



The data from the Manini Connect condition monitoring systems converge in the monitoring center, but can also be accessed via cloud, tablet and smartphone thanks to the open automation architecture and PC-based control.

PC and EtherCAT-based control technology for monitoring solution implemented in shell construction

## Reliable and dynamic condition monitoring for load-bearing building structures

Load-bearing structures of bridges, high-rise buildings and other buildings are permanently subject to weather influences such as rain, snow and wind up to hurricane force or, at times, extreme events such as earthquakes. With increasing age, the static condition of buildings, especially in tectonically active regions, should therefore be carefully monitored, and it's even better if the necessary monitoring technology has already been thought of in the shell construction. Italian construction company Manini Prefabbricati SpA has developed an active monitoring system for load-bearing structures that uses PC-based control from Beckhoff.

When natural events of above-average magnitude (earthquakes, heavy and sudden rain, wind and snow) affect buildings, the resulting high dynamic loads change the stresses in the structural members. This has a more or less permanent effect on the structural properties and nominal life of a structure. The Italian Ministry of Infrastructure and Transport takes this into account in its structural standard NTC 18, raising awareness of the need for greater protection and monitoring of new building structures.

Manini Prefabbricati SpA in Assisi (PG), together with the Institute of Civil and Environmental Engineering of the University of Perugia and the system integrator Umbra Control Srl, has developed an innovative monitoring solution for this purpose: Manini Connect is able to determine in real time whether the functionality and stability of a structure are in accordance with the design parameters. That is, dynamic structural monitoring makes it possible to evaluate the structural behavior of the building and thus also its stability. With the automated processing system, anomalies in the behavior of a structure after exceptional events can be detected immediately. In this way, the dynamic structural monitoring function helps to specifically evaluate the structural behavior of buildings.

### Real-time data acquisition provided from the start

The condition monitoring system is based on PC-based control from Beckhoff, EtherCAT for connecting the sensor technology, and an algorithm developed at the University of Perugia for managing the assessment criteria for earthquakes, the so-called seismic factor. Umbra Control Srl is responsible for the implemen-

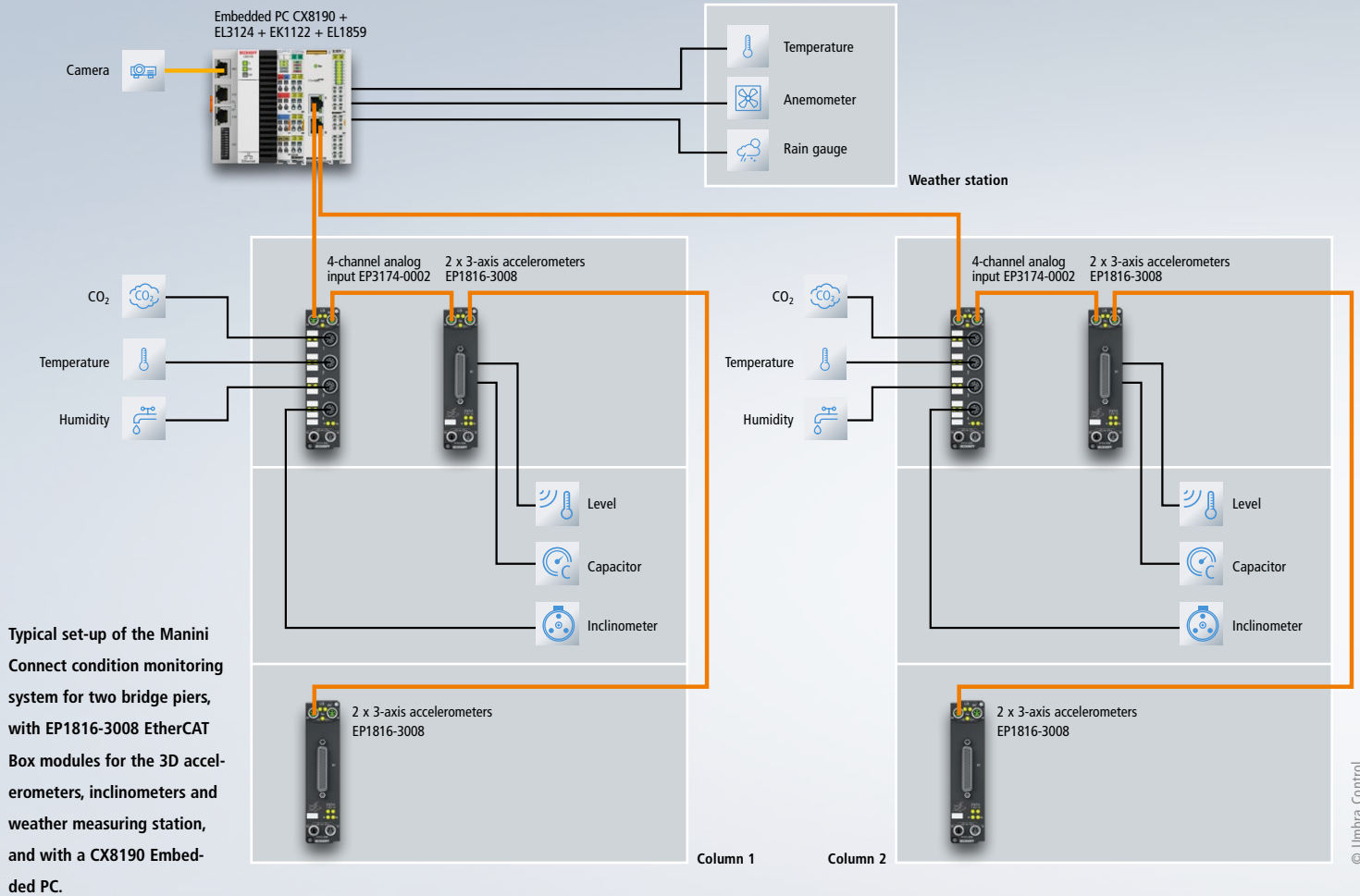
tation, from the design of the system architecture to the commissioning and maintenance of the cloud-based platform.

Already during production, the sensor technology of Manini Connect is integrated into the supporting concrete structures of a building and, after completion of the building, connected to the control cabinet for data evaluation and transmission to the monitoring center. Various sensors record the external and internal thermohygrometric properties of the building as well as their changes during dynamic loading. Special algorithms evaluate the signals and send early warnings or, if necessary, an alarm to the Manini Prefabbricati control center after special events such as an earthquake.

Since all sensor signals are sent to the control center in high resolution, the structural behavior of the structure can be monitored from there in real time. The corresponding software was developed by Umbra Control. It is used to manage all data and information and to control the installed sensor technology. If required, the installed sensors of an object can be checked, activated or deactivated – not only locally in the control room, but also via tablet and smartphone.

### Robust industrial solution chosen as backbone

Umbra Control uses CX8190 Embedded PCs as control hardware and EtherCAT as communication backbone for Manini Connect. With the Embedded PCs and the open software architecture, the system integrator says it builds an optimal bridge between the sensor technology in the field and the cloud-based mon-



itoring platform, with the Beckhoff automation software TwinCAT providing the foundation through its openness: data acquisition runs in real time in the TwinCAT Runtime and thus separately from downstream data transmission, processing and storage via the control center.

The use of EtherCAT as a powerful communication technology results in a maximally flexible and modularizable monitoring system, as the experts from Umbra Control explain: Regardless of topology changes or network expansions, the process image does not show any significant fluctuations with regard to the update time. The implemented solution can therefore be scaled as required, depending on the project, without having to adapt the monitoring system.

EtherCAT also ensures synchronization of the sensor data acquired in the field and simple integration of the various sensors connected via EtherCAT Box modules. With their high IP67 protection rating and the wide operating temperature range from  $-25\text{ °C}$  to  $+60\text{ °C}$ , the fully encapsulated I/O modules of the EP series also have no difficulty to withstand the often harsh operating conditions. Furthermore, the wide range of modules supports the integration of even special sensor signals, e.g. from the acceleration and inclination sensors that are already cast in during the concreting of the load-bearing structures.

The CX8190 Embedded PCs record both ambient conditions (temperature, wind strength and direction, humidity) and mechanical variables, correlate all acquired values and use them to detect emergency situations. PC-based control

enables sufficiently fast sampling of the mechanical quantities to reconstruct the effects that a structure may have suffered after a seismic event using specific algorithms. Last but not least, the fact that Manini Connect was designed with proven industrial components ensures easy diagnostics, product interoperability through the use of standard protocols and long system life.

### Efficiency, safety and continuous prevention

With Manini Connect, the structural behavior of the building can be interpreted in relation to the various external influencing factors. The monitoring system enables predictive maintenance according to the principles of intelligent building management. The aim is to maintain the functionality and stability of a building over its entire service life. Monitoring for anomalies reveals previously hidden signs of aging in good time and allows maintenance measures to be initiated long before the stability is endangered. PC-based control as an open control system ensures low installation costs and significantly reduced insurance premiums.

More information:

[www.manini.it](http://www.manini.it)

[www.umbracontrol.it](http://www.umbracontrol.it)

[www.beckhoff.com/building](http://www.beckhoff.com/building)