

# ESCSI Guide Specifications for Internally Cured Concrete

## *Note to Specifier:*

*Prewetted expanded shale, clay or slate (ESCS) lightweight aggregate is incorporated into a conventional concrete mixture to provide reservoirs of water within the concrete that slowly release the water after the concrete sets to provide “internal curing” to the mixture. Internal curing has been shown to improve the mechanical and durability properties of concrete by enabling more complete hydration of the portland cement and continued reaction of supplementary cementitious materials.*

## **General**

This guide specification shall be used for modifying a conventional normal weight concrete mixture to provide internal curing of the concrete by replacing a portion of the normal weight fine aggregate with prewetted fine or intermediate expanded shale, clay or slate (ESCS) lightweight aggregate.

The conventional concrete mixture being modified shall satisfy all project requirements and specifications for constituent materials and for both fresh and hardened concrete properties.

The internally cured concrete mixture shall meet all project requirements and specifications for constituent materials and for both fresh and hardened concrete properties, including the additional requirements in this guide specification.

## **ESCS Lightweight Aggregate**

ESCS lightweight aggregate for internal curing shall conform to the requirements in ASTM C 330 [AASHTO M 195] *Standard Specification for Lightweight Aggregate for Structural Concrete*.

A fine aggregate gradation is typically used for internally cured mixtures. The use of smaller aggregate gradations for internal curing reduces the spacing between moisture-carrying lightweight aggregate particles, which provides a better distribution of internal curing moisture in the paste. Intermediate size aggregate gradations may also be used to provide a more uniform overall aggregate grading for the mixture in addition to providing internal curing. References to lightweight aggregate in this guide specification shall be taken to apply to both fine and intermediate gradations.

## **Prewetting and Testing of Lightweight Aggregate**

ESCS lightweight aggregate shall be prewetted prior to adding to the concrete mixture. The recommendations of the lightweight aggregate supplier shall be followed to ensure that the lightweight aggregate has achieved the target minimum absorbed moisture content at the time of batching.

The free and absorbed moisture content of the lightweight aggregate at the time of batching shall be determined using the test method recommended by ESCSI.

Batch quantities shall not be adjusted for the water absorbed in the lightweight aggregate.

*Notes to Specifier:*

*The ESCSI test method gives the most consistent and accurate results with lightweight aggregates, due to their unique physical properties. The test method can be obtained from the ESCSI website ([www.escsi.org](http://www.escsi.org)) or from a lightweight aggregate supplier.*

*The water absorbed in the lightweight aggregate remains in the aggregate during mixing and placement and does not contribute to the mixing water.*

**Quantity of Prewetted Lightweight Aggregate Required for Internal Curing**

The concrete supplier shall compute the weight of prewetted lightweight aggregate ( $W_{LWA}$ ) required to supply internal curing water using the following relationship:

$$W_{LWA} = 0.07 (\text{total weight of cementitious material}) (1 + \text{absorption}) / ((\text{absorption})(\text{desorption}))$$

Where:

- the total weight of cementitious material is expressed in lbs,
- the absorption and desorption values are expressed as decimal fractions, and
- the absorption and desorption values used to compute  $W_{LWA}$  shall be for the specific source of aggregate selected for use in the internally cured concrete mixture.

For guidance on computing  $W_{LWA}$ , see the ESCSI *Guide for Calculating the Quantity of Prewetted ESCS Lightweight Aggregates for Internal Curing* attached as Appendix A or on the ESCSI website.

*Notes to Specifier:*

*The quantity of prewetted lightweight aggregate ( $W_{LWA}$ ) computed using the above relationship supplies enough internal moisture to compensate for the typical chemical shrinkage of portland cement of 7%. The 0.07 coefficient can be adjusted for different values of chemical shrinkage or to provide additional compensation for other sources of moisture loss, such as loss of moisture by evaporation.*

*While absorption and desorption values vary between sources and gradations of lightweight aggregate, it has been shown that internal curing can be achieved with any of the ESCS aggregates produced in the US. Absorption and desorption values for the different lightweight aggregates may be obtained from aggregate suppliers or published references.*

**Internally Cured Concrete Mixture**

The proportions of the internally cured concrete mixture shall be determined by modifying the proportions of the conventional normal weight concrete mixture in the following manner: the volume of prewetted lightweight aggregate that corresponds to  $W_{LWA}$  computed above shall replace an equal volume of normal weight fine aggregate. Other minor adjustments to the mixture may be made to achieve mixture performance requirements. Trial batches shall be conducted to demonstrate that the internally cured concrete mixture satisfies project requirements.

Submit the internally cured concrete mixture design and any test results as required by the contract documents. Submittal shall include the absorption and desorption values for the selected source of lightweight aggregate that were used to compute the quantity of prewetted lightweight aggregate required to supply the water for internal curing.

## **Construction Requirements**

The lightweight aggregate shall be stockpiled and handled in accordance with the contract requirements for normal weight aggregates. The lightweight aggregate shall be prewetted, according to the recommendations of the lightweight aggregate supplier, to ensure that the target absorbed moisture content has been achieved at the time of batching.

The internally cured concrete mixture shall be batched, transported, placed and finished to meet all requirements specified in the contract documents for the conventional normal weight concrete mixture.

The free moisture content of the prewetted lightweight aggregate shall be determined immediately prior to batching as specified above. Batching weights shall be adjusted to account for the free moisture in the lightweight aggregate.

Water absorbed in the lightweight aggregate is retained within the aggregate during mixing and does not affect the quantity of mix water. Therefore, batching weights shall not be adjusted for the absorbed moisture on the prewetted lightweight aggregate.

### *Note to Specifier:*

*Internally cured concrete contains a relatively small volume of prewetted lightweight aggregate. Most of the accessible pores in the aggregate particles are filled with water. Therefore, air content tests during concrete production can be made using a pressure meter because pressure and volumetric tests will typically give similar results. If desired, both tests can be conducted initially to calibrate the pressure meter readings.*

## **Density of Internally Cured Concrete**

Density of internally cured concrete shall not be used as a basis for field acceptance.

### *Note to Specifier:*

*For internally cured concrete, the lightweight aggregate is being used as an agent to deliver internal curing moisture and not as a means to reduce the concrete density. However, since some of the normal weight fine aggregate is replaced with prewetted lightweight aggregate in internally cured concrete, the density of the concrete will be reduced. This reduction in density is not significant for some concrete applications while for other applications it may need to be considered in the design.*