## Section 552. — STRUCTURAL CONCRETE

11/08/21–FP14

WFL Specification 07/03/14 5520010

Include the following when integral concrete coloring is required.

Material

### 552.02

Add the following to the material list:

Concrete coloring agent 711.05

WFL Specification 07/03/14 5520020

Include the following when work is required in this Section.

Construction Requirements

### 552.03 Composition (Concrete Mix Design).

Amend as follows:

WFL Specification 11/08/21 5520030

Include the following when internally cured concrete is required. Consult with Structures/Materials.

Delete the first paragraph and substitute the following:

Design and produce concrete mixtures that conform to Tables 552-1, 552-2 and 552-3 for the class of concrete specified. For the concrete bridge deck furnish Class A(AE) concrete, except substitute a portion of the normal weight fine aggregate (on a cubic yard basis) for Lightweight Fine Aggregate (LWFA) conforming to AASHTO M195.

Determine the quantity of LWFA (pounds per cubic yard) by the following calculations:

**(a)** Cementitious Factor = Cementitious Content (pound per cubic yard) /100

where:

Cementitious Content is the inclusion of Portland Cement and any supplementary cementitious materials in the submitted concrete mixture;

**(b)** LWFA quantity = (Cementitious Factor \*7.0) / ((% absorption of LWFA/100) / (1+(% absorption of LWFA/100))); and

**(c)** Round calculated LWFA quantity to nearest pound per cubic yard.

Adjust the Concrete Mix Design normal weight fine aggregate quantity after determining the saturated surface dry (SSD) volume of the LWFA. Subtract the SSD LWFA volume from the original volume of normal weight fine aggregate. Calculate new adjusted SSD weight of normal weight fine aggregate on a pound per cubic yard basis.

Determine design strength values according to Section 4 of ACI 301. In addition, design structural concrete mixes according to the following ACI specifications:

**(a)** ACI 211.1 *Standard Practice for Selecting Proportions for Normal, Heavy Weight and Mass Concrete*; and,

**(b)** ACI 211.3 *Guide for Selecting Proportions of No-Slump Concrete*.

WFL Specification 07/03/14 5520040

Include the following when internally cured concrete is NOT required.

Delete the first paragraph and substitute the following:

Design and produce concrete mixtures that conform to Tables 552-1, 552-2, and 552-3 as required for the class specified. Determine design strength values according to Section 4 of ACI 301, *Specifications for Structural Concrete*.

WFL Specification 04/02/21 5520050

Include the following when work is required in this Section.

Delete Table 552-1 and substitute the following:

|  |  |  |  |
| --- | --- | --- | --- |
| Table 552-1  **Composition of Concrete** | | | |
| **Class**  **of**  **Concrete** | **Minimum**  **Compressive Strength**  **@ 28-Days, f’c,**  **psi (MPa)** | **Maximum**  **Water/**  **Cementitious**  **Material**  **Ratio** | **Coarse Aggregate**  **Size Number**  **AASHTO M 43 (1)** |
| A | 4500 (31.0) | 0.45 | 5, 56, 57, 6, 67, 68 |
| A(AE) | 4500 (31.0) | 0.45 | 5, 56, 57, 6, 67, 68 |
| A (Drilled Shafts) | 4500 (31.0) | 0.45 | 8, 89 |
| C | 4500 (31.0) | 0.45 | 7, 78 |
| C(AE) | 4500 (31.0) | 0.45 | 7, 78 |
| D(AE) (2) | 5000 (34.5) | 0.40 | 5, 56, 57, 6, 67, 68 |
| P (Prestressed) (3) | See plans | – | 6,7,67,68,78 |
| P(AE) (3) | See plans | – | 6,7,67,68,78 |
| S (Seal) | – | 0.54 | 5, 56, 57 |
| (1) Meet the processing requirements of AASHTO M 43, *Table 1 – Standard Sizes of Processed Aggregate*.  (2) The maximum water-soluble chloride ion (Cl-) content is 0.15 percent by mass of cement. Determine the water-soluble chloride ion content of concrete made with mix ingredients at an age between 28 and 48 days according to ASTM C1218. Submit test results with the concrete mix design for approval.  (3) The maximum water-soluble chloride ion (Cl-) content is 0.06 percent by mass of cement. Determine the water-soluble chloride ion content of concrete made with mix ingredients at an age between 28 and 48 days according to ASTM C1218. Submit test results with the concrete mix design for approval. | | | |

Delete the first sentence of the third paragraph and substitute the following:

Verify mixture design with trial mixes prepared according to Section 4 of ACI 301 from proposed sources or with previous concrete production data for the mixture design submitted from proposed sources.

Delete item **(w)** from the third paragraph and substitute the following:

**(w)** Specified design strength (f’c) and required average strength (f’cr) for the concrete mixture at 28 days as determined by the process described in Section 4 of ACI 301. This process and associated calculations are outlined on FHWA Form 1608, pages 4 and 5. Pending 28-day strength results, a mix design may be approved on the basis that 7-day compressive strength results meet or exceed 85 percent of the required average strength (f’cr) at 28 days;

WFL Specification 01/01/14 5520060

Include the following when integral concrete coloring is required.

Add the following:

Add a coloring agent to provide integrally colored concrete for Pay item [INSERT ITEM NUMBER & DESCRIPTION]. Add enough agent to match the Standard Color Chart Number [INSERT #] of Federal Specification 595B once concrete has cured.

Prepare five square textured test panels with each panel being 12 by 12 inches (300 by 300 millimeters). Determine coloring agent batch amounts by weight. The maximum amount of coloring agent is not to exceed 10 percent of the weight of the cement. Use coarse and fine aggregates and cement as delivered on the project at the job mix rates with variable quantities of coloring agent as directed by the CO. Provide additional mixing time as recommended by the manufacturer. Give the test panels a Class [INSERT #] finish according to Subsection 552.16.

After the test panels have had at least 2 weeks exposure to sun, the CO will select a test panel to serve as a guide for the colored concrete. Use the same rate of coloring agent used in the selected panel on all relative subsequent work. Include the approved amount of coloring agent in the concrete mix design submittal.

Use an approved form release agent which will produce a minimum of staining, air holes, and hydration discoloration.

WFL Specification 01/01/14 5520070

Include the following when work is required in this Section.

### 552.08 Delivery.

Add the following to paragraph (a):

Do not exceed 300 total revolutions, including both mixing and agitating speed.

WFL Specification 04/02/21 5520080

Include the following when using Section 552 concrete.

### 552.09 Quality Control of Mix.

Add the following:

**(c) Curing and Shipping.** Provide the appropriate initial curing of concrete cylinders taken for compressive strength testing, and transport the cylinders to the project curing facility. Provide suitable containers to protect and continue the curing of cylinders while transporting. Deliver cylinders to the Vancouver Laboratory according to Subsection 154.03. Cylinders will be tested at 7, 14, and 28 days from the date molded. Ensure cylinders arrive at the Vancouver Laboratory at least 1 business day before the designated test date.

WFL Specification 03/31/16 5520090

Include the following in projects with precast bridge substructure elements.

### 552.11(b)(6)

Delete this Subsection and substitute the following:

**(6) Precast elements.**

*(a)* Plant Casting. Use a precast concrete manufacturing plant certified by the Precast/Prestressed Concrete Institute Plant Certification Program with a “B-4 Prestressed Deflected-Strand Bridge Beams (Superstructure)” certification. Use the same precast plant for the fabrication of all the precast elements used in the bridge system. Submit proof of certification prior to starting production.

*(b)* Site Casting. Do not utilize site casting plants.

*(c)* Tolerances. Fabricate precast bridge elements conforming to the tolerances of Tables 552-10, 552-11, and 552-12. The CO will reject any element fabricated outside of specified tolerances.

Place and consolidate concrete so that shrinkage cracks are not produced in the member.

Verify that the prefabricated elements will fit-up and align properly before shipping from the precast facility. Assembling each superstructure and substructure composed of prefabricated elements in the yard prior to shipping the elements to the project site would be a suitable way for performing such verification. If assembled in the yard, use blocking to simulate the support of the elements and the spacing between the elements. Verify all elements are constructed in compliance with all plan requirements. Dry fit all connections in the fabrication yard prior to installation of the elements at the bridge site.

Table 552-10

Precast Bent Cap Fabrication Tolerances

|  |  |
| --- | --- |
| Length | ±¾ in (19 mm) |
| Width (overall) | ±¼ in (6 mm) |
| Depth (overall) | ±¼ in (6 mm) |
| Variation from specified plan end squareness or skew | ±¼ in/12” width  (±6 mm/300 mm width)  ±½ in max. (±6 mm max.) |
| Variation from specified elevation end squareness or skew | ±¼ in/12 in width  (±6 mm/300 mm width)  ±½ in max.  (±13 mm max.) |
| Location of grouted splice coupler measured from a common reference point | ±½ in max.  (±13 mm max.) |
| Local smoothness of any surface | ±¼ in in 10 ft (±6 mm in 3 m) |
| Erection elevation tolerance | ±¼ in (±6 mm) |

Table 552-11

Precast Abutment and Wall Elements Fabrication Tolerances

|  |  |
| --- | --- |
| Length | ±¼ in (±6 mm) |
| Width (overall) | ±¼ in (±6 mm) |
| Depth (overall) | ±¼ in (±6 mm) |
| Variation from specified plan end squareness or skew | ±⅛ in/12 in width  (±3 mm/300 mm width)±½ in max.  (±13 mm max.) |
| Variation from specified elevation end squareness or skew | ±¼in/12 in width  (±6 mm/300 mm width)  ±½ in max. |
| Location of grouted splice coupler measured from a common reference point | ±¼ in (±6 mm) |
| Local smoothness of any surface | ±¼ in in 10 ft  (±6 mm in 3 m width) |
| Location of blockouts for piles or voids | ±1 in (±25 mm) |

Table 552-12

Precast Approach Slab Fabrication Tolerances

|  |  |
| --- | --- |
| Length | ±¼ in (±6 mm) |
| Width (overall) | ±¼ in (±6 mm) |
| Depth (overall) | ±¼ in (±6 mm) |
| Variation from specified plan end squareness or skew | ±½ in (±13 mm) |
| Location of leveling bolts | ±1 in (±25 mm) |
| Sweep over member length | ±⅜ in (±10 mm) |
| Location of projecting reinforcing measured from a common reference point | ±½ in (±13 mm) |
| Local smoothness of any surface | ±⅛ in in 10 ft.  (±3 mm in 3 m) |
| Erection elevation tolerance (surface approach slab only) | ±⅛ in (±3 mm) |
| Location of blockouts | ±½ in (±13 mm) |

*(d)* Submittals. Submit fabrication and installation drawings for approval according to Subsection 104.03.

(*1*)Fabrication drawings. Show all details necessary for fabrication, including the following:

*(a)* Details and location of all lifting holes, inserts, hardware, devices, and any additional reinforcing required for lifting. Include supporting calculations and lifting procedures.

*(b)* Describe the method of curing, handling, storing, and transporting the elements.

*(c)* Leveling inserts in the deck and leveling procedure.

*(d)* Details of vertical elevation adjusting hardware.

*(e)* Minimum compressive strength to be attained prior to handling precast concrete deck and deck overhang elements.

*(f)* Details of structural steel, shear connectors, bearing assemblies, and elastomeric bearing pads.

*(g)* Concrete volume, reinforcing steel weight and total section weight for each element.

Do not order materials or begin work until receiving final approval of the shop drawings.

*(2)*Assembly Plan. Prepare an assembly plan under the seal of a licensed Professional Engineer. Submit 5 sets for approval 28 days before fabrication. Describe all details necessary for assembly, including the following:

*(a)* A work area plan depicting utilities overhead and below the work area, drainage inlet structures, protective measures, temporary staging areas, crane locations, and other features of the site necessary for successful assembly.

*(b)* Details of all equipment and devices (including slings, hooks, and jacks) used for lifting and assembling the superstructure, substructure and approach slabs. Include the make, model, lift capacity, and operating radii.

*(c)* Computations showing the magnitude of stress in the prefabricated components during erection is within allowable limits, and that all of the erection equipment has adequate capacity for the work to be performed*.*

*(d)* Detailed sequence of construction activities, and a Critical Path Method (CPM) schedule according to Section 155 for all operations. Include setting and cure time for grout, concrete closure pours, splice couplers, and fill of pile pockets.

*(e)* Methods of providing temporary support of the elements. Include methods of adjusting, bracing and securing the element after placement.

*(f)* Procedures for controlling tolerance limits.

*(g)* Methods of forming closure pours and fill concrete, and sealing lifting holes.

*(h)* Methods for curing grout, closure pours, and lifting hole concrete.

*(i)* A list of personnel that will be responsible for grouting the reinforcing splice couplers. Include proof of completion of two successful installations within the last 2 years. Training of new personnel within 3 months of installation by a manufacturer’s technical representative is an acceptable substitution for this experience. In this case, provide proof of training.

*(e)*Quality Assurance.

*(1)* Permanently mark each element with date of fabrication, supplier identification and module identification. Stamp markings in fresh concrete.

*(2)* Prevent cracking or damage of precast components during handling and storage.

*(3)* Replace or repair defective or broken precast concrete deck and concrete deck overhang elements according to Section 106. Requests to repair defective or broken elements are subject to the following:

*(a)* Obtain approvalbefore performingconcrete repairs.

*(b)* Concrete repair work must reestablish the module’s structural integrity, durability, and aesthetics to the satisfaction of the CO.

*(c)* Describe the cause of damage and the corrective action taken to eliminate future damage.

*(d)* An updated CPM schedule showing the effects of repair work on project completion.

*(4)* Elements will be rejected if they do not conform to the contract documents, and for the following reasons:

*(a)* Elements fabricated before the date that shop drawings are approved.

*(b)* Full-depth cracking of concrete, and concrete breakage that is not repairable.

*(c)* Cracks that extend to the nearest reinforcement plane, or fine surface cracks that do not extend to the nearest reinforcement plane but are numerous or extensive.

*(d)* Camber that does not meet the requirements of the plans or fabrication drawings.

*(e)* Honeycombed texture.

*(f)* Dimensions exceeding the allowable tolerances.

*(g)* Damage during fabrication, transportation, erection, or construction.

*(5)* Document all test results for structural concrete. Show in the quality control files at least the following information:

*(a)* Element identification.

*(b)* Date and time of fabrication concrete pour.

*(c)* Concrete cylinder test results.

*(d)* Concrete mix design and the batch print out.

*(e)* Form-stripping date.

*(f)* Location and number of blockouts and lifting inserts.

*(g)* Temperature, moisture, and duration of curing period.

*(h)* Approved repair procedures.

*(f)*Handling, storing and transporting*.*

*(1)* Damage/Cracking. Prevent cracking or damage of prefabricated elements and modules during handling, storing and transporting.

*(2)* Precast Element Sizes. Finalize the size of precast elements with consideration for shipping restrictions, equipment availability and site constraints. Show the final element sizes on the assembly plan.

*(3)* Lifting Devices. The design and detail of the lifting devices is the responsibility of the Contractor. Use lifting devices in a manner that does not cause damage, cracking or torsional forces. Place the lifting devices in locations that are not visible once the prefabricated element is placed, or within recessed pockets that can be patched after installation.

*(4)* Safety. The Contractor is responsible for the safety and stability of prefabricated elements during all stages of handling, transportation and construction.

*(5)* Handling and Storing. Store the precast units in a horizontal and upright position, supported at their designated bearing points. Follow Chapter 5 of the *PCI Design Handbook* for handling and erection bracing requirements.

Lift the precast elements so that the angle between the top surface of the precast element and the lifting line is not less than 60 degrees when measured from the top surface of the precast elements to the lifting line. If two cranes are used, then the lifting lines shall be vertical. Lift the modules at the designated points. The Contractor is responsible for handling stresses in the modules. Choose the locations of the lifting points so that the anticipated flexural tensile stress induced in the top of the structural concrete for the assumed support locations is not greater than the allowable stress.

Select smooth and well compacted storage areas to prevent damage due to differential settlement. Support precast elements during storage to prevent cracking or creep induced deformation (sagging). Check precast elements at least once per month to ensure that creep-induced deformation does not occur.

Protect the elements from freezing temperatures for 5 days after casting or until precast concrete attains design compressive strength. Do not remove thermal protection any time before the units attain the specified compressive strength when the surrounding air temperature is below 20 °F (-6 °C).

Elements may be loaded on a trailer as described below. Use shock-absorbing material at all bearing points during transportation. Locate the tie-down straps at the lines of blocking only. Replace or repair units damaged during storage or handling.

*(g)* Transportation. Move elements after the concrete reaches a minimum compressive strength of 4,500 pound per square inches (31.0 megapascals) or as provided in the project plans.

Transport modules horizontal with beams on the bottom side for support. Support the modules at approximately the same points they will be supported when installed.

WFL Specification 01/01/14 5520100

Include the following when using Section 552 concrete.

### 552.11(e)(1) Tremies.

Delete the text of this subsection and substitute the following:

Use watertight tremies, with a diameter sufficient to ensure that aggregate-induced blockages will not occur. Use multiple tremies as required. Make tremies capable of being rapidly lowered to retard or stop the flow of concrete.

Seal the discharge end and fill the tremie tube with concrete at the start of concrete placement. Keep the tremie tube full of concrete to the bottom during placement. If water enters the tube, withdraw the tremie and reseal the discharge end. Maintain continuous concrete flow until the placement is completed.

WFL Specification 03/31/16 5520110

Include the following in projects with precast bridge substructure elements.

### 552.15 Curing Concrete.

Add the following:

**(d) Precast concrete curing.**

**(1)** Use an approved method of curing that prevents loss of moisture and maintains an internal concrete temperature at least 40 °F (4 °C) during the curing period.

**(2)** When using accelerated heat curing, do so under a suitable enclosure. Use equipment and procedures that will ensure uniform control and distribution of heat and prevent local overheating. Ensure the curing process is under the direct supervision and control of an individual certified by PCI for Plant Quality Personnel, Level I or higher.

**(3)** When accelerated heat is used to obtain temperatures above 100 °F (38 °C), record the temperature of the interior of the concrete using a system capable of automatically producing a temperature record at intervals of no more than 15 minutes during the curing period. Space the systems at a minimum of one location per 100 feet (30 m) of length per unit or fraction thereof, with a maximum of three locations along each line of units being cured. Ensure all systems, when calibrated individually, are accurate within ±5 °F (±3 °C). Do not artificially raise the temperature of the concrete above 100 °F for a minimum of 2 hours after the units have been cast. After the 2-hour period, the temperature of the concrete may be raised to a maximum temperature of 160 °F (71 °C) at a rate not to exceed 25 °F (15 °C) per hour. Lower the temperature of the concrete at a rate not to exceed 40 °F (22 °C) per hour by reducing the amount of heat applied until the interior of the concrete has reached the temperature of the surrounding air.

**(4)** In all cases, cover the concrete and leave covered until curing is completed. Do not under any circumstances remove units from the casting bed until the strength requirements are met.

WFL Specification 04/02/21 5520120

Include the following when using Section 552 or Section 601 concrete.

### 552.16 Finishing Formed Concrete Surfaces.

Amend as follows:

Delete the first paragraph and substitute the following:

Finish sound, formed concrete surfaces as described below. If any finished concrete surface that is exposed to view (e.g., piers, columns, web walls, etc.) has become streaked and unsightly due to spilled mortar, leaching, or some other cause, clean and refinish the concrete according to the appropriate class.

Delete paragraph (a) and substitute the following:

**(a) Class 1 - Ordinary surface finish.** Finish the following surfaces with a Class 1 ordinary surface finish:

**(1)** Under surfaces of slab spans, box girders, filled spandrel arch spans, and the roadway deck slab between superstructure girders;

**(2)** Inside vertical surface of T-girders of superstructures; and,

**(3)** Surfaces to be buried and culvert surfaces above finished ground that are not visible from the traveled way or a walkway.

Begin finishing as soon as the forms are removed. Remove fins and irregular projections from all surfaces that are exposed or will be waterproofed. Remove bulges and offsets with carborundum stones or discs. Remove localized, poorly-bonded rock pockets and honeycombed concrete, and replace with sound concrete or packed mortar. Fill all holes with mortar in the same cement/aggregate ratio as the concrete being finished, and float to an even, uniform finish. A bonding agent may be used with the approval of the CO.

Clean and point form tie cavities, holes, broken corners and edges, and other defects. Saturate the area with water. Finish the area with mortar that is less than 1-hour old. After the mortar is set, rub it (if required) and continue curing. Match exposed surfaces to surrounding concrete.

Carefully tool and remove free mortar and concrete from construction and expansion joints. Leave joint filler exposed for its full length with clean, true edges.

Rub or grind bearing surfaces on piers and abutments to the specified elevation and slope.

If the final finished surface is not true and uniform, rub it according to Subsection 552.16(b).

Delete paragraph (b) and substitute the following:

**(b) Class 2 - rubbed finish.** Finish the following surfaces with a Class 2 rubbed finish:

**(1)** Surfaces of bridge superstructures except those surfaces designated to receive a Class 1 or other finish;

**(2)** Surfaces of bridge piers, piles, columns and abutments, and retaining walls above finished ground and to at least 12 inches (300 millimeters) below finished ground;

**(3)** Surfaces of open spandrel arch rings, spandrel columns and abutment towers;

**(4)** Surfaces of pedestrian undercrossings except floors and surfaces to be covered with earth;

**(5)** Surfaces above finished ground of culvert headwalls and endwalls when visible from the traveled way or walkway;

**(6)** Inside surfaces of culvert barrels higher than 48 inches (1200 millimeter) that are visible from the traveled way. Finish for a distance inside the barrel at least equal to the height of the culvert; and,

**(7)** Surfaces of railings.

Complete a Class 1 finish according to Subsection 552.16(a).

Create a Class 2 rubbed finish according to steps (1) through (6), below.

**(1)** Thoroughly wash the surface of the concrete with water. Proceed with step (2) only after completing other work that could affect the surface;

**(2)** Brush on a mortar approved by the CO at a 1:1 cement/aggregate ratio.

**(3)** Brush on no more mortar than can be finished in 1 day;

**(4)** Rub the mortar with burlap or a piece of carpet as soon as it takes initial set (before it reaches final set);

**(5)** Fog-spray water over the finish as soon as the mortar has reached final set; and

**(6)** Keep the surface damp for at least 2 days.

If the mortar becomes too hard to rub as described in step (4), then rub the surface with a carborundum stone and water until form marks, projections, and irregularities are removed. Random grinding is not permitted. Leave a uniform surface free from all unsound patches, paste, powder, and objectionable marks.

Continue with the Class 2 rubbed finish until the entire surface has a smooth texture and uniform color.

When steel forms have been used and the surface has a smooth, uniform texture and color including the surface of the filled holes, steps (1) through (6) above may be omitted with the approval of the CO.

WFL Specification 04/02/21 5520121

Include the following when using Section 552 concrete.

### 552.18 Loads on New Concrete Structures.

Add the following:

For bridge approach slabs do not allow traffic on new concrete earlier than 14 days after concrete placement unless concrete tests indicate one of the following conditions is obtained:

**(a)** Flexural strength of 550 pounds per square inch (4 megapascals) according to AASHTO T 97; or,

**(b)** Compressive strength of 4000 pounds per square inch (28 megapascals) according to AASHTO T 22.

Do not allow traffic on the approach slab when joint sealant is tacky and traffic debris would imbed into the sealant.

WFL Specification 04/02/21 5520122

Include the following when using Section 552 or Section 601 concrete.

### 552.20 Acceptance.

Add the following to Table 552-9 Note (2):

Transportation of specimens to laboratory may exceed time limits specified in AASHTO T 23.

WFL Specification 01/01/14 5520130

Include the following when concrete footings are to be poured against undisturbed rock.

Measurement

### 552.21

Add the following:

The volume of concrete required, outside the neat lines of the footing, to pour against undisturbed rock as shown on the plans will not be measured for payment or subject to adjustment according to Subsection 109.02(c). When the CO directs the removal of material below the established elevation of the bottom of the footing, the volume of concrete required to fill the void will be measured for payment.