Structural Analysis of the Proton Accelerator Research Center in PEFP

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1. Introduction

PEFP(Proton Engineering Frontier Project) was Launched in 2002 as one of the 21st Century Frontier R&D Programs of MOST(Ministry of Science & Technology). Gyeongju city was selected as the project host site in March, 2006, where 'Proton Accelerator Research Center' was going to be constructed. After starting the design in 2005, the Architectural and Civil design work has been performed by 2010. Since the Earthwork was started in 2009, the Construction works of Accelerator Facilities has been going smoothly to complete by 2012.

In this paper, we describe Structural Analysis of the Proton Accelerator Research Center in PEFP, focusing on the Accelerator & Beam Application Research Building.

2. Design Standard & Analysis Program

The structural design is conformable to following standards :

I. Korea Building Code–Structural
(Architectural Institute of Korea,)
II. Korea Structural Concrete Design Code
(Ministry of Construction & Transportation)
III. American Concrete Institute(ACI)
- ACI 318 Build Code Requirements for Structural Concrete
- ACI 350 Code Requirements for Environmental Concrete Structures
IV. American Institute of Steel Construction(AISC)

To analyze building structure, the analysis programs as given below are used.

I. Seismic Analysis
- SAP 2000, MIDAS/Gen
II. Structural Analysis
- MIDAS/Gen
III. Member Design
- Basement : SPA 2000
- Wall, Beam, Column : MIDAS/Gen
- Slab : SAFE

3. Load Combination

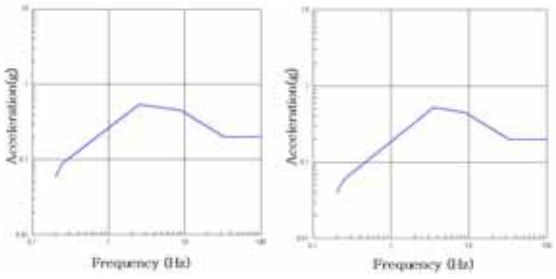
The Loads applied to structural Analysis include Dead Load(D), Live Load(L), Wind Load(W), Snow Load(S), and Seismic Load.

I. Reinforced Concrete Structure
A. 1.4D+1.7L
B. 0.75(1.4D+1.7L+1.7Wx)
C. 0.75(1.4D+1.7L+1.7Wy)
D. 0.75(1.4D+1.7L-1.7Wx)
E. 0.75(1.4D+1.7L-1.7Wy)
F. 0.9D+1.3Wx
G. 0.9D+1.3Wy
H. 0.9D-1.3Wx
I. 0.9D-1.3Wy
J. $0.75 \times 1.4D \pm [(RSx \pm ESx)^2+(RSy \pm ESy)^2 +RSv^2]^{1/2}$
K. $0.75 \times (1.4D+1.7L) \pm [EX^2+ EY^2+ EVT^2]^{1/2}$
L. $0.9D \pm [EX^2+ EY^2+ EVT^2]^{1/2}$
M. $0.75 \times 1.4D \pm [EX^2+ EY^2+ EVT^2]^{1/2}$

II. Steel Structure
A. Dead+Live
B. Dead+Live+Crane
C. Dead+Live+Wind
D. Dead+Live+Snow
E. Dead+Live+Earthquake

Table I : Design velocity pressure according to Elevation

Elevation(m)	ρ(N×sec2/m4)	V0 (m/sec)	Kzr	Kzt	Iw	Vz (m/sec)	qz (kg/m2)
0.0 ~ 10.0	1.25	45	1.00	1.27	1.1	62.9	252
13.0	1.25	45	1.04	1.27	1.1	65.6	274
19.2	1.25	45	1.11	1.27	1.1	69.5	308
24.0	1.25	45	1.14	1.27	1.1	71.9	329



(a) Horizontal design response spectrum (b) Vertical design response spectrum

Fig. 1. **Design ground response spectrum**

Ground response spectrums are shown in Fig. 1.

Peak response accelerations for the floor elevation to reflect seismic load are shown as Table II .

Table II : Design velocity pressure according to Elevation

Floor Elevation (m)	East West Acceleration (g)	North South Acceleration (g)	Vertical Acceleration	
			Wall (g)	Slab (g)
5.4 m	0.255	0.270	0.246	0.477
6.3 m	0.258	0.259	0.246	0.428
10.3 m	0.427	0.465	0.254	0.564
13.0 m	0.394	0.420	0.259	0.572
17.2 m	0.737	0.651	0.263	0.538
19.2 m	0.542	0.585	0.265	0.530
24.0 m	0.694	1.090	0.282	0.487

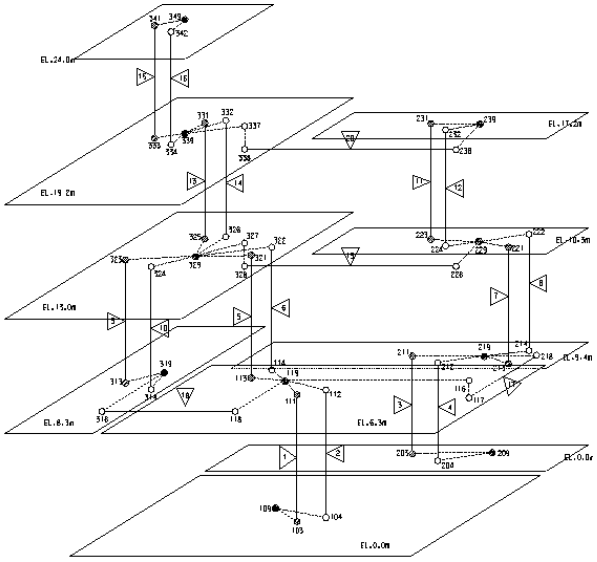


Fig. 2. 3D Modeling of the lumped beam element for the Accelerator & Beam Application Building

4. The Result of Structural Analysis

In this chapter, we describe the Result of structural analysis for Accelerator & Beam Application Building.

4.1 Slab Analysis

In the structural analysis of slab, SAFE program applied finite element method is used.

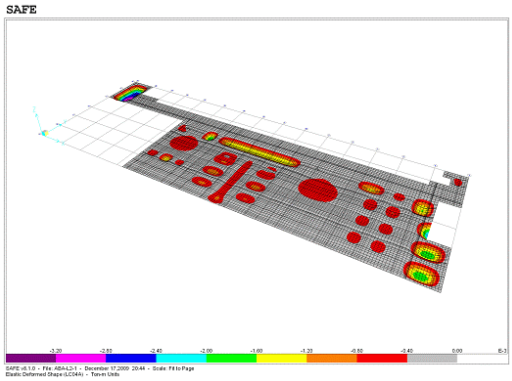


Fig. 3. 2nd Floor slab deflection (SAFE)

Structural analysis of slab had evaluated Deflection, moment, shearing force for the each floor. The 2nd floor slab deflection is shown as Fig. 3 in the character of results.

4.2 Wall Analysis

In the structural analysis of wall, MIDAS/Gen program is used after building 3D modeling of finite element method. The 3D interpreted model for the Accelerator & Beam Application Building is shown as Fig. 4 in the character of the modeling results.

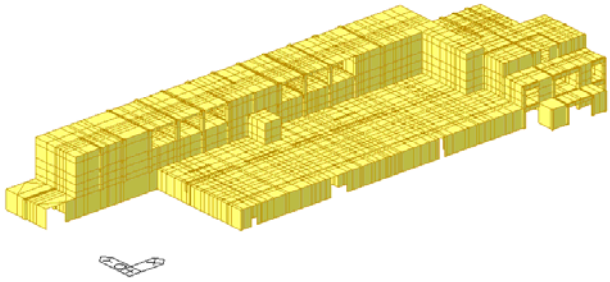


Fig. 4. 3D Interpreted Model for the Accelerator & Beam Application Building

4.2 Seismic Analysis

Seismic analysis has performed according to Seismic category II. Seismic load was applied to Safe Shutdown Earthquake.

As the result of response spectrum analysis, Peak response member force and response displacement through the m**odeling of the lumped beam element** has calculated.

4. Conclusions

In this paper, we describe Structural Analysis of the Proton Accelerator Research Center in PEFP focusing on the Accelerator & Beam Application Research Building. Structural Analysis contains the result of the basement, slab, wall and seismic analysis.

Acknowledgement

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