ACI 305R-10

Guide to Hot Weather Concreting

Reported by ACI Committee 305

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Environmental factors, such as high ambient temperature, low humidity, high wind, or both low humidity and high wind, affect concrete properties and the construction operations of mixing, transporting, and placing of the concrete materials. This guide provides measures that can be taken to minimize the undesirable effects of these environmental factors and reduce the potential for serious problems.

This guide defines hot weather, discusses potential problems, and presents practices intended to minimize them. These practices include selecting materials and proportions, precooling ingredients, and batching. Other topics discussed include length of haul, consideration of concrete temperature as placed, facilities for handling concrete at the site, and, during the early curing period, placing and curing techniques, and appropriate testing and inspection procedures in hot weather conditions.

The materials, processes, quality control measures, and inspections described in this document should be tested, monitored, or performed as applicable only by individuals holding the appropriate ACI certifications or equivalent.

Keywords: air entrainment; cooling; curing; evaporation; high temperature; hot weather construction; plastic shrinkage; production methods; retempering; slump tests; water content.

CONTENTS

ACI 305R-10 supersedes ACI 305R-99 and was adopted and published October 2010.

CHAPTER 1—INTRODUCTION AND SCOPE

1.1—Introduction

Hot weather can create problems in mixing, placing, and curing hydraulic-cement concrete that adversely affect the properties and serviceability of the concrete. Most of these problems relate to the increased rate of cement hydration at higher temperature and increased evaporation rate of moisture from the freshly mixed concrete. The rate of cement hydration depends on ambient and concrete temperature, cement composition and fineness, amount and type of supplementary cementitious materials, and admixtures used.

A maximum as-placed concrete temperature is often specified in an effort to control rate of setting, strength, durability, plastic shrinkage cracking, thermal cracking, and drying shrinkage. The placement of concrete in hot weather, however, is too complex to be dealt with by setting a maximum as-placed or as-delivered concrete temperature. Concrete durability is defined as the ability of concrete to resist weathering action, chemical attack, abrasion, or any other process of deterioration (ACI 201.2R). Generally, if concrete strengths are satisfactory and curing practices are sufficient to avoid undesirable drying of surfaces, the durability of hot weather concrete will not differ greatly from similar concrete placed at normal temperatures.

Where an acceptable record of field tests is not available, concrete proportions can be determined by trial batches (ACI 301 and 211.1). Trial batches should be made at temperatures anticipated in the work and mixed following one of the procedures described in Section 4.10, Proportioning. The concrete supplier is generally responsible for determining concrete proportions to produce the required quality of concrete unless specified otherwise.

If the initial 24-hour curing is at 100°F (38°C), the 28-day compressive strength of the test specimens may be 10 to 15% lower than if cured at the required ASTM C31/C31M curing temperature (Gaynor et al. 1985). If the cylinders are allowed to dry at early ages, strengths will be reduced even further (Cebeci 1987). Therefore, proper curing of the test specimens during hot weather is critical, and steps should be taken to ensure that the specified procedures are followed.

The effects of high air temperature and low relative humidity are more pronounced with increases in wind speed. The potential problems of hot weather concreting can occur at any time of the year, but generally occur during the summer season. Drying conditions can occur even at lower ambient temperatures, with slower set times, lower relative humidity, and wind, all of which are conducive to higher evaporation. Precautionary measures required on a windy, sunny day will be stricter than those required on a calm, humid day, even if air temperatures are identical.

1.2—Scope

This guide identifies problems associated with hot weather concreting and describes practices that alleviate these potential adverse effects. These practices include suggested preparations and procedures for use in general types of hot weather construction, such as pavements, bridges, and buildings. Temperature, volume changes, and cracking problems associated with mass concrete are treated more thoroughly in ACI 207.1R, 207.2R, and 224R.

CHAPTER 2—NOTATION AND DEFNITIONS

2.1—Notation

E = evaporation rate, lb/ft^2/h (kg/m^2/h)

e_a = water vapor pressure in mmhg (psi) in the air surrounding the concrete obtained by multiplying the saturation vapor pressure at the temperature of the air surrounding the concrete by the relative humidity of the air. Air temperature and relative humidity are measured approximately 1.2 to 1.8 m (4 to 6 ft) above the concrete surface on the windward side and shielded from the sun's rays

e_o = saturation water vapor pressure in mmhg (psi) in the air immediately over the concrete surface, at the concrete temperature. Obtain e_o from Table 4.2(a) or (b)

e_s = saturation vapor pressure, kPa (psi)

r = (relative humidity percent)/100

T = temperature, °C (°F)

T_a = air temperature, °F (°C)