Job-Site Tips

EPOXY TYPES:

Do’s and Don’ts of Matching the Product to the Task

USP STRUCTURAL CONNECTORS MiTek

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Not All Epoxy Products Are Alike, and Many Are Individually Engineered for Specific Performance Traits. Watch Your Sag and Gel Times!

“Just grab me any two-part epoxy at the lumber yard!” You may have heard that on your way to make a materials run. But it’s wrong to assume that all epoxies are alike. They’re not. Types and resulting performance vary widely among epoxy choices and their applications, and product features including nozzle time, gel time, load time, sag, cure time, and chemical resistance will affect how to match the epoxy to the task.

Link to Video ▶

What are the different epoxy types and ideal applications for each? First, let’s define the three general classes of epoxy, and then review their specific performance features by class.

1. Pure epoxy is typically just an epoxy resin and a hardener. (Epoxy doesn’t “dry,” it cures and the hardener starts the curing process.) Pure epoxy cures at a slower rate than the other product classes (polyesters and epoxy acrylates), and as a result offers less shrinkage, excellent adhesion, and very high strength performance. That said, with slow cure times, pure epoxy isn’t recommended for low-temperature applications – generally limited to a 40F-degree minimum substrate temp – nor can it be loaded as quickly as other alternatives. So, in some situations, like overhead installation, it may not be the ideal choice. Pure epoxy components are mixed together at relatively close mixing ratios (1:1, 2:1 or 3:1) and can usually be identified if the dual cartridges are the same size.

A pure epoxy offers excellent anchoring performance as well as chemical resistance against corrosive chlorine, but its slow cure rate makes it prone to sagging. Pure epoxy would be ideal for the downward installation, shown, of an anchor bolt in dry concrete, yielding best-in-class strength.

2. Unlike pure epoxy with its slow cure times, **polyester resins** cure through polymerization that is relatively fast, which means polyester products are good for lower temperatures (down to as low as 35°-F), and applications can be loaded much sooner after being installed. Polyester resins are often used for CMU wall construction.

3. A third choice, **epoxy acrylates**, offers the best features of pure epoxy with the best of polyester resins. Epoxy acrylates resins cure quickly, yet they offer the good chemical resistance properties of pure epoxy. Epoxy acrylates can also achieve high characteristic loads and are ideal for application in damp substrates or at relatively low temperatures. On the other hand, they are a “stiffer” epoxy making them inappropriate for applications involving cracked concrete.

The components of an epoxy acrylate are mixed in larger mixing ratios (10:1) which are easily identified in side-by-side cartridges.

You may see yet another epoxy product on the shelves, and that’s **“vinylester,”** which is a polyester / epoxy acrylate formulation. Vinylester is really just a term often used by marketers, so it is important to check the manufacturers literature to know exactly what you are getting.

Does color matter for any of these epoxy classes? No. In general, the industry standard is a white resin and black hardener, but these colors aren’t important for performance; the mixed color of grey, without streaks serves as an indicator that the components have been proportionately mixed.

What Makes Epoxies Different?

Epoxy types in each of the three classes named above offer widely ranging performance traits. Imagine that you are installing overhead bolts in an indoor pool application. A pure epoxy offers chemical resistance against corrosive chlorine, but its slow cure rate makes it prone to sagging. An epoxy acrylate may be the ideal choice, due to its combination of a fast cure time and chemical resistance. By comparison, pure epoxy would be ideal for the downward installation of an anchor bolt in dry concrete, yielding best-in-class strength.

The manufacturer’s printed installation instructions (MPII) will explain product performance characteristics, so that you are not installing anchors with compromised bonds. For instance, every epoxy has a **Bolt Up Time,** the “safe harbor” time between applying the uncured (wet) epoxy and when you can bolt hardware to it. But this is not the time that allows for the full load to be applied, just for the hardware installation. Here, a worker inserts a bolt that will accommodate a nut and tie-down bracket.

Nozzle Time, typically ranging from 3 to 15 minutes, depends on the epoxy type. It is the amount of time that the mixing nozzle can remain inactive with epoxy inside of it and still be able to dispense epoxy for the next anchor. Exceed the working time does not impact the integrity of the epoxy in the cartridges, it just means you need to install a new (empty) mixing nozzle because the epoxy in the nozzle began to cure.

Always use the drill diameter stated in the manufacturer’s technical data sheet. Generally, it will be 1/16” or 1/8” larger than the anchor diameter. If the hole is too large, the capacity of the anchor may be reduced. Too small, and it can be difficult to install the anchor and with enough room for the epoxy to form a bond.

Need to use an epoxy into a relatively cold concrete substrate? Polyester resins might be the better product for you.

When matching the product to the task, be absolutely sure to read the MPII (manufacturer's printed installation instructions). These instructions will inform you of the specific product performance characteristics, so that you are not installing an anchor or implementing a repair that will have a dangerously compromised bond.
Briefly, here are definitions of the various terms that are often found in the MPII, or in other product literature.

- **Bolt Up Time**

o The "safe harbor" time between applying the uncured (wet) epoxy and when you can bolt hardware to it. This is not the time that allows for the full load to be applied, just for the hardware installation.

- **Bond Strength**

o Also expressed as tensile strength, it's the maximum allowable bond stress that an epoxy can be subjected to. "Stress" is expressed in units of psi, which may not be directly helpful in determining what you need. Most manufacturers also provide sample load tables that translate "psi" into "lbs." for a given set of specific conditions.

- **Chemical Resistance**

o There are myriad chemicals, even in residential settings, which could act as corrosives on epoxy, such as oil, gasoline, chlorine, salt, or chemicals used in wood preservation. Understanding the chemical resistance of the intended epoxy is essential if such exposure is expected.

- **Load Time (a.k.a. Cure Time)**

o The time from when the resin is extruded until it can be safely loaded to it's published allowable load. In other words, it's the time it takes to fully cure. This time is greatly dependent upon the temperature of the substrate. Once a bonded anchor is installed, it should not be fully loaded until the loading time has elapsed.

- **Nozzle Time**

o Typically ranging from 3 to 15 minutes, this is dependent on the epoxy type, and is the amount of time that the mixing nozzle can remain inactive with epoxy inside of it and still be reusable for the next anchor. Exceed the working time does not impact the integrity of the epoxy

Most manufacturers recommend the hole to be blown out and cleaned with a specific brush. These brushes also serves to roughen the interior surface of the hole for increased bond strength so using the recommended diameter is important. **Always drill, blow, brush, blow, brush, and blow.**

There are specific epoxies for crack repair which can provide either cosmetic non-structural repairs or structural repair via crack injection. Ensure you choose the correct product for your type of repair.

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- **Sag**

o Horizontal and overhead applications require a non-sag product to prevent the epoxy from dripping out of the hole. Overhead applications usually require special plugs regardless of the sag properties. ,

- **Shelf Life**

o This determines how long the product can sit after being manufactured and still be usable. In most cases, an epoxy that has exceeded its shelf life will be too difficult to extract from the cartridge. It is based on unopened cartridges being properly stored and typically ranges from 12 to 24 months. Check the label for an expiration date before buying.

- **Substrate Temperature Range**

o This rates the high and low temperature range of the concrete, CMU wall, etc. within which the epoxy will still perform as designated by the manufacturer. It also influences mixing and cure times.

- **Working time (a.k.a. Gel Time)**

o When an uncured (wet) epoxy is applied, this is the window of time when the epoxy can be safely manipulated (as when a submerged bolt is positioned) and the epoxy will not be compromised. After the gel time has expired, manipulating the epoxy will compromise the bond.

How to Read a Manufacturer's Label

- **There are a few important things to check on the label, such as:**

o Recommended substrate, concrete or CMU
o Certifications, such as ICC-ES, IAPMO, ASTM and DOT
o Good for wet or saturated conditions
o Expiration date
o Temperature range for nozzle time, working time, cure time
o Installation instructions

The guideline here is to find a product that meets the requirements of your specific application.

General Considerations for Epoxy Use

Determine if the "substrate" installation into unsound, weak, or contaminated concrete: Damaged concrete can affect the strength of the bond and can also reduce the capacity of the concrete to resist the loads applied to the anchor, causing premature concrete breakout failure. Epoxy isn't magical, and it's only as strong as the substrate it is bonding to.

Drill the correct hole diameter when setting bolts in epoxy: Always use the drill diameter stated in the manufacturer's technical data sheet. In general, it will be 1/16" or 1/8" larger than the anchor diameter. If the hole is too large, the capacity of the anchor can be reduced. If the hole is too small, it can be difficult to install the anchor and still allow room for enough epoxy to form a bond.

Clean the hole properly: Most manufacturers recommend the hole to be blown out and cleaned with a specific brush. These brushes also serves to roughen the interior surface of the hole for increased bond strength so using the recommended diameter is important. If the MPII is unavailable, best practice is to drill, blow, brush, blow, brush, and blow.

Concrete integrity: Ideally, a bonded anchor should be installed into concrete of known compressive strength. Engineers who specify epoxy anchors also specify the compressive strength to ensure the epoxy can achieve its published bond strength. If the compressive strength or overall integrity is unknown, they sometimes require field testing of the embedded anchor to determine if the concrete is good enough. If you don't know the concrete integrity, find out. Never install epoxy anchors into concrete that appears to be unsound, weak, contaminated or otherwise substandard. Also, as a general rule, concrete should always be left to cure for a minimum of 28 days before installing bonded anchors.

Is It Seismic Work? Epoxy anchors used for seismic loads are tested to a very specific set of design standards and require a design professional to be properly designed per Code.