

## Four-Story three-dimensional Model with Passive Control Devices

### Description:

The four-story steel buildings are selected from the JSSI (Japan Society of Seismic Isolation) manual (Refs. [1] and [2]). The term of Conventional Type and Trimmed Type are used for the building designed without passive damper devices and with passive damper devices, respectively. Figures 1, 2 and 3 give the layout configurations of the building. Also, the lists of column and beam size of Conventional Type and Trimmed Type are presented in Table 1 and Table 2, respectively.

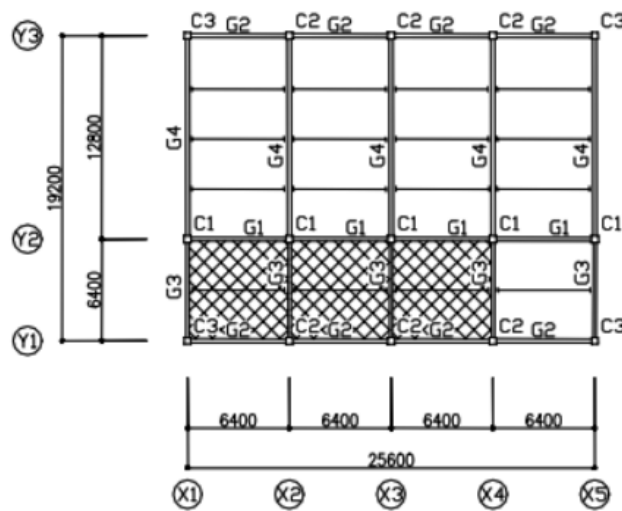


Figure 1. Building plan

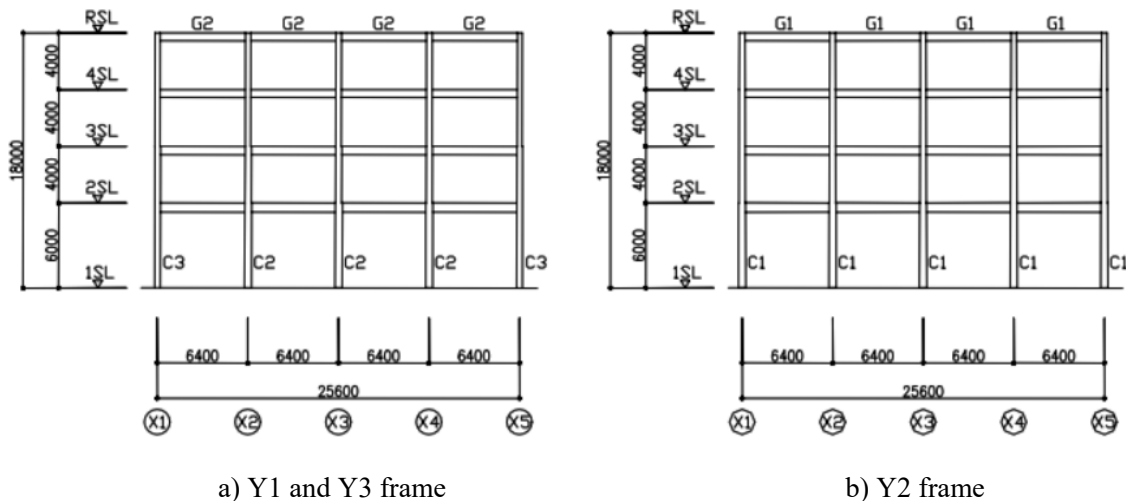
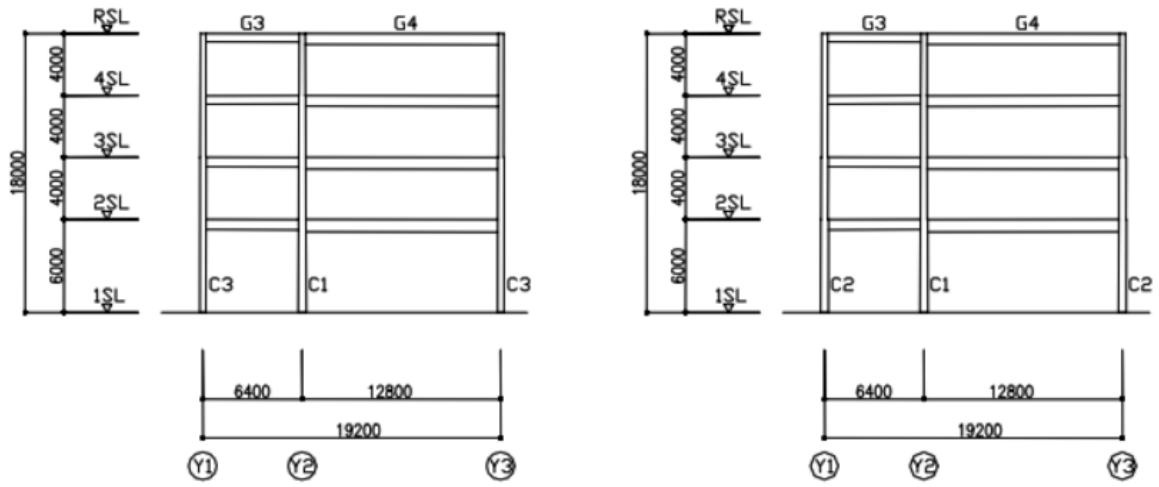


Figure 2. Longitudinal elevation



a) X1 and X5 frame

b) X2-X4 frame

Figure 3. Transversal elevation

Table 1. Box column [steel] detail

Floor	C1					
	Conventional Type			Trimmed Type		
	H (mm)	B (mm)	t (mm)	H (mm)	B (mm)	t (mm)
4	400	400	16	300	300	19
3	450	450	19	350	350	14
2	450	450	22	350	350	19
1	500	500	22	350	350	25
Floor	C2					
	Conventional Type			Trimmed Type		
	H (mm)	B (mm)	t (mm)	H (mm)	B (mm)	t (mm)
4	400	400	16	300	300	12
3	400	400	19	300	300	12
2	450	450	19	300	300	14
1	500	500	19	350	350	14
Floor	C3					
	Conventional Type			Trimmed Type		
	H (mm)	B (mm)	t (mm)	H (mm)	B (mm)	t (mm)
4	350	350	16	300	300	9
3	350	350	16	300	300	9
2	400	400	19	300	300	12
1	400	400	19	350	350	12

Table 2. H-beam [steel] detail

Floor	B1							
	Conventional Type				Trimmed Type			
	H (mm)	B (mm)	t1 (mm)	t2 (mm)	H (mm)	B (mm)	t1 (mm)	t2 (mm)
R	550	200	9	16	300	250	9	22
4	550	250	9	19	350	300	12	28
3	600	250	12	22	400	300	16	28
2	650	250	12	25	450	300	19	28
Floor	B2							
	Conventional Type				Trimmed Type			
	H (mm)	B (mm)	t1 (mm)	t2 (mm)	H (mm)	B (mm)	t1 (mm)	t2 (mm)
R	550	200	9	16	300	200	9	25
4	550	250	9	19	350	200	12	28
3	600	250	12	22	400	200	12	25
2	650	250	12	22	450	200	19	28
Floor	B3							
	Conventional Type				Trimmed Type			
	H (mm)	B (mm)	t1 (mm)	t2 (mm)	H (mm)	B (mm)	t1 (mm)	t2 (mm)
R	550	250	12	22	350	300	9	19
4	550	200	12	22	350	300	12	22
3	600	200	12	25	400	300	12	25
2	650	200	12	25	400	300	16	28
Floor	B4							
	Conventional Type				Trimmed Type			
	H (mm)	B (mm)	t1 (mm)	t2 (mm)	H (mm)	B (mm)	t1 (mm)	t2 (mm)
R	700	300	12	22	400	300	12	19
4	700	250	12	22	400	300	12	22
3	750	250	14	25	400	300	16	22
2	800	250	14	25	450	300	12	22

Note: the yield strength of steel is 325 MPa.

### Steel & Oil Damper:

The force-deformation relationships of the steel and oil dampers are presented in Figure 4 and 5. Tables 3 and 4 provide the parameters of steel dampers and oil dampers of each story including story height and story total weight of the building, respectively. Figure 6 presents the layout of the passive control devices. The devices are considered only in the longitudinal direction of the building.

The parameters of individual device are obtained dividing the force and stiffness (damping coefficient) by the number of devices in a story.

Table 3. Parameters of steel dampers in each story

Floor	W	H	K	K0	Fy	K1/K0
	kN	mm	kN/mm	kN/mm	kN	
4	4,894.0	4,000.0	62.7	69.3	462.0	0.02
3	3,669.0	4,000.0	72.9	111.8	745.5	0.02
2	3,691.0	4,000.0	91.0	128.5	856.5	0.02
1	3,762.0	6,000.0	56.2	102.6	1,025.8	0.02

Table 4. Parameters of oil dampers in each story

Floor	W	H	K	Kb	C1	C2/C1	Vr
	kN	mm	kN/mm	kN/mm	kN*s/mm		mm/s
4	4,894.0	4,000.0	62.7	45.6	6.1	0.02	62.8
3	3,669.0	4,000.0	72.9	53.0	7.1	0.02	62.8
2	3,691.0	4,000.0	91.0	66.2	8.9	0.02	62.8
1	3,762.0	6,000.0	56.2	40.9	5.5	0.02	94.0

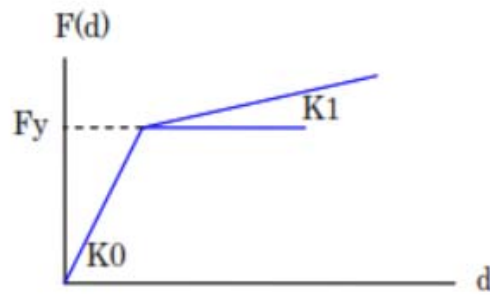


Figure 4. Force-deformation relationship of steel damper

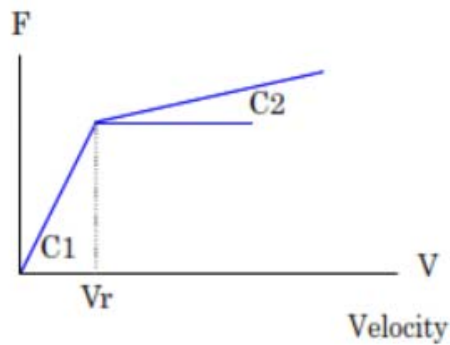
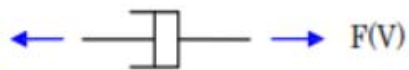


Figure 5. Force-velocity relationship of oil damper

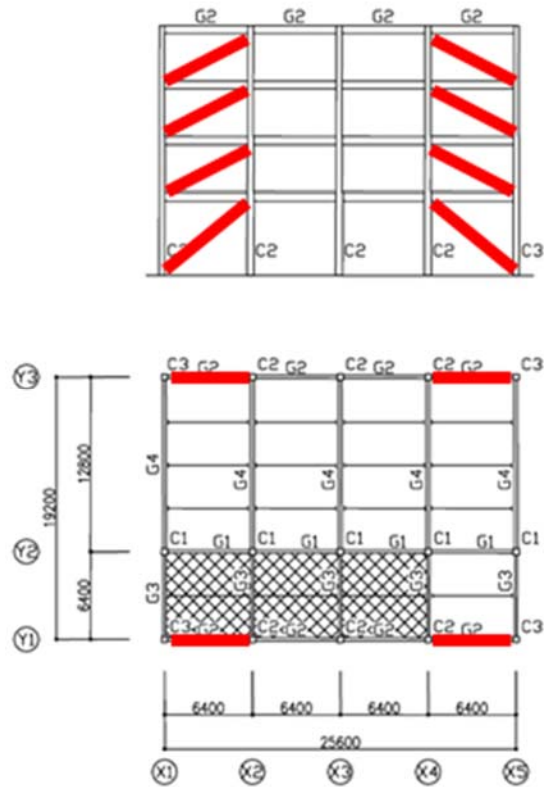


Figure 6. Layout of the passive control devices

## Reference,

[1] Manual of Design and Construction of Passive Control Structure, the Japan Society of Seismic Isolation, 2013.11 (in Japanese) <http://www.jssi.or.jp>

[2] Details of 4, 10, and 20-story theme structure used for Passive Control Design Examples, *Eiichi SEKIYA, Hiroshige MORI, Toshiyuki OHBUCHI, Keisuke YOSHIE, Hiroshi HARA, Fumiko ARIMA, Yuri TAKEUCHI, Yoshihito SAITO, Masato ISHII, and Kazuhiko KASAI, Symposium on Passive Control Structure, Tokyo Institute of Technology* (in Japanese)