PARAGON
STRUCTURAL ENGINEERING

MAINTENANCE OF GROUND SUPPORTED FOUNDATIONS

Overview:
The performance of structures built on ground supported foundations depends not only on proper design and construction, but also on a proper foundation maintenance program performed by the occupant and/or owner of the property. A properly designed and constructed foundation may still experience distress from soils which undergo volumetric changes caused by non-climatic moisture sources such as irrigation, leaking pools, or leaking underground utility lines (i.e. water, sewer, sprinkler, etc.). For example, any increase in the monthly water bill without any apparent reason, can indicate the presence of a plumbing leak that should be investigated and corrected immediately.

Most problems resulting from expansive soils involve shrinking or swelling as evidenced by downward or upward movement of the foundation, resulting in distress to the structure. This shrinking/swelling corresponds with changes in moisture content of expansive soils. The soil expands as the moisture content increases. Conversely, the soil shrinks as the moisture content decreases. Therefore, the difference between the soil moisture content at the time of construction and the equilibrium soil moisture content is an important consideration. Soils that have higher initial moisture contents will have a larger potential to shrink, while soils that have lower initial moisture contents will have a larger potential to swell. Soil moisture contents and shrink/swell movements may vary seasonally, even after equilibrium moisture is reached.

When the foundation is constructed, the moisture content of the soil beneath the foundation is relatively uniform. The foundation acts as a covering that seals off and helps to stabilize the moisture content in the soil below. However, shrinking/swelling can take place around the perimeter of the foundation due to environmental factors. Many foundations experience distress from shrink/swell movements as the result of improper installation, maintenance, or alterations to the drainage system and landscaping. If the moisture content under the foundation is maintained in a stable condition, the foundation will tend to be more stable, and thus deflection or cracking in the structure will be minimized. This maintenance is especially important during the first ten (10) years after construction, as this is usually the time when the most severe adjustment between the new foundation and its soil support occurs.

The objective of the following maintenance program is to maintain uniform moisture content for the soil both around the perimeter and under the foundation.

Grading and Drainage:
Initial site grading shall provide drainage away from the foundation perimeter (positive drainage). The site drainage plan developed by the civil engineer shall be maintained throughout the life of the structure. In general, the civil engineer develops a site drainage plan for the individual property or entire subdivision in which the subject property is located. Drainage swales or other discharge channels are designed to accommodate water runoff. These drainage channels shall be kept clear of debris at all times, allowing for water to discharge away from the perimeter of the foundation.

The most commonly used technique for achieving adequate drainage is positive grading away from the foundation to promote rapid runoff and to avoid ponding water adjacent to the foundation. Positive drainage is imperative in minimizing soil-related foundation problems. Inadequate drainage

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or ponding water can increase soil moisture content, resulting in swelling of the supporting soils, causing foundation movements. It is recommended that adjacent grades and vegetative areas have adequate drainage away from the foundation. Adequate drainage is defined by International Building Codes to be a minimum slope of five percent (5%) in the first ten (10) feet away from the perimeter of the foundation and a minimum slope of two percent (2%) elsewhere. A slope of five percent (5%) in the first ten (10) feet equates to a six inch (6") drop, and a slope of two percent (2%) equates to approximately a quarter inch (1/4") drop in one foot (1'-0"). After final grading and landscaping, the top of the foundation shall extend above finished grade a minimum of four inches (4") where masonry veneer is used and a minimum of six inches (6") elsewhere.

Grading for sites with greater than nine percent (9%) slope shall ensure that groundwater is not trapped on the cut (uphill side) of the foundation. A slope of nine percent (9%) equates to approximately a one inch (1") drop in one foot (1'-0"). The drainage provided to remove this water from around the foundation shall be located far enough away from the perimeter of the foundation to prevent the water flow from undermining the foundation. This drainage will also minimize seepage through backfills into adjacent basement walls.

Subsurface drains may be used to control a rising water table, groundwater, and surface water penetrating through pervious, fissured, or highly permeable soil. Since drains cannot stop the migration of moisture beneath the foundation, they will not prevent long term swelling. Moisture barriers, while expensive, can be effective if placed near the edge of the foundation to minimize moisture migration beneath the foundation. The geotechnical engineer of record can be contacted to recommend the proper depth and material for a moisture barrier system.

Should the site drainage be inadequate, or if the owner changes the drainage pattern, properly compacted fill materials can be utilized near the grade beams to reestablish positive drainage. The geotechnical engineer of record can be contacted to recommend the proper fill material and the degree of compaction required. Proper compaction is required to minimize subgrade settlements near the foundation and to prevent the subsequent ponding of surface water. An alternate drain system may be provided if the reestablishment of positive drainage is not possible.

Area drains can be utilized around the foundation to minimize ponding of water adjacent to the foundation. Area drains must be inspected periodically to ensure that they are clear and are properly functioning. The drains shall be provided with outlets or sumps to collect water and pumps to expel water, if gravity drainage away from the foundation is not possible.

Any changes in the exterior layout of the property, flower beds, decks, patios, fences, trees, and shrubs must be planned such that positive drainage away from any foundation structure and off the property is provided at all times.

Landscaping:
Ground supported foundations constructed using proper foundation design, construction techniques, and adequate drainage systems can still experience distress due to improperly installed and/or maintained landscaping and/or irrigation. One of the most critical aspects of landscaping is the continual maintenance of properly designed slopes. Initial landscaping or hardscaping shall be done on all sides and in a manner that allows positive drainage away from the foundation. Adequately-watered partial landscaping on one side of the foundation may cause swelling on the

landscaped side of the foundation, resulting in distress to the structure. Landscaping shall be installed in a manner to avoid water ponding at any location adjacent to the perimeter of the foundation. The installation of landscaping edges or the berming of landscape beds, while visually appealing, can create a damming effect between the landscape edge or berm and the foundation that may prevent water from draining away. Special consideration must be given to these areas by providing additional methods of draining water, such as area drains. Landscaping and ground cover can help to prevent erosion and, if properly maintained, protect the ground from losing moisture.

Watering:

It is important to note that consistent moisture content of supporting soils is the key to proper foundation performance. Watering shall be done in a uniform, systematic manner as equally as possible on all sides of the foundation. PSE recommends implementing a uniform irrigation regimen to maintain uniform moisture contents in the perimeter soils and to mitigate the effects of cyclical moisture flux. A uniform irrigation regimen may require operating some sprinkler zones longer than others as well as relocating, extending, and/ or capping some sprinkler heads in order to maintain uniform moisture contents in the perimeter soils. Areas of soil that do not have ground cover may require more moisture as they are more susceptible to evaporation. In areas where silty and sandy material is present, excessive watering can cause the soil to lose bearing capacity and result in foundation settlement. In areas where expansive clays are present, excessive watering will cause swelling of the supporting soils, while insufficient moisture will cause shrinkage of the supporting soils. Sprinkler systems are beneficial in maintaining uniform moisture content in the soil that surrounds the foundation; as such, they shall be installed around the entire perimeter of the foundation. Some critical items regarding sprinkler systems are: the proper backfilling of excavations for the sprinkler lines, monitoring for leaks, and setting controls so that a uniform amount of water is achieved for all areas. It is also important that the main sprinkler lines are not placed next to the foundation. Instead, the main sprinkler lines and heads shall be located a minimum horizontal distance of six feet (6'-0") away from the perimeter of the foundation and discharge towards the foundation.

Trees:

Studies have shown that trees and large shrubs located adjacent to a foundation can be a potential contributing factor to foundation distress. Over time, vegetation will remove moisture from the clay soil, resulting in shrinking of the subgrade. This shrinking will cause settlement to occur for ground supported foundations. All trees shall be planted a minimum horizontal distance of one-and-a-half (1-1/2) times the mature height of the tree from the foundation. If trees already exist adjacent to the foundation, or if trees will be planted adjacent to the foundation, a vertical root barrier shall be installed between the tree and the foundation. As a minimum, the barrier shall consist of a four-inch (4") wide, six feet (6'-0") deep, lean concrete wall. A minimum six (6) mil thick polyethylene sheet, draped within the excavation and backfilled using sand or gravel, can be used as an alternative to concrete. Vegetation shall be planted outside of the root barrier, away from the foundation. It is recommended to consult with a certified arborist regarding root barrier depth and installation based on site-specific information (height, age, species, distance, etc.). In areas with expansive clay soils, the root systems of trees and large bushes tend to dehydrate the soil due to the moisture absorption of the root system; therefore, when they are removed, soil swelling can occur. Tree removal can be safely accomplished provided that the tree is no older than any part of the foundation, because subsequent swelling can only return the foundation to its original elevation. It is not advisable to remove a tree that is older than the foundation, because subsequent swelling can result in raising the

foundation above its original elevation. In this instance, pruning, such as crown thinning, crown reduction, or pollarding can be considered. This work shall be performed by or under the supervision of a certified arborist.

Gutters and Downspouts:
Full gutters and downspouts shall be installed to route roof runoff away from the perimeter of the foundation. Downspouts shall be connected to flexible pipe extensions so that the roof runoff is drained at least five feet (5'-0") beyond the edge of the foundation and past any adjacent planting beds. As an alternate, downspouts can be tied to other subsurface drains or into the storm drain. Gutters and downspouts must be checked periodically to ensure that they are clear of obstructions and function properly. The amount of water discharged from the condensate drain line for the air conditioning system can be significant and should therefore be routed and discharged in the same manner as a downspout.

It is recommended that all property owners conduct a yearly survey of their foundation and perform any maintenance necessary to improve drainage and prevent the ponding of water adjacent to foundations.

Sincerely,

Brian C. Eubanks, M.S.C.E., P.E., D.F.E.
Principal Structural Engineer

The seal appearing on this document was authorized by Brian C. Eubanks, P.E. 96528 on April 27, 2017.

BCE/

Owner Acknowledgement:

Address: _____ City: _____ State: _____

Name: _____ Signature: _____

NOTARY PUBLIC:

State of: _____ County:_____

This instrument was ACKNOWLEDGED, SUBSCRIBED AND SWORN TO BEFORE ME on

This _____ day of _____, by _____
(Month) (Year) (Owner's Name)

Notary Public: _____ My Commission Expires:_____