Ductal® Ultra-High Performance, Fiber Reinforced Concrete: A Revolutionary Material for Innovative New Solutions

The innovation: Ductal® ultra-high performance, fiber reinforced concrete ("UHPFRC") is a revolutionary material that offers superior strength, durability, ductility and aesthetic design flexibility. It is significantly stronger than conventional concrete, with compressive strengths up to 30,000 psi and flexural strengths up to 6,000 psi. It is blended with metallic or PVA fibers, depending on strength and rheology requirements, exposure to corrosive agents, desired aesthetics and other factors. Available in a range of colors, it is extremely moldable and replicates form materials with great precision. By utilizing Ductal's combination of superior properties, designers can create thinner sections and longer spans that are lighter, more graceful and innovative in geometry and form, while providing improved durability and impermeability against corrosion, abrasion and impact.

Why it is innovative:

- The ductile behaviour is a first for a concrete material; with the capacity to deform and support flexural and tensile loads, even after initial cracking.
- Its superior strength allows for solutions with smaller elements, without the use of passive reinforcing steel and, in most applications, without prestressed or post-tensioned reinforcement.
- There is almost no carbonation or penetration of chlorides and sulphides. The material has improved freeze-thaw and abrasion resistance due to an optimized gradation of fine powders, selected for relative grain size (maximum 600 microns) and chemical reactivity. Ductal is approximately 5% denser than conventional concrete. This "denseness", along with small, similar sized, non-connected pores throughout the cementitious matrix, attributes to its imperviousness and durability against adverse conditions and aggressive agents.
- The material has almost no shrinkage or creep, making it suitable for prestressed applications.
- The material is highly moldable due to the fine grain constituents, self consolidating properties, and absence of reinforcing steel, thereby allowing designers to develop new, lighter complex shapes with enhanced surface aspects.
- Advantages may include: reduced global construction costs, formworks, labor and maintenance, which relates to improved site construction safety, speed of construction and, extended usage life.

What it changed or replaced: Many economies gained with Ductal are a result of engineering new solutions for old problems. With its combined, superior properties and related benefits, Ductal replaces conventional building materials (including steel) with attractive, durable and cost-competitive solutions for a variety of innovative applications. The proven successes to date demonstrate its unique capabilities and leads to new possibilities for civil engineering, structural reinforcement and contemporary architectural works.

Competing Products: We are aware of other UHPFRCs, or "flexible concretes" in various stages of research and development however; to date, we are unaware of other commercially available, competing materials that have achieved the same level or combination of superior properties.

Where and when it originated, has been used, and is expected to be used in the future: In 1994, Lafarge S.A., Bouygues S.A., and Rhodia Chemie S.A., entered into a collaborative R & D agreement with intent to globally commercialize a UHPC with ductility. The technology is covered by one of many patents in a range of UHPCs, all under the Ductal trademark. Today, there are numerous Ductal projects around the world including: bridges, canopies, wall, roof and floor systems, furnishings and others. The following is a small sample of some innovative, North American projects:

- In 1997, the first North American Ductal pedestrian bridge was built in Sherbrooke, Quebec. It is constructed from 6 post-tensioned segments, spanning 200 feet with an unreinforced deck (1-1/8″ thick) and trusses made with Ductal.
- In 2001, a clinker silo in Joppa, Illinois became the first building in the world to have a long-span Ductal roof system. The material was used to construct 1 of 3 clinker silo roofs and a conventional steel solution was used on the other 2; allowing a comparative study. The Ductal roof consists of 24 non-reinforced, ultra-light pre-cast, pie-shaped panels ½" thick and 58' in diameter. It easily provided an essential air and watertight roof while the steel system achieved this with great difficulty. The Ductal system also provided faster construction (11 days to install vs. 30), improved aesthetics, superior durability and impermeability, plus reduced maintenance and a longer structural life span.
- In 2004, the world's first ultra-thin Ductal canopy system was completed at the Shawnessy LRT Station in Calgary, Canada. This project involved a collaboration that combined inventive design, emerging technology, rigid testing and manufacturing savvy. The 24 off-white canopies (18 ft x 20 ft x ¾ in. thick), supported on single columns, provide protection from the elements and lighting to the platform below. *This remarkable project won 7 prestigious awards including the "FIB (International Federation for Structural Concrete) Award for Outstanding Structures".*
- In 2006, the first North American Ductal highway bridge was completed in Wapello County, Iowa; the result of 5 years of collaborative R&D between the FHWA, IDOT, ISU and Lafarge. A simple, single-span bridge with a 3-beam cross section, it provides a significant step towards *The Bridge of the Future*, utilizing three 110-ft Ductal girders with no rebar for shear stirrups. *This project won a 2006 PCA (Portland Cement Association) Concrete Bridge Award.*
- In 2006, the Gold Bar Wastewater Treatment Plant in Edmonton, Canada became the first water treatment facility to use Ductal troughs. The troughs sit directly on top of plate-settlers, making structural strength, durability and lightweight critical requirements. Conventional concrete could be used but required additional support. Stainless steel met the strength, durability and weight criteria, however it was not the most cost effective. With Ductal, the physical property requirements were met and the solution generated significant value for the owner.


Joppa Clinker Silo
Sherbrooke Bridge
Shawnessy LRT Station
Wapello County Mars Hill Bridge
Gold Bar Wastewater Treatment Plant
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