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Report on High-Strength Concrete

Reported by ACI Committee 363

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Report on High-Strength Concrete

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This report summarizes currently available information about high-strength concrete (HSC). Topics discussed include selection of materials, concrete mixture proportions, ordering, batching, mixing, transporting, placing, quality control, concrete properties, structural design, economic considerations, and applications.

Keywords: concrete properties; economic considerations; high-strength concrete; material selection; mixture proportions; structural applications; structural design; quality control.

CONTENTS

Chapter 1—Introduction, p. 363R-2
1.1—Historical background
1.2—Definition of high-strength concrete
1.3—Scope of report

Chapter 2—Notation, definitions, and acronyms, p. 363R-3
2.1—Notation
2.2—Definitions
2.3—Acronyms

Chapter 3—Selection of material, p. 363R-5
3.1—Introduction
3.2—Cementitious materials
3.3—Admixtures
3.4—Aggregates
3.5—Water

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Chapter 4—Concrete mixture proportions, p. 363R-10
4.1—Introduction
4.2—Strength required
4.3—Test age
4.4—Water-cementitious material ratio
4.5—Cementitious material content
4.6—Air entrainment
4.7—Aggregate proportions
4.8—Proportioning with supplementary cementitious materials and chemical admixtures
4.9—Workability
4.10—Trial batches

Chapter 5—Ordering, batching, mixing, transporting, placing, curing, and quality-control procedures, p. 363R-19
5.1—Introduction
5.2—Ordering
5.3—Batching
5.4—Mixing
5.5—Transporting
5.6—Placing procedures
5.7—Curing
5.8—Quality control and testing

Chapter 6—Properties of high-strength concrete, p. 363R-23
6.1—Introduction
6.2—Stress-strain behavior in uniaxial compression
6.3—Modulus of elasticity
6.4—Poisson's ratio
6.5—Modulus of rupture
6.6—Splitting tensile strength
6.7—Fatigue behavior
6.8—Unit density
6.9—Thermal properties
6.10—Heat evolution due to hydration
6.11—Strength gain with age
6.12—Resistance to freezing and thawing
6.13—Abrasion resistance
6.14—Shrinkage
6.15—Creep
6.16—Permeability
6.17—Scaling resistance
6.18—Fire resistance

Chapter 7—Structural design considerations, p.363R-35
7.1—Introduction
7.2—Concentrically loaded columns
7.3—Beams and one-way slabs
7.4—Prestressed concrete beams
7.5—Eccentrically loaded columns

Chapter 8—Economic considerations, p. 363R-47
8.1—Introduction
8.2—Cost studies
8.3—Selection of materials
8.4—Quality control
8.5—Conclusions

Chapter 9—Applications, p. 363R-51
9.1—Introduction
9.2—Buildings
9.3—Bridges
9.4—Offshore structures
9.5—Other applications

Chapter 10—Summary, p. 363R-54

Chapter 11—References, p. 363R-55
11.1—Referenced standards and reports
11.2—Cited references

CHAPTER 1—INTRODUCTION

1.1—Historical background

The use and definition of high-strength concrete (HSC) has seen a gradual and continuous development over many years. In the 1950s, concrete with a compressive strength of 5000 psi (34 MPa) was considered high strength. In the 1960s, concrete with compressive strengths of 6000 and 7500 psi (41 and 52 MPa) were produced commercially. In the early 1970s, 9000 psi (62 MPa) concrete was produced. Today, compressive strengths approaching 20,000 psi (138 MPa) have been used in cast-in-place buildings. Laboratory researchers using special materials and processes have achieved "concretes" with compressive strengths in excess of 116,000 psi (800 MPa) (Schmidt and Fehling 2004). As materials technology and production processes evolve, it is likely the maximum compressive strength of concrete will continue to increase and HSC will be used in more applications.

Demand for and use of HSC for tall buildings began in the 1970s, primarily in the U.S.A. Water Tower Place in Chicago, IL, which was completed in 1976 with a height of 859 ft (260 m) and used 9000 psi (62 MPa) specified compressive strength concrete in the columns and shear walls. The 311 South Wacker building in Chicago, completed in 1990 with a height of 961 ft (293 m), used 12,000 psi (83 MPa) specified compressive strength concrete for the columns. In their time, both buildings held the record for the world's tallest concrete building. Two Union Square in Seattle, WA, completed in 1989, holds the record for the highest specified compressive strength concrete used in a building at 19,000 psi (131 MPa).

High-strength concrete is widely available throughout the world, and its use continues to spread, particularly in the Far East and Middle East. All of the tallest buildings constructed in the past 10 years have some structural contribution from HSC in vertical column and wall elements. The world's tallest building, at 1670 ft (509 m), is Taipei 101 in Taiwan, completed in 2004. The structural system uses a mix of steel and concrete elements, with specified concrete compressive strengths up to 10,000 psi (69 MPa) in composite columns. Petronas Towers 1 and 2, completed in 1998 in Kuala Lumpur, Malaysia, used concrete with specified cube strengths up to 11,600 psi (80 MPa) in columns and shear walls. At the time of this report, these towers are the second and third tallest buildings in the world, both at 1483 ft (452 m). The world's tallest building constructed entirely with a reinforced concrete structural system is the CITIC Plaza