

Guide Specification for

The Use of Rotary Kiln Lightweight Aggregate for Internal Curing of Concrete

This guide specification supplements the architect/engineer's standard concrete specifications. Boxed comments precede or follow each specification section and should be deleted from the final specifications.

Part 1. GENERAL

1.1 Reference Standards

This guide specification follows the 16 Division Format of the Construction Specification Institute's, Section 03313 Concrete.

The enclosed text and commentary are intended to assist the architect/engineer write specifications that include appropriate limits so that quality internally cured concrete can be provided economically.

Reference Standards are incorporated in this guide specification and an appendix lists additional publications that will help the architect/engineer/designer prepare concrete specifications.

American Society for Testing & Materials (ASTM)

C 31 Practice for Making and Curing Concrete Test Specimens in the Field
C 33 Specification for Concrete Aggregates
C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 94 Specification for Ready-Mix Concrete
C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregates
C 138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
C 143 Test Method for Slump of Hydraulic Cement Concrete
C 150 Specification for Portland Cement
C 172 Practice for Sampling Freshly Mixed Concrete
C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
C 260 Specification for Air-Entraining Admixtures for Concrete
C 330 Specification for Lightweight Aggregates for Structural Concrete
C 494 Specification for Chemical Admixtures for Concrete

C 567 Test Method for Density of Structural Lightweight Concrete
C 595 Specification for Blended Hydraulic Cements
C 618 Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
C 845 Specification for Expansive Hydraulic Cement
C 989 Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars
C 1017 Specification for Chemical Admixtures for Use in Producing Flowing Concrete
C 1240 Specification for Use of Silica Fume as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout

American Concrete Institute (ACI)

ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete
ACI 301 Specifications for Structural Concrete for Buildings
ACI 304.2 Placing Concrete by Pumping Methods
ACI 318 Building Code Requirements for Reinforced Concrete
ACI 213 Guide for Structural Lightweight Aggregate Concrete

1.2 Performance

Except as modified or exceeded by these specifications. All concrete work shall conform to ACI 301.

1.3 **Storage of Materials Cement:** Store in accordance with ACI 318.

Aggregates: Each grading and type shall be stockpiled separately. Storage shall minimize segregation and prevent contamination.

1.3.1 Lightweight aggregate must be pre-conditioned to a minimum moisture content of ____% of dry weight before batching the concrete.

Each lightweight aggregate source and gradation may have slightly different physical properties. The producer should be consulted to obtain the minimum % moisture content appropriate for the material to be used.

Part II. PRODUCTS

2.1 Materials

Cement: Shall meet ASTM C 150, C 595, or C 845

The compatibility of various combinations of cement, pozzolans, and admixtures are generally the same in internally cured concrete as in normal weight concrete.

Aggregates: Normal weight aggregate shall meet ASTM C 33. Expanded Shale, Clay, or Slate (ESCS) lightweight aggregate produced by the rotary kiln method shall meet ASTM C 330.

Expanded Shale, Clay, or Slate (ESCS) is a unique ceramic lightweight aggregate prepared by expanding select minerals in a rotary kiln at temperatures of 1000 C. Their properties allow for proper absorption and desorption of internal curing water.

Water: Shall meet ACI 318.

Air-Entraining Admixtures: Shall meet ASTM C 260.

Admixtures have demonstrated satisfactory performance with internally cured concretes. Consult the concrete producer for information on admixture performance and recommendations, especially if the concrete is to be pumped.

Chemical Admixtures: Set-controlling and water-reducing admixtures shall meet ASTM C 494 and the manufacturer's recommendations.

Fly Ash: Shall meet ASTM C 618.

Ground Granulated Blast-Furnace Slag: Shall meet ASTM C 989.

Silica Fume: Shall meet ASTM C 1240.

2.2 Concrete Properties

Repeat this section if the design requires more than one type of concrete. ACI 211.1 provides guidance for proportioning mixtures.

Strength: Materials shall be proportioned to produce concrete with a minimum compressive strength ____psi (____MPa) at 28 days.

ESCS aggregate used for internal curing has been furnished at compressive strength levels common to construction practices today.

Slump: Concrete shall be delivered at the minimum slump necessary for efficient mixing, placing, and finishing. The maximum slump shall be ____ in. (____mm) with a tolerance of +/- ____in. (____mm). Consult ASTM C 94 for guidance on tolerances.

Air: The air content shall be ____ percent by volume with a tolerance of +/- 1.5 percent.

Mixture Proportions: The contractor shall furnish the mixture proportions that will meet the strength and other requirements of the concrete specified. The mixture proportion shall be prepared in accordance with ACI 318, and subject to the approval of the architect/engineer. The addition of lightweight aggregate shall be at ____ pounds/cubic yard (kilograms/cubic meter)

It is recommended that the writer contact the lightweight aggregate producer to be used on the project for guidance on the optimum dosage of ESCS for internal curing. Alternately the formula found in "Mixture Proportioning for Internal Curing" by Dale Bentz et al, in the February 2005 issue of Concrete International, may be used to calculate the quantity to specify. <http://ciks.cbt.nist.gov/bentz/ICnomographEnglishunit.pdf>

Batching and Mixing: The concrete shall be batched and mixed in accordance with the applicable section of ACI 301 and ASTM C 94.

The concrete producer's quality control personnel or a qualified laboratory should establish and maintain the mixture proportions based on the material producer recommendation.

PART III. FIELD CONTROL

3.1 Control: The control of the concrete shall be under the supervision of the architect/engineer. Field-testing shall be performed by an ACI Certified Field Technician.

Pumping: If the concrete is to be pumped, follow the recommendations of ACI 304.2R.

Sampling: Samples of concrete shall be obtained in accordance with ASTM C 172 and shall be transported to a place on the site where tests can be made and cylinders stored without being disturbed for the first 24 hours. If the concrete is placed by pumping, samples shall be obtained from the end of the pump discharge line.

Pumping may result in the reduction of slump and/or air content. Therefore, the concrete mixture should be proportioned to provide the desired fresh concrete properties at the point of placement.

Concrete Specimens: Compressive strength specimens shall be made in accordance with ASTM C 31 and tested in accordance with ASTM C 39. Density, slump, and air content of fresh concrete shall be determined from each batch of concrete sampled for compressive strength tests. Fresh density, slump, and air content shall be determined by ASTM C 138 and C 143.

APPENDIX: The following publications will assist the architect/engineer when preparing structural concrete specifications.

ACI 212.3R Chemical Admixtures for Concrete
ACI 213R Guide for Structural Lightweight Aggregate Concrete
ACI 304R Guide for Measuring, Mixing, Transporting and Placing Concrete
ACI 305R Hot Weather Concreting
ACI 306R Cold Weather Concreting
ACI 311.1R ACI Manual of Concrete Inspection
ACI 311.4R Guide for Concrete Inspection
ACI 347R Guide for Formwork for Concrete
ASTM STP 169C Significance of Tests and Properties of Concrete and Concrete-Making Materials