DIVISION 400

PORTLAND CEMENT CONCRETE
SECTION 401

EQUIPMENT

Unless otherwise noted, equipment shall conform to the requirements specified in Division 150.
SECTION 402
CLASSIFICATION AND PROPORTIONING

402.01 DESCRIPTION.

Concrete shall consist of a mixture of: (a) Portland cement, water and mixed aggregate or coarse and fine aggregate with or without air entraining or other admixtures, or (b) Portland cement, water and lightweight aggregate (modified) with air-entraining and with or without other admixtures, or (c) Portland cement, fly ash, water and mixed aggregate or coarse and fine aggregate with or without air entraining or other admixtures.

402.02 MATERIALS.

Materials shall conform to the requirements specified in the Materials Division.

<table>
<thead>
<tr>
<th>Material</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>2400</td>
</tr>
<tr>
<td>Portland Cement</td>
<td>2000</td>
</tr>
<tr>
<td>Fly Ash</td>
<td>2000</td>
</tr>
<tr>
<td>Mixed Aggregate</td>
<td>1100</td>
</tr>
<tr>
<td>Fine Aggregate</td>
<td>1100</td>
</tr>
<tr>
<td>Coarse Aggregate</td>
<td>1100</td>
</tr>
<tr>
<td>Lightweight Aggregate (Modified)</td>
<td>1100</td>
</tr>
<tr>
<td>Admixtures</td>
<td>1400</td>
</tr>
</tbody>
</table>

402.03 COMPOSITION.

(a) General.

The actual mix proportions of the concrete mix shall be the responsibility of the Contractor and the mix shall be designed using information from the appropriate table shown in Section 402.04. Changes made by the Contractor in mix proportioning, previously approved, must be approved by the Engineer. Failure of the mixed concrete to meet specifications as determined by the Engineer will be grounds to reject the concrete. Upon receipt of a written request from the Contractor, the Engineer may design or assist in the design of the mix.

The Engineer shall designate the slump or slumps at the point of delivery.

When air-entrained concrete is specified, the percent of air in the concrete will be designated. The Contractor shall determine the required amount of air-entraining agent.
(b) Portland Cement.

Unless otherwise specified on the Plans or in the Contract, either Type IP Portland-Pozzolan cement, Type I(PM) Pozzolan-Modified Portland cement or Type II Portland cement shall be used for the construction of bridge decks (wearing course) and concrete pavement. Either Type IP Portland-Pozzolan cement, Type I (PM) Pozzolan-Modified Portland cement, Type I or Type II Portland cement may be furnished for all other types of construction unless specified otherwise on the Plans or in the Contract.

(c) Fly Ash Modified Concrete.

Fly ash modified concrete shall be any concrete containing fly ash or blended cement. At the option of the Contractor, fly ash from an approved source may be used as a partial replacement for Portland cement. The source and type of fly ash and cement shall not be changed for a project. The consistency of fly ash modified concrete shall be the same as for mixed aggregate or coarse and fine aggregate concrete as shown in (a) above.

The amount of cement that may be replaced with fly ash shall not exceed 15 percent of the minimum kilograms of cement per cubic meter listed in Section 402.04.

Fly ash may be substituted for the displaced cement at a rate of one to 1½ kilograms of fly ash for each kilogram of cement removed.

When fly ash modified concrete is furnished, the kilograms of water per kilogram of cement plus fly ash or kilograms of water per kilogram of blended cement shall not exceed the values specified for kilograms of water per kilogram of cement listed as maximums in Section 402.04.

Fly ash will not be permitted as a partial replacement for cement if Type IP, I(PM) or Type III cement is furnished.

At least 15 days before placement of fly ash modified concrete on the project, the Contractor shall furnish to the Engineer complete mix design data including proportions and sources of all mix ingredients and the results of strength tests representing the mix(es) he proposes to use. This strength data shall come from project records for previous KDOT projects or from tests in an independent laboratory, and shall be equal to or exceed the strength requirements listed in Table 1. Test specimens shall be prepared in accordance with Section 2500. Flexural tests shall be performed in accordance with Section 2500. Compressive strength tests shall be in accordance with ASTM
C-39. Laboratories performing these tests must be regularly inspected by the Cement and Concrete Reference Laboratory (CCRL) (N.B.S.).

If the Contractor plans to replace a part of the cement in the mix with fly ash, he shall furnish to the Engineer the results of mortar expansion tests using the same fly ash and the same cement he proposes to use on the project. The tests shall be as described in ASTM C441 and results shall not exceed the maximum of 0.020% expansion specified in ASTM C618, Table 2A. Tests shall be conducted by a laboratory regularly inspected by the CCRL and results shall be furnished to the Engineer at least 15 days before placement of concrete on the project.

NOTE: After sufficient data has been collected, the strength test requirements may be waived but only with the approval of the Chief, Bureau of Materials and Research.

<table>
<thead>
<tr>
<th>Concrete Class</th>
<th>Specimen Age</th>
<th>Unit Strength (mPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>28 days</td>
<td>38 Compressive</td>
</tr>
<tr>
<td>AAA (AE)</td>
<td>28 days</td>
<td>36 Compressive</td>
</tr>
<tr>
<td>A</td>
<td>28 days</td>
<td>30 Compressive</td>
</tr>
<tr>
<td>A (AE)</td>
<td>28 days</td>
<td>28 Compressive</td>
</tr>
<tr>
<td>Pavement</td>
<td>7 days</td>
<td>3 'Flexural</td>
</tr>
<tr>
<td>B or B (AE)</td>
<td>--</td>
<td>Not Required</td>
</tr>
</tbody>
</table>

* Third Point Loading

402.04 CLASSIFICATION.

The limiting values for each respective type of concrete are as follows:

(a) General.

The cement, water and air content specified herein will be verified. Maximum limits shown for kilograms of water per kilogram of cement shall include free water in aggregates but excludes water of absorption of the aggregates.
(b) Concrete for Pavement-Air Entrained.

<table>
<thead>
<tr>
<th>Pavement (Surface Course):</th>
<th>Minimum Kilograms of Cement per Cubic Meter of Concrete</th>
<th>Maximum Kilograms of Water Per Kilogram of Cement</th>
<th>Percent of Air by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse and Fine</td>
<td>357</td>
<td>0.49</td>
<td>6±2</td>
</tr>
<tr>
<td>Mixed or Total Aggregate</td>
<td>367</td>
<td>0.49</td>
<td>6±2</td>
</tr>
</tbody>
</table>

(c) Concrete for Structures:

<table>
<thead>
<tr>
<th>Class AAA Concrete:</th>
<th>Minimum Kilograms of Cement per Cubic Meter of Concrete</th>
<th>Maximum Kilograms of Water per Kilogram of Cement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixed Aggregate with less than 30% (by Mass) on 4.75 mm Sieve</td>
<td>413</td>
<td>0.49</td>
</tr>
<tr>
<td>Mixed Aggregate with 30% or more (by Mass) on 4.75 mm Sieve</td>
<td>379</td>
<td>0.49</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate</td>
<td>357</td>
<td>0.49</td>
</tr>
<tr>
<td>Class A Concrete:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Aggregate with less than 30% (By Mass) on 4.75 mm Sieve</td>
<td>379</td>
<td>0.55</td>
</tr>
<tr>
<td>Mixed Aggregate with 30% or more (By Mass) on 4.75 mm Sieve</td>
<td>357</td>
<td>0.55</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate</td>
<td>334</td>
<td>0.55</td>
</tr>
<tr>
<td>Class B Concrete:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Aggregates</td>
<td>312</td>
<td>0.58</td>
</tr>
</tbody>
</table>
(d) Concrete for Structures—Air Entrained.

TABLE 4

<table>
<thead>
<tr>
<th></th>
<th>Minimum Kilograms of Cement per Cubic Meter of Concrete</th>
<th>Maximum Kilograms of Water per Kilogram of Cement</th>
<th>Percent of Air by Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class AAA Concrete (AE):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Aggregate with less than 30% (by Mass) on the 4.75 mm Sieve</td>
<td>413</td>
<td>0.44</td>
<td>6±2</td>
</tr>
<tr>
<td>Mixed Aggregate with 30% or more (by Mass) on the 4.75 mm Sieve</td>
<td>379</td>
<td>0.44</td>
<td>6±2</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate</td>
<td>357</td>
<td>0.44</td>
<td>6±2</td>
</tr>
<tr>
<td>Class A Concrete (AE):</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mixed Aggregate with less than 30% (by Mass) on the 4.75 mm Sieve</td>
<td>390</td>
<td>0.49</td>
<td>6±2</td>
</tr>
<tr>
<td>Mixed Aggregate with 30% or more (by Mass) on the 4.75 mm Sieve</td>
<td>367</td>
<td>0.49</td>
<td>6±2</td>
</tr>
<tr>
<td>Coarse and Fine Aggregate</td>
<td>357</td>
<td>0.49</td>
<td>6±2</td>
</tr>
<tr>
<td>Lightweight Aggregate (Modified)</td>
<td>390</td>
<td></td>
<td>6±2</td>
</tr>
<tr>
<td>Class B Concrete (AE)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All Aggregates</td>
<td>312</td>
<td>0.53</td>
<td>6±2</td>
</tr>
</tbody>
</table>

(e) Control of Design Air Content.

The percent air to be used for the design of air-entrained concrete shall be at the middle of the range of the class of concrete as designated in these Specifications. Occasional deviations below the specified cement content will be permitted if it is due to the air content of the concrete exceeding the designated air content, but only up to the plus two percent tolerance in the air content. Continuous operation below the specified cement content for any reason will not be permitted.

(f) Mortar.

Mortar for laying stone for grouted stone riprap, grouted stone wash checks or grouted stone ditch lining shall be composed of one part of Portland cement and three parts of fine aggregate by volume with sufficient water added to make a workable and plastic mix of such consistency as to perform properly the functions required for the work being done.

Mortar for laying brick or concrete blocks shall be composed of \( \frac{1}{2} \) part of masonry cement, \( \frac{1}{2} \) part of Portland cement, and
three parts of fine aggregate, either commercially produced masonry sand or FA-M. The sand used will be visually inspected for acceptance. The components shall be measured by volume with sufficient water added to make a workable mix of such consistency that will perform properly the functions required for the work being done. Air-entraining agents shall not be used in mixing mortar for masonry work. Any recognized brand of Portland cement and masonry cement that is free of lumps may be accepted upon visual inspection.

(g) Changes in Proportion.

As the work progresses, the Engineer reserves the right to require the Contractor to change the proportions from time to time if conditions warrant such changes to produce a satisfactory mix. Any such changes may be made within the limits of the Specifications at no additional compensation to the Contractor.

(h) Information Available.

A prospective bidder may contact the District Materials Engineer for any available information to help determine approximate proportions which will produce concrete having the required characteristics for any given project.

402.05 CONSISTENCY.

(a) Mixed Aggregate or Coarse and Fine Aggregate Concrete.

The consistency of concrete shall be determined by the Standard Kansas Test Method for Slump of Portland Cement Concrete. The consistency of concrete at the time of delivery will be designated by the Engineer.

When the designated slump is 75 millimeters or less, the tolerance shall be plus or minus 20 millimeters or limited by the maximum allowable slump for individual types of construction.

When the designated slump is greater than 75 millimeters, the tolerance shall be plus or minus 25 percent of the designated slump.

Refer to the following sections for slumps of:

Rigid Pavement .................................................. Section 502
Concrete Structures .............................................. Section 701
(b) Lightweight Aggregate (Modified) Concrete.

The consistency of Lightweight Aggregate (Modified) Concrete shall be controlled by the slump test and the slump shall not exceed 50 millimeters.

402.06 REQUIREMENTS FOR COMBINED MATERIALS.

(a) Measurement for Proportioning Materials.

(1) Cement. The cement shall be measured as packed by the manufacturer. A sack of cement is considered as 0.03 cubic meter weighing 42.6 kilograms net. Bulk cement shall be measured by mass. In either case, the measurement shall be accurate to within 0.5 percent throughout the range of use.

(2) Fly Ash. Fly ash proportioning and batching equipment shall be subject to the same controls as required for cement. Fly ash may be weighed accumulatively with the cement or separately. If weighed accumulatively, the cement shall be weighed first.

(3) Water. The mixing water shall be measured by mass or by volume. In either case the measurement shall be accurate to within one percent throughout the range of use.

(4) Aggregates. The aggregates shall be measured by mass. The measurement shall be accurate to within 0.5 percent throughout the range of use.

(5) Admixtures. Liquid admixtures shall be measured by mass or volume. When liquid admixtures are used in small quantities in proportion to the cement as in the case of air-entraining agents, readily adjustable mechanical dispensing equipment capable of being set to deliver the required amount and to cut off the flow automatically when this amount has been discharged shall be used. The measurement shall be accurate to within three percent of the quantity required.

(b) Assembly and Handling of Materials.

(1) Assembly.

Prior to batching of concrete, aggregate from each source shall be sampled and tested by the Department to determine compliance with specifications. Batching will not be permitted until the Engineer has determined that the aggregates will meet specifications. Acceptance sampling shall be at the batching site.

After initial testing is complete and the Engineer has determined that the aggregate process control is satisfactory, the aggregates may be used concurrently with sampling and test-
ing as long as tests indicate compliance with specifications. During batching operations, aggregates may be accepted at the batch plant by testing aggregate samples taken from the stream as the storage bins or weigh hoppers are loaded. If test results indicate that an aggregate does not comply with specifications, concrete production using that aggregate shall cease. Additional aggregate from that source and specified gradation will not be used until subsequent sampling and testing of that aggregate indicate compliance with specifications, unless a tested and accepted stockpile for that aggregate is available at the batch plant. When tests are completed and the Engineer is satisfied that process control is again adequate, production of concrete using aggregates sampled and tested concurrently with production may resume. If samples cannot be reasonably taken from the stream, production shall be from approved stockpiles. In any case, sampling shall be as near to the point of batching as is feasible.

Accepted stockpiles will be permitted only at the batch plant and only for small concrete pours or for the purpose of maintaining concrete production. The accepted stockpile shall be marked with “Approved Materials” signs. Suitable stockpile area shall be provided at the batch plant so that aggregates can be stored without detrimental segregation or contamination. Unless otherwise approved by the Engineer, no more than 250 metric tons of coarse aggregate and no more than 250 metric tons of fine aggregate tested and accepted by the Engineer shall be stockpiled at the plant. If mixed aggregate is to be used, the accepted stockpile shall be limited to 500 metric tons, the size of each being proportional to the amount of each aggregate to be used in the mix.

When Durability Class I or VI aggregate is required, at least two weeks before production of the aggregate is to begin, the Contractor shall notify the Engineer in writing as to the source and the date production is to begin. Failure to notify the Engineer, as required, may result in rejection of the aggregate as Durability Class(ed) aggregate. Separate stockpiles are to be maintained at the quarry for durable aggregates and they are to be so marked.

Aggregates shall enter the mixer in such a manner that no material foreign to the concrete or material capable of changing the desired proportions is included. In the event two or more sizes or types of coarse or fine aggregates are used on the same project, only one size or type of each aggregate may be used on one continuous concrete placement.
(2) Segregation.
Segregated aggregates shall not be used until they have been thoroughly remixed and the resultant pile is of uniform and acceptable gradation at any point from which a representative sample is taken.

(3) Cement and Fly Ash.
Cement and fly ash in storage or stockpiled on the site shall be protected from any damage by climatic conditions which would change the characteristics or usability of the material.

(4) Moisture.
If the moisture content of accepted aggregates remains constant within a tolerance of 0.5 percent plus or minus from the average for that day, they may be used. However, if the moisture content in the aggregate varies by more than the above tolerance, then whatever corrective measures are necessary to bring the moisture to a constant and uniform quantity shall be taken before any more concrete is placed. This may be accomplished by handling or manipulating the stockpiles to reduce the moisture content or by adding moisture to the stockpiles in a manner that will produce a uniform moisture content through all portions of the stockpile.

If plant equipment includes an approved accurate moisture-determining device which will make possible the determination of the free moisture in the aggregates and provisions are made for batch to batch correction of the amount of water and the mass of aggregates added, the above requirements relative to handling or manipulating the stockpiles for moisture control will be waived. However, any procedure used will not relieve the producer of the responsibility for delivery of concrete of uniform slump within the limits specified.

No aggregate in the form of frozen lumps shall be used in the manufacture of concrete.

(5) Moisture Control for Lightweight Aggregates.
The aggregate shall be handled and stored in such a manner that the gradation and moisture of the material will remain reasonably uniform. The Contractor shall supply adequate sprinkling systems for keeping the aggregates at a uniform moisture content during storage and mixing operations. The Engineer reserves the right to designate the amount of wetting. The lightweight aggregate shall have a moisture content of approximately five percent prior to its introduction into the mixer.

(6) Separation of Materials in Tested and Accepted Stockpiles.
Only K.D.O.T.-Tested Materials shall be used. Separate means shall be provided for storing materials approved by the
Department. If the producer elects to use K.D.O.T.-Tested Materials for other work for his own convenience, during the progress of a project requiring K.D.O.T.-Tested Material, he shall so inform the Engineer and agree to pay all costs of having the additional materials tested.

All conveyors, bins, and hoppers shall be cleaned of unapproved materials before starting to manufacture concrete for the work.

402.07 MIXING AND DELIVERY.

(a) General Requirements.

Concrete shall be mixed in quantities required for immediate use. Concrete shall not be used which has developed initial set or is not in place 1/2 hour after the water has been added for non-agitated concrete. Agitated concrete must be in place 1 1/2 hours after the water has been added when the ambient air temperature at the time of batching is 23°C or less. When the ambient air temperature at the time of batching is between 24°C and 31°C concrete must be in place within one hour after the water has been added unless an approved set retarding admixture is used. If an approved set retarding admixture is used, the concrete must be in place within 1 1/2 hours after the water has been added. The use of an approved set retarding admixture for ambient air temperatures between 24°C and 31°C shall be the Contractors choice and if used will be at his expense. When the ambient air temperature is 32°C or above, concrete shall be in place within one hour after introduction of water to the cement.

In all cases, if the temperature of the concrete at time of placement is 32°C or above, or under conditions contributing to quick stiffening of the concrete, the concrete shall be in place within 45 minutes after introduction of water to the cement.

Concrete shall be discharged without delay and when discharged shall be of the consistency and workability required for the job. The rate of discharge of the plastic concrete from the mixer drum shall be controlled by the speed of rotation of the drum in the discharge direction with the discharge gate fully open.

Adding water to concrete will not be permitted, except when concrete is delivered in truck mixers. Water, not to exceed ten liters per cubic meter of concrete, may be withheld from the load at the batch site, and if needed, added at the construction site to control the slump to meet the specified requirements.
The need for addition of water shall be determined as soon as possible after the load has arrived at the construction site. The adjustment shall be made to the entire load as much as possible, to assure the water-cement ratio has not been exceeded. After additional water is added, the drum or blades shall be turned an additional 20 to 30 revolutions at mixing speed. Additional water will not exceed the amount withheld from any load. Adding water shall be under the Engineers supervision and shall be permitted no more than one time per load and only after the initial revolutions at mixing speed have been completed. Calibrated water measuring devices shall be used for dispensing water. In no case shall the water-cement ratio exceed the design water-cement ratio. Concrete that is not within the specified slump limits at the time of placement shall not be used.

The concrete may be mixed at the site of the work, in a central-mix plant, or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials, except water, are in the drum.

Plant capacity and delivery capacity shall be sufficient to insure continuous delivery at the rate required. The rate of delivery of concrete during concreting operations shall provide for the proper handling, placing and finishing of the concrete.

When drum mixed at the site of the work or in a central mixing plant, the mixing time shall not be less than 60 seconds and a maximum of five minutes with the total mixing revolutions not to exceed 60 revolutions. Mixing time begins after all solid materials are in the drum and ends when the discharge chute opens. Transfer time in multiple drum mixers is included in mixing time. The contents of an individual mixer drum shall be removed before a succeeding batch is emptied therein.

If necessary to increase the mixing period in order to control the entrainment of the required amount of air in air-entraining concrete, the required mixing time will be set by the Engineer.

The mixer shall be operated at a drum speed as shown on the manufacturers name plate on the approved mixer. Any concrete mixed less than the specified time shall be discarded and disposed of by the Contractor at his expense. The volume of concrete mixed per batch shall not exceed the mixer's nominal capacity in cubic meters as shown on the manufacturer's standard rating plate on the mixer; except that an overload up to ten percent above the mixer's nominal capacity for other than truck mixers may be permitted provided concrete test data for
strength, segregation, and uniform consistency are satisfactory, and provided no spillage of concrete takes place.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 15 seconds of the mixing period. The throat of the drum shall be kept free of such accumulations as may restrict the free flow of materials into the drum.

When a truck mixer is used for complete mixing, each batch of concrete shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades at mixing speed. All rotation after mixing, shall be at agitating speed. The total revolutions (mixing and agitating) shall not exceed 300 revolutions.

Unless the mixing unit is equipped with an accurate and dependable device which will indicate and control the number of revolutions at mixing speed, the mixing shall be done at the proportioning plant and the mixing unit shall be operated at agitating speed while traveling from the plant to the job site.

When a truck mixer or truck agitator is used in transporting concrete that has been completely mixed in a stationary central mixer, agitating during transportation shall be at the speed designated by the manufacturer of the equipment as agitating speed. The total revolutions (additional remixing and agitating) shall not exceed 200 revolutions.

When a truck mixer or agitator is used for transporting concrete, the concrete shall be delivered to the site of the work and discharge shall be completed within the maximum time allowed in this section after the addition of the cement to the water. Each batch of concrete delivered at the job site will be accompanied by a time slip issued at the batching plant, bearing the time of charging of the mixer drum with cement and aggregates, except that on paving projects and other high volume work, the Engineer may determine the haul time and thereafter make random checks, and tickets for every load will not be required.

When non-agitating equipment is used for transportation of concrete, approved covers shall be provided for protection against the weather when required by the Engineer.

(b) Concreting in Cold Weather and Night Concreting.

No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.
Unless authorized by the Engineer, mixing and concreting operations shall be discontinued when the descending ambient air temperature reaches 4°C, and not resumed until an ascending ambient air temperature reaches 2°C.

When concreting is authorized during cold weather, the aggregates may be heated by either steam or dry heat prior to being placed in the mixer. The apparatus used shall heat the mass uniformly and shall be so arranged as to preclude the possible occurrence of overheated areas which might injure the materials. Aggregates shall not be heated directly by gas or oil flame or on sheet metal over fire. Aggregates may be used which are heated in bins, by steam-coil or water-coil heating, or by other methods not detrimental to the aggregates. The use of live steam on or through binned aggregates will not be permitted. Unless otherwise authorized, the temperature of the mixed concrete shall be not less than 10°C and not more than 32°C at the time of placing it in the forms. Under no circumstances shall concreting operations continue when the ambient air temperature is less than −7°C.

If the ambient air temperature is 2°C or less at the time of placing concrete, the Engineer may require the water and/or the aggregates to be heated to not less than 21°C nor more than 65°C. No concrete shall be placed on frozen subgrade nor shall frozen aggregates be used in the concrete.

Fly ash or blended cement shall not be used between October 1, and April 1.

(c) Control Tests for Air-Entrained Concrete.

The tests for air content in air-entrained concrete will be made as the work progresses and the frequency will be that which is necessary to control the air content uniformly throughout the concreting operations.

Samples of fresh concrete for the determination of mass per cubic meter and percent of air shall be obtained from the site at which the concrete is placed, directly from the mixer, or at other points as designated. Air content shall be determined in accordance with Section 2500.

Strength test specimens shall be cast in sets of three at a rate prescribed by the Engineer. Specimens shall be made, stored, and tested in accordance with the standard practice currently in use for making, storing, and testing strength test specimens of concrete. This shall be performed in accordance with Section 2500.
402.08 HIGH EARLY STRENGTH CONCRETE.

High early strength concrete shall be proportioned in the same manner as specified for Portland cement concrete in the preceding articles for various classes of concrete except Type III cement shall be required.

402.09 CONCRETE ADMIXTURES FOR WATER REDUCTION AND SET RETARDATION.

Water reducing admixtures, which may include set retarding, may be required in all classes of concrete construction when the placing and finishing properties of the concrete are adversely affected by unfavorable weather or other conditions. The use of the admixtures will be at the option of the Contractor with approval of the Engineer. A list of approved admixtures will be maintained by the Bureau of Materials and Research of the Kansas Department of Transportation. The Contractor shall select the type of admixture from the approved list and the continued use will be based upon performance. It is the contractor's responsibility to assure himself that the admixture will work as intended without detrimental effects. The amount of the admixture to be used in the mix will be determined by the Contractor.

The Contractor shall be responsible for all labor and equipment necessary for the proper mixing, measuring and dispensing of the admixture. No additional compensation will be allowed for furnishing and incorporating the admixture in the mix.

402.10 INSPECTION AND TESTING.

Adequate and safe facilities for the Department testing, lab, stoves, etc., shall be provided at the batch site for the Engineer to inspect ingredients and processes used in the manufacture and delivery of the concrete. The manufacturer shall afford the inspector representing the Engineer all reasonable facilities without charge, for securing samples and conducting tests to determine whether the concrete is being furnished in accordance with these Specifications.

Approval of any concrete plant will be granted only when an inspection of the plant indicates that the equipment, the method of storing and handling of materials, the production procedures, the transportation and rate of delivery of concrete from the plant to the point of use, meet the requirements set forth herein.
Permission to use concrete from any previously approved plant may be rescinded at any time upon failure to comply with the requirements of these Specifications.
Tests shall be made at intervals designated by the Engineer to determine the acceptability of the concrete.

402.11 CERTIFIED CONCRETE.

When authorized by the Engineer, concrete may be used from approved plants when State inspection forces are not available on a temporary basis. Approval for this operation will be based on certification of the plant and plant personnel according to Department standards and may be withdrawn any time that certification procedures are not followed. Each load of certified concrete shall be accompanied by a ticket listing mix proportions, time of batching and setting on revolution counter, total mixing revolutions and shall be signed by certified plant personnel.
Certified concrete shall not be used for major structures such as bridges, RCB box bridges, RCB culverts, permanent main line and ramp pavement, or other structurally critical items.

402.12 COMMERCIAL GRADE CONCRETE.

Commercial grade concrete may be used on items designated on the Plans. When commercial grade concrete is used, the following stipulations shall govern:

(a) Materials and Composition.
The commercial grade concrete mix shall be approved by the Engineer. This approval will in general be based upon the following conditions:
All materials shall be those normally used for the production and sale of concrete in the vicinity of the project.
The mixture produced shall have a minimum cement content of 7.85 sacks (335 kilograms) of cement per cubic meter of concrete. The water-cement ratio will be as designated by the Engineer. The maximum water-cement ratio permitted shall not exceed 0.55 kilograms of water per kilogram of cement including free water in the aggregate.
Type I, II, III, IP or I(PM) cement may be used unless otherwise designated. Fly ash from an approved source as specified above may be substituted for not more than 15 percent of the required minimum cement content. Fly Ash may be substituted for the displaced cement at a rate of one to 1½ kilograms of fly ash for each kilogram of cement removed. The maximum water-cement ratio shall not exceed 0.55 kilograms of water per
kilogram of cement plus kilograms of fly ash. Fly ash shall not be used as a partial replacement for Type IP, Type I(PM) or Type III cement. Fly ash or blended cement shall not be used between October 1 and April 1. No additives other than air entraining agent will be allowed.

The Contractor will not be required to furnish the results of strength tests when submitting mix design data to the Engineer.

(b) Equipment.

Good engineering judgment shall be exercised in determining what equipment will be allowed for use in proportioning, mixing, transporting, placing, consolidating and finishing the concrete.

(c) Construction Requirements.

Construction and placing requirements will be in accordance with the best current industry practices and techniques.

Before unloading at the site, the ready-mix concrete plant shall provide with each load of concrete, a delivery ticket containing the following information:
1. Name and location of plant.
2. Time of batching concrete.
3. Mix proportions of concrete (or a mix designation approved by the Engineer).
4. Number of cubic meters of concrete batched.

The various items poured shall be cured the length of time stipulated in subsection 701.03(h).

Commercial grade concrete may be test sampled by molding sets of three cylinders. This will be for informational purposes only. No slump or unit mass tests will be required.

402.13 METHOD OF MEASUREMENT.

The quantities of concrete constituting all or a portion of a completed pavement or structure shall be measured as provided in the several sections involved.

402.14 BASIS OF PAYMENT.

The quantities of concrete, measured as provided above, shall be paid for at the Contract unit prices as prescribed in the several sections involved, which prices and payments shall be full compensation for all items as enumerated in the several sections.