SHM of a prestressed concrete bridge using long-gauge FBG fibre optic sensors

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To deploy an accurate safety-reliable structural health monitoring, the utmost care and in-depth knowledge of the monitored structure must be assured. Challenges such as the reliability to detect unexpected anomalies due to the failure of a component, the correct setting of thresholds and triggers to discern changes due to environmental conditions from critical events, and the high expense in terms of hardware and personnel availability need be taken into account. Although the current approaches of SHM systems using traditional single-point sensors – such as electric strain sensors, accelerometers, and GPS-based sensors – have appropriate measurement precision for SHM purposes, they present challenges when deployed in real scale applications, given the limited number of possible points to assess the structural behaviour and the harsh environmental conditions during operation. When it comes to reinforced concrete structures, the development of health monitoring and damage identification presents further challenges, since this type of structure is affected by a variety of chemical, physical and mechanical degradation processes, and has a heterogeneous composition and nonlinear behaviour. On the other hand, the fibre optic (FO) technology can provide integrated sensing along with extensive measurements lengths with high sensitivity, durability, and stability, which makes them ideal for SHM of concrete structures. Therefore, an SHM system using quasi-distributed FO FBG sensors is proposed to continuously monitor the strain changes of a 57 m long prestressed concrete bridge due to traffic loads and environmental changes. A total of 89 long-gauge strain sensors were installed to monitor the strain distribution in two lines along the complete length and 5 lines in the shear direction. Each strain sensor has an integrated FBG temperature sensor for temperature compensation of the strain sensors and to correctly detect the strain changes due to temperature variation on the bridge. Additionally, four FBG temperature sensors and two FBG acceleration sensors were installed. Thanks to the multiplexing characteristic of the FBG technology, all 184 sensors were connect using only eight channels into one reading unit that measures all sensors simultaneously and continuously at 200 samples per second. In this work, the measurement values are presented to demonstrate the potential of FO to provide a reliable SHM system to monitor large concrete structures and a discussion on the interpretation of the measured data to correctly predict the structural behaviour of prestressed concrete bridges is carried out.