DYNAMIC STRUCTURAL ANALYSIS OF THE SECTOR MAGNET OF THE RIKEN SSC

M. Hara, T. Wada and M. Deto*

The Institute of Physical and Chemical Research
* Nihon University

Abstract

Dynamic structural analysis of the sector magnet of the RIKEN SSC was performed using three-dimensional code SAP-5 for earthquake resistant design. It was found that the sector magnet can withstand a sinusoidal external force with strength of about 200 Gal.

1. Introduction

Finite element method is widely used not only for structural analyses but also for thermal conductive, fluid-dynamical, and electromagnetic field problems. It is used because of flexibility in the complicated structures and because of easy handling of boundary conditions. We used three-dimensional code SAP-5 for the static and dynamic structural analyses of the sector magnet. In the present case, we calculated eigenvalues/eigenvectors and forced dynamic response by mode superposition.

2. Eigenvalue/eigenvector Solution

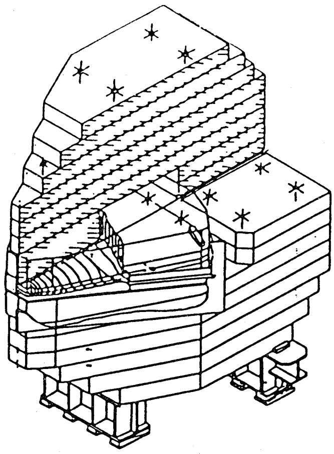
In static analysis of the sector magnet, we used solid and truss type elements. In dynamic analysis, solid type elements only are used. The supporting feet of the magnet are fixed on the floor. Figure 1 shows the layout of the magnet and the subdivision for carrying out the calculations. Element type is eight node brick, and the numbers of nodal points and elements are 2407 and 1656, respectively. Table 1 lists the materials and their physical constants which are used in the present analyses. Table 2 shows the calculated characteristic frequencies of the sector magnet. Figure 2 shows the 1st mode oscillation.

3. Forced Dynamic Response by Mode Superposition

In this case, two kinds of sinusoidal force are used. At first, an external force with frequency of 14.0 Hz and amplitude of 20.0 Gal was applied in X-direction and after 0.25 sec, another force with 6.0 Hz and 200.0 Gal superimposed on the Y-direction in order to simulate earthquake waves(S and P waves). In the response history analysis, used are five mode shapes and frequencies in the eigenvalue solution. The damping factor of 0.02 is applied for the magnet. The forced dynamic response is calculated in the time of 0.002 sec. Tables 3 and 4 show the histories and the maxima of displacement and stress of the front gap spacer.

References

1) K. J. Bathe et al.: "SAP-5 User's Manual", University of California Report NO. EERC 73-11(1974)
2) Y. IKEGAMI et al.: RIKEN Accelerator Progress Report, 15, 166(1981)



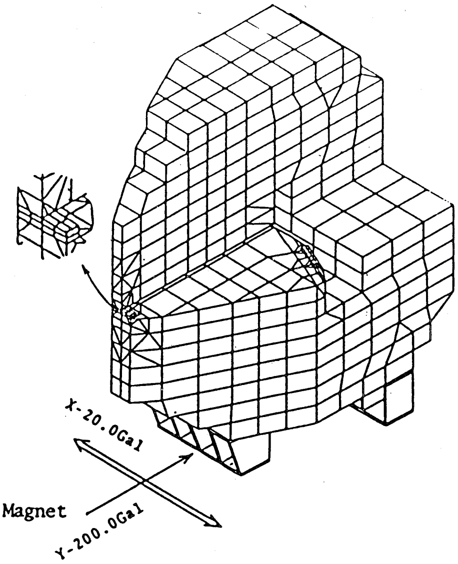


Fig.1 Layout and Subdivision of Sector Magnet

Table 1 Materials and their physical constants

Part	Material	Specific gravity	Young's modulus (kg/mm^2)	Poisson's ratio
Pole	Pure iron	7.87	21000	0.3
Yoke	Soft iron	7.70	21000	0.3
Spacer	SUS	8.03	21000	0.3

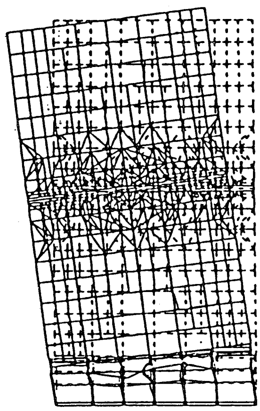


Fig.2 1st mode (front view)
f=10.2078 Hz

Table 2 Characteristic Frequencies

Mode	Frequency (Hz)
1	10.2078
2	18.3596
3	24.5187
4	52.3578
5	70.5038
6	70.9365
7	82.1998
8	110.356
9	119.129
10	144.263

Table 3 Displacement Maxima

Node NO.	Displacement Component	Maximum Value (mm)	Time at Maximum (sec)
622	X	3.21E-4	1.78E-2
622	Y	2.15E-2	2.92E-1
623	X	1.70E-4	1.78E-2
623	Y	2.15E-2	2.92E-1
624	X	6.06E-6	1.78E-2
624	Y	2.15E-2	2.92E-1
625	X	1.80E-4	1.78E-2
625	Y	2.15E-2	2.92E-1
626	X	3.31E-4	1.78E-2
626	Y	2.15E-2	2.92E-1

Table 4 Stress Component Maxima

Elm NO.	Stress Component	Maximum Value (kg/mm^2)	Time at Maximum (sec)
595	X-X	6.40E-4	1.78E-2
595	Y-Y	3.75E-4	2.92E-1
595	YZ	1.29E-2	2.92E-1
595	ZX	1.44E-3	1.78E-2
596	X-X	6.61E-4	1.78E-2
596	Y-Y	5.63E-4	2.92E-1
596	YZ	1.91E-2	2.92E-1
596	ZX	1.11E-3	1.78E-2
597	X-X	6.52E-4	1.78E-2
597	Y-Y	5.32E-4	2.92E-1
597	YZ	1.91E-2	2.92E-1
597	ZX	1.08E-3	1.78E-2
598	X-X	6.51E-4	1.78E-2
598	Y-Y	3.80E-4	2.92E-1
598	YZ	2.59E-3	2.92E-1
598	XZ	1.82E-3	1.78E-2