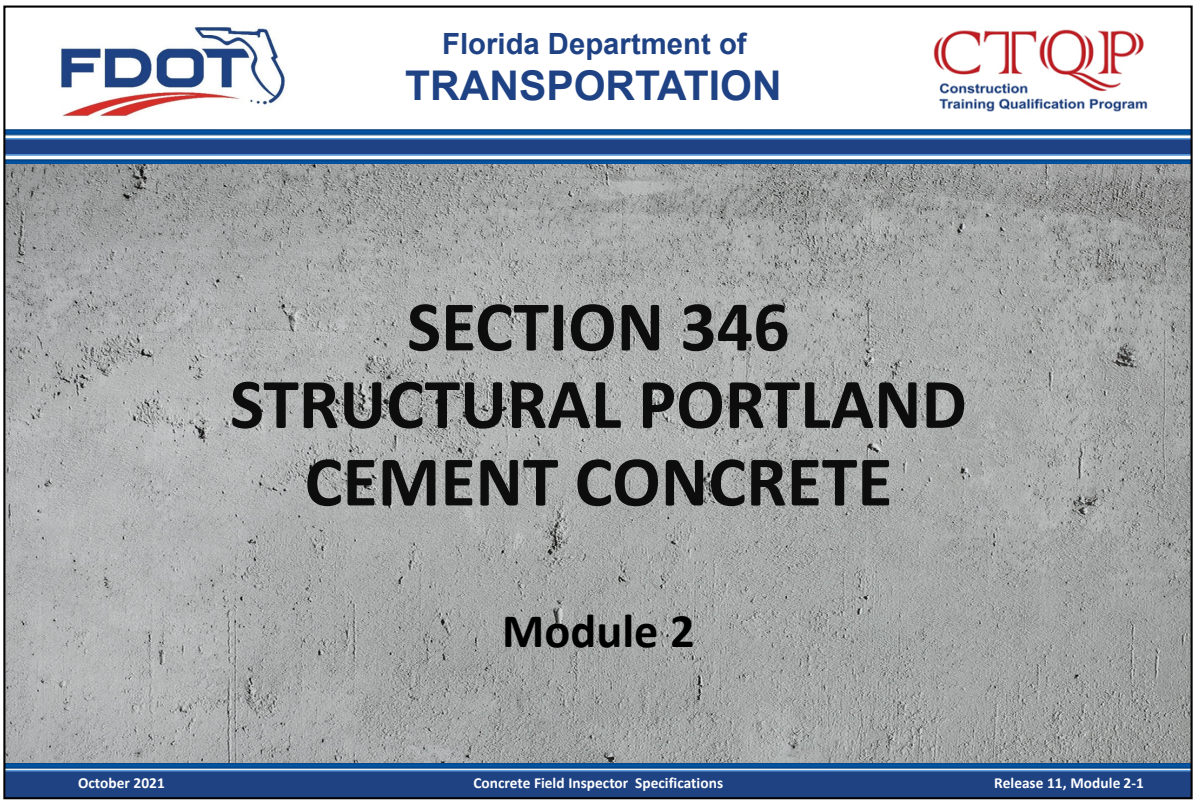
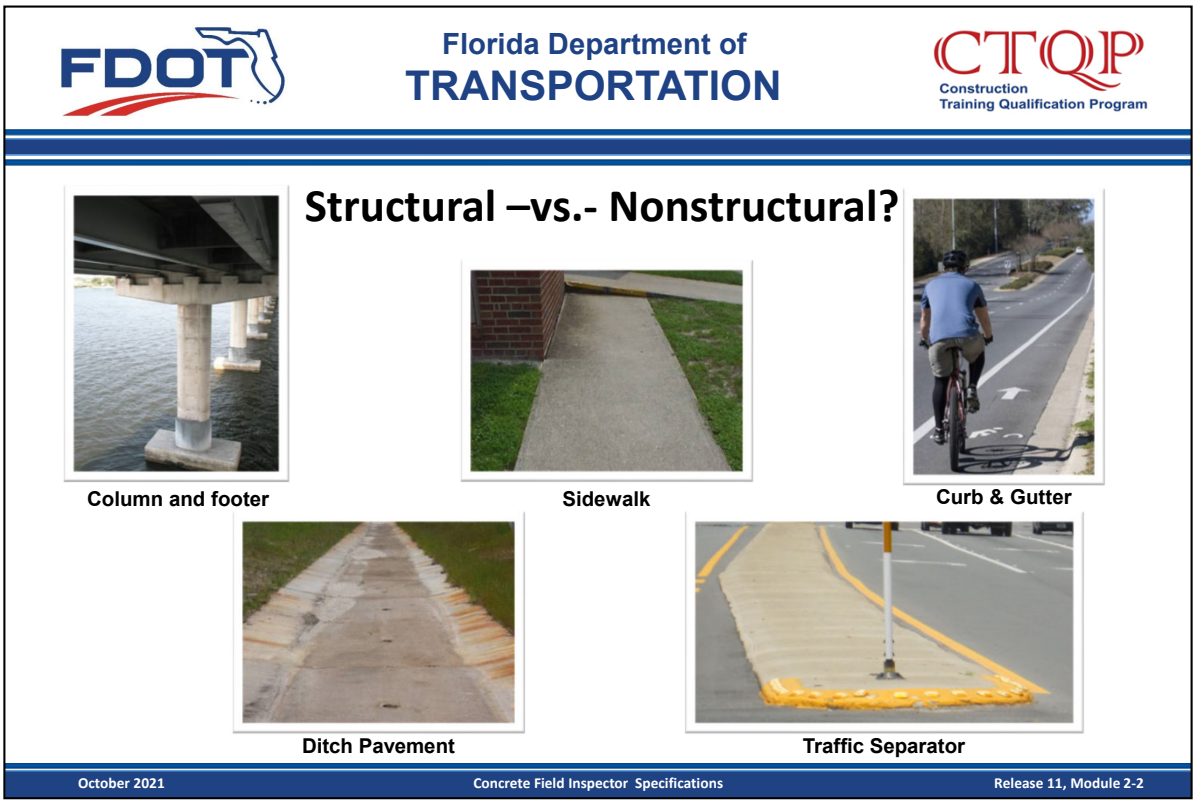

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STRUCTURAL PORTLAND
CEMENT CONCRETE
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Photographs of concrete structures and a sidewalk.

What is non-structural concrete? Non-structural concrete is non-load bearing and typically non-reinforced.

In these pictures, structural concrete is used in the columns and footer of the bridge structures. The nonstructural (NS) Class concrete is used in the sidewalk, curb and gutter, ditch pavement, and traffic separators.

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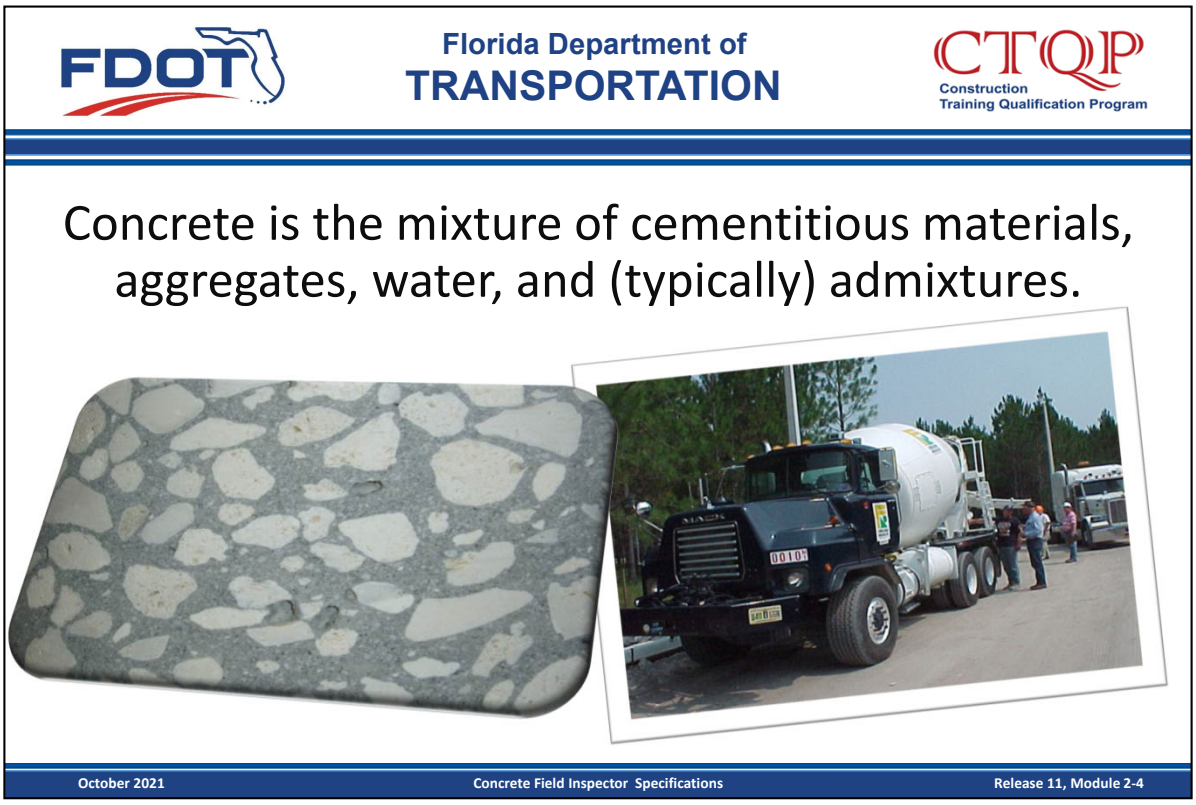
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Examples of the Use of Structural Concrete

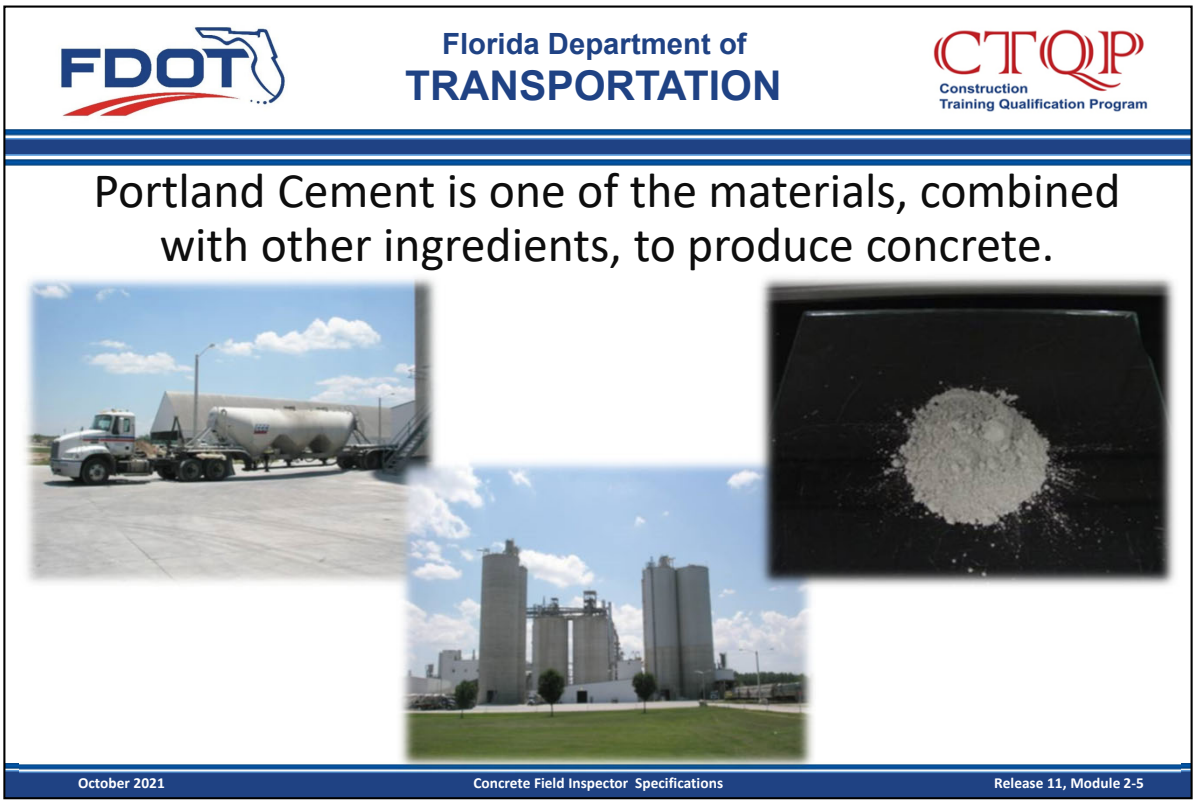


Concrete has been used in construction of the structures for hundreds of years. When concrete structures are properly constructed and maintained, they will stay around for many years.

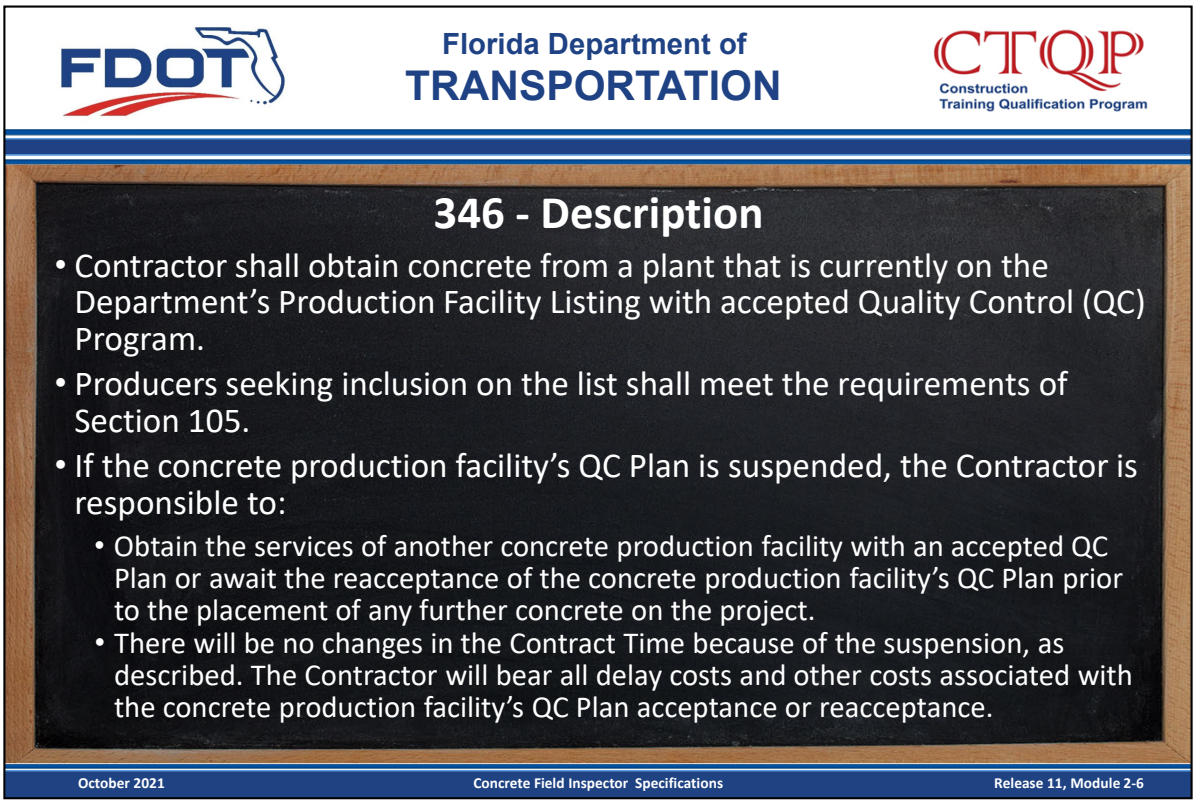
This is the old 7 mile bridge (old) and the Hathaway bridge (new).



Photograph of a concrete mixer truck and close-up of concrete and aggregate distribution.



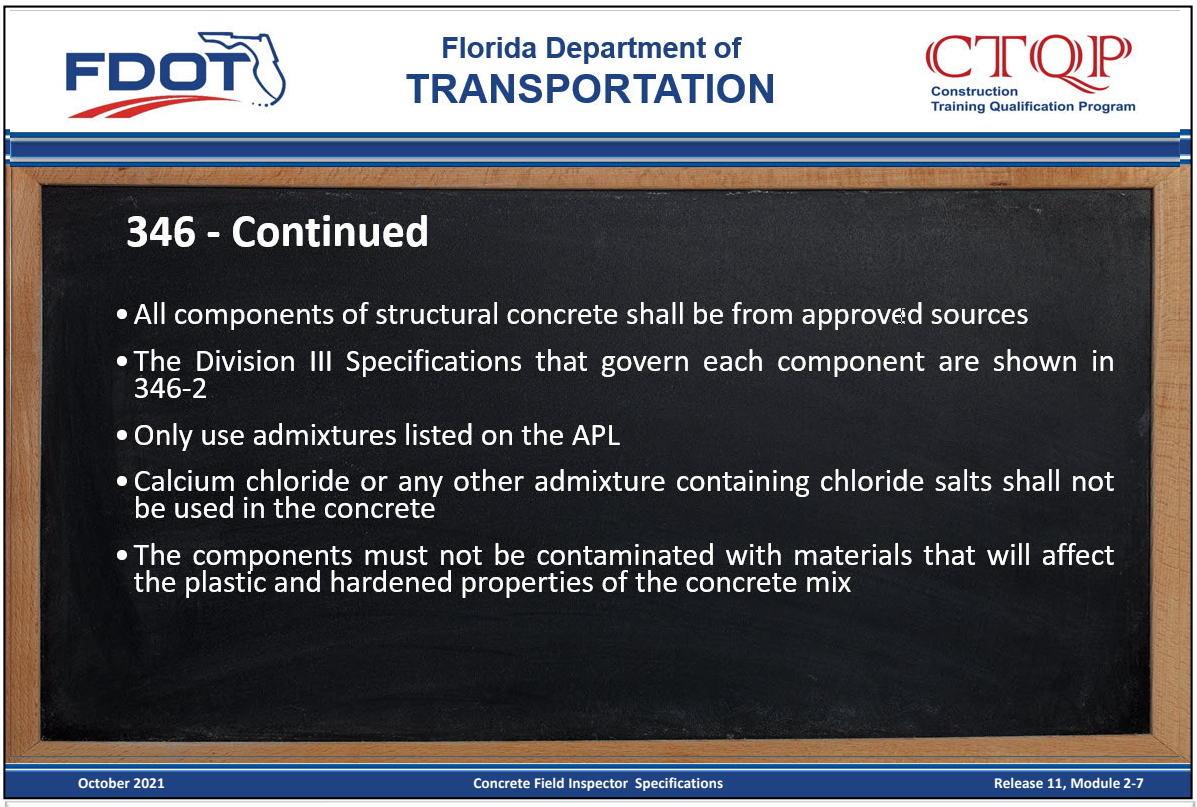
Pictures of cement tanker truck, cement production facility, and cement.

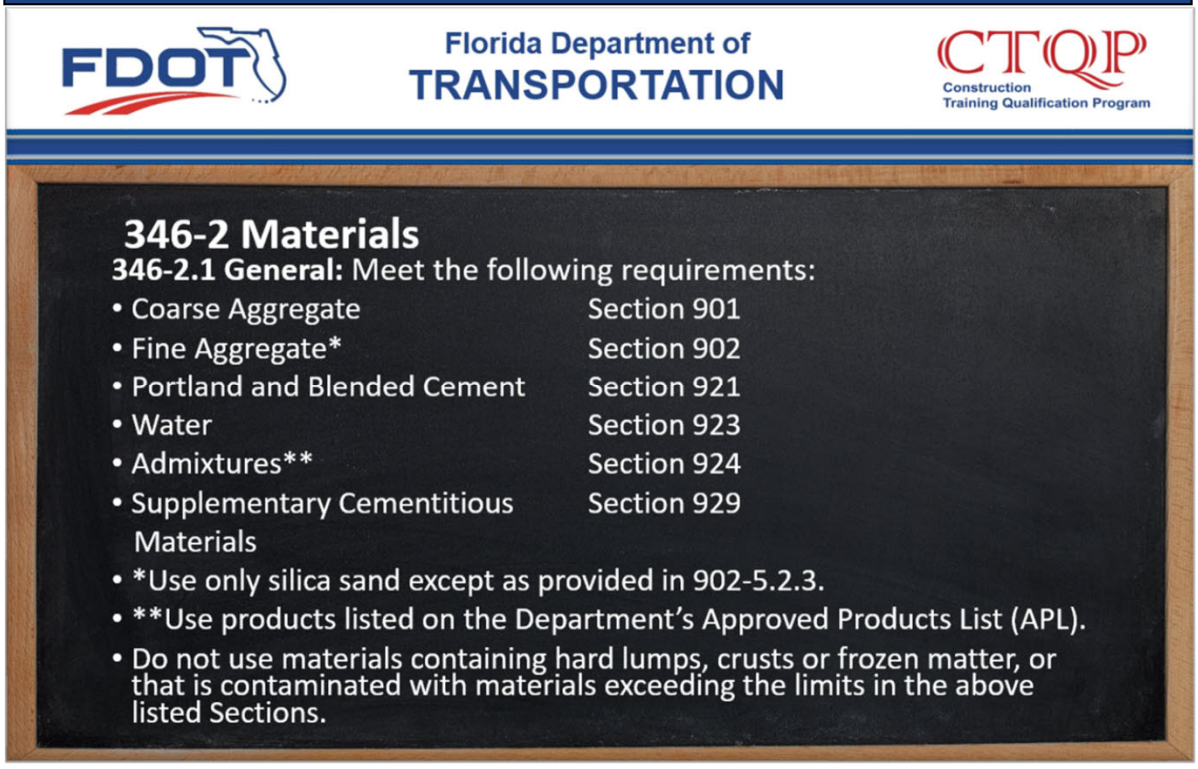


346-1 Description.

Use concrete composed of a mixture of Portland cement, aggregate, water, and, where specified, admixtures, and supplementary cementitious materials. Deliver the Portland cement concrete to the site of placement in a freshly mixed, unhardened state.

Obtain concrete from a plant that is currently on the Department's Production Facility Listing. Producers seeking inclusion on the list shall meet the requirements of Section 105 (Article 105-4) Specifications. If the concrete production facility's Quality Control (QC) Plan is suspended, the Contractor is solely responsible to obtain the services of another concrete production facility with an accepted QC Plan or await the reacceptance of the concrete production facility's QC Plan prior to the placement of any further concrete on the project. There will be no changes in the Contract Time because of the suspension, as described. Bear all delay costs and other costs associated with the concrete production facility's QC Plan acceptance or reacceptance.


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346 - Continued
• All components of structural concrete shall be from approved sources
• The Division III Specifications that govern each component are shown in 346-2
• Only use admixtures listed on the APL
• Calcium chloride or any other admixture containing chloride salts shall not be used in the concrete
• The components must not be contaminated with materials that will affect the plastic and hardened properties of the concrete mix
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346-2 Materials
346-2.1 General: Meet the following requirements:
• Coarse Aggregate Section 901
• Fine Aggregate* Section 902
• Portland and Blended Cement Section 921
• Water Section 923
• Admixtures** Section 924
• Supplementary Cementitious Materials Section 929
• *Use only silica sand except as provided in 902-5.2.3.
• **Use products listed on the Department's Approved Products List (APL).
• Do not use materials containing hard lumps, crusts or frozen matter, or that is contaminated with materials exceeding the limits in the above listed Sections.

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901-1.1 Coarse Aggregate Composition

- Coarse aggregate shall be from an approved source
- It shall be material substantially retained on a No. 4 sieve
- It must be free of deleterious substances (clay lumps, salt, organic matter, soft and friable materials, etc…)



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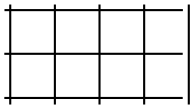
901-1 General.

901-1.1 Composition: Coarse aggregate shall consist of naturally occurring materials such as gravel, or resulting from the crushing of parent rock, to include natural rock, slags, expanded clays and shales (lightweight aggregates) and other approved inert materials with similar characteristics, having hard, strong, durable particles, conforming to the specific requirements of this Section.

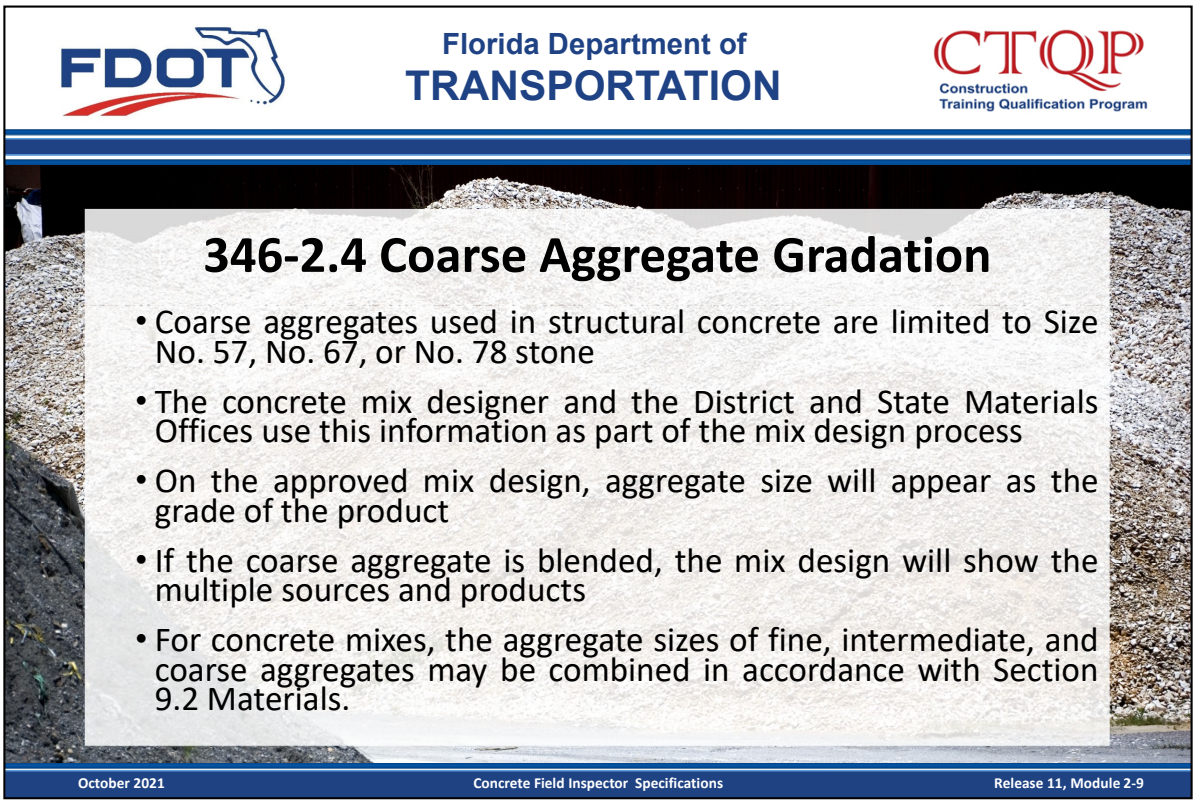
Materials substantially retained on the No. 4 sieve, shall be classified as coarse aggregate.

Approval of mineral aggregate sources shall be in accordance with 6-2.3.

Photograph of stockpiled aggregate.



Approx. actual size of openings on a No.4 (4.75 mm) sieve.



This language allows for the use of size 8 and 89 as well as the most common sizes shown on the slide. The concrete mix design may also call for a blend of different sizes. This is mostly seen for concrete mix designs used in precast/prestressed operations and deck slabs.

346-2.4 Coarse Aggregate Gradation: Produce all concrete using Size No. 57, 67 or 78 coarse aggregate. With the Engineer's approval and input from the District Materials Office with Producer QC Plan acceptance authority, Size No. 8, Size No. 89, or other gradations may be used either alone or blended with Size No. 57, 67 or 78 coarse aggregate. Submit sufficient statistical data to establish production quality and uniformity of the subject aggregates and establish the quality and uniformity of the resultant concrete. Aggregate gradations sized larger than nominal maximum size of 1.5 inch may be used blended with smaller size coarse aggregate as two components.

346-2.4.1 Optimized Aggregate Gradation: Improve the aggregate packing density at the Contractor's option, by adding an intermediate-size coarse aggregate. Meet the requirements of Section 9.2 of the Materials Manual, on the methods used to produce combined aggregate gradation of fine, intermediate, and coarse aggregate sizes for the concrete mixes.

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902-1.1 Composition

- Fine aggregate shall be from an approved source
- It shall be free of deleterious substances (clay lumps, salt, organic matter, soft and friable materials, etc.)
- Silica sand cannot have more than 4% passing No. 200 Sieve (200 openings per square inch)



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Fine aggregate fills the voids between the coarse aggregates. With less voids in the concrete, we gain greater strength. Section 902 also allows the use of screenings in addition to silica sand.

902-1 General.

902-1.1 Composition: Fine aggregate shall consist of natural silica sand, screenings, local materials, or subject to approval, other inert materials with similar characteristics, or combination thereof, having hard, strong, durable particles, conforming to the specific requirements of this Section.

Approval of mineral aggregate sources shall be in accordance with 6-3.

***902-1.2* Deleterious Substances:** All fine aggregate shall be reasonably free of lumps of clay, soft or flaky particles, salt, alkali, organic matter, loam or other extraneous substances. The weight of deleterious substances shall not exceed the following percentages:

Shale 1.0

Coal and lignite 1.0

Cinders and clinkers 0.5

Clay Lumps 1.0

Photograph of stockpile materials for producing concrete.

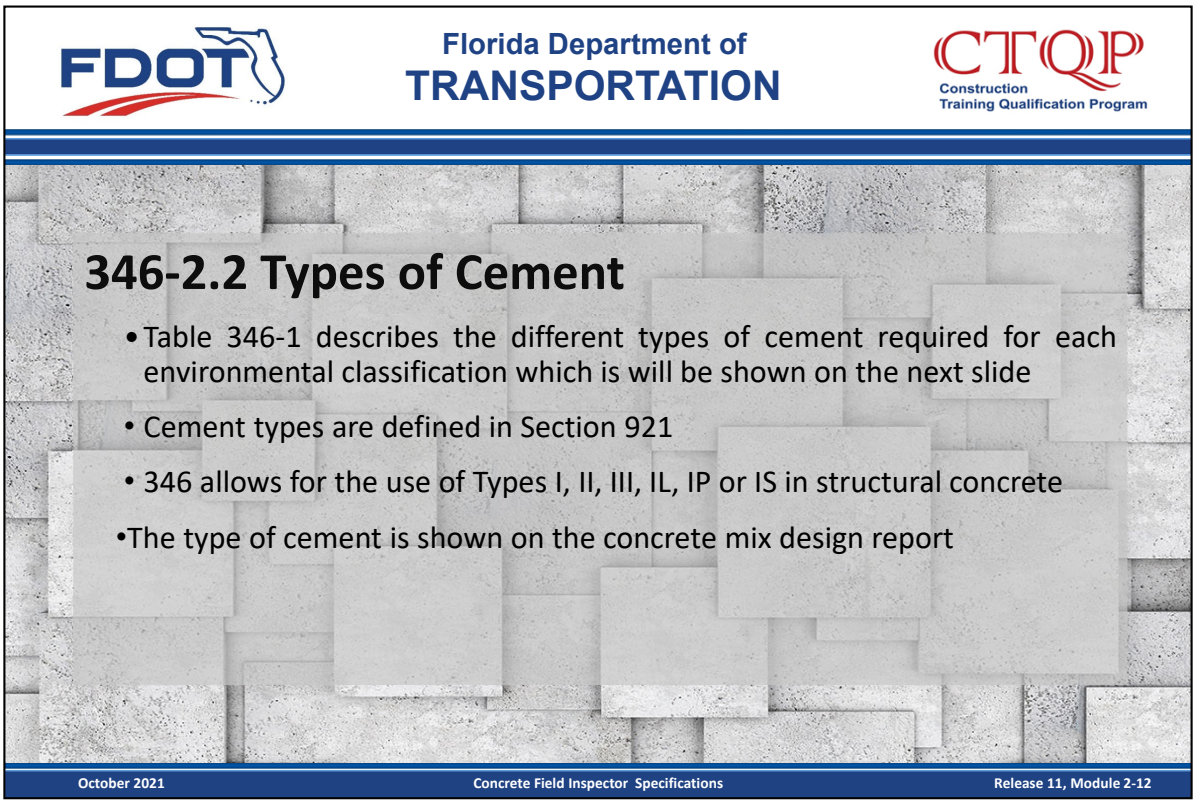


The environmental classification of a structure, as determined by the designer, dictates the type of cement that can be used in the structure.

The environmental classification may be found in a variety of places in plans, typically in “general notes” and structures pages. The technician needs to be aware that classifications are not always presented in the same manner. Classifications can change from structure to structure on the same project. Different types of classifications require different types of cements to be used for each environment which will be explained later.

Photos show the difference between an inland area like Gainesville and a coastal area like South Florida.





There are other types of cement, but these types may or may not be used. The project inspector should verify that the type of cement shown on the concrete delivery ticket matches the concrete mix design report. The inspector also needs to know which cement goes with each environment.

Types of Cement - Use

Type I - For use when the special properties specified for any other type are not required

Type II - For general use, more especially when moderate sulfate resistance or moderate heat of hydration is desired

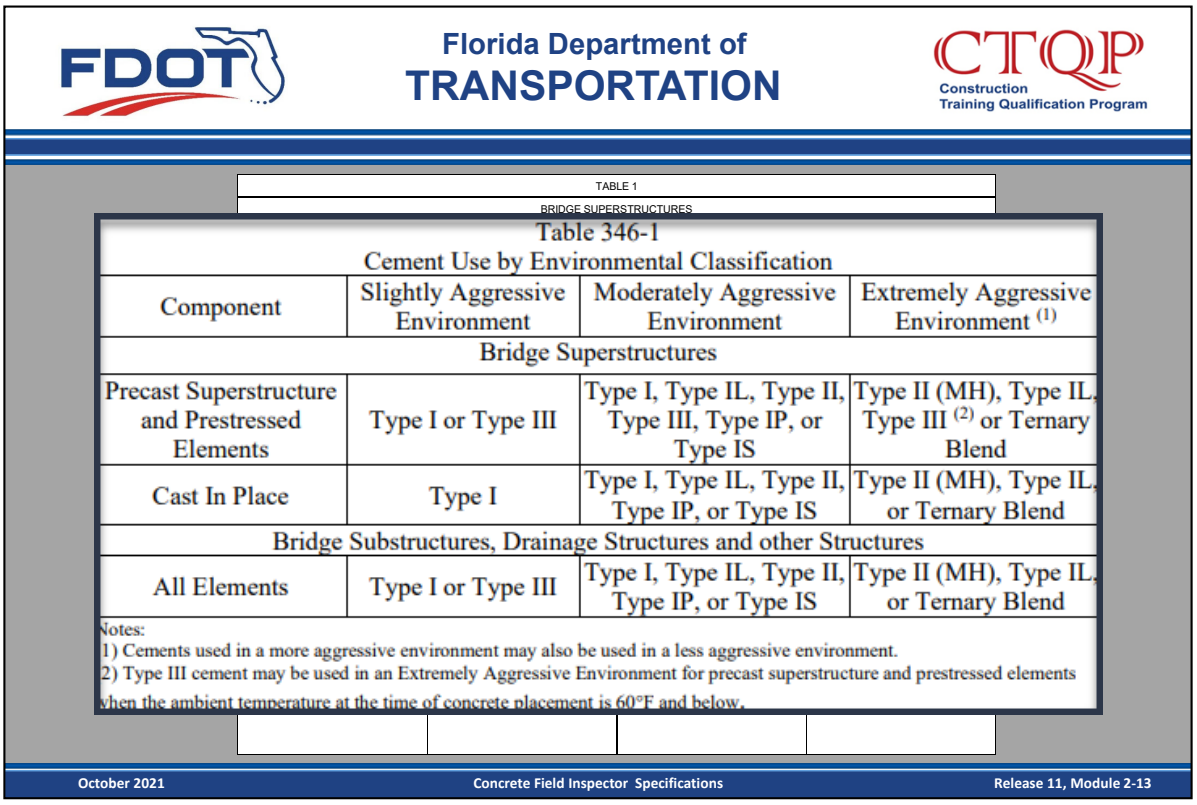
Type II(MH) – For use in extremely aggressive environments and for mass concrete

Type III - For use when high early strength is desired

Type IL - For use in moderately and extremely aggressive environments

Type IP - Portland-pozzolan cement for use in general concrete construction

Type IS - Portland blast-furnace slag cement for use in general construction



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TABLE 1

BRIDGE SUPERSTRUCTURES

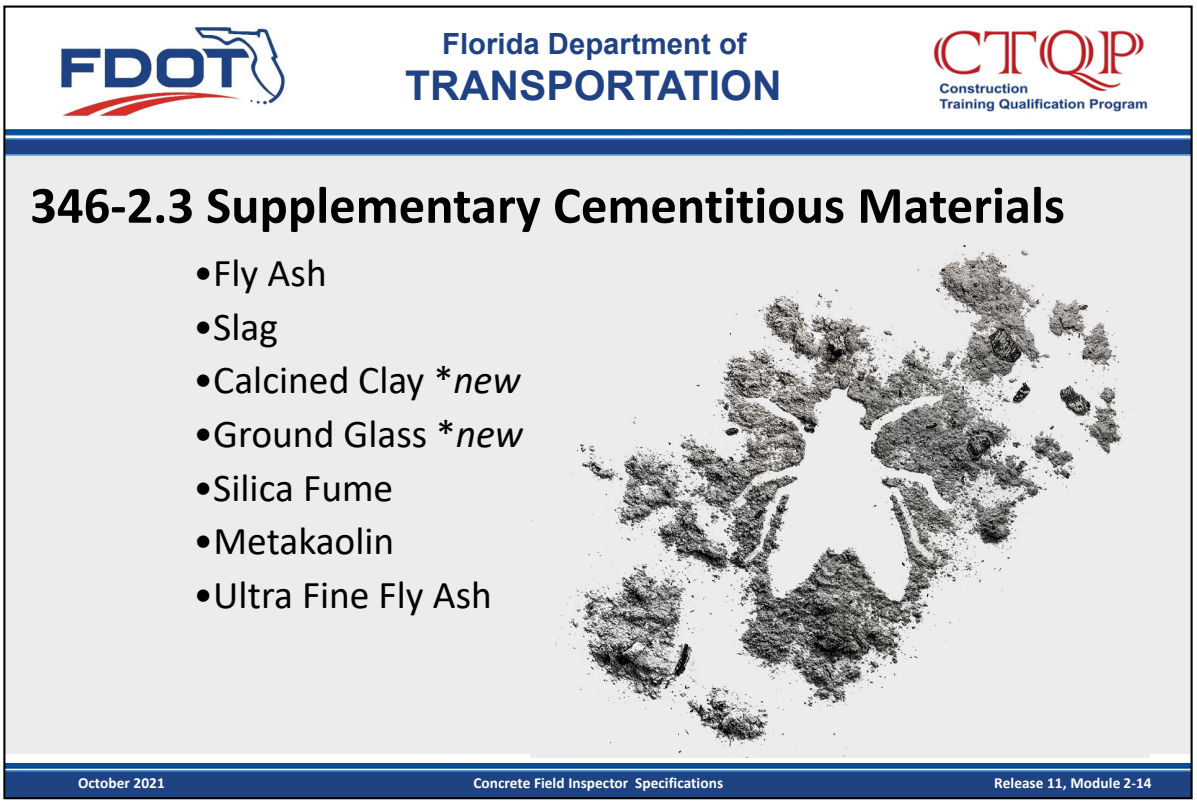
Table 346-1
Cement Use by Environmental Classification

Component	Slightly Aggressive Environment	Moderately Aggressive Environment	Extremely Aggressive Environment (1)
Bridge Superstructures			
Precast Superstructure and Prestressed Elements	Type I or Type III	Type I, Type IL, Type II, Type III, Type IP, or Type IS	Type II (MH), Type IL, Type III (2) or Ternary Blend
Cast In Place	Type I	Type I, Type IL, Type II, Type IP, or Type IS	Type II (MH), Type IL, or Ternary Blend
Bridge Substructures, Drainage Structures and other Structures			
All Elements	Type I or Type III	Type I, Type IL, Type II, Type IP, or Type IS	Type II (MH), Type IL, or Ternary Blend

Notes:
1) Cements used in a more aggressive environment may also be used in a less aggressive environment.
2) Type III cement may be used in an Extremely Aggressive Environment for precast superstructure and prestressed elements when the ambient temperature at the time of concrete placement is 60°F and below.

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Table 346-1 shows that the use of cement types depends on the types of structural components, their environmental classifications, and ambient temperature at the time of concrete placement.



These are different types of supplementary cementitious materials that can be used in a concrete mix design. Project personnel should verify that the type of supplementary cementitious material(s) shown on the concrete delivery ticket matches the concrete mix design report. Concrete mix designs will have cement and one other type of cementitious material, such as fly ash or slag. Some concrete mix designs can contain additional supplementary cementitious material(s), like silica fume. The quantity of portland cement replaced with supplemental cementitious materials must be on an equal weight replacement basis of the total cementitious materials with the limitations, shown in Table 346-2.

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Table 346-2
Cementitious Materials Concrete Mix Proportions (%)
(Environmental classification is extremely aggressive, unless otherwise noted)

Application	Portland Cement	Fly Ash Type F	Slag	Highly Reactive Pozzolans [4]		
				Silica Fume	Metakaolin	Ultra-Fine Fly Ash
General Use	70-82	18-30				
	66-78	15-25		7-9		
	66-78	15-25			8-12	
	66-78	15-25				8-12
	30-40	10-20	50-60			
	30-75 [1]		25-70 [1]			
	30-50		50-70			
	36-43		50-55	7-9		
	33-42		50-55		8-12	
	33-42		50-55			8-12
Precast / Prestressed	70-85 [1]	15-30 [1]				
	70-82	18-30				
	66-78	15-25		7-9		
	66-78	15-25			8-12	
	66-78	15-25				8-12
	30-40	10-20	50-60			
	30-50		50-70			
	36-43		50-55	7-9		
	33-42		50-55		8-12	
	33-42		50-55			8-12
Drilled Shaft	63-67	33-37				
	38-42		58-62			
	30-40	10-20	50-60			
Mass Concrete	50-82 [2]	18-50 [2]				
	50-65 [3]	35-50 [3]				
	66-78	15-25		7-9		
	66-78	15-25			8-12	
	66-78	15-25				8-12
	30-40	10-20	50-60			
	30-50		50-70			
	36-43		50-55	7-9		
	33-42		50-55		8-12	
	33-42		50-55			8-12

Notes:
(1) Slightly Aggressive and Moderately Aggressive environments.
(2) For Concrete with Core Temperature T≤165°F.
(3) For Concrete with Core Temperature T≥165°F.
(4) Highly reactive pozzolans may be used below the specified ranges to enhance strength and workability.



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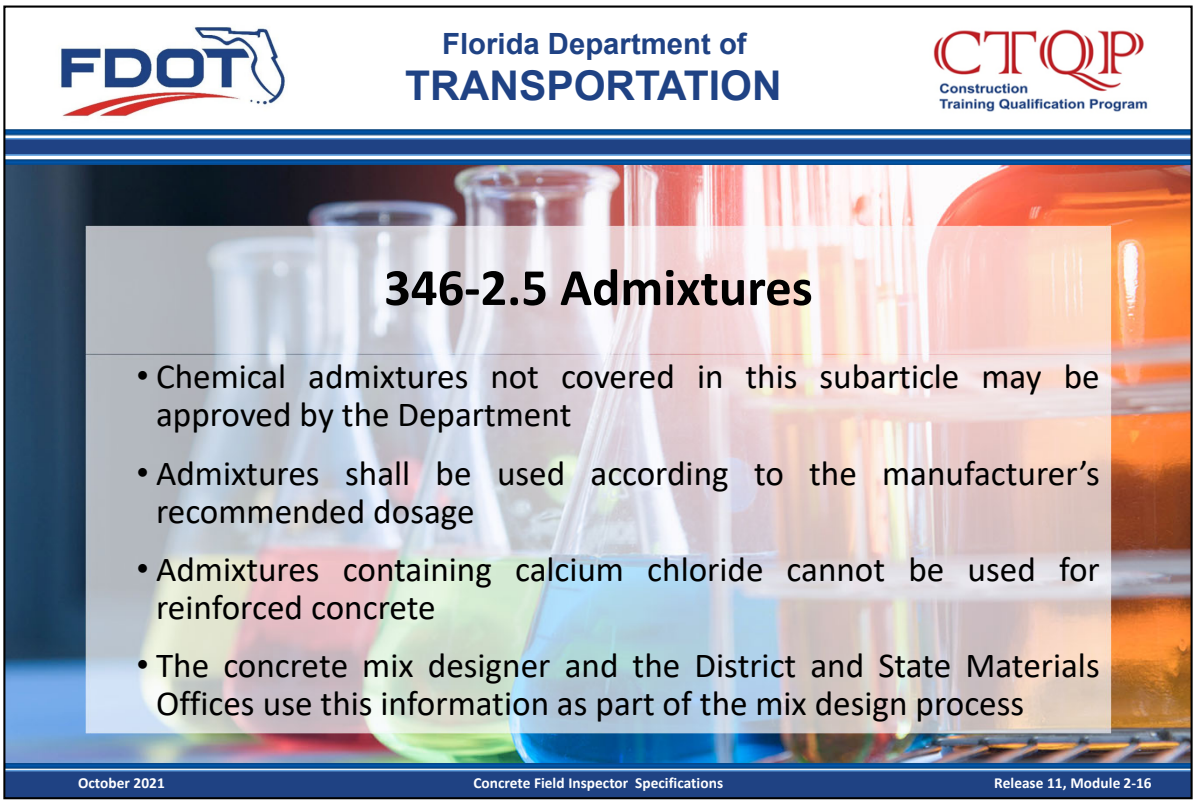
The Table 346-2 provides the mix proportions of the cementitious materials, which are based on the project's environmental classifications and application of the mix design.

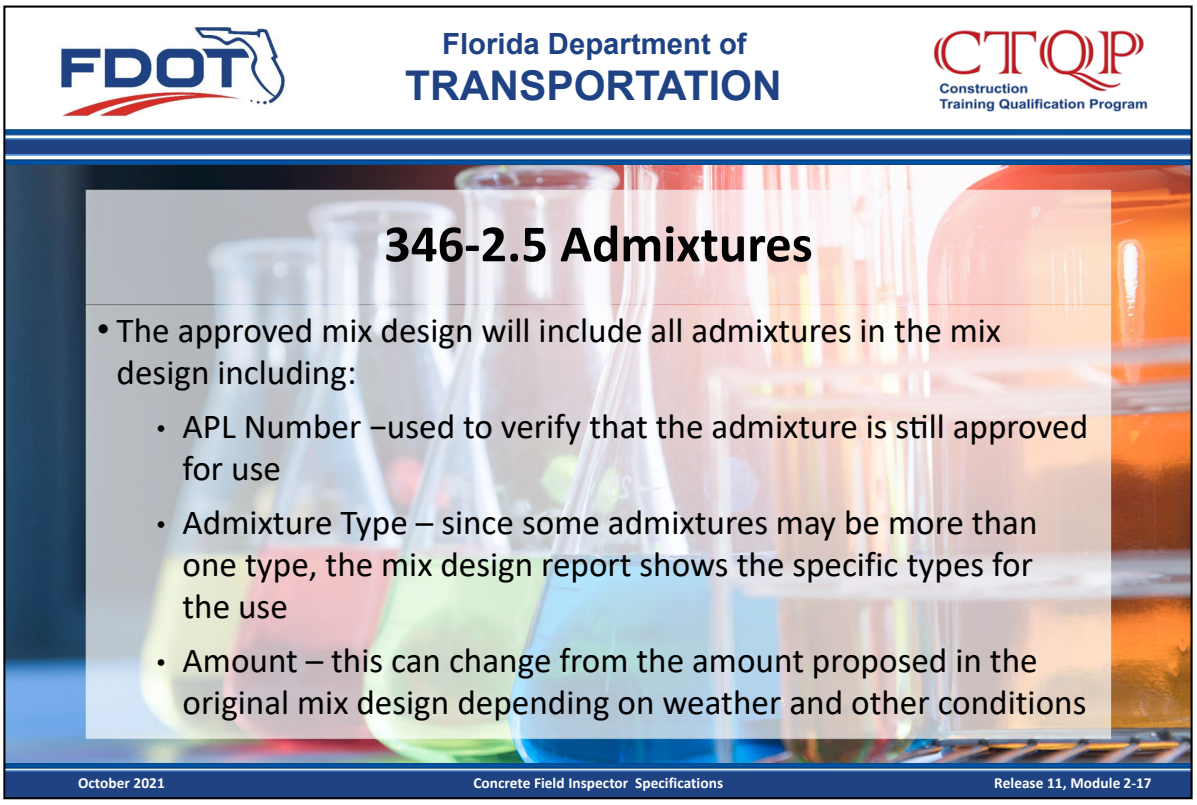
The mix design may contain the following ingredients.

- Highly Reactive Pozzolans: Silica fume, metakaolin and ultrafine fly ash.

- Binary Concrete Mixes: Concrete mixes containing portland cement and one supplementary cementitious material.

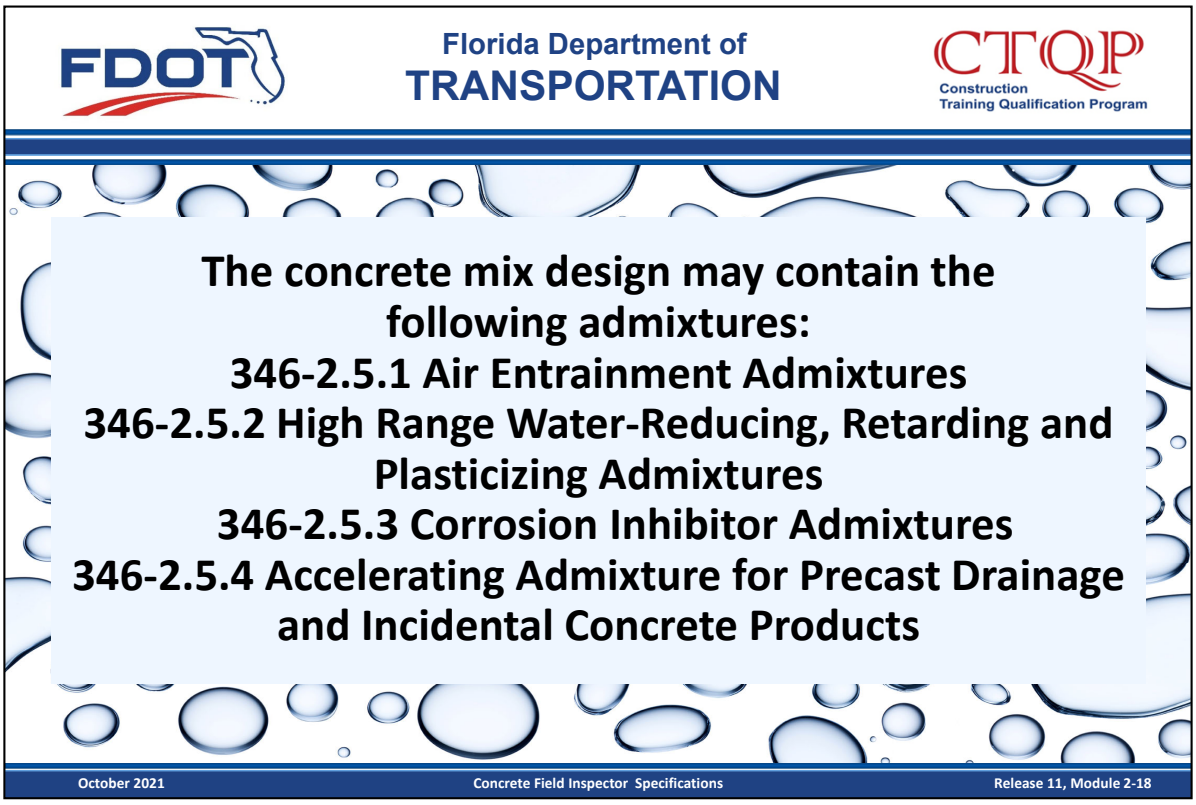
- Ternary Concrete Mixes: Concrete mixes containing portland cement and any two of supplementary cementitious materials, either fly ash, slag, calcined clay, ground glass, or highly reactive pozzolans.


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346-2.5 Admixtures
• Chemical admixtures not covered in this subarticle may be approved by the Department
• Admixtures shall be used according to the manufacturer's recommended dosage
• Admixtures containing calcium chloride cannot be used for reinforced concrete
• The concrete mix designer and the District and State Materials Offices use this information as part of the mix design process
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346-2.5 Admixtures: Use admixtures in accordance with the requirements of this subarticle. Chemical admixtures not covered in this subarticle may be approved by the Department. Submit statistical evidence supporting successful laboratory and field trial mixes which demonstrate improved concrete quality or handling characteristics.

Use admixtures in accordance with the manufacturer's recommended dosage rate. Do not use admixtures or additives containing calcium chloride (either in the raw materials or introduced during the manufacturing process) in reinforced concrete.



346-2.5.1 Air Entrainment Admixtures: Use an air entraining admixture in all concrete mixes except counterweight and dry cast concrete. For precast concrete products, the use of air entraining admixture is optional for Class I and Class II concrete.

346-2.5.2 High Range Water-Reducing, Retarding and Plasticizing Admixtures: When a highly reactive pozzolan is incorporated into a concrete mix design, use a high range water-reducing admixture Type I, II, F or G.

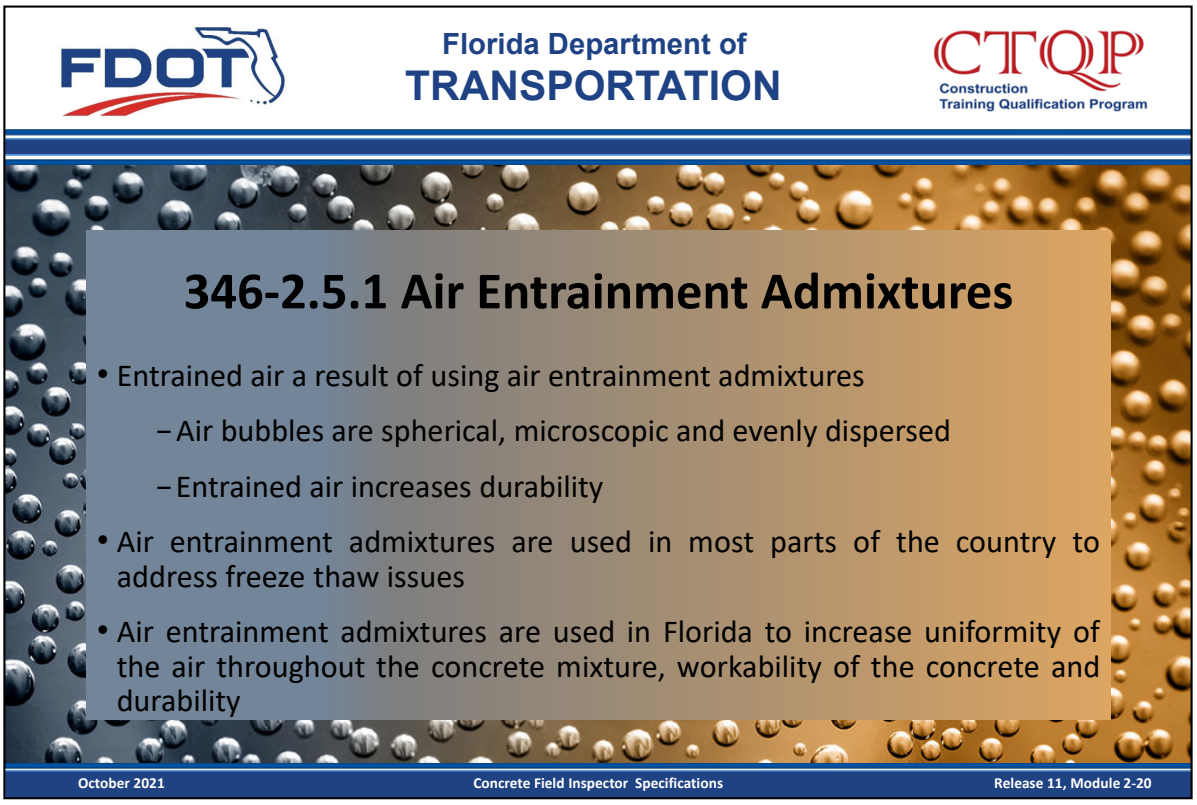
346-2.5.2.1 Flowing Concrete Admixtures for Precast/Prestressed Concrete: Use a Type I, II, F or G admixture for producing flowing concrete. If Type F or G admixture is used, verify the distribution of aggregates in accordance with ASTM C1610 except allow for minimal vibration for consolidating the concrete. The maximum allowable difference between the static segregation is less than or equal to 15 %. Add the flowing concrete admixtures at the concrete production facility.

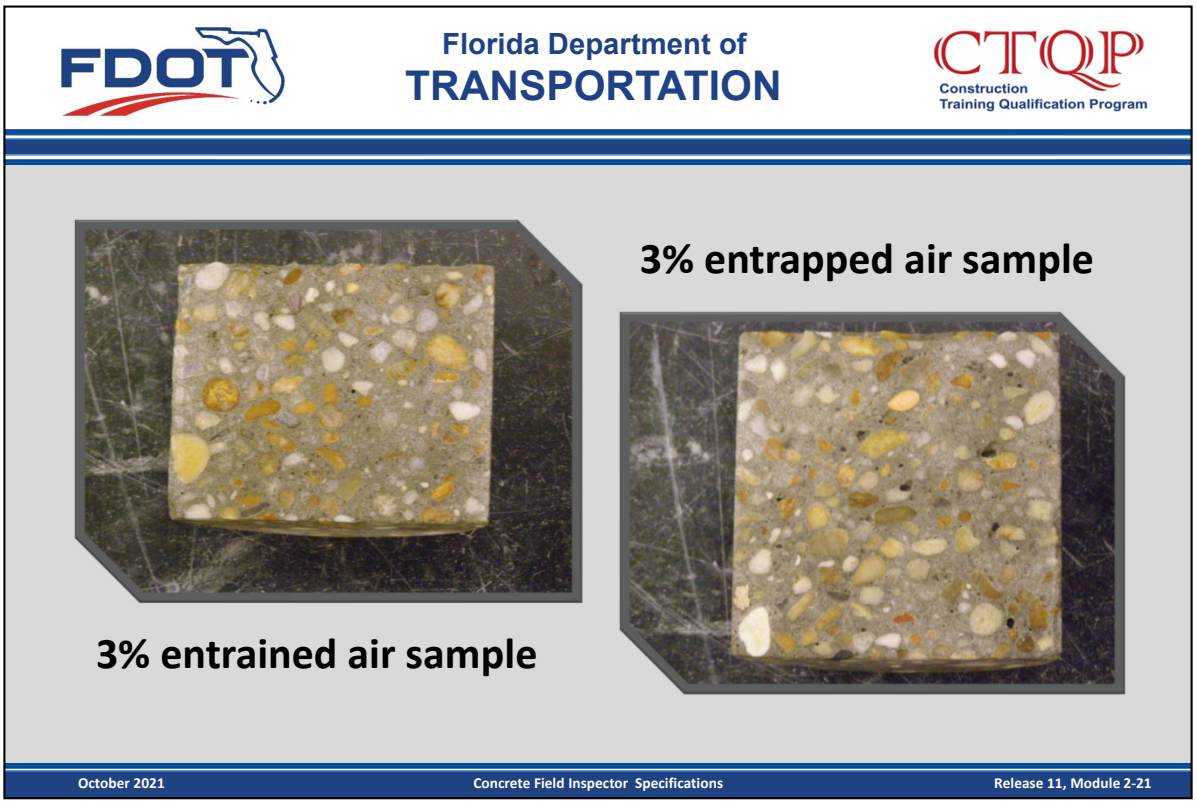
346-2.5.3 Corrosion Inhibitor Admixtures: Use a water-reducing and retarding admixture, Type D, or a high range water-reducing and retarding admixture, Type G, to normalize the setting time of concrete.

346-2.5.4 Accelerating Admixture for Precast Drainage and Incidental Concrete Products: Use non-chloride accelerating admixtures, Type C or accelerating and water-reducing, Type E, only in the manufacturing of precast drainage and incidental concrete products.



346-2.5.1 Air Entrainment Admixtures: Use an air entraining admixture in all concrete mixes except counterweight and dry cast concrete. For precast concrete products, the use of air entraining admixture is optional for Class I and Class II concrete.

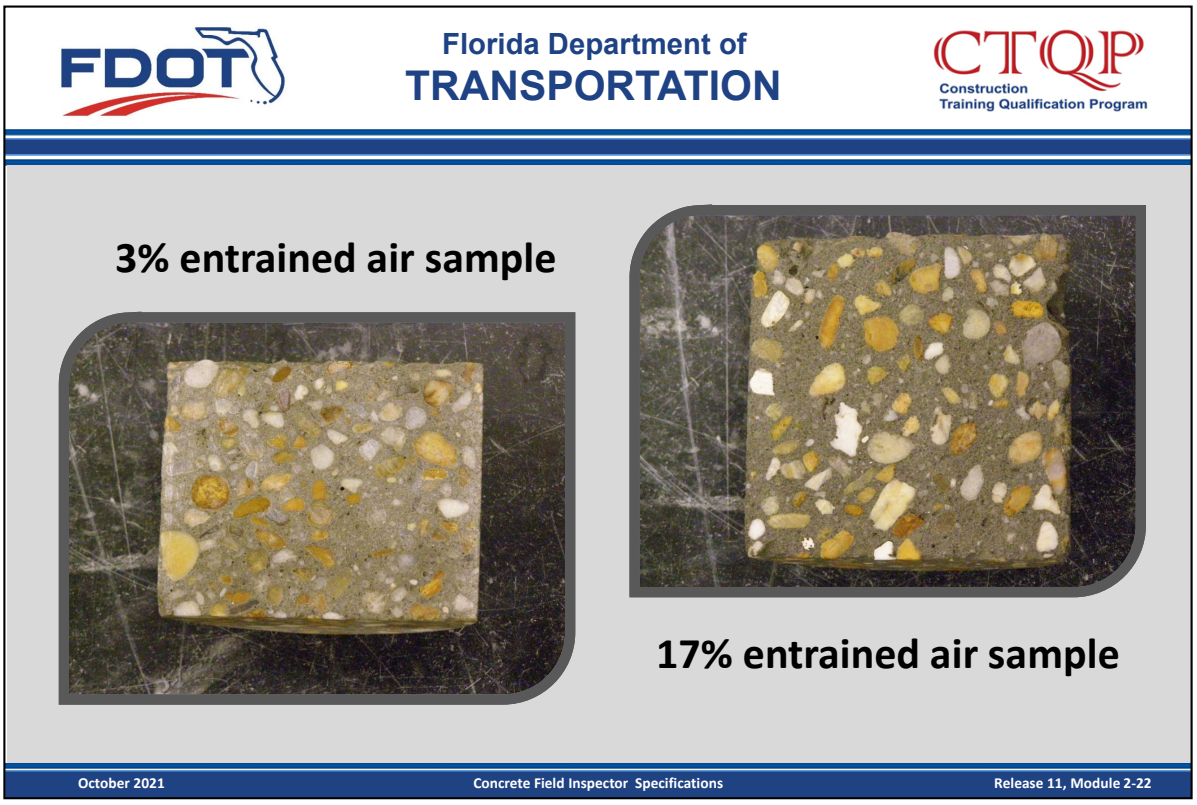

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346-2.5.1 Air Entrainment Admixtures
• Entrained air a result of using air entrainment admixtures
– Air bubbles are spherical, microscopic and evenly dispersed
– Entrained air increases durability
• Air entrainment admixtures are used in most parts of the country to address freeze thaw issues
• Air entrainment admixtures are used in Florida to increase uniformity of the air throughout the concrete mixture, workability of the concrete and durability
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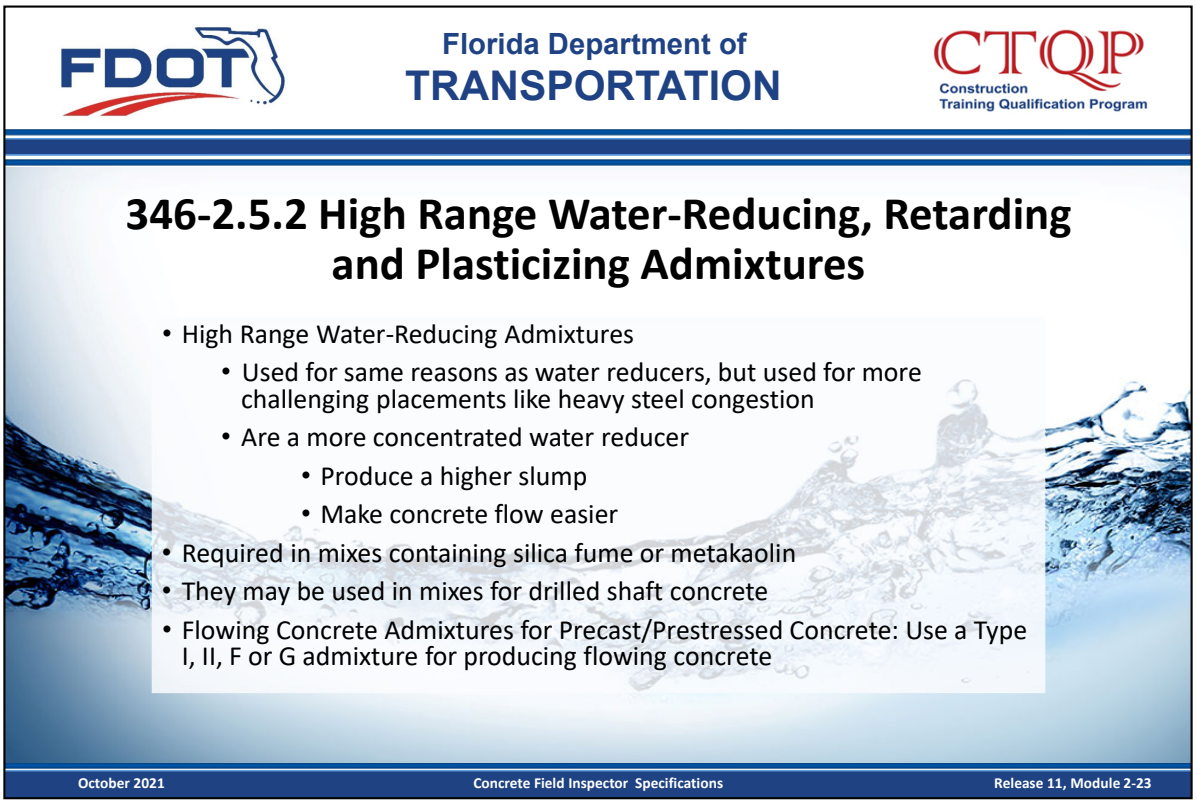
These photos give an indication of the difference between entrapped air and entrained air. Both samples have the same amount of air content (3%), but the entrapped air sample has large bubbles and air void spaces. The entrained air bubbles are microscopic and evenly distributed.

Air-entrained concrete contains billions of microscopic air cells per cubic foot. These air pockets relieve internal pressure on the concrete by providing tiny chambers for water to expand into when it freezes.

Entrapped air is created during improper mixing, consolidating and placement of the concrete. Air pockets, or irregularly sized air voids, are spread throughout the concrete and have negative effects on product appearance, strength and durability.

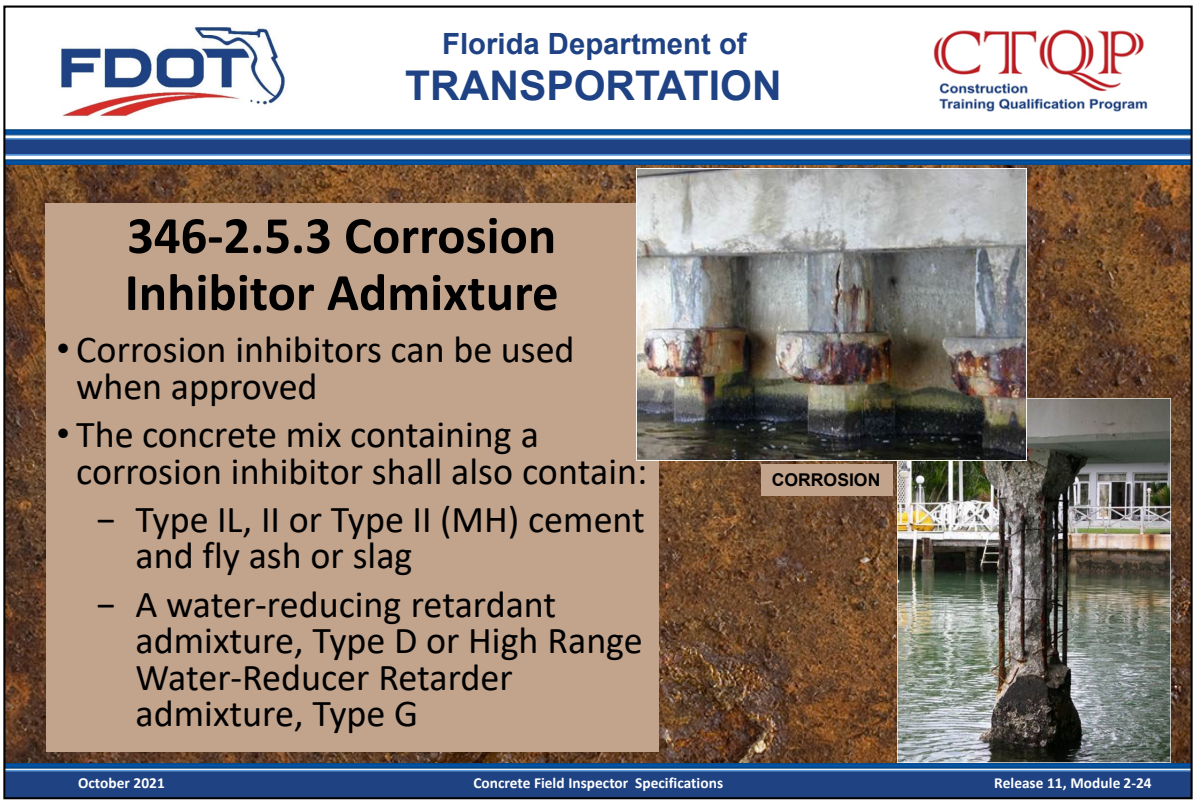


In this photo, both samples have entrained air, but the difference between the percentages is imperceptible to the naked eye.



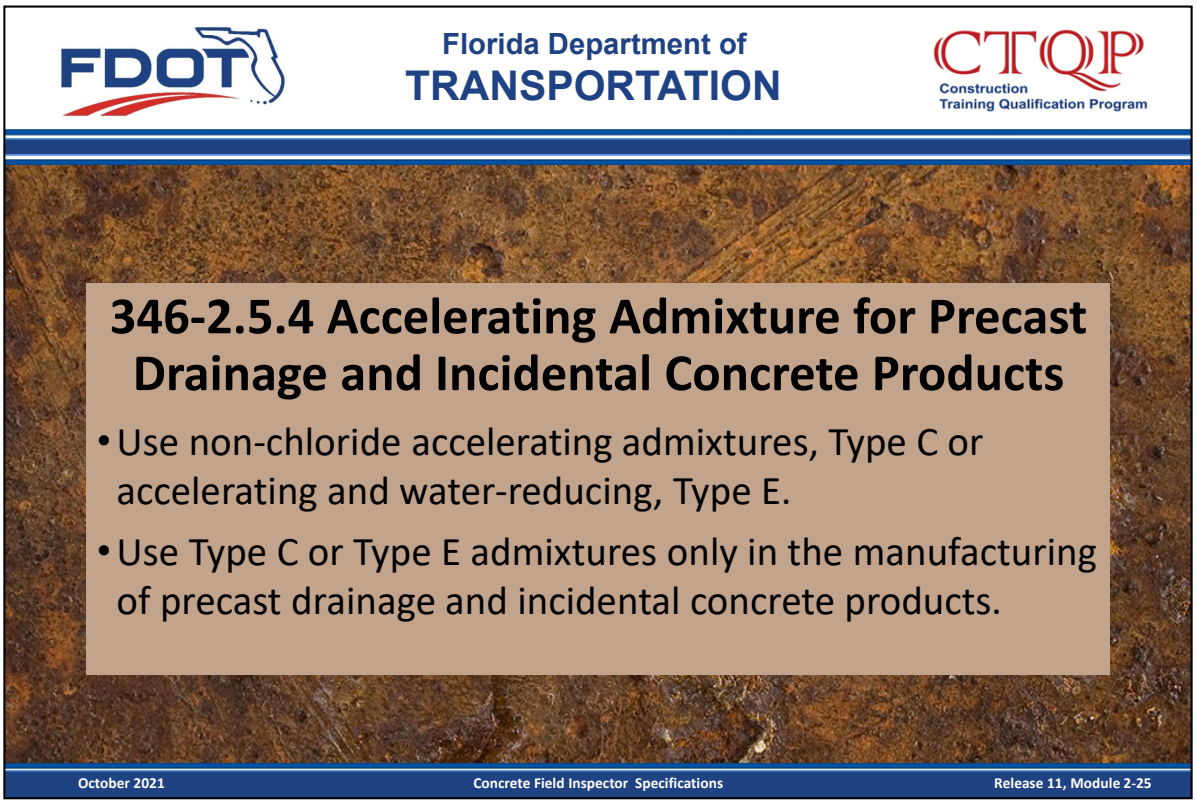
346-2.5.2 High Range Water-Reducing, Retarding and Plasticizing Admixtures: When a highly reactive pozzolan is incorporated into a concrete mix design, use a high range water-reducing admixture Type I, II, F or G.

346-2.5.2.1 Flowing Concrete Admixtures for Precast/Prestressed Concrete: Use a Type I, II, F or G admixture for producing flowing concrete. If Type F or G admixture is used, verify the distribution of aggregates in accordance with ASTM C1610 except allow for minimal vibration for consolidating the concrete. The maximum allowable difference between the static segregation is less than or equal to 15 %. Add the flowing concrete admixtures at the concrete production facility.

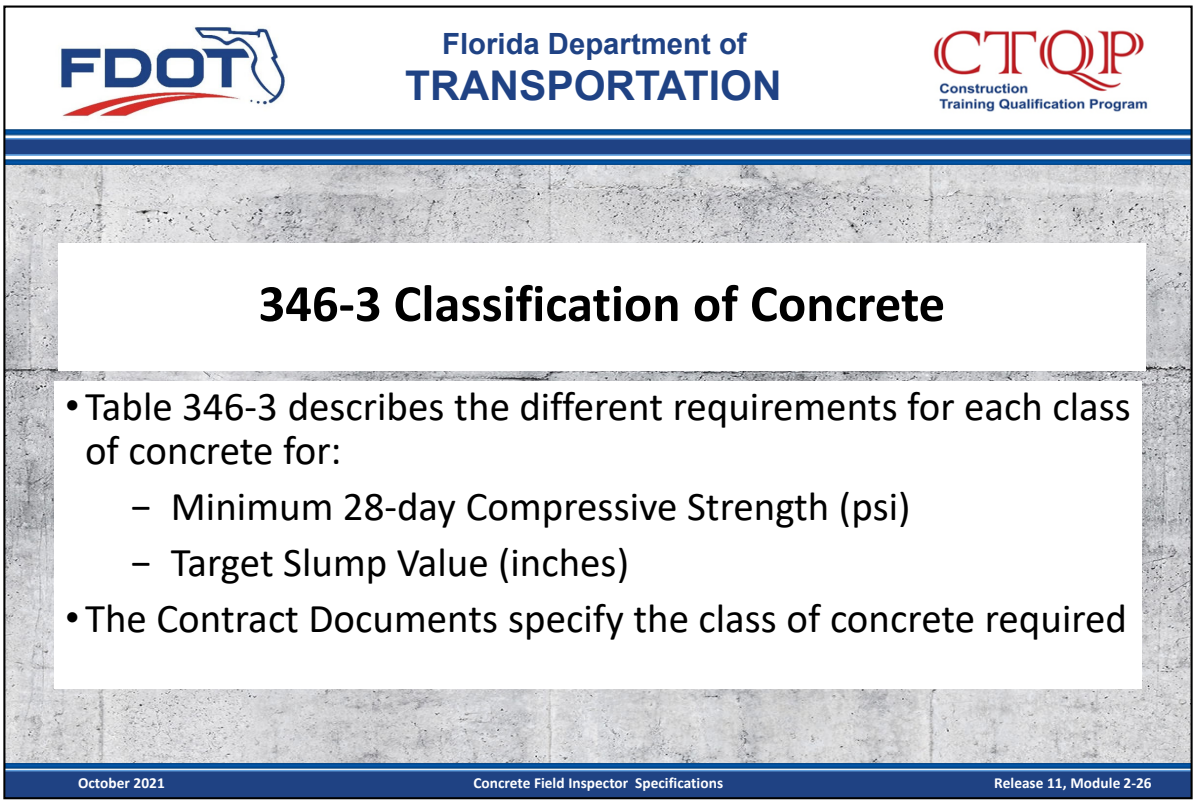


Photos show high corrosion in an extremely aggressive environment

346-2.5.3 Corrosion Inhibitor Admixtures: Use a water-reducing and retarding admixture, Type D, or a high range water-reducing and retarding admixture, Type G, to normalize the setting time of concrete



346-2.5.4 Accelerating Admixture for Precast Drainage and Incidental Concrete Products: Use non-chloride accelerating admixtures, Type C or accelerating and water-reducing, Type E, only in the manufacturing of precast drainage and incidental concrete products



Previous versions of specification sections 346 and 347 both had Class I designation. The Class I in 346 was denoted as “Class I special” to differentiate between the structural Class I and the non-structural Class I. However, the standard plans only showed “Class I”. To someone looking at the document could not tell if it was Class I structural (Class I special) or Class I non-structural. To clear up the confusion, the department changed 346 and 347 and all the standard plans to reflect that Class I structural is denoted simply as Class I and Class I non-structural is denoted as class NS. There is no longer a class known as Class I special.

TABLE 2

Class of Concrete	Specified Minimum Strength (28-day) (psi)	Target Slump Value (inches) (c)	Air (%)
STRUCTURAL CONCRETE			
I (a)	3,000	3 (b)	1.0 to 6.0
I (Pavement)	3,000	2	1.0 to 6.0
II (a)	3,400	3 (b)	1.0 to 6.0
II (Bridge Deck)	4,500	3 (b)	1.0 to 6.0
III (e)	5,000	3 (b)	1.0 to 6.0
III (Seal)	3,000	8	1.0 to 6.0
IV	5,500	3 (b) (d)	1.0 to 6.0
IV (Drilled Shaft)	4,000	8.5	0.0 to 6.0
V (Special)	6,000	3 (b) (d)	1.0 to 5.0
V	6,500	3 (b) (d)	1.0 to 5.0
VI	8,500	3 (b) (d)	1.0 to 5.0

See specification for footnote legend.

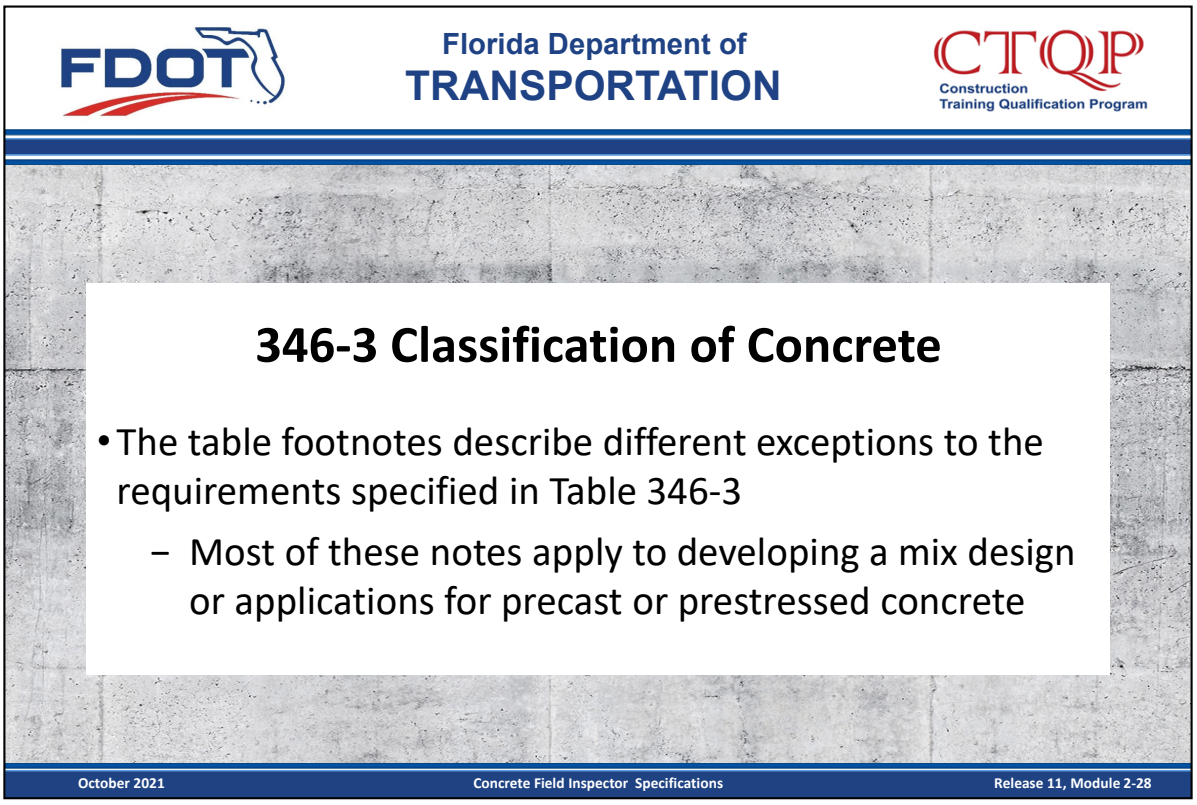
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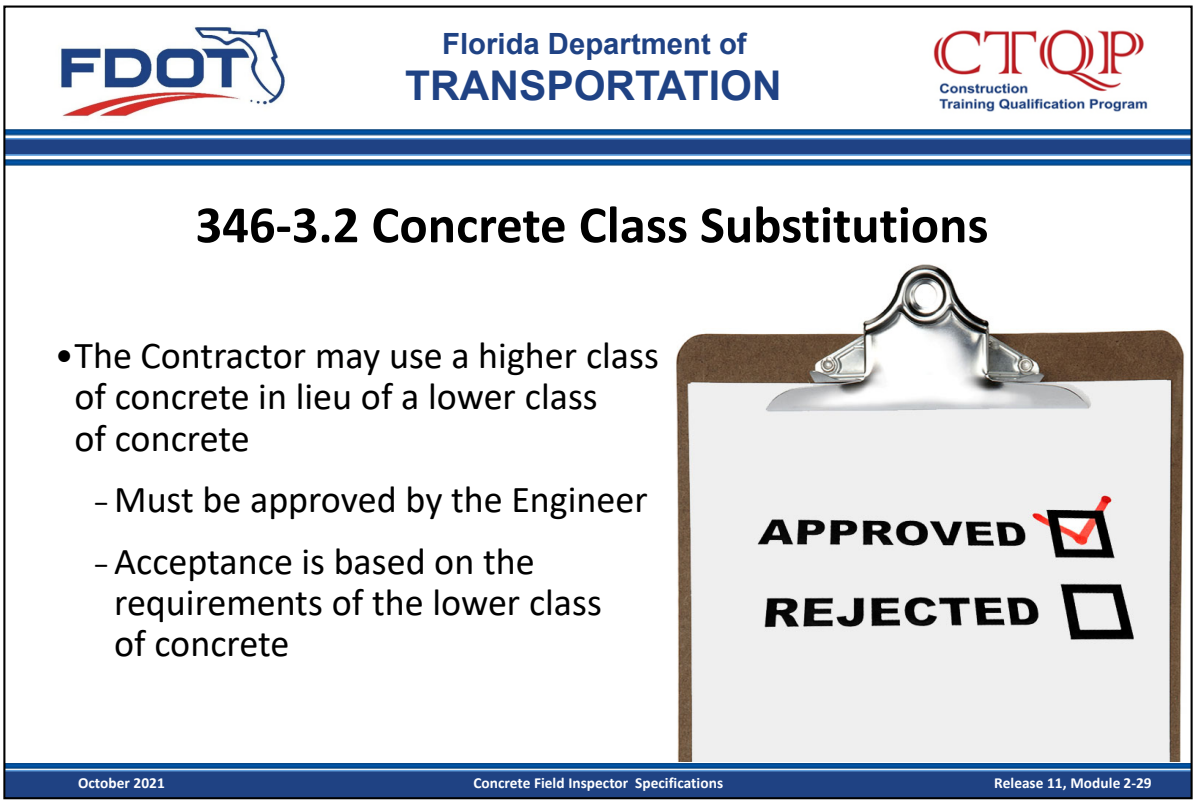
Table 346-3
Master Proportion Table

Class of Concrete	28-day Specified Minimum Compressive Strength (f_c') (psi)	Maximum Water to Cementitious Materials Ratio (pounds per pounds)	Target Slump Value (inches) [3]
I [1]	3,000	0.53	3 [2]
I (Pavement)	3,000	0.50	1.5 or 3 [5]
II [1]	3,400	0.53	3 [2]
II (Bridge Deck)	4,500	0.44	3 [2]
III [4]	5,000	0.44	3 [2]
III (Seal)	3,000	0.53	8
IV	5,500	0.41[6]	3 [2]
IV (Drilled Shaft)	4,000	0.41	8.5
V (Special)	6,000	0.37[6]	3 [2]
V	6,500	0.37[6]	3 [2
VI	8,500	0.37[6]	3 [2]
VII	10,000	0.37[6]	3 [2]

Notes:
(1) 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 (2). The Contractor is permitted to use concrete meeting the requirements of ASTM C478 (4,000 psi) in lieu of the specified Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.
(2) 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, meet the requirements of Section 8.6 of the Materials Manual.
(3) 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.
(4) 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 (2).
(5) Meet the requirements of Section 350.
(6) When silica fume or metakaolin is required, 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.

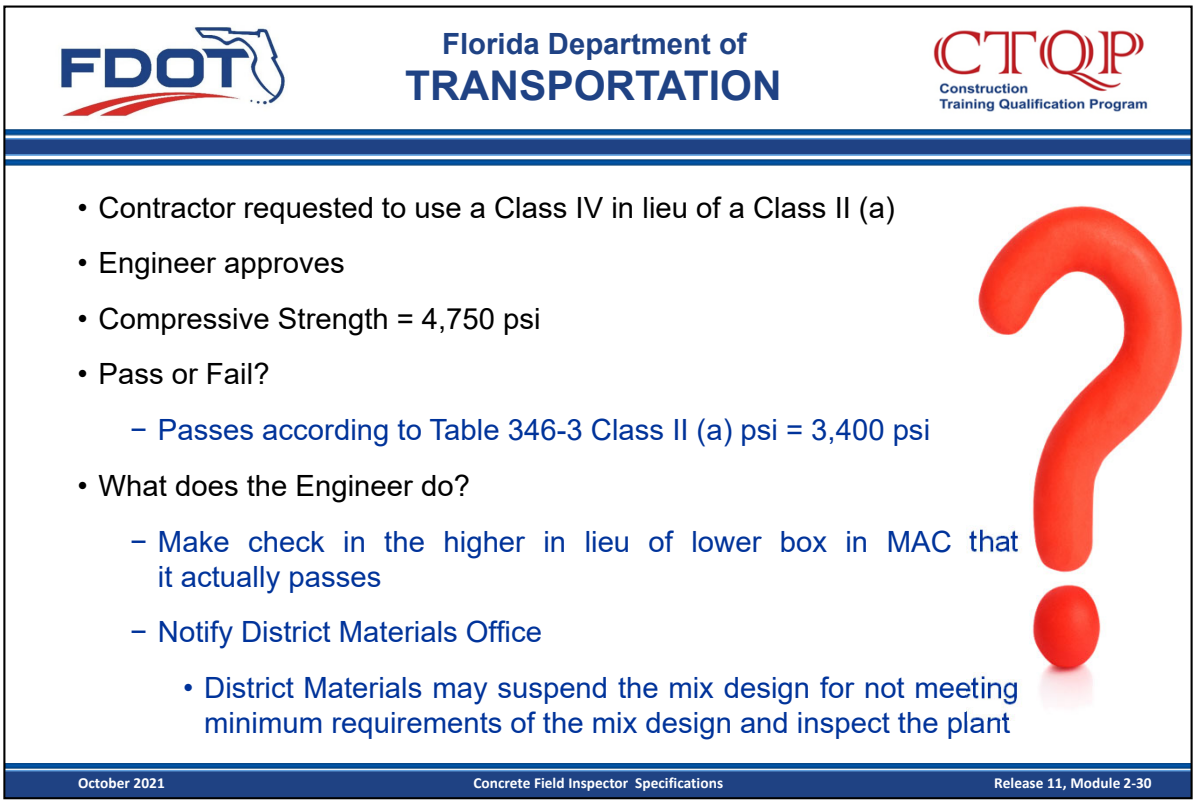


The target slump value in table 346-3 is used to calculate the tolerance range, along with language we will see later in 346-6.4



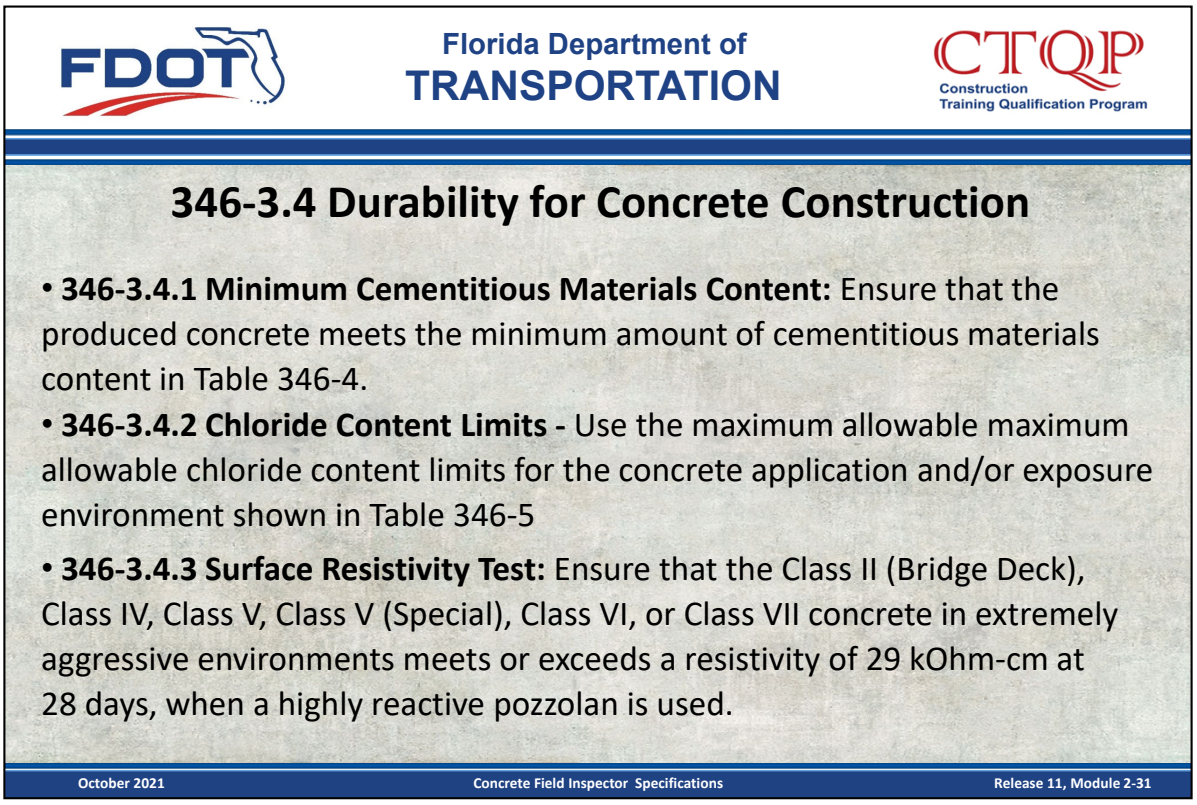
346-3.2 Concrete Class Substitutions: The Engineer may allow the substitution of a higher-class concrete in lieu of the specified class concrete when the substituted concrete mixes are included as part of the QC Plan, or for precast concrete, the Precast Concrete Producer QC Plan. The substituted higher-class concrete must meet or exceed the requirements of the specified class of concrete.

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 346-3 for the specified class of concrete. Do not place concrete with a slump more than plus or minus 1.5 inches from the target slump value specified in Table 346-3.



There is a difference between determining if the concrete is acceptable per the project (contract) specific acceptance requirements and the concrete not meeting the minimum mix designs requirements. The concrete in the example is acceptable based on the project specific requirements and is good enough to warrant full pay and no exception to the final project materials certification. It does not meet the minimum requirements for the specific class, which is a materials issue, not a project specific acceptance issue. The project personnel should notify the concrete personnel of the District Materials and Research Office (DMRO) that the sample did not meet the requirements of a Class IV mix. From that point, the DMRO will determine if there will be action taken on the concrete mix design and/or the production facility.

The test results indicate that the concrete is accepted based on the contract requirements. So, if the plans call for 4500 psi and the contractor deliver 5500 psi that meets strength the concrete is accepted at full pay. If the plans call for 4500 psi concrete and the contractor places 5500 psi concrete but only gets 5000 psi concrete the concrete is left in place at full pay, but the Engineer should notify the DMRO that the concrete did not meet its intended strength and the DMRO can then investigate the plant operations.



For durability of concrete, a minimum amount of total cementitious materials have been specified for each class of concrete based on the concrete applications and their environmental classifications, as described in Table 346-4. Additionally, there are limits on the maximum allowable chloride content of the concrete mixes, based on their applications and their environmental classifications, as described in **346-3.4.2 Chloride Content Limits.**

346-3.4.3 Surface Resistivity Test: Ensure that the Class II (Bridge Deck), Class IV, Class V, Class V (Special), Class VI, or Class VII concrete in extremely aggressive environments meets or exceeds a resistivity of 29 kOhm-cm at 28 days, when a highly reactive pozzolan is used.

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Table 346-4 Minimum Amount of Total Cementitious Materials Content (pounds per cubic yard of concrete)			
Concrete Application	Environmental Classification		
	Extremely Aggressive	Moderately Aggressive	Slightly Aggressive
Reinforced Concrete (1)	600	550	510
Non-reinforced Concrete	470		

Notes:
(1) The Engineer may allow a lower total amount of cementitious materials content in concrete Class I, Class I (Pavement), Class II and Class III.

Table 346-5 Chloride Content Limits for Concrete Construction		
Application/Exposure Environment		Maximum Allowable Chloride Content, (pounds per cubic yard of concrete)
Non-Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

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DRILLED SHAFTS



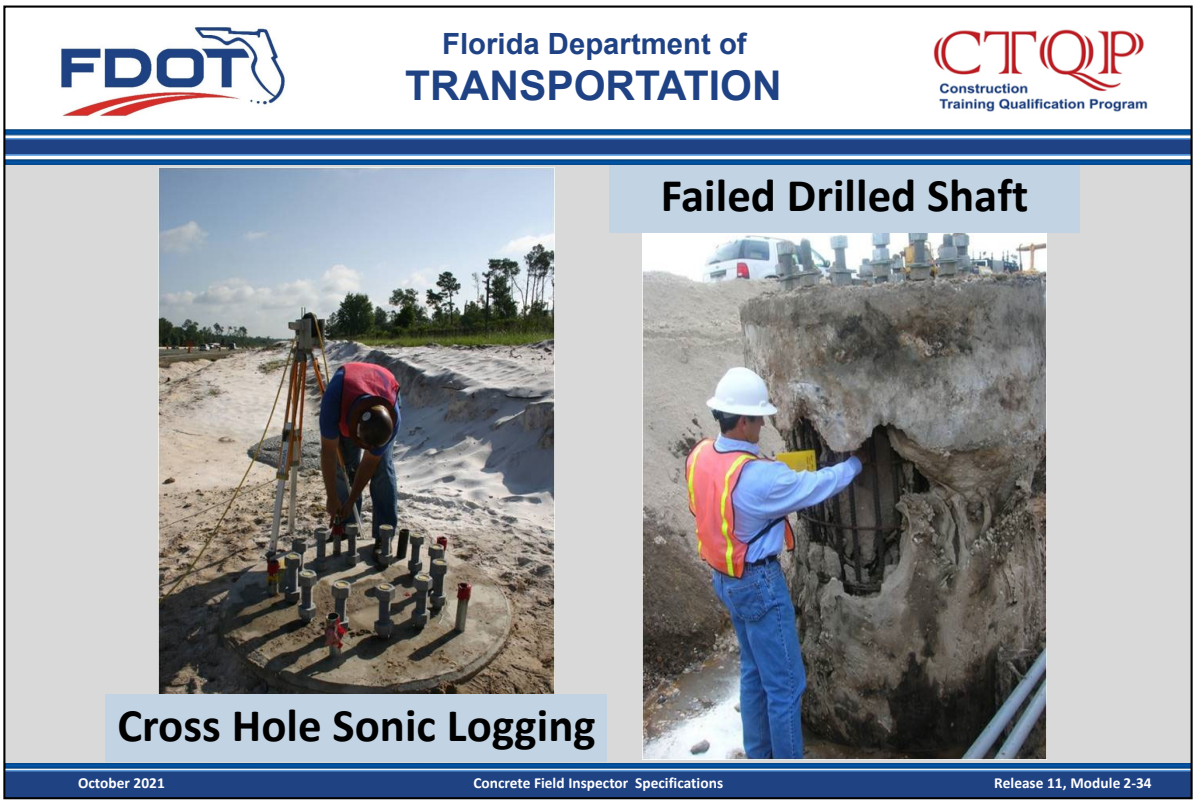


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These are drilled shafts in various stages of construction. Drilled shaft concrete is important because so many things can go wrong.

The left photo shows a drilled shaft with a temporary casing and being dewatered prior to placing the cage or any concrete.

The right photo shows the hose going into a drilled shaft which is typically used for during placement for dewatering or pumping out bentonite slurry, or other materials that may come to the top of the shaft while concrete is being placed.



The photo on the left illustrates preparation for cross-hole sonic logging (CSL). The drilled shaft on the right indicates that the concrete was not at the correct slump during the placement. The void may also have been caused by the slump loss data not being right for the amount of time needed to place the concrete or for the temperature at the time of placement.

This CSL testing gives a profile on the long axis of the drilled shaft and reveals if there are any voids. These voids in the shaft which are illustrated by the other picture on the slide. Unless the drilled shaft is excavated (as in the case of right-side picture) the voids cannot be detected by inspection.

In this example, the concrete was found to be not plastic enough to fill the shaft.

Testing for drilled shaft issues is complicated and careful placement and inspection during placement minimizes the need for forensic investigations.

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- Drilled Shaft concrete has specific slump loss requirements
  - The slump loss procedure is performed by the Producer and observed by the District Materials Office



- Concrete elapsed time =
  - Mixing time + transit time + concrete placement time for entire shaft + time for removal of any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the temporary casing + bolt/embedment installation

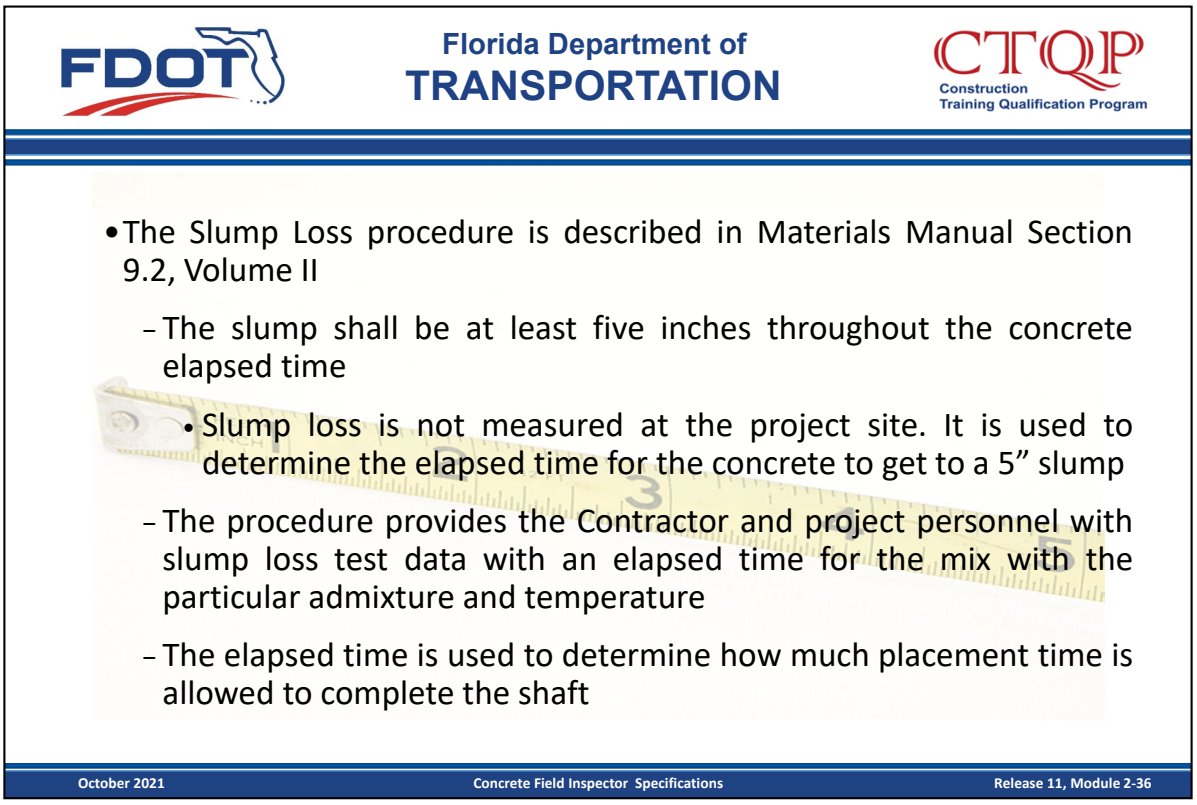
Photo of an excavated drilled shaft showing unacceptable placement.

- The concrete elapsed time is not the same as the transit time for an individual load of concrete.
- The concrete was not fluid enough to pass through the reinforcing steel cage so now there is no protection for the steel.

The concrete should not be accepted unless the delivery ticket admixture dosage rate matches the slump loss data provided with the concrete mix design.

346-3.1 Drilled Shaft Concrete: When drilled shaft concrete is placed, provide concrete in accordance with the specified slump loss requirements.

Test each load of concrete for slump to ensure the concrete is within the limits of 346. Initially cure acceptance cylinders for 48 hours before transporting to the laboratory. The concrete elapsed time is the sum of the mixing time, transit time, the placement time for the entire shaft, the time required for removal of any temporary casing that causes or could cause the concrete to flow into the space previously occupied by the temporary casing and bolt/embedment installation.



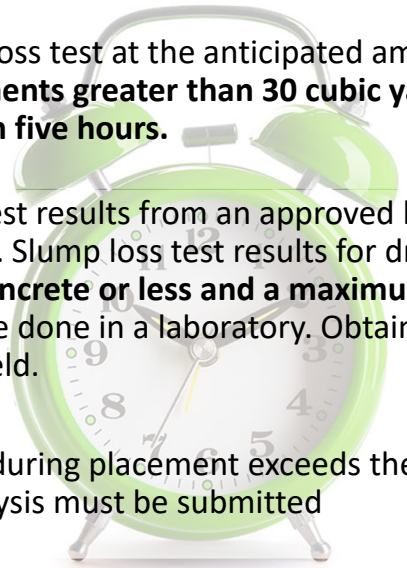
Don’t confuse the 5” slump shown here with the slump target value in Table 346-3.

- This 5” slump is used in the slump loss test for determining the elapsed time before the concrete is no longer fluid enough to be acceptable.
- The slump loss limit is determined by the time it takes for the concrete to reach a 5” slump.

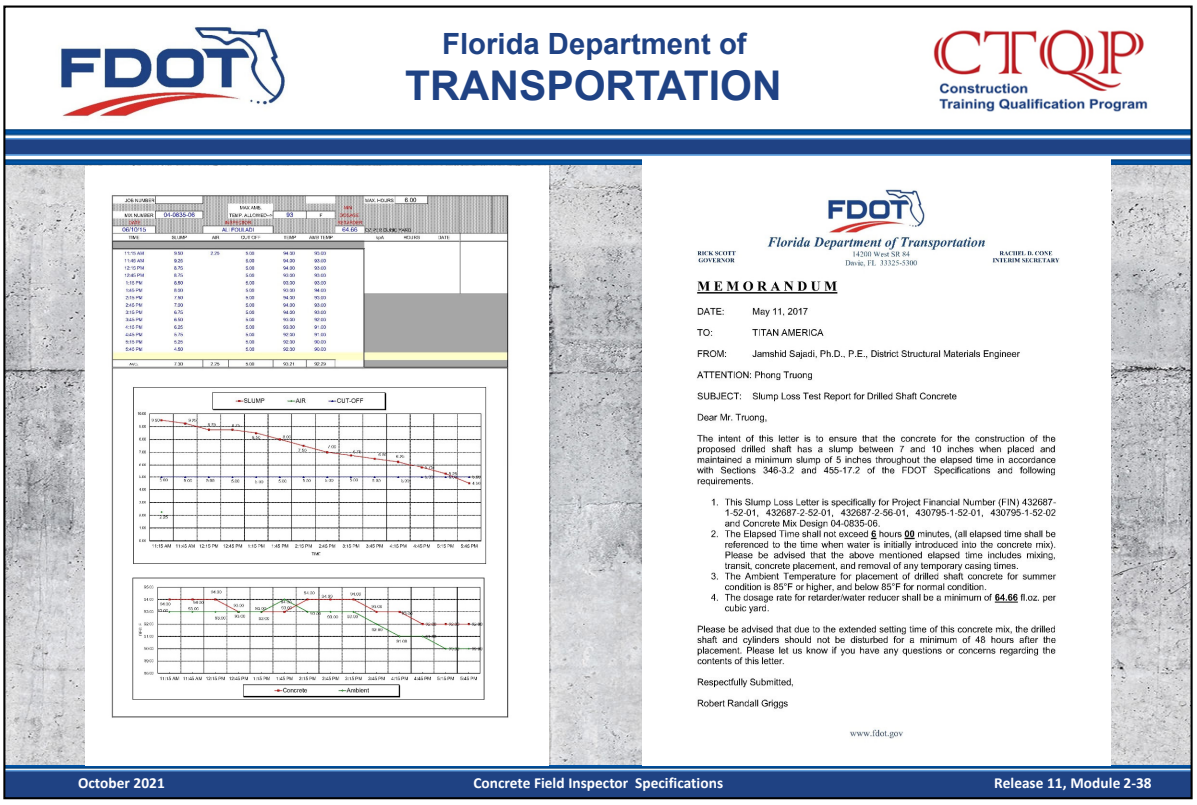
Slump loss test requirements: Provide slump loss tests before drilled shaft concrete operations begin, demonstrating that the drilled shaft concrete maintains a slump of at least 5” throughout the concrete elapsed time. Inform the Engineer at least 48 hours before performing such tests. Perform slump loss testing of the drilled shaft mix using personnel meeting the requirements of Materials Manual Volume II Section 9.2. The ambient temperature conditions for placing drilled shaft concrete for summer condition is 85°F or higher or the normal condition below 85°F. Obtain slump loss test results from an approved laboratory or from a field demonstration.

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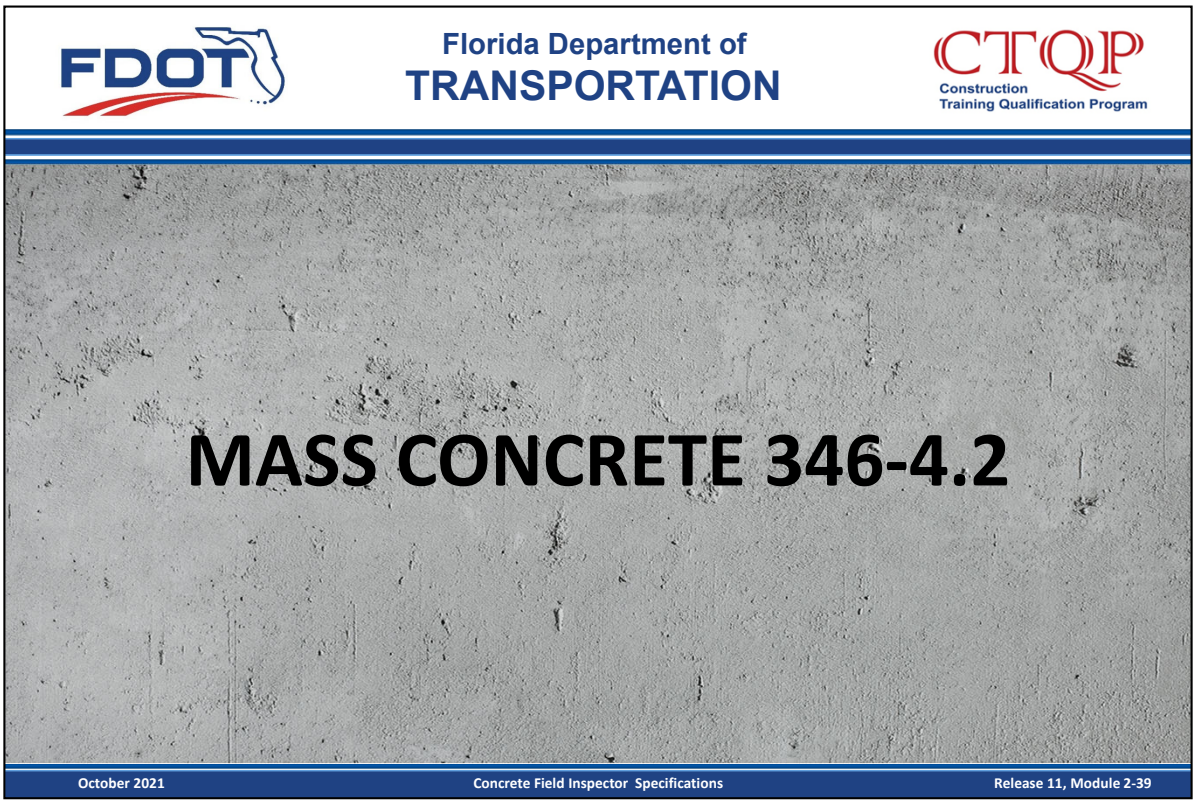
- Perform the slump loss test at the anticipated ambient temperature for **drilled shaft placements greater than 30 cubic yards and an elapsed time of greater than five hours.**
- Obtain slump loss test results from an approved laboratory or from a field demonstration. Slump loss test results for drilled shafts requiring **30 cubic yards of concrete or less and a maximum elapsed time of five hours or less** may be done in a laboratory. Obtain all other slump loss test results in the field.
- If the elapsed time during placement exceeds the slump loss test data, an engineering analysis must be submitted

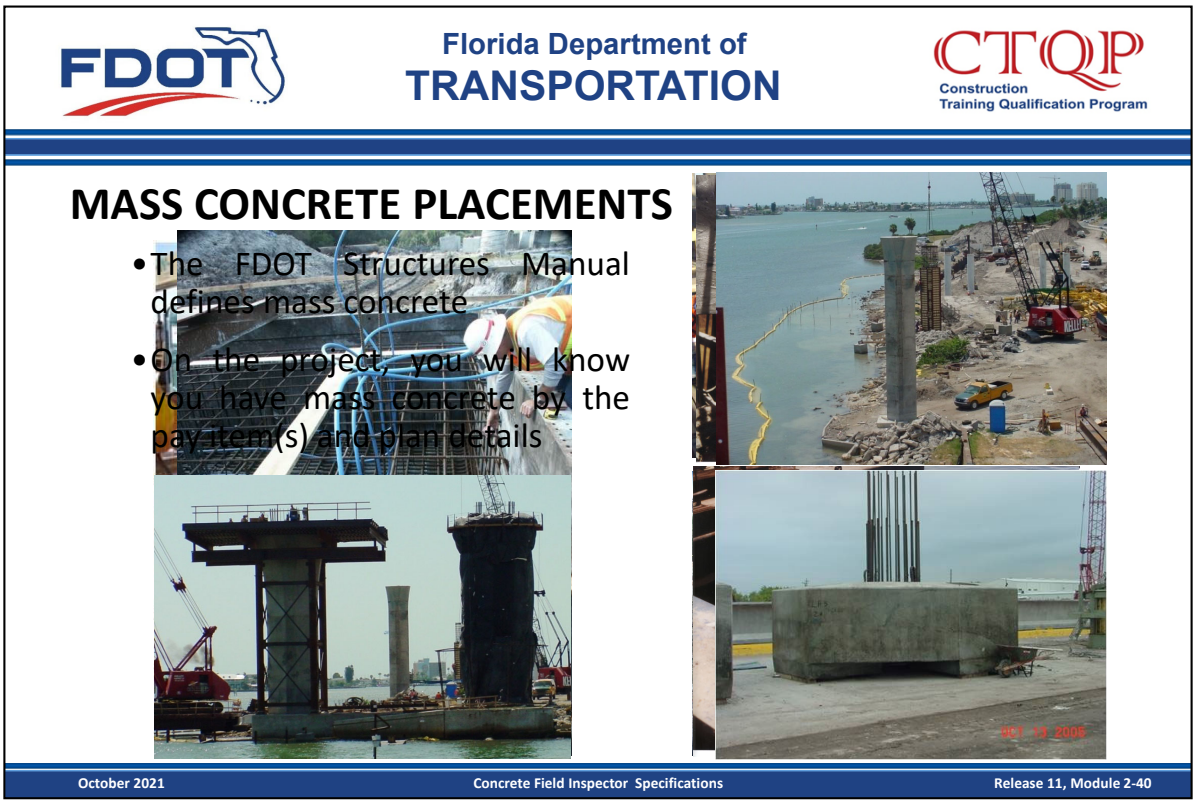


This graph on the left is generated from the data gathered in the slump loss test. It vividly demonstrates the importance of time in the placement of drilled shaft concrete. As elapsed time passes, the concrete slump decreases until there is a drastic drop off, around six hours in this example.

Obtain the Engineer's approval of slump loss test results in terms of elapsed time before concrete placements.

The Memorandum on the right shows an example of the drilled shaft slump loss test data, including the elapsed time of 6 hours. The concrete elapsed time is defined in Section 455. In the 2021 version of the Standard Specifications, drilled shaft is included in Section 346-4.1.


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MASS CONCRETE 346-4.2
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Photos of mass concrete elements showing placement and insulation.

The department's definition of mass concrete is not cut and dry. It is the designer's responsibility to determine if an element should be designated as mass concrete and noted on the plan sheet for that structure. If you have a question why a particular element is designated as mass concrete or why it is not, contact the engineer of record.

346-4.2 Mass Concrete:

When mass concrete is designated in the Contract Documents, provide an analysis, by a Specialty Engineer, of the anticipated thermal developments in the mass concrete elements for all expected project temperature ranges using the selected mix design, casting procedures, and materials.

Describe the measures and procedures intended for use to maintain a temperature differential of 35°F or less between the interior core center and exterior surface(s) of the designated mass concrete elements during curing. Submit both the mass concrete mix design and the proposed mass concrete plan to monitor and control the temperature differential to the Engineer for acceptance. Provide temperature monitoring devices to record temperature development between the interior core center and exterior surface(s) of the elements in accordance with the accepted mass concrete plan.





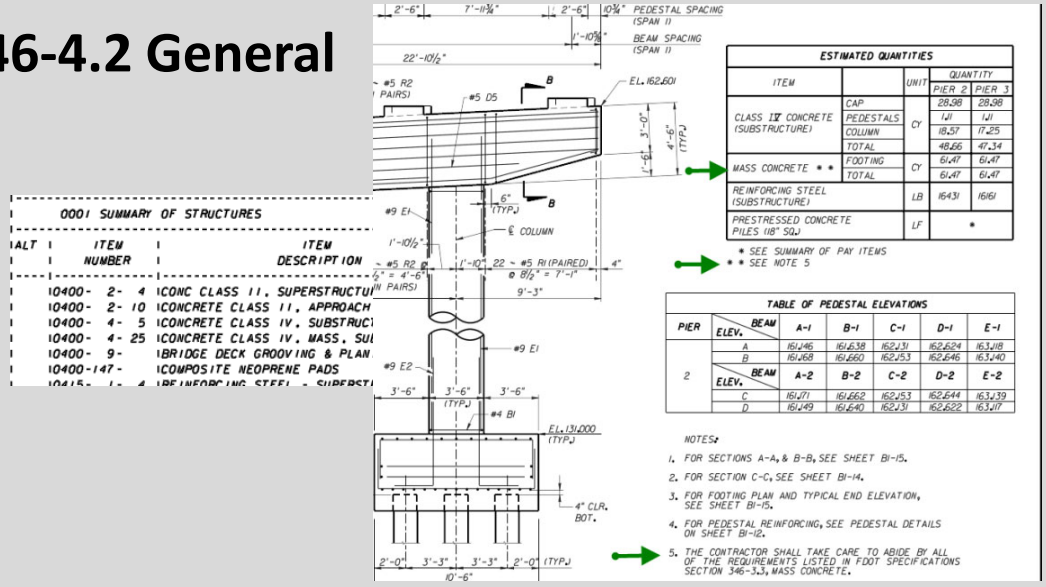




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346-4.2 General



0001 SUMMARY OF STRUCTURES

ALT	ITEM NUMBER	ITEM DESCRIPTION
	10400- 2- 4	CONC CLASS II, SUPERSTRUCTU
	10400- 2- 10	CONCRETE CLASS II, APPROACH
	10400- 4- 5	CONCRETE CLASS IV, SUBSTRUC
	10400- 4- 25	CONCRETE CLASS IV, MASS, SU
	10400- 9-	BRIDGE DECK GROOVING & PLAN
	10400-147-	COMPOSITE NEOPRENE PADS

ESTIMATED QUANTITIES

ITEM		UNIT	QUANTITY PIER 2	QUANTITY PIER 3
CLASS IV CONCRETE (SUBSTRUCTURE)	CAP	CY	28.98	28.98
	PEDESTALS		1.11	1.11
	COLUMN		18.57	17.25
	TOTAL		48.66	47.34
MASS CONCRETE * *	FOOTING	CY	61.47	61.47
	TOTAL		61.47	61.47
REINFORCING STEEL (SUBSTRUCTURE)		LB	16431	16161
PRESTRESSED CONCRETE PILES (18" SQ.)		LF	*	

* SEE SUMMARY OF PAY ITEMS
* * SEE NOTE 5

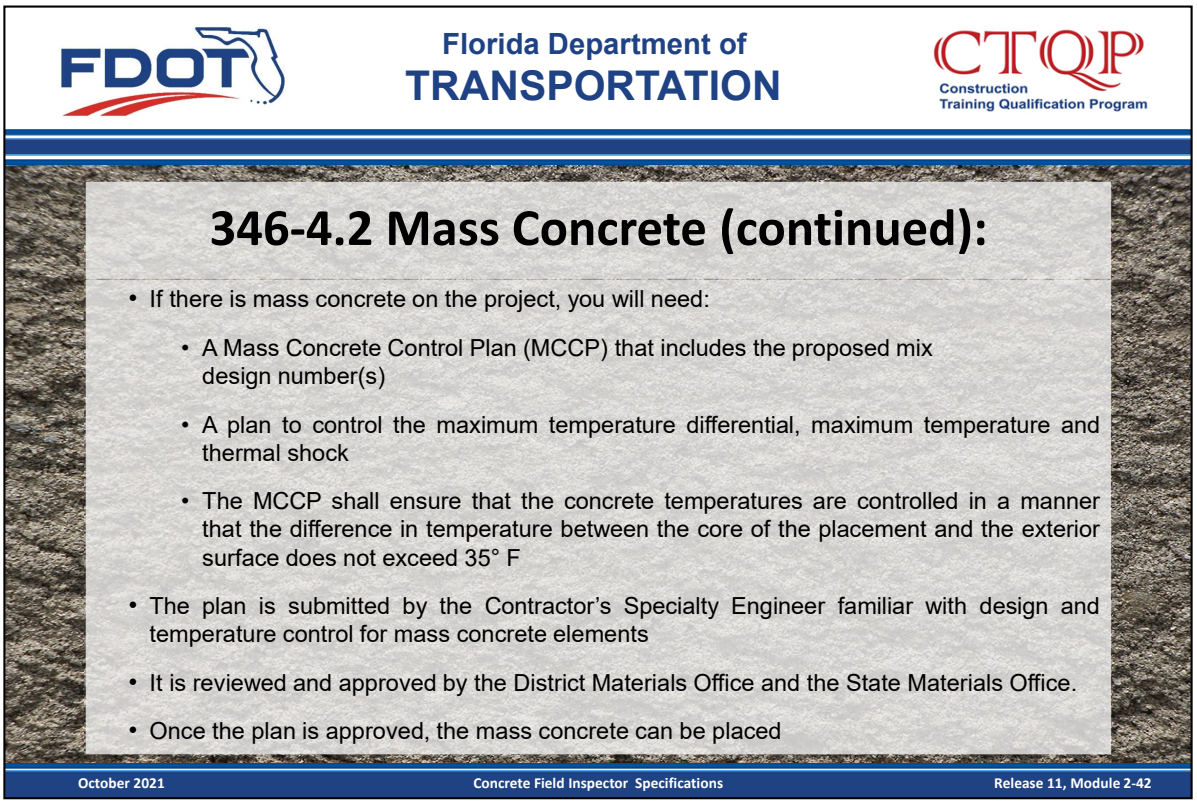
TABLE OF PEDESTAL ELEVATIONS

PIER	BEAM / ELEV.	A-1	B-1	C-1	D-1	E-1
2	A	161.46	161.38	162.31	162.24	163.18
	B	161.68	161.60	162.53	162.46	163.40
	BEAM / ELEV.	A-2	B-2	C-2	D-2	E-2
	C	161.71	161.62	162.53	162.44	163.39
	D	161.49	161.40	162.31	162.22	163.17

NOTES:
1. FOR SECTIONS A-A, & B-B, SEE SHEET BI-15.
2. FOR SECTION C-C, SEE SHEET BI-14.
3. FOR FOOTING PLAN AND TYPICAL END ELEVATION, SEE SHEET BI-15.
4. FOR PEDESTAL REINFORCING, SEE PEDESTAL DETAILS ON SHEET BI-12.
5. THE CONTRACTOR SHALL TAKE CARE TO ABIDE BY ALL OF THE REQUIREMENTS LISTED IN FDOT SPECIFICATIONS SECTION 346-3.3, MASS CONCRETE.

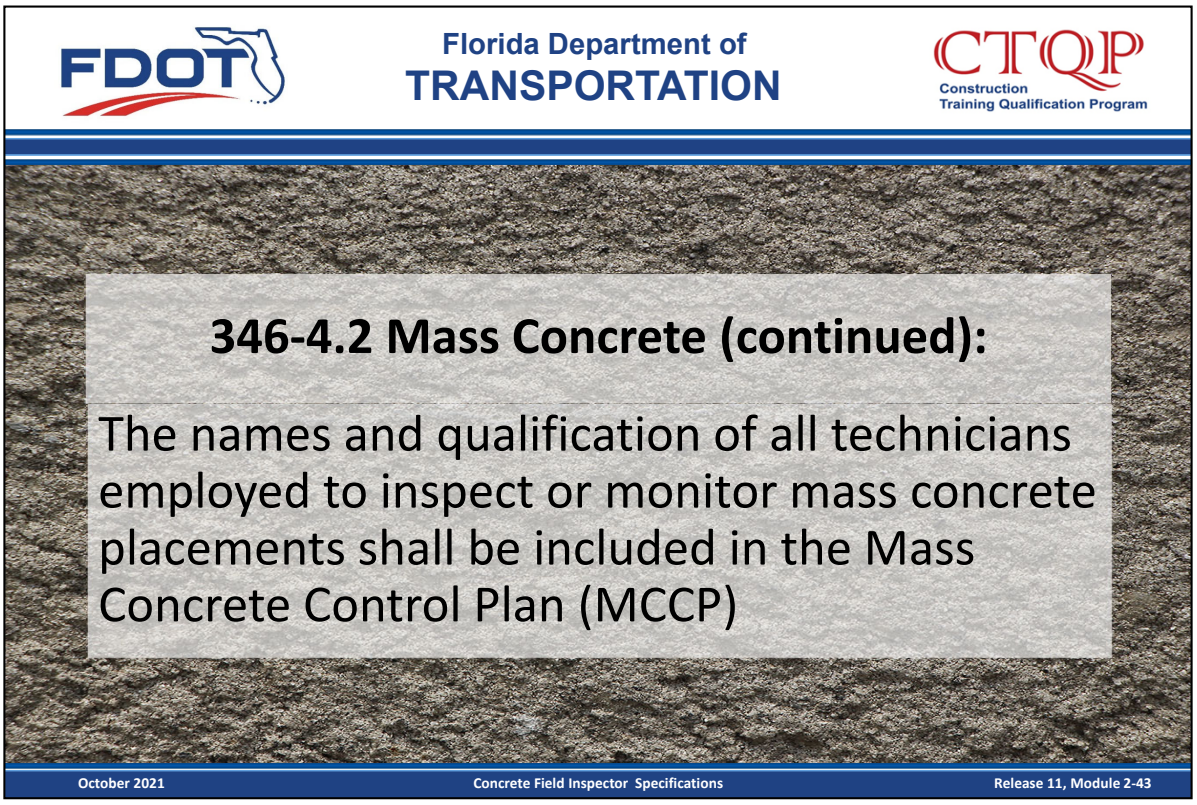
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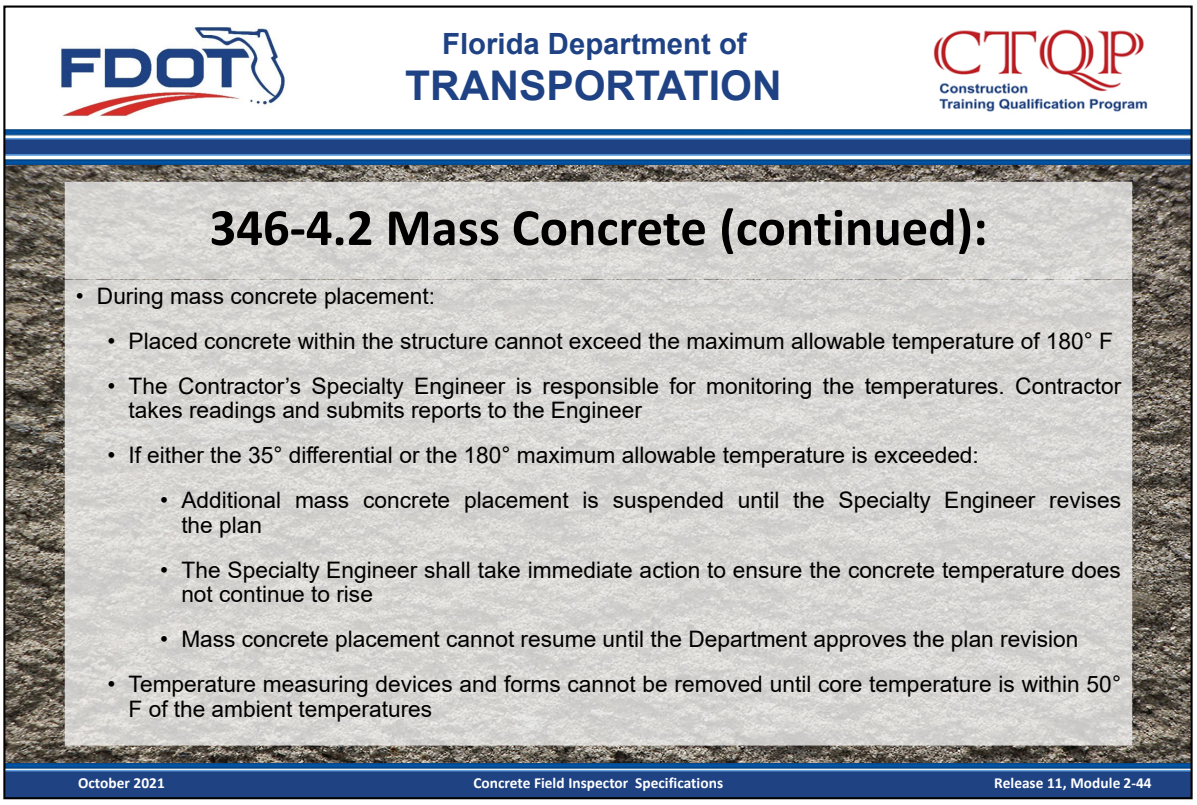
You will see which element or elements are mass concrete by the plan details and notes. again, if you have a question relating to whether or not something should be designated for mass concrete, contact the Engineer of Record.



346-4.2 Mass Concrete (continued):

The Specialty Engineer, or a qualified technician employed by the Specialty Engineer, shall personally inspect and approve the installation of monitoring devices and verify that the process for recording temperature readings is effective for the first placement of each size and type mass component. The names and qualification of all technicians employed to inspect or monitor mass concrete placements shall be included in the Mass Concrete Control Plan (MCCP).


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346-4.2 Mass Concrete (continued):
The names and qualification of all technicians employed to inspect or monitor mass concrete placements shall be included in the Mass Concrete Control Plan (MCCP)
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Don't confuse the maximum temperature of 180°f with the maximum allowable concrete temperature from 346-7.5 of 85°f or 100°f. This temperature is for the maximum temperature of the concrete after placement in the forms, not maximum delivered concrete. in some cases, the mass concrete mix design will designate a maximum temperature for the delivered concrete that will be less than 85°f or 100°f. This is done in order to control the concrete temperature and shall be verified by project personnel if the MCCP requires it.

Section 400 has language for form removal, this does not apply to mass concrete. Form removal for mass concrete is determined by the MCCP, not the time frames in 400-14 Removal of Forms. This is required to reduce thermal shock and prevent cracking.

346-4.2 Mass Concrete (continued):

If the 35°F differential or the 180°F maximum allowable temperature has been exceeded, take immediate action as directed by the Specialty Engineer to retard further growth of the temperature differential. Describe methods of preventing thermal shock in the MCCP. Use a Specialty Engineer to revise the previously accepted plan to ensure compliance on future placements. Do not place any mass concrete until the Engineer has accepted the MCCP.

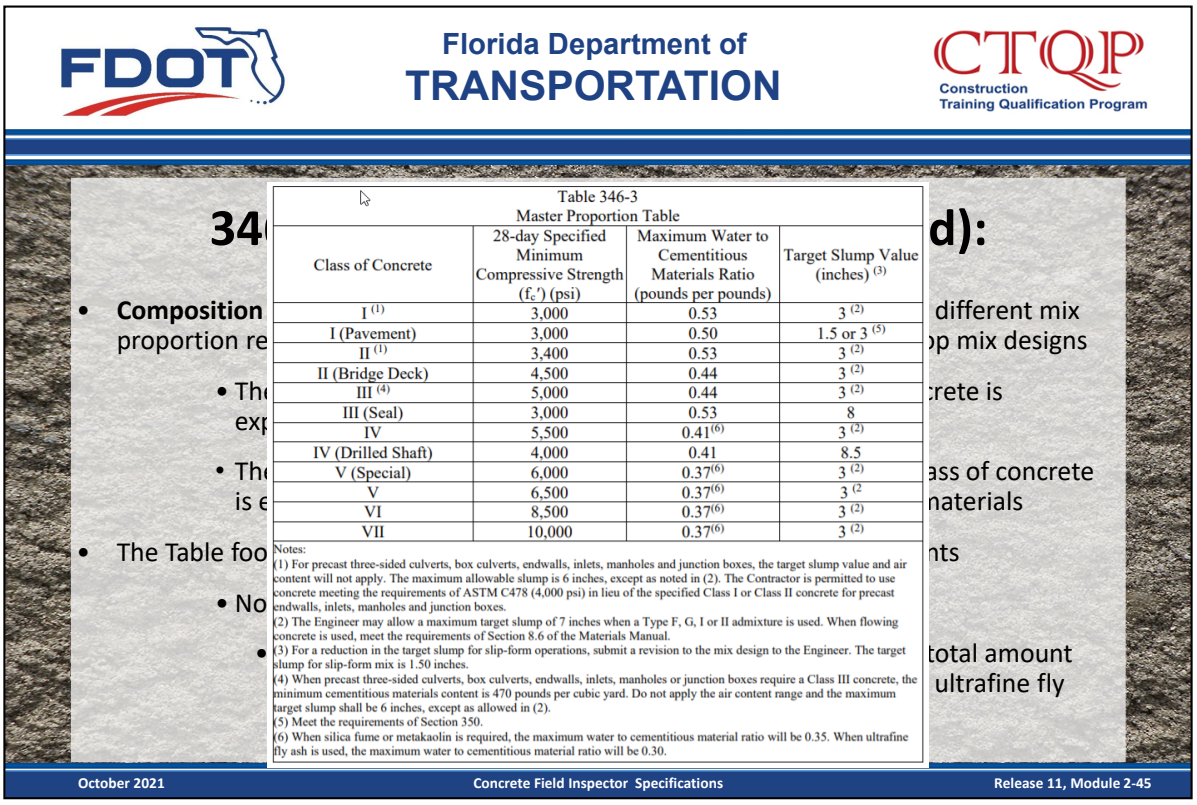


Table 346-3
Master Proportion Table

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I (1)	3,000	0.53	3 (2)
I (Pavement)	3,000	0.50	1.5 or 3 (5)
II (1)	3,400	0.53	3 (2)
II (Bridge Deck)	4,500	0.44	3 (2)
III (4)	5,000	0.44	3 (2)
III (Seal)	3,000	0.53	8
IV	5,500	0.41(6)	3 (2)
IV (Drilled Shaft)	4,000	0.41	8.5
V (Special)	6,000	0.37(6)	3 (2)
V	6,500	0.37(6)	3 (2
VI	8,500	0.37(6)	3 (2)
VII	10,000	0.37(6)	3 (2)

Notes:
(1) 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 (2). The Contractor is permitted to use concrete meeting the requirements of ASTM C478 (4,000 psi) in lieu of the specified Class I or Class II concrete for precast endwalls, inlets, manholes and junction boxes.
(2) 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, meet the requirements of Section 8.6 of the Materials Manual.
(3) 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.
(4) 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 (2).
(5) Meet the requirements of Section 350.
(6) When silica fume or metakaolin is required, 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.

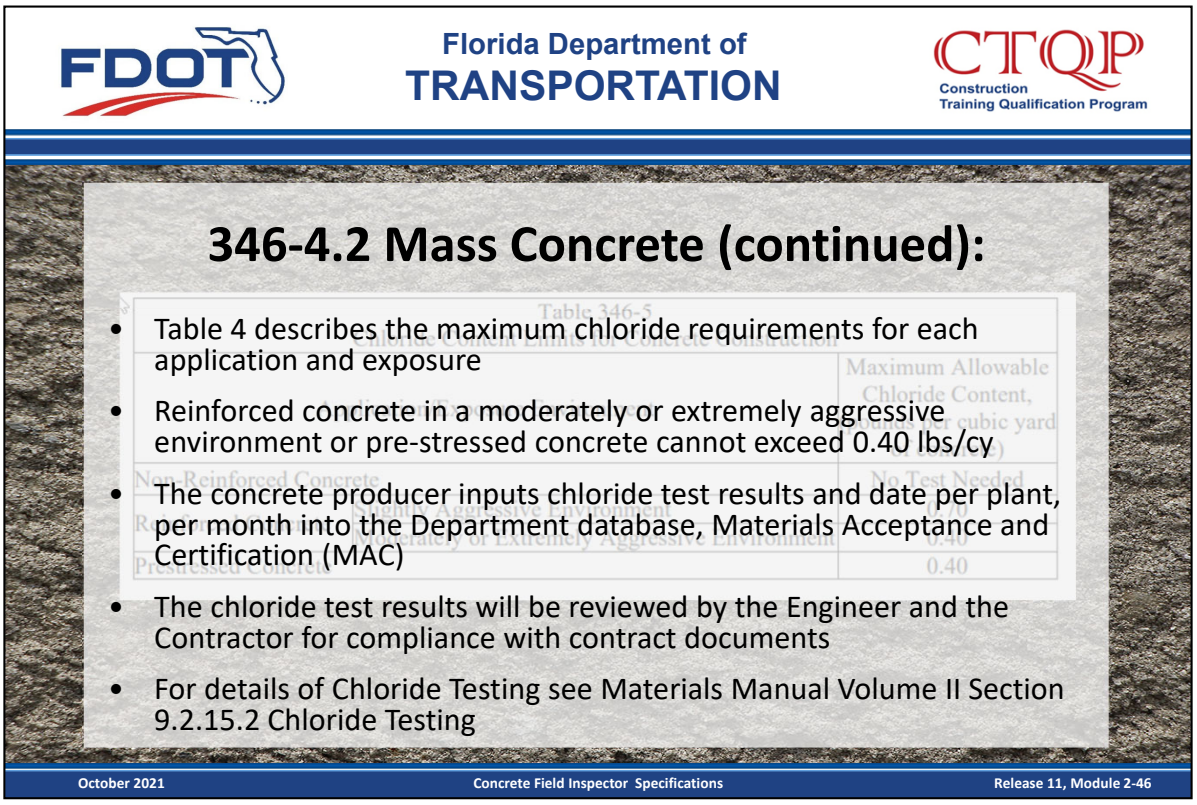
Table 346-3 also lists the maximum water to cementitious materials ratio allowed for a particular class of concrete. the water to cementitious ratio for a particular concrete mix design may be less than that shown in table 346-3, but it cannot be more. The maximum water to cementitious material ratio should be determined by the concrete mix design requirements, not this table.

Note ** applies to Class IV, Class V (special), Class V, and Class VI – the w/cm ratio is reduced when silica fume or metakaolin is required, not just because the concrete mix design may contain silica fume or metakaolin. If the contract or plan notes denote that the contractor **shall** use silica fume or metakaolin, then the ** footnote limits apply.

TABLE 3

Class of Concrete	Minimum Total Cementitious Materials Content lb/yd^3	*Maximum Water to Cementitious Materials Ratio lb/lb
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**

*The calculation of the water to cementitious materials ratio (w/cm) is based on the total cementitious material including cement and any supplemental cementitious materials that are used in the mix.
**When the use of silica fume or metakaolin is required, the maximum water to cementitious material ratio will be 0.35. When the use of ultrafine fly ash is required, the maximum water to cementitious material ratio will be 0.30.



The Producer may elect to test only the mix design with the greatest cementitious content.

When this language was originally included in 346, the department required the producer to submit a **separate certification** for the chloride results. The requirement has since been relaxed and the chloride contents are now reported in the department database, MAC.

A summary of chloride test reports will be developed for use.

346-3.4.2 Chloride Content Limit

Ensure that the chloride content of all produced reinforced concrete does not exceed the maximum allowable limits specified in Table 346-5. When the source of any component material, including admixtures, for the concrete is changed, sampling for chloride determination shall restart the first day of production of the mix with the new component material.

Ensure the chloride test results from the testing lab are submitted to the concrete production facility within fourteen calendar days.

TABLE 4

Application/Exposure Environment		Maximum Allowable Chloride Content, lb/yd^3
Non Reinforced Concrete		No Test Needed
Reinforced Concrete	Slightly Aggressive Environment	0.70
	Moderately or Extremely Aggressive Environment	0.40
Prestressed Concrete		0.40

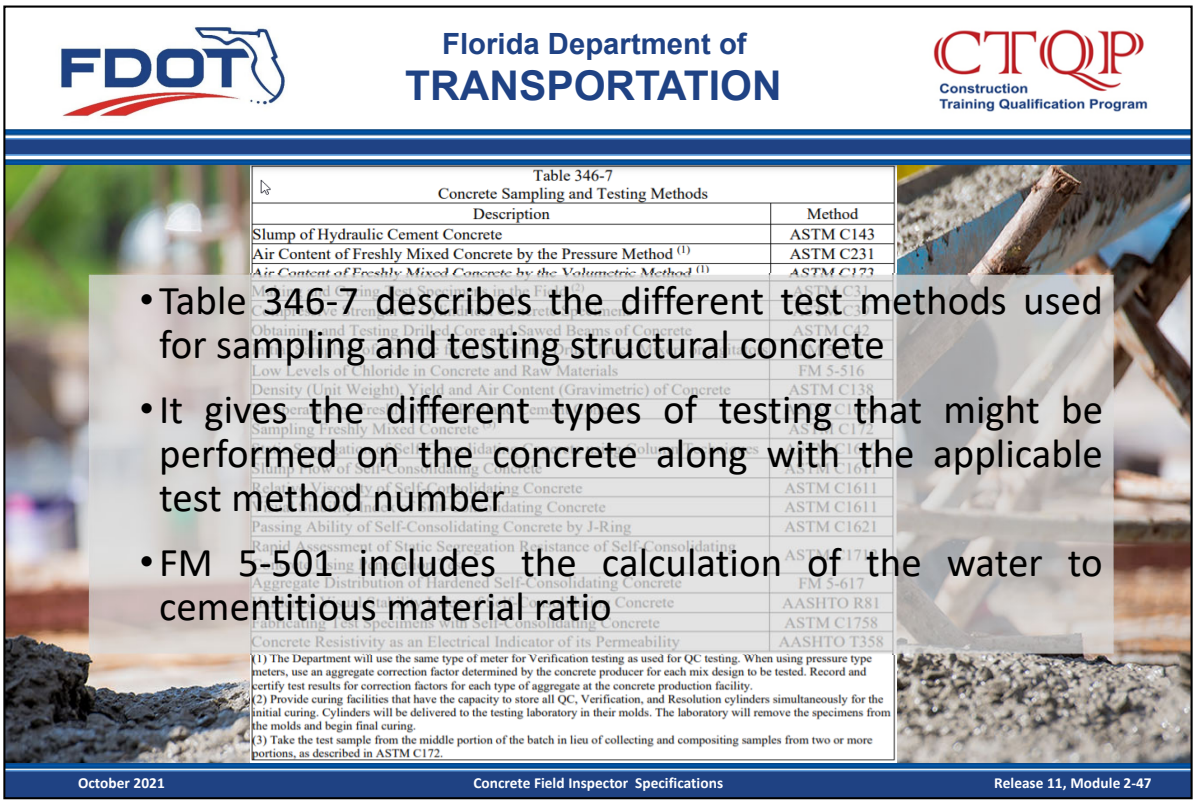


TABLE 5	
Description	Method
Slump of Hydraulic Cement Concrete	ASTM C 143
Air Content of Freshly Mixed Concrete by the Pressure Method*	ASTM C 231
Air Content of Freshly Mixed Concrete by the Volumetric Method*	ASTM C 173
Making and Curing Test Specimens in the Field	ASTM C 31
Compressive Strength of Cylindrical Concrete Specimens**	ASTM C 39
Obtaining and Testing Drilled Core and Sawed Beams of Concrete	ASTM C 42
Early Sampling of Fresh Concrete from Revolving Drum Truck Mixers or Agitators	FM 5-501
Low Levels of Chloride in Concrete and Raw Materials	FM 5-516
Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete	ASTM C 138
Temperature of Freshly Mixed Portland Cement Concrete	ASTM C 1064
Sampling Freshly Mixed Concrete	ASTM C 172
Static Segregation of Self Consolidating Concrete using Column Techniques	ASTM C 1610
Slump Flow of Self Consolidating Concrete	ASTM C 1611
Passing Ability of Self Consolidating Concrete by J-Ring	ASTM C 1621
Concrete Resistivity as an Electrical Indicator of its Permeability	FM 5-578
*Use the same type of meter for QC tests as the Department uses for Verification testing. When using pressure type meters, use an aggregate correction factor determined by the concrete producer for each mix design to be tested. Record and certify test results for correction factors for each type of aggregate at the concrete production facility. **Use 4 x 8 or 6 x 12 inch cylinders for determination of the compressive strength.	

All the test methods shown in Table 346-7 are national standards (ASTM) except FM 5-501, FM 5-516, and FM 5 -617. Florida Sampling and Testing Methods (FSTM) are used when the national standard does not address a material or testing issue unique to Florida, like chloride content.
Curing requirements are defined by ASTM C31. The contractor is responsible for providing initial curing for all test cylinders in accordance with ASTM C31.

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CTQP Construction Training Qualification Program

346-5 Sampling and Testing Methods

Footnote (1) Applies to air content testing.
- The Department must use the same type of meter Verification Testing as Quality Control testing

Footnote (2) Applies to compressive strength testing.
- ASTM C31 Provide a curing facility with the capacity to store QC, V, IV, & Resolution cylinders simultaneously for the initial curing

Footnote (3) Applies to concrete sampling.
- Take the test sample from the middle portion of the batch in lieu of collecting and compositing samples from two or more portions, as described in ASTM C17



CURING BOXES

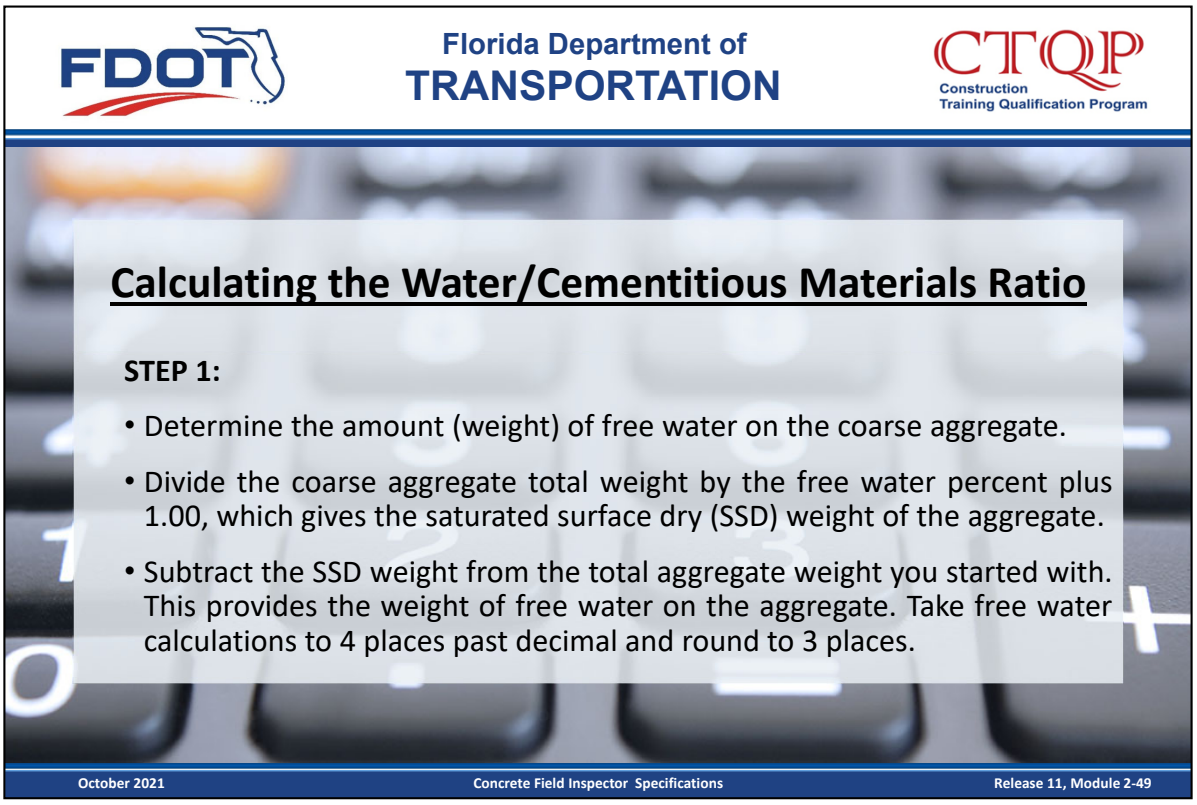


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The initial curing temperature shall be maintained between 60° and 80° F for mixes with a specified strength of less that 6000 psi. For mixes with a specified strength of 6000 psi or greater, the initial curing temperature shall be between 68° and 78° F.

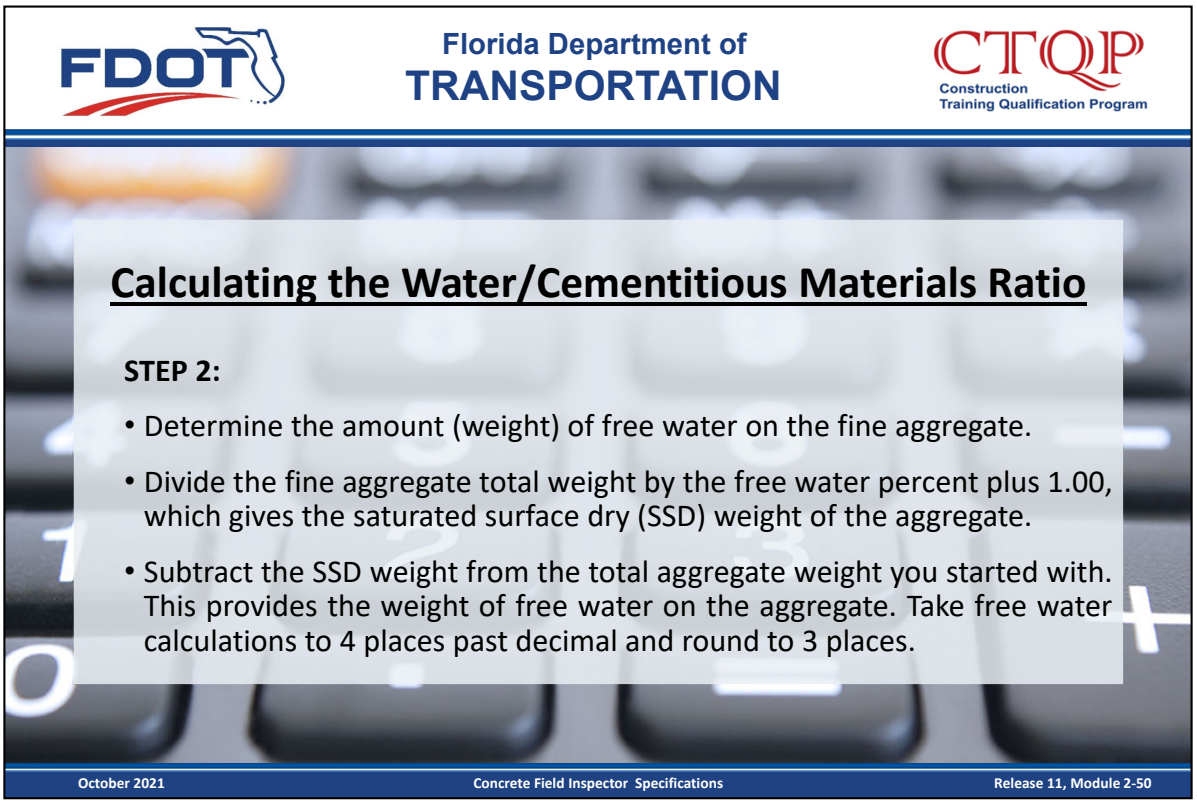
ASTM C172 is the test method that defines sampling concrete. The sample is taken from the middle portion of the load as a single sample (the composite sampling has been waived). There are two different test methods for determining the air content of concrete. Either one may be used, depending on the concrete mix design components or other determining factors. The technician should be familiar with which method is being used and report the results accordingly. Most laboratories prefer the use of 4” x 8” cylinders because it puts less strain on the compressive testing machines, especially on very high strength mixes. The verification technician will use the same size cylinders as the quality control technician

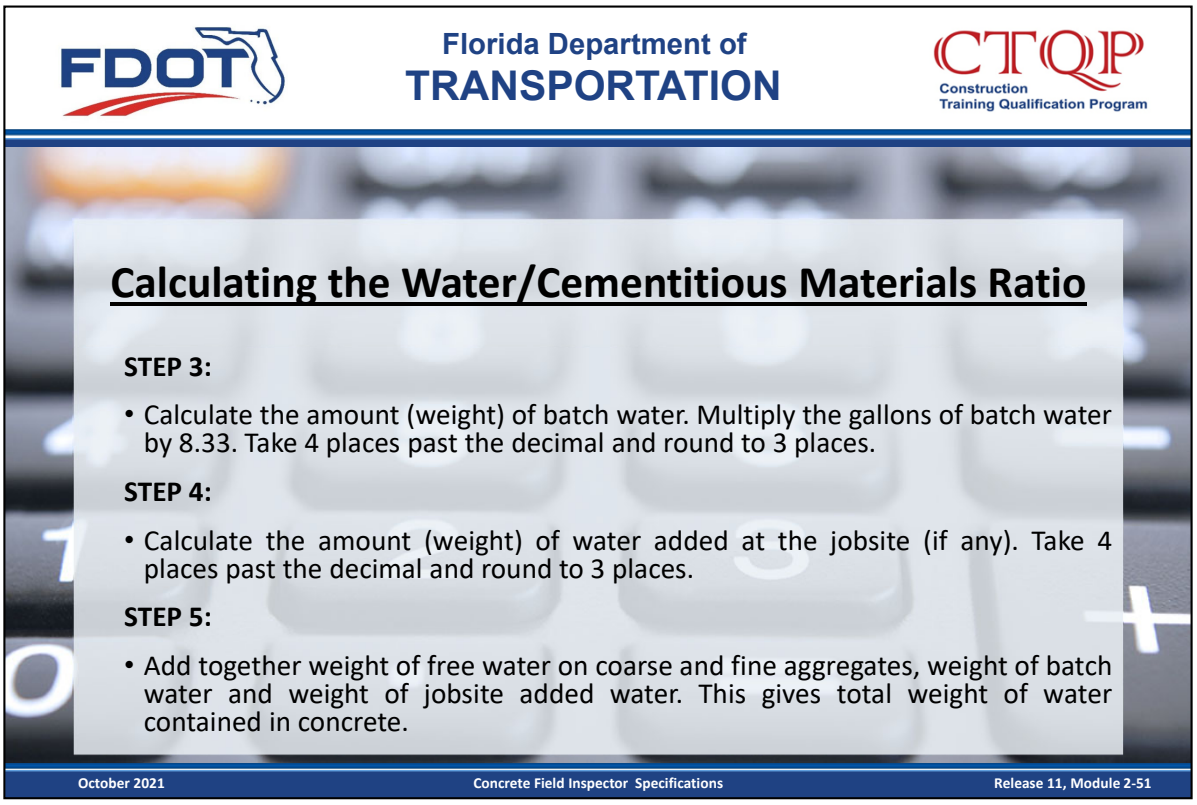
This includes a curing box (pictured above) with adequate storage room for all cylinders, temperature control (hi/lo thermometer typically used).

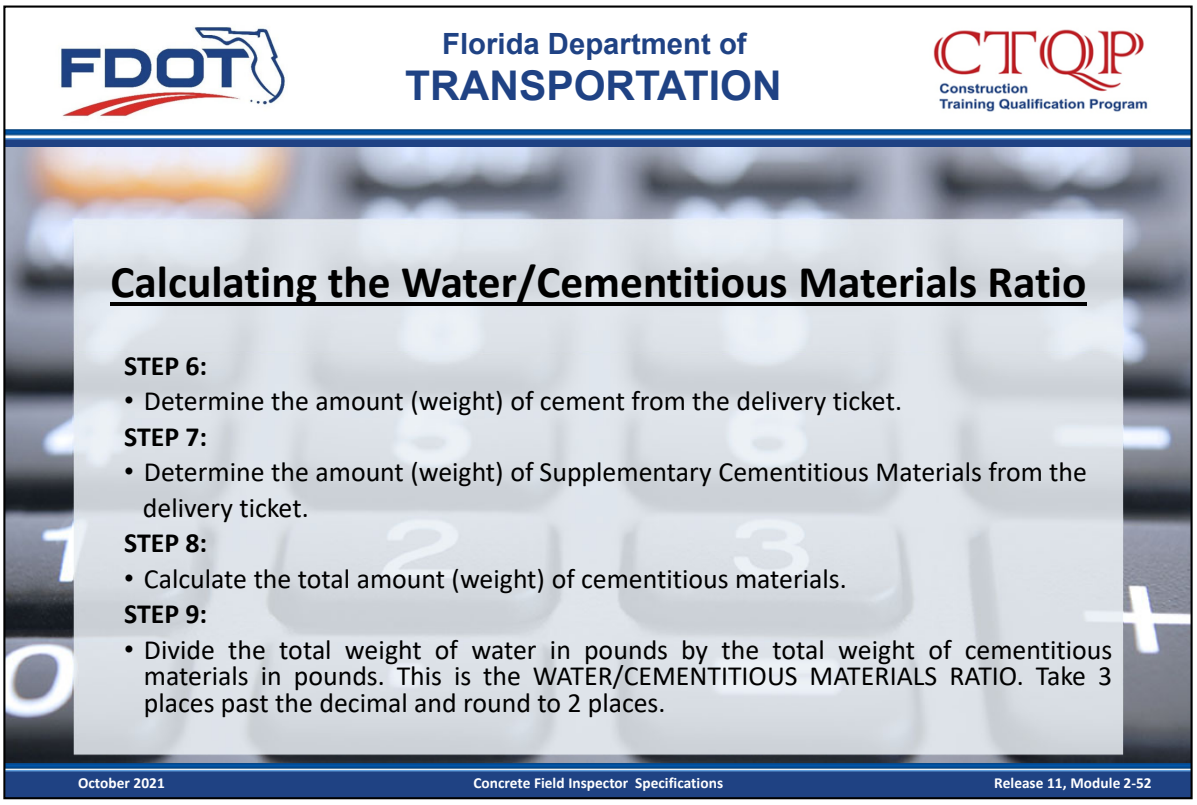


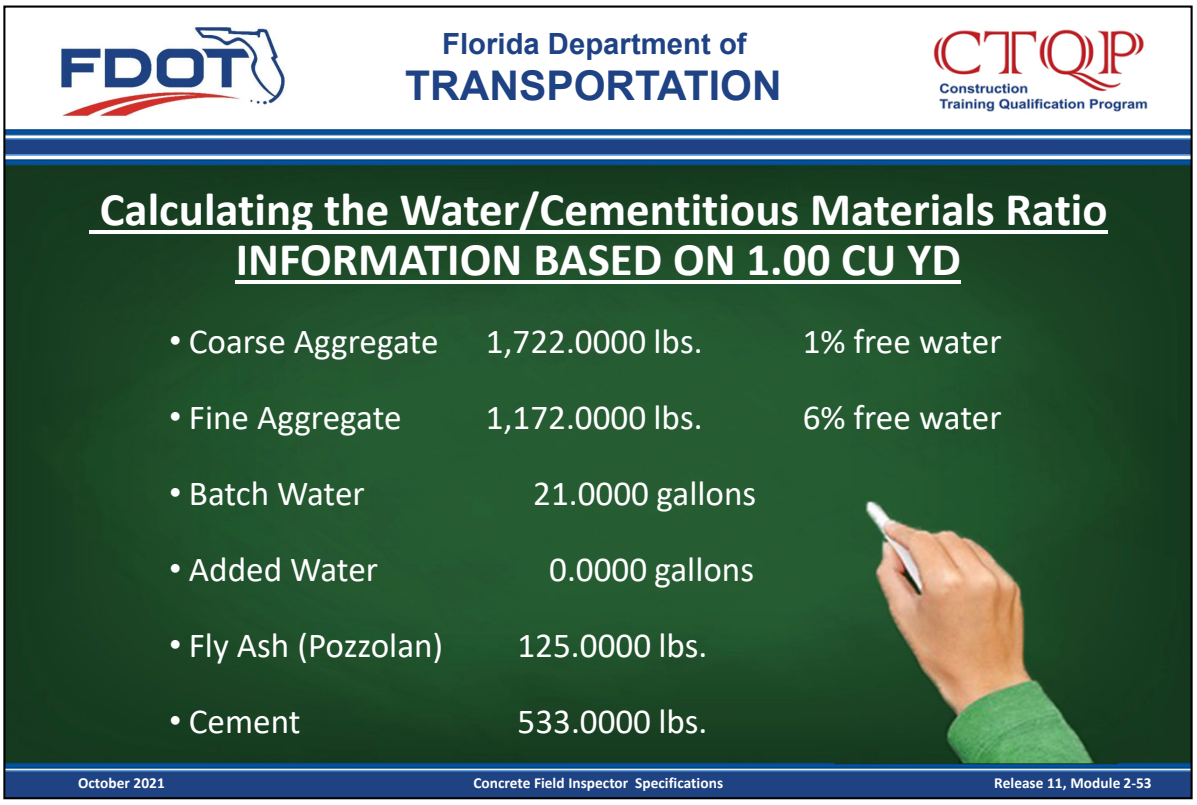
The Water/Cementitious Materials Ratio (W/CM) is a calculation you must become proficient at performing. Ensure that this is the first thing that is completed on testing.

A website (app) may be used to determine the water/cementitious ratio in lieu of the instructions in FM 5-501. The website (app) must be initially verified by comparing the results from the website (app) with calculation from FM 5-501.


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Calculating the Water/Cementitious Materials Ratio
STEP 2:
• Determine the amount (weight) of free water on the fine aggregate.
• Divide the fine aggregate total weight by the free water percent plus 1.00, which gives the saturated surface dry (SSD) weight of the aggregate.
• Subtract the SSD weight from the total aggregate weight you started with. This provides the weight of free water on the aggregate. Take free water calculations to 4 places past decimal and round to 3 places.
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Calculating the Water/Cementitious Materials Ratio
STEP 3:
• Calculate the amount (weight) of batch water. Multiply the gallons of batch water by 8.33. Take 4 places past the decimal and round to 3 places.
STEP 4:
• Calculate the amount (weight) of water added at the jobsite (if any). Take 4 places past the decimal and round to 3 places.
STEP 5:
• Add together weight of free water on coarse and fine aggregates, weight of batch water and weight of jobsite added water. This gives total weight of water contained in concrete.
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Calculating the Water/Cementitious Materials Ratio
STEP 6:
• Determine the amount (weight) of cement from the delivery ticket.
STEP 7:
• Determine the amount (weight) of Supplementary Cementitious Materials from the delivery ticket.
STEP 8:
• Calculate the total amount (weight) of cementitious materials.
STEP 9:
• Divide the total weight of water in pounds by the total weight of cementitious materials in pounds. This is the WATER/CEMENTITIOUS MATERIALS RATIO. Take 3 places past the decimal and round to 2 places.
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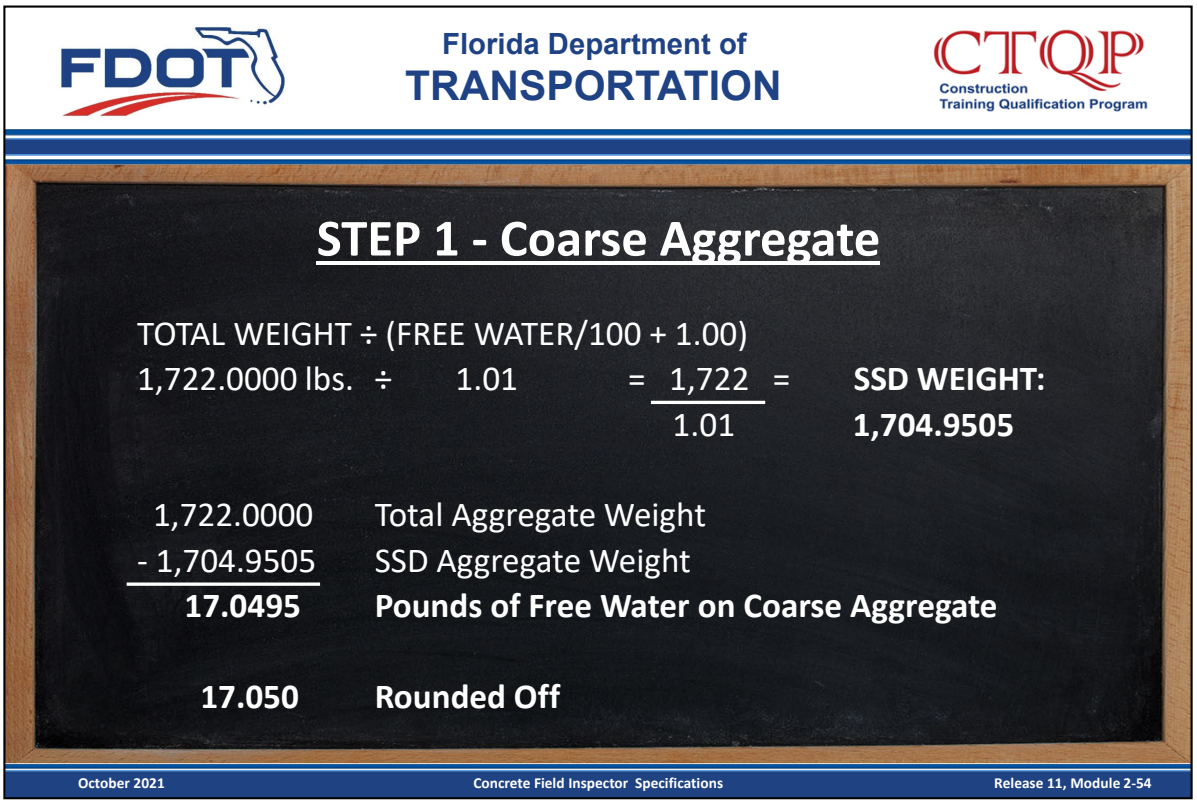
Sample Problem

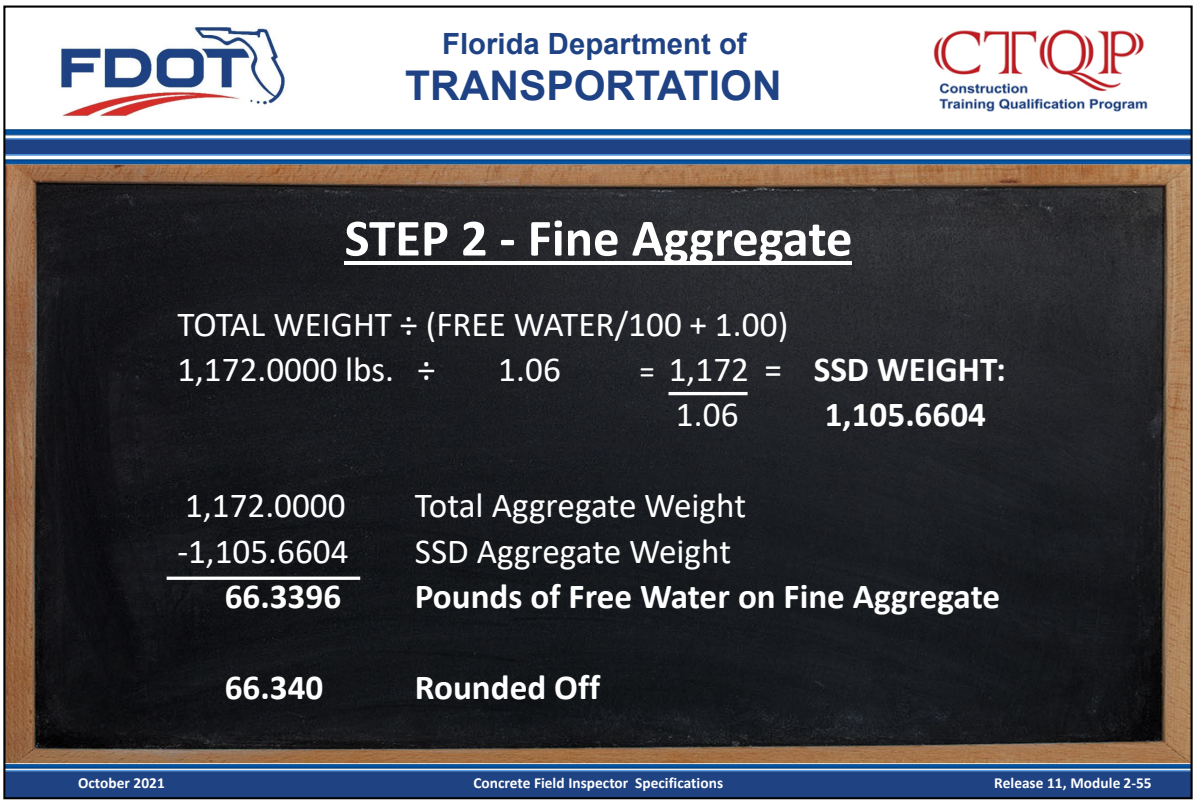
(All weights are for 1.0 cubic yards)

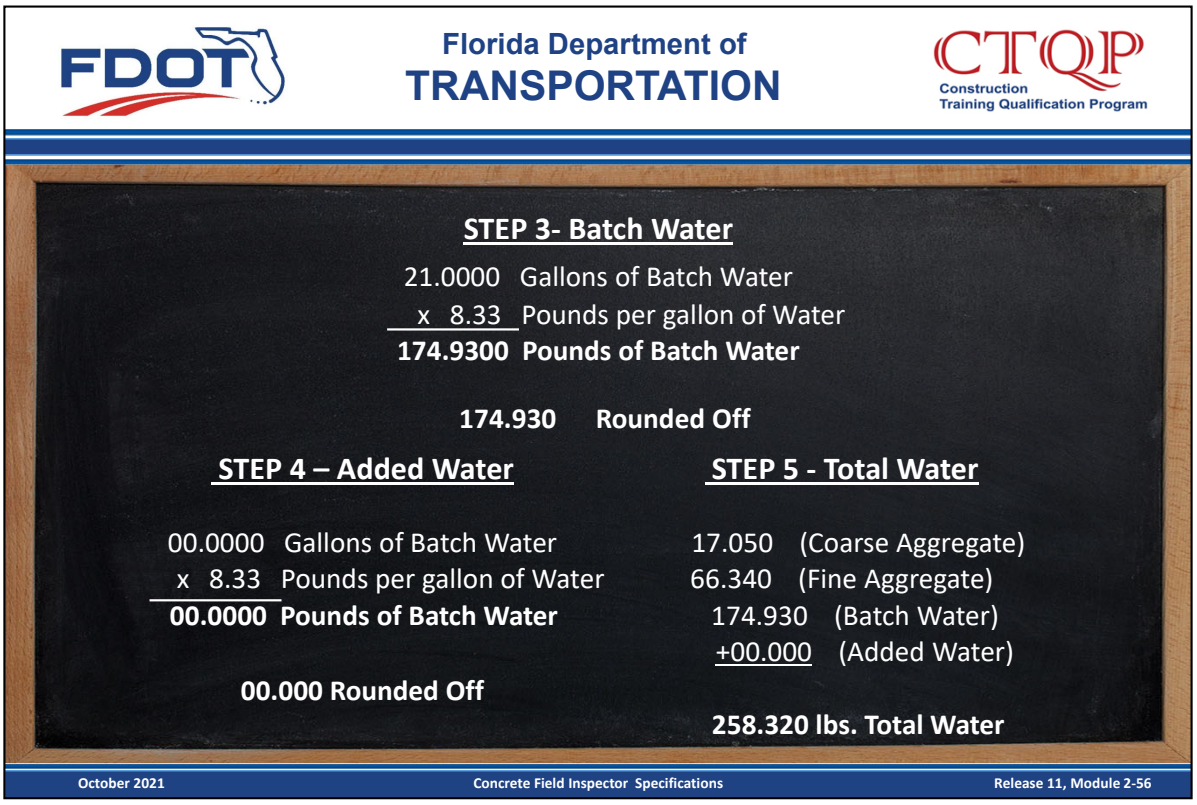
Delivery ticket information:

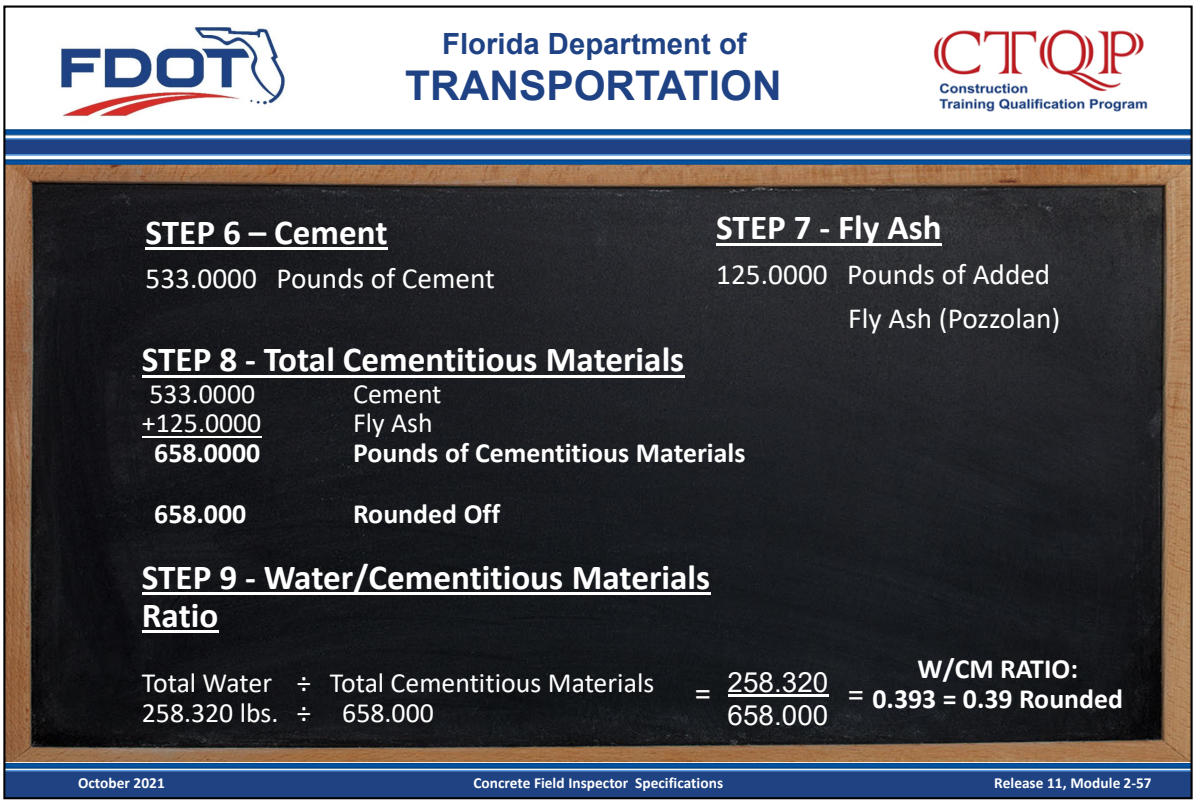
Coarse Aggregate:	1,722.0000 pounds	1% free water
Fine aggregate	1,172.0000 pounds	6% free water
Batch water	21.0000 gallons	
Added water:	0.0000 gallons	
Fly Ash (Pozzolan)	125.0000 pounds	
Cement	533.0000 pounds	

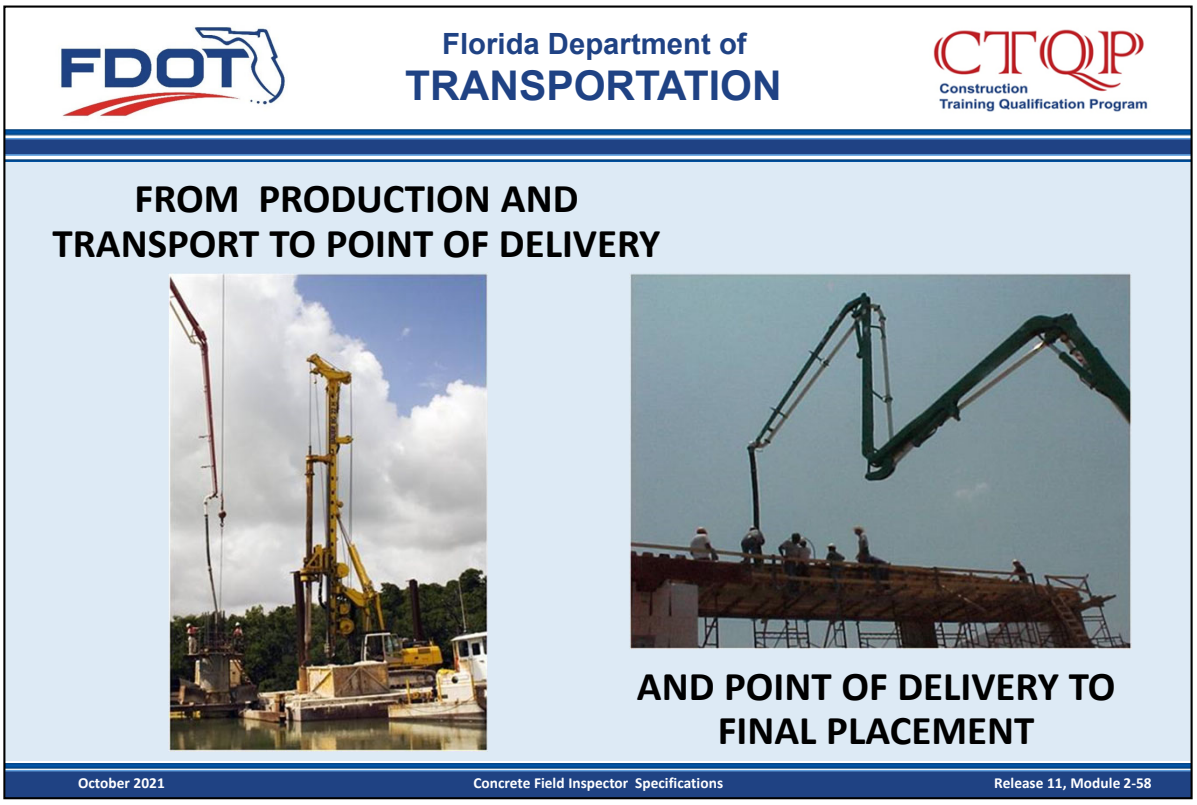
Note: All weights in this example are for 1.00 cubic yard.


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STEP 1 - Coarse Aggregate
TOTAL WEIGHT ÷ (FREE WATER/100 + 1.00)
1,722.0000 lbs. ÷ 1.01 = 1,722 / 1.01 = SSD WEIGHT: 1,704.9505
1,722.0000 Total Aggregate Weight
- 1,704.9505 SSD Aggregate Weight
17.0495 Pounds of Free Water on Coarse Aggregate
17.050 Rounded Off
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STEP 2 - Fine Aggregate
TOTAL WEIGHT ÷ (FREE WATER/100 + 1.00)
1,172.0000 lbs. ÷ 1.06 = 1,172 / 1.06 = SSD WEIGHT:
1,105.6604
1,172.0000 Total Aggregate Weight
-1,105.6604 SSD Aggregate Weight
66.3396 Pounds of Free Water on Fine Aggregate
66.340 Rounded Off
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STEP 3- Batch Water
21.0000 Gallons of Batch Water
x 8.33 Pounds per gallon of Water
174.9300 Pounds of Batch Water
174.930 Rounded Off
STEP 4 – Added Water
00.0000 Gallons of Batch Water
x 8.33 Pounds per gallon of Water
00.0000 Pounds of Batch Water
00.000 Rounded Off
STEP 5 - Total Water
17.050 (Coarse Aggregate)
66.340 (Fine Aggregate)
174.930 (Batch Water)
+00.000 (Added Water)
258.320 lbs. Total Water
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STEP 6 – Cement
533.0000 Pounds of Cement
STEP 7 - Fly Ash
125.0000 Pounds of Added
Fly Ash (Pozzolan)
STEP 8 - Total Cementitious Materials
533.0000 Cement
+125.0000 Fly Ash
658.0000 Pounds of Cementitious Materials
658.000 Rounded Off
STEP 9 - Water/Cementitious Materials Ratio
Total Water ÷ Total Cementitious Materials = 258.320 / 658.000 = W/CM RATIO:
258.320 lbs. ÷ 658.000 = 0.393 = 0.39 Rounded
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Examples of pumping operations which may be used and discussed during the pre-pour meetings and further defined in Section 400.

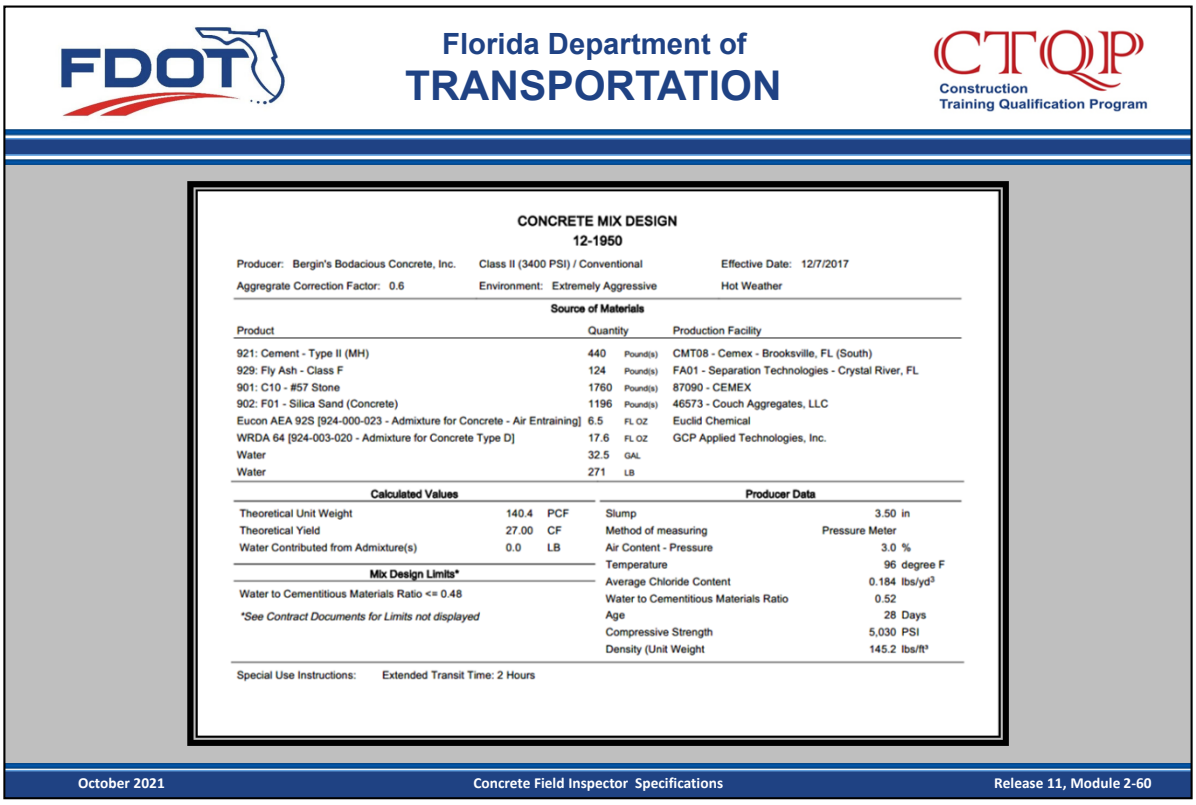


QC inspection activities should be performed by the contractor. The QC technician should visually inspect every load of concrete to ensure that the concrete is in compliance with the Specifications. Randomly, the VT should also visually inspect the concrete. If it appears “too wet” or “too dry” from the visual inspection, the QC technician should perform a slump test. If you see the concrete visually change color, aggregate distribution, etc., you may want to perform further testing.

346-6.1 General: Perform QC activities to ensure materials, methods, techniques, personnel, procedures and processes utilized during production meet the specified requirements. For precast/pre-stressed operations, ensure that the QC testing is performed by the producer.

Accept the responsibility for QC inspections on all phases of work. Ensure all materials and workmanship incorporated into the project meet the requirements of the Contract Documents.

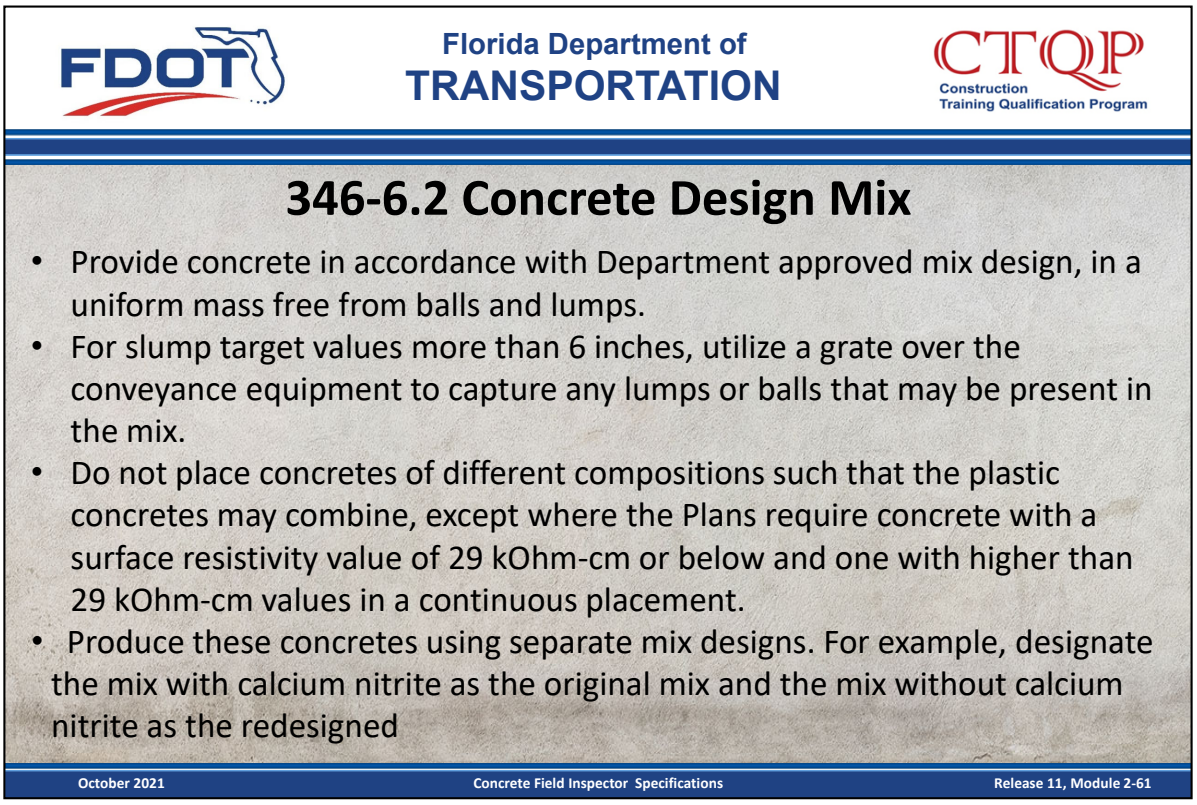
When concrete plastic properties (slump, air content and temperature) could be significantly affected by handling between the point of delivery and the point of final placement, including the use of pumps, conveyor belts, troughs, chutes, barge transport or other means, sample the plastic concrete for all testing at the point of final placement.



MAC is used to input the mix design information, submit for review of the DMRO which will be forwarded to the SMO for acceptance and mix design number assignment. The contractor adds the mix design to their QC Plan which is then forwarded to the Engineer and the DMRO to determine if the mix(es) are acceptable. Project personnel should obtain a copy of the mix design to be used from the contractor or the Engineer before concrete placement begins.

Project personnel should verify that the components and quantities shown on the delivery ticket match the concrete mix design. First, make sure it's the right mix design. Then make sure that the delivery ticket and components match.

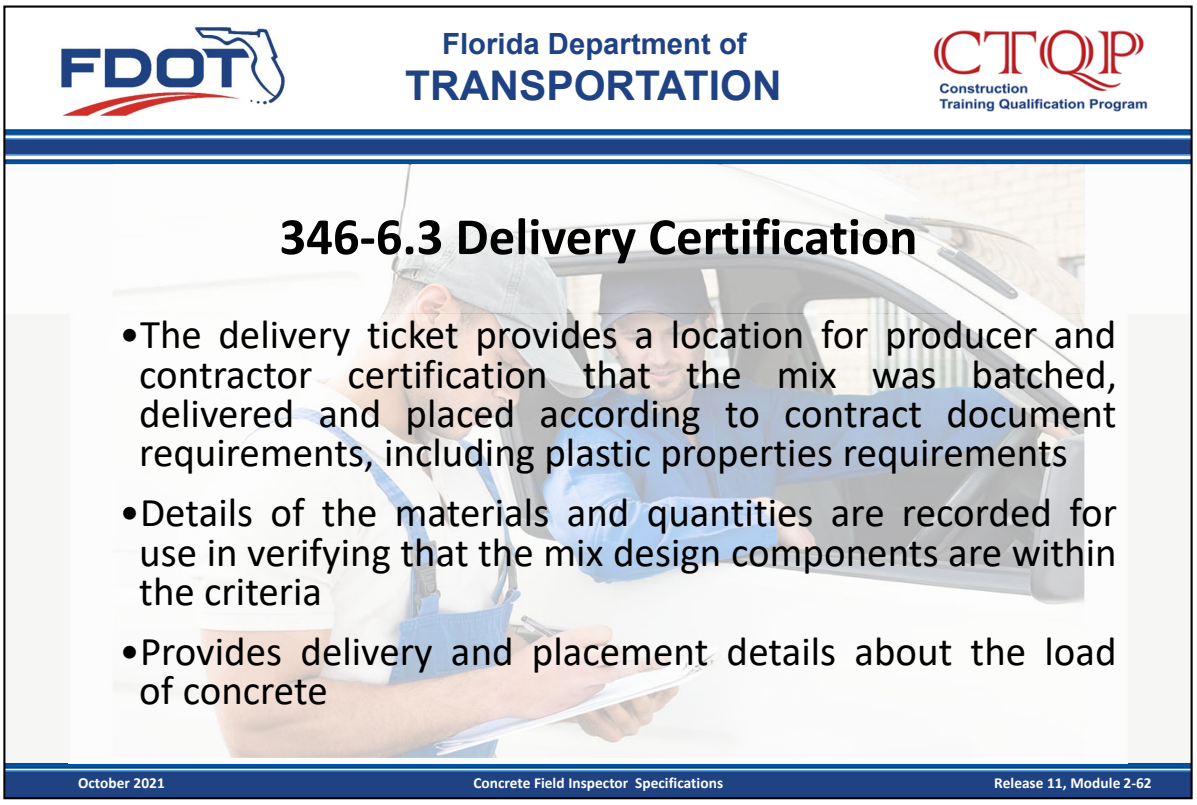
For adjusted concrete mixes, such as slip-form mixes, the project personnel should get with the DMRO before the concrete placement. The DMRO and SMO will revise the database to show the adjusted quantities and targets on a mix design with a new number. The new mix design number will be the base mix design number with a suffix for the adjustment, for example, 1-0001sf for a mix design adjusted for slip form operations.



When multiple plants are producing the same concrete mix design for the same project, this is normally considered to be different mix designs. Project personnel should track the sample and lot numbers separately. There are instructions in the sample number/lot number system and we will see an example of this later.

346-6.2 Concrete Design Mix (cont.):

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.



The delivery ticket serves as certification from the producer and contractor. The department uses certification as a means of acceptance for many materials. It is important that everyone understand the significance of certifications. When a producer or contractor signs a certification statement, they are legally bound by it. Deliberate falsification of a certification is a serious issue and can result in criminal prosecution.

346-6.3 Delivery Certification: Ensure that an electronic delivery ticket is furnished with each batch of concrete before unloading at the placement site. The delivery ticket may be proprietary software or in the form of an electronic spreadsheet, but shall be printed. Ensure that the materials and quantities incorporated into the batch of concrete are printed on the delivery ticket. Include the following information on the Delivery Ticket:

(1) Arrival time at jobsite.

(2) Time that concrete mix has been completely discharged.

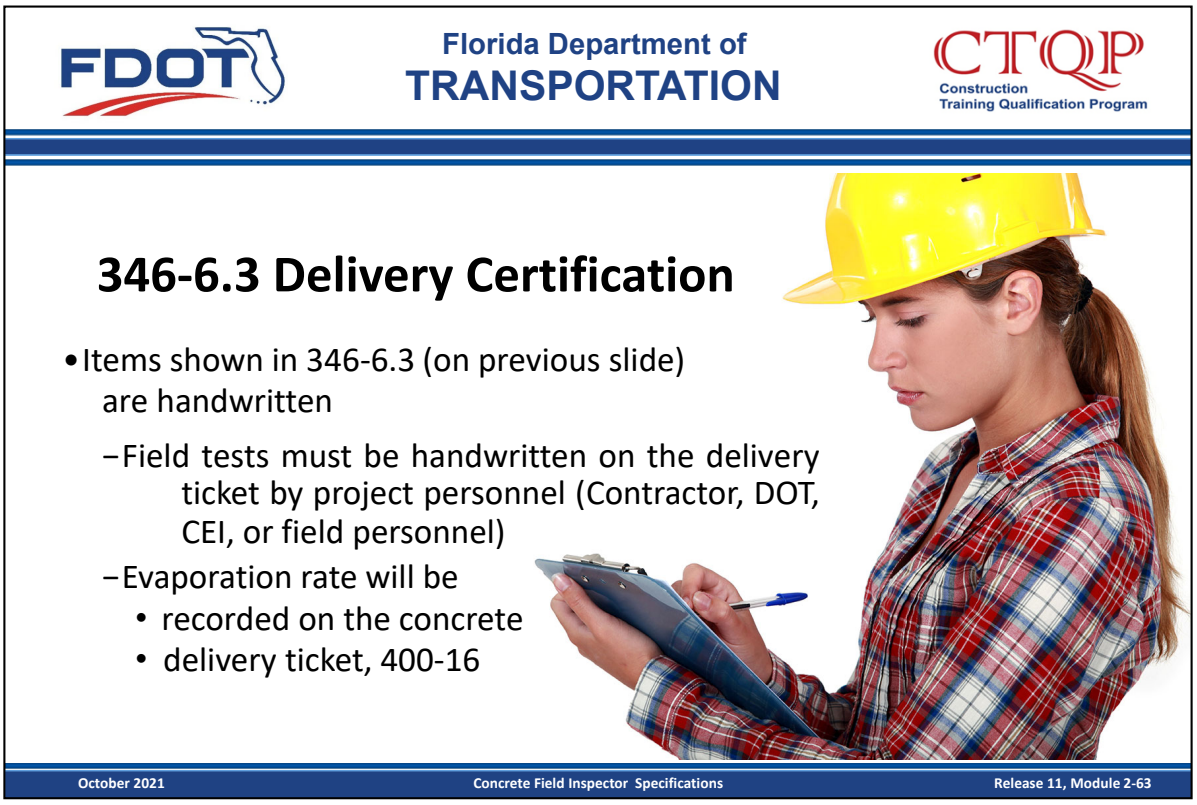
(3) Number of revolutions upon arrival at the jobsite.

(4) Total gallons of water added at the jobsite.

(5) Additional mixing revolutions when water is added.

(6) Total number of revolutions at mixing and agitating speed.

Items 3 through 6 do not apply to non-agitating concrete transporting vehicles.



Items shown in 346-6.3 (on previous slide) are handwritten by project personnel at the jobsite.

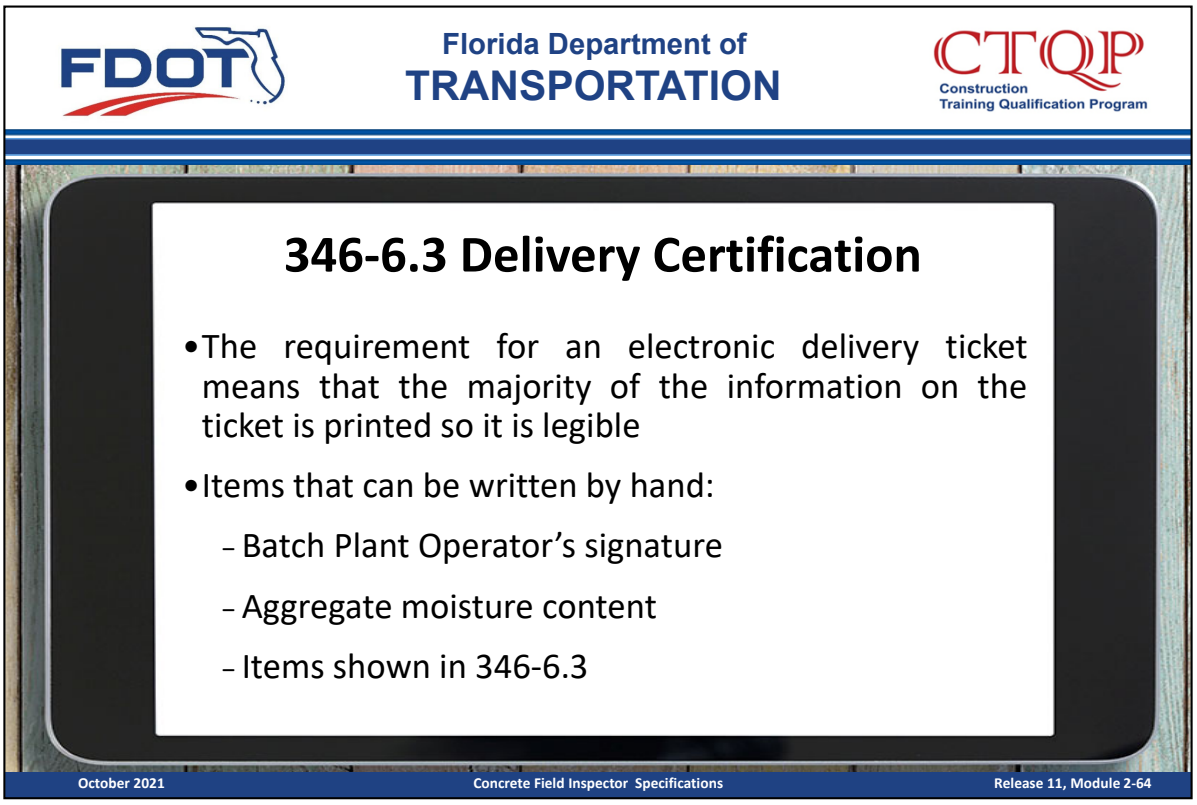
Some of the information on the delivery ticket must be handwritten. Field tests must be handwritten on the delivery tickets, but for this class we have typed his information for clarity. Test information will be handwritten when trucks arrive at the project.

Project personnel are people working for the Department and may be Career service DOT, CEI's employed by the Department and their staff. Field personnel are typically technicians testing concrete at the project or providing inspecting services, Contractor is considering anyone who is working for the contractor and may include subcontractors to the contractor.

346-6.3 Delivery Certification:

Ensure the batcher responsible for production of the batch of concrete signs the delivery ticket, certifying the batch of concrete was produced in accordance with the Contract Documents.

Sign the delivery ticket certifying that the design mix maximum specified water to cementitious materials ratio was not exceeded due to any jobsite adjustments to the batch of concrete, and that the batch of concrete was delivered and placed in accordance with the Contract Documents.


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346-6.3 Delivery Certification
•The requirement for an electronic delivery ticket means that the majority of the information on the ticket is printed so it is legible
•Items that can be written by hand:
– Batch Plant Operator's signature
– Aggregate moisture content
– Items shown in 346-6.3
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Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

Sample Delivery Ticket for Structural Concrete

Financial Project No.: 1909701A101 Serial No.: 123456

Plant No.: 26-999 Date: 1/01/2017

Concrete Supplier: Soft Concrete Delivered to: Ishee Construction Company

Phone Number: 352-981-1234 Phone Number: 904-964-0101

Address: P. O. Box ABC Address: P. O. Box DEF

Anywhere, FL 32605 Gone, FL 32561

Truck No.	DOT Class	DOT Mix No.	Cubic Yards This Load
Soft-1	II	01-9999	10.00
Allowable Jobsite Water Addition (gal. or lbs.) 10.00 GA	Time Loaded 9:00 pm	Mixing revolutions or time 75	Cubic Yards Total Today 10.00

Cement			Fly Ash:	FA01	F		1220
				Source	Class		Amount
CMT01	II	4430	Slag:	NA			
Source	Type	Amount		Source	Class		Amount
Coarse Agg.			Air Entrainment Admixture				
87-090	2.0	17570	S924-0002	W.R. Grace	AEA		65.0
Source Num.	Moisture (%)	Amount	Source	Brand	Type		Amount
Fine Agg.			Admixture				
36-256	5.5	11860	S924-0320	W. R. Grace	D		176.0
Source Num.	Moisture (%)	Amount	Source	Brand	Type		Amount
Batch Water ((gals.) or lbs.)			Admixture				
		196.0	N/A				
		Amount	Source	Brand	Type		Amount

Issuance of this ticket constitutes certification that the batched concrete was produced and is in compliance with the ***Contract Document*** requirements for Structural Concrete.

B12345678-000 Technician Identification Number

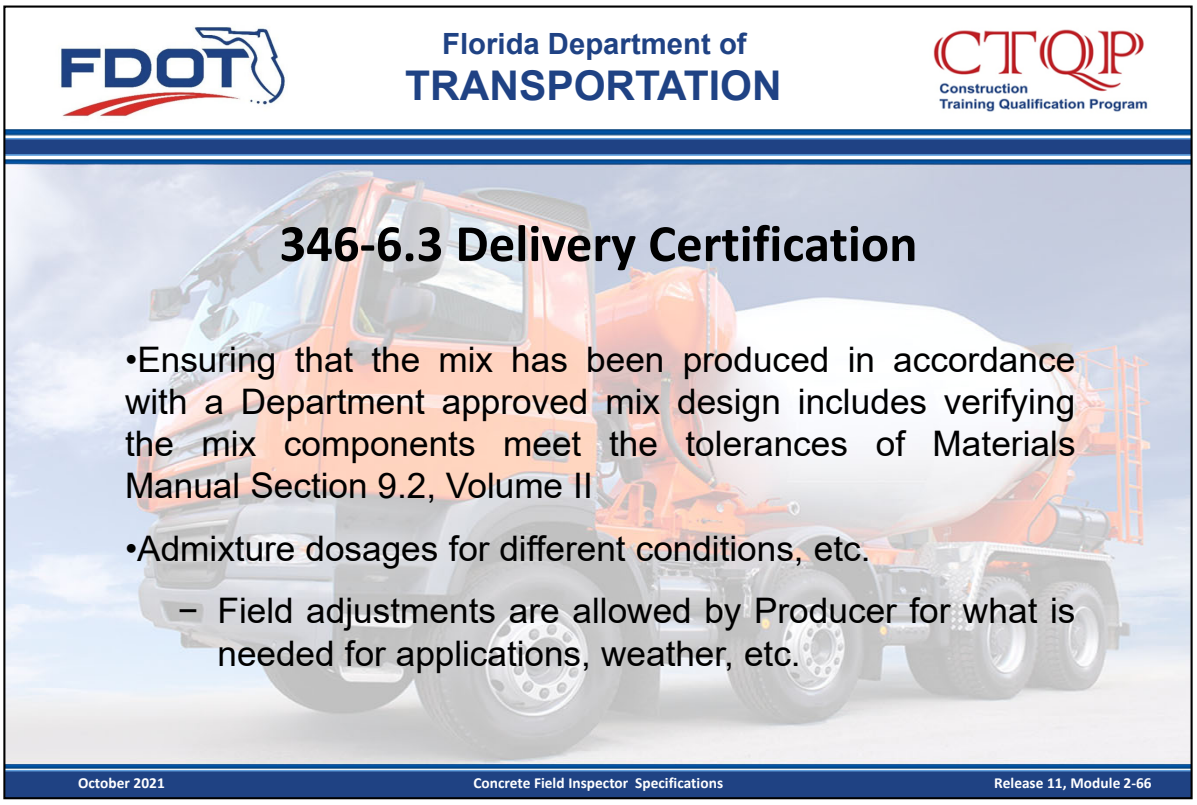
Signature of Batch Plant Operator

Arrival time at job site 9:30 pm		Number of revolutions upon arrival at job site 110	
Total Water added at job site (gallons) 7.00	Admixtures added at the job site (ounces) N/A	Additional mixing revolutions with added water 35	
Time concrete completely discharged 10:30 pm	Time admixture added N/A	Total number of revolutions 247	
Initial Slump 4.00	Initial Air 4.00	Initial Concrete Temp. 87	Initial w/cm Ratio
Acceptance Slump 4.25	Acceptance Air 3.80	Acceptance Concrete Temp. 87	Acceptance w/cm Ratio

Signature on this ticket constitutes certification that the maximum specified water cementitious materials ratio was not exceeded and the batch was delivered and placed in compliance with the ***Contract Document*** requirements.

S12345678-000 Technician Identification Number

Signature of Contractor's Representative



As stated before, project personnel should verify that the components and quantities shown on the delivery ticket match the concrete mix design. However, as stated earlier, admixture dosage rates can be varied based on the specific material and other conditions so the amount on the delivery ticket may not be within the tolerances.



This is an additional classroom exercise to be used if you need additional practice in calculation of w/cm ratio.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

WATER/CEMENTITIOUS MATERIALS CALCULATIONS WORKSHEET

STEP 1: 17570 (Total Wt. of Coarse Agg.) ÷ 1.020 (1.000 + Free Moisture) = 17225.490 lbs. (SSD Weight) *

17570 (Total Wt. of Coarse Agg.) - 17225.490 (SSD Weight) = 344.510 lbs. (Wt. of Free Water in C.A.) **(1)

STEP 2: 11860 (Total Wt. of Fine Agg.) ÷ 1.055 (1.000 + Free Moisture) = 11241.706 lbs. (SSD Weight) *

11860 (Total Wt. of Fine Agg.) - 11241.706 (SSD Weight) = 618.294 lbs. (Wt. of Free Water in C.A.) **(2)

STEP 3: 196.0 (Gallons of Batch Water) × 8.33 (8.33 lbs/gal.) = 1632.680 lbs. (Wt. of Batch Water) * *(3)

STEP 4: 7.0 (Gallons of Jobsite Water) × 8.33 (8.33 lbs/gal.) = 58.310 lbs. (Wt. of Jobsite Water) * *(4)

STEP 5: (344.510 + 618.294 + 1632.680 + 58.310) (Total of Steps 1 through 4) = 2653.794 lbs. (Total Wt. of Water) **

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Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

WATER/CEMENTITIOUS MATERIALS CALCULATIONS WORKSHEET

STEP 6: $\frac{4430}{\text{Wt. of Cement (From Delivery Ticket)}}$ ** = 4430.000

STEP 7: $\frac{1220}{\text{Wt. of Pozzolans (From Delivery Ticket)}}$ ** = 1220.000

STEP 8: $\frac{4430.000 + 1220.000}{\text{Total Weight of Cementitious Material}}$ ** = 5650.000

STEP 9: $\frac{2653.794}{\text{Total Weight of Water}} \div \frac{5650.000}{\text{Total Wt. of Cementitious}} = \frac{0.47}{\text{W/C}}$ ***

* Rounded to 4 decimal places
** Rounded to 3 decimal places
*** Rounded to 2 decimal places

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Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

Delivery ticket 123456
Mix Design 01-9999 Verification

Coarse Aggregate =
17570 ÷ 10 CY = 1757 LB / CY
1757 ÷ 1.02 = 1722.5 LB / CY SSD
1722.5 - 1740 = 17.5
17.5 ÷ 1740 x 100 = 1%
Within 1% tolerance

Fine Aggregate =
11860 ÷ 10 CY = 1186 LB / CY
1186 ÷ 1.055 = 1124.2 LB / CY SSD
1176 – 1124.2 = 51.8
51.8 ÷ 1176 x 100 = 4.4%
Not within 1% tolerance

Cementitious Materials
Cement = 4430 ÷ 10 CY = 443 LB / CY
Fly Ash = 1220 ÷ 10 CY = 122 LB / CY
443 + 120 = 563 LB / CY Cementitious from ticket
440 + 124 = 564 LB / CY Cementitious from mix design
564 – 563 = 1 LB
1 ÷ 564 x 100 = 0.18
Within 1% tolerance for batches of more than 3 CY

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WATER/CEMENTITIOUS MATERIALS CALCULATIONS WORK SHEET

STEP 1: _____ Total Weight of Coarse Agg. ÷ _____ 1.000 + Free Moist. = _____ lbs. SSD Weight *

_____ Total Weight of Coarse Agg. - _____ SSD Weight = _____ lbs. Wt. of Free Water in C.A. **(1)

STEP 2: _____ Total Weight of Fine Agg. ÷ _____ 1.000 + Free Moist. = _____ lbs. SSD Weight *

_____ Total Weight of Fine Agg. - _____ SSD Weight = _____ lbs. Wt. of Free Water in C.A. **(2)

STEP 3: _____ Gallons of Batch Water x _____ 8.33 lbs/gal. = _____ lbs. Wt. of Batch Water **(3)

STEP 4: _____ Gallons of Jobsite Water x _____ 8.33 lbs/gal. = _____ lbs. Wt. of Jobsite Water **(4)

STEP 5: _____ _____ _____ _____ Total of Steps 1 through 4 = _____ lbs. Total Wt. of Water **

STEP 6: _____ Wt. of Cement (From Delivery Ticket) ** = _____

STEP 7: _____ Wt. of Pozzolan (From Delivery Ticket) ** = _____

STEP 8: _____ _____ Total Weight of Cementitious Material ** = _____

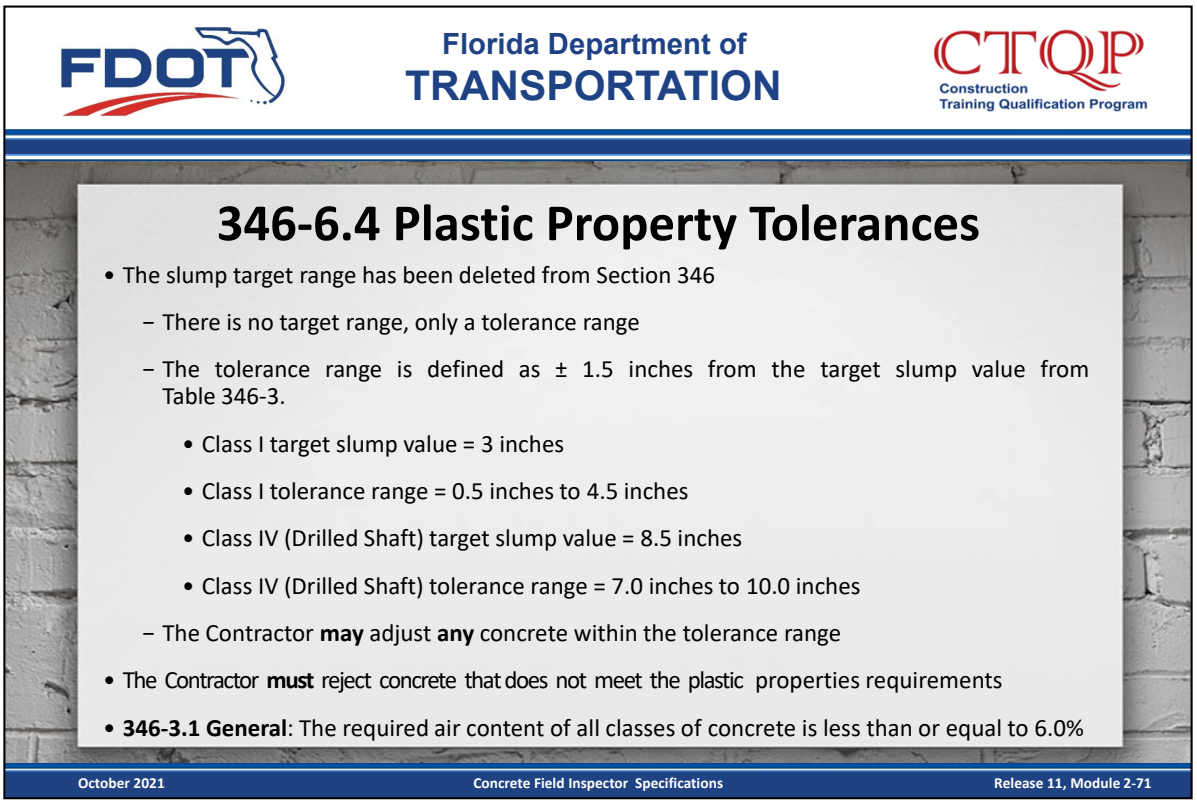
STEP 9: _____ Total Wt. of Water ÷ _____ Total Wt. of Cementitious = _____ W/C lbs. ***

* Rounded to 4 Decimal Places

** Rounded to 3 Decimal Places

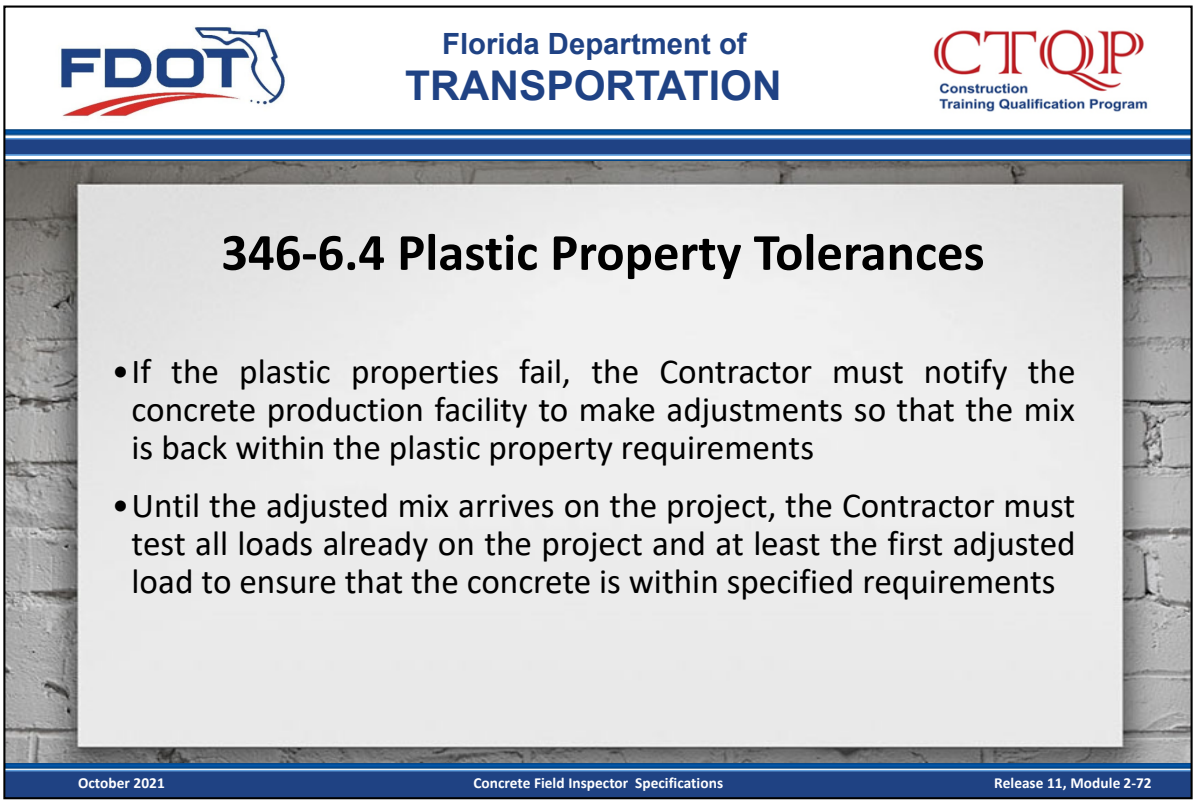
*** Rounded to 2 Decimal Places

The above information is used to evaluate the batch plant performance, contact the DMRO when batch tolerances are exceeded



346-6.4 Plastic Property Tolerances: Reject concrete with slump or air content that does not fall within the specified tolerances and immediately notify the concrete production facility that an adjustment of the concrete mixture is required. If a load does not fall within the tolerances, test each subsequent load and the first adjusted load. If failing concrete is not rejected or adjustments are not implemented, the Engineer may reject the concrete and terminate further production until the corrections are implemented.
Do not allow concrete to remain in a transporting vehicle to reduce slump. Water may be added only upon arrival of the concrete to the jobsite and not thereafter.

346-3.1 General: The required air content for all classes of concrete is less than or equal to 6.0%.



The contractor may now adjust any load that is within tolerance, as long as the adjustment does not put the slump out of the tolerance range. It is up to the contractor to ensure that concrete within tolerance that is adjusted stays within tolerance. There is no longer a red, yellow and green situation.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-6.4 Plastic Property Tolerances

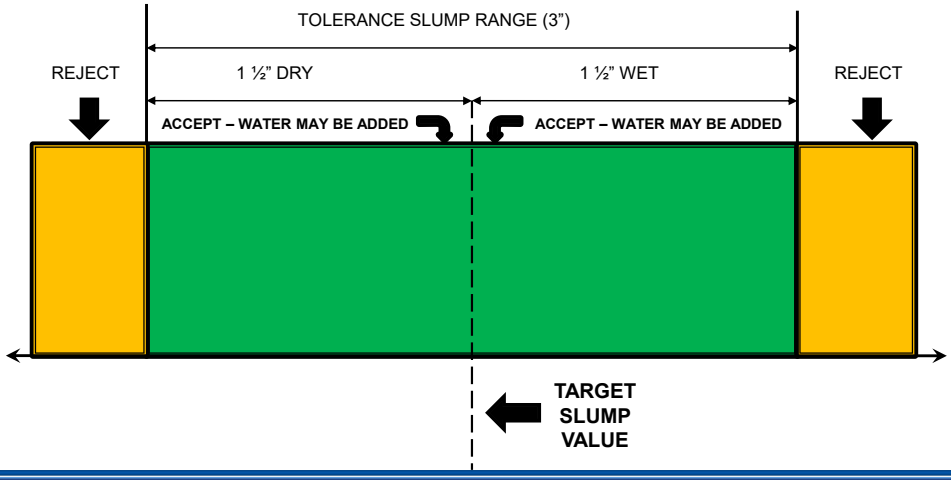
- If the Contractor does not reject the failing concrete or adjustments are not implemented, the Engineer may reject the concrete and terminate further production until the corrections are implemented
- The Contractor is not allowed to let the concrete remain in a transporting vehicle to reduce slump
- The Contractor can add water only upon arrival of the concrete to the jobsite and not thereafter

REJECT

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ACCEPTANCE OF CONCRETE BASED ON SLUMP TESTING AT THE PROJECT SITE



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CTQP Construction Training Qualification Program

346-6.4 Plastic Properties



The Contractor is responsible for rejecting loads of concrete not in compliance with the specifications or outside the allowable tolerances.

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The QC Plan is the contractor's, and it is the contractor's responsibility to reject concrete that is not in conformance with their approved plan.

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346-7 Mixing and Delivering Concrete

- All concrete mixers should operate at speeds per the manufacturer's design or recommendation on mixer rating plate.
- Plant mixers should operate per manufacturer's design.



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The transient revolutions are normally around 3-5 revolutions per minute, not high enough for mixing. The transient revolutions should not be added to the mixing revolutions shown on the delivery ticket.

346-7 Mixing and Delivering Concrete.

346-7.1 General Requirements: Operate all concrete mixers at speeds and volumes per the manufacturer's design or recommendation as stipulated on the mixer rating plate.

Photograph of a concrete transit mixer.

Florida Department of TRANSPORTATION

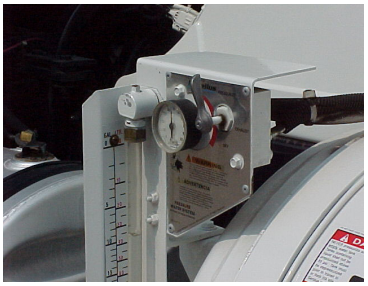
CTQP Construction Training Qualification Program



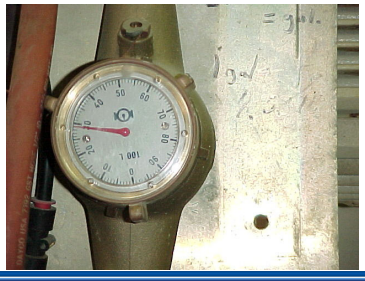
Rating plate



Water gauge



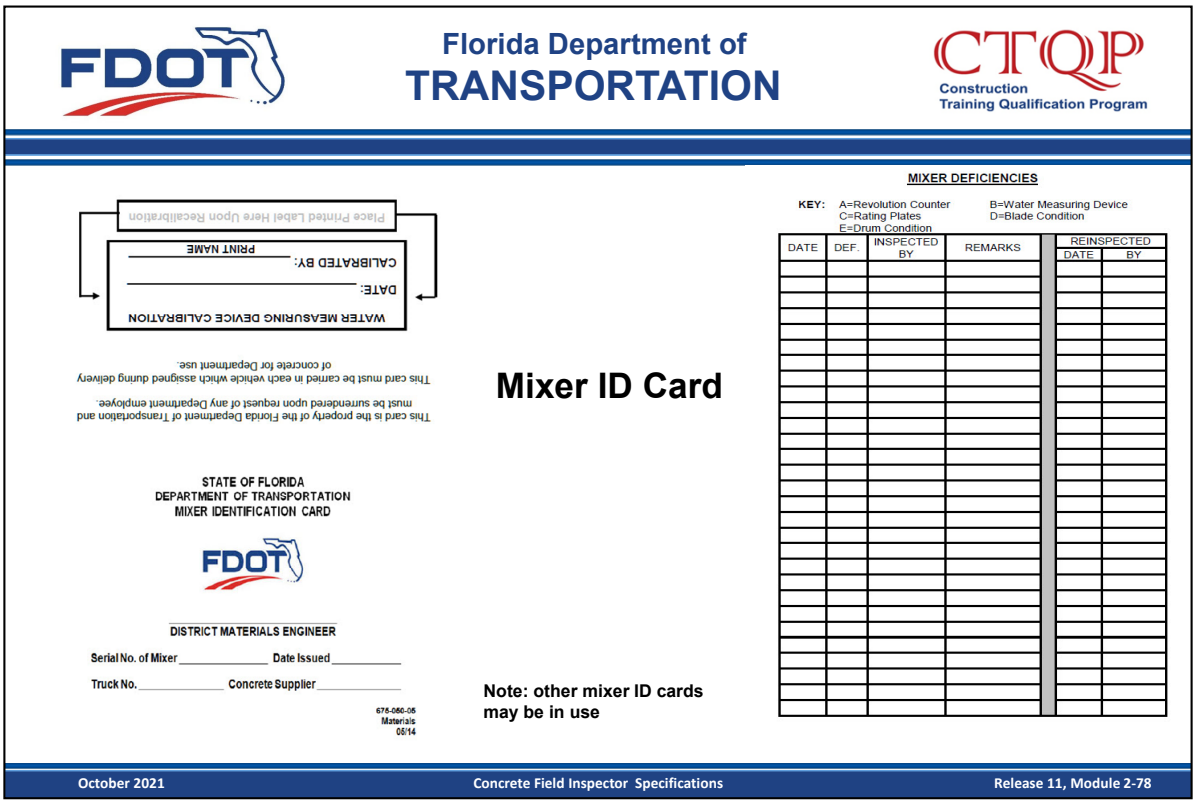
Water gauge



Water meter



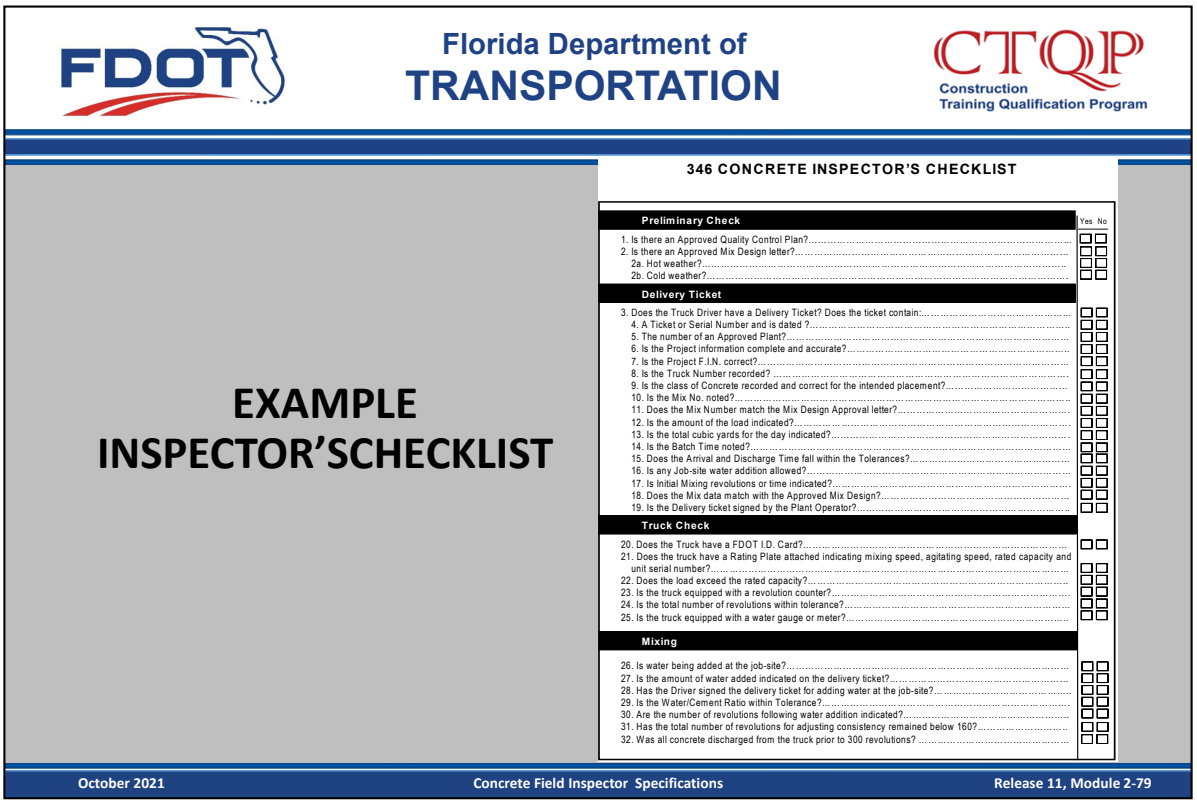
Revolution counter



Each concrete truck mixer arriving on the job-site is to have onboard a Mixer ID card. This card contains a record of the inspections performed on the mixer and any resultant repairs.

For example:

The truck arrives on site and you notice the revolution counter is not working. The driver says that it must have broke on the way, as it was working. You review the Mixer ID Card and do not find any note referring to the broken counter. When the identification card is removed for noncompliance, the Contractor shall note the deficiency on the identification card and forward the identification card to the DMRE in the District with QC Plan acceptance authority.



Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

EXAMPLE INSPECTOR'SCHECKLIST

346 CONCRETE INSPECTOR'S CHECKLIST

	Yes	No
Preliminary Check		
1. Is there an Approved Quality Control Plan?	☐	☐
2. Is there an Approved Mix Design letter?	☐	☐
2a. Hot weather?	☐	☐
2b. Cold weather?	☐	☐
Delivery Ticket		
3. Does the Truck Driver have a Delivery Ticket? Does the ticket contain:	☐	☐
4. A Ticket or Serial Number and is dated ?	☐	☐
5. The number of an Approved Plant?	☐	☐
6. Is the Project information complete and accurate?	☐	☐
7. Is the Project F.I.N. correct?	☐	☐
8. Is the Truck Number recorded?	☐	☐
9. Is the class of Concrete recorded and correct for the intended placement?	☐	☐
10. Is the Mix No. noted?	☐	☐
11. Does the Mix Number match the Mix Design Approval letter?	☐	☐
12. Is the amount of the load indicated?	☐	☐
13. Is the total cubic yards for the day indicated?	☐	☐
14. Is the Batch Time noted?	☐	☐
15. Does the Arrival and Discharge Time fall within the Tolerances?	☐	☐
16. Is any Job-site water addition allowed?	☐	☐
17. Is Initial Mixing revolutions or time indicated?	☐	☐
18. Does the Mix data match with the Approved Mix Design?	☐	☐
19. Is the Delivery ticket signed by the Plant Operator?	☐	☐
Truck Check		
20. Does the Truck have a FDOT I.D. Card?	☐	☐
21. Does the truck have a Rating Plate attached indicating mixing speed, agitating speed, rated capacity and unit serial number?	☐	☐
22. Does the load exceed the rated capacity?	☐	☐
23. Is the truck equipped with a revolution counter?	☐	☐
24. Is the total number of revolutions within tolerance?	☐	☐
25. Is the truck equipped with a water gauge or meter?	☐	☐
Mixing		
26. Is water being added at the job-site?	☐	☐
27. Is the amount of water added indicated on the delivery ticket?	☐	☐
28. Has the Driver signed the delivery ticket for adding water at the job-site?	☐	☐
29. Is the Water/Cement Ratio within Tolerance?	☐	☐
30. Are the number of revolutions following water addition indicated?	☐	☐
31. Has the total number of revolutions for adjusting consistency remained below 160?	☐	☐
32. Was all concrete discharged from the truck prior to 300 revolutions?	☐	☐

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This is an example of one type of technician checklist that might be used. Other checklists are used throughout the department and some contractors have developed their own for QC inspection items. It is a good idea to utilize whatever checklists are available to ensure that the truck and other items are within compliance.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-7 Mixing and Delivering Concrete

- The concrete must be mixed an additional 30 drum revolutions if water is added at the jobsite
- Do not make more than two mix adjustments
- Seek approval from the Engineer prior to using a central mixer and depositing the batch into a truck mixer.



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346-7.2 Transit Truck Mixing: Produce a completely uniform mixed concrete in a truck mixer for 70 to 100 revolutions at the mixing speed designated by the truck manufacturer.

Prior to starting the discharge of the concrete at the jobsite, when water is added, record the added quantity and mix the concrete 30 additional drum mixing revolutions. Do not make more than two mix adjustments. Seek approval from the Engineer prior to using a central mixer and depositing the batch into a truck mixer.

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CTQP Construction Training Qualification Program

346-7.2.1 Transit Time

The allowable time permitted between initial water introduction into the mix and placement of the concrete is:

TABLE 346-8	
Non-Agitator Trucks	Agitator Trucks
45 minutes	60 minutes
75 minutes*	90 minutes*
*When a water-reducing and retarding admixture (Type D, Type G or Type II) is used.	



Different Types of Drum mixers



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The initial water added when the truck is batched starts the clock. Emphasize this is different from slump loss time; it's the allowable time the truck has to unload.

346-7.2.1 Transit Time: Ensure compliance with Table 346-8 between the initial introduction of water into the mix and completely discharging all the concrete from the truck. Reject concrete exceeding the maximum transit time. For critical placements, with the Engineer's approval, the transit time may be extended to the allowable mixing time shown in the mix design.

346-7.2.2 Placement Time: All the concrete in a load must be in its final placement position a maximum of 15 minutes after the transit time has expired unless a time extension is approved in advance by the Engineer.

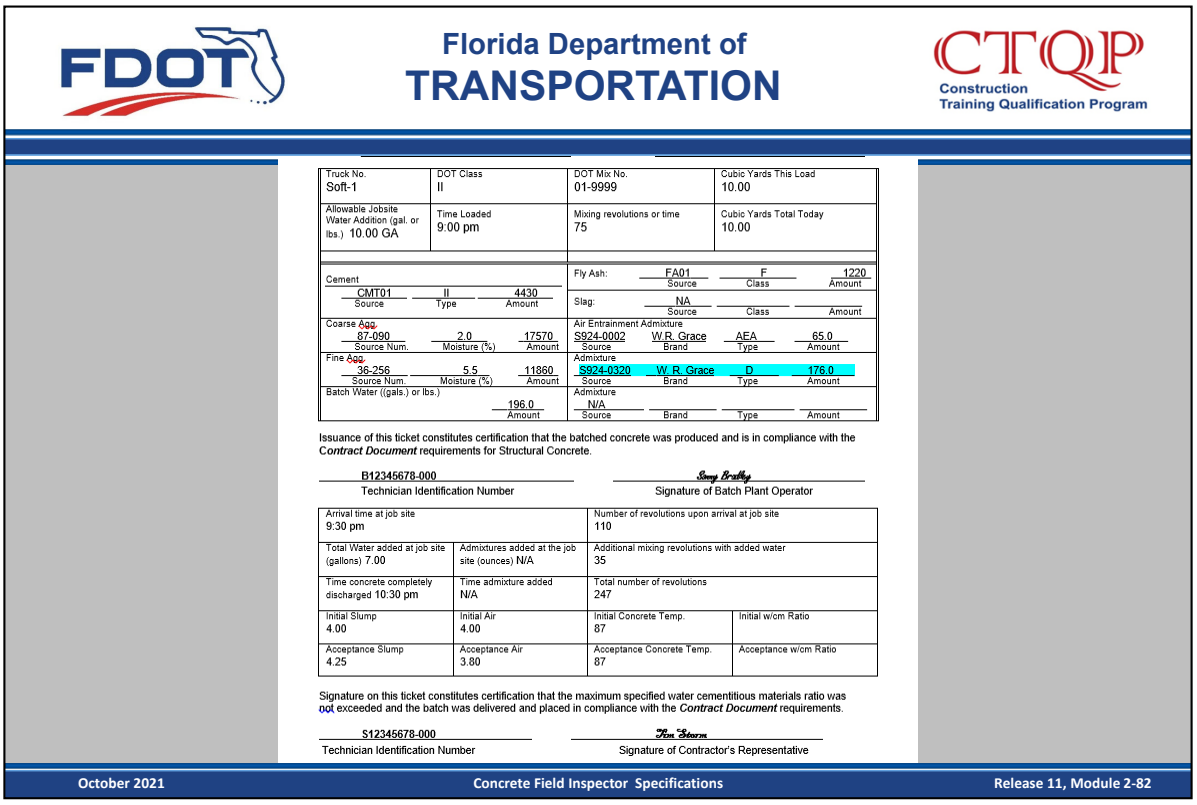
346-7.3 On-site Batching and Mixing: Use a mixer of sufficient capacity to prevent delays that may be detrimental to the quality of the work. Ensure that the accuracy of batching equipment is in accordance with requirements of this Section.



Non-Agitator Truck



Agitator Truck



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Truck No.	DOT Class	DOT Mix No.	Cubic Yards This Load
Soft-1	II	01-9999	10.00
Allowable Jobsite Water Addition (gal. or lbs.) 10.00 GA	Time Loaded 9:00 pm	Mixing revolutions or time 75	Cubic Yards Total Today 10.00

Cement: CMT01 (Source)	II (Type)	4430 (Amount)	Fly Ash: FA01 (Source)	F (Class) 1220 (Amount)
Coarse Agg. 87-090 (Source Num.)	2.0 (Moisture (%))	17570 (Amount)	Slag: NA (Source)	(Class) (Amount)
Fine Agg. 36-256 (Source Num.)	5.5 (Moisture (%))	11860 (Amount)	Air Entrainment Admixture: S924-0002 (Source) W.R. Grace (Brand) AEA (Type) 65.0 (Amount)	
Batch Water ((gals.) or lbs.)		196.0 (Amount)	Admixture: S924-0320 (Source) W. R. Grace (Brand) D (Type) 176.0 (Amount)	
			Admixture: N/A (Source) (Brand) (Type) (Amount)	

Issuance of this ticket constitutes certification that the batched concrete was produced and is in compliance with the ***Contract Document*** requirements for Structural Concrete.

B12345678-000 — Technician Identification Number

Signature of Batch Plant Operator

Arrival time at job site 9:30 pm		Number of revolutions upon arrival at job site 110	
Total Water added at job site (gallons) 7.00	Admixtures added at the job site (ounces) N/A	Additional mixing revolutions with added water 35	
Time concrete completely discharged 10:30 pm	Time admixture added N/A	Total number of revolutions 247	
Initial Slump 4.00	Initial Air 4.00	Initial Concrete Temp. 87	Initial w/cm Ratio
Acceptance Slump 4.25	Acceptance Air 3.80	Acceptance Concrete Temp. 87	Acceptance w/cm Ratio

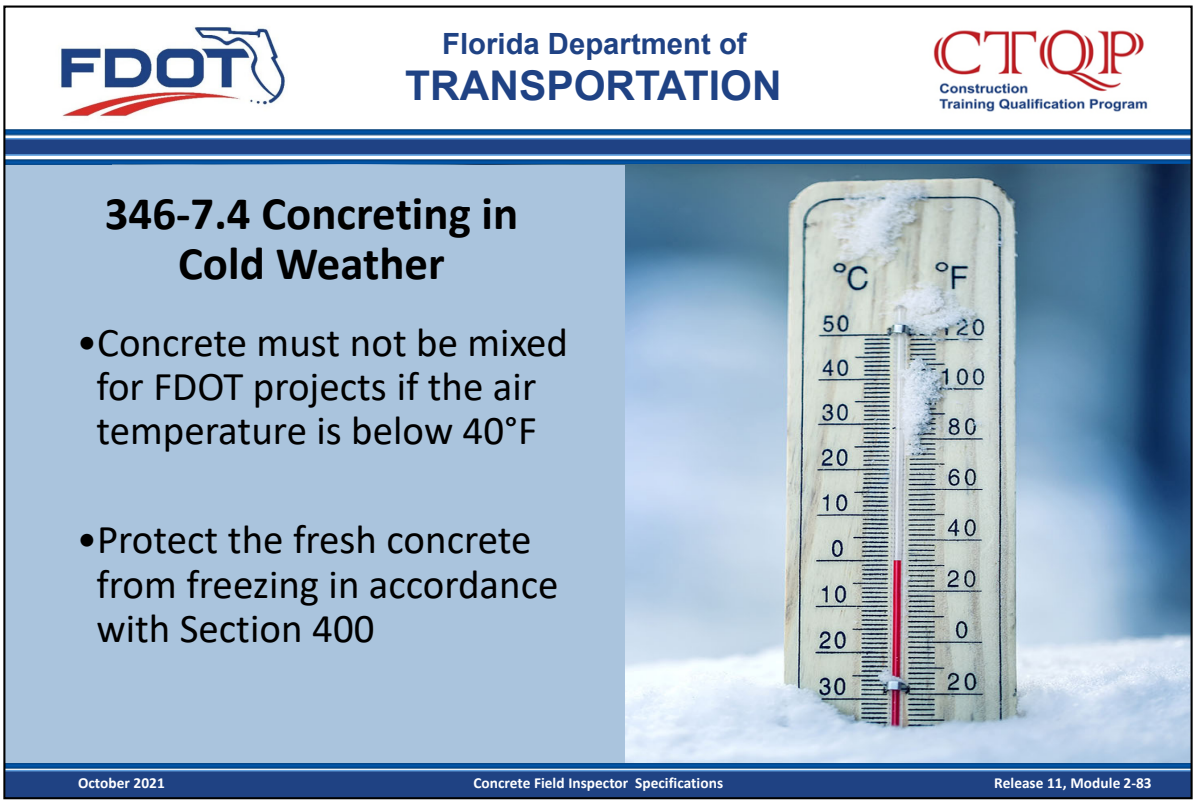
Signature on this ticket constitutes certification that the maximum specified water cementitious materials ratio was not exceeded and the batch was delivered and placed in compliance with the ***Contract Document*** requirements.

S12345678-000 — Technician Identification Number

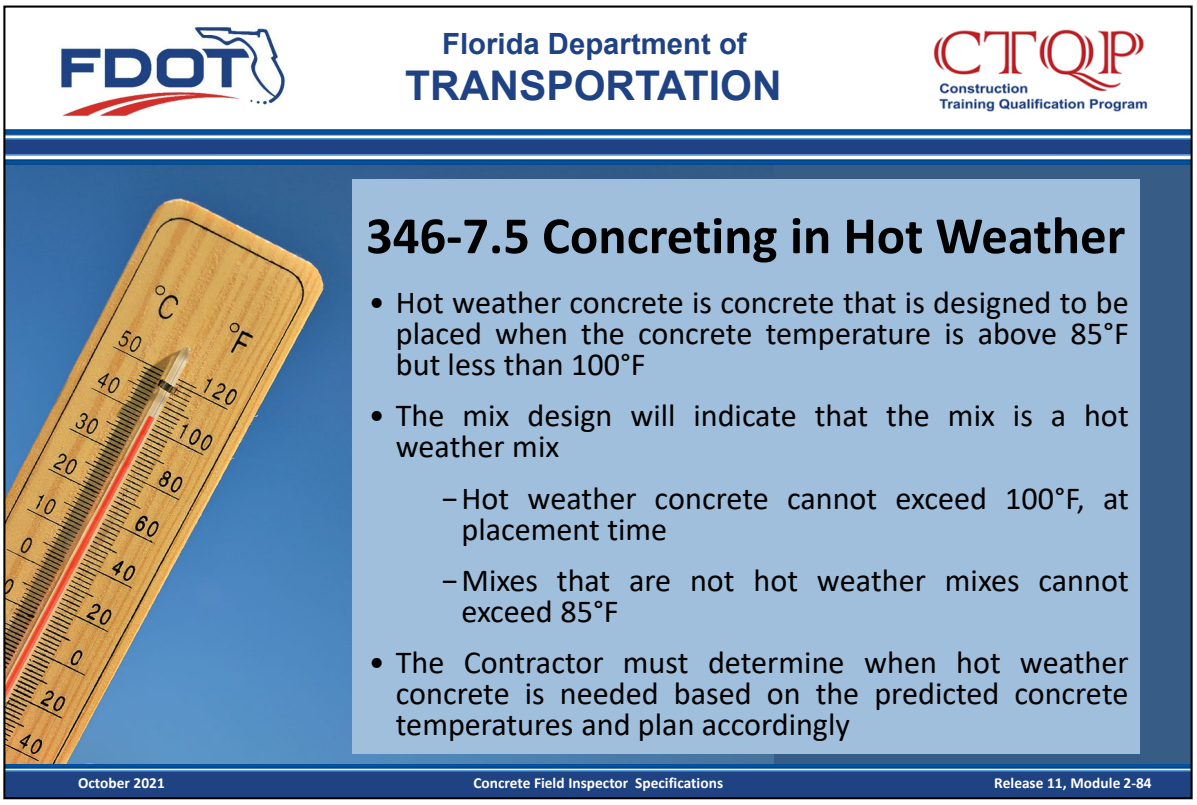
Signature of Contractor's Representative

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Was this load discharged within the allowable time?



346-7.4 Concreting in Cold Weather: Do not mix or place concrete when the air temperature is below 40ºF. Protect the fresh concrete from freezing in accordance with Section 400. The requirements of concreting in cold weather are not applicable to precast concrete mixing and placement operations occurring in a temperature-controlled environment



•Hot weather presents:

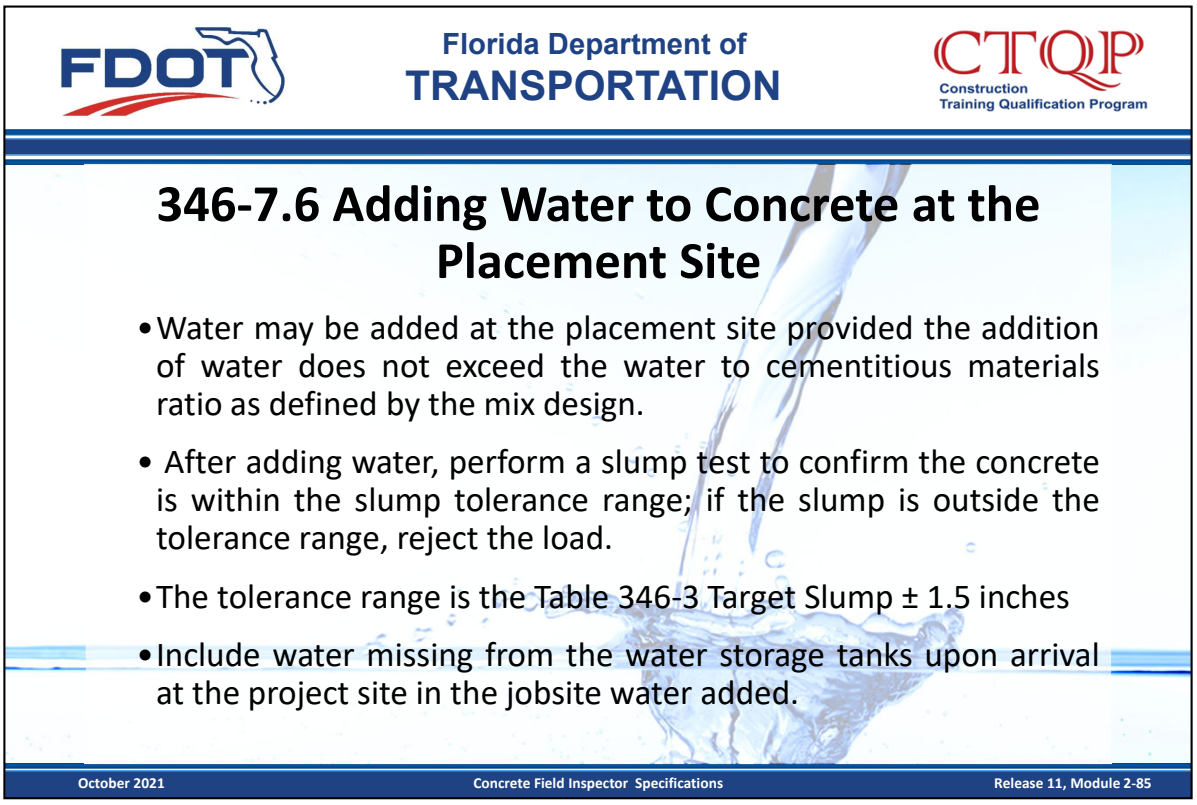
- •Increased water demand
- •Accelerated slump loss
- •A faster set time
- •Increased tendency for plastic cracking
- •Difficulty controlling entrained air
- •Need for prompt early curing

•*Adding water at site can:*

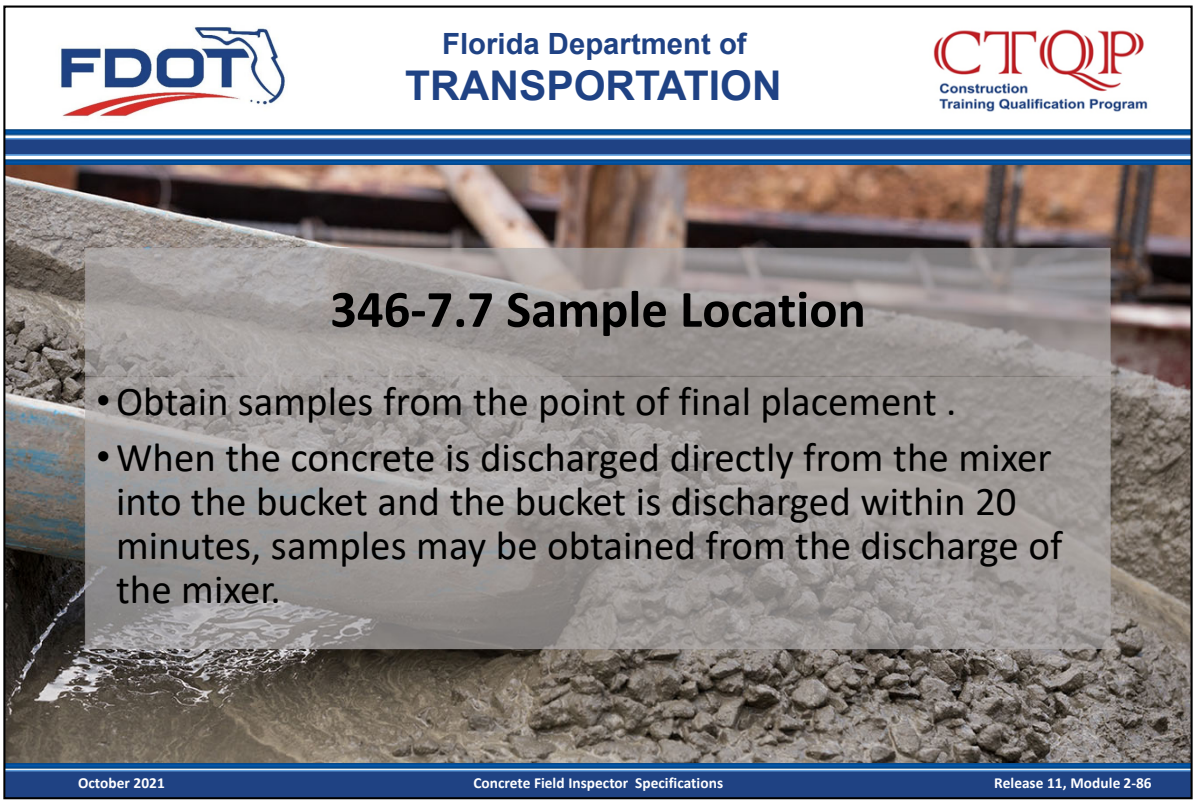
- Decrease strength
- Decrease durability and water tightness
- Cause non uniform surface appearance
- Cause increased tendency for drying shrinkage

346-7.5 Concreting in Hot Weather: Hot weather concreting is defined as the production, placing and curing of concrete when the concrete temperature at placing exceeds 85ºF but is less than 100ºF.

Unless the specified hot weather concreting measures are in effect, reject concrete exceeding 85ºF at the time of placement. Regardless of special measures taken, reject concrete exceeding 100ºF. Predict the concrete temperatures at placement time and implement hot weather measures to avoid production shutdown.



346-7.6 Adding Water to Concrete at the Placement Site: Water may be added at the placement site provided the addition of water does not exceed the water to cementitious materials ratio as defined by the mix design. After adding water, perform a slump test to confirm the concrete is within the slump tolerance range. If the slump is outside the tolerance range, reject the load. If an adjustment is made at the concrete production facility, perform a slump test on the next load to ensure the concrete is within the slump tolerance range. Do not place concrete represented by slump test results outside of the tolerance range. Include water missing from the water storage tanks upon arrival at the project site in the jobsite water added.

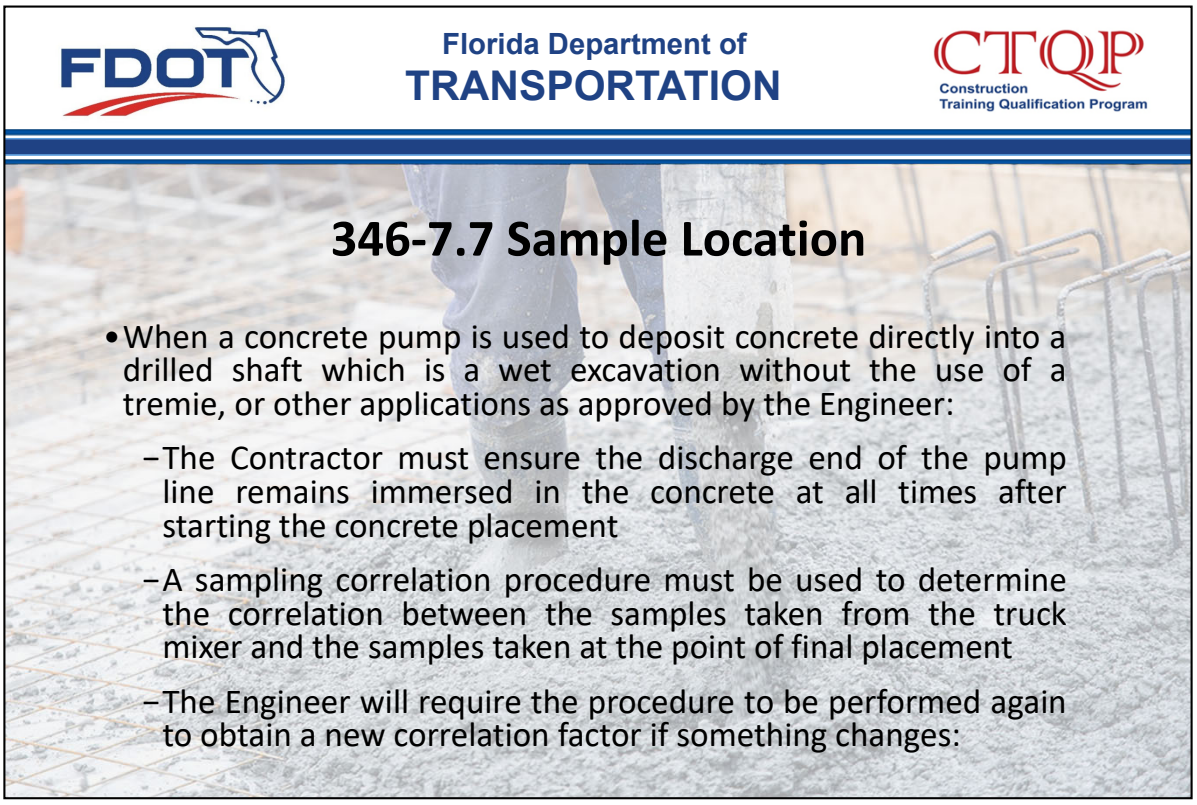


346-7.7 Sample Location: Obtain samples from the point of final placement .

Where concrete buckets are used to discharge concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge of the bucket. When the concrete is discharged directly from the mixer into the bucket and the bucket is discharged within 20 minutes, samples may be obtained from the discharge of the mixer.

Where conveyor belts, troughs, pumps, or chutes are used to transport concrete directly to the point of final placement or into the hopper of a tremie pipe, samples will be obtained from the discharge end of the entire conveyor belt, trough, pump, or chute system.

Where concrete is placed in a drilled shaft or other element using a tremie pipe and a concrete pump, samples will be obtained from the discharge of the pump line at the location of the tremie hopper.



346-7.7 Sample Location:

For all other placement methods, prior to each placement, obtain Department approval for sampling at the discharge of the mixer in lieu of sampling at the point of final placement. Submit the sampling correlation procedure to the Engineer for approval prior to the placement of the concrete. Once the comparative sampling correlation is approved by the Engineer, apply this correlation to the plastic properties tolerances for samples obtained from the discharge of mixer.

Where a concrete pump is used to deposit concrete directly into a drilled shaft which is a wet excavation without the use of a tremie, or other applications as approved by the Engineer, ensure the discharge end of the pump line remains immersed in the concrete at all times after starting concrete placement.

NOTE: The correlation may not be applicable to all individual placements.

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Examples of Point of Final Placement



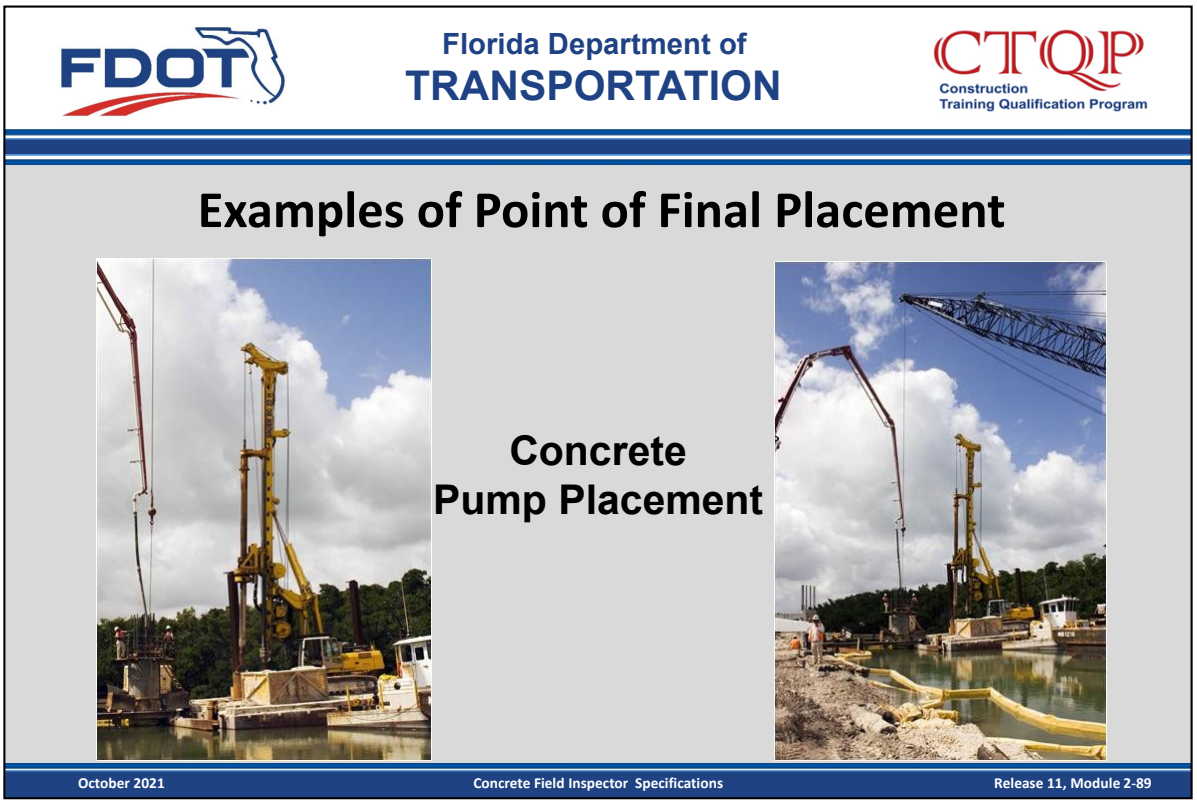
Concrete Pump Truck



Discharge to Concrete Pump

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These are examples of pumping operations that show a desirable configuration of the boom. There are no sharp angles which can cause either the concrete to compress on one side of the angle or a vacuum to form. In the second photo you can see a truck delivering the concrete to the back of the pump.



Where would the sample correlation process might have to be used? The concrete is being placed at the top of the column. The material can't be sampled from the end of the boom because it can't swing out to a place where the samples can be taken properly. There's no good place for it to swing out to. The barge may not be stable enough or level enough to have the boom swing out there and get the samples.

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CTQP Construction Training Qualification Program



Truck Discharging into Bucket

Bucket is Barged to Footer

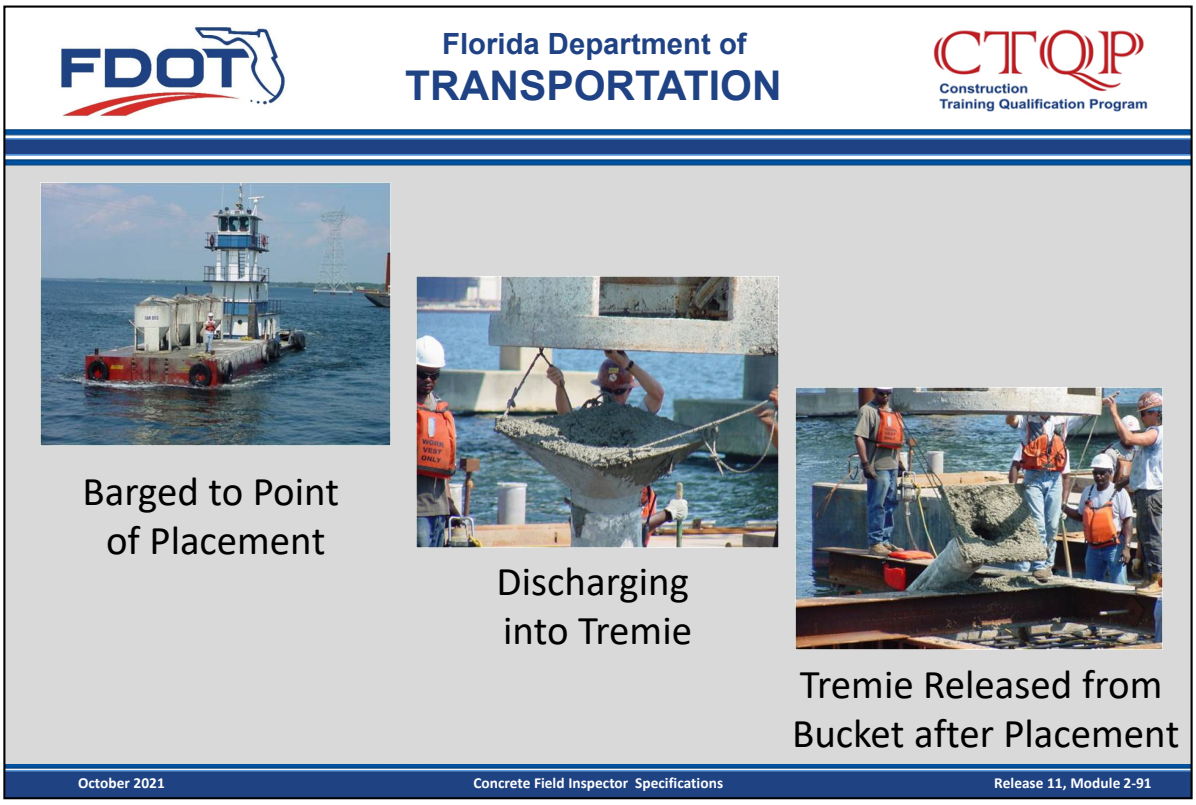




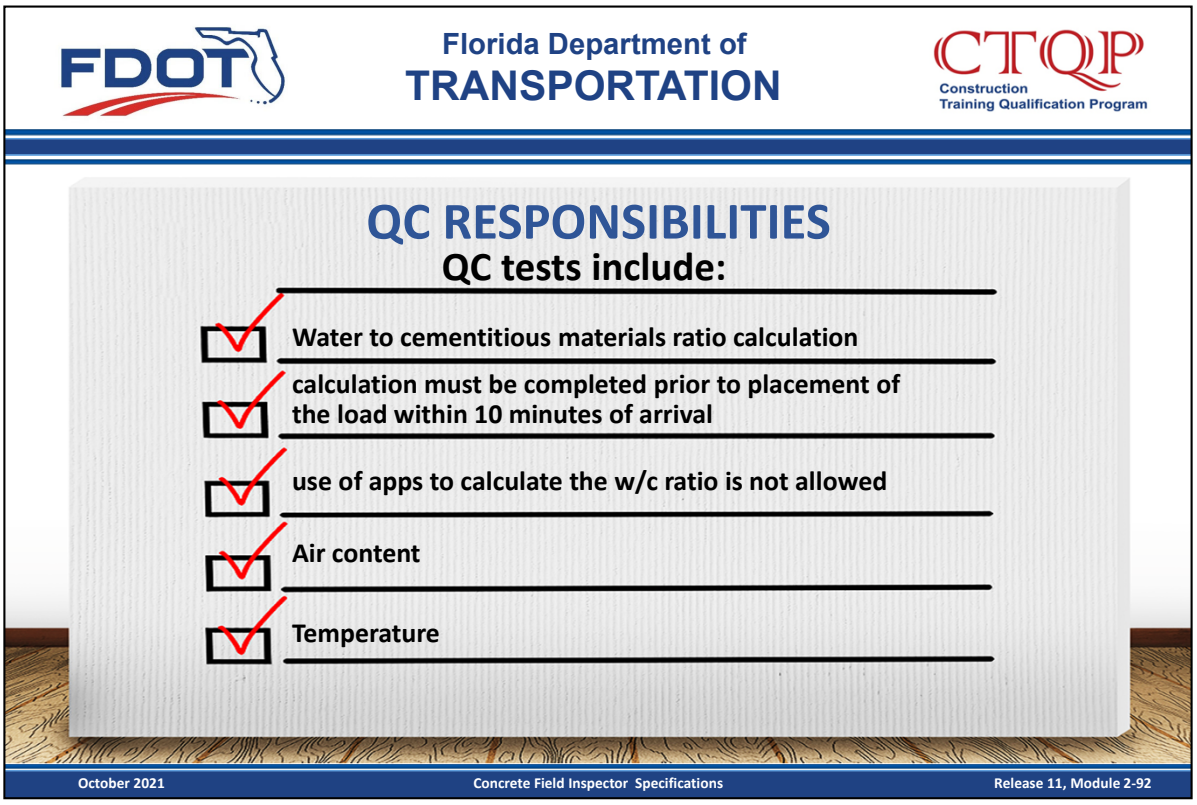
Bucket Discharging into Footer

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This sequence of operations does not change the concrete very much. A sample correlation between the concrete coming out of the truck to the concrete coming out of the bucket would probably not be needed.



The sample correlation process would be used to determine the difference between the concrete from the delivery truck to the concrete as placed through the tremie at the point of final placement. This is because the concrete must be dropped more than 5' with this configuration. Section 346 requires that the samples be taken at the point of final placement with the exception of material that has been evaluated using the sample correlation process. We won't go into the details for the process, but if you need more information, you can contact the appropriate DMRO Concrete personnel for directions.

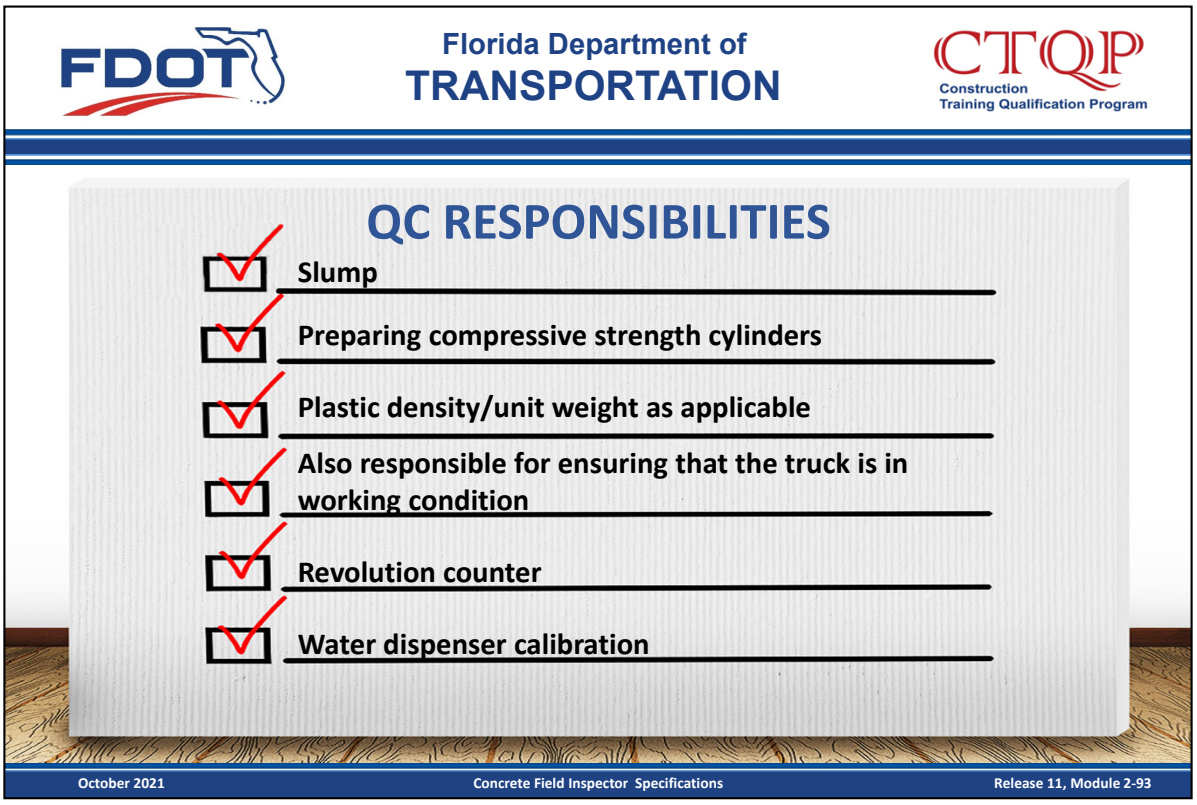


The 346 specification does not require unit weight but it may be required based on mix designs of other specifications. Note: evaporation rate may be required as stated in section 400-16, additional discussion will be in section 400

Perform QC tests in accordance with Table 346-7. Calculate the water to cementitious materials ratio first, include air content, temperature, slump, and preparing compressive strength cylinders for testing at later dates.

Determine the water/cementitious ratio using the attached instructions and example (water/cementitious ratio calculation) as a guide. The elapsed time shall not exceed 10 minutes between the beginning and the end of the water/cementitious ratio calculation.

Note: The water/cementitious ratio calculation must be completed prior to placement of the load.



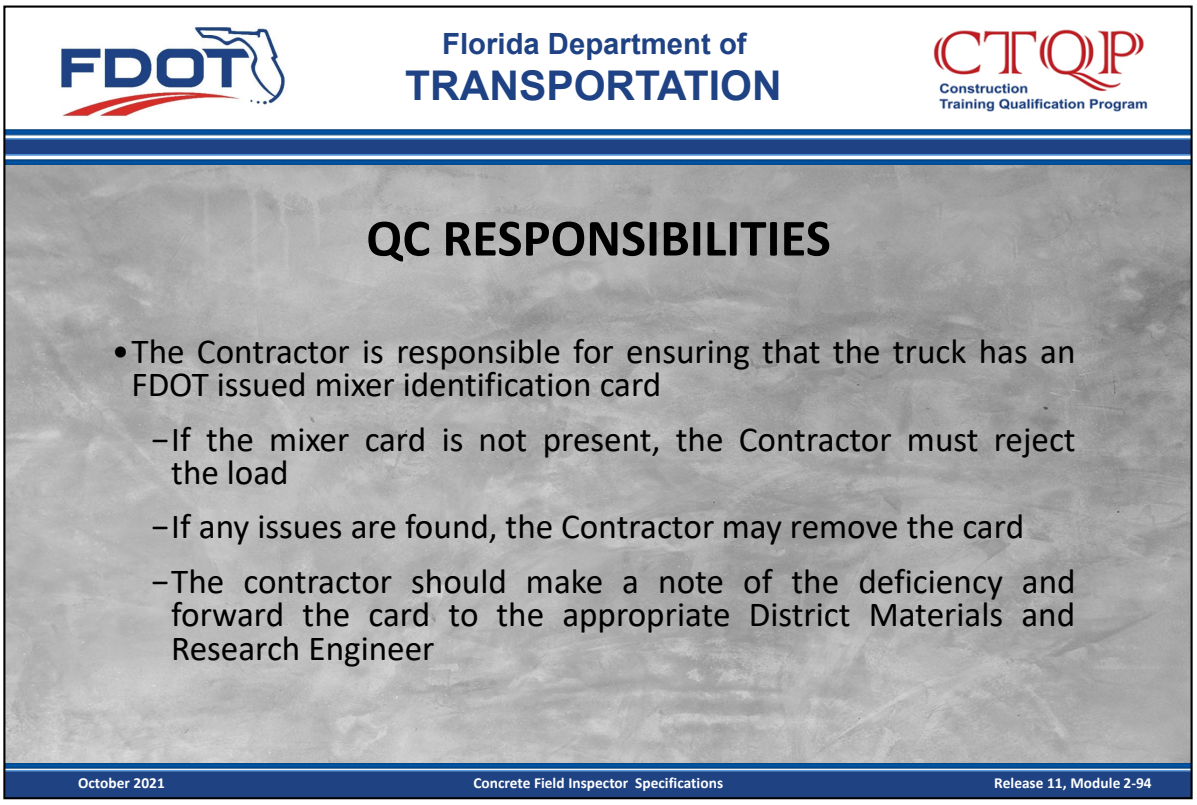
The 346 specification does not require unit weight but it may be required based on mix designs of other specifications. Note: evaporation rate may be required as stated in section 400-16, additional discussion will be in section 400

346-8 Plastic Concrete Sampling and Testing.

Perform QC tests in accordance with Table 346-7. Calculate the water to cementitious materials ratio first, include air content, temperature, slump, and preparing compressive strength cylinders for testing at later dates.

Determine the water/cementitious ratio using the attached instructions and example (water/cementitious ratio calculation) as a guide. The elapsed time shall not exceed 10 minutes between the beginning and the end of the water/cementitious ratio calculation.

Note: The water/cementitious ratio calculation must be completed prior to placement of the load.



346-8 Plastic Concrete Sampling and Testing.

Ensure that each truck has a valid mixer identification card issued by the Department, the revolution counter on the mixer is working properly, and calibration of the water dispenser has been performed within the last twelve months. Reject any concrete batches that are delivered in trucks that do not have mixer identification cards. The Contractor may remove the mixer identification cards when a truck mixer is discovered to be in noncompliance and the mixer deficiencies cannot be repaired immediately. When the mixer identification card is removed for noncompliance, make note of the deficiency or deficiencies found, and forward the card to the District Materials and Research Engineer in the District which has Producer QC Plan acceptance authority.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-8 Plastic Concrete Sampling and Testing

- The Contractor must perform plastic properties testing on the initial load of each concrete mix design each day
- The Contractor must have at least one qualified technician present and testing at each placement site
- Multiple placements require multiple technicians

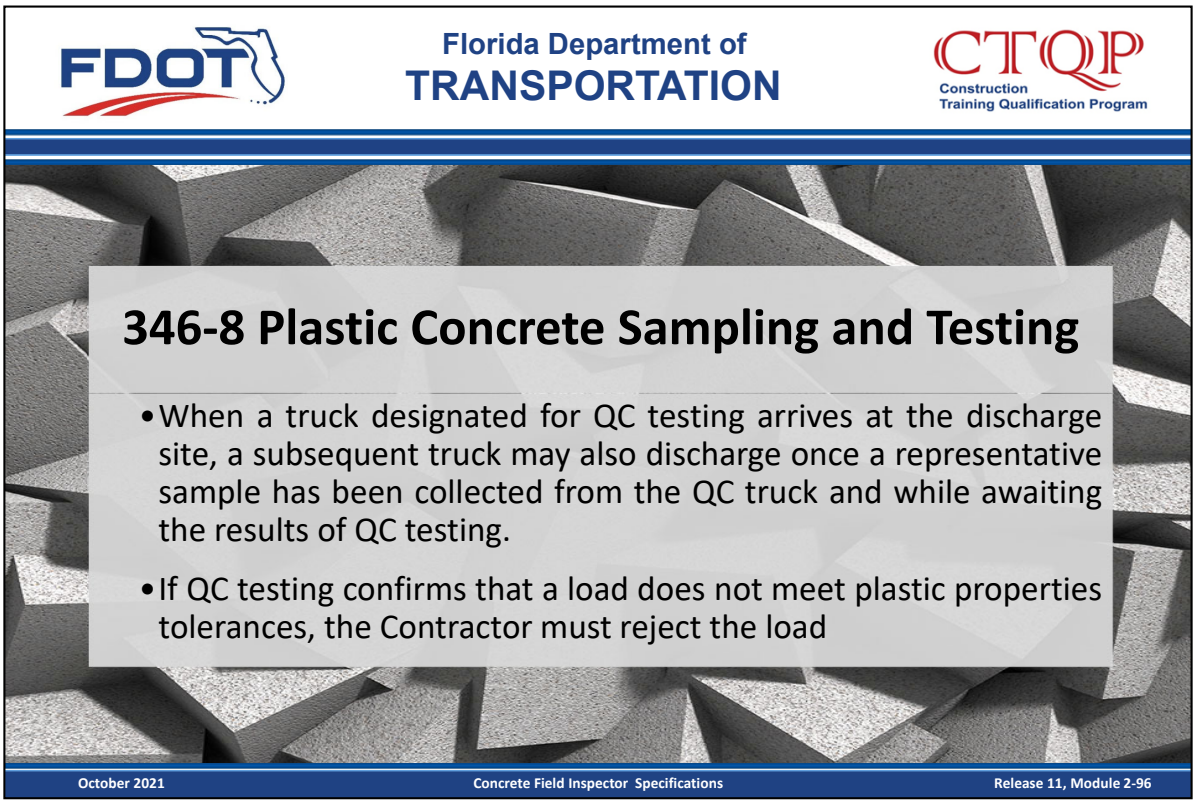


Pressure Meter

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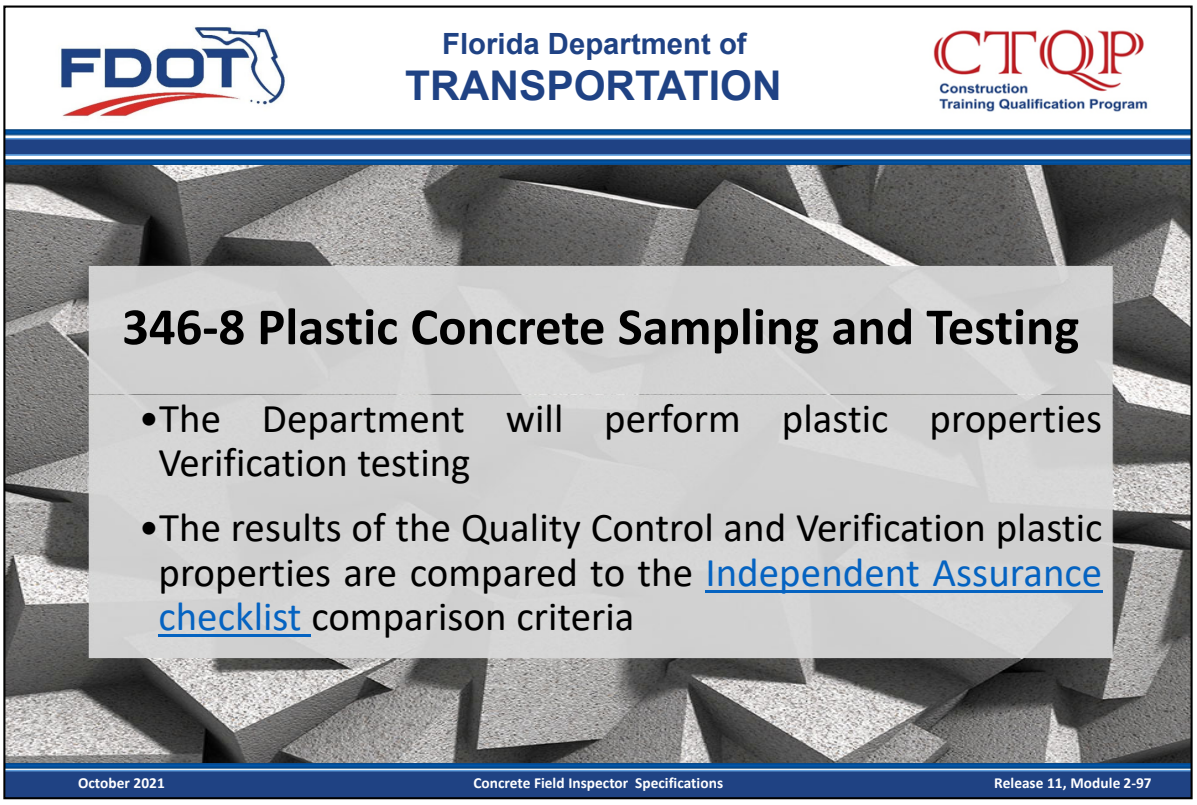
346-8 Plastic Concrete Sampling and Testing.

Perform plastic concrete tests on the initial delivery of each concrete design mix each day. Ensure QC technicians meeting the requirements of Section 105 are present and performing tests throughout the placement operation. Ensure one technician is present and performing tests throughout the placement operation at each placement site. If a project has multiple concrete placements at the same time, identify the technicians in the QC Plan to ensure minimum sampling and testing frequencies are met. Ensure that the equipment used for delivery, placement and finishing meets the requirements of this Specification.



346-8 Plastic Concrete Sampling and Testing (continued).

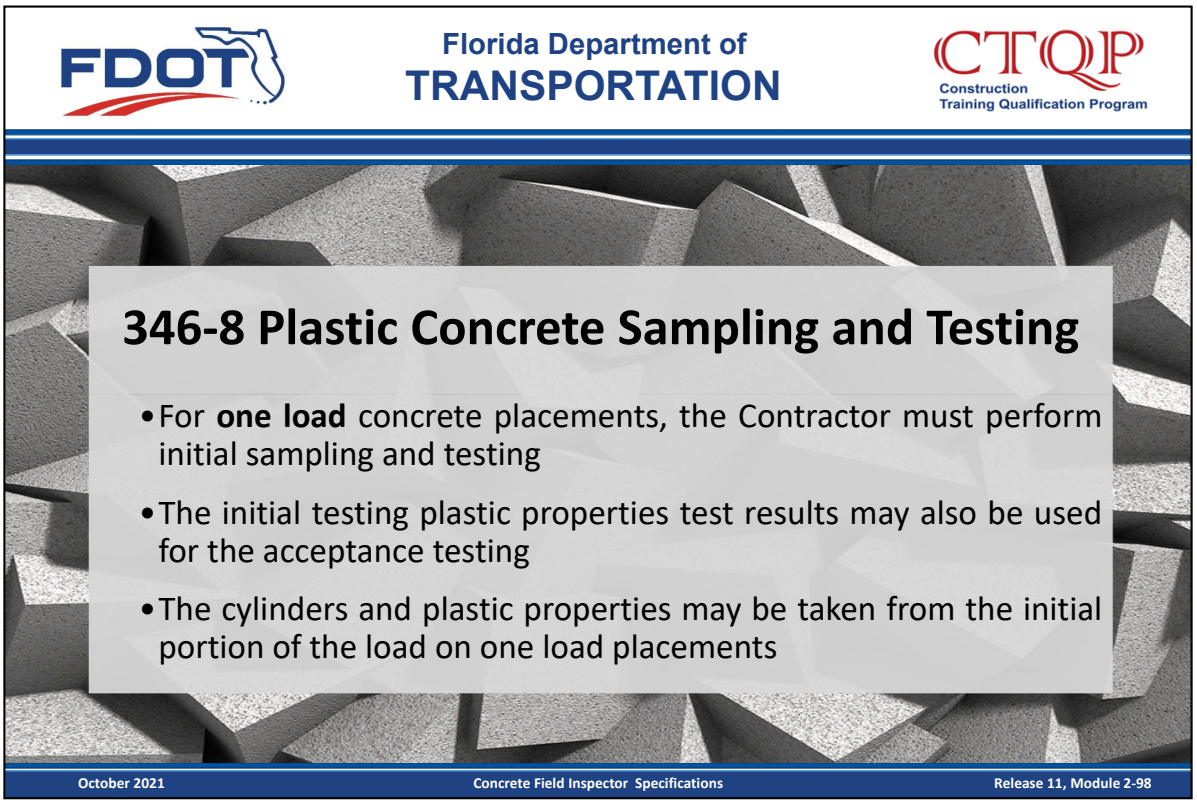
When a truck designated for QC testing arrives at the discharge site, a subsequent truck may also discharge once a representative sample has been collected from the QC truck and while awaiting the results of QC testing. . Reject non-complying loads at the jobsite. Ensure that corrections are made on subsequent loads. Immediately cease concrete discharge of all trucks if the QC truck has failing test. Perform plastic properties tests on all trucks prior to the first corrected truck and the corrected truck. When more than one truck is discharging into a pump simultaneously, only the truck designated for QC testing may discharge into the pump to obtain a representative sample of concrete from the QC truck only.



The IA checklist comparison criteria can be found on the Website Links page contained in Appendix 3.

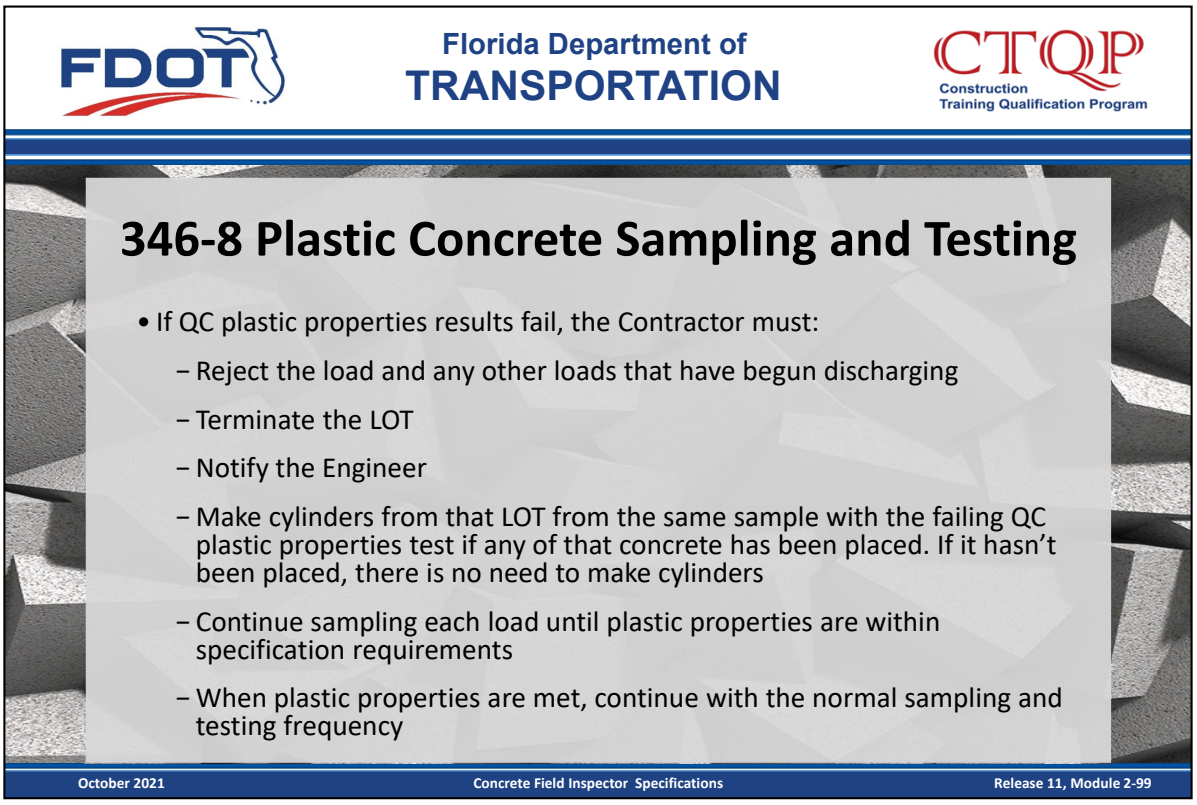
346-8 Plastic Concrete Sampling and Testing (continued).

Furnish sufficient concrete of each design mix as required by the Engineer for verification testing. When the Engineer's verification test results do not compare with the QC plastic properties test results, within the limits defined by the Independent Assurance (IA) checklist comparison criteria, located in Materials Manual Chapter 5, disposition of the concrete will be at the option of the Contractor. Note: Both technicians may be evaluated by Independent Assurance



346-8 Plastic Concrete Sampling and Testing (continued).

On concrete placements consisting of only one load of concrete, perform initial sampling and testing in accordance with this Section. The acceptance sample and plastic properties tests may be taken from the initial portion of the load.

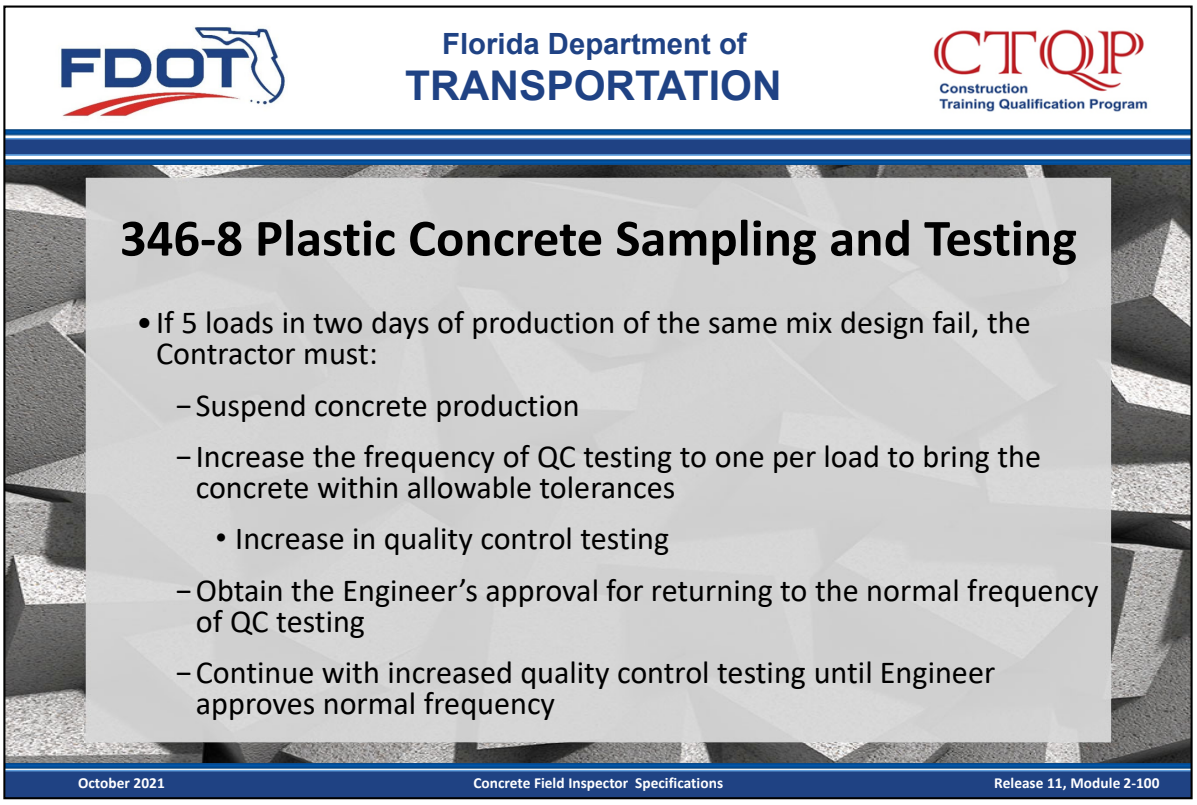


The information on this slide applies to all QC plastic properties failures. we're no longer talking about the procedure for one load placements, but any time the QC plastic properties fail.

346-8 Plastic Concrete Sampling and Testing (continued).

If any of the QC plastic properties tests fail, reject the remainder of that load, and any other loads that have begun discharging, terminate the LOT and notify the Engineer. Make cylinders representing that LOT from the same sample of concrete.

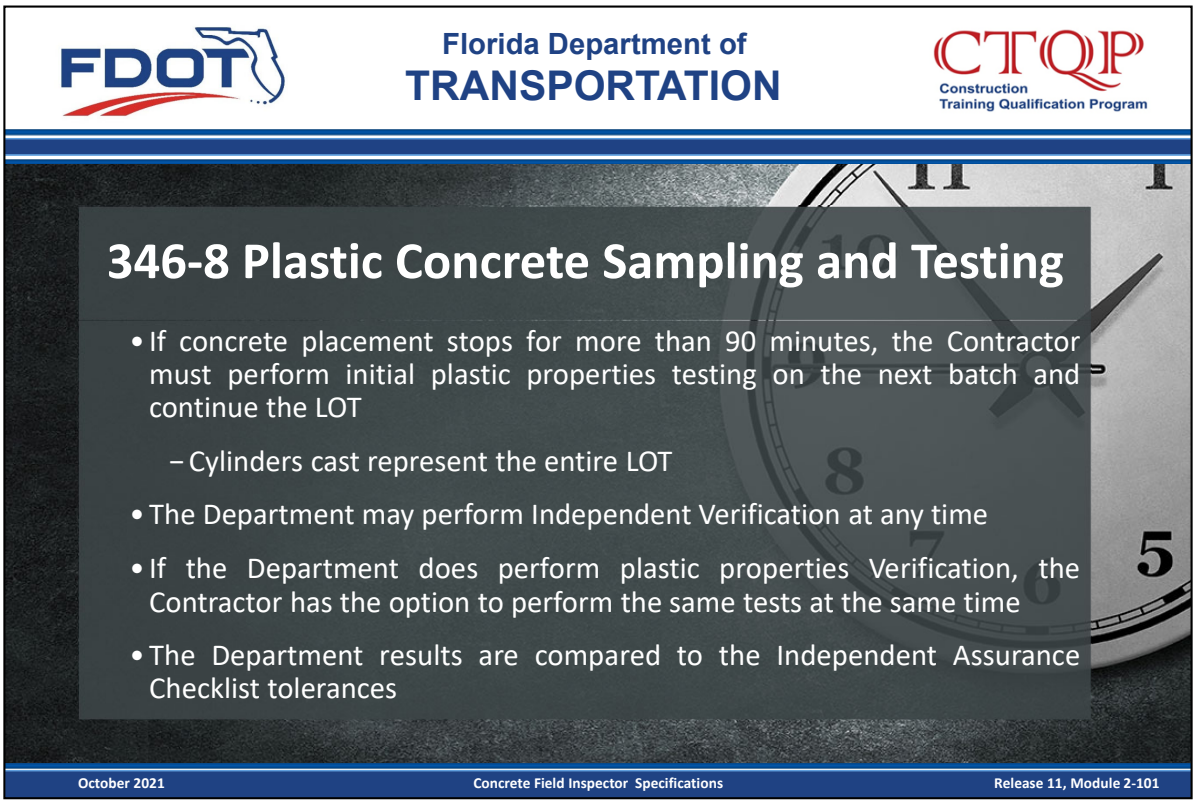
Following termination of a LOT, obtain samples from a new load, and perform plastic properties tests until such time as the water to cementitious materials ratio, air content, temperature and slump comply with the Specification requirements. Initiate a new LOT once the testing indicates compliance with Specification requirements.



Suspend concrete production when any five(5) loads in two(2) days production of the same mix design fail plastic property testing. The Producer QC Plan may need to be revised, depending on the situation. The contractor does not really suspend the concrete facility but suspends placement on the project and notifies the Engineer. It is the contractor's responsibility to do this.

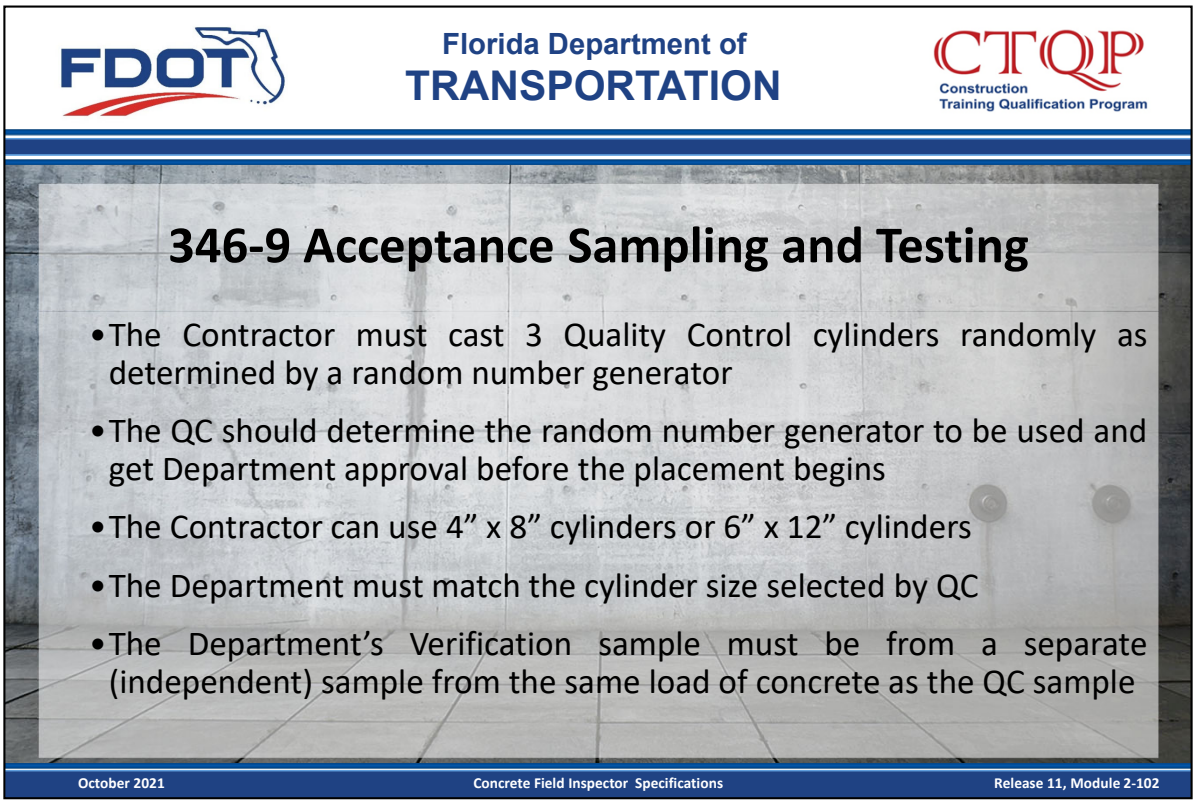
346-8 Plastic Concrete Sampling and Testing (continued).

Suspend production when any five loads in 2 days production of the same mix design are outside the specified tolerances. Increase the frequency of QC testing to one per load to bring the concrete within allowable tolerances. After production resumes, obtain the Engineer's approval before returning to the normal frequency of QC testing.



346-8 Plastic Concrete Sampling and Testing (continued).

If concrete placement stops for more than 90 minutes, perform initial plastic properties testing on the next batch and continue the LOT. Cylinders cast for that LOT will represent the entire LOT.



The reason for the separate sample is to meet the Code of Federal Requirements (CFR) requirement that VT samples must be separate from QC samples. QC and VT Samples size must match even if 4” x 8” or 6” x 12” are allowed. For QC and VT Sample, they must be the same size. These samples must also match for identification. The QC and VT samples are independent, but they come from the same load. they should have the same mix design, plant number, etc.

346-9 Acceptance Sampling and Testing.

346-9.1 General: Perform plastic properties tests in accordance with 346-8 and cast a set of three QC cylinders, for all structural concrete incorporated into the project. Take these acceptance samples randomly as determined by a random number generator acceptable to the Department. The Department will independently perform VT plastic properties tests and cast a set of VT cylinders. The VT cylinders will be the same size cylinder selected by the Contractor, from a separate sample from the same load of concrete as the Contractor’s QC sample.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-9 Acceptance Sampling and Testing

- For each set of QC cylinders verified by the Department, cast two additional cylinders from the same sample, and identify them as the quality control resolution (QR) test cylinders. The Department will also cast two additional verification resolution (VR) test cylinders from each VT sample
- The Contractor must provide curing facilities big enough for all cylinders cast for the structural concrete on the project for initial curing
- All cylinders must be clearly identified



Plastic Properties Field Test

October 2021 Concrete Field Inspector Specifications Release 11, Module 2-103

The standardized sample/lot numbering system should assist project personnel with tracking the status of concrete during the life of the project and identify issues with the concrete portion of the project for the final project materials certification (like missing frequency).

The cylinders need to be delivered to the QC and VT testing labs after 24 hours but within 48 hours of casting. In addition, they need to be transported as close to the same time as possible. After casting they should be cured in an approved curing box.

The QR test cylinders go to the lab and are cured the same as the acceptance cylinders. They are not held on the job but are kept until the verification is completed and QC and VT comparison is completed.

Extra cylinders cast by the contractor for information, such as form removal, etc, do not go into the curing box and are not for acceptance, should be taken to the laboratory the day of test.

346-9.1 General (continued): For each set of QC cylinders verified by the Department, cast two additional cylinders from the same sample, and identify them as the quality control resolution (QR) test cylinders. The Department will also cast two additional verification resolution (VR) test cylinders from each VT sample. All cylinders will be clearly identified as outlined in the Sample/Lot Numbering System instructions located on the State Materials Office website.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-9 Acceptance Sampling and Testing

- The Contractor delivers the QC cylinders to the QC testing facility for final curing and testing
- The Department will deliver the VT samples, including the VR cylinders, to their final curing facility.



Cylinders in Curing Room

October 2021 Concrete Field Inspector Specifications Release 11, Module 2-104

The standardized sample/lot numbering system should assist project personnel with tracking the status of concrete during the life of the project and identify issues with the concrete portion of the project for the final project materials certification (like missing frequency).

The cylinders need to be delivered to the QC and VT testing labs after 24 hours but within 48 hours of casting. In addition, they need to be transported as close to the same time as possible. After casting they should be cured in an approved curing box.

The VR test cylinders go to the lab and are cured the same as the acceptance cylinders. They are not held on the job but are kept until the verification is completed and QC and VT comparison is completed.

Extra cylinders cast by the contractor for information, such as form removal, etc, do not go into the curing box and are not for acceptance, should be taken to the laboratory the day of test.

346-9.1 General (continued): Deliver the QC samples, including the QR cylinders to the final curing facility in accordance with ASTM C31. Concurrently, the Department will deliver the VT samples, including the VR cylinders, to their final curing facility.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program





CURING BOXES



CURING BOX WITH HI/LO THERMOMETER

October 2021 Concrete Field Inspector Specifications Release 11, Module 2-105

A typical curing box will need to be insulated, with provisions for regulating the temperature, in compliance with the appropriate test method ASTM C31.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-9.1 General

- The Contractor must test the QC cylinders at 28 days, or at any other age specified, in a qualified lab
- The test results must be reported in the Department's database within 24hours
  - If the tests cannot be reported in the database within 24 hours, the QC laboratory will notify the contractor
  - The QC lab then has 72 hours to input the data into the Department's database



Compression Strength Testing



October 2021 Concrete Field Inspector Specifications Release 11, Module 2-106

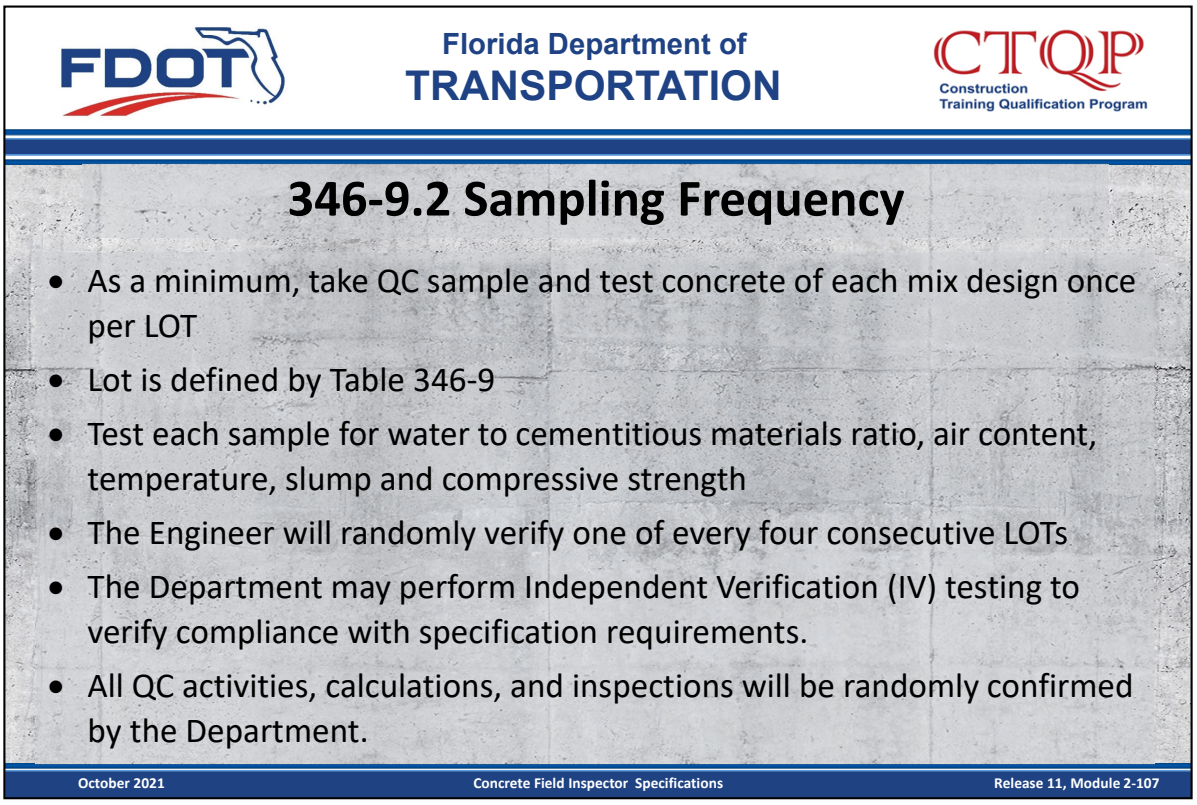
Technical special provisions may have acceptance criteria based on an age other than 28 days, such as 7 days.

Standard specifications section 105 describes the lab qualification program. The note in relation to 72 hours input time relates to when the database is unavailable, not being able to get the data input.

346-9.1 General (continued): Test the QC laboratory cured samples for compressive strength at the age of 28 days, in a laboratory meeting and maintaining at all times the qualification requirements listed in Section 105.

The QC testing laboratory will input the compressive strength test results into the Department's Materials Acceptance and Certification (MAC) system within 24 hours. When the QC testing laboratory cannot input the compressive strength test results into MAC within 24 hours, the QC testing laboratory will notify the VT testing laboratory within 24 hours of testing the cylinder and provide the VT testing laboratory the compressive strength test results. Ensure the compressive strength results are input into MAC within 72 hours of determining the compressive strength of the cylinders.

The Department will compare the VT sample compressive strength test results with the corresponding QC sample test results.



346-9.2 Sampling Frequency: As a minimum, sample and test concrete of each mix design for water to cementitious materials ratio, air content, temperature, slump and compressive strength once per LOT as defined by Table 346-9. The Engineer will randomly verify one of every four consecutive LOTs of each mix design based on a random number generator. The Department may perform Independent Verification (IV) testing to verify compliance with specification requirements. All QC activities, calculations, and inspections will be randomly confirmed by the Department.

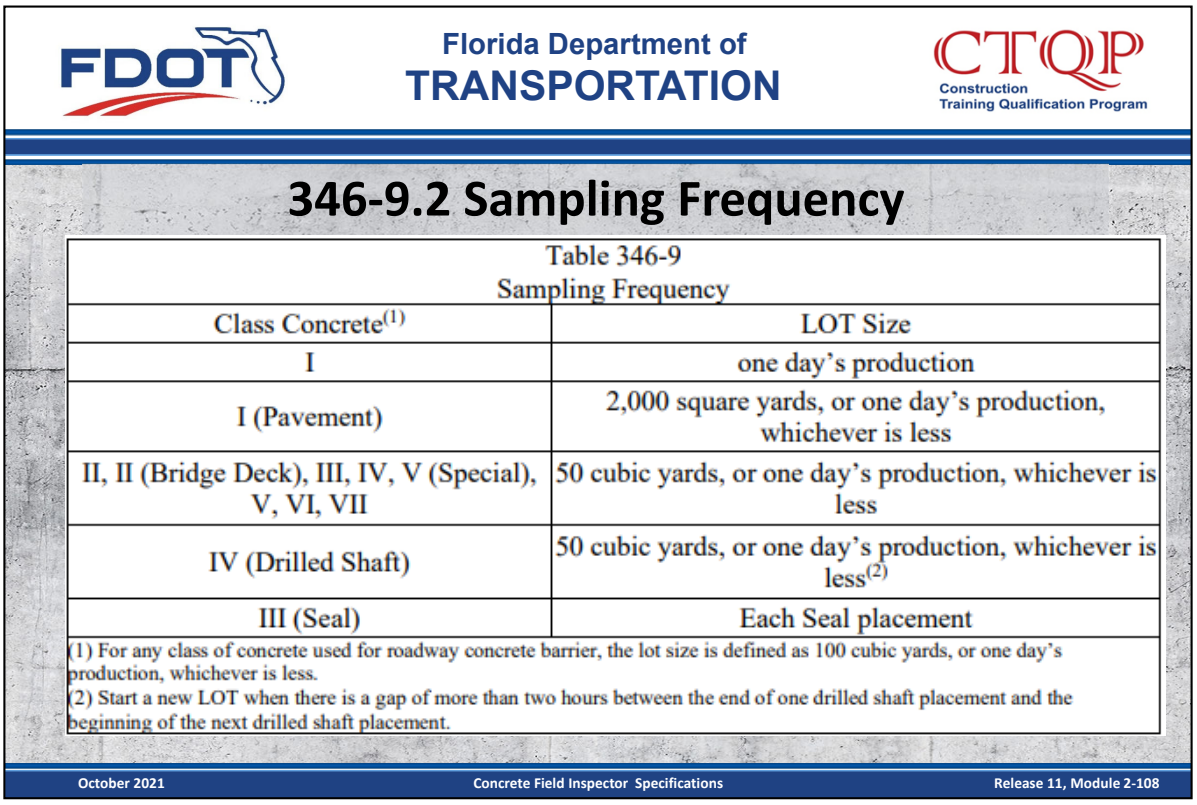


Table 346-9 defines the maximum LOT size for each class of concrete

Different Classes have different LOT sizes

I = one day's production

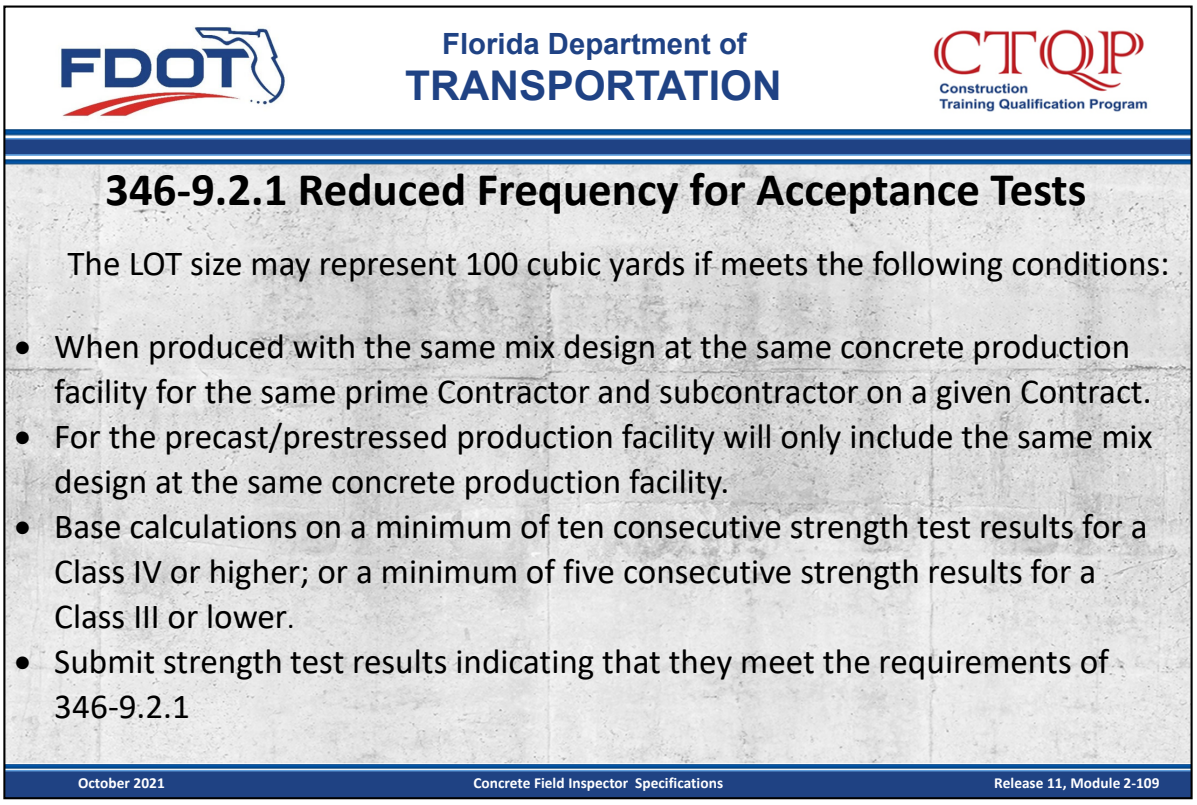
I (Pavement) = 2,000 square yards, or one day's production, whichever is less

II, II (Bridge Deck), III, IV, V (Special), V, VI = 50 yd^3, or one day's production, whichever is less

IV (Drilled Shaft) = 50 yd^3, or two hours between placements, whichever is less

III (Seal) = each placement

NOTE: for any class of concrete used for roadway barrier wall, the lot sized is defined as 100 cubic yards, or one day's production, whichever is less



346-9.2.1 Reduced Frequency for Acceptance Tests: The LOT size may represent 100 cubic yards when produced with the same mix design at the same concrete production facility for the same prime Contractor and subcontractor on a given Contract. As an exception, the requirements for the precast/prestressed production facility will only include the same mix design at the same concrete production facility.

Submit strength test results indicating that the two following criteria are met:

1. The average of the acceptance compressive strengths is equal to or greater than the specified minimum compressive strength (f_c') plus 2.33 standard deviations minus:
   a. 500 psi, if f_c' is 5,000 psi or less.
   b. 0.10 f_c', if f_c' is greater than 5,000 psi.
2. Every average of three consecutive strength test equals or exceeds the f_c' plus 1.34 standard deviations.

Base calculations on a minimum of ten consecutive strength test results for a Class IV or higher; or a minimum of five consecutive strength results for a Class III or lower.

The average of the consecutive compressive strength test results, based on the class of concrete, can be established using historical data from a previous Department project. The tests from the previous Department project must be within the last calendar year or may also be established by a succession of samples on the current project. Only one sample can be taken from each LOT. Test data must be from a laboratory meeting the requirements of Section 105. Obtain Department approval before beginning reduced frequency LOTs.

If at any time a strength test is not verified or the average strength of the previous ten or five consecutive samples based on the class of concrete from the same mix design and the same production facility does not conform to the above conditions, return to the frequency represented by the LOT as defined in Table 346-9. Notify the Engineer that the initial frequency is reinstated. In order to reinitiate reduced frequency, submit a new set of strength test results.

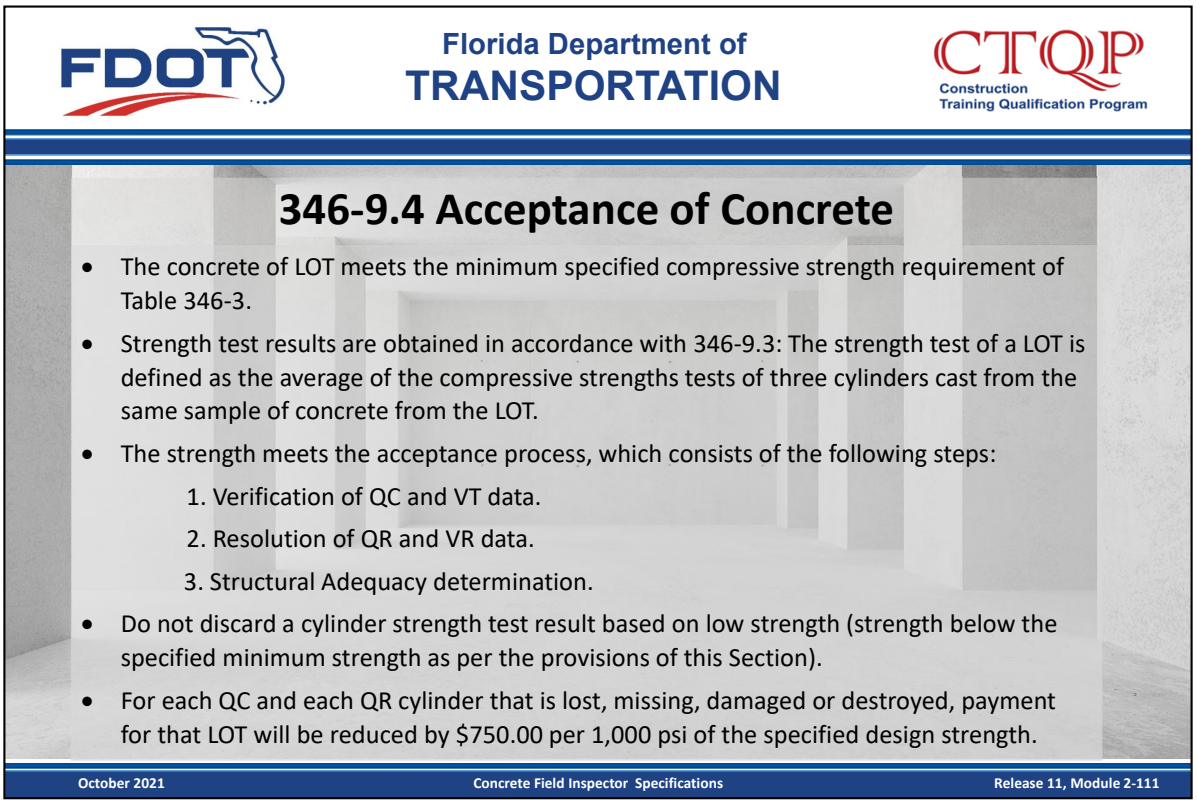
Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-9.3 Strength Test Definition

- The strength of a LOT is defined as the average of the compressive strengths tests of three 4x8 cylinders cast from the same sample of concrete from the LOT





346-9.4 Acceptance of Concrete: The Engineer will accept the concrete of a given LOT when it meets the minimum specified compressive strength requirement of Table 346-3. Ensure that the hardened concrete strength test results are obtained in accordance with 346-9.3.

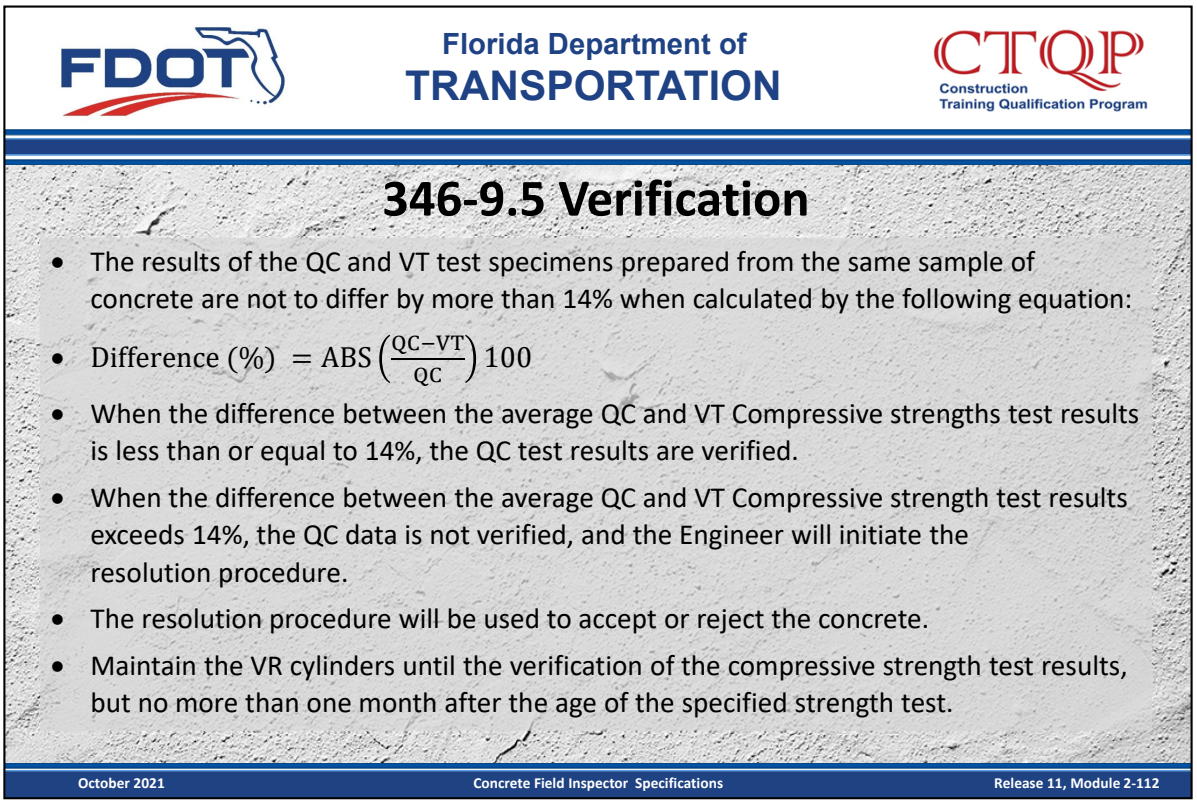
The process of concrete compressive strength acceptance consists of the following steps:

1. Verification of QC and VT data.
2. Resolution of QR and VR data.
3. Structural Adequacy determination.

Do not discard a cylinder strength test result based on low strength (strength below the specified minimum strength as per the provisions of this Section).

When one of the three QC cylinders from a LOT is lost, missing, damaged or destroyed, determination of compressive strength will be made by averaging the remaining two cylinders. If more than one QC cylinder from a LOT is lost, missing, damaged or destroyed, the Contractor will core the structure at no additional expense to the Department to determine the compressive strength. Acceptance of LOT may be based on VT data at the discretion of the Engineer. Obtain the approval of the Engineer to core, and of the core location prior to coring.

For each QC and each QR cylinder that is lost, missing, damaged or destroyed, payment for that LOT will be reduced by $750.00 per 1,000 psi of the specified design strength [Example: loss of two Class IV (Drill Shaft) QC cylinders that has no VT data will require the element to be cored and a pay reduction will be assessed (4,000 psi / 1,000 psi) x $750 x 2 = $6,000]. This reduction will be in addition to any pay adjustment for low strength.



346-9.5 Verification: The results of properly conducted test by QC and VT laboratories on specimens prepared from the same sample of concrete are not to differ by more than 14%.

$$\text{Difference (\%)} = \text{ABS}\left(\frac{\text{QC}-\text{VT}}{\text{QC}}\right)100$$

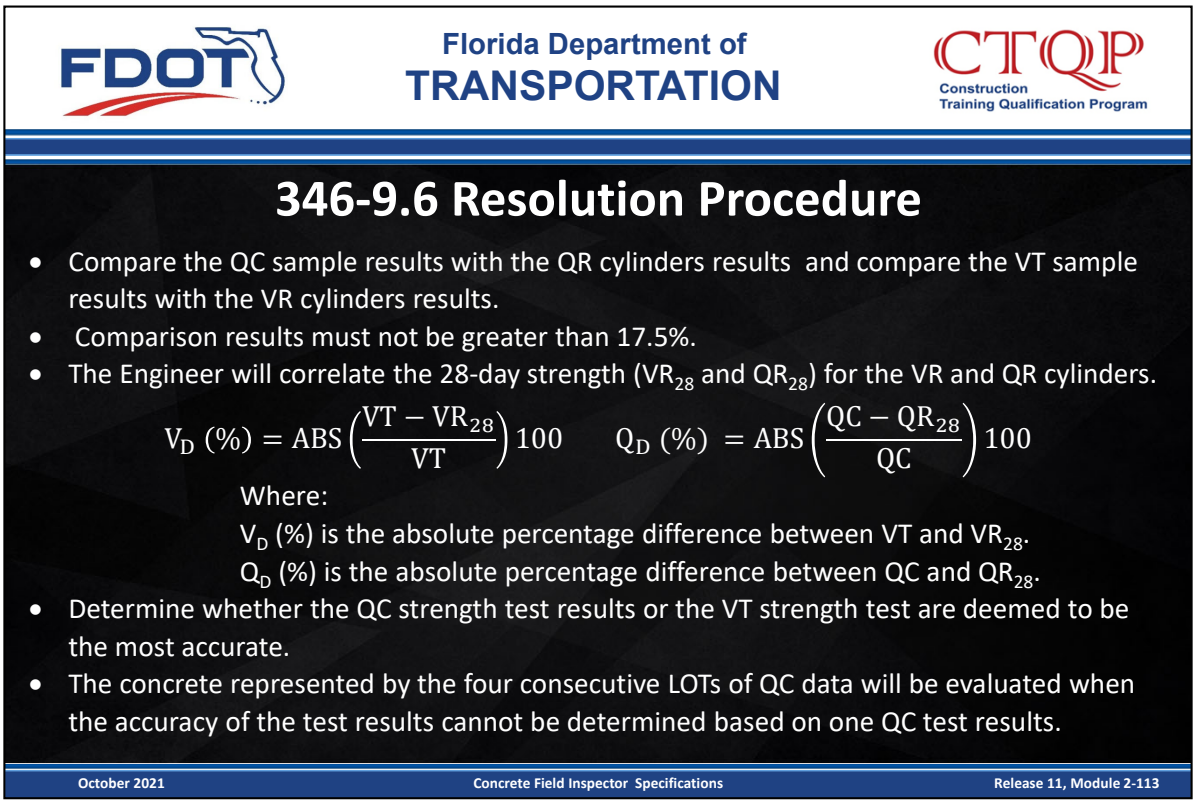
Where:

Difference (%) is the absolute percentage difference between QC and Verification Test.

The procedure consists of verifying if the QC and Verification Test compressive strengths data meet the established comparison criteria:

1. When the difference between the average compressive strength of QC and the average compressive strength of Verification Test is less than or equal to 14%, the QC test results are verified, the Engineer will accept the concrete based on QC test results. The Engineer will accept at full pay only LOTs of concrete represented by plastic property results which meet the requirements of the approved mix design and strength test results which equal or exceed the respective specified minimum strength.

2. When the difference between the average compressive strength of QC and the average compressive strength of Verification Test data exceeds 14%, the QC data is not verified, and the Engineer will initiate the resolution procedure. The resolution procedure will be used to accept or reject the concrete. Maintain the VR cylinders until the verification of the compressive strength test results, but no more than one month after the age of the specified strength test.



346-9.6 Resolution Procedure: The resolution procedure may consist of, but need not be limited to, a review of sampling and testing of fresh concrete, calculation of water to cementitious materials ratio, handling of cylinders, curing procedures and compressive strength testing.

Compare the VT sample results with the VR cylinders results. Compare the QC sample results with the QR cylinders results. Comparison results must not be greater than 17.5%. Core samples of the hardened concrete may be required. The Engineer will correlate the 28-day strength (VR_{28} and QR_{28}) for the VR and QR cylinders.

$$V_D\ (\%) = ABS\left(\frac{VT - VR_{28}}{VT}\right)100$$

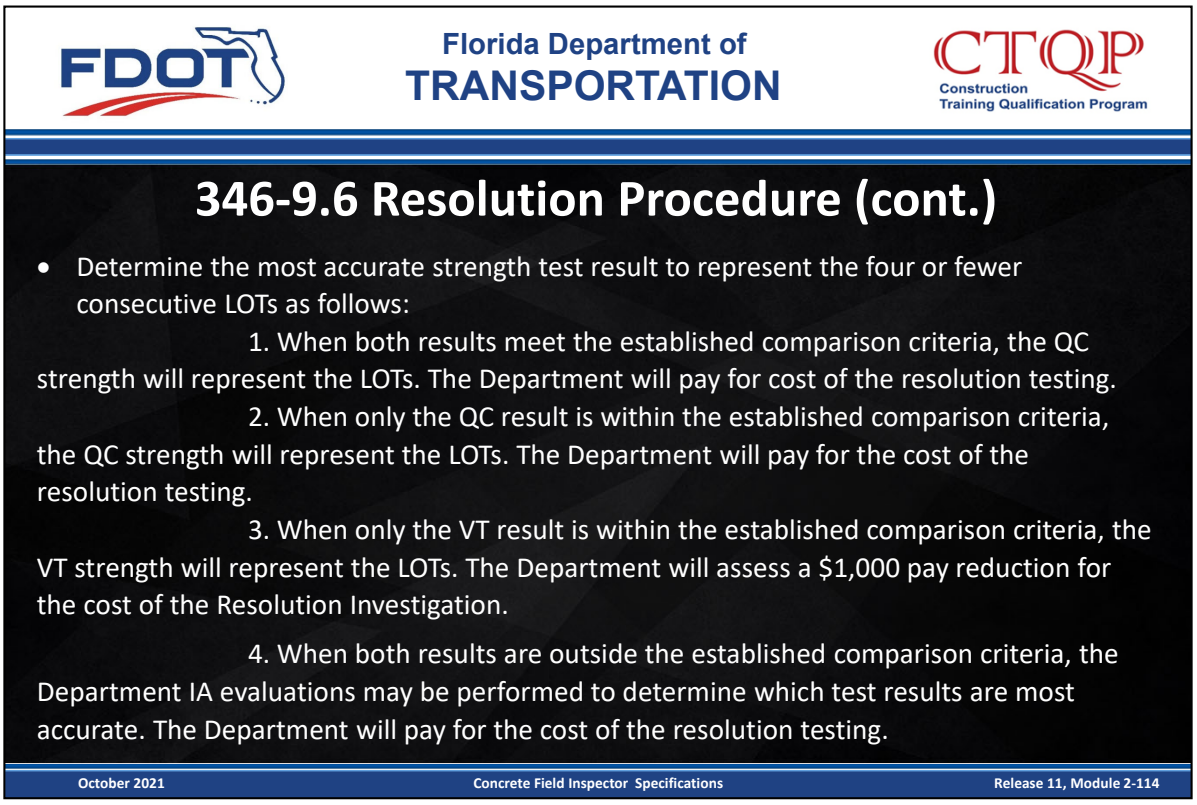
$$Q_D\ (\%) = ABS\left(\frac{QC - QR_{28}}{QC}\right)100$$

Where:

V_D (%) is the absolute percentage difference between VT and VR_{28}.

Q_D (%) is the absolute percentage difference between QC and QR_{28}.

The resolution procedure will use the above equations. The Engineer will determine through the resolution procedure whether the QC strength test results or the VT strength test are deemed to be the most accurate, LOTS will then be considered to be verified. When the Engineer cannot determine which strength test results are the most accurate, the concrete represented by the four consecutive LOTs will be evaluated based on the QC data. The Engineer will inform the QC and VT laboratories within three calendar days of the acceptance compressive strength test to transport their QR and VR cylinders to the resolution laboratory. The QC and VT laboratories will transport their own hold cylinders to the resolution testing laboratory within three calendar days after the Engineer notifies the Contractor that a resolution procedure is required. In addition, the Engineer will ensure that the QR and VR cylinders are tested within 14 calendar days of the acceptance strength tests.



346-9.6 Resolution Procedure (cont.)

The Engineer will determine the most accurate strength test result to represent the four or fewer consecutive LOTs as follows:

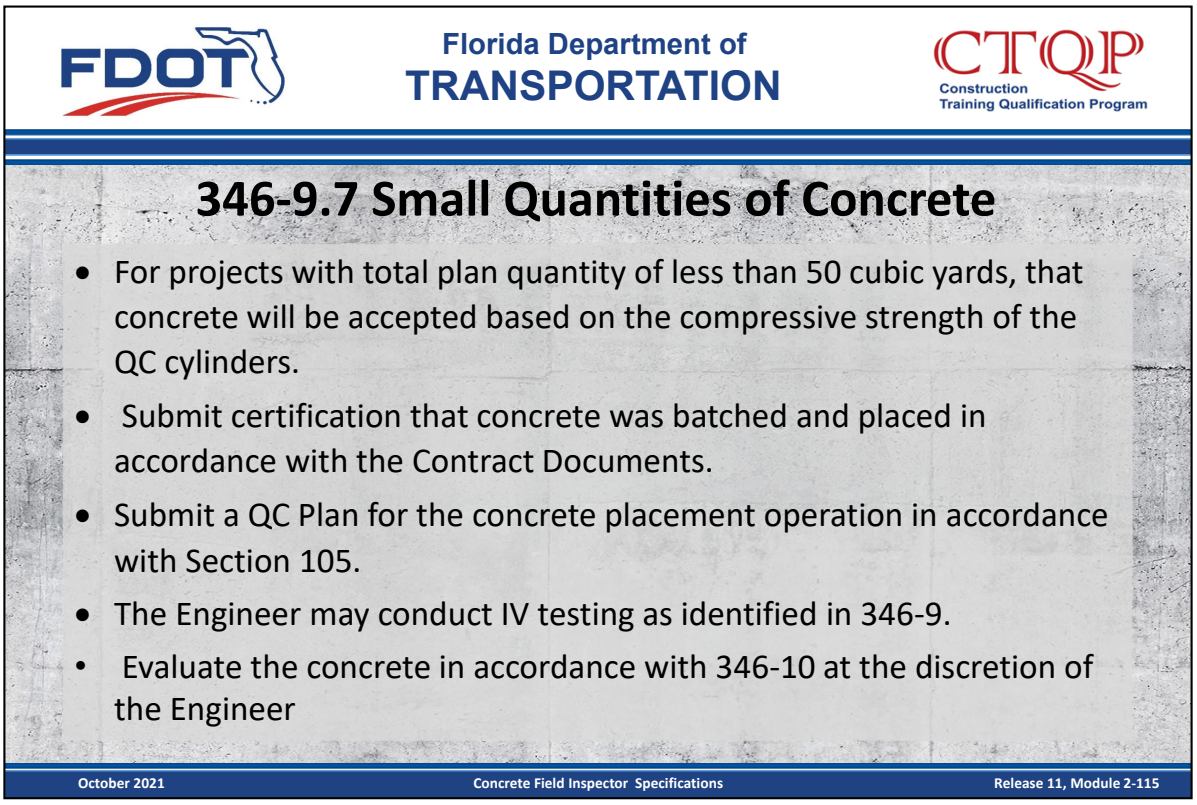
1. When both results meet the established comparison criteria, both are deemed accurate and the QC strength will represent the LOTs. The Department will pay for cost of the resolution testing.

2. When only the QC result is within the established comparison criteria, the QC strength is deemed as most accurate and will represent the LOTs. The Department will pay for the cost of the resolution testing.

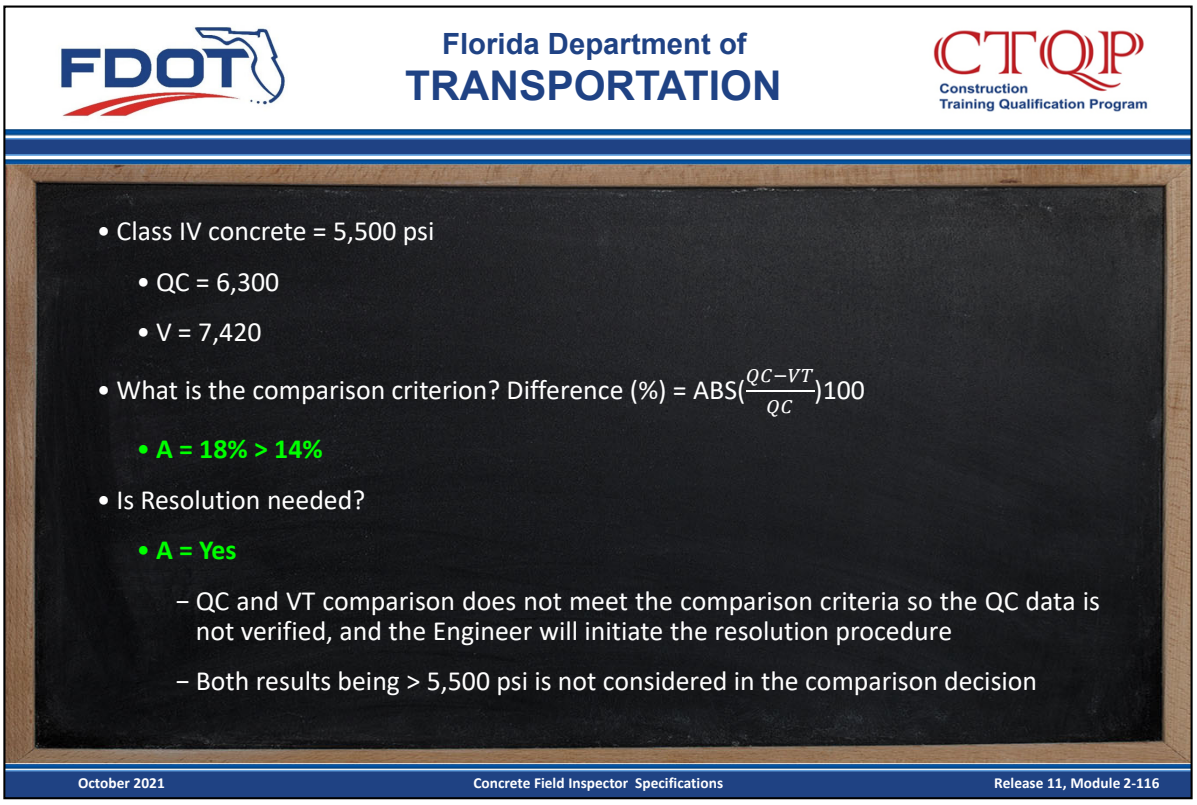
3. When only the VT result is within the established comparison criteria, the VT strength is deemed as most accurate and will represent the LOTs. The Department will assess a $1,000 pay reduction for the cost of the Resolution Investigation.

4. When both results are outside the established comparison criteria, the Engineer, with input from the District Materials Office, will determine if any Department IA evaluations are required and which test results are most accurate. The Department will pay for the cost of the resolution testing.

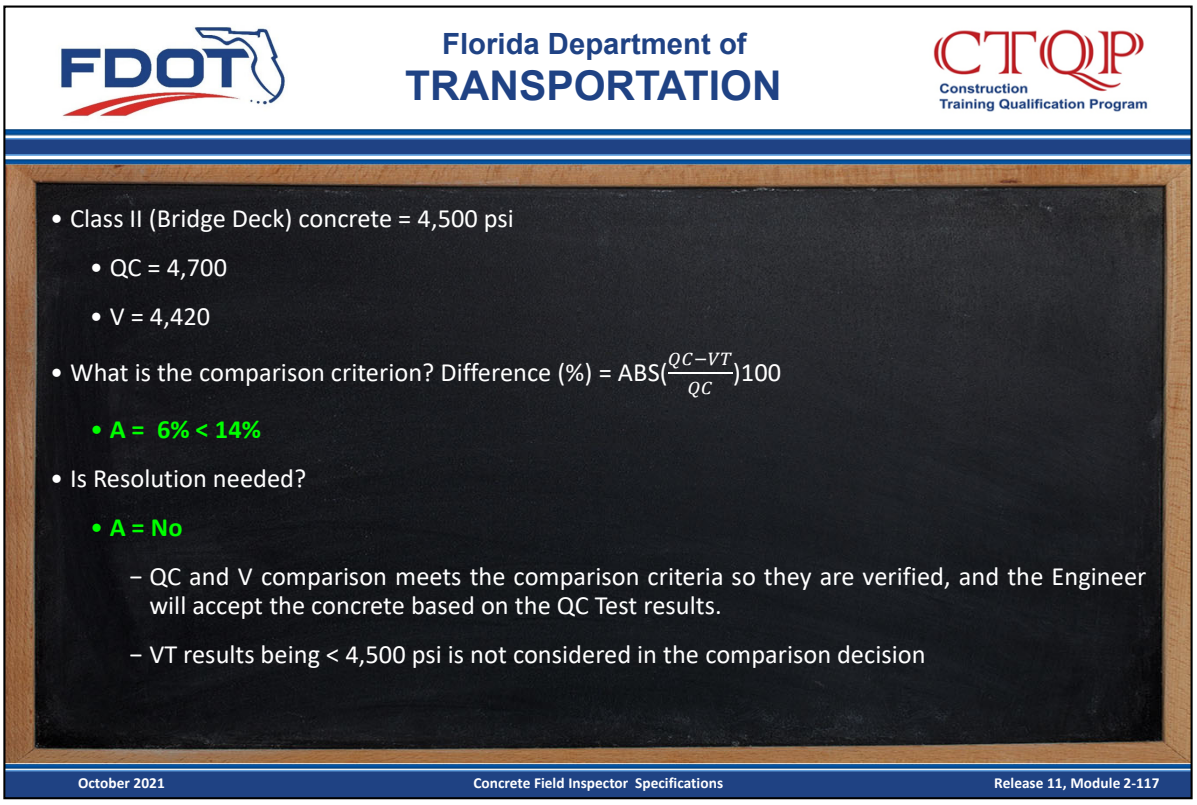
The results of the resolution procedure will be forwarded to the Contractor within five working days after completion of the investigation.



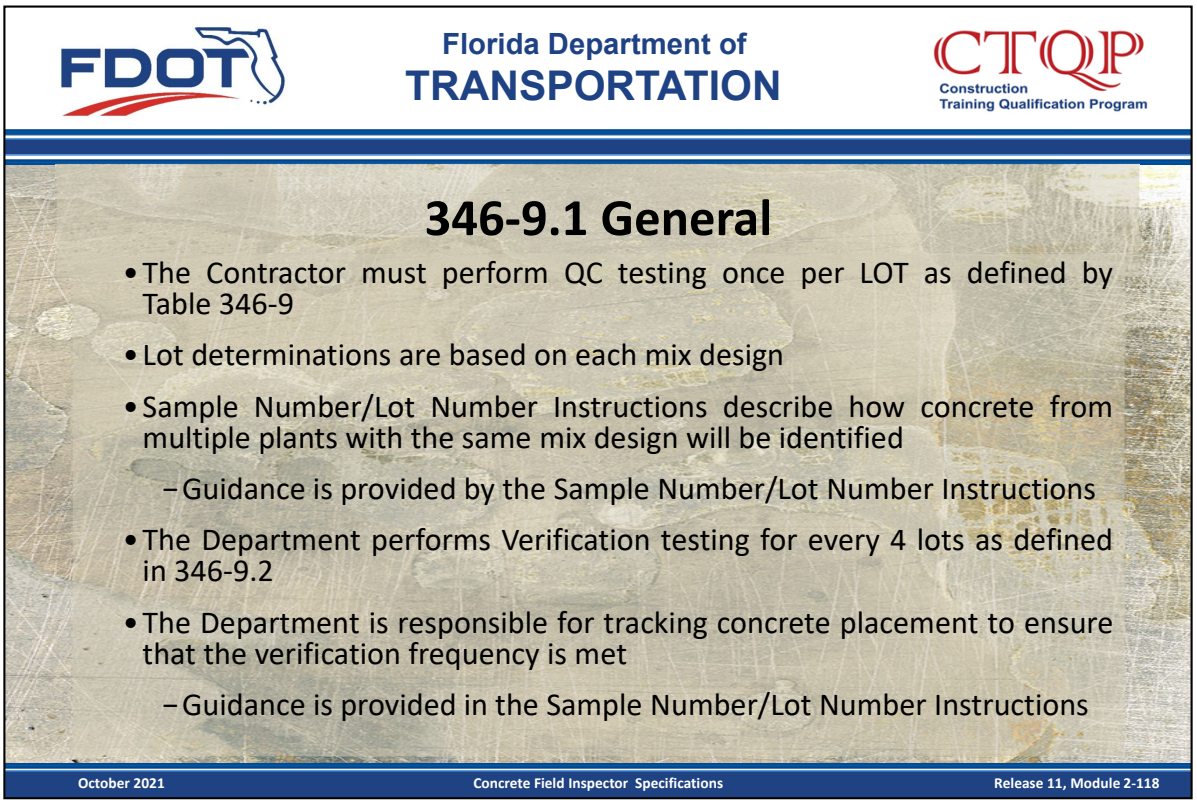
346-9.7 Small Quantities of Concrete: When a project has a total plan quantity of less than 50 cubic yards, that concrete will be accepted based on the satisfactory compressive strength of the QC cylinders. Submit certification to the Engineer that the concrete was batched and placed in accordance with the Contract Documents. Submit a QC Plan for the concrete placement operation in accordance with Section 105. In addition, the Engineer may conduct IV testing as identified in 346-9. Evaluate the concrete in accordance with 346-10 at the discretion of the Engineer.



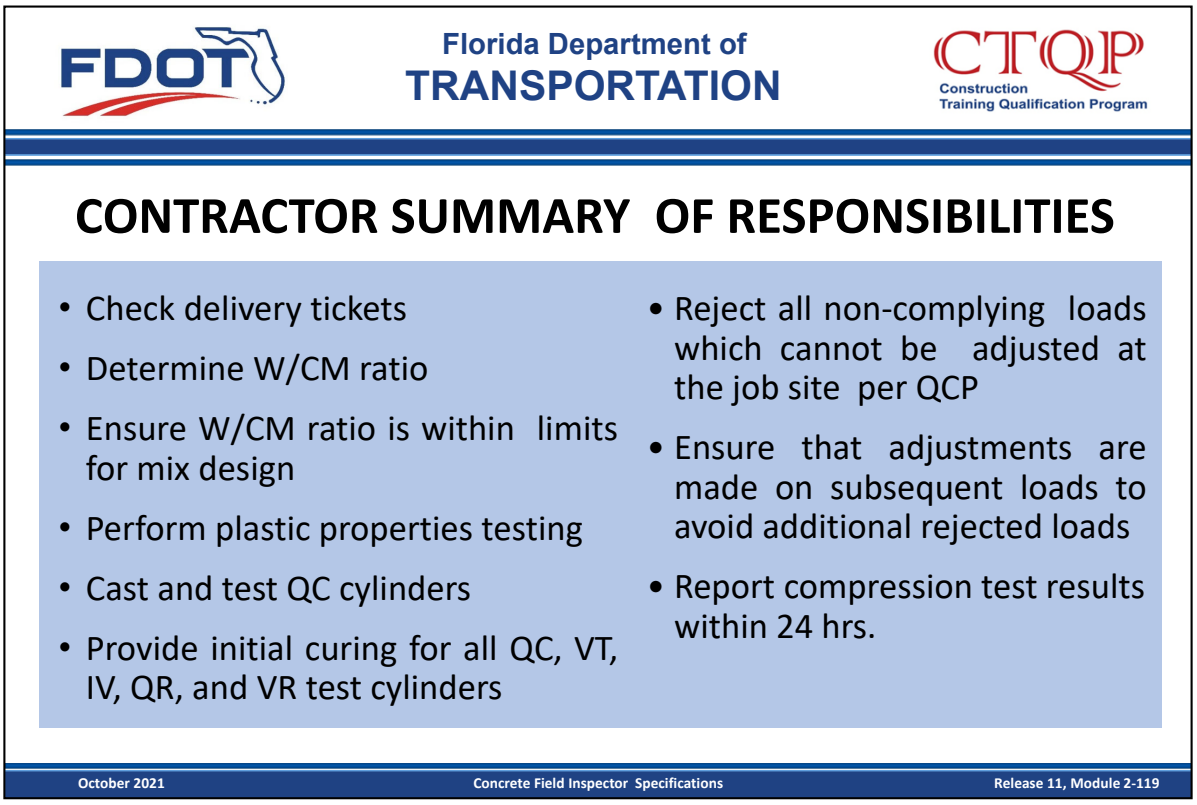
Even though both samples are above the required minimum strength, they are not verified. Verified data is required for acceptance. It is incorrect to determine that since both samples are above the minimum strength, they do not need to compare. Resolution must still be performed to determine why there is a difference between the two that is not within the acceptable comparison criteria. Resolution may involve a lab review of both the QC and V labs, a review of the curing methods, and an IA evaluation of the sampling and testing technicians to determine why there is a difference.



The purpose of verification is to compare with QC. Verification does not pass or fail. In this example, it would be easy to be confused with verification results being less than the minimum required 4,500 psi for the class ii bridge deck. This is not part of the consideration, only that the two results are within the comparison criteria from the table. Since they are, the QC is considered to be upheld. Since QC results pass, the material is considered to be acceptable.



The Department may use independent verification (IV) at any time. One occasion where IV may be performed is if the project personnel suspect that placement for a particular concrete mix design may be nearing completion and the random number for VT sampling has not yet occurred. If the project personnel suspect that VT sampling may not be performed, they should use IV to ensure the minimum frequency is met. Again, this means that someone representing the Department needs to be prepared to sample the material.



The contractor is required to provide the facilities for initial curing of **all** cylinders. After initial curing, all cylinders must be transported to the appropriate lab at the same time. The final curing is provided by the appropriate lab.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

VERIFICATION RESPONSIBILITES

- Verification Technician determines W/CM ratio and ensures it is within limits for mix design
- Verification Technician ensures plastic properties are within limits
- Verification Technician compares QC results to validate data
- Verification Technician casts VT cylinders
- Verification Lab tests VT cylinders
- Engineer determines comparison criteria conformance

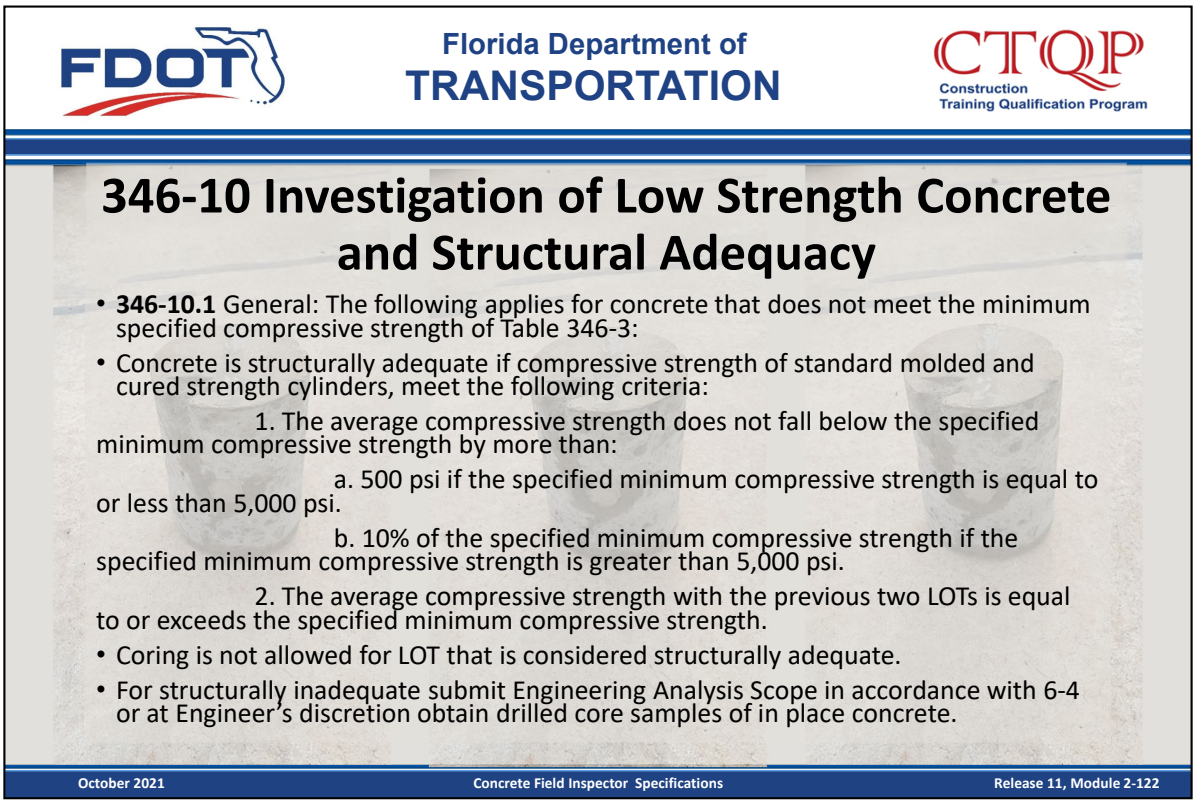
Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program



What if the QC tests fail?

- The remainder of the load is to be rejected
- The LOT is terminated
- Make a set of cylinders to represent the LOT already placed
- Reinitiate initial plastic properties tests until slump, air and temperature comply with the specifications
- Start a new LOT when test results are in compliance
- Contractor elects to place failing material – penalty
- Contractor elects to place failing material with Engineer's approval – no penalty, material is still failing material



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 346-3.

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 is equal to or exceeds the specified minimum compressive strength. This condition only applies if there are two or more 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 of the in-place concrete or require an engineering analysis based on the compressive strength of the test cylinders.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-10.2 Coring for Determination of Structural Adequacy

- The Contractor must furnish drilled core samples, a minimum of 3
- The Engineer must approve the core locations
- The concrete must be cored in accordance with ASTM C42
- The core locations should be in the same approximate vicinity of test cylinders that failed



Coring operation

Coring operation

Engineers approval required to core and for the core locations

October 2021 Concrete Field Inspector Specifications Release 11, Module 2-123

Project personnel should consult with the DMRO personnel well before the coring operation begins.

346-10.2 Coring for Determination of Structural Adequacy: Notify the Engineer 48 hours prior to taking core samples. 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.

Obtain and test the cores in accordance with ASTM C 42. Report the test results to the Engineer within seven calendar days of the Engineer's written approval





Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

346-11.3 Calculating Pay Adjustments

- The Department will apply a pay reduction to concrete that is determined to be failing as defined in 346-3, 346-9, and 346-10
- Price adjustments for low strength are determined by the certified invoice price of the concrete or precast product
- The Engineer computes the reduction in pay as the percentage of concrete cylinder strength (specified minimum strength minus actual strength divided by specified minimum strength)

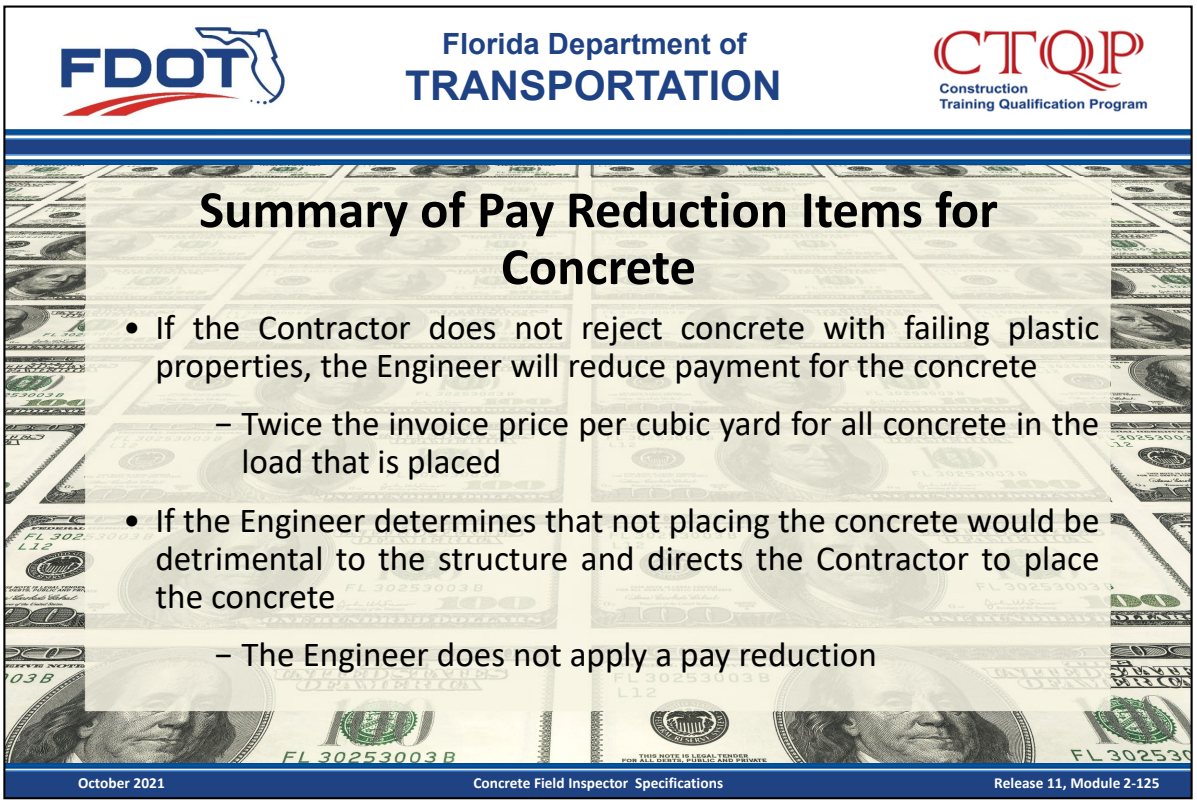


October 2021 Concrete Field Inspector Specifications Release 11, Module 2-124

346-11.3 Calculating Pay Adjustments: The Engineer will determine payment reductions for low strength concrete accepted by the Department and represented by either cylinder or core strength test results below the specified minimum strength, in accordance with the following:

Reduction in Pay is equal to the reduction in percentage of concrete cylinder strength (specified minimum strength minus actual strength divided by specified minimum strength).

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.



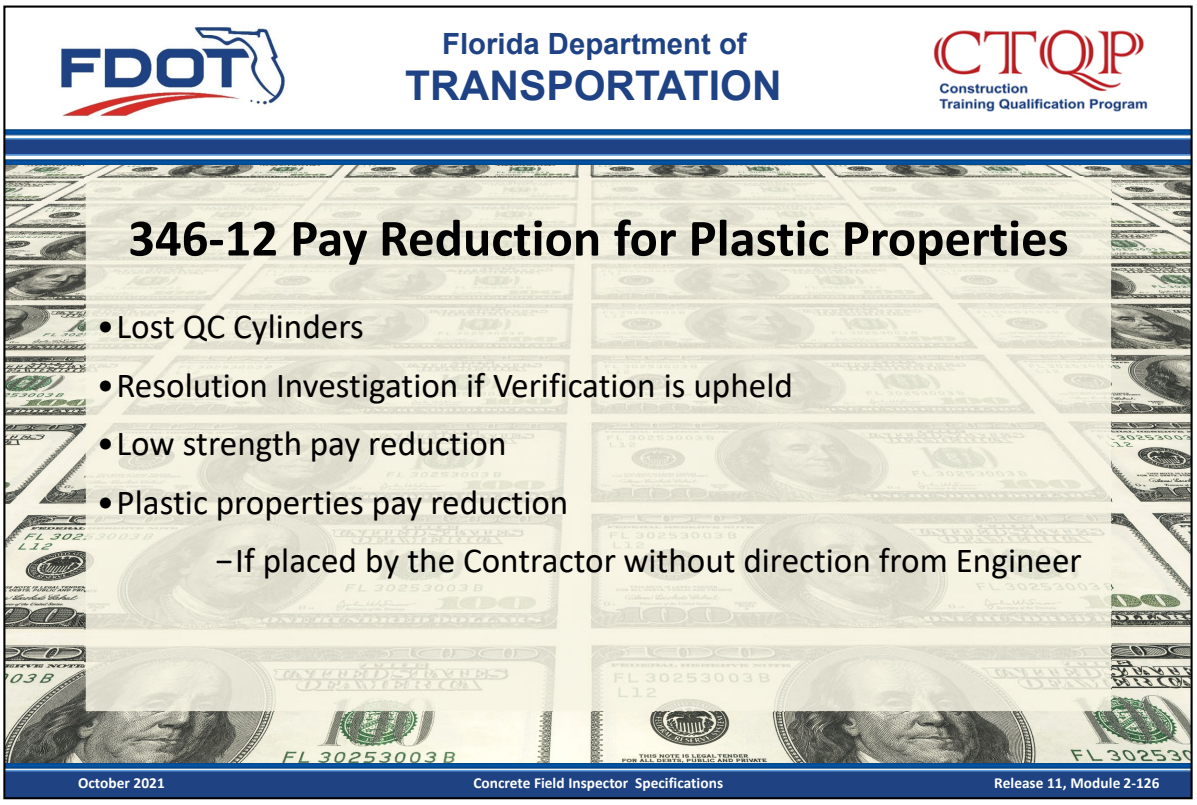
The invoice price is the price that the contractor pays the supplier for the material. The department requests the invoice from the contractor in these cases. the invoice price is generally lower than the contract bid price.

346-12 Pay Reduction for Plastic Properties

If concrete is placed even when the result of plastic properties testing requires its rejection, the payment for concrete represented by the plastic property tests will be reduced by twice the invoice price per cubic yard for all concrete in the load that is placed.

The pay reduction for placing a rejected load of concrete into a precast product will be applied to that percentage of the precast product that is composed of the concrete in the rejected load. The percentage will be converted to a reduction factor which is a numerical value greater than zero but not greater than one. The precast product payment reduction will be twice the Contractor's billed price from the Producer for the precast product multiplied by the reduction factor.

If the Engineer authorizes placement of the concrete, there will be no pay reduction.



All 4 pay reductions may be applied on the same concrete if QC cylinders are lost and plastic properties fail and the compressive strength fails.

Florida Department of TRANSPORTATION

CTQP Construction Training Qualification Program

Materials Acceptance and Certification System (MAC)

- MAC is used to report and track materials sampling and testing
- Project personnel enter sample and test data into the database
  - Sample Header Information
    - Sample Location
    - Pay Item
    - MAC Specification Material ID
    - Mix Design
    - Plant Number
  - Test Results
  - Result of Comparison Criteria (sample approval)



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MAC Information is vital to the FDOT Materials Program. Correct, complete data is needed to ensure that the Project Final Materials Certification requirements are met. The data is used for other materials related purposes like annual summary reports to FHWA and review of producer performance for QC Program. In order to make these reports and determinations we have to have the data be correct, right plant number, right mix number, etc.

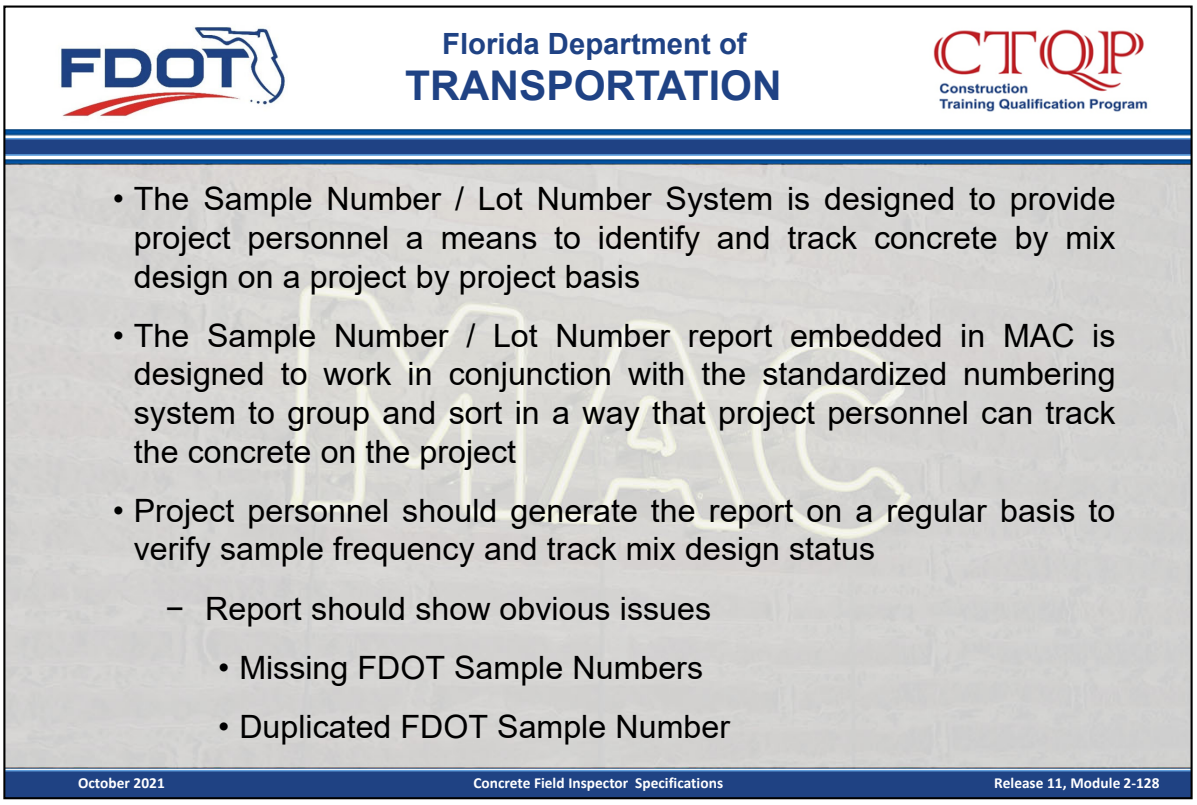
A user from the lab/field office that sampled the concrete is to log the sample into MAC using the MAC specification for guidance in the log in procedure.

See the SMO website for guidance:

http://https://mac.fdot.gov/

http://http://www.fdot.gov/materials/mac/

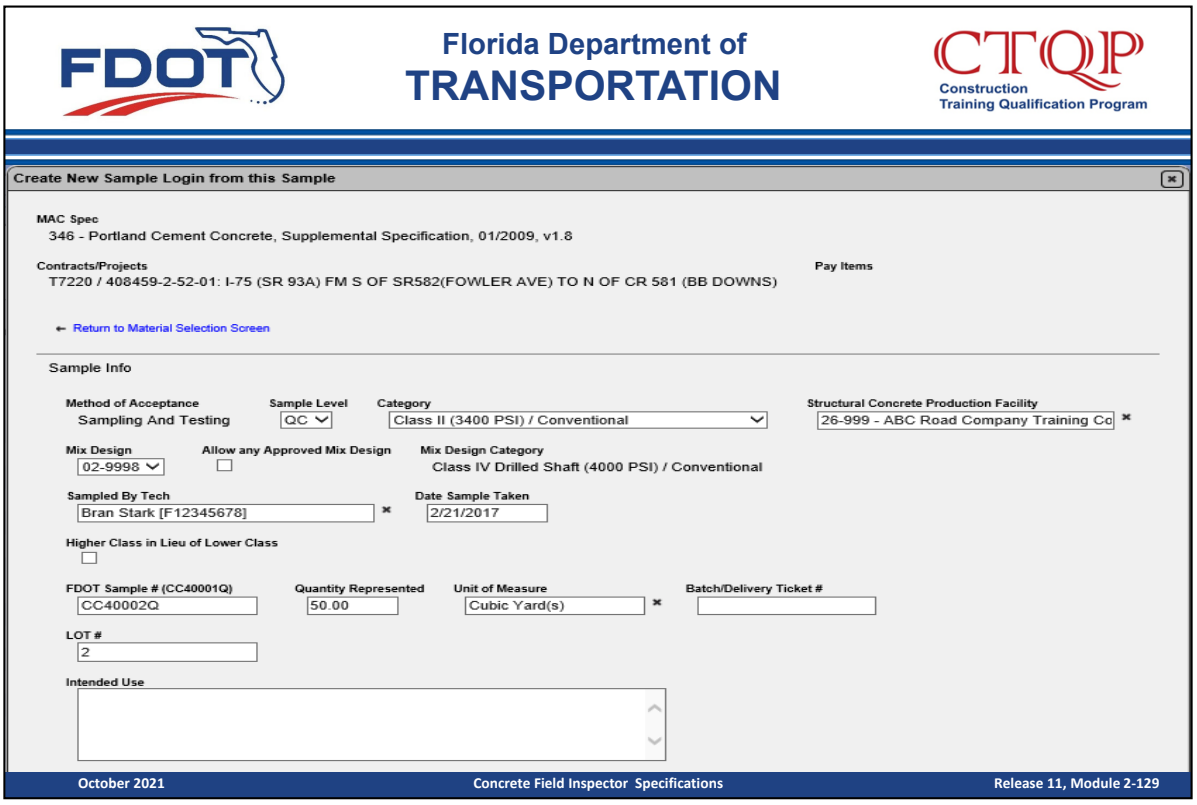
There are instructions for concrete related tutorials for plastic properties, cylinders, sample approval, project reports, draincrete, and other Physical Lab related materials, such as reinforcing steel, curing compound, bricks, blocks and pavers, and materials that are accepted based on certified mill analysis.



The specification requires lots to be accounted for on a mix design basis. the sample number / lot number report can be generated on older projects not using the standardized numbering system and can provide some assistance in tracking the concrete status, even on these projects. under the standardized system, fdot sample numbers may be used more than once on a project, but should not be duplicated under a specific mix design. the grouping and sorting function of the report will divide the samples that have duplicated numbers in different mix designs. if fdot sample numbers are accidentally duplicated under the same mix design, the report will show this.

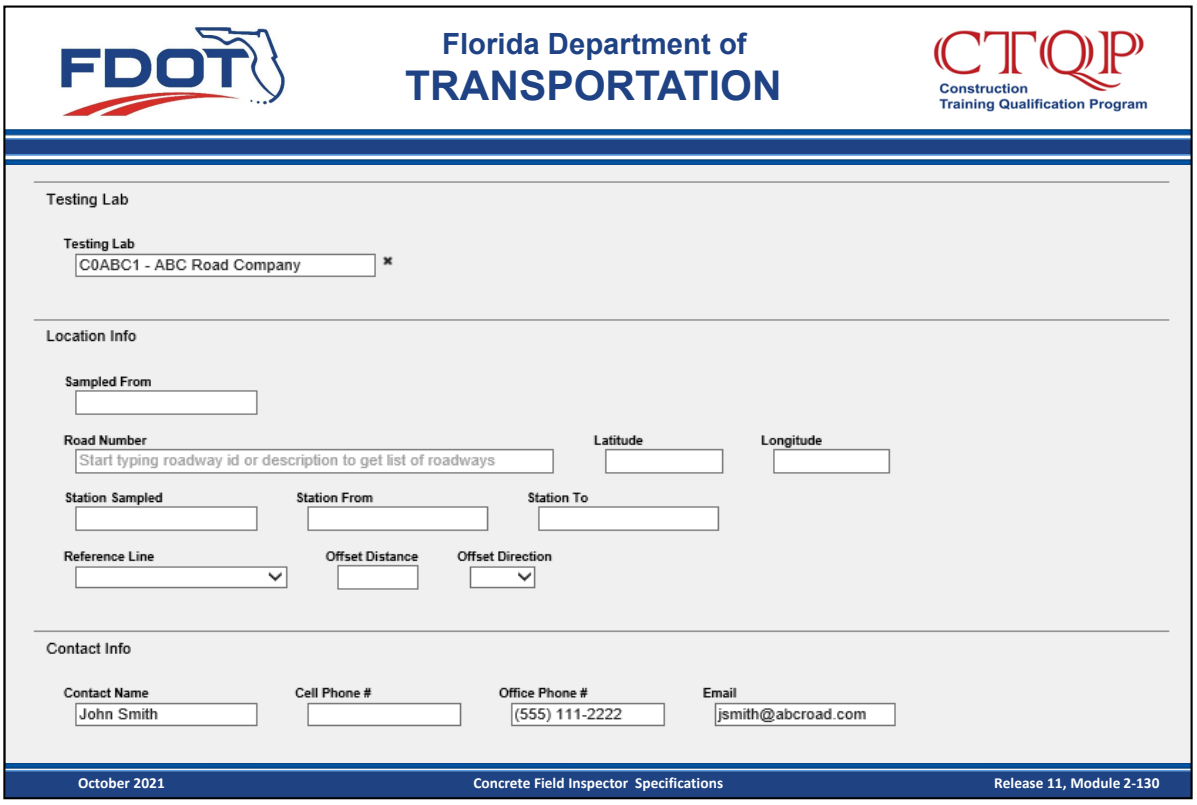
There are instructions for the sample number / lot number system on the SMO website. The instructions include examples of different reports, FAQs, what to do about multiple projects on one contract, multiple plants producing the same mix design for the same project and what to do if the standardized system will not work (for jobs like IROX).

The Department's "Structural Concrete Standardized Sample Number/Lot Number Instructions" may be found in the Self Study Materials in Appendix 7. The CPAM Chapter 10, found in Appendix 5, also contains instructions for crack inspection.

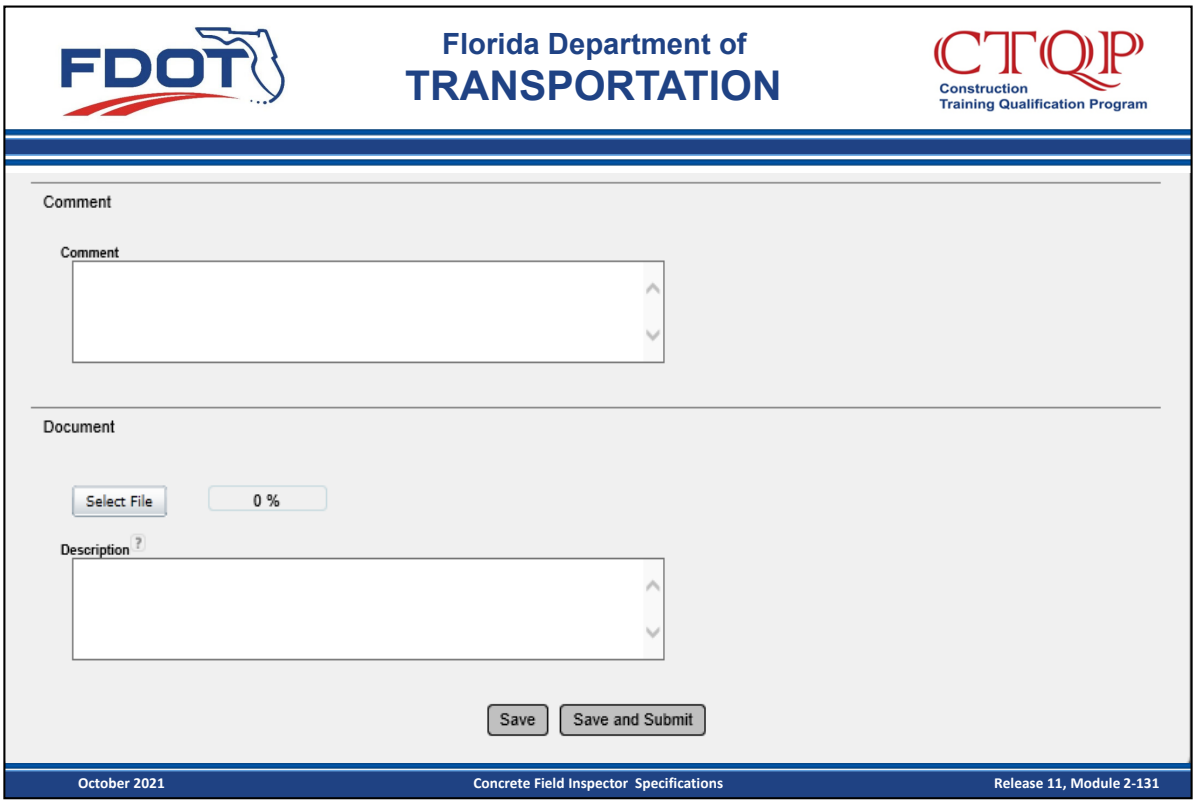


The concrete sample login screen is required to be used on all field and lab samples for structural concrete. The required fields are shown on the example screen here. In addition, there is programming in MAC that checks the Financial Project ID / mix design number / plant number combination when the sample is initiated to ensure that the information has been pre-assigned for use by the District Materials Office concrete personnel. The MAC instructions mentioned earlier include information on how to review the data before you log the sample and how to address error messages.

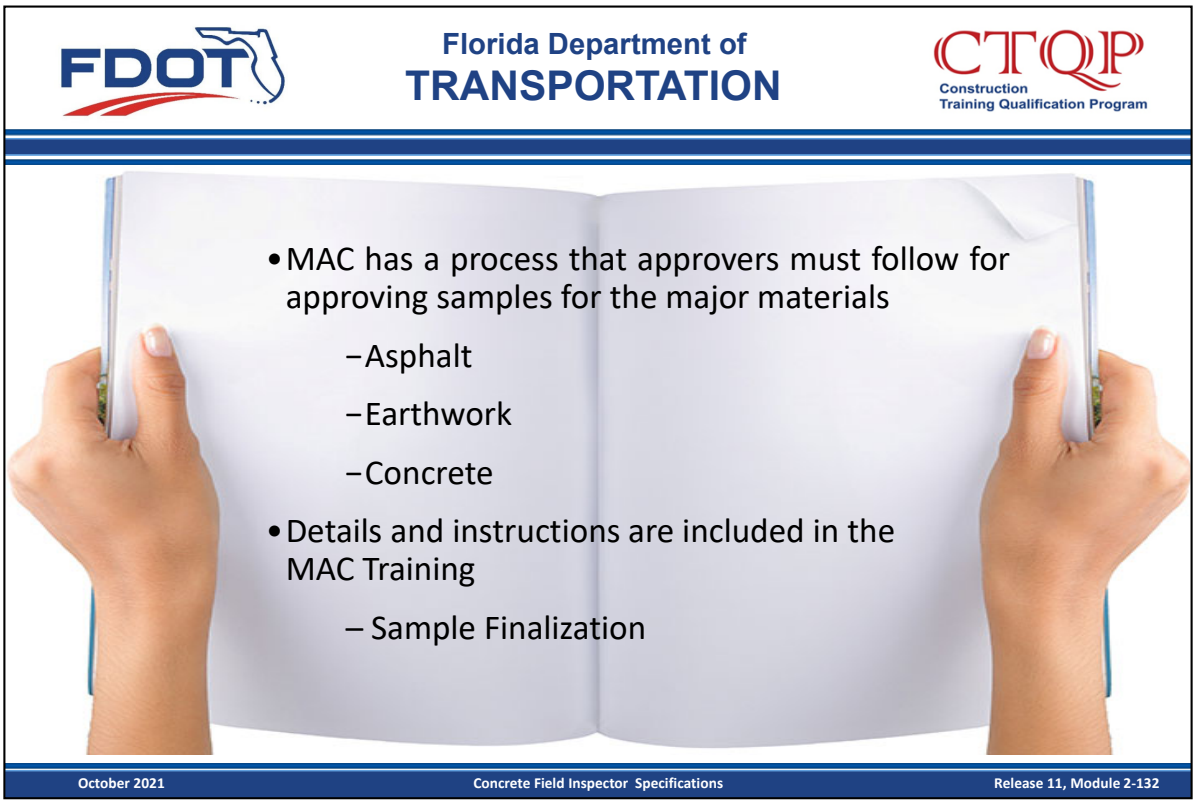
This slide and the next two slides represent the concrete sample login for MAC. These are example slides.



Example log in screen



Example log in screen



Not everyone will be responsible for approving samples. For those attendees who will be responsible for approving concrete samples, they should review the MAC concrete tutorials that include information on the sample approval process for concrete samples.


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Questions?
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