Acoustic SSH Model Design/Assembly Guide

Snehith John & Arturo Whipple

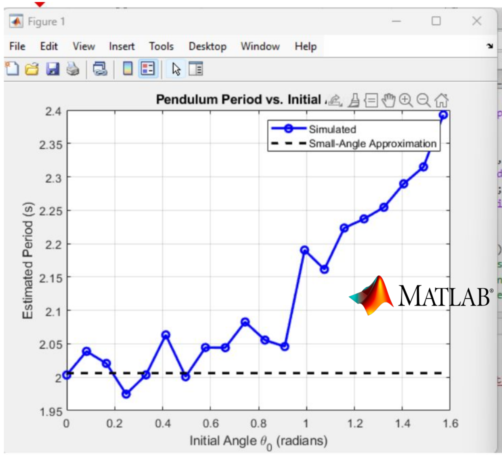
Github Repository: https://github.com/SJJOHN736/SSH-Model

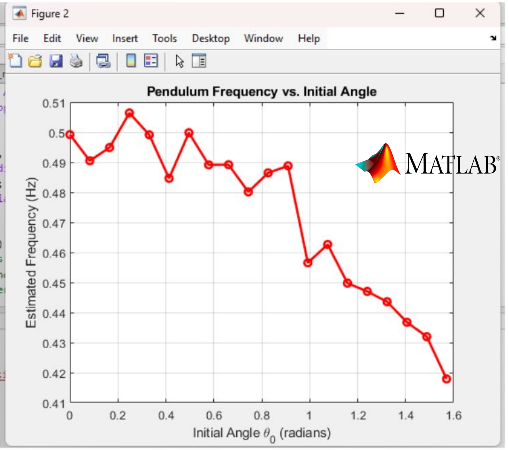
Any questions? Email snehithjj@gmail.com or avwhi331@arizona.edu

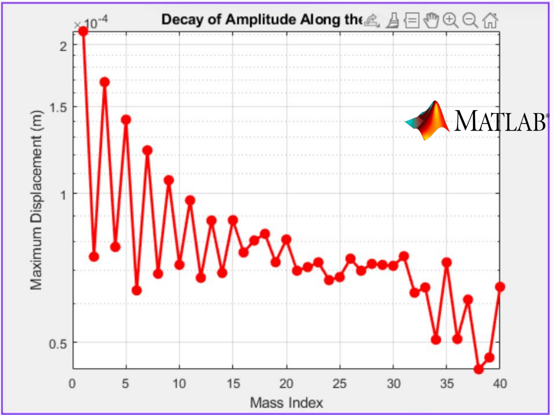
Overview

Matlab Simulations & Code
Spring Testing & Design
Experimental Design & Assembly

Matlab Code & Simulations







- Started with Simple Single Mass Pendulum to learn MATLAB ODE45
- Expanded to a 20 Mass Lattice to get Experimental results for our SSH Model (*Realized later odd number of masses was better since we need the mass being excited to be grounded by a stiffer spring. We chose 19)*
- *NOTE: All code can be found when clicking on matlab logo on each graph. 39 Mass simulation can be found on the github*

Spring Design

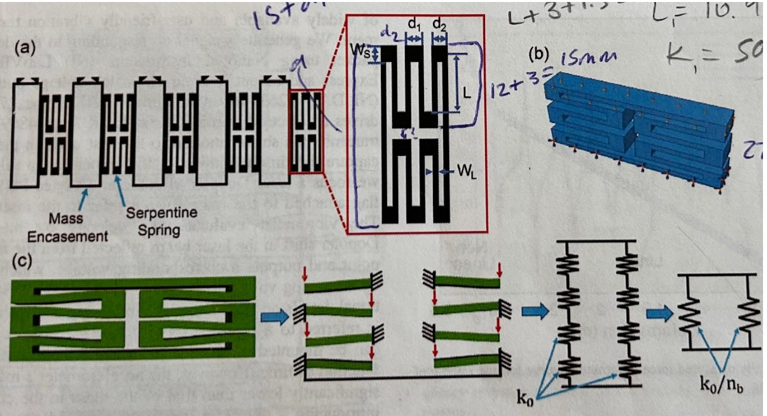


Fig. 5. (a) Schematic of the serpentine spring identifying pertinent dimensions with values given in Table I. (b) Finite element (FE) model an[d] ...tions. Displacements of nodes on the bottom surface of the structure are arrested, and compressive load is applied at the nodes on the top su[rface] ... predicted spring deformation for a compression of 2 mm. Also shown is the FE mesh along with how the beam stiffnesses (k_0 each) combin[e] ... stiffness of the spring. Note that n_b is the number of beams in one half of the serpentine spring ($n_b = 4$ in this figure).

$$\boxed{k_y = 2 \times \frac{k_0}{n_b} = \frac{2EtW_L^3}{n_b L^3},} \qquad (11)$$

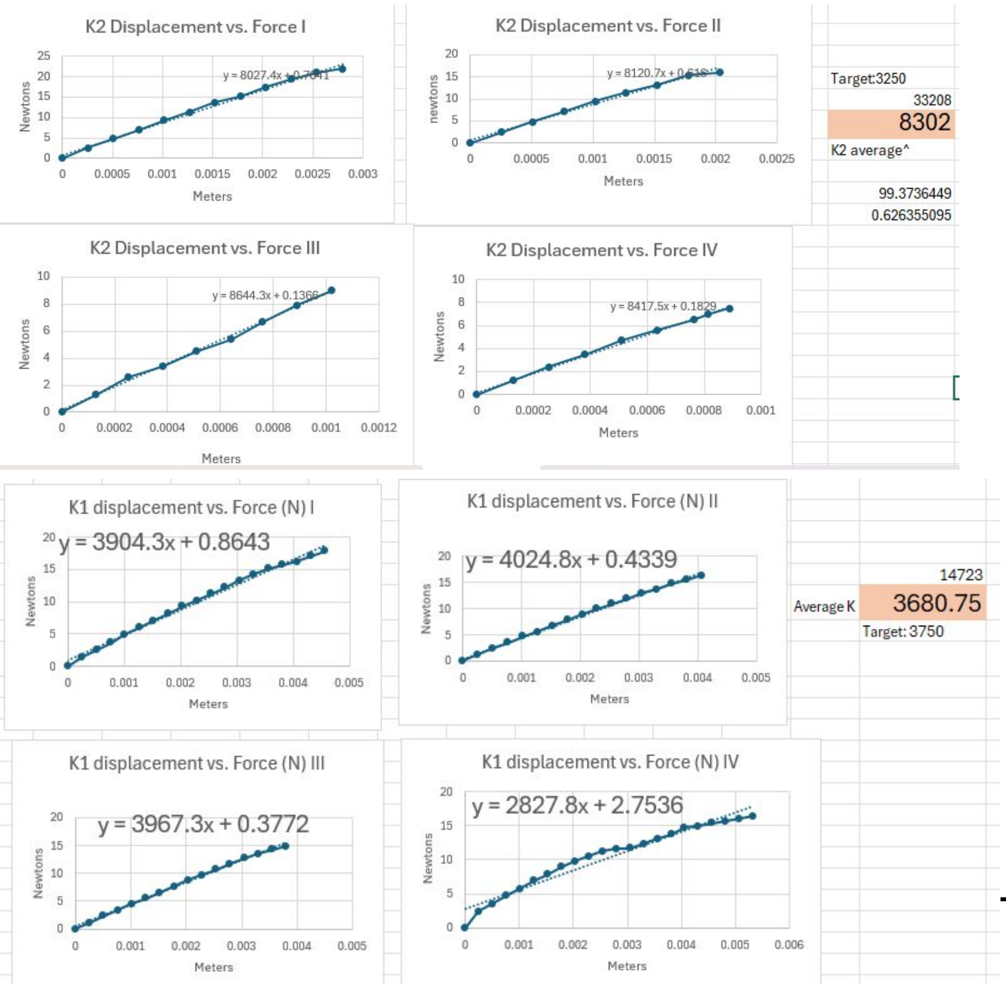
Simulating small displacements provides a dir[ect] ... ality between the reaction force and the applie[d] ... with the ratio of the two being the spring's sti[ffness] ...

Spring parameters

Length (L)	10.50 mm
Width (W_L)	1.000 mm
Thickness (t)	5.000 mm
Elastic modulus (E)	2.600 GPa
End thickness (W_S)	3.000 mm
End height (middle d_1)	3.500 mm
End height (top/bottom d_2)	3.000 mm

- Our experiment is a better version of an experiment titled *Experimental realization of an additively manufactured monatomic lattice for studying wave propagation*
- We simply recreated their experiment with better metal structures rather than wood, and are alternating between stiff and weak springs rather than uniform springs.
- Used the paper's dimensional equation of the serpentine spring design to create our target spring constants: 3750 and 8250 N/m

Spring Testing



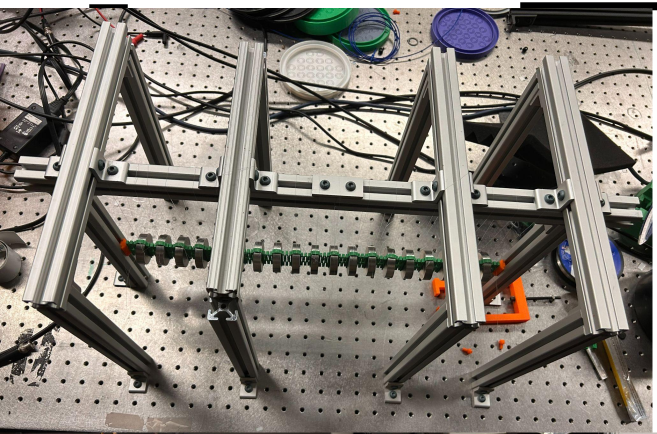
- Our target spring constants were 3750 and 8250 N/m to observe the edge mode.
- After testing, saw a 6% discrepancy between theoretical spring stiffness and tested stiffness.
- Redesigned both springs to be theoretically 6% stiffer and got low margins of error after testing.

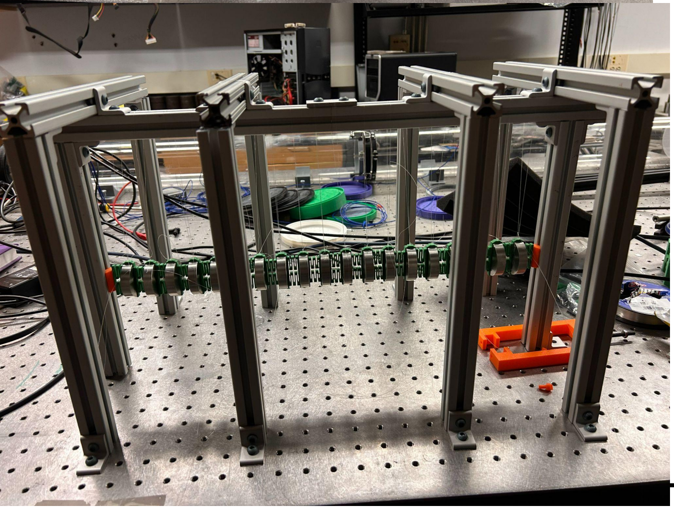
NOTE: Spring Files in the Github that start with “[TEST]” are spring designs meant for testing only since both ends were made thicker to take into consideration the thickness of the mass casing. The springs used for the experiment start with “[PRINT]”

Experimental Design

- Using OnShape, we designed our experiment to figure out exactly how much material to buy and how our experiment would look. You can see our design with this link
- We also designed different “clamping” mechanisms to clamp the 19th mass to the shaker so that it can be excited these designs can be found here and to see how they work in the larger assembly can be seen with this link.
- Flags were also designed so the Laser Doppler Vibrometer can measure the velocity of each mass. Dummy flags were also created to keep a uniform mass on the masses.

SSH Model Assembly





- After designing our experiment on CAD we ordered all parts:
    - T-Slotted Frame - 4633N77
    - Stainless Steel Cylindrical Stock
    - Flat Framing Bracket - 4844N136
    - Elbow Bracket - 4844N123
    - Fishing Wire
- Printed our serpentine spring and mass encasement lattice, and all other CAD items
- Assembled the structure and bolted down to optical table