

**NATURAL RESOURCES CONSERVATION SERVICE  
CONSTRUCTION SPECIFICATION**

**CONCRETE**

1. SCOPE

This specification covers concrete construction for CO-01 practices.

2. DESIGN OF THE CONCRETE MIX

The contractor shall be responsible for the design of the concrete mix and for providing a letter certifying that the concrete mix (with admixtures if used) will provide the required compressive strength verified with test results. This letter shall be provided to the landowner with copies to the NRCS engineer or representative at the pre-construction conference.

The proportions of the aggregate shall be such as to produce a concrete mixture that will work readily into the corners and angles of the forms and around reinforcement when consolidated but will not segregate or exude free water during consolidation.

The concrete mix shall have a 28-day compressive strength of 4,000 psi and a minimum of 6 bags of cement per cubic yard. Cement may be replaced with fly ash in quantities of up to 20 percent by weight of the total required cement. The water-cement ratio (w/c) shall not exceed 0.49.

Entrained air must be used in all concrete that will be exposed to freezing and thawing. The air content by volume shall be 5 to 8 percent.

The slump shall be a maximum of 5 inches.

Superplasticizers may be used, provided the NRCS engineer or his or her representative at the pre-construction conference approves their use. Superplasticizers shall be used according to manufacturer's recommendations. The maximum slump before adding superplasticizers shall be 2 ½ inches. The maximum slump after adding superplasticizer shall be 7 ½ inches.

The designer or landuser may add synthetic fibers to the concrete mix. The fibers shall be polypropylene and added per manufacturer's recommendation.

Synthetic fibers aid in the bleeding process, helps reduce segregation of the concrete mix, and helps reduce the formation of shrinkage cracks while the concrete is in the plastic state and during the first few hours of curing.

Synthetic fibers are not a substitute for steel reinforcement.

3. MATERIAL SPECIFICATIONS

All materials used in concrete construction shall meet the applicable ASTM standards and/or ACI specifications.

#### 4. BATCH TICKET INFORMATION

The contractor shall obtain from the supplier a delivery ticket for each batch of concrete before unloading at the site. The following minimum information shall be included on the ticket:

- a. Name of concrete supplier.
- b. Name of purchase and job location.
- c. Date of delivery.
- d. Amount of concrete delivered.
- e. Time loaded.
- f. Design mix designation.
- g. Admixture(s) – Type and Quantity.
- h. Quantity of cement on truck.
- i. Quantity of water added at plant.

The contractor shall be responsible for any changes to the design mix. The batch ticket shall also include the following information:

- a. Time the concrete arrived at the site.
- b. Water added by the receiver of the concrete.
- c. Admixture(s) added on site – type, quantity, and time admixture added to the concrete.
- d. Time the concrete was unloaded.

Upon completion of the placement, copies of all batch tickets shall be provided to the landowner.

#### 5. CONCRETE SLABS

Design slabs considering the required performance and the critical applied loads. The subgrade material must be evaluated as to the suitability and denseness. A 4-inch thick layer of crushed gravel or limestone shall be provided as a uniform subbase. Where the subgrade is uniform and dense, a Type S-1 concrete slab is acceptable. Type S-2 concrete slabs shall be used where the subgrade material is non-uniform or has variable density, and it is not economical or feasible to improve the subgrade. The subgrade thickness in question is generally 12 inches, but could be more depending on the soil profile. Type S-3 concrete slabs shall be used when the contraction (control) joint spacing is to be more than 15 feet, when no contraction (control) joints are wanted, when reduced seepage is required, or when a watertight slab is required.

Type S-1 Concrete Slab:

Slab thickness shall be 5 inches.

Steel reinforcement is not required.

Contraction (control) joints shall be at a maximum spacing of 15 feet in both directions.

Contraction (control) joints shall be continuous, not staggered or offset.

Aspect ratio (length to width) of slab panels shall be a maximum of 1.5 to 1; however, a ratio of 1 to 1 is preferred. L- and T- shaped panels shall be avoided.

Expansion joints are not required.

Isolation joints are required when complete freedom of vertical and horizontal movement is required.

Type S-2 Concrete Slab:

Slab thickness shall be 6 inches.

Steel reinforcement shall be #4 bars at 18 inches center to center.

Reinforcing bars shall be located in the top portion of the slab so the top steel rebar has 2 inches of concrete cover.

Reinforcing steel shall not extend across the contraction joint.

Contraction (control) joints shall be at a maximum spacing of 15 feet in both directions.

Contraction (control) joints shall be continuous, not staggered or offset.

Aspect ratio (length to width) of slab panels shall be a maximum of 1.5 to 1; however, a ratio of 1 to 1 is preferred. L- and T- shaped panels shall be avoided.

Expansion joints are not required.

Isolation joints are required when complete freedom of vertical and horizontal movement is required.

When required, vertical displacement at contraction (control) joints shall be controlled by smooth steel dowels, ¾ inch diameter, 16 inches in length, 12 inches center to center, place in the center of the slab thickness.

Type S-3 Concrete Slabs:

Slab thickness shall be 5 inches plus total steel thickness.

Steel reinforcement shall be based on contraction (control) joint spacing. See table below.

Reinforcing steel shall not extend across the contraction (control) joint.

Reinforcing bars shall be located in the top portion of the slab, so the top steel rebars have a minimum of 1.5 inches to maximum of 2.0 inches of concrete cover. No other tolerance permitted.

When required, vertical displacement of contraction (control) joints shall be controlled by smooth steel dowels (same as Type S-2 concrete slab).

Contraction (control) joint spacing, steel requirements, and slab thickness shall be from the following table. The contraction (control) joint spacing is based on Grade 60 steel.

<u>Contraction Joint Spacing</u>	<u>Rebar Size and Spacing</u>	<u>Slab Thickness</u>	<u>Lap Splice</u>
20 ft.	#4 bars 16" cc	6"	20"
30 ft.	#4 bars 12" cc	6"	20"
40 ft.	#5 bars 15" cc	6 1/2"	25"
50 ft.	#5 bars 12" cc	6 1/2"	25"
60 ft.	#6 bars 15" cc	6 1/2"	30"
70 ft.	#6 bars 14" cc	6 1/2"	30"
80 ft.	#6 bars 12" cc	6 1/2"	30"

The rebar in the longest direction shall be placed nearest the top of the concrete slab.

Rebar lap splice length shall be a minimum of 40 bar diameters.

## 6. REINFORCEMENT

Welded wire reinforcement is not a substitute for steel reinforcement.

Synthetic fibers are not a substitute for steel reinforcement.

Reinforcing steel shall be deformed bars manufactured specifically for concrete reinforcement and shall be a minimum of Grade 40.

Reinforcing steel shall be free from loose rust, concrete, oil, grease, paint, or other deleterious coatings.

All reinforcing steel shall be cold-bent, if bends are required.

Welding of reinforcing steel is not permitted.

## 7. FORMS

Forms shall be of wood, plywood, steel, or other approved materials and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so the finished concrete will conform to the specified dimensions and contours. Form surfaces shall be smooth and free from holes, dents, sags, or other irregularities.

## 8. PREPARATION OF SUBGRADE

Prior to placement of concrete, the forms and subgrade shall be free of chips, sawdust, debris, water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings. Any oil on the reinforcing steel or other surfaces required to be bonded to the concrete shall be removed. Rock surfaces shall be cleaned by wire brush scrubbing, wet sandblasting, or air-water cutting, as necessary, and shall be firm and damp prior to placement of concrete. All other subgrade surfaces shall be firm and damp prior to placement of concrete. Placement of concrete on mud, dried earth, uncompacted fill, or frozen subgrade will not be permitted.

## 9. FORM AND STEEL PLACEMENT

Forms shall be coated with a non-staining form release agent before being set into place.

Form ties shall have a minimum 2-inch clearance from reinforcing steel.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly.

Weepholes in walls or slabs shall be formed with non-ferrous materials.

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Reinforcing steel shall be supported by precast concrete bricks or manufactured chairs. Except for dowel rods, placing steel reinforcement into concrete already in place will not be permitted.

Splices of reinforcing bars shall be made only at the locations shown on the drawings, unless otherwise approved by the engineer.

Unless otherwise indicated on the drawings, splices of reinforcing bars shall be a minimum 30-bar diameters of the largest bar involved in splice.

The minimum concrete cover on reinforcing bars is 2 inches on formed or exposed surfaces and 3 inches from earth or granular base surfaces.

Maximum variation from indicated bar spacing is 1/12 of the indicated bar spacing, but the required number of bars shall not be reduced.

Steel tying and form construction adjacent to concrete in place shall not be started until the concrete has cured at least 12 hours. Before new concrete is deposited on or against concrete that has hardened, the forms shall be retightened.

## 10. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1½ hours after the introduction of the cement to the aggregates. In hot weather or under conditions contributing to quick stiffening of the concrete, or when the temperature of the concrete is 85° F or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

Concrete shall be conveyed from the mixer to the forms as rapidly as practicable by methods that will prevent segregation of the aggregates or loss of mortar.

Superplasticizer may be used with the approval of the NRCS Engineer.

## 11. PLACING

Concrete shall not be placed until the subgrade, forms, and steel reinforcement have been inspected and approved by the NRCS representative. Reasonable notice shall be given to this person prior to the time of concrete placement. Such notice shall be far enough in advance to give adequate time to inspect the subgrade, forms, steel reinforcement, and other preparations for compliance with the specifications before the concrete is delivered for placing.

The concrete shall be deposited as closely as possible to its final position in the forms, and shall be worked into the corners and angles of the forms, and around all reinforcement and embedded items in a manner to prevent segregation of aggregates or excessive laitance. There shall be no excessive lateral movement of concrete by the use of a vibrator in either forms or slabs.

Slab concrete shall be placed to design thickness in one continuous layer. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Hoppers and chutes, concrete pumps, pipes, or "elephant trunks" shall be used when vertical drop is in excess of 5 feet to prevent splashing of mortar on the forms and reinforcing steel and to prevent segregation.

Immediately after the concrete is placed, it shall be consolidated by vibrating as necessary to ensure smooth surfaces and dense concrete. Each layer shall be consolidated to ensure monolithic bond with the preceding layer. If the surface of a layer of concrete in place sets to the degree that it will not flow and merge with the succeeding layer when vibrated, the placement of concrete will be discontinued and a construction joint will be made.

If placing is discontinued when an incomplete horizontal layer is in place, a vertical bulkhead shall form the unfinished end of the layer.

In reinforced concrete construction, new concrete shall not be placed until the hardened concrete has cured at least 12 hours.

In non-reinforced concrete construction, the 12-hour limit does not apply.

## 12. CONSTRUCTION JOINTS

Construction joints are stopping places in the process of construction. A true construction joint should bond new concrete to existing concrete and permit no movement. Because extra care is needed to make a true construction joint, they are usually designed and built to function as, and align with, contraction or isolation joints.

Construction joints are placed in a slab where concreting operations are concluded for the day, generally in conformity with a predetermined joint layout. If at any time, concreting is interrupted long enough for the placed concrete to harden, a construction joint must be used.

Construction joints shall be made at the locations shown on the drawings. If construction joints are needed that are not shown on the drawings, they shall be placed in locations and in a manner approved by the NRCS representative.

Construction joints on unformed surfaces shall have a rough surface.

Construction joints shall moist cured for seven (7) days or until the adjoining concrete is placed.

Surfaces of all construction joints shall be cleaned of all unsatisfactory concrete, laitance, coatings, or debris by washing and scrubbing with a wire brush or wire broom, or by other means approved by the NRCS representative. The surfaces shall be kept moist for at least one hour prior to placement of the new concrete if past initial curing period.

### 13. ISOLATION (EXPANSION) JOINTS

Isolation joints are often called expansion joints, because they are intended to isolate structural units that behave in different ways. They permit both horizontal and vertical differential movements at adjoining parts of a structure. They are used to isolate walls from floors, columns from floors, slabs from existing structures or slabs, and in other locations where restraint or transmission of secondary forces is not desired.

Isolation joints require the use of an expansion joint material, which can be as thin as ¼ inch, but ½-inch thick material is commonly used. Preformed expansion joint filler shall be bituminous, cork, or rubber.

Isolation joints shall be made only at locations shown or noted on the drawings.

Exposed concrete edges at isolation joints shall be carefully tooled or chamfered, and the joints shall be free of mortar and concrete. Joint filler shall be left exposed for its full length with clean true edges.

Preformed expansion joint filler shall be held firmly in the correct position as the concrete is placed.

Expansion joints are not required at 30-foot intervals. Only contraction (control) joints are to be used, unless the designer determines isolation joints are necessary.

### 14. CONTRACTION (CONTROL) JOINTS

Contraction joints are often called control joints, because they are intended to control crack location. Contraction (control) joints are purposely made planes of weakness and are designed to regulate cracking caused by drying and thermal shrinkage of the concrete.

The maximum spacing of contraction (control) joints in concrete slabs on ground shall be as specified in Section 5.

The panels shall be as square as possible, but with a maximum aspect ratio (length to width) of 1.5 to 1. Avoid "L" or "T" shaped panels. Add joint at re-entrant corners. Contraction (control) joints shall be made only at locations shown or noted on the drawings.

Contraction (control) joints are to be made to a depth of  $\frac{1}{4}$  the thickness of the slab.

Sawing is the most commonly used method to make contraction (control) joints.

Contraction (control) joints also can be formed in the fresh concrete with hand groovers or by placing strips of metal, or other suitable material at the joint location. The edges of these open joints shall be finished with an edging tool prior to removal of the joint strips.

#### 15. WATERSTOPS

Waterstops shall be held firmly in the correct position as the concrete is placed. Joints in metal waterstops shall be soldered, brazed, or welded. Joints in rubber or plastic waterstops shall be cemented, welded, or vulcanized as recommended by the manufacturer. Wall pours shall not be continuous past waterstops. Vertical waterstops shall be held firmly in place by a bulkhead attached to the wall forms.

#### 16. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then float finished.

Excessive floating or troweling of surface while the concrete is soft will not be permitted.

The addition of dry cement or water to the surface of the screeded concrete to expedite finishing will not be allowed.

Joints and edges on surfaces that will be exposed to view shall be chamfered or finished with molding tools.

#### 17. REMOVAL OF FORMS

Forms for walls and columns shall remain tight and in place for a minimum of 24 hours and a maximum of 48 hours after placing the concrete. Forms for slabs shall not be loosened or removed for at least 12 hours after placing concrete.

Forms, which support beams or covers, shall not be removed for at least 7 days, or as otherwise stated on the drawings. Forms for beams or covers, which are to support additional forms or shoring, shall not be removed for at least 14 days.

Removal of forms shall be done in a manner that will not damage the concrete surface nor induce sudden or excessive stresses.

#### 18. FINISHING FORMED SURFACES

Immediately after the removal of the forms, the surfaces shall be kept wet until all defects, holes, and other irregularities have been repaired.

All fins and irregular projections shall be removed from exposed surfaces.

Holes produced on all surfaces by the removal of form ties, cone-bolts, she-bolts, and other items shall be cleaned, wetted, and filled with a dry-pack mortar, consisting of one part Portland cement, three parts sand that will pass a No. 16 sieve, and sufficient water to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed. An NRCS representative prior to their use must approve other patching material and procedures.

#### 19. CONCRETE REPAIR

Concrete that is honey combed, damaged, or otherwise defective shall be repaired or removed and replaced.

The NRCS engineer or his or her representative will determine the required extent of removal, replacement, or repair. The plan for effecting the repair must be approved by the NRCS representative prior to the beginning of the repair work.

#### 20. CURING

Concrete shall be prevented from drying for a curing period of at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist for the entire period or until curing compound is applied as specified below. Sprinkling, flooding, fog spraying shall maintain moisture, or by covering with continuously moistened canvas, cloth mats, straw, sand, or other approved materials. Formed surfaces shall be thoroughly wetted immediately after forms are removed and shall be kept wet until patching and repairs are completed. Water or covering shall be applied in such a way that the concrete surface is not eroded or otherwise damaged.

Concrete, except at construction joints, may be coated with an approved curing compound in lieu of continued application of moisture. The compound shall be sprayed on the moist concrete surfaces, as soon as free water has disappeared but shall not be applied to any surface until patching, repairs, and finishing of that surface are completed. The compound shall be applied at a uniform rate of not less than one gallon per 150<sup>o</sup> square feet of surface, or at the manufacturer's recommendation, and shall form a continuous adherent membrane over the entire surface. Curing compound shall not be applied to surfaces requiring bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items. If the membrane is damaged during the concrete curing period, the damaged areas shall be resprayed at the rate of application specified above.

The use of white curing compound is strongly recommended.

#### 21. BACKFILLING NEW CONCRETE WALLS

Placement and compaction of fill adjacent to new concrete walls shall not begin less than 14 days after placement of concrete. Walls that can be backfilled on both sides simultaneously, may be backfilled after 7 days.

Heavy equipment shall not be allowed within 3 feet of a new concrete wall. Provide compaction near the wall by means of hand tamping or small, manually directed equipment. Vibrating equipment shall not be permitted.

## 22. CONCRETING IN COLD WEATHER

Cold weather concreting procedures shall be used for all concrete mixed and placed between November 1 and April 1, regardless of weather forecasts.

Cold weather concreting procedures may be required before November 1 and after April 1, when the atmospheric temperature is less than 40° at the time of placement or predicted to fall below 32° in the following 24 hours.

The contractor shall submit a written plan, detailing how the concrete is going to be protected from freezing and how the required temperatures of the concrete and adjacent air will be maintained. The written plan shall be approved by the NRCS engineer or his or her representative, prior to any work on the project, except earthwork.

Cold weather concreting requirements are:

a. Required concrete temperature:

Minimum mixing temperature	60° F
Minimum placing temperature	55° F
Maximum placing temperature	75° F
Minimum temperature of concrete in-place	55° F

(For the required curing period.)

b. When the cement is added to the mix, the temperature of the mixing water shall not exceed 140° F nor shall the temperature of the aggregate exceed 150° F.

c. The temperature of the adjacent air shall be maintained between 50° F and 90° F for a period of 7 days. The 7-day period starts at the time of concrete placement and continues for 7 consecutive days.

d. The concrete shall be immediately protected after placement by methods of covering, insulating, housing, or heating that will be sufficient to maintain the minimum temperature adjacent to the concrete surface.

e. At the end of the protection period, the concrete shall be allowed to cool gradually. The maximum decrease in temperature at the concrete surface in the first 24 hours shall not exceed 40° F.

The use of antifreeze compounds will not be allowed.

In the event that there is no plan or no cold weather provisions available, concrete placement will not be permitted.

## 23. CONCRETING IN HOT WEATHER

Concreting in hot weather shall be in accordance with the requirements set forth below.

For the purpose of this specification, hot weather is defined as any combination of the following conditions that may potentially impair the quality of freshly mixed or hardened concrete by

accelerating the rate of moisture loss and rate of cement hydration, or otherwise, resulting in detrimental results:

- \*\*\* High ambient temperature.
- \*\*\* High concrete temperature.
- \*\*\* Low relative humidity.
- \*\*\* Wind velocity.
- \*\*\* Solar radiation.

Whenever the above conditions exist or when climatic conditions are such that the temperature of the concrete may reasonably be expected to exceed 90° F at the time of delivery to the work site or during the placement operations, the following provisions shall apply:

a. The contractor shall maintain the temperature of the concrete below 90° F during mixing, conveying, and placing.

b. Exposed concrete surfaces which tend to dry or set too rapidly shall be continuously moistened by means of fog sprays or other means to maintain adequate moisture during the time between placement and finishing. Water shall not be sprinkled or added directly to the surface of the concrete prior to finishing.

c. Finishing of slabs and other exposed surfaces shall be started as soon as the condition of the concrete allows and shall be completed without delay. Water shall not be sprinkled or added to the surface of the concrete during the darbying, bull floating, or other finishing operations to facilitate finishing.

d. When any single or combination of conditions may result in very rapid setting or drying of the concrete, extreme conditions exist. For flatwork and slab construction, extreme conditions exist when the evaporation rate exceeds 0.2 lb/ft<sup>2</sup>/hr.

e. The engineer or his or her representative may (1) restrict placement to the most favorable time of the day, (2) restrict the depth of layers to ensure coverage of the previous layer, while it will still respond readily to vibration, (3) suspend placement until conditions improve, and (4) restrict the removal of forms, repair, and patching to small areas, which can be protected with curing compound immediately.

f. The evaporation rate for flatwork and slab construction may be determined by calculating the evaporation rate from a shallow cake pan, having a surface area of at least 1 square foot or by other methods approved by the engineer.

g. The contractor shall submit a written plan, detailing procedures of mixing, placing, protection, curing, and temperature monitoring during hot weather. The NRCS engineer or his or her representative prior to the ordering of the concrete shall approve the written plan.

#### 24. LOADING

This section deals with loads being applied to each structure after the construction has been approved.

Slabs – Do not drive on or load slabs before 14 days have elapsed after concrete placement, unless specified differently on the drawings.

Walls – Load shall not be applied to new concrete walls before 14 days have elapsed after concrete placement, unless specified differently on the drawings. Backfill is considered a load.

Columns and Beams – Load shall not be applied to new concrete columns before 28 days or when the concrete obtains a compressive strength of 4,000 psi; whichever comes first, unless specified differently on the drawings.

## 25. SAFETY CONCERNS

All work shall be conducted within applicable Federal, State, and local regulations. Utility locations, overhead obstacles, excavation safety, steel placement, impalement protection, and working with fresh concrete are of particular concern. Contractors shall have necessary safety equipment and procedures in place prior to commencement of construction.

## 26. ITEMS OF WORK AND CONSTRUCTION DETAILS

This section is to be used to add site specific details that are not covered under sections 1 through 25. This section would be on a separate page and attached to the specifications for the project.

