Minimum Guidelines for the Design and Use of Underpins When Performing Foundation Stabilization and/or Supplementation

UP-08

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1. Title

   Minimum Guidelines for the Design and Use of Underpins When Performing Foundation Stabilization and/or Supplementation.

2. Designation

   This guideline is issued under the fixed designation UP; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates an editorial. This standard has been peer reviewed and approved by the Florida Association of Sinkhole Stabilization Specialists for use throughout this industry.

3. List of Figures

4. Scope

4.1 This guideline provides a general overview of minimum specifications and standards that should be utilized and incorporated when designing and performing foundation stabilization and/or supplementation for residential and commercial structures not to exceed 2 stories in height.

4.2 This standard does not purport to address all of the safety concerns associated with the installation and/or use of foundation underpins. It is the responsibility of the contractor to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to installation.

4.3 This standard is not intended to preclude the design and specification requirements of the Engineer of Record. It is recommended that each underpinning application for a particular site be evaluated by a qualified engineer to provide specific design and specification requirements that meet or exceed the minimum requirements set forth herein.

5. Referenced Documents

5.1 Florida Building Code, 2004

5.2 American Concrete Institute ACI-318 – Building Code Requirements for Structural Concrete (latest edition)

5.3 American Institute of Steel Construction, Inc. (AISC), Steel Construction Manual

5.4 ASTM

5.5 Portland Cement Association (PCA) Design and Control of Concrete Mixtures (latest edition)

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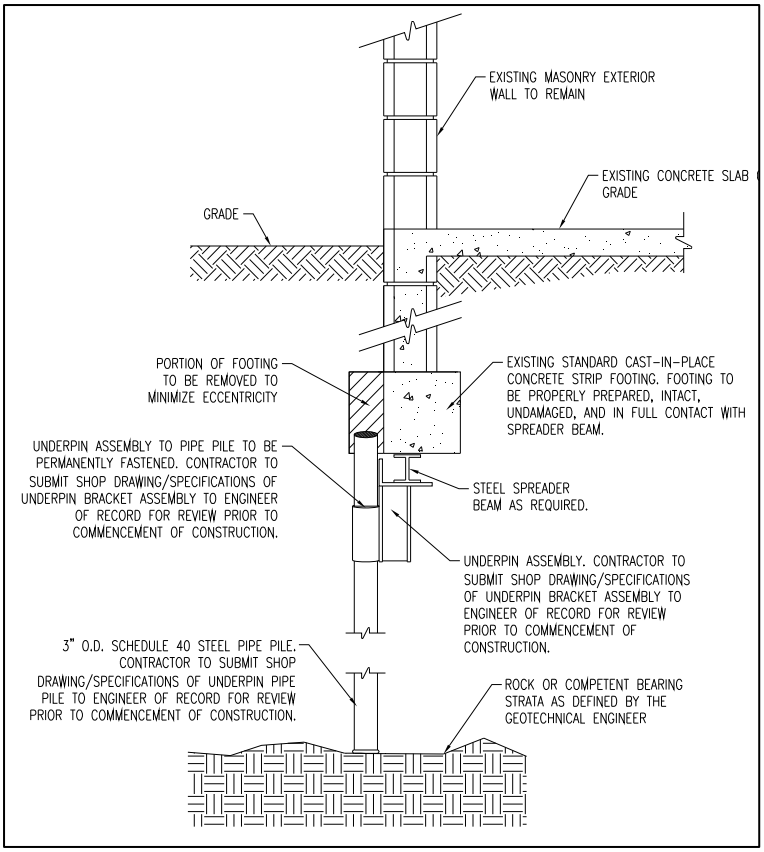

Figure 1: Detailed drawing of a typical underpin on an exterior strip footing wall system

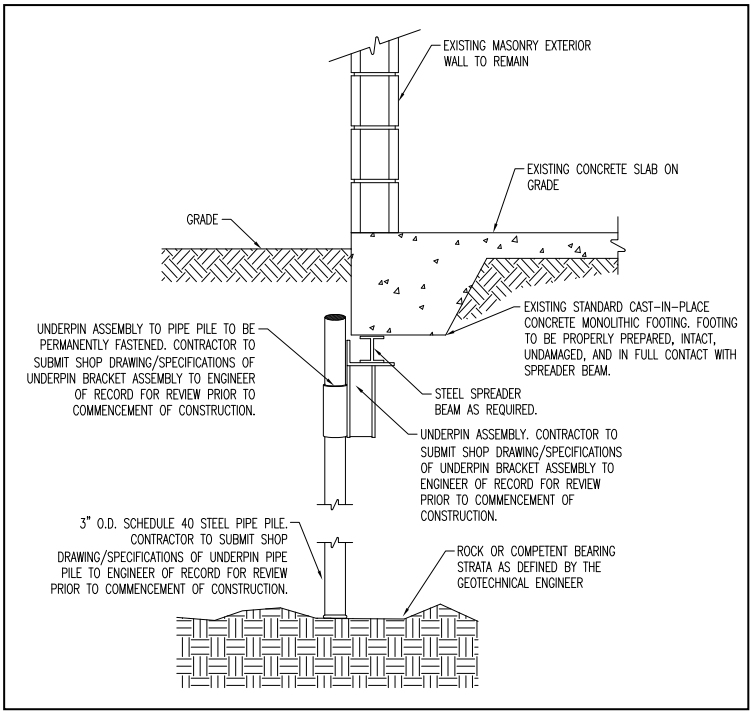

Figure 2: Detailed drawing of a typical underpin on a monolithic thickened edge foundation system

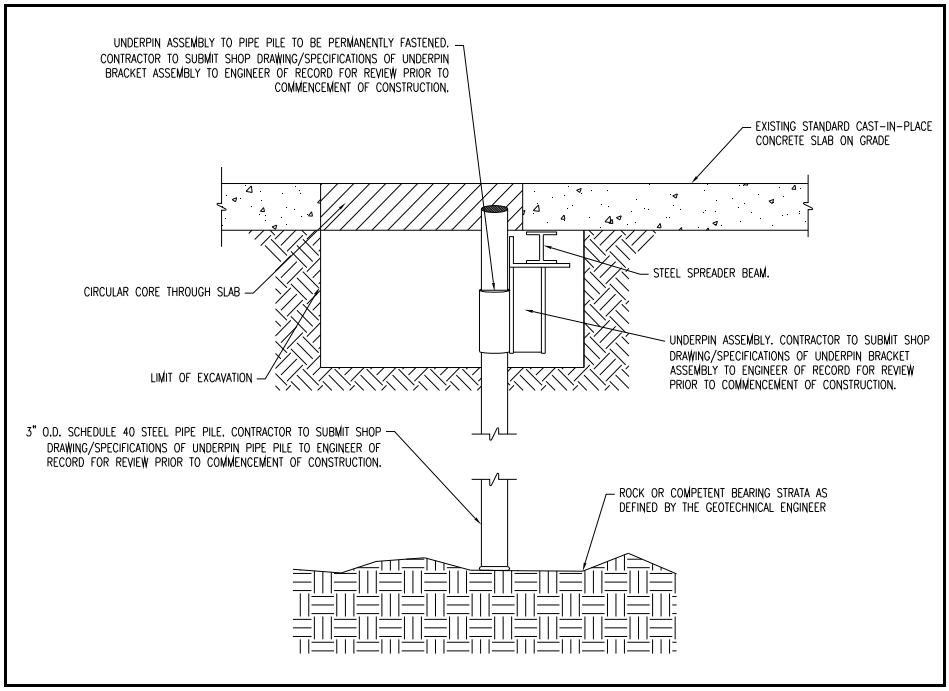

Figure 3: Detailed drawing of a typical underpin on an interior concrete slab on grade.

6. Terminology

6.1 Definitions of Terms Specific to This Standard:

6.1.1 Bracket – The portion of an underpin system that is in direct contact with the structure or spreader beam, and is connected to the steel pile.

6.1.2 Bushed – Dressing a concrete surface through the use of a power driven hammer to ensure that the surface of the concrete is flat.

6.1.3 Driving Pressure – The pressure used to advance the steel underpin pipe into the ground, typically recorded for each section of pipe.

6.1.4 Eccentricity – The distance of the geometric center of a structural component (wall, column, etc.) from the axis of rotation (i.e. underpin pile).

6.1.5 Grade Beam – A reinforced concrete beam placed on the ground to provide support to an overlying wall or structural element.

6.1.6 Spreader Beam – A steel W4X13 beam, or an equivalent beam with an equal or greater Section Modulus.

6.1.7 High Plastic Clays – Clayey soils which will shrink and swell due to moisture fluctuations, resulting in heaving and settlement of the ground surface.

6.1.8 Jetting – A method of installing an underpin by using a jet of water to break or loosen the soil ahead of the underpin during installation.

6.1.9 Lift Pressure – The pressure used to lift the structure during the underpin lift.

6.1.10 SPT – Abbreviation for Standard Penetration Test, which is a standardized method for collecting soil samples in a split-spoon sampler allowing for the interpretation of subsurface soil conditions.

6.1.11 Underpin – Permanent support for walls, columns, and floor slabs used to transfer structural loads from the foundation to competent subsurface soil strata at depth through steel piles

6.1.12 Stabilitive Underpin Approach - A Stabilitive approach is intended to stabilize the structure in its current condition. Stabilitive underpin designs limit the potential for collateral damages which could result from lifting the structure.

6.1.13 Restorative Underpin Approach - A Restorative underpin approach is intended to restore the structure to a pre-event state while addressing and relieving displacement related distress. A Restorative approach is intended to restore structural integrity to those portions of the structure affected by displacement of the structure.

6.1.14 Preventative Underpin Approach - A Preventative approach is intended to isolate the structure from the problematic soils and transfer the loads from the structure to more stable soils existing below the problem zone.

7. Underpin Design

7.1 Prior to designing the underpin system, the Engineer of Record shall establish the appropriate underpin approach to be utilized. The three underpin approaches are as follows; stabilitive, restorative, preventative. The definition of these approaches can be found within section 6 (Terminology).

7.2 Underpins shall be a minimum 3 inch outer diameter Schedule 40 steel pipe, or an equivalent assembly tested by an independent engineer. Testing documentation shall be submitted with shop drawings to the Engineer of Record.

7.3 Each underpin assembly supporting load bearing components shall be capable of supporting a minimum axial service load of 30 kips.

7.4 The Contractor shall provide shop drawings of the complete proposed underpin system. Any alternative designs, exceptions taken to the plans and/or alternative comparable systems shall be submitted for approval by the engineer of record prior to construction.

7.5 Calculations shall be performed by the Engineer of Record to ensure that the diameter and size of the underpins are adequate to support the structure, particularly as underpin depths exceed 60 feet.

7.6 Underpins shall be installed to end bearing unless otherwise specified in writing by a geotechnical engineer for the specific project.

8. Underpin Spacing

8.1 Underpins Supporting Exterior and Load Bearing Walls

8.1.1 The actual spacing of underpins supporting exterior walls, and interior load bearing walls, will depend to some extent on contractor means and methods, and on in-situ conditions, but should be spaced no greater than 6 feet on center, with the following exceptions:

8.1.1.1 Underpins may be spaced at distances greater than 6 feet if calculations performed by the Engineer of Record indicate that strength and deflection requirements of both the structure and underpin system are met.

8.1.1.2 Some 2-story masonry structures may require additional calculations to ensure that 6 feet spacing of underpins is adequate.

8.1.2 Spreader beams (minimum 3 feet in length) shall be located on each side of window and door openings. Window or door openings greater than 6 feet in width will require the Engineer of Record to specify spreader beam size and length. Spreader beams shall be mechanically attached to the bracket.

8.1.3 Existing large roof and/or floor girder placement may require additional consideration and may require underpins to be located under these point loads.

8.1.4 In cases where underpinning is performed at the corner of a structure, the underpins shall be located within 2 feet of the corner.

8.1.5 Underpins should not be installed below window or door openings, except in rare cases where such installation has been justified by the Engineer of record, in which case the underpin pipe shall be pre-drilled or jetted.

8.2 Underpins Supporting Interior Floor Slabs

8.2.1 Interior underpins supporting the floor slab shall be capable of supporting a minimum axial service load of 10 kips.

8.2.2 The actual spacing of underpins supporting interior floor slabs will depend to some extent on contractor means and methods, and on in-situ conditions, and should be spaced no greater than 5 feet on center, in a grid layout unless otherwise specified by the engineer of record.

8.2.3 Spacing of interior underpins may be extended in the event that the underpin design incorporates alternative approaches such as the use of two-way reinforced grade beams.

9. Footing Preparation and Bracket Installation

9.1 Continuous strip footings 8 inches thick or less shall be saw-cut and bushed as necessary to ensure that the eccentricity between the wall load and the underpin bracket is minimized. Footing thicknesses greater than 8 inches shall be analyzed by the engineer of record to determine acceptable eccentricity.

9.2 A corrosion inhibitor shall be applied to any rebar that is exposed as a result of saw cutting the footer to ensure that the intent of the rebar “cover” is not diminished.

9.3 The concrete footing shall be properly prepared so that it is intact, undamaged, and in full contact with the bracket or spreader beam. Full contact may also be accomplished through seating the foundation to the bracket or spreader beam with a bed of non-shrink structural grout.

9.4 Where adequate footings do not exist, it may be necessary for the Engineer of Record to design a retrofit grade beam to be constructed prior to the installation of the underpins.

9.5 Upon final lift of the structure, underpin brackets are to be permanently fastened to the underpin pipe through a method approved by the engineer of record, and the bracket excavation shall be backfilled to grade.

9.6 The top of the underpin pipe should be sealed to prevent moisture and soil from entering.

10. Underpin Pipe Installation

10.1 Each underpin shall be driven to refusal as determined by SPT boring verification as to depth to competent bearing capacity material.

10.2 High plastic clayey soils within the upper 15 feet shall not constitute competent bearing capacity material. In the event that shallow high plastic clayey soils are encountered, the underpins are to be pre-drilled, or jetted, and/or advanced thru the clay by some other means as approved by the Engineer of record.

10.3 The angle of the underpins should be as close to vertical as possible, and under no circumstance should the angle be greater than 5 degrees from vertical.

10.4 During underpin pipe installation, adjacent underpins should never be installed concurrently.

10.5 The Contractor shall continuously monitor the structure during installation to verify that lift is not occurring. The installation of the pin shall cease in the event that 1/16 inch of lift has occurred, unless otherwise directed by the Engineer of Record.

11. Underpin Lift

11.1 The purpose of lifting is to bring the structure back to an acceptable level of serviceable tolerance as determined by the Engineer of Record, and to ensure that structural loads are adequately transferred to the underpins. It should be understood that completely leveling the structure may not be practical.

11.2 The final lift of the structure shall be performed under the oversight of the Engineer of Record, or qualified representative.

11.3 Any void space between the footers or interior floor slab and soil, that is created by lifting the structure should be filled with an adequate strength material to restore bearing between the structure and soil.

12. Underpin Completion Reports

12.1 The following shall be included in any Underpin Completion report that is issued in regard to the underpinning work:

12.1.1 Individual underpin pressures and depths. The Contractor shall be responsible for recording underpin driving pressures and depths, and shall provide these records to the Engineer of record.

12.1.2 Final underpin lift pressures, and amount of building lift at each underpin. The Engineer of record shall oversee the final underpin lift, record the final lift pressures, and amount of building lift at each underpin.

12.1.3 Details of any footing prep work that was completed.

12.1.4 As-built drawing of underpin locations.

12.1.5 Recommendations to allow the structure to stabilize a minimum of 30 days prior to commencement of cosmetic repairs for an underpinning system designed for stabilization, and 60 to 90 days for an underpinning system designed to lift the structure.

13. Quality Assurance

13.1 The Contractor shall have in place and continuously maintain a quality assurance program and designated quality assurance personnel onsite during all underpin installation procedures.

13.2 Calibration of equipment and gauges should be performed in accordance with manufacturer specifications.

13.3 At a minimum the Engineer of Record (or a representative) shall maintain a daily presence onsite during driving of the underpin pipe and final lifting of the structure.

13.4 Jobsite Safety

13.4.1 As previously mentioned, this guideline does not purport to address all of the safety concerns associated with underpin installation. It is the responsibility of the user of this guideline to establish appropriate safety and health practices and to comply with all applicable regulatory and non-regulatory requirements. However, safety is important and a few safety concerns that should be followed are listed in this section.

13.4.2 Prior to performing any work, the Contractor shall be responsible for having buried utilities located and marked, and contacting the property owner to inquire of any addition information they may have regarding the location of buried utilities or structures.

13.4.3 OSHA Standards, including access/egress requirements and shoring requirements, shall be followed whenever excavations are made. Installers shall wear clothing and safety equipment appropriate for the work, and/or as dictated by project specific guidelines.

13.4.4 All excavations shall be temporarily covered or barricaded when the contractor is not actively working in that area.