

**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 will be 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, treatment with cement-based coatings, etc.

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

2. MATERIAL SPECIFICATIONS

The following material specifications are complementary to Construction Specification 31:

- a. Aggregates Specification 522
- b. Cement Specification 531
- c. Fly Ash Specification 532
- d. Blast -Furnace Slag Specification 532
- e. Air-Entraining Admixtures Specification 533
- f. Water-Reducing and/or Retarding Admixtures Specification 533
- g. Plasticizing Admixtures Specification 533
- h. Accelerating and Water-Reducing and Accelerating Admixtures Specification 533
- i. Curing Compounds Specification 534.
- j. Preformed Joint Filler Specification 535
- k. Sealing Compound for Joints Specification 536

l. Non-Metallic Waterstops Specification 537

m. Metal Waterstops Specification 538

n. Dowels Specification 539

o. Metal Specification 581.

3. ITEMS TO BE INCLUDED IN CONTRACT SPECIFICATIONS AND DRAWINGS

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. Deviations, if any, from the specified concrete temperature ranges in Section 21, CONCRETING IN COLD WEATHER.

d. Specify dowel size, spacing, length, and treatment of moveable dowel ends (plastic sleeve, grease, etc.). Also specify deviations, if any, from dowels specified.

e. Deviations, if any, from specifications requiring:

(1) Placement of slab concrete in a single layer.

(2) Consolidation of concrete with vibrators.

f. Section 3, Concrete Mix Design, Method 1. Specify and/or consider the following items:

(1) Class of concrete.

(2) Type of cement.

(3) If water-cement ratios greater than 0.50 will be 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° F.)

(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) 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 C 618). If there is no mention of fly ash or slag 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.

- g. 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.
- h. Section 9, Conveying. The hot weather limitations for non-plasticized 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° F. 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.
- i. 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.
- j. Section 16, Removal of Forms, Supports, and Protective Coverings.

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.

Cumulative Time option. Form removal time for this option is based upon the structural live load (the final in service 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 will require longer form removal times (See Footnote 2/ for the Accumulative Form Removal Time table.). 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.

- k. Specify the finish in Section 25 if a finish other than that required in Section 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.

- l. 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 exceeding 0.2 lb/ft<sup>2</sup>/hr. 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.
- m. Section 23, Acceptance of Concrete Work.

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 will occasionally occur even though 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: A 9 percent chance (1 in 11) that an individual strength test will fall below  $f'_c$ , a 1 percent chance (1 in 100) that an individual strength test will fall more than 500 psi below  $f'_c$ , and a 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 psi 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% 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 required to take actions to improve the strength test averages. The criterion of the average of three consecutive strength 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.

Structure Dimensions. Specify acceptable tolerances for the structure if the tolerances shown under Structure Dimensions affect the function, strength, or appearance of the structure.

#### 4. DISCUSSION OF METHODS

##### a. Section 3, Concrete Mix Design

- (1) Method 1 is 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.

(2) Method 2 is 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.

b. Section 13, Construction Joints

(1) Method 1 is 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.

(2) Method 2 is intended for use in circumstances where bond between old and new concrete is not a critical element.

c. Section 24, Measurement and Payment

(1) Method 1 is 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).

(2) Method 2 is 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 specifications are prepared using electronic procedures and all but one method are deleted for use in a contract specification, delete "All Methods The following provisions apply to all methods of measurement and payment." and left justify the remaining text.