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Bureau of Development Services
FROM CONCEPT TO CONSTRUCTION

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Structural Requirements for Underpinning of Residential Structures with Slender Piles, Including Helical Piles and Push Piers

The use of slender piles to mitigate foundation settlement on residential structures is not uncommon in Portland. The scope of work on these projects can range from a single pile/pier to supporting an entire structure. These piles/piers are designed to stop settlement by providing additional support for existing foundations. This support changes the way the gravity loads on the foundations interact with the soils and in turn, alter the lateral load resistance. These changes can range from insignificant to substantial dependent on the scope of the underpinning. On a local level, such as with one or two isolated piles/piers, these changes may be within the allowances of section 3404 of the 2014 Oregon Structural Specialty Code (OSSC) for increase in gravity and lateral loads and may not need additional justification. In situations where underpinning is provided for a larger portion of a foundation and where allowances of section 3404 of the 2014 OSSC are exceeded, such as along an entire wall line, the following guidelines have been provided to ensure adequate calculations are provided for review. Permit applicants seeking acceptance for underpinning projects should include the information indicated in these guidelines as a minimum before their submittals will be considered for acceptance.

Gravity Considerations:

1) The ability of the existing foundation to span between piles/piers should be considered and strengthening added where needed. Assumptions regarding existing reinforcing should be clearly indicated on the drawings and accepted ACI 318 methods for flexure and shear should be included in the calculations. Note that ACI 318-11 22.7.3 indicates that plain concrete shall not be used for footings on piles. Any calculation for a plain concrete member must follow an ACI approved design method specifically for unreinforced beams. As an alternative arching of the existing foundation may be used provided the maximum spacing of piles/piers does not exceed two times the depth of the existing foundation (and monolithic stem wall). The width of the footing bracket may be used to reduce the concrete span. The capacity of the foundation and stem wall must be adequate to resist loads on the pier. Any existing cracking in the foundation and stem wall should be noted and existing shear capacities should be adjusted accordingly. Assumed foundation stem wall depths must be indicated on the drawings for inspector verification.
2) When used for supplemental reinforcement of existing single-family dwellings, compliance with 2014 OSSC 1810.2.2 is not required provided there is at least 1 post-installed anchor used to attach each bracket to the foundation. Additionally, there must be a positive connection of the bracket at the top of a pier/pile to the existing foundation based on the requirements of ASCE 7-10 12.1.3 in Seismic Design Category (SDC) D. At a minimum a capacity of 0.4 percent of the shaft's allowable axial capacity in compression should be provided in the connection. This is a value similarly used by the City of Los Angeles for similar slender piles. The special inspection requirement for anchors may be omitted where the piles/piers are not being used to resist lateral loading. The use of eccentric piles/piers is acceptable for lightly loaded flexible systems such as wood framing, however, unreinforced masonry or otherwise brittle wall and foundation systems may require additional stability mitigation and review. Soil depths on both the interior and

exterior sides of the footings must be clearly indicated on the drawings for review. Additional stability measures may be required depending on specific site and existing foundation layout.

3) The bracket and pile/pier assembly must have a third-party verification report from an accepted agency, such as ICC. The report must specifically cover helical piles, hydraulically driven steel piles (push piers), or whatever foundation system is indicated in the permit package. A copy of the applicable report must be included with the calculations package. An assembly without approval requires full calculations and special inspections of steel fabrication and welding.

Lateral Considerations:

1) Lateral resistance of the foundation system must be considered and must follow through to soil below. Where a portion of a structure is supported by new piles/piers it is allowed to consider the sliding resistance of the portion of the foundation which is still in full bearing contact with the existing soil to resist the lateral load (wind, seismic, or unbalanced soil) on the foundation. A reasonable rationale should be shown in the calculations for the point where full soil bearing occurs adjacent to a pile/pier. The portion of the foundation which is not supported by piles/piers must have collector continuity to the portion that is supported by piles/piers and should have some path for tension loading, such as longitudinal reinforcement or continuous sill plates. Longitudinal reinforcement or other continuity devices should be justified if they are assumed in the existing structure. Shear friction factors and passive resistance values for concrete foundations in soil higher than the minimum allowed by OSSC 1806 and shear friction values on the side of basement walls require a soils report prepared by a professional engineer with experience in geotechnical engineering (reviewed by Site Development). If there is not enough shear capacity remaining between the soil and footing still supporting gravity loads to resist the wind or seismic loads (in either direction) and lateral earth loads along any line of support, then additional lateral support must be provided. Any of the following may be considered for additional support:
    a. **Passive resistance of the existing foundation** perpendicular to the loaded foundation over a reasonable area adjacent at each end. The depth of the existing footings versus adjacent soils must be indicated clearly on the drawings.
    b. **Passive resistance of a concrete encased bracket** at top of pile/pier. The dimensions of the additional concrete including depth of adjacent soils must be indicated on the drawings. A positive connection of the concrete encasement to the existing foundation must be provided. Friction is not considered a positive connection and the new concrete should be in direct contact with the existing foundation and not placed lower on a pile/pier. Alternative materials to concrete may be submitted for approval where they can be shown to have the compressive capacity and stiffness needed to function in the same capacity as concrete.
    c. **Lateral loading in tension or compression on a battered pile/pier** in the direction of loading. In a case that involves lateral instability in two orthogonal directions, piles/piers in orthogonal directions may be required.
    d. **Shear friction between an existing concrete slab** on grade and the soil below adjacent to the foundation provided the attachment of the slab to the foundation is known or added. Existing slab reinforcement should also be considered and indicated on the drawings. Note that the shear resistance at the soil interface of a thin slab is not very large and that diaphragm type distribution to other points of resistance may be needed, hence reinforcement in the slab should be considered.
    e. **Lateral loading on the piles/piers** is permitted where ALL of the following limitations are met:
        i. Lateral capacity is specified in a report from an approved third-party testing and evaluation service (such as ICC-ES or similar) applicable to SDC D, E and F.

ii. The engineer of record has verified that the differential displacement of foundations supported by piles/piers is compatible with areas where foundations are supported by shallow foundations with soil friction. No gravity members or connections may be compromised by this displacement.
iii. There is a positive mechanical connection of some type between the existing foundation and the new pile/pier shown to be capable of resisting the design lateral load. Special inspection is required for post installed anchors used to resist lateral loading.

f. **Any other rational analysis** method, not specifically prohibited by this document, that resolves the lateral loads in the structure and has full calculations. Methods outside of the listed methods will be subject to additional review which may require project intake.

Additional Considerations:

1) Information should be provided on the drawings/site plan indicating the proximity of any foundation work in relationship to property lines and existing adjacent structures. Estimated depths of adjacent foundations, such as where a basement is present, should also be provided where work being done in the permit may affect the existing structure. Any shoring that is required in a permit to protect an adjacent structure must be shown to be adequate to meet code required loading.

2) If an existing concrete basement floor slab is used to resist out-of-plane soil loading during basement excavation, or on a permanent basis, calculations justifying the adequacy of the slab should be provided and any assumptions regarding the slab thickness noted on the drawings.

3) Any work that alters an existing load path such that shoring is required, must have an indication on the drawings that the building is NOT occupied during construction. If occupancy is desired during construction, an occupant safety plan shall be submitted as part of the permit submittal. The occupant safety plan shall include among other things all shoring and sequencing along with complete calculations and details signed and sealed by an engineer indicating that the building meets code at all times while work is being done.

Please note that this memo is intended to cover primarily structural aspects of underpinning. A more comprehensive code guide will be issued in the future that will include geotechnical specific requirements, including minimum report requirements.

Prepared by D. Tarries 01-27-17
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