DESIGN OF LIGHTWEIGHT AGGREGATE CONCRETE AND ITS QUALITY CONTROL

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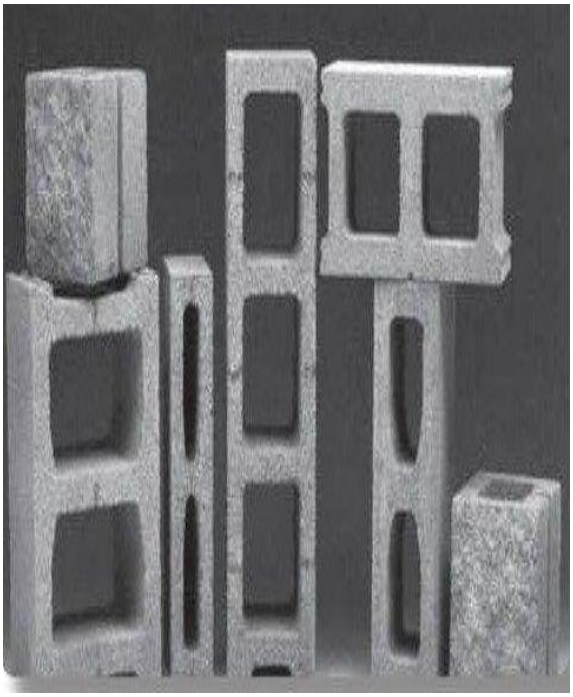
Abstract

There are number of reasons that deter application of mix design methods (as applied to normal weight concrete) in case of light weight aggregate concrete. The lack of accurate value of absorption, specific gravity and the free moisture content in the aggregate make it difficult to apply the water/cement ratio accurately for mix proportioning.

Light-weight concrete mix design is usually established by trial mixes. The proportions of fine to coarse aggregate and cement and water requirement are estimated based on the previous experiences with particular aggregate. Various degree of water absorption by different light-weight aggregates is one of the serious difficulties in the design of light weight concrete. Reliable information of saturated, surface-dry bulk specific gravity is not always available.



Sometimes the aggregate is saturated before mixing so that it does not take up the water used for mixing. The quality of concrete does not get altered on account of absorption by aggregate. It has been seen that the strength of the resulting concrete is about 5 to 10% lower than when dry aggregate is used for the same content and workability. This is due to the fact that in the latter case some of the mixing water is absorbed prior to setting. This water having contributed to the workability at the time of placing gets absorbed later. This reduces the bad effect of excess of water. Moreover, the density of concrete made with saturated aggregate is higher and the durability of such concrete, especially its resistance to frost is lower. On the other hand, when aggregate with high absorption is used, it is difficult to obtain a sufficiently workable and yet cohesive mix and generally aggregates with absorption of over 10% are presoaked.

Mixing Procedure of Lightweight Aggregate Concrete

Mixing procedure for light-weight concretes may vary with different types of aggregates. The general practice for structural light-weight concrete is to mix the aggregate and about 2/3 of the mixing water for a period up to one minute prior to the addition of cement and the balance mixing water. Mixing is done continuously as required for homogeneity. Usually 2 or more minutes are required to get uniform mixing. In case of some insulating concrete, the aggregate is added at the end of mixing to minimize degradation.

Quality Control of Lightweight Concrete

To get good normal weight concrete, an engineer writes a good specification and sees that concrete quality is assured by proper control procedures at the job. With lightweight concrete, the engineer specifies a C330* aggregate and the 28- day strength and air-dry weight necessary to meet design requirements. Slump and air content are also required to be specified.

The combination of strength and unit weight will, in most cases, eliminate undesirable or unsatisfactory materials. For example, suppose a lightweight aggregate has difficulty in achieving good strength. It will require an excess of cement to meet specifications and this will boost both the unit weight and the cost. It will lose out on two counts. An engineer today can obtain reliable test data from aggregate producers on their material showing shrinkage values, modulus of elasticity, strength vs. cement content and other properties.

More and more companies that provide aggregate for structural concrete have PUSHOUT test results on their material and will be able to provide an engineer this additional information. With such data, the specification can be closed to one type of aggregate or even to a given brand, taking into account all of the local conditions and the job requirements. In general, quality control of lightweight concrete is achieved by-

(1) Periodic slump measurements that will control the amount of water being mixed with concrete and since lightweight concrete is proportioned with a given cement content and mixed to a given slump, this will in effect control the net effective water-cement ratio and all subsequent concrete properties.

(2) Fresh unit weight of the concrete (another simple check) is measured in half or quarter cubic foot containers. This weight should conform to the fresh unit weight determined from trial mixes and it is related to the 28-day air-dry weight, which could be used as the basis for design. When the weight and slump are satisfactory, the mix and the yield are reasonably correct.

(3) If the weight changes, the usual cause is a change in air content (entrained air is generally used in lightweight concrete to improve its workability and handling characteristics). Then the third control test is run, namely, an air content test using the volumetric method. If the percent of air is incorrect, an adjustment is made at the plant to get the air content back into line.

(4) If the air content is satisfactory, further checks must then be made on gradation and specific gravity of the aggregate and possibly on the batching and handling procedures.

Generally, with attention to the basic principles of concrete mix design, good quality lightweight structural concrete is furnished to the field without difficulty. With increasing frequency, compressive strength evaluations of lightweight concrete have shown coefficients of variation <10% and rated excellent for job-furnished concrete.

Note:

***ASTM designation C330** defines lightweight aggregates for structural concrete in a number of ways: it names most available materials; it lists maximum permissible unit weights of coarse and fine fractions; it describes limiting aggregate tests; and it specifies tests for concrete-making ability.

Acknowledgement:

The information provided in this article has been compiled from various sources including internet, books, manuals etc. For further information, clarification if any, readers may feel free to contact the author Prof. (Dr.) Arnab Sarma, M. ASCE. @ 97067-68066. The author teaches civil engineering subjects at the Assam Kaziranga University, Jorhat and is the Director of Research.

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