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Experimental Modal Analysis of a Skateboard

# 1 Introduction

Vibration transmitted through the suspension and deck of a skateboard is a common cause of fatigue among high-frequency riders. In practice, this vibration is reduced by low-durometer wheels and bushings within the truck’s axle hangers. Alternatively, placement of the resting foot during acceleration may have a positive impact in mitigated undesired vibration. The purpose of this experiment was to examine the vibratory characteristics of the system by performing experimental modal analysis of the system using two different resting foot positions.

# 1.1 Physical Vibration System

The physical vibration system used in this experiment was an Arbor Skateboards Zeppelin. It is 32 inches (81.28 cm) in length with a maximum width of nine inches (22.86 cm). It is fitted with Gullwing Sidewinder II trucks, which have an axle length of ten inches (25.4 cm).

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| **Figure 1.** Arbor Skateboards Zeppelin (Source: https://images-na.ssl-images-amazon.com/images/I/61PY5srElYL.\_SL1000\_.jpg) |

# 1.2 Experimental Design

Discussion of the choice of response and excitation locations, excitation type, signal processing parameters and boundary conditions. Include drawings with relevant dimensions indicating response and excitation locations, and boundary conditions. Also include clear photographs of the experimental setup.

To test the vibratory characteristics of the system, seven [INSERT ACCELEROMETER MODEL HERE] accelerometers measured the impact from an [INSERT HAMMER MODEL HERE] impact hammer. Figure 2 shows the placement of accelerometers on the board face: the locations were chosen in order to counteract potential node point placement.

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| ../../../Downloads/vibrations_project_photos/accel%20locations%20annotated.png |
| **Figure 2.** Accelerometer placement on skateboard deck. |

[Here is some more discussion about how the experiment was performed.]

# 2 Results and Discussion

# 2.1 Unmodified System

Tabulate natural frequencies and damping ratios from Requirement 3 in a single table. Do not tabulate mode shapes. Instead plot the mode shapes one figure per mode. Note that since mode shapes can be 3-dimensional, mode shapes should reflect the physical system’s appearance. Also, superimpose mode shapes over the system’s static shape.

# 2.2 Modified System

Tabulate the natural frequencies predicted from Requirement 5 and from the modal model experimentally determined from Requirement 6. Include percentage errors in this table. Do not tabulate the mode shapes; instead, follow the aforementioned practice and overlay predicted versus measured mode shapes.

# 3 Conclusions

Draw conclusions about discrepancies in the different methods drawing upon assumptions made, data processing and methodology.

# 4 Appendix A—Measured Frequency Response and Coherence Functions

All measured frequency response and coherence functions. Place magnitude of each frequency response and corresponding coherence function on their own page column-wise.

# 4.1 Appendix A1—Unmodified Physical System

Measured FRF and Coherence Functions from original physical system. *(n x m figures)*

# 4.2 Appendix A2—Modified Physical System

Measured FRF and Coherence Functions from system with added mass. *(n x m figures)*

# 5 Appendix B—Measured and Synthesized Frequency Response Functions

Magnitude and phase of all synthesized frequency response functions superimposed with corresponding measured frequency response functions. Place magnitude of each frequency response & corresponding phase on their own page column-wise.

# 5.1 Appendix B1—Unmodified Physical System

Measured and synthesized FRFs from original physical system. *(n x m figures)*

# 5.2 Appendix B2—Modified Physical System

Measured and synthesized FRFs from the system with added mass. *(n x m figures)*