Pavement & Materials Partnering Committee
Work Product Scoping Document
New
Concrete Pavement Acceptance Based on Compressive Strength
May 22, 2020

Task Group

Concrete Task Group

Problem Process

☒ Annual
☐ Expedited
☐ Emerging Initiative

Title

Concrete Pavement Acceptance Based on Compressive Strength

Statement of Effort/Improvement

Working to improve pavement quality and reduce jobsite issues, Caltrans and the concrete pavement industry plan to investigate the use of compressive strength cylinders (ASTM C31) for accepting pavement strength. Concrete pavement design relies on the concrete modulus of rupture (MOR) – flexural strength – as a primary design input. Since MOR is used for pavement design, Caltrans specifies MOR for accepting concrete pavement strength. Problems with MOR testing are widely understood and as a result most DOT's have moved to compressive strength for opening strength and acceptance testing while continuing to use MOR for pavement design. Investigating this topic in more detail will allow Caltrans to make a knowledgeable decision about specifying compressive strength for accepting concrete pavement strength.

Purpose

The objectives of this project are the following: review existing concrete pavement acceptance criteria from other states and develop specification language, if warranted, to accept concrete pavement based on compressive strength.

Background

Concrete pavement is currently accepted based on 28-day flexural strength. It is well known that there is not a direct global correlation between compressive and flexural strength values, however, there is an excellent correlation for a specific mix design. The Federal Highway Administration (FHWA) has demonstrated such strong correlation when they tested concrete pavement mixes in separate Demo Projects during recent visits with the Mobile Concrete Technology Center (MCTC) to Caltrans projects. Many States use compressive strength as a surrogate for flexural strength. As a result, our STG would like to evaluate accepting concrete pavements based on compressive strength correlated with the design flexural strength during the concrete pavement mix design process.

There are two main benefits to have this as a top priority: compressive strength testing is much easier to handle and compressive strength has about half of the variability of flexural strength. This evaluation would be based on compiling the best practices proposed by FHWA and at least 5 other DOTs that have lots of concrete pavements.

Concrete strength is characterized under three modes of loading: compression, tension and flexure. While concrete has a great capacity to carry loads in compression, it is much less effective in tension. Concrete pavements develop cracking primarily when tensile stresses exceed the tensile strength of the concrete; therefore, tensile stresses are very important in developing performance relationships for concrete pavements. Since a simple and reliable test procedure for directly measuring concrete tensile strength has not been developed, pavement engineers use MOR. The MOR test simulates the bending stresses experienced in concrete pavement and indirectly measures tensile strength. Most concrete pavement design tools rely on MOR as a primary input for predicting the performance of concrete pavements. This includes AASHTO Pavement ME which was used by Caltrans to develop their pavement design catalog.

While MOR works well for pavement design, the test procedure is far from ideal in the field. MOR tests are extremely sensitive to specimen preparation, handling, and curing procedures. In addition, these specimens are bulky weighing approximately 65 lbs each after demolding. As a result, most state DOT's have moved away from using MOR for opening strength and acceptance. FHWA indicates a clear trend towards the use of compressive strength on projects. A common practice for state DOT's is to establish a correlation between compressive and flexural strength during a project's concrete mix design development. After this correlation is established, compressive testing can reliably be used for accepting concrete strength. The following list of the advantages of using compression test cylinders, as opposed to flexural test beams:

- Cylinders are less sensitive to variations in testing procedures.
- Cylinders are smaller in size, weigh less, and therefore are easier to make, handle, transport, and test.
- Construction and inspection personnel are better acquainted with proper casting and testing procedures for cylinders.
- Compression tests have a lower coefficient of variation.
- Statistical data for concrete mix designs are more commonly available for compressive strength versus flexural strength.

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.

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

Team Members

CT/Industry	Division/Firm Name	Member Name
CT Chair	HQ Pavements	Dulce Rufino Feldman
CT	HQ Construction Standards	Debora Yost
CT	HQ Materials Engineering and Testing Services (METS)	Larry McCrum
CT	District 7 Construction	Alex Perez
Industry Lead	Southwest Concrete Pavement Association (SWCPA)	Charles Stuart
Industry	Southwest Concrete Pavement Association (SWCPA)	Bruce Carter
Industry	G3 Quality	Marc Robert
Industry	Twinning Laboratories	Boris Stein

Objectives/Deliverables/Due Dates

Description:

1. Review specifications from at least 5 State DOTs to obtain their concrete pavement requirements regarding acceptance of concrete pavement strength.
2. Develop a document summarizing the analysis of the State DOT specification review with the objective to evaluate if Caltrans can use compressive strength to accept concrete pavement.
3. Develop specification language if the review and analysis of State DOT specifications support changes to accept concrete pavement in Section 40 using compressive strength.

Details:

Milestones	Name - Responsible Party	Due Date (Start/Complete)
Review other DOT Specifications	Dulce Rufino Feldman and Charles Stuart	Jul 2020/ Nov 2020
Report the summary and analysis of existing specifications	Debora Yost and Bruce Carter	Dec 2020/ Mar 2021
Develop specification language	Dulce Rufino Feldman and Charles Stuart	Apr 2021/ Jun 2021

Resources To Develop and Implement

	Caltrans Hours	Industry Hours
	FY 20/21	FY 20/21
Review other DOT Specifications	140	110
Report the summary and analysis of existing specifications	130	120
Develop specification language	40	40

Benefits

- Cost savings attributed to a better efficiency from less expensive and time-consuming test procedure to accept concrete pavement strength.
- Increased worker safety due to smaller and lighter concrete pavement samples.

Estimated Impact to Caltrans and Contractor

- Change to Section 40 (Caltrans Concrete Pavement Specification).
- Use innovative practices to accept concrete pavement strength adopted by many other State DOTs.
- Ability to prepare and test more samples due to easier handling and test procedure.

Impediments to Completion of Deliverables

- Unwillingness within Caltrans to approve updated specification.
- Delays due to factors outside the control of the Working Group.
- Unforeseen need for additional resources.

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Scoping Document
Concrete Task Group/ Cast In-Place Pavement Sub-Task Group
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Recommendation and Approval

This scoping document for *Concrete Pavement Acceptance Based on Compressive Strength* 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