

**DIVISION 7****CONCRETE**7.01 Description:

Concrete shall consist of a mixture of Air-Entraining Portland Cement, fine aggregate, coarse aggregate and water combined in the proportions specified for the various grades.

7.02 Materials:

7.02.01 Portland Cement – Portland Cement when permitted by the Engineer shall conform to the requirements for Type I of the current Specifications for Portland Cement, A.S.T.M. Designation: C-150.

7.02.02 High-Early Strength Portland Cement – When required, shall conform to the requirements for Type III of the current Specifications for Portland Cement, A.S.T.M. Designation: C-150.

7.02.03 Air-Entraining Portland Cement – Shall conform to the requirements for Type I-A of the current Specifications for Air-Entraining Portland Cement, A.S.T.M. Designation: C-175.

7.02.04 High-Early-Strength Air-Entraining Portland Cement – Shall conform to the requirements of the current Specifications for Type IIIA for Air-Entraining Portland Cement, A.S.T.M. Designation: C-175.

7.02.05 Admixtures – Admixture shall be used only with the Engineer’s acceptance and shall be from the MDOT’s approved admixtures list.

Concrete Accelerator – Catexol 2000 R.H.E. or Calcium chloride for use in on-the-job preparation of admixture solutions shall conform to the requirements specified for Type I or Type II calcium chloride for A.S.T.M. D-98, and shall be added as specified in the Michigan Department of Transportation Standard Specifications for Highway Construction.

Water Reducers – Use of a Low Range water reducer (NC400) may be used with prior approval of the Engineer.

7.02.06 Fine Aggregate – Fine Aggregate shall conform to the requirements for “Natural Sand 2NS,” of the current Specifications of the Michigan Department of Transportation.

7.02.07 Coarse Aggregate – Coarse Aggregate shall be 100% Limestone and conform to the requirements for “Coarse Aggregate 6AA, 6A, 17A” of the current Specifications of the

Michigan Department of Transportation. The particular coarse aggregate to be used shall be that specified under the item for which the coarse aggregate is to be used.

7.02.08 Water – The water used for mixing and curing the concrete shall be from a potable water source, unless otherwise specified.

7.02.09 Fly Ash Grout:

(a) Materials:

		<u>Specific Gravities***</u>
Portland Cement	701 MDOT Std. Specs.	3.15
Fly Ash	ASTM C 618(1)*	2.40
Granular Material Class II**	902 MDOT Std. Specs	2.60
Water	911 MDOT Std. Specs	

\* Except there is no limit on the loss of ignition.

\*\* Except that 100% shall pass 3/4 inch sieve.

\*\*\* Specific gravity values used for mix proportions given. If material used differs from these values, appropriate adjustments should be made.

(b) Optional Flowable Fill (FF) Mixtures:

1. FF Mix Number One - Cement Stabilized Fly Ash Mixture (Class F Fly Ash)

Portland Cement	100 lbs/cu yd
Fly Ash (Class F)	2000 lbs/cu yd
Water	Sufficient water to produce the desired flowability (approx. 80 gal/cu yd)

2. FF Mix Number Two - Controlled Density Fill Mixture (Class F Fly Ash)

Portland Cement	50 lbs/cu yd
Fly Ash (Class F)	500 lbs/cu yd
Granular Material	2850 lbs/cu yd
Water	Sufficient water to produce the desired flowability (approx. 40 gallons)

3. FF Mix Number Three - Controlled Density Fill Mixture (Class C Fly Ash)

Fly Ash (Class C)	300 lbs/cu yd
Granular Material	2800 lbs/cu yd
Water	Sufficient water to produce the desired flowability (approx. 40 gal/cu yd)

7.03 Construction Methods:

7.03.01 Furnishing, Storing and Handling – of aggregate shall be performed in a manner which will insure uniformity of grading at the time of batching. Fine and course aggregates, aggregates from different sources, and separate sizes of course aggregates shall be placed in separate bins or stockpiles, such that they cannot become mixed before batching. The area on which stockpiles are to be placed shall be firm and reasonably level and shall be cleaned of all foreign materials.

7.03.02 Mixing and Equipment:

- (a) The Mixer shall meet the requirements as specified under Concrete Pavement as specified in the Michigan Department of Transportation Standard Specifications for Highway Construction. The mixing of each batch shall continue for a period not less than one and one-half (1-1/2) minutes in mixers of less capacity than eighteen (18) cubic feet, not less than one and one-quarter (1-1/4) minutes in mixers of capacity of at least eighteen (18) cubic feet and less than thirty eight (38) cubic feet and not less than one (1) minute in mixers of capacity of thirty eight (38) cubic feet and greater, after the materials composing the batch are in the mixer. During this time, the drum shall revolve at the rate of not less than fourteen (14) nor more than twenty (20) revolutions per minute. The drum shall be entirely emptied after each batch before recharging. The volume of mixed material in each batch shall not exceed the Associated General Contractors of America rated capacity of the mixer, and as stamped on the mixer.
- (b) Ready Mixed Concrete – Ready Mixed Concrete is concrete which has been mixed, and transported in a freshly mixed state, ready for placement, to the site of the work.

The mixing of concrete in truck mixers enroute from the batching plant to the site of the work will be permitted only for mixers equipped with an approved revolution counter which will either record the number of revolutions of the mixer drum at mixing speeds and the number of revolutions at agitating speeds, for each batch, or will record the revolutions of the mixer drum only when the mixer is operating at mixing speeds. Truck mixers not so equipped shall mix the concrete at the batching plant site. The mixing shall be done on a reasonable level area, sloping not more than two (2) percent in any direction.

The mixer drum shall be entirely emptied after each batch before recharging. Truck mixers shall be operated in a manner that will assure discharge of water collected in the mixer drum through washing operations. Concrete or mortar which has partially hardened shall not be retempered or remixed. The mixer shall be cleaned thoroughly each time when out of operation for more than thirty (30) minutes.

The concrete shall be discharged within a period of one hour after the introduction of the mixing water with the dry materials or within a period of one and one-half (1-1/2) hours after the cement has been placed in contact with the aggregates, and it shall be within the specified limits for consistency and air content and it shall not be segregated.

- (c) Hand Mixing – Hand Mixing will be permitted only in case of a breakdown or other emergency or for very small units, and then only upon written permission from the Engineer or his representative. When so permitted, hand mixing shall be done on a watertight wood or metal surface of a suitable size. The cement and aggregate shall be mixed without the addition of water until a mixture of uniform color is produced. Water shall then be added to produce the specified consistency and the whole mass turned not less than six (6) times.
- (d) The Quantities of Concrete – mix shall be only as required for immediate use and any which has developed initial set shall not be used. Concrete or mortar which has partially hardened, shall not be retempered or remixed. The use of a fractional sack of cement will not be permitted unless the fractional part is measured by weight. The mixer shall be cleaned thoroughly each time when out of operation for more than thirty (30) minutes.

7.03.03 The Consistency of Concrete – mixes will be measured as described in the current “Method of Slump Test for Consistency of Portland Cement Concrete” of the A.S.T.M., Designation C-143.

The concrete shall at all times be of such consistency and workability, that it can be worked readily into corners and angles of the forms and around joints, dowels, tie bars and reinforcement without excessive spading, segregation or undue accumulation of water on the surface. The Engineer shall vary the proportions as provided in order to produce this workability, and if the aggregates have characteristics which require such changes in proportions to secure the specified workability and consistency, so that the cement factor is increased above that required for the basic proportions, no extra compensation for such increased cement factor will be allowed.

7.03.04 Air-Entrained Concrete – shall be constituted so that the total entrained air content in the concrete shall be not less than 5% and not more than 8% and shall be obtained and controlled by one of the following methods:

- (a) Air-Entraining Portland Cement – When air-entraining Portland Cement is used, and it is found that the air content of the concrete is greater than the specified maximum, the Contractor shall immediately discontinue its use and provide an air-entraining Portland Cement which will provide an air content within the specified limits; or in lieu of thereof, he may blend the air-entraining Portland cement, with Portland cement, manufactured at the same mill, in a ratio which will reduce the air content to a value within the specified

limits. The ratio of the two kinds of cement in the blend shall be approved by the Engineer.

- (b) High-Early-Strength Air-Entraining Portland Cement – When high-early-strength air-entraining Portland Cement is used, the air content of the concrete shall be controlled in the same manner as specified for air-entraining Portland Cement in paragraph (a) of this section.
- (c) Portland Cement and Air-Entraining Agent – When the use of Portland Cement, or high-early-strength Portland Cement is permitted, the air-entraining agent shall be Neutralized Vinsol Resin or Darex AEA. These agents shall be used as specified in the current Michigan Department of Transportation Specifications and subject to the approval of the Engineer.

7.03.05 Concrete Accelerator – Concrete Accelerator shall be used only when directed by the Engineer and shall be considered incidental to the concrete.

7.03.06 Curing – On all concrete placed, the Contractor shall apply one coating of a white membrane-curing compound. The curing compound shall be that as specified by the Michigan Department of Transportation Specifications. Coverage shall be one gallon to 200 square feet of surface.

7.04 Design:

7.04.01 Classification and Proportioning – of concrete shall be on the basis of strength requirements. The proportions of fine and coarse aggregates shall be the quantities of these materials which, with the specified quantity of mixing water and cement, will produce a plastic and workable concrete free from stone pockets, honeycombing, or segregation.

There will be four grades of concrete, designated at AA, A, B, and C. The following table shows, for each grade of concrete, the approximate proportions of cement, fine and coarse aggregate, the minimum compressive strength in pounds per square inch, the minimum number of sacks of cement per cubic yard of concrete:

<u>GRADE</u>	<u>APPROXIMATE PROPORTIONS BY VOLUME</u>	<u>MINIMUM COMPRESSIVE STRENGTH</u>	<u>ESTIMATED COMPRESSIVE STRENGTH</u>	<u>MINIMUM CEMENT Sacks/CY of Concrete</u>
		<u>Lbs./Sq.In. 28 Days</u>	<u>Lbs./Sq.In. 7 Days</u>	
AA	1 : 1.9 : 3.0	4,000	2,500	6.5
A	1 : 2.1 : 3.4	3,500	2,120	6.0
B	1 : 2.4 : 3.7	3,000	1,746	5.5
C	1 : 3.0 : 5.0	2,000	1,034	5.0

Any modifications to the proportions for the addition of admixtures (water reducers) requires prior approval of the Engineer.

7.04.02 The Proportioning of Aggregates and Cement – shall be by weight except on those projects where volume method is specifically permitted by the Engineer. In both methods, water shall be measured in a container which will discharge the correct amount within a maximum variation of two percent. The container shall be so constructed and calibrated, that the amount of water may be observed and controlled at all times. Other accurate means may be employed if approved by the Engineer. If Ready Mixed Concrete is used, the quantities shall be shown on the delivery tickets for each batch.

- (a) By Weight – When the aggregates are proportioned by weight, the proportions shall be computed by the Engineer according to the current Michigan Department of Transportation Specifications for the “Mortar Voids” theory of design.
- (b) By Volume – When aggregates are proportioned by volume, the unit of measure shall be the cubic foot. The standard sack of cement containing 94 pounds, net weight, will be taken as the unit measure of cement and will be considered as having a volume of one cubic foot.

The volume of each aggregate to be used in the batch will be determined by the Engineer by converting to volume the predetermined weights of dry loose materials required for the batch. Aggregates shall be accurately measured in suitable carts, boxes, or bins. Shovel methods of measuring will not be permitted.

7.04.03 Strength Tests – Strength Tests shall be made with concrete test cylinders molded at frequent intervals from the concrete of routine batches being incorporated in the work. Concrete for test specimens and assistance for making them on the project, will be furnished by the Contractor. Molds and testing equipment will be furnished by the City.

If the average results from test specimens cured at an average temperature of 70 degrees F. are below the 28-day required compressive strength, it will be sufficient reason for rejecting for further use, the materials entering into the concrete, and for removal of defective material or reducing the unit price of same.

7.04.04 High-Early-Strength Concrete – when required, shall be obtained by the substitution of high-early-strength cement for Portland Cement.

7.05 Method of Measurement:

Concrete will be measured as provided under the Section covering the structure where it is used, in the units indicated by the Proposal Item.

7.06 Basis of Payment:

“Concrete” will be paid for as provided under the section covering the structure where it is used, in the units indicated by the proposal item. Curing will be considered included in the placement of the concrete. No additional compensation will be considered.