

A novel approach to ultrasonic inspection of solid railway axles

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The traditional approach to the ultrasonic inspection of solid railway axles, applied in Italy since the '70s of the last century, is based on the so called rotating probe, a device composed by mono-crystal piezoelectric transducers generating longitudinal ultrasonic waves differently angled in order to inspect all of the critical sections of the axle from its ends. Even if such approach has proven to be more efficient with respect to the basic one based on single ultrasonic probes applied at the sides of the axle, the known limits of this technique are mainly related to the surface conditions of axle ends: in particular, the identification markings must not be so deep to influence sensitivity and the presence of the threaded holes for the application of the taps of the axle boxes can shadow longitudinal portions of the axle. The present research proposes a novel technical solution able to improve furtherly the performance of the rotating probe, while mitigating, at the same time, its known limits. First, the phased array ultrasonic technique is implemented in place of the traditional mono-crystal one: indeed, preliminary studies have shown a better uniformity of sensitivity can be achieved adopting the phased array technology with respect to the traditional one. Then, the application of the rotating probe is no more at the ends of the axles, but at blind holes suitably manufactured on the same ends. The validation of the developed inspection system is carried out by a dedicated experimental campaign based on full-scale axles directly taken from the production line and provided with artificial defects manufactured by electro-discharge machining and characterized by different shapes, dimensions and positions along the axles themselves. The reliability of the developed inspection technique was, then, derived, in terms of Probability of Detection curves, by a "Model-Assisted Probability of Detection" approach. Finally, the developed procedure was successfully applied to a case study dealing with the in-service maintenance of assembled wheelsets.