ORIGINATION FORM

THE INFORMATION BELOW IS TO BE PROVIDED BY THE ORIGINATOR

X Modify Specification _____4000000SS_____
Section/File number

☐ New Section _____.
Section number

Subject: Classification of Cracks in Concrete Structures to be Sealed.

Origination date: 06/07/06

Originator: Jeffrey A. Pouliotte
Office/Phone: State Construction Office/850-414-1416 (SC 994-4146)
Email address/ Userid: jeffrey.pouliotte@dot.state.fl.us
CN982JP

Problem statement: There is confusion from Contractor, CEI and District Construction Personnel on how to inspect/identify, evaluate, monitor and determine the structural effects of cracks for cast-in-place concrete components; who is responsible for doing the identification and evaluation of cracks; when cracked concrete should be replaced or repaired; how to properly repair cracked concrete; and who is responsible for making these decisions.

Information source: Rodney Powers, Michael Bergin and Ivan Lasa (State Materials Office), Larry Sessions (State Structures Design Office) and John Locke (District Structures and Facilities Engineer, District 3)

Background data: The proposed change to Specification Subsection 400-21 will clarify how to inspect, evaluate, monitor, and repair or replace cracked concrete. Proposed Tables 1 and 2, in conjunction with the proposed change to the Text of 400-21, specifically directs repairs for nonstructural cracked concrete, and the specification change specifically identifies when the Contractor needs to hire a Specialty Engineer to structurally evaluate and develop repairs for cracked concrete components. Also, the elimination of existing Table I in favor of proposed Tables 1 and 2 incorporates the latest thinking in the application of appropriate repair procedures for nonstructural cracks. The revised specification also clarifies the responsibilities of the Contractor and the authority of the Engineer. Finally, the proposed specification change in conjunction with recent changes to

Construction Project Administration Manual Section 10.3 clarifies the administrative process for how to evaluate and remediate cracked concrete components.

Recommended Usage Note: The change to Specification Subsection 400-21is recommended for all future projects.

Expected fiscal impact, if implemented: Negligible.

Implementation of these changes, if and when approved, will begin with the July 2007 letting.

Florida Department of Transportation

JEB BUSH
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

DENVER J. STUTLER, JR.
SECRETARY

M E M O R A N D U M

DATE: December 8, 2006

TO: Specification Review Distribution List

FROM: Duane F. Brautigam, P.E., State Specifications Engineer

SUBJECT: Proposed Specifications Change: **4002100.D01-Disposition of Cracks In Cast-In-Place Concrete**

In accordance with Specification Development Procedures, we are sending you a copy of a proposed new specification change for Disposition of Cracks In Cast-In-Place Concrete.

This change was proposed by Jeffrey Pouliotte of the State Construction Office to clarify how to inspect, evaluate monitor and repair or replace cracked concrete.

Please share this proposal with others within your responsibility. Review comments are due within four weeks and should be sent to Mail Station 75 or to my attention via e-mail at SP965DB or duane.brautigam@dot.state.fl.us. Comments received after January 5, 2007 may not be considered. Your input is encouraged.

DFB/sh

Attachment

COMMENTS: _____

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Submitted by: _____ Phone #: _____

DISPOSITION OF CRACKS IN CAST-IN-PLACE CONCRETE.
(REV ~~7-19-06~~*~~9-28-06~~11-14-0612-8-06*)**

ARTICLE 400-21 (Pages 390 and 391) is deleted and the following substituted:

~~**400-21 Classification of Cracks in Concrete Structures to be Sealed.**~~

~~Cracks are classified as structural and nonstructural. Do not seal or repair structural cracks without having a repair procedure approved in advance by the Engineer. Seal nonstructural cracks in accordance with the criteria listed in Table I below. Structural cracks are those which are induced by external forces which produce internal stresses exceeding the tensile strength of the concrete, commonly referred to as working cracks, and those caused by overloads. Nonstructural cracks are those which appear as a result of atmospheric effects and localized constraint effects, commonly called shrinkage cracks. In any case, the Engineer will determine the classification of cracks.~~

~~Table I~~			
~~Criteria for Sealing Nonstructural Cracks During Construction~~			
~~Environment (*4)~~	~~Crack Width~~	~~Location (*2)~~	~~Treatment (*3) (*1)~~
~~Extremely Aggressive~~	~~Less than 0.006 inch~~	~~Substructure and Superstructure~~	~~Coat with penetrant sealer~~
	~~Greater than 0.006 inch and less than 0.012 inch~~	~~Substructure including Superstructure less than 18 feet above existing ground or high water elevation~~	~~Epoxy injection~~
		~~Superstructure including Substructure more than 18 feet above existing ground or high water elevation~~	~~Coat with penetrant sealer~~
	~~Greater than 0.012 inch and less than 0.025 inch~~	~~Substructure and Superstructure~~	~~Epoxy injection~~
~~Moderately Aggressive~~	~~Less than 0.006 inch~~	~~Substructure and Superstructure~~	~~No treatment~~
	~~Greater than 0.006 inch and less than 0.012 inch~~	~~Substructure including Superstructure less than 18 ft above existing ground or high water elevation~~	~~Coat with penetrant sealer~~
		~~Superstructure including Substructure more than 18 ft above existing ground or high water elevation~~	~~No treatment~~
	~~Greater than 0.012 inch and less than 0.025 inch~~	~~Substructure and Superstructure~~	~~Coat with penetrant sealer~~

~~Table I~~			
~~Criteria for Sealing Nonstructural Cracks During Construction~~			
~~Environment (*4)~~	~~Crack Width~~	~~Location (*2)~~	~~Treatment (*3) (*1)~~
~~Slightly Aggressive~~	~~Less than 0.025 inch~~	~~All locations~~	~~No treatment~~

~~Notes: (*1) Cracks greater than 0.025 inch require individual investigation. Report these cracks to the Engineer for initiation of an investigation.~~
~~(*2) When the substructure crack elevation is 18 feet above the high water elevation or ground level, use the same method of treatment as the superstructure for that environment.~~
~~(*3) (a) Perform epoxy injection of cracks in accordance with Section 411. Apply penetrant sealers in accordance with Section 413.~~
~~(b) Use penetrant sealers to repair cracks that are compatible with previously applied materials.~~
~~(c) Use sealers to repair riding surfaces that are designated for that purpose.~~
~~(d) The Contractor may also repair riding surfaces of bridge decks with a methacrylate sealer for crack widths greater than 0.006 inch in extremely aggressive environments.~~
~~(e) Clean for epoxy injection in compliance with Section 411. Clean for penetrant sealer application in compliance with Section 413.~~
~~(f) Recoat cracks which reopen after the initial application of penetrant sealer with penetrant sealer.~~
~~(*4) Investigate cracks which occur underwater prior to treatment.~~

~~Seal cracks determined by the Engineer to be excessive due to inadequate curing effort or inadequate construction practice at no expense to the Department. Seal all other cracks occurring in concrete in accordance with the above and Sections 411 and 413. When such work is authorized by the Engineer, the Department will pay for the work under the appropriate pay items contained in Sections 411 and 413.~~

~~Prepare the surface, clean the surface, and apply the sealant in accordance with the sealant material manufacturer's recommendations.~~

400-21 Disposition of Cracks in Cast-in-Place Concrete.

400-21.1 General: *The disposition of cracks that develop in cast-in place concrete shall be in accordance with this section.*

400-21.2 Investigation, Documentation and Monitoring: *The Engineer will perform a thorough inspection of the concrete surfaces for cracks. If cracks are found, the Engineer will measure crack lengths and widths. The Engineer will inspect concrete surfaces as soon as surfaces are fully visible after casting, between 7 and 31 days after the component has been burdened with full dead load, and a minimum of 7 days after the bridge has been opened to full unrestricted traffic. The Engineer will measure the width, length, termination points and precise location of all cracks and display, to scale, the results on a drawing referred to as a crack map. After initial inspection, the Engineer will monitor and document the growth of individual cracks at an inspection interval determined by the Engineer. Provide the access, equipment and personnel needed for the Engineer to perform this work.*

400-21.3 Classification of Cracks: *The Engineer will classify cracks as either nonstructural or structural. In general, nonstructural cracks are shallow depth cracks, which form during curing. Structural cracks are cracks that extend beyond the depth of the reinforcing steel, which can form as a result of excessive load or inadequate support conditions during casting or from uncontrolled temperature gradients. The Contractor will be given an opportunity to review and comment on the Engineer's classification of cracks. The Engineer will make the final determination as to whether cracks are nonstructural or structural.*

400-21.3.1 Cracking Significance: *The Engineer will determine the cracking significance on the basis of total crack area as a percentage of concrete surface area. Cracking shall be categorized as Isolated, Occasional, Moderate or Severe according to the criteria in*

Tables 1 and 2. Computations for purposes of determining cracking significance shall be done on a LOT by LOT basis where a LOT is made up of not more than 100 square feet of concrete surface area on bridge substructures, or not more than 400 square feet of bridge deck. Where cracking is localized, the LOT will be reduced to encompass only the immediate area of cracks. Individual evaluation and repairs will be performed on a LOT by LOT basis as directed by the Engineer.

The area to be used in Tables 1 or 2 is the summation of the product of the crack length times the average crack width of all the cracks in a LOT computed in square feet.

The Engineer will identify cracks that are not representative of the overall typical cracking of the LOT(s) and evaluate these separately.

The Contractor will be given an opportunity to review and comment on the Engineer's determination of cracking significance. The Engineer will make the final determination of cracking significance with regard to Tables 1 and 2.

400-21.4 Resolution: *Repair nonstructural cracks in accordance with Tables 1 or 2 where applicable. For disposition of structural cracks provide a structural evaluation and written recommendation by a Specialty Engineer.*

Where Table 1 or 2 requires investigation to determine adequate repair or rejection, either replace the defective concrete or engage a Specialty Engineer to determine the structural and durability significance of the cracking and develop recommended repair methods for approval of the Engineer.

Cracks shown in Table 1 or 2 with no repair methods listed are considered unacceptable and the affected portions of the structure are required to be removed and replaced.

The Engineer will make the final determination of whether the cracked concrete shall be repaired or replaced, and must approve repair methods prior to start of the work.

No additional compensation or contract time shall be allowed for repairing or replacing cracked concrete that was caused by inadequate curing effort or inadequate construction practice as determined by the Engineer.

Table 1
CAST-IN-PLACE SUBSTRUCTURES AND SUPERSTRUCTURES OTHER THAN DECKS

	Crack Width [2] *(inch)*	*Crack Total Area (In Percent of Concrete Surface)* [1]											
		<0.005%			*0.005%-0.017%*			*0.017%-0.029%*			*>0.029%*		
		Isolated			*Occasional*			*Moderate*			*Severe*		
		Environment			*Environment*			*Environment*			*Environment*		
		SA	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*
Elevation 0 to 6 ft AMHW	*x≤0.004*	*NT*	*NT*	*PS*	*NT*	*PS*	*PS*	*PS*	*PS*				
	0.004< x ≤0.008	*NT*	*PS*	*EI*[3]	*PS*	*EI*[3]	*EI*[3]	*PS*					
	0.008< x ≤0.012	*PS*	*PS*	*EI*									
	0.012< x ≤0.016	*PS*	Investigate to Determine Appropriate Repair [4, 5] or Rejection										
	0.016< x ≤0.020												
	0.020< x ≤0.024								Reject and Replace				
	0.024< x ≤0.028												
	0.028< x												
Elevation 6 to 12 ft AMHW	*Crack Width*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*
	x ≤0.004	*NT*	*NT*	*PS*	*NT*	*PS*	*PS*	*PS*	*PS*	*PS*	*PS*		
	0.004< x ≤0.008	*NT*	*PS*	*EI*[3]	*PS*	*PS*	*EI*[3]	*PS*	*EI*[3]				
	0.008< x ≤0.012	*NT*	*PS*	*EI*	*EI*	*EI*							
	0.012< x ≤0.016	*PS*	*EI*	*EI*	*EI*								
	0.016< x ≤0.020	*EI*											
	0.020< x ≤0.024		Investigate to Determine Appropriate Repair [4, 5] or Rejection							Reject and Replace			
	0.024< x ≤0.028												
	0.028< x												
Elevation 12 ft plus AMHW	*Crack Width*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*	*SA*	*MA*	*EA*
	x ≤0.004	*NT*	*NT*	*NT*	*NT*	*PS*	*PS*	*PS*	*PS*	*PS*	*PS*		
	0.004< x ≤0.008	*NT*	*PS*	*PS*	*PS*	*PS*	*EI*[3]	*PS*	*EI*[3]	*EI*[3]	*PS*		
	0.008< x ≤0.012	*NT*	*PS*	*EI*	*EI*	*EI*	*EI*	*EI*	*EI*				
	0.012< x ≤0.016	*PS*	*EI*	*EI*	*EI*	*EI*	*EI*						
	0.016< x ≤0.020	*EI*	*EI*	*EI*	*EI*								
	0.020< x ≤0.024	*EI*	Investigate to Determine Appropriate Repair [4, 5] or Rejection										
	0.024< x ≤0.028									Reject and Replace			
	0.028< x												

Table 2
CAST-IN-PLACE BRIDGE DECK

	Crack Width (2) (inch)	Crack Total Area (In Percent of Concrete Surface) (1)											
		<0.005% Isolated Environment			0.005%-0.017% Occasional Environment			0.017%-0.029% Moderate Environment			>0.029% Severe Environment		
		SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
Up to 12 feet AMHW	x ≤0.004	NT	NT	PS	NT	PS	PS	PS	PS	PS			
	0.004< x ≤0.008	NT	NT	EI/M(3)	NT	PS	EI/M(3)	EI/M(3)	EI/M(3)	EI/M(3)			
	0.008< x ≤0.012	NT	PS	EI/M	PS	EI/M	EI/M	EI/M	EI/M				
	0.012< x ≤0.016	PS	PS	EI/M	PS	EI/M							
	0.016< x ≤0.020	PS	PS	EI	EI								
	0.020 < x ≤0.024	PS	EI	EI	Investigate to Determine Appropriate Repair (4, 5) or Rejection						Reject and Replace		
	0.024< x ≤0.028	PS	EI										
	0.028< x												
12 feet plus AMHW or over Land	Crack Width	SA	MA	EA	SA	MA	EA	SA	MA	EA	SA	MA	EA
	x ≤0.004	NT	NT	PS	NT	NT	PS	PS	PS	PS			
	0.004< x ≤0.008	NT	NT	PS	NT	PS	EI/M(3)	PS	EI/M(3)	EI/M(3)			
	0.008< x ≤0.012	NT	NT	EI/M	PS	PS	EI/M	EI/M	EI/M				
	0.012< x ≤0.016	NT	PS	EI/M	PS	EI/M							
	0.016< x ≤0.020	NT	PS	EI	PS								
	0.020< x ≤0.024	NT	PS	EI	Investigate to Determine Appropriate Repair (4, 5) or Rejection						Reject and Replace		
	0.024< x ≤0.028	NT	PS										
	0.028< x												

PS = Penetrant Sealer
EI = Epoxy Injection
NT = No Treatment
M = Methacrylate
AMHW = Above Mean High Water
SA = Slightly Aggressive
MA = Moderately Aggressive
EA = Extremely Aggressive

Table Notes (Both Tables)

(1) Calculate total crack area by multiplying the average of 3 width measurements on each crack by the length of the crack and adding the results of all the cracks within the designated representative LOT.

(2) Use the average width of all the cracks representative of the LOT to determine the table crack size.

(3) For cracks 0.004 inch to 0.008 inch, determine if injectable. If not injectable, use penetrant sealer or methacrylate as directed by the Engineer.

(4) (a) Perform epoxy injection of cracks in accordance with Section 411. Seal cracks with penetrant sealer or methacrylate as per Section 413. (b) Use methacrylate or penetrant sealer to repair cracks that are compatible with previously applied materials or remove such materials. (c) Use sealers to repair riding surfaces that are designed for that purpose.

(5) Seal the cracks after it has been determined that no additional growth will occur.

(6) Investigate cracks which occur underwater or at elevations below zero to determine appropriate repair.