

Excitation of axisymmetric and non-axisymmetric guided waves in elastic hollow cylinders by magnetostrictive transducers

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Pipeline Transportation

Pipeline transport is the transportation of goods or material through a pipe. The best data, in 2014, gives a total of slightly less than 3.5 million km of pipeline in 120 countries of the world.



Nearly 3.5 million km of pipeline

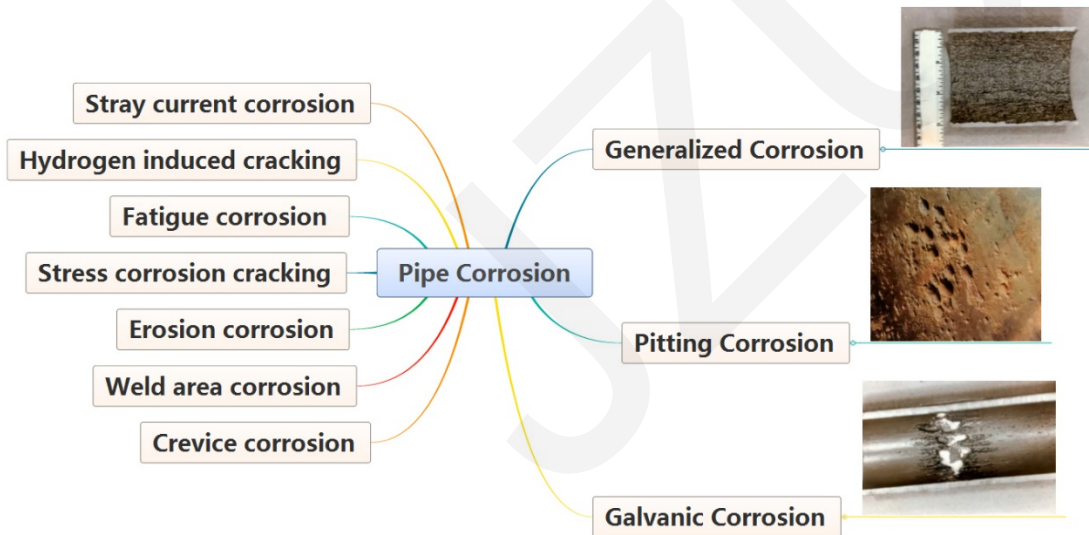
United States 65%

Russia 8%

Canada 3%

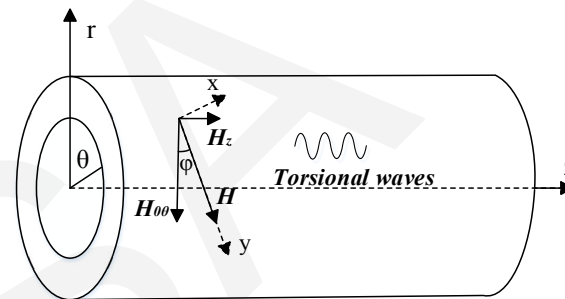
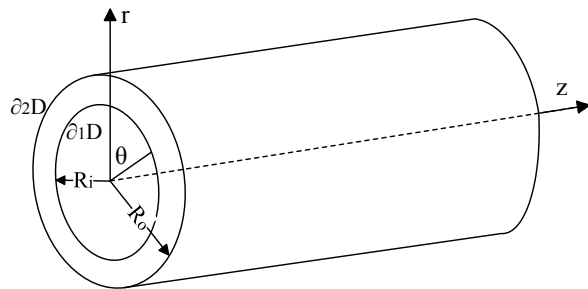
China 3%

Others 21%

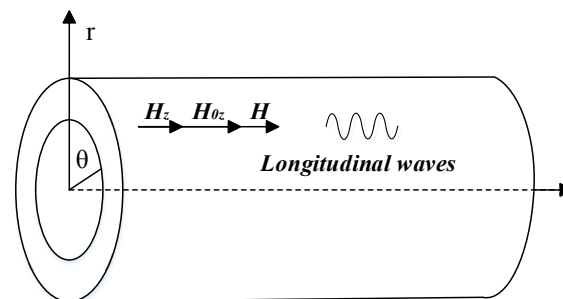
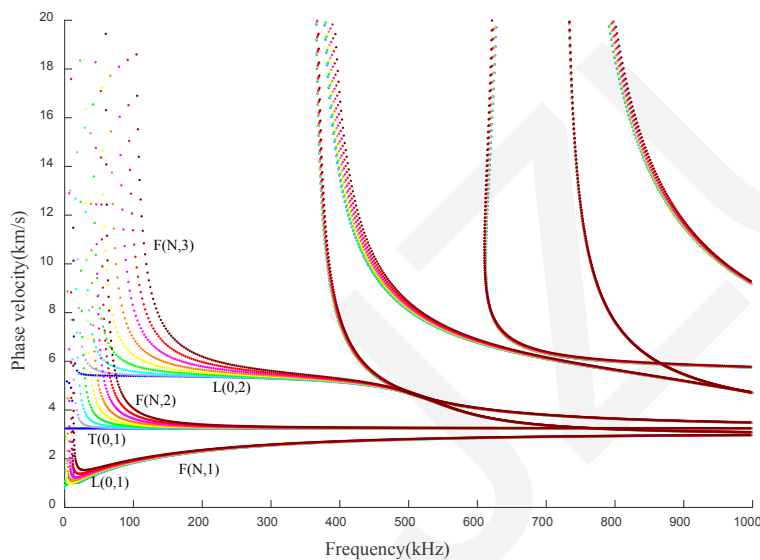


Corrosion is one of the leading causes of failure in transmission pipelines throughout the world.

Guided waves in hollow cylinders

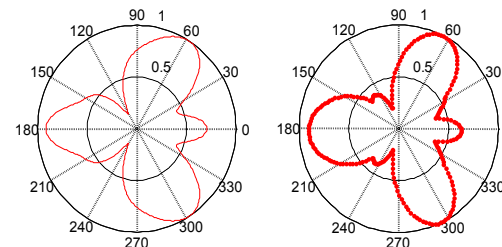
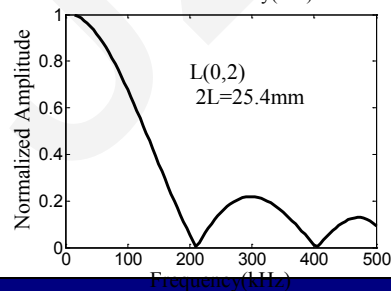
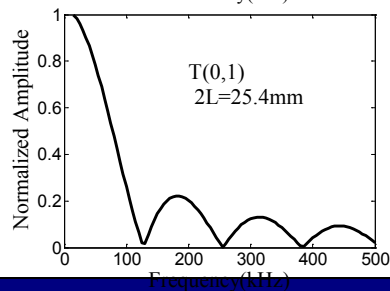
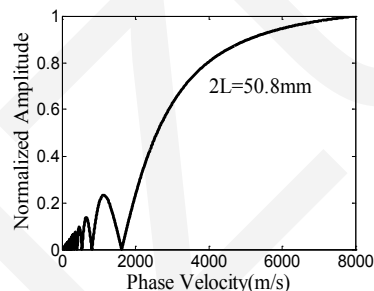
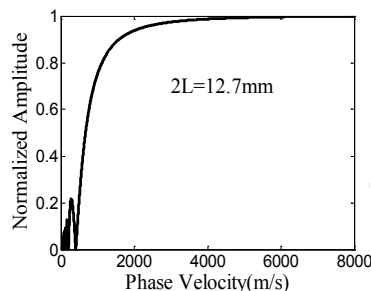
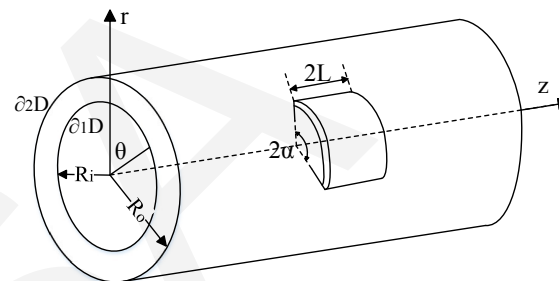
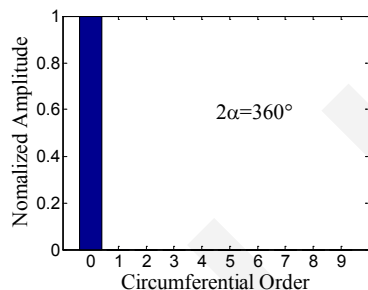
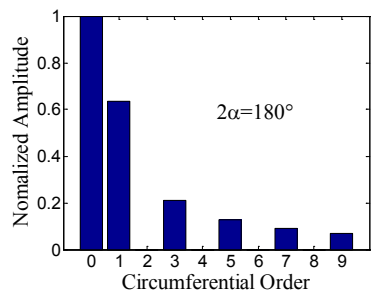
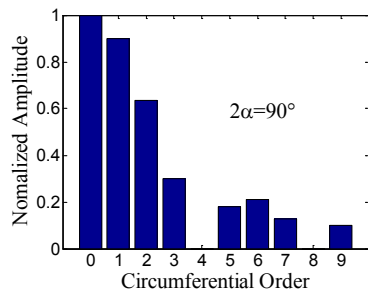
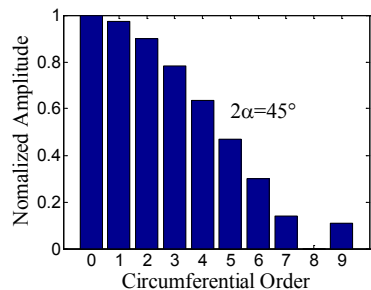


$$\begin{cases} \tilde{S}_3 = s_{33}\tilde{T}_3 + d_{33}\tilde{H}_z \\ B_z = d_{33}\tilde{\sigma}_3 + \mu_3\tilde{H}_z \end{cases}$$

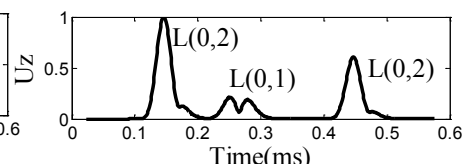
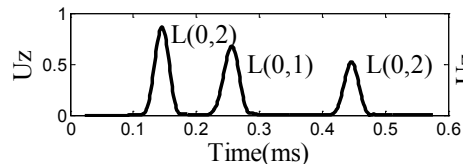
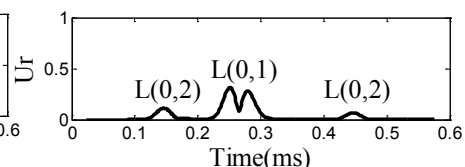
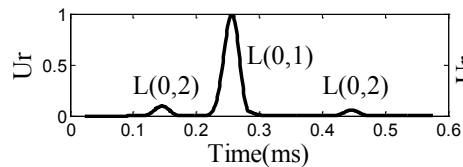
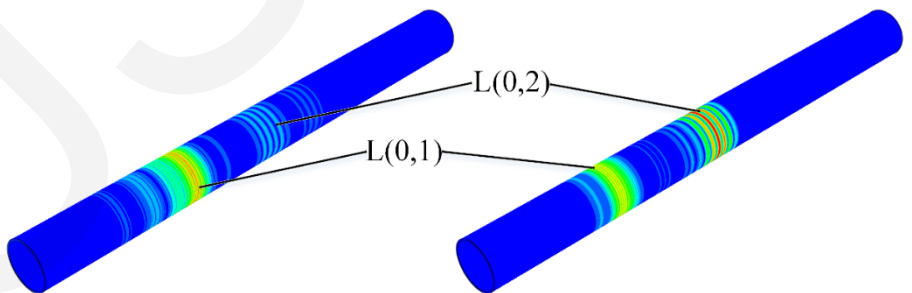
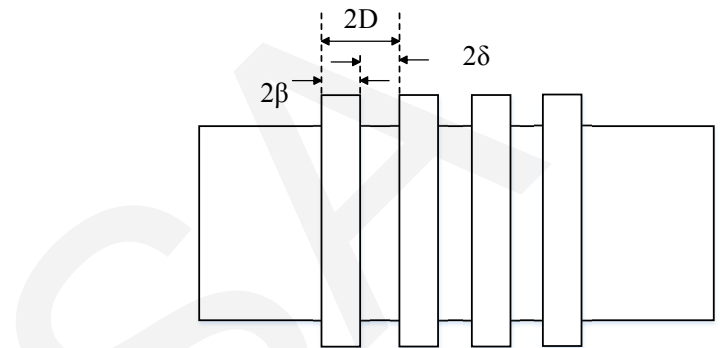
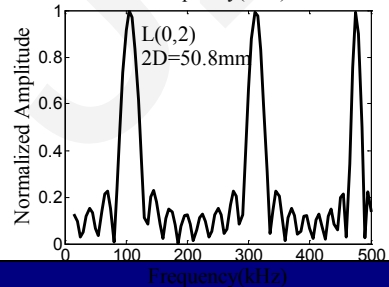
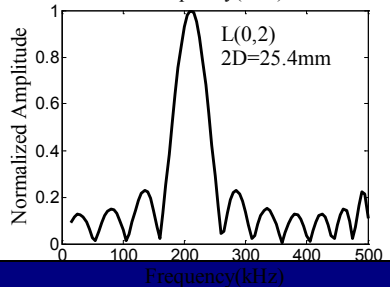
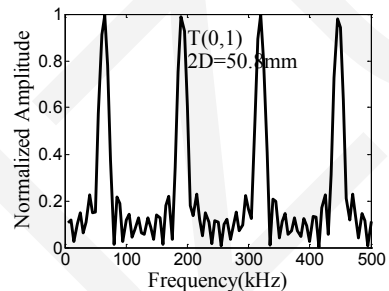
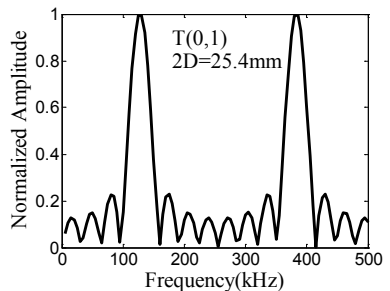
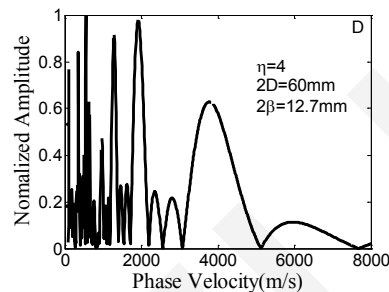
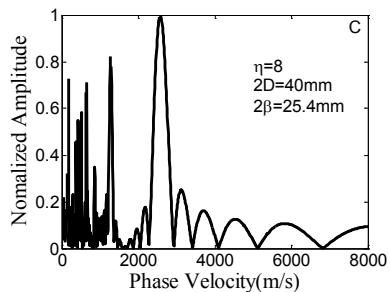
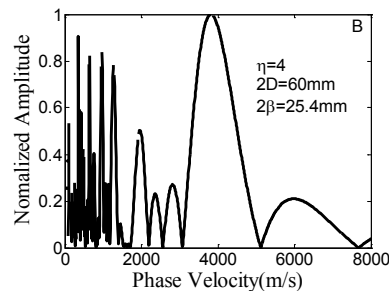
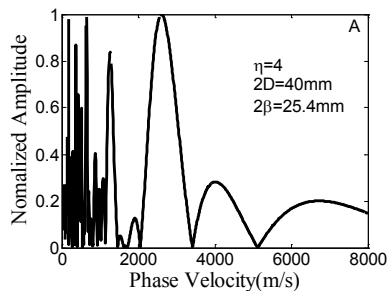


$$\begin{cases} \tilde{S}_4 = s_{44}\tilde{T}_4 + d_{43}\tilde{H}_z \\ B_z = d_{43}\tilde{T}_3 + \mu_3\tilde{H}_z \end{cases}$$

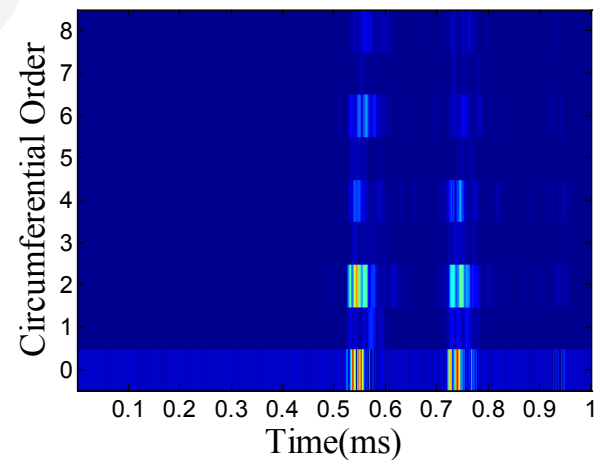
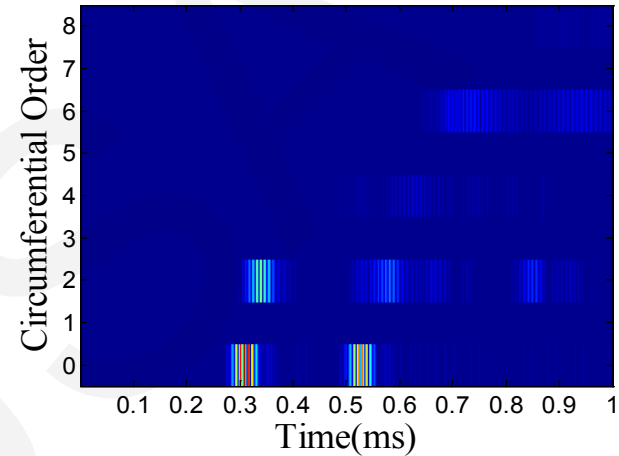
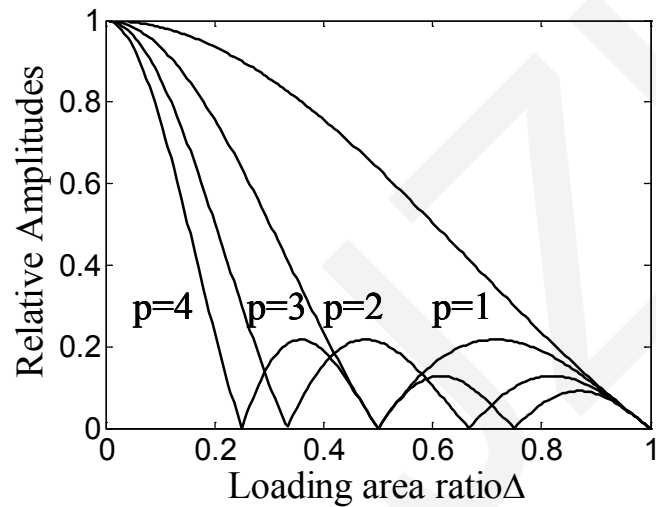
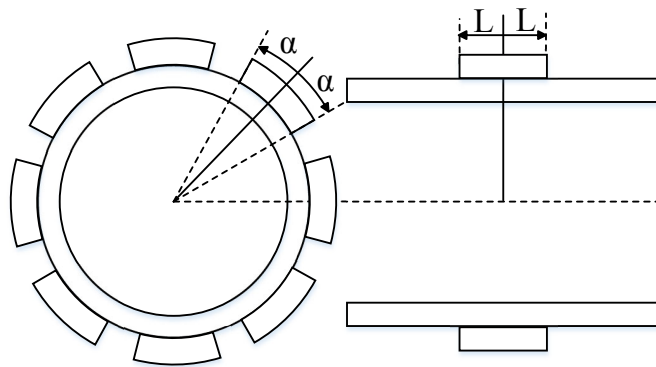
Magnetostrictive partial loading



Magnetostrictive axial array loading



Magnetostrictive circular array loading



Conclusions

- Magnetostrictive partial loading is able to excite guided wave modes of the same family, but has poor phase velocity and frequency selectivity. Axisymmetric loading excites axisymmetric modes only. Angular profiles in a hollow cylinder are sensitive to the circumferential loading length.
- Magnetostrictive axial array loading has good phase velocity and frequency selectivity and guided wave mode controllability. According to phase velocity and frequency spectra, center phase velocity and center frequency are mainly determined by element distance.
- Magnetostrictive circular array load only excites guided wave modes whose circumferential order is integer multiple of the number of elements.

Related publications

- Xiao-wei ZHANG, 2016, Excitation of dominant flexural guided waves in elastic hollow cylinders using time delay circular array transducers. *Wave Motion*, 62:41-45. [doi:10.1016/j.wavemoti.2015.09.010]
- Xiao-wei ZHANG, 2014. Numerical Simulation and Experimental Investigation on Ultrasonic Guided Waves in Multilayered Pipes Based on SAFE. *J Mech Eng*, 50(8):10-16. [doi: 10.3901/JME.2014.08.010]
- Xiao-wei ZHANG, 2016, Non-destructive evaluation of spiral-welded pipes using flexural guided waves, 42nd Annual Review of Progress in Quantitative Nondestructive Evaluation (QNDE), AIP Conference Proceedings 1706, 160005. [doi: 10.1063/1.4940622]