

## **Vibration monitoring, Grotta Palazzese, Italy**



**Case study**

July 2015

## Vibration monitoring of the “Grotta Palazzese” and surrounding buildings in Polignano a Mare (Italy) using SYSKOM MR3000C instruments

### Abstract

The historical centre of Polignano a Mare (Italy) suffers of unexpected vibration because it is built above natural caverns. Dedicated consolidation work and a scrupulous vibration monitoring with Syscom Instruments will help to significantly improve the safety of people and structures.

#### KEY FACTS

City:	Polignano a Mare (BA), Italy
Customer:	Municipality of Polignano a Mare
Objective:	Vibration monitoring during consolidation work, to stabilize the caves under the city
Locations:	Cave and buildings
Recorders:	4
Sensors:	3 accelerometers and 1 velocity sensor
Survey duration:	3 years



Figure 1. The historical centre of Polignano a Mare.



### Introduction

The city of Polignano a Mare, situated in the region of Puglia, in the South-East of Italy, is a very important touristic place. Its historical centre has been built on rocks and natural caves that create wonderful landscapes (see Figure 1).

In the last months, several buildings above the caves have suffered of unexpected vibrations due to small collapses of the caverns. The worse situation was in the "Grotta Palazzese", the most renown of the city (see Figure 2).



Figure 2. The "Grotta Palazzese" cave.

After these warnings, the municipality of Polignano a Mare decided to plan accurate consolidation work to strengthen both the caves and the surrounding structures.

In parallel, a complete monitoring system with instruments dedicated to vibration, displacement and environmental parameters has been installed to detect and prevent any kind of anomalies and collapses.

The monitoring system will remain active for minimum three years, in order to measure the structural state before, during and after the consolidation work.

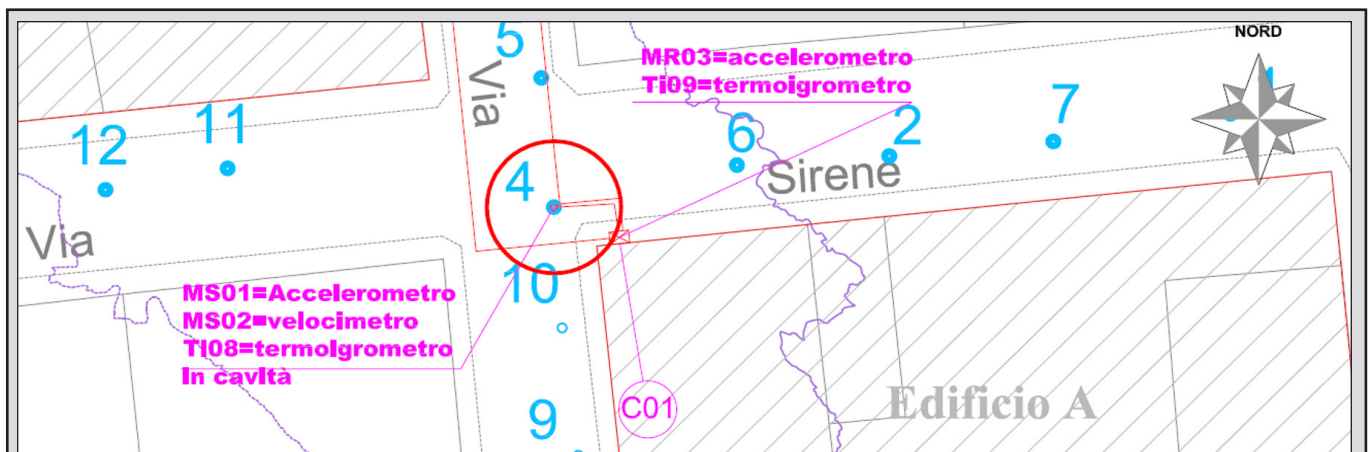
### The monitoring project

The whole consolidation work and the monitoring project are managed by the company Favellato Claudio SPA ([www.favellatoclaudiospa.com](http://www.favellatoclaudiospa.com)), while the installation has been performed by the company Ti Zero ([www.tizeroing.it](http://www.tizeroing.it)).

The monitoring system includes different types of sensors, as described in Figure 3. A central cabinet (see Figure 4a) is installed at the intersection between Via delle Sirene and Via Gelsomino and includes:

An Ethernet switch, to connect all the instruments in a LAN network;

- An ADSL router for web access, allowing MRs to automatically send e-mails and push every file recorded to the desired FTP address;
- The acquisition unit for static measurements;



The violet line indicates the delimitation of the underlying cavern "Grotta Palazzese".

C01 Cabinet with Ethernet Switch, ADSL router, UPS unit

### Dynamic Monitoring (supplied by Syscom)

MR01+MS01	MR3000C in the cabinet with external accelerometer MS2008+ in the cavern (point 4)
MR02+MS02	MR3000C in the cabinet with external velocity sensor MS2003+ in the cavern (point 4)
MR03	MR3000C with internal accelerometer MS2008+ in the building basement (in C01)
MR04	MR3000C with internal accelerometer MS2008+ in the building basement (point 3)

### Static Monitoring (not supplied by Syscom)

Extensio-inclinometer (point 5), Thermo-hygrometer in the cavern (point 4) and thermo-hygrometer outdoor (in C01)

Figure 3. Overview of the monitoring project.

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- The recorders MR01, MR02 and MR03
- A UPS (Uninterruptible Power Supply) unit, in case of temporary power loss;

The 2 MS (Motion Sensors) installed in the cave were directly fixed to the ceiling, as shown in Figure 5.

The choice of having an accelerometer and a velocity sensor is due to authorities, who are interested in having direct information on acceleration and velocity. Two 25 meter cables were used to connect the sensors to the respective recorders.



a)



b)

Figure 4. The main cabinet and the components inside its central part.

In addition, MR03 is installed close to the building "Edificio A" (see Figure 3), and protected by the lower part of the cabinet, while MR04 is installed on the ground of another building, in an existing hole in Via Gelsomino (see Figure 6). In this case, a power cable of 30 meters was used to connect the battery to the main power inside the cabinet.

Finally, each MR is equipped with a SIM card, for immediate SMS (Short Message) alerting in case of exceedance of the pre-defined vibration thresholds.

### Data acquisition

All the MRs record the events exceeding the threshold values, defined a priori based on previous experiences on similar structures. An empiric method is then used to fine adjust these thresholds: during the first month of the monitoring, background data are saved in daily files, in order to measure the structural background noise, to be able to successively define proper trigger and alarm values.



Figure 5. MS01 and MS02 installed in the cave ceiling.



Figure 6. MR04 installed in Via Gelsomino.

### Conclusion

The installation of all the instruments and the implementation of the monitoring system was done in less than 2 days. The data are now constantly evaluated by engineers and the consolidation work will be adapted according to the vibration levels recorded.

The vibration monitoring now in place ensures a better risk management and safety to people and structures at Polignano a Mare.

**Special thanks to Ti Zero Srl, Favellato Claudio Spa and Bartec Italy, who allowed us to write this case study.**

### About Syscom

SYSCOM Instruments is part of Terra Insights platform of trusted monitoring technology brands. Terra Insights is the industry's first, end-to-end sensor to cloud data delivery platform that supports proactive, risk-informed decision making and monitoring. SYSCOM Instruments SA is a leading supplier of vibration and seismic monitoring equipment for the civil engineering and safety markets, in particular for nuclear power plants and LNG plants. The reputation of SYSCOM Instruments SA is based on the reliability of its products, resulting from a meticulous control of all aspects of design and production.

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