FIBRAIN

Automatic roof deflection monitoring

Reinforce safety and reduce maintenance costs

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Automatic roof deflection monitoring – reinforces safety and reduces maintenance costs of buildings.

Structural health monitoring systems check the conditions of constructions and buildings. For this purpose, measurement systems consisting of sensors, data transmission systems, and central units are used. These systems aim at detecting and locating a potential threat, and then notifying the building administrator about the danger. Such a system allows the user to locate the potential source of the problem and prevent further degradation, pursuant to the principle that prevention is better than cure. Reliability, durability and failure-free operation are essential in such systems, preferably in a combination with ease of use and low maintenance costs. Although various technologies are used in SHM systems, fiber optic structural monitoring systems are undoubtedly the best choice. One of the areas that is developing very dynamically and where **fiber optic** cables are irreplaceable is the monitoring of the flat roof conditions (e.g., logistics centers, warehouses, or production centers). Unfortunately, we all remember the recent construction disasters caused by the snow load on roofs, and the increasingly unpredictable weather, perhaps paradoxically, makes it even more difficult to forecast critical moments of danger and respond appropriately.

Roof deflection monitoring is an innovative technology supporting building management offered by FIBRAIN. It allows you to control the stresses of the roof structure in real time, and owing to this you can take decisions relating to infrastructure at the right time.

Buildings with low-angle roofs require performing numerous activities aiming at controlling their technical conditions by the administrators. It is absolutely necessary to monitor the deflection of steel structures as their overload may lead to damage to buildings and, ultimately, even to a construction disaster. Ignoring the **lying snow** on the roofs, whose weight may change drastically depending on the weather conditions, can pose a threat and be extremely dangerous. Roof monitoring allows you to take a right decision about snow removal, which is undoubtedly **expensive** and often leads to **damage to the roof**, as it is more and more often performed by unskilled workers. **Water** remaining on the roof, as a result of clogged roof inlets, may also put in danger to the building. The accumulated liquid overloads the roof structure, which may lead to its damage, and thus extra costs for the facility manager. It goes without saying that, carrying out unnecessary work on the roof without proper preparation can also damage the structure of the building. Besides, in case of storing equipment or construction materials in an unsuitable place, there may be a risk of overloading the roof.

Figure 1. Production center with flat roof – an example of roof monitoring system

All the above-mentioned dangers relate to a huge number of buildings in the world. This is caused by the growing popularization of flat roofs, which are perfect for large-scale buildings such as warehouses, logistics centers and production centers. However, flat roofs are not only reserved for industry and warehouses. Popular **shopping centers, sport and leisure halls and other public utility buildings** with flat roofs also require monitoring of roof deflections, as safety has to be ensured, and therefore a well-managed building is cheaper to maintain.

The fiber optic roof deflection monitoring system consists of several components. This is a **passive system** where only one element requires power. An interrogator (an active device responsible for emitting and detecting light, as well as signal processing and analyzing), located in the server room/rack together

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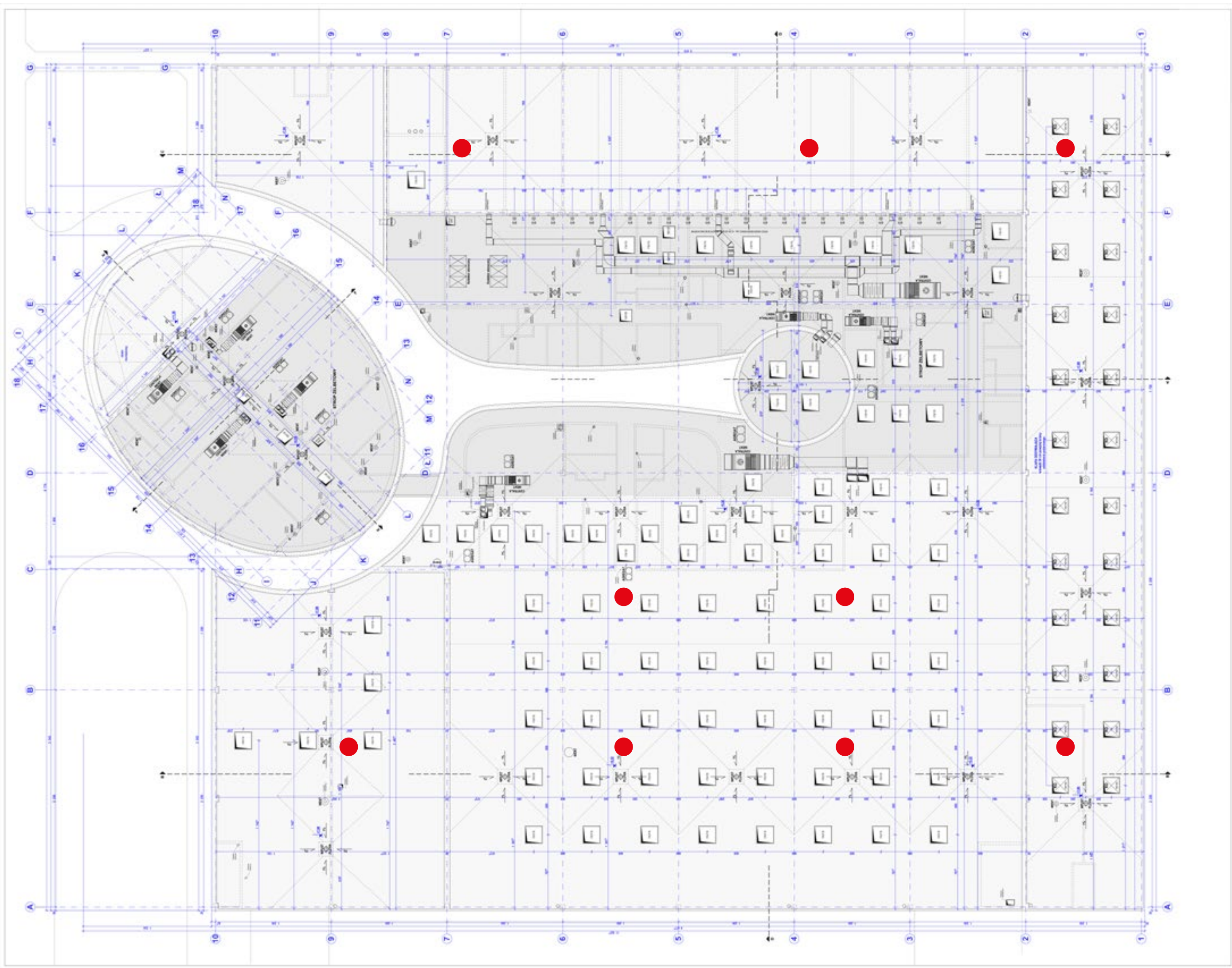


Figure 2. Monitoring points on the production center roof from Fig.1

with IT equipment and the emergency power supply system, is the central part of the system.

Sensors responsible for measuring stress and temperature are ***Fiber Bragg Gratings***, which are attached to a monitored beam or a girder. The communication between the interrogator and sensors is ensured by a fiber optic cable playing a role of a medium for transmitting information.

The **AIDA** software, that is responsible for analyzing and visualizing sensor readings, is a complement to the hardware interface. Access to data and visualization can be performed locally and remotely. As a matter of fact, decentralization allows you to monitor the condition of a roof structure from anywhere in the world, and in case of a network failure, the local server continues to monitor the building and provides necessary information to the service present on site. For organizations with multiple sites, parallel access to cloud data facilitates management, as the controller has simultaneous access 24/7 to all data on the computer, tablet, or smartphone.

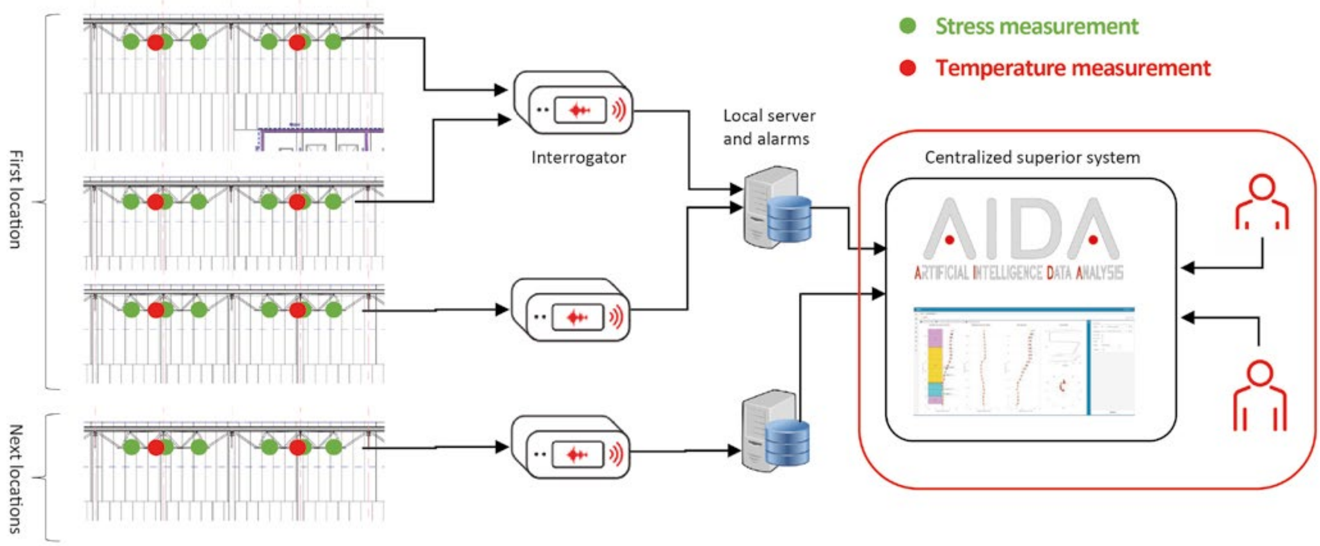


Figure 3. FIBRAIN fiber optic roof deflection monitoring system

Roof deflection monitoring offered by FIBRAIN gives the possibility to distribute up to 320 measuring points, which monitor not only the deflection, but also the temperature. A quantity and distribution of measurement points are selected individually for each building in order to optimally balance the technical capability and cost of the system. Interestingly, the high accuracy of the measurement system can detect even the minor deformation in **µm** or temperature changes by **0.1°C.** The fiber-optic fiber technology applied in this system guarantees the reliability and long lifetime of the equipment (fiber optic components can operate continuously for a few decades) and at the same time extremely low maintenance costs (opex). Passive sensors based on Bragg gratings do not require power, and therefore the installation does not require electric cables for each measurement point, while the electricity consumption of the entire system is comparable to one computer.

The fiber optic roof deflection monitoring system is totally resilient to electromagnetic interference (frequent in many industrial environments), in contrast to other similar solutions based on active sensors and radio communication that can be easily disrupted by electromagnetic radiation.

The operation of the system is based on detecting deformations of the roof construction (beam, girder) by a set of appropriately arranged Bragg gratings (that change the reflected wavelength when strained). This information is transmitted to the interrogator, which converts an analogue optical signal into digital information understandable to a computer and processed on-site by the appropriate software. The results are available in easy-to-interpret results and graphs to the administrator. And besides, this data is available locally and remotely through the advanced and transparent AIDA platform.

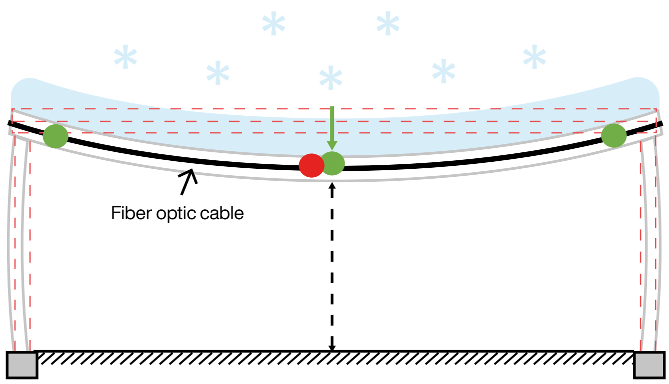


Figure 4. Deflection measurement

Figure 5. FBG sensors

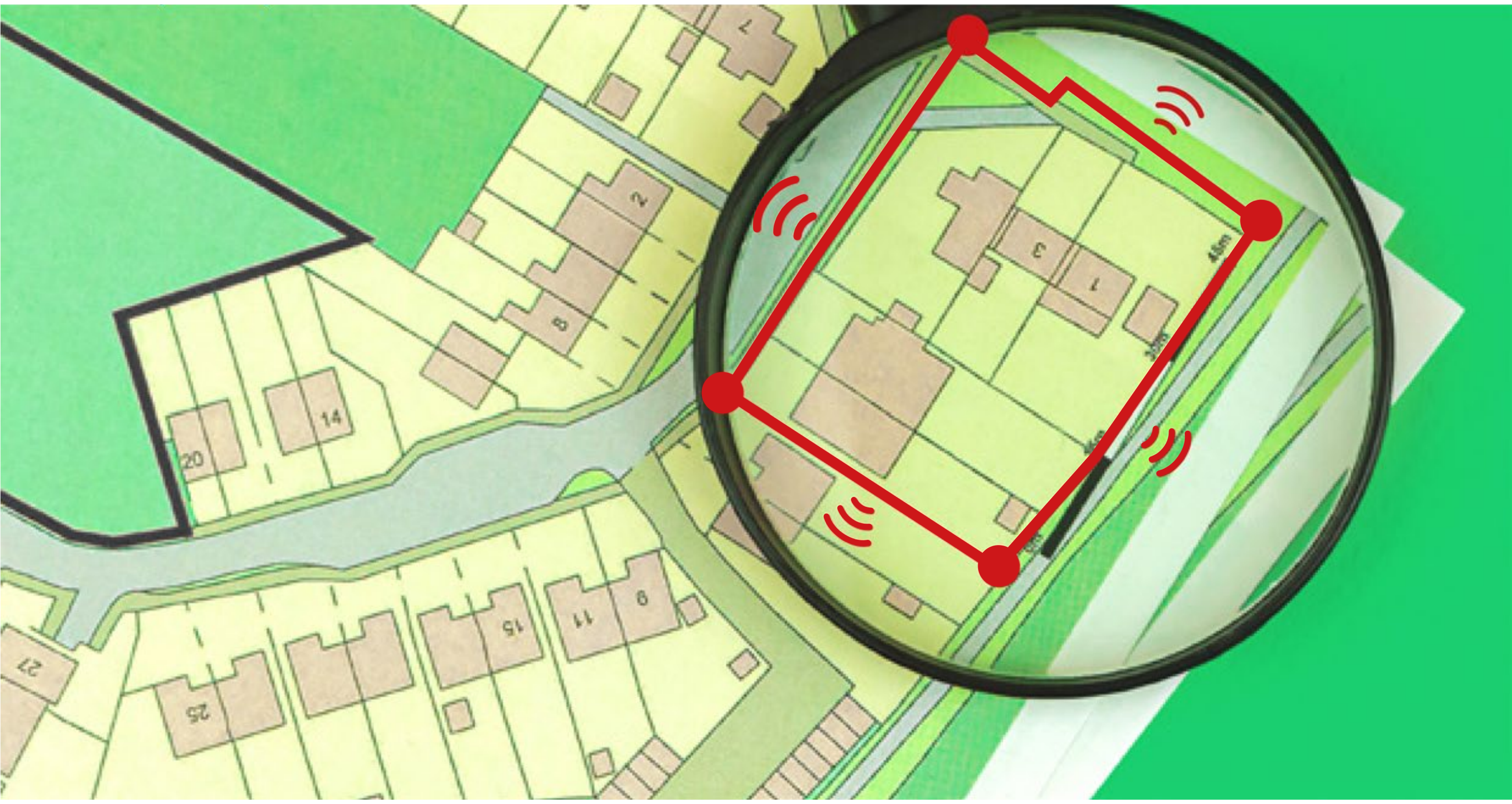
To conclude, compared to other solutions, our monitoring systems based on fiber optic cables have **many advantages** and the key ones are listed below:

1. **Passive system** – there is no need to supply power to many points, often in difficult places (no to mention additional cost, as it is usually the customer's responsibility to supply power to designated points).
2. **Very low operating costs** – as it only relates to energy consumption of the central unit, corresponding to consumption of a standard computer. In addition, there is no need to service, perform maintennace etc. – usually only the interrogator (easily accessible in a rack on level 0) may require access and visits.
3. **Minimum risk of system breakdown** - passive elements can only be damaged mechanically, while each electronic device has a finite breakdown risk, and it always increases with time (drying of capacitors, dust, etc.). And more importantly, communication between the interrogator and sensors is done via passive optic cables – in case of solutions using active devices, they mainly use Wi-Fi. As a matter of fact, communication through Wi-Fi can be tricky and troublesome as it often breaks for example resetting the Wi-Fi access point located 10 m above the ground it's not pleasant. Undoubtedly, such situations do not seem to be the pleasant ones. Naturally, any failure of the key infrastructure is unacceptable.
4. **Permanent access to data** – data processed locally and in the cloud. In case of solutions with cloud-based processing there is a risk of server failure (and unfortunately, such situations quite often take place as even in the largest commercial clouds system breakdowns occur) – the highest risk of losing communication is during difficult weather conditions that is precisely when the system should work effectively and be reliable. When the system is installed in several locations, the advanced AIDA software (so-called umbrella system) provides a very comfortable view of the state of a building at any place. At the same time, the local building maintenance service can see the status of their building on the local monitor.
5. **Insensitivity to mechanical damage** – naturally, everything can be damaged mechanically, but elements of this system do not protrude beyond the girders, thus they are well protected from an accidental damage. Compared to this, other solutions such as laser beams are sensitive to positioning and protrude beyond a beam, which is relevant, for instance, in case of operating a forklift. Moreover, it is completely irrelevant what lies on the floor – and in turn, in the case of solutions which for example actively measure the distance to the work floor, measuring points cannot be used as storage space. Likewise, dust or air humidity are totally irrelevant and do not affect the operating quality of the system.

All the above-mentioned advantages, together with exceptional accuracy, make the fiber optic technology the most optimal in SHM applications. Undoubtedly, fiber optic technology is extremely prospective as its popularity is constantly growing. This is mainly because the versatility, flexibility and multitasking nature of fiber optic cables make them the best possible solution to be used in wide range of fields. Proper use of optical fiber combined with high-class equipment and software provides a reliable system.

FIBRAIN, as the leading and independent Polish producer of fiber optic technologies and integrator of active solution, offers a top-quality support in designing and maintaining roof deflection monitoring. Upon customer request, we are ready to support in installing our systems or organizing necessary trainings. Having installed and performed a wide range of projects in Poland and worldwide, we can easily perform any investment comprehensively. Such a combination of professional service and technical support guarantee failure-free operation for many years.

Owing to our solution, there are not any fixed or subscription costs. Consequently, it translates into lower opex costs, and in practice it may effectively offer additional savings, as the whole system cost can be depreciated accroding to local accounting rules.



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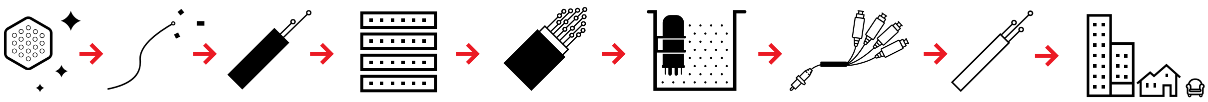

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