Guide for Proportioning Concrete Mixtures with Ground Limestone and Other Mineral Fillers

Reported by ACI Committee 211

ACI 211.7R-15

American Concrete Institute
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First Printing
May 2015
ISBN: 978-1-942727-15-6

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The use of ground limestone and other mineral fillers can enhance the performance, economy, and sustainability of concrete mixtures. Modifications to the conventional proportioning methods in ACI 211.1 are needed to incorporate these materials. This document describes ground limestone and other mineral fillers, including their properties, characterization, and qualification, and effects on concrete properties and sustainability. Recommendations are provided for proportioning concrete mixtures with these materials.

Keywords: dust-of-fracture; ground limestone; mineral fillers; mixture proportioning; paste volume; powder content; proportioning.

CONTENTS

ACI 211.7R-15 was adopted and published May 2015.

CHAPTER 1—INTRODUCTION

This guide provides recommendations for proportioning normalweight concrete with ground limestone and dust-of-fracture mineral fillers. It is intended to supplement ACI 211.1. Proportioning methods for ground limestone and for dust-of-fracture mineral filler are discussed separately.

Mineral filler is defined as a finely divided mineral product at least 65 percent of which passes the No. 200 (75 µm) sieve. Ground limestone is a purposefully manufactured fine product composed primarily of calcium carbonate and with particles sized within narrow ranges. Ground limestone has been used successfully in concrete in Europe for decades, either added to the concrete mixture separately from the cement or interground with clinker to form portland-limestone cement.

Dust-of-fracture mineral filler is rock dust created during production, processing, or handling of quarried stone. Such materials are not purposefully manufactured and can vary in mineral composition and other physical characteristics, depending on the parent stone from which they are derived, the crushing process, and the washing or air separation process.

This guide does not address precipitated calcium carbonate or material finer than the No. 200 (75 µm) sieve in natural sand. Although ground limestone typically falls within the definition of mineral filler, it is dealt with separately in this guide from other mineral fillers. It is manufactured under controlled conditions to be a consistent product. Dust-of-fracture mineral filler consisting primarily of calcium carbonate is not considered ground limestone.

The aggregate suspension mixture proportioning method described in ACI 211.6T has been used to proportion concrete with ground limestone and dust-of-fracture mineral filler.

Concrete mixture proportioning is becoming more critical with changing government regulations and policies for sustainable development in the construction industry. Ground limestone has a lower embodied energy and lower CO_2 emission during its production than an equivalent mass of portland cement. This guide can facilitate the use of ground limestone and other mineral fillers as a means of optimizing the cementitious materials content of concrete, thereby increasing sustainability.

Applicability of these materials is not limited to a select class or type of concrete but can be considered for use in a wide variety of applications and production methods. The described proportioning methods provide a first approximation of proportions intended for trial batches in the laboratory or field, which should be adjusted as necessary to produce the desired characteristics of the concrete.

Ground limestone and dust-of-fracture mineral filler can also be used in structural lightweight concrete. The principles described herein can be similarly used to modify ACI 211.2 to incorporate these materials.

CHAPTER 2—DEFINITIONS

ACI provides a comprehensive list of definitions through an online resource, "ACI Concrete Terminology," http://www.concrete.org/tools/concreteterminology.aspx. Definitions provided herein complement that source.

ground limestone—material with specified amount of calcium carbonate and produced by milling the rock to a specific particle size distribution.

paste volume—volume of cementitious materials and other powders, water, and chemical admixtures.

powder—solid materials finer than approximately 75 µm including cement, supplementary cementitious materials, and the portion of fine aggregate, ground limestone, and other minerals fillers finer than 75 µm.

water-powder ratio—ratio of the mass of water, excluding that absorbed by the aggregate, to the mass of powder in a mixture, stated as a decimal and abbreviated *w*/*p*.

CHAPTER 3—CONSTITUENT MATERIALS

3.1—Introduction

The selection of constituent materials when proportioning concrete with ground limestone or dust-of-fracture mineral filler is very similar to the typical selection process described in ACI 211.1. Mixture constituents such as coarse and fine aggregate (ACI 221R), cementitious materials (ACI 225R; ACI 232.2R; ACI 233R; ACI 234R), admixtures (ACI 212.3R), and water that are commonly used for proportioning concrete are usually suitable when proportioning with ground limestone and dust-of-fracture mineral filler. The most significant adjustments to proportions will be in amount of water used, the type and dosage of admixtures, and minor changes to coarse and fine aggregate ratios.