Florida Department of Transportation

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KEVIN J. THIBAULT, P.E.
SECRETARY

January 9, 2020

Khoa Nguyen
Director, Office of Technical Services
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

Re: State Specifications Office
Section: **346**
Proposed Specification: **3460301 Structural Portland Cement Concrete.**

Dear Mr. Nguyen:

We are submitting, for your approval, two copies of the above referenced Supplemental Specification.

The changes are proposed by Jose Armenteros from the State Materials Office to add durability of concrete, move language to the Materials Manual, and clarify the penalties for not obtaining the specified minimum compressive strength.

Please review and transmit your comments, if any, within two weeks. Comments should be sent via email to daniel.strickland@dot.state.fl.us.

If you have any questions relating to this specification change, please call me at 414-4130.

Sincerely,

Signature on file

Daniel Strickland, P.E.
State Specifications Engineer

DS/rf
Attachment
cc: Florida Transportation Builders' Assoc.
State Construction Engineer

STRUCTURAL PORTLAND CEMENT CONCRETE
(REV 1~~1~~-7~~20~~-20~~19~~)

SUBARTICLE 346-3.1 is deleted and the following substituted:

346-3 Classification, Strength, Slump and Air Content.

346-3.1 General: The classifications of concrete covered by this Section are designated as Class I, Class I Pavement, Class II, Class II Bridge Deck, Class III, Class III Seal, Class IV, Class IV Drilled Shaft, Class V, Class V Special, Class VI, and Class VII. Strength and slump are specified in Table 3. The required air content for all classes of concrete is less than or equal to 6.0%.

Substitution of a higher class concrete in lieu of a lower class concrete may be allowed when the substituted concrete mixes are included as part of the QC Plan, or for precast concrete, the Precast Concrete Producer QC Plan. The substituted higher class concrete must meet or exceed the requirements of the lower class concrete and both classes must contain the same types of mix ingredients. When the compressive strength acceptance data is less than the minimum compressive strength of the higher design mix, notify the Engineer. Acceptance is based on the requirements in Table 3 for the lower class concrete. Do not place concrete with a slump more than plus or minus 1.5 inches from the target slump value specified in Table 3.

~~When a highly reactive pozzolan, or a ternary blend is used in Class IV, Class V, Class V (Special), Class VI, or Class VII concrete, ensure that the concrete meets or exceeds a resistivity of 29 kOhm-cm at 28 days, when tested in accordance with AASHTO T358. Submit three 4 x 8 inch cylindrical test specimens to the Engineer for resistivity testing before mix design approval. Take the resistivity test specimens from the concrete of the laboratory trial batch or from the field trial batch of at least 3 cubic yards. Verify the mix proportioning of the design mix and take representative samples of trial batch concrete for the required plastic and hardened property tests. Cure the field trial batch specimens according to the standard laboratory curing methods. Submit the resistivity test specimens at least 7 calendar days prior to the scheduled 28 day test. The average resistivity of the three cylinders, eight readings per cylinder, is an indicator of the permeability of the concrete mix.~~

TABLE 3
Structural Concrete Class, Compressive Strength, and Slump

Class of Concrete	28-day Specified Minimum Compressive Strength (f_c') (psi)	Target Slump Value (inches) (c)
I [(a)]	3,000	3 [(b)]
I (Pavement)	3,000	2
II [(a)]	3,400	3 [(b)]
II (Bridge Deck)	4,500	3 [(b)]
III [(d)]	5,000	3 [(b)]
III (Seal)	3,000	8
IV	5,500	3 [(b)]
IV (Drilled Shaft)	4,000	8.5
V (Special)	6,000	3 [(b)]

V	6,500	3 (b)
VI	8,500	3 (b)
VII	10,000	3 (b)

(a) For precast three-sided culverts, box culverts, endwalls, inlets, manholes and junction boxes, the target slump value and air content will not apply. The maximum allowable slump is 6 inches, except as noted in (b). The Contractor is permitted to use concrete meeting the requirements of ASTM C478 4,000 psi in lieu of Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.
(b) The Engineer may allow a maximum target slump of 7 inches when a Type F, G, I or II admixture is used. When flowing concrete is used, the target slump is 9 inches.
(c) For a reduction in the target slump for slip-form operations, submit a revision to the mix design to the Engineer. The target slump for slip-form mix is 1.50 inches.
(d) When precast three-sided culverts, box culverts, endwalls, inlets, manholes or junction boxes require a Class III concrete, the minimum cementitious materials content is 470 pounds per cubic yard. Do not apply the air content range and the maximum target slump shall be 6 inches, except as allowed in (b).

SUBARTICLE 346-4.1 is deleted and the following substituted:

346-4 Composition of Concrete.

346-4.1 Master Proportion Table: Proportion the materials used to produce the various classes of concrete in accordance with Table 4:

TABLE 4
Concrete Master Proportions

Class of Concrete	Minimum Total Cementitious Materials Content pounds per cubic yard *	Maximum Water to Cementitious Materials Ratio pounds per pounds**
I	470	0.53
I (Pavement)	470	0.50
II	470	0.53
II (Bridge Deck)	611	0.44
III	611	0.44
III (Seal)	611	0.53
IV	658	0.41***
IV (Drilled Shaft)	658	0.41
V (Special)	752	0.37***
V	752	0.37***
VI	752	0.37***
VII	752	0.37***

* A lower total cementitious materials content may be used provided the plastic, hardened, and durability properties meet the requirements of this Section.
** The calculation of the water to cementitious materials ratio (w/cm) is based on the total cementitious material including cement and any supplementary cementitious materials that are used in the mix.
*** When silica fume or metakaolin is used, the maximum water to cementitious material ratio will be 0.35. When ultrafine fly ash is used, the maximum water to cementitious material ratio will be 0.30.

346-4.2 ~~Chloride Content Limits~~Durability for Concrete Construction:

346-4.2.1 Chloride Content Limits~~General~~: Use the following maximum chloride content limits for the concrete application and/or exposure environment shown:

TABLE 5
Chloride Content Limits for Concrete Construction

Application/Exposure Environment		Maximum Allowable Chloride Content, pounds per cubic yard
Non-Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

If chloride test results exceed the limits of Table 5, suspend concrete placement immediately for every mix design represented by the failing test results, until corrective measures are made. Submit an Engineering Analysis Scope in accordance with 6-4 by a Specialty Engineer knowledgeable in the areas of corrosion and corrosion control, to determine if the material meets the intended service life of the structure on all concrete produced from the mix design failing chloride test results to the previous passing test results.

346-4.2.2 Surface Resistivity Test~~Control Level for Corrective Action~~: ~~If chloride test results exceed the limits of Table 5, suspend concrete placement immediately for every mix design represented by the failing test results, until corrective measures are made. Submit an Engineering Analysis Scope in accordance with 6-4 by a Specialty Engineer knowledgeable in the areas of corrosion and corrosion control, to determine if the material meets the intended service life of the structure on all concrete produced from the mix design failing chloride test results to the previous passing test results.~~Ensure that the concrete meets or exceeds a resistivity of 29 kOhm-cm at 28 days, when a highly reactive pozzolan, or a ternary blend is used in Class IV, Class V, Class V (Special), Class VI, or Class VII concrete.

SUBARTICLE 346-6.2 is deleted and the following substituted:

346-6.2 Concrete Design Mix: Provide concrete that has been produced in accordance with a Department approved design mix, in a uniform mass free from balls and lumps.

For slump target values in excess of 6 inches, including flowing and self consolidating concrete, utilize a grate over the conveyance equipment to capture any lumps or balls that may be present in the mix. The grate must cover the entire opening of the conveyance equipment and have an opening that is a maximum of 2-1/2 inches in any one direction. Remove the lumps or balls from the grate and discard them. Discharge the concrete in a manner satisfactory to the Engineer. Perform demonstration batches to ensure complete and thorough placements in complex elements, when requested by the Engineer.

Do not place concretes of different compositions such that the plastic concretes may combine, except where the Plans require concrete with a surface resistivity value of 29 kOhm-cm or below and one with higher than 29 kOhm-cm values in a continuous placement. Produce these concretes using separate mix designs ~~mixes~~. For example, designate the mix with

calcium nitrite as the original mix and the mix without calcium nitrite as the redesigned mix. Ensure that both mixes contain the same cement, fly ash or slag, coarse and fine aggregates and admixtures. Submit both mixes for approval as separate mix designs, both meeting all requirements of this Section. Ensure that the redesigned mix exhibits plastic and hardened qualities which are additionally approved by the Engineer as suitable for placement with the original mix. The Engineer will approve the redesigned mix for commingling with the original mix and for a specific project application only. Alternately, place a construction joint at the location of the change in concretes as approved by the Engineer.

ARTICLE 346-10 is deleted and the following substituted:

346-10 Investigation of Low Strength Concrete and Structural Adequacy.

346-10.1 General: The following applies for concrete that does not meet the minimum specified compressive strength of Table 3.

For standard molded and cured strength cylinders, the compressive strength of concrete is satisfactory provided that the two following criteria are met:

1. The average compressive strength does not fall below the specified minimum compressive strength by more than:

a. 500 psi if the specified minimum compressive strength is equal to or less than 5,000 psi.

b. 10% of the specified minimum compressive strength if the specified minimum compressive strength is greater than 5,000 psi.

2. The average compressive strength with the previous two LOTs equal or exceed the specified minimum compressive strength. This condition only applies if there are two previous LOTs to calculate the average.

The Engineer will consider the concrete for a given LOT as structurally adequate and coring will not be allowed when a concrete compressive strength test result falls below the specified minimum strength but has met the above conditions.

When a concrete compressive strength test result falls below the specified minimum strength, and does not meet the above conditions, perform one of the following options:

1. Submit an Engineering Analysis Scope in accordance with 6-4 to establish structural and durability adequacy. When the scope is approved by the Engineer, submit an Engineering Analysis Report (EAR) in accordance with 6-4 that includes a full structural analysis. If the results of the structural analysis indicate adequate strength to serve its intended purpose with adequate durability, and is approved by the Engineer, the Contractor may leave the concrete in place subject to the requirements of 346-11, otherwise, remove and replace the LOT of concrete in question at no additional expense to the Department.

2. At the Engineer's discretion, obtain drilled core samples as specified in this Section~~346-10.3~~ to determine the in-place strength of the LOT of concrete in question, at no additional expense to the Department. The Engineer will determine whether to allow coring or require an engineering analysis.

~~Obtain and test the cores in accordance with ASTM C42. Test the cores after obtaining the samples within seven calendar days and report the data to the Engineer within 14 calendar days of the 28-day compressive strength tests.~~

~~Core strength test results obtained from the structure will be accepted by both the Contractor and the Department as the in-place strength of the LOT of concrete in question. The core strength test results will be final and used in lieu of the cylinder strength test results for determination of structural adequacy and any pay adjustment. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. This will be accepted as the actual measured value. Obtain the Engineer's approval before taking any core samples.~~

346-10.2 ~~—~~Coring for Determination of Structural Adequacy: Core strength test results obtained from the structure will be accepted by both the Contractor and the Department as the in-place strength of the LOT of concrete in question. The core strength test results will be used in lieu of the cylinder strength test results for determination of structural adequacy. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. This will be accepted as the actual measured value.

Obtain the Engineer's written approval before taking any core samples. Notify the Engineer 48 hours prior to taking core samples. Obtain and test the cores in accordance with ASTM C42. Report the test results to the Engineer within seven calendar days of the Engineer's written approval. The Engineer will select the size and location of the drilled cores so that the structure is not impaired and does not sustain permanent damage after repairing the core holes. Sample three undamaged cores taken from the same approximate location where the questionable concrete is represented by the low strength concrete test cylinders. Repair core holes after samples are taken with a product in compliance with Section 930 or 934 and meeting the approval of the Engineer.

~~For cores tested no later than 42 calendar days after the concrete was cast, the Engineer will accept the core strengths obtained as representing the equivalent 28-day strength of the LOT of concrete in question. The Engineer will calculate the strength value to be the average of the compressive strengths of the three individual cores. The Engineer will accept this strength at its actual measured value.~~

~~For cores tested later than 42 calendar days after the concrete was cast, the Engineer will establish the equivalency between 28-day strength and strength at ages after 42 calendar days. The Engineer will relate the strength at the actual test age to the 28-day strength for the design mix represented by the cores using appropriate strength-time correlation equations.~~

The Engineer with input from the District Materials Office, will consider the concrete as structurally adequate, in area represented by core tests at the actual test age, if the average compressive strength of cores does not fall below the specified minimum compressive strength by more than:

a. 500 psi when the specified minimum compressive strength is equal to or less than 5,000 psi.

b. 10% of the specified minimum compressive strength when the specified minimum compressive strength is greater than 5,000 psi.

The Engineer may also require the Contractor to perform additional testing as necessary to determine structural adequacy of the concrete.

ARTICLE 346-11 is deleted and the following substituted:

346-11 Pay Adjustments for Low Compressive Strength Concrete.

346-11.1 General: For any LOT of concrete failing to meet the specified minimum strength as defined in 346-3, 346-9, 346-10 and satisfactorily meeting all other requirements of the Contract Documents, including structural adequacy, the Engineer will individually reduce the price of each low strength LOT in accordance with this Section.

346-11.2 Basis for Pay Adjustments: The Engineer will determine payment reductions based on the 28 day compressive strength, represented by either acceptance compressive strength or correlated cores strength test results based on the following criteria:

1. When the ~~an~~ acceptance compressive strength test result falls below the specified minimum compressive strength, but no more than the limits established in 346-10.1 below the specified minimum strength, ~~core samples may be obtained from the respective LOT of concrete represented by the low acceptance strength test result for determining pay adjustments.~~ do not core hardened concrete for determining pay adjustments. Use the acceptance compressive strength.

2. When the acceptance compressive strength test result falls below the specified minimum compressive strength by more than the limits established in 346-10.1, the structure may be cored for determination of structural adequacy as directed by the Engineer. Use the result of the 28 day correlated core compressive strength or the acceptance compressive strength test, whichever is less.

-A price adjustment will be applied to the certified invoice price the Contractor paid for the concrete or the precast product.

The Engineer will relate the strength at the actual test age to the 28 day strength for the design mix represented by the cores using appropriate strength time correlation equations.

~~Do not core hardened concrete for determining pay adjustments when the 28 day acceptance cylinder strength test results fall below the specified minimum strength by no more than the limits established in 346-10.1.~~

~~The results of strength tests of the drilled cores, subject to this Section, will be used as the acceptance results and will be used in place of the cylinder strength test results for determining pay adjustments.~~

In precast concrete operations, excluding prestressed concrete, ensure that the producer submits acceptable core sample test results to the Engineer. The producer may elect to use the products in accordance with this Section. Otherwise, replace the concrete in question at no additional cost to the Department. For prestressed concrete, core sample testing is not allowed for pay adjustment. The results of the cylinder strength tests will be used to determine material acceptance and pay adjustment.

346-11.3 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete accepted by the Department. The 28-day strength is represented by either cylinders or correlated cores strength test results in accordance with 346-11.2.

Reduction in Pay is equal to the reduction in percentage of concrete compressive strength below the specified minimum strength:

$$\text{Reduction in Pay (\%)} = \left(\frac{f_c' - \text{28 day Strength}}{f_c'}\right) 100$$

For the elements that payments are based on the per foot basis, the Engineer will adjust the price reduction from cubic yards basis to per foot basis, determine the total linear feet of the elements that are affected by low strength concrete samples and apply the adjusted price reduction accordingly.

STRUCTURAL PORTLAND CEMENT CONCRETE
(REV 1-7-20)

SUBARTICLE 346-3.1 is deleted and the following substituted:

346-3 Classification, Strength, Slump and Air Content.

346-3.1 General: The classifications of concrete covered by this Section are designated as Class I, Class I Pavement, Class II, Class II Bridge Deck, Class III, Class III Seal, Class IV, Class IV Drilled Shaft, Class V, Class V Special, Class VI, and Class VII. Strength and slump are specified in Table 3. The required air content for all classes of concrete is less than or equal to 6.0%.

Substitution of a higher class concrete in lieu of a lower class concrete may be allowed when the substituted concrete mixes are included as part of the QC Plan, or for precast concrete, the Precast Concrete Producer QC Plan. The substituted higher class concrete must meet or exceed the requirements of the lower class concrete and both classes must contain the same types of mix ingredients. When the compressive strength acceptance data is less than the minimum compressive strength of the higher design mix, notify the Engineer. Acceptance is based on the requirements in Table 3 for the lower class concrete. Do not place concrete with a slump more than plus or minus 1.5 inches from the target slump value specified in Table 3.

TABLE 3
Structural Concrete Class, Compressive Strength, and Slump

Class of Concrete	28-day Specified Minimum Compressive Strength (f_c') (psi)	Target Slump Value (inches) (c)
I [(a)]	3,000	3 [(b)]
I (Pavement)	3,000	2
II [(a)]	3,400	3 [(b)]
II (Bridge Deck)	4,500	3 [(b)]
III [(d)]	5,000	3 [(b)]
III (Seal)	3,000	8
IV	5,500	3 [(b)]
IV (Drilled Shaft)	4,000	8.5
V (Special)	6,000	3 [(b)]
V	6,500	3 [(b)]
VI	8,500	3 [(b)]
VII	10,000	3 [(b)]

(a) For precast three-sided culverts, box culverts, endwalls, inlets, manholes and junction boxes, the target slump value and air content will not apply. The maximum allowable slump is 6 inches, except as noted in (b). The Contractor is permitted to use concrete meeting the requirements of ASTM C478 4,000 psi in lieu of Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.
(b) The Engineer may allow a maximum target slump of 7 inches when a Type F, G, I or II admixture is used. When flowing concrete is used, the target slump is 9 inches.
(c) For a reduction in the target slump for slip-form operations, submit a revision to the mix design to the Engineer. The target slump for slip-form mix is 1.50 inches.
(d) When precast three-sided culverts, box culverts, endwalls, inlets, manholes or junction boxes require a Class III concrete, the minimum cementitious materials content is 470 pounds per cubic yard. Do not apply the air content range and the maximum target slump shall be 6 inches, except as allowed in (b).

SUBARTICLE 346-4.1 is deleted and the following substituted:

346-4 Composition of Concrete.

346-4.1 Master Proportion Table: Proportion the materials used to produce the various classes of concrete in accordance with Table 4:

TABLE 4
Concrete Master Proportions

Class of Concrete	Minimum Total Cementitious Materials Content pounds per cubic yard *	Maximum Water to Cementitious Materials Ratio pounds per pounds**
I	470	0.53
I (Pavement)	470	0.50
II	470	0.53
II (Bridge Deck)	611	0.44
III	611	0.44
III (Seal)	611	0.53
IV	658	0.41***
IV (Drilled Shaft)	658	0.41
V (Special)	752	0.37***
V	752	0.37***
VI	752	0.37***
VII	752	0.37***

* A lower total cementitious materials content may be used provided the plastic, hardened, and durability properties meet the requirements of this Section.
** The calculation of the water to cementitious materials ratio (w/cm) is based on the total cementitious material including cement and any supplementary cementitious materials that are used in the mix.
*** When silica fume or metakaolin is used, the maximum water to cementitious material ratio will be 0.35. When ultrafine fly ash is used, the maximum water to cementitious material ratio will be 0.30.

346-4.2 Durability for Concrete Construction:

346-4.2.1 Chloride Content Limits: Use the following maximum chloride content limits for the concrete application and/or exposure environment shown:

TABLE 5 Chloride Content Limits for Concrete Construction		
Application/Exposure Environment		Maximum Allowable Chloride Content, pounds per cubic yard
Non-Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

If chloride test results exceed the limits of Table 5, suspend concrete placement immediately for every mix design represented by the failing test results, until corrective measures are made. Submit an Engineering Analysis Scope in accordance with 6-4 by a Specialty Engineer knowledgeable in the areas of corrosion and corrosion control, to determine if the material meets the intended service life of the structure on all concrete produced from the mix design failing chloride test results to the previous passing test results.

346-4.2.2 Surface Resistivity Test: Ensure that the concrete meets or exceeds a resistivity of 29 kOhm-cm at 28 days, when a highly reactive pozzolan, or a ternary blend is used in Class IV, Class V, Class V (Special), Class VI, or Class VII concrete.

SUBARTICLE 346-6.2 is deleted and the following substituted:

346-6.2 Concrete Design Mix: Provide concrete that has been produced in accordance with a Department approved design mix, in a uniform mass free from balls and lumps.

For slump target values in excess of 6 inches, including flowing and self consolidating concrete, utilize a grate over the conveyance equipment to capture any lumps or balls that may be present in the mix. The grate must cover the entire opening of the conveyance equipment and have an opening that is a maximum of 2-1/2 inches in any one direction. Remove the lumps or balls from the grate and discard them. Discharge the concrete in a manner satisfactory to the Engineer. Perform demonstration batches to ensure complete and thorough placements in complex elements, when requested by the Engineer.

Do not place concretes of different compositions such that the plastic concretes may combine, except where the Plans require concrete with a surface resistivity value of 29 kOhm-cm or below and one with higher than 29 kOhm-cm values in a continuous placement. Produce these concretes using separate mix designs. For example, designate the mix with calcium nitrite as the original mix and the mix without calcium nitrite as the redesigned mix. Ensure that both mixes contain the same cement, fly ash or slag, coarse and fine aggregates and admixtures. Submit both mixes for approval as separate mix designs, both meeting all requirements of this Section. Ensure that the redesigned mix exhibits plastic and hardened qualities which are additionally approved by the Engineer as suitable for placement with the original mix. The Engineer will approve the redesigned mix for commingling with the original mix and for a specific project application only. Alternately, place a construction joint at the location of the change in concretes as approved by the Engineer.

ARTICLE 346-10 is deleted and the following substituted:

346-10 Investigation of Low Strength Concrete and Structural Adequacy.

346-10.1 General: The following applies for concrete that does not meet the minimum specified compressive strength of Table 3.

For standard molded and cured strength cylinders, the compressive strength of concrete is satisfactory provided that the two following criteria are met:

1. The average compressive strength does not fall below the specified minimum compressive strength by more than:

a. 500 psi if the specified minimum compressive strength is equal to or less than 5,000 psi.

b. 10% of the specified minimum compressive strength if the specified minimum compressive strength is greater than 5,000 psi.

2. The average compressive strength with the previous two LOTs equal or exceed the specified minimum compressive strength. This condition only applies if there are two previous LOTs to calculate the average.

The Engineer will consider the concrete for a given LOT as structurally adequate and coring will not be allowed when a concrete compressive strength test result falls below the specified minimum strength but has met the above conditions.

When a concrete compressive strength test result falls below the specified minimum strength, and does not meet the above conditions, perform one of the following options:

1. Submit an Engineering Analysis Scope in accordance with 6-4 to establish structural and durability adequacy. When the scope is approved by the Engineer, submit an Engineering Analysis Report (EAR) in accordance with 6-4 that includes a full structural analysis. If the results of the structural analysis indicate adequate strength to serve its intended purpose with adequate durability, and is approved by the Engineer, the Contractor may leave the concrete in place subject to the requirements of 346-11, otherwise, remove and replace the LOT of concrete in question at no additional expense to the Department.

2. At the Engineer's discretion, obtain drilled core samples as specified in this Section to determine the in-place strength of the LOT of concrete in question, at no additional expense to the Department. The Engineer will determine whether to allow coring or require an engineering analysis.

346-10.2 Coring for Determination of Structural Adequacy: Core strength test results obtained from the structure will be accepted by both the Contractor and the Department as the in-place strength of the LOT of concrete in question. The core strength test results will be used in lieu of the cylinder strength test results for determination of structural adequacy. The Department will calculate the strength value to be the average of the compressive strengths of the three individual cores. This will be accepted as the actual measured value.

Obtain the Engineer's written approval before taking any core samples. Notify the Engineer 48 hours prior to taking core samples. Obtain and test the cores in accordance with ASTM C42. Report the test results to the Engineer within seven calendar days of the Engineer's written approval. The Engineer will select the size and location of the drilled cores so that the structure is not impaired and does not sustain permanent damage after repairing the core holes. Sample three undamaged cores taken from the same approximate location where the questionable concrete is represented by the low strength concrete test cylinders. Repair core

holes after samples are taken with a product in compliance with Section 930 or 934 and meeting the approval of the Engineer.

The Engineer with input from the District Materials Office, will consider the concrete as structurally adequate, in area represented by core tests at the actual test age, if the average compressive strength of cores does not fall below the specified minimum compressive strength by more than:

a. 500 psi when the specified minimum compressive strength is equal to or less than 5,000 psi.

b. 10% of the specified minimum compressive strength when the specified minimum compressive strength is greater than 5,000 psi.

The Engineer may also require the Contractor to perform additional testing as necessary to determine structural adequacy of the concrete.

ARTICLE 346-11 is deleted and the following substituted:

346-11 Pay Adjustments for Low Compressive Strength Concrete.

346-11.1 General: For any LOT of concrete failing to meet the specified minimum strength as defined in 346-3, 346-9, 346-10 and satisfactorily meeting all other requirements of the Contract Documents, including structural adequacy, the Engineer will individually reduce the price of each low strength LOT in accordance with this Section.

346-11.2 Basis for Pay Adjustments: The Engineer will determine payment reductions based on the 28 day compressive strength, represented by either acceptance compressive strength or correlated cores strength test results based on the following criteria:

1. When the acceptance compressive strength test result falls below the specified minimum compressive strength, but no more than the limits established in 346-10.1 below the specified minimum strength, do not core hardened concrete for determining pay adjustments. Use the acceptance compressive strength.

2. When the acceptance compressive strength test result falls below the specified minimum compressive strength by more than the limits established in 346-10.1, the structure may be cored for determination of structural adequacy as directed by the Engineer. Use the result of the 28 day correlated core compressive strength or the acceptance compressive strength test, whichever is less.

A price adjustment will be applied to the certified invoice price the Contractor paid for the concrete or the precast product.

The Engineer will relate the strength at the actual test age to the 28 day strength for the design mix represented by the cores using appropriate strength time correlation equations.

In precast concrete operations, excluding prestressed concrete, ensure that the producer submits acceptable core sample test results to the Engineer. The producer may elect to use the products in accordance with this Section. Otherwise, replace the concrete in question at no additional cost to the Department. For prestressed concrete, core sample testing is not allowed for pay adjustment. The results of the cylinder strength tests will be used to determine material acceptance and pay adjustment.

346-11.3 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete accepted by the Department. The 28-day strength is represented by either cylinders or correlated cores strength test results in accordance with 346-11.2.

Reduction in Pay is equal to the reduction in percentage of concrete compressive strength below the specified minimum strength:

$$\text{Reduction in Pay (\%)} = \left(\frac{f_c' - \text{28 day Strength}}{f_c'}\right) 100$$

For the elements that payments are based on the per foot basis, the Engineer will adjust the price reduction from cubic yards basis to per foot basis, determine the total linear feet of the elements that are affected by low strength concrete samples and apply the adjusted price reduction accordingly.