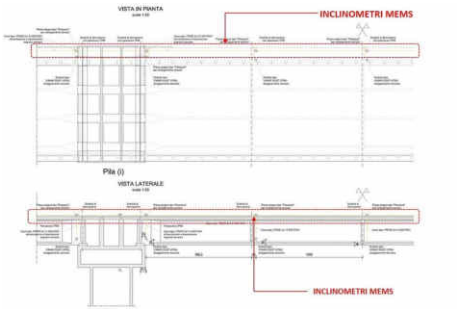
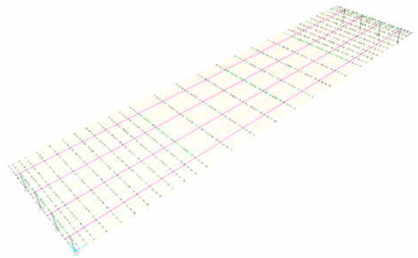
Real time bridge and viaduct monitoring system

Viadotto Italia
The viaduct has been instrumented as first test case





FEM Model of the instrumented slab

Sacertis has developed a diagnostic system based on an innovative, affordable and minimally invasive monitoring, able to provide the final user with real-time information on the state of health of the structure.

The sensors network is set to cover all the needed information characterizing the structure in terms of static and dynamic behaviors. Once the sensors have been installed on the main structural bridge elements, the engineers team develops the structural Finite Elements Model to post-process the recorded measurements in order to fully detect potential activated kinematics and prevent risks.

The peculiarity of the system lies in being composed of low-cost sensors based mainly on MEMS technology, capable of monitoring various physical quantities. The sensors are connected to each other with different technologies for data transfer and sensor power supply. The recorded data are initially processed directly on board, then sent to the cloud, where they can be further processed or made available for subsequent treating. The retrieved data are to be compared with the expected response calculated through the use of mathematical models of the structure.

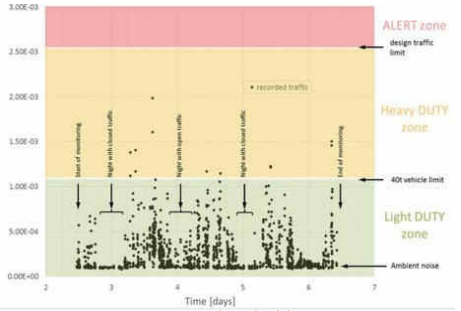
These systems have been verified in top University labs and already installed in various facilities (the first being the semi collapsed Viadotto Italia on the Reggio Calabria Highway in 2015) ; these processes are also supported by an important ecosystem of global world leading companies (AXA, IBM, STMicroelectronics).

Among the monitoring products that Sacertis has developed, two main sensors families are specific for viaducts and bridges applications. The first sensors typology is the accelerometer, able to read accelerations as low as 1/1000 g to detect the variations of the main vibration modes of the structure. The second group consists of stress sensors, which can either be embedded in the structural element before casting, or post-installed in existing ones, to detect in real time the effective load condition to whom structural elements are subject during their service life. These devices can be applied on different elements such as external tendons, strands, piers, beams, slab abutments, and installed on different materials (concrete, steel, masonry etc.). Tests carried out at University Laboratories demonstrated the coherence between the applied actions and the sensors readings.

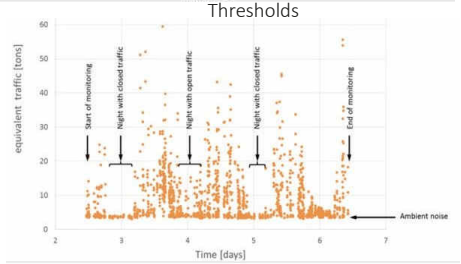
The sensors network has already been tested in different tunnels showing a precision of a few thousandth of one degree. One of the first test, carried out breaking down the final consolidated diaphragm wall of a highway tunnel, showed accurate results comparable to the georeferenced measurements.

Based on the data collected, more sophisticated mathematical models can be developed and calibrated with the possibility to simulate variations in loads as well as catastrophic events, including seismic actions, by verifying the correspondence between the measured response on the structure and the expectations of the mathematical model. The cost of such analyses will depend on their complexity. The cost of the monitoring service will be proportional to the amount of generated data and the required certifications.

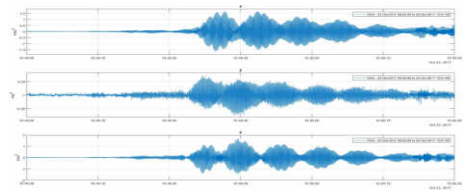
Compared to other systems available on the market, two of the most obvious advantages of Sacertis system are scalability and flexibility. On one side, it is possible to scale the system thinking of applications that involve the installation of a few sensor units, as well as the use of several hundred instruments, capable of measuring the most varied physical quantities; on the other side, can be customized a monitoring system able to combine different typologies of sensors (clinos, accelerometers, crackmeters , stress sensors etc.) to obtain a complete structural overview.



Thresholds



Post processing results



Instrumented prestressed cables