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Numerical Simulation of the Stress-Strain State of Thin-Layer Rubber-Metal Vibration Absorber Elements Under Nonlinear Deformation

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Stress-strain state components of thin-layer rubber-metal elements are investigated. The compression level of a thin rubber layer under the action of vertically applied stress is calculated. For simplified hypotheses the relationship between the rubber layer thickness reduction and its radius-thickness ratio was analytically derived. The problem was solved under linear-elastic deformation of a rubber layer vulcanized onto the metal plates. For numerical calculations, weak rubber compressibility was simulated with the moment finite element scheme for weakly compressible materials, involving the triple approximation of displacement fields, strain components, and a volume variation function. The numerical solution was obtained by the finite element method for different layer radii and thicknesses under geometrically nonlinear elastic and viscoelastic deformation of the rubber material. The geometrical nonlinearity is described by the nonlinear strain tensor. Viscoelastic rubber properties are simulated by the hereditary Boltzmann– Volterra theory with the Rabotnov relaxation kernel. Nonlinear boundary problems are solved by the modified Newton–Kantorovich method. The calculation is effected for the two cases of curing the rubber layer onto the metal elements of the structure. The first case assumes that the rubber layer is vulcanized onto the metal plates, in the second one, it can freely slide over their surface. For the first case, numerical results are compared with the analytical solution. The effect of geometrical nonlinearity and viscoelastic rubber properties on the rubber layer thickness reduction was examined.

Keywords

thin-layer rubber-metal elements thickness reduction viscoelasticity nonlinearity moment finite element scheme weakly compressible material

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