

Utilizing the Maturity Concept for Determining Early Opening Strength of Concrete Elements

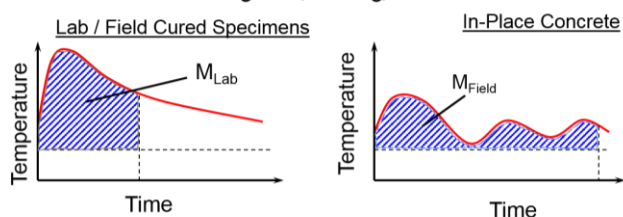
Observations from the FHWA Mobile Concrete Trailer (MCT)



Maturity is a proven, yet underutilized, technology that provides several advantages over conventional techniques for determining when to open a pavement to traffic or when to strip forms from a structural placement. While common practice is to base these decisions on strength tests of laboratory-cured or field-cured concrete specimens, this assumes that the strength of the concrete specimens reflects the strength of in-place concrete. This is typically not the case because of different exposure conditions. Concrete strength specimens are cured under standard conditions while the pavement is affected by daily temperature and sun exposure cycles. Summer placements will yield faster strength gain but cold weather placements will retard it. The mass of the in-place concrete is much greater than the strength specimens which will impact rate of hydration and strength gain. To better approximate the strength of the actual in place concrete, in-situ, non-destructive maturity testing is preferred.

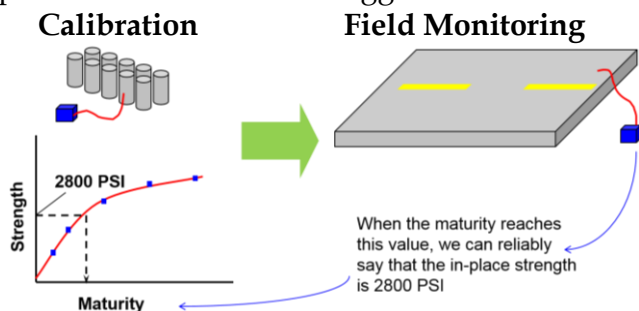
Concept: The Maturity Method is a standardized technique (ASTM C1074) used to predict the in-place strength of concrete at early ages (up to 14 days) based on the temperature history of the concrete. It uses the principle that concrete strength is a function of its time and temperature history - defined as its maturity. Strength develops as cement hydrates; maturity is a measure of how far hydration has progressed. The method assumes that samples of a given concrete mixture attain equal strengths if they attain equal values of maturity.

$$M = \int_0^t (T - T_0) dt$$



When $M_{Field} = M_{Lab}$, the strengths are the same

Implementation: Maturity is a relatively simple technique to implement in the field. Agencies such as Iowa DOT have been using it for well over two decades. The concept requires building a calibration curve* first and then measuring the maturity of the in-place concrete with data loggers in the field.



*While this has usually been done in a laboratory, developing the curve in the field is a viable alternative

Benefits of using this concept:

- More reliable in-place strength estimates
- Shortened Construction Schedules
- Reduced Construction Cost
- Increased Safety; formwork removal based on actual in-place strength

Things to be aware of:

- The method works under the assumption that same materials and proportions are used in the laboratory and field concrete.
- There are up-front effort and costs to establish the maturity curve.
- Newer dataloggers are smart sensors that are smaller in size, easy to use, and send maturity data wirelessly. Some of these sensors allow for real-time monitoring of strength gain remotely.

Summary:

Despite its documented benefits, based on the MCT field visits, there are still many agencies and contractors that are not taking advantage of the maturity concept. Use of maturity during concrete construction, can result in reduction of construction timelines, costs, and safety related issues. Allowing maturity can be a win-win for both agencies and contractors. Additional information on this topic can be found at:

<https://www.fhwa.dot.gov/pavement/pccp/pubs/06004/06004.pdf>