TECHNICAL BULLETIN # 8

Reducing Ready Mixed Concrete Temperatures in Hot Weather

Concrete is designed and proportioned to meet industry standards and project specifications to provide a durable and long lasting product. The producer is expected to deliver a consistent product from one load to the next. In summer months, the producer is often presented with an additional performance requirement from the owner, concrete temperature, which they are challenged to meet by the impact of ambient temperatures on the materials used to make ready mixed concrete. Concrete temperature affects the performance outcomes of the concrete in both its plastic and hardened states. However, several provisions can be put in place by the producer to address these challenges. The most common approaches will be discussed here but numerous others may be employed by operations that are required to meet this challenge on a frequent basis.

The most practical approach to lowering concrete temperature is to reduce the temperature of the materials that go into the mix. Since aggregates make up the largest proportion of most mix designs (70-85% by weight on average), they have the greatest potential to influence the temperature of the final mixed product. A general rule of thumb necessitates the lowering of aggregate temperature by 1 ° C for every 0.5 ° C of overall concrete temperature. This can be accomplished by shading aggregate piles and by sprinkling them with water, especially when the relative humidity is low and there is a substantial breeze, as there is, most days, in most parts of Alberta. Some modern facilities that produce substantial volumes of concrete may have aggregate air chillers installed in their production line.

Portland Cement loses heat slowly in storage at the manufacturing facility and because inventories tend to be low during peak construction season (usually the summer months), cement is often received in a relatively warm state. However, because it only usually represents less than 15% of the mix materials, its contribution to the overall temperature of concrete is far less significant than the other components.

The ingredient that is the easiest to cool is the water and it has a relatively moderate reduction effect on the final mixed concrete temperature. Water when not readily available from municipal sources should be stored in tanks out of the direct sunlight. Tanks can be painted white to reflect sunlight and lines and/or tanks can be buried under ground to keep their contents cool. Water needs to be cooled about 2 ° C for every 0.5 ° C lower of the overall concrete temperature. But because it represents a relatively

small proportion of the mix, it's impact on the overall temperature of concrete is usually limited to less than 5 ^{o} C.

A concrete producer's next option to meet project's temperature standard in hot weather is to replace a certain portion of that water with shaved or cubed ice. But the ice must be completely melted by the time the concrete is fully mixed. Ice should replace water on a one to one basis by weight and is generally limited to a maximum of about 75% of the mix water. Batch sequencing will depend on the ingredients in the mix, and one should keep in mind that aggregates will be most influenced by the heat of fusion effect of the ice and should therefore receive as much direct contact with the ice as possible to release the heat and to ensure the ice is broken down in an efficient manner both mechanically and thermally. An ergonomically correct and safe method for introduction of ice into the mixer should be provided. A sampling of ice bags should be conducted to confirm consistent content weight to ensure that overall water content is maintained within design parameters. In any event, the use of ice to cool concrete comes at an additional material and labour cost to the concrete producer and, as such, should be anticipated by the contractor to be reflected as a line item in the final quote from the supplier.

In extreme circumstances where all efforts mentioned above still result in a shortfall from the specified concrete temperature, liquid nitrogen may be injected into the central mixer or directly into the mixer drum during the batching process. Caution should be taken to prevent the liquid nitrogen from coming in direct contact with the drum as it may crack the drum. Though liquid nitrogen does not replace any of the mix water requirements, the resulting lowered concrete temperature may the reduce water demand of the mix. Again, in extreme circumstances, this provision may be the only option for the producer to achieve the required concrete temperature in the project specification.

References: Kosmatka, Steven H, Kerkhoff, Beatrix, Hooton, R. Douglas, and McGrath, Richard J. *Design and Control of Concrete Mixtures: The Guide to Applications, Methods and Materials Eighth Canadian Edition* Cement Association of Canada, 2011, 411pp.