Testing and simulation
The underground hydraulic plant of Grand'Maison

CONTEXT & PROJECT OBJECTIVES

- Needs of the EDF Hydraulic Engineering Centre (CIH)
  - Avoid problems encountered on La Coche (natural frequency of the plant at rotation speed)
  - Challenge the manufacturer hypotheses taken on the civil work

- Purpose of the tests and simulations
  - Validate the model and approach of the CIH, based on the example of the Grand'Maison plant (large power, underground plant with piling at the top, \( f_{\text{francis}} = 10\,\text{Hz}, f_{\text{peilto}} = 7\,\text{Hz} \))
    - Carry out a vibration test campaign
    - Compare the experimental results with those calculated
    - Identify potential improvements on the FE models
    - Propose numerical analysis methods that dynamically couple the civil work and the turbine units

APPROACH & MAIN RESULTS

- Preliminary numerical model
  - Have a first idea of the expected modes
  - Determine the appropriate location of sensors

- Experimental mesh and instrumentation
  - Prepare the intervention with the site through a Prevention Plan
  - Deployment of tri-axial accelerometers on the machine and the civil work
    - LMS Acquisition systems : 4
    - Number of sensors : 39 A17/A15
    - Operation sensors : 15
    - Total number of sensors : 132
  - 6 jours d’instrumentation, 4 jours de mesure et 4 jours de repli
    - Équipe de 2 techniciens et 2 ingénieurs

- Signal processing
  - Analyze RMS levels to assess overall vibration levels
  - Extract the eigenmodes of the machine and the civil work from the acceleration measurements during operation
    - Development of a Python signal processing library in order to make it the tool for collaboration and transfer of competence within the team
    - Tricky analysis due to the high noise level of the measurements

- Identified vibration modes
  - Alternator casing
    - Pumping 6 Hz
    - Toggle 27 Hz
  - Flexion 10 Hz
  - Torsion 40 Hz
  - Alternator support
    - Pumping 13 Hz
  - Pumping (phase opposition) 69 Hz

OUTLOOK

- FE model updating
  - Improve the model
    - Integration of the shaft line
    - Possible modifications to the links between the different structures
  - Identify the material property values

- Methodology for modelling a hydraulic plant to ensure its representativeness
  - Write a methodological guide for the CIH