

# Seismic behavior of rockfill dams with a dry stone rip-rap: a mixed DEM-FEM modeling

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This PhD thesis is carried out within the framework of a CIFRE contract between the stake holder Electricité de France (EDF) and ITASCA SAS.

## 1. Background

Rockfill dams with a dry stone rip-rap are composed of a backfill with compacted decameter blocks which is protected with a rip-rap made of hand-placed stones (Figure 1). EDF operates approximately ten dams of this kind that were built in the early 20<sup>th</sup> century.



(a)



(b)

Figure 1: Dry stone rip-rap under construction: (a) Castillon dam; (b) Araing dam

The batter is unusual with a very steep slope of 1/1. The mechanical behavior of such structure is not very well understood, however, past modeling using a fully DEM approach showed that the rip-rap plays a significant role for the dam stability allowing to resist to seismic motions up to 0.5g. Such findings needed confirmation which incite to EDF to fund scaled-down experiments within the research project PEDRA (2011-2014) funded by the French Ministry of Ecological Transition. Pseudo-static tests were carried out by progressively inclining a 1/10 scaled-down dam up to failure (Figure 2).



Figure 2: Scaled-down rockfill dam: (a) construction; (b) mock-up installed in a truck box which is progressively inclined

## 2. Objectives

The first objective of this PhD thesis is to validate a numerical approach for the modeling of the mechanical behavior of rockfill dams with a rip-rap made of stones. To reach this goal, the pseudo-static experiments that were carried out within PEDRA will be modeled where the backfill will be associated to a continuum medium and a rip-rap to a discrete system composed of individual blocks.

The second objective is to study the influence of the rip-rap and of the blocks composing the rip-rap in the seismic resistance of rockfill dams. The loading situation will correspond to that existing on site and a pseudo-static approach will be chosen to address the problem.

The third objective is to understand what phenomena can induce the pathologies observed on site and what the reduction of the safety factor is if such events are triggered.

## 3. Conditions

The PhD candidate will be hired by ITASCA SAS Lyon under a CIFRE contract.

Salary: 20690 € net/year

Location: Ecole Centrale de Lyon, France / ITASCA SAS Lyon, France

Duration: 3 years

Expected PhD starting date: 1<sup>st</sup> October, 2020

Send application with curriculum at: [eric.vincens@ec-lyon.fr](mailto:eric.vincens@ec-lyon.fr)

Closure of applications: 31<sup>th</sup> May 2020

The call will be closed before the 31<sup>th</sup> May if a relevant application is received.