Florida Department of Transportation Research

Slab Replacement Maturity Guidelines
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Concrete sets in hours at moderate temperatures, but the bonds that make concrete strong continue to mature over days to years. However, for replacement concrete slabs on highways, it is crucial that concrete develop enough strength within a few hours so that the lane under repair can be reopened for traffic. The Florida Department of Transportation (FDOT) specifies that concrete in this application have compressive strength of at least 2,200 pounds per square inch (psi) before reopening and 3,000 psi at 24 hours. The earlier that engineers know the concrete will meet its maturity, the better. There is a tradeoff between opening too early and damaging the concrete or waiting and incurring additional costs.

Traditionally, strength testing is performed on concrete cylinders made from the same batch at the same time and held at the same conditions as the slab. A lab and staff must be available at whatever time of day is needed to do this testing, adding to contractor costs, and yet the strength of the cylinders may differ from the slab by 20%.

In this project, University of Florida researchers investigated an alternative to traditional strength testing, the maturity method, which uses the temperature history of curing concrete to predict its strength development. Developing the method required evaluating effects of various factors on the maturity-compressive-strength relationship of concrete at early age, developing procedures to apply the method, and validating the accuracy of the method's predictions.

Researchers began by evaluating four temperature recorders in various curing environments to select equipment for the method. Both 4-in x 8-in and 6-in x 12-in cylinders were tested under ambient conditions (85-90°F), but the smaller cylinders were also cured in a 73°F water bath and a 113°F curing room. Some smaller cylinders cured in the 73°F water bath were tested for compressive strength at intervals ranging from 4 to 168 hours.

Researchers set temperature sensors in four locations in the space prepared to receive a replacement slab.

In a second set of experiments, researchers evaluated the effects of various conditions on concrete strength as predicted by the maturity method, and they determined the most appropriate procedure for accurate concrete strength predictions. Four different maturity meters were used with several curing temperatures to determine the more accurate meter. Some samples were cured in water, some in air, and some covered with polymer-coated burlap fabric. Data were collected for concrete properties to allow a parametric study of both Nurse-Saul and Arrhenius maturity-compressive-strength relationships. Hyperbolic, exponential, and logarithmic functions were used to determine best fit to maturity-compressive-strength data.

The developed method was used in field trials on actual slab replacements in Florida. Field-developed and laboratory-developed maturity-strength curves were compared to validate strength prediction. Temperature histories recorded on site were used to calculate equivalent age and to predict strengths of the in-place concrete at different locations in the slab.

The maturity method developed in this project will help engineers complete pavement repairs more quickly with lower construction costs and less inconvenience to the traveling public.

Project Manager: Michael Bergin, FDOT Materials Office
Principal Investigator: Mang Tia, University of Florida
For more information, visit http://www.dot.state.fl.us/research-center