Specifications for Implementing ConcreteWorks

(in partial fulfillment of Product P1 for TxDOT Project 5-4563)

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Background

Under TxDOT Project 5-4563, the research team at the Concrete Durability Center (CDC) at the University of Texas has developed an approach to specifying crack-resistant and corrosion resistant reinforced concrete structures using ConcreteWorks. This brief memo presents the research team's approach to specifications for (a) preventing thermal cracking, and (b) preventing corrosion of reinforcing steel. It is the goal of this project to apply these specification approaches to new construction projects in Texas during the course of the project.

Specification Approach for Implementing ConcreteWorks – Thermal Cracking

The approaches to specifying and implementing ConcreteWorks presented next are intended to give a range of options for contractors, ranging from simple (straight 35 °F specification limit) to advanced (based on thermal cracking risk). It is intended that one or more of these will be implemented during the course of this project. The three proposed specifications approaches are as follows:

1. *Keep the specification unchanged; therefore, the maximum temperature difference for all mass concrete members is limited to 35° F (20° C).*
2. *Use a temperature difference modification factor (TDMF); the maximum temperature difference is determined by the compressive strength development, concrete member size, and concrete coefficient of thermal expansion as per TxDOT test method Tes-428A. An example of a TDMF chart for a rectangular column is shown in Figure 1. The TDMF chart for other concrete member types will need to be developed as part of future research. The least column dimension shown in Figure 1 is the least dimension of a rectangle that contains the whole rectangular column. The maximum temperature difference selected for the temperature difference modification factor varies with the in-place concrete compressive strength, as shown in Figure 2. The in-place concrete compressive strength is determined using a concrete strength-maturity relationship previously developed during the mixture prequalification and the temperature history measured at the concrete surface. The maximum temperature difference is limited to between 20° F (-6.67° C) and 60° F (15.6° C).*
3. *Specify a maximum temperature difference developed from a concrete thermal stress analysis.*

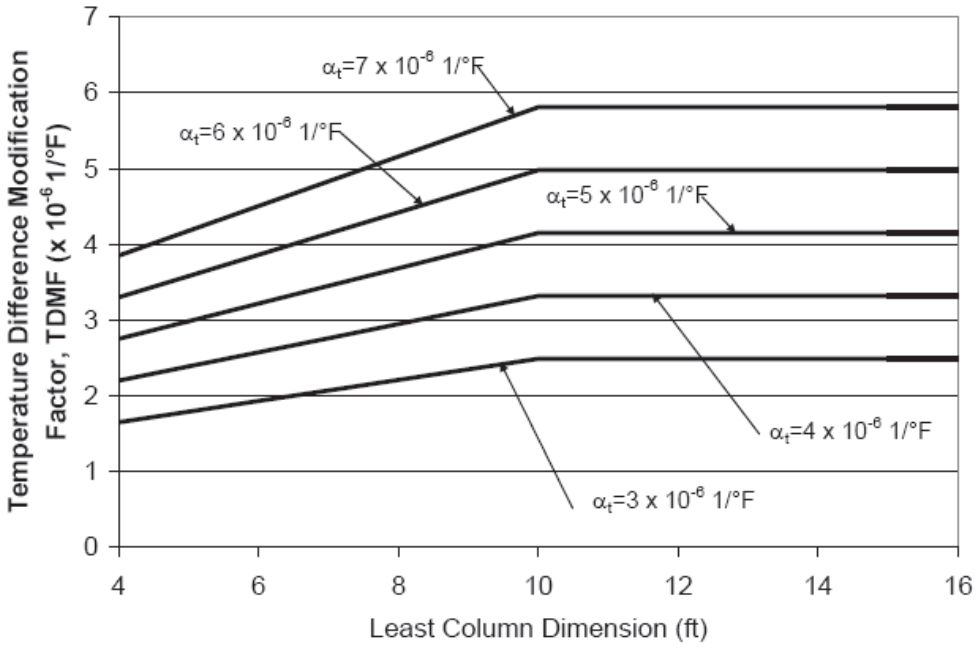

Figure 1 -- Temperature Difference Modification Factor Chart for a Rectangular Column

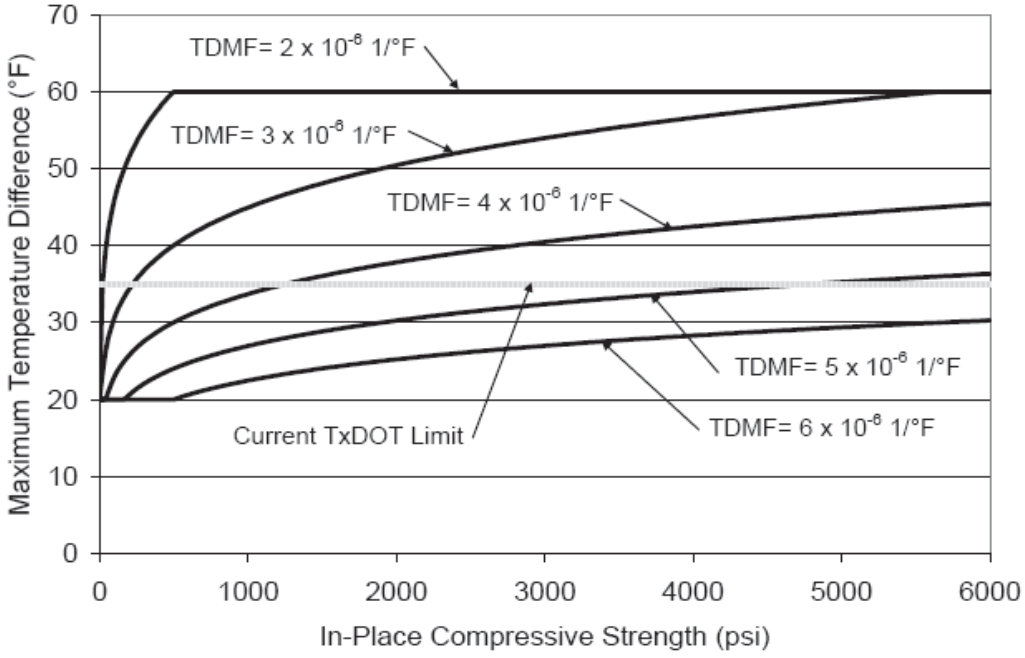

Figure 2 -- Maximum temperature Difference Versus the in-place Concrete Compressive Strength for Different Temperature Difference Modification Factors

Specification Approach for Implementing ConcreteWorks – Corrosion of Reinforcing Steel

Corrosion of reinforcing steel in concrete is the leading cause of infrastructure deterioration worldwide. ConcreteWorks addresses this durability issue by allowing users to predict the rate at which chlorides reach the reinforcing steel (based on diffusion) and by allowing users to use various materials that can effectively increase the chloride threshold above which corrosion is initiated. Various options are available within ConreteWorks to achieve a target service life (e.g., 75 years), including:

- Low-permeability concrete (e.g., lower w/cm, SCMs, etc.)
- Barriers and sealers
- Corrosion resistant steels
- Corrosion inhibitors

ConcreteWorks allows users to compare the above options and combinations thereof, with the intention of securing the desired service life of the subject structure. To allow for flexibility in the users' approaches to achieving the desired durability, a performance-based specification approach has been developed, which is as follows:

- Use ConcreteWorks to ensure that corrosion of reinforcing steel does not occur during the target service life period of 75 years. As such, a concrete mixture and construction process should be selected such that the chloride threshold value is not reached during this 75-year period.

Summary

This memo has briefly summarized the approaches to be taken under TxDOT 5-4563 to specify and implement ConcreteWorks to (a) prevent thermal cracking and (b) prevent corrosion of reinforcing steel exposed to external chlorides. These specification approaches will be implemented during the course of this project.