

TECH NOTE

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The Effects of Cold Weather on Xypex Waterproofing

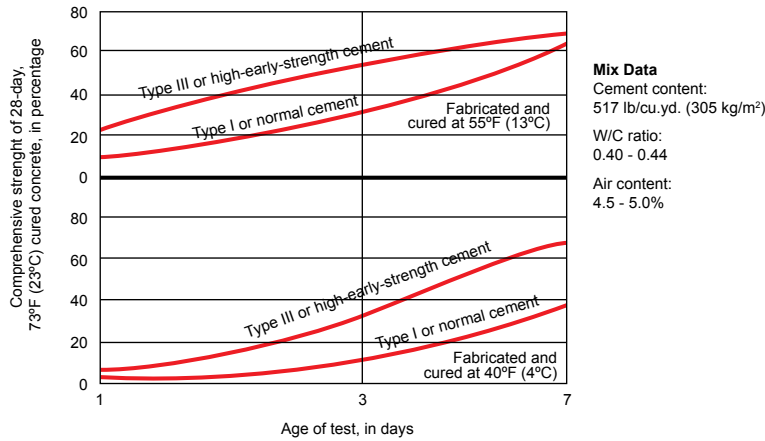
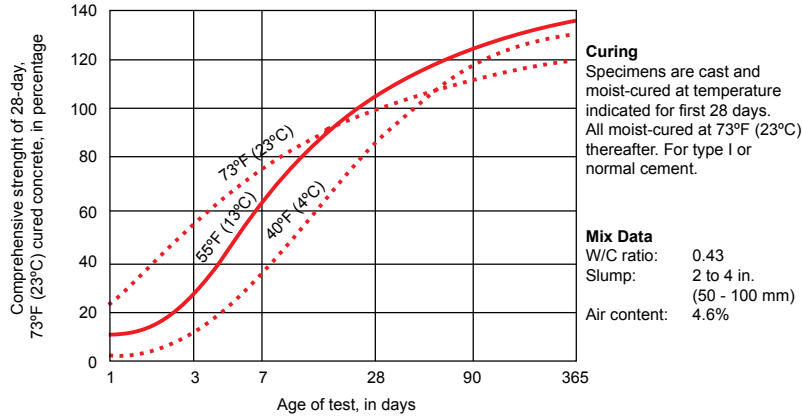
Cold temperatures, that are near or below freezing for extended periods of time, can occur in many areas of both the northern and southern hemispheres. Most concrete producers and contractors are well aware of the tools and techniques needed to address the typical problems and issues facing cold weather concreting. However, the impact of cold temperatures on concrete strength-gain and on Xypex waterproofing effects is often not well understood. Most methods for waterproofing concrete structures, including Xypex coatings and admixtures, are affected to some degree by cold temperatures. In fact, many coatings cannot be installed in cold temperatures. Elastomeric materials often lose their elongation capabilities as the temperature drops, and most crack-injection products react slowly and become too viscous to penetrate well, thus becoming ineffective. Further, if there is any ice in a crack, injection materials will normally fail.

Although the following information is not intended as an authoritative reference regarding the impact of cold temperatures on cement and concrete, but rather as a brief description of what can be expected when using the Xypex Crystalline Technology in cold environments, a basic awareness of the effects of cold temperatures on Portland cement materials in general can help in the understanding of Xypex-treated concrete under such conditions.

The process by which concrete hardens is called “hydration”. Hydration is an exothermic chemical reaction in which heat is generated, and a hardened cement paste (calcium-silicate-hydrate gel or C-S-H) is produced. Early on, the heat from the reaction builds up in the concrete mass, and then dissipates slowly over time. The time frame of the cooling process depends on many variables, including temperature, the size of the structural element, and measures taken by the contractor to insulate the concrete.

Chemical reactions in concrete are driven by a number of factors but, generally, the rate of chemical reactions will slow down as the temperature drops. This is true of cement’s hydration rate and, thus, dropping temperatures will slow down the strength-gain and maturation process of concrete. Scientific publications indicate that the strength-gain of concrete will continue until approximately 14°F (-10°C) but at a much-reduced rate. The graphs below are from several reference texts and provide a general illustration of the effects of temperature on the early and long-term strength-gain of concrete. When the rate of strength-gain increases in cold temperatures, it is largely driven by the heat that develops as the concrete hydrates.

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The Xypex treatment of concrete is performed in two primary ways – either as a coating system or as an admixture. For new construction, one advantage of the admixture over most coating systems is that the Xypex Admix products can be installed during temperatures that are below freezing. Regardless of which installation method is used, cold temperatures will affect how the Xypex technology reacts with moisture and the concrete, although with each method the contributing factors are slightly different. As a coating system, the active chemical ingredients in Xypex must first diffuse into the concrete’s cement matrix from the surface (diffusion is driven by the random movement of molecules, called “Brownian Motion”). As the temperature drops, the overall movement of molecules slows down, as does the rate of diffusion. This condition results in a slower introduction of Xypex chemicals into the concrete and therefore a correspondingly slower overall Xypex effect. As an admixture, Xypex’s active chemicals also diffuse, but from within the concrete matrix itself. If a crack occurs and water enters the concrete, the diffusion of chemicals helps speed up the crack healing process but, again, the crystalline process (and its effect) as a whole will be slowed in such colder temperatures.

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Xypex crystalline development is generated from cement-chemistry-based reactions that result in the formation of a secondary crystal structure within the concrete. The growth of this Xypex crystalline structure depends partially on the availability of calcium hydroxide, other alkalis in the pore water, and the migrating water itself – in essence, the Xypex crystal-building blocks. The slowing of the hydration process in concrete caused by low temperatures will also slow the rate at which by-products of cement hydration, including calcium hydroxide, will be available for the Xypex crystalline reactions. Thus, if cold temperatures occur soon after the initial Xypex treatment, it should be expected that the development of the full waterproofing and crack healing effectiveness of the Xypex treatment will be slowed to some degree.

The Xypex Coating System is normally applied to existing concrete or to concrete after it has been placed for at least several weeks and has cooled to ambient temperatures. Xypex Admix, on the other hand, begins to develop a crystal structure immediately after placement while the concrete is still warm, resulting in the healing of some of the shrinkage cracks before the concrete cools. Load-induced cracking typically occurs months after concrete placement when the structural element has cooled. If concrete temperatures are near or below the freezing mark, the crack healing effect of Xypex treatment may be so slow as to appear to have stopped. However, general concrete chemistry principles plus field experience provide two positive indicators for both the Xypex Coating System and the Xypex Admix:

1. At temperatures approaching freezing (i.e. several degrees above freezing), the Xypex crystalline formation will still occur if only at a significantly reduced rate.
2. As temperatures rise (e.g. as in the spring), Xypex waterproofing and crack healing effects will speed up and react normally.

Indeed, experience confirms that, as with concrete strength-gain, low temperatures have no long-term negative impact on the waterproofing effectiveness of the Xypex Crystalline Technology. Note that, even in low temperatures, earlier Xypex healing and waterproofing can be achieved by hoarding-and-heating or other techniques used for the curing of concrete in cold temperatures. Alternatively, Xypex applications may be planned for time frames or seasons when temperatures are rising as opposed to falling.

Summary

The Xypex waterproofing and protection system, like most other waterproofing technologies, is affected by low temperatures. If the temperature drops soon after installation of the Xypex system, the rate of formation of the Xypex crystalline structure in the concrete will become slower. In freezing temperatures the Xypex effects may slow to the point of being essentially stopped. However, as the concrete warms, the Xypex system will reactivate and the crack-healing and overall concrete waterproofing effectiveness will reach its full capability. Further, the process can be sped up through hoarding-and-heating or other techniques to warm the concrete.

Please contact your local Xypex representative or Xypex Technical Services for additional information.