

Case Introduction – Revisions to MAG Section 725 and the associated portion of Section 701 – Submitted on March 4, 2009

Rationale:

Section 725 of the MAG Specifications have not been revised or updated for many years – perhaps decades. With the inevitable changes in concrete technology, materials, and construction methods, other associated Industry Standards have continued to be enhanced and updated leaving this section far behind. Some of the issues with the existing specification were:

- 1) Much of the wording was out of date regarding current Industry practice
- 2) Many currently used concreting materials were not included
- 3) Some of the organization of information was redundant or needed re-working to provide a clearer, easier to use and more complete document for field personnel
- 4) References to other widely recognized Industry Standards were missing – ASTM, ACI, ADOT, etc. This did not take advantage of accepted technical information and standards that could make this section a more living document – able to change with future advancements without the need for major re-writing

To correct or augment the existing language, individual Agencies were prompted to write their own supplemental documents. This negates the original design of the MAG Specifications themselves – one document that would provide a unified standard for all the Agencies in Maricopa County and beyond. Many individuals have come together from a number of perspectives - cities, testing laboratories, contractors, and material suppliers - to work together to provide current input and develop a more technically usable document for all. We submit this to the MAG Specifications and Details Committee with the request to make this a case for consideration.

Some of the major changes/revisions are:

- 1) Elimination of the 14 day compressive strength requirement in Table 725-1
- 2) Increase in the allowable amount of fly ash or natural pozzolan (SCM) to provide additional long term durability to align other similar Industry Specifications (ADOT, ACI) – 725.2.1
- 3) Moving concrete aggregate requirements to section 701 where they are more appropriate – 725.3, 725.4
- 4) Inclusion of a new section on additional concrete additives – 725.6
- 5) Re-organizing much of the sections on mix design proportioning, mixing, and delivery to provide a more up-to date and clear presentation of the technical requirements – 725.7, 725.8
- 6) Elimination of no longer needed or applicable language – 725.9
- 7) Re-wording and clarifying key components to the fields testing section to provide a better reference document for field personnel – 725.10
- 8) Additions to the Acceptance section involving plastic concrete properties and updating of the compressive strength acceptance criteria and adjustment table – 725.11
- 9) Updated references throughout to appropriate ACI and ASTM documents

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PORTLAND CEMENT CONCRETE**725.1 GENERAL:**

Portland cement concrete shall be composed of cementitious materials, fine and coarse aggregates, water, and, if provided for or allowed, certain chemical admixtures and additives.

CONCRETE CLASSES MINIMUM REQUIREMENTS			
Class of Concrete	Minimum Cementitious Materials Content (Lbs. Per Cu Yard)	Minimum Compressive Strength (1)	
		at 28 Days psi	
AA	600		4000
A	520		3000
B	470		2500
C	420		2000

(1) In accordance with section 725.10.

Class AA concrete shall be used as specified.

Class A concrete shall be used for concrete structures, either reinforced or non-reinforced, and for concrete pavements.

Class B concrete may be used for curbs, gutters and sidewalks.

Class C concrete may be used for thrust blocks, encasements, fill or over-excavation, etc.

725.2 CEMENTITIOUS MATERIALS:

Cementitious materials to be used or furnished under this specification shall be:

Portland cement, meeting the requirements of ASTM C-150
 Type II, low alkali, when no other specific type is specified
 Type III, low alkali, for high early strength, when applicable
 Type V, low alkali, when specified in the special provisions for use in concrete which will be exposed to contact with soils or waters containing water soluble sulfates (as SO₄) in concentration greater than 0.20% by weight of soil or 1500 PPM in solutions

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Portland Pozzolan Cement ASTM C-595
Type IP (MS), when no other specific type is specified

Supplementary cementitious (pozzolanic) materials shall not be used as an additional cementitious materials replacement in concrete in combination with Portland Pozzolan Cement.

Cementitious materials shall be sampled and tested as prescribed in the applicable ASTM specifications. The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the material manufacturer, identifying the cementitious material and stating that the cementitious material delivered to the batching site complies with the appropriate specifications. When requested by the Engineer, the Contractor shall furnish 3 copies of the cementitious materials certification. The cost of furnishing tested cementitious materials shall be considered as included in the contract bid price and no additional allowance will be made therefore.

When suitable facilities, as recommended by the Concrete Plant Manufacturer's Bureau, and approved by the Engineer, are available for handling and weighing bulk cementitious materials, such facilities shall be used. Otherwise the cementitious material shall be delivered in original unopened sacks that bear the name or brand of the manufacturer. The type of cementitious material, and the weight contained in each sack shall be plainly marked thereon.

Cementitious materials shall be stored in such manner as to permit ready access for the purpose of inspection and identification, and so as to be suitably protected against damage by contamination or moisture. Should any lot of bulk cementitious material be delivered to the site show evidence of contamination, the Engineer may require that such lot be removed from the site.

725.2.1 Supplementary Cementitious (Pozzolan) Materials (SCM): Supplementary cementitious (pozzolanic) materials to be used in concrete or furnished under this specification shall conform to the appropriate ASTM requirements as follows:

Fly ash or natural pozzolan	ASTM C-618 and C-311
Silica Fume	ASTM C-1240

Up to 25 percent by weight of the Table 725-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. Additional pozzolanic material in excess of the minimum Table 725-1 requirements may be incorporated into a concrete mix design to achieve enhanced performance, upon approval of the Engineer or Agency.

The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the pozzolan supplier identifying the pozzolanic material and stating the pozzolan delivered to the batching site complies with the appropriate specifications. The cost of furnishing tested pozzolan shall be considered as included in the contract bid price and no additional allowance will be made therefore.

Pozzolanic materials shall be handled and stored in the same manner as other cementitious materials. When facilities for handling a bulk pozzolan are not available, the pozzolan shall be delivered in original unopened sacks bearing the name and brand of the supplier, the type and source of the pozzolan, and the weight contained in each sack plainly marked thereon.

725.3 AGGREGATES:

Coarse aggregates, consisting of crushed rock or gravel or a combination thereof, and fine aggregate shall conform to the requirements prescribed in Section 701.3.3. Prior to the delivery of the aggregates, the Contractor will be required to furnish samples for testing, and shall notify the Engineer as to when and where they will be available. Thereafter, additional required samples shall be furnished at the expense of the Contractor, but the cost of testing and making the grading analysis will be borne by the Contracting Agency. Samples shall be taken by the Engineer or in the presence of the Engineer.

725.4

725.5 WATER:

The water used for mixing concrete shall be potable or shall meet the requirements of ASTM C-1602, when tested by a qualified independent testing laboratory.

725.6 ADMIXTURES AND ADDITIVES:

Admixtures or additives of any type, except as otherwise specified, shall not be used unless incorporated into the approved mix design or authorized by the Engineer or appropriate Agency representative.

Water Reducing admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C-494 for the appropriate type.

Air-entraining admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C-260.

Pigments incorporated into the approved concrete mix design for integrally colored concrete shall meet the requirements of ASTM C-979.

Fibers incorporated into the approved concrete mix shall meet the requirements of ASTM C-1116.

Any admixtures used shall be included in the bid price for that item.

725.7 MIX DESIGN PROPORTIONING:

A concrete mix design carrying the producer's designated mix number for each type of concrete being furnished under these specifications shall be submitted to the Agency or Engineer at least once each year for approval. Each design shall utilize the proper proportioning of ingredients to produce a concrete mix that is homogeneous and sufficiently workable to provide a consistent and durable concrete product that meets the specified compressive strength and other properties as required by the application. In the event there is a modification to the mix design proportions:

A) Modifications that will not require a new mix design submittal/approval:

- 1 Modifications which do not result in batch target weights for the fine aggregate or combined coarse aggregates changing by more than 5 percent from the original approved mix design.
- 2 Modifications to the percentage of coarse aggregate fractions that do not change the total coarse aggregate volume.
- 3 Modifications to dosages of chemical or air-entraining admixtures, within the manufacturer's recommendations.
- 4 The incorporation or elimination of chemical admixtures which are listed on the mix design to effect a change in the time-of-set (retarders or accelerators).

B) Modifications that will require a new mix design submittal/approval and may require performance verification:

- 1 Modification to the class of concrete per Table 725-1.
- 2 Modification to the type/class of cement, fly ash, natural pozzolan, or silica fume.
- 3 Modification to the percentage of fly ash, natural pozzolan, or silica fume.
- 4 Modification to a coarse aggregate size designation.
- 5 Modification of the type of chemical admixture, or the incorporation or elimination, of an air-entraining admixture.
6. Modification of coarse or fine aggregate source

725.8 MIXING:

All proportioning/batching/mixing equipment shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association or National Ready Mixed Concrete Association. The

proportioning shall consist of combining the specified sizes of aggregates with cement, supplementary cementitious materials, admixtures/additives, and water as herein provided. No method which may cause the segregation or degradation of materials shall be used.

Weighing and metering devices used for the purpose of proportioning materials shall fulfill requirements as to accuracy and tolerance prescribed by the Weights and Measures Division of the State of Arizona and shall be sealed and certified in accordance with the procedures established by this agency. This certification shall not be over 12 months old and shall be renewed whenever required by the Engineer. When portable plants are set up at a new or temporary location, the scales and scale assembly shall be inspected and certificate issued regardless of the date when the scales were last tested. The Engineer may require the Contractor to run a quick scale check at any time with certified weights furnished by the Contractor and order the scale recertified if necessary.

Any admixture shall be measured accurately by mechanical means into each batch by equipment or in a method approved by the Engineer.

The equipment for measuring and supplying the water in the mixer shall be so constructed and arranged that the amount of water to be added to the mixture can be measured, in gallons or by weight, positively. The amount of water shall be varied in accordance with the percentage of free moisture in the material and the requirements of the workability of the aggregate.

Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical; in which latter event hand mixing will be permitted, only to the extent necessary. Regardless of the method employed, mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates. All concrete mixers shall be of such design and construction, and so operated, as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed.

725.8.1 Paving and Stationary Mixers: Paving and stationary mixers shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association.

Mixers shall be maintained in proper and serviceable working condition, and any part or portion thereof that is out of order, or becomes worn to such extent as to detrimentally affect the quality of mixing, shall be promptly repaired or replaced.

The proper proportions of aggregate, cement, Pozzolan and water for each batch of concrete shall be placed in the mixer, and shall be mixed for a period of not less than 50 seconds after all such materials are in the drum.

The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.

725.8.2 Transit Mixers: Transit mixers shall meet the requirements of the Truck Mixer Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. Ready mix concrete and shall comply with ASTM C-94 except as herein specified.

Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades.

Each mixer shall have an identification number painted on the truck in such a location that it can be easily read from the batching platform.

The total volume of materials introduced into the mixer for mixing purposes shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this section, the amount of materials charged into the mixer shall be reduced.

The rotation speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

Each batch of concrete placed in the mixer shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades, at the speed designated by the manufacturer of the equipment as mixing speed. Additional mixing shall be at the agitating speed designated by the manufacturer of the equipment. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum. Before any portion of the materials for any batch of concrete is placed therein, the drum of the mixer shall be completely emptied of the previously mixed batch.

At the time of delivery to the job site, the Agency or Engineer shall be provided with a legible delivery ticket which shall contain the following information:

Date and Truck Number.

Name of the Supplier.

Name of the Contractor.

Specific designation of job (name and location).

Number of cubic yards in the batch.

Time the transit mixer is loaded.

Amount of water added at the job site at request of receiver, and his signature or initials.

Suppliers' mix design code number.

Type and amount of admixture or additive that is not already included in the approved mix design, if any.

Serial number of the ticket.

Additional water may be added at the point of discharge in accordance with ASTM C-94 Tolerances in Slump section to adjust slump providing the slump after such water addition does not exceed the maximum allowed by these specifications in section 725.11 and that water so added is mixed into the batch for a minimum of 30 additional revolutions at mixing speed. Loss of cement mortar during discharge which in the opinion of the Engineer would be of sufficient amount to affect the homogeneity of the concrete will be cause for rejection of the load. The Contractor shall be responsible for all concrete to which water is added at the job site.

725.8.3 Hand Mixed Concrete: Hand mixed concrete shall be prepared on a watertight level platform in batches of not to exceed 1/3 cubic yard each. The required amount of coarse aggregate shall first be spread on the platform in an even and uniform layer, over which the proper proportion of fine aggregate shall then be likewise spread. The combined depth of both such layers shall not be greater than one foot. The required quantity of cement shall then be evenly distributed over the fine aggregate; following which the entire batch shall be turned with shovels at least twice before the water is added. The proper amount of water shall then be uniformly sprinkled or sprayed over the batch, which shall thereafter be returned with shovels not less than 3 times before being removed from the platform.

725.8.4 Dry batched Unmixed Concrete: Should the Contractor elect to use dry batched unmixed concrete, an accurate batch weight shall be provided to record the quantities of cementitious materials, aggregate and water batched into the containers. The date of batching, the container number and the batching certificate number shall be recorded at the time of batching. Copies of the batch weight records shall be submitted to the Agency or Engineer upon request.

All dry batched unmixed concrete delivered to the job site shall be stored in containers so constructed that the cement cannot come in contact with the water and aggregate within the container. Any admixture added to powder form shall be added to the cement; if added in liquid form, it shall be added to the water.

The contents of the container shall be discharged into a mixer at the job site. Following discharge of the first container into the mixer, the mixer shall be operated at mixing speeds during the discharge of the remaining containers. After the contents of the last container have been discharged into the mixer, the concrete shall be mixed as specified in this specification for transit mixers, and drum or turbine type mixers.

Any spillage of cement, aggregate, water or admixture during the filling, transporting, or the discharging of the container, shall be cause for rejection of the container or the

contents of the mixer if any portion of the rejected container is discharged into the mixer.

725.9

725.10 TESTS AND TEST METHODS:

725.10.1 Concrete shall be sampled in accordance with ASTM C-172 for determination of temperature, slump, unit weight and yield (when required) and air content (when required) as well as for fabrication of test cylinders for compressive strength determination at 28 days. Samples shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders but in no case less than 1 cubic foot. Concrete shall be sampled during discharge of the middle portion of the batch. At the discretion of the Agency and/or Engineer or his representative, a sample may be obtained at the beginning of the discharge if the properties of the concrete do not appear to be within the specification limits for slump or temperature.

All testing shall be done by a certified technician meeting the requirements of the ACI Concrete Field Testing Technician, Grade I or equivalent.

Temperature of the concrete mixture will be determined in accordance with ASTM C-1064.

Slump of the concrete mixture will be determined in accordance with ASTM C143.

Air content of the concrete mixture (when required) will be determined in accordance with ASTM C-231 or C-173, whichever is applicable.

Unit weight and yield of the concrete mixture (when required) will be determined in accordance with ASTM C-138.

All compressive strength test specimens will be made, cured, handled, protected, and transported in accordance with the requirements of ASTM C-31. The contractor shall provide and maintain for the sole use of the testing laboratory/technician adequate facilities for safe storage and proper curing of concrete test cylinders on the project site including sufficient access on weekends and holidays to allow the timely pick-up of cylinders specimens. Any and all deviations from the standard procedure of any test method shall be promptly identified and corrected. Any deviations shall be clearly noted by the testing laboratory on all written reports. Testing results obtained from non-standard testing procedures may be considered invalid and discarded by the Agency and/or Engineer.

725.10.2 In accordance with ACI 318 Chapter 5 Section 5.6.2.4, a cylinder strength test shall be the average of the strengths of at least two 6 inch by 12 inch cylinders or at least three 4 inch by 8 inch cylinders made from the same sample of concrete and tested at 28 days. An adequate number of cylinder specimens will be made for each 50

cubic yards or not less than each half-day's placement of each class of concrete. All specimens will be tested in a laboratory approved by the Agency and/or Engineer in accordance with ASTM C-39 for concrete acceptance. Should an individual cylinder show evidence of improper sampling, molding, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining cylinder(s). Additional cylinder specimens may be made and tested at other ages to obtain additional compressive strength information and may not be considered as acceptance tests.

725.10.3 If the 28-day strength test does not meet the compressive strength requirements, the contractor may choose to contest the compressive strength results of any test for purposes of acceptability or payment. This may involve an engineering study to determine the acceptability of the concrete in question or core testing to determine in-place concrete strengths. If core testing is performed, at least three representative cores shall be obtained, conditioned and tested in accordance with ASTM C-42 from each concrete member or area of concrete to be tested at locations designated by the Agency and/or Engineer. Cores damaged subsequent to or during removal shall be rejected and additional core samples taken. Cores must be obtained and delivered to a laboratory acceptable to the Agency and/or Engineer in time to allow complete strength testing within 48 days of original concrete placement. The contractor may elect to have a representative present during sampling and testing. A core strength test shall be the average of the results of the three cores. Should an individual core show evidence of improper sampling, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining core(s). Results of the core strength testing will replace the results of the cylinder strength test for that sample.

725.11 ACCEPTANCE:

A) Plastic Concrete Properties

- 1) The slump of the concrete shall meet the requirements of ASTM C-94 Tolerances in Slump section. When the approved mix design or project specification requirements for slump are a "maximum" or "not to exceed", the following tolerances will apply:

Specified slump:	If 3" or less	If more than 3"
Plus tolerance	0 inch	0 inch
Minus tolerance	1 1/2 inch	2 1/2 inch

When the approved mix design or project specification requirements for slump are not written as a "maximum" or "not to exceed", the following tolerances will apply:

For design slump of:	Tolerance
2 inch and less	+/- 1/2 inch
More than 2 through 4 inch	+/- 1 inch

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More than 4 inch

+/- 1 1/2 inch

- 2) Per ACI 305, Specification for Hot Weather Concreting, limit the maximum allowable temperature of the concrete mixture immediately before placement to 95 degrees F unless otherwise specified or unless a higher allowable temperature is accepted by the Engineer/Agency. This acceptance can be based upon past field experience or preconstruction testing using a concrete mixture similar to one known to have been successfully used at a higher concrete temperature.

Per ACI 306, Specification for Cold Weather Concreting, when the atmospheric temperature at the time of placing concrete is above 30°F the temperature of the concrete, as placed, shall not be less than 60°F. When the atmospheric temperature at the time of placing concrete is between 0°F and 30°F the temperature of the concrete, as placed, shall not be less than 65°F.

- 3) Air entrained concrete shall meet the requirements of ASTM - Air-Entrained Concrete section. The air content of air-entrained concrete when sampled from the transportation unit at the point of discharge shall be within the approved mix design tolerance or +/- 1.5 % of the specified value. When a representative sample taken prior to discharge shows an air content below the specific level by more than the allowable tolerance, additional air entraining admixture may be used to achieve the desired air content level, followed by a minimum of 30 revolutions at mixing speed.
- 4) Per ASTM C-94 Mixing and Delivery section, discharge of the concrete shall be completed within 1 1/2 hour after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. The Engineer/Agency or their representative may allow the continuation of concrete placement after the 1 1/2 hour time limit has been reached if the concrete is of such slump or workability that it can be placed without the addition of water to the batch.

Concrete failing to meet the tolerances for plastic concrete properties in 1-4 above shall be reviewed by the Engineer/Agency or their representative and may be subject to rejection.

B) Hardened Concrete Properties – Compressive Strength

- 1) Concrete represented by a cylinder strength test obtained in accordance with section 725.10.2 shall be acceptable if the 28-day strength meets or exceeds the specified design strength. Concrete achieving at least 85% of the specified 28-day strength will be evaluated by the Agency and/or Engineer for acceptability. Core strength tests obtained in accordance with section 725.10.3 shall be considered satisfactory if their average is equal to or greater than 85 percent of the specified strength and no single core is less than 75 percent of the specified

strength. If the core strength test meets or exceeds the minimum 28-day strength, the concrete will be accepted by the Agency at full contract price. All concrete failing to meet the acceptability requirement as evidenced by tests of either standard cylinder or drilled core specimens shall be rejected, removed and replaced by the Contractor at the contractor's expense, unless the Contractor can submit evidence that will indicate to the Agency and/or Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable and be allowed to remain in place.

- 2) When concrete is accepted on the basis of cylinder or core strength tests of less than 100% of the required minimum 28-day compressive strength, an adjustment in the concrete unit price may be made for the quantity of concrete represented by such strength tests in accordance with the following schedule:

Adjustment in Concrete Unit Price Based on Cylinder or Core Strength Testing

Percent of Specified Minimum 28-day Compressive Strength Attained (Nearest 1%)	Percent of concrete Unit Price Allowed
100 % or greater	100
95-99	95
90-94	90
85-89	85

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PORTLAND CEMENT CONCRETE

725.1 GENERAL:

Portland cement concrete shall be composed of portland cement or portland Pozzolan cement, Pozzolonic Materials, fine and coarse aggregates, water, and, if provided for or allowed, certain ~~admixtures.~~ → chemical admixtures and additives.

~~All of the materials used for concrete shall be in accordance with these specifications and requirements for the particular material as provided herein.~~ → Deleted – redundant

~~Weighing and metering devices used for the purpose of proportioning materials shall fulfill requirements as to accuracy and tolerance prescribed by the Weights and Measures Division of the State of Arizona and shall be sealed and certified in accordance with the procedures established by this agency. This certification shall not be over 12 months old and shall be renewed whenever required by the Engineer. When portable plants are set up at a new or temporary location, the scales and scale assembly shall be inspected and certificate issued regardless of the date when the scales were last tested. The Engineer may require the Contractor to run a quick scale check at any time with certified weights furnished by the Contractor and order the scale recertified if necessary.~~ → Moved to section 725.8

TABLE 725-1
CONCRETE CLASSES MINIMUM REQUIREMENTS

Class of Concrete	Min. Cement Content Lbs. Per Cu Yard	Minimum Compressive Strength (1)	
		at 14 Days psi	at 28 Days psi
AA	600	3200	4000
A	520	2400	3000
B	470	2000	2500
C	420	1600	2000

→ rename to - Minimum Cementitious Materials Content

In accordance with section 725.10.
(1) As tested in accordance with ASTM C-39. Maximum slump 5 inches when tested in accordance with ASTM C-143. → removed and handled in section 725.11 Acceptance

Class AA concrete shall be used as specified.

Class A concrete shall be used for concrete structures, either reinforced or non-reinforced, and for concrete pavements.

Class B concrete may be used for curbs, gutters and sidewalks.

Class C concrete may be used for thrust blocks, encasements, fill or over-excavation, etc.

725.2 PORTLAND CEMENT:

Cement to be used or furnished under this specification shall be Portland cement, conforming with the requirements of ASTM C-150, Type II, low alkali, or Portland Pozzolan Cement, conforming with the requirements of ASTM C-595, Type IP (MS), low alkali, except when another type including high early strength is specified in the special provisions or shown on the plans. Type V cement (ASTM C-150) shall be specified in the special provisions for use in concrete which will be exposed to contact with soils or waters containing water soluble sulfates (as S04) in concentration greater than 0.20% by weight of soil or 1500 PPM in solutions. Pozzolonic materials shall not be used as a directly added ingredient in concrete in combination with Portland Pozzolan Cement.

Reorganize and reword this paragraph in list form for increased clarity.

Cementitious materials to be used or furnished under this specification shall be:

- Portland cement, meeting the requirements of ASTM C-150
 - Type II, low alkali, when no other specific type is specified
 - Type III, low alkali, for high early strength, when applicable
 - Type V, low alkali, when specified in the special provisions for use in concrete which will be exposed to contact with soils or waters containing water soluble sulfates (as S04) in concentration greater than 0.20% by weight of soil or 1500 PPM in solutions
- Portland Pozzolan Cement ASTM C-595
 - Type IP (MS), when no other specific type is specified

Supplementary cementitious (pozzolanic) materials shall not be used as an additional cementitious materials replacement in concrete in combination with Portland Pozzolan Cement.

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Cement shall be sampled and tested as prescribed in applicable ASTM specifications. The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the cement manufacturer, identifying the cement and stating that the cement delivered to the batching site complies with those specifications. When requested by the Engineer, the Contractor shall furnish him with 3 copies of said certification. The cost of furnishing tested cement shall be considered as included in the contract bid price and no additional allowance will be made therefore.

When suitable facilities, as recommended by the Concrete Plant Manufacturer's Bureau, and approved by the Engineer, are available for handling and weighing bulk cement, such facilities shall be used. Otherwise the cement shall be delivered in original unopened sacks that have been filled at the mill and bear the name or brand of the manufacturer. The type of cement, and the weight of cement contained in each sack shall be plainly marked thereon.

Cement shall be stored in such manner as to permit ready access for the purpose of inspection and identification, and so as to be suitably protected against damage by contamination or moisture. Should any lot of bulk cement be delivered to the site show evidence of contamination, the Engineer may require that such lot be removed from the site.

~~A cement shall not be mixed with any other brand or type unless written permission has first been obtained from the Engineer. All cement used in the manufacture of concrete for any individual structure shall be of the same brand unless otherwise approved by the Engineer.~~

Remove as no longer needed.

~~725.2.1 Pozzolonic Materials: Pozzolonic materials to be used in concrete or furnished under this specification shall conform to the requirements of ASTM C-618.~~

~~If an approved pozzolonic material is used, 15 percent by weight of the Table 725-1 minimum portland cement requirements shall be replaced. The replacement ratio shall be 1.2 pounds of pozzolan per pound of replaced portland cement. If the class of concrete is not from Table 725-1, the amount of pozzolonic material used will be 17.5 percent of the combined weight of pozzolonic material and portland cement.~~

Supplementary Cementitious (Pozzolanic) Materials (SCM): Supplementary cementitious (pozzolanic) materials to be used in concrete or furnished under this specification shall conform to the appropriate ASTM requirements as follows:

Fly ash or natural pozzolan	ASTM C-618 and C-311
Silica Fume	ASTM C-1240

~~Pozzolans shall be sampled and tested as prescribed in ASTM C-618 and ASTM C-311. The Contractor shall obtain and deliver to the Engineer a certification of compliance signed by the Pozzolan supplier identifying the Pozzolan and stating the Pozzolan delivered to the batching site complies with applicable specifications. The cost of furnishing tested Pozzolan shall be considered as included in the contract bid price and no additional allowance will be made therefore.~~

~~Pozzolan material shall be handled and stored in the same manner as portland cement. When facilities for handling bulk Pozzolan are not available, the Pozzolan shall be delivered in original unopened sacks bearing the name and brand of the supplier, the type and source of the Pozzolan, and the weight contained in each sack plainly marked thereon.~~

Up to 25 percent by weight of the Table 725-1 minimum cementitious materials requirements may be an approved fly ash or natural pozzolan. Additional pozzolonic material in excess of the minimum Table 725-1 requirements may be incorporated into a concrete mix design to achieve enhanced performance, upon approval of the Engineer or Agency.

~~A Pozzolan shall not be mixed with any other brand or type unless written permission has first been obtained from the Engineer. All Pozzolan used in the manufacture of concrete for any individual structure shall be of the same type, and from the same source unless otherwise approved by the Engineer.~~

Remove as no longer needed.

725.3 AGGREGATES:

~~Aggregates shall be crushed rock or gravel or a combination thereof and sand conforming to the requirements prescribed in Section 701. Prior to the delivery of the aggregates, the Contractor will be required to furnish samples for testing, and shall notify the Engineer as to when and where they will be available. Thereafter, additional required samples shall be furnished at the expense of the Contractor, but the cost of testing and making the grading analysis will be borne by the Contracting Agency. Samples shall be taken by the Engineer or in the presence of the Engineer.~~

Coarse aggregates, consisting of crushed rock or gravel or a combination thereof, and fine aggregate shall conform to the requirements prescribed in Section 701.3.3.

~~No method which may cause the segregation, degradation or the combining of materials of different grading shall be used.~~

Unclear wording and location – the proper section is 725.8 Mixing and the method of combining materials is addressed there

725.4 AGGREGATE GRADING:

~~Aggregates for each batch of concrete to be prepared shall be combined from materials separately stored in the various sizes and gradations as prescribed in Section 701. The relative proportions of each aggregate used will be as required to meet the provisions of this specification and will be the responsibility of the Contractor.~~

Moved and reworded to the proper section 701.3.3 on aggregate grading

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~~Except where the amount of concrete for any one job is 10 cubic yards or less, various sizes of both coarse and fine aggregate shall be proportioned by weight unless permission to do otherwise has first been obtained from the Engineer. Aggregates that are proportioned by volume shall be measured in containers of known capacity. Regardless of the method employed, either by weight or volume, each individually stored size of aggregate shall be proportioned separately, but not necessarily weighed individually.~~

Remove as redundant and misplaced – mixing is properly handled in section 725.8

~~The maximum size of the aggregate shall not be larger than one-fifth of the narrowest dimension between forms of the members for which the concrete is to be used, or larger than 3/4 of the minimum clear spacing between reinforcing bars.~~

Removed as a misplaced item in the Portland Cement Concrete section – should be handled in the design specifications/standard drawings

725.5 WATER:

~~The amount of water shall be varied in accordance with the percentage of free moisture in the material and the requirements of the workability of the aggregate.~~

~~The equipment for measuring and supplying the water in the mixer shall be so constructed and arranged that the amount of water to be added to the mixture can be measured, in gallons or by weight, positively and that the predetermined quantity of water required can be discharged rapidly in one operation into the mixing drum without dribbling. Tanks or other equipment for measuring and discharging water into the mixer shall be sufficiently accurate that the amount of water delivered to the mixer for any batch shall not vary more than 1 percent from the required quantity. Adequate means for determining and checking the accuracy of the equipment shall be provided and made available to the Engineer at all times.~~

Moved and reworded to the proper section 725.8 on Mixing - also handled in the required Concrete Plant/ARPA certification

~~The water used for mixing with concrete shall be potable and free from oil, vegetable matter and other deleterious substances, and shall conform to the following requirements:~~

The water used for mixing concrete shall be potable or shall meet the requirements of ASTM C-1602, when tested by a qualified independent testing laboratory.

~~Water for prestressed concrete shall not contain chlorides calculated as sodium chloride in excess of 1,000 parts per million nor sulphates calculated as sodium sulphate in excess of 1,000 parts per million nor any sulphates calculated as sulphate in excess of 1,000 parts per million. Water shall not contain an amount of impurities that will cause a change in the time of setting of portland cement of more than 25 percent nor a reduction in the compressive strength of portland cement mortar of more than 5 percent compared to results obtained with distilled water.~~

Included in the requirements of ASTM C-1602

725.6 ADMIXTURES: **AND ADDITIVES:**

~~Admixtures of any type, except as otherwise specified, shall not be used unless written authorization has been obtained from the Engineer.~~

~~If an air-entraining agent is authorized, the amount used will be limited to the extent that the amount of entrained air by volume shall not be more than 6 percent. Air-entraining agents complying with AASHTO M-154 or ASTM C-260 will be permitted as long as strength requirements are met. Any admixture shall be measured accurately by mechanical means into each batch by equipment and in a method approved by the Engineer. Any admixtures used shall be included in the bid price for that item.~~

Admixtures or additives of any type, except as otherwise specified, shall not be used unless incorporated into the approved mix design or authorized by the Engineer or appropriate Agency representative.
Water Reducing admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C-494 for the appropriate type.
Air-entraining admixtures incorporated into the approved concrete mix design shall meet the requirements of ASTM C-260.
Pigments incorporated into the approved concrete mix design for integrally colored concrete shall meet the requirements of ASTM C-979.
Fibers incorporated into the approved concrete mix shall meet the requirements of ASTM C-1116.

725.7 PROPORTIONING: **MIX DESIGN PROPORTIONING:**

~~All proportioning equipment shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. The proportioning shall consist of combining the specified sizes of aggregates, each stored in a separate bin with cement, Pozzolanic Materials, and water as herein provided. Weigh hoppers shall be charged from bins located directly over the weigh hoppers or from conveyor belts. When conveyor belts are used, there shall be a separate belt for each size of aggregate.~~

moved to the proper section 725.8 on Mixing

~~Bulk cement shall be weighed in an individual hopper and shall be kept separate from the aggregates until the batch ingredients are released for discharge. The cement hopper shall be attached to a separate scale for individual weighing.~~

Moved and reworded to the proper section 725.8 on Mixing

~~All Pozzolan that is to be incorporated into the concrete as a separate ingredient shall be weighed. When the cement scales are used for weighing both cement and Pozzolan, the cement shall be weighed first. If separate scales are provided, they shall be accurate to ± 0.3 percent of the scale capacity.~~

~~Scales utilized in the proportioning device may be of the springless dial type or of the multiple-beam type.~~

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~~If the dial-type, the dial shall be of such size and so arranged that it may be read easily from the operating platform.~~

~~If the multiple beam-type, the scales shall be provided with an indicator operated by the main beam which will give positive visible evidence of over or under weight. The indicator shall be so designed that it will operate during the addition of the last 400 pounds of any weighing. The over travel of the indicator hand shall be at least 1/3 of the loading travel. Indicators shall be enclosed against moisture and dust.~~

~~Weighing equipment shall be as recommended by the Concrete Plant Manufacturer's Bureau and be insulated against vibration or movement of other operating equipment in the plant. When the entire plant is running, the scale reading at cutoff shall not vary from the weight designated by the Engineer more than 1 percent for cement, Pozzolan or Cement Pozzolan, 1 1/2 percent for any size of aggregate, nor 1 percent for the total aggregate in any batch.~~

~~When proportioned at a central mixing plant there shall be an approved moisture meter, accurate within 1/2 percent, installed to indicate the moisture in the fine aggregate.~~

~~A concrete mix design carrying the producer's designated mix number of the concrete being furnished under these specifications shall be submitted to the Contracting Agency at least once each year. In the event there is any change in the source of material, another mix design shall be submitted.~~

725.8 MIXING:

~~Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical; in which latter event hand mixing will be permitted, only to the extent necessary. Regardless of the method employed, mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates.~~

~~The temperature of materials as charged in the mixer shall be such that the temperature of the mixed concrete at the time it is placed in final position does not exceed 90°F. When the atmospheric temperature at the time of placing concrete is less than 40°F the temperature of the concrete, as placed, shall not be less than 60°F.~~

~~All concrete mixers shall be of such design and construction, and so operated, as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed.~~

All proportioning/batching/mixing equipment shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association or the National Ready Mixed Concrete Association. The proportioning shall consist of combining the specified sizes of aggregates with cement, supplementary cementitious materials, admixtures/additives, and water as herein provided. No method which may cause the segregation or degradation of materials shall be used.

Weighing and metering devices used for the purpose of proportioning materials shall fulfill requirements as to accuracy and tolerance prescribed by the Weights and Measures Division of the State of Arizona and shall be sealed and certified in accordance with the procedures established by this agency. This certification shall not be over 12 months old and shall be renewed whenever required by the Engineer. When portable plants are set up at a new or temporary location, the scales and scale assembly shall be inspected and certificate issued regardless of the date when the scales were last tested. The Engineer may require the Contractor to run a quick scale check at any time with certified weights furnished by the Contractor and order the scale recertified if necessary.

Any admixture shall be measured accurately by mechanical means into each batch by equipment or in a method approved by the Engineer.

The equipment for measuring and supplying the water in the mixer shall be so constructed and arranged that the amount of water to be added to the mixture can be measured, in gallons or by weight, positively. The amount of water shall be varied in accordance with the percentage of free moisture in the material and the requirements of the workability of the aggregate.

Machine mixing will be required in all cases other than those in which it would obviously prove to be impractical; in which latter event hand mixing will be permitted, only to the extent necessary. Regardless of the method employed, mixing shall be commenced as soon as possible after the cement is placed in contact with the aggregates. All concrete mixers shall be of such design and construction, and so operated, as to provide a thoroughly and properly mixed concrete in which the ingredients are uniformly distributed

included in the Concrete Plant/ARPA certification

Each design shall utilize the proper proportioning of ingredients to produce a concrete mix that is homogeneous and sufficiently workable to provide a consistent and durable concrete product that meets the specified compressive strength and other properties as required by the application. In the event there is any modification to the mix design proportions:

- A) Modifications that will not require a new mix design submittal/approval:
 - 1 Modifications which do not result in batch target weights for the fine aggregate or combined coarse aggregates changing by more than 5 percent from the original approved mix design.
 - 2 Modifications to the percentage of coarse aggregate fractions that do not change the total coarse aggregate volume.
 - 3 Modifications to dosages of chemical or air-entraining admixtures, within the manufacturer's recommendations.
 - 4 The incorporation or elimination of chemical admixtures which are listed on the mix design to effect a change in the time-of-set (retarders or accelerators).
- B) Modifications that will require a new mix design submittal/approval and may require performance verification:
 - 1 Modification to the class of concrete per Table 725-1.
 - 2 Modification to the type/class of cement, fly ash, natural pozzolan, or silica fume.
 - 3 Modification to the percentage of fly ash, natural pozzolan, or silica fume.
 - 4 Modification to a coarse aggregate size designation.
 - 5 Modification of the type of chemical admixture, or the incorporation or elimination, of an air-entraining admixture.
 6. Modification of coarse or fine aggregate source

moved to later in the section

moved to section 725.11 Acceptance and expanded

included in the required Concrete Plant/ARPA certification

moved from section 725.7

moved from section 725.1

moved from section 725.6

moved from 725.5

moved from earlier in the section

725.8.1 Paving and Stationary Mixers: Paving and stationary mixers shall comply with the standards of the Concrete Plant Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. ~~They shall be equipped with an accurate automatic timing device so designed and constructed as to lock the discharge lever before aggregate, cement and Pozzolan enter the drum, and release such lever only after the specified mixing time has elapsed. The regulation of the setting of said device shall be under the supervision of the Engineer. Water control equipment as described in this specification shall also be provided with each concrete mixer.~~

no longer needed as this is included in the required Concrete Plant/ARPA certification

Mixers shall be maintained in proper and serviceable working condition, and any part or portion thereof that is out of order, or becomes worn to such extent as to detrimentally affect the quality of mixing, shall be promptly repaired or replaced.

The proper proportions of aggregate, cement, Pozzolan and water for each batch of concrete shall be placed in the mixer, and shall be mixed for a period of not less than 50 seconds after all such materials are in the drum.

The rotating speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.

too subjective and not needed

725.8.2 Transit Mixers: Transit mixers shall ~~be high quality equipment and~~ meet the requirements of the Truck Mixer Manufacturer's Bureau and the certification requirements of the Arizona Rock Products Association. Ready mix concrete shall comply with ASTM C-94 except as herein specified.

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~~The total elapsed time between the addition of water at the batch plant and depositing the complete mix shall not exceed 90 minutes. Each mixer and agitator shall have attached thereto in a prominent place a metal plate or plates, installed by the manufacturer, on which is plainly marked the capacity of the drum in terms of the volume of mixed concrete and the speed of rotation for the agitating and mixing speeds of the mixing drum or blades.~~

move to the proper section 725.11 on Acceptance and expanded

Each mixer shall have an identification number painted on the truck in such a location that it can be easily read from the batching platform.

The total volume of materials introduced into the mixer for mixing purposes shall not exceed the manufacturer's guaranteed mixing capacity. If the concrete so mixed does not meet the uniformity requirements of this section, the amount of materials charged into the mixer shall be reduced.

The rotation speed at which the mixer shall be operated shall conform to that recommended by the manufacturer.

The total volume of materials mixed in any one batch shall neither exceed the water level capacity of the mixer nor the manufacturer's catalog rated capacity of the mixer.

Each batch of concrete placed in the mixer shall be mixed for not less than 70 nor more than 100 revolutions of the drum or blades, at the speed designated by the manufacturer of the equipment as mixing speed. Additional mixing shall be at the agitating speed designated by the manufacturer of the equipment. The revolving of the drum shall be continuous until the concrete is completely emptied from the drum. Before any portion of the materials for any batch of concrete is placed therein, the drum of the mixer shall be completely emptied of the previously mixed batch.

At the time of delivery to the job site, the Engineer shall be provided with a legible weighmaster's certificate (delivery ticket) which shall contain the following information:

Agency or

Date and Truck Number.

Name of the Supplier.

Name of the Contractor.

Specific designation of job (name and location).

Number of cubic yards in the batch.

~~Type of cement.~~

~~Type of Pozzolan, if any.~~

Time the transit mixer is loaded.

Amount of water added at the job site at request of receiver, and his signature or initials.

Suppliers' mix design code number.

Type and amount of admixture, if any.

Serial number of the ticket.

or additive that is not already included in the approved mix design

not needed based on required Concrete Plant/ARPA certification in section 725.8

Not needed based on required mix design submittal/approval process in section 725.7

redundant – already required earlier in the section

~~The type, capacity and manner of operation of the mixing and transporting equipment for ready-mix concrete shall conform to the current Standards for Operation of Truck Mixers and Agitators of the National Ready Mixed Concrete Association and the Truck Mixer and Agitator Standards of the Truck Mixer Manufacturer's Bureau. Water shall not be added to the batch during transit. Additional water may be added at the point of discharge to adjust slump providing the slump after such water addition does not exceed the maximum allowed by these specifications and that water so added is mixed into the batch for a minimum of 30 additional revolutions at mixing speed. Loss of cement mortar during discharge which in the opinion of the Engineer would be of sufficient amount to affect the homogeneity of the concrete will be cause for rejection of the load. The Contractor shall be responsible for all concrete to which water is added at the job site.~~

Additional water may be added at the point of discharge in accordance with ASTM C-94 Tolerances in Slump section to adjust slump providing the slump after such water addition does not exceed the maximum allowed by these specifications in section 725.11 and that water so added is mixed into the batch for a minimum of 30 additional revolutions at mixing speed.

725.8.3 Hand Mixed Concrete: Hand mixed concrete shall be prepared on a watertight level platform in batches of not to exceed 1/3 cubic yard each. The required amount of coarse aggregate shall first be spread on the platform in an even and uniform layer, over which the proper proportion of fine aggregate shall then be likewise spread. The combined depth of both such layers shall not be greater than one foot. The required quantity of cement shall then be evenly distributed over the fine aggregate; following which the entire batch shall be turned with shovels at least twice before the water is added. The proper amount of water shall then be uniformly sprinkled or sprayed over the batch, which shall thereafter be returned with shovels not less than 3 times before being removed from the platform.

~~**725.8.4 Drybatched Unmixed Concrete:** Should the Contractor elect to use drybatched unmixed concrete, an accurate automatic batch weight recorder shall be provided to record the quantities of cement, aggregate and water batched into the containers, the weight of cement shall be recorded on either a separate chart from the aggregate or on the same chart using a separate needle. The recorder shall produce an autographic readable record on a visible chart of the weights of each of the materials batched. After batching, the needle on the chart shall return to zero. The chart scale along the ordinate shall be such that the major portion of the chart is used to record the total weights of the aggregates and water, and the cement. The date of batching, the container number and the batching certificate number shall be recorded on the recorder chart at the time of batching. The recorder charts, or copies thereof, shall become the property of the Contracting Agency and shall be submitted upon request.~~

Should the Contractor elect to use dry batched unmixed concrete, an accurate batch weight shall be provided to record the quantities of cementitious materials, aggregate and water batched into the containers. The date of batching, the container number and the batching certificate number shall be recorded at the time of batching. Copies of the batch weight records shall be submitted to the Agency or Engineer upon request.

All drybatched unmixed concrete delivered to the job site shall be stored in containers so constructed that the cement cannot come in contact with the water and aggregate within the container. Any admixture added to powder form shall be added to the cement; added in liquid form, it shall be added to the water.

The contents of the container shall be discharged into a mixer at the job site. Following discharge of the first container into the mixer, the mixer shall be operated at mixing speeds during the discharge of the remaining containers. After the contents of the last container have been discharged into the mixer, the concrete shall be mixed as specified in this specification for transit mixers, and drum or turbine type mixers.

Any spillage of cement, aggregate, water or admixture during the filling, transporting, or the discharging of the container, shall be cause for rejection of the container or the contents of the mixer if any portion of the rejected container is discharged into the mixer.

~~725.9 LOADING AND TRANSPORTATION OF MATERIALS AND MIXED CONCRETE:~~

~~The compartments of trucks or other equipment used for the purpose of transporting proportioned aggregates, bulk cement or mixed concrete, shall be sufficiently high and tight, and otherwise suitably constructed and adequately protected, to prevent loss or leakage of the contents thereof during transit or charging.~~

→ this section is no longer needed in the Portland Cement Concrete Section

725.10 TESTS: TESTS AND TEST METHODS:

~~Concrete specimens for compression tests will be taken in the field by a representative of the Engineer in accordance with ASTM C-172 and C-31 or AASHTO T-23, except as noted hereinafter.~~

~~Concrete samples shall be taken from the approximate middle 50 percent of the batch in an uninterrupted stream from the chute directly into the wheelbarrow or similar equipment. Where excessive slump is suspected, a controlling slump test may be made from any portion of the batch, except for the approximate 5 percent on each end of the discharge. If excessive slump is verified, at any time, the remainder of the load shall be rejected and removed from the project and a set of cylinders for compressive strength shall be taken from the batch, if any concrete from the batch was placed. The rate of discharge of the batch shall be regulated by the rate of revolutions of the drum and not by the size of the gate opening. Specimens for compression tests shall be stored in the field in accordance with methods approved by the Contracting Agency and protected from vibration and other disturbances, for a minimum of 28 hours and maximum of 76 hours. A maximum storage period would be involved only where weekends or holidays are involved. Cylinders stored in the field for the maximum period shall have the same validity as cylinders that have been stored overnight and brought in the following day.~~

→ rewritten, expanded and divided into 3 new sections for clarity

~~Not less than 4 cylinder specimens will be made for each 50 cubic yards of each class of concrete with a minimum of 4 specimens for each class placed or not less than 4 specimens for each half-day's pour. Specimens will be tested in a laboratory designated by the Engineer in accordance with ASTM C-39 at the expense of the Contracting Agency.~~

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725.10.1 Concrete shall be sampled in accordance with ASTM C-172 for determination of temperature, slump, unit weight and yield (when required) and air content (when required) as well as for fabrication of test cylinders for compressive strength determination at 28 days. Samples shall be of sufficient size to perform all the required tests and fabricate the necessary test cylinders but in no case less than 1 cubic foot. Concrete shall be sampled during discharge of the middle portion of the batch. At the discretion of the Agency and/or Engineer or his representative, a sample may be obtained at the beginning of the discharge if the properties of the concrete do not appear to be within the specification limits for slump or temperature.

All testing shall be done by a certified technician meeting the requirements of the ACI Concrete Field Testing Technician, Grade I or equivalent.

Temperature of the concrete mixture will be determined in accordance with ASTM C-1064.

Slump of the concrete mixture will be determined in accordance with ASTM C143.

Air content of the concrete mixture (when required) will be determined in accordance with ASTM C-231 or C-173, whichever is applicable.

Unit weight and yield of the concrete mixture (when required) will be determined in accordance with ASTM C-138.

All compressive strength test specimens will be made, cured, handled, protected, and transported in accordance with the requirements of ASTM C-31. The contractor shall provide and maintain for the sole use of the testing laboratory/technician adequate facilities for safe storage and proper curing of concrete test cylinders on the project site including sufficient access on weekends and holidays to allow the timely pick-up of cylinders specimens. Any and all deviations from the standard procedure of any test method shall be promptly identified and corrected. Any deviations shall be clearly noted by the testing laboratory on all written reports. Testing results obtained from non-standard testing procedures may be considered invalid and discarded by the Agency and/or Engineer.

~~Two cylinders shall be tested at 14 days. If their strength meets or exceeds the minimum 14-day requirements, the Contracting Agency will accept the concrete. The Engineer may test the other two cylinders at 28 days or discard at 60 days.~~

14 day requirements removed from Table 725-1 as acceptance testing is based on 28 day results. Additional early testing may be performed as noted in section 725.10.2

~~If this strength does not meet the 14-day requirement, the Contractor shall schedule and pay for two cores to be taken, on the 29th day, from the area of concrete represented by the cylinders. The Engineer shall be present when the coring is accomplished or additional cores will be required.~~

removed due to confusing language and impossible timing requirement - see section 725.10.3 for references to widely accepted coring procedure/analysis method in ASTM C-42 and ACI 318 and current ADOT specifications

~~The Engineer will test the remaining two cylinders on the 28th day. If this test meets or exceeds the 28-day minimum compressive strength requirement, the Contracting Agency will accept the concrete and the Contractor may cancel the scheduled coring.~~

~~If the 28-day cylinder test does not meet the minimum 28-day compressive strength requirement, the cores will be tested in accordance with ASTM C-42 in a laboratory designated by the Contracting Agency. If the cores meet or exceed the minimum 28-day strength, the concrete will be accepted by the Contracting Agency.~~

reworded and expanded in section 725.10.3

~~If the strength of the 28-day cylinders and the strength of the cores as calculated in accordance with ASTM C-42 are deficient, the Contractor shall remove all of the concrete represented by the failing test specimens with the exception that if the Contractor believes that the deficient concrete was confined to a single batch, he may immediately cut a minimum of 4 additional cores, two on either side of the affected batch. The cores would be compared with the minimum specified compressive strength, for the purpose of defining the confines of the deficient concrete. All coring done to establish this premise would be at the expense of the Contractor. Evaluation of the cores shall be by the Engineer, or by a substitute agent designated by the Contracting Agency, and his decision shall be final.~~

moved to proper section 725.11 on Acceptance and rewritten to reflect widely accepted coring procedure/analysis method in ASTM C-42 and ACI 318 and current ADOT specifications

725.10.2 In accordance with ACI 318 Chapter 5 Section 5.6.2.4, a cylinder strength test shall be the average of the strengths of at least two 6 inch by 12 inch cylinders or at least three 4 inch by 8 inch cylinders made from the same sample of concrete and tested at 28 days. An adequate number of cylinder specimens will be made for each 50 cubic yards or not less than each half-day's placement of each class of concrete. All specimens will be tested in a laboratory approved by the Agency and/or Engineer in accordance with ASTM C-39 for concrete acceptance. Should an individual cylinder show evidence of improper sampling, molding, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining cylinder(s). Additional cylinder specimens may be made and tested at other ages to obtain additional compressive strength information and may not be considered as acceptance tests.

725.10.3 If the 28-day strength test does not meet the compressive strength requirements, the contractor may choose to contest the compressive strength results of any test for purposes of acceptability or payment. This may involve an engineering study to determine the acceptability of the concrete in question or core testing to determine in-place concrete strengths. If core testing is performed, at least three representative cores shall be obtained, conditioned and tested in accordance with ASTM C-42 from each concrete member or area of concrete to be tested at locations designated by the Agency and/or Engineer. Cores damaged subsequent to or during removal shall be rejected and additional core samples taken. Cores must be obtained and delivered to a laboratory acceptable to the Agency and/or Engineer in time to allow complete strength testing within 48 days of original concrete placement. The contractor may elect to have a representative present during sampling and testing. A core strength test shall be the average of the results of the three cores. Should an individual core show evidence of improper sampling, curing, or testing, the results shall be discarded and the compressive strength shall be the result of the average of the remaining core(s). Results of the core strength testing will replace the results of the cylinder strength test for that sample.

725.11 ACCEPTANCE:

•Plastic Concrete Properties

•The slump of the concrete shall meet the requirements of ASTM C-94 Tolerances in Slump section. When the approved mix design or project specification requirements for slump are a "maximum" or "not to exceed", the following tolerances will apply:

Specified slump:	If 3" or less	If more than 3"
Plus tolerance	0 inch	0 inch
Minus tolerance	1 1/2 inch	2 1/2 inch

→ expanded from footnote of Table 725-1 on maximum slump

When the approved mix design or project specification requirements for slump are not written as a "maximum" or "not to exceed", the following tolerances will apply:

For design slump of:	Tolerance
2 inch and less	+/- 1/2 inch
More than 2 through 4 inch	+/- 1 inch
More than 4 inch	+/- 1 1/2 inch

•Per ACI 305, Specification for Hot Weather Concreting, limit the maximum allowable temperature of the concrete mixture immediately before placement to 95 degrees F unless otherwise specified or unless a higher allowable temperature is accepted by the Engineer/Agency. This acceptance can be based upon past field experience or preconstruction testing using a concrete mixture similar to one known to have been successfully used at a higher concrete temperature.

→ expanded from section 725-8 on minimum and maximum temperature

Per ACI 306, Specification for Cold Weather Concreting, when the atmospheric temperature at the time of placing concrete is above 30°F the temperature of the concrete, as placed, shall not be less than 60°F. When the atmospheric temperature at the time of placing concrete is between 0°F and 30°F the temperature of the concrete, as placed, shall not be less than 65°F.

•Air entrained concrete shall meet the requirements of ASTM - Air-Entrained Concrete section. The air content of air-entrained concrete when sampled from the transportation unit at the point of discharge shall be within the approved mix design tolerance or +/- 1.5 % of the specified value. When a representative sample taken prior to discharge shows an air content below the specific level by more than the allowable tolerance, additional air entraining admixture may be used to achieve the desired air content level, followed by a minimum of 30 revolutions at mixing speed.

→ expanded from section 725-6 on air-entraining

•Per ASTM C-94 Mixing and Delivery section, discharge of the concrete shall be completed within 1 1/2 hour after the introduction of the mixing water to the cement and aggregates or the introduction of the cement to the aggregates. The Engineer/Agency or their representative may allow the continuation of concrete placement after the 1 1/2 hour time limit has been reached if the concrete is of such slump or workability that it can be placed without the addition of water to the batch.

→ expanded from section 725-8.2 on maximum delivery time

Concrete failing to meet the tolerances for plastic concrete properties in 1-4 above shall be reviewed by the Engineer/Agency or their representative and may be subject to rejection.

~~Concrete represented by a strength test of at least 95% of the required 28-day compressive strength will be acceptable. All concrete failing to meet this requirement as evidenced by tests of either standard cylinder or drilled core specimens shall be rejected, removed and replaced by the Contractor at the Contractor's expense.~~

re-written and expanded to encompass widely accepted coring procedure/analysis method in ASTM C-42 and ACI 318 and current ADOT specifications

•Hardened Concrete Properties – Compressive Strength

• Concrete represented by a cylinder strength test obtained in accordance with section 725.10.2 shall be acceptable if the 28-day strength meets or exceeds the specified design strength. Concrete achieving at least 85% of the specified 28-day strength will be evaluated by the Agency and/or Engineer for acceptability. Core strength tests obtained in accordance with section 725.10.3 shall be considered satisfactory if their average is equal to or greater than 85 percent of the specified strength and no single core is less than 75 percent of the specified strength. If the core strength test meets or exceeds the minimum 28-day strength, the concrete will be accepted by the Agency at full contract price. All concrete failing to meet the acceptability requirement as evidenced by tests of either standard cylinder or drilled core specimens shall be rejected, removed and replaced by the Contractor at the contractor's expense, unless the Contractor can submit evidence that will indicate to the Agency and/or Engineer that the strength and quality of the concrete is such that the concrete should be considered acceptable and be allowed to remain in place.

When concrete is accepted on the basis of strength tests of less than 100% of the required minimum 28-day compressive strength, an adjustment in the ~~contract~~ unit price will be made for the quantity of concrete represented by such strength tests in accordance with the following schedule:

cylinder or core

Concrete

Based on Cylinder or Core Strength Testing

~~Adjustment in Contract Unit Price for Strength Deficiency~~

Percent of Specified Minimum 28-Day Compressive Strength Attained (Nearest 1%)	Percent of Concrete Unit Price Allowed
100% or greater	100
98-99 95-99	90 95
96-97 90-94	85 90
95 85-89	80 85

End of Section

ROCK, GRAVEL, AND SAND

701.1 GENERAL:

The following specifications set forth the requirements for crushed rock, gravel, sand, and quarry stone. Samplings and sieve analysis shall be performed in accordance with ASTM D-75 and ASTM C-136. Sand equivalents shall be determined in accordance with AASHTO T-176. The liquid limit and plasticity index shall be determined in accordance with AASHTO T-89 and T-90.

701.2 CRUSHED ROCK AND GRAVEL:

Rock and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

701.2.1 Crushed Rock: Crushed rock shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for 3/4 inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than 3/4 inch shall consist of particles which have at least one rough, angular surface produced by crushing. All material that will pass a grizzly with bars spaced 15 inches apart, clear opening, shall be crushed when producing from the Contracting Agency's source.

The gradation of crushed rock shall comply with ASTM D-448.

701.2.2 Gravel: Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn. Crushed rock obtained by crushing rock which exceeds ASTM D-448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

701.3 AGGREGATE:

Sand shall be fine granular material produced by the crushing of rock or gravel or naturally produced by disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay, and other deleterious substances to be thoroughly suitable for the purpose for which it is intended.

701.3.1 Sand for Asphalt Concrete Pavement: Sand for asphalt concrete pavement shall comply with AASHTO M-29 except that grading requirements shall be deleted and have a minimum sand equivalent of not less than 50 and shall be non-plastic when tested in accordance with AASHTO T-89 and T-90.

701.3.2 Sand for Mortar and Plaster: It shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances.

The average value of sand equivalent determined on 3 successive samples shall not be less than 70. No individual sample shall have a sand equivalent less than 65.

The size and grading of sand to be used in mortar, and plaster shall be such as to conform with the requirements specified as follows:

Mortar: ASTM C-144

Plaster: ASTM C-35

701.3.3 Aggregate for Portland Cement Concrete: Coarse and fine aggregate shall conform to the applicable requirements of ASTM C-33.

Coarse aggregate grading requirements shall conform to the appropriate rock size designation in the Grading Requirements for Coarse Aggregate Table. Fine aggregate grading requirements shall conform to the Fine Aggregate Grading section .

The average value of 3 successive sand equivalent samples shall not be less than 70 when tested in accordance with AASHTO T-176. No individual sample shall have a sand equivalent less than 65.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

701.3.4 Aggregate for Masonry Grout: The size and grading of the fine or coarse aggregate to be used in masonry grout shall conform with ASTM C-404.

701.3.5 Aggregate for Controlled Low Strength Material: Coarse aggregate shall conform to ASTM C-33 grading size No. 57. The size and gradation of fine aggregates (sand) shall conform to ASTM C-33.

701.4 QUARRY STONE:

701.4.1 General: Quarry stone shall be angular, sound, durable, hard, resistant to abrasion; free from laminations, weak cleavages, and undesirable weathering, leaching, exfoliation tendencies, and slaking; and of such character that it will not disintegrate from the action of air, water, or the conditions to be met in handling and placing. Stone shall be clean and free from deleterious impurities, including alkali, earth, clay, refuse, and adherent coatings. Suitable tests and/or service records will be used to determine the acceptability of the stone. Tests to which the material may be subjected include petrographic analysis, X-ray diffraction, specific gravity, absorption, abrasion, rock drop, soundness, wetting and drying, and such other tests as may be considered necessary

to demonstrate to the Engineer that the materials are acceptable for use in the work. In connection therewith, the Contractor shall notify the Engineer in writing at least 60 days prior to use of the intended sources of quarry stone.

701.4.2 Test Requirements: Quarry stone shall meet the following requirements except as may be otherwise provided on the plans and in the special provisions:

(A) Apparent specific gravity: 2.65 minimum.

(B) Breakdown:

Rock drop breakdown:	5 percent maximum
Abrasion breakdown at 1000 revolutions:	40 percent maximum
Breakdown after 10 cycles of wetting and drying:	5 percent maximum
Solubility in water, breakdown, or softening:	None

701.4.3 Test Methods: Unless otherwise specified in the special provisions or indicated on the plans, test methods for quarry stone shall be as follows:

Apparent specific gravity per ASTM C-127.

(B) Abrasion characteristics to be determined by either Rock Drop Test or Los Angeles Rattler, ASTM C-131, as required on the plans or the special provisions.

(1) Standard Rock Drop Test. Tests shall be made on groups of 5 accurately weighed sizes of rocks: No. 1, ranging from 75 to 100 lbs.; No. 2, 100 to 125 lbs.; No. 3, 125 to 150 lbs.; No. 4, 150 to 175 lbs.; No. 5, 175 to 225 lbs.

Each rock of the 5 sizes shall be dropped 3 times on the group of the other 4, in an enclosure, from successive heights of 10, 15, and 18 feet. The enclosure shall have a flexible medium weight galvanized iron floor or equivalent, set on a solid foundation. Order of dropping shall be Nos. 3, 2, 4, 1, 5. All rock passing a 3 inch square mesh screen after test shall be weighed and recorded as a percentage of the total initial weight of the 5 rocks.

(2) Los Angeles abrasion machine, per ASTM C-131, Grading B.

C) Wetting and drying. The stone shall be crushed, screened, and 1000 or 1500 grams of the 3/4 inch to 3/8 inch fraction taken for the test.

The crushed and graded stone shall be submerged in water for 18 hours at room temperature, after which the sample shall be drained and oven-dried at 140°F. When dry, the sample shall be cooled to room temperature. This would complete one cycle.

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The percent loss shall be determined by screening the tested sample on a No. 4 sieve and shall be computed as follows:

$$\frac{100 \times \text{Weight of Materials Passing No. 4 Sieve}}{\text{Total Weight of Sample}} = \% \text{ Loss}$$

(D) Accelerated water breakdown and solubility test. Air-dry samples of representative stone weighing approximately 1 lb. each shall be immersed for 8 hours at 140°F., in distilled water, local tap water, or 3.5 percent sodium chloride solution.

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SECTION 701

ROCK, GRAVEL, AND SAND

701.1 GENERAL:

The following specifications set forth the requirements for crushed rock, gravel, sand, and quarry stone. Samplings and sieve analysis shall be performed in accordance with ASTM D-75 and ASTM C-136. Sand equivalents shall be determined in accordance with AASHTO T-176. The liquid limit and plasticity index shall be determined in accordance with AASHTO T-89 and T-90.

701.2 CRUSHED ROCK AND GRAVEL:

Rock and gravel shall be clean, hard, sound, durable, uniform in quality, and free of any detrimental quantity of soft, friable, thin elongated, or laminated pieces, disintegrated material, organic matter, oil, alkali, or other deleterious substance.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

701.2.1 **Crushed Rock:** Crushed rock shall consist of the product obtained by crushing rock, stone, or gravel so that at least 50 percent by weight of aggregate retained on the No. 4 sieve for 3/4 inch or larger maximum sizes, and 50 percent retained on the No. 8 sieve for maximum sizes less than 3/4 inch shall consist of particles which have at least one rough, angular surface produced by crushing. All material that will pass a grizzly with bars spaced 15 inches apart, clear opening, shall be crushed when producing from the Contracting Agency's source.

The gradation of crushed rock shall comply with ASTM D-448.

701.2.2 **Gravel:** Material designated herein as gravel shall be composed entirely of particles that are either fully or partially rounded and water-worn. Crushed rock obtained by crushing rock which exceeds ASTM D-448 maximum gradation sizes may be combined provided it is uniformly distributed throughout and blended with the gravel. The quality and gradation requirements shall be as stated in this specification.

701.3 SAND:

Change the title of section 701.3 to Aggregate

Sand shall be fine granular material produced by the crushing of rock or gravel or naturally produced by disintegration of rock and shall be sufficiently free of organic material, mica, loam, clay, and other deleterious substances to be thoroughly suitable for the purpose for which it is intended.

701.3.1 **Sand for Asphalt Concrete Pavement:** Sand for asphalt concrete pavement shall comply with AASHTO M-29 except that grading requirements shall be deleted and have a minimum sand equivalent of not less than 50 and shall be non-plastic when tested in accordance with AASHTO T-89 and T-90.

Delete Portland Cement Concrete from the title of 701.3.2

701.3.2 **Sand for Portland Cement Concrete, Mortar and Plaster:** It shall be thoroughly and uniformly washed and shall be entirely free from oil and deleterious substances.

The average value of sand equivalent determined on 3 successive samples shall not be less than 70. No individual sample shall have a sand equivalent less than 65.

Delete cement concrete, and , after mortar

The size and grading of sand to be used in cement concrete, mortar, and plaster shall be such as to conform with the requirements specified as follows:

Delete Concrete ASTM C-33

Concrete:	ASTM C-33
Mortar:	ASTM C-144
Plaster:	ASTM C-35

SECTION 701

Delete Coarse in the title of 701.3.3

~~701.3.3 Coarse Aggregate for Portland Cement Concrete: Coarse aggregate shall conform to ASTM C-33 grading size No. 467, 57, 67, and 7.~~

701.3.4 Aggregate for Masonry Grout: The size and grading of the fine or coarse aggregate to be used in masonry grout shall conform with ASTM C-404.

701.3.5 Aggregate for Controlled Low Strength Material: Coarse aggregate shall conform to ASTM C-33 grading size No. 57. The size and gradation of fine aggregates (sand) shall conform to ASTM C-33.

701.4 QUARRY STONE:

701.4.1 General: Quarry stone shall be angular, sound, durable, hard, resistant to abrasion; free from laminations, weak cleavages, and undesirable weathering, leaching, exfoliation tendencies, and slaking; and of such character that it will not disintegrate from the action of air, water, or the conditions to be met in handling and placing. Stone shall be clean and free from deleterious impurities, including alkali, earth, clay, refuse, and adherent coatings. Suitable tests and/or service records will be used to determine the acceptability of the stone. Tests to which the material may be subjected include petrographic analysis, X-ray diffraction, specific gravity, absorption, abrasion, rock drop, soundness, wetting and drying, and such other tests as may be considered necessary to demonstrate to the Engineer that the materials are acceptable for use in the work. In connection therewith, the Contractor shall notify the Engineer in writing at least 60 days prior to use of the intended sources of quarry stone.

701.4.2 Test Requirements: Quarry stone shall meet the following requirements except as may be otherwise provided on the plans and in the special provisions:

(A) Apparent specific gravity: 2.65 minimum.

(B) Breakdown:

Rock drop breakdown:	5 percent maximum
Abrasion breakdown at 1000 revolutions:	40 percent maximum
Breakdown after 10 cycles of wetting and drying:	5 percent maximum
Solubility in water, breakdown, or softening:	None

701.4.3 Test Methods: Unless otherwise specified in the special provisions or indicated on the plans, test methods for quarry stone shall be as follows:

A) Apparent specific gravity per ASTM C-127.

(B) Abrasion characteristics to be determined by either Rock Drop Test or Los Angeles Rattler, ASTM C-131, as required on the plans or the special provisions.

(1) Standard Rock Drop Test. Tests shall be made on groups of 5 accurately weighed sizes of rocks: No. 1, ranging from 75 to 100 lbs.; No. 2, 100 to 125 lbs.; No. 3, 125 to 150 lbs.; No. 4, 150 to 175 lbs.; No. 5, 175 to 225 lbs.

Each rock of the 5 sizes shall be dropped 3 times on the group of the other 4, in an enclosure, from successive heights of 10, 15, and 18 feet. The enclosure shall have a flexible medium weight galvanized iron floor or equivalent, set on a solid foundation. Order of dropping shall be Nos. 3, 2, 4, 1, 5. All rock passing a 3 inch square mesh screen after test shall be weighed and recorded as a percentage of the total initial weight of the 5 rocks.

(2) Los Angeles abrasion machine, per ASTM C-131, Grading B.

Delete existing text of 701.3.3 and insert the following:

Coarse and fine aggregate shall conform to the applicable requirements of ASTM C-33.

Coarse aggregate grading requirements shall conform to the appropriate rock size designation in the Coarse Aggregate Grading Table . Fine aggregate grading requirements shall conform to the Fine Aggregate Grading section.

The average value of 3 successive sand equivalent samples shall not be less than 70 when tested in accordance with AASHTO T-176. No individual sample shall have a sand equivalent less than 65.

The loss by abrasion in the Los Angeles abrasion machine, determined as prescribed in ASTM C-131, Grading A, shall not exceed 10 percent, by weight, after 100 revolutions nor 40 percent after 500 revolutions.

SECTION 701

(C) Wetting and drying. The stone shall be crushed, screened, and 1000 or 1500 grams of the 3/4 inch to 3/8 inch fraction taken for the test.

The crushed and graded stone shall be submerged in water for 18 hours at room temperature, after which the sample shall be drained and oven-dried at 140°F. When dry, the sample shall be cooled to room temperature. This would complete one cycle.

The percent loss shall be determined by screening the tested sample on a No. 4 sieve and shall be computed as follows:

$$\frac{100 \times \text{Weight of Material Passing No. 4 Sieve}}{\text{Total Weight of Sample}} = \% \text{ Loss}$$

(D) Accelerated water breakdown and solubility test. Air-dry samples of representative stone weighing approximately 1 lb. each shall be immersed for 8 hours at 140°F., in distilled water, local tap water, or 3.5 percent sodium chloride solution.

End of Section

