

## Strong Motion Monitoring of the Hsin-Shan dam in Taiwan

### Summary

Bartec Syscom is proud to present a case study concerning the strong motion monitoring of a dam. In 2008, 3 MR2002-CE recorders and 3 MS2002+ triaxial accelerometers have been installed on the Hsin-Shan earth dam in Taiwan. The dam is located in the north part of the country in a zone where the seismic risk is quite significant (see Figure 1). The related reservoir is one of the most important of Taiwan, especially for Taipei, very close to the dam.

Taiwan is one of the most seismic countries in the world, with 9 earthquakes with magnitude greater than 6 on the Richter scale since 2006. The most recent destructive earthquake has been recorded in February 2016 in Tainan, in the South of the country, causing 117 deaths.

### Project summary

Site name	Hsin-Shan reservoir
Dam typology	Earth dam
Location	Between Taipei and Keelung, Taiwan
Recorders	3 MR2002-CE recorders
Sensors	3 MS2002+ triaxial accelerometers
Connections	Fiber optic cables
Installation year	2008

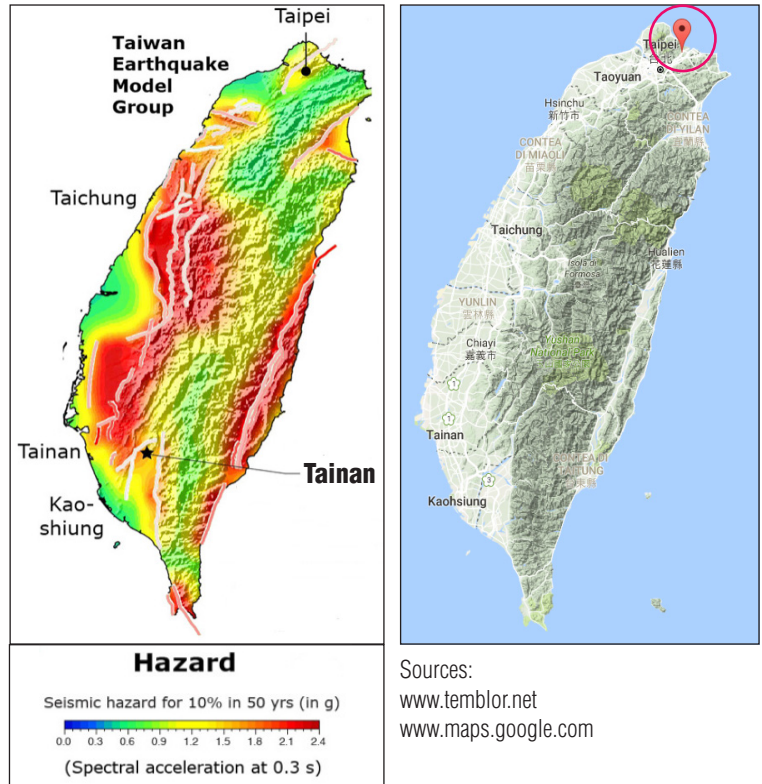


Figure 1. Seismic map of Taiwan, proposed by the Taiwan Earthquake Model Group with the location of the Tainan earthquake in 2016 (left), and location of the Hsin-Shan dam on the map (right).

### The monitoring system

Three strong motion units, composed by a recorder and a triaxial accelerometer, are installed in order to monitor vibrations in different points of the dam (Figure 2):

- 1 measurement point at the dam top
- 1 measurement point at the dam foundation
- 1 measurement point in the free field

The instruments are installed in dedicated cabinets. While the accelerometers on the structure (top and foundation) are installed directly on the dam, the free-field accelerometer is installed on two concrete blocks, to be perfectly coupled with the ground (Figure 3).

The different strong motion units are connected to the control center by means of fiber optic cables. The control center is a building located at the dam abutment where the data coming from all the sensors installed on the dam are collected.



Figure 2. The Hsin-Shan dam with the location of the measurement points.

## Case study Hsin-Shan dam MR2002-CE and MS2002+ systems

### Data analysis

The data recorded by the three monitoring stations are visualized in a dedicated control panel inside the control center (see Figure 4). In case the trigger threshold is exceeded, the maximum values on the three axes are shown on the panel. The rows indicate the three instruments: top, foundation and free field.

The last column indicates a qualitative estimation of the earthquake intensity according to the Central Weather Bureau (CWB) of Taiwan (Teng & Lee, 2000). The intensity is directly linked to the maximum Peak Ground Acceleration (PGA) recorded by each strong motion unit. The intensity scale is divided in eight categories, starting from a micro earthquake (Intensity 0) up to a great earthquake (Intensity 7). See Table 1 for more details.

Table 1. Seismic Intensity Scale according to CWB Taiwan.

Intensity		Ground acceleration
0	Micro	< 0.8 mg
1	Very minor	0.8 - 2.5 mg
2	Minor	2.5 - 8.2 mg
3	Light	8.2 - 25.5 mg
4	Moderate	25.5 - 81.6 mg
5	Strong	81.6 - 254.9 mg
6	Very Strong	254.9 - 407.9 mg
7	Great	> 407.9 mg

### Conclusions

The strong motion monitoring system installed in the Hsin-Shan dam is continuously operating since more than 9 years without having encountered any problem.

Moreover, the system is completely autonomous and it does not require any periodic maintenance nor calibration. Test pulses are automatically generated by the system once per month, in order to check the self status. In case of some malfunctioning, the system immediately signals the error.

The strong motion monitoring provided by Bartec Syscom is able to give information about structural integrity and then to improve the risk assessment and the sustainability.

#### About BARTEC SYSCOM

SYSCOM Instruments SA is a subsidiary of BARTEC GROUP, a multinational manufacturer of industrial safety equipment. SYSCOM Instruments SA is a leading provider of vibration and seismic monitoring equipment for civil engineering and safety related markets, especially for NPP and LNG plants.



Figure 3. The cabinets for dam top (left) and the free field (right) units.



Figure 4. Panel control concerning the seismic monitoring.



Figure 5. View of the dam from the main entrance of the control center.

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