Pavement & Materials Partnering Committee
Work Product Scoping Document
New
Evaluating Maturity to Estimate Open to Traffic Strength of Concrete Pavement
June 5, 2020

Task Group

Concrete Task Group

Problem Process

☒ Annual

☐ Expedited

☐ Emerging Initiative

Title

Evaluating Maturity to Estimate Open to Traffic Strength of Concrete Pavement

Statement of Effort/Improvement

As the titles indicates, this work will focus on using maturity for concrete pavements to estimate open to traffic strength only and it will not be used for acceptance. The in-situ strength of concrete pavement for opening to traffic is currently determined on Caltrans projects by testing field cured beams in the same environment as the pavement. Even under the best circumstances these field cured beams do not exactly replicate the in-situ strength of the concrete pavement, although they do provide a reasonable estimation of the in-situ strength. The field cured beams are subject to disturbance and environmental effects that reduce the accuracy in representing is-situ strengths.

Maturity is a non-destructive method to estimate in-situ strength of concrete. It is used by other agencies and has been used by Caltrans in structural concrete applications. This method has two national standards: ASTM C1074 "Standard Practice for Estimating Concrete Strength by the Maturity Method" and AASHTO T 325 "Standard Method of Test for Estimating the Strength of Concrete in Transportation Construction by Maturity Tests," Maturity has been in use by the Concrete Industry for more than thirty years. This technology is not new to State DOTs, as Iowa has been using maturity for over 20 years. It is also important to point out that FHWA supports the adoption of this innovative technology.

Purpose

The objectives of this project are the following: review existing methods to test concrete pavement strength at opening to traffic from other states and develop specification language to use maturity to determine the age for opening concrete pavement to traffic.

Background

Caltrans has been improving its specifications to accommodate accelerated construction schedules. The ten-day minimum age requirement before opening pavement to traffic has been removed, now simply requiring a specified flexural strength prior to opening to traffic. Depending upon the mixture and materials utilized this strength can be achieved in as early as a few hours, to several days. In an accelerated construction schedule, many field cured beams will be required to get tested in order to determine the earliest possible age to open for traffic.

Maturity testing can provide a real time estimate of the in-situ strength of the concrete. Maturity testing is a procedure that utilizes the principle that strength gain is a function of time and temperature. The procedure entails determining the strength-maturity relationship of the specific concrete mixture in the laboratory (usually during the mix design development) by casting test cylinders or beams to break at regular intervals and recording the temperature history of those specimens.

To evaluate the in-situ strength, temperature sensors are embedded in the concrete pavement during construction. These sensors continuously collect real-time temperature and time data at regular intervals. The recorded temperature history is used to calculate the maturity index of the field-cured concrete. Using the calculated maturity index and the strength-maturity relationship developed in the laboratory, the strength of the in-situ strength of the field concrete is estimated.

Caltrans tried to implement maturity over 10 years ago but their laboratories were never set up for maturity. They will not need to be set up to do maturity because it is anticipated that maturity curves will be developed by the Contractor with help from the supplier and submitted for their approved mix design. The maturity curve will be validated prior to and regularly during field implementation. Per ASTM, it will be required that at least 5 samples be used to develop a maturity curve but that can be modified based on type of mix design (e.g., rapid strength concrete). When validating the maturity curve, the strength of beams will be estimated from maturity data of the specimen with the embedded sensor and compared that to the average strength obtained by breaking the other specimens. The frequency of this procedure will be based on balancing existing best practices and cost. In any case, the time required for maturity testing and validation/verification will be equal or less than the time currently take to test flexural strength based on beam testing only. Processing maturity data for validation may require some more time but it is anticipated it will be a simple review of test reports. For comparison, this will be much simpler and less costly than providing large, secure, temperature-controlled curing environment for flexural beams on projects.

Caltrans field personnel could be set up to perform maturity under quality assurance (QA). In this case, the equipment costs would be included in the project Contract. The type of system selected would be left to the Contractor to promote equal opportunity since there are different systems available on the market and they all have different ways of protecting and sharing data. Likely, Caltrans would simply require the Contractor to provide devices to collect and access data.

Approach

1. Street-Ready Assurance
   Upon reviewing other DOT's specifications and evaluating the process, a street-ready specification language will be prepared.

2. Performance Tracking/Management
   Tasks will be simple and manageable.

3. Consistently Implemented
   Implementation will take place through the Office of Concrete Pavements. The new specification language will be clearly documented and consistently applied by a lead individual from this office.

4. Pilot Projects (if anticipated)
   None at this time. A street-ready specification can be developed without a pilot projects because there is 30+ years of history in the U.S. with the use of maturity and it will not be used for acceptance but only to open concrete pavements to traffic.

5. Research Needs (if necessary)
   None at this time.

Team Members

CT/Industry	Division/Firm Name	Member Name
CT Chair	HQ Pavements	Deepak Maskey
CT	HQ Pavements	Dulce Rufino Feldman
CT	HQ Construction Standards	Debora Yost
CT	HQ Materials Engineering and Testing Services (METS)	Divyesh Vora
Industry Lead	Southwest Concrete Pavement Association (SWCPA)	Bruce Carter
Industry	Southwest Concrete Pavement Association (SWCPA)	Charles Stuart
Industry	Cemex	Hernan Jose Perez Rodriguez
Industry	The Transtec Group	Sabrina Garber

Objectives/Deliverables/Due Dates

Description:

1. Review specifications from at least 5 State DOTs to obtain their concrete pavement requirements regarding how to determine opening-to-traffic strength and whether maturity is allowed.
2. Develop a document summarizing the analysis of the State DOT specification review with the objective to evaluate if Caltrans can use maturity to estimate open to traffic strength for concrete pavement.
3. Develop specification language based on the review and analysis of State DOT specifications to estimate opening-to-traffic strength in Section 40 using maturity. This step will be divided into the following language:
    a. Submittal and approval of maturity curves.
    b. Validation/verification in the field of opening strength.

Details:

Milestones	Name - Responsible Party	Due Date (Start/Complete)
Review other DOT Specifications	Deepak Maskey and Bruce Carter	Jul 2020/ Nov 2020
Report the summary and analysis of existing specifications	Deepak Maskey and Debora Yost	Oct 2020/ Mar 2021
Develop specification language for the submittal and approval of maturity curves	Dulce Rufino Feldman and Bruce Carter	Mar 2021/ May 2021
Develop specification language for the validation/verification of field strength	Dulce Rufino Feldman and Bruce Carter	Mar 2021/ Jun 2021

Resources To Develop and Implement

	Caltrans Hours	Industry Hours
	FY 20/21	FY 20/21
Review other DOT Specifications	120	100
Report the summary and analysis of existing specifications	100	110
Develop specification language for the submittal and approval of maturity curves	30	30
Develop specification language for the validation/verification of field strength	20	20

Benefits

- Enhance quality control for the evaluation of early-age strength.
- Reduce the number of test specimens.
- Provide a strength testing procedure that compliments accelerated construction schedules.
- Produces a specification that can be applied throughout the state.

Estimated Impact to Caltrans and Contractor

- Change to Section 40 (Caltrans Concrete Pavement Specification).
- Ability to be innovative when opening to traffic time due to real time estimate of concrete strength for the designed concrete mixes selected for concrete pavement projects.
- Fewer delays and claims.
- Additional expense to perform Maturity testing. However overall QC costs should go down due to the reduction in flexural strength testing.

Impediments to Completion of Deliverables

- Lack of coordination and contribution of working group members.
- Lack of human and material resources.
- Lack of support by managers, functional units, and staff.
- Lack of staff to provide adequate training for implementation.
- Stakeholder resistance to change.

Recommendation and Approval

This scoping document for *Evaluating Maturity to Estimate Open to Traffic Strength of Concrete Pavement* was prepared by *the Cast In-Place Concrete Sub-Task Group* to address a priority issue with statewide significance and is within the Pavement & Materials Partnering Committee mission as described in the Pavement & Materials Partnering Committee Charter. The Subtask Group members have determined the scope, resources required and timeline for delivery of this project to attempt to ensure that the deliverables are achievable. A signature here indicates that each Task Group and PMPC Executive Committee is committed to providing the resources to support this effort within the prescribed timeframes. Furthermore, it is everyone's responsibility to ensure that the final effort/improvement will be:

1) Street-Ready,
2) Monitored and reported for performance,
3) Successfully implemented statewide as appropriate.

Scoping Document Recommendation and Industry Concurrence by (name and date):

Caltrans Name (Recommendation)	Date	Industry Name (Concurrence)	Date
	6/10/20		6/10/20
Keith Hoffman, Caltrans Task Group Chair		Kirk McDonald, Industry Task Group Lead	
Kuo-Wei Lee	6/15/20		6/10/20
Kuo-Wei Lee, Caltrans Task Group Member		Mark Hill, Industry Task Group Co-Member	
	6/15/20		
Ken Solak, Caltrans Task Group Member			

Scoping Document Approval and Industry Concurrence by (name and date):

Caltrans Name (Approval)	Date	Industry Name (Concurrence)	Date
	6/18/20		6/18/20
Sergio Aceves, Caltrans PMPC Executive Committee – Chair		Brandon Millar, Industry PMPC Executive Committee - Member	
	6/18/20		6/18/20
Ray Hopkins, Caltrans PMPC Executive Committee - Member		Charley Rea, Industry PMPC Executive Committee - Member	
Dolores Valls	6/18/20		
Tom Ostrom, Caltrans PMPC Executive Committee - Member			
	6/18/20		
Roberto Lacalle, Caltrans PMPC Executive Committee - Member			

Approval Date: 6/18/20