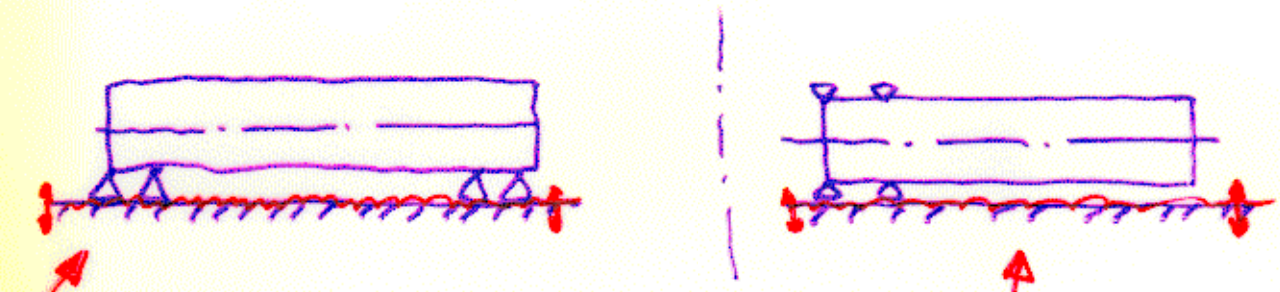
4. Spectrum Analysis.



KEK (Tsukuba exp hall)

3 mHz — 3 μm.
100 mHz — 1 μm
1 Hz — 10 nm
3 Hz — 5 nm

IV/217

(Reference)

MEASUREMENT OF THE SEISMIC MOTION AND THE DISPLACEMENT OF THE FLOOR IN THE TRISTAN RING

Ryuhei Sugahara, Kuninori Endo and Yasunobu Ohsawa
National Laboratory for High Energy Physics, Tsukuba-shi, Ibaraki-ken, Japan

1. INTRODUCTION

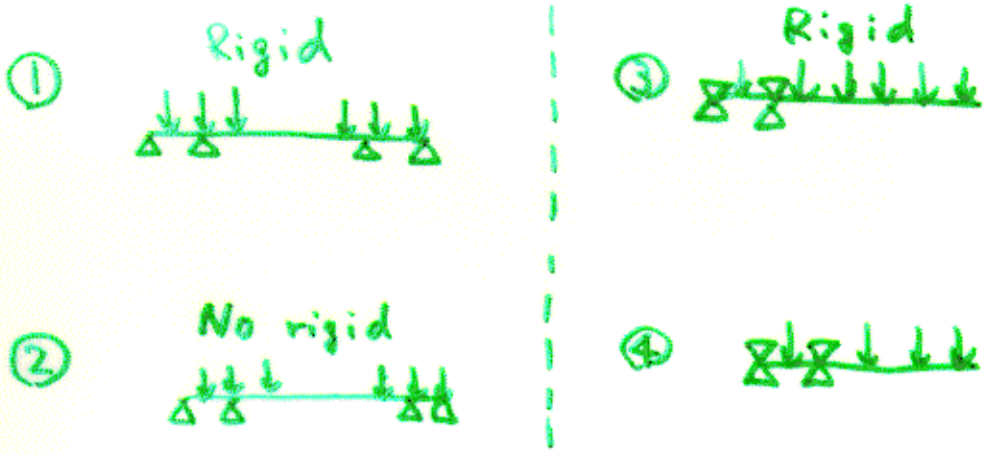
The design value for the beam size at the KEK B-factory is:

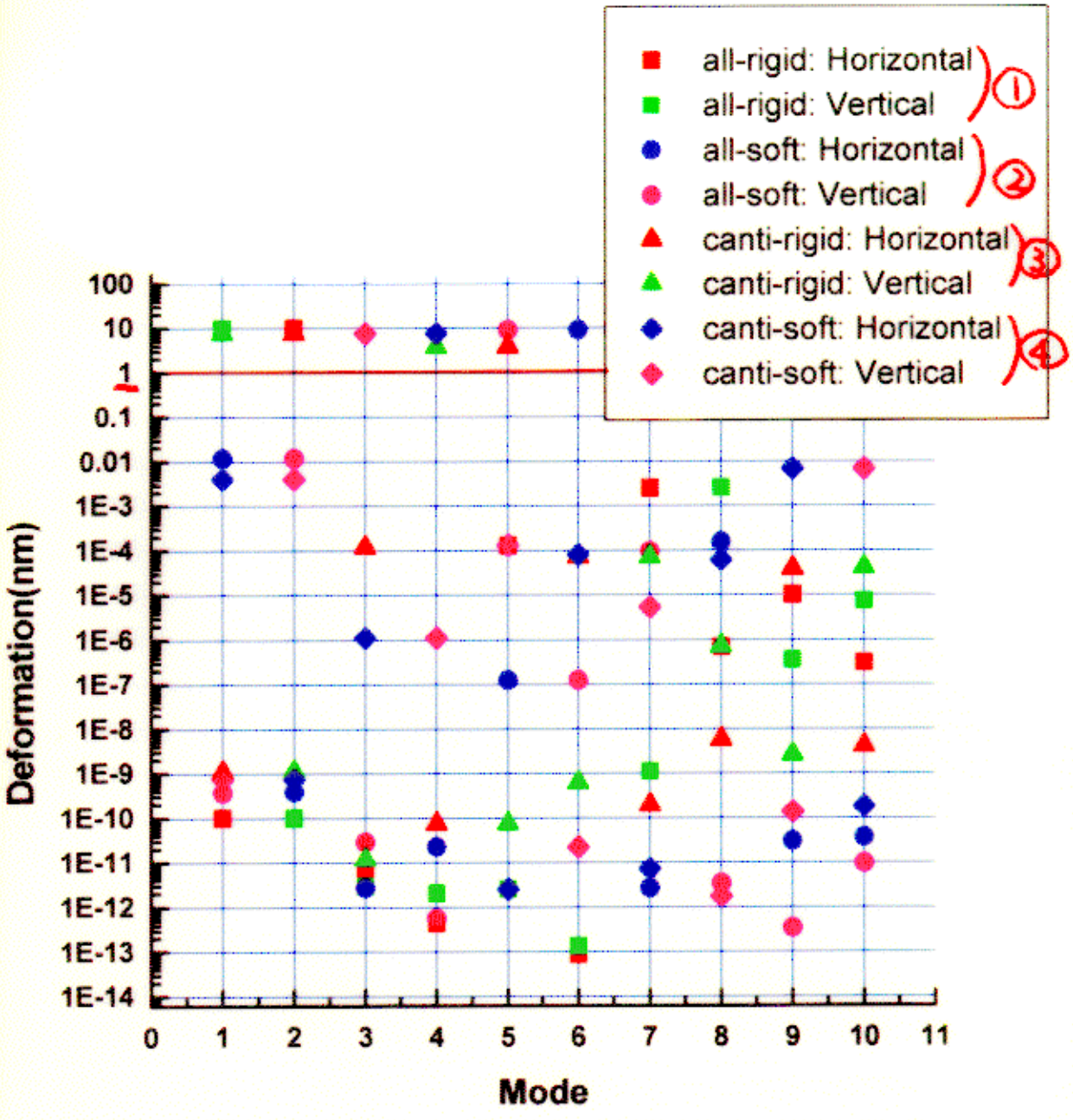
$\sigma_x = 140$ μm and $\sigma_y = 1.4$ μm [1].

Hereafter the coordinate system is defined as: X is the horizontal axis and Y the vertical axis in the plane perpendicular to the beam axis, and Z is along the beam axis. The beam collision is sensitive to the displacement of magnets located around the interaction point. For example, if the final quadrupole magnet moves vertically by 0.1 mm or more, the luminosity will drop noticeably. TRISTAN ring, electron-positron collider with diameter of 1 km, is planned to be modified as a B-factory.

The seismic motion and the displacement of the floor at TRISTAN ring were measured. Measurement was carried out in Fuji and Tsukuba interaction regions. At TRISTAN ring are located four experimental halls; two are big halls and other two are relatively small. Fuji and Tsukuba experimental halls are big ones having almost the same structure and located diagonally each other. In the B-factory project, the collision point is to be placed in Fuji experimental hall at present. The plan view of the experimental hall is shown in Fig.1. The floor in the experimental hall is 16.5 m deep and that in the accelerator straight section is 12.1 m deep from the ground surface. In the experimental hall, magnets are fixed on the movable base whose top surface is 5.7 m high above the concrete floor.

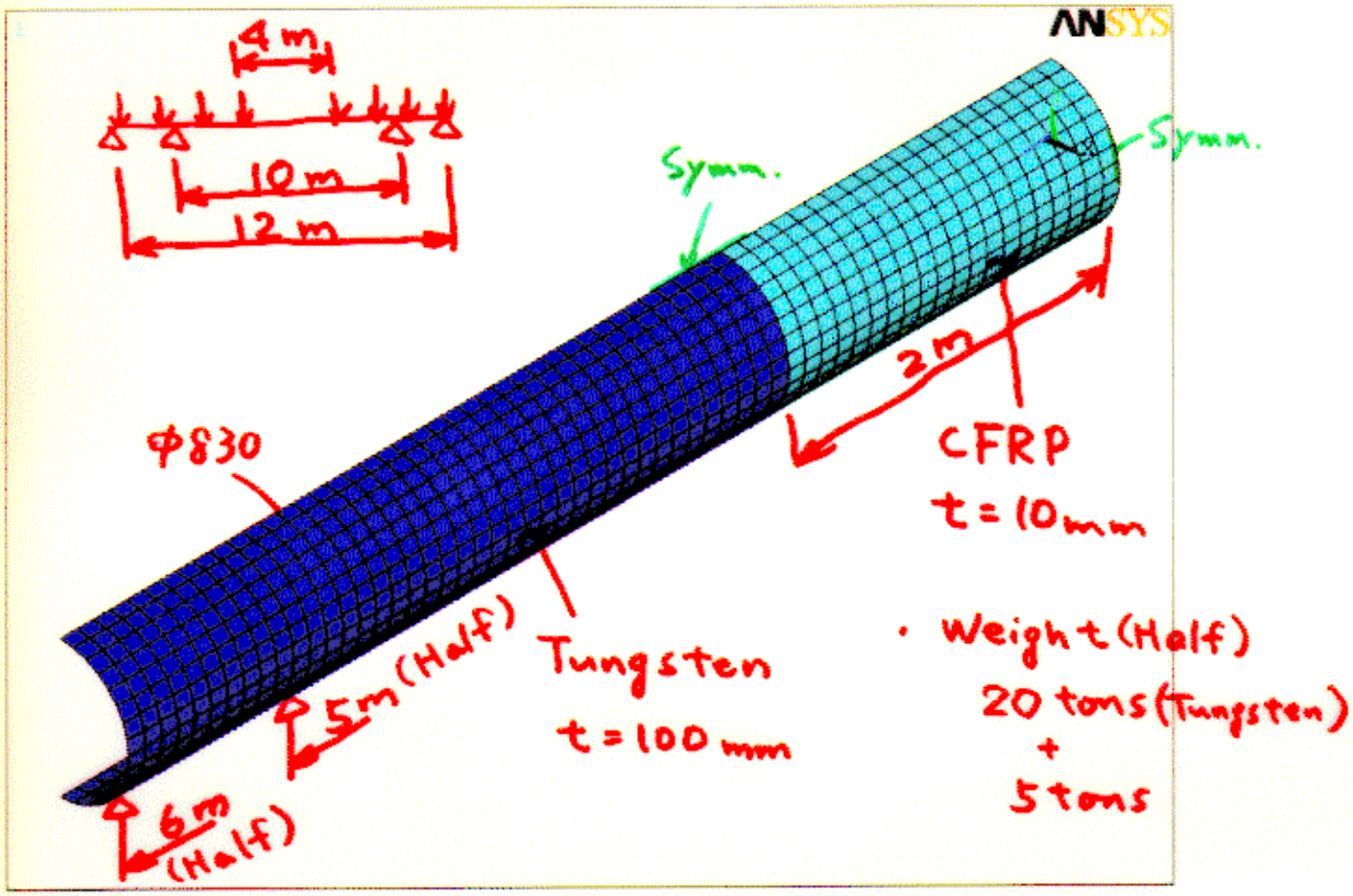
(2) Deformation response





2. Static Analysis

(1)-a Simply supported at both ends



O CFRP

Young's modulus: $1.5 \times 10^4 kg/mm^2$(150GPa)

Density : $1.5 \times 10^{-6} kg/mm^2$

O Tungsten

Young's modulus: $4.15 \times 10^4 kg/mm^2$(415GPa)

Density : $19.3 \times 10^{-6} kg/mm^2$

!! Rigidity of Tungsten is taking account.

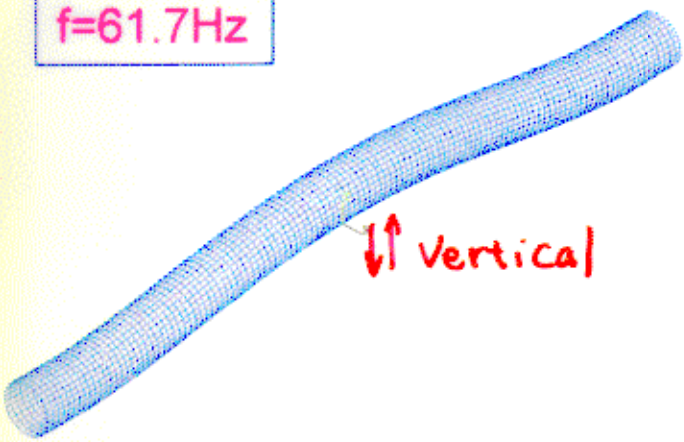
↳ $D = E_T \cdot I_T$ (Tungsten) + $E_c \cdot I_c$ (CFRP) $I = \frac{\pi(d_o^4 - d_i^4)}{64}$

3. Natural Frequency

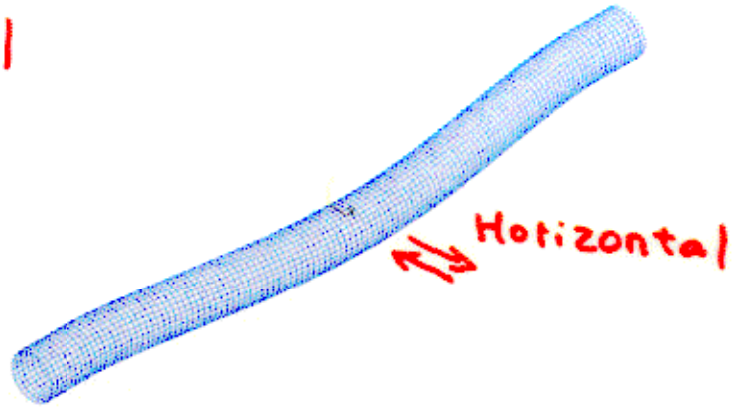
(1) In case of rigid Tungsten mask

(1)-a Simply supported at both ends

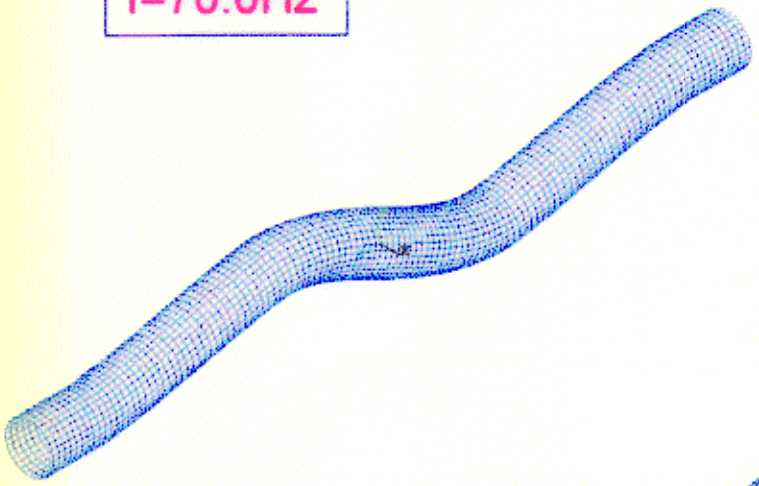
1st mode
f=61.7Hz



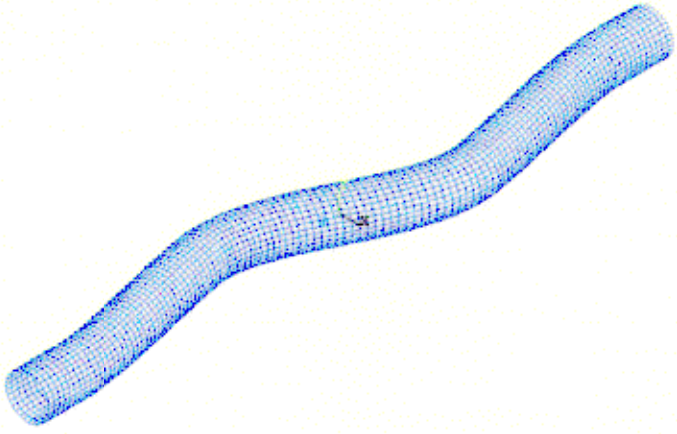
2nd mode
f=61.9Hz



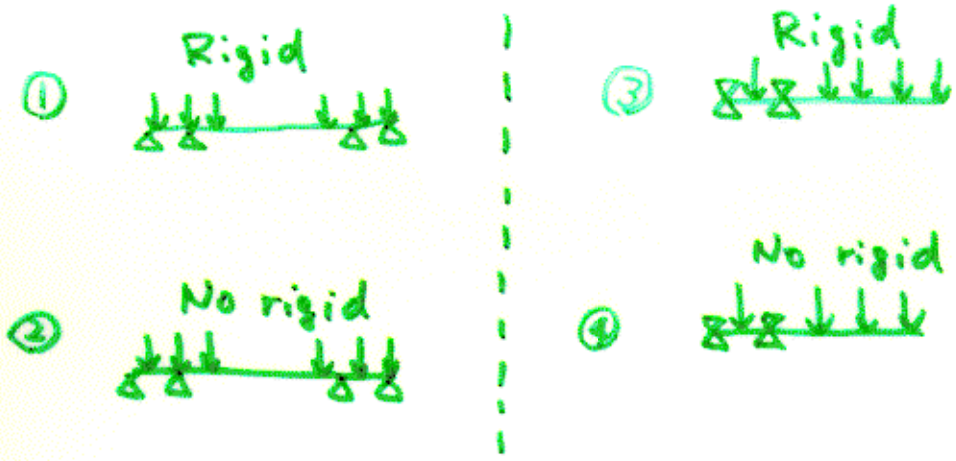
3rd mode
f=70.0Hz

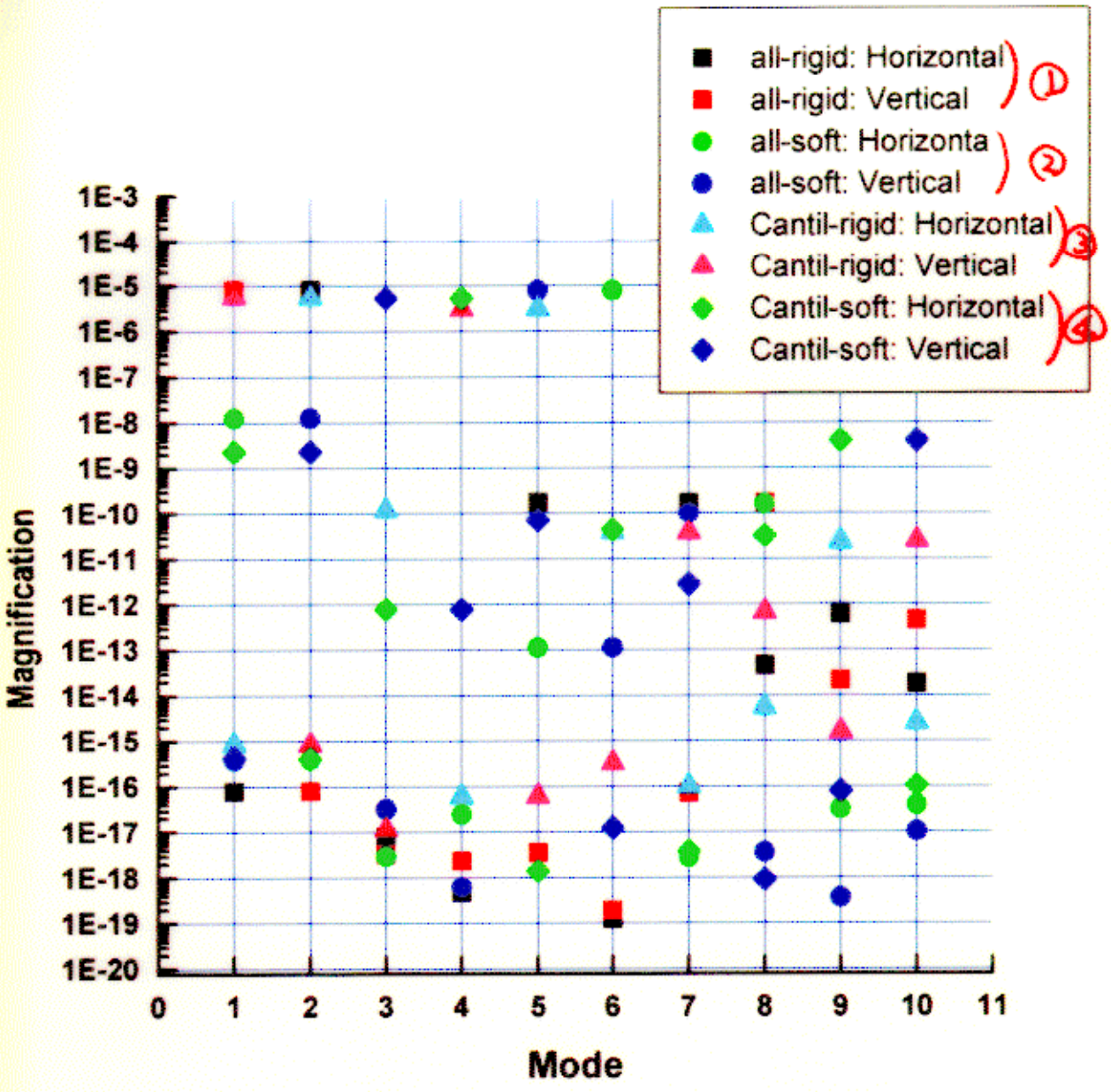


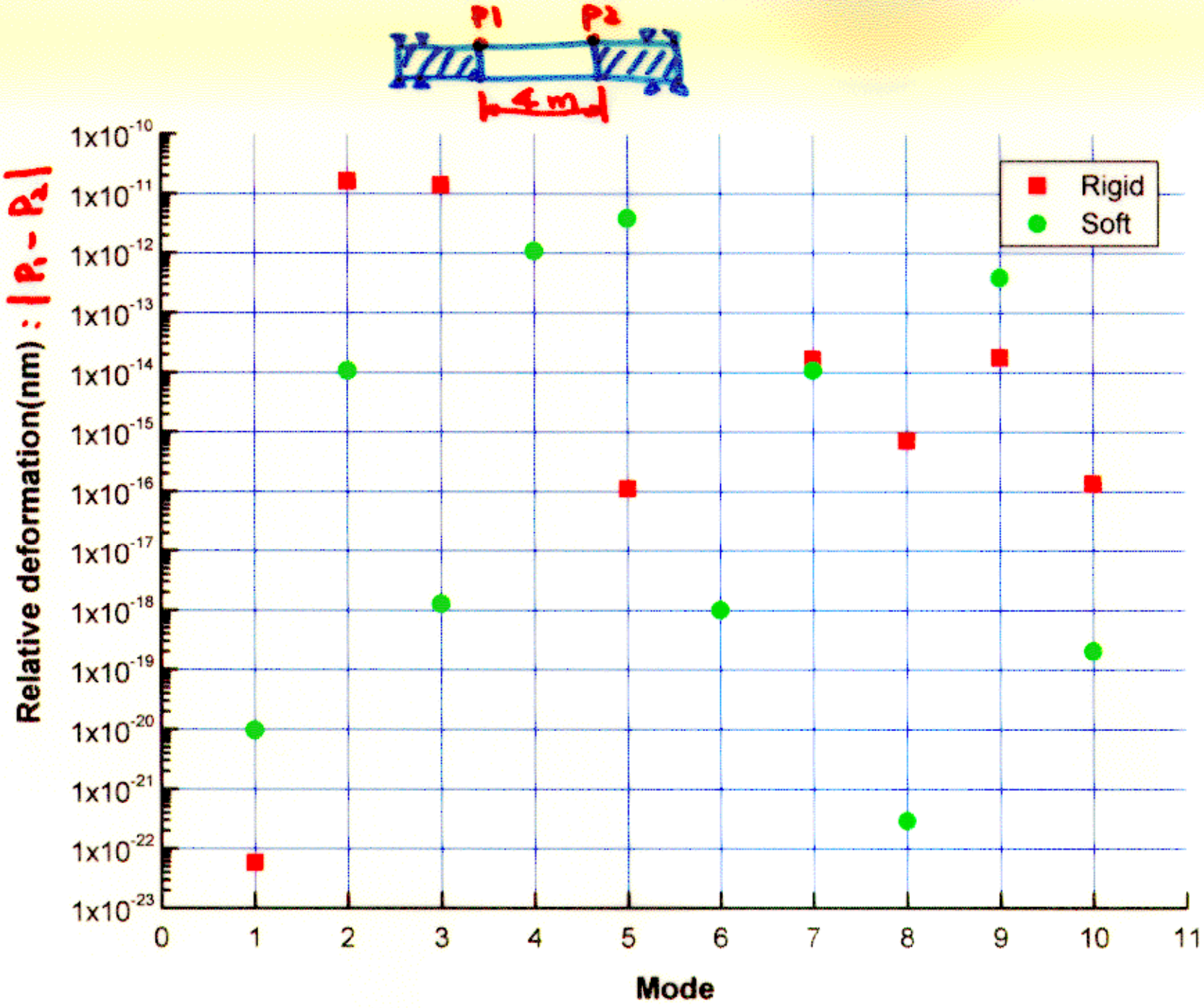
4th mode
f=70.2Hz



(2) Magnification

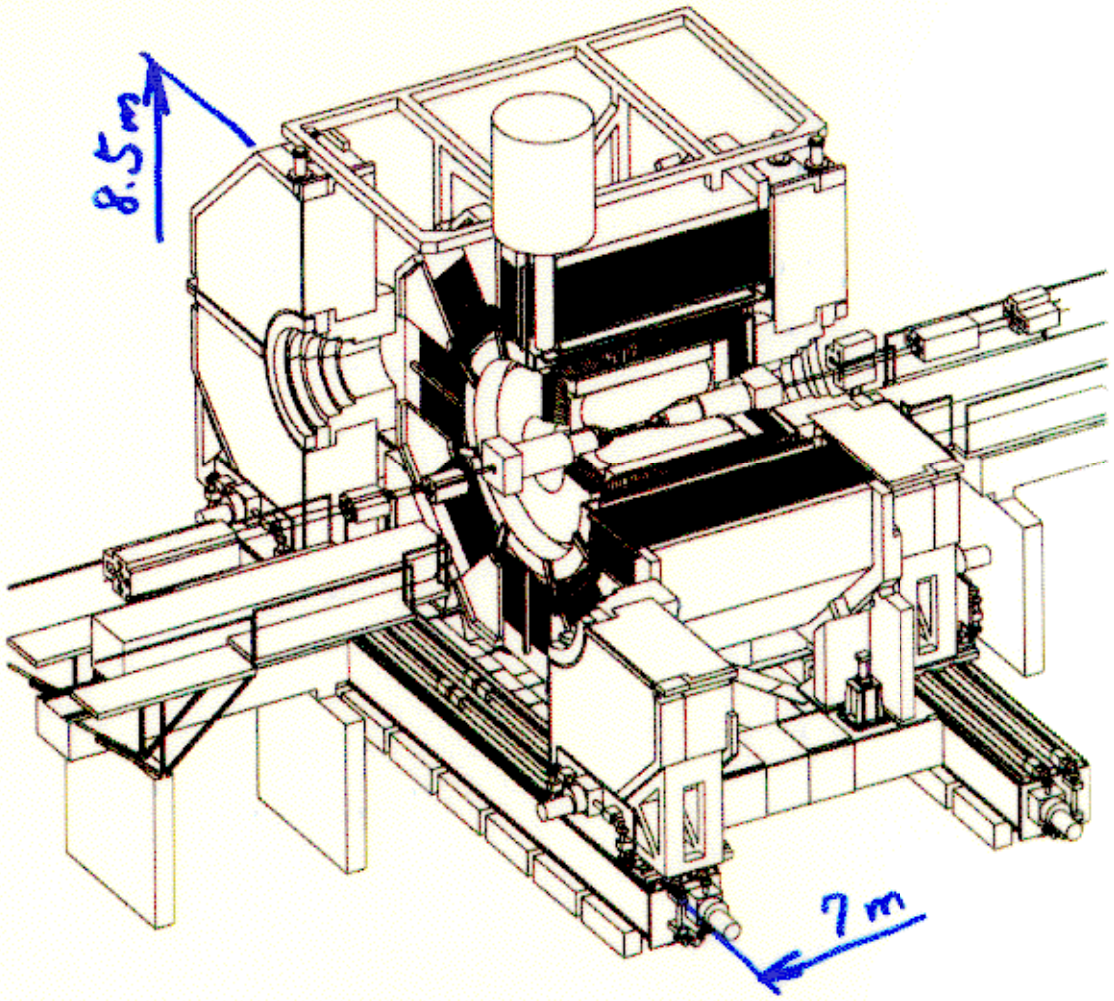





P1
P2
4m
Relative deformation(nm) : |P1 - P2|
1x10-10
1x10-11
1x10-12
1x10-13
1x10-14
1x10-15
1x10-16
1x10-17
1x10-18
1x10-19
1x10-20
1x10-21
1x10-22
1x10-23
0
1
2
3
4
5
6
7
8
9
10
11
Mode
Rigid
Soft

Configuration

Overview



- **Weight**
  - B. Yoke: 620tonnes
  - E. Yoke: 550tonnes
  - TOPAZ stand: 60tonnes
  - Others: 90tonnes

  Total: 1320tonnes

- **Iron: S10C**

  (Carbon: 0.01wt%)

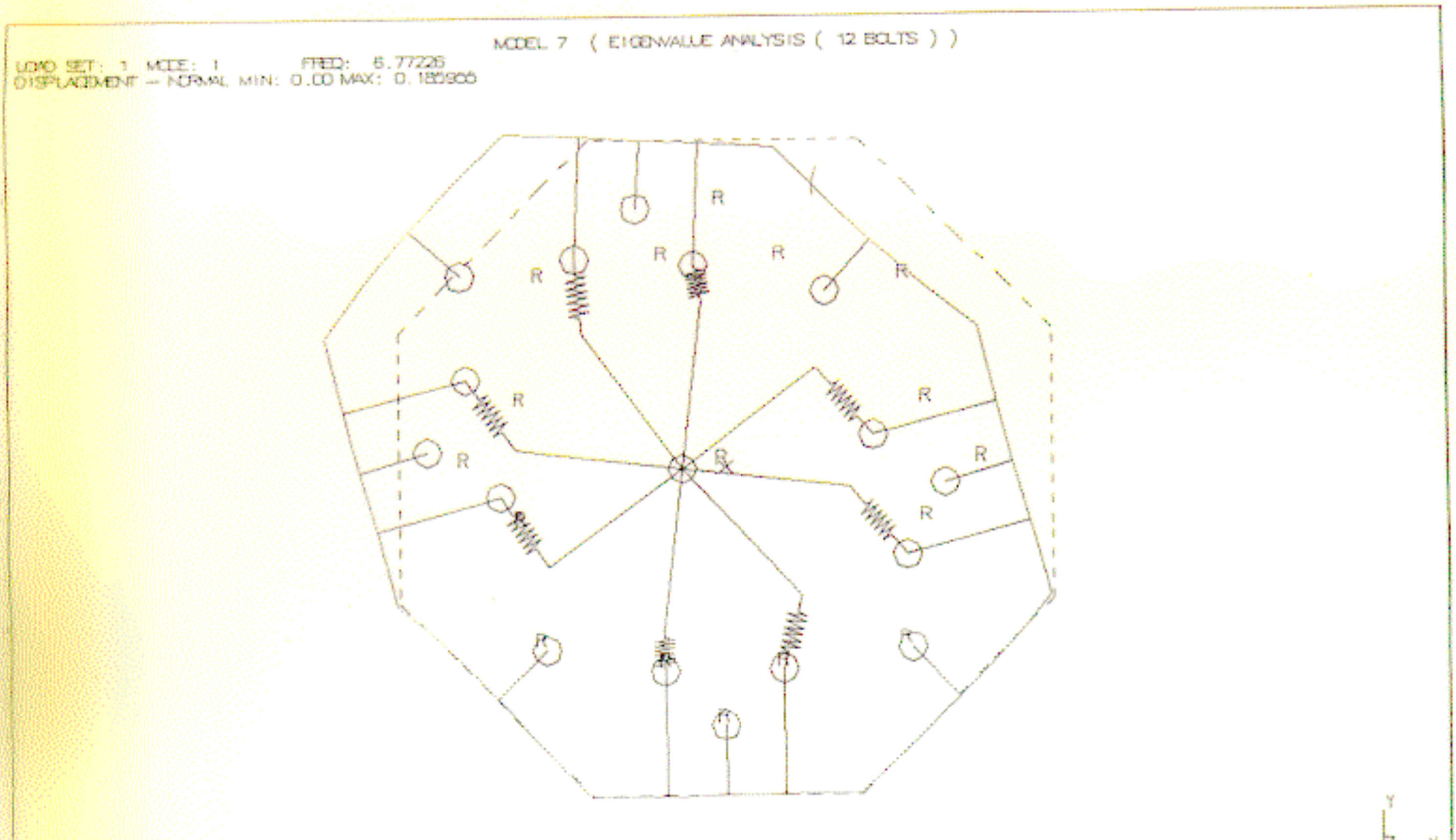


図-2　1次振動モード（水平方向1次）

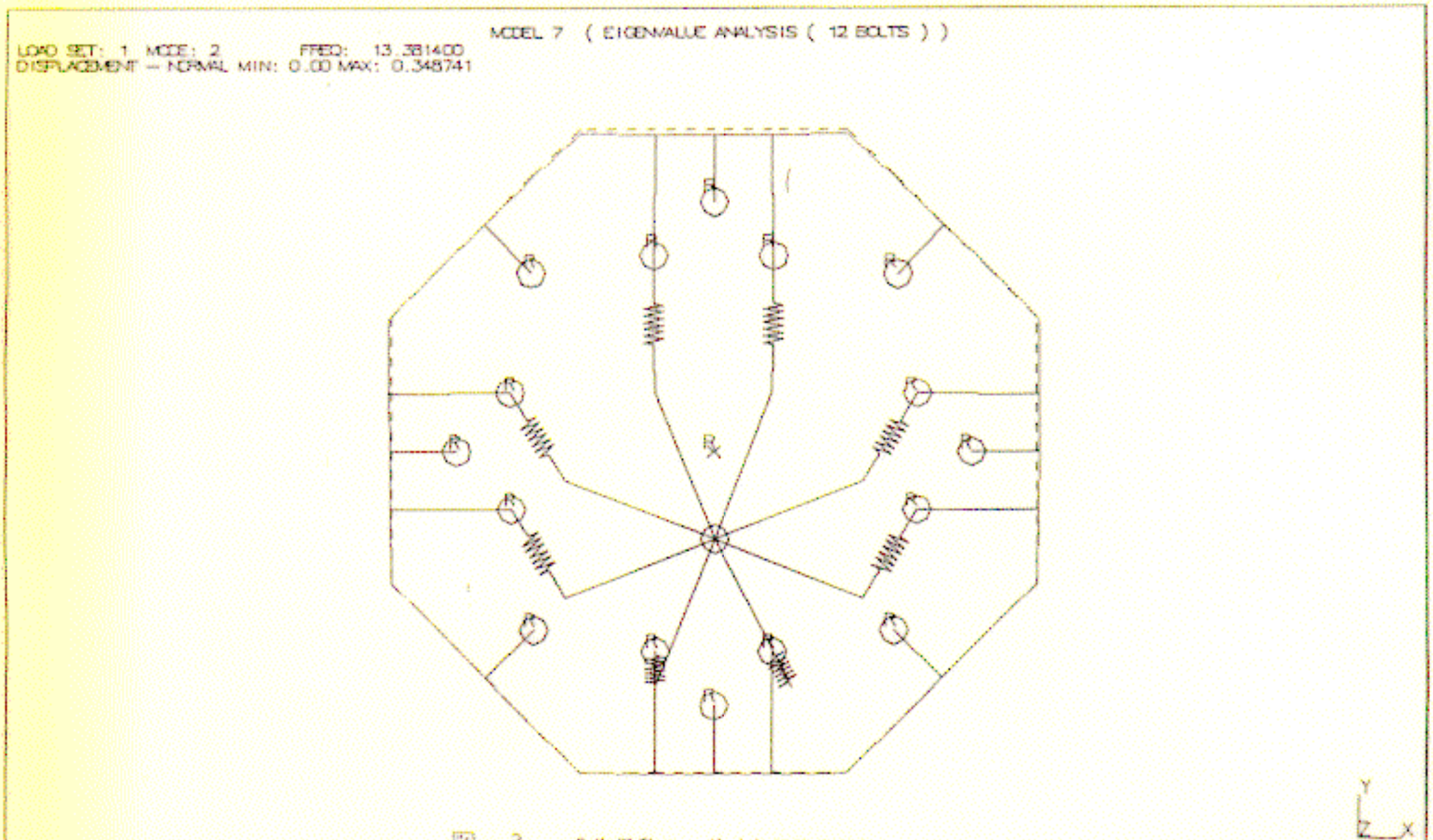
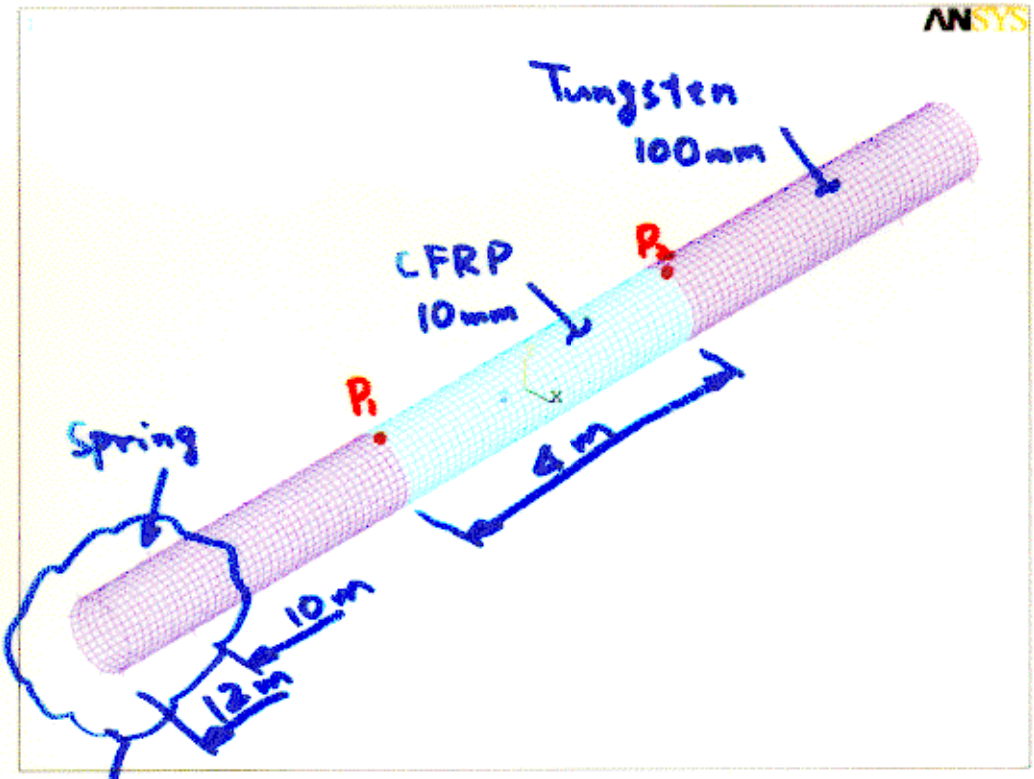
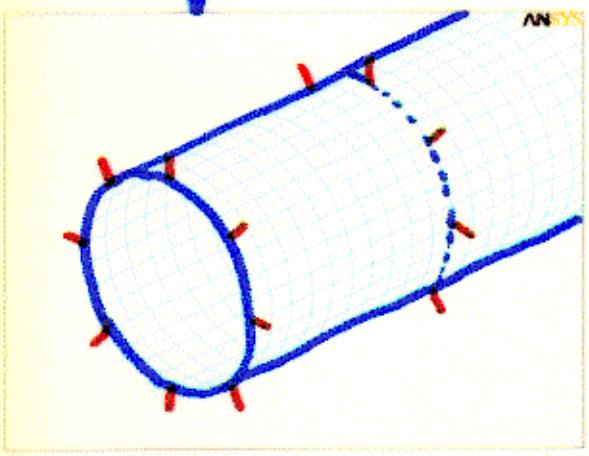
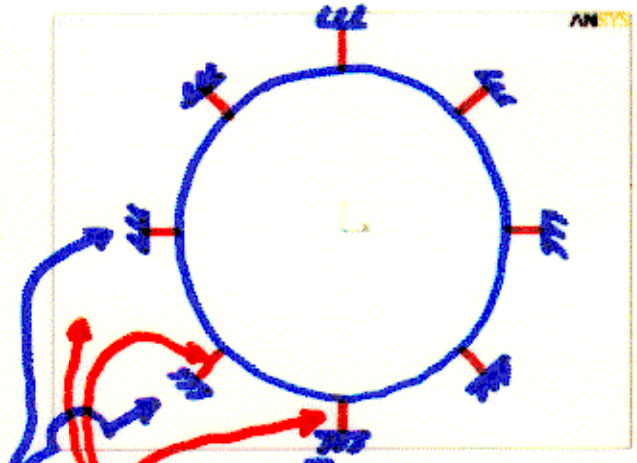


図-3　2次振動モード（内部検出器）



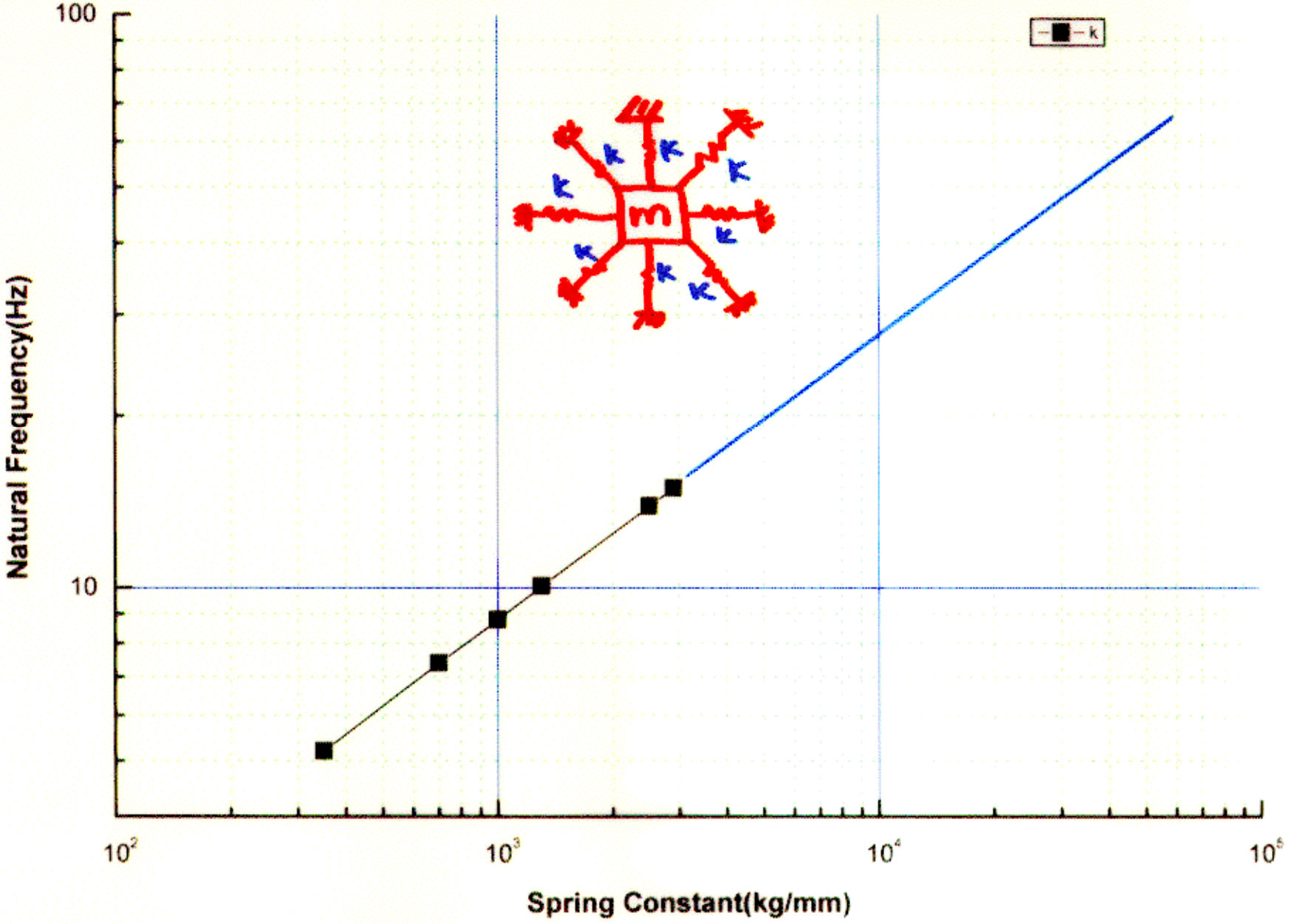




Spring Constant : k

3m Hz : 3 μm
100m Hz : 1 μm
1 Hz : 10 nm
3 Hz : 5 nm

f = 5 Hz
10 Hz
15 Hz
50 Hz
100 Hz


100
10
Natural Frequency(Hz)
k
m
k
k
k
k
k
k
k
k
k
10^2
10^3
10^4
10^5
Spring Constant(kg/mm)

5Hz

① 5.2Hz

② 5.2Hz

③ 10.2

④ 10.2

5. 93.0

6. 93.0

7. 102

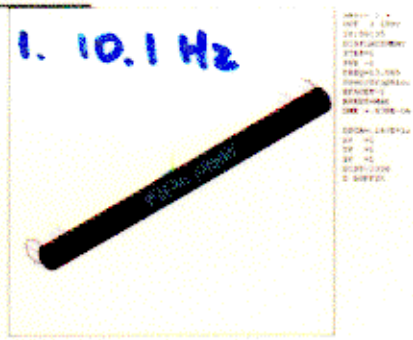
8. 102

9. 310

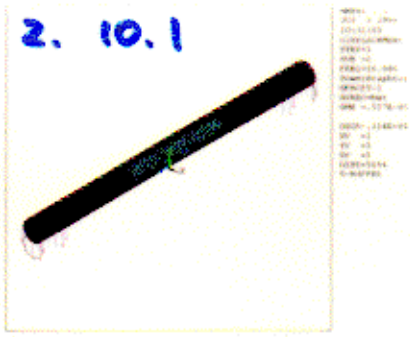
10. 310

10Hz

1. 10.1 Hz

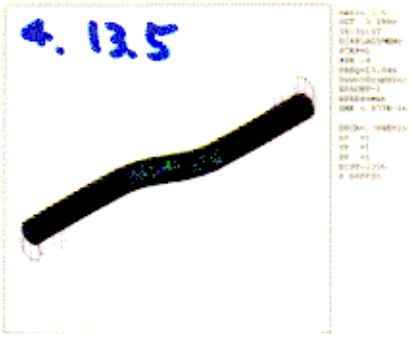


2. 10.1



3. 13.5

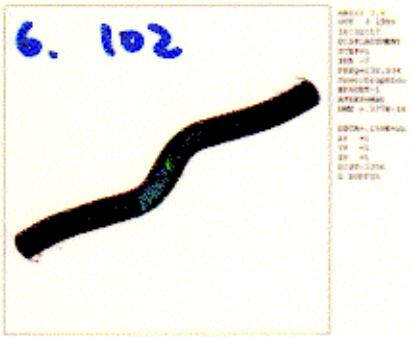
4. 13.5



4. 93.3

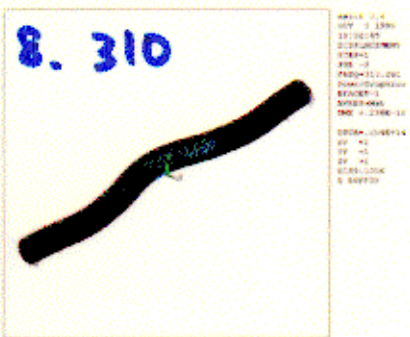
5. 93.3

6. 102



7. 102

8. 310

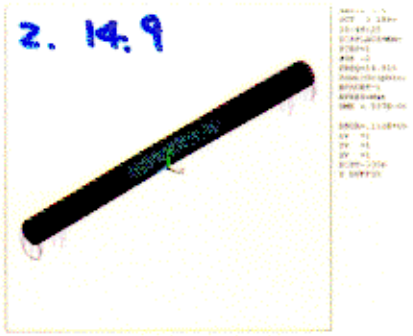


10. 310

15Hz

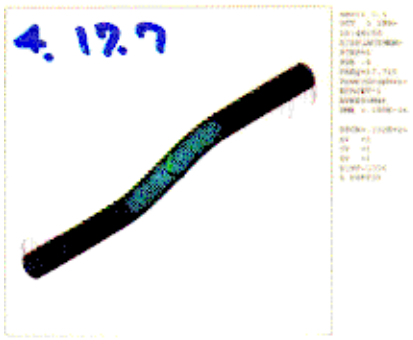
1. 14.9 Hz

2. 14.9



3. 17.7

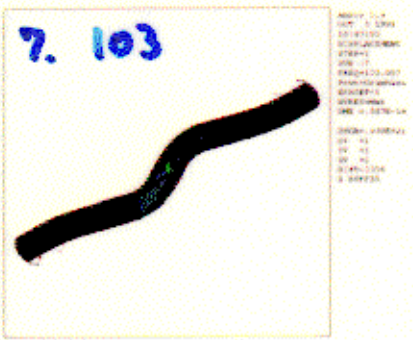
4. 17.7



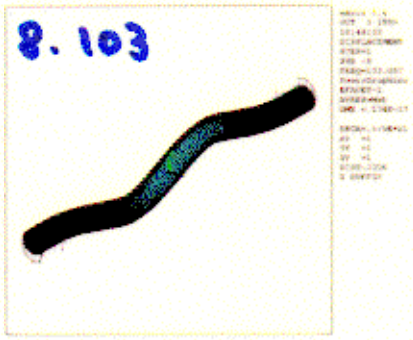
5. 93.9

6. 93.9

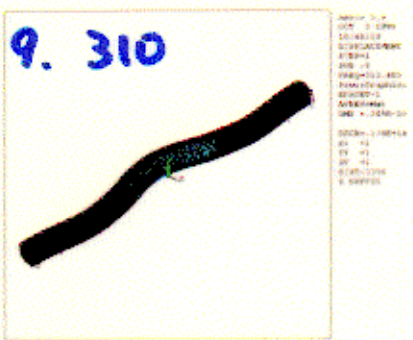
7. 103



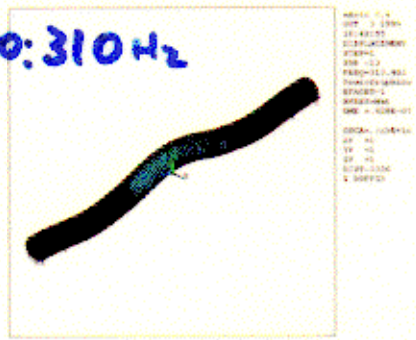
8. 103



9. 310



10. 310 Hz



50Hz

1. 49.9 Hz

2. 49.9

3. 53.7

4. 53.7

5. 114

6. 114

7. 121

8. 121

9. 317

10. 317

100Hz

1. 57.2

2. 57.2

3. 63.2

4. 63.2

5. 134

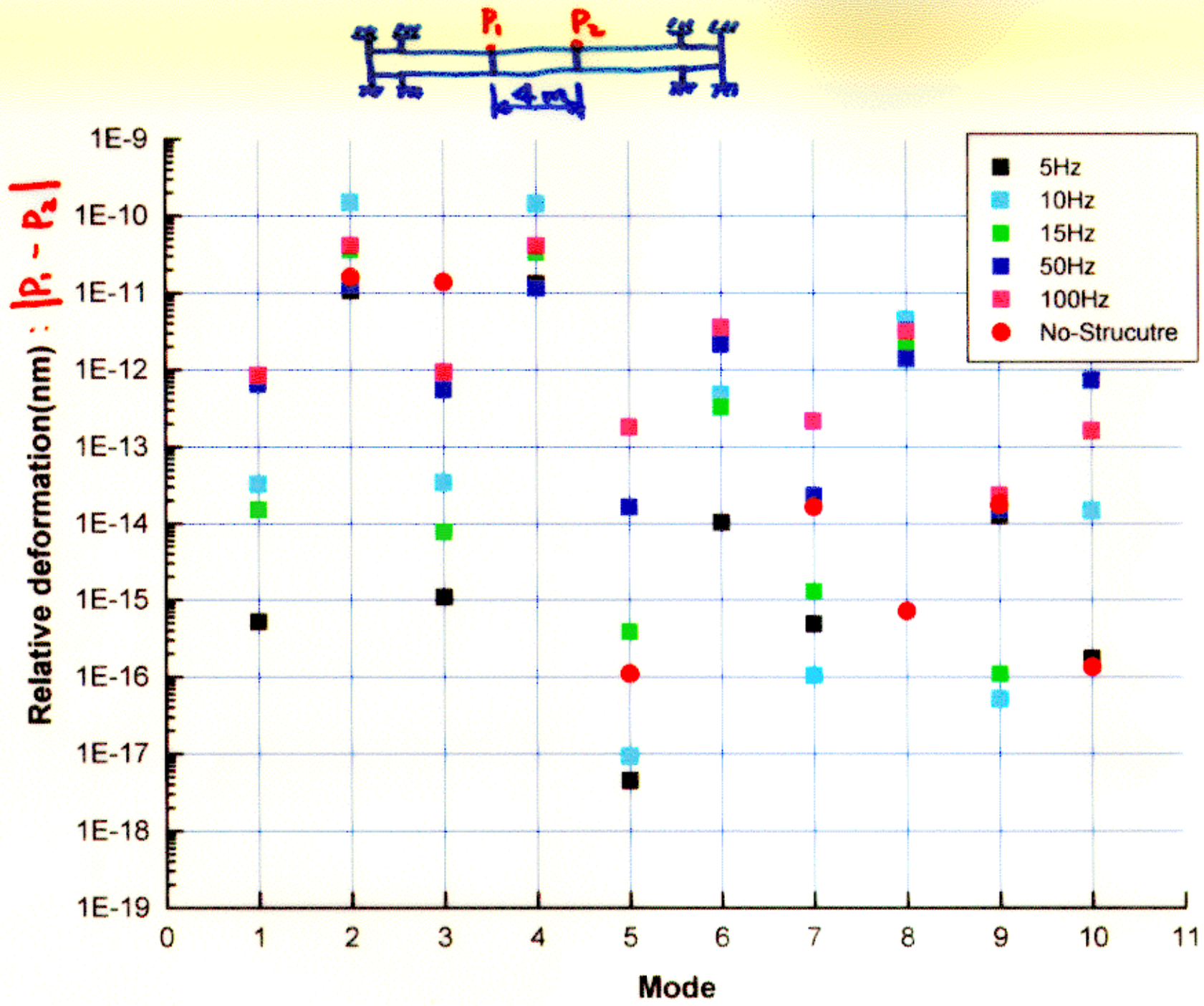
6. 134

7. 139

8. 139

9. 323

10. 323


P1
P2
4m
Relative deformation(nm) : |P1 - P2|
1E-9
1E-10
1E-11
1E-12
1E-13
1E-14
1E-15
1E-16
1E-17
1E-18
1E-19
0
1
2
3
4
5
6
7
8
9
10
11
Mode
5Hz
10Hz
15Hz
50Hz
100Hz
No-Strucutre