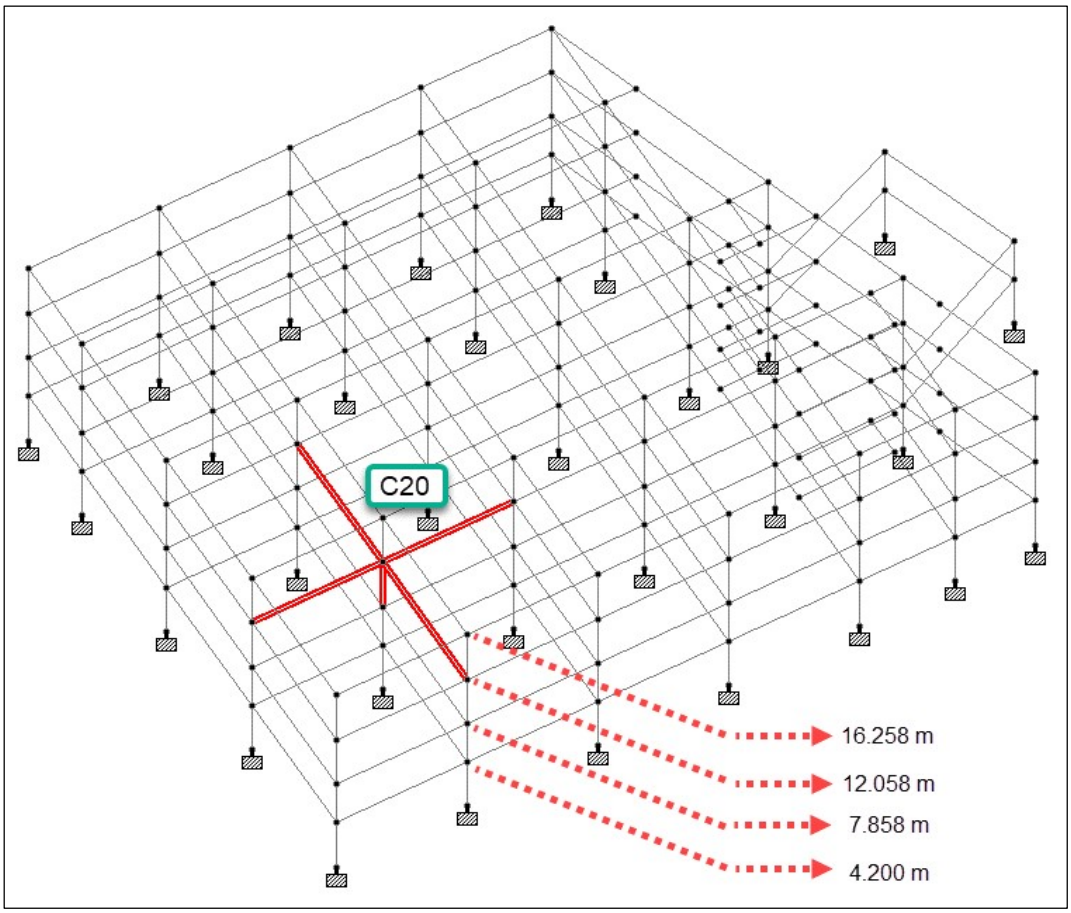
EFFECTIVE LENGTH FACTOR CALCULATION

Calculation of Stability Index:

Bottom Level of Column	=	7.858	m	
Top Level of Column	=	12.058	m	
Column	=	C20		
Column Width	=	600	mm	
Column Depth	=	900	mm	
Concrete Grade for Column, fck-c	=	25	N/sqmm	
Reinforcement Grade for Column, fy-c	=	420	N/sqmm	
Concrete Grade for Beam, fck-b	=	25	N/sqmm	
Reinforcement Grade for Beam, fy-b	=	420	N/sqmm	
Height of Column,H	=	(12.058-7.858)x1000		
	=	4200	mm	
Elastic Modulus of fck-c	=	4700xSQRT(25)		Clause 6.2.3.1
	=	23500	N/sqmm	
Elastic Modulus of fck-c	=	4700xSQRT(25)		Clause 6.2.3.1
	=	23500	N/sqmm	

COLUMN LOCATION AND LEVELS



Sway Calculation (Stability Index)

For Global X direction

Level	Load Combination	Storey Height (m)	Gravity Load P (kN)	Relative Displacements (mm)	Storey Shear (kN)	Stability Index (Q)	Sway Condition
		A	B	C	D	B x C / (A x D)	
0 m to 4.2 m	5	4.2	94969.95	2.06	2802.1	0.017	Non Sway
4.2 m to 7.858 m	5	3.66	84547.91	2.19	2730.53	0.019	Non Sway
7.858 m to 12.058 m	5	4.2	54752.02	2.69	2447.85	0.014	Non Sway
12.058 m to 16.258 m	4	4.2	25227.45	2.67	1813.22	0.009	Non Sway

Story Height (A)	=	4200 mm	
Gravity Load,p (B)	=	54752 kN	
Relative Displacement (Eq-X) (C)	=	2.69 mm	
Story Shear (D)	=	2447.9 kN	
Stability Index,Q	=	54752.02 x 2.69 / (4200 x 2447.853)	
	=	0.0143	Clause 6.6.4.3
Check	=	Non Sway	Clause 6.6.4.3

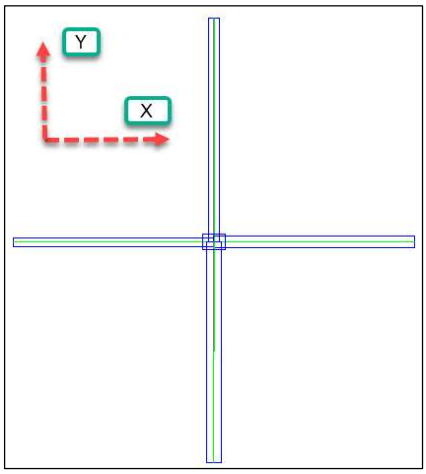
For Global X direction

Level	Load Combination	Storey Height (m)	Gravity Load P (kN)	Relative Displacements (mm)	Storey Shear (kN)	Stability Index (Q)	Sway Condition
		A	B	C	D	B x C / (A x D)	
0 m to 4.2 m	6	4.2	94969.95	2.18	2802.1	0.018	Non Sway
4.2 m to 7.858 m	6	3.66	84547.91	2.26	2730.53	0.019	Non Sway
7.858 m to 12.058 m	6	4.2	54752.02	2.73	2447.85	0.015	Non Sway
12.058 m to 16.258 m	6	4.2	25227.45	1.71	1813.22	0.006	Non Sway

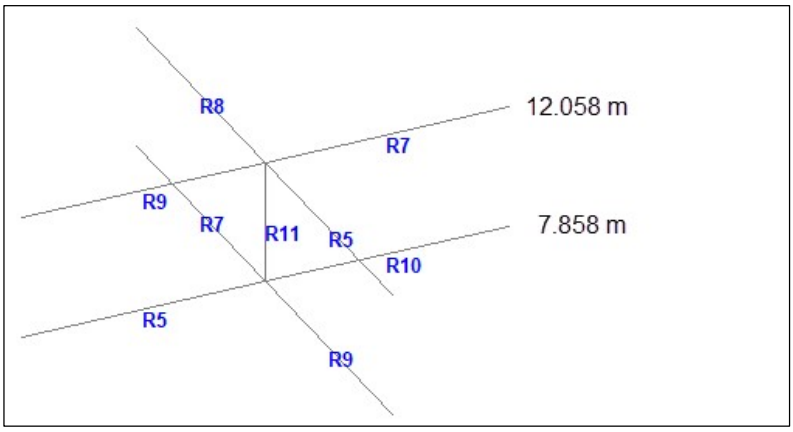
Story Height (A)	=	4200 mm	
Gravity Load,p (B)	=	54752 kN	
Relative Displacement (Eq-X) (C)	=	2.73 mm	
Story Shear (D)	=	2447.9 kN	
Stability Index,Q	=	54752.02 x 2.73 / (4200 x 2447.853)	
	=	0.0145	Clause 6.6.4.3
Check	=	Non Sway	Clause 6.6.4.3

Note: Validation of Values B,C and D are provided at end of this document.

Column Orientation W.R.T. Global Axis



Beam Column Layout



Beam Details at 7.858 m level

R10 Along Major Direction of Column

Beam Width	=	300	mm
Beam Depth	=	800	mm
Beam Length	=	8000	mm
Beam Stiffness	=	4x300x800^3/12x23500/8000/10^9	
	=	150.4	N-m

R5 Along Major Direction of Column

Beam Width	=	600	mm
Beam Depth	=	900	mm
Beam Length	=	8000	mm
Beam Stiffness	=	4x600x900^3/12x23500/8000/10^9	
	=	428.29	N-m

R9 Along Minor Direction of Column

Beam Width	=	350	mm
Beam Depth	=	750	mm
Beam Length	=	8950	mm
Beam Stiffness	=	4x350x750^3/12x23500/8950/10^9	
	=	129.23	N-m

R7 Along Minor Direction of Column

Beam Width	=	450	mm
Beam Depth	=	700	mm
Beam Length	=	9050	mm
Beam Stiffness	=	4x450x700^3/12x23500/9050/10^9	
	=	133.6	N-m

Beam Details at 12.058 m level

R7 Along Major Direction of Column

Beam Width	=	450	mm
Beam Depth	=	700	mm
Beam Length	=	8000	mm
Beam Stiffness	=	4x450x700^3/12x23500/8000/10^9	
	=	151.13	N-m

R9 Along Major Direction of Column

Beam Width	=	350	mm

Beam Depth	=	750	mm
Beam Length	=	8000	mm
Beam Stiffness	=	4x350x750^3/12x23500/8000/10^9	
	=	144.58	N-m

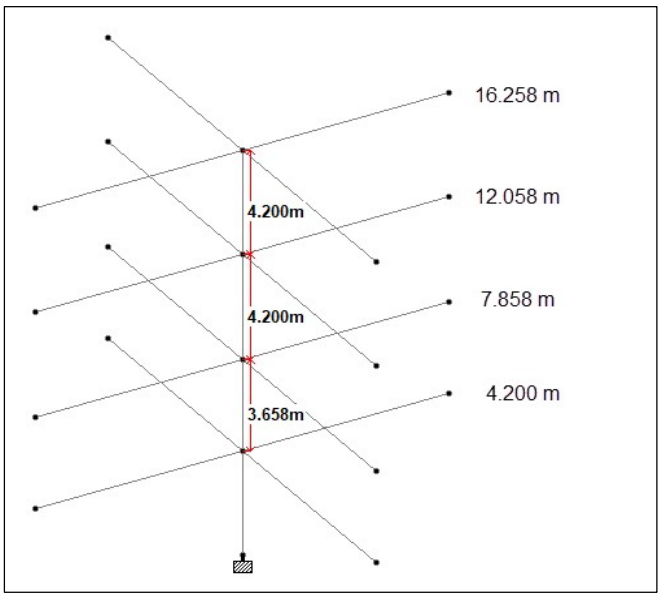
R10 Along Minor Direction of Column

Beam Width	=	600	mm
Beam Depth	=	900	mm
Beam Length	=	8950	mm
Beam Stiffness	=	4x600x900^3/12x23500/8950/10^9	
	=	382.83	N-m

R8 Along Minor Direction of Column

Beam Width	=	400	mm
Beam Depth	=	600	mm
Beam Length	=	9050	mm
Beam Stiffness	=	4x400x600^3/12x23500/9050/10^9	
	=	74.78	N-m

Column Layout



For Global X direction

Column Details above 12.058 m level

Column Width	=	600	mm
COlumn Depth	=	900	mm
Column Length	=	4200	mm
Column Stiffness	=	4x600x900^3/12x23500/4200/10^9	
	=	815.79	N-m

Column Details below 12.058 m level

Column Width	=	600	mm
COlumn Depth	=	900	mm
Column Length	=	4200	mm
Column Stiffness	=	4x600x900^3/12x23500/4200/10^9	
	=	815.79	N-m

Column Details below 7.858 m level

Column Width	=	600	mm

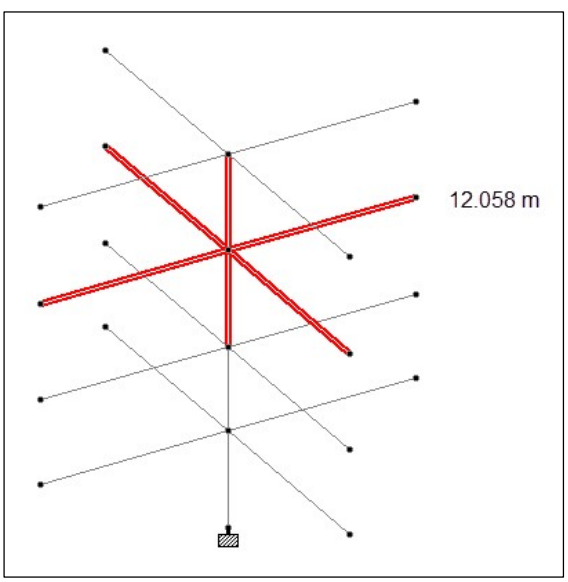
COlumn Depth		=	900 mm
Column Length		=	3658 mm
Column Stiffness		=	4x600x900^3/12x23500/3658/10^9
		=	936.66 N-m

For Global Y direction

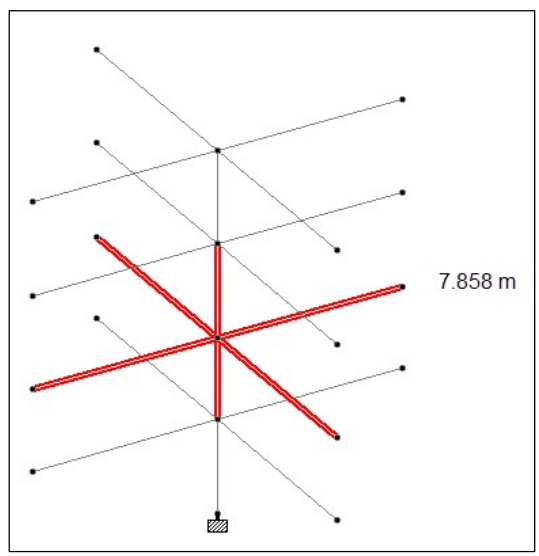
Column Details above	12.058	m level	
Column Width		=	600 mm
COlumn Depth		=	900 mm
Column Length		=	4200 mm
Column Stiffness		=	4x600x900^3/12x23500/4200/10^9
		=	362.57 N-m
Column Details below	12.058	m level	
Column Width		=	600 mm
COlumn Depth		=	900 mm
Column Length		=	4200 mm
Column Stiffness		=	4x600x900^3/12x23500/4200/10^9
		=	362.57 N-m
Column Details below	7.858	m level	
Column Width		=	600 mm
COlumn Depth		=	900 mm
Column Length		=	3658 mm
Column Stiffness		=	4x600x900^3/12x23500/3658/10^9
		=	416.29 N-m

Effective Length Calculation

Fig R6.2.5



Beam and Column for Top Joint



Beam and Column for Bottom Joint

Calculation of Ψ Factor Along Major Axis Of Column

Top	=	(815.79+815.79)/(151.13+144.58)
	=	5.518
Bottom	=	(815.79+936.66)/(150.4+428.29)

= 3.028

Calculation of Beta Factor Along Minor Axis Of Column

Top = (362.57+362.57)/(382.83+74.78)

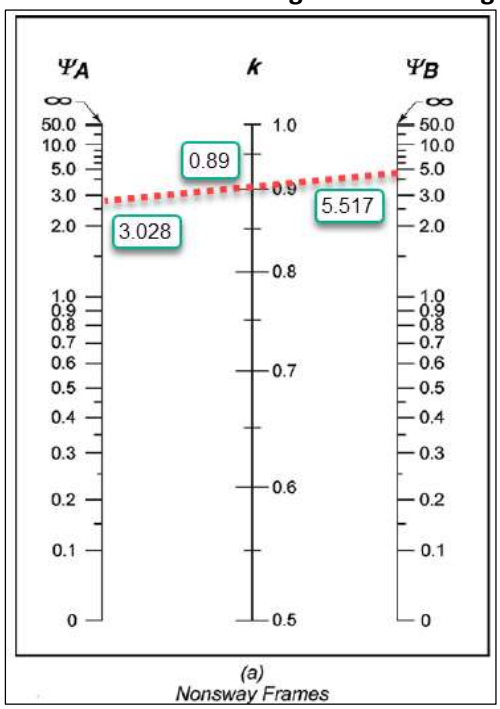
= 1.585

Bottom = (362.57+416.29)/(129.23+133.6)

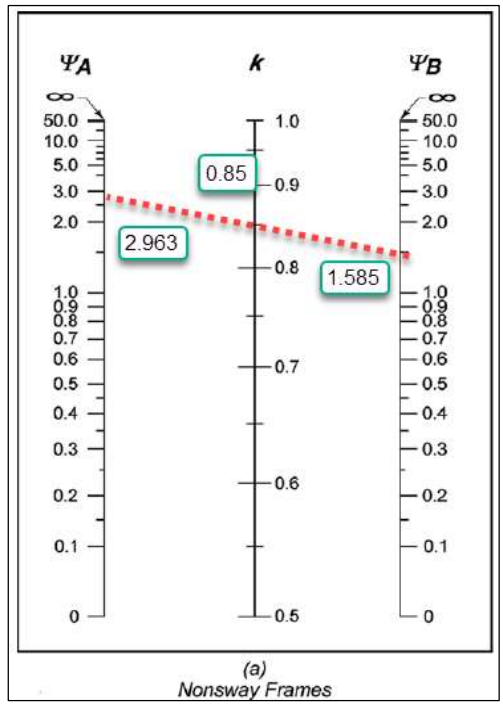
= 2.963

Note: For the calculation of the Ψ factor, all members connected to the joint at the level are considered. Ψ Factor is calculated at top and bottom joint of the column.

Calculation of Effective length factors Using Fig. R6.2.5



Along Major Axis Of Column



Along Minor Axis Of Column

Calculation Along Major Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		ψ
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	815.79	8000 x 300 x 800	8000 x 600 x 900	150.4	428.29	3.028
Top	815.79	8000 x 450 x 700	8000 x 350 x 750	151.13	144.58	5.517

Sway Condition (as per Stability Index) = Non Sway

Effective Length Factor along Major Axis = 0.89

Calculation Along Minor Axis Of Column

Joint	Column Stiffness	Beam Sizes		Beam Stiffness		ψ
		Beam 1 (Length x Width x Depth)	Beam 2 (Length x Width x Depth)	Beam 1	Beam 2	
	N-m x 10^6	mm	mm	N-m x 10^6	N-m x 10^6	
Bottom	362.57	8950 x 350 x 750	9050 x 450 x 700	129.23	133.6	2.963
Top	362.57	8950 x 600 x 900	9050 x 400 x 600	382.83	74.78	1.585

Sway Condition (as per Stability Index) = Non Sway

Effective Length Factor along Minor axis = 0.85

Table showing calculation of Gravity Load

Beam	L/C	Node	Axial Force kN	Shear-Y kN	Shear-Z kN	Torsion kN-m	Moment-Y kN-m	Moment-Z kN-m
3021	15	151	445.435	15.734	27.532	0	61.021	-37.258
1521	15	136	595.142	44.741	24.698	0	45.384	-95.183
421	15	125	781.319	-18.641	-76.723	0	-161.41	28.495
21	15	121	813.619	137.824	-41.795	0	-89.784	-293.356
2221	15	143	1066.394	48.868	-17.562	0	-45.693	-102.053
2421	15	145	1102.441	141.845	117.495	0	241.083	-302.09
221	15	123	1295.082	89.117	-57.096	0	-123.498	-193.22
121	15	122	1295.552	91.071	-56.915	0	-123.974	-199.538
321	15	124	1309.814	89.06	-58.881	0	-127.378	-190.765
2921	15	150	1314.47	85.1	203.212	0	430.298	-179.714
521	15	126	1579.376	176.613	-71.743	0	-150.14	-371.564
2821	15	149	1605.927	51.032	167.171	0	341.529	-113.438
2521	15	146	1761.955	88.693	154.169	0	305.248	-195.572
2621	15	147	1763.786	86.016	154.2	0	311.65	-187.104
2721	15	148	1768.129	86.352	152.452	0	307.714	-186.542
921	15	130	1789.097	13.146	-84.19	0	-170.299	-34.272
1721	15	138	1822.132	163.612	3.831	0	11.879	-318.476
1021	15	131	1900.54	178.671	-1.87	0	-4.575	-374.039
1421	15	135	2078.248	-0.585	-52.383	0	-114.077	-3.79
821	15	129	2532.519	100.547	-104.71	0	-220.416	-216.175
721	15	128	2546.299	101.834	-101.847	0	-214.293	-219.999
621	15	127	2557.612	107.243	-101.59	0	-214.231	-236.418
2121	15	142	2664.586	59.031	-81.351	0	-156.875	-132.496
1821	15	139	2943.906	84.859	-0.373	-3.866	-3.223	-189.683
1121	15	132	3026.33	102.946	7.225	0	13.333	-226.791
1921	15	140	3074.4	91.1	3.361	0	13.813	-196.626
1321	15	134	3092.62	90.681	-8.103	0	-19.26	-192.901
1221	15	133	3097.137	96.85	-4.64	0	-11.734	-208.445
2021	15	141	3106.278	101.047	0.234	0	7.099	-214.511
		SUM	54730.15					

Table showing calculation of Story Drift

For Global-X Direction

Deflection at 12.058m level

Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
160	15	-6.667	-10.508	-1.398	12.523	0.001	0	0.002
157	15	-6.666	-7.093	-1.052	9.79	0.001	0	-0.004
153	15	-6.487	-6.006	-1.067	8.905	0.001	0	0
155	15	-6.487	-4.779	-1.253	8.154	0.001	0	0.001
159	15	-6.587	-4.183	-1.399	7.928	0.003	0	0.001
124	15	-7.614	-1.935	-0.314	7.862	0	0	0
149	15	-7.418	-2.375	-1.026	7.856	-0.001	0	0.001
122	15	-7.62	-1.911	-0.042	7.856	0	0	0

123	15	-7.615	-1.911	-0.101	7.852	0	0	0
146	15	-7.438	-2.512	0.02	7.851	0	0	0
147	15	-7.429	-2.533	-0.029	7.849	0	0	0
148	15	-7.424	-2.537	-0.239	7.849	0	0	0
141	15	-6.593	-4.223	-0.268	7.834	0	0	0
133	15	-6.592	-4.212	-0.076	7.823	0	0	0
134	15	-6.582	-4.206	-0.288	7.816	0	0	0
140	15	-6.599	-4.184	-0.057	7.814	0	0	0
150	15	-7.416	-1.999	-1.397	7.806	-0.001	0	0
132	15	-6.606	-4.117	-0.023	7.784	0	0	0
125	15	-7.607	-1.152	-1.095	7.772	0	0	0.001
127	15	-6.944	-3.488	-0.038	7.771	0	0	0
128	15	-6.936	-3.48	-0.096	7.761	0	0	0
129	15	-6.933	-3.466	-0.309	7.757	0	0	0
121	15	-7.633	-1.266	0.067	7.738	0	0	0
142	15	-6.588	-3.778	-1.062	7.668	0	0	0
145	15	-7.454	-1.672	0.092	7.64	0	0	0
139	15	-6.603	-3.614	-0.004	7.527	0	0	0
151	15	-7.415	-0.656	-1.112	7.526	0	0	0.001
130	15	-6.937	-2.429	-1.097	7.432	0	0	0.001
158	15	-6.717	-2.768	-1.353	7.39	0.041	0	0.126
126	15	-6.961	-2.313	0.067	7.336	0	0	0
152	15	-6.938	-1.809	-1.304	7.287	0	0	0
135	15	-6.574	-2.882	-1.068	7.257	0	0	0.001
143	15	-6.587	-2.546	-1.4	7.199	0	0	0.001
131	15	-6.626	-2.757	0.072	7.177	0	0	0
138	15	-6.643	-2.688	0.076	7.166	0	0	0
156	15	-6.574	-2.087	-1.256	7.011	0.001	0	0
154	15	-6.487	-2.151	-1.436	6.984	0.001	0	0.001
136	15	-6.574	-1.419	-1.409	6.871	0	0	0

Average 6.94 mm

Deflection at 7.858m level

Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
120	15	-4.063	-9.725	-0.316	10.544	0.001	0	0.002
117	15	-4.066	-6.43	-0.375	7.617	0.001	0	-0.003
113	15	-4.105	-5.09	-0.405	6.551	0.001	0	0
115	15	-4.106	-4.061	-0.488	5.795	0.001	0	0.001
93	15	-4.157	-3.139	-0.027	5.209	0	0	0
94	15	-4.134	-3.135	-0.16	5.191	0	0	0
119	15	-4.039	-3.237	-0.33	5.186	0.003	0	0
92	15	-4.181	-3.069	0.012	5.186	0	0	0
101	15	-4.042	-3.147	-0.126	5.125	0	0	0
100	15	-4.046	-3.119	0.007	5.109	0	0	0
87	15	-4.385	-2.6	-0.018	5.098	0	0	0
88	15	-4.362	-2.597	-0.058	5.077	0	0	0

89	15	-4.341	-2.587	-0.191	5.057	0	0	0
102	15	-4.036	-2.854	-0.386	4.958	0	0	0
106	15	-4.569	-1.897	0.117	4.949	-0.001	0	0
107	15	-4.543	-1.917	0.039	4.931	-0.001	0	0
108	15	-4.516	-1.921	-0.094	4.908	-0.001	0	0
99	15	-4.061	-2.688	0.057	4.87	0	0	0
109	15	-4.49	-1.814	-0.346	4.855	-0.001	0	0.001
82	15	-4.625	-1.456	-0.024	4.849	0	0	0
83	15	-4.603	-1.456	-0.065	4.828	0	0	0
84	15	-4.582	-1.475	-0.198	4.818	0	0	0
105	15	-4.594	-1.284	0.111	4.771	0	0	0
81	15	-4.647	-0.977	0.023	4.748	0	0	0
86	15	-4.409	-1.761	0.029	4.748	0	0	0
110	15	-4.479	-1.538	-0.28	4.744	-0.001	0	0
90	15	-4.321	-1.805	-0.439	4.704	0	0	0.001
91	15	-4.206	-2.094	0.057	4.699	0	0	0
85	15	-4.567	-0.874	-0.433	4.67	0	0	0.001
95	15	-4.115	-2.159	-0.414	4.665	0	0	0.001
118	15	-3.994	-2.27	-0.564	4.628	0.034	0	0.103
98	15	-4.074	-2.053	0.087	4.563	0	0	0
103	15	-4.039	-1.967	-0.55	4.526	0	0	0.001
111	15	-4.477	-0.493	-0.402	4.522	0	0	0.001
112	15	-4.321	-1.13	-0.5	4.495	0	0	0
114	15	-4.107	-1.72	-0.541	4.486	0.001	0	0.001
116	15	-4.114	-1.422	-0.489	4.38	0.001	0	0
96	15	-4.113	-1.091	-0.548	4.29	0	0	0

Average 4.28 mm

Story Drift = 6.94-4.28

= 2.660 mm

For Global-Y Direction

Deflection at 12.058m level

Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
160	16	0.117	-9.798	6.987	12.034	0.001	0	0.003
157	16	0.116	-7.395	6.998	10.181	0.001	0	-0.003
153	16	0.135	-6.238	6.976	9.359	0.001	0	0
155	16	0.135	-5.078	6.946	8.605	0.001	0	0.001
131	16	0.082	-2.63	8.179	8.591	0	0	0
138	16	0.058	-2.564	8.191	8.583	0	0	0
132	16	0.101	-4.2	7.462	8.564	0	0	0
126	16	0.107	-2.284	8.165	8.479	0.001	0	0
145	16	-0.135	-1.666	8.213	8.381	0	0	0
139	16	0.106	-3.593	7.531	8.345	0	0	0
127	16	0.122	-3.619	7.43	8.265	0.001	0	0
121	16	-0.063	-0.957	8.164	8.22	0.001	0	0
159	16	0.154	-4.179	6.983	8.139	0.003	0	0.001

133	16	0.112	-4.216	6.889	8.077	0	0	0
140	16	0.129	-4.115	6.911	8.044	0	0	0
141	16	0.142	-4.211	6.847	8.04	0	0	0
134	16	0.121	-4.205	6.824	8.017	0	0	0
146	16	-0.126	-2.63	7.566	8.012	0	0	0
142	16	0.151	-3.789	6.986	7.948	0	0	0
128	16	0.129	-3.594	6.866	7.75	0.001	0	0
129	16	0.133	-3.563	6.801	7.679	0.001	0	0
122	16	-0.053	-1.689	7.421	7.611	0.001	0	0
158	16	0.151	-2.983	6.92	7.537	0.105	0	0.318
135	16	0.129	-2.849	6.971	7.531	0	0	0
149	16	-0.135	-2.412	7.029	7.432	0	0	0
147	16	-0.126	-2.647	6.941	7.43	0	0	0
130	16	0.13	-2.622	6.934	7.414	0	0	0
152	16	0.129	-2.694	6.896	7.405	0	0	0
143	16	0.155	-2.601	6.914	7.389	0	0	0.001
148	16	-0.131	-2.656	6.878	7.374	0	0	0
154	16	0.135	-2.548	6.915	7.371	0	0	0.001
156	16	0.13	-2.257	6.946	7.304	0.001	0	0
150	16	-0.138	-1.999	6.997	7.278	0	0	0
151	16	-0.139	-0.979	7.027	7.096	0	0	0
136	16	0.131	-1.59	6.913	7.095	0	0	0
123	16	-0.046	-1.696	6.86	7.066	0.001	0	0
125	16	-0.028	-1.053	6.934	7.014	0.001	0	0
124	16	-0.039	-1.708	6.795	7.006	0.001	0	0
			Average	7.16				

Deflection at 7.858m level

Node	L/C	X-Trans mm	Y-Trans mm	Z-Trans mm	Absolute mm	X-Rotan rad	Y-Rotan rad	Z-Rotan rad
120	16	0.014	-8.903	4.824	10.126	0.001	0	0.003
117	16	0.01	-6.77	4.549	8.156	0.001	0	-0.003
113	16	-0.024	-5.357	4.513	7.005	0.001	0	0
115	16	-0.025	-4.384	4.515	6.293	0.001	0	0.001
119	16	-0.001	-3.222	4.809	5.788	0.003	0	0
92	16	-0.01	-3.132	4.503	5.485	0	0	0
98	16	-0.095	-1.948	5.008	5.374	0.001	0	0
102	16	0.001	-2.862	4.536	5.363	0.001	0	0
91	16	-0.03	-1.992	4.972	5.356	0.001	0	0
101	16	-0.014	-3.137	4.295	5.319	0	0	0
93	16	0.01	-3.142	4.29	5.317	0	0	0
100	16	-0.032	-3.066	4.326	5.302	0	0	0
99	16	-0.077	-2.682	4.558	5.289	0.001	0	0
94	16	0.029	-3.135	4.259	5.288	0	0	0
86	16	-0.016	-1.738	4.94	5.237	0.001	0	0
87	16	0.004	-2.708	4.475	5.23	0.001	0	0
105	16	-0.109	-1.278	5.042	5.202	0	0	0

118	16	0.147	-2.497	4.499	5.148	0.109	0	0.332
110	16	-0.021	-1.536	4.864	5.1	0	0	0
106	16	-0.092	-1.988	4.642	5.05	0	0	0
88	16	0.025	-2.689	4.256	5.035	0.001	0	0
114	16	-0.026	-2.124	4.54	5.012	0	0	0.001
89	16	0.046	-2.667	4.225	4.996	0.001	0	0
81	16	-0.023	-0.729	4.937	4.991	0.001	0	0
95	16	0.044	-2.131	4.501	4.98	0	0	0
103	16	-0.001	-2.009	4.545	4.97	0	0	0
112	16	0.069	-2.081	4.482	4.942	0	0	0
109	16	-0.029	-1.843	4.585	4.941	0	0	0
90	16	0.07	-1.961	4.468	4.88	0.001	0	0
107	16	-0.071	-2.009	4.363	4.804	0	0	0
116	16	0.043	-1.591	4.516	4.788	0.001	0	0
108	16	-0.05	-2.016	4.332	4.778	0	0	0
96	16	0.043	-1.229	4.509	4.673	0	0	0
82	16	-0.008	-1.277	4.472	4.65	0.001	0	0
111	16	-0.019	-0.753	4.561	4.623	0	0	0
85	16	0.059	-0.793	4.474	4.544	0.001	0	0
83	16	0.015	-1.282	4.251	4.44	0.001	0	0
84	16	0.039	-1.292	4.22	4.413	0.001	0	0
104	16	-0.99	-0.233	2.43	2.634	0	0	0
97	16	-0.824	-0.212	2.392	2.539	0	0	0
			Average	4.42				

Story Drift = 7.16-4.42

= 2.740 mm