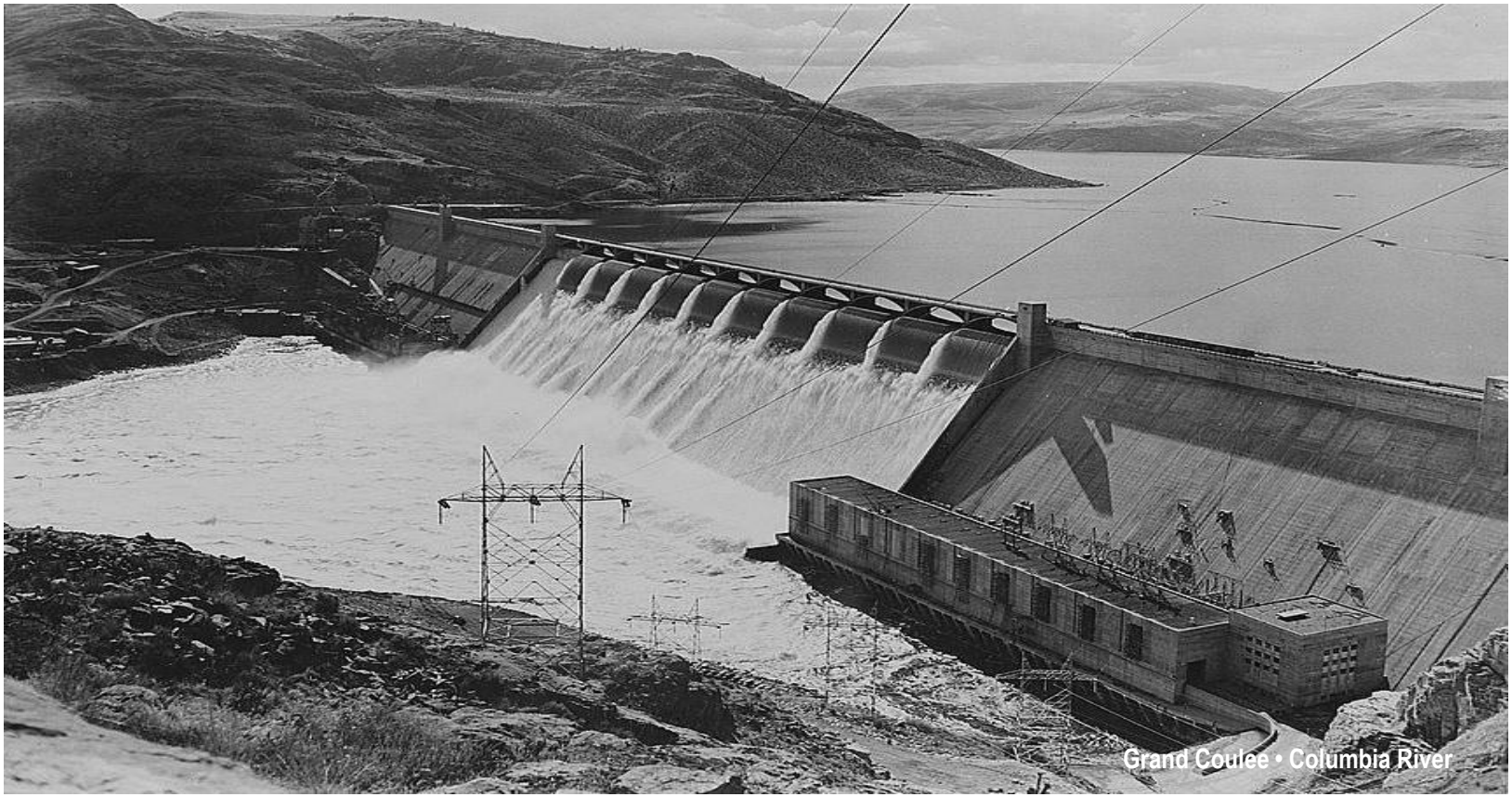

Cement Changes and Solutions to the Industry

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Project Overview

Cement Changes and Solutions to the Industry

This work is aimed at developing a concrete alternative for hydropower facilities with enhanced water tightness, and resistance to cracking.

The Challenge:

- Concrete is subject to cracking
- Cracks can lead to corrosion in reinforcing
- Reduced service life
- Increased maintenance cost

Partners: Iowa State University; lab facilities, material resources

Next Generation Hydropower (HydroNEXT)

Optimization

- Optimize technical, environmental, and water-use efficiency of existing fleet
- Collect and disseminate data on new and existing assets
- Facilitate interagency collaboration to increase regulatory process efficiency
- Identify revenue streams for ancillary services

Growth

- **Lower costs of hydropower components and civil works**
- Increase power train efficiency for low-head, variable flow applications
- Facilitate mechanisms for testing and advancing new hydropower systems and components
- Reduce costs and deployment timelines of new PSH plants
- Prepare the incoming hydropower workforce

Sustainability

- Design new hydropower systems that minimize or avoid environmental impacts
- Support development of new fish passage technologies and approaches
- Develop technologies, tools, and strategies to evaluate and address environmental impacts
- Increase resilience to climate change

Next Generation Hydropower (HydroNEXT)

Growth

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The Impact

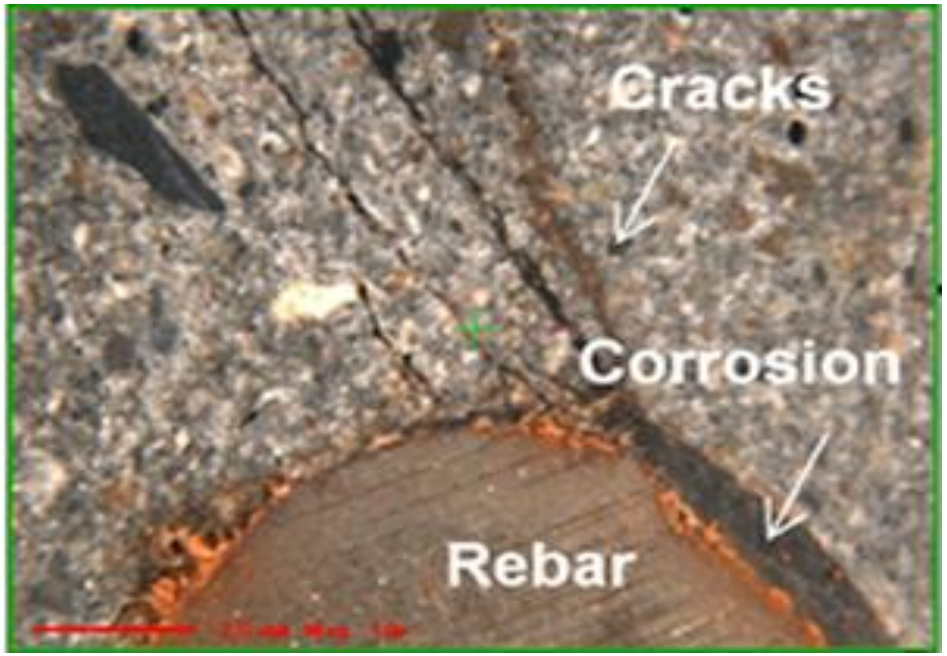
- Cost savings from maintenance, environmental benefits
- Parameters of concrete such as resistance-to-cracking, resistivity will be improved
- Concrete alternative with better durability.

Technical Approach

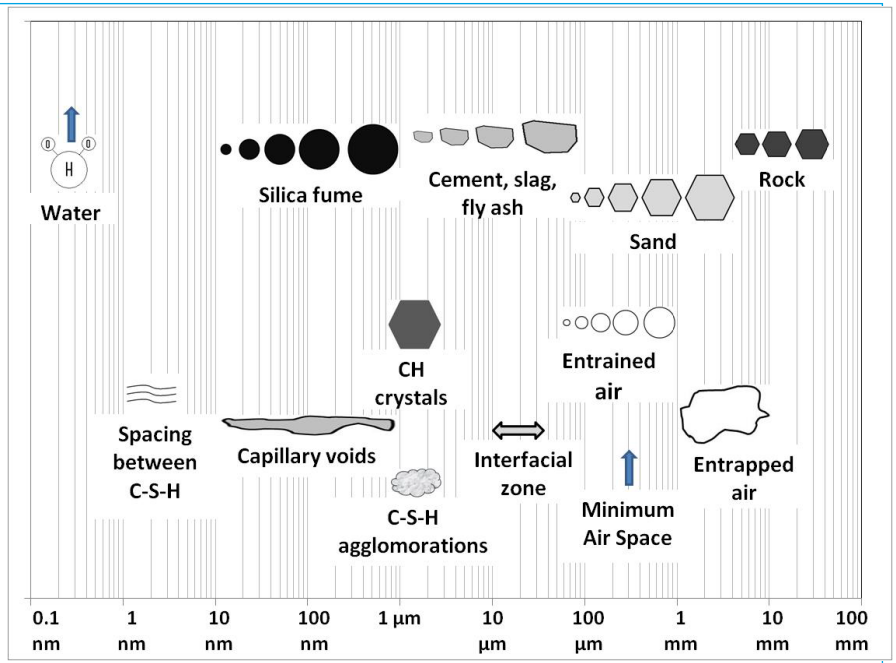
	Plain	Fly Ash F	Fly Ash C	Nanosilica
Coarse ground cement	X			
Type I/II cement Low C_3A (Tri-Calcium Aluminate)	X	X (Internal curing)	X	X
Type I cement High C_3A (Tri-Calcium Aluminate)	X (Internal curing)	X	X	X
Type IL cement (Portland Limestone Cement)	X	X	X	X

- To investigate the difference in shrinkage between Coarse Ground cement and Type IL cement (Portland Limestone Cement)
- To explore engineering properties between Coarse Ground cement and Type IL cement (Portland Limestone Cement)
- To blend various SCMs (Supplementary Cementitious Materials) to potentially achieve improved performance characteristics.

Technical Approach



Source: Applied Petrography Group



Source: Iowa State University

- Primary changes in cementitious system
- Mechanical tests such as ring test
- Micro CT for porosity and void size distribution
- Fluorescence microscopy for micro-crack quantification.

Accomplishments and Progress

In 2016, four cementitious combinations were selected for Phase II to be tested with fibers:

- Coarse ground cement with no SCMs (Control)
- Type IL cement with no SCMs
- Type I/II cement with Class F Fly Ash (20% replacement of binder)
- Type IL cement with Class C Fly Ash (30% replacement of binder).

Improvements marked were:

- Resistivity at 28 days
- Compressive strength at 28 days
- Restrained, free shrinkage, and plastic shrinkage.

Project Plan & Schedule

- Start Date: 01/01/2016
- Tentative End Date: 12/31/2017
- All the milestones were met for Phase I
- Final Phase I Report submitted ahead of schedule
- Initialized preliminary tests for Phase II
- Go/No-Go decision point: Milestones were met for Phase I and recommendations made for Phase II per Final Report.

Project Budget

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$0	$0	$0	$0	$128.901k	$32.334k

- Project budget on schedule
- Expenditures were slightly lower than the planned budget
- 95% is expected to be spent at the end of 2016.

Research Integration & Collaboration

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Partners, Subcontractors, and Collaborators: PI—North Dakota State University, and co-PI—Iowa State University

Communications and Technology Transfer:

- Phase I Final Report
- Better Concrete Conference
- National Concrete Consortium

Next Steps and Future Research

FY17/Current research:

- Fiber studies
- Sustainability review
- Cost applications
- Final documentation

Proposed future research:

- Freeze-thaw durability