MIKE BY DHI CASE STORY

HYDROPOWER LOAD REJECTION MODELLING

Hydro-Québec saves money and reduces risks by modelling the hydraulic impacts of load rejections

Hydro-Québec generates, transmits and distributes electricity and is currently operating 60 hydroelectric generating stations throughout Quebec and Eastern Canada. Occasionally, a station may experience a load rejection, where the load is suddenly removed from the generator, causing a stopped turbine to rotate if a downstream safety device, such as a gate or stop logs, is not put in place. For safety considerations it is important for Hydro-Québec to be able to estimate the hydraulic response in the power plant tailrace in the event of a load rejection.

Traditional methods of determining the hydraulic response involved physical monitoring of water levels in the tailrace during a test load rejection. In this study, Hydro-Québec selected MIKE 11 to evaluate the feasibility of using a numerical model to estimate the water level response in the tail race due to a typical load rejection scenario.

Hydro-Québec's Beauharnois generating station.© Photo credits: Hydro-Québec

SUMMARY

CLIENT

- Hydro-Québec

CHALLENGE

- Estimate hydraulic behaviour in a power plant tailrace due to load rejection
- Reduce costs for load rejection testing

SOLUTION

Use hydraulic modelling to estimate the hydraulic behaviour of the tailrace due to a load rejection event.

VALUE

- Reduce material and operating costs associated with physical testing of load rejection
- Gain a better understanding of the hydraulics in the tailrace following a load rejection
- Increase worker safety during load rejection events

LOCATION/COUNTRY

Quebec, Canada

SOFTWARE USED

- MIKE 11

MARKET AREA

Water resources

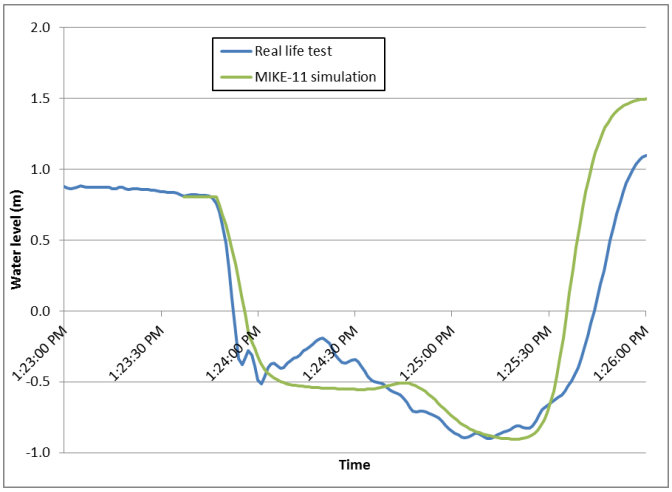
COST REDUCTION

The traditional method of evaluating the response from a potential load rejection was to run a test at a power plant. This meant costs for field staff and to instrument the test, and lost revenue in production as these tests typically take a few days.

Hydro-Québec decided to evaluate the potential of numerical modelling to estimate the hydraulic impacts of load rejection because the potential for cost reduction was substantial if a field test was no longer necessary in some cases.

Hydro-Québec chose MIKE 11 because it included very good after-market support, great flexibility and the option to run a simulation with a one second time step, as was necessary in order to observe the short period oscillations.

For example, in this particular case, the flow at normal operation was 395 cms and it was shut down in 10 seconds. The following graphic shows the variation in time of the water level of both the real operational test and the MIKE 11 simulation.



Comparison of measured water levels vs. MIKE 11 calculated water levels for a load rejection test. © Hydro-Québec

ABOUT HYDRO-QUÉBEC

Hydro-Québec generates, transmits and distributes over 35,000 MW of electricity to customers throughout Quebec, eastern Canada and Northeastern USA. It is one of the largest electricity producers in North America and it uses mainly renewable energy sources, with 98% of the energy it produces coming from hydropower operations.

PROOF OF CONCEPT

As shown in the figure, the timing and magnitude of the water level variations in the tail race, as simulated with the MIKE 11 model, is very similar to the water levels measured at the power plant during a load rejection test.

Another factor that influenced the selection of MIKE 11 for this study is the geometry of the tail race. In this case, the tail race is very straight and the section geometry is quite uniform, which minimises any lateral flows or recirculation. In cases where the tail race is meandering with irregular geometry it would require a 2D model to account for lateral flows and recirculation.

ABOUT MIKE 11

MIKE 11 is one of the world's most well-proven, widely applied and flexible 1D river system modelling packages available. It is the preferred choice of professional river engineers when reliability, versatility, productivity and quality are not just important, but rather they are necessary to do the job right.

MIKE 11 provides an integrated modelling environment capable of simulating a complete range of river processes including:

- Hydrodynamics
- Structure operations
- Rainfall runoff
- Sediment transport
- Water quality
- Dam breaks
- Flood forecasting

In addition, MIKE 11 can be coupled with MIKE 21 for integrated 1D and 2D river and floodplain modelling, and it can be coupled with MIKE SHE for integrated watershed hydrology modelling

TYPICAL MIKE 11 APPLICATIONS

- Optimisation of hydropower operations
- Flood analysis and flood alleviation design studies
- Dam break analysis
- Real-time flood forecasting
- Optimisation of reservoir and canal gate operations
- Sediment transport and long-term river morphology
- Salinity intrusion in rivers and estuaries

CLIENT TESTIMONIAL

> *"Overall, we are pleased with how well the simulations replicated the real test. Not having to perform a test at every power plant we manage will save us a lot of money in the future."*
> *Martin Hallée, ing. jr - Ingénieur - Unité Stratégies et Caractérisation - Hydro-Québec*

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