The meaning of transit times of ultrasonic pulses in NDT of reinforced concrete

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Resumen:

Transit times of longitudinal pulses that travel near the reinforcing steel bars are usually smaller than in plain concrete. Chung first, and then Bungey, demonstrated the importance of including bar diameters in the correction factors when pulses propagating parallel and near to the bars can not be avoided (1), (2). Besides the influence of geometric dispersion and mode conversion on pulse propagation (3) (4), there is an effect due to a specific pattern of radial variation of longitudinal wave velocities from the surface of the embedded steel bar. Wall effects produce a region (a sheath) of concrete surrounding the steel bar, with smaller longitudinal pulse velocities in comparison with the velocity farther away from the bar. Then the acoustic energy travels trapped in a kind of composite leaky waveguide with a velocity less than the compression (P) wave velocity in steel and in concrete but greater than the extensional wave velocity in steel.

A mathematical model of the propagation of a longitudinal wave-packet is constructed, taking into account both attenuation and dispersion effects. An asymptotic analysis of pulse propagation and the introduction of a threshold of detection in the receiving transducer, allows the derivation of an approximate analytical formula for transit times. Then the meaning of transit times in NDT of concrete is discussed. The abovementioned formula is used to study the effects of the reinforcing bar radius, the propagation parameters in plain concrete and in the sheath surrounding the steel bar, the path length between the transmitting and the receiving transducers, and the energy and

the spectral composition of the pulse injected by the emitter in the tested body. Chung's and Bungey's half empirical correlations between the measured pulse velocity and bar radius are reviewed and a new correlation is proposed.

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Key words:
ultrasonic testing of reinforced concrete, transit times of longitudinal pulses, leaky waveguide, mathematical model