CONSTRUCTION SPECIFICATION

MI-158. REINFORCED CONCRETE

1. SCOPE

This specification covers steel reinforced concrete construction. This specification only covers construction performed when the anticipated daily low air temperature is 40°F or higher for at least 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

Place concrete on a smoothly graded soil or sand subgrade well compacted, to a uniform density throughout, unless otherwise indicated on the construction drawings. Correct over-excavation with a procedure approved by the NRCS inspector.

Ensure forms and subgrade are free of wood chips, sawdust, debris, standing water, ice, snow, extraneous form release agent, mortar, or other harmful substances or coatings prior to the placement of concrete.

Place concrete on firm and damp surfaces. Placement of concrete on plastic, mud, dried earth, uncompacted fill or frozen subgrade will not be permitted.

3. FORMS

Use forms of wood, plywood, steel or other mortar tight approved material. If using constructed forms, fabricate substantial and unyielding forms so that finished concrete will conform to the specified dimensions and contours. Use form release agents appropriate for the form materials and concrete admixtures. Apply form release agents prior to putting the forms up. Form ties may be metal, plastic or fiberglass.

Embed items in the concrete accurately and anchor firmly.

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

4. REINFORCING STEEL

Use deformed bars manufactured specifically for concrete reinforcement meeting a minimum of Grade 60 or as shown on the drawings (more details can be found in ASTM A615 or ASTM A996).

Use reinforcing bars that are free from loose rust, concrete, oil, grease, paint or other deleterious coatings.

Accurately place and secure reinforcing bars in position to prevent displacement during the placement of concrete. Holding reinforcing bars in position with temporary supports is not permitted. Tack welding of reinforcing bars is not permitted. Heating of reinforcing bars to facilitate bending is not permitted.

In structural members, metal chairs, metal hangers, metal spacers, high density or structural plastic rebar accessories or precast concrete bricks (not clay bricks) may be used to support reinforcing steel. Place metal hangers, spacers, and ties in such a manner that they are not exposed in the finished concrete surface. Use stainless steel or a protective coating or finish on the legs of metal chairs or side of form spacers that may be exposed on
any face of slabs, walls, beams, or other concrete surfaces. The coating or finish can be hot
dip galvanizing, epoxy coating, or plastic coating. Use a minimum cover of 0.75 inch of
cement over the unprotected metal part of metal chairs and spacers not stainless steel or
fully covered by a protective coating or finish. The exception is that those with plastic
coatings may have a minimum cover of 0.5 inch of concrete over the unprotected metal
part. Ensure precast concrete chairs are clean and moist at the time concrete is placed.

In slabs, support reinforcing steel by precast concrete bricks (not clay bricks), metal chairs
or plastic chairs. Metal chairs in direct contact with the subgrade must have a coating or
finish (ex. hot dipped galvanizing, epoxy coating, or plastic coating). Minimum cover is
as listed for structural members.

Do not place any reinforcing steel until the prepared site has been inspected and approved
by the NRCS inspector. Do not place any concrete until the reinforcing steel is 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. Over-excavation backfilled with
   concrete will 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. Minimum cover for ends of all reinforcing bars is 1 1/2 inches of concrete.

Unless otherwise indicated on the drawings, provide lap splices of reinforcing bars of not
less than 30 diameters of the smaller bar and 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

Provide the NRCS inspector a batch ticket showing the following information as a
minimum:
- name of redi-mix company;
- date;
- truck number;
- name and location of job;
- amount of concrete in cubic yards;
- time of loading;
- type, brand, and amount of cement;
- grade or class and amount of pozzolan if applicable;
- type, brand, and amount of admixtures;
- Michigan Department of Transportation (MDOT) type and amount of aggregates;
- free water of all aggregates;
- amount of batch water;
- water to cement ratio;
- signature or initials of concrete producer or producer’s representative.

Any concrete load delivered without a batch ticket containing the above information
is to be rejected by the contractor or landowner.
Use of Type I or II (Type II is preferred) Portland cement meeting the requirements of ASTM C150 is required. Type III cement may be used as part of a cold weather concreting plan. The use of cement that is partially hydrated (hardened), or otherwise damaged, is not permitted. Fly ash meeting the requirements of ASTM C618 (Class F or C) may replace cement in quantities ranging from 15-25 percent by weight of the total required cementitious materials. Ground blast furnace slag meeting the requirements of ASTM C989 may replace cement in quantities ranging from 30-50 percent by weight of total required cementitious materials. Silica fume meeting the requirements of ASTM C1240 may replace cement in quantities ranging from 5-10 percent by weight of total required cementitious materials. Cementitious materials shall be within ± 1% of the mix design weight.

Air entrainment is required for concrete exposed to freeze-thaw cycles and in contact with the ground or frequent exposure to moisture. For a maximum aggregate size of 3/8 inch to 1 inch the allowable air content at the time of placement is 5-7%. For a maximum aggregate size of over 1 inch, the allowable air content at the time of placement is 4-6%. Concrete protected from moisture by an impervious material or cover, or from freezing during its design life may have a total air content as specified above based on maximum aggregate size.

Aggregates are required to be clean, hard, strong and durable particles that are free of silt, clay or any other material that may affect bonding of the cement paste. Tolerance for the batched aggregate weight from the mix design is ± 2%. Fine aggregate meeting the requirements of ASTM C33 fine aggregate or MDOT 2NS is required. Coarse aggregate meeting the requirements of ASTM C33, size numbers 57 or 67 or MDOT Classes 6A or 17A. Use of other aggregate sizes is not permitted without prior approval from the NRCS inspector.

The maximum water/cement ratio (W/C Ratio) for any condition is 0.50. Use of water that is clean and free of injurious amounts of oil, salt, acid, alkali, organic matter or other deleterious substances is required. Include aggregate moisture (both fine and coarse) in the total water quantity calculations.

Water reducing admixtures conforming to ASTM C494, 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 will be 3 to 5 inches. Maximum slump of concrete prior to adding Type A or D water reducers is 4 inches and maximum slump after adding Type A or D water reducers is 6 ½ inches. Maximum slump of concrete prior to adding Type F or G (high range) water reducers is 2 ½ inches and maximum slump after adding Type F or G water reducers is 7 ½ inches.

Where the design concrete strength shown on the drawings is 3500 psi or less, a mix containing the materials and properties referenced above, and the cementitious material and water quantities shown below in options 1 or 2, may be accepted without strength tests:

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<tbody>
<tr>
<td>1</td>
<td>564</td>
<td>0.50</td>
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<tr>
<td>2</td>
<td>517</td>
<td>0.45</td>
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</tbody>
</table>

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, the minimum 28-day compressive strength is 3,500 psi or the minimum specified in the drawings, as shown by strength tests. Perform compressive strength tests as a minimum, once each day concrete
is placed; once for each 150 cubic yards of concrete placed; or once for each 5000 sq. ft. of surface area of slabs and walls.

**ADDITIONAL REQUIREMENTS FOR AGRICHEMICAL HANDLING FACILITIES (AHF’s)**

Use of fly ash, ground blast furnace slag, or silica fume in the quantities listed previously is required.

Use of the following may be accepted without strength tests for AHF’s:

<table>
<thead>
<tr>
<th>Min. Cementitious Material</th>
<th>Max. W/C Ratio</th>
<th>(Water Amounts)</th>
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<tbody>
<tr>
<td>lb./cu. yd.</td>
<td>.40</td>
<td>lb./cu.yd.</td>
</tr>
<tr>
<td>564</td>
<td>225</td>
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</tbody>
</table>

Where the cementitious material quantities are less than shown above for AHF’s, the minimum 28-day compressive strength is 5,000 psi. Perform compressive strength tests as a minimum, once each day concrete is placed; or once for each 30 cubic yards of concrete placed.

6. **MIXING AND PLACING CONCRETE**

Thoroughly mix all concrete when delivered to the job site. Do not exceed the rated capacity of revolving drum truck mixers for the quantity of concrete delivered. 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.

Do not exceed the maximum w/c ratios listed above. 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 w/c 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 if the truck has a functioning sight gauge or meter, and the before and after readings are recorded on the batch ticket and initialed by the purchaser or their representative. Adding water on-site to the truck can only be done once per load and should be done before any significant quantity of concrete is discharged.

When adding admixtures on the job, turn the mixer a minimum of 30 revolutions at mixing speed before discharging the concrete.

Do not place concrete until the subgrade, forms and steel reinforcement have been inspected and approved by the NRCS inspector. Notify the inspector a minimum of 72 hours in advance to provide time for inspection.

Discharge concrete into the forms, vibrate and spade 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.

Deposit concrete as close as possible to its final position. Concrete without Type F or G water reducers will not be allowed to drop more than 5 feet from a chute or “elephant trunk”. Concrete with Type F or G water reducers will not be allowed to drop more than 12 feet from the chute or “elephant trunk”. If concrete must be dropped more than allowed above, use hoppers and chutes, "elephant trunks", etc., to prevent segregation.

Do not allow concrete to flow laterally more than 8 feet. If required to move concrete laterally more than 8 feet, use of shoveling, chutes, conveyors, wheelbarrows or similar equipment is required.
Place concrete in slabs at design thickness in one layer. Place concrete in walls at essentially horizontal layers not more than 24 inches high. Place successive layers and consolidate 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, use of a construction joint (of the type shown in the plan) is required.

Immediately after placement, consolidate concrete by spading and vibrating, or spading and hand tamping. Consolidate wall concrete with internal type mechanical vibrators. Work concrete 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 is not to be used to make concrete flow in the forms.

Ensure concrete surfaces are 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 is not allowed.

7. FORM REMOVAL AND CONCRETE REPAIR

Do not remove structure wall forms until 24 hours or more after concrete placement. When forms are removed in less than 7 days, spray the concrete with a curing compound or keep continuously wet by methods allowed in Section 8 of this specification.

Remove forms in such a way as to prevent damage to the concrete. Remove forms before walls are backfilled.

Remove form ties flush with or below the concrete surface. Patch form ties that are removed to a depth of 1/2 inch or greater with dry-pack mortar. Dry-pack mortar is one part Portland cement and three parts sand, with just enough water to produce a workable consistency.

Remove areas of the concrete surface where the concrete is "honeycombed", damaged or otherwise defective. Wet the area and then fill with a dry-pack mortar. Remove and/or repair damaged or defective concrete so as to retain the structural integrity of the member.

8. CURING

Prevent concrete from drying for at least 7 days after it is placed. Keep exposed surfaces 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. Keep forms left in place during the curing period 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. Spray the compound on moist concrete surfaces as soon as free water has disappeared, but not on any surface until patching, repairs and finishing of that surface are completed.

Apply curing compound 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 recommendations.
9. **CONCRETING IN COLD WEATHER**

Do not mix or place concrete when the daily atmospheric low temperature is less than 40°F unless facilities are provided to prevent the concrete from freezing. The contractor will 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 are:

a. Use of warm concrete with temperatures from 55°F 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.

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. Ensure concrete temperatures of 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.

Do not begin backfilling and compaction of fill adjacent to new concrete walls 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. Use backfill material of the type indicated on the drawings and 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.