Wide Spread Of The Acoustical Wavefront Of Low Frequency Transducers Utilized For Concrete Inspection

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With regard to structural health monitoring, ultrasonic (UT) measurements provide a method of non-destructively testing structural systems by allowing for the viewing of defects within the bulk or body of a structure by propagating and receiving sound waves transmitted through the material. Our research focuses on the application of low frequency transducers (< 100 kHz) to the inspection of concrete as lower frequency transducers are commonly required to limit the dissipation of acoustic energy (attenuation) associated with concrete. Through our investigations, we have determined that low frequency transducers present unique challenges that do not exist with higher frequencies. In particular, our broader research goals require the use of beam spreading, a phenomenon in which UT transducers generate sound waves at exceedingly large angles, commonly producing a hemispherical wavefront in tests conducted. A hemispherical acrylic tank was procured to investigate this wide spreading of the acoustic waves. The hemisphere was filled with water, and a transmitting transducer was suspended into the top of the tank. The system is designed for a receiving transducer to be placed at the bottom and outside of the acrylic shell to receive acoustic signals. Demarcations were used to move the receiving transducer to record signals at regular intervals across the tank. The experiment was repeated for 25, 50, and 100 kHz transducers. All transducers, regardless of frequency, developed a hemispherical wavefront. Maximum amplitudes were recorded and were found to increase and decrease at different angular measurements, regardless of the frequency utilized. Of particular note is that shear waves can not develop within liquids, so the received acoustic signals were exclusively longitudinal waves. Each frequency developed its own intensity plots, and some divots in intensity exist at quasi-regular intervals. Tests were repeated with aluminum, high density polyethylene, and concrete and the existence of lobes of intensity exist in all samples. Of particular interest to the field of UT testing of concrete and other highly attenuating materials is that these lobes must be accounted for in measurement systems for proper analysis. This means that interpretation of the signals is required if a transmitting transducer is held stationary while a receiving transducer is swept through a range of locations. In other words, if a transmitting transducer is kept stationary and a receiving transducer is swept, readings must incorporate these lobes as baselines for interpretation if a defect occurs at a particular angle. The most likely cause is a diffraction pattern associated with the acoustic waves passing through an aperture, as the transducer itself has a diameter well below the wavelength of the sound waves in water at all frequencies.