Online ICOLD Benchmark Workshop - final call

Registrations to the online workshop are still possible by **March 28th, 2022,** by contacting the organizing committee directly to icold-bw2022@fgg.uni-lj.si.

The following themes will be presented:

- On April 5: Theme A
- On April 6: Open theme, Theme C, and Theme B

Theme A: Dam behaviour prediction
The formulators: Richard Malm & Rikard Hellgren, KTH Royal Institute of Technology, Sweden); Mateja Klun, University of Ljubljana, Slovenia; Alexandre Simon, EDF Hydro, France; Fernando Salazar, CIMNE, Spain
Data: https://icold-bw2022.fgg.uni-lj.si/theme-a-2/

In this benchmark problem, denoted as Theme A in the 2022 ICOLD BW, a double curvature arch dam, located in the south of France and owned by the EDF (Électricité de France) is used as a case study. The name of the dam will remain undisclosed. The aim of the theme is to establish a prediction model for the dam. For this task, all types of models are welcome to use (statistical, hybrid, deterministic, machine learning, finite element modelling) from the simplest to the most complex ones.

The geometry, material properties, and the loads have been defined and are delivered by the formulators. The participants are given the monitoring data from the dam for the period 2000-2012. The provided data has been pre-processed and can be directly used for the analysis, e.g. no further cleaning is necessary. Furthermore, the data is provided without any modification of the actual time series and is measured with different frequencies. The participants are asked to build a model, calibrate it, and use it for long-term and short-term predictions using the provided data and by making their assumptions and choose suitable approaches to solve the problem.

Theme A consists of mandatory and optional tasks that are divided among three cases: calibration (Case A), short-term predictions (Case B), and long-term predictions (Case C). For the participants, it is mandatory to consider the radial displacement from two pendulums, evaluate them and provide results for all three cases. Other variables (crack opening, piezometric level, and seepage) are provided as well, while interpretation and prediction of them are optional.

Theme B: AAR affected dam: Evaluation and prediction of the behaviour of the Beauharnois dam
The formulators: Simon-Nicolas Roth, Hydro-Quebec, Canada and Benjamin Miquel, Hydro-Quebec, Canada
Data: https://icold-bw2022.fgg.uni-lj.si/theme-b-2/

The alkali-aggregate reaction (AAR) can cause serious concerns about the integrity of concrete structures. Moreover, the operation of hydraulic structures such as dams, power plants and spillways affected by this reaction can be compromised. To assess the integrity usability of these structures and to predict the long-term performance and the scale of the investments required to keep the structures in safe conditions, it may be necessary to use numerical models.

The objective of this benchmark is to perform modelling of a concrete power plant affected by AAR. The data necessary for the calibration of the model are provided and a prediction phase is proposed. Divided into four tasks, a step-by-step method is proposed to integrate the physics affecting the chemical reaction. Participants are invited to provide the displacements at certain topographic points, the resultant forces on given interfaces and to provide certain plots to qualitatively describe the cracking computed.

The phases of the studies are as follows:

- Calibration and prediction (50%): The formulators of the benchmark provide information necessary to perform the time-history studies of the structure, including geometry, details and arrangement of the reinforcement, finite element model, material characteristics, boundary conditions (displacements, thermal and hygral), static loading (self-weight and hydrostatic pressure due to reservoir loads). The participants are expected to analyze the data provided and the required results. They may introduce additional data, and refine the finite element mesh provided if required for the purposes of the envisaged analysis. It is underlined that the current benchmark problem concerns only the concrete body and excludes those related to the dam foundation.
- Results, evaluations and conclusions (30%): The expected results include the temporal displacements, the interface loads history and the structure stiffness change according to the progression of the alkali-aggregate reaction. A number of plots should be provided by the participants to identify the principal cracks. Cross sections are suggested to facilitate understanding and allow comparison with those of the other participants. It is also suggested that the participants comment and explain these results. It is recommended to define the possible failure mechanisms associated with the cracking computed. High emphasis should be given to the engineering interpretation and analysis of the obtained results in view of the dam's safety.
- A critical review of the numerical model (10%): A critical review of the numerical model employed within the context of the benchmark is requested. The participant may discuss the level of physics required to correctly predict the effect of the AAR.
- Proposals for stability and functionality analysis (10%): Participants are asked to give ideas on methods that could be used to evaluate the stability and functionality of the power plant based on computed damage, displacements, etc. Proposals and recommendations for further consideration are requested.

Theme C: Behaviour of the embankment dam

The formulators: Pavel Žvanut and Barbara Likar, Slovenian National Building and Civil Engineering Institute; Žiga Likar, Geoportal d.o.o.; Vanja Selan, Elea iC d.o.o; Mateja Klun, University of Ljubljana, Faculty of Civil and Geodetic Engineering
Data: https://icold-bw2022.fgg.uni-lj.si/theme-c-3/

Embankment dams represent in total over 80% of the dams built in the world. Additionally, the majority of dams were built in previous decades. Unlike concrete dams, embankment dams can accommodate a wide option of foundation conditions, construction material is usually available close to the dam location.

During the construction and commissioning embankment dams are subjected to various loading conditions. Internal erosion is a common issue in embankment dams. For example, approximately 40% of all embankment dam failures have been attributed to soil instability due to uncontrolled seepage through the dam body or its sub-base. Moreover, the dams were more or less built in the past considering different safety, design, and construction standards. Additionally, we are often dealing with the lack of data and we need to adopt various modelling assumptions to perform numerical analysis. The main aim of this topic is to present a case from Slovenia. We prepared a case of an embankment dam with an interesting history and design. The dam is monitored, however, still there is a lack of data that demands engineering judgement that can be described using various modelling approaches.

The identity of the dam in this topic will remain confidential, and may be revealed to the contributors at the conclusion of the workshop at the synthesis of the results. In the formulation document the main features of the dam are presented including its structure, material description, chronological description of the construction and operation, detailed description of leakage, and available monitoring data. The dam was built in 1989 for agriculture purposes (irrigation) and flood protection. The reservoir provides seasonal storage of water, where the excessive rainwater is collected during the cold part of the year, when the inflow discharges are high; while in spring and summer months the reservoir water is used primarily for irrigation.

The embankment shape and geometry is very complex. We will ask the contributors to consider 2-D analyses as obligatory and 3-D analysis as optional. In the analysis, the consideration of the foundation layer is obligatory, material properties of the foundation layer are provided. During the geotechnical investigations it was estimated that the foundation is almost impermeable, some permeable zones were grouted and are now considered almost impermeable. The contributors may decide of which constitutive laws and material models for the foundation rock will be used. For the ground we ask the participants to assume ground as homogenous. We ask the participants to describe their modelling assumptions in detail. The theme is divided in 4 cases. In the analysis we anticipate that all contributors will use the same geometry, material properties, and basic loads, in case when the participants decide to use different parameters, we ask them to explain their decision. The majority of the cases are obligatory, with some optional cases.

Open Theme

In the open theme, participants may present their own topics and projects within the field of numerical analyses of dams that are of interest to the dam community. These topics could for instance present cases, which may be considered as themes for future benchmark workshops.

Preliminary programme

Tuesday, April 5, 2022, start at 9:00 (UTC/GMT + 2h)

Opening of the workshop
Welcome in introduction
Theme A: Dam behaviour prediction
Introduction of the theme by formulators
Presentations by the participants
Synthesis of the theme A
Closing of day 1

Wednesday, April 6, 2022, start at 9:00 (UTC/GMT + 2h)

Opening of day 2
Theme B: AAR affected dam
Introduction of the theme by formulators
Presentations by the participants
Synthesis of the theme B
Theme C: Behaviour of the embankment dam
Introduction of the theme by formulators
Presentations by the participants
Synthesis of the theme C

Open theme presentations
Summary of the workshop
Closing of the workshop