Temperature Dependence of Ultrasonic Longitudinal Guided Wave Propagation in Long Range Steel Strands

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Abstract: Ultrasonic guided wave inspection is an effective non-destructive testing method which can be used for stress level evaluation in steel strands. Unfortunately the propagation velocity of ultrasonic guided waves changes due to temperature shift making the prestress measurement of steel strands inaccurate and even sometimes impossible. In the course of solving the problem, this paper reports on quantitative research on the temperature dependence of ultrasonic longitudinal guided wave propagation in long range steel strands. In order to achieve the generation and reception of a chosen longitudinal mode in a steel strand with a helical shaped surface, a new type of magnetostrictive transducer was developed, characterized by a group of thin clips and three identical permanent magnets. Excitation and reception of ultrasonic guided waves in a steel strand were performed experimentally. Experimental results shows that in the temperature range from –4 ℃ to 34 ℃, the propagation velocity of the L(0,1) mode at 160 kHz linearly decreased with increasing temperature and its temperature dependent coefficient was ( ) which is very close to the theoretical prediction. The effect of dimension deviation between the helical and center wires and the effect of the thermal expansion of the steel strand on ultrasonic longitudinal guided wave propagation were also analyzed. It was found that these effects could be ignored compared with the change in the material mechanical properties of the steel strands due to temperature shift. It was also observed that the longitudinal guided wave mode was somewhat more sensitive to temperature changes compared with conventional ultrasonic waves theoretically. Therefore, it is considered that the temperature effect on ultrasonic longitudinal guided wave propagation in order to improve the accuracy of stress measurement in prestressed steel strands. Quantitative research on the temperature dependence of ultrasonic guided wave propagation in steel strands provides an important basis for the compensation of temperature effects in stress measurement in steel strands by using ultrasonic guided wave inspection.

Key words: steel strand, ultrasonic guided waves, mode, temperature coefficient, magnetostrictive transducer

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