Structural-Acoustic Coupling Study Of Tyre-Cavity Resonance

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ABSTRACT
The tyre cavity resonance induced cabin noise has been a major unsolved customer complaint issue for a long time. A study of coupled tyre-cavity structural-acoustic system using impedance compact mobility matrix is presented in this paper. This method offers a better physical interpretation and numerical prediction about a coupled tyre-cavity system than previous models. It can calculate the sound pressure inside the tyre cavity as well as the tread wall vibration velocity at the same time. The analytical results have been verified by the results of the VAOne vibro-acoustic model. The VAOne software was also validated by the results from a case study of a rectangular box-cavity system in previous literature. From the analytical calculation, the tyre cavity coupling modal frequency is found to be split into two close resonance frequencies if the tyre structural natural frequency is close to the fluid cavity resonance frequency. The geometric coupling coefficient has been calculated using Matlab code. This study provides a better insight into the resonance coupling phenomenon of the tyre cavity to the tyre structure and its root causes. It demonstrates more clear physical meaning of the tyre cavity coupling model and its inherent characteristics than that from 'black box' finite element software. This develops a better understanding of the problem and its root causes facilitates effective solutions for the problem. Even though the study was conducted in a tyre-cavity system, the solution and methodology are applicable to other toroidal shape structural-acoustic systems.

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