# PRACTICAL MODELING OF VIBRATION ISOLATION ON WEAK AND FINITE SUPPORTS

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## 1. INTRODUCTION

An approach to estimating the vibration isolation machines on weak and finite supports is discussed in principle. The model should hold inversely and be able to predict the forces acting on the foundation from the measured motion; data often requested by constructors. The novelty lies not in the utilized theory but rather in the endeavor of creating a base model that can be improved along the way and adapted to various situations, thus providing tenable solutions without resorting to constructions with unnecessarily high safety factors.

## 2. THE MODEL AND ITS PARAMETERS

The model relies on the different impedances inherent to the system, primarily the point impedances. In its simplest form this involves the impedance of the source (the mass), the isolator (the stiffness) and the support. For an existing support, finding the impedance is readily done through an impact excitation. Adopting the resulting data in the model, the resonant characteristics of the support are captured.

For nonexistent structures the impedance needs to be calculated beforehand. Specifying the boundary conditions and characteristics of the structure and assuming mode shapes, the modal mass and eigenfrequency can be calculated-it turns out that in practice it is often the lowest mode that is of interest since the dispersive characteristics of bending waves bring the higher eigenfrequencies well above the excitation frequency. The eigenfrequencies are obtainable through regular formulas for simple structures that often work well as approximations. Once the eigenfrequency and modal mass are established, the support can be modelled as a simple mass spring system whose impedance shows a resonance dip. Next, setting up the equations for the vibration isolation is straightforward.

## 3. EXTENDING THE MODEL

There are various aspects related to the impedances in this model that can be developed further:

Rubber is an often used material for vibration damping. Due to its complex characteristics standard formulas relying on static stiffness is likely to produce large errors. The more so the higher the frequency since viscoelasticity is proportional to the strain rate. A suitable way to model viscoelasticity is through fractional derivatives that in the frequency domain becomes a handy method.

A second rubber feature to be incorporated is the amplitude dependent non-linearity referred to as the Fletcher-Gent effect. This phenomenon proves to be especially important for low frequencies where displacement amplitudes are normally high.

In a foreseeable future smart materials should be on the market even for rather simple applications; extending the model to cover such isolators is a natural step as the demand for such solutions will increase.

When structures are complicated the modal mass and stiffness should be evaluated through FEM calculations.