Resonance Structures: Beam and Tower

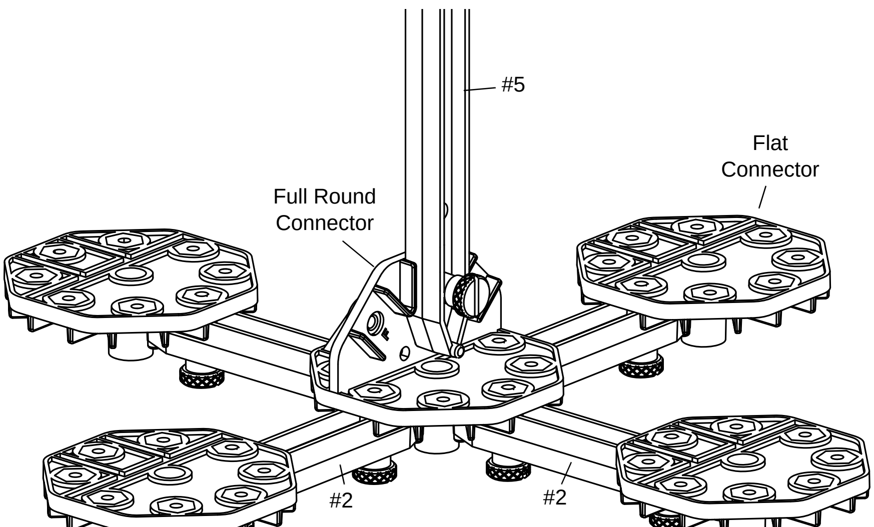
The PASCO Structures System can be used to demonstrate resonance in complex structures. Resonance is the tendency of a structure to oscillate at a greater amplitude at some frequencies than at others. These are known as the structure's resonance frequencies. At these frequencies, even small periodic driving forces can produce large amplitude oscillations.

Resonance occurs when a structure is able to store and transfer energy between two or more different storage modes (such as kinetic energy and potential energy in the case of a pendulum). However, there are some losses from cycle to cycle, called damping. When damping is small, the resonant frequency is approximately equal to the natural frequency of the structure, which is a frequency of unforced vibrations. Some structures have multiple, distinct, resonant frequencies.

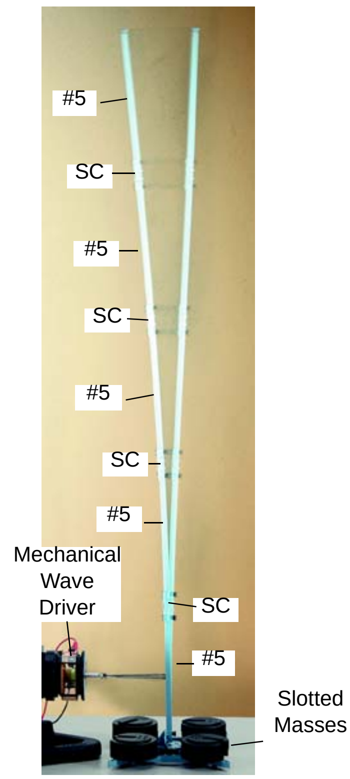
Resonance phenomena occur with all types of vibrations or waves. The resonance structures demonstrate mechanical resonance. Unlike a standing wave on a string vibrating between two rods which has nodes at both ends, the resonance beam has a node at one end and an antinode at the other.

Resonance Beam

Build a resonance beam using five #5 I-beams and four Straight Connectors (SC). Use four Flat Connectors, four #2 I-beams, and a Full Round Connector to build a base for the beam as shown below.



Resonance Beam Base



Place slotted masses (such as those from the ME-7566 Large Slotted Mass Ses) on top of the Flat Connectors to stabilize the resonance beam.

Mount a Mechanical Wave Driver (SF-9324) on a support rod so that its drive post is horizontal. Align the driver so that you can attach the drive post to the middle of the first #5 I-beam of the resonance beam. One way to attach the drive post to the I-beam is to loop a piece of yellow cord through the hole in the middle of the I-beam and then through the hole on the accessory banana plug of the driver. Another way to attach the drive post is to mount a Sliding Connector to the middle of the I-beam. Loop a piece of yellow cord through the Cord Clip and attach the Cord Clip to the Sliding Connector. Connect the cord to the drive post.

You can control the Mechanical Wave Driver with a PI-8127 Function Generator, or with a PASCO Interface and Power Amplifier.

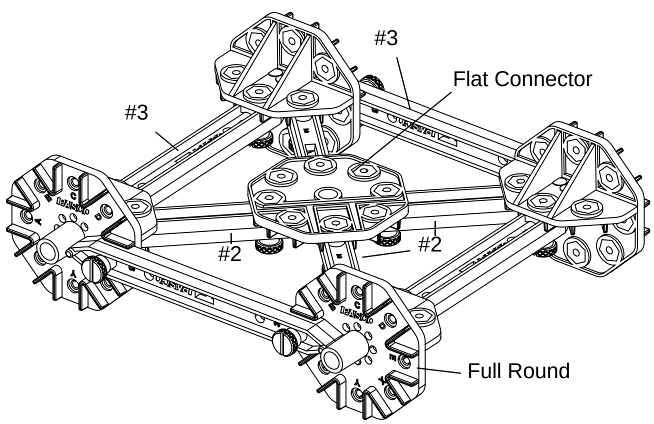
Equipment Needed	Part Number
Mechanical Wave Driver	SF-9324
Function Generator	PI-8127
Rod, 25 cm, threaded	ME-8988
Small “A” Base	ME-8976
Banana Plug Patch Cords	SE-9750 or SE-9751

Resonance Tower

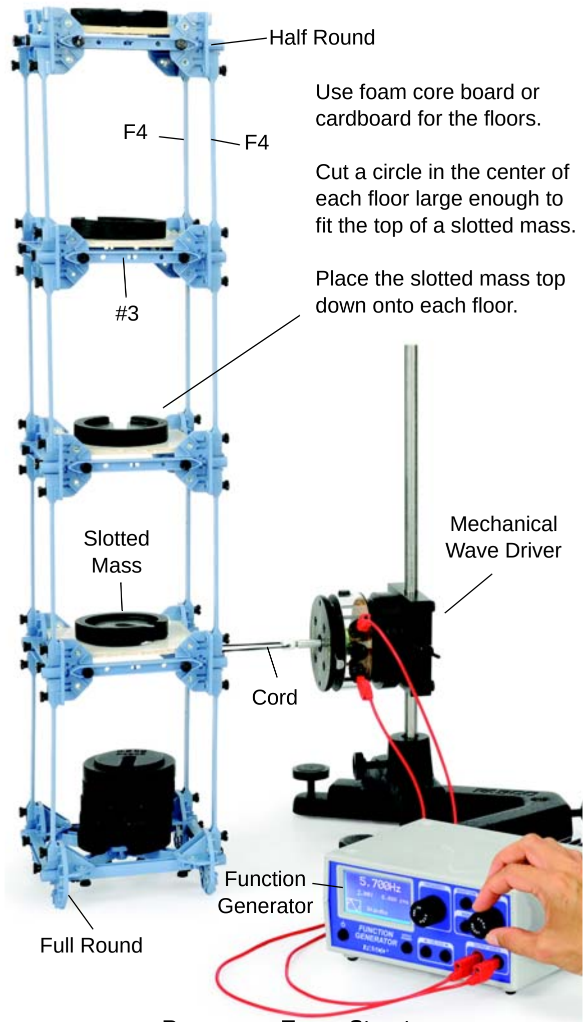
The Resonance Tower is a model of a building frame constructed with F4 Flat Members, #3 I-beams, #2 I-beams, Full Round Connectors, Half Round Connectors, and a Flat Connector.

As with the Resonance Beam, you can use the Mechanical Wave Driver controlled by a Function Generator to shake the building. In addition, you can use a 5 N Load Cell PS-2201 to measure the acceleration of the Resonance Tower and use a Motion Sensor to measure the amplitude of its movement.

Use four #2 I-beams and a Flat Connector (as shown) to build the support for the slotted masses at the ground floor of the structure.



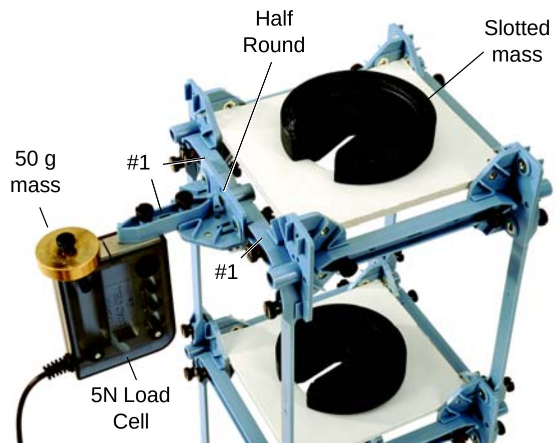
Resonance Tower Base



Resonance Tower Structure

Measure Acceleration

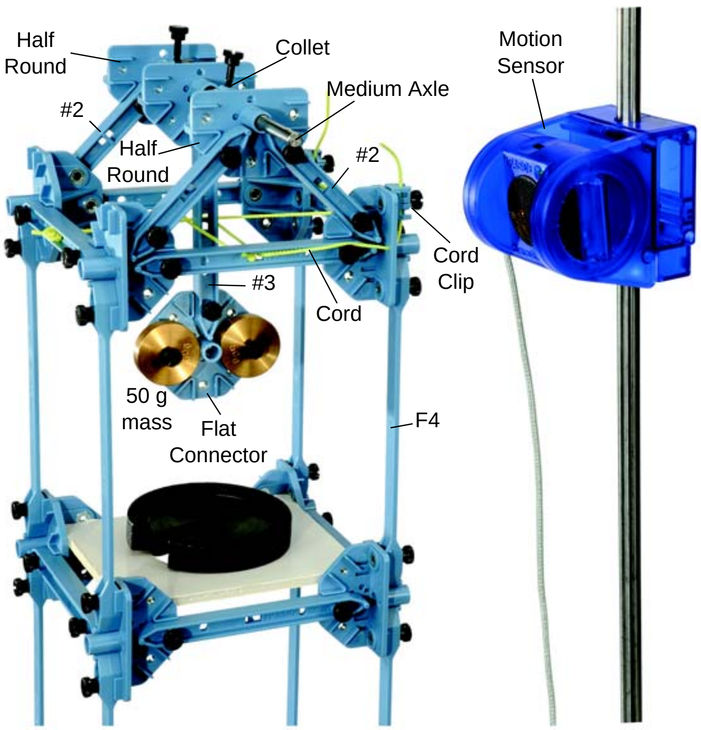
To measure the acceleration of the Resonance Tower, replace one of the #3 I-beams at the top floor of the tower with a Half Round Connector and two #1 I-beams as shown. Connect the 5 N Load Cell to the tower with a #1 I-beam, and mount a 50 g mass on the Load Cell.

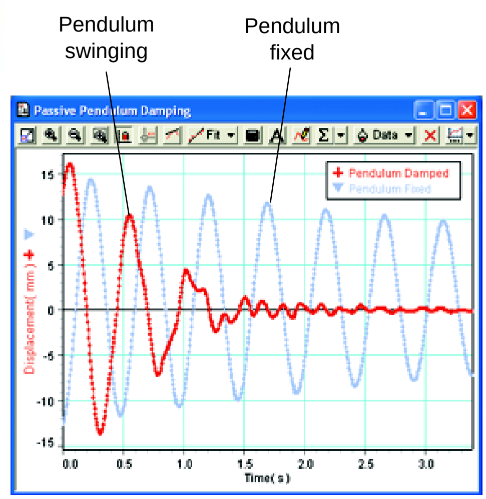


Measure Acceleration

Measure Oscillations

To study damped oscillations, replace the top floor of the tower with a ‘pendulum’ as shown. When the pendulum is tied in place with cord and cannot swing, the tower’s oscillations persist. When the pendulum is allowed to swing, the oscillations are damped. Mount a Motion Sensor on a support rod to measure the oscillations.





Measure Oscillations