

4 ENCOURAGING THE SELF-DIAGNOSIS OF STRUCTURES

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Structural Health Monitoring (SHM²) aims to provide continuous information about a structure capacity to bear the loads for which it was designed, for example the weight of trucks on a bridge; to identify the onset of damage, or monitor its development and evaluate its impact on the structure strength; to know the actual loads structures are subjected to.

Civil engineering structures which perform self-diagnosis offer a paradigm shift with regard to maintenance, which is still usually conducted on the basis of periodic inspections and the application of progressive monitoring in the case of a disorder. Self-diagnosis would make it possible to implement detailed inspections when necessary while helping to characterise changes in the structure or its loading, in order to reduce life-cycle costs.

These technologies also play a key role in improving winter services by better optimising the use of de-icing products or heating cycles in the case of critical infrastructure. Self-diagnosis has the potential, still barely exploited, to increase the productivity and safety of civil engineering works, such as the driving of tunnels. It also makes it possible to install systems to dampen vibrations

in the case of flexible structures such as cable-stayed bridges that are subjected to wind.

New approaches in response to new challenges

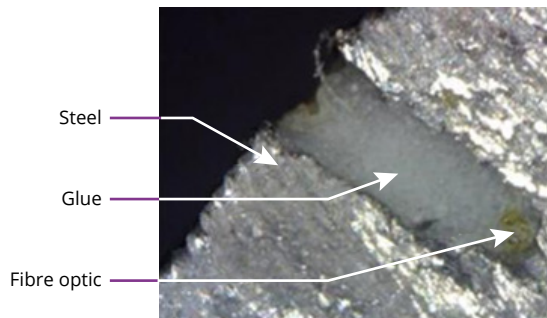
Self-diagnosis requires a close cooperation between measurement technologies, performance models and data processing techniques. It involves the observation of systems and constitutes a scientific and technological challenge in its own: the existence of self-diagnosis cannot simply be decreed and it has the potential to generate large costs. It requires a large number of sensors which must be compatible with all the physical phenomena that are at play, discriminating digital models, fast algorithms to process a very large amount of data, techniques to eliminate the impact of

environmental factors such as temperature or humidity (which are often larger and more apparent than the effects of the damage in question). The science of data must be mustered for the sake of structures. For transport infrastructure, preference will be given to techniques which cost only increases moderately with the length or surface area to be monitored.

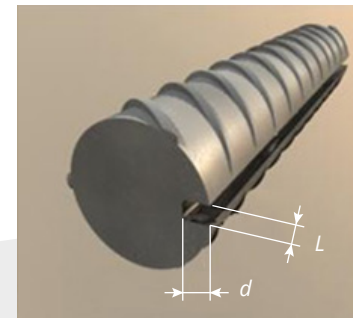
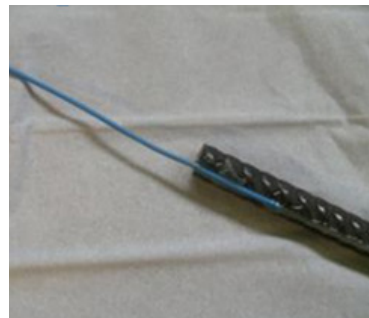
Opportunities for innovation

The cost of these innovative networks of sensors based on nanotechnology, photonics (optical fibres, infrared thermography) or electrical wave propagation, becomes reasonable once the volume of data to be processed exceeds a certain threshold, and they will be fitted to infrastructure on a massive scale, particularly in urban areas. When combined with fixed or vehicle-borne satellite technology, at network level, these sensors will provide original high-output health monitoring methodologies for roads, railways and wind farms, with major impacts on availability and maintenance. It will become easier for transport operators to perform weigh-in-motion, to estimate the real loads carried by roads and bridges and to predict their service life. These innovative sensors will form the cyber-physical infrastructure of information systems that will be integrated within the city and infrastructure of all types, in particular very high performance ultra-light prefabricated structures such as bridges made from composite materials. Countless variants of these systems will improve the energy efficiency of the city and transport systems, and enhance the real time assessment of urban operation with regard to mobility and energy, air, water and soil quality and electromagnetic pollution.

“Self-diagnosis would make it possible to implement detailed inspections [...]”



▲ A fibre-optic sensor bonded to the rebars of reinforced concrete structures



1. COSYS: Components and systems Department
2. Structural Health Monitoring