Graduation Project I I

Analysis and Design of UMT Building .

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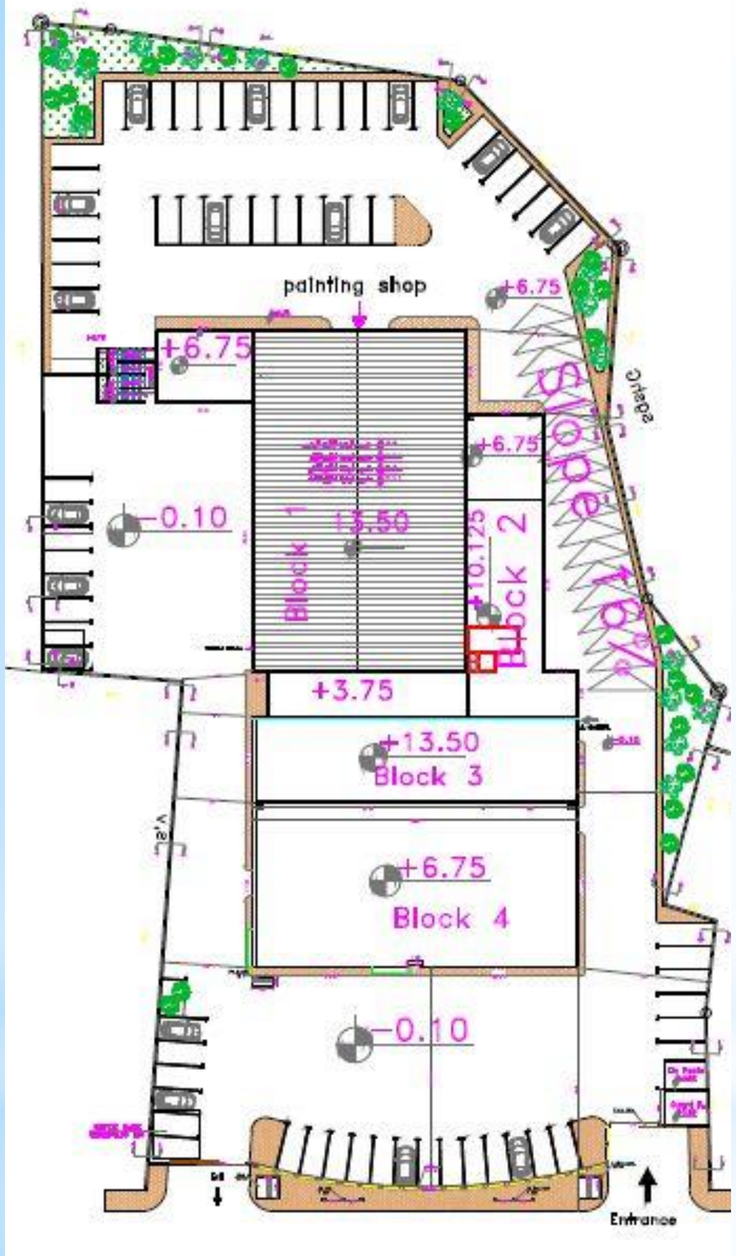
Contents*

* General Description for UMT Building.
* Gravity Analysis.
* Seismic Analysis.
* Checking the seismic performance using Pushover Analysis
* Detailing

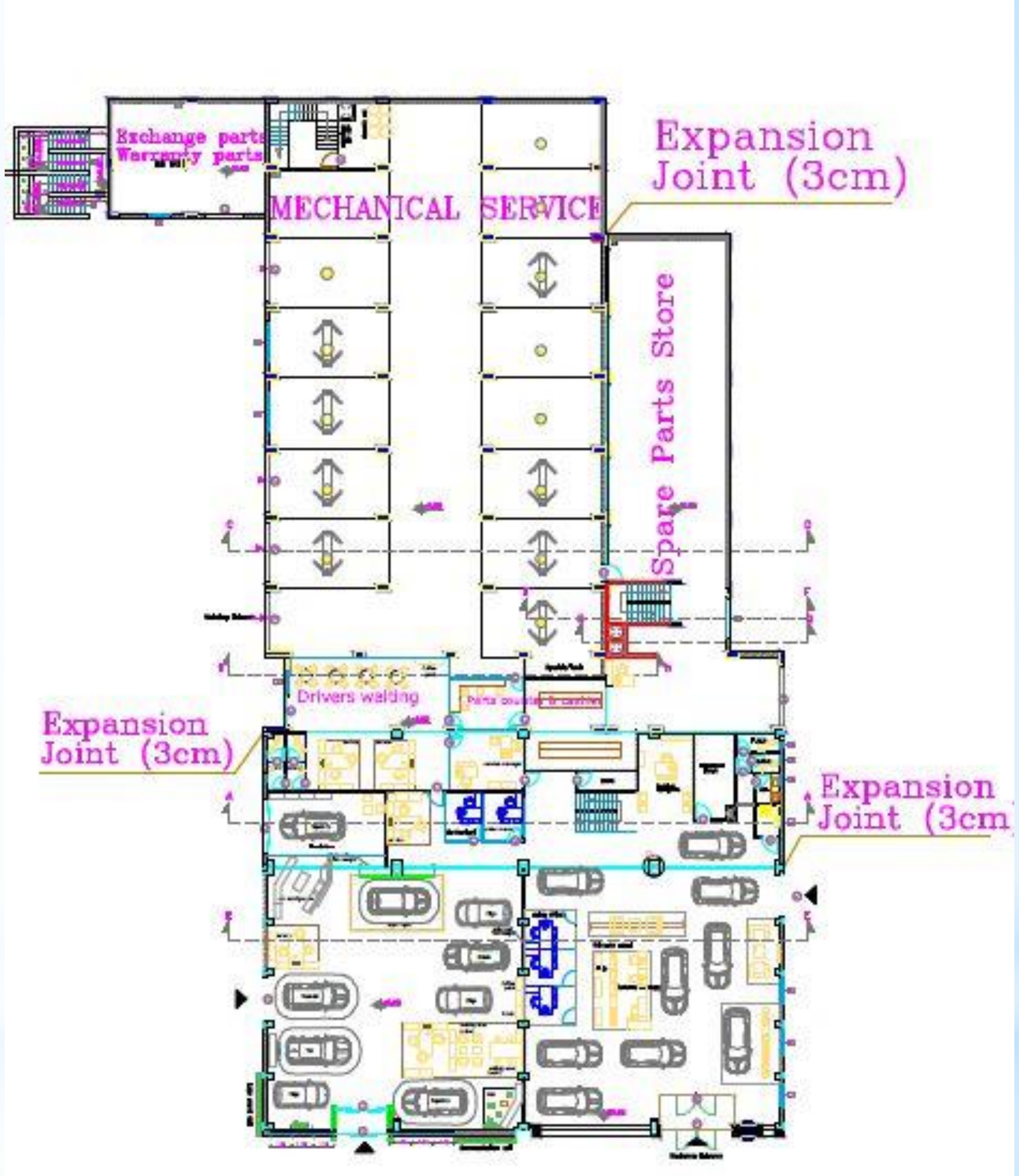
* General Description:

* The total area for the building=4000 m^2
* Typical floor height=+3.375 m
* A36 for structural steel
* Reinforced steel GR60
* Concrete compressive strength=28 MPa

*WHY UMT ?!



Plan Drawing



Usage of the Ground floor

*Combinations used

Service load Combinations

1. D
2. D+L
3. D+0.75L
4. 0.6D
5. $1.095D+0.91E_{hx}+0.273E_{hy}$
6. $1.07D+0.68\ E_{hx}+0.205\ E_{hy}+0.75L$
7. $0.505D+0.91\ E_{hx}+0.273E_{hy}$

Ultimate load Combinations

1. 1.4D
2. 1.2D+1.6L
3. 1.2D+1.0L
4. 0.9D
5. $1.366D+1.3\ E_{hx}+0.39\ E_{hy}+L$
6. $1.366D+1.3\ E_{hy}+0.39\ E_{hx}+L$
7. $0.764D+1.3E_{hx}+0.39E_{hy}$
8. $0.764D+1.3E_{hy}+0.39E_{hx}$

*Gravity Analysis

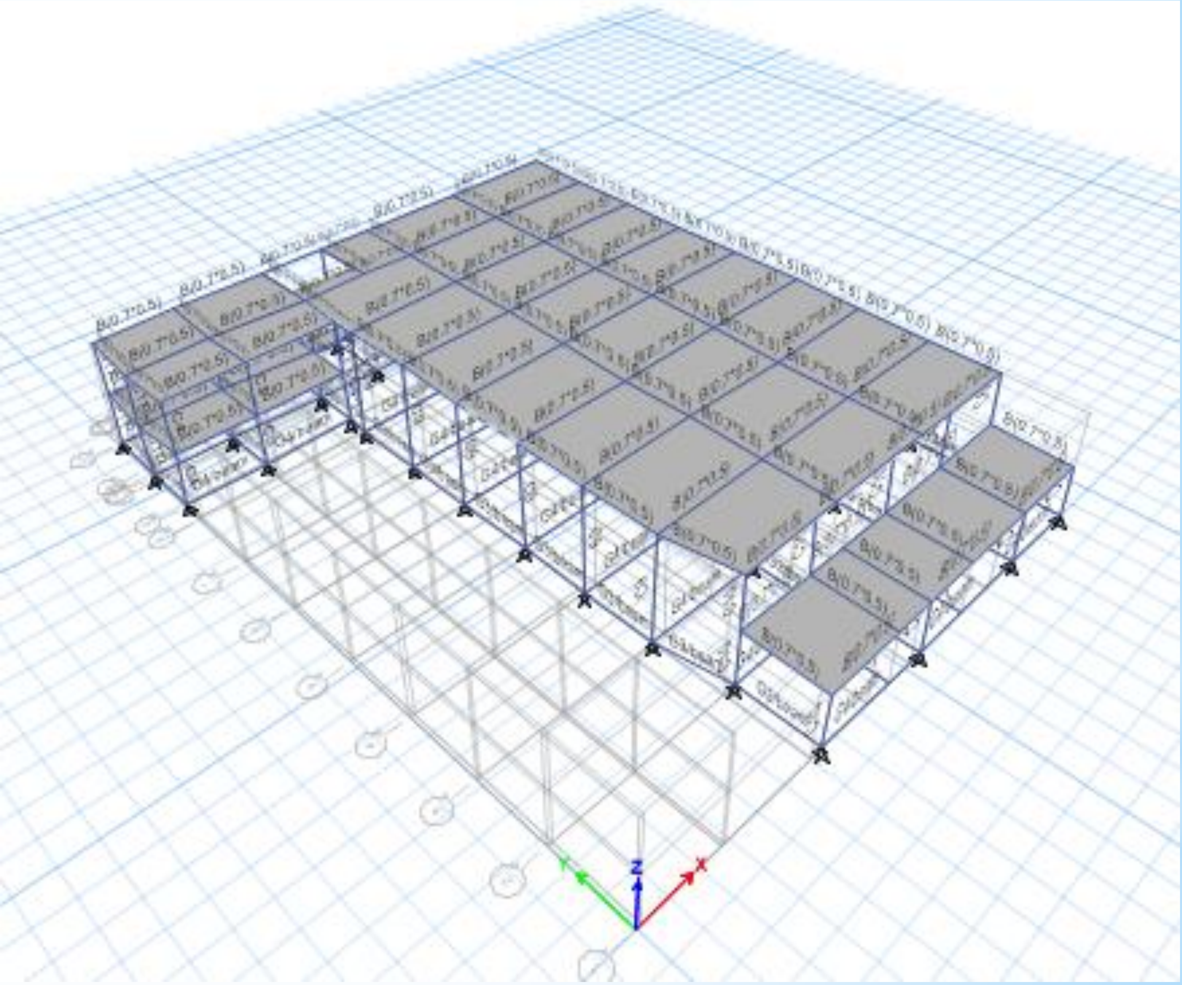
General Checks:

- Compatibility Check.
- Equilibrium Check.
- Internal Check.

*Gravity Analysis

Block 1:

- Block Area=1276 m^2
- Period=0.411 second.
- Dead error=1.7%
- Live error=0.7%
- Superimposed error=0.01%
- Max internal Check error=5.66%



*Gravity Analysis

Block 1:

Chosen Frames for internal Check

#	X coordinate	Y Coordinate	Moment from Sap(kN.m)	Total moment every three points(sap) (kN.m)	Total moment every three points (Manual) (kN.m)	%Error
1	X1=21.25 X2=28.05	Y1= 9.72 Y2=9.72	M1= 142			
2	X1=21.25 X2=28.05	Y1= 11.35 Y2=11.35	M2= -190			
3	X1=21.25 X2=28.05	Y1= 12.98 Y2=12.98	M3= 93	307.5	294.89	4.4
4	X1=21.25 X2=28.05	Y1= 23.32 Y2=23.32	M1= 119			
5	X1=21.25 X2=28.05	Y1= 24.9 Y2=24.9	M2= -184			
6	X1=21.25 X2=28.05	Y1= 26.48 Y2=26.48	M3= 102	294.5	277	6.3

Manual And Etabs Results X-frame

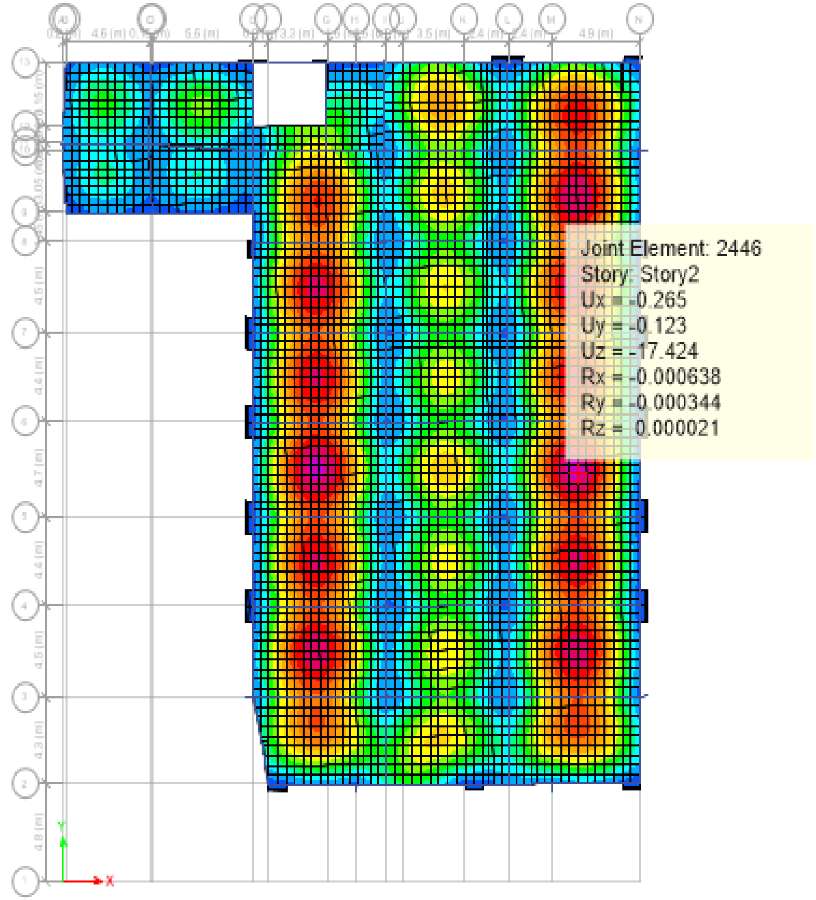
*Gravity Analysis

Block 1:

* Etabs max Deflection=17.42mm
* Allowable max Deflection=

$$\frac{L_{shortest\ span}}{240} = \frac{4700}{240} = 19.58 \text{ mm}$$

* Etabs<Max Deflection → ok

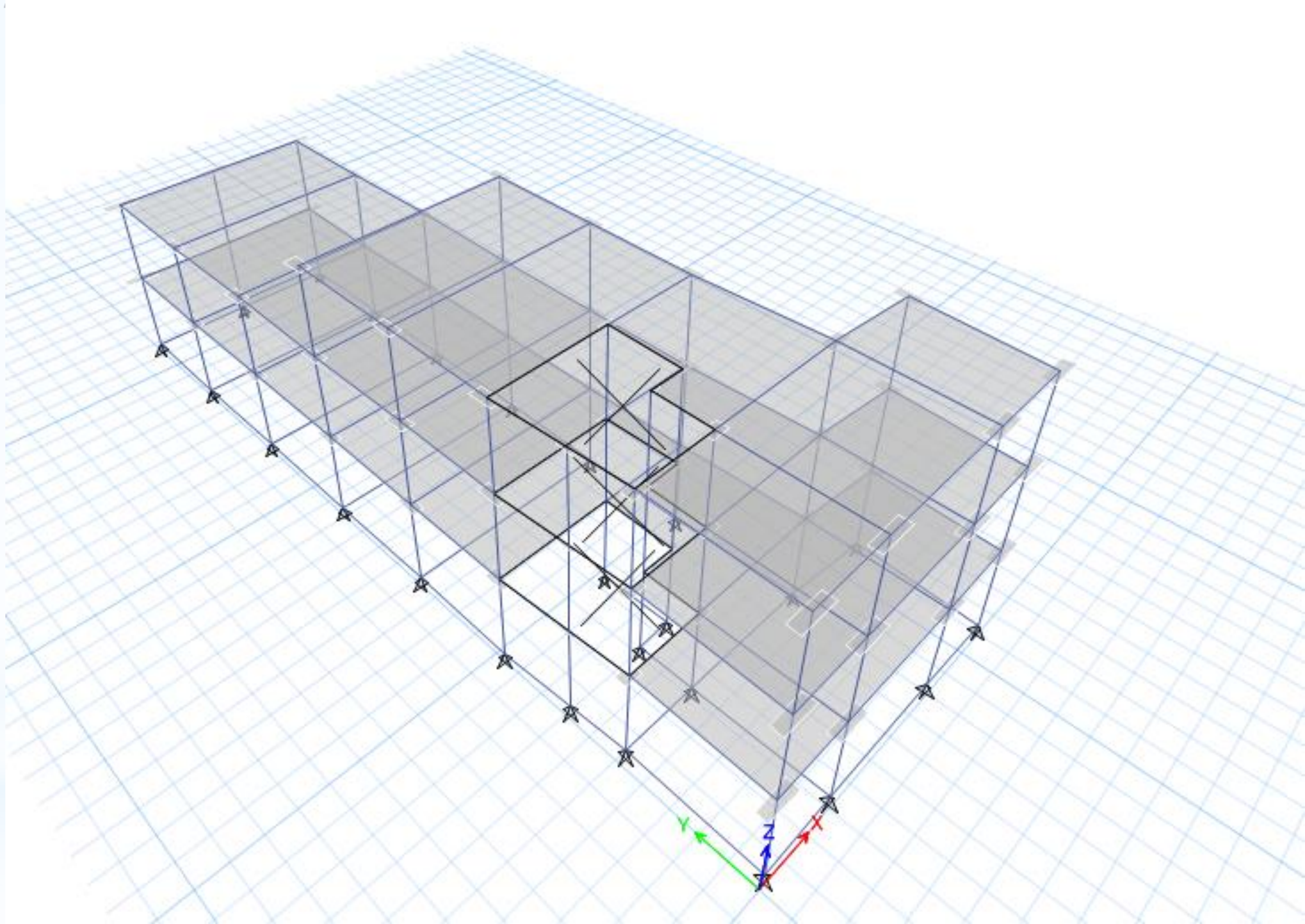


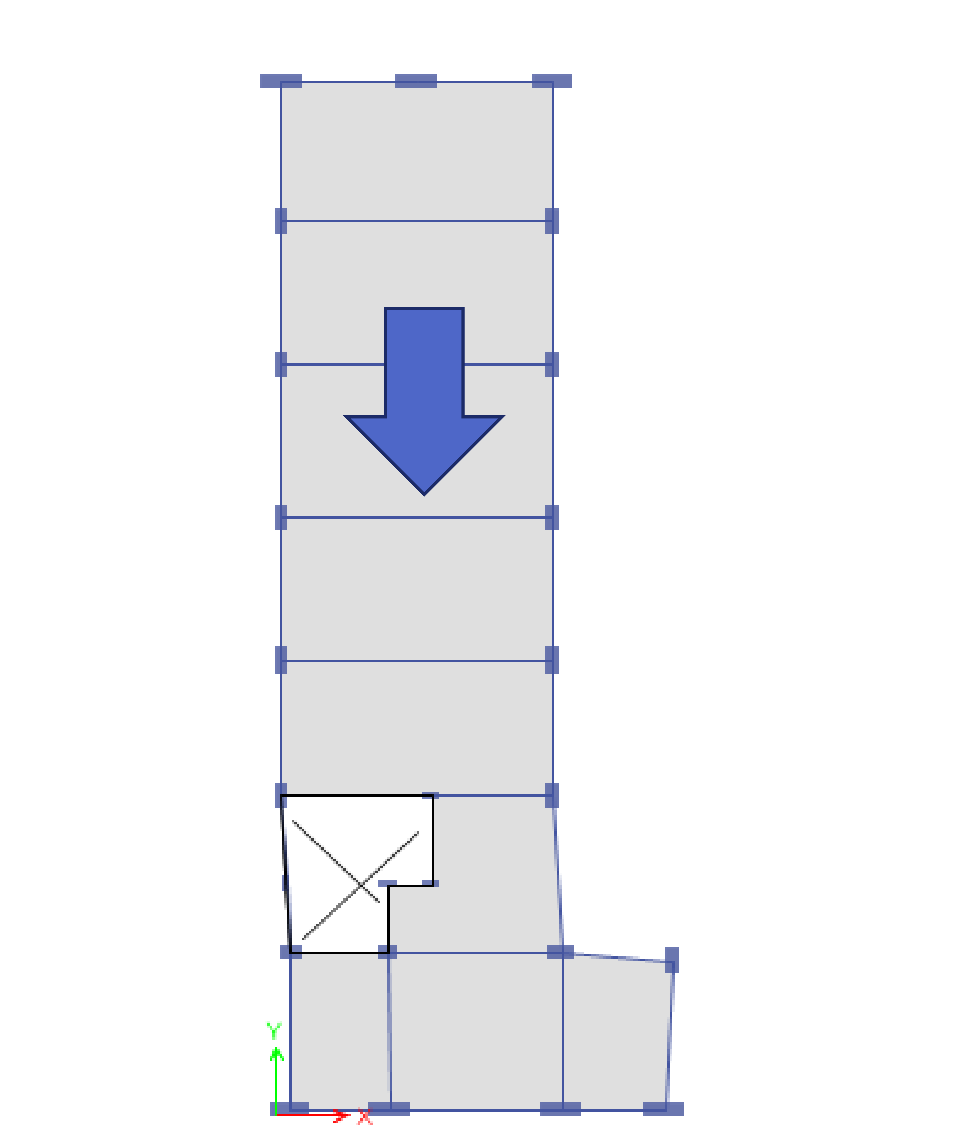
Deflection Check Using Etabs

*Gravity Analysis

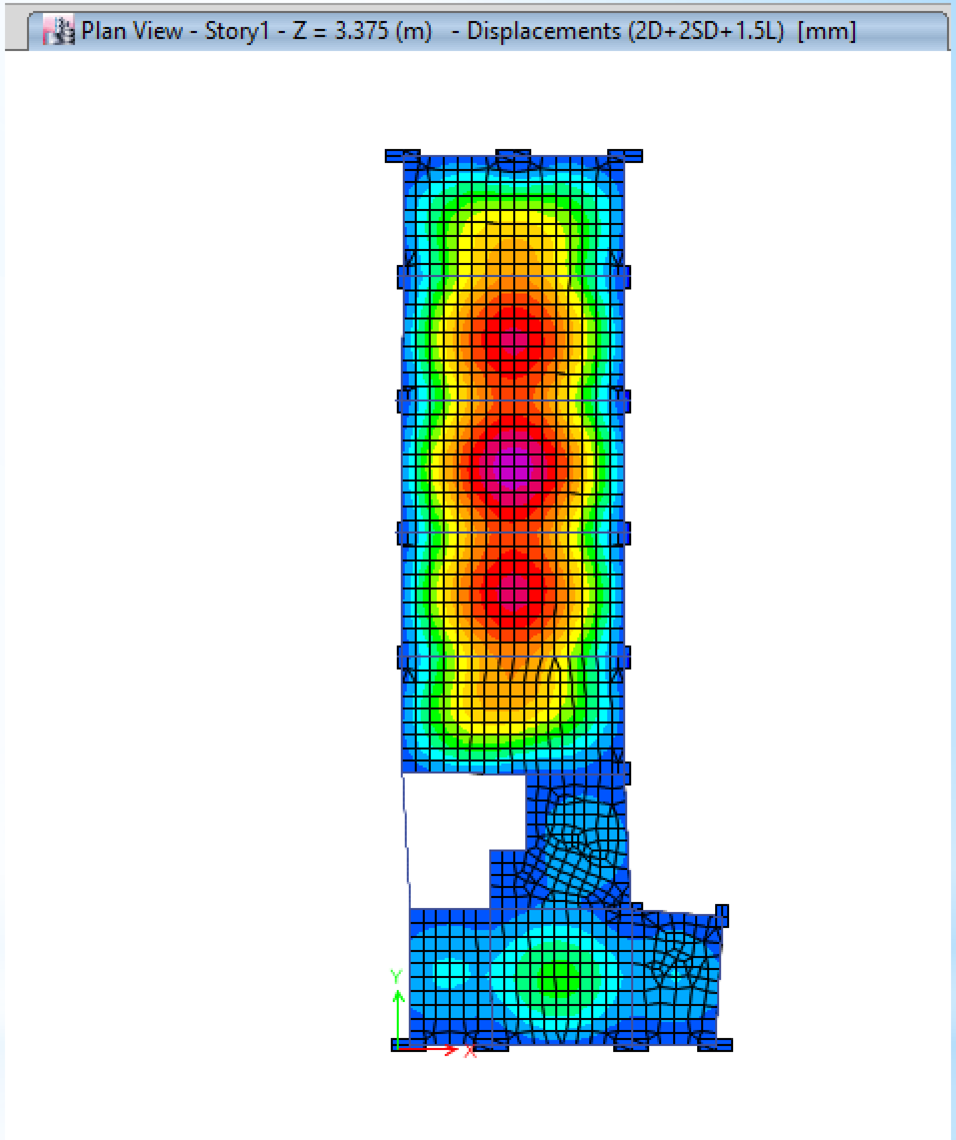
Block 2:

* Block Area=631 m^2
* Period=0.654 second.
* Dead error=0.3%
* Live error=0.77%
* Superimposed error= 0.3%
* Max internal Check error=5.66%





Chosen Frame for internal Check

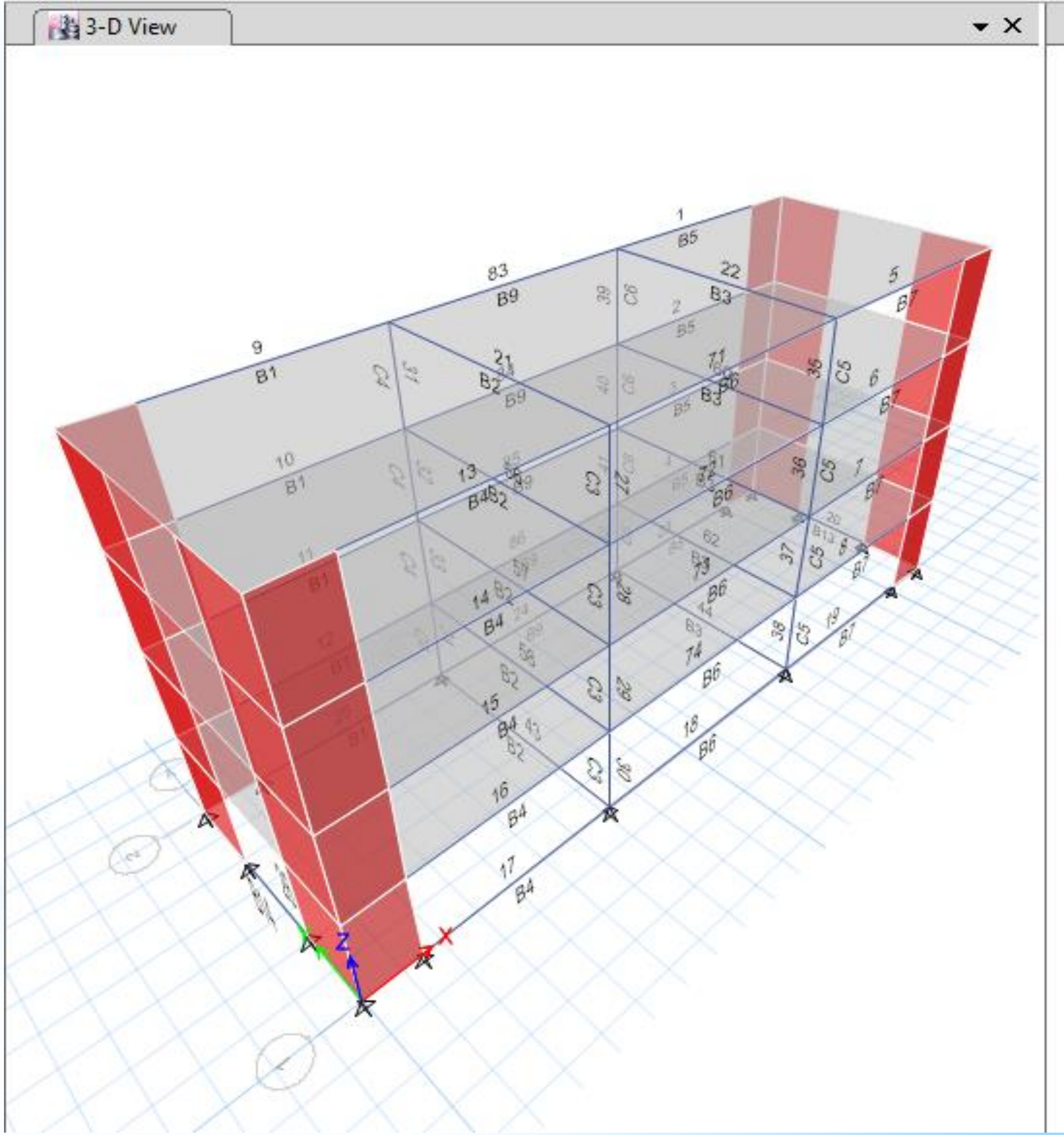


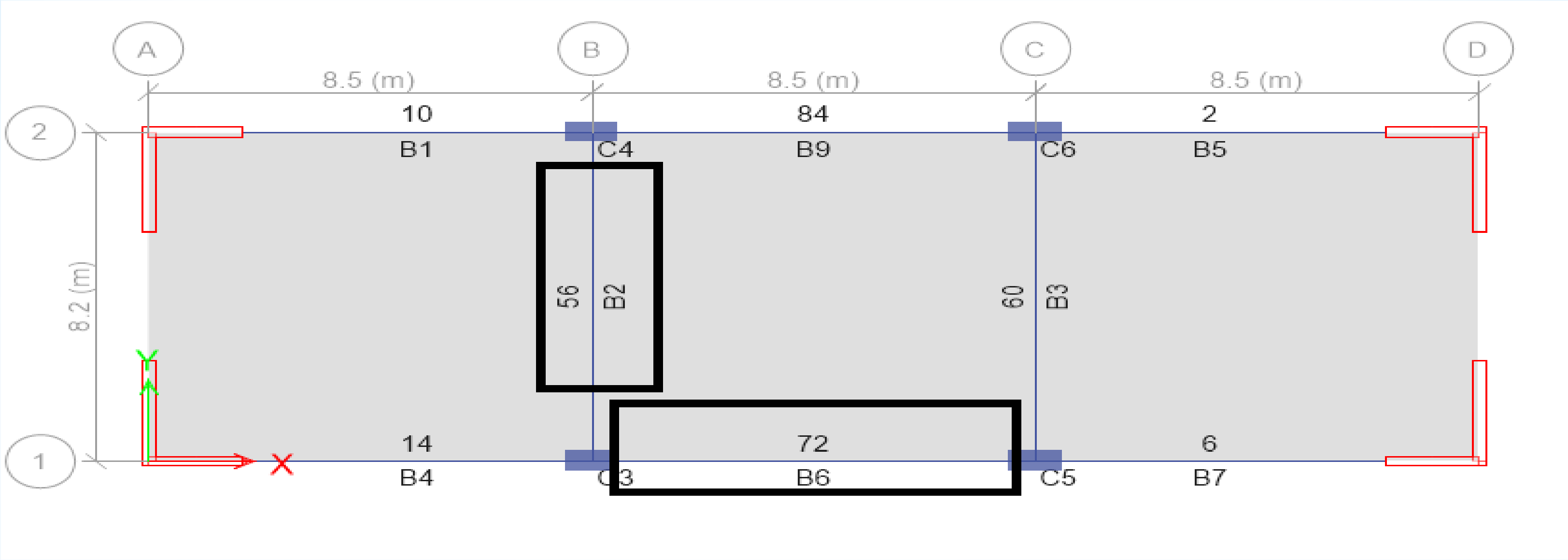
Deflection Check.

Gravity Analysis

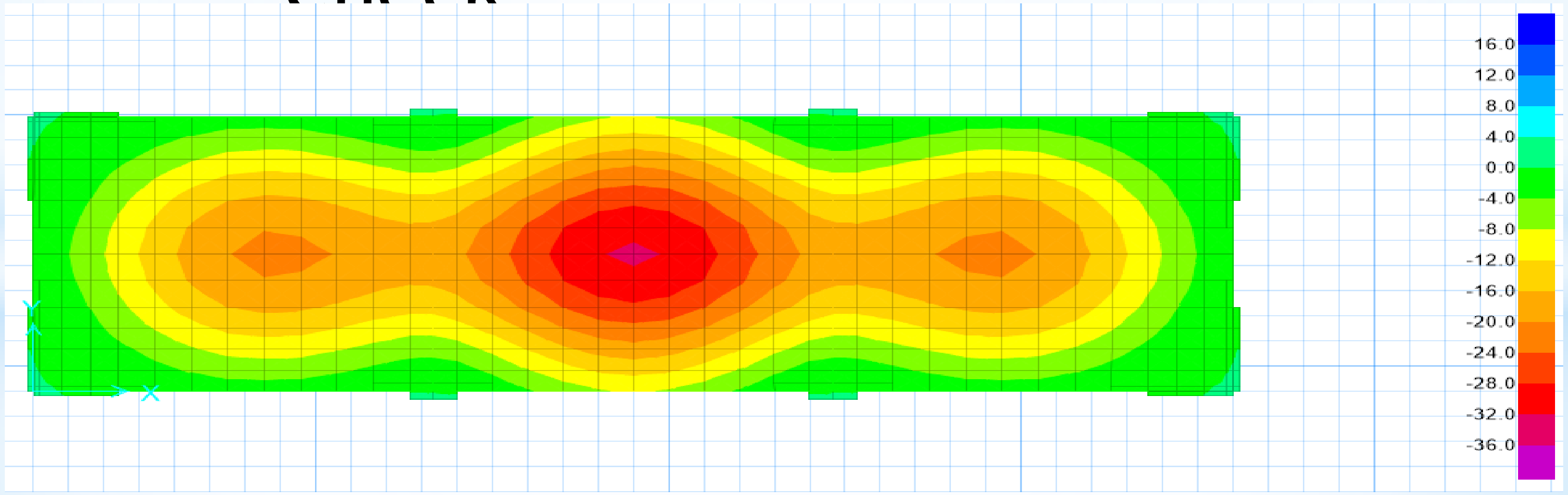
Block 3:

- Block Area=210 m^2
- Period=0.476 second.
- Dead error=2.07%
- Live error=0.0%
- Max internal Check error=4.6%





Chosen Frame for internal Check



Deflection Check.

*Seismic Analysis And Design

- General Description for the location parameter.
- Geometry of the structure.
- Vertical and Horizontal irregularities.
- Seismic Analysis method.

*Seismic Analysis

General Description for the location

- Occupancy Category

Risk Category of Buildings and Other Structures for Flood, Wind, Snow, Earthquake, and Ice Loads

Use or Occupancy of Buildings and Structures	Risk Category
Buildings and other structures that represent low risk to human life in the event of failure	I
All buildings and other structures except those listed in Risk Categories I, III, and IV	II
Buildings and other structures, the failure of which could pose a substantial risk to human life	III
Buildings and other structures, not included in Risk Category IV, with potential to cause a substantial economic impact and/or mass disruption of day-to-day civilian life in the event of failure	
Buildings and other structures not included in Risk Category IV (including, but not limited to, facilities that manufacture, process, handle, store, use, or dispose of such substances as hazardous fuels, hazardous chemicals, hazardous waste, or explosives) containing toxic or explosive substances where the quantity of the material exceeds a threshold quantity established by the Authority Having Jurisdiction and is sufficient to pose a threat to the public if released[a]	
Buildings and other structures designated as essential facilities	IV

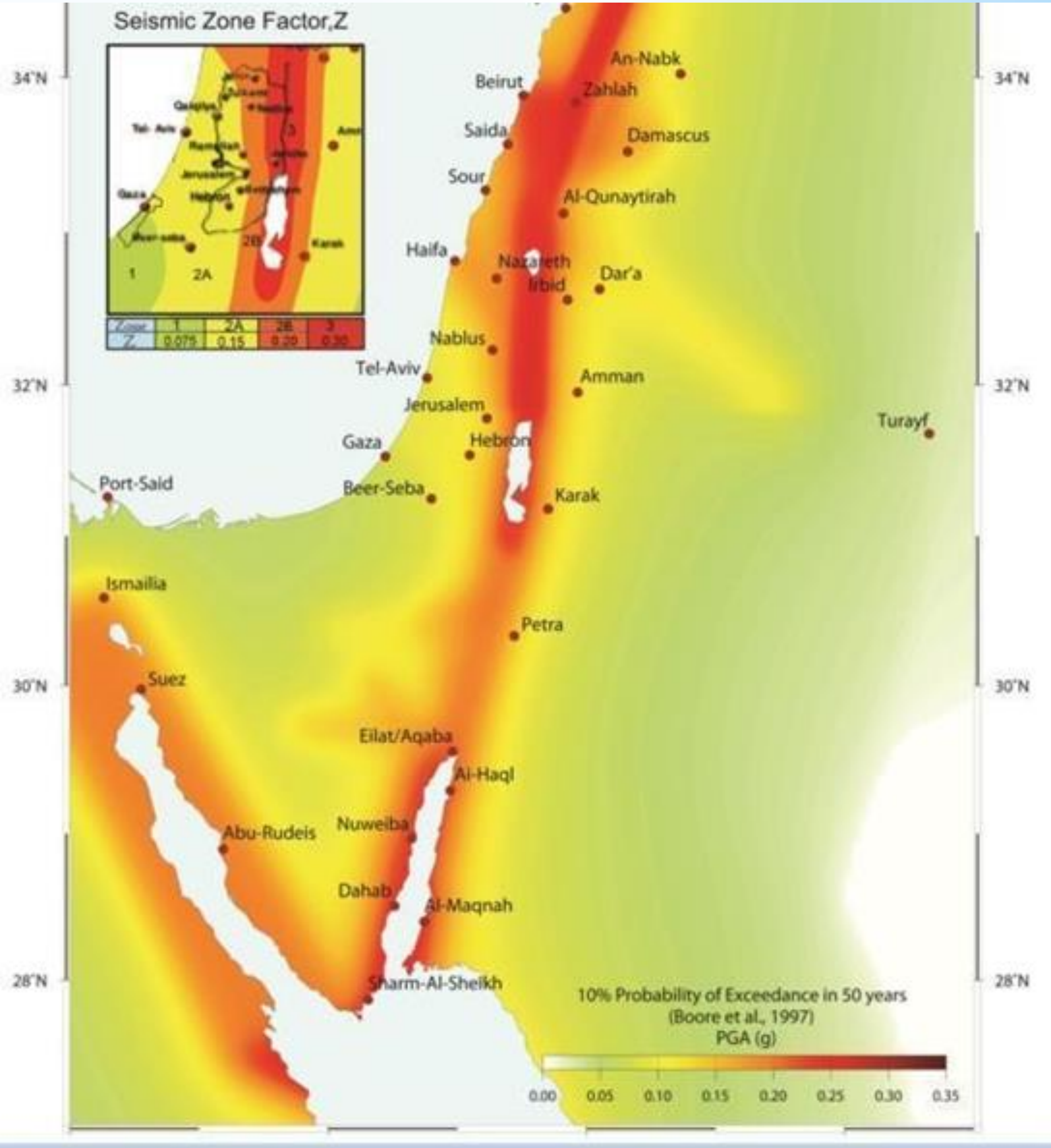
*Seismic Analysis

General Description for the location

- Ground Motion Parameter

$(S_1) = 1.25*Z = 1.25*.2 = 0.25$

$(S_s) = 2.5*Z = 2.5*.2 = 0.5$



*Seismic Analysis

General Description for the location

- Soil Type ⟹ C

Site Classification

Site Class	$\bar{v}_s$	$\bar{N}$ or $\bar{N}_{ch}$	$\bar{s}_u$
A. Hard rock	>5,000 ft/s	NA	NA
B. Rock	2,500 to 5,000 ft/s	NA	NA
C. Very dense soil and soft rock	1,200 to 2,500 ft/s	>50 blows/ft	>2,000 lb/ft^2
D. Stiff soil	600 to 1,200 ft/s	15 to 50 blows/ft	1,000 to 2,000 lb/ft^2
E. Soft clay soil	<600 ft/s	<15 blows/ft	<1,000 lb/ft^2
	Any profile with more than 10 ft of soil that has the following characteristics: — Plasticity index $PI > 20$, — Moisture content $w \geq 40\%$, — Undrained shear strength $\bar{s}_u < 500$ lb/ft^2		
F. Soils requiring site response analysis in accordance with Section 21.1	See Section 20.3.1		

Note: For SI: 1 ft = 0.3048 m; 1 ft/s = 0.3048 m/s; 1 lb/ft^2 = 0.0479 kN/m^2.

*Seismic Analysis

General Description for the location

- Site coefficient:

  $(F_a) = 1.3$

  $(F_v) = 1.5$

Site Coefficient, F_a

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at Short Period				
	$S_S \le 0.25$	$S_S = 0.5$	$S_S = 0.75$	$S_S = 1.0$	$S_S \ge 1.25$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of S_S.

Site Coefficient, F_v

Site Class	Mapped Risk-Targeted Maximum Considered Earthquake (MCE_R) Spectral Response Acceleration Parameter at 1-s Period				
	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See Section 11.4.7				

Note: Use straight-line interpolation for intermediate values of S_1.

*Seismic Analysis

General Description for the location

- Design Spectral Accelerations

$$SD_1 = \frac{2}{3} * F_V * S_1 \Rightarrow SD_1 = 1 * 1.5 * 0.25 = 0.375$$

$$SD_s = \frac{2}{3} * F_a * S_s \Rightarrow SD_s = 1 * 1.3 * 0.5 = 0.65$$

*Seismic Analysis

General Description for the location

- Importance Factor ⇨ I=1
- Seismic Design category ⇨ D,D

  We choose the worst ⇨ D

Risk Category from Table 1.5-1	Snow Importance Factor, I_s	Ice Importance Factor—Thickness, I_i	Ice Importance Factor—Wind, I_w	Seismic Importance Factor, I_e
I	0.80	0.80	1.00	1.00
II	1.00	1.00	1.00	1.00
III	1.10	1.15	1.00	1.25
IV	1.20	1.25	1.00	1.50

	Risk Category	
Value of S_{DS}	I or II or III	IV
$S_{DS} < 0.167$	A	A
$0.167 \le S_{DS} < 0.33$	B	C
$0.33 \le S_{DS} < 0.50$	C	D
$0.50 \le S_{DS}$	D	D

Seismic Design Category Based on 1-s Period Response Acceleration Parameter

	Risk Category	
Value of S_{D1}	I or II or III	IV
$S_{D1} < 0.067$	A	A
$0.067 \le S_{D1} < 0.133$	B	C
$0.133 \le S_{D1} < 0.20$	C	D
$0.20 \le S_{D1}$	D	D

*Seismic Analysis

Geometry of the Structure

- Frame System Used

Two types of Frame systems

1- Moment Resisting Frame

2- Building frame system

Table 12.2-1 Design Coefficients and Factors for Seismic Force-Resisting Systems

Seismic Force-Resisting System	ASCE 7 Section Where Detailing Requirements Are Specified	Response Modification Coefficient, R^a	Overstrength Factor, Ω_0^b	Deflection Amplification Factor, C_d^c
C. MOMENT-RESISTING FRAME SYSTEMS				
1. Steel special moment frames	14.1 and 12.2.5.5	8	3	5½
2. Steel special truss moment frames	14.1	7	3	5½
3. Steel intermediate moment frames	12.2.5.7 and 14.1	4½	3	4
4. Steel ordinary moment frames	12.2.5.6 and 14.1	3½	3	3
5. Special reinforced concrete moment frames[m]	12.2.5.5 and 14.2	8	3	5½
6. Intermediate reinforced concrete moment frames	14.2	5	3	4½
7. Ordinary reinforced concrete moment frames	14.2	3	3	2½

*Seismic Analysis

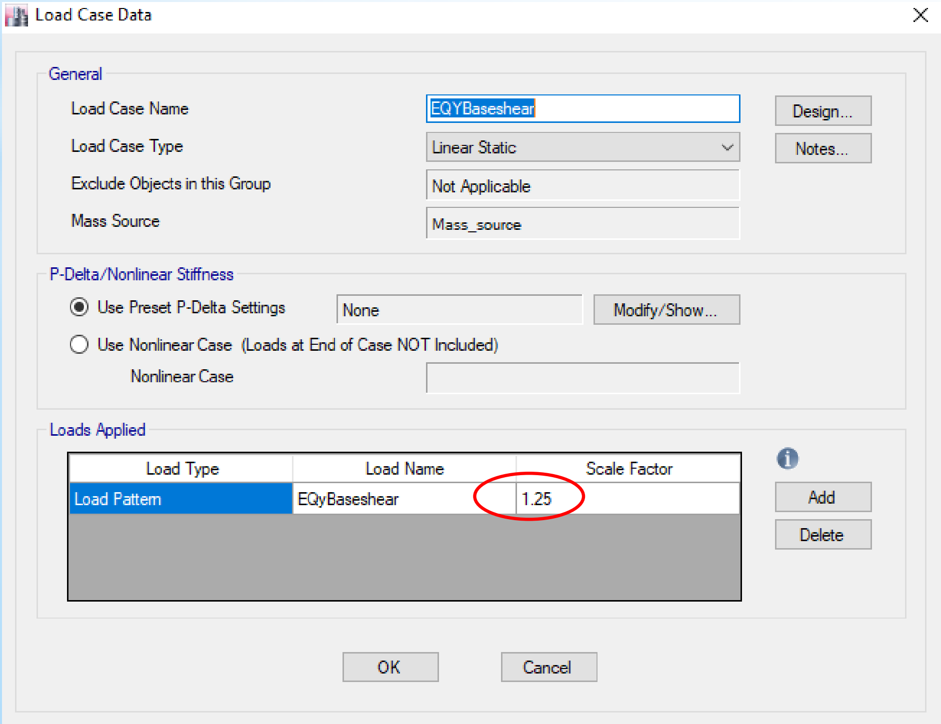
Horizontal irregularities.

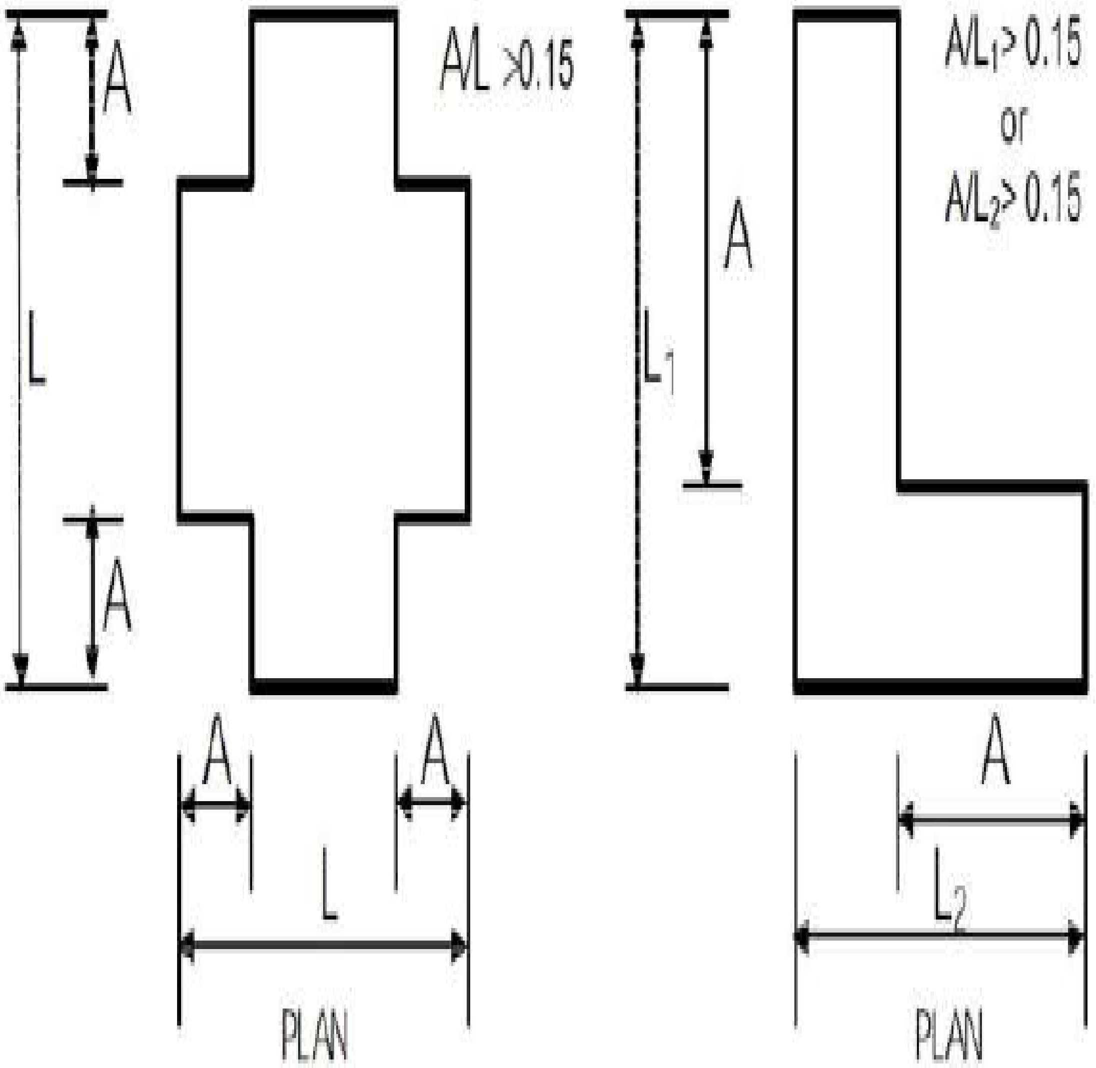
Type	Description	Reference Section	Seismic Design Category Application
1a.	**Torsional Irregularity:** Torsional irregularity is defined to exist where the maximum story drift, computed including accidental torsion with $A_x = 1.0$, at one end of the structure transverse to an axis is more than 1.2 times the average of the story drifts at the two ends of the structure. Torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.	12.3.3.4 12.7.3 12.8.4.3 12.12.1 Table 12.6-1 16.3.4	D, E, and F B, C, D, E, and F C, D, E, and F C, D, E, and F D, E, and F B, C, D, E, and F
1b.	**Extreme Torsional Irregularity:** Extreme torsional irregularity is defined to exist where the maximum story drift, computed including accidental torsion with $A_x = 1.0$, at one end of the structure transverse to an axis is more than 1.4 times the average of the story drifts at the two ends of the structure. Extreme torsional irregularity requirements in the reference sections apply only to structures in which the diaphragms are rigid or semirigid.	12.3.3.1 12.3.3.4 12.3.4.2 12.7.3 12.8.4.3 12.12.1 Table 12.6-1 16.3.4	E and F D D B, C, and D C and D C and D D B, C, and D
2.	**Reentrant Corner Irregularity:** Reentrant corner irregularity is defined to exist where both plan projections of the structure beyond a reentrant corner are greater than 15% of the plan dimension of the structure in the given direction.	12.3.3.4 Table 12.6-1	D, E, and F D, E, and F
3.	**Diaphragm Discontinuity Irregularity:** Diaphragm discontinuity irregularity is defined to exist where there is a diaphragm with an abrupt discontinuity or variation in stiffness, including one that has a cutout or open area greater than 50% of the gross enclosed diaphragm area, or a change in effective diaphragm stiffness of more than 50% from one story to the next.	12.3.3.4 Table 12.6-1	D, E, and F D, E, and F
4.	**Out-of-Plane Offset Irregularity:** Out-of-plane offset irregularity is defined to exist where there is a discontinuity in a lateral force-resistance path, such as an out-of-plane offset of at least one of the vertical elements.	12.3.3.3 12.3.3.4 12.7.3 Table 12.6-1 16.3.4	B, C, D, E, and F D, E, and F B, C, D, E, and F D, E, and F B, C, D, E, and F
5.	**Nonparallel System Irregularity:** Nonparallel system irregularity is defined to exist where vertical lateral force-resisting elements are not parallel to the major orthogonal axes of the seismic force-resisting system.	12.5.3 12.7.3 Table 12.6-1 16.3.4	C, D, E, and F B, C, D, E, and F D, E, and F B, C, D, E, and F

*Seismic Analysis

Horizontal irregularities

- Reentrant irregularity ➡ Exist

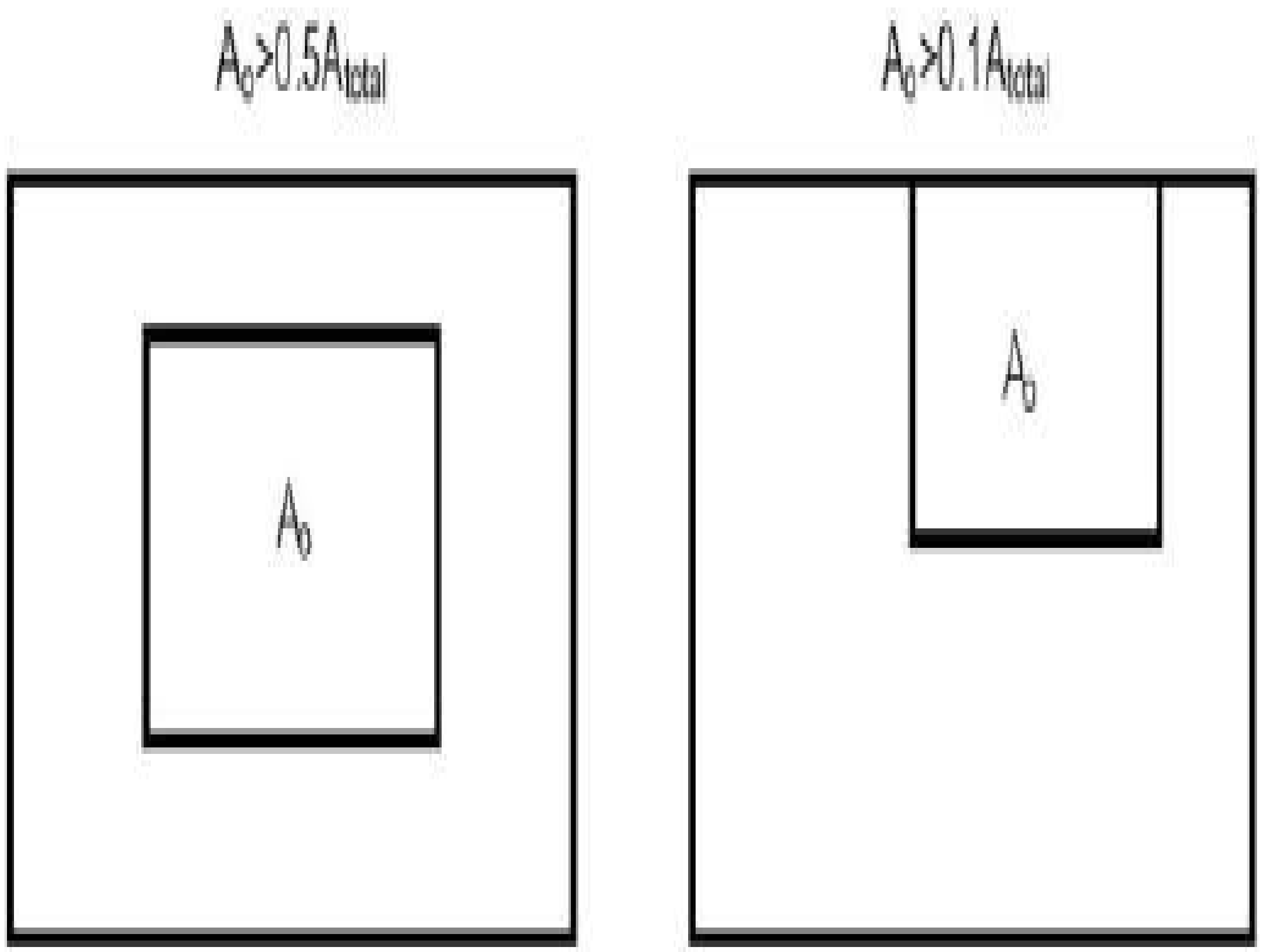




*Seismic Analysis

Horizontal irregularities

- Diaphragm Discontinuity irregularity ⇒ Does not exist

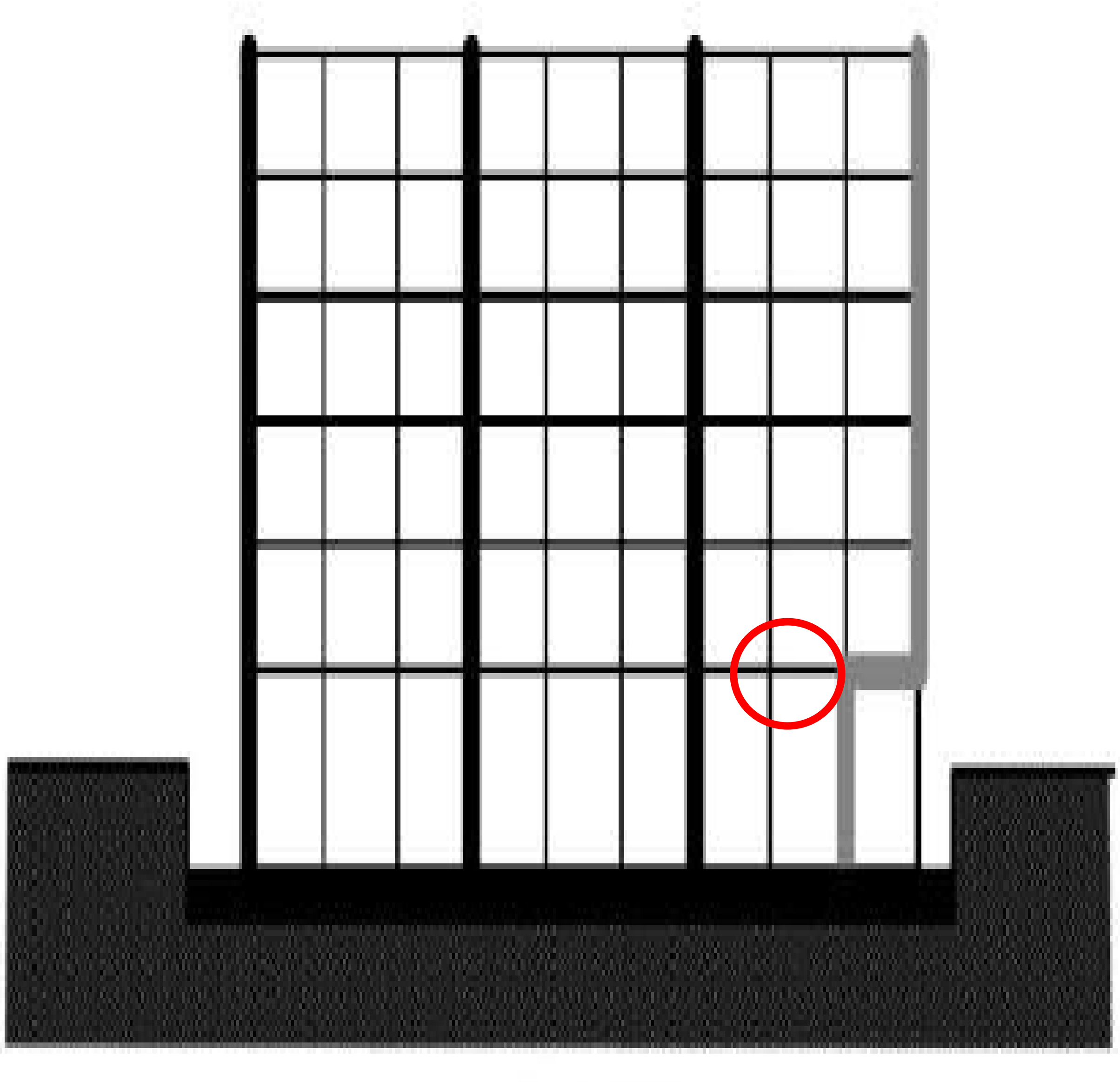


*Seismic Analysis

Horizontal irregularities

- Out of Plan offset irregularity ➡

No discontinuity in the lateral force resisting frame ➡ Not Exist

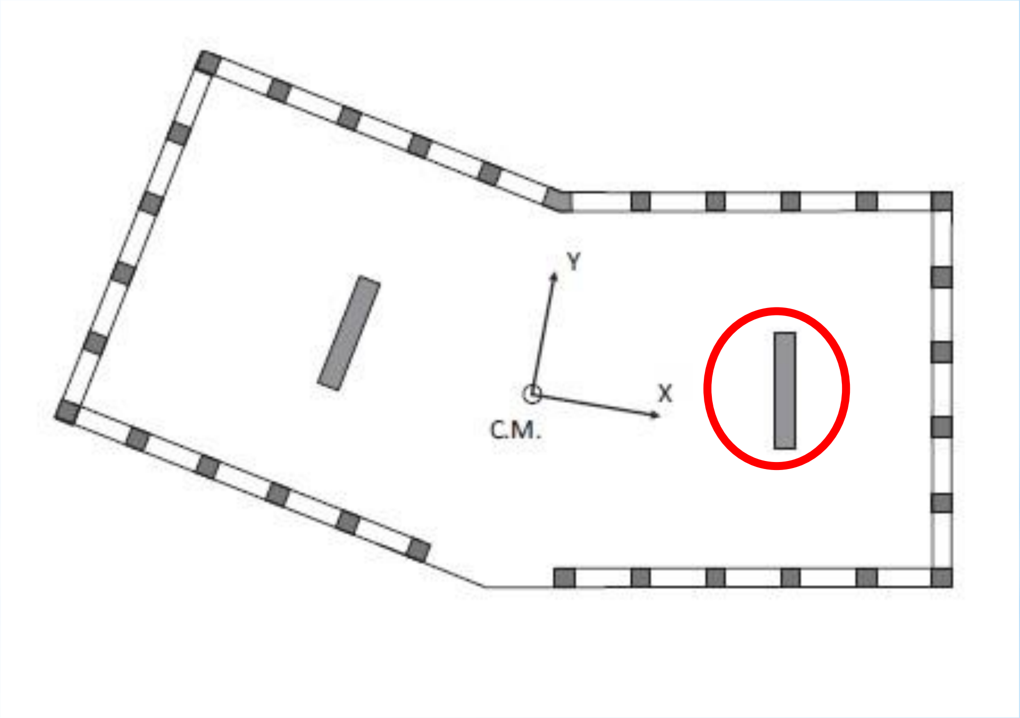


*Seismic Analysis

Horizontal irregularities

- Non-Parallel Lateral Load Resisting System ➡

All the lateral force-resisting elements Parallel ➡ Not Exist



*Seismic Analysis

Vertical irregularities.

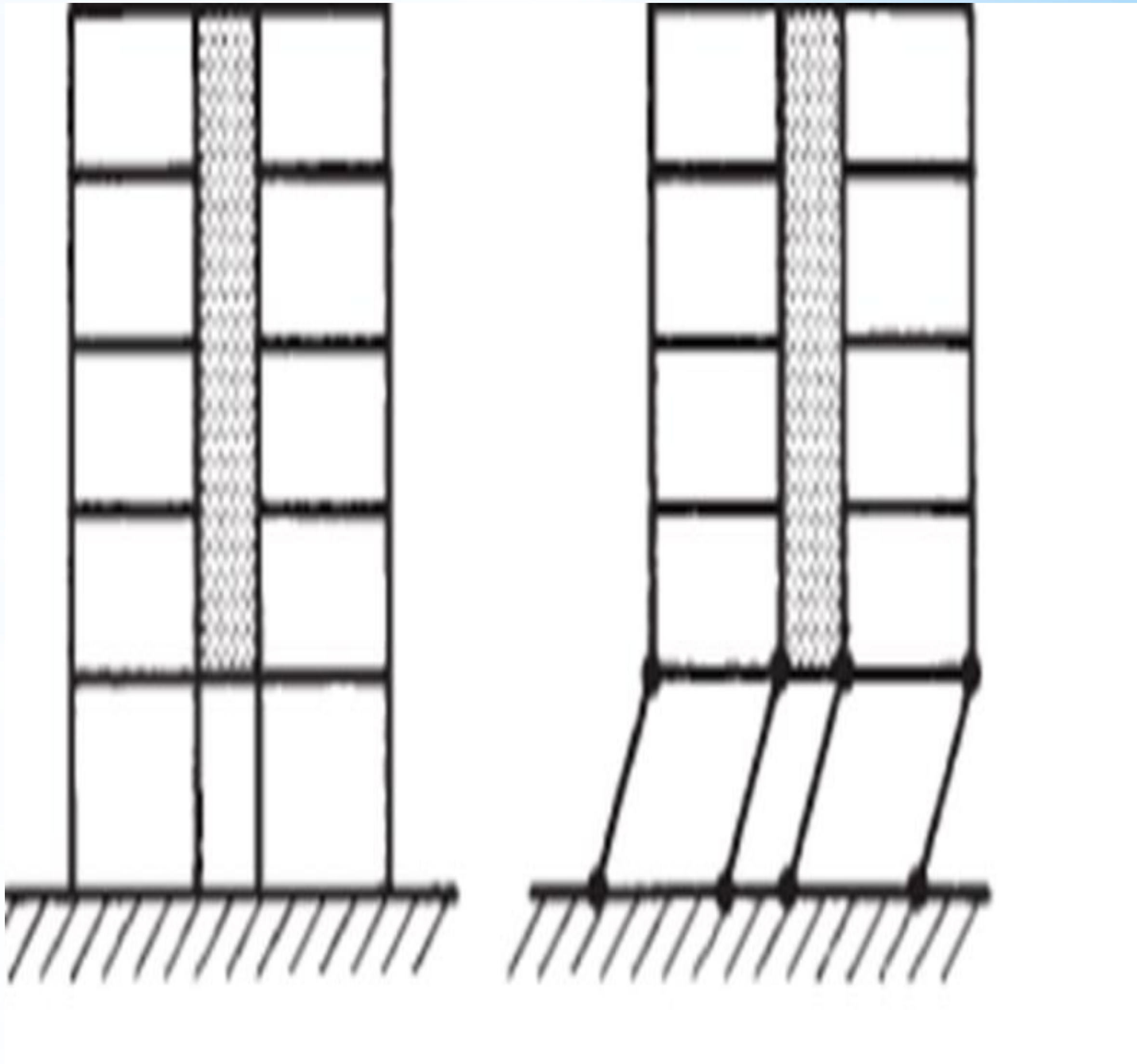
Type	Description	Reference Section	Seismic Design Category Application
1a.	**Stiffness–Soft Story Irregularity:** Stiffness–soft story irregularity is defined to exist where there is a story in which the lateral stiffness is less than 70% of that in the story above or less than 80% of the average stiffness of the three stories above.	Table 12.6-1	D, E, and F
1b.	**Stiffness–Extreme Soft Story Irregularity:** Stiffness–extreme soft story irregularity is defined to exist where there is a story in which the lateral stiffness is less than 60% of that in the story above or less than 70% of the average stiffness of the three stories above.	12.3.3.1 Table 12.6-1	E and F D, E, and F
2.	**Weight (Mass) Irregularity:** Weight (mass) irregularity is defined to exist where the effective mass of any story is more than 150% of the effective mass of an adjacent story. A roof that is lighter than the floor below need not be considered.	Table 12.6-1	D, E, and F
3.	**Vertical Geometric Irregularity:** Vertical geometric irregularity is defined to exist where the horizontal dimension of the seismic force-resisting system in any story is more than 130% of that in an adjacent story.	Table 12.6-1	D, E, and F
4.	**In-Plane Discontinuity in Vertical Lateral Force-Resisting Element Irregularity:** In-plane discontinuity in vertical lateral force-resisting element irregularity is defined to exist where there is an in-plane offset of a vertical seismic force-resisting element resulting in overturning demands on supporting structural elements.	12.3.3.3 12.3.3.4 Table 12.6-1	B, C, D, E, and F D, E, and F D, E, and F
5a.	**Discontinuity in Lateral Strength–Weak Story Irregularity:** Discontinuity in lateral strength–weak story irregularity is defined to exist where the story lateral strength is less than 80% of that in the story above. The story lateral strength is the total lateral strength of all seismic-resisting elements sharing the story shear for the direction under consideration.	12.3.3.1 Table 12.6-1	E and F D, E, and F
5b.	**Discontinuity in Lateral Strength–Extreme Weak Story Irregularity:** Discontinuity in lateral strength–extreme weak story irregularity is defined to exist where the story lateral strength is less than 65% of that in the story above. The story strength is the total strength of all seismic-resisting elements sharing the story shear for the direction under consideration.	12.3.3.1 12.3.3.2 Table 12.6-1	D, E, and F B and C D, E, and F

*Seismic Analysis

Vertical irregularities

- **Stiffness-soft story Irregularities** ➡

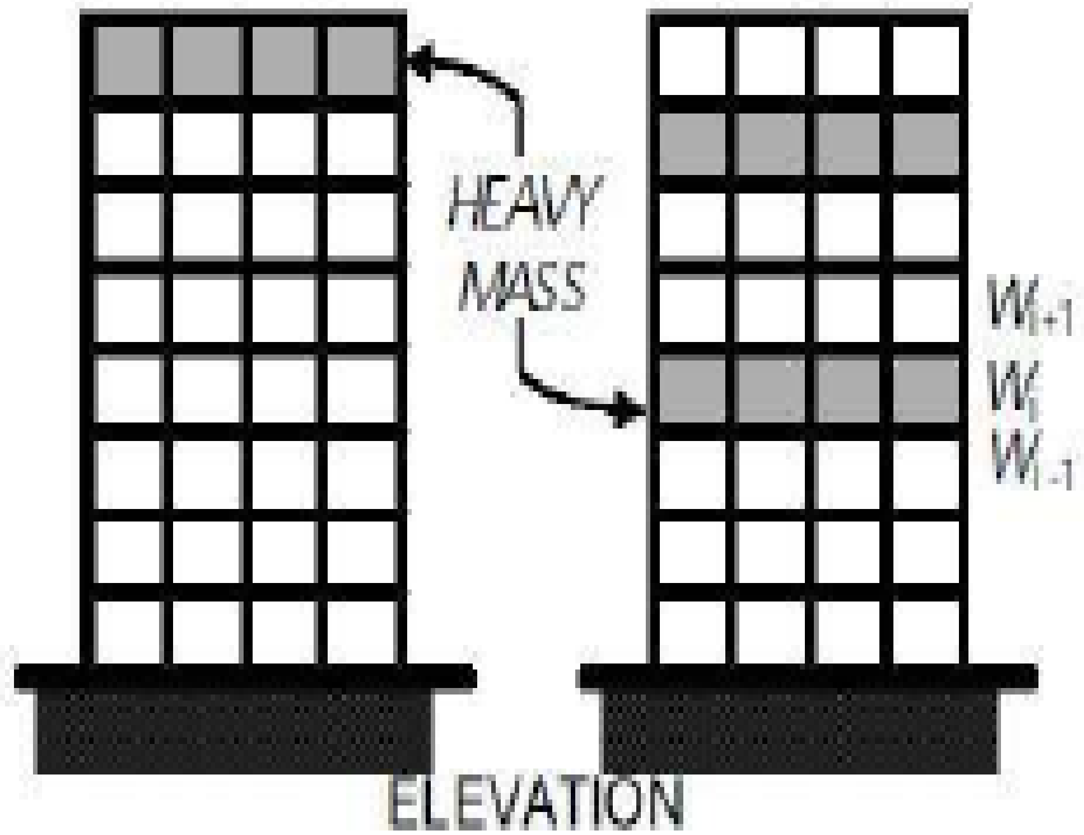
Stiffness Weak Story ➡



*Seismic Analysis

Vertical irregularities

- Weight mass Irregularity ➡



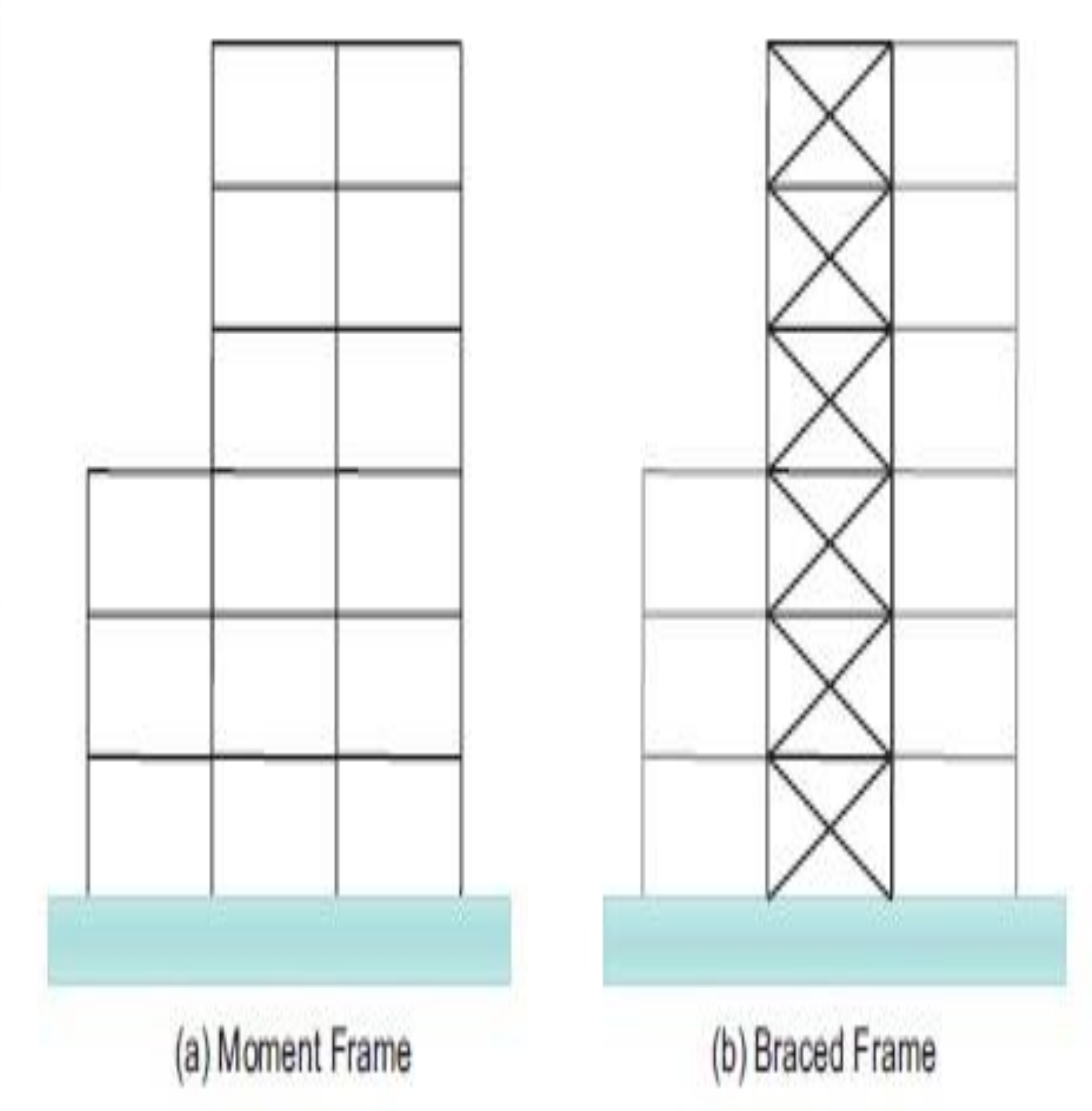
*Seismic Analysis

Vertical irregularities

- Vertical geometric Irregularity ➡

horizontal dimension of the seismic force system in any story is more than 130% of that in the adjacent story ➡

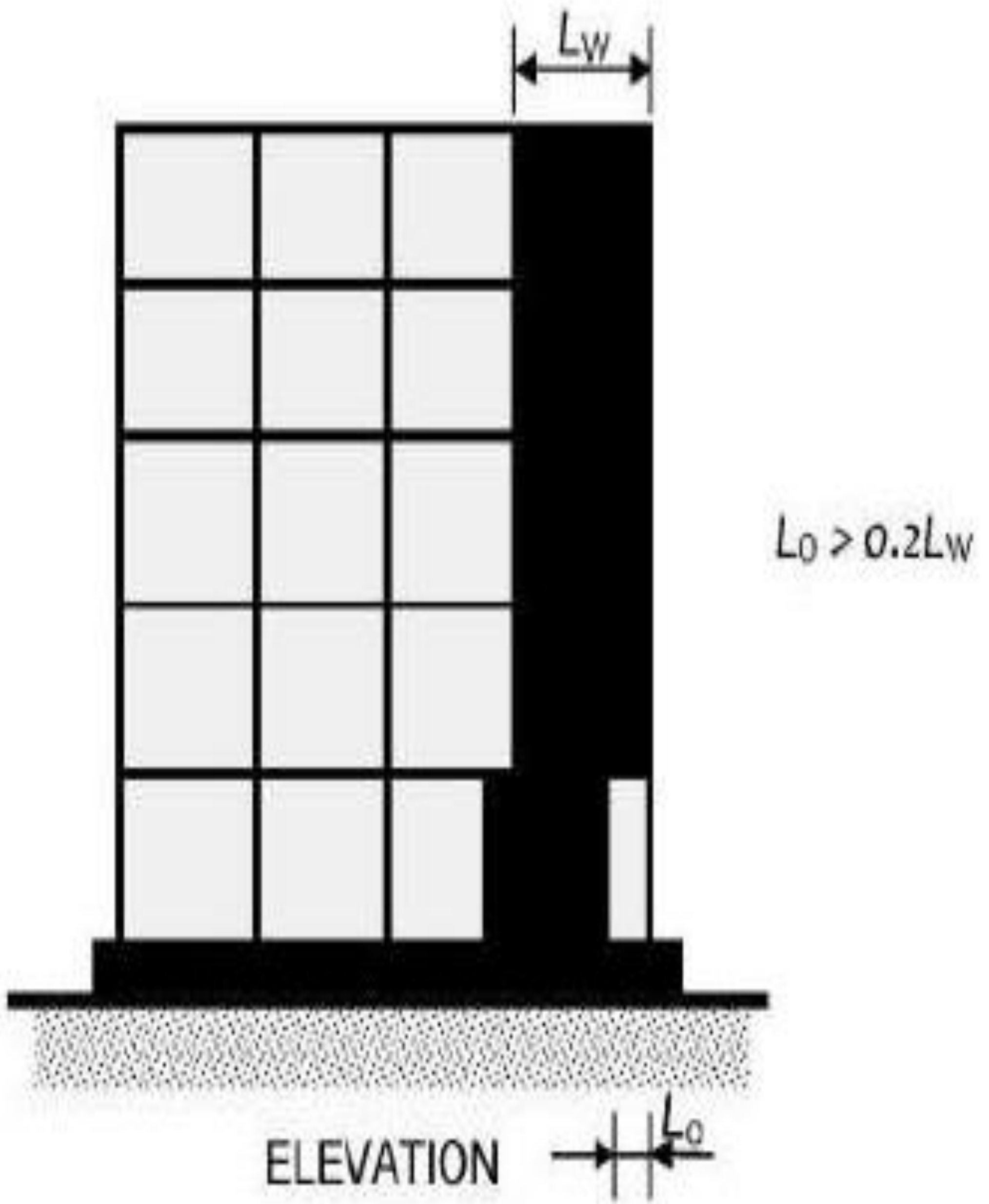
Exist in Block 2



*Seismic Analysis

Vertical irregularities

- In-Plane Discontinuity in Vertical Element Resisting Lateral Force ➡
- in-plane offset of the lateral force resisting elements ➡ No ➡ Not Exist



*Seismic Analysis

Seismic Analysis Methods

- Equivalent Lateral Force Method (ELF).
- Response Spectrum Analysis(MCER).
- Time History Analysis .
- Static nonlinear analysis (pushover analysis)

Sample calculation on block 3*

Modal analysis & Mass participation ratio

Case	Mode	Period sec	UX	UY	UZ	Sum UX	Sum UY
Modal	1	0.592	0.71	0	0	0.71	0
Modal	2	0.419	0	0.7111	0	0.71	0.7111
Modal	3	0.237	0	0	0	0.71	0.7111
Modal	4	0.124	0.2056	0	0	0.9156	0.7111
Modal	5	0.114	0	0.1921	0	0.9156	0.9031

- Program calculated period
- 90%mass 5 modes needed

*Seismic Analysis

Equivalent Lateral Force Method (ELF).

Block 3:

- Seismic Weight ➡

Story number	Mass of one floor Etabs (Kg)	Weight of one floor Etabs (KN)
4	293600.35	2880.219434
3	306828.78	3009.990332
2	306828.78	3009.990332
1	306828.78	3009.990332
base	60767.6	596.130156
total weight	1214086.69	11910.19043

- V=Cs*W
- Cs max=SDs*I/R
- Cs = SD1*I/(T*R)
- Cs min =.04 SD1 *I

Ty	0.42	sec
W	11906.12	KN
		V=Cs*W
Cs	0.11	1289.83
Cs max	0.15	1775.973
Cs min	0.03	340.5151

*Seismic Analysis

Equivalent Lateral Force Method (ELF).

Block 3:

- Program calculated period ➡
- Period in X direction =0.592 s
- Period in Y direction = 0.419 s

Case	Mode	Period sec	UX	UY
Modal	1	0.592	0.71	0
Modal	2	0.419	0	0.7111

*Seismic Analysis

Equivalent Lateral Force Method (ELF).

Block 3:

- Manual period
- Lower limit of period =
- $T = C_t * h_n^x = 0.425 S$
- Upper limit of period
- $T_a = C_u * C_t * h_n^x = 1.4 * .425 = 0.595\ S$

T from program is less than 0.595 & more than 0.425 → Ok

Coefficient for Upper Limit on Calculated Period

Design Spectral Response Acceleration Parameter at 1 s, S_{D1}	Coefficient C_u
≥0.4	1.4
0.3	1.4
0.2	1.5
0.15	1.6
≤0.1	1.7

Structure Type	C_t	x
Moment-resisting frame systems in which the frames resist 100% of the required seismic force and are not enclosed or adjoined by components that are more rigid and will prevent the frames from deflecting where subjected to seismic forces:		
Steel moment-resisting frames	0.028 (0.0724)[a]	0.8
Concrete moment-resisting frames	0.016 (0.0466)[a]	0.9
Steel eccentrically braced frames in accordance with Table 12.2-1 lines B1 or D1	0.03 (0.0731)[a]	0.75
Steel buckling-restrained braced frames	0.03 (0.0731)[a]	0.75
All other structural systems	0.02 (0.0488)[a]	0.75

[a]Metric equivalents are shown in parentheses.

*Seismic Analysis

Equivalent Lateral Force Method (ELF).

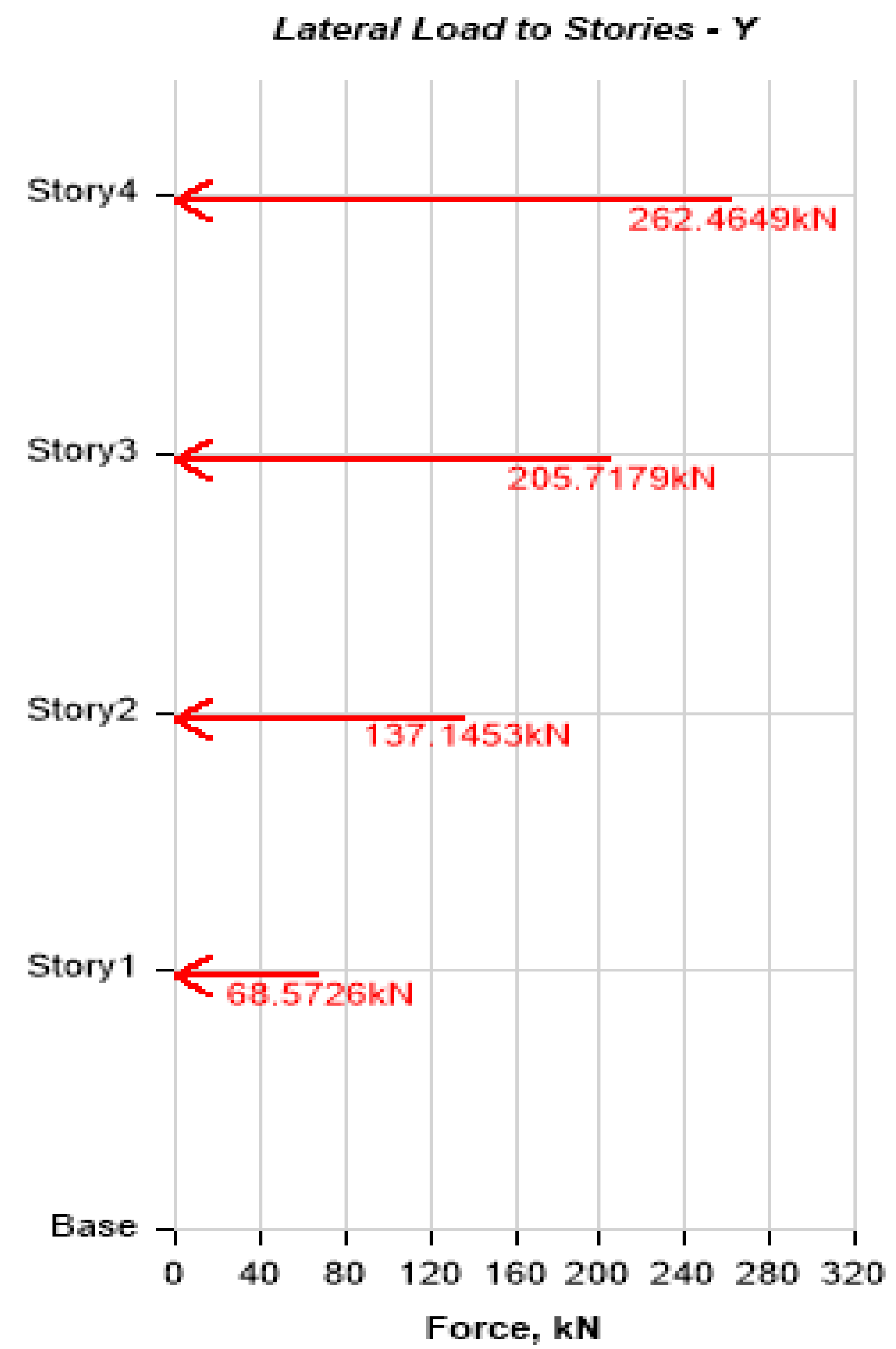
Block 3:

Base Shear Calculation:

- Base Shear Distribution ➡

Lateral load to stories X :-

	h	elevation	weight	w*h	F(KN)	error %
Story4	3375	13500	2880.219	38882.962	219.5309	0.03413
Story3	3375	10125	3009.99	30476.152	172.0666	0.03416
Story2	3375	6750	3009.99	20317.435	114.711	0.03413
Story1	3375	3375	3009.99	10158.717	57.35552	0.03421



*Seismic Analysis

Equivalent Lateral Force Method (ELF).

Block 3:

Torsional Irregularity Check X-Direction:

- Ratio=$\frac{delta\ max}{delta\ Avg}$ ⇒ <1.2 no irregularity

Story	Load Case/Combo	Direction	Maximum	Average	Ratio	irregularity
			mm	mm		
Story4	EQx 2	X	4.586	4.569	1.004	None
Story3	EQx 2	X	3.247	3.224	1.007	None
Story2	EQx 2	X	1.847	1.83	1.009	None
Story1	EQx 2	X	0.648	0.632	1.025	None

*Seismic Analysis

Equivalent Lateral Force Method (ELF).

Block 3:

Accidental Torsion Calculation

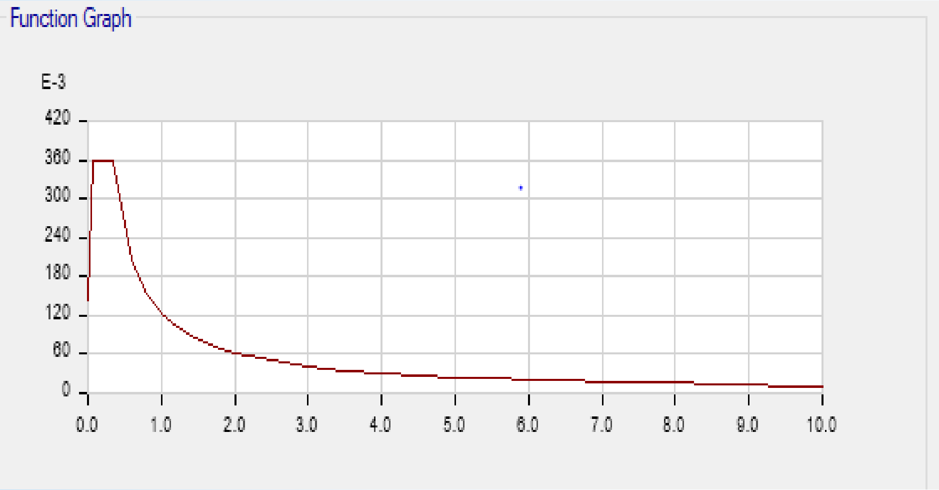
Ratio= $\frac{delta\ max}{delta\ Avg}$ ⇒ <1.4 no accidental Torsion

Ax = ($\frac{delta\ max}{1.2x delta\ Avg\text{^}2}$)

Story	Load Case/Combo	Direction	Maximum delta mm	Average delta mm	Ratio	Ax calculated	Ax calculated
Story4	EQx 2	X	4.589	4.569	1.005	0.70053737	1
Story3	EQx 2	X	3.249	3.224	1.008	0.70525612	1
Story2	EQx 2	X	1.848	1.831	1.01	0.70739951	1
Story1	EQx 2	X	0.648	0.632	1.026	0.73005127	1

Response spectrum *

- SDs =0.65 sec
- SD1 =0.375 sec



Horizontal Response spectrum

Response spectrum scaling *

* Based on ASCE 7-16
* The base shear from response spectrum must be equal or more than 100 % from base shear from ELF .If its not a scaling for response must be made .

response spectrum scaling	responce base shear (befor scaling)	equvilant base shear	scale factor	responce base shear (after scaling)
for base shear force	951.0061	1289.83	1.36	1289.83

*Seismic Analysis

Response Spectrum Analysis(MCER).

Drift Check

Amplified drift=Cd*Story drift Etabs

Allowable Drift ⟹ from Table

Allowable Drift=0.02*h(story)=67.5mm.

	Risk Category		
Structure	I or II	III	IV
Structures, other than masonry shear wall structures, four stories or less above the base as defined in Section 11.2, with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts	$0.025h_{sx}$ [c]	$0.020h_{sx}$	$0.015h_{sx}$
Masonry cantilever shear wall structures[d]	$0.010h_{sx}$	$0.010h_{sx}$	$0.010h_{sx}$
Other masonry shear wall structures	$0.007h_{sx}$	$0.007h_{sx}$	$0.007h_{sx}$
All other structures	$0.020h_{sx}$	$0.015h_{sx}$	$0.010h_{sx}$

[a] h_{sx} is the story height below level x.
[b] For seismic force-resisting systems solely comprising moment frames in Seismic Design Categories D, E, and F, the allowable story drift shall comply with the requirements of Section 12.12.1.1.
[c] There shall be no drift limit for single-story structures with interior walls, partitions, ceilings, and exterior wall systems that have been designed to accommodate the story drifts. The structure separation requirement of Section 12.12.3 is not waived.
[d] Structures in which the basic structural system consists of masonry shear walls designed as vertical elements cantilevered from their base or foundation support that are so constructed that moment transfer between shear walls (coupling) is negligible.

*Seismic Analysis

Response Spectrum Analysis(MCER).

Block 3:

Drift Check

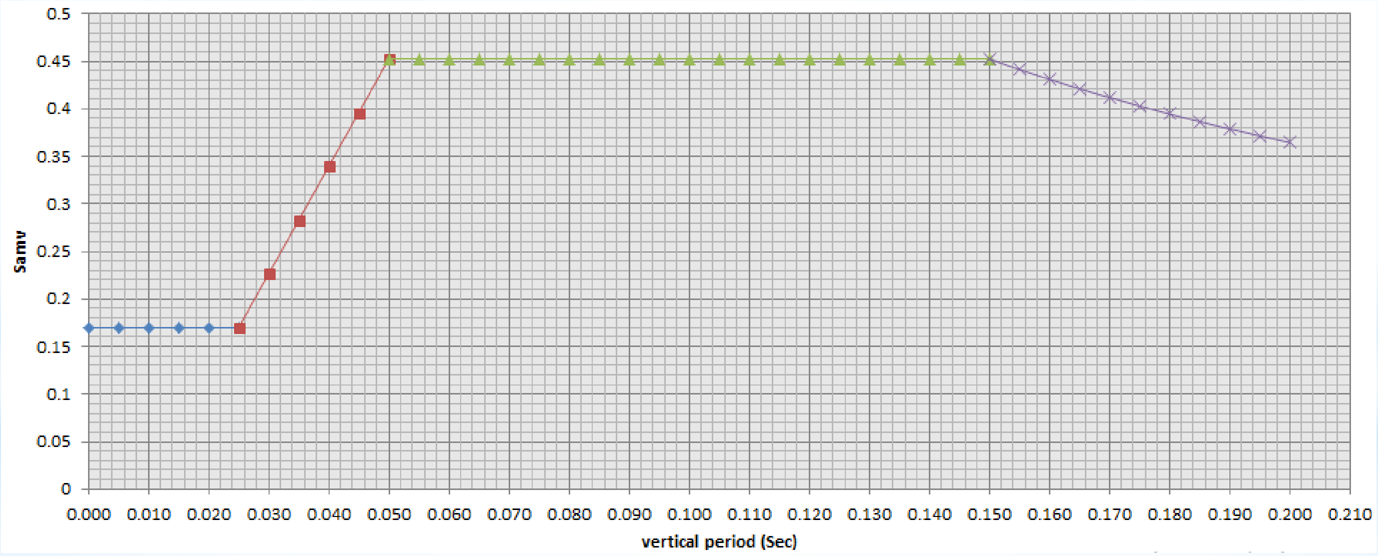
Amplified drift=4.5*Story drift Etabs

Allowable Drift=0.02*3375=67.5 mm.

story	load case	load direction	maximum displacment	drift	drift * Cd/I
Story4	EQYres Max	Y	8.857	2.873	14.365
Story3	EQYres Max	Y	5.984	2.757	13.785
Story2	EQYres Max	Y	3.227	2.214	11.07
Story1	EQYres Max	Y	1.013	1.013	5.065

story	load case	load direction	maximum displacment	drift	drift * Cd/I
Story4	EQXres Max	X	16.477	5.397	26.985
Story3	EQXres Max	X	11.08	5.149	25.745
Story2	EQXres Max	X	5.931	4.078	20.39
Story1	EQXres Max	X	1.853	1.853	9.265

Vertical Response spectrum



Equation=0.3Sav*D

Time History analysis

Time history analysis was made from a data for a previous earthquake happened in turkey area

So the data was scaled based on response spectrum for building area

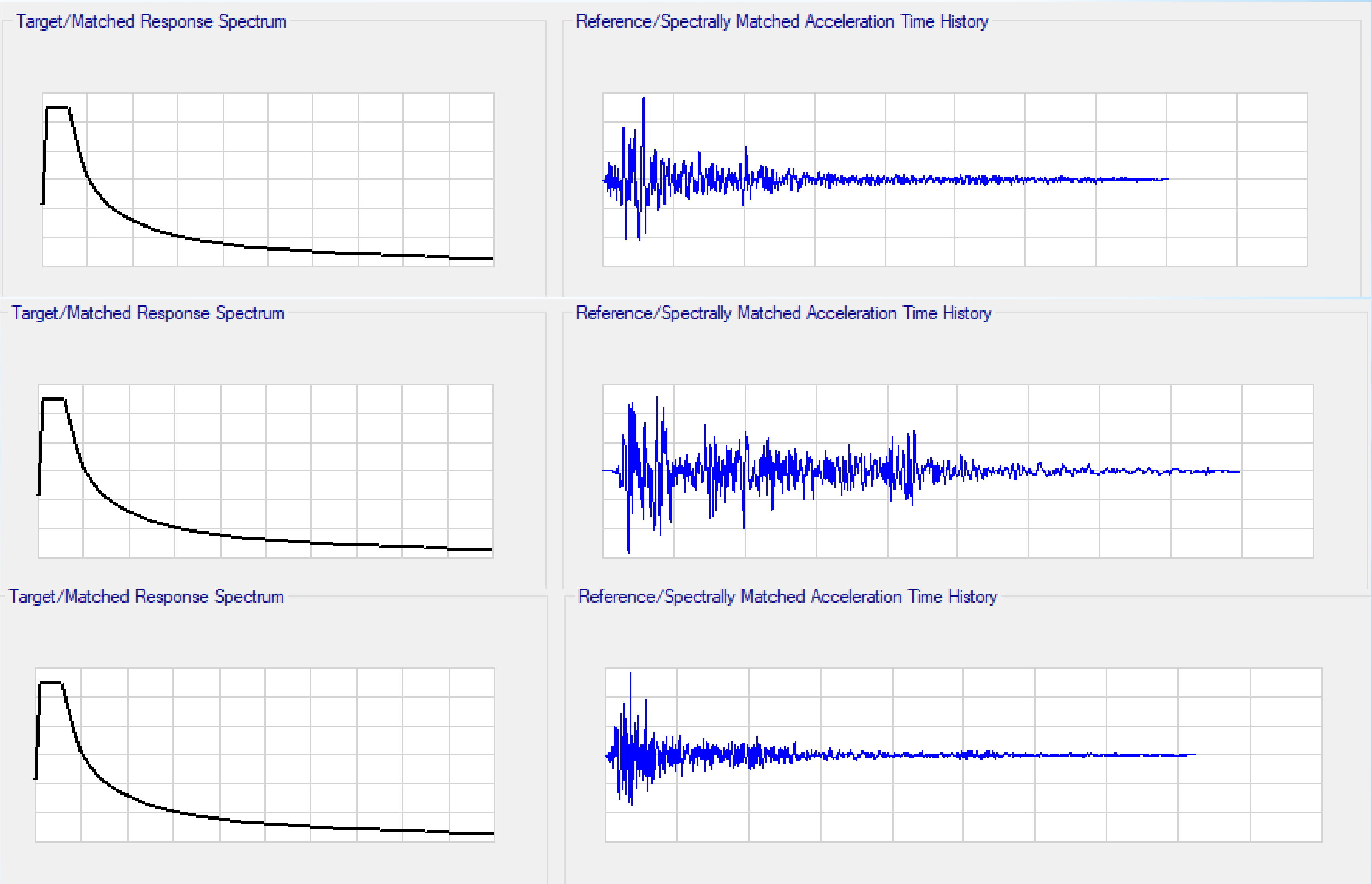
3 earthquakes were used and scaled

Matched time history *

Th-1

Th-2

Th-2



Time History scale*

Based on ASCE 7-16

The base shear from response spectrum must be equal or more than 100 % from base shear from ELF .If its not a scaling for response must be made .

scaling time history	time history base shear (befor scaling)	equivilant base shear	scale factor	time History base shear (after scaling)
for base shear force	989.6329	1289.83	1.3033419	1289.83

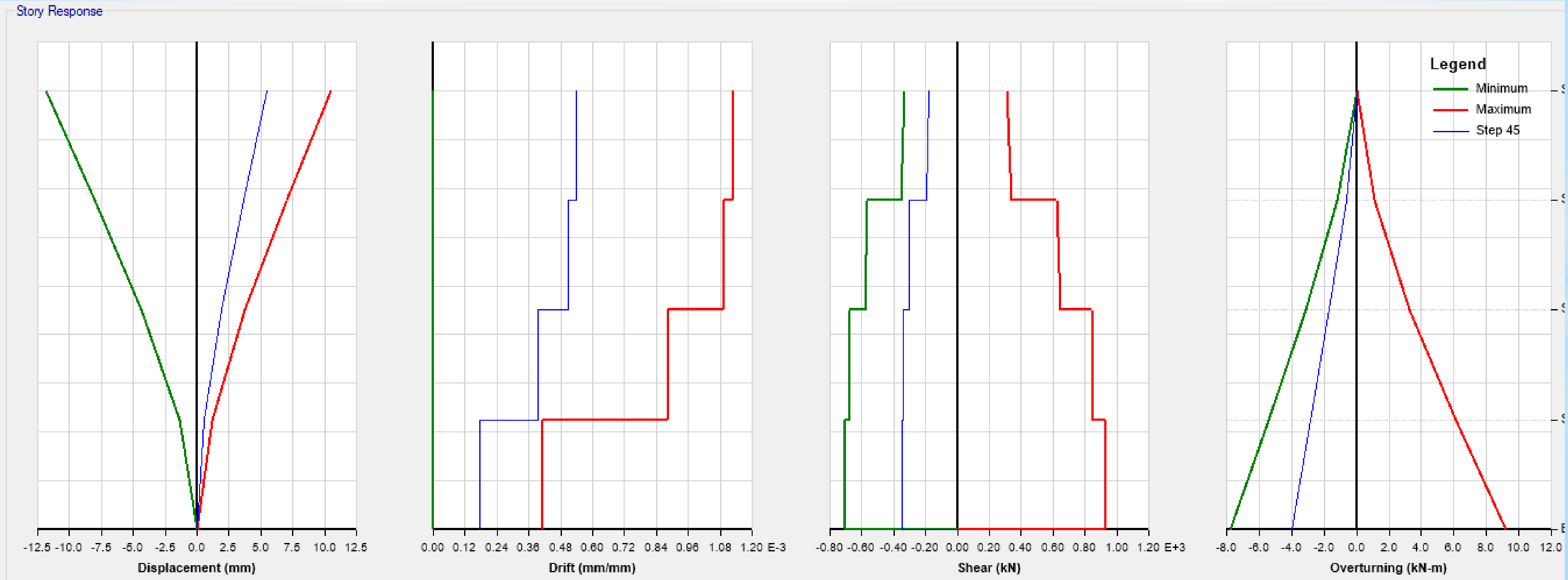
Time History drift*

* Because the numbers of time history data are less than 7 the maximum drift form the 3 file was taken

story	load case	load direction	maximum displacment	drift	drift * Cd/I
Story4	time history Y Max	Y	7.964	2.495	12.475
Story3	time history Y Max	Y	5.469	2.465	12.325
Story2	time history Y Max	Y	3.004	2.048	10.24
Story1	time history Y Max	Y	0.956	0.956	4.78

story	load case	load direction	maximum displacment	drift	drift * Cd/I
Story4	time history X Max	X	14.937	5.002	25.01
Story3	time history X Max	X	9.935	4.71	23.55
Story2	time history X Max	X	5.225	3.627	18.135
Story1	time history X Max	X	1.598	1.598	7.99

Time History Results*

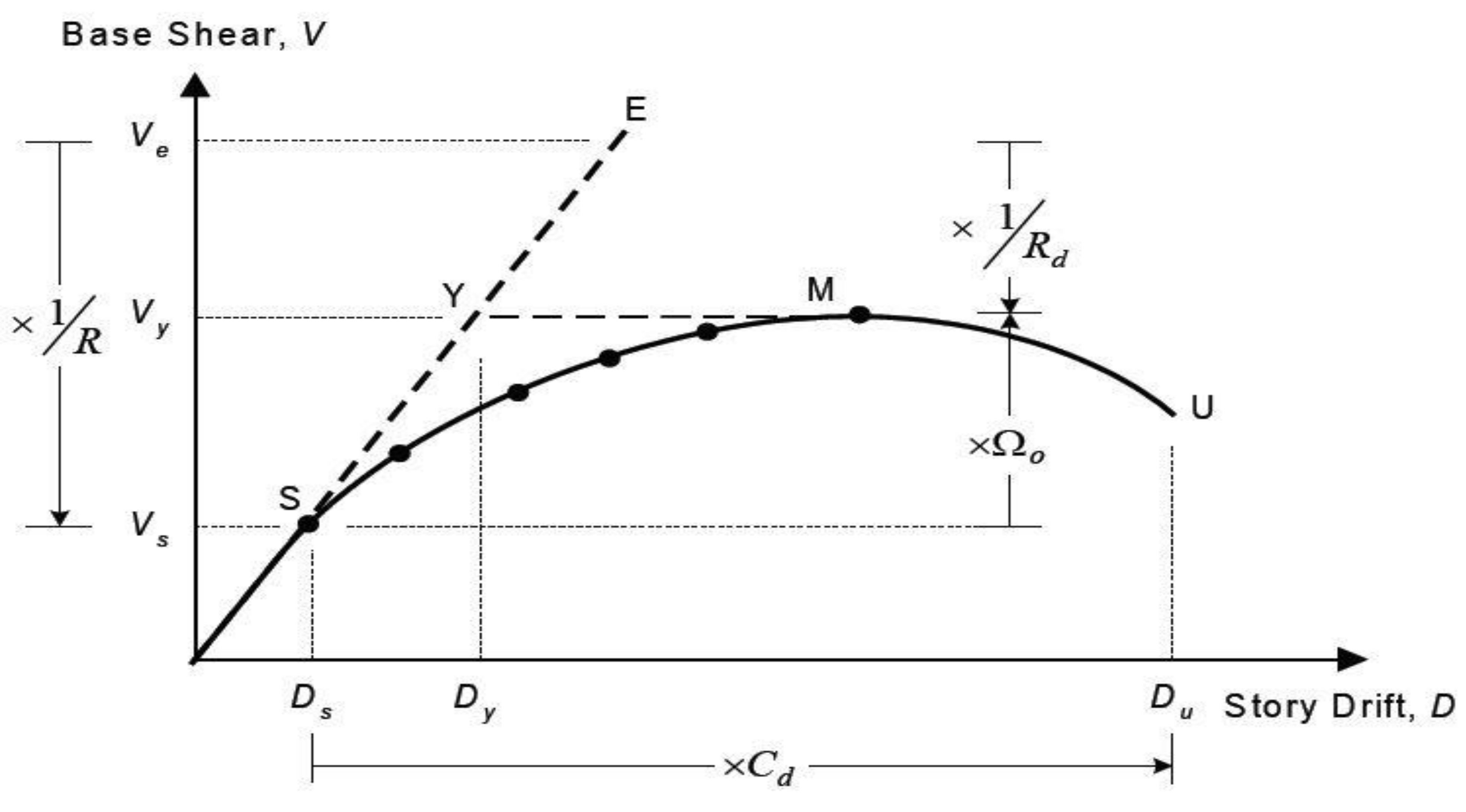


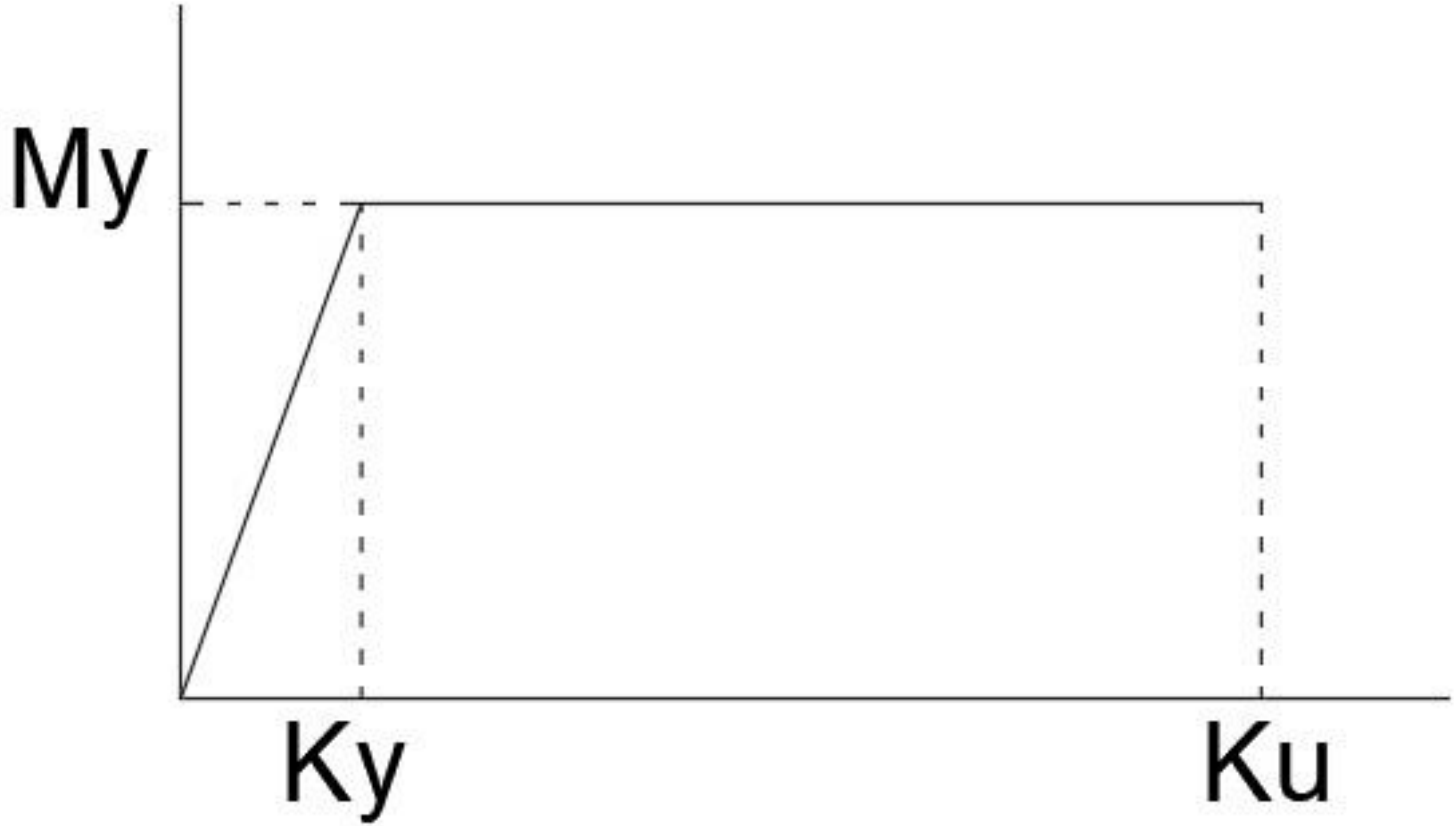
Summery of displacement

story	load direction	equivelant	response	history
Story4	Y	13.175	14.365	12.475
Story3	Y	12.84	13.785	12.325
Story2	Y	10.54	11.07	10.24
Story1	Y	5.005	5.065	4.78

story	load direction	equivelant	response	history
Story4	X	26.265	26.985	25.01
Story3	X	25.285	25.745	23.55
Story2	X	20.31	20.39	18.135
Story1	X	9.39	9.265	7.99

*Push-over Analysis

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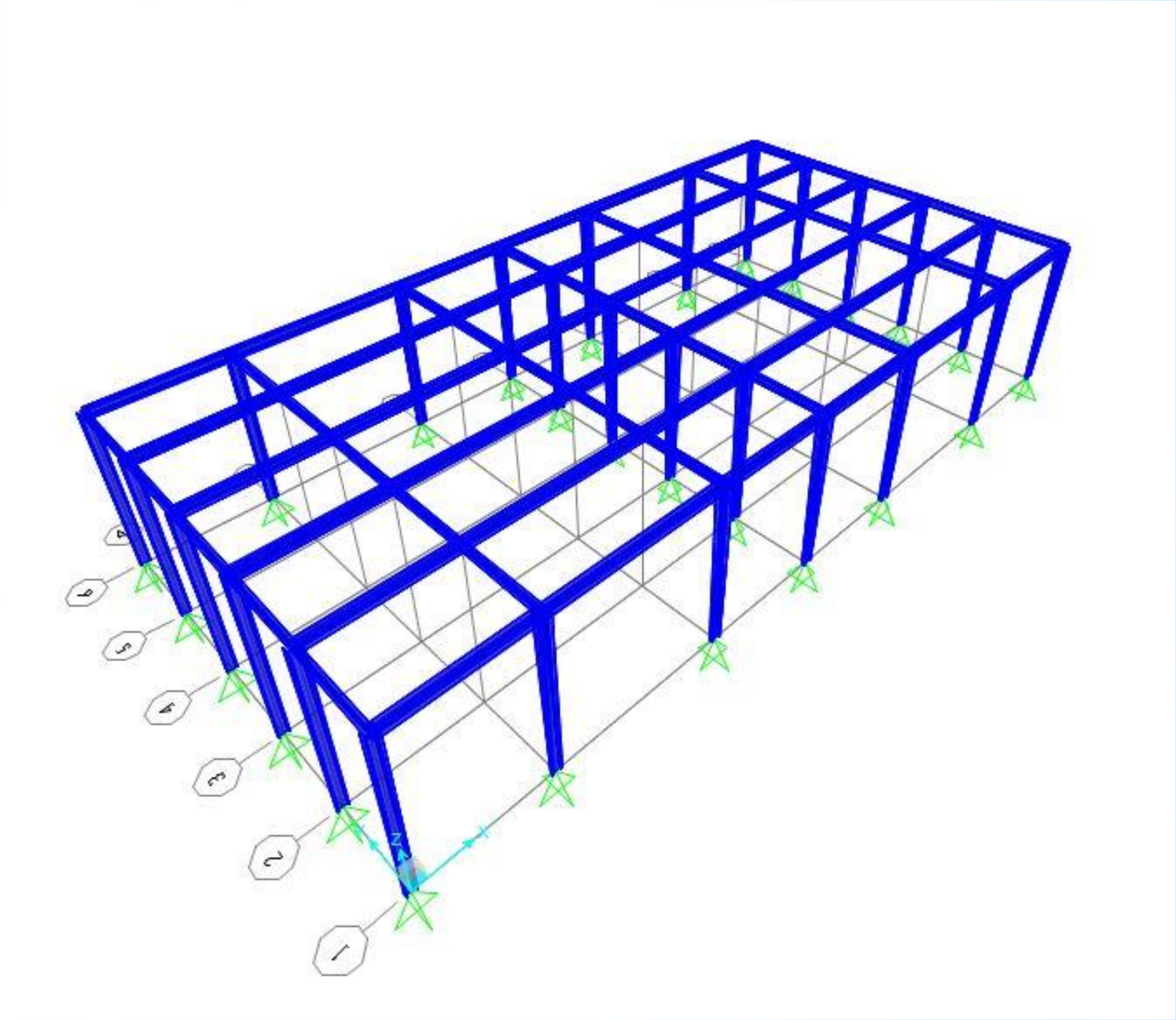
Push-over Analysis

Block 4 Performance:

Models

- Moment resisting frame



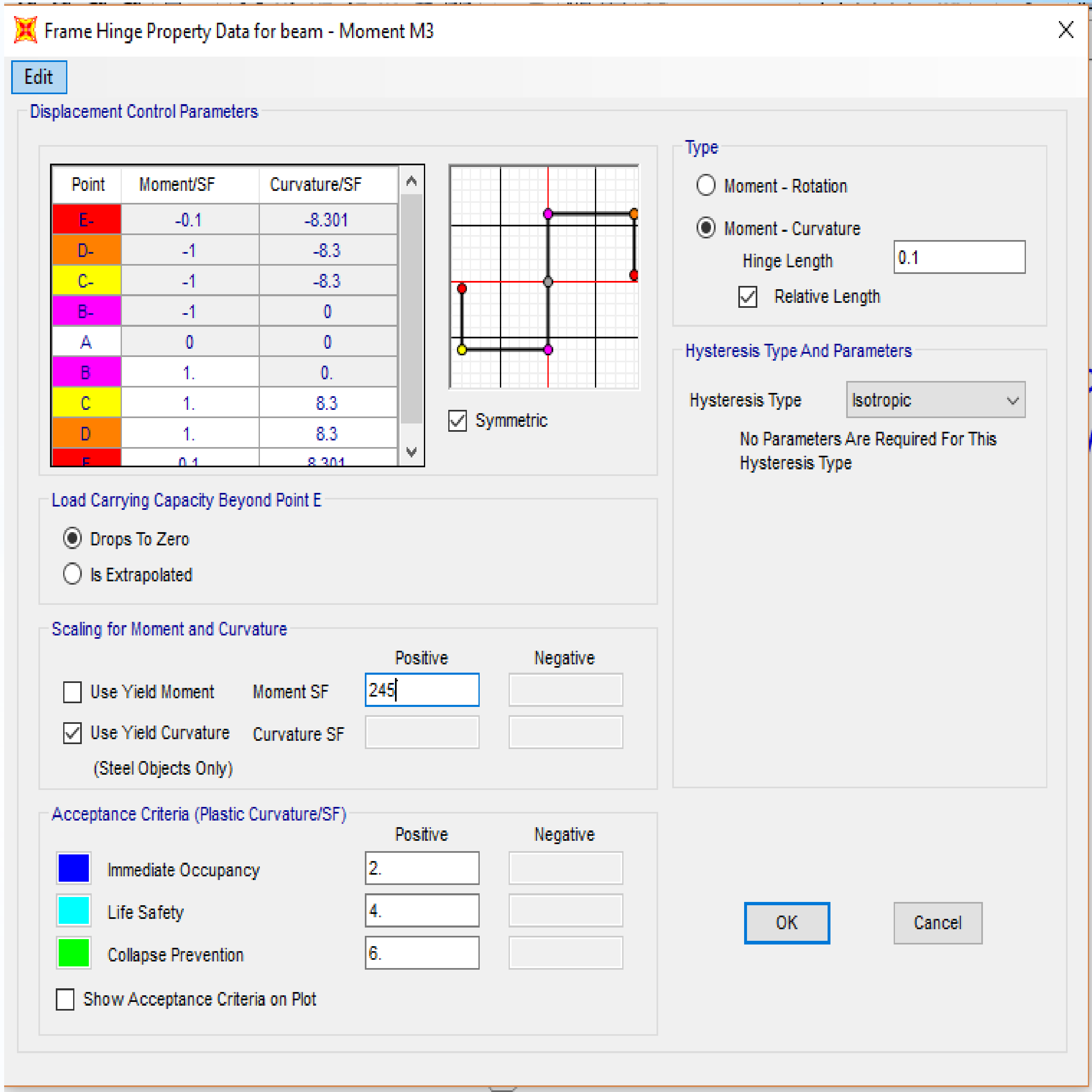
*Push-over Analysis

Block 4 Performance:

Bracing Model:

- Moment Hinge

Elastic Perfectly plastic Behavior

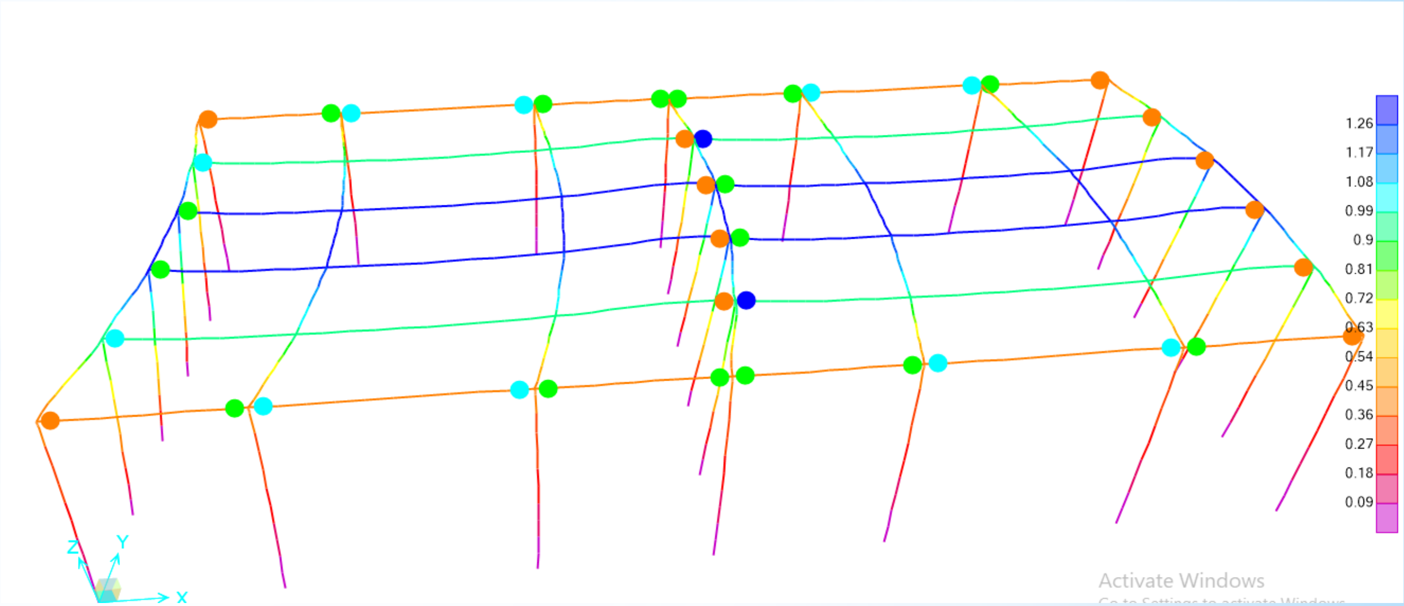


*Push-over Analysis

Block 4 Performance:

- Assigning hinges in the beginning, middle and end of the members.

➡ Result Failure mode.



*Push-over Analysis

Block 4 Performance:

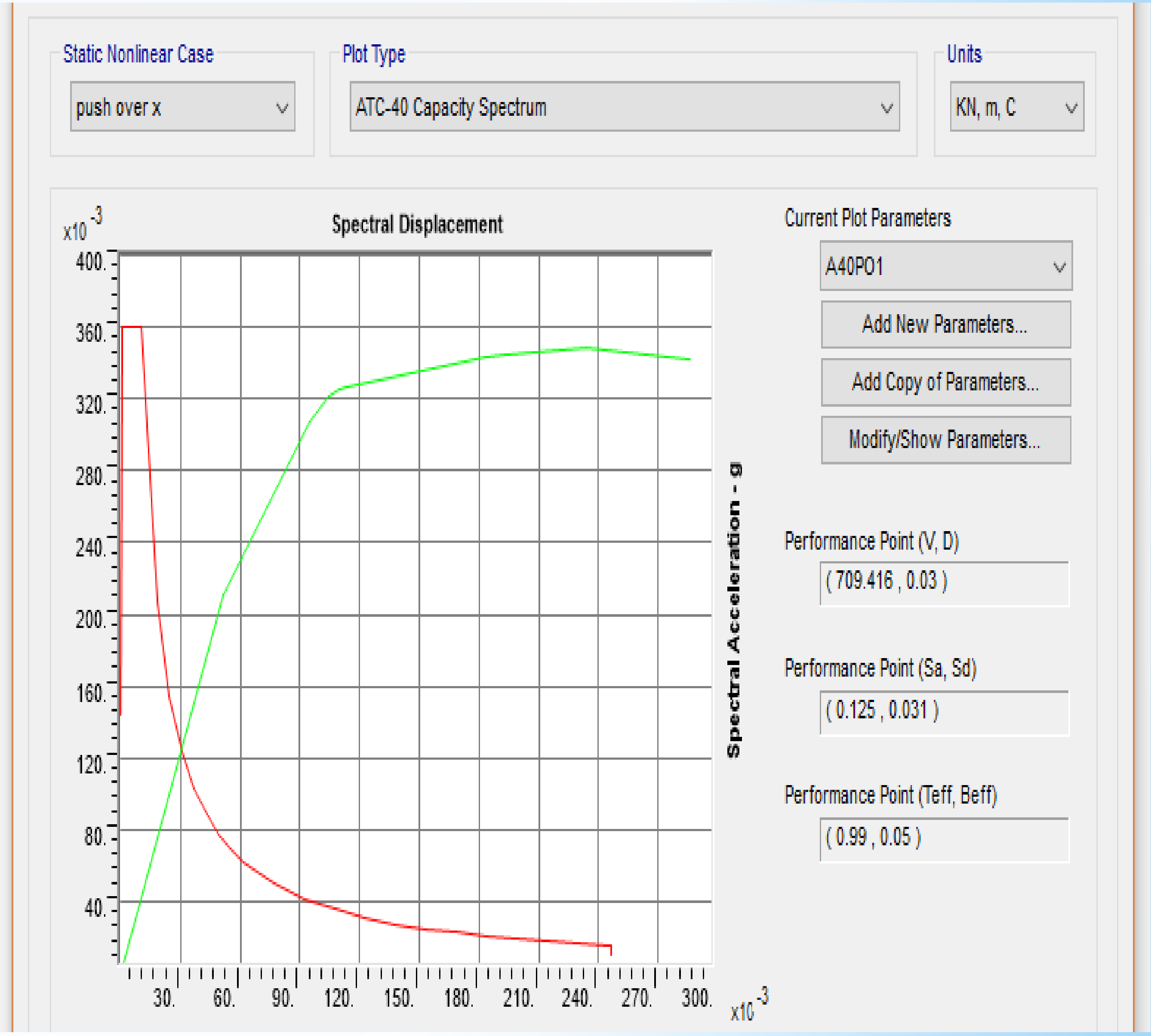
Bracing Model:

- Result Push over curve.

Manual check :

Summation of external works =summation of internal works

$$\sum P\Delta = \sum Mp * \theta$$



*Push-over Analysis

Block 4 Performance:

Bracing Model:

Manual check :

$$\sum P\Delta = \sum Mp * \theta$$

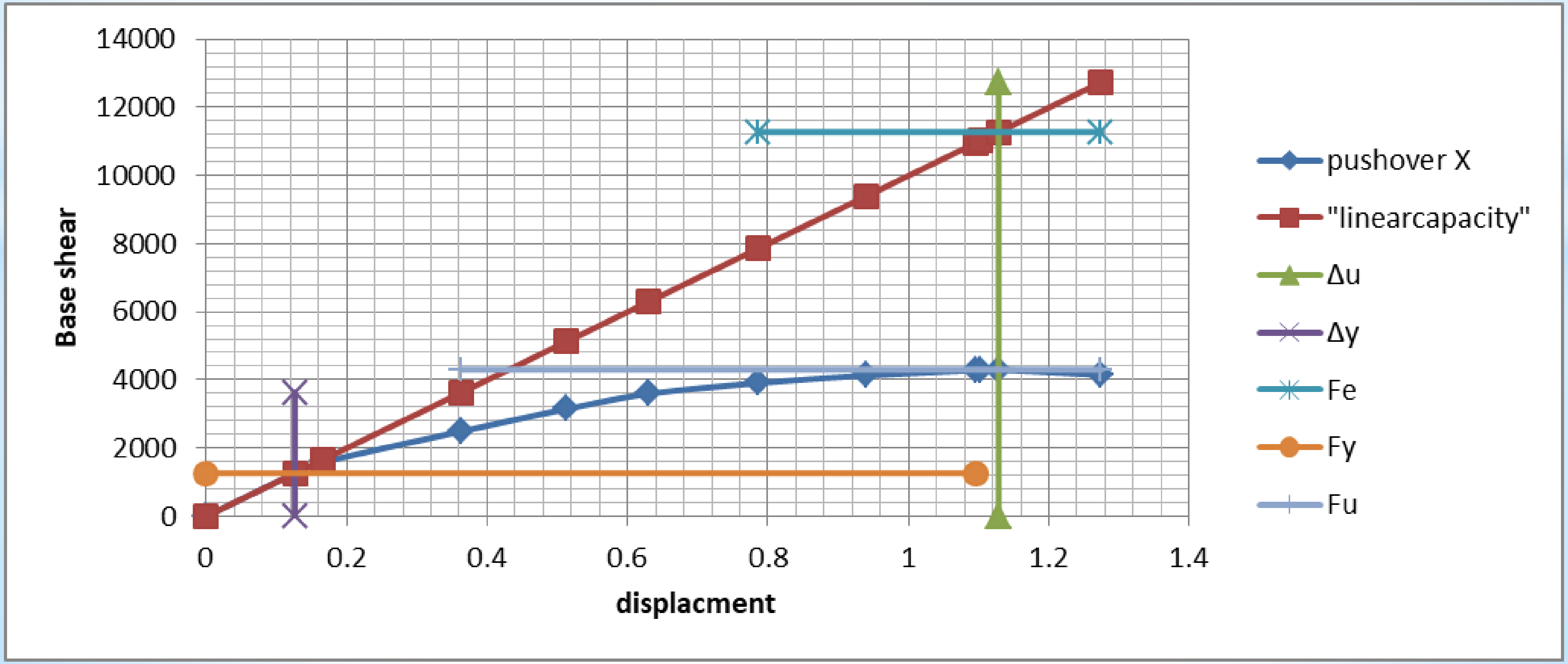
TABLE: Pushover Capacity Curve X			
LoadCase	Step	Displacement	BaseForce
Text	Unitless	m	KN
push over x	0	0.000255	0
push over x	1	0.126329	1260.525
push over x	2	0.166491	1586.268
push over x	3	0.363835	2493.029
push over x	4	0.513835	3147.911
push over x	5	0.630407	3591.762
push over x	6	0.786691	3907.754
push over x	7	0.939921	4128.501
push over x	8	1.096304	4287.505
push over x	9	1.102395	4291.582
push over x	10	1.12826	4299.066
push over x	11	1.274711	4150.062

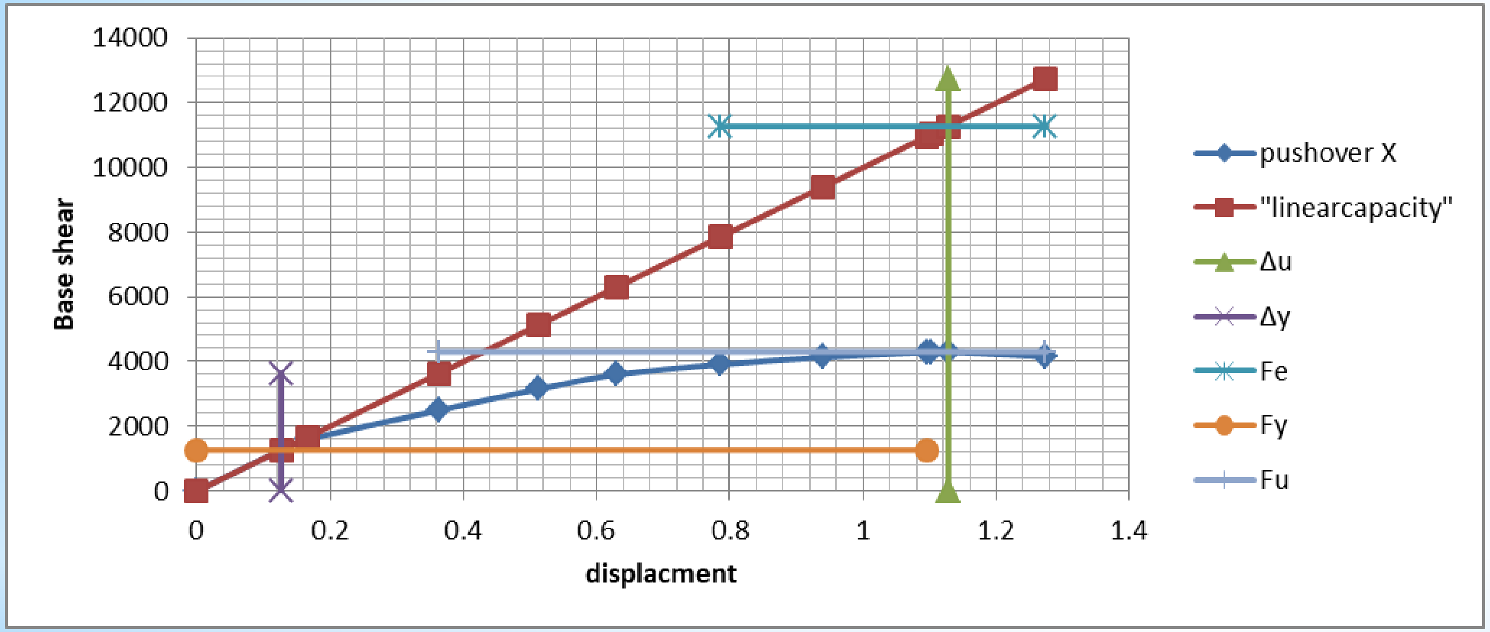
	sap 2000 result	manual result	error %
base shear	4299.066	4567.525926	5.8775786

*Push-over Analysis

Block 4 Performance:

Push over curve in X direction





Response Modification Coefficient, Ra	8.95
Overstrength Factor, Ω0	3.41
Deflection Amplification Factor, Cd	8.93

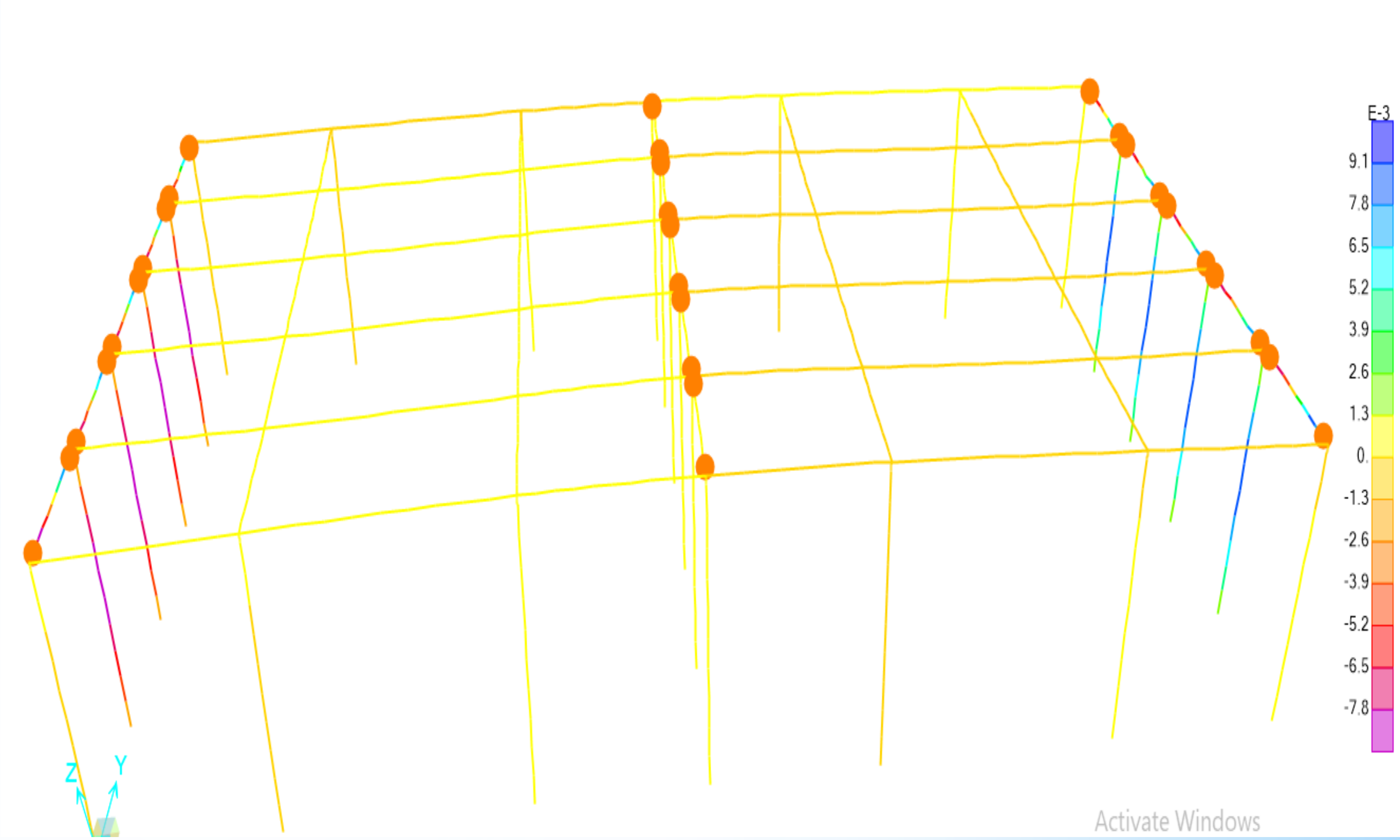
*Push-over Analysis

Block 4 Performance:

Y direction:

- Assigning hinges in the beginning, middle and end of the members.

  ➡ Result Failure mode.



*Push-over Analysis

Block 4 Performance:

TABLE: Pushover Capacity Curve Y			
LoadCase	Step	Displacement	BaseForce
Text	Unitless	m	KN
push over y	0	3.73E-06	0
push over y	1	0.049886	382.247
push over y	2	0.066907	504.65
push over y	3	0.084663	545.724
push over y	4	0.084663	545.724
push over y	5	0.08559	546.166
push over y	6	0.120404	556.088
push over y	7	0.400035	328.073
push over y	8	0.550035	200.503
push over y	9	0.700035	73.308

- Result Push over curve.

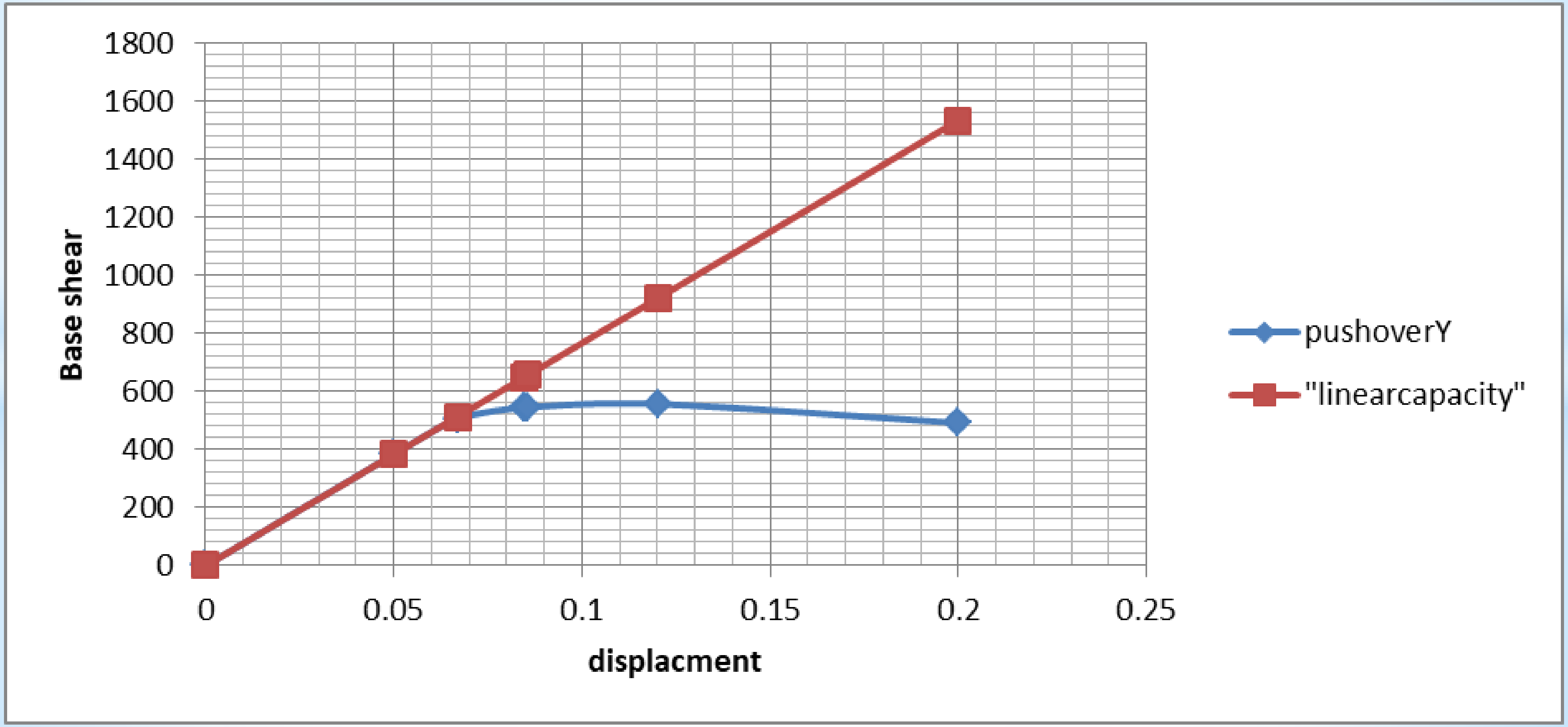
Manual check :

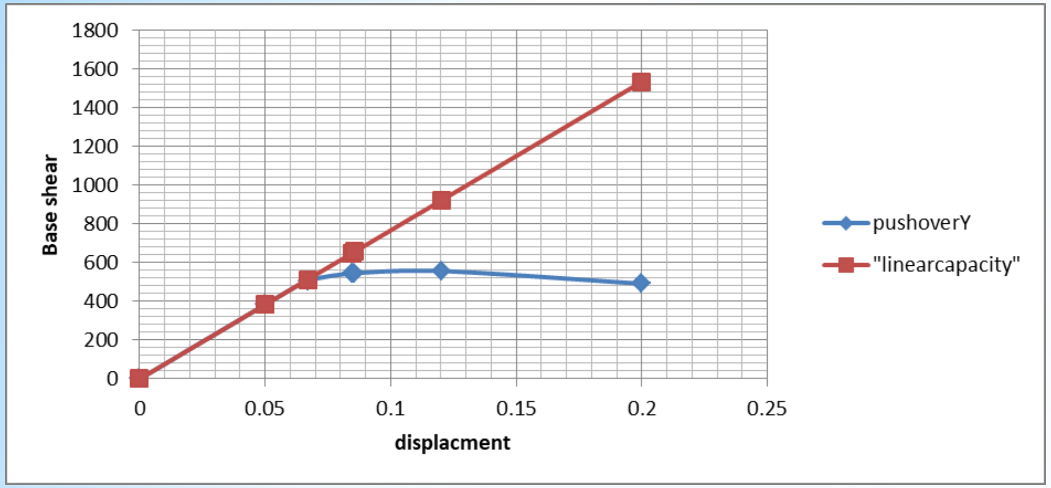
Summation of external works =summation of internal works

$$\sum P\Delta = \sum Mp * \theta$$

	sap 2000 result	manual result	error %
base shear	556.088	663.7866667	16.22489153

Push over curve in Y direction





Response Modification Coefficient, Ra	2.41
Overstrength Factor, Ω0	1.45
Deflection Amplification Factor, Cd	2.41

Difference between building parameter from Code ASCE-7 2016 and pushover analysis results

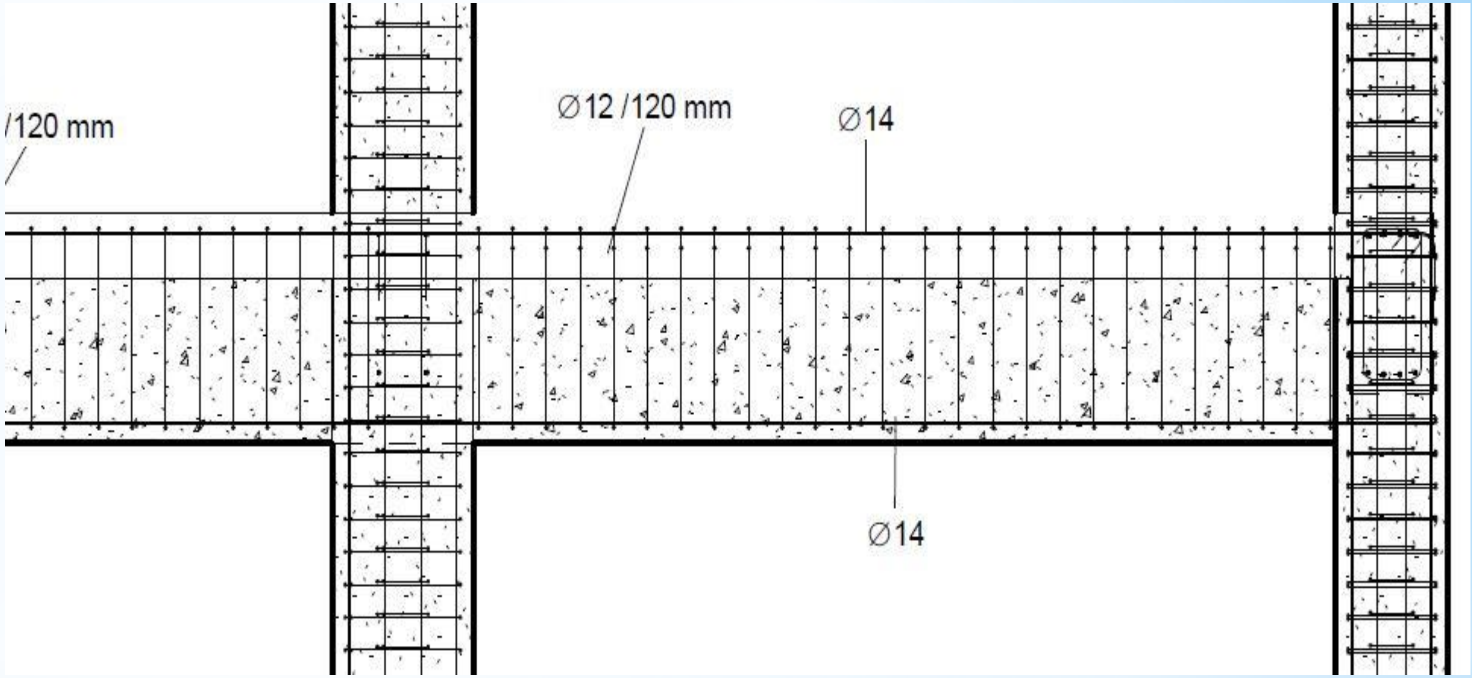
X direction			
from push-over analysis		from code	
Response Modification Coefficient, Ra	8.95	Response Modification Coefficient, Ra	4.50
Overstrength Factor, Ω0	3.41	Overstrength Factor, Ω0	3.00
Deflection Amplification Factor, Cd	8.93	Deflection Amplification Factor, Cd	4.00

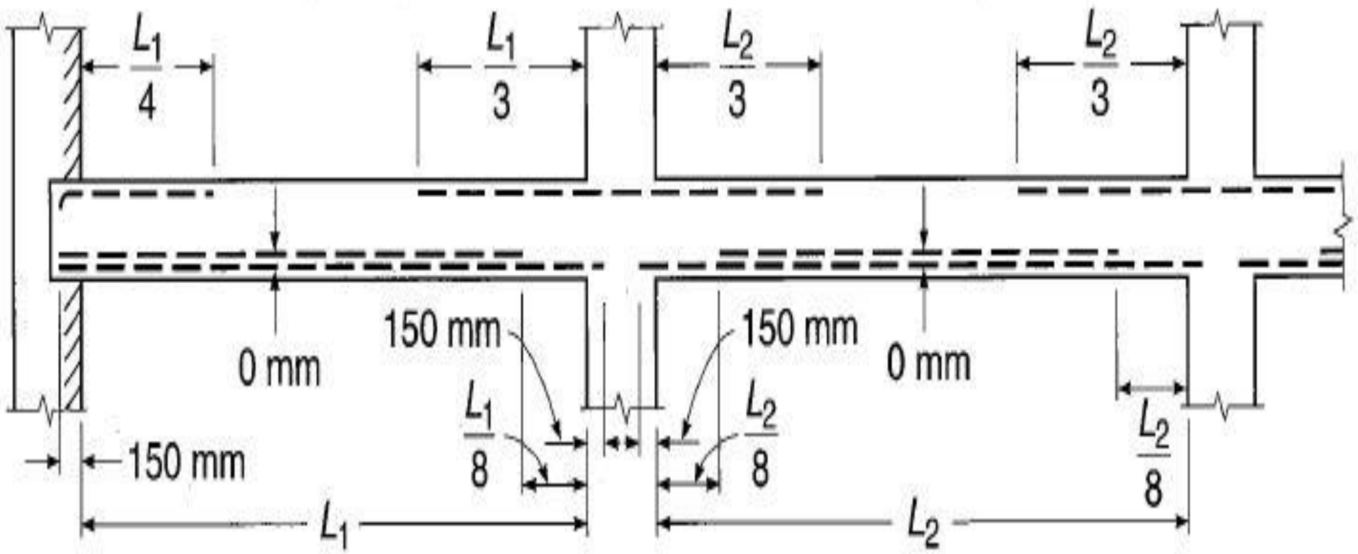
Y direction			
from push-over analysis		from code	
Response Modification Coefficient, Ra	2.41	Response Modification Coefficient, Ra	4.50
Overstrength Factor, Ω0	1.45	Overstrength Factor, Ω0	3.00
Deflection Amplification Factor, Cd	2.41	Deflection Amplification Factor, Cd	4.00

*Detailing

Beams Detailing

- Cross section in Beams:
- Lap splices:
- Continuity in bars:
- *Stirrups at distance 2h*:
  $\leq$ d/4.
  $\leq$ 6db.
  $\leq$ 150 mm.
  spacing = 100 mm.
- *Stirrups at mid of the beam*:
  $\leq S = d/2.$





*Detailing

Column Detailing

Cross Sections:

L_o:

$\geq$ max column dimension.

$\geq$ 1/6 of clear height of column.

$\geq$ 450 mm.

splicing:

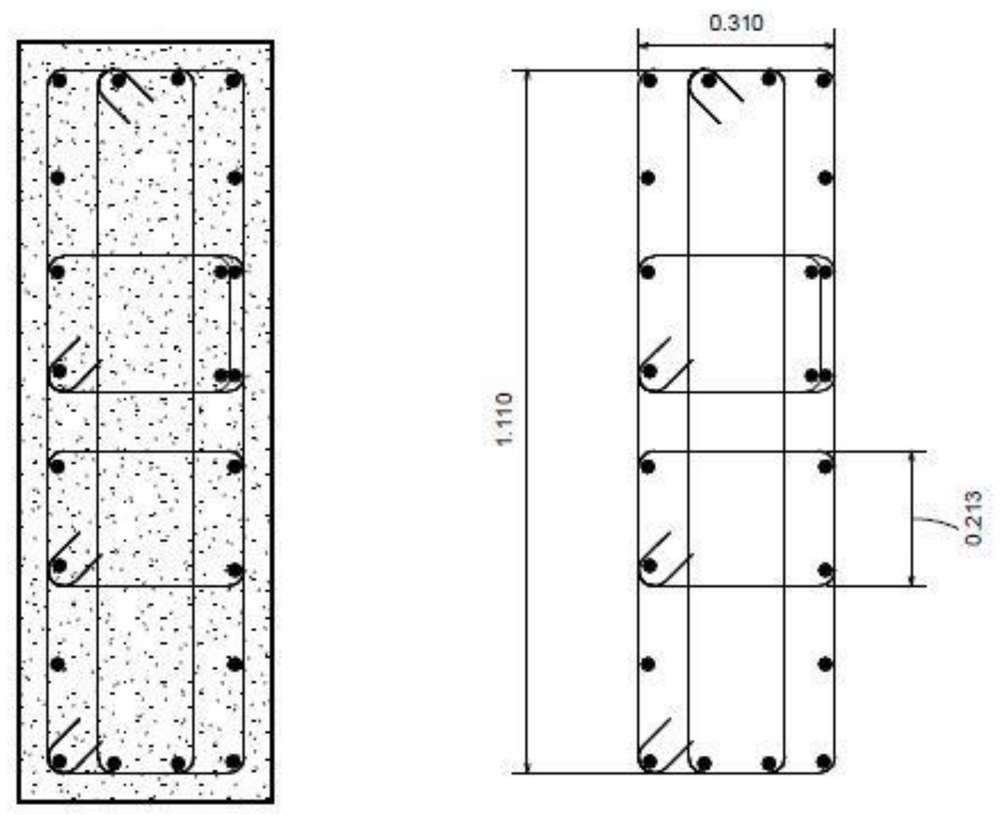
500 mm

Transverse steel:

$\leq$ ¼ minimum member dimension.

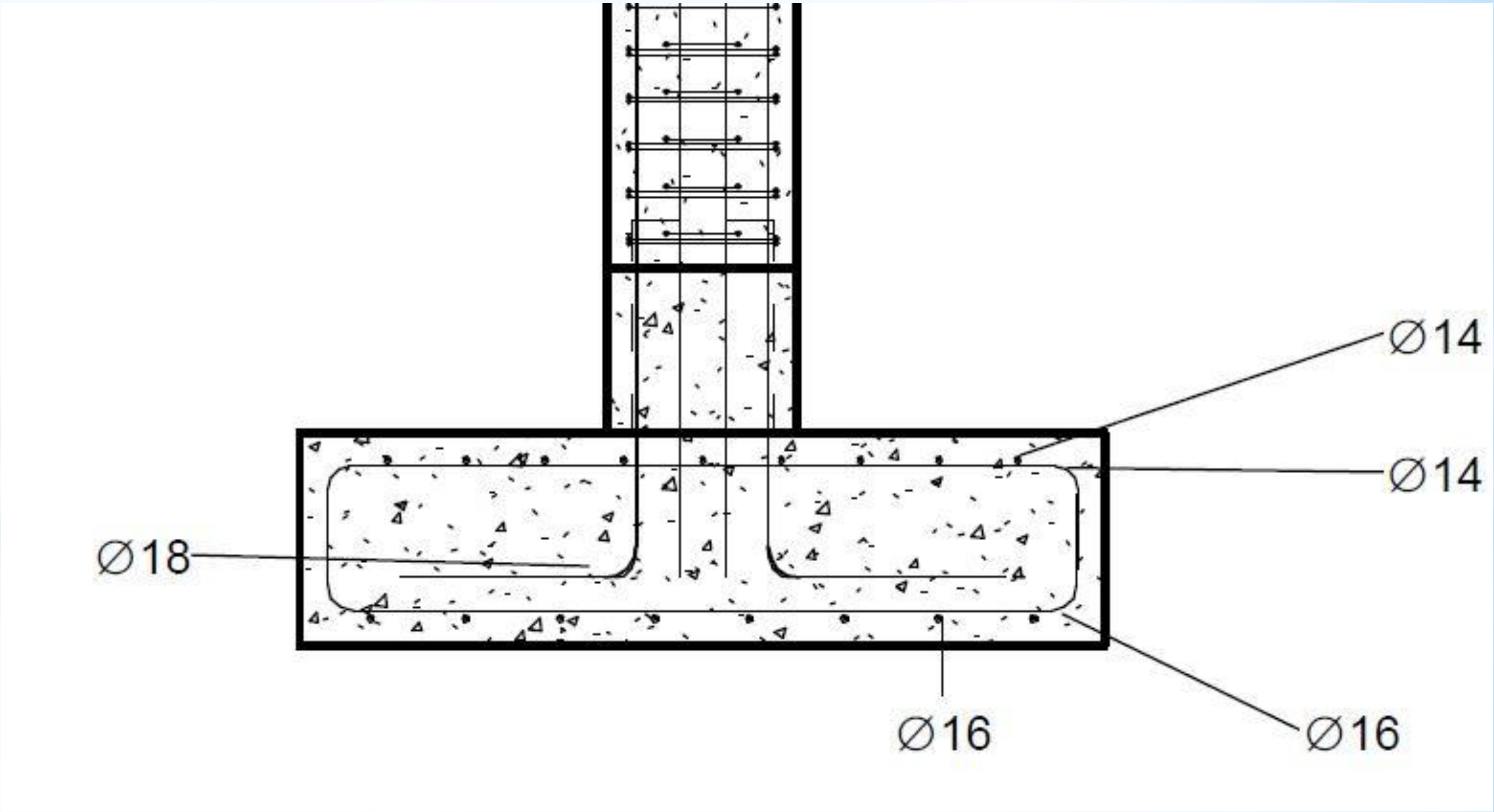
$\leq$ 6 db.

$\leq S_o$



*Detailing

Footing Detailing



*Detailing

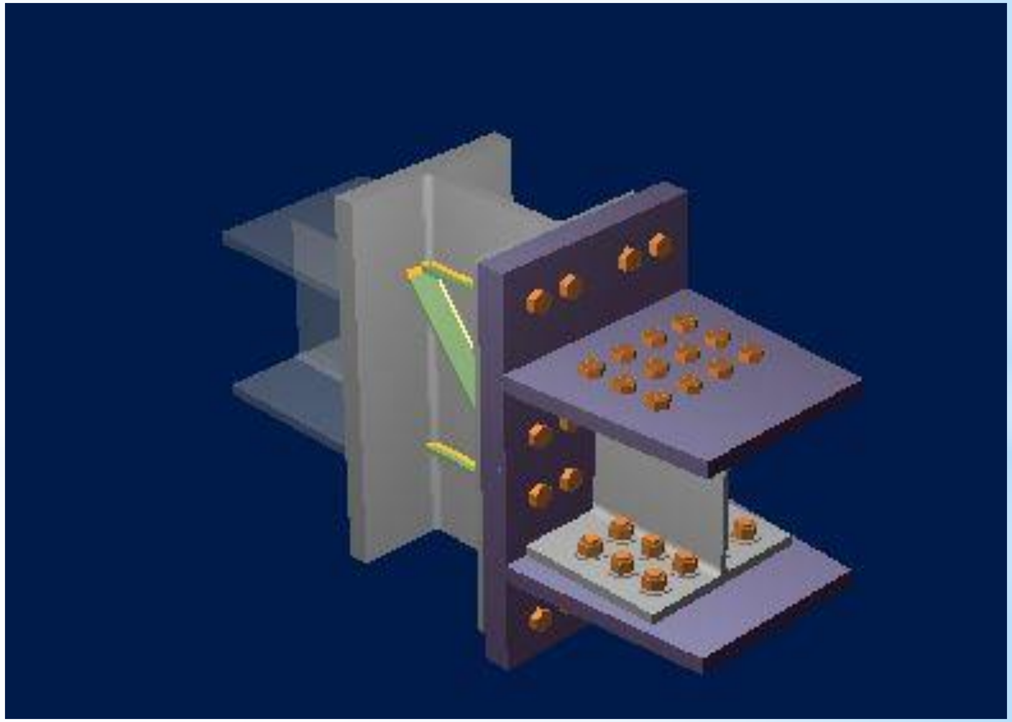
Steel Connections:

Beam-Column Flange Connection

Stiffeners are used

Beam-Column Web Connection

Beam-Girder Connection



Thank you