

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 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.

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, 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. Form ties may be metal, plastic or fiberglass.

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

Tolerance on formed concrete is $\pm 3/8$ inch. Tolerance on concrete formed in earth is -1 inch to +6 inches.

4. REINFORCING STEEL

Reinforcing steel shall be deformed bars manufactured specifically for concrete reinforcement and shall be a minimum of Grade 40 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 to prevent its displacement during the placement of concrete. Holding steel reinforcement in position with temporary supports is not permitted. Tack welding of bars is not permitted. Reinforcing steel shall not be heated to facilitate bending.

In structural members, metal chairs, metal hangers, metal spacers, high density or structural plastic rebar accessories or concrete bricks (not clay bricks) may be used to support reinforcing steel. Metal hangers, spacers, and ties shall be placed in such a

manner that they are not exposed in the finished concrete surface. The legs of metal chairs or side form spacers that may be exposed on any face of slabs, walls, beams, or other concrete surfaces shall be stainless steel or shall have a protective coating or finish. The coating or finish can be hot dip galvanizing, epoxy coating, or plastic coating. Metal chairs and spacers not stainless steel or fully covered by a protective coating or finish shall have a minimum cover of 0.75 inch of concrete over the unprotected metal part. The exception is that those with plastic coatings may have a minimum cover of 0.5 inch of concrete over the unprotected metal part. Precast concrete chairs shall be clean and moist at the time concrete is placed.

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

Reinforcing steel shall not be placed until the prepared site has been inspected and approved by the NRCS inspector. After placement of the reinforcement, concrete shall not be placed until the reinforcement has been inspected and approved by the NRCS inspector.

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

- a. Where 1 1/2 inches clear distance is shown between reinforcing bars and forms, allowable clear distance is 1 1/8 to 1 1/2 inches.
- b. Where 2 inches clear distance is shown between reinforcing bars and forms, allowable clear distance is 1 5/8 to 2 inches.
- c. Where 3 inches clear distance is shown between reinforcing bars and earth or forms, allowable clear distance is 2 1/2 to 3 inches. 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.
- e. The ends of all reinforcing bars shall be covered with at least 1 1/2 inches of concrete.

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. Bars will not be spliced by welding. Welded wire fabric shall be lapped at least one mesh width.

5. CONCRETE MIX

When ready-mixed concrete is furnished, the Contractor shall furnish the NRCS inspector a batch ticket showing the time of loading and the total quantities of materials used for each load of concrete. The quantities of materials shall include mixing water and estimated free water in the aggregates. **Any concrete load delivered without a batch ticket containing the above information will be rejected by the contractor.**

Portland cement shall be Type I or II (Type I is preferred). Type III cement may be used as part of a cold weather concreting plan. Cement that is partially hydrated (hardened), or otherwise damaged, shall not be used. Except during cold weather, 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 25% by weight of the total required cement. Except during cold weather, ground granulated blast-furnace slag may be used as a substitution for Portland cement in amounts between 25 and 70 percent by weight of total required cement. Cementitious materials shall be within $\pm 1\%$ of the design mix weight.

Concrete not protected from moisture and freezing during its design life shall be air entrained at 4 to 7 percent. Concrete protected from moisture by an impervious material or cover, or from freezing during its design life may be air entrained at 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. Aggregate weights shown on the batch ticket shall be within $\pm 2\%$ of the design mix weight. 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.

The water-cement ratio (W/C Ratio) shall be 0.50 or less. 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.

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 70° F.

The slump of the concrete without water reducers shall be 3 to 5 inches. Maximum slump of concrete prior to adding Type A or D water reducers shall be 4 inches. Maximum slump after adding Type A or D water reducers shall be 6 ½ inches. Maximum slump of concrete prior to adding Type F or G (high range) water reducers shall be 2 ½ inches. Maximum slump after adding Type F or G water reducers shall be 7 ½ inches.

Where design concrete strength shown on the drawings is 3500 psi or less, a mix containing the materials and properties referenced above, and the following cementitious material and water quantities, may be accepted without strength tests:

Option	Min. Cementitious Material lb./cu. yd..	Max. W/C Ratio (Water Amounts) lb./cu.yd.
1	564	0.50
2	517	0.45

Where the design concrete strength is greater than 3500 psi or where the cementitious material quantities are less than shown above in options 1 or 2, strength tests shall show a minimum 28-day compressive strength of 3,500 psi or the minimum compressive strength shown on the drawings, as appropriate. Compressive strength tests shall be performed not less than once each day concrete is placed, nor less than once for each 150 cubic yards of concrete placed, nor less than once for each 5000 sq. ft. of surface area of slabs and walls.

6. MIXING AND PLACING CONCRETE

Concrete shall be uniform and thoroughly mixed when delivered to the job site. Revolving drum truck mixers shall have the capability of mixing the quantity of concrete delivered. Trucks shall deliver a maximum load no greater than the truck manufacturer's recommendation for truck-mixed concrete or 63% of the gross volume of the drum, whichever is less.

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. Water to compensate for up to a 1-inch loss in slump (up to 1 gallon/cu. yd.) may be added, not to exceed the design maximum water/cement ratio. Withholding some of the mixing water until the concrete arrives on the job, then adding the remaining water and turning the mixer 30 revolutions at mixing speed is allowed.

When adding admixtures on the job, the mixer shall be turned a minimum of 30 revolutions at mixing speed before discharge of the concrete.

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.

Concrete shall be discharged into the forms, vibrated and spaded within 90 minutes after the cementitious materials have been introduced into the aggregates. When air temperatures are above 85°F, this time is 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 from a chute or "elephant trunk". Concrete with Type F or G water reducers shall not be allowed to drop more than 12 feet from the chute or "elephant trunk". If concrete must be dropped more than allowed above, hoppers and chutes, "elephant trunks", etc., shall be used to prevent segregation.

Concrete shall not be allowed to flow laterally more than 8 feet . If concrete must be moved laterally more than 8 feet, it shall be moved by shoveling, chutes, conveyors, wheelbarrows or similar equipment.

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 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.

Immediately after placement, concrete shall be consolidated by spading and vibrating, or spading and hand tamping. Wall concrete shall be consolidated with internal type mechanical vibrators. Concrete 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". Vibration shall not be used to make concrete flow in the forms.

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, the coating manufacturer's recommendations for surface preparation shall be followed.

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

7. 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 8 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. Form ties removed to a depth of 1/2 inch or greater shall be patched with dry-pack mortar. Dry-pack mortar

shall consist of one part Portland cement and three parts sand, with just enough water to produce a workable consistency.

Where areas of the concrete surface is "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.

8. 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 flooding, misting, 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 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 of surface or to manufacturer's recommendation.

9. CONCRETING IN COLD WEATHER

Concrete shall not be mixed nor placed when the daily atmospheric low temperature is less than 40°F unless facilities are provided to prevent the concrete from freezing. The contractor shall furnish to NRCS, for approval, a written plan that shows how the contractor will meet the requirements of this specification.

Minimum requirements for cold weather concreting shall consist of:

- a. Use of warm concrete with temperatures from 55° to 65°F.
- b. Adequate protection from the weather, including, if needed, the use of artificial heat, to prevent the temperature of the concrete from falling below 50°F for a period of 3 days when using type I cement and 2 days when using a set accelerator or type III cement. Alternatively, adequate protection from the weather, including the use of artificial heat, if needed, to prevent the temperature of the concrete from falling below 40°F for a period of 6 days when using type I cement and 4 days when using a set accelerator or type III cement.
- c. Chloride accelerators such as calcium chloride may not be used to speed the hardening of concrete. Type III cement and non-chloride accelerators are allowed as part of a cold weather concreting plan. Fly ash and ground granulated blast-furnace slag may not be used in cold weather concrete.
- d. Where reinforced concrete structures will be loaded such as in backfilling walls or supporting heavy equipment, the load shall not be applied until the concrete has been tested to have at least 75% of its design strength. Test cylinders left on site until testing will be used to determine concrete strength.

10. CONCRETING IN HOT WEATHER

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

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

11. LOADING NEW REINFORCED CONCRETE STRUCTURES

Heavy equipment may not be operated within 3 feet of the new concrete wall.

Compaction within 3 feet 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 where the concrete temperature has been maintained at 50°F or higher or until the concrete has been tested to have at least 75% of its design strength. Test cylinders left on site until testing will be used to determine concrete strength. Backfill material shall be the type indicated on the drawings and shall be free of large stones or debris.

Heavy equipment traffic or other loads may not be applied to a new slab until the concrete has attained at least 65% of its design strength. Test cylinders left on site until testing may be used to determine concrete strength.

Concrete may be assumed to have attained at least 65% of its design strength when:

- 1) Concrete temperature has been maintained at 50°F or higher for a minimum of 7 days after placement, or
- 2) The concrete temperature has been maintained at less than 50°F, but above 32°F for 14 days after placement.