Ten-Story three-dimensional Model with Passive Control Devices

Description:

The ten-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.

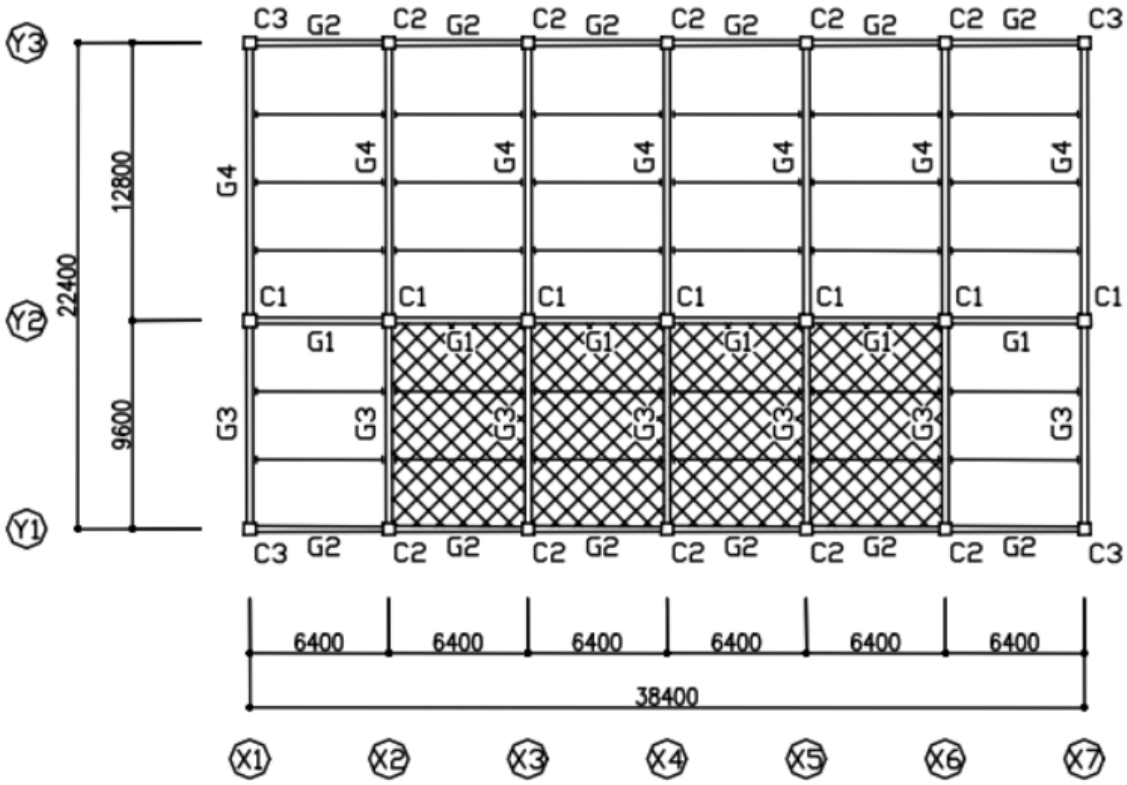
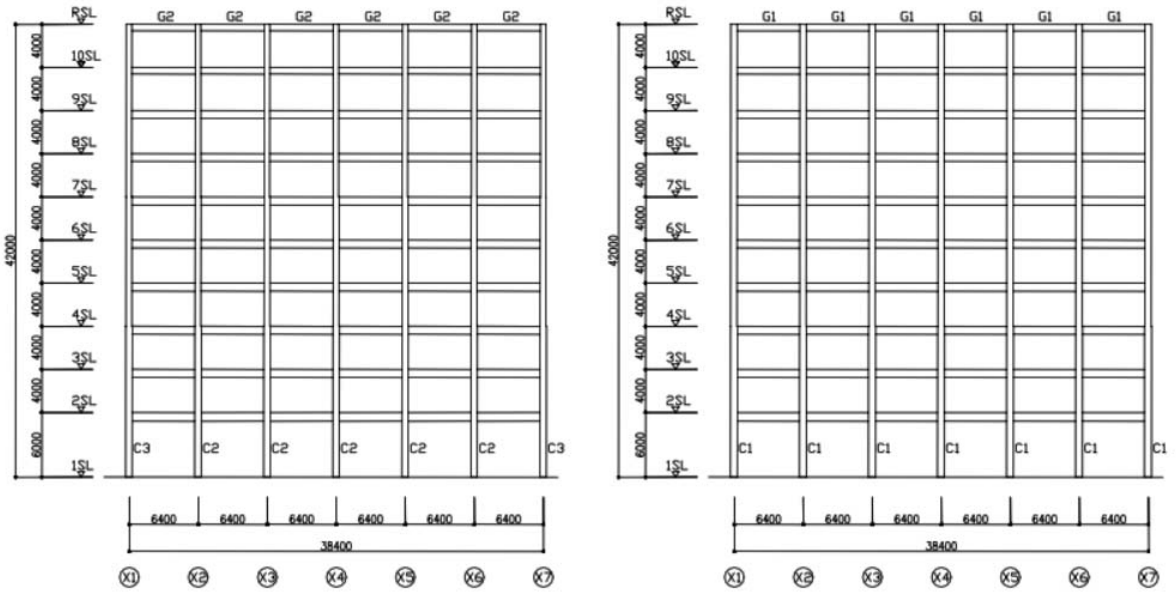
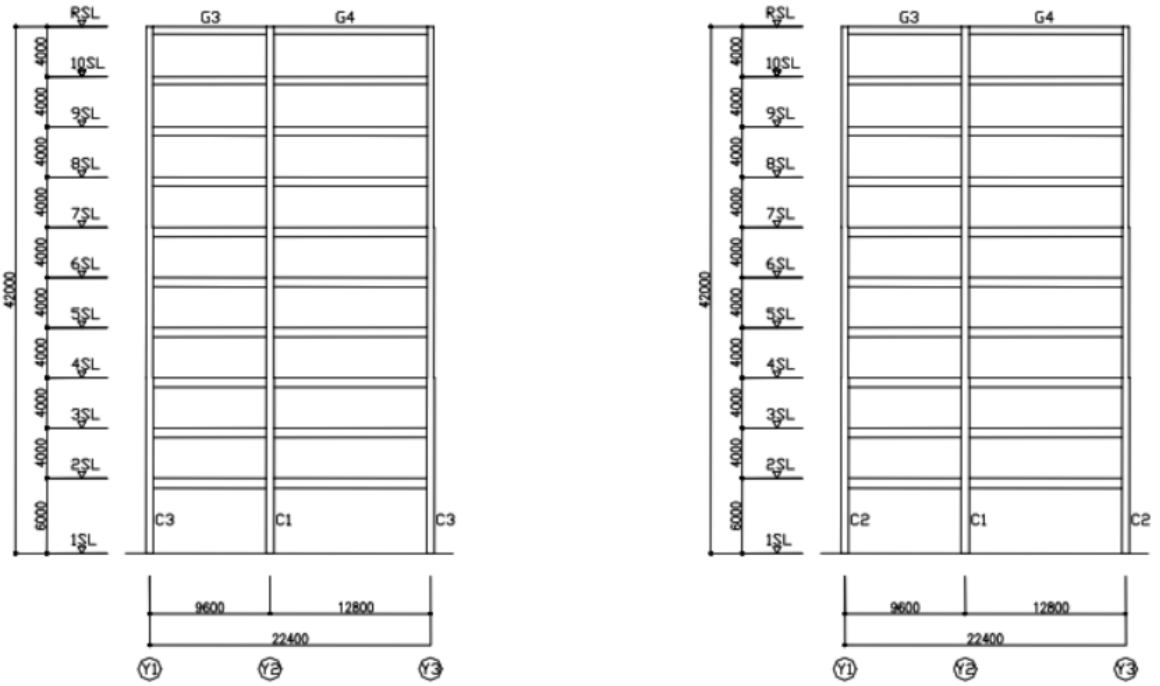


Figure 1. Building plan



a) Y1 and Y3 frame b) Y2 frame

Figure 2. Longitudinal elevation



a) X1 and X7 frame b) X2-X6 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)
9-10	550	550	22	350	350	25
8	550	550	22	400	400	25
7	550	550	22	400	400	28
5-6	600	600	28	450	450	25
4	600	600	28	450	450	28
3	650	650	28	500	500	28
2	650	650	28	500	500	28
1	650	650	28	500	500	36
Floor	**C2**					
	Conventional Type			Trimmed Type		
	H (mm)	**B** (mm)	**t** (mm)	**H** (mm)	**B** (mm)	**t** (mm)
9-10	500	500	22	350	350	25
8	500	500	22	350	350	25
7	500	500	22	350	350	28
5-6	550	550	25	400	400	25
4	550	550	25	400	400	25
3	600	600	25	450	450	25
2	600	600	25	450	450	25
1	600	600	28	450	450	36
Floor	**C3**					
	Conventional Type			Trimmed Type		
	H (mm)	**B** (mm)	**t** (mm)	**H** (mm)	**B** (mm)	**t** (mm)
9-10	500	500	19	350	350	16
8	500	500	19	350	350	16
7	500	500	19	350	350	16
5-6	550	550	22	400	400	19
4	550	550	22	400	400	19
3	600	600	22	450	450	19
2	600	600	22	450	450	19
1	600	600	25	450	450	28

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	600	300	12	22	450	200	9	16
10	600	300	12	22	450	300	9	16
9	700	300	12	22	500	300	12	19
8	700	300	12	22	500	350	12	19
7	750	300	16	25	500	350	12	22
6	750	300	16	25	500	350	12	22
5	750	300	16	28	500	350	16	25
4	750	300	16	28	500	350	16	28
3	750	300	16	28	500	350	16	28
2	800	300	16	32	500	350	16	32
Floor	**B2**							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
R	600	250	12	22	450	200	9	12
10	600	250	12	22	450	200	12	19
9	700	250	12	22	500	300	9	16
8	700	250	12	22	500	300	12	19
7	750	250	14	25	500	300	12	22
6	750	250	14	25	500	300	12	22
5	750	250	16	28	500	300	16	25
4	750	250	16	28	500	300	16	25
3	750	250	16	28	500	300	16	25
2	800	300	16	28	500	300	16	28
Floor	**B3**							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
R	600	300	14	25	450	300	16	28
10	600	300	14	25	450	300	12	19
9	700	300	14	25	500	300	12	25
8	700	300	14	25	500	300	12	25
7	750	300	16	28	500	350	12	25
6	750	300	16	28	500	350	16	28
5	750	350	16	28	500	350	16	28
4	750	350	16	28	500	350	16	32
3	750	350	16	28	500	350	16	32
2	800	300	16	32	500	350	16	36

Floor	B4							
	Conventional Type				Trimmed Type			
	H (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)	**H** (mm)	**B** (mm)	**t1** (mm)	**t2** (mm)
R	600	300	14	32	450	350	16	32
10	600	300	14	32	450	300	16	28
9	700	300	16	32	500	300	16	32
8	700	300	16	32	500	300	16	32
7	750	300	16	32	500	350	16	32
6	750	300	16	32	500	350	16	32
5	750	350	16	32	500	350	16	36
4	750	350	16	32	500	350	16	36
3	750	350	16	32	500	350	16	36
2	800	300	16	32	500	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	
10	8,579.0	4,000.0	158.6	16.8	112.2	0.02
9	6,365.0	4,000.0	180.1	56.0	373.5	0.02
8	6,431.0	4,000.0	220.3	74.5	496.8	0.02
7	6,470.0	4,000.0	244.8	96.8	645.5	0.02
6	6,539.0	4,000.0	291.8	98.5	656.7	0.02
5	6,567.0	4,000.0	306.2	116.7	777.7	0.02
4	6,622.0	4,000.0	328.2	124.6	830.7	0.02
3	6,664.0	4,000.0	383.0	105.7	704.8	0.02
2	6,680.0	4,000.0	383.5	118.2	787.7	0.02
1	6,859.0	6,000.0	280.0	67.9	679.3	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
10	8,579.0	4,000.0	158.6	27.3	5.7	0.02	38.6
9	6,365.0	4,000.0	180.1	31.0	6.5	0.02	38.6
8	6,431.0	4,000.0	220.3	37.9	7.9	0.02	38.6
7	6,470.0	4,000.0	244.8	42.1	8.8	0.02	38.6
6	6,539.0	4,000.0	291.8	50.2	10.5	0.02	38.6
5	6,567.0	4,000.0	306.2	52.7	11.0	0.02	38.6
4	6,622.0	4,000.0	328.2	56.5	11.8	0.02	38.6
3	6,664.0	4,000.0	383.0	65.9	13.7	0.02	38.6
2	6,680.0	4,000.0	383.5	66.0	13.7	0.02	38.6
1	6,859.0	6,000.0	280.0	48.2	10.0	0.02	57.9

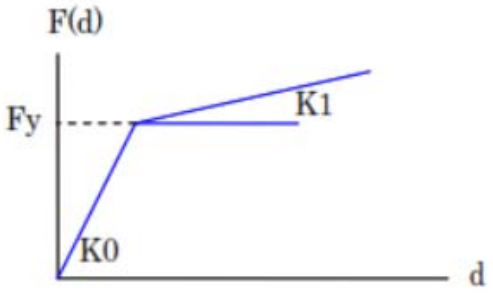


Figure 4. Force-deformation relationship of steel damper

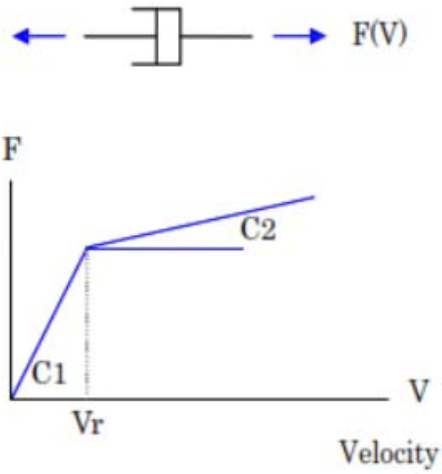


Figure 5. Force-deformation relationship of oil damper

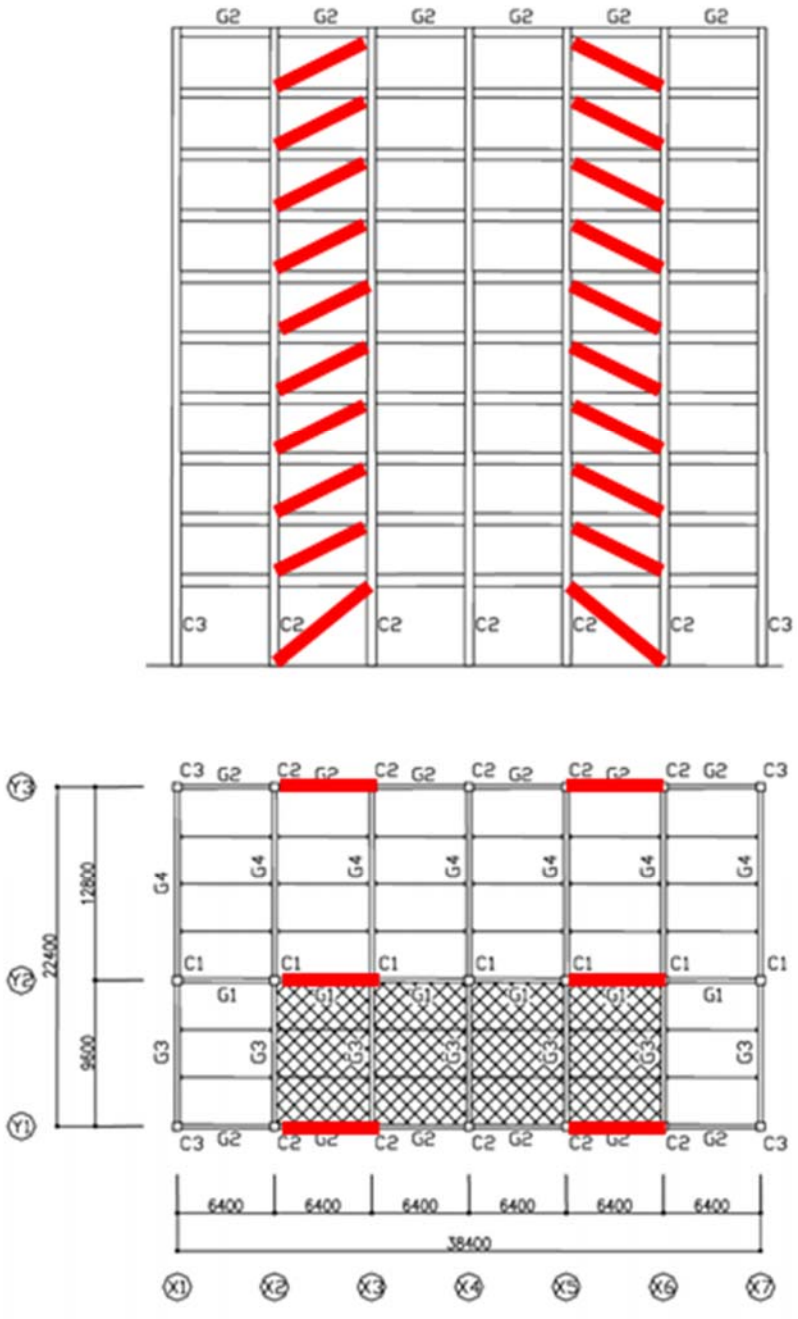


Figure 6. Layout of the passive control devices

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)