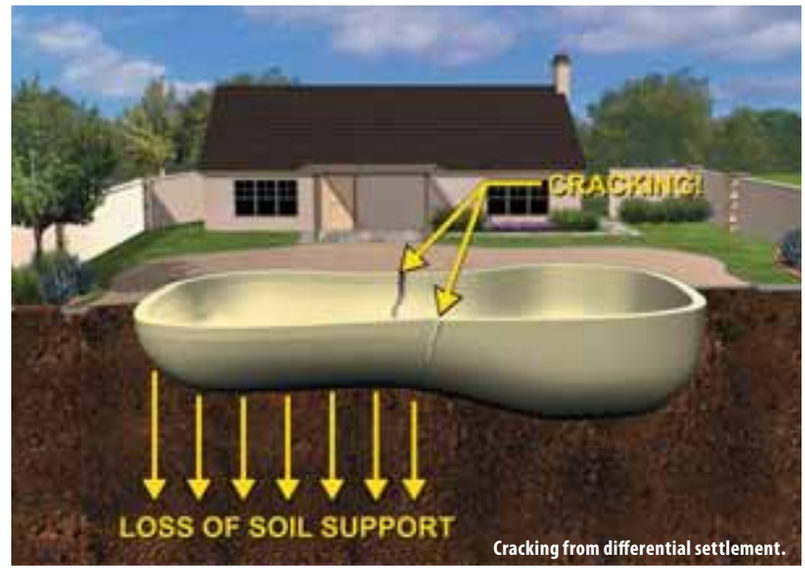
Building Pools in Hillside Areas

BY RON LACHER, P.E., CBP,
POOL ENGINEERING, INC.

AS PART OF our specialized practice in structural engineering for swimming pools, we are often asked to investigate all sorts of pool-related problems to determine the cause. Over the years, we've learned many valuable lessons from these investigations, particularly on the topic of hillside pool construction and the construction of pools near descending slopes.

Pools experience serious structural distress most frequently when they are located near descending slopes. The natural occurrence of "slope creep" causes the majority of these failures. Hillside areas are a popular location for swimming pools and that, combined with the frequency of hillside pools experiencing distress, makes slope creep the single most common cause of structural distress resulting in costly repair and mitigation.

The typical pool structure is a thin-walled concrete shell designed to resist the pressure of the surrounding soil, much like a retaining wall. A properly-designed retaining wall must be built upon a foundation or footing that is supported by firm soil. In the case of a swimming pool, the floor of the pool serves as the foundation or footing.



Cracking from differential settlement.

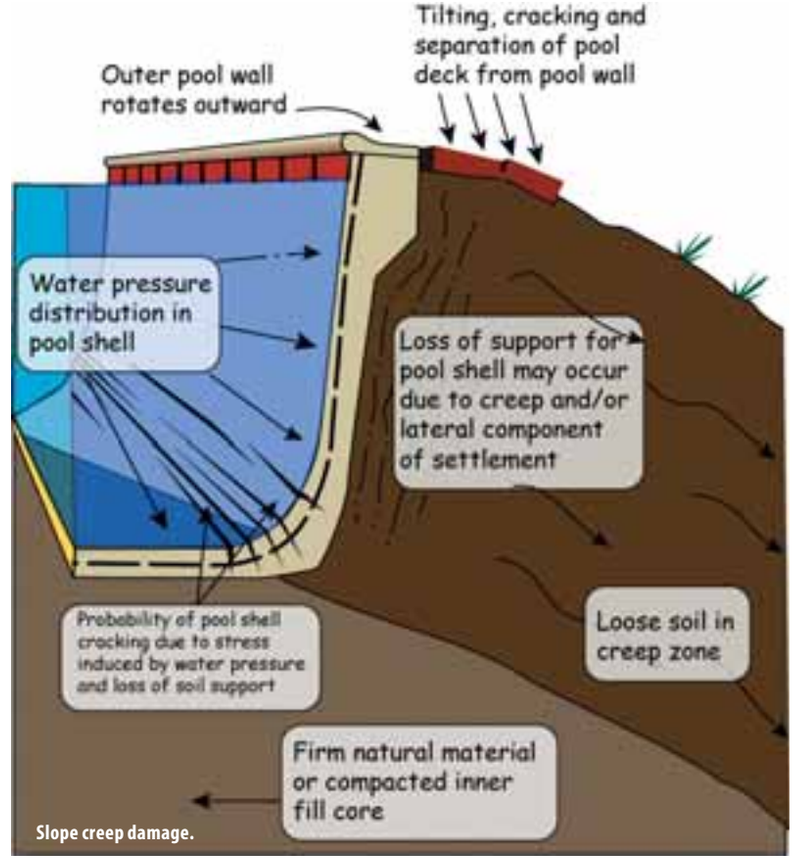
But a pool varies from a retaining wall in that it often holds 200,000 pounds or more of water in addition to the pressure from surrounding soil. If the soil under a portion of the pool doesn't support the pool, that area of the pool will settle. When a portion of the pool settles while the remainder of the pool is properly supported and does not settle, it is called differential settlement – which frequently results in cracking of the pool.

A number of soil and geotechnical issues will result in differential settlement. By far, the greatest percentage of differential settlement-related structural distress is caused by slope creep, which can occur when pools are located near descending slopes.

Slope Creep

When clay soil becomes wet, it tends to swell like a sponge – this is called "expansive soil." And when expansive soil absorbs moisture and swells, it moves. On level ground, it heaves or moves upward. If the ground is sloped, expansive soil moves upward and sideways. When expansive soil dries, it shrinks back almost to its original size. When descending slopes containing expansive soil experience repeated cycles of wetting and drying over time, that and the force of gravity results in an ongoing movement or creep of soil down the face of the slope. Creep is slow, nearly continuous, and has a progressive effect that can reach a downhill rate of 1/4 inch per year.

Soil moisture content tends to become more uniform with increasing depth; that is, without wetting and drying cycles. The weight of overlying soil also tends to reduce the amount of volume change that can occur. Therefore, the deeper the soil, the less



Slope creep damage.

Pool rotates and becomes out of level. Note water line at tile on left slope side versus right side.

problematic the soil tends to be from expansive soil and slope creep. Most soil engineers believe that slope creep affects the upper or outer five to

When a portion of the pool settles while the remainder of the pool is properly supported and does not settle, it is called differential settlement – which frequently results in cracking of the pool.

Side property line walls will crack usually 10 to 15 ft. from the slope.

eight feet of soil on a slope. The typical manufactured slope today is graded at one foot vertical to two feet horizontal. This means that slope creep can affect structures and other improvements 10 to 16 feet or more from the top of a descending slope.

Slope creep can be particularly brutal to swimming pools and associated improvements. If the soil under a portion of the pool doesn't support the pool, that area of the pool will settle and crack. If a pool is located in an area containing expansive soil and within the zone subject to slope creep, the portion of the pool within the

creep zone will lose support and settle, rotate, and crack as a result of slope creep. Once the cracking begins, water leaking from the pool typically exacerbates the problem.

Resisting the Effects of Slope Creep

The International Building Code requires that swimming pools constructed on or near descending slopes be built differently than pools built in level yards. These building code provisions, in Section 1805.3, have two very specific but differing requirements for pools built near descending slopes. Both of these requirements must be met.

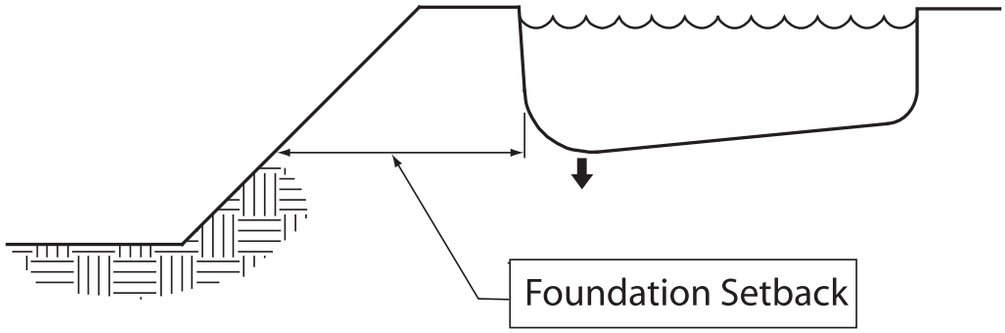
The first is **1805.3.3 Pools.** That portion of the pool wall within a horizontal distance of seven feet from the top of the slope shall be capable of supporting the water in the pool without soil support.

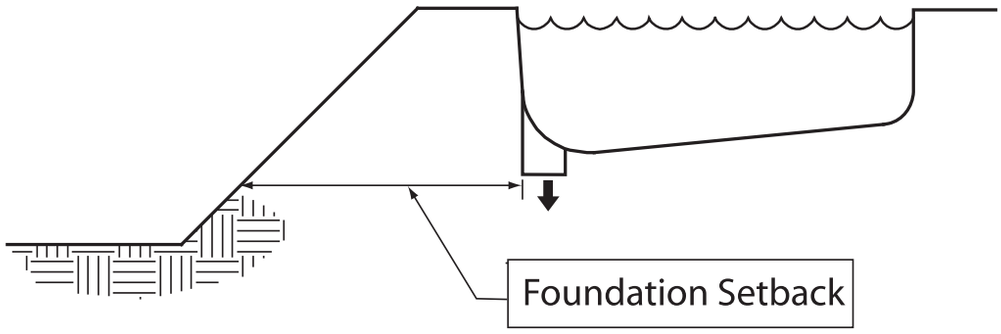
A common term used in the pool industry, "freestanding wall," is synonymous with the code language "capable of supporting the water in the pool without soil support."

Although 7 ft. is the code-required distance from the top of the slope where freestanding walls are required, it is highly recommended that a greater distance such as 10 ft. or more be utilized in practice.

The second is **1805.3.2 - footing setback from descending slope surface.** Footings on or adjacent to slope surfaces shall be founded in firm material with an embedment and setback from the slope surface sufficient to provide vertical and lateral support for the footing without detrimental settlement. The foundation of the pool (the bottom) must be set back from the face of the slope a distance equal to the total height of the slope divided by six. The International Building Code does not specify a minimum foundation setback. However, experience has proven that a minimum of 15 ft. or greater is recommended.

Don't overlook the requirement that the footing (pool bottom) must be founded in firm material sufficient to provide vertical and lateral support. How can you be assured that this is the case? We recommend that pool contractors building pools on or near a descending slope obtain the services of a geotechnical engineer to address the all-important geotechnical issues. This becomes even more critical when the proposed pool site is in an area where the original





site grading was not supervised and certified by a professional geotechnical consultant.

Increasing the Foundation Setback

If a swimming pool is proposed near a descending slope, the risk of building in that location can be reduced by increasing the foundation setback. The foundation setback can be increased either by deepening the pool or by the construction of a footing or key under the outermost wall of the pool near the descending slope. If the descending slope is graded at two feet horizontal to one foot vertical, each added foot of pool depth or footing depth will add two feet to the foundation setback. If the descending slope is graded at 1.5 feet horizontal to one foot vertical, each added foot of pool depth or footing depth will add 1.5 feet to the foundation setback.

Other Precautions

Repeated cycles of wetting and drying will result in creep of soil down the face of the slope. Therefore, it is important to maintain moisture content of the soils on and adjacent to the slope as relatively constant as possible.

Surface and subsurface drainage must be carefully installed and maintained to minimize ponding of water near the top of the descending slope. Irrigation systems should be adjusted to provide the minimum water needed to sustain landscaping and prevent excessive drying of the soils. Both over watering and under watering of landscape areas must be avoided. Landscaping must not obstruct the drainage pattern or cause surface water to collect near the descending slope. Elevated planters adjacent to the slope should be lined with a membrane to minimize the penetration of water into the adjacent sub-grade.

Gophers and other rodents should be removed as their burrows provide easy entry of surface water that will saturate the slope.

Some of the most stunning locations for swimming pools are in hillside areas. By being fully informed of the critical issues we've discussed and implementing the requirements and recommendations into the planning and construction, swimming pools can be safely built in hillside locations. AQ

Ron Lacher is a CBP Certified Building Professional® and a member of the APSP Builders Council.