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An analytical study of the vibroacoustic response of a ribbed plate

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Abstract: An analytical model is developed to investigate the sound transmission loss from orthogonally rib-stiffened plates structure under diffuse acoustic field excitation. The validity and feasibility of the model are verified by comparing the present theoretical predictions with numerical and experimental results published previously. The influences of modal coupling terms, boundary condition and stiffener spacing on sound power and sound transmission loss are subsequently presented. Numerical discussion of the model demonstrates the significant influence of both boundary conditions and stiffener spacing upon the mode shape, sound power and sound transmission loss for stiffened plate, wherein sound power decreases and sound transmission loss increases as the amount of constraint increases.

Keywords: Vibration; Sound transmission loss; Sound radiation; Periodic structures;

1.Introduction

The periodic stiffened structures are extensively used in many engineering applications such as ship hulls, high-speed rail and vehicles due to the lightweight and high stiffness structural properties. It is very important to estimate the noise radiated during its design stage. For example, stiffened plate is most generally used in aerospace, which can be considered as the simplified model of cabin skin of aircraft to evaluate the structure borne noise. Typically, these periodic structures are usually subjected to sound excitation or dynamic impact. Further, the stiffeners play an important role in the vibration and acoustic characteristics of the whole structure, particularly when the bending wave length is comparable with the periodical spacing of the stiffeners [1-2]. Therefore, it is necessary to study their vibro-acoustic response and sound transmission loss characteristics.

There exist numerous approximate theoretical methods for the periodic structures. For examples, Mead and Pujara [3] applied space harmonic expansion to investigate a variety of periodically stiffened structures. It was demonstrated that only as few as three terms of space harmonics were required to obtain a solution of acceptable accuracy in comparison with the exact solution. Mejdi and Atalla [4] used the modal expansion method to explore the vibro-acoustic

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