The elastic slit membrane: the concept and the target transient modes

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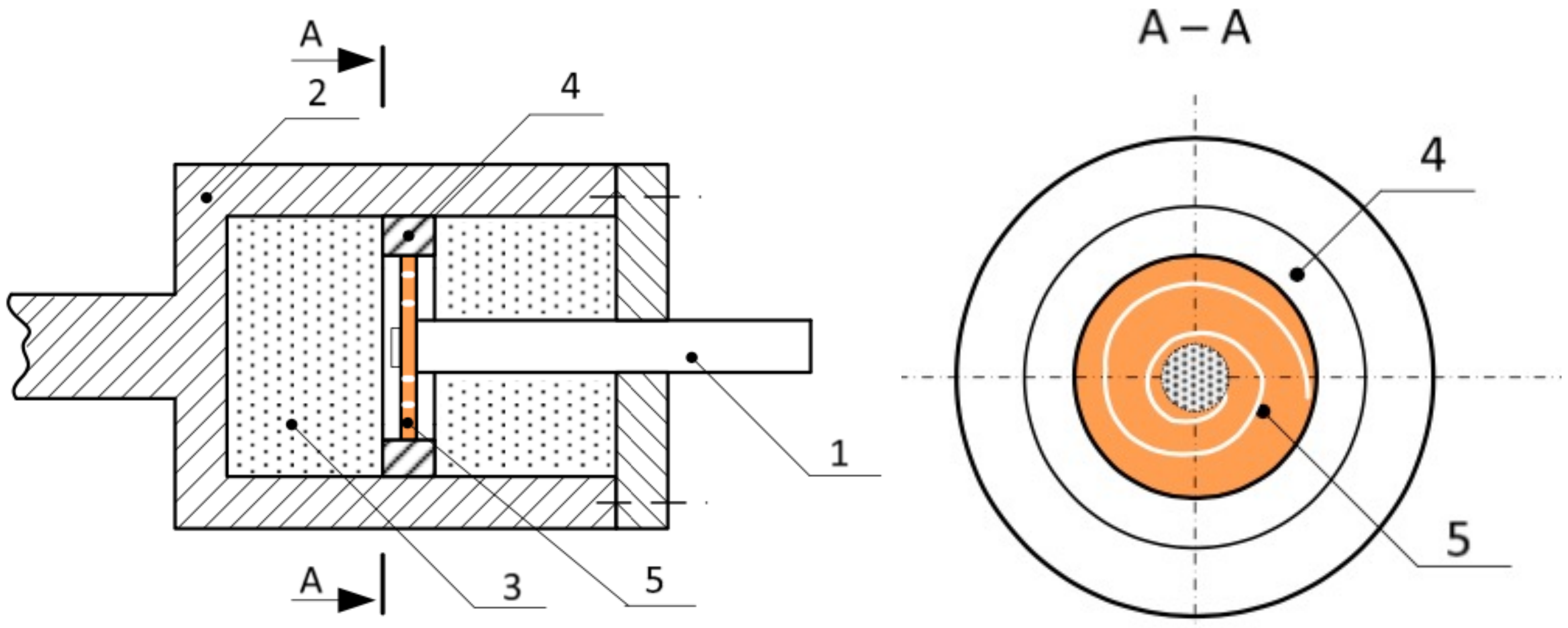


The conceptual structure of slit membrane damper:
1—rod, 2—cylinder, 3—viscous fluid, piston's ring,
5—slit membrane, 4—piston's ring, 5—slit membrane.

$$S(C,a) = 2\pi \int_0^a z \sqrt{1 + \left(C \frac{dJ_0\left(\frac{\alpha_{01}}{a} z\right)}{dz} \right)^2} dz$$

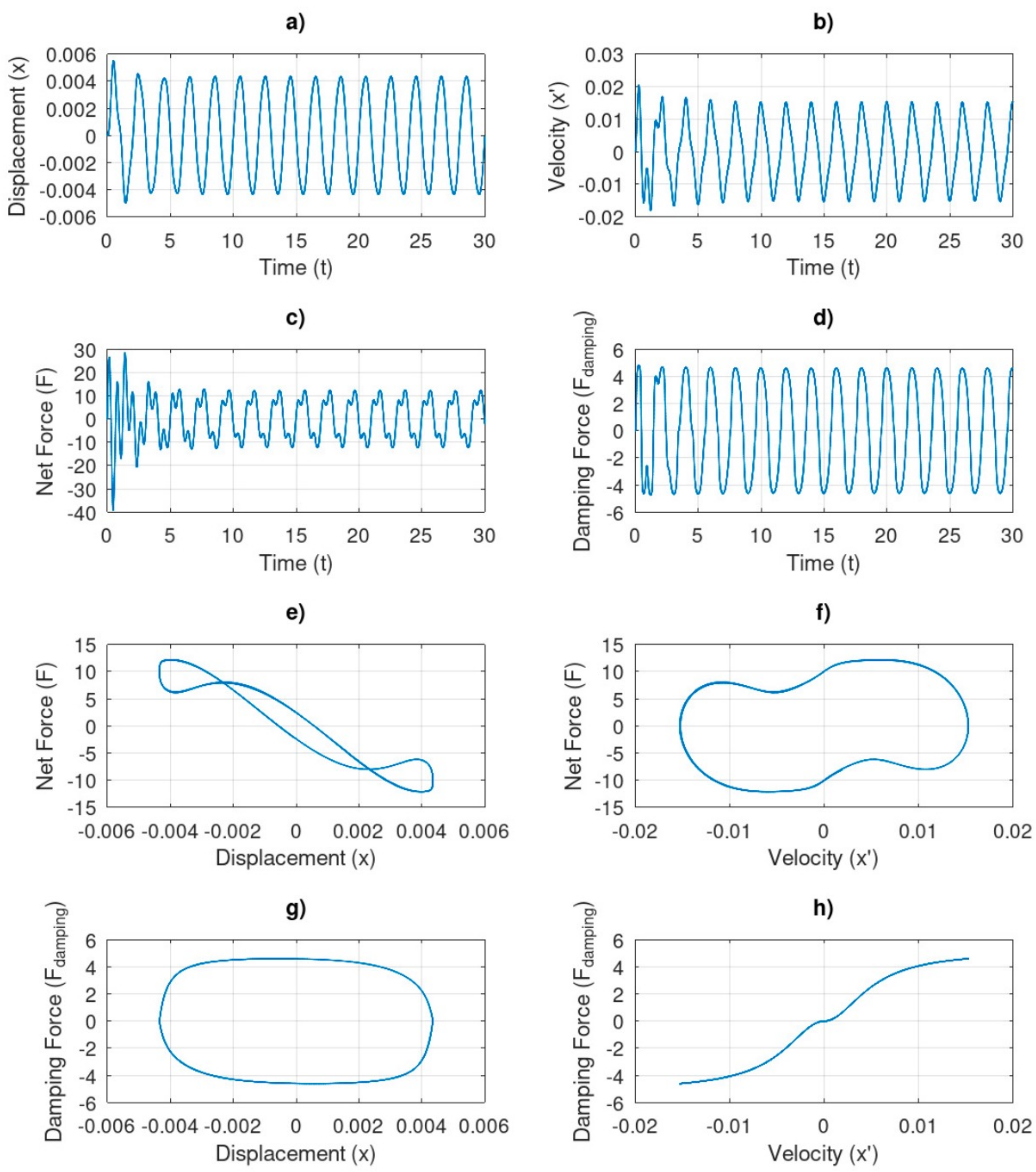
Abstract: This article presents the concept and the mathematical model of the elastic slit membrane. The complex structure of the membrane requires a non-standard approach for building the mathematical model and the numerical simulation scheme for the representation of the transient dynamics of the membrane. It is assumed that slits move in accordance with the fundamental axisymmetric mode of the circular-shaped membrane. The mathematical model incorporates the separable variables in time and the solution of a special case of Bessel's differential equation in space. A large-scale optimization strategy is used to generate the target transient modes of the membrane.

Geometric Constraints

- The flexible membrane of the damper is flat and circular in the state of equilibrium.
- The flat circular membrane with slits moves in accordance with the fundamental axisymmetric vibration mode.
- When the flat circular membrane is deflected, the slits open. The area of the open slits is equal to the difference between the area of the deformed membrane and the area of the circular-shaped non-deformed membrane.
- The flat circular membrane with slits blocks the whole cylinder in the state of equilibrium (all slits are closed).

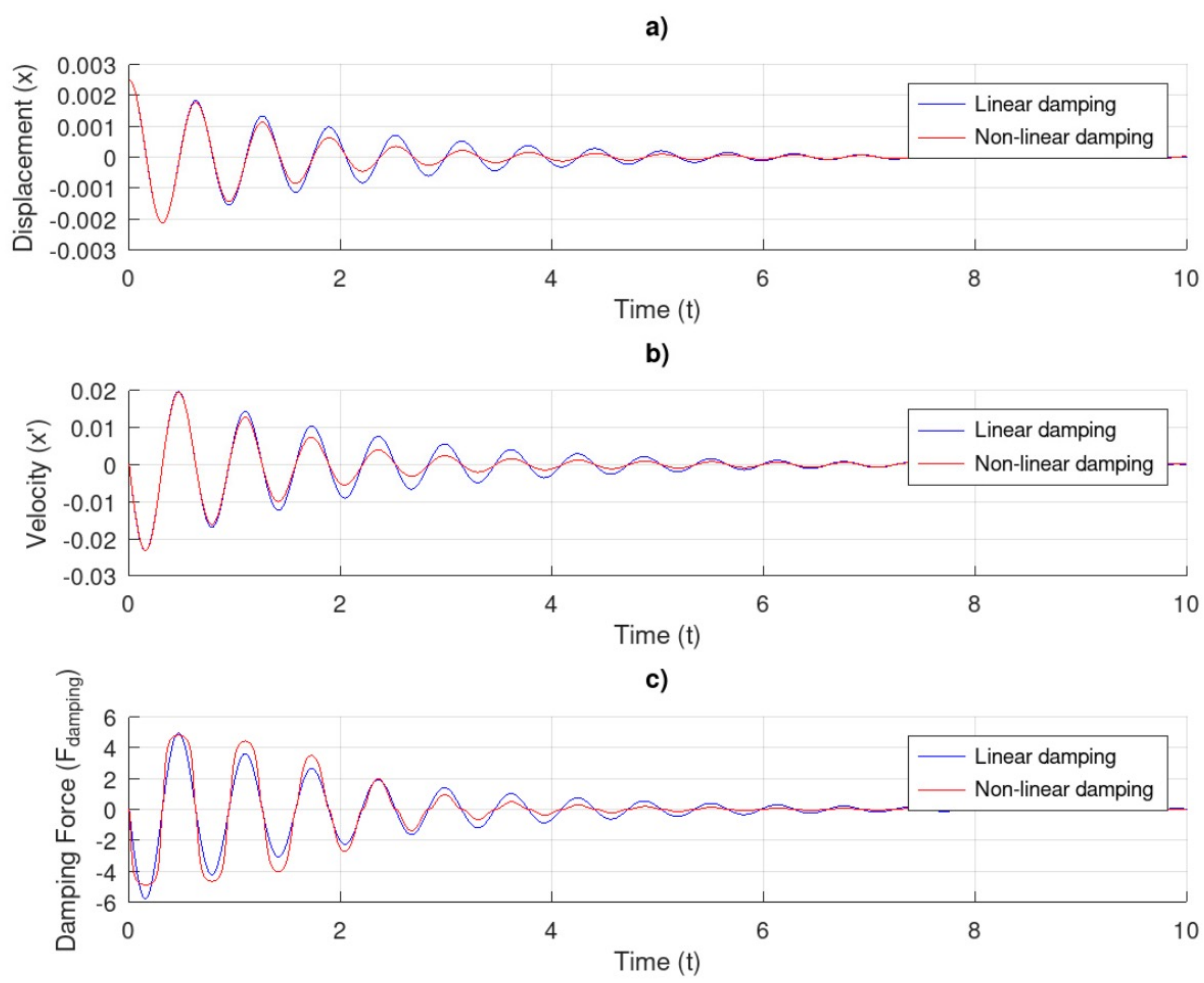
Physical Constraints

- The drag force is assumed to be proportional to the square of the velocity (due to the high viscosity of the fluid
- The higher the velocity, the larger the area of open slits
- The higher the area of open slits, the smaller the drag force
- The drag force is not infinite when all the slits are closed



$$D(\dot{x}) = h \cdot sign(\dot{x}) \cdot (\dot{x})^2 \cdot \frac{1}{\delta(\theta \dot{x}, a) + \varepsilon}$$

Stochastic Optimization of Target Transient Modes



A Nonlinear Damper with Dynamic Load and an Elastic Slit Membrane: Modelling and Interaction Analysis. **Appl. Sci.** 2024, 14, 7663.