Twenty-Story three-dimensional Model with Passive Control Devices

Description:

The twenty-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.

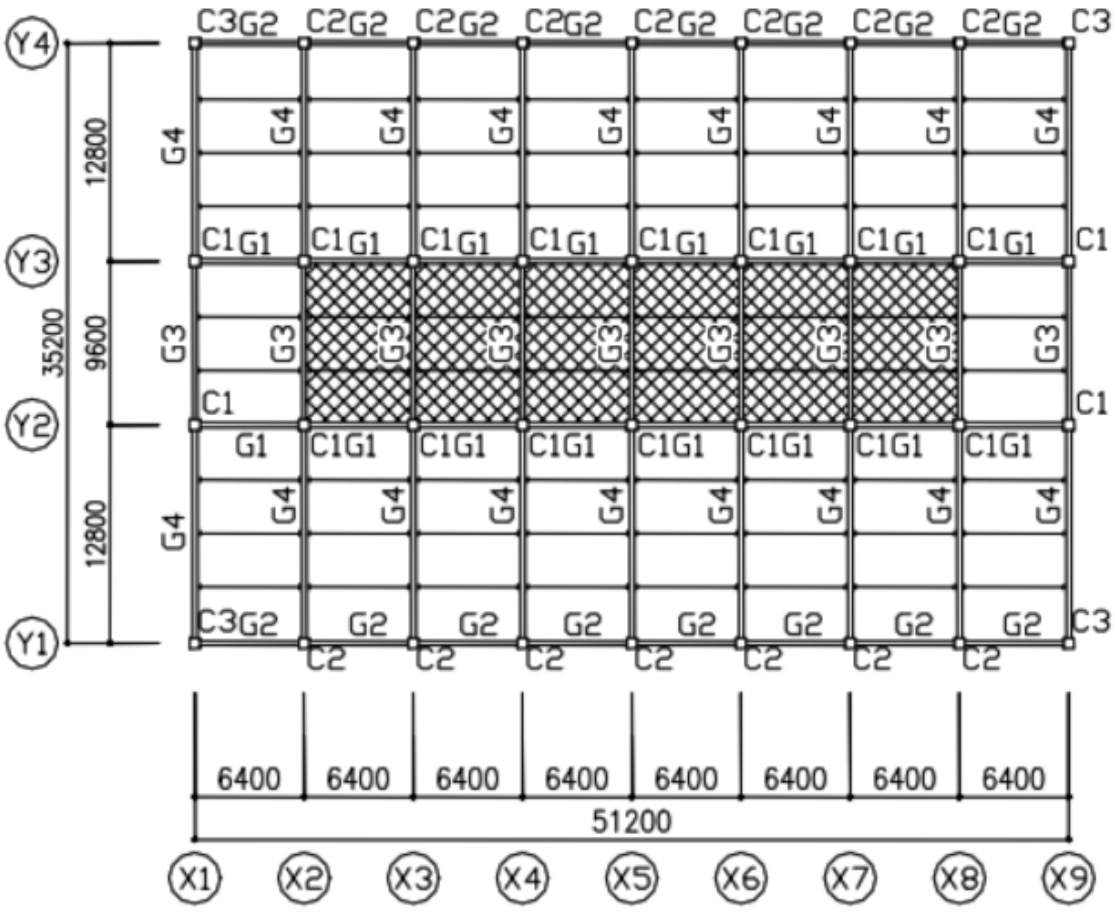
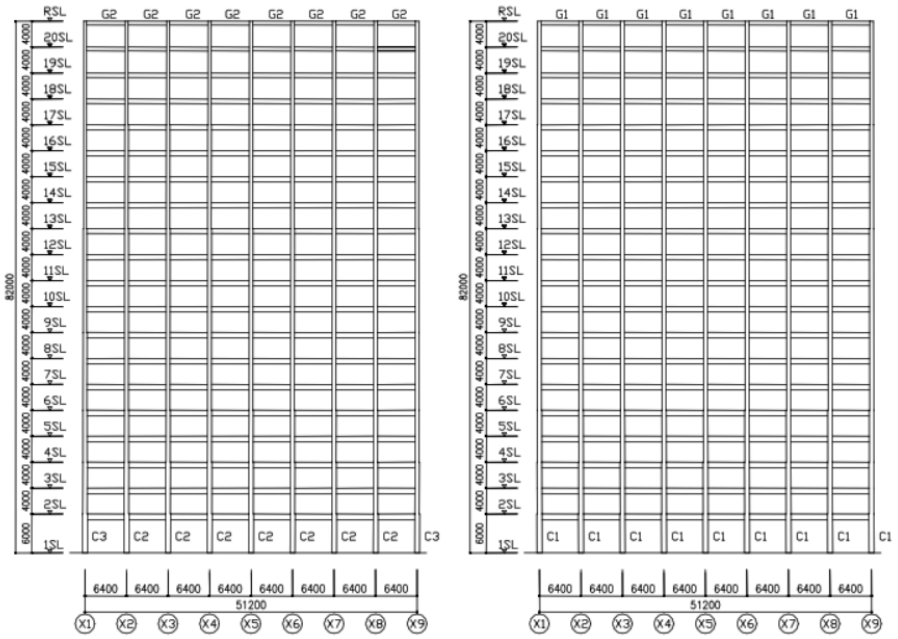
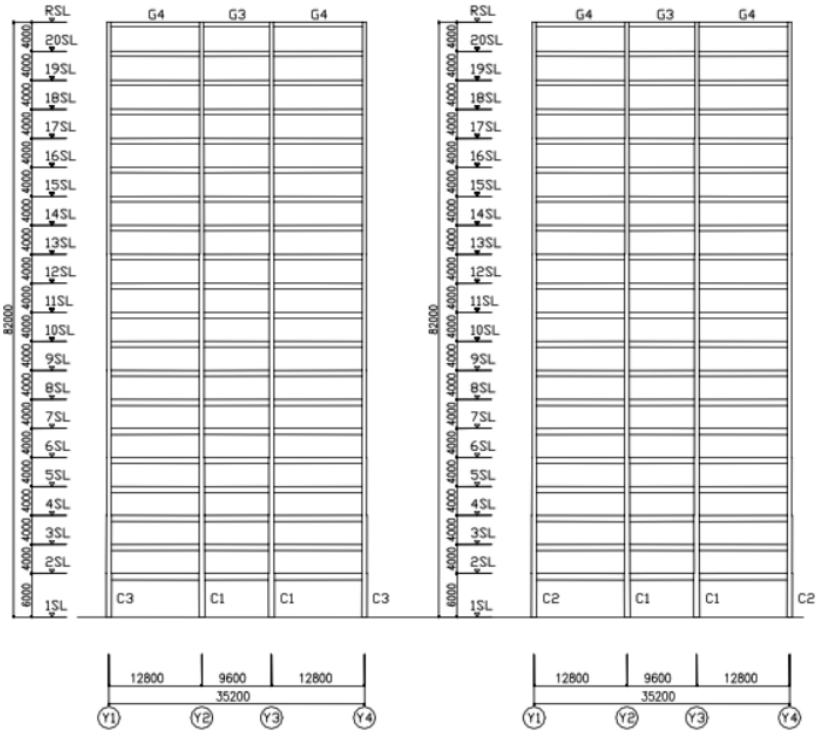


Figure 1. Building plan



a) Y1 and Y4 frame b) Y2 and Y3 frame

Figure 2. Longitudinal elevation



a) X1 and X9 frame b) X2-X8 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)
17-20	550	550	25	350	350	28
13-16	600	600	28	400	400	32
9-12	650	650	28	450	450	36
6-8	650	650	32	450	450	40
4-5	700	700	32	500	500	40
2-3	750	750	36	500	500	45
1	800	800	36	550	550	55
Floor	**C2**					
	Conventional Type			Trimmed Type		
	H (mm)	**B** (mm)	**t** (mm)	**H** (mm)	**B** (mm)	**t** (mm)
17-20	500	500	22	350	350	25
13-16	550	550	25	350	350	32
9-12	600	600	28	400	400	32
6-8	600	600	28	400	400	36
4-5	650	650	28	450	450	36
2-3	700	700	36	450	450	45
1	750	750	36	500	500	50
Floor	**C3**					
	Conventional Type			Trimmed Type		
	H (mm)	**B** (mm)	**t** (mm)	**H** (mm)	**B** (mm)	**t** (mm)
17-20	500	500	19	300	300	25
13-16	500	500	19	300	300	25
9-12	550	550	22	350	350	25
6-8	600	600	25	400	400	28
4-5	650	650	28	450	450	32
2-3	700	700	32	450	450	36
1	750	750	32	500	500	36

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)
20-R	600	300	14	25	450	250	9	19
18-19	700	300	14	22	450	250	12	25
15-17	750	300	16	25	500	250	16	32
12-14	750	300	16	32	500	300	16	32
9-11	800	300	16	32	500	300	16	36
6-8	850	300	16	32	550	300	16	32
3-5	850	300	16	32	550	300	16	32
2	900	300	19	32	600	300	16	32
Floor	**B2**							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
20-R	600	250	12	22	450	200	9	19
18-19	700	300	14	22	450	250	9	19
15-17	750	300	16	25	500	250	9	19
12-14	750	300	16	32	500	250	12	22
9-11	800	300	16	25	500	250	12	25
6-8	850	250	16	25	550	250	12	25
3-5	850	300	16	25	550	250	16	28
2	900	300	19	25	600	250	16	32
Floor	**B3**							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
20-R	600	300	14	25	450	300	12	25
18-19	700	300	14	28	450	300	12	25
15-17	750	350	16	28	500	300	16	28
12-14	750	350	16	28	500	300	16	36
9-11	800	300	16	32	500	350	16	36
6-8	850	250	16	32	550	350	16	36
3-5	850	300	16	32	550	350	16	36
2	900	300	19	32	600	350	16	40

Floor	B4							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
20-R	600	300	14	32	450	300	16	36
18-19	700	350	16	32	450	300	16	36
15-17	750	350	16	36	500	350	16	32
12-14	750	350	16	36	500	300	16	36
9-11	750	300	16	32	500	350	16	36
6-8	800	300	16	32	550	350	16	36
3-5	850	300	16	32	550	350	16	36
2	900	300	19	32	600	350	16	36

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	
20	17,937.0	4,000.0	278.9	-	-	0.02
19	13,363.0	4,000.0	292.9	39.4	263.0	0.02
18	13,410.0	4,000.0	312.5	77.7	518.3	0.02
17	13,410.0	4,000.0	342.8	105.6	703.9	0.02
16	13,565.0	4,000.0	443.9	94.5	630.1	0.02
15	13,613.0	4,000.0	453.0	126.2	841.4	0.02
14	13,613.0	4,000.0	473.3	149.2	994.8	0.02
13	13,739.0	4,000.0	491.3	170.8	1,138.9	0.02
12	13,790.0	4,000.0	599.2	145.0	966.8	0.02
11	13,842.0	4,000.0	613.9	163.3	1,088.9	0.02
10	13,895.0	4,000.0	630.6	178.3	1,188.9	0.02
9	13,895.0	4,000.0	638.1	195.5	1,303.6	0.02
8	13,928.0	4,000.0	694.7	186.0	1,239.9	0.02
7	13,975.0	4,000.0	729.1	185.3	1,235.3	0.02
6	13,975.0	4,000.0	736.7	195.8	1,305.5	0.02
5	14,020.0	4,000.0	854.9	148.9	992.4	0.02
4	14,092.0	4,000.0	875.9	148.4	989.4	0.02
3	14,148.0	4,000.0	930.8	128.9	859.1	0.02
2	14,203.0	4,000.0	974.2	113.0	753.3	0.02
1	14,653.0	6,000.0	842.9	-	-	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
20	17,937.0	4,000.0	278.9	35.1	11.0	0.02	21.2
19	13,363.0	4,000.0	292.9	36.9	11.6	0.02	21.2
18	13,410.0	4,000.0	312.5	39.4	12.4	0.02	21.2
17	13,410.0	4,000.0	342.8	43.2	13.6	0.02	21.2
16	13,565.0	4,000.0	443.9	55.9	17.7	0.02	21.2
15	13,613.0	4,000.0	453.0	57.1	18.0	0.02	21.2
14	13,613.0	4,000.0	473.3	59.6	18.8	0.02	21.2
13	13,739.0	4,000.0	491.3	61.9	19.5	0.02	21.2
12	13,790.0	4,000.0	599.2	75.5	23.8	0.02	21.2
11	13,842.0	4,000.0	613.9	77.3	24.4	0.02	21.2
10	13,895.0	4,000.0	630.6	79.4	25.1	0.02	21.2
9	13,895.0	4,000.0	638.1	80.4	25.4	0.02	21.2
8	13,928.0	4,000.0	694.7	87.5	27.6	0.02	21.2
7	13,975.0	4,000.0	729.1	91.8	29.0	0.02	21.2
6	13,975.0	4,000.0	736.7	92.8	29.3	0.02	21.2
5	14,020.0	4,000.0	854.9	107.7	34.0	0.02	21.2
4	14,092.0	4,000.0	875.9	110.3	34.8	0.02	21.2
3	14,148.0	4,000.0	930.8	117.2	37.0	0.02	21.2
2	14,203.0	4,000.0	974.2	122.7	38.7	0.02	21.2
1	14,653.0	6,000.0	842.9	106.2	33.5	0.02	31.8

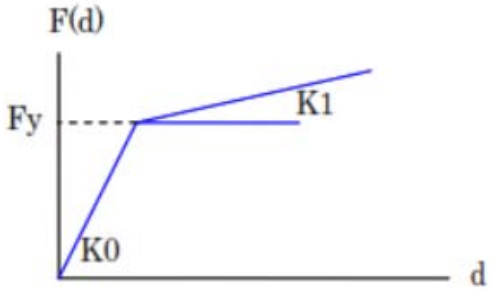


Figure 4. Force-deformation relationship of steel damper

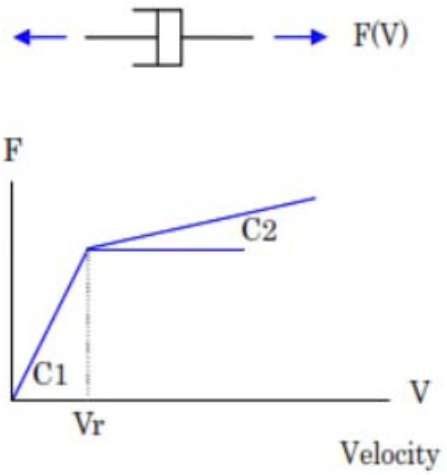


Figure 5. Force-deformation relationship of oil damper

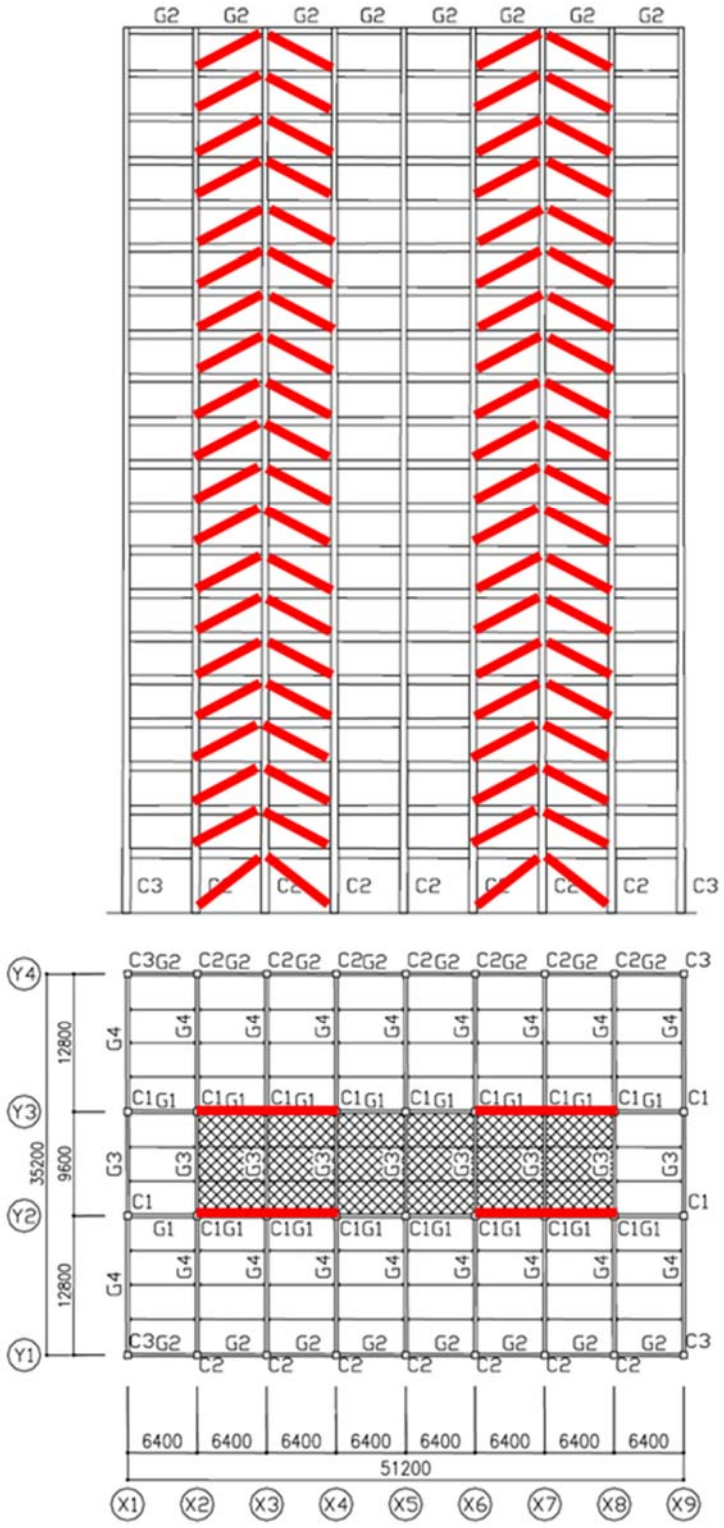


Figure 6. Layout of the passive control devices

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)