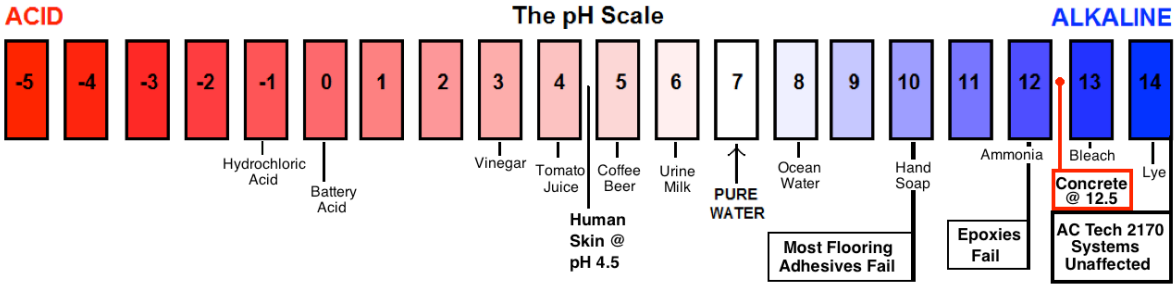
Alkalinity in Concrete Slabs; The Real Culprit

In general the flooring industry believes "concrete moisture related" floor failures are due to high moisture vapor emission rates (MVER) and/or moisture content. In 1996, FCICA (Floor Covering Installation Contractors Association) research found that alkalinity plays a major role in flooring failures.

Defined: pH or the "potential of Hydrogen", is the measure of how acidic (low pH) or alkaline (high pH) any given solution is where a pH of 7 is neutral. Healthy concrete has a high pH ~12.0 – pH 13.3. Alkalinity forms as a result of Portland cements reaction with water during the hydration phase. The excess (alkaline saturated) mix water moves towards the surface forming capillaries throughout the concrete. As the concrete "dries out", calcium hydroxide remains inside these capillaries.

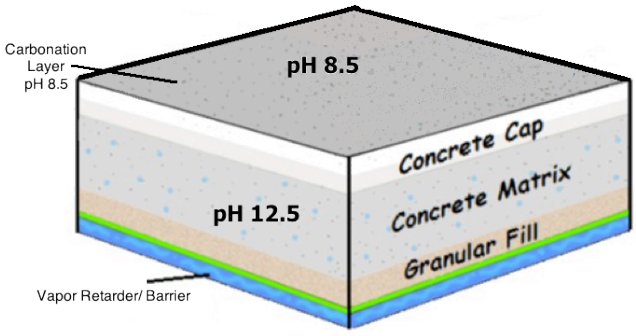


Water Soluble Salts:

In the presence of moisture, alkalinity is always an integral part of concrete or other cement based materials. The degree to which alkalinity exists depend largely on the composition of the cement used for construction.

Primarily responsible for high alkalinity levels are highly soluble metal oxides such as Potassium and Sodium Hydroxides. Calcium hydroxide also contributes to alkalinity, but often to a lesser extent. It is not unusual to find alkalinity levels of up to pH 13-14 contained in floor-blister water (condensate) on top of water vapor driven concrete substrates.

In new cured concrete, it is expected to find a pH 11 – pH 13.5 with the norm being somewhere around pH of 12.5 this is normal and should be. If there is carbonation, a curing agent, or other contaminants on the surface, the pH will generally be ~pH 6.0 – 8.0, which indicates that the concrete has not been properly prepared. The pH level in this case rarely equates to alkalinity.



In cases where the concrete has been water cured or exposed to weathering for several weeks, and sometimes years, a carbonation layer forms on the cap and the surface pH may

be as low as ~8.5 – 9.0. This would appear to indicate a safe surface for installation of a flooring system or epoxy coating.

Some of signs of alkalinity damage are

- Adhesive randomly becomes soft or re-emulsifies;
- Epoxy coating or epoxy adhesive bubbling occurs, with a solvent-like odor.
- Crystallized (dried out) adhesive is visible.

Adhesive Reaction to Alkalinity

Waterborne glues & adhesives: It is very common that the glue contains acrylate co-polymers for binders. These become hydrolysed in humid or alkaline environments. Other constituents of interest in the adhesive are the tackifiers and the thickeners. When subjected to the highly alkaline/water condensate such as will build up in the bond interface between the adhesive and concrete (with a high moisture content), water-based adhesives will usually re-emulsify and turn to a brownish mush, loosing all adhesive properties and lead to a subsequent floor failure.

By far the most common reason for adhesive failure is the exposure of the adhesive to the combination of moisture and corrosive alkalinity found in concretes with high levels of water/vapor transmission.

High alkalinity will destroy the bonding properties of most flooring and tile adhesives as shown in the photo on right.

Alkalinity Testing:

ASTM F710 (overall standard): "This practice covers the procedure for determining the acceptability of concrete floors for the installation of resilient flooring…All concrete slabs should be tested for moisture regardless of age or grade level while all concrete floors should be tested for pH before installing resilient flooring."

ASTM D4262 (standard for etched or chemically treated concrete): Residual chemicals not removed by water rinsing may adversely affect the performance and adhesion of coatings applied over prepared concrete surfaces. It is the intent of this test method to determine that residual chemicals have been removed by measuring the acidity or alkalinity of the final rinsed surface.
1. Scope 1.1 This test method covers procedures for determining the acidity or alkalinity of concrete surfaces prepared by chemical cleaning or etching prior to coating.

Testing damaged or suspected high alkaline areas with pH paper can quickly confirm alkalinity damage. If there is a rapid color change to the paper, it usually indicates alkaline concentration.

Using pH test papers (left) and an electronic pH tester (right) to determine pH of surface. Concrete surface must be free of all coatings, coverings, adhesive, carbonation layer etc. to get an accurate reading. ASTM F710 covers pH testing in concrete.

Right: A pH "pencil" for quick checking of concrete deck.