CARBON CURE™

# Guide: Best Practices for Hot Weather Concreting

## How to pour with success in high temperatures

# Introduction

While concrete is used extensively in every region of the world, it is not without its challenges—especially in hot weather. The key to success lies in understanding how environmental factors affect concrete properties and the construction operations of mixing, transporting, and placing of the concrete materials.

By understanding how these factors affect the curing of concrete, producers in Latin America, Asia Pacific, Europe, and the Middle East can adjust mix designs and compensate in a variety of other ways to maintain high quality standards and avoid issues with the finished product.

Follow these best practices and results like the recently completed **Girls and Boys Club in south central Mexico** are within reach. Created by **Centro de Colaboración Arquitectónica (CCA)**, the building effectively communicates the Club's values of playful, attractive architecture, while also showcasing just what's possible with concrete in warmer climates.

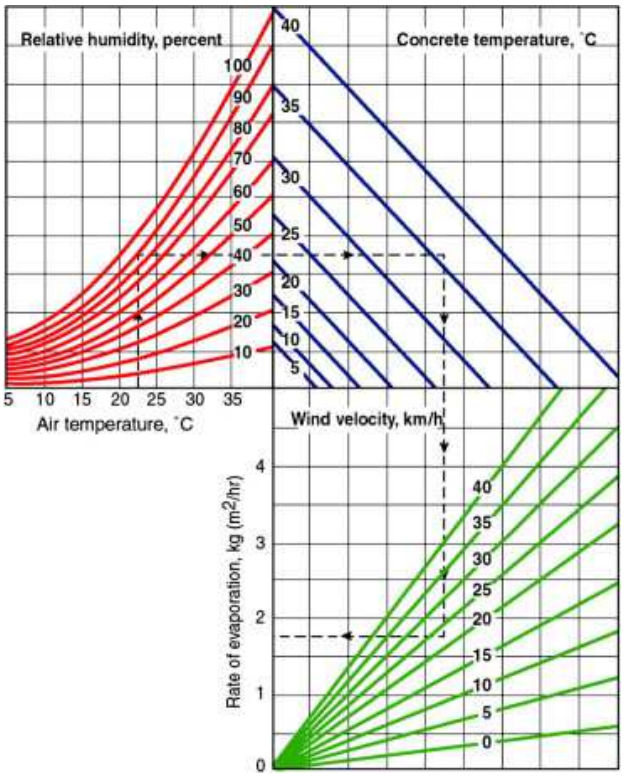
# What is Hot Weather Concreting?

The peak body for the heavy construction materials industry in Australia, **Cement Concrete & Aggregates Australia (CCAA), defines hot weather concreting as** "any combination of high ambient temperature, low relative humidity, and high wind speed."

While standards differ slightly around the world, the Australian standard AS 1379 provides this benchmark for hot weather concreting: "AS 1379 places a 35°C limit on the maximum concrete temperature at the time of delivery. However, when air temperature rises above 30°C, it is usually recommended that precautions be taken, particularly if there is also hot dry wind."

Evaporation rate is another indicator of hot weather conditions for concrete—when the evaporation rate is greater than 1 kg of water per square metre of concrete per hour (1kg/m2/hr), precautionary measures should be taken (see diagram).

In hot countries, climatic conditions of high winds, low relative humidity, and solar radiation can occur any time. As such, hot weather concreting is any period of high temperature in which special precautions need to be taken to ensure proper handling, placing, finishing, and curing of concrete.




*This Evaporation Nomograph features in many design and control manuals and takes the air temperature, relative humidity, concrete temperature, and wind velocity to produce the rate of evaporation. Use this as a guide to know when to act to prevent plastic-shrinkage cracking.*

*Source: Portland Cement Association,* ***Design and Control of Concrete Mixtures***

# Hot Weather Concreting Challenges

While it is generally advised not to place concrete in high temperatures, Australian distributor **CE Construction Solutions acknowledges that this isn't always possible** through summer months in the warmer regions of the world.

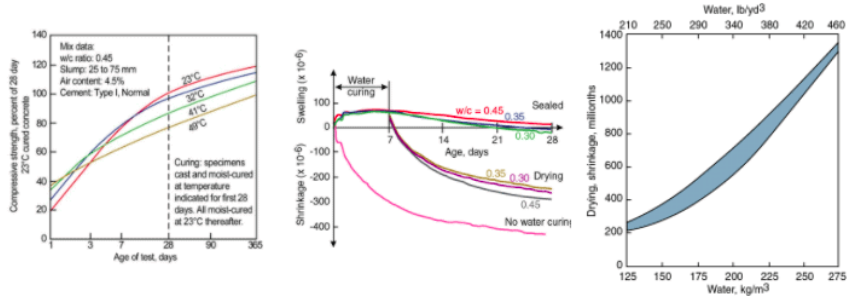
Hot weather conditions can lead to problems in mixing, placing, and curing hydraulic cement concrete that can adversely affect the properties and serviceability of the concrete. If precautions are not effectively implemented during hot weather, the concrete may be damaged through plastic-shrinkage cracking, thermal cracking, and decreased 28-day strengths.

**In the freshly mixed state, hot weather challenges include:**

- Increased water demand, which reduces the water-cementitious ratio.
- Increased slump loss leading to the requirement to add water at the job site.
- Accelerated setting time, which creates issues with handling, compacting, and finishing, and a greater risk of cold joints.
- Increased potential for plastic shrinkage and thermal cracking, mainly due to the evaporation of water on the surface of the placement.
- Difficulty controlling air content—depending on the cementitious system and admixture package, a gel may form and causes air bubbles to break, decreasing the air content.
- The need for the concrete to be promptly cured and cut early. Concrete that is cured at high temperatures at an early age will not be as strong at a later age as concrete cured at more favorable temperatures.

**Once the concrete hardens, problems caused by hot weather can never be fully rectified and deficiencies often include:**

- Increased potential for drying shrinkage and differential thermal cracking from either cooling of the overall structure or from temperature differentials within the cross-section of the slab.
- Decreased compressive strength resulting from higher water demand.
- Increased potential for cold joints, color differences, or other variations in surface appearance, due to different rates of hydration or different water-cementitious material ratios (w/cm).
- Decreased water-tightness and durability due to cracking.




**Impacts of temperature on compressive strength** | **Influence of curing on shrinkage** | **Shrinkage and Water content**

*These charts demonstrate the real impact that hot weather can have on your concrete as delivered to the site, the increased risk of drying shrinkage, and cracking of the concrete.*

*Source: Portland Cement Association, **Design and Control of Concrete Mixtures***

# Best Practices for Hot Weather Concreting

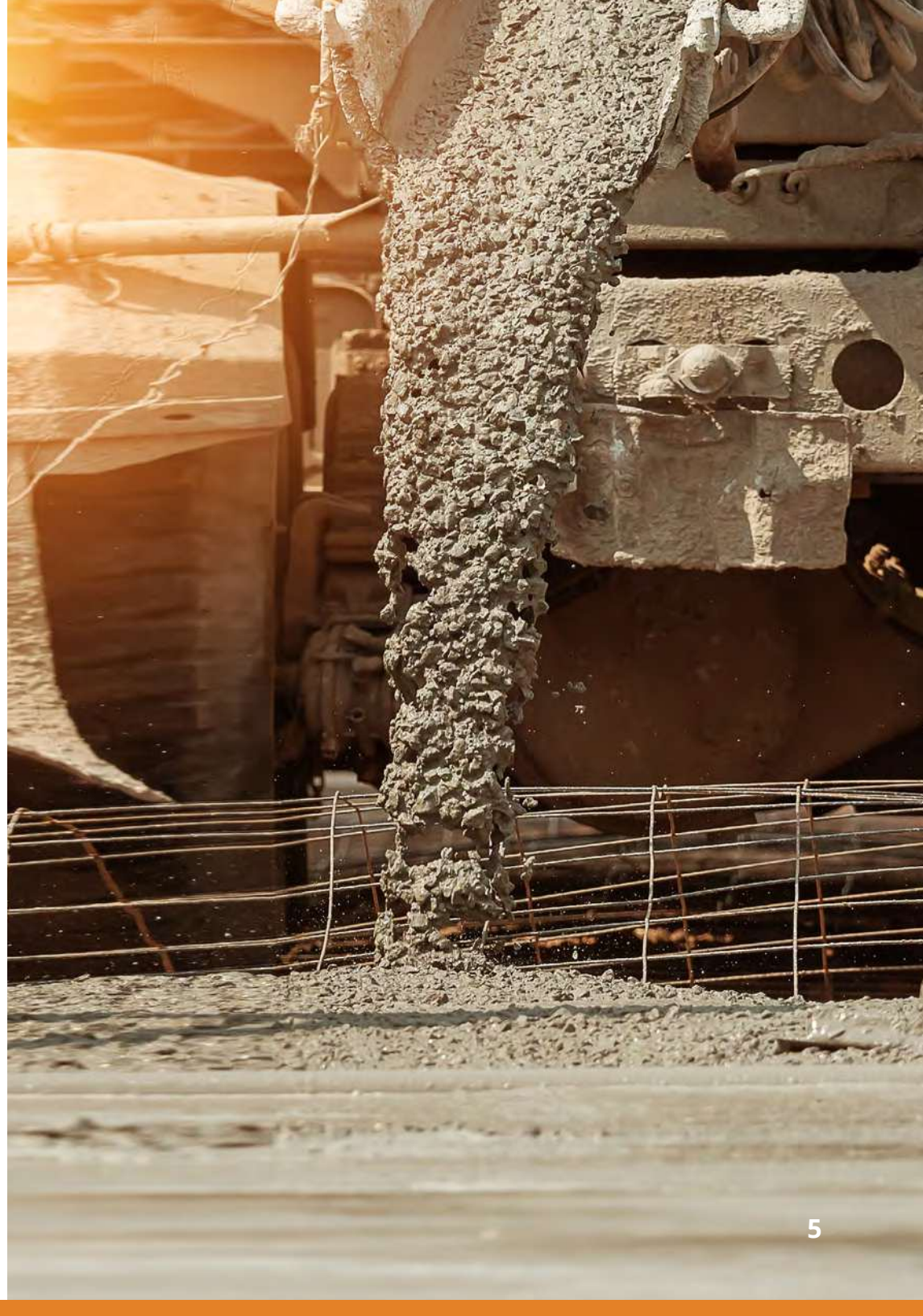
A successful hot weather concrete pour requires planning for both internal processes at the plant and external processes at the job site.

Ensure teams are adequately trained to handle concrete in hot weather conditions. If your team is unaware of the different hydration control admixtures or the effects of the admixtures in hot weather, check with your admixture supplier and with your cement supplier for best practices for your mix scenario.

Take a collaborative approach by holding meetings with contractors and the end customer to set expectations. Ensure everyone is aware of the risks including the potential for plastic shrinkage.

While you may not need to take all of the recommended precautions described here, each hot-weather scenario should be analysed individually by qualified personnel, who should find the optimum mix of quality, practicability, and cost-efficiency. Particularly when using speciality mixes, it's important to assess whether any additional precautions are required.

Lastly, adapt based on the realities on the ground and postpone if necessary. **Holcim Australia** describes this keeping your "weather eye" open because "a gentle breeze on a hot, dry day cannot be ignored." Pour with care, caution, and adopt these best practices when pouring concrete in hot weather.



## At the Plant

- Reduce the temperature of aggregates by **shading stockpiles from the sun** and dampening those that are dry and absorptive. This can be done using typical sprinklers and, if you have the bin capacity and space at the yard, dampen the aggregate the night before use so you can drain it before use. This will bring it back to a controllable moisture content and avoid issues with slump control. Painting bins white to reduce heat absorption from the sun is another **recommendation from CCAA**.
- **Monitor temperature continuously using a trusted formula**, keeping the concrete temperature low by cooling the aggregates and mixing water—you can even use ice for the mixing water because, as **CCAA outlines**, "the latent heat of the ice is considerably higher than that of water".
- Consider investing in liquid nitrogen cooling for high volume production—if you're only doing a couple of placements a week, it may not be cost effective.
- Monitor drum revolutions to avoid excessive mixing, but turn the drum **at least 70 to 100 revolutions** at the mixing speed designated by the manufacturer.

## At the Job Site

- Use set-retarders, noting the **caution from CCAA** that "the surface may appear ready for finishing, but the concrete below the surface layer may still be plastic from the retarder. This can lead to a 'spongy' feel under foot during concrete finishing and potentially to cracking of the finished surface."
- Practice prompt discharge from the trucks so there's less time for the concrete to react before placement. Program the work for cooler parts of the day (early morning/late afternoon) or **CCAA suggests** that concreting at night can be advantageous, if permitted.
- According to **Structure Magazine**, "Maintaining the required concrete temperatures during hot weather periods can be done many ways without reducing the concrete strength. The most common methods include: The use of cold water in the concrete mix, the addition of retarding admixtures and hydration set control admixture, cooling of the aggregate by sprinklering and shading, and the use of fly ash and slag to reduce the cement content."
- Cure the concrete immediately. On bridge decks or overpasses where there is a high potential for evaporation, the white curing compound takes a while to become a membrane. Spray it on right after the finishing process and cover it with wet burlap. Using white-pigmented curing compounds helps with coverage to reflect heat from the concrete surface. **Holcim Australia** adds, "As 23°C is considered the ideal temperature for hydration, it is desirable to maintain concrete temperature at or about this figure as curing proceeds."
- Protect your test cylinders. They should be continually moist and in a 16°C to 27°C condition for both acceptance or rejection. Water baths are very effective for this but ensure you monitor the water temperature and don't put too many cylinders in one water bath.

# Innovate with Concrete in Every Climate

The concrete industry is in the midst of a shift towards sustainability, with the UN highlighting its critical role if we are to meet the requirements of the Paris Climate Agreement. Producers have the opportunity to make a difference by adopting innovative sustainable concrete technologies that are compatible for use in hot weather conditions.

Installed in nearly 300 concrete plants across the globe, CarbonCure is the leading provider of carbon removal solutions for concrete production and has been used for many years in warmer climates.

It won't contribute to any of the issues described above, nor will it prevent any of them. While $CO_2$ is a cooling material, the CarbonCure technology only uses a very small amount of $CO_2$—not significant enough to alter the temperature of the concrete.

**For more information, visit carboncure.com or contact a CarbonCure representative at info@carboncure.com or +1 (902) 442-4020.**

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