Using a tail field to differentiate surface and internal defects during high-speed MFL testing

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We studied a special magnetodynamic effect that occurs during high-speed testing of conductive objects by the Magnetic Flux Leakage (MFL) method. At a significant speed of motion of the magnetizing system relative to the test object, under the influence of eddy currents, the region of the maximum level of object magnetization shifts in the direction opposite to the direction of motion. As a result, behind the back pole of the magnetizing system an extensive magnetization zone forms, which is a tail field. The structure of the tail field and the possibility of using the results of its leakage as additional NDT data were studied. The rail was taken as a test object, since it is precisely during the railway track inspection that the control speeds are high and the magnetodynamic effects play an important role. A three-dimensional computer simulation of the interaction of a fixed conductive steel rail and the magnetizing system moving at speeds of 30-60 km/h was carried out [1]. The distribution of the magnetic field inside the test object and on its surface behind the back pole of the magnetizing system was investigated. Also, we considered the leakage of the tail field by surface and internal defects. The results of the calculations indicate the presence of two oppositely directed magnetic fluxes behind the back pole of the magnetizing system, one of which propagates in the interior of the metal, and the other flows on its surface. With growing speed, the effect of eddy currents increases and the internal magnetic flux strengthens. As a result, the maximum magnetization of the metal layers most distant from the surface is achieved not in the interpolar space, but behind the back pole of the magnetizing system. Surface defects scatter the surface magnetic flux, while deep defects scatter the internal one. Since the direction of fluxes is opposite, the signals of sensors located behind the back pole of the magnetizing system have different polarity depending on whether the defect is surface or internal. Thus, the resulting distribution of the magnetic field behind the back pole can be used to differentiate surface and internal flaws. [1] Antipov, A.G. and Markov, A.A., 3D simulation and experiment on high speed rail MFL inspection, NDT&E International, 2018, vol. 98, pp. 177–185