

Evaluation of the penetration zone thickness in weld by ultrasonic method

Ryszard Mańczak¹

¹Faculty of Civil and Transport Engineering, Poznan University of Technology, Poland

In evaluation the quality of welded joints, it is important to assess the depth of weld penetration. The penetration depth is defined as part of the cross-sectional height of the connected elements at which the weld was formed. In the literature, there are solutions for measuring systems using ultrasonic waves that allow for a non-destructive evaluation of the depth of penetration in weld. Some of these solutions are covered by patent protection. Sometimes they even allow to control the welding process to shape the weld with a specific penetration depth. Increasingly, in addition to the penetration depth, an important parameter in the evaluation of welded joints is to check the thickness of the penetration zone. Thickness of the penetration zone in weld is a different parameter than the depth of penetration in weld. Thickness of the penetration zone means the dimension of the area from the original edges of the weld to the fusion lines. This parameter is particularly important when assessing welded joints of thin-walled sheets, especially in the automotive industry. At present, there is no method that would allow evaluation of the penetration zone thickness in a non-destructive way. This evaluation is carried out in a destructive manner, by optical measurement of the thickness of the penetration zone on the metallographic specimen. The article presents the concept of a solution to the measurement of penetration zone thickness by using ultrasonic waves. The essence of the measurement consists in measuring the time of wave passage through the weld area and the area of native material in a direction perpendicular to the weld fusion line. The diversity of the wave velocity values in the weld material and native material allows the calculation of the penetration zone thickness, if the geometrical dimensions of the joined elements are known. As part of the research were carried out, experimental measurements of the value of ultrasonic wave velocity in the native material of the joint and in the material of the weld. In addition was verified the dispersion of velocity values in weld and native material with the dispersion of wave velocity occurring in reference materials K1 and K2. The results of the exploratory tests were satisfactory and allowed the development of an analytical model for measuring the thickness of the penetration zone. In the model, it is necessary to know the value of the wave speed in the weld material and in the native material. The measurement is possible using a longitudinal or transverse wave. The choice of the wave is determined by the joint geometry. Experimental research was also carried out on a selected example of a welded joint to verify the results obtained based on the model. The obtained experimental results confirmed the validity of the analytical model for evaluation of the penetration zone thickness.