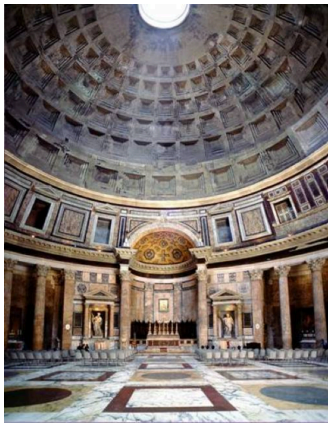
Lightweight Concrete

From ancient domes to modern elevated decks, the use of lightweight concrete continues to provide structural efficiency and economic advantages. With the use of lightweight aggregates, such as natural pumice or manufactured expanded shale, a 25% reduction in density, comparable compressive strengths, and enhanced thermal behavior compared to normal weight concrete is achieved. Well-documented performance over a period of decades and centuries has demonstrated that lightweight concrete can be used reliably in most concrete applications. Natural lightweight aggregates were used in some of the earliest concrete structures including those built by the Romans. For example, the Roman Pantheon was built with pumice-lightweight concrete about 125 A.D. and is still in use today. It is impressive that many of these ancient structures exhibited strength and durability characteristics that rival today's structures.



The characteristics of lightweight aggregates lead to an improved interaction with the mortar matrix compared to normal weight aggregates. This results in enhanced behavior of lightweight concrete. The porosity of lightweight aggregates such as pumice provides a better bond with the mortar matrix and an inherent resistance to freeze-thaw cycles. The use of lightweight concrete has an effect on the mix design, mixture proportioning, and construction methods that may be used when designing a concrete structure. The greatest applications of lightweight concrete are those that take advantage of the inherent performance benefits of lightweight concrete.

The primary advantage of lightweight concrete is the reduction of the dead load in a structure. Reduced dead load allows designers the opportunity to increase span lengths, decrease structural member depth, and reduce foundation loads. Additionally, lightweight concrete may require less reinforcing steel because of the reduced dead loads. Precast lightweight concrete products are lighter so producers can potentially transport more product in each shipment. The use of lightweight concrete floor slabs supported on metal decking in steel frame buildings is a popular design option in mid- and high-rise construction. Lightweight concrete allows the use of a thinner slab than normal weight concrete for the same fire rating. The inherent fire resistance of lightweight concrete may often permit the avoidance of an unnecessary spray fireproofing on the decks. Lightweight concrete also provides benefits in other areas, such as enhanced durability through reduced cracking and lower permeability compared to normal weight concrete of similar

proportions. These opportunities provide designers a strong economic incentive to use lightweight concrete.

Typical Properties of Lightweight and Normal Weight Concretes		
	Lightweight Concrete	Nornal Weight Concrete
Design density, (lb/ft3)	115	150
Compressive strength, (psi)	3,000-7,500	3,000 - 10,000
Tensile Strength, (psi)	360	435
Modulus of elasticity, (psi x 106)	17-28	20-40
Thermal conductivity, (B · in/hr · ft2 °F)	4-6	10-20

Lightweight concrete aggregates specified by ASTM C330, *Standard Specification for Lightweight Aggregates for Structural Concrete,* include natural materials like pumice, and manufactured expanded shales, clays and slates, pelletized or extruded fly ash, and expanded slags.

The most obvious characteristic of lightweight concrete is its lower density. This is a direct result of the relatively porous nature of the aggregates used. The lowest density lightweight concrete uses lightweight aggregate for both fine and coarse aggregate fractions.

The fire resistance of lightweight concrete is generally greater than normal weight concrete for the same thickness. The basis for this behavior is the reduced thermal conductivity and thermal expansion provided by lightweight aggregates. The durability of lightweight concrete is equal to or better than normal weight concrete.

Mixture proportioning, the volumetric method (damp loose volume) relies upon trial mixture proportions that are based on damp loose material volumes converted to batch weights. This method estimates required batch weights, including cement contents, based upon the required compressive strength. The batch proportions represent the actual in-situ moisture condition of the material at the time of batching.

Prewetting (or presoaking) is a simple but proven and effective precaution against absorption of mix water by lightweight aggregate such as pumice. Prewetting is not intended to completely saturate lightweight aggregate particles. Rather, prewetting is intended to allow the lightweight aggregate particles an opportunity to absorb as large a portion of their total absorptive capacity as is practical. The 24-hour absorption test, specified by ASTM C127 and C128, provides an indication that can be used for comparison against the total absorptive capacity. Lightweight aggregate particles immersed for 24 hours will generally be not fully saturated although their rate of moisture absorption may be low enough that weight measurements will remain unchanged.