# OpenSees: Static, Cyclic, and Dynamic Analysis Examples

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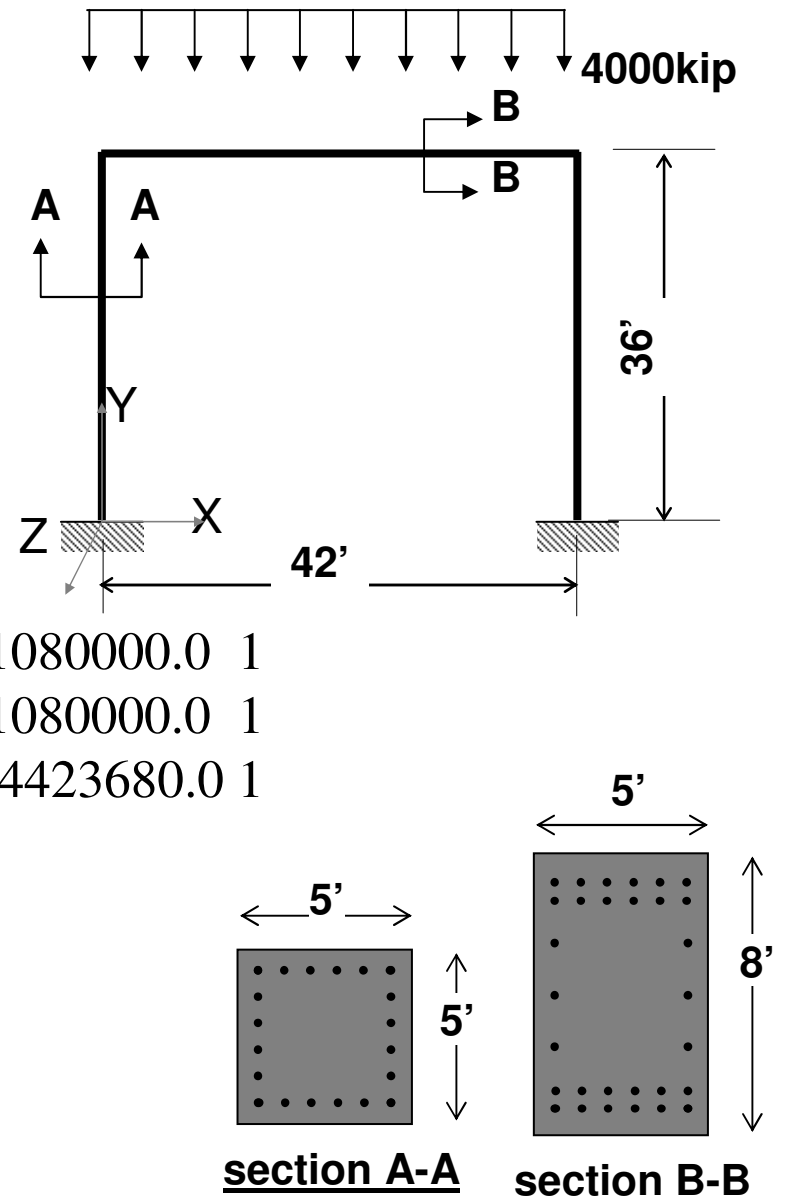
# Model (example.tcl):

```
model Basic -ndm 2 -ndf 3
node 1    0.0    0.0
node 2 504.0    0.0
node 3    0.0 432.0
node 4 504.0 432.0
fix 1 1 1 1
fix 2 1 1 1
mass 3 5.18 0.0 0.0
mass 4 5.18 0.0 0.0
geomTransf Linear 1
element elasticBeamColumn 1 1 3 3600.0 4227.0 1080000.0  1
element elasticBeamColumn 1 4 3 3600.0 4227.0 1080000.0  1
element elasticBeamColumn 3 3 4 5760.0 4227.0  4423680.0 1
pattern Plain 1 Linear {
    load 3 0.0 -2000.0 -168074.0
    load 4 0.0 -2000.0  168074.0
}
```

**source example.tcl**

4000kip

B

B

A   A

36'

Y

X

Z

42'

5'

5'

5'

8'

section A-A    section B-B

# Gravity Load Analysis

```
# first source in the model
source example.tcl

# create analysis & perform analysis
constraints transformation
numberer RCM
system BandGeneral
test NormDispIncr 1.0e-6 6 2
algorithm Newton
integrator LoadControl 0.1
analysis Static
analyze 10

# look at what happened to node 3
print node 3
```

* We will call this file example1.tcl for future examples

# Cyclic Lateral Load Analysis

```tcl
# first source in the model and do gravity load analysis
source example1.tcl

# set gravity loads constant & reset time in domain
loadConst -time 0.0

# create load pattern for lateral loads
pattern Plain 2 Linear {
    load 3 200.0 0.0 0.0
    load 4 200.0 0.0 0.0
}

# do some cyclic analysis
foreach {numSteps stepSize} {10 0.1 10 -0.1 10 -0.1 10 0.1 10 0.1} {
    integrator LoadControl $stepSize
    analyze $numSteps

    set time [getTime]
    set disp [nodeDisp 3 1]
    puts "Time: $time Displacement $disp"
}
```

# Transient Analysis - Uniform Excitation

```
# first source in the model and do gravity load analysis
source example1.tcl

# set gravity loads constant & reset time in domain
loadConst -time -0.01

# create load pattern
set motion IELC180
source READSMDFile.tcl
ReadSMDFile $motion.AT2 $motion.acc dt
set accelSeries "Path -filePath $motion.acc -dt $dt -factor 386.4"
pattern UniformExcitation 2 1 -accel $accelSeries

# set damping factors
rayleigh 0.0 0.0 0.0 0.0 0.0

# create the analysis
wipeAnalysis
System ProfileSPD
Test NormDispIncr 1.0e-16 10
Algorithm Newton
Integrator Newmark 0.5 0.25
Analysis Transient

# create a recorder
recorder Node -time -file example3.out -node 3 -dof 1 disp

analyze 4000 $dt
```

# Transient Analysis - MultiSupport Excitation

```
# first source in the model and do gravity load analysis
source example1.tcl

# set gravity loads constant & reset time in domain
loadConst -time -0.01

# remove some sp constraints
remove sp 0
remove sp 3



# create load pattern
set motion IELC180
source READSMDFile.tcl
ReadSMDFile $motion.DT2 $motion.disp dt
set dispSeries "Path -filePath $motion.disp -dt $dt -factor 0.3937"
pattern MultiSupport 2 {
    groundMotion 5 Plain -disp $dispSeries
    imposedMotion 1 1 5
    imposedMotion 2 1 5
}

# set damping factors
rayleigh 0.0 0.0 0.0 0.0 0.0



# create a recorder
recorder Node -time -file example4.out -node 3 -dof 1 disp
```

```
# set damping factors
rayleigh 0.0 0.0 0.0 0.0 0.0

# create the analysis
wipeAnalysis
system ProfileSPD
test NormDispIncr 1.0e-16 10
algorithm Newton
integrator Newmark 0.5 0.25
analysis Transient


analyze 4000 $dt
```
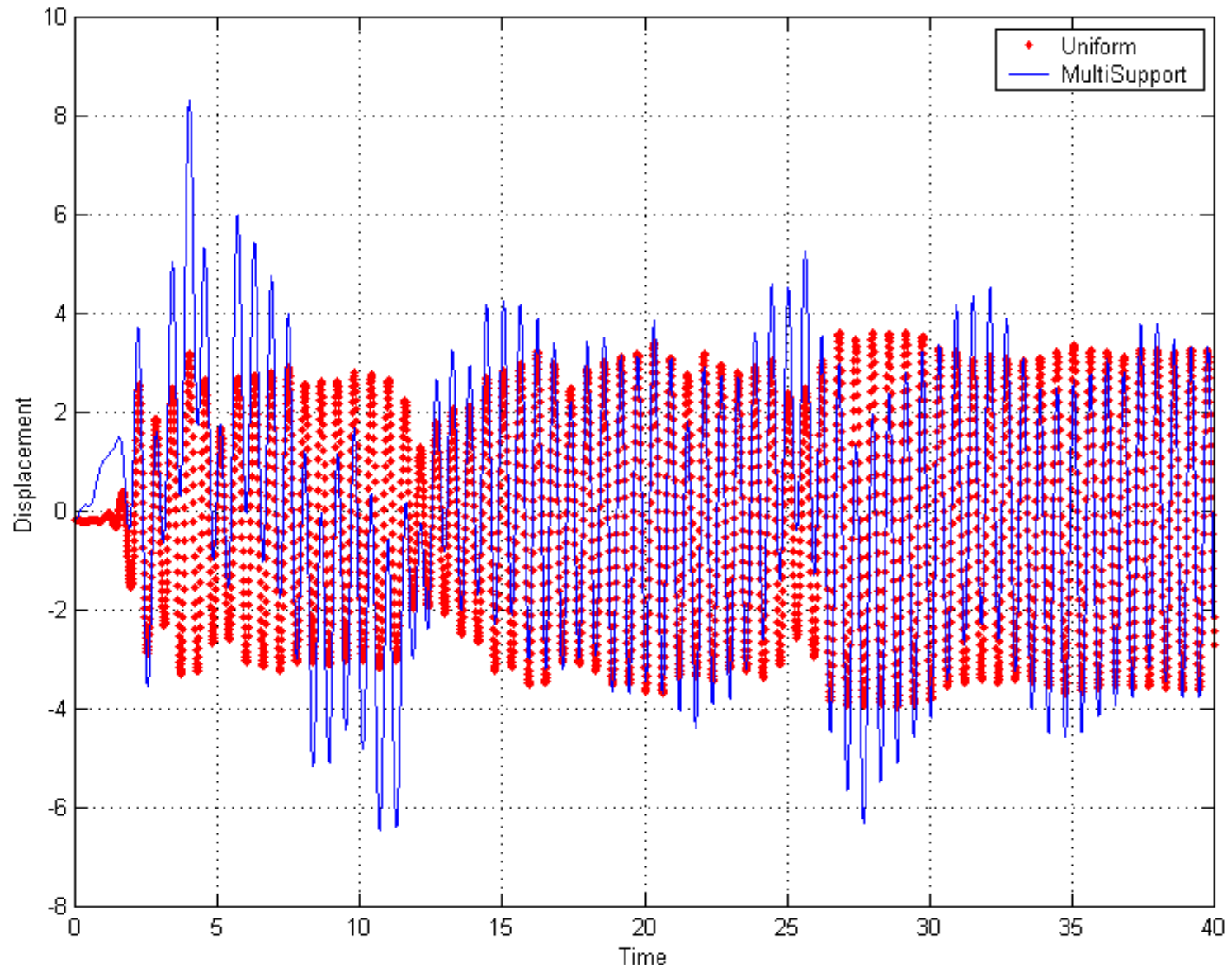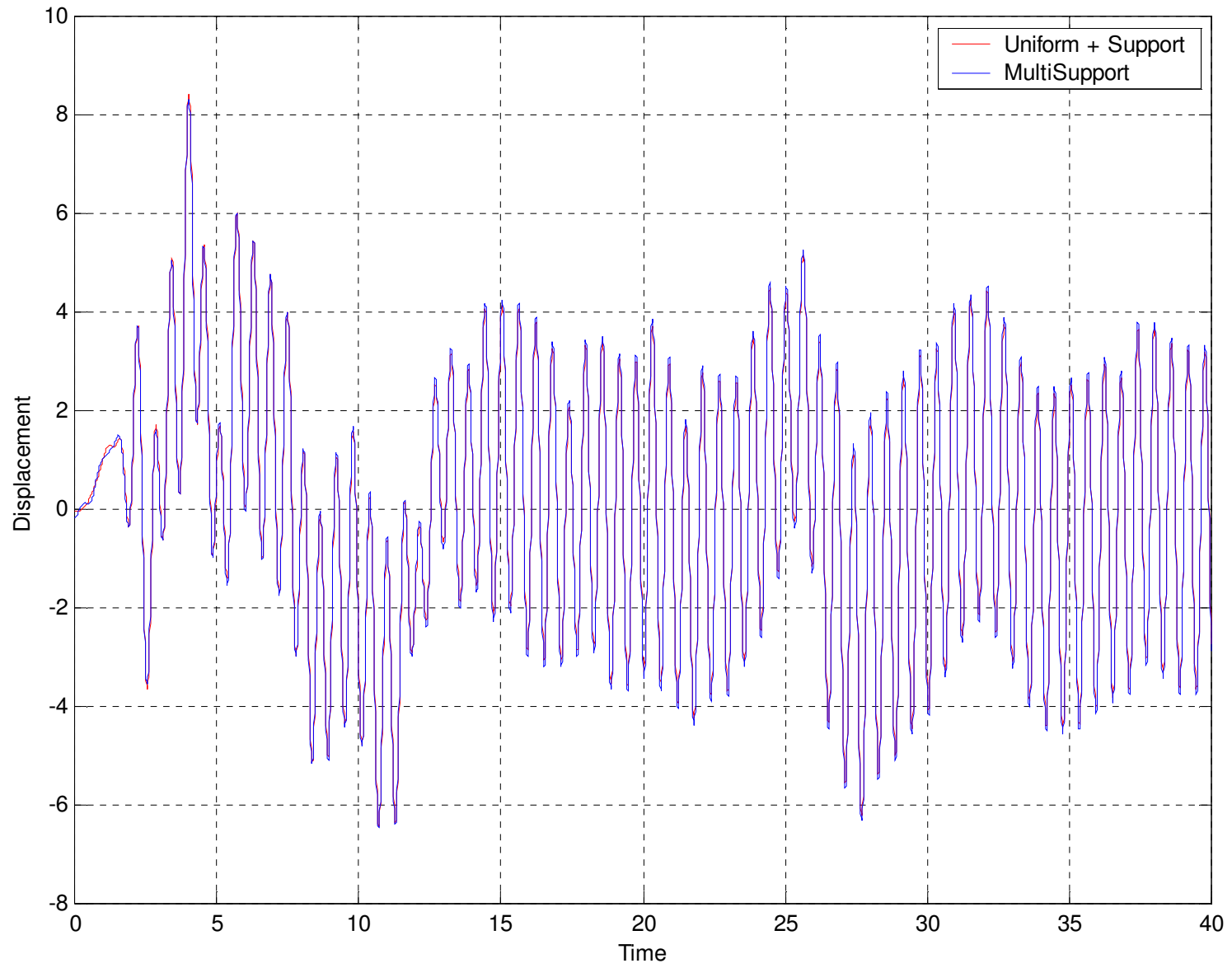
# Parameter Study - Response Spectra

```tcl
source READSMDFile.tcl
modelBuilder BasicBuilder -ndm 1 -ndf 1

# set a bunch of parameters
set PI 3.14159265
set g 386.4
set TnMin 0.1;  #min period
set TnMax 2.0; #max period
set TnIncr 0.1; #period incr
set M 1.0;         #mass
set A 1.0;         #area
set L 1.0;         #length
set motion ELCENTRO
set outFilename spectrum.dat

# open output file
Set outFileID [open $outFilename w]

#create accel series
ReadSMDFIle $motion.AT2 $motion.acc dt
Set accelSeries "Path -filePath $motion.acc \
     -dt $dt -factor $g"

# loop over period range
Set Tn $TnMin
while {$Tn <= $TnMax} {
    wipe
     set w [expr 2.0 * $PI / $Tn]
     set K [expr $w * $w * $M]
     set E [expr $k * $l / $A
```

```tcl
     node 1 0.0
     node 2 $l -mass $M
     fix 1 1
     uniaxialMaterial Elastic 1 $E
     element truss 1 1 2 $A 1
     pattern UniformExcitation 2 1 -accel $accelSeries
     rayleigh 0.0 0.0 0.0 0.0 0.0

     recorder EnvelopeNode -file envelope.out -node 2 -dof 1 disp
     system ProfileSPD
     test NormDispIncr 1.0e-16 10
    algorithm Newton
    integrator Newmark 0.5 0.25
    analysis Transient
    analyze 2000 $dt

    if [catch {open envelope.out r} inFileID]
        puts puts "ERROR - could not open file"

    set min [gets $inFileID]
    set max [gets $inFileID]
    set absMax [gets $inFileID]
    close $inFileID
    puts $outFileID "$Tn $absmax"
    set Tn [expr $Tn + $TnIncr]
}
close $outFileID
```