Concrete Pile Testing and Monitoring Using Structure-Integrated Fibre-Optic Strain Wave Sensors

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Abstract

Reinforced concrete piles are used when structures are constructed on soft ground, because it is necessary to transfer the loads into deeper strata with a sufficient bearing capacity. Usually, static and dynamic pile tests are carried out in order to determine the pile's behaviour and possible damages. The dynamic measurements can show the bearing behaviour and the structural integrity by using the theory of one-dimensional wave propagation. Commonly, the sensors are installed on the top of the pile head or embedded near the pile head. With the purpose of receiving more precise information about the pile features, now, a string of sensors is embedded at different levels of the pile. A fibre optic strain wave sensor, based on the extrinsic Fabry-Perot interferometer (EFPI), was developed to detect the introduced deformation caused by the static loading and the dilatational wave during dynamic loading.

The optimised sensor was embedded in cast-in-situ bored piles and tested at the BAM Test Site Technical Safety in Horstwalde, South of Berlin. Additionally to the EFPI sensors, fibre Bragg grating (FBG) sensors, temperature sensors and resistance strain gauge (RSG) sensors were embedded in order to verify the performance of the newly designed strain wave sensors. The tests have clearly shown the good correlation between the responses of dynamic and static loading. Another set of sensors was embedded in precast driven piles, which have been casted in the factory of our project partner, Centrum Pfähle GmbH, Hamburg/Germany. The piles were driven and tested on one of their big construction sites close to the being built big harbour area in Wilhelmshaven/North Germany. As a result, all sensors survived the driving process and showed the integrity or the driven piles.