

NATURAL RESOURCES CONSERVATION SERVICE
CONSTRUCTION SPECIFICATION
North Dakota

REINFORCED CONCRETE
(Code 103)

1. SCOPE

The work shall consist of furnishing, forming, placing, finishing, and curing Portland cement concrete and furnishing and placing steel reinforcement as required to build the structures as shown on the drawings. Any materials or construction details contained within the design package supersede those of this construction specification.

2. LOCATION

Concrete and accompanying reinforcing steel shall be installed at the locations, and in the configurations, as shown on the drawings and staked in the field. Any deviation from the drawings requires approval from NRCS prior to installation.

3. QUALITY CONTROL

Quality Control of all materials and construction procedures is the responsibility of the producer and installer. NRCS will make periodic review(s) of work for the benefit of the agency which will include final construction inspection.

4. MATERIALS

Steel bars for concrete reinforcement shall be grade 40, 50, or 60 deformed bars as listed on the drawings, conforming to one of the following specifications:

- Deformed and plain billet-steel bars for concrete reinforcement, ASTM A615
- Rail-steel deformed bars for concrete reinforcement, ASTM A996
- Axle-steel deformed bars for concrete reinforcement, ASTM A996

Dowels shall be plain round bars conforming to the same specifications listed above for steel bars.

Fabricated deformed steel bar mats for concrete reinforcement shall conform to the requirements of ASTM A184.

Plain steel welded wire reinforcement for concrete reinforcement shall conform to the requirements of ASTM A497. Gauges, diameters, spacing, and arrangement of wires for the specified welded wire fabric shall be as defined for the specified style designation.

Epoxy-coated steel bars for concrete reinforcement shall conform to the requirements of ASTM A775.

Portland cement shall conform to the requirements of ASTM C150. If a type is not specified, Type I or Type IA shall be used.

Aggregates – Concrete aggregates shall conform to the requirements of ASTM C33. Where aggregates conforming to these specifications are not obtainable, a specialized mix design based on Portland Cement Association design guidelines may be utilized with approval from NRCS (additional testing may be required).

Fly ash shall conform to ASTM C618, Class C or F except the loss of ignition shall not exceed 3.0%.

Water – Water used in mixing shall be reasonably clean, free from objectionable quantities of sediment, organic matter, salts, acid, alkali, or other impurities.

Air entraining admixtures shall conform to the requirements of ASTM C260.

Plasticizing admixtures shall conform to the requirements of ASTM C1017.

Water reducing and/or retarding admixtures shall conform to ASTM C494, Type A, B, D, F, or G.

Accelerating (Type C) or water-reducing and accelerating admixtures (Type E), shall be non-corrosive and conform to ASTM C494.

Waterstops shall be non-metallic and conform to NRCS National Material Specification 537.

Preformed expansion joint filler shall conform to the requirements of the appropriate ASTM, as specified in the drawings or Items of Construction Detail.

Sealing compound for joints shall conform to ASTM C920.

Curing compound shall conform to ASTM C309 Type 2 Class A or B (white pigmented) or Type 1 D (clear with fugitive dye).

Storage of Materials – Steel reinforcement stored at the site of the work shall be stored above the ground surface on platforms, skids, or other supports and shall be protected from mechanical injury and corrosion. Cement and aggregate shall be stored at the site in such a manner as to prevent deterioration or intrusion of foreign matter. Damaged materials will be rejected and not permitted to be used in the work.

5. BENDING BAR REINFORCEMENT

Reinforcing bars may not be field milled or field bent unless specifically authorized by the NRCS. All bends shall be made in accordance with standard approved practice and by approved machine methods. All bends shall be made without heating. Bars with kinks, cracks, or improper bends will be rejected.

6. SPLICING BAR REINFORCEMENT

The length of splices of reinforcing bars shall be as shown on the drawings. When not shown on the drawings, the length of splices shall provide an overlap equal to at least 36 times the diameter of the smaller bar being spliced but not less than 12-inches.

7. SPLICING WELDED WIRE REINFORCEMENT

Unless otherwise specified, welded wire fabric shall be spliced in the following manner:

- Adjacent sections shall be spliced end to end (longitudinal lap) by overlapping a minimum of one full mesh plus 2 inches plus the length of the two end overhangs. The splice length is measured from the end of the longitudinal wires in one piece of fabric to the end of the longitudinal wires in the lapped piece of fabric.
- Adjacent sections shall be spliced side to side (transverse lap) a minimum of one full mesh plus 2 inches. The splice length shall be measured from the centerline of the first longitudinal wire in one piece of fabric to the centerline of the first longitudinal wire in the lapped piece of fabric.

8. SUPPORTING REINFORCEMENT

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. Holding steel reinforcement in position with temporary supports, tack welding of bars, and the direct driving of the reinforcement into the ground is not permitted.

Metal chairs, metal hangers, metal spacers, plastic chairs, or precast concrete chairs or blocks shall be used to support the reinforcement. Reinforcement shall not deflect or sag between supports. Metal hangers, spacers and ties shall be placed in such a manner that they will not be exposed in the finished concrete surface.

Precast concrete chairs shall be manufactured of the same class of concrete as that specified for the structure and shall have tie wires securely anchored in the chair or a V-shaped groove at least 3/4-inch in depth molded into the upper surface to receive the steel bar at the point of support. Precast concrete chairs shall be clean and moist at the time concrete is placed.

Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete. On structures exceeding 2 cubic yards in concrete volume, the subgrade and placement of the reinforcing material shall be inspected by NRCS prior to placing the concrete.

9. PLACING REINFORCEMENT

The following tolerances will be permitted in the placement of bars as shown on the drawings:

Variation in protective cover:

1/4 inch for 2-inch cover

1/2 inch for 3-inch cover

Variation of spacing:

1/12 of indicated spacing

Before reinforcement is placed, the surfaces of the bars and fabric and any metal supports shall be cleaned to remove any loose, flaky rust, mill scale, oil, grease or other coatings or foreign substances. After placement, the reinforcement shall be maintained in a clean condition until it is completely embedded in the concrete. On structures exceeding 2 cubic yards in concrete volume, the subgrade and placement of the reinforcing material shall be inspected by NRCS prior to placing the concrete.

10. PROPORTIONING THE CONCRETE MIX

Concrete shall be classified as shown below:

Class of Concrete	Maximum Net Water Content (gallons/bag)		Minimum Cement Content (bags/cubic yard)	
	Without Air Entrainment	With Air Entrainment	Without Strength Test	With Strength Test
3000	7	6	6	5
4000	6	5	6.5	6

Note: A bag of cement weighs 94 pounds.

Table 1

Concrete shall be composed of Portland cement, fine and coarse aggregates, water, and unless otherwise specified, an air-entraining admixture mixed in such proportions so as to produce the specified minimum compressive strength at the end of 28 days. Calcium chloride or other corrosive accelerators shall not be used unless otherwise specified. The maximum gallons of water per bag of cement and the minimum number of bags of cement per cubic yard of concrete for the specified class of concrete shall be as tabulated in Table 1. Maximum water to cement ratio shall be 0.5.

Concrete mixtures shall be designed to use a maximum size of coarse aggregate of 1-1/2 inches. The proportioning of cement, sand, and coarse aggregate shall produce a concrete mixture, neither too sandy nor too harsh, 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.

Fly ash may be used as a partial substitution for Portland cement in an amount not greater than 25 percent (by weight) of cement in the concrete mix. Ground granulated blast-furnace slag may be used as a partial substitution for Portland cement in amounts between 25 to 70 percent (by weight) of cement in the concrete mix unless otherwise specified.

Unless otherwise specified (or when superplasticized concrete is specified), the slump at the time of placement shall be 3 to 5 inches. Air content by volume shall be 5-7% of the volume of the concrete for maximum aggregate sizes of 3/8-in to 1-in or 4-6% for maximum aggregate sizes larger than 1-inch.

Superplasticized concrete shall be a mix containing either a water-reducing, high rate admixtures (ASTM C494 Type F or G) or a plasticizing admixture (ASTM C1017) at a dosage rate that reduces the quantity of water required to produce a concrete mix within the specified slump range by 12 percent or more.

11. DEVELOPMENT OF JOB MIX

Prior to placement of any concrete, NRCS shall be provided access to the proposed fine and coarse aggregate to be utilized in the mix, as well as a proposed mix design giving the proportions by dry weight of cement, aggregates, water and admixtures that they intend to use. If requested by NRCS, evidence shall be furnished that proves satisfactory to NRCS that the proportions selected will produce concrete of the quality specified. The materials and proportions so stated shall constitute the "job mix."

After a job mix has been approved, neither the source, character, grading of the aggregates nor the type or brand of cement or admixture shall be changed without prior notice to NRCS. If such changes are necessary, no concrete containing such new or altered materials shall be placed until NRCS has approved a revised job mix.

12. INSPECTION AND TESTING

NRCS shall have free entry to the plant and equipment furnishing concrete. Proper facilities shall be provided for NRCS to inspect materials, equipment, and processes and to obtain samples of the concrete. All tests and inspections will be conducted so as not to interfere unnecessarily with manufacture and delivery of the concrete.

If specified in the Items of Work below, standard tests of the compressive strength of the concrete will be made by the Installer from concrete test cylinders cast by NRCS in conformance with ASTM C31. The Installer shall provide cylinder molds and shall have the cylinders tested by an approved laboratory (the Installer bearing the costs of such testing).

One strength test shall consist of three standard cylinders made from a composite sample secured from a single load of concrete in accordance with ASTM C172 and tested at 28 days. The test results at 28 days shall be the average of the strength of three specimens determined in accordance with ASTM C39, except that if one specimen shows manifest evidence of improper sampling, molding, or testing, it shall be discarded and the strengths of the remaining two specimens shall be averaged. Should more than one specimen representing a test show such defects, the entire test shall be discarded.

One strength test, consisting of three test cylinders, shall be made for (1) each day's run or (2) for each 25 cubic yards of concrete placed, or fraction thereof. A record shall be made of the particular load of concrete tested, and the exact location in the work at which each load represented by a strength test is deposited. In the event that concrete tested in accordance with all requirements stated above fails to meet the strength requirements of these specifications, the **Installer** shall provide an acceptable new or adjusted mix.

13. HANDLING AND MEASUREMENT OF MATERIALS

Materials shall be stockpiled and batched by methods that will prevent segregation or contamination of aggregates and insure accurate proportioning of the ingredients of the mix.

Cement shall be measured by weight or in bags of 94 pounds each. When cement is measured in bags, no fraction of a bag shall be used unless weighed.

Aggregates shall be measured by weight. Mix proportions shall be based on saturated, surface-dry weights. The batch weight of each aggregate shall be the required saturated, surface-dry weight plus the weight of surface moisture it contains.

Water shall be measured, by volume or by weight, to accuracy within 1% of the total quantity of water required for the batch. Admixtures shall be measured within a limit of accuracy of 3%.

14. MIXERS AND MIXING

Concrete may be furnished by batch mixing at the site of the work or by ready-mix methods. Mixers shall be capable of thoroughly mixing the concrete ingredients into a uniform mass and of discharging the mix without segregation.

Concrete shall be uniform and thoroughly mixed when delivered to the work site. Variations in slump of more than 1 inch within a batch will be considered evidence of inadequate mixing and shall be corrected by changing batching procedures, increasing mixing time, changing mixers, or other means.

For stationary mixers, the mixing time after all cement and aggregates are in the mixer drum shall be not less than 1-1/2 minutes. When concrete is mixed in a truck mixer, the number of revolutions of the drum or blades at mixing speed shall be not less than 70 nor more than 100.

Unless otherwise specified, volumetric batching and continuous mixing at the construction site will be permitted. The batching and mixing equipment shall conform to the requirements of ASTM Specification C-685 and shall be demonstrated prior to placement of concrete, by tests with the job mix, to produce concrete meeting the specified proportioning and uniformity requirements. Concrete made by this method shall be produced, inspected, and certified in conformance with Sections 6, 7, 8, 13, and 14 of ASTM Specification C-685.

No mixing water in excess of the amount called for by the job mix shall be added to the concrete during mixing or hauling or after arrival at the delivery point.

When truck ready-mixed or truck-mixed concrete is used, the Installer shall submit to NRCS, with each mixer load, a certified delivery ticket giving the quantities of cement, fine aggregate, coarse aggregate, water, and admixtures, if any, contained in the batch and the time the cement was introduced to the aggregates.

15. FORMS

Forms shall be of wood, plywood, steel, or other approved material and shall be mortar tight. The forms and associated false-work shall be substantial, unyielding and shall be constructed so that 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. Forms shall be coated with a non-staining form release agent before being set into place.

Metal ties or anchorages within the forms shall be equipped with cones, she-bolts or other devices that permit their removal to a depth of at least 1 inch without injury to the concrete. Ties designed to break off below the surface of the concrete shall not be used without cones.

All edges that will be exposed to view when the structure is completed shall be chamfered, unless finished with molding tools.

16. PREPARATION OF FORMS AND 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. The temperature of all surfaces to be in contact with the new concrete shall be no colder than 40 degrees Fahrenheit. 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 air-water cutting, wet sandblasting or wire brush scrubbing, as necessary, and shall be wetted immediately prior to placement of concrete. Earth surfaces shall be firm and damp. Placement of concrete on mud, dried earth or un-compacted fill or frozen subgrade will not be permitted.

Items to be embedded in the concrete shall be positioned accurately and anchored firmly. Weep holes in walls or slabs shall be formed with non-ferrous materials.

17. CONVEYING

Concrete shall be delivered to the site and discharged into the forms within 1-1/2 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 degrees Fahrenheit or above, the time between the introduction of the cement to the aggregates and discharge shall not exceed 45 minutes.

NRCS may allow a longer time, provided the setting time of the concrete is increased a corresponding amount by the addition of an approved set-retarding admixture. In any case, 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.

18. PLACING AND CURING TEMPERATURES

Concrete shall not be placed until the subgrade; forms and steel reinforcement have been inspected and approved by the NRCS. The Installer shall give a minimum of 2 business days to the NRCS each time he or she intends to place concrete.

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. Formed concrete shall be placed in horizontal layers not more than 20 inches thick. Concrete shall not be dropped more than 5 feet vertically unless suitable equipment is used to prevent segregation. Hoppers and chutes, pipes or "elephant trunks" shall be used as necessary to prevent segregation and the splashing of mortar on the forms and reinforcing steel above the layer being placed.

Immediately after the concrete is placed in the forms, it shall be consolidated by spading, hand tamping or vibration as necessary to insure smooth surfaces and dense concrete. Each layer shall be consolidated to insure a 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 spaded or vibrated, the Installer shall discontinue placing concrete and shall make a construction joint according to the procedure specified herein.

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

19. CONSTRUCTION JOINTS

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

Where a feather edge would be produced at a construction joint, as in the top surface of a sloping wall, an insert form shall be used so that the resulting edge thickness on either side of the joint is not less than 3 inches.

In walls and columns, as each lift is completed, the top surfaces shall be immediately and carefully protected from any condition that might adversely affect the hardening of the concrete.

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. New concrete shall not be placed until the hardened concrete has cured at least 12 hours.

Surfaces of 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 NRCS. The surfaces shall be kept moist for at least 1 hour prior to placement of the new concrete.

20. EXPANSION AND CONTRACTION

Expansion and contraction joints shall be made only at locations shown on the drawings.

Exposed concrete edges at expansion and contraction 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 and true edges.

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

When open joints are specified, they shall be constructed by the insertion and subsequent removal of a wooden strip, metal plate or other suitable template in such a manner that the corners of the concrete will not be chipped or broken. The edges of open joints shall be finished with an edging tool prior to removal of the joint strips.

21. 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.

22. REMOVAL OF FORMS

Forms shall be removed in such a way as to prevent damage to the concrete. Supports shall be removed in a manner that will permit the concrete to take the stresses due to its own weight uniformly and gradually.

Forms shall not be removed sooner than the following minimum times after the concrete is placed. These periods represent cumulative number of days and fractions of days, not necessarily consecutive, during which the temperature of the air adjacent to the concrete is above 50 degrees Fahrenheit.

Forms		Time ^{1/}
Sides of slabs or beams		12 hours
Undersides of slabs or beams	Clear span	^{2/}
	< 10 ft	4 days
	10 - 20 ft	7 days
	> 20 ft	14 days
Sides of walls or columns	Height above form	^{3/ 4/}
	< 10 ft	12 hours
	< 20 ft	24 hours
	> 20 ft	72 hours

1/ Table values apply to normal concrete. Values for concrete that contains cements or admixtures that significantly retard or accelerate strength gain will be determined by the engineer and based on actual design mix data.

2/ Values apply to members designed to support significant superimposed loads. Values for members designed for only self weight when placed in service shall be 50 percent greater.

3/ Values apply to members not subject to significant horizontal loads. Additional time or rebracing is needed for members subject to significant wind or other horizontal loads.

4/ Subsequent higher lifts may be placed after 12 hours.

23. FINISHING FORMED SURFACES

All concrete surfaces shall be true and even and shall be free from open or rough spaces, depressions or projections. Immediately after the removal of the forms:

- All fins and irregular projections shall be removed from exposed surfaces.
- The holes produced on all surfaces by the removal of form ties, cone-bolts, and she-bolts 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 just sufficient water to produce a consistency such that the filling is at the point of becoming rubbery when the material is solidly packed.

24. FINISHING UNFORMED SURFACES

All exposed surfaces of the concrete shall be accurately screeded to grade and then wood or magnesium float finished, unless specified otherwise.

Excessive floating or troweling of surfaces 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 unformed surfaces that will be exposed to view shall be chamfered or finished with molding tools.

25. 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.

Moisture shall be maintained by sprinkling, flooding or fog spraying or by covering with continuously moistened canvas, cloth mats, straw, sand or other approved material. Wood forms left in place during the curing period shall be kept continuously wet. 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 except as otherwise specified in the special provisions. 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 1 gallon per 175 square feet of surface and shall form a continuous adherent membrane over the entire surface. Curing compound shall be thoroughly mixed before applying and continuously agitated during application. Curing compound shall not be applied to surfaces requiring a bond to subsequently placed concrete, such as construction joints, shear plates, reinforcing steel and other embedded items. If the membrane is damaged during the curing period, the damaged area shall be re-sprayed at the rate of application specified above. Surfaces covered by the membrane shall not be trafficked unless protected from wear.

26. REMOVAL AND REPLACEMENT OR REPAIR

When concrete is honeycombed, damaged or otherwise defective, the Installer shall remove and replace the structure or structural member containing the defective concrete or, where feasible, correct or repair the defective parts. NRCS will determine the required extent of removal, replacement or repair.

27. CONCRETING IN COLD WEATHER

Methods for concreting in cold weather shall be performed when, for more than 3 consecutive days, the following conditions exist:

- The average daily air temperature at the job site is less than 40 degrees Fahrenheit. (The average daily air temperature is the average of the highest and lowest temperatures occurring during the period from midnight to midnight.)
- The air temperature at the job site is not more than 50 degrees Fahrenheit for more than half of any 24-hour period.

Concrete shall be protected against freezing during the first 24 hours after placement whether or not the average weather conditions specified above for cold weather concreting exist. The following provisions also shall apply unless otherwise specified:

- a. When the cement is added to the mix, the temperature of the mixing water shall not exceed 140 degrees Fahrenheit nor shall the temperature of the aggregate exceed 150 F.
- b. The temperature of the concrete at the time of placing shall be within the placement temperature range shown below, unless otherwise specified.

Least dimension of section, inches	Placement temperature, °F
Less than 12	55 – 75
12 to 36	50 – 70
36 to 72	45 – 65
Greater than 72	40 – 60

- c. The minimum temperature of the concrete for the first 72 hours after placement shall not be less than the minimum temperature shown above. Concrete structures shall be immediately protected after concrete placement by covering, housing, insulating, or heating concrete structures sufficiently to maintain the minimum temperature adjacent to the concrete surface. If the minimum temperature requirements are not met and the concrete did not freeze, the protection time will be extended a period equal to twice the number of hours the temperature was below the minimum temperature.
- d. Exhaust flue gases from combustion heaters shall be vented to the outside of the enclosure. The heat from heaters and ducts shall be directed in such a manner as to not overheat or dry the concrete in localized areas or to dry the exposed concrete surface.
- e. At the end of the protection period, the concrete shall be allowed to cool gradually. The maximum decrease at the concrete surface in a 24-hour period shall not exceed 40 degrees Fahrenheit.

28. CONCRETING IN HOT WEATHER

The Installer shall apply effective means to maintain the temperature of the concrete below 90 degrees Fahrenheit during mixing, conveying and placing.

Formed surfaces shall be kept completely and continuously wet for the duration of curing period (prior to, during and after form removal) or until curing compound is applied.

Concrete surfaces, especially flat work placed with large areas of surface, shall be covered as soon as the concrete has sufficiently hardened and shall be kept continuously wet for at least 24 hours of the curing period. This protective method may be continued for the required curing period or until curing compound is applied.

Moist curing may be discontinued before the end of the curing period if white pigmented curing compound is applied immediately, in accordance with the procedures specified in **Section 29 – Items of Construction Detail**.

29. ITEMS OF CONSTRUCTION DETAIL

Items of work to be performed in accordance with this specification and construction details are:

a)