Using Water Reducers in Artisan Concrete

A Study of Plasticizers in Concrete for Architectural Applications

It has been said a number of times and is one of the most important aspects of understanding artisan concrete: The finished product is a snapshot of a moment in time. Just as stone embodies the movement of magma and eons of pressure, the final look of concrete reveals what was happening at the moment of casting. Becoming a craftsman with the material requires an understanding of how to identify and manipulate concrete during the casting process. The consistency of the concrete itself is among the most important elements in the conversation about manipulating the outcome.

Rheology

Rheology (from the Greek *rhéō*, "flow" and *-logia*, "study of") is the study of the flow and movement of a material. Wikipedia gets very specific about this if you want in-depth reading on the practice.

When we talk about the rheology of a concrete mix, we are essentially describing the consistency of the mix: cookie dough, pancake batter, milkshake, sloppy, stiff, runny, snotty, soft, hard, flowable, consolidating, blubber, and so on. Rheology is complex, and is not as simple as describing concrete by its slump, which is typical in the world of concrete work.

We can simplify the conversation somewhat and say that there are two areas that are the most important aspects of rheology for our purpose: how does the concrete move; and how well does it stay together when it is moving.

So, What Makes Concrete Move?

If we are going to talk about rheology, we need to understand some of the things that affect the way concrete moves. Here are some of the more important influences on how concrete moves: water; the size, shape, and proportions of the ingredients in the mix; the temperature of the mix; external forces; and the chemistry of the ingredients.

Water: This is the most obvious influence on the way concrete moves. Add more water and the concrete moves more. The problem is that when you add more water you weaken the concrete.

Most artisan concrete is made at very low water-to-cement ratios in order to produce high-quality concrete. Typically, the amount of water that can go into a mix is fixed and should not be changed drastically to influence movement. The specific ratio of water to cement is by no means a constant and will vary from region to region and shop to shop, but we aren't going to go into great detail about water to cement ratios here.

Size, shape, and proportions of the ingredients: This merits its own study. Here are the basics, however.

Size matters: the larger the particles are in your mix, the less surface area there is to lubricate with water and, thus, the more flow you will get from the ingredients.

The shape of the ingredients determines how well they will move against each other. Imagine the difference between a pile of marbles and a pile of jacks. One flows much better than the other, serving to illustrate the difference between round and angular sands. This example also illustrates what happens when fiber is added to the mix.

The shape inside the ingredients also matters. Hollow and porous materials are going to absorb water and slow down flow, while amorphous materials will leave more water available to facilitate flow. The ratios of these materials in the mix has obvious implications.

Temperature of the mix: Once concrete reaches a certain temperature—we use 70F/21C as the tipping point—reactions begin. An easy way to visualize what is happening is to imagine ice crystals forming in a glass of water, which is similar to what happens inside concrete when the temperature hits that magic place. As the crystals begin to form, they slow down the ability of the fluid to move freely.

External forces: A mix can appear non flowable but, placed on a vibration table, it might consolidate instantly. External forces don't need to be so dramatic, though. Mixes that require large amounts of plasticizer, or that use a plasticizer that is too powerful for the job, can appear stable until the slightest touch causes the consolidation to begin to perpetuate itself.

Chemistry! Finally we're getting to the point of this article: the magic of chemistry. A concrete mix can be stiff or flowable at first but, with a pinch of chemistry, it can exhibit the opposite characteristics.

This is accomplished using water reducers (also called plasticizers), to increase the flow, or by using VMAs (Viscosity Modifying Admixtures) to decrease the flow.

Chemistry can also extend the workability of hot mixes with the use of retarders. When simplified like this, it seems straightforward, but there is a catch. Each of these admixtures represents entire categories of chemicals exhibiting widely different characteristics. Do a quick search for water reducers, or VMA in concrete, or retarders for concrete, and you will quickly find yourself with a massive range of options to choose from. That is where we come along.

Picking The Admixture That's Right For You

We are constantly evaluating and experimenting with new and existing materials. We do this in an effort to provide a product line that serves our customer's wide range of needs. In the case of the VMA and retarder mentioned before, we have found admixes that do very well at serving the needs of our entire audience.

We offer a VMA that is exceptionally powerful, only requiring a pinch to bring a mix that is too fluid back to a manageable state. We also have a retarding admix that extends workability, even in hot conditions. When it comes to water reducers though, the choices can't be boiled down so simply.

Every water reducer on the market has a different set of characteristics. Each has a different effect on range of flow, working time, retardation, type of carrier (water or dry), cost, compatibility, and more. When choosing water reducers to offer to our customers, we take into account the range of shop conditions and needs of the fabricator so that our offering meets this wide range of demands.

Before we start, we don't list dosage ranges. Why not? Because the range is dependent upon too many variables to be a useful point of reference. In each of our base mixes, we offer a water reducer recommendation in the Catalog. This can serve as a point of reference if that is the mix you are working with. If you are working with your own mix, there is no way to determine what the dosage should be. This brings us to the most important method of determining which water reducer is right for you: You really should just try it first. Discussing water reducers in the abstract can only get us so far. After all, everyone has a different idea of what constitutes milkshake consistency, or any other description.

Test these in your working conditions and see for yourself. Hopefully, this discussion will have you prepared enough to know some cues to look for.

WHEN TO ADD WATER REDUCERS

Ideally, dry water reducers (WRs) should be pre-blended with the dry ingredients and liquid WRs should be pre-blended with the liquid ingredients. In reality however, it is hard to predict exactly how much WR you will need. Water reducer is often added after mixing (and depending on the mix, after any false set has occurred) to adjust the consistency as needed.

If you use a dry WR such as WR310 for this adjustment purpose, recognize that you need to mix it in thoroughly and that it takes some time for WR310 to reach its full potency. If you use a liquid WR, it will disperse more easily and is therefore faster acting.

Keep in mind also that some WRs such as WR420 have a relatively short window of time during which the plasticizing effect lasts, so you may need to add more later.

Experience is the only way to learn how much of which WR you can add to your mixes at which times (pre-blended or for adjustment), and how your environmental conditions such as humidity and temperature affect quanitites and timing of WRs.

HERE ARE SOME USEFUL TERMS:

Segregation: The separation of the ingredients in the mix. Segregation can be slight, with extra water or pigment floating to the surface. It can also be dramatic, causing all of the sand to drop to the bottom and water to float to the top.

Flow: The ability of a mix to move.

Homogenous Flow: Taffy-like flow. A mix that is especially homogenous will begin to flow between your fingers if placed in your hand, without separating from the mix that is still in your palm.

Soft Flow: Soft flow is more akin to whipped cream than taffy. This type of flow is better for tasks such as spraying or troweling, as the mix is more willing to separate from itself than a flow that is homogenous.

Sag/Slump: The tendency of a water reducer to cause a mix to slump or sag after being placed.

HERE ARE THE OPTIONS:

WR310 (Formerly known as Super Flowz)
This water reducer is potent! It has the capacity to make the most stubborn mixes flow. Very low doses create a noticeable impact. For example, 10 grams of this in a 50lb bag of GFRC is likely to have the mix reaching a point of segregation. This is the drawback to this water reducer: its tendency to be unstable at higher ranges of flow. You can go from a nice mix to a mix that is separating badly with only a few additional grams. With the right ingredients in the mix, this water reducer can create a very nice homogenous flow.

- Powder
- Should be preblended into dry ingredients.
- Needs to be given a minute to reach its full potency in a mix.
- Plasticizing effect can last for a considerable period of time.

WR205 (Formerly known as Super Sealz)
This is exactly 10% the potency of WR310, and contains ingredients that stabilize the mix. One benefit to this formula is the ease of measuring compared to WR310. It is a lot easier to get 100 grams weighed accurately than it is 10 grams. This water reducer can be used at low doses to soften the mix, or at higher doses to achieve flow. This water reducer has the same risk of segregation as the 310, although it is slightly more stable.

- Powder
- Needs to be given a minute to reach its full potency in a mix.
- Plasticizing effect can last for a considerable period of time.

WR ADVA 555

ADVA 555 is used widely in the artisan GFRC world as the go-to plasticizer for SCC mixes. This water reducer can achieve a good flow, but includes a VMA in the formulation, which allows for more flow with less chance of segregation. While this is used for mixes that aren't intended to fully flow, it is ideal for higher flow mixes.

- Liquid
- Relatively fast acting.
- Plasticizing effect can last for a considerable period of time.

WR420 (Formerly known as Liquid Flowz)

This plasticizer is designed to be especially effective with mixes that have a high content of finer sands and particles. It can be used to achieve a homogenous flow in mixes with high fines, a softer flow in mixes like GFRC, and can soften a mix slightly without imparting too much sag or slump. 420 is often used to temper mixes that have been plasticized with 310 or 205. This combination of water reducers often allows the fabricator a wide range of possibilities in responding to environmental conditions.

- Liquid
- Relatively fast acting.
- The window of plasticity is short at lower doses, and similar to 555 at higher doses.