

**MICHIGAN DEPARTMENT OF TRANSPORTATION
BUREAU OF AERONAUTICS - STANDARD SPECIFICATION
P-610
Structural Portland Cement Concrete**

DESCRIPTION

1.1 This item shall consist of either plain or reinforced structural portland cement concrete, prepared and constructed in accordance with these specifications, at the locations and of the form and dimensions shown on the plans. The concrete shall be composed of coarse aggregate, fine aggregate, portland cement, and water.

MATERIALS

2.1 **General.** Only approved materials, conforming to the requirements of these specifications, shall be used in the work. They may be subjected to inspection and tests at any time during the progress of their preparation or use. The source of supply of each of the materials shall be approved by the Engineer before delivery or use is started. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to insure the preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed therein.

In no case shall the use of pit-run or naturally mixed aggregates be permitted. Naturally mixed aggregate shall be screened and washed, and all fine and coarse aggregates shall be stored separately and kept clean. The mixing of different kinds of aggregates from different sources in one storage pile or alternating batches of different aggregates will not be permitted.

When this specification is used for fence post footings, manholes, catch basins, inlets,

headwalls, light bases, windcone and beacon footings, electrical duct, sidewalk, curbing, cable markers, and other non-critical structures, the requirements for testing, as specified in 2.2 through 2.11 and 3.2 through 3.5, will be waived if either the concrete is furnished by a reputable transit mix firm approved by the Engineer, or the materials are approved by the Engineer when the concrete is mixed on the site. However, when any items, such as electrical duct or poured manholes are placed in or under a pavement intended to support aircraft of 60,000 pounds or more gross weight, such tests will be required. When large amounts of concrete are used on the project, such tests may be required if so indicated on the plans.

When the project includes portland cement concrete pavement, P-501, the paving aggregates may be used for P-610 concrete, unless construction conditions dictate that a finer aggregate is required. This provision does not apply to buildings.

2.2 **Coarse Aggregate.** The coarse aggregate for concrete shall meet the requirements of AASHTO M 80. The percentage of wear shall be not more than 45 at 500 revolutions as determined by AASHTO T 96.

Coarse aggregate shall be well graded from coarse to fine and shall meet one of the gradations shown in Table 1, using AASHTO T 27.

2.3 **Fine Aggregate.** The fine aggregate for concrete shall meet the requirements of AASHTO M 6.

The fine aggregate shall be well graded from fine to coarse and shall meet the grading requirements in Table 2, when tested in accordance with AASHTO T 27:

TABLE 1
REQUIREMENTS FOR GRADATION OF COARSE AGGREGATE

Sieve designation (square openings)	Percentage by weight passing sieves						
	2"	1 1/2"	1"	3/4"	1/2"	3/8"	No. 4
No. 4 to 3/4 inch	---	—	100	90-100	—	20-55	0-10
No. 4 to 1 inch	---	100	90-100	—	25-60	—	0-10
No. 4 to 1 1/2 inch	100	95-100	—	35-70	—	10-30	0-5

TABLE 2
REQUIREMENTS FOR GRADATION OF FINE AGGREGATE

<u>Sieve designation</u>	<u>Percentage by weight</u>
3/8 inch	100
No. 4	95-100
No. 16	45-80
No. 30	25-55
No. 50	10-30
No. 100	2-10

Blending will be permitted, if necessary, in order to meet the gradation requirements for fine aggregate. Fine aggregate deficient in the percentage of material passing the No. 50 mesh sieve may be accepted, provided that such deficiency does not exceed 5% and is remedied by the addition of pozzolanic or cementitious materials other than portland cement, as specified in 2.6 on admixtures, in sufficient quantity to produce the required workability as approved by the Engineer.

2.4 Cement. The cement used shall be portland cement conforming to the requirements of the type specified:

- (a) Portland cement AASHO M 85
- (b) Air-entraining portland cement . . .
. AASHO M 134
- (c) Portland blast-furnace slag cement
. AASHO M 151

(d) Air-entraining portland blast furnace slag cement
. AASHO ;M 151

The Contractor shall furnish vendors' certified test reports for each carload, or equivalent, of cement shipped to the project. The report shall be delivered to the Engineer before permission to use the cement is granted. All such test reports shall be subject to verification by testing sample materials received for use on the project.

2.5 Water. The water used in concrete shall be free from sewage, oil, acid, strong alkalies, vegetable matter, and clay and loam. If the water is of questionable quality, it shall be tested in accordance with AASHO T 26.

2.6 Admixtures. The use of any material added to the concrete mix shall be approved by the Engineer. Before approval of any material, the

Contractor shall be required to submit the results of complete physical and chemical analyses made by an acceptable testing laboratory. Subsequent tests shall be made of samples taken by the Engineer from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

Pozzolanic admixtures shall be fly ash meeting the requirements of ASTM C 350 or raw or calcined natural pozzolans meeting the requirements of ASTM C 402.

Air-entraining admixtures shall meet the requirements of AASHTO M 154. Air-entraining admixtures shall be added at the mixer in the amount necessary to produce the specified air content.

Water-reducing, set-controlling admixtures shall meet the requirements of ASTM C 494, Type A, water reducing or Type D, water-reducing and retarding. Water-reducing admixtures shall be added at the mixer separately from air-entraining admixtures in accordance with the manufacturer's printed instructions.

2.7 Premolded Joint Material. Premolded joint material for expansion joints shall meet the requirements of one of the following: AASHTO M 33, M 90, M 153, or M 213.

2.8 Joint Filler. The filler for joints shall meet the requirements of AASHTO M 18, grade A or B, or item P-605, unless otherwise specified in the proposal.

2.9 Steel Reinforcement. Concrete reinforcing shall consist of deformed bars of either structural, intermediate, or hard grade billet steel meeting AASHTO M 31; deformed bars of rail steel meeting AASHTO M 42; or welded wire fabric meeting AASHTO M 55. To qualify as deformed, bars shall conform to the requirements of AASHTO M 137.

2.10 Calcium Chloride. When calcium chloride is permitted by the Engineer in the

concrete as an accelerator, it shall meet the requirements of AASHTO M 144.

2.11 Cover Materials for Curing. Curing materials shall conform to one of the following specifications:

- (a) Cotton Mats for Curing Concrete AASHTO M 73
- (b) Waterproof Paper for Curing Concrete AASHTO M 139
- (c) Polyethylene Sheeting for Curing Concrete AASHTO M 171
- (d) Burlap Cloth made from Jute or Kenaf AASHTO M 182
- (e) Liquid Membrane-Forming Compounds for Curing Concrete (Type 2) AASHTO M 148

CONSTRUCTION METHODS

3.1 General. The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified herein. All machinery and equipment owned or controlled by the Contractor, which he/she proposes to use on the work, shall be of sufficient size to meet the requirements of the work, and shall be such as to produce satisfactory work; all work shall be subject to the inspection and approval of the Engineer. The Contractor shall employ at all times a sufficient force of workmen of such experience and ability that the work can be prosecuted in a satisfactory and workmanlike manner.

3.2 Concrete Proportions. The concrete shall consist of a mixture of coarse aggregate, fine aggregate, portland cement, and water. All aggregates and bulk cement shall be measured by weight. In proportioning aggregates and mixing water, compensation shall be made for the weight of moisture in the aggregates, and this shall be determined periodically.

CONCRETE PROPORTIONS
(Materials for one cubic yard of concrete)

Type of coarse aggregate	Cement content (min. bags)	Net water (max. gallons)	Weights in pounds dry aggregate		Slump range (inches)
			Fine Aggregate	Total aggregate	
Gravel	6	35	1070-1190	3210	2-5
Crushed stone	6	38	1220-1360	3200	2-5
Slag	6	38	1330-1470	2930	2-5

The proportions in the above table are based on the use of well-graded aggregates. If it is impossible with the aggregates selected to prepare concrete of the proper consistency without exceeding the maximum net water content specified, the total weight of aggregate shall be reduced by the Engineer until concrete of the proper consistency is obtained without exceeding the maximum net water content specified. However, the Contractor shall not be compensated for any additional cement which may be required by such adjustment.

The weights specified in the above table were calculated for aggregates of the following bulk specific gravities: Natural sand and gravel, 2.65; crushed stone, 2.70; slag 2.30. For aggregates of specific gravities differing more than ± 0.02 from those given above, the weights given in the tables shall be corrected. The quantities shown for cement and water shall control, and the weights of aggregates shall be varied to secure the proper yield based on absolute volumes. When a special mix requiring a reduction in the amount of water is desired, the quantities of aggregates shall be increased to maintain the specified yield.

Yield test, made in accordance with specification AASHTO T 121, shall be made by the Engineer for the purpose of determining the cement content per cubic yard of concrete. If at any time such cement content is found to be less than that specified per cubic yard, the batch weights shall be reduced until the amount of

cement per cubic yard of concrete conforms to the requirements.

The net mixing water shall be adjusted for the moisture contained in the aggregates, and for the moisture which they will absorb, in order to determine the amount of water to be added at the mixer. The absorption of the fine and coarse aggregates shall be determined by AASHTO T 84 and T 85.

When an air-entraining agent or air-entraining portland cement is used, there will be a bulking of the mortar of the concrete due to the amount of entrained air. To keep the cement factor specified at the correct amount, the weight of the fine aggregate shall be reduced, as directed by the Engineer. The reduction in the fine aggregate shall be determined by yield tests as specified. Under average conditions the reduction of the sand should be about 3% of the total weight of the fine and coarse aggregate. The air content of the concrete shall be between 3 and 6%, by volume.

The air content by volume shall be based on measurements made on concrete immediately after discharge from the mixer in accordance with AASHTO T 121 or T 152.

When tests are waived, as heretofore mentioned, the concrete shall be a standard 6 bag mix, with 1" maximum coarse aggregate, unless otherwise specified, and shall have a slump range of 2-5 inches.

3.3 Control Tests. When directed by the Engineer, the Contractor shall make test cylinders or beams from the concrete as mixed for the work as herein specified.

Concrete cylindrical test specimens shall be made in accordance with AASHTO T 23 and beam specimens shall be made in accordance with AASHTO T 97. The Contractor shall cure and store the test specimens under such conditions as directed. The Engineer will make the actual tests on the specimens at no expense to the Contractor.

3.4 Proportioning and Measuring Devices. When package cement is used, the quantity for each batch shall be equal to one or more whole sacks of cement. The aggregates shall be measured separately by weight. If aggregates are delivered to the mixer in batch trucks, the exact amount for each mixer charge shall be contained in each batch compartment. Weighing boxes or hoppers shall be approved by the Engineer and shall provide means of regulating the flow of aggregates into the batch box so that the required and exact weight of aggregates can be readily obtained.

3.5 Consistency. The consistency of the concrete shall be checked by the slump test specified in AASHTO T 119.

3.6 Mixing. Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. Whichever mixing process is used, concrete of the specified proportions and consistency shall be produced.

3.7 Mixing Conditions. The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F without permission of the Engineer. If permission is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F nor more than 100°F. The Contractor shall be held responsible for any

defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his or her expense.

Retempering of concrete by adding water or any other material shall not be permitted.

The delivery of concrete to the job shall be in such a manner that batches of concrete will be deposited at uninterrupted intervals.

3.8 Forms. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the Engineer. Forms shall be of suitable material and shall be of the type, size, shape, quality and strength to build the structure as designed on the plans. The forms shall be true to line and grade and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The Contractor shall bear responsibility for their adequacy. The surfaces of forms shall be smooth and free from irregularities, dents, sags and holes.

The internal ties shall be arranged so that, when the forms are removed, no metal will show in the concrete surface or discolor the surface when exposed to weathering. All forms shall be wetted with water or with a nonstaining mineral oil which shall be applied shortly before the concrete is placed. Forms shall be constructed so that they can be removed without injuring the concrete or concrete surface. The forms shall not be removed before the expiration of at least 30 hours from vertical faces, walls, slender columns, and similar structures; forms supported by falsework under slabs, beams, girders, arches, and similar construction shall not be removed until tests indicate that at least 60% of the design strength of the concrete has developed.

3.9 Placing Reinforcement. All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concreting. Bars shall be fastened together at intersections. The

reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

3.10 Embedded Items. Before placing concrete, any items that are to be embedded shall be firmly and securely fastened in place as indicated. All such items shall be clean and free from coating, rust, scale, oil or any foreign matter. The embedding of wood shall be avoided. The concrete shall be spaded and consolidated around and against embedded items.

3.11 Placing Concrete. All concrete shall be placed during daylight, unless otherwise approved. The concrete shall not be placed until the depth and character of foundation, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved. Concrete shall be placed as soon as practical after mixing and in no case later than one hour after water has been added to the mix. The method and manner of placing shall be such to avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. Dropping the concrete a distance of more than five feet, or depositing a large quantity at one point, will not be permitted. Concrete shall be placed upon clean, damp surfaces, free from running water, or upon properly consolidated soil.

The concrete shall be compacted with suitable mechanical vibrators operating within the concrete. When necessary, vibrating shall be supplemented by hand spading with suitable tools to assure proper and adequate compaction. Vibrators shall be manipulated so as to work the concrete thoroughly around the reinforcement and embedded fixtures and into corners and angles of the forms. The vibration at any joint shall be of sufficient duration to accomplish compaction but shall not be prolonged to the point where segregation occurs. Concrete deposited under water shall be carefully placed

in a compact mass in its final position by means of a tremie, a closed bottom dump bucket, or other approved method and shall not be disturbed after being deposited.

3.12 Construction Joints. When the placing of concrete is suspended, necessary provisions shall be made for joining future work before the placed concrete takes its initial set. For the proper bonding of old and new concrete, such provisions shall be made for grooves, steps, keys, dovetails, reinforcing bars or other devices as may be prescribed. The work shall be arranged so that a section begun on any day shall be finished during daylight of the same day. Before depositing new concrete on or against concrete which has hardened, the surface of the hardened concrete shall be cleaned by a heavy steel broom, roughened slightly, wetted, and covered with a neat coating of cement paste or grout.

3.13 Expansion Joints. Expansion joints shall be constructed at such points and of such dimensions as may be indicated on the drawings. The premolded filler shall be cut to the same shape as that of the surfaces being joined. The filler shall be fixed firmly against the surface of the concrete already in place in such manner that it will not be displaced when concrete is deposited against it.

3.14 Defective Work. Any defective work disclosed after the forms have been removed shall be immediately removed and replaced. If any dimensions are deficient, or if the surface of the concrete is bulged, uneven, or shows honeycomb, which in the opinion of the Engineer cannot be repaired satisfactorily, the entire section shall be removed and replaced at the expense of the Contractor.

3.15 Surface Finish. All exposed concrete surfaces shall be true, smooth, free from open or rough spaces, depressions, or projections. The concrete in horizontal plane surfaces shall be brought flush with the finished top surface at the proper elevation and shall be struck-off with a

straightedge and floated. Mortar finishing shall not be permitted, nor shall dry cement or sand-cement mortar be spread over the concrete during the finishing of horizontal plane surfaces.

When directed, the surface finish of exposed concrete shall be a rubbed finish. If forms can be removed while the concrete is still green, the surface shall be pointed and wetted and then rubbed with a wooden float until all irregularities are removed. If the concrete has hardened before being rubbed, a carborundum stone shall be used to finish the surface. When approved, the finishing can be done with a rubbing machine.

3.16 Curing and Protection. All concrete shall be properly cured and protected by the Contractor. The work shall be protected from the elements, flowing water, and from defacement of any nature during the building operations. The concrete shall be cured as soon as it has sufficiently hardened by covering with an approved material. Water-absorptive coverings shall be thoroughly saturated when placed and kept saturated for a period of at least three days. All curing mats or blankets shall be sufficiently weighed or tied down to keep the concrete surface covered and to prevent the surface from being exposed to currents of air. Where wooden forms are used, they shall be kept wet at all times until removed to prevent the opening of joints and drying out of the concrete. Traffic shall not be allowed on concrete surfaces for seven days after the concrete has been placed.

Special curing protection may be waived by the Engineer if the areas of finished concrete exposed to the weather are small.

3.17 Drains or Ducts. Drainage pipes, conduits and ducts that are to be encased in concrete shall be installed by the Contractor before the concrete is placed. The pipe shall be held rigidly so that it will not be displaced or moved during the placing of the concrete.

3.18 Cold Weather Protection. When concrete is placed at temperatures below 40°F, the Contractor shall provide satisfactory methods and means to protect the mix from injury by freezing. The aggregates, or water, or both, shall be heated in order to place the concrete at temperatures between 50° and 100°F..

Calcium chloride may be incorporated in the mixing water when directed by the Engineer. Not more than two pounds of Type 1 nor more than 1.6 pounds of Type 2 shall be added per bag of cement. After the concrete has been placed, the Contractor shall provide sufficient protection such as cover, canvas, framework, heating apparatus, etc., to enclose and protect the structure and maintain the temperature of the mix at not less than 50°F until at least 60% of the designed strength has been attained.

3.19 Filling Joints. All joints which require filling shall be thoroughly cleaned, and any excess mortar or concrete shall be cut out with proper tools. Joint filling shall not be started until after final curing and shall be done only when the concrete is completely dry. The cleaning and filling shall be carefully done with proper equipment and in a manner to obtain a neat looking joint free from excess filler.

METHOD OF MEASUREMENT

4.1 The yardage of portland cement concrete to be paid for shall be the number of cubic yards of concrete complete in place and accepted. In computing the yardage of concrete for payment, the dimensions used shall be those shown on the plans or ordered by the Engineer. No measurement or other allowances shall be made for forms, falsework, cofferdams, pumping, bracing, expansion joints, or finishing of the concrete. No deductions in yardage shall be made for the volumes of reinforcing steel or embedded items.

4.2 The amount of reinforcing steel to be paid for shall be the calculated theoretical

number of pounds placed, as shown on the plans, complete in place and accepted. The unit weight used for deformed bars shall be the weight of plain square or round bars of equal nominal size. If so indicated on the plans, the amount to be paid for shall include the weight of metal pipes and drains, metal conduits and ducts, or similar materials indicated and included.

BASIS OF PAYMENT

5.1 Payment shall be made at the contract unit price per cubic yard for structural portland cement concrete and per pound for reinforcing steel. These prices shall be full compensation for furnishing all materials, and for all labor, equipment, tools and incidentals necessary to complete the item.

Payment will be made under the nomenclature and seven digit item number specified in the plans and proposal for each type of portland cement concrete and reinforcing steel work required per cubic yard, per square foot, per linear foot, or per pound, as applicable.

The first three digits of any item number for work included under this specification shall be 610, i.e. 610XXXX.

TESTING AND MATERIAL REQUIREMENTS

Test and Short Title

- AASHTO T 27 - Gradation
- AASHTO T 96 - Abrasion
- AASHTO T 26 - Water
- AASHTO T 121 - Yield
- AASHTO T 84 - Absorption
- AASHTO T 85 - Absorption
- AASHTO T 152 - Air Content
- AASHTO T 23 - Cylinders
- AASHTO T 97 - Beams
- AASHTO T 119 - Slump

Material and Short Title

- AASHTO M 80 - Aggregate
- AASHTO M 6 - Aggregate
- AASHTO M 85 - Portland Cement
- AASHTO M 134 - Air-Entrained Portland Cement
- AASHTO M 151 - Slag Portland Cement Concrete
- ASTM C 350 - Fly-Ash
- ASTM C 402 - Pozzolans
- AASHTO M 154 - Air-Entrained Add.
- ASTM C 494 - Retarder
- AASHTO M 33 - Joint Material
- AASHTO M 90 - Joint Material
- AASHTO M 153 - Joint Material
- AASHTO M 213 - Joint Material
- AASHTO M 18 - Joint Material
- AASHTO M 31 - Steel
- AASHTO M 42 - Steel
- AASHTO M 55 - Steel
- AASHTO M 137 - Steel
- AASHTO M 144 - Accelerator
- AASHTO M 73 - Cotton Mats
- AASHTO M 139 - Paper
- AASHTO M 171 - Polyethylene
- AASHTO M 182 - Burlap
- AASHTO M 148 - Membrane