Seismic Monitoring of Dams

Güralp Instruments Monitoring Seismic Activity at Sangtuda Dam, Tajikistan

Summary

The Sangtuda HPP-1, located on the Vakhsh River, 160 kilometres south of Dushanbe in Tajikistan, has the ability, when at full output, to supply 12% of the country's electricity demand.

The dam lies in a seismically active zone which has experienced frequent earthquakes in excess of M_0 6.0.

Figure 1. Map showing the location of the Sangtuda Dam and Sangtuda 1 Hydroelectric Power Plant, indicated by the red star.

Güralp supplied 14 '5TCDE' digital accelerometers and two '6TD' digital broadband seismometers; which transmit real-time data for an alarm system and later analysis. These instruments were selected for their ability to overcome field and network limitations due to their compact build. A Network Module 'NAM' was also supplied in order to provide control for NTP timing and for a Traffic Light Alarm System.

Figure 2. Sangtuda Dam, the surrounding area is very prone to earthquakes. Strong motion accelerometers are needed to measure the vibrational responses of large structures to nearby events.

Background

Construction commenced during the Soviet period in the 1980s but was not completed until 2009. Due to the risk of earthquakes causing structural damage that could lead to flooding downstream, it is critical that the vibrational response of the dam to nearby seismic events is monitored using accelerometers. In addition, stations in the near and free-field, can show input motion from earthquakes without being affected by the dam itself.

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Güralp Solution

Fourteen 5TCDE digital accelerometers were deployed across the dam to identify the effects of seismic activity on the structural integrity of the dam. The accelerometers monitor the vibrational modes in response to both nearby and long distance seismic events. The 5TCDE was selected due to its combination of compact build, large dynamic range and its ability to store data if the transmission network is interrupted.

The 6TD was chosen for monitoring seismic activity away from the dam due to its portability, enabling it to be transported to remote locations, and its ability to store data in its internal memory.

Figure 3. Image of a 5 series digital accelerometer. The compact design makes it easy to transport and use in remote locations.

Figure 4. Example of a pit with Güralp products installed.

Güralp also supplied a custom-designed Traffic Light Alarm System for use in the central data centre of the dam. Software for the alarm system was developed and optimised remotely by Güralp technicians and engineers during the installation on the dam. One of the key features of the system is the transmission of data via fibre optic cables to overcome signal degradation over long distances that would be experienced with copper-based cabling.

Timing for each station is supplied via Network Timing Protocol (NTP) using a single master GPS antenna and Network Acquisition Module at the central data centre, as the majority of stations are unable to receive GPS signal due to their position within the structure of the dam.

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Outcomes

The system at Sangtuda HPP-1 became fully operational on 14th June 2018. However, during the test period, seismic monitoring systems were able to detect earthquakes before full system integration. At 10:41 GMT on 9th May 2018, at the border between Afghanistan and Tajikstan, an earthquake struck of M_0 6.7. Figure 5. shows the waveforms from this event recorded by the station which is installed on the top of the dam. The dam is now fully networked for monitoring structural responses to future events.

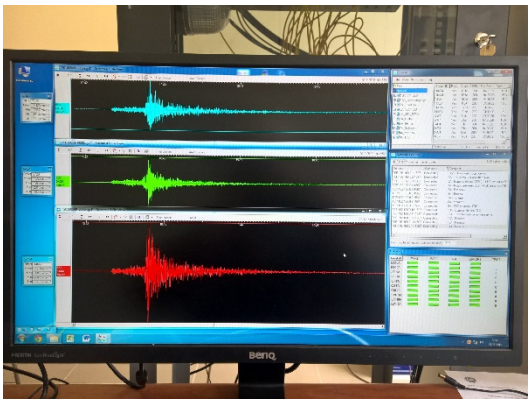

Figure 5. Waveforms from the earthquake event on 9th May 2018, picked up by Güralp sensors at Sangtuda Dam.

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