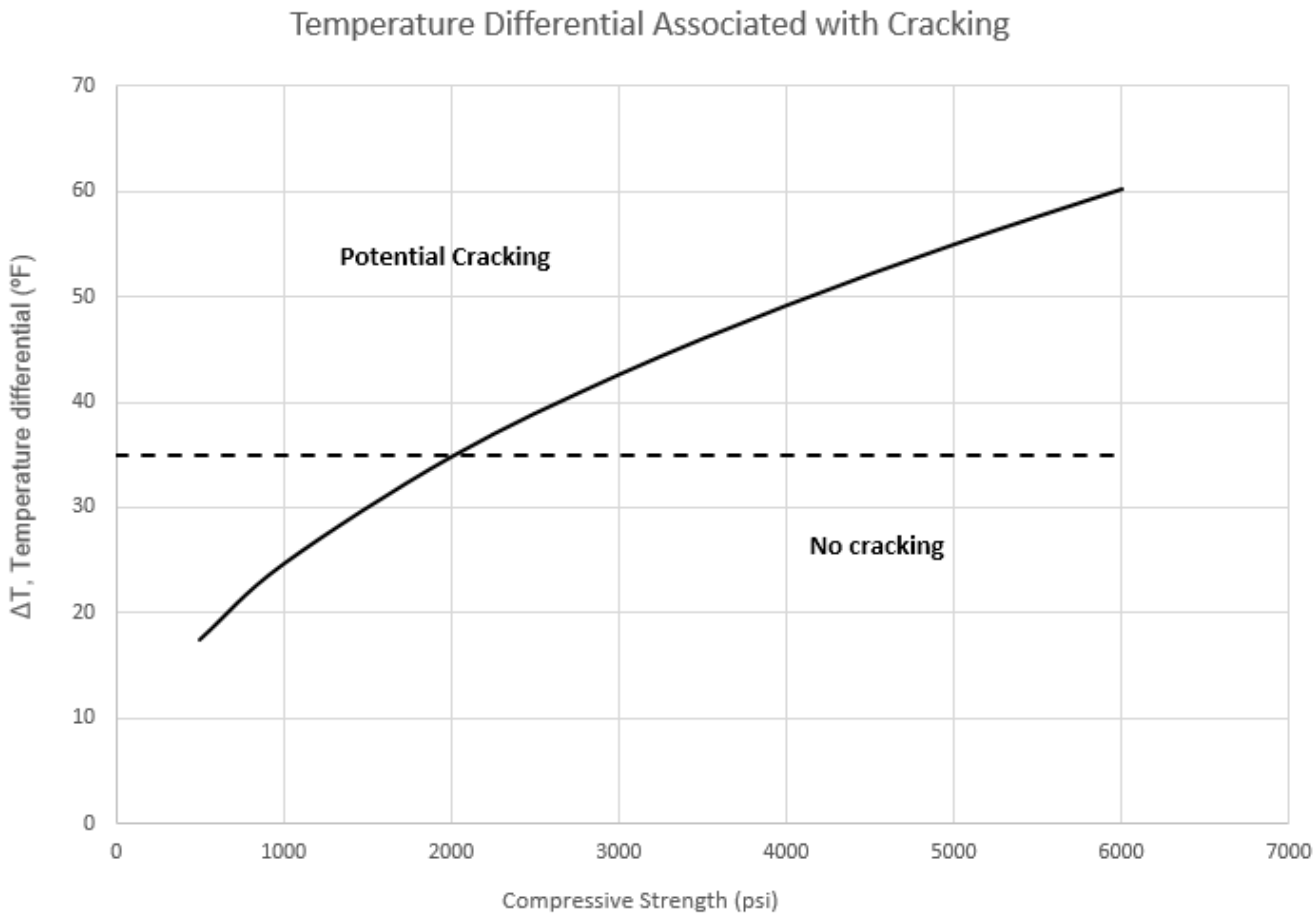
Determining the Allowable Variation in Concrete Temperature with the Maturity Method

Measuring the temperature differential in mass concrete elements is essential. Because of the mass effect, the concrete core can have a really high temperature while the surface, which is greatly affected by environmental conditions, tends to be cooler. If the difference in temperature between the core and the surface is too large, it can cause internal thermal stress. If the tensile strength of the concrete is not high enough to withstand the thermal stress it can create significant cracking.

The ACI 207- Mass Concrete guideline states that the difference in temperature between the center of the element and the surface must remain smaller than 20ºC (68 ºF) during curing. In the majority of cases this approach is very conservative, in other cases it can be an overestimation of the allowable gradient.



As concrete hardens the tensile strength increases, which means that the concrete is actually able to withstand higher temperature gradient differential as it cures. In the past, obtaining the actual in-place strength was a challenge, but with recent developments in technology, using concrete maturity testing to determine the in-place strength as become a lot easier. By measuring the in-place strength based on maturity, it is possible to determine the actual temperature differential allowed in order to prevent cracking. The following temperature difference limit equation can be used:

Temperature Difference Limit (°F)` = (f't)/(E*CTE*R*C)`

F’t, which represents the tensile strength, can be monitored at the surface of the mass element by using the maturity method. This requires a maturity calibration to be done before the pour. “E” represents the modulus of elasticity and “C” the creep factor, which can be taken as 1 to be conservative. The coefficient of thermal expansion (CTE) can be obtained by performing the AASHTO T336 test. Additional information on how to obtain these factors are provided in ACI 207.2R.

Using concrete maturity testing to determine the allowable variation in temperature in your mass pour can reduce the amount of heating or the cooling required as well as provide the appropriate length of time for curing.

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