# Passive Vibration Isolation by Compliant Mechanism Using Topology Optimization

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Compliant mechanisms have been designed for various types of applications to transmit desired forces and motions. In this paper, we explore an application of compliant mechanisms for passive vibration isolation systems. For this, a compliant isolator is used to cancel undesired disturbances, resulting in attenuated output amplitude. A compliant mechanism is equipped with an isolator, while a compliant mechanism also functions as a transmission of force and controls the amount of displacement that is transmitted from it. It can be used as passive vibration isolation. Here, by introducing compliance into the connection, the transmission of applied forces is reduced at some frequencies at the expense of increasing transmission at other frequencies. While transmitted force is the key parameter from the receiver's perspective, motion at the isolated machine is uninteresting. The force transmissibility is numerically identical to the motion transmissibility. The structural optimization approach is focused on the determination of the topology, shape, and size of the mechanism. The building blocks are used to optimize a structure for force transmission. The flexible building blocks method is used for the optimal design of compliant mechanisms. This approach is used to establish the actuator model of the block and its validation by commercial finite element software. A library of compliant elements is proposed in FlexIn. These blocks are limited in number, and the basis is composed of 36 elements. The force transmitted to the rigid foundation through the isolator is reduced in order to avoid the transmission of vibration to other machines. The preliminary results of FEA from ANSYS demonstrate that compliant mechanism can be effectively used to reduce the amount of force transmitted to the surface.

## NOMENCLATURE

| | |
|---|---|
| $\delta_{st}$ | Static deflection, mm |
| $k$ | Stiffness, N/m2 |
| $m$ | Applied mass, kg |
| $X$ | Displacement amplitude, mm |
| $c$ | Damping coefficient |
| $\omega$ | Forcing frequency, rad/sec |
| $\omega_n$ | Natural frequency, rad/sec |
| $I$ | area moment of inertia, mm$^4$ |
| $L$ | Length of strip, mm |
| $R$ | Frequency ratio |
| $\eta$ | Isolation efficiency |
| $Tr$ | Transmissibility ratio |
| $F_T$ | Force transmitted, kN |
| $E$ | Young's modulus, N/m$^2$ |

## 1. INTRODUCTION

### 1.1. Compliant Mechanism

Compliant mechanism is the mechanism that relies on its own elastic deformation to transfer or transform motion or force.[1] Common compliant mechanisms function under the application of force at certain location (input) and generate a desired force or deflection at another location (output). Compliant mechanism is designed for passive vibration isolation system (PVIS). In this system, the existing element (i.e., the coil spring isolator) is replaced with the new designed element in order to reduce the amount of force transmitted to the ground or to the foundation of the machine, which tends continuously to damage the base over a longer period of time. This happens because the initial starting machine gives rise to huge amplitude up to the frequency ratio one. This region is identified as the amplification region, and during this, a large amount of vibration force is transmitted. By reducing the force transmit-