Non-destructive concrete strength evaluation using smart piezoelectric transducer—a comparative study

Abstract

Concrete strength monitoring, providing information related to the readiness of the structure for service, is important for the safety and resource planning in the construction industry. In this paper, a semi-analytical model of surface bonded piezoelectric (lead zirconate titanate) based wave propagation (WP) technique was developed for strength evaluation of mortar with different mix, throughout the curing process. Mechanical parameters of the mortar specimen were mathematically evaluated from the surface wave (R-wave) and pressure wave (P-wave) using elastic wave equations. These parameters were then empirically correlated to the strength. The model was found to be very robust as it could be generalized to account for different water to cement (W/C) ratio. The performance of the WP technique was then compared to the electromechanical impedance technique and other conventional techniques, such as the ultrasonic pulse velocity (UPV) test and the rebound hammer test. Results showed that the WP technique performed equally well as the conventional counterparts. The proposed technique is also advantageous over embedded WP technique and the UPV test, in terms of its capability to capture two types of waves for the evaluation of dynamic modulus of elasticity and Poisson's ratio. A separate study was finally conducted to verify the applicability of this technique on heterogeneous concrete specimen. With the inherent capability of the WP technique in enabling autonomous, real-time, online and remote monitoring, it could potentially replace its conventional counterparts, in providing a more effective technique for the monitoring of concrete strength.