

Section 10.4: Structural Safety

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1. Answers may vary. Sample answer:

When a car is stuck in the snow, you should rock the tires back and forth rather than only trying to move them forward. The movement will create the resonating frequency, which will increase the amplitude of the movement, and will help get the car unstuck faster.

2. Answers may vary. Sample answer:

Marching in unison across a swinging footbridge may cause aeroelastic flutter, which will add more energy to the vibrations than could be lost to natural damping. Extreme vibrations may cause the bridge to break.

3. Answers may vary. Sample answer:

(a) Due to mechanical resonance, the energy from pendulum A transfers to pendulum E along their shared string. Pendulum E then starts resonating at the same frequency.

(b) Pendulum A will stop swinging if pendulum E has a large amplitude swing.

(c) Due to conservation of wave energy, the sum of their amplitudes must either remain the same or decrease.

(d) Pendulum E should be dunked in the beaker. Then, any sympathetic vibrations will lose their energy in the water. Pendulum A will be damped because pendulum E is damped.

4. Answers may vary. Sample answer:

Concrete walls are inflexible and can crack and collapse when vibrating at resonating frequency. Also, the methods used to reinforce concrete buildings are very expensive compared to other building technologies.

5. Answers may vary. Sample answer:

Mechanical resonance: physical contact required; total mechanical energy is conserved.

Aeroelastic flutter: no physical contact necessary; total energy may not be conserved.

Both: high amplitudes produced; vibrations occur at natural frequency.

6. Answers may vary. Sample answer:

There is significant disagreement among scientists on the primary cause of the collapse of the Tacoma Narrows Bridge. It may have been mechanical resonance where the wind's energy was transferred into the concrete material of the bridge. Or, it could have been because of aerolastic flutter where wind acted as a stimulator to negate natural damping.

7. Answers may vary. Sample answer:

Reducing the size of floors as the elevation increases means there is less surface area for the wind to blow against and there is less mass higher up in the structure.

Base isolation pads act as shock absorbers for a building, especially in an earthquake. They limit the building's contact with the vibrating ground and dampen the waves passing into the building.