

Optimization of concrete mix design using a statistical approach

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Abstract

A comprehensive and rational design of a concrete mix is extremely complex as it is controlled by numerous factors which depend upon the properties and source of the materials, besides the methods of preparation, compaction, placement and curing of concrete and the requirements of the construction job. When these factors are incorporated in the design of a concrete mix, the task of selecting proportions of ingredients becomes difficult and in most cases inaccuracies in the required properties of concrete result, which are corrected by trial and error procedures.

In order to optimize concrete mix design the effects of the three most important parameters influencing the strength and workability of concrete, viz., water-cement ratio, coarse-to-total aggregate ratio, and aggregate-cement ratio have been investigated in this study. Instead of the traditional method of keeping all other factors constant and varying one factor at a time, to determine its effects, a Factorial Experimental Design was adopted which enables one to evaluate the combined effects of two or more variables and their interactions when used simultaneously.

Aggregates from Riyadh, Saudi Arabia, were considered and various physical and chemical tests were carried out on the aggregates to ascertain their quality. The experimental data for workability, measured in terms of slump, and the 28-day compressive strength was subjected to regression analysis and models developed for strength and workability. The equations for strength and workability so developed were used to generate mix design tables. A computer program has been prepared to predict economic mix proportions for given strength and workability requirements.