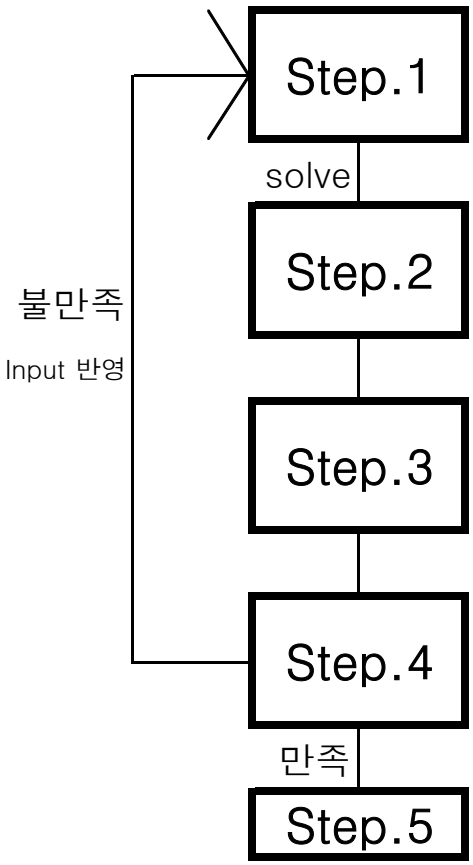
※ 반복시산법을 통한 축강성 결정 순서도



Strut 및 Tie의 축강성을 가정한다.

부정정 스트럿-타이 모델에 대한 구조해석

각 Strut 및 Tie의 단면력을 결정

단면력을 각 Strut 및 Tie의 유효강도로 나누어 Strut 및 Tie의 단면적 결정

Strut 및 Tie의 단면적에 탄성계수를 곱하여 Strut 및 Tie의 축강성을 결정

Step.1의 가정된 축강성과 Step.3의 축강성 차이가 허용한계를 만족

결정된 단면력과 필요 단면적으로 검토

1. 두부보 설계(Strut Tie Model)

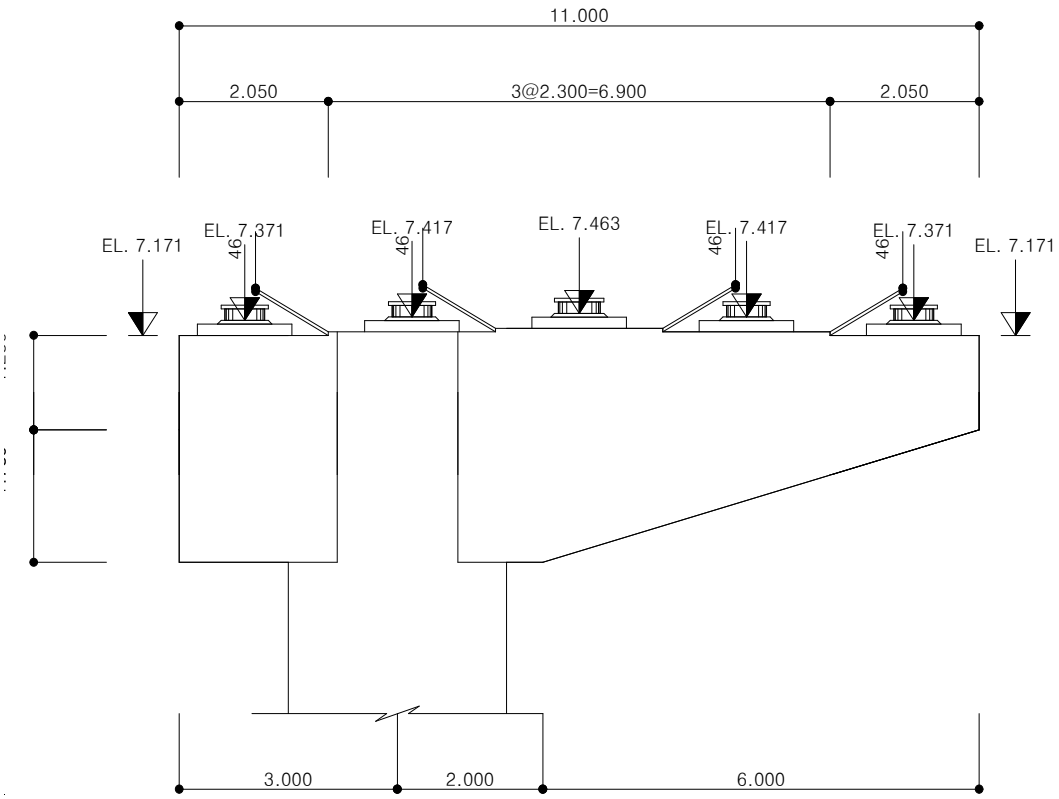
7.8 깊은보에 대한 전단 설계와 7.9 브라킷과 내민받침에 대한 전단설계 의 적용사항을 부록III 스트럿-타이 모델로 설계 검토 진행한다. 『콘크리트 구조설계기준 해설2012』

1.1 설계조건

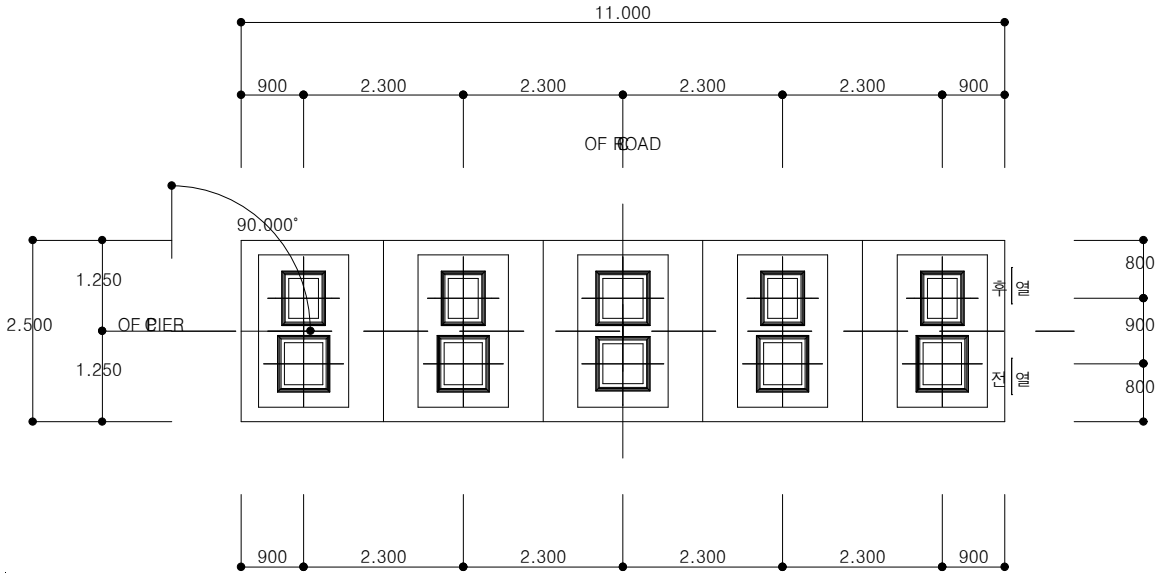
1) 본체강도 : fck = 27 MPa
2) 철근강도 : fy = 400 MPa
3) 두부보폭 : 2500 mm

1.2 단면형상

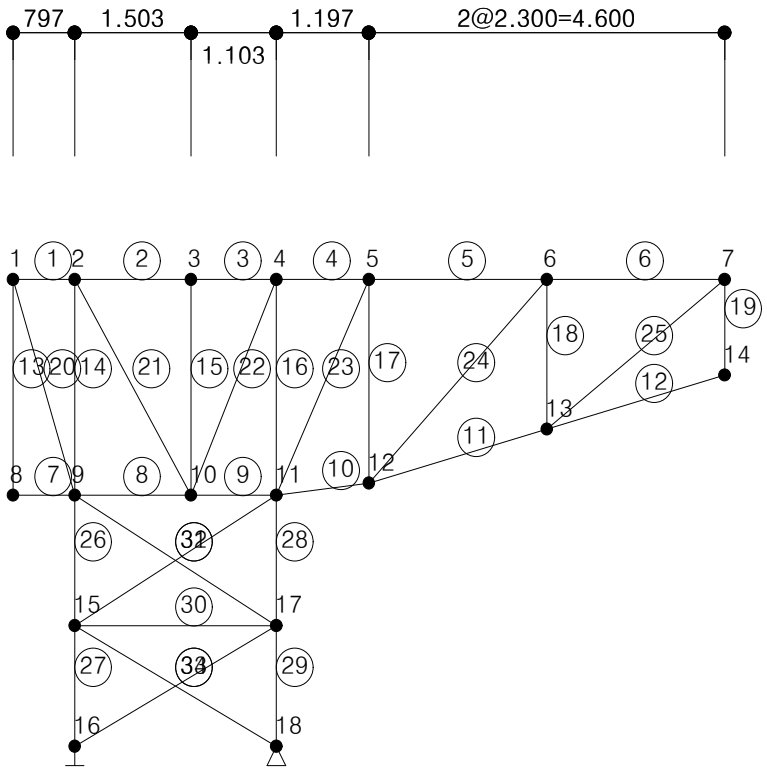
1) 정면도



2) 평면도



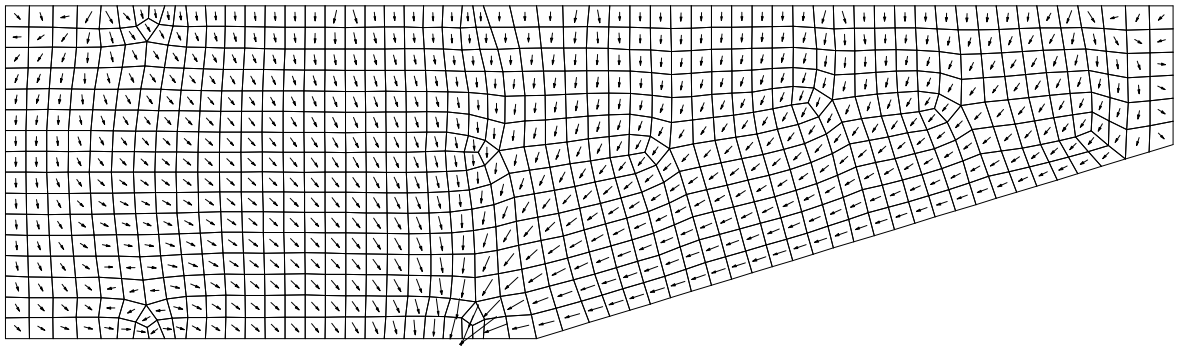
1.3 해석 모델링



1) 절점 좌표

구분	X	Z	절점	구분	X	Z	절점
1	0.900	1.050	1	10	3.200	-1.630	10
2	1.697	1.050	2	11	4.303	-1.630	11
3	3.200	1.050	3	12	5.500	-1.479	12
4	4.303	1.050	4	13	7.800	-0.808	13
5	5.500	1.050	5	14	10.100	-0.138	14
6	7.800	1.050	6	15	1.697	-3.250	15
7	10.100	1.050	7	16	1.697	-4.750	16
8	0.900	-1.630	8	17	4.303	-3.250	17
9	1.697	-1.630	9	18	4.303	-4.750	18

2) 주응력 흐름도



1.4 하중산정

1) 상부반력 및 두부보 자중

: 두부보 자중은 구간별 평균두께로 산정하여 상부절점에 분할하여 재하한다.

절점	분담폭	평균두께	폭	단위중량	하중(KN)
1	2.050	3.000	2.500	25.000	-384.375
3	2.300	3.044	2.500	25.000	-437.598
5	2.300	2.914	2.500	25.000	-418.956
6	2.300	2.231	2.500	25.000	-320.731
7	2.050	1.551	2.500	25.000	-198.728

※ 상부반력은 『2. 하중계산』, 2.1 상부반력 및 교각자중 참조.

2) 풍하중 : 교축직각방향

: 수평력은 두부보 측면에, 모멘트는 수직력으로 환산하여 받침위치에 재하한다.

① 상부구조에 작용하는 풍하중

Hx = 366.000 kN

My = 1043.100 kN.m

② 두부보에 작용하는 풍하중

Hx = 18.750 kN

③ 모델링 상면 재하하중

절점	상부구조 My(Z)	상부구조 Hx	두부보 Hx
1	-90.704	-73.200	-22.500
3	-45.352	-73.200	
5	0.000	-73.200	
6	45.352	-73.200	
7	90.704	-73.200	

3) 활하중에 작용하는 풍하중

: 수평력은 두부보 측면에, 모멘트는 수직력으로 환산하여 받침위치에 재하한다.

① 활하중에 작용하는 풍하중

Hx = 45.000 kN

My = 218.790 kN.m

② 모델링 상면 재하하중

절점	My	Hx	비고
1	-19.026	-9.000	
3	-9.512	-9.000	
5	0.000	-9.000	
6	9.512	-9.000	
7	19.026	-9.000	

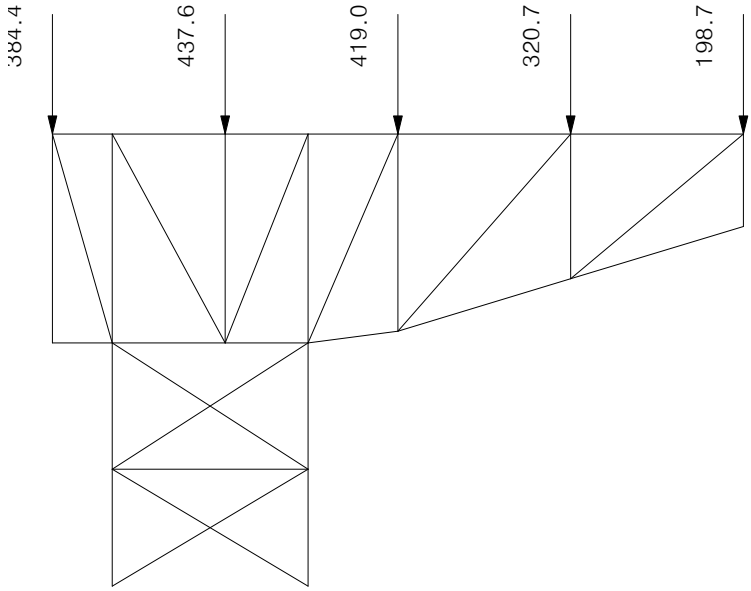
4) 지진하중 : 교축직각방향

: 교축직각방향 지진하중(수평력)을 받침위치에 재하한다.

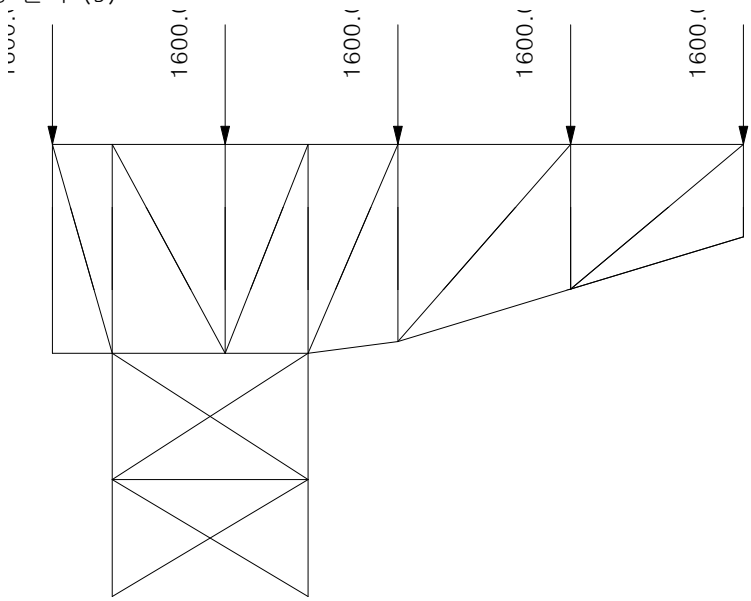
절점	수평력(X)	비고
1	231.537	
3	231.916	
5	232.004	
6	231.879	
7	231.692	

1.5 하중 재하도

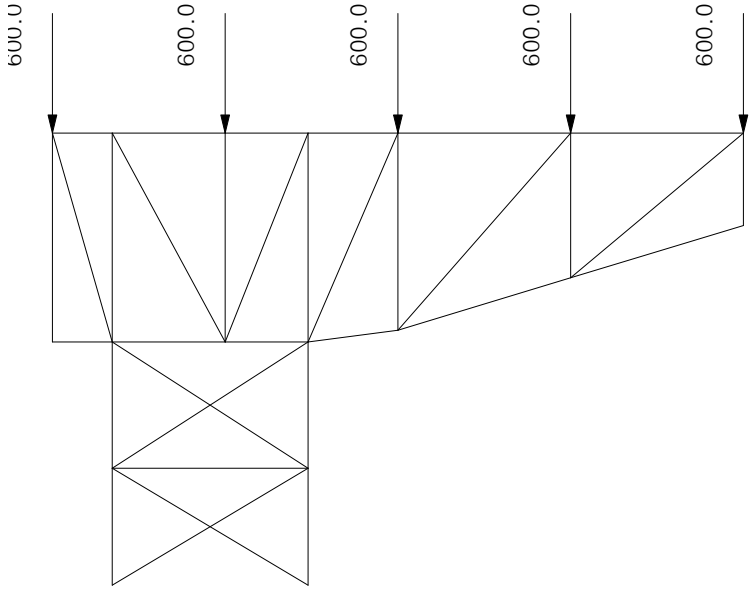
1) 두부보 자중 (SW)



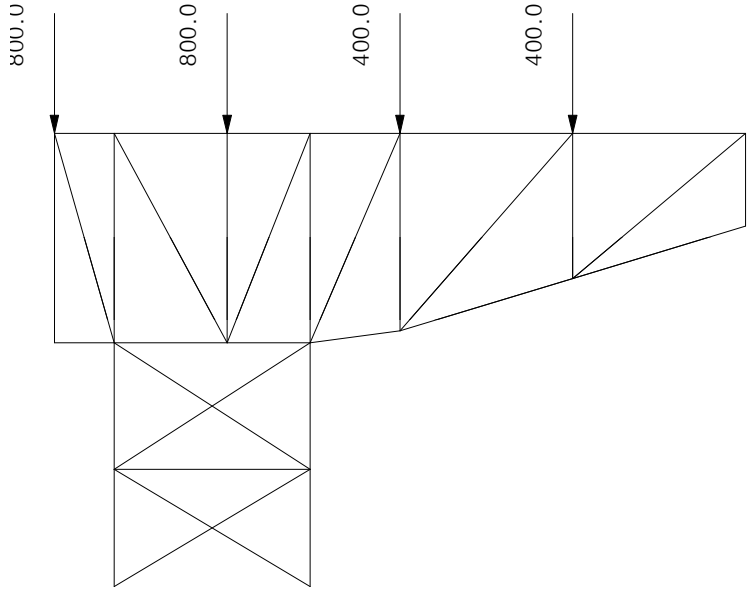
2) 상부 고정하중 반력 (D)



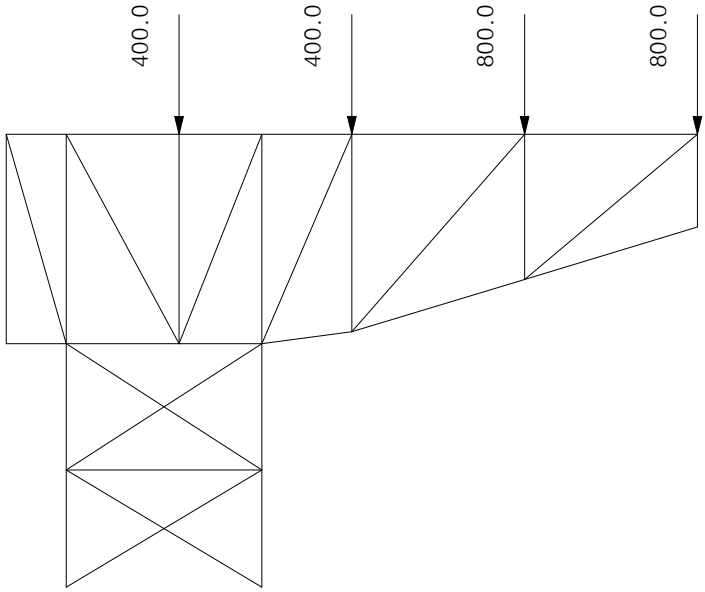
3) 상부 활하중 반력 : LC1 (L1)



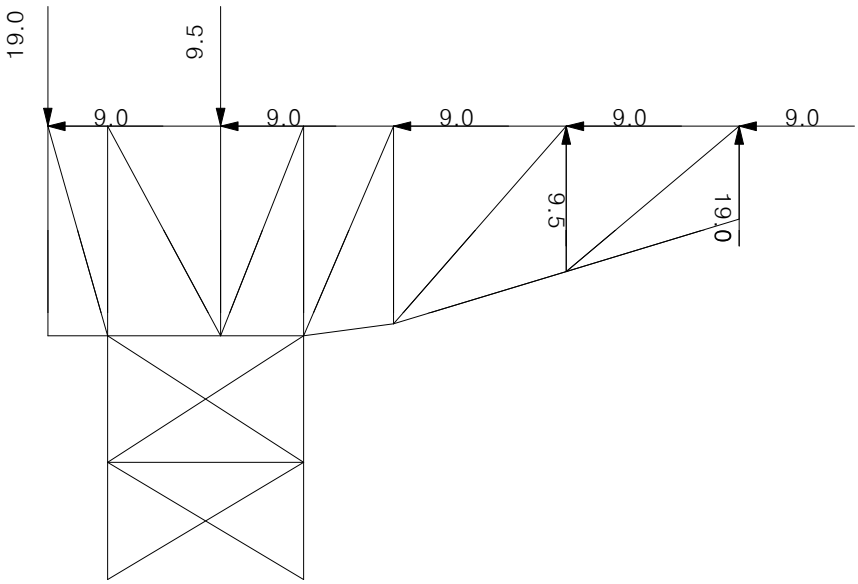
4) 상부 활하중 반력 : LC2 (L2)



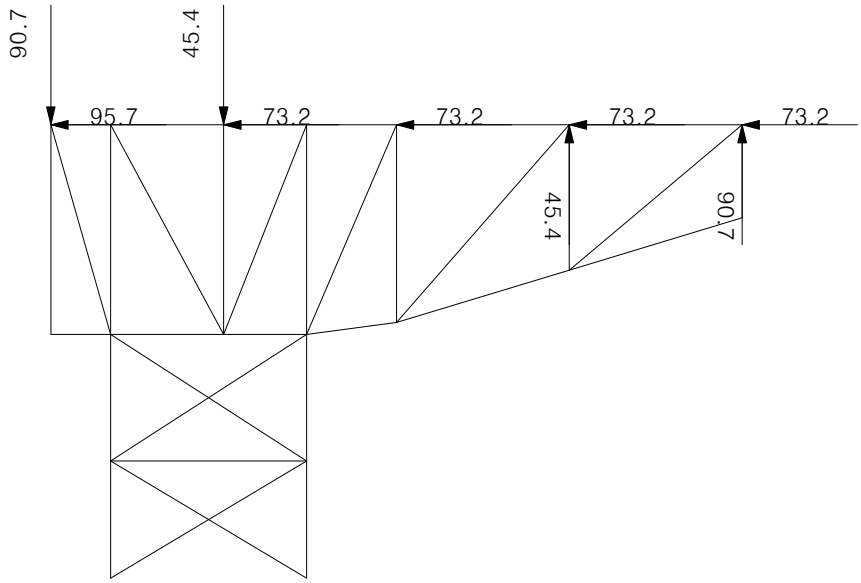
5) 상부 활하중 반력 : LC3 (L3)



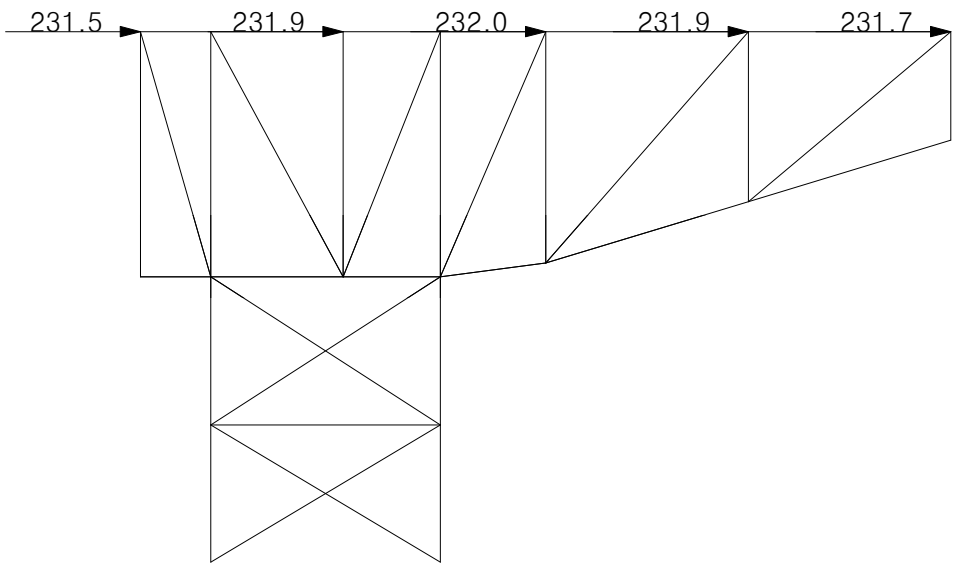
6) 활하중에 작용하는 풍하중 (WL)



7) 풍하중 : 교축직각방향 (W-TR)



8) 지진하중 : 교축직각방향 (E-TR)



1.6 하중조합

구분	D	L1	L2	L3	W	WL	E
LC01	1.30	2.15					
LC02	1.30		2.15				
LC03	1.30				1.30		
LC04	1.30			1.30	0.65	1.30	
LC05	1.00						1.00

D = 고정하중 또는 이에 따른 단면력

L = 활하중 또는 이에 따른 단면력

W = 풍하중 또는 이에 따른 단면력

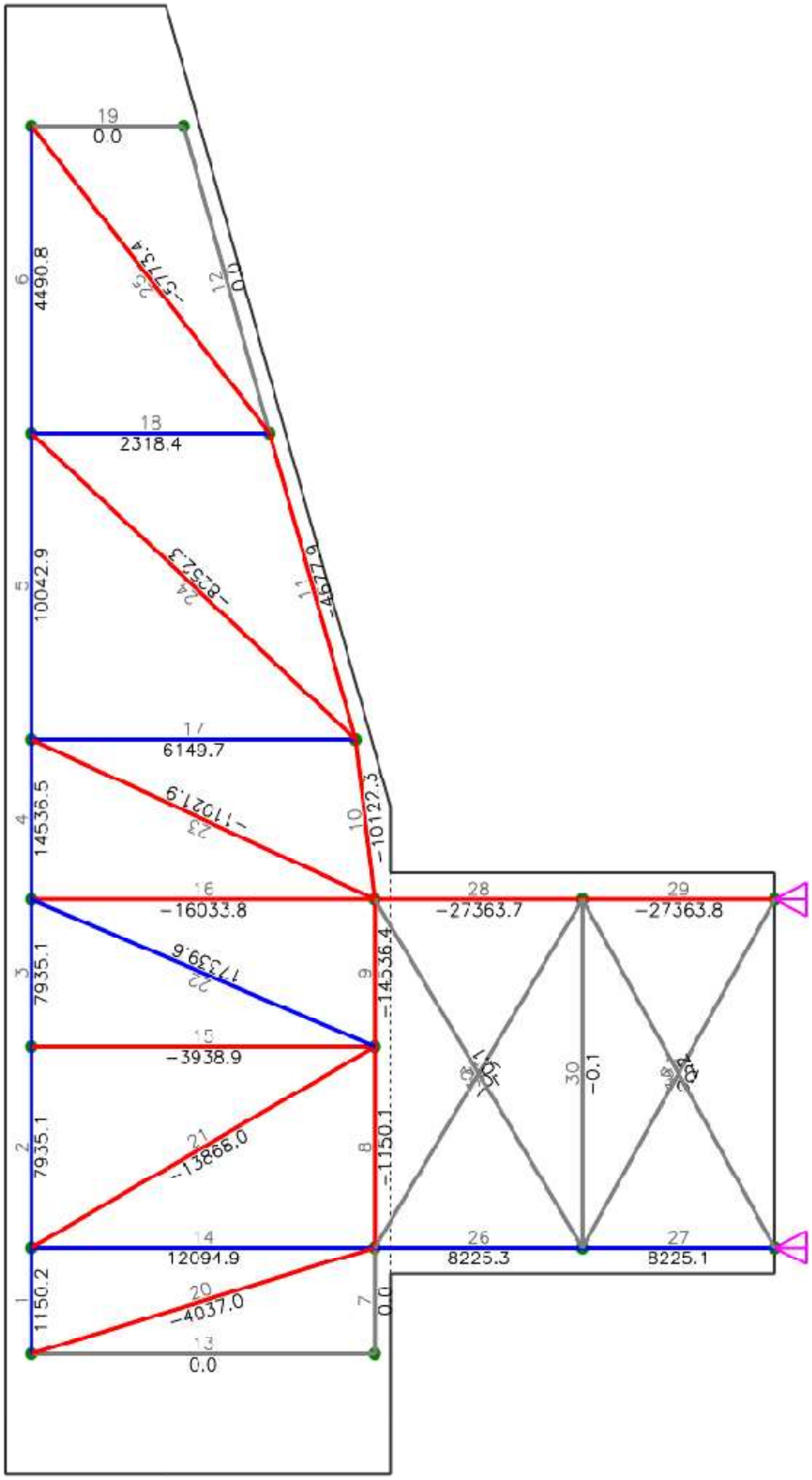
WL = 차량활하중에 작용하는 풍하중 또는 이에 따른 단면력

E = 지진하중 또는 이에 따른 단면력

CF = 원심하중 또는 이에 따른 단면력

ASTM

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1

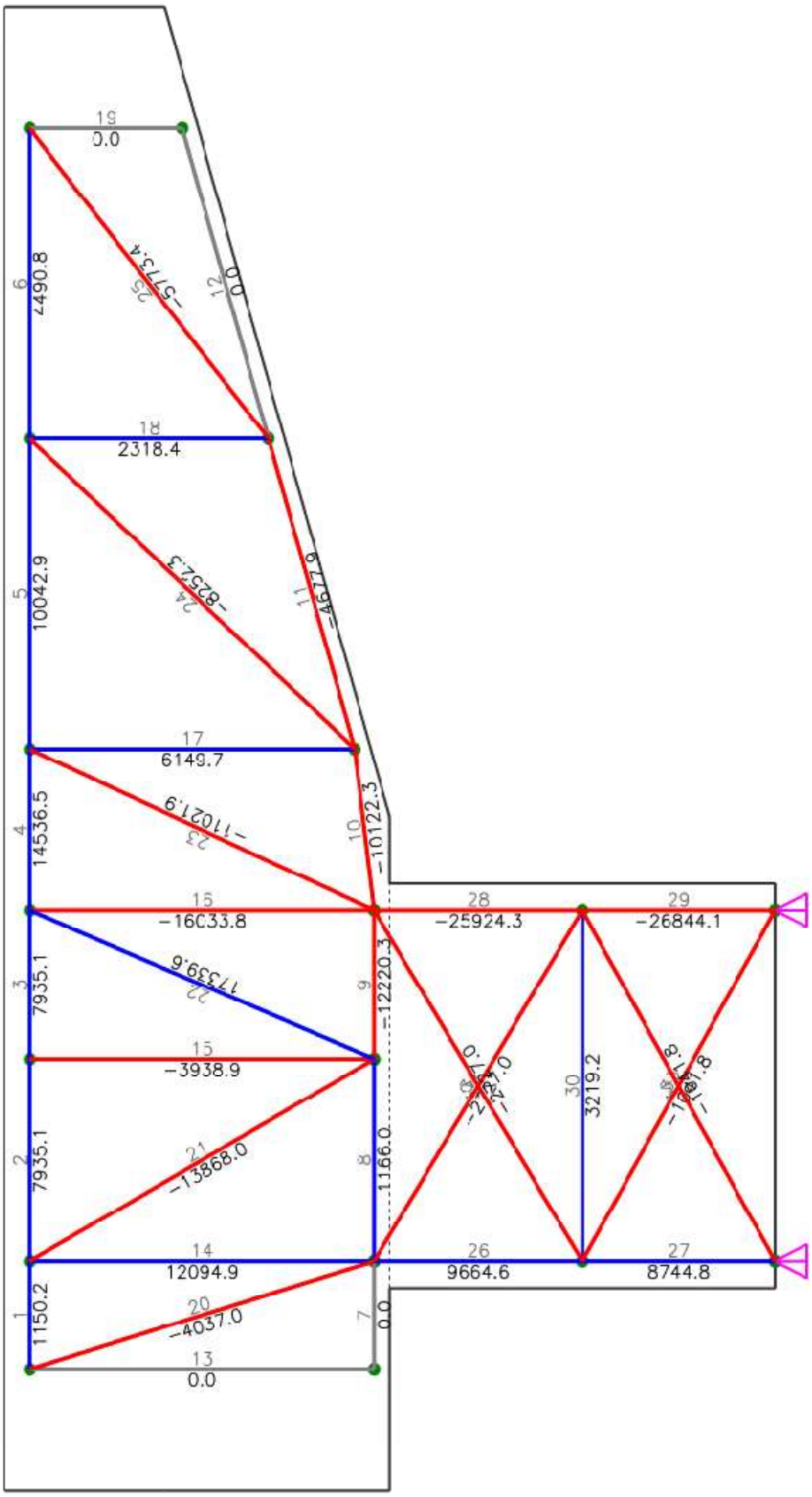


ASTM

Element	ASTM			SAP2000		SAP대비 Force
	Force	Material	Area	Force	Area	
01	1141.72	STEEL1	0.002854	1150.24	0.002876	-0.7%
02	7876.32	STEEL1	0.019691	7935.12	0.019838	-0.7%
03	7876.3	STEEL1	0.019691	7935.1	0.019838	-0.7%
04	14428.8	STEEL1	0.036072	14536.48	0.036341	-0.7%
05	9960.92	STEEL1	0.024902	10042.84	0.025107	-0.8%
06	4440.84	STEEL1	0.011102	4490.76	0.011227	-1.1%
07	0	STEEL1	0	0	0	0.0%
08	1141.6	CONC1	0.083	1150.1	0.0835	-0.7%
09	14428.7	CONC1	1.04775	14536.3	1.05575	-0.7%
10	10038.9	CONC1	0.729	10122.3	0.735	-0.8%
11	4625.8	CONC1	0.336	4677.9	0.33975	-1.1%
12	0	STEEL1	0	0	0	0.0%
13	0	STEEL1	0	0	0	0.0%
14	12094.9	STEEL1	0.030237	12094.9	0.030237	0.0%
15	3938.9	CONC1	0.286	3938.9	0.286	0.0%
16	16033.8	CONC1	1.1645	16033.8	1.1645	0.0%
17	6166.6	STEEL1	0.015417	6149.7	0.015374	0.3%
18	2333.2	STEEL1	0.005833	2318.4	0.005796	0.6%
19	0	STEEL1	0	0	0	0.0%
20	4034.6	CONC1	0.293	4037	0.29325	-0.1%
21	13843.5	CONC1	1.00525	13868	1.007	-0.2%
22	0	STEEL1	0	17339.6	0.043349	0.0%
23	11027	CONC1	0.80075	11021.9	0.8005	0.0%
24	8241.8	CONC1	0.5985	8252.3	0.59925	-0.1%
25	5734.6	CONC1	0.4165	5773.4	0.41925	-0.7%
26	8225.3	STEEL1	0.020563	8225.3	0.020563	0.0%
27	8225.1	STEEL1	0.020563	8225.1	0.020563	0.0%
28	27363.7	CONC1	1.98725	27363.6	1.98725	0.0%
29	27363.8	CONC1	1.98725	27363.8	1.98725	0.0%
30	0	STEEL1	0	0	0	0.0%
31	0	STEEL1	0	0	0	0.0%
32	0	STEEL1	0	0	0	0.0%
33	0	STEEL1	0	0	0	0.0%
34	0	STEEL1	0	0	0	0.0%

SAP2000-STAGE01

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1

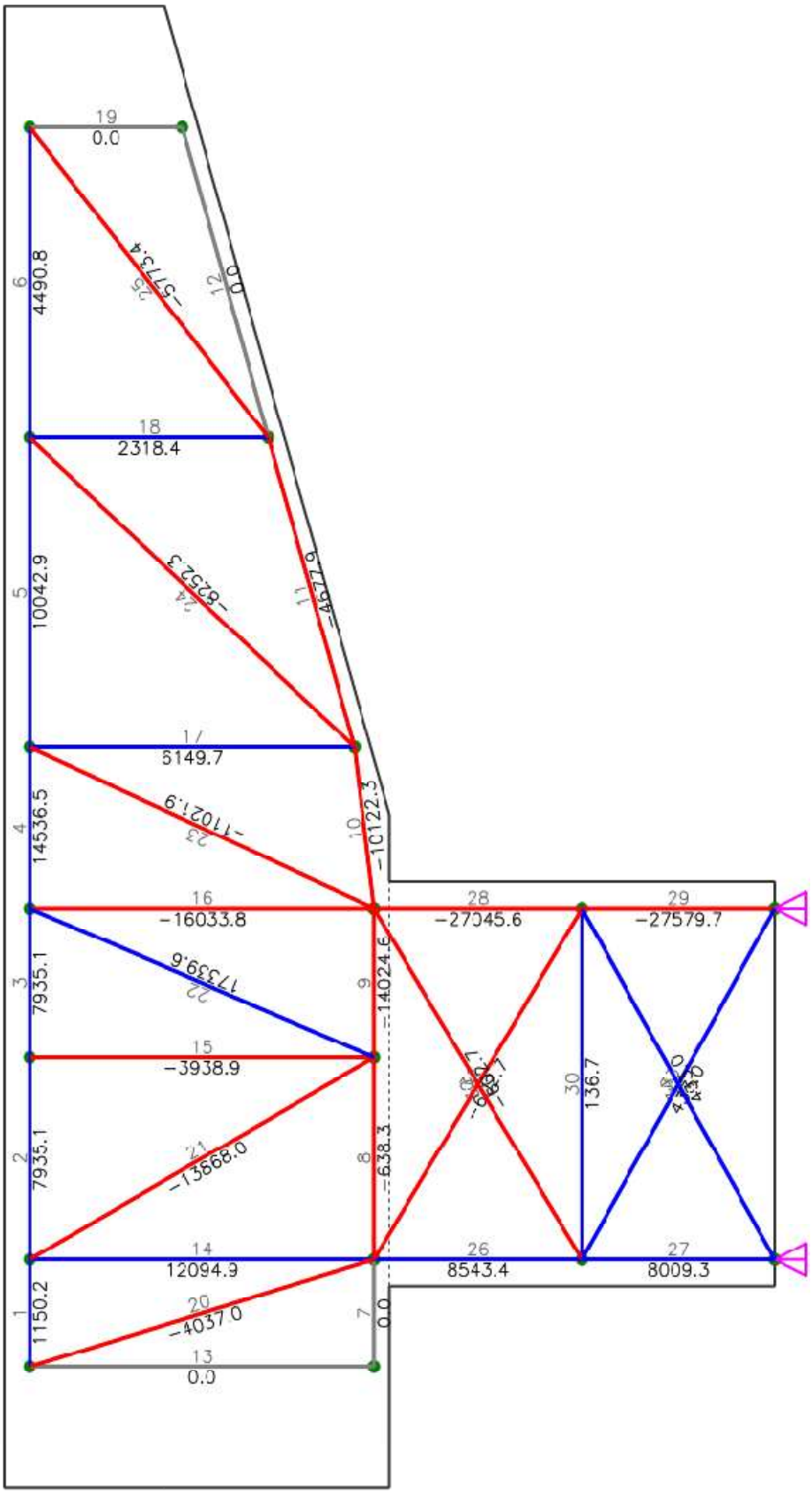


STAGE01

Element	Force	Material	Area
01	1141.72	STEEL1	0.002854
02	7876.32	STEEL1	0.019691
03	7935.1	STEEL1	0.019838
04	14428.8	STEEL1	0.036072
05	9960.92	STEEL1	0.024902
06	4440.84	STEEL1	0.011102
07	0	STEEL1	0
08	1153.7	STEEL1	0.002884
09	12133.4	CONC1	0.88125
10	10038.9	CONC1	0.729
11	4625.8	CONC1	0.336
12	0	STEEL1	0
13	0	STEEL1	0
14	12094.9	STEEL1	0.030237
15	3938.9	CONC1	0.286
16	16033.8	CONC1	1.1645
17	6166.6	STEEL1	0.015417
18	2333.2	STEEL1	0.005833
19	0	STEEL1	0
20	4034.6	CONC1	0.293
21	13843.5	CONC1	1.00525
22	17321	STEEL1	0.043303
23	11027	CONC1	0.80075
24	8241.8	CONC1	0.5985
25	5734.6	CONC1	0.4165
26	9664.6	STEEL1	0.024162
27	8744.8	STEEL1	0.021862
28	25954.9	CONC1	1.885
29	26841.4	CONC1	1.94925
30	3203.1	STEEL1	0.008008
31	2693.3	CONC1	0.1955
32	2693.3	CONC1	0.1955
33	1047.2	CONC1	0.076
34	1047.2	CONC1	0.076

SAP2000-STAGE02

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1

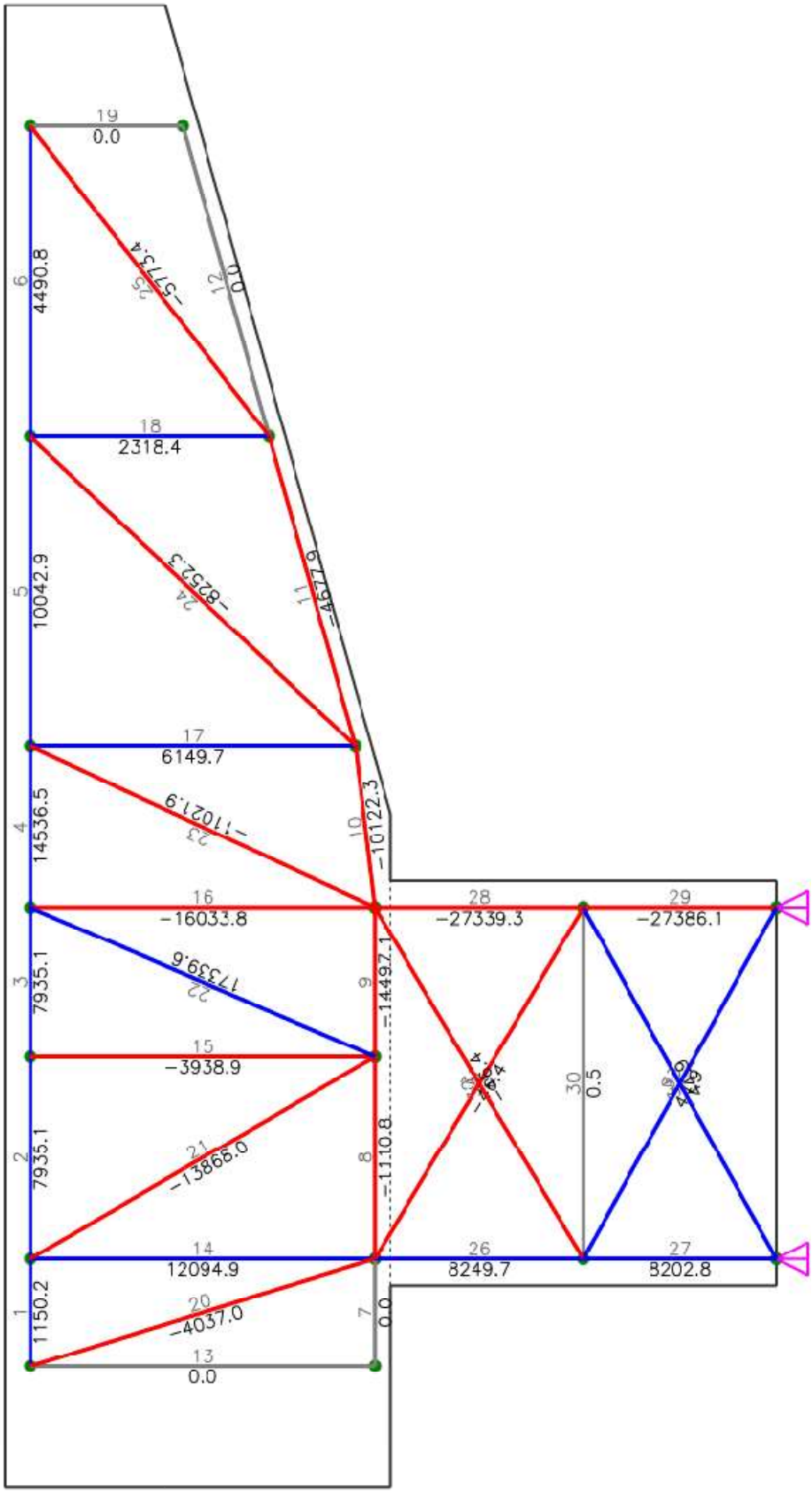


STAGE02

Element	Force	Material	Area	증감율
01	1150.24	STEEL1	0.002876	0.7%
02	7935.12	STEEL1	0.019838	0.7%
03	7935.1	STEEL1	0.019838	0.0%
04	14536.48	STEEL1	0.036341	0.7%
05	10042.84	STEEL1	0.025107	0.8%
06	4490.76	STEEL1	0.011227	1.1%
07	0	STEEL1	0	0.0%
08	638.3	CONC1	0.04625	93.8%
09	14024.6	CONC1	1.0185	13.5%
10	10122.3	CONC1	0.735	0.8%
11	4677.9	CONC1	0.33975	1.1%
12	0	STEEL1	0	0.0%
13	0	STEEL1	0	0.0%
14	12094.9	STEEL1	0.030237	0.0%
15	3938.9	CONC1	0.286	0.0%
16	16033.8	CONC1	1.1645	0.0%
17	6149.7	STEEL1	0.015374	-0.3%
18	2318.4	STEEL1	0.005796	-0.6%
19	0	STEEL1	0	0.0%
20	4037	CONC1	0.29325	0.1%
21	13868	CONC1	1.007	0.2%
22	17339.6	STEEL1	0.043349	0.1%
23	11021.9	CONC1	0.8005	0.0%
24	8252.3	CONC1	0.59925	0.1%
25	5773.4	CONC1	0.41925	0.7%
26	8543.4	STEEL1	0.021359	-13.1%
27	8009.3	STEEL1	0.020023	-9.2%
28	27045.6	CONC1	1.964	4.0%
29	27579.7	CONC1	2.003	2.7%
30	30	STEEL1	0.000075	#######
31	602.7	CONC1	0.04375	-346.9%
32	602.7	CONC1	0.04375	-346.9%
33	433	STEEL1	0.001083	-6920.8%
34	433	STEEL1	0.001083	-6920.8%

SAP2000-STAGE03

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1

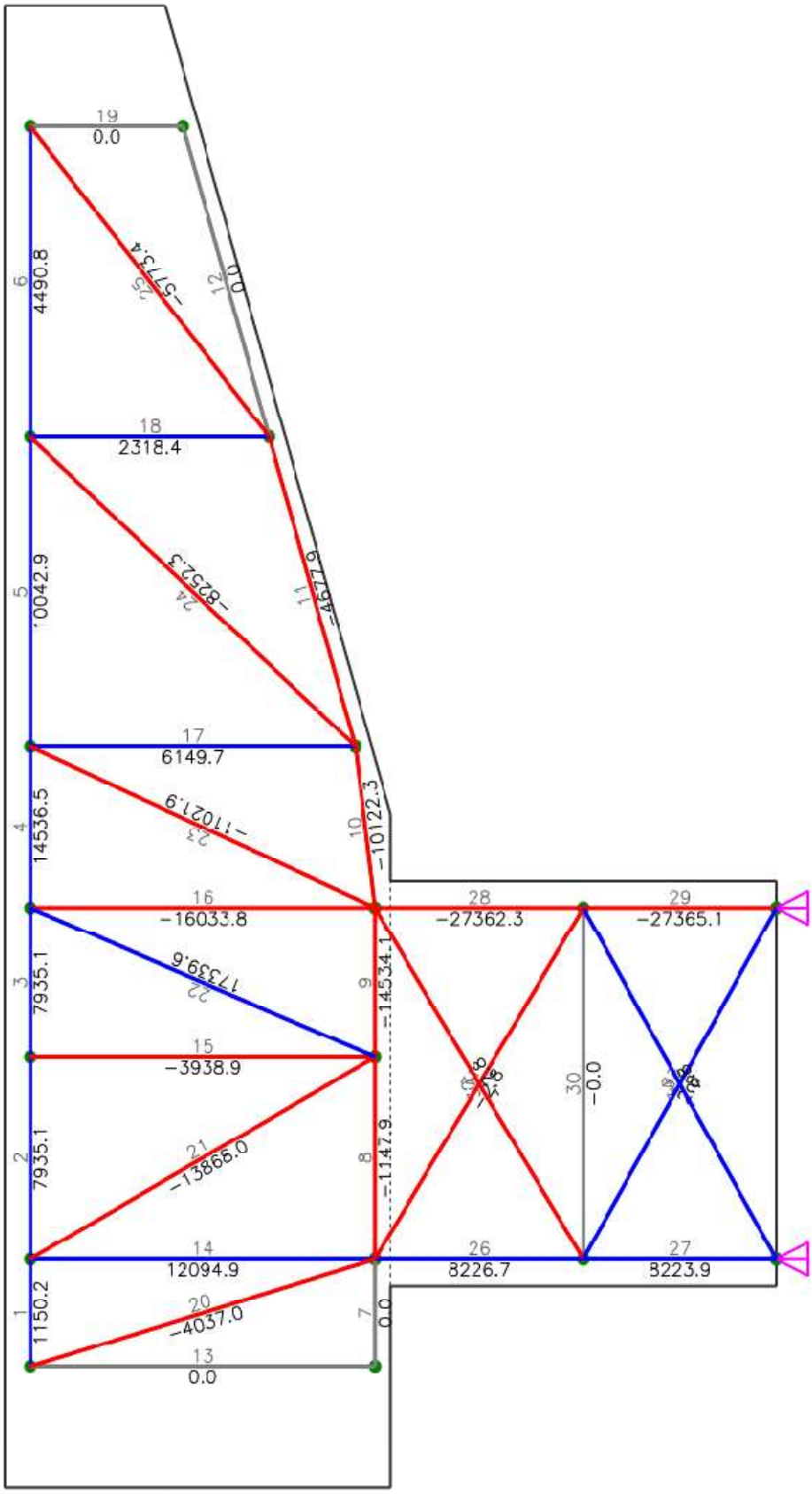


STAGE03

Element	Force	Material	Area	증감율
01	1150.24	STEEL1	0.002876	0.0%
02	7935.12	STEEL1	0.019838	0.0%
03	7935.1	STEEL1	0.019838	0.0%
04	14536.48	STEEL1	0.036341	0.0%
05	10042.84	STEEL1	0.025107	0.0%
06	4490.76	STEEL1	0.011227	0.0%
07	0	STEEL1	0	0.0%
08	1110.8	CONC1	0.08075	42.7%
09	14497.1	CONC1	1.05275	3.3%
10	10122.3	CONC1	0.735	0.0%
11	4677.9	CONC1	0.33975	0.0%
12	0	STEEL1	0	0.0%
13	0	STEEL1	0	0.0%
14	12094.9	STEEL1	0.030237	0.0%
15	3938.9	CONC1	0.286	0.0%
16	16033.8	CONC1	1.1645	0.0%
17	6149.7	STEEL1	0.015374	0.0%
18	2318.4	STEEL1	0.005796	0.0%
19	0	STEEL1	0	0.0%
20	4037	CONC1	0.29325	0.0%
21	13868	CONC1	1.007	0.0%
22	17339.6	STEEL1	0.043349	0.0%
23	11021.9	CONC1	0.8005	0.0%
24	8252.3	CONC1	0.59925	0.0%
25	5773.4	CONC1	0.41925	0.0%
26	8249.7	STEEL1	0.020624	-3.6%
27	8202.8	STEEL1	0.020507	2.4%
28	27339.3	CONC1	1.9855	1.1%
29	27386.1	CONC1	1.98875	-0.7%
30	0.5	STEEL1	1.3E-06	-5669.2%
31	46.4	CONC1	0.00325	-1246.2%
32	46.4	CONC1	0.00325	-1246.2%
33	44.9	STEEL1	0.000112	-863.9%
34	44.9	STEEL1	0.000112	-863.9%

SAP2000-STAGE04

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1

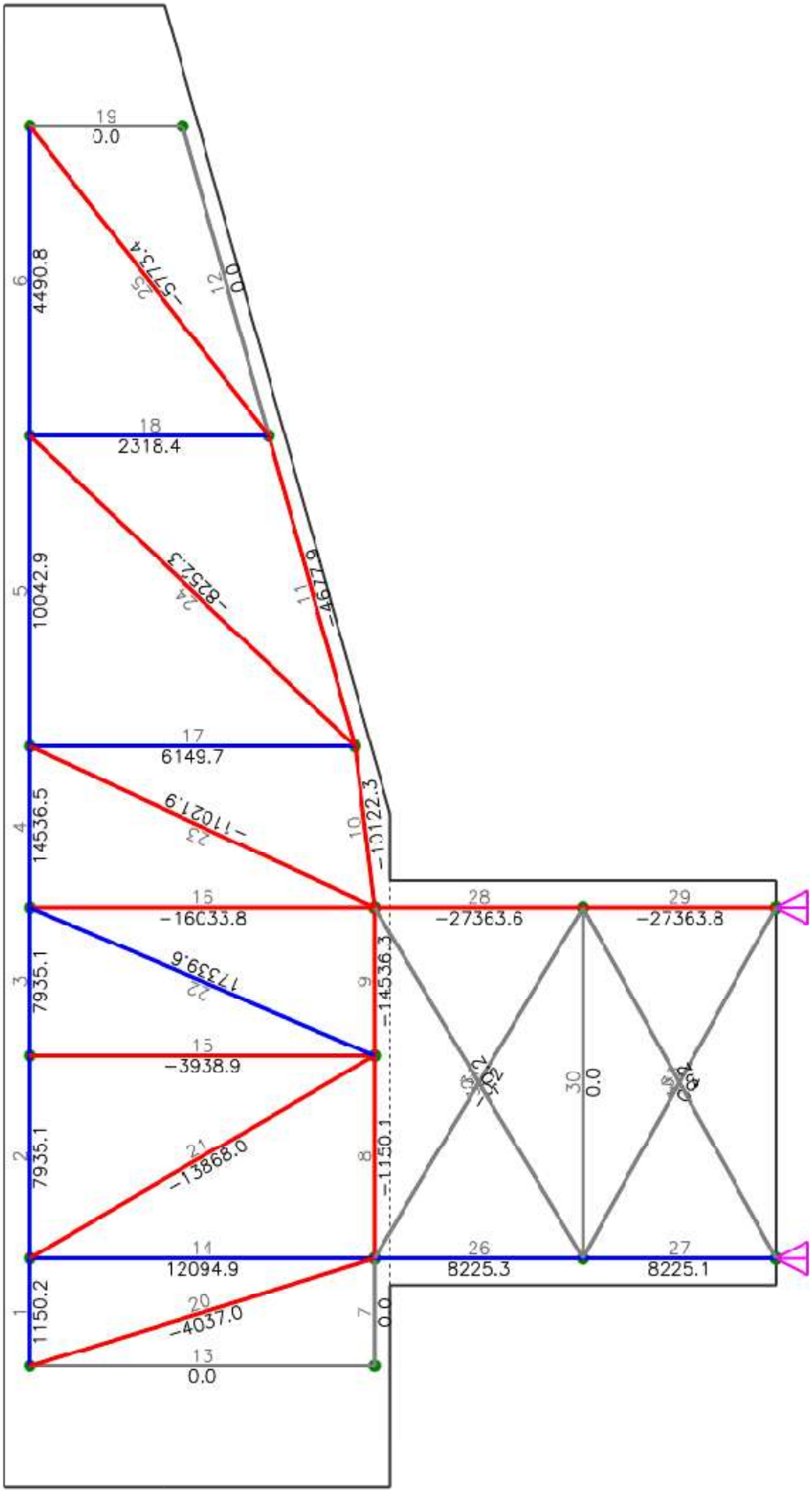


STAGE04

Element	Force	Material	Area	증감율
01	1150.24	STEEL1	0.002876	0.0%
02	7935.12	STEEL1	0.019838	0.0%
03	7935.1	STEEL1	0.019838	0.0%
04	14536.48	STEEL1	0.036341	0.0%
05	10042.84	STEEL1	0.025107	0.0%
06	4490.76	STEEL1	0.011227	0.0%
07	0	STEEL1	0	0.0%
08	1147.9	CONC1	0.08325	3.0%
09	14534.1	CONC1	1.0555	0.3%
10	10122.3	CONC1	0.735	0.0%
11	4677.9	CONC1	0.33975	0.0%
12	0	STEEL1	0	0.0%
13	0	STEEL1	0	0.0%
14	12094.9	STEEL1	0.030237	0.0%
15	3938.9	CONC1	0.286	0.0%
16	16033.8	CONC1	1.1645	0.0%
17	6149.7	STEEL1	0.015374	0.0%
18	2318.4	STEEL1	0.005796	0.0%
19	0	STEEL1	0	0.0%
20	4037	CONC1	0.29325	0.0%
21	13868	CONC1	1.007	0.0%
22	17339.6	STEEL1	0.043349	0.0%
23	11021.9	CONC1	0.8005	0.0%
24	8252.3	CONC1	0.59925	0.0%
25	5773.4	CONC1	0.41925	0.0%
26	8226.7	STEEL1	0.020567	-0.3%
27	8223.9	STEEL1	0.02056	0.3%
28	27362.3	CONC1	1.987	0.1%
29	27365.1	CONC1	1.98725	-0.1%
30	0	STEEL1	0	0.0%
31	2.8	CONC1	0.00025	-1200.0%
32	2.8	CONC1	0.00025	-1200.0%
33	2.8	STEEL1	0.000007	-1504.3%
34	2.8	STEEL1	0.000007	-1504.3%

SAP2000-STAGE05

하중조합 UL01 : 1.3 SW + 1.3 D + 2.1 L1



STAGE05

Element	Force	Material	Area	증감율
01	1150.24	STEEL1	0.002876	0.0%
02	7935.12	STEEL1	0.019838	0.0%
03	7935.1	STEEL1	0.019838	0.0%
04	14536.48	STEEL1	0.036341	0.0%
05	10042.84	STEEL1	0.025107	0.0%
06	4490.76	STEEL1	0.011227	0.0%
07	0	STEEL1	0	0.0%
08	1150.1	CONC1	0.0835	0.3%
09	14536.3	CONC1	1.05575	0.0%
10	10122.3	CONC1	0.735	0.0%
11	4677.9	CONC1	0.33975	0.0%
12	0	STEEL1	0	0.0%
13	0	STEEL1	0	0.0%
14	12094.9	STEEL1	0.030237	0.0%
15	3938.9	CONC1	0.286	0.0%
16	16033.8	CONC1	1.1645	0.0%
17	6149.7	STEEL1	0.015374	0.0%
18	2318.4	STEEL1	0.005796	0.0%
19	0	STEEL1	0	0.0%
20	4037	CONC1	0.29325	0.0%
21	13868	CONC1	1.007	0.0%
22	17339.6	STEEL1	0.043349	0.0%
23	11021.9	CONC1	0.8005	0.0%
24	8252.3	CONC1	0.59925	0.0%
25	5773.4	CONC1	0.41925	0.0%
26	8225.3	STEEL1	0.020563	0.0%
27	8225.1	STEEL1	0.020563	0.0%
28	27363.6	CONC1	1.98725	0.0%
29	27363.8	CONC1	1.98725	0.0%
30	0	STEEL1	0	0.0%
31	0	STEEL1	0	0.0%
32	0	STEEL1	0	0.0%
33	0	STEEL1	0	0.0%
34	0	STEEL1	0	0.0%