

IN-LB

Inch-Pound Units

SI

International System of Units

Selecting Proportions for Normal-Density and High-Density Concrete— Guide

Reported by ACI Committee 211

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Selecting Proportions for Normal-Density and High-Density Concrete—Guide

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Selecting Proportions for Normal-Density and High-Density Concrete—Guide

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This guide to concrete proportioning provides background information on, and a procedure for, selecting and adjusting concrete mixture proportions. It applies to normal-density concrete, both with and without chemical admixtures, supplementary cementitious materials, or both. The procedure uses calculations based on the absolute volumes occupied by the mixture constituents. The procedure incorporates consideration of requirements for aggregate gradation, workability, strength, and durability. Example calculations are provided, including adjustments based on the results of the first trial batch. Appendixes cover laboratory tests and proportioning of high-density concretes.

Keywords: absolute volume; admixtures; air content; durability; mixture proportioning; supplementary cementitious materials; trial batching; water-cementitious materials ratio (w/cm); workability; yield.

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CHAPTER 1—INTRODUCTION AND SCOPE**1.1—Historical background**

The ability to tailor concrete properties in accordance with project requirements reflects technological developments that have taken place, for the most part, since the early 1900s. The use of the water-cement ratio (w/c)—one of the key parameters of mixture proportioning—as a tool for estimating strength was recognized in approximately 1918. In the early 1940s, improvements in durability were achieved with the use of air entrainment. These major developments in concrete technology were augmented by the development of chemical admixtures to achieve special properties, counteract possible deficiencies, and improve cost effectiveness (ACI 212.3R). The first water-reducing admixture was developed in the 1920s and was patented in Europe in 1932, and then in the United States in 1939. Slowly, water-reducing admixtures came into widespread use in the 1970s and played a major role in improving workability, thereby adjusting mixture proportions. Around this time, it was also found that some concrete characteristics could be improved with the addition of certain industrial by-products, now called supplementary cementitious materials (SCMs). The use of these materials has not only improved various concrete properties, but also played a major role in contributing to environmental sustainability. With the implementation of these technological developments, in current practice, most commercially produced concrete contains some type of chemical admixtures, SCM, or both, and their presence needs to be considered while mixture proportioning.

1.2—Introduction

Concrete is composed principally of aggregates, a portland or blended cement, and water, and may contain SCMs, chemical admixtures, or both. It will contain some amount of entrapped air and may also contain purposely entrained air created with the use of an admixture or air-entraining cement. Chemical admixtures are frequently used to accelerate or retard the time of setting, improve workability, or reduce water requirements (ACI 212.3R). Their use may affect strength and other concrete properties. Depending on the type and amount, certain SCMs such as fly ash (ACI 232.2R), natural pozzolans, slag cement (ACI 233R), and silica fume (ACI 234R) may be used in conjunction with portland or blended cement. They are added to provide specific properties such as higher strength, decreased permeability, resistance to the intrusion of aggressive solutions,