IN-LB	Inch-Pound Units
SI	International System of Units

Mass Concrete—Guide

Reported by ACI Committee 207

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This guide contains a history of the development of mass concrete practice and discussion of materials and concrete mixture proportioning, properties, construction methods, and equipment. It covers traditionally placed and consolidated mass concrete for massive structures such as dams and provides information applicable to mass structural heavily reinforced concrete and for thermally controlled concrete such as bridge elements and building foundations. This guide does not cover roller-compacted concrete.

Keywords: cement; cracking; fly ash; heat of hydration; mass concrete; mixture proportioning; supplementary cementitious materials; temperature rise; thermal control plan; thermal expansion; volume change.

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CHAPTER 1—INTRODUCTION AND HISTORICAL DEVELOPMENTS

1.1—Scope

Mass concrete covered by this guide generally falls into two classifications, or types. The first type is the traditional mass concrete of structures such as dams, where most of the structure is mass concrete and is constructed of intertwined placements. The second type consists of individual or distinct placements such as high-rise building foundations or bridges, and is increasingly referred to as thermally controlled concrete. Both types of mass concrete have similar principles and basic considerations; however, thermally controlled concrete is often constructed with commercial ready mixed concrete. Thus, it may be designed to be pumpable and can consist of self-consolidating, high-strength, or high-performance concrete, which typically results in concrete containing much higher cementitious materials content than traditional mass concrete. Although this guide mainly focuses on guidance for traditional mass concrete, much of the information can also be applicable to thermally controlled concrete.

The design of traditional mass concrete structures, such as dams, is generally based on durability, economy, and thermal requirements. Strength performance is often a secondary requirement, rather than a primary concern, and is sometimes specified to be achieved at an age of 56 or 90 days instead of 28 days.

The one characteristic that distinguishes mass concrete from other concrete work is thermal behavior. Because the reaction between water and cement is exothermic by nature, the temperature rise within a large concrete mass, where the heat is not quickly dissipated, can be quite high. Significant tensile stresses and strains may result from a decline in temperature as heat from hydration is dissipated at the volume extremities but not at the mass core. Measures should be taken where cracking due to thermal behavior may adversely affect structural integrity, durability, or aesthetics.

This guide contains a history of the development of mass concrete practice and a discussion of materials and concrete mixture proportioning, properties, construction methods, and equipment.

Mass concreting practices were developed largely from concrete dam construction, where temperature-related cracking was first identified. Temperature-related cracking has also been experienced in other concrete structures, including mat foundations, pile caps, bridge piers, superstructure elements, roadway patches, and tunnel linings.

High compressive strengths are not typically required in traditional mass concrete structures; however, there are some cases, such as thin arch dams, where high-strength concrete may be specified. Massive structures, such as gravity dams, resist loads primarily by their shape and mass; strength is of secondary importance. Of more importance are durability and properties connected with temperature behavior and the tendency for cracking.

The effects of heat generation, restraint, and volume changes on the design and behavior of massive reinforced elements and structures are discussed in ACI 207.2R. Cooling and insulating systems for mass concrete are addressed in ACI 207.4R.

1.2—History

Historically, mass concrete considerations evolved out of the use of concrete in dams. The first concrete dams were relatively small, and the concrete was mixed by hand. The portland cement usually had to be aged to comply with a boiling soundness test, the aggregate was bank-run sand and gravel, and proportioning was by the shovelful (Davis 1963). Tremendous progress has been made since the early 1900s, and the art and science of dam building practiced today has reached a highly advanced state. Presently, the selection and proportioning of concrete materials to produce suitable strength, durability, and impermeability of the finished product can now be predicted and controlled with accuracy.

Covered herein are the principal steps from those very small beginnings to the present. In large dam construction, there is now exact and automatic proportioning and mixing of materials. Concrete in 12 yd^3 (9 m^3) buckets can be placed by conventional methods at the rate of 10,000 yd^3/day (7650 m^3/day) at a temperature of less than 50°F (10°C) as placed, even during extremely hot weather. Grand Coulee Dam still holds the record monthly placing rate of 536,250 yd^3 (410,020 m^3), followed by the Itaipu Dam on the Brazil-Paraguay border with 440,550 yd^3 (336,840 m^3) (Itaipu Binacional 1981).

1.2.1 *Before 1900*—Before the beginning of the twentieth century, much of the portland cement used in the United States was imported from Europe. All cements were very coarse by present standards, and quite commonly they were underburned and had a high free lime content. For dams of