Cellular Cofferdam for Hydropower Use

Marte Gutierrez
Colorado School of Mines
mgutierr@mines.edu, 303-273-3507
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Cellular Cofferdam for Hydropower Use:

This project will conduct a comprehensive study on the use of cellular cofferdams as basis for the design and construction of more permanent water-retaining structures to sustainably and cost-effectively harness hydropower.

The Challenge: Cellular cofferdams are temporary water retaining structures that have been very rarely utilized as the main permanent structure for hydropower dams.

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

- In-water dam construction
- Lower cost of construction and decommissioning
- Faster construction and decommissioning.

Project's impact on the industry

- Acceptance of cellular cofferdams as permanent structures for hydropower use.

Project's endpoint or final product

- Design concepts for permanent cellular cofferdams for hydropower use
- Analytical and computational design procedures for permanent designs of cellular cofferdams.

Next Generation Hydropower (HydroNEXT)

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 of evaluate and address environmental impacts
- Increase resilience to climate change

The impact

- Reduced environmental impact due to faster and in-water dam construction and removal

Project's impact on the industry

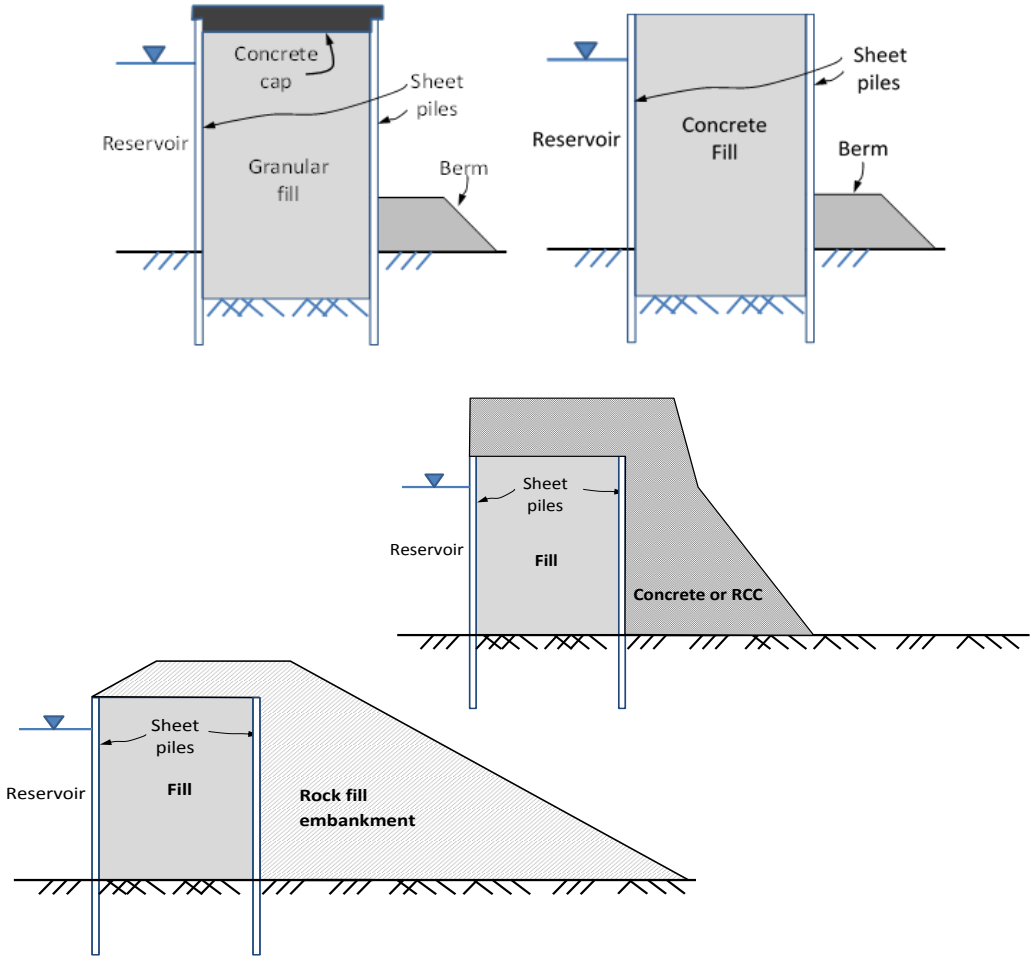
- Acceptance of cellular cofferdam construction practices to reduce impact on the environment

Project's endpoint or final product

- Environmental impact assessment procedure for cellular cofferdams for hydropower use.

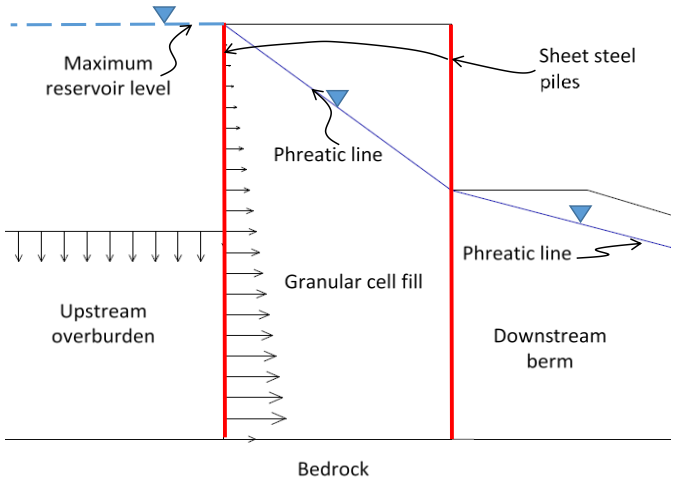
Technical Approach

- Review of conventional designs of cellular cofferdams for temporary use
- Develop design concepts to adapt cellular cofferdams for permanent hydropower applications
- Analytical and computational modeling to validate design concepts.

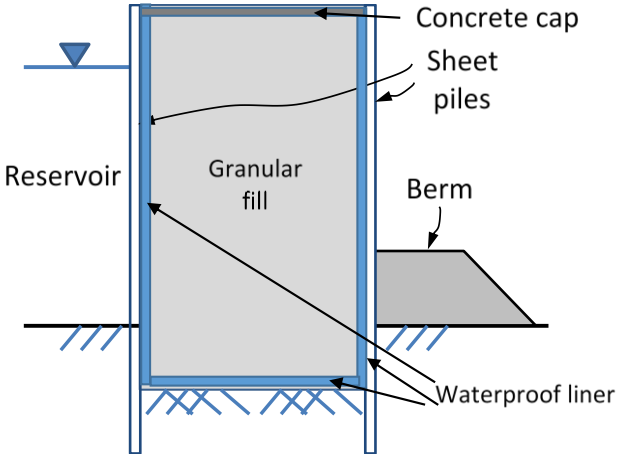


Cellular cofferdam design concepts for permanent hydropower applications

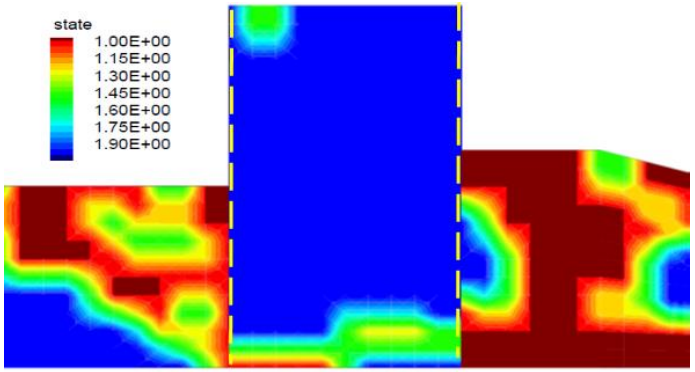
Technical Approach



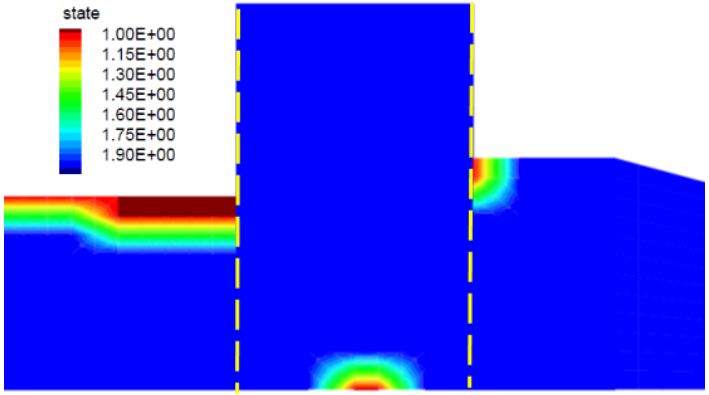
Loading conditions for "*wet construction*"



Design concept for "*dry construction*"



Potential failure zones in "*wet construction*"



Potential failure zones in "*dry construction*"

Factor of safety against sliding, $FS_{sliding}$	Wet construction	Dry construction
Sliding below berm	1.31	2.38
Passive failure of berm	1.18	2.74

Accomplishments and Progress

1) Validated a “dry construction” design concept for permanent use of cellular cofferdam with increased factors of safety and reduced risk for failure and seepage
2) Validated computational modeling techniques against field case histories of cellular cofferdam construction
3) Validated manual design procedures against computational modeling results
4) Project is on track in terms of accomplishments measured against original technical targets.

Project Plan & Schedule

- Project start date: January 1, 2016
- Project end date: December 31, 2017
- Go/No-Go decision points (FY 2016 and end of M12):
  - ✓ Demonstrate finite element procedure can model selected case histories of applications of cellular-cofferdam for temporary use with 95% accuracy
  - ✓ Submission of detailed results of the structural, geotechnical, and seepage analyses for design concepts
  - ✓ Demonstrated performance in meeting prior milestones and deliverables.

Project Budget

Budget History			
FY2016		FY2017	
DOE	Cost-share	DOE	Cost-share
$98.944k	$24.59k	$103.91k	$25.759k

- Expenditures as of 10/2016:
- Total Spent: $78.912k (64% of total budget for FY 2016)
- Govt. Spent: $61.584k
- Cost Share Spent: $17.328k (14% of total spent)

Research Integration & Collaboration

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

Partners, Subcontractors, and Collaborators:

Colorado School of Mines is sole contractor for this project

Communications and Technology Transfer:

Conference and journal papers under preparation

Next Steps and Future Research

FY17/Current research:

- Continue to develop and propose additional design concepts for permanent hydropower use of cellular cofferdams
- Validate the new design concepts using computational and manual design procedures
- Address issues related to environmental and economic benefits of the proposed design concepts
- Disseminate project results through publications and presentations in relevant conferences and meetings
- Evaluate potential to patent some of the proposed design concepts.