Advanced Application 1

Steel Structure

Steel Structure

Summary

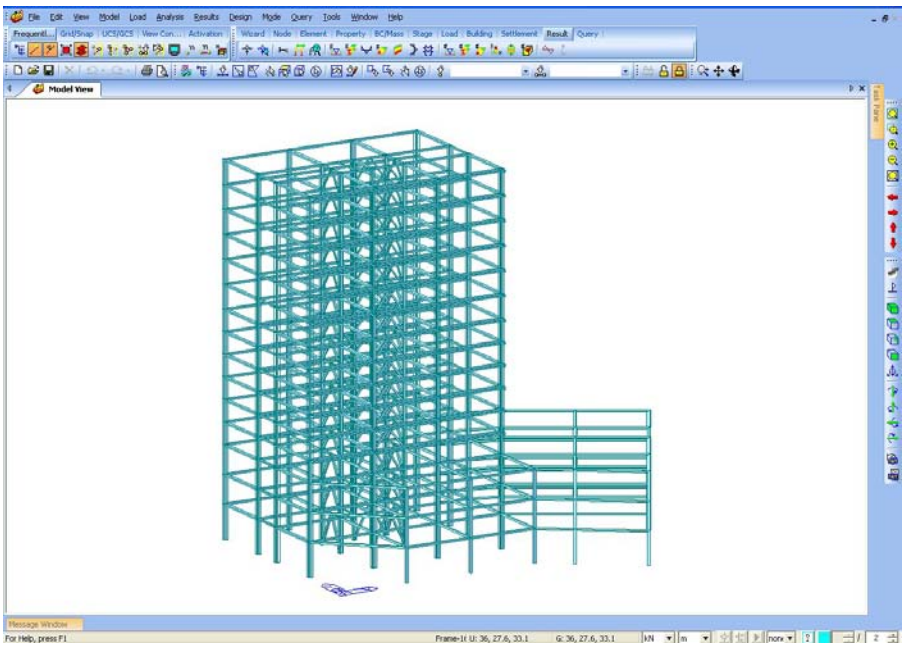
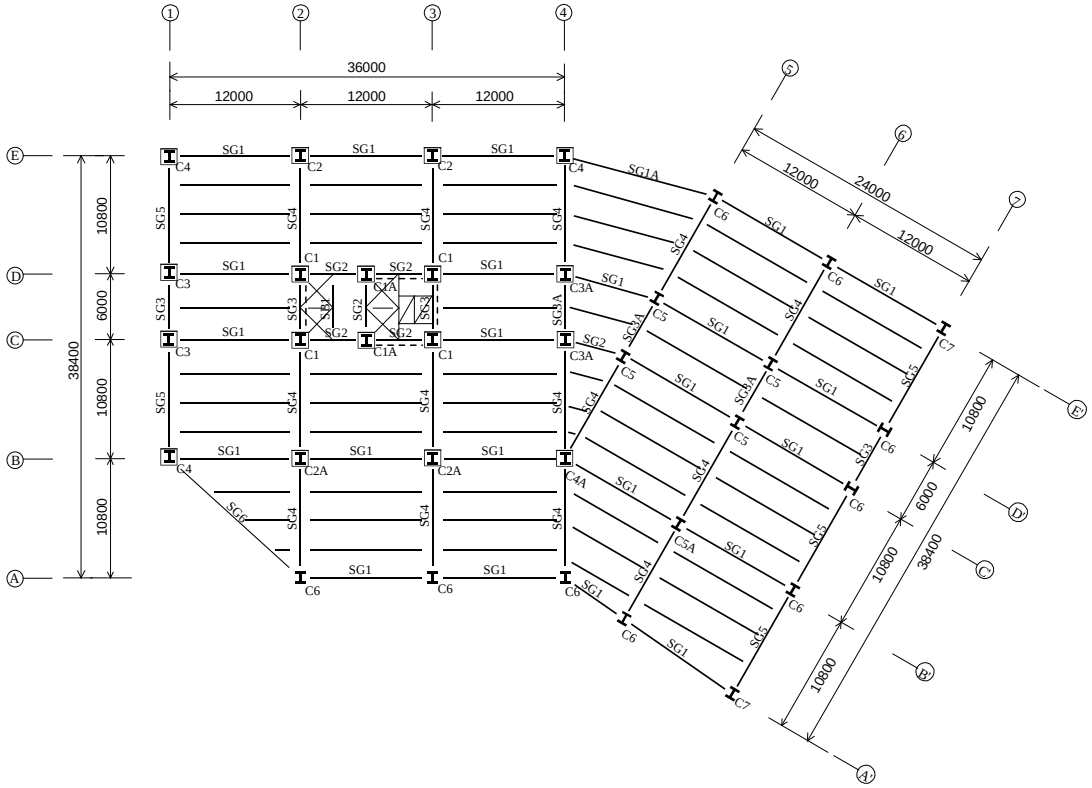


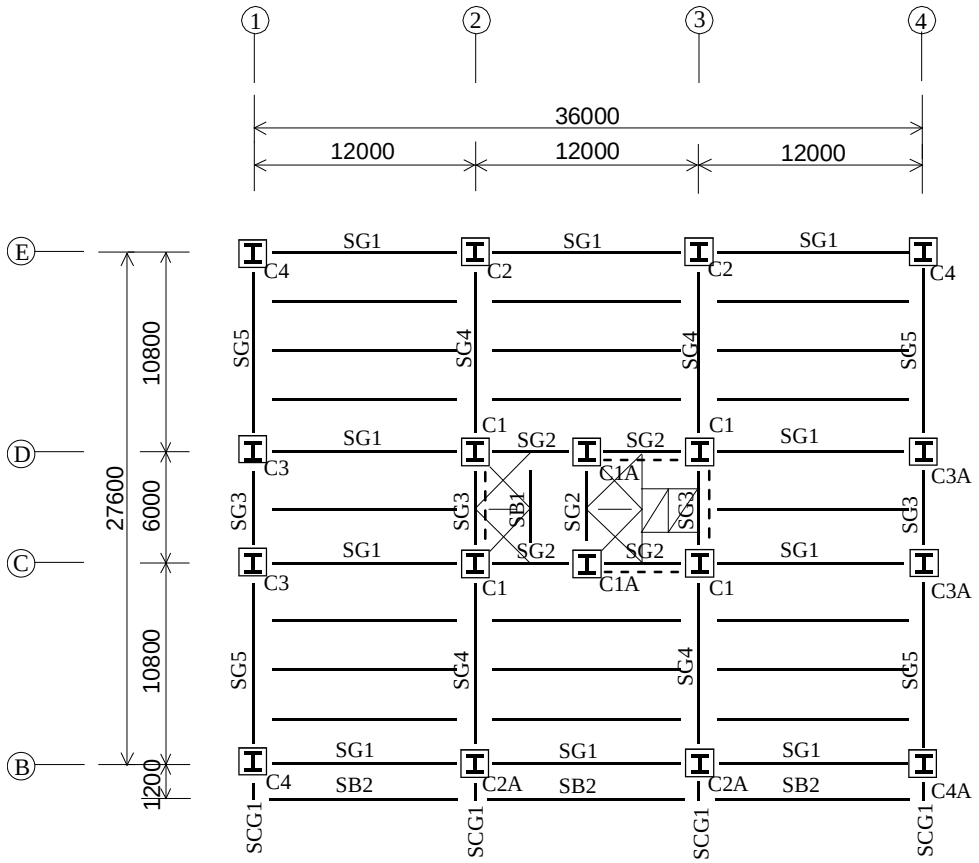
Figure 1.1 Steel Building

Structural Plans & Section



Element Name	Section ID	DB	Section Size
SG1	221	AISC	W24x76
SG2	222	AISC	W18x55
SG3	223	AISC	W18x55
SG4	224	AISC	W12x136
SG5	225	AISC	W24x103
SG6	226	AISC	W18x86
SB1	231	AISC	W12x26
SG1A	241	AISC	W12x53
SG3A	243	AISC	W24x76

Figure 1.2 Structural Plan of the lower part (2~4F)



Element Name	Section ID	DB	Section Size
SG1	521	AISC	W24x76
SG2	522	AISC	W21x62
SG3	523	AISC	W14x48
SG4	524	AISC	W27x129
SG5	525	AISC	W24x103
SB1	531	AISC	W12x26
SB2	532	AISC	W8x31
SCG1	571	AISC	W14x34

Figure 1.3 Structural Plan of the upper part (5~Roof)

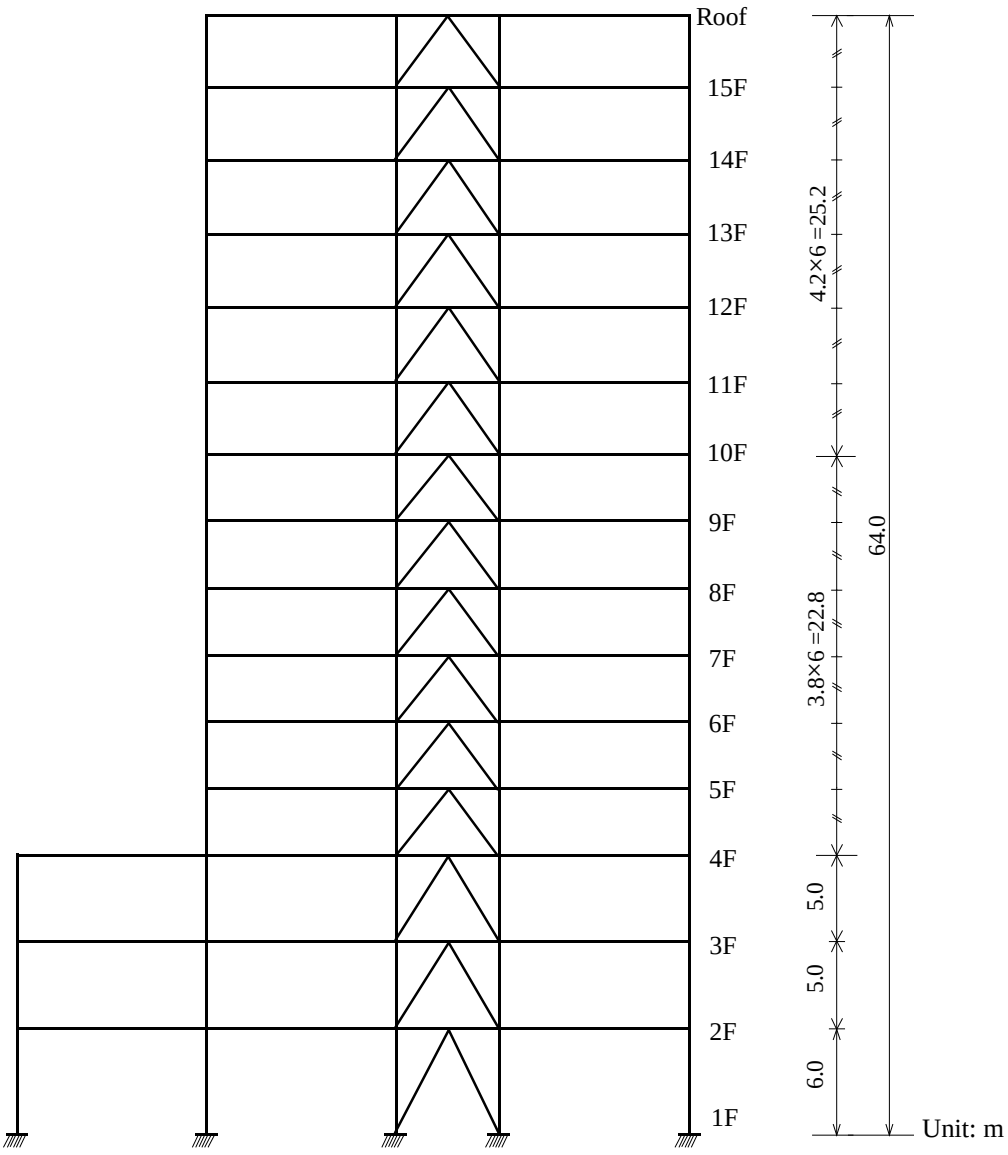


Figure 1.4 The cross section (Section–②)

Applied Codes

- Applied Load / UBC(1997)
- Steel Design Code / AISC-LRFD2K
- SRC Design Code / SSRC79

Used Materials

- Beam, Brace: A36

- Column: A572-50
  Concrete Grade C4000

Applied Loads

- **Gravity loads**

unit: kN/m^2

Use	Shop	Office	Roof
Floor	2~3	4~15	4, Roof
Dead Load	3.6	4.2	5.1
Live Load	3.9	2.5	2.0

- **Wind loads**

  - Basic Wind Speed: 80 mph
  - Exposure Category: C
  - Importance Factor: 1.0
  - Pressure Coefficient: 1.3

➢ **Seismic Load**

- Seismic Zone Factor: Z = 1 (0.075)
- Importance Factor: 1.0
- Soil Coefficient: Sc
- Height of the building: Hn = 64 m
- Width of the building: Bx = 70.58 m, By = 48.95 m
- Response Modification Coefficient
  Rx: 4.2 (Steel with steel OMRF)
  Ry: 4.2 (Steel with steel OMRF)

➢ **Unit Load Cases**

Load Case Number		Name	Applied loads
Static Load Cases	1	Self	Self weight
	2	DL	Dead Load
	3	LL	Live Load
	4	WX	Wind Load (X-direction in the global coordinates)
	5	WY	Wind Load (Y-direction in the global coordinates)
Dynamic Load Cases		RX	Response Spectrum Seismic Load (X-direction in the global coordinates)
		RY	Response Spectrum Seismic Load (Y-direction in the global coordinates)

Structural Modeling

Initial Window & Unit System Setting

File /  ***New Project***

File /  ***Save (Steel)***

Tools / ***Unit System***

Length > **m** ; Force > **N**

Tools / Customize / ***Toolbars***

Joint On/Off > **Node** (on), **Element** (on), **Property** (on)

(Refer to Figure 1.5)

 ***Point Grid*** (off),  ***Point Grid Snap*** (off),  ***Line Grid Snap*** (off)

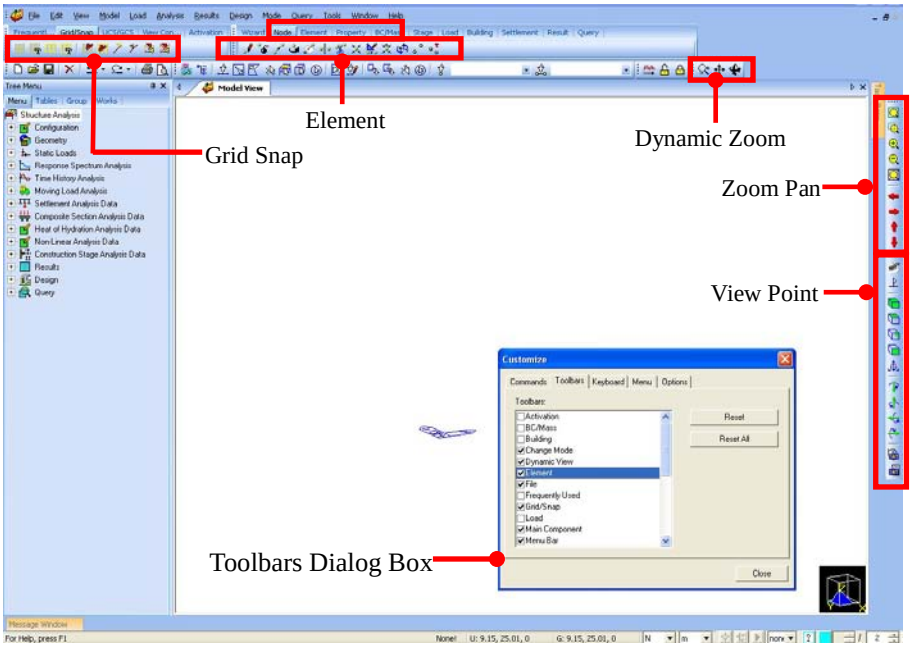


Figure 1.5 Initial Window Setting

Input Material Property & Section Data

Property Number	Name	Type	Property Type
1	Girder	Steel	A36
2	Steel Column	Steel	A53
3	SRC Column	SRC	A53 + Grade 3500
4	Brace	Steel	A36

Table 1.1 Used material properties

Model / Properties / ***Material***

Name > **Girder** ; Type > **Steel**

Standard > **ASTM(S)** ; DB > **A36**

Name > **Steel Column** ; Type > **Steel**

Standard > **ASTM(S)** ; DB > **A572-50**

Name > **SRC Column** ; Type > **SRC**

Steel Standard > **ASTM(S)** ; DB > **A572-50**

Concrete Standard > **ASTM(RC)** ; DB > **Grade4000**

Type > **Steel** ; Name > **Brace**

Standard > **ASTM(S)** ; DB > **A36** .↵

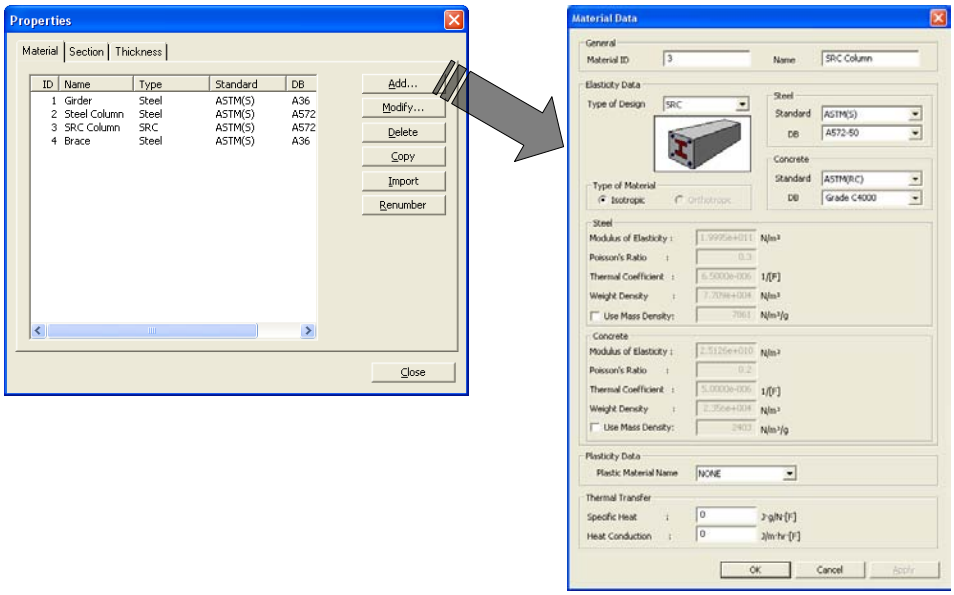
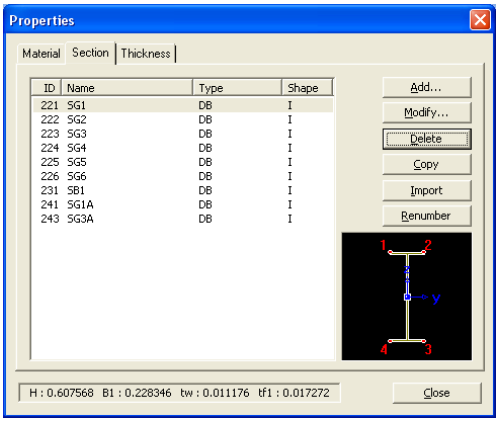


Figure 1.6 Input material properties

Figure 1.7 Input the section data of the lower part girders



(refer Figure 1.2 for section sizes)

Input the 2nd floor Elements

Hidden (on), ***Node Number*** (on), ***Element Number*** (on)

Model / Structure Wizard / ***Frame***

Input tab

X Coord. / Distance > **12** ; Repeat > **3**

Add X-Coord.

Z Coord./ Distance > **10.8** ; Repeat > **2**

Add Z-Coord.

Z Coord./ Distance > **6** ; Repeat > **1**

Add Z-Coord.

Z Coord./ Distance > **10.8** ; Repeat > **1**

Add Z-Coord.

Edit tab

Beta Angle > **90 Deg**.

Material > **1** ; Section > **221**

Insert tab

Insert Point > **0, 0, 6**

Rotations / Alpha > **-90** .

Zoom Fit

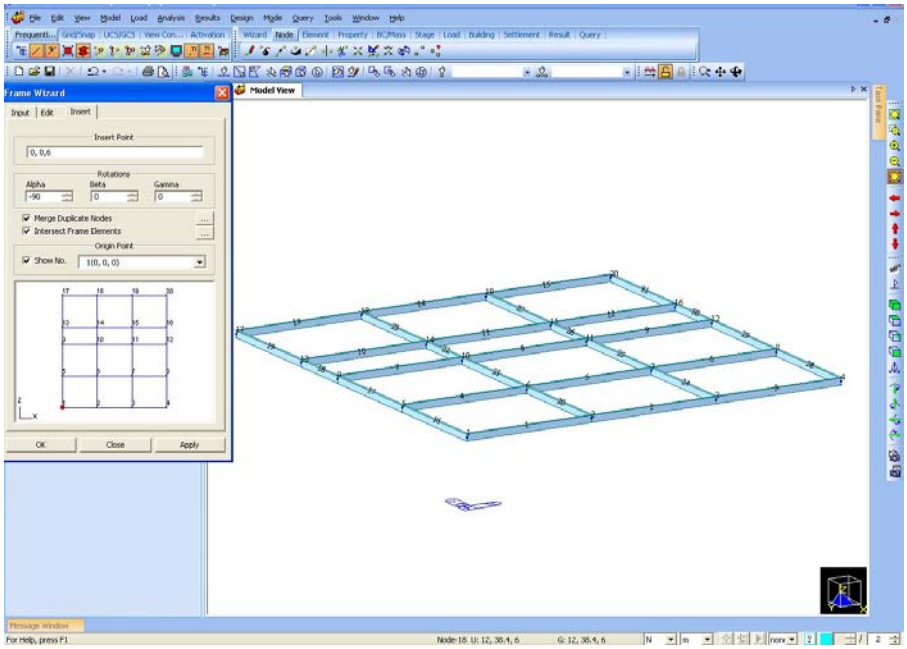


Figure 1.8 Create the 2nd floor elements using Frame Wizard

Top View

Select Window (Node 1)

Delete ↵

Model / Elements / ***Create Element***

Material Name> **1:Girder**

Section Name > **226:SG6**

Nodal Connectivity > **2**, **5**

Material Name> **1:Girder**

Section Name > **222:SG2**

Nodal Connectivity > Element **33** (Refer to Figure 1.9)

Material Name> **1:Girder**

Section Name > **231:SB1**

Nodal Connectivity > Element **36** (Refer to Figure 1.9)

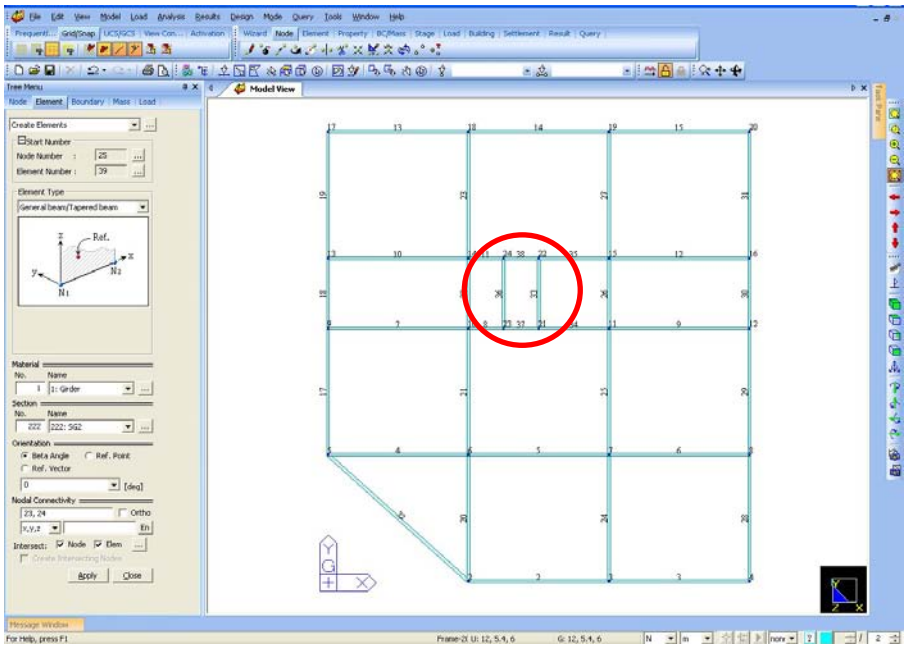


Figure 1.9 Modify the 2nd floor elements

Display > Node > **Node Number** (off)

Tree Menu > **Works tab**

Select Single (**8, 11, 34, 35, 37, 38**)

Display > Property > **Property Name** (on)

Properties > Section > **222:SG2** (Drag & Drop)

Similarly change properties of **SG1 to SG3A, SG4 & SG5** by Drag & Drop

(Refer to Figure 1.2)

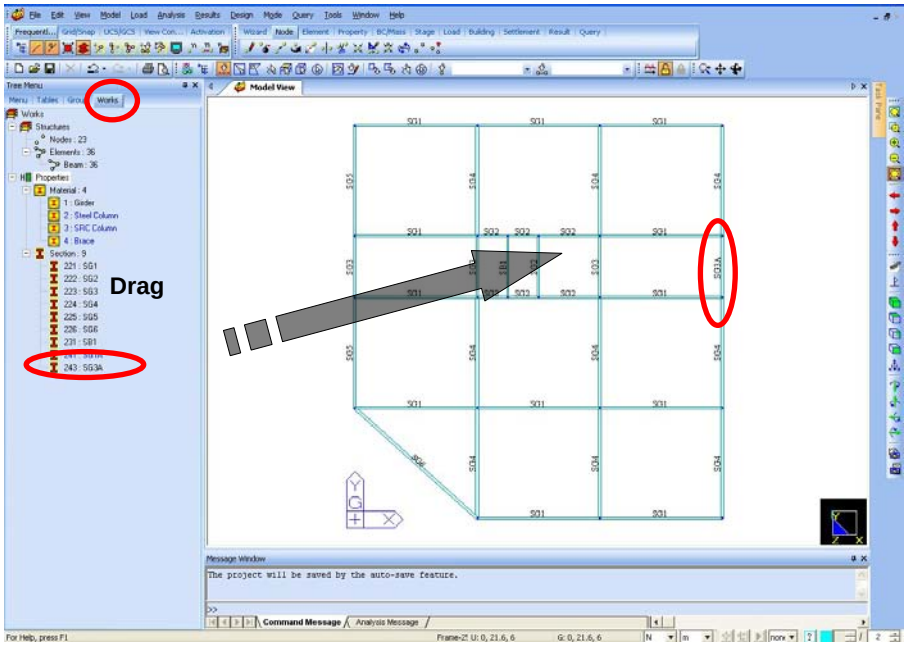


Figure 1.10 Change the section numbers using Drag & Drop

UCS & Line Grid Setting

Node Number (on)

Display > Property > **Property Name** (off)

X-Y

Coordinates Origin > **36, 10.8, 6** (**Node 8**)

Angle > **-30** ↵

Set Line Grid

Grid Name > **Skew Plane**

X-Grid Lines [Add]

Line > **2@12** . ↵

Y-Grid Lines [Add]

Levels > **-10.8, 2@10.8, 6, 10.8** ↵

Add/Modify Grid Lines ↵ ↵

Zoom Fit (on), ***Line Grid Snap*** (on)

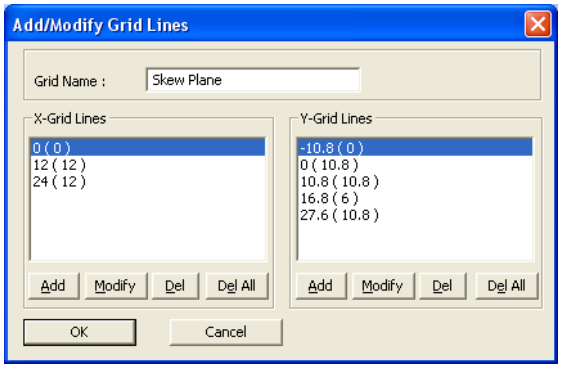


Figure 1.12 Define the grid lines

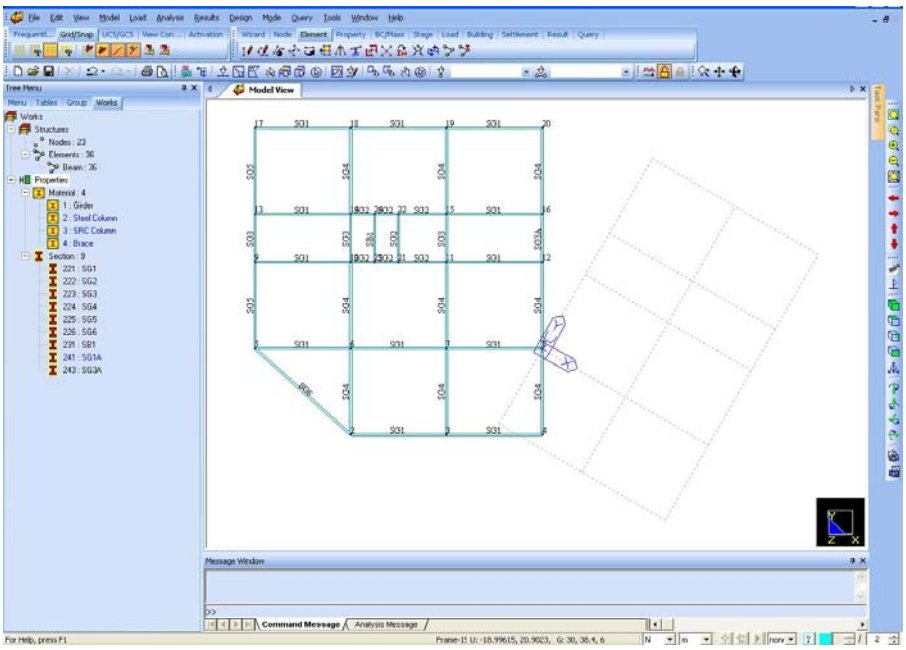


Figure 1.13 UCS & Line Grid setting

Create Elements of the Skewed Part

Model / Elements / ***Create Elements***

Section Name > **221:SG1**

Nodal Connectivity > **Node 4 & corner of Line Grid**

(Refer to ❶ of Figure 1.14)

Create the Remainders (Refer to Figure 1.15)

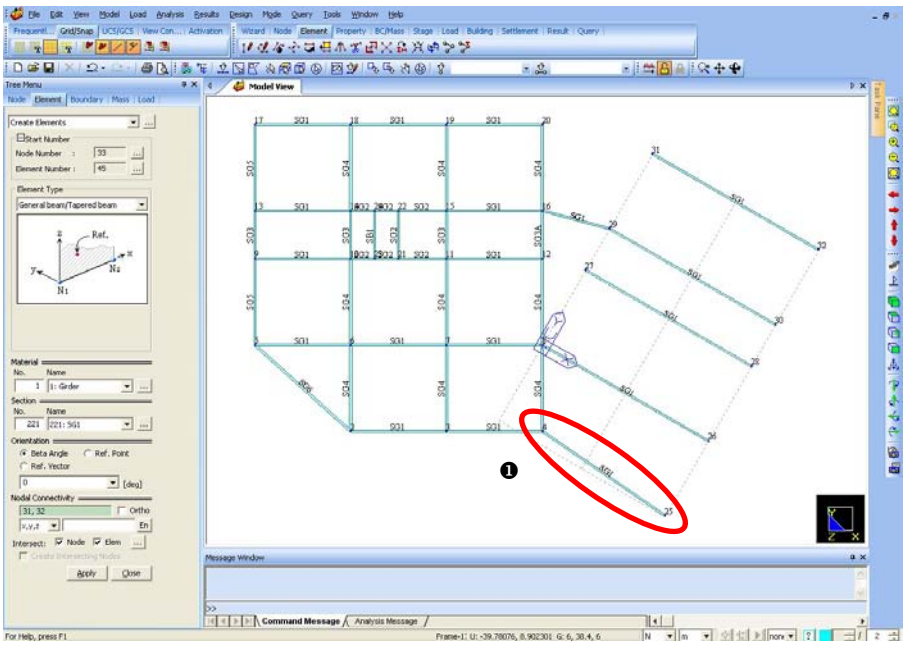


Figure 1.14 Input SG1 of the 2nd floor of the skewed part

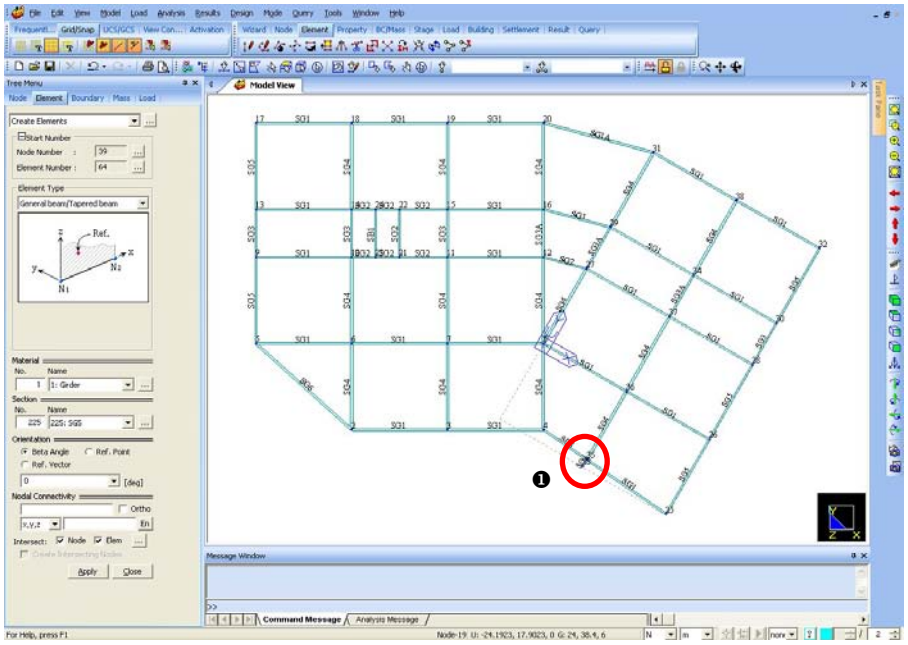


Figure 1.15 Input the beam element of the 2nd floor of the skewed part

Select Single (**unnecessary node & element**; ❶ of Figure 1.15)

Delete ↵

Display Reset All ↵

GCS (on), ***Line Grid*** (off), ***Line Grid Snap*** (off)

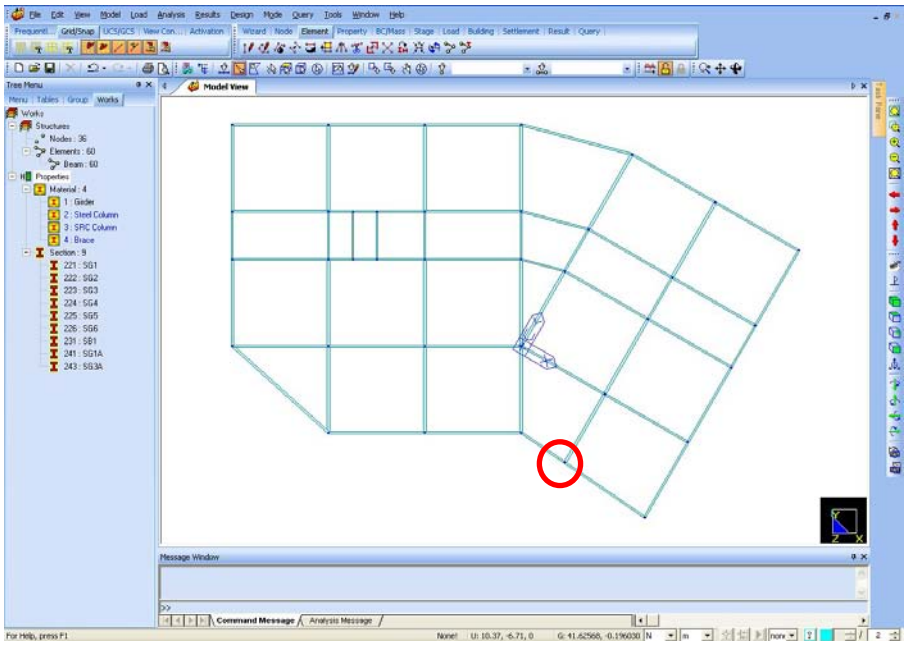


Figure 1.16 Delete the unnecessary node and element

Input the Beam End Release Conditions

Display > Property > **Property Name** (on) ↵

Select Single (**SB1-element 36**)

Model Entity tab/ ***Boundary***

Beam End Release (Refer to ❶ of Figure 1.17)

Pined-Pined ↵

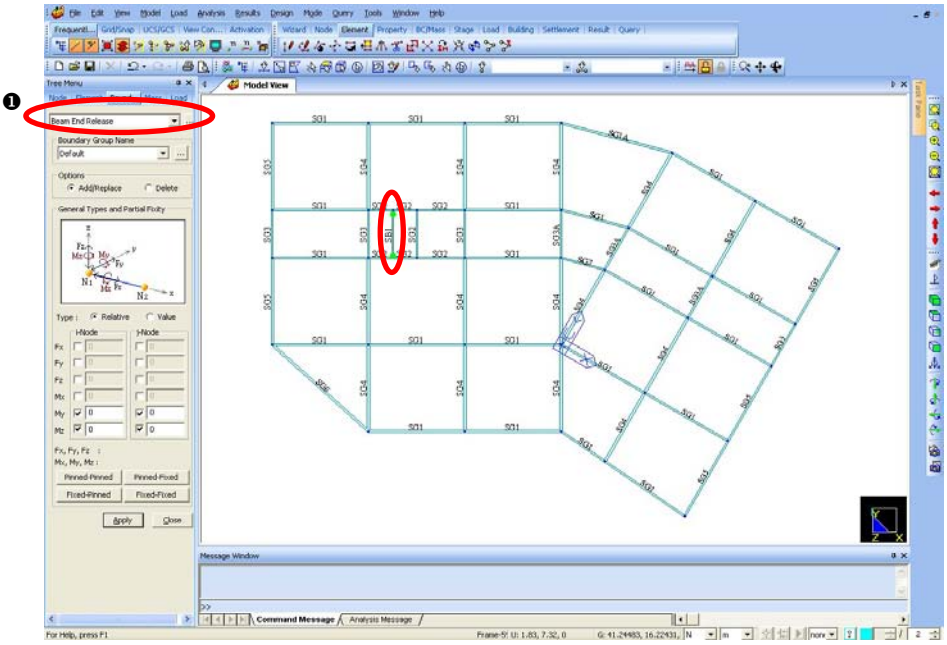


Figure 1.17 Input the Beam End Release condition

The following column section data have been inputted in the file Steel(import).mgb

		C1			C1A		
Unit	Story	Section Number	Steel	RC	Section Number	Steel	RC
6	14~15	106	W 14 × 176	700 × 700	156	W 10 × 54	600 × 600
5	11~13	105	W 14 × 145	700 × 700	155	W 10 × 54	600 × 600
4	8~10	104	W 14 × 176	700 × 700	154	W 10 × 54	600 × 600
3	5~7	103	W 14 × 211	700 × 700	153	W 12 × 72	600 × 600
2	3~4	102	W 18 × 258	700 × 700	152	W 12 × 72	600 × 600
1	1~2	101	W 18 × 258	700 × 700	151	W 12 × 136	600 × 600

		C2			C2A		
Unit	Story	Section Number	Steel	RC	Section Number	Steel	RC
6	14~15	206	W 14 × 109	700 × 700	256	W 12×96	700 × 700
5	11~13	205	W 14 × 109	700 × 700	255	W 12×65	700 × 700
4	8~10	204	W14 × 120	700 × 700	254	W 14×109	700 × 700
3	5~7	203	W 14 × 159	700 × 700	253	W 14×176	700 × 700
2	3~4	202	W 18 × 175	700 × 700	252	W 14×193	700 × 700
1	1~2	201	W 18 × 211	700 × 700	251	W 14×283	700 × 700

Table 1.2 Column Section Data (1)

		C3			C3A		
Unit	Story	Section Number	Steel	RC	Section Number	Steel	RC
6	14~15	306	W 12 × 72	700×700	356	W 12×96	700×700
5	11~13	305	W 12 × 65	700×700	355	W 12×65	700×700
4	8~10	304	W 12 × 65	700×700	354	W 12×65	700×700
3	5~7	303	W 12 × 96	700×700	353	W 12×96	700×700
2	3~4	302	W 12 × 120	700×700	352	W 14×145	700×700
1	1~2	301	W 12 × 152	700×700	351	W 14×193	700×700

		C4			C4A		
Unit	Story	Section Number	Steel	RC	Section Number	Steel	RC
6	14~15	406	W12 × 96	700×700	456	W 12×96	700×700
5	11~13	405	W 12 × 65	700×700	455	W 12×65	700×700
4	8~10	404	W 12 × 65	700×700	454	W 12×65	700×700
3	5~7	403	W 12 × 65	700×700	453	W 14×99	700×700
2	3~4	402	W 14 × 120	700×700	452	W 14×99	700×700
1	1~2	401	W 14 × 159	700×700	451	W 14×176	700×700

		C5			C5A		
Unit	Story	Section Number	DB	Steel	Section Number	DB	Steel
2	3	502	AISC	W 14×99	552	AISC	W 12×65
1	1~2	501	AISC	W 14×132	551	AISC	W 14×132

		C6			C7		
Unit	Story	Section Number	DB	Steel	Section Number	DB	Steel
2	3	602	AISC	W 14×176	702	AISC	W 14×176
1	1~2	601	AISC	W 14×176	701	AISC	W 14×176

Table 1.2 Column Section Data (2)

Typical method for inputting SRC sections:

Model / Properties / ***Section***

Add> **SRC tab**

Section ID > **101** ; Name > **C1**

Shape > **Rect-IBeam**

Concrete Data

HC > **0.7** ; BC > **0.7**

Steel Data / DB > **AISC**

Steel Name > **W 18×258**

Material > Select Material from DB...

Concrete Material>DB>**ASTM(RC)**

Concrete Material / Name > **Grade C4000**

Steel Material>DB>**ASTM(S)**

Steel Material / Name > **A572-50** ↵

Replace steel **(on) ;** Shear Deformation **(on)** ↵

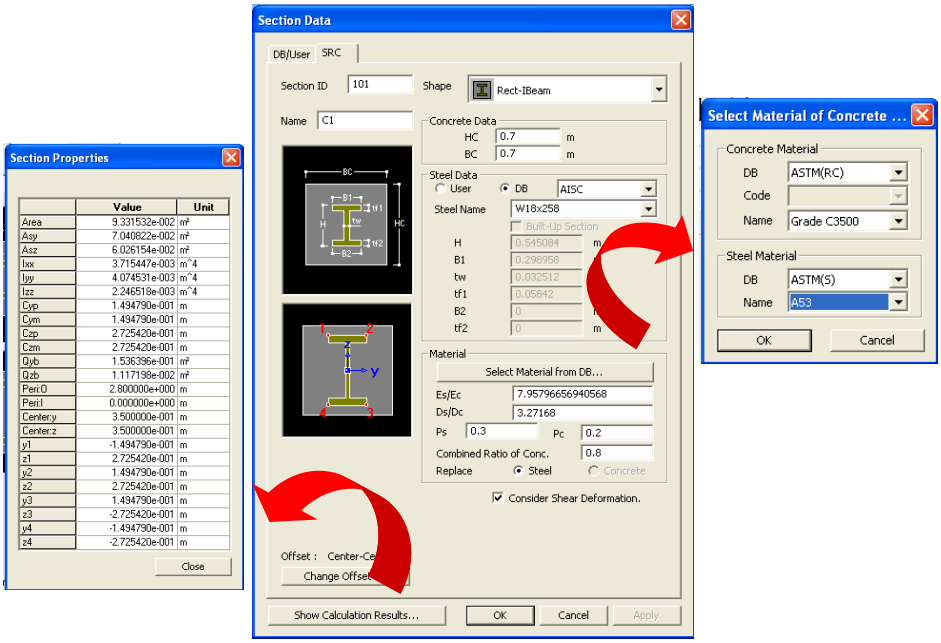


Figure 1.18 Input SRC Sections

Model / Properties / *Section* > Import (❶ of Figure 1.19)

Application folder > **Steel(import).mgb** Open

Import the column section data > None

Close

(Refer to Figure 1.20)

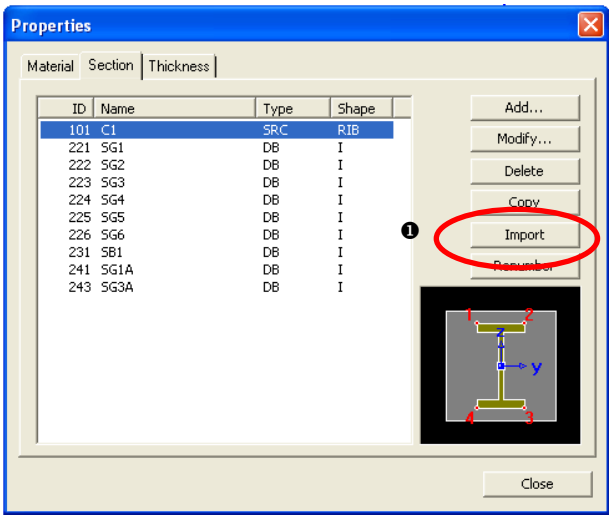


Figure 1.19 Section data before Import

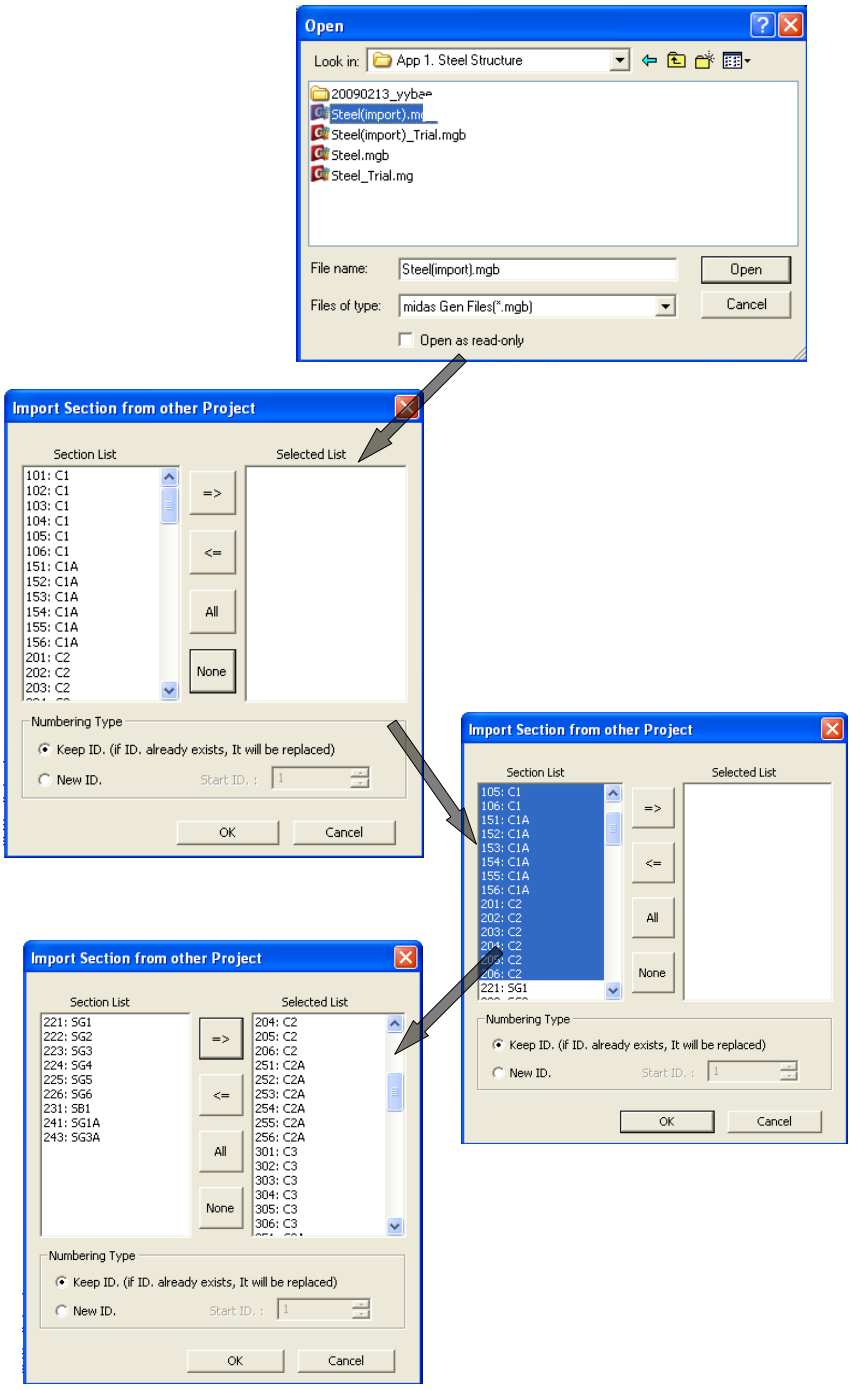


Figure 1.20 Input the section data using import function

Input Columns

Redraw

Node Number (on)

Display > Property > **Property Name** (off) ↵

Iso View, ***Rotate Dynamic*** ***Zoom Fit*** (Refer to Figure 1.21)

Select All

Unselect Window (**Node 23, 24**)

Model / Elements / ***Extrude Elements***

Extrude Type > **Node → Line Element**

Reverse I-J (on) ; Element Type > **Beam**

Material > **3 : SRC Column** ; Section > **101 : C1**

Generation Type > **Translate** ; Translate > **Equal Distance**

Beta angle > **0** ; Number of Times > **1**

dx, dy, dz > **0, 0, -6** ↵

Display > Element > **Local Direction** (on) ↵

Display > Element > **Local Direction** (off) ↵

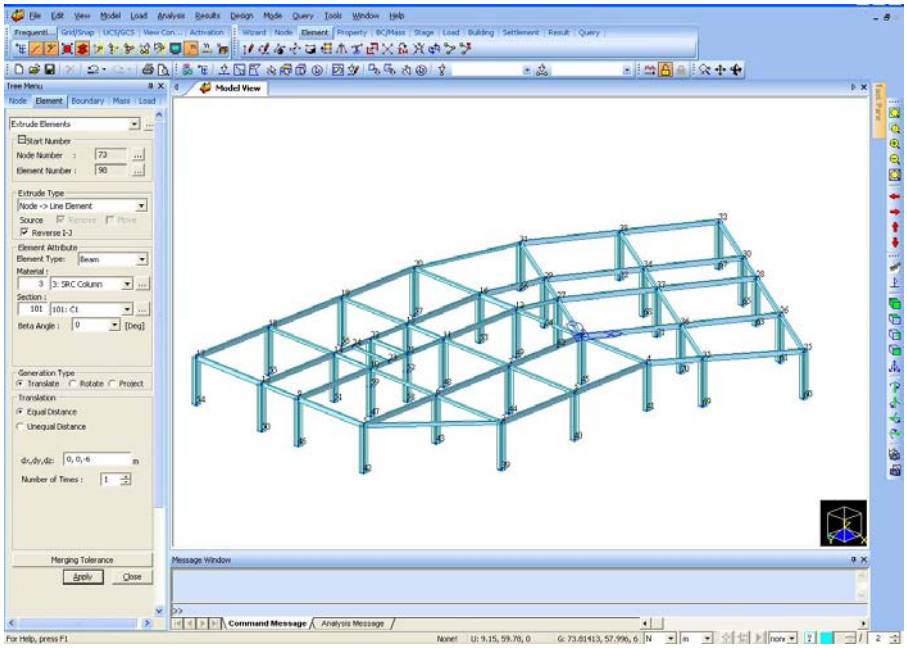


Figure 1.21 Create the columns of the 1st floor

Select Recent Entities **(Columns)**

Model > Elements > ***Change Element Parameters***

Parameter Type > Element Local Axis

Mode > Assign > Beta Angle > **90** ↵

Select Previous

Unselect Polygon (Columns with Beta Angle = 90°)

Beta Angle > **60** ↵

Select Single (Refer to ❶ of Figure 1.22)

Assign > Beta Angle > **-30** ↵

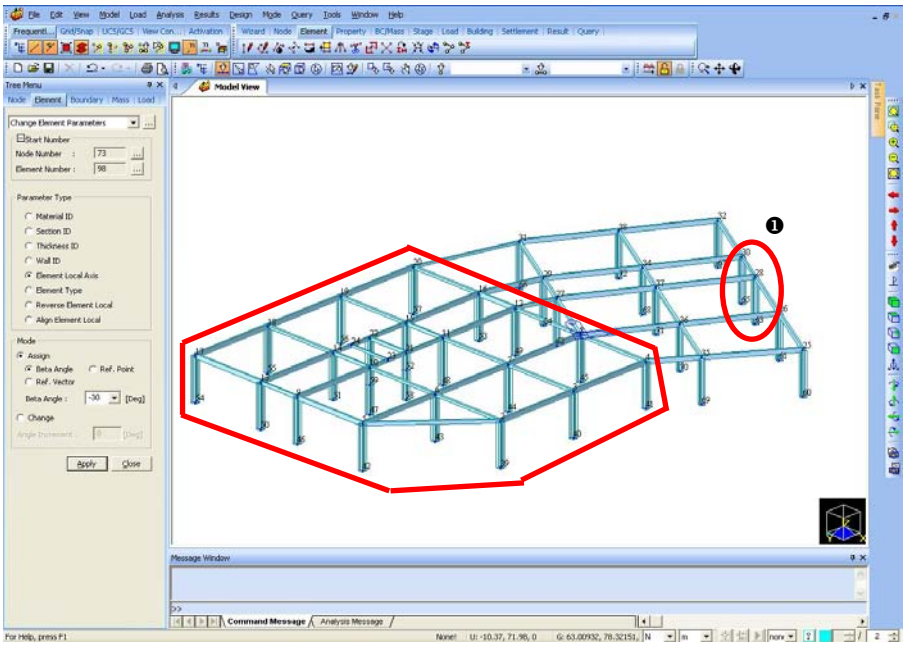


Figure 1.22 Unselect Polygon

Status bar > Filter > **z (Columns)**

Select All

Unselect Polygon (**Columns**) (Refer to Figure 1.23)

Tree Menu / **Works tab**

Properties > Material > **2 : Steel Column** (Drag & Drop)

Select All, ***Active***, ***Node Number*** (off)

Display > Property > **Property Name** (on) ↵

Select Single (E**lements 83, 84**) (Refer to Figure 1.24)

Properties > Material > **151 : C1A** (Drag & Drop)

Modify the others in the same way (Refer to Figure 1.2)

Active All

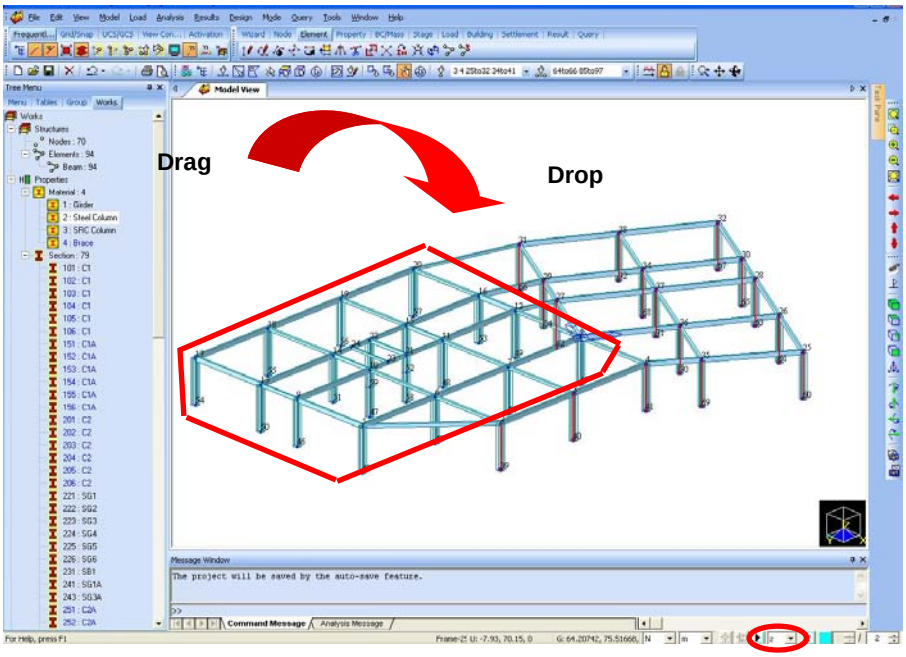


Figure 1.23 Modify beta angles and material properties

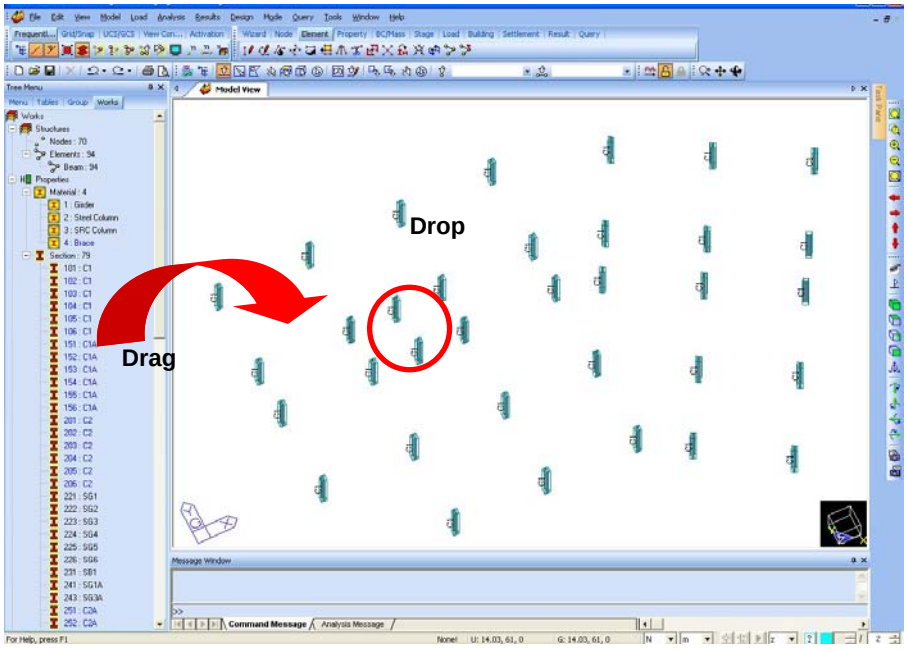


Figure 1.24 Modify the column number using Drag & Drop

Input the Diagonal Elements

Story	X-direction		Y-direction	
	Section Number	Section size	Section Number	Section size
4~15	1002	W 12 × 40	2002	W 14 × 68
1~3	1001	W 10 × 60	2001	W 14 × 68

Table 1.3 Section list of the diagonal elements

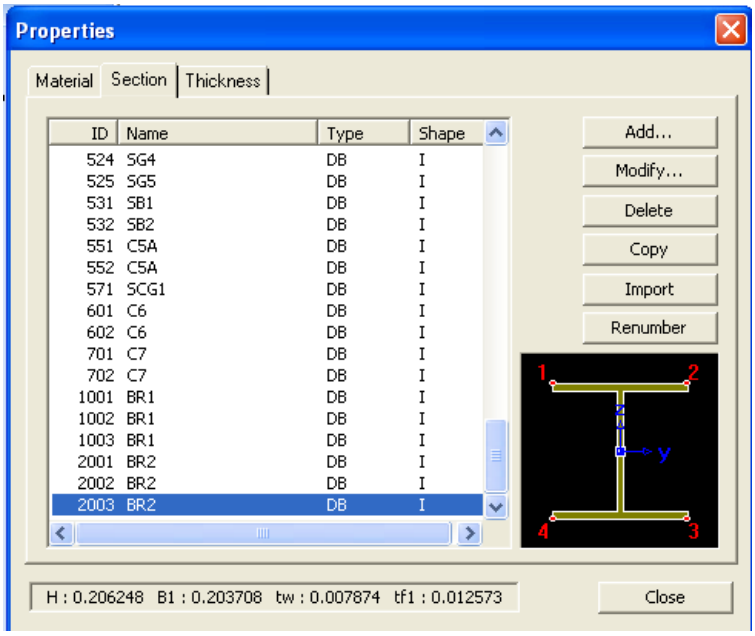


Figure 1.25 Input the Brace section data

Shrink (off)

Zoom Window (**core part**)

Node Number (on) , ***Element Number*** (on)

Model > Elements > ***Create Elements***

Element Type > **Truss**

Material Name > **4 : Brace**

Section Name > **1001 : BR1**

Nodal Connectivity > **X-directional Braces** (Refer to Figure 1.26)

Section No. > **2001:BR2**

Nodal Connectivity > **Y-directional Braces** (Refer to Figure 1.26)

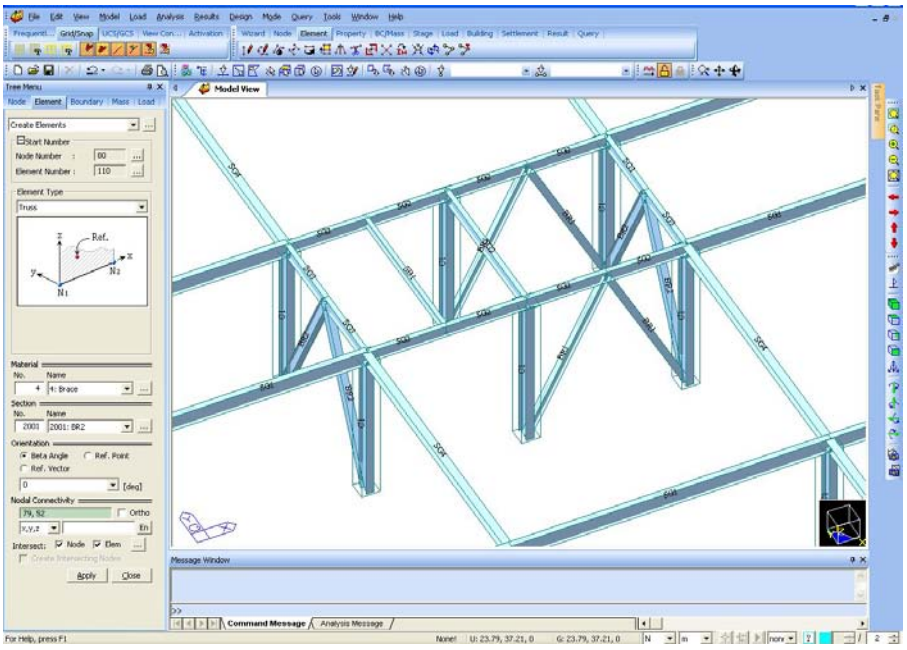


Figure 1.26 Input the Braces

Building Generation

Auto Fitting (on)

Node Number (off), ***Elements Number*** (off)

Status bar > Filter > **none**

Select All

Model / Building / ***Building Generation***

Building Generation > Number of Copies > **2**

Distance(Global Z) > **5** ; Operations > Add

Building Generation > Number of Copies > **6**

Distance(Global Z) > **3.8** ; Operations > Add

Building Generation > Number of Copies > **6**

Distance(Global Z) > **4.2** ; Operations > Add

Building Generation Table>

Insert the increment of the section numbers (Refer to Figure 1.27)

Copy Element Attributes (on) > ...

Boundaries > **Beam Release** (on) ↵ ↵

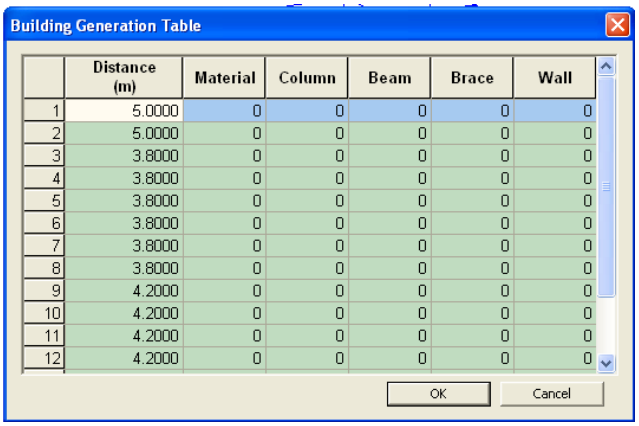


Figure 1.27 Building Generation Table

Select Plane

XY Plane > Z Position > **64** ↵

Active

Display > Boundary > **Beam End release Symbol** (on) ↵

Display > Boundary > **Beam End release Symbol** (off) ↵

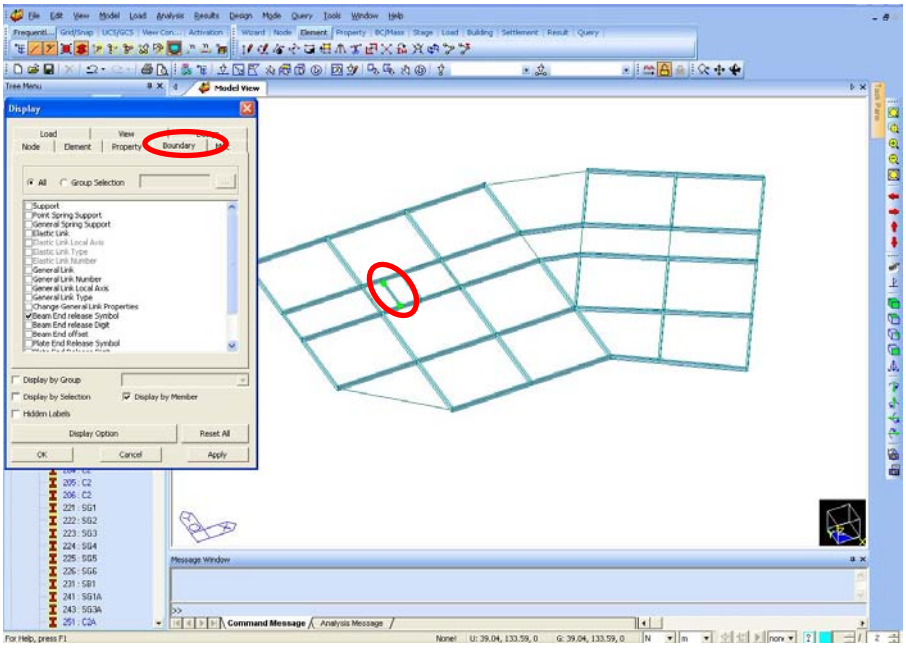


Figure 1.28 Building Generation

Modify the upper part of the model

Element Name	Section Number	Section Size
SG1	521	W 24 × 76
SG2	522	W 21 × 62
SG3	523	W 14 × 48
SG4	524	W 27 × 129
SG5	525	W 24 × 103
SB1	531	W 12 × 26
SB2	532	W 8 × 31
SCG1	571	W 14 × 34

Table 1.4 Sections of the upper part beams/girders

 ***Active All,***  ***Top View***

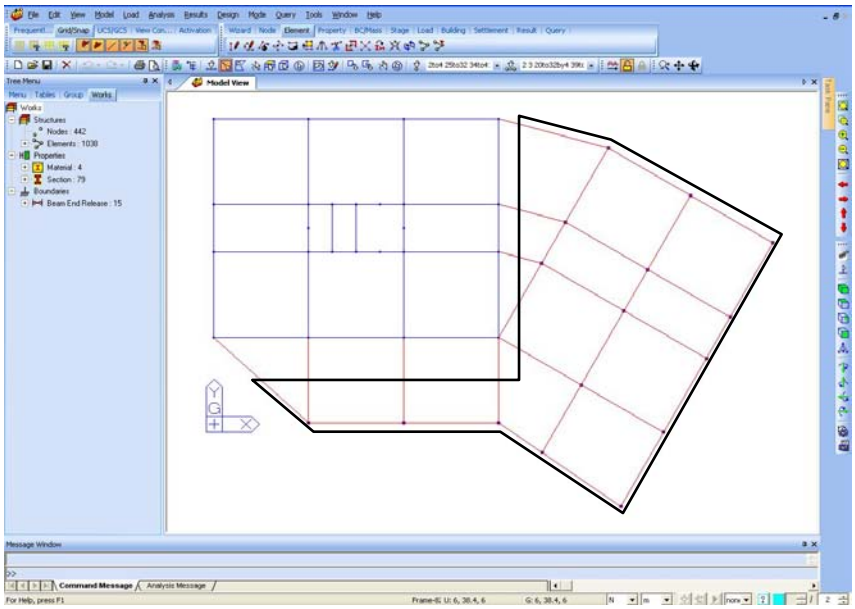
 ***Select Polygon*** + **Ctrl key** in Keyboard (**Top View of Figure 1.29**)

 ***Front View***

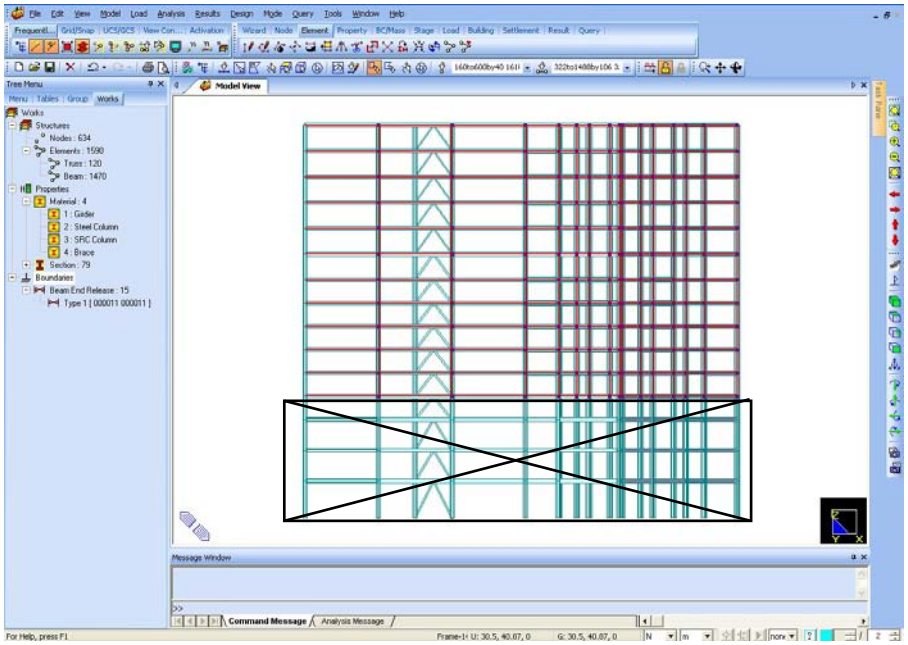
 ***Unselect Window*** (**Front View of Figure 1.29**)

 ***Iso View***

Delete Key in Keyboard (**Selected Nodes & Elements**)



Top view



Front view

Figure 1.29 Select the non-existent elements

 ***Select-Identity Element***

Select Type > **Section**

List > **543** Add, Close

Tree Menu / **Works tab**

Properties>Section > **523:SG3** (Drag & Drop)

 ***Select-Identity Element***

Select Type > **Section**

List > **524 : SG4**

Add, Close

 ***Top View***

 ***Unselect Window*** (Refer to Figure 1.31)

Tree Menu/ **Works tab**

Properties > Section > **525:SG5** (Drag & Drop)

 ***Iso View***

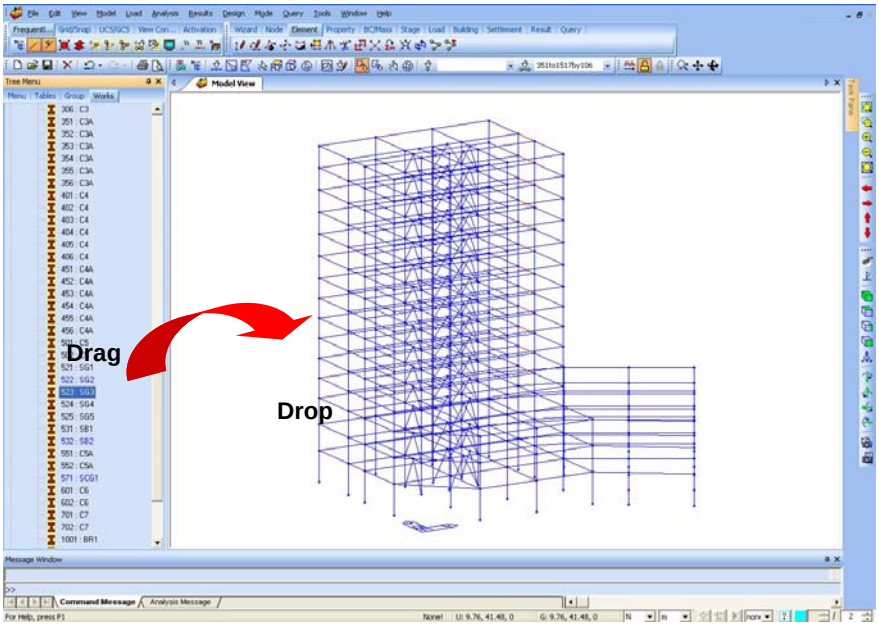


Figure ***1.30 Modify the model using Works Tree***

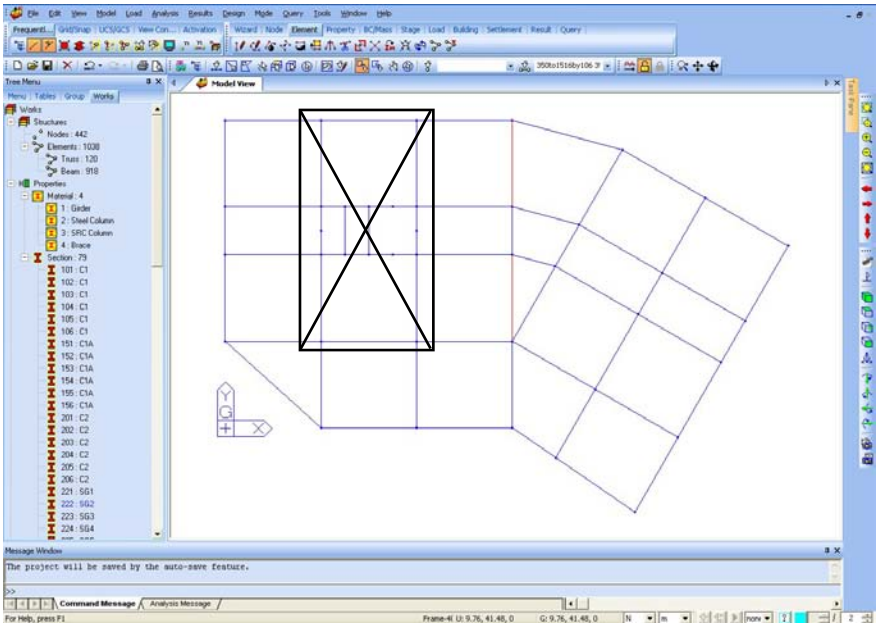


Figure 1.31 Modify the model using Unselect Window

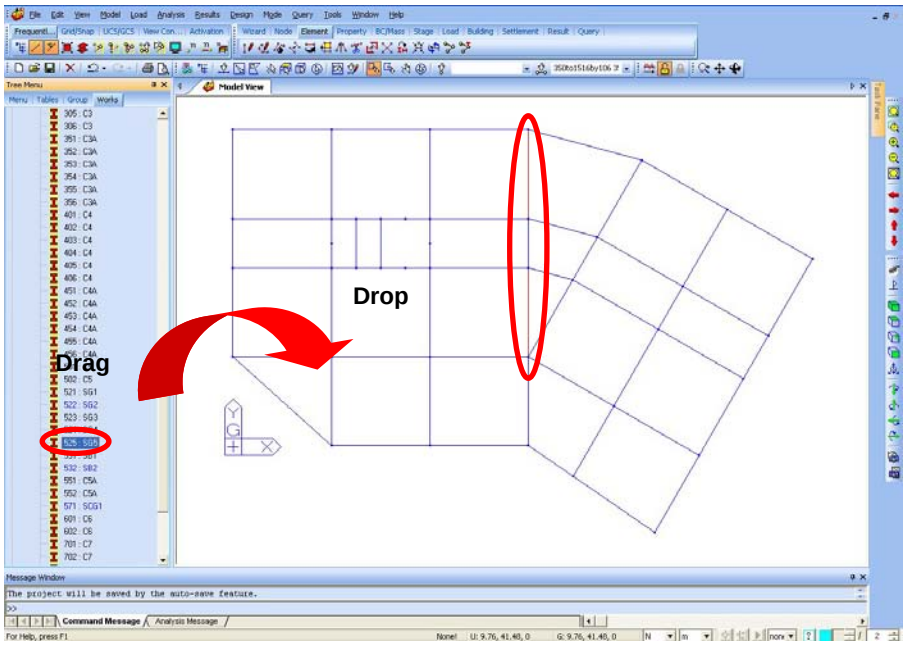


Figure 1.32 Modify the upper part of the model

Input Story Data

Model / Building / ***Story***

Auto Generate Story Data ↵

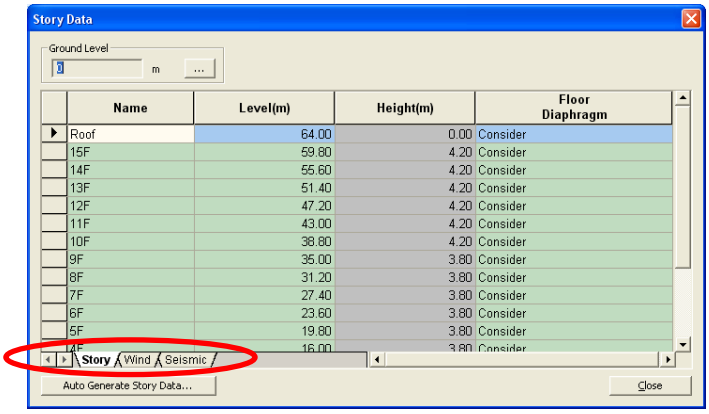


Figure 1.33 Story Data

Input the Cantilever Beams

Model / ***Named Plane***

Plane Name > **B**

Plane Type > **X-Z Plane**

Y Position > **10.8**

Add

Select All

Active Identity > Named Plane > **B**

Active, Close

Display > Node > **Story Name** (on)

Display > Boundary > **Beam End release Symbol** (on) ↵

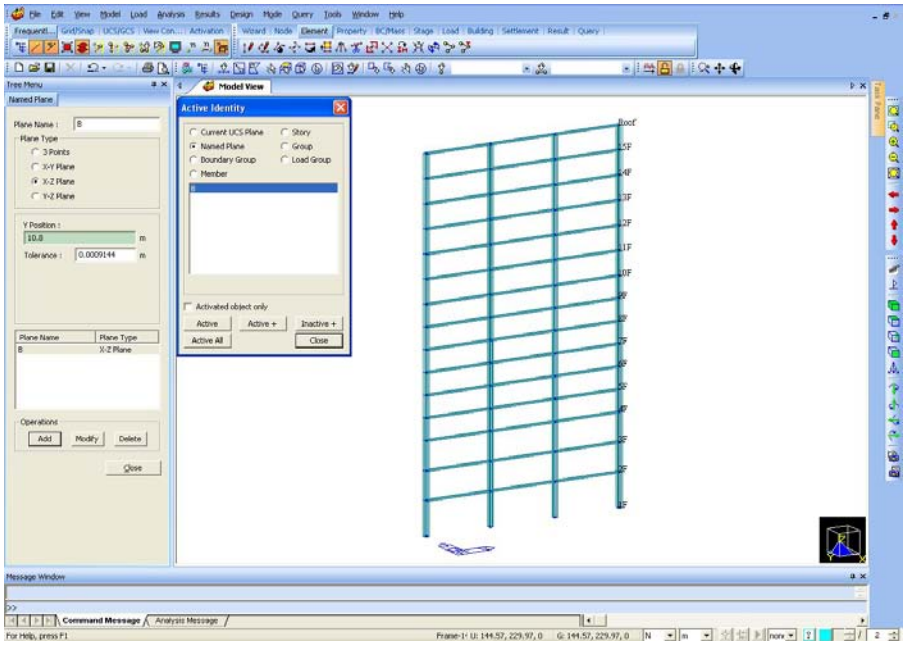


Figure 1.34 Activate the Named Plane

Model / Elements / ***Extrude Elements***

Extrude Type > **Node →Line Element > Reverse I-J** (on)

Element Type > **571:SCG1 ;** Material > **1:Girder**

Section > **571:SCG1**

Equal Distance > dx, dy, dz > **0, -1.2, 0**

Number of Times > **1**

Select Polygon (**Nodes over the 5th Floor**) ↵

Model / Elements / ***Create Elements***

Element Type > **General beam/Tapered beam**

Material > **1:Girder** ; Section No. > **532:SB2**

Zoom Window (**the grid of the 5th Floor**)

Nodal Connectivity > **637**

Zoom Fit

Zoom Window (**the grid of the 5th Floor**)

Zoom Window (off)

Nodal Connectivity > **637, 640**

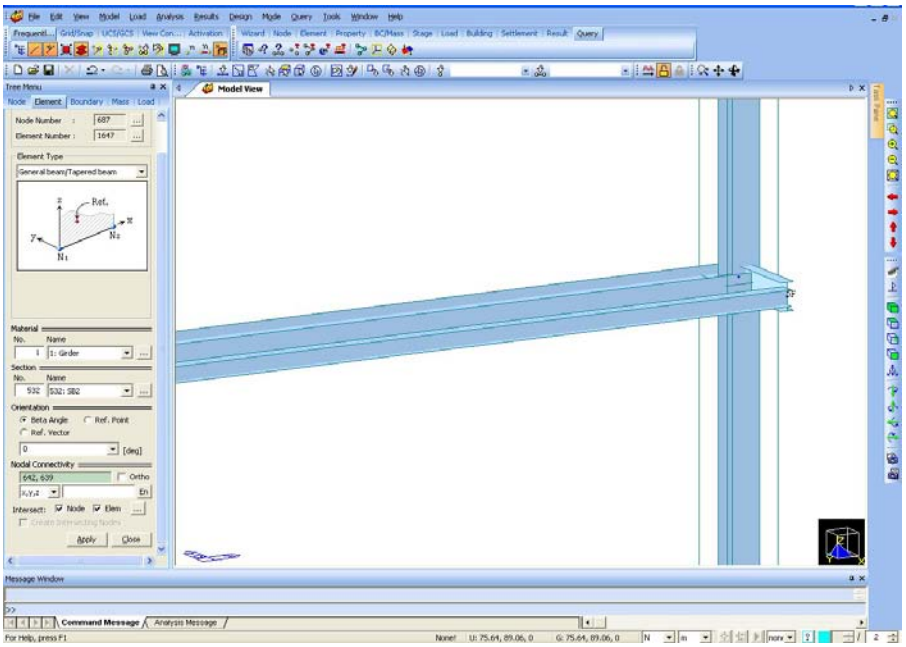


Figure 1.35 Input the Cantilever Beam

Zoom Fit

Select Recent Entities

Model Entity tab / Boundary

Beam End Release

Pined-Pined ↵

Select Previous

Model / Elements / ***Translate Elements***

Translation > **Unequal Distance**

Axis > **Z**

Distances > **5@3.8, 6@4.2**

Copy Node Attributes (on)

Copy Element Attributes (on) ↵

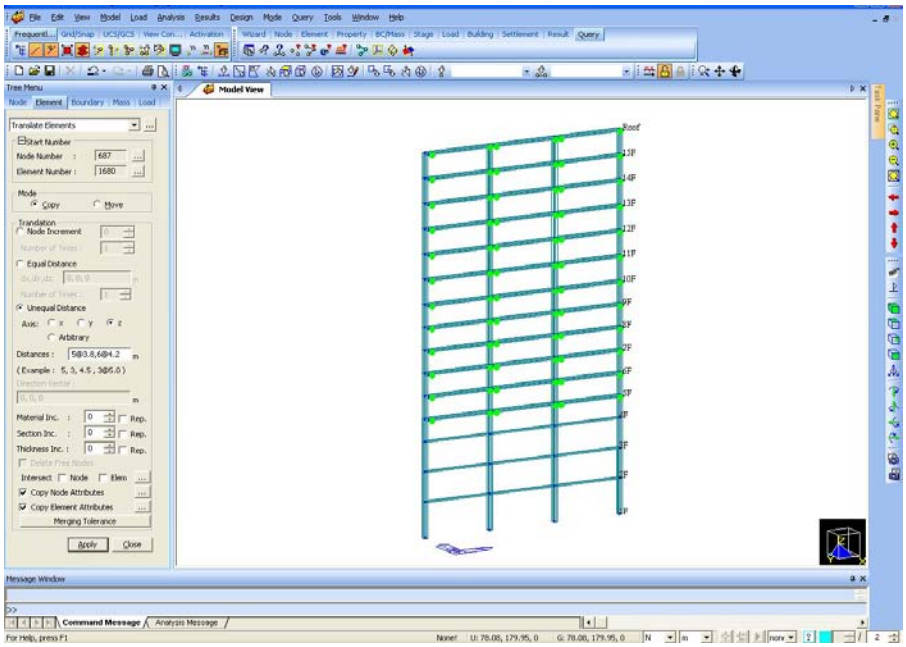


Figure 1.36 Copy the outer Cantilever Beam

Input the Boundary Conditions

Active All

Display > Node > **Story Name** (on) ↵

Select Plane

XY Plane > Z Position > **0**

Model Entity tab / Boundary

Supports

D-All (on) ; **R-All** (on) ↵

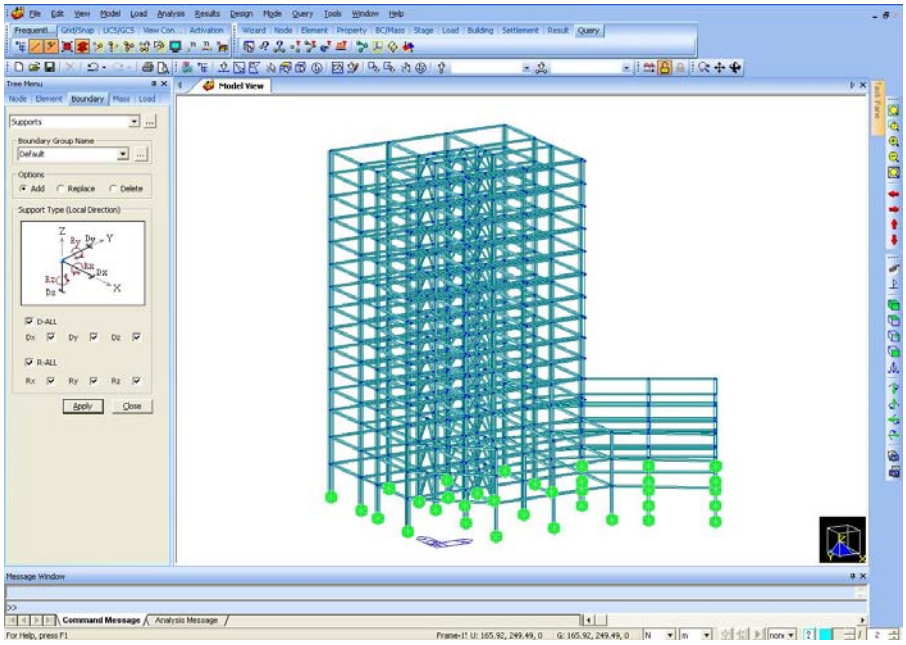


Figure 1.37 Input the Support Condition of the structure

Input Loads

Load Cases Setting

Load / ***Static Load Cases***

Input as Figure 1.38

Close

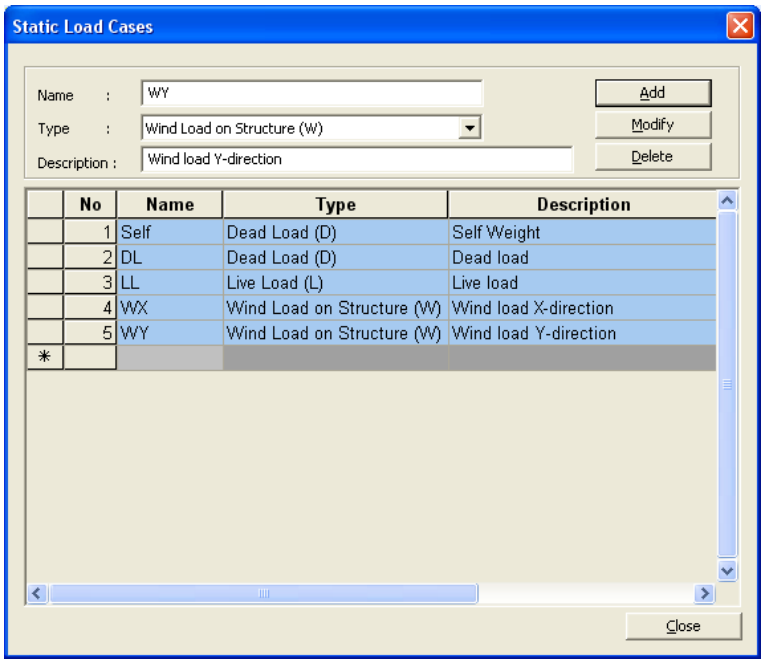


Figure 1.38 Static unit load case setting

Input Self-weight

Refer to other “Tutorials”.

Input the Floor Loads

Model Entity tab / Load

Assign Floor Loads

Load Type > ...

Define Floor Load Type (Refer to Figure 1.39)

Refer to "**Applied Loads**" on page 5.

Close

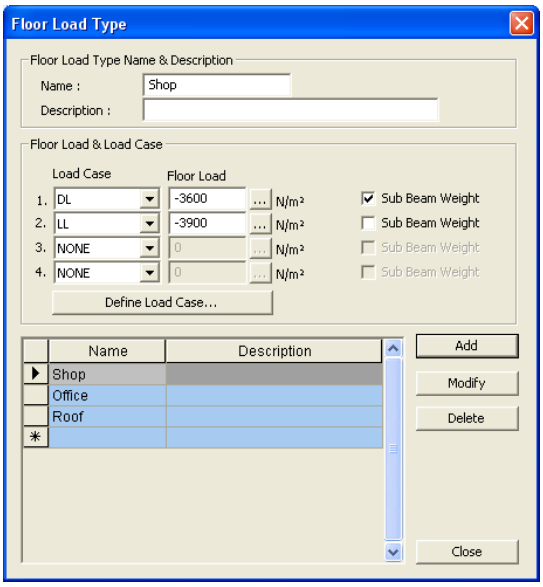


Figure 1.39 Define Floor Load Type

Active Identity

Story > **2F** **+Below** (on)

Active , Close

Node Number (on)

Hidden (off)

Angle View

Horizontal > **50** ; Vertical > **60** ↵

Model Entity tab / Load

Assign Floor Loads

Load Type > **Shop**

Distribution Type > **One Way** ; Load Angle (A1) > **0**

No. of Sub Beams > **3 ;** Sub Beam Angle (A2) > **90**

Unit Self Weight > **883 N/m** ; **Copy Floor Load** (on)

Load Direction > **Global Z ;** Projection > **Yes**

Axis > **Z** ; Distances > **5**

Nodes Defining Loading Area > **4,12, 9, 5, 2, 4**

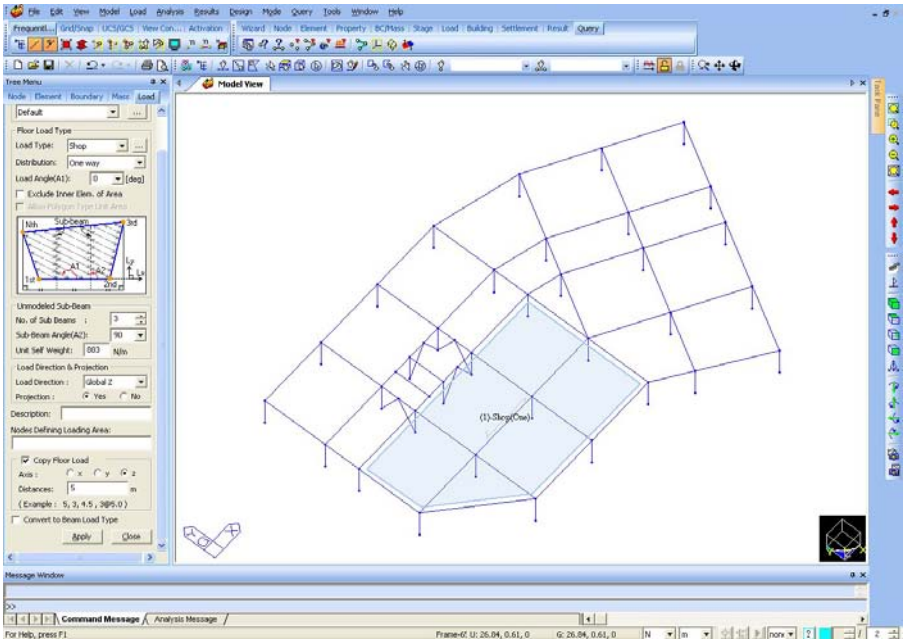


Figure 1.40 Input the Floor Loads

Nodes Defining Loading Area > **17, 13, 16, 20, 17**

Nodes Defining Loading Area > **25, 28, 27, 8, 4, 25**

Nodes Defining Loading Area > **30, 32, 31, 29, 30**

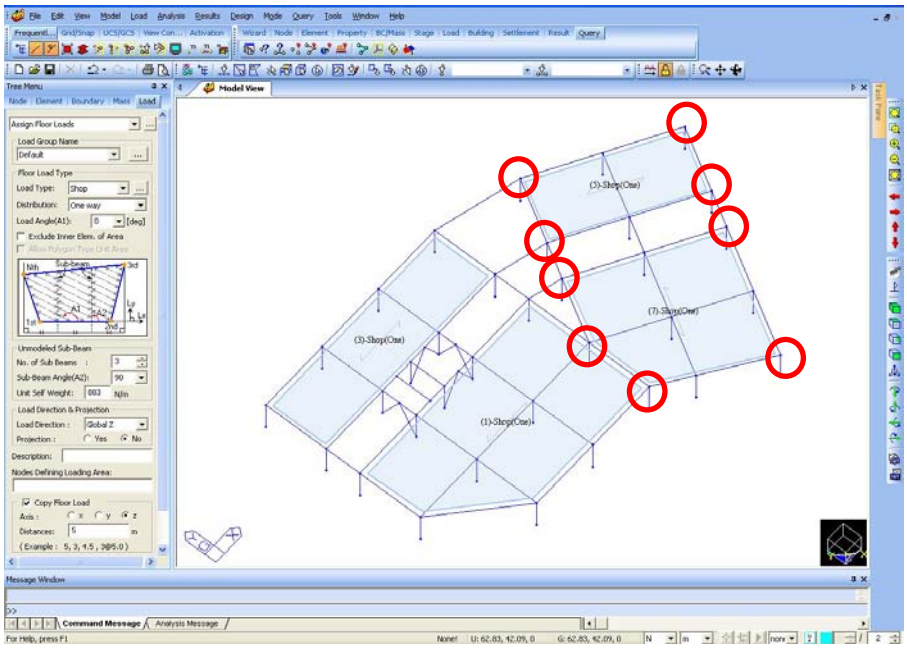


Figure 1.41 Input the Floor Loads of the skewed part

Load Angle(A_1) > **90**

Sub-Beam Angle(A_2) > **0**

Nodes Defining Loading Area > **12, 27, 8, 12**

Nodes Defining Loading Area > **20, 31, 29, 16, 20**

Display > Load > **Floor Load Name** (on) ↵

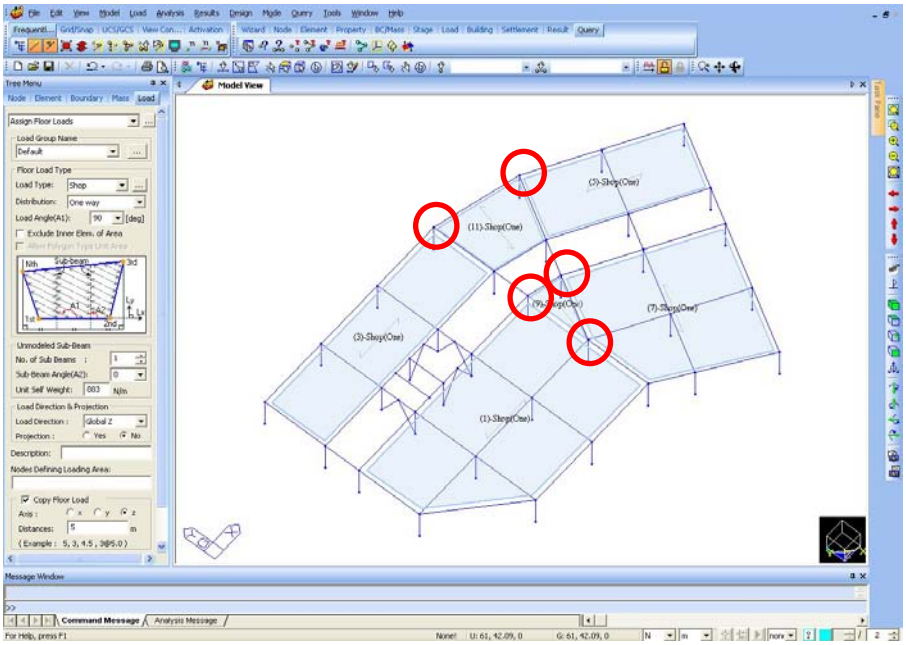


Figure 1.42 Confirm the inputted floor loads by Floor Load Name

No. of Sub Beams > **1**

Nodes Defining Loading Area > **16, 29, 27, 12, 16**

Nodes Defining Loading Area > **13, 14,10, 9, 13**

Nodes Defining Loading Area > **15, 16, 12, 11, 15**

Nodes Defining Loading Area > **29, 30, 28, 27, 29**

No. of Sub Beams > **0**

Nodes Defining Loading Area > **22, 21, 23, 24, 22**

Active All

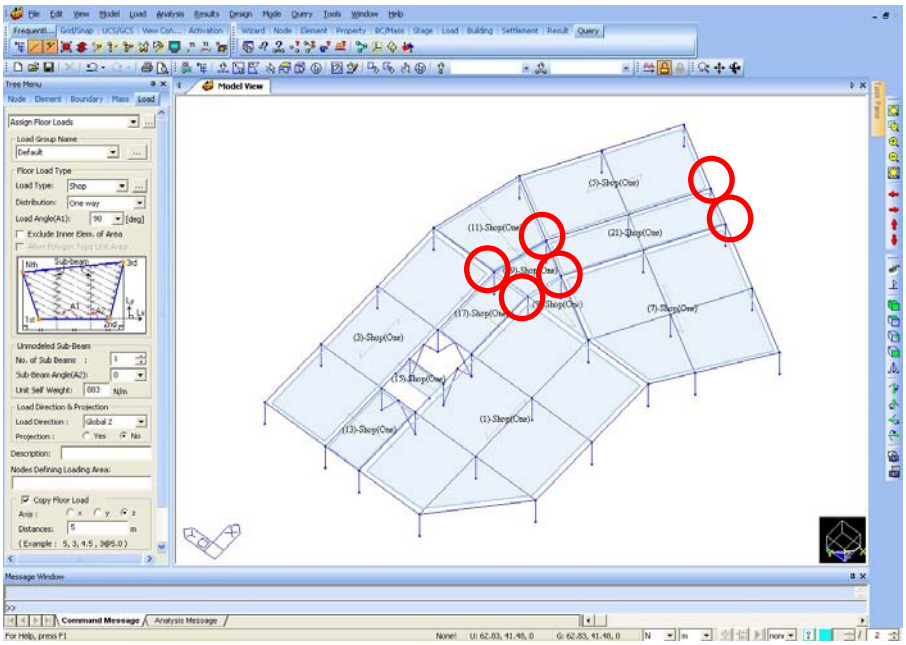


Figure 1.43 Confirm the inputted floor loads by Floor Load Name

Active Identity

Story > **4F** **+Below** (on)

Active, Close

Display > Load > **Floor Load Name** (off) ↵

Load Type > **Office**

Distribution Type > **One Way**

Load Angle (A1) > **90**

No. of Sub Beams > **3**

Sub-Beam Angle (A2) > **0**

Unit Self Weight > **883 N/m**

Copy Floor Load (on) ; Axis > **z**

Distances > **6@3.8, 5@4.2**

Nodes Defining Loading Area > **124, 127, 123, 120, 124**

Input the others in the same way (Refer to Figure 1.44)

Node Number (off)

Active All, ***Front View***

Tree Menu / **Works tab**

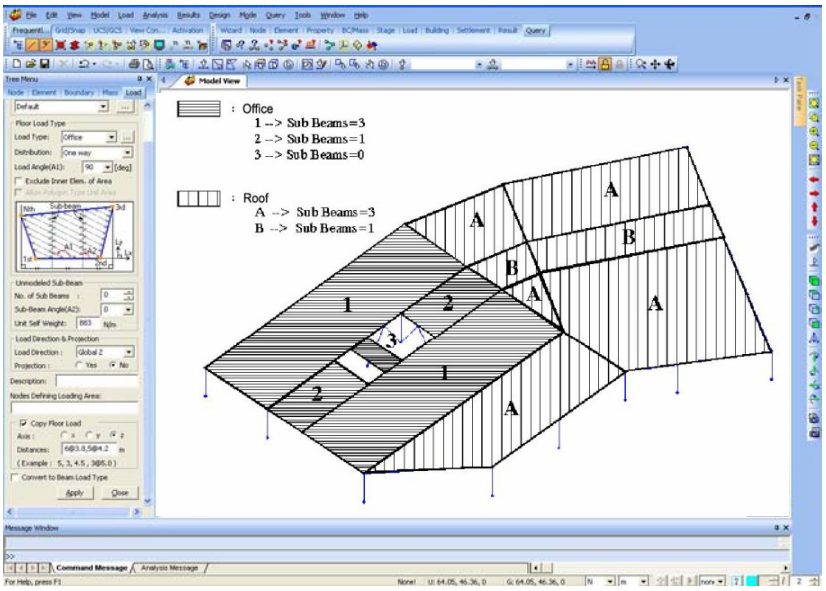


Figure 1.44 Loading Plan of the upper part over the 4th floor

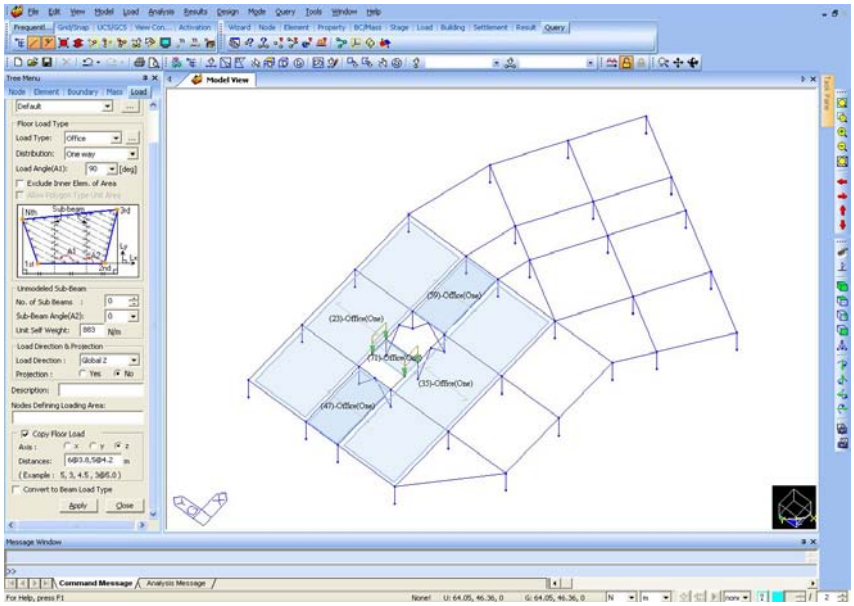


Figure 1.45 Confirm the inputted floor loads on the upper Office

Active Identity

Story > **4F** ; **+Below** (on)

Active , Close

Angle View

Horizontal > **50** ; Vertical > **60** ↵

Zoom Fit

Load Type > **roof** ; Description > **4F roof**

Copy Floor Load (off)

Nodes Defining Loading Area > **Roof Loads**

** Notice: Load Angle, Sub-Beam Angle, Number of Sub Beams*

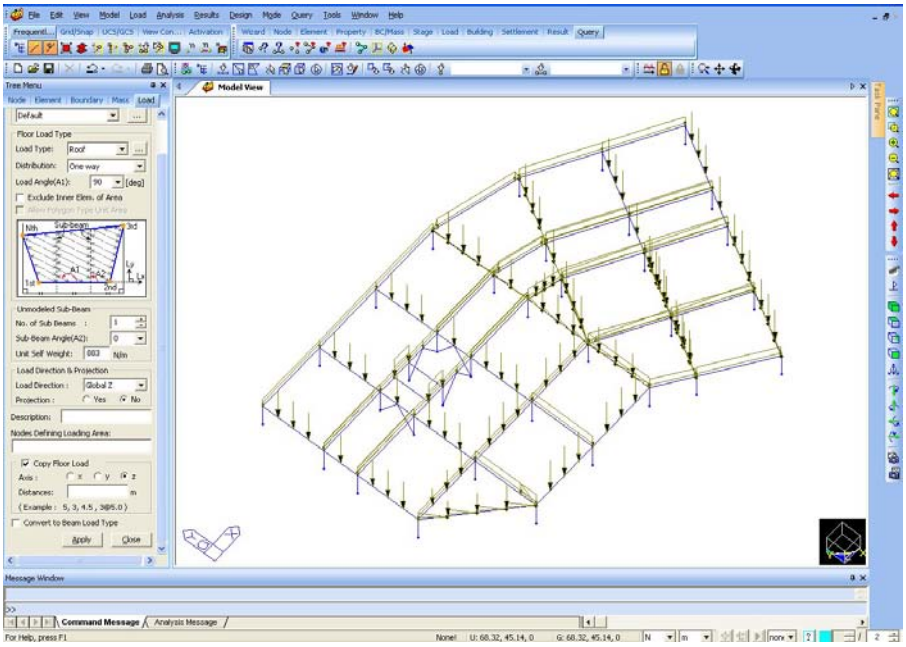


Figure 1.46 Input the 4th floor loads

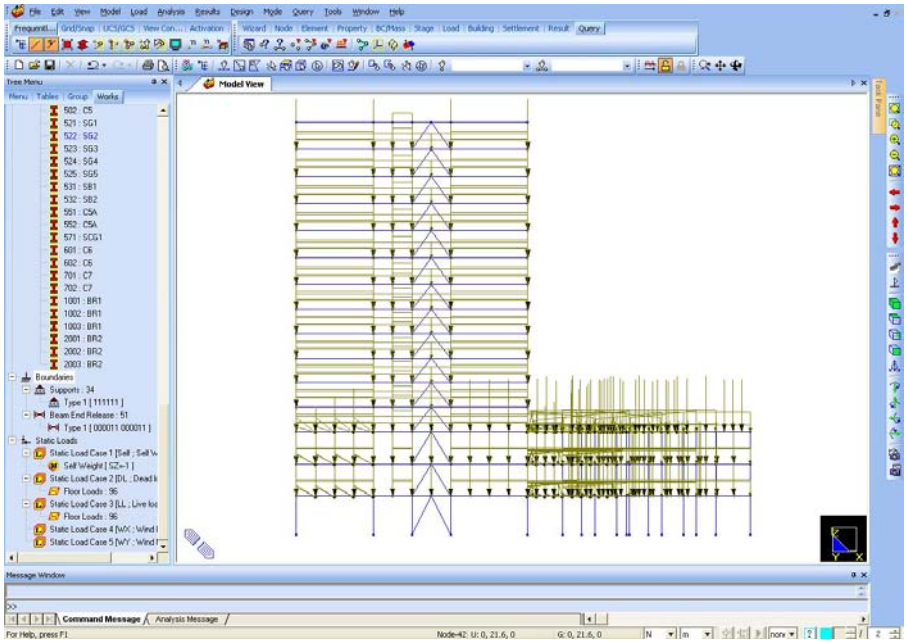


Figure 1.47 Confirm the inputted loads by Works Tree

Active Identity

Story > **5F** ; **+Below** (on)

Active, Close

Load Type > **Office**

Distribution Type > **One Way**

No. of Sub Beams > **0**

Description > *Delete*

Copy Floor Load (on)

Z Axis Distances > **5@3.8, 5@4.2**

Nodes Defining Loading Area > **Cantilever**

**Consider Load Angle (A1)*

Active Identity

Story > **15F** ; **+Below** (on)

Active

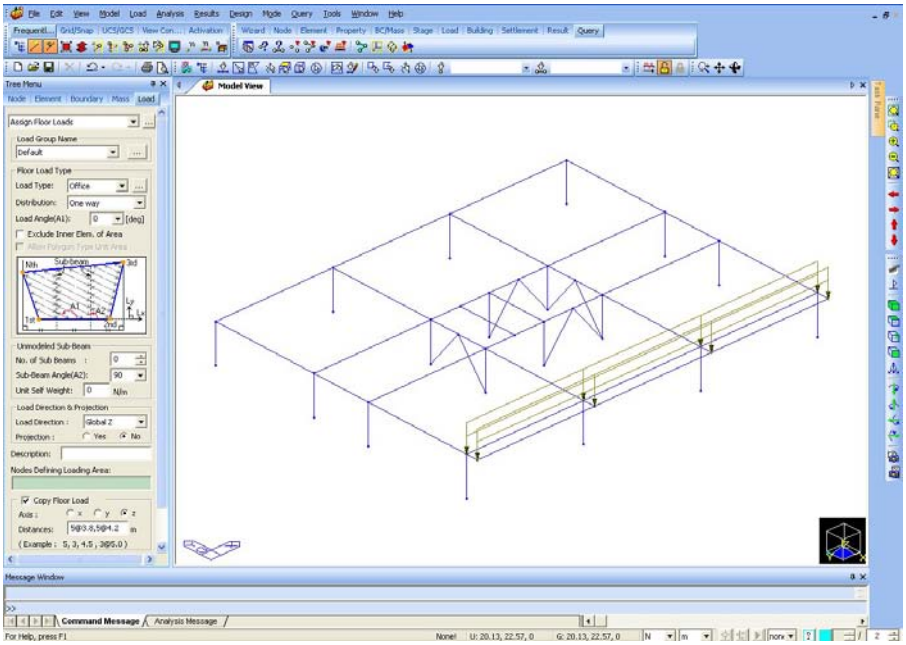


Figure 1.48 Input the Floor Loads of the upper part cantilever

Active Identity

Story > **Roof** ; **+Below** (on)

Active , Close

Load Type > **roof**

No. of Sub Beams > **3**

Copy Floor Load (off)

Nodes Defining Loading Area > **Roof Floor**

Cantilever portion:

No. of Sub Beams > **0**

Active All

Assign Floor Loads > ...

Floor Load Table > (Refer to Figure 1.50)

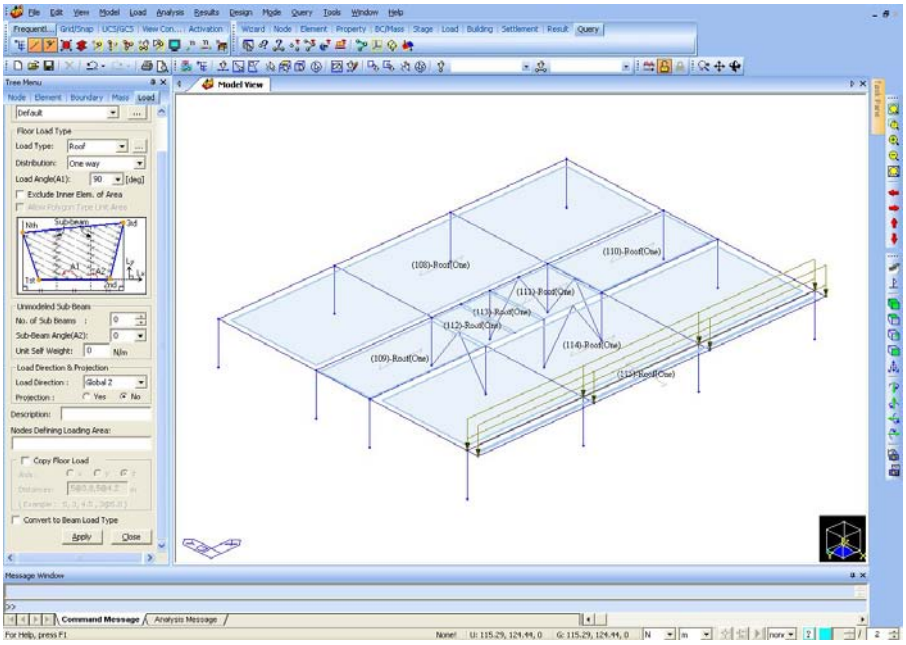
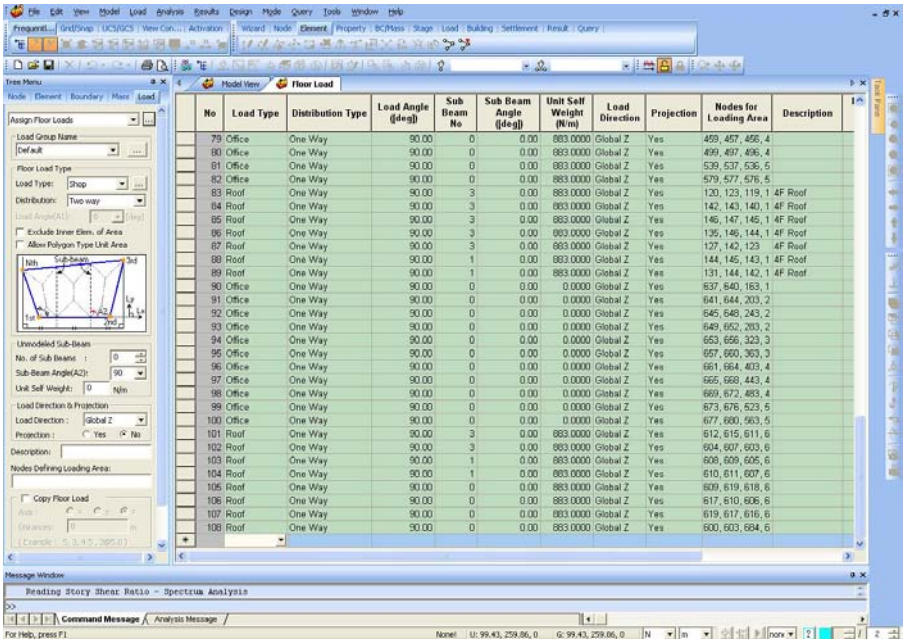


Figure 1.49 Input the floor loads of the roof



No	Load Type	Distribution Type	Load Angle ([deg])	Sub Beam No	Sub Beam Angle ([deg])	Unit Self Weight (N/m)	Load Direction	Projection	Nodes for Loading Area	Description
79	Office	One Way	90.00	0	0.00	883.0000	Global Z	Yes	459, 457, 456, 4	
80	Office	One Way	90.00	0	0.00	883.0000	Global Z	Yes	499, 497, 496, 4	
81	Office	One Way	90.00	0	0.00	883.0000	Global Z	Yes	539, 537, 536, 5	
82	Office	One Way	90.00	0	0.00	883.0000	Global Z	Yes	579, 577, 576, 5	
83	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	120, 123, 119, 1	4F Roof
84	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	142, 143, 140, 1	4F Roof
85	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	146, 147, 145, 1	4F Roof
86	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	135, 146, 144, 1	4F Roof
87	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	127, 142, 123	4F Roof
88	Roof	One Way	90.00	1	0.00	883.0000	Global Z	Yes	144, 145, 143, 1	4F Roof
89	Roof	One Way	90.00	1	0.00	883.0000	Global Z	Yes	131, 144, 142, 1	4F Roof
90	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	637, 640, 163, 1	
91	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	641, 644, 203, 2	
92	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	645, 648, 243, 2	
93	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	649, 652, 283, 2	
94	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	653, 656, 323, 3	
95	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	657, 660, 363, 3	
96	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	661, 664, 403, 4	
97	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	665, 668, 443, 4	
98	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	669, 672, 483, 4	
99	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	673, 676, 523, 5	
100	Office	One Way	90.00	0	0.00	0.0000	Global Z	Yes	677, 680, 563, 5	
101	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	612, 615, 611, 6	
102	Roof	One Way	90.00	3	0.00	883.0000	Global Z	Yes	604, 607, 603, 6	
103	Roof	One Way	90.00	1	0.00	883.0000	Global Z	Yes	608, 609, 605, 6	
104	Roof	One Way	90.00	1	0.00	883.0000	Global Z	Yes	610, 611, 607, 6	
105	Roof	One Way	90.00	0	0.00	883.0000	Global Z	Yes	609, 619, 618, 6	
106	Roof	One Way	90.00	0	0.00	883.0000	Global Z	Yes	617, 610, 606, 6	
107	Roof	One Way	90.00	0	0.00	883.0000	Global Z	Yes	619, 617, 616, 6	
108	Roof	One Way	90.00	0	0.00	883.0000	Global Z	Yes	600, 603, 684, 6	

Figure 1.50 Floor Load Table

Input the Wind Loads

Model / Building / ***Story***

Wind tab (❶ of Figure 1.51)

Auto Generate Story Data ↵

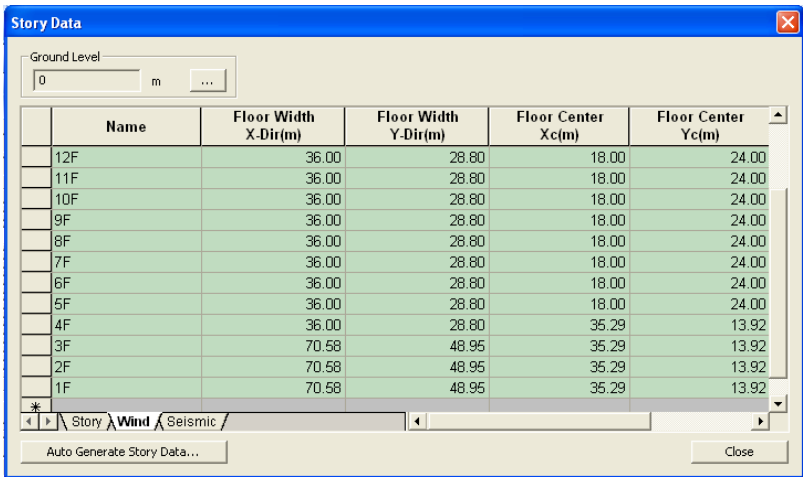


Figure 1.51 Story Data

Load / Lateral Loads / ***Wind Loads***

Add

Load Case Name > **WX** Wind Load Code > **UBC(1997)**

Projected Area Method > **(on)** ;

Exposure Category > **C** ; Basic Wind Speed > **80**

Importance Factor > **1** ; Pressure Coefficient > **1.3**

Scale Factor in Global Y > **1** ; Scale Factor in Global Y > **0**

Wind Load Profile

Story Shear (GL) > **3241920.0 N** Close ↵

Add

Load Case Name > **WY** Wind Load Code > **UBC(1997)**

Projected Area Method > **(on)** ;

Exposure Category > **C** ; Basic Wind Speed > **80**

Importance Factor > **1** ; Pressure Coefficient > **1.3**

Scale Factor in Global X > **0** ; Scale Factor in Global Y > **1**

Wind Load Profile

Story Shear (GL) > **4212477.0 N** Close ↵

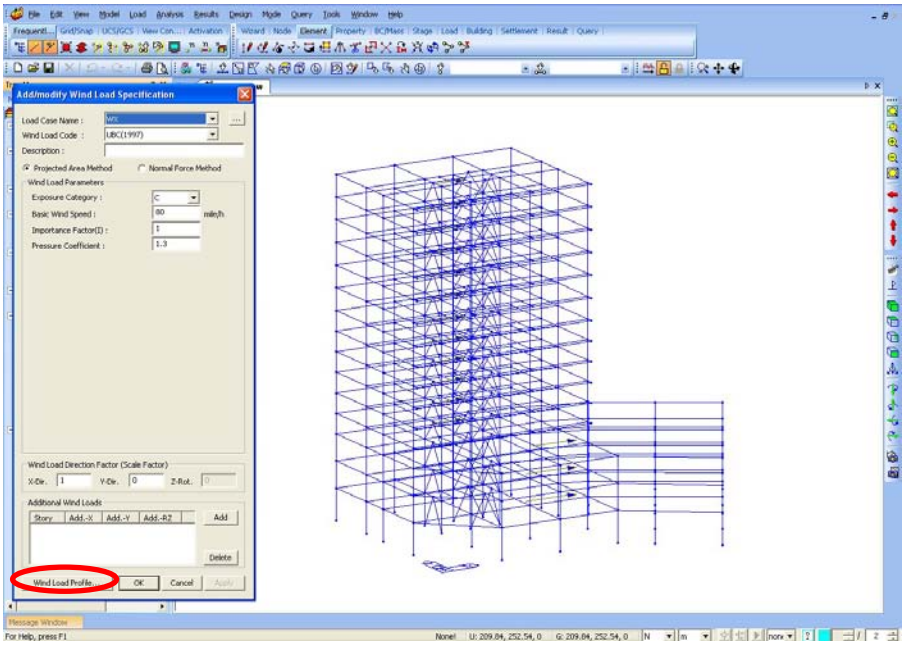


Figure 1.52 Dialog box to input the wind load

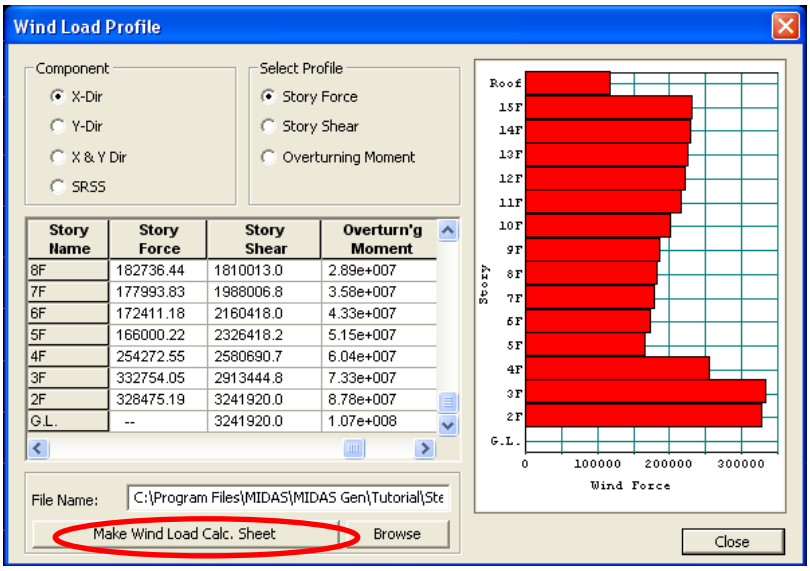
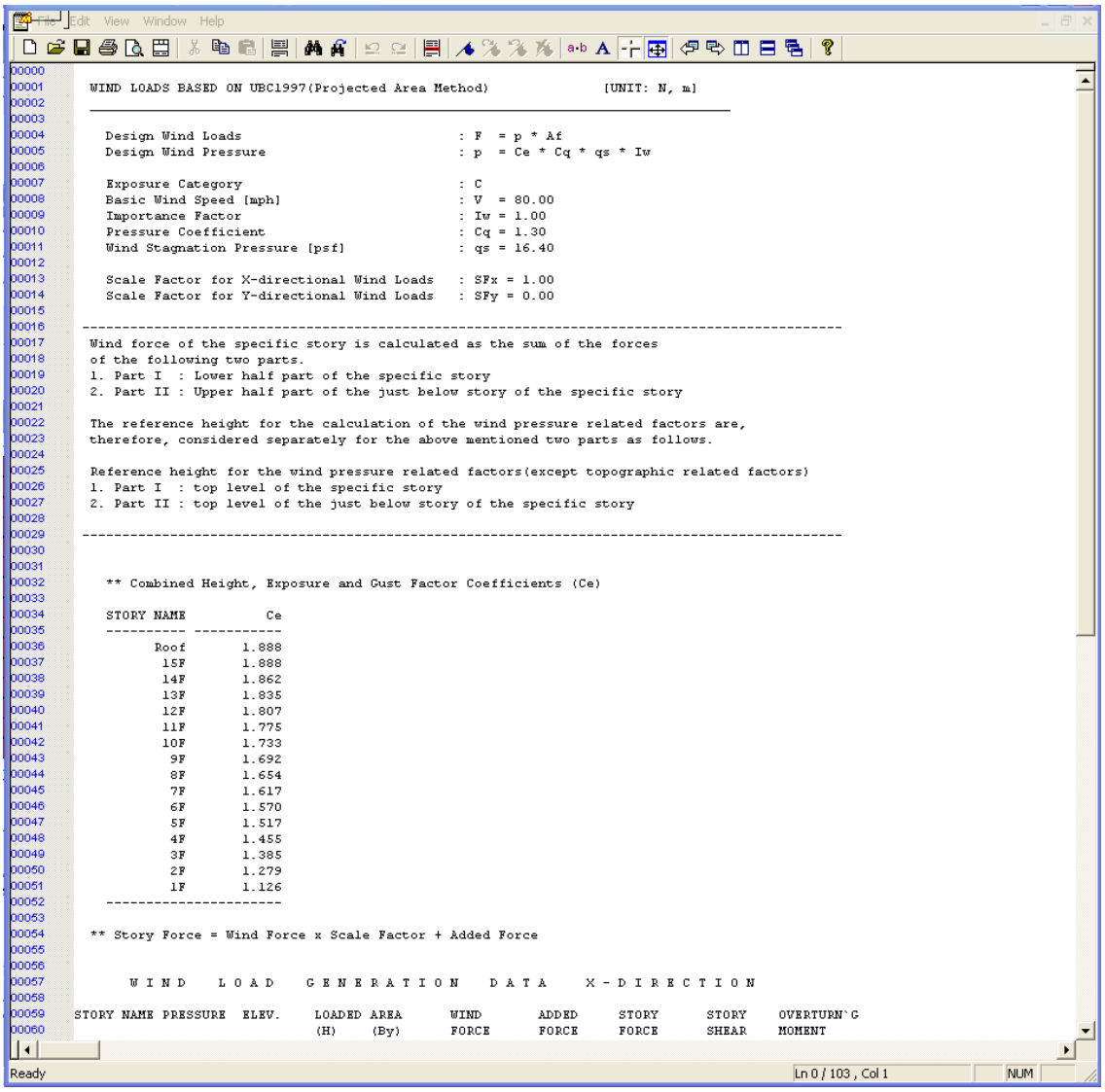


Figure 1.53 Wind Load Profile



```
00000
00001   WIND LOADS BASED ON UBC1997(Projected Area Method)              [UNIT: N, m]
00002   ____________________________________________________________________________
00003
00004     Design Wind Loads                          : F  = p * Af
00005     Design Wind Pressure                       : p  = Ce * Cq * qs * Iw
00006
00007     Exposure Category                          : C
00008     Basic Wind Speed [mph]                     : V  = 80.00
00009     Importance Factor                          : Iw = 1.00
00010     Pressure Coefficient                       : Cq = 1.30
00011     Wind Stagnation Pressure [psf]             : qs = 16.40
00012
00013     Scale Factor for X-directional Wind Loads  : SFx = 1.00
00014     Scale Factor for Y-directional Wind Loads  : SFy = 0.00
00015
00016  ------------------------------------------------------------------------------------------
00017   Wind force of the specific story is calculated as the sum of the forces
00018   of the following two parts.
00019   1. Part I  : Lower half part of the specific story
00020   2. Part II : Upper half part of the just below story of the specific story
00021
00022   The reference height for the calculation of the wind pressure related factors are,
00023   therefore, considered separately for the above mentioned two parts as follows.
00024
00025   Reference height for the wind pressure related factors(except topographic related factors)
00026   1. Part I  : top level of the specific story
00027   2. Part II : top level of the just below story of the specific story
00028
00029  ------------------------------------------------------------------------------------------
00030
00031
00032     ** Combined Height, Exposure and Gust Factor Coefficients (Ce)
00033
00034     STORY NAME          Ce
00035     ---------- -----------
00036           Roof       1.888
00037            15F       1.888
00038            14F       1.862
00039            13F       1.835
00040            12F       1.807
00041            11F       1.775
00042            10F       1.733
00043             9F       1.692
00044             8F       1.654
00045             7F       1.617
00046             6F       1.570
00047             5F       1.517
00048             4F       1.455
00049             3F       1.385
00050             2F       1.279
00051             1F       1.126
00052     ----------------------
00053
00054   ** Story Force = Wind Force x Scale Factor + Added Force
00055
00056
00057        W I N D    L O A D    G E N E R A T I O N    D A T A    X - D I R E C T I O N
00058
00059  STORY NAME PRESSURE  ELEV.    LOADED AREA      WIND       ADDED      STORY      STORY    OVERTURN`G
00060                               (H)    (By)      FORCE      FORCE      FORCE      SHEAR    MOMENT
```

Ready Ln 0 / 103 , Col 1 NUM

Figure 1.54 Wind loads calculation

Input the Response Spectrum Analysis Conditions

Model / ***Structure Type***

Converting Type of Model weight to Masses > **Convert to X, Y**

Gravity Acceleration > **9.806**

Align Top of Beam Section to Floor(X-Y Plane) for Panel Zone Effect/Display (on) ↵

Model / Masses / ***Loads to Masses***

Mass Direction > **X, Y**

Load Type for Converting > *all* (on)

Load Case > **DL** ; Scale Factor > **1** Add ↵

Query / ***Story Mass Table***

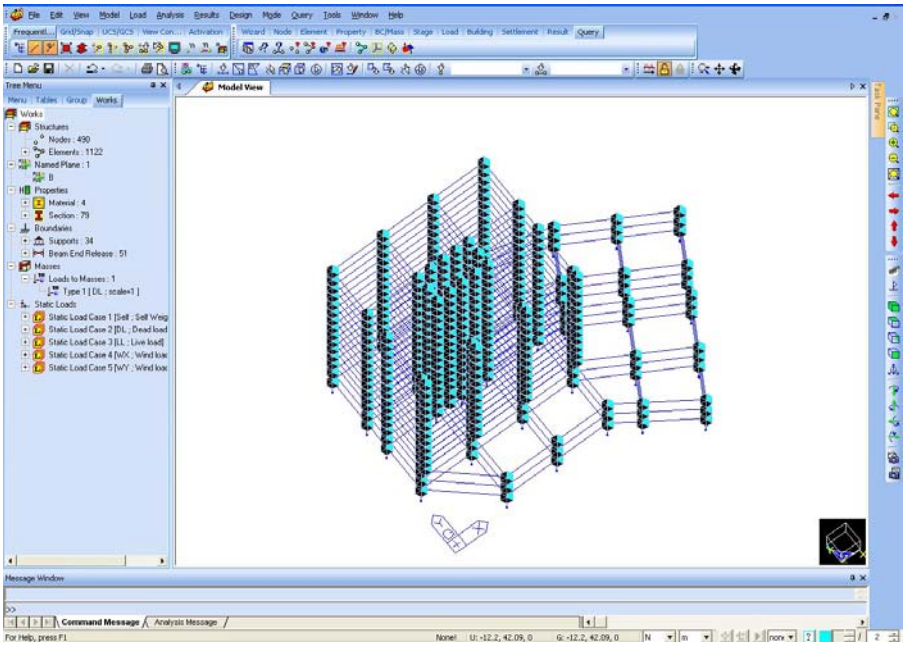


Figure 1.55 Create the mass data automatically

Model View | Story Mass

Story	Level (m)	Translational Mass X-DIR (N/g)	Translational Mass Y-DIR (N/g)	Rotational Mass (N/g·m²)	Center of Mass X-Coord (m)	Center of Mass Y-Coord (m)
Use Ground Level : OFF						
Consider Mass under Ground Level : ON						
Roof	64.0000	645136.68606728	645136.68606728	141281192.9186	18.0047	24.0555
15F	59.8000	575947.13095109	575947.13095109	132410589.8530	17.9917	24.0906
14F	55.6000	575110.66496643	575110.66496643	132176720.1439	17.9884	24.0930
13F	51.4000	574274.19898178	574274.19898178	131942830.6907	17.9851	24.0955
12F	47.2000	574274.19898178	574274.19898178	131942830.6907	17.9851	24.0955
11F	43.0000	574782.72697327	574782.72697327	132007300.0601	17.9851	24.0926
10F	38.8000	570701.93447961	570701.93447961	130936139.9686	17.9848	24.0854
9F	35.0000	566112.61399445	566112.61399445	129799570.9894	17.9845	24.0811
8F	31.2000	567185.29200383	567185.29200383	130020262.7571	17.9866	24.0778
7F	27.4000	568257.97001322	568257.97001322	130240936.3183	17.9888	24.0744
6F	23.6000	568257.97001322	568257.97001322	130240936.3183	17.9888	24.0744
5F	19.8000	569369.70960840	569369.70960840	130551725.2479	17.9885	24.0779
4F	16.0000	1375284.4967255	1375284.4967255	680456233.3978	32.6022	17.7996
3F	11.0000	1122173.1404367	1122173.1404367	556081076.4084	31.2885	18.3200
2F	6.0000	1139130.9057821	1139130.9057821	564124422.7625	31.1603	18.3796
1F	0.0000	0.00000000	0.00000000	0.0000	0.0000	0.0000
	Total	10565999.639980	10565999.639980			

ADDITIONAL MASSES FOR THE CALCULATION OF EQUIVALENT SEISMIC FORCE

Story	Level (m)	Translational Mass X-DIR	Translational Mass Y-DIR
Roof	64.0000	0.00000000	0.00000000
15F	59.8000	0.00000000	0.00000000
14F	55.6000	0.00000000	0.00000000
13F	51.4000	0.00000000	0.00000000
12F	47.2000	0.00000000	0.00000000
11F	43.0000	0.00000000	0.00000000
10F	38.8000	0.00000000	0.00000000
9F	35.0000	0.00000000	0.00000000
8F	31.2000	0.00000000	0.00000000
7F	27.4000	0.00000000	0.00000000
6F	23.6000	0.00000000	0.00000000
5F	19.8000	0.00000000	0.00000000
4F	16.0000	0.00000000	0.00000000
3F	11.0000	0.00000000	0.00000000
2F	6.0000	0.00000000	0.00000000
1F	0.0000	86434.16602112	86434.16602112

Note: The above additional masses represent masses in between two adjacent stories or on the nodes released from the floor rigid diaphragm by *Diaphragm Disconnect command. For static seismic analysis, the masses between two adjacent stories (ie, masses on columns, braces & walls) are proportionally distributed to upper/lower stories based on their vertical locations. For dynamic analysis, however, floor masses and masses on vertical elements remain at their original locations.

Story Mass | X-Dir | Y-Dir | Z-Dir

Figure 1.56 Story Mass Table

Load / Response Spectrum Analysis Data / ***Response Spectrum Load Case***

Eigenvalue Analysis Control...

Number of Frequencies > **15** ↵

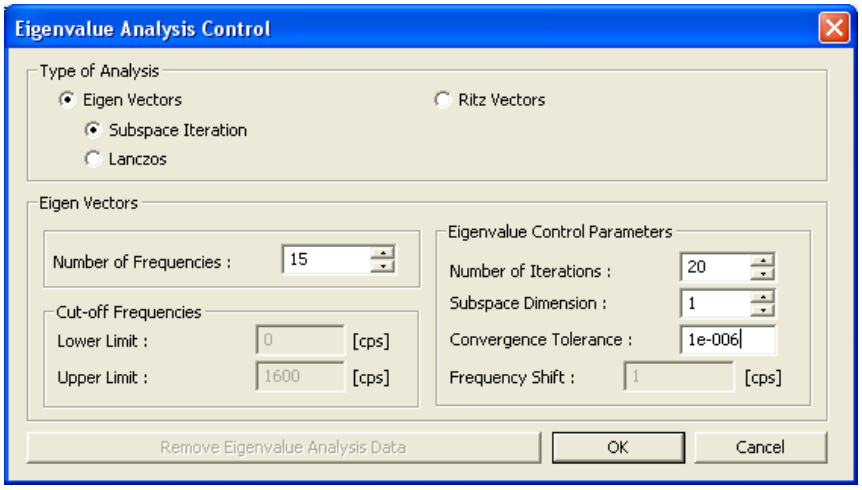


Figure 1.57 Eigenvalue analysis conditions setting

Response Spectrum Control...

Modal Combination Type > **SRSS** ↵

Response Spectrum Functions...

Add

Design Spectrum

Design Spectrum > **UBC(1997)**

Seismic Coefficients Calculation Option > **Automatic** (on)

Soil Profile Type (S) > **Sc**

Seismic Zone Factor (Z) > **1 (0.075)**

Seismic Coefficient (Ca) > **0.09**

Seismic Coefficient (Cv) > **0.13**

Max. Period > **10** (sec) ↵

Scale Factor (I_E/R) > **0.238** (Refer to Figure 1.59) ↵

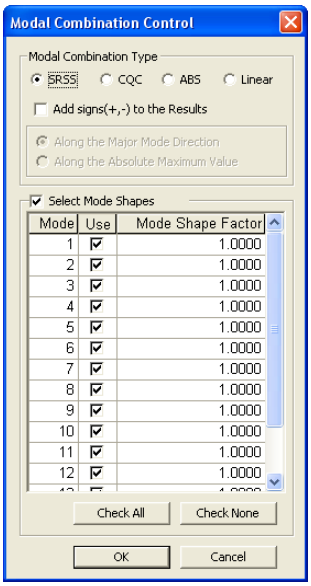


Figure 1.58 Assign the method of the mode combination

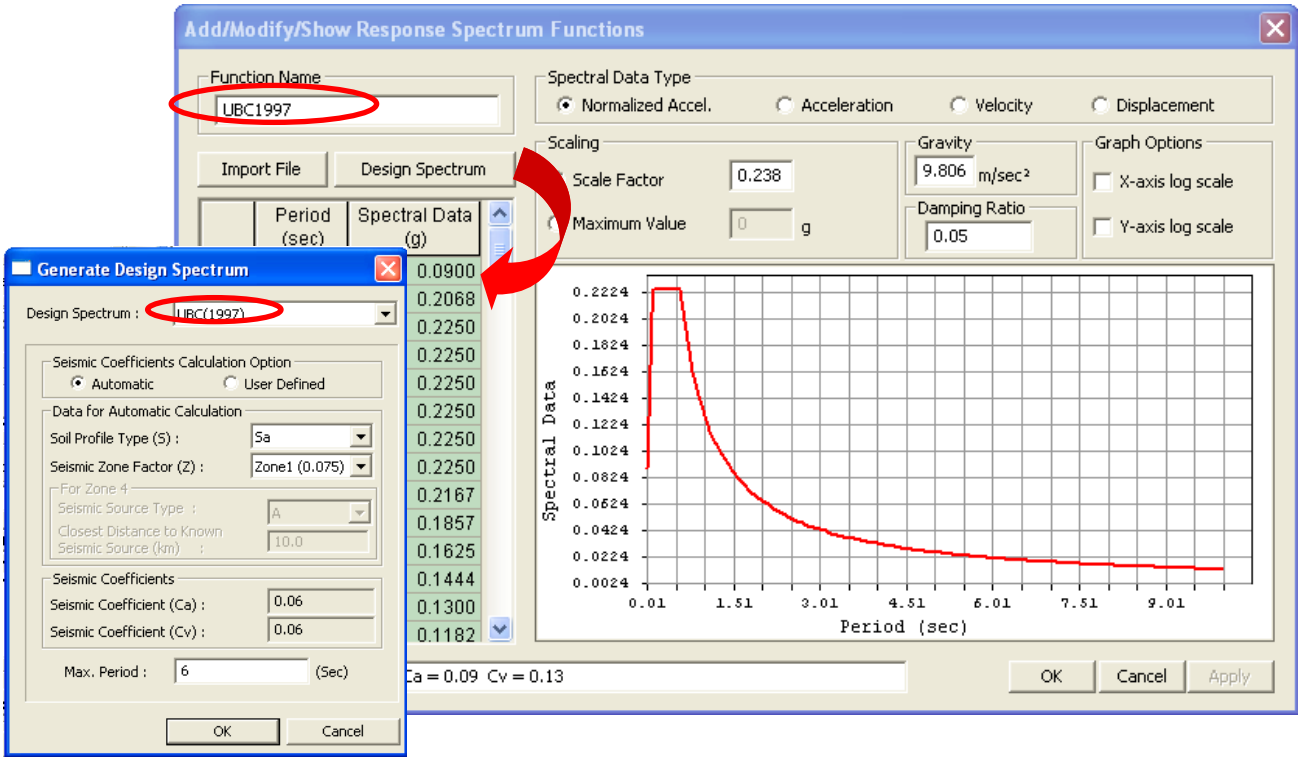


Figure 1.59 Dialog box to create the Design Spectrum automatically

Load / Response Spectrum Analysis Data / ***Response Spectrum Load Case***

Load Case Name > **RX**

Direction > **X-Y**

Excitation Angle > **0**

Scale Factor > **1**

Period Modification Factor > **1**

Function Name > **UBC1997** (on)

Operations > Add

Load Case Name > **RY**

Excitation Angle > **90**

Operations > Add

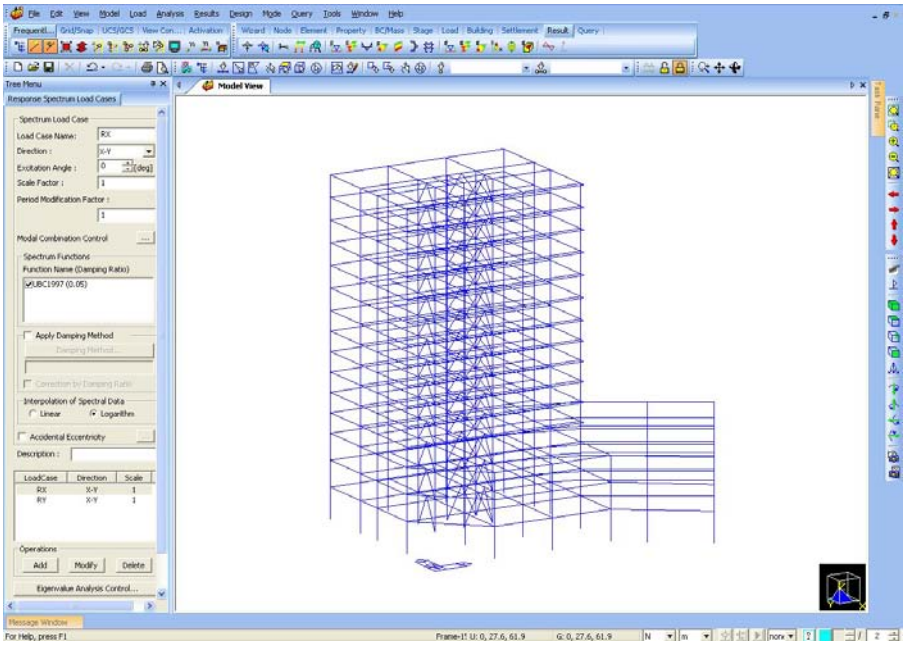


Figure 1.60 Input the response spectrum load cases

Analysis / ***Perform Analysis***

Tools / Customize / ***Toolbars***

Toolbar List > **Results** (on), **Property** (on)

Toolbars > Customize...

Command tab

Categories > **Query**

Buttons > (Drag) ↵

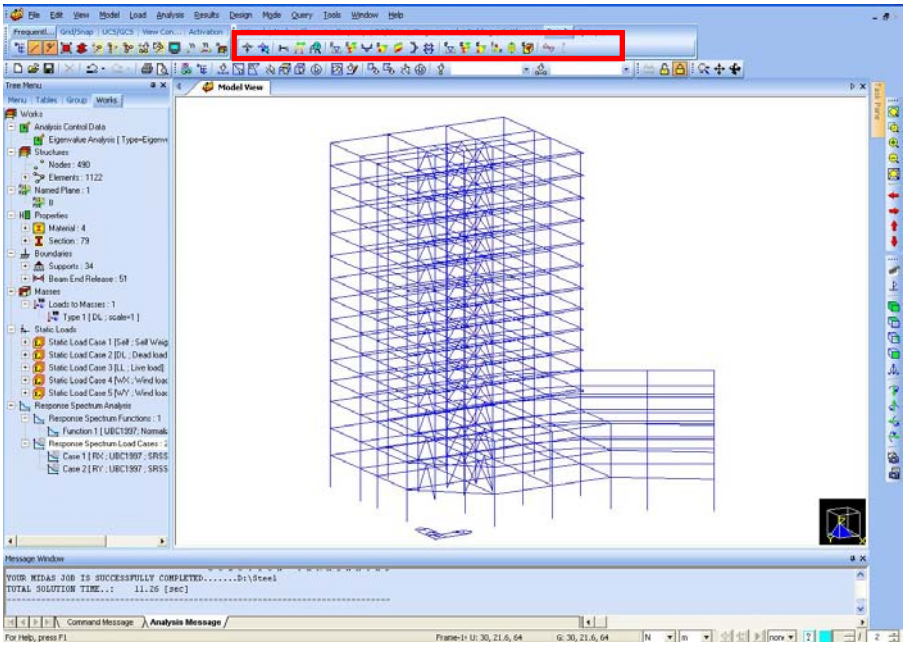


Figure 1.61 Toolbar setting to confirm the results

Confirm the Analysis Results

Examine Reactions

Tools / ***Unit System***

Force > **kN**

Active Identity

Story > **2F** ; **+Below** (on)

Active, Close

Results / Reactions / ***Reaction Forces/Moments***

Load Case/Combinations > **ST : DL**

Components > **FZ**

Type of Display > **Values** (on)**, Legend** (on)

Values > ...

Decimal Points > **2** ↵

Results Menu / Result Tables / ***Reaction***

Load Combination > **Self(ST)** (on), **DL(ST)** (on), **LL(ST)** (on) ↵

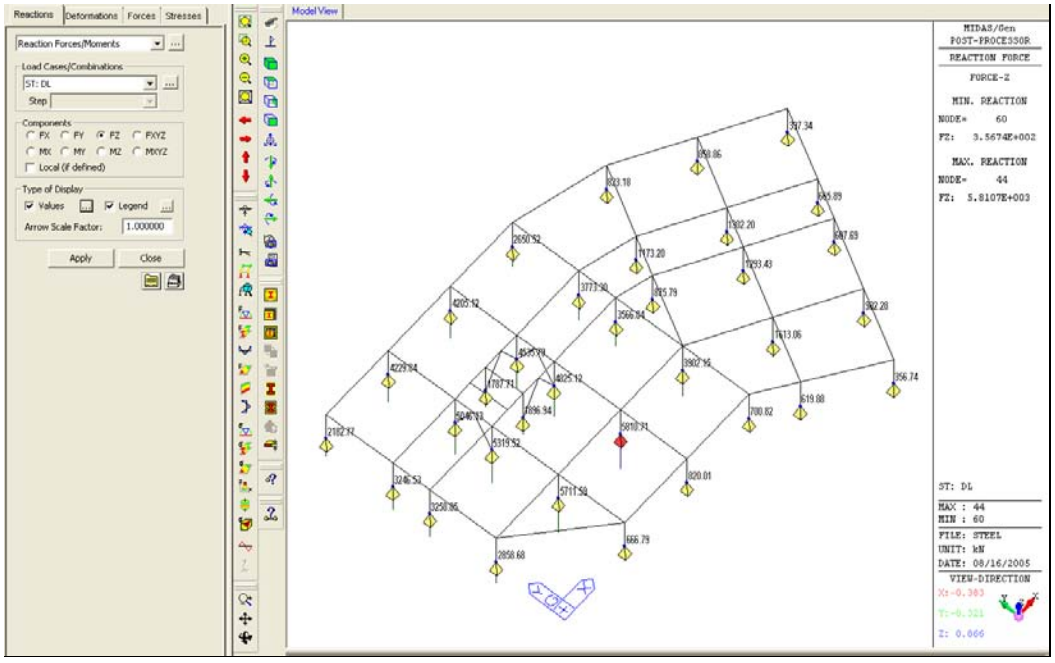


Figure 1.62 Confirm the reactions in the gravity direction

Model View | Result-[Reaction]

	Node	Load	FX (kN)	FY (kN)	FZ (kN)	MX (kN-m)	MY (kN-m)	MZ (kN-m)
	69	DL	10.595756	18.959593	1302.196744	-36.819985	20.248471	0.000061
	70	DL	-10.398800	-17.161918	1293.432356	32.157335	-19.837213	0.000061
	71	DL	4.478951	6.552928	1613.058086	-13.073888	8.663931	0.000061
	72	DL	17.320191	22.771829	619.878814	-44.055234	33.356336	0.000131
	39	LL	-1.714124	32.327392	500.498516	-62.355402	-3.458218	0.000145
	40	LL	0.326749	36.389361	619.635363	-70.216480	0.595542	0.000145
	41	LL	-0.712800	27.186221	522.882782	-52.803806	-1.469301	0.000145
	42	LL	24.154682	7.623601	1748.092019	-16.745216	46.956615	0.044888
	43	LL	0.191680	7.200066	3522.294784	-16.851123	-0.287122	0.045301
	44	LL	0.358226	-1.292108	3600.172003	-0.773994	0.041240	0.045301
	45	LL	9.476606	4.545521	2521.881704	-11.891371	18.057593	0.044921
	46	LL	6.469377	-11.691479	1974.509681	21.148772	11.929777	0.044917
	47	LL	-2.827558	-9.751373	3214.397568	70.777521	-6.474691	0.048887
	48	LL	-4.857837	-9.369538	2931.147828	69.105292	14.925048	0.048887
	49	LL	-5.697853	-14.286473	2202.276402	24.747418	-12.106886	0.044961
	50	LL	6.402153	12.594566	1967.789953	-26.371907	11.658241	0.044917
	51	LL	-2.893063	22.429254	3033.752801	-79.346858	-6.757595	0.048887
	52	LL	-4.960627	24.372648	2739.577618	-79.624765	14.474443	0.048887
	53	LL	-5.605076	27.402262	2367.572672	-56.595282	-12.075604	0.044961
	54	LL	6.163734	-18.714963	1307.087149	34.695902	10.865782	0.044888
	55	LL	0.373492	-38.844539	2539.814231	72.435302	-0.562117	0.048670
	56	LL	0.453251	-38.684229	2526.592248	71.626397	-0.404911	0.048670
	57	LL	-4.890300	-39.091131	1658.823717	73.433012	-10.894537	0.044888
	58	LL	3.829114	0.144515	1118.330941	-1.646283	-8.730584	0.024268
	59	LL	3.031843	0.145507	1054.095480	-1.648231	-8.642858	0.024268
	60	LL	3.861214	11.874138	270.278540	-23.227680	7.338613	0.000022
	61	LL	-7.590652	4.144861	672.387961	-9.246913	-14.815737	0.000145
	62	LL	-3.141211	-11.287844	672.643803	21.099769	-5.715513	0.000067
	63	LL	-8.168602	-3.139460	469.997410	5.709231	-16.360248	0.000145
	64	LL	11.323910	16.118439	898.397236	-31.287152	21.812719	0.000067
	65	LL	-0.128975	10.887265	507.441087	-22.180286	-0.440453	0.000145
	66	LL	-15.817019	-34.902108	631.345073	65.806943	-29.836374	0.000145
	67	LL	-9.402474	-10.363178	299.148762	19.185897	-18.069992	0.000022
	68	LL	-18.636642	-32.611818	647.475341	61.192455	-35.399245	0.000145
	69	LL	9.660127	17.387497	993.197654	-33.867228	18.538428	0.000067
	70	LL	-9.562936	-15.704964	988.774725	29.327563	-18.161904	0.000067
	71	LL	4.461360	6.286675	1205.507145	-12.606994	8.720205	0.000067
	72	LL	16.070230	20.675415	467.925347	-40.121891	31.095595	0.000145

SUMMATION OF REACTION FORCES PRINTOUT

Load	FX (kN)	FY (kN)	FZ (kN)
Self	0.000000	-0.000000	21972.507485
DL	0.000000	-0.000000	82485.258416
LL	0.000000	-0.000000	52395.745545

Reaction(Global) | Reaction(Local)

Figure 1.63 Reaction Table

Examine the Eigenvalue Analysis Results

Results / Result Tables / ***Vibration Mode Shape***

Active Dialog > Cancel

Node No.	Governing Direction	Participation Masses (%)	Period(sec)
1	ROTN-Z	52.80	2.807
2	TRAN-X	67.57	2.744
3	TRAN-Y	68.52	2.363

Model View | Result-[Eigenvalue Mode]

Node	Mode	UX	UY	UZ	RX	RY	RZ

EIGENVALUE ANALYSIS

Mode No	Frequency (rad/sec)	Frequency (cycle/sec)	Period (sec)	Tolerance
1	2.237933	0.356178	2.807584	3.5468e-016
2	2.289660	0.364411	2.744157	3.3884e-016
3	2.658642	0.423136	2.363306	1.2566e-016
4	5.303959	0.844151	1.184622	3.7886e-016
5	6.846156	1.089600	0.917768	1.5160e-016
6	7.756732	1.234522	0.810030	1.1810e-016
7	9.110669	1.450008	0.689651	1.7121e-016
8	12.533757	1.994809	0.501301	5.4276e-016
9	14.526177	2.311913	0.432542	1.3469e-016
10	15.996177	2.545871	0.392793	2.2215e-016
11	18.709125	2.977650	0.335835	4.8719e-016
12	19.403266	3.088126	0.323821	0.0000e+000
13	23.383706	3.721632	0.268699	7.4641e-014
14	24.025078	3.823710	0.261526	6.4040e-012
15	26.130943	4.158869	0.240450	2.6329e-011

MODAL PARTICIPATION MASSES(%) PRINTOUT

Mode No	TRAN-X		TRAN-Y		TRAN-Z		ROTN-X		ROTN-Y		ROTN-Z	
	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM	MASS	SUM
1	1.01	1.01	2.34	2.34	0.00	0.00	0.00	0.00	0.00	0.00	52.80	52.80
2	67.57	68.58	0.03	2.37	0.00	0.00	0.00	0.00	0.00	0.00	0.72	53.52
3	0.00	68.58	68.52	70.90	0.00	0.00	0.00	0.00	0.00	0.00	2.50	56.02
4	1.77	70.35	4.35	75.24	0.00	0.00	0.00	0.00	0.00	0.00	20.85	76.87
5	19.76	90.11	0.40	75.64	0.00	0.00	0.00	0.00	0.00	0.00	0.61	77.47
6	0.08	90.19	15.79	91.43	0.00	0.00	0.00	0.00	0.00	0.00	1.44	78.91
7	0.19	90.38	0.62	92.05	0.00	0.00	0.00	0.00	0.00	0.00	2.51	81.42
8	5.27	95.64	0.08	92.13	0.00	0.00	0.00	0.00	0.00	0.00	0.69	82.11
9	0.05	95.70	1.46	93.60	0.00	0.00	0.00	0.00	0.00	0.00	0.14	82.25
10	0.00	95.70	2.09	95.68	0.00	0.00	0.00	0.00	0.00	0.00	6.03	88.28
11	0.17	95.87	0.74	96.42	0.00	0.00	0.00	0.00	0.00	0.00	1.93	90.21
12	1.50	97.37	0.00	96.42	0.00	0.00	0.00	0.00	0.00	0.00	0.87	91.08
13	0.04	97.41	0.21	96.63	0.00	0.00	0.00	0.00	0.00	0.00	0.32	91.40
14	0.03	97.43	1.26	97.88	0.00	0.00	0.00	0.00	0.00	0.00	3.77	95.17
15	1.27	98.70	0.00	97.88	0.00	0.00	0.00	0.00	0.00	0.00	0.79	95.96

EIGEN VECTOR

Eigenvalue Mode

Figure 1.64 Confirm the Eigenvalue analysis results

Model View tab

Iso View, *Active All*, *Initial View*

Results / *Vibration Mode Shapes*

Load Cases (Mode Numbers) > **Mode 1**

Components > **Md-XYZ** (on)

Type of Display > Mode Shape > ...

Mode Shape Scale Factor > **3.0** ↵

Animate (on) > ...

Animation Mode > **Repeat Full Cycle** ↵ ↵

Record

Stop

Close

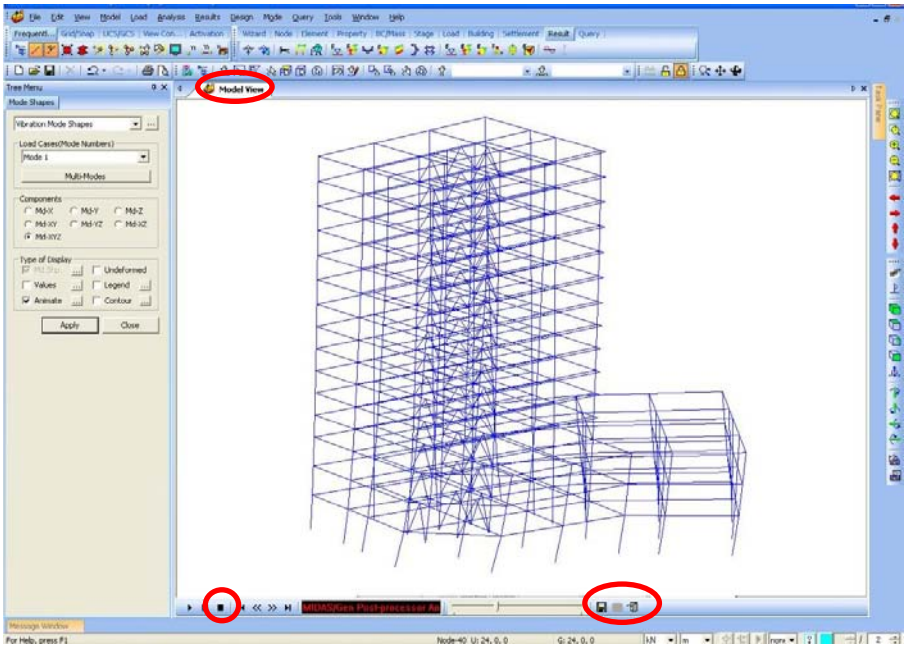


Figure 1.65 Vibration Mode Shapes

Steel Member Design

➢ Applied Design Code: AISC-LRFD2K

Create the Load Combinations

All Windows except **Model View** > ✕

Results / Combinations

Steel Design tab

Auto Generation...

Design Code > **AISC-LRFD2K**

Scale Up Factor > **2.719, RX** Add

Scale Up Factor > **2.504, RY** Add

↵ ↵

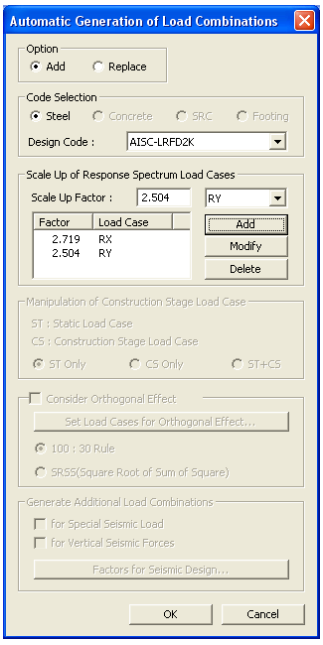


Figure 1.66 Input the Design Code & the Scale Up Factor

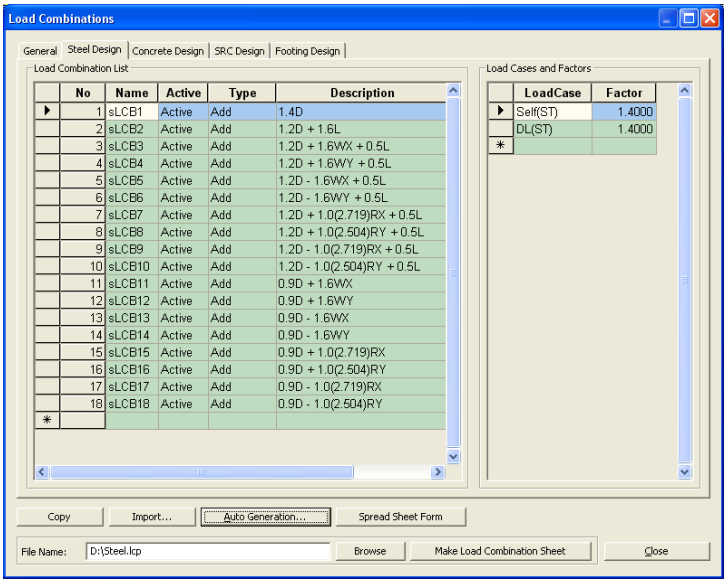


Figure 1.67 Create the load combinations

Input the Design Parameters

Design / General Design Parameter / ***Definition of Frame***

X-Direction Frame > **Braced | Non-sway**

Y-Direction Frame > **Braced | Non-sway**

Design Type > **3-D** (on) ↵

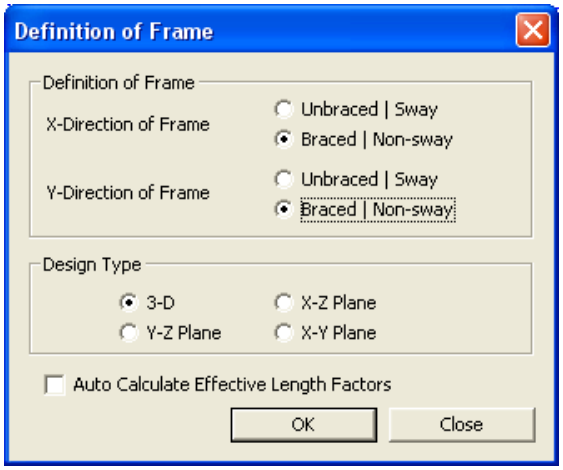


Figure 1.68 Definition of Frame

Initial View

Select Identity-Element

Select Type > **Section**

List > **221 : SG1** Add

List > **226 : SG6** Add

List > **521 : 5SG1** Add

Close

Design / General Design Parameter / ***Unbraced Length (L, Lb)***

Add / Replace > **(on)**

Laterally Unbraced Length Lb > **4** ↵

Input the remainders ; Refer to Table 1.5

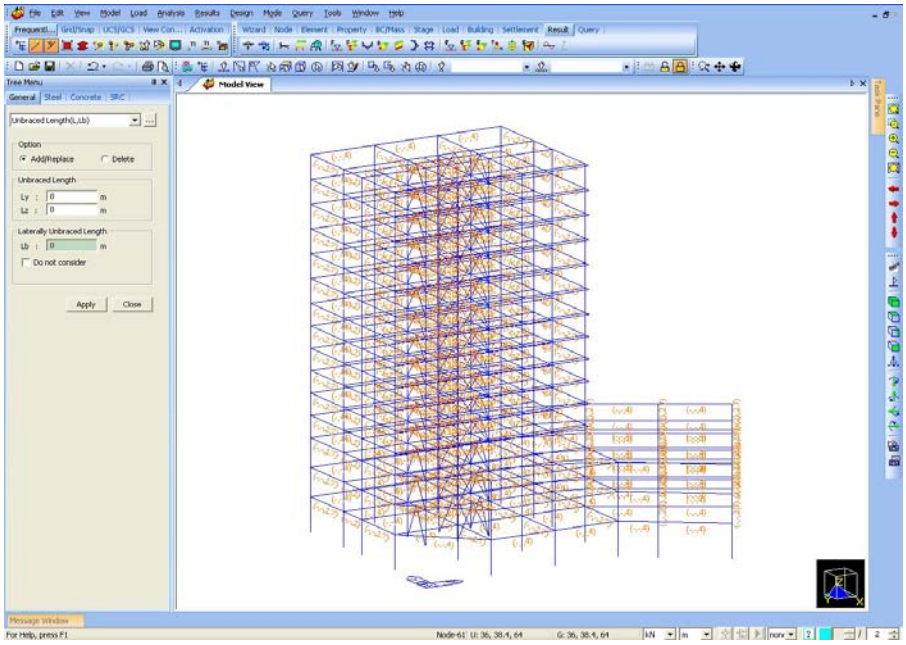


Figure 1.69 Input lateral unbraced lengths

Section Number	Laterally Unbraced Length (m)
241	4.8
221, 226, 521	4.0
224, 225, 524, 525	2.7
222, 223, 243, 522, 523	2.0

Table 1.5 Laterally Unbraced Length of the girders

Design / Steel Design Parameter / ***Design Code***

Design Code > **AISC-LRFD2K**

All Beams/Girders are Laterally Braced (on) ↵

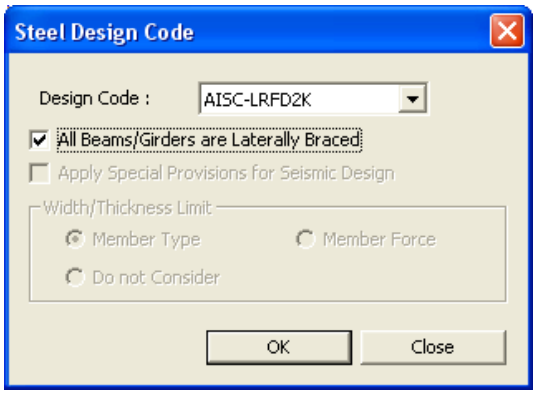


Figure 1.70 Select the design code

Steel Code Check

Redraw

Design / ***Steel Code Check***

>>

Result View Option > **NG**

Select All (Refer to Figure 1.71)

Close

Change...

Property No. > **224**

Search Satisfied Section

Select (SEL) **W 30×116** Change & Close (Refer to Figure 1.73)

Select (SEL) > Property No. > **224**

Graphic... (Refer to Figure 1.72)

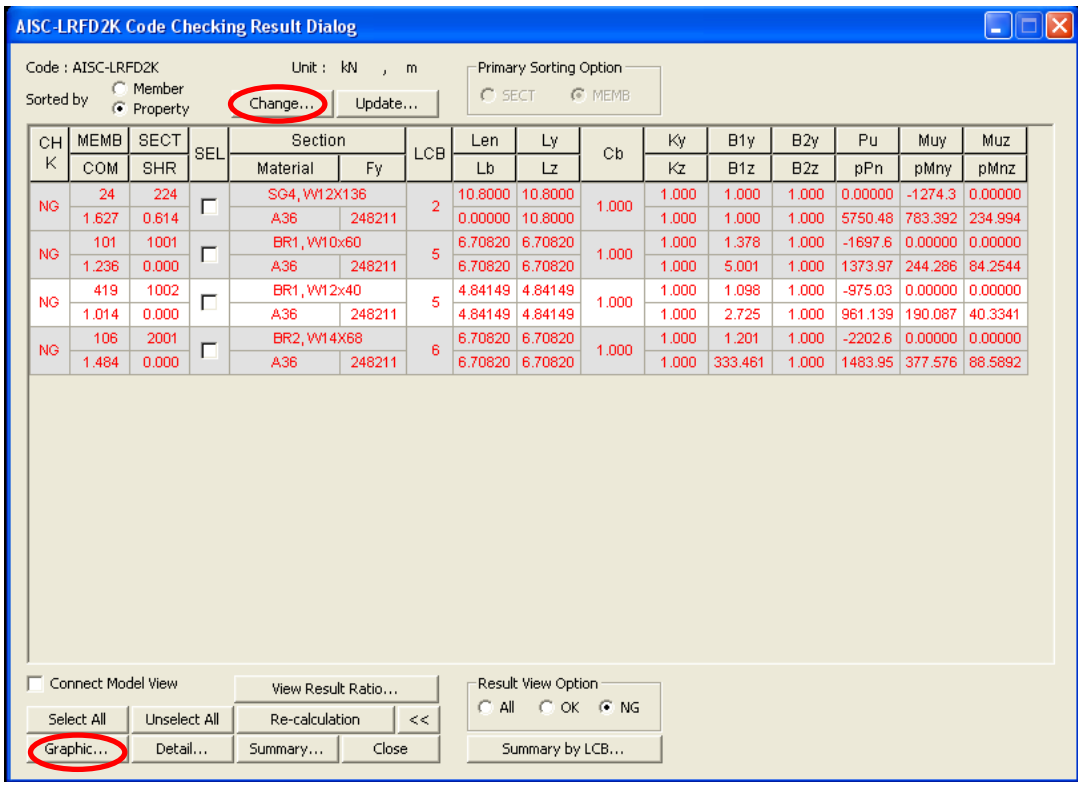
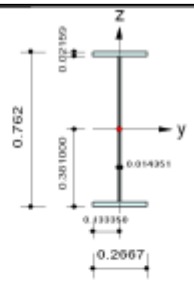


Figure 1.71 Automatic Design Result Dialog box

1. Design Information

Design Code	AISC-LRFD2K
Unit System	kN, m
Element No	24
Material	A36 (No:1)
	(Fy = 248211, Es = 199948024)
Section Name	SG4 (No:224)
	(Rolled : W30X116).
Member Length	: 10.8000



Depth	0.76200	Web Thick	0.01435
Top F Width	0.26670	Top F Thick	0.02159
Bot.F Width	0.26670	Bot.F Thick	0.02159
Area	0.02206	Asz	0.01094
Qyb	0.21313	Qzb	0.00889
Iyy	0.00205	Izz	0.00007
Ybar	0.13335	Zbar	0.38100
Syy	0.00539	Szz	0.00051
ry	0.30480	rz	0.05563

2. Member Forces

Axial Force	Fxx = 0.00000 (LCB: 2, POS:J)
Bending Moments	My = -1345.5, Mz = 0.00000
End Moments	Myi = -855.15, Myj = -1345.5 (for Lb)
	Myi = -855.15, Myj = -1345.5 (for Ly)
	Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces	Fyy = 0.00000 (LCB: 16, POS:I)
	Fzz = 588.718 (LCB: 2, POS:J)

3. Design Parameters

Unbraced Lengths	Ly = 10.8000, Lz = 10.8000, Lb = 0.00000
Effective Length Factors	Ky = 1.00, Kz = 1.00
Moment Factor / Bending Coefficient	
	Cmy = 1.00, Cmz = 1.00, Cb = 1.00

4. Strength Checking Results

Axial Strength

Slenderness Ratio L/r = 194.2 < 300.0 ..... O.K

Pu/phiPn = 0.00/4928.99 = 0.000 < 1.000 ..... O.K

Bending Strength

Muy/phiMny = 1345.54/1383.75 = 0.972 < 1.000 ..... O.K

Muz/phiMnz = 0.000/114.354 = 0.000 < 1.000 ..... O.K

Combined Strength (Tension+Bending)

Pu/phiPn = 0.00 < 0.20

Rmax = Pu/(2*phiPn) + [Muy/phiMny + Muz/phiMnz] = 0.972 < 1.000 ..... O.K

Shear Strength

Vuy/phiVny = 0.000 < 1.000 ..... O.K

Vuz/phiVnz = 0.402 < 1.000 ..... O.K

Figure 1.72 Summary of Design Results

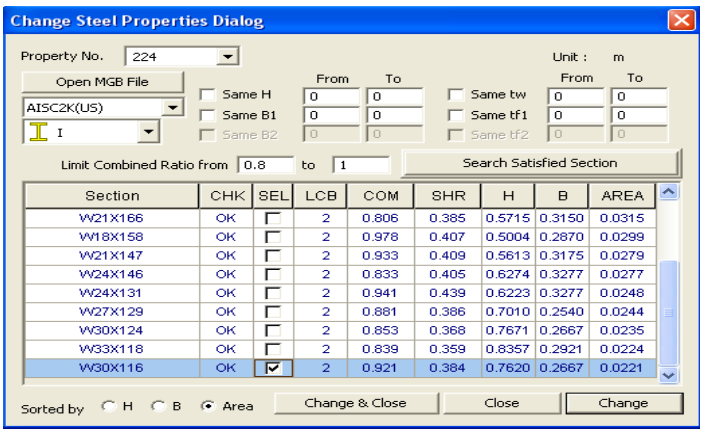


Figure 1.73 Change Steel Properties Dialog box

Design / ***Section for Design*** Modify...

1001 > **W 30×132** ; 1002 > **W 12×50** ; 2001 > **W 14×90** ↵

Select Identity-Element > Select Type > Section

224(on), **1001**(on), **1002**(on), **2001**(on)

Design / ***Steel Code Check*** Re-calculation

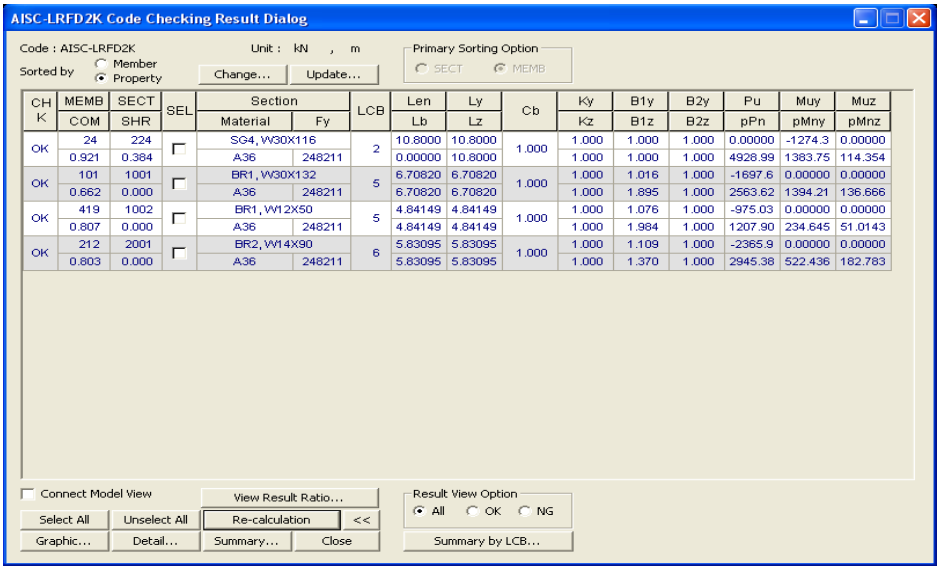


Figure 1.74 Code Checking Result Dialog box after modifying the sections

Unselect All

Design / ***Steel Code Check***

Result View Option > **All**

<<

View Result Ratio...

Select (SEL) > **221**

Show Graph of Result Ratio

Ratio Limit > From > **0** ; To > **0.75**

Select Elements ↵

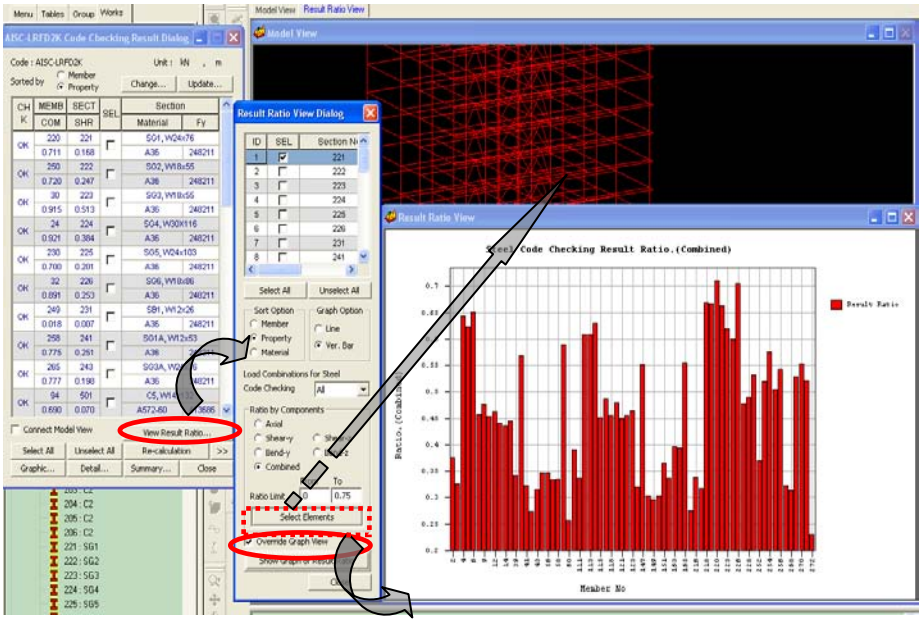


Figure 1.75 Modify section numbers using the design results

Code Checking Result Dialog > (Minimize)

Model View tab

The right side of ***Select Identity-Element*** (Refer to ❶ of Figure 1.76)

[Ctrl]+[**C**] in Keyboard (Copy Command)

Code Checking Result Dialog > (Restore)

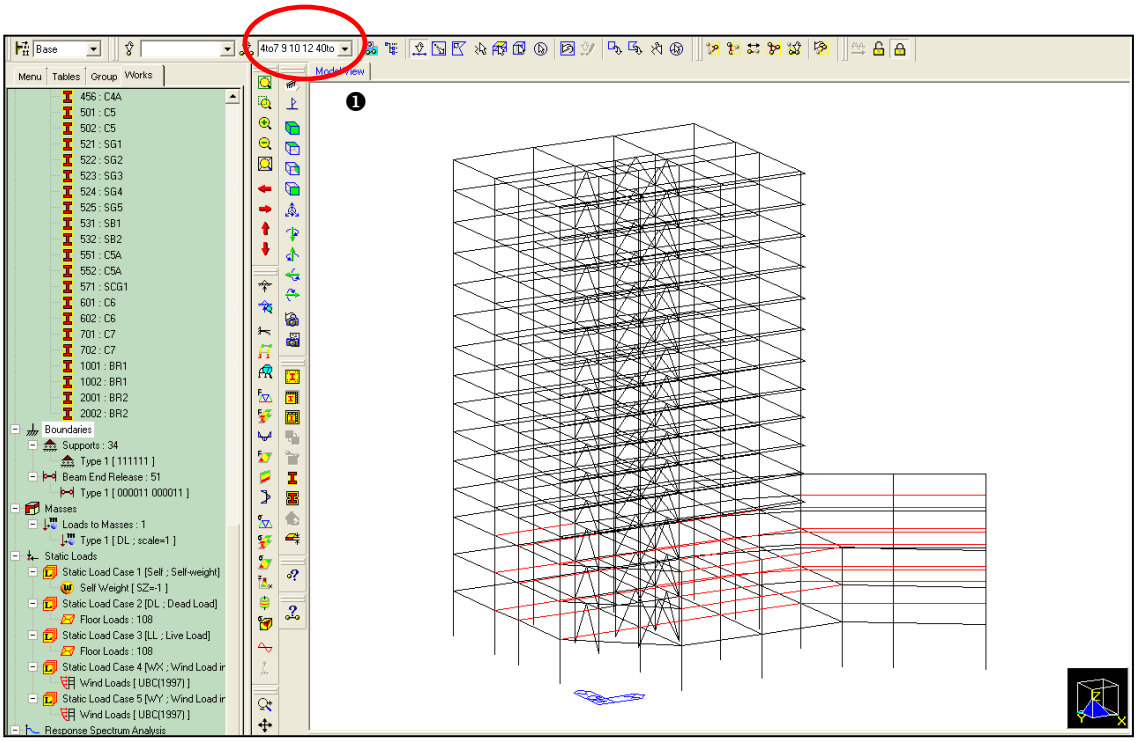


Figure 1.76 Select elements to modify the sections

Re-analyze/Re-design reflecting the Design Results

Code Checking Result Dialog > Update...

Select (SEL) > **224**(on), **1001**(on), **1002**(on), **2001**(on)

<- (Refer to Figure 1.77)

"Analysis / design results will be deleted. Continue?"

Yes

Close

The right side of ***Select Identity-Element*** (Refer to ❶ of Figure 1.76)

[Ctrl]+**[V]** in Keyboard (Paste Command) Enter

Model / Elements / ***Change Element Parameters***

Parameter Type > **Section ID**

Assign No. > **522**

Apply

Analysis / ***Perform Analysis*** **OR** ***Re-analysis*** (Refer to Figure 1.78)

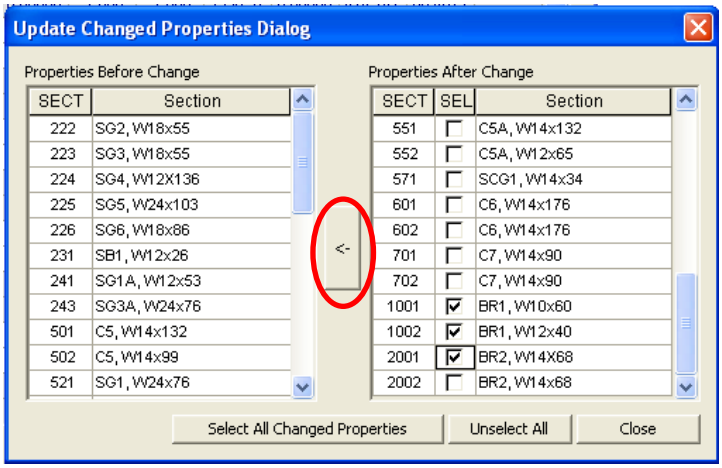


Figure 1.77 Update Changed Properties Dialog

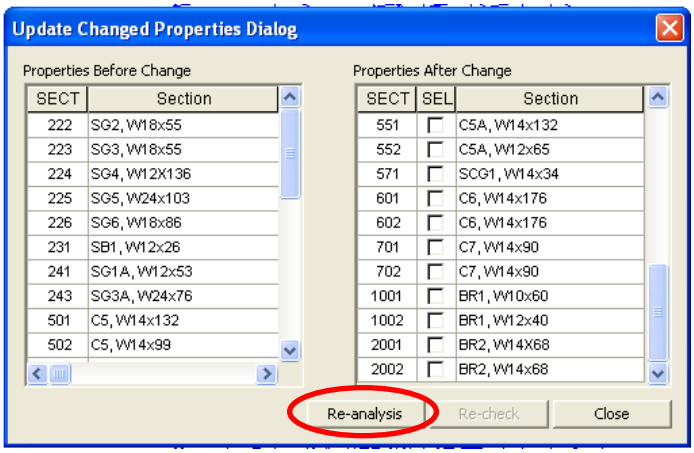


Figure 1.78 Dialog box after updating the selected sections

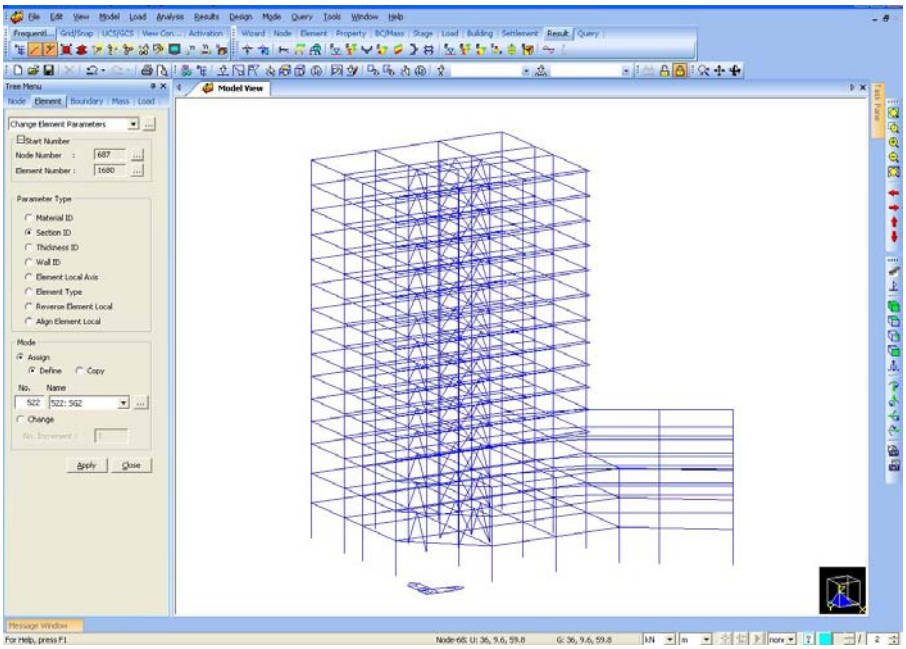


Figure 1.79 Modify sections using the Change Element Parameter

Select Identity-Element

Select Type > **Section**

List > **224:SG4, 522:SG2, 1001:BR1, 1002:BR1, 2001:BR2** Add

Close

Design / ***Steel Code Check***

View Result Ratio... (Refer to Figure 1.80)

Select (SEL) > **224**

Show Graph of Result Ratio (Refer to Figure 1.81)

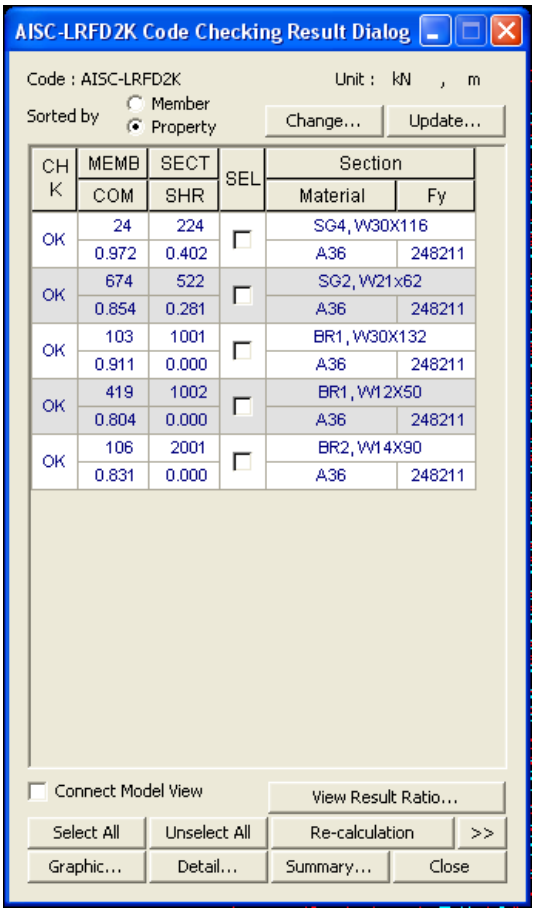


Figure 1.80 Confirm the results of the re-design

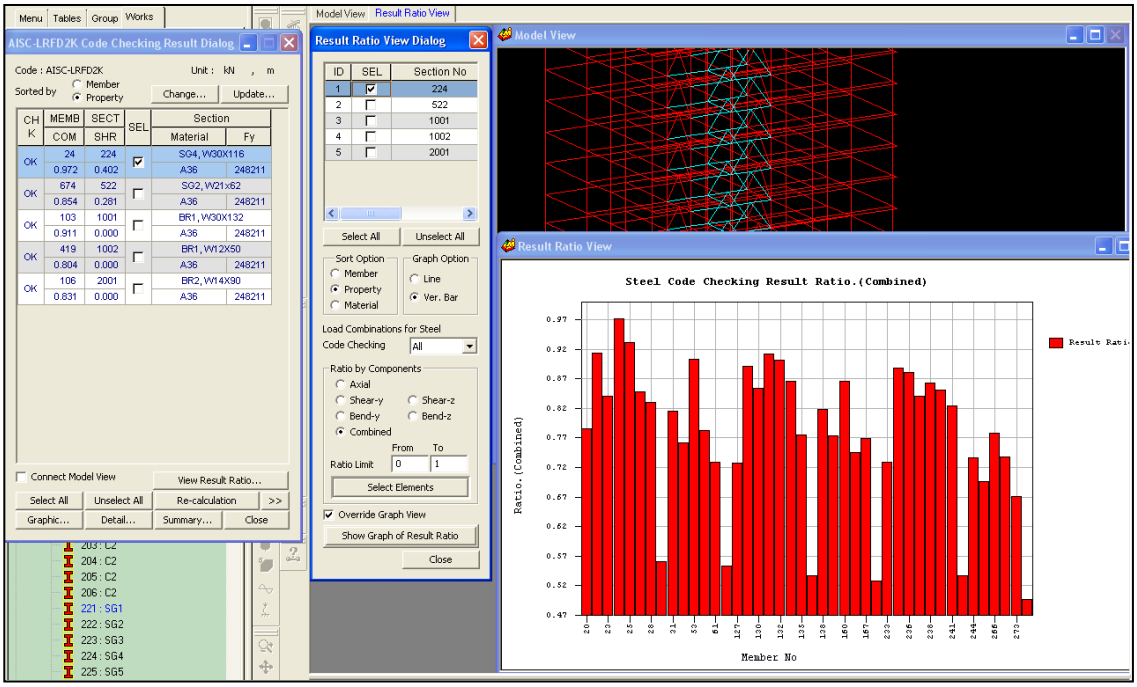


Figure 1.81 Stress ratio graph of 2~4F SG1 (after modifying sections)

SRC Column Design

➢ Applied Design Code: SSRC79

Create the Load Combinations

Unselect All

Result / ***Combination***

SRC Design tab

Auto Generation...

Option **> Add** (on)

Design Code > **SSRC79**

Scale Up Factor > **2.719, RX** Add

Scale Up Factor > **2.504, RY** Add

↵ ↵

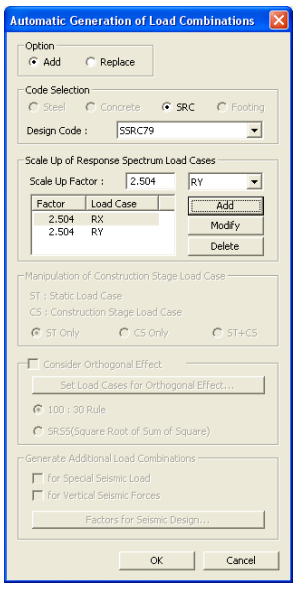


Figure 1.82 Select the SRC Design Code

Input the Design Parameters

Design / SRC Design Parameter / ***Design Code***

Design Code > **SSRC79** ↵

Tools / ***Unit System***

Length > **cm**

Design / SRC Design Parameter / ***Modify SRC Column Section Data***

SEL > Section ID > **151 ~ 156**

Reinforcing Main Bar > **Auto Calculate Rebar Space** (on)

Rebar > **12 - #8**

Number of Rows > **4** ↵

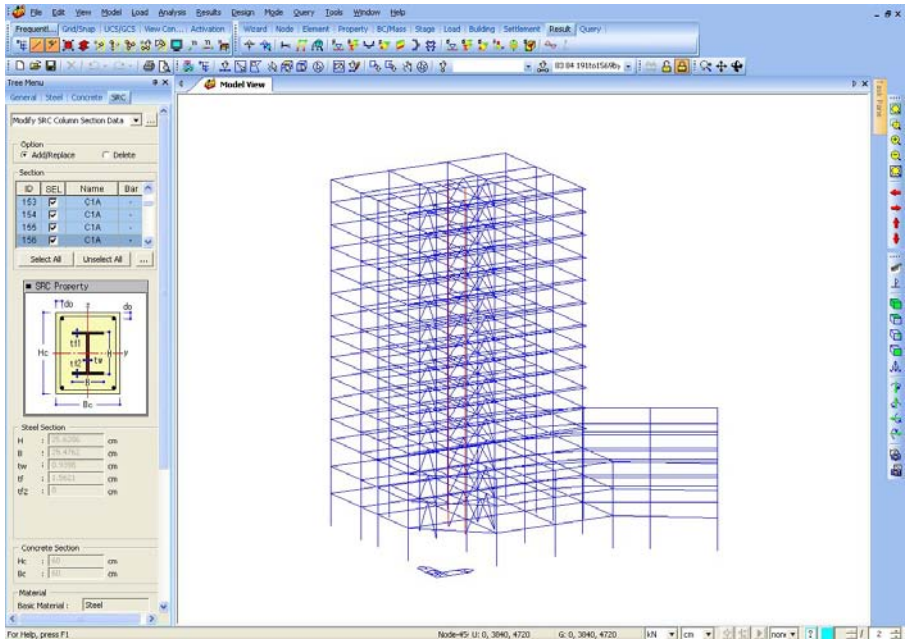
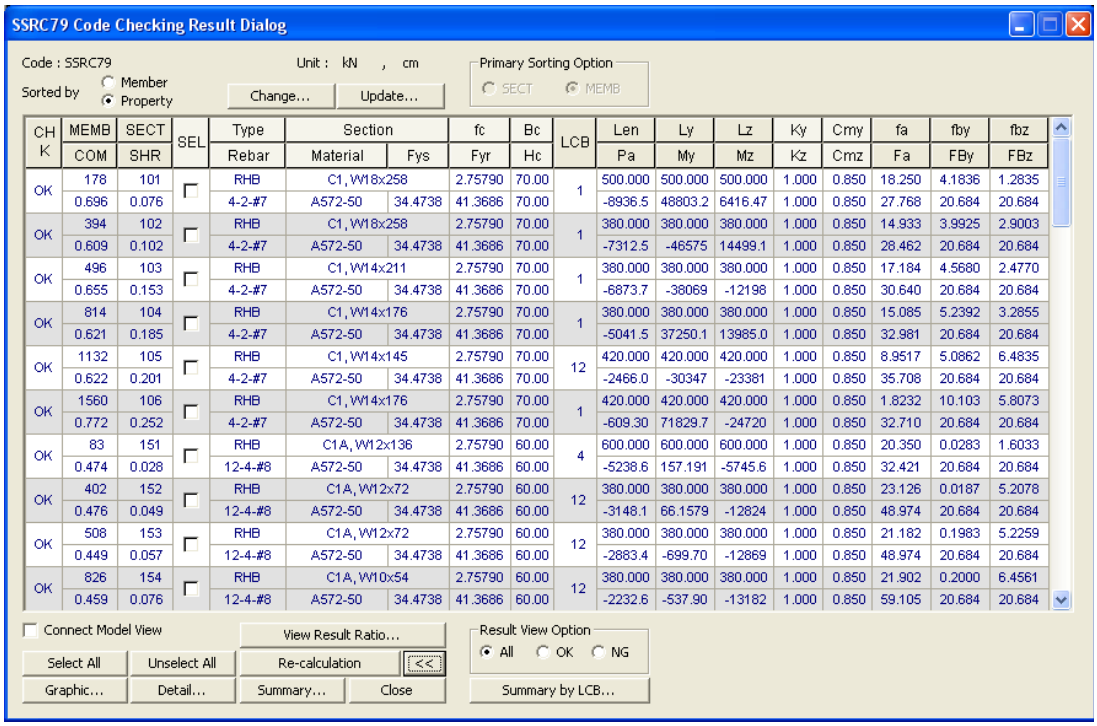


Figure 1.83 Modify SRC Column Section Data

SRC Code Check

Design > ***SRC Code Check*** > **Column Checking**

>>



CHK	MEMB	SECT	SEL	Type	Section		fc	Bc	LCB	Len	Ly	Lz	Ky	Cmy	fa	fby	fbz
	COM	SHR		Rebar	Material	Fys	Fyr	Hc		Pa	My	Mz	Kz	Cmz	Fa	FBy	FBz
OK	178	101	☐	RHB	C1,W18x258		2.75790	70.00	1	500.000	500.000	500.000	1.000	0.850	18.250	4.1836	1.2835
	0.696	0.076		4-2-#7	A572-50	34.4738	41.3686	70.00		-8936.5	48803.2	6416.47	1.000	0.850	27.768	20.684	20.684
OK	394	102	☐	RHB	C1,W18x258		2.75790	70.00	1	380.000	380.000	380.000	1.000	0.850	14.933	3.9925	2.9003
	0.609	0.102		4-2-#7	A572-50	34.4738	41.3686	70.00		-7312.5	-46575	14499.1	1.000	0.850	28.462	20.684	20.684
OK	496	103	☐	RHB	C1,W14x211		2.75790	70.00	1	380.000	380.000	380.000	1.000	0.850	17.184	4.5680	2.4770
	0.655	0.153		4-2-#7	A572-50	34.4738	41.3686	70.00		-6873.7	-38069	-12198	1.000	0.850	30.640	20.684	20.684
OK	814	104	☐	RHB	C1,W14x176		2.75790	70.00	1	380.000	380.000	380.000	1.000	0.850	15.085	5.2392	3.2855
	0.621	0.185		4-2-#7	A572-50	34.4738	41.3686	70.00		-5041.5	37250.1	13985.0	1.000	0.850	32.981	20.684	20.684
OK	1132	105	☐	RHB	C1,W14x145		2.75790	70.00	12	420.000	420.000	420.000	1.000	0.850	8.9517	5.0862	6.4835
	0.622	0.201		4-2-#7	A572-50	34.4738	41.3686	70.00		-2466.0	-30347	-23381	1.000	0.850	35.708	20.684	20.684
OK	1560	106	☐	RHB	C1,W14x176		2.75790	70.00	1	420.000	420.000	420.000	1.000	0.850	1.8232	10.103	5.8073
	0.772	0.252		4-2-#7	A572-50	34.4738	41.3686	70.00		-609.30	71829.7	-24720	1.000	0.850	32.710	20.684	20.684
OK	83	151	☐	RHB	C1A,W12x136		2.75790	60.00	4	600.000	600.000	600.000	1.000	0.850	20.350	0.0283	1.6033
	0.474	0.028		12-4-#8	A572-50	34.4738	41.3686	60.00		-5238.6	157.191	-5745.6	1.000	0.850	32.421	20.684	20.684
OK	402	152	☐	RHB	C1A,W12x72		2.75790	60.00	12	380.000	380.000	380.000	1.000	0.850	23.126	0.0187	5.2078
	0.476	0.049		12-4-#8	A572-50	34.4738	41.3686	60.00		-3148.1	66.1579	-12824	1.000	0.850	48.974	20.684	20.684
OK	508	153	☐	RHB	C1A,W12x72		2.75790	60.00	12	380.000	380.000	380.000	1.000	0.850	21.182	0.1983	5.2259
	0.449	0.057		12-4-#8	A572-50	34.4738	41.3686	60.00		-2883.4	-699.70	-12869	1.000	0.850	48.974	20.684	20.684
OK	826	154	☐	RHB	C1A,W10x54		2.75790	60.00	12	380.000	380.000	380.000	1.000	0.850	21.902	0.2000	6.4561
	0.459	0.076		12-4-#8	A572-50	34.4738	41.3686	60.00		-2232.6	-537.90	-13182	1.000	0.850	59.105	20.684	20.684

Figure 1.84 SRC Code Checking Result Dialog