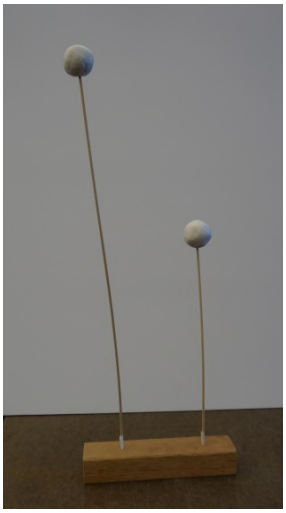
Activity:
Single Degree-of-Freedom/Lollipop Model

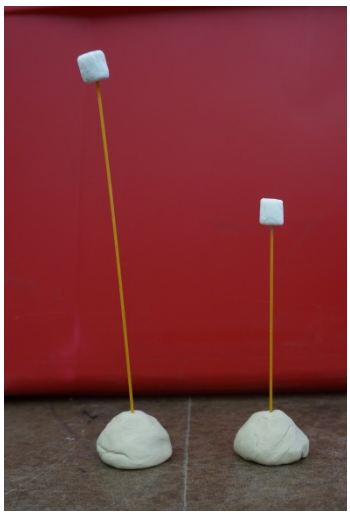
THAYER SCHOOL OF ENGINEERING AT DARTMOUTH

Background: A single degree-of-freedom (SDOF) model, also referred to as a lumped mass model or more informally as a lollipop model, is used to represent the response of a one-story building where all of the mass of the building is at the floor level and the stiffness of the columns is represented by a single column.

Questions: How does the height of a SDOF affect the response? How does the mass of a SDOF/Lollipop Model affect the response? Other questions?

Build a SDOF/lollipop model using a wooden dowel and clay or a piece of uncooked spaghetti and clay or a small marshmallow. The wooden dowel or piece of spaghetti represents the columns of the building, while the clay or marshmallow represents the mass of the building.





If you are using a wooden dowel, I'd recommend starting with a dowel with a diameter of less than ~3mm and a length of ~30cm and a lump of clay with a diameter of 2-3cm.

If you are using a piece of uncooked spaghetti, I'd recommend starting with a small marshmallow or a lump of clay with a diameter of <1cm.

Place the lump of clay or marshmallow (the mass) on one end of the dowel or piece of uncooked spaghetti. Either hold the other end of the dowel or piece of spaghetti with your hand or place it in a block of wood or another lump of clay that is secured to a table.

Pluck the mass (a lump of clay or a marshmallow) by displacing it laterally and letting it go. How long does it take for the mass to return to the position from which it was released? Measure the amount of time it takes for the mass to complete 5 cycles of motion (one cycle of motion is the time it takes for the mass to return to its released position); repeat this test 2-3 times to verify the results. Average the amount of time it takes for the model to complete five cycles of motion.

SDOF Model 1:

Trial	Time for 5 cycles (sec)
1	
2	
3	
Average	

SDOF Model 2 ***(reduced height):*** Vary the height of your model by decreasing the height of the column (cut the dowel or break the piece of spaghetti).

Trial	Time for 5 cycles (sec)
1	
2	
3	
Average	

SDOF Model 3: ***(increased mass):*** Vary the mass of your model by increasing the amount of mass that is added to the SDOF Model 2.

Trial	Time for 5 cycles (sec)
1	
2	
3	
Average	

Consider your results:

- How much variation was there in the time you measured for each model?
- As the height decreases, what happens to the time required for 5 cycles of motion?
- As the mass increases, what happens to the time required for 5 cycles of motion?
- What relationship do you notice, if any, between the variables (height or weight) and the average time for 5 cycles of motion?
- What other experiments could you run?

This activity was adapted from FEMA Seismic Sleuths
https://www.fema.gov/media-library/assets/documents/15229