Concrete

Lecture - 7

Course Coordinator
Dr. Raju Sharma
Assistant Professor
Department of Civil Engineering
Thapar Institute of Engineering and Technology
Patiala, Punjab

Content

1. Introduction of High Performance Concrete
2. ACI Definition of HPC
3. Definition as per US Highway Administration
4. Summary

High Performance Concrete

- *Conventionally, products that last longer are called high-performance products.*
- *From laboratory investigations many researchers have reported that properly proportioned and cured mixtures of superplasticized concrete, with 0.4 or less w/cm, show a little or no permeability, which is the most desired property for long-term durability of structures exposed to corrosive environments.*

High Performance Concrete

- *In fact, superplasticized concrete mixtures made with blended portland cements containing mineral additives exhibit unusually low permeability ratings in the ASTM C 1202, rapid chloride penetration test.*

Road Map (Development of High Performance Concrete)

Globally Recognized

FHWA has revised the definition of HPC for highway structures.

The definition and commentary that was approved by the ACI in 1998 are as follows: HPC is defined as a concrete meeting special combination of performance and uniformity requirements that cannot always be achieved routinely using conventional constituents and normal mixing, placing, and curing practices.

1998

In a 1990 publication Mehta and Aitcin suggested the term high-performance concrete (HPC) for concrete mixtures that possess the following three properties high-workability high-strength, and high durability

1990

In 1991, ACI's Technical Activities Committee formed a task-group on high performance concrete to develop a definition and description of the performance characteristics of HPC.

1991

ACI Definition

According to the commentary on the definition, a high-performance concrete is a concrete in which certain characteristics are developed for a particular application and environment. Examples of characteristics that may be considered critical for particular application are:

- Ease of Placement
- Compaction without segregation
- Early age strength
- Permeability
- Long-term strength and mechanical properties
- Density
- Toughness
- Heat of Hydration
- Long life in severe environments
- Volume Stability

ACI Definition

Note that according to the ACI definition, durability under severe environmental conditions is an optional, not a mandatory requirement for HPC. This can be problematic for those who assume that the term high-performance automatically implies a long service life. As described next, field experience with cast in- place HPC mixtures, meeting the ACI definition, shows that those possessing a very-high early strength are prone to cracking at early-age from high autogenous shrinkage and high thermal shrinkage.

As Per U.S. Federal Highway Administration (FHWA)

Based on SHRP recommendations, the U.S. Federal Highway Administration (FHWA) sponsored a national program of field testing HPC bridge decks. The assumption that "*stronger concrete mixtures would be more durable" did not turn* out to be true in the case of many *cast-in-place and exposed concrete structures,* therefore FHWA has revised the definition of HPC for highway structures.

HPC is a concrete that has been designed to be more durable and if necessary, stronger than conventional concrete. HPC mixtures are essentially composed of the same materials as conventional concrete mixtures. But the proportions are designed or engineered to provide the strength and durability needed for the structural and environmental requirements of the project

Comparison of ACI and FHWA Definition

Unlike the ACI definition of HPC, which is broad in one sense (e.g., an attempt to cover all types of concrete) and restrictive in another sense (e.g., use of special materials and construction practices), the FHWA guideline for HPC is more practical and useful. First, by bringing the issue of concrete durability in the forefront, it emphasizes that strength is not synonymous with durability and, *for high-performance, high durability is more important* than high strength. Second, it encourages the use of local materials, which is a step in the right direction from standpoint of cost, and materials and energy conservation.

Application of HPC

Many sophisticated concrete structures are now being designed for longer service life, for example, 100 to 120 years. When exposed to aggressive fluids and demanding environmental exposure conditions, it is essential that the concrete should remain crack-free and impermeable for a long period. HPC mixtures are being used for the construction of structural components of offshore oil drilling platforms, long-span bridges, and highway bridge decks. Examples of HPC mixtures and relevant features of the construction practice are described as follows:

Application of HPC

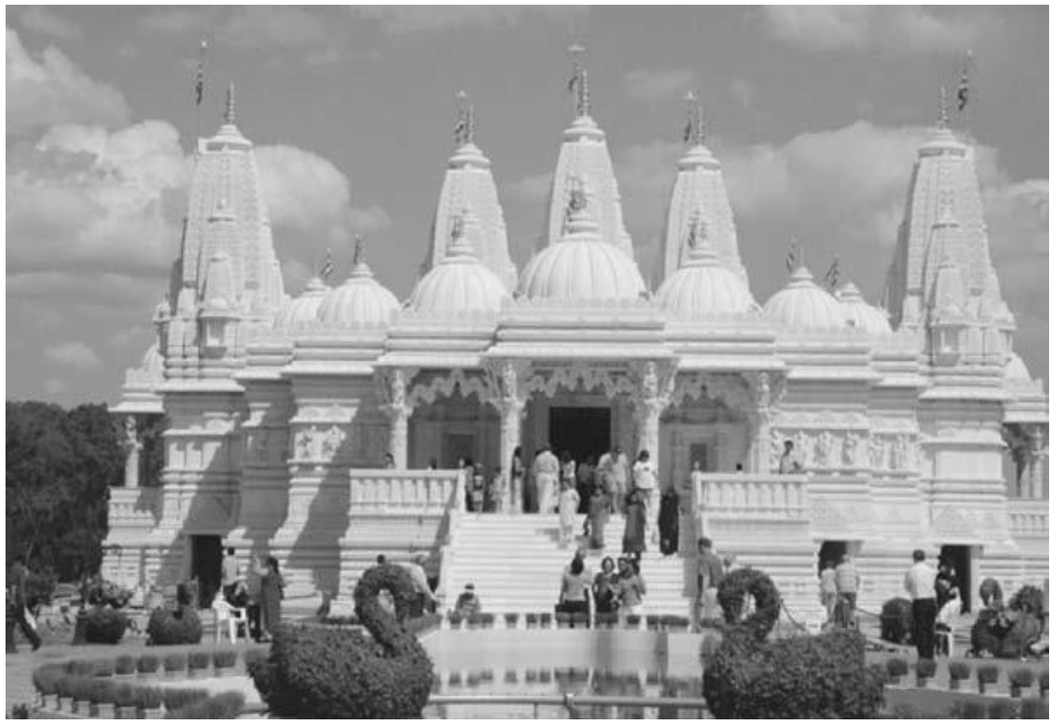
Construction of the Great Belt Link.

At a cost of 4 billion USD, the Great Belt fixed link in Denmark provided a major improvement to the Northern European transportation system. The island of Sprogo divides the 18-km Great Belt into two parts. The Great Belt link has a railway tunnel, a high level motorway bridge across the East Channel and a low level bridge for rail and motorway across the West Channel. High-quality precast concrete segments were fabricated on dry docks under controlled environment. Even for the 50,000-tonne precast concrete units, construction tolerances were within a few centimeters. [photograph, courtesy of Ben Gerwick].

Application of HPC

Hindu Temple, Kauai Island, Hawaii. (*a) Placement and finishing of HVFA* concrete, (*b) Monolith, HVFA concrete foundation supporting an assembly of carved* column and beam sections, designed for a service life of 1000 years

Application of HPC



Placement and consolidation of the HFVA concrete for the BAPS

Temple and Cultural Complex, Chicago; (b) BAPS temple in Houston, supported by drilled piers and a massive foundation, both made of HVFAconcrete. (*c) Heavily* reinforced shear halls for the seismic retrofit of Barker Hall at the University of California's Berkeley campus are built with HVFAconcrete. (*Source: D. Manmohan and P.K. Mehta, Concrete Intl., Vol. 24, No. 8, 2002, pp. 64–70)*

Summary

- ***High Performance Concrete***

- *Introduction*
- *Development of HPC*
- *Application of HPC*

THANK YOU