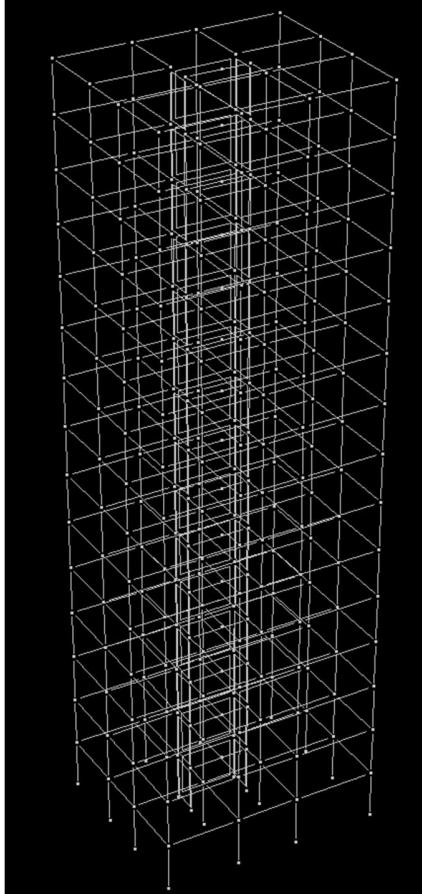
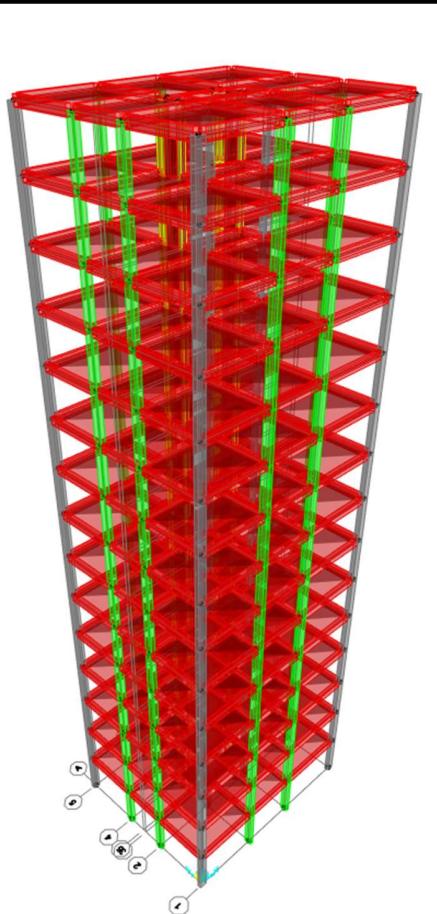
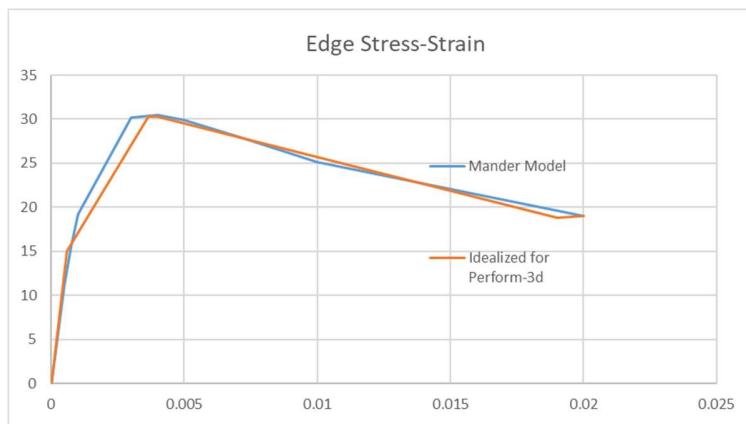


STRUCTURAL APPRAISAL

REPORT OF BURAK'S BUILDING



With Performance Based
Design Methodology



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11.06.2020

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İSTANBUL

2020

I declare that all material in this project is my own work and does not involve plagiarism.

Burak AYYILMAZ

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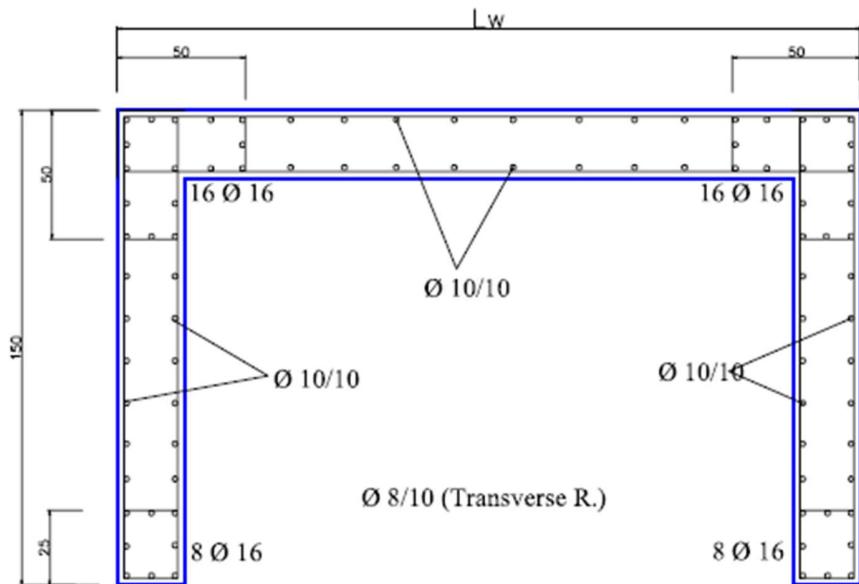
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1 Introduction

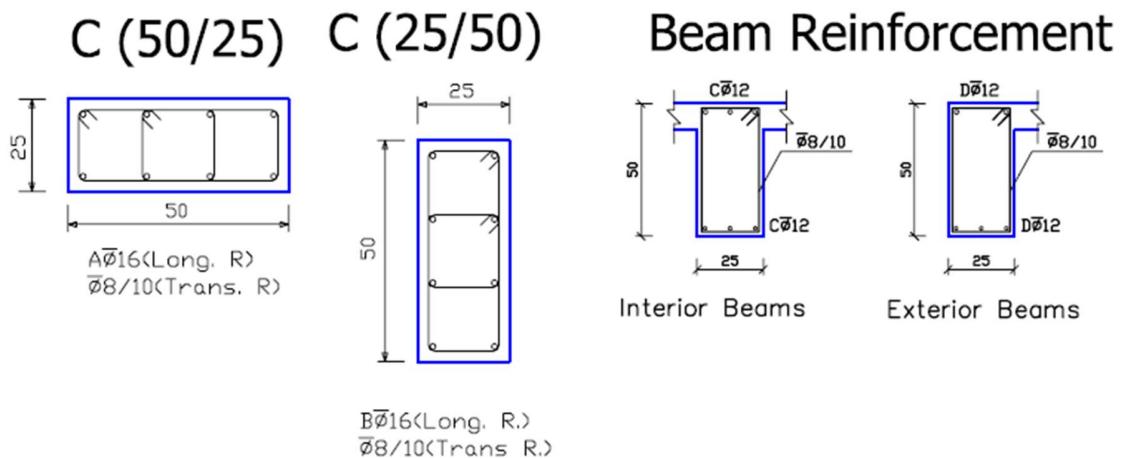
Building Information

Shear wall detail;

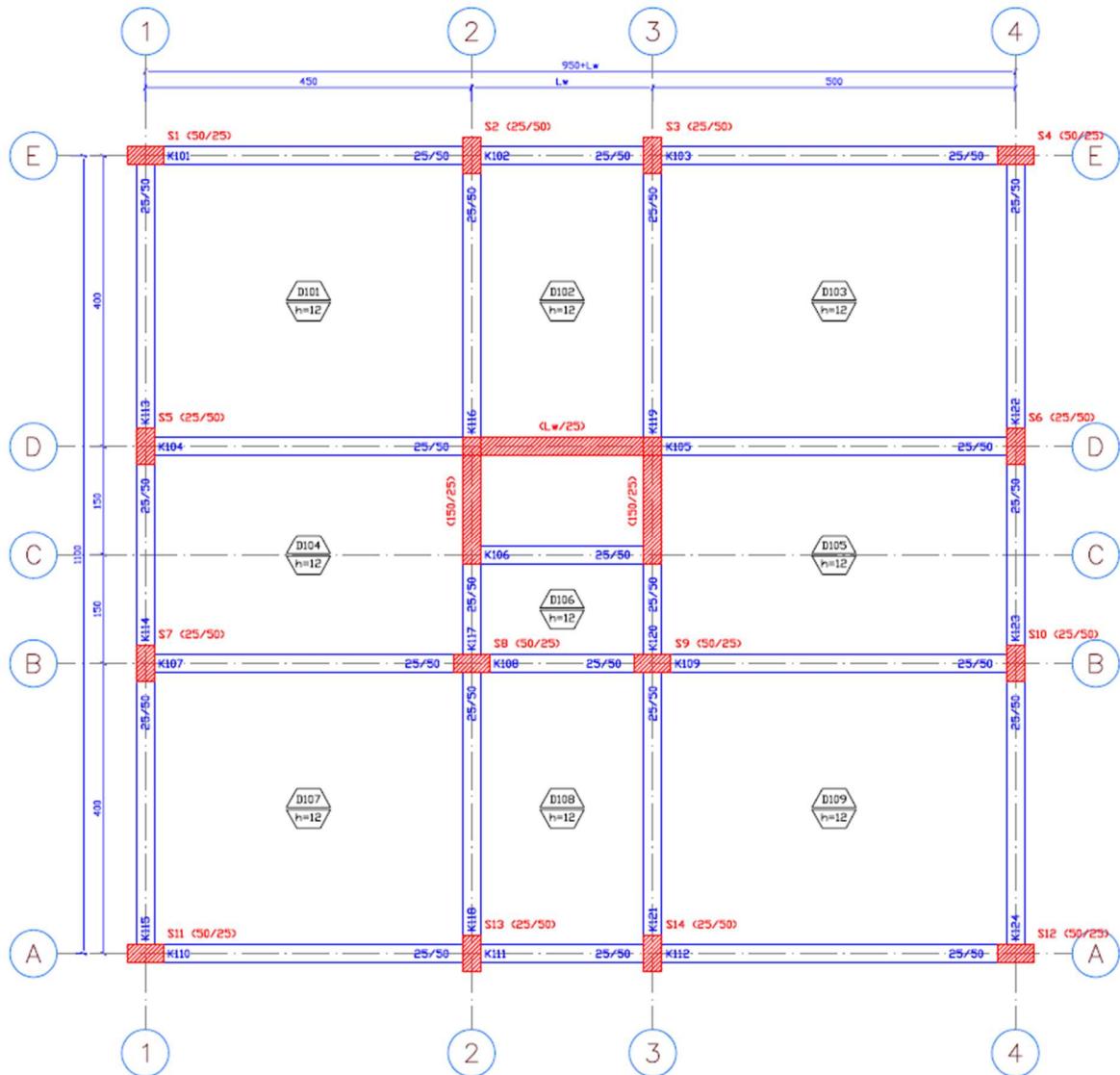
Structural Wall Reinforcement Details



Beam and column member details;



Story plan;



Data;

Number of Story	15m
L _w	3.75m
A	10
B	8
C, D	3

Materials

Tablo 5.1. Beklenen (Ortalama) Malzeme Dayanımları

Beton	$f_{ct} = 1.3 f_{ck}$
Donatı çeliği	$f_{ye} = 1.2 f_{yk}$
Yapı çeliği (S235)	$f_{ye} = 1.5 f_{yk}$
Yapı çeliği (S275)	$f_{ye} = 1.3 f_{yk}$
Yapı çeliği (S355)	$f_{ye} = 1.1 f_{yk}$
Yapı çeliği (S460)	$f_{ye} = 1.1 f_{yk}$

In analyses, expected material strength of steel and concrete were used. Except shear strength calculation, characteristic strength values used for shear capacity of members.

Loads

Considered loads for analyses are structure self-weight, superimposed dead load and live load. For calculating self-weight of structure, density of concrete taken as 25 kN/m³. Respectively superimposed DL and live load were taken as 2.5 kN/m² and 2 kN/m². For cracking analysis, SW and SDL taken as normally but live-load reduced with multiplier 0.3.

2 Component Section Property Calculations and Damage

Limits

Dead Load Analysis

		Member Name													
		S 1	S 2	S 3	S 4	S 5	S 6	S 7	S 8	S 9	S 10	S 11	S 12	S 13	S 14
Storey	1	-877	-1167	-1216	-942	-982	-999	-1042	-1075	-927	-1027	-776	-875	-914	-851
	2	-827	-1087	-1132	-887	-910	-897	-933	-996	-856	-950	-726	-801	-836	-797
	3	-774	-1007	-1048	-830	-839	-807	-838	-919	-787	-874	-675	-731	-763	-742
	4	-720	-928	-964	-772	-769	-724	-751	-843	-719	-801	-624	-664	-692	-686
	5	-664	-848	-881	-712	-700	-649	-672	-768	-654	-729	-572	-600	-625	-630
	6	-606	-769	-798	-650	-633	-578	-599	-695	-590	-658	-520	-539	-560	-573
	7	-548	-690	-716	-588	-566	-512	-530	-622	-527	-589	-467	-479	-498	-516
	8	-488	-611	-634	-524	-501	-449	-464	-551	-466	-521	-415	-422	-438	-458
	9	-428	-533	-553	-459	-436	-389	-402	-480	-406	-454	-362	-366	-380	-400
	10	-367	-456	-473	-394	-372	-330	-341	-410	-346	-387	-310	-311	-323	-343
	11	-305	-379	-393	-327	-309	-274	-283	-340	-287	-321	-257	-258	-268	-285
	12	-243	-303	-314	-261	-246	-218	-225	-271	-228	-256	-205	-205	-213	-227
	13	-180	-227	-235	-194	-183	-164	-170	-202	-171	-191	-152	-153	-160	-169
	14	-118	-151	-157	-127	-121	-110	-114	-134	-113	-126	-100	-101	-105	-110
	15	-54	-75	-79	-59	-60	-58	-61	-66	-56	-62	-47	-51	-54	-52
	Section Type	C1	C2	C2	C1	C2	C1	C1	C2	C2	C2	C1	C2	C2	C1

C1 Type Member	Story	Mean Axial Load (kN)
	1,2,3,4	-812.4
	5,6,7	-588.1
	8,9,10	-406.9
	11,12,13,14,15	-171.6

C2 Type Member	Story	Mean Axial Load (kN)
	1,2,3,4,5	-872.6
	6,7,8	-586.3
	9,10,11,12	-352.3
	13,14,15	-126.3

Interaction Surface Analysis

Yield moments of members were determined by interaction surface analysis. XTract section analysis program was used. Maximum steel and minimum concrete strains were determined according to code for concrete 0.0035 and for steel 0.01.

5.3.1.5 – Betonarme plastik mafsal kesitlerinin *etkin akma momentleri*'nin tanımlanmasına ilişkin koşullar aşağıda **(a)**, **(b)**, **(c)**'de verilmiştir:

- (a)** Malzeme dayanımları **5.4.1.5**'e göre alınacaktır.
- (b)** Etkin akma momentinin hesabında betonun basınç birim şekildeğiştirmesi 0.0035, donatı çeliğinin birim şekildeğiştirmesi ise 0.01 alınabilir.
- (c)** Etkin akma momentinin hesabında düşey yüklerden meydana gelen eksenel kuvvetler dikkate alınacaktır.

		Zero Moment.		Balanced Condition		Zero Axial
		Pc(kN)	Pt(kN)	P(kN)	M(kNm)	M(kNm)
C1	3-3	3998	530.9	1641	274.9	115.1
	2-2	3998	530.9	1574	132.1	53.56
C2	2-2	3871	424.7	1619	122.9	44.09
	3-3	3871	424.7	1646	265.5	93.03
B	3-3	-	-	-	-	39.95

Cracked Section Analysis

For C1 type elements;

	Effective Stiffness Modifiers		Effective Inertia	
Storey	3-3	2-2	3-3	2-2
1,2,3,4	0.26	0.30	6.647E-04	1.940E-04
5,6,7	0.24	0.27	6.158E-04	1.733E-04
8,9,10	0.22	0.24	5.617E-04	1.578E-04
11,12,13,14,15	0.18	0.20	4.739E-04	1.323E-04

For C2 type elements

	Effective Stiffness Modifiers		Effective Inertia	
Story	3-3	2-2	3-3	2-2
1,2,3,4,5	0.25	0.27	6.447E-04	1.727E-04
6,7,8	0.22	0.25	5.736E-04	1.619E-04
9,10,11,12	0.20	0.22	5.103E-04	1.453E-04
13,14,15	0.15	0.20	4.033E-04	1.292E-04

For Beam type elements

Member	Effective Inertia	Effective Stiffness Modifiers
K101,K104,K107,K110	2.30059E-04	0.09
K103,K105,K109,K112	2.428E-04	0.09
K115,K118,K121,K124, K113,K116,K119,K122	2.153E-04	0.08
K102,K106,K108,K111	2.071E-04	0.08
K114,K123	1.782E-04	0.07
K117,K120	9.379E-05	0.04

Damage Strains

Strain limits of column and beam elements;

C1 Damage States					
B	250	S	100	mm	
H	500	b0	200	sb	0.750
d	25	h0	450	sh	0.889
d_transversal	8	h_#_Tr	4	SH6	0.713
a	50.27	b_#_Tr	2	Alfa	0.475
d_longitudinal	16	ai_B	100	Omega	0.022
Fce	26	ai_H	150.0	Ult	0.009
Fye	264	ph_H	0.004468		
		ph_B	0.005027		
		Sınırlı Hasar	Kontrollü Hasar	Göçme Öncesi	
C1	Concrete Strain	0.0025	0.0070	0.0094	
	Steel Strain	0.0075	0.036	0.048	

C2 Damage States					
B	250	S	100	mm	
H	500	b0	200	sb	0.750
d	25	h0	450	sh	0.889
d_transversal	8	h_#_Tr	3	SH6	0.588
a	50.27	b_#_Tr	2	Alfa	0.392
d_longitudinal	16	ai_B	100	Omega	0.013
Fce	26	ai_H	225.0	Ult	0.008
Fye	264	ph_H	0.003351		
		ph_B	0.005027		
		Sınırlı Hasar	Kontrollü Hasar	Göçme Öncesi	
C2	Concrete Strain	0.0025	0.0061	0.0081	
	Steel Strain	0.0075	0.036	0.048	

B Damage States					
B	250	S	100	mm	
H	500	b0	192	sb	0.740
d	25	h0	442	sh	0.887
d_transversal	8	h_#_Tr	4	SH6	0.820
a	50.27	b_#_Tr	2	Alfa	0.538
d_longitudinal	16	ai_B	96	Omega	0.025
Fce	26	ai_H	110.5	Ult	0.010
Fye	264	ph_H	0.0045		
		ph_B	0.0052		
		Sınırlı Hasar	Kontrollü Hasar	Göçme Öncesi	
B	Concrete Strain	0.0025	0.0074	0.0098	
	Steel Strain	0.0075	0.036	0.048	

Strain limits of Shear Wall;

SW Free_Boun Damage States					
B	250	S	100	mm	
H	250	b0	200	sb	0.750
d	25	h0	200	sh	0.750
d_transversal	8	h_#_Tr	3	SH6	0.750
a	50.27	b_#_Tr	2	Alfa	0.422
d_longitudinal	16	ai_B	100	Omega	0.022
Fce	26	ai_H	100.0	Ult	0.009
Fye	264	ph_H	0.0075		
		ph_B	0.005027		
		Sınırlı Hasar	Kontrollü Hasar	Göçme Öncesi	
SW_Free	Concrete Strain	0.0025	0.0070	0.0094	
	Steel Strain	0.0075	0.036	0.048	

SW Int_Boun Damage States					
B	250	S	100	mm	
H	500	b0	225	sb	0.778
d	25	h0	475	sh	0.895
d_transversal	8	h_#_Tr	4	SH6	0.726
a	50.27	b_#_Tr	2	Alfa	0.505
d_longitudinal	16	ai_B	112.5	Omega	0.022
Fce	26	ai_H	158.3	Ult	0.009
Fye	264	ph_H	0.004233		
		ph_B	0.004468		
		Sınırlı Hasar	Kontrollü Hasar	Göçme Öncesi	
SW_Int	Concrete Strain	0.0025	0.0070	0.0094	
	Steel Strain	0.0075	0.036	0.048	

Plastic Rotation Limits

C1 Type Members						
	Göçme öncesi		Sınırlı Hasar		Yield Rotation	
Storey	3-3	2-2	3-3	2-2	3-3	2-2
1,2,3,4	0.012	0.016	0.009	0.012	0.0052	0.0031
5,6,7	0.014	0.022	0.010	0.017	0.0050	0.0030
8,9,10	0.015	0.036	0.012	0.027	0.0049	0.0030
11,12,13,14,15	0.025	0.036	0.019	0.027	0.0048	0.0030

	C2 Type Members					
	Göçme Öncesi	Sınırlı Hasar		Yield Rotation		
Storey	3-3	2-2	3-3	2-2	3-3	2-2
1,2,3,4,5	0.008	0.013	0.00615	0.009	0.00605	0.0032
6,7,8	0.012	0.018	0.009	0.013	0.0057	0.0031
9,10,11,12	0.019	0.028	0.014	0.021	0.0054	0.0030
13,14,15	0.023	0.036	0.018	0.027	0.0051	0.0030

B Type Elements				
Member	Göçme Öncesi	Sınırlı Hasar	Yield Rotation	
K101,K104,K107,K110	0.036	0.027	0.0052	
K103,K105,K109,K112	0.036	0.027	0.0055	
K115,K118,K121,K124, K113,K116,K119,K122	0.035	0.027	0.0049	
K102,K106,K108,K111	0.035	0.027	0.0048	
K114,K123	0.035	0.026	0.0045	
K117,K120	0.032	0.024	0.0043	

Shear Strength Limits of Components

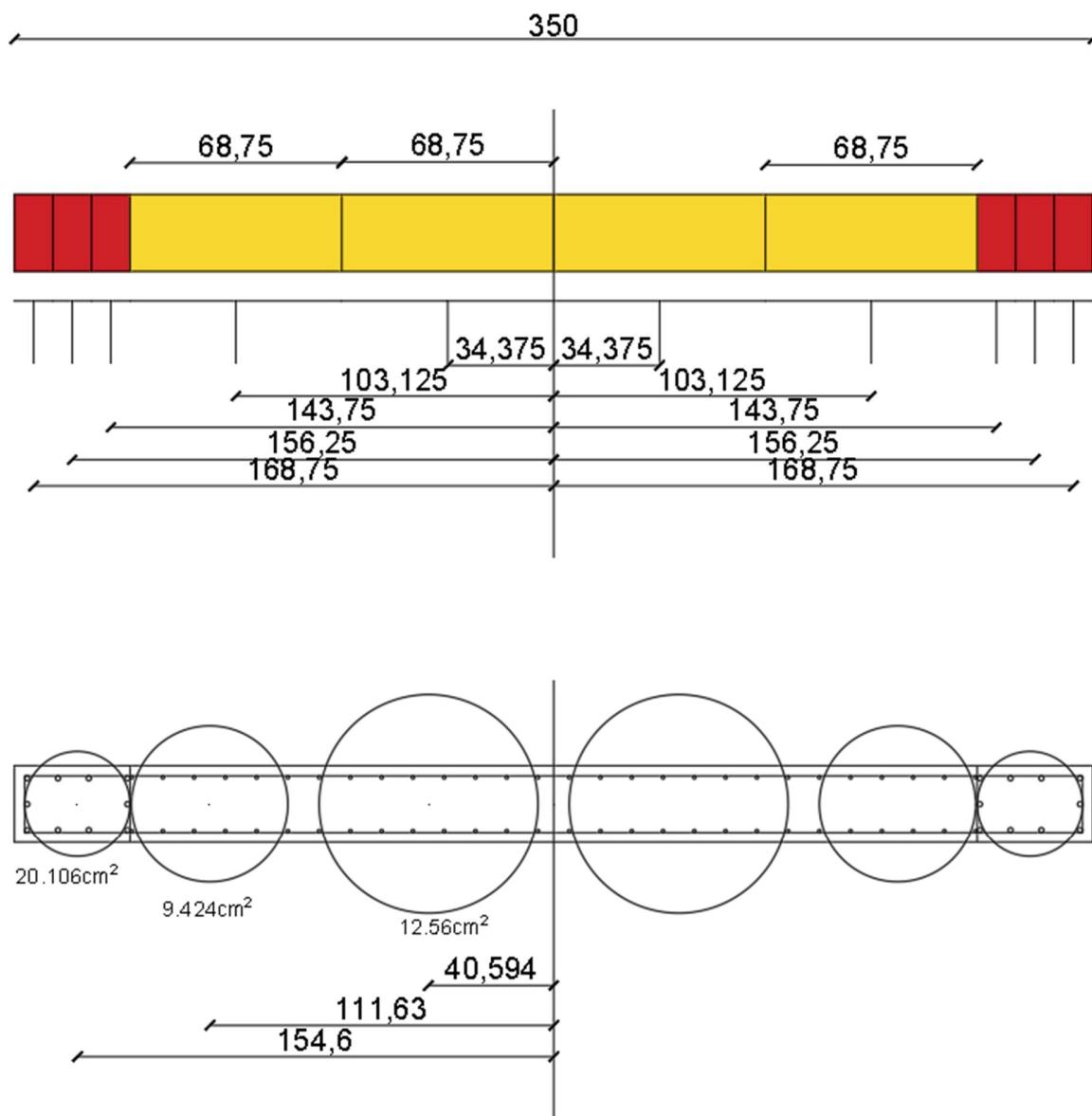
Shear strength limits;

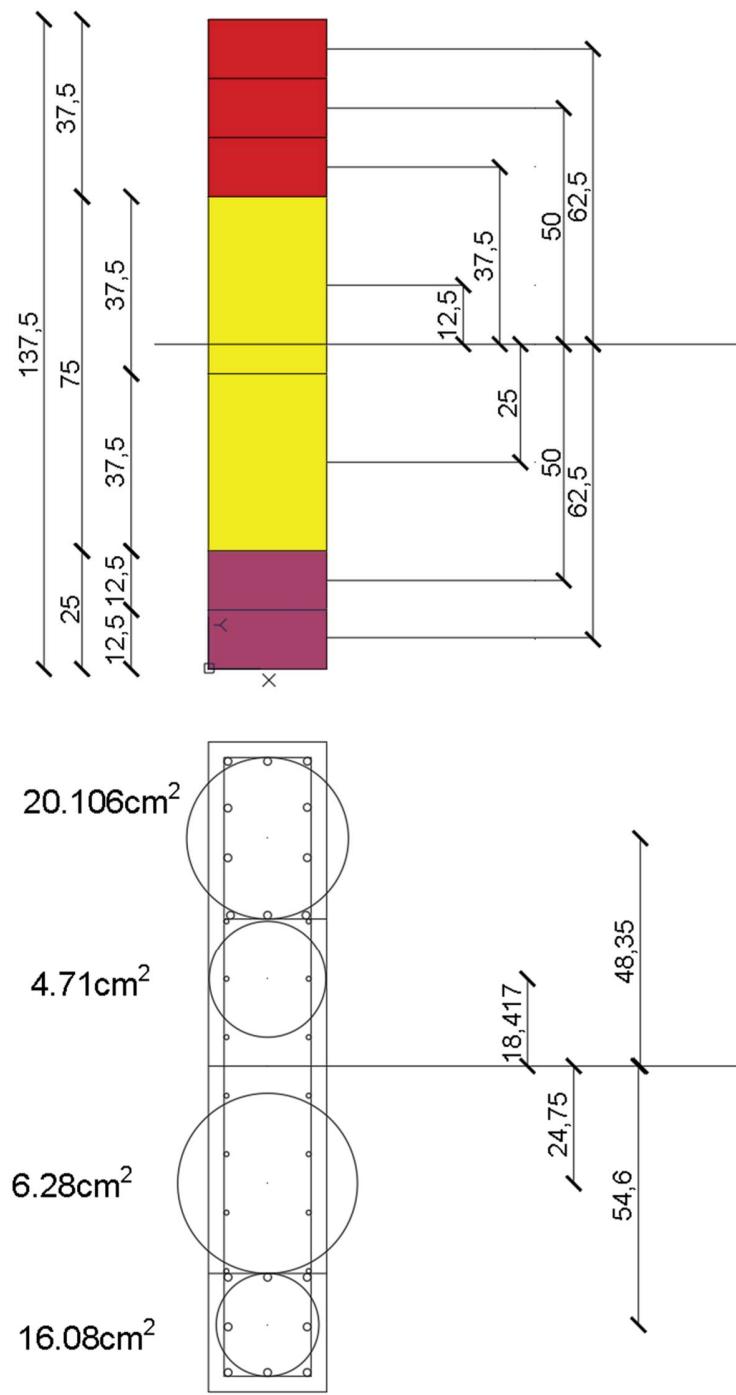
Member	d(mm)	b(mm)	Diam.(mm)	#of bars	S(mm)	Fy(Mpa)	Fc(Mpa)	Vreinforcement (kN)	Vconcrete(kN)	Vtotal(kN)
C1_2-2	450	250	8	2	100	220	20	99.5	117	216.5
C1_3-3	200	450	8	4	100	220	20	88.5	93.6	182.1
C2_2-2	450	250	8	2	100	220	20	99.5	117	216.5
C2_3-3	200	450	8	4	100	220	20	88.5	93.6	182.1
Beam	450	250	8	2	100	220	20	99.5	117	216.5
Shear Wall Long_Axis	3650	250	8	2	100	220	20	807.3	949	1756.3
Shear Wall Short_Axis	1400	250	8	2	100	220	20	619.3	728	1347.3

3 Mathematical Model of Structure

Idealization of Shear Wall

Because of its shape, shear wall has been modelled with two part. Some losses occurred intersection part but not important for accuracy of model.





Perform-3d Model Information

Materials **Strength Sects** **Compound**
Inelastic **Elastic** **Cross Sects.**

Type: Column, Reinforced Concrete Section

Name: C11

Length Unit: m Force Unit: kN

Status: Saved.

Check Save Save As Delete

Symmetry: Yes No

Stiffness, Dimensions **Inelastic Strength** **Elastic Strength**

Shape and Dimensions

Section Shape: Rectangle

B: 0.25 D: 0.5

To calculate the section properties for the above dimensions, press this button.
If you wish, you can edit the properties after they have been calculated.

Calculate

Axis 2 Axis 3 B

Section Properties

Axial Area	0.125	Torsional Inertia	0.0018987
Shear Area along Axis 2	0.10417	Bending Inertia about Axis 2	0.000194
Shear Area along Axis 3	0.10417	Bending Inertia about Axis 3	0.0006647

Shear area = 0 means no shear deformation.

Material Stiffness

Young's Modulus: 2.5E+07 Poisson's Ratio: 0.2 Shear Modulus: 1.0417E+07

All beams and columns are modelled with its effective section property

COMPONENT PROPERTIES

Materials **Strength Sects** **Compound**
Inelastic **Elastic** **Cross Sects.**

Type: Column, Reinforced Concrete Section

Name: C11

Length Unit: m Force Unit: kN

Status: Saved.

Check Save Save As Delete

Symmetry: Yes No

Inelastic Strength

You can use these strengths for inelastic components such as hinges.

Axial/Bending **Shear** **Torsion**

Strength at U Point: Yes No

Axial Forces

Tension (PT)	530.9	Moments at Balance Point (MB)
Compression (PC)	3998	Axis 2 (1-3 plane) 132.1 Axis 3 (1-2 plane) 274.9
Balance point (PB)	1600	At 45 degrees (optional - for checking yield surface) 0

Moments at P = 0 (optional - for checking yield surface)

Axis 2 (1-3 plane)	53.46	Axis 3 (1-2 plane)	115.1
--------------------	-------	--------------------	-------

Shape of P-M2-M3 Yield Surface

P exponent, Alpha, for P-M interaction
 PB to PC vs. M2: 2 PB to PC vs. M3: 2
 PB to PT vs. M2: 1.5 PB to PT vs. M3: 1.5
 Min 1.5, Max 3.0, Suggested = 2.0

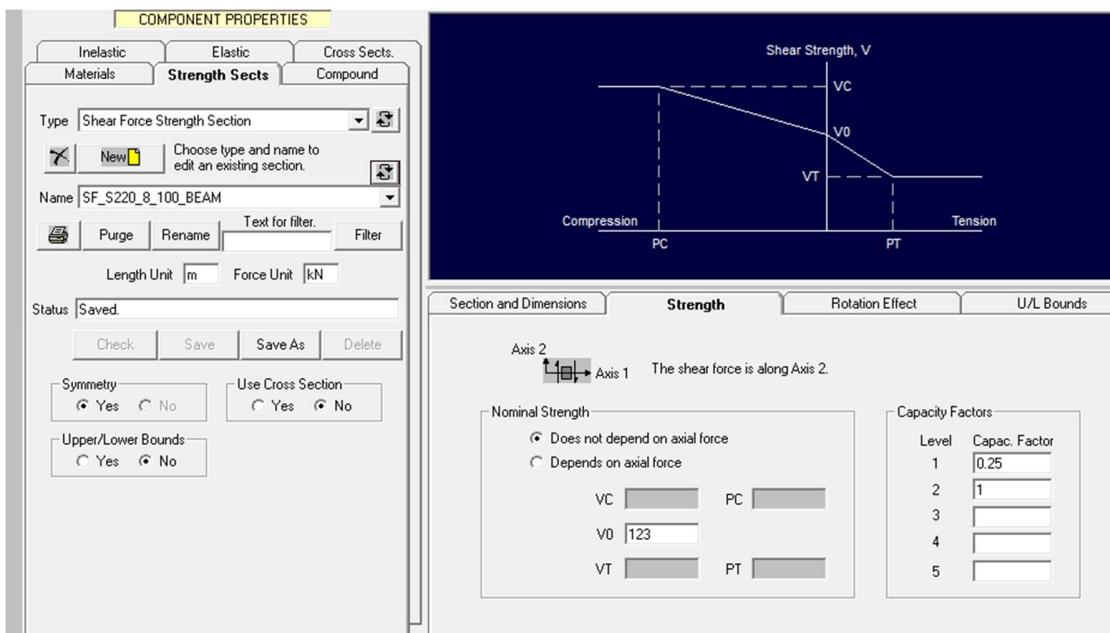
M exponent, Beta, for P-M interaction: 1.1
 Min 1.1, Max 3.0, Suggested = 1.1

M exponent, Gamma, for M-M interaction: 1.4
 Min 1.1, Max 3.0, Suggested = 1.4

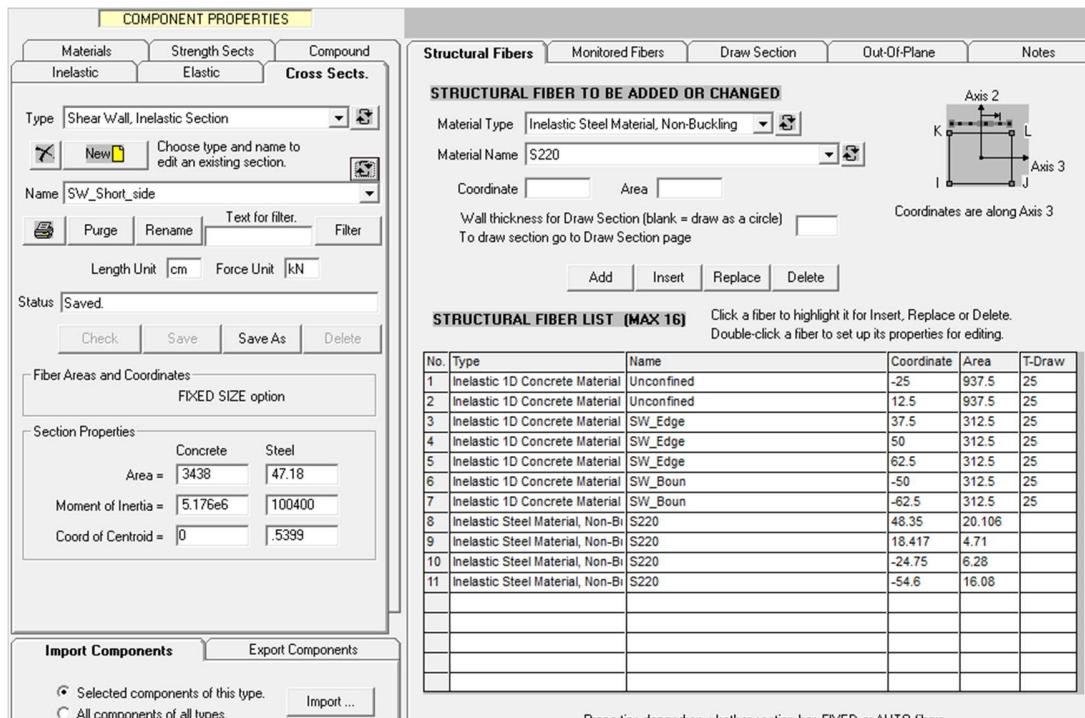
P-M2-M3 M2-M3 Close Plot

Compression Tension

Interaction diagram of columns are modelled with basic properties, controlled and calibrated.



For obtaining damage type, strength sections are assigned to beams and columns. Capacity factor 0.25 is concrete cracking force, 1.00 is total collapse force according to code.



Shear wall are modelled with fiber elements.

COMPONENT PROPERTIES

Materials	Strength Sects	Compound
Inelastic	Elastic	Cross Sects.

Type: Shear Wall, Inelastic Section

New Choose type and name to edit an existing section.

Name: SW_Short_side

Purge Rename Text for filter Filter

Length Unit: cm Force Unit: kN

Status: Saved.

Check Save Save As Delete

Fiber Areas and Coordinates
FIXED SIZE option

Section Properties

Concrete	Steel
Area = 3438	47.18
Moment of Inertia = 5.176e6	100400
Coord of Centroid = 0	.5399

Import Components Export Components

Selected components of this type. All components of all types. Import ...

OUT-OF-PLANE BENDING (ASSUMED TO BE ELASTIC)

Bending Thickness: 25 Young's Modulus: 625

Torsion Thickness: 25 Poisson Ratio: 0.2

COMPONENT PROPERTIES

Inelastic	Elastic	Cross Sects.
Materials	Strength Sects	Compound

Type: Elastic Shear Material for a Wall

New Choose type and name to edit an existing material.

Name: SW_Shear_Mat

Purge Rename Text for filter Filter

Length Unit: mm Force Unit: N

Status: Saved.

Check Save Save As Delete

Symmetry: Yes No Stress Capacities: Yes No

Upper/Lower Bounds: Yes No

Stiffness and Strength

$F = \text{shear stress}, D = \text{shear strain}$

Stiffness, K: Shear Modulus, G: 5000

Shear Stress Capacities

Shear stress: VC, VO, VT, Tens
Axial stress: PC, PC, VT, PT

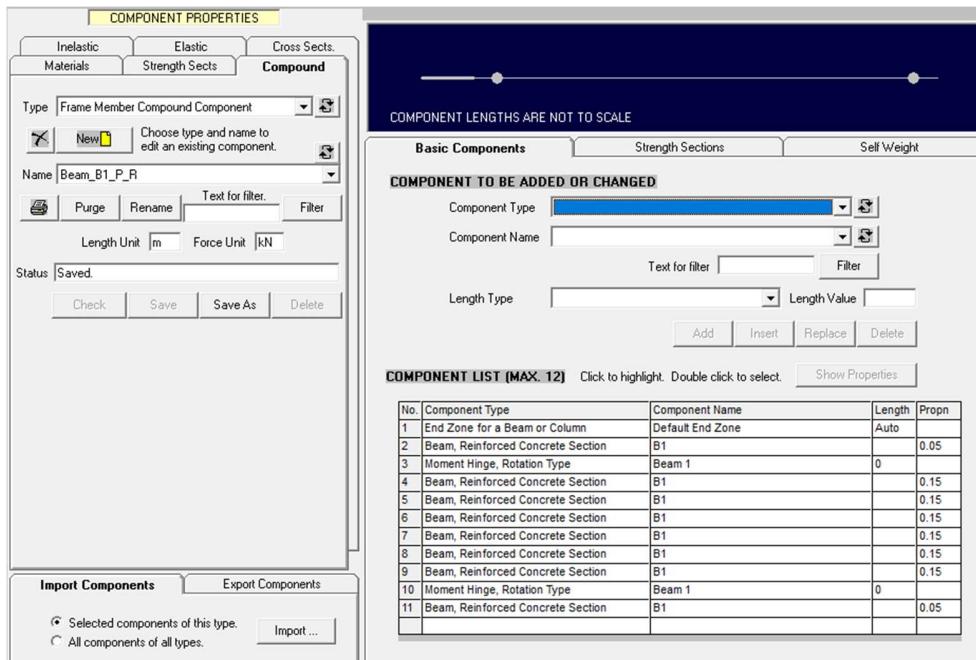
Capacity Factors

Level	Factor
1	[Bar]
2	[Bar]
3	[Bar]
4	[Bar]
5	[Bar]

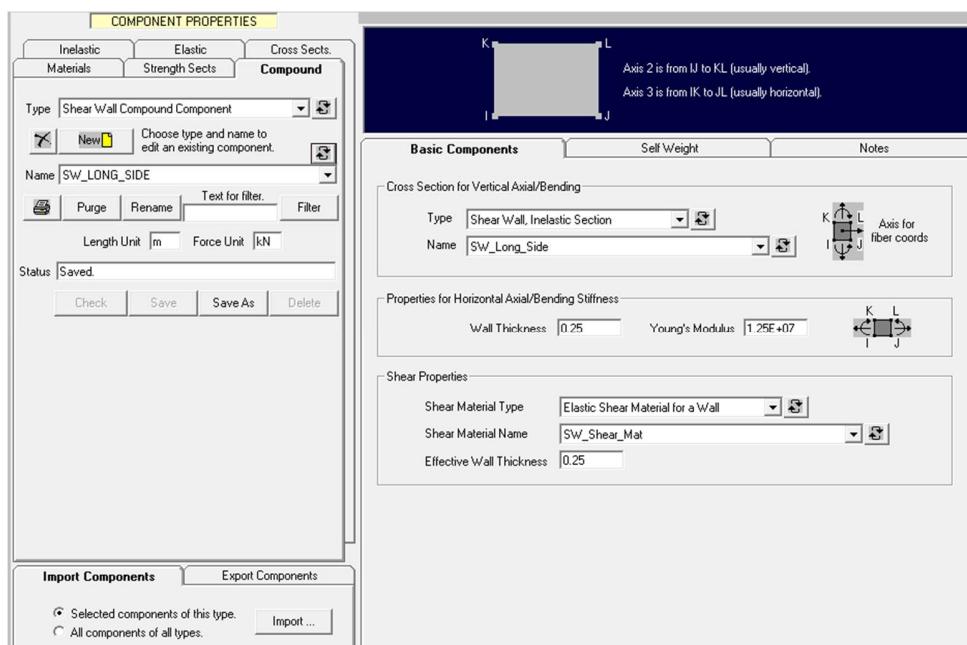
Import Components Export Components

Selected components of this type. All components of all types. Import ...

Shear wall effective stiffness behavior is given by modulus reduction.



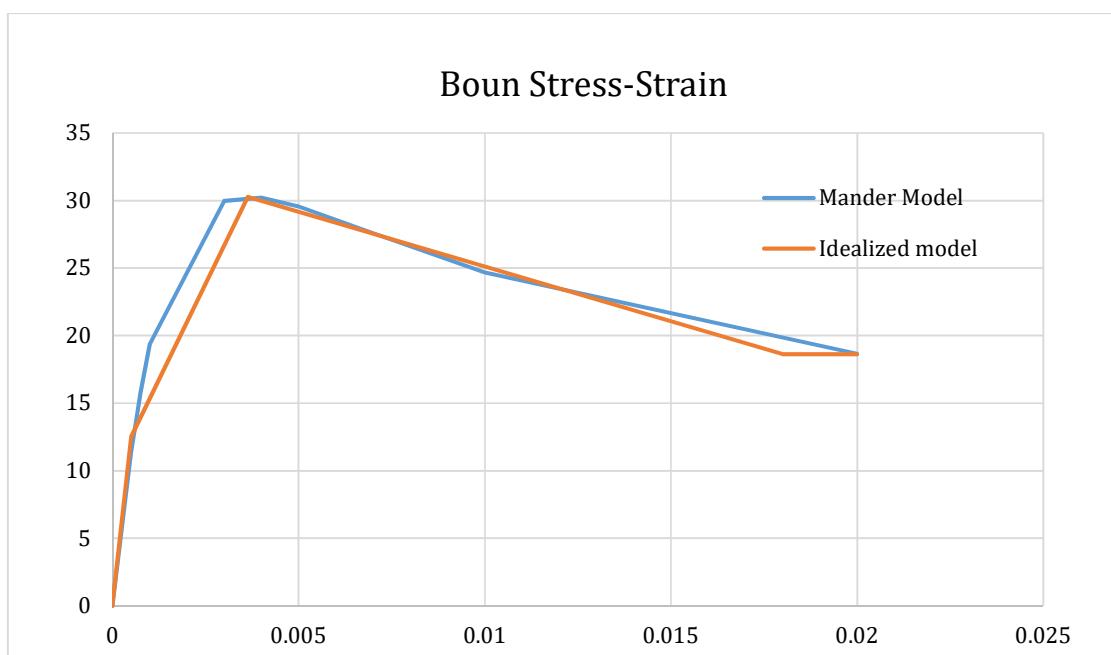
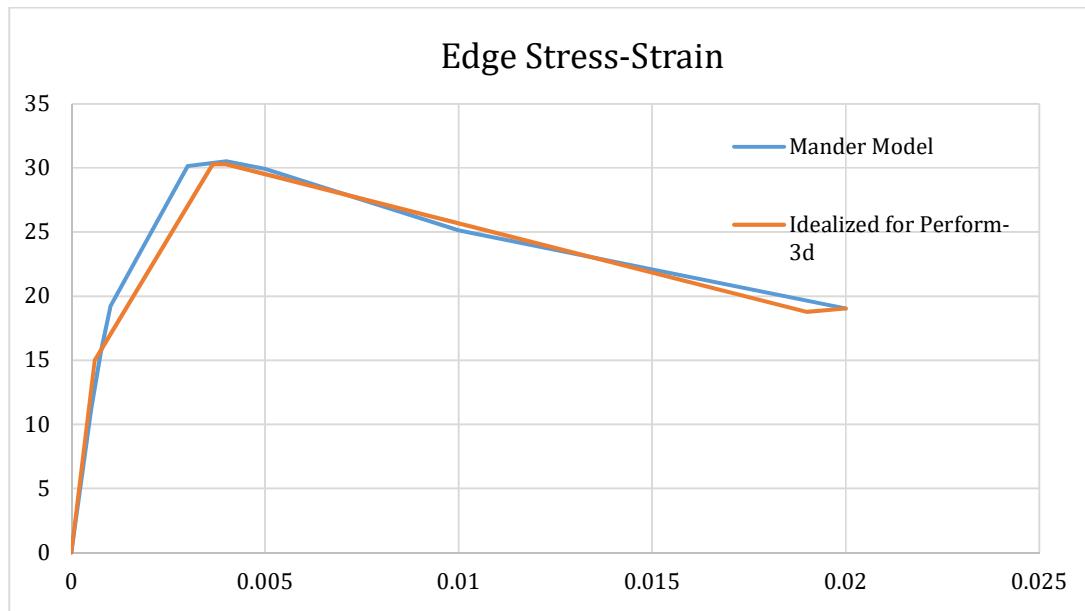
Beam and column compounds.



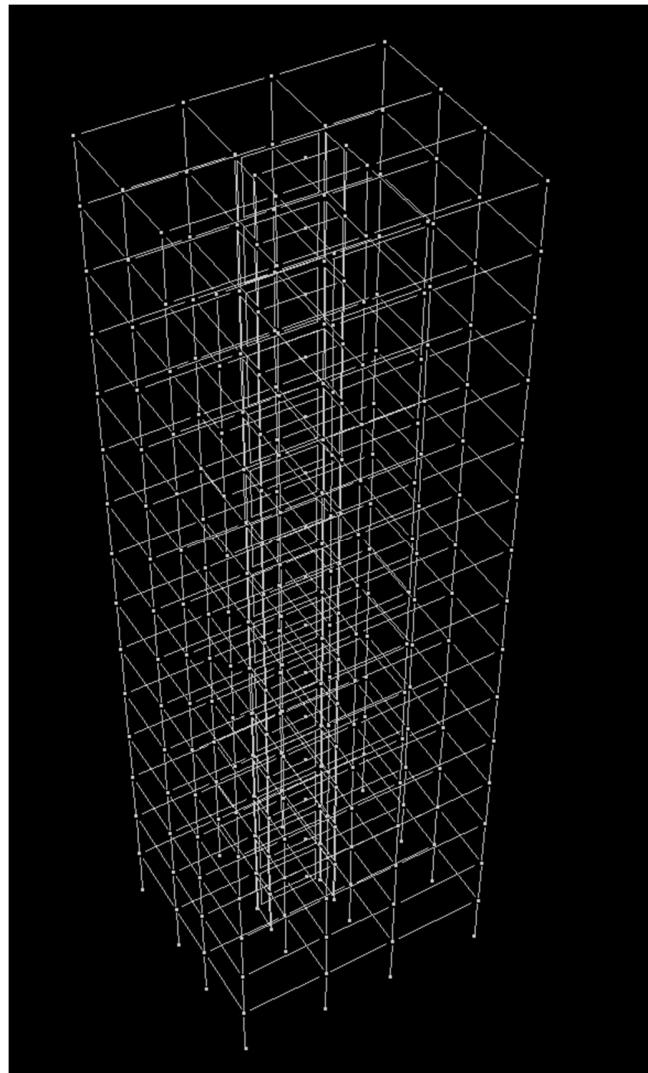
Shear wall compound.

Material Models

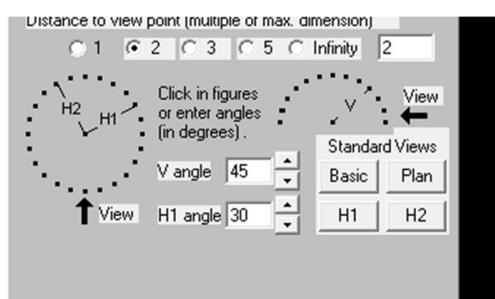
Limitations of perform-3d, allows trilinear model of materials usually. For this reason, Mander confined model were idealized truly.



Building structural model;



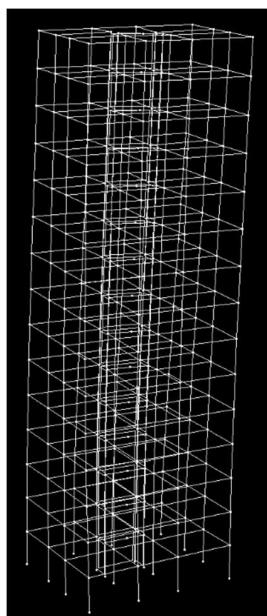
Directions;



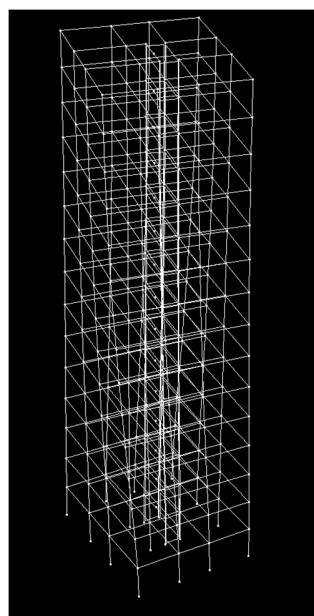
4 Dynamic Properties, Model Verification of Structure and Earthquake Records

Mod Shapes and Period Information

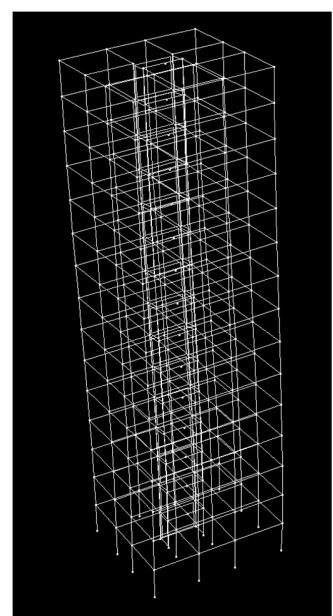
First three mod shape of structure is given below.



First Mode



Second Mode



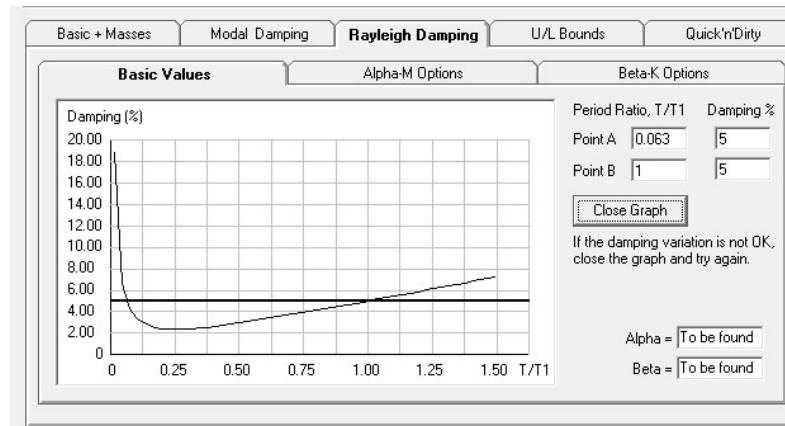
Third Mode

First three mode of structure were compared with SAP200 for model verification. The results is common with perform. Perform-3d model is accepted.

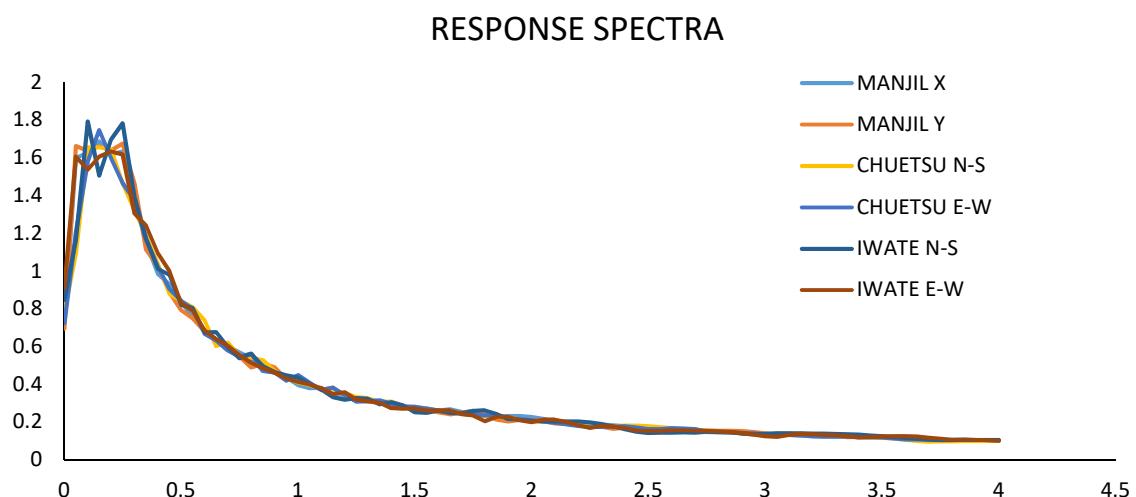
Mode	SAP2000	Perform-3d
1.	3.705	3.798
2.	3.52	3.485
3.	2.034	2.129

Damping Properties

Rayleigh damping model is used for conducting analyses.



Response Spectra of the Records



LOAD CASES

Load Case Type: Dynamic Earthquake | Status: Saved.

New | Select name to edit an existing load case. Load Case Name: CHUETSU_1 | Save | Save As | Delete | UnChange | Add/Review/Delete Earthquakes

Control Information for Dynamic Analysis

- Total Time (sec): 80 | Time Step (sec): 0.01 | Limit State to Stop Analysis. Type: Drift
- Max Events in any Step (analysis stops if exceeded): 2000 | Name: DR_1
- Save results every 1 time steps (default = every step) | Reference Drift: Roof_Drift_H1
- This affects time history plots. Usage ratios are still calculated every step. This is used only for "thumbnail" plots of the response.

Earthquake Direction in Plan

Angle from structure H1 axis to earthquake Q1 axis (degrees): 0 | Q2 angle: H2_01

Q1 Earthquake

- Group: M_E_R | Name: X_CHUETSU
- Peak Acceln (g) = -0.7826 | Duration (sec) = 60 | Acceln Scale Factor: 1 | Time Scale Factor: 1

Q2 Earthquake

- Group: M_E_R | Name: Y_CHUETSU
- Peak Acceln (g) = -0.7336 | Duration (sec) = 70 | Acceln Scale Factor: 1 | Time Scale Factor: 1

V Earthquake (usually not applied)

- Group: NONE | Name:
- Peak Acceln (g) = | Duration (sec) = | Acceln Scale Factor: 1.0 | Time Scale Factor: 1.0

LOAD CASES

Load Case Type: Dynamic Earthquake | Status: Saved.

New | Select name to edit an existing load case. Load Case Name: CHUETSU_2 | Save | Save As | Delete | UnChange | Add/Review/Delete Earthquakes

Control Information for Dynamic Analysis

- Total Time (sec): 80 | Time Step (sec): 0.01 | Limit State to Stop Analysis. Type: Drift
- Max Events in any Step (analysis stops if exceeded): 2000 | Name: DR_1
- Save results every 1 time steps (default = every step) | Reference Drift: Roof_Drift_H1
- This affects time history plots. Usage ratios are still calculated every step. This is used only for "thumbnail" plots of the response.

Earthquake Direction in Plan

Angle from structure H1 axis to earthquake Q1 axis (degrees): 0 | Q2 angle: H2_01

Q1 Earthquake

- Group: M_E_R | Name: Y_CHUETSU
- Peak Acceln (g) = -0.7336 | Duration (sec) = 70 | Acceln Scale Factor: 1 | Time Scale Factor: 1

Q2 Earthquake

- Group: M_E_R | Name: X_CHUETSU
- Peak Acceln (g) = -0.7826 | Duration (sec) = 60 | Acceln Scale Factor: 1 | Time Scale Factor: 1

V Earthquake (usually not applied)

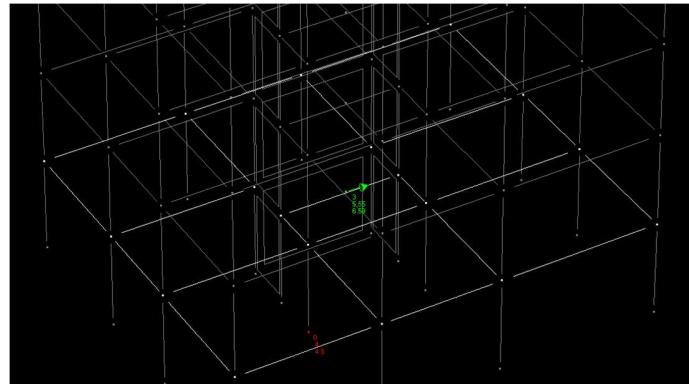
- Group: NONE | Name:
- Peak Acceln (g) = | Duration (sec) = | Acceln Scale Factor: 1.0 | Time Scale Factor: 1.0

As one see, record directions are changed.

5 Control of Relative Story Drift Ratios

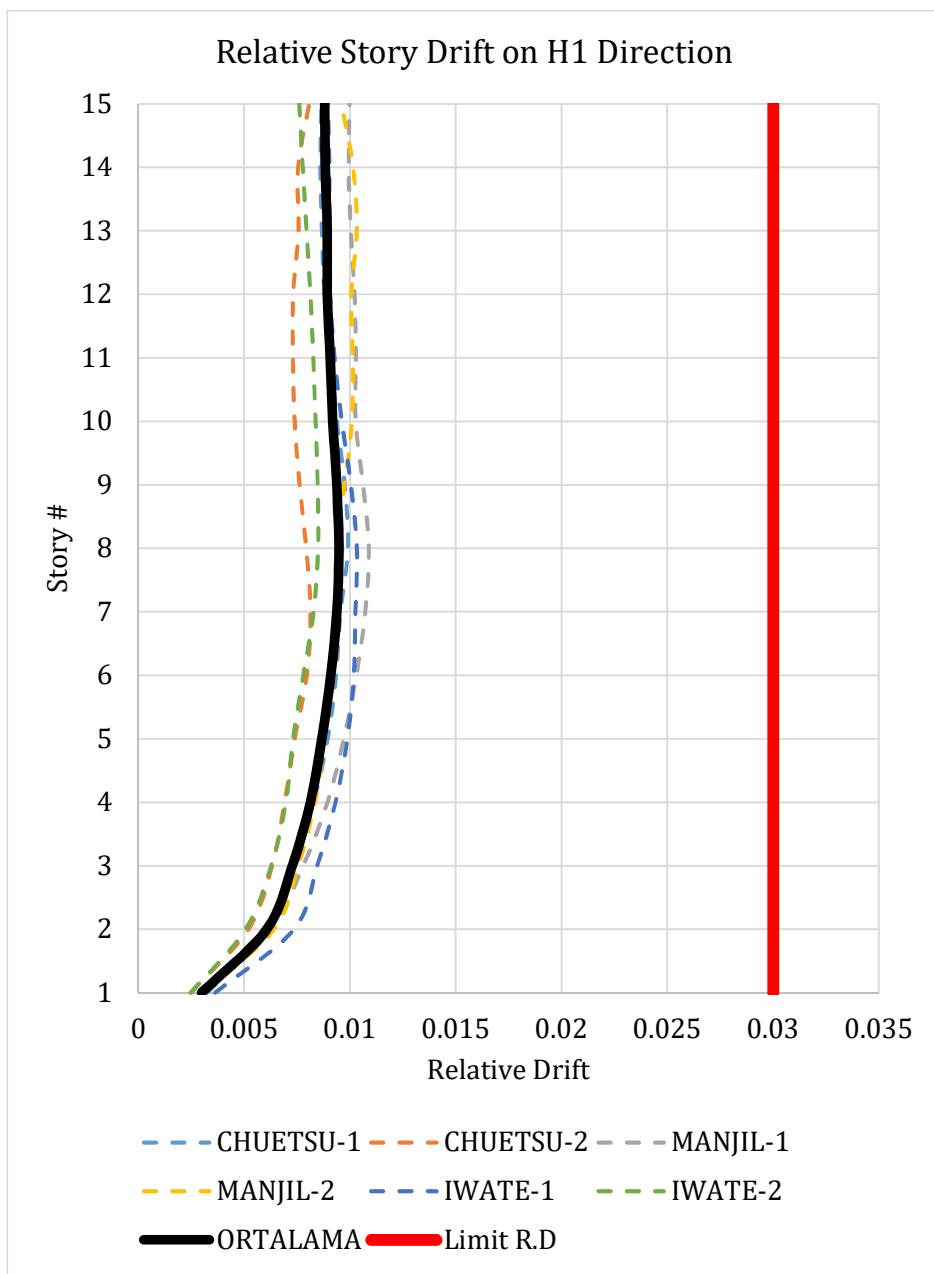
Control Nodes

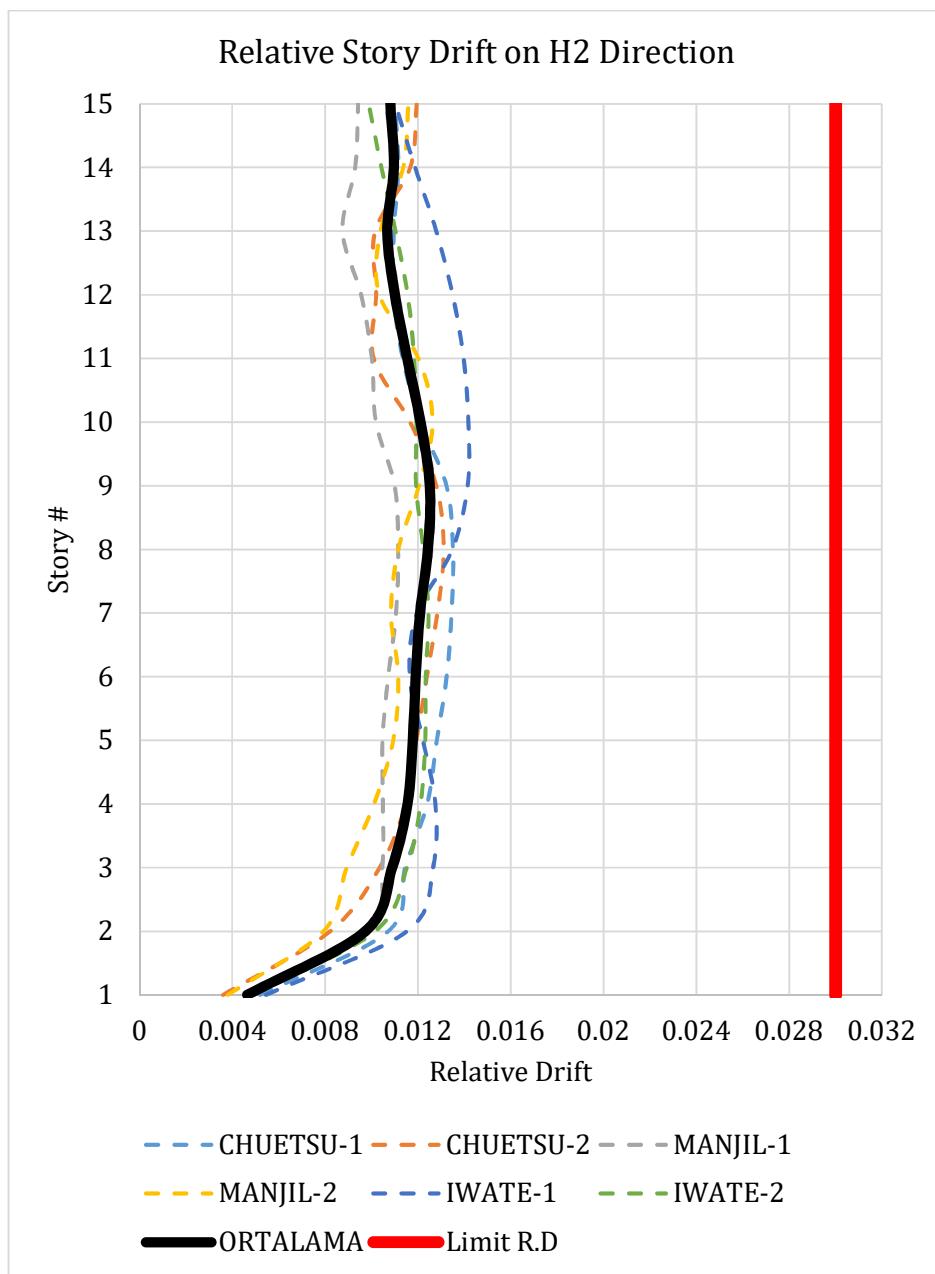
Center of gravity of story were determined as a control node for 15 stories.



Limit Story Drift Ratio

Limit story drift ratio is taken from TBSC. Limit R.S.D is taken as 0.03 for average of each records. 0.045 for one record.

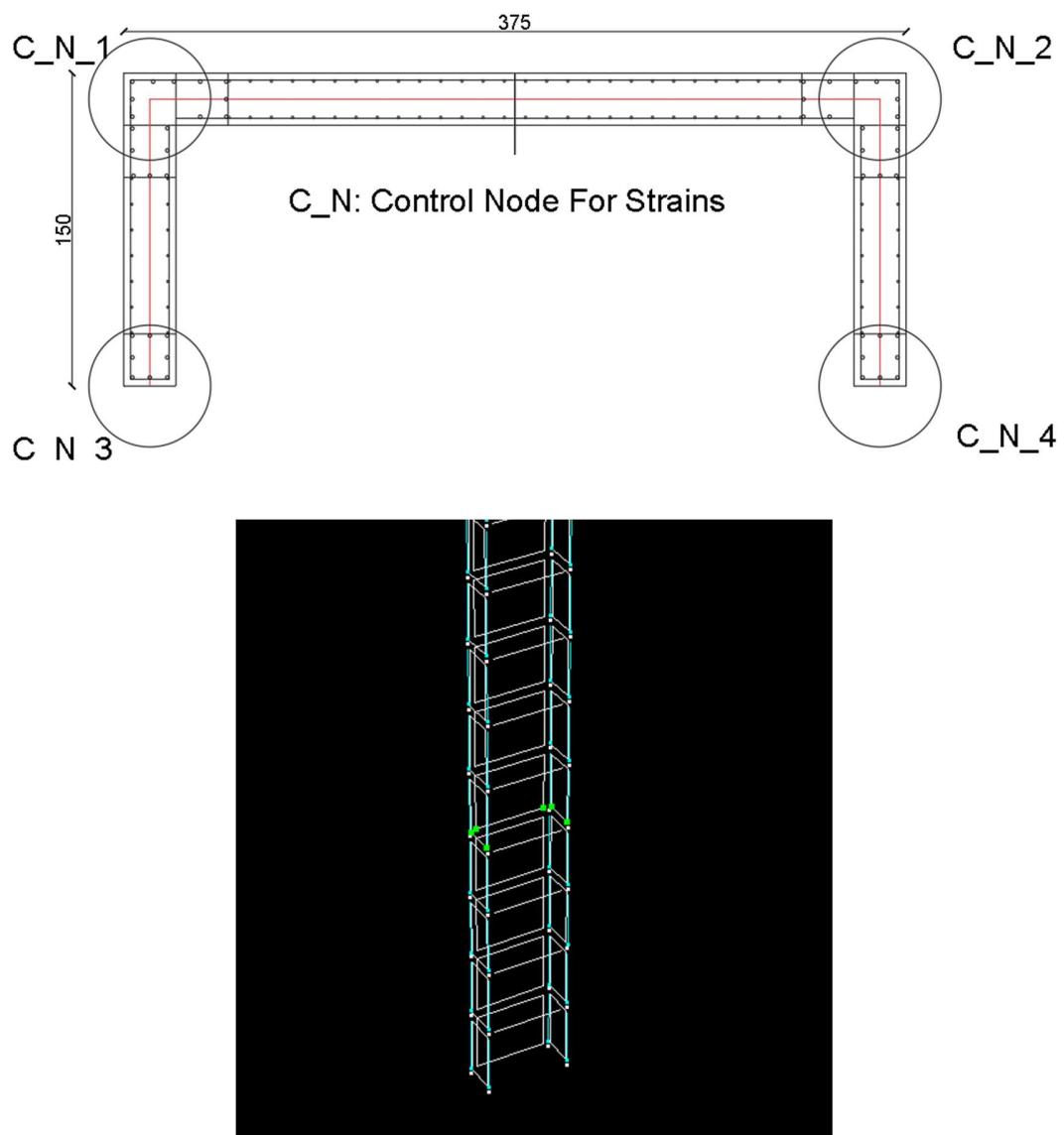




6 Strains and Shear Strength Control of Shear Wall

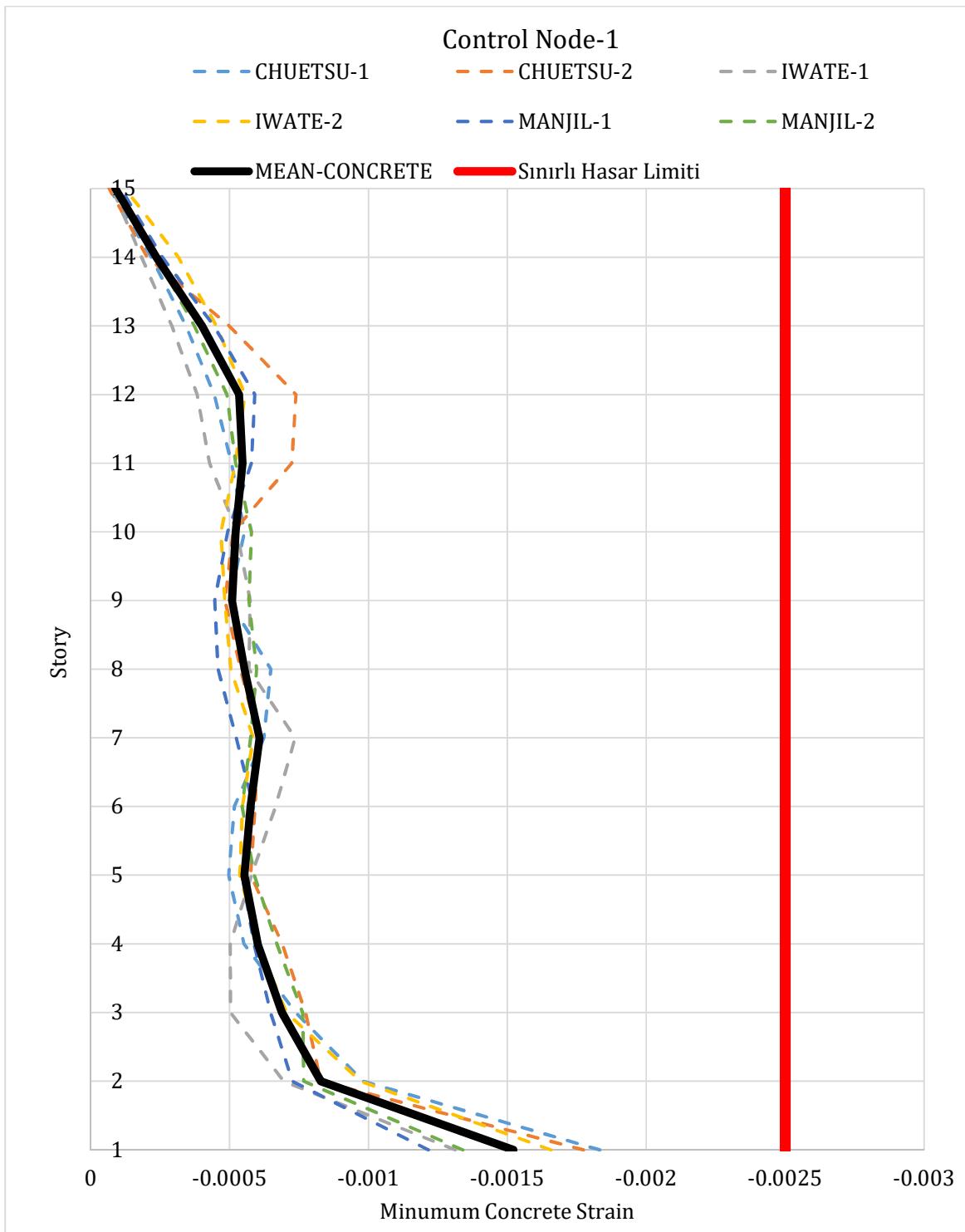
Control Nodes

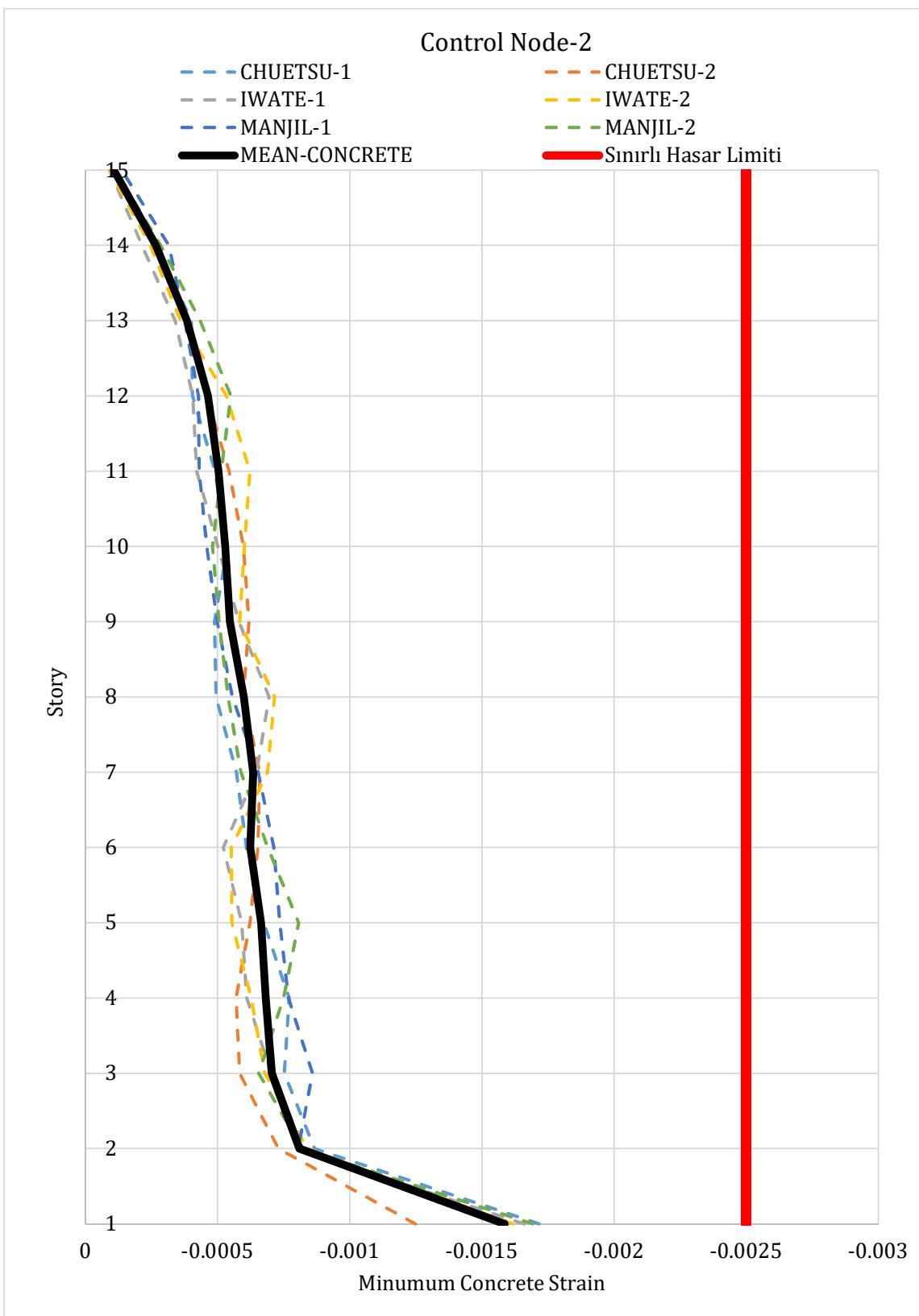
For calculating envelope strains, control nodes were chosen most critical points. Strain gage elements were assigned for measure the strain.

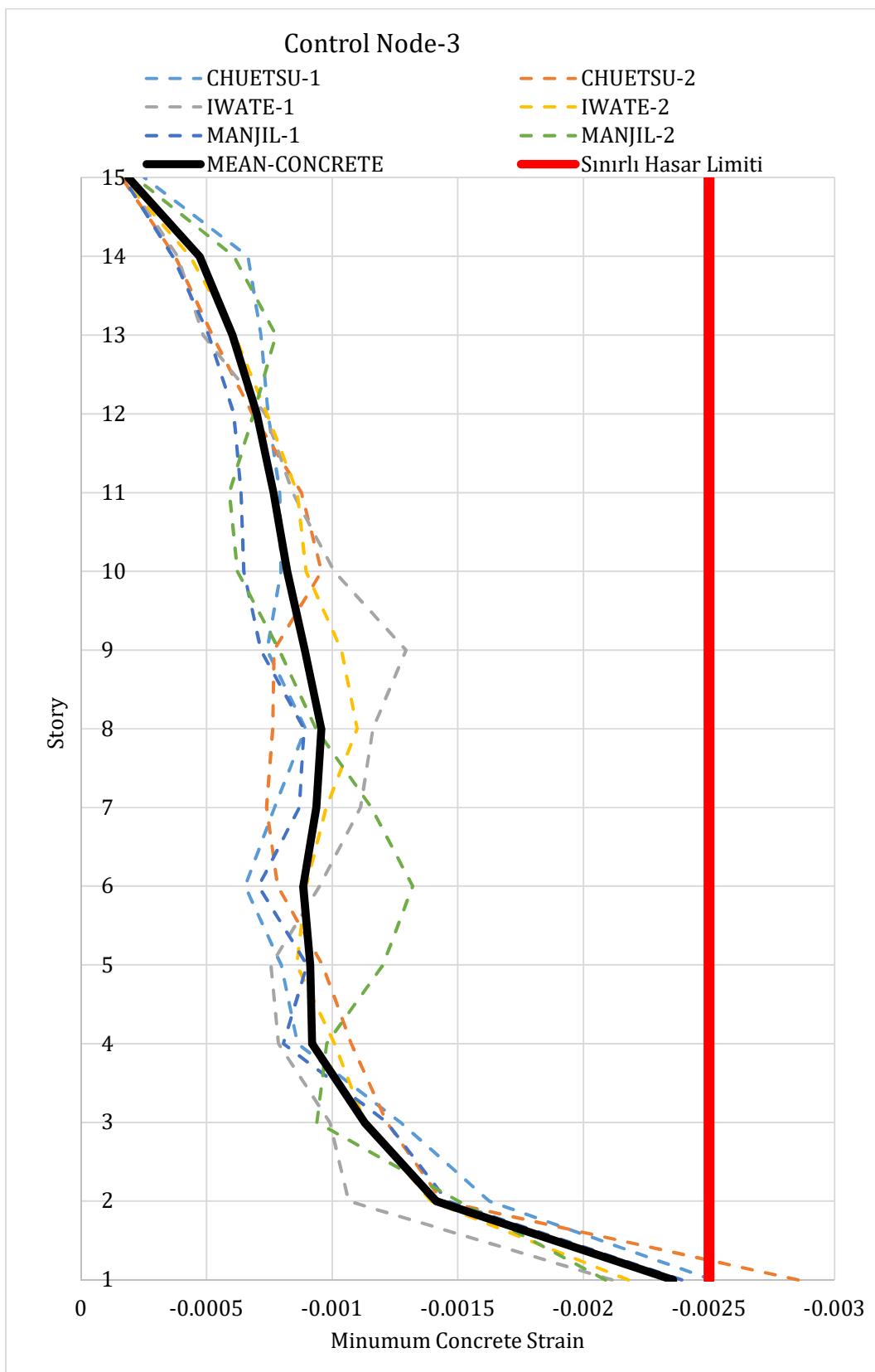


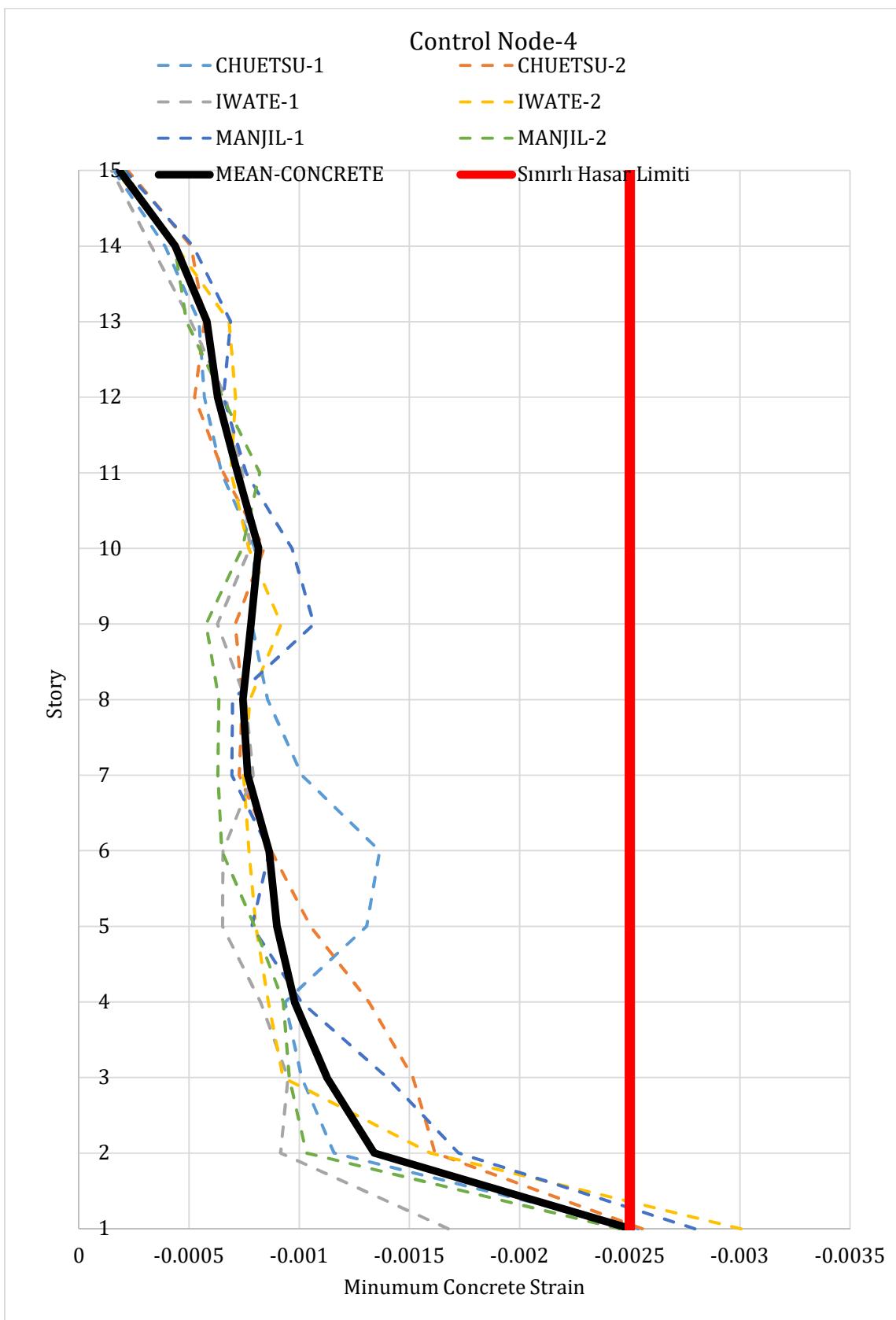
Structure section elements were assigned to the shear wall for determining the shear forces.

Minimum Concrete Strains of Control Nodes

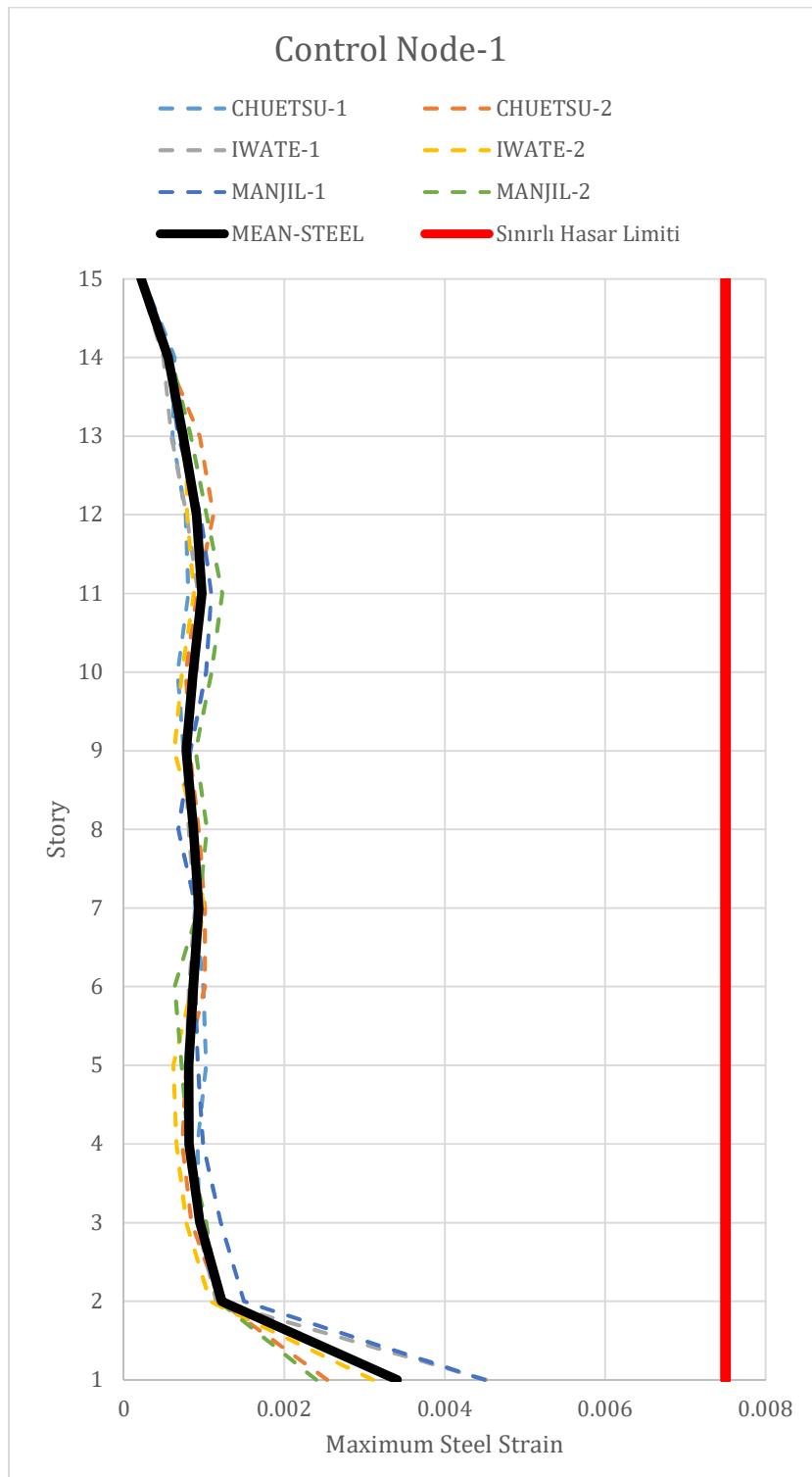




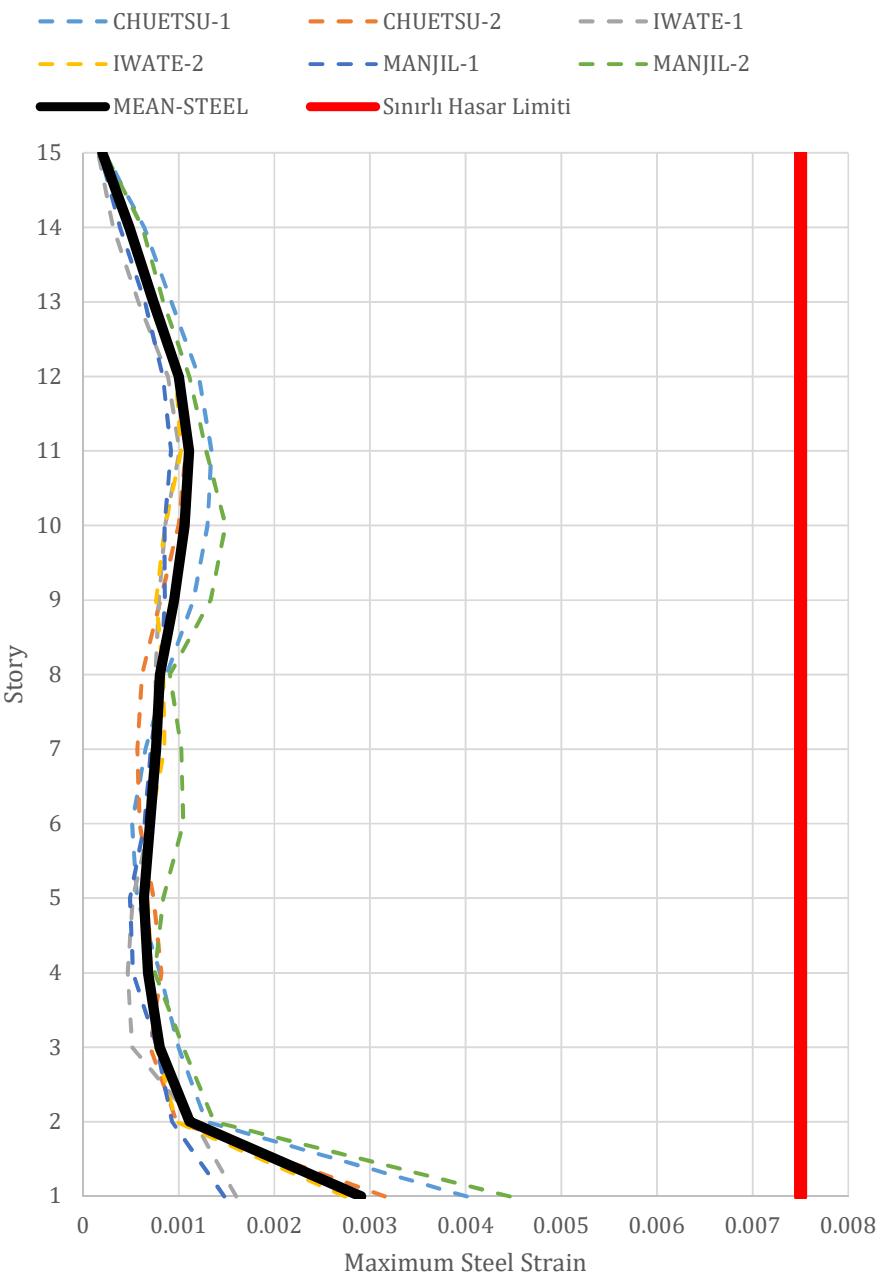


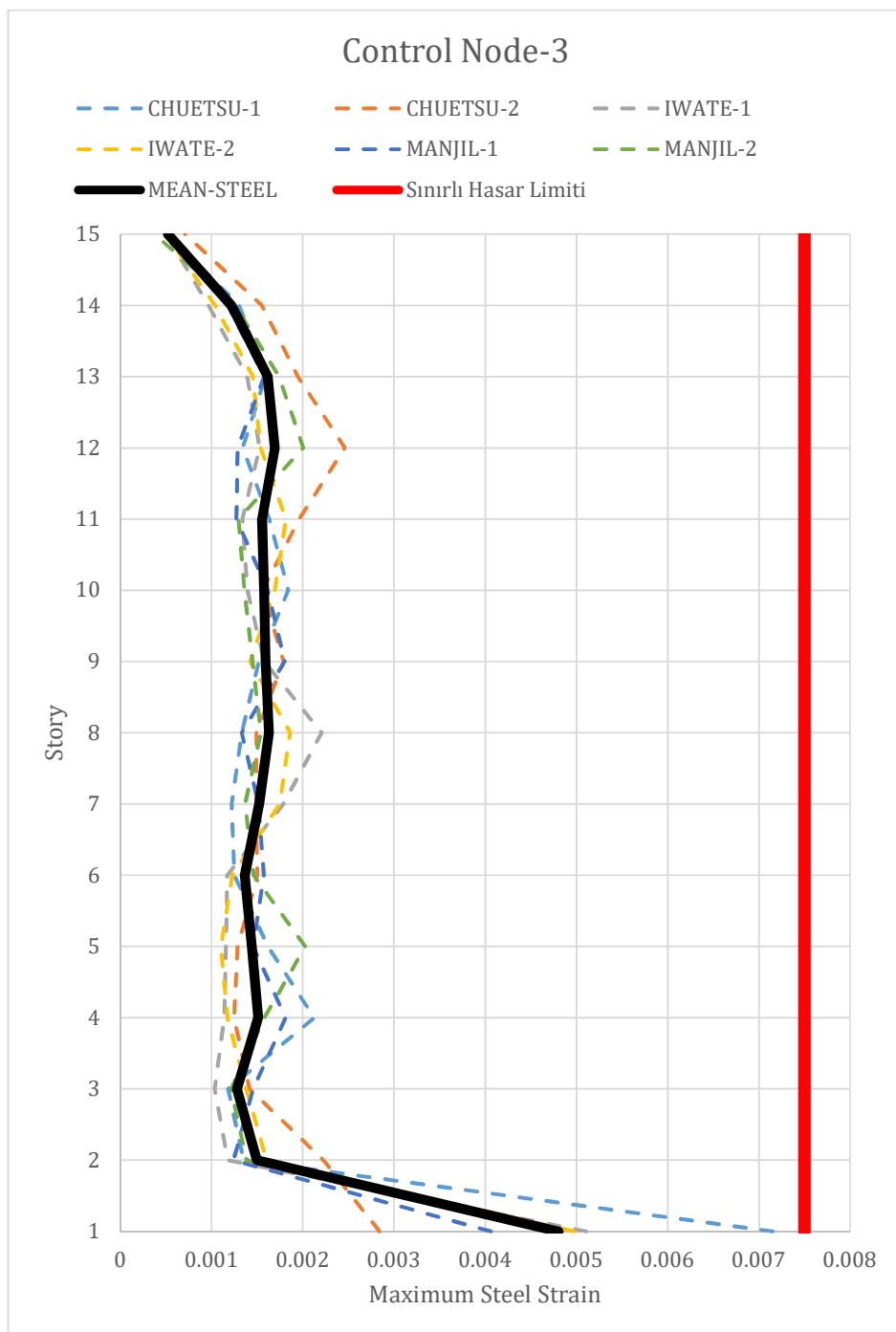


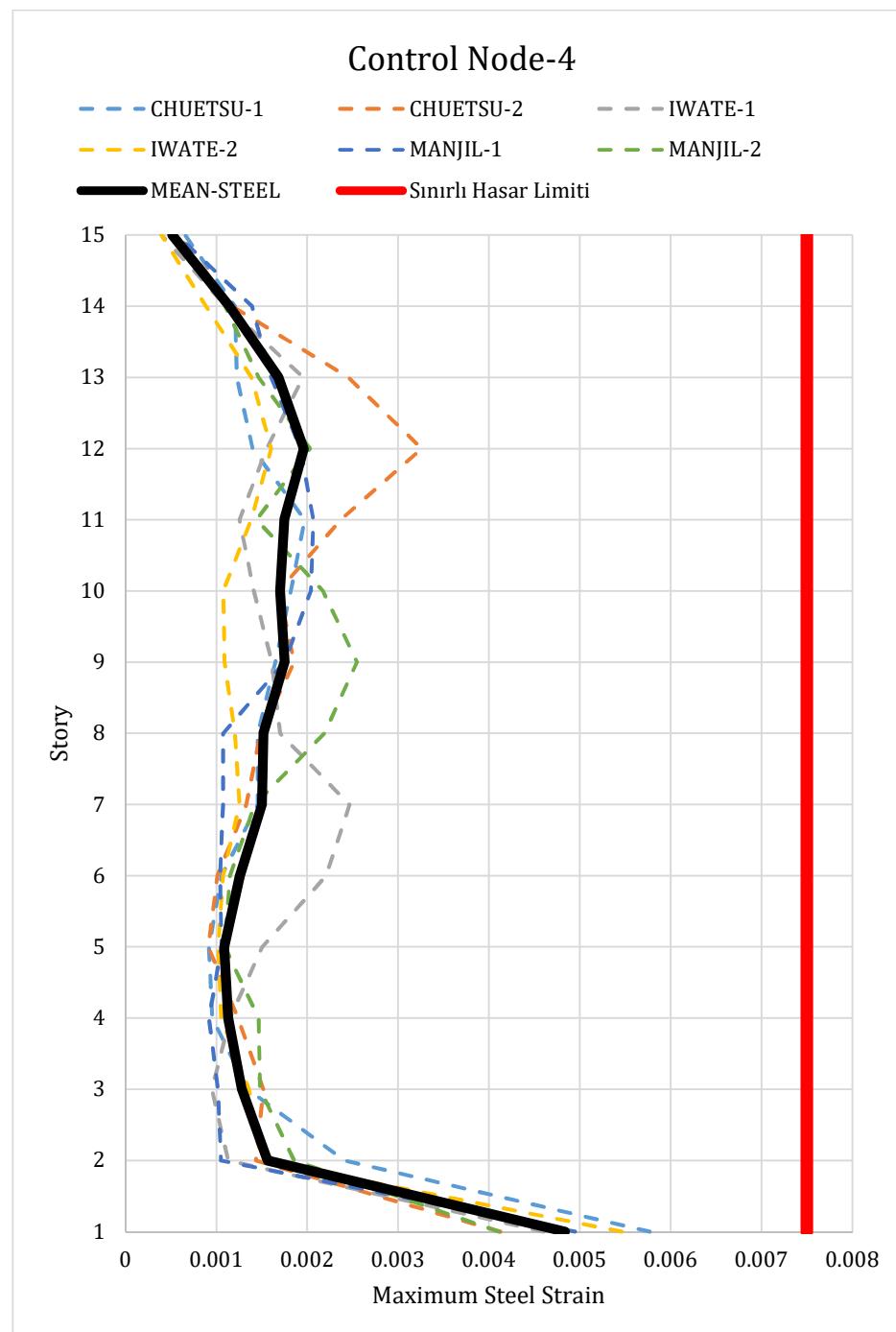
Maximum Steel Strain



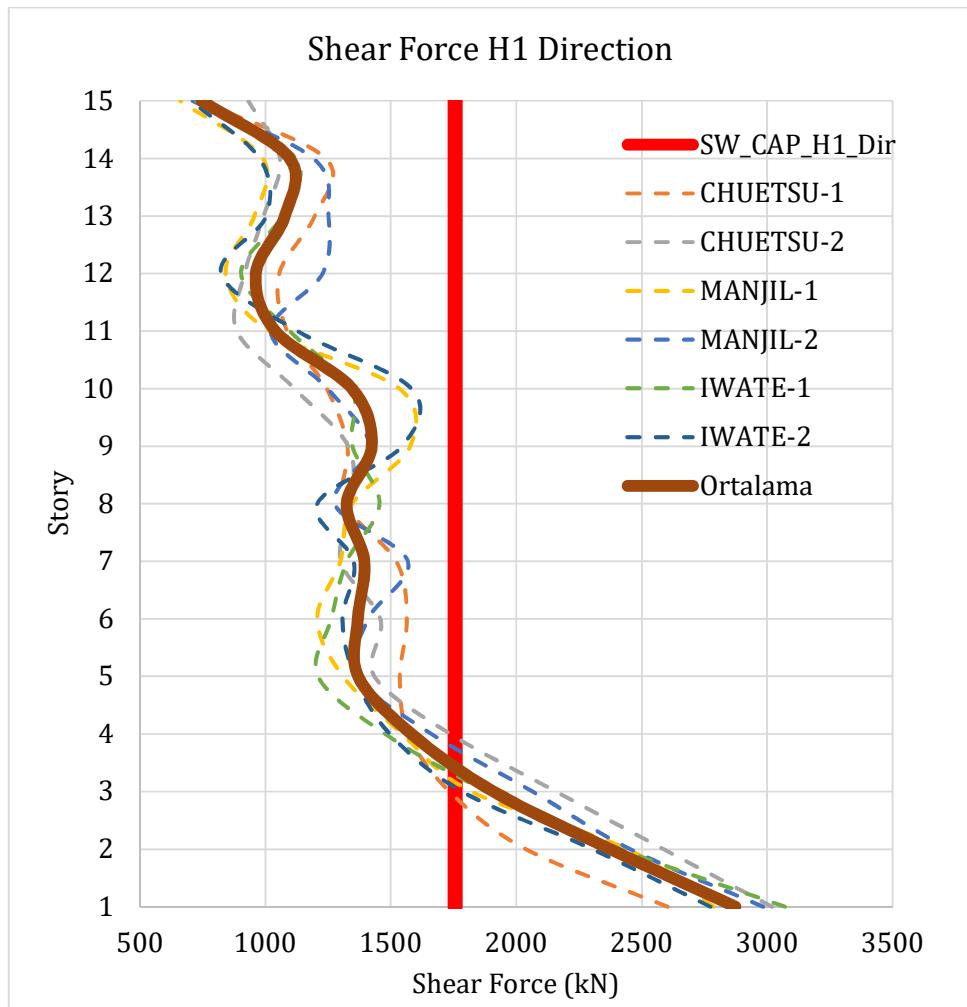
Control Node-2

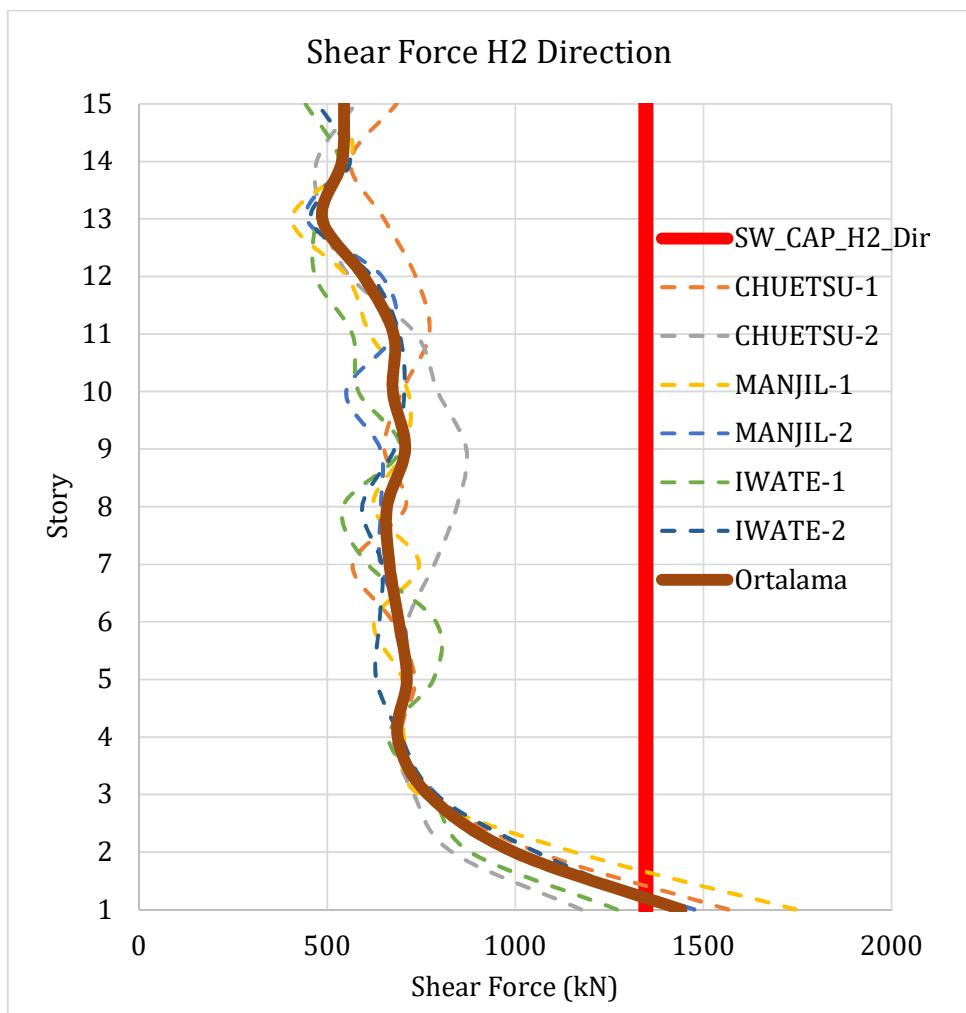






Shear Strength Control of Shear Wall





7 Damage Characterization

Structural Components Expected to be Damaged

Damage characteristic of structure will evaluate with two components, shear wall and frame system. Performance level will be determined by forces such as shear and flexural. Also relative story drift ratio will be controlled.

Shear Wall

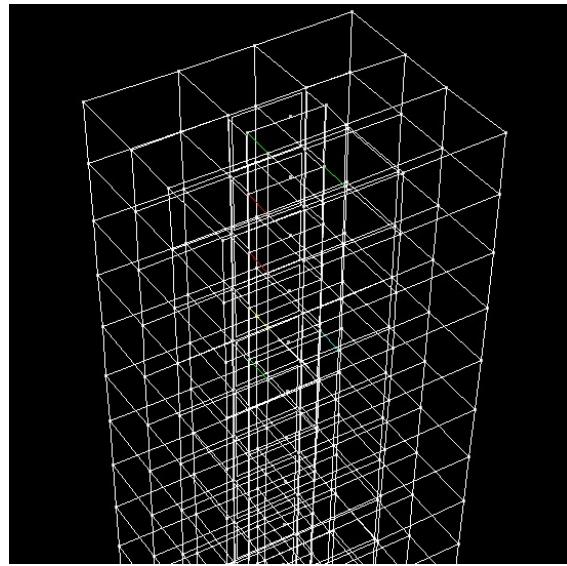
As we see, Shear wall can take damage due to forces shear and flexural.

Average minimum concrete strains are lower than the sınırlı hasar capacity

Average maximum steel strains are lower than the sınırlı hasar capacity

Average shear forces are higher than the shear capacity.

Frame System



Flexural damages of the frame system are not pass sınırlı hasar limit state for 6 NTHA.

Results of analyses are shown that shear damage will not occur.

Story Drift Ratio

Relative story drift ratios are lower than the code criteria.

8 Executive Report

Structural Reliability

The BURAK' building is not safe for seismic performance because of shear failure. Retrofitting is required for preventing shear collapses.

	Shear Damage	Flexural Damage
Frame System	No Damage	Sınırlı Hasar
Shear Wall	Collapse	Sınırlı Hasar

Recommendations

FRP material can be used for retrofitting process.