SYSCOM Instruments

Structures & buildings monitoring,

Use Case- Strong motion monitoring

Use study

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SYSCOM Instruments

Strong motion monitoring of buildings with MR3000SB devices in a daisy-chain configuration network

Abstract

An earthquake is completely unpredictable and systems such as EEW (Earthquake Early Warning) are already able to raise alarms few seconds before being hit by primary waves, allowing valuable time for people to take cover. In order to mitigate risks on a larger scale after the damaging shear waves and aftershocks, it is mandatory to have reliable monitoring devices on structures themselves, that quickly allow to assess the global situation post-earthquake and take prompt actions. Key factors of efficiency are data accessibility and centralization, for quick evaluation by structural experts at a glance. The present document illustrates precisely this aspect of the monitoring solution with MR3000SB.

Figure 1. High-rise Atlantis building in Panama City in a very high seismic hazard zone, equipped with 3 MR3000SB monitoring devices located at the basement, mid and top floors.

KEY FACTS

Target:	Any building in green to brown seismic zones highlighted in the map below.
Objective:	Permanent strong motion monitoring inside buildings for structural integrity assessment.
Zones:	Low to very high seismic zones.
Instrumentation:	Typically 3 MR3000SB with internal MEMS acceleration sensors, located in the basement, mid and top floors.
Duration:	Permanent earthquake monitoring, during the entire life of the building.
Output:	True motion amplitude of the monitored structure excited by an earthquake.

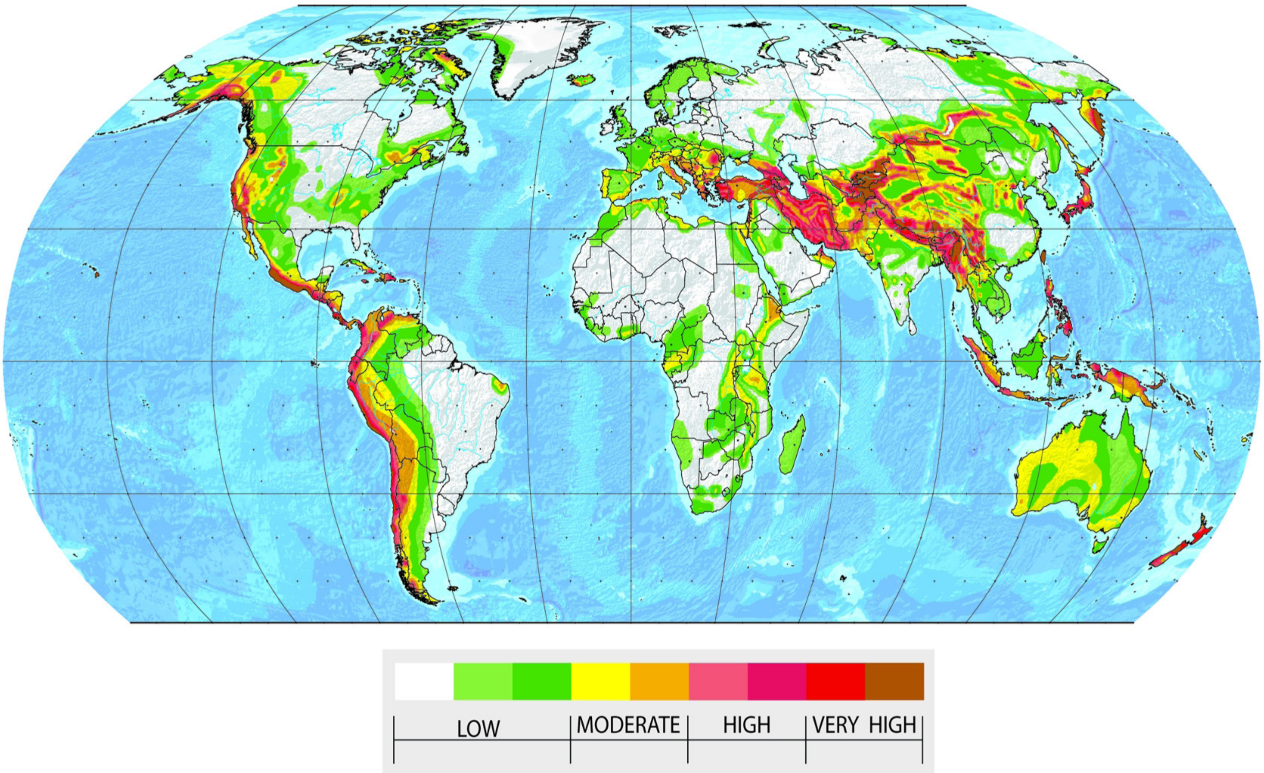

Figure 2. Worldwide map of main seismic hazard zones.

Building monitoring

A typical monitoring system setup for multistorey building is usually designed with three monitoring devices located at:

- Basement level, to detect and record the input motion amplitude and frequency spectrum
- At mid-level for average amplitudes and frequencies
- At top floor, to detect the maximum accelerations amplified by the height of the building.

The devices are installed and tightly fixed on the main holding structure to measure true accelerations, to be less affected by slabs deformation *(See Fig 3 and 4.)*.

Also for better structural analysis, the monitoring devices are always oriented in the same direction, using the same XYZ referential. This procedure facilitates curve comparisons among every recorded channels and avoid miscalculations and interpretation of the data *(See Fig 5.)*.

Figure 3. Monitored municipality building of Antakya in Turkey.

The location of the monitoring devices must be carefully chosen: the sensing element should be protected to avoid any spurious activation and it should also be easily accessible. Instruments should be installed vertically or horizontally according to the applications.

Instrumentation reliability is a must in case of an earthquake and therefore seismically certified devices are mandatory. Self-operating networkable monitoring devices with internal batteries and distributed intelligence is currently granting the most reliable configuration, ensuring data acquisition even in case of power outage or network breakdown.

Finally permanent self-tests on the devices, such as periodic sensor test-pulse or battery life checks, optimize potential preventive maintenance and provides the lowest total cost of ownership for the complete seismic monitoring system.

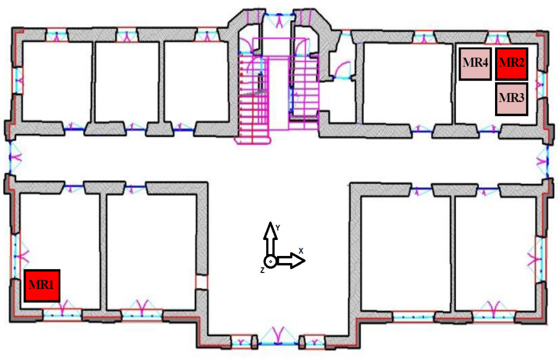

Figure 4. MR3000SB floor plan locations.

Networking capabilities

Monitoring devices need to be interconnected in a unique network mainly for:

- Time synchronization for wave propagation analysis
- Data accessibility, with only one access point needed for the whole interconnected LAN network
- Advanced capabilities such as "common trigger" voting logic. Such kind of logic, typically 2 out of 3 (2oo3), highly increase system reliability by basically avoiding any spurious activation of the system.
- Relay activation based on above mentionned common logic in case of an earthquake, driving gas valves or any other building safety related features for example.

Daisy-chain connection between monitoring devices is very practical, especially for high-rise building, and it limits the total cabling compared to star-network configuration cabling *(See Fig 5.)*.

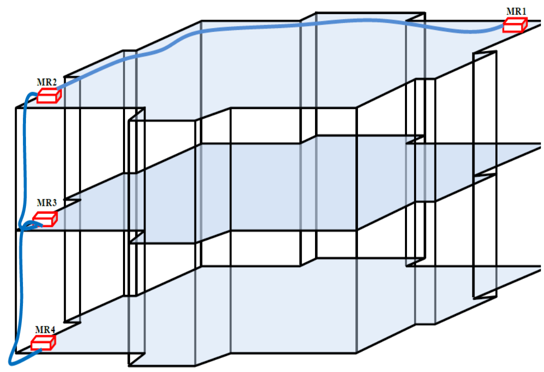

Figure 5. Four MR3000SB in a daisy-chain network.

In order to optimize the data accessibility, internet access to the local network can be added. This will ensure automatic data transmission to preconfigured recipient and it will allow all recorded data coming from every buildings equipped with MR3000SB to be centralized into one place *(See Table 1.)*.

This best practice configuration should be aimed at for optimum risk management in case of an earthquake.

Table 1. MR3000SB key features.

MR3000SB	Key features
Sensor	MEMS triaxial acceleration sensor
Housing	Heavy duty IP67 all-in-one aluminum casing
Battery	Internal lead-acid with > 60 hours autonomy
State Of Health	Permanent self-tests with periodic test-pulses
Communication	Daisy-chain network with FTP, VPN and SCS (Syscom Cloud Software) data accessibility.
Regulation	CE, IEC61326-1, IEEE344 seismically tested

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Data reliability and accessibility

In order to decide with best certainty if the structure integrity is not damaged, key factors are data reliability, data trustworthiness and data accessibility.

Data reliability is achieved by guaranteeing non-corruptible data recorded by the system, typically by proceeding as follows:

- Distributed data storage locally in each monitoring device, ensuring data safety even if some devices are down.
- System permanent self-test with warning state notification in case of any malfunctionning, ensuring maximum up-time of the recording devices.

Data trustworthiness is achieved by proceeding methodically during the following stages of installation and data recovering:

- Properly installed, commissioned and documented monitoring system.
- Adequate parametrization of the system, with input from structural engineers regarding trigger and alarming thresholds, and regarding data recovery procedures in case of an earthquake.

Data accessibility which involves data gathering, formatting and reporting. Data accessibility is fundamental to ensure quick and appropriate response in case of any post-earthquake emergency crisis.

Highly networkable monitoring systems, such as MR3000SB devices, improve data accessibility and automated processing. Therefore quick situation evaluation on a large scale is made possible, which is typically needed when an earthquake occurs.

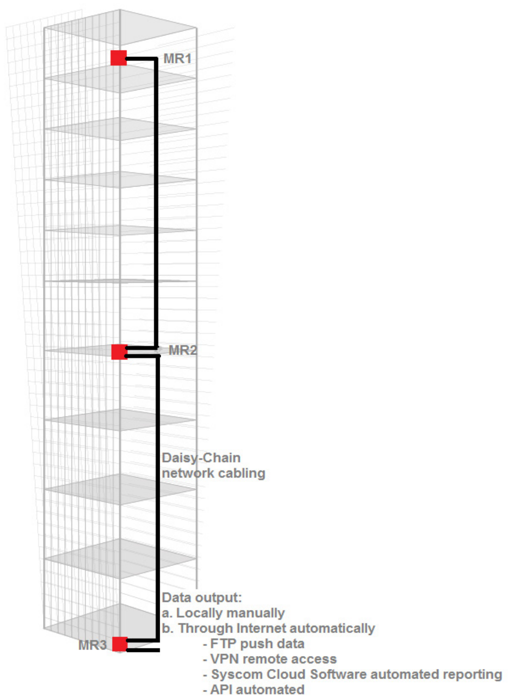

Figure 6. Data output accessibility locally or with FTP, VPN, SCS or API.

Conclusion

Earthquakes cannot be prevented or detected prior to happening and therefore post-events risks mitigation is fundamental.

One of the affordable solutions giving a good return on investment is a quick assessment of the structural situation of all the buildings affected by the strong motions, with warnings in case of potentially endangered structures. Such structural assessment can nowadays be processed efficiently with the latest monitoring devices available on the market and relevant actions can be semi-automated.

BMS (Building Management Systems) are already able to regulate and drive many systems inside buildings, and it can easily be interfaced with seismic monitoring systems such as MR3000SB. An expected achievement is an highly increased overall safety.

Extended connectivity capabilities and data accessibility bring centralized monitoring platform into reality with easily scalable solution into the market. Global "structural strong motion" overview of large scale hazards such as earthquakes can efficiently be managed with a global analysis followed by targeted local actions. This should be aimed at and MR3000SB monitoring devices can give the right input!

For more information on the MR3000SB and its monitoring capabilities over structures and buildings, please contact SYSCOM at: info@syscom-instruments.com

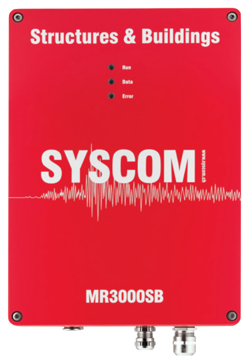

Figure 7. MR3000SB seismic monitoring device.

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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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