

Civil**FEM**[®]

INTRO ESSENTIAL

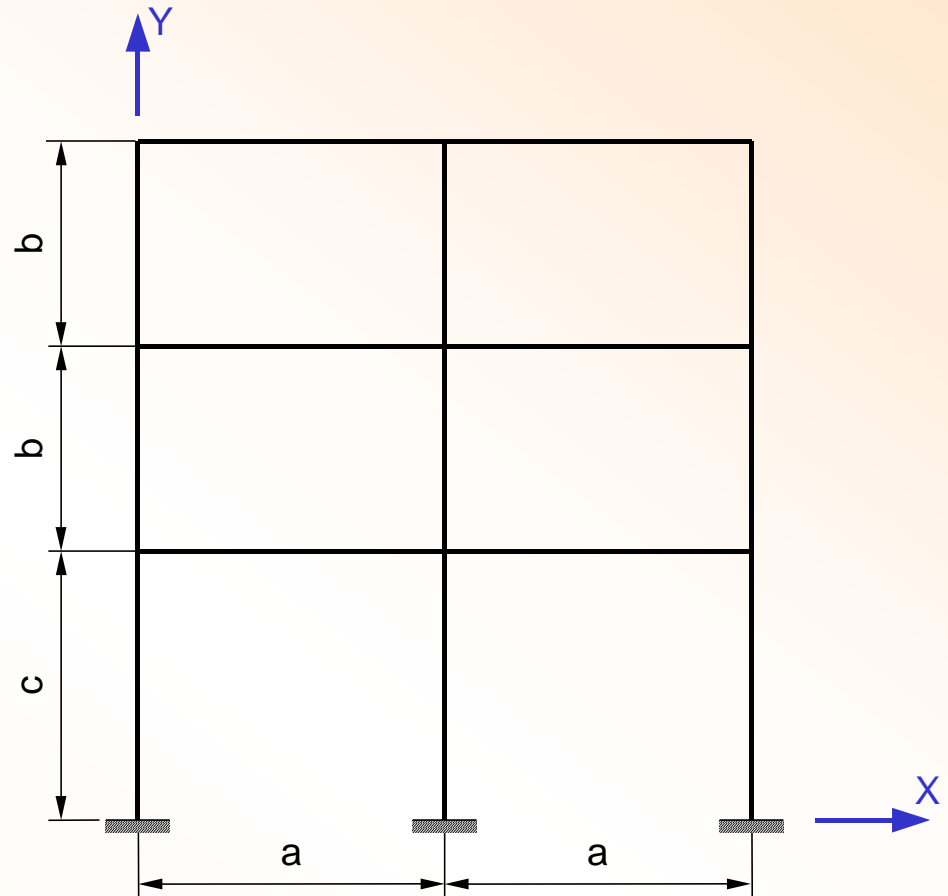
Practice 18 - Spectral
Analysis in a 2D Frame

Approach

The following frame is subjected to a linear response spectrum according to Eurocode No.8; the horizontal component is described below.

Objective

- Determine the seismic bending moment.



Geometric Properties

- $a = 5\text{m}$
- $b = 3.5\text{m}$
- $c = 4\text{m}$

Analysis Assumptions

- Units: m and N
- Element: Beam 3

Loads

- Dead load: 7.5 kN/m on floors and roof
- Live load: 5.0 kN/m on floors and roof

Spectral Analysis in a 2D Frame

0. CivilFEM Setup: Code & Units

- Select System international units and codes EC2, EC3, EC2 and EC8.

Or issue:

```
~UNITS,SI
```

```
~CODESEL,EC3-92,EC2-91,EC2-91,,EC8-94
```

1. Define materials.

- Select A42 steel from material library.

Or issue:

```
/PREP7
```

```
~CFMP,1,LIB,STEEL,EA,A42
```

2. Define element types.

- Select Beam 3 from the civil beams window.

Or issue: ET,1,BEAM3

3. Define sections.

- Select HE 300 B and HE 400 B from hot rolled sections library.

Or issue: ~SSECLIB,1,1,6,11

```
~SSECLIB,2,1,6,15
```

4. Define Beam & Shell properties (real constants)

- Define Beam1 with cross section 1 and Beam 2 with cross section 2.

Or issue:

```
~BMSHPRO,1,BEAM,1,1,,,3,1,0 ! Real 1
```

```
~BMSHPRO,2,BEAM,2,2,,,3,1,0 ! Real 2
```

5. Add mass of gravity loads (7.5 + 5.0 kN/m).

```
Issue:RMODIF,2,6,12500/9.81
```

Modifies Constant No.6 = ADDMAS = 12500/9.81 N/m

This command cannot be accessed from a menu.

6. Solid model

6.1 Column at X=0

Create Keypoints:

Keypoint	X	Y	Keypoint	X	Y
1	0	0	2	0	4
3	0	7.5	4	0	11

Create lines between keypoints 1 and 2, 2-3, 3-4.

Or issue

K,1

K,2,,4

K,3,,3.5+4

K,4,,3.5+4+3.5

L,1,2

L,2,3

L,3,4

Spectral Analysis in a 2D Frame

6.2 Columns at X=5 and 10

Generate copies of the left column at X=5 and X=10.

Or issue: LGEN, 3, 1, 3, , 5, , , 4

6.3 Assign Column Attributes.

Main menu>Preprocessor>Meshing>Mesh Attributes>All Lines

Select Mat 1, Real 1 and Type 1 for all the columns.

Or issue: LATT, 1, 1, 1

6.4 Beams

- Create a line between keypoints 2-6.
- Copy this line to generate all beams.

Or issue

L, 2, 6

LGEN, 2, 10, 10, , 5, , , 4

LGEN, 3, 10, 11, , , 3.5, , 1

6.5 Beams Attributes

Select Beam lines and assign the Mat 1, Real 2 and Type 1.

Select everything.

```
Or issue  
LSEL,S,,,10,15  
LATT,1,2,1  
LSEL,ALL
```

7. Mesh

Define element size=6 and mesh all lines.

```
Or issue  
ESIZE,,6  
LMESH,ALL
```

8. Constraints

Constrain all DOFs at keypoints 1,5, 9.

```
Or issue:  
/SOLU  
DK,1,ALL  
DK,5,ALL  
DK,9,ALL
```


9. CivilFEM Seismic Design

9.1 Define spectrum.

Main Menu>Seismic Design>Define Spectrum>By code

Or issue:

```
~DEFSPEC, ALL, 1.2753, A, LINEAR, 1, 1, 5
```

[~DEFSPEC] Define spectrum for analysis by Eurocode No.8 (EN 1998-1-1: 1994)

Design ground acceleration [ag] (Part 1-1, 4.2.2(1)P)
[ag] AG 1.2753

Subsoil class (Part 1-1, 3.2.(1)P)
SCLASS Class A
 Class B
 Class C

Spectrum type (Part 1-1, 4.2.2 and 4.2.4)
SPTYPE Design
 Elastic

Behavior factor [q] (Part 1-3, Sections 2.3)
Horizontal behavior fact. QH 1
Vertical behavior fact. QV 1

Damping factor (Part 1-1, 4.2.2)
DMPRAT 5

Map
OK Cancel Help

9.2 Plot the spectrum horizontal component.

Main Menu>Seismic Design>Plot Spectrum

Or issue

```
~P_SPEC, HORIZONTAL, 0, 3.5,
```

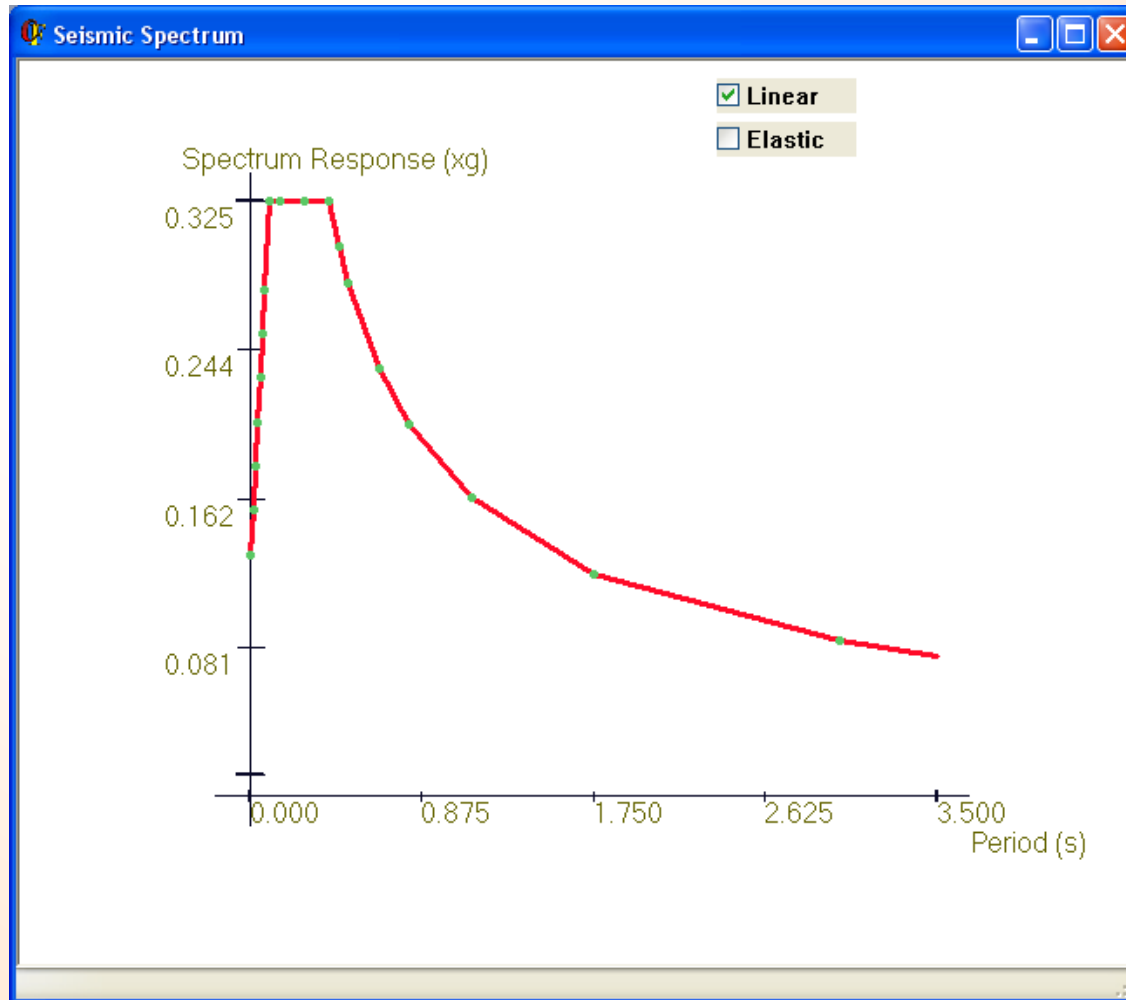
[~P_SPEC] Plot spectrum

Spectrum component SPCMP Sd(T) Horizontal
 Sd(T) Vertical

Period range T1 T2 0 3.5

Results

9.2 Horizontal Spectrum



Spectral Analysis in a 2D Frame

9.3 Extract Modes

Main Menu>Seismic Design>Modal Solution

- **Extract 20 modes.**

Or issue

~MODLSOL, 20

9.4 Combine the modes.

Main Menu>Seismic Design>Combine Modes

Or issue

~CMBMOD, HORIZONTAL, VERTICAL, NONE, 0, 0.0001

9.5 List Modes

Main Menu>Seismic Design>List Modes

- **Press enter.**

Or issue:~L_MOD,,,

[~MODLSOL] Obtain modal solution

Number of modes to be extracted

Extraction Method

Block Lanczos

Subspace iteration

Householder (reduced)

[~CMBMOD] Combination of modal responses

X-Direction spectrum comp. CMPX

None

Horizontal

Vertical

Y-Direction spectrum comp. CMPY

None

Horizontal

Vertical

Z-Direction spectrum comp. CMPZ

None

Horizontal

Vertical

Coordinate system KCS

Significance factor SGNFACT

Selection

SRSS

CQC

DSUM

GRP

NRLSUM

Results

9.5 List Modes

LIST OF MODES (MODE COMBINATION RESULTS)

From 1 to 20

X Direction

Mode	Period (s)	Frequency (1/s)	Omega (1/s)	Spectral values (Normalized by gravity)	Combination Coefficient	Participation Factor	Effective Mass
1	371.860E-03	2.689E+00	16.897E+00	44.351E-03	2.292E+00	205.280E+00	42.139E+03
2	118.800E-03	8.417E+00	52.888E+00	45.217E-03	67.460E-03	59.184E+00	3.503E+03
3	70.026E-03	14.280E+00	89.726E+00	45.384E-03	-7.567E-03	-23.275E+00	541.732E+00
4	46.853E-03	21.343E+00	134.103E+00	45.463E-03	-186.906E-06	-1.545E+00	2.387E+00
5	46.791E-03	21.372E+00	134.281E+00	45.463E-03	2.112E-09	17.511E-06	306.645E-12
6	41.424E-03	24.141E+00	151.680E+00	45.482E-03	188.978E-06	2.099E+00	4.404E+00
7	39.555E-03	25.281E+00	158.848E+00	45.488E-03	-147.653E-06	-1.832E+00	3.355E+00
8	32.931E-03	30.367E+00	190.801E+00	45.511E-03	-72.985E-12	-1.389E-06	1.930E-12
9	31.797E-03	31.449E+00	197.602E+00	45.515E-03	45.947E-12	948.520E-09	899.689E-15
10	24.191E-03	41.338E+00	259.734E+00	45.541E-03	-3.530E-09	-136.550E-06	18.646E-09
11	18.203E-03	54.936E+00	345.170E+00	45.561E-03	-4.782E-06	-347.740E-03	120.926E-03
12	13.682E-03	73.088E+00	459.227E+00	45.577E-03	12.643E-06	1.733E+00	3.002E+00
13	13.452E-03	74.337E+00	467.074E+00	45.577E-03	403.534E-12	57.423E-06	3.297E-09
14	13.281E-03	75.298E+00	473.112E+00	45.578E-03	-33.315E-06	-4.872E+00	23.740E+00
15	13.084E-03	76.430E+00	480.221E+00	45.579E-03	-99.496E-12	-15.007E-06	225.202E-12
16	12.383E-03	80.753E+00	507.385E+00	45.581E-03	-115.404E-12	-19.500E-06	380.268E-12
17	12.163E-03	82.216E+00	516.578E+00	45.582E-03	-512.708E-12	-89.907E-06	8.083E-09
18	11.880E-03	84.177E+00	528.900E+00	45.583E-03	1.151E-09	211.990E-06	44.941E-09
19	11.668E-03	85.706E+00	538.509E+00	45.584E-03	2.242E-09	428.380E-06	183.508E-09
20	9.581E-03	104.377E+00	655.820E+00	45.591E-03	7.981E-06	2.291E+00	5.248E+00

Spectral Analysis in a 2D Frame

10. Plot of the bending moments about the Z axis.

10.1 Read Results

- Read combined modes results (load step 2)**

Or issue: `~CFSET,,2`

10.2 Plot bending moments about the Z axis.

Main Menu>Civil Postprocessor>Beam Utilities>Graph Results>Forces/Moments

Or issue: `~PLLSFOR,M,Z,-1`

Results

10.2 Bending moments about the Z axis

