

# Nonlinear Vibration Control

By  
Diala Uchenna

# INTRODUCTION/ BACKGROUND

- The aim of vibration isolation is to curb undesirable vibration to keep its harmful effects maintained within tolerable levels.
- Transmissibility is a concept broadly used as a performance measure for vibration isolation systems.

# AIMS AND OBJECTIVES

- To develop a model of the vibration isolation system (test rig) present in the Active Noise and Vibration laboratory of the University of Sheffield.
- To compare the performances of the vibration isolation system using linear and nonlinear viscous damping characteristics by analyzing the force transmissibility curve of all cases.

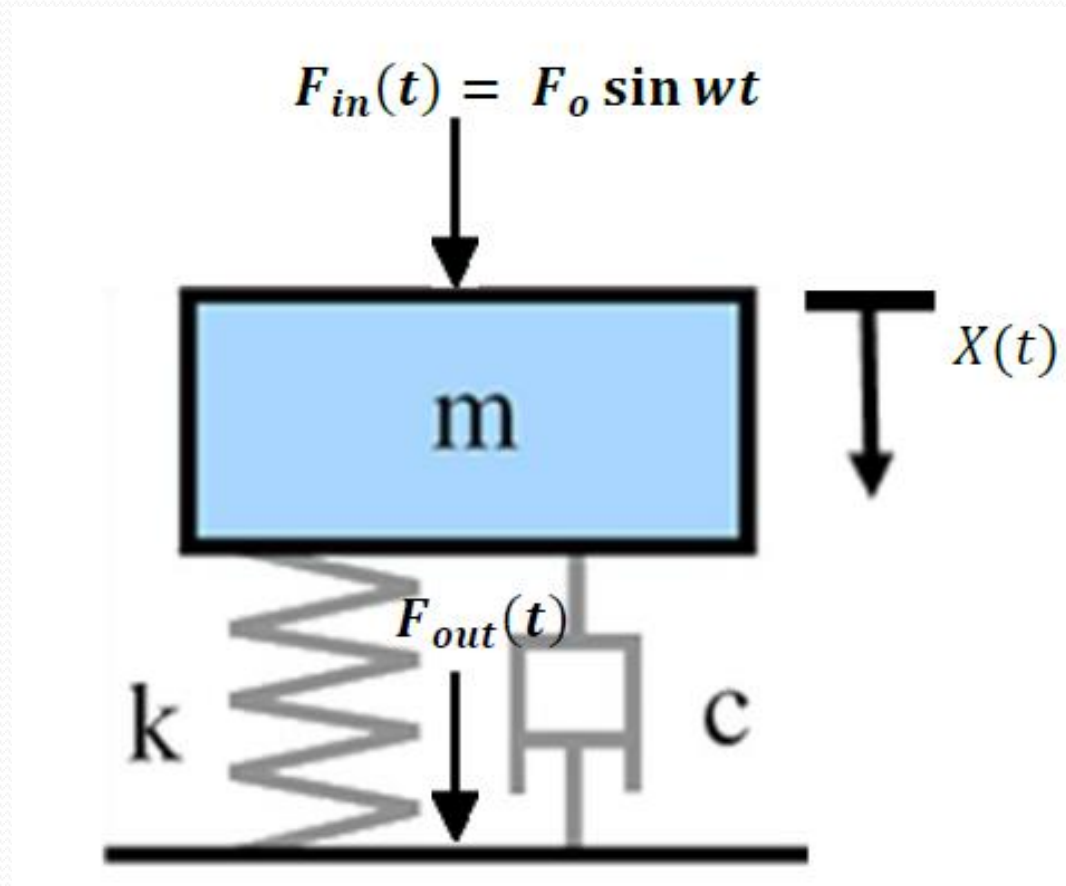
# AIMS AND OBJECTIVES...contd

- To implement the nonlinear viscous damping characteristic using a simulated model of an MR damper.
- To design a controller to track the desired nonlinear viscous damping force.
- Finally, to analyze and compare the force transmissibility of the vibration isolation system with the MR damper to that achieved using the desired viscous damping force.

# Methodology

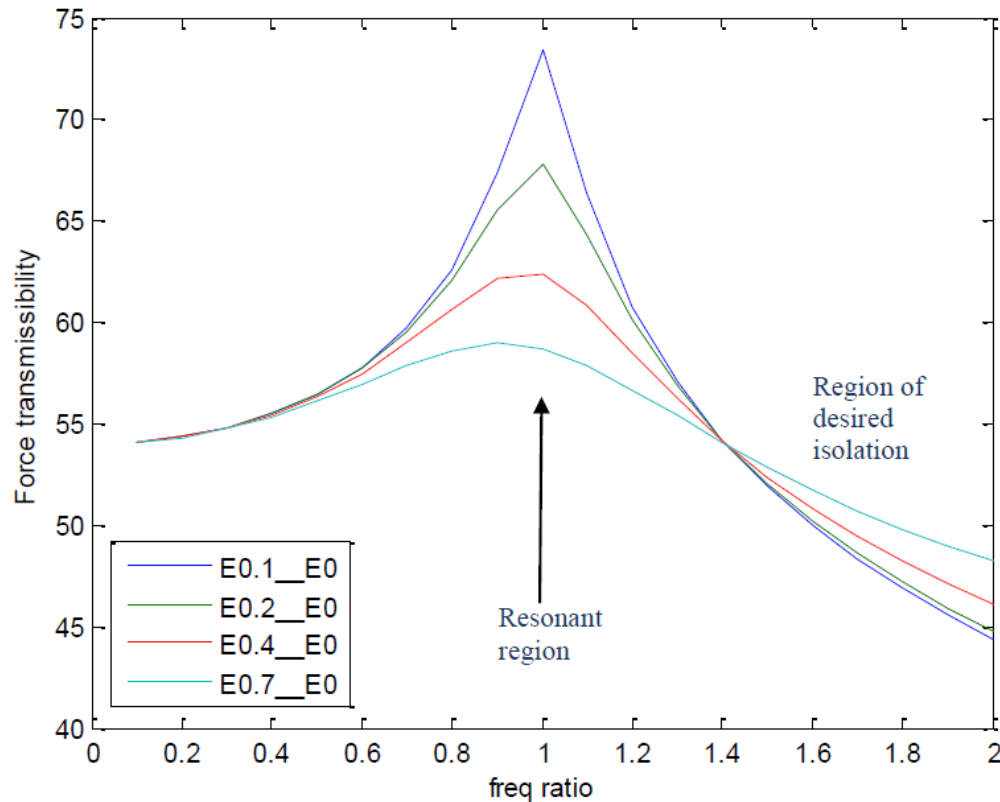
- This study focuses on the effects of nonlinear viscous damping on vibration isolation of single and two degree-of-freedom (sdof and 2dof) systems and its implementation using semi-active techniques.
- A Magnetorheological damper (MR damper) model was used in deploying the semi-active method.
- Simulation studies were carried out to analyse the effect of the cubic viscous damping characteristic parameter (implemented using an MR damper) on the transmissibility of sdof and 2dof vibration isolators.

# Linear Vibration Control



**Figure 1: SDOF vibration isolator system with linear viscous damping characteristic**

# Effect of linear Vibration Control



**Figure 2: Transmissibility curve for vibration isolator system with linear viscous damping characteristics**

# Nonlinear Vibration Control

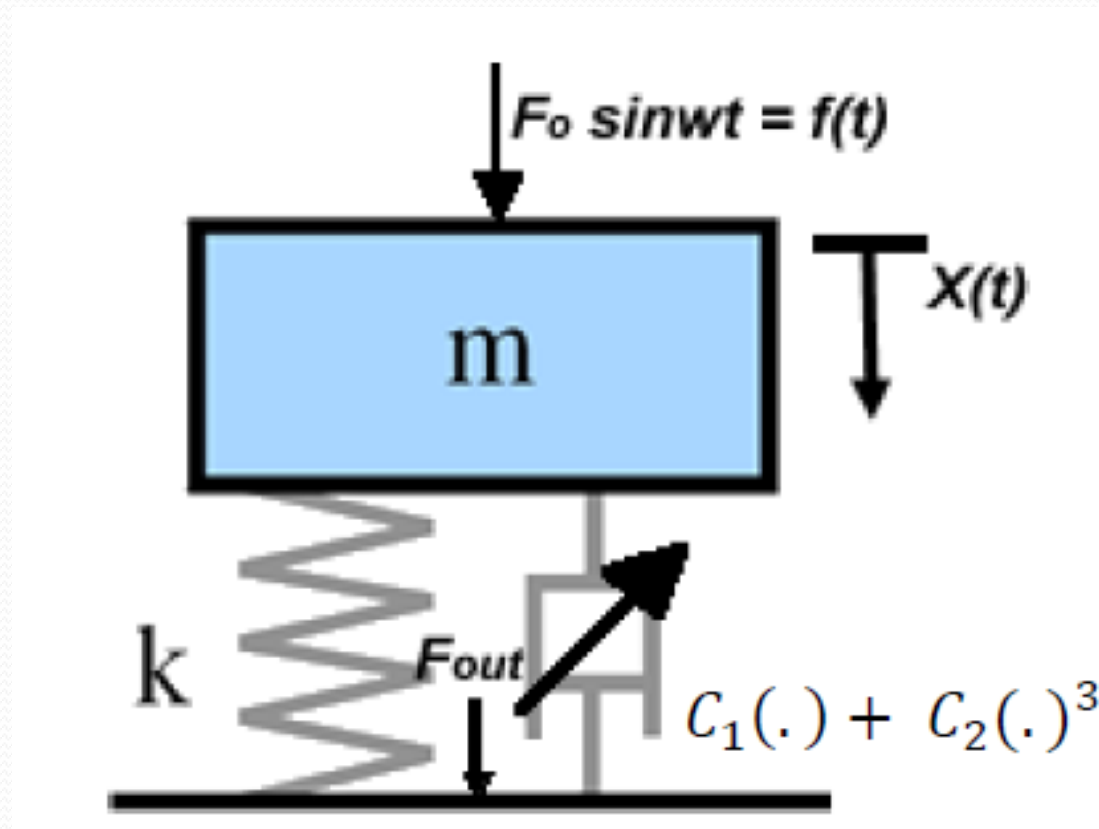


Figure 3: SDOF vibration isolator system with cubic nonlinear viscous damping characteristics.



# Nonlinear Vibration Control

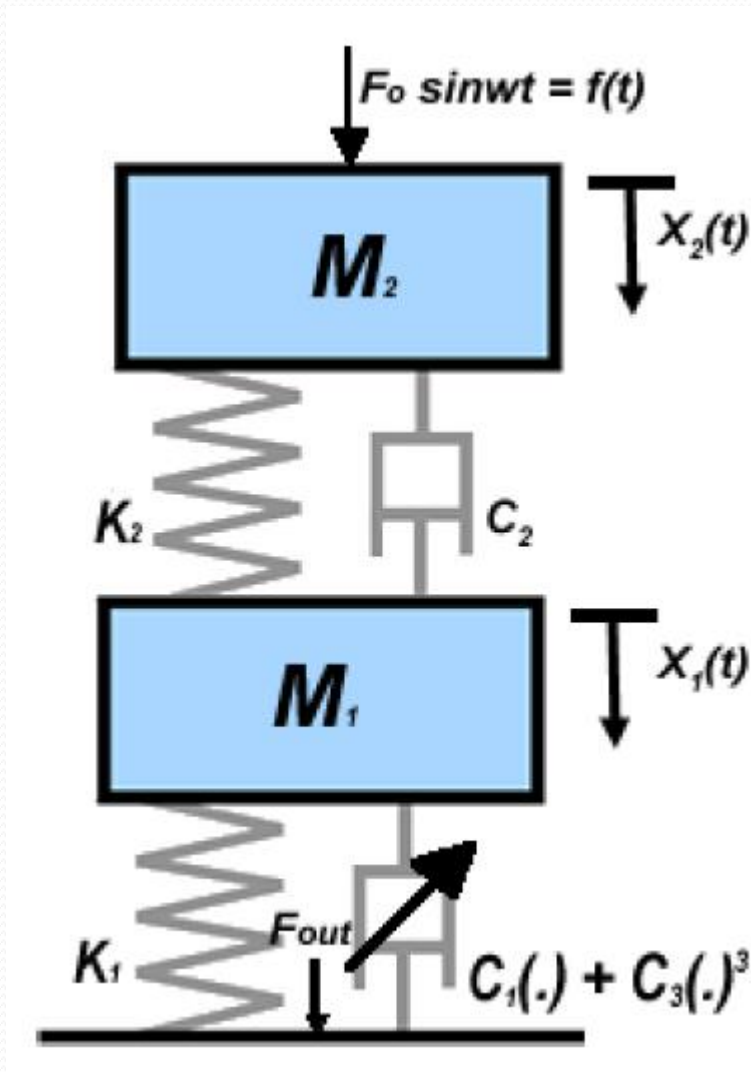
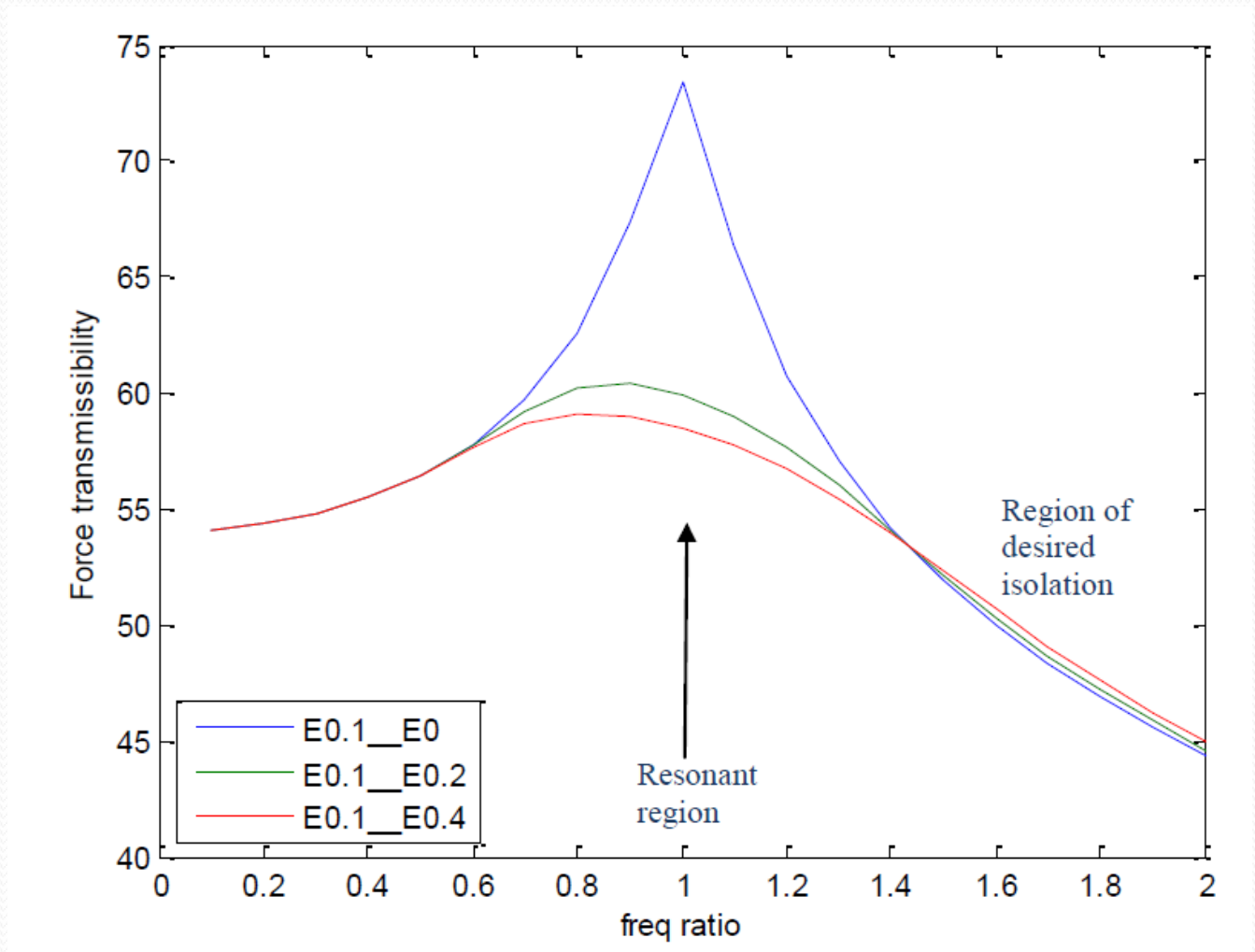


Figure 4: 2DOF vibration isolator system with a cubic nonlinear viscous damping characteristic

# Effect of Nonlinear Vibration Control



**Figure 4: Transmissibility curve for vibration isolation system with nonlinear viscous damping characteristics**

# Implementation

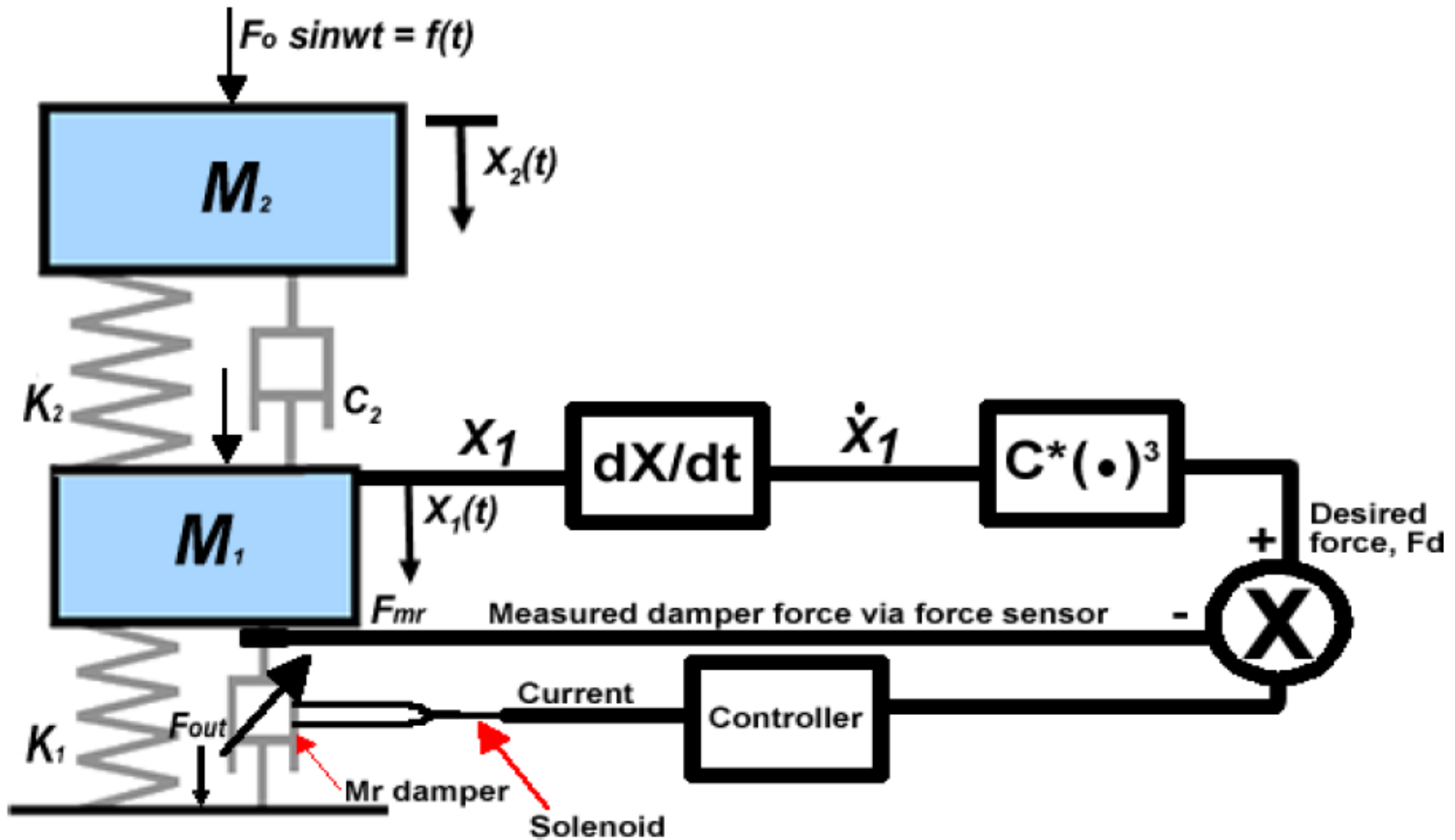


Figure 5: Schematic of a nonlinear damping characteristic implemented using an MR damper

# MR Damper

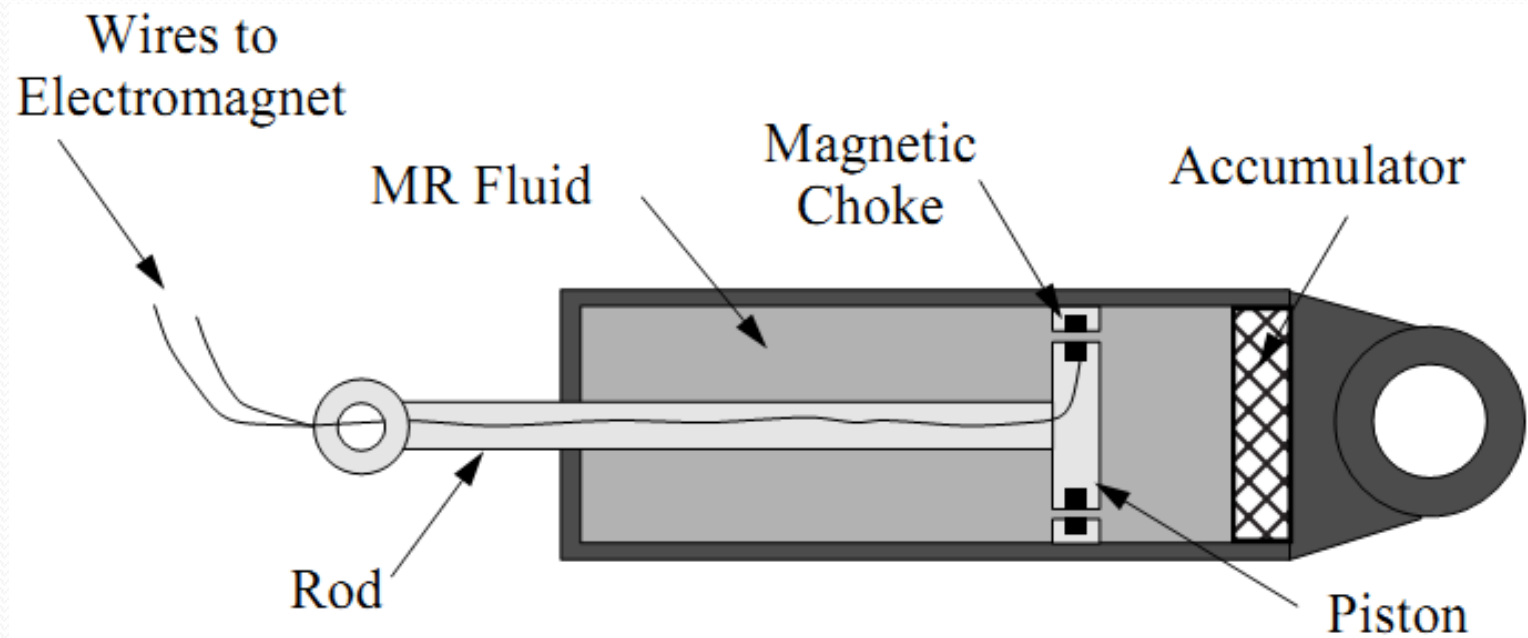
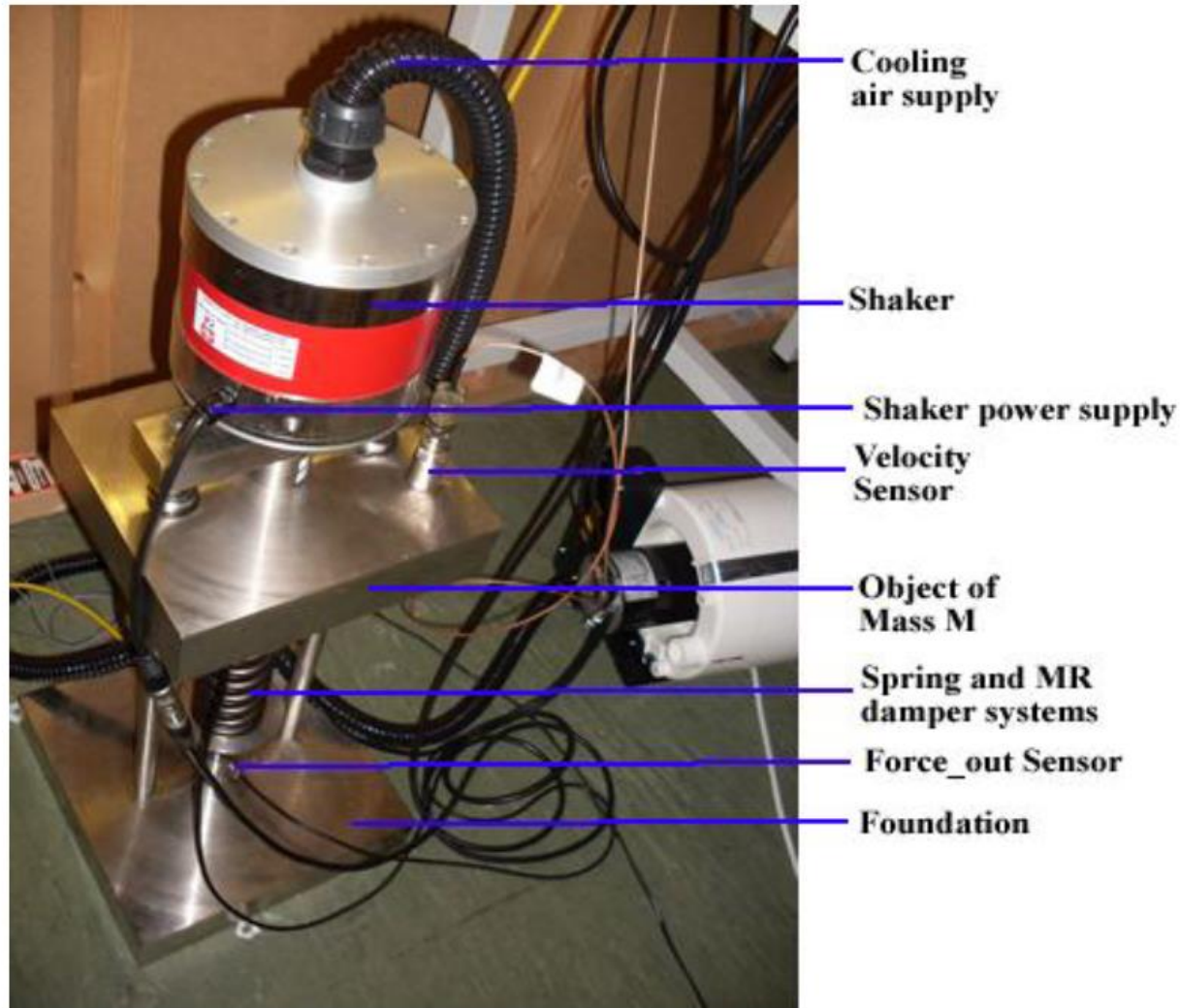


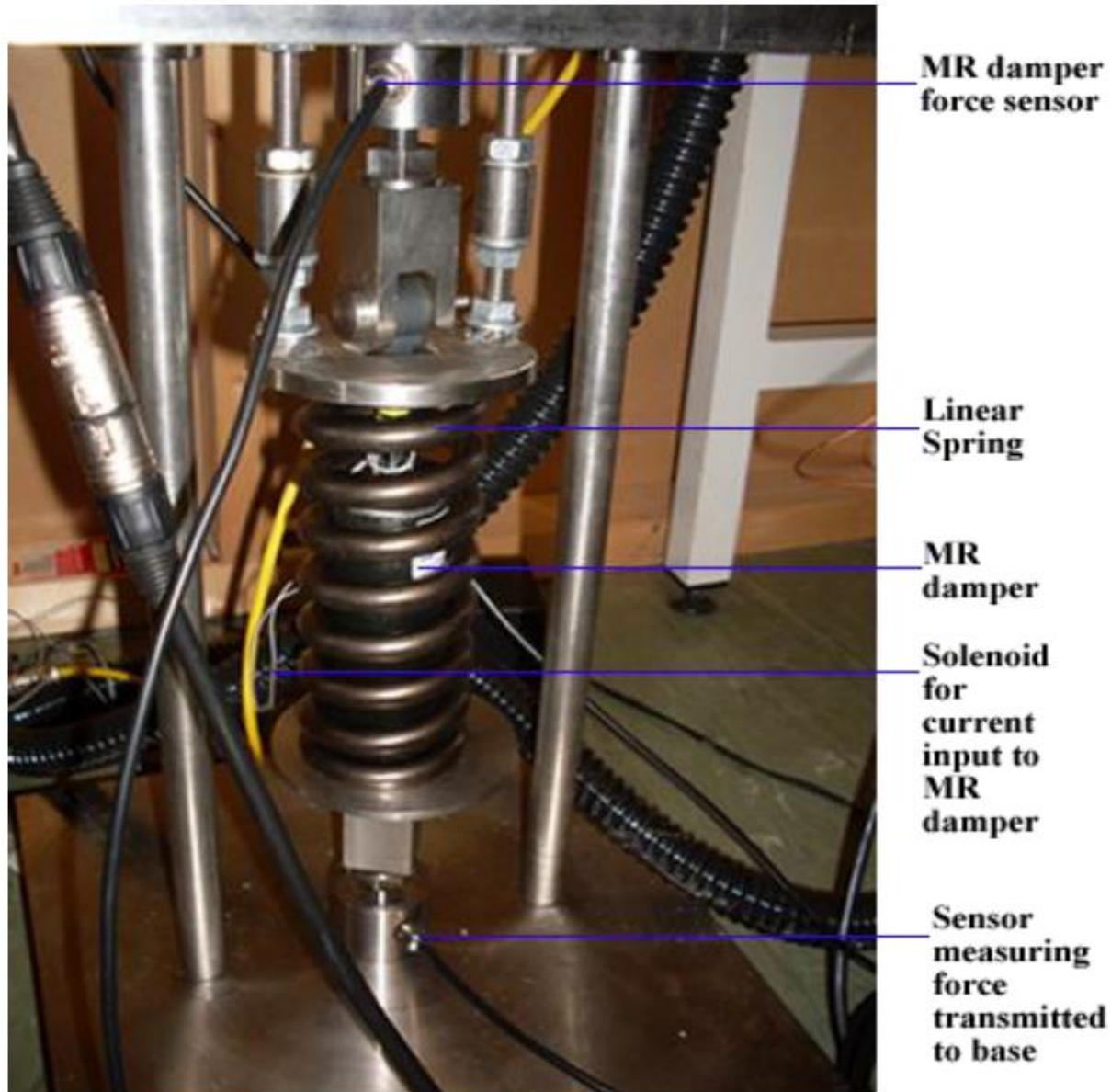
Figure 6: MR damper

# Test Rig



**Figure 7: Laboratory test rig for vibration control research**

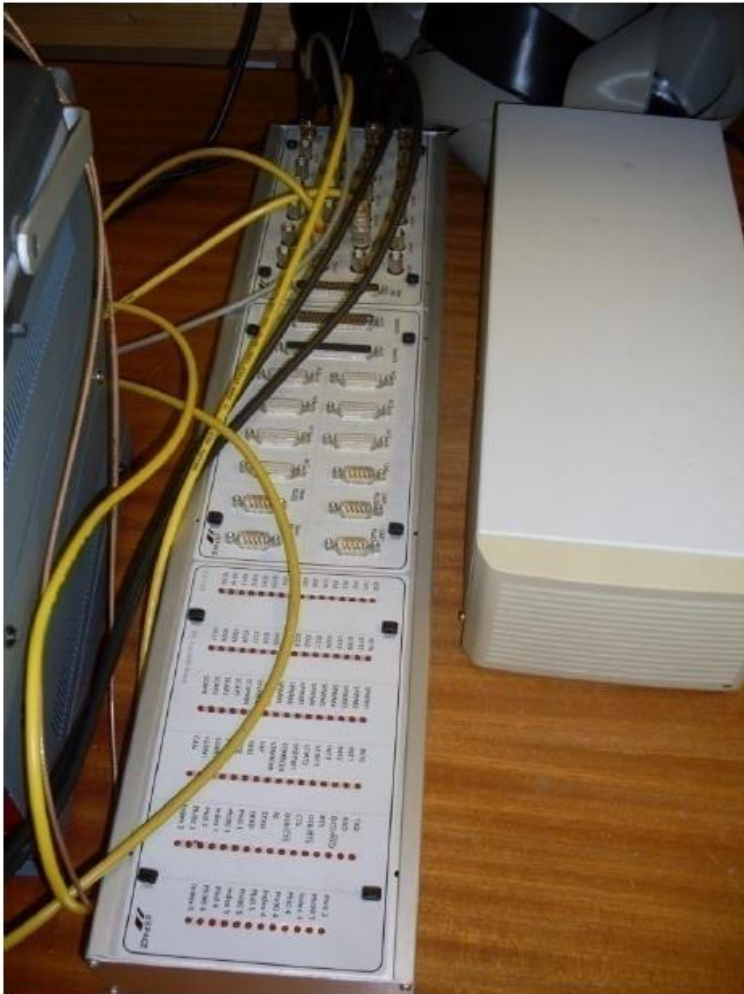
# Test Rig contd...



**Figure 8: Laboratory test rig showing the isolation subsystem**



# ADC/DAC Device



**Figure 9: dSPACE ADC/ DAC Laboratory equipment for the test rig signal conversion**

# Results

- The simulation studies showed that the cubic nonlinear viscous damping is capable of achieving vibration isolation of great performance.
- The resonant region alone is suppressed by the damping.
- The non-resonant regions are not affected in any way irrespective of the amount of damping applied to the system.
- This research has substantial deductions for the analysis and design of viscously damped vibration isolators for a broad scope of engineering applications.



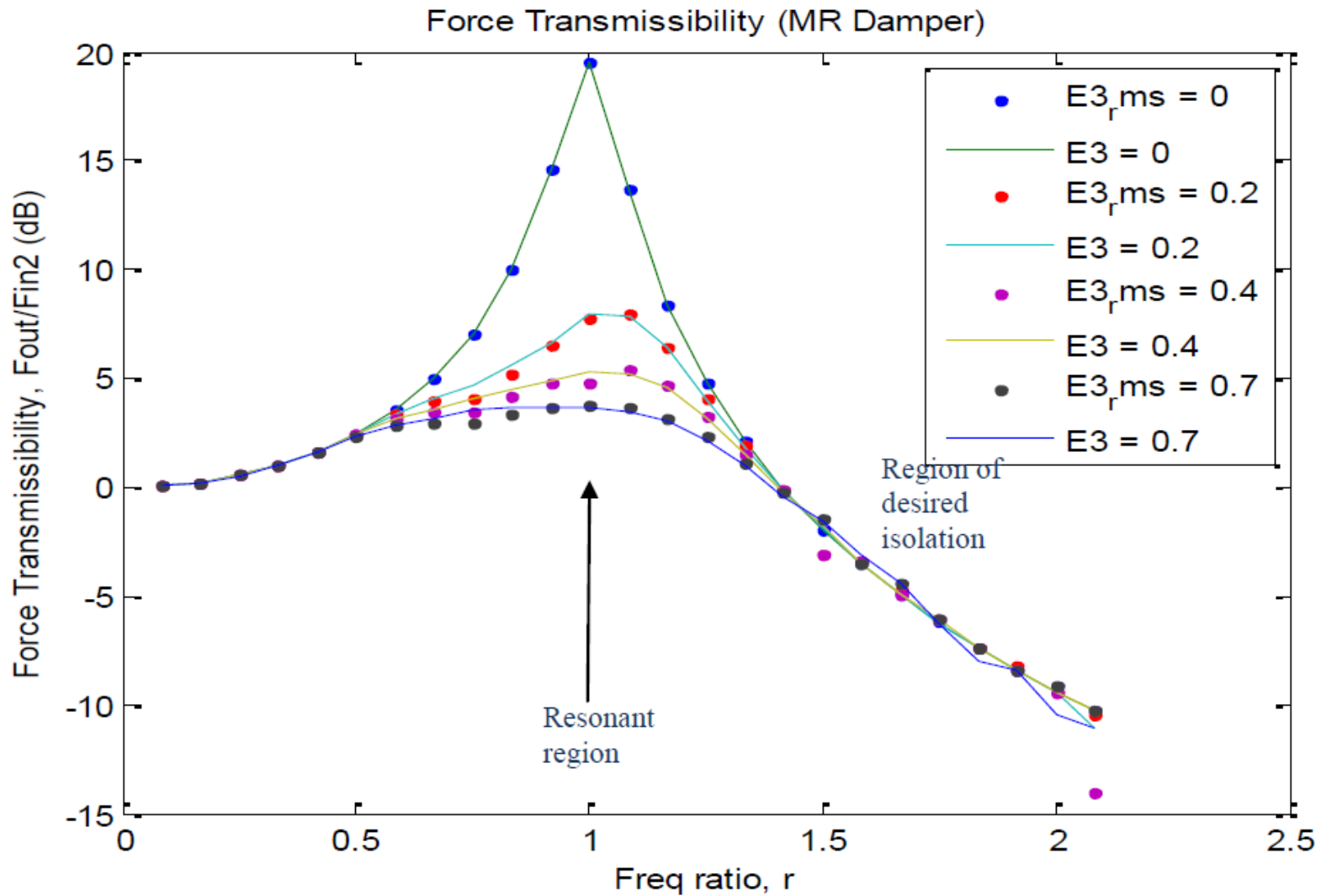
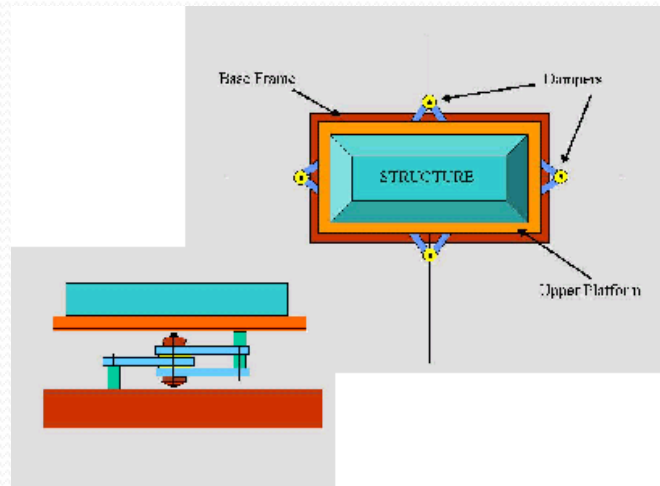
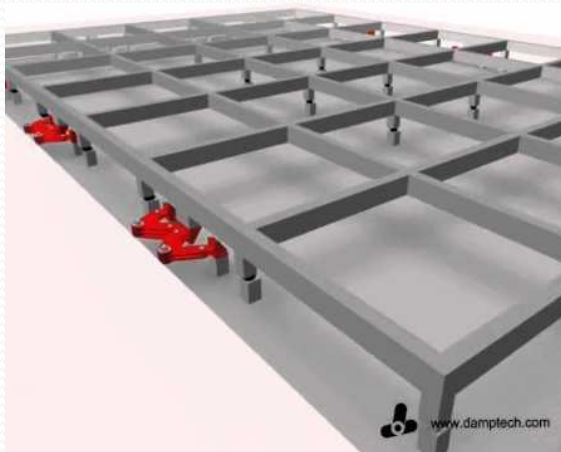
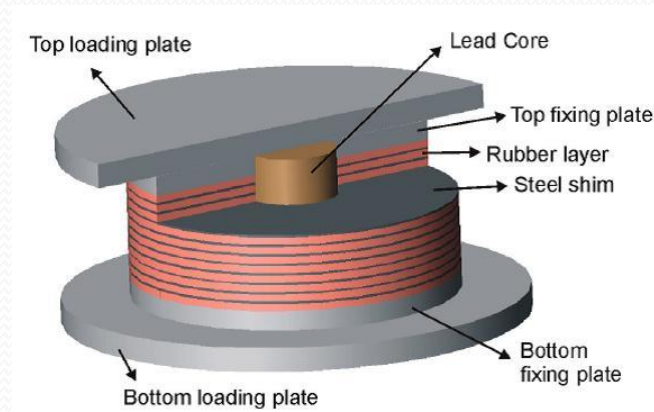
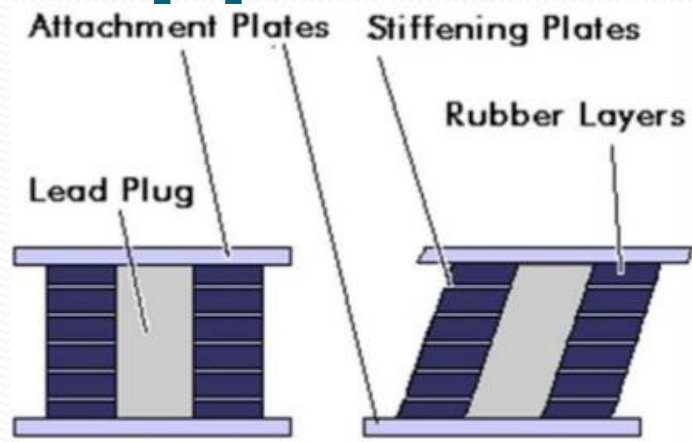


Figure 10: Force transmissibility plot using an MR damper

# Applications



# Conclusion

- The MR damper implementation is shown to be very efficient.
- The Control strategy tracked the MR damper force almost accurately.
- Further damping designs are being developed and tested.



**Thank you!**