Improved computational efficiency of vibration-based sound power measurements through employing multi-layered radiation resistance matrix symmetries

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Vibration-based sound power (VBSP) measurements are becoming an established practice in structural acoustics. This practice involves a geometry-dependent radiation resistance matrix being multiplied on the left- and right-hand side by a measured velocity vector to compute the frequency-dependent sound power. Limitations in application may arise from the substantial computational costs when constructing the resistance matrix, even for simple geometries. Upon computation of the resistance matrix for flat, rectangular geometries, multi-layered Toeplitz and centrosymmetric symmetries were discovered within the radiation resistance matrix for baffled and unbaffled conditions, respectively. The Toeplitz symmetries reduce the number of computations required to populate the full radiation resistance matrix to only a single row of said matrix. The centrosymmetric symmetries only require about 25% of the matrix computations. In addition to a reduction in computation time, these symmetries also allow the resistance matrix to be efficiently compressed and re-built as needed using their patterns. The reduction in computation time will be demonstrated using simple case studies.

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