Temperature based seepage monitoring at Höljes Embankment Dam, Sweden

case study
environmental

Challenge

To install a distributed temperature based seepage monitoring system in an earth filled embankment dam at Höljes, Sweden. As this is an older dam improved monitoring was required to bring it up to today's standards but due to the condition of the dam foundations and high downstream water level, installation of a traditional leak detection system was not possible.

Solution

HydroResearch proposed to the dam owner, Fortum, that high accuracy temperature measurements be made using Silixa's ULTIMA-DTS to interrogate optical fibre cable installed in standpipes in the downstream part of the dam. Four standpipes were installed on the two upper terraces of the dam and eleven along the dam toe. All standpipes were drilled through the downstream fill, the permeable soil layers in the old river bed and approximately 1m into the bedrock. Measurements were made with a fine spatial sampling (0.12 m) allowing abnormal water flow to be observed with high resolution in the vertical direction. Using such a technique generates large data sets and to enable effective data collection, HydroResearch's proprietary web based software (XSeepT ™) was deployed.

Results

It was established early on that the level of water flow through the dam is low. The seasonal variations were in line with those expected but that significant differences of temperature existed throughout the standpipes indicating differences in water flow. Data continues to be collected.

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Discussion

Leakage detection through temperature measurement is becoming more and more widespread. The most common application today is based on temperature measurements utilising a fibre optic cable installed along the dam. (There are about 80 installations in Sweden alone.) Optical fibre can also be placed in standpipes to provide temperature information through the dam. The Höljes project builds on work carried out by HydroResearch at Bergeforsen, Sweden, where measurements have been made since 2005. Additionally fibre optic cables have in recent years been installed in standpipes in the Mica and WAC Bennet dams in Canada, also in cooperation with HydroResearch.

Such detailed insights into dam condition are only made possible by utilising the highest quality instrumentation to provide the precise temperature measurements necessary to detect small changes within the dam. Silixa's range of DTS products, ULTIMA DTS and XT-DTS, deliver unrivalled resolution enabling the early detection of any increase in flow.

A typical example of seepage flow analysis on the right shows seepage flow rates passing through the dam analysed in space and time. The temperature is measured with the fibre optic cable installed along the dam.

The upper graph can plot either seepage flow or temperature on the Y axis and measured length or section on the X axis. The user can choose one of the predefined seepage zones and select start and stop date. Each coloured curve represents a specific measurement, sorted by time. The five dates are evenly spread between the selected start and stop date.

The Höljes Dam monitoring project was carried out for Fortum by HydroResearch utilising Silixa's ULTIMA DTS.

HydroResearch

fortum