THE MID-WEST CONCRETE INDUSTRY BOARD, INC.

CONCRETE STANDARDS

TABLE OF CONTENTS

THE MID-WEST CONCRETE INDUSTRY BOARD, INC.

CONCRETE SPECIFICATION

SECTION 1

CONCRETE MATERIALS

PART 1 - GENERAL

1.1 DESCRIPTION

This specification covers the requirements for concrete materials - water, cementitious materials, fine and coarse aggregates, and chemical admixtures. This standard is for use in the greater metropolitan Kansas City area.

1.2 REFERENCES

A. Referenced Standards: The following Standards are applicable for concrete materials. Utilize the current edition of the Standards at the time of bid.

1. ASTM - ASTM-International:

a. ASTM C 40, Standard Test Method for Organic Impurities in Fine Aggregates.
b. ASTM D 75, Standard Practice for Sampling Aggregates
c. ASTM C 88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
d. ASTM C 94, Standard Specification for Ready-Mixed Concrete.
e. ASTM C 117, Standard Test Method for Material Finer Than No. 200 Sieve in Mineral Aggregates by Washing.
f. ASTM C 123, Standard Test Method for Lightweight Pieces in Aggregate.

g. ASTM C 127, Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
h. ASTM C 128, Standard Test Method for Specific Gravity and Absorption of Fine Aggregate.
i. ASTM C 131, Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
j. ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
k. ASTM C 142, Standard Test Method for Clay Lumps and Friable Particles in Aggregates.
l. ASTM C 150, Standard Specification for Portland Cement.
m. ASTM C 173, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
n. ASTM C 231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
o. ASTM C 233, Standard Methods of Testing Air-Entraining Admixtures for Concrete.
p. ASTM C 260, Standard Specification for Air-Entraining Admixtures for Concrete.
q. ASTM C 311, Standard Method for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland Cement Concrete.
r. ASTM C 403, Standard Test Method for Time of Setting of Concrete Mixtures by Penetration Resistance.
s. ASTM C 494, Standard Specification for Chemical Admixtures for Concrete.
t. ASTM C 595, Standard Specification for Blended Hydraulic Cements.
u. ASTM C 618, Standard Specification for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
v. ASTM C 666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing, Procedure B.
w. ASTM C 989, Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars,
x. ASTM C 1064, Standard Test Method for Temperature of Freshly Mixed Portland Cement Concrete.
y. ASTM C 1157, Standard Performance Specification for Hydraulic Cement.
z. ASTM C 1260, Standard Test Method for Potential Reactivity of Aggregates (Mortar Bar Method).
aa. ASTM C 1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar Bar Method).
bb. ASTM C 1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
cc. ASTM C 1603, Standard Test Method for Measurement of Solids in Water.
dd. ASTM E 11, Standard Specification for Wire-Cloth Sieves for Testing Purposes.

2. AASHTO - American Association of State Highway and Transportation Officials:

a. AASHTO T 103, Soundness of Aggregates by Freezing and Thawing.
b. AASHTO T 161, Resistance of Concrete to Rapid Freezing and Thawing

3. KDOT - Kansas Department of Transportation:

a. Subsection 1115, Test Methods for Division 1100, Aggregates.
b. Test Method KT-8, Shale or "Shale-like" Materials in Aggregate.
c. KT-MR-21, Soundness and Modified Soundness of Aggregates by Freezing and Thawing.
d. KT-MR-22, Resistance of Concrete to Rapid freezing and Thawing.

4. MoDOT – Missouri Department of Transportation

a. Test Method T-71, Deleterious Content of Aggregate
b. Test Method T14, Soundness Test of Coarse Aggregate Water-Alcohol Freeze Method.

1.3 SUBMITTALS

A. Material Certificates: Submit recent certifications for each material used in the production of concrete under this specification.

1. Chemical Admixtures: Submit documentation from the admixture manufacturer that all admixtures supplied for use in the concrete are compatible.

1.4 MATERIAL HANDLING

A. Cementitious Materials: Store, handle, and batch cement in accordance with ASTM C 94.

B. Aggregates: Build and use stockpiles in a manner to avoid excessive segregation and to prevent contamination with other materials or with other aggregates.

C. Admixtures: Store in a manner that will avoid contamination, evaporation, or damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Mixing Water: Use mixing water that is clean and free from injurious amounts of sewage, oil, acid, alkali, salt, or organic matter. Potable water is acceptable without testing. Test other water sources (using ASTM C 1603) to determine whether it meets the acceptance criteria in ASTM C 1602.

B. Cementitious Materials: Provide current test reports for each source of cementitious materials. Use the same type of cementitious material in the work that was used to select concrete proportions. Cementitious materials that may be used are the following:

Portland Cement – ASTM C 150, Type I, II, or III
Blended Hydraulic Cement – ASTM C595 Types IP and IS,
Hydraulic Cement – ASTM C1157 Types GU, HE, MS, and HS
Fly Ash and Natural Pozzolans – ASTM C 618
Ground Granulated Blast Furnace Slag (GGBFS) – ASTM C 989

Subject to approval: Use of fly ash, calcined natural pozzolan or GGBFS in concrete is subject to approval by the Architect/Engineer.

1. Quality:

   a. Fly ash and calcined natural pozzolan shall meet ASTM C 618 except as modified herein:

      Loss on Ignition:
      Class C - Less than 2 percent.
      Class F - Less than 3 percent.

   b. GGBFS shall meet ASTM C 989, Grade 100, or Grade 120.

2. Effect on setting time: The listed mineral admixtures typically retard the setting time of concrete. When setting time limits are specified by the Architect/ Engineer or may adversely impact the concrete placement, the effect of the mineral admixture on the setting time of the concrete shall be determined by the concrete supplier at the expected temperature of placement, and in accordance with ASTM C 403. Results shall be provided to the Architect/Engineer.

3. Supplemental Cementitious Material Limitations: Total supplemental cementing agents shall not exceed 40% of the total cementitious material content.

C. Fine Aggregate:

1. General Characteristics: Fine aggregate shall consist of natural sand, manufactured sand, or a combination of both.

2. Grading Requirements: The fine aggregate will meet the gradation requirements of ASTM C 33.

3. Deleterious Substances:

a. Quantitative Materials: The amount of deleterious substances in fine aggregate that complies with the grading requirements of Section 2.3.B. shall not exceed the following limits in percent by weight:

Clay lumps	0.25
Material finer than No. 200 sieve	2.0 [(a)]
Coal and lignite	0.25
Other deleterious material	0.25

Note (a): For manufactured sand, if the material finer than the No. 200 sieve consists of the dust of fracture, essentially free of clay or shale, this limit may be increased to 5.0%.

b. Organic Impurities: Fine aggregate shall be free of injurious amounts of organic impurities.

EXCEPTION: A fine aggregate failing the organic impurities test may be used provided that, when tested for mortar-making properties, the mortar develops a compressive strength at 7 and 28 days of not less than 95 percent of that developed by a similar mortar made from another portion of the same sample which has been washed in a 3 percent solution of sodium hydroxide followed by thorough rinsing in water. The washing treatment shall be sufficient to produce a color lighter than the standard.

4. Soundness: Comply with one of the following

ASTM C 88, loss after 5 cycles,

Using sodium sulfate	10% max.
Using magnesium sulfate	15% max.

D. Coarse Aggregate:

1. Coarse aggregate shall meet the following requirements:

   a. Los Angeles Abrasion (ASTM C 131), loss ..... 40% max.

   b. Durability: Concrete for pavement, including curb and gutter, shall use durable aggregates that meet the following criteria:

2. Submit laboratory test reports:

   a. Coarse aggregate sources shall have production samples which demonstrate a durability factor (DF) of at least 95 when tested in accordance with ASTM C 666, Procedure B, AASHTO T 161, Procedure B, Kansas Test Method KT-MR-22 (minimum DF = 97 for 1-inch stone), or Missouri Test Method TM-67. Production sample durability testing must be conducted using the same gradation as the production gradation unless KT-MR-22 is used (with a minimum DF = 97). Sources which have submitted passing samples for durability testing within the last 12 months shall be judged to have met the durability factor requirement.

   b. Potential alkali-silica reactivity of the combined cementitious materials and aggregates shall be evaluated using the procedures outlined in ASTM C 1567 or C 1260. Expansion shall be less than 0.1%. Coarse and fine aggregate blending should be the same as proposed in the current concrete mix and tested under ASTM C 1567.

      EXCEPTION: In lieu of testing a current concrete mix, an alternate test of cementitious materials may be conducted by using 100% Missouri River sand from the Riverside pit as the mix aggregate.

TABLE 2.1.D-1

COARSE AGGREGATE GRADATION LIMITS, % PASSING

	Nominal Maximum Size			
Sieve	1-1/2"	1"	3/4"	1/2"
2"	100			
1-1/2"	95-100	100		
1"	---	95-100	100	
3/4"	35-70	---	90-100	100
1/2"	---	25-60	---	80-100
3/8"	10-30	---	20-55	40-70
No. 4	0-5	0-10	0-10	0-15
No. 8	---	0-5	0-5	0-5
No. 200	0-3	0-3	0-3	0-3

E. Combined Aggregate Gradation Alternative:

1. Quality: A combined aggregate material is presented as an alternative to the gradation limits listed or referenced in Section 2.1.C. and Section 2.1.D. The combined aggregate material shall meet the specified quality criteria listed in both the fine and coarse aggregate sections. Aggregate portions used to make up the combined gradation which pass the No. 4 sieve are considered fine aggregate fraction and will meet all criteria for fine aggregates in Section 2.1.C., except for gradation. Aggregate portions which are retained on the No. 4 sieve are considered coarse and must meet the appropriate criteria for coarse aggregates in Section 2.1.D., except for gradation.

2. Gradation: In place of the separate fine and coarse aggregate gradations, a combined aggregate gradation, using a number of aggregates, may be used. Meet the following combined aggregate gradation limits:

   a. Representative materials: Aggregates used in concrete shall have a combined aggregate distribution within ±5 percent of each sieve size of the aggregates used in the concrete represented by field test data or used in trial mixtures. Include standard sieve sizes 1-1/2", 1", 3/4", 1/2", 3/8", No. 4, No. 8, No. 16, No. 30, No. 50, No. 100, and No. 200 in gradation reports of individual aggregates.

   b. Limits: Do not exceed the nominal maximum aggregate size allowed as determined in Table 2.1.D.1. The combined aggregate shall be well graded from the coarsest to the finest sieve with not more than 22 percent or less than 6 percent of the combined

aggregate retained on any individual sieve. The amount of material passing the No. 200 sieve is limited to 3 percent.

F. Chemical Admixtures:

1. Air-Entraining Agents: Meet all applicable requirements of ASTM C 260.

a. Air entrainment is required in concrete subject to freezing and thawing in a moist condition or exposed to deicer chemicals.

b. Test Methods: Measure the air content of freshly mixed air-entrained concrete in accordance with ASTM C 231 or ASTM C 173 for normal weight concrete.

c. Air-Content Limits: Provide a minimum air content for fresh concrete of 5.0% behind the paver. If the point of acceptance is at a location other than behind the paver, meet the limits of 6 – 8% for the measured air content. Air contents greater than 8% but less than 10% will not be cause for rejection, but adjustments must be made at the plant to bring the air content back within limits in an expeditious manner.

2. Water-reducing Admixtures:

a. Meet all applicable requirements of ASTM C 494 for any of the following types:

(1) Type A: Water-reducing admixture
(2) Type D: Water-reducing and retarding admixture
(3) Type F: Water-reducing, high range admixture
(4) Type G: Water-reducing, high range, and retarding admixture

b. Use Manufacturer's Recommendations: For compliance with this specification, meet the manufacturer's recommendations for dosage rate, batching method, and time of admixture introduction into the mix.

G. Supplemental (Secondary) Reinforcement: Fibers shall meet ASTM C 1116.

THE MID-WEST CONCRETE INDUSTRY BOARD, INC.

"Organized for Quality Concrete"

CONCRETE SPECIFICATION

SECTION 2

OUTDOOR CONCRETE EXPOSED TO FREEZING AND THAWING

PART 1 - GENERAL

1.1 DESCRIPTION

This specification covers the requirements for concrete pavement, curb and gutter, sidewalk, and other concrete exposed to freezing and thawing conditions. This standard is intended for use in the metropolitan Kansas City area, and is based on locally available materials and practices.

1.2 REFERENCES

A. ASTM - Refer to Section 1 of these specifications for a complete list of applicable ASTM Standards and Test methods.

B. ACI - American Concrete Institute

1. ACI 301, Specifications for Structural Concrete
2. ACI 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete
3. ACI 305R, Hot Weather Concreting
4. ACI 306R, Cold Weather Concreting
5. ACI 308, Standard Practice for Curing Concrete

6. ACI 309R, Guide for Consolidation of Concrete

7. ACI 318, Building Code Requirements for Structural Concrete

1.3 TESTING

A. Sample fresh concrete in accordance with ASTM C 172. Slump shall be determined in accordance with ASTM C 143. The total air content shall be determined in accordance with ASTM C 231 or ASTM C 173. Concrete temperature shall be determined in accordance with ASTM C 1064.

B. Sets of four compression test cylinders shall be made, cured, and stored in accordance with ASTM C 31, and tested in accordance with ASTM C 39. Test one cylinder at an age of 7 days, two cylinders at an age of 28 days, and hold one cylinder for any additional testing.

1.3 PROPORTIONING

A. Concrete shall be proportioned by one of the following three methods:

1. The mix design tables presented in Section 3 of these specifications and accompanied by the full mix design information, including admixtures and material sources.

2. Concrete mix design based on previous data. Provide concrete mix designs based on previous 28-day compressive strength test data from similar concrete mixtures. Similar mixtures are within 1000 psi of the specified 28-day compressive strength, and are produced with the same type and sources of cementitious materials, admixtures, and aggregates. Mixes that have changes of more than 10% in proportions of cementitious, aggregates or water are not considered similar. Air entrained mixes are not considered similar to non-air entrained mixes. Test data should represent at least 30 separate batches of the mix. One set of data is the average of at least 2 cylinders from the batch. The data shall represent a minimum of 45 days of production within the past 12 months. Do not include data over 1 year old. When fewer than 30 data sets are available the standard deviation of the data must be corrected to compensate for the fewer data points.

Provide a concrete mix design that will permit no more than 5% of the 28-day compressive strength tests to fall below the specified 28-day compressive

strength ($f'c$) based on equation A, and no more than 1% of the 28-day compressive strength tests to fall below the specified 28-day compressive strength ($f'c$) by more than 500 psi based on equation B.

Equation A: $f'cr = f'c + 1.34 * k * s$

Equation B: $f'cr = (f'c - 500) + 2.33 * k * s$

Where: $f'cr$ = average 28-day compressive strength required to meet the above criteria.

$f'c$ = specified 28-day compressive strength
s = standard deviation of test data
k = constant based on number of data points
n = number of data points

$k = 1.3 - n / 100$
where $15 < n < 30$

$k = 1$
where $n > 30$

Provide a concrete mix design that has an average compressive strength that is equal to the larger of Equation A or Equation B. Submit all supporting test data with the mix design.

3. All other concrete mix designs. For concrete mixes that have fewer than 15 data points, or if no statistical data is available then use Equations A and B to calculate $f'cr$ using the following values.

f'cr = f'c + 1200 psi

Provide 28-day compressive strength data at 3 different water-cementitous ratios showing compliance with required $f'cr$. Each set of test data shall be the average of a minimum of 3 cylinders. These mixes shall utilize materials that will be used on the project.

1.4 SUBMITTALS

A preliminary review is not required when the mix design tables presented in Section 3 of this specification are used. The Architect/Engineer may require a preliminary review in the project specifications.

1.5 JOB CONDITIONS

A. Cold Weather Concreting: Adapt concreting practices in cold weather in accordance with ACI 301 and recommendations of ACI 306R.

B. Hot Weather Concreting: Adapt concreting practices in hot weather in accordance with ACI 301 and recommendations of ACI 305R.

PART 2 – MATERIALS

2.1. Refer to Section 1 of these specifications.

PART 3 - PERFORMANCE AND DESIGN REQUIREMENTS

3.1 Mix Design - Each cubic yard of concrete shall conform to the following limiting requirements:

A. Minimum cementitious material content - 560 lb.

B. Minimum compressive strength - 4500 psi at 28 days.

C. Water reducing admixture in accordance with the manufacturer's recommendations.

D. Maximum water-to-cementitious material ratio - 0.42 lb. of water per lb. of cementitious material.

E. Air-entrainment - Provide a minimum air content for fresh concrete of 5.0% behind the paver. If the point of acceptance is at a location other than behind the paver, meet the limits of 6 – 8% for the measured air content. Air contents greater than 8% but less than 10% will not be cause for rejection, but adjustments must be made at the plant to bring the air content back within limits in an expeditious manner.

F. Aggregate proportions – Refer to Section 1 of these specifications.

G. Slump - 4 inches, maximum without water reducing admixture.

3.2 Limiting Requirements - Concrete mix designs shall be controlled within the limits specified.

3.3 Maximum Total Water - The maximum quantity of total water used to produce each cubic yard of each mix design shall be in pounds as required not to exceed the specified maximum water-to-cementitious material ratio. Total water shall be based on saturated surface-dry aggregate and appropriate corrections shall be made when batching the mixing water to account for any free moisture on the aggregate.

3.4 Water-to-Cementitious Material Ratio - The maximum water-to-cementitious material ratio used to produce each cubic yard of concrete shall not exceed the specified maximum.

3.5 Air-Entrained Concrete - The air content for normal weight concrete with a water-reducing admixture shall be measured in accordance with ASTM C 231 or ASTM C 173.

PART 4 - PRODUCTION

4.1 Producer's Responsibility - Produce concrete in accordance with ASTM C 94. The producer shall frequently measure the moisture content of the aggregates and shall adjust the quantity of water in the mix designs to compensate for variations. The producer shall check for variations in the aggregate gradation and shall adjust proportions to compensate for variations. The producer shall be responsible for quality control of ingredients used to produce the mix design. All concrete delivery tickets shall include the plant name, design w/c ratio, batch weights per cubic yard, total batched weight of all materials for quantity delivered, time batched, design slump, water withheld (2 gal/yd maximum), allowable slump range, moisture correction for aggregates, and dosages of all approved admixtures.

4.2 Water-to-Cementitious Material Ratio - The actual water requirement may be less than that required to achieve the specified maximum water-to-cementitious material ratio. If the quantity of total water used is less than the allowable maximum water to meet the specified water-to-cementitious material ratio, no reduction in cement will be allowed. If the quantity of total water is greater than the allowable maximum, sufficient additional cement shall be added to maintain the water-to-cementitious material ratio at or below the specified maximum value.

PART 5 - EXECUTION

Refer to APWA Section 2208 for Paving Specification Requirements. The following specification requirements may be used in lieu of the APWA Specification 2208 at the discretion of the Architect/Engineer.

5.1 EXCAVATION

Excavate the subgrade to the lines and grades required for proper drainage with a minimum one percent slope. The subgrade shall be uniformly compacted to achieve 95 per cent of the maximum laboratory density determined in accordance with ASTM D 698. Re-roll or hand-tamp the subgrade to correct any irregularities caused by the trucking of materials.

5.2 PAVING EQUIPMENT

Furnish the paving and finishing equipment applicable to the type of construction as follows:

A. Slip-form Machines – Furnish slip-form machines capable of spreading, consolidating, screeding, and float finishing the freshly placed concrete in one pass to provide a dense and homogeneous pavement with minimal hand finishing.

B. Self-Propelled Form-Riding Machines – Furnish mechanical, self-propelled spreading and finishing machines capable of consolidation and finishing the concrete with minimal hand finishing. Do not use machines that displace the fixed side forms.

C. Manual Fixed-Form Paving Machines – Furnish spreading and finishing machines capable of consolidating and finishing the concrete with minimal hand finishing.

D. Vibrators

1. Furnish internal immersed tube or multiple spud vibrators for all paving more than 8 inches thick. Operate the vibrators at frequencies within 5000-8000 vibrations/minute.

2. Furnish a surface pan vibrator as an alternate to immersed tube or multiple spud vibrators for consolidation of 8 inch or thinner concrete slabs. Operate the surface pan vibrator at a frequency no less than 3500 vibrations/minute.

3. For construction of irregular areas, use hand-held vibrators. Operate the vibrator at a frequency in the range recommended by the manufacturer for the vibrator's head diameter.

5.2. FORMS

Use only clean, straight forms of the required depth with a form-release agent applied. The top of the forms shall be checked to ensure proper elevation and a minimum 1 percent slope.

5.3 REINFORCEMENT

If reinforcement is required, the reinforcement shall be supported on chairs and located uniformly as indicated on the plans.

5.4 PLACEMENT

Uniformly dampen the prepared roadbed surface before paving. Do not place concrete on frozen subgrade or subbase. Concrete shall be delivered and spread to provide uniform progress. Necessary hand spreading shall be done with shovels or come-alongs, not with rakes or vibrator.

5.5 FINISHING

Hand-float the surface only as needed to produce a uniform surface. No finishing shall be accomplished with water standing on the surface. A burlap drag, when used, shall be at least 2 feet wide and be of sufficient length to cover the entire slab width. The drag shall be kept clean and saturated while in use. The drag shall be laid on the surface and dragged in the direction the concrete is placed. For a broom finish, draw a stiff bristled broom across the full slab width, with adjacent strokes slightly overlapping to produce surface corrugations of uniform appearance.

5.6 JOINTING

Contraction joints shall be made by forming or sawing. When sawing joints, begin as soon as the concrete hardens sufficiently to prevent excessive raveling along the saw cut and finish before conditions induce uncontrolled cracks, regardless of the time or weather. Saw longitudinal contraction joints immediately after sawing transverse joints. Saw joints shall be one quarter to one-third the depth of the slab.

Use isolation (expansion) joints where new concrete is placed against an existing structure or as designated on the plans. Install the preformed joint filler full-depth, perpendicular to the subgrade, and conform to the details shown in the plans.

5.7 CURING

Protect concrete against loss of moisture and rapid temperature change. Use moist curing, waterproof paper, polyethylene sheeting, or white-pigmented liquid membrane-forming compound. Cover the entire surface of the newly placed concrete by the curing medium selected immediately after finishing operations have been completed. For moist curing, keep the burlap or fabric mats continuously wet; no alternating of wetting and drying is allowed. For the membrane-forming, spray-applied method of curing, complete and uniform coverage in accordance with manufacturer's recommendations shall be attained. The concrete surface must be moist (not dried out) during the application of the membrane-forming curing compound.

THE MID-WEST CONCRETE INDUSTRY BOARD, INC.

CONCRETE SPECIFICATION

SECTION 3

CONCRETE MIX DESIGN TABLES

PART 1 - GENERAL

1.1 DESCRIPTION

This specification covers the requirements for using the MCIB Concrete Mix Design Tables. This document is for use in the greater metropolitan Kansas City area, and is based on local materials and practices.

1.2 REFERENCE STANDARDS

The Standards applicable to the work under this section are as listed. Use the most current edition of the Standards at the time of bid.

A. ASTM - Refer to Section 1 of these specifications for a complete list of applicable ASTM Standards and Test methods.

B. ACI - Refer to Section 2 of these specifications for a complete list of applicable ACI Standards.

1.3 SUBMITTALS

Preliminary Review: A preliminary review is not required when a concrete mix design from the MCIB Concrete Mix Design Tables is specified. The Architect/Engineer may still require a preliminary review in the project documents.

1.4 QUALITY ASSURANCE

A. Testing

1. Testing of individual materials

a. Test all materials in accordance with MCIB Concrete Specification, Section 1, "Concrete Materials".

2. Field testing of fresh concrete:

a. Architect/Engineer will specify frequency of testing.

b. Refer to Section 2.1.3.

1.5 JOB CONDITIONS

A. Cold Weather Concreting: Adapt concreting practices in cold weather in accordance with ACI 301 and recommendations of ACI 306R.

B. Hot Weather Concreting: Adapt concreting practices in hot weather in accordance with ACI 301 and recommendations of ACI 305R.

PART 2 - PRODUCTS

2.1 MATERIALS

Reference MCIB Concrete Specification, Section 1, "Concrete Materials".

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Mix Designs

1. Type of Cement: MCIB Concrete Mix Design Tables are based on using ASTM C 150, Type I or Type II Portland cement. Blended hydraulic cement, fly ash and slag may be substituted on a pound-for-pound basis.

2. Design Strength: Use the design compressive strength as specified in the project contract documents. Design compressive strengths (f'_c) at 28 days are listed in the first column of the MCIB Concrete Mix Design Tables.

3. Slump: Produce concrete with a slump as specified by the project documents. The slump tolerance is plus-or-minus 1 inch with a maximum of a 4-inch slump design.

4. Maximum Size of Coarse Aggregate: Select the maximum nominal size of the coarse aggregate to be not be more than: one-fifth of the narrowest dimension between forms, one-third of the thickness of slabs, or three-fourths of the minimum clear space between reinforcing bars or between reinforcing bars and forms. –Subject to these limitations, maximum coarse aggregate sizes of 1 inch, ¾ inch, and ½ inch for concrete mix designs are listed in the third column of the MCIB CONCRETE MIX DESIGN TABLES.

5. Cement Factor: The minimum quantity of cement in pounds used to produce each cubic yard of each mix design is listed in the fifth column of the MCIB CONCRETE MIX DESIGN TABLES for concrete.

6. Maximum Total Water: The maximum quantity of total water in pounds used to produce each cubic yard of each normal-weight concrete mix design is listed in the sixth column of the MCIB Concrete Mix Design Tables. Total water is based on the moisture condition of the aggregates being SATURATED-SURFACE-DRY, and therefore, make appropriate corrections when batching the mixing water to account for the actual moisture condition of the aggregates.

7. Water-to-Cement Ratio: The maximum water-to-cement ratio used to produce each cubic yard of each concrete mix design is be in pounds of water per pounds of cement as listed in the seventh column of the MCIB CONCRETE MIX DESIGN TABLES.

8. Air-Entrained Concrete:

   a. Measure the air content for normal weight concrete, with or without a water-reducing admixture in accordance with ASTM C 231 or ASTM C 173, as stipulated in paragraph 1.2.B.1.d. of this standard.

   b. Provide a minimum air content for fresh concrete of 5.0% behind the paver. If the point of acceptance is at a location other than behind the paver, meet the limits of 6 – 8% for the measured air content. Air contents greater than 8% but less than 10% will not be cause for rejection, but adjustments must be made at the plant to bring the air content back within limits in an expeditious manner.

9. Admixtures: Follow the manufacturer's recommendations for admixture dosage rate, batching methods, and time of introduction to the mix.

2.3 MCIB MIX DESIGN NUMBERING SYSTEM

A. The mix design numbers are listed in the fourth column for normal-weight concrete and the third column for lightweight concrete in the MCIB MIX DESIGN TABLES. These mix design numbers are composed of four separate elements, each element identifies a particular characteristic of the mix design:

1. FIRST ELEMENT: The prefix letter, if any, indicates the special feature of the mix design:

   "A" indicates the use of and air-entraining agent.

   "W" indicates the use of a water-reducing admixture.

2. SECOND ELEMENT: The numerical value following the prefix, if any, and preceding the first hyphen is the MINIMUM weight in pounds of cement per cubic yard for the mix design.

3. THIRD ELEMENT: The numerical value after the first hyphen is the MAXIMUM size of coarse aggregate in inches for the mix design.

4. FOURTH ELEMENT: The numerical value after the second hyphen is the NOMINAL slump in inches for the mix design.

5. FIFTH ELEMENT: The numerical value after the third hyphen is the MAXIMUM allowable ratio of the weight of water to the weight of cementitious material for normal-weight concrete.

B. Examples

1. WA561-1-2-0.410 indicates an air-entrained concrete containing a water-reducing admixture, a minimum of 561 pounds of cementitious material per cubic yard, 1 inch maximum size coarse aggregate, a nominal 2-inch slump and a maximum water-to-cementitious material ratio of 0.410.

2.4 PRODUCTION

A. General: Produce and deliver ready-mixed concrete in accordance with ASTM C 94.

B. Producer's Responsibility: The producer is responsible for quality control of ingredients used to produce the mix design. It is the producer's responsibility to frequently measure the moisture content of the aggregates and make proper adjustments to the amount of water in the mix to compensate for variations from "saturated-surface-dry" condition. Perform sufficient aggregate gradation testing to monitor variations in the aggregate gradation. Make adjustments to the mix proportions to compensate for variations that will adversely effect the concrete properties.

C. Aggregate Proportions (Sand Factor): In each mix design optimize the ratio of the percentage of fine aggregate to total aggregate for workability, finishability, density or other desired property in accordance with the requirements outlined in Section 1 of this specification. It is the producer's responsibility to adjust proportions of fine and coarse aggregate to obtain optimum value provided the maximum water-to-cement ratio is not exceeded.

D. Water-Cement Ratio: If the quantity of total water used is less than the allowable maximum, no reduction in cement will be allowed which will cause the water-cement ratio to be slightly less than the maximum allowed. IF, HOWEVER, THE QUANTITY OF TOTAL WATER IS GREATER THAN THE ALLOWABLE MAXIMUM, ADD SUFFICIENT CEMENT TO MAINTAIN THE WATER-TO-CEMENT RATIO AT OR BELOW THE SPECIFIED MAXIMUM.

E. Durability: Specify the mix designs and materials to obtain durability under the climatic and service conditions to which the concrete will be subjected.

SECTION 3 - CONCRETE MIX DESIGN TABLES

TABLE 3-1 AIR-ENTRAINED CONCRETE CONTAINING A WATER-REDUCING ADMIXTURE

Design Strength, PSI (2.2.B.2)	Design Slump, Inches (2.2.B.3)	Max. Size Coarse Aggr., Inches (2.2.B.4)	MCIB Mix No. (2.3)	Minimum Cement, Pounds (2.2.B.5)	Max. Water, Pounds (2.2.B.6)	Max. W/C Ratio by Weight (2.2.B.7)
4,500	2	1	WA561-1-2-0.410	561	230	0.42
		¾	WA585-¾-2-0.410	585	240	
		½	WA622-½-2-0.410	622	255	
	4	1	WA610-1-4-0.410	610	250	
		¾	WA634-¾-4-0.410	634	260	
		½	WA683-½-4-0.410	683	280	
5,000	2	1	WA655-1-2-0.359	655	235	0.39
		¾	WA682-¾-2-0.359	682	245	
		½	WA724-½-2-0.359	724	260	
	4	1	WA710-1-4-0.359	710	255	
		¾	WA738-¾-4-0.359	738	265	
		½	WA794-½-4-0.359	794	285	

For mixes used under previous additions of the MCIB specifications, please contact the MCIB representative Sharon Schick at sschick@kc.rr.com.

Concrete Pre-placement Meeting Agenda

Attendees: The following representatives shall attend this meeting: Owner, Architect, Structural Engineer, General Contractor, Placement Contractor, Testing Firm, Concrete Supplier

1. Concrete mix designs review

   A. Concrete Mix (*Note this review shall occur for each mix design)*
      1. Review Location/Application
      2. Water to Cement ratio
      3. Identify slump +/- range with and w/o admixtures.
      4. Air content +/- range
      5. Unit weight +/- range
      6. Identify temperature +/- range (hot and cold weather)
      7. Identify transportation limits (discharge time, drum revolutions, load size, etc.)
      8. Unique admixtures used and possible effects to mix.
      9. Other

2. Quality Control/Assurance
      a. Lab accreditation requirements
      b. Certification requirements for testing personnel
      c. Advance notice for scheduling testing personnel
      d. Concrete sampling and testing specification requirements
      e. Test cylinder storage and transportation
      f. Acceptance criteria for hardened concrete and report distribution
      g. Testing of hardened in-place concrete

3. Job specific issues
   A. Backup Strategies
      1. Backup plant from primary supplier (*Verify availability of like materials and admixtures)*
      2. Backup supplier and approved mix designs.
      3. Identify transportation limits

   B. Mix Modifications - on site
      1. Discuss limitations regarding the addition of water, including documentation.
      2. Identify procedure for adding, mixing and re-testing when water or chemical admixtures are added on site.
      3. The supplier shall perform addition of admixtures or water at the request of the designated responsible individuals.
      4. The supplier shall document additional admixtures and/or water on the delivery ticket.

C. Onsite testing
   1. Identify frequency of test
      a. Cylinders for compressive strength. (Identify type and number of cylinders including extras for post tension and hold cylinders for shoring removal.)
      b. Air content
      c. Plastic unit weight
      d. Temperature
      e. Transportation limits and methods of transportation of strength specimens from site to testing lab.
      f. Other

   2. Identify point for sampling (discharge of truck, point of placement after placement) and where testing area will be located on site

   3. Strength specimen initial curing procedure, (wet bath, insulated box, under tarp, temperature controlled environment, designated storage area, temperature record)

   4. The plastic concrete field test properties shall be performed and results determined prior to the first load of concrete being placed. This information can be compared to the data collected by the supplier to determine the effects of transportation on the mix (refer to 3C below) Samples for casting strength test specimens shall not be obtained from the initial or final 10% of a delivered load.

D. Rejection of fresh concrete

   1. Identify individuals that will be on site that have the authority to accept and reject concrete based on plastic test properties.
   2. Testing agency shall immediately notify one of the designated individuals regarding any fresh concrete test results that are outside the specified limits.

   3. Concrete outside the specified parameters shall be grounds for rejection.

4. Supplier-specific job requirements.

   A. Verify availability of backup plant 24 hours prior to scheduled pour.

   B. Provide delivery tickets containing the following information:
      1. Mix number corresponding to the approved submittal
      2. Batch time
      3. Arrival time
      4. Approved mix materials withheld at the plant, including water, will be identified on the delivery ticket. If nothing is withheld the ticket shall state "as designed".
      5. Start and finish time associated with unloading
      6. Truck and ticket numbers shall be recorded by the testing firm with each cylinder test.

C. Discuss supplier's quality control testing frequency. Include supplier's test information on delivery tickets so the impact transportation time has on mix can be assessed..

5. Job requirements.

   A. The concrete placement contractor will provide the designated responsible individual(s) to receive all delivery tickets, document the unload time, and reject out-of-spec material as identified by the testing agency.

   B. Hot and/or Cold Weather procedures *(If applicable)*

   C. Method of placement
      1. Conveyance
      2. Consolidation

6. Finishing Process

   A. Curing
      1. Method (water, membrane, chemical, etc.)
      2. Compatibility with flooring finishes/treatments

   B. Weather conditions (ACI 308-3 Evaporation Chart)

   C. Surface finish (FF/FL, texture, etc.)

7. Other Job Specific Requirements

7. The General Contractor will provide a sign-up sheet and issue minutes of the meetings.

MCIB Technical Bulletin
Initial Curing Concrete Test Specimens in the Field

1) ASTM C31 is the standard practice for making, initial curing, and transporting of concrete specimens made in the field. This bulletin is not intended to replace ASTM C31. This bulletin suggests practical methods that will help to fully comply with ASTM C31 regarding concrete specimens used for acceptance testing. This section is not intended as a standard for evaluating actual strength of in-place concrete or field-cured specimens.

    a. **Cylinder Molds** - The use of 4x8 cylinder molds meeting ASTM C470 may be used for acceptance testing of concrete provided the maximum aggregate size in the concrete mix is not larger than 1-¼". Casting 4x8 molds requires the use of a 3/8"-diameter tamping rod and filling molds in two lifts instead of three. Cardboard molds are not allowed if the exterior of the cylinder is going to be in contact with additional moisture. For high-strength concrete, (6000 PSI design strength or higher), it is recommended either plastic 4x8 molds or rigid steel 6x12 molds be utilized.
    b. **Field Technicians** – The field technicians performing acceptance testing shall be certified ACI Concrete Field Testing Technicians, Grade I. Alternative technician certification programs shall include both written and performance examinations, and be approved by the design professional of record.
    c. **Sampling** – The point at which samples are obtained shall be identified previous to concrete placement, preferably during a pre-pour meeting or in the project specifications. Acceptance sampling shall not occur from the initial or final 10% of the load.
    d. **Specimen Storage** – In order to provide the required curing environment, the contractor's and ready-mix supplier's participation and assistance will be required and expected. It is suggested that a location be predetermined, in the pre-pour conference, to be the initial curing location for test specimens. All specimens for acceptance testing shall be placed in that predetermined location for the initial curing period. If specimens are cast at a location different than the initial curing location, refinishing of the top surfaces may be required after movement to avoid an uneven top surface.
    e. **Initial Curing Temperature** - For mixes with a design strength less than 6000 PSI, the initial curing temperature range shall be between 60 and 80 degrees Fahrenheit. For mixes with a design strength of 6000 PSI or above, the initial curing temperature range shall be between 68 and 78 degrees Fahrenheit. Minimum/maximum thermometers shall be used to determine the temperature range during the initial curing period. The measured initial curing temperature range shall be included on the compression test report.
    f. **Hot weather initial curing environment** - If the ambient air temperature is forecasted to be above 80 degrees Fahrenheit during the initial curing period, specimens shall be immediately immersed in water saturated with calcium hydroxide during the initial curing period while maintaining the required temperature range. (A 5-gallon bucket containing four, 4x8 cylinders immersed in water is acceptable.) Cylinders initially

cured underwater should be covered with properly fitting plastic caps. The method of initial curing shall be included on compression test report.

g. **Cold weather initial curing environment** - If the ambient air temperature is forecasted to be below 50 degrees Fahrenheit during the initial curing period the plastic-capped cylinders shall be placed in a temperature-controlled environment maintained within the required temperature range. (Ex.: A thermostatically controlled curing box, inside of a heated job trailer, etc.) The method of initial curing shall be included in the compression test report.

h. **Transportation to Lab** – Concrete test specimens initially cured in the field shall be transported to the final curing location within 48 hrs. of being cast, but no sooner than 8 hrs. after final set has been achieved. Leaving test specimens on site over a weekend is not acceptable. Access and compensation shall be provided for the retrieval of cylinders within the prescribed time limit. From the time the cylinders are picked up it shall not take longer than 4 hrs. to transport the specimen to the final curing location. Provide protection of test specimens during transportation as described in ASTM C31.