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Sound Radiation Modes of a Tire on a Reflecting Surface

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Wave number decomposition of a tire's radial vibration can be used to reveal the wave propagation characteristics of tires. In this paper, the relationship between the structural wave propagation characteristics of a tire excited at one point and its sound radiation is considered. The sound radiation resulting from structural vibration of a tire in contact with the ground was investigated by using boundary element analysis. In particular, the orthogonal radiation modes of a tire in the presence of a reflecting surface, along with their radiation efficiency characteristics, were calculated by applying an eigenvector analysis to the tire's radiation resistance matrix. The latter analysis made use of acoustic transfer vectors and a recovery surface appropriate for a pass-by noise test. The radiation mode results reveal that it is the vibration in the region close to the contact patch that primarily controls sound radiation. In particular, to reduce pass-by noise levels, it is necessary to mismatch the tire's structural ring mode and the radiation modes with high radiation efficiencies. It has also been found that the radiation from a tire is controlled by a relatively small number of radiation modes (although the number of contributing modes increases with frequency).