BARTEC SYSCOM

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Use Case - Vibration monitoring in Tunnels

Vibration monitoring in tunnels: possible configurations

Abstract

In tunnels the monitoring surveys are very complicated because of the limited space, the overvoltage and the difficult communication with the outdoors. Even if in almost all the tunnels the main power is present, 3G/4G connectivity and LAN network are only sometimes available.

For these reasons, the configuration of the monitoring must be deeply studied case by case, in order to find the most cost-competitive solution to power the instruments and to transfer the recorded data/alarms outside the tunnel.

The vibration devices can be installed on the ground, on the ceiling or on the tunnel walls, depending on the location of the vibration source and on the tunnel typology.

The present document illustrates the different aspects of the vibration monitoring in tunnels, by using the MR3000C made by Bartec Syscom. In particular, five monitoring configurations are described and compared based on different tunnel typologies.

Summary

Target:	Tunnels, Metro lines
Objective:	Vibration monitoring in presence of vibration sources inside or close to the tunnel (for example excavation works, blasting operations, construction sites ...).
Installation:	Ground, ceiling or wall mounted
Instrumentation:	MR3000C with internal or external triaxial velocity sensor
Duration:	Depending on the vibration source
Output:	Maximum velocities and frequencies in the three directions, alarms

Possible configurations

In tunnels, transfering information to theoutside is fundamental to:

- visualize and post-process data, by stocking them on a FTP site or on SCS cloud software (**scs.bartec-syscom.com**)
- send immediate notifications to the user-defined contacts in case of alarms due to high vibrations.

For these reasons, it is recommended that all the MR3000C devices installed in the tunnel have an Internet connection. Nowadays, in many tunnels, the 3G connection is present, therefore the MR3000C can be easily equipped with a SIM card. For all the other tunnels, a special solution must be put in place.

In the following (see Figure 2), some configurations are proposed to solve the connectivity problem in different situations.

CONFIG. 1. Connection to an existing LAN network, which has already an Internet connection through an external modem/router.

CONFIG. 2. Connection through Powerline devices installed on the power grid to transfer Internet connection from an external modem/router through main power cables.

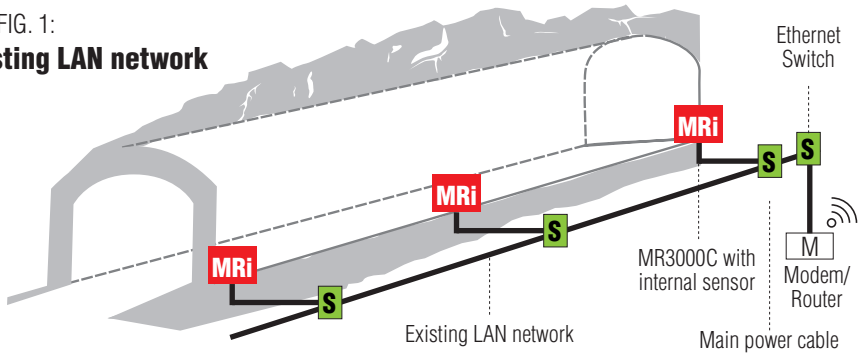
CONFIG. 3. All the devices are interconnected through fiber optic cables. They must be preferred to classical Ethernet cables because:

- The maximum length achievable varies from 2 km (multi-mode) to about 80 km (single-mode), instead of 100 m
- No interferences can affect the cables
- Advanced protection against overvoltage events is guaranteed.

CONFIG. 4. If many different devices (not only for vibration measurements) are used at the same time, a practical solution is a central monitoring station that collects the data coming from the different units and sends the data to the outside with a long communication cable, with Internet access. In long tunnels, if required, many monitoring stations have to be installed to cover the total length.

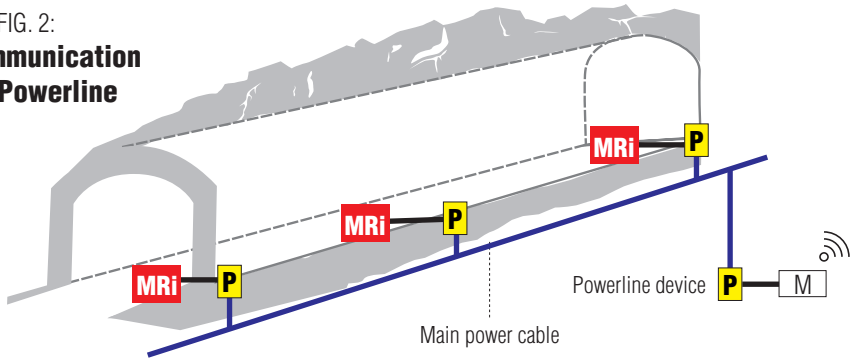
Figure 1. Preparation of boreholes for blast excavation.

CONFIG. 1:
Existing LAN network



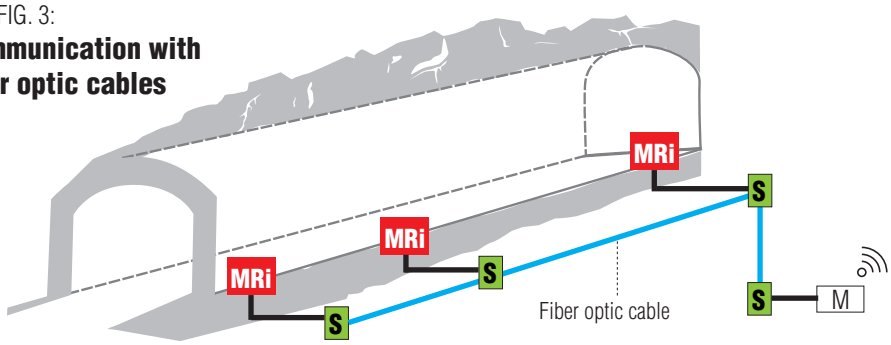
+ Need only of Ethernet cables from MR to the closest LAN port
+ No need of power cables if PoE is available
+ Highly cost-effective
– LAN network only sometimes available

CONFIG. 2:
Communication via Powerline



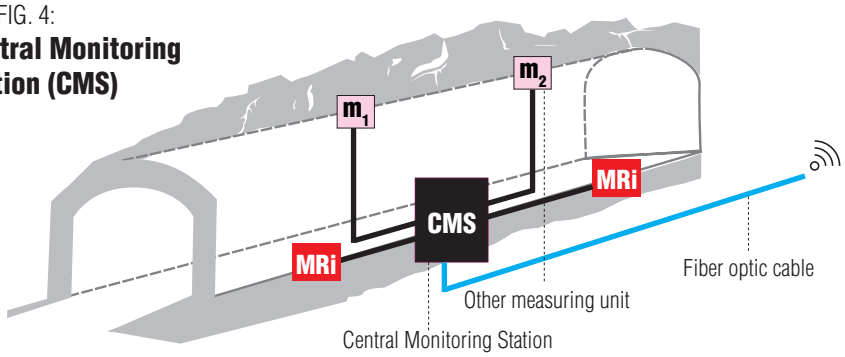
+ Internet access through main power cables
+ Need only of short Ethernet cables
+ Highly cost-effective
– Not applicable in long tunnels (up to 300 m between 2 Powerline devices)

CONFIG. 3:
Communication with fiber optic cables



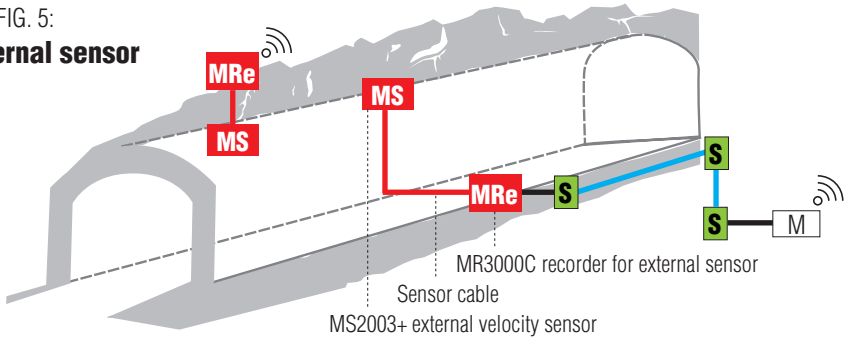
+ Ideal for long tunnels
+ Fiber optic cables not sensitive to interferences and overvoltage events
– Fiber optic cable price

CONFIG. 4:
Central Monitoring Station (CMS)



+ Centralized information
+ One communication cable without need of Ethernet switches
– Suitable only when multiple different sensors are used

CONFIG. 5:
External sensor



+ Ideal in case of limited space, especially at the ceiling
– More expensive than the solution with internal sensor
– Need to excavate a hole for the sensor cable if the sensor is outside the tunnel

Figure 2. Typical configurations for vibration monitoring in tunnels.

Table 1. Suitability of the five configurations to different tunnel typologies.

Tunnel typology	CONFIG. 1	CONFIG. 2	CONFIG. 3	CONFIG. 4	CONFIG. 5
Tunnel with existing LAN newtwork	***			*	
Short/medium tunnel (<5 km), no LAN network		***	**	*	*
Long tunnel (> 5 km), no LAN network			***	*	*
Tunnel under construction, sporadic power connections		***	**	*	*
Tunnel very close (< 10 m) to the outdoors	*	*	*	*	**
Tunnel with many monitoring instruments				***	*
Tunnel with measurement points in critical locations	**		**	*	***

*Possible solution **Suitable solution ***Best solution

CONFIG. 5. If the space available for the installation is not sufficient for the MR3000C, it is possible to install the external velocity sensor MS20003+ and connect it to the MR3000C recorder. This configuration can be also used to install the MR3000C outside the tunnel, in order to easily access the web.

In Table 1, the 5 configurations are evaluated based on the suitability to different tunnel typologies.

Instrument installation

According to the requirements, the instruments can be placed on the ground, on the wall or on the ceiling of the tunnel.

Since usually the installation on the ground can disturb the normal transit of people and machines, the installation on mounting wall is generally preferred. In this case, the MR3000C devices are installed either directly on the wall (vertical installation) or with a 90° mounting plate, that keeps the devices in horizontal position, as shown in Figure 3.

Figure 3. MR3000C with external battery pack installed on the tunnel wall inside an undergound train station.

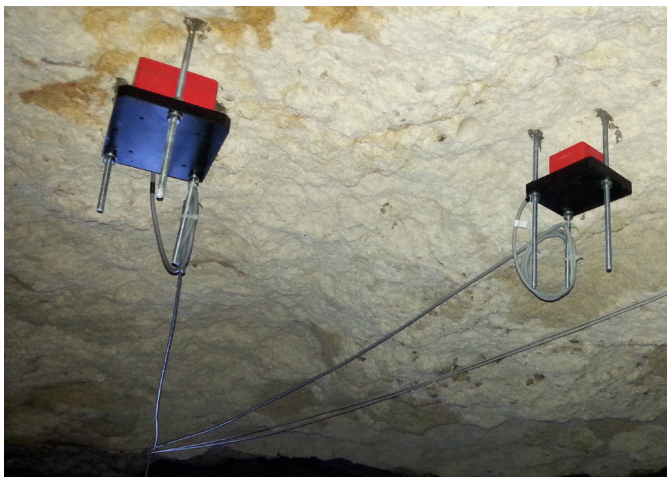


Figure 4. External velocity sensors MS2003+ installed at the ceiling of a cave, with MR3000C recorder installed in the above street, according to CONFIG. 5.

In case of ceiling installation, a MR3000C or an external sensor (connected to the MR3000C recorder) can be chosen. The last possibility is advisable in case of limited space or if the recorder can be easily installed in a favorable position for Internet access (CONFIG. 5 in Figure 2).

Conclusions

The vibration monitoring in tunnels highly depends on the tunnel length, vibration sources, communication availability and tender requirements. The Internet access to the devices must be guaranteed in order to:

- transfer data to a desired FTP site or to the SCS Cloud software
- send alarms to user-defined contacts, in case of critical events.

Different configurations are possible, by combining the flexibility of the MR3000C with all the most advanced off-the-shelf communication technologies.

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 SA reputation rests on the reliability of its products, coming from a meticulous control of every design and production aspects.

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