

CONSTRUCTION SPECIFICATION

MI-158. REINFORCED CONCRETE

1. SCOPE

This specification covers steel reinforced concrete construction. Construction work covered by this specification shall not be performed unless the anticipated atmospheric daily low temperature is 40° F (4° C) or higher for a minimum of three days after placement unless the site conditions and/or the construction methods to be used have been reviewed and approved in writing by the NRCS engineer or their designated representative.

2. PREPARATION OF FORMS AND SUBGRADE

Unless otherwise indicated on the construction drawings, concrete shall be placed on a smoothly graded soil or sand subgrade compacted, as necessary, to a uniform density throughout. Over-excavation shall be corrected by a procedure approved by the NRCS inspector.

Concrete shall not be placed until the subgrade, forms, and steel reinforcement have been inspected and approved by the NRCS inspector. The inspector shall be notified far enough in advance to provide time for the inspection.

Prior to placement of concrete, the forms and subgrade shall be free of wood chips, sawdust, debris, standing water, ice, snow, extraneous oil, mortar, or other harmful substances or coatings.

Surfaces against which concrete is to be placed shall be firm and damp. Placement of concrete on plastic, mud, dried earth, or uncompacted fill or frozen subgrade will not be permitted.

3. FORMS

Forms shall be of wood, plywood, steel, or other approved material and shall be mortar tight. The forms and associated falsework shall be substantial and unyielding and shall be constructed so that the finished concrete will conform to the specified dimensions and contours. Form release agents appropriate for the form materials and concrete admixtures shall be used.

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

Tolerance on formed concrete is $\pm 3/8$ inch (± 10 mm). Tolerance on concrete formed in earth is -1 inch to +6 inches (-25 mm to +150 mm).

4. CONCRETE MIX

When ready-mixed concrete is furnished, the Contractor shall furnish the NRCS inspector a statement-of-delivery ticket showing the time of loading, the revolution counter reading at the time of loading, and the quantities of materials used for each load of concrete. The quantities of materials shall include mixing water and estimated free water in the aggregates.

Portland cement shall be Type I, IA, II, or IIA (Type IA is preferred). If Type IA or IIA cement is used, additional air entrainment admixture shall be the same type used in the cement. Cement that is partially hydrated (hardened), or otherwise damaged, shall not be used. Pozzolan (fly ash) meeting the requirements of ASTM C 618, Class F or C, may be used. Cement may be replaced with fly ash in quantities of up to 20 percent by weight of the total required cement.

Air entrainment shall be 4 to 7 percent.

Aggregates shall consist of clean, hard, strong, and durable particles that are free of silt, clay, or any other material that may affect bonding of the cement paste.

Fine aggregate shall meet the requirements of ASTM C 33 fine aggregate or Michigan Department of Transportation Aggregate Number 2NS. Coarse aggregate shall meet the requirements of ASTM C 33, size numbers 57 or 67 or Michigan Department of Transportation Michigan Series and Classes 6A or 17A.

Water shall be clean and free of injurious amounts of oil, salt, acid, alkali, organic matter, or other deleterious substances. Aggregate moisture shall be included in water quantity calculations. The water-cement ratio shall be 0.49 or less.

Water reducing admixtures conforming to ASTM C 494, Types A, D, F, or G may be used. Types D or G may be used at the discretion of the contractor/supplier when the air temperature is over 80° F (27° C).

Concrete for structures shall have a minimum 28-day compressive strength of 3,500 psi (24 MPa) or be as shown on the drawings. In lieu of strength tests, a mix containing the following per cubic yard (cubic meter) may be accepted:

Mix Number	Min. Cement lb./bags (kg)	Fly Ash lb.(kg)	Max. Water lb./gal.(kg)
1	564/6 (335)	0(0)	275/33(163)
2	470/5 (279)	90(54)	259/31(154)

The slump of the concrete without water reducers shall be 3 to 5 inches (75 to 125 mm). Maximum slump of concrete prior to adding high range water reducers shall be 2 1/2 inches (65 mm). Maximum slump after adding high range water reducers shall be 6 1/2 inches (165 mm).

5. MIXING AND PLACING CONCRETE

Concrete shall be uniform and thoroughly mixed when delivered to the job sites.

Concrete shall be discharged into the forms, vibrated, and spaded within 90 minutes after the cement has been introduced into the aggregates. When air temperatures are above 85°F (29°C), this time must be reduced to 45 minutes. The inspector may allow a longer time if an approved set retarding admixture is used.

Concrete shall be deposited as close as possible to its final position. Concrete without Type F or G water reducers shall not be allowed to drop more than 5 feet (1.5 m) from a chute or “elephant trunk.” Concrete with Type F or G water reducers shall not be allowed to drop more than 10 feet (3.0 m) from the chute or “elephant trunk.” Concrete shall not be allowed to flow laterally more than 8 feet (2.5 m).

If concrete must be dropped more than allowed above, hoppers and chutes, “elephant trunks,” etc. shall be used to prevent segregation.

If concrete must be moved laterally more than 8 feet (2.5 m), it shall be moved by shoveling, chutes, conveyors, wheelbarrows, or similar equipment.

Immediately after placement, concrete shall be consolidated by spading and vibrating or spading and hand tamping. It shall be worked into corners and angles of the forms and around all reinforcement and embedded items in a manner which prevents segregation or the formation of "honeycomb." Excessive vibration which results in segregation of materials will not be allowed. Vibration shall not be used to make concrete flow in the forms.

Concrete in slabs shall be placed at design thickness in one layer, but walls should be placed in essentially horizontal layers not more than 24 inches (0.6 m) high. Successive layers shall be placed and consolidated fast enough to ensure a good bond between layers and to prevent "cold joints."

If the surface of a layer in place will develop its initial set before more concrete is placed on it, a construction joint (of the type shown in the plan) shall be made.

Concrete surfaces shall be smooth and even. Careful screeding (striking-off) and/or wood or magnesium float finishing are required. If an impervious, protective coating will be applied to the surface of the concrete, follow the coating manufacturer's recommendations for surface preparation.

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

6. REINFORCING STEEL

Reinforcing steel shall be deformed bars manufactured specifically for concrete reinforcement and shall be a minimum of Grade 40 (300 MPa) or as shown on the drawings (more details can be found in ASTM-A-615, A-616, or A-617).

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

Reinforcement shall be accurately placed and secured in position in a manner that will prevent its displacement during the placement of concrete. This shall be accomplished by tying reinforcing steel or special tie bars to the form "snap ties" or by other methods of tying. No welding of either stress steel or temperature and shrinkage steel will be permitted. Reinforcing steel shall not be heated to facilitate bending.

In slabs, steel shall be supported by precast concrete bricks (not clay bricks), corrosion resistant metal chairs, or plastic chairs.

The following tolerances will be allowed in the placement of reinforcing bars.

- a. Where 1.5 inches (38 mm) clear distance is shown between reinforcing bars and forms, allowable clear distance is 1 1/8 to 1 1/2 inches (28 to 38 mm).
- b. Where 2 inches (50 mm) clear distance is shown between reinforcing bars and forms, allowable clear distance is 1 5/8 to 2 inches (40 to 50 mm).
- c. Where 3 inches (75 mm) clear distance is shown between reinforcing bars and earth or forms, allowable clear distance is 2 1/2 to 3 inches (63 to 76 mm). Overexcavation backfilled with concrete shall not count toward clear distance.
- d. Maximum variation from indicated reinforcing bar spacing: 1/12th of indicated spacing, but no reduction in amount of bars specified.

Unless otherwise indicated on the drawings, splices of reinforcing bars shall provide a lap of not less than 30 diameters of the smaller bar but not less than 12 inches (300 mm). Bars will not be spliced by welding. Welded wire fabric shall be lapped at least one mesh width.

The ends of all reinforcing bars shall be covered with at least 1 1/2 inches (38 mm) of concrete.

7. CURING

Concrete shall be prevented from drying for at least 7 days after it is placed. Exposed surfaces shall be kept continuously moist during this period by covering with moistened canvas, burlap, straw, sand, or other approved material, unless they are sprayed with a curing compound or covered with a 4 mil (0.1 mm) or thicker polyethylene. Forms left in place during the curing period shall be kept wet.

If an impervious, protective coating will be applied to the surface of the concrete, follow the coating manufacturer's recommendation for concrete curing beyond the 7 days required above. Other concrete, except at construction joints, may be coated with a curing compound in lieu of continued application of moisture. The compound shall be sprayed on 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.

Curing compound shall be applied in a uniform layer over all surfaces requiring protection at a rate of not less than 1 gallon per 150 square feet (0.27 l/m²) of surface or to manufacturer's recommendation, whichever is greater.

8. FORM REMOVAL AND CONCRETE REPAIR

Forms for structure walls shall not be removed until 24 hours or more after concrete placement. When forms are removed in less than 7 days, the concrete shall be sprayed with a curing compound or be kept wet continuously by methods allowed in Section 7 of this specification.

Forms shall be removed in such a way as to prevent damage to the concrete. Forms shall be removed before walls are backfilled.

Form ties shall be removed flush with or below the concrete surface for structures which are not required to be liquid tight.

Form ties shall be removed to a minimum depth of 1/2 inch (12 mm) for structures which are to be liquid tight. In lieu of this requirement for waste storage tanks, an asphalt type sealer may be put on the entire wall surface.

All cavities resulting from form tie removal shall be patched with dry-pack mortar.

Where areas of the concrete surface are "honeycombed," damaged, or otherwise defective, it shall be removed, the area wetted, and then filled with a dry-pack mortar. Damaged or defective concrete shall be removed and/or repaired so as to retain structural integrity of the member. Dry-pack mortar shall consist of one part Portland cement and three parts sand, with just enough water to produce a workable consistency.

9. CONCRETING IN COLD WEATHER

Concrete shall not be mixed nor placed when the daily atmospheric low temperature is less than 40°F (4°C) unless facilities are provided to prevent the concrete from freezing.

Facilities for cold weather concreting shall consist of:

- a. Use of warm concrete with temperatures from 55° to 65°F (13° to 18°C).
- b. Adequate protection from the weather, including the use of artificial heat, to prevent the temperature of the concrete from falling below 50°F (10°C) for a period of 3 days, and the relative humidity of the air near the concrete from falling below 40 percent.
- c. Accelerators such as calcium chloride may not be used to speed the hardening of concrete. Use of Type III cement is allowed as part of a cold weather concreting plan.
- d. The contractor shall furnish to NRCS for approval, a written plan that shows how the contractor will meet the requirements of this specification. The plan must also show how the requirements of ACI Specification 306 will be met.

10. CONCRETING IN HOT WEATHER

Hot weather precautions should be taken when air temperatures are at or above 85°F (29°C).

Concrete temperature shall be less than 90°F (32°C) during mixing, conveying, and placing.

11. BACKFILLING NEW CONCRETE WALLS

Heavy equipment may not be operated within 3 feet (1 m) of the new concrete wall.

Compaction within 3 feet (0.9 m) of the wall will be by means of hand tamping or small hand-held tamping or vibrating equipment.

Backfilling and compaction of fill adjacent to new concrete walls shall not begin in less than 10 days after placement of the concrete or until the concrete strength at the site has been tested to be at least 2600 psi (18 MPa). Backfill material shall be the type indicated on the drawings and shall be free of large stones or debris.