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Reactive Powder Concrete

Purdue ECT Team
Purdue University, ectinfo@ecn.purdue.edu

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REACTIVE POWDER CONCRETE

THE NEED

The upper limit of compressive strength for materials that can be used in commercial applications continues to be pushed higher and higher. Within the past three years Portland cement based materials have been developed which have compressive strengths greater than 200 MPa (2 to 4 times greater than High Performance Concrete). These materials allow remarkable flexural strength and extremely high ductility, more than 250 times greater than that of conventional concrete.

FIGURE 1 SHERBROOKE BRIDGE, QUEBEC, CANADA

THE TECHNOLOGY

Reactive Powder Concrete is an ultra high-strength and high ductility composite material with advanced mechanical properties. Developed in the 1990s by Bouygues' laboratory in France. It consists of a special concrete where its microstructure is optimized by precise gradation of all particles in the mix to yield maximum density. It uses extensively the pozzolanic properties of highly refined silica fume and optimization of the Portland cement chemistry to produce the highest strength hydrates.

RPC represents a new class of Portland cement-based material with compressive strengths in excess of 200 MPa range. By introducing fine steel fibers, RPC can achieve remarkable flexural strength up to 50 MPa. The material exhibits high ductility with typical values for energy absorption approaching those reserved for metals.

THE BENEFITS

- RPC is a better alternative to High Performance Concrete and has the potential to structurally compete with steel.

- Its superior strength combined with higher shear capacity results in significant dead load reduction and limitless structural member shape.
- With its ductile tension failure mechanism, RPC can be used to resist all but direct primary tensile stresses. This eliminates the need for supplemental shear and other auxiliary reinforcing steel.
- RPC provides improve seismic performance by reducing inertia loads with lighter members, allowing larger deflections with reduced cross sections, and providing higher energy absorption.
- Its low and non-interconnected porosity diminishes mass transfer making penetration of liquid/gas or radioactive elements nearly non-existent. Cesium diffusion is non-existent and Tritium diffusion is 45 times lower than conventional containment materials.

STATUS

The firm HDR Engineering Inc. is responsible for the development and promotion of RPC in North America. An application of RPC can be seen in the Pedestrian Bridge in the city of Sherbrooke, Quebec, Canada. RPC has also been used for isolation and containment of nuclear waste of several projects in Europe. This product was nominated for the 1999 Nova Awards from the Construction Innovation Forum.

BARRIERS

In a typical RPC mixture design, the least costly components of conventional concrete have been basically eliminated or replaced by more expensive elements. The fine sand used in RPC becomes equivalent to the course aggregate of conventional concrete, the Portland cement fills the role of the fine aggregate and the silica fume that of the cement. The mineral component optimization alone results in a substantial increase in cost over and above that of conventional concrete (5 to 10 times higher than High Performance Concrete.)

RPC should be used in areas where substantial weight savings can be realized and where some of the remarkable characteristics of the material can be fully utilized.

POINTS OF CONTACT

William Dowd, HDR Engineering, Inc.

Tel: (402) 399-1080, Fax: (409) 399-4979, Email: bdow@hdrinc.com

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REVIEWERS

Peer reviewed as an emerging construction technology

DISCLAIMER

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