3460202 STRUCTURAL PORTLAND CEMENT CONCRETE
COMMENTS FROM INTERNAL/INDUSTRY REVIEW

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Comments: (Internal 6-03-20)
What is the background behind the optimized gradation language in 346-2.4.1? When would the Contractor elect to do this?
Response:
Dan,
Thank you for your feedback.
The Contractors can elect this option if their concrete supplier(s) have a concrete facility plant with the technological conditions created. Basically, having a sufficient storage area, suitable bins, conveyors, stockpiles or silos to store and identify at least three different aggregates (sand and two coarse aggregates) without mixing, segregating, degradation or contamination of the different sources or grades. A mixer that can combine all the components of the concrete into a thoroughly mixed and uniform mass is also needed.
Regarding the technical background:
1. The statements below are quoted from the following reference:
Peter Taylor (2015), Blended Aggregates for Concrete Mixture Optimization – Best Practices for Jointed Concrete Pavements, FHWA Tech Brief FHWA-HIF-15-019, July 2015.
Mixtures that have well graded aggregate and are responsive to vibration can lead to significant savings during construction because less effort is required to consolidate and finish the slab and are likely to last longer because less abuse has been applied to the surface to create the required finish.
Another significant benefit of designing a well-graded aggregate system is that the paste content of the mixture can be managed and potentially reduced. Concrete mixtures containing excess paste (i.e., more than is needed for placing and finishing) exhibit numerous undesirable characteristics, including the following:
- Increased shrinkage, which can result in cracking .
- Higher permeability leading to critical saturation of the paste fraction (i.e., lower resistance to freeze-thaw deterioration).
- Higher heat of hydration.
- Increased cost.

Portland cement concrete mixtures used for slipformed pavements should be designed to meet all performance objectives (strength, durability, thickness, smoothness, etc.) and delivered with a workability that produces a nearly vertical edge and minimizes the need for excessive vibration and/or hand finishing (Figure 1). A well graded aggregate system is one tool that can be used to help achieve this aim.
Reducing the paste content of a concrete paving mixture (within limits) through careful management of the aggregate system is therefore desirable for improved performance and at the same time for improved sustainability.

2. The Department has funded two research projects in recent years on this subject:

2.1 Project BDV31-977-47 Mitigation of Cracking in Florida Structural Concrete.
Benefits of optimized aggregate gradation (OAG):

- Improved workability.
- Comparable strengths.
- Lower elastic moduli.
- Can reduce paste content without adversely affecting properties.
- Lower paste contents can increase durability by reducing shrinkage, cracking tendency, and permeability.

2.2 Project BDV31-977-86 Reducing Portland Cement Content and Improving Concrete Durability.
Benefits of optimized aggregate gradation (OAG):
- The cementitious content of typical Florida pavement and structural concrete can be reduced by as much as 10 to 15% or more without loss in workability, decrease in strength and reduction in durability.
- Rapid chloride permeability and surface resistivity tests showed that the permeability of structural concrete decreased as the paste volume of the concrete was reduced.

Please let me know if you have questions.
Thank you.

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Comments: (Internal 6-03-20)
Is there a detailed matrix of what is being changed?
Response: (Daniel Strickland, State Specifications Engineer)
See the attached (above Response) correspondence from Jose at SMO. I think this will help answer your question but let me know otherwise.
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Comments: (Internal 06-09-20)
What is the intent/need for Table 346-6 in 346-4.2.11?
Response:
Table 346-6 in Spec 346-4.2 (11) was created last Specification cycle (July 2020) based on industry review comments (see attached document pages 6 and 7).
Previously existing language in the January 2020 Specification, Section 346-3.3, Item 11 of the list of items to include in the MCCP was the following:
11. Analysis of anticipated thermal developments for the various mass concrete elements for all anticipated ambient temperature ranges.
In the Industry Review Comments for the July 2020 Specification, it was indicated that the phrase “for all anticipated ambient temperature ranges” was confusing and the intent of this

phrase should be clearly stated. It was decided that the clearest way to indicate what was needed was with a table. This table would list the maximum concrete placement temperature allowed for each 10°F ambient temperature increment ranging from 40°F to 99°F. An example table template was also included (current Table 346-6).
The only proposed modification in this cycle (January 2021) is the format of the table. The table number has been added.
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(Industry Comments referenced from pgs. 6-7 above):

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Comments: (11-19-19, Internal)
Page 1 Number 11 needs better wording to define 40F to 100F ambient temperature range.
Since a mass concrete plan is written weeks and months ahead of the actual pours, is the ambient temperature range 40F to 100F based on the start of the placement, or the end of curing, or the average ambient temperature over the curing days required to control the temperatures?
And then there is an execution and enforcement that needs to be right. Even though the ambient temperature right now is 65F, the plan needs to predict the maximum concrete placing temperature based on the anticipated ambient conditions while the concrete cures.
So the ambient temperature range cannot be a variable. For example, the low temperature in Tampa today is 60F, high 72F. Right now the temp is 65F. All of those temperatures are within the 40F to 100F ambient temperature range, so which one would be executed by or enforced on the contractor as far as maximum concrete placing temperature?

I advise using a reference website, like Southeast Regional Climate Center, that has historical ambient temperatures based on monthly average ambient or monthly maximum ambient or monthly minimum ambient. I like the monthly average ambient for modeling the anticipated thermal developments because the daily highs and lows are averaged for a month for as many years as there are records. It is possible for the department to also assign the years into which the average monthly ambient can be assigned. 1981 to 2010 is popular.
Then decide which stations in Florida will be used. The international airports, for example. They usually have good temperature monitoring data that can be used for these applications.

Anyway, that is a lot of wordage for saying that the ambient temperature range 40F to 100F needs to be defined
Response: The concerns were responded during July 2020 specification revision cycle.

Actions: No response is needed for this item and no change is needed in the proposed specification.
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Anthony Mosier
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Comments: (Industry 6-11-20)
The specification for small quantities 346-9.7 is not in proposed changes. Is the intent to Verify all concrete placed?
Response: No applicable.
This item is not related to the proposed Specification changes and it will be included as a

discussion item of the upcoming Concrete Materials Technical Advisory Group (CMTAG) meeting.

Actions: No change is needed in the proposed specification.

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Steven Nolan
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Comments: (Industry 6-11-20)
Please change all instances of fc' to f'c to be consistent with the AASHTO format`
Response: Agree.

Actions: The inconsistencies have been amended in the proposed specification changes.

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Thomas Frank
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Comments: (Industry 6-11-20)
In Table 346-7, the text in the description for FM 5-501 appears that it may be a different font from the rest of the descriptions in the table.
Response: Agree.

Actions: The editorial change has been made by Specification Office. No additional change is needed.

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Comments: (Industry 6-17-20)

a. 346-2.3 Supplementary Cementitious Materials: The following verbiage in parentheses needs to be added back in this section. 346-2.3 Pozzolans and Slag: Fly ash or slag materials are required in all classes of concrete except for the following when used in slightly aggressive environments: Class II 3400, Class I 3000, (and concrete requiring a coloring agent used in slightly aggressive environments. When a concrete requiring a coloring agent is used in a moderately or extremely aggressive environment, slag must be used.) Use fly ash or slag materials as a cement replacement, on an equal weight replacement basis with the following limitations District One and Seven have multiple round-a-bouts that require the use of colored concrete in the truck aprons.
   Response: Not Applicable.
   The comments and suggested changes about concrete coloring are not related to the proposed specification changes.
   The Standard Specifications identify the use of fly ash or slag based on the project's environmental conditions. The use of color is a project specific requirement. Achieving a specified color with fly ash or slag is up to the contractor and producer.
   The need for adding additional language in the Standard Specification concerning the use of color can be discussed at the next Concrete Materials Technical Advisory Group (CMTAG) meeting.

Actions: No change is needed.

b. Subarticle 346-2.4.1 is deleted and the following substituted Not sure why this sub-article needs to be deleted, the subarticle is not in the July 2020 specification, it needs to be added.
Response: Agree.
Currently Subarticle 346-2.4.1 does not exist. The proposed changes should state "expanded" in lieu of "deleted" as described below.

Actions: Change the wording as follow:
"SUBARTICLE 346-2.4.1 is deleted and the following substituted"
to: "SUBARTICLE 346-2.4 is expanded by the following:"

c. Table 346-3 I (Pavement) and Note 3 Should we have slump range of 0 to 3 inches if ASTM C143 has the below statement? ASTM C143 Note 2 states Concrete having slumps less than ½ inch may not be adequately plastic for this test to have significance.
Response: Disagree.
According to Note 5 of Table 346-3 for Class I (Pavement) the slump range will be based on Section 350 (see 350-2 excerpt below):

> For concrete pavement placed using the slip-form method of construction, utilize concrete with a target slump of 1.5 inches plus or minus 1 inch. For concrete pavement placed by hand in constructed forms, utilize concrete with a target slump of 3 inches plus or minus 1.5 inches.

Zero slump concrete is sometimes needed, even with this caution statement in ASTM C143.
In case of a discrepancy between the requirements of ASTM and Department Specifications, the requirement of Department Specifications will govern.
However, if you consider that this aspect should be addressed, it can be included as a discussion item of the upcoming Rigid Pavement Committee (RPC) meeting.

Actions: No change is needed in the proposed specification.

d. Caution should be exercised in interpreting such results. 346-3.4.1 Minimum Cementitious Materials Content: Since 9.2 Volume II Table 1 dated May 15, 2020 has a Maximum Allowable 28-day Compressive Strength requirement for the producers, I do not think there should be a minimum Cementitious content requirement in the specification.
Response: Disagree.
The minimum cementitious materials content has been proposed to meet structural concrete's durability requirements.
There is no contradiction between these two requirements. It is possible to design concrete mixes that meet both.

Actions: No change is needed.

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Comments: (Industry 6-17-20)

a. 346-2.4.1 Optimized Aggregate Gradation: Is there any definition that what aggregate falls into intermediate-size aggregate? Is #89 aggregate a intermediate aggregate?

Response: Not applicable.
The definitions of intermediate size aggregate are described in Appendix B Section 9.2 Volume II of Materials Manual.
Yes, aggregate size # 89 may be considered as an intermediate size aggregate if it meets the other optimized aggregate gradation requirements of Section 9.2.

Actions: No change is needed.

b. 346-3.1 General: As new specification has "maximum allowable strength" for each class and a higher class concrete most probably exceed maximum allowable strength of the specified class concrete, a clarification is needed to exempt that maximum allowable strength is not included in the requirement of the specified class concrete.
Response: Not applicable.
The proposed changes in Section 346 do not include the maximum allowable compressive strength for each class of concrete.
The maximum allowable compressive strength requirements are applicable to all concrete classes and is part of Section 9.2 Volume II of Materials Manual language. The proper mix design will ensure that the concrete strengths will remain within the specified allowable strength range.
Other details and explanations, if needed, may be described in Section 9.2 Volume II of Materials Manual, not in the Standard Specification.

Actions: No change is needed.

c. Table 346-3 Note (6): Maximum allowable strength and 0.35 w/cm limits counteracts each other. In reality, we need to lower w/cm to meet durability requirement (29 kOhm-cm) so that actual strength mostly exceeds the maximum allowable strength for CL IV class in particular for fly ash mixes. If there is a durability requirement for that type of concrete, why there is w/cm limit that is a kind of redundant and that limits flexibility of concrete mix designs.
Response: Disagree.
When a project requires the use of a concrete with a surface resistivity value of 29 kOhm-cm based on the project's the environmental conditions, this criterion has no contradiction with the maximum allowable W/CM ratio of Table 346-3, which ensures and enforces that the concrete meet the durability and strength requirements.
In applications that require a surface resistivity value of 29 kOhm-cm, the State Materials Office will evaluate each requirement on the case by case, based on the data provided by the concrete producer.
Any necessary changes in the maximum allowable compressive strength must be proposed in Section 9.2 Volume II of Materials Manual.

Actions: No change is needed.

d. Table 346-4: This is confusing as FDOT just removed minimum cementitious materials content and included maximum allowable strength. Here are concerns: - Why don't we just put previously existent minimum materials content, which at least have different levels of limits depending on concrete class. This new limitation doesn't consider concrete class. Therefore, low class mixes such as CL I may not meet and not be used for extremely or moderately aggressive environmental classification. This is very serious issue to us! - Note mention that

the Engineer may allow a lower total amount of cementitious materials content in concrete Class I, II and III. The Engineer's approval is very cumbersome to get it in a timely manner. All burdens related to this topic will come to concrete producers as contractors want to get away from any issues. FDOT specifications and modifications need to stay "Be consistent". This makes all to be confused what FDOT wants to do.
Response: Disagree.
The “Minimum Total Cementitious Materials Content” in the current Specification 346 needs to be revised. Cementitious materials have significantly improved their quality in recent years, and it is no longer necessary to maintain those minimum levels that were established years ago.
With the new approach based on durability, all approved concrete mix designs can be used if they meet the requirements of footnote (1) of Table 346-4.
Concrete mixes to be used in a project must be included in the approved QC plan approved before the start of project. This process is not cumbersome.
The Department has generally discussed the changes with the industry, before proposing them to the State Specification Office.

Actions: No change is needed.

e. 346-3.4.3 Surface Resistivity Test: Please clarify what a highly reactive pozzolan is or at least what materials fall into a highly reactive pozzolan. The surface resistivity requirement is set to secure certain period of service life such as 75 or 100 yrs. The service life model is mostly related to rebar corrosion. Can we simply use corrosion inhibitor to meet the same purpose and is there any FDOT's stand about "Corrosion inhibitor" vs. "Surface resistivity"
Response: Not Applicable.
   1. Clarification of highly reactive pozzolan already exists in Specification Section 346-2.3.1 as well as in Table 346-2. The detailed description of each highly reactive pozzolan is described in Specification Section 929, article 929-4 Highly Reactive Pozzolans.
   2. The Department does not object to using a corrosion inhibitor, however the long-term effectiveness of such products has not been determined and no correlation exists between the two, as such corrosion inhibitor cannot be used in lieu of a mix that meets the required surface resistively value. The FDOT Standard Specifications require that the concrete mix must meet the surface resistivity requirement. The corrosion inhibitor may be used when contract documents allow its use. No data is available regarding the service life extension of the structure due to the use of corrosion inhibitor.

   Actions: No change is needed.

f. Table 346-8, Note (1): Is this Type II cement? Please clarify.
Response: Disagree.
Note (1) states “When a water-reducing and retarding admixture (Type D, Type G, or Type II) is used”. In this case Type II refers to an admixture, Plasticizing and Retarding (reference Specification Section 924).

   Actions: No change is needed.

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Anonymous

Comments: (Industry 6-26-20)

a. 346-2.3.3 Ternary Concrete Mixes: Tables 346-2 and 346-4 break across 2 pages, but it's just the notes. Omitting the header information would remove clutter and make the table easier to read. Also, there's a blank line between notes 3 and 4 in table 346-2, and the formatting is different for the word "Notes" in table 346-4 (centered instead of left-aligned).
Response: The editorial change has been made by Specification Office.

Actions: No additional change is needed.

b. 346-3.3 Master Proportion Table: The subsection heading is "Master Proportion Table," but the table is not labeled as the "Master Proportion Table." It's labeled as "Structural Concrete Class, Compressive Strength, Water to Cementitious Materials Ratio and Slump."
Response: Agree.
The subsection heading "Master Proportion Table" is the current wording used.
New Table 346-3 combine Tables 3 and 4. Table 346-3 label should be "Master Proportion Table".

Actions: Table 346-3 label will be modified. The title "Structural Concrete Class, Compressive Strength, Water to Cementitious Materials Ratio and Slump" will be changed to "Master Proportion Table".

c. 346-3.4.1 Minimum Cementitious Materials Content: Ensure that the produced concrete meet the minimum amount of cementitious materials content in Table 346-4. "Meets" should be pluralized.
Response: Agree.

Actions: In the first sentence of 346-3.4.1, change the word "meet" to "meets".

d. 346-4.23.3 Mass Concrete: Below Table 346-6: "Do not place concrete until the proposed MCCP has been approved …" has been is passive voice, replace with "… MCCP is approved …"
Response: Agree.

Actions: The words "has been approved" will be changed to "is approved".

e. 346-10 Investigation of Low Strength Concrete and Structural Adequacy. 2. At the Engineer's discretion, obtain drilled core samples … to determine the in-place strength of the LOT of concrete in question … The Engineer will determine whether to allow coring of the in-place concrete or require an engineering analysis based on the compressive strength of the test cylinders. There is no criteria included other than the statement "… based on the compressive strength of the test cylinders." This encourages inconsistent rulings. Suggest adding compressive strength criteria to base this judgment upon.
Response: Disagree.

Yes, that is the intent. The Engineer will decide whether core sample should be taken or not. The Engineer's decision is based on the concrete's location in the structure, the amount of compressive strength reduction below the specified minimum compressive strength amongst other factors.

Actions: No change is needed.

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Comments: (Industry 6-29-20)
Hello, I have an inquiry in regards to the use of Mass Concrete and table 346-2. Is the use of mass concrete mix designs permitted in non- 'mass concrete' situations and placements? If so, than why do general use concrete mixes limit fly ash to 30% when mass concrete fly ash can have as much as 50%, according to table 346-2. Those are my only inquiries. Thank you.

Response: Not Applicable.
Mass concrete mixes are not allowed for general use concrete.

Actions: No change is needed.