Seismic Analysis of Concrete Dams
2017 USSD Annual Conference Workshop
Research Needs

April 7, 2017
Session Outline

• Recent Research Efforts
  • White Papers, Technical Notes
  • Large-scale Shake Table Testing

• Innovative Structural Dynamic Solutions

• Future Path Forward – Challenges and Opportunities
Research Needs – Recent Efforts

- NSF - NEES Grand Challenge Proposal
  - CU – Boulder Workshop
  - Other NSF Grants

- USSD White Paper (2014 Draft)


- USBR 2007 Report “Research Topics to Validate Seismic Response of Dams”

- Current Large-Scale Shake Table Test @ UCSD
More than 75 million Americans in 39 states live in towns and cities at risk for earthquake devastation.

The National Science Foundation (NSF) created the George E. Brown, Jr. Network for Earthquake Engineering Simulation (NEES) to give researchers the tools to learn how earthquakes and tsunami affect the buildings, bridges, utility
White Paper
Research Needs for Concrete Dams and Spillways
USSD Committee for Earthquakes and Numerical Methods
April 6, 2014

Introduction
This white paper presents research needs for the structural analyses of concrete dams (and 2 topics for spillways) developed by the Earthquakes and Numerical Methods Committee of the United States Society of Dams (USSD). Members ranked the topics according to the need of the research and ease of accomplishment. Other topics that could have been developed, but were not, are in the areas of planning, promotion, design, construction, monitoring, and maintenance, and dam safety activities.

Funding
R&D Gaps for Concrete Dams

By Robert L. Hall, Larry K. Nuss and Ziyan H. Duron

PURPOSE: This technical note uses the results of the failure at Wanapum Dam on February 24, 2014, a retrofit of a concrete dam in British Colombia, and a recent benchmarking exercise to argue that the need for new advances in dam safety evaluation and operating procedures is higher today than it has ever been. The case studies point to a common shortcoming in current dam safety practice, which is the absence of a demonstrated understanding of how a dam actually operates and the implications of changing operating requirements for continued and safe operations. Key gaps between how dams are operated on a daily basis and predictions of potential failure under extreme loading conditions are identified which lead to recommendations for
Main Categories of “Data Gaps”

1. Determine the Present “Health” of Concrete Dams
2. Validate FEM Analyses and Failure Modes
3. Develop the Next Generation of Dam Engineers

Emphasis on Performance-Based Methods
Research Topics to Validate the Seismic Response of Dams

Compiled by:
Larry K. Nuss and Dave Gillette (Reclamation)
Robin Charlwood (Consultant)
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NHERI @ UC San Diego Large High Performance Outdoor Shake Table

The world’s first outdoor shake table is also the largest in the U.S. [learn more]

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Seismic Response of a 7-Story RC Building

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Completed Projects

Spillway Retaining Wall Shake Table Test Program 2016

This research aims ultimately to provide seismic performance of a spillway based on experimentally validated engineering procedures with variation of topographical ground conditions. The research work involves intensive dynamic tests for the steel spillway specimen (3.3 ft height, 6 ft width, and 9 ft long in model scale). This spillway is buried in the laminar soil shear container. Dimensions of the container are a length of 22 ft, a width of 9.6 ft, and a height of 11 ft. It will be extensively instrumented to acquire measurements of accelerations, displacements, earth/soil pressures, etc, during the shaking. Each soil-foundation system will be tested with a series of earthquakes starting with slow motions with low amplitude and followed by fast earthquake motions (Northridge and Takatori records).
Challenges for Future Research

• Funding Funding Funding

• Perception of Need
  • Concrete Dams have Performed Well in Past EQs

• Collaboration & Coordination Complications
  • Multiple Agencies
  • Multiple Researchers
  • Multiple Facilities
Workshop Discussion Topics

• Case Studies, Calibration Studies, Blind Prediction
• Failure Modes
• Material Testing and Property Selection Issues
• Instrumentation
• Foundation and Abutment Rock Analyses
• General Agreement on State of the Practice
  • Mass Foundation
  • Water Compressibility
  • GM Application
• Ground Motion Selection & Processing
• Accuracy of Models and Sensitivity Studies
• Owner’s Perspective on Value of Modeling
• Research Needs
• Improving Collaboration