Utah Water Research Lab team builds scale model of Oroville spillway

Published in Utah State Engineer – Oct. 2, 2017 – When heavy winter rains filled Northern California’s Lake Oroville earlier this year, the torrential outflow tore apart the dam’s spillway, sending public safety officials and engineers scrambling for answers.

In the days that followed, engineers at the state’s department of water resources picked up the phone and called a trusted expert who they’d turned to before.

Dr. Michael Johnson is a leading expert in experimental hydraulics and chief engineer on the Oroville model study.

“We got a call and they said, ‘hey, can you please help us with this?’
Dr. Michael Johnson knew the voices on the other end. He had been asked to help with projects at Oroville Dam in the past. A leading expert in experimental hydraulics, Johnson helped design a solution that improves the Feather River valve outlet system in low-level reservoir conditions. His work helped alleviate the effects of drought in the Central Valley from 2014-2016.

This time, the stakes were even higher.

“They asked us to help the hydraulics team ensure that a new spillway design at Oroville would perform safely and have the capacity to handle the required flood releases,” said Johnson, a research professor at the Utah Water Research Lab. “And all this needed to happen very quickly. Repairs need to be finished by November when the rainy season starts again.”

Johnson and his colleague Dr. Zachary Sharp worked with a team of 15 engineers, technicians and students to construct a 1:50 scale model of the Oroville Dam spillway in just 40 days.

Engineering technician Andy Lee welds steel cross-sections.

The 100-foot-long, 60-foot-wide model was built to replicate the jagged terrain conditions left in the wake of the damaging flows. Engineers in California provided the UWRL team with precise terrain measurements that were incorporated into the model through dozens of laser-cut steel cross-sections. The spaces between each section were then filled with cement to create a continuous surface.
Johnson says the model will provide useful information about hydraulic conditions in and around the damaged spillway. He and his team are currently taking measurements on various sections of the model to determine the depth of flows, wave action, pressures, velocity profiles and more.

“Our goal is to assist the design team in California in making the best decisions moving forward with data from the model,” said Johnson. “The data will provide useful information that will help engineers make better-informed decisions about repair and replacement.”

Since its original construction, the team has reconfigured the model to reflect the latest repair designs. The acrylic spillway chute now features specially-designed aerators that reduce the amount of energy in the descending flows, a change that is expected to significantly improve the spillway design.

Since 1965, the UWRL has modeled a wide range of spillways, energy dissipaters, channels, chutes, pipes, valves and other hydraulic structures, including dozens of large dams and spillways. These physical models have improved designs, cut costs and increased the safety of hydraulic structures around the globe.

Model Information:

# Scale 1:50

# constructed of wood, acrylic, steel, and concrete
# Size: Approx. 100 feet long by 60 feet wide. The model simulates a prototype dam and spillway area of over 4.4 million square feet

# A team of 15 engineers, engineering technicians, and engineering students constructed the model in 40 days

# The model supplies just over 7,030 gallons per minute to simulate a flow of 277,000 cubic feet per second

# An elevation change of 15 feet in the scale model simulates an elevation change of ~750 feet

# Model is constructed of wood, acrylic, steel and concrete

# 20,000 lbs of concrete were used to form the topography

# The topography was obtained using LIDAR then imported into CAD to create cross-sections

# Steel cross sections were cut using a laser cutter

# Budgeted Model Cost: $277,000

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