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CHAPTER 1

INTRODUCTION

1-1 BACKGROUND. The Grip-Tite® Wall Anchoring System is used to anchor, secure, and stabilize earth retaining walls. Typically, the system is utilized to anchor walls located below grade – basement walls – constructed of masonry or cast-in-place concrete. Furthermore, it can be utilized on walls constructed of wood and steel sheeting. It can also be utilized as a top restraint for earth retaining walls to increase their capacity. The system was initially developed to eliminate the need to remove and rebuild basement walls that had become cracked or bowed as a result of lateral earth pressure loads exceeding the allowable design capacity of the wall. The system works by helping to resist lateral earth pressure loading acting on a wall and thus redistributing the stress in the wall resulting from the loading to acceptable levels.

1-2 PURPOSE. This document provides design guidance and site application information for installation Grip-Tite® Wall Anchoring System. Information contained herein can be utilized to:

- Simplify permit applications.
- Determine preliminary installation requirements based on a soil investigation report.
- Provide design and installation requirements based on soil classifications found in the *International Building Code*® (*IBC*) and *International Residential Code*® for One- and Two-Family Dwellings (*IRC*).

1-3 REFERENCES. The following references have been used in this manual:

- ACI 530. 02/ASCE 6-02/TMS 402-02 Building Code Requirements for Masonry Structures, American Concrete Institute, Structural Engineering Institute of the American Society of Civil Engineers, and the Masonry Society, 2002
- ASTM A108 Standard Specification for Steel Bar, Carbon Alloy, Cold Finished
- ASTM A153 Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware
- ASTM A 1011 Standard Specification for Steel, Sheet, Strip, Hot Rolled Carbon, Structural, High-Strength Low-Alloy with Improved Formability
- ASCE 7-02 Minimum Design Loads for Buildings and Other Structures, American Society of Civil Engineers, 2003
- Grip-Tite® Wall Anchor System (brochure), Grip-Tite® Manufacturing Company, Inc., 1995
- International Code Counsel Internet Site http://www.iccsafe.org
- NAVFAC DM-7.2 Foundations and Earth Structures, Department of the Navy, May 1982
- Soil Mechanics and Engineering Practice, Terzaghi and Peck, John Wiley and Sons, 1967
1-4 **SCOPE.** This manual shall be utilized by qualified professionals. Utilize information presented as guide for preliminary sizing, spacing, and location of Grip-Tite® Wall Anchor Systems.

1-4.1 **Analysis.** The analyses performed and presented in this manual along with associated charts represent average soil properties that may be encountered for given soil classifications. Where applicable, the properties used for loading and strength determinations are average properties. Likewise, various geometries are assumed and may in some instances, not represent actual site conditions. Verify and confirm actual site conditions prior to using the information presented herein. Differing site conditions from conditions as indicated by this manual should be considered independently. Analysis of differing site conditions should be conducted by qualified professionals (Professional Engineer).

1-4.2 **Site and Soil Investigation.** Site and soil investigations shall be performed prior to using this manual.

1-4.2.1 **Site Investigation.** A proper site investigation shall be performed to verify the following minimum information:

- Geometry – wall height, soil depth, water table elevation (within wall height), site constraints.
- Material parameters – wall material, thickness.
- Construction quality – existing construction, connections (floor to top of wall), grouted CMU, reinforced CMU or concrete, etc.

1-4.2.2 **Soil Investigation.** A soil investigation, while not specifically required by the International Building Code or International Residential Code, is recommended. A soil investigation should be performed to verify the following minimum information:

- Soil Classification.
- Soil strength parameters – unit weight ($\gamma$), angle of internal friction ($\Phi$), Cohesion ($c$).
- Water table elevation.

When soil investigations are not conducted to determine the above parameters, the IBC requires the use of prescribed lateral soil pressures. These lateral pressures exceed the average soil parameters assumed for this manual. Thus, it is assumed that a soil investigation will be performed to determine actual soil parameters to determine applicable portions of this manual.
CHAPTER 2

*Grip-Tite® WALL ANCHORING SYSTEM*

2-1 **GENERAL.** The *Grip-Tite®* Wall Anchoring System is manufactured by Grip-Tite Manufacturing Co., Inc. of Winterset, Iowa. The system is patented and covered by U.S. patent No. 4,189,891.

Typically, the system is used to anchor, secure and stabilize walls located below grade – basement walls – constructed of masonry or cast-in-place concrete.

2-2 **Grip-Tite® WALL ANCHORING SYSTEM COMPONENTS.** The *Grip-Tite®* Wall Anchoring System is referred to as the GT250 or GT250A System. The system consists of an earth anchor, wall plate, anchor rod, nuts, washer and wall sleeve. See Figure 2-1.

![Figure 2-1. *Grip-Tite®* Wall Anchoring System.](Photo: Grip-Tite® Manufacturing Co., Inc.)

Typical installed configuration of the *Grip-Tite®* Wall Anchoring System can be seen in Figure 2-2.
2-2.1 **Wall Plate.** The wall plate is manufactured from 10 gage (0.1345" thick) C1008-C1010 hot rolled steel in accordance with ASTM A1011. Approximate size of the plate is 0'-11" x 1'-6". The plate is embossed to increase its section properties for plate bending resistance and to distribute the anchor rod load over a larger area of the plate and reduce bearing pressure against the wall. The plate is hot dipped galvanized in accordance with ASTM A-153 after fabrication.

2-2.2 **Earth Anchor.** The earth anchor plates are manufactured from 10 gage (0.1345" thick) C1008-C1010 hot rolled steel in accordance with ASTM A1011. Approximate size of the plates are 0'-11" x 1'-4" with 1" flanged edges across the 11" width (1'-6" bent plate – 1" flanges at each end). The plates are embossed to increase its section properties for plate bending resistance. Two (2) plates are tack welded at right angles to one another to makeup the earth anchor, See Figure 2-1. A square nut is welded to the plates for attachment of the anchor rod. The completed earth anchor is hot dipped galvanized in accordance with ASTM A-153 after fabrication.

2-2.3 **Anchor Rod.** The anchor rod connects the earth anchor with the wall plate and is manufactured from cold drawn round grade 1018 steel in accordance with ASTM A108, nominal diameter 0.734", with a minimum tensile strength of 23,000 lbs and minimum yield strength of 36,000 psi. Typical length of the anchor rods are 9'-0" and are continuously threaded. The anchor rod is hot dipped galvanized in accordance with ASTM A-153 after fabrication.
2-2.4 **Rod Coupler.** The rod coupler is manufacturer from DOM???. Mechanical steel tubing conforming to ASTM 513 – Type 5, Grade 1020. The rod coupler is approximately 8" long. The anchor rod (each end) must be threaded into the coupler a minimum of distance of 2" minimum to fully engage the rod. The rod coupler is utilized when the anchor rod must be extended to increase the earth anchor distance away from the wall.

2-3 **ICC ES LEGACY REPORT 22-03.** The Grip-Tite® Wall Anchoring System has been evaluated by International Code Counsel Evaluation Service (ICC-ES) for compliance with BOCA® National Building Code and the International Residential Code® for One- and Two-Family Dwellings.

The ICC-ES is a nonprofit, public-benefit corporation that does technical evaluations of building products, components, methods, and materials. The evaluation process culminates with the issuance of reports on code compliance, which are made available free of charge, on the worldwide Web, to building regulators, contractors, specifiers, architects, engineers, and anyone else with an interest in the building industry and construction.

ICC-ES has issued legacy report 22-03 for the GT250 GRIP-TITE® WALL ANCHOR SYSTEM. A copy of the report can be obtained at the following website: [http://www.icc-es.org](http://www.icc-es.org). Appendix A also contains a copy of the report issued May 1, 2004. The report can be utilized by building regulators, contractors, specifiers, architects, engineers, and anyone else with an interest in the building industry and construction. The evaluation report provides evidence that products and systems meet code requirements.

2-4 **INSTALLATION.** Proper installation of the Grip-Tite® Wall Anchor System begins with a proper site evaluation to determine application and design requirements, followed by any permitting requirements and finally, installation of the system.

2-4.1 **Site Application, Design and Permitting.** Installation of the Grip-Tite® Wall Anchoring System begins with a proper site evaluation to determine if the anchor system is an acceptable solution to provide additional restraint to the wall. Likewise, general site conditions and measurements are taken to establish preliminary installation requirements of the system. A determination is made on the extent of soil parameters and soils information that will be required to size the system. Once the site evaluation is complete and the proper soils information is obtained, a responsible professional will determine the final design and installation requirements for the system. In some jurisdictions, building permits will be required prior to installation of the system.

2-4.2 **Site Installation.** To install a Grip-Tite® Wall Anchoring System the system is laid out to determine the earth anchor locations. The earth anchor locations can be adjusted to miss obstructions (sidewalks, patios, decks, etc.). Once the earth anchor locations are determined, holes are dug to a depth as required by the design or at a minimum below the frost penetration depth. A flat bearing surface – squaring off of the hole - parallel to the basement wall is established for the earth anchor to properly seat. From the inside of the basement wall at the proper elevation, a 1 1/8” diameter hole is drilled through the basement wall. Through this hole, the anchor rod is “screwed” thought the hole at a slight downward angle and into the soil for attachment to the earth.
anchor. Once the earth anchor is installed on the anchor rod, the wall plate is positioned over the anchor rod and a washer and double nuts (for rod tightening) are installed. The anchor rod is turned until the earth anchor is seated against solid earth. One nut is then removed from the inside wall plate and the remaining nut is tightened to approximately 80 ft-lb of torque. Installing the Grip-Tite® Wall Anchor System usually takes less than a day.
CHAPTER 3

BUILDING CODE REQUIREMENTS

3-1 BUILDING CODES. The International Codes or the “I-Codes” are quickly becoming the model building code for many states and cities. The “I-Codes” make up various codes that include the International Building Code (IBC), International Residential Code for One- and Two- Family Dwellings (IRC) and the International Existing Building Code (IEBC), Figure 3-1.

![Figure 3-1. “I-Codes” – IBC, IEBC and IRC.](image)

Typically, states and cities will have their own building codes that rely primarily on adoption of the, “I-Codes” with minor amendments that may specify additional requirements or nullify requirements of the “I-Codes”. Figure 3-2 depicts the states currently utilizing the “I-Codes”.

3-2 INTERNATIONAL BUILDING CODE. The IBC provides standards for facilities essential to insure that structures are safe and fit for occupancy and use. The IBC represents a comprehensive set of building regulations for building systems consistent with and inclusive of the scope of the BOCA National Building Code, ICBO Building Code (Uniform Building Code), and the Southern Building Code. With the development of the IBC and the other International “I-Codes”, the development and maintenance of the other codes was discontinued.

The IBC was first released in 2000 (IBC 2000). The current version is the 2003 International Building Code (IBC 2003). The IBC applicability is as follows:

“the construction, alteration, movement, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances, connected or attached to such buildings or structures.

Exceptions:
1. Detached one and two family dwellings and multiple single family dwellings (town houses) not more than three stories above grade plane in height with a separate means of egress and their accessory structures shall comply with the International Residential Code.

2. Existing buildings undergoing repair, alterations or additions and change of occupancy shall be permitted to comply with the International Existing Building Code.”

International Code Adoptions

- 44 states plus Washington, D.C. and the Department of Defense use the International Building Code
- 44 states plus Washington, D.C. use the International Residential Code
- 36 states plus Washington, D.C. use the International Fire Code

Figure 3-2. International Code Adoption

INTERNATIONAL RESIDENTIAL CODE. The International Residential Code for One- and Two-Family Dwellings provides minimum prescriptive construction requirements for one- and two-family dwellings. Where design and construction deviates above the minimums stipulated or requirements are not identified the IRC defaults and specifies compliance with the IBC. The application of anchored retaining
and anchored basement walls is not specifically addressed by the IRC thus, the design and application must conform to the requirements of the IBC.

3-4 **INTERNATIONAL EXISTING BUILDING CODE.** The IEBC applicability covers existing buildings and alteration requirements. For the most part, the IEBC defaults to the IBC for structural issues relating to design and construction.

3-5 **SOIL PARAMETERS.** Soil parameters can vary considerably. Where values used for design exceed or are less conservative than those specified in the IBC, a soils investigation is required. The soil investigation shall provide a classification of the soils in accordance with ASTM D 2487, *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* as well as the necessary soil strength parameters that justify the use of alternative values.

3-6 **MATERIAL SPECIFIC CODES.** The IBC addresses concrete and masonry material specific requirements. Concrete requirements are addressed in Chapter 19 CONCRETE and masonry requirements are addressed in Chapter 21 MASONRY. The materials are generally addressed by reference to the American Concrete Institute ACI 318 Building Code Requirements for Structural Concrete and Commentary and ACI 530/ASCE 6/TMS 402 Building Code Requirements for Masonry Structures. However, the IBC does stipulate certain additions to and/or amendments to the material specific codes.

![Figure 3-3. ACI 318 and ACI 530.](image)

3-6.1 **Concrete.** Concrete design requirements are addressed in the IBC with reference to **ACI 318 Building Code Requirements for Structural Concrete and Commentary**.

3-6.2 **Masonry.** Masonry design requirements are addressed in the IBC with reference to **ACI 530/ASCE 6/TMS 402 Building Code Requirements for Masonry Structures**.
PERMIT REQUIREMENTS. Permit application requirements will vary but generally should follow the requirements of the IBC and the ICC-ES legacy report 22-03 for the GT250 GRIP-TITE® WALL ANCHOR SYSTEM. Following these requirements should speed the permit approval process. Appendix A and B provide typical permit application information. The permit application should provide the following information:

- ICC-ES legacy report 22-03 for the GT250 GRIP-TITE® WALL ANCHOR SYSTEM (Appendix A).
- Construction documents prepared by individuals competent and qualified in the application of the engineering and design principals involved, and shall possess registration or licenses in accordance with the professional registration laws of the state in which the project is constructed.
  - Plan view of structure indicating the location of the Grip-Tite® Wall Anchoring System and required spacing.
  - General Information indicating:
    - method used to determine soil classification, soil type(s)/classification(s)
    - allowable or assumed soil bearing pressures
    - presence or absence of corrosives in the soil and the appropriateness of the use of galvanized steel in the soil
    - presence of stone, rocks or other debris in the soil strata and their effects on the suitability of the soil for use with the Grip-Tite® Wall Anchor System
  - Section cut of the basement wall indicating overall geometry, location of the wall plate, distance form the structure to the earth anchor, depth of the earth anchor, location of the ground water table and frost penetration depth.
4-1 GENERAL. Design and analysis of basement walls restrained using the Grip-Tite® Wall Anchoring System involves the consideration of many different variables. These range from various soil parameters, lateral earth pressures, lateral bearing capacities, wall heights, unbalanced backfill heights, hydrostatic pressures, and materials.

4-2 DESIGN. Chapter 16 of the IBC covers structural design of buildings, structures and portions thereof. It stipulates that buildings, structures and parts thereof shall be designed and constructed in accordance with strength design (load factors or load and resistance factor design - LRFD), allowable stress design (ASD), empirical design or conventional construction methods. Since basement walls are typically not initially designed or constructed using the Grip-Tite® Wall Anchoring System, this method of construction is not addressed by the codes with empirical design or conventional construction methods. Basement walls utilizing the Grip-Tite® Wall Anchoring System must be designed using strength design or allowable stress design. The method of design will generally depend on the method chosen by the designer. Typically, concrete basement walls with the Grip-Tite® Wall Anchoring System will be designed using strength design - LRFD. Masonry walls with the Grip-Tite® Wall Anchoring System can be designed utilizing strength design or allowable stress design. Both methods of masonry design yield essentially the same results. For the purposes of this manual and consistency between the loadings of concrete and masonry design, strength design is utilized.

4-3 LOADS AND LOAD FACTORS. IBC Chapter 16 addresses loads and load combinations using strength design.

4-3.1 Loads and Load Combinations. Load combinations for both strength design and allowable stress design are addressed in the code. As mentioned previously, strength design will be utilized for the purposes of this manual. There are numerous load combinations that are required to be addressed by the code. However, basement walls restrained by Grip-Tite® Wall Anchor Systems will generally be governed by the following equation in low seismic areas:

\[
1.2(D) + 1.6(L+H) + 0.5(S) \quad \text{[Eq. 4-1]}
\]

- \(D\) = dead load
- \(L\) = live load
- \(H\) = load due to lateral earth pressure and/or ground water pressure
- \(S\) = snow load
4-3.1.1 **Dead and Live Load.** The dead load and live load acting on a basement wall will vary with the structure’s construction material, spans, and framing schemes. Dead load stems from the structure (floors, walls, roofs, etc.) supported by the basement wall. Live load stems from the live load acting on the floor(s) and roof system as it may impart load on the basement wall similar to the dead load. Table 3-1 provides some representative values of unfactored dead plus live load that may act at the top of a basement wall.

<table>
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<tr>
<th>Foundation Sized For</th>
<th>Approximate Working Load</th>
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<tr>
<td>Conventional light-frame construction(^a)</td>
<td></td>
</tr>
<tr>
<td>1-story</td>
<td>1000 plf</td>
</tr>
<tr>
<td>2-story</td>
<td>1875 plf</td>
</tr>
<tr>
<td>3-story</td>
<td>2875 plf</td>
</tr>
<tr>
<td>4-inch brick veneer over light-frame or 8-inch hollow concrete masonry(^a)</td>
<td></td>
</tr>
<tr>
<td>1-story</td>
<td>1333 plf</td>
</tr>
<tr>
<td>2-story</td>
<td>2666 plf</td>
</tr>
<tr>
<td>3-story</td>
<td>4000 plf</td>
</tr>
<tr>
<td>8-inch solid or fully grouted masonry(^a)</td>
<td></td>
</tr>
<tr>
<td>1-story</td>
<td>2000 plf</td>
</tr>
<tr>
<td>2-story</td>
<td>3625 plf</td>
</tr>
<tr>
<td>3-story</td>
<td>5250 plf</td>
</tr>
</tbody>
</table>

\(^a\) Values derived from table R403.1 International Residential Code for One and Two Family Dwellings.

Table 4-1. Dead + Live Load Values for Framing Supported by Basement Walls.

4-3.1.2 **Snow Load.** The ground snow load should be considered in the design of earth anchors as an overburden pressure acting adjacent to the foundation wall if the ground snow load is deemed excessive (above 20 PSF snow load should be considered). For the purposes of this manual, the snow load is not considered significant and is neglected.

4-3.1.3 **Lateral Earth Pressure Load.** Lateral earth pressure loads are defined in the in section 1610 and section 1804 of the IBC. Table 4-2 provides design lateral loads based on these requirements as shown in the IBC. Most retaining walls and basement walls with the addition of Grip-Tite® Wall Anchoring System will need to be designed using the “At-rest Pressure.” These values would need to be assumed unless specific values for determining lateral earth pressures have been determined based on a soils investigation.
<table>
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<th>UNIFIED SOIL CLASSIFICATION</th>
<th>DESIGN LATERAL SOIL LOAD a (pound per square foot per foot of depth)</th>
<th>Active Pressure</th>
<th>At-rest Pressure</th>
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<tr>
<td>Well-graded, clean gravels; gravel-sand mixes</td>
<td>GW</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Poorly graded clean gravels; gravel-sand mixes</td>
<td>GP</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Silty gravels, poorly graded gravel-and-clay mixes</td>
<td>GM</td>
<td>40</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Clayey gravels, poorly graded gravel-and-clay mixes</td>
<td>GC</td>
<td>45</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Well-graded, clean sands; sand-gravel mixes</td>
<td>SW</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Poorly graded clean sands; sand-gravel mixes</td>
<td>SP</td>
<td>30</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Silty sands, poorly graded sand-silt mixes</td>
<td>SM</td>
<td>45</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Sand-silt clay mix with plastic fines</td>
<td>SM-SC</td>
<td>45</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Clayey sands, poorly graded sand-clay mixes</td>
<td>SC</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Inorganic silts and clayey silts</td>
<td>ML</td>
<td>45</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Mixture of inorganic silt clay</td>
<td>ML-CL</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Inorganic clays of low to medium plasticity</td>
<td>CL</td>
<td>60</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Organic silts and silt clays, low plasticity</td>
<td>OL</td>
<td>Note b</td>
<td>Note b</td>
<td></td>
</tr>
<tr>
<td>Inorganic clayey silts, elastic silts</td>
<td>MH</td>
<td>Note b</td>
<td>Note b</td>
<td></td>
</tr>
<tr>
<td>Inorganic clays of high plasticity</td>
<td>CH</td>
<td>Note b</td>
<td>Note b</td>
<td></td>
</tr>
<tr>
<td>Organic clays and silty clays</td>
<td>OH</td>
<td>Note b</td>
<td>Note b</td>
<td></td>
</tr>
</tbody>
</table>

For SI: 1 pound per square foot per foot of depth = 0.157 kPa/m, 1 foot = 304.8 mm.

- Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostat.
- Unsuitable as backfill material.
- The definition and classification of soil materials shall be in accordance with ASTM D 2487.

Table 4-2. IBC Soil Classification and Lateral Load Requirements (IBC 2003, Table 1610.1)

4-3.1.4 Representative Lateral Earth Pressure Load. Once a soils investigation is conducted and soil strength parameters are determined, a better representation of lateral soil pressures can be determined. This provides more realistic lateral earth pressures in lieu of the conservative lateral pressures required for design by the IBC in the absence of a soil investigation. Table 4-3 provides average soil parameters and average “At-rest” lateral earth pressure loads based on the unified soil classification system (soil group). Note that these are averages and actual soil strength parameters should be compared to the values shown for applicability of the estimated lateral soil pressures at a specific site.
## Soil Properties and Strength Characteristics defined by Unified Soil Classification (Soil Group)

| United Soil Classification Group | Description of Backfill Material | Unified Soil Classification | Unit Weight, lb/ft^3 (Note 1) | Angle of Internal Friction, \( \Phi \) (degrees) (Note 2) | Cohesion, \( c \) (Note 3) | Active Pressure Coefficient, \( k_a \) (Note 4) | Passive Pressure Coefficient, \( k_p \) (Note 5) | All Rest Pressure Coefficient, \( k_r \) (Note 6) | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN | Low | High | DSGN |
|---------------------------------|----------------------------------|-----------------------------|-------------------------------|---------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|
| 1                               | Well-graded, clean gravel, gravel-cobble mixtures | GW 109 | 124 | 113 | 35 | 30 | 36 | 0.27 | 0.22 | 0.20 | 3.84 | 4.33 | 3.86 | 0.43 | 0.39 | 0.41 | 46.7 |
| 1                               | Poorly graded clean gravel, gravel-cobble mixtures | GP 109 | 123 | 114 | 35 | 40 | 36 | 0.27 | 0.22 | 0.20 | 3.84 | 4.50 | 3.86 | 0.43 | 0.39 | 0.41 | 46.7 |
| 1                               | Well-graded, clean sand, sand-gravel mixtures | SW 06 | 124 | 113 | 31 | 30 | 36 | 0.32 | 0.30 | 0.23 | 3.17 | 4.33 | 3.46 | 0.46 | 0.38 | 0.48 | 28.8 |
| 1                               | Poorly graded clean sand, sand-gravel mixtures | SP 06 | 124 | 113 | 31 | 30 | 36 | 0.32 | 0.30 | 0.23 | 3.17 | 4.33 | 3.46 | 0.46 | 0.38 | 0.48 | 28.8 |
| 2                               | Silty gravel, poorly graded gravel-sand-clay mixtures | GM 100 | 128 | 110 | 25 | 33 | 26 | 0.37 | 0.30 | 0.39 | 2.73 | 3.39 | 2.66 | 0.54 | 0.48 | 0.56 | 61.9 |
| 2                               | Clayey gravel, poorly graded gravel-sand-clay mixtures | GC 100 | 128 | 110 | 25 | 30 | 26 | 0.41 | 0.39 | 0.39 | 2.43 | 3.30 | 2.56 | 0.56 | 0.60 | 0.53 | 61.9 |
| 2                               | Silty sand, poorly graded sand-cobble mixtures | SM 06 | 124 | 113 | 21 | 20 | 26 | 0.47 | 0.36 | 0.29 | 2.11 | 2.90 | 2.16 | 0.36 | 0.59 | 0.51 | 82.8 |
| 2                               | Sand-cobble mix with plastic fines | SM-SC 06 | 124 | 116 | 21 | 20 | 26 | 0.47 | 0.36 | 0.29 | 2.11 | 2.90 | 2.16 | 0.36 | 0.59 | 0.51 | 82.8 |
| 2                               | Inorganic silts and clayey silts | ML 78 | 114 | 95 | 13 | 22 | 15 | 0.65 | 0.48 | 0.69 | 1.58 | 2.17 | 1.70 | 0.77 | 0.63 | 0.63 | 76.4 |
| 3                               | Clayey sand, poorly graded sand-clay mixtures | SC 95 | 124 | 113 | 13 | 22 | 15 | 0.63 | 0.48 | 0.69 | 1.58 | 2.17 | 1.70 | 0.77 | 0.63 | 0.63 | 76.4 |
| 3                               | Mixture of inorganic silty clay | ML-CL 78 | 114 | 75 | 12 | 10 | 7.0 | 0.79 | 0.60 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |
| 3                               | Inorganic clays of low to medium plasticity | CL 78 | 114 | 75 | 12 | 10 | 7.0 | 0.79 | 0.60 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |
| 3                               | Inorganic clayey silts, elastic silts | NH 82 | 100 | 80 | 10 | 10 | 10 | 0.90 | 0.80 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |
| 4                               | Organic silts and silt clays, low plasticity | CL 82 | 100 | 80 | 10 | 10 | 10 | 0.90 | 0.80 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |
| 4                               | Inorganic clays of high plasticity | CH 82 | 100 | 80 | 10 | 10 | 10 | 0.90 | 0.80 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |
| 4                               | Inorganic clays and silt clays | CH 82 | 100 | 80 | 10 | 10 | 10 | 0.90 | 0.80 | 0.80 | 1.27 | 2.00 | 1.35 | 0.58 | 0.67 | 0.81 | 96.3 |

Notes:
1. Unit weights (Low/High) values are for soils compacted to 95% of its maximum density at optimum moisture content for modified standard AASHTO compactive effort CE55.
2. Angle of internal friction, \( \Phi \), (Low/High) values have been derived from design lateral pressures taken from IBC 2003, Table 1610.1 and unit weights as determined in note 1.
3. Cohesion, \( c \), has been taken as 500 psi for those soils that may exhibit cohesion.
4. Active pressure coefficient, \( k_a \), (Low/High) values have been derived from the angle of internal friction. \( k_a = \tan^2(45 - \Phi/2) \)
5. Passive pressure coefficient, \( k_p \), (Low/High) values have been derived from the angle of internal friction. \( k_p = \tan^2(45 + \Phi/2) \)
6. All-rest pressure coefficient, \( k_r \), (Low/High) values have been derived from the angle of internal friction. \( k_r = 1 - \sin \Phi \)
4-3.1.5 **Lateral Bearing Pressure.** Lateral bearing pressures (lateral resistance) are defined in section 1804 of the IBC. Table 4-3 provides allowable lateral bearing pressure based on requirements of the IBC. These values would need to be assumed in the absence of a soil investigation to determine soil strength parameters.

<table>
<thead>
<tr>
<th>CLASS OF MATERIALS</th>
<th>ALLOWABLE FOUNDATION PRESSURE (psf)</th>
<th>LATERAL BEARING (psf/f below natural grade)</th>
<th>LATERAL SLIDING</th>
<th>RESISTANCE (psf)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Crystalline Bedrock</td>
<td>12,000</td>
<td>1,200</td>
<td>0.7</td>
<td>-</td>
</tr>
<tr>
<td>2. Sedimentary and foliated rock</td>
<td>4,000</td>
<td>400</td>
<td>0.35</td>
<td>-</td>
</tr>
<tr>
<td>3. Sandy Gravel and/or gravel (GW and GP)</td>
<td>3,000</td>
<td>200</td>
<td>0.35</td>
<td>-</td>
</tr>
<tr>
<td>4. Sand, silty sand, clayey sand, silty gravel, and clayey gravel (SW, SP, SM, SC, GM and GC)</td>
<td>2,000</td>
<td>150</td>
<td>0.25</td>
<td>-</td>
</tr>
<tr>
<td>5. Clay, sandy clay, silty clay, clayey silt, silt and sandy silt (CL, ML, MH AND CH)</td>
<td>1,500</td>
<td>100</td>
<td>-</td>
<td>130</td>
</tr>
</tbody>
</table>

Table 4-3. IBC Allowable Foundation and Lateral Pressure Requirements (IBC 2003, Table 1804.2)

4-3.2 **Computation of Wall Pressures.** The pressure on basement walls is a function of the relative movement between the wall and the surrounding soil. The IBC permits basement walls extending not more than 8 feet below grade and supporting flexible floor systems to be designed for active pressures. This assumes that the movement of the wall allows the shear strength of the soil to be mobilized. Installation of Grip-Tite® Wall Anchors in a basement wall will in effect restrain movement and prevent mobilization of the shear strength of the soil. Thus, at-rest lateral earth pressures must be assumed for designing the anchor system and checking the allowable strength of the wall. Lateral at-rest earth pressures can be derived from the coefficient of earth pressure at rest, $K_o$, and the unit weight of the soil, $\gamma$. $K_o$ for granular soils and normally consolidated cohesive soils is approximately:

$$K_o = 1 - \sin \Phi \quad [Eq. 4-1]$$

where $\Phi$ is the angle of internal friction. For a basement wall with homogeneous soil backfill and no surcharge load, the lateral earth pressure at any height along the wall can be computed using the following equation:

$$\sigma = (\gamma) K_o z - 2(c) \tan(45 - \Phi/2) \quad [Eq. 4-2]$$

where $\gamma$ is the unit weight of soil, $K_o$ is the at-rest earth pressure coefficient, $z$ is the depth at which the pressure is being determined and $c$ is the cohesion. The cohesion term can be neglected for conservative design of the basement wall and anchor system. Equation 4-2 then becomes:

$$\sigma = (\gamma) K_o z \quad [Eq. 4-3]$$
If water is trapped behind the wall creating a hydrostatic head pressure, this must also be considered in the pressure calculation. Figure 4-1 summarizes the pressure equations and also the effects of hydrostatic head pressure.

**Figure 4-1 Computation of At-rest Wall Pressures**

4-3.3 **Masonry**

4-3.3.1 **Unreinforced Masonry Wall Design.** Masonry design requirements are addressed in the IBC with reference to ACI 530/ASCE 6/TMS 402 Building Code Requirements for Masonry Structures. Basement walls utilizing the Grip-Tite Wall Anchoring System must be designed using strength design or allowable stress design. As mentioned in Chapter 3, the method of design will generally depend on the method chosen by the designer. Masonry walls with the Grip-Tite Wall Anchoring System can be designed utilizing strength design - LRFD - or allowable stress design. For consistency between masonry and concrete design addressed by this manual, the use of strength design has been chosen.

4-3.3.2 **Loads and Load Factors.** Basement walls shall be designed so that their design strength equals or exceeds the effects of factored loads in the following equation:

\[
R_U = 1.2(D) + 1.6(L+H) + 0.5(S)
\]  

**[Eq. 4-4]**

- \(D\) = dead load
- \(L\) = live load
- \(H\) = load due to lateral earth pressure and/or ground water pressure
- \(S\) = snow load

**NOTE:** The load equation presented represents one of several loadings that must be considered. It will generally govern the design of basement walls restrained by Grip-Tite Wall Anchor Systems in low seismic areas. Likewise, for the purposes of this manual,
the snow load and any surcharge loads are assumed to be zero (0). For situations where a ground snow load or surcharge load should be considered, these should be evaluated on an individual basis.

4-3.3.3 Masonry Strength. For the purposes of this manual, masonry walls where the Grip-Tite Wall Anchoring System is being consider for installation are considered unreinforced. Reinforced masonry can be considered, however, it is beyond the scope of this manual since reinforcing size, spacing, layout (1 and 2 layers) can vary considerably and would need to be evaluated on a case-by-case basis.

Strengthening of unreinforced masonry walls with the addition of grout is addressed. Grouted masonry walls are considered unreinforced masonry walls.

Strength design of masonry is addressed in Chapter 3 of ACI 530. Masonry members - basement wall - shall be proportioned such that the design strength equals or exceeds the required strength, \( R_u \). Design strength is the nominal strength multiplied by the strength reduction factor, \( \phi \) (not to be confused with the angle of internal friction for soil).

\[
R_u = \phi R_n \quad \text{[Eq. 4-5]}
\]

Strength reduction factors, \( \phi \), for masonry are as follows:

- **Combinations of flexure and axial load in unreinforced masonry**: \( \phi = 0.60 \)
- **Shear in unreinforced/reinforced masonry**: \( \phi = 0.80 \)
- **Bearing on masonry**: \( \phi = 0.60 \)

Material properties for determining the nominal strength of masonry (having a specified compressive strength, \( f'_{m} \), equal to or greater than 1500 psi) are a dependent on the the load under consideration. The material properties for nominal strength determination for masonry are as follows:

- **Masonry compressive strength**: \( f'_{m} = 4,000 \text{ psi} \)
- **Grout Compressive Strength**: \( f'_{g} = 4,000 \text{ psi} \) 
  (must equal or exceed \( f'_{m} \))
- **Masonry modulus of rupture**: \( f_r = \text{ACI 530, Table 3.1.7.2.1} \)

The modulus of rupture, \( f_r \), will very considerably based on the following:

- Direction of flexural tensile stress - Determined by governing span direction and loading.
- Masonry type - Solid units or hollow units. Consideration is given to the the extent of grouting.
- Construction - Running bond or stacked bond construction must be considered.
Mortar types - Various types of cement must be considered along with the mortar type designation - M, S or N.

For the purposes of this manual, Table 4-4 provides the Modulus of Rupture values that are assumed based on ACI 530, table 3.1.7.2.1:

<table>
<thead>
<tr>
<th>Direction of flexural tensile stress and masonry type</th>
<th>Mortar Type N, Portland cement/lime or mortar cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal to bed joints in running bond or stacked bond</td>
<td></td>
</tr>
<tr>
<td>Solid units</td>
<td>( f_r = 75 ) psi</td>
</tr>
<tr>
<td>Hollow units:</td>
<td></td>
</tr>
<tr>
<td>Ungrouted</td>
<td>( f_r = 48 ) psi</td>
</tr>
<tr>
<td>Fully grouted</td>
<td>( f_r = 145 ) psi</td>
</tr>
<tr>
<td>Parallel to bed joints in running bond</td>
<td></td>
</tr>
<tr>
<td>Solid units</td>
<td>( f_r = 150 ) psi</td>
</tr>
<tr>
<td>Hollow units</td>
<td></td>
</tr>
<tr>
<td>Ungrouted or partially grouted</td>
<td>( f_r = 95 ) psi</td>
</tr>
<tr>
<td>Fully grouted</td>
<td>( f_r = 150 ) psi</td>
</tr>
<tr>
<td>Parallel to bed joints in stacked bond</td>
<td>( f_r = 0 ) psi</td>
</tr>
</tbody>
</table>

Table 4-4 Modulus of Rupture 9ACI 530, Table 3.1.7.2.1

The modulus of rupture specified for direction of flexural stress "parallel to bed joints in running bond and stacked bond" is used to force the governing nominal strength condition to be governed by the "normal to bed joints in running bond or stacked bond". By controlling the geometry of the anchor locations - vertical location and horizontal location, the modulus of rupture values are governed by the values for "normal to bed joints in running bond or stacked bond".

4-3.3.4 Flexural Strength. The flexural strength of unreinforced masonry members is based on the following assumptions as stipulated in ACI 530:

- Strength design of members for factored flexure and axial load shall be in accordance with principles of engineering mechanics.
- Strain in masonry shall be directly proportional to the distance from the neutral axis.
- Flexural tension in masonry shall be assumed to be directly proportional to strain.
- Flexural compressive stress in combination with axial compressive stress in masonry shall be assumed directly proportional to strain. Nominal compressive strength shall not exceed a stress corresponding to 0.80 \( f'_m \).
- The nominal flexural tensile strength of masonry shall be determined from ACI 530, Table 3.1.7.2.1.

4-3.3.4.1 Flexural Strength Determination. Flexural design strength must equal or exceed the required flexural strength, \( M_U \). Flexural design strength in accordance with
Equation 4-1 is the nominal strength, $M_n$, multiplied by the strength reduction factor for flexure, $\phi$, equal 0.6.

$$M_u = \phi M_n \quad \text{[Eq. 4-6]}$$

The nominal moment is capacity can be derived from principals of engineering mechanics as follows:

$$M_n = f_r S \quad \text{[Eq. 4-7]}$$

Where $f_r$ is the modulus of rupture and $S$ is the section modules of the masonry taking into account any allowances for grouting. Table 4-5 shows average section properties for concrete masonry units - ungrouted and grouted.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>6 in.</td>
<td>32 42 50 58</td>
<td>139 334 635 1065</td>
<td>50 88 132 183</td>
<td>43 50 59 69</td>
</tr>
<tr>
<td>8 in.</td>
<td>48 52 61 71</td>
<td>145 356 676 1147</td>
<td>52 93 141 197</td>
<td>49 60 72 85</td>
</tr>
<tr>
<td>10 in.</td>
<td>40 52 63 74</td>
<td>147 360 685 1163</td>
<td>52 95 142 200</td>
<td>50 62 75 89</td>
</tr>
<tr>
<td>12 in.</td>
<td>32 55 66 78</td>
<td>148 367 697 1188</td>
<td>53 96 145 204</td>
<td>51 65 78 93</td>
</tr>
<tr>
<td>Solid 8 in.</td>
<td>24 59 71 84</td>
<td>152 378 718 1229</td>
<td>54 99 149 211</td>
<td>53 69 85 102</td>
</tr>
<tr>
<td></td>
<td>16 68 82 97</td>
<td>158 400 759 1311</td>
<td>56 105 158 225</td>
<td>58 75 92 111</td>
</tr>
<tr>
<td></td>
<td></td>
<td>177 466 884 1556</td>
<td>63 122 184 268</td>
<td>68 92 116 140</td>
</tr>
</tbody>
</table>

Table 4-5. Average Section Properties of Concrete Masonry Units

4-3.3.4.2 **Axial Design Strength.** Axial design strength on unreinforced masonry members must equal or exceeds the required axial strength, $P_u$. Axial design strength is the nominal strength multiplied by the strength reduction factor for axial load, $\phi$, equal 0.6.

$$P_u = \phi P_n \quad \text{[Eq. D-5]}$$

4-3.3.4.3 **Shear Design Strength.** Shear design strength must equal or exceeds the required shear strength, $V_u$. Shear design strength is the nominal strength multiplied by the strength reduction factor for shear, $\phi$, equal 0.8.

$$V_u = \phi V_n \quad \text{[Eq. D-6]}$$
The nominal shear capacity of masonry is governed by ACI 530, section 3.3.4 as follows:

\[ V_n = 3.8A_n(\sqrt{f_m}) < 300A_n < 56A_n + 0.45N_v < 90A_n + 0.45N_v \]  \[\text{[Eq. D-7]}\]
APPENDIX A

ICC-ES REPORT NO. 22-03 GT250 GRIP-TITE® WALL ANCHORING SYSTEM
APPENDIX B

PERMIT SKETCHES

Appendix B provides permit forms that can be utilized for simplifying the permit application process. The forms must be prepared by individuals competent and qualified in the application of the engineering and design principals involved for specifying and designing basement walls utilizing the Grip-Tite® Wall Anchoring System. They shall possess registration or licenses in accordance with the professional registration laws of the state in which the permit is submitted and the project is constructed.
1. The Grip-Tite Wall Anchor System has been evaluated by the International Code Counsel Evaluation Service, Inc. ICC ES Report No. 22-03 has been issued and can be obtained from the following website: http://www.icc-es.org.

2. The required spacing of the Grip-Tite Wall Anchor System shall be as indicated on the PLAN VIEW sketch above.

3. The depth of the earth anchor plate below the ground surface shall be ______ ft.

4. The distance from the structure to the earth anchor shall be ______ ft. unless noted otherwise on the PLAN VIEW sketch above.

5. The soil type at each anchor location is as indicated below. The soil has been classified in accordance with ASTM D 2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

   Soil Class GW, GP, SW, SP
   Soil Class SC, ML-CL, CL, MH
   Soil Class GM, GC, SM, SM-SC, ML
   Soil Class OL, CH, OH

   NOTE: Unsuitable as backfill

6. Allowable Soil Bearing Pressure #/ft²

7. Location of the ground water table is as indicated on the SECTION sketch on the following page.

8. Maximum anticipated frost depth is ______ in.

9. Corrosive effects of the soil have been evaluated. Galvanized steel in contact with the soil shall perform well and provide acceptable service life.

10. The presence of stone, rocks or other debris in the soil strata and their effects on the suitability of the soil for use with the Grip-Tite Wall Anchor System has been evaluated. Unless indicated below in the special requirements, the Grip-Tite Wall Anchor System installed as indicated should perform as designed.

   Special Requirements: 

   ___________________________________________________________________________

   ___________________________________________________________________________

   ___________________________________________________________________________

   ___________________________________________________________________________
Permit Application - Grip-Tite Wall Anchor System

**Grip-Tite Wall Anchor System**

**Site Conditions/Site Geometry:**

- Height of Wall, $H_w = ______$
- Height of Soil (Backfill), $H_s = ______$
- Hydrostatic Head, $H_{hyd} = ______$

**Grip-Tite Wall Anchor System Installation Requirements:**

- Anchor Distance, $A_d = ______$
- Height of Anchor, $H_a = ______$
- Depth of Earth Anchor, $D_{ea} = ______$

Special Requirements: __________________________________________
________________________________________________________________
________________________________________________________________
________________________________________________________________

Permit Application Section Sketch
APPENDIX C

MASSONRY WALL DESIGN AND ANALYSIS CALCULATIONS

C-1  6" CMU WALL, 7'-0" HIGH, 5'-8" UNBALANCED FILL
C-2  10" CMU WALL, 10'-0" HIGH, 8'-0" UNBALANCED FILL
Unreinforced Masonry Wall Analysis:

A unit width of wall, 1 foot width, is considered for the analysis.

Masonry Properties for Analysis:

**Modules of Rupture, \( f_r \), shall be taken as follows in accordance with ACI 530, Table 3.1.7.2.2:**

<table>
<thead>
<tr>
<th>Mortar Type</th>
<th>Normal to bed joints in running or stacked bond</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Solid Units</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ungrouted</td>
<td>( f_r = 63 ) psi</td>
</tr>
<tr>
<td></td>
<td>Fully Grouted</td>
<td>( f_r = 170 ) psi</td>
</tr>
</tbody>
</table>

For partially grouted between ungrouted and fully grouted use linear interpretation.

For basement walls undergoing retrofits using the Grip-Tite Wall Anchoring System, the likelihood of knowing the mortar type will be highly unlikely. Thus, for design/analysis the values for type N mortar are assumed.

**Masonry Compressive Strength, \( f'_m \), shall be taken as 1500 psi in accordance with ACI 530, paragraph 3.1.7.1.1.**

\[
f'_m = 1500 \text{ psi}
\]

**Strength Reduction Factors, \( \Phi \):**

**Combinations of Flexure and Axial Load.** The strength reduction factor, \( \Phi \), for combinations of flexure and axial load in unreinforced masonry shall be taken as 0.60

\[
\Phi = 0.60
\]

**Shear.** The strength reduction factor for shear shall be taken as 0.80.

\[
\Phi = 0.80
\]
Masonry Wall Properties for Analysis:

When analyzing a basement wall, the wall thickness will be required along with the other pertinent geometry discussed in Chapter 1. It may also be necessary to identify the extent of grouting that is present. This will help to identify the appropriate section properties of the wall for the or analysis and or preliminary wall anchor layout.

<table>
<thead>
<tr>
<th>Grout</th>
<th>Area A (in²/ft)</th>
<th>Moment of Inertia I (in⁴/ft)</th>
<th>Section Modulus S (in³/ft)</th>
<th>Weight of Wall lb/ft²</th>
<th>Modulus of Rupture fₑ (psi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Grout</td>
<td>6 in. 32</td>
<td>8 in. 42</td>
<td>10 in. 50</td>
<td>12 in. 58</td>
<td>6 in. 139</td>
</tr>
<tr>
<td>48</td>
<td>38</td>
<td>50</td>
<td>61</td>
<td>71</td>
<td>145</td>
</tr>
<tr>
<td>40</td>
<td>39</td>
<td>52</td>
<td>63</td>
<td>74</td>
<td>147</td>
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<tr>
<td>32</td>
<td>41</td>
<td>55</td>
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<td>78</td>
<td>148</td>
</tr>
<tr>
<td>24</td>
<td>44</td>
<td>59</td>
<td>71</td>
<td>84</td>
<td>152</td>
</tr>
<tr>
<td>16</td>
<td>49</td>
<td>68</td>
<td>82</td>
<td>97</td>
<td>158</td>
</tr>
<tr>
<td>Solid 8 in.</td>
<td>67</td>
<td>94</td>
<td>114</td>
<td>137</td>
<td>177</td>
</tr>
</tbody>
</table>

1. Weight based on normal weight hollow masonry units, 145#/ft.
2. Type N, Portland cement/lime or mortar cement.
3. For partially grouted masonry, modulus of rupture value shall be determined on the basis of linear interpolation between hollow units that are fully grouted ungrouted based on amount (percentage) of grouting.
Basement Wall Analysis

6" CMU Wall, 7'-0" High, 5'-8" Unbalanced Backfill

\( \gamma_d = 95 \text{ lb/ft}^3, \; \Phi = 15^\circ, \; c = 500 \text{ lb/ft}^2 \)

Wall Geometry:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height of wall (ft)</td>
<td>7.00</td>
</tr>
<tr>
<td>Height of soil (ft)</td>
<td>5.67</td>
</tr>
<tr>
<td>Height of anchor (ft)</td>
<td>2.83</td>
</tr>
<tr>
<td>Anchor Distance (ft)</td>
<td>9.56</td>
</tr>
<tr>
<td>Anchor Down Angle (deg)</td>
<td>2.00</td>
</tr>
<tr>
<td>Depth Earth Anchor (ft)</td>
<td>4.00</td>
</tr>
<tr>
<td>Hydrostatic Head (ft)</td>
<td>2.00</td>
</tr>
<tr>
<td>Weight of Water (lb/ft^3)</td>
<td>62.40</td>
</tr>
<tr>
<td>Wall Thickness cmu</td>
<td>6</td>
</tr>
<tr>
<td>Elastic Modulus (lb/in^2)</td>
<td>112500</td>
</tr>
<tr>
<td>Moment of Inertia (in^4/ft)</td>
<td>367</td>
</tr>
</tbody>
</table>

Soil Parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of Soil, ( \gamma_d ) (lb/ft^3)</td>
<td>95.0</td>
</tr>
<tr>
<td>Saturated Weight of Soil, ( \gamma_{sat} ) (lb/ft^3)</td>
<td>104.5</td>
</tr>
<tr>
<td>At Rest Soil Pressure Coefficient, ( k_o )</td>
<td>0.74</td>
</tr>
<tr>
<td>Active Pressure Coefficient, ( k_a )</td>
<td>0.59</td>
</tr>
<tr>
<td>Passive Pressure Coefficient, ( k_p )</td>
<td>1.70</td>
</tr>
<tr>
<td>Design Lateral Soil Load (lb/ft^2/ft)</td>
<td>70.41</td>
</tr>
<tr>
<td>Cohesion, ( c ) (lb/ft^2/ft)</td>
<td>500.00</td>
</tr>
</tbody>
</table>

Maximum Wall Moment and Shear from Analysis:

\( V_{max} = 462.8 \text{ lb} \)
\( M_{max} = 225.7 \text{ ft-lb} \)

Anchor Reaction/lineal foot of Wall from Analysis:

\( R_a = 732.5 \text{ lb/lineal ft} \)
AT-REST EARTH PRESSURE, $\sigma_A$, AND HYDROSTATIC PRESSURE, $\sigma_w$

NOTE: Soil cohesion is ignored when determining lateral soil pressure.

Conventional Light-frame
Construction, 1-Story,
Structure Reaction at Top
of Wall (Dead + Live), $R_w = 500 \text{ Pounds} / \text{Linear Foot (PLF)}$

Unit Weight of Soil (Mold), $\gamma = 95 \text{ Pounds} / \text{Cubic Foot (PCF)}$

Angle of Internal Friction, $\phi = 15^\circ$

At-rest Pressure Coefficient, $k_o = 0.741$

Cohesion, $c = 500 \text{ Pounds} / \text{Square Foot (PSF)}$

LOADS AND REACTIONS

LOADS DERIVED FROM AT-REST PressURES AND HYDROSTATIC PRESSURE

REACTIONS DETERMINED FROM ANALYSIS ASSUMING A 2-SPAN CONTINUOUS BEAM, PINNED AT EACH END.

$\sigma_A = \gamma(Z1)(\text{ko})$

$\sigma_A = \frac{95 \text{#/FT}^3 \cdot (3.666 \text{ FT}) \cdot (0.741)}{12} = 258.07 \text{#/FT}^2$

$\sigma_A = \gamma(Z1)(\text{ko}) + \gamma_{\text{SUB}(ZZ)}(\text{ko})$

$\sigma_A = 258.07 \text{#/FT}^2 + (104.5 \text{#/FT}^3 \cdot 30.4 \text{#/FT}^2) \cdot (0.741) = 320.46 \text{#/FT}^2$

$\sigma_w = \gamma_{\text{water}}(Z2)$

$\sigma_w = 62.4 \text{#/FT}^2 \cdot (2.0 \text{ FT}) = 124.80 \text{#/FT}^2$

$\sigma_{\text{tot}} = \sigma_A + \sigma_w$

$\sigma_{\text{tot}} = 320.46 \text{#/FT}^2 + 124.80 \text{#/FT}^2 = 445.26 \text{#/FT}^2$

FOUNDATION WALL WITH GRIP–TITE WALL ANCHOR SYSTEM
LOADS AND REACTIONS
LOADS DERIVED FROM AT-REST PRESSURES AND HYDROSTATIC PRESSURE
REACTIONS DETERMINED FROM ANALYSIS ASSUMING A 2-SPAN CONTINUOUS BEAM, PINNED AT EACH END.

SHEAR DIAGRAM
POINTS OF 'O' SHEAR = MAXIMUM MOMENT

MOMENT DIAGRAM

FOUNDATION WALL WITH GRIP-TITE WALL ANCHOR SYSTEM
UNFACTORED LOAD/SHEAR/MOMENT DIAGRAMS
Unfactored Loads From Analysis:

Unfactored maximum shear from lateral earth pressure and hydrostatic load as determined by analysis:

\[ V = 462.8 \text{ lb} \]

Unfactored moment from lateral earth pressure and hydrostatic load as determined by analysis:

\[ M = 225.7 \text{ ft-lb} \]

Unfactored axial load from structure applied at top of wall:

\[ P = 500.00 \text{ lb} \] On story conventional framed construction

Ultimate Loads:

The shear and moment shown above are the direct result of lateral earth pressure and hydrostatic load. The load factor applied to shear and moment in accordance with Eq. D-1 is 1.6.

The axial load represents a combination of dead load and live load. The proportions of dead to live load are unknown. However, since the basement wall analysis/design will be governed by moment capacity of the wall (tension moment capacity of the wall) and the axial load will help to offset the tension moment capacity, the load factor 1.2 will be applied to the total axial load.

Ultimate loads are determined as follows:

\[ V_u = 1.6 V \quad V_u = 741 \text{ lb} \]
\[ M_u = 1.6 M \quad M_u = 361 \text{ ft-lb} \]
\[ P_u = 1.2 P \quad P_u = 600 \text{ lb} \]
**Design Strength:**

**Flexure and Axial Load:**

ACI 530, Section 3.3.2 *Flexural strength of unreinforced masonry members*... "the strength design of members for factored flexural and axial load shall be in accordance with principals of engineering mechanics".

For members under combined axial load and bending the stress at the extreme fibers can be computed by the following equation:

\[
\sigma = \frac{P}{A} \pm \frac{Mc}{I}
\]

- \(\sigma\) = Stress due to bending.
- \(\sigma\) = Stress due to axial load.

\[\sigma_u = \frac{P_u}{A_n} \pm \frac{M_u c}{I_n}\]

\[\Phi \sigma_n \geq \sigma_u\]

\[\sigma_n \geq \sigma_u / \Phi\]

\[\sigma_n \geq \frac{P_u}{A_n \Phi} \pm \frac{M_u c}{I_n \Phi}\]

\[\sigma_n = f_r\]

\[f_r \geq \frac{P_u}{A_n \Phi} \pm \frac{M_u}{S_n \Phi}\]

**Shear:**

Shear design strength must equal or exceeds the required shear strength, \(V_u\). Shear design strength is the nominal strength multiplied by the strength reduction factor for shear, \(\Phi\).

\[\Phi V_n \geq V_u\]

\[V_n = \text{Smallest of the following:}\]

- \(3.8 A_n \sqrt{f'm}\)
- \(300 A_n\)
- \(56 A_n + 0.45 N_v\)

\[A_n = \text{Net cross section area of masonry, in.}^2\]

\[c = \text{Distance from neutral axis to extreme fiber in bending, in.}\]

\[f_r = \text{Modulus of Rupture, psi}\]

\[I_n = \text{Net moment of inertia of masonry, in.}^4\]

\[M_u = \text{Ultimate moment from factored loads, in-lb.}\]

\[P_u = \text{Ultimate load from factored loads, lb.}\]

\[S_n = \text{Net section modulus of masonry, in.}^3\]

\[\sigma_n = \text{Allowable nominal stress due to bending and axial load, psi}\]

\[\sigma_u = \text{Ultimate stress due to bending and axial load, psi}\]

\[\Phi = \text{Strength reduction factor for axial load and bending}\]
Wall Analysis:

The flexural capacity of the wall significantly benefits from the axial load/compression force within the wall provided that the compression force does not control the flexural capacity. For basement walls the flexural capacity will be governed by the tension stress due to moment in the wall. Thus, the weight of the wall should be considered in conjunction with the axial force applied at the top of the wall.

Height of masonry Wall, $H_w = 7.00$ ft.
App. Maximum moment location from the analysis = 2.33 ft.
Masonry Wall Size = 6 in.
Approximate Weight of CMU wall = 43 psf
$A_n = 32.2$ in$^2$

Approximate axial load in masonry wall at point of approximate maximum flexure:

$P_{cmu} = 201$ lb = Weight of ungrouted CMU Wall (Conservative)
$P_{ucmu} = 241$ lb = $1.2 \times P_{cmu}$
$P_{uTotal} = 841$ lb = $P_{ucmu} + P_u$  
$N_s = 701$ lb = $P_{uTotal} / 1.2$
Combined Flexure and Axial Load Check:

**6” Ungrouted CMU wall strength check:**

\[
f_r \geq \frac{P_u}{A \Phi} + \frac{M_u}{S \Phi}
\]

\[
f_r \geq \frac{841 \text{ lb}}{32 \text{ in}^2 \times 0.60} + \frac{361 \text{ ft-lb} \times 12 \text{ in/ft}}{50 \text{ in}^3 \times 0.60}
\]

\[
f_r \geq 102.4 \text{ psi}
\]

\[
f_r = 48.0 \text{ psi} < 102.4 \text{ psi} \quad \text{No Good - allowable tensile stress is exceeded. Apply grout.}
\]

**6” CMU, Grouted @ 16” O/C wall strength check:**

\[
f_r \geq \frac{P_u}{A \Phi} + \frac{M_u}{S \Phi}
\]

\[
f_r \geq \frac{841 \text{ lb}}{49 \text{ in}^2 \times 0.60} + \frac{361 \text{ ft-lb} \times 12 \text{ in/ft}}{56 \text{ in}^3 \times 0.60}
\]

\[
f_r \geq 100.3 \text{ psi}
\]

\[
f_r = 96.5 \text{ psi} < 100.3 \text{ psi} \quad \text{Close but No Good - allowable tensile stress is exceeded. Grout solid.}
\]

**6” CMU, Grouted Solid wall strength check:**

\[
f_r \geq \frac{P_u}{A \Phi} + \frac{M_u}{S \Phi}
\]

\[
f_r \geq \frac{841 \text{ lb}}{67 \text{ in}^2 \times 0.00} + \frac{361 \text{ ft-lb} \times 12 \text{ in/ft}}{63 \text{ in}^3 \times 0.00}
\]

\[
f_r \geq 94.0 \text{ psi}
\]

\[
f_r = 145.0 \text{ psi} > 94.0 \text{ psi} \quad \text{Okay - 6” CMU, Solid Grout.}
\]
Shear Check:

\[ \Phi V_n \geq V_u \]

\[ V_n = 4104 \text{ lb} \]

\[ \Phi V_n = 0.80 \times 4104 \text{ lb} \]

\[ \Phi V_n = 3283 \text{ lb} > V_u = 741 \text{ lb} \text{ Okay.} \]

<table>
<thead>
<tr>
<th>Smallest of the following:</th>
</tr>
</thead>
<tbody>
<tr>
<td>( A_n = 67 \text{ in}^2 )</td>
</tr>
<tr>
<td>( 3.8 A_n \sqrt{f'm} = 9791 \text{ lb} )</td>
</tr>
<tr>
<td>( 300 A_n = 19957 \text{ lb} )</td>
</tr>
<tr>
<td>( 56 A_n + 0.45 N_v = 4104 \text{ lb} )</td>
</tr>
</tbody>
</table>
Determining Anchor Requirements:

Determining Wall Plate Location/Height:
The wall plate should be positioned and installed at 1/2 the backfill height above the floor slab. This is the ideal location to achieve a close balance of moments in the wall - both above and below the wall plate. The moment in the wall below the wall plate typically governs the required strength of the wall.

\[ H_a = \frac{1}{2} H_s \]  
Depth of Earth Anchor

\[ H_a = \frac{1}{2} (5.667') \]  
\[ D_{ea} = H_a + 0.5' + 0.66' \]

\[ H_a = 2.83 \text{ ft} \]  
\[ D_{ea} = 3.99 \text{ ft} \]

Determining Minimum Earth Anchor Distance:
The anchor distance, \( A_d \), is determined from geometry based on the \( \Phi \) angle of the backfill, the height of the backfill (\( H_s \)), and height of the anchor plate (\( H_a \)). To simplify and account for the 2° down angle of the anchor rod, 6" is used and added to the geometric calculations as mentioned above. By doing so, the earth anchor is positioned to prevent the passive soil wedge from overlapping the active soil wedge.

\[ A_d = (H_s) \tan(45-\Phi/2) + (H_a + 0.5' + 0.67') / \tan(45-\Phi/2) \]

- 0.67' (8") used to account for 1/2 the height of the earth anchor plate.
- 0.5' (6") used to account for 2° down angle of rod.

\[ A_d = (5.667') \tan(45-15/2) + (2.83' + 0.5' + 0.67') / \tan(45-15/2) \]

\[ A_d = 9.6 \text{ ft.} \]
Determining Earth Anchor Capacity and Maximum Spacing:

The determination of the earth anchor capacity and spacing follows the procedure as presented in DM 7.2 Foundations and Earth Structures. Chapter 3, Figure 20 Design Criteria for Deadman Anchors, provides design guidance for the case where the height of the earth anchor plate, 1'-4", is less than 1/2 the depth of the earth anchor. Thus, for cases where the minimum depth of the earth anchor is 2'-8" this design guidance is applicable.

The ultimate anchor pull per lineal foot of wall equals the bearing capacity of a strip footing of width equal to the height of the earth anchor plate and a surcharge load of the soil unit weight times the depth soil to the center of the earth anchor plate, $\gamma_{soil}(D_{ea}-1.333'/2)$.

Design guidance to determine the ultimate bearing capacity of a strip footing shallow foundation is presented in Chapter 4, Figure 1 Ultimate Bearing Capacity of Shallow Foundations with Concentric Loads. When using this procedure for deadman anchors, a modified phi angle, $\Phi'$, equal to 0.6tan$\Phi$ is utilized (specified in Chapter 3, Figure 20).

$$\tan \Phi' = 0.6 \tan \Phi$$

$$\Phi = 15 \text{ degrees}$$

$$\Phi' = 9.1 \text{ degrees}$$

Ultimate Bearing Capacity:
Square or Rectangular Footing

$$q_{ult} = c \cdot N_c (1 + 0.3 \frac{B}{L}) + \gamma D N_d + 0.4 \gamma B N_v$$
Bearing capacity factors, \( N_c \), \( N_q \) and \( N_\gamma \) are determined from Chapter 4, Figure 1 using the modified phi angle, \( \Phi' \).

\[
\Phi = 15 \text{ degrees} \quad N_c = 7.6 \\
\Phi' = 9.1 \text{ degrees} \quad N_q = 2.1 \\
N_\gamma = 0
\]

Other variables are as follows:

- \( c = \) Cohesion \( c = 500 \text{ lb/ft}^2 \)
- \( B = \) Height of earth anchor \( B = 1.33 \text{ ft} \)
- \( L = \) Length of earth anchor \( L = 1.33 \text{ ft} \)
- \( D = \) Depth to middle of earth anchor, Dea - 1.33'/2 \( D = 3.338 \text{ ft} \)
- \( \gamma = \) Unit weight of Soil \( \gamma = 95 \text{ lb/ft}^3 \)

\[
q_{ult} = (500 \text{ lb/ft}^2)(7.6)(1 + 0.3 \frac{(1.33/1.33)}{1.3}) + (95 \text{ lb/ft}^3)(3.418 \text{ ft})(2.1) + 0.4(95 \text{ lb/ft}^3)(1.33 \text{ ft})(0)
\]

\[
q_{ult} = 5606 \text{ lb/ft}^2
\]

**Allowable Lateral Earth Anchor Bearing Capacity:**
The allowable bearing capacity equals the ultimate bearing capacity/2. Factor of safety of 2 against failure.

\[
q_{all} = 2803 \text{ lb/ft}^2
\]

**Allowable Earth Anchor Capacity:**
The allowable earth anchor capacity equals the allowable bearing capacity times the area of the earth anchor plates. The area of the earth anchor plates is taken as 1.60 square feet. This can be calculated as follows:

- Plate Area: \( 11" \times 11" = 121 \text{ in}^2 \)
- \( 4 \times 2.5" \times 11" = 110 \text{ in}^2 \)
- Total = 230 \text{ in}^2

\[
\text{Plate Area: } 230 \text{ in}^2 / (144 \text{ in}^2/\text{ft}) = 1.60 \text{ ft}^2
\]

**Allowable Earth Anchor Capacity =** \( (2811 \text{ lb/ft}^2)(1.60 \text{ ft}^2) \)

**Allowable Earth Anchor Capacity =** 4485 lb/plate

**Anchor Rod Spacing:**
The maximum spacing of the anchor rods is determined by Allowable Earth Anchor Capacity divided by the Anchor Reaction per lineal foot of wall.

\[
\text{Maximum Anchor Rod Spacing} = \frac{(4497 \text{ lb})}{(732.5 \text{ lb/ft})} = 6.12 \text{ ft.}
\]
APPENDIX E

CMU WALL DESIGN CHARTS

5' CMU WALL CHART (Unbalanced backfill 4', 5')
6' CMU WALL CHART (Unbalanced backfill 4', 5', 6')
7' CMU WALL CHART (Unbalanced backfill 4', 5', 6', 7')
8' CMU WALL CHART (Unbalanced backfill 4', 5', 6', 7', 8')
9' CMU WALL CHART (Unbalanced backfill 4', 5', 6', 7', 8', 9')
10' CMU WALL CHART (Unbalanced backfill 4', 5', 6', 7', 8', 9' 10')
Soil Investigation/Properties:

- $\gamma_d = 113 \text{ lb/ft}^3$
- $\Phi = 36^\circ$
- $q_o = 46.7 \text{ lb/ft}^3$
- $c = 0 \text{ lb/ft}^3$

Typical Soils:

- **GW**: Well-graded, clean gravels; gravel-sand mixes
- **GP**: Poorly graded clean gravels; gravel-sand mixes
- **SW**: Well-graded, clean sands; sand-gravel mixes
- **SP**: Poorly graded clean sands; sand-gravel mixes

Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 6'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2" hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\Phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DM7.2, Chapter 4, Figure 1, page 7.2-131.
### Soil Investigation/Properties:
- $\gamma_d = 110$ lb/ft$^3$
- $\phi = 26^\circ$
- $q_c = 60.0$ lb/ft$^3$
- $c = 500$ lb/ft$^3$

### Typical Soils:
- GM - Silty gravels, poorly graded gravel-and-clay mixes
- GC - Clayey gravels, poorly graded gravel-and-clay mixes
- SM - Silty sands, poorly graded sand-silt mixes
- SM-SC - Sand-silt clay mix with plastic fines
- ML - Inorganic silts and clayey silts

### Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 6'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2" hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 95 \text{ lb/ft}^3 \]
\[ \Phi = 15^\circ \]
\[ q_o = 70.4 \text{ lb/ft}^3 \]
\[ c = 500 \text{ lb/ft}^3 \]

Typical Soils:
SC - Clayey sands, poorly graded sand-clay mixes
MH - Mixture of inorganic silt clay
ML - CL - Inorganic clays of low to medium plasticity
CL - Inorganic clayey silts, elastic silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 6'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\( \Phi \), 2° down angle of anchor rod and 1/2 height of anchor plate (8")).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
6' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

**Code Min./No Soil Investigation:**

<table>
<thead>
<tr>
<th>Soil Classification</th>
<th>q&lt;sub&gt;s&lt;/sub&gt; = 60 lb/ft&lt;sup&gt;3&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>GW - Well-graded, clean gravels; gravel-sand mixes</td>
<td></td>
</tr>
<tr>
<td>GP - Poorly graded clean gravels; gravel-sand mixes</td>
<td></td>
</tr>
<tr>
<td>GM - Silty gravels, poorly graded gravel-and-clay mixes</td>
<td></td>
</tr>
<tr>
<td>GC - Clayey gravels, poorly graded gravel-and-clay mixes</td>
<td></td>
</tr>
<tr>
<td>SW - Well-graded, clean sands; sand-gravel mixes</td>
<td></td>
</tr>
<tr>
<td>SP - Poorly graded clean sands; sand-gravel mixes</td>
<td></td>
</tr>
<tr>
<td>SM - Silty sands, poorly graded sand-silt mixes</td>
<td></td>
</tr>
</tbody>
</table>

**Notes:**
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 6'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
### 6’ CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

**Code Min./No Soil Investigation:**

\[ q_o = 100 \text{ lb/ft}^2 \]

**Soil Classification:**

- **SM-SC** - Sand-silt mix with plastic fines
- **SC** - Clayey sands, poorly graded sand-clay mixes
- **ML** - Inorganic silts and clayey silts
- **ML - CL** - Inorganic clays of low to medium plasticity
- **CL** - Inorganic clayey silts, elastic silts

### Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4’ and 6’. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0” above the floor elevation - 2’ hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry \( \Phi \), 2° down angle of anchor rod and 1/2 height of anchor plate (8”).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 113 \text{ lb/ft}^3 \]
\[ \Phi = 36^\circ \]
\[ q_c = 46.7 \text{ lb/ft}^3 \]
\[ c = 0 \text{ lb/ft}^3 \]

Typical Soils:
- **GW**: Well-graded, clean gravels; gravel-sand mixes
- **GP**: Poorly graded clean gravels; gravel-sand mixes
- **SW**: Well-graded, clean sands; sand-gravel mixes
- **SP**: Poorly graded clean sands; sand-gravel mixes

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 7'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\( \Phi \)), 2 ° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:

- $\gamma_d = 110 \text{ lb/ft}^3$
- $\Phi = 26^\circ$
- $q_{u} = 60.0 \text{ lb/ft}^3$
- $c = 500 \text{ lb/ft}^3$

Typical Soils:

- GM: Silty gravels, poorly graded gravel-and-clay mixes
- GC: Clayey gravels, poorly graded gravel-and-clay mixes
- SM: Silty sands, poorly graded sand-silt mixes
- SM-SC: Sand-silt clay mix with plastic fines
- ML: Inorganic silts and clayey silts

Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 7'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\Phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8').
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:

γ_d = 95 lb/ft³
Φ = 15°
q_o = 70.4 lb/ft³
c = 500 lb/ft³

Typical Soils:

SC - Clayey sands, poorly graded sand-clay mixes
MH - Mixture of inorganic silt clay
ML - CL - Inorganic clays of low to medium plasticity
CL - Inorganic clayey silts, elastic silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 7'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2° down angle of anchor rod and 1/2 height of anchor plate (8').
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
7' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

**Code Min./No Soil Investigation:**

- q_o = 60 lb/ft³

**Soil Classification:**

- GW - Well-graded, clean gravels; gravel-sand mixes
- GP - Poorly graded clean gravels; gravel-sand mixes
- GM - Silty gravels, poorly graded gravel-and-clay mixes
- GC - Clayey gravels, poorly graded gravel-and-clay mixes
- SW - Well-graded, clean sands; sand-gravel mixes
- SP - Poorly graded clean sands; sand-gravel mixes
- SM - Silty sands, poorly graded sand-silt mixes

**Notes:**

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 7'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2 ° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
7' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

Code Min./No Soil Investigation: Soil Classification:

q_o = 100 lb/ft^2

SM-SC - Sand-silt mix with plastic fines
SC - Clayey sands, poorly graded sand-clay mixes
ML - Inorganic silts and clayey silts
ML - CL - Inorganic clays of low to medium plasticity
CL - Inorganic clayey silts, elastic silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 7'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:

\[ \gamma_d = 113 \text{ lb/ft}^3 \]
\[ \Phi = 36^\circ \]
\[ q_u = 46.7 \text{ lb/ft}^3 \]
\[ c = 0 \text{ lb/ft}^3 \]

Typical Soils:

GW - Well-graded, clean gravels; gravel-sand mixes
GP - Poorly graded clean gravels; gravel-sand mixes
SW - Well-graded, clean sands; sand-gravel mixes
SP - Poorly graded clean sands; sand-gravel mixes

Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 8'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\(\Phi\)), 2° down angle of anchor rod and 1/2 height of anchor plate (8”).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 110 \text{ lb/ft}^3 \]
\[ \phi = 26^\circ \]
\[ q_u = 60.0 \text{ lb/ft}^3 \]
\[ c = 500 \text{ lb/ft}^3 \]

Typical Soils:
- GM - Silty gravels, poorly graded gravel-and-clay mixes
- GC - Clayey gravels, poorly graded gravel-and-clay mixes
- SM - Silty sands, poorly graded sand-silt mixes
- SM-SC - Sand-silt clay mix with plastic fines
- ML - Inorganic silts and clayey silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 8'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry \( \phi \), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DM7.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:

- $\gamma_d = 95\ \text{lb/ft}^3$
- $\phi = 15^\circ$
- $q_o = 70.4\ \text{lb/ft}^3$
- $c = 500\ \text{lb/ft}^3$

Typical Soils:

- SC - Clayey sands, poorly graded sand-clay mixes
- MH - Mixture of inorganic silt clay
- ML - CL - Inorganic clays of low to medium plasticity
- CL - Inorganic clayey silts, elastic silts

Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 8'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DM7.2, Chapter 4, Figure 1, page 7.2-131.
8' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

Code Min./No Soil Investigation:  

Soil Classification:

- **GW** - Well-graded, clean gravels; gravel-sand mixes
- **GP** - Poorly graded clean gravels; gravel-sand mixes
- **GM** - Silty gravels, poorly graded gravel-and-clay mixes
- **GC** - Clayey gravels, poorly graded gravel-and-clay mixes
- **SW** - Well-graded, clean sands; sand-gravel mixes
- **SP** - Poorly graded clean sands; sand-gravel mixes
- **SM** - Silty sands, poorly graded sand-silt mixes

\[ q_w = 60 \text{ lb/ft}^3 \]

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 8'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2° down angle of anchor rod and 1/2 height of anchor plate (8”).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
### Soil Classification:

- **SM-SC** - Sand-silt mix with plastic fines
- **SC** - Clayey sands, poorly graded sand-clay mixes
- **ML** - Inorganic silts and clayey silts
- **ML-CL** - Inorganic clays of low to medium plasticity
- **CL** - Inorganic clayey silts, elastic silts

### Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 4' and 8'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (Φ), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:  
\[ \gamma_d = 113 \text{ lb/ft}^3 \]  
\[ \Phi = 36^\circ \]  
\[ q_c = 46.7 \text{ lb/ft}^3 \]  
\[ c = 0 \text{ lb/ft}^3 \]

Typical Soils:  
GW - Well-graded, clean gravels; gravel-sand mixes  
GP - Poorly graded clean gravels; gravel-sand mixes  
SW - Well-graded, clean sands; sand-gravel mixes  
SP - Poorly graded clean sands; sand-gravel mixes

Notes:  
1. Wall height assumed to be constant.  
2. Backfill depth may vary between 6' and 9'. Backfill assumed to be horizontal or slightly sloping away from wall.  
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.  
4. Anchor height taken as 1/2 the backfill depth.  
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.  
6. Minimum depth of anchor determined from geometry (\( \Phi \)), 2 \(^\circ\) down angle of anchor rod and 1/2 height of anchor plate (8").  
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT 2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 110 \text{ lb/ft}^3 \]
\[ \Phi = 26^\circ \]
\[ q_s = 60.0 \text{ lb/ft}^3 \]
\[ c = 500 \text{ lb/ft}^3 \]

Typical Soils:
- **GM** - Silty gravels, poorly graded gravel-and-clay mixes
- **GC** - Clayey gravels, poorly graded gravel-and-clay mixes
- **SM** - Silty sands, poorly graded sand-silt mixes
- **SM-SC** - Sand-silt clay mix with plastic fines
- **ML** - Inorganic silts and clayey silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 9'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\(\Phi\)), 2° down angle of anchor rod and 1/2 height of anchor plate (8`).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 95 \text{ lb/ft}^3 \]
\[ \Phi = 15^\circ \]
\[ q_s = 70.4 \text{ lb/ft}^3 \]
\[ c = 500 \text{ lb/ft}^3 \]

Typical Soils:
- SC - Clayey sands, poorly graded sand-clay mixes
- MH - Mixture of inorganic silt clay
- ML - CL - Inorganic clays of low to medium plasticity
- CL - Inorganic clayey silts, elastic silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 9'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\( \Phi \)), 2 \(^\circ\) down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
9' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

Code Min./No Soil Investigation:

\[ q_{c} = 60 \text{ lb/ft}^2 \]

Soil Classification:

- **GW**: Well-graded, clean gravels; gravel-sand mixes
- **GP**: Poorly graded clean gravels; gravel-sand mixes
- **GM**: Silty gravels, poorly graded gravel-and-clay mixes
- **GC**: Clayey gravels, poorly graded gravel-and-clay mixes
- **SW**: Well-graded, clean sands; sand-gravel mixes
- **SP**: Poorly graded clean sands; sand-gravel mixes
- **SM**: Silty sands, poorly graded sand-silt mixes

**Notes:**

1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 9'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
9' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

Code Min./No Soil Investigation: Soil Classification:

$q_o = 100 \text{ lb/ft}^2$

SM-SC - Sand-silt mix with plastic fines
SC - Clayey sands, poorly graded sand-clay mixes
ML - Inorganic silts and clayey silts
ML - CL - Inorganic clays of low to medium plasticity
CL - Inorganic clayey silts, elastic silts

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 9'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\Phi$), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
### Soil Investigation/Properties:

\[ \gamma_d = 113 \text{ lb/ft}^3 \]
\[ \Phi = 36^\circ \]
\[ q_c = 46.7 \text{ lb/ft}^3 \]
\[ c = 0 \text{ lb/ft}^3 \]

### Typical Soils:

- **GW** - Well-graded, clean gravels; gravel-sand mixes
- **GP** - Poorly graded clean gravels; gravel-sand mixes
- **SW** - Well-graded, clean sands; sand-gravel mixes
- **SP** - Poorly graded clean sands; sand-gravel mixes

### Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 10'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\(\Phi\)), 2° down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
## Soil Investigation/Properties:
- $\gamma_d = 110 \text{ lb/ft}^3$
- $\Phi = 26^\circ$
- $q_u = 60.0 \text{ lb/ft}^3$
- $c = 500 \text{ lb/ft}^3$

## Typical Soils:
- **GM** - Silty gravels, poorly graded gravel-and-clay mixes
- **GC** - Clayey gravels, poorly graded gravel-and-clay mixes
- **SM** - Silty sands, poorly graded sand-silt mixes
- **SM-SC** - Sand-silt clay mix with plastic fines
- **ML** - Inorganic silts and clayey silts

### Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 10'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\Phi$), 2 ° down angle of anchor rod and 1/2 height of anchor plate (8°).
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
Soil Investigation/Properties:
\[ \gamma_d = 95 \text{ lb/ft}^3 \]
\[ \phi = 15^\circ \]
\[ q_u = 70.4 \text{ lb/ft}^3 \]
\[ c = 500 \text{ lb/ft}^3 \]

Typical Soils:
- SC - Clayey sands, poorly graded sand-clay mixes
- MH - Mixture of inorganic silt clay
- ML - CL - Inorganic clays of low to medium plasticity
- CL - Inorganic clayey silts, elastic silts

**Notes:**
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 10'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\( \phi \)), 2 \( ^\circ \) down angle of anchor rod and 1/2 height of anchor plate (8'').
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
### 10' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

**Code Min./No Soil Investigation:**

\[ q_o = 60 \text{ lb/ft}^3 \]

**Soil Classification:**

- **GW**: Well-graded, clean gravels; gravel-sand mixes
- **GP**: Poorly graded clean gravels; gravel-sand mixes
- **GM**: Silty gravels, poorly graded gravel-and-clay mixes
- **GC**: Clayey gravels, poorly graded gravel-and-clay mixes
- **SW**: Well-graded, clean sands; sand-gravel mixes
- **SP**: Poorly graded clean sands; sand-gravel mixes
- **SM**: Silty sands, poorly graded sand-silt mixes

#### Notes:

1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 10'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry (\( \Phi = 27^\circ \)), 2" down angle of anchor rod and 1/2 height of anchor plate (8").
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
10' CMU Wall Chart - Variable Fill Heights - Variable Soil Parameters

Code Min./No Soil Investigation:

Soil Classification:

- SM-SC - Sand-silt clay mix with plastic fines
- SC - Clayey sands, poorly graded sand-clay mixes
- ML - Inorganic silts and clayey silts
- ML - CL - Inorganic clays of low to medium plasticity
- CL - Inorganic clayey silts, elastic silts

$q_o = 100 \text{ lb/ft}^2$

Notes:
1. Wall height assumed to be constant.
2. Backfill depth may vary between 6' and 10'. Backfill assumed to be horizontal or slightly sloping away from wall.
3. Water table assumed to be 2'-0" above the floor elevation - 2' hydrostatic head.
4. Anchor height taken as 1/2 the backfill depth.
5. Minimum anchor spacing based on the lesser of that determined based on soil bearing capacity or 1.5 times the anchor height.
6. Minimum depth of anchor determined from geometry ($\Phi=0^\circ$), 2" down angle of anchor rod and 1/2 height of anchor plate (8")
7. Allowable lateral bearing capacity determined for depth of anchor plate. Capacity determined from DMT.2, Chapter 4, Figure 1, page 7.2-131.
APPENDIX G

EXPANSIVE SOIL (BELLEVILLE DISC SPRING – CONCEPT)
Appendix H provides detailed instructions of using the manual, permit forms and charts to create a permit application to the building official. The permit application should in most cases provide the necessary information for the building official to make an informed decision on the adequacy and approval of the *Grip-Tite®* Wall Anchoring System.
**Step 1:** Perform the necessary site investigation to determine the following minimum information:

- **Geometry** – wall height, soil depth, water table elevation (within wall height), site constraints.
- **Material parameters** – wall material, thickness.
- **Construction quality** – existing construction, connections (floor to top of wall), grouted CMU, reinforced CMU or concrete, etc.

**Step 2:** Perform a soil investigation to verify the following minimum information:

- **Soil Classification.**
- **Soil strength parameters** – unit weight ($\gamma$), angle of internal friction ($\Phi$), Cohesion ($c$).
- **Water table elevation.**

**NOTE:** At a minimum, a soil classification is required to utilize IBC minimum soil load parameters. Utilizing IBC minimum soil load parameters will result in stringent construction requirements that do not fully take advantage of soil strength parameters determined from a thorough soil investigation. It is highly recommended that a soil investigation be conducted to not only classify the soil but also identify the soil strength parameter.

**Step 3:** Begin the permit application by utilizing the permit application sketches provided in Appendix B and information obtained from Step 1 and 2. Enter the site conditions and soil classification for the given site conditions.
Step 4:  With the soil classification and strength parameters select the wall chart from Appendix E that closely and conservatively approximate the site conditions.

![Wall Chart from Appendix E](image)

Step 5:  With the wall chart selected from Appendix E, enter the chart on the left side. Locate the backfill height determined from the site investigation, and move from the left to the right. The first colored bar that you come to indicates the acceptable wall and grout spacing required for the given condition.

![Wall Chart Diagram](image)
Step 6: The wall required is selected as 6” CMU fully grouted. Other walls that satisfy the requirement are 8” CMU grouted at 48” O/C minimum, all 10” CMU walls and all 12” CMU walls. Enter the wall section from the chart that will be utilized for the project. Enter this in “Special Requirements” area of the permit application.

Step 7: Determine the wall plate anchor rod height (1/2 the height of the backfill) and enter this on the permit application (page 2).

Step 8: Determine the maximum anchor spacing and enter this on the permit application (page 2).

Step 9: Determine the minimum anchor distance that the earth anchor must be placed away form the wall. Enter this on the permit application (page 2).

Step 10: Determine the minimum depth of the earth anchor and enter this on the permit application (page 2).

Step 11: Determine the allowable lateral soil bearing capacity and enter this on the permit application (page 1).

Step 12: Attach the ICC –ES Report No. 22-03 to the permit application.

Step 13: Assemble the completed permit application information to include the permit application (2 pages), the appropriate wall chart for the site and soil conditions, and the IC-ES report. Seal and stamp the permit (Professional Engineer) if required.