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Topology Optimization of Rubber Bushing with Viscoelastic Material

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Abstract

The rubber bushings are widely used as vibration isolators in vehicle to prevent the vibration of an engine and noise from tire. The requirements of rubber bushing are vibration and noise isolation from passenger and offer static stiffness for manoeuvring and shock excitation caused by acceleration and braking etc. Therefore both the static and dynamic behaviours of rubber bushing should be considered simultaneously. The mathematical model of the rubber bushing is modelled to viscoelastic material to represent the viscous damping for small oscillation in high-frequency range. Furthermore, static or low-frequency vibration induced by the road or driving manoeuvring are described by hyper-elastic model with large deformation.

In order to determine the optimum topology of the rubber bushing, based upon the idea of the SIMP method, topology optimization is used to find optimum layout of rubber bushing. The requirements of bushing are trade-off between the stable static deflection and vibration isolation. So, to satisfy the requirements of the rubber bushing, the objective function is minimize transmissibility for vibration isolation to a certain direction and low-frequency vibrations are considered simultaneously as static stiffness constraints to secure the structural stability from inertia forces and the unexpected vibration such as shock vibration. Some numerical examples are presented to show the application and demonstrate the optimization results.