Sensors and Materials, Vol. 18, No. 6 (2006) 283–299
MYU Tokyo

S & M 0650

Design and Mechanical Characterization of Fibre Optic Plate Sensor for Crack Monitoring

Paulo J. S. Cruz*, Abraham Diaz de Léon, João P. Nunes and Christopher K. Y. Leung[1]

Engineering School University of Minho, Azurém, 4800-058 Guimarães, Portugal
[1]Hong Kong University of Science & Technology, Clear Water Bay, Hong Kong, China

(Received November 11, 2005; accepted September 27, 2006)

Key words: fibre optic sensor, cracking, monitoring, polyester, OTDR

The condition of many important concrete structures can be partially assessed through the detection and monitoring of cracking. Usually, crack detection in bridges is based on visual inspection. This procedure is time consuming, expensive, and unreliable; therefore, the use of cracking sensors is highly recommended. Nevertheless, most existing sensors/transducers are quite limited in their ability to detect and monitor cracks. This paper outlines the characteristics of fibre optic sensors for crack monitoring and a describes the improvements. The proposed technique does not require prior knowledge of crack locations, which is a significant benefit over existing crack monitoring techniques. Moreover, several cracks can be detected, located, and monitored with a single fibre. An ideal application of the sensor is in the monitoring of flexural cracks in bridges, which may appear at arbitrary locations along the deck, but are essentially perpendicular to the spanning direction. This report describes recent improvements introduced in the sensor to attain the necessary mechanical properties that enable the plate to crack together with the concrete, mainly by assuring that the plate has a brittle behaviour and breaks under a small strain. Consequently, the mechanical properties after the curing of polyester were evaluated considering different combinations of catalyst and accelerant. Bearing in mind the ductile behaviour of the polyester, different particles were added to change the sensitivity of the sensor. By changing the particle size distribution, the geometry (aspect ratio) and the density of the material added, it is possible to control the sensor's sensitivity, e.g., to obtain a sensor that detects thinner or wider cracks. For measuring and improving the adhesion of the sensor plate to concrete, a study of polyesters and epoxies as adhesives was conducted and pull-off tests were performed.

*Corresponding author, e-mail address: pjscruz@gmail.com