INFORMATIONAL GUIDE TO THE REPAIRING & RE-SURFACING OF STRUCTURALLY CRACKED POOLS & SPAS

This informational guide will explain the causes, concerns & repairs associated with structurally cracked pools and spas.

We have constructed the information in this guide based on over 30 years of industry experience and knowledge.

Along with this knowledge, we have included articles from numerous experts on the topic so that you, the homeowner, can have the best information available to make an informed decision.

The most common occurrence of pool cracking in Southern California seems to happen when pools are built on hillside lots. Following this page is an excellent article written by Ron Lacher, P.E. of Pool Engineering, explaining how hillside soil movement can contribute to structural failure and cracking. When foundational soils that surround and support a pool shell recede, contract or expand, it creates stress on the pool structure. This often results in cracked and broken pool shells / structures.

There are many reasons why swimming pools crack and structurally break.

Below are some other reasons for structural failures:

- Low PSI gunite/shotcrete installed at time of installation
- The gunite/ shotcrete was installed too thin
- Defective and weak rebound gunite/shotcrete was reused during the pool construction
- Improperly placed structural steel at time of construction
- Improper expansion / separation joints around the pool deck to pool bond beam area
- Long plumbing runs placed inside the gunite/shotcrete structure
- Improper engineering at time of construction

Any of these scenarios, or any combination, can lead to structural failure and pool shell cracking. Most of these situations are practically undetectable after a pool is built and filled with water. Forensic analysis is often necessary to accurately prescribe the best repair method, or if repair is even a possibility. Draining the pool and taking core samples, along with a site evaluation from a qualified engineer, would be strongly encouraged so that the pool owner can be properly educated about their options of repair. Even after knowing all of this, it's often impossible to fully know what's in or under the pool that is possibly contributing to failure.

Combination of thin rebound gunite & steel placed too close to surface.

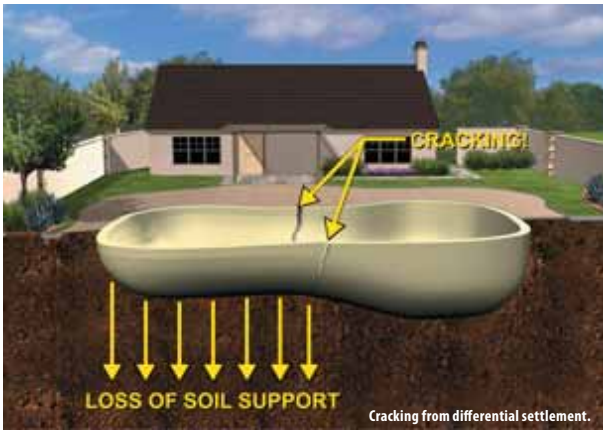
Building Pools in Hillside Areas

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.

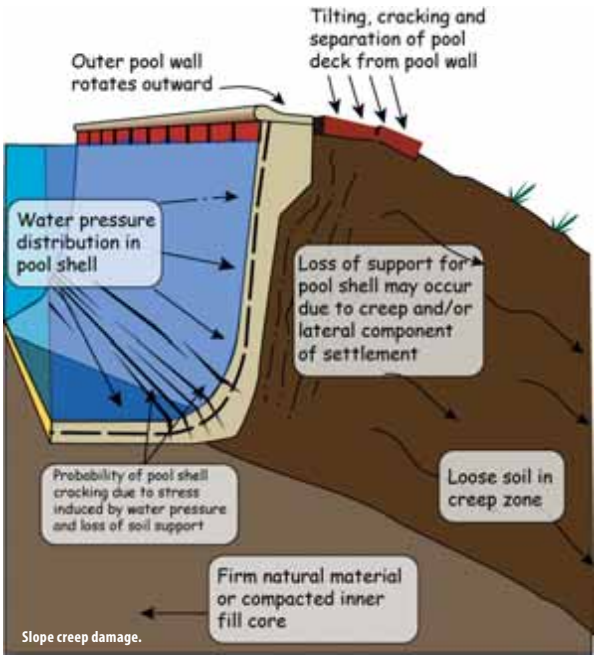
But a pool varies from a retaining wall in that it often holds 200,000 pounds or more of water in addition to the pressure from surrounding soil. If the soil under a portion of the pool doesn't support the pool, that area of the pool will settle. When a portion of the pool settles while the remainder 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 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 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 damage.


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


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

> 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.

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.

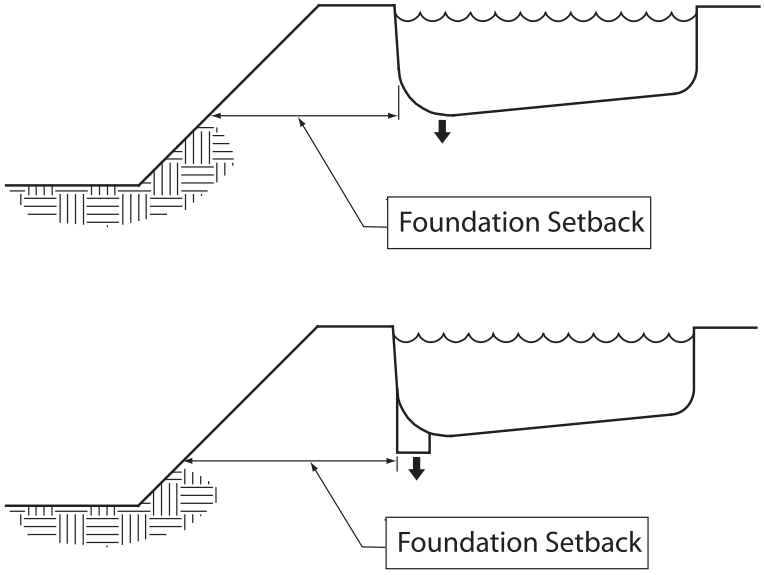
The first is **1805.3.3 Pools.** That portion of the pool wall within a horizontal distance of seven feet from the top of the slope shall be capable of supporting the water in the pool without soil support.

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.

STRUCTURAL REPAIR OPTIONS

Option 1

The best type of crack repair for swimming pools involves removing the gunite / shotcrete on either side of the crack for a total distance between 18-24" wide. The removed gunite is replaced with higher strength material (not to exceed 4,500 PSI) and placed at least 1 ½ times the thickness of the material removed. Any deteriorated reinforcing steel should be replaced.

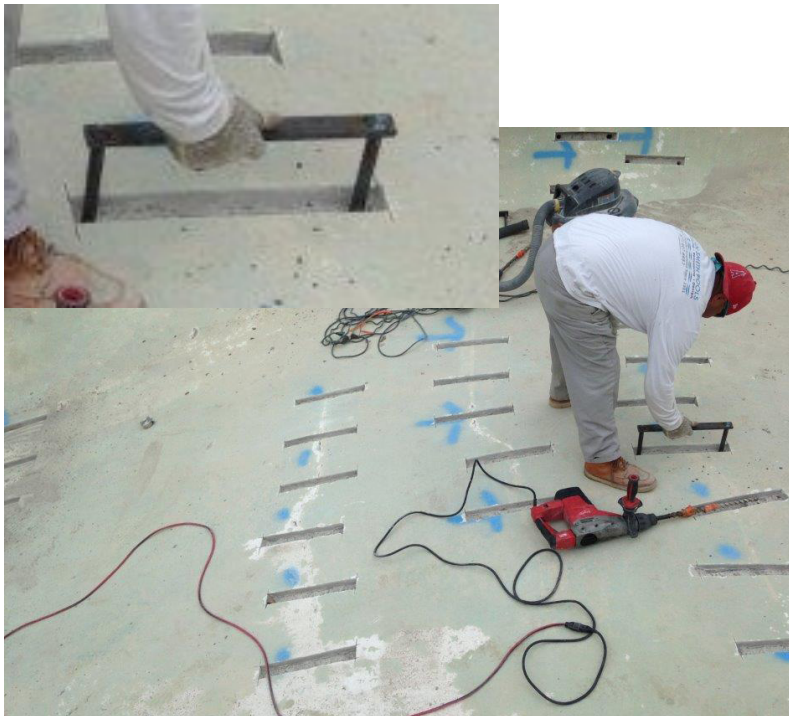
Option 2

The next method involves overlapping structural steel rebar over the cracked area that has been epoxy embedded into the gunite 2-3" deep by 2-3' long and covered with gunite.

STRUCTURAL REPAIR OPTIONS

Option 3

This last method is to install large 12-18" long steel staples with 6" pins at each end. These staples are installed every 12-18" perpendicular with the crack. These staples are installed using high strength epoxy, followed with a high pressure epoxy injection of the crack itself. The staples are covered with water resistant cement.



Each of these repair methods comes with a different cost point. The only repair method we at Alan Smith offer is the staple and epoxy injection. Since we do not have any control of how the pool was built, or if any geological soil movement is occurring, we offer NO warranty on Pool Shell Re-Cracking. We simply cannot warranty what we cannot control.

For the more extensive repair methods available, we suggest you contact these other swimming pool structural repair companies for consulting and pricing.

County Leaks
714-632-0117

Water Savers
949-955-1233

For onsite evaluation from a qualified engineering firm, we recommend ***George Tindall Engineering, Inc.***, apc (949) 222-0165
georgetindallengr@yahoo.com

Re-Surfacing Preparation Methods

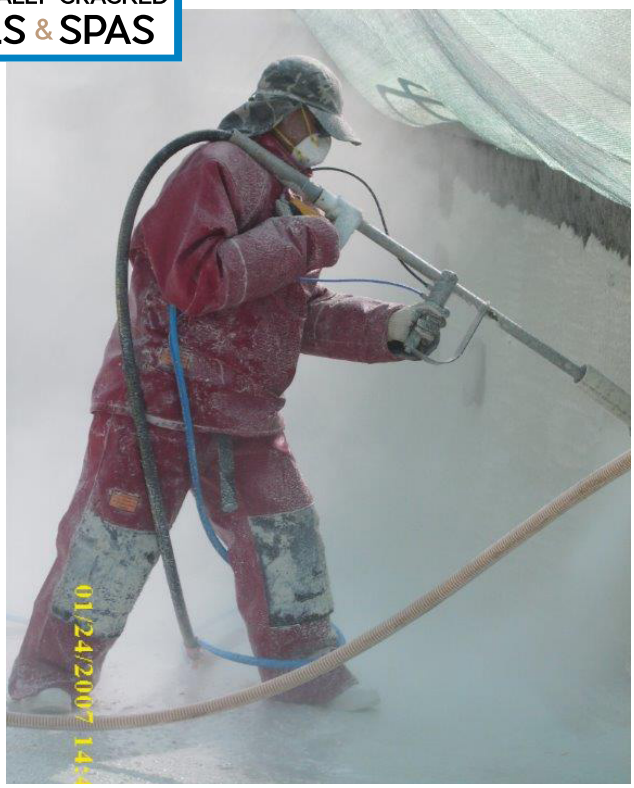
Do's + Don'ts for Cracked Pools

When re-surfacing a structurally compromised pool shell, every precaution should be taken to not further "weaken" the already cracked pool. There are two predominant methods used today:

don't

Method 1

The first method is to jack hammer or strip the old pool plaster material off using pneumatic or electric jack / chipping hammers. We believe and know that this method will remove some of the existing pool gunite material and cause micro bruising of the already compromised pool shell. We strongly do not recommend this method.



Re-Surfacing Preparation Methods

Do's & Don'ts for Cracked Pools

do

Method 2

The other method which we prefer and use is to remove and or scarify the old pool surface using high pressure water blasting. This high pressure water blasting method does not cause further shell trauma and offers a better bonding surface for our new plastering material. This superior method enables Alan Smith Pool Plastering to give 10 year warranties against plaster delamination.

Please see the attached informational letters from Civil and Structural engineers on the stripping vs. hyrdoblasting preparation methods.

ALAN SMITH POOLS
Plastering Remodeling Design
Pool Resurfacing Specialists Since 1981

RE-PLASTERING PREPARATION METHODS:

Hydro Blasting vs. Stripping

- **Hydro Blasting cuts plaster with high pressure water**
- **Hydro Blasting leaves an excellent profile for new material bonding (ASP gives 10 year warranties)**
- **Hydro Blasting does not impact and bruise the gunite substrate**
- **Hydro Blasting does not expose structural steel**
- **Hydro Blasting leaves a surface that is uniform for new product placement (No highs and lows)**
- **Hydro Blasting does not cause shell trauma**

pool engineering inc.

Swimming Pool Resurfacing

Best practices in Bonding New Surfaces to Existing

This article is in response to numerous requests received by Pool Engineering, Inc. for information on the best practices for surface preparation in swimming pool resurfacing.

When resurfacing an existing swimming pool, the importance of surface preparation of the existing surface cannot be overstated. Research has demonstrated that bond strength between the old and new surface is directly related to the surface preparation. Bond is a critical factor in determining the overall performance, durability and longevity of the resurface. The goal in surface preparation is to create a sound, clean, open pore surface free of bond inhibiting materials.

Over the years there have been a number of surface preparation techniques that have been successfully (and unsuccessfully) utilized in the swimming pool industry. Today, the two most frequently utilized methods for surface preparation are: 1) Stripping of the existing surface by light weight impact hammers and 2) High pressure hydro-blasting.

To minimize damage to the pool's shotcrete substrate and ensure long-term performance of the resurface, hydro-blasting is the preferred surface preparation method. Hydro-blasting is most effective at preventing micro-cracking and surface bruising of the substrate that often results from using impact hammers.

It is important to differentiate between high-pressure hydro-blasting and pressure washers. High pressure hydro-blasting is capable of cutting into concrete surfaces. Depending on the concrete substrate hardness, the required pressure can vary between 10,000 and 40,000 psi, substantially greater than pressure washers. Surface preparation must be preceded by removal of any layers of deteriorated or unsound shotcrete down to layers of sound shotcrete before the surface preparation takes place.

In summary, research has shown that hydro-blasting will result in bond values up to 50% higher than more invasive methods. Also, surface preparation by hydro-blasting is minimally invasive to the underlying shotcrete shell and, when necessary, can be repeated for future resurfacing.

If you require any additional information or if I can be of any further assistance, please feel free to call me at (714) 630-6100.

Best Regards,

Ron Lacher, P.E., C.B.P.
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A.C. I. Shotcrete Examineer

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Alan Smith
Alan Smith Pool Company

Tindall Engineering, Inc. specializes in the forensic analysis of concrete swimming pools. We assist pool owners, who have structural problems with swimming pools, make informed decisions on what is the best option for them to repair their pool. The principal of Tindall Engineering has been involved in the pool industry for over 30 years and has evaluated hundreds of swimming pools for both residential and commercial uses.

We routinely advise our clients who are considering re-plastering their swimming pool to use a very high PSI "hydro blasting" technique for removing existing pool plaster. Typical removal techniques using electric and air hammers can be harmful to the pool structure. Every time a chipping/stripping process is used to remove old pool plaster, some of the structural gunite/shotcrete is removed also, thus, the strength of the pool is reduced, ultimately requiring major reconstruction. In addition, the thickness of concrete over the pool reinforcing steel is reduced often exposing the reinforcing steel. This can lead to the development of rust stains in the pool. Hydroblasting eliminates these issues and also provides a better surface for bonding the new pool plaster. By eliminating the removal of gunite/shotcrete within the pool, hydroblasting prolongs the life of the pool structure; and, allows the pool to be re-plastering more times without shell damage. This is especially true in the commercial pool market where pools and spas have been repeatedly stripped.

Hydroblasting is one of the best construction technologies to become available to the pool industry in several decades.

George Tindall, P.E. MSCE (C19921, TR 502)
Tindall Engineering, Inc.