

Case study **Evinos & Mornos Dam** Strong motion monitoring

Strong motion monitoring of Evinos Dam and Mornos Dam in Western Greece using BARTEC SYSCOM MR3000DMS instruments

Abstract

Greece is one of the most seismic regions in Europe, with six earthquakes with a Richter magnitude greater than 6 in the last ten years. For this reason, the government decided recently to install strong motion systems in two large dams in the Western part of the country: the Evinos dam and the Mornos dam, in order to increase the safety of the structure and of the people leaving downstream of the dam. The MR3000DMS made by Bartec Syscom were chosen for the installation because of the reliability, the seismic certifications, the full protection against lightning surge and the full conformity to specifications.

Summary

Location: Central/Western Greece
Customer: EYDAP SA, Greece
Engineering: Set Point Technologies
Objective: Strong motion monitoring on two dams
Recorders: MR3000DMS with triaxial MEMS accelerometers



Figure 1. Location of Evinos and Mornos dams.



EVINOS DAM		MORNOS DAM	
			
Region:	Aitolokarnania Prefecture	Region:	Fokida Prefecture
Dam type:	Embankment - rockfill	Dam type:	Embankment - rockfill
Dam height:	126 m	Dam height:	125 m
Dam volume:	14'000'000 m ³	Dam volume:	17'000'000 m ³
Reservoir capacity:	138'000'000 m ³	Reservoir capacity:	764'000'000 m ³
Installed devices:	5 MR3000DMS	Installed devices:	3 MR3000DMS

Figure 2. Technical details of the two monitored dams.

Introduction

The lakes of Evinos and Mornos are the main water supply resources of the Athens Water Supply and Sewerage Company (EYDAP SA - www.eydap.gr/en/), which serves approximately 4'300'000 customers.

Some studies were conducted on the two dams in case of collapse, in particular on Evinos dam [1], showing a realistic downstream flood wave scenario resulting in a peak elevation of about 18 m and a peak velocity of about 18 m/s at 60 km downstream, close to Evinoxori (about 2 hours after the breach). The results of this study were used to formulate the emergency action plan, the strategic asset and the safety-purpose monitoring.

Set Point Technologies (www.setpoint.gr), representative of Bartec Syscom in Greece, was awarded in 2015 the project for the installation of the Strong Motion Recorders networks of Mornos and Evinos dams in Central/Western Greece, as part of the emergency action plan of the project.

The monitoring project

The strong motion network of Evinos and Mornos dams consists of 5 and 3 instruments respectively. In Figure 3 the strong motion network configuration of the two dams is shown. The measurement points on the dam are located on:

- Free field, downstream of the dam, to characterize the earthquakes and to measure the ground motion;

- In-structure, to measure the dam response at the locations with maximal modal deflections;
- Abutment, to measure the soil-structure interaction;
- Foundation, in a service gallery, to measure wave propagation in the dam foundation. The instrument at the dam foundation is present only in the Evinos dam.

The compact strong motion recorders MR3000DMS, with internal back-up battery and triaxial MEMS accelerometer, are installed inside cabinets and interconnected with OM1 62.5/125 μ m heavy duty fiber optic cables. Since MEMS sensors have a negligible drift, they can be used for long term monitoring, without recalibration needs. The interconnection allows to synchronize the devices in time, with the NTP (Network Time Protocol) functionality. An external router connected to the same network allows to have internet connection for remote acces, data sending and state-of-health control. In addition, the MR3000DMS are equipped with an OVP (Over Voltage Protection) to protect the instruments from lighting surges.

For the two projects, all triggered event recordings are automatically sent to the FTP server of the Water Authority, with the FTP push functionality of the MR3000DMS firmware, ensuring quick data analysis and earthquake assessment. Moreover, all the involved engineers and geophysicists can remotely access the devices through the VPN connection of the MR3000DMS and they are immediately notified via E-mails in case of alarm threshold exceedance.

EVINOS DAM



ER1	Free-field
ER2	In-structure
ER3	Foundation (in a dam tunnel)
ER4	In-structure
ER5	Abutment
ECR	Evinos Control Room

MORNOS DAM



MR1	Free-field
MR2	In-structure
MR3	Abutment
MCR	Mornos Control Room

Figure 3. Overview of the monitoring project on the two dams with the locations of the measurement points.



Figure 4. Horizontal mount MR3000DMS with GPS antenna at location ER4 in Evinos dam.

Regarding Evinos dam, the control room is located 1.8 km away from the dam and the network access is achieved through point-to-multi-point wireless Ethernet extenders. For this dam, a total fiber optic cable length of more than 2 km is used.

In Figure 4, the MR3000DMS in the measurement point ER4 of the Evinos dam is shown. A GPS antenna is connected in order to have an absolute time reference for all the monitoring. In Figure 5, a wall-mounted MR3000DMS is installed in a service gallery of the same dam, in the ER3 measurement point.

Conclusions

The Evinos and Mornos dams, fundamental water resources in Greece, are now equipped with 5 and 3 MR3000DMS strong motion systems, that are continuously monitoring and are able to automatically:

- send the data on a FTP server
- send e-mails in case of alarms
- allow remote control through VPN

in case of earthquake. The devices are integrated in the emergency action plan of the dams, to ensure their safety and sustainability. Since they immediately send notification after a seismic event, prompt actions can be quickly taken to reduce risk on people and structures downstream of the dam.



Figure 5. The vertical MR3000DMS at location ER3 (a), installed in the foundation of the Evinos dam, in a service gallery (b).

[1] KOTSOVINOS et al., Dam break Analysis of Evinos earth dam: forecasting the characteristics of the downstream flood wave, XXIX IAHR Congress September 17-21, 2001, Beijing, China.

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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. SYSCOM Instruments reputation rests on the reliability of its products, coming from a meticulous control of every design and production aspect. SYSCOM Swiss manufacturing facility utilizes modern, automated production and test equipment to assure cost-competitiveness and high quality products.