Sound Transmission Loss Behavior of Meta-Acoustic Barriers with Anomalous Effective-Mass

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Abstract

Meta-acoustic barriers that are inspired by acoustic metamaterials offer opportunities to defy mass law-driven sound transmission loss (STL) performance that is a characteristic of conventional acoustic barriers. In this numerical parametric study, the STL behavior of meta-acoustic barriers that incorporate various local oscillator configurations are analyzed using their effective-mass models. Resonant, damped, inertant oscillator configurations that result in negative and complex effective mass for the meta-acoustic barrier are considered. The influence of the local configuration's orientation, oblique incidence and the presence of multiple oscillator types are examined using non-dimensionalized metrics. It is shown that due to their anomalous effective-mass, such barriers display tunable STL bandwidths exceeding that of the mass-equivalent monolithic barrier. These bandwidths can be tuned to match low frequencies (< _˜1000 Hz) which otherwise usually require more massive barriers. Using broadband bulk absorbers in conjunction with meta-acoustic barriers could offset the reduction in their higher frequency STL. Inasmuch as these meta-acoustic barrier structures can be realized using recent advances in additive and hybrid manufacturing techniques, opportunities exist to improve light-weight barriers for tonal and broadband acoustic applications.
Keywords: Meta-acoustic barriers, Sound transmission loss, metamaterials, and effective mass

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