Mechanical Vibrations

What is Vibration?

What is Vibration?

- ## Scientific Definition

  Any motion that repeats itself after an interval of time

What is Vibration?

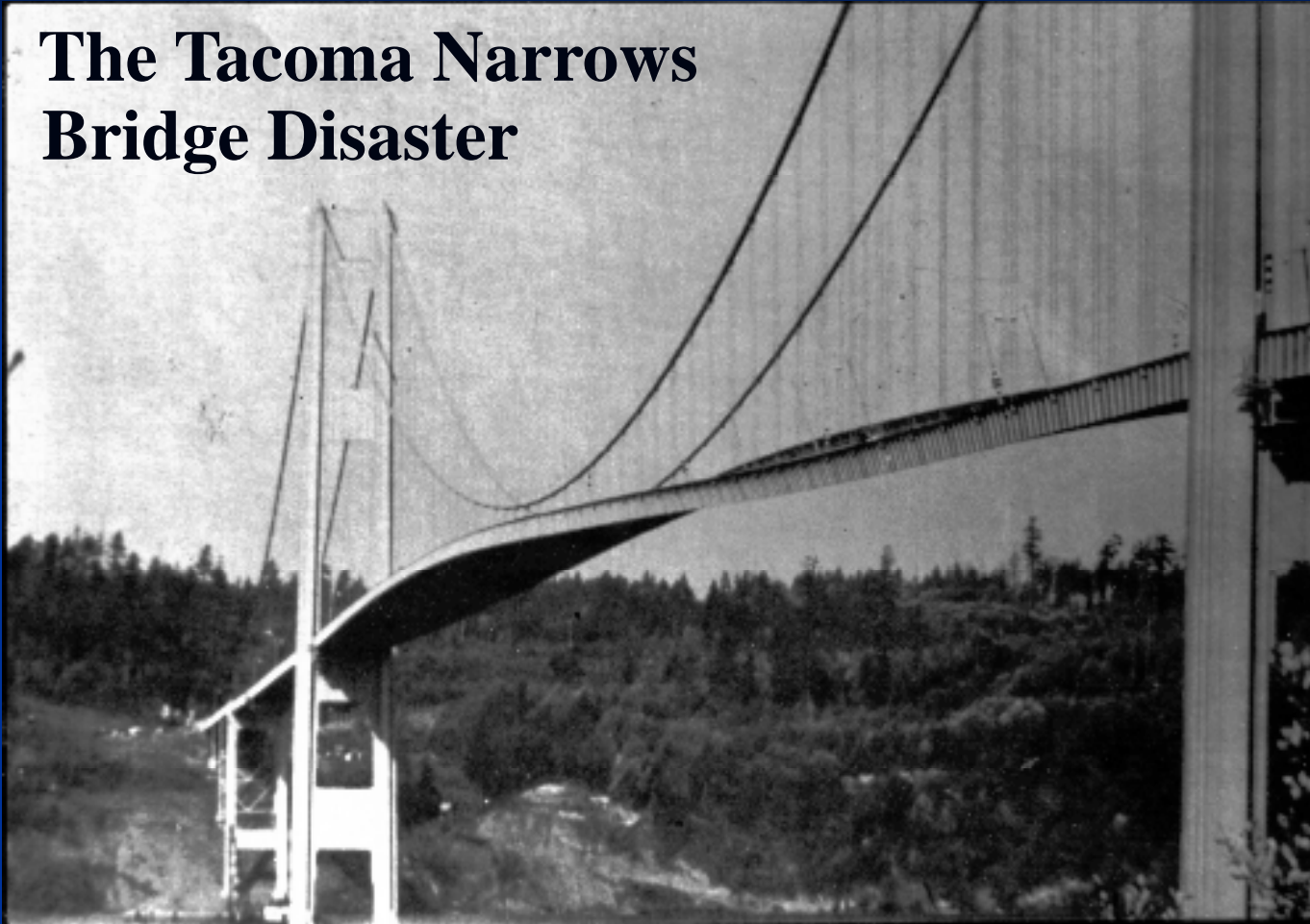- **Scientific Definition**

  Any motion that repeats itself after an interval of time

  - **Engineering Definition**

    Deals with the relationship between forces and oscillatory motion of mechanical systems

Why is Vibration Important?
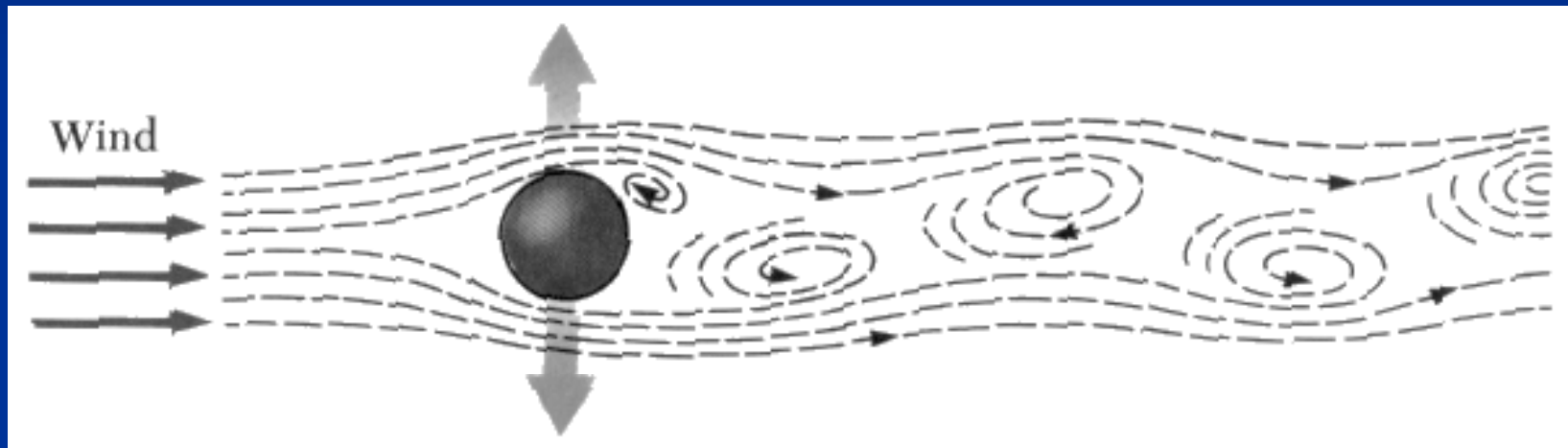

The Tacoma Narrows
Bridge Disaster

Why is Vibration Important?
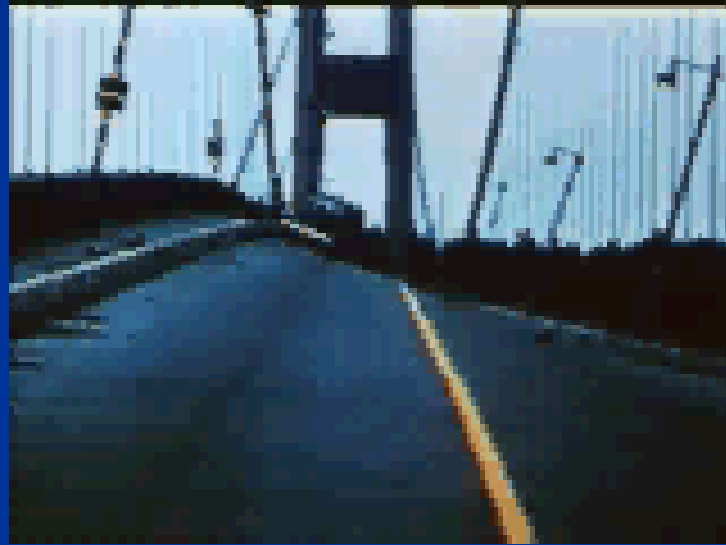

Amplitude of oscillation reached 14 feet!
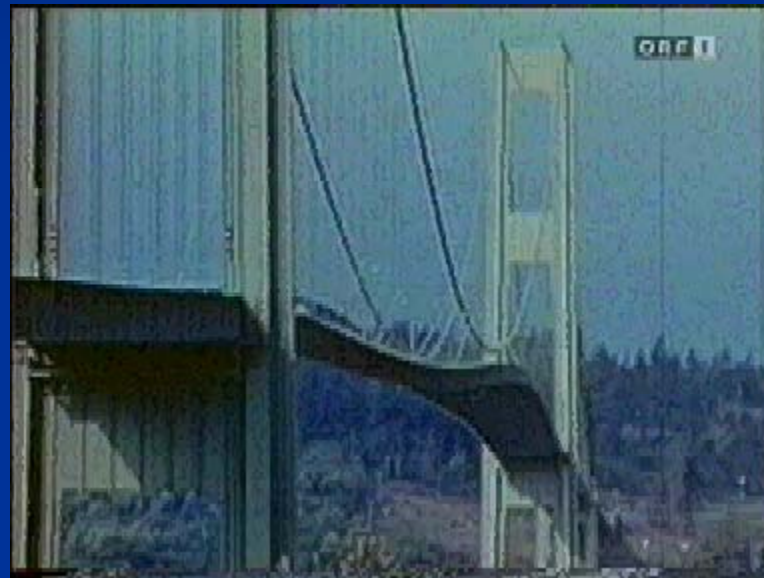
What was the cause?

Vortex Shedding

…Caused Wind-Induced Vibration (?)

Why is Vibration Important?

Why is Vibration Important?

Why is Vibration Important?

Wing Flutter Failures

Basic Concepts

Every object has:

- **Frequencies** at which it "likes" to vibrate

- **Characteristic geometries** of vibration

Basic Concepts

Every object has:

- **Frequencies** at which it "likes" to vibrateç

  Natural

  Frequencies

- **Characteristic geometries** of vibration

  Mode

  Shapes

Modeling Vibration

1

The Ingredients:

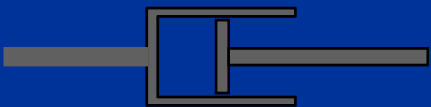1. Inertia (stores kinetic energy)

2. Elasticity (stores potential energy)

Realistic Addition:

3. Energy Dissipation

Modeling Vibration

1

2

The Ingredients:

1. Inertia (stores kinetic energy)

2. Elasticity (stores potential energy)

Realistic Addition:

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Modeling Vibration

1

2

3

The Ingredients:

1. Inertia (stores kinetic energy)

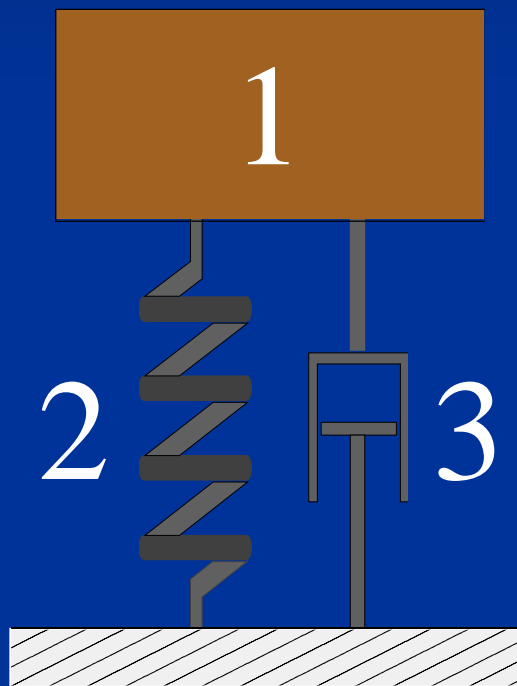2. Elasticity (stores potential energy)

Realistic Addition:

3. Energy Dissipation

Modeling Vibration

The Ingredients:

1. Inertia (stores kinetic energy)

2. Elasticity (stores potential energy)

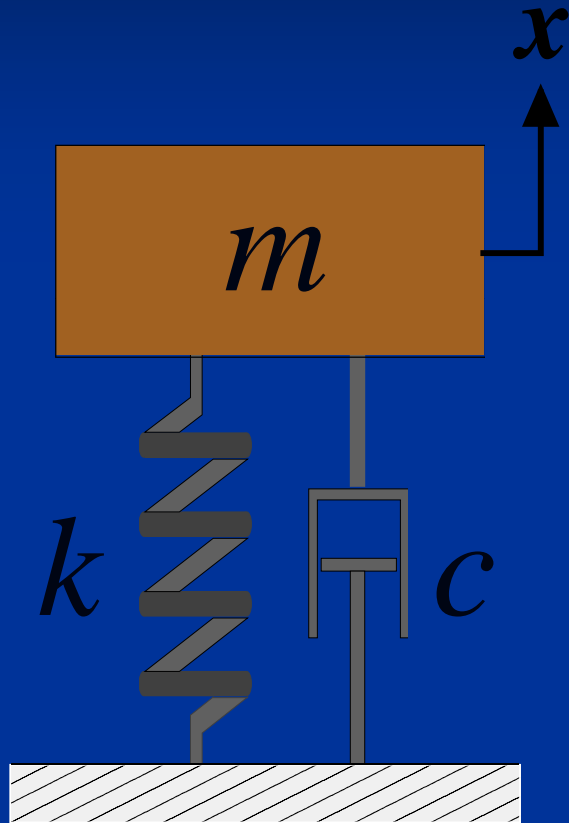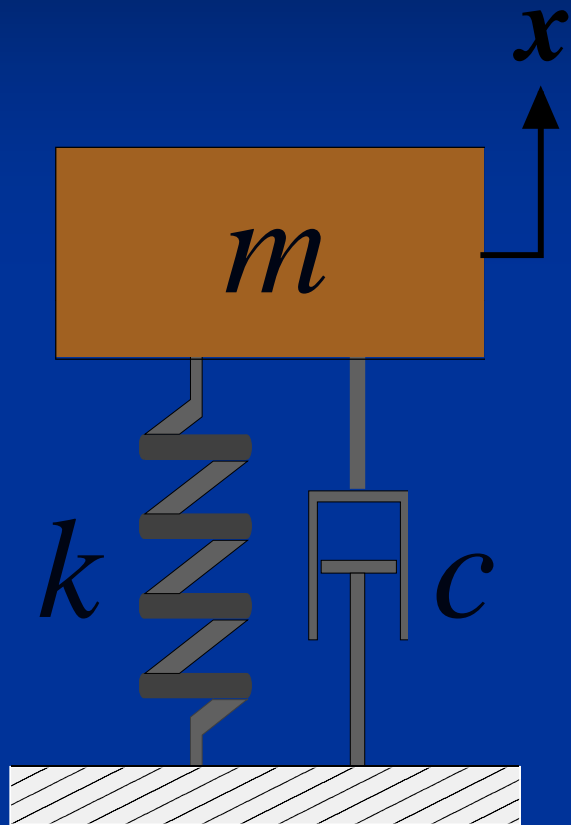## Realistic Addition:

3. Energy Dissipation

Modeling Vibration

The Ingredients:

1. Mass, m
2. Stiffness, k

Realistic Addition:

3. Damping, c

x

m

k *c*

How is this model useful?

Basic Concepts

- **Resonance**

Basic Concepts

- **Resonance**

  - A vibration of large amplitude

  - Occurs when an object is forced near its natural frequency

Resonance

- A vibration of large amplitude

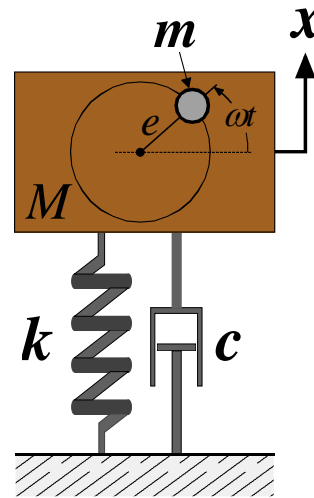- Occurs when an object is forced near its natural frequency

Object

Resonance

- A vibration of large amplitude
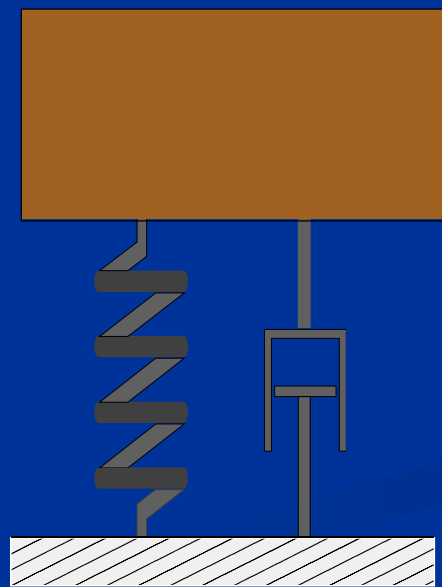- Occurs when an object is forced near its natural frequency

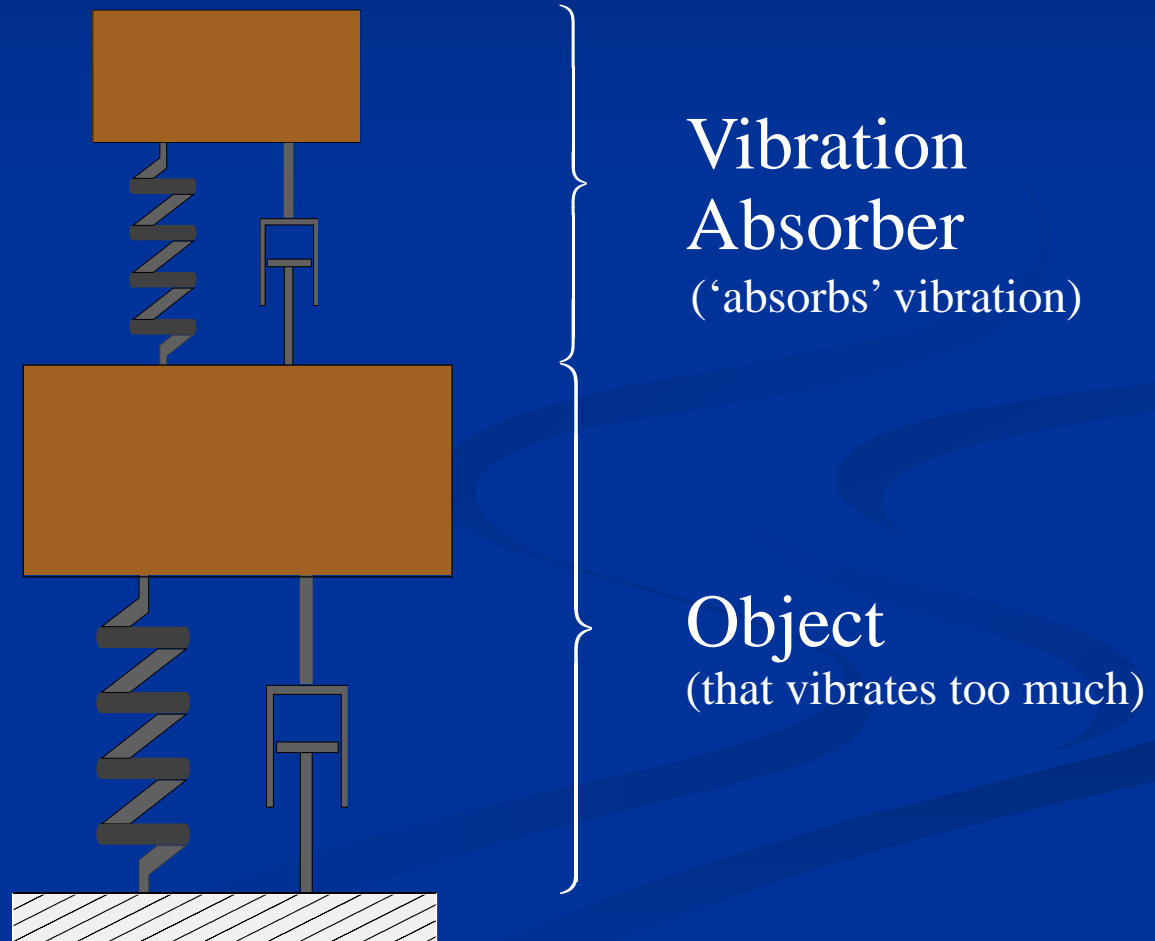Object   Model

Vibration Absorbers

■ Used to eliminate vibration of an object
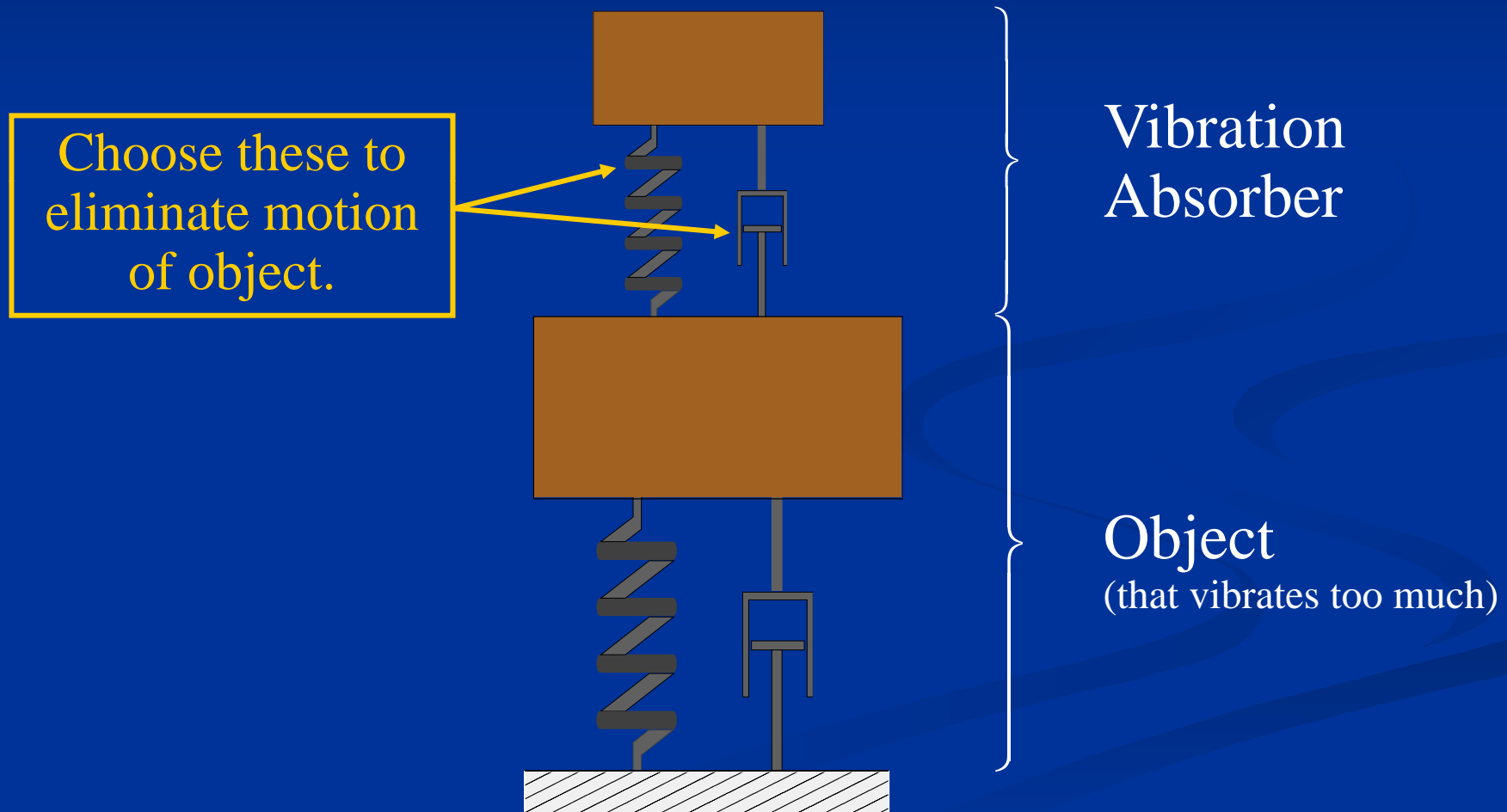

Object
(that vibrates too much)

Vibration Absorbers
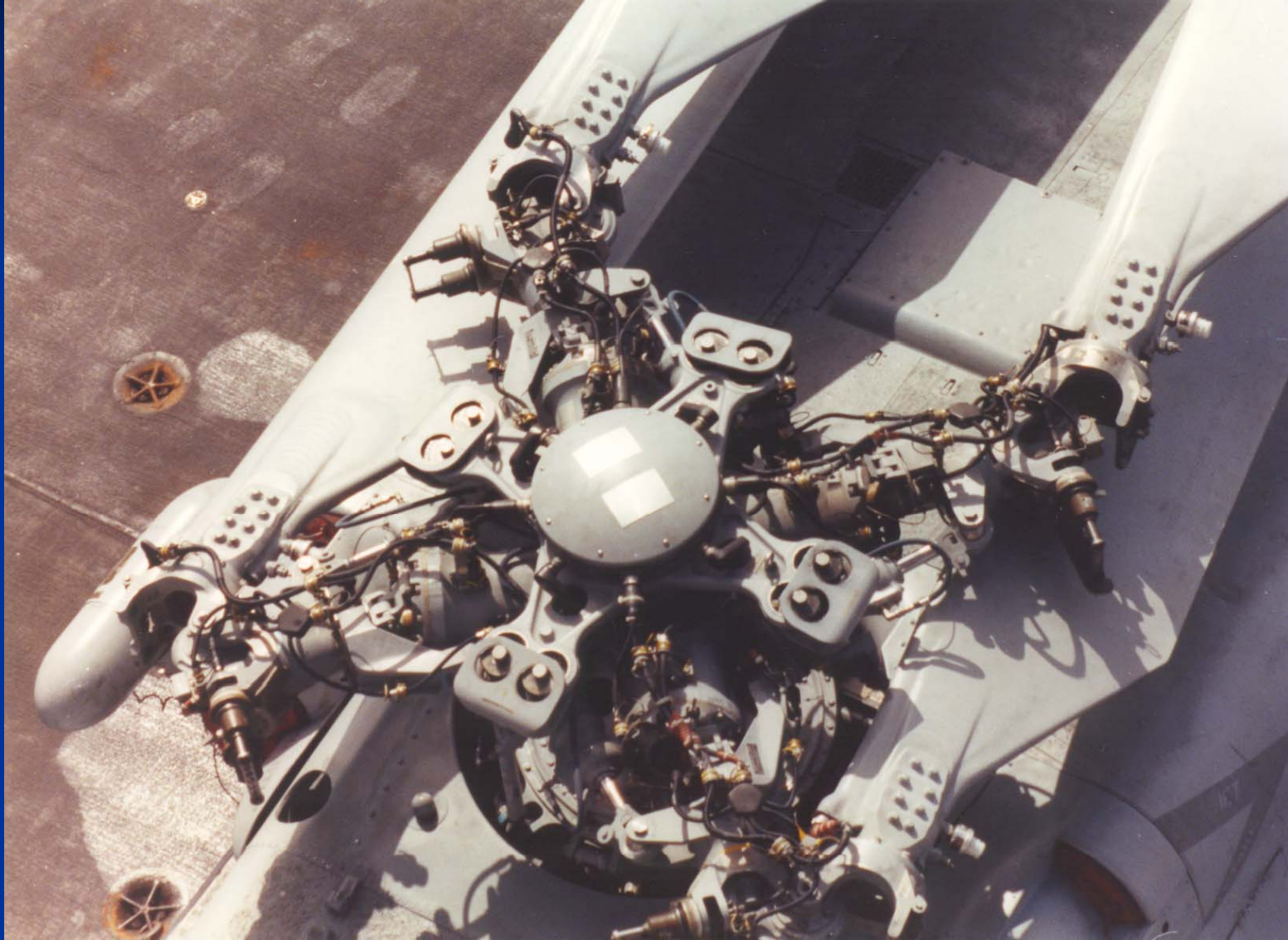
- Used to eliminate vibration of an object

Vibration
Absorber
('absorbs' vibration)

Object
(that vibrates too much)

Vibration Absorbers

- Used to eliminate vibration of an object

Vibration Absorbers

Mode Shapes

"Characteristic Geometry" of Vibration

- **Mode Shapes**

- **Resonance**

- **Natural Frequencies**