

Technology in Practice

What, Why & How?



TIP 9 - Density of Structural Lightweight Concrete

This TIP outlines the determination of density of lightweight concrete for project requirements

WHAT is Equilibrium Density?

The equilibrium density of lightweight concrete is a standardized value that approximates the density of in-place concrete in service. The ACI 318 Building Code for Structural Concrete defines lightweight concrete as concrete containing lightweight aggregate meeting the requirements of ASTM C330 with an equilibrium density of the lightweight concrete between 90 and 115 lb/ft³. Lower concrete density may be specified for non structural applications.

ASTM C567 is the standard test method for determining the density of structural lightweight concrete in various conditions and the relationships between them. ASTM C567 provides procedures for determining the freshly mixed concrete density, equilibrium density, and oven-dry density of lightweight concrete.

- Fresh Bulk Density (Freshly Mixed Concrete Density) is measured according to ASTM C138 using a ½ cubic foot measure. This is the highest value of density. This would be the basis of acceptance of lightweight concrete at the jobsite.
- Equilibrium density is defined as the density reached by structural lightweight concrete after exposure in a relative humidity of 50 ± 5% at a temperature of 73.5 ± 3.5°F [23 ± 2°C] for a period of time until there is no significant loss of weight. Because it takes a long time to obtain the measured equilibrium density, ASTM C567 provides a method of calculating the approximate equilibrium density from the oven-dry density, discussed below.
- Oven dry density is defined as the density reached by structural lightweight concrete after placing the concrete in an oven at 230 ± 5°F [110 ± 5°C] for a period of time sufficient to reach constant weight. C567 provides a method of calculating the oven-dry density from the mixture proportions of the lightweight concrete.

The density of structural lightweight aggregate concrete will decrease as it dries and will eventually reach equilibrium with its environment. The absorption and moisture content of the lightweight aggregate are the principal factors that impact the difference between the fresh bulk density of lightweight concrete and its equilibrium density. To measure the equilibrium density in accordance with C567, it can take as long as 90 days in the drying environment for typical lightweight concrete; and as long as 180 days for high strength lightweight concrete. In service conditions, the decrease in density is a function of aggregate moisture content, ambient conditions, and the ratio of the surface area to the volume of the concrete member. There are different types of lightweight aggregate depending on the source materials and method of manufacture. Absorption of lightweight aggregate sources can range typically from 6 to 20% or more. Lightweight concrete made with aggregates with a higher porosity (absorption) may take a longer time to reach equilibrium density. In C567, it is indicated that based on extensive tests the equilibrium density will be approximately 3.0 lb/ft³ [50 kg/m³] greater than its oven-dry density. Equilibrium density is used in specifications and for structural design of structures.