



## UNDERSTANDING AND USING BENDABLE CONCRETE

A New Short Course Presented by the Inventor of an Improved, More Environmentally Friendly Engineered Cementitious Composite (ECC)

### LEARN HOW THIS REVOLUTIONARY MATERIAL MEETS STRUCTURAL AND DURABILITY CHALLENGES

June 24–26, 2008  
Ann Arbor, Michigan

Mixed and applied using traditional methods, this advanced synthetic fiber-reinforced engineered material offers unique properties when compared to traditional concrete:

- Able to bend like a metal
- Stronger, more durable, and lasts longer
- Non-brittle (containing only two percent by volume of short fibers)
- 500 times more resistant to cracking
- Up to 40 percent lighter
- Reduces or eliminates steel reinforcement
- Reduces project cost
- Faster precast or on-site construction
- Minimizes maintenance cost
- Reduces environmental impacts

One of the "10 Tech Concepts You Need to Know for 2007"  
*Popular Mechanics*

One of the "Top 5 Concrete and Masonry Products of 2006"  
*Architectural Record*

Recently featured in  
*Concrete Engineering International*

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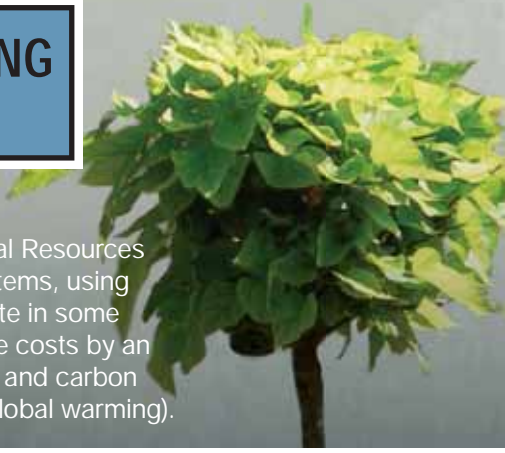


Michigan**Engineering**

# UNDERSTANDING AND USING BENDABLE CONCRETE

## A Green Solution

Based on a study by the U-M School of Natural Resources and Environment's Center for Sustainable Systems, using this composite to replace conventional concrete in some infrastructure applications can reduce life cycle costs by an estimated 37%, energy consumption by 40%, and carbon dioxide emissions by 39% (a major cause of global warming).



## ABOUT THE PROGRAM

Reducing the brittle nature of concrete has opened a new world of possibilities to enhance the safety, durability, and sustainability of the next generation of civil infrastructure. In this new ECC material which was under development at U-M for 10 years, specially coated microscopic polymer fibers slide past each other instead of snapping under stress, giving it incredible ductility previously only seen in ductile metals. The fresh properties of ECC have been tuned for ease in field casting using familiar construction equipment.

Cost savings can be realized through more efficient design as well as reductions in material volume, labor cost, steel reinforcement, and less frequent repairs. When long-term cost and environmental impacts are accounted for, the advantages offered by ECC over conventional concrete become compelling. The material is currently emerging in the repair, manufactured product, pre-cast, and ready-mix markets as well as in the bridge, pavement, agriculture, housing, and business industries where a lightweight, strong, and durable building material is needed.

## WHO SHOULD ATTEND

This program is intended for engineers and industry professionals who can benefit by learning about what can be accomplished with less brittle concrete. Business development consultants and entrepreneurs may find applications for new market opportunities. Markets open to the incorporation of ECCs include transportation, building, water, and energy supply infrastructure as well as the housing, architectural, and manufactured concrete product industries. It may be of particular interest to those with experience in the following fields:

- Civil engineering design
- Architecture
- Construction
- Transportation
- Concrete repair consulting
- Concrete product manufacturing
- Housing
- Government Officials (Bureau of Land Management, ERDC, DHS, DOT, and others)
- Chemical and material production (cement, fiber, admixtures)
- Supply industries (energy, water)
- Agriculture

## THE ACE-MRL LABORATORY

<http://ace-mrl.engin.umich.edu>

The Advanced Civil Engineering Materials Research Laboratory (ACE-MRL) is a unique research laboratory which combines chemistry, mechanics, structural design, and industrial ecology in the development of next generation concrete materials that are lighter, stronger, tougher, more durable, and more environmentally friendly. The laboratory partners with industry and governmental agencies to bring ECC technology to bear on the challenges of civil infrastructure. The ACE-MRL holds itself responsible for training the next generation of engineers who serve to enhance the performance of infrastructure in harmony with the natural environment through advanced materials technology.

**Right:** When subjected to extreme flexural loading, the bendable engineered cementitious composite (ECC) developed in the ACE-MRL Laboratory bends but does not break.



## PROGRAM DIRECTORS



**VICTOR LI, Ph.D.**, is the E. Benjamin Wylie collegiate chair professor of Civil and Environmental Engineering at the University of Michigan. He is the Director of the Advanced Civil Engineering Materials Research Laboratory where ECC (bendable concrete) was invented. Professor Li is a frequent keynote speaker in major national and international conferences and often serves as the invited speaker at society meetings of concrete professionals. Together with Drs. G. Fischer and M. Lepech, he founded Li, Fischer, Lepech & Associates, a materials consulting firm specializing in the application of ECC in commercial applications.



**MICHAEL D. LEPECH, Ph.D.**, Assistant Professor of Civil and Environmental Engineering at Stanford University, has been working with Engineered Cementitious Composites since 2001. His research specializations include the durability of ECC materials and structures, the use of ECC in large-scale infrastructure applications, and improving the environmental sustainability of built environments using ECC materials. In 2005, he spearheaded the first large-scale demonstration of ECC in the United States working with the Michigan Department of Transportation. He also serves as a principal of Li, Fischer, Lepech & Associates.

## PROGRAM COMPONENTS

### DAY 1: BENDABLE CONCRETE MATERIALS

#### Session 1: ECC Materials Development

- Constituent materials
- Materials design methodology
- Unique properties of ECC

#### Session 2: ECC Processing

- Fresh self-consolidating material properties
- Large scale mixing using commercial concrete batching plants and trucks
- Specialty processing techniques (spraying, extrusion, precasting)
- Laboratory demonstration mixing

### DAY 2: BENDABLE CONCRETE APPLICATIONS

#### Session 3: Structural Design with ECC

- Experimental structural studies
  - Shear behavior
  - Seismic resistance
- Project case study—bridge infrastructure
- Construction specifications, material quality assurance, and quality control (QA/QC)
- Impacts of design code requirements

#### Session 4: Durability of ECC

- Overcoming repeated concrete repairs through advanced concrete materials
- Durability of ECC in laboratory studies
- ECC field performance in the U.S. and Japan

### DAY 3 (HALF DAY): BENDABLE CONCRETE ECONOMICS

#### Session 5: Economic and Life Cycle Considerations

- Initial material and construction costs
- Life cycle costing and assessment methods for durable ECC materials
- Worldwide implementation highlights

**\$1,950\* COVERS THE ENTIRE PROGRAM** Fee includes tuition, instructional materials, continental breakfast, lunch, and breaks each day. Fee is payable in advance.\* Upon registration, you will receive an email confirmation including directions to the program site and recommended lodging.

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