Amend Section 601- STRUCTURAL CONCRETE to read as follows:

"DIVISION 600 - MISCELLANEOUS CONSTRUCTION

SECTION 601 - STRUCTURAL CONCRETE

601.01 Description. This section describes structural concrete, which consists of Portland Cement, fine aggregate, coarse aggregate, and water. It may also include adding admixtures for the purpose of entraining air, retarding or accelerating set, tinting, and other purposes as required or permitted. All concrete designs for structural concrete to be placed on HDOT Highway projects must use technology to reduce the embodied carbon footprint of concrete used in the highway infrastructure. e.g., carbon dioxide mineralization or equivalent technology such as C-S-H nanoparticle-based strength-enhancing admixture (CSH-SEA), or technology or material that allows the reduction in the size of the carbon footprint of the mix, e.g., strength improving admixtures, supplementary cementitious materials (SCMs), or other Engineer accepted methods that can reduce the embodied carbon footprint of the concrete.

601.02 Materials.

Portland Cement	701.01
Fine Aggregate for Concrete	703.01
Coarse Aggregate for Portland Cement Concrete	703.02
Admixtures	711.03
Water	712.01

Use coarse aggregate for lightweight concrete conforming to ASTM C330 except for Sections 5, 7, and 9.

601.03 Construction.

(A) Quality Control. Portland Cement concrete production requires the Contractor's responsibility for quality control of materials during handling, blending, mixing, placement, and curing operations.

Sample, test, and inspect concrete to ensure the quality of the components, materials, and concrete using quality control methods and testing. Sampling and testing for quality control must be performed by certified ACI Concrete Field Technician Grade I following the requirements of the standard test methods. Perform quality control tests for the slump, air content, temperature, unit weight, a Box Test for slip form concrete, or other required properties during the production of structural concrete other than concrete for incidental construction. Submit quality control test results.

(B) Design and Designation of Concrete. Design concrete mixture for concrete work specified. Submit mix design using State Highways Division form DOT 4-151 or an equivalent form accepted by the Engineer. Do not start work until the Engineer accepts the mix design. The Engineer will accept a concrete mix design complying with the information given in Table 601.03-1 - Design of Concrete, and other pertinent requirements.

Whenever the concrete's 28-day compressive strength, f'_c, is 4,000 psi or greater, designate concrete by the required minimum 28-day compressive strength.

The concrete's 28-day compressive strength, f'_c, which is less than 4,000 psi listed in Table 601.03-1 – Design of Concrete, is for design information and designation of a class.

Proportion concrete that is designated by a compressive strength so that the concrete conforms to the required strength.

Design concrete placed in bridge decks and pavements exposed to traffic wear, with air content of 3 percent, unless otherwise specified, including entrapped and entrained air. Maintain air content for plastic concrete within a tolerance of 1 percent, plus or minus, during the work.

Use Class BD concrete in the bridge deck unless the concrete is designated by compressive strength. Incorporate into the bridge deck concrete: water-reducing, shrinkage-reducing, and migrating corrosion-inhibiting admixtures. Allow also, set-retarding admixtures in the concrete with the capability to vary the degree of retardation without adversely affecting other characteristics of concrete. Submit all the design admixture dosages.

Class A concrete must be used when the type of concrete is not indicated in the contract documents.

Design concrete as specified in Table 601.03-1 – Design of Concrete.

<table>
<tr><th colspan="8">TABLE 601.03-1 - DESIGN OF CONCRETE
(800 Maximum Cement Content lbs. /c.y.)</th></tr>
<tr><th>Class of Concrete</th><th>28-Day Strength f'c, psi.</th><th>Minimum Cement Content lbs. /c.y.</th><th>Maximum Water-Cement Ratio, lb./lb.</th><th>Minimum Cement Content with Mineralized CO_2 lbs./c.y.</th><th>Maximum Water-Cement Ratio with Mineralized CO_2 lb./lb.</th><th>Minimum Cement Content with SCM lbs. /c.y.</th><th>Maximum Water-Cement Ratio with SCM lb./lb.</th></tr>
<tr><td>A</td><td>3000</td><td>532</td><td>0.59</td><td>504</td><td>0.62</td><td rowspan="6">NA</td><td rowspan="6">NA</td></tr>
<tr><td>B</td><td>2500</td><td>475</td><td>0.66</td><td>450</td><td>0.70</td></tr>
<tr><td>C</td><td>2000</td><td>418</td><td>0.75</td><td>396</td><td>0.79</td></tr>
<tr><td>D</td><td>1500</td><td>380</td><td>0.85</td><td>360</td><td>0.87</td></tr>
<tr><td>BD</td><td>3750</td><td>610</td><td>0.49</td><td>NA</td><td>NA</td></tr>
<tr><td>SEAL</td><td>3000</td><td>610</td><td>0.55</td><td>NA</td><td>NA</td></tr>
<tr><td>Designated by Strength f'c or *f'r</td><td>As Specified</td><td>610</td><td>0.49</td><td>NA</td><td>NA</td><td>NA</td><td>NA</td></tr>
<tr><td colspan="6">*f'r = Specified Modulus of Rupture</td><td></td><td></td></tr>
</table>

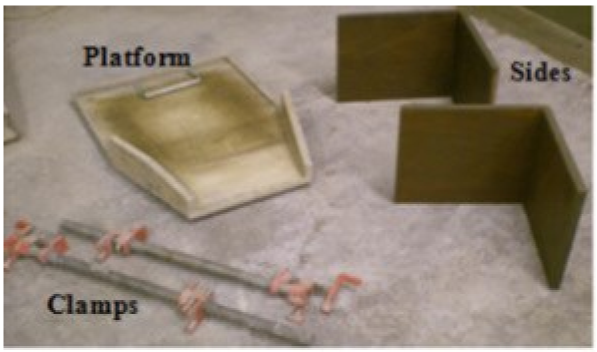
Structural Concrete Design – The Carbon Dioxide mineralization process is our preferred method for CO_2 footprint reduction for structural concrete. Other Carbon Dioxide reduction options, materials, or technologies may be considered for structural concrete mix designs if a Carbon Dioxide mineralization system on the island is unavailable, or Carbon Dioxide is in short supply. Other options to reduce concrete's Carbon Dioxide footprint includes but are not limited to adding Supplementary Cementitious Materials, admixtures, blended hydraulic cements, or a combination thereof. Additional means and methods of CO_2 footprint reduction not listed herein may be used if their use can be justified and accepted by the Engineer.

The reduced carbon footprint concrete mix design for all islands must have a reduction of Portland Cement content and still comply with the concrete design strength and other durability requirements as specified. See Table 601.03-1 Design of Concrete's specified limits for cement content, water cement ratio, and other properties when using CO_2 mineralization.

It should be noted that in some cases the use of SCMs in mixes may not result in it having the same strength curve as their cement counterpart and more curing time will be needed to meet and exceed the design strength. In such cases, the Contractor may request a waiver from the 28-day limit. Submit laboratory test data with the request to the Engineer. The waiver may be granted on a case-by-case basis, e.g., mass concrete. The Engineer reserves the right to limit the amount of SCMs in the mix or reject the mix design.

Slipform Concrete Design – The Box Test method measures the response of a slip form concrete mixture to vibration and the ability of the concrete to hold a vertical edge, thus determining the workability and suitability of the concrete mixture for slip-formed paving applications

Dimensions of the Box Test



The Figure above shows the components and the constructed inside dimensions. The Box Test used:

4 pcs - ½” nominal thickness or greater HDO Plyform with a hard, semi-opaque surface of thermosetting phenolic resin-impregnated material for the Test Box form, with a length, width, and height such that when the Test Box is constructed must have internal dimensions of 12” X12” X 12”.

1 pc - ½” nominal thickness or greater HDO Plyform with a hard, semi-opaque surface of thermosetting phenolic resin-impregnated material approximately 24” X 24” or greater for the platform. It is optional that the platform is constructed as shown in the photos.

4 pcs- 2” X 2” L-brackets to be attached at two opposite external corners to hold the two Plyform pieces in an L-shape. (More brackets may be used if determined it is needed to keep the Test Box forms square, ridged, and in an L-shape.) Screws, glue, etc. if used must not cause bulges or protrude into the interior of the form.

Two each - 1.5ft pipe clamps

I each - hand scoop

1 each - 1” square head pencil vibrator that must be able to vibrate at a minimum of 12,500 vibrations per minute. Provide a power source for the vibrator. Round-headed or larger vibrators must not be used.

1 each - ruler

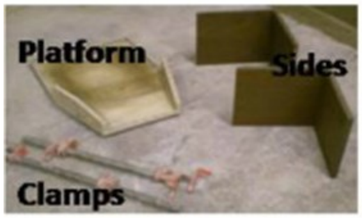
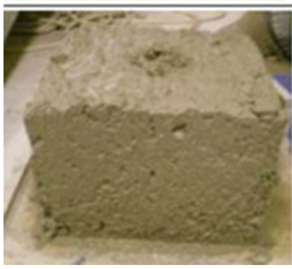
1 each – 16-inch by 24-inch L-shaped steel framing square.

1 each – 18 or 24-inch I-Beam Level Spirit Level Tool

The Box Test Steps

Sample concrete according to AASHTO R 60 Standard Practice for Sampling Freshly Mixed Concrete.

Dampen the forms and platform with form oil and assemble the Box Test components (forms, platform, and clamps) on a flat and level surface. The assembled 1 ft^3 Test Box is held together by the pipe clamps and L-brackets on the platform. Scoop into the box the fresh concrete, each scoop must be uniformly distributed in the box, so each layer is approximately uniformly level. Stop the concrete placement when it reaches a height of approximately 9.5”. Do not do any compaction during the placement of the concrete except for the dropping of concrete in the Test Box. With the vibrator at 12,500 vibrations per minute and keeping the head of the vibrator perpendicular to the platform and centered in the box, consolidate the concrete by inserting the 1” square head pencil vibrator. Take three seconds to lower the vibrator into the concrete until it almost reaches the bottom of the box. Do not touch the platform with the vibrator. Upon reaching the proximity of the bottom of the box immediately start raising the vibrator upward taking three seconds to remove the vibrator from the concrete. Do not do any further compaction or finishing of the concrete. Immediately, and carefully remove the pipe clamps from the side of the box, and then carefully with minimal disturbance of the concrete, remove the Box Test forms in an ascending vertical direction. Care must be taken to ensure the concrete will not stick to the L-shaped side wall forms. Immediately do a surface void evaluation and edge slump measurement of the concrete sample.

	Step 1	Gather the different components of the Box Test.
	Step 2	Construct box and place clamps tightly around box. Hand scoop mixture into box until the concrete height is 9.5" (241.3 mm).
	Step 3	Insert vibrator downward for 3 seconds and upward for 3 seconds. Remove vibrator.
	Step 4	After removing clamps and the forms, inspect the sides for surface voids and edge slumping.

Surface Void Evaluations

The grading of the response of a mixture to vibration must be assessed by comparing the surface voids observed on the sides of the box using Figure 3.

The void area for any of the four sides must not exceed what is shown in photo 2 of Figure 3, i.e., the void area must not be similar to the void areas shown in photos 3 and 4 or exceed them, to be considered an acceptable mix design for slip form pavement concrete.

If a mixture responded well to vibration, the overall surface voids should be minimal because the mortar was able to flow and fill these voids, hence the surface would have a small total void area. However, if the sides of the concrete formed by the box test had large amounts of surface voids, the mixture did not acceptably respond to the vibration. If the concrete did not respond acceptably to the vibration the mix design must be adjusted until the voids do not exceed the voids shown in photo 2 of Figure 3.

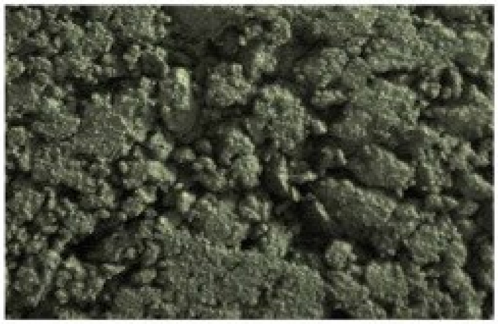
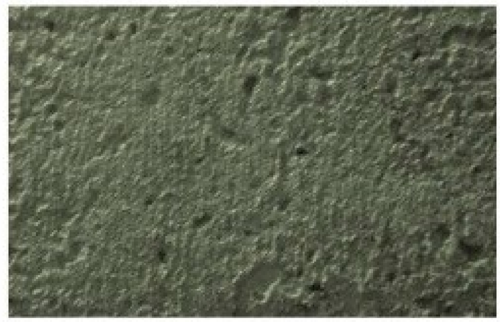
	
4	**3**
Over 50% overall surface voids.	**30-50% overall surface voids.**
	
2	**1**
10-30% overall surface voids.	**Less than 10% overall surface voids.**

Figure 3 shows the estimated surface voids.

Top or Bottom Edge Slumping

The top or bottom edge slumping must be measured by placing an L-shaped steel framing square straightedge at the point the concrete sample protrudes at each face the most. Use the I-Beam Spirit Level and a tape measure or ruler with the L-shaped steel framing square to measure the distance between the I-Beam Level Spirit Level and the upper surface of the concrete sample along its edge. that is not protruding and is vertical to find the length of the longest extruding point for each face. Do a measurement on each of the four sides, measuring the top and bottom slump of the test sample.

If no vertical face can be found on a side the concrete mix design is not suitable for use in slip forming. If the top or bottom edge slumping exceeds ¼“ for any side, the concrete mix design is not suitable for use in slip forming.

Videos of Box Test

https://youtu.be/XnKbxs3bAoQ

https://youtu.be/P6MKXItCiU8

Verify that the concrete is an acceptable concrete mix design by performing a minimum of two more acceptable consecutive Box Tests that did not exceed the maximum void area and edge slump requirements. If the two acceptable consecutive Box Tests cannot be accomplished, then adjust the concrete mix design and start the testing process over again.

In addition to the Box Test performed during the testing of the mix design in the Contractor's material testing laboratory perform additional Box Tests on production concrete in the field during the test strip or first production pour whichever is earliest. Adjust the mix if the results indicate the concrete does not meet the above requirements. Perform Box Test in the field once a month if pouring is continuous or when the Engineer requests it to be performed.

Use the absolute volume method to proportion concrete materials in accordance with requirements of concrete designated by class, cement content in pounds per cubic yards, or specified 28-day compressive strength. Use absolute volumetric proportioning methods as outlined in the American Concrete Institute (ACI) Standard 211.1, "Recommended Practices for Selecting Proportions for Normal and Heavyweight Concrete".

Use coarse aggregate size No. 57 (one inch to No. 4) or No. 67 (3/4 inch to No. 4) for concrete. For concrete placed in bottom slabs and stems of box girders, use No. 67 size aggregate. Smaller size aggregates may be permitted when encountering limited space between forms and reinforcement or between reinforcement when accepted by the Engineer in writing. Maximum aggregate size must not be greater than 1/3 of the space between reinforcing steel bars or reinforcing steel and the form.

Use the following standard methods in Table 601.03-2 – Standard Methods for determining compliance with requirements indicated in this subsection:

TABLE 601.03-2 – STANDARD METHODS	
Sampling Fresh Mixed Concrete	AASHTO T 141
Mass Per Cubic Meter (Cubic Foot) Yield and Air Content (Gravimetric) of Concrete	AASHTO T 121
Slump of Hydraulic Cement Concrete	AASHTO T 119
Air Content of Freshly Mixed Concrete by the Pressure Method	AASHTO T 152
Specific Gravity and Absorption of Fine Aggregate	AASHTO T 84
Specific Gravity and Absorption of Coarse	AASHTO T 85

Aggregate	
Temperature of Freshly Mixed Portland Cement Concrete	ASTM C1064
Making and Curing Concrete Test Specimens in the Field	AASHTO T 23
Compressive Strength of Molded Concrete Cylindrical Specimens	AASHTO T 22 (4-inch by 8-inch or 6-inch by 12-inch cylinders)
Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)	AASHTO T 97

When concrete is designated by compressive strength, f'_c, or flexural strength, f'_r, or includes CO_2 Mineralization technology, CSH-SEA, or SCMs, prequalification of materials and mix proportions proposed for use before placing such concrete is mandatory. The Engineer will prequalify concrete based when data is available based on past performance records using statistical computations of population sizes and (n-1) weighting, or trial batch test reports in compliance with computed minimum average strength for material and mix proportions. The Engineer will determine the minimum average strength on the probability of not more than one in 20 tests falling below the specified strength for the following conditions:

(1) When past performance records are available, furnish the following documented performance records:

(a) Minimum of 15 consecutive 28-day strength tests from projects having the same materials and mix proportions.

(b) Two groups totaling 30 or more test results representing similar materials in which mix proportion strengths are within 20 percent of specified strength, from data obtained within one year of the proposed use.

The Engineer will analyze performance records to establish the standard deviation.

(2) When sufficient past performance records are not provided, the Engineer will assume the current standard deviation to be 500 psi for compressive strength, f'_c, and 50 psi for flexural strength, f'_r.

Unless sufficient performance records are available from other projects at DOT Materials Testing and Research Branch (MTRB), submit test performance records or trial test reports for prequalifications, based on data of the most recent tests made on the concrete of the proposed mix design. The data must be from tests that have been performed within one year of the proposed use and done at an accredited material testing laboratory by certified material testing personnel.

Include the following information in test data and trial batch test reports: date of mixing; mixing equipment and procedures used; the size of batch in cubic yards and weight, type, and source of ingredients used; slump of concrete; air content of concrete when using an air-entraining agent; the age of the sample at the time of testing; and strength of concrete cylinders or beams tested.

Show that concrete strength tests equal or exceed minimum average strength in trial test reports. The test is an average of 28-day test results of five consecutive concrete cylinders or concrete beams taken from a single batch. No cylinder or beam must have a strength less than 85 percent of the minimum average strength.

Submit test data and trial test reports signed by an official of an accredited laboratory that performed tests.

The Engineer reserves the right to stop work when a series of low-strength tests occur. Do not continue concrete work until the cause is established and the Engineer is informed of and accepts, the necessary corrective action to be taken.

(C) Batching. Measure and batch materials in accordance with the following provisions:

(1) Portland Cement. Either sacked or bulk cement may be used. Do not use a fraction of the sack of cement in the concrete batch unless cement is weighed.
Weigh bulk cement on weighing device accepted by the Engineer. Seal and vent bulk cement-weighing hopper properly to preclude dusting during operation. Do not suspend the discharge chute from the weighing hopper. Arrange the discharge chute so that cement will not lodge in the hopper or leak from the hopper.

Batching accuracy must be within 1 percent, plus or minus, of the required weight.

(2) Water. Measure water by volume or by weight. Use a readily adjustable device for measurement of water, with accuracy within 1 percent, plus or minus, of the quantity of water required for a batch. Arrange the device so that variable pressure in the water supply line does not affect measurements. Equip measuring tanks with outside taps and valves or other accepted means to allow for checking calibration.

(3) Aggregates. When storing and stockpiling aggregates, avoid separation of coarse and fine particles within each size, and do not intermix various sizes before proportioning. Protect stored or stockpiled aggregates from dust or other foreign matter. Do not stockpile together, aggregates from different sources and of different gradations.

When transporting aggregates from stockpiles or other sources to batching plant, ensure uniform grading of material is maintained. Do not use aggregates that have become segregated or mixed with earth or foreign matter. Stockpile or bin aggregates at least 12 hours before batching. Produce or handle aggregates by hydraulic methods and wash and drain aggregates. If aggregates exhibit high or non-uniform moisture content, the Engineer may order storage or stockpiling for more than 12 hours or remixing of the stockpile, or other remedial methods. Keep using remedial methods until moisture content problems are resolved. When there is clay or dirt on the aggregate wash the aggregate until they are in a quantity that no longer affects the concrete mix and is accepted by the Engineer.

Proportion aggregates by weight, with an exception being that aggregates in concrete for minor structures, curbs, and sidewalks may be proportioned by either volume or weight. For volumetric proportioning, use measuring boxes of known capacity to measure the quantity of each aggregate size.

Use batch weight based on dry materials plus the total weight of moisture (both absorbed and surface) contained in aggregate. Measure individual aggregates to within 2 percent, plus or minus, of required weight, and the total weight of aggregates to within 1 percent, plus or minus, of the required weight.

(4) Admixtures. Ensure that all admixtures used are compatible with all the other admixtures used in the concrete mix. Store, proportion, and dispense admixtures in accordance with the following provisions:

(a) Liquid Admixtures. Dispense chemical admixtures, in liquid form, e.g., air-entraining admixtures, and corrosion inhibiting admixtures. Use mechanical dispensers for liquid admixtures with sufficient capacity to measure the prescribed quantity for each batch of concrete. Include a graduated measuring unit in each dispenser to measure liquid admixtures to within 5 percent, plus or minus, of the prescribed quantity for each batch. Read graduations accurately from point of measuring unit, and control proportioning operations to permit a visual check of batch accuracy before discharging. Mark each measuring unit clearly for type and quantity of admixture.

Arrange with the supplier to provide a sampling device consisting of a valve located in a safe and accessible location for sampling admixtures. Sampling is not required if not otherwise provided.

When using more than one liquid admixture for concrete mix, use a separate measuring unit for each liquid admixture and dispense separately to avoid interaction that may interfere with admixture efficiency and adversely affect concrete. Dispense liquid admixture by injecting so as not to mix admixture at high concentrations.

When using liquid admixtures in concrete that are completely mixed in paving or continuous mixers, operate dispensers automatically with batching control equipment. Equip such dispensers with an automatic warning system that will provide visible or audible signals at the point where proportioning operations are controlled, when the following occurs: quantity of admixture measured for each batch of concrete varies from pre-selected dosage by more than 5 percent, or the entire contents of measuring unit from the dispenser are not emptied into each batch of concrete.

Unless liquid admixtures are added to the batch with pre-measured water, discharge liquid admixtures into the stream of water that disperses admixtures uniformly throughout the batch. An exception is that air-entraining admixtures may be dispensed directly into moist sand in batching bins, provided adequate control of concrete air content can be maintained.

Measure and disperse special admixtures, as recommended by the admixture manufacturer, and as accepted by the Engineer. Special admixtures include high-range water reducers requiring dosages greater than the capacity of conventional dispensing equipment. For site added, high-range water reducers, use calibrated, portable dispenser supplied by the manufacturer.

(b) Mineral Admixtures. Protect mineral admixtures from exposure to moisture or other deleterious conditions until used. Pile sacked material of each shipment to permit access for tally, inspection, and identification.

Provide adequate facilities to ensure that mineral admixtures meeting specified requirements are kept separate from other mineral admixtures and that only specified mineral admixtures can enter the work's concrete mix. Provide safe and suitable facilities for sampling mineral admixtures at weigh hopper or in the feed line immediately in advance of the hopper.

Incorporate mineral admixtures into the concrete using equipment complying with the requirements for Portland Cement weigh hoppers and charging and discharging mechanisms specified in ASTM C94 and Subsection 601.03(C) - Batching.

When concrete is completely mixed in stationary paving or continuous mixers, weigh mineral admixture in a separate weigh hopper. Introduce mineral admixture and cement simultaneously into the mixer, proportionately with aggregate.

When interlocks are required for cement-charging mechanisms, and cement and mineral admixtures are weighed cumulatively, interlock their charging mechanisms to prevent the introduction of mineral admixture until the mass of cement in the weighing hopper is within tolerances specified in Subsection 601.03(C)(1) - Portland Cement.

In determining the maximum quantity of free water that may be used in concrete, consider mineral admixture to be cement.

(5) Bins and Scales. At the batching plant, use individual bins, hoppers, and scales for each aggregate size. Include a separate bin, hopper, and scale for bulk cement and fly ash.

Except when proportioning bulk cement for pavement or structures, the cement weigh hopper may be attached to a separate scale for individual weighing or to an aggregate scale for cumulative weighing. If cement is weighed cumulatively, weigh cement before other ingredients.

When proportioning for pavement or structures, keep bulk cement scale and weigh hopper separate and distinct from aggregate weighing equipment.

Use a springless-dial or beam-type batching scales. When using beam-type scales, make provisions to show the operator that the required load in the weighing hopper is approaching. Use devices that show conditions within the last 200 pounds of load and within 50 pounds of overload.

Maintain scale accuracy to 0.5 percent throughout the range of use. Design poises to lock to prevent an unauthorized change of position. Use scales inspected by the State Measurement Standards Branch of the Department of Agriculture to ensure their continued accuracy. Provide not less than ten 50-pound weights for testing scales.

Batching plants may be equipped to proportion aggregates and bulk cement by automatic weighing devices.

(6) Batching and Hauling. When mixing is to be performed at the work site, transport aggregates from batching plant to the mixer in batch boxes, vehicle bodies, or other containers of adequate capacity and construction. Use partitions to separate batches and prevent spilling from one compartment to another while in transit or during dumping.

Transport bulk cement to the mixer in tight compartments carrying the full quantity of cement required for the batch. Once the cement is placed in contact with aggregates, batches must be mixed and placed within 1-1/2 hours of contact. Cement in original shipping packages may be transported on top of aggregates. Ensure that each batch contains the number of sacks required by the job mix.

Deliver batches to mixer intact. Charge each batch into the mixer without loss of cement. When carrying more than one batch on a truck, charge the batch into the mixer without spilling material from one batch compartment into another.

(D) Mixing. Mix concrete in mechanically operated mixers. When accepted by the Engineer, batches that do not exceed 1/3 cubic yard may be hand-mixed in accordance with methods described at end of this subsection.

Use stationary or truck mixers that distribute materials thoroughly and produce concrete uniform in color and appearance. When there is variation in mixed concrete attributable to worn pickup or throw-over blades, the Engineer will inspect the mixer. If the inspection reveals that blades are worn more than one inch below the original height of the manufacturer's design, or are damaged repair or replace blades. Upon request, make a copy of the manufacturer's design, showing the dimensions and arrangement of blades.

Charge batches into central or truck mixers so that portion of mixing water enters ahead of cement and aggregates. Deliver a uniform flow of water. Place the entire amount of batch water in the mixer by end of the first quarter of the mixing period. When mixers with multiple compartment drums are used, the time required to transfer material between compartments will be included as mixing time. Use drum rotation speed as designated by the manufacturer. If mixing does not produce concrete of uniform and smooth texture, provide additional revolutions at the same speed until thorough mixing of each concrete batch is attained. Begin measuring mixing time from the time cement, aggregates, and 60 percent of water are in the drum. Do not exceed the manufacturer's rated capacity for the volume of concrete mixed in each batch.

Equip central or truck mixers with an attachment for automatically timing the mixing of each concrete batch. The timing device must include an automatic feature for locking the discharge chute and a device for warning the operator when the required mixing duration has been met. If the timing or locking device fails to operate, immediately furnish a clock or watch that indicates seconds, to the mixer operator. If the timing device is not repaired within three days after becoming inoperative, shut down batching operation until the timing device is repaired.

For stationary mixers, use mixing time between 50 seconds and 5 minutes. Select mixing time, as necessary, to produce concrete that meets uniformity criteria when tested in accordance with Section 11.3.3 of ASTM C94. The Contractor may designate mixing time for which uniformity tests are to be performed, provided mixing time is not less than 50 seconds or more than 5 minutes. Before using concrete for pavements or structures, mix concrete to meet specified uniformity requirements. The Contractor must furnish labor, sampling equipment, and materials required for conducting uniformity tests, including the Box Test, and the Contractor's quality control for the concrete mixture. The Engineer will not furnish for the Contractor's quality control, testing equipment, e.g., scales, cubic measure, and air meter; and will not perform the Contractor's quality control tests. The Engineer will not pay separately for the Contractor's quality control, e.g., labor, equipment, materials, or testing, but will consider the costs incidental to concrete. After batching and mixing operational procedures are established, the Engineer will not allow changes in procedures without the Contractor re-establishing procedures by conducting uniformity tests. Repeat mixer performance tests whenever the appearance of concrete or coarse aggregate content of samples is not complying with the requirements of ASTM C94. For truck mixers, add four seconds to the specified mixing time if timing starts as soon as the skip reaches its maximum raised position.

Unless otherwise indicated in the Contract Documents or accepted by the Engineer, concrete must be mixed at proportioning plant. Operate mixer at agitating speed while in transit. Concrete may be truck-mixed only when cement or cement and mixing water are added at the point of delivery. Begin mixing truck-mixed concrete immediately after the introduction of mixing water to cement and aggregates, or introduction of cement to aggregates.

Inclined-axis, revolving drum truck mixers must comply with Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards TMMB 100-01, 15th Revision, or later published by Truck Mixer Manufacturers Bureau. Truck mixers must produce a thoroughly mixed and uniform mass of concrete and must discharge concrete without segregation.

The manufacturer's standard metal rating plate must be attached to each truck mixer, stating maximum rating capacity in terms of volume of mixed concrete for various uses, and maximum and minimum mixing speeds. When using truck mixers for mixing, adhere to the maximum capacity shown on the metal rating plate for the volume of concrete in each batch.

Operate truck mixers at the mixing speed designated by the manufacturer, but at not less than 6 or more than 18 revolutions per minute. Mix truck-mixed concrete initially between 70 and 100 revolutions at manufacturer-designated mixing speed, after ingredients, including water, are in the mixer. Water may be added to the mixture not more than two times after the initial mixing is completed. The addition of water at the project site must comply with the requirements of Subsection 503.03. Each time that water is added, turn the drum an additional 30 revolutions or more at mixing speed until the concrete is mixed uniformly.

When furnishing shrink-mixed concrete, transfer partially mixed concrete at the central plant to a truck mixer. Apply requirements for truck-mixed concrete. The Engineer will not credit the number of revolutions at mixing speed for partial mixing in the central plant.

When accepted by the Engineer, concrete batches not exceeding 1/3 cubic yard may be hand-mixed on a watertight, level platform. Measure the proper amount of coarse aggregate in measuring boxes and spread it on the platform. Spread fine aggregate on that coarse aggregate layer. Limit coarse and fine aggregate layers to a total depth of one foot. Spread dry cement on this mixture. Turn whole mass not less than two times dry. Add sufficient clean water, and distributed it evenly. Turn whole mass again, not less than three times, not including placing in carriers or forms. Mortar mixers of appropriate size may be used when accepted by the Engineer.

(E) Transporting Mixed Concrete. Transport central-mixed concrete to the delivery point in truck agitators or truck mixers operating at speed designated by the equipment manufacturer as agitating speed; or in non-agitating hauling equipment, provided consistency and workability of mixed concrete upon discharge at the delivery point suitable for placement and consolidation in place. The mixed concrete after hauling to the delivery point must comply with the uniformity criteria when tested as specified in Section 12.5 of ASTM C94.

For revolving drum truck mixers transporting central-mixed concrete, limit concrete volume to the manufacturer's rated capacity for agitator operation. Maintain agitating speed for both revolving drum mixers and revolving blade type agitators as designated on the manufacturer's metal data plate. Equip truck mixers or truck agitators with electrically or mechanically actuated counters. Activate counters after introducing cement to aggregates.

Bodies of non-agitating hauling equipment must be smooth, watertight, metal containers equipped with gates to permit control of concrete discharge. Protect open-topped haul vehicle against the weather and wind with cover accepted by the Engineer.

When hauling concrete in non-agitating trucks, complete discharge within 30 minutes after introducing mixing water to cement and aggregates.

When a truck mixer or agitator is used for transporting central-mixed concrete to the delivery point, complete discharge within 1-1/2 hours, after the introduction of mixing water to cement and aggregates, or cement to aggregates. For truck-mixed concrete, complete concrete discharge within 1-1/2 hours. This time limitation is permitted to be waived by the Engineer if after the 1-1/2-hour time limit has been reached, the concrete has a slump that it can be placed, without the addition of water to the batch and hydration of the concrete has not started, i.e., the temperature of the concrete is less than 90 degrees F or the required maximum temperature of the concrete. Also, the set time is increased by the use of a retarder in the mix design and acceptance of the increased set time is obtained before use from the Engineer.

Submit delivery tickets from manufacturers of truck-mixed concrete and central-mixed concrete with each truckload of concrete before unloading at the jobsite. Printed, stamped, or written delivery ticket must include the following information:

(1) Name of concrete plants.

(2) Serial number of the ticket.

(3) Date and truck number.

(4) Name of Contractor.

(5) Specific project, route, or designation of job (name and location).

(6) Specific class or designation of concrete in accordance with Contract Documents.

(7) Quantity of concrete in cubic yards.

(8) Time of loading batch or mixing of cement and aggregates.

(9) Water added by the receiver of concrete and receiver's initials.

(10) Information that is necessary to calculate the total mixing water added by the producer. Total mixing water includes free water on aggregates, water, and water added by the truck operator from the mixer tank at the project site.

(11) The amount of water held back from the batched concrete mix that can be added to the concrete mix at the project and still not cause the mix to exceed the accepted mix design water to cement ratio.

(12) Readings of non-resettable revolution counters of truck mixers after the introduction of cement to aggregates, or introduction of mixing water to cement aggregates

(13) Supplier's mix number or code and include the mix design name.

Furnish additional information designated by the Engineer and required by job specifications upon request.

(F) Consistency. Regulate the quantity of water and admixtures used in concrete mixes so that concrete consistency, as determined by the AASHTO T 119 test method, is within the nominal slump range specified in Table 601.03-3 - Slump for Concrete. If the concrete slump exceeds the nominal slump, adjust subsequent batches of the mixture. If slump exceeds maximum slump, the Engineer will reject concrete unless it is solely deemed by the Engineer as satisfactory for use.

The Engineer will also reject harsh or unworkable concrete that cannot be properly placed. Remove rejected concrete at no increase in the contract price or contract time.

Slump for concrete must be as specified in "Table 601.03-3 – Slump for Concrete".

TABLE 601.03-3 - SLUMP FOR CONCRETE		
Type of Work	**Nominal Slump Inches**	***Maximum Slump Inches**
Concrete Pavements	0 – 3	3-1/2
Reinforced Concrete Structures: Sections Over 12 Inches Sections 12 Inches Thick or Less	 0 – 4 2 – 5	 5 6
Non-Reinforced Concrete Facilities	1 – 3	4
Concrete Placed Underwater	6 – 8	9
Bridge Decks	0 – 3	3-1/2

*A waiver to the maximum slump requirement may be requested from the Engineer. Submit justification for the granting of the waiver request along with how the mix design's components ensure that the mix will not segregate.

In adverse or difficult conditions that may affect the placement of concrete, the above slump limitations may be exceeded for placement workability, with the addition of admixture conforming to Subsection "711.03 – Admixtures", if the design mix redesign is accepted by the Engineer in writing and the water-cement ratio is complies with Contract Documents requirements. Provide additional cement and water, or admixture at no increase in the contract price or contract time.

(G) Forms. Construct forms in accordance with applicable sections.

(H) Placing Concrete. Place concrete in accordance with applicable sections.

(I) Finishing Concrete Surfaces. Finish concrete surfaces in accordance with applicable sections.

(J) Curing Concrete. Cure concrete in accordance with applicable sections.

601.04 Measurement. The Engineer will measure concrete in accordance with the applicable sections.

601.05 Payment. The Engineer will pay for the accepted concrete under the applicable sections."

END OF SECTION 601