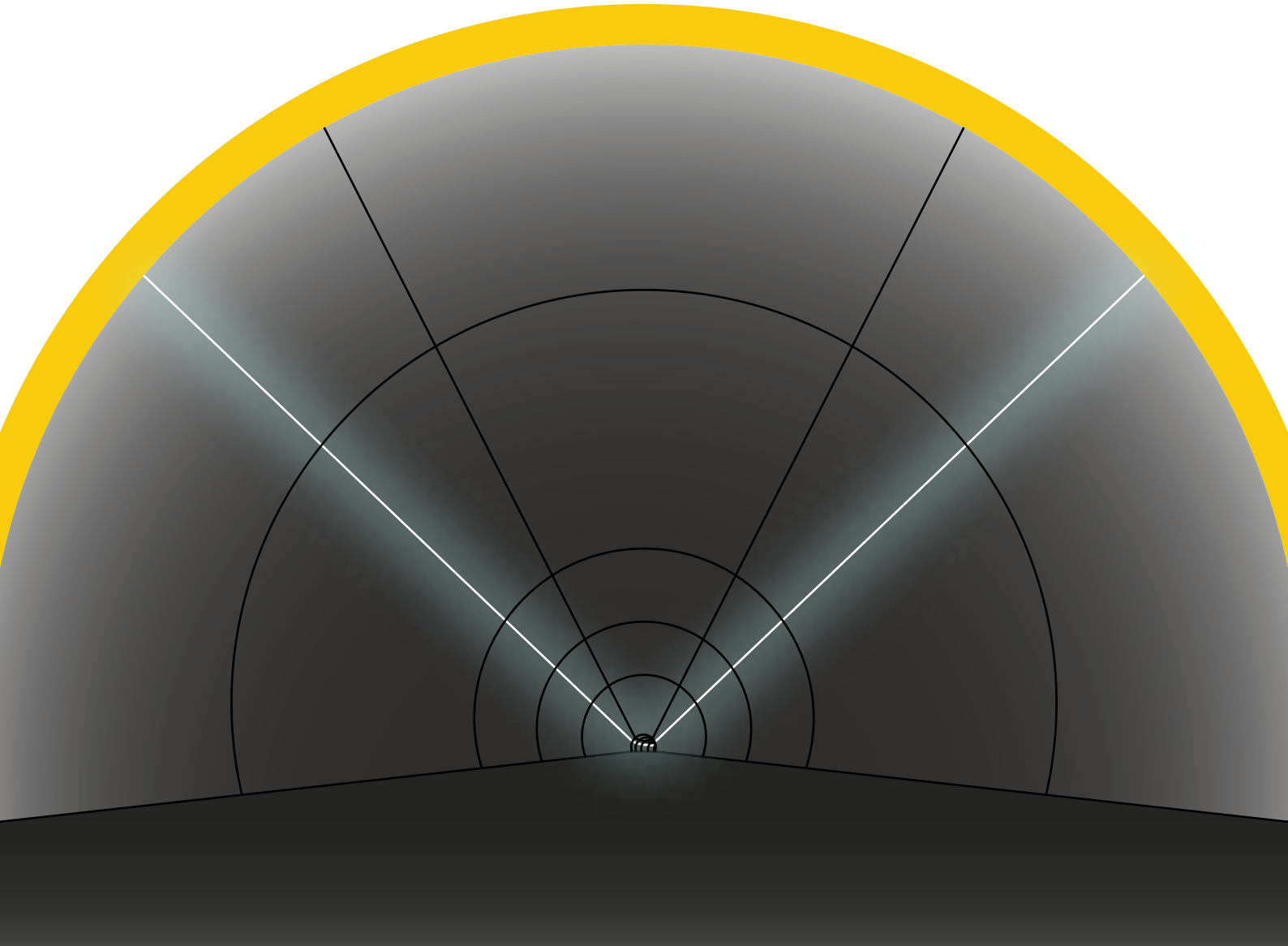
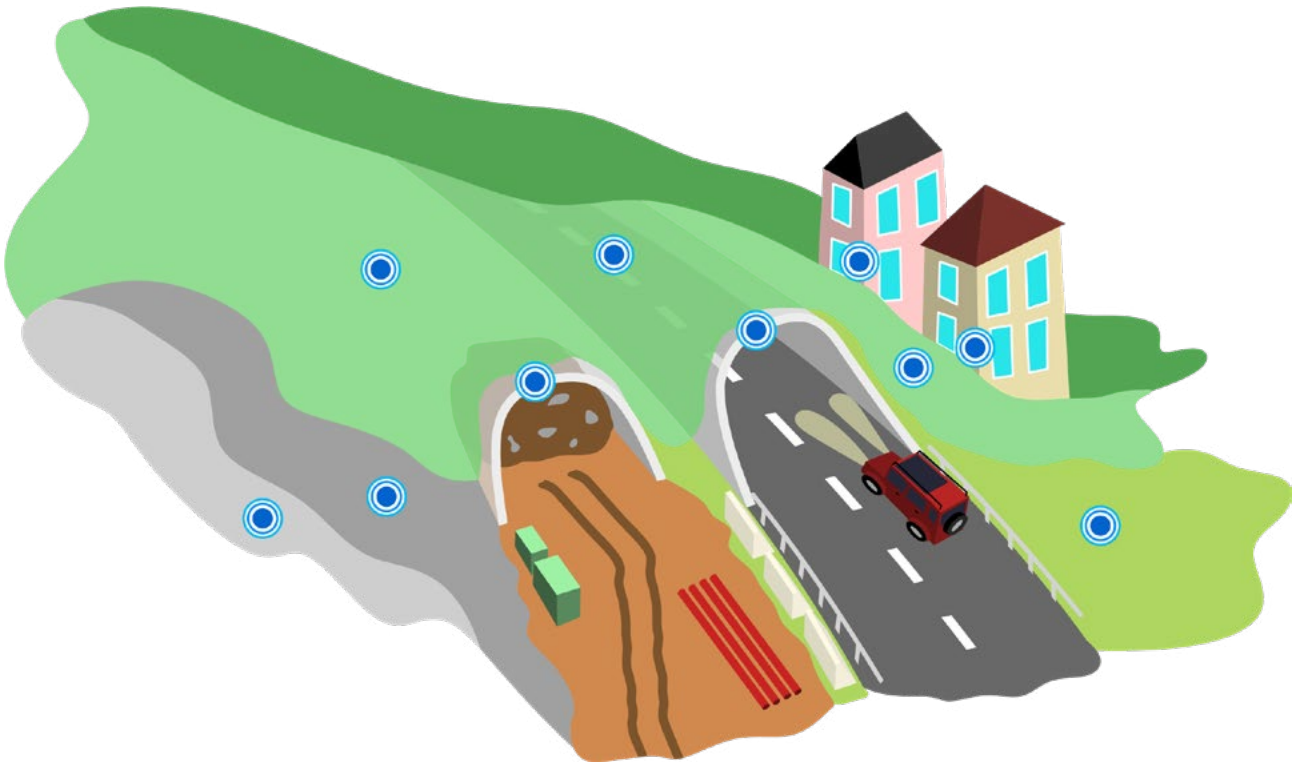
APPLICATION NOTE

Tunnels Monitoring



Introduction

The monitoring of a tunnel is fundamental for the control in the **short and long period** of the **stability of the tunnel** itself, as well as of the **surrounding terrain** and **adjacent buildings**.
The monitoring can be performed either **during the excavation** of a tunnel in progress or for an **existing tunnel**.
All the tensions that are created around the excavation of a tunnel are due to multiple factors, among which the most important relate to the **geological-stratigraphic characteristics** in which the work is located, the geotechnical and mechanical characteristics of the **materials**, the **methodologies of excavation** and its operational phases and finally the geometric and elastic characteristics of the **coating works**.
The analysis of all these components leads, in the design and excavation phase, to a correct assessment of both the **pressures** exerted by the **soils** and, once the work is completed, the definitive **loads** that will weigh on the **coating**.



To analyze the behavior over time of a tunnel in operation and the events that can affect and compromise the stability of the work, monitoring and control are necessary, consisting of a differentiated **instrumentation system** organized in several **measurement stations** and divided into several phases.
The equipment for the detection of static parameters is used according to a dual purpose:

- a **continuous monitoring** of the same parameters during the excavation and use phases;
- a **real-time monitoring**, thanks to a flexible and automated data acquisition system, so as to be able to carry out a precise control of the structural conditions of the work and arrive at a timely and correct diagnosis of all the events that the work can undergo.

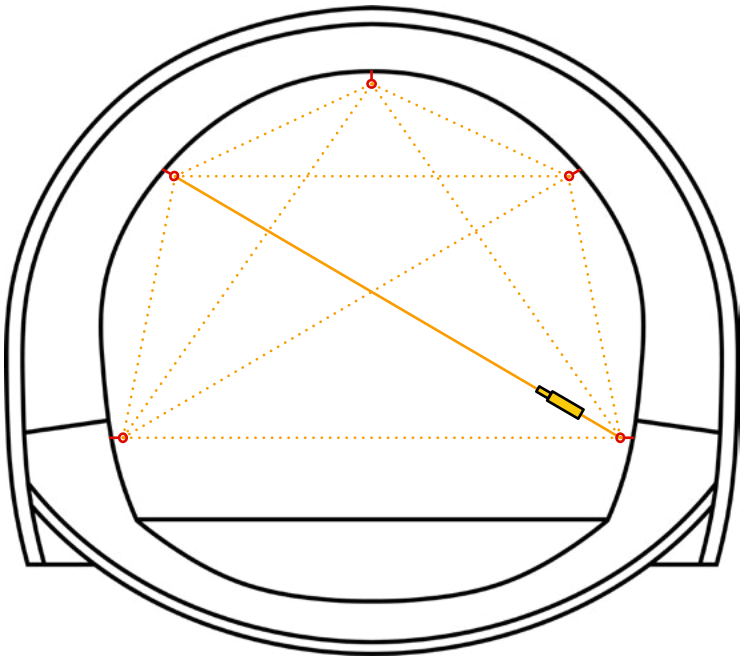
Our solutions

SIM STRUMENTI provides all the necessary facilities for the monitoring (**sensors**, **data acquisition units**, **modem**, **cables**, etc...) as well as **personal assistance on-site or by phone** if needed, during the entire project and monitoring process. In this way, the professional will be able to evaluate the available instrumentation and the data over time.

Monitoring systems can be **manual** or **automatic** and **centralized** or **decentralized**. They can be equipped with **alarm systems** both local and distant. Moreover the acquired data can be sent via **FTP** to a server.

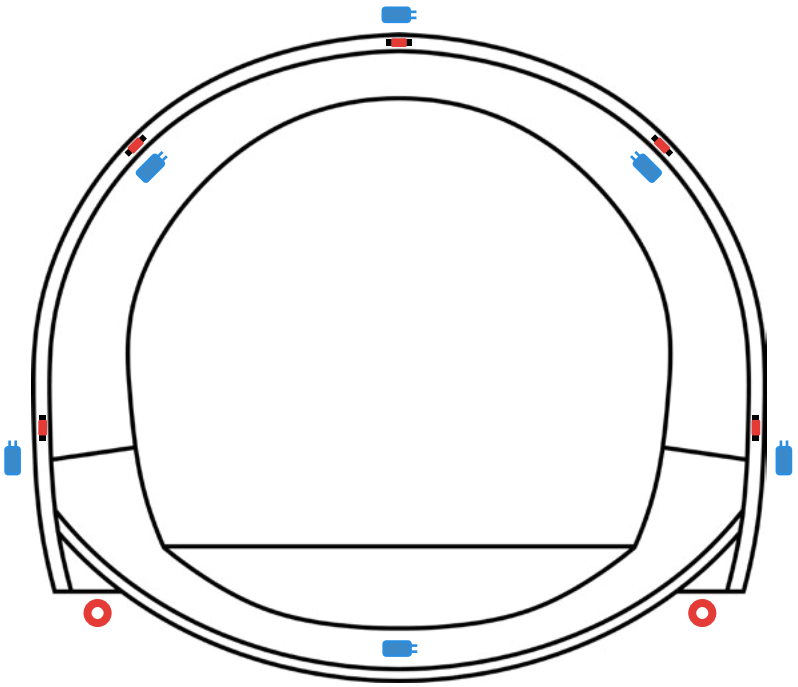
CONVERGENCE CONTROL

Topic	Instrumentation
Control of the convergence	Convergence meter



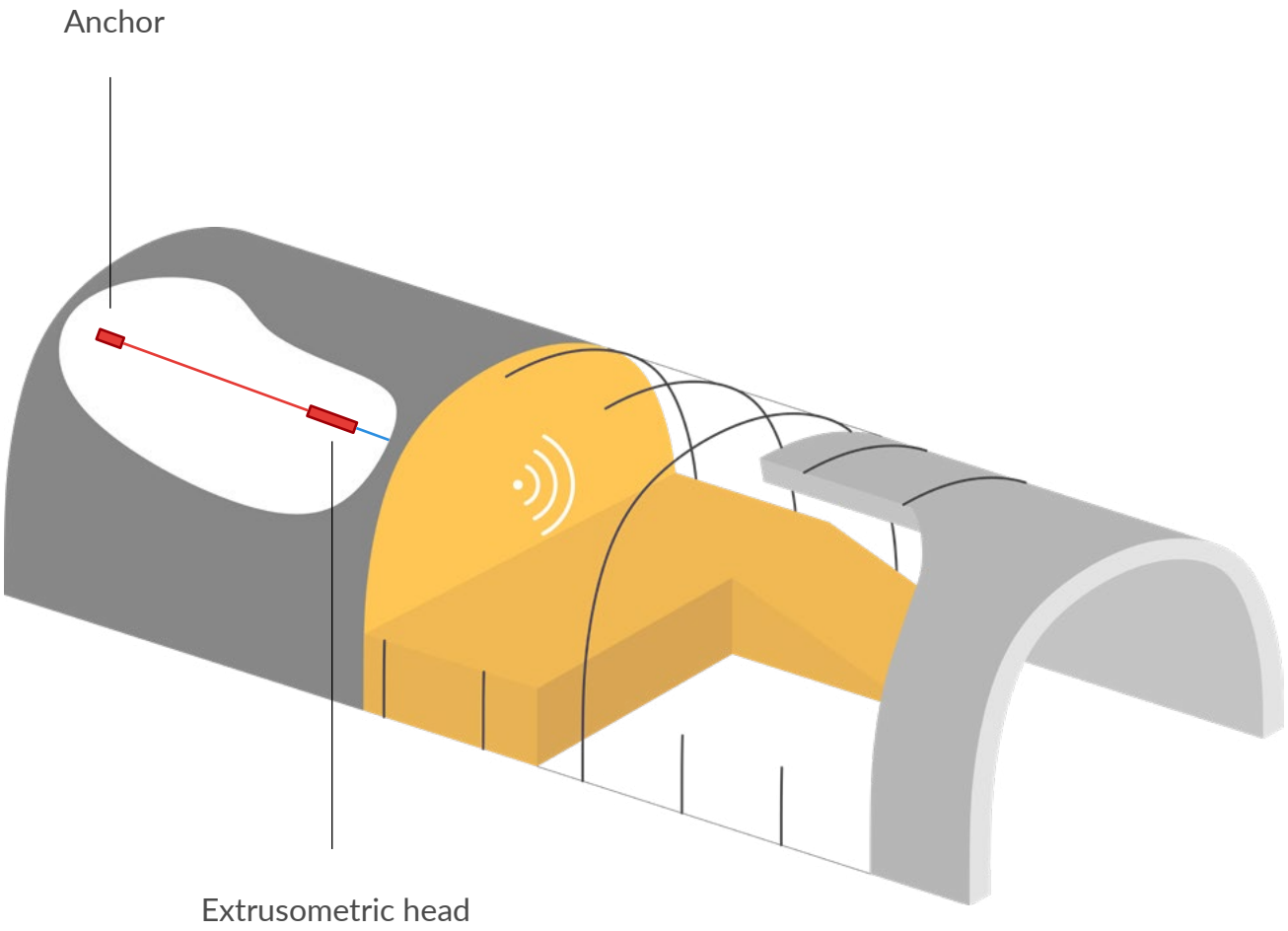
LOAD CONTROL

Topic	Instrumentation
Pressure control between ground and rib	Pressure cell **PR310**
Load measurement at the foot of the rib	Load cell **LC255**
Deformation control of the rib	Embedment strain gauge **LC220**



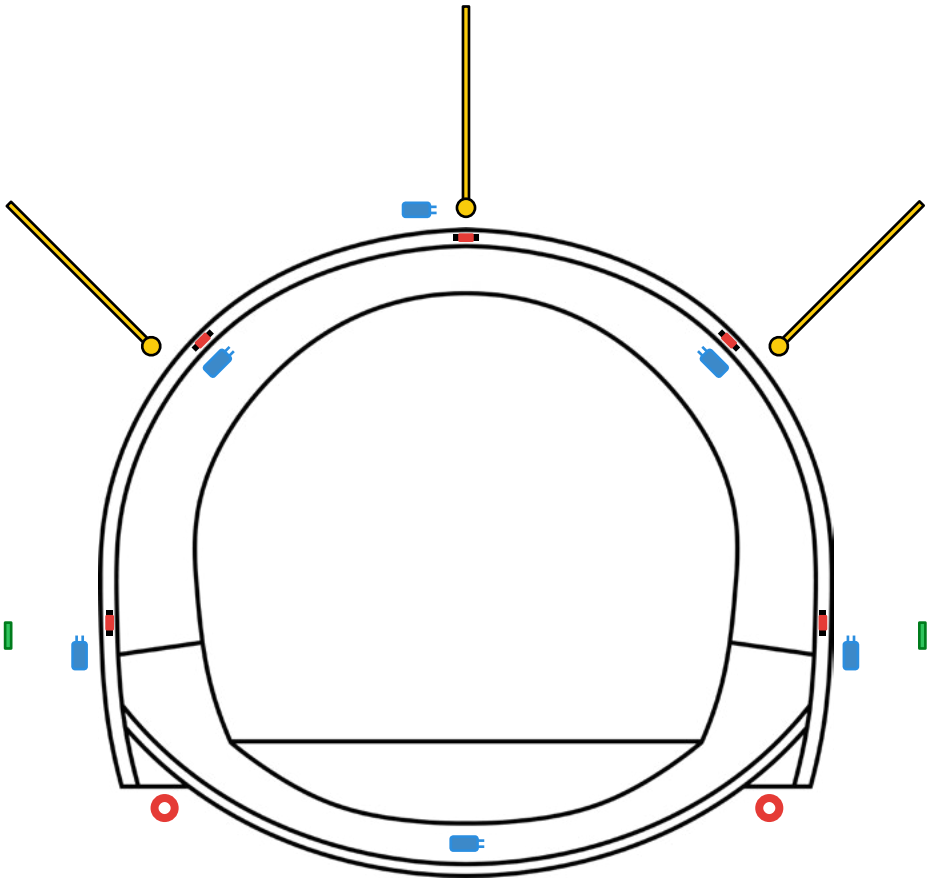
EXTRUSOMETRIC CONTROL

Topic	Instrumentation
Deformations control of the frontage in progress	Fixed extrude meter **DS840**

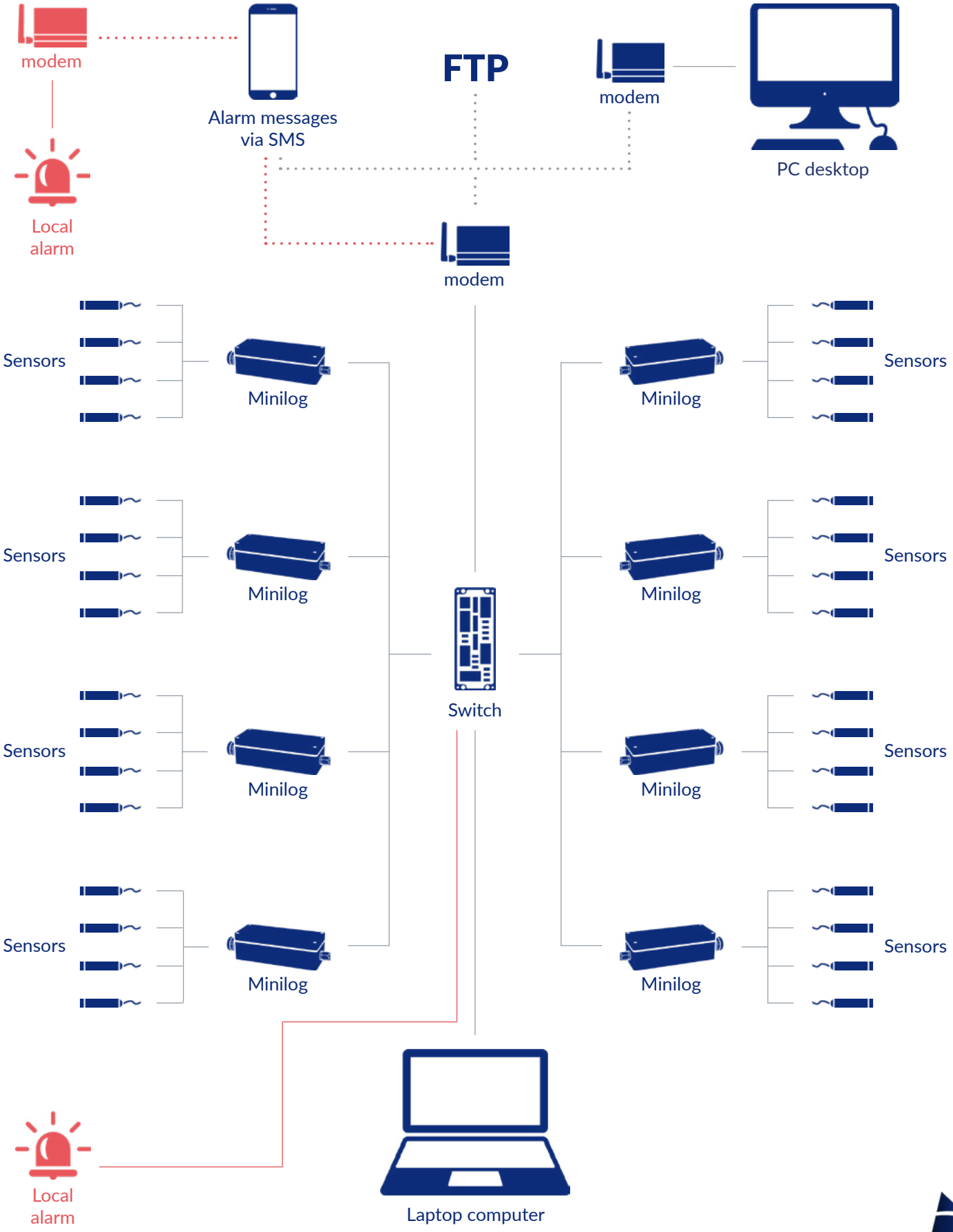


LOAD CONTROL

Topic	Instrumentation
Pressure control between ground and rib	Pressure cell **PR310**
Load measurement at the foot of the rib	Load cell **LC255**
Deformation control of the rib	Embedment strain gauge **LC220**
Control of the stability of the overlying soil	Multipoint borehole extensometer **DS830**
Control of interstitial pressures	Electric piezometer **LV610**



Monitoring system



Case study: Strada delle Gallerie (Road of Tunnels)

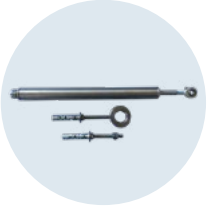
Location

Moneglia (Liguria)

Description

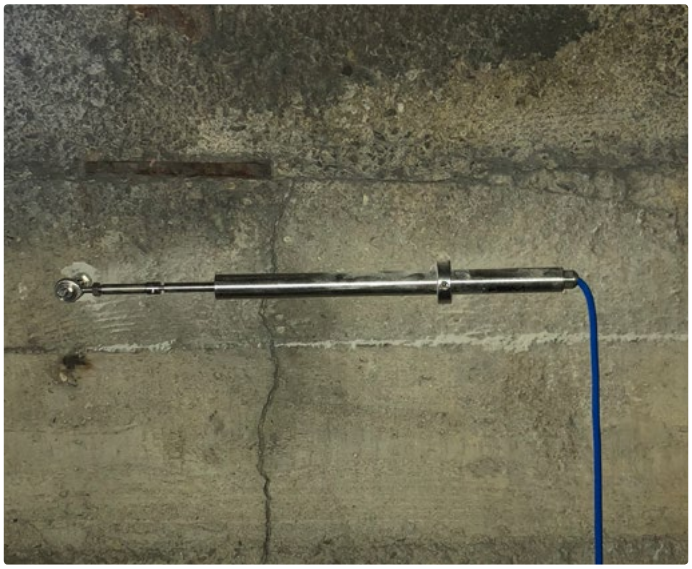
The aim for the monitoring of the Strada delle Gallerie, was to control the **stability of the tunnels** as well as the **rocky wall**.

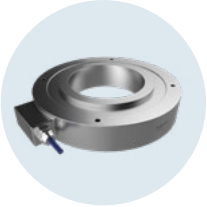
Installed instrumentation



Joint meters - DS811

For the control of the **cracks** inside the tunnels.





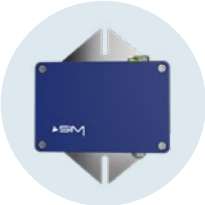
Load cells - LC210

For the control of the **load exerted** on the ribs.

Case study: Strada delle Gallerie (Road of Tunnels)

Embedment strain gauges - LC220

For the control of the **deformation** of the ribs.



Wall fixed inclinometer - IN920-EL

For the control of the tunnel **rotation**.

Data acquisition unit - MINILOG

For the **Data** control.
Equipped with **alarm system** (via SMS).
Links:
- via USB cable
- via modem GSM / GPRS

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