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Self-Leveling Self-Help

Key Differences and Practical Applications for Cement and Gypsum Underlayments

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Have you ever been asked to provide an underlayment recommendation to level, resurface, or fill space over a structural element? This article can provide a framework for developing appropriate options.

By definition, underlayments are not structural. The term underlayment is often used in reference to several types of products including poured toppings, either cement or gypsum, and sheet materials. This article focuses on underlayments defined as the layer between a structural subfloor and a finished floor that facilitates leveling and adhesion. Underlayments commonly enter the conversation when there is a specified floor height or when a correction of the structural floor element is required. Although both cement and gypsum topping products present self-leveling characteristics, many factors drive the decision of which product type best suits the project at hand. Armed with answers to a few project-related questions, narrowing that scope is a relatively straightforward process.

What are you trying to accomplish?

To identify whether your project requires a gypsum or cement underlayment, the most important question to ask is, "What problem or need am I addressing?" *Figure 1* provides several common floor issues mitigated by each type of product.

When asked to recommend a lightweight solution to meet a specific floor height, it is important to consider the depth of space to be filled. As a structural engineer, you might be asked to strike a balance between structural needs and weight considerations in a project where a specific thickness has been included in the project plans. Gypsum and cement underlayments possess lower densities than regular concrete while also achieving a flat surface ready for floor coverings. This makes them viable options for filling space and meeting thickness requirements. In applications that require significant thickness to be filled, an alternative lightweight underlayment might be considered as an addition to the floor system. One such option is Expanded Polystyrene Foam (EPS), a highly cost-effective, rigid sheet of foam that is well suited as a deep-fill solution in spaces with a consistent depth to be filled. Another option is a deep-fill screed, a gypsum or cement underlayment that has been pre-blended with a lightweight aggregate, such as EPS beads, which is mixed with water on the job site and installed as a liquid. This lightweight deep-fill screed can weigh as little as 30 pounds per cubic foot (pcf) and provides a suitable replacement for EPS foam sheets when density is of the utmost concern. There are a few scenarios when a deep-fill screed may be more advantageous than EPS foam.

- Significant levelness issues: for example, severe undulations in the subfloor take less time to correct with a cementitious, lightweight product than with a foam board.
- Requirement of a fully bonded floor system throughout the entire floor assembly: EPS foam is loosely laid over the subfloor while a cementitious, lightweight underlayment will bond to the subfloor.
- Depth of space excludes the use of EPS: EPS foam with holes or EPS foam topped with reinforcement requires a minimum 1-inch topping over the EPS. EPS without holes or not topped with reinforcement requires a minimum 1½-inch topping over the EPS. A deep-fill screed requires only a ¾-inch topping.
- If conduit or cable needs to be encapsulated within the buildup, then a cementitious, lightweight topping will be less time consuming, as foam board would need to be cut and placed around the conduit or cable.

It is important to note that both EPS foam and deep-fill screeds require a topping with a weight that is equal to or greater than 110 pcf before flooring installation (*Figure 2*). The gypsum or cement underlayment topping provides the density and

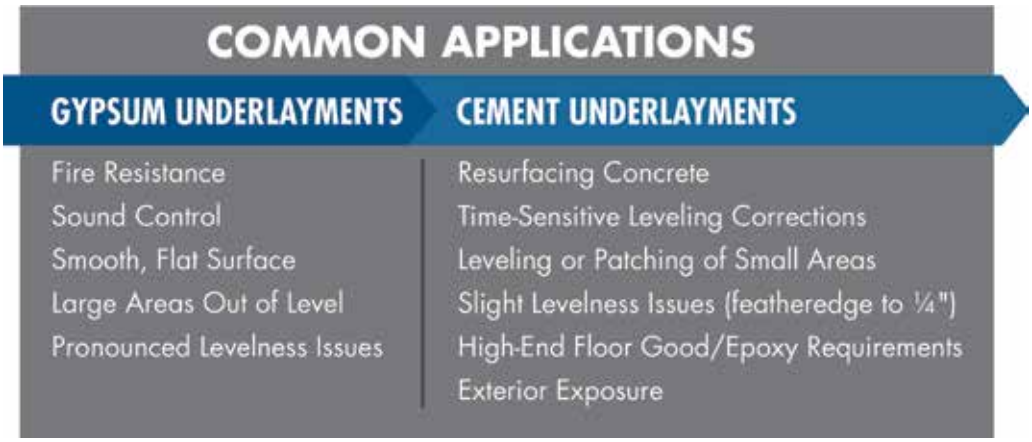

Figure 1. Common uses for gypsum and cement underlayments.

Figure 2. In this project, a lightweight deep-fill screed was installed and allowed to dry overnight. The next day, the hardened screed was topped with a gypsum underlayment to provide the density and compressive strength needed for point load dispersion and floor bonding compatibility.

compressive strength required for adequate point load dispersion, as well as meeting the flatness and bond compatibility requirements for floor coverings.

What is the structural building material?

Because of wood's flexural properties, underlayments used over wood subfloors must possess the ability to resist cracking caused by movement. Cement underlayments can achieve high, concrete-like compressive strengths. With proper floor preparation, they achieve excellent bonding to concrete subfloors. (*Many cement underlayments require shot blasting of the concrete to a Concrete Surface Profile of 3-5. Check with the underlayment manufacturer for proper floor preparation procedures.*) Although this makes them ideal for many concrete applications, the stiffness associated with cement binders make them susceptible to cracking. This phenomenon is exacerbated by the elasticity of the subfloor.

Given the typical end-uses of light wood frame construction, a high compressive strength is not often needed. However, if the underlayment will be exposed to construction traffic for an extended period, or its end use requires exceptional strength, a high-end gypsum underlayment can achieve a compressive strength in the neighborhood of 4500 pounds per square inch (psi) and offers the potential for better crack resistance than its cement counterpart.

While wood frame projects using an underlayment will typically necessitate the use of a gypsum underlayment, concrete floor slabs require further consideration to determine which type of underlayment provides the optimum solution. If the subfloor is concrete, several additional questions will assist in selecting the best solution for the project.

What is the available time for repair?

Often the flooring installer discovers levelness or surface quality issues on a job site. Typically, they will also be the ones to correct the issue. Such a discovery may require that the problem is remedied quickly. Cement underlayments pre-mix the binder, aggregate, and additives in the bag, creating a highly homogeneous mixture which is combined with water at the job site. Due to the product's inherent levelness-seeking properties and the characteristic compactness of job scope, installation of a cement self-leveler is not complicated once proper technique is learned. These products are readily available to flooring installers at home improvement and specialty stores.

Additionally, several cement underlayments include calcium aluminate as part of the composition. Calcium aluminate will give a self-leveler rapid strength formation, provide self-drying characteristics, and include a robust performance ability when exposed to occasional moisture or exterior elements during the construction process. This makes it ideal for time-sensitive projects by significantly shortening the waiting period before the floor covering installation. These characteristics also allow it to be installed earlier in the construction process if needed.

Typically, gypsum underlayments are installed by mixing the gypsum binder, locally sourced sand, and water into a pump. The liquid screed is sent through a hose into the building where a crew installs the material to a specified depth. The crew runs periodic quality checks of the material, ensuring consistency throughout the project scope. Due to the size of most projects, gypsum underlayments are sourced directly from the manufacturer and often shipped directly to the job site. This requires that jobs be scheduled in advance to allow time for crew mobilization and shipping of the material. It should be noted that a limited selection of bagged, pre-sanded gypsum underlayments are available through retail outlets to meet the needs of uncommon specialty projects.

What is the budget?

Cement underlayments can be quite expensive due to the cost of the binder and additives. This is offset to some degree by the inclusion of silica sand in the bag; however, the cost remains prohibitive for large spaces unless other factors demand their use. Large jobs requiring a cement self-leveler will typically be outsourced to a company that specializes in the pumped application of underlayments.

In large projects, a gypsum underlayment can provide a suitable, cost-effective alternative. High-end gypsum underlayments offer a quality compressive strength and the ability to be poured extremely thin (*Figure 3* and *Figure 4*). If absolute flatness is required, two options exist:

Figure 3. The floor of this train station needed significant work prior to repurposing. In this photo, extensive floor height variations can be seen in the locations where tracks were removed.

Figure 4. The same area is pictured following the installation of a high-end gypsum underlayment, which leveled the floors and created a smooth surface ready for floor coverings.

Figure 5. Gypsum and cement underlayment average material square foot price. Installed cost can vary widely depending on the scope of a project.

1) A cement underlayment can be used. Cement underlayments contain exceptionally fine silica sand, which allows them to achieve a true featheredge.
2) A gypsum underlayment can be installed but will need to be buffed once it is dry. Buffing is required because the aggregate added to a gypsum underlayment is coarser than silica sand.

Figure 5 is an average cost continuum of an economical gypsum underlayment, a high-end gypsum underlayment, and a cement underlayment. These numbers are material cost averages; installed cost can vary widely depending on the scope of a given project.

As you can see, the cost between a standard underlayment and a cement underlayment can vary significantly. Your project conditions will dictate which product is best suited for the application but knowing that several options exist will pay off either through cost or time savings.

What is the depth of the levelness correction that is needed?

Cement underlayments are designed with the primary purpose of self-leveling. The composition of these underlayments include additives that make them more viscous. This compels the material to level out on its own, which makes them exceedingly effective in thin applications. Therefore, any application that requires a very thin layer of material (featheredge to < ¼ inch) will often justify a cement underlayment (*Figure 6*).

Floors with areas that are significantly out-of-level will almost certainly benefit from a gypsum underlayment. They provide an economical solution, are available from 2000 psi to 4500 psi, and can be installed thick or thin. For depths greater than 1½ inches, the installer may recommend the underlayment be installed in two lifts to facilitate drying.

If the project is a renovation of a gypsum subfloor, resurfacing should always be performed using a gypsum underlayment or gypsum compatible patch to ensure a strong bond.

Unique project variables may come up during an underlayment discussion. These might include acoustical requirements, the presence of excessive moisture vapor in the concrete slab, or a project with strict subfloor requirements. Some, though not all, uncommon project variables may influence the type of underlayment that best suits the project.

Are there unique considerations for the project?

Both gypsum and cement underlayments may provide airborne sound reduction, which is measured as Sound Transmission Class (STC). Airborne sound reduction is a function of mass; the greater the mass, the more significant the reduction. Given that gypsum underlayments are installed at a much greater depth than cement underlayments, it is reasonable to infer that a gypsum underlayment will give a better STC performance. In fact, gypsum underlayments are commonly used in tandem with sound control mats as part of a floating floor/ceiling sound control system. The total system of a sound mat under a gypsum underlayment is installed to address both types of sound, airborne and impact sound waves. Installation of cement underlayment over a sound control mat is not recommended. The stiffness of the cement underlayment, combined with the thinness at which it is installed, can cause widespread cracking.

Gypsum and cement underlayments possess similar moisture vapor transmission characteristics. Neither type of underlayment will block the passage of moisture vapor; however, both can be installed over moisture mitigation systems, such as an epoxy vapor barrier. Like most cement underlayments, an epoxy vapor barrier requires floor preparation, such as shot blasting or removal of surface contaminants, to ensure the epoxy is absorbed into the top of the concrete slab.

Though most floor coverings will only require around 2,000 to 3,000 psi for installation, thin glued flooring materials in commercial projects will require a high compressive strength. Commonly used in hospitals, schools, and sports floors, thin resilient floor finishes are more likely to telegraph imperfections in the subfloor. A high-strength underlayment is more tolerant to the high point load needs of commercial floors. This type of project will likely include additional floor preparation on the front or back-end. This is because cement self-leveling underlayments that can achieve a zero edge require the floor to be shot blast prior to installation of the underlayment, while high-end gypsum underlayments will likely require rework (buffing) of the underlayment following installation. If a significant portion of the average floor depth is less than ¼-inch, it likely makes sense to invest in preparation work and a polymer modified cement-based self-leveling underlayment.

While gypsum and cement underlayments share many similarities, understanding their subtle differences will enable you to confidently recommend the best solution for any project. The rationale behind product usage often comes from different parties on a project. The owner of the project has a timeline and cost in mind, the general contractor is mindful of budget related to floor corrections, the structural engineer is alert to weight considerations, and the flooring installer is concerned with floor covering considerations. The key to making a well-informed underlayment decision is to ensure all the details – assembly, end-use, timeline, and unique variables – are well understood and addressed.▪

Figure 6. Installation of a cement underlayment in which the thinness of the application can be observed. Prior to installation, the concrete subfloor had to be shot blast to ensure adequate bonding of the underlayment.