HYDROACOUSTICS FOR HYDROPOWER PLANTS (ME-443)

Mini-project Part II: Numerical simulation

SIMSEN simulation models of the FMHL power plant are made available to study the hydraulic transients of the plant in its new 420MW configuration with 60 MW in reserve. The increase in the equipment flow rate induces various problems at high and low lake levels, which are studied by numerical simulation.

Two simulation models, one in generating mode and one in pumping mode are provided. They include: the upstream reservoir, the gallery, the surge shaft, the penstock, and either a 5-injector equivalent turbine or a pump, depending on the operation mode. Each student group must study 2 load cases, one in generation mode and one in pumping mode, for which it is asked to identify the specific problems and optimize the singular head losses of the diaphragm located at the inlet of the surge shaft by changing the diaphragm reference cross section Ao. Each scenario will result in different unfavourable moments and optimal diaphragm cross-section Ao. The scenarios, whose corresponding SIMSEN models have been uploaded on Moodle in a .zip file named after each group, are listed below. In each group file, the folder contains one model for the generating mode at high lake level (TLHXXXMWXXm2) and one model for the pumping mode at low lake level (PLBXXXMWXXm2).

Table 1 : Group parameter definition

Group number	Output power [MW]	Surge tank cross-section [m2]
1	420	50
2	420	70
3	420	90
4	480	50
5	480	70
6	480	90

The following is asked of each group:

1. First, analyse in details both load cases in generating and pumping mode, provide a description of the load cases and explain which quantities are critical for both scenarios;
2. Both in generating and pumping mode, vary the TAU parameter, which corresponds to the emergency shutdown moment, and identify the most unfavourable moments with regard to the quantities to be examined (listed in Table 2);
3. Explain for the most unfavourable moments the reason why they are unfavourable;
4. In generating mode, optimize surge shaft head losses by varying its diaphragm cross-section Ao to optimize the hydraulic transient behaviour of the layout for the most unfavourable moments, while analysing the repercussions on critical quantities;
5. Test this diaphragm cross-section Ao in pumping mode, study its impact on the hydraulic transient behaviour and, if necessary, adapt Ao.
6. Write a report presenting the starting model, the simulation scenario to be analysed, the results of the study and a conclusion.

Table 2 : Load cases for the verification of the surge tank

Model	Operating mode	Lake level	Scenario	Quantities examined	Parameters to vary
TLH	Turbine	High	Simultaneous load acceptance and emergency shutdown	Maximum pressure in the pipeways and surge tank overflow	Time of emergency shutdown (TAU) and diaphragm cross-section (Ao)
PLB	Pump	Low	Simultaneous load acceptance and emergency shutdown	Minimum pressure in the pipeways and minimum surge tank level	Time of emergency shutdown (TAU) and diaphragm cross-section (Ao)

=> Week 14: Report 2 on numerical methods

This information and the SIMSEN software are available on the Moodle site of the Hydroacoustic for hydropower plants ME-443 course.