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Sound insulation performance of plate with interconnected distributed piezoelectric patches

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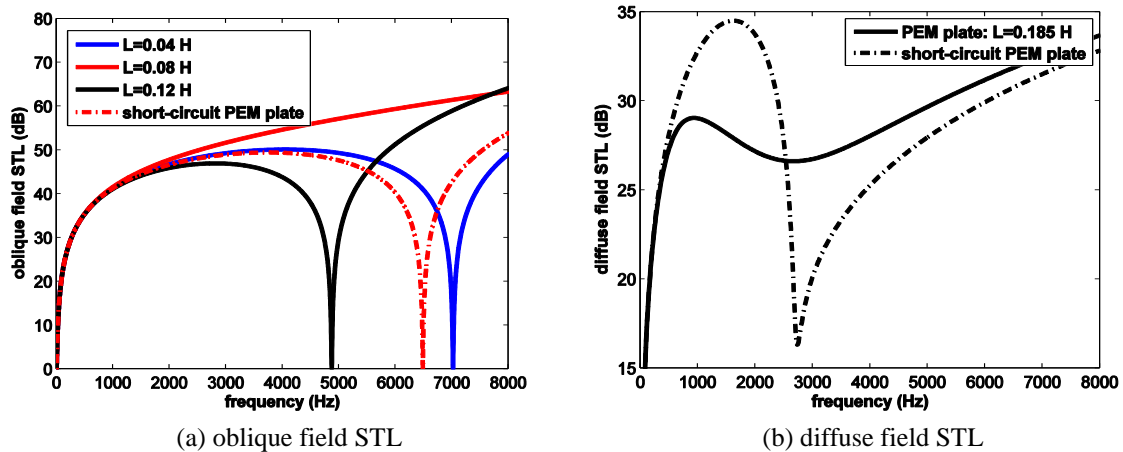
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Abstract

The intensive use of light plate-like structures in aircraft industry and transport industry result in more serious vibration and noise issues for their higher dynamical sensitivities. To deal with these problems, techniques based on piezoelectric materials have been proposed and numerous papers have contributed to their development and application^[1-7]. In these applications, periodically distributed piezoelectric control strategies^[4-7] attracted many researchers for their abilities to modify the equivalent dynamical parameters of the piezo-mechanical system to obtain new desired vibro-acoustic functionalities, i.e., materializing “integrated smart structure” or “metacomposite”^[8]. However, previous works who used the periodically distributed piezoelectric techniques mainly focused on controlling vibration, associated sound radiation^[9] or wave propagation on the structures, few of research concerns control sound transmission.

In our work, wave propagation properties and sound insulation performance of a thin plate with interconnected distributed piezoelectric patches via an inductive circuit network were studied. Firstly, analytical dynamical equations for this piezo-electromechanical plate (PEM plate for short) were established by using homogenization method under sub-wavelength assumption. Then, dispersion relationships and energy density of the wave modes propagating in PEM plate were analyzed. At last, the coincidence frequency as well as the sound transmission loss (STL) were studied. The results obtained lead to the following conclusions:

- (1) Two free bending waves exist in PEM plate with different wave speeds and translate energy both in mechanical field and in electric field.*
- (2) There exists a region for the incident angle of sound wave of PEM plate, if the incident angle of sound wave lies in the region then there is not the coincidence frequency around where the insulation effect is worst.*
- (3) The disappearance of coincidence frequency can be used to optimize the value of inductance to considerably improve the sound insulation performance of PEM plate in coincidence region as illustrated in figure 1.*



(a) oblique field STL

(b) diffuse field STL

Figure 1 STL of PEM plates and short-circuit PEM plate

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