ECS 2023 Interlaken

Workshop: Earthquakes and dams

Date and time: Tuesday September 5, 2023, 10.00-12.00 a.m.

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INTRODUCTION

Unlike buildings and other structures, which are mainly designed to resist ground shaking, large dams can be affected in different ways by strong earthquakes, i.e.

1. Ground shaking causing cracks and deformations in concrete and rockfill dams, spillways, bottom outlets and appurtenant structures (powerhouse, switchyard, etc.).
2. Movements of active faults or discontinuities in footprint of dam or spillways.
3. Rockfalls and mass movements at dam site and in reservoir causing (i) impulse waves that may overtop the dam, (ii) blocking intakes of safety-critical spillways and low-level outlets, (iii) damaging the dam body, spillway gates, equipment and appurtenant structures, and (iv) blocking access roads to the dam.
4. Liquefaction in earth dams causing large deformations in dam and/or foundation (liquefaction of loose sediments in reservoirs and turbidity currents blocking intakes), etc.

It is important to note that storage dams with a large damage potential, must be able to withstand the strongest ground motion to be expected at the dam site. This is different from building structures, which are designed against earthquakes using earthquake ground motion parameters with a return period of typically 475 years, whereas large storage dams must withstand ground motions with a return period of up to 10,000 years as well as the effects of the worst-case earthquake scenario for the dam site.

If we use modern seismic design criteria for large dams (ICOLD Bulletin 148), the following, very general, safety and performance criteria apply for the effects of the strongest ground motion at a dam site:

1. to retain the reservoir and to protect people from the catastrophic release of water from the reservoir,
2. to control the reservoir level after an earthquake as a dam could be overtopped and destroyed if the inflowing water into the reservoir cannot be released through damaged spillways or low-level outlets, and
3. to lower the reservoir level after an earthquake (i) for repair works or (ii) for increasing the safety of a damaged dam or when there are doubts about the safety of a dam.

The following structures and components of a large dam project must be checked for the safety evaluation earthquake:

1. Dam body;
2. Safety-critical components and equipment (spillways, low-level outlets);
3. Stability of abutment rock (important for arch dams); and
4. Stability of reservoir slopes (impulse waves in reservoir; overtopping of embankment dams).

As safety-critical elements must function after strong earthquakes, the hydro-mechanical and electro-mechanical engineers must also be familiar with the seismic safety philosophy used for large dams. The same applies to geologists and engineering geologists, who have to assess the stability of abutments, the reservoir slopes and slopes in the catchment area.

This workshop will provide (i) an overview on the state-of-practice on seismic aspects of dam design documented in different ICOLD bulletins and guidelines, and (ii) some examples on the seismic design and seismic safety evaluation of existing concrete and embankment dams.

PROGRAM OF WORKSHOP

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The two main themes proposed for the workshop are:

Seismic design and safety criteria for large dams

1. ICOLD's seismic design and safety criteria for large storage dams
2. Evaluation of ground motion parameters of design earthquakes for dams
3. Risk classification of dams and future developments in seismic design and safety criteria

Seismic safety evaluation and upgrading of existing dams

1. Need for the seismic safety evaluation of existing dams and results of comprehensive seismic safety evaluations
2. Seismic aspects of small dams and levees
3. Case study: earth core rockfill dam and concrete face rockfill dam
4. Case study: concrete gravity dam and arch dam