Tall Building Active Damping

Final Design Project

2.004 System Dynamics and Control
Fall 2007
Our Problem:

Modify a tall building’s dynamic response to reject wind disturbances and earthquakes
Shanghai World Finance Center Building

To be completed in 2008

101 floors
492 m (1,614 ft)
Taipei 101

435 m
101 Floors

Distributed Damper System

Image from Wikimedia Commons, http://commons.wikimedia.org
MIT 2.004 Dynamics and Control II  Harry Asada and Franz Hover
Here is a **Passive Damper**
(Dynamic Vibration Absorber)

Wind force, $F_W(t)$

Sliding Mass, $m_2$

Spring

Damper

Building: approximated as a beam?
This Lab: **Active Damper Design**

The actuator is commanded by a **control system**, which requires **sensors**.
Project Goals

• Design Goals
  – Damp out Induced Vibrations
  – Improve Upon Passive Solution

• Project Deliverables
  – Model of System (LAB 7)
  – Open-Loop Design (LAB 8)
  – Closed-Loop Design (LAB 8) \[ \text{Matlab & Simulink} \]
  – Final Design and Experimental Verification (LAB 9)
  – Design History and Performance Record Document
Lab 7

• Create Linear Model of System
  – Inputs?
  – Output?
  – State Space?
  – Transfer Function(s)?
  – System Parameters?
    • Mass, damping, stiffness…

• Deliverable
  – State Space or Transfer Function Model verified by Instructor
  – Estimates of System Parameters
Modeling:
- Make your own sketch of the system
- Draw an icon model: mass, spring, damper, actuator, etc.
- Define parameters
- Develop governing equations

Actuator: Voice Coil

MEMS Accelerometer

Air Bearings

Spring

Relative Velocity Sensor: Voice Coil
A schematic with all the parameters and variables you need!
Today's Lab

• Understanding the system
• Modeling
• Parameter Identification