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Propagation of a long wave in a curved duct. I: Basic analysis of long wave propagation in a curved duct with variable cross section. (English) Zbl 0542.76095

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The propagation of an acoustic wave in a slender curved duct with slowly varying cross-sectional area using the long wave approximation is presented. The typical cross-sectional size of the duct,a, is assumed to be much smaller than the wave length k^{-1} and the other geometric parameters of the duct, namely, the typical radius of curvature and the reciprocal of the torsion of the center line of the duct. It is shown that for each order of ka the three-dimensional Helmholtz equation is decomposed into a two-dimensional problem defined by the local cross- sectional area with s as a parameter and a one-dimensional Webster equation in s, where s is the arc length along the center line of tube. To the leading order in ka, the wave propagates like in a straight tube with varying cross-sectional area. In general, the effects of the curvature and torsion appear in the first order and the second order terms, respectively. When the cross-section shape has certain symmetry, the effects of curvature and torsion will be delayed by one order in ka. An example of wave propagation in a curved circular duct is presented.

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MSC:

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Keywords:

linear acoustics; duct acoustics; propagation; slender curved duct with slowly varying cross-sectional area; long wave approximation; three- dimensional Helmholtz equation is decomposed; one-dimensional Webster equation; effects of the curvature and torsion; first order and the second order terms; example

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