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CONCRETE PAVEMENTS – MATURITY TESTING

(See also PIN 38 – Concrete Pavements – Latest Research)

There are now a number of non-destructive concrete strength testing methods available to predict the development of concrete strength at early ages.

Background

Back in 1951, a researcher A G A Saul demonstrated that provided a mix is properly placed, compacted and cured, its strength at any time is a function of age and the temperature history. The first ASTM standard was published in 1987.

The Maturity Method of testing recognises this combined effect of time and temperature and provides the basis of estimating the in-situ strength gain of concrete by monitoring the temperature over time. This capability enables engineers to determine the appropriate time for sawing or opening the pavement to traffic. Recent advances in technology and equipment have resulted in a number of OTS systems being available.

The maturity (Index) is an indicator of the time-temperature history of the concrete and is often taken as the product of time and temperature.

Equipment

The basic instruments are a temperature probe and a clock. The latest equipment that is available monitors and records pavement temperature as a function of time. The devices connect to a thermocouple embedded in concrete, which in turn can be programmed to compute maturity via special software and display the stored data at defined intervals. (Obviously, several locations within the pavement can be monitored).

The stored data can be downloaded at any time, some even by wireless means. Examples of this type of equipment include "iButtons" and "intelliRock" devices and "i-QT' wireless tags. You can find out more by looking up in Google as "Concrete Pavements Maturity Testing".

The Testing Process

The first step is the development of a maturity calibration curve of the Maturity Index vs age, for measuring the in-place strength of concrete. This is usually done in the laboratory before the actual paving is undertaken:

1. Casting of cylinder specimens of the mix and recording also slump and air content;
2. 12-15 cylinders required;
3. Embedding of one or two temperature sensors (thermocouples or microprocessors) at the mid depth of two of the cylinders. These

specimens will not be tested, but will be used to monitor the maturity of the concrete;

4 All cylinders are then cured in the standard way;
5 Starting as early as possible, test two cylinders for compressive strength and record the Maturity Index at the same time and at a specified time ranges.
6 Plot the strengths against the maturity values and draw a curve of best fit. This will then be used to estimate the strength of the in-place concrete.

Limitations

The maturity method has the following limitations:

- Calibration curve must be developed using the project specific materials, ie same as in the trial mix;
- The effects of early age concrete temperature on long term ultimate strength may not be fully characterised. (This applies more to high temperature curing).
- Some factors, like compaction, may not be reflected in maturity measurements.

Summary

Advantages:
It is recognised that maturity testing is an effective means of monitoring early strength gain in pavements. The benefits are:

- Relatively fast results;
- Non-destructive test, and
- Provides continuous monitoring of strength gain.

Disadvantages:
These are:

- The inherent assumption that the same materials and mix proportions are being used in the field, and
- The significant up-front effort and costs associated with establishing the maturity curve for a given mix.

Reference: CPTP (Concrete Pavement Technology Program) – Maturity Testing for Concrete Pavement Applications, FHWA – IF -06 – 004, November 2005.