

**Instructions for use****Construction Specification 31—Concrete for Major Structures****1. Applicability**

Construction Specification 31 is applicable to the types of concrete construction entailed in NRCS operations where high material quality is not negotiable. Supplementary specifications are required for works of a special nature, such as:

- a. Placing concrete under water.
- b. Concrete exposed to seawater.
- c. Concrete exposed to alkali soils or alkaline water.
- d. High strength concrete using microsilica.
- e. Special finishes, such as sack rubbed, stone rubbed, and treatment with cement-based coatings.

Examples of such specifications and guides are in Standard Specifications for Highway Bridges, AASHTO, and the ACI Manual of Concrete Practice.

**2. Material specifications**

The following material specifications complement Construction Specification 31:

**Aggregates**—Specification 522, Aggregates for Portland Cement Concrete

**Cement**—Specification 531, Portland Cement

**Fly ash**—Specification 532, Supplementary Cementitious Materials

**Blast-furnace slag**—Specification 532, Supplementary Cementitious Materials

**Air-entraining admixtures**—Specification 533, Chemical Admixtures for Concrete

**Water-reducing and/or retarding admixtures**—Specification 533, Chemical Admixtures for Concrete

**Plasticizing admixtures**—Specification 533, Chemical Admixtures for Concrete

**Accelerating and water-reducing and accelerating admixtures**—Specification 533, Chemical Admixtures for Concrete

**Curing compounds**—Specification 534, Concrete Curing Compound

**Preformed joint filler**—Specification 535, Preformed Expansion Joint Filler

**Sealing compound for joints**—Specification

536, Sealing Compound for Joints in Concrete and Concrete Pipe

**Nonmetallic waterstops**—Specification 537, Nonmetallic Waterstops

**Metal waterstops**—Specification 538, Metal waterstops

**Dowels**—Specification 539, Steel Reinforcement (for concrete)

**Metal**—Specification 581, Metal

**3. Included items**

Items to be included in contract specifications and drawings follow:

- a. Complete engineering and structural detail drawings of the structure. (See Section 6, National Engineering Handbook.)
- b. Type, size, and quality of joint filler, waterstops, and metal plates.
- c. Where joints are to be sealed, specify the type, grade, class, and use of joint sealant and the backing material (aka. backer rod). On the drawings, include a detailed section of the joint sealant installation showing the backer rod and the tooled surface. Include dimensions such as the joint width, diameter of backing material, the depth of any concave tooled surface and the length of the substrate or sealant bonding surface. Reference ASTM C1193.
- d. Deviations, if any, from the specified concrete temperature ranges in Section 21, Concreting in cold weather.
- e. Specify dowel size, spacing, length, and treatment of moveable dowel ends (plastic sleeve, grease). Also specify deviations, if any, from dowels specified.
- f. Deviations, if any, from specifications requiring:
  - (1) Placement of slab concrete in a single layer
  - (2) Consolidation of concrete with vibrators
- g. Section 3, Concrete mix design, method 1. Specify or consider the following items:
  - (1) Class of concrete
  - (2) Type of cement

- (3) If water-cement ratios greater than 0.50 are allowed, they must be specified in Section 25.
  - (4) Any deviation from the air content and slump specified in section 3, method 1, must be specified in section 25. (The air content specified in section 3 may not be reduced for structures where the average annual minimum air temperature is below 20 degrees Fahrenheit.)
  - (5) Aggregate data. Specify only the nominal maximum size of coarse aggregate and not the ASTM size designation for coarse aggregates. If Material Specification 522 does not apply, specify the applicable specification and/or the salient properties for aggregate.
  - (6) Types of admixtures, if any.
  - (7) Any deviation in the allowable amounts of fly ash, ground granulate blast-furnace slag, or silica fume.
  - (8) Fly ash and slag considerations. Specify in section 25 if fly ash or ground blast-furnace slag is required or is not allowed in the design mix as a partial substitute for cement. Specify in section 25 if the fly ash class is restricted to either Class F or C (ASTM C618). If fly ash or slag is not mentioned in section 25, the contractor has the option to use either fly ash (Class F or C) or slag (any grade) in the design mix under method 1, section 3. For fly ash, specify supplementary optional physical requirements listed in ASTM C618 if applicable. For example, if fly ash is required to control alkali-silica reaction, specify, "In Section 2, fly ash shall meet the supplemental optional physical requirement for effectiveness in controlling alkali-silica reaction as stated in ASTM C618." If it is required to improve resistance to moderate sulfate attack, specify, "In Section 2, fly ash shall meet the supplemental optional physical requirement for effectiveness in contributing to sulfate resistance, Procedure A for moderate sulfate exposure after 6 months exposure as stated in ASTM C618."
- h. Section 3, Concrete mix design, method 2. Specify the material proportions and batch weights for the initial job mix, which includes water-cement ratio, cement type and content/cy, coarse aggregate nominal maximum size and content/cy, fine aggregate content/cy, percent air content required, slump requirements, fly ash class and content/cy (if any), slag grade and content/cy (if any), and any other admixtures that will be used.
  - i. Section 7, Forms. If it is important that the formed surface contain only a few bug-holes (air bubbles which are entrapped at the formed surface), specify that the release agent be formulated for use with plasticized concrete or provide a statement from the manufacturer that formed concrete surfaces made using the form release agent with plasticized concrete have not varied significantly from non-plasticized concrete surfaces made using the same form release agent. Discussion: Some release agents prevent entrapped air bubbles from traveling up the formed surface and exiting the concrete during the process of consolidating the concrete by vibration. These release agents are generally characterized by relatively high viscosity and may be referred to as an oil or paste. Bug-holes are common in most formed surfaces and are considered acceptable for most non-architectural concrete.
  - j. Section 9, Conveying. The hot weather limitations for nonplasticized concrete may be waived by the engineer if the concrete continues to remain within the allowable slump range and the temperature of the concrete does not exceed 90 degrees Fahrenheit. This is consistent with industry practices, but the waiver must be based on the performance of the concrete onsite, and the engineer should exercise caution and judgment when waiving the limitations.
  - k. Section 10, Placing. Specify a placement plan when required. Placement plans should be considered only when complex placement and/or control is required or expected or when a high volume of concrete is involved.
  - l. Section 16, Removal of forms, supports, and protective coverings.

- (1) Strength test option. Specify a minimum concrete compressive strength for the form removal of structure member in section 25. The designer and the government assume the risk of form removal at that designated strength.
- (2) Cumulative time option. Form removal time for this option is based upon the structural live load (the final inservice load the member must support) being substantially greater than the structural dead load (load of the member only) and no significant horizontal loads on the member when the forms are removed. If the structural dead load is near to or larger than the structural live load, identify in section 25 the members that require longer form removal times. (See footnote 2 for the accumulative form removal time table in the construction specification.) For walls and columns where forms may be removed quickly and may be exposed to significant horizontal loads, such as wind loads, different removal times should be specified or the Strength Test option required. (See footnote 3 for the accumulative form removal time table.) ACI 347R, Guide to Formwork for Concrete, Paragraph 3.7.2.3 may be used as a reference for removal times.
- m. Specify the finish in section 25 if a finish other than that required in sections 17 and 18 is needed, such as an architectural surface, a special finish, or other necessary restrictions. USBR Concrete Manual, Chapter VI, Sections 119 and 121 may be used as a reference for different finishes.
- n. Section 22, Concreting in hot weather. Extreme conditions for formed concrete is a manner of professional judgment on the part of the engineer. Extreme conditions for flatwork and slab construction is defined as when the evaporation rate exceeds 0.2 pound per square foot per hour. Another method that may be specified in section 25 or approved is figure 11-8, page 135, "Design and Control of Concrete," Thirteenth Edition, Portland Cement Association, 5420 Old Orchard Road, Skokie, IL 60077-1083.
- o. Section 23, Acceptance of concrete work.
- (1) **Concrete strength.** The basic premise for acceptance is the approved job mix is delivered to the structure. Strength test failing to meet the required criteria occasionally occurs although concrete strength and uniformity are satisfactory. The probabilities of a low strength test result from a job mix meeting the criteria in section 3 are:
- 9 percent chance (1 in 11) that an individual strength test will fall below  $f'_c$
  - 1 percent chance (1 in 100) that an individual strength test will fall more than 500 pounds per square inch below  $f'_c$
  - 1 percent chance that the average of three consecutive strength tests will fall below  $f'_c$
- Allowances should be made for such statistically expected variations in deciding whether the strength level being produced is adequate. The criterion of an individual strength test falling more than 500 pounds per square inch below  $f'_c$  adapts well to small numbers of tests (small concrete volumes) and is the strongest indicator that something is wrong with the concrete mix. Although there is a 1 percent chance that concrete strength will not meet this criteria, verification of the in-place strength should be required if it does not meet the criteria and the contractor is required to take actions to improve the strength test averages. The criterion of the average of three consecutive tests being equal to or greater than the  $f'_c$  is a good trend indicator and not as critical as the other criterion. An occasional average below  $f'_c$  can be tolerated; however, if it occurs two or more consecutive times, consideration should be given to verifying the in-place concrete strength and requiring the contractor to take actions to improve the strength test averages.
- (2) **Structure dimensions.** Specify acceptable tolerances for the structure if the tolerances shown under Structure Dimensions affect the function, strength, or appearance of the structure.

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#### 4. Methods

##### Section 3, Concrete mix design

**Method 1**—Intended for use when strength is to be used as one of the criteria for acceptance of the concrete and the contractor is to be responsible for the mix.

**Method 2**—Intended for use when the engineer is to be responsible for and prescribe the concrete mix and strength will not govern acceptance from the contractor.

##### Section 13, Construction joints

**Method 1**—Intended for use in circumstances where maximum bond between old and new concrete is desired. When such joint treatment is specified, it is permissible to design horizontal construction joints as flat plane surfaces without keyways or metal plates. Method 1 is preferred for all structures that are continuously or intermittently exposed to water.

**Method 2**—Intended for use in circumstances where bond between old and new concrete is not a critical element.

##### Section 24, Measurement and payment

**Method 1**—Intended for use with method 1 in section 3 when the design and control of the concrete mix is the responsibility of the contractor (that is, when the compressive strength of the concrete is one of the criteria determining acceptability).

**Method 2**—Intended for use with method 2 in section 3 when the job mix is designed and controlled by the engineer. A bid item for cement should be included in the specification and the bid schedule.

When all methods but one are deleted for use in a contract specification, delete from the last paragraph **All Methods The following provisions apply to all methods of measurement and payment.** Left justify the remaining text.

#### 5. Items of work and construction details

Starting at the top of page 31–21, prepare and outline job specific "Items of Work and Construction Details" (IWCD) in accordance with these instructions.

**Table A-31** Concrete curing or curing and sealing compounds

Designation	Description	Usage
ASTM C309	Curing Compound	For curing only. This product will work for most applications. It should not be used if the surface to which it is applied will be painted or bonded to other finishes or toppings.
Type 1	Clear or translucent without dye	Use where a white curing compound would be aesthetically unacceptable. May be used for small surface areas where assurance of uniform coverage can be had without the aid of a dye.
Type 1-D	Clear or translucent with fugitive dye	Use where a white curing compound would be aesthetically unacceptable. The fugitive dye promotes assurance of uniform coverage. The dye dissipates in about 4 hours.
Type 2	White pigmented	Use where a white curing compound is aesthetically acceptable or otherwise will be removed. Recommended for hot weather concreting because its reflective qualities tend to reduce solar-heat gain, thus reducing the concrete temperature.
Class A	Unrestricted composition (usually used to designate wax based products)	Typically not restricted for NRCS work.
Class B	Resin-based compositions.	Typically not restricted for NRCS work.
ASTM C1315	Curing and Sealing Compound	For curing and sealing. This product has better water retention characteristics than the C309 curing compounds. The white pigmented C1315 compound is slightly more reflective than the C309 compounds. C1315 compounds provide protection from acids and alkalis, are resistant to degradation from UV light, and exhibit adhesion-promoting qualities. Use this product may be used in lieu of C309 compounds. Specify C1315
Type I	Clear or translucent	Use where a white curing compound would be aesthetically unacceptable. May be used for small surface areas where assurance of uniform coverage can be had without the aid of a dye.
Type II	White pigmented	Use where a white curing compound is aesthetically acceptable or otherwise will be removed. Recommended for hot weather concreting because its reflective qualities tend to reduce solar-heat gain, thus reducing the concrete temperature.
Class A	Non-yellowing	Use where yellowing would be aesthetically unacceptable.
Class B	Moderate yellowing	Not restricted for NRCS work unless yellowing is aesthetically unacceptable.
Class C	Unrestricted with regard to yellowing	Not restricted for NRCS work unless yellowing is aesthetically unacceptable.

