\ of \begin{Bmatrix} d/4 \\ 12" \end{Bmatrix} \; when \; V_s < 4\sqrt{f_c'}b_w d$$

$$SHEAR - FRICTION\ METHOD$$
$$V_u \le \phi V_n$$
$$V_n = A_{vf} f_y \mu \le 0.2 f_c' A_c \; and \le 800\,A_c$$
$$A_c = b_w h$$

where:

λ	Correction factor related to unit weight of concrete = 1.0 for normal weight concrete per ACI 11.7.4	dimensionless
μ	Coefficient of friction per ACI 11.7.4 Concrete placed monolithically .... 1.4λ Concrete placed against hardened concrete with surface intentionally roughened ¼ inch (6.4 mm).......... 1.0λ Concrete placed against hardened concrete not intentionally roughened .... 0.6λ Concrete anchored to as-rolled structural steel by headed studs or by reinforcing bars.......... 0.7λ	dimensionless
ϕ	Strength reduction factor = 0.85 per ACI 9.3.2	dimensionless
A_c	Area of concrete section resisting shear transfer	inch^2
A_v	Area of shear vertical reinforcement within distance, s	inch^2
A_{vf}	Area of shear-transfer vertical reinforcement	inch^2
b_w	Web width, Refer to Figure 1-1	inch
d	Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, Refer to Figure 1-1	inch
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of shear reinforcement ≤ 60,000 psi per ACI 11.5.2 and 11.7.6	psi
h	Concrete wall thickness, Refer to Figure 1-1	inch
s	Spacing of shear reinforcement per ACI 11.5.4	inch

V_c	Nominal shear strength of concrete per ACI 11.3.1.1	lb
V_n	Nominal shear strength per ACI 11.1.1 or ACI 11.7.4	lb
V_u	Factored shear force at section	lb
V_s	Nominal shear strength of steel reinforcement per ACI 11.5.6, assume $V_s = 0$ when $V_u \leq \phi V_c$ for ease of ICF construction	lb

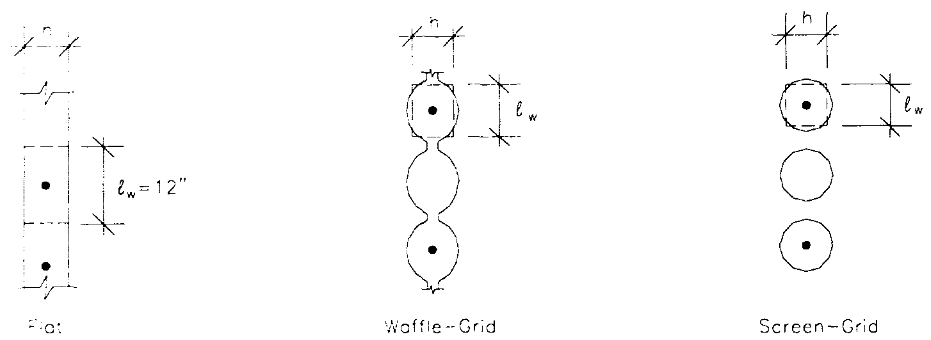

Figure 1-2 Design Variables Defined for Parallel (In-Plane) Shear Calculations for Structural Reinforced Concrete Walls

1.2.4 Check Parallel (In-Plane) Shear

The following equations are taken from ACI 11.10 to check parallel wall shear. All vertical cores, both reinforced and unreinforced, are often assumed to resist parallel wall shear. Dimensions are often simplified for waffle- and screen-grid wall systems that have complex cross-sectional geometries. Design variables for determining parallel shear for various ICF wall types are illustrated in Figure 1-2. The level of parallel shear encountered in residential concrete construction typically does not require the use of shear reinforcement unless the wall is constructed with a large number of openings or is in an area with large lateral loads from wind or seismic forces. If shear reinforcement is required, the use of vertical and horizontal steel reinforcement may be used to increase the shear capacity of the wall.

$$V_u \leq \phi V_n$$
$$V_n = V_c + V_s$$
$$V_s = \frac{A_v f_y d}{s_2} \quad when \ V_u > \phi V_c$$
$$d = 0.8 l_w$$
$$V_c = 2\sqrt{f_c{'}}hd$$

where:

ϕ	Strength reduction factor = 0.85 per ACI 9.3.2	dimensionless
A_v	Area of horizontal shear reinforcement within a distance, s_2, and distance, d per ACI 11.10	inch^2
d	As in equation per ACI 11.10.4	inch
fc'	Specified compressive strength of concrete	psi
fy	Specified yield strength of shear reinforcement	psi
h	Concrete wall thickness, Refer to Figure 1-2	inch

l_w	Length of reinforced segment, Refer to Figure 1-2	inch
s_2	Spacing of horizontal shear reinforcement per ACI 11.10.9	inch
V_c	Nominal shear strength of concrete per ACI 11.10.5	lb
V_n	Nominal shear strength per ACI 11.2	lb
V_s	Nominal shear strength of shear reinforcement per ACI 11.10.9, assume $V_s = 0$ when $V_u \leq \phi V_c$	lb
V_u	Factored shear force at section	lb

1.2.5 Sway Determination

Determine whether the wall is part of a non-sway or sway frame by comparing the total lateral stiffness of the compression member to that of the bracing elements. A compression member may be assumed braced if it is located in a story in which bracing elements provide resistance against large lateral deflections so as not to affect the column strength substantially. Most homes built with flat, waffle-grid, or screen-grid ICF wall systems on all four sides can be categorized as non-sway frames provided reasonable limits on the amount of wall openings are met.

1.2.6 Determine Slenderness

ACI 10.10.2 allows an approximation method for walls with a slenderness ratio, kl_u/r, of 100 or less to account for slenderness effects in a wall. Walls with a slenderness ratio, kl_u/r , greater than 100 require a second-order analysis in accordance with ACI 10.10.1. The approximation method described in detail here is referred to as the moment magnifier method and is ideal for typical residential-scale construction with slenderness ratios less than 100.

1.2.6.1 Non-Sway Frames (ACI 10.12)

If the following condition is satisfied, the designer may ignore slenderness and go to Section 1.2.7.

$$\frac{kl_u}{r} < 34 - 12\frac{M_1}{M_2}$$

where:

k	Effective length factor $\leq$ 1.0; for most residential construction, k = 1.0 if the wall is tied to the footing, floors, and roof	dimensionless
l_u	Unsupported length of compression member	inch
M_1/M_2	Ratio of smaller factored end moment to larger factored end moment $\geq$ -0.5	dimensionless
M_1	Smaller factored end moment, very often assumed to be 0	in-lb
M_2	Larger factored end moment	in-lb
r	Radius of gyration of cross-section per ACI 10.11.2, Refer to Appendix B $\approx$0.3h for rectangular members or $\approx$0.25d for circular compression members	inch

1.2.6.2 Sway Frames (ACI 10.13)

For residential construction, the following condition is rarely satisfied; therefore, slenderness must be accounted for in a sway frame analysis using the magnified moment method described in Section 1.2.7. If the following condition is satisfied, the designer may ignore slenderness and go to Section 1.2.7.

$$\frac{kl_u}{r} < 22$$

where:

h	Concrete wall thickness; Refer to Figure 1-2	inch
k	Effective length factor $\geq$ 1.0 per ACI 10.13.1	dimensionless
l_u	Unsupported length of compression member	inch
r	Radius of gyration of cross-section per ACI 10.11.2, Refer to Appendix B $\approx$0.3h for rectangular members or $\approx$0.25d for circular compression members	inch

1.2.7 Determine Magnified Moment

1.2.7.1 Non-Sway Frames

Tables are provided in Appendix C to determine the moment magnifier for flat, waffle-grid, and screen-grid walls. Unreinforced vertical cores and webs are often not assumed to resist moments and axial loads experienced by the wall. To use the moment magnifier tables in Appendix C, calculate the following variables:

$$e = \frac{M_2}{P_u}$$

$$M_{2,min} = P_u(0.6 + 0.03h)$$

$$\beta_d = \frac{P_{u,dead}}{P_u}$$

$$\rho = \frac{A_s}{A_g}$$

where:

β_d	Ratio of dead axial load to total axial load	dimensionless
ρ	Ratio of the area of vertical reinforcement to gross concrete area, assume ρ = 0.0012	dimensionless
A_g	Gross area of concrete	inch^2
A_s	Area of vertical steel reinforcement	inch^2
e	Overall eccentricity of axial load in the wall	inch
h	Concrete wall thickness, Refer to Figure 1-2	inch
M_2	Larger factored end moment determined in Section 1.2.2	in-lb
$M_{2,min}$	Minimum permissible value of M_2	in-lb
P_u	Factored axial load determined in Section 1.2.2	lb
$P_{u,dead}$	Factored axial dead load determined in Section 1.2.2	lb

Using the calculated values for e, P_u, and β_d and the initial assumed value for ρ of 0.0012, select the value of the moment magnifier, δ_{ns}, from the moment magnifier tables in Appendix C for the given wall height, ICF wall system type, wall thickness, and concrete compressive strength. For wall types that do not meet the minimum dimensions on which the Appendix C tables are based, calculate the moment magnifier using the equations in Appendix C, "Non-Sway Frames".

Determine the magnified moment using the following equation:

$$M_{ns} = \begin{Bmatrix} \delta_{ns} M_2 \\ \delta_{ns} M_{2,min} \end{Bmatrix} \textit{ whichever is greater}$$

where:

δ_{ns}	Moment magnifier from Appendix C	dimensionless
M_2	Larger factored end moment	in-lb
$M_{2,min}$	Minimum value of M_2	in-lb
M_{ns}	Magnified factored moment of a non-sway frame	in-lb

1.2.7.2 Sway Frames

Moment magnifier tables for sway frames do not appear in this document. Determine the magnified moment, δ_s, using the equations in Appendix C, "Sway Frames".

1.2.8 Determine Reinforcement

To determine if the wall section is adequately reinforced, plot the magnified moment and the corresponding total factored axial load from Section 1.2.7 on an interaction diagram. Partial interaction diagrams can be found in Appendix D for most residential applications. The reinforcement plot line that lies below and to the right of the plotted point is the minimum vertical reinforcement required for the given wall section. If the plotted point lies directly on a reinforcement plot line, select that line for the minimum vertical reinforcement. Refer to Appendix D for more information on interaction diagrams and the equations used to construct complete interaction diagrams.

Tests have shown that horizontal and vertical reinforcement spacing limited to 8 times the wall thickness or 48 inches (1.2 m) results in good performance;[5] therefore, it is suggested that the designer limit the vertical and horizontal reinforcement spacing to 8 times the wall thickness, not to exceed 48 inches (1.2 m).

Per ACI 14.3.7, the designer is required to provide additional reinforcement around all window and door openings to distribute loads; however, the requirement for two #5 bars around openings may be excessive for residential loading and a smaller amount of reinforcement may be used around openings when justified by structural analysis. Refer to Section 2.4.7.2 for an example on how to determine reinforcement required around wall openings by structural analysis.

1.2.9 Check Deflection

ACI 318 does not limit wall deflection specifically; however, since many interior and exterior finishes applied to an ICF wall are susceptible to damage by large wall deflections, a conservative deflection limit of *L/360* for live service loads and *L/240* for total service loads is suggested for above-grade walls. For below-grade walls, a conservative deflection limit of *L/240* for live service loads is suggested since earth loads are immediate and are not expected to change with time. These

[5]John Roller, *Design Criteria for Insulating Concrete Form Wall Systems (RP 116)*, Portland Cement Association, Skokie, Illinois, 1996.

deflection limits are conservative suggestions; deflection limits should be specified by the designer based on the finishes being used. When using the moment magnifier concept, it is recommended that the calculated moment magnification factor be applied to the service load moments used in conducting the deflection calculations.

To calculate wall deflection at service load levels, effective section properties of the assumed cracked concrete section must be established. According to test results,[6] calculating deflection using $0.1E_cI_g$ was found to be conservative but more accurate than calculating deflection based on the cracking moment per ACI 9.5.2.3.

If service load deflections are found to be unacceptable, the designer may either increase the wall thickness or increase the quantity of vertical reinforcement. For most ICF wall configurations and residential loading conditions, however, satisfying service load deflection limits should not be a limiting condition.

[6]John Roller, *Design Criteria for Insulating Concrete Form Wall Systems (RP 116)*, Portland Cement Association, Skokie, Illinois, 1996.

1.3 STRUCTURAL PLAIN CONCRETE WALLS

Structural plain concrete walls are concrete walls that either have no reinforcement or less than the minimum amount specified by ACI for reinforced concrete. Structural plain concrete walls are designed according to the provisions of ACI 318 Chapter 22, which limits the use of plain concrete walls to members provided with continuous vertical support throughout the member's length. ACI 22.3 further requires contraction and isolation joints to provide flexural discontinuity and to control cracking. ICF walls may be exempt from the required contraction joints because random cracking due to creep, shrinkage, and temperature is assumed to have a negligible impact on the structural integrity of the wall. Some nominal level of reinforcement to control crack width may be included at the designer's discretion.

Limitations on the use of structural plain concrete are listed in ACI 22.6.6 and include the following:

- The horizontal length of wall to be considered effective for each vertical concentrated load is not greater than the distance between loads, or width of bearing plus 4 times the wall thickness.
- The wall thickness is not less than 1/25 of the supporting wall height or length of the wall, whichever is smaller.
- The wall thickness is not less than 5.5 inches (140 mm) for above-grade walls or 7.5 inches (190 mm) for basement walls.
- Walls are braced against lateral translation.
- Window and door openings require not less than two #5 bars around the openings extending not less than 24 inches (610 mm) beyond the corners of the openings.

There is evidence to show that the requirement for two #5 bars around openings may be excessive for residential loading. The *Standard Building Code* and *National Building Code* have clauses modifying this requirement to one #4 bar provided that vertical bars span continuously from support to support and horizontal bars extend a minimum of 24 inches (610 mm) beyond the opening. Likewise, there is evidence to show that minimum wall thickness requirements, particularly for basements, may be conservative for many residential conditions. The *One- and Two-Family Dwelling Code* permits unreinforced basement walls of 5.5-inch (140 mm) thickness when the height of unbalanced fill is less than a prescribed maximum. Analysis will confirm this practice depending on the lateral soil loads present.

ICF wall geometry and loading conditions often do not satisfy the limitations of the empirical design method specified in ACI 22.6.5; therefore, the design procedure below provides a more flexible approach by which walls are designed as compression members in accordance with ACI 22.5. Although not discussed in detail here, walls may be designed in accordance with ACI 22.6.5 using the empirical design method if the following additional limiting conditions are satisfied:

- The wall cross-section is solid.

- The resultant of all axial loads acts within the middle one-third of the wall thickness.

1.3.1 Select Trial Wall Section and Properties

Select an ICF wall system type (flat, waffle-grid, or screen-grid), a trial wall thickness for each wall story, and a trial concrete compressive strength. The selection of a particular ICF wall system type may be an issue of personal preference, cost, availability, or other concerns.

1.3.2 Determine Nominal and Factored Loads

Determine the loads acting on all structural concrete walls in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Determine the critical factored axial load and moment for each applicable ACI load case listed in ACI 9.2.

For above-grade walls, applicable ACI load cases are generally

(1) 1.4 Dead + 1.7 Live
(2) 0.75 (1.4 Dead + 1.7 Live + 1.7 Wind)
(3) 0.9 Dead + 1.3 Wind
(4) 0.75 (1.4 Dead + 1.7 Live + 1.87 Seismic)
(5) 0.9 Dead + 1.43 Seismic

For below-grade walls, applicable ACI load cases are generally

(1) 1.4 Dead + 1.7 Live
(2) 0.75 (1.4 Dead + 1.7 Live + 1.7 Earth)
(3) 0.9 Dead + 1.7 Earth

ACI Load Case (1) rarely governs design, and ACI Load Cases (4) and (5) rarely govern design unless the structure is situated in regions of high seismic risk. To simplify calculations further, each wall story may be conservatively assumed to act as a simple span with pinned ends. Appendix A contains basic load diagrams and equations to assist in calculating typical loading conditions encountered in residential design. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

1.3.3 Check Perpendicular Shear

The equations below are taken from ACI 22.5.4 to check perpendicular wall shear. Greater shear capacity may be obtained by increasing the thickness of the wall, increasing the compressive strength of the concrete, or adding shear reinforcement. Dimensions are often simplified for waffle- and screen-grid wall systems that have complex cross-sectional geometries. Refer to Figure 1-3 for the design variables used in determining perpendicular shear for various ICF wall types. Refer to Section 1.2, "Structural Reinforced Concrete Walls", if shear reinforcement is required.

$$V_u \le \phi V_n$$
$$V_n = \frac{4}{3}\sqrt{f_c'}bh$$

where:

ϕ	Strength reduction factor = 0.65 per ACI 9.3.5	dimensionless
b	Width of concrete member, Refer to Figure 1-3	inch
h	Concrete wall thickness, Refer to Figure 1-3	inch
f_c'	Specified compressive strength of concrete	psi
V_n	Nominal shear strength at section per ACI 22.5.4 for normal weight concrete	lb
V_u	Factored shear force at section	lb

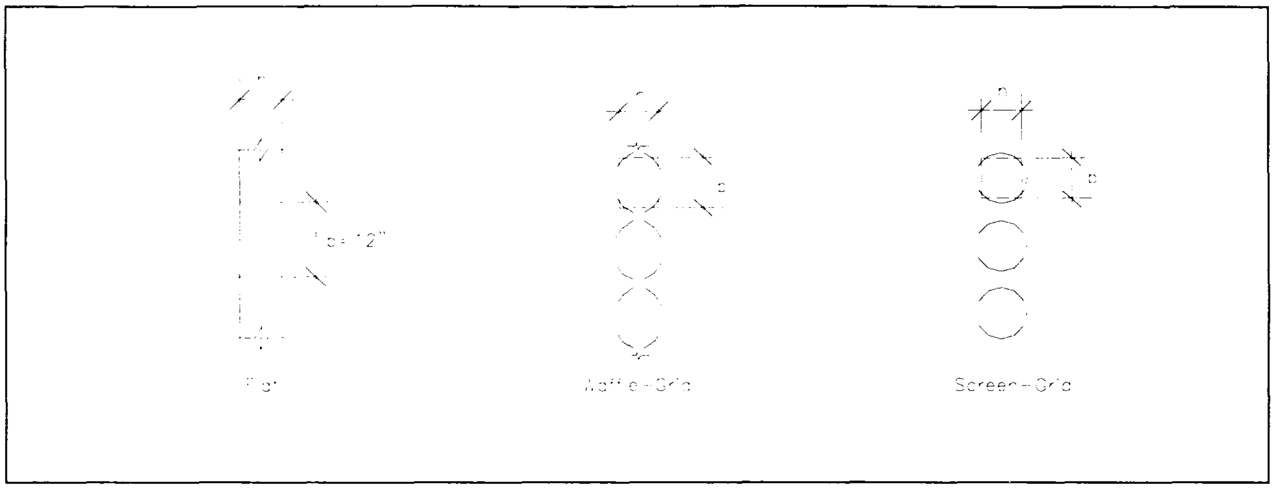

Figure 1-3 Design Variables Defined for Perpendicular Shear Calculations for Structural Plain Concrete Walls

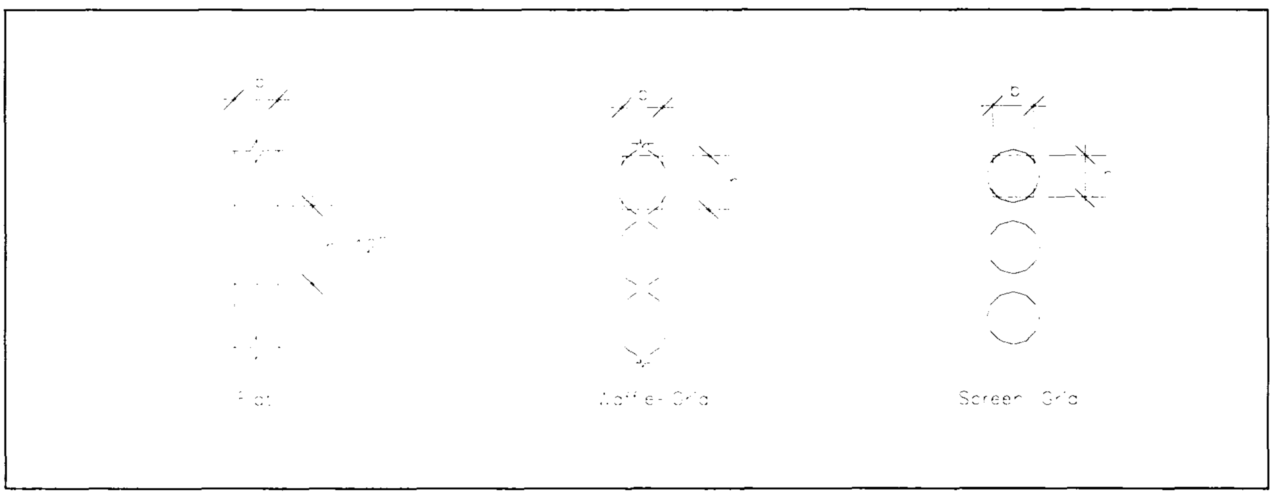

Figure 1-4 Design Variables Defined for Parallel (In-Plane) Shear Calculations for Structural Plain Concrete Walls

1.3.4 Check Parallel (In-Plane) Shear

The equations below are taken from ACI 22.5.4 to check parallel wall shear. Design variables for determining parallel shear for various ICF wall types are illustrated in Figure 1-4. The level of parallel shear encountered in residential concrete construction typically does not require the use of shear reinforcement unless the wall is constructed with a large number of openings or is in an area with large lateral loads from wind or seismic forces. Greater shear capacity may be obtained by increasing the thickness of the wall, increasing the compressive strength of the concrete, reducing the number of openings in the walls, or adding shear reinforcement. Refer to Section 1.2, "Structural Reinforced Concrete Walls", if shear reinforcement is required.

$$V_u \leq \phi V_n$$
$$V_n = \frac{4}{3}\sqrt{f_c'}bh$$

where:

ϕ	Strength reduction factor = 0.65 per ACI 9.3.5.	dimensionless
b	Thickness of concrete member, Refer to Figure 1-4	inch
h	Width of concrete member, Refer to Figure 1-4	inch
f_c'	Specified compressive strength of concrete	psi
V_n	Nominal shear strength at section per ACI 22.5.4 for normal weight concrete	lb
V_u	Factored shear force at section	lb

1.3.5 Check Compression and Tension

To determine if the wall section is capable of resisting the design loads, plot the factored moment and the corresponding total factored axial load from Section 1.3.2 on an interaction diagram for structural plain concrete. The minimum factored moment required for design by ACI 22.6.3 is

$$M_{u,min} = 0.1hP_u$$

where:

h	Concrete wall thickness, Refer to Figure 1-3	inch
P_u	Factored total axial load	lb
$M_{u,min}$	Minimum factored bending moment	in-lb

Interaction diagrams can be found in Appendix E for most residential applications. If the plotted point lies within the lower tension boundary, the upper compression boundary for the given wall height, and the reference axes, the wall section is adequate. Refer to Appendix E for more information on interaction diagrams and the equations used to construct them.

If the wall section is not adequate, repeat Sections 1.3.1 through 1.3.5 with an increased wall thickness or increased concrete compressive strength. Alternatively, design the wall in accordance with Section 1.2, "Structural Reinforced Concrete Walls", using steel reinforcement to obtain the strength required.

1.3.6 Check Deflection

ACI 318 does not limit wall deflection specifically; however, since many interior and exterior finishes applied to an ICF wall are susceptible to damage by large wall deflections, a conservative deflection limit of *L/360* for live service loads and *L/240* for total service loads is suggested for above-grade walls. For below-grade walls, a conservative deflection limit of *L/240* for service live loads is suggested since earth loads are immediate and are not expected to change with time. These deflection limits are conservative suggestions; deflection limits should be specified by the designer based on the finishes being used.

To calculate wall deflection at service load levels, effective section properties of the assumed uncracked concrete section are based on $E_c I_g$.

If service load deflections are found to be unacceptable, the designer may either increase the wall thickness or add vertical reinforcement. For most ICF wall configurations and residential loading conditions, however, satisfying service load deflection limits should not be a limiting condition.

1.3.7 Determine Reinforcement

Although the wall is designed as a structural plain concrete wall, a nominal amount of reinforcement is typically specified. Tests have shown that horizontal reinforcement spacing limited to 8 times the wall thickness or 48 inches (1.2 m) results in good performance;[7] therefore, it is suggested that the designer limit the horizontal reinforcement spacing to 8 times the wall thickness, not to exceed 48 inches (1.2 m).

Per ACI 22.6.6.5, the designer is required to provide two #5 bars around all window and door opening; however, this may be excessive for residential loading. The *Standard Building Code* and *National Building Code* have clauses modifying this requirement to one #4 bar provided that vertical bars span continuously from support to support and horizontal bars extend a minimum of 24 inches (610 mm) beyond the opening. In addition, one continuous #4 bar at the top of the wall is suggested. Lintels and narrower sections of wall near openings may require reinforcement in accordance with Section 1.2, "Structural Reinforced Concrete Walls".

[7]John Roller, *Design Criteria for Insulating Concrete Form Wall Systems (RP 116)*, Portland Cement Association, Skokie, Illinois, 1996.

1.4 LINTELS

Lintels are concrete beams typically placed above doors and windows to support the floor, roof, and/or wall above. Lintel design is governed by the provisions of ACI Chapter 10, "Flexure and Axial Loads", and Chapter 11, "Shear and Torsion".

1.4.1 Select Trial Lintel Section and Properties

Select a lintel depth, thickness, area of steel reinforcement for shear and bending, and a reinforcement yield strength.

1.4.2 Determine Nominal and Factored Loads

Determine loads acting on lintels in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Determine the critical factored load and moment for each applicable ACI load case listed in ACI 9.2. For lintels, the applicable ACI load case is generally

$$1.4 \text{ Dead} + 1.7 \text{ Live}$$

Each lintel is conservatively assumed to act as a simple span with each end pinned to simplify calculations. To some degree, the lintel may behave like a fixed-end beam; however, if such a model is assumed, the lintel should also be reinforced near the top. If the lintel is assumed to act as a fixed-end beam, sufficient embedment of the top and bottom reinforcement beyond each side of the opening should be provided to fully develop a moment resisting end in the lintel. Appendix A contains basic load diagrams and equations to assist in calculating typical structural loads. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

1.4.3 Check Deflection

Windows and doors are susceptible to damage by large lintel deflections; therefore, a conservative deflection limit of $L/480$ for service dead loads and sustained live loads is suggested. This limit is very conservative when the installation of the window and door components is properly detailed to allow for significant lintel deflection; deflection limits should be specified by the designer for given applications.

To calculate lintel deflection at service load levels, effective section properties of the assumed cracked concrete section must be established. According to test results,[8] deflection calculated using $0.1E_cI_g$ was found to be conservative but more accurate than deflection based on the cracking moment per ACI 9.5.2.3.

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[8] John Roller, *Design Criteria for Insulating Concrete Form Wall Systems (RP 116)*, Portland Cement Association, Skokie, Illinois, 1996.

If service load deflections are found to be unacceptable, the designer may either increase the lintel depth, increase the quantity of reinforcement, or use a modified lintel.

1.4.4 Check Nominal Moment Strength

ICF lintels are designed for bending using the equations below in accordance with ACI Chapter 10, "Flexure and Axial Loads". The width of the compression face varies for each type of ICF wall system; refer to Figure 1-5 for the appropriate width dimension.

$$M_u \leq \phi M_n$$

$$\phi M_n = \phi A_s f_y \left(d - \frac{a}{2}\right)$$

$$a = \frac{A_s f_y}{0.85 f_c{}' b}$$

where:

ϕ	Strength reduction factor = 0.9 for flexure per ACI 9.3.2	dimensionless
a	Depth of equivalent rectangular stress block	inch
A_s	Area of tensile reinforcement	inch^2
b	Width of compression face of member, Refer to Figure 1-5	inch
d	Distance from extreme compression fiber to centroid of tensile reinforcement, Refer to Figure 1-5	inch
$f_c{}'$	Specified compressive strength of concrete	psi
f_y	Specified yield strength of reinforcement	psi
M_n	Nominal moment strength	in-lb
M_u	Factored moment at section	in-lb

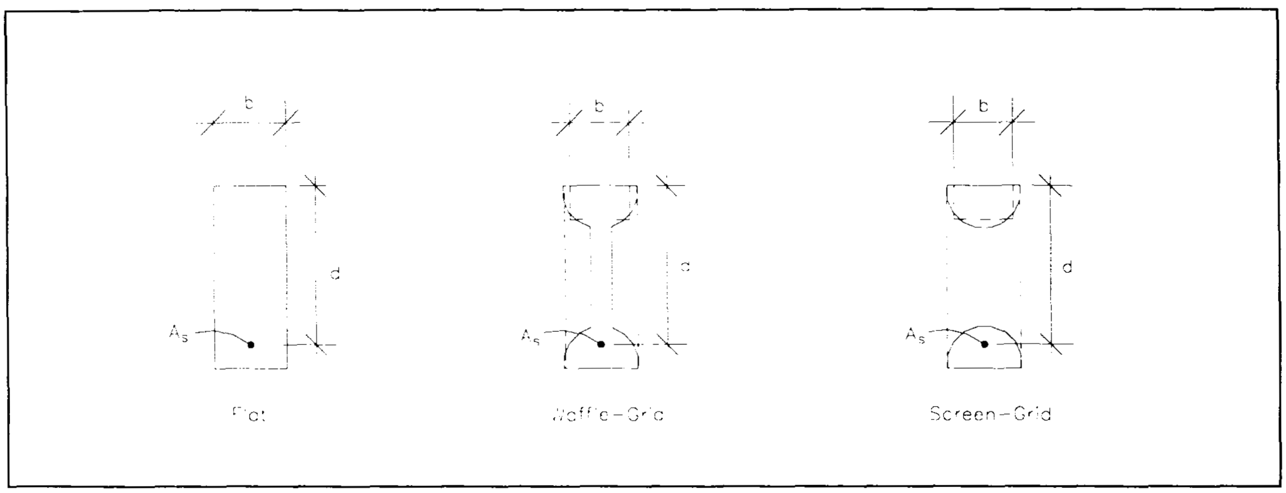


Figure 1-5 Design Variables Defined for Lintel Bending

If greater bending capacity is required, increasing the lintel depth, the yield strength of the reinforcement, or the area of reinforcement is suggested. The lintel thickness is often limited to the thickness of the wall in which it is placed. The lintel depth is also often limited by the floor-to-floor height and the vertical placement of the opening in the wall based on aesthetic, functional, or economic reasons. For waffle- and screen- grid wall systems, it may be necessary to use special lintel blocks or modified standard blocks to create solid cross-sections for longer spans where the lintel depth cannot be increased. In many cases, increasing the amount of bottom reinforcement is the most economical solution. However, care must be taken to avoid overcrowding of the reinforcement. When possible, one reinforcing bar of the appropriate size should be specified. Using more than two bars in a small area can be detrimental if there is not enough space between the bars or between the bars and the wall for concrete to flow around the bars. ACI 10.3.3 limits the amount of reinforcement to 0.75 of the reinforcement ratio, ρ_b, that would produce balance strain conditions for the section under flexure without axial load.

1.4.5 Check Nominal Shear Strength

ICF lintels are designed for shear resulting from wall, roof, and floor loads above using the equations below in accordance with ACI Chapter 11, "Shear and Torsion". The web width varies for each type of ICF wall system; refer to Figure 1-6 for the appropriate web width dimension.

$$V_u \le \phi V_n$$
$$V_n = V_c + V_s$$
$$V_c = 2\sqrt{f_c'}b_w d$$
$$V_s = \frac{A_v f_y d}{s} \le 8\sqrt{f_c'}b_w d \ when\, V_u > \phi V_c$$
$$A_{v,min} = \frac{50 b_w s}{f_y} \ when\, V_u > \frac{\phi V_c}{2}$$
$$s \le minimum of \begin{Bmatrix} d/2 \\ 24" \end{Bmatrix}$$
$$s \le minimum of \begin{Bmatrix} d/4 \\ 12" \end{Bmatrix} when\, V_s > 4\sqrt{f_c'}b_w d$$

where:

ϕ	Strength reduction factor = 0.85 for flexure per ACI 9.3.2	dimensionless
A_v	Area of shear reinforcement within distance s	inch^2
$A_{v,min}$	Minimum area of shear reinforcement	inch^2
b_w	Web width, Refer to Figure 1-6	inch
d	Distance from extreme compression fiber to centroid of longitudinal tension reinforcement, Refer to Figure 1-6	inch
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of shear reinforcement	psi
s	Spacing of shear reinforcement per ACI 11.5.4	inch
V_n	Nominal shear strength	lb
V_c	Nominal shear strength provided by concrete	lb
V_s	Nominal shear strength provided by shear reinforcement, $V_s = 0$ if no stirrups used	lb
V_u	Factored shear force	lb

If greater shear capacity is required, increasing the lintel thickness, the lintel depth, the yield strength of the reinforcement, or the area of reinforcement is suggested. Often the lintel thickness is limited to the thickness of the wall in which it is placed. The lintel depth is also often limited by the floor-to-floor height and the vertical placement of the opening in the wall based on aesthetic, functional, or economic reasons. For waffle- and screen- grid wall systems, it may be necessary to use special lintel blocks or modified standard blocks to create solid cross-sections for longer spans where the lintel depth cannot be increased. Recent unpublished testing[9] has provided data showing that predicted shear capacity provided by the concrete, V_C, is very conservative. Future testing may conclude that stirrups are not required for ICF lintels used for short spans in residential construction.

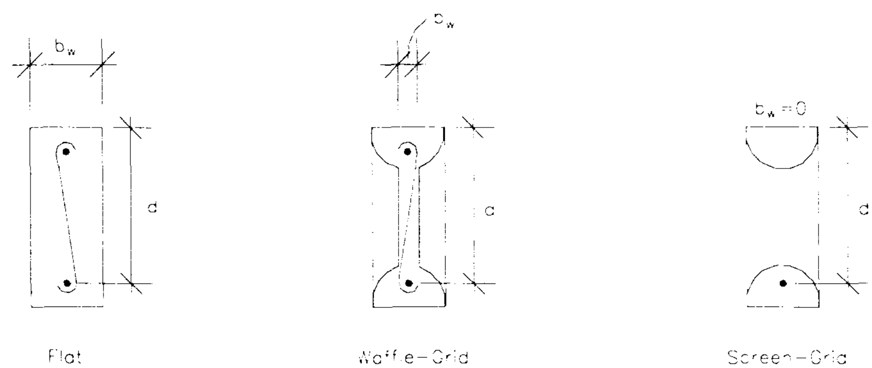


Figure 1-6 Design Variables Defined for Lintel Shear

[9] NAHB Research Center, Inc., Unpublished Lintel Test Data, NAHB Research Center, Inc., Upper Marlboro, Maryland, 1998.

1.5 FOOTING CONNECTIONS

Footing connections transmit axial and shear loads from the wall to the footing below. Wall-to-footing connections for residential construction are constructed in one of the following three ways:

- No vertical reinforcement or key
- Key only
- Dowels only

1.5.1 Check Bearing Strength of Footing

Determine whether the bearing strength of the concrete is adequate per ACI 10.17. If the bearing strength is adequate, skip Sections 1.5.2 and 1.5.3. Bearing strength is typically sufficient for residential construction; however, use dowels if additional bearing strength is required.

$$B_c \leq \phi 0.85 f_c' A_1$$

When the supporting surface is wider on all sides than the loaded area, the design bearing strength on the loaded area is permitted to be

$$B_c \leq \phi 0.85 f_c' A_1 \sqrt{\frac{A_2}{A_1}} \quad where \quad \sqrt{\frac{A_2}{A_1}} \leq 2$$

where:

ϕ	Strength reduction factor = 0.7 per ACI 9.3.2	dimensionless
A_1	Loaded area of concrete; Refer to Figure 1-7	inch^2
A_2	Projected loaded area of concrete; Refer to Figure 1-7	inch^2
B_c	Bearing strength of concrete	lb
f_c'	Specified compressive strength of concrete	psi

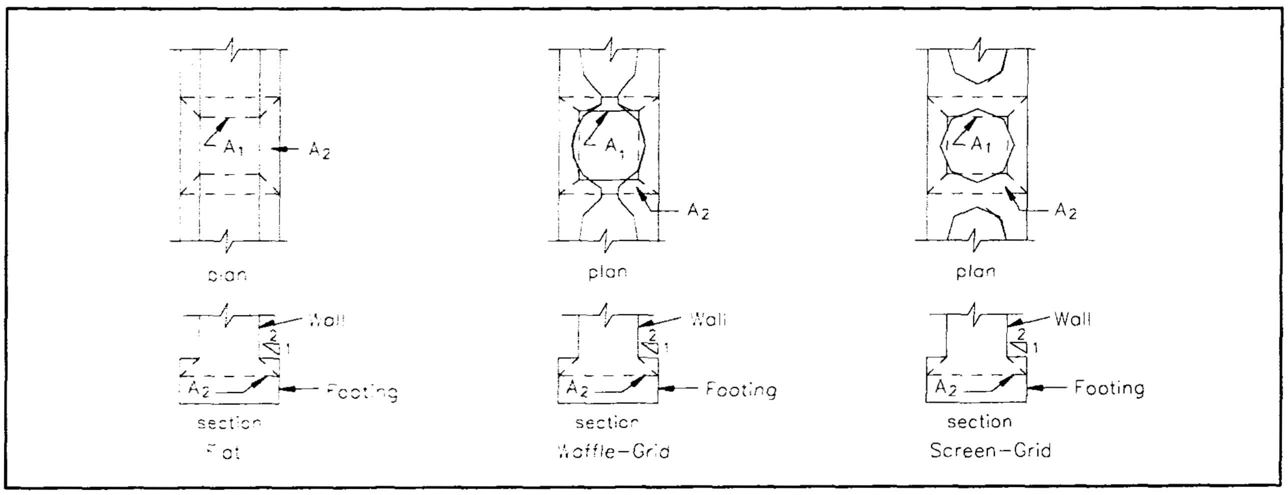


Figure 1-7 Loaded Area of Footing for Bearing Strength

1.5.2 Use Dowels to Increase Bearing Capacity

If additional bearing strength is required as determined in Section 1.5.1, dowels are placed across the wall-footing interface. The development length of the dowel into the footing and into the wall is calculated per ACI 10.17. Refer to Figure 1-8 for typical dowel placement.

$$B \le \phi\left(B_c + B_s\right)$$
$$B_c = 0.85 f_c' A_1$$
$$B_s = A_s f_y$$

When the supporting surface is wider on all sides than the loaded area, the design bearing strength on the loaded area is permitted to be

$$B \le \phi\left(B_c + B_s\right)\sqrt{\frac{A_2}{A_1}} \quad where \quad \sqrt{\frac{A_2}{A_1}} \le 2$$
$$B_c = 0.85 f_c' A_1$$
$$B_s = A_s f_y$$

where:

ϕ	Strength reduction factor = 0.7 per ACI 9.3.2	dimensionless
A_1	Loaded area of concrete; Refer to Figure 1-7	inch^2
A_2	Projected loaded area of concrete; Refer to Figure 1-7	inch^2
A_s	Area of bearing reinforcement	inch^2
B	Design bearing strength	lb
B_c	Bearing strength of concrete	lb
B_s	Bearing strength of reinforcement	lb
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of bearing reinforcement	psi

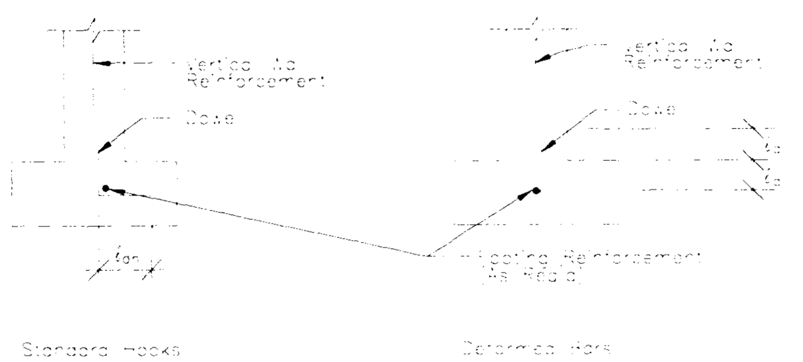


Figure 1-8 Design Variables Defined for Dowels in Wall-Footing Interface

1.5.3 Determine Development Length of Dowels for Bearing Capacity

If dowels are used to increase the bearing capacity of the concrete, use the following equations, taken from ACI 12.3, to determine the minimum development length required:

$$l_{db} = \frac{0.02 d_b f_y}{\sqrt{f_c'}} \geq 0.0003 d_b f_y$$

$$l_d = l_{db}\left(\frac{A_{s,req'd}}{A_{s,provided}}\right) \geq 8"$$

where:

A_s	Area of bearing reinforcement	inch^2
d_b	Diameter of bearing reinforcement bar	inch
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of bearing reinforcement	psi
l_d	Development length of bearing reinforcement, Refer to Figure 1-8	inch
l_{db}	Basic development length of bearing reinforcement	inch

1.5.4 Check Shear Transfer

Shear forces existing at the base of the wall may require a key or dowels to transfer the shear forces from the wall to the footing. The following equations are taken from ACI 11.7, "Shear-Friction Method", to develop shear resistance by using vertical reinforcement (dowels) across the wall-footing interface. If a key is preferred to transfer shear forces from the wall to the footing instead of dowels, skip this Section and go to Section 1.5.6.

$$V_u \leq \phi V_n$$

$$V_n = A_{vf} f_y \mu \leq 0.2 f_c' A_c \quad and \quad \leq 800 A_c$$

$$A_{vf} = \frac{V_u}{\phi f_y \mu}$$

where:

λ	Correction factor related to unit weight on concrete =1.0 for normal weight concrete per ACI 11.7.4	dimensionless
μ	Coefficient of friction per ACI 11.7.4 Concrete placed monolithically .... 1.4λ Concrete placed against hardened concrete with surface intentionally roughened ¼ inch (6.4 mm) .... 1.0λ Concrete placed against hardened concrete not intentionally roughened .... 0.6λ Concrete anchored to as-rolled structural steel by headed studs or by reinforcing bars 0.7λ	dimensionless
ϕ	Strength reduction factor = 0.85 for shear per ACI 9.3.2	dimensionless
A_c	Area of concrete section resisting shear transfer	inch^2
A_{vf}	Area of shear-transfer reinforcement	inch^2
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of reinforcement ≤ 60,000 psi	psi
V_n	Nominal shear strength per ACI 11.7.4	lb
V_u	Factored shear force at section	lb

1.5.5 Determine Development Length of Dowels for Shear Transfer

If dowels are used to transfer shear forces from the base of the wall to the footing, use the following equations to determine the minimum development length required. Refer to Figure 1-8 for typical dowel placement.

If dowels are required for both bearing and shear force transfer, the size and development length of the dowels only need to be adequate for the more severe of the horizontal or vertical load transfer conditions.

Standard Hooks (ACI 12.5)

$$l_{hb} = \frac{1200 d_b}{\sqrt{f_c'}} \quad where \;\; f_y = 60{,}000\ psi$$

$$l_{dh} = maximum\ of \begin{Bmatrix} = l_{hb}\xi\psi\omega \\ \geq 8d_b \\ \geq 6" \end{Bmatrix}$$

$$\xi = \frac{f_y}{60{,}000}$$

$$\omega = \frac{A_{s,req'd}}{A_{s,provided}}$$

Deformed Bars (ACI 12.2)

$$l_{db} = \left(\frac{3f_y}{40\sqrt{f_c'}}\right)\left(\frac{\alpha\beta\gamma\lambda}{\frac{c+K_{TR}}{d_b}}\right)$$

$$2.5 \geq \left(\frac{c+K_{TR}}{d_b}\right)$$

$$l_d = l_{db}\left(\frac{A_{s,req'd}}{A_{s,provided}}\right) \geq 12"$$

where:

α	Reinforcement location factor per ACI 12.2.4 Horizontal reinforcement placed so that more than 12 inches (305 mm) of fresh concrete is cast in the member below the development length .... 1.3 Other reinforcement 1.0	dimensionless
β	Coating factor =1.0 for uncoated reinforcement, per ACI 12.2.4	dimensionless
γ	Reinforcement size factor per ACI 12.2.4 Bars No. 6 and smaller .... 0.8 Bars No. 7 and larger........ 1.0	dimensionless
λ	Concrete type factor = 1.0 for normal weight concrete per ACI 12.2.4	dimensionless
ω	Excess reinforcement factor	dimensionless
ξ	Reinforcement yield strength factor	dimensionless
ψ	Concrete side cover factor = 0.7 per ACI 12.5.3	dimensionless

A_s	Area of shear-transfer reinforcement	inch²
c	The smaller of shear-transfer reinforcement spacing or concrete cover dimension	inch
d_b	Diameter of shear-transfer reinforcement	inch
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of shear-transfer reinforcement	psi
K_{TR}	Transverse reinforcement index, assume = 0	dimensionless
l_d	Development length of shear-transfer reinforcement bar, Refer to Figure 1-8	inch
l_{db}	Basic development length of shear-transfer reinforcement bar	inch
l_{dh}	Development length of shear-transfer reinforcement hook, Refer to Figure 1-8	inch
l_{hb}	Basic development length of shear-transfer reinforcement hook	inch

1.5.6 Use Key to Provide Adequate Shear Transfer

A key may be used in lieu of dowels. In residential construction, a key is often formed using a 2x4 wood board with chamfered edges. Refer to Figure 1-9 for a footing with a key; although a flat wall is depicted in Figure 1-9, a key may also be used with a waffle-grid or screen-grid ICF wall system. Shear resistance developed by the key is computed using the following equations:

$$V_u \leq \phi V_n$$

$$V_n = \frac{4}{3}\sqrt{f_c'}bh$$

where:

ϕ	Strength reduction factor =0.85 for shear per ACI 9.3.2	dimensionless
b	Shear width of section, Refer to Figure 1-9	inch
f_c'	Specified compressive strength of concrete	psi
h	Shear height of section, Refer to Figure 1-9	inch
V_n	Nominal shear strength at section per ACI 22.5.4	lb
V_u	Factored shear force at section	lb

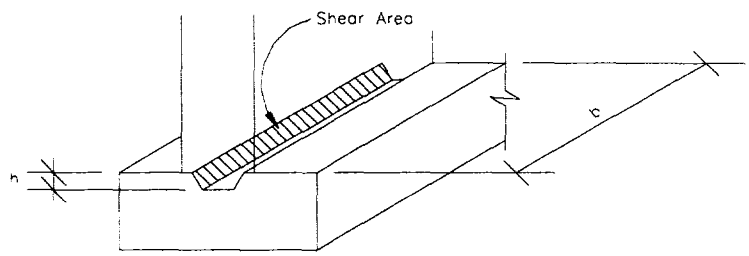


Figure 1-9 Footing with Key

1.6 ROOF CONNECTION: BOLTED SILL PLATE

Roofs for residential-scale construction may be constructed of a variety of materials; however, the design procedure described herein assumes a wood-framed roof structure bearing on the ICF walls below. Where appropriate, the following design procedure should be altered by the designer for roof structures other than wood-framed.

1.6.1 Determine Design Loads

Determine axial loads, shear loads, wind loads, and uplift loads in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

1.6.2 Assume Connection Spacing and Size

Select a trial bolt diameter and spacing and sill plate size, grade, and species. Refer to "Part 4 Connections" in the American Institute of Steel Construction's (AISC) *Manual of Steel Construction* for engineering data on bolts and the American Forest and Paper Association's (AF&PA) *Design Values for Wood Construction* for wood data.

1.6.3 Check Shear in Bolt

Determine whether the bolt diameter and spacing is adequate to resist shear loads calculated in Section 1.6.1 using the equations below. If greater shear capacity in the bolt is required, increase the bolt diameter or reduce the bolt spacing. In residential construction, a 5/8-inch (16 mm) diameter anchor bolt is typically used for sill plate connections to concrete.

$$f_v \leq F_v$$

$$f_v = \frac{V}{A_b}$$

$$A_b = \frac{\pi d^2}{4}$$

where:

A_b	Area of bolt	inch^2
d	Threaded shank diameter of the bolt	inch
f_v	Actual shear stress of bolt	psi
F_v	Allowable shear stress of bolt, Refer to AISC's *Manual of Steel Construction*	psi
V	Shear force on bolt, Refer to Figure 1-10	lb

1.6.4 Check Tension in Bolt Due to Uplift and Shear-Friction

Determine whether the bolt diameter and spacing is adequate to resist tensile loads calculated in Section 1.6.1 using the equations below. If greater tensile capacity in the bolt is required, increase the bolt diameter or reduce the bolt spacing.

$$f_t \le F_t$$
$$f_t = \frac{T}{A_b}$$
$$T = T_{uplift} + \frac{V}{\mu}$$
$$A_b = \frac{\pi d^2}{4}$$

where:

μ	Coefficient of friction, assume μ = 0.6	dimensionless
A_b	Area of bolt	inch^2
d	Diameter of bolt	inch
f_t	Actual tensile stress of bolt due to uplift and shear-friction	psi
F_t	Allowable tensile stress of bolt, Refer to AISC's *Manual of Steel Construction*	psi
T	Tensile force on bolt due to uplift and shear-friction	lb
T_{uplift}	Tensile force on bolt due to uplift, calculated in Section 1.6.1	lb
V	Shear force on bolt, Refer to Figure 1-10	lb

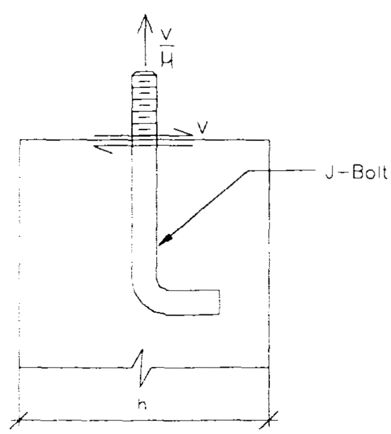


Figure 1-10 Forces on Bolt for Bolted Sill Plate Roof Connection

1.6.5 Check Tension in Concrete (Anchorage Capacity)

Use the following equations to determine whether the concrete shear area of each bolt is sufficient to resist pull-out from the ICF wall due to uplift forces and shear-friction:

$$V_u \le \phi V_c$$
$$V_c = 4 A_v \sqrt{f_c'}$$
$$A_v = \text{minimum of} \begin{Bmatrix} \pi l_b^2 \\ \pi h^2 \end{Bmatrix}$$

where:

ϕ	Strength reduction factor = 0.85 for shear per ACI 9.3.2	dimensionless

A_V	Shear area of concrete right circular cone	inch
f_c'	Specified compressive strength of concrete	psi
h	Concrete wall thickness, Refer to Figure 1-11	inch
l_b	Embedment length of bolt, Refer to Figure 1-11	inch
V_c	Nominal shear strength provided by concrete	lb
V_u	Factored shear force in concrete due to uplift and shear-friction (Nominal shear force = tensile force on bolt due to uplift and shear-friction, Refer to Section 1.6.4)	lb

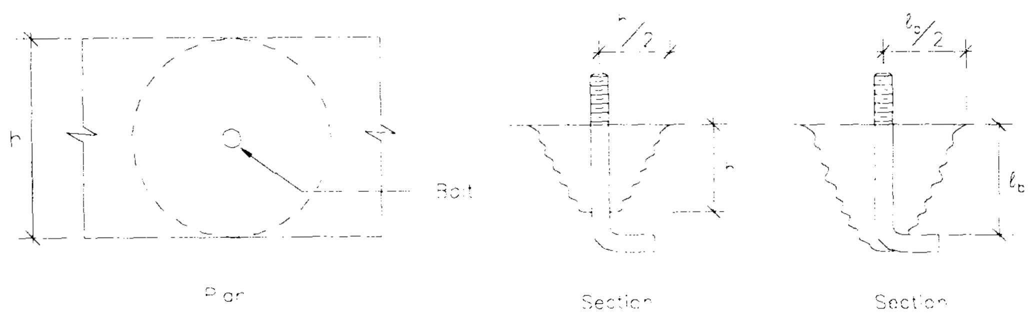


Figure 1-11 Assumed Cone Shear Failure Surface for Bolted Sill Plate Roof Connection

1.6.6 Check Bending, Bearing, and Shear in Sill Plate

A sill plate is commonly installed on top of concrete walls to provide a fastening surface for a wood-framed roof. Determine if the spacing of bolts is adequate to prevent overstresses in the sill plate due to bending, bearing, and shear. In low wind and seismic conditions in the United States, it is common practice to use 1/2-inch to 7-inch diameter j-bolts spaced at 6 feet on center and within 12 inches of the end of, or a joint in, the sill plate. For sill plates constructed of lumber, refer to AF&PA's *Design Values for Wood Construction* for allowable bending, bearing, and shear stresses. Refer to Chapter 2, "ICF Design Example", for detailed calculations.

1.6.7 Check Bearing Strength of ICF Wall

Determine whether the bearing strength of the concrete is adequate per ACI 10.17. The bearing strength of the concrete is typically adequate for loads encountered in residential construction.

$$B_c \leq \phi 0.85 f_c' A_1$$

When the supporting surface is wider on all sides than the loaded area, the design bearing strength on the loaded area is permitted to be

$$B_c \leq \phi 0.85 f_c' A_1 \sqrt{\frac{A_2}{A_1}} \quad where \quad \sqrt{\frac{A_2}{A_1}} \leq 2$$

where:

ϕ	Strength reduction factor = 0.7 per ACI 9.3.2	dimensionless
A_1	Loaded area of concrete; Refer to Figure 1-12	inch^2
A_2	Projected loaded area of concrete; Refer to ACI 10.17	inch^2
B_c	Bearing strength of concrete	lb
f_c'	Specified compressive strength of concrete	psi

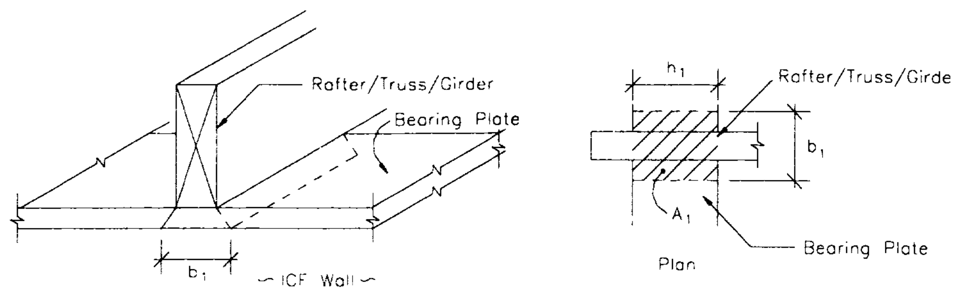


Figure 1-12 Design Variables Defined for Bolted Sill Plate Bearing on ICF Wall

1.7 ROOF CONNECTION: STRAP

Roofs for residential-scale construction may be constructed of a variety of materials; however, the design procedure described herein assumes a wood-framed roof structure bearing directly on the ICF walls below. Where appropriate, the following design procedure should be altered by the designer for roof structures other than wood-framed.

A strap connection consists of roof trusses or rafters that bear directly on the ICF wall and are held in place with a tie-down strap or bracket. This type of construction is more common in areas subject to hurricane force winds. In lower wind and seismic regions of the United States, it is common practice to toe nail the rafter or truss to a wood sill plate as shown in Figure 1-12. Refer to Figure 1-13 for a typical strap connection detail.

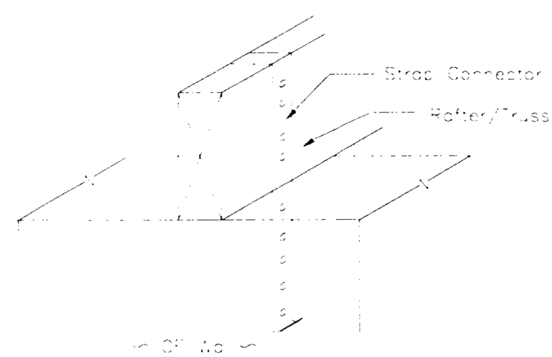


Figure 1-13 Strap Connection

1.7.1 Determine Design Loads

Determine axial loads, shear loads, and wind uplift in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

1.7.2 Assume Strap Connector Size

Each roof truss or rafter should be anchored to the concrete wall to resist uplift and lateral forces from wind loads. One end of the strap connector or bracket is embedded in the concrete and the other end is fastened by nails or bolts to the roof rafter or truss. Select from the manufacturer's catalog, a trial strap connector that has sufficient capacity to resist the tensile loads calculated in Section 1.7.1.

1.7.3 Check Tension in Concrete (Anchorage Capacity)

In some cases, the manufacturer's strap data is based on specific embedment and concrete wall thickness requirements. If these conditions are met, the calculation of tension in the concrete may not be necessary as it is inherent to the rated capacity of the connector.

If the manufacturer's strap data does not specify embedment or wall thickness requirements, use the following equations to determine whether the concrete shear area of each strap is sufficient to resist pull-out from the ICF wall due to uplift forces:

$$V_u \leq \phi V_c$$

$$V_c = 4 A_v \sqrt{f_c'}$$

$$A_v = \text{minimum of} \begin{Bmatrix} \pi l_b^2 \\ \pi h^2 \end{Bmatrix}$$

where:

ϕ	Strength reduction factor = 0.85 for shear per ACI 9.3.2	dimensionless
A_v	Shear area of concrete right circular cone	inch
f_c'	Specified compressive strength of concrete	psi
h	Concrete wall thickness, Refer to Figure 1-14	inch
l_b	Embedment length of strap, Refer to Figure 1-14	inch
V_c	Nominal shear strength provided by concrete	lb
V_u	Factored shear force in concrete due to uplift (Nominal shear force = tensile force on strap due to uplift)	lb

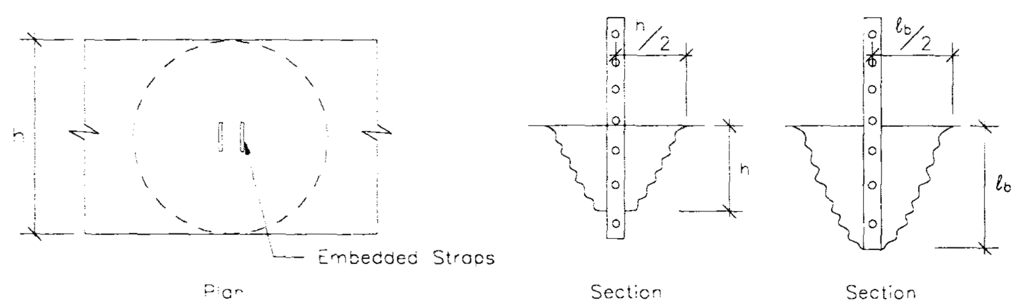


Figure 1-14 Assumed Cone Shear Failure Surface for Strap Connection

1.7.4 Check Bearing Strength of ICF Wall

Determine whether the bearing strength of the concrete is adequate per ACI 10.17. The bearing strength of the concrete is typically adequate for residential construction.

$$B_c \leq \phi 0.85 f_c' A_1$$

When the supporting surface is wider on all sides than the loaded area, the design bearing strength on the loaded area is permitted to be

$$B_c \leq \phi 0.85 f_c' A_1 \sqrt{\frac{A_2}{A_1}} \quad where \quad \sqrt{\frac{A_2}{A_1}} \leq 2$$

where:

ϕ	Strength reduction factor = 0.7 per ACI 9.3.2	dimensionless
A_1	Loaded area of concrete; Refer to Figure 1-15	inch^2
A_2	Projected loaded area of concrete; Refer to ACI 10.17	inch^2
B_c	Bearing strength of concrete	lb
f_c'	Specified compressive strength of concrete	psi

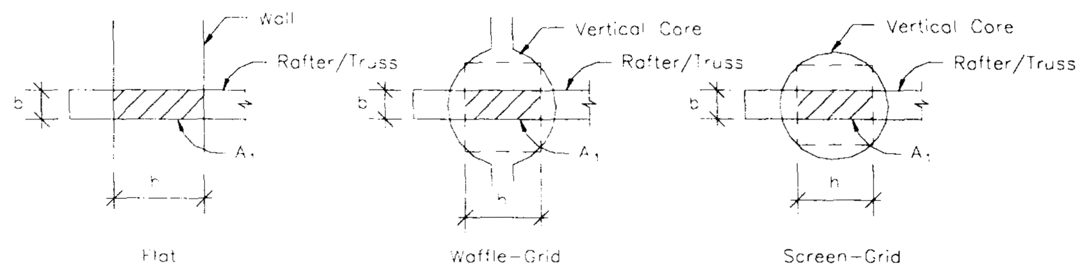


Figure 1-15 Roof Bearing Directly on ICF Wall

1.8 FLOOR CONNECTION: LEDGER

Floors for residential-scale construction may be constructed of a variety of materials; however, the design procedure described herein assumes a wood-framed floor structure. Where appropriate, the following design procedures should be altered by the designer for floor structures other than wood-framed.

The ledger connection is very common in ICF construction. It consists of a 2x- or 3x-wood ledger board bolted to the side of an ICF wall with j-bolts. The floor joists are hung from the ledger board with joist hangers. Refer to Figure 1-16 for a typical side-bearing ledger connection.

The designer should recognize the importance of the ledger connection because the floor live and dead loads are transferred to the wall through a series of connections which is not typical of platform wood-framed construction. In high wind or seismic regions, straps may be needed. A strap is not shown in Figure 1-16; however, if a strap is required, one end of the strap connector is embedded in the concrete and the other end is fastened to the bottom edge of the floor joist by nails or bolts. The use of a strap may not be desired because it may interfere with the ceiling finish attachment. Perimeter edge nailing of the subflooring to the ledger may provide sufficient lateral restraint of the wall in lieu of using a strap.

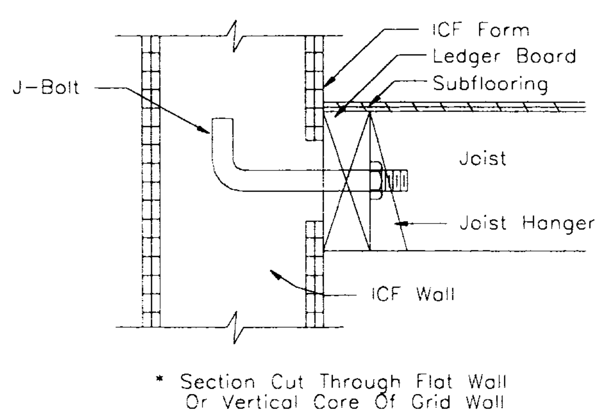


Figure 1-16 Side-Bearing Ledger Connection

1.8.1 Determine Design Loads

Determine axial loads, shear loads, and bending moments at the floor-wall connection in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

1.8.2 Assume Connection Spacing and Size

Select a trial bolt diameter, bolt spacing, nominal ledger board size, grade, and species. Refer to "Part 8: Bolts" in AF&PA's *National Design Specifications for Wood Construction* for engineering data on bolts and AF&PA's *Design Values for Wood Construction* for wood data.

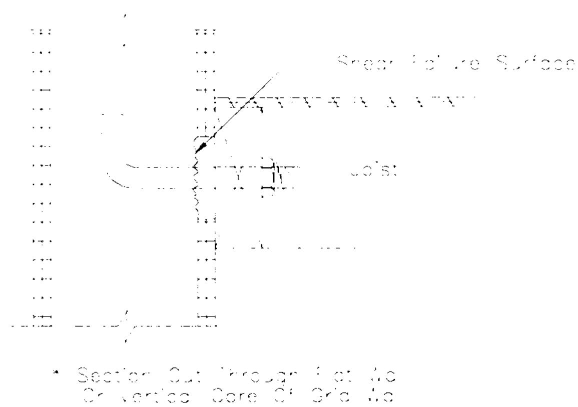


Figure 1-17 Assumed Shear-Friction Failure Surface for Ledger Connection

1.8.3 Check Shear-Friction in Concrete

Shear forces from the floor joist must be transferred to the concrete wall. The following equations are taken from ACI 11.7, "Shear-Friction Method", to develop shear resistance by using j-bolts across the concrete wall-ledger interface:

$$V_u \le \phi V_n$$
$$V_n = A_{vf} f_y \mu \le 0.2 f_c' A_c \quad and \quad \le 800 A_c$$
$$A_{vf} = \frac{V_u}{\phi f_y \mu}$$
$$A_c = \pi\left(l_{be}^{\ 2}\right)$$

where:

λ	Correction factor related to unit weight on concrete, $\lambda = 1.0$ for normal weight concrete per ACI 11.7.4	dimensionless
μ	Coefficient of friction per ACI 11.7.4 Concrete placed monolithically .... 1.4λ Concrete placed against hardened concrete with surface intentionally roughened ¼ inch (6.4 mm) .... 1.0λ Concrete placed against hardened concrete not intentionally roughened .... 0.6λ Concrete anchored to as-rolled structural steel by headed studs or by reinforcing bars 0.7λ	dimensionless
ϕ	Strength reduction factor, =0.85 for shear per ACI 9.3.2	dimensionless
A_c	Area of concrete section resisting shear transfer	inch^2

A_{vf}	Area of bolt	inch^2
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of reinforcement $\leq$ 60,000 psi	psi
l_{be}	Distance from bolt to nearest edge of concrete ledge, Refer to Figure 1-18	inch
V_n	Nominal shear strength per ACI 11.7.4	lb
V_u	Factored shear force at section	lb

1.8.4 Check Tension in Concrete (Anchorage Capacity)

Use the following equations to determine whether the concrete shear area of each bolt is sufficient to resist pull-out from the ICF wall due to wind suction pressure on the wall, lateral (out-of-plane) seismic forces on the wall, and prying action from eccentric floor loads:

$$V_u \leq \phi V_c$$

$$V_c = 4 A_v \sqrt{f_c'}$$

$$A_v = minimum\,of \begin{Bmatrix} \pi (2 l_{be})^2 \\ \pi \, l_b^{\,2} \end{Bmatrix}$$

where:

ϕ	Strength reduction factor = 0.85 for shear per ACI 9.3.2	dimensionless
A_v	Shear area of concrete right circular cone	inch
f_c'	Specified compressive strength of concrete	psi
l_b	Embedment length of bolt, Refer to Figure 1-18	inch
l_{be}	Distance from bolt to nearest edge of concrete ledge, Refer to Figure 1-18	inch
V_c	Nominal tensile strength provided by concrete	lb
V_u	Tensile force on bolt	lb

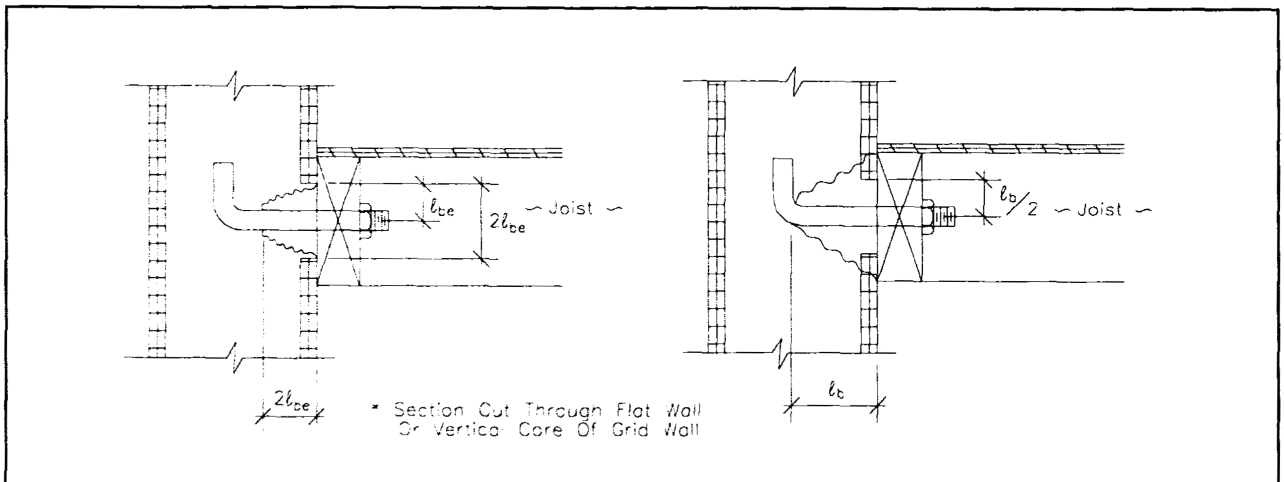


Figure 1-18 Assumed Cone Shear Failure Surface for Ledger Connection

1.8.5 Check Tension in Bolt

Determine whether the bolt diameter and spacing is adequate to resist tensile loads due to wind suction pressure on the wall, lateral (out-of-plane) seismic forces on the wall, and prying action from eccentric floor loads using the equations below. If greater tensile capacity in the bolt is required, increase the bolt diameter or reduce the bolt spacing.

$$f_t \le F_t$$

$$f_t = \frac{T}{A_b}$$

$$A_b = \frac{\pi d^2}{4}$$

where:

A_b	Area of bolt	inch^2
d	Diameter of bolt	inch
f_t	Actual tensile stress of bolt	psi
F_t	Allowable tensile stress of bolt	psi
T	Tensile force on bolt	lb

1.8.6 Check Shear in Bolt

Determine whether the bolt diameter and spacing is adequate to resist shear loads calculated in Section 1.8.1 using the equations below. If greater shear capacity in the bolt is required, increase the bolt diameter or reduce the bolt spacing.

$$f_v \le F_v$$

$$f_v = \frac{V}{A_b}$$

$$A_b = \frac{\pi d^2}{4}$$

where:

A_b	Area of bolt	inch^2
d	Diameter of bolt	inch
f_v	Actual shear stress of bolt	psi
F_v	Allowable shear stress of bolt, Refer to AF&PA's *National Design Specifications for Wood Design*	psi
V	Shear force on bolt	lb

1.8.7 Check Bending, Bearing, and Shear in Ledger Board

Determine if the spacing of bolts is adequate to prevent overstresses in the ledger board due to bending, bearing, and shear. For ledger boards constructed of lumber, refer to AF&PA's *Design Values for Wood Construction* and "Part 8: Bolts" in AF&PA's *National Design Specifications for Wood Construction*. Refer to Chapter 2, "ICF Design Example", for detailed calculations.

1.9 FLOOR CONNECTION: DIRECT BEARING

Floors for residential-scale construction may be constructed of a variety of materials; however, the design procedure described herein assumes a wood-framed floor structure. Where appropriate, the following design procedures should be altered by the designer for floor structures other than wood-framed.

The direct bearing connection consists of a wood sill plate bolted to the top of an ICF wall; floor joists bear on, and are fastened to, the sill plate. This floor connection is usually used for the ground floor on a below-grade ICF wall that has wood-framed construction above or for the first floor on a first-story ICF wall that has a wood-framed second story constructed above. Refer to Figure 1-19 for a direct bearing connection detail. The design procedure is similar to roof connection design and is not repeated here; refer to Section 1.6, "Roof Connections: Bolted Sill Plate".

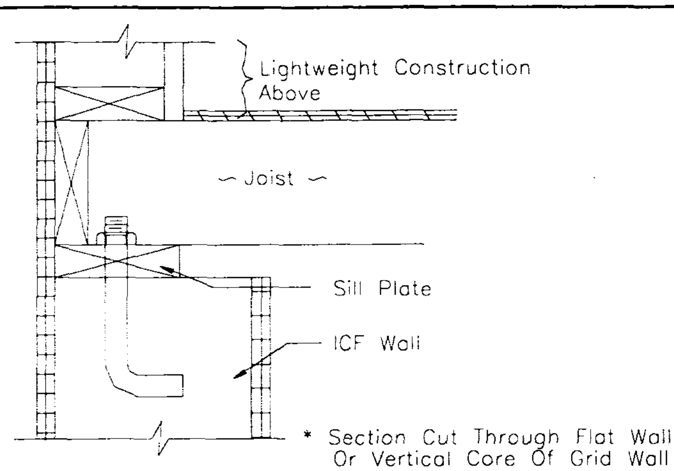


Figure 1-19 Direct Bearing Floor Connection

1.10 FLOOR CONNECTION: POCKET

Floors for residential-scale construction may be constructed of a variety of materials; however, the design procedure described herein assumes a wood-framed floor structure. Where appropriate, the following design procedures should be altered by the designer for floor structures other than wood-framed.

The pocket connection consists of a void or "pocket" in the ICF wall formed by placing a wood block in the wall cavity before pouring the concrete. Pockets for waffle- and screen-grid wall systems must be placed at the centerline of a vertical core. Once the concrete has set, the wood block is removed and the floor joist is placed in the pocket. The floor joist may be required to be fire cut by the locally approved building code to allow the floor joist to fall free from the wall in the event of a fire. Some manufacturers of ICFs provide special metal brackets in lieu of using wood blocks to create "pockets" in the ICF wall. Alternatively, the floor joists can be embedded in the forms before the concrete is placed, wrapped in building paper, and cast into the concrete. Refer to Figure 1-20 for a pocket connection detail. Care must be taken to insure that the use of a pocket does not adversely affect the strength of the wall since the pocket connections may interfere with the continuity of the vertical reinforcement in the wall. The minimum pocket depth is typically 3 to 4 inches (76 to 102 mm) to allow for adequate bearing for the floor joist. Where adequate bearing cannot be achieved due to wall thickness; a pocket connection cannot be used and the designer should refer to Section 1.9 for a ledger board connection.

1.10.1 Determine Design Loads

Determine axial loads, shear loads, and bending moments in accordance with the applicable provisions of the locally approved building code and recognized principles of engineering mechanics. Refer to Chapter 2, "ICF Design Example", for examples on how to calculate loads.

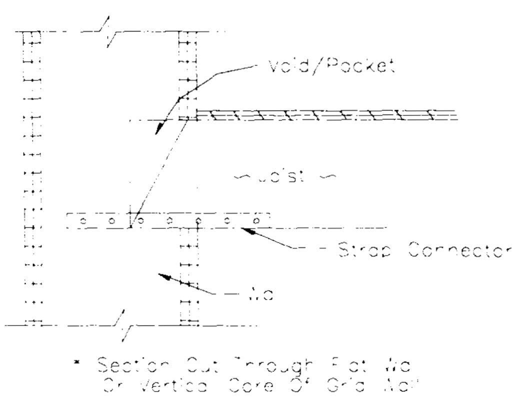


Figure 1-20 Pocket Connection

1.10.2 Assume Strap Connector Size

Each floor joist should be anchored to the concrete wall to prevent pull-out due to lateral wall movement from the forces expected in high wind or high seismic regions. One end of the strap connector is embedded in the concrete and the other end is fastened by nails or bolts to the floor joist. Select from the manufacturer's catalog, a trial strap connector that has sufficient capacity to resist the loads calculated in Section 1.10.1.

Refer to a wood connector manufacturer's catalog for engineering data on strap connectors, appropriate number and spacing of fasteners, and recommended embedment lengths. Also, refer to the strap connector manufacturer's test data and minimum concrete compressive strength requirements.

1.10.3 Check Bearing Strength of ICF Wall

Determine whether the bearing strength of the concrete is adequate per ACI 10.17.

$$B_c \leq \phi 0.85 f_c' A_1$$

where:

ϕ	Strength reduction factor = 0.7 per ACI 9.3.2	dimensionless
A_1	Loaded area of concrete; Refer to Figure 1-21	inch^2
B_c	Bearing strength of concrete	lb
f_c'	Specified compressive strength of concrete	psi

1.10.4 Check Bearing and Shear in Floor Joist

For floor joists constructed of lumber, refer to AF&PA's *Design Values for Wood Construction* for allowable bending, bearing, and shear stresses. Refer to Chapter 2, "ICF Design Example", for detailed calculations.

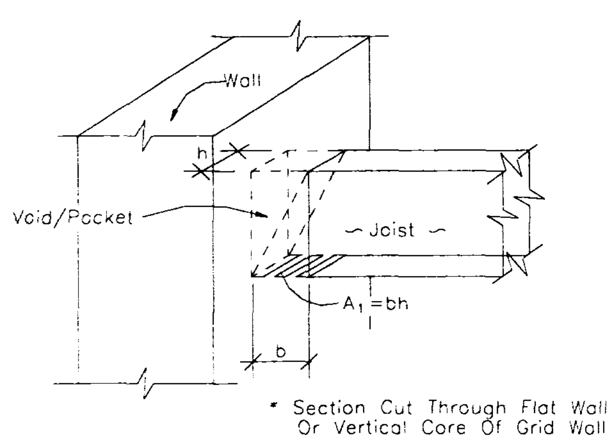


Figure 1-21 Variables Defined for Bearing Strength for Pocket Connection

1.11 REFERENCES

American Concrete Institute.

Building Code Requirements for Structural Concrete and Commentary, ACI Standard 318-95, American Concrete Institute, Farmington Hills, Mich , 1995. (Available from PCA as LT125.)

American Forest and Paper Association.

Design Values for Wood Construction, A Supplement to the 1997 National Design Specification for Wood Construction, American Forest and Paper Association, Washington, D.C., 1997.

American Forest and Paper Association.

National Design Specification for Wood Construction, American Forest and Paper Association, Washington, D.C., 1997.

American Institute of Steel Construction.

Manual of Steel Construction Allowable Stress Design, Ninth Edition, American Institute of Steel Construction, Inc., Chicago, 1989.

Building Officials and Code Administrators International, Inc.

National Building Code, 1996, Building Officials and Code Administrators International, Inc., Country Club Hills, Ill., 1996.

The Council of American Building Officials.

One- and Two-Family Dwelling Code, 1995, The Council of American Building Officials, Falls Church, Va., 1995.

Ghosh, S.K., David A. Fanella and Basile G. Rabbat.

Ghosh, S.K., Fanella, D. A., and Rabbat, B. G., *Notes on ACI 318-95: Building Code Requirements for Structural Concrete* (EB070), Portland Cement Association, Skokie, Ill., 1996.

International Conference of Building Officials.

Uniform Building Code, 1997, International Conference of Building Officials, Whittier, Calif., 1997.

Roller, John.

Roller, John, *Design Criteria for Insulating Concrete Form Wall Systems* (RP116), Portland Cement Association, Skokie, Ill., 1996.

Southern Building Code Congress International.

Standard Building Code, 1994, Southern Building Code Congress International, Birmingham, Ala., 1994.

VanderWerf, Pieter A., Stephen J. Feige, Paula Chammas, and Lionel A. Lemay.
VanderWerf, P. A., Feige, S. J., Chammas, P., and Lemay, L. A., *Insulating Concrete Forms for Residential Design and Construction*, McGraw-Hill, New York, 1997. (Available from PCA as SP208.)

VanderWerf, Pieter A. and W. Keith Munsell.
VanderWerf, P. A. and Munsell, W. K., *Insulating Concrete Forms Construction Manual Successful Methods & Techniques* (SP202), Portland Cement Association, Skokie, Ill., 1996.

Chapter 2

ICF DESIGN EXAMPLE

2.1 PROBLEM STATEMENT

Figure 2-1 contains the pre-determined design loads for a hypothetical geographic area where the house illustrated in Figures 2-2 through 2-4 is situated. Figures 2-2 through 2-4 depict a two-story house with a basement for which we will conduct engineering calculations in accordance with the design procedures described in Chapter 1, "ICF Design Procedure".

Given Loading Conditions

Dead Loads:		
Ground Floor	10.0	psf (479 Pa)
First Floor	10.0	psf (479 Pa)
Roof & Ceiling	12.0	psf (575 Pa)
6" ICF Waffle-Grid Wall	55.0	psf (2.63 kPa)
8" ICF Waffle-Grid Wall	75.0	psf (3.59 kPa)
Live Loads:		
Ground Floor	40.0	psf (1.92 kPa)
First Floor	30.0	psf (1.44 kPa)
Roof	35.0	psf (1.68 kPa)
Attic	10.0	psf (479 Pa)
Equivalent fluid density:	30.0	pcf (4.71 kN/m^3)
Wind Load:	+/- 21.0	psf (1.01 kPa)
Wind Uplift Load:	19.0	psf (910. Pa)
Seismic Zone:	1.0	

Figure 2-1 Design Loads

Although the following design example assumes the house is constructed with a waffle-grid ICF wall system, the design example may be followed for a flat ICF wall system by simply designing the walls on a per lineal foot basis instead of per vertical core and substituting the dimensions of the flat ICF wall for the waffle-grid ICF wall. Refer to the figures in Chapter 1, "ICF Design Procedure", for the correct dimensions to use when making substitutions. The design example may also be followed for an ICF wall system which supports a light-framed wall system above by calculating the axial load experienced by the ICF wall below based on the weight of the light-framed materials above. Refer to Appendix G for the weights of typical light-framed walls.

The house is situated in a low-risk seismic area; therefore, the following design example does not show seismic calculations since the design seismic loads are substantially lower than the design wind loads induced on the structure. However, in higher seismic zones, special consideration of seismic forces and detailing will likely be necessary especially since the dead load of ICF walls is much higher than light-framed walls.

There are some building codes and standards that calculate wind pressure based on the fastest mile wind speed and some that calculate wind pressure based on a 3-second gust. Note that only the resulting hypothetical wind pressure is given in Figure 2-1 without reference to wind speed or exposure rating to simplify load calculations. In addition, the given wind pressure states that the inward acting wind pressure is equivalent to the outward acting wind pressure to further simplify calculations. The designer should be aware that inward and outward acting wind pressures are rarely equivalent on a building structure and should be calculated in accordance with the locally approved building code and recognized principles of engineering mechanics for a given wind speed and exposure rating.

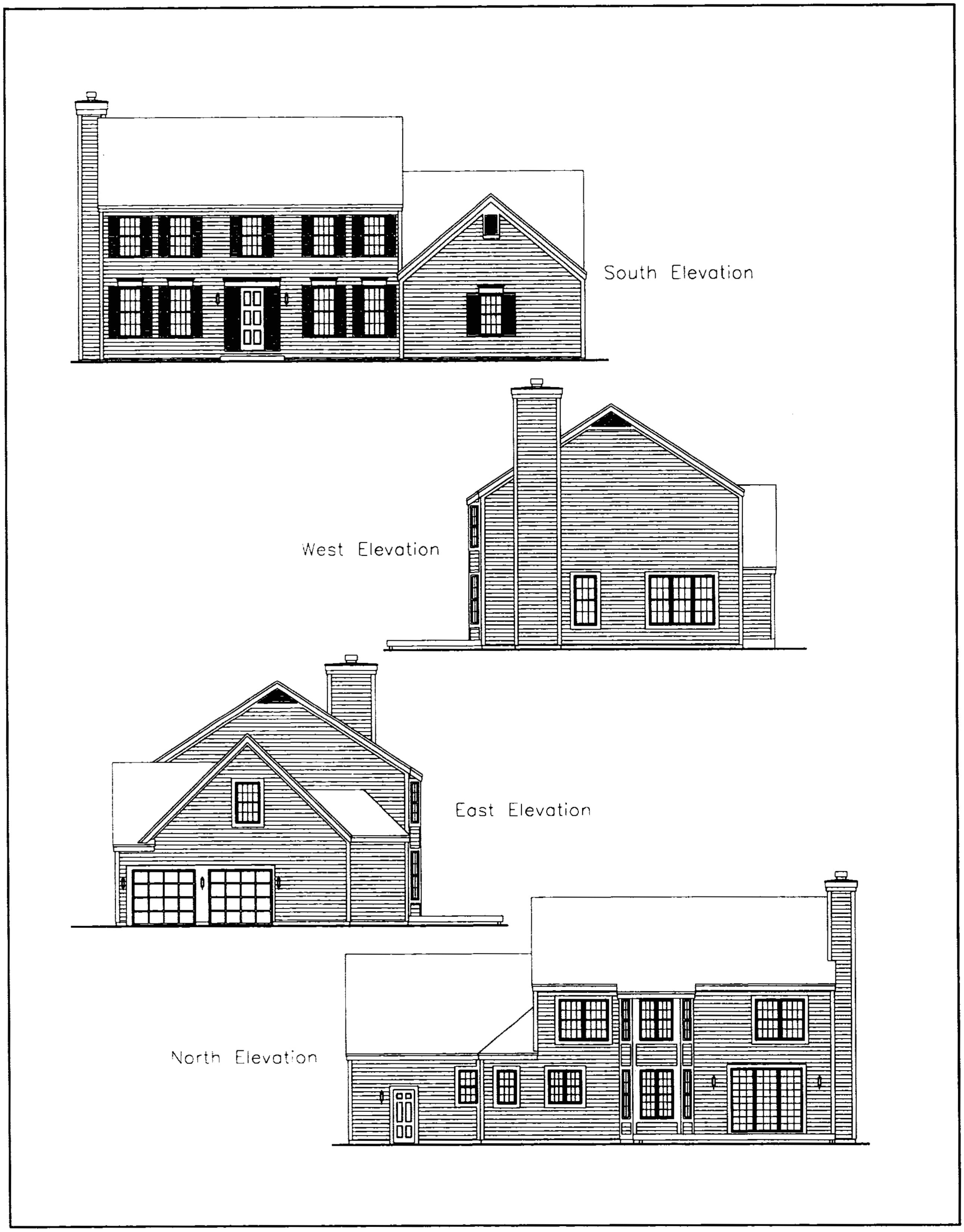


Figure 2-2 Exterior Elevations

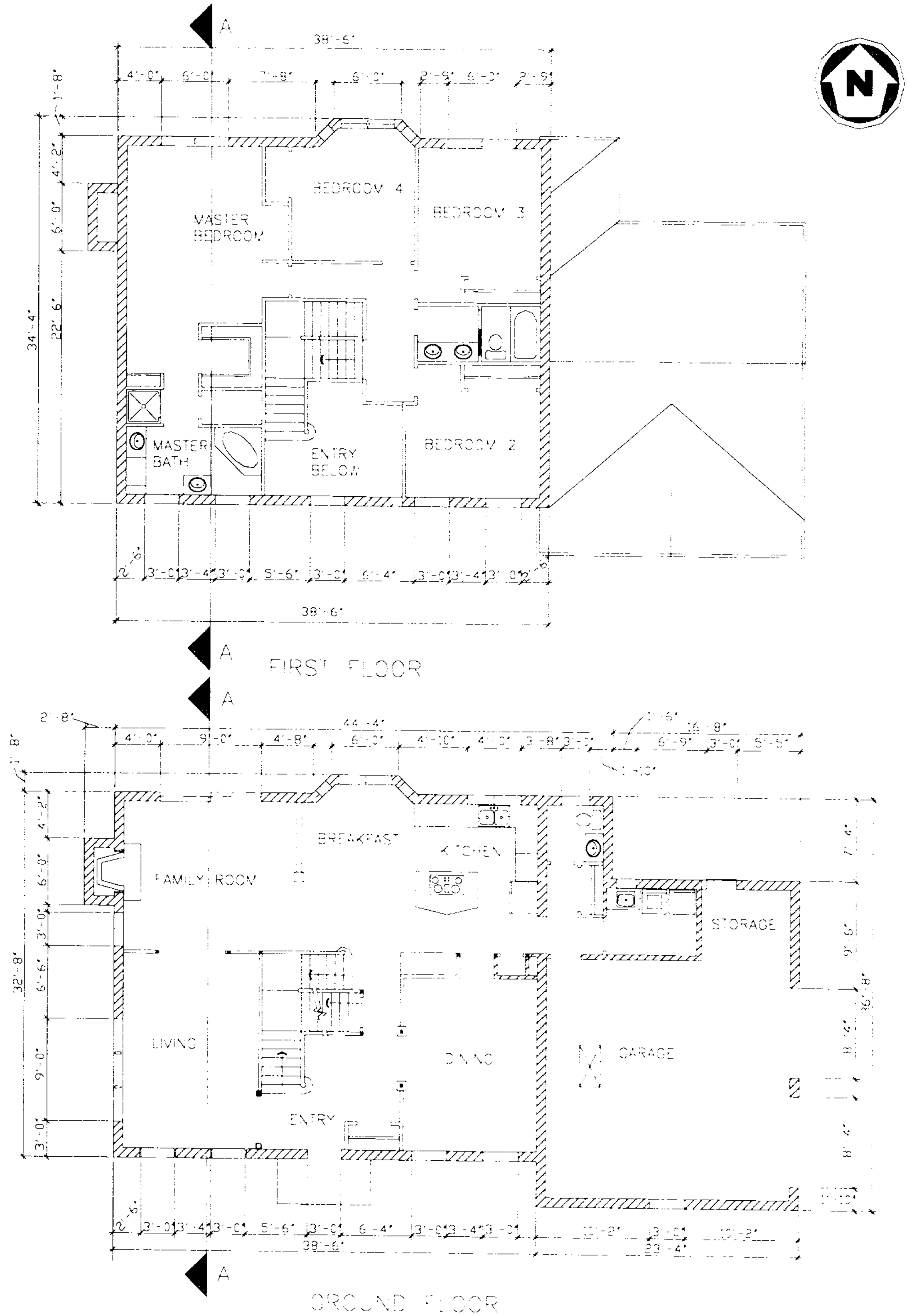


Figure 2-3 Floor Plans

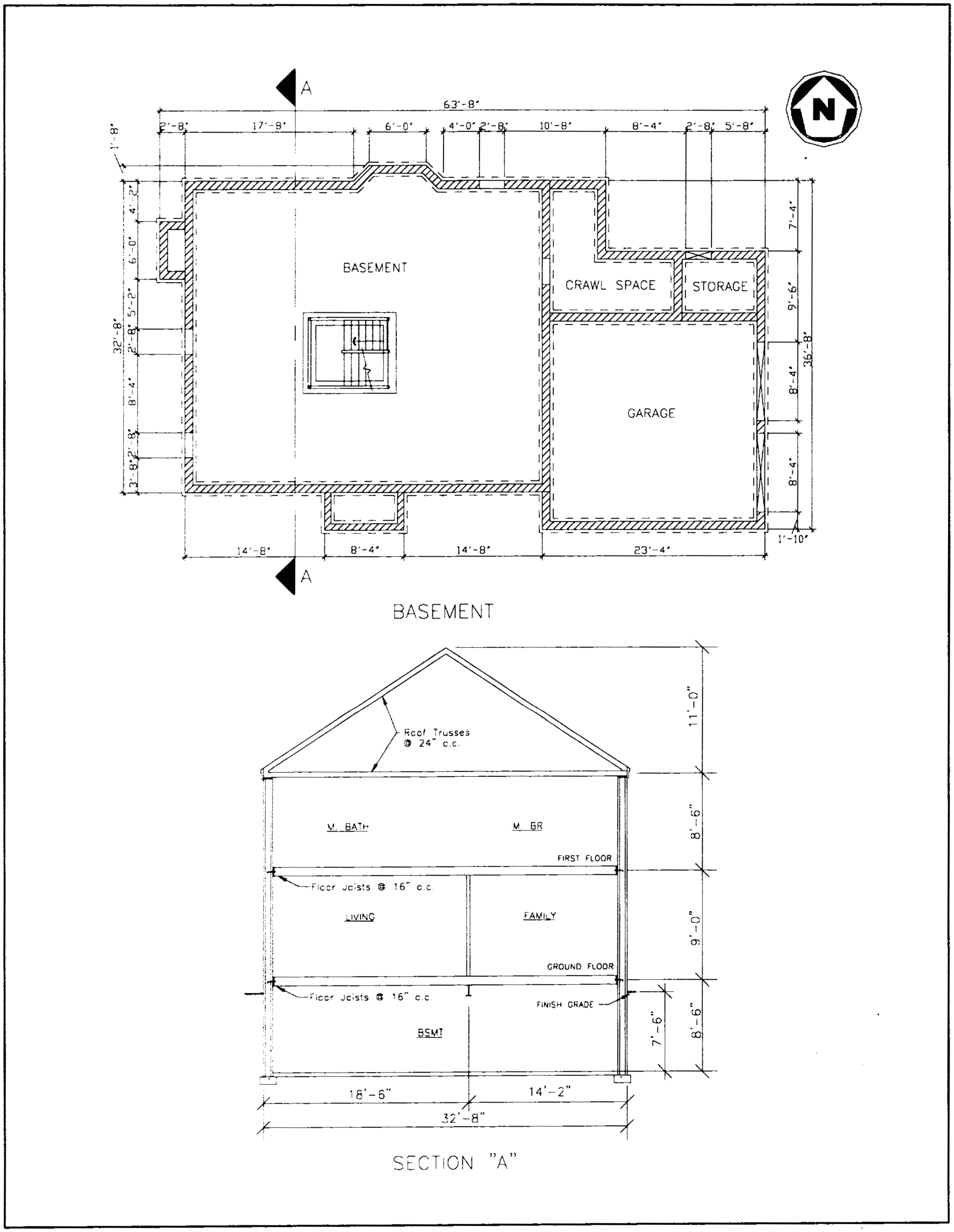


Figure 2-4 Floor Plans and Building Section

2.2 DETERMINE NOMINAL AND FACTORED LOADS

The loads calculated below are based on a 6-inch (152 mm) waffle-grid trial wall section for above-grade walls and an 8-inch (203 mm) waffle-grid trial wall section for below-grade walls.

The following nominal axial loads and moments are determined for the south wall at Section A where the loads will be the greatest; assume that the wall has no openings. Figure 2-5 illustrates the distribution of axial loads throughout the south wall section and notes the values of eccentricity at the roof, floors, and walls needed to calculate the moments. The eccentricities calculated in Figure 2-5 are based on the actual thickness of the vertical core; refer to the core wall sections in Figure 2-5 for the correct dimensions. Figure 2-6 illustrates the distribution of parallel shear loads from wind, and Figures 2-7 and 2-8 summarize the nominal and factored loads calculated in this Section.

Dead Loads

Ground Floor	$0.5(18.5\,ft)(10.0\,psf) = 93\,plf$	[1.4 *kN/m*]
First Floor	$0.5(18.5\,ft)(10.0\,psf) = 93\,plf$	[1.4 *kN/m*]
Roof and Ceiling	$0.5(32.7\,ft)(12.0\,psf) = 196\,plf$	[2.9 *kN/m*]
Second-Story Wall	$0.5(8.5\,ft)(55.0\,psf) = 234\,plf$ *@ mid-height*	[3.4 *kN/m*]
First-Story Wall	$0.5(9.0\,ft)(55.0\,psf) = 248\,plf$ *@ mid-height*	[3.6 *kN/m*]
Foundation Wall	$0.5(8.5\,ft)(75.0\,psf) = 319\,plf$ *@ mid-height*	[4.7 *kN/m*]

Live Loads

Ground Floor	$0.5(18.5\,ft)(40.0\,psf) = 370\,plf$	[5.4 *kN/m*]
First Floor	$0.5(18.5\,ft)(30.0\,psf) = 278\,plf$	[4.1 *kN/m*]
Roof and Ceiling	$0.5(32.7\,ft)(35.0\,psf) = 572\,plf$	[8.3 *kN/m*]
Attic	$0.5(32.7\,ft)(10.0\,psf) = 163\,plf$	[2.4 *kN/m*]

Dead Load Moments

Second-Story Wall @ top

$(196\,plf)(0\,in) = 0\ in-lb/lf$ [0 *N-m/m*]

First-Story Wall @ top

$(196\,plf + 2(234\,plf))(0\ in) + (93\,plf)(-4.6\,in) = -428\ in-lb/lf$ [-159 *N-m/m*]

Foundation Wall @ top

$[196\,plf + 2(234\,plf) + 93\,plf + 2(248\,plf)](0.9\,in) + (93\,plf)(-5.5\,in) = 616\ in-lb/lf$ [228 *N-m/m*]

Live Load Moments

Second-Story Wall @ top

$(572\,plf + 163\,plf)(0\ in) = 0\ in-lb/lf$ [0 *N-m/m*]

First-Story Wall @ top

$(572\,plf + 163\,plf)(0\ in) + (278\,plf)(-4.6\ in) = -1{,}279\ in-lb/lf$ [-474 *N-m/m*]

Foundation Wall @ top

$(572\,plf + 163\,plf + 278\,plf)(0.9\ in) + (370\,plf)(-5.5\ in) = -1{,}123\ in-lb/lf$ [-416 *N-m/m*]

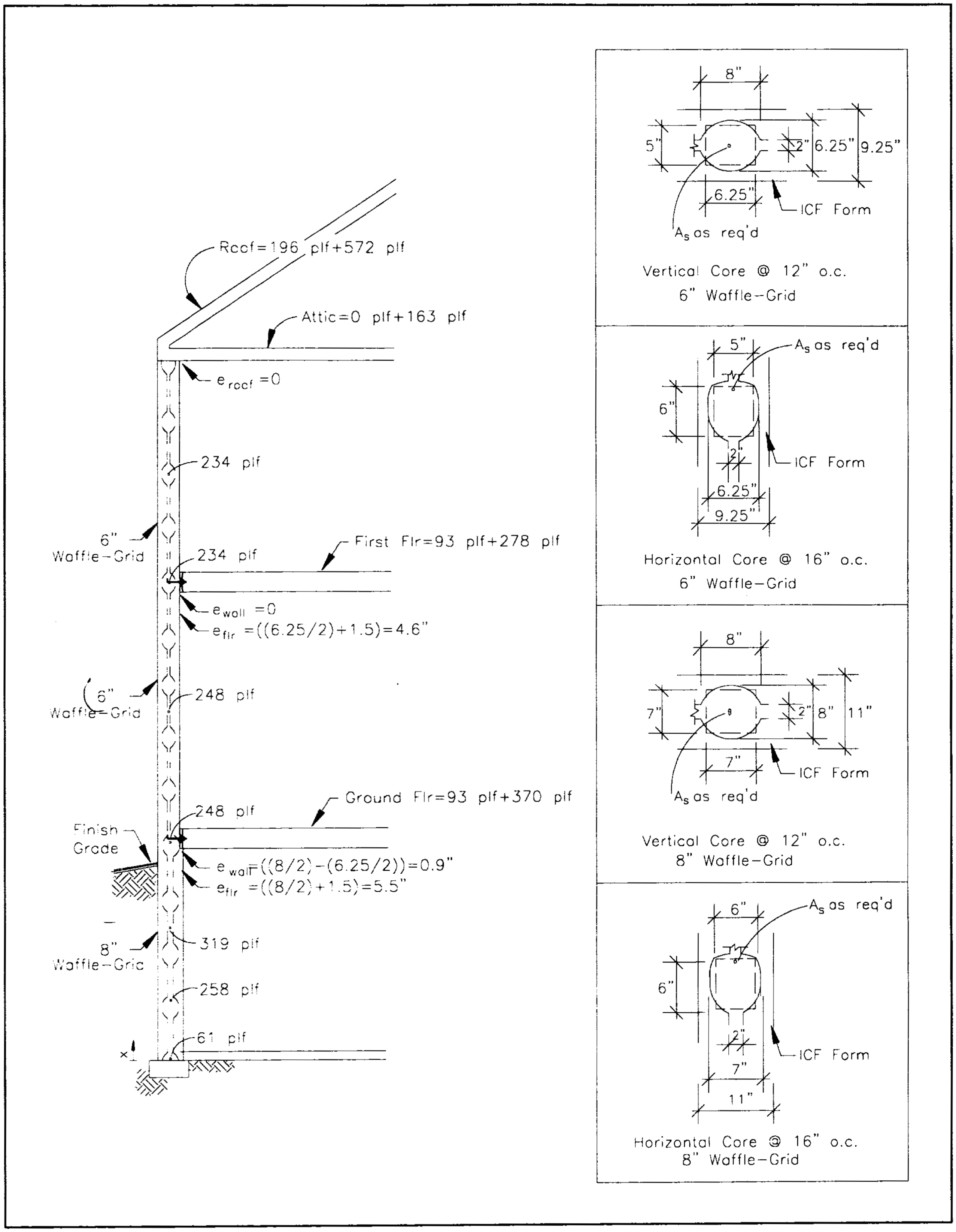


Figure 2-5 South Wall Section and Distribution of Gravity Loads

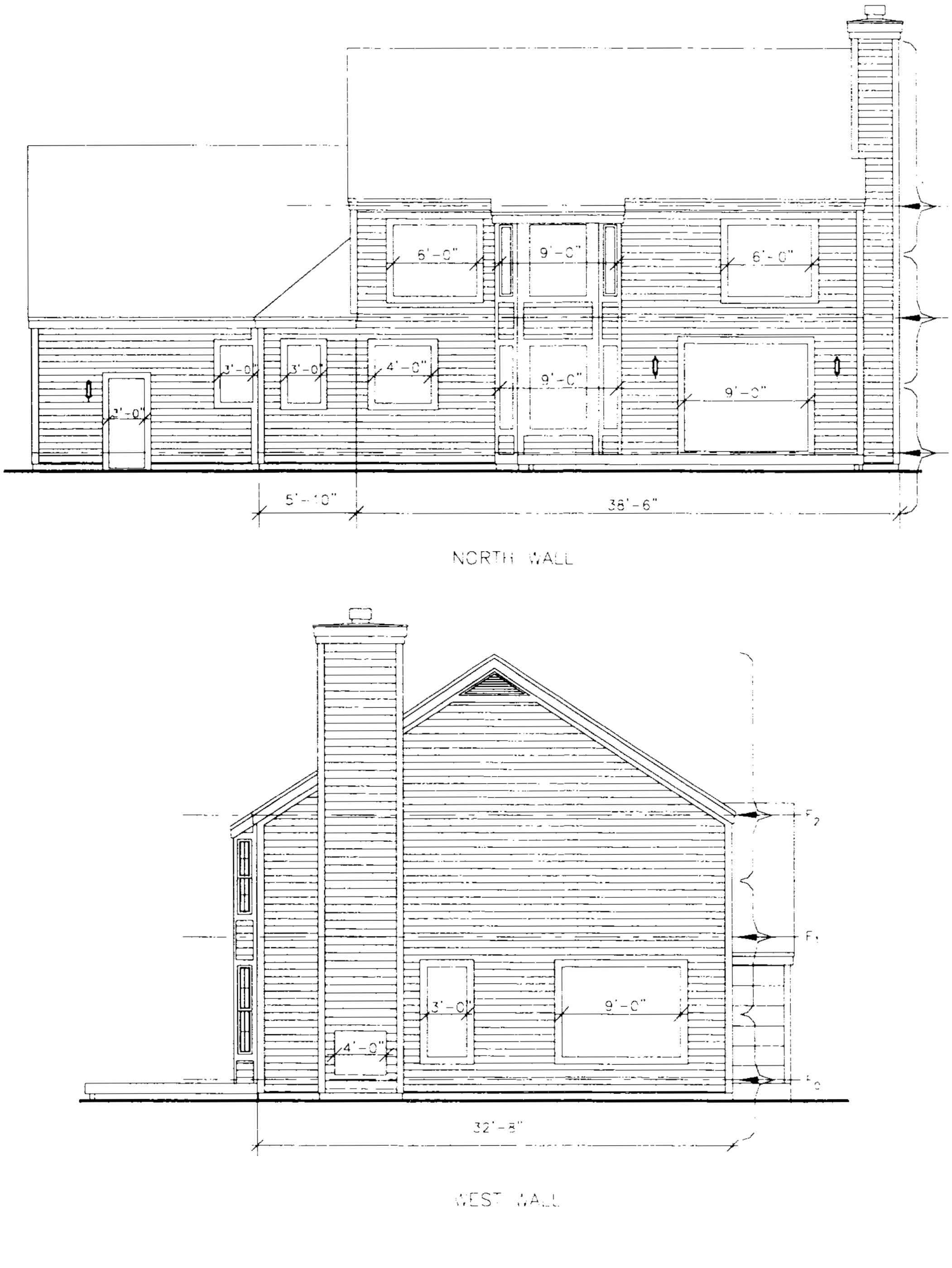


Figure 2-6 Parallel Shear Loads Due to Wind

Wind Moments	Refer to Figure A-1 for equations and Figure 2-7 for values.
Earth Moments	Refer to Figure A-3 for equations and Figure 2-7 for values.

Perpendicular Shear

Second-Story Wall	Refer to Figure A-1 for equations and Figure 2-7 for values.
First-Story Wall	Refer to Figure A-1 for equations and Figure 2-7 for values.
Foundation Wall	Refer to Figure A-3 for equations and Figure 2-7 for values.

Parallel Shear: Refer to Figure 2-6 for the parallel shear load distribution. Parallel shear loads are calculated based on a simple model that applies a horizontal projection of positive pressure on the windward wall and roof with no suction pressure applied on the leeward side of the building. This simple and conservative model is used for this design example; however, the designer should calculate parallel shear in accordance with the locally approved building code.

Second-Story Wall: The second-story wall design is based on the north wall because it experiences the highest shear loads per lineal foot resulting from the design wind loads.

$$V_{parallel} = F_2 = 0.5(32.7\ ft)(21.0 psf)\left(\frac{11 ft}{2} + \frac{8.5\ ft}{2}\right) = 3{,}348\ lb \qquad [14.9\ kN]$$

First-Story Wall: The first-story wall design is based on the west wall because it experiences the highest shear loads per lineal foot resulting from the design wind loads.

$$V_{parallel} = F_1 + F_2 = 0.5(38.5\ ft)(21.0\ psf)\left(\frac{9\ ft}{2} + 8.5 ft + 11\ ft\right) = 9{,}702\ lb \qquad [43.2\ kN]$$

Foundation Wall: Refer to Figure 2-6 for the parallel shear load distribution. Parallel shear on the foundation wall should be neglected since the walls are restrained by the soil lateral pressure on three or more sides.

$$V_{parallel} = F_0 = 0 \qquad [0\ kN]$$

NOMINAL STRUCTURAL LOAD SUMMARY

Story	Vertical Location within Wall	Dead		Live		Wind[1]			Earth		
		Axial (plf)	Moment (in-lb/lf)	Axial (plf)	Moment (in-lb/lf)	Moment (in-lb/lf)	Shear, perp (plf)	Shear, par (lb)	Moment (in-lb/lf)	Shear, perp (plf)	Shear, par (lb)
Second	Top	196	0	735	0	0.0	89	3,348			
	Midht	430	0	735	0	2,276	0				
	Bottom	664	0	735	0	0	89				
First	Top	757	-428	1,013	-1,279	0	95	9,702			
	Midht	1,005	-214	1,013	-640	2,552	0				
	Bottom	1,253	0	1,013	0	0	95				
Foundation	Top	1,346	616	1,383	-1,123				0	248	
	Midht	1,665	308	1,383	-562				10,597	90	
	x = 3.43 ft	1,923	249	1,383	-453				11,053	0	
	Bottom	1,984	0	1,383	0				0	596	0

[1] Values listed for wind are magnitudes only and therefore are non directional.

Figure 2-7 Nominal Load Summary

Figure 2-7 is a summary sheet of the greatest loading conditions described above. To determine the moments at various locations in each wall story, refer to Figure A-2. To determine the axial loads at various locations in each wall story, refer to Figure 2-5. Figure 2-8 is a summary sheet of the ACI factored loads for each wall story. The values listed in Figure 2-8 are determined by substituting the values from Figure 2-7 into the equations listed in the left column of Figure 2-8.

FACTORED STRUCTURAL LOAD SUMMARY

SECOND STORY WALL

ACI 318 Load Cases[1]	Vertical Location within Wall	Factored Loads										
		Dead		Live		Wind[2]			Total[3]			
		Axial (plf)	Moment (in-lb/lf)	Axial (plf)	Moment (in-lb/lf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)	Axial (plf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)
1. U = 1.4D + 1.7L	Top	274	0	1,250	0				1,524	0		
	Midht	602	0	1,250	0				1,852	0		
	Bottom	930	0	1,250	0				2,180	0		
2. U = 0.75(1.4D + 1.7L +/- 1.7W)	Top	206	0	937	0	0	113	4,269	1,143	0	113	4,269
	Midht	452	0	937	0	2,902	0		1,389	2,902	0	
	Bottom	697	0	937	0	0	113		1,634	0	113	
3. U = 0.9D +/- 1.3W	Top	176	0			0	116	4,352	176	0	116	4,352
	Midht	387	0			2,959	0		387	2,959	0	
	Bottom	598	0			0	116		598	0	116	

FIRST STORY WALL

ACI 318 Load Cases[1]	Vertical Location within Wall	Factored Loads										
		Dead		Live		Wind[2]			Total[3]			
		Axial (plf)	Moment (in-lb/lf)	Axial (plf)	Moment (in-lb/lf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)	Axial (plf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)
1. U = 1.4D + 1.7L	Top	1,060	-599	1,722	-2,174				2,782	2,773		
	Midht	1,407	-300	1,722	-1,088				3,129	1,388		
	Bottom	1,754	0	1,722	0				3,476	0		
2. U = 0.75(1.4D + 1.7L +/- 1.7W)	Top	795	-450	1,292	-1,631	0	121	12,370	2,087	2,081	121	12,370
	Midht	1,055	-225	1,292	-816	3,254	0		2,347	4,295	0	
	Bottom	1,316	0	1,292	0	0	121		2,608	0	121	
3. U = 0.9D +/- 1.3W	Top	681	-385			0	124	12,613	681	385	124	12,613
	Midht	905	-193			3,318	0		905	3,511	0	
	Bottom	1,128	0			0	124		1,128	0	124	

FOUNDATION WALL

ACI 318 Load Cases[1]	Vertical Location within Wall	Factored Loads										
		Dead		Live		Earth			Total[3]			
		Axial (plf)	Moment (in-lb/lf)	Axial (plf)	Moment (in-lb/lf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)	Axial (plf)	Moment (in-lb/lf)	Shear, $_{perp}$ (plf)	Shear, $_{par}$ (lb)
1. U = 1.4D + 1.7L	Top	1,884	862	2,351	-1,909				4,235	1,047		
	Midht	2,331	431	2,351	-955				4,682	524		
	x = 3.43 ft	2,692	349	2,351	-770				5,043	421		
	Bottom	2,778	0	2,351	0				5,129	0		
2. U = 1.4D + 1.7L + 1.7H	Top	1,884	862	2,351	-1,909	0	422	0	4,235	1,047	422	0
	Midht	2,331	431	2,351	-955	18,014	153		4,682	17,490	153	
	x = 3.43 ft	2,692	349	2,351	-770	18,790	0		5,043	18,369	0	
	Bottom	2,778	0	2,351	0	0	1,013		5,129	0	1,013	
3. U = 0.9D + 1.7H	Top	1,211	554			0	422	0	1,211	554	422	0
	Midht	1,499	277			18,014	153		1,499	18,291	153	
	x = 3.43 ft	1,731	224			18,790	0		1,731	19,014	0	
	Bottom	1,786	0			0	1,013		1,786	0	1,013	

[1] D = Dead Load, L = Live Load, W = Wind Load, H = Earth Load
ACI 318 Load Case Equations for first- and second-story walls are modified to take into account wind forces creating internal positive or negative pressure.
[2] Values listed for wind load are critical magnitudes only and therefore are non directional
[3] Values listed for total load are critical magnitudes only and therefore are non directional.

Figure 2-8 Factored Load Summary

2.3 DESIGN SECOND-STORY WALL

2.3.1 Select Trial Wall Section and Properties

Try a structural plain concrete 6-inch (152 mm) waffle-grid wall system and assume the concrete compressive strength is 3,000 psi (21 MPa). Refer to Figure 2-5 for the appropriate dimensions of the waffle-grid wall section. The following example follows the design procedure described in Section 1.3 for structural plain concrete walls.

2.3.2 Determine Nominal and Factored Loads

Refer to Figures 2-7 and 2-8 for a summary of nominal and factored loads acting on the second-story wall.

2.3.3 Check Perpendicular Shear

According to Figure 2-8, the critical factored perpendicular shear load, V_u, experienced by the second-story wall occurs at the bottom of the wall story due to ACI Load Case (3).

$$V_u = 116\ plf\left(\frac{ft}{1\,vertical\,core}\right) = 116\ lb/post \qquad [516\ N/post]$$

$$\phi V_n = 0.65\left(\frac{4}{3}\right)\sqrt{3{,}000psi}(6.25in)(5in) = 1{,}483\ lb/post \qquad [6.6\ kN/post]$$

$$V_u \le \phi V_n \quad OK$$

2.3.4 Check Parallel (In-Plane) Shear

According to Figure 2-8, the critical factored parallel shear load, V_u, experienced by the second-story wall occurs due to ACI Load Case (3). Recall that we calculated the parallel shear on the north wall since it experiences the highest loads per lineal foot of solid wall. Refer to Figure 2-6 for the north wall elevation. Note that the critical factored parallel shear load is divided by the total length of the north wall minus any openings in the wall since this is the portion of the wall available to resist shear. While this method has the advantage of being simple, the designer should use caution when the solid wall segments become too narrow. The designer should consider neglecting any narrow wall segments when calculating parallel shear resistance, particularly when much longer and stiffer segments exist in the same wall line.

$$V_u = \frac{4{,}352\ lb}{\left(38.5ft - (6ft + 9ft + 6ft)\right)}\left(\frac{ft}{1\,vertical\,core}\right) = 249\ lb/post \qquad [1.1\ kN/post]$$

$$\phi V_n = 0.65\left(\frac{4}{3}\right)\sqrt{3{,}000\,psi}(5in)(6.25in) = 1{,}483\,lb/post \qquad [6.6\ kN/post]$$

$$V_u \le \phi V_n \quad OK$$

2.3.5 Check Compression and Tension

According to Figure 2-8, the critical maximum total moment, M_u, experienced by the second-story wall occurs at mid-height due to ACI Load Case (3). The corresponding total factored axial load, P_u, is also taken at the mid-height of the second-story wall based on ACI Load Case (3).

$$M_u = 2{,}959\ in-lb/ft\left(\frac{ft}{1\,vertical\,core}\right) = 2{,}959\ in-lb/post \qquad [334\ N\text{-}m/post]$$

$$= 0.25\,ft-kip/post \longleftarrow GOVERNS$$

$$P_u = 387\ plf\left(\frac{ft}{1\,vertical\,core}\right) = 387\,lb/post = 0.39\ kip/post \qquad [1.72\ kN/post]$$

$$M_{u,min} = 0.1(5in)(387\,plf)\left(\frac{ft}{1\,vertical\,core}\right) = 194\ in-lb/post \qquad [21.9\ N\text{-}m/post]$$

$$= 0.02\ ft-kip/post$$

Plot M_u and P_u on the interaction diagram for a 6-inch (152 mm) waffle-grid wall. The interaction diagram can be found in Appendix E; however, the interaction diagram is reproduced in Figure 2-9 with the location of the plotted point illustrated. The plotted point lies within the lower tension boundary, the upper compression boundary for an 8.5-foot (2.6 m) wall height, and the reference axes; therefore, a 6-inch (152 mm) waffle-grid structural plain concrete wall is sufficient for the given loading conditions.

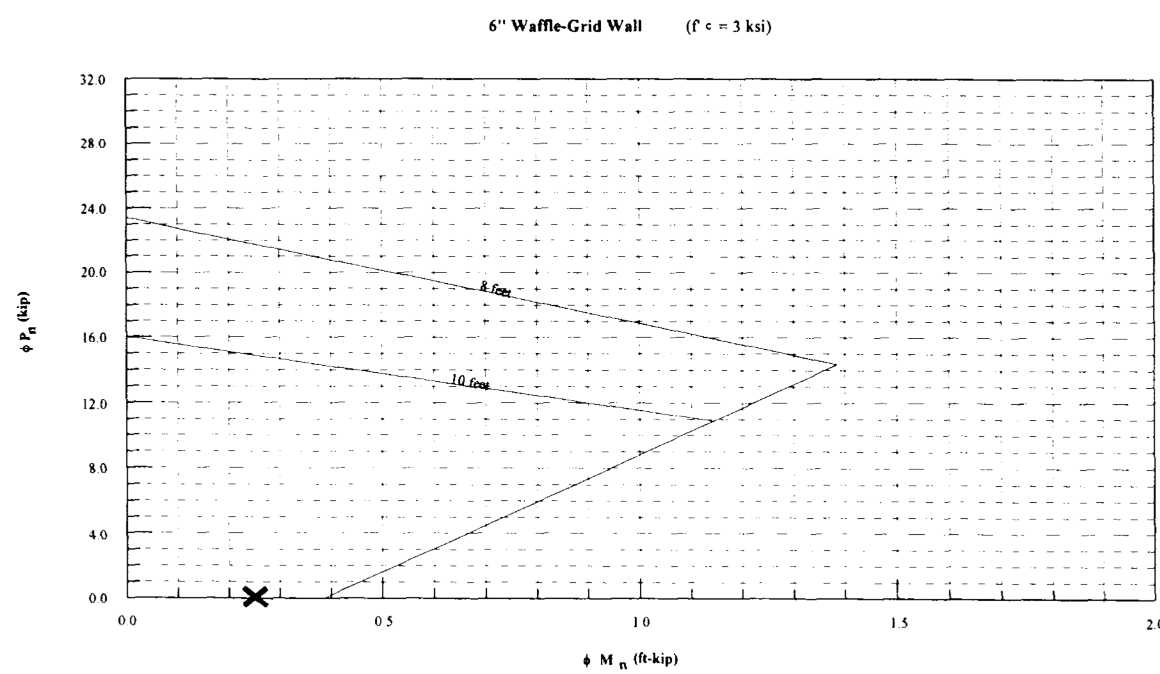


Figure 2-9 6-inch (152 mm) Waffle-Grid ICF Structural Plain Concrete Interaction Diagram

2.3.6 Check Deflection

Assume a gypsum board interior finish exposed to view. The deflection calculations below are based on suggestions made in Section 1.3.6 for service live loads taking only wind load into account. Refer to Figure A-1 for the maximum deflection equation.

$$\Delta_{actual} = \frac{5(21.0\,psf)(1\,ft)(8.5\,ft)^4\left(\dfrac{1{,}728\,in^3}{ft^3}\right)}{384(3{,}122{,}019\,psi)\left(\dfrac{(6.25\,in)(5\,in)^3}{12}\right)} = 0.012\ in \qquad [0.3\ mm]$$

$$\Delta_{allowable} = \frac{(8.5\,ft)\left(\dfrac{12\,in}{ft}\right)}{360} = 0.28\ in \qquad [7\ mm]$$

$$\Delta_{actual} \le \Delta_{allowable} \qquad OK$$

2.3.7 Determine Reinforcement

A nominal amount of reinforcement is required in a structural plain concrete wall. Based on the suggestions of Section 1.3.6, the following reinforcement will be installed:

2.3.7.1 Horizontal Reinforcement

$$8(5\,in) = 40\,in \longleftarrow GOVERNS \qquad [1\ m]$$
$$max = 48\ in \qquad [1.2\ m]$$
$$horizontal\ core\ spacing = 16\,in\ \therefore\ space\ reinforcement\ 32\ inches\ on\ center \qquad [0.8\ m]$$
$$32\ in \le 40\ in \qquad OK \qquad [0.8\ m < 1\ m]$$

Install one Grade 40 (276 MPa), minimum #3 bar at 32 inches (813 mm) on center. At least one continuous horizontal reinforcement bar should be placed within the top 12 inches (305 mm) of the wall story.

2.3.7.2 Reinforcement Around Openings

Recall in Section 2.2 that the loads were determined assuming that the wall had no openings. Wall openings create greater loads on the vertical core adjacent to the opening; therefore, check to determine if the reinforcement around openings suggested in Section 1.3.7 is sufficient.

Check the vertical core adjacent to the master bedroom window in the north wall since this is the largest opening in the second-story wall at Section A as shown in Figures 2-3 and 2-4. The designer may use the same design procedure as follows to check the required reinforcement around other openings in the second-story wall; however, calculations for other openings in the second-story wall are not included here. The following example follows the design procedures described in Section 1.2 for structural reinforced concrete walls.

(a) Determine Factored Loads

Refer to Section 2.2 for moments calculated and refer to Figure 2-14 in Section 2.6 for lintel loads transmitted to the vertical core.

$$P_u = \left[1.4(251\ plf) + 1.7(735\ plf)\right]\left(\frac{6.5\ ft}{2}\right) = 5{,}203\ lb \qquad [23.1\ kN]$$

$$M_u = 2{,}959\ in-lb \qquad [334\ N\text{-}m]$$

(b) Determine Slenderness

Note that the unbraced length of the vertical core is assumed to be the height of the window opening.

$$\frac{(1)(5\ ft)\left(\frac{12\ in}{ft}\right)}{0.3(5\ in)} = 40 \quad \therefore\ slender$$

(c) Determine Magnified Moment

Use the equations in Appendix C for non-sway frames since the tables in Appendix C do not include heights less than 8 feet (2.4 m). Try one #4 bar in the vertical core. Refer to Section 2.2 for moments calculated and refer to part (a) of this section for the factored axial load.

$$M_u = 2{,}959\ in-lb \qquad [338\ N\text{-}m]$$

$$P_u = 5{,}203\ lb \qquad [23.1\ kN]$$

$$P_{u,dead} = 1.4(251\ plf)\left(\frac{6.5\ ft}{2}\right) = 1{,}142\ lb \qquad [5.1\ kN]$$

$$M_{u,min} = 5{,}203\ lb(0.6 + 0.03(5\ in)) = 3{,}902\ in-lb \quad \longleftarrow \quad GOVERNS \qquad [441\ N\text{-}m]$$

$$e = \frac{3{,}902\ lb}{5{,}203\ lb} = 0.75\ in \qquad [19\ mm]$$

$$\beta_d = \frac{1{,}142\ lb}{5{,}203\ lb} = 0.22$$

$$\rho = \frac{0.20\ in^2}{(5\ in)(6.25\ in)} = 0.0064$$

$$E_c = 57{,}000\sqrt{3{,}000\ psi} = 3{,}122{,}019\ psi \qquad [21.5\ GPa]$$

$$\beta = 0.9 + 0.5(0.22)^2 - 12(0.0064) = 0.85 \quad \therefore\ use\ 1.0$$

$$EI = \frac{0.4(3{,}122{,}019\ psi)\left(\dfrac{6.25\ in(5\ in)^3}{12}\right)}{1.0} = 81{,}302{,}578\ psi \qquad [560.6\ GPa]$$

$$C_m = 1.0$$

$$P_c = \frac{\pi^2(81{,}302{,}578\ psi)}{\left[1(5\ ft)\left(\dfrac{12\ in}{ft}\right)\right]^2} = 222{,}896\ lb \qquad [991.5\ kN]$$

$$\delta_{ns} = \frac{1}{1 - \dfrac{5{,}203\ lb}{0.75(222{,}896\ lb)}} = 1.03$$

$$M_{ns} = 1.03(3{,}902\ in-lb) = 4{,}019\ in-lb = 0.3\ ft-kip \qquad [450\ N\text{-}m]$$

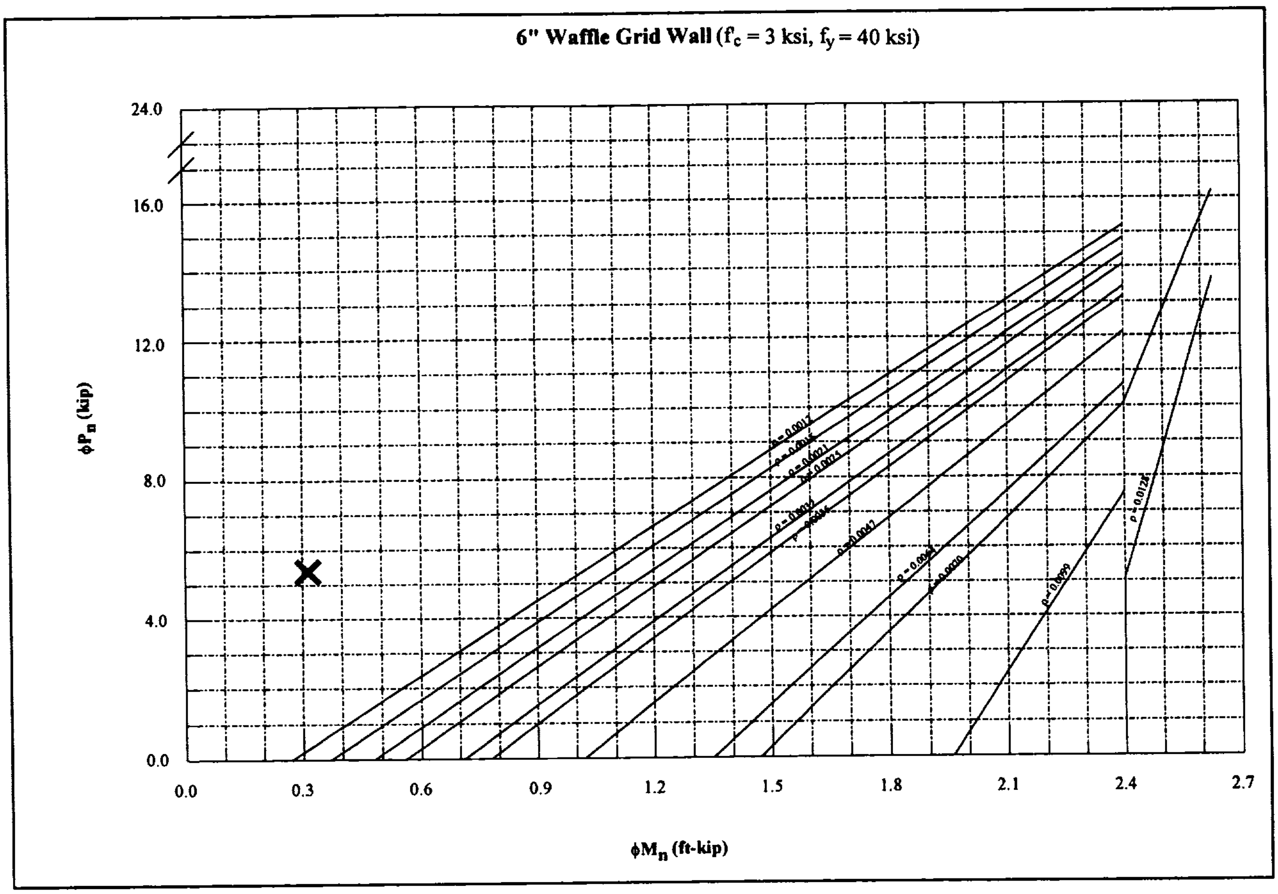


Figure 2-10 6-inch (152 mm) Waffle-Grid ICF Structural Reinforced Concrete Interaction Diagram

(d) Determine Reinforcement

Plot M_{ns} and P_u from (c) on the interaction diagram for a 6-inch (152 mm) waffle-grid wall with f_c' = 3,000 psi (21 MPa) and f_y = 40,000 psi (276 MPa). The interaction diagram can be found in Appendix D; however, the interaction diagram is reproduced in Figure 2-10 with the location of the plotted point illustrated. The plotted point lies well above and to the left of the reinforcement line for $\rho = 0.0064$; therefore, one #4 bar is sufficient for this opening.

Based on the calculations above and assuming that other wall openings in the second-story wall yield similar results although not shown here, use the following reinforcement for openings in the second-story wall.

For openings less than 2 feet (0.6 m) in width:		No reinforcement by inspection
For openings 2 to 4 feet (0.6 to 1.2 m) in width:		One #4 bar at bottom and top of opening extending 24 inches (610 mm) beyond each side of the opening
For openings greater than 4 feet (1.2 m) in width		One #4 bar at bottom of opening extending 24 inches (610 mm) beyond each side of the opening.
	Plus	One #4 bar placed vertically on each side of the opening spanning the wall story height
	Plus	Horizontal reinforcement at top of opening as required by lintel design.

2.4 DESIGN FIRST-STORY WALL

2.4.1 Select Trial Wall Section and Properties

Try a structural plain concrete 6-inch (152 mm) waffle-grid wall system and assume the concrete compressive strength is 3,000 psi (21 MPa). Refer to Figure 2-5 for the appropriate dimensions of the waffle-grid wall section. The following example follows the design procedure described in Section 1.3 for structural plain concrete walls.

2.4.2 Determine Nominal and Factored Loads

Refer to Figures 2-7 and 2-8 for a summary of nominal and factored loads acting on the first-story wall.

2.4.3 Check Perpendicular Shear

According to Figure 2-8, the critical factored perpendicular shear load, V_u, experienced by the first-story wall occurs at the bottom of the wall story due to ACI Load Case (3).

$$V_u = 124\,plf\left(\frac{ft}{1\,vertical\,core}\right) = 124\,lb\,/\,post \qquad [552\ N/post]$$

$$\phi V_n = 0.65\left(\frac{4}{3}\right)\sqrt{3{,}000\,psi}\,(6.25\,in)(5\,in) = 1{,}483\ lb\,/\,post \qquad [6.6\ kN/post]$$

$$V_u \le \phi V_n \qquad OK$$

2.4.4 Check Parallel (In-Plane) Shear

According to Figure 2-8, the critical factored parallel shear load, V_u, for the first-story wall occurs due to ACI Load Case (3). Recall that we calculated the parallel shear on the west wall since it experiences the highest loads per lineal foot of solid wall. Refer to Figure 2-6 for the west wall elevation. Note that the critical factored parallel shear load is divided by the total length of the west wall minus any openings in the wall since this is the portion of the wall available to resist shear.

$$V_u = \frac{12{,}613\ lb}{(32.7\,ft - (9\,ft + 3\,ft + 4\,ft))}\left(\frac{ft}{1\,vertical\,core}\right) = 755\ lb\,/\,post \qquad [3.4\ kN/post]$$

$$\phi V_n = 0.65\left(\frac{4}{3}\right)\sqrt{3{,}000\ psi}\,(5\,in)(6.25\,in) = 1{,}483\ lb\,/\,post \qquad [6.6\ kN/post]$$

$$V_u \le \phi V_n \qquad OK$$

2.4.5 Check Compression and Tension

According to Figure 2-8, the critical maximum total moment, M_u, experienced by the first-story wall occurs at mid-height due to ACI Load Case (2). The corresponding total factored axial load, P_u, is also taken at the mid-height of the second-story wall based on ACI Load Case (2).

$$M_u = 4{,}295\ in-lb/ft\left(\frac{ft}{1\,vertical\,core}\right) = 4{,}295\ in-lb/post \qquad [485\ N\text{-}m/post]$$

$$= 0.36\,ft-kip/post \longleftarrow GOVERNS$$

$$P_u = 2{,}347\ plf\left(\frac{ft}{1\,vertical\,core}\right) = 2{,}347\,lb/post = 2.35\ kip/post \qquad [10.4\ kN/post]$$

$$M_{u,min} = 0.1(5\,in)(2{,}347\ plf)\left(\frac{ft}{1\,vertical\,core}\right) = 1{,}174\ in-lb/post \qquad [133\ N\text{-}m/post]$$

$$= 0.10\ ft-kip/post$$

Plot M_u and P_u on the interaction diagram for a 6-inch (152 mm) waffle-grid wall. The interaction diagram can be found in Appendix E; however, the interaction diagram is reproduced in Figure 2-11 with the location of the plotted point illustrated. The plotted point lies within the lower tension boundary, the upper compression boundary for a 9-foot (2.7 m) wall height, and the reference axes; therefore, a 6-inch (152 mm) waffle-grid structural plain concrete wall is sufficient for the given loading conditions.

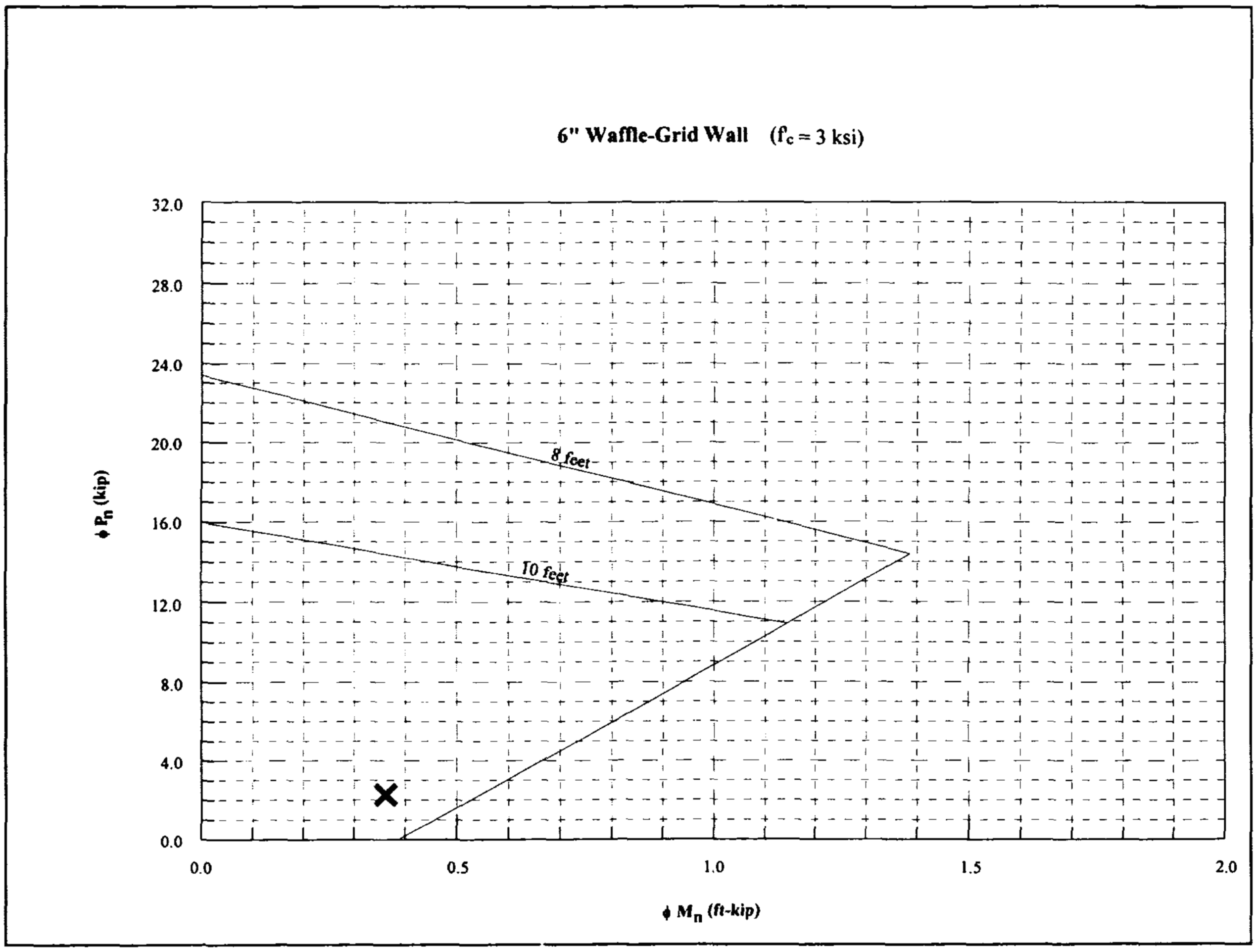


Figure 2-11 6-inch (152 mm) Waffle-Grid ICF Structural Plain Concrete Interaction Diagram

2.4.6 Check Deflection

Assume a gypsum board interior finish exposed to view. The following deflection calculations are based on suggestions made in Section 1.3.6 for service live loads taking only wind loads into account. Refer to Figure A-1 for the maximum deflection equation.

$$\Delta_{actual} = \frac{5(21.0\,psf)(1\,ft)(9\,ft)^4\left(\frac{1{,}728\,in^3}{ft^3}\right)}{384(3{,}122{,}019\,psi)\left(\frac{(6.25\,in)(5\,in)^3}{12}\right)} = 0.02\ in \qquad [0.5\ mm]$$

$$\Delta_{allowable} = \frac{(9\,ft)\left(\frac{12\,in}{ft}\right)}{360} = 0.3\ in \qquad [8\ mm]$$

$$\Delta_{actual} \le \Delta_{allowable} \qquad OK$$

2.4.7 Determine Reinforcement

A nominal amount of reinforcement is required in a structural plain concrete wall. Based on the suggestions of Section 1.3.7, the following reinforcement will be installed:

2.4.7.1 Horizontal Reinforcement

$8(5\,in) = 40\,in \longleftarrow \; GOVERNS$ [1 *m*]

$max = 48\ in$ [1.2 *m*]

$horizontal\ core\ spacing = 16\,in \ \therefore\ space\ reinforcement\ 32\ inches\ on\ center$ [0.8 *m*]

$32\ in \leq 40\ in \qquad OK$ [0.8 *m* < 1 *m*]

Install one Grade 40 (276 MPa), minimum #3 bar at 32 inches (813 mm) on center. At least one continuous horizontal reinforcement bar should be placed within the top 12 inches (305 mm) of the wall story.

2.4.7.2 Reinforcement Around Openings

Recall in Section 2.2. that the loads were determined assuming that the wall had no openings. Wall openings create greater loads on the vertical core adjacent to the opening; therefore, check to determine if the reinforcement around openings suggested in Section 1.3.7 is sufficient.

Check the vertical core adjacent to the family room door in the north wall since this is the largest opening in the first-story wall at Section A as shown in Figures 2-3 and 2-4. The designer may use the same design procedure as follows to check the required reinforcement around other openings in the first-story wall; however, calculations for other openings in the first-story wall are not included here. The following example follows the design procedures described in Section 1.2 for structural reinforced concrete walls.

(a) Determine Factored Loads

Refer to Section 2.2 for moments calculated and refer to Figure 2-15 in Section 2.7 for lintel loads transmitted to the vertical core.

$$P_u = \left[1.4(254\ plf) + 1.7(213\ plf)\right]\left(\frac{9.5\ ft}{2}\right) = 3{,}409\ lb \qquad [15.2\ kN]$$

$$M_u = 4{,}295\ in-lb \qquad [485.3\ N\text{-}m]$$

(b) Determine Slenderness

Note that the unbraced length of the vertical core is assumed to be the height of the door opening.

$$\frac{(1)(7\ ft)\left(\frac{12\ in}{ft}\right)}{0.3(5\ in)} = 56 \quad \therefore\ slender$$

(c) Determine Magnified Moment

Use the equations in Appendix C for non-sway frames since the tables in Appendix C do not include heights less than 8 feet (2.4 m). Try one #4 bar in the vertical core.

$$M_u = 4{,}295\ in-lb \quad \longleftarrow \quad GOVERNS \qquad [485.3\ N\text{-}m]$$

$$P_u = 3{,}409\ lb \qquad [15.2\ kN]$$

$$P_{u,dead} = 1.4(254\ plf)\left(\frac{9.5\ ft}{2}\right) = 1{,}689\ lb \qquad [7.5\ kN]$$

$$M_{u,min} = 3{,}409\ lb(0.6 + 0.03(5\ in)) = 2{,}557\ in-lb \qquad [289\ N\text{-}m]$$

$$e = \frac{4{,}295\ lb}{3{,}409\ lb} = 1.3\ in \qquad [32\ mm]$$

$$\beta_d = \frac{1{,}689\ lb}{3{,}409\ lb} = 0.5$$

$$\rho = \frac{0.20\ in^2}{(5\ in)(6.25\ in)} = 0.0064$$

$$E_c = 57{,}000\sqrt{3{,}000\ psi} = 3{,}122{,}019\ psi \qquad [21.5\ GPa]$$

$$\beta = 0.9 + 0.5(0.5)^2 - 12(0.0064) = 0.95 \quad \therefore use\ 1.0$$

$$EI = \frac{0.4(3{,}122{,}019\ psi)\left(\frac{6.25\ in(5\ in)^3}{12}\right)}{1.0} = 81{,}302{,}578\ psi \qquad [560.6\ GPa]$$

$$C_m = 1.0$$

$$P_c = \frac{\pi^2(81{,}302{,}578\ psi)}{\left[1(7\ ft)\left(\frac{12\ in}{ft}\right)\right]^2} = 113{,}722\ lb \qquad [505.9\ kN]$$

$$\delta_{ns} = \frac{1}{1 - \frac{3{,}409\ lb}{0.75(113{,}722\ lb)}} = 1.04$$

$$M_{ns} = 1.04(4{,}295\ in-lb) = 4{,}467\ in-lb = 0.37\ ft-kip \qquad [505\ N\text{-}m]$$

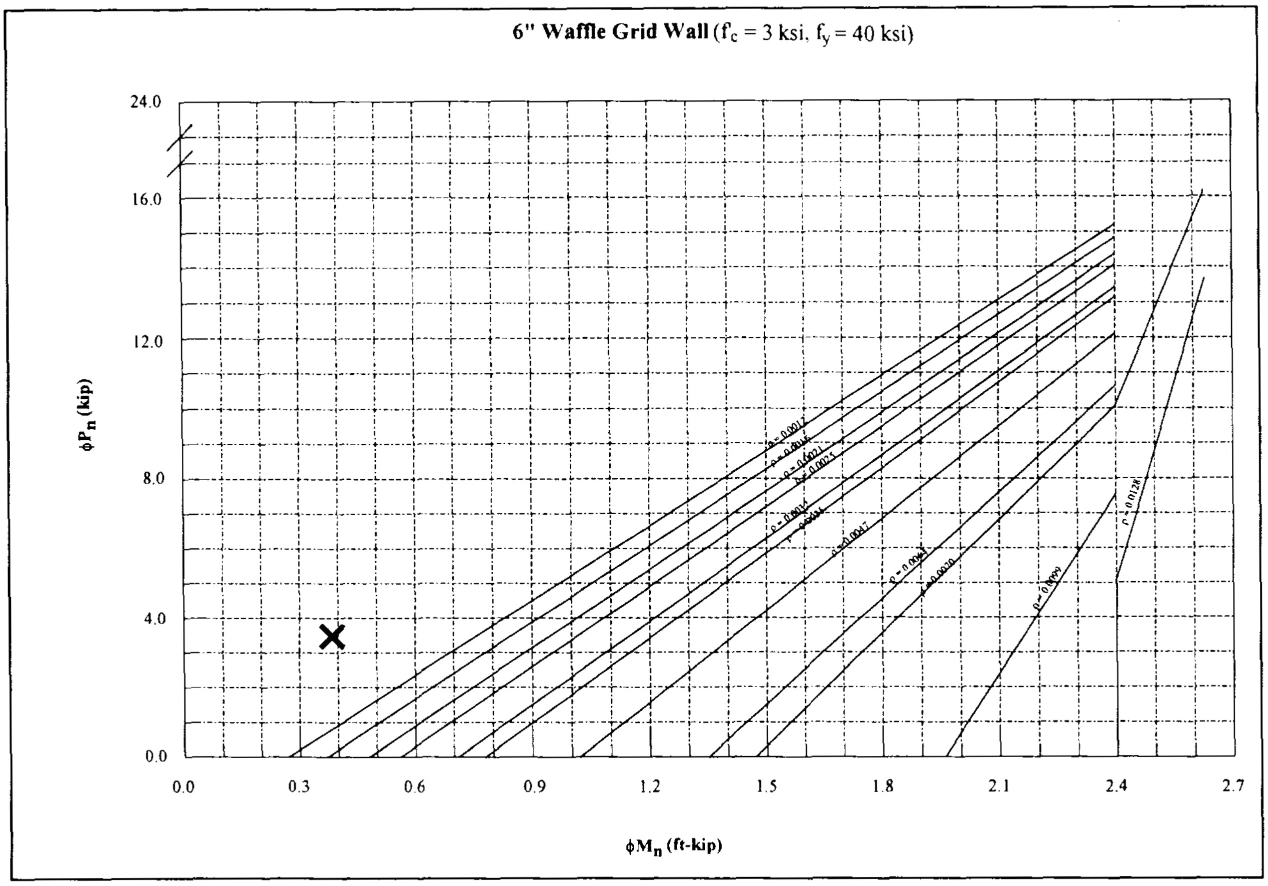


Figure 2-12 6-inch (152 mm) Waffle-Grid ICF Structural Reinforced Concrete Interaction Diagram

(d) Determine Reinforcement

Plot M_{ns} and P_u from (c) on the interaction diagram for a 6-inch (152 mm) waffle-grid wall with $f_c{}'$ = 3,000 psi (21 MPa) and f_y = 40,000 psi (276 MPa). The interaction diagram can be found in Appendix D; however, the interaction diagram is reproduced in Figure 2-12 with the location of the plotted point illustrated. The plotted point lies well above and to the left of the reinforcement line for $\rho = 0.0064$; therefore, one #4 bar is sufficient for this opening.

Based on the calculation above and assuming that other wall openings in the first-story wall yield similar results although not shown here, use the following reinforcement for openings in the first-story wall.

For openings less than 2 feet (0.6 m) in width:	No reinforcement by inspection
For openings 2 to 4 feet (0.6 to 1.2 m) in width:	One #4 bar at bottom and top of opening extending 24 inches (610 mm) beyond each side of the opening

For openings greater than 4 feet (1.2 m) in width:		One #4 bar at bottom of opening extending 24 inches (610 mm) beyond each side of the opening
	Plus	One #4 bar placed vertically on each side of the opening spanning the wall story height
	Plus	Horizontal reinforcement at top of opening as required by lintel design.

2.5 DESIGN FOUNDATION WALL

2.5.1 Select Trial Wall Section and Properties

Try a structural reinforced concrete 8-inch (203 mm) waffle-grid wall system and assume the concrete compressive strength is 3,000 psi (21 MPa) and the yield strength of reinforcement is 40,000 psi (276 MPa). Refer to Figure 2-5 for the appropriate dimensions of the waffle-grid wall section. Try a vertical reinforcement spacing at 24 inches (610 mm) on center. The following example follows the design procedure described in Section 1.2 for structural reinforced concrete walls.

2.5.2 Determine Nominal and Factored Loads

Refer to Figures 2-7 and 2-8 for a summary of nominal and factored loads acting on the foundation wall.

2.5.3 Check Perpendicular Shear

According to Figure 2-8, the critical factored perpendicular shear load, V_u, experienced by the foundation wall occurs at the bottom of the wall story due to ACI Load Case (2) or (3). Note that only the reinforced vertical cores are assumed to resist perpendicular wall shear.

$$V_u = (1{,}013\, plf)\left(\frac{2\, ft}{1\, reinforced\ vertical\ core}\right) = 2{,}026\, lb/post \qquad [9.0\ kN/post]$$

$$V_s = 0 \quad assume\ no\ stirrups$$

$$\phi V_n = 0.85(2)\sqrt{3{,}000 psi}(7\, in)\left(\frac{7\ in}{2}\right) = 2{,}281\ lb/post \qquad [10.1\ kN/post]$$

$$V_u \le \phi V_n \qquad OK$$

2.5.4 Check Parallel (In-Plane) Shear

The basement walls are constrained against lateral loads by the passive pressure of the soil and soil-wall friction. Parallel shear on the basement wall can be neglected by design inspection.

2.5.5 Sway Determination

This home is determined to be a non-sway structure by observation since all four walls are constructed and braced with an ICF bearing wall system.

2.5.6 Determine Slenderness

To determine whether the wall is slender, the radius of gyration is approximated as *0.3h* for rectangular compression members and *k* is assumed to be 1.0 since the wall is tied to the footing below and the floor above.

$$\frac{(1)(8.5\,ft)\left(\frac{12\ in}{ft}\right)}{0.3(7\ in)} = 49 \qquad \leq 34 \qquad N.G.$$

The slenderness ratio is larger than 34 but less than 100; therefore, the wall is considered slender and may be designed using the moment magnifier method in lieu of second-order analysis.

2.5.7 Determine Magnified Moment

When designing foundation walls, it is often recommended that backfilling occur after the first-story above-grade walls are constructed and at least seven days after the concrete is poured for the foundation walls. However, the designer should be aware that backfilling typically occurs three days after pouring the concrete for the foundation walls on a residential construction job site. To prevent foundation wall failure during construction due to early backfilling, the contractor should adequately brace the foundation walls. In certain situations, the designer may also elect to design the foundation wall for construction conditions assuming minimal bracing as discussed in Section 2.5.7.1. The designer may skip Section 2.5.7.1 if backfilling occurs as specified or the contractor provides adequate temporary bracing.

2.5.7.1 Determine Magnified Moment for Construction Conditions

$$\textit{Design load considered} = \textit{factored dead load} + \textit{factored earth load}$$

To use the tables in Appendix C, the values for the variables below are calculated using the factored loads from Figure 2-8. Note that only the reinforced vertical cores are assumed to resist moments and axial loads experienced by the wall.

$$M_u = \left(\frac{19{,}014\, in-lb}{ft}\right)\left(\frac{2\,ft}{1\, reinforced\ vertical\ core}\right) = 38{,}028\ in-lb/post \qquad [4.3\ kN\text{-}m/post]$$

$$= 3.2\,ft-kip/post \longleftarrow GOVERNS$$

$$P_u = (1{,}731\,plf)\left(\frac{2\,ft}{1\,reinforced\ vertical\ core}\right) = 3{,}462\,lb/post = 3.5\,kip/post \qquad [15.4\ kN/post]$$

$$P_{u,dead} = P_u$$

$$M_{u,min} = 3{,}462\,lb/post(0.6+0.03(7\ in)) = 2{,}804\ in-lb/post \qquad [317\ kN\text{-}m/post]$$

$$= 0.23\,ft-kip/post$$

$$e = \frac{38{,}028\,in-lb/post}{3{,}462\,lb/post} = 11\,in \qquad [280\ mm]$$

$$\beta_d = \frac{3{,}462\ lb/post}{3{,}462\ lb/post} = 1.0$$

$$\rho = 0.0014\ \ assumed$$

Using the Non-Sway Moment Magnifier Table found in Appendix C for an 8-inch (203 mm) waffle-grid wall with f_c' = 3,000 psi (21 MPa) and a wall height of 8.5 feet (2.6 m), the moment magnifier, δ_{ns}, is approximately 1.12. The magnified moment is

$$M_{ns} = 1.12\left(\frac{3.2\,ft-kip}{post}\right) = 3.6\,ft-kip\,/\,post \qquad [4.9\ kN\text{-}m/post]$$

2.5.7.2 Determine Magnified Moment for Final Conditions

Design load considered = factored dead load + factored live load + factored earth load

To use the tables in Appendix C, the values for the variables below are calculated using the factored loads from Figure 2-8. Note that only the reinforced vertical cores are assumed to resist moments and axial loads experienced by the wall.

$$M_u = \left(\frac{18{,}369\,in-lb}{ft}\right)\left(\frac{2\,ft}{1\,reinforced\ vertical\ core}\right) = 36{,}738\ in-lb\,/\,post \qquad [4.2\ kN\text{-}m/post]$$

$$= 3.1\,ft-kip\,/\,post \longleftarrow GOVERNS$$

$$P_u = (5{,}043\,plf)\left(\frac{2\,ft}{1\,reinforced\ vertical\ core}\right) = 10{,}086\,lb\,/\,post \ = \ 10\,kip\,/\,post \qquad [45\ kN/post]$$

$$P_{u,dead} = (2{,}692\,plf)\left(\frac{2\,ft}{1\,reinforced\ vertical\ core}\right) = 5{,}384\ lb\,/\,post \ = \ 5.4\,kip\,/\,post \qquad [24\ kN/post]$$

$$M_{u,min} = 10{,}086\,lb\,/\,post(0.6 + 0.03(7\ in)) = 8{,}170\ in-lb\,/\,post \qquad [923\ N\text{-}m/post]$$

$$= \ 0.68\,ft\ -\ kip\,/\,post$$

$$e = \frac{36{,}738\ in-lb\,/\,post}{10{,}086\,lb\,/\,post} = 3.6\,in \qquad [91\ mm]$$

$$\beta_d = \frac{5{,}384\ lb\,/\,post}{10{,}086\ lb\,/\,post} = 0.5$$

$$\rho = 0.0014\ \ assumed$$

Using the Non-Sway Moment Magnifier Table found in Appendix C for an 8-inch (203 mm) waffle-grid wall with f_c' = 3,000 psi (21 MPa) and a wall height of 8.5 feet (2.6 m), the moment magnifier, δ_{ns}, is approximately 1.32. The magnified moment is

$$M_{ns} = 1.32\left(\frac{3.1\,ft-kip}{post}\right) = 4\,ft-kip\,/\,post \qquad [5.4\ kN\text{-}m/post]$$

2.5.8 Determine Reinforcement

Plot M_{ns} and P_u from Sections 2.5.7.1 and 2.5.7.2 on the interaction diagram found in Appendix D for an 8-inch (203 mm) waffle-grid wall with f'_c = 3000 psi (21 MPa) and f_y = 40,000 psi (276 MPa). The interaction diagram can be found in Appendix D; however, the interaction diagram is reproduced in Figure 2-13 with the location of the plotted points illustrated. The plotted points lie well above and to the left of the reinforcement lines for ρ = 0.0063 and ρ = 0.0082. Vertical reinforcement required in the foundation wall is

therefore use: One #4 bar at 6 inches (152 mm) on center (ρ = 0.0082) for the construction condition

or use: One #5 bar at 12 inches (305 mm) on center (ρ = 0.0063) for the final condition

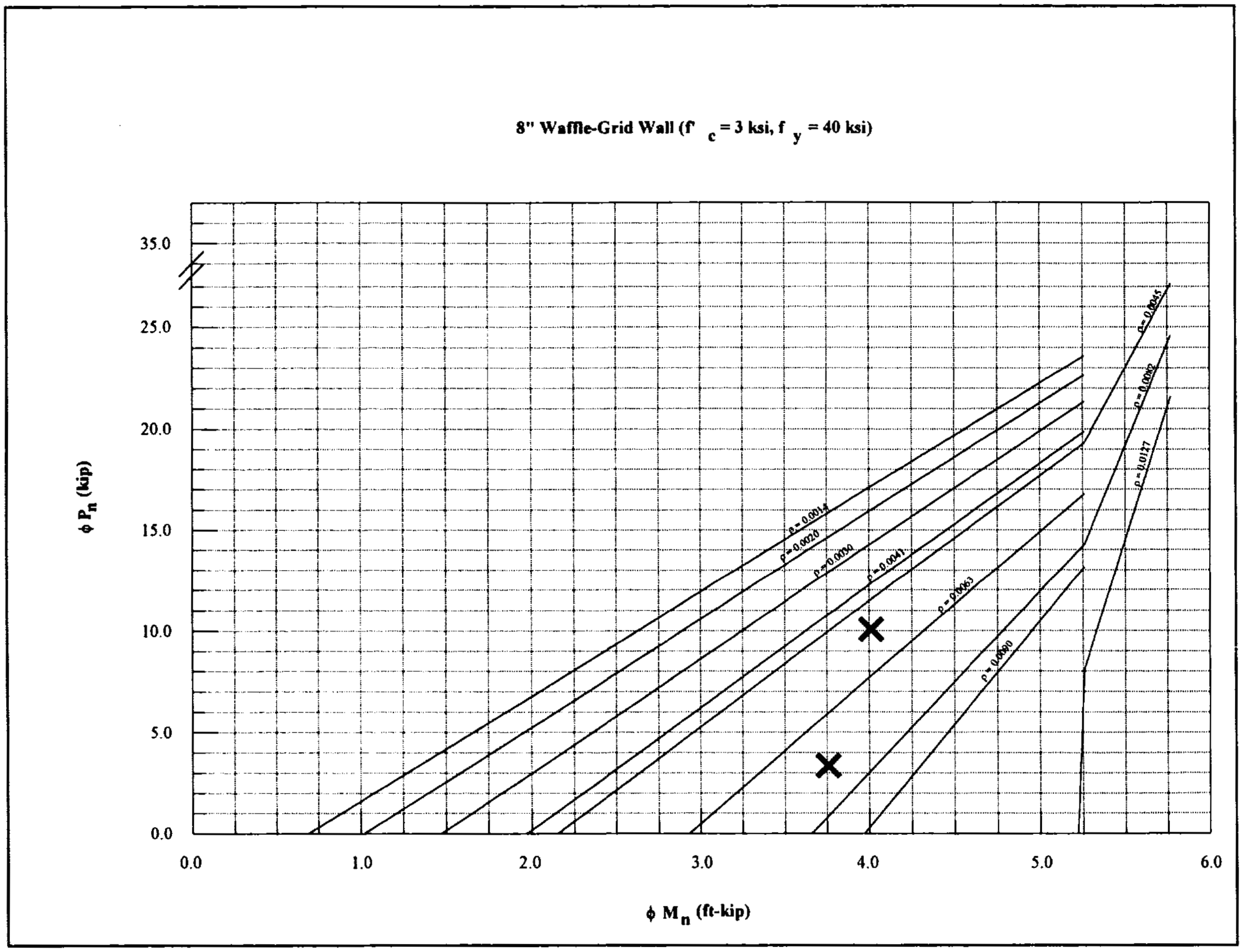


Figure 2-13 8-Inch (203 mm) Waffle-Grid Structural Reinforced Concrete Interaction Diagram

Based on the suggestions of Section 1.2.8, the following reinforcement will be installed in addition to the vertical reinforcement specified above:

2.5.8.1 Horizontal Reinforcement

$8(7\,in) = 56\,in$ [1.4 m]

$max = 48\ in \longleftarrow\ GOVERNS$ [1.2 m]

$horizontal\ core\ spacing = 16\,in\ \therefore\ space\ \ reinforcement\ 48\ inches\ \ on\ \ center$

$48\ in \leq 48\ in \quad OK$ $[1.2\ m = 1.2\ m]$

Install one Grade 40 (276 Mpa), minimum #3 bar at 48 inches (1.2 mm) on center. At least one continuous horizontal reinforcement bar should be placed within the top 12 inches (305 mm) of the wall story.

2.5.8.2 Reinforcement Around Openings

Recall in Section 2.2. that the loads were determined assuming that the wall had no openings. Wall openings create greater loads on the vertical core adjacent to the opening; however, since the openings in the basement wall are small and do not occur in the north or south walls where the heaviest loads occur, the following reinforcement is installed by observation.

For openings less than 2 feet (0.6 m) in width		No reinforcement by inspection
For openings 2 to 4 feet (0.6 to 1.2 m) in width:		One #4 bar at bottom and top of opening extending 24 inches (610 mm) beyond each side of the opening
For openings greater than 4 feet (1.2 m) in width:		One #4 bar at bottom of opening extending 24 inches (610 mm) beyond each side of the opening
	Plus	One #4 bar placed vertically on each side of the opening spanning the wall story height
	Plus	Horizontal reinforcement at top of opening as required by lintel design

2.5.9 Check Deflection

Assume a gypsum board interior finish exposed to view. The following deflection calculations are based on the suggestions made in Section 1.2.9 for service live loads taking only earth loads into account. Note that the service load moment is multiplied by the moment magnification factor as suggested. Assume the earth load acts on the entire wall height for simplicity when calculating the maximum deflection.

$$\Delta_{maximum} = \frac{0.01304(1.32)(0.5)(30.0\ pcf)(1\ ft)(8.5\ ft)^5}{(0.1)(3{,}122{,}019\ psi)\left(\dfrac{(7\ in)(7\ in)^3}{12}\right)}\left(\frac{1{,}728\ in^3}{ft^3}\right) = 0.31\ in \qquad [8\ mm]$$

$$\Delta_{allowable} = \frac{(8.5\ ft)\left(\dfrac{12\ in}{ft}\right)}{240} = 0.43\ in \qquad [11\ mm]$$

$$\Delta_{actual} \leq \Delta_{allowable} \qquad OK$$

2.6 DESIGN SECOND-STORY LINTEL

Design the lintel above the master bedroom window in the north wall (refer to Figures 2-2 through 2-4) since this is the largest span in the second-story wall with the greatest loads and assume the lintel has 6 inches (152 mm) of bearing on each side of the opening. The following example follows the design procedure described in Section 1.4 for lintels.

2.6.1 Select Trial Lintel Section and Properties

Assume the lintel depth is 12 inches (305 mm) and constructed of a 6-inch (152 mm) waffle-grid wall form. The concrete compressive strength is assumed to be 3,000 psi (21 MPa) and the yield strength of reinforcement is assumed to be 40,000 psi (276 MPa). Refer to Figure 2-14 for the lintel cross-section. The geometric properties of the trial lintel cross-section are calculated below assuming the section is unreinforced.

$$NA_x = \frac{\Sigma Ay}{\Sigma A} = \frac{(5\ in)(4\ in)(10\ in)+(5\ in)(3\ in)(1.5\ in)+(2\ in)(5\ in)(5.5\ in)}{(5\ in)(4\ in)+(5\ in)(3\ in)+(2\ in)(5 in)} = 6.17\ in \qquad [157\ mm]$$

$$I_g = \frac{bh^3}{12} + Ad^2 = \frac{(5 in)(4 in)^3}{12} + (5 in)(4 in)(3.83 in)^2 + \frac{(5 in)(3 in)^3}{12} + (5 in)(3 in)(4.67 in)^2 + \frac{(2\ in)(5\ in)^3}{12} + (2\ in)(5\ in)(0.67\ in)^2 = 684\ in^4 \qquad [2.8\ dm^4]$$

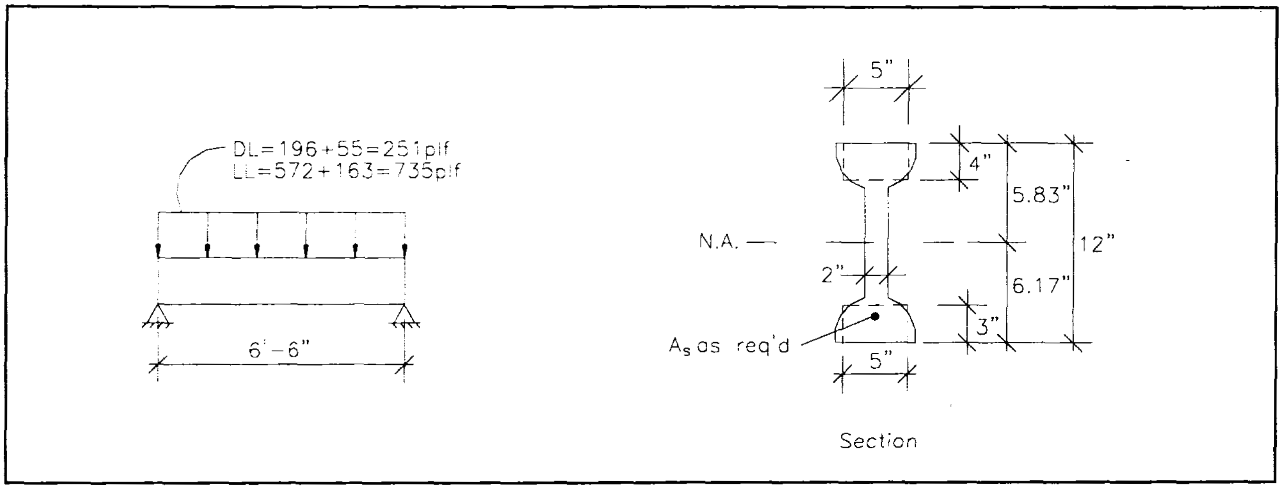


Figure 2-14 Lintel above Master Bedroom Window

2.6.2 Determine Nominal and Factored Loads

Refer to Figure 2-14 for the nominal lintel loading diagram. The loads in Figure 2-14 are based on the calculations in Section 2.2. Factored loads will be determined in the sections below as required in accordance with Section 1.4.2. The trial lintel section is 12 inches (305 mm) deep and is constructed of a 6-inch (152 mm) waffle-grid wall form; therefore, the lintel dead weight is 55 plf (803 N/m).

2.6.3 Check Deflection

For purposes of calculating deflection, assume the lintel supports 100 percent of the dead load and assume 33 percent of the live load is sustained. In addition, assume that the maximum deflection limit for the window below is L/360. Refer to Figure A-1 for the maximum deflection equation.

$$\Delta_{allowable} = \frac{6.5\,ft\left(\frac{12\ in}{ft}\right)}{360} = 0.22\ in \qquad [5.6\ mm]$$

$$\Delta_{actual} = \frac{5\left(251\,plf + (0.33)735\,plf\right)(6.5\,ft)^4}{384(0.1)(3{,}122{,}019\,psi)\left(684\ in^4\right)}\left(\frac{1{,}728\,in^3}{ft^3}\right) = 0.09\ in \qquad [2.2\ mm]$$

$$\Delta_{actual} \le \Delta_{allowable} \qquad OK$$

2.6.4 Check Nominal Moment Strength

The nominal moment strength of the lintel is calculated based on the ACI Load Case in Section 1.4.2. Refer to Figure 2-14 for the nominal loads acting on the lintel and for the lintel dimensions. Assume the lintel is reinforced with one #5 bar ($A_s = 0.31$ in^2 (200 mm^2)).

$$M_u = \frac{\left[1.4(251\,plf) + 1.7(735\,plf)\right](6.5ft)^2}{8} = 8{,}455\,ft-lb = 101{,}460\ in-lb \qquad [11.5\ kN\text{-}m]$$

$$a = \frac{\left(0.31\ in^2\right)(40{,}000\,psi)}{0.85(3{,}000psi)(5\ in)} = 0.97\ in \qquad [24.6\ mm]$$

$$\phi M_n = 0.9\left(0.31\ in^2\right)(40{,}000\,psi)\left((12\ in - 1.5in\ cover - 0.375\ in\ stirrup) - {}^{0.97\ in}\!/_{2}\right) \qquad [12\ kN\text{-}m]$$

$$= 107{,}582\ in-lb$$

$$M_u \le \phi\, M_n \qquad OK$$

2.6.5 Check Nominal Shear Strength

The nominal shear strength of the lintel is calculated based on the ACI Load Case in Section 1.4.2. Refer to Figure 2-14 for the nominal loads acting on the lintel and for the lintel dimensions.

$$V_u = \left[1.4(251\,plf) + 1.7(735\,plf)\right]\frac{6.5\,ft}{2} = 5{,}203\,lb \qquad [23.1\ kN]$$

$$\phi V_c = (0.85)(2)\sqrt{3{,}000\,psi}(2\ in)(10.13\ in) = 1{,}886\,lb \qquad [8.4\ kN]$$

$$V_u \ge \frac{\phi V_c}{2} \qquad \therefore\ use\ stirrups$$

Try one #3 stirrup 6 inches (152 mm) on center (two per vertical core)

$$A_{v,min} = \frac{50(2\ in)(6\ in)}{40{,}000\,psi} = 0.02\ in^2 \qquad [12.9\ mm^2]$$

$$\phi V_s = \frac{0.85\left(0.11\ in^2\right)\left(40{,}000\ psi\right)\left(10.13\ in\right)}{6\,in} = 6{,}311\ lb \qquad \longleftarrow \ GOVERNS \qquad [28\ kN]$$

$$\phi V_{s,max} = 0.85(8)\sqrt{3{,}000\ psi}\left(2\ in\right)\left(10.13\ in\right) = 7{,}542\ lb \qquad [33.5\ kN]$$

$$\phi V_n = \left(1{,}886\,lb + 6{,}311\,lb\right) = 8{,}197\,lb \qquad [36.5\ kN]$$

$$V_u \le \phi V_n \qquad OK$$

2.7 DESIGN FIRST-STORY LINTEL

Design the lintel above the family room door in the north wall since it is the largest span in the first-story wall and assume the lintel has 6 inches (152 mm) of bearing on each side of the opening. The following example follows the design procedure described in Section 1.4 for lintels.

2.7.1 Select Trial Lintel Section and Properties

Assume the lintel is 16 inches (406 mm) deep and is constructed of a 6-inch (152 mm) waffle-grid wall form. The concrete compressive strength is assumed to be 3,000 psi (21 MPa) and the yield strength of reinforcement is assumed to be 40,000 psi (276 MPa). Refer to Figure 2-15 for the lintel cross-section. The geometric properties of the trial lintel section are calculated as follows assuming the section is unreinforced:

$$NA_x = \frac{\Sigma Ay}{\Sigma A} = \frac{(5\ in)(4\ in)(14\ in) + (5\ in)(3\ in)(1.5\ in) + (2\ in)(9\ in)(7.5\ in)}{(5\ in)(4\ in) + (5\ in)(3\ in) + (2\ in)(9\ in)} = 8.25\,in \qquad [210\ mm]$$

$$I_g = \frac{bh^3}{12} + Ad^2 = \frac{(5\,in)(4\,in)^3}{12} + (5\,in)(4\,in)(6.06\,in)^2 + \frac{(5\,in)(3\,in)^3}{12} + (5\,in)(3\,in)(6.44\ in)^2$$
$$+ \frac{(2\,in)(5\ in)^3}{12} + (2\ in)(5\,in)(0.75)^2 = 1{,}421\,in^4 \qquad [5.9\ dm^4]$$

2.7.2 Determine Nominal and Factored Loads

Refer to Figure 2-15 for nominal lintel loading diagram. The loads in Figure 2-15 are based on the calculations in Section 2.2. Factored loads will be determined in the following sections as required in accordance with Section 1.4.2. The trial lintel section is 16 inches (406 mm) deep and is constructed of a 6-inch (152 mm) waffle-grid wall form; therefore, the lintel dead weight is 73 plf (1.07 kN/m).

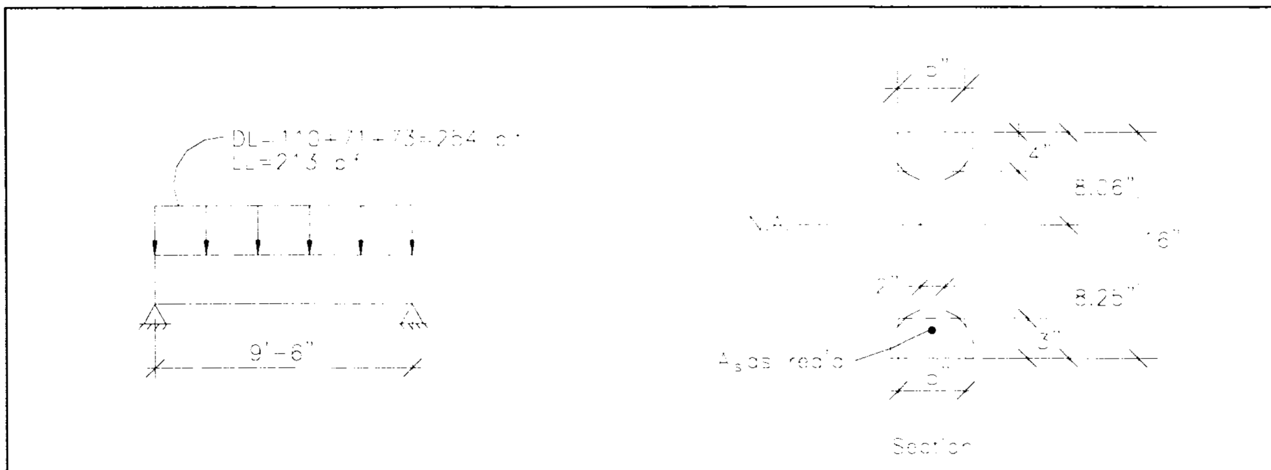


Figure 2-15 Lintel above Family Room Door

2.7.3 Check Deflection

For purposes of calculating deflection, assume that the lintel supports 100 percent of the dead load and assume 33 percent of the live load is sustained. In addition, assume that the maximum deflection limit for the French doors below is L/360. Refer to Figure A-1 for the maximum deflection equation.

$$\Delta_{allowable} = \frac{9.5\,ft\left(\frac{12\ in}{ft}\right)}{360} = 0.32\ in \qquad [8\ mm]$$

$$\Delta_{actual} = \frac{5\left(254\,plf + (0.33)213\,plf\right)(9.5\,ft)^4}{384(0.1)(3{,}122{,}019\,psi)\left(1{,}421\ in^4\right)}\left(\frac{1{,}728\,in^3}{ft^3}\right) = 0.19\,in \qquad [4.8\ mm]$$

$$\Delta_{actual} \le \Delta_{allowable} \qquad OK$$

2.7.4 Check Nominal Moment Strength

$$M_u = \frac{\left[1.4(254\,plf) + 1.7(213\,plf)\right](9.5ft)^2}{8} = 8{,}097\ ft-lb = 97{,}164\ in-lb \qquad [11\ kN\text{-}m]$$

$$a = \frac{\left(0.31\ in^2\right)(40{,}000\,psi)}{0.85(3{,}000psi)(5\ in)} = 0.97\ in \qquad [24.6\ mm]$$

$$\phi M_n = 0.9\left(0.31\ in^2\right)(40{,}000\,psi)\left((16\,in - 1.5\,in\ cover - 0.375\,in\ stirrup) - {}^{0.97\ in}\!/_{2}\right) \qquad [17.2\ kN\text{-}m]$$

$$= 152{,}222\ in-lb$$

$$M_u \le \phi\, M_n \qquad OK$$

2.7.5 Check Nominal Shear Strength

The nominal shear strength of the lintel is calculated based on the ACI Load Case in Section 1.4.2. Refer to Figure 2-15 for the nominal loads acting on the lintel and for the lintel dimensions.

$$V_u = \left[1.4(254\,plf) + 1.7(213\,plf)\right]\frac{9.5\,ft}{2} = 3{,}409\,lb \qquad [15.2\ kN]$$

$$\phi V_c = 0.85(2)\sqrt{3{,}000\,psi}(2\ in)(14.13\,in) = 2{,}630\,lb \qquad [11.7\ kN]$$

$$V_u \ge \frac{\phi V_c}{2} \qquad \therefore\ use\ stirrups$$

Try one #3 stirrup 6 inches (152 mm) on center (two per vertical core)

$$A_{v,min} = \frac{50(2\ in)(6\ in)}{40{,}000\,psi} = 0.02\ in^2 \qquad [12.9\ mm^2]$$

$$\phi V_s = \frac{0.85\left(0.11\ in^2\right)(40{,}000\,psi)(14.13\ in)}{6} = 8{,}805\ lb \quad \longleftarrow \quad GOVERNS \qquad [39.2\ kN]$$

$\phi V_{s,max} = 0.85(8)\sqrt{3{,}000\ psi}(2\ in)(14.13\ in) = 10{,}522\ lb$ [46.8 *kN*]

$\phi V_n = (2{,}630\,lb + 8{,}805\,lb) = 11{,}435\,lb$ [50.9 *kN*]

$V_u \le \phi V_n \qquad OK$

2.8 DESIGN FOOTING CONNECTION

The following example follows the design procedure described in Section 1.5 for footing connections. Design the footing connection for the south wall since it experiences the highest loads and assume the footing is 16 inches (406 mm) wide by 12 inches (305 mm) deep due to soil conditions.

2.8.1 Check Bearing Strength of Footing

Refer to Figure 2-5 for nominal loads acting on the footing and refer to Figure 2-16 for the dimensions used for the footing connection calculations.

$$B_{c,actual} = 1.4\left(\frac{ft}{1\,vertical\,core}\right)\left(2(234\,plf + 248\,plf + 319\,plf + 93\,plf) + 196\,plf\right)$$
$$+1.7\left(\frac{ft}{1\,vertical\,core}\right)(370\,plf + 278\,plf + 163\,plf + 572\,plf) = 5{,}129\,lb \qquad [22.8\ kN]$$

$$B_{c,allowable} = 0.7(0.85)(3{,}000\,psi)(49\,in^2)(2.0) = 174{,}930\ lb \qquad [778\ kN]$$

$$B_{c,actual} \le B_{c,allowable} \quad OK \quad \therefore\ no\ dowels\ required\ for\ bearing$$

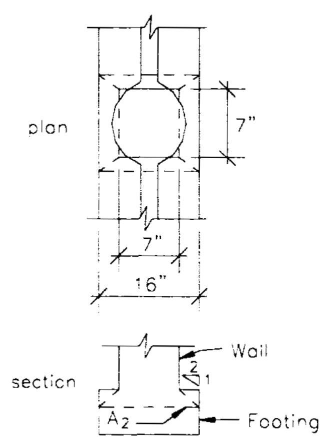


Figure 2-16 Footing

2.8.2 Check Shear Transfer

According to Figure 2-8, the critical factored perpendicular shear load, V_u, occurring at the bottom of the wall is due to ACI Load Case (2) or (3). Assume the coefficient of friction is 0.6 and one Grade 40 (276 MPa), #3 bar (A_V=0.11 in^2 (71 mm^2)) is spaced every 2 feet (0.6 m) on center. Note that only the reinforced vertical cores are assumed to transfer shear.

$$V_u = 1{,}013\,plf\left(\frac{2\,ft}{1\,reinforced\,vertical\,core}\right) = 2{,}026\,lb\,/\,post \qquad [9.0\ kN/post]$$

$$A_{vf} = \frac{2{,}026\,lb/post}{0.85(40{,}000\,psi)(0.6)} = 0.10\,in^2/post$$ [64.5 mm^2]

$$\phi V_n = 0.85\left(0.11\,in^2\right)(40{,}000\,psi)(0.6) = 2{,}244\,lb/post \quad \longleftarrow \quad GOVERNS$$ [10 *kN/post*]

$$V_n \le 0.2(3{,}000\,psi)(7\,in)^2 = 29{,}400\,lb/post$$ [130.8 *kN/post*]

$$V_n \le 800(7\,in)^2 = 39{,}200\,lb/post$$ [174.4 *kN/post*]

$$V_u \le \phi V_n \qquad OK$$

2.8.3 Determine Development Length of Dowels for Shear Transfer

$$l_{hb} = \frac{1200(0.375\,in)}{\sqrt{3000}} = 8.2\,in$$ [208 *mm*]

$$l_{dh} = maximum\ of \left\{ \begin{array}{l} (8.2\,in)\left(\dfrac{40{,}000\,psi}{60{,}000\,psi}\right)(0.7)\left(\dfrac{0.10\,in^2/post}{0.11\,in^2/post}\right) = 3.5\,in \\ 8(0.375\,in) = 3\,in \\ 6\,in \end{array} \right\} = 6\,in$$ [152 *mm*]

2.9 DESIGN ROOF CONNECTION: BOLTED SILL PLATE

The following example follows the design procedure described in Section 1.6 for bolted sill plate roof connections. Design the roof connection for the south or north wall and refer to Figure 2-17 for the building plan and building sections.

2.9.1 Determine Design Loads

Refer to Figure 2-1 for the given wind and uplift pressures on the structure and neglect the negative pressure acting on the leeward wall. The calculations for unit shear perpendicular to the grain for the sill plate conservatively assume that the roof diaphragm is more flexible than the concrete walls below. Therefore, the shear load experienced by the bolts in the sill plate is the result, V_b, of the wind load on the vertical projection of the roof area. If the designer has reason to assume that the roof diaphragm is more stiff than the concrete walls below (not shown in the example below), the shear load experienced by the bolts in the sill plate would be the result of the wind load acting on the top half of the second-story wall since the roof diaphragm is assumed to rigidly support the top of the wall. In reality, the actual model is somewhere between these two extremes.

$$V_a = (0.5)(21.0\,psf)(0.5)(11\,ft)(32.7\,ft) = 1{,}888\ lb \qquad [8.4\ kN]$$

$$v_a = \frac{1{,}888\,lb}{38.5\,ft} = 49\ plf \qquad [715\ N/m]$$

$$V_b = (0.5)(21.0\,psf)(11\,ft)(38.5\,ft) = 4{,}447\ lb \qquad [19.8\ kN]$$

$$v_b = \frac{4{,}447\,lb}{38.5\,ft} = 116\ plf \qquad [1.7\ kN/m]$$

2.9.2 Assume Connection Spacing and Size

Try a ½-inch (13 mm) diameter ASTM A36 anchor bolt (A_b=0.196 in^2 (126.5 mm^2)), 6 inches (152 mm) long and spaced 4 feet (1.2 m) on center. Assume the washers are 1-1/4 inches (32 mm) in diameter. According to Part 4, "Connections", in ASD/AISC's *Manual of Steel Construction*, the allowable tensile strength of the bolt, F_t, the ultimate tensile strength of the bolt, F_u, and the allowable shear strength of the bolt , F_v, are as follows:

$$F_u = 58{,}000\,psi \qquad [400\ MPa]$$

$$F_t = 19{,}100\,psi \qquad [132\ MPa]$$

$$F_t = \sqrt{44^2 - 4.39 f_v{}^2} \quad \textit{for combined shear and tension}$$

$$F_t = \sqrt{57.2^2 - 4.39 f_v{}^2} \quad \textit{for combined shear and tension due to wind or seismic}$$

$$F_v = (0.17)(58{,}000\,psi) = 9{,}860\,psi \ \textit{for threads included in shear plane} \qquad [68\ MPa]$$

$$F_v = (0.22)(58{,}000\,psi) = 12{,}760\,psi \ \textit{for threads excluded from shear plane} \qquad [88\ MPa]$$

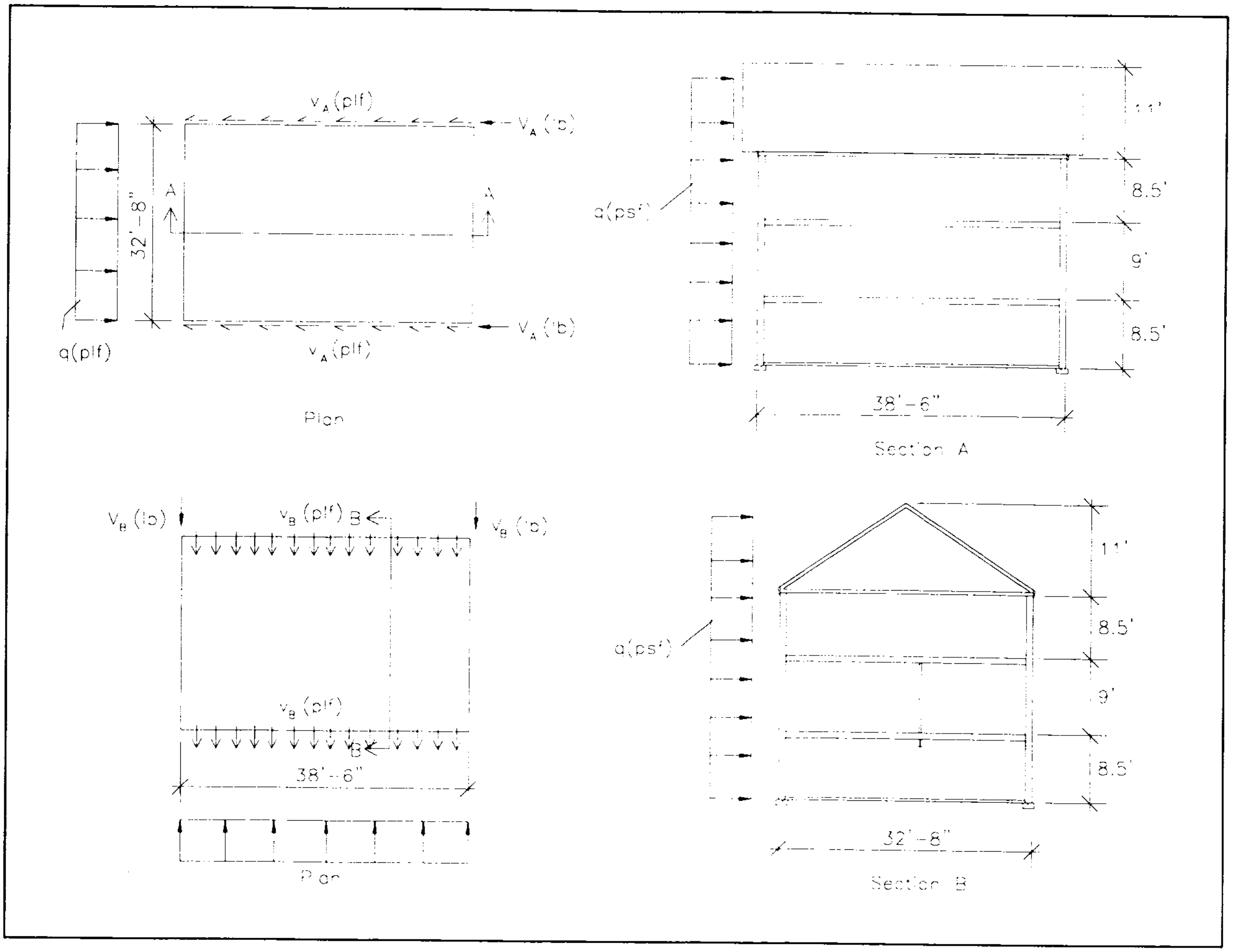


Figure 2-17 Roof Diaphragm Shear

Assume the sill plate is constructed of a No.2 grade Douglas Fir-Larch 2x8 with the following properties as taken from Table 4A in AF&PA's *Design Values for Wood Construction.*

$F_b = 900\ psi$ [6.2 MPa]

$F_b' = (1.15)(1.6)(1.2)(900\ psi) = 1{,}987\ psi$ *modified for flat use, wind load duration, and size* [13.7 MPa]

$F_{c\perp} = 625\ psi$ [4.3 MPa]

$F_{c\perp}' = \left(\dfrac{1.25+0.375}{0.375}\right)(625\ psi) = 813\ psi$ *modified for small bearing area* [5.6 MPa]

$F_c = 1{,}350\ psi$ [9.3 MPa]

$F_c' = (1.05)(1.6)(1{,}350\ psi) = 2{,}268\ psi$ *modified for size and wind load duration* [15.6 MPa]

$S_{yy} = 2.719\ in^3$ [44.6 cm^3]

$h = 1.5\ in$ [38 mm]

$b = 7.25\ in$ [184 mm]

2.9.3 Check Shear in Bolt

Refer to Section 2.9.1 for the unit shear in the south wall sill plate and refer to Section 2.9.2 for the allowable bolt shear assuming the threads are included in the shear plane.

$$F_v = 9{,}860\ psi \qquad [68\ MPa]$$

$$f_{v_a} = \frac{49\ plf(4\ ft\ bolt\ spacing)}{0.196\ in^2} = 1{,}000\ psi \qquad [6.9\ MPa]$$

$$f_{v_b} = \frac{116\ plf(4\ ft\ bolt\ spacing)}{0.196\ in^2} = 2{,}367\ psi \qquad [16.3\ MPa]$$

$$f_v \le F_v \qquad OK$$

2.9.4 Check Tension in Bolt Due to Uplift and Shear-Friction

Refer to Section 2.9.1 for the calculated unit shear in the south wall sill plate and refer to Section 2.9.2 for the allowable tensile load on the bolt for combined shear and tension. Note that the total tensile load on the bolt is the difference between the factored uplift load and the factored dead load on the roof structure plus the factored tensile load due to shear friction.

$$F_{t_a} = \sqrt{57.2^2 - 4.39(1\ kip)^2} = 57.2\ ksi = 57{,}200\ psi \qquad [394\ MPa]$$

$$F_{t_b} = \sqrt{57.2^2 - 4.39(2.4\ kip)^2} = 57\ ksi = 57{,}000\ psi \qquad [393\ MPa]$$

$$T_a = ((1.3)19\ psf - (0.9)12\ psf)\left(\frac{32.7\ ft}{2}\right)(4\ ft\ bolt\ spacing) + \frac{(1.3)49\ plf(4\ ft\ bolt\ spacing)}{0.6} = 1{,}334\ lb \qquad [5.9\ kN]$$

$$T_b = ((1.3)19\ psf - (0.9)12\ psf)\left(\frac{32.7\ ft}{2}\right)(4\ ft\ bolt\ spacing) + \frac{(1.3)116\ plf(4\ ft\ bolt\ spacing)}{0.6} = 1{,}914\ lb \qquad [8.5\ kN]$$

$$f_{t_a} = \frac{1{,}334\ lb}{0.196\ in^2} = 6{,}806\ psi \qquad [46.9\ MPa]$$

$$f_{t_b} = \frac{1{,}914\ lb}{0.196\ in^2} = 9{,}765\ psi \qquad [67.3\ MPa]$$

$$f_t \le F_t \qquad OK$$

2.9.5 Check Tension in Concrete (Anchorage Capacity)

Note that the tension in the concrete, V_u, is equivalent to the total tensile load on the bolt.

$$V_{u_a} = 1{,}334\ lb \qquad [5.9\ kN]$$

$$V_{u_b} = 1{,}914\ lb \qquad [8.5\ kN]$$

$$A_v = minimum\ of \begin{Bmatrix} \pi(6\,in)^2 = 113\ in^2 \\ \pi(5\,in) \ \ = 78.5\ in^2 \end{Bmatrix} = 78.5\ in^2 \qquad [506.5\ cm^2]$$

$$\phi V_c = 0.85(4)(78.5\ in^2)\sqrt{3{,}000\ psi} = 14{,}619\ lb \qquad [65\ kN]$$

$$V_u \le \phi V_c \qquad OK$$

2.9.6 Check Bending, Bearing, and Shear in Sill Plate

Bending: Refer to Section 2.9.2 for the sill plate's allowable bending stress about its weak axis. Note that the allowable bending stress is modified by the flat use factor, the wind load duration factor, and the size factor per AF&PA's *National Design Specification for Wood Construction.* Also note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_b' = 1{,}987\ psi \qquad [13.7\ MPa]$$

$$M = \frac{(19\ psf - 12\ psf)\left(\frac{32.7\ ft}{2}\right)(4\ ft\ bolt\ spacing)^2}{8} = 229\ ft-lb = 2{,}748\ in-lb \qquad [310\ kN\text{-}m]$$

$$S_{yy} = 2.719\ in^3 \qquad [44.6\ cm^3]$$

$$f_b = \frac{2{,}748\ in-lb}{2.719\ in^3} = 1{,}011\ psi \qquad [7\ MPa]$$

$$f_b \le F_b' \qquad OK$$

Bearing: Determine if the 1-1/4 inch (32 mm) diameter washers are large enough to withstand the uplift forces acting on the sill plate without failing the wood by compression at the washer. Refer to Section 2.9.2 for the sill plate's allowable compressive stress perpendicular to the grain. Note that the allowable compressive stress is modified by the small bearing factor per AF&PA's *National Design Specification for Wood Construction.* Also note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_{c\perp}' = 813\ psi \qquad [5.6\ MPa]$$

$$T = (19\ psf - 12\ psf)\left(\frac{32.7\ ft}{2}\right)(4\ ft\ bolt\ spacing) = 458\ lb \qquad [2.0\ kN]$$

$$A_{washer} = \pi\left(\frac{1.25\ in}{2}\right)^2 - \pi\left(\frac{0.5\ in}{2}\right)^2 = 1.03\ in^2 \qquad [664.5\ mm^2]$$

$$f_{c\perp} = \frac{458\ lb}{1.03\ in^2} = 445\ psi \qquad [3\ MPa]$$

$$f_{c\perp} \le F_{c\perp}' \quad OK$$

Shear Compression Parallel to the Grain at the Bolt Hole: Refer to Section 2.9.2 for the sill plate's allowable compression parallel to the grain and refer to Section 2.9.1 for unit shear in the sill plate. Note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_c' = 2{,}268\ psi \qquad [15.6\ MPa]$$

$$f_c' = \frac{(49\ plf)(4\ ft\ bolt\ spacing)}{(1.5\ in)(0.5\ in)} = 261\ psi \qquad [1.8\ MPa]$$

$$f_c' \le F_c' \qquad OK$$

<u>Shear Compression Perpendicular to the Grain at the Bolt Hole:</u> Refer to Section 2.9.2 for the sill plate's allowable compression perpendicular to the grain and refer to Section 2.9.1 for the unit shear in the sill plate. Note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_{c\perp}' = 813\ psi \qquad [5.6\ MPa]$$

$$f_{c\perp}' = \frac{(116\ plf)(4\ ft\ bolt\ spacing)}{(1.5\ in)(0.5\ in)} = 619\ psi \qquad [4.3\ MPa]$$

$$f_{c\perp}' \le F_{c\perp}' \qquad OK$$

Determine if the actual bolt spacings, as controlled by wood compression parallel to the grain, are greater than those required by AF&PA's *National Design Specification for Wood Construction.*

End distance	$12\ in$ OK	$[305\ mm]$
Edge distance	$4(0.5\ in) = 2\ in \le \frac{7.25\ in}{2} = 3.6\ in$ OK	$[91\ mm]$
Spacing between bolts	$3(0.5\ in) = 1.5\ in \le 48\ in$ OK	$[38\ mm < 1.2\ m]$

2.9.7 Check Bearing Strength of ICF Wall

The bearing strength of the ICF wall is determined using the nominal loads shown in Figure 2-5 and calculated in Section 2.2. Note that the roof truss spacing is 2 feet (0.6 m) on center.

$$B_{c,actual} = 1.4(2\ ft)(196\ plf) + 1.7(2\ ft)(163\ plf + 572\ plf) = 3{,}048\ lb \qquad [13.6\ kN]$$

$$B_{c,allowable} = 0.7(0.85)(3{,}000\ psi)(4.5\ in)(7.25\ in) = 58{,}236\ lb \qquad [259\ kN]$$

$$B_{c,actual} \le B_{c,allowable} \qquad OK$$

2.10 DESIGN ROOF CONNECTION: STRAP

The following example follows the design procedure described in Section 1.7 for strap connections. Design the strap connection for the south or north wall and refer to Figure 2-17 for the building plan and sections.

2.10.1 Determine Design Loads

Note that the total tensile load on the strap is the difference between the factored uplift load and the factored dead load on the roof structure.

$$T_a = \left((1.3)19\ psf - (0.9)12\ psf\right)\left(\frac{32.7\,ft}{2}\right)(2\ ft\ strap\ spacing) = 455\,lb \qquad [2\ kN]$$

2.10.2 Assume Strap Connector Size

Per a strap connector manufacturer's literature, try an 18 gauge coiled strap tie cut to a 20 inch (508 mm) length. Embedment length is 4 inches (102 mm) and fastened to the truss with eight 10d fasteners. Refer to Section 2.9.1 for previously calculated shear loads.

$$T_{actual} = 455\,lb \qquad [2\ kN]$$

$$T_{strap} = 1{,}160\,lb\ \ rated\ capacity\ from\ strap\ manufacturer \qquad [5.2\ kN]$$

$$T_{actual} \leq T_{strap} \qquad OK$$

$$V_{actual} = (116 plf)(2\ ft\ strap\ spacing) = 232\,lb \qquad [1\ kN]$$

$$V_{strap} = 300\,lb\ \ rated\ capacity\ from\ strap\ manufacturer \qquad [1.3\ kN]$$

$$V_{actual} \leq V_{strap} \qquad OK$$

2.10.3 Check Tension in Concrete (Anchorage Capacity)

Note that the tension in the concrete, V_u, is equivalent to the total uplift load on the strap.

$$V_u = 455\ lb \qquad [2\ kN]$$

$$A_v = minimum\ of \begin{Bmatrix} \pi(4\,in)^2 = 50.3\ in^2 \\ \pi(5\,in) \ \ = 78.5\ in^2 \end{Bmatrix} = 50.3\ in^2 \qquad [325\ cm^2]$$

$$\phi V_c = 0.85(4)\left(50.3\ in^2\right)\sqrt{3{,}000\,psi} = 9{,}367\,lb \qquad [41.6\ kN]$$

$$V_u \leq \phi V_c \qquad OK$$

2.10.4 Check Bearing Strength of ICF Wall

The bearing strength of the ICF wall is determined using the nominal loads shown in Figure 2-5 and calculated in Section 2.2. Note that the roof truss spacing is 2 feet (0.6 m) on center.

$B_{c,actual} = 1.4(2\ ft)(196\ plf) + 1.7(2\ ft)(163\ plf + 572\ plf) = 3{,}048\ lb$ [13.6 *kN*]

$B_{c,allowable} = 0.7(0.85)(3{,}000\ psi)(1.5\ in)(5\ in) = 13{,}388\ lb$ [59.6 *kN*]

$B_{c,actual} \leq B_{c,allowable}$ *OK*

2.11 DESIGN FLOOR CONNECTION: LEDGER

The following example follows the design procedure described in Section 1.8 for ledger connections. Design the ledger connection for the south wall where the highest loads occur. The designer should recognize the importance of the ledger connection because the floor live and dead loads are transferred to the wall through a series of connections which is not typical of platform wood-framed construction.

2.11.1 Determine Design Loads

Refer to Figure 2-5 and Section 2.2 for the nominal loads acting on the ledger connection. Note that the floor joist spacing is 16 inches (406 mm) on center. The designer should be aware that a waffle-grid ICF wall has a vertical core spacing of 12 inches on center. The bolts for a ledger connection must coincide with the centerline of the vertical cores. To eliminate construction conflicts due to the different joist and vertical core spacing, the floor joist spacing is increased to 24 inches on center in this example. Assume that the floor joists are sized properly for the additional loads based on the new 24-inch joist spacing.

$$V_{DL} = 93\,plf \qquad [1.4\ kN/m]$$
$$V_{LL} = 278\,plf \qquad [4.1\ kN/m]$$
$$V = 93\,plf + 278\,plf = 371\,plf \qquad [5.4\ kN/m]$$
$$V_u = 1.4(93\,plf) + 1.7(278\,plf) = 603\,plf \qquad [8.8\ kN/m]$$

2.11.2 Assume Connection Spacing and Size

Try a 5/8-inch (16 mm) diameter ASTM A36 anchor bolt (A_b=0.306 in^2 (197 mm^2)), 6 inches (152 mm) long and spaced 12 inches (305 mm) on center. Assume the washer is 1-3/8 inches (35 mm) in diameter. According to Part 4, "Connections", in ASD/AISC's *Manual of Steel Construction*,the allowable tensile strength of the bolt, F_t, the ultimate tensile strength of the bolt, F_u, and the allowable shear strength of the bolt, F_v, are as follows:

$$F_u = 58{,}000\,psi \qquad [400\ MPa]$$
$$F_t = 19{,}100\,psi \qquad [132\ MPa]$$
$$F_t = \sqrt{44^2 - 4.39 f_v^{\,2}} \quad \textit{for combined shear and tension}$$
$$F_t = \sqrt{57.2^2 - 4.39 f_v^{\,2}} \quad \textit{for combined shear and tension due to wind or seismic}$$
$$F_v = (0.17)(58{,}000\,psi) = 9{,}860\,psi \ \textit{for threads included in shear plane} \qquad [68\ MPa]$$
$$F_v = (0.22)(58{,}000\,psi) = 12{,}760\,psi \ \textit{for threads excluded from shear plane} \qquad [88\ MPa]$$

The following allowable bolt design values for single shear are taken from Table 8.2E in AF&PA's *National Design Specification for Wood Construction* assuming a bending strength, F_y, of 36,000 psi (248 MPa).

$$Z_{allowable} = \frac{520\,lb}{bolt}\left(\frac{12\ \ in\,bolt\ spacing}{12\,in\,/\,ft}\right) = 520\,lb \qquad [2.3\ kN]$$

$$Z'_{allowable} = (1.0)520 = 520\,lb\ \ modified\,for\ live\,load\,duration \qquad [2.3\ kN]$$

Assume the ledger board is a No. 1 grade, Douglas Fir-Larch 2x12 with the following properties as taken from Table 4A in AF&PA's *Design Values for Wood Construction.*

$$F_b = 1{,}200\,psi \qquad [8.3\ MPa]$$

$$F_b' = 1.2(1.6)(1.0)(1{,}200\,psi) = 2{,}304\,psi\ \ modified\ for\ flat\ use, wind\ load\ duration, and\ size \qquad [10.2\ MPa]$$

$$F_b' = (1.0)(1.0)(1{,}200\,psi) = 1{,}200\,psi\ \ modified\ for\ live\ load\ duration\ and\ size \qquad [8.3\ MPa]$$

$$F_{c\perp} = 625\,psi \qquad [4.3\ MPa]$$

$$F_{c\perp}' = \left(\frac{1.375+0.375}{1.375}\right)(625\,psi) = 813\,psi\ modified\ for\ small\ bearing\ area \qquad [5.6\ MPa]$$

$$F_v = 95\,psi \qquad [655\ kPa]$$

$$F_v' = (2)95\,psi = 190\,psi\ \ modified\,for\ no\ splits \qquad [1.3\ MPa]$$

$$S_{yy} = 4.219\ in^3 \qquad [69\ cm^3]$$

$$S_{xx} = 31.64\,in^3 \qquad [518.5\ cm^3]$$

$$h = 1.5\ in \qquad [38\ mm]$$

$$b = 11.25\ in \qquad [286\ mm]$$

2.11.3 Check Shear-Friction in Concrete

Refer to Section 2.11.1 for the factored shear force at the section. Assume an 8-inch (203 mm) diameter hole is cut into the form around the bolt to allow installation.

$$V_u = \frac{603\,plf}{0.6}\left(\frac{12\,in\,bolt\ spacing}{12\ in\,/\,ft}\right) = 1{,}005\,lb \qquad [4.5\ kN]$$

$$A_c = \pi(4\ in)^2 = 50.3\ in^2 \qquad [325\ cm^2]$$

$$V_n = (0.306\ in^2)(36{,}000\,psi)(0.6) = 6{,}610\,lb \quad \longleftarrow\ GOVERNS \qquad [29.4\ kN]$$

$$V_{n,\max} = 0.2(3{,}000\,psi)(50.3\ in^2) = 30{,}180\,lb \qquad [134.2\ kN]$$

$$\phi V_n = 0.85(6{,}610\,lb) = 5{,}619\ \ lb \qquad [25\ kN]$$

$$V_u \le \phi V_n \quad OK$$

2.11.4 Check Tension in Concrete (Anchorage Capacity)

Assume an 8-inch (203 mm) diameter hole is cut into the form around the bolt to allow installation. Assume the coefficient of friction is 0.6. Note that the tension in the concrete, V_u, is equivalent to the total shear load on the ledger board as calculated in Section 2.11.1 divided by the coefficient of friction plus the tension resulting from wind suction pressure. Refer to Figure

2-18 for wind suction pressure acting on the connection. Note that the tension load is factored for ACI load case, U = 0.75[1.4 Dead + 1.7 Live + 1.7 Wind].

$$V_u = 0.75\left(\left(\frac{603\,plf}{0.6}\right)+(1.7)(21.0\,psf)\left(\frac{9\,ft}{2}+\frac{8.5\,ft}{2}\right)\right)\left(\frac{12\,in\,bolt\,spacing}{12in/ft}\right) = 988\,lb \qquad [4.4\ kN]$$

$$A_v = minimum\,of\begin{Bmatrix}\pi(6in)^2 = 113in^2\\ \pi(8in)^2 = 201in^2\end{Bmatrix} = 113in^2 \qquad [325\ cm^2]$$

$$\phi V_c = 0.85(4)(113in^2)\sqrt{3{,}000psi} = 21{,}044lb \qquad [93.6\ kN]$$

$$V_u \le \phi V_c \quad OK$$

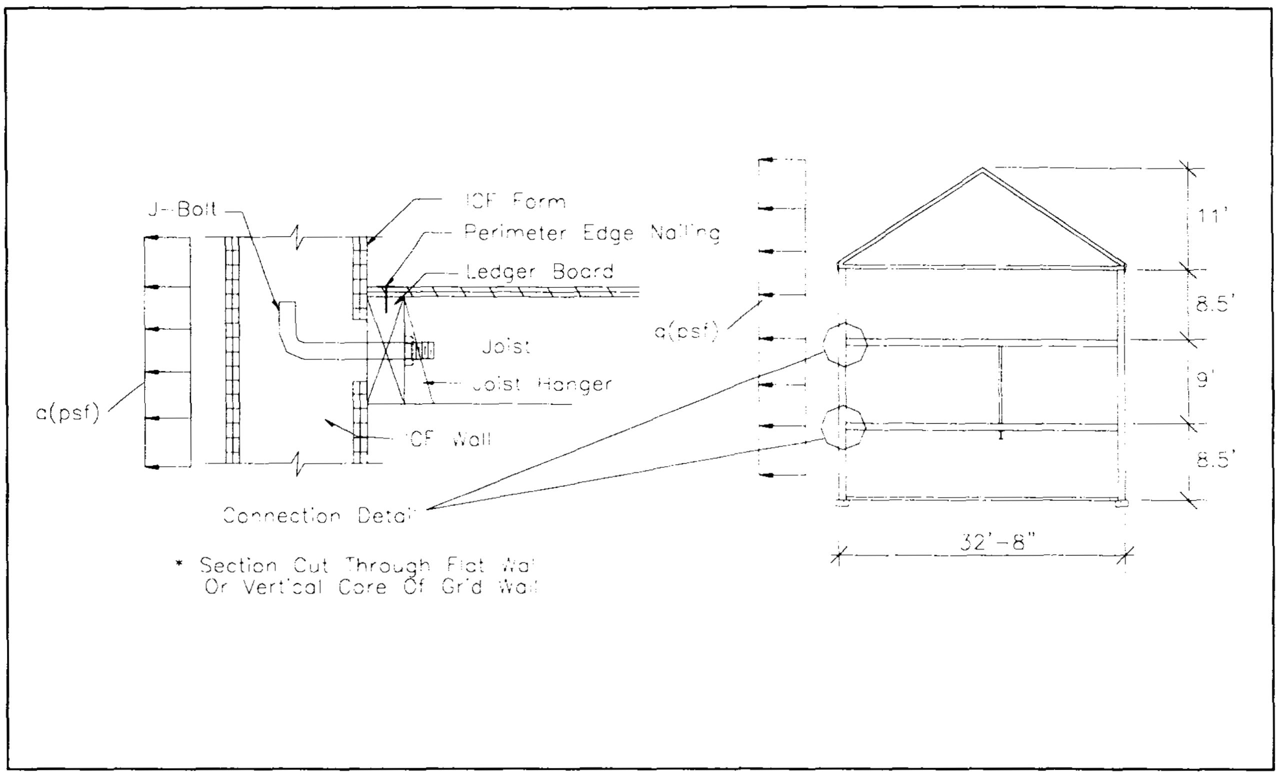


Figure 2-18 Wind Suction Pressure on Ledger Board Connection

2.11.5 Check Tension in Bolt Due to Shear-Friction and Wind Suction Pressure

Refer to Section 2.11.2 for the allowable tensile strength, F_t, of the bolt and Section 2.11.4 for the factored tensile load on the bolt. Note that the factored tensile load on the bolt is equivalent to V_u in Section 2.11.4.

$$F_t = 19{,}100psi \qquad [303.4\ MPa]$$

$$T = 0.75\left(\left(\frac{603\,plf}{0.6}\right)+(1.7)(21.0\,psf)\left(\frac{9\,ft}{2}+\frac{8.5\,ft}{2}\right)\right)\left(\frac{12\,in\,bolt\,spacing}{12in/ft}\right) = 988\,lb \qquad [4.4\ kN]$$

$$f_t = \frac{988\ lb}{0.306\ in^2} = 3{,}229\ psi \qquad [22.3\ MPa]$$

$f_t \le F_t \quad OK$

2.11.6 Check Shear in Bolt

Refer to Section 2.11.2 for the allowable bolt shear and refer to Section 2.11.1 for nominal shear resulting from floor loads.

$$Z'_{allowable} = 520\,lb \qquad [2.3\ kN]$$

$$Z_{actual} = (371\,plf)\left(\frac{12\,in\ bolt\ spacing}{12\,in/ft}\right) = 371\ lb \qquad [1.7\ kN]$$

$$Z_{actual} \le Z_{allowable} \quad OK$$

2.11.7 Check Bending, Bearing, and Shear in Ledger Board

Bending About Strong Axis: Refer to Section 2.11.2 for the allowable bending stress for the ledger board. Note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_b = 1{,}200\,psi \qquad [8.3\ MPa]$$

$$M = \frac{Pl}{4} = \frac{(371\,plf)(2\,ft\ joist\ spacing)\left(\dfrac{12\ in\,bolt\ spacing}{12\ in/ft}\right)}{4} = 186ft-lb = 2{,}232\ \ in-lb \qquad [252\ N\text{-}m]$$

$$S_{xx} = 31.64\ in^3 \qquad [518.5\ cm^3]$$

$$f_b = \frac{2{,}232\ in-lb}{31.64\ in^3} = 70.5\,psi \qquad [486\ kPa]$$

$$f_b \le F_b \quad OK$$

Bending About Weak Axis Due to Wind Suction Pressure: Refer to Section 2.11.2 for the allowable bending stress for the ledger board. Note that the allowable bending stress is modified by the flat use, wind load duration, and size factors per AF&PA's *National Design Specification for Wood Construction.* Also note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F'_b = 2{,}304\,psi \qquad [8.3\ MPa]$$

$$w = (21.0\,psf)\left(\frac{9\,ft}{2} + \frac{8.5\,ft}{2}\right) = 184\,plf \qquad [2.7\ kN/m]$$

$$M = \frac{(184\,plf)\left(\dfrac{12\ in\,bolt\ spacing}{12\ in/ft}\right)^2}{8} = 23ft-lb = 276\ \ in-lb \qquad [3.2\ N\text{-}m]$$

$$S_{yy} = 4.219\ in^3 \qquad [69.1\ cm^3]$$

$$f_b = \frac{276\ in-lb}{4.219\ in^3} = 65\,psi \qquad [448\ kPa]$$

$$f_b \le F_b' \quad OK$$

Bearing At Washer Due to Weak Axis Bending: Determine if the 1-3/8 inch diameter washers are large enough to withstand the tensile forces acting on the ledger board without failing by compression. Refer to Section 2.11.2 for the ledger board's allowable compressive stress perpendicular to the grain. Note that the allowable compressive stress is modified by the small bearing factor per AF&PA's *National Design Specifications for Wood Construction.* Also note that the design loads are not factored since AF&PA's *National Design Specifications for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor. A load acting perpendicular to the grain resulting from wind suction pressure is assumed.

$$F_{c\perp}' = 813\,psi \qquad [5.6\ MPa]$$

$$T = (21.0\,psf)\left(\frac{9\,ft}{2} + \frac{8.5\,ft}{2}\right)\left(\frac{12\ in\ bolt\ spacing}{12\,in/ft}\right) = 184\ lb \qquad [818\ N]$$

$$A_{washer} = \pi\left(\frac{1.375\ in}{2}\right)^2 - \pi\left(\frac{0.625\ in}{2}\right)^2 = 1.18\ in^2 \qquad [761\ mm^2]$$

$$f_{c\perp} = \frac{184\ lb}{1.18\ in^2} = 156\,psi \qquad [1.1\ MPa]$$

$$f_{c\perp} \le F_{c\perp}' \quad OK$$

In areas of high wind and high seismic risk, it is imperative that the floor diaphragm be properly attached to prevent the floor diaphragm and framing from pulling away from the ledger and wall. The designer may either use a strap connector at the bottom of the floor joist to properly anchor the floor to the wall or the designer may require a closer nail spacing along the exterior perimeter of the subfloor sheathing into the ledger. (Refer to Figure 2-18). Since a strap connector may interfere with the ceiling finish attachment, the following calculations are based on the closer perimeter nail spacing alternative. Assume 8d nails are used to attach the 3/4-inch subfloor sheathing to the ledger. Refer to Table 12.3A in AF&PA's *National Design Specifications for Wood Construction* for nail design values and UBC-97 for the seismic coefficient for seismic zone 1.

$$Z = 72\,lb/nail \qquad [320\ N/nail]$$

$$Z' = (1.6)(72\,lb/nail) = 115\ lb/nail \ \ \textit{modified for wind/seismic load duration} \qquad [512\ N/nail]$$

$$V = (21.0\,psf)\left(\frac{9\,ft}{2} + \frac{8.5\,ft}{2}\right) = 184\,plf \ \ \textit{for wind conditions} \quad \longleftarrow GOVERNS \qquad [2.7\ kN/m]$$

$$W_{wall} = (55\,psf)\left(\frac{9\,ft}{2} + \frac{8.5\,ft}{2}\right) = 481\,plf \qquad [7\ kN/m]$$

$$V = \frac{3C_a}{R}W = \frac{3(0.07)}{3.5}(481\,plf) = 29\,plf \ \ \textit{for seismic conditions} \qquad [423\ N/m]$$

$$spacing = \left(\frac{184\ plf}{115\ lb/nail}\right) = 1.6\ ft \approx 2\ ft \qquad [610\ mm]$$

$$\therefore use\ one\ 8d\ nail\ @\ 2\ ft\ (610mm)\ on\ center\ along\ exterior\ perimeter\ edge\ of\ subfloor\ sheathing$$

Shear Compression at Bolt Hole: Already accounted for when using the bolt design value, Z, tables in AF&PA's *National Design Specification for Wood Construction*; refer to Section 2.11.6.

Shear Parallel to the Grain: Refer to Section 2.11.2 for the ledger board's allowable shear parallel to the grain. Note that the design loads are not factored since the AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_v' = 190\ psi \qquad [1.3\ MPa]$$

$$f_v = \frac{3V}{2bd} = \frac{3(371\ plf)(2\ ft\ joist\ spacing)}{2(1.5\ in)(11.25\ in)} = 66\ psi \qquad [0.46\ MPa]$$

$$f_v \le F_v' \qquad OK$$

Determine if actual bolt spacings are greater than those required by AF&PA's *National Design Specification for Wood Construction.*

End distance	$12\ in$	OK	$[305\ mm]$
Edge distance	$4(0.625\ in) = 2.5\ in \le \frac{11.25\ in}{2} = 5.63\ in$	OK	$[143\ mm]$
Spacing between bolts	$3(0.625\ in) = 1.9\ in \le 12\ in$	OK	$[48\ mm < 406\ mm]$

Although one 5/8-inch bolt at 12 inches on center is adequate, a better connection would be to use two 5/8-inch bolts at 24 inches on center. Not only does this alleviate spacing conflicts during construction between the floor joist spacing and the bolt spacing in this particular example, but it adds another level of safety against ledger board failure due to poor quality in lumber, poor installation, or inadequate design assumptions. Using two bolts instead of one bolt, moves the bolts out of the neutral axis of the ledger board providing greater resistance to bending about the weak axis and shear parallel to the grain. For ledger boards which do not allow for two bolts to be installed as shown in Figure 2-19, the bolts may be staggered to produce a similar result.

Vertical Spacing between bolts	$3(0.625\ in) = 1.9\ in \le 6.25\ in$	OK	$[48\ mm < 159\ mm]$

Please note that this design example (Section 2.11) should be repeated using the new bolt spacing to verify that the bolt size and new spacing is adequate for the design loads; however, the calculations for the new bolt spacing are not shown here.

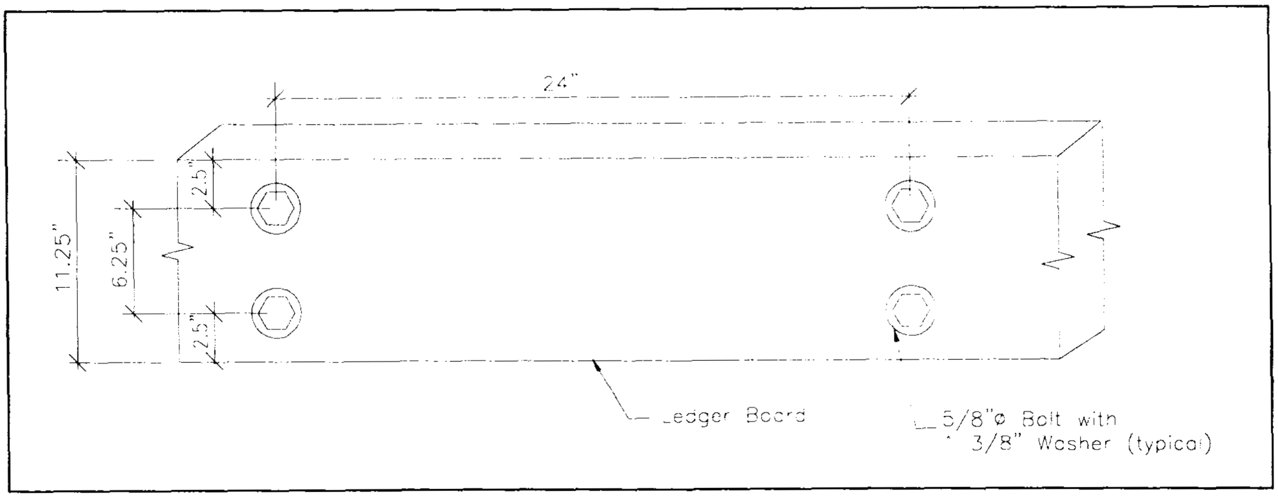


Figure 2-19 Ledger Board Bolt Placement

2.12 DESIGN FLOOR CONNECTION: POCKET

The following example follows the design procedure described in Section 1.10 for pocket connections. Design the pocket connection for the south wall where the highest loads occur. Assume that the floor is wood-framed; therefore, blocking between joists at the perimeter of the floor is required to ensure proper floor diaphragm strength to resist and distribute lateral loads resulting from wind or seismic forces.

2.12.1 Determine Design Loads

Refer to Figure 2-5 and Section 2.2 for the nominal loads acting on the pocket connection. Note that the floor joist spacing is 16 inches (406 mm) on center. The designer should be aware that a waffle-grid ICF wall has a vertical core spacing of 12 inches on center. The bolts for a ledger connection must coincide with the centerline of the vertical cores. To eliminate construction conflicts due to the different joist and vertical core spacing, the floor joist spacing is increased to 24 inches on center in this example. Assume that the floor joists are sized properly for the additional loads based on the new 24-inch spacing. Assuming wind suction on the walls, the following tensile load occurs at the pocket connection location.

$V_{DL} = 93\ plf$ [1.6 *kN/m*]

$V_{LL} = 278\ plf$ [4 *kN/m*]

$V = 93\ plf + 278\ plf = 371\ plf$ [15.4 *kN/m*]

$V_u = 1.4(93 plf) + 1.7(278\ plf) = 603\ plf$ [8.8 *kN/m*]

$T_{actual} = 21.0\ psf\left(\frac{8.5\ ft}{2} + \frac{9\ ft}{2}\right)\left(\frac{24\ \ in\ strap\ spacing}{12\ \ in/ft}\right) = 368\ lb$ [1.6 *kN*]

2.12.2 Assume Strap Connector Size

Per a strap connector manufacturer's literature, try an 18 gauge coiled strap, 12 inches (305 mm) long cut to length. Embedment length is 4 inches (102 mm) and fastened to the joist with four 10d fasteners when the concrete compressive strength is 3,000 psi (21 MPa).

$T_{actual} = 368\ lb$ [1.6 *kN*]

$T_{strap} = 580\ lb$ *rated capacity of the strap* [2.6 *kN*]

$T_{actual} \le T_{strap}$ *OK*

Assume the floor joist is a No. 1 grade, Douglas Fir-Larch 2x12 with the following properties as taken from AF&PA's *Design Values for Wood Construction.*

$F_{c\perp} = 625\ psi$ [4.3 *MPa*]

$F_{c\perp}' = \left(\frac{4 + 0.375}{4}\right)(625\ psi) = 688\ psi$ *modified for small bearing area* [4.7 *MPa*]

$F_v = 95\ psi$ [655 *MPa*]

$F_v' = (2)(95\ psi) = 190\ psi$ *modified for no splits* [1.3 *MPa*]

$b = 1.5\ in$ [38 mm]

$h = 11.25\ in$ [286 mm]

2.12.3 Check Bearing Strength of ICF Wall

The bearing strength of the ICF wall is determined using the nominal loads in Section 2.12.1. Note that the joist spacing is 24 inches (610 mm) on center. Assume the joists have 4 inches (102 mm) minimum bearing at each support.

$$B_{c,actual} = 1.4\left(\frac{24\ in\ strap\ spacing}{12\ in/ft}\right)(93\ plf) + 1.7\left(\frac{24\ in\ strap\ spacing}{12\ in/ft}\right)(278\ plf) = 1{,}206\ lb \qquad [5.4\ kN]$$

$$B_{c,allowable} = 0.7(0.85)(3{,}000\ psi)(1.5\ in)(4\ in) = 10{,}710\ lb \qquad [47.6\ kN]$$

$$B_{c,actual} \le B_{c,allowable} \quad OK$$

2.12.4 Check Bearing and Shear in Floor Joist

Bearing: Determine if the joists have adequate bearing area to resist floor loads. Refer to Section 2.12.2 for the allowable compressive stress perpendicular to the grain and to Section 2.12.1 for the floor loads. Note that the allowable compressive stress is modified by the small bearing factor per AF&PA's *National Design Specifications for Wood Construction.* Also note that the design loads are not factored since AF&PA's *National Design Specifications for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

$$F_{c\perp}' = 688\ psi \qquad [4.7\ MPa]$$

$$V = 371\ plf\left(\frac{24\ in\ joist\ spacing}{12\ in/ft}\right) = 742\ lb \qquad [3.3\ kN]$$

$$A_{bearing} = (1.5\ in)(4\ in) = 6\ in^2 \qquad [38.7\ cm^2]$$

$$f_{c\perp} = \frac{742\ lb}{6\ in^2} = 124\ psi \qquad [855\ kPa]$$

$$f_{c\perp} \le F_{c\perp}' \quad OK$$

Shear Parallel to Grain: Refer to Section 2.12.2 for the allowable parallel shear for the joist. Note that the design loads are not factored since AF&PA's *National Design Specification for Wood Construction* is an allowable stress design method in which the allowable stresses already include a safety factor.

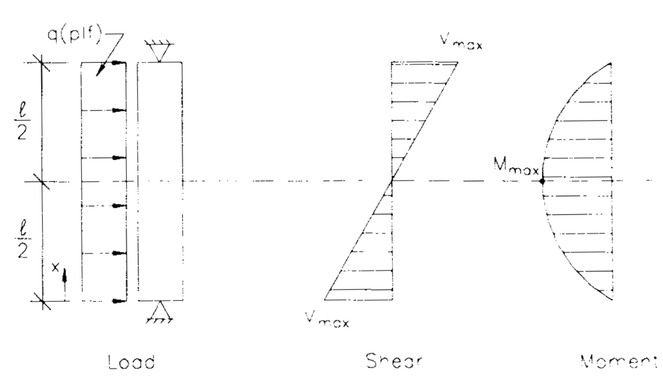
$$F_v' = 190\ psi \qquad [1.3\ MPa]$$

$$f_v = \frac{3V}{2bd} = \frac{3(371\ plf)\left(\frac{24\ in\ joist\ spacing}{12\ in/ft}\right)}{2(1.5\ in)(11.25\ in)} = 66\ psi \qquad [455\ kPa]$$

$$f_v \le F_v' \quad OK$$

APPENDIX A

BEAM DIAGRAMS WITH TYPICAL LOADING CONDITIONS



$$V_{max} = \frac{ql}{2}$$

$$V_x = q\left(\frac{l}{2} - x\right)$$

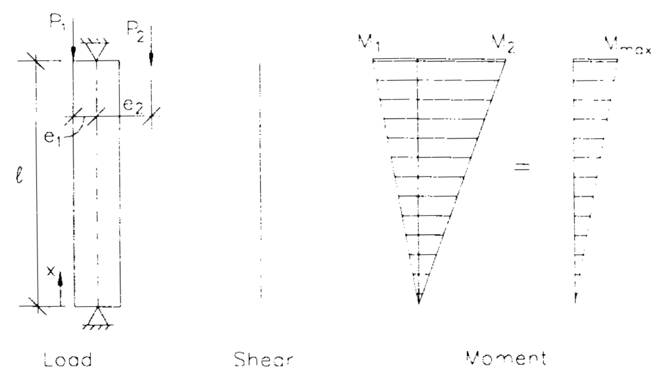
$$M_{max} = \frac{ql^2}{8}$$

$$M_x = \frac{qx}{2}(l - x)$$

$$\Delta_{max@center} = \frac{5ql^4}{384EI}$$

$$\Delta_x = \frac{qx}{24EI}\left(l^3 - 2lx^2 + x^3\right)$$

Figure A-1 Uniform Load, Simple Span



$$V_{max} = V_x = 0$$

$$M_{max} = |M_2| - |M_1| \quad where \quad |M_2| > |M_1|$$

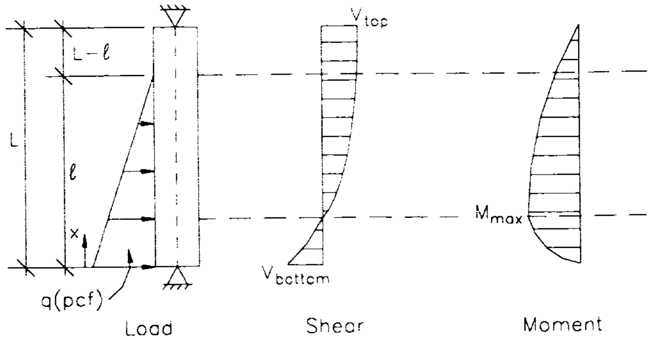
$$M_{max} = |M_1| - |M_2| \quad where \quad |M_1| > |M_2|$$

$$M_2 = P_2 e_2$$

$$M_1 = P_1 e_1$$

$$M_x = M_{max}\left(\frac{x}{l}\right)$$

Figure A-2 Eccentric Point Loads, Simple Span



$$V_{top} = \frac{ql^3}{6L}$$

$$V_{bottom} = \frac{ql^2}{2} - \frac{ql^3}{6L}$$

$$V_x = qlx - \frac{qx^2}{2} - V_{bottom} \quad \text{where } x < l$$

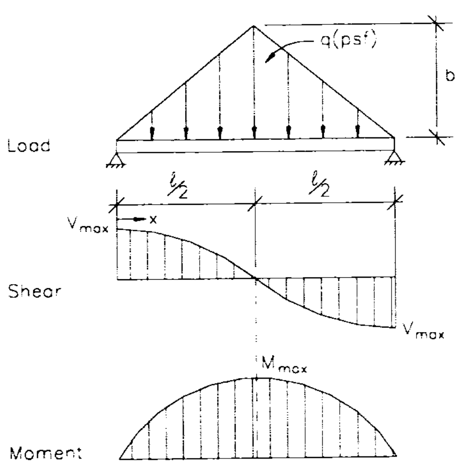
$$V_x = V_{top} \quad \text{where } x \geq l$$

$$M_x = -\frac{qlx^2}{2} + \frac{qx^3}{6} + V_{bottom}x \quad \text{where } x < l$$

$$M_x = \frac{ql^3}{6L}(L - x) \quad \text{where } x \geq l$$

$$x_{@M_{max}} = \frac{ql - \sqrt{q^2 l^2 - 2qV_{bottom}}}{q}$$

Figure A-3 Partial Triangular Load, Simple Span



$$V_{max} = \frac{1}{4}bql$$

$$V_x = \frac{bq}{4l}\left(l^2 - 4x^2\right) \quad \text{where } x < \frac{l}{2}$$

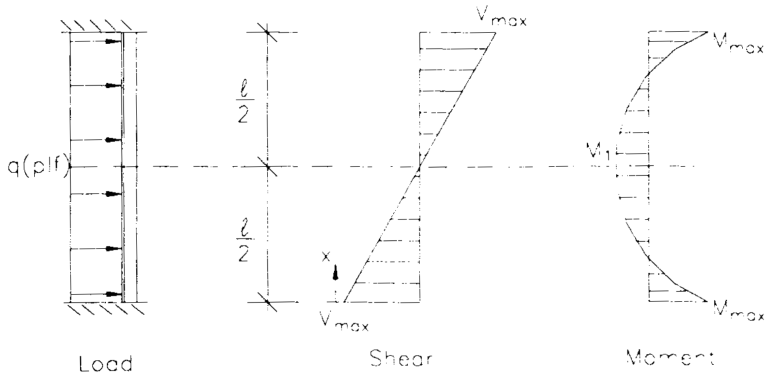
$$M_{max} = \frac{1}{12}bql^2$$

$$M_x = \frac{bqlx}{2}\left(\frac{1}{2} - \frac{2x^2}{3l^2}\right) \quad \text{where } x < \frac{l}{2}$$

$$\Delta_{max\,@\,center} = \frac{bql^4}{120EI}$$

$$\Delta_x = \frac{bqx}{960EI\,l}\left(5l^2 - 4x^2\right)^2 \quad \text{where } x < \frac{l}{2}$$

Figure A-4 Load Uniformly Increasing to Center, Simple Span



$$V_{max} = \frac{ql}{2}$$

$$V_x = q\left(\frac{l}{2} - x\right)$$

$$M_{max} = \frac{ql^2}{12}$$

$$M_1 = \frac{ql^2}{24}$$

$$M_x = \frac{q}{12}\left(6lx - l^2 - 6x^2\right)$$

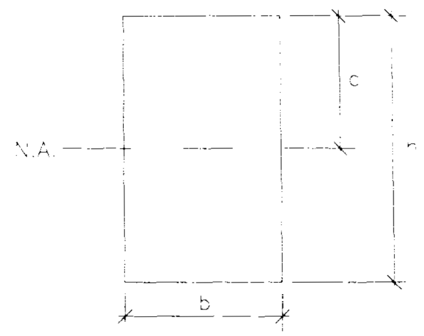
$$\Delta_{max@center} = \frac{ql^4}{384EI}$$

$$\Delta_x = \frac{qx^2}{24EI}(l - x)^2$$

Figure A-5 Uniform Load, Fixed-End Simple Span

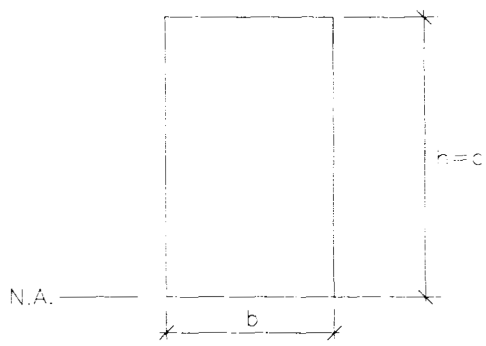
APPENDIX B

PROPERTIES OF GEOMETRIC SECTIONS



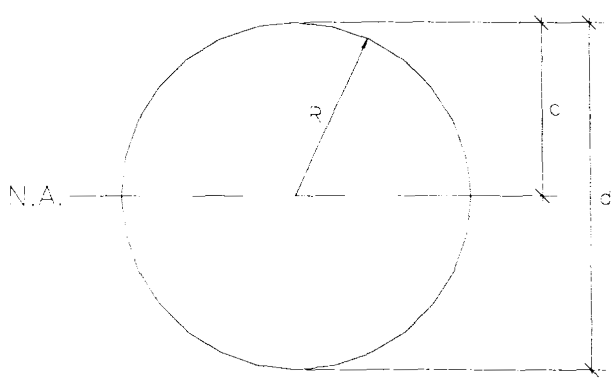
$$A = bh$$
$$c = \frac{h}{2}$$
$$I = \frac{1}{12} bh^3$$
$$S = \frac{1}{6} bh^2$$
$$r = \frac{h}{\sqrt{12}}$$

Figure B-1 Rectangle, Axis of Moments through Center



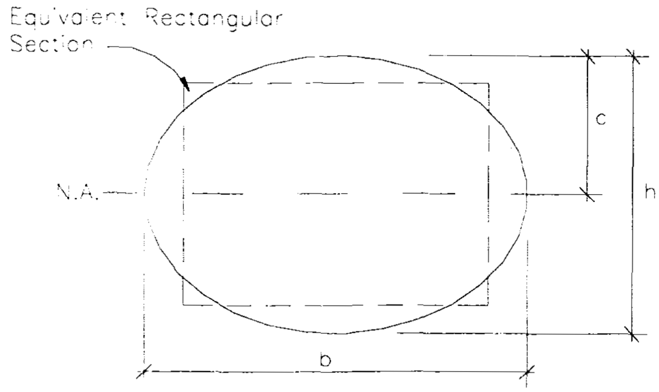
$$A = bh$$
$$c = h$$
$$I = \frac{1}{3} bh^3$$
$$S = \frac{1}{6} bh^2$$
$$r = \frac{h}{\sqrt{3}}$$

Figure B-2 Rectangle, Axis of Moments on Base



$$A = \frac{1}{4} \pi d^2 = \pi R^2$$
$$c = \frac{d}{2} = R$$
$$I = \frac{\pi d^4}{64} = \frac{\pi R^4}{4}$$
$$S = \frac{\pi d^3}{32} = \frac{\pi R^3}{4}$$
$$r = \frac{d}{4} = \frac{R}{2}$$

Figure B-3 Circle, Axis of Moments through Center



$$A = \frac{\pi bh}{4}$$

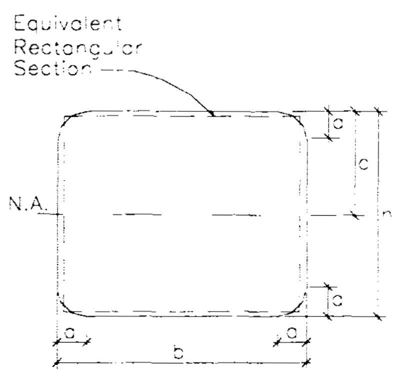
$$c = \frac{h}{2}$$

$$I = \frac{\pi bh^3}{64}$$

$$S = \frac{\pi bh^2}{32}$$

$$r = \frac{h}{4}$$

Figure B-4 Ellipse, Axis of Moments through Center



$$A = bh - 4a^2\left(1 - \frac{\pi}{4}\right)$$

$$c = \frac{h}{2}$$

$$I = \frac{bh^3}{12} - 4\left[a^4\left(\frac{1}{3} - \frac{\pi}{16} - \frac{1}{36\left(1 - \frac{\pi}{4}\right)}\right) + a^2\left(1 - \frac{\pi}{4}\right)\left(c - a + \frac{a}{6\left(1 - \frac{\pi}{4}\right)}\right)^2\right]$$

$$S = \frac{I}{c}$$

$$r = \sqrt{\frac{I}{A}}$$

Figure B-5 Rounded Rectangle, Axis of Moments through Center

APPENDIX C

MOMENT MAGNIFIERS

The moment magnifier method is an approximation method used to account for slenderness in a structural reinforced concrete wall. ACI 10.10.2 allows the moment magnifier method to be used in lieu of second-order analysis for walls with a slenderness ratio less than or equal to 100. The tables in this appendix contain the moment magnifier for non-sway frames constructed of ICF flat, waffle-, or screen-grid walls with slenderness ratios less than or equal to 100. To generate moment magnifier tables for use with as many ICF manufacturers as possible, the tables are based on an equivalent rectangular section with the following dimensions:

Non-Sway Moment Magnifier Tables								
ICF Wall Type	Nominal Thickness		Minimum Equivalent Thickness (h)		Minimum Equivalent Width (b)		Vertical Core Spacing	
	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)
Flat	4	101.6	3.5	88.9	12.0	304.8	N.A.	N.A.
	6	152.4	5.5	139.7	12.0	304.8	N.A.	N.A.
	8	203.2	7.5	190.5	12.0	304.8	N.A.	N.A.
	10	254.0	9.5	241.3	12.0	304.8	N.A.	N.A.
Waffle-Grid	6	152.4	5.0	127.0	6.25	158.8	12	304.8
	8	203.2	7.0	177.8	7.0	177.8	12	304.8
Screen-Grid	6	152.4	5.5	139.7	5.5	139.7	12	304.8

Figure C-1 Dimensions used for Moment Magnifier Tables

The moment magnifier tables were also generated using the equations contained in this appendix and are based on the following assumptions:

$$M_1 = 0$$
$$C_m = 1.0$$
$$w_c = 150$$
$$\rho = 0.0012$$

where:

ρ	Ratio of vertical reinforcement area to gross concrete area	dimensionless
C_m	Factor relating moment diagram to equivalent uniform moment diagram	dimensionless
M_1	Smaller factored end moment	in-lb
w_c	Weight of concrete	pcf

The reinforcement ratio was determined to have a minor impact on the moment magnifier values; therefore, a conservative value of ρ is used to generate the moment magnifier tables. The moment magnifiers listed in the following tables are also limited to a maximum value of 4.0 to ensure stability. Interpolation between the wall height, e, β_d, and the total factored axial load is permissible when using the tables in this appendix.

As a result of generating moment diagrams representative of current ICF products, some design efficiency has been sacrificed. In addition, moment magnifier tables have not been generated for ICF wall types constructed in sway frames since most residential structures meet the non-sway criteria. Designers may either use the moment magnifier tables found in this appendix or calculate the moment magnifier using the following equations.

C.1 Non-Sway Frames (ACI 10.12)

The equations below are taken from ACI 10.12 with one exception. The equation for *EI*, as listed in ACI 10.12.3, is applicable for wall sections that contain a double layer of reinforcement. Since ICFs contain only one layer of reinforcement, the equation for *EI* listed below is used instead.[10]

$$M_{ns} = \delta_{ns} M_2$$

$$\delta_{ns} = \frac{C_m}{1 - \left(P_u / 0.75 P_c \right)} \geq 1.0$$

$$P_c = \frac{\pi^2 EI}{(kl_u)^2}$$

$$C_m = 0.6 + 0.4\left(M_1 / M_2 \right) \geq 0.4$$

[10]S.K. Ghosh, David A. Fanella and Basile G. Rabat, *Notes on ACI 318-95: Building Code Requirements for Structural Concrete*, Portland Cement Association, Skokie, Illionois, 1996.

$$or$$

$$C_m = 1.0 \; for\, members\, with\, transverse\, loads\, between\, supports$$

$$M_{2,min} = P_u(0.6 + 0.03h)$$

$$EI = \frac{0.4E_c I_g}{\beta} \geq \frac{E_c I_g\left(0.5 - \frac{e}{h}\right)}{\beta} \geq \frac{0.1E_c I_g}{\beta}$$

$$e = \frac{M_2}{P_u}$$

$$\beta = 0.9 + 0.5\beta_d^{\,2} - 12\rho \geq 1.0$$

$$\rho = \frac{A_s}{A_g}$$

$$\beta_d = \frac{P_{u,dead}}{P_u}$$

$$E_c = 57{,}000\sqrt{f_c'} \;\; or \;\; w_c^{1.5}33\sqrt{f_c'}$$

where:

β	As defined in the given equation	dimensionless
β_d	Ratio of dead axial load to total axial load	dimensionless
δ_{ns}	Moment magnification factor for non-sway frames	dimensionless
ρ	Ratio of vertical reinforcement area to gross concrete area	dimensionless
A_g	Gross concrete area	inch^2
A_s	Area of vertical steel reinforcement	inch^2
C_m	Factor relating moment diagram to equivalent uniform moment diagram	dimensionless
e	Overall eccentricity of axial load in the wall	inch
E_c	Modulus of elasticity of concrete per ACI 8.5.1	psi
EI	Flexural stiffness of compression member	psi
f_c'	Specified compressive strength of concrete	psi
h	Wall thickness, Refer to Figure 1-1	inch
I_g	Moment of inertia of gross concrete section	inch^4
k	Effective length factor $\leq$ 1.0. For most residential construction, k = 1.0 if the wall is tied to the footing, floors, and roof.	dimensionless
l_u	Unsupported length of compression member	inch
M_1/M_2	Ratio of smaller factored end moment to larger factored end moment $\geq$ -0.5	dimensionless
M_1	Smaller factored end moment	in-lb
M_2	Larger factored end moment	in-lb
$M_{2,min}$	Minimum value of M_2	in-lb
M_{ns}	Magnified factored moment to be used for designing compression members	in-lb
P_c	Critical buckling load	lb
P_u	Factored total axial load	lb
$P_{u,dead}$	Factored axial dead load	lb
w_c	Weight of concrete	pcf

C.2 Sway Frames (ACI 10.13)

With one exception, the following equations are taken from ACI 10.13.4.3. The equation for *EI*, as listed in ACI 10.12.3, is applicable for wall sections that contain a double layer of reinforcement.

Since ICFs contain only one layer of reinforcement, the equation for *EI* listed below is used instead.[11]

$$M_s = M_{ns} + \delta_s M_2$$

$$\delta_s = 1.0 \le \frac{1}{1 - \dfrac{\sum P_u}{0.75 \sum P_c}} \le 2.5$$

$$P_c = \frac{\pi^2 EI}{(kl_u)^2}$$

$$e = \frac{M_2}{P_u}$$

$$\beta_d = \frac{P_{u,dead}}{P_u}$$

$$EI = \frac{0.4 E_c I_g}{\beta} \ge \frac{E_c I_g \left(0.5 - \frac{e}{h}\right)}{\beta} \ge \frac{0.1 E_c I_g}{\beta}$$

$$\beta = 0.9 + 0.5 \beta_d^{\,2} - 12\rho \ge 1.0$$

$$\rho = \frac{A_s}{A_g}$$

$$E_c = 57{,}000\sqrt{f_c'} \quad or \quad w_c^{1.5} 33\sqrt{f_c'}$$

where:

β	As defined in the given equation	dimensionless
β_d	Ratio of dead axial load to total axial load	dimensionless
δ_s	Moment magnification factor for sway frames	dimensionless
ρ	Ratio of vertical reinforcement area to gross concrete area	dimensionless
b	Wall width, Refer to Figure 1-1	inch
e	Overall eccentricity of axial load in wall	inch
E_c	Modulus of elasticity of concrete	psi
EI	Flexural stiffness of compression member	psi
f_c'	Specified compressive strength of concrete	psi
h	Wall thickness, Refer to Figure 1-1	inch
I_g	Moment of inertia of gross concrete section	$inch^4$
l_u	Unsupported length of compression member	inch
k	Effective length factor $\ge$ 1.0	dimensionless
M_2	Larger factored end moment	in-lb
$M_{2,min}$	Minimum value of M_2	in-lb
M_s	Magnified factored moment to be used for designing compression members for sway frames	in-lb
M_{ns}	Magnified factored moment to be used for designing compression members for non-sway frames	in-lb
P_u	Factored axial load	lb
$P_{u,dead}$	Factored axial dead load	lb
ΣP_c	Summation for all sway-resisting columns in a story	lb

[11]S.K. Ghosh, David A. Fanella and Basile G. Rabat, *Notes on ACI 318-95: Building Code Requirements for Structural Concrete*, Portland Cement Association, Skokie, Illinois, 1996.

ΣP_u	Summation for all the vertical loads in a story	lb
w_c	Weight of concrete	pcf

Check the following equation for each individual compression member in a sway frame:

$$\frac{l_u}{r} \geq \frac{35}{\sqrt{P_u / f_c' A_g}}$$

where:

A_g	Gross area of concrete	$inch^2$
f_c'	Specified compressive strength of the concrete	psi
l_u	Unsupported length of compression member	inch
h	Wall thickness, Refer to Figure 1-1	
P_u	Factored axial load	lb
r	Radius of gyration of cross-section per ACI 10.11.2 $\approx$0.3h for rectangular members or $\approx$0.25d for circular compression members	inch

If the above equation is true for an individual compression member, it shall be designed in accordance with "Non-Sway Frames", with the following substitutions made to the variables per ACI 10.13:

$$M_1 = M_{1ns} + \delta_s M_{1s}, \text{ often assumed to be 0}$$
$$M_2 = M_{2ns} + \delta_s M_{2s}$$

Non-Sway Moment Magnifier
for
4" Flat Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<=0.40	<=0.40	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.28	1.32	1.36	1.41	1.46	1.51	1.57	1.63	1.69	1.77	1.85	1.93	2.03	2.13	2.25	2.37	2.52
	0.60	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.35	1.39	1.45	1.50	1.56	1.63	1.70	1.78	1.86	1.95	2.06	2.17	2.30	2.45	2.61	2.80
	0.80	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.35	1.41	1.47	1.54	1.61	1.69	1.77	1.87	1.98	2.10	2.23	2.39	2.57	2.77	3.02	3.31	3.66
	1.00	1.03	1.07	1.11	1.15	1.20	1.25	1.31	1.36	1.43	1.50	1.58	1.67	1.77	1.88	2.00	2.15	2.31	2.51	2.74	3.01	3.35	3.77			
0.60	<=0.40	1.03	1.06	1.09	1.13	1.16	1.20	1.25	1.29	1.34	1.39	1.45	1.51	1.58	1.66	1.74	1.83	1.93	2.04	2.16	2.31	2.47	2.65	2.87	3.12	3.42
	0.60	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.43	1.50	1.57	1.65	1.73	1.83	1.93	2.05	2.19	2.34	2.52	2.73	2.97	3.27	3.62	
	0.80	1.04	1.07	1.11	1.16	1.21	1.26	1.31	1.38	1.44	1.52	1.60	1.69	1.80	1.91	2.05	2.20	2.38	2.59	2.84	3.15	3.53				
	1.00	1.04	1.09	1.13	1.19	1.24	1.31	1.38	1.46	1.55	1.65	1.76	1.89	2.04	2.22	2.43	2.69	3.00	3.40	3.93						
0.80	<=0.40	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.60	1.70	1.80	1.92	2.06	2.21	2.40	2.61	2.87	3.18	3.57				
	0.60	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.49	1.58	1.67	1.78	1.90	2.05	2.21	2.41	2.64	2.92	3.27	3.71					
	0.80	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.49	1.59	1.70	1.83	1.98	2.16	2.37	2.63	2.95	3.36	3.90							
	1.00	1.05	1.10	1.17	1.23	1.31	1.40	1.50	1.61	1.75	1.90	2.09	2.32	2.61	2.98	3.47										
1.00	<=0.40	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.53	1.64	1.77	1.91	2.09	2.30	2.55	2.87	3.27	3.82								
	0.60	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.59	1.71	1.86	2.04	2.25	2.51	2.84	3.27	3.85									
	0.80	1.06	1.12	1.19	1.26	1.35	1.46	1.58	1.72	1.89	2.10	2.36	2.69	3.13	3.74											
	1.00	1.06	1.14	1.22	1.32	1.43	1.56	1.73	1.93	2.18	2.51	2.95	3.59													
1.20	<=0.40	1.06	1.13	1.22	1.31	1.42	1.55	1.71	1.90	2.14	2.45	2.87	3.45													
	0.60	1.07	1.14	1.23	1.34	1.46	1.61	1.79	2.02	2.31	2.71	3.27														
	0.80	1.08	1.17	1.27	1.40	1.55	1.75	2.00	2.33	2.80	3.49															
	1.00	1.09	1.20	1.33	1.49	1.70	1.97	2.35	2.91	3.82																
>=1.40	<=0.40	1.10	1.23	1.39	1.59	1.87	2.26	2.87	3.91																	
	0.60	1.11	1.25	1.42	1.66	1.98	2.47	3.27																		
	0.80	1.13	1.29	1.51	1.81	2.28	3.06																			
	1.00	1.15	1.35	1.63	2.06	2.81																				

		Total Factored Axial Load (kips)																								
e (in)	β_d	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<=0.40	<=0.40	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.71	1.83	1.96	2.12	2.30	2.52	2.78	3.11	3.52						
	0.60	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.57	1.67	1.79	1.93	2.09	2.28	2.51	2.80	3.15	3.61							
	0.80	1.05	1.10	1.16	1.22	1.29	1.37	1.47	1.57	1.69	1.83	2.00	2.20	2.44	2.75	3.14	3.66									
	1.00	1.06	1.12	1.19	1.26	1.35	1.46	1.58	1.72	1.89	2.09	2.35	2.68	3.11	3.72											
0.60	<=0.40	1.05	1.10	1.15	1.21	1.28	1.36	1.45	1.55	1.66	1.79	1.95	2.13	2.35	2.63	2.97	3.42									
	0.60	1.05	1.10	1.16	1.23	1.31	1.39	1.49	1.61	1.74	1.89	2.08	2.30	2.58	2.94	3.41										
	0.80	1.06	1.12	1.19	1.27	1.36	1.47	1.60	1.74	1.92	2.14	2.42	2.78	3.26	3.95											
	1.00	1.07	1.14	1.23	1.32	1.44	1.58	1.75	1.96	2.23	2.58	3.07	3.78													
0.80	<=0.40	1.06	1.12	1.19	1.27	1.37	1.47	1.60	1.75	1.93	2.15	2.43	2.80	3.29	3.99											
	0.60	1.06	1.13	1.21	1.30	1.40	1.52	1.66	1.84	2.06	2.33	2.69	3.17	3.87												
	0.80	1.07	1.15	1.24	1.35	1.48	1.63	1.82	2.07	2.39	2.82	3.45														
	1.00	1.08	1.17	1.29	1.42	1.59	1.80	2.08	2.46	3.01	3.87															
1.00	<=0.40	1.07	1.16	1.26	1.37	1.51	1.69	1.90	2.19	2.57	3.11	3.94														
	0.60	1.08	1.17	1.28	1.41	1.57	1.77	2.02	2.37	2.86	3.61															
	0.80	1.09	1.20	1.33	1.49	1.69	1.96	2.34	2.89	3.79																
	1.00	1.10	1.23	1.39	1.60	1.89	2.29	2.92																		
1.20	<=0.40	1.10	1.23	1.38	1.59	1.86	2.25	2.84	3.84																	
	0.60	1.11	1.25	1.42	1.65	1.97	2.45	3.22																		
	0.80	1.13	1.29	1.50	1.81	2.26	3.02																			
	1.00	1.15	1.34	1.62	2.05	2.78																				
>=1.40	<=0.40	1.17	1.41	1.77	2.39	3.66																				
	0.60	1.18	1.45	1.87	2.63																					
	0.80	1.21	1.54	2.11	3.34																					
	1.00	1.25	1.67	2.53																						

Non-Sway Moment Magnifier
for
4" Flat Walls
f'_c = 4000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<=0.40	<=0.40	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.26	1.30	1.33	1.37	1.41	1.46	1.50	1.55	1.60	1.66	1.72	1.78	1.85	1.92	2.00	2.09
	0.60	1.02	1.05	1.07	1.10	1.13	1.15	1.18	1.22	1.25	1.29	1.32	1.36	1.41	1.45	1.50	1.55	1.61	1.67	1.73	1.80	1.88	1.96	2.05	2.15	2.25
	0.80	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.54	1.61	1.67	1.75	1.83	1.92	2.01	2.12	2.24	2.38	2.53	2.70
	1.00	1.03	1.06	1.10	1.13	1.17	1.21	1.25	1.30	1.35	1.41	1.47	1.53	1.60	1.68	1.77	1.86	1.97	2.09	2.22	2.37	2.55	2.75	2.99	3.27	3.62
0.60	<=0.40	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.42	1.47	1.52	1.58	1.65	1.71	1.79	1.87	1.96	2.06	2.17	2.29	2.43	2.58
	0.60	1.03	1.06	1.09	1.12	1.15	1.19	1.22	1.26	1.31	1.35	1.40	1.46	1.51	1.58	1.64	1.72	1.80	1.89	1.99	2.09	2.22	2.35	2.51	2.68	2.88
	0.80	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.42	1.48	1.55	1.62	1.71	1.80	1.90	2.01	2.14	2.28	2.45	2.64	2.86	3.12	3.44	3.83
	1.00	1.04	1.07	1.11	1.16	1.20	1.26	1.31	1.37	1.44	1.51	1.60	1.69	1.79	1.91	2.04	2.19	2.37	2.57	2.82	3.12	3.49	3.96			
0.80	<=0.40	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.42	1.48	1.55	1.63	1.71	1.80	1.90	2.02	2.15	2.29	2.46	2.65	2.88	3.15	3.48	3.87
	0.60	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.34	1.40	1.46	1.53	1.61	1.70	1.79	1.90	2.02	2.16	2.32	2.51	2.72	2.98	3.29	3.67		
	0.80	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.56	1.65	1.75	1.87	2.00	2.16	2.34	2.55	2.81	3.12	3.52					
	1.00	1.04	1.09	1.14	1.20	1.26	1.33	1.40	1.49	1.59	1.70	1.83	1.97	2.15	2.36	2.61	2.92	3.32	3.85							
1.00	<=0.40	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.71	1.82	1.96	2.11	2.29	2.51	2.77	3.09	3.50						
	0.60	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.56	1.67	1.79	1.93	2.09	2.28	2.51	2.78	3.13	3.58							
	0.80	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.57	1.69	1.83	1.99	2.19	2.43	2.74	3.12	3.64									
	1.00	1.05	1.12	1.19	1.26	1.35	1.45	1.57	1.71	1.88	2.09	2.34	2.67	3.10	3.69											
1.20	<=0.40	1.05	1.11	1.18	1.26	1.34	1.44	1.56	1.70	1.86	2.05	2.29	2.60	3.00	3.54											
	0.60	1.06	1.12	1.20	1.28	1.38	1.49	1.62	1.78	1.97	2.20	2.51	2.90	3.45												
	0.80	1.07	1.14	1.23	1.33	1.45	1.59	1.76	1.98	2.25	2.62	3.12	3.87													
	1.00	1.08	1.17	1.27	1.40	1.55	1.74	1.99	2.32	2.77	3.45															
>=1.40	<=0.40	1.09	1.19	1.32	1.48	1.67	1.94	2.29	2.81	3.64																
	0.60	1.09	1.21	1.35	1.52	1.75	2.06	2.51	3.19																	
	0.80	1.11	1.24	1.41	1.64	1.94	2.40	3.12																		
	1.00	1.13	1.29	1.50	1.81	2.26	3.03																			

		Total Factored Axial Load (kips)																								
e (in)	β_d	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
<=0.40	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.30	1.35	1.42	1.48	1.56	1.64	1.74	1.84	1.96	2.09	2.25	2.42	2.63	2.88	3.18	3.54			
	0.60	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.39	1.46	1.53	1.62	1.72	1.82	1.95	2.09	2.25	2.45	2.67	2.95	3.28	3.71				
	0.80	1.04	1.09	1.13	1.19	1.24	1.31	1.38	1.46	1.55	1.65	1.76	1.89	2.05	2.23	2.44	2.70	3.02	3.43	3.96						
	1.00	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.57	1.69	1.83	1.99	2.19	2.43	2.72	3.11	3.62									
0.60	<=0.40	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.44	1.53	1.62	1.73	1.85	1.99	2.16	2.35	2.58	2.87	3.22	3.67						
	0.60	1.04	1.09	1.14	1.20	1.26	1.32	1.40	1.48	1.58	1.69	1.81	1.96	2.13	2.33	2.58	2.88	3.27	3.77							
	0.80	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.59	1.71	1.86	2.03	2.24	2.50	2.83	3.25	3.83									
	1.00	1.06	1.12	1.19	1.27	1.36	1.47	1.59	1.74	1.91	2.13	2.40	2.75	3.23	3.89											
0.80	<=0.40	1.05	1.10	1.16	1.23	1.30	1.39	1.48	1.59	1.72	1.86	2.04	2.25	2.52	2.85	3.28	3.87									
	0.60	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.98	2.19	2.46	2.80	3.24	3.86										
	0.80	1.06	1.13	1.20	1.29	1.39	1.50	1.64	1.81	2.01	2.27	2.60	3.04	3.66												
	1.00	1.07	1.15	1.24	1.35	1.47	1.63	1.82	2.06	2.37	2.80	3.41														
1.00	<=0.40	1.06	1.13	1.21	1.31	1.42	1.54	1.70	1.89	2.12	2.42	2.83	3.39													
	0.60	1.07	1.14	1.23	1.33	1.46	1.60	1.78	2.00	2.29	2.67	3.21														
	0.80	1.08	1.16	1.27	1.40	1.55	1.74	1.98	2.31	2.76	3.43															
	1.00	1.09	1.19	1.32	1.48	1.69	1.95	2.32	2.87	3.74																
1.20	<=0.40	1.09	1.19	1.32	1.47	1.67	1.93	2.28	2.78	3.58																
	0.60	1.09	1.21	1.34	1.52	1.74	2.05	2.48	3.15																	
	0.80	1.11	1.24	1.41	1.63	1.93	2.38	3.09																		
	1.00	1.12	1.29	1.50	1.80	2.25	2.99																			
>=1.40	<=0.40	1.14	1.34	1.61	2.01	2.70																				
	0.60	1.15	1.37	1.67	2.16	3.04																				
	0.80	1.18	1.44	1.84	2.54																					
	1.00	1.21	1.54	2.10	3.31																					

Non-Sway Moment Magnifier
for
6" Flat Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.12	1.14	1.16	1.17	1.19	1.21	1.23	1.24	1.26	1.28	1.30	1.32	1.35	1.37	1.39	1.42	1.44
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.49
	0.80	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.22	1.24	1.26	1.28	1.31	1.34	1.36	1.39	1.42	1.45	1.48	1.52	1.55	1.59
	1.00	1.02	1.04	1.05	1.07	1.09	1.11	1.14	1.16	1.18	1.20	1.23	1.26	1.28	1.31	1.34	1.37	1.41	1.44	1.48	1.51	1.55	1.60	1.64	1.69	1.74
1.00	<=0.40	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.60
	0.60	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.24	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.47	1.51	1.55	1.59	1.63	1.67
	0.80	1.02	1.04	1.06	1.08	1.10	1.12	1.15	1.17	1.20	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.45	1.49	1.53	1.57	1.62	1.67	1.72	1.77	1.83
	1.00	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.26	1.30	1.33	1.37	1.41	1.46	1.50	1.55	1.60	1.66	1.72	1.78	1.85	1.92	2.00	2.09
1.40	<=0.40	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.19	1.21	1.24	1.27	1.31	1.34	1.38	1.41	1.45	1.50	1.54	1.59	1.64	1.70	1.75	1.82	1.88	1.95
	0.60	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.26	1.30	1.33	1.37	1.41	1.45	1.50	1.55	1.60	1.65	1.71	1.78	1.84	1.92	2.00	2.08
	0.80	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.49	1.55	1.60	1.67	1.74	1.81	1.89	1.98	2.07	2.18	2.30	2.43
	1.00	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.28	1.32	1.37	1.42	1.48	1.54	1.61	1.68	1.76	1.85	1.95	2.06	2.18	2.32	2.47	2.65	2.85	3.09
1.80	<=0.40	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.29	1.33	1.38	1.44	1.50	1.56	1.64	1.71	1.80	1.89	2.00	2.12	2.25	2.40	2.57	2.77	2.99	3.27
	0.60	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.42	1.48	1.55	1.62	1.71	1.80	1.90	2.01	2.14	2.28	2.45	2.64	2.86	3.13	3.45	3.84
	0.80	1.03	1.07	1.11	1.15	1.20	1.25	1.31	1.37	1.43	1.50	1.58	1.67	1.77	1.88	2.01	2.15	2.32	2.51	2.75	3.02	3.36	3.79			
	1.00	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.44	1.53	1.62	1.73	1.86	2.00	2.17	2.36	2.60	2.89	3.25	3.71						
>=2.20	<=0.40	1.05	1.11	1.17	1.24	1.32	1.40	1.51	1.62	1.76	1.92	2.12	2.35	2.65	3.04	3.56										
	0.60	1.05	1.11	1.18	1.26	1.34	1.44	1.56	1.69	1.85	2.04	2.28	2.58	2.98	3.51											
	0.80	1.06	1.13	1.21	1.30	1.41	1.53	1.68	1.86	2.08	2.37	2.75	3.26													
	1.00	1.07	1.15	1.25	1.36	1.50	1.66	1.87	2.13	2.49	2.98	3.71														

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.02	1.04	1.06	1.08	1.11	1.13	1.15	1.18	1.21	1.24	1.27	1.30	1.33	1.37	1.40	1.44	1.48	1.53	1.57	1.62	1.67	1.73	1.79	1.85	1.92
	0.60	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.36	1.40	1.44	1.49	1.53	1.58	1.63	1.69	1.75	1.82	1.89	1.96	2.04
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.38	1.43	1.48	1.53	1.59	1.65	1.71	1.78	1.86	1.94	2.03	2.13	2.24	2.37
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.47	1.53	1.59	1.66	1.74	1.82	1.92	2.02	2.13	2.26	2.40	2.57	2.76	2.97
1.00	<=0.40	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.49	1.55	1.60	1.67	1.74	1.81	1.89	1.98	2.07	2.18	2.30	2.43
	0.60	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.33	1.38	1.43	1.48	1.54	1.60	1.67	1.74	1.82	1.91	2.01	2.11	2.23	2.36	2.51	2.68
	0.80	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.29	1.34	1.40	1.45	1.52	1.58	1.66	1.74	1.83	1.93	2.04	2.17	2.31	2.48	2.66	2.88	3.14	3.44
	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.30	1.35	1.42	1.48	1.56	1.64	1.74	1.84	1.96	2.09	2.24	2.42	2.63	2.88	3.17	3.54			
1.40	<=0.40	1.03	1.07	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.51	1.58	1.66	1.75	1.84	1.95	2.08	2.22	2.38	2.57	2.78	3.04	3.35	3.74	
	0.60	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.56	1.64	1.73	1.84	1.95	2.08	2.24	2.41	2.62	2.86	3.15	3.51	3.97		
	0.80	1.04	1.08	1.12	1.17	1.23	1.28	1.35	1.42	1.50	1.58	1.68	1.79	1.92	2.06	2.23	2.43	2.67	2.96	3.32	3.79					
	1.00	1.04	1.09	1.15	1.20	1.27	1.34	1.42	1.51	1.61	1.73	1.87	2.03	2.22	2.45	2.73	3.09	3.56								
1.80	<=0.40	1.05	1.09	1.15	1.21	1.28	1.35	1.44	1.53	1.64	1.77	1.91	2.09	2.29	2.55	2.86	3.27	3.81								
	0.60	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.59	1.71	1.86	2.03	2.24	2.50	2.83	3.26	3.84									
	0.80	1.06	1.12	1.19	1.26	1.35	1.46	1.58	1.72	1.89	2.10	2.35	2.68	3.12	3.73											
	1.00	1.06	1.14	1.22	1.32	1.43	1.56	1.73	1.93	2.18	2.51	2.95	3.58													
>=2.20	<=0.40	1.08	1.18	1.29	1.43	1.60	1.82	2.10	2.50	3.07	3.98															
	0.60	1.09	1.19	1.31	1.47	1.66	1.92	2.27	2.77	3.55																
	0.80	1.10	1.22	1.37	1.57	1.82	2.18	2.72	3.60																	
	1.00	1.12	1.26	1.45	1.71	2.08	2.65	3.66																		

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.44	1.50	1.56	1.63	1.71	1.79	1.88	1.99	2.10	2.23	2.38	2.54	2.74	2.96	3.22
	0.60	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.31	1.36	1.42	1.48	1.55	1.62	1.70	1.79	1.89	2.00	2.12	2.27	2.43	2.61	2.83	3.09	3.40	3.77
	0.80	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.43	1.50	1.58	1.66	1.76	1.87	2.00	2.14	2.30	2.49	2.72	2.99	3.32	3.73			
	1.00	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.44	1.52	1.62	1.73	1.85	1.99	2.15	2.34	2.58	2.86	3.21	3.66						
1.00	<=0.40	1.04	1.07	1.11	1.16	1.20	1.26	1.31	1.37	1.44	1.51	1.59	1.69	1.79	1.90	2.03	2.19	2.36	2.57	2.81	3.11	3.47	3.93			
	0.60	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.57	1.66	1.77	1.89	2.02	2.18	2.37	2.59	2.86	3.19	3.60					
	0.80	1.04	1.09	1.14	1.20	1.26	1.32	1.40	1.49	1.58	1.69	1.82	1.96	2.13	2.34	2.58	2.89	3.28	3.78							
	1.00	1.05	1.10	1.16	1.23	1.31	1.39	1.49	1.60	1.73	1.89	2.07	2.29	2.57	2.92	3.38										
1.40	<=0.40	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.94	2.12	2.33	2.60	2.93	3.37	3.95								
	0.60	1.05	1.10	1.16	1.23	1.31	1.39	1.49	1.60	1.73	1.88	2.06	2.28	2.56	2.90	3.36	3.99									
	0.80	1.06	1.12	1.19	1.27	1.36	1.47	1.59	1.74	1.91	2.13	2.40	2.75	3.21	3.87											
	1.00	1.06	1.14	1.22	1.32	1.44	1.58	1.74	1.95	2.21	2.56	3.03	3.71													
1.80	<=0.40	1.07	1.14	1.23	1.33	1.45	1.60	1.78	2.00	2.28	2.66	3.19	3.99													
	0.60	1.07	1.15	1.25	1.36	1.50	1.66	1.87	2.14	2.49	2.99	3.73														
	0.80	1.08	1.18	1.29	1.43	1.60	1.82	2.11	2.51	3.10																
	1.00	1.09	1.21	1.35	1.53	1.76	2.08	2.54	3.25																	
>=2.20	<=0.40	1.12	1.28	1.48	1.76	2.17	2.83																			
	0.60	1.13	1.30	1.53	1.85	2.35	3.22																			
	0.80	1.15	1.35	1.64	2.08	2.86																				
	1.00	1.18	1.43	1.81	2.49	3.96																				

Non-Sway Moment Magnifier
for
6" Flat Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.70	1.82	1.95	2.11	2.29	2.51	2.77	3.09	3.49						
	0.60	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.56	1.67	1.79	1.92	2.08	2.27	2.50	2.78	3.13	3.58							
	0.80	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.57	1.69	1.83	1.99	2.19	2.43	2.73	3.12	3.63									
	1.00	1.05	1.12	1.18	1.26	1.35	1.45	1.57	1.71	1.88	2.09	2.34	2.66	3.09	3.68											
1.00	<=0.40	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.59	1.71	1.86	2.03	2.24	2.50	2.82	3.25	3.82									
	0.60	1.05	1.11	1.17	1.24	1.33	1.42	1.52	1.65	1.79	1.97	2.18	2.44	2.77	3.21	3.81										
	0.80	1.06	1.13	1.20	1.29	1.39	1.50	1.64	1.80	2.00	2.25	2.58	3.01	3.61												
	1.00	1.07	1.15	1.24	1.34	1.47	1.62	1.81	2.05	2.36	2.77	3.37														
1.40	<=0.40	1.06	1.14	1.22	1.31	1.43	1.56	1.72	1.92	2.17	2.49	2.92	3.54													
	0.60	1.07	1.15	1.24	1.34	1.47	1.62	1.81	2.04	2.35	2.76	3.35														
	0.80	1.08	1.17	1.28	1.41	1.56	1.76	2.02	2.36	2.85	3.59															
	1.00	1.09	1.20	1.33	1.50	1.71	1.99	2.38	2.97	3.94																
1.80	<=0.40	1.09	1.20	1.34	1.52	1.74	2.04	2.47	3.12																	
	0.60	1.10	1.22	1.37	1.57	1.83	2.19	2.73	3.63																	
	0.80	1.11	1.26	1.44	1.69	2.05	2.60	3.54																		
	1.00	1.13	1.31	1.55	1.89	2.43	3.41																			
>=2.20	<=0.40	1.17	1.42	1.79	2.42	3.76																				
	0.60	1.19	1.46	1.88	2.67																					
	0.80	1.22	1.55	2.13	3.42																					
	1.00	1.26	1.69	2.57																						

Non-Sway Moment Magnifier for 6" Flat Walls f'_c = 4000 psi

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.60	<=0.40	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.22	1.24	1.25	1.27	1.29	1.30	1.32	1.34	1.36
	0.60	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	0.80	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.39	1.42	1.44	1.47
	1.00	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.24	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.45	1.48	1.51	1.55	1.58
1.00	<=0.40	1.01	1.03	1.04	1.06	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.48
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.29	1.31	1.33	1.36	1.39	1.41	1.44	1.47	1.50	1.53
	0.80	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.39	1.43	1.46	1.49	1.53	1.57	1.61	1.65
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.44	1.48	1.52	1.57	1.61	1.66	1.71	1.77	1.82
1.40	<=0.40	1.02	1.04	1.05	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.23	1.25	1.28	1.31	1.34	1.37	1.40	1.44	1.47	1.51	1.55	1.59	1.64	1.68	1.73
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.44	1.48	1.52	1.56	1.61	1.66	1.71	1.76	1.82
	0.80	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.19	1.22	1.26	1.29	1.32	1.36	1.40	1.44	1.48	1.53	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.04
	1.00	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.49	1.54	1.60	1.66	1.73	1.80	1.88	1.97	2.06	2.17	2.29	2.41
1.80	<=0.40	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.28	1.32	1.36	1.41	1.45	1.51	1.56	1.62	1.69	1.76	1.84	1.93	2.02	2.12	2.24	2.36	2.51
	0.60	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.34	1.39	1.44	1.50	1.56	1.62	1.69	1.77	1.86	1.95	2.05	2.16	2.29	2.43	2.60	2.78
	0.80	1.03	1.06	1.10	1.13	1.17	1.21	1.25	1.30	1.35	1.41	1.47	1.53	1.60	1.68	1.77	1.86	1.97	2.09	2.23	2.38	2.55	2.76	3.00	3.28	3.63
	1.00	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.43	1.50	1.58	1.67	1.76	1.87	2.00	2.14	2.31	2.50	2.72	2.99	3.33	3.74			
>=2.20	<=0.40	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.71	1.84	1.99	2.17	2.39	2.65	2.98	3.40	3.96							
	0.60	1.05	1.10	1.15	1.22	1.28	1.36	1.45	1.55	1.66	1.79	1.95	2.13	2.35	2.63	2.97	3.42									
	0.80	1.05	1.11	1.18	1.25	1.33	1.43	1.54	1.67	1.82	2.00	2.23	2.50	2.86	3.34											
	1.00	1.06	1.13	1.21	1.30	1.40	1.53	1.67	1.85	2.07	2.35	2.72	3.23	3.97												

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.60	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.28	1.30	1.33	1.36	1.39	1.43	1.46	1.50	1.53	1.57	1.62	1.66	1.71
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.43	1.47	1.51	1.55	1.59	1.64	1.69	1.74	1.79
	0.80	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.32	1.35	1.39	1.43	1.47	1.52	1.56	1.61	1.67	1.72	1.79	1.85	1.92	2.00
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.38	1.43	1.47	1.53	1.58	1.64	1.71	1.78	1.85	1.93	2.02	2.12	2.23	2.35
1.00	<=0.40	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.19	1.22	1.26	1.29	1.32	1.36	1.40	1.44	1.48	1.53	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.04
	0.60	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.24	1.28	1.31	1.35	1.39	1.44	1.48	1.53	1.59	1.64	1.70	1.77	1.84	1.92	2.00	2.09	2.19
	0.80	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.33	1.37	1.42	1.47	1.52	1.58	1.65	1.72	1.79	1.88	1.97	2.07	2.18	2.30	2.44	2.59
	1.00	1.03	1.06	1.09	1.13	1.16	1.20	1.25	1.29	1.34	1.39	1.45	1.51	1.58	1.65	1.74	1.82	1.92	2.03	2.16	2.30	2.46	2.64	2.85	3.11	3.40
1.40	<=0.40	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.46	1.52	1.59	1.66	1.73	1.82	1.91	2.01	2.12	2.25	2.39	2.55	2.73	2.95
	0.60	1.03	1.06	1.09	1.13	1.16	1.20	1.25	1.29	1.34	1.39	1.45	1.51	1.58	1.65	1.73	1.82	1.92	2.03	2.15	2.29	2.45	2.63	2.84	3.09	3.38
	0.80	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.40	1.47	1.54	1.62	1.71	1.81	1.92	2.04	2.18	2.34	2.53	2.76	3.02	3.34	3.74		
	1.00	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.49	1.58	1.67	1.78	1.91	2.05	2.22	2.41	2.65	2.93	3.29	3.74					
1.80	<=0.40	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.70	1.82	1.95	2.11	2.29	2.51	2.77	3.09	3.49						
	0.60	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.56	1.67	1.79	1.92	2.08	2.27	2.50	2.78	3.13	3.58							
	0.80	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.57	1.69	1.83	1.99	2.19	2.43	2.73	3.12	3.63									
	1.00	1.05	1.12	1.18	1.26	1.35	1.45	1.57	1.71	1.88	2.08	2.34	2.66	3.09	3.68											
>=2.20	<=0.40	1.07	1.15	1.24	1.35	1.48	1.64	1.83	2.08	2.40	2.85	3.49														
	0.60	1.07	1.16	1.26	1.38	1.53	1.71	1.94	2.24	2.65	3.24															
	0.80	1.08	1.19	1.31	1.46	1.64	1.88	2.21	2.67	3.38																
	1.00	1.10	1.22	1.37	1.56	1.82	2.17	2.70	3.56																	

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.60	<=0.40	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.27	1.31	1.36	1.40	1.45	1.50	1.56	1.62	1.68	1.75	1.83	1.92	2.01	2.11	2.22	2.34	2.48
	0.60	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.34	1.39	1.44	1.49	1.55	1.62	1.69	1.76	1.85	1.94	2.04	2.15	2.27	2.41	2.57	2.75
	0.80	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.35	1.40	1.46	1.53	1.60	1.68	1.76	1.86	1.96	2.08	2.21	2.36	2.53	2.73	2.96	3.24	3.57
	1.00	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49	1.57	1.66	1.76	1.86	1.99	2.13	2.29	2.48	2.70	2.96	3.28	3.68			
1.00	<=0.40	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.31	1.36	1.42	1.48	1.54	1.62	1.70	1.79	1.89	2.00	2.12	2.26	2.42	2.61	2.82	3.08	3.39	3.76
	0.60	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.33	1.39	1.46	1.52	1.60	1.69	1.78	1.88	2.00	2.14	2.29	2.47	2.67	2.92	3.21	3.57		
	0.80	1.04	1.08	1.12	1.16	1.22	1.27	1.33	1.39	1.47	1.55	1.64	1.74	1.85	1.98	2.13	2.31	2.51	2.76	3.05	3.42	3.90				
	1.00	1.04	1.09	1.14	1.19	1.26	1.32	1.40	1.48	1.58	1.69	1.81	1.95	2.12	2.32	2.57	2.86	3.24	3.73							
1.40	<=0.40	1.04	1.08	1.13	1.18	1.23	1.30	1.36	1.44	1.52	1.61	1.72	1.84	1.98	2.14	2.33	2.56	2.83	3.17	3.61						
	0.60	1.04	1.09	1.14	1.19	1.25	1.32	1.40	1.48	1.57	1.68	1.81	1.95	2.12	2.31	2.55	2.85	3.22	3.70							
	0.80	1.05	1.10	1.16	1.22	1.30	1.38	1.47	1.58	1.70	1.85	2.02	2.23	2.48	2.80	3.21	3.76									
	1.00	1.06	1.12	1.19	1.27	1.36	1.46	1.59	1.73	1.90	2.12	2.38	2.72	3.18	3.82											
1.80	<=0.40	1.06	1.12	1.19	1.28	1.37	1.48	1.61	1.76	1.95	2.18	2.47	2.85	3.37												
	0.60	1.06	1.13	1.21	1.30	1.40	1.53	1.68	1.86	2.08	2.36	2.73	3.24	3.99												
	0.80	1.07	1.15	1.24	1.35	1.48	1.64	1.84	2.09	2.42	2.87	3.54														
	1.00	1.08	1.18	1.29	1.43	1.60	1.82	2.10	2.50	3.07	3.99															
>=2.20	<=0.40	1.10	1.23	1.39	1.60	1.88	2.28	2.89	3.96																	
	0.60	1.11	1.25	1.43	1.66	1.99	2.48	3.30																		
	0.80	1.13	1.29	1.51	1.82	2.29	3.08																			
	1.00	1.15	1.35	1.63	2.07	2.83																				

Non-Sway Moment Magnifier
for
6" Flat Walls
f'_c = 4000 psi

[redacted]

e (in)	β_d	Total Factored Axial Load (kips) 2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.56	1.64	1.73	1.84	1.95	2.09	2.24	2.41	2.62	2.86	3.15	3.52	3.97		
	0.60	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.38	1.45	1.53	1.62	1.71	1.82	1.94	2.08	2.24	2.43	2.66	2.93	3.26	3.67				
	0.80	1.04	1.09	1.13	1.19	1.24	1.31	1.38	1.46	1.55	1.65	1.76	1.89	2.04	2.22	2.43	2.68	3.00	3.40	3.92						
	1.00	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.56	1.68	1.82	1.98	2.18	2.41	2.71	3.09	3.59									
1.00	<=0.40	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.56	1.67	1.78	1.92	2.08	2.27	2.50	2.77	3.12	3.56							
	0.60	1.04	1.09	1.15	1.21	1.27	1.34	1.42	1.52	1.62	1.74	1.88	2.04	2.24	2.48	2.77	3.14	3.62								
	0.80	1.05	1.11	1.17	1.24	1.32	1.41	1.51	1.63	1.77	1.93	2.13	2.37	2.68	3.07	3.61										
	1.00	1.06	1.12	1.20	1.28	1.38	1.50	1.63	1.80	1.99	2.24	2.56	2.98	3.57												
1.40	<=0.40	1.05	1.12	1.18	1.26	1.35	1.45	1.57	1.71	1.87	2.07	2.32	2.64	3.06	3.64											
	0.60	1.06	1.12	1.20	1.28	1.38	1.50	1.63	1.79	1.99	2.23	2.55	2.96	3.54												
	0.80	1.07	1.14	1.23	1.33	1.45	1.60	1.78	2.00	2.28	2.66	3.19	3.99													
	1.00	1.08	1.17	1.27	1.40	1.56	1.76	2.01	2.35	2.82	3.54															
1.80	<=0.40	1.08	1.17	1.28	1.42	1.58	1.79	2.06	2.43	2.96	3.79															
	0.60	1.09	1.19	1.31	1.46	1.65	1.89	2.22	2.68	3.40																
	0.80	1.10	1.22	1.36	1.55	1.80	2.14	2.64	3.45																	
	1.00	1.11	1.26	1.44	1.69	2.04	2.58	3.50																		
>=2.20	<=0.40	1.15	1.34	1.62	2.03	2.75																				
	0.60	1.16	1.37	1.68	2.18	3.10																				
	0.80	1.18	1.44	1.85	2.58																					
	1.00	1.21	1.54	2.12	3.39																					

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 3000 psi

Total Factored Axial Load (kips)

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.12	1.13	1.14
	0.60	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15
	0.80	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17
	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18	1.19	1.20
1.20	<=0.40	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.13	1.14	1.15	1.15	1.16
	0.60	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.17
	0.80	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19	1.20
	1.00	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.22	1.23	1.24
1.60	<=0.40	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
	0.60	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	0.80	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.24	1.25
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.24	1.25	1.27	1.28	1.30
2.00	<=0.40	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.21	1.22	1.23	1.24	1.25
	0.60	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.23	1.25	1.26	1.28
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.31	1.32
	1.00	1.01	1.02	1.03	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
2.40	<=0.40	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.32	1.34	1.36
	0.60	1.01	1.02	1.03	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	0.80	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.23	1.25	1.27	1.30	1.32	1.34	1.36	1.39	1.41	1.44	1.46
	1.00	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.26	1.28	1.30	1.33	1.35	1.38	1.41	1.44	1.47	1.50	1.54	1.57
2.80	<=0.40	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.21	1.23	1.26	1.29	1.33	1.36	1.40	1.43	1.47	1.52	1.56	1.61	1.66	1.71	1.77	1.83	1.90
	0.60	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.32	1.35	1.39	1.43	1.48	1.52	1.57	1.62	1.67	1.73	1.80	1.86	1.94	2.01
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.33	1.38	1.42	1.47	1.52	1.57	1.63	1.70	1.76	1.84	1.92	2.01	2.10	2.21	2.32
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.22	1.27	1.31	1.35	1.40	1.46	1.52	1.58	1.65	1.72	1.80	1.89	1.99	2.10	2.22	2.36	2.52	2.69	2.90
>=3.00	<=0.40	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.21	1.23	1.26	1.29	1.33	1.36	1.40	1.43	1.47	1.52	1.56	1.61	1.66	1.71	1.77	1.83	1.90
	0.60	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.32	1.35	1.39	1.43	1.48	1.52	1.57	1.62	1.67	1.73	1.80	1.86	1.94	2.01
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.33	1.38	1.42	1.47	1.52	1.57	1.63	1.70	1.76	1.84	1.92	2.01	2.10	2.21	2.32
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.22	1.27	1.31	1.35	1.40	1.46	1.52	1.58	1.65	1.72	1.80	1.89	1.99	2.10	2.22	2.36	2.52	2.69	2.90

Total Factored Axial Load (kips)

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.23	1.24	1.25
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.19	1.21	1.22	1.23	1.25	1.26	1.28	1.29
	1.00	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.21	1.23	1.25	1.26	1.28	1.30	1.31	1.33	1.35
1.20	<=0.40	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.22	1.24	1.25	1.26	1.28
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.30
	0.80	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.32	1.34	1.35
	1.00	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.12	1.14	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
1.60	<=0.40	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35
	0.60	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.34	1.36	1.38
	0.80	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.38	1.40	1.42	1.45
	1.00	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.30	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.56
2.00	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.23	1.25	1.27	1.30	1.32	1.34	1.36	1.39	1.41	1.44	1.46
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.14	1.16	1.17	1.19	1.21	1.23	1.25	1.28	1.30	1.32	1.34	1.37	1.40	1.42	1.45	1.48	1.51
	0.80	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.38	1.41	1.44	1.47	1.51	1.54	1.58	1.62
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.42	1.46	1.50	1.54	1.58	1.63	1.68	1.73	1.78
2.40	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.33	1.36	1.39	1.42	1.45	1.49	1.53	1.57	1.61	1.65	1.70
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.29	1.32	1.36	1.39	1.42	1.46	1.50	1.54	1.58	1.63	1.67	1.72	1.78
	0.80	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.65	1.71	1.77	1.84	1.90	1.98
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.29	1.33	1.38	1.42	1.47	1.52	1.57	1.63	1.69	1.76	1.83	1.91	2.00	2.10	2.20	2.32
2.80	<=0.40	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.30	1.35	1.39	1.44	1.48	1.54	1.60	1.66	1.72	1.80	1.87	1.96	2.05	2.16	2.27	2.40
	0.60	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.33	1.38	1.42	1.48	1.53	1.59	1.66	1.73	1.81	1.89	1.99	2.09	2.21	2.33	2.48	2.64
	0.80	1.03	1.06	1.09	1.13	1.16	1.20	1.25	1.29	1.34	1.39	1.45	1.51	1.58	1.65	1.73	1.82	1.92	2.02	2.15	2.28	2.44	2.62	2.83	3.07	3.37
	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.55	1.63	1.72	1.83	1.94	2.07	2.22	2.39	2.59	2.83	3.11	3.46	3.89		
>=3.00	<=0.40	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.42	1.48	1.55	1.62	1.71	1.80	1.90	2.01	2.14	2.28	2.44	2.63	2.86	3.12	3.44	3.82
	0.60	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.34	1.40	1.46	1.53	1.61	1.69	1.79	1.89	2.01	2.15	2.31	2.49	2.70	2.95	3.25	3.62		
	0.80	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.55	1.64	1.75	1.86	1.99	2.15	2.32	2.53	2.79	3.09	3.48	3.97				
	1.00	1.04	1.09	1.14	1.20	1.26	1.33	1.40	1.49	1.58	1.69	1.82	1.97	2.14	2.34	2.59	2.90	3.29	3.80							

Non-Sway Moment Magnifier for 8" Flat Walls f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.37
	0.60	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.40
	0.80	1.01	1.03	1.04	1.06	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.48
	1.00	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.46	1.49	1.53	1.56	1.60
1.20	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.36	1.38	1.40	1.43	1.46
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.14	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.32	1.34	1.36	1.39	1.42	1.44	1.47	1.50
	0.80	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.61
	1.00	1.02	1.04	1.05	1.07	1.09	1.12	1.14	1.16	1.18	1.21	1.24	1.26	1.29	1.32	1.35	1.38	1.42	1.45	1.49	1.53	1.57	1.62	1.66	1.71	1.76
1.60	<=0.40	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.17	1.20	1.22	1.24	1.26	1.29	1.31	1.34	1.36	1.39	1.42	1.45	1.48	1.52	1.55	1.59
	0.60	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.61	1.65
	0.80	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.37	1.40	1.44	1.47	1.51	1.56	1.60	1.65	1.70	1.75	1.81
	1.00	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.45	1.49	1.54	1.59	1.64	1.70	1.76	1.83	1.90	1.97	2.06
2.00	<=0.40	1.02	1.04	1.06	1.08	1.10	1.12	1.15	1.17	1.20	1.22	1.25	1.28	1.31	1.34	1.38	1.41	1.45	1.49	1.53	1.57	1.62	1.67	1.72	1.78	1.84
	0.60	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.54	1.59	1.64	1.69	1.75	1.81	1.87	1.94
	0.80	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.25	1.28	1.32	1.36	1.40	1.44	1.49	1.54	1.60	1.65	1.72	1.78	1.86	1.94	2.02	2.12	2.22
	1.00	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.55	1.61	1.68	1.75	1.83	1.92	2.02	2.13	2.25	2.39	2.54	2.71
2.40	<=0.40	1.02	1.05	1.08	1.10	1.13	1.17	1.20	1.23	1.27	1.31	1.35	1.40	1.44	1.49	1.55	1.61	1.67	1.74	1.81	1.90	1.99	2.08	2.19	2.31	2.44
	0.60	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.54	1.61	1.67	1.75	1.83	1.92	2.01	2.12	2.24	2.38	2.53	2.70
	0.80	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.34	1.40	1.46	1.52	1.59	1.66	1.75	1.84	1.94	2.05	2.18	2.32	2.49	2.68	2.90	3.16	3.48
	1.00	1.03	1.07	1.11	1.15	1.20	1.24	1.30	1.35	1.42	1.49	1.56	1.65	1.74	1.85	1.97	2.10	2.26	2.44	2.65	2.90	3.20	3.58			
2.80	<=0.40	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.43	1.51	1.59	1.68	1.77	1.89	2.02	2.16	2.33	2.53	2.76	3.05	3.39	3.83			
	0.60	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.48	1.56	1.65	1.75	1.87	2.00	2.16	2.34	2.55	2.81	3.12	3.52					
	0.80	1.04	1.09	1.14	1.19	1.25	1.32	1.40	1.48	1.57	1.68	1.80	1.94	2.11	2.31	2.55	2.84	3.21	3.69							
	1.00	1.05	1.10	1.16	1.23	1.30	1.39	1.48	1.59	1.72	1.87	2.05	2.26	2.53	2.87	3.31	3.91									
>=3.00	<=0.40	1.04	1.09	1.15	1.21	1.27	1.34	1.42	1.52	1.62	1.74	1.88	2.04	2.24	2.47	2.76	3.13	3.61								
	0.60	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.57	1.69	1.83	1.99	2.19	2.43	2.74	3.12	3.64									
	0.80	1.05	1.11	1.18	1.26	1.34	1.44	1.56	1.70	1.86	2.05	2.29	2.60	3.00	3.55											
	1.00	1.06	1.13	1.21	1.31	1.42	1.55	1.70	1.89	2.13	2.44	2.84	3.42													

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.24	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.45	1.48	1.51	1.55	1.58
	0.60	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.36	1.39	1.42	1.46	1.49	1.53	1.56	1.60	1.65
	0.80	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.59	1.64	1.69	1.74	1.80
	1.00	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.19	1.22	1.26	1.29	1.32	1.36	1.40	1.44	1.48	1.53	1.58	1.63	1.69	1.75	1.81	1.88	1.96	2.04
1.20	<=0.40	1.02	1.04	1.05	1.07	1.09	1.11	1.14	1.16	1.18	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.41	1.44	1.48	1.52	1.56	1.60	1.64	1.69	1.74
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.15	1.17	1.20	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.45	1.49	1.53	1.57	1.62	1.66	1.72	1.77	1.83
	0.80	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.49	1.54	1.59	1.64	1.70	1.76	1.82	1.89	1.97	2.05
	1.00	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.49	1.55	1.61	1.67	1.74	1.81	1.89	1.98	2.08	2.19	2.31	2.44
1.60	<=0.40	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.29	1.32	1.36	1.39	1.43	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94	2.02
	0.60	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.35	1.39	1.43	1.48	1.53	1.58	1.63	1.69	1.76	1.82	1.90	1.98	2.07	2.16
	0.80	1.02	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.41	1.46	1.52	1.58	1.64	1.71	1.78	1.86	1.95	2.05	2.15	2.27	2.41	2.56
	1.00	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.44	1.51	1.57	1.64	1.72	1.81	1.91	2.02	2.14	2.27	2.43	2.60	2.81	3.05	3.33
2.00	<=0.40	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.25	1.29	1.33	1.38	1.42	1.48	1.53	1.59	1.66	1.73	1.81	1.89	1.99	2.09	2.20	2.33	2.47	2.63
	0.60	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.46	1.52	1.59	1.66	1.73	1.82	1.91	2.01	2.12	2.25	2.39	2.55	2.74	2.95
	0.80	1.03	1.06	1.10	1.14	1.18	1.22	1.26	1.31	1.37	1.43	1.49	1.56	1.64	1.72	1.81	1.92	2.03	2.17	2.32	2.49	2.69	2.93	3.21	3.55	3.97
	1.00	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.81	1.93	2.06	2.22	2.41	2.62	2.88	3.20	3.60				
2.40	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.47	1.55	1.63	1.72	1.82	1.93	2.06	2.21	2.38	2.57	2.80	3.08	3.42	3.84		
	0.60	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.80	1.92	2.06	2.21	2.40	2.61	2.87	3.18	3.57				
	0.80	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.63	1.74	1.87	2.02	2.19	2.39	2.63	2.93	3.31	3.80						
	1.00	1.05	1.10	1.15	1.22	1.29	1.37	1.45	1.55	1.67	1.80	1.96	2.15	2.38	2.66	3.02	3.49									
2.80	<=0.40	1.05	1.10	1.16	1.22	1.30	1.38	1.47	1.58	1.70	1.84	2.01	2.21	2.46	2.78	3.18	3.72									
	0.60	1.05	1.11	1.17	1.24	1.32	1.41	1.52	1.64	1.78	1.95	2.15	2.41	2.73	3.14	3.71										
	0.80	1.06	1.12	1.20	1.28	1.38	1.49	1.63	1.79	1.98	2.23	2.54	2.95	3.53												
	1.00	1.07	1.15	1.23	1.34	1.46	1.61	1.80	2.03	2.33	2.73	3.30														
>=3.00	<=0.40	1.06	1.13	1.21	1.30	1.41	1.53	1.68	1.86	2.09	2.38	2.75	3.28													
	0.60	1.07	1.14	1.23	1.33	1.45	1.59	1.76	1.97	2.25	2.61	3.11	3.85													
	0.80	1.08	1.16	1.26	1.39	1.54	1.72	1.96	2.26	2.69	3.31															
	1.00	1.09	1.19	1.32	1.47	1.67	1.93	2.28	2.79	3.60																

Non-Sway Moment Magnifier for 8" Flat Walls f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.33	1.37	1.41	1.44	1.49	1.53	1.58	1.62	1.68	1.73	1.79	1.86	1.93
	0.60	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.49	1.53	1.58	1.64	1.69	1.76	1.82	1.89	1.97	2.05
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.39	1.43	1.48	1.53	1.59	1.65	1.72	1.79	1.86	1.95	2.04	2.14	2.25	2.38
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.36	1.41	1.47	1.53	1.59	1.67	1.74	1.83	1.92	2.02	2.14	2.27	2.42	2.58	2.77	2.99
1.20	<=0.40	1.02	1.05	1.07	1.10	1.13	1.15	1.18	1.22	1.25	1.29	1.32	1.36	1.41	1.45	1.50	1.55	1.61	1.67	1.73	1.80	1.88	1.96	2.05	2.15	2.25
	0.60	1.02	1.05	1.08	1.10	1.13	1.17	1.20	1.23	1.27	1.31	1.35	1.40	1.45	1.50	1.55	1.61	1.67	1.74	1.82	1.90	1.99	2.09	2.20	2.32	2.45
	0.80	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.37	1.42	1.47	1.54	1.60	1.67	1.75	1.84	1.93	2.04	2.16	2.29	2.44	2.61	2.81	3.03
	1.00	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.38	1.45	1.51	1.59	1.67	1.76	1.86	1.97	2.10	2.25	2.41	2.61	2.83	3.11	3.43	3.84	
1.60	<=0.40	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.46	1.52	1.59	1.65	1.73	1.81	1.90	2.00	2.12	2.24	2.38	2.54	2.73	2.94
	0.60	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.45	1.51	1.58	1.65	1.73	1.82	1.92	2.02	2.15	2.28	2.44	2.62	2.83	3.07	3.36
	0.80	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.40	1.47	1.54	1.62	1.70	1.80	1.91	2.04	2.18	2.34	2.53	2.75	3.01	3.33	3.72		
	1.00	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.49	1.58	1.67	1.78	1.91	2.05	2.21	2.41	2.64	2.92	3.27	3.72					
2.00	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.55	1.64	1.73	1.83	1.95	2.08	2.23	2.40	2.60	2.84	3.13	3.48	3.93		
	0.60	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.38	1.45	1.53	1.61	1.71	1.81	1.94	2.07	2.24	2.42	2.64	2.91	3.23	3.64				
	0.80	1.04	1.08	1.13	1.19	1.24	1.31	1.38	1.45	1.54	1.64	1.75	1.88	2.03	2.21	2.42	2.67	2.98	3.37	3.88						
	1.00	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.56	1.68	1.82	1.98	2.17	2.40	2.69	3.06	3.55									
2.40	<=0.40	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.51	1.61	1.72	1.86	2.02	2.20	2.43	2.70	3.05	3.50								
	0.60	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.56	1.67	1.81	1.97	2.16	2.39	2.68	3.04	3.52									
	0.80	1.05	1.11	1.18	1.25	1.34	1.44	1.55	1.68	1.84	2.03	2.26	2.55	2.93	3.44											
	1.00	1.06	1.13	1.21	1.30	1.41	1.54	1.69	1.87	2.10	2.39	2.78	3.32													
2.80	<=0.40	1.06	1.14	1.22	1.31	1.43	1.56	1.72	1.91	2.16	2.48	2.91	3.53													
	0.60	1.07	1.15	1.24	1.34	1.47	1.62	1.80	2.04	2.34	2.75	3.33														
	0.80	1.08	1.17	1.28	1.40	1.56	1.76	2.02	2.36	2.84	3.57															
	1.00	1.09	1.20	1.33	1.49	1.71	1.99	2.38	2.96	3.91																
>=3.00	<=0.40	1.08	1.18	1.29	1.43	1.61	1.83	2.12	2.53	3.13																
	0.60	1.09	1.19	1.32	1.48	1.67	1.94	2.29	2.81	3.64																
	0.80	1.10	1.22	1.38	1.57	1.84	2.21	2.76	3.70																	
	1.00	1.12	1.27	1.46	1.72	2.10	2.69	3.75																		

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.41	1.46	1.52	1.57	1.64	1.71	1.78	1.86	1.95	2.04	2.15	2.27	2.40	2.55
	0.60	1.03	1.05	1.08	1.12	1.15	1.18	1.22	1.26	1.30	1.35	1.40	1.45	1.51	1.57	1.64	1.71	1.79	1.88	1.97	2.08	2.20	2.33	2.48	2.65	2.84
	0.80	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.31	1.36	1.42	1.48	1.54	1.62	1.70	1.79	1.88	1.99	2.12	2.26	2.42	2.60	2.82	3.07	3.38	3.75
	1.00	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.44	1.51	1.59	1.68	1.78	1.89	2.02	2.17	2.34	2.54	2.78	3.07	3.43	3.87			
1.20	<=0.40	1.03	1.06	1.09	1.13	1.16	1.20	1.25	1.29	1.34	1.39	1.45	1.51	1.58	1.65	1.73	1.82	1.92	2.03	2.15	2.29	2.45	2.63	2.84	3.08	3.38
	0.60	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.43	1.49	1.56	1.64	1.72	1.82	1.92	2.04	2.17	2.33	2.50	2.70	2.94	3.23	3.57	
	0.80	1.04	1.07	1.11	1.16	1.20	1.26	1.31	1.37	1.44	1.51	1.60	1.69	1.79	1.91	2.04	2.19	2.36	2.57	2.82	3.11	3.48	3.95			
	1.00	1.04	1.08	1.13	1.18	1.24	1.31	1.38	1.45	1.54	1.64	1.75	1.88	2.03	2.20	2.41	2.66	2.97	3.36	3.86						
1.60	<=0.40	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.43	1.50	1.58	1.67	1.77	1.88	2.00	2.15	2.31	2.51	2.73	3.01	3.35	3.77			
	0.60	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.55	1.64	1.74	1.86	1.99	2.14	2.32	2.53	2.78	3.09	3.47	3.95				
	0.80	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.57	1.67	1.79	1.93	2.10	2.29	2.52	2.81	3.17	3.63							
	1.00	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.59	1.71	1.86	2.04	2.25	2.51	2.84	3.27	3.85									
2.00	<=0.40	1.04	1.09	1.14	1.20	1.26	1.33	1.40	1.49	1.59	1.70	1.82	1.97	2.14	2.35	2.60	2.91	3.30	3.82							
	0.60	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.10	2.32	2.58	2.90	3.33	3.89								
	0.80	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.98	2.19	2.46	2.80	3.25	3.87										
	1.00	1.06	1.13	1.21	1.29	1.40	1.52	1.66	1.83	2.05	2.32	2.67	3.14	3.83												
2.40	<=0.40	1.06	1.12	1.19	1.27	1.36	1.47	1.59	1.74	1.92	2.14	2.41	2.76	3.24	3.91											
	0.60	1.06	1.13	1.20	1.29	1.40	1.52	1.66	1.83	2.04	2.31	2.65	3.12	3.80												
	0.80	1.07	1.15	1.24	1.34	1.47	1.63	1.81	2.05	2.36	2.79	3.39														
	1.00	1.08	1.17	1.28	1.42	1.58	1.79	2.06	2.44	2.97	3.80															
2.80	<=0.40	1.08	1.18	1.29	1.43	1.61	1.83	2.12	2.53	3.13																
	0.60	1.09	1.19	1.32	1.48	1.67	1.93	2.29	2.81	3.63																
	0.80	1.10	1.22	1.38	1.57	1.84	2.21	2.76	3.69																	
	1.00	1.12	1.26	1.46	1.72	2.10	2.69	3.74																		
>=3.00	<=0.40	1.11	1.24	1.40	1.62	1.92	2.35	3.03																		
	0.60	1.11	1.26	1.44	1.69	2.04	2.58	3.50																		
	0.80	1.13	1.30	1.53	1.86	2.36	3.25																			
	1.00	1.15	1.36	1.66	2.13	2.97																				

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 3000 psi

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.80	<=0.40	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.43	1.49	1.56	1.64	1.73	1.82	1.93	2.04	2.18	2.33	2.51	2.71	2.95	3.24	3.58	
	0.60	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.40	1.47	1.54	1.62	1.71	1.81	1.92	2.05	2.19	2.36	2.55	2.78	3.05	3.38	3.79		
	0.80	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.57	1.66	1.77	1.89	2.03	2.19	2.38	2.60	2.87	3.21	3.63					
	1.00	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.71	1.84	2.00	2.18	2.40	2.66	2.99	3.42	3.99							
1.20	<=0.40	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.39	1.46	1.53	1.62	1.72	1.82	1.95	2.09	2.25	2.44	2.67	2.94	3.28	3.70				
	0.60	1.04	1.08	1.12	1.17	1.23	1.29	1.35	1.42	1.50	1.59	1.69	1.80	1.93	2.08	2.25	2.45	2.70	3.00	3.37	3.86					
	0.80	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.50	1.61	1.72	1.85	2.01	2.20	2.42	2.69	3.03	3.48								
	1.00	1.05	1.11	1.17	1.24	1.32	1.41	1.51	1.63	1.76	1.93	2.13	2.37	2.67	3.07	3.60										
1.60	<=0.40	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.49	1.59	1.70	1.83	1.98	2.15	2.36	2.62	2.94	3.34	3.88							
	0.60	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.11	2.33	2.60	2.93	3.36	3.95								
	0.80	1.05	1.11	1.18	1.25	1.33	1.42	1.53	1.66	1.81	1.99	2.21	2.48	2.82	3.29	3.93										
	1.00	1.06	1.13	1.21	1.30	1.40	1.52	1.67	1.84	2.06	2.33	2.69	3.18	3.88												
2.00	<=0.40	1.05	1.11	1.18	1.25	1.34	1.44	1.55	1.68	1.84	2.03	2.26	2.55	2.93	3.44											
	0.60	1.06	1.12	1.19	1.28	1.37	1.48	1.61	1.76	1.94	2.17	2.46	2.84	3.35												
	0.80	1.07	1.14	1.22	1.32	1.44	1.58	1.75	1.95	2.22	2.57	3.04	3.74													
	1.00	1.08	1.16	1.27	1.39	1.54	1.73	1.97	2.28	2.71	3.35															
2.40	<=0.40	1.07	1.15	1.25	1.36	1.49	1.65	1.85	2.11	2.44	2.91	3.60														
	0.60	1.08	1.16	1.27	1.39	1.54	1.72	1.96	2.27	2.70	3.33															
	0.80	1.09	1.19	1.31	1.46	1.65	1.90	2.24	2.73	3.48																
	1.00	1.10	1.22	1.38	1.57	1.83	2.20	2.75	3.67																	
2.80	<=0.40	1.10	1.23	1.39	1.60	1.87	2.27	2.88	3.94																	
	0.60	1.11	1.25	1.42	1.66	1.99	2.48	3.29																		
	0.80	1.13	1.29	1.51	1.82	2.28	3.07																			
	1.00	1.15	1.35	1.63	2.07	2.83																				
>=3.00	<=0.40	1.13	1.31	1.55	1.90	2.44	3.44																			
	0.60	1.14	1.34	1.61	2.01	2.70																				
	0.80	1.17	1.40	1.75	2.32	3.48																				
	1.00	1.20	1.49	1.97	2.90																					

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 4000 psi

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.80	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11	1.12
	0.60	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11	1.12	1.12
	0.80	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.12	1.13	1.14	1.14
	1.00	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17
1.20	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.12	1.13	1.14
	0.60	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15
	0.80	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17
	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19	1.20
1.60	<=0.40	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17
	0.60	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18
	0.80	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	1.00	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23	1.25
2.00	<=0.40	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23
	0.80	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.19	1.20	1.22	1.23	1.24	1.25	1.27
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.30	1.32
2.40	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.24	1.25	1.26	1.28	1.29
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.30	1.32
	0.80	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.34	1.36	1.38
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.20	1.21	1.23	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.43	1.46
2.80	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.30	1.33	1.35	1.39	1.42	1.45	1.49	1.52	1.56	1.60	1.65	1.69
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.26	1.29	1.32	1.35	1.39	1.42	1.46	1.50	1.54	1.58	1.62	1.67	1.72	1.77
	0.80	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.65	1.71	1.77	1.83	1.90	1.97
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.29	1.33	1.37	1.42	1.47	1.52	1.57	1.63	1.69	1.76	1.83	1.91	2.00	2.09	2.20	2.31
>=3.00	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.20	1.22	1.24	1.27	1.30	1.33	1.35	1.39	1.42	1.45	1.49	1.52	1.56	1.60	1.65	1.69
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.26	1.29	1.32	1.35	1.39	1.42	1.46	1.50	1.54	1.58	1.62	1.67	1.72	1.77
	0.80	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.65	1.71	1.77	1.83	1.90	1.97
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.29	1.33	1.37	1.42	1.47	1.52	1.57	1.63	1.69	1.76	1.83	1.91	2.00	2.09	2.20	2.31

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.80	<=0.40	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.18	1.19
	0.60	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	0.80	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.22	1.23	1.24
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.19	1.21	1.22	1.23	1.25	1.26	1.28	1.29
1.20	<=0.40	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.23	1.24	1.25
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.24	1.25	1.26	1.28	1.29
	1.00	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.30	1.32	1.33	1.35
1.60	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.29
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.21	1.22	1.23	1.25	1.26	1.28	1.30	1.31
	0.80	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.09	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.40	1.42	1.45
2.00	<=0.40	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.34	1.36	1.38
	0.60	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13	1.15	1.16	1.18	1.20	1.21	1.23	1.25	1.27	1.29	1.30	1.33	1.35	1.37	1.39	1.41
	0.80	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.14	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.34	1.36	1.38	1.41	1.44	1.46	1.49
	1.00	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.30	1.32	1.35	1.38	1.41	1.44	1.47	1.50	1.54	1.57	1.61
2.40	<=0.40	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.45	1.49	1.52	1.55
	0.60	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.25	1.27	1.29	1.32	1.35	1.37	1.40	1.43	1.47	1.50	1.53	1.57	1.61
	0.80	1.02	1.04	1.05	1.07	1.09	1.11	1.14	1.16	1.18	1.21	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.45	1.48	1.52	1.56	1.61	1.65	1.70	1.75
	1.00	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.34	1.38	1.42	1.46	1.50	1.55	1.60	1.65	1.71	1.76	1.83	1.90	1.97
2.80	<=0.40	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.29	1.32	1.36	1.39	1.43	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94	2.02
	0.60	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.35	1.39	1.43	1.48	1.53	1.58	1.63	1.69	1.76	1.82	1.90	1.98	2.07	2.16
	0.80	1.02	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.41	1.46	1.52	1.58	1.64	1.71	1.78	1.86	1.95	2.05	2.15	2.27	2.41	2.56
	1.00	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.44	1.51	1.57	1.64	1.72	1.81	1.91	2.01	2.14	2.27	2.43	2.60	2.81	3.05	3.33
>=3.00	<=0.40	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.34	1.39	1.44	1.50	1.56	1.62	1.69	1.77	1.85	1.95	2.05	2.16	2.29	2.43	2.59	2.77
	0.60	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.37	1.43	1.49	1.55	1.62	1.69	1.77	1.86	1.96	2.07	2.20	2.34	2.50	2.68	2.89	3.14
	0.80	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.38	1.45	1.51	1.59	1.67	1.76	1.86	1.97	2.10	2.25	2.42	2.61	2.84	3.11	3.44	3.85	
	1.00	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.55	1.64	1.74	1.85	1.99	2.14	2.31	2.52	2.76	3.06	3.44	3.91				

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 4000 psi

[redacted]

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.29	1.31
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.08	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.31	1.33
	0.80	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.37	1.40	1.43	1.45	1.48
1.20	<=0.40	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.37
	0.60	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41
	0.80	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.48
	1.00	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.46	1.49	1.53	1.56	1.60
1.60	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.35	1.37	1.39	1.42	1.45	1.47
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.38	1.40	1.43	1.46	1.49	1.52
	0.80	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.21	1.23	1.25	1.28	1.30	1.33	1.36	1.39	1.42	1.45	1.48	1.52	1.55	1.59	1.63
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.60	1.64	1.69	1.75	1.80
2.00	<=0.40	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.61	1.65
	0.60	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.23	1.25	1.28	1.31	1.34	1.37	1.40	1.43	1.47	1.51	1.55	1.59	1.63	1.68	1.73
	0.80	1.02	1.04	1.06	1.08	1.11	1.13	1.15	1.18	1.21	1.24	1.26	1.30	1.33	1.36	1.40	1.44	1.48	1.52	1.57	1.61	1.67	1.72	1.78	1.84	1.91
	1.00	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.25	1.28	1.32	1.36	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.78	1.85	1.93	2.01	2.11	2.21
2.40	<=0.40	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.49	1.53	1.58	1.64	1.69	1.75	1.82	1.89	1.97	2.05
	0.60	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.24	1.28	1.32	1.35	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.77	1.84	1.92	2.01	2.10	2.20
	0.80	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.25	1.29	1.33	1.37	1.42	1.47	1.53	1.59	1.65	1.72	1.80	1.88	1.97	2.08	2.19	2.31	2.45	2.61
	1.00	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.29	1.34	1.40	1.45	1.52	1.58	1.66	1.74	1.83	1.93	2.04	2.17	2.31	2.47	2.66	2.88	3.13	3.44
2.80	<=0.40	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.35	1.41	1.47	1.54	1.61	1.69	1.77	1.87	1.98	2.10	2.24	2.39	2.57	2.78	3.02	3.31	3.66
	0.60	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.39	1.45	1.52	1.59	1.67	1.77	1.87	1.98	2.11	2.26	2.43	2.63	2.86	3.14	3.48	3.90	
	0.80	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.46	1.54	1.63	1.73	1.84	1.96	2.11	2.28	2.48	2.71	3.00	3.35	3.79				
	1.00	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.48	1.57	1.67	1.80	1.94	2.10	2.29	2.53	2.82	3.18	3.64							
>=3.00	<=0.40	1.04	1.08	1.12	1.17	1.23	1.28	1.35	1.42	1.50	1.58	1.68	1.79	1.92	2.07	2.24	2.44	2.68	2.97	3.33	3.80					
	0.60	1.04	1.09	1.13	1.19	1.24	1.31	1.38	1.46	1.55	1.65	1.76	1.89	2.04	2.22	2.43	2.69	3.01	3.41	3.93						
	0.80	1.05	1.10	1.15	1.22	1.29	1.36	1.45	1.55	1.67	1.80	1.96	2.14	2.37	2.64	3.00	3.46									
	1.00	1.05	1.11	1.18	1.26	1.34	1.44	1.56	1.69	1.85	2.04	2.28	2.58	2.97	3.50											

[redacted]

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.39	1.41	1.44	1.47
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.19	1.21	1.23	1.26	1.28	1.30	1.32	1.35	1.37	1.40	1.43	1.45	1.48	1.51
	0.80	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.23	1.25	1.27	1.30	1.33	1.35	1.38	1.41	1.44	1.48	1.51	1.55	1.58	1.62
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.43	1.47	1.51	1.55	1.59	1.64	1.68	1.74	1.79
1.20	<=0.40	1.01	1.03	1.05	1.06	1.08	1.10	1.12	1.13	1.15	1.17	1.19	1.22	1.24	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.45	1.48	1.51	1.55	1.58
	0.60	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.36	1.39	1.43	1.46	1.49	1.53	1.57	1.61	1.65
	0.80	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.60	1.64	1.69	1.74	1.80
	1.00	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.32	1.36	1.40	1.44	1.49	1.53	1.58	1.63	1.69	1.75	1.82	1.89	1.96	2.04
1.60	<=0.40	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.29	1.32	1.36	1.39	1.42	1.46	1.50	1.54	1.58	1.63	1.67	1.72	1.78
	0.60	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.20	1.23	1.26	1.29	1.32	1.35	1.39	1.42	1.46	1.50	1.55	1.59	1.64	1.70	1.75	1.81	1.87
	0.80	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.27	1.30	1.34	1.38	1.42	1.46	1.51	1.56	1.61	1.67	1.73	1.79	1.87	1.94	2.02	2.12
	1.00	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.28	1.32	1.36	1.41	1.46	1.51	1.57	1.63	1.70	1.77	1.85	1.94	2.04	2.14	2.26	2.39	2.54
2.00	<=0.40	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.35	1.39	1.43	1.48	1.52	1.58	1.63	1.69	1.75	1.82	1.90	1.98	2.07	2.16
	0.60	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.34	1.38	1.42	1.47	1.52	1.58	1.64	1.70	1.77	1.84	1.93	2.02	2.11	2.22	2.34
	0.80	1.03	1.05	1.08	1.12	1.15	1.18	1.22	1.26	1.30	1.35	1.40	1.45	1.51	1.57	1.64	1.71	1.79	1.87	1.97	2.08	2.19	2.33	2.47	2.64	2.84
	1.00	1.03	1.06	1.10	1.14	1.17	1.22	1.26	1.31	1.37	1.42	1.49	1.56	1.63	1.71	1.81	1.91	2.03	2.15	2.30	2.47	2.67	2.90	3.17	3.50	3.91
2.40	<=0.40	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.33	1.39	1.44	1.50	1.57	1.64	1.72	1.80	1.90	2.01	2.12	2.26	2.41	2.58	2.78	3.02	3.29
	0.60	1.03	1.06	1.10	1.13	1.17	1.22	1.26	1.31	1.36	1.42	1.48	1.55	1.63	1.71	1.80	1.90	2.02	2.15	2.29	2.46	2.66	2.88	3.15	3.48	3.88
	0.80	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.43	1.51	1.59	1.68	1.77	1.89	2.02	2.16	2.33	2.53	2.76	3.05	3.39	3.83			
	1.00	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.53	1.63	1.74	1.86	2.01	2.18	2.38	2.61	2.91	3.28	3.75						
2.80	<=0.40	1.04	1.09	1.13	1.19	1.25	1.31	1.38	1.46	1.55	1.66	1.77	1.90	2.06	2.24	2.46	2.73	3.06	3.48							
	0.60	1.04	1.09	1.14	1.20	1.27	1.34	1.42	1.51	1.61	1.73	1.87	2.03	2.21	2.44	2.72	3.08	3.53								
	0.80	1.05	1.11	1.17	1.24	1.31	1.40	1.50	1.62	1.75	1.91	2.11	2.34	2.63	3.01	3.52										
	1.00	1.06	1.12	1.20	1.28	1.38	1.49	1.62	1.78	1.97	2.21	2.52	2.93	3.48												
>=3.00	<=0.40	1.05	1.11	1.18	1.25	1.33	1.43	1.54	1.67	1.82	2.01	2.23	2.51	2.87	3.36											
	0.60	1.06	1.12	1.19	1.27	1.36	1.47	1.60	1.75	1.93	2.15	2.43	2.79	3.27	3.97											
	0.80	1.06	1.14	1.22	1.32	1.43	1.57	1.73	1.94	2.19	2.53	2.98	3.64													
	1.00	1.07	1.16	1.26	1.38	1.53	1.71	1.95	2.25	2.67	3.28															

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 4000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.18	1.20	1.22	1.25	1.28	1.30	1.33	1.36	1.39	1.43	1.46	1.50	1.54	1.58	1.62	1.67	1.71
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.59	1.64	1.69	1.74	1.80
	0.80	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.32	1.35	1.39	1.43	1.47	1.52	1.57	1.62	1.67	1.73	1.79	1.86	1.93	2.01
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.38	1.43	1.48	1.53	1.59	1.65	1.71	1.78	1.86	1.94	2.03	2.13	2.24	2.36
1.20	<=0.40	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.33	1.37	1.41	1.45	1.49	1.53	1.58	1.63	1.68	1.74	1.80	1.86	1.93
	0.60	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.49	1.54	1.59	1.64	1.70	1.76	1.82	1.89	1.97	2.05
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.39	1.43	1.48	1.53	1.59	1.65	1.72	1.79	1.87	1.95	2.04	2.15	2.26	2.38
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.36	1.42	1.47	1.53	1.60	1.67	1.75	1.83	1.92	2.03	2.14	2.28	2.42	2.59	2.78	3.01
1.60	<=0.40	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.34	1.38	1.42	1.47	1.52	1.58	1.63	1.70	1.77	1.84	1.92	2.01	2.11	2.21	2.33
	0.60	1.02	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.41	1.46	1.52	1.58	1.64	1.71	1.78	1.86	1.95	2.05	2.15	2.27	2.41	2.56
	0.80	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.43	1.49	1.56	1.63	1.70	1.79	1.88	1.98	2.10	2.23	2.37	2.54	2.73	2.95	3.21
	1.00	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.34	1.40	1.46	1.53	1.61	1.70	1.80	1.90	2.03	2.17	2.32	2.51	2.73	2.98	3.29	3.68		
2.00	<=0.40	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.45	1.51	1.57	1.65	1.73	1.82	1.91	2.02	2.14	2.28	2.44	2.61	2.82	3.06	3.35
	0.60	1.03	1.06	1.10	1.14	1.18	1.22	1.26	1.31	1.37	1.43	1.49	1.56	1.64	1.72	1.81	1.92	2.03	2.17	2.32	2.49	2.69	2.92	3.20	3.54	3.96
	0.80	1.04	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.44	1.51	1.59	1.68	1.79	1.90	2.03	2.18	2.35	2.56	2.80	3.09	3.46	3.91			
	1.00	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.64	1.75	1.88	2.02	2.20	2.40	2.65	2.95	3.33	3.83						
2.40	<=0.40	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.49	1.57	1.67	1.77	1.90	2.04	2.20	2.39	2.62	2.90	3.24	3.67					
	0.60	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.63	1.74	1.87	2.02	2.19	2.39	2.63	2.93	3.31	3.80						
	0.80	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.11	2.33	2.59	2.92	3.35	3.93								
	1.00	1.05	1.11	1.18	1.25	1.34	1.43	1.55	1.68	1.83	2.02	2.24	2.53	2.90	3.40											
2.80	<=0.40	1.05	1.12	1.18	1.26	1.35	1.45	1.57	1.71	1.87	2.07	2.32	2.63	3.05	3.62											
	0.60	1.06	1.12	1.20	1.28	1.38	1.49	1.63	1.79	1.98	2.23	2.54	2.95	3.52												
	0.80	1.07	1.14	1.23	1.33	1.45	1.60	1.77	1.99	2.28	2.65	3.18	3.97													
	1.00	1.08	1.17	1.27	1.40	1.56	1.75	2.01	2.34	2.82	3.53															
>=3.00	<=0.40	1.07	1.15	1.24	1.35	1.49	1.65	1.85	2.10	2.44	2.90	3.58														
	0.60	1.08	1.16	1.26	1.39	1.54	1.72	1.96	2.26	2.69	3.31															
	0.80	1.09	1.19	1.31	1.46	1.65	1.90	2.24	2.71	3.46																
	1.00	1.10	1.22	1.37	1.57	1.83	2.20	2.74	3.65																	

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.04	1.07	1.09	1.12	1.14	1.17	1.20	1.23	1.27	1.30	1.34	1.38	1.42	1.46	1.51	1.56	1.61	1.67	1.73	1.79	1.86	1.94	2.02	2.11
	0.60	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.46	1.51	1.56	1.62	1.68	1.74	1.82	1.89	1.98	2.07	2.17	2.28
	0.80	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.34	1.39	1.44	1.49	1.55	1.62	1.68	1.76	1.84	1.93	2.03	2.14	2.27	2.41	2.56	2.74
	1.00	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.36	1.41	1.47	1.54	1.61	1.69	1.78	1.88	1.99	2.11	2.25	2.40	2.59	2.80	3.04	3.34	3.70
1.20	<=0.40	1.02	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.41	1.46	1.52	1.58	1.64	1.71	1.78	1.86	1.95	2.05	2.16	2.28	2.41	2.56
	0.60	1.03	1.05	1.08	1.12	1.15	1.18	1.22	1.26	1.31	1.35	1.40	1.45	1.51	1.57	1.64	1.71	1.79	1.88	1.97	2.08	2.20	2.33	2.48	2.66	2.85
	0.80	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.31	1.36	1.42	1.48	1.54	1.62	1.70	1.79	1.89	2.00	2.12	2.26	2.43	2.61	2.83	3.09	3.39	3.77
	1.00	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.44	1.51	1.59	1.68	1.78	1.90	2.03	2.18	2.35	2.55	2.79	3.08	3.44	3.89			
1.60	<=0.40	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.35	1.41	1.47	1.53	1.60	1.68	1.77	1.86	1.97	2.09	2.22	2.37	2.55	2.75	2.99	3.27	3.61
	0.60	1.03	1.07	1.10	1.14	1.18	1.23	1.27	1.33	1.38	1.45	1.51	1.59	1.67	1.76	1.86	1.97	2.10	2.25	2.41	2.61	2.83	3.10	3.43	3.84	
	0.80	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.39	1.46	1.54	1.62	1.72	1.83	1.95	2.10	2.26	2.45	2.68	2.96	3.30	3.73				
	1.00	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.47	1.56	1.67	1.79	1.93	2.09	2.28	2.51	2.79	3.14	3.59							
2.00	<=0.40	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.55	1.64	1.74	1.86	1.99	2.14	2.32	2.52	2.77	3.08	3.45	3.94				
	0.60	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.52	1.61	1.71	1.83	1.97	2.13	2.31	2.54	2.81	3.14	3.56						
	0.80	1.04	1.09	1.15	1.21	1.27	1.35	1.43	1.52	1.63	1.75	1.89	2.06	2.26	2.50	2.80	3.18	3.68								
	1.00	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.97	2.18	2.44	2.78	3.22	3.82										
2.40	<=0.40	1.05	1.10	1.16	1.23	1.30	1.38	1.48	1.58	1.71	1.85	2.03	2.24	2.49	2.81	3.23	3.80									
	0.60	1.05	1.11	1.17	1.24	1.33	1.42	1.52	1.65	1.79	1.96	2.17	2.43	2.76	3.19	3.79										
	0.80	1.06	1.12	1.20	1.29	1.38	1.50	1.64	1.80	2.00	2.25	2.57	3.00	3.59												
	1.00	1.07	1.15	1.24	1.34	1.47	1.62	1.81	2.04	2.35	2.76	3.35														
2.80	<=0.40	1.07	1.15	1.24	1.35	1.49	1.65	1.85	2.10	2.43	2.89	3.57														
	0.60	1.07	1.16	1.26	1.39	1.54	1.72	1.95	2.26	2.69	3.30															
	0.80	1.09	1.19	1.31	1.46	1.65	1.90	2.23	2.71	3.45																
	1.00	1.10	1.22	1.37	1.57	1.83	2.19	2.74	3.64																	
>=3.00	<=0.40	1.09	1.20	1.33	1.50	1.71	1.99	2.38	2.97	3.94																
	0.60	1.10	1.21	1.36	1.55	1.79	2.13	2.62	3.41																	
	0.80	1.11	1.25	1.43	1.67	2.00	2.50	3.33																		
	1.00	1.13	1.30	1.53	1.85	2.35	3.22																			

Non-Sway Moment Magnifier
for
8" Flat Walls
f'_c = 4000 psi

[redacted]

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.03	1.05	1.08	1.12	1.15	1.18	1.22	1.26	1.31	1.35	1.40	1.45	1.51	1.57	1.64	1.71	1.79	1.88	1.98	2.08	2.20	2.34	2.49	2.66	2.86
	0.60	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.44	1.50	1.56	1.63	1.71	1.80	1.89	2.00	2.11	2.24	2.39	2.56	2.76	2.99	3.26
	0.80	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.33	1.39	1.46	1.53	1.60	1.69	1.78	1.89	2.01	2.14	2.30	2.47	2.68	2.93	3.23	3.59		
	1.00	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.56	1.66	1.76	1.88	2.02	2.18	2.36	2.58	2.85	3.17	3.58					
1.20	<=0.40	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.37	1.43	1.49	1.57	1.64	1.73	1.82	1.93	2.05	2.18	2.34	2.51	2.72	2.96	3.25	3.60	
	0.60	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.47	1.55	1.63	1.72	1.81	1.93	2.05	2.20	2.37	2.56	2.79	3.06	3.40	3.81		
	0.80	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.57	1.66	1.77	1.89	2.03	2.19	2.38	2.61	2.88	3.22	3.65					
	1.00	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.72	1.85	2.00	2.18	2.40	2.67	3.01	3.44								
1.60	<=0.40	1.04	1.08	1.12	1.17	1.22	1.27	1.33	1.40	1.47	1.56	1.65	1.75	1.87	2.00	2.15	2.33	2.54	2.80	3.11	3.50	3.99				
	0.60	1.04	1.08	1.13	1.18	1.23	1.30	1.36	1.44	1.52	1.61	1.72	1.84	1.98	2.14	2.33	2.56	2.83	3.17	3.61						
	0.80	1.04	1.09	1.15	1.21	1.27	1.35	1.43	1.53	1.63	1.76	1.90	2.07	2.27	2.52	2.82	3.21	3.73								
	1.00	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.98	2.19	2.46	2.80	3.25	3.87										
2.00	<=0.40	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.11	2.33	2.59	2.92	3.35	3.93								
	0.60	1.05	1.10	1.16	1.23	1.30	1.39	1.49	1.60	1.73	1.88	2.06	2.28	2.55	2.89	3.34	3.96									
	0.80	1.06	1.12	1.19	1.27	1.36	1.46	1.59	1.73	1.91	2.12	2.39	2.74	3.20	3.85											
	1.00	1.06	1.14	1.22	1.32	1.44	1.57	1.74	1.95	2.21	2.55	3.02	3.69													
2.40	<=0.40	1.06	1.13	1.21	1.29	1.40	1.52	1.66	1.83	2.05	2.32	2.67	3.15	3.83												
	0.60	1.06	1.14	1.22	1.32	1.43	1.57	1.74	1.94	2.20	2.54	3.00	3.66													
	0.80	1.07	1.16	1.26	1.38	1.52	1.70	1.92	2.21	2.61	3.18															
	1.00	1.09	1.19	1.31	1.46	1.65	1.90	2.23	2.70	3.44																
2.80	<=0.40	1.09	1.19	1.32	1.48	1.68	1.94	2.30	2.83	3.66																
	0.60	1.09	1.21	1.35	1.53	1.76	2.07	2.52	3.21																	
	0.80	1.11	1.24	1.41	1.64	1.95	2.41	3.14																		
	1.00	1.13	1.29	1.51	1.81	2.27	3.05																			
>=3.00	<=0.40	1.11	1.26	1.44	1.69	2.05	2.59	3.52																		
	0.60	1.12	1.28	1.49	1.77	2.20	2.89																			
	0.80	1.14	1.33	1.59	1.97	2.61	3.85																			
	1.00	1.17	1.40	1.74	2.31	3.44																				

Non-Sway Moment Magnifier
for
10" Flat Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100
<=1.00	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.13
	0.60	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.12	1.13	1.14	1.14
	0.80	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17
	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20
1.40	<=0.40	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.14	1.15
	0.60	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.16
	0.80	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19
	1.00	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
1.80	<=0.40	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18
	0.60	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19
	0.80	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
	1.00	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.22	1.24	1.25	1.26
2.20	<=0.40	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21
	0.60	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.22	1.23
	0.80	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.21	1.23	1.24	1.25	1.26
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.21	1.22	1.24	1.25	1.27	1.28	1.30	1.32
2.60	<=0.40	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.22	1.23	1.25	1.26
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.25	1.27	1.28
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.30	1.31	1.33
	1.00	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.30	1.31	1.33	1.35	1.38	1.40
3.00	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.08	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.21	1.22	1.24	1.25	1.27	1.29	1.30	1.32	1.34
	0.60	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37
	0.80	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.12	1.14	1.15	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.37	1.39	1.41	1.44
	1.00	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.31	1.34	1.36	1.39	1.42	1.44	1.47	1.51	1.54
3.40	<=0.40	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.17	1.19	1.21	1.22	1.24	1.26	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.49
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.29	1.31	1.34	1.36	1.39	1.41	1.44	1.47	1.50	1.54
	0.80	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.61	1.65
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.15	1.17	1.20	1.22	1.25	1.28	1.31	1.34	1.37	1.41	1.45	1.48	1.53	1.57	1.62	1.66	1.72	1.77	1.83
>=3.80	<=0.40	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.39	1.42	1.46	1.50	1.55	1.59	1.64	1.69	1.75	1.81	1.87
	0.60	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.66	1.71	1.77	1.84	1.91	1.98
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.46	1.51	1.56	1.62	1.68	1.74	1.81	1.89	1.97	2.07	2.17	2.28
	1.00	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.35	1.40	1.45	1.50	1.56	1.63	1.70	1.78	1.87	1.96	2.06	2.18	2.31	2.46	2.62	2.81

		Total Factored Axial Load (kips)																								
e (in)	β_d	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100
<=1.00	<=0.40	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.23
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.22	1.23	1.24
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.29
	1.00	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.31	1.32	1.34
1.40	<=0.40	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.22	1.23	1.25	1.26
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.23	1.24	1.25	1.27	1.28
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.30	1.31	1.33
	1.00	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.40
1.80	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.29	1.31
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.08	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.31	1.33
	0.80	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.37	1.40	1.43	1.45	1.48
2.20	<=0.40	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.37
	0.60	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.23	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41
	0.80	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.13	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.46	1.48
	1.00	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.32	1.34	1.37	1.40	1.43	1.46	1.49	1.53	1.56	1.60
2.60	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.35	1.37	1.39	1.42	1.45	1.47
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.38	1.40	1.43	1.46	1.49	1.52
	0.80	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.21	1.23	1.25	1.28	1.30	1.33	1.36	1.39	1.42	1.45	1.48	1.52	1.55	1.59	1.63
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.60	1.64	1.69	1.75	1.80
3.00	<=0.40	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.17	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.37	1.40	1.43	1.46	1.50	1.53	1.57	1.61	1.65
	0.60	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.23	1.25	1.28	1.31	1.34	1.37	1.40	1.43	1.47	1.51	1.55	1.59	1.63	1.68	1.73
	0.80	1.02	1.04	1.06	1.08	1.11	1.13	1.15	1.18	1.21	1.23	1.26	1.30	1.33	1.36	1.40	1.44	1.48	1.52	1.57	1.61	1.67	1.72	1.78	1.84	1.91
	1.00	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.25	1.28	1.32	1.36	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.78	1.85	1.93	2.01	2.10	2.21
3.40	<=0.40	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.49	1.53	1.58	1.64	1.69	1.75	1.82	1.89	1.96	2.05
	0.60	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.24	1.28	1.32	1.35	1.40	1.44	1.49	1.54	1.59	1.65	1.71	1.77	1.84	1.92	2.01	2.10	2.20
	0.80	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.25	1.29	1.33	1.37	1.42	1.47	1.53	1.59	1.65	1.72	1.80	1.88	1.97	2.07	2.19	2.31	2.45	2.61
	1.00	1.03	1.06	1.09	1.13	1.17	1.20	1.25	1.29	1.34	1.40	1.45	1.52	1.58	1.66	1.74	1.83	1.93	2.04	2.17	2.31	2.47	2.66	2.87	3.13	3.43
>=3.80	<=0.40	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.35	1.41	1.47	1.54	1.61	1.69	1.77	1.87	1.98	2.10	2.23	2.39	2.57	2.77	3.02	3.31	3.66
	0.60	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.39	1.45	1.52	1.59	1.67	1.77	1.87	1.98	2.11	2.26	2.43	2.63	2.86	3.14	3.48	3.90	
	0.80	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.46	1.54	1.63	1.73	1.84	1.96	2.11	2.28	2.47	2.71	2.99	3.34	3.79				
	1.00	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.48	1.57	1.67	1.80	1.94	2.10	2.29	2.53	2.81	3.17	3.64							

Non-Sway Moment Magnifier
for
10" Flat Walls
$f'_c = 4000$ psi

Total Factored Axial Load (kips)

e (in)	β_d	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100
<=1.00	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.07	1.08	1.08	1.09	1.09	1.10	1.10	1.11	1.11
	0.60	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.11	1.12	1.12
	0.80	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.13	1.14
	1.00	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.09	1.10	1.11	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.16
1.40	<=0.40	1.00	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.11	1.12	1.12	1.13
	0.60	1.00	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.05	1.06	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.11	1.12	1.13	1.13	1.14
	0.80	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16
	1.00	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18	1.19
1.80	<=0.40	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.14	1.15
	0.60	1.01	1.01	1.02	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.10	1.11	1.12	1.12	1.13	1.14	1.15	1.15	1.16
	0.80	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.13	1.14	1.15	1.16	1.17	1.18	1.19
	1.00	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
2.20	<=0.40	1.01	1.01	1.02	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.14	1.15	1.16	1.17	1.18
	0.60	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.16	1.16	1.17	1.18	1.19
	0.80	1.01	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.10	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
	1.00	1.01	1.02	1.03	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.22	1.24	1.25	1.26
2.60	<=0.40	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23
	0.80	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.21	1.22	1.23	1.25	1.26	1.27
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.31	1.33
3.00	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.25	1.27	1.28
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.24	1.26	1.27	1.29	1.30
	0.80	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.32	1.34	1.36
	1.00	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.12	1.14	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.41	1.43
3.40	<=0.40	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.40
	0.60	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.12	1.14	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.38	1.41	1.43
	0.80	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.38	1.40	1.43	1.46	1.49	1.52
	1.00	1.02	1.03	1.05	1.07	1.09	1.10	1.12	1.14	1.16	1.19	1.21	1.23	1.26	1.28	1.31	1.34	1.36	1.39	1.43	1.46	1.49	1.53	1.57	1.61	1.65
>=3.80	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.22	1.24	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.48	1.51	1.55	1.59	1.63	1.67
	0.60	1.02	1.04	1.05	1.07	1.09	1.11	1.14	1.16	1.18	1.21	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.45	1.48	1.52	1.56	1.61	1.65	1.70	1.75
	0.80	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.54	1.58	1.64	1.69	1.75	1.81	1.87	1.94
	1.00	1.02	1.05	1.07	1.10	1.13	1.15	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.45	1.50	1.56	1.61	1.67	1.74	1.81	1.88	1.97	2.06	2.15	2.26

Total Factored Axial Load (kips)

e (in)	β_d	4	8	12	16	20	24	28	32	36	40	44	48	52	56	60	64	68	72	76	80	84	88	92	96	100
<=1.00	<=0.40	1.01	1.01	1.02	1.03	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.15	1.16	1.17	1.18	1.19
	0.60	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.19	1.20
	0.80	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.23	1.24
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.21	1.23	1.24	1.26	1.27	1.28
1.40	<=0.40	1.01	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.09	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22
	0.60	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.20	1.21	1.22	1.23
	0.80	1.01	1.02	1.03	1.04	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.23	1.25	1.26	1.27
	1.00	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.31	1.33
1.80	<=0.40	1.01	1.02	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.19	1.21	1.22	1.23	1.24	1.25
	0.60	1.01	1.02	1.03	1.04	1.05	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.15	1.16	1.17	1.18	1.20	1.21	1.22	1.23	1.25	1.26	1.28
	0.80	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.13	1.15	1.16	1.17	1.19	1.20	1.21	1.23	1.24	1.26	1.27	1.29	1.31	1.32
	1.00	1.01	1.02	1.03	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
2.20	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.25	1.26	1.28	1.29	1.31
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.08	1.09	1.10	1.11	1.12	1.14	1.15	1.16	1.18	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.32	1.33
	0.80	1.01	1.02	1.04	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.26	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.22	1.24	1.26	1.28	1.31	1.33	1.35	1.38	1.40	1.43	1.45	1.48
2.60	<=0.40	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.10	1.11	1.13	1.14	1.15	1.17	1.18	1.20	1.22	1.23	1.25	1.27	1.29	1.30	1.32	1.34	1.36	1.39
	0.60	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.22	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.40	1.42
	0.80	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.14	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.30	1.32	1.34	1.37	1.39	1.42	1.45	1.47	1.50
	1.00	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.23	1.25	1.28	1.30	1.33	1.36	1.38	1.41	1.45	1.48	1.51	1.55	1.59	1.63
3.00	<=0.40	1.01	1.03	1.04	1.06	1.07	1.09	1.11	1.12	1.14	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.38	1.40	1.43	1.46	1.49	1.52
	0.60	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.26	1.28	1.30	1.33	1.36	1.38	1.41	1.44	1.47	1.50	1.54	1.57
	0.80	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.33	1.36	1.39	1.42	1.46	1.49	1.53	1.57	1.61	1.65	1.70
	1.00	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.21	1.23	1.26	1.29	1.33	1.36	1.40	1.43	1.47	1.52	1.56	1.61	1.66	1.71	1.77	1.83	1.90
3.40	<=0.40	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.59	1.64	1.69	1.74	1.80
	0.60	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.20	1.23	1.26	1.29	1.33	1.36	1.40	1.43	1.47	1.51	1.56	1.61	1.66	1.71	1.77	1.83	1.89
	0.80	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.34	1.38	1.43	1.47	1.52	1.57	1.62	1.68	1.75	1.81	1.89	1.97	2.05	2.15
	1.00	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.33	1.37	1.42	1.47	1.52	1.58	1.65	1.72	1.79	1.87	1.96	2.06	2.17	2.30	2.43	2.59
>=3.80	<=0.40	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.54	1.61	1.67	1.75	1.83	1.92	2.01	2.12	2.24	2.38	2.53	2.70
	0.60	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.37	1.42	1.47	1.54	1.60	1.67	1.75	1.84	1.93	2.04	2.16	2.29	2.44	2.61	2.81	3.04
	0.80	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.50	1.57	1.65	1.74	1.84	1.94	2.07	2.20	2.36	2.54	2.76	3.01	3.31	3.68	
	1.00	1.04	1.08	1.12	1.16	1.21	1.26	1.32	1.39	1.46	1.54	1.62	1.72	1.83	1.95	2.10	2.26	2.46	2.69	2.97	3.31	3.74				

Non-Sway Moment Magnifier for 6" Waffle-Grid Walls f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.55	1.63	1.72	1.82	1.94	2.07	2.21	2.38	2.58	2.82	3.10	3.44	3.87		
	0.60	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.81	1.93	2.06	2.22	2.40	2.62	2.88	3.20	3.59				
	0.80	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.64	1.75	1.87	2.02	2.19	2.40	2.64	2.95	3.33	3.82						
	1.00	1.05	1.10	1.15	1.22	1.29	1.37	1.45	1.56	1.67	1.81	1.97	2.16	2.39	2.67	3.03	3.51									
0.80	<=0.40	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.40	1.48	1.56	1.66	1.76	1.88	2.02	2.18	2.36	2.58	2.85	3.17	3.58					
	0.60	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.44	1.53	1.62	1.73	1.85	2.00	2.16	2.36	2.59	2.88	3.24	3.70						
	0.80	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.53	1.64	1.77	1.92	2.09	2.30	2.55	2.87	3.28	3.82								
	1.00	1.05	1.11	1.18	1.25	1.33	1.43	1.54	1.67	1.82	2.00	2.22	2.49	2.85	3.32	3.98										
1.00	<=0.40	1.04	1.09	1.14	1.20	1.26	1.32	1.40	1.49	1.58	1.69	1.82	1.96	2.13	2.33	2.58	2.89	3.27	3.77							
	0.60	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.53	1.64	1.77	1.92	2.09	2.30	2.56	2.88	3.29	3.84								
	0.80	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.97	2.18	2.44	2.78	3.22	3.82										
	1.00	1.06	1.13	1.20	1.29	1.39	1.51	1.66	1.83	2.04	2.30	2.65	3.12	3.78												
1.20	<=0.40	1.05	1.10	1.16	1.23	1.31	1.39	1.49	1.61	1.74	1.89	2.08	2.30	2.58	2.94	3.41										
	0.60	1.05	1.11	1.18	1.25	1.34	1.43	1.54	1.67	1.82	2.01	2.23	2.52	2.88	3.37											
	0.80	1.06	1.13	1.21	1.29	1.40	1.52	1.66	1.83	2.05	2.32	2.67	3.14	3.82												
	1.00	1.07	1.15	1.24	1.35	1.48	1.64	1.84	2.09	2.42	2.88	3.55														
1.40	<=0.40	1.06	1.13	1.20	1.29	1.39	1.50	1.64	1.80	2.00	2.26	2.58	3.01	3.62												
	0.60	1.06	1.13	1.22	1.31	1.42	1.55	1.71	1.90	2.15	2.46	2.88	3.47													
	0.80	1.07	1.16	1.25	1.37	1.51	1.67	1.89	2.16	2.53	3.04	3.82														
	1.00	1.08	1.18	1.30	1.45	1.63	1.86	2.17	2.61	3.27																
1.60	<=0.40	1.07	1.16	1.26	1.37	1.52	1.69	1.91	2.20	2.58	3.13	3.98														
	0.60	1.08	1.17	1.28	1.41	1.57	1.77	2.03	2.38	2.88	3.64															
	0.80	1.09	1.20	1.33	1.49	1.70	1.97	2.35	2.91	3.82																
	1.00	1.10	1.23	1.39	1.61	1.89	2.30	2.94																		
1.80	<=0.40	1.10	1.21	1.36	1.54	1.78	2.11	2.58	3.33																	
	0.60	1.10	1.23	1.39	1.59	1.87	2.27	2.88	3.94																	
	0.80	1.12	1.27	1.46	1.73	2.12	2.72	3.82																		
	1.00	1.14	1.32	1.57	1.94	2.54	3.67																			
>=2.00	<=0.40	1.14	1.32	1.58	1.96	2.58	3.77																			
	0.60	1.15	1.35	1.64	2.09	2.88																				
	0.80	1.17	1.42	1.80	2.44	3.82																				
	1.00	1.20	1.51	2.04	3.12																					

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.05	1.11	1.18	1.25	1.34	1.43	1.54	1.68	1.83	2.02	2.24	2.53	2.90	3.39											
	0.60	1.06	1.12	1.19	1.27	1.37	1.48	1.60	1.75	1.93	2.16	2.44	2.81	3.31												
	0.80	1.06	1.14	1.22	1.32	1.44	1.57	1.74	1.94	2.21	2.55	3.01	3.69													
	1.00	1.08	1.16	1.26	1.39	1.54	1.72	1.96	2.26	2.69	3.31															
0.80	<=0.40	1.06	1.13	1.20	1.29	1.39	1.51	1.65	1.82	2.03	2.29	2.63	3.08	3.73												
	0.60	1.06	1.14	1.22	1.32	1.43	1.56	1.72	1.92	2.17	2.50	2.94	3.57													
	0.80	1.07	1.16	1.26	1.37	1.51	1.69	1.91	2.19	2.57	3.11	3.95														
	1.00	1.08	1.18	1.31	1.45	1.64	1.88	2.20	2.66	3.36																
1.00	<=0.40	1.07	1.15	1.24	1.34	1.47	1.62	1.81	2.04	2.35	2.76	3.35														
	0.60	1.07	1.16	1.26	1.37	1.52	1.69	1.91	2.19	2.58	3.12	3.97														
	0.80	1.08	1.18	1.30	1.44	1.63	1.86	2.17	2.60	3.25																
	1.00	1.10	1.21	1.36	1.55	1.79	2.13	2.62	3.42																	
1.20	<=0.40	1.08	1.17	1.28	1.42	1.58	1.79	2.06	2.43	2.96	3.79															
	0.60	1.09	1.19	1.31	1.46	1.65	1.89	2.22	2.69	3.40																
	0.80	1.10	1.22	1.36	1.55	1.80	2.14	2.64	3.45																	
	1.00	1.11	1.26	1.44	1.69	2.04	2.58	3.50																		
1.40	<=0.40	1.10	1.21	1.35	1.53	1.77	2.09	2.56	3.29																	
	0.60	1.10	1.23	1.39	1.59	1.86	2.25	2.85	3.87																	
	0.80	1.12	1.27	1.46	1.72	2.10	2.70	3.76																		
	1.00	1.14	1.32	1.57	1.93	2.52	3.61																			
1.60	<=0.40	1.12	1.27	1.47	1.74	2.14	2.76	3.91																		
	0.60	1.13	1.29	1.52	1.83	2.31	3.12																			
	0.80	1.15	1.34	1.63	2.05	2.79																				
	1.00	1.17	1.42	1.79	2.44	3.80																				
1.80	<=0.40	1.16	1.38	1.70	2.21	3.16																				
	0.60	1.17	1.41	1.78	2.40	3.68																				
	0.80	1.20	1.49	1.98	2.94																					
	1.00	1.23	1.61	2.32																						
>=2.00	<=0.40	1.24	1.62	2.35																						
	0.60	1.26	1.69	2.58																						
	0.80	1.30	1.86	3.25																						
	1.00	1.36	2.13																							

Non-Sway Moment Magnifier
for
6" Waffle-Grid Walls
f'_c = 4000 psi

[redacted]

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.44	1.50	1.57	1.64	1.72	1.81	1.90	2.01	2.13	2.26	2.42	2.59	2.79	3.03	3.31
	0.60	1.03	1.06	1.10	1.14	1.17	1.22	1.26	1.31	1.37	1.42	1.49	1.56	1.63	1.71	1.81	1.91	2.02	2.15	2.30	2.47	2.67	2.89	3.17	3.50	3.90
	0.80	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.43	1.51	1.59	1.68	1.78	1.89	2.02	2.17	2.34	2.54	2.77	3.06	3.41	3.85			
	1.00	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.53	1.63	1.74	1.87	2.01	2.18	2.38	2.62	2.92	3.29	3.77						
0.80	<=0.40	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.39	1.45	1.52	1.60	1.68	1.78	1.88	2.00	2.13	2.28	2.46	2.66	2.90	3.19	3.54	3.98	
	0.60	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.43	1.50	1.58	1.66	1.76	1.87	2.00	2.14	2.30	2.49	2.72	2.99	3.31	3.72			
	0.80	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.71	1.82	1.96	2.11	2.30	2.51	2.77	3.10	3.51						
	1.00	1.05	1.09	1.15	1.21	1.28	1.35	1.43	1.53	1.64	1.76	1.91	2.08	2.28	2.53	2.85	3.24	3.77								
1.00	<=0.40	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.47	1.55	1.64	1.74	1.85	1.98	2.13	2.30	2.51	2.75	3.05	3.42	3.89				
	0.60	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.51	1.60	1.71	1.83	1.96	2.12	2.30	2.52	2.78	3.11	3.52						
	0.80	1.04	1.09	1.15	1.21	1.27	1.34	1.43	1.52	1.62	1.74	1.88	2.05	2.24	2.48	2.77	3.15	3.63								
	1.00	1.05	1.11	1.17	1.24	1.32	1.42	1.52	1.64	1.79	1.96	2.17	2.43	2.76	3.19	3.77										
1.20	<=0.40	1.04	1.09	1.14	1.20	1.26	1.32	1.40	1.48	1.58	1.69	1.81	1.96	2.13	2.33	2.58	2.88	3.26	3.77							
	0.60	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.53	1.64	1.77	1.92	2.09	2.30	2.56	2.88	3.29	3.83								
	0.80	1.05	1.11	1.17	1.24	1.33	1.42	1.53	1.65	1.79	1.97	2.18	2.44	2.77	3.21	3.82										
	1.00	1.06	1.13	1.20	1.29	1.39	1.51	1.66	1.83	2.04	2.30	2.65	3.11	3.77												
1.40	<=0.40	1.05	1.11	1.17	1.24	1.32	1.41	1.51	1.63	1.77	1.93	2.13	2.37	2.68	3.08	3.62										
	0.60	1.05	1.11	1.18	1.26	1.35	1.45	1.56	1.70	1.86	2.06	2.30	2.61	3.01	3.56											
	0.80	1.06	1.13	1.21	1.30	1.41	1.54	1.69	1.87	2.10	2.39	2.77	3.31													
	1.00	1.07	1.15	1.25	1.36	1.50	1.67	1.88	2.15	2.51	3.01	3.77														
1.60	<=0.40	1.06	1.13	1.21	1.31	1.42	1.55	1.70	1.89	2.13	2.44	2.84	3.42													
	0.60	1.07	1.14	1.23	1.34	1.46	1.60	1.78	2.01	2.30	2.69	3.24														
	0.80	1.08	1.17	1.27	1.40	1.55	1.74	1.99	2.32	2.77	3.46															
	1.00	1.09	1.20	1.32	1.49	1.69	1.96	2.33	2.88	3.77																
1.80	<=0.40	1.08	1.18	1.29	1.43	1.61	1.83	2.13	2.54	3.15																
	0.60	1.09	1.19	1.32	1.48	1.68	1.94	2.30	2.83	3.66																
	0.80	1.10	1.22	1.38	1.58	1.84	2.21	2.77	3.72																	
	1.00	1.12	1.27	1.46	1.72	2.11	2.70	3.77																		
>=2.00	<=0.40	1.12	1.27	1.47	1.74	2.13	2.75	3.89																		
	0.60	1.13	1.29	1.51	1.83	2.30	3.11																			
	0.80	1.15	1.34	1.62	2.05	2.77																				
	1.00	1.17	1.42	1.79	2.43	3.77																				

[redacted]

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.54	1.65	1.77	1.92	2.10	2.31	2.57	2.89	3.31	3.87								
	0.60	1.05	1.10	1.16	1.23	1.30	1.39	1.48	1.59	1.72	1.87	2.05	2.26	2.53	2.86	3.30	3.90									
	0.80	1.06	1.12	1.19	1.27	1.36	1.46	1.58	1.73	1.90	2.11	2.37	2.71	3.16	3.79											
	1.00	1.06	1.14	1.22	1.32	1.43	1.57	1.73	1.94	2.19	2.53	2.98	3.64													
0.80	<=0.40	1.05	1.11	1.17	1.24	1.32	1.41	1.52	1.64	1.78	1.95	2.16	2.41	2.73	3.15	3.72										
	0.60	1.05	1.12	1.18	1.26	1.35	1.45	1.57	1.71	1.88	2.08	2.33	2.66	3.08	3.67											
	0.80	1.06	1.13	1.21	1.31	1.42	1.54	1.70	1.89	2.12	2.43	2.83	3.39													
	1.00	1.07	1.16	1.25	1.37	1.51	1.68	1.90	2.18	2.55	3.08	3.89														
1.00	<=0.40	1.06	1.12	1.20	1.28	1.38	1.50	1.63	1.79	1.99	2.24	2.55	2.97	3.55												
	0.60	1.06	1.13	1.21	1.31	1.42	1.55	1.70	1.89	2.13	2.43	2.84	3.41													
	0.80	1.07	1.15	1.25	1.36	1.50	1.67	1.87	2.14	2.50	3.00	3.74														
	1.00	1.08	1.18	1.30	1.44	1.62	1.85	2.15	2.58	3.22																
1.20	<=0.40	1.07	1.15	1.24	1.34	1.47	1.62	1.81	2.04	2.35	2.76	3.35														
	0.60	1.07	1.16	1.26	1.37	1.51	1.69	1.91	2.19	2.57	3.12	3.98														
	0.80	1.08	1.18	1.30	1.44	1.62	1.86	2.16	2.60	3.24																
	1.00	1.10	1.21	1.36	1.55	1.79	2.13	2.62	3.41																	
1.40	<=0.40	1.08	1.18	1.29	1.43	1.60	1.83	2.12	2.52	3.11																
	0.60	1.09	1.19	1.32	1.47	1.67	1.93	2.28	2.80	3.61																
	0.80	1.10	1.22	1.37	1.57	1.83	2.20	2.75	3.66																	
	1.00	1.12	1.26	1.46	1.72	2.09	2.68	3.72																		
1.60	<=0.40	1.10	1.23	1.38	1.58	1.85	2.24	2.81	3.80																	
	0.60	1.11	1.24	1.42	1.65	1.96	2.43	3.19																		
	0.80	1.12	1.29	1.50	1.80	2.25	3.00																			
	1.00	1.15	1.34	1.62	2.04	2.76																				
1.80	<=0.40	1.13	1.31	1.55	1.90	2.45	3.45																			
	0.60	1.14	1.34	1.61	2.02	2.71																				
	0.80	1.17	1.40	1.75	2.33	3.49																				
	1.00	1.20	1.49	1.97	2.91																					
>=2.00	<=0.40	1.20	1.50	1.99	2.97																					
	0.60	1.21	1.55	2.13	3.41																					
	0.80	1.25	1.67	2.50																						
	1.00	1.30	1.85	3.22																						

Non-Sway Moment Magnifier
for
8" Waffle-Grid Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.01	1.02	1.03	1.04	1.05	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.18	1.20	1.21	1.23	1.24	1.26	1.28	1.29	1.31	1.33	1.35
	0.60	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.10	1.11	1.12	1.14	1.15	1.17	1.18	1.20	1.21	1.23	1.25	1.26	1.28	1.30	1.32	1.34	1.36	1.38
	0.80	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.18	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.38	1.40	1.43	1.45
	1.00	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.25	1.27	1.30	1.32	1.35	1.37	1.40	1.43	1.46	1.49	1.52	1.56
1.20	<=0.40	1.01	1.02	1.04	1.05	1.06	1.08	1.09	1.11	1.12	1.14	1.15	1.17	1.19	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.41	1.44
	0.60	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.12	1.13	1.15	1.17	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.33	1.35	1.37	1.40	1.42	1.45	1.48
	0.80	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.26	1.28	1.31	1.33	1.36	1.38	1.41	1.44	1.47	1.51	1.54	1.58
	1.00	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.23	1.25	1.28	1.31	1.34	1.37	1.40	1.43	1.47	1.51	1.55	1.59	1.63	1.68	1.72
1.60	<=0.40	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.24	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.45	1.48	1.51	1.54	1.58
	0.60	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.23	1.26	1.28	1.31	1.33	1.36	1.39	1.42	1.46	1.49	1.53	1.56	1.60	1.64
	0.80	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.17	1.19	1.22	1.24	1.27	1.30	1.33	1.36	1.40	1.43	1.47	1.51	1.55	1.59	1.64	1.69	1.74	1.79
	1.00	1.02	1.04	1.07	1.09	1.11	1.14	1.17	1.19	1.22	1.26	1.29	1.32	1.36	1.40	1.44	1.48	1.53	1.58	1.63	1.69	1.75	1.81	1.88	1.95	2.04
2.00	<=0.40	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.17	1.20	1.23	1.26	1.29	1.32	1.35	1.39	1.42	1.46	1.50	1.55	1.59	1.64	1.69	1.75	1.81	1.87
	0.60	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.66	1.71	1.77	1.84	1.91	1.98
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.46	1.51	1.56	1.62	1.68	1.74	1.81	1.89	1.97	2.07	2.17	2.28
	1.00	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.26	1.30	1.35	1.40	1.45	1.50	1.56	1.63	1.70	1.78	1.87	1.96	2.06	2.18	2.31	2.46	2.62	2.81
2.40	<=0.40	1.03	1.05	1.08	1.11	1.15	1.18	1.22	1.25	1.30	1.34	1.39	1.44	1.49	1.55	1.61	1.68	1.76	1.84	1.93	2.03	2.14	2.26	2.40	2.56	2.73
	0.60	1.03	1.06	1.09	1.12	1.16	1.19	1.23	1.28	1.32	1.37	1.42	1.48	1.54	1.61	1.68	1.76	1.85	1.95	2.06	2.18	2.31	2.47	2.64	2.85	3.08
	0.80	1.03	1.07	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.51	1.58	1.66	1.75	1.85	1.96	2.08	2.22	2.39	2.58	2.80	3.06	3.37	3.76	
	1.00	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.46	1.54	1.63	1.73	1.84	1.97	2.12	2.29	2.48	2.72	3.01	3.37	3.82				
>=2.80	<=0.40	1.04	1.09	1.14	1.19	1.25	1.31	1.39	1.47	1.56	1.66	1.78	1.92	2.08	2.26	2.49	2.76	3.10	3.54							
	0.60	1.04	1.09	1.15	1.20	1.27	1.34	1.42	1.51	1.62	1.74	1.88	2.04	2.23	2.47	2.76	3.12	3.60								
	0.80	1.05	1.11	1.17	1.24	1.32	1.41	1.51	1.62	1.76	1.93	2.12	2.36	2.66	3.06	3.58										
	1.00	1.06	1.12	1.20	1.28	1.38	1.50	1.63	1.79	1.99	2.23	2.55	2.97	3.55												

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.22	1.24	1.27	1.29	1.32	1.35	1.38	1.41	1.44	1.48	1.51	1.55	1.59	1.63	1.68
	0.60	1.02	1.04	1.05	1.07	1.09	1.12	1.14	1.16	1.18	1.21	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.45	1.49	1.52	1.57	1.61	1.65	1.70	1.75
	0.80	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.54	1.59	1.64	1.69	1.75	1.81	1.88	1.95
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.46	1.51	1.56	1.61	1.67	1.74	1.81	1.89	1.97	2.06	2.16	2.27
1.20	<=0.40	1.02	1.04	1.06	1.08	1.10	1.13	1.15	1.18	1.21	1.23	1.26	1.29	1.33	1.36	1.40	1.44	1.48	1.52	1.56	1.61	1.66	1.72	1.77	1.83	1.90
	0.60	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.29	1.32	1.36	1.39	1.43	1.48	1.52	1.57	1.62	1.68	1.74	1.80	1.87	1.94	2.02
	0.80	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.34	1.38	1.42	1.47	1.52	1.58	1.64	1.70	1.77	1.84	1.92	2.01	2.11	2.21	2.33
	1.00	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.46	1.52	1.58	1.65	1.72	1.81	1.90	2.00	2.11	2.23	2.37	2.53	2.71	2.91
1.60	<=0.40	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.30	1.34	1.38	1.43	1.47	1.52	1.58	1.64	1.70	1.77	1.85	1.93	2.02	2.12	2.23	2.35
	0.60	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.24	1.28	1.32	1.37	1.42	1.47	1.52	1.58	1.64	1.71	1.79	1.87	1.96	2.06	2.16	2.29	2.42	2.57
	0.80	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.44	1.50	1.56	1.63	1.71	1.79	1.89	1.99	2.11	2.24	2.39	2.56	2.75	2.98	3.24
	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.34	1.40	1.47	1.54	1.62	1.70	1.80	1.91	2.04	2.18	2.34	2.53	2.75	3.01	3.33	3.72		
2.00	<=0.40	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.35	1.41	1.47	1.54	1.61	1.69	1.77	1.87	1.98	2.10	2.23	2.39	2.57	2.77	3.02	3.31	3.66
	0.60	1.03	1.07	1.10	1.14	1.18	1.23	1.28	1.33	1.39	1.45	1.52	1.59	1.67	1.77	1.87	1.98	2.11	2.26	2.43	2.63	2.86	3.14	3.48	3.90	
	0.80	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.46	1.54	1.63	1.73	1.84	1.96	2.11	2.28	2.47	2.71	2.99	3.34	3.79				
	1.00	1.04	1.09	1.14	1.19	1.25	1.32	1.39	1.48	1.57	1.67	1.80	1.94	2.10	2.29	2.53	2.81	3.17	3.64							
2.40	<=0.40	1.04	1.09	1.13	1.19	1.25	1.31	1.38	1.46	1.55	1.66	1.77	1.91	2.06	2.25	2.47	2.73	3.07	3.49							
	0.60	1.04	1.09	1.15	1.20	1.27	1.34	1.42	1.51	1.61	1.73	1.87	2.03	2.22	2.45	2.73	3.08	3.55								
	0.80	1.05	1.11	1.17	1.24	1.31	1.40	1.50	1.62	1.75	1.92	2.11	2.34	2.64	3.02	3.53										
	1.00	1.06	1.12	1.20	1.28	1.38	1.49	1.62	1.78	1.98	2.22	2.53	2.93	3.50												
>=2.80	<=0.40	1.07	1.14	1.23	1.33	1.45	1.60	1.77	1.99	2.28	2.65	3.18	3.96													
	0.60	1.07	1.15	1.25	1.36	1.50	1.66	1.87	2.13	2.48	2.97	3.70														
	0.80	1.08	1.18	1.29	1.43	1.60	1.82	2.11	2.50	3.08																
	1.00	1.09	1.21	1.35	1.53	1.76	2.07	2.53	3.23																	

Non-Sway Moment Magnifier
for
8" Waffle-Grid Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.39	1.43	1.48	1.54	1.59	1.65	1.72	1.79	1.87	1.95	2.05	2.15	2.26	2.39
	0.60	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.25	1.29	1.33	1.37	1.42	1.48	1.53	1.59	1.66	1.73	1.81	1.89	1.98	2.08	2.20	2.33	2.47	2.63
	0.80	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.45	1.51	1.57	1.65	1.73	1.81	1.91	2.02	2.14	2.28	2.43	2.61	2.82	3.06	3.34
	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.55	1.63	1.72	1.82	1.94	2.06	2.21	2.38	2.58	2.81	3.09	3.43	3.86		
1.20	<=0.40	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.43	1.49	1.55	1.62	1.69	1.78	1.87	1.97	2.08	2.20	2.34	2.50	2.69	2.90	3.15
	0.60	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.35	1.41	1.47	1.54	1.61	1.69	1.77	1.87	1.98	2.10	2.24	2.39	2.57	2.78	3.02	3.31	3.67
	0.80	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49	1.57	1.65	1.75	1.85	1.97	2.11	2.27	2.45	2.67	2.93	3.24	3.62			
	1.00	1.04	1.08	1.13	1.18	1.23	1.29	1.36	1.43	1.52	1.61	1.71	1.83	1.97	2.13	2.31	2.53	2.80	3.13	3.55						
1.60	<=0.40	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49	1.57	1.66	1.75	1.86	1.98	2.12	2.28	2.47	2.69	2.95	3.27	3.66			
	0.60	1.04	1.08	1.12	1.16	1.21	1.27	1.33	1.39	1.46	1.54	1.63	1.73	1.84	1.97	2.12	2.29	2.49	2.73	3.02	3.38	3.84				
	0.80	1.04	1.09	1.14	1.19	1.25	1.31	1.39	1.47	1.56	1.66	1.78	1.92	2.07	2.26	2.48	2.76	3.10	3.53							
	1.00	1.05	1.10	1.16	1.22	1.30	1.38	1.47	1.58	1.70	1.84	2.01	2.22	2.47	2.79	3.19	3.74									
2.00	<=0.40	1.04	1.09	1.14	1.20	1.26	1.34	1.41	1.50	1.60	1.72	1.85	2.01	2.19	2.42	2.69	3.03	3.47								
	0.60	1.05	1.10	1.15	1.22	1.29	1.37	1.45	1.55	1.67	1.81	1.96	2.15	2.38	2.66	3.02	3.49									
	0.80	1.05	1.11	1.18	1.25	1.34	1.43	1.55	1.68	1.83	2.02	2.25	2.54	2.91	3.41											
	1.00	1.06	1.13	1.21	1.30	1.41	1.53	1.68	1.87	2.09	2.38	2.76	3.29													
2.40	<=0.40	1.06	1.13	1.21	1.30	1.40	1.52	1.67	1.84	2.06	2.33	2.69	3.17	3.88												
	0.60	1.06	1.14	1.22	1.32	1.44	1.57	1.74	1.95	2.21	2.55	3.02	3.70													
	0.80	1.07	1.16	1.26	1.38	1.52	1.70	1.93	2.22	2.63	3.21															
	1.00	1.09	1.19	1.31	1.46	1.65	1.90	2.24	2.72	3.47																
>=2.80	<=0.40	1.10	1.22	1.37	1.56	1.81	2.17	2.69	3.54																	
	0.60	1.11	1.24	1.40	1.62	1.92	2.34	3.02																		
	0.80	1.12	1.28	1.48	1.76	2.18	2.85																			
	1.00	1.14	1.33	1.59	1.99	2.64	3.93																			

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.03	1.07	1.10	1.14	1.19	1.23	1.28	1.34	1.40	1.46	1.53	1.61	1.70	1.80	1.90	2.03	2.16	2.32	2.51	2.72	2.98	3.29	3.68		
	0.60	1.03	1.07	1.11	1.16	1.20	1.25	1.31	1.37	1.44	1.51	1.59	1.68	1.78	1.89	2.02	2.17	2.34	2.55	2.78	3.07	3.43	3.88			
	0.80	1.04	1.08	1.13	1.18	1.24	1.30	1.36	1.44	1.52	1.62	1.72	1.84	1.98	2.15	2.34	2.57	2.85	3.19	3.64						
	1.00	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.11	2.33	2.59	2.92	3.35	3.93								
1.20	<=0.40	1.04	1.08	1.13	1.17	1.23	1.29	1.35	1.42	1.50	1.59	1.69	1.80	1.93	2.08	2.26	2.47	2.71	3.02	3.40	3.89					
	0.60	1.04	1.09	1.13	1.19	1.25	1.31	1.38	1.46	1.55	1.66	1.77	1.91	2.06	2.24	2.46	2.73	3.06	3.48							
	0.80	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.56	1.68	1.81	1.97	2.16	2.39	2.68	3.05	3.53									
	1.00	1.05	1.11	1.18	1.26	1.35	1.45	1.56	1.70	1.86	2.06	2.31	2.62	3.02	3.58											
1.60	<=0.40	1.05	1.10	1.16	1.22	1.29	1.37	1.46	1.56	1.68	1.82	1.98	2.17	2.41	2.70	3.07	3.57									
	0.60	1.05	1.11	1.17	1.24	1.32	1.40	1.50	1.62	1.76	1.92	2.12	2.35	2.65	3.04	3.56										
	0.80	1.06	1.12	1.19	1.28	1.37	1.48	1.61	1.77	1.95	2.18	2.48	2.86	3.39												
	1.00	1.07	1.14	1.23	1.33	1.45	1.60	1.77	1.99	2.28	2.65	3.18	3.97													
2.00	<=0.40	1.06	1.13	1.21	1.30	1.40	1.52	1.66	1.84	2.05	2.32	2.68	3.16	3.86												
	0.60	1.06	1.14	1.22	1.32	1.44	1.57	1.74	1.94	2.20	2.55	3.01	3.68													
	0.80	1.07	1.16	1.26	1.38	1.52	1.70	1.93	2.22	2.62	3.19															
	1.00	1.09	1.19	1.31	1.46	1.65	1.90	2.23	2.71	3.45																
2.40	<=0.40	1.08	1.18	1.30	1.45	1.64	1.87	2.19	2.64	3.32																
	0.60	1.09	1.20	1.33	1.50	1.71	1.99	2.38	2.96	3.92																
	0.80	1.10	1.23	1.39	1.60	1.88	2.28	2.90	3.99																	
	1.00	1.12	1.27	1.48	1.76	2.17	2.82																			
>=2.80	<=0.40	1.14	1.32	1.58	1.95	2.57	3.74																			
	0.60	1.15	1.35	1.64	2.08	2.86																				
	0.80	1.17	1.42	1.79	2.43	3.79																				
	1.00	1.20	1.51	2.03	3.09																					

Non-Sway Moment Magnifier
for
8" Waffle-Grid Walls
f'_c = 4000 psi

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.80	<=0.40	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.10	1.11	1.12	1.13	1.14	1.16	1.17	1.18	1.19	1.20	1.22	1.23	1.25	1.26	1.27	1.29
	0.60	1.01	1.02	1.03	1.04	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.14	1.15	1.17	1.18	1.19	1.21	1.22	1.24	1.25	1.27	1.28	1.30	1.31
	0.80	1.01	1.02	1.03	1.05	1.06	1.07	1.08	1.09	1.11	1.12	1.13	1.15	1.16	1.18	1.19	1.21	1.22	1.24	1.26	1.28	1.29	1.31	1.33	1.35	1.37
	1.00	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.21	1.23	1.25	1.27	1.29	1.31	1.33	1.35	1.38	1.40	1.42	1.45
1.20	<=0.40	1.01	1.02	1.03	1.04	1.06	1.07	1.08	1.09	1.10	1.12	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.23	1.25	1.27	1.28	1.30	1.32	1.34	1.36
	0.60	1.01	1.02	1.03	1.05	1.06	1.07	1.09	1.10	1.11	1.13	1.14	1.16	1.17	1.19	1.20	1.22	1.24	1.25	1.27	1.29	1.31	1.33	1.35	1.37	1.39
	0.80	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.23	1.25	1.27	1.30	1.32	1.34	1.36	1.39	1.41	1.44	1.46
	1.00	1.01	1.03	1.05	1.06	1.08	1.10	1.11	1.13	1.15	1.17	1.19	1.21	1.23	1.26	1.28	1.30	1.33	1.36	1.38	1.41	1.44	1.47	1.50	1.54	1.57
1.60	<=0.40	1.01	1.03	1.04	1.05	1.07	1.08	1.10	1.11	1.13	1.15	1.16	1.18	1.20	1.22	1.24	1.26	1.28	1.30	1.32	1.34	1.36	1.39	1.41	1.44	1.47
	0.60	1.01	1.03	1.04	1.06	1.07	1.09	1.10	1.12	1.14	1.16	1.18	1.19	1.21	1.23	1.26	1.28	1.30	1.32	1.35	1.37	1.40	1.42	1.45	1.48	1.51
	0.80	1.02	1.03	1.05	1.07	1.08	1.10	1.12	1.14	1.16	1.18	1.20	1.23	1.25	1.27	1.30	1.33	1.35	1.38	1.41	1.44	1.47	1.51	1.54	1.58	1.62
	1.00	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.30	1.33	1.36	1.39	1.43	1.46	1.50	1.54	1.59	1.63	1.68	1.73	1.79
2.00	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.19	1.22	1.24	1.26	1.29	1.32	1.35	1.38	1.41	1.44	1.48	1.51	1.55	1.59	1.63	1.67
	0.60	1.02	1.04	1.05	1.07	1.09	1.11	1.14	1.16	1.18	1.21	1.23	1.26	1.29	1.32	1.35	1.38	1.41	1.45	1.48	1.52	1.56	1.61	1.65	1.70	1.75
	0.80	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.54	1.58	1.64	1.69	1.75	1.81	1.87	1.94
	1.00	1.02	1.05	1.07	1.10	1.13	1.15	1.19	1.22	1.25	1.29	1.33	1.37	1.41	1.45	1.50	1.56	1.61	1.67	1.74	1.81	1.88	1.96	2.06	2.15	2.26
2.40	<=0.40	1.02	1.05	1.07	1.10	1.12	1.15	1.18	1.21	1.25	1.28	1.32	1.36	1.40	1.44	1.49	1.54	1.60	1.65	1.72	1.78	1.86	1.94	2.02	2.12	2.22
	0.60	1.02	1.05	1.08	1.10	1.13	1.16	1.20	1.23	1.27	1.31	1.35	1.39	1.44	1.49	1.54	1.60	1.66	1.73	1.80	1.88	1.97	2.06	2.17	2.28	2.41
	0.80	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.31	1.36	1.41	1.47	1.53	1.59	1.66	1.74	1.82	1.91	2.01	2.13	2.25	2.40	2.56	2.74	2.96
	1.00	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.50	1.58	1.65	1.74	1.84	1.95	2.07	2.21	2.37	2.56	2.77	3.03	3.33	3.71	
>=2.80	<=0.40	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.38	1.45	1.53	1.61	1.71	1.81	1.94	2.07	2.23	2.42	2.64	2.91	3.23	3.64				
	0.60	1.04	1.08	1.12	1.17	1.23	1.28	1.35	1.42	1.49	1.58	1.68	1.79	1.92	2.06	2.23	2.43	2.67	2.96	3.32	3.78					
	0.80	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.71	1.84	2.00	2.18	2.40	2.66	2.99	3.42	3.99							
	1.00	1.05	1.11	1.17	1.24	1.31	1.40	1.50	1.62	1.76	1.92	2.11	2.35	2.64	3.03	3.54										

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
		Total Factored Axial Load (kips)																								
<=0.80	<=0.40	1.01	1.03	1.04	1.06	1.08	1.09	1.11	1.13	1.14	1.16	1.18	1.20	1.22	1.24	1.27	1.29	1.31	1.34	1.36	1.39	1.42	1.44	1.47	1.51	1.54
	0.60	1.02	1.03	1.05	1.06	1.08	1.10	1.12	1.14	1.15	1.18	1.20	1.22	1.24	1.26	1.29	1.31	1.34	1.37	1.39	1.42	1.46	1.49	1.52	1.56	1.59
	0.80	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.16	1.18	1.20	1.23	1.25	1.28	1.31	1.34	1.37	1.40	1.44	1.47	1.51	1.55	1.59	1.63	1.68	1.73
	1.00	1.02	1.04	1.06	1.08	1.11	1.13	1.16	1.18	1.21	1.24	1.27	1.30	1.34	1.37	1.41	1.45	1.49	1.54	1.58	1.63	1.69	1.74	1.80	1.87	1.94
1.20	<=0.40	1.02	1.03	1.05	1.07	1.09	1.11	1.13	1.15	1.17	1.20	1.22	1.25	1.27	1.30	1.33	1.36	1.39	1.42	1.45	1.49	1.53	1.57	1.61	1.65	1.70
	0.60	1.02	1.04	1.06	1.08	1.10	1.12	1.14	1.16	1.19	1.21	1.24	1.27	1.29	1.32	1.36	1.39	1.42	1.46	1.50	1.54	1.58	1.63	1.67	1.72	1.78
	0.80	1.02	1.04	1.06	1.09	1.11	1.13	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.38	1.42	1.46	1.51	1.55	1.60	1.66	1.71	1.77	1.84	1.90	1.98
	1.00	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.22	1.26	1.29	1.33	1.38	1.42	1.47	1.52	1.57	1.63	1.69	1.76	1.83	1.91	2.00	2.10	2.20	2.32
1.60	<=0.40	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.31	1.35	1.39	1.42	1.47	1.51	1.56	1.61	1.66	1.72	1.78	1.84	1.91	1.99
	0.60	1.02	1.04	1.07	1.09	1.12	1.15	1.17	1.20	1.24	1.27	1.30	1.34	1.38	1.42	1.47	1.51	1.56	1.62	1.67	1.73	1.80	1.87	1.95	2.03	2.13
	0.80	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.27	1.32	1.36	1.40	1.45	1.50	1.56	1.62	1.69	1.76	1.84	1.92	2.01	2.11	2.23	2.35	2.49
	1.00	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.43	1.49	1.56	1.63	1.70	1.79	1.88	1.98	2.10	2.23	2.37	2.54	2.73	2.95	3.21
2.00	<=0.40	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.54	1.61	1.67	1.75	1.83	1.92	2.01	2.12	2.24	2.38	2.53	2.70
	0.60	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.37	1.42	1.47	1.54	1.60	1.67	1.75	1.84	1.93	2.04	2.16	2.29	2.44	2.61	2.81	3.04
	0.80	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.50	1.57	1.65	1.74	1.84	1.94	2.07	2.20	2.36	2.54	2.76	3.01	3.31	3.68	
	1.00	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.39	1.46	1.54	1.62	1.72	1.83	1.95	2.10	2.26	2.46	2.69	2.96	3.31	3.74				
2.40	<=0.40	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.81	1.93	2.06	2.22	2.40	2.62	2.88	3.19	3.58				
	0.60	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.49	1.58	1.67	1.78	1.91	2.05	2.22	2.41	2.64	2.93	3.28	3.73					
	0.80	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.49	1.59	1.71	1.84	1.99	2.16	2.38	2.64	2.96	3.37	3.92							
	1.00	1.05	1.11	1.17	1.23	1.31	1.40	1.50	1.61	1.75	1.91	2.10	2.33	2.62	2.99	3.49										
>=2.80	<=0.40	1.06	1.12	1.19	1.28	1.37	1.48	1.61	1.76	1.94	2.17	2.46	2.84	3.35												
	0.60	1.06	1.13	1.21	1.30	1.40	1.53	1.67	1.85	2.07	2.35	2.72	3.22	3.96												
	0.80	1.07	1.15	1.24	1.35	1.48	1.64	1.84	2.08	2.41	2.86	3.51														
	1.00	1.08	1.18	1.29	1.43	1.60	1.81	2.10	2.49	3.05	3.96															

Non-Sway Moment Magnifier
for
8" Waffle-Grid Walls
f'_c = 4000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.02	1.04	1.06	1.09	1.11	1.14	1.16	1.19	1.22	1.25	1.28	1.32	1.35	1.39	1.43	1.48	1.52	1.57	1.62	1.67	1.73	1.80	1.86	1.94	2.01
	0.60	1.02	1.04	1.07	1.09	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.35	1.39	1.43	1.47	1.52	1.57	1.63	1.69	1.75	1.82	1.89	1.97	2.06	2.16
	0.80	1.02	1.05	1.08	1.11	1.14	1.17	1.20	1.24	1.28	1.32	1.36	1.41	1.46	1.51	1.57	1.64	1.70	1.78	1.86	1.94	2.04	2.15	2.26	2.40	2.54
	1.00	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.44	1.50	1.57	1.64	1.72	1.81	1.90	2.01	2.13	2.26	2.42	2.59	2.79	3.03	3.31
1.20	<=0.40	1.02	1.05	1.08	1.10	1.13	1.17	1.20	1.23	1.27	1.31	1.35	1.40	1.44	1.49	1.55	1.61	1.67	1.74	1.82	1.90	1.99	2.08	2.19	2.31	2.44
	0.60	1.03	1.05	1.08	1.11	1.14	1.18	1.21	1.25	1.29	1.34	1.38	1.43	1.49	1.54	1.61	1.68	1.75	1.83	1.92	2.02	2.12	2.24	2.38	2.53	2.70
	0.80	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.34	1.40	1.46	1.52	1.59	1.68	1.75	1.84	1.94	2.05	2.18	2.33	2.49	2.68	2.90	3.16	3.48
	1.00	1.03	1.07	1.11	1.15	1.20	1.24	1.30	1.36	1.42	1.49	1.56	1.65	1.74	1.85	1.97	2.10	2.26	2.44	2.65	2.90	3.20	3.58			
1.60	<=0.40	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.35	1.40	1.46	1.52	1.59	1.67	1.75	1.84	1.95	2.06	2.19	2.34	2.51	2.70	2.93	3.19	3.51
	0.60	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.50	1.58	1.66	1.74	1.84	1.95	2.08	2.22	2.38	2.56	2.78	3.04	3.35	3.73	
	0.80	1.04	1.07	1.12	1.16	1.21	1.26	1.32	1.38	1.45	1.53	1.61	1.71	1.81	1.93	2.07	2.23	2.42	2.64	2.90	3.23	3.63				
	1.00	1.04	1.09	1.14	1.19	1.25	1.31	1.38	1.46	1.55	1.66	1.77	1.91	2.06	2.25	2.47	2.74	3.07	3.49							
2.00	<=0.40	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.57	1.66	1.77	1.89	2.03	2.19	2.38	2.61	2.88	3.21	3.64					
	0.60	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.53	1.63	1.74	1.86	2.01	2.18	2.38	2.62	2.91	3.28	3.76						
	0.80	1.05	1.10	1.15	1.21	1.28	1.36	1.44	1.54	1.65	1.78	1.93	2.10	2.32	2.58	2.90	3.32	3.89								
	1.00	1.05	1.11	1.18	1.25	1.34	1.43	1.54	1.67	1.82	2.01	2.23	2.52	2.88	3.37											
2.40	<=0.40	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.98	2.19	2.46	2.80	3.25	3.87										
	0.60	1.06	1.12	1.19	1.27	1.36	1.46	1.58	1.73	1.90	2.11	2.38	2.72	3.17	3.81											
	0.80	1.06	1.14	1.22	1.31	1.42	1.56	1.72	1.91	2.16	2.47	2.90	3.51													
	1.00	1.07	1.16	1.26	1.38	1.52	1.70	1.92	2.21	2.61	3.17															
>=2.80	<=0.40	1.08	1.18	1.30	1.45	1.63	1.87	2.19	2.64	3.32																
	0.60	1.09	1.20	1.33	1.49	1.71	1.99	2.38	2.96	3.92																
	0.80	1.10	1.23	1.39	1.60	1.88	2.28	2.90	3.99																	
	1.00	1.12	1.27	1.48	1.76	2.17	2.82																			

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.80	<=0.40	1.03	1.06	1.09	1.12	1.16	1.20	1.24	1.28	1.33	1.38	1.43	1.49	1.55	1.62	1.70	1.78	1.87	1.97	2.09	2.21	2.36	2.52	2.71	2.92	3.18
	0.60	1.03	1.06	1.10	1.13	1.17	1.21	1.26	1.30	1.36	1.41	1.47	1.54	1.61	1.69	1.78	1.88	1.99	2.11	2.25	2.40	2.59	2.80	3.05	3.34	3.71
	0.80	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49	1.57	1.66	1.75	1.86	1.98	2.12	2.28	2.47	2.69	2.95	3.27	3.66			
	1.00	1.04	1.08	1.13	1.18	1.23	1.30	1.36	1.44	1.52	1.61	1.72	1.84	1.98	2.14	2.32	2.55	2.82	3.16	3.59						
1.20	<=0.40	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.47	1.55	1.63	1.72	1.82	1.93	2.06	2.21	2.38	2.57	2.81	3.08	3.42	3.85		
	0.60	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.80	1.92	2.06	2.22	2.40	2.61	2.87	3.18	3.57				
	0.80	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.63	1.74	1.87	2.02	2.19	2.39	2.64	2.94	3.31	3.80						
	1.00	1.05	1.10	1.15	1.22	1.29	1.37	1.45	1.55	1.67	1.80	1.96	2.15	2.38	2.66	3.02	3.49									
1.60	<=0.40	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.54	1.64	1.75	1.88	2.03	2.20	2.41	2.65	2.96	3.35	3.85						
	0.60	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.71	1.84	1.99	2.17	2.39	2.65	2.98	3.40	3.95							
	0.80	1.05	1.10	1.16	1.23	1.31	1.39	1.49	1.60	1.73	1.89	2.07	2.29	2.57	2.92	3.38										
	1.00	1.06	1.12	1.19	1.28	1.37	1.48	1.61	1.76	1.94	2.17	2.46	2.84	3.35												
2.00	<=0.40	1.05	1.11	1.17	1.25	1.33	1.42	1.53	1.65	1.80	1.97	2.19	2.45	2.79	3.23	3.85										
	0.60	1.06	1.12	1.19	1.27	1.36	1.46	1.58	1.73	1.90	2.11	2.37	2.71	3.16	3.79											
	0.80	1.06	1.14	1.22	1.31	1.42	1.55	1.71	1.91	2.15	2.47	2.89	3.49													
	1.00	1.07	1.16	1.26	1.38	1.52	1.70	1.92	2.21	2.60	3.16															
2.40	<=0.40	1.07	1.16	1.25	1.37	1.51	1.68	1.89	2.17	2.53	3.06	3.85														
	0.60	1.08	1.17	1.27	1.40	1.56	1.75	2.01	2.34	2.82	3.53															
	0.80	1.09	1.19	1.32	1.48	1.68	1.95	2.31	2.85	3.70																
	1.00	1.10	1.23	1.39	1.59	1.87	2.27	2.88	3.93																	
>=2.80	<=0.40	1.12	1.27	1.46	1.73	2.12	2.73	3.85																		
	0.60	1.13	1.29	1.51	1.82	2.29	3.09																			
	0.80	1.15	1.34	1.62	2.04	2.76																				
	1.00	1.17	1.41	1.78	2.42	3.74																				

Non-Sway Moment Magnifier
for
6" Screen-Grid Walls
f'_c = 3000 psi

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.03	1.06	1.09	1.12	1.15	1.19	1.23	1.27	1.32	1.37	1.42	1.47	1.53	1.60	1.67	1.75	1.83	1.93	2.03	2.15	2.28	2.43	2.60	2.79	3.02
	0.60	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.30	1.35	1.40	1.46	1.52	1.59	1.66	1.75	1.84	1.94	2.05	2.18	2.33	2.49	2.68	2.91	3.17	3.48
	0.80	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.48	1.55	1.63	1.72	1.82	1.94	2.07	2.21	2.38	2.58	2.82	3.10	3.44	3.87		
	1.00	1.04	1.08	1.13	1.17	1.23	1.29	1.35	1.42	1.50	1.59	1.69	1.80	1.93	2.08	2.25	2.46	2.70	3.01	3.38	3.87					
1.00	<=0.40	1.03	1.07	1.11	1.15	1.20	1.25	1.30	1.36	1.42	1.49	1.57	1.65	1.75	1.85	1.97	2.11	2.27	2.45	2.66	2.92	3.23	3.61			
	0.60	1.04	1.08	1.12	1.16	1.21	1.27	1.32	1.39	1.46	1.54	1.63	1.73	1.84	1.96	2.11	2.28	2.47	2.71	2.99	3.34	3.78				
	0.80	1.04	1.09	1.13	1.19	1.25	1.31	1.38	1.46	1.55	1.66	1.77	1.91	2.06	2.25	2.47	2.73	3.06	3.49							
	1.00	1.05	1.10	1.16	1.22	1.29	1.38	1.47	1.57	1.69	1.84	2.00	2.21	2.45	2.76	3.16	3.69									
1.40	<=0.40	1.04	1.09	1.15	1.21	1.27	1.34	1.43	1.52	1.62	1.74	1.88	2.05	2.24	2.48	2.77	3.14	3.63								
	0.60	1.05	1.10	1.16	1.22	1.29	1.37	1.47	1.57	1.69	1.83	2.00	2.20	2.44	2.75	3.14	3.66									
	0.80	1.05	1.11	1.18	1.26	1.35	1.45	1.56	1.70	1.86	2.06	2.30	2.61	3.01	3.56											
	1.00	1.06	1.13	1.22	1.31	1.42	1.55	1.70	1.90	2.13	2.44	2.85	3.43													
1.80	<=0.40	1.06	1.14	1.22	1.32	1.43	1.57	1.74	1.94	2.20	2.54	2.99	3.66													
	0.60	1.07	1.15	1.24	1.35	1.48	1.63	1.82	2.07	2.39	2.82	3.45														
	0.80	1.08	1.17	1.28	1.41	1.57	1.78	2.05	2.40	2.92	3.70															
	1.00	1.09	1.20	1.34	1.51	1.72	2.01	2.42	3.04																	
>=2.2	<=0.40	1.12	1.26	1.46	1.72	2.10	2.69	3.73																		
	0.60	1.13	1.29	1.50	1.80	2.26	3.02																			
	0.80	1.14	1.34	1.61	2.02	2.71																				
	1.00	1.17	1.41	1.77	2.38	3.63																				

		Total Factored Axial Load (kips)																								
e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.04	1.09	1.14	1.20	1.26	1.33	1.41	1.50	1.60	1.72	1.85	2.01	2.19	2.41	2.68	3.02	3.46								
	0.60	1.05	1.10	1.15	1.22	1.29	1.36	1.45	1.55	1.67	1.80	1.96	2.15	2.38	2.66	3.01	3.48									
	0.80	1.05	1.11	1.18	1.25	1.34	1.43	1.55	1.68	1.83	2.02	2.24	2.53	2.90	3.40											
	1.00	1.06	1.13	1.21	1.30	1.41	1.53	1.68	1.86	2.09	2.38	2.76	3.28													
1.00	<=0.40	1.05	1.11	1.18	1.26	1.35	1.45	1.56	1.70	1.86	2.06	2.30	2.61	3.01	3.56											
	0.60	1.06	1.12	1.20	1.28	1.38	1.49	1.62	1.78	1.97	2.21	2.51	2.91	3.47												
	0.80	1.07	1.14	1.23	1.33	1.45	1.59	1.77	1.98	2.26	2.63	3.14	3.89													
	1.00	1.08	1.17	1.27	1.40	1.55	1.75	1.99	2.32	2.78	3.47															
1.40	<=0.40	1.07	1.15	1.25	1.36	1.50	1.67	1.87	2.14	2.50	2.99	3.74														
	0.60	1.08	1.17	1.27	1.40	1.55	1.74	1.99	2.31	2.77	3.44															
	0.80	1.09	1.19	1.32	1.47	1.67	1.93	2.28	2.79	3.60																
	1.00	1.10	1.23	1.38	1.58	1.86	2.24	2.82	3.82																	
1.80	<=0.40	1.10	1.23	1.40	1.61	1.90	2.31	2.96																		
	0.60	1.11	1.25	1.43	1.68	2.02	2.53	3.40																		
	0.80	1.13	1.30	1.52	1.84	2.33	3.17																			
	1.00	1.15	1.36	1.65	2.10	2.90																				
>=2.2	<=0.40	1.20	1.49	1.96	2.89																					
	0.60	1.21	1.53	2.09	3.30																					
	0.80	1.25	1.65	2.45																						
	1.00	1.29	1.83	3.12																						

Non-Sway Moment Magnifier
for
6" Screen-Grid Walls
f'_c = 4000 psi

Total Factored Axial Load (kips)

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.02	1.05	1.07	1.10	1.13	1.16	1.19	1.23	1.26	1.30	1.34	1.39	1.43	1.48	1.53	1.59	1.65	1.72	1.79	1.86	1.95	2.04	2.14	2.25	2.38
	0.60	1.03	1.05	1.08	1.11	1.14	1.17	1.21	1.25	1.29	1.33	1.37	1.42	1.47	1.53	1.59	1.65	1.72	1.80	1.88	1.98	2.08	2.19	2.31	2.45	2.61
	0.80	1.03	1.06	1.09	1.13	1.16	1.20	1.24	1.29	1.34	1.39	1.44	1.50	1.57	1.64	1.72	1.81	1.90	2.01	2.13	2.27	2.42	2.59	2.80	3.03	3.32
	1.00	1.03	1.07	1.11	1.15	1.19	1.24	1.29	1.35	1.41	1.47	1.55	1.63	1.72	1.82	1.93	2.06	2.20	2.37	2.56	2.79	3.07	3.41	3.82		
1.00	<=0.40	1.03	1.06	1.09	1.13	1.17	1.21	1.25	1.29	1.34	1.40	1.46	1.52	1.59	1.66	1.75	1.84	1.94	2.05	2.18	2.32	2.49	2.68	2.90	3.16	3.47
	0.60	1.03	1.06	1.10	1.14	1.18	1.22	1.27	1.32	1.38	1.44	1.50	1.57	1.65	1.74	1.83	1.94	2.06	2.20	2.36	2.54	2.76	3.01	3.31	3.68	
	0.80	1.04	1.07	1.11	1.16	1.21	1.26	1.32	1.38	1.45	1.52	1.61	1.70	1.81	1.92	2.06	2.22	2.40	2.62	2.87	3.19	3.58				
	1.00	1.04	1.09	1.13	1.19	1.25	1.31	1.38	1.46	1.55	1.65	1.77	1.90	2.05	2.23	2.45	2.71	3.04	3.45	3.99						
1.40	<=0.40	1.04	1.08	1.12	1.17	1.23	1.28	1.35	1.42	1.50	1.58	1.68	1.79	1.92	2.07	2.24	2.44	2.68	2.98	3.35	3.82					
	0.60	1.04	1.09	1.13	1.19	1.24	1.31	1.38	1.46	1.55	1.65	1.76	1.89	2.05	2.22	2.44	2.70	3.02	3.42	3.96						
	0.80	1.05	1.10	1.15	1.22	1.29	1.36	1.45	1.55	1.67	1.80	1.96	2.15	2.37	2.65	3.01	3.47									
	1.00	1.05	1.11	1.18	1.26	1.34	1.44	1.56	1.69	1.85	2.05	2.29	2.59	2.98	3.52											
1.80	<=0.40	1.06	1.12	1.19	1.27	1.36	1.46	1.58	1.72	1.89	2.10	2.36	2.70	3.14	3.76											
	0.60	1.06	1.13	1.20	1.29	1.39	1.50	1.64	1.81	2.01	2.27	2.60	3.04	3.66												
	0.80	1.07	1.14	1.23	1.34	1.46	1.61	1.79	2.02	2.32	2.72	3.28														
	1.00	1.08	1.17	1.28	1.41	1.57	1.77	2.04	2.39	2.89	3.66															
>=2.2	<=0.40	1.10	1.22	1.37	1.57	1.83	2.19	2.73	3.63																	
	0.60	1.11	1.24	1.41	1.63	1.93	2.38	3.08																		
	0.80	1.12	1.28	1.49	1.78	2.20	2.90																			
	1.00	1.14	1.34	1.60	2.01	2.68																				

Total Factored Axial Load (kips)

e (in)	β_d	2	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50
<=0.60	<=0.40	1.04	1.08	1.12	1.17	1.22	1.28	1.34	1.41	1.48	1.57	1.66	1.77	1.89	2.03	2.19	2.38	2.60	2.87	3.20	3.62					
	0.60	1.04	1.08	1.13	1.18	1.24	1.30	1.37	1.45	1.53	1.63	1.74	1.86	2.01	2.17	2.37	2.61	2.91	3.27	3.75						
	0.80	1.05	1.10	1.15	1.21	1.28	1.35	1.44	1.54	1.65	1.77	1.92	2.10	2.31	2.57	2.90	3.32	3.88								
	1.00	1.05	1.11	1.18	1.25	1.33	1.43	1.54	1.67	1.82	2.01	2.23	2.51	2.87	3.36											
1.00	<=0.40	1.05	1.10	1.15	1.22	1.29	1.36	1.45	1.55	1.67	1.80	1.96	2.14	2.37	2.65	3.01	3.47									
	0.60	1.05	1.10	1.17	1.23	1.31	1.40	1.50	1.61	1.74	1.90	2.09	2.32	2.61	2.97	3.46										
	0.80	1.06	1.12	1.19	1.27	1.37	1.47	1.60	1.75	1.93	2.16	2.44	2.81	3.30												
	1.00	1.07	1.14	1.23	1.33	1.45	1.59	1.76	1.97	2.25	2.61	3.11	3.84													
1.40	<=0.40	1.06	1.13	1.21	1.30	1.41	1.53	1.68	1.86	2.08	2.36	2.73	3.25	3.99												
	0.60	1.07	1.14	1.23	1.33	1.44	1.58	1.75	1.97	2.24	2.59	3.09	3.81													
	0.80	1.07	1.16	1.26	1.39	1.53	1.72	1.95	2.25	2.67	3.28															
	1.00	1.09	1.19	1.32	1.47	1.67	1.92	2.27	2.77	3.56																
1.80	<=0.40	1.09	1.20	1.33	1.49	1.69	1.97	2.35	2.90	3.81																
	0.60	1.10	1.21	1.35	1.54	1.77	2.10	2.57	3.32																	
	0.80	1.11	1.25	1.42	1.65	1.98	2.46	3.24																		
	1.00	1.13	1.29	1.52	1.83	2.31	3.14																			
>=2.2	<=0.40	1.16	1.39	1.74	2.30	3.42																				
	0.60	1.18	1.43	1.83	2.52																					
	0.80	1.21	1.52	2.05	3.15																					
	1.00	1.24	1.65	2.43																						

APPENDIX D

INTERACTION DIAGRAMS FOR STRUCTURAL REINFORCED CONCRETE WALLS

Interaction diagrams represent the relationship of the combined effects of axial load and bending moment on a concrete wall and are used as design aids to assist the designer with the selection of reinforcement. Points located within the interaction curve and the reference axes represent a combination of axial load and bending moment that the wall can support. The interaction diagram can be approximately constructed by connecting five basic points with straight lines (refer to Figure D-1).

(1) Pure compression with zero bending moment (concrete compression failure)
(2) Stress in reinforcement closest to the tension face = 0 (concrete compression failure)
(3) Stress in reinforcement closest to the tension face = 0.5 times the yield stress (concrete compression failure)
(4) Stress in reinforcement closest to the tension face = yield stress (balanced concrete compression failure and reinforcement tensile yielding)
(5) Pure bending with zero axial load (under-reinforced with ductile reinforcement tensile failure)

Due to the low structural loads that exist in residential-scale structures, the interaction diagrams in Appendix D represent only the portion of the curve bounded by points (4) and (5). The

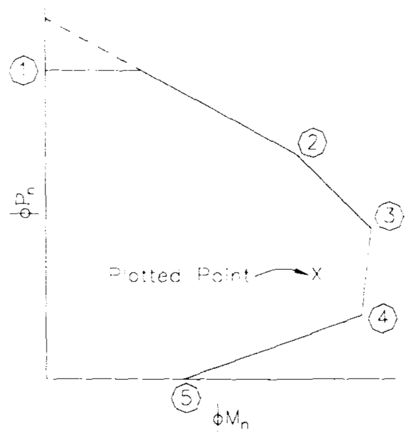


Figure D-1 Interaction Diagram for Structural Reinforced Concrete Walls

reinforcement ratios are calculated in Appendix H to assist the designer and are based on the gross area of the concrete equivalent rectangular section. To construct interaction diagrams representing as many ICF manufacturers as possible, the interaction diagrams were determined using the dimensions shown in Figure D-2; the reinforcement is assumed to be placed in the center of the wall.

Non-Sway Moment Magnifier Tables								
ICF Wall Type	**Nominal Thickness**		**Minimum Equivalent Thickness (h)**		**Minimum Equivalent Width (b)**		**Vertical Core Spacing**	
	(inch)	**(mm)**	**(inch)**	**(mm)**	**(inch)**	**(mm)**	**(inch)**	(mm)
Flat	4	101.6	3.5	88.9	12.0	304.8	N.A.	N.A.
	6	152.4	5.5	139.7	12.0	304.8	N.A.	N.A.
	8	203.2	7.5	190.5	12.0	304.8	N.A.	N.A.
	10	254.0	9.5	241.3	12.0	304.8	N.A.	N.A.
Waffle-Grid	6	152.4	5.0	127.0	6.25	158.8	12	304.8
	8	203.2	7.0	177.8	7.0	177.8	12	304.8
Screen-Grid	6	152.4	5.5	139.7	5.5	139.7	12	304.8

Figure D-2 Dimensions Used for Interaction Diagrams for Structural Reinforced Concrete Walls

As a result of constructing interaction diagrams representative of current ICF manufacturers, some design efficiency has been sacrificed, particularly in the screen-grid wall type because of the variety of dimensions available. Therefore, the designer may wish to construct custom interaction diagrams to obtain a more efficient design. The coordinates of each point on the interaction diagram may be computed using the following equations:

Point 1: Pure Compression

$$\phi P_n = \phi(C_c + C_s)$$
$$\phi P_{n,max} = 0.8\phi P_n$$
$$\phi M_n = 0$$
$$C_c = 0.85 f_c'(A_g - A_s)$$
$$C_s = A_s f_y$$

Point 2: Stress in Reinforcement = 0

$$\phi P_n = \phi(C_c)$$
$$\phi M_n = \phi C_c\left(d - \tfrac{a}{2}\right)$$
$$C_c = 0.85 a b f_c'$$
$$a = \beta c$$
$$c = d$$

Point 3: Stress in Reinforcement = $0.5f_y$

$$\phi P_n = \phi(C_c - T_s)$$
$$\phi M_n = \phi C_c\left(d - \tfrac{a}{2}\right)$$
$$C_c = 0.85 a b f_c'$$
$$T_s = A_s(0.5 f_y)$$
$$a = \beta c$$
$$c = \left(\frac{\varepsilon_c}{\varepsilon_c + 0.5\varepsilon_y}\right)d$$
$$\varepsilon_y = \frac{f_y}{E_s}$$
$$\varepsilon_c = 0.003$$

Point 4: Balanced Condition

$$
\begin{aligned}
\phi P_n &= \phi\left(C_c - T_s\right) \\
\phi M_n &= \phi C_c\left(d - \tfrac{a}{2}\right) \\
T_s &= A_s f_y \\
C_c &= 0.85 a b f_c' \\
a &= \beta c \\
c &= \left(\frac{\varepsilon_c}{\varepsilon_c + \varepsilon_y}\right) d \\
\varepsilon_y &= \frac{f_y}{E_s} \\
\varepsilon_c &= 0.003
\end{aligned}
$$

Point 5: Pure Bending

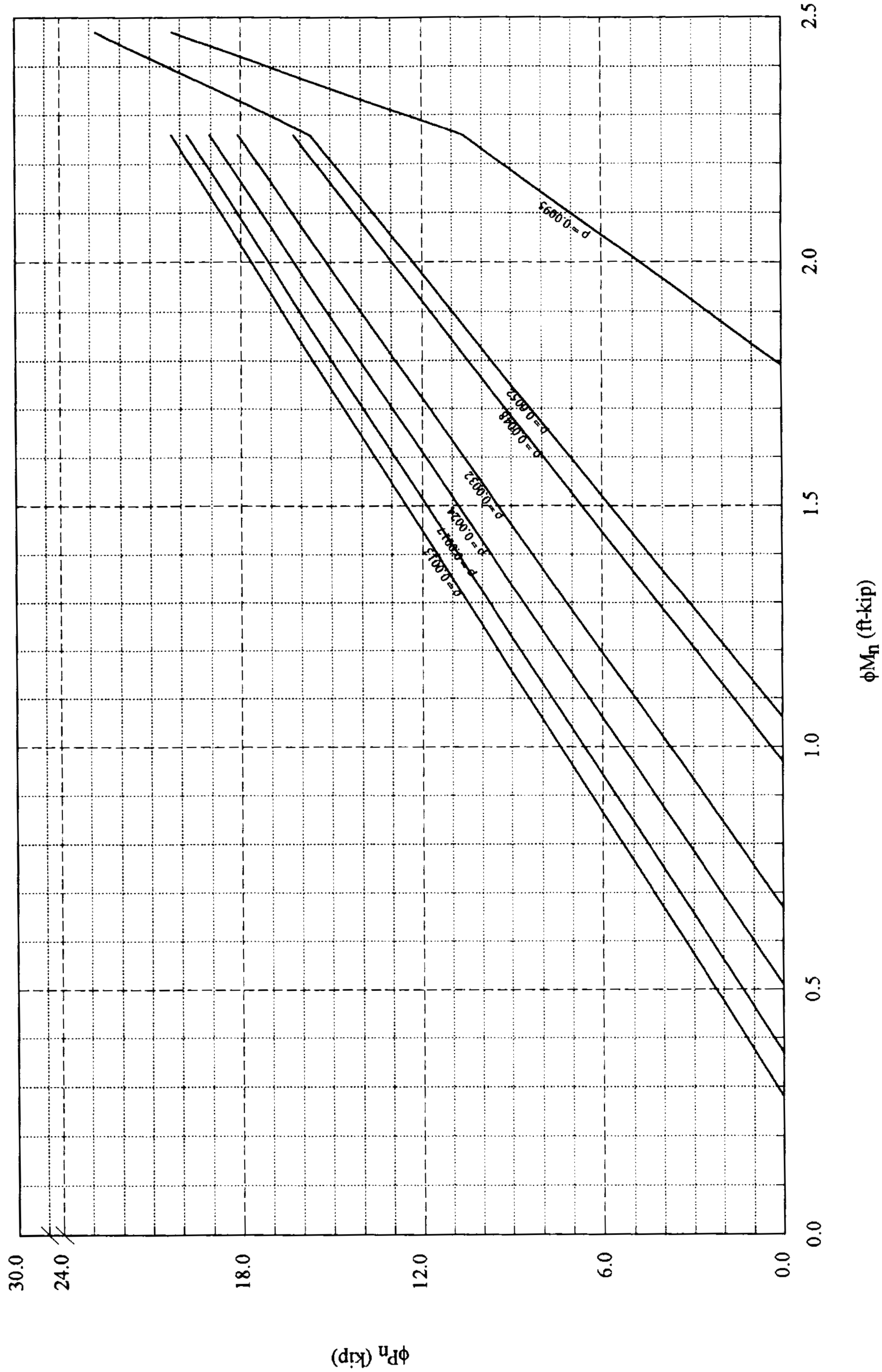
$$
\begin{aligned}
\phi P_n &= 0 \\
\phi M_n &= \phi A_s f_y\left(d - \frac{a}{2}\right) \\
a &= \frac{A_s f_y}{0.85 f_c' b}
\end{aligned}
$$

where:

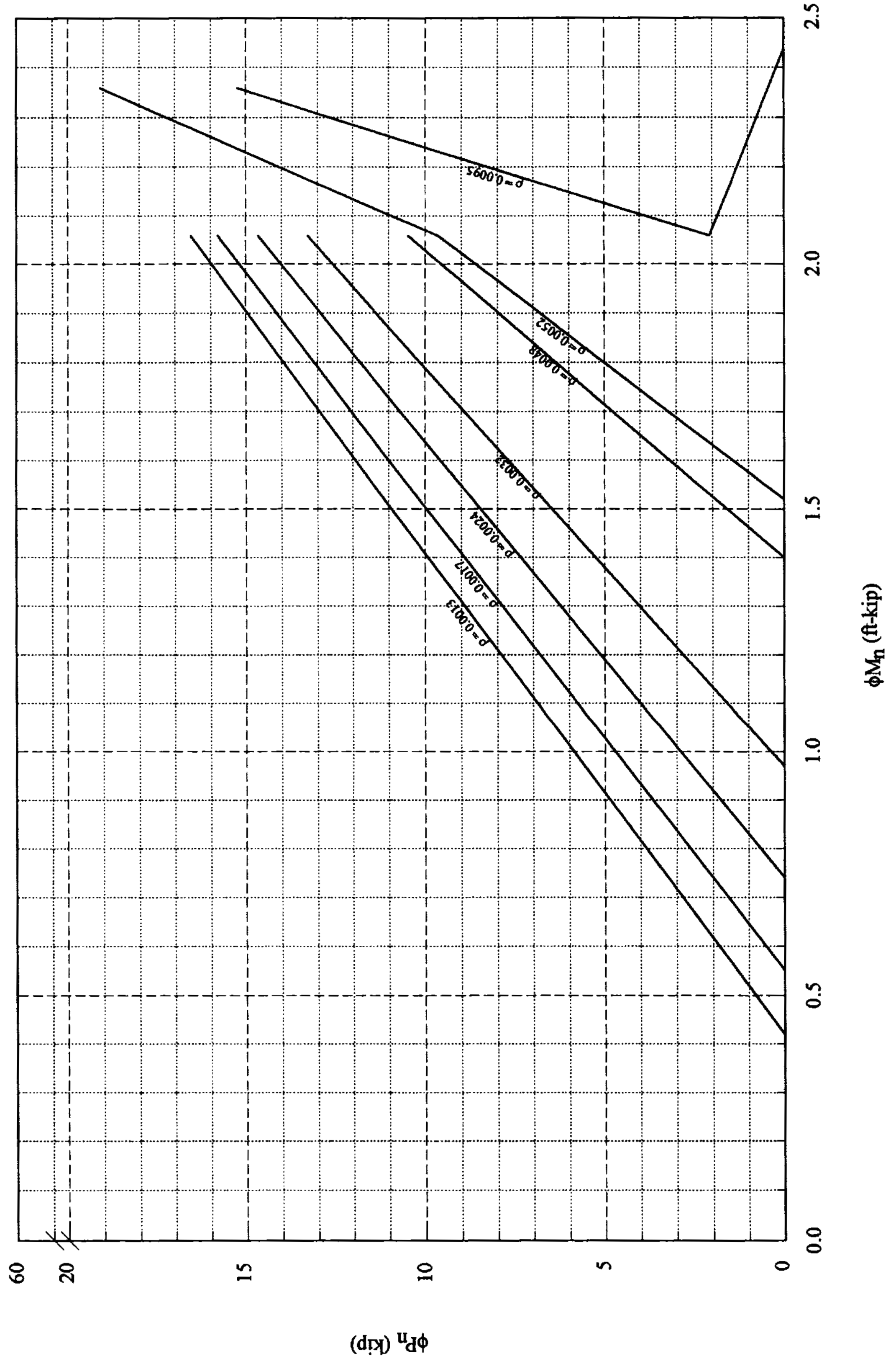
β	Factor 0.85 for $f_c' \le 4000$ psi per ACI 10.2.7.3	dimensionless
ε_c	Strain in concrete	dimensionless
ε_y	Yield strain of tensile reinforcement	dimensionless
ϕ	Strength reduction factor 0.7 for combined axial load and flexure per ACI 9.3.2 and 0.9 for pure flexure per ACI 9.3.2	dimensionless
a	Depth of equivalent rectangular stress block per ACI 10.2.7.1	inch
A_g	Gross area of concrete section	inch^2
A_s	Area of tensile reinforcement	inch^2
b	Width of compression face, Refer to Figure 1-3	inch
c	Distance from extreme compression fiber to neutral axis	inch
C_c	Compression force in concrete	lb
C_s	Compression force in reinforcement	lb
d	Distance from extreme compression fiber to centroid of tension reinforcement	inch
E_s	Modulus of elasticity of reinforcement 29,000,000 psi per ACI 8.5.2	psi
f_c'	Specified compressive strength of concrete	psi
f_y	Specified yield strength of reinforcement	psi
h	Thickness of concrete wall, Refer to Figure 1-1	inch

M_n	Nominal flexural strength	in-lb
P_n	Nominal axial load strength	lb
$P_{n,max}$	Maximum nominal axial load strength	lb
T_s	Tensile force in reinforcement	lb

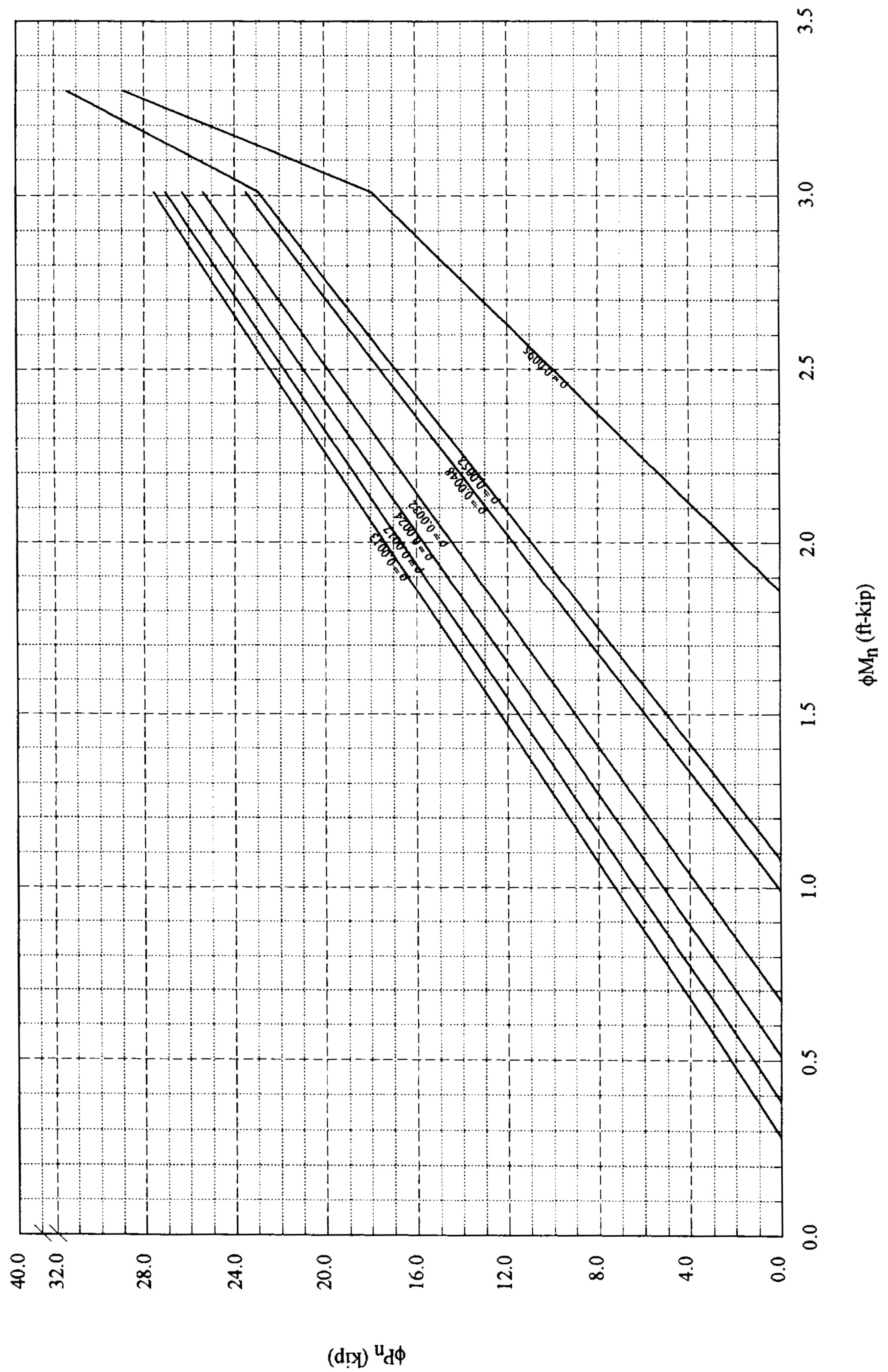
4" Flat Wall (f_c = 3 ksi, f_y = 40 ksi)



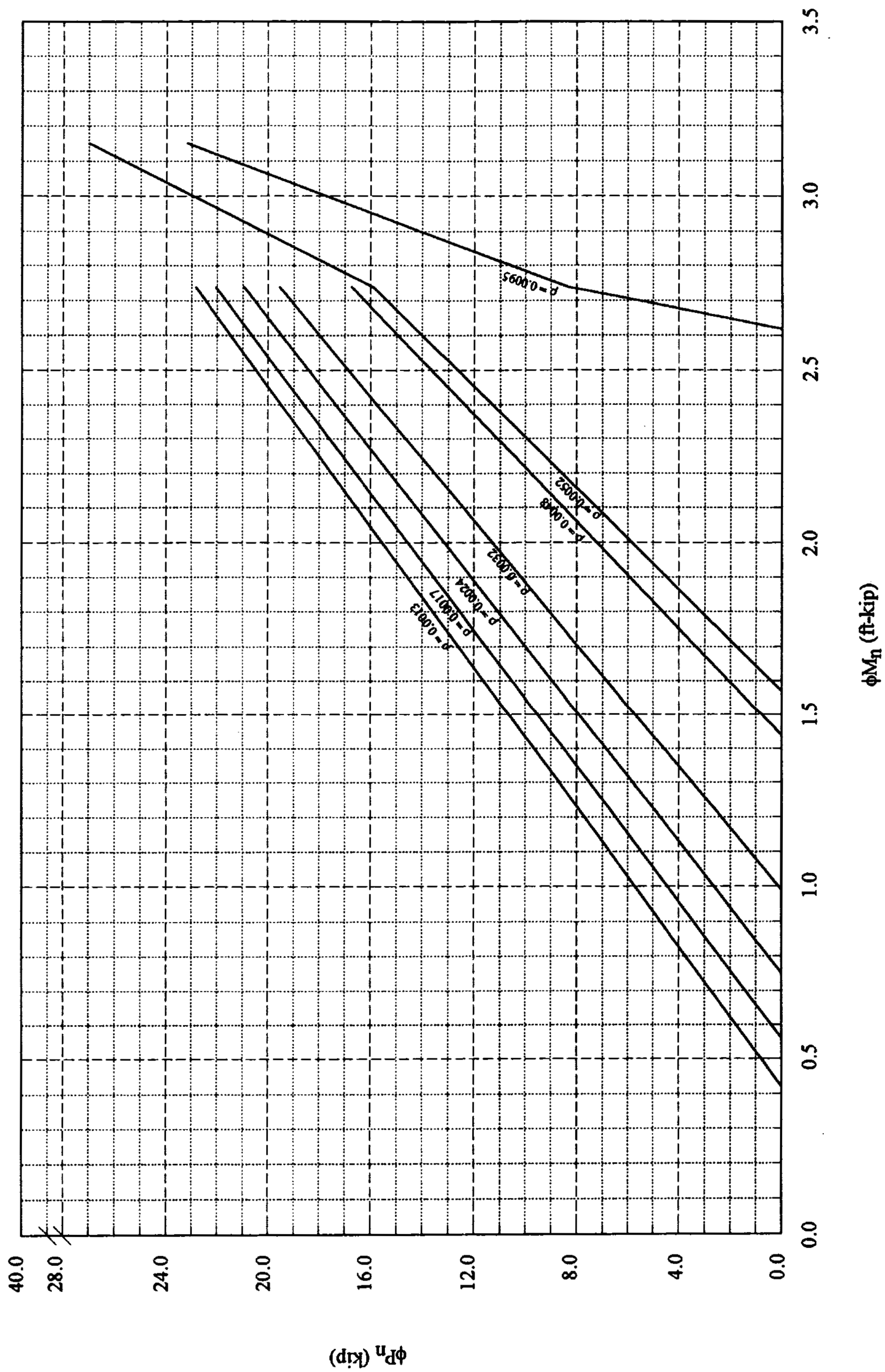
4" Flat Wall (f_c = 3 ksi, f_y = 60 ksi)



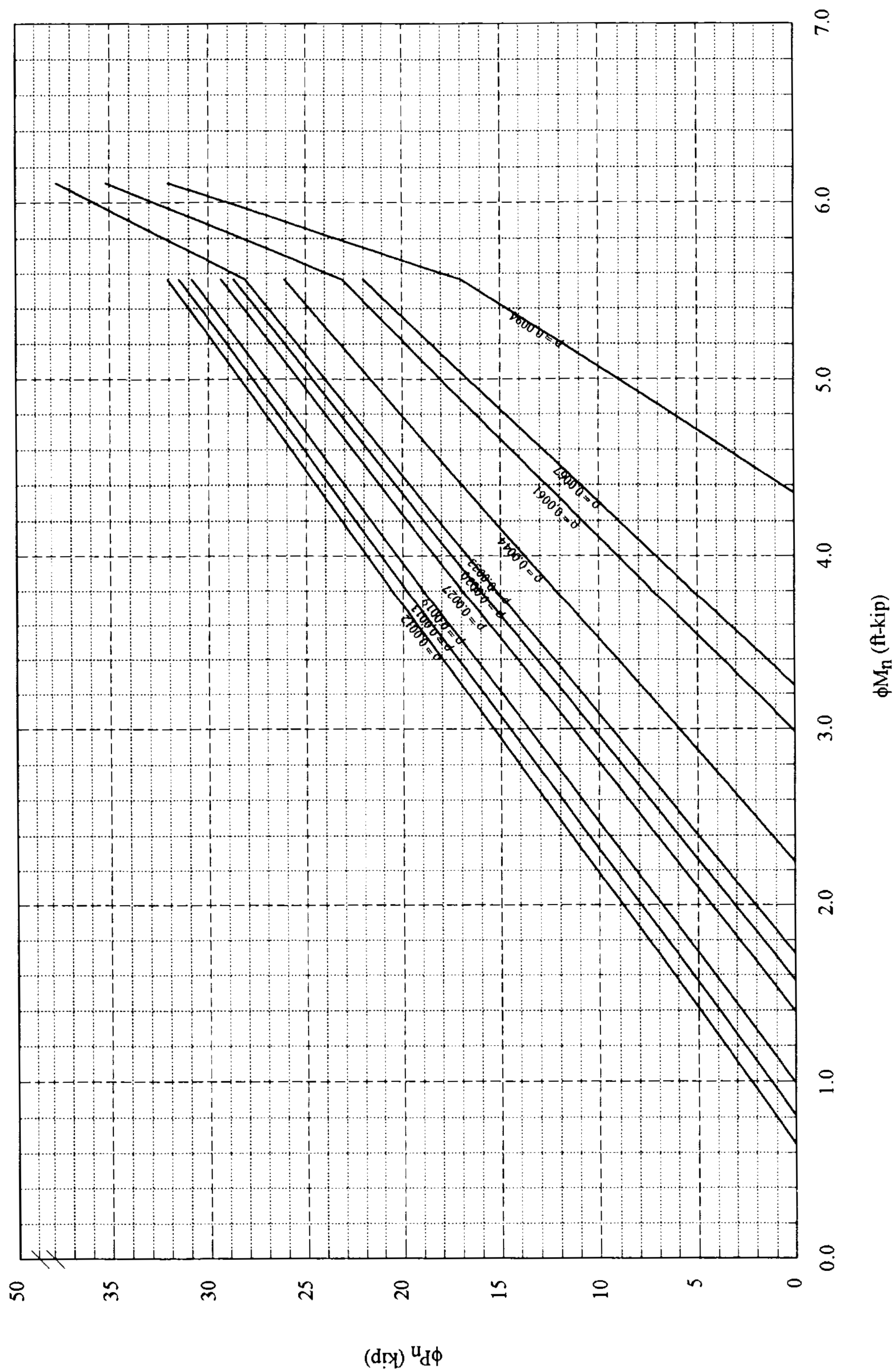
4" Flat Wall (f_c = 4 ksi, f_y = 40 ksi)



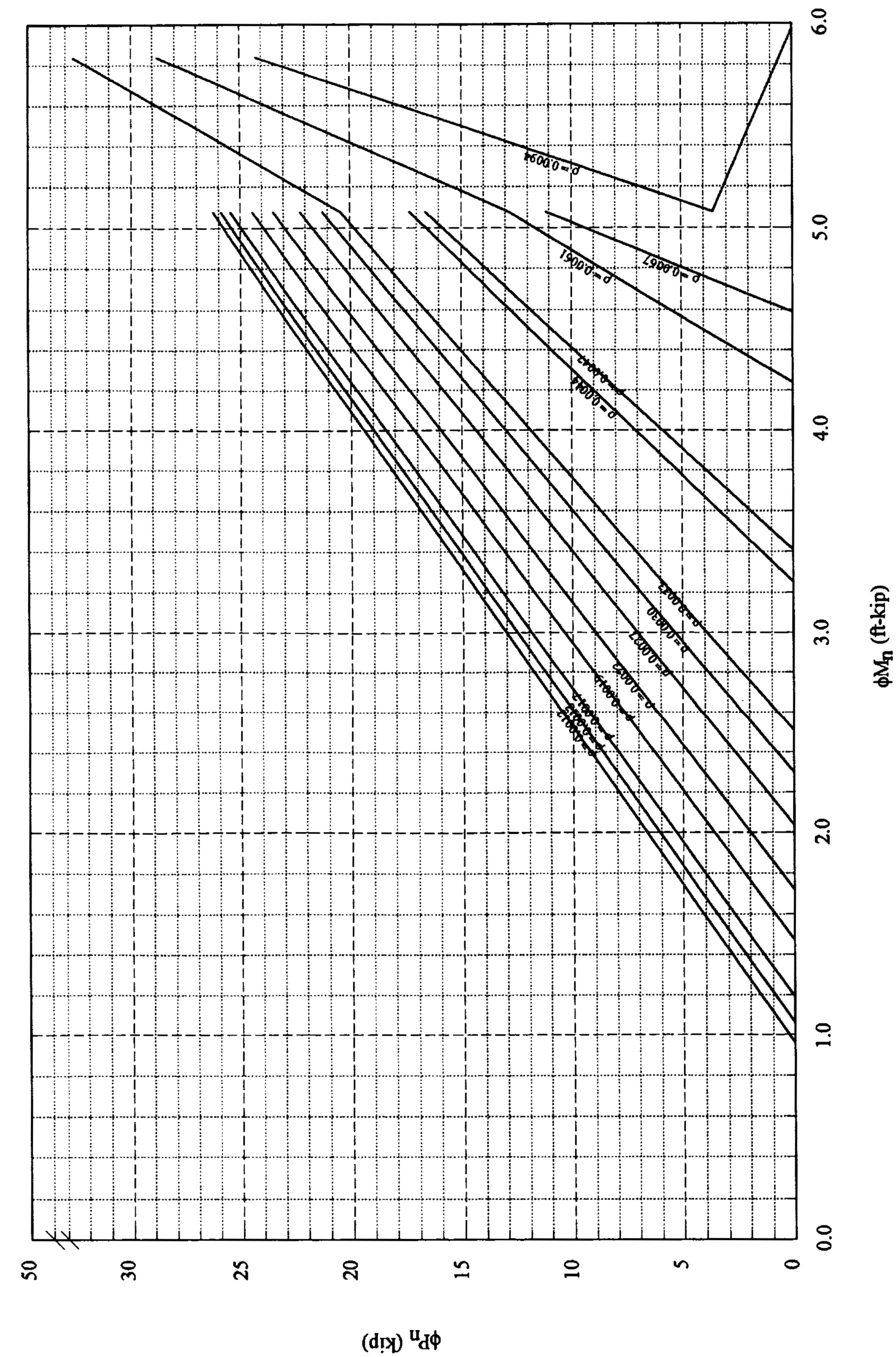
4" Flat Wall ($f_c = 4$ ksi, $f_y = 60$ ksi)



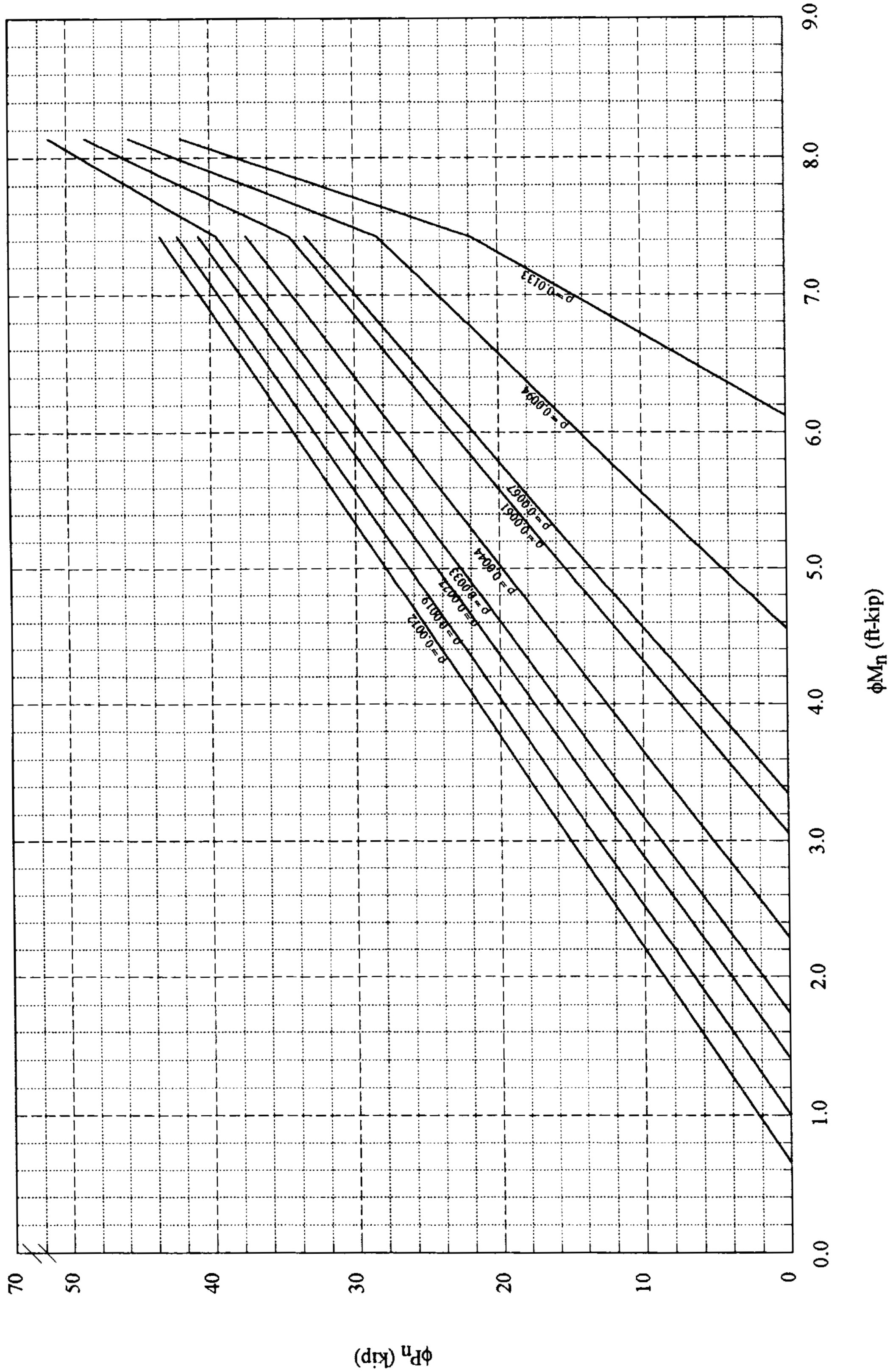
6" Flat Wall (f_c = 3 ksi, f_y = 40 ksi)



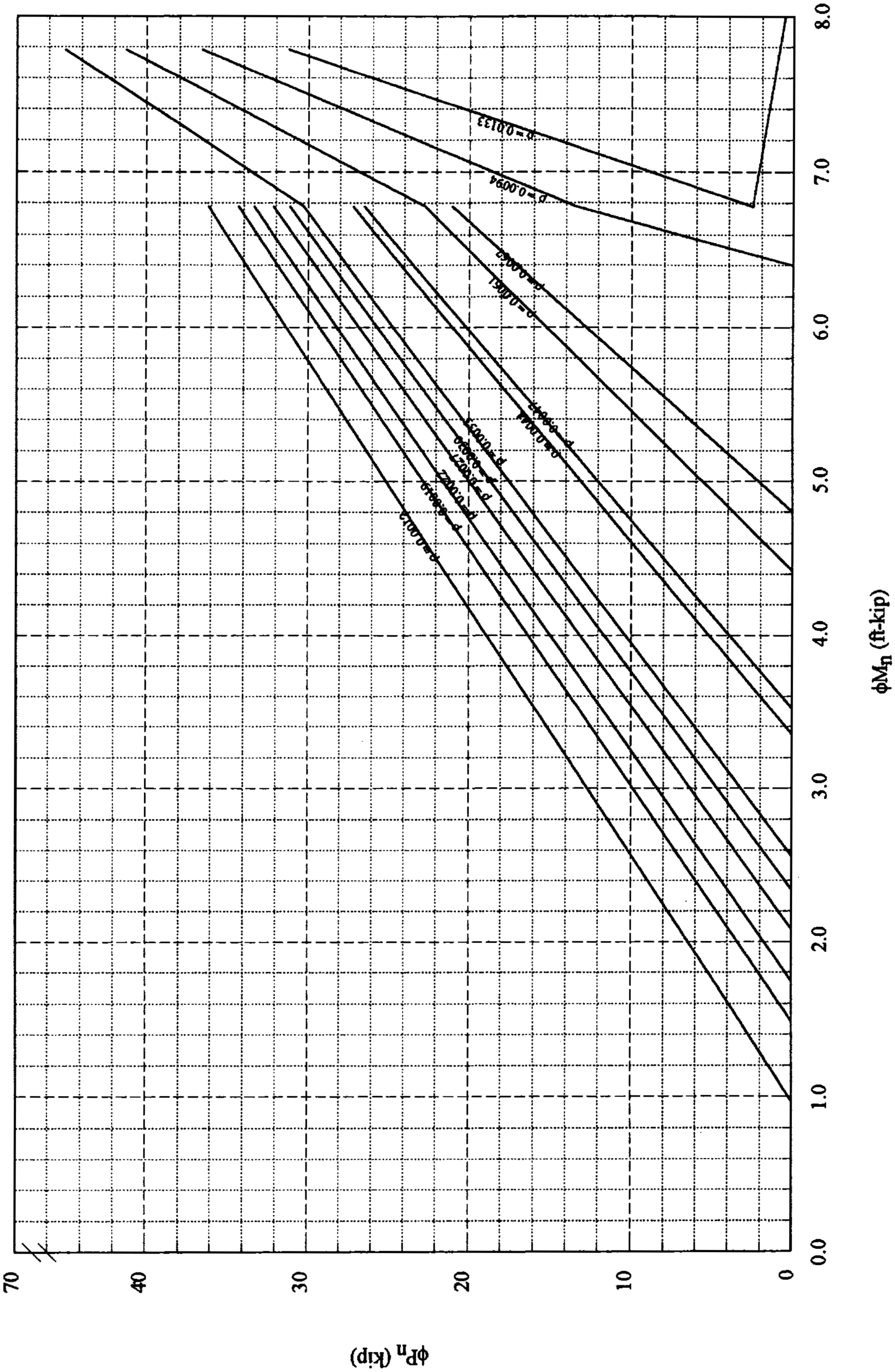
6" Flat Wall (f'_c = 3 ksi, f_y = 60 ksi)



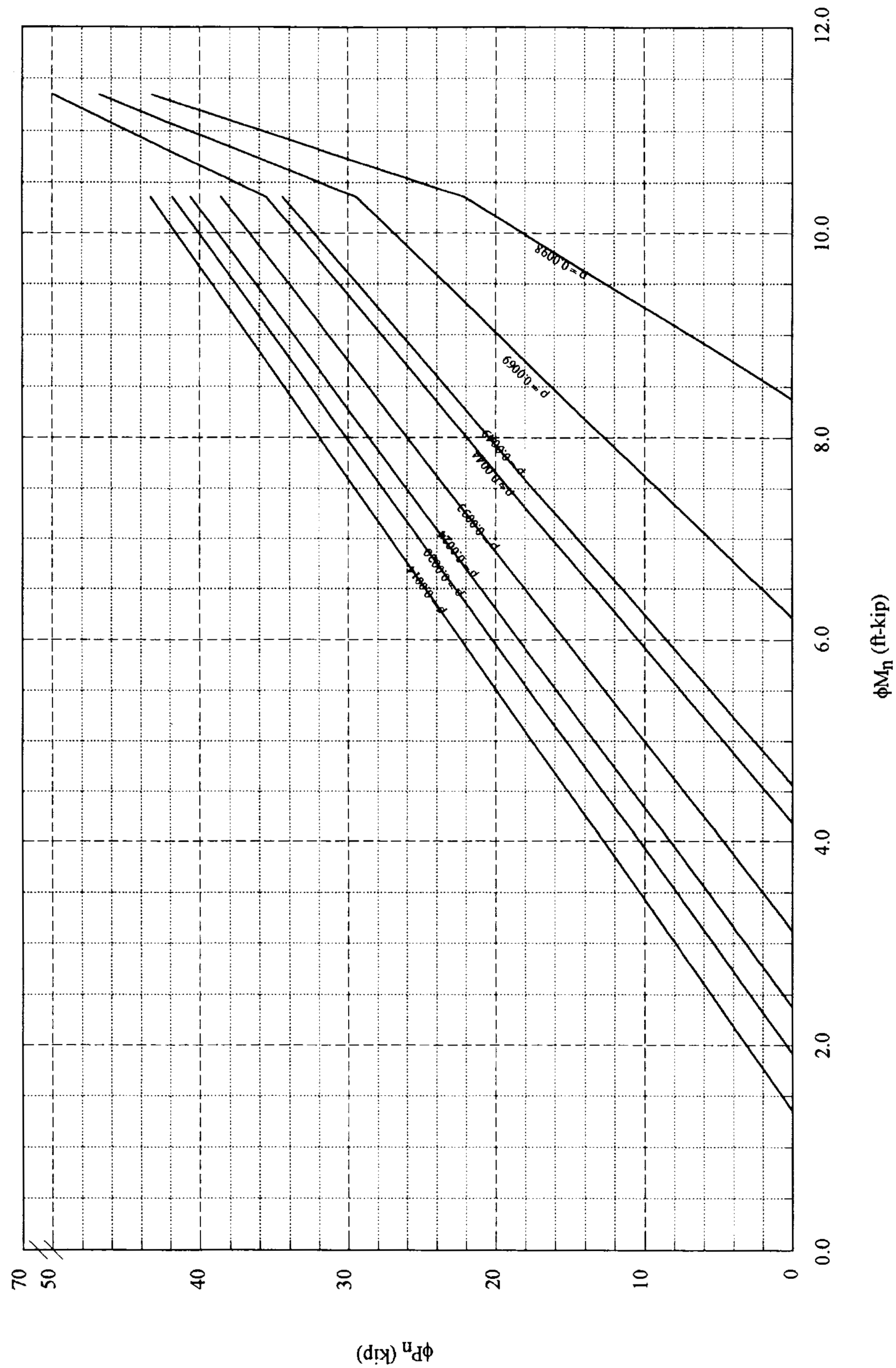
6" Flat Wall (f'_c = 4 ksi, f_y = 40 ksi)



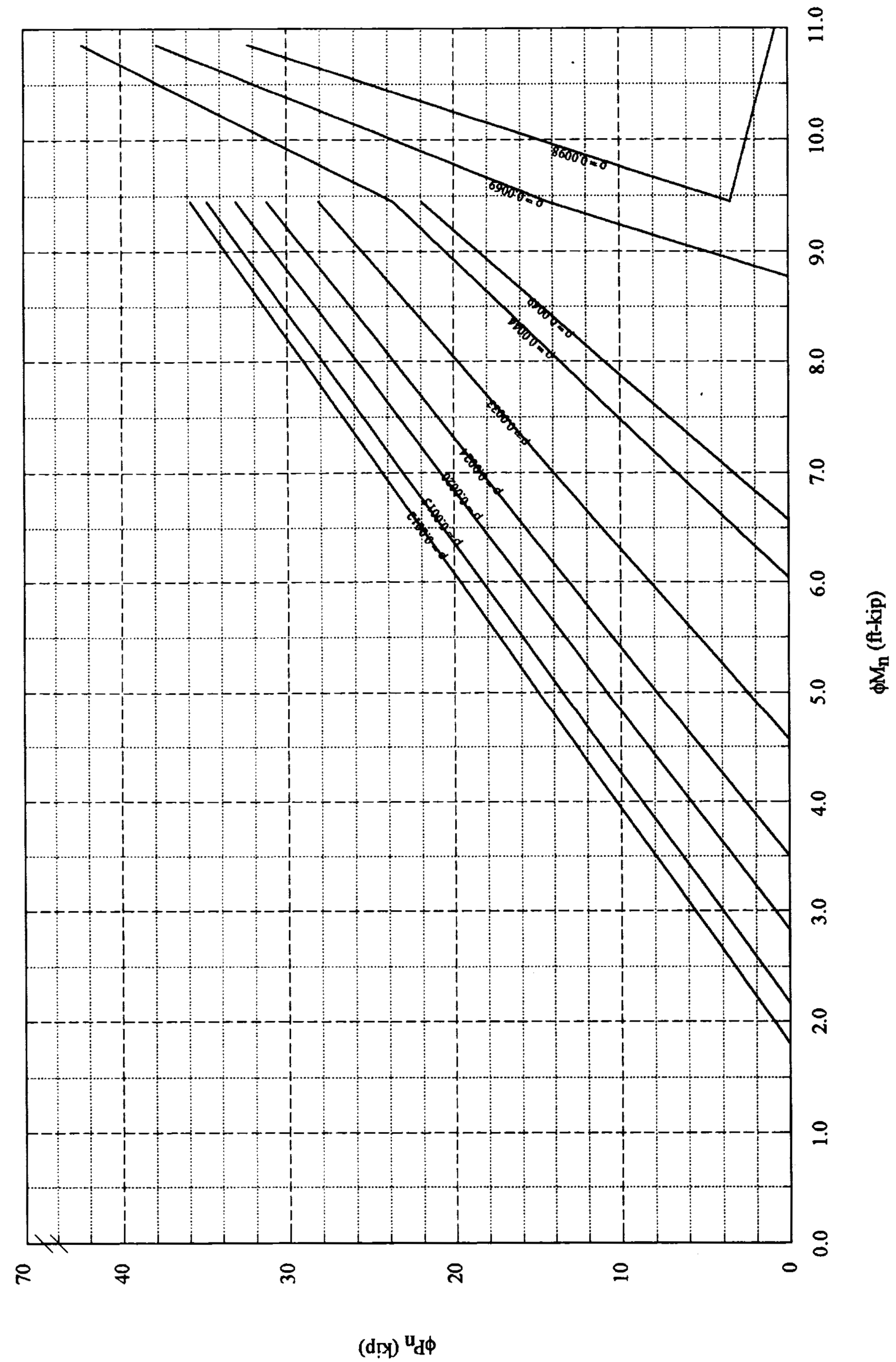
6" Flat Wall (f_c = 4 ksi, f_y = 60 ksi)



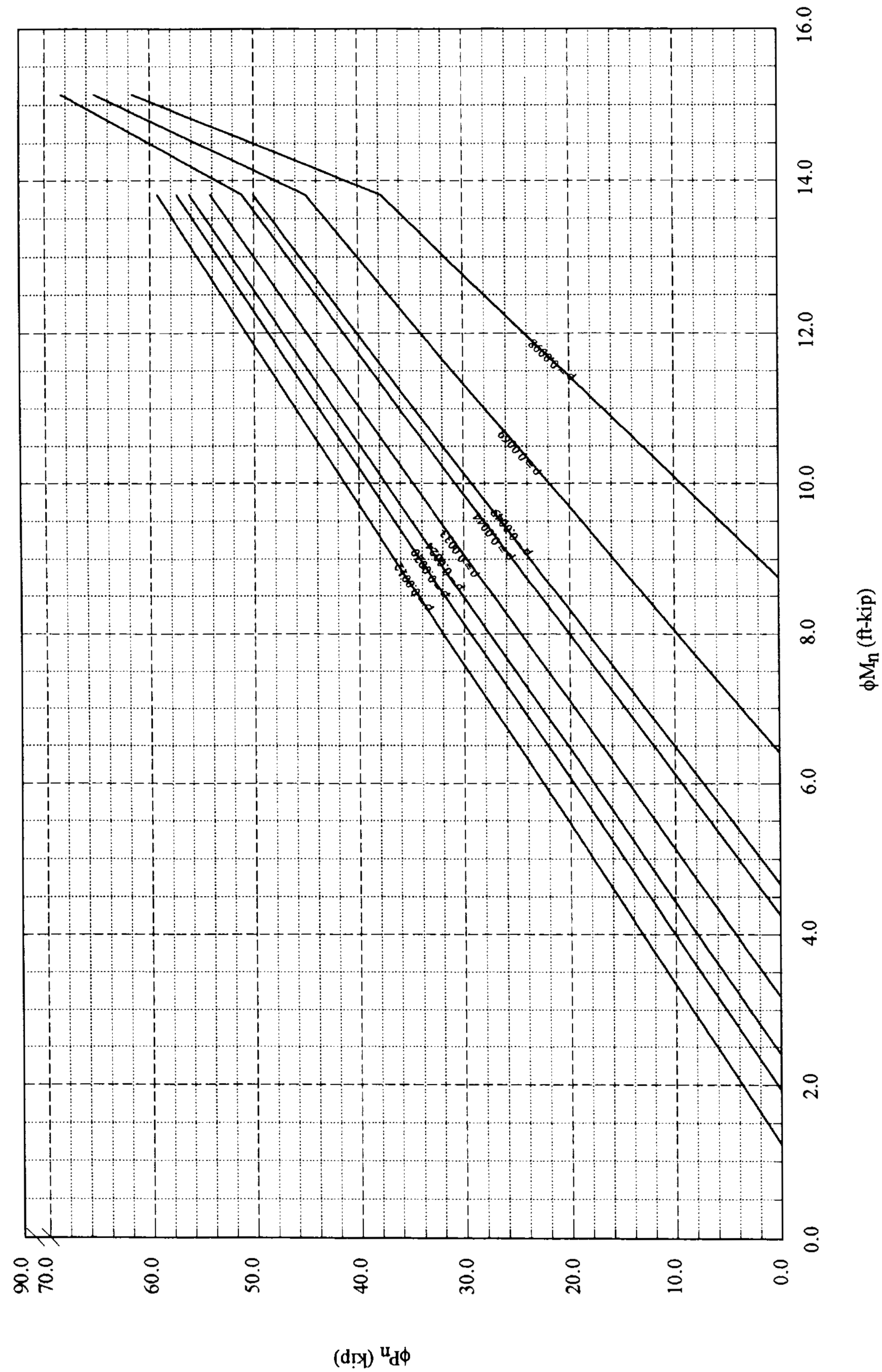
8" Flat Wall (f_c = 3 ksi, f_y = 40 ksi)



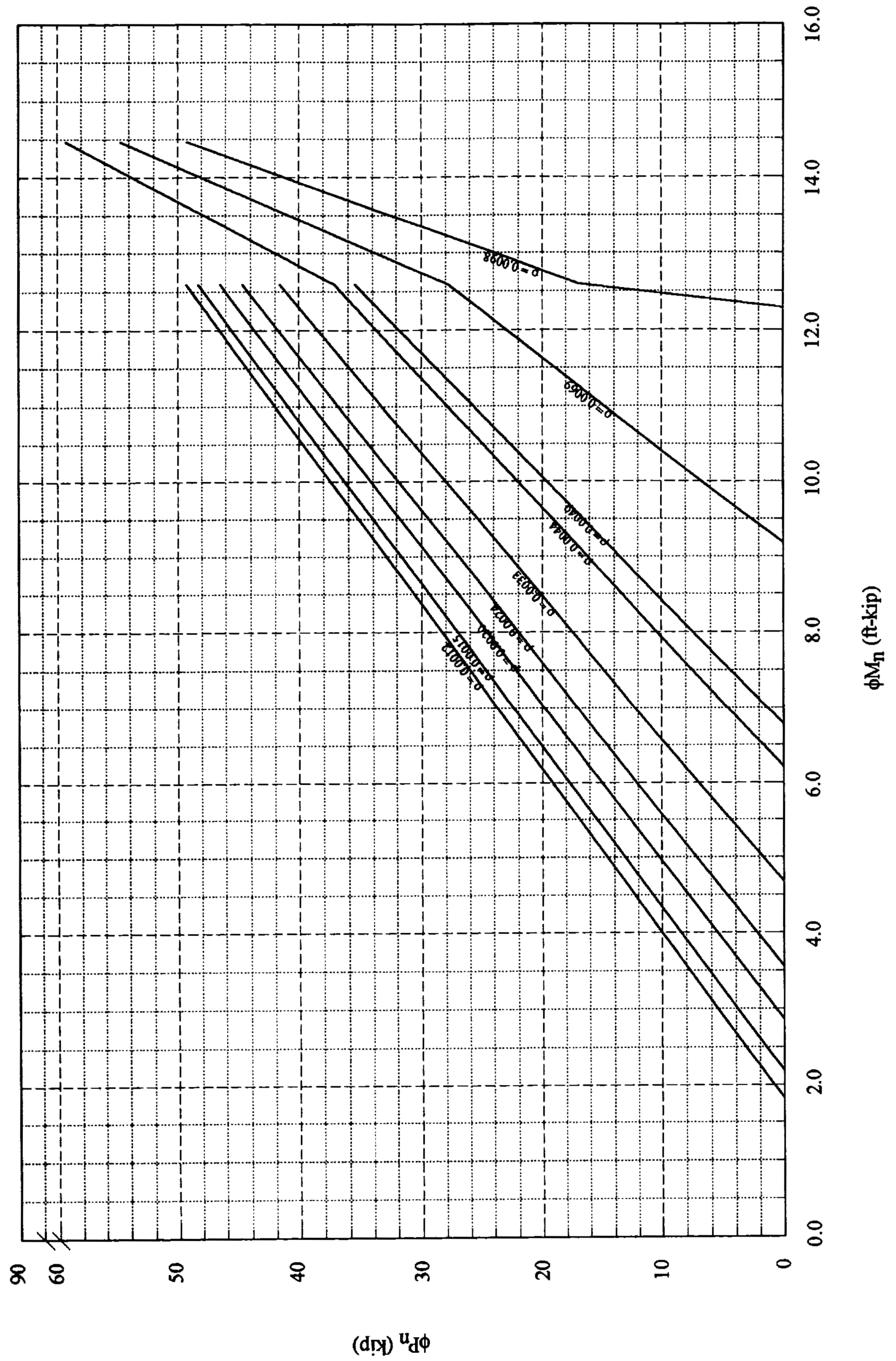
8" Flat Wall (f_c = 3 ksi, f_y = 60 ksi)



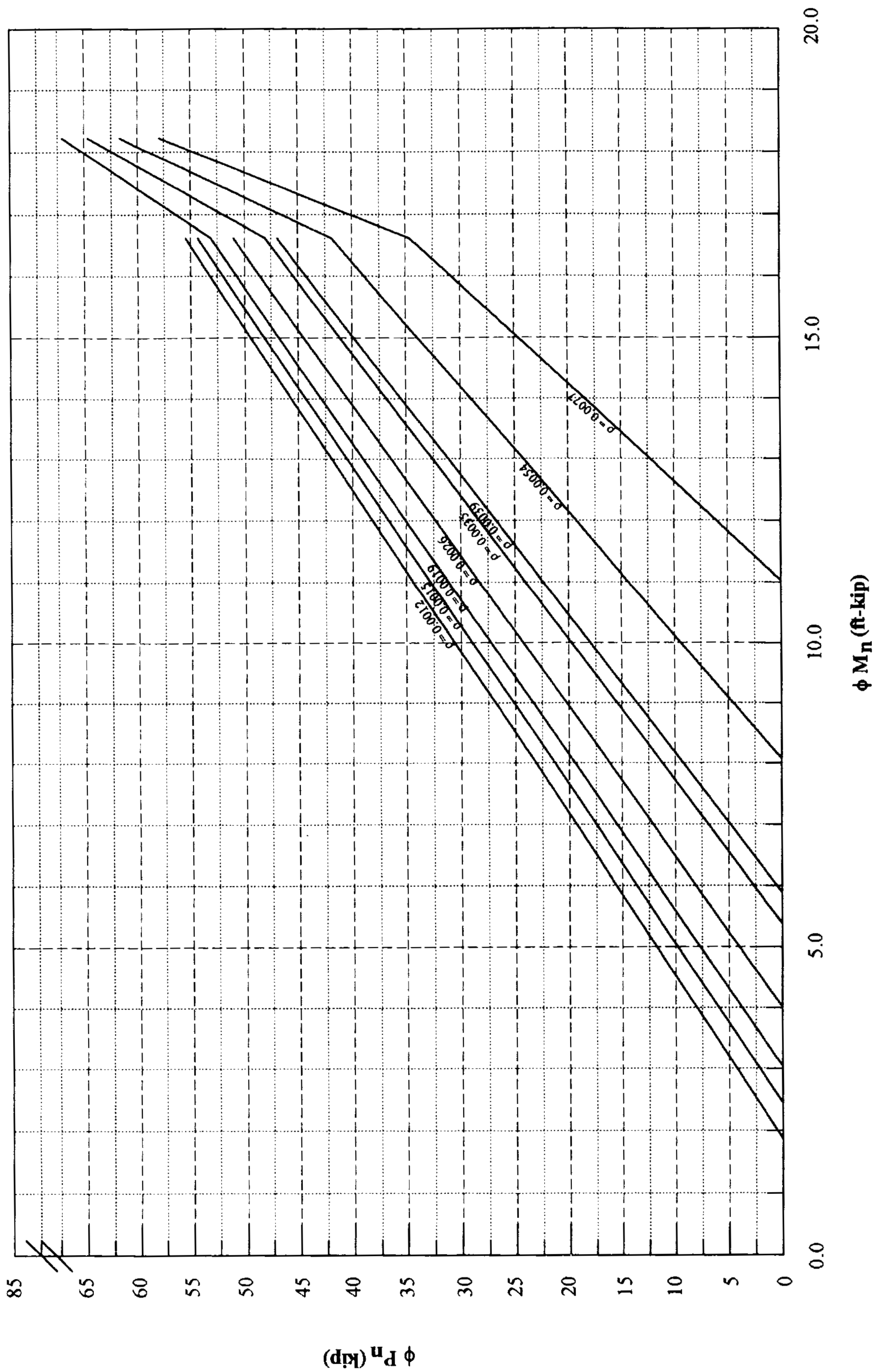
8" Flat Wall (f_c = 4 ksi, f_y = 40 ksi)



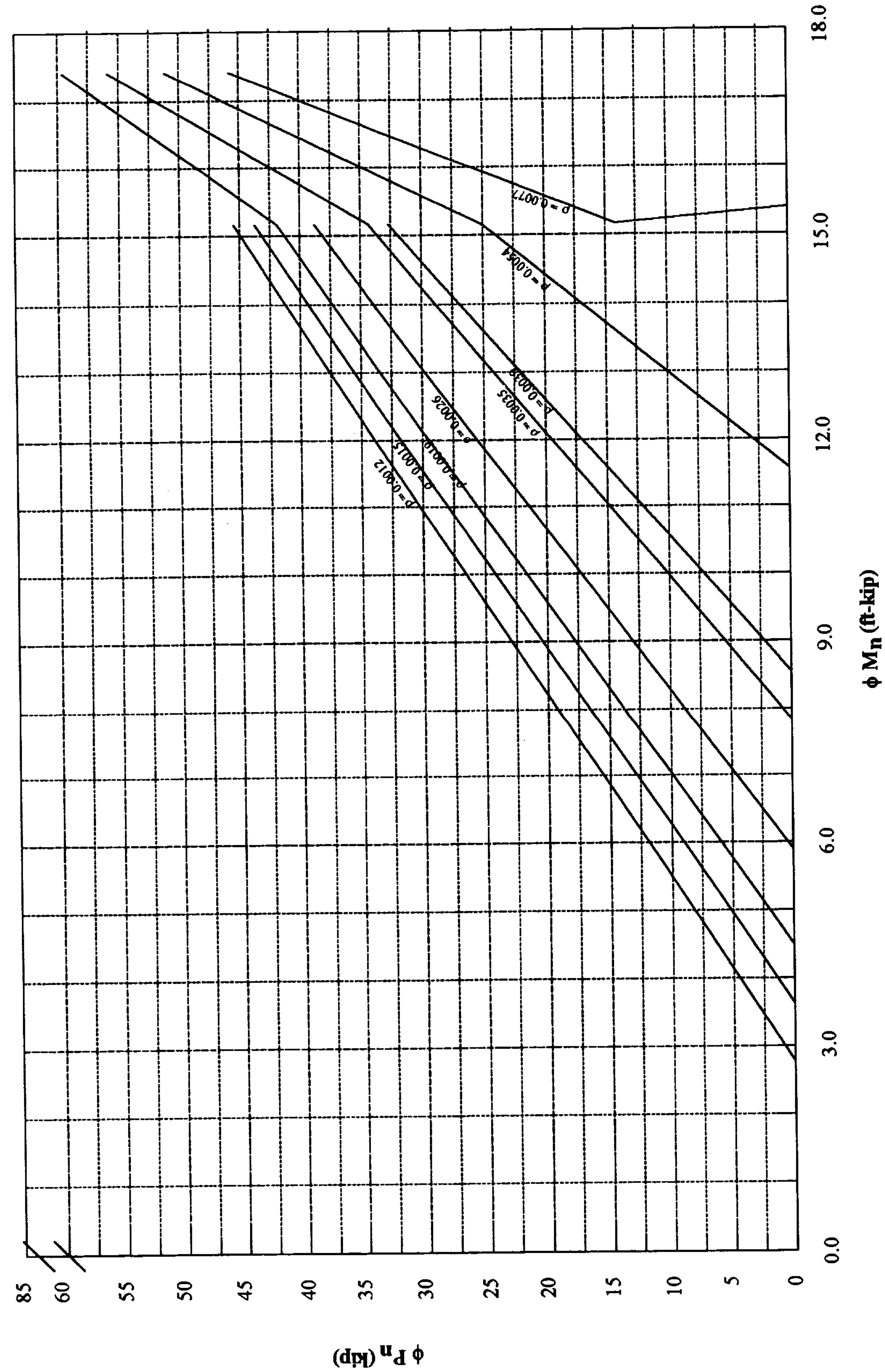
8" Flat Wall ($f_c = 4$ ksi, $f_y = 60$ ksi)



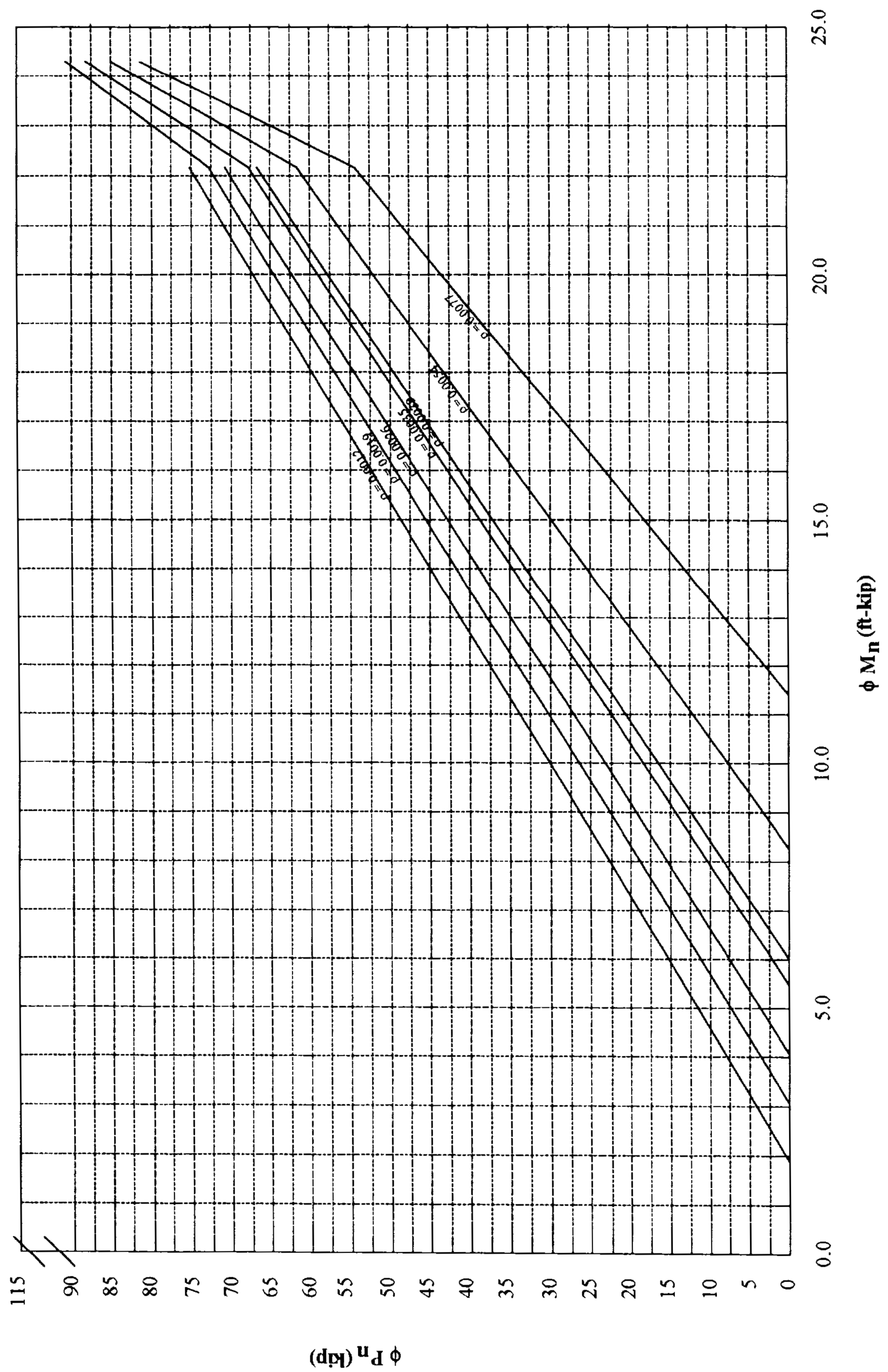
10" Flat Wall (f_c = 3 ksi, f_y = 40 ksi)



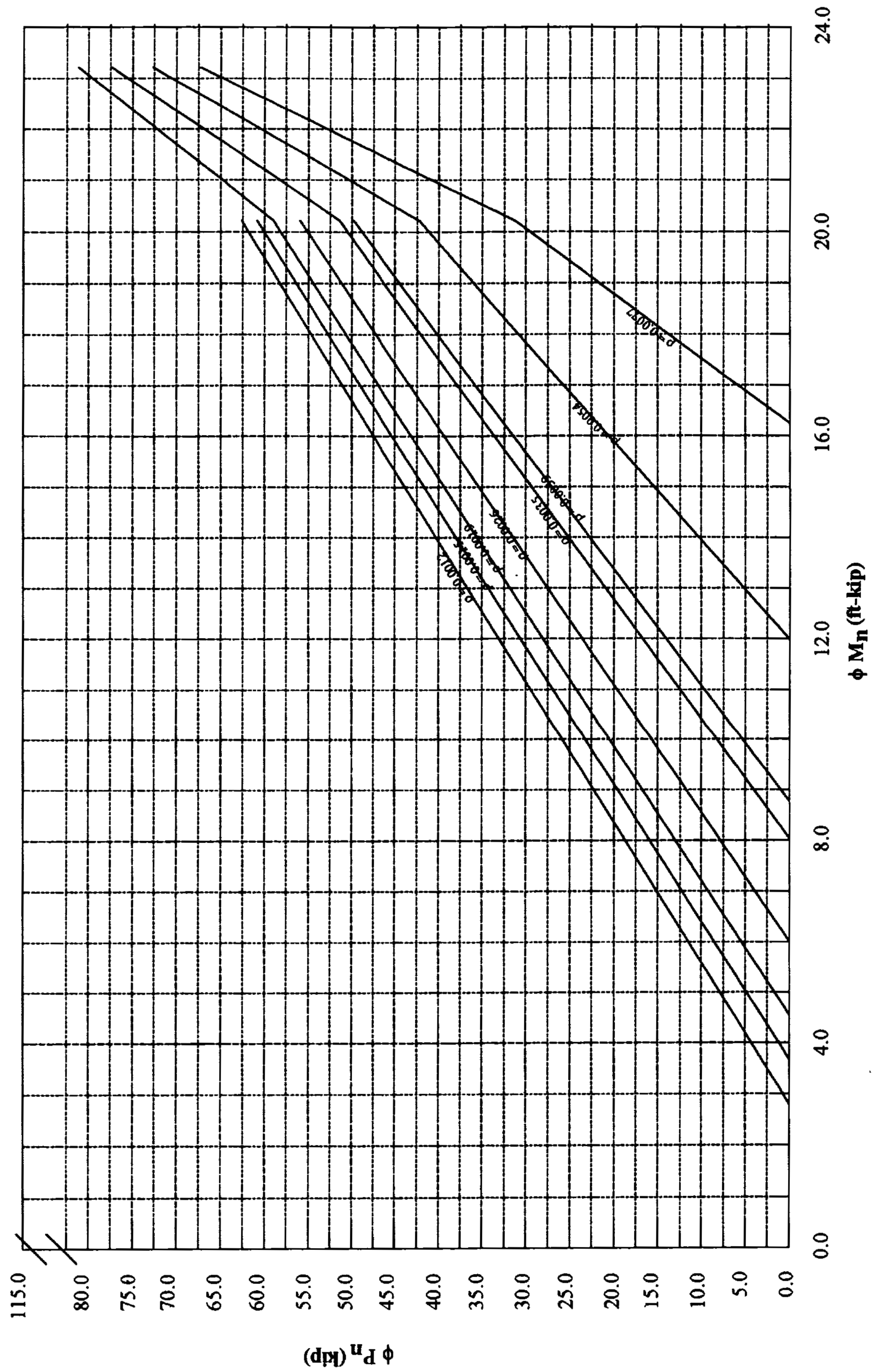
10" Flat Wall (f_c = 3 ksi, f_y = 60 ksi)



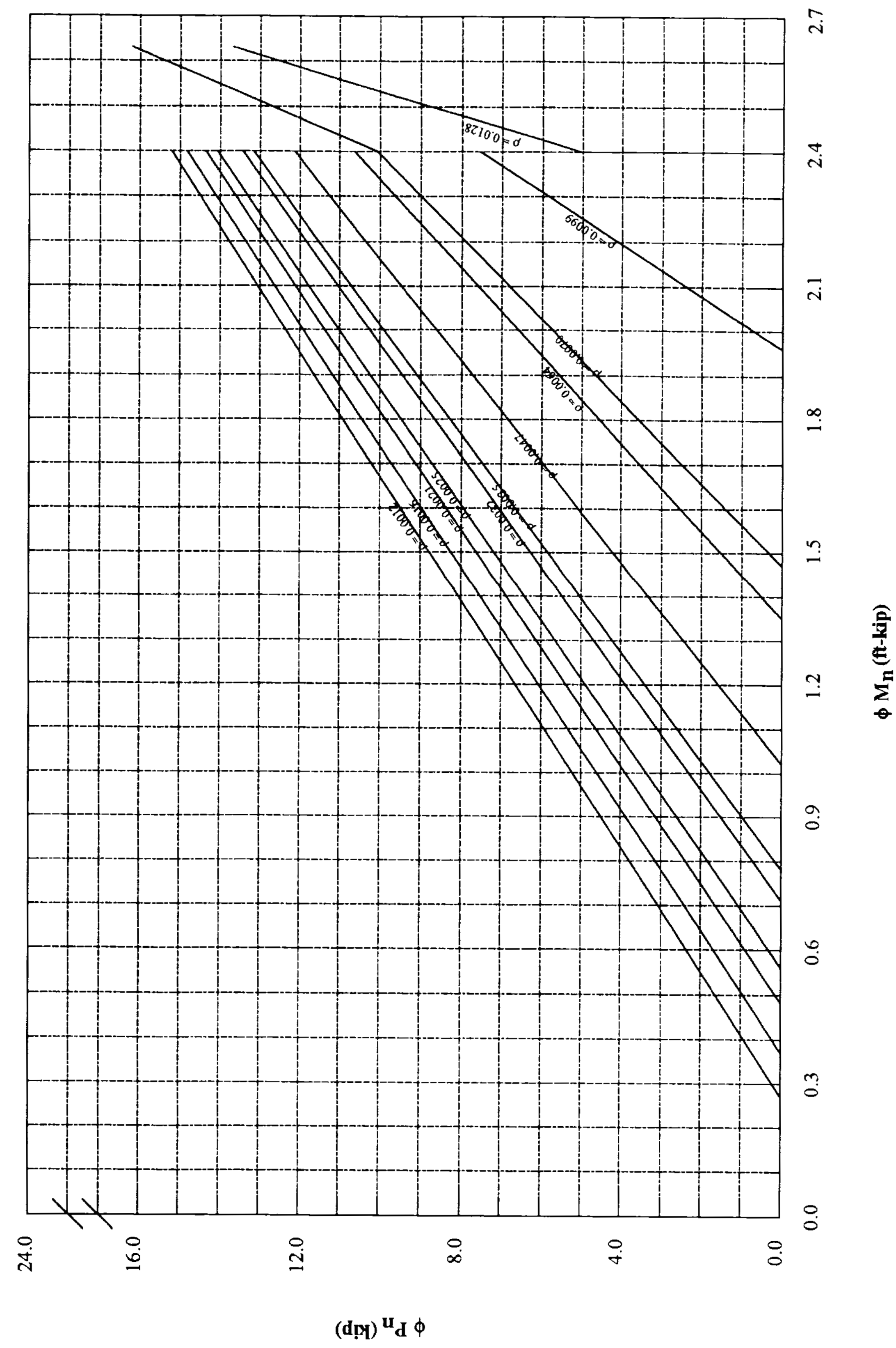
10" Flat Wall (f_c = 4 ksi, f_y = 40 ksi)



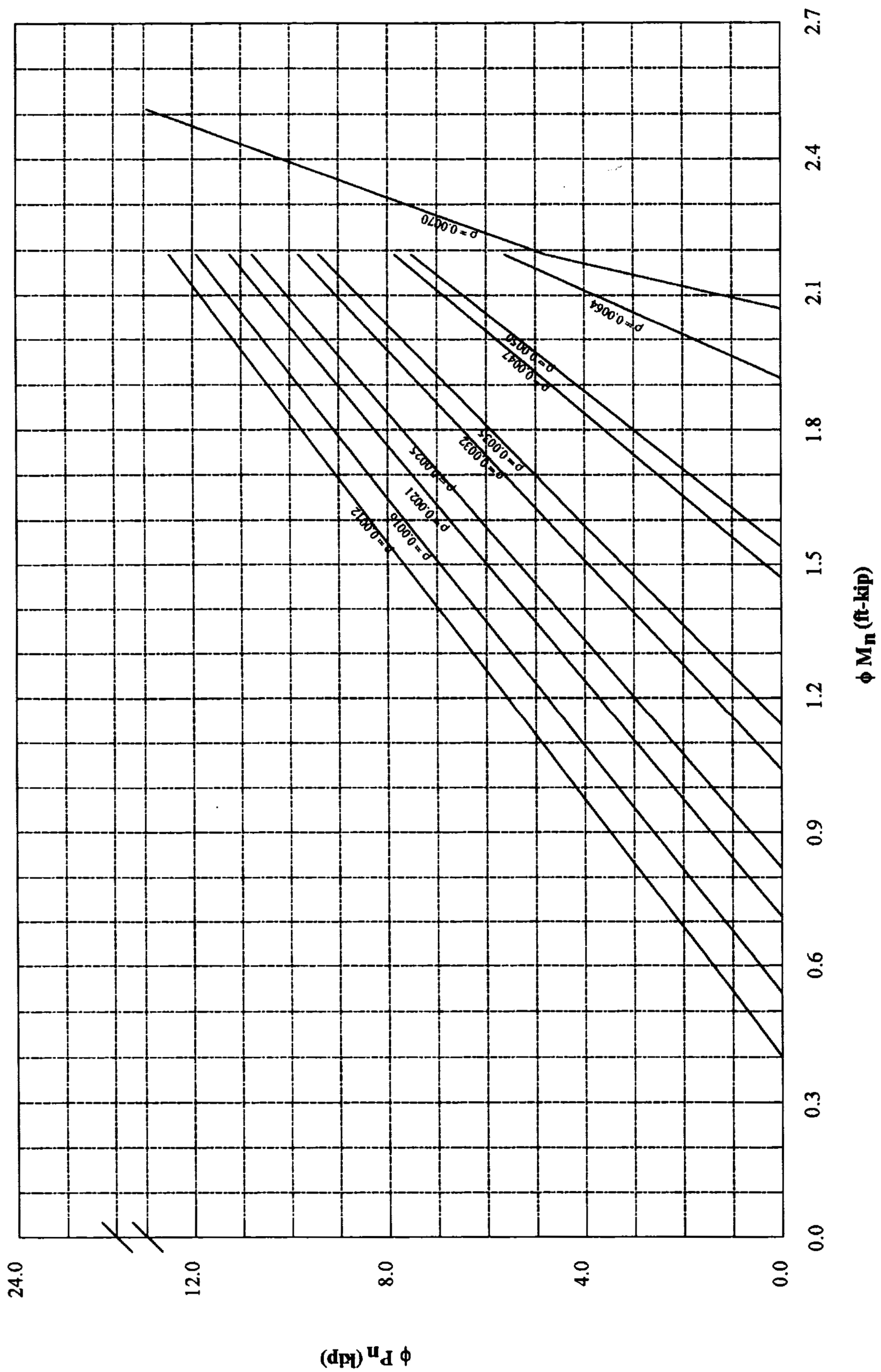
10" Flat Wall (f_c = 4 ksi, f_y = 60 ksi)



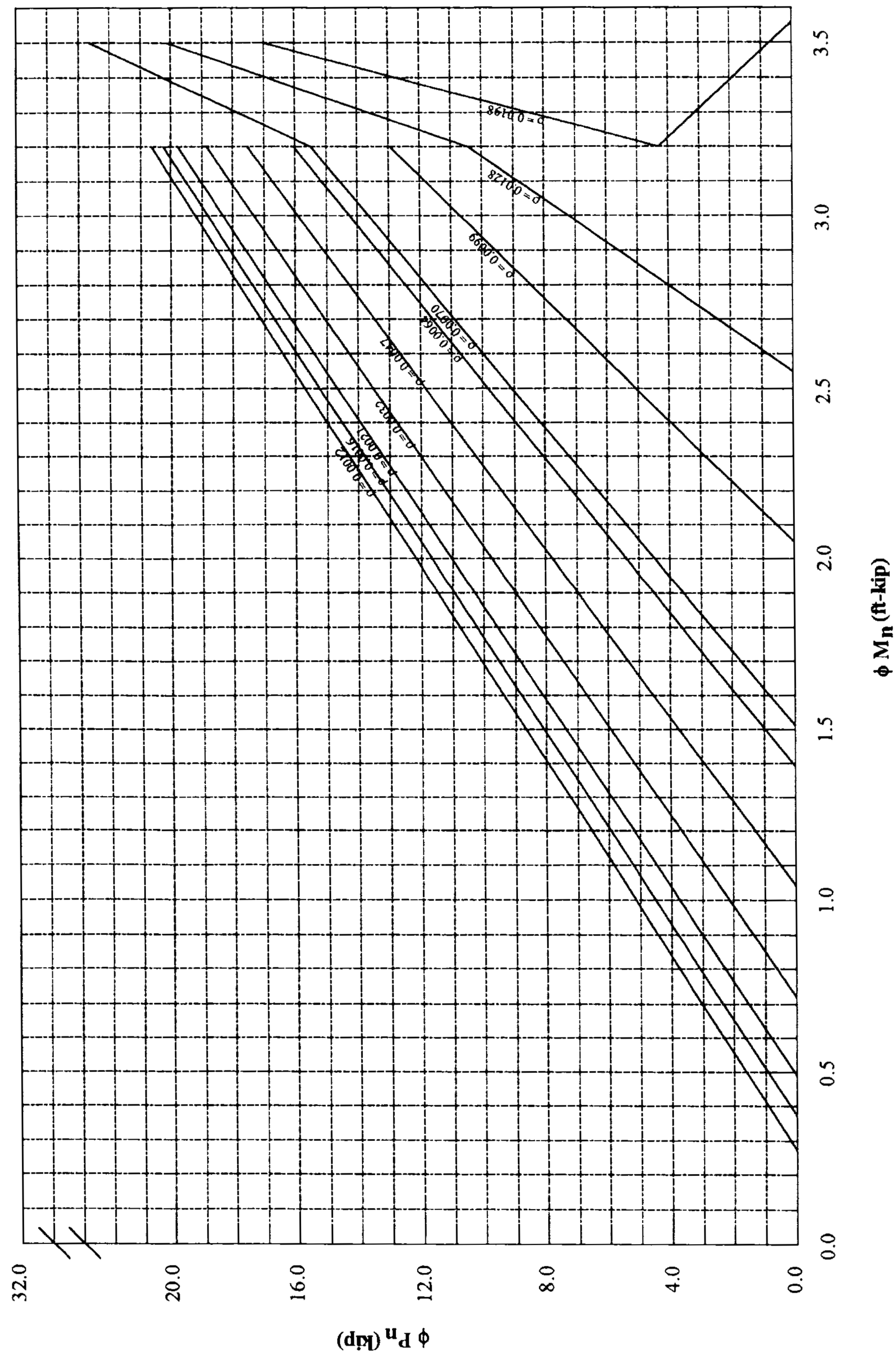
6" Waffle Grid Wall (f_c = 3 ksi, f_y = 40 ksi)



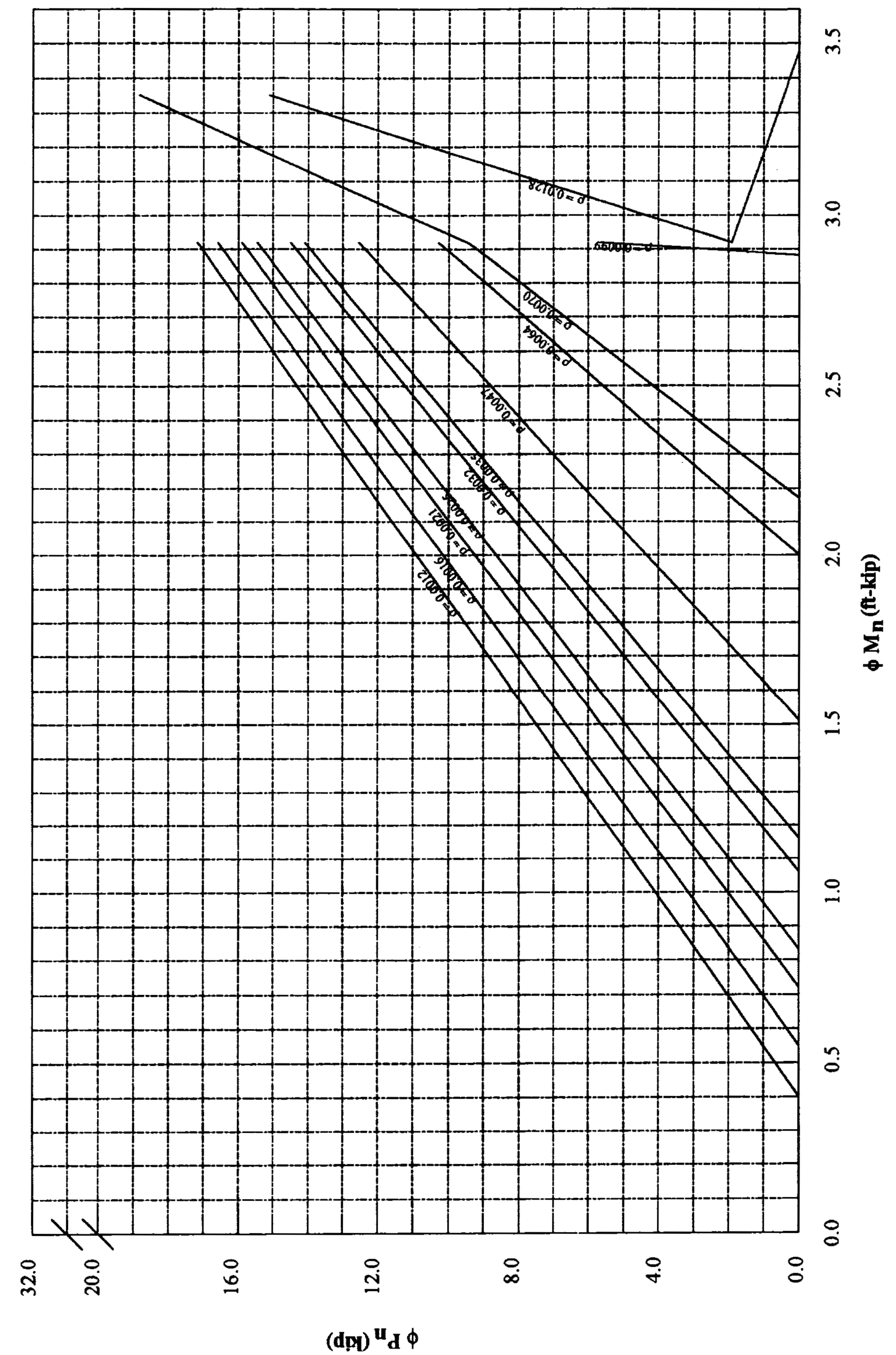
6" Waffle Grid Wall (f_c = 3 ksi, f_y = 60 ksi)

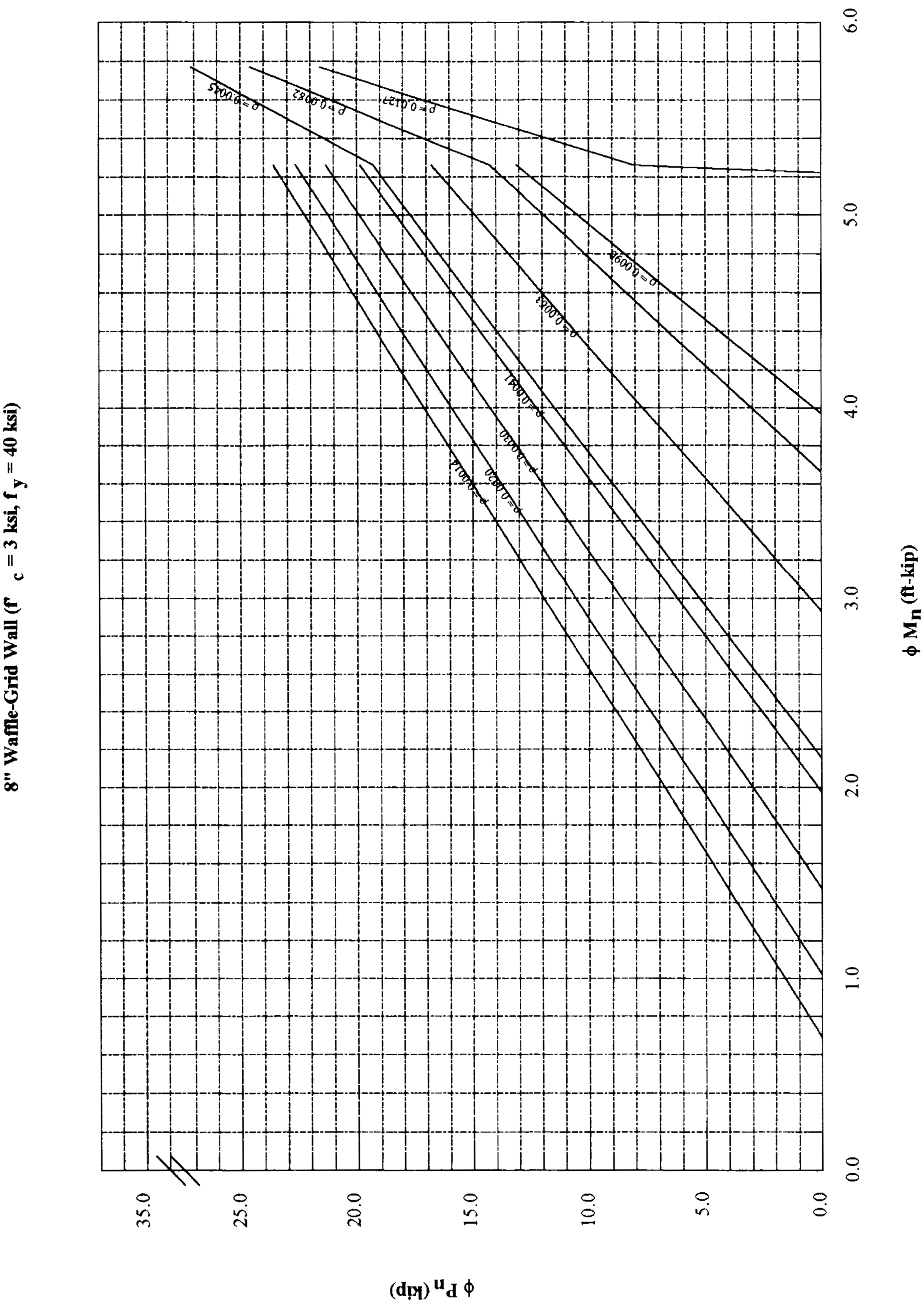


6" Waffle Grid Wall (f'_c = 4 ksi, f_y = 40 ksi)

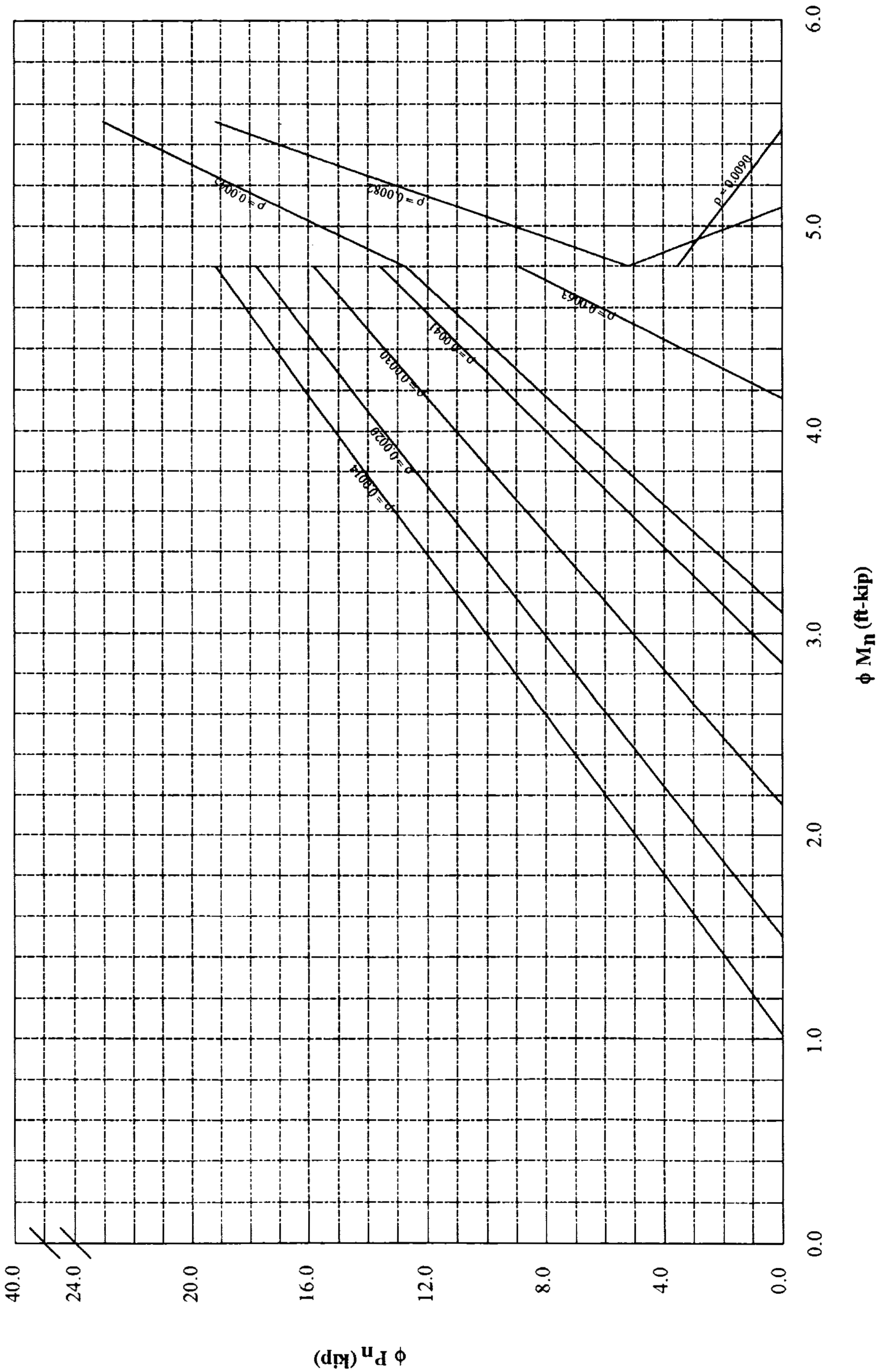


6" Waffle Grid Wall (f_c = 4 ksi, f_y = 60 ksi)

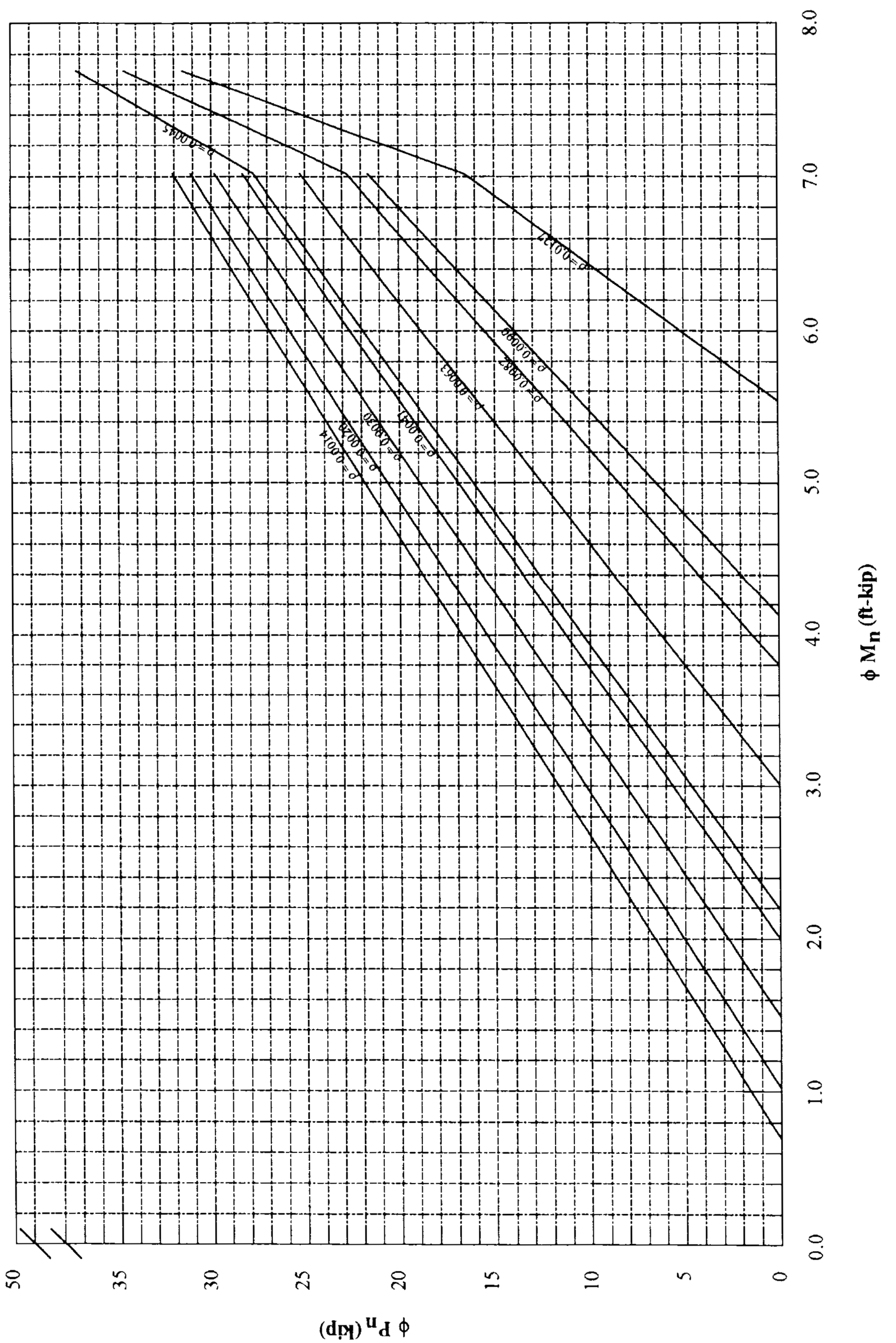



8" Waffle-Grid Wall (f'c = 3 ksi, f y = 40 ksi)
ρ = 0.0045
ρ = 0.0082
ρ = 0.0127
ρ = 0.0098
ρ = 0.0063
ρ = 0.0041
ρ = 0.0030
ρ = 0.0020
ρ = 0.0014
φ Mn (ft-kip)
φ Pn (kip)
0.0
1.0
2.0
3.0
4.0
5.0
6.0
35.0
25.0
20.0
15.0
10.0
5.0
0.0

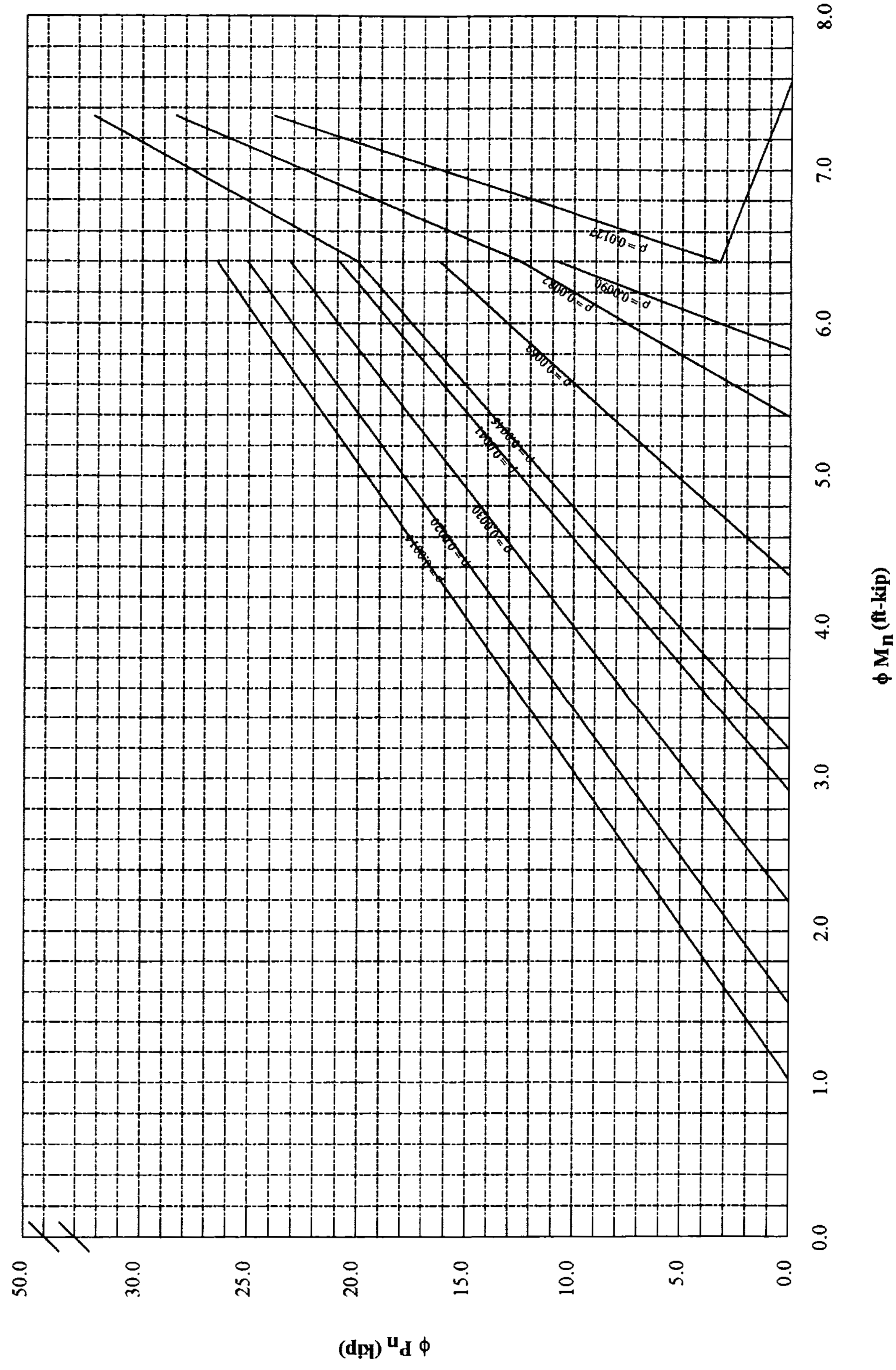
8" Waffle Grid Wall (f_c = 3 ksi, f_y = 60 ksi)



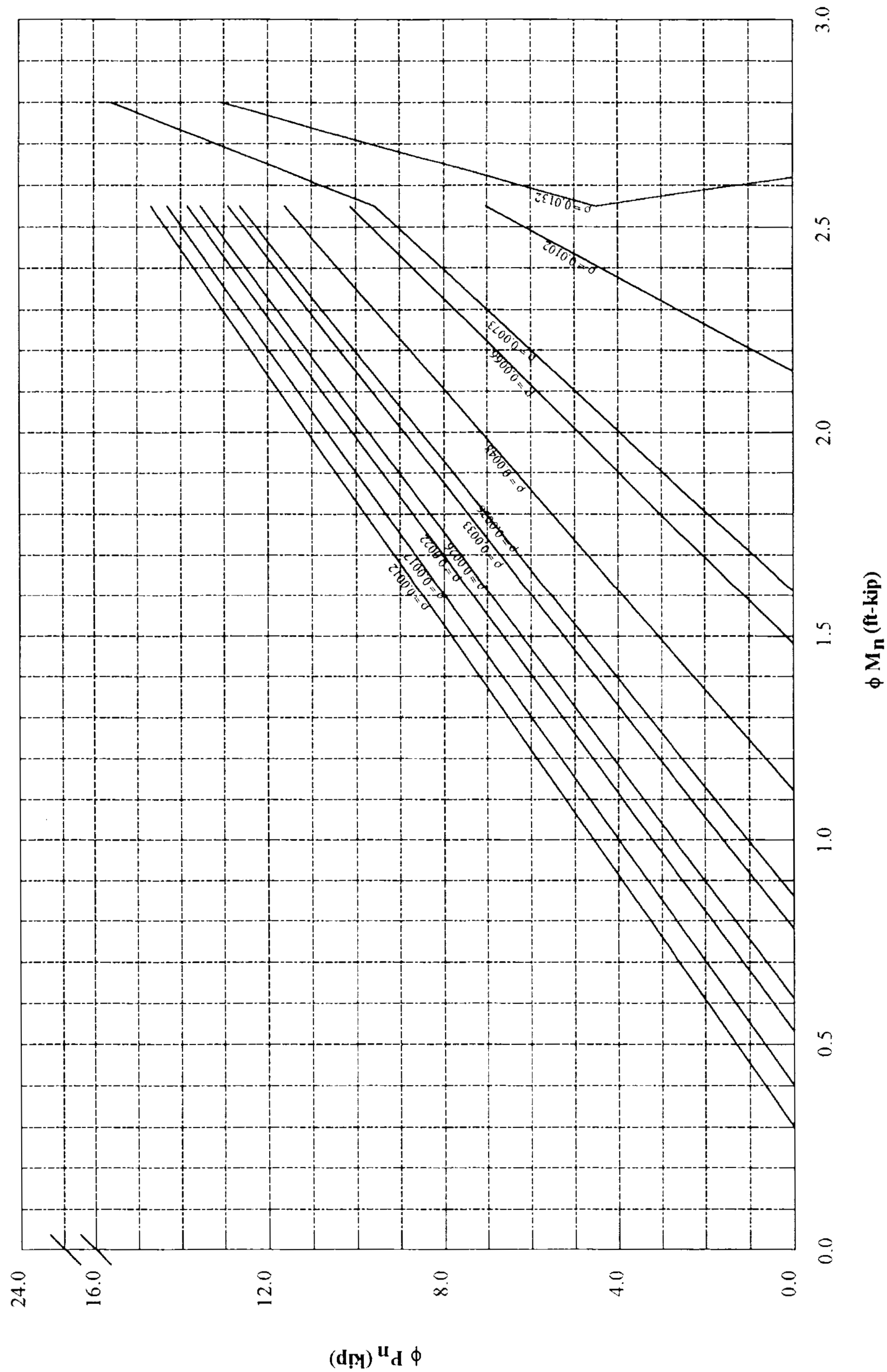
8" Waffle Grid Wall (f_c = 4 ksi, f_y = 40 ksi)



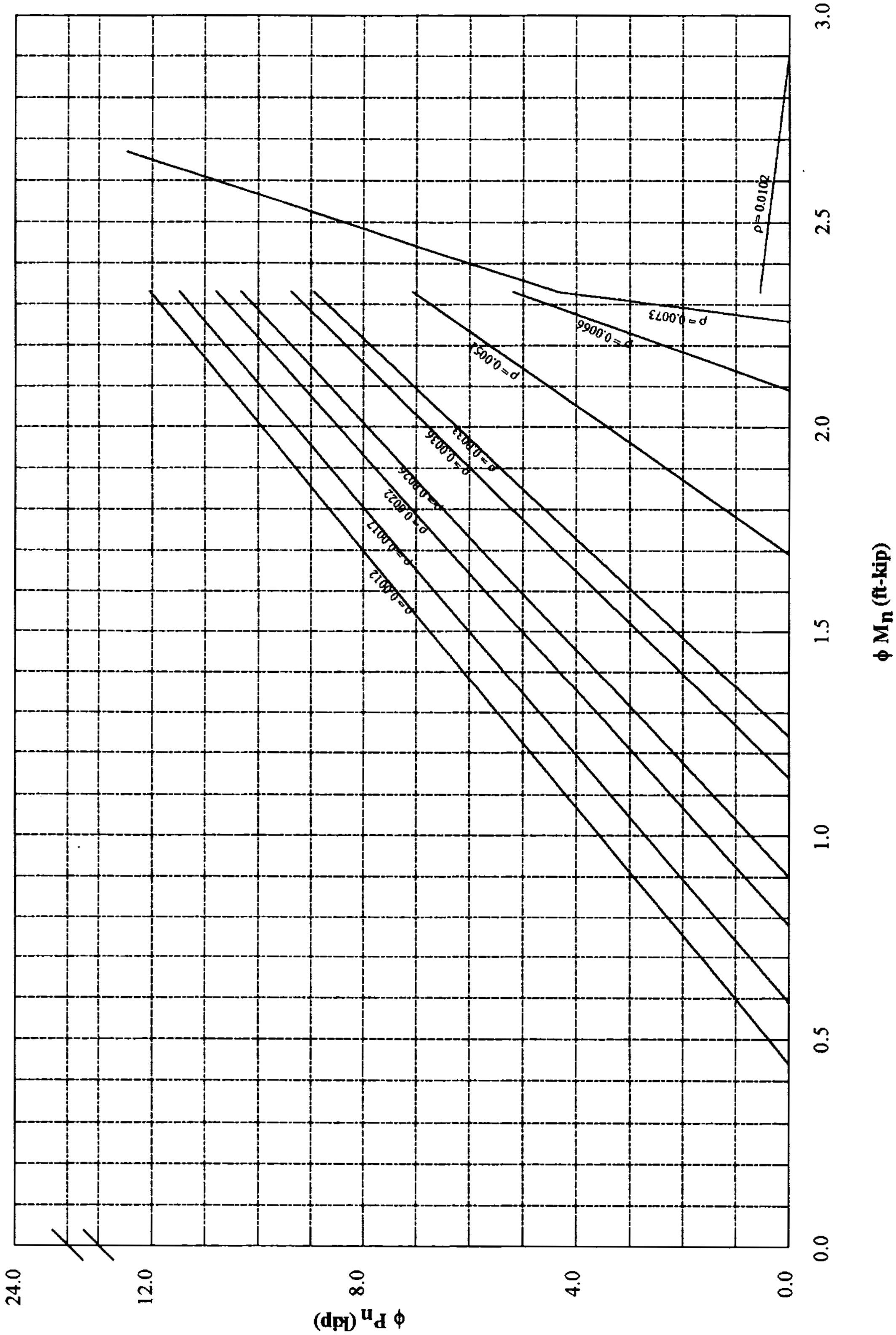
8" Waffle Grid Wall (f'_c = 4 ksi, f_y = 60 ksi)



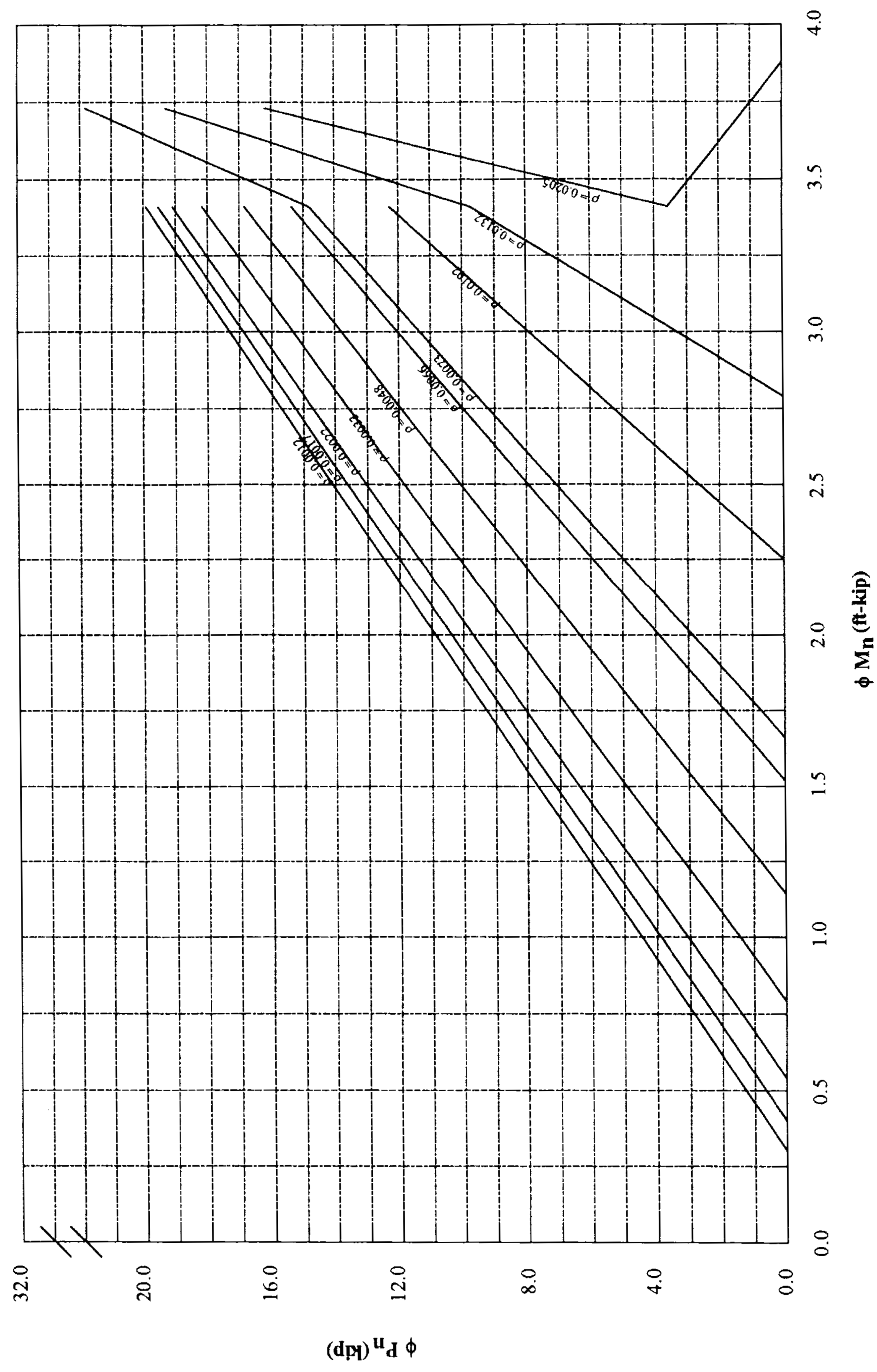
6" Screen Grid Wall (f'_c = 3 ksi, f_y = 40 ksi)



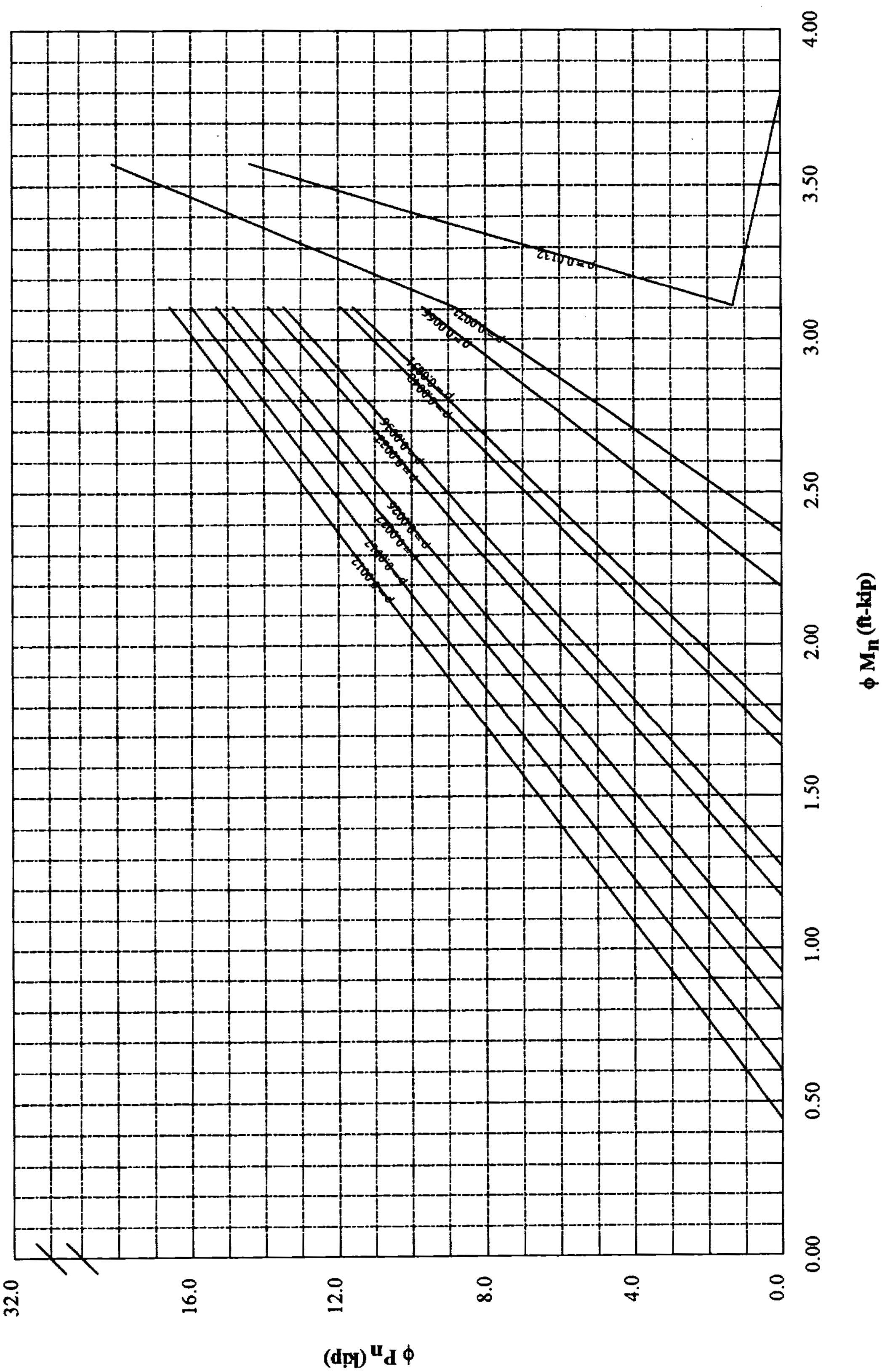
6" Screen Grid Wall (f_c = 3 ksi, f_y = 60 ksi)



6" Screen Grid Wall (f_c = 4 ksi, f_y = 40 ksi)



6" Screen Grid Wall (f_c = 4 ksi, f_y = 60 ksi)



APPENDIX E

INTERACTION DIAGRAMS FOR STRUCTURAL PLAIN CONCRETE WALLS

Interaction diagrams represent the relationship of the combined effects of axial load and bending moment on a concrete wall and are used as design aids to assist the designer in determining the wall's structural adequacy. Points located within the interaction curve for a given wall height and the reference axes represent a combination of axial load and bending moment that the wall can support. To construct interaction diagrams representing as many ICF manufacturers as possible, the interaction diagrams were determined using the dimensions shown in Figure E-1.

Non-Sway Moment Magnifier Tables								
ICF Wall Type	Nominal Thickness		Minimum Equivalent Thickness (h)		Minimum Equivalent Width (b)		Vertical Core Spacing	
	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)	(inch)	(mm)
Flat	4	101.6	3.5	88.9	12.0	304.8	N.A.	N.A.
	6	152.4	5.5	139.7	12.0	304.8	N.A.	N.A.
	8	203.2	7.5	190.5	12.0	304.8	N.A.	N.A.
	10	254.0	9.5	241.3	12.0	304.8	N.A.	N.A.
Waffle-Grid	6	152.4	5.0	127.0	6.25	158.8	12	304.8
	8	203.2	7.0	177.8	7.0	177.8	12	304.8
Screen-Grid	6	152.4	5.5	139.7	5.5	139.7	12	304.8

Figure E-1 Dimensions Used for Interaction Diagrams for Structural Plain Concrete Walls

As a result of constructing interaction diagrams representative of current ICF manufacturers, some design efficiency has been sacrificed, particularly in the screen-grid wall type because of the variety of dimensions available. The designer may wish to construct custom interaction diagrams to obtain a more efficient design. The interaction diagram is constructed using the following two linear equations in accordance with ACI 22.5.3:

$$\frac{P_u}{\phi P_n} + \frac{M_u}{\phi M_n} \leq 1 \quad \textit{on the compression face}$$

$$\frac{M_u}{S} - \frac{P_u}{A_g} \leq 5\phi\sqrt{f_c'} \quad \textit{on the tension face}$$

$$P_n = 0.6 f_c'\left[1 - \left(\frac{l_c}{32h}\right)^2\right] A_g$$

$$M_n = 0.85 f_c' S$$

$$M_{u,min} = 0.1 h P_u$$

where:

ϕ	Strength reduction factor = 0.65 per ACI 9.3.5	dimensionless
A_g	Gross area of concrete section	inch²
f_c'	Specified compressive strength of concrete	psi
h	Thickness of wall, Refer to Figure E-2	inch
l_c	Vertical distance between supports	inch
M_n	Nominal moment strength at section	in-lb
M_u	Factored moment at section	in-lb
$M_{u,min}$	Minimum factored moment per ACI 22.6.3	in-lb

P_n	Nominal axial load strength at section	lb
P_u	Factored axial load at section	lb
S	Elastic section modulus of section	inch^3

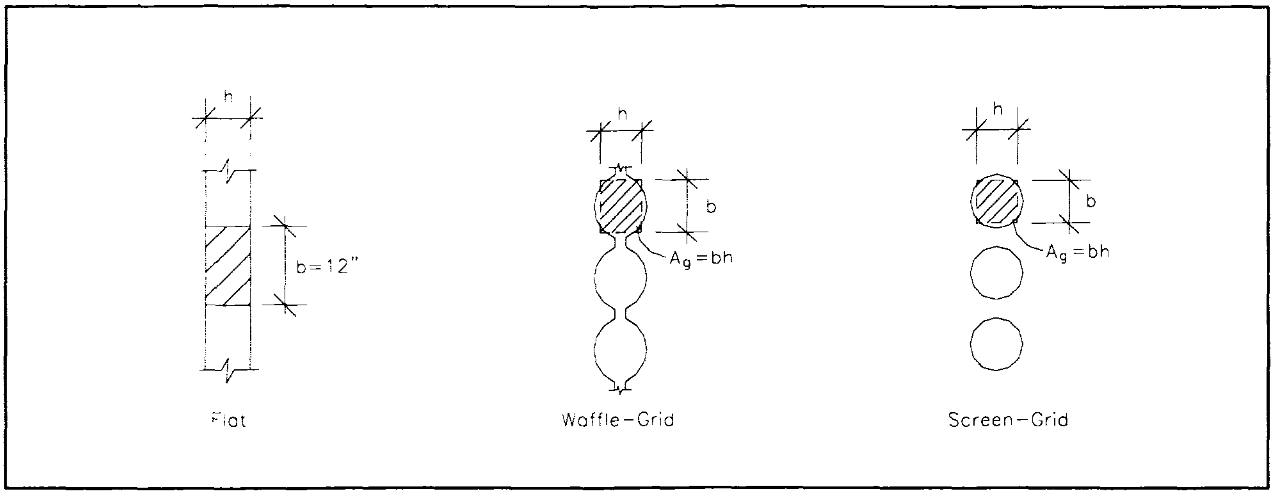
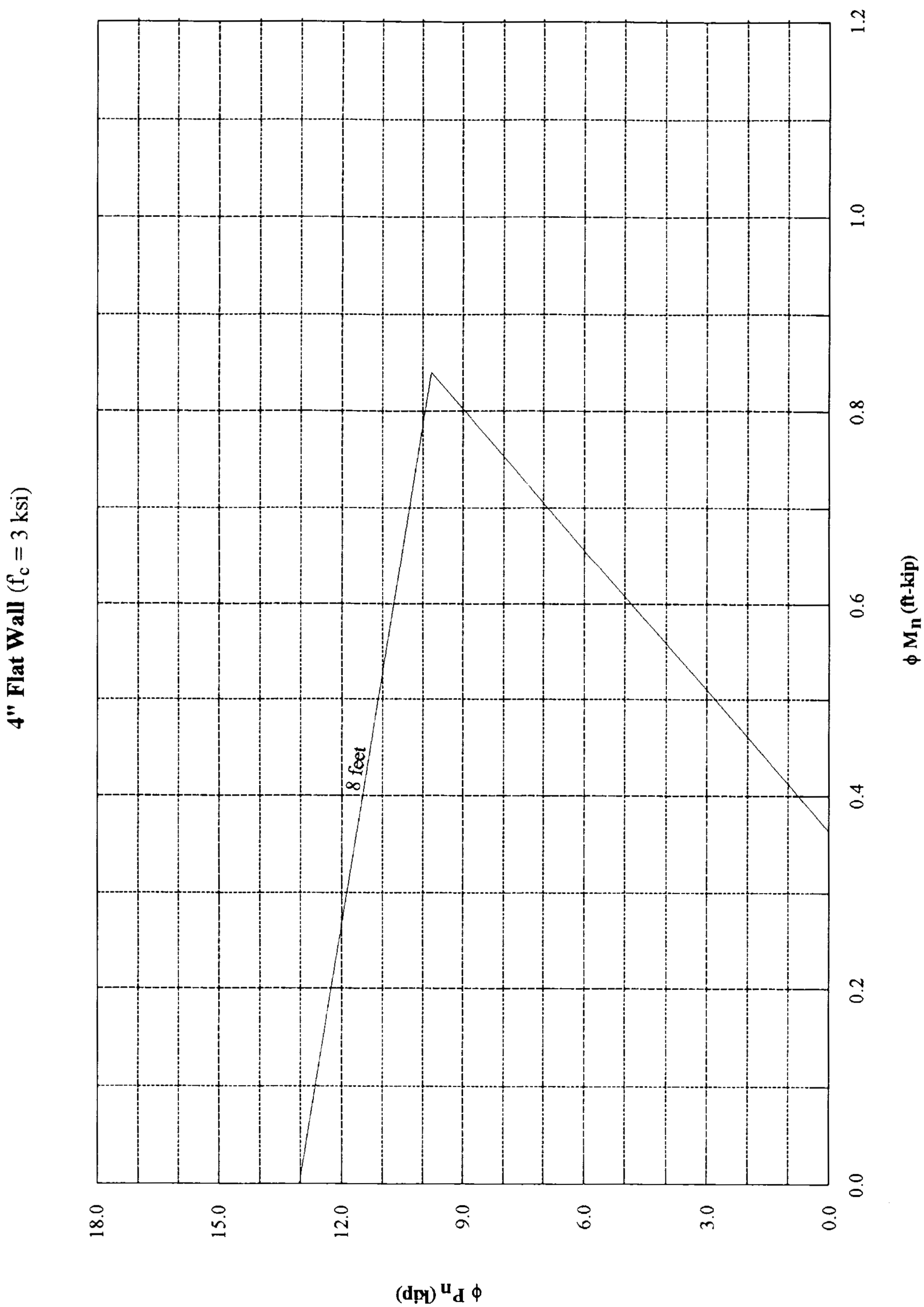
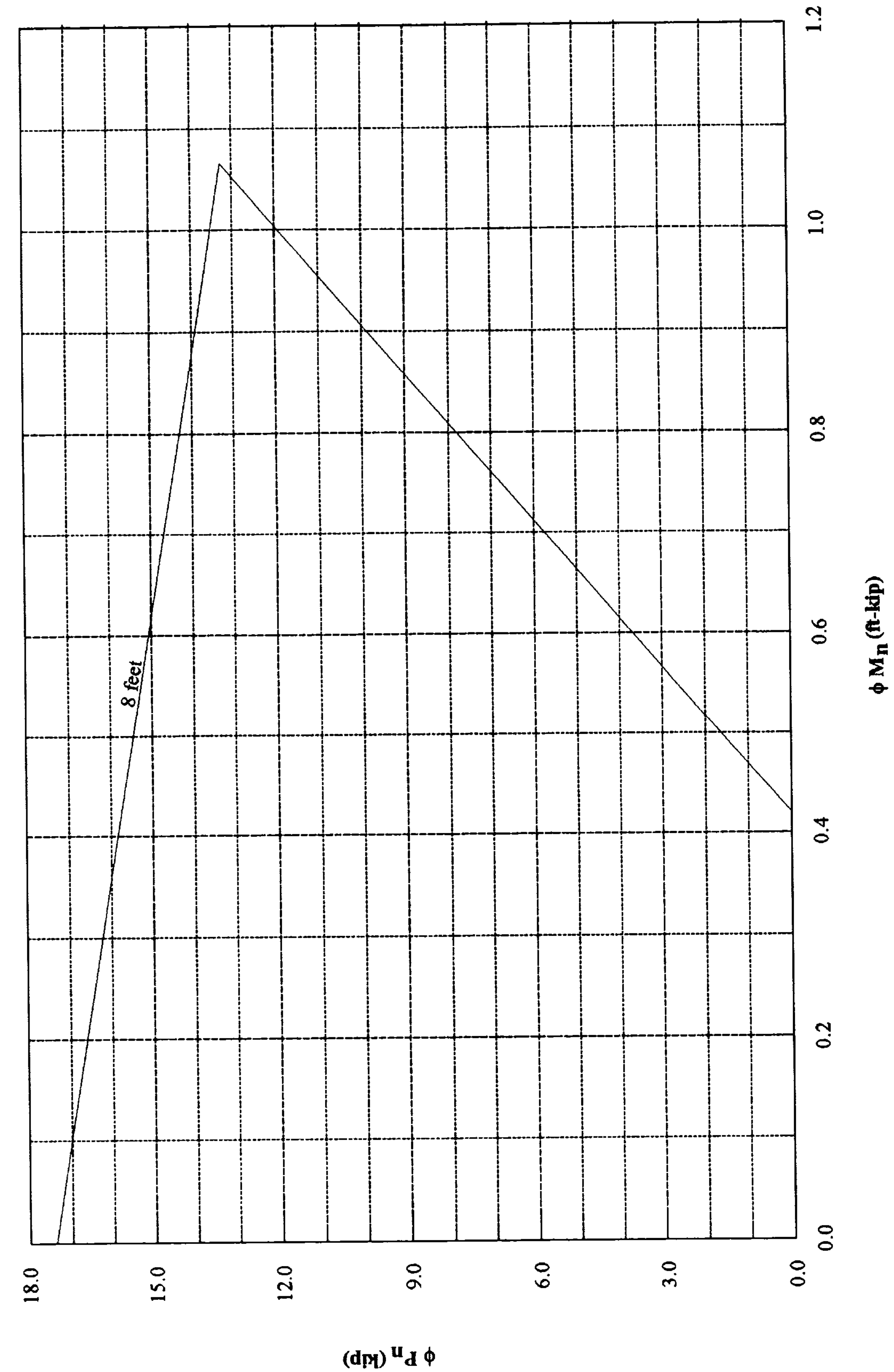


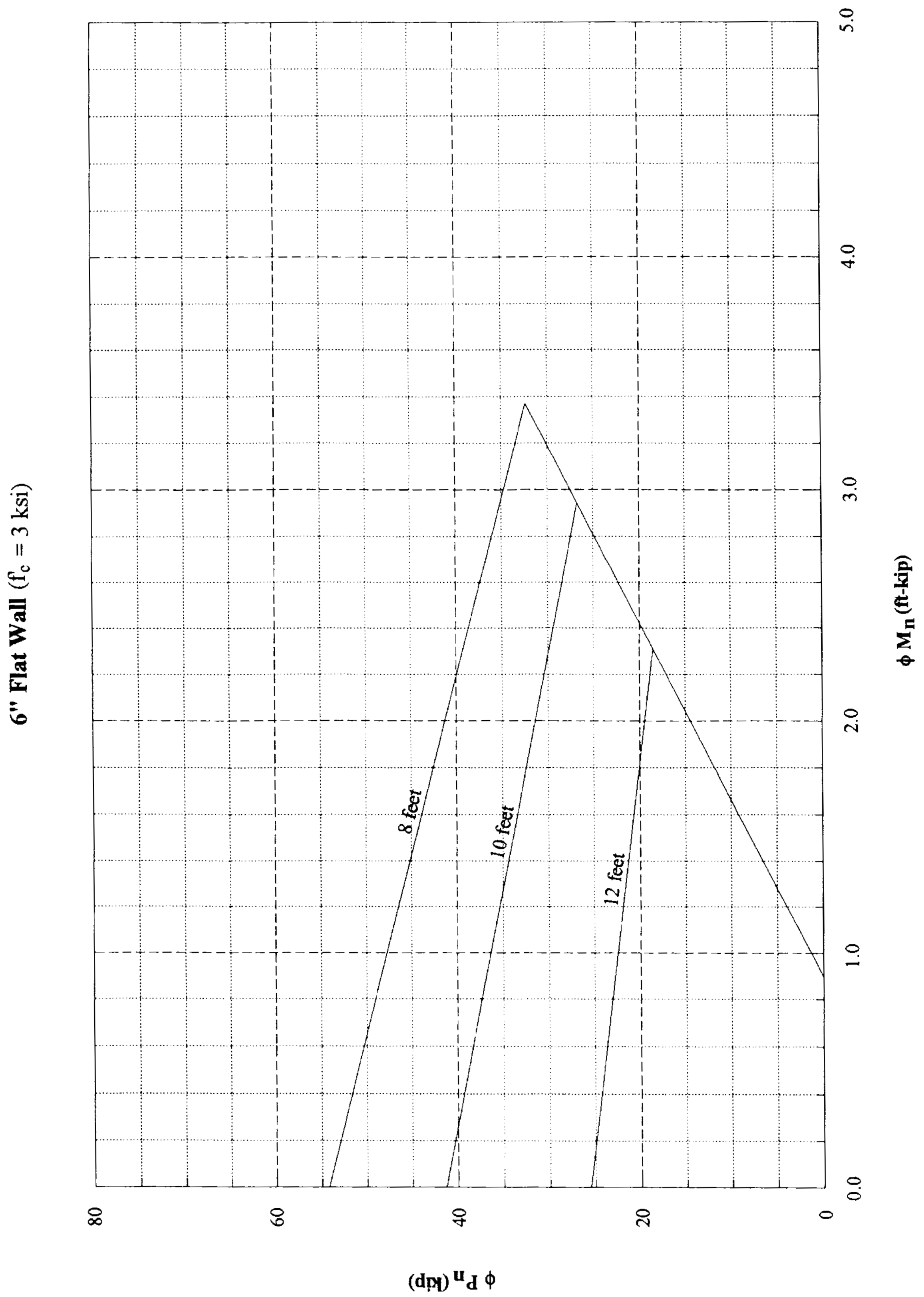
Figure E-2 Variables Defined for Interaction Diagrams for Structural Plain Walls

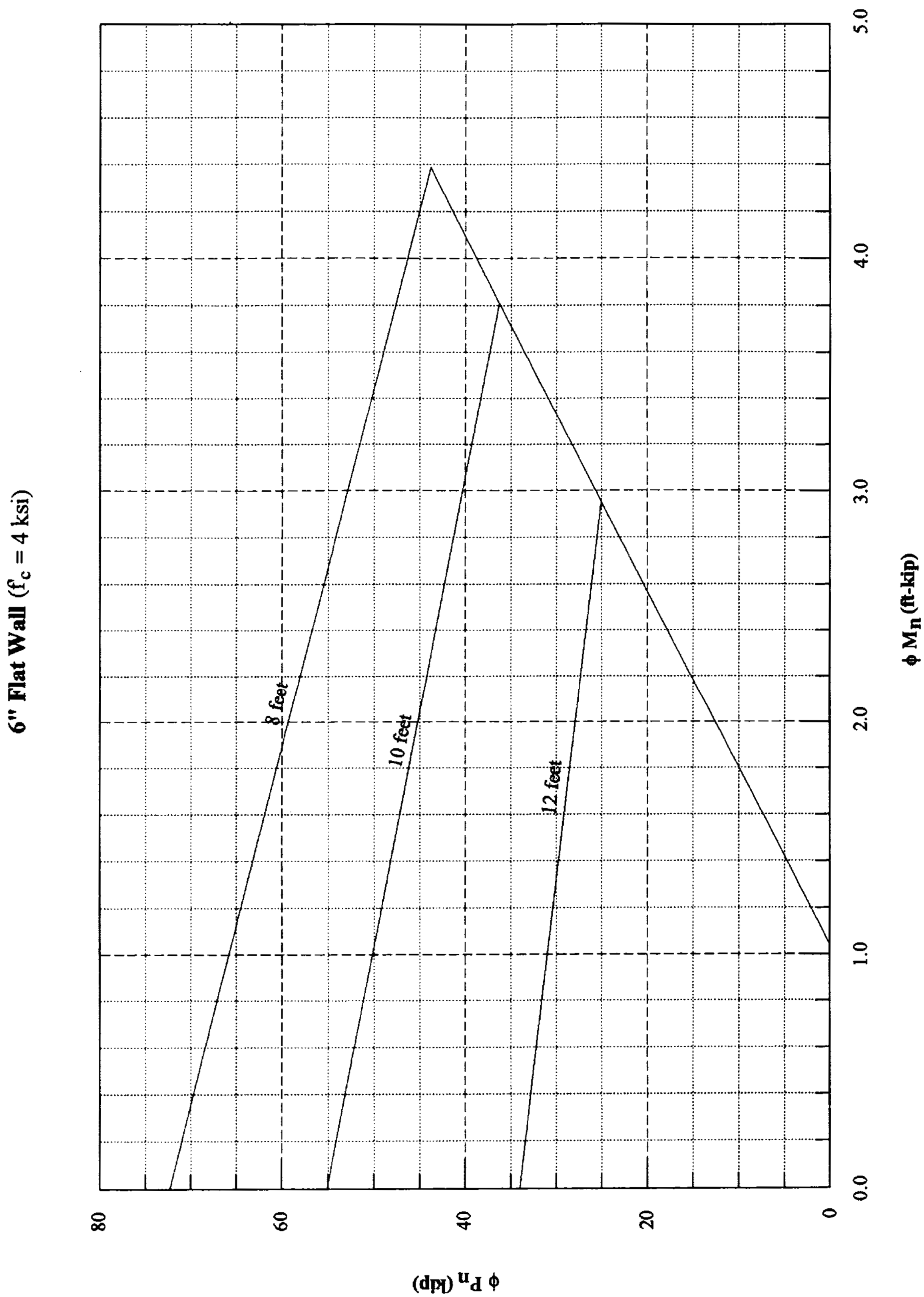


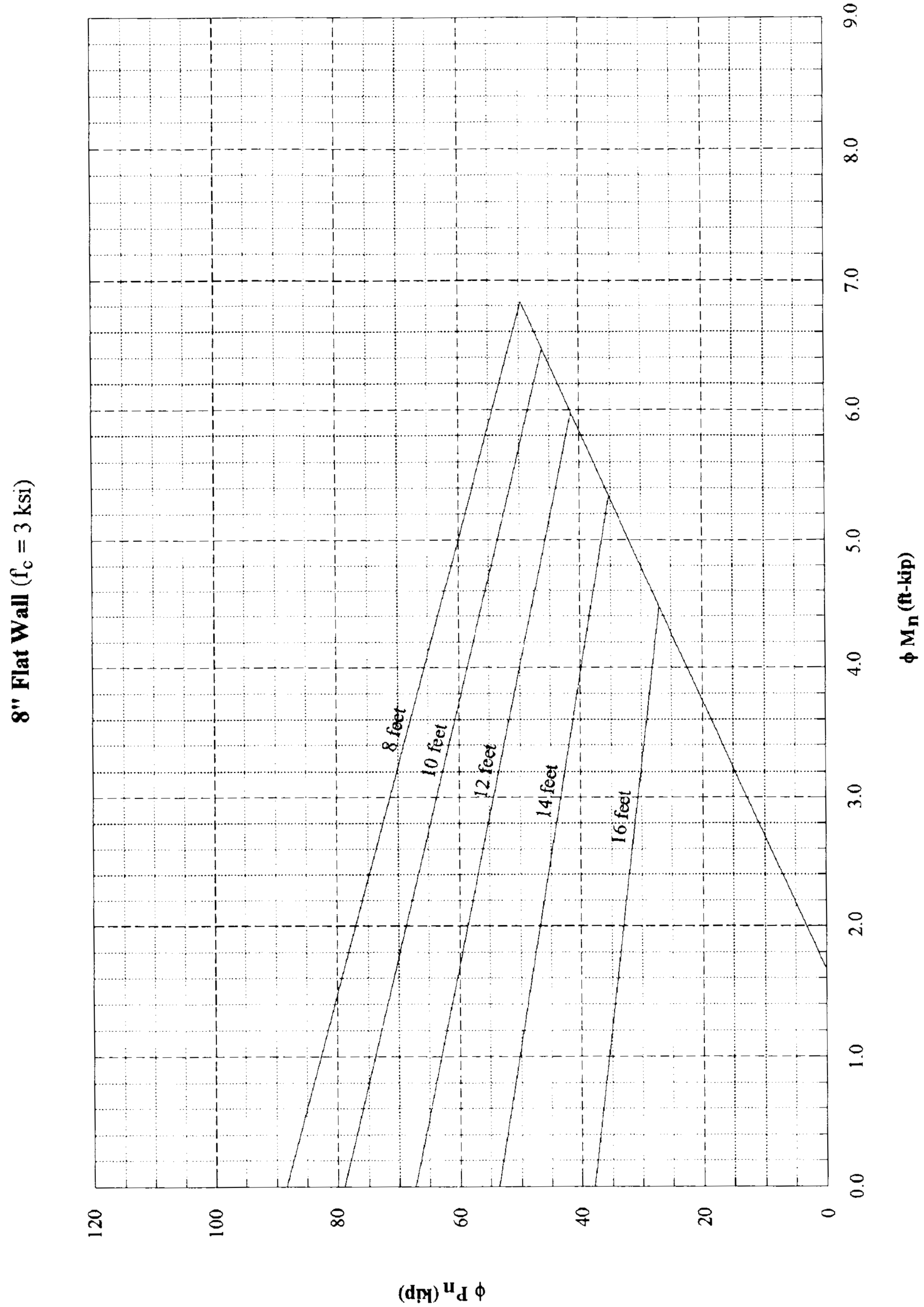
4" Flat Wall (f'c = 3 ksi)
8 feet
0.0
0.2
0.4
0.6
0.8
1.0
1.2
φ Mn (ft-kip)
18.0
15.0
12.0
9.0
6.0
3.0
0.0
φ Pn (kip)

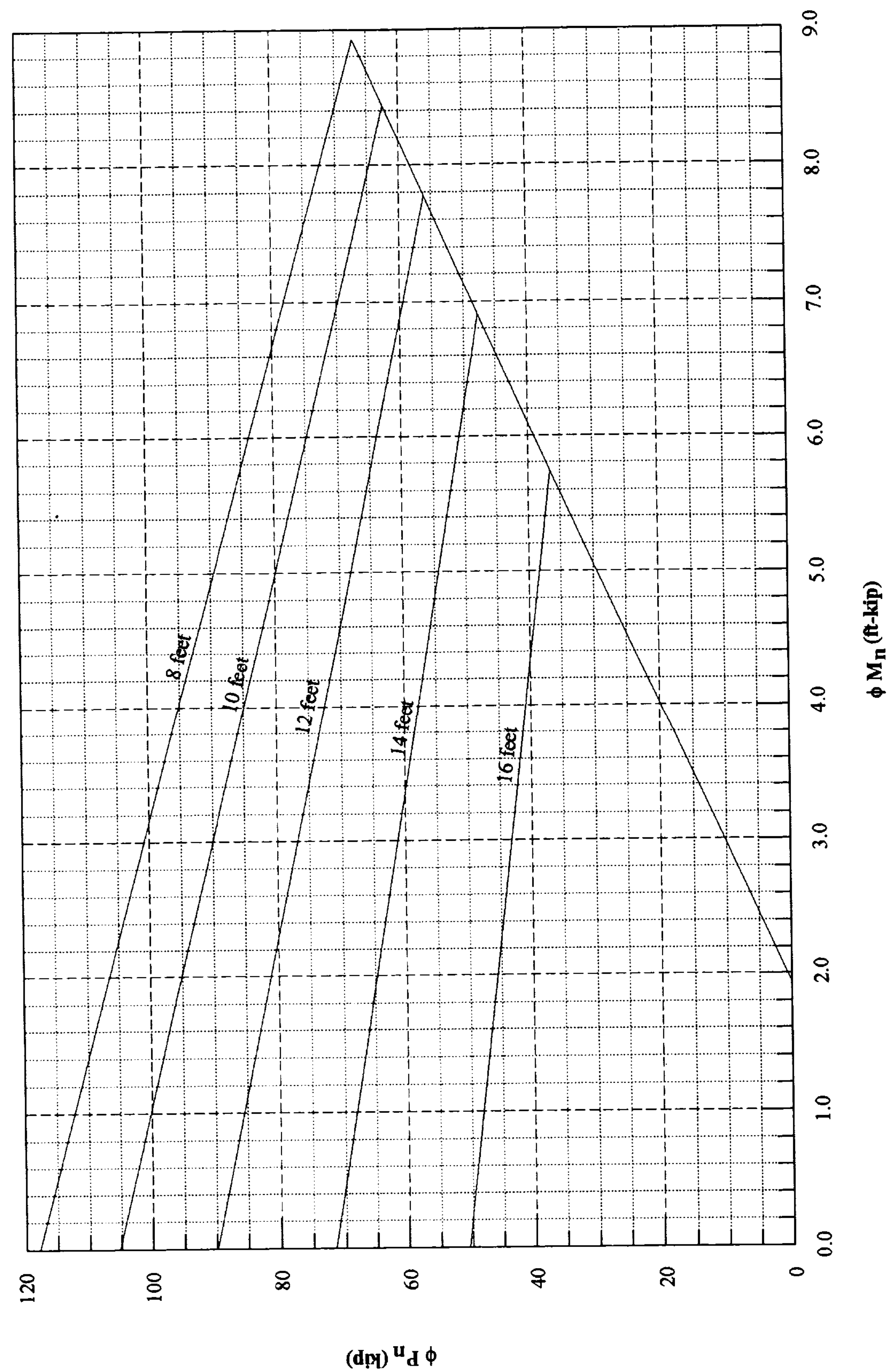
4" Flat Wall (f_c = 4 ksi)



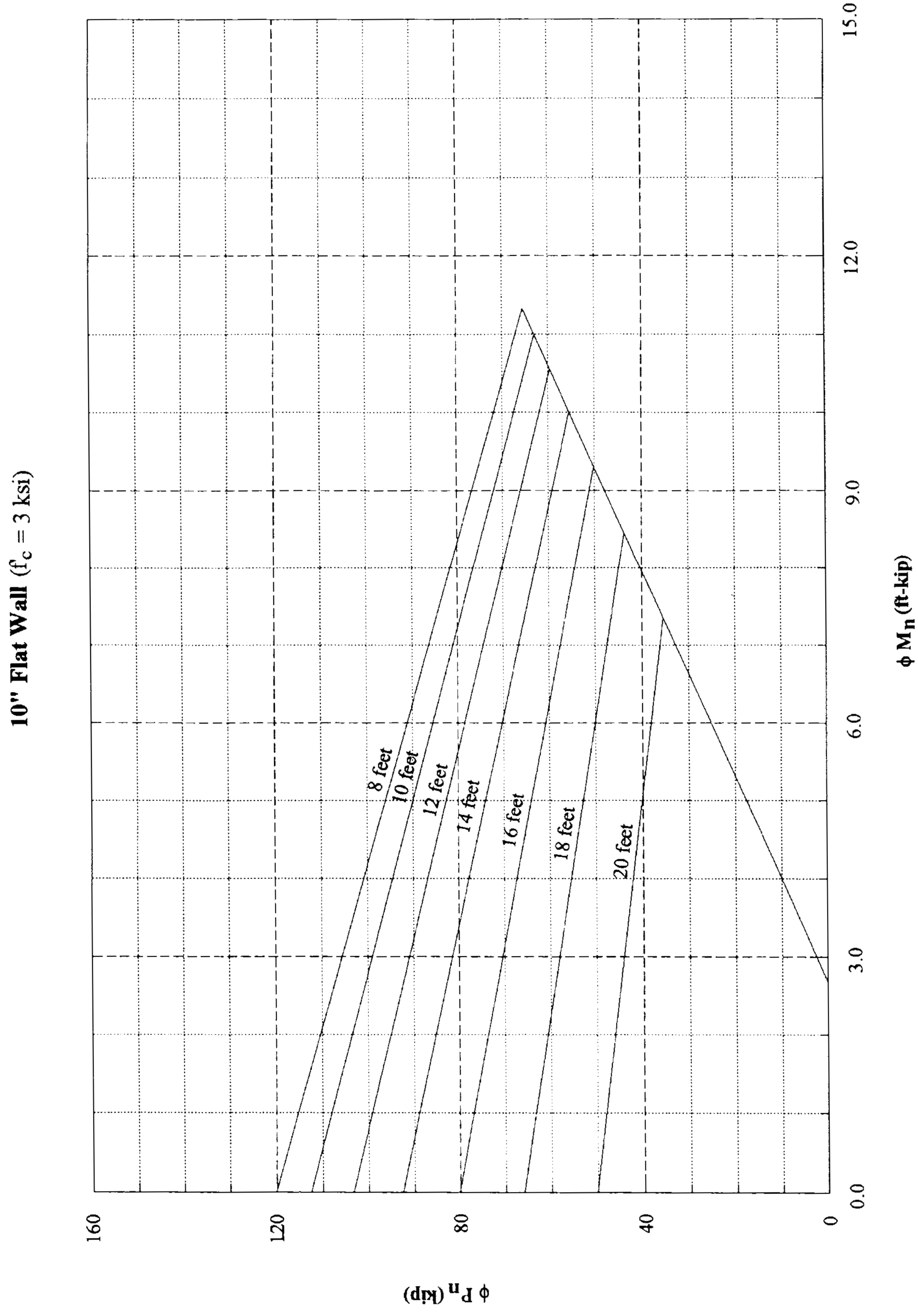

6" Flat Wall (f_c = 3 ksi)
8 feet
10 feet
12 feet
ϕ M_n (ft-kip)
ϕ P_n (kip)
0.0
1.0
2.0
3.0
4.0
5.0
0
20
40
60
80


6" Flat Wall (f_c = 4 ksi)
8 feet
10 feet
12 feet
ϕ M_n (ft-kip)
ϕ P_n (kip)
0.0
1.0
2.0
3.0
4.0
5.0
0
20
40
60
80

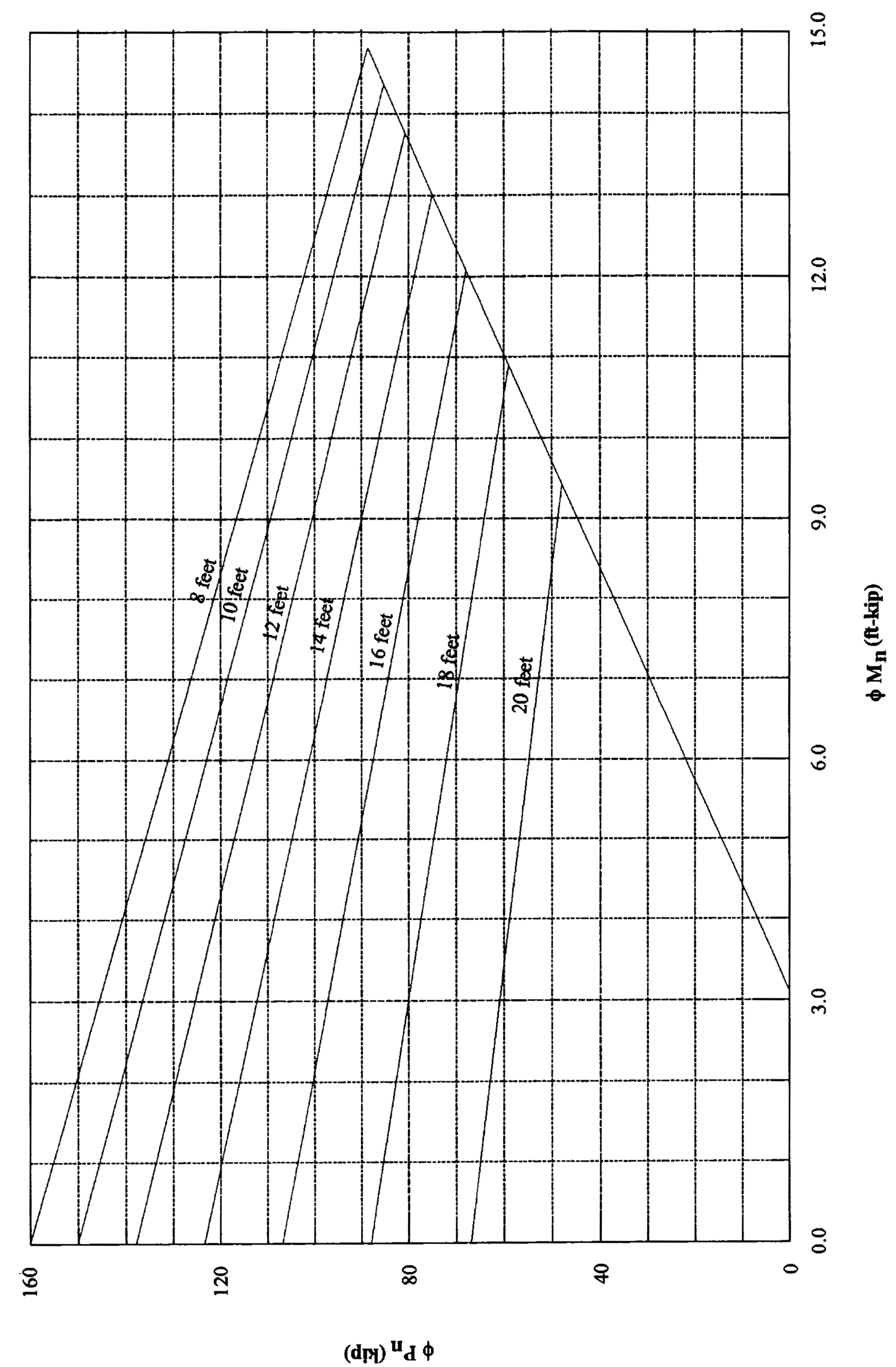

8" Flat Wall (f_c = 3 ksi)
ϕM_n (ft-kip)
ϕP_n (kip)
8 feet
10 feet
12 feet
14 feet
16 feet
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
9.0
0
20
40
60
80
100
120

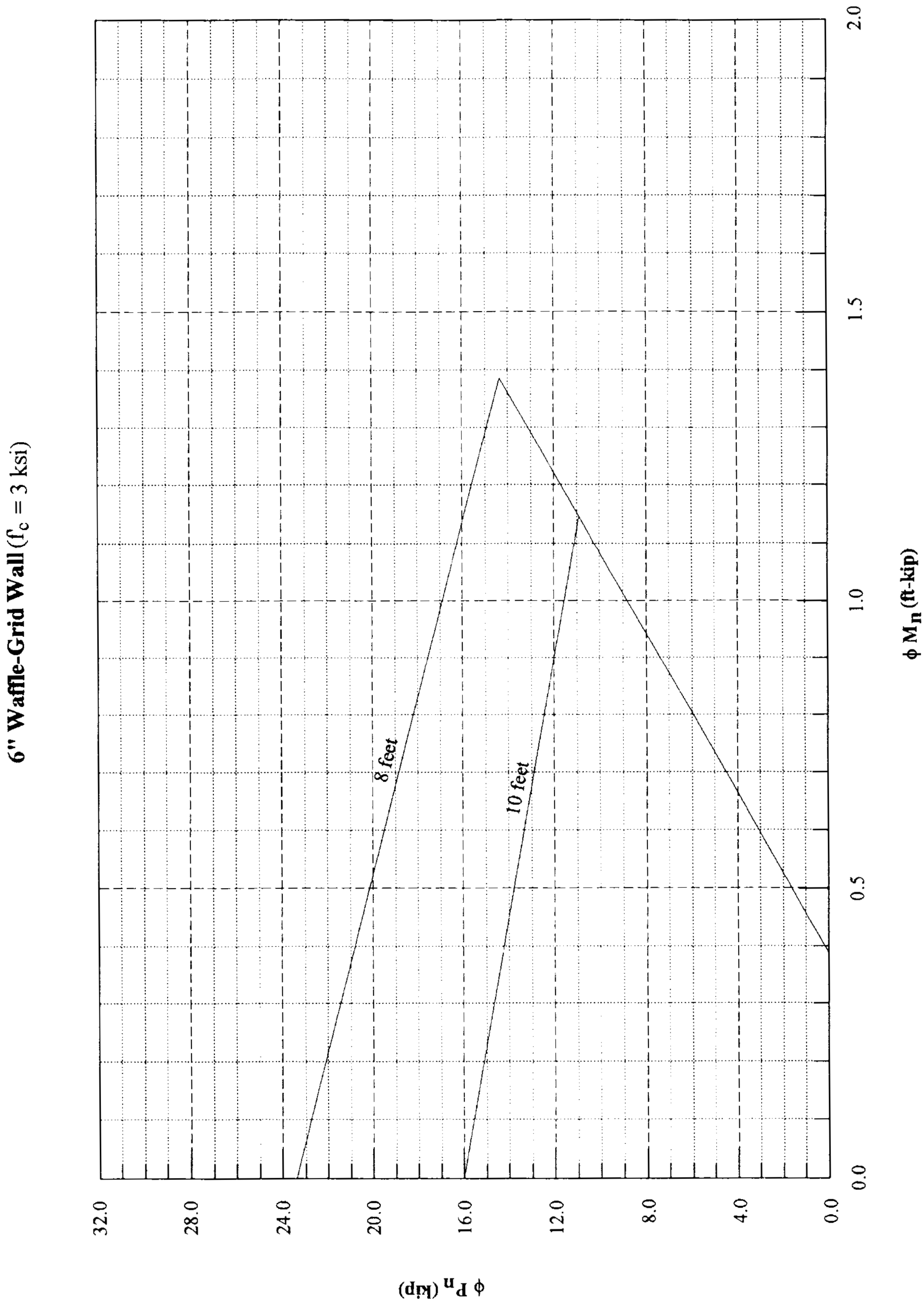


8" Flat Wall (f_c = 4 ksi)

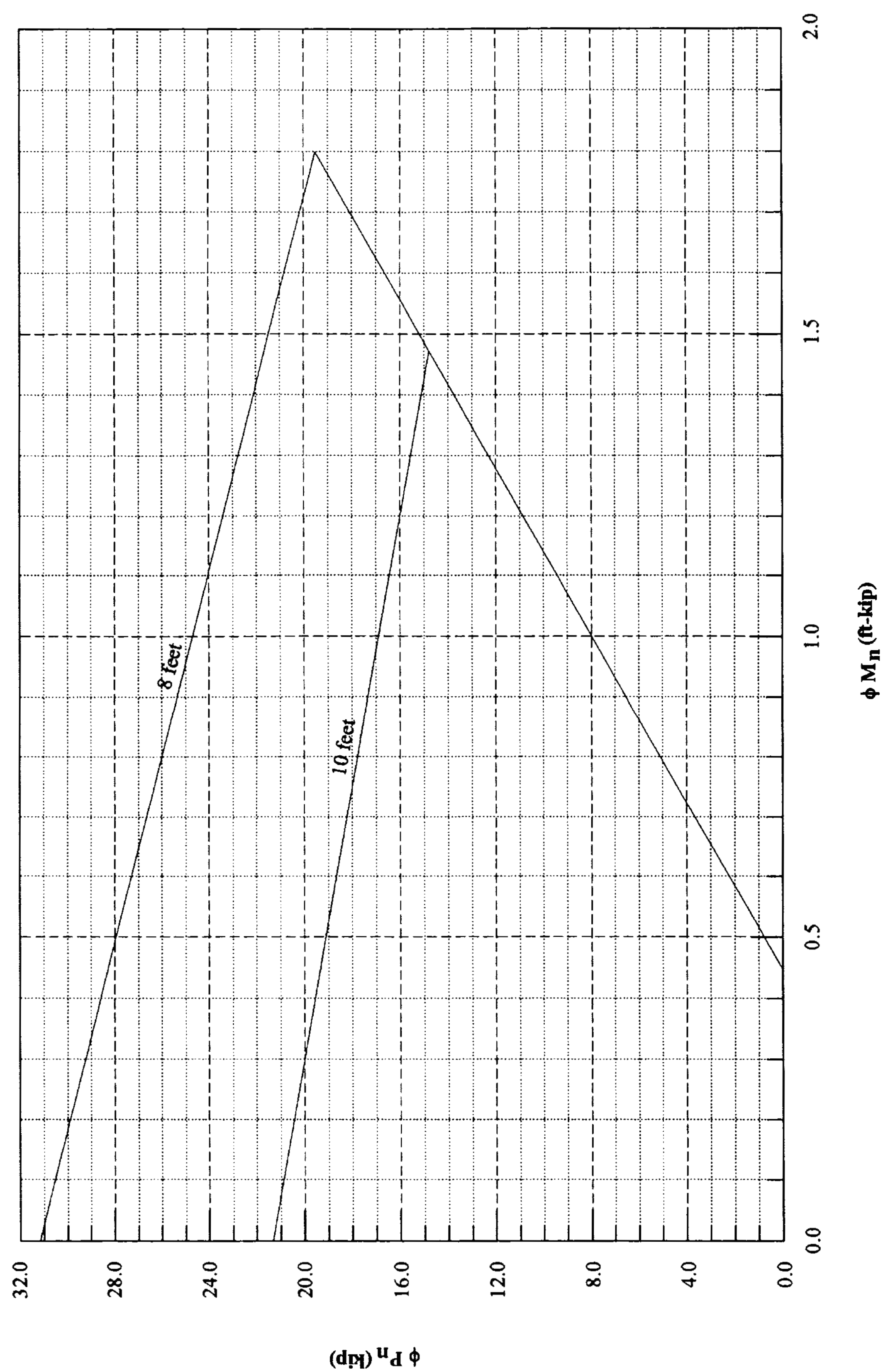

10" Flat Wall (f'c = 3 ksi)
8 feet
10 feet
12 feet
14 feet
16 feet
18 feet
20 feet
ϕ Mn (ft-kip)
0.0
3.0
6.0
9.0
12.0
15.0
ϕ Pn (kip)
0
40
80
120
160

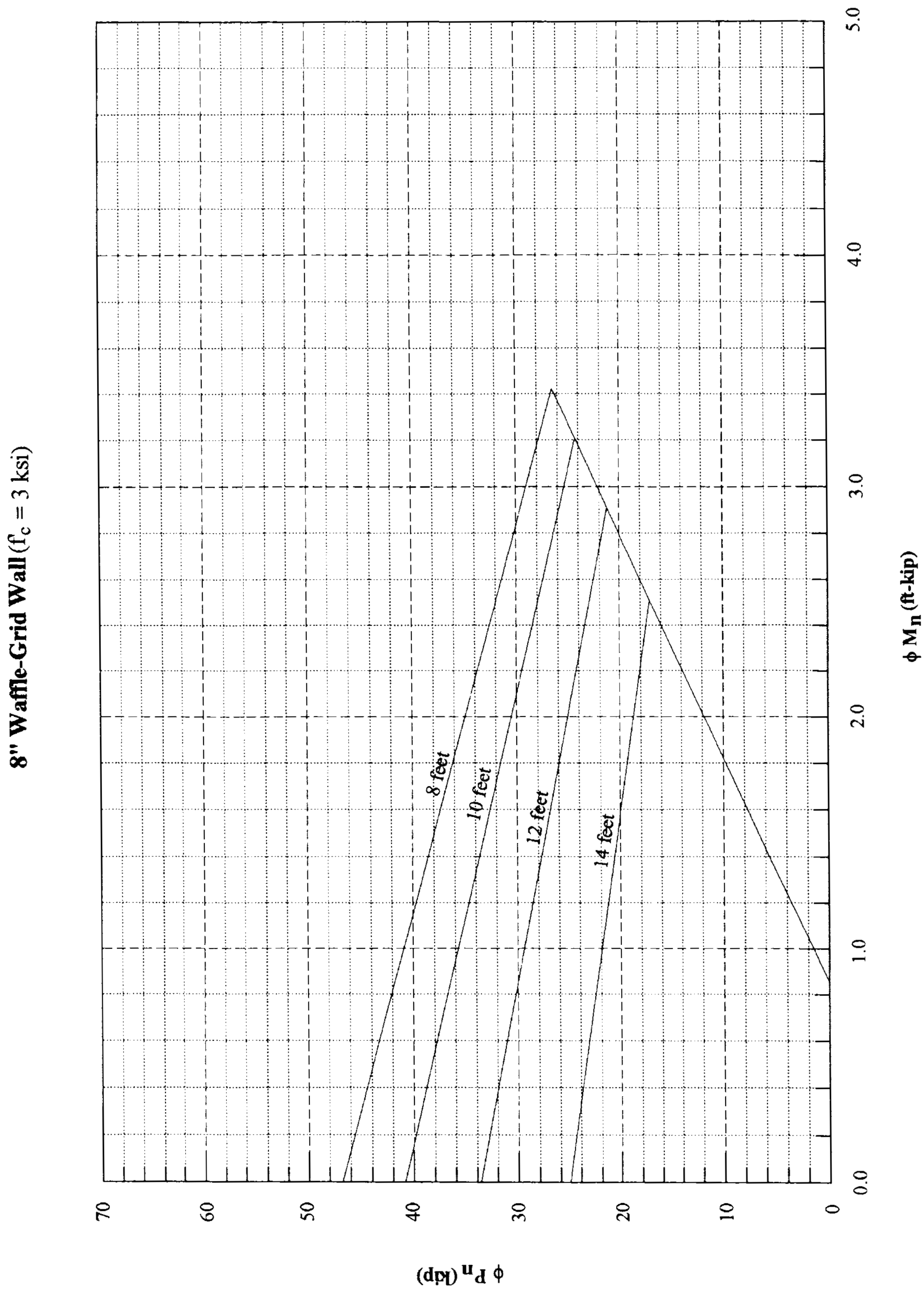
10" Flat Wall (f_c = 4 ksi)



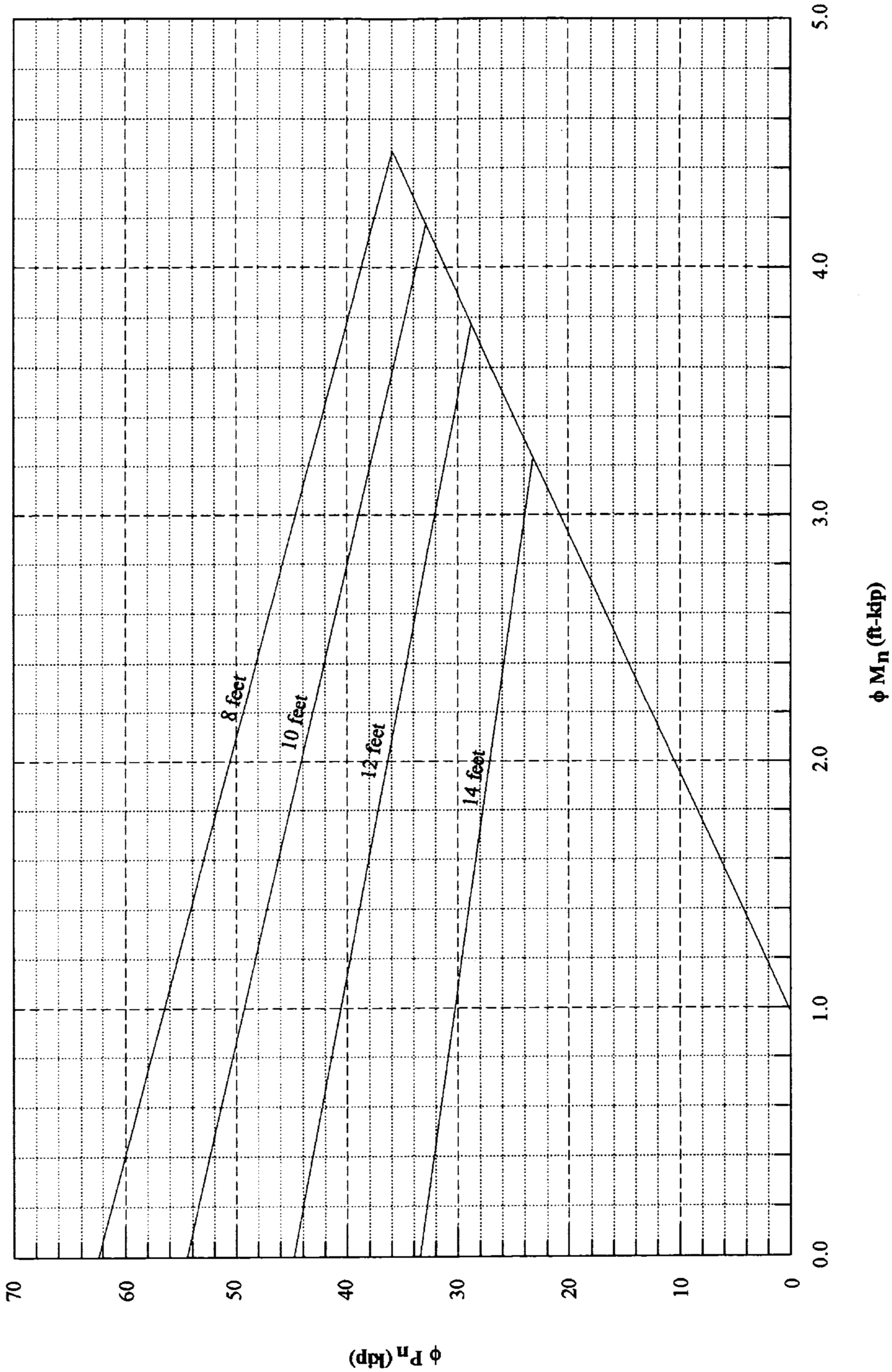

6" Waffle-Grid Wall (f'c = 3 ksi)
8 feet
10 feet
φ Mn (ft-kip)
φ Pn (kip)
0.0
0.5
1.0
1.5
2.0
0.0
4.0
8.0
12.0
16.0
20.0
24.0
28.0
32.0

6" Waffle-Grid Wall (f'_c = 4 ksi)

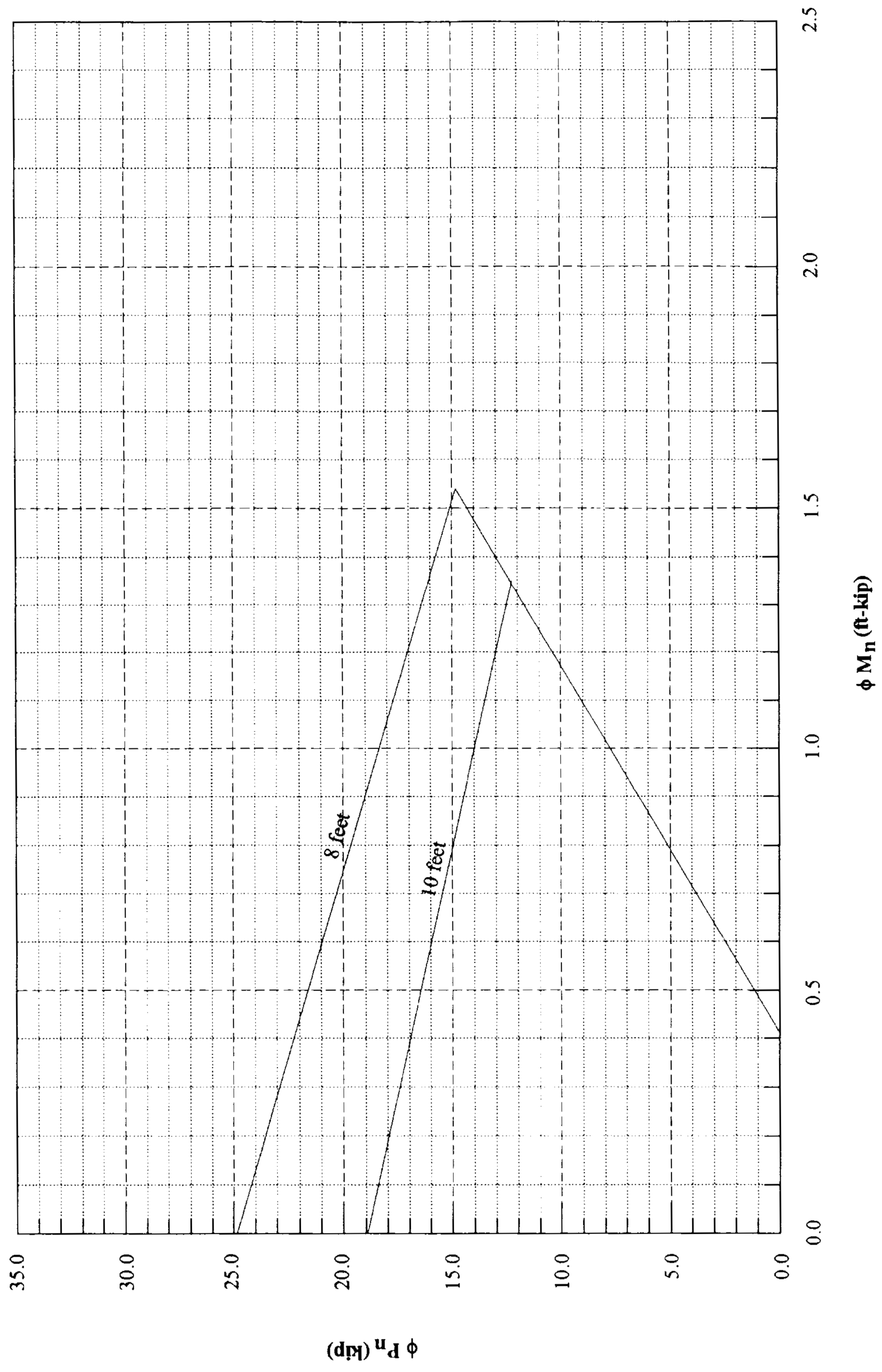



8" Waffle-Grid Wall (f_c = 3 ksi)
8 feet
10 feet
12 feet
14 feet
ϕM_n (ft-kip)
ϕP_n (kip)
0.0
1.0
2.0
3.0
4.0
5.0
0
10
20
30
40
50
60
70

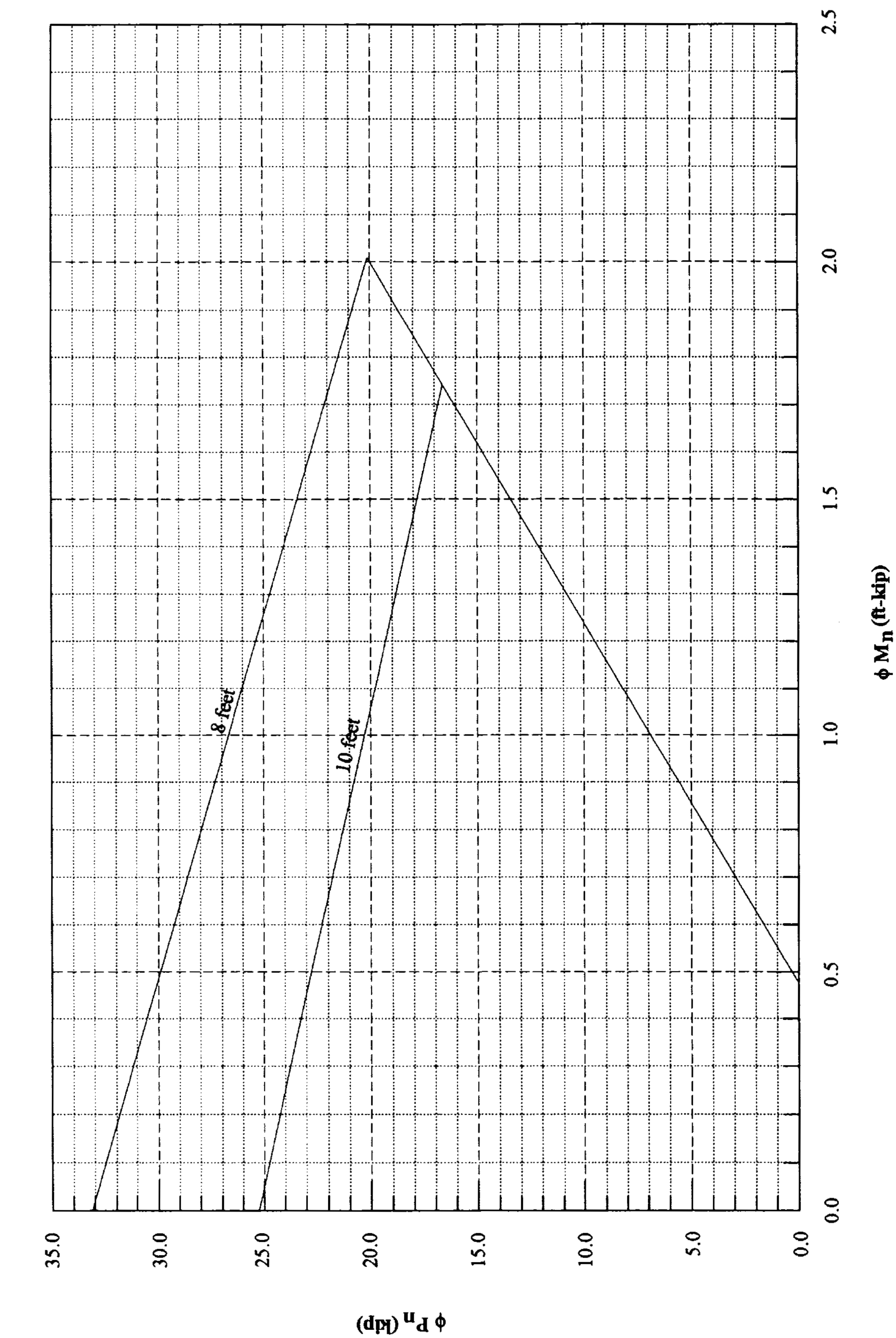
8" Waffle-Grid Wall (f_c = 4 ksi)



6" Screen Grid Wall (f'_c = 3 ksi)



6" Screen Grid Wall (f_c = 4 ksi)



APPENDIX F

CONVERSION FACTORS

Angle	Degree	deg	1.745329 E-02	Radian	rad
Area	Square Inch Square Foot	in^2 ft^2	6.451600 E-04 9.290304 E-02	Square Meter Square Meter	m^2 m^2
Bending-Moment	Inch-Pound Foot-Pound	in-lb ft-lb	1.129848 E-01 1.355818 E+00	Newton-Meter Newton-Meter	N-m N-m
Bending-Moment Unit Length	Inch-Pound per Linear Inch Inch-Pound per Linear Foot Foot-Pound per Linear Inch Foot-Pound per Linear Foot	in-lb/in in-lb/ft ft-lb/in ft-lb/ft	4.448222 E+00 3.706850 E-01 5.337866 E+01 4.448222 E+00	Newton-Meter per Meter Newton-Meter per Meter Newton-Meter per Meter Newton-Meter per Meter	N-m/m N-m/m N-m/m N-m/m
Force	Kip (1000 Pound)	kip	4.448222 E+03	Newton	N
Force per Unit Length	Pound per Linear Foot	plf	1.459390 E+01	Newton per Meter	N/m
Length	Inch Foot	in ft	2.540000 E-02 3.048000 E-01	Meter Meter	m m
Force per Unit Area, Stress	Pounds per Square Inch Pounds per Square Foot	psi psf	6.894757 E+03 4.788026 E+01	Pascal Pascal	Pa Pa
Volume	Cubic Inch Cubic Foot Cubic Yard	in^3 ft^3 yd^3	1.638706 E-05 2.831685 E-02 7.645549 E-01	Cubic Meter Cubic Meter Cubic Meter	m^3 m^3 m^3
Force per Unit Volume	Pounds per Cubic Foot	pcf	1.570877 E+02	Newton per Cubic Meter	N/m^3

1 Pascal = 1000 N/m^2

SI PREFIXES	exa	peta	tera	giga	mega	kilo	hecto	deka
Symbol	E	P	T	G	M	k	h	da
Multiplication Factor	10^{18}	10^{15}	10^{12}	10^9	10^6	10^3	10^2	10^1

SI PREFIXES	deci	centi	milli	micr	nano	pico	femto	atto
Symbol	d	c	m	μ	n	p	f	a
Multiplication Factor	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}	10^{-15}	10^{-18}

[illegible]	[illegible]	Symbol	[illegible]	[illegible]	Symbol
Angle	Radian	rad	5.729579 E+01	Degree	deg
Area	Square Meter	m^2	1.550003 E+03	Square Inch	in^2
	Square Meter	m^2	1.076391 E+01	Square Foot	ft^2
Bending-Moment	Newton-Meter	N-m	8.850748 E+00	Inch-Pound	in-lb
	Newton-Meter	N-m	7.375621 E-01	Foot-Pound	ft-lb
Bending-Moment	Newton-Meter per Meter	N-m/m	2.248089 E-01	Inch-Pound per Linear Inch	in-lb/in
	Newton-Meter per Meter	N-m/m	2.697708 E+00	Inch-Pound per Linear Foot	in-lb/ft
Unit Length	Newton-Meter per Meter	N-m/m	1.873408 E-02	Foot-Pound per Linear Inch	ft-lb/in
	Newton-Meter per Meter	N-m/m	2.248089 E-01	Foot-Pound per Linear Foot	ft-lb/ft
Force	Newton	N	2.248089 E-04	Kip (1000 Pound)	kip
Force per Unit Length	Newton per Meter	N/m	6.852170 E-02	Pound per Linear Foot	plf
Length	Meter	m	3.937008 E+01	Inch	in
	Meter	m	3.280840 E+00	Foot	ft
Force per Unit Area, Stress	Pascal	Pa	1.450377 E-04	Pounds per Square Inch	psi
	Pascal	Pa	2.088543 E-02	Pounds per Square Foot	psf
Volume	Cubic Meter	m^3	6.102376 E+04	Cubic Inch	in^3
	Cubic Meter	m^3	3.531466 E+01	Cubic Foot	ft^3
	Cubic Meter	m^3	1.307951 E+00	Cubic Yard	yd^3
Force per Unit Volume	Newton per Cubic Meter	N/m^3	6.365871 E-03	Pounds per Cubic Foot	pcf

1 Pascal = 1000 N/m^2

SI PREFIXES	exa	peta	tera	giga	mega	kilo	hecto	deka
Symbol	E	P	T	G	M	k	h	da
Multiplication Factor	10^{18}	10^{15}	10^{12}	10^{9}	10^{6}	10^{3}	10^{2}	10^{1}

SI PREFIXES	deci	centi	milli	micr	nano	pico	femto	atto
Symbol	d	c	m	μ	n	p	f	a
Multiplication Factor	10^{-1}	10^{-2}	10^{-3}	10^{-6}	10^{-9}	10^{-12}	10^{-15}	10^{-18}

APPENDIX G

WEIGHTS OF COMMON BUILDING MATERIALS

	MATERIAL	WEIGHT (psf)	MATERIAL	WEIGHT (psf)
Roof	Copper or Tin	1.5-3	Asphalt Shingles	1.5-3
	3-ply BUR with Gravel	6	Clay Tile Shingles	9-15
	5-ply BUR with Gravel	6-7	Plywood, 5/8"	2
	Metal Decking	2.2-3.6	Gypsum Sheathing, 1"	4
	Wood Shingles	2-3	Wood Roof Framing	5-7
Ceiling	Suspension System	1	Acoustic Fiber Tile	1.0-1.5
	1/2" Gypsum Board	2		
Insulation	Loose, 1"	0.5	Rigid, 1"	0.75-1.5
	Poured-in-Place, 1"	2	Batts, Blanket, 1"	0.1-0.4
Wall	Hollow Concrete Block, 4"	21-30	Brick, 4"	40
	Hollow Concrete Block, 6"	30-43	Brick, 8"	80
	Hollow Concrete Block, 8"	38-55	Brick, 12"	120
	Hollow Concrete Block, 12"	55-80	Stone, 4"	48-55
	Reinforced Concrete, 12"	111-150	Glass Block, 4"	18
	Plain Concrete, 12"	90-144	Windows	8
	Wood Stud Partition, 4" - 6"	6-11	Cold-Formed Metal Stud Partition, 4" - 6"	4-10
Partition	2 x 4 Wood Studs	3-4	Cement Plaster, 1"	10
	Metal Studs	2	Metal Lath	0.5
	Gypsum Plaster, 1"	5	Gypsum Board, 1/2"	2
Floor	Vinyl Tile, 1/8"	1.33	Plywood, 3/4"	3
	Quarry Tile, 1/2" -3/4"	5.5-8.5	Reinforced Concrete, 1"	7-13
	Terrazzo, 1"	13-25	Plain Concrete, 1"	3-13
	Hardwood Flooring, 7/8"	4	Gypsum Fill, 1"	6
	Wood Floor Framing	5-10		

APPENDIX H

STANDARD REINFORCING BAR DATA

Bar No.	Diameter		Cross-Sectional Area		Unit Weight	
	(inch)	(mm)	($inch^2$)	(mm^2)	(plf)	(kg/m)
3	0.375	9.52	0.11	71	0.376	0.560
4	0.500	12.70	0.20	129	0.668	0.994
5	0.625	15.88	0.31	200	1.043	1.552
6	0.750	19.05	0.44	284	1.502	2.235
7	0.875	22.22	0.60	387	2.044	3.042
8	1.000	25.40	0.79	510	2.670	3.973
9	1.128	28.65	1.00	645	3.400	5.060
10	1.270	32.26	1.27	819	4.303	6.404

Reinforcement Ratios

ICF	Spacing		Reinforcement Bar Size				ICF	Spacing		Reinforcement Bar Size			
Wall Type	(Inch)	(mm)	#3	#4	#5	#6	Wall Type	(Inch)	(mm)	#3	#4	#5	#6
4" Flat	6	152.4	0.0052	0.0095	0.0148	0.0210	8" Flat	6	152.4	0.0024	0.0044	0.0069	0.0098
(101.6 mm)	12	304.8	0.0026	0.0048	0.0074	0.0105	(203.2 mm)	12	304.8	0.0012	0.0022	0.0034	0.0049
	18	457.2	0.0017	0.0032	0.0049	0.0070		18	457.2	0.0008	0.0015	0.0023	0.0033
	24	609.6	0.0013	0.0024	0.0037	0.0052		24	609.6	0.0006	0.0011	0.0017	0.0024
	30	762	0.0010	0.0019	0.0030	0.0042		30	762	0.0005	0.0009	0.0014	0.0020
	36	914.4	0.0009	0.0016	0.0025	0.0035		36	914.4	0.0004	0.0007	0.0011	0.0016
	42	1066.8	0.0007	0.0014	0.0021	0.0030		42	1066.8	0.0003	0.0006	0.0010	0.0014
	48	1219.2	0.0007	0.0012	0.0018	0.0026		48	1219.2	0.0003	0.0006	0.0009	0.0012
6" Flat	6	152.4	0.0033	0.0061	0.0094	0.0133	10" Flat	6	152.4	0.0019	0.0035	0.0054	0.0077
(152.4 mm)	12	304.8	0.0017	0.0030	0.0047	0.0067	(254.0 mm)	12	304.8	0.0010	0.0018	0.0027	0.0039
	18	457.2	0.0011	0.0020	0.0031	0.0044		18	457.2	0.0006	0.0012	0.0018	0.0026
	24	609.6	0.0008	0.0015	0.0023	0.0033		24	609.6	0.0005	0.0009	0.0014	0.0019
	30	762	0.0007	0.0012	0.0019	0.0027		30	762	0.0004	0.0007	0.0011	0.0015
	36	914.4	0.0006	0.0010	0.0016	0.0022		36	914.4	0.0003	0.0006	0.0009	0.0013
	42	1066.8	0.0005	0.0009	0.0013	0.0019		42	1066.8	0.0003	0.0005	0.0008	0.0011
	48	1219.2	0.0004	0.0008	0.0012	0.0017		48	1219.2	0.0002	0.0004	0.0007	0.0010
6" Waffle-Grid	6	152.4	0.0070	0.0128	0.0198	0.0282	8" Waffle-Grid	6	152.4	0.0045	0.0082	0.0127	0.0180
(152.4 mm)	12	304.8	0.0035	0.0064	0.0099	0.0141	(203.2 mm)	12	304.8	0.0022	0.0041	0.0063	0.0090
	24	609.6	0.0018	0.0032	0.0050	0.0070		24	609.6	0.0011	0.0020	0.0032	0.0045
	36	914.4	0.0012	0.0021	0.0033	0.0047		36	914.4	0.0007	0.0014	0.0021	0.0030
	48	1219.2	0.0009	0.0016	0.0025	0.0035		48	1219.2	0.0006	0.0010	0.0016	0.0022
6" Screen-Grid	6	152.4	0.0073	0.0132	0.0205	0.0291							
(152.4 mm)	12	304.8	0.0036	0.0066	0.0102	0.0145							
	24	609.6	0.0018	0.0033	0.0051	0.0073							
	36	914.4	0.0012	0.0022	0.0034	0.0048							
	48	1219.2	0.0009	0.0017	0.0026	0.0036							

APPENDIX I

SYMBOLS

Symbol	Definition	English Unit
β_d	Ratio of dead axial load to total axial load	dimensionless
Δ_{actual}	Actual deflection	inch
$\Delta_{allowable}$	Allowable deflection	inch
Δ_{max}	Maximum deflection	inch
δ_{ns}	Moment magnification factor for non-sway frames	dimensionless
δ_s	Moment magnification factor for sway frames	dimensionless
Δ_x	Deflection at distance x	inch
ε_c	Strain in concrete	dimensionless
ε_y	Yield strain of reinforcement	dimensionless
ϕ	Strength reduction factor	dimensionless
γ	Reinforcement size factor	dimensionless
λ	Correction factor related to unit weight of concrete or concrete type factor	dimensionless
μ	Coefficient of friction	dimensionless
ρ	Ratio of area of vertical reinforcement to gross concrete area	dimensionless
ξ	Reinforcement yield strength factor	dimensionless
ω	Excess reinforcement factor	dimensionless
ψ	Concrete side cover factor	dimensionless
a	Depth of equivalent rectangular stress block	inch
A_1	Loaded area of concrete	$inch^2$
A_2	Projected loaded area of concrete	$inch^2$
A_b	Area of bolt	$inch^2$
A_c	Area of concrete section	$inch^2$
A_g	Gross area of concrete	$inch^2$
A_s	Area of reinforcement	$inch^2$
A_v	Area of reinforcement or area of concrete right circular cone	$inch^2$
$A_{v,min}$	Minimum area of reinforcement	$inch^2$
A_{vf}	Area of shear-friction reinforcement	$inch^2$
A_{washer}	Area of a washer	$inch^2$
β	Coating factor or reinforcement factor	dimensionless
B	Total bearing strength	lb
b	Width	inch
B_c	Bearing strength of concrete	lb
B_s	Bearing strength of reinforcement	lb
b_w	Web width	inch
c	Reinforcement spacing or concrete cover	inch
C_c	Compression force in concrete	lb
C_m	Factor relating moment diagram to equivalent uniform moment diagram	dimensionless
C_s	Compression force in reinforcement	lb
d	Distance from extreme compression fiber to centroid of	inch
d_b	Diameter of reinforcement	inch
e	Eccentricity of axial load	inch
E_c	Modulus of elasticity of concrete	psi

EI	Flexural stiffness of compression member	psi
E_s	Modules of elasticity of reinforcement	psi
fb	Actual bending stress	psi
F_b	Allowable bending stress	psi
$fc_{\perp}$	Actual compressive stress perpendicular to the grain	psi
$Fc_{\perp}$	Allowable compressive stress perpendicular to the grain	psi
fc'	Specified compressive strength of concrete	psi
ft	Actual tensile stress	psi
F_t	Allowable tensile stress	psi
fv	Actual shear stress	psi
F_v	Allowable shear stress	psi
fy	Specified yield strength of steel reinforcement	psi
h	Thickness	inch
I_g	Moment of inertia of gross concrete section	$inch^4$
k	Effective length factor	dimensionless
K_{TR}	Transverse reinforcemen index	dimensionless
l_b	Embedment length	inch
l_{be}	Distance from fastener to nearest edge of concrete ledge	inch
l_d	Development length of reinforcement bar	inch
l_{db}	Basic development length of reinforcement bar	inch
l_{dh}	Development length of reinforcement hook	inch
l_{hb}	Basic development length of reinforcement hook	inch
l_u	Unsupported length	inch
l_w	Length of wall	inch
M_1	Smaller factored end moment	inch-lbs
M_2	Larger factored end moment	inch-lbs
$M_{2,min}$	Minimum permissible value of M_2	in-lb
M_n	Nominal moment strength	in-lb
M_{ns}	Magnified factored moment to be used for designing compression	in-lb
M_s	Magnified factored moment to be used for designing compression	in-lb
M_u	Factored bending moment	in-lb
$M_{u,min}$	Minimum factored bending moment	inch-lb
NA_x	Neutral axis about the x axis	inch
P_c	Critical buckling load	lb
P_u	Factored axial load	lb
$P_{u,dead}$	Factored axial dead load	lb
ΣP_c	Summation for all sway-resisting columns	lb
ΣP_u	Summation for all the vertical loads	lb
r	Radius of gyration of cross-section	inch
s	Spacing of reinforcement	inch
s_2	Spacing of reinforcement	inch
S_{xx}	Section modulus of section about the x-x axis	$inch^3$
S_{yy}	Secton modulus of section about the y-y axis	$inch^3$
T	Tensile force	lb
T_{uplift}	Tensile force due to uplift	lb

V	Shear force	lb
V_c	Nominal shear strength of concrete	lb
V_n	Nominal shear strength	lb
V_s	Nominal shear strength provided by shear reinforcement	lb
V_u	Factored shear force	lb
w_c	Weight of concrete	pcf
Z_{actual}	Actual bolt shear	lb
$Z_{allowable}$	Allowable bolt shear	lb

INDEX

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