Hybrid Simulation Demonstration with Instructional Equipment

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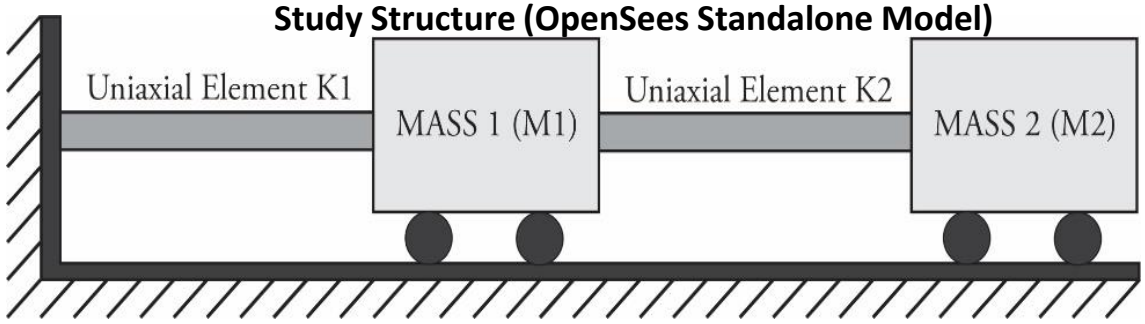
Introduction

- **Overview**
  - Study structure description
  - Substructures for the hybrid testing demonstration
  - Testing setup overview
  - Hybrid simulation demonstration
  - Results

Study Structure Description

- **One-dimensional two DOF system**
  - Lumped masses: M1=M2=20 kg
  - Uniaxial elements stiffness: K1=K2=**5 N/mm** (spring)
  - Rayleigh damping equal to 2% for the 1st and 2nd response mode
  - Eigen value analysis: 0.643 and 0.246 sec
  - Excitation case: Artificial ground motion properly scaled with duration equal to 2.4 sec plus 0.6 sec free vibration

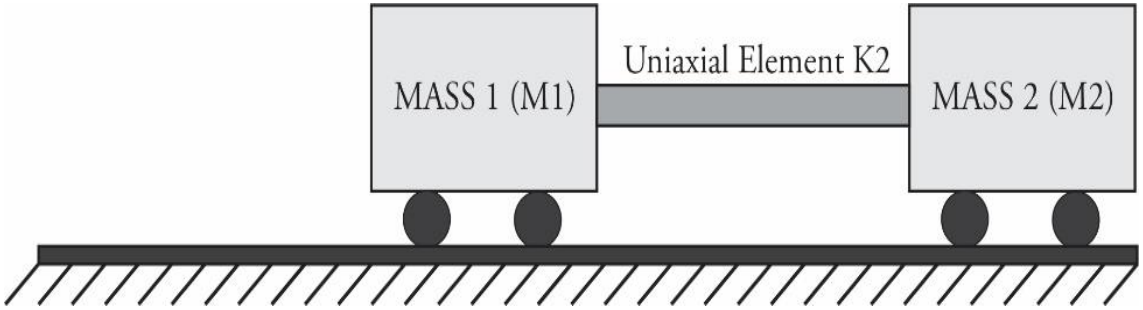
Study Structure (OpenSees Standalone Model)



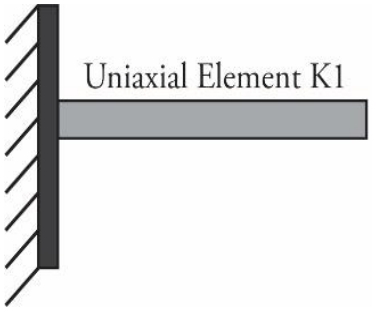
Substructures for the Hybrid Testing

❑ Substructures Description

- Numerical Substructure & Integration Modules: OpenSees

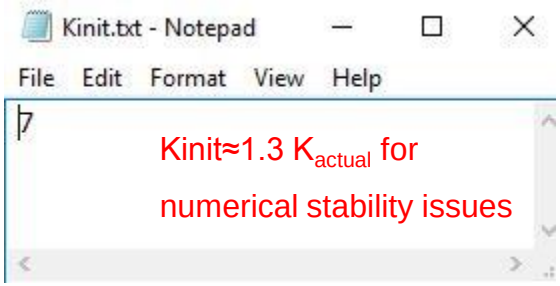


- Experimental Substructure: Physically tested specimen

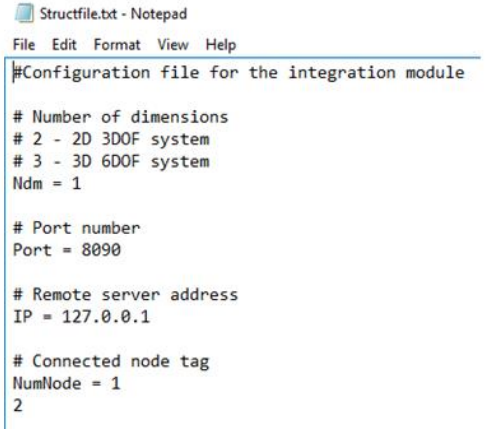


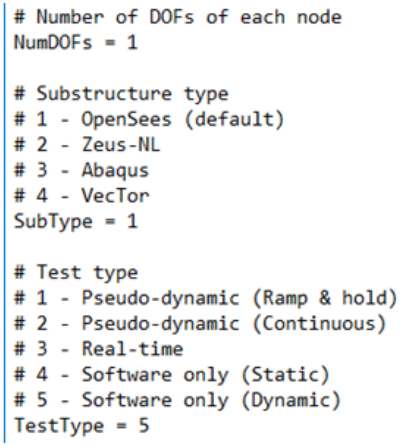
Substructures for the Hybrid Testing

- **Integration module input files**
  - Numerical substructure/integration module script: ‘HM.tcl’
  - Dynamic link library (.dll) files
  - Experimental substructure initial stiffness: ‘Kinit.txt’



  - Substructure configuration file: ‘Stuctfile.txt’





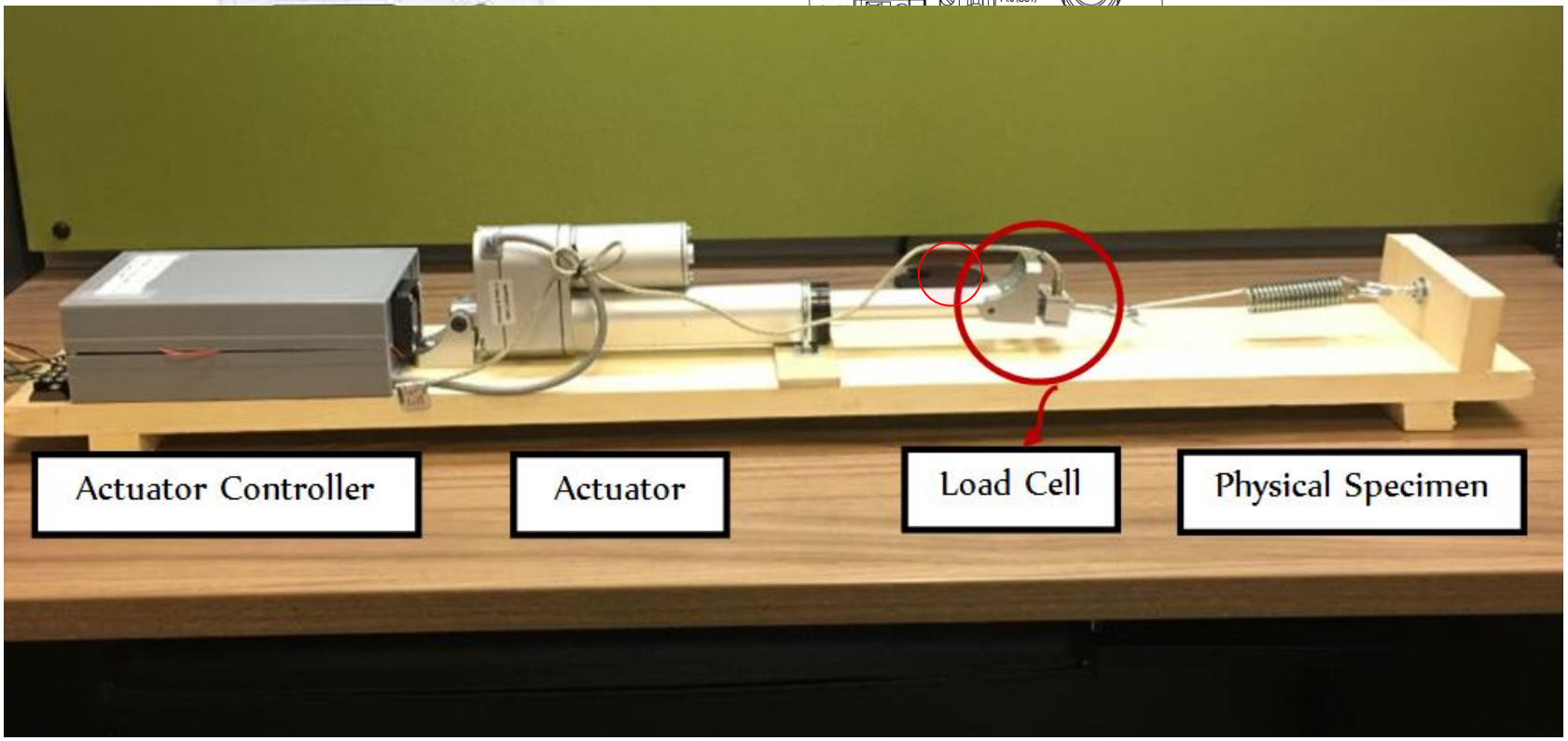
Substructures for the Hybrid Testing

- **Network Interface for Controllers (NICON) input file**
  - NICON Configuration file: NICON_Config.xml

```
<?xml version="1.0" standalone="true"?>
- <LVData xmlns="http://www.ni.com/LVData">
    <Version>9.0.1</Version>
  - <Cluster>
      <Name>Configuration Cluster In</Name>
      <NumElts>29</NumElts>
    + <U32>
    + <DBL>
    + <DBL>
    - <Path>
        <Name>PathTimeHistory</Name>
        <Val>C:\Users\George\Desktop\Workshop NICON example\opensees-controller\NICON\mytimehistory.txt</Val>
      </Path>
    - <U32>
        <Name>PolynomialOrder</Name>
        <Val>5</Val>
      </U32>
    - <Boolean>
        <Name>RampMode</Name>
        <Val>1</Val>
      </Boolean>
    - <DAQChannel>
        <Name>OutputCh</Name>
        <Val>Dev1/ao1</Val>
      </DAQChannel>
    - <DAQChannel>
        <Name>InputCh1</Name>
        <Val>Dev1/ai0</Val>
      </DAQChannel>
    - <DAQChannel>
        <Name>InputCh2</Name>
        <Val>Dev1/ai1</Val>
      </DAQChannel>
```

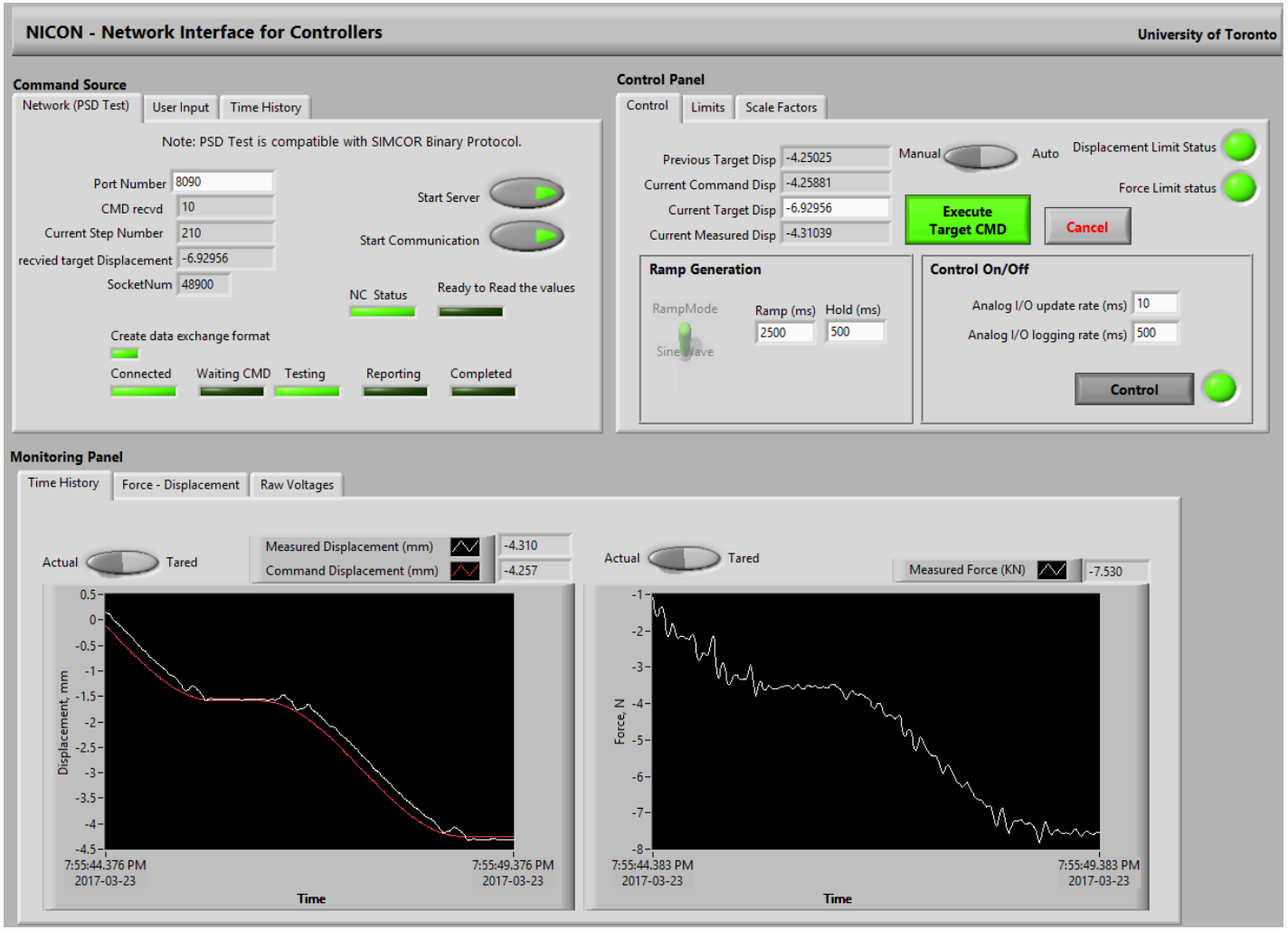
Testing Setup Overview

- Data Acquisition System (DAQ): NI USB-6128 BNC



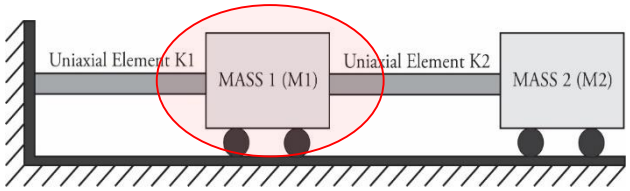
Hybrid Simulation Demonstration

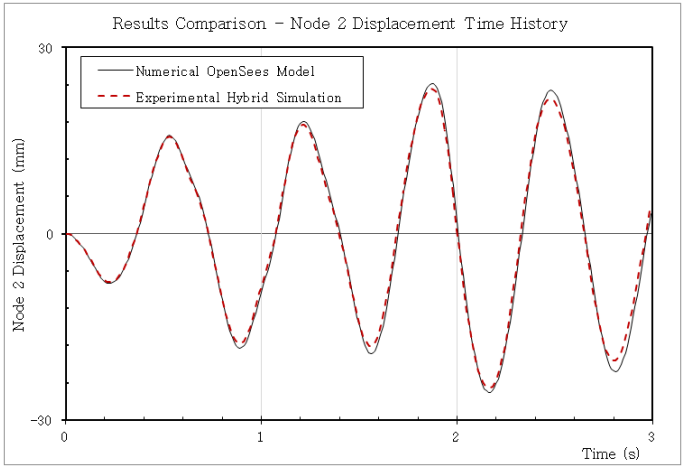
- Moving to NICON Environment



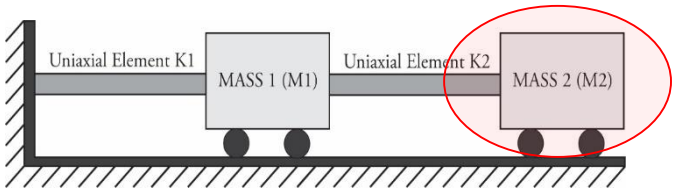
Results

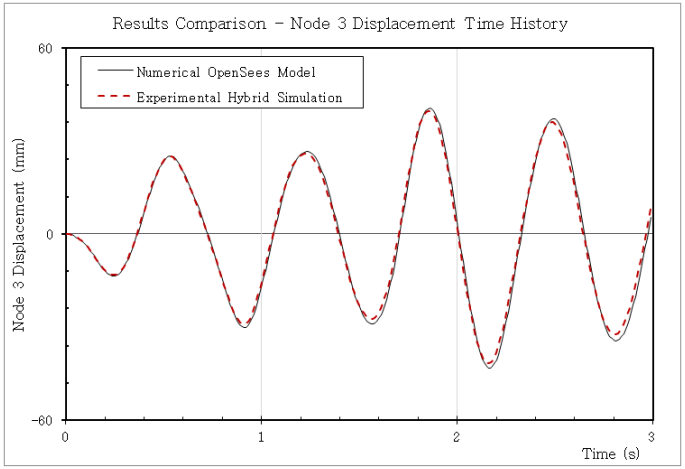
- **Displacement time history comparison**
  - Node 2: Mass 1





  - Node 3: Mass 2





Thank you for you attention.
Questions?

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