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EXPLAINER

Extending the Service Life of Structures

Chuncheon Grand Bridge, an access bridge to LEGOLAND Theme Park, is the first ultra-high performance concrete cable-stayed bridge in the world and was constructed using SUPER Concrete. Photo credit: KICT, Daelim Industrial Co.

Using a new cement compound that applies nanoparticles can extend the service life of structures to 200 years or more.

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Introduction

SUPER Concrete is the Republic of Korea's ultra-high performance concrete. Developed by Korea Institute of Civil Engineering and Building Technology researchers, this technology offers high compressive strength, guarantees long service life, and reduces construction costs for bridges, wind turbine towers, and other civil and building structures.

What makes SUPER Concrete different from conventional concrete?

Typically, conventional concrete is cheap but heavy. Composed of sand and crushed stones, it implodes quickly with strong pressure. Embedded steel rebars in conventional concrete structures corrode easily thus limiting the service life of these structures to up to 30 or 50 years only.

Meanwhile, SUPER Concrete is a cement compound reinforced with:

- nano-sized materials and super-plasticizers to lessen particle segregation or porosity between cement and sand, and
- steel fibers to increase resistance, tensile strength, and structural ductility.

It reduces the use of reinforcing materials such as rebars and allows slimmer cross-section, therefore, reducing the total weight by over 30% without sacrificing the capacity of the structure to withstand load. Its composition makes the structure five times stronger. SUPER Concrete is capable of compressive strength of 80 to 180 megapascal (MPa). This allows the construction of low-cost, long-life, and high-quality structures with 50 to 100% higher durability. It can reduce the construction cost as well as the maintenance cost by 10 to 20%. Building and/or infrastructures made from SUPER Concrete can last more than 200 years and can reduce carbon emissions by over 30%.

Likewise, because of its durability and fluidity, engineers and architects are given more flexibility to design slender and/or non-uniform structures with reduced cost.

What are the classifications of SUPER Concrete?

The institute has developed prototype mixes of SUPER Concrete. They are SC80, SC100, SC120, SC120f, SC150f, and SC180f. Each one is designed for a specific construction purpose.

These prototypes are very economical, incurring only 50 to 80% of the typical domestic and overseas manufacturing costs. Compared with the use of the normal concrete, the use of SUPER Concrete in a 200 to 1,000-meter cable-stayed bridge would reduce the superstructure construction costs by up to 16%. In addition, the application of SC80 to girder bridges of over 60 meters in length would reduce construction cost by more than 10%.

For a 150-meter wind turbine tower, using SC80 would reduce the construction costs for the steel-reinforced tower by up to 77%. Likewise, the application of SC100 to a landing stage would reduce the generic concrete construction costs by up to 18% and the construction costs for the structural components by about 10%.

Site Application

This is the formwork installation for SUPER Concrete pouring for KOSMOS – the world's first UHPC building structure. Photo credit: KICT, KOLON Global Co., The System Lab.

SUPER Concrete was recently used in the construction of the cable-stayed bridge to LEGOLAND Theme Park in Chuncheon, Gangwon-do and the Healing Stay KOSMOS Resort in Ulleung Island, recorded as the world's first ultra-high performance concrete bridge and building respectively.

In October 2015, the Hawkeye Bridge in Iowa, USA was completed. This marked the first application of this technology to the US market. In the same year, the bridge that is part of the Yangon-Mandalay Highway in Myanmar was also constructed using this technology.

SC80 is now used in the construction of the Goduk Grand Bridge over the Han River in Seoul. Once completed, this would be recorded as the concrete cable-stayed bridge with the longest central span in the world.

This will also be used in the planned construction of the DMZ-crossing bridge also known as "The Bridge of Peace."

Resources

Korea Institute of Civil Engineering and Building Technology (KICT). 2016. *World's First Super Concrete Material and Structural Technology.*

KICT. 2016. *Convergence of Advanced Material and Core Design Technology Gives Birth to Super Concrete.*

Byung-Suk Kim
Bridge Committee Chairman, Korean Construction Standards Center

Prior to his current role, Dr. Kim was the vice president of Korea Institute of Civil Engineering and Construction Technology and was the head researcher for ultra-high performance concrete studies. He served as chairman of the following committees: Korean Peninsular Infrastructure Special Committee, Bridge Standards Committee of Korea Society of Civil Engineers, and Specification and Standards Subdivision of Korea Society of Civil Engineers. He has been a Central Construction Deliberation Committee Member in Korean Ministry of Land, Infrastructure and Transport (MOLIT) since 2015 and the vice president of Korean Institute of Bridge and Structural Engineers since 2014. Dr. Kim holds BS, MS, and PhD degrees from Seoul National University.

Korea Institute of Civil Engineering and Building Technology (KICT)

The Korea Institute of Civil Engineering and Building Technology contributes to the development of the Korean construction industry, improves quality of life standards, furthers national economic growth, and improves social welfare. It promotes original technology in the fields of land, infrastructure, and construction.