

Advanced Application 2

Seismic Design for Reinforced Concrete Building

Seismic Design for Reinforced Concrete Building

Overview

This example problem is meant to demonstrate the design of a Reinforced Concrete building structure subjected to floor loads, wind loads and seismic loads.

Description

Seismic Design Data

- Dual system (special reinforced concrete structural walls with special moment frame) in the transverse direction
- Special moment frame in the longitudinal direction
- Assigned to a high seismic zone

Methodology

- Response spectrum analysis
- P-Delta analysis

Model

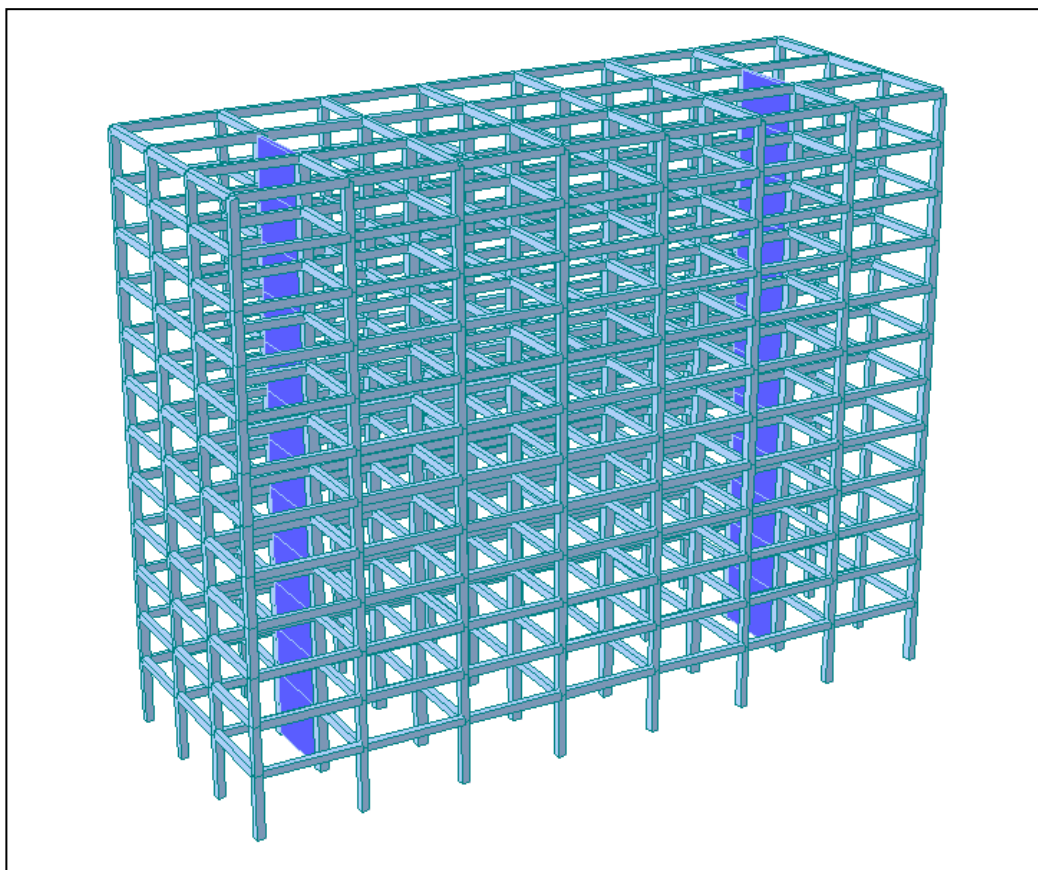


Figure 1 : Reinforced Concrete Building Model

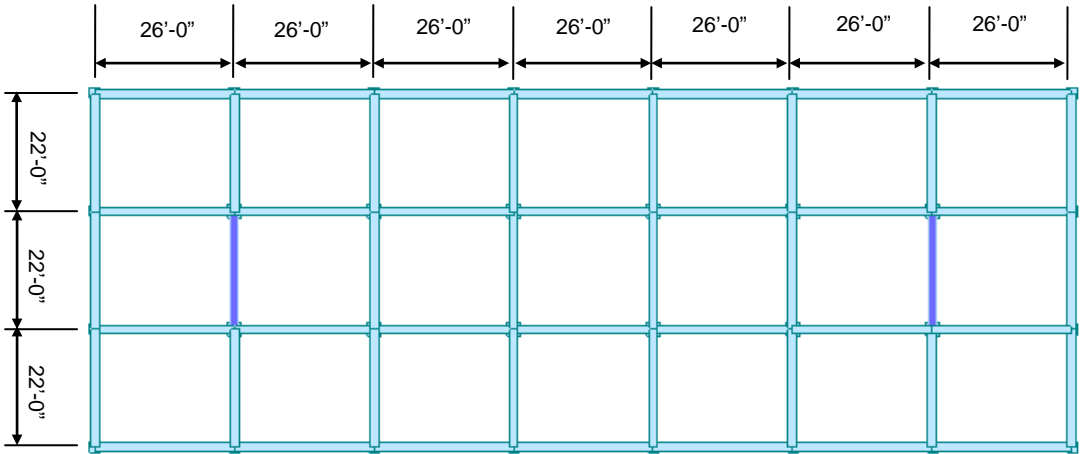


Figure 2 : Typical Floor Plan

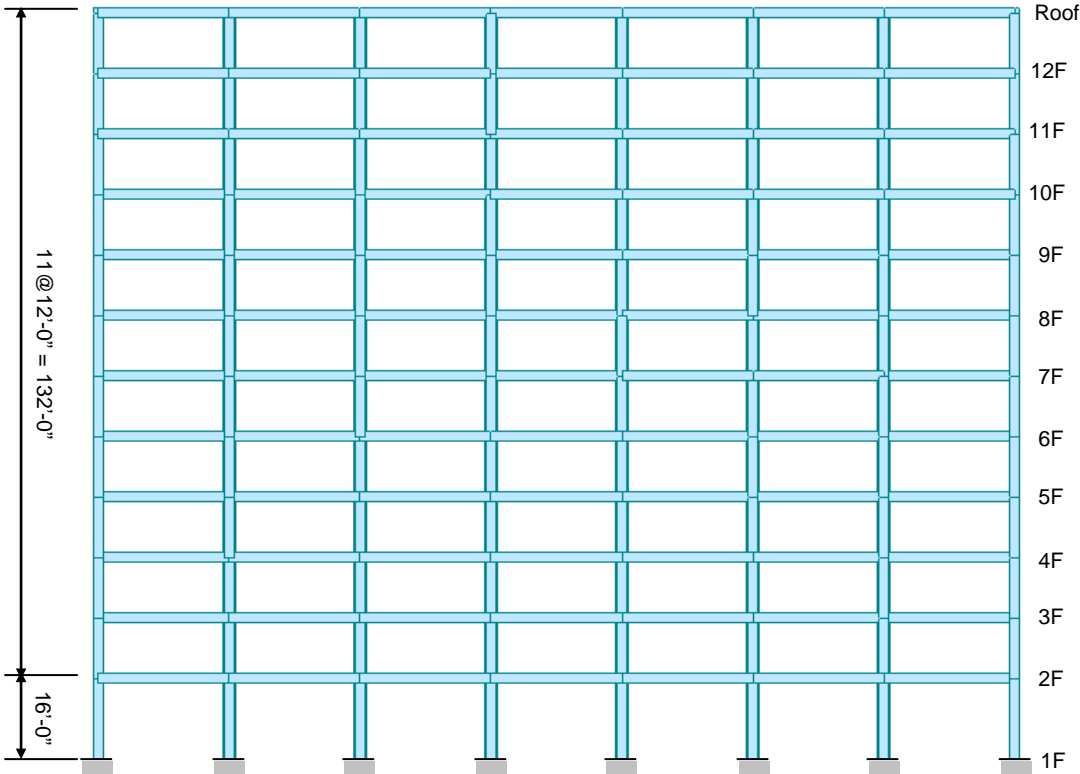


Figure 3 : Longitudinal Section

Design Procedure

1. Material & Section Properties Input

Material

- Concrete $f_c' = 4,000$ psi
- Reinforcement $f_y = 60,000$ psi

Section

- Edge columns 24×24 in.
- Interior columns 30×30 in.
- Beams 20×24 in.
- Walls 18 in. (In-plane & Out-of-plane)

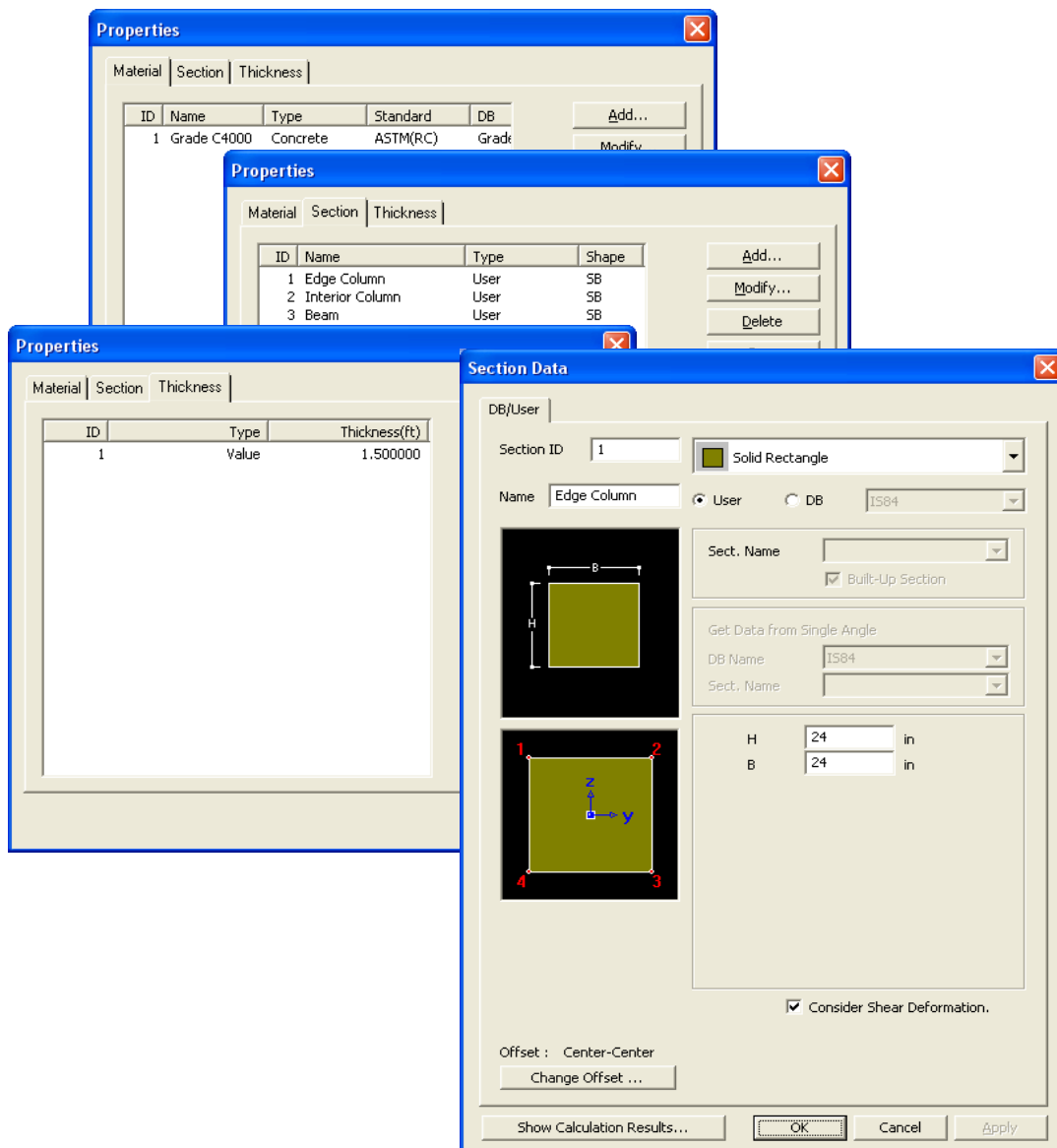



Figure 4 : Material & Section Properties Input

2. Create Model


Units : Length > ft

 Set UCS to X-Y Plane

Origin : 0, 0, 16

Change View Direction > (on)

OK

 Set Line Grid Add

Grid Name = 2F

X-Grid Lines Add

Relative > (on)

'7@26' OK

Y-Grid Lines Add

Relative > (on)

'3@22' OK

Add/Modify Grid Lines OK

Define Grids OK

  Line Grid, Line Grid Snap (toggle on)

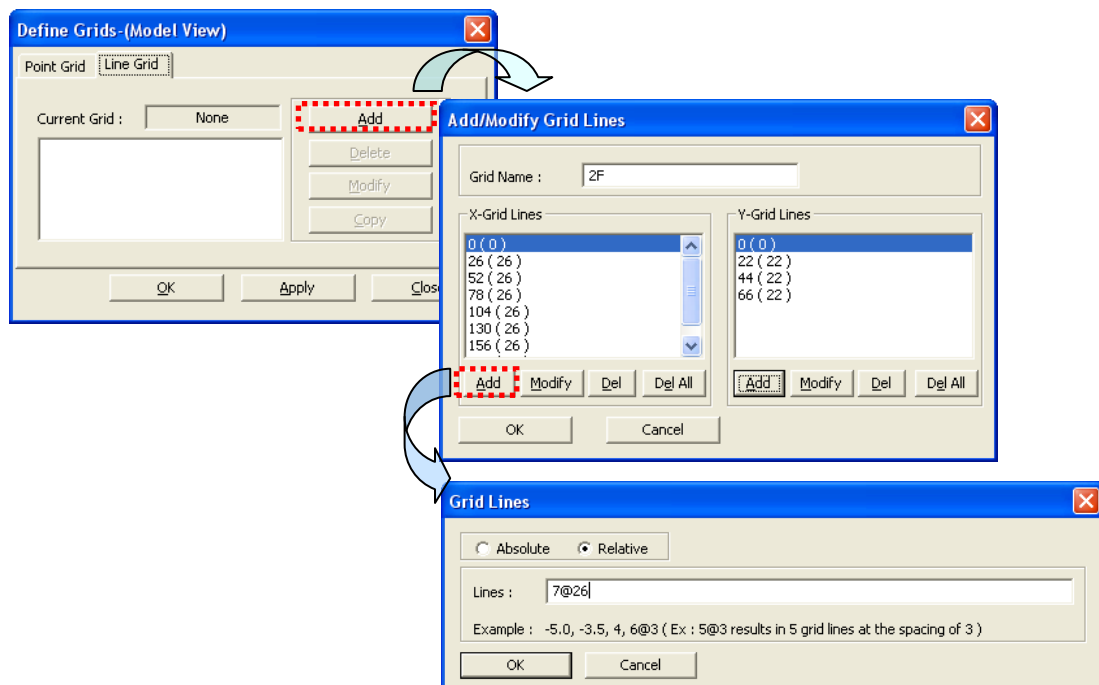


Figure 5 : Create Grid Lines

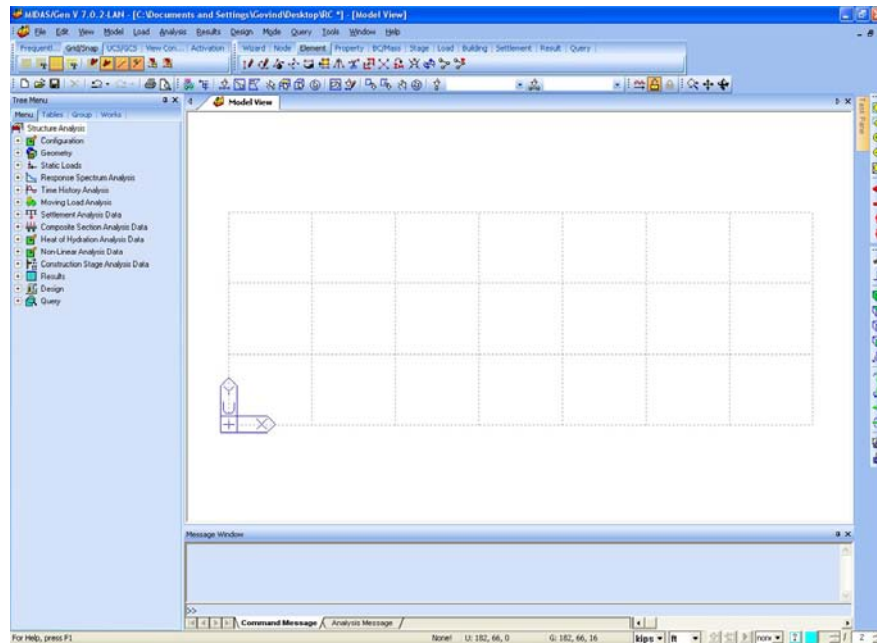


Figure 5 : Grid Lines in X-Y Plane

Generate Floor Plan

Hidden, Node Number, Element Number (toggle on)

Create Elements

Element Type = General Beam / Tapered Beam

Section Name = 3 : Beam

Draw Elements as shown (Refer Figure 6)

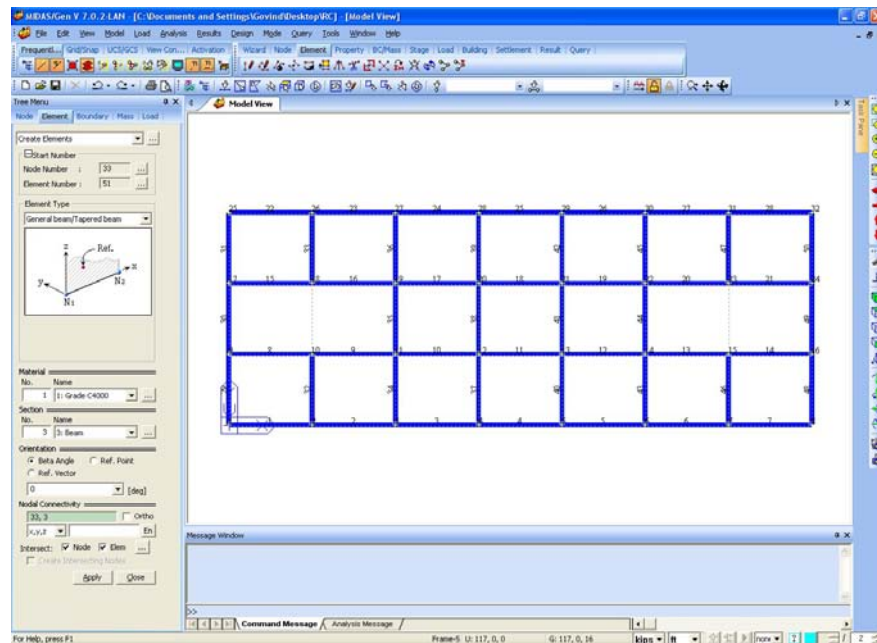





Figure 6 : Floor Plan

Generate Columns

 Change to GCS

 Select All

 Extrude Element

Node → Line Element

Reverse I-J > (on)

Element Type = Beam

Material = 1 : Grade C4000

Section = 1 : Edge column

$d_x, d_y, d_z = 0, 0, -16$



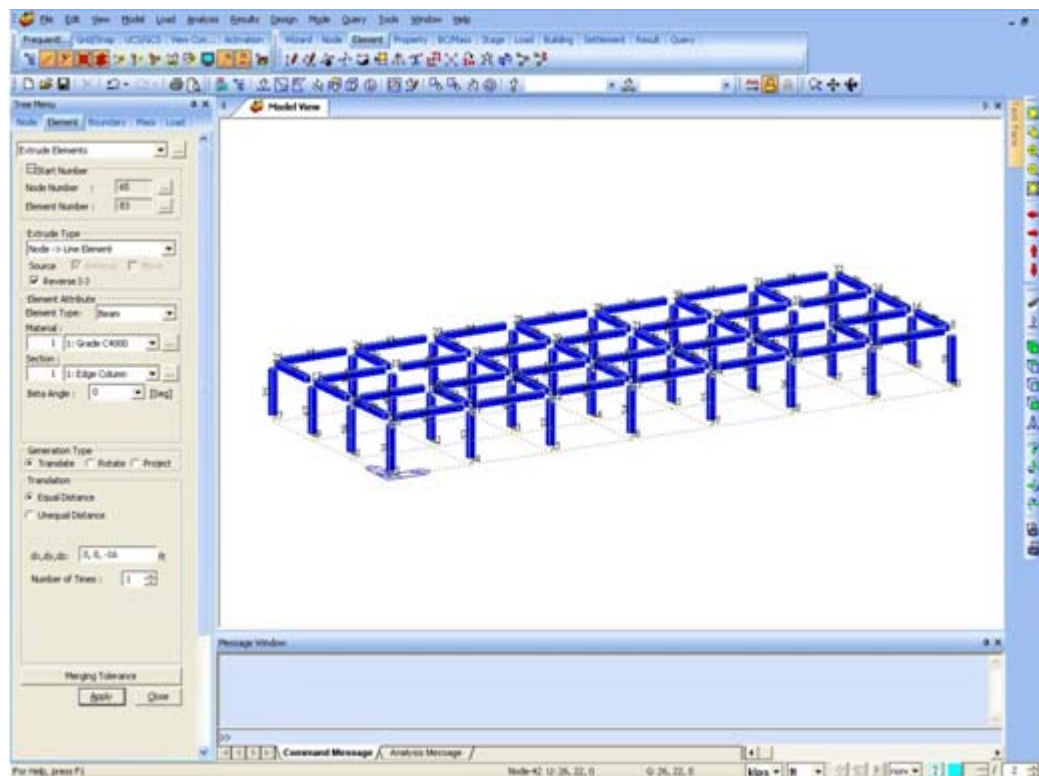

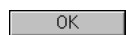


Figure 7 : Generate Columns

Change Properties of Interior Columns

Work > Properties > Section : 1 : Edge column = Active

 Display > Property > Property Name > (on)



Isometric View (Refer Figure 8)

Top View >  Select Window > Select Interior Columns

Work > Properties > Section = 2 : Interior column

Drag & Drop (Refer Figure 9)

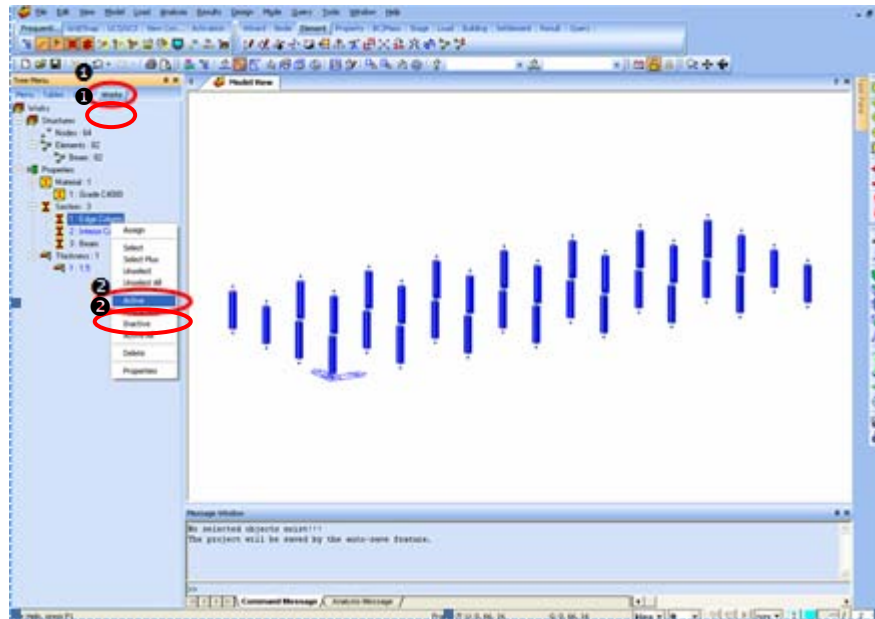


Figure 8 : Inactivate Beams

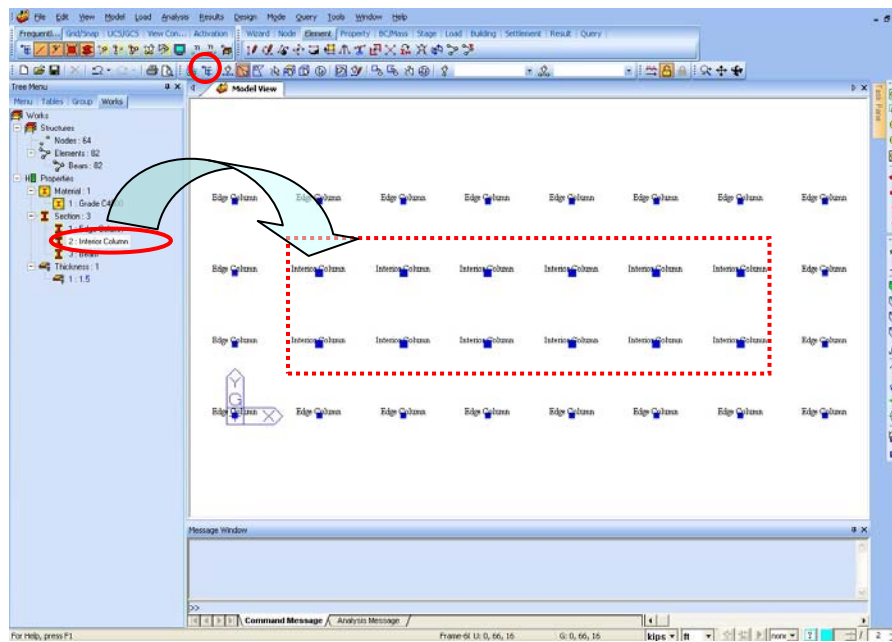




Figure 9 : “Drag & Drop” Interior Column Properties

Drop

Generate Walls

 Hidden (toggle off) ;  Node Number (toggle on)

 Display > Property > Property Name > (off)

 Select Window (Refer Figure 10)

 Active

 Create Elements

Element Type : Wall


Membrane > (on)

Wall ID > Auto Inc. > 1

Material Name > 1:Grade C4000


Thickness > 1:1.5000

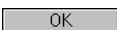
Intersect Node > (on)

Nodal Connectivity > 50, 42, 10, 18 (Refer  on Figure 11)

Select Single > Wall Element 1

Translate Element > Copy

Equal Distance (d_x, d_y, d_z) > 130, 0, 0 

Wall ID Increment = 1 

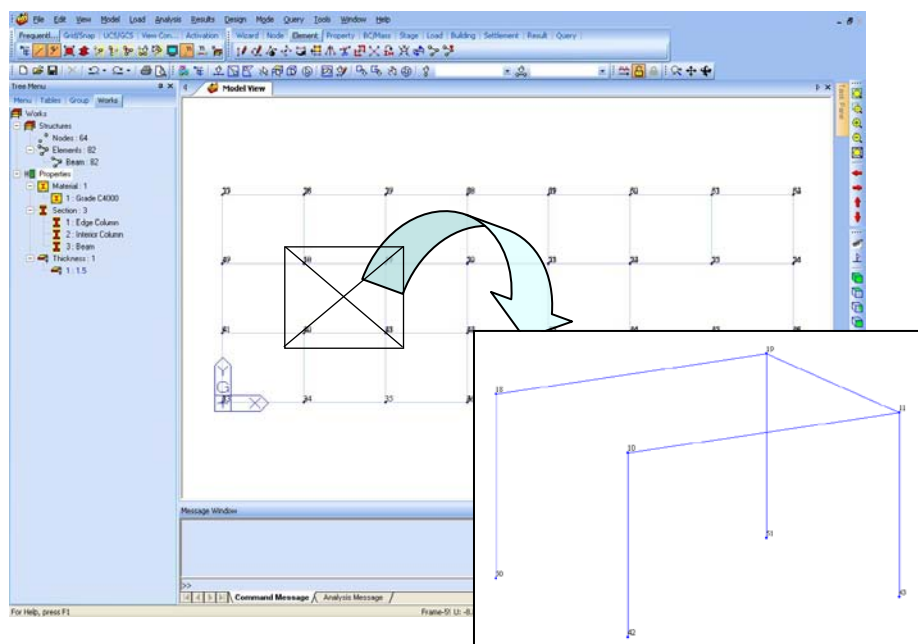


Figure 10 : Location of Wall Element

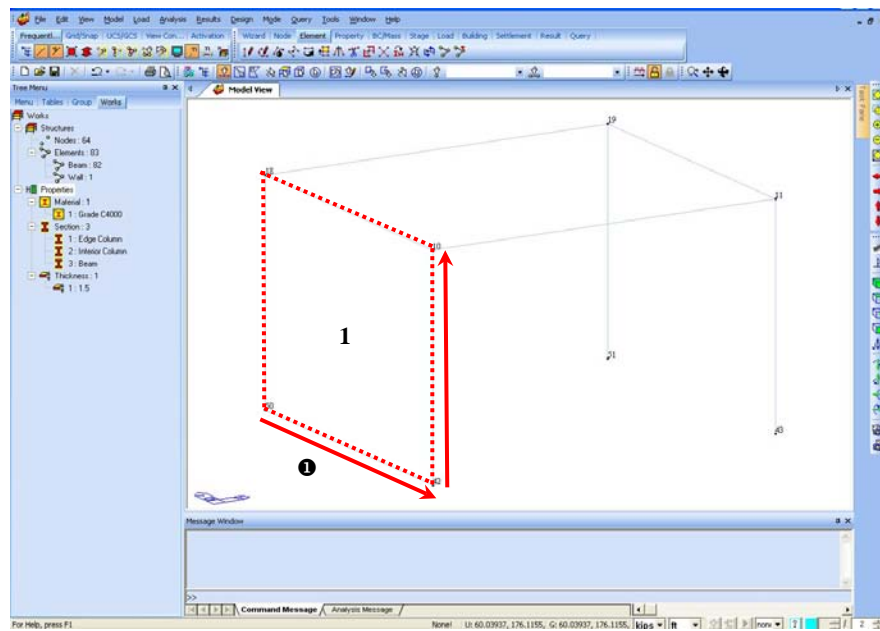


Figure 11 : Nodal Connectivity of Wall Element

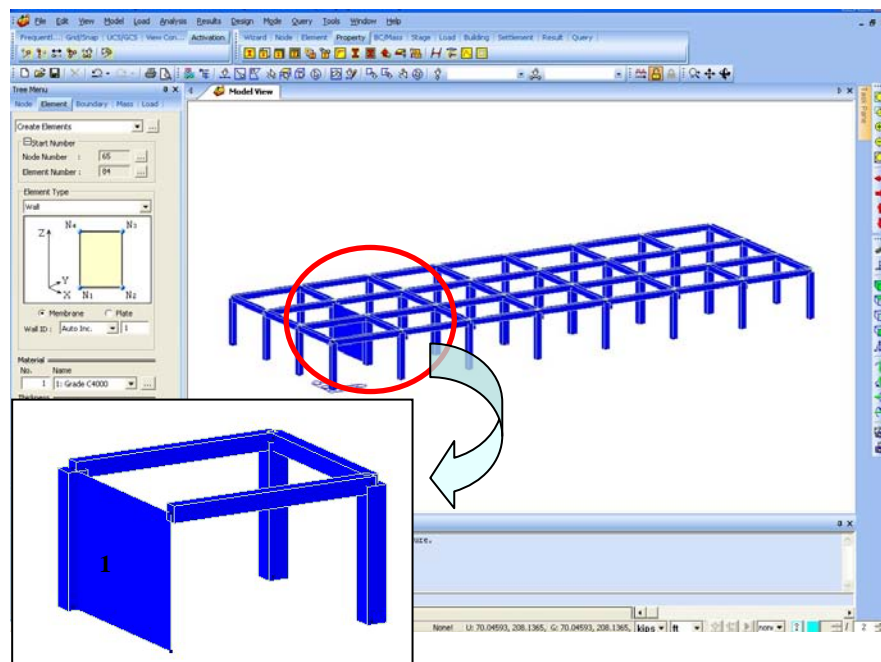


Figure 12 : Generation of Wall Element

Building Generation

Select All

Model > Building > Building Generation

Number of Copies = 11

Distance(Global Z) = 12

Add

Apply

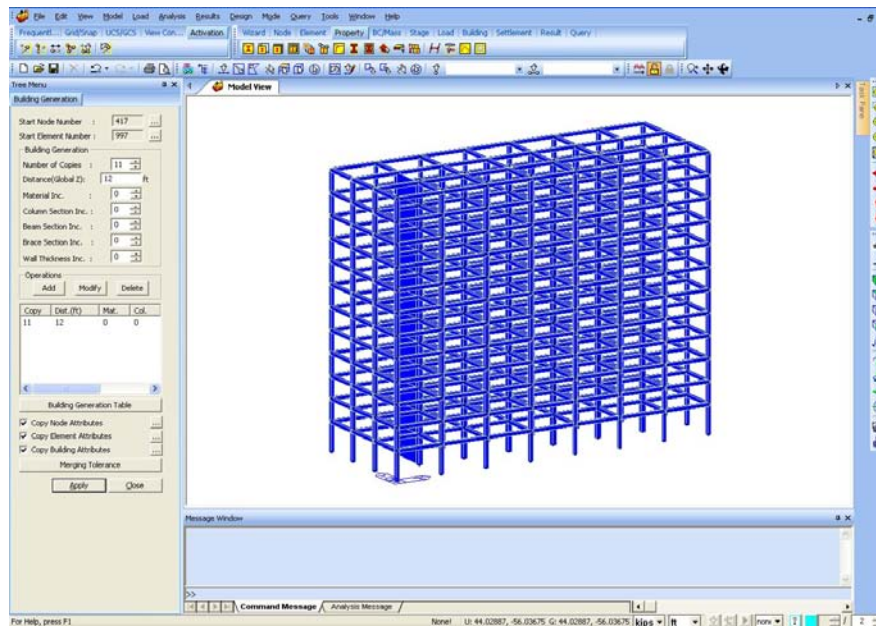


Figure 13 : Building Generation

Generate Story Data

Model > Building > Story

Auto Generate Story Data...

OK

Close

Story Data

Ground Level
0 ft

	Name	Level(ft)	Height(ft)	Floor Diaphragm
	Roof	148.00	0.00	Consider
	12F	136.00	12.00	Consider
	11F	124.00	12.00	Consider
	10F	112.00	12.00	Consider
	9F	100.00	12.00	Consider
	8F	88.00	12.00	Consider
	7F	76.00	12.00	Consider
	6F	64.00	12.00	Consider
	5F	52.00	12.00	Consider
	4F	40.00	12.00	Consider
	3F	28.00	12.00	Consider
	2F	16.00	12.00	Consider
	1F	0.00	16.00	Do not consider

Story Wind Seismic

Auto Generate Story Data...

Close

Automatic Generation of Story Data

Unselected List		Selected List			
No	Level	No	Name	Level	Height
		1	1F	0	16
		2	2F	16	12
		3	3F	28	12
		4	4F	40	12
		5	5F	52	12
		6	6F	64	12
		7	7F	76	12
		8	8F	88	12
		9	9F	100	12
		10	10F	112	12
		11	11F	124	12
		12	12F	136	12
		13	Roof	148	0

☒ Include Accidental Eccentricity : 5 % of Plan Dimension

OK Cancel

Figure 14 : Generation of Story Data


3. Boundary Conditions Input

The lower ends of the columns are assumed fixed.

Model > Boundary > Supports

D – All > (on)

R – All > (on)

 Select Window



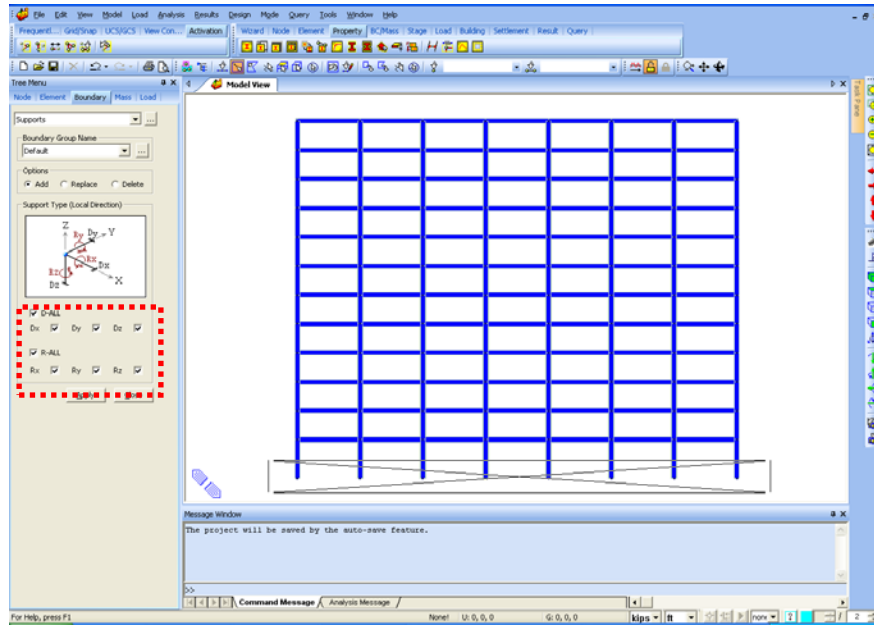


Figure 15 : Boundary Supports

4. Loading Data Input

Load > Static Load Cases

- Dead Load
- Live Load
- Wind Load (X-direction)
- Wind Load (Y-direction)
- Earthquake Load (X-direction, Eccentricity direction-Positive)
- Earthquake Load (X-direction, Eccentricity direction-Negative)
- Earthquake Load (Y-direction, Eccentricity direction-Positive)
- Earthquake Load (Y-direction, Eccentricity direction-Negative)

No	Name	Type	Description
1	DL	Dead Load (D)	Dead Load
2	LL	Live Load (L)	Live Load
3	WX	Wind Load on Structure (W)	Wind Load in X-direction
4	WY	Wind Load on Structure (W)	Wind Load in Y-direction
5	EXP	Earthquake (E)	Earthquake Load in X-dir. (+ve Eccentricity)
6	EXN	Earthquake (E)	Earthquake Load in X-dir. (-ve Eccentricity)
7	EYP	Earthquake (E)	Earthquake Load in Y-dir. (+ve Eccentricity)
8	EYN	Earthquake (E)	Earthquake Load in Y-dir. (-ve Eccentricity)
*			

Figure 16 : Loading Data Input

Self Weight

Load > Self Weight

Z = -1

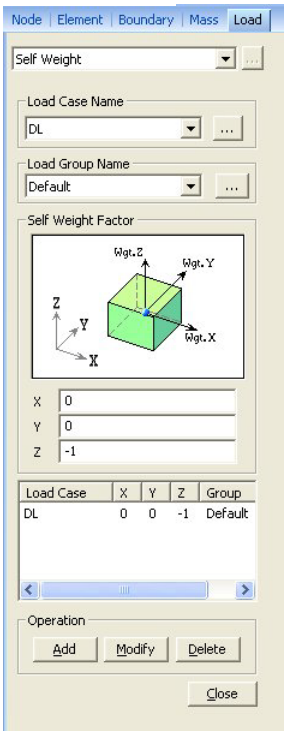


Figure 17 : Self Weight Load

Floor Load

Load > Define Floor Load Type

- Name > Typical Floor : DL = -30 psf, LL = -75 psf Add
- Name > Roof Level : DL = -10 psf, LL = -20 psf Add

Load > Assign Floor Load

- Load Type > Typical Floor
- Two Way Distribution
- Copy Floor Load > (on)
- Axis > z (on)
- Distance > 10@12
- Assign Nodes Defining Loading Area > (1, 8, 32, 25)

Similarly, assign floor load at roof level :

- Load Type > Roof Level
- Copy Floor Load > (off)
- Assign Nodes Defining Loading Area > (386, 387, 417, 410)

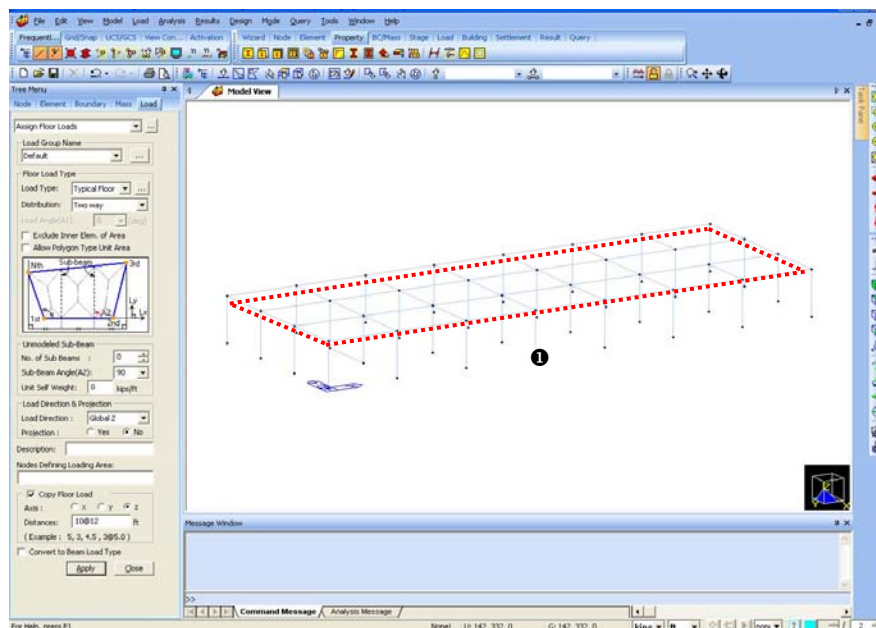
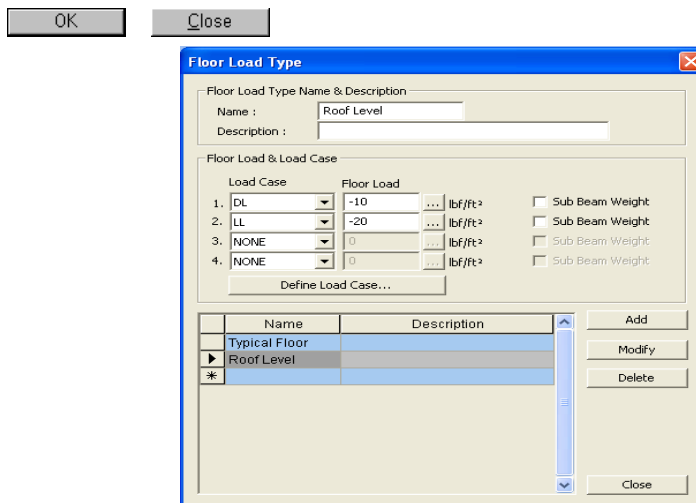


Figure 18 : Assign Floor Loads

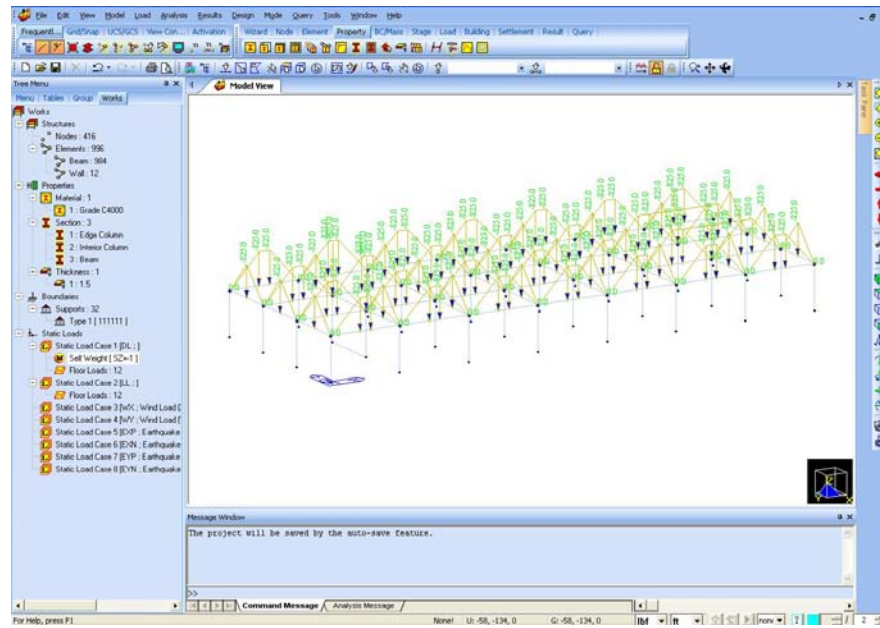


Figure 19 : Floor Load Distribution

Wind Loads

Load > Lateral Loads > Wind Loads

Add

- Load Case Name > WX
- Wind Load Code > IBC2000 (ASCE7-98)
- Simplified Procedure > (on)
- Basic Wind Speed > 85 mile/h
- Importance Factor > 1
- Exposure Category > B
- Scale Factor in Global X > 1
- Scale Factor in Global Y > 0

Apply

- Load Case Name > WY
- Scale Factor in Global X > 0
- Scale Factor in Global Y > 1

Apply

OK

Close

Add/modify Wind Load Specification

Load Case Name : WX

Wind Load Code : IBC2000(ASCE7-98)

Description :

☒ Simplified Procedure ☐ Analytical Procedure

Wind Load Parameters

Basic Wind Speed : 85 mile/h

Importance Factor(I) : 1.00

Exposure Category : B

Wind Load Direction Factor (Scale Factor)

X-Dir. 1 Y-Dir. 0 Z-Rot. 0

Additional Wind Loads

Story	Add.-X	Add.-Y	Add.-RZ

Wind Load Profile...

OK Cancel Apply

Wind Loads

Load Case	Code Name	Description
WX	IBC2000	
WY	IBC2000	

Add Modify Delete Close

Figure 20 : Input Wind Loads

Convert Model Weight & Loads to Masses

Model > Structure Type

- Structure Type > 3-D (on)
- Convert to X, Y (on)
- Gravity Acceleration > 32.1719 (ft/sec²)

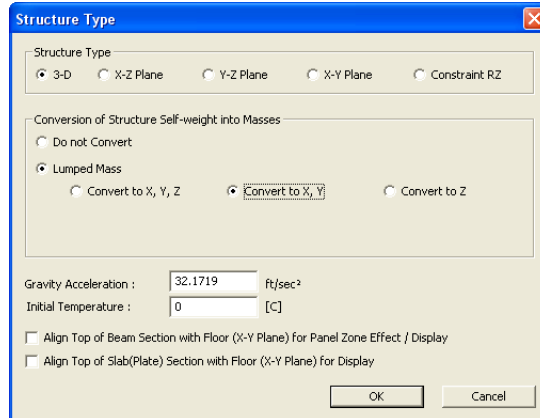


Figure 21 : Convert Model Weight to Masses

Model > Masses > Loads to Masses

- Mass Direction > X, Y (on)
- Load Type for Converting > All (on)
- Gravity > 32.1719 (ft/sec²)
- Load Case > DL
- Scale Factor > 1
- Add
- Load Case > LL
- Scale Factor > 0.25
- Add
- OK

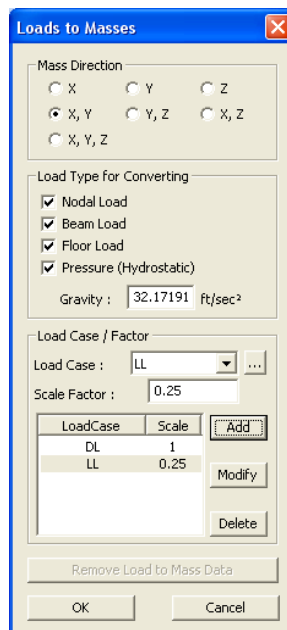


Figure 22 : Covert Model Loads to Masses

Static Seismic Loads

Load > Lateral Loads > Static Seismic Loads

- Load Case Name > EXP
- Seismic Load Code > IBC2000 (ASCE7-98)
- Seismic Design Category > E
- Site Class > C
- $S_s = 1.0$
- $S_1 = 0.3$
- Importance Factor (I) = 1
- Period (Code) > X-Dir. = 1.2 ; Y-Dir. = 0
- Response Modification Coef. (R) > X-Dir. = 8 (Special moment frame),
Y-Dir. = 8 (Dual system: special reinforced concrete structural walls with special moment frame)
- Scale Factor in Global X = 1
- Scale Factor in Global Y = 0
- Accidental Eccentricity in X-direction > Positive (on)
- Accidental Eccentricity in Y-direction > Positive (on)

- Load Case Name > EXN
- Period (Code) > X-Dir. = 1.2 ; Y-Dir. = 0
- Scale Factor in Global X = 1
- Scale Factor in Global Y = 0
- Accidental Eccentricity in X-direction > Negative (on)
- Accidental Eccentricity in Y-direction > Negative (on)

- Load Case Name > EYP
- Period (Code) > X-Dir. = 0 ; Y-Dir. = 1.2
- Scale Factor in Global X = 0
- Scale Factor in Global Y = 1
- Accidental Eccentricity in X-direction > Positive (on)
- Accidental Eccentricity in Y-direction > Positive (on)

- Load Case Name > EYN
- Period (Code) > X-Dir. = 0 ; Y-Dir. = 1.2
- Scale Factor in Global X = 0
- Scale Factor in Global Y = 1
- Accidental Eccentricity in X-direction > Negative (on)
- Accidental Eccentricity in Y-direction > Negative (on)

Static Seismic Loads

Load Case	Code Name	Description
EXP	IBC2000(ASCE...	
EXN	IBC2000(ASCE...	
EYP	IBC2000(ASCE...	
EYN	IBC2000(ASCE...	

Add

Modify

Delete

Close

Add/modify Seismic Load Specification

Load Case Name : EXP

Seismic Load Code : IBC2000(ASCE7-98)

Description :

Seismic Load Parameters

Seismic Design Category : E

Site Class : C

Mapped Spectral Response Acceleration at Short Periods(Ss) : 1.0

Mapped Spectral Response Acceleration at 1 Second Period(S1) : 0.3

Importance Factor : 1.0

Structural Parameters

X-Dir.

Y-Dir.

Period(Analysis) : 0

Period(Code) : 1.2

Response Modification Coef.(R) : 8

Seismic Load Direction Factor (Scale Factor)

X-Direction : 1

Y-Direction : 0

Accidental Eccentricity

X-Direction (Ex) : Positive

Y-Direction (Ey) : Positive

Torsional Amplification

Accidental Eccentricity

Inherent Eccentricity

Additional Seismic Loads

Story	Add.-X	Add.-Y
-------	--------	--------

Add

Delete

Seismic Load Profile...

OK

Cancel

Apply

Figure 23 : Input Static Seismic Loads

20

Response Spectrum Load

Load > Response Spectrum Analysis Data > Response Spectrum Functions

Add

Design Spectrum

- Design Spectrum > IBC2000 (ASCE7-98)
- Site Class > C
- $S_s = 1.0$
- $S_1 = 0.3$

OK

OK

Close

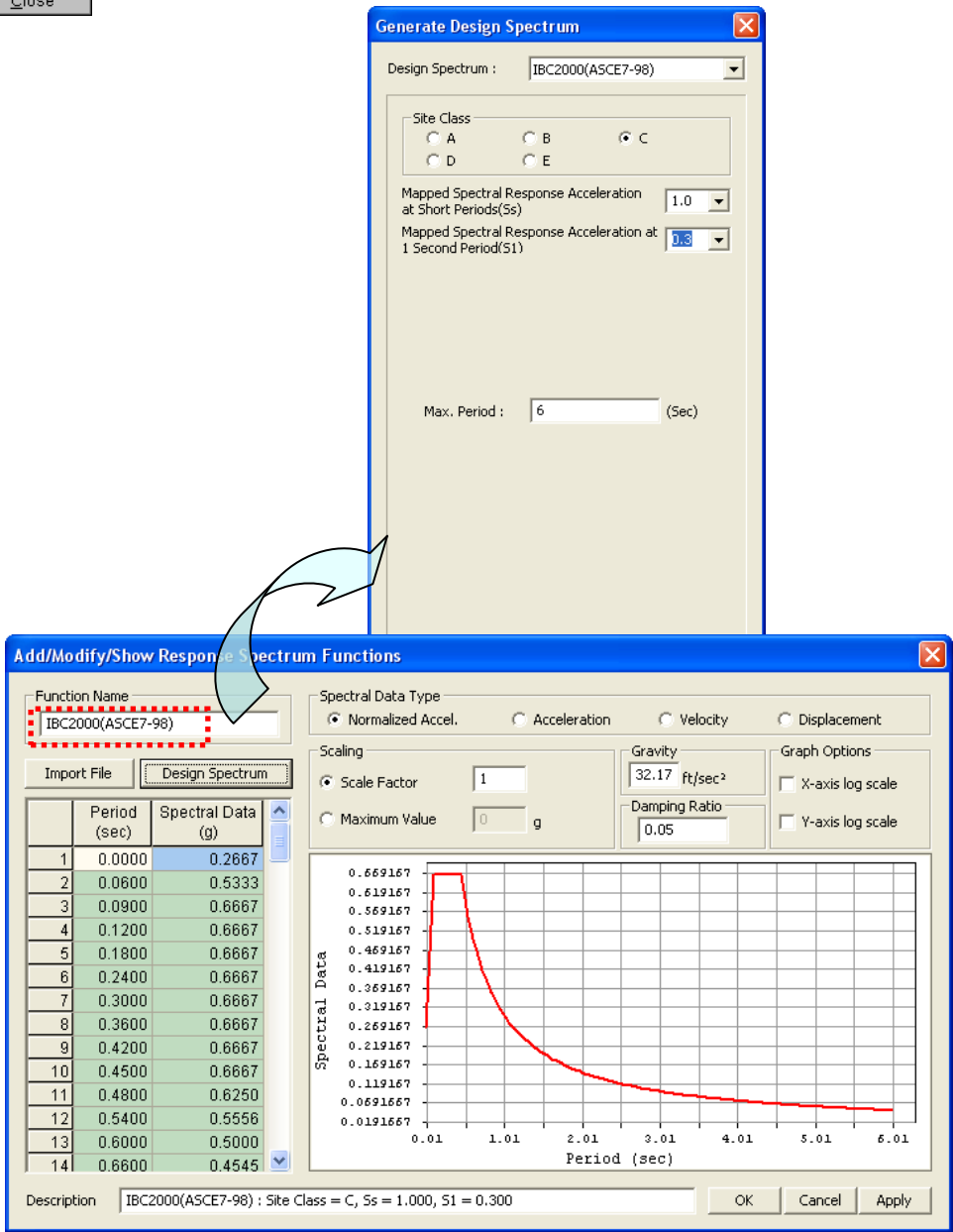


Figure 24 : Response Spectrum Loads

Load > Response Spectrum Analysis Data > Response Spectrum Load Cases

- Load Case Name > RX
- Direction > X-Y
- Excitation Angle = 0 (deg.)
- Scale Factor (I/R) > $1/8 = 0.125$
- Period Modification Factor = 1
- Function Name (Damping Ratio) > IBC2000(ASCE7-98) (0.05) > (on)
- Interpolation of Spectral Data > Linear (on)
- Accidental Eccentricity > (on)
- Modal Combination Type > SRSS

Add

- Load Case Name > RY
- Excitation Angle = 90 (deg.)
- Modal Combination Type > SRSS

Close

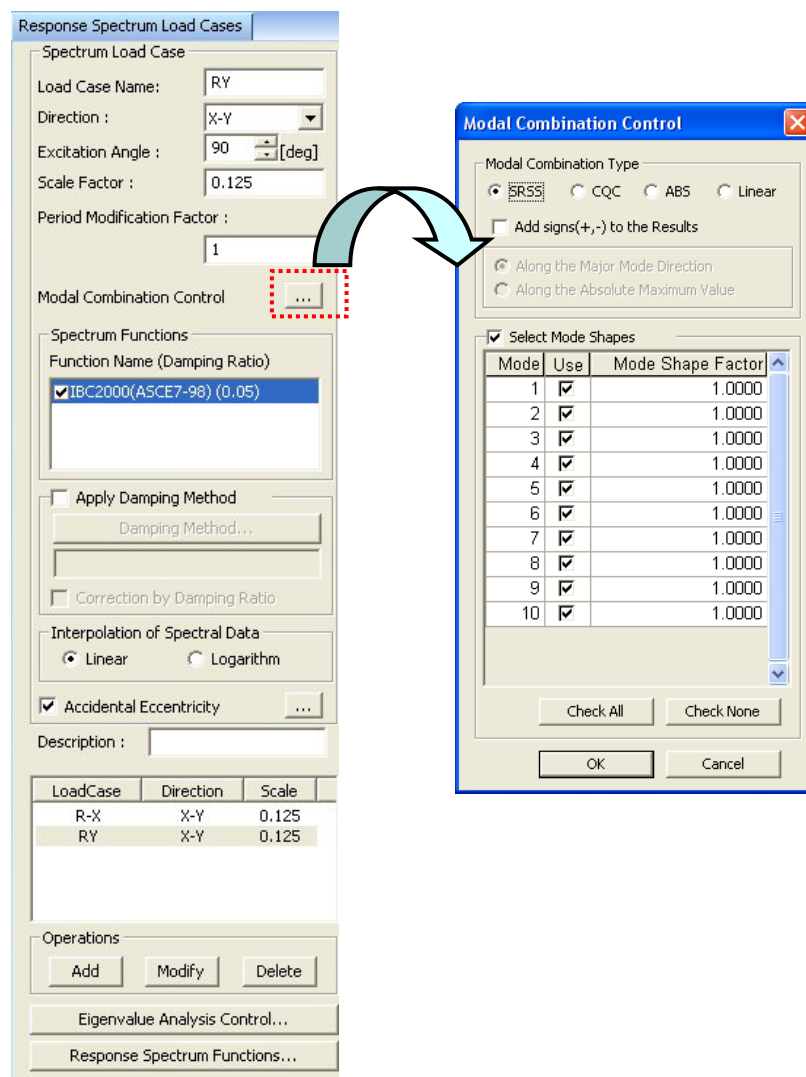


Figure 25 : Response Spectrum Analysis

5. Analysis

Analysis > P-Delta Analysis Control

- Number of Iterations = 5
- Convergence Tolerance = 1e-005
- P-Delta Combination > Load Case > DL ; Scale Factor > 1

Add

- P-Delta Combination > Load Case > LL ; Scale Factor = 0.25

Add

OK

Analysis > Eigenvalue Analysis Control

- Type of Analysis > Eigen Vectors (on) > Subspace Iteration (on)
- Number of Frequencies = 10
- Number of Iterations = 20
- Subspace Dimension = 0
- Convergence Tolerance = 1e-010

OK

Perform Analysis

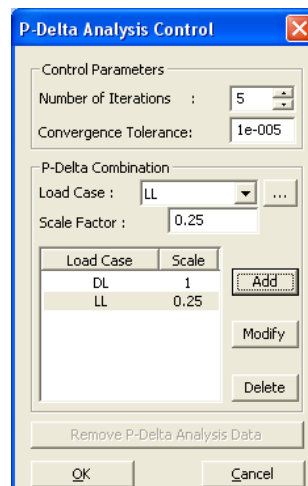
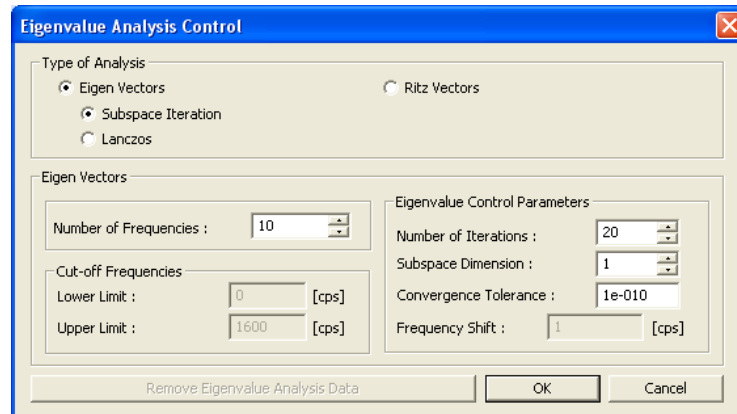


Figure 27 : P-Delta and Eigenvalue Analysis Control

6. Design Input

Results > Combinations

Concrete Design > Auto Generation

- Option > Add (on)
- Design Code > ACI318-02
- Scale Up Factor = 1.48 ; RX
- Scale Up Factor = 1 ; RY

Add

Add

OK

Bi-directional combination
needs to be investigated, but
omitted in this tutorial.

Load Combinations

General | Steel Design | Concrete Design | SRC Design | Footing Design

Load Combination List:

No	Name	Active	Type	Description
1	cLCB1	Stren	Add	1.4D
2	cLCB2	Stren	Add	1.2D + 1.6L
3	cLCB3	Stren	Add	1.2D + 1.6WX + 1.0L
4	cLCB4	Stren	Add	1.2D + 1.6WY + 1.0L
5	cLCB5	Stren	Add	1.2D - 1.6WX + 1.0L
6	cLCB6	Stren	Add	1.2D - 1.6WY + 1.0L
7	cLCB7	Stren	Add	1.2D + 1.0EXP + 1.0L
8	cLCB8	Stren	Add	1.2D + 1.0EXN + 1.0L
9	cLCB9	Stren	Add	1.2D + 1.0EYP + 1.0L
10	cLCB10	Stren	Add	1.2D + 1.0EYN + 1.0L
11	cLCB11	Stren	Add	1.2D - 1.0EXP + 1.0L
12	cLCB12	Stren	Add	1.2D - 1.0EXN + 1.0L
13	cLCB13	Stren	Add	1.2D - 1.0EYP + 1.0L
14	cLCB14	Stren	Add	1.2D - 1.0EYN + 1.0L
15	cLCB15	Stren	Add	1.2D + 1.0(1.48)(R-X(RS)+R-X(E
16	cLCB16	Stren	Add	1.2D + 1.0(1.48)(R-X(RS)-R-X(E
17	cLCB17	Stren	Add	1.2D + 1.0(1.0)(RY(RS)+RY(ES
18	cLCB18	Stren	Add	1.2D + 1.0(1.0)(RY(RS)-RY(ES
19	cLCB19	Stren	Add	1.2D - 1.0(1.48)(R-X(RS)+R-X(E
20	cLCB20	Stren	Add	1.2D - 1.0(1.48)(R-X(RS)-R-X(E
21	cLCB21	Stren	Add	1.2D - 1.0(1.0)(RY(RS)+RY(ES

Load Cases and Factors:

LoadCase	Factor
DL(ST)	1.4000
*	

Copy Import... Auto Generation... Spread Sheet Form

File Name: C:\Documents and Settings\Govind\Desktop\RC\ Copy Browse Make Load Combination Sheet Close

Automatic Generation of Load Combinations

Option: ☒ Add ☐ Replace

Code Selection:
☐ Steel ☒ Concrete ☐ SRC ☐ Footing
 Design Code: ACI318-02

Scale Up of Response Spectrum Load Cases:
 Scale Up Factor: 1 RX
 Factor Load Case Add Modify Delete

Manipulation of Construction Stage Load Case:
 ST: Static Load Case
 CS: Construction Stage Load Case
☒ ST Only ☐ CS Only ☐ ST+CS

Consider Orthogonal Effect:
☐ Set Load Cases for Orthogonal Effect...
☒ 100 : 30 Rule
☐ SRSS(Square-Root-of-Sum-of-Squares)

Generate Additional Load Combinations:
☒ For Special Seismic Load
☒ For Vertical Seismic Forces
 Factors for Seismic Design...

Will Execute Construction Stage Analysis:
☐ Consider Losses For Prestress Load Cases
 Transfer Stage: 1 Define Factors
 Service Load Stage: 1
 OK Cancel

Figure 28 : Generation of Load Combinations for Concrete Design

Compare RX (RY) with EX (EY)

RX (RY):

Results > Result Tables > Story > Story Shear (Response Spectrum Analysis)

- Spectrum Load Cases > RX(RS) (on) & RY(RS) (on)
- Shear Force (Without Spring)

OK

Story	Level (ft)	Spectrum	Inertia Force		Shear Force						Eccentricity (ft)	Story Force (lb)	Eccentric Moment (ft-lb)
			X (lb)	Y (lb)	X (lb)	Y (lb)	Without Spring	With Spring	With Spring	With Spring			
Roof	148.000	RX(RS)	5.1709e+004	0.0000e+000	0.0000e+000	0.0000e+000	0.000000e+00	0.000000e+00	0.0000e+000	0.0000e+000	3.3000e+000	5.1709e+004	1.7064e+005
Roof	148.000	RY(RS)	1.0606e-005	8.2332e+004	0.0000e+000	0.0000e+000	0.000000e+00	0.000000e+00	0.0000e+000	0.0000e+000	9.1000e+000	8.2332e+004	7.4922e+005
12F	136.000	RX(RS)	6.6489e+004	0.0000e+000	0.0000e+000	0.0000e+000	5.170940e+00	0.000000e+00	5.1709e+004	0.0000e+000	3.3000e+000	6.6489e+004	2.1941e+005
12F	136.000	RY(RS)	1.3637e-005	1.0413e+005	0.0000e+000	0.0000e+000	1.060578e+00	8.233237e+00	1.0606e-005	8.2332e+004	9.1000e+000	1.0413e+005	9.4760e+005
11F	124.000	RX(RS)	5.7482e+004	0.0000e+000	0.0000e+000	0.0000e+000	1.159338e+00	0.000000e+00	1.1593e+005	0.0000e+000	3.3000e+000	5.7482e+004	1.8969e+005
11F	124.000	RY(RS)	1.1790e-005	7.9195e+004	0.0000e+000	0.0000e+000	2.377843e+00	1.858519e+00	2.3778e-005	1.8585e+005	9.1000e+000	7.9195e+004	7.2067e+005
10F	112.000	RX(RS)	5.3392e+004	0.0000e+000	0.0000e+000	0.0000e+000	1.634063e+00	0.000000e+00	1.6341e+005	0.0000e+000	3.3000e+000	5.3392e+004	1.7619e+005
10F	112.000	RY(RS)	1.0951e-005	6.5364e+004	0.0000e+000	0.0000e+000	3.351521e+00	2.614140e+00	3.3515e-005	2.6141e+005	9.1000e+000	6.5364e+004	5.9482e+005
9F	100.000	RX(RS)	5.3730e+004	0.0000e+000	0.0000e+000	0.0000e+000	1.993348e+00	0.000000e+00	1.9933e+005	0.0000e+000	3.3000e+000	5.3730e+004	1.7731e+005
9F	100.000	RY(RS)	1.1020e-005	6.6553e+004	0.0000e+000	0.0000e+000	4.088426e+00	3.139025e+00	4.0884e-005	3.1390e+005	9.1000e+000	6.6553e+004	6.0563e+005
8F	88.000	RX(RS)	5.4505e+004	0.0000e+000	0.0000e+000	0.0000e+000	2.273778e+00	0.000000e+00	2.2738e+005	0.0000e+000	3.3000e+000	5.4505e+004	1.7987e+005
8F	88.000	RY(RS)	1.1179e-005	7.5427e+004	0.0000e+000	0.0000e+000	4.663539e+00	3.515359e+00	4.6636e-005	3.5154e+005	9.1000e+000	7.5427e+004	6.8636e+005
7F	76.000	RX(RS)	5.6123e+004	0.0000e+000	0.0000e+000	0.0000e+000	2.509605e+00	0.000000e+00	2.5096e+005	0.0000e+000	3.3000e+000	5.6123e+004	1.8520e+005
7F	76.000	RY(RS)	1.1510e-005	8.2318e+004	0.0000e+000	0.0000e+000	5.147267e+00	3.840497e+00	5.1473e-005	3.8405e+005	9.1000e+000	8.2318e+004	7.4909e+005
6F	64.000	RX(RS)	5.7092e+004	0.0000e+000	0.0000e+000	0.0000e+000	2.720390e+00	0.000000e+00	2.7204e+005	0.0000e+000	3.3000e+000	5.7092e+004	1.8840e+005
6F	64.000	RY(RS)	1.1710e-005	8.2208e+004	0.0000e+000	0.0000e+000	5.579814e+00	4.189556e+00	5.5798e-005	4.1896e+005	9.1000e+000	8.2208e+004	7.4809e+005
5F	52.000	RX(RS)	5.8322e+004	0.0000e+000	0.0000e+000	0.0000e+000	2.923029e+00	0.000000e+00	2.9230e+005	0.0000e+000	3.3000e+000	5.8322e+004	1.9246e+005
5F	52.000	RY(RS)	1.1962e-005	7.3775e+004	0.0000e+000	0.0000e+000	5.995235e+00	4.581744e+00	5.9952e-005	4.5817e+005	9.1000e+000	7.3775e+004	6.7135e+005
4F	40.000	RX(RS)	5.7401e+004	0.0000e+000	0.0000e+000	0.0000e+000	3.125463e+00	0.000000e+00	3.1255e+005	0.0000e+000	3.3000e+000	5.7401e+004	1.8942e+005
4F	40.000	RY(RS)	1.1773e-005	5.8127e+004	0.0000e+000	0.0000e+000	6.410434e+00	4.978989e+00	6.4104e-005	4.9789e+005	9.1000e+000	5.8127e+004	5.2895e+005
3F	28.000	RX(RS)	5.3145e+004	0.0000e+000	0.0000e+000	0.0000e+000	3.331439e+00	0.000000e+00	3.3314e+005	0.0000e+000	3.3000e+000	5.3145e+004	1.7538e+005
3F	28.000	RY(RS)	1.0900e-005	3.8144e+004	0.0000e+000	0.0000e+000	6.832897e+00	5.321972e+00	6.8329e+005	5.3220e+005	9.1000e+000	3.8144e+004	3.4711e+005
2F	16.000	RX(RS)	3.9772e+004	0.0000e+000	0.0000e+000	0.0000e+000	3.522904e+00	0.000000e+00	3.5229e+005	0.0000e+000	3.3000e+000	3.9772e+004	1.3125e+005
2F	16.000	RY(RS)	8.1573e-006	1.8738e+004	0.0000e+000	0.0000e+000	7.225598e+00	5.556890e+00	7.2256e-005	5.5569e+005	9.1000e+000	1.8738e+004	1.7051e+005
1F	-0.000	RX(RS)	0.0000e+000	0.0000e+000	0.0000e+000	0.0000e+000	3.685208e+00	0.000000e+00	3.6852e+005	0.0000e+000	0.0000e+000	0.0000e+000	0.0000e+000
1F	-0.000	RY(RS)	0.0000e+000	0.0000e+000	0.0000e+000	0.0000e+000	7.517468e+00	5.673309e+00	7.5175e-005	5.6733e+005	0.0000e+000	0.0000e+000	0.0000e+000

Figure 29 : Story Shear (Response Spectrum Analysis)

EX (EY):

Load > Lateral Loads > Static Seismic Loads

Load Case > EXP > Modify > Seismic Load Profile

- Story Shear (on)

Similarly, select Load Cases EXN, EYP & EYN

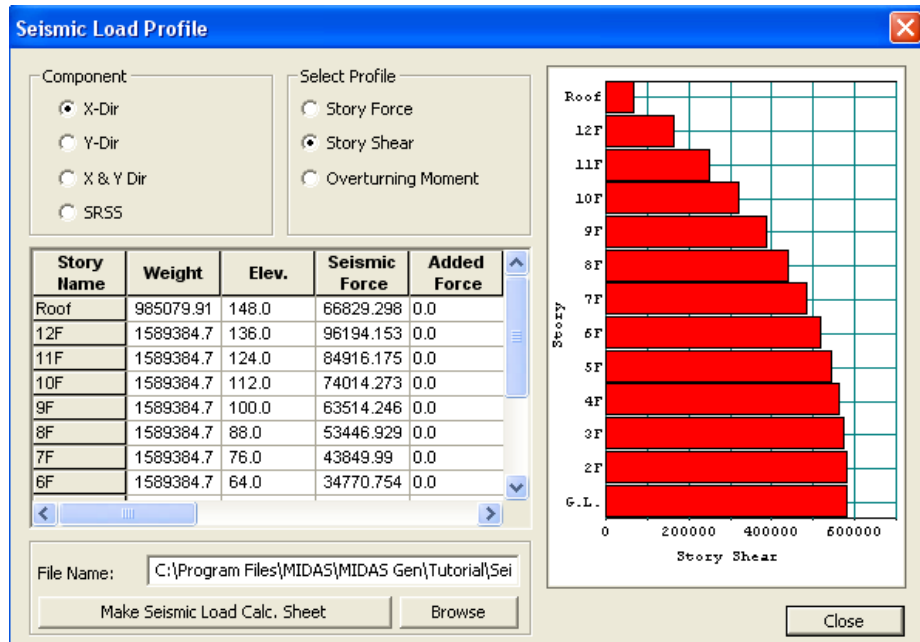


Figure 30 : Story Shear (Static Seismic Loads)

Design > General Design Parameter > Definition of Frame

- X-direction > Unbraced | Sway (on)
- Y-direction > Braced | Non-Sway (on)
- Design Type > 3-D
- Auto Calculate Effective Length Factors > (on)

OK

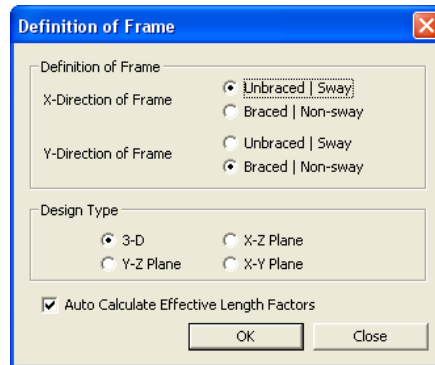



Figure 31 : Definition of Frame

Design > General Design Parameter > Modify Live Load Reduction Factor
General Tab

- Option > Add/Replace (on)
- Applied Components > Axial Force (on)
- Top View > Select Window 

- Interior columns: Reduction Factor = 0.56

Apply

- Edge column: Reduction Factor = 0.69

Apply

- Corner column: Reduction Factor = 0.88

Apply

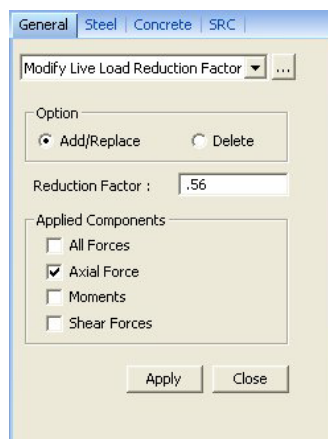




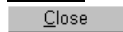
Figure 32 : Modify Live Load Reduction Factor

- Unbraced Length (L, Lb)
- Option > Add/Replace (on)
- Unbraced Length > Ly=0 ; Lx=0
- Laterally Unbraced Length > Do not consider (on)
- Select All 



- Equivalent Moment Correction Factor (Cm)
- Option > Add/Replace (on)
- Moment Factor > Calculate by Program (on)
- Select All 





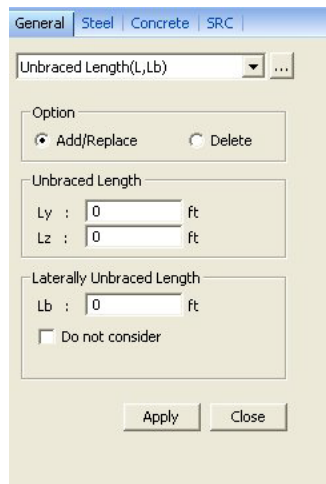


Figure 33 : Unbraced Length

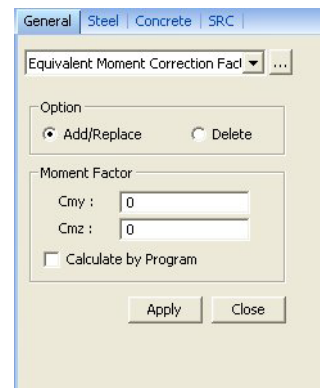
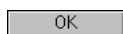


Figure 34 : Equivalent Moment Correction Factor

Design > Concrete Design Parameter > Design Code

- Design Code > ACI318-02
- Apply Special Provisions for Seismic Design > (on)
- Select Frame Type > Special Moment Frames (on)



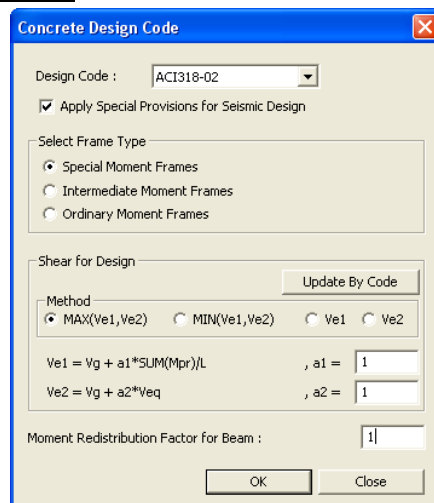


Figure 35 : Concrete Design Code

Design > Concrete Design Parameter > Strength Reduction Factors
- Update By Code

OK

Strength Reduction Factors

Design Code : ACI318-02 Update By Code

Strength Reduction Factors

For Flexure (ϕ_b) : 0.9

For Axial Tension with Flexure (ϕ_t) : 0.9

For Axial Compression, and Axial Compression with Flexure

- Member with Spiral Reinforcement (ϕ_{c1}) : 0.7

- Other Reinforced Member (ϕ_{c2}) : 0.65

For Shear (ϕ_v) : 0.75

OK Close

Figure 36 : Strength Reduction Factors

Design > Concrete Design Parameter > Design Criteria for Rebars (Refer Figure 37)

Design Criteria for Rebars

For Beam Design

Main Rebar : #7, #8 Rebar...

Stirrups : #3 Arrangement : 2

Side Bar : #4

dt : 0 ft d8 : 0 ft

Option of Spliced Bars

☐ None ☒ 50% ☐ 100%

For Column Design

Main Rebar : #8 Rebar...

Ties/Spirals : #4 Arrangement : Y: 2

do : 0 ft Z: 2

Option of Spliced Bars

☐ None ☒ 50% ☐ 100%

For Brace Design

Main Rebar : #7 Rebar...

Ties/Spirals : #3 Arrangement : Y: 2

do : 0 ft Z: 2

Option of Spliced Bars

☐ None ☒ 50% ☐ 100%

For Shear Wall Design

Vertical Rebar : #5 Rebar...

Horizontal Rebar : #5

End Rebar From : #5

de : 0 ft dw : 0 ft

Input Additional Wall Data...

OK Close

Figure 37 : Design Criteria for Rebars

Design > Concrete Design Parameter > Modify Concrete Materials

Select material ID #1

Rebar Selection

- Code > ASTM (RC)
- Grade of Main Rebar > Grade 60
- Grade of Sub-Rebar > Grade 40

Modify

Close

Modify Concrete Materials

Material List

ID	Name	fc fck R	Main-bar	Sub-bar
1	Grade C4000	576000	Grade 60	Grade 40

Concrete Material Selection

Code : Grade :

Specified Compressive Strength (fc|fck) : lbf/ft²

Rebar Selection

Code :

Grade of Main Rebar : Fy : lbf/ft²

Grade of Sub-Rebar : Fys : lbf/ft²

Modify Close

Figure 38 : Modify Concrete Materials

7. Design Output

Design > Concrete Code Design > Beam Design
Sorted by > Member (on) >>

ACI318-02 RC-Beam Design Result Dialog

Code : ACI318-02 Unit : lbf , ft

Sorted by ☒ Member ☐ Property

Primary Sorting Option ☐ SECT ☒ MEMB

MEMB	SECT	Span	Section	fc	fy	POS	N(-) Mu	LCB	AsTop	Rebar	P(+) Mu	LCB	AsBot	Rebar	Vu	LCB	AsV	Stirrup
			Bc Hc	bf hf	fys													
1			Beam	576000	I	190745	11	0.0143	3-#8	95372.4	11	0.0093	2-#8	39636.1	20	0.0021	2-#3 @5"	
3			1.666 2.000	8640000	M	52798.9	31	0.0051	2-#7	75015.0	7	0.0073	2-#7	23338.1	20	0.0021	2-#3 @8.5"	
26.000			0.000 0.000	5760000	J	190747	7	0.0143	3-#8	95373.6	7	0.0093	2-#8	40295.6	20	0.0021	2-#3 @5"	
2			Beam	576000	I	187268	11	0.0140	3-#8	93634.0	11	0.0091	2-#8	40133.1	20	0.0021	2-#3 @5"	
3			1.666 2.000	8640000	M	46927.4	31	0.0045	2-#7	61538.2	11	0.0060	2-#7	23175.6	20	0.0021	2-#3 @8.5"	
26.000			0.000 0.000	5760000	J	183336	7	0.0137	3-#8	91668.0	7	0.0090	2-#8	39798.7	20	0.0021	2-#3 @5"	
3			Beam	576000	I	185768	11	0.0139	3-#8	92884.0	11	0.0091	2-#8	39971.6	20	0.0021	2-#3 @5"	
3			1.666 2.000	8640000	M	46889.2	31	0.0045	2-#7	60712.1	11	0.0059	2-#7	23014.1	20	0.0021	2-#3 @8.5"	
26.000			0.000 0.000	5760000	J	185589	7	0.0139	3-#8	92794.7	7	0.0091	2-#8	39960.2	20	0.0021	2-#3 @5"	
4			Beam	576000	I	185709	11	0.0139	3-#8	92854.3	11	0.0091	2-#8	39965.9	20	0.0021	2-#3 @5"	
3			1.666 2.000	8640000	M	46867.9	27	0.0045	2-#7	60587.1	7	0.0059	2-#7	23008.4	40	0.0021	2-#3 @8.5"	
26.000			0.000 0.000	5760000	J	185709	7	0.0139	3-#8	92854.3	7	0.0091	2-#8	39965.9	20	0.0021	2-#3 @5"	
5			Beam	576000	I	185589	11	0.0139	3-#8	92794.7	11	0.0091	2-#8	39960.2	20	0.0021	2-#3 @5"	
3			1.666 2.000	8640000	M	46889.2	27	0.0045	2-#7	60712.1	7	0.0059	2-#7	23014.1	20	0.0021	2-#3 @8.5"	
26.000			0.000 0.000	5760000	J	185768	7	0.0139	3-#8	92884.0	7	0.0091	2-#8	39971.6	20	0.0021	2-#3 @5"	

☐ Connect Model View

Select All Unselect All Re-calculation

Graphic... Detail... Summary... <<

Option for Detail Print Position ☒ End I. ☐ Mid. ☐ End J.

Update Rebar

Result View Option ☒ All ☐ OK ☐ NG

Copy Table

Close

Figure 39 : Concrete Beam Design

Design > Concrete Code Design > Column Design
Sorted by > Member (on) >>

ACI318-02 RC-Wall Design Result Dialog

Code : ACI318-02 (Method 1) Unit : lbf , ft

Sorted by ☒ Wall ID + Story ☐ Wall ID (WID)

Sort Result...

Primary Sorting Option ☐ WID ☒ Story

WID	SEL	Wall Mark	fc	fy	Ratio	Pu	Mc	Vu	As-V	V-Rebar	End-Rebar
Story		Lw HTw	hw	fys	Rat-V		LCB	LCB	As-H	H-Rebar	Bar Layer
1		wM0001	576000	8640000	0.362	2574939	1.0E+07	298035	0.0043	#5 @12"	Not Use
1F		22.000 16.000	1.5000	5760000	0.386	10	34	0.0037	#5 @13"	Double	
2		wM0002	576000	8640000	0.362	2574939	1.0E+07	298035	0.0043	#5 @12"	Not Use
1F		22.000 16.000	1.5000	5760000	0.386	9	33	0.0037	#5 @13"	Double	
1		wM0001	576000	8640000	0.317	2792400	0.00000	264266	0.0043	#5 @12"	Not Use
2F		22.000 12.000	1.5000	5760000	0.301	2	34	0.0037	#5 @13"	Double	
2		wM0002	576000	8640000	0.317	2792400	0.00000	264266	0.0043	#5 @12"	Not Use
2F		22.000 12.000	1.5000	5760000	0.301	2	33	0.0037	#5 @13"	Double	
1		wM0001	576000	8640000	0.289	2542547	0.00000	243155	0.0043	#5 @12"	Not Use
3F		22.000 12.000	1.5000	5760000	0.246	2	34	0.0037	#5 @13"	Double	
2		wM0002	576000	8640000	0.289	2542547	0.00000	243155	0.0043	#5 @12"	Not Use
3F		22.000 12.000	1.5000	5760000	0.246	2	33	0.0037	#5 @13"	Double	
1		wM0001	576000	8640000	0.260	2288378	0.00000	221525	0.0043	#5 @12"	Not Use
4F		22.000 12.000	1.5000	5760000	0.216	2	34	0.0037	#5 @13"	Double	
2		wM0002	576000	8640000	0.260	2288378	0.00000	221525	0.0043	#5 @12"	Not Use
4F		22.000 12.000	1.5000	5760000	0.216	2	33	0.0037	#5 @13"	Double	
1		wM0001	576000	8640000	0.197	2030659	0.00000	199415	0.0043	#5 @12"	Not Use
5F		22.000 12.000	1.5000	5760000	0.231	2	34	0.0037	#5 @13"	Double	
2		wM0002	576000	8640000	0.231	2030659	0.00000	199415	0.0043	#5 @12"	Not Use
5F		22.000 12.000	1.5000	5760000	0.197	2	33	0.0037	#5 @13"	Double	

☐ Connect Model View

Select All Unselect All Re-calculation

Graphic... Detail... Summary... <<

Draw PM Curve... Update Rebar

Result View Option ☒ All ☐ OK ☐ NG

Copy Table

Close

Figure 40 : Concrete Column Design

Design > Concrete Code Design > Wall Design
 Sorted by > Wall ID + Story (on) >>
 SEL (Select) > WID (Wall ID) = 1 ; Story = 1F
 Graphic

ACI318-02 RC-Wall Design Result Dialog

Code : ACI318-02 (Method 1) Unit : lbf , ft Primary Sorting Option
 Sorted by ☒ Wall ID + Story ☐ Wall ID (WID) Sort Result...

WID	SEL	Wall Mark	fc	fy	Ratio	Pu	Mc	Vu	As-V	V-Rebar	End-Rebar
Story		Lw	HTW	hw	fys	Rat-V	LCB	LCB	As-H	H-Rebar	Bar Layer
1	<input type="checkbox"/>	wM0001	576000	8640000	0.362	2574939	1.0E+07	298035	0.0043	#5 @12"	Not Use
1F	<input type="checkbox"/>	22.000	16.000	1.5000	5760000	0.386	10	34	0.0037	#5 @13"	Double
2	<input type="checkbox"/>	wM0002	576000	8640000	0.362	2574939	1.0E+07	298035	0.0043	#5 @12"	Not Use
1F	<input type="checkbox"/>	22.000	16.000	1.5000	5760000	0.386	9	33	0.0037	#5 @13"	Double
1	<input type="checkbox"/>	wM0001	576000	8640000	0.317	2792400	0.00000	264266	0.0043	#5 @12"	Not Use
2F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.301	2	34	0.0037	#5 @13"	Double
2	<input type="checkbox"/>	wM0002	576000	8640000	0.317	2792400	0.00000	264266	0.0043	#5 @12"	Not Use
2F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.301	2	33	0.0037	#5 @13"	Double
1	<input type="checkbox"/>	wM0001	576000	8640000	0.289	2542547	0.00000	243155	0.0043	#5 @12"	Not Use
3F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.246	2	34	0.0037	#5 @13"	Double
2	<input type="checkbox"/>	wM0002	576000	8640000	0.289	2542547	0.00000	243155	0.0043	#5 @12"	Not Use
3F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.246	2	33	0.0037	#5 @13"	Double
1	<input type="checkbox"/>	wM0001	576000	8640000	0.260	2288378	0.00000	221525	0.0043	#5 @12"	Not Use
4F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.216	2	34	0.0037	#5 @13"	Double
2	<input type="checkbox"/>	wM0002	576000	8640000	0.260	2288378	0.00000	221525	0.0043	#5 @12"	Not Use
4F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.216	2	33	0.0037	#5 @13"	Double
1	<input type="checkbox"/>	wM0001	576000	8640000	0.231	2030659	0.00000	199415	0.0043	#5 @12"	Not Use
5F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.197	2	34	0.0037	#5 @13"	Double
2	<input type="checkbox"/>	wM0002	576000	8640000	0.231	2030659	0.00000	199415	0.0043	#5 @12"	Not Use
5F	<input type="checkbox"/>	22.000	12.000	1.5000	5760000	0.197	2	33	0.0037	#5 @13"	Double

☐ Connect Model View

Select All Unselect All Re-calculation
 Graphic... Detail... Summary... <<
 Draw RC Curve... Update Rebar Close

Result View Option
☒ All ☐ OK ☐ NG

Copy Table



Figure 41 : Concrete Wall Design

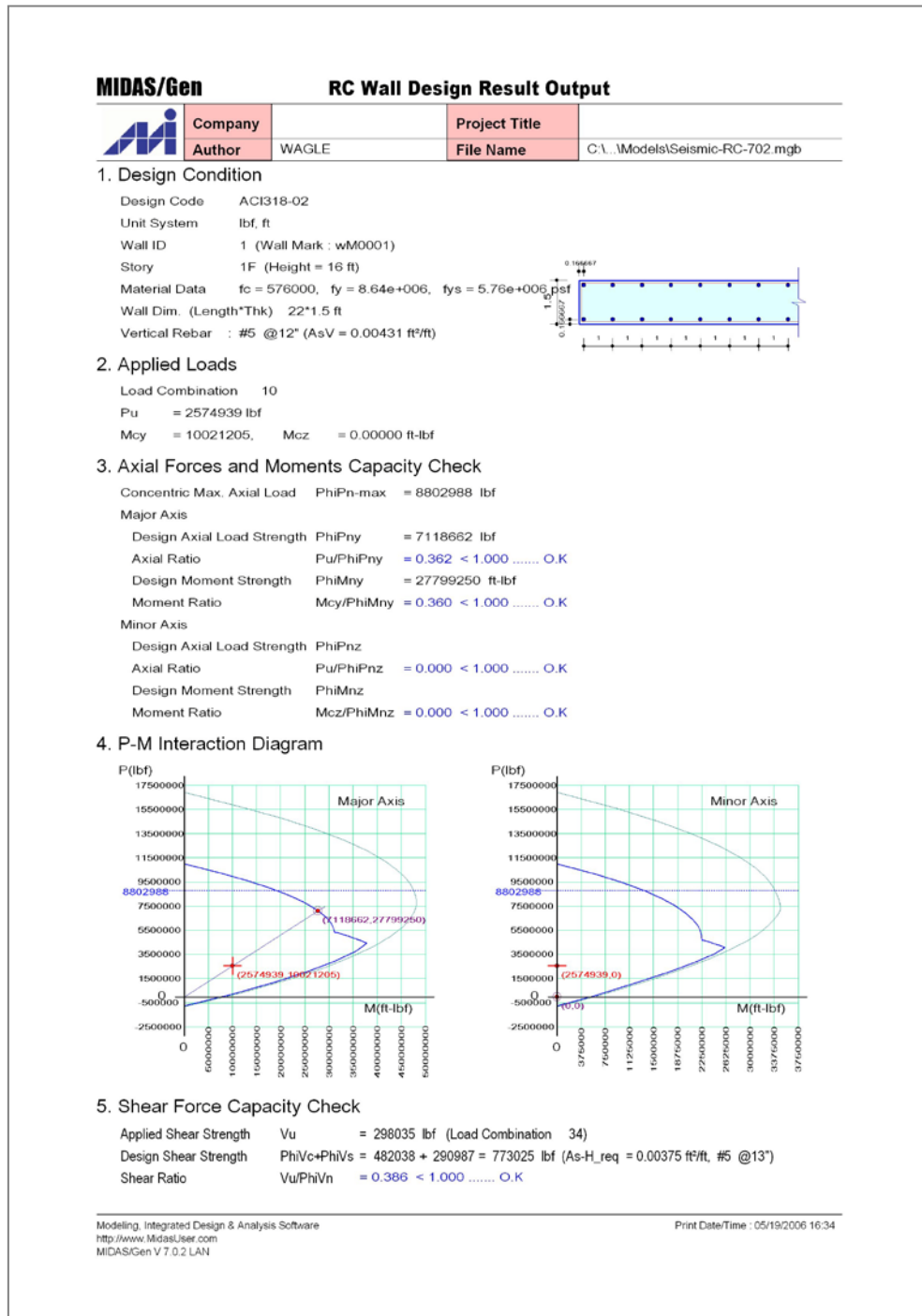


Figure 42 : Typical Output of Concrete Wall Design