



**Guide Specification for  
Structural Concrete Mixes Utilizing Expanded Shale, Clay,  
and Slate (ESCS) Lightweight Aggregates for Internal Curing**

This guide specification supplements the architect/ engineer's standard concrete specification. Box comments precede or follow.

**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.

- C 128 *Test Method for Density, Relative Density*
- C 138 *Test Method for Unit Weigh, Yield, and Air Content (Gravimetric) of Concrete*
- C 143 *Test Method for Slump of Hydraulic Cement Concrete*
- C 150 *Specification for Portland Cement*
- C 173 *Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method*
- C 231 *Test Method for Air Content of Freshly Mixed Concrete by the Pressure 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*

**New York State Department of Transportation (NYDOT)**

- NY 703-19E *Test Method for Determining Total, Absorbed, and Surface (free) Moisture of ESCS Fine Aggregates used for Internal Curing of Portland Cement Concrete*

**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 70 *Test Method for Surface Moisture in Fine Aggregate*
- C 94 *Specification for Ready-Mix concrete*
- C 127 *Test Method for Specific Gravity and Absorption of Coarse Aggregates*

**American Concrete Institute (ACI)**

- ACI 211.1 *Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete*
- ACI 213 *Guide for Structural Lightweight Aggregate Concrete*
- ACI 301 *Specification for Structural Concrete for Buildings*
- ACI 304.2 *Placing Concrete by Pumping Methods*
- ACI 318 *Building Code Requirements for Reinforced 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 ESCS lightweight aggregate must be pre-wetted to a minimum internal moisture content of 15% before batching of concrete when tested in accordance with ASTM C 70 or NY 703-19E.

## PART II. PRODUCTS

Each ESCS lightweight aggregate source and gradation may have slightly different physical properties. The producer should consult the ESCS producer to find the volume of ESCS material needed to achieve the requirement of 7 lbs. of moisture per 100 lbs. of cementitious material designed in the concrete mixture.

Note: ESCS shall be added by volume for internal moisture. (Reference: "Guide for Concrete Mixture Designs using Pre-wetted ESCS Lightweight Aggregate for Internal Curing" by Utelite Corporation for interactive calculator table.)

Field testing for moisture content shall be in accordance with ASTM C 70 and NY 703-19E

### 2.1 Materials

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

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

**Aggregate:** Expanded Shale, Clay, or Slate (ESCS) lightweight aggregate produced by the rotary kiln method shall meet ASTM C 330 with the exception of "Grading" which may vary to obtain desired concrete performance. Normalweight aggregate shall meet ASTM C 33.

Expanded Shale, Clay, or Slate (ESCS) lightweight aggregate is a unique ceramic lightweight aggregate prepared by expanding selected minerals in a rotary kiln at temperature of 2000° F.

**Water:** Shall meet ACI 318

**Air-Entraining Admixtures:** Shall meet ASTM C 260

Admixtures have demonstrated satisfactory performance with ESCS internally cured concrete. Consult the ESCS 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 ASMT 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 lightweight aggregate has been used in concrete for practically every type of structural application. It has been furnished at all 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.

**Entrained Air:** Recommended target air contents for air-entrained concrete shall meet the recommendation of ACI 211.1

**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 ESCS lightweight aggregate shall be calculated at the volume necessary to supply 7 lbs of internal moisture for every 100 lbs. of cementitious material per cubic yard of concrete. Calculation shall be determined by using 90% of the absorption value of the ESCS lightweight aggregate used, as reported per ASTM C 127 and/ or ASTM C 128. The calculated volume ESCS lightweight aggregates used to meet the requirements for internal curing, shall be a direct replacement of an equal volume of the standard aggregate. Adjustments to the concrete mix design shall be made prior to batching, as to achieve the 7 lbs. of internal moisture per 100 lbs. total cementitious weight.



It is recommended that the writer contact the producer of the ESCS lightweight aggregate to be used on the project for guidance on the proper dosage of ESCS lightweight aggregate. Alternatively, 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. Introduce ESCS pre-wetted aggregate into the mixer drum first, along with the mixing water, or at least a sufficient quantity to ensure ESCS remains at SSD as drier, less absorptive materials are sequentially batched after the introduction of the pre-wetted aggregate.

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 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 the compressive strength tests. Fresh density, slump, and air content shall be determined by ASTM C 138, C 143, and C 231 respectively.

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

<i>ACI 211.1</i>	<i>Standard Practice for Selecting Proportions for Normal, Heavyweight and Mass Concrete</i>
<i>ACI 212.3R</i>	<i>Chemical Admixtures for Concrete</i>
<i>ACI 213R</i>	<i>Guide for Structural Lightweight Aggregate Concrete</i>
<i>ACI 304R</i>	<i>Guide for Measuring, Mixing, Transporting and Placing Concrete</i>
<i>ACI 304.5R</i>	<i>Batching, Mixing, and Job Control of Lightweight Concrete</i>
<i>ACI 305R</i>	<i>Hot Weather Concreting</i>
<i>ACI 306R</i>	<i>Cold Weather Concreting</i>
<i>ACI 311.1R</i>	<i>ACI Manual of Concrete Inspection</i>
<i>ACI 311.4R</i>	<i>Guide for Concrete Inspection</i>
<i>ACI 347R</i>	<i>Guide to Formwork for Concrete</i>
<i>ASTM STP 169 C</i>	<i>Significance of Tests and Properties of Concrete and Concrete-Making Materials</i>

Additional information on internal curing can be found at the following links:

<http://ciks.cbt.nist.gov/lwagg.html>  
[www.utelite.com](http://www.utelite.com)

