CustomTECH®
FLOORING PREPARATION SYSTEMS

Technical White Paper
SELF-LEVELING FORMULATIONS

Understanding Self-Leveling Underlayment Formulation and Usage

Self-leveling underlayments (SLUs) are the go-to technology for preparing a floor to receive tile, stone, resilient and wood finishes. More stringent requirements for floor flatness, floor levelness and smoothness — as well as the needs of fast-track construction — have led to the increased use of SLUs. From residential remodels to tenant improvements to new high-rise construction, SLUs provide value to the owner, designer/architect and contractor. The CustomTech® line of flooring preparation products includes a range of SLUs is designed to provide the right product for a variety of floor leveling needs.

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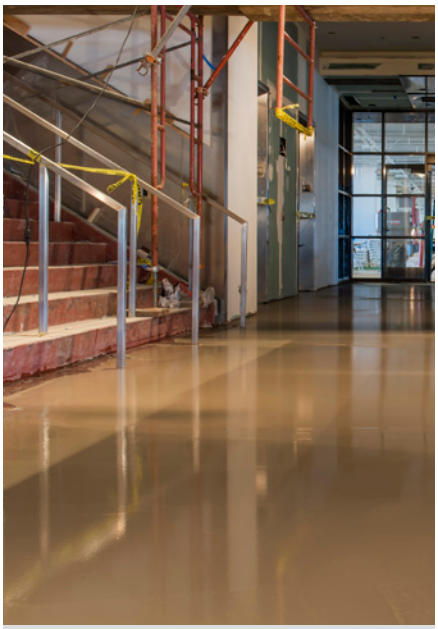

Large format natural stone and ceramic tiles also benefit from increased floor flatness.

Today, floor flatness is more important than ever with luxury vinyl planks and large format ceramic tiles. A deeper discussion of floor flatness can be reviewed in Custom Building Products' White Paper WP125 "Achieving Resilient and Wood Floor Covering Flatness Requirements with High Performance, Cementitious Self-Leveling Underlayments". Most floor covering manufacturers require a high degree of flatness. The flatness of the floor is most important when the full expanse of the floor is viewed. Any waviness or variation in the floor can easily distract from the beauty of the floor covering itself. ASTM / American Society for Testing and Materials, practice F710 – "Standard Practice for Preparing Concrete Floors to Receive Reslient Flooring" defines the requirements for a flat floor that will receive resilient floor covering. It requires that the variation in floor flatness be no more than 3/16" in 10' and 1/32" in 12".

Large format natural stone and ceramic tiles also benefit from increased floor flatness – see ACI / American Concrete Institute 117. For tile with one edge longer than 15" and for natural stone tiles, the ANSI or The American National Standards Institute defines the maximum allowable substrate variation can be no more the 1/8" in 10' and 1/16" in 24". When thin bed epoxy mortars are used, the variation can be no more than 1/16" in 36" with no abrupt irregularities greater than 1/32" *(TCNA 2018 Handbook for Ceramic, Glass, and Stone Tile Installations; detail F116E.*)

More recently, the industry has begun to adopt the ACI method of measuring the levelness and flatness of a concrete slab after placement of the floor. F-numbers (*Ff* floor flatness and *Fl* floor levelness) are determined through testing procedures in ASTM E1155, and are also referenced in ACI 302. In some instances the architect or designer will require the more stringent finish tolerance, and the subsurface specification or tile specification should reflect this.

Construction efficiency is also improved by the use of SLUs. Since it will be the substrate for the flooring finish, new concrete slabs can be left with a simple screed finish, eliminating the need for high cost concrete finishing practices such as use of sealers or densifiers, hard troweling and power troweling equipment/manpower. Within days after concrete placement, a moisture mitigation membrane meeting ASTM F3010 can be applied to the concrete to mitigate excessive moisture vapor emission rates. This also helps prevent slab curling that affects floor flatness. An SLU placed over the membrane creates a very flat floor that can easily meet the requirements of the flooring and also speeds the construction of interior walls and built-ins such as cabinets. Self-leveling underlayments are the surest way to achieve the highest degree of floor flatness required by flooring manufacturers and valued by architects, contractors and building owners.

Modern Self-Leveling Underlayment Formulas

A range of technologies can be used to make self-leveling underlayments. The most common products are based either on gypsum or a combination of Portland and Calcium Aluminate Cements (CAC). SLUs based on Portland cement as the only binder are also used, but are less common. Gypsum SLUs have several benefits including fire ratings for many designs as well as the need for very little floor prep before installation. However, gypsum

SLUs are slow to dry and will significantly delay the flooring installation. Furthermore, gypsum SLUs are only suitable for dry areas and cannot be used where standing water might be anticipated. Gypsum SLUs are less resistant to damage from trade traffic.

SLUs derived from Calcium aluminate cements are rapid curing/drying and can be used in all interior locations. Calcium aluminate-based SLUs are complex mixtures of cement, plasticizers to provide flow, accelerators and retarders to manage reaction times, polymers to increase bond and enhance tensile strength, and stabilizers to eliminate segregation of the highly fluid mixtures. Aluminate cements react rapidly with water to form ettringite, the main mineral phase responsible for the SLU strength and durability. Unlike SLUs based solely on Portland cement, properly formulated SLUs incorporating aluminate cements are dimensionally stable and crack resistant. Measurements of performance properties, including flow, flow retention, viscosity, healing time, setting time, compressive strength, flexural strength, and length change are described in ASTM C1708/C1708-16 *Standard Test Methods for Self-leveling Mortars Containing Hydraulic Cements and ANSI A118.16 American National Standard Specifications for Cementitious Self-Leveling Underlayment (SLU)* – currently un-published and under review in 2019.

By judicious combination of the different chemical components, SLUs can be optimized for specific floor leveling situations. As described below, specific SLUs are developed for extremely deep pours, high load conditions, and floors with significant deflection (such as wood subfloors). Economy SLUs can provide lower unit cost at the expense of some performance attributes (for instance, shorter heal time or lower compressive strength or longer time to install flooring). Some low prep SLUs require no mechanical preparation over suitable substrates, which significantly reduces installation time and labor.

CustomTech Self-Leveling Underlayments

Custom Building Products offers a comprehensive line of SLUs under the CustomTech brand, which is intended for all commercial and residential flooring preparation applications.

TechLevel™ 100 is an economical SLU for less demanding applications. This product requires a stable, well prepared substrate (see below and refer to the Technical Data Sheet). While providing an excellent degree of leveling, this product has less flow and is not meant to level to a feather edge.

TechLevel™ 125 is designed for leveling highly uneven floors. Depths up to three inches can be achieved in a single lift. This highly formulated product is dimensionally stable and resists cracking at depths up to three inches without the use of pea gravel. The flow has been engineered to allow controlled placement in deeper sections without the extensive use of dams.

TechLevel™ 150 is a workhorse SLU for most commercial and residential applications. This advanced, low prep formula does not require mechanical prep of the substrate, thereby accelerating the entire floor leveling process. Engineered for high flow and easy placement, Techlevel 150 readily seeks its own level from a feather edge up to an inch and a half in a single lift.

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TechLevel™ XP-1 is an innovative, high performance formula for demanding applications, especially where heavy rolling loads are anticipated. With a compressive strength of 5500 psi, Techlevel XP-1 supports the highest point load of any CustomTech SLU. Techlevel XP-1 provides a durable wear surface for construction traffic; however, it is not recommended as a long-term wear surface. Additionally, this product contains the low prep feature.

TechLevel™ WSF is a fiber-reinforced SLU that is ideal for leveling wood subfloors without the need for metal lath. This low modulus (high elasticity) formula has flexural performance similar to wood subfloors allowing the underlayment to conform to the wood subfloor within the normal movement in the design. Higher polymer loading aids in this flexibility and provides for a superior bond to the substrate. This low prep formula will self-level down to 1/4-inch.

TechLevel™ HPT is a self-leveling, high performance topping that is intended as a durable, long-term wear surface. This high compressive strength formula is suitable for heavy service conditions.

Installation of Self-Leveling Underlayments

The first step in installing self-leveling underlayment is to understand the application and choosing the correct product. The descriptions above and the information on the product Technical Data Sheets can serve as a useful guide. How much out of level or flatness is the floor – i.e., how deep will the lift of the leveler need to be to achieve level/flat? Does the floor need to be level or just flat? Will a feather edge be needed? How much load will the floor experience when in regular use? What is the substrate and does it deflect?

Primers are essential to achieve a good result with SLUs.

Once the correct product is chosen, site conditions need to be considered. As with the application most construction materials, planning and preparation are critical. All surfaces must be structurally sound, clean, dry and free from contaminants that would prevent a good bond. Substrate surface absorptivity is also important to achieving good bond and can be measured according to ASTM F 3191–16 *Standard Practice for Field Determination of Substrate Water Absorption (Porosity) for Substrates to Receive Resilient Flooring*. If the substrate surface is weak, spalling or contaminated, or if using an economy grade SLU, the surface should be mechanically scarified by shotblasting, sandblasting, water-jetting, scarifying, or diamond-grinding. Do not sand the surface, as this creates a fine dust that inhibits the bond. With the low prep TechLevel products, just clean the surface to remove loose dirt and debris, prime the surface, and then apply the SLU for most service conditions and requirements.

Primers are essential to achieve a good result with SLUs. The best primers not only promote adhesion, they also minimize outgassing of the slab (reducing air bubbles and pinholes) and minimize water loss from the SLU, thus retaining good flow and healing. CustomTech offers two primers to meet all installation and service conditions. For floors that will experience heavy service conditions, **TechPrime™ E**, an epoxy primer, should be used with a sand broadcast. **TechPrime™ A**, a water-borne acrylic primer, is the best choice for all other situations. **TechPrime A** can be used over all porous and non-porous substrates including applications over epoxy moisture vapor barriers such as **TechMVC™**.

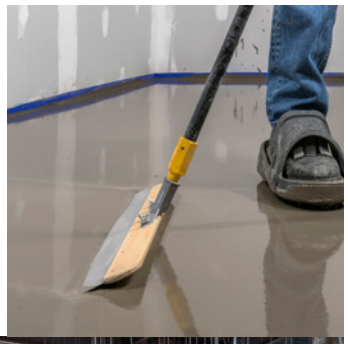
Barrel mixing may be as effective as pumping, even for larger pours.

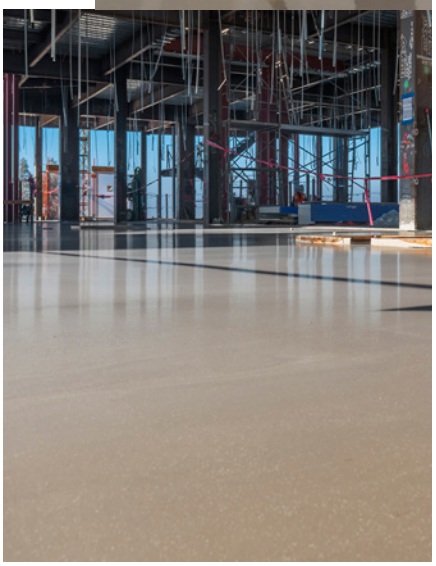
Environmental conditions also need to be considered. SLUs have an optimal temperature range. If it is too hot, the reactivity of the formula will be too fast, leading to insufficient flow and healing. If too cold, several issues may arise. Effective mixing and dissolution of the chemicals in the SLU powder is difficult at low temperatures, which could lead to surface defects such as pin-holing and splotches. Additionally, the cure time will be slowed such that walk on time and the time when floor finishes can be installed will be delayed. When considering the application temperature, the SLU material, substrate and air should be within the application temperature range of the product. Excessively cold or warm water may need to be conditioned prior to mixing with the SLU. Humidity is less of an issue; however, extremely dry or windy conditions can desiccate the surface during the cure of the SLU. Conversely, very humid conditions can stretch out the period needed prior to installing some moisture-sensitive floorings.

In all conditions, it is essential that thorough mixing is achieved by closely following the manufacturer's mixing instructions. This is often longer than is required for the mixture to appear homogeneous, as many of the chemicals require more mixing time to fully dissolve and become active. Thirty seconds more mixing time is better than 30 seconds too little mixing time. It is common to use mixing barrels for smaller jobs and a mixing pump for larger jobs or where local staging of materials may be difficult. The choice often comes down to the labor cost in a particular region. Given sufficient labor, barrel mixing may be as effective as pumping, even for larger pours. When using a mixing pump it is important to maintain the mixer to factory tolerances. Sloppy tolerances result in poorly mixed SLU and will lead to disappointing fluid and hardened properties.

Carefully planning the actual application can solve many issues before they become problems. One should consider:

- Lift heights should be determined by shooting the floor with a laser level and pinning the floor.
- Material staging should be done before the application starts
- Penetrations should be sealed and barriers should be placed to honor movement joints. It may be useful to set boundaries to the pour using temp dams for large rooms and creating bays or at door jambs down a office hall.
- Labor requirements – for larger pours with barrel mixing, six or more barrels may be needed to maintain a wet edge on the SLU. Several workers will be needed for mixing and transporting materials in addition to those pouring and spreading.
- If using a pump, one should identify a flush out area prior to beginning the application.
- It may be useful to pre-patch any large depressions with a cement based patching compound to minimize slu lift depth..
- Slab cracks should be evaluated and determined to be non-moving/ non-structural or static, then filled with an appropriate patch to eliminate SLU flowing through the crack.





The applicator should maintain a wet edge for the duration of the pour. A gauge rake should be used to control the pour depth and move material to where needed. While the material is still in its fluid state, a smoother is commonly employed to even out the pour and to release entrapped air bubbles that may lead to pinholes. Different SLUs flow at different rates and may take several minutes to achieve level. Observing reflections in the surface of the SLU provides an indication of the flatness achieved. Sharp, crisp reflections without undulations indicate a flat surface. Many installers like to use pin or spiked rollers, which tend to even out the appearance of the surface by reducing water marks; however, this may leave visible dots on the surface.

Curing and Performance Expectations

Modern SLUs are rapid curing and can be walked on in 1-2 hours under ordinary conditions. Continued curing will occur over roughly 24 hours through 28 days or so. Depending on the product, the compressive strength will exceed that of the concrete substrate. If installed correctly, the surface will be significantly flatter than a finished concrete slab. A level slab will be achieved if the floor was pinned and poured accordingly. One should expect a crack-free surface. The surface of all CustomTech levelers are sufficiently wear resistant for normal subsequent trades. Moisture insensitive ceramic tile and stone can be installed in as little as 2 to 4 hours. Moisture-sensitive flooring can typically be installed within a day, but this varies depending on the self-drying nature of the SLU and environmental conditions.

About the Author

Will White is Director of Technical Communications and Training for Custom Building Products, He is a member of the National Tile Contractors Association (NTCA), Tile Council of North America (TCNA), Materials & Methods standards Association (MMSA) and committee member of American National Standards Institute (ANSI).

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