國家實驗研究院

Taiwan Earthquake Assessment for Structures by Pushover Analysis (TEASPA)

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Outline

- Tools
- Flowchart
- A Single Input File
- EXE Programs
- Example

Tools

- **ETABS commercial software ：**

To perform pushover analysis

--- Need version 16.

- **MATLAB compiled .EXE programs：**

COLPH.exe : get plastic hinges for columns

BWPH.exe : get plastic hinges for brick walls

PGA.exe : get PGA for performance points

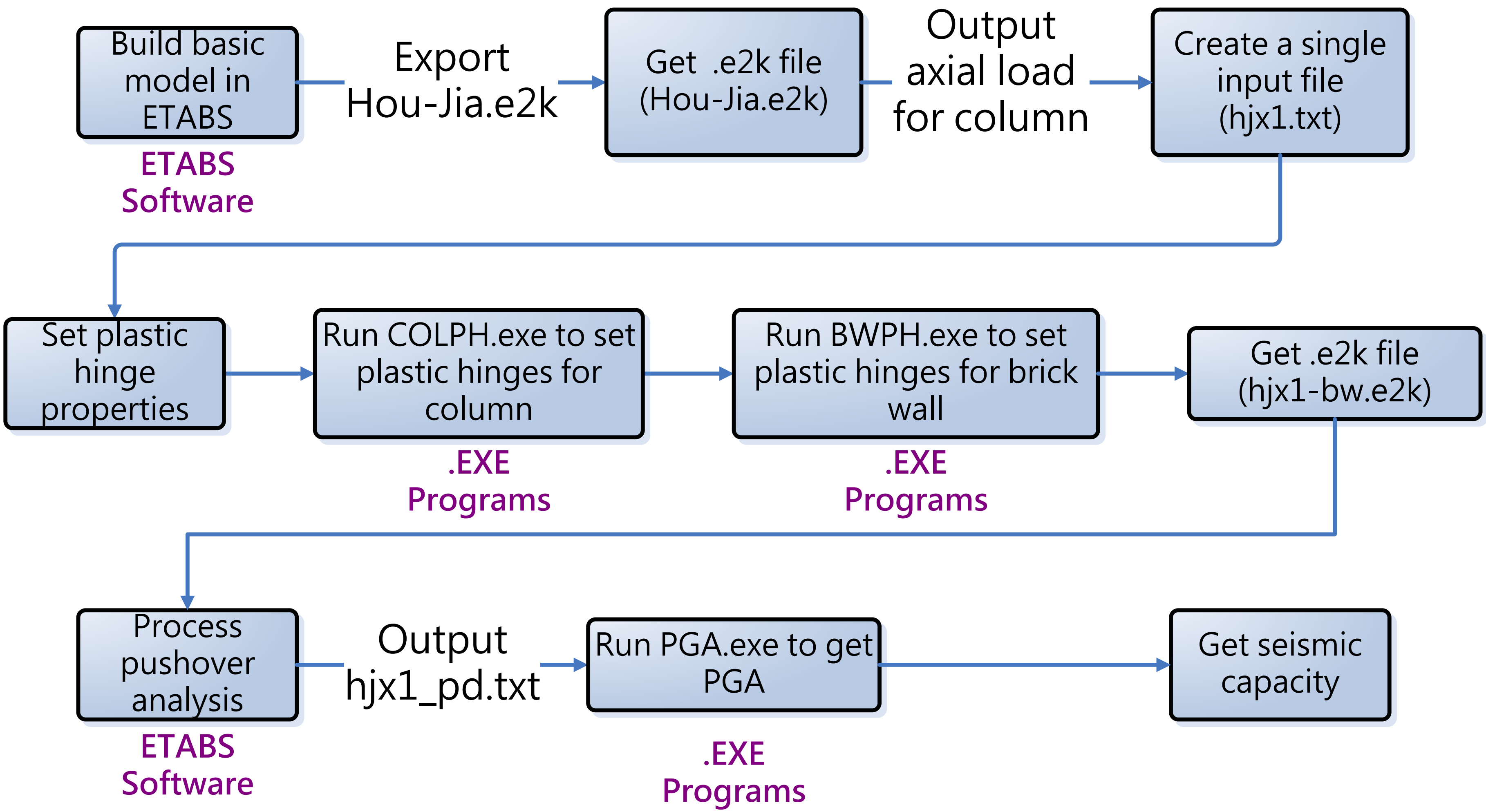
- **Attention!**
Install MCRInstaller.exe first!
(http://w3.ncree.org/rcbpa/191MB/MCRInstaller.exe)

Assistant programs from NCREE

Before running following programs, please install MCRInstaller.exe first.

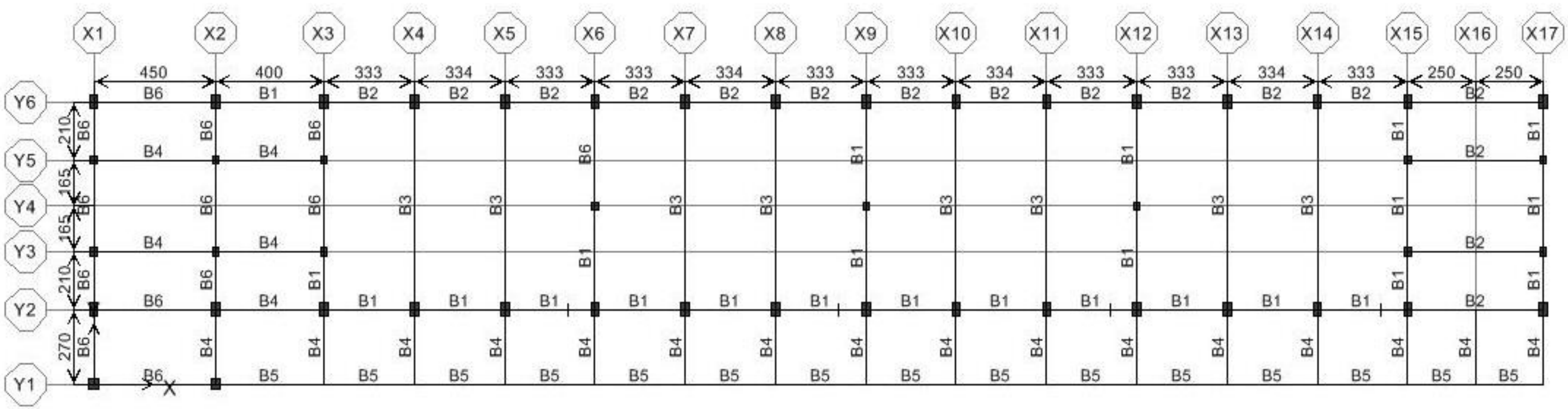
Calculate the nonlinear hinges for beam and column	COLPH	COLPH.EXE	Unit: kgf, cm
Calculate the nonlinear hinges for brick wall	BWPH	BWPH.EXE	Unit: kgf, cm
Calculate the nonlinear hinges for RC wall	SWPH	SWPH.EXE	Unit: kgf, cm
Calculate the PGA for performance point	PGA	PGA.EXE	Unit: kgf, cm

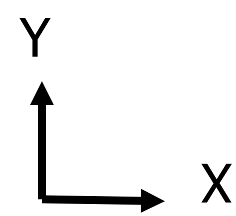
Flowchart for pushover analysis with TEASPA



Direction for pushover

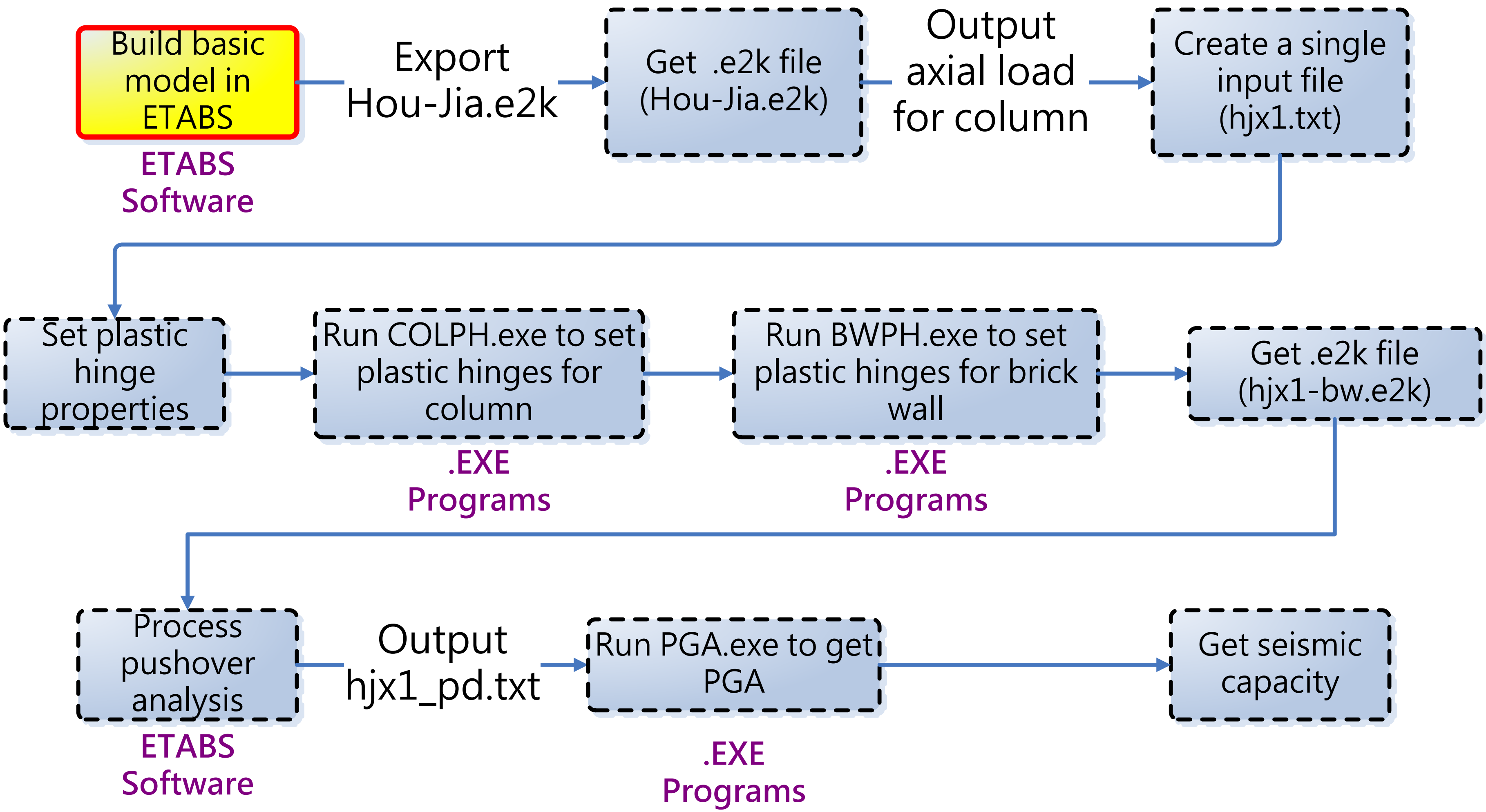
- In practical, 4 directions included
  <u>+</u>X and <u>+</u> Y are needed.





- For instruction, only +X direction
  is introduced.

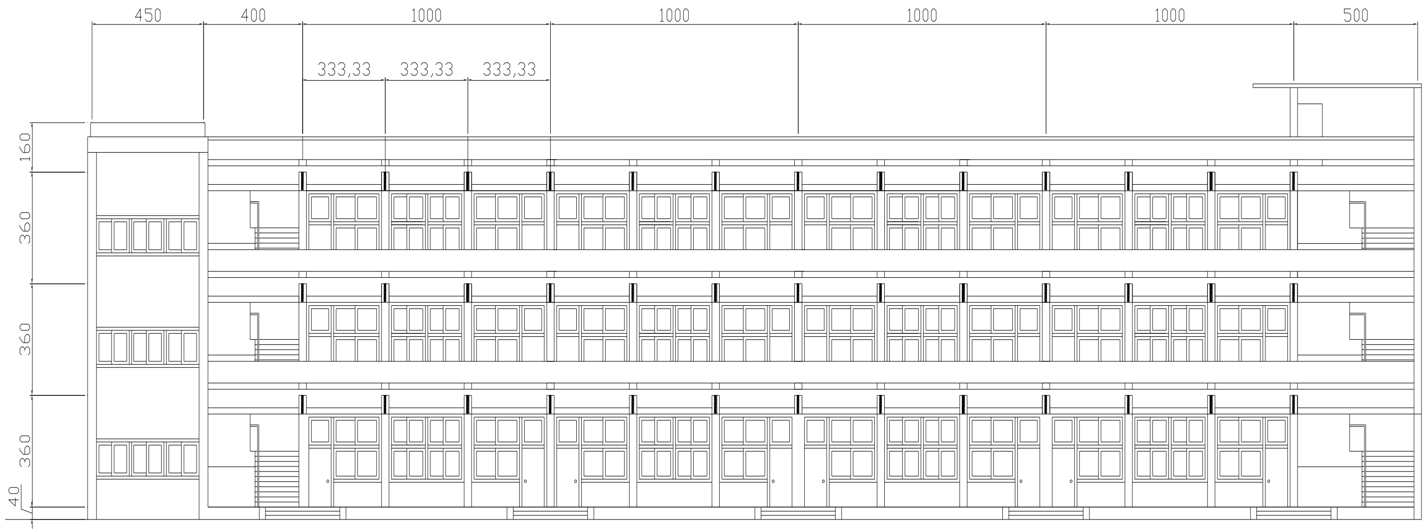
Flowchart (1/9)

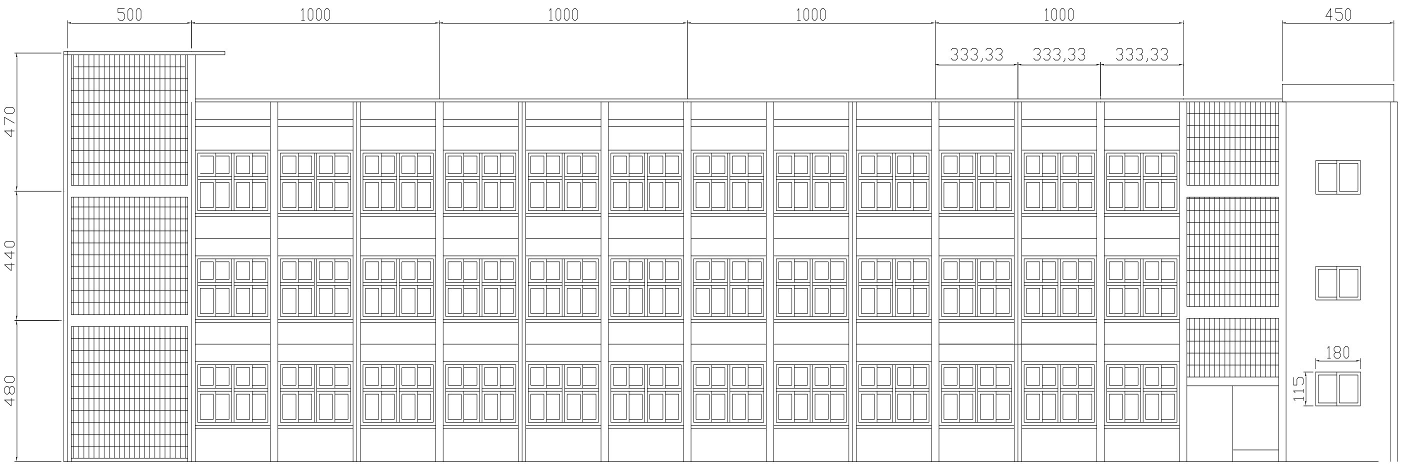


Basic information for target building

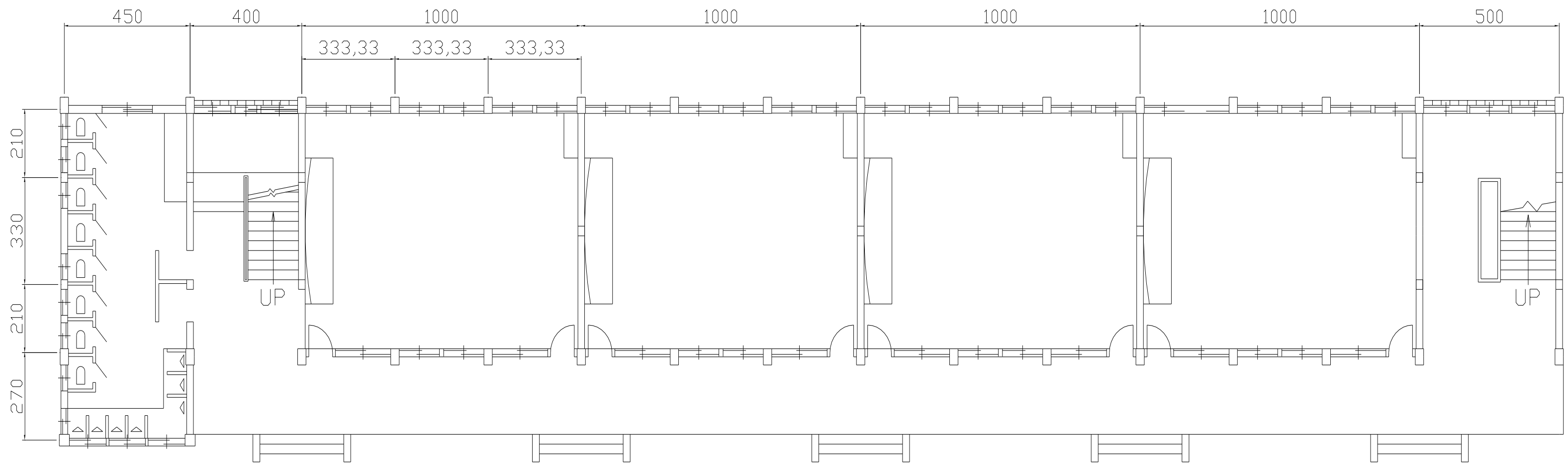
- The school was located in East area of Tainan city, and the site class is normal site.
- The school building was a 3-story RC school building. Each story is 3.6 m high.
- The total length along the corridor (X-direction) was 53.5m and the transverse width (Y-direction) was 10.2m.
- Each floor consisted of 4 classrooms and a unilateral hallway without exterior columns. Each classroom consisted of 3 spans, which lay along the longitudinal direction.

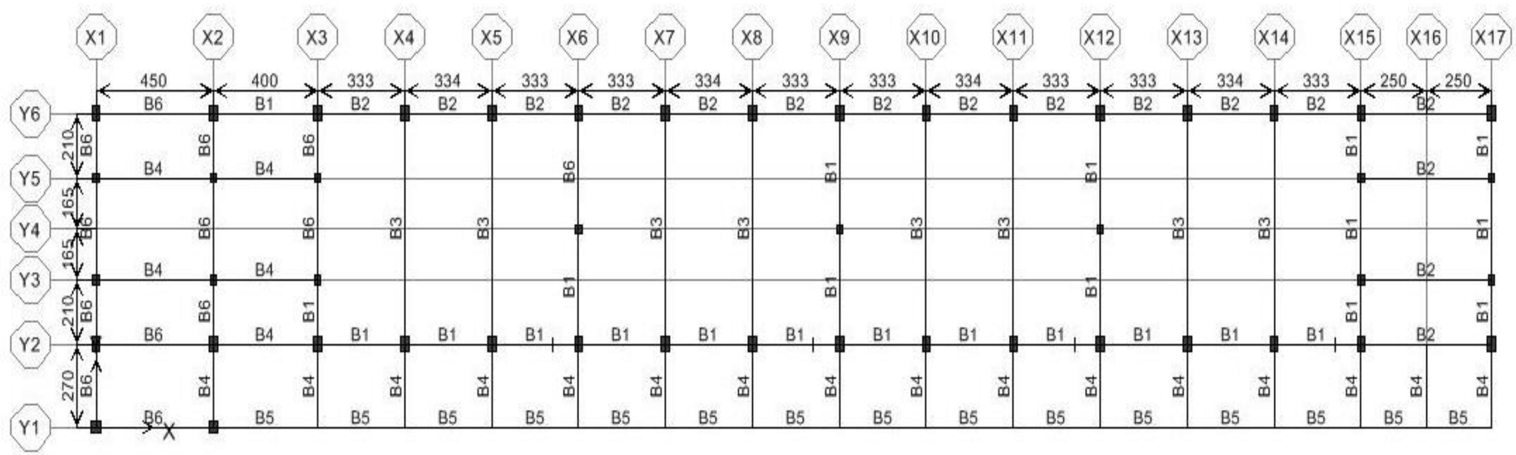
Front view


450
400
1000
1000
1000
1000
500
333,33
333,33
333,33
160
360
360
360
40

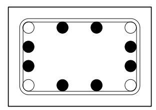
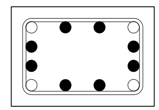
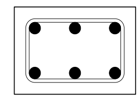
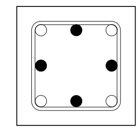

500
1000
1000
1000
1000
450
333,33
333,33
333,33
470
440
480
180
115

Plan view

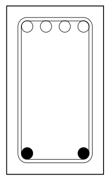
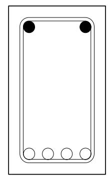
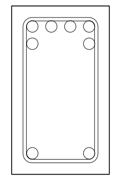
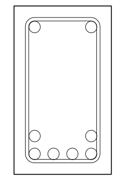
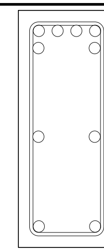
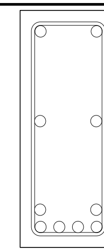

450
400
1000
1000
1000
1000
500
333,33
333,33
333,33
210
330
210
270
UP
UP


X1
X2
X3
X4
X5
X6
X7
X8
X9
X10
X11
X12
X13
X14
X15
X16
X17
Y6
Y5
Y4
Y3
Y2
Y1
450
400
333
334
333
333
334
333
333
334
333
333
334
333
250
250
210
165
165
210
270

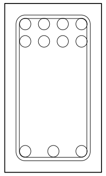
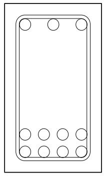
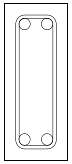
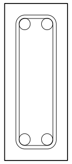
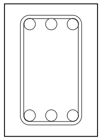
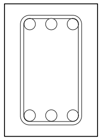
Dimension and Detail : Column (1/3)

Name	C1L	C1S	C2	C3
Section				
Longitudinal Steel	4-D22 8-D19	4-D22 8-D19	6-D16	4-D19 4-D16
Transverse Steel	D9@25	D9@25	D9@25	D9@25
Dimension	50×30	50×30	30×24	36×36

Dimension and Detail : Beam (2/3)

Name	B1		B2		B3	
	End	Mid.	End	Mid.	End	Mid.
Section						
Longitudinal Steel	○ 4-D19 ● 2-D16		○ 8-D22		○ 10-D22	
Transverse Steel	D9@25		D9@25		D9@25	
Dimension	25×60		30×60		30×90	

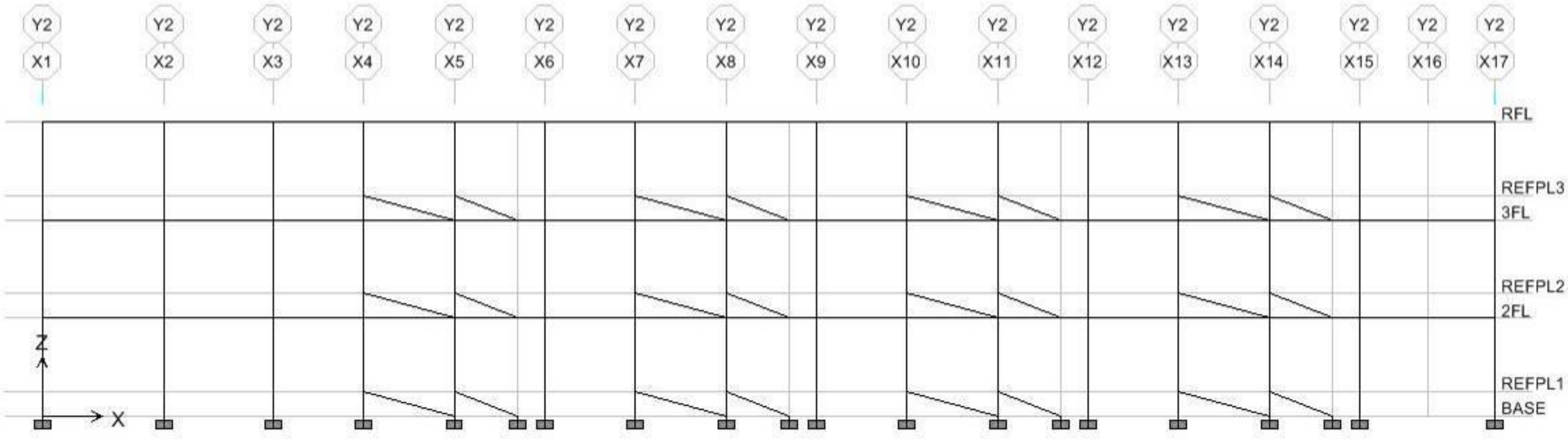
Dimension and Detail : Beam (3/3)

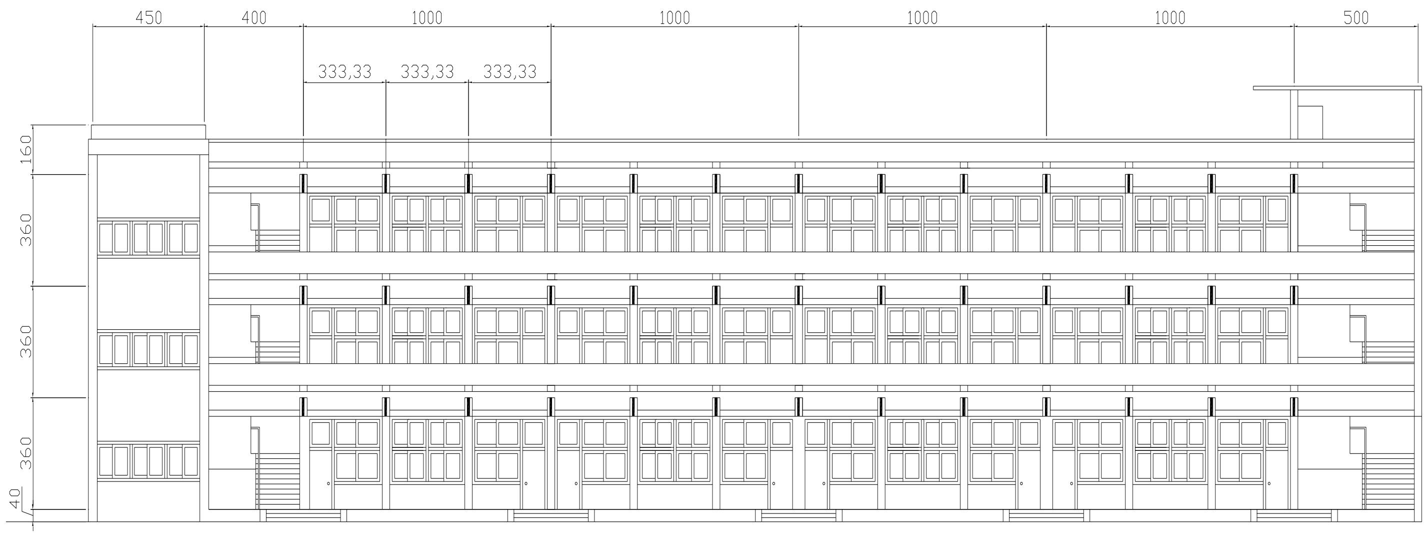
Name	B4		B5		B6	
Section	End	Mid.	End	Mid.	End	Mid.
						
Longitudinal Steel	○ 11-D22		○ 4-D13		○ 6-D16	
Transverse Steel	D9@25		D9@25		D9@25	
Dimension	30×55		15×55		24×45	

Material List

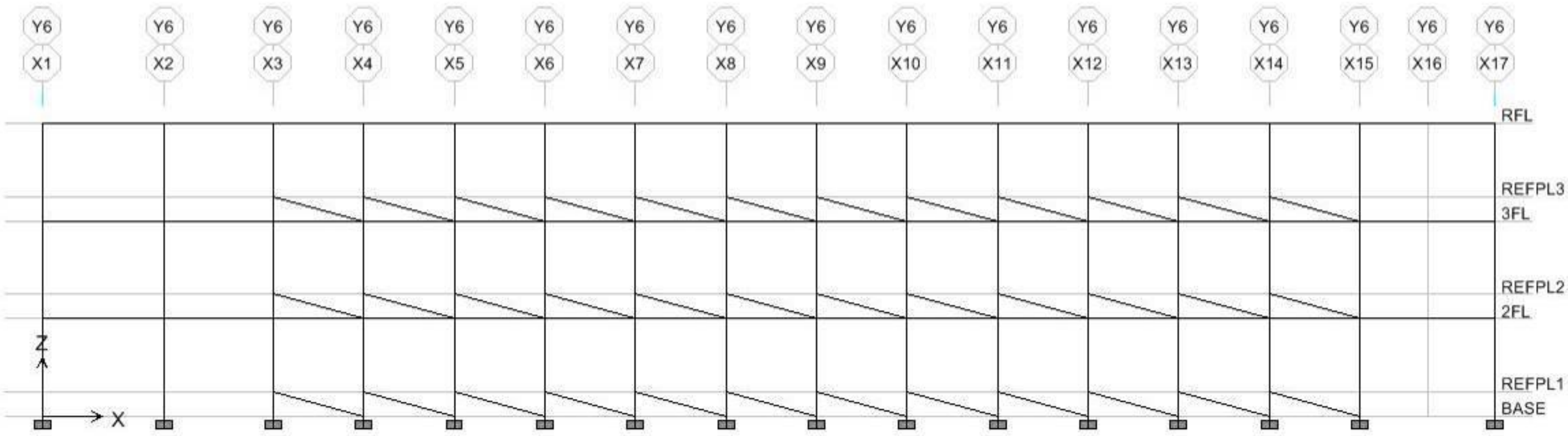
Compression strength of concrete	$f_c' = 160\text{kgf/cm}^2$
Yield strength of longitudinal steel	$f_y = 2800\text{kgf/cm}^2$
Yield strength of transverse steel	$f_y = 2800\text{kgf/cm}^2$
Compression strength of brick	$f_{bc} = 150\text{kgf/cm}^2$
Split strength of brick	$f_{bt} = 33\text{kgf/cm}^2$
Compression strength of mortar	$f_{mc} = 210\text{kgf/cm}^2$
Split strength of mortar	$f_{tm} = 21\text{kgf/cm}^2$
Split strength of interface of brick and mortar	$f_{mbt} = 2.04\text{kgf/cm}^2$

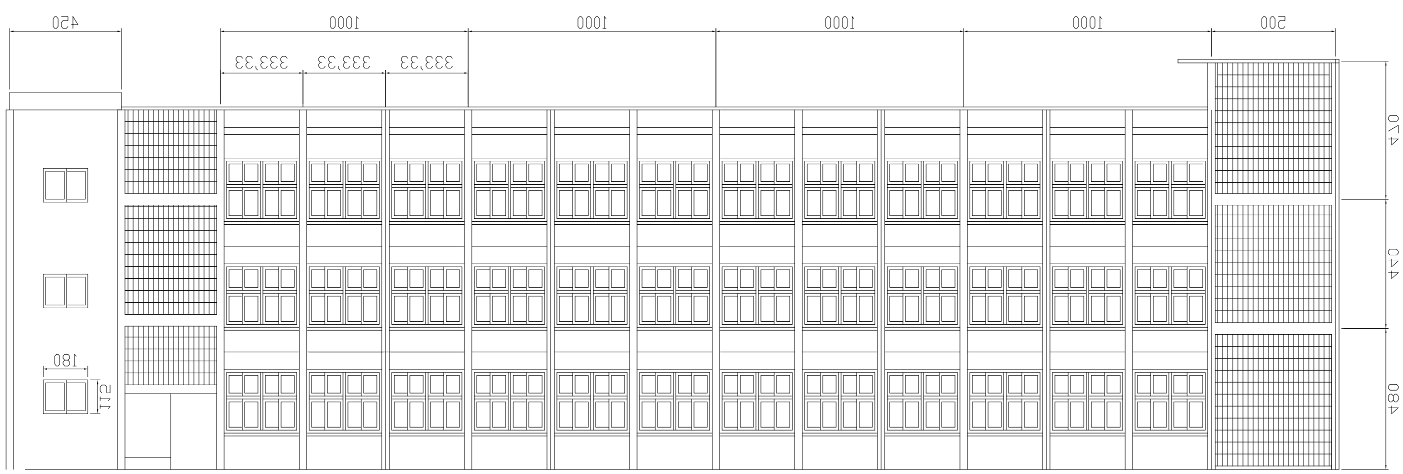
Brick wall and window sill





Brick wall and window sill

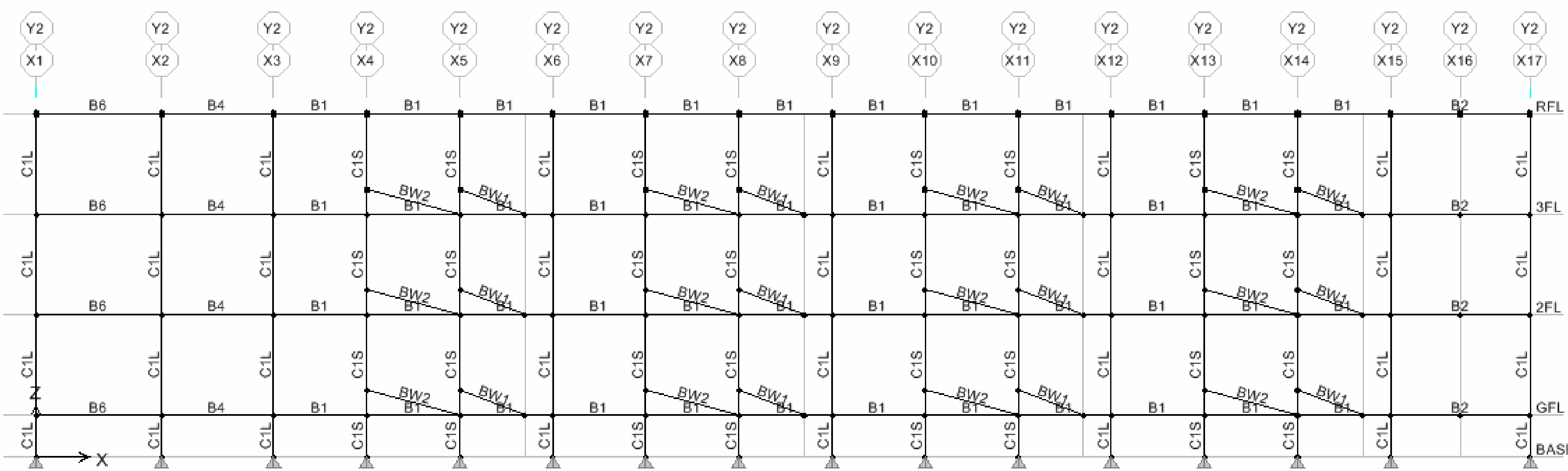




Brick wall and window sill

Dir.	Name	Width (cm)	Height (cm)	Thick. (cm)	Confinement
X	BW1	218	90	24	Window sill
	BW2	303	90	24	Window sill

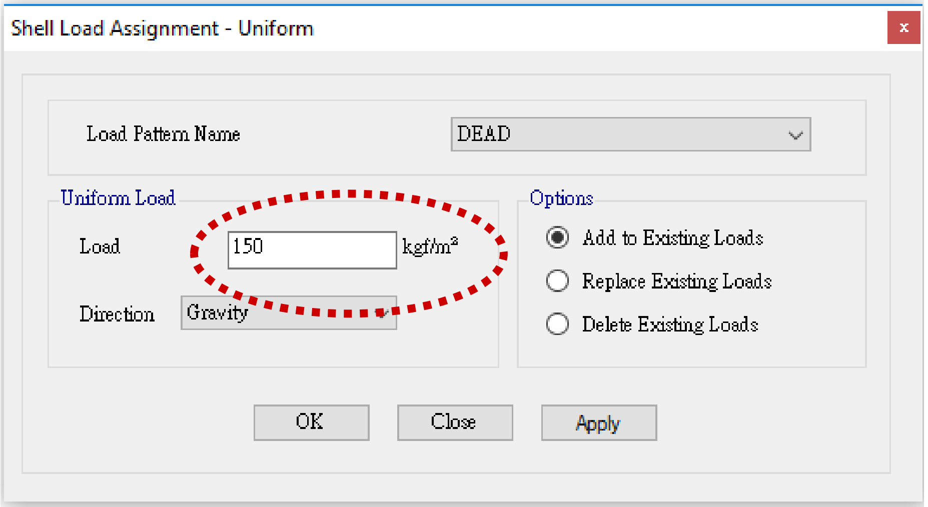
Line	Brace
Y-2	BW1 、BW2
Y-6	BW1



Note for modeling (1/6)

- **Define dead load and live load**

Applied Load = DL+ 0.5LL, 0.5LL= 150 kgf/m²

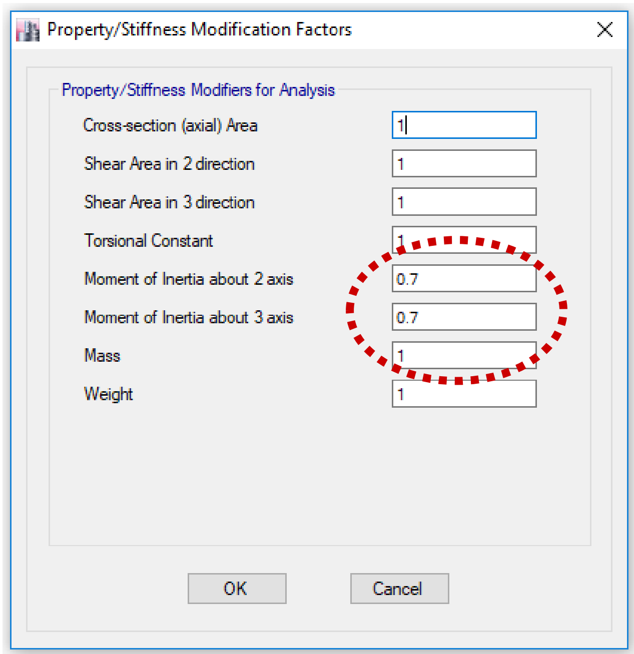


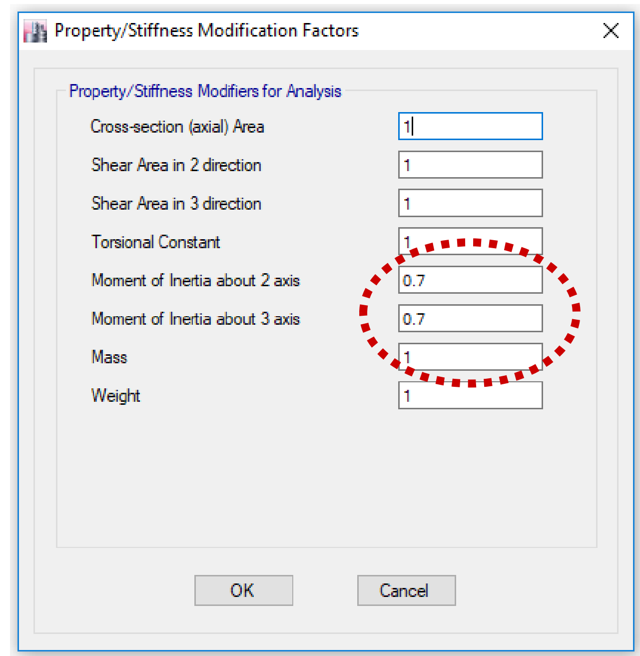
1. Use [Select/by Area Object Type] to select all floor
2. Use [Assign/Shell Loads/Uniform] to define live load

Note for modeling (2/6)

- **Stiffness reduction factor for column and beam**

Stiffness reduction factor : Column=0.7 E_c I_g, Beam=0.7 E_c I_g





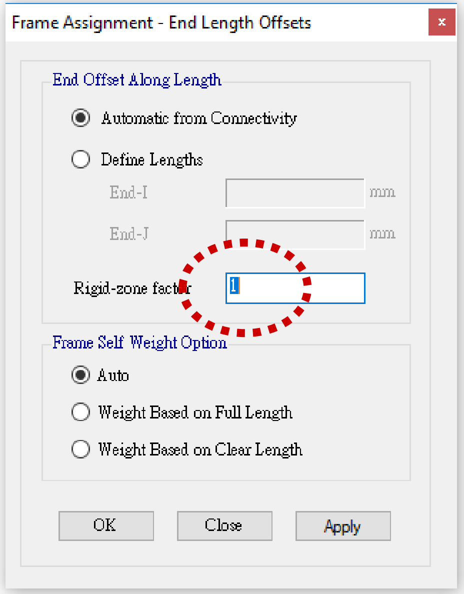
1. Use [Select/by Line Object Type] to select Column or Beam.

2. Then use [Assign/Frame/Property Modifiers] to set I2 and I3 = 0.7.

Note for modeling (3/6)

- **Rigid zone factor**

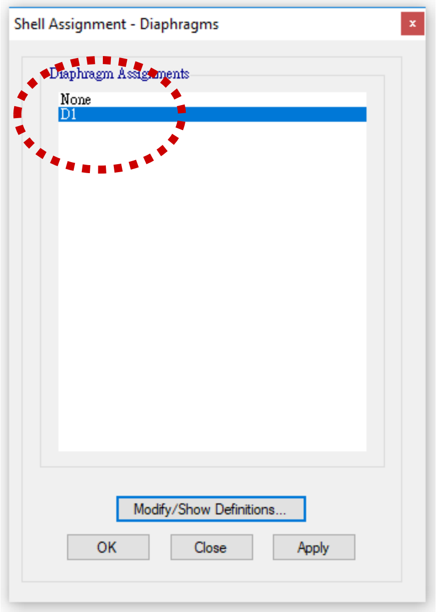
Set rigid zone factor=1, when default value is 0.



1. Use [Select/by line Object Type], select all Column and Beam
2. Use [Assign/Frame/End Length Offsets] to set [Rigid-zone factor] = 1

Note for modeling (4/6)

- **Rigid diaphragm**

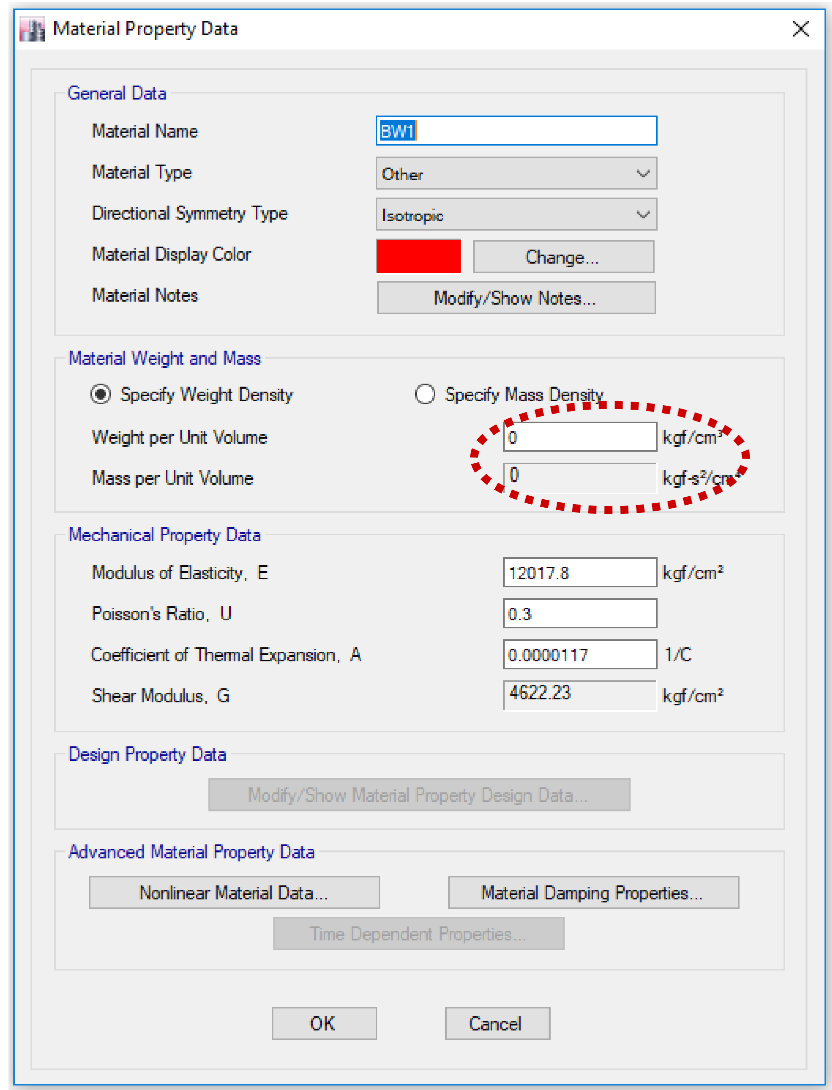


1. Use [Select/by Area Object Type] to select floors.
2. Use [Assign/Shell/Diaphram] to set D1

Note for modeling (5/6)

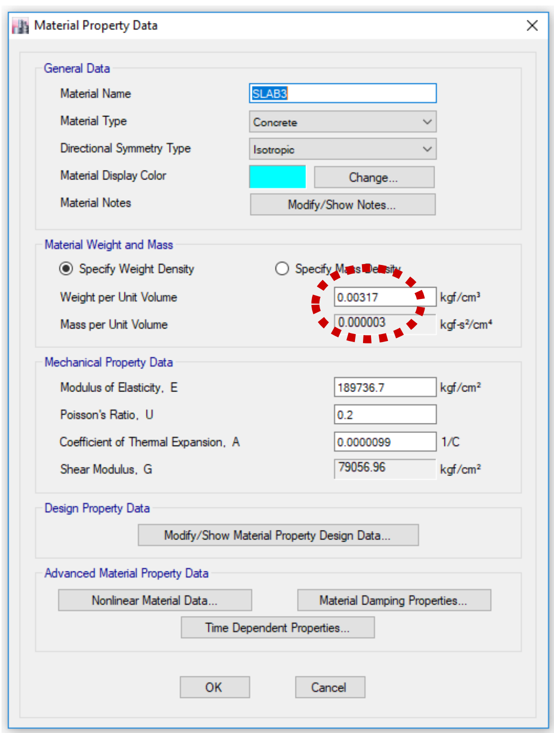
- **Weight of brick wall and partition wall**

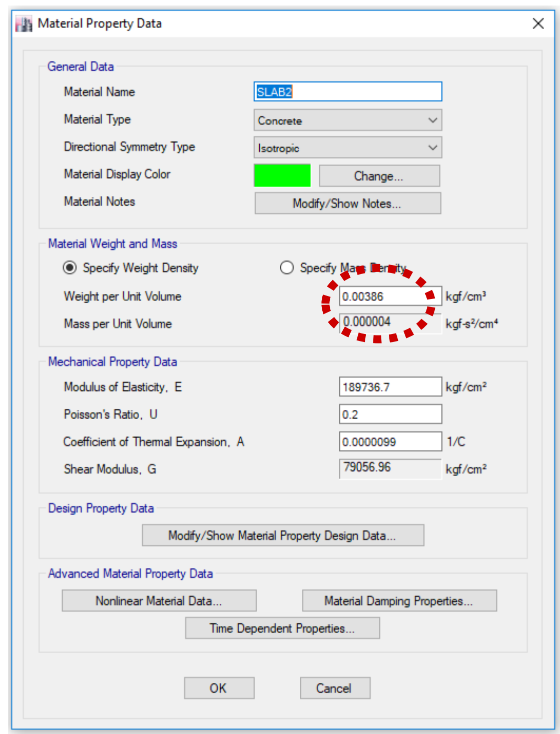
1. **Because the density of equilibrium truss simulating brick wall was set as zero, the weight of brick wall and partition wall could be considered from slab.**

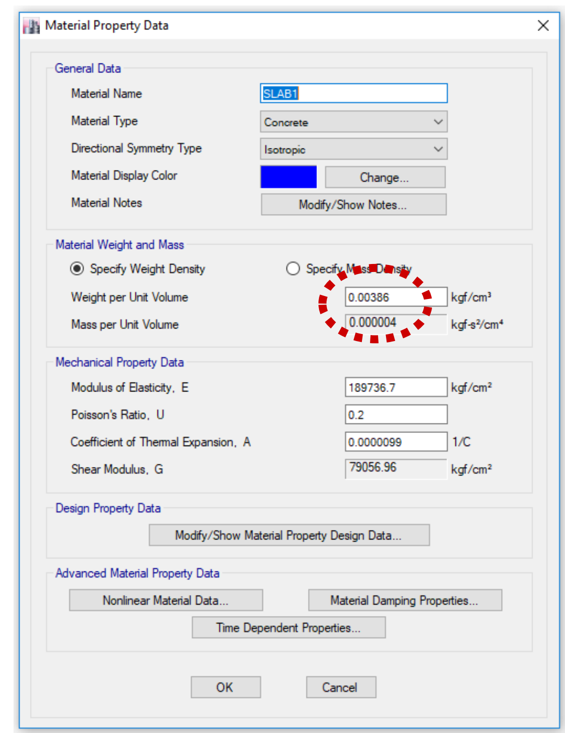


Note for modeling (6/6)

2. The density of slab could be consider as original weight plus weight of brick wall and partition wall over the slab area.





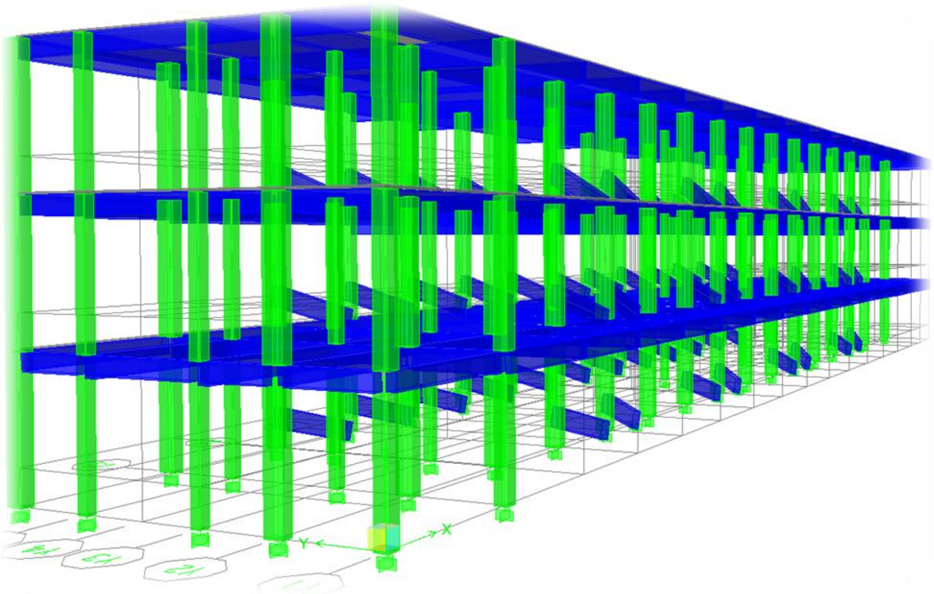


Use [Define/Material Property] to modify SLAB3, SLAB2 and SLAB1.

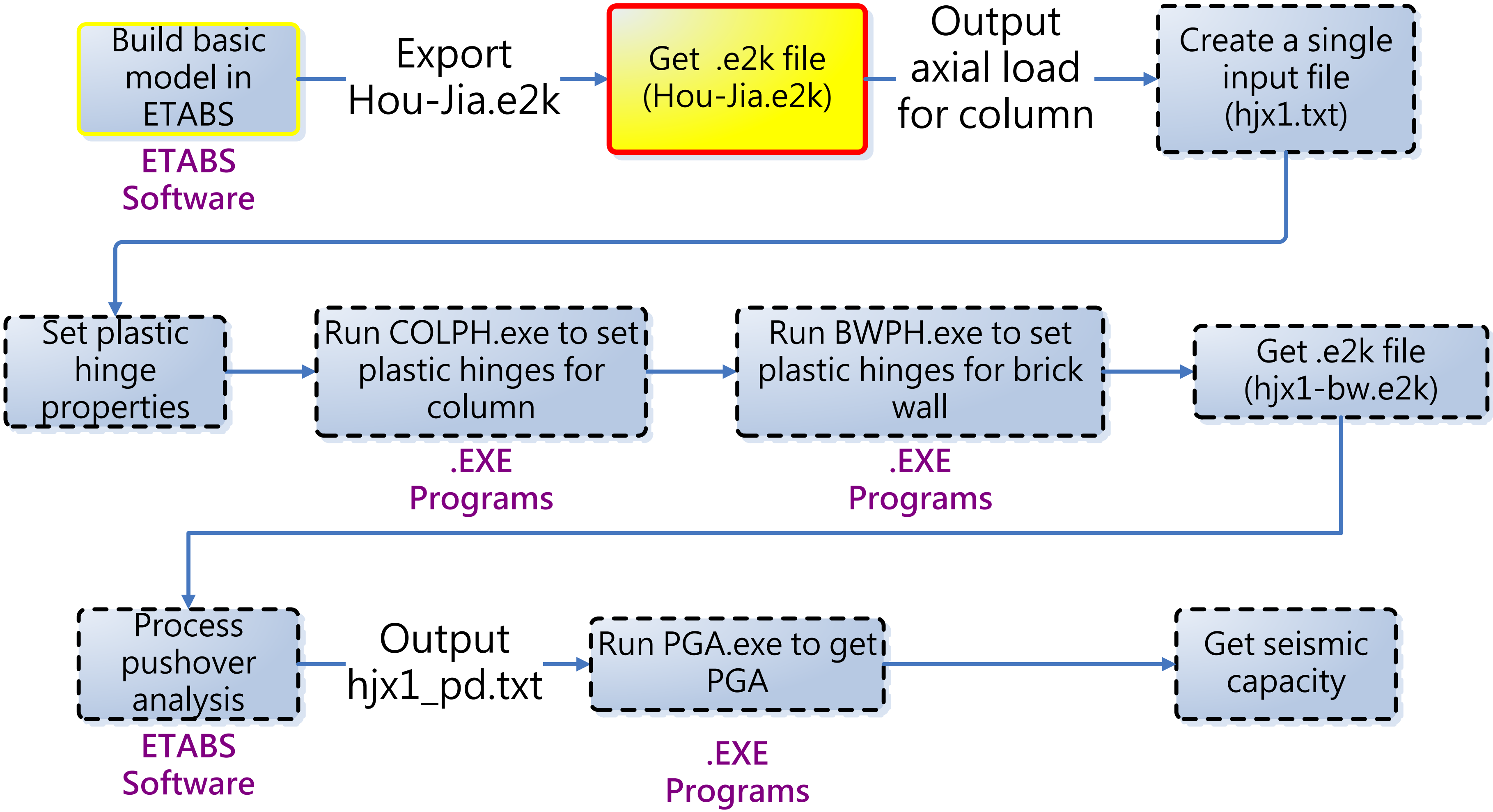
In Hou-Jia.e2k

- Stiffness reduction factor for beam and column
- Rigid zone factor
- Rigid diaphragm
- Weight of brick wall and partition wall

Analytical model in ETABS

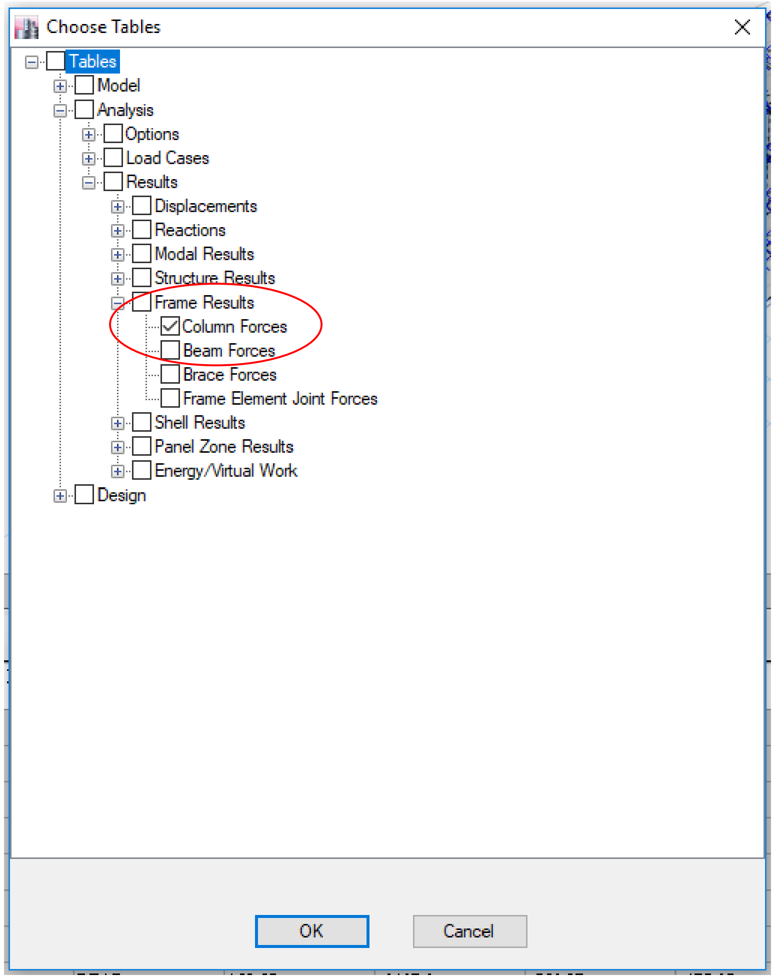


Flowchart (2/9)



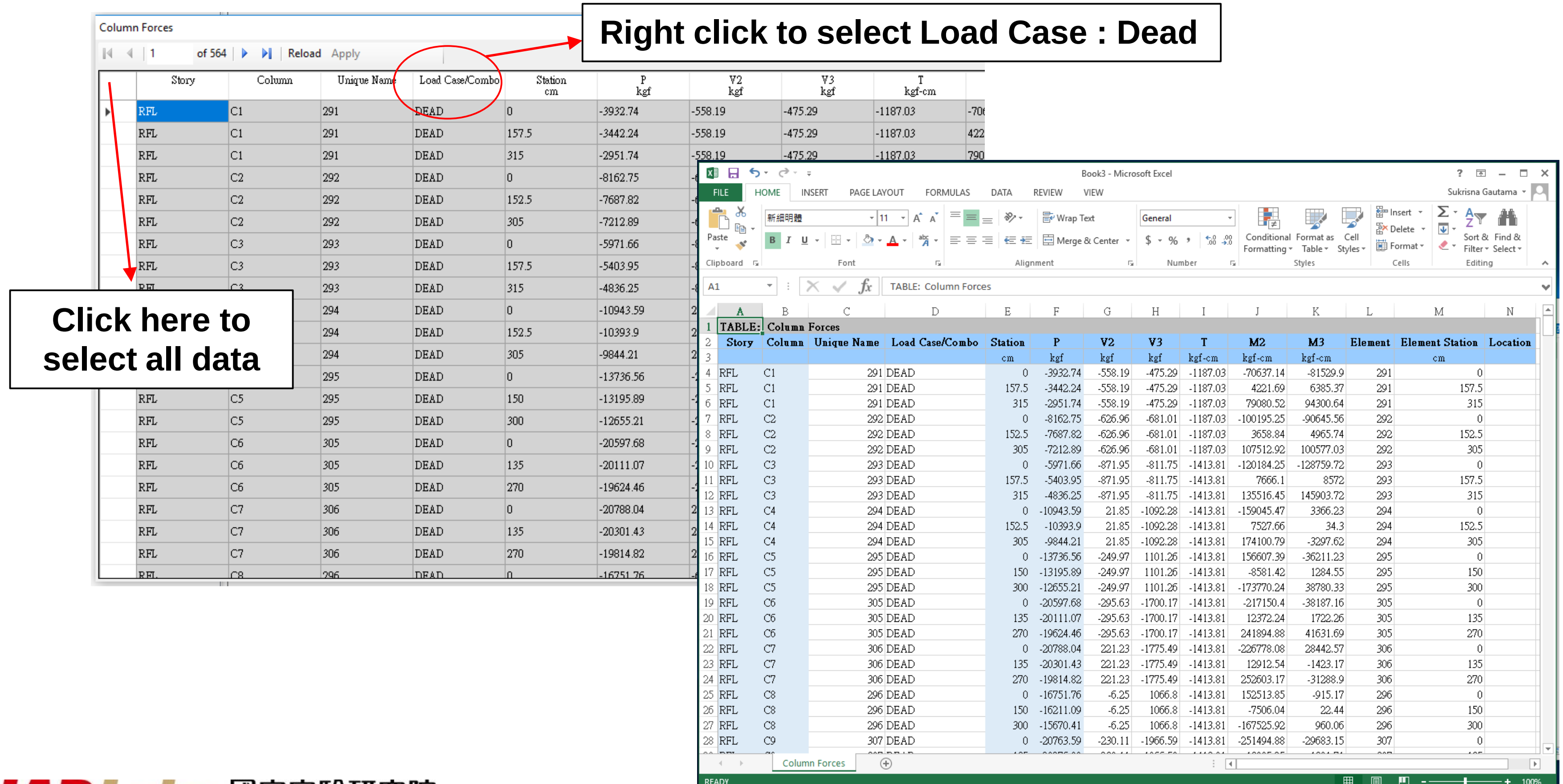
Output axial load for column

1. Use [Analyze/Run Analysis], perform static analysis
2. Use [Display/Show Tables], check [Frame Results]



Output axial load for column

3. Choose [Column Forces] ➔ Select [Load Case/Combo: Dead]. Copy all data to EXCEL by selecting all data [right click ➔ export to Excel], and only keep [Story], [Column], [Station], [P] for a single input file.



	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	TABLE:	Column Forces												
2	Story	Column	Unique Name	Load Case/Combo	Station	P	V2	V3	T	M2	M3	Element	Element Station	Location
3					cm	kgf	kgf	kgf	kgf-cm	kgf-cm	kgf-cm		cm	
4	RFL	C1	291	DEAD	0	-3932.74	-558.19	-475.29	-1187.03	-70637.14	-81529.9	291	0	
5	RFL	C1	291	DEAD	157.5	-3442.24	-558.19	-475.29	-1187.03	4221.69	6385.37	291	157.5	
6	RFL	C1	291	DEAD	315	-2951.74	-558.19	-475.29	-1187.03	79080.52	94300.64	291	315	
7	RFL	C2	292	DEAD	0	-8162.75	-626.96	-681.01	-1187.03	-100195.25	-90645.56	292	0	
8	RFL	C2	292	DEAD	152.5	-7687.82	-626.96	-681.01	-1187.03	3658.84	4965.74	292	152.5	
9	RFL	C2	292	DEAD	305	-7212.89	-626.96	-681.01	-1187.03	107512.92	100577.03	292	305	
10	RFL	C3	293	DEAD	0	-5971.66	-871.95	-811.75	-1413.81	-120184.25	-128759.72	293	0	
11	RFL	C3	293	DEAD	157.5	-5403.95	-871.95	-811.75	-1413.81	7666.1	8572	293	157.5	
12	RFL	C3	293	DEAD	315	-4836.25	-871.95	-811.75	-1413.81	135516.45	145903.72	293	315	
13	RFL	C4	294	DEAD	0	-10943.59	21.85	-1092.28	-1413.81	-159045.47	3366.23	294	0	
14	RFL	C4	294	DEAD	152.5	-10393.9	21.85	-1092.28	-1413.81	7527.66	34.3	294	152.5	
15	RFL	C4	294	DEAD	305	-9844.21	21.85	-1092.28	-1413.81	174100.79	-3297.62	294	305	
16	RFL	C5	295	DEAD	0	-13736.56	-249.97	1101.26	-1413.81	156607.39	-36211.23	295	0	
17	RFL	C5	295	DEAD	150	-13195.89	-249.97	1101.26	-1413.81	-8581.42	1284.55	295	150	
18	RFL	C5	295	DEAD	300	-12655.21	-249.97	1101.26	-1413.81	-173770.24	38780.33	295	300	
19	RFL	C6	305	DEAD	0	-20597.68	-295.63	-1700.17	-1413.81	-217150.4	-38187.16	305	0	
20	RFL	C6	305	DEAD	135	-20111.07	-295.63	-1700.17	-1413.81	12372.24	1722.26	305	135	
21	RFL	C6	305	DEAD	270	-19624.46	-295.63	-1700.17	-1413.81	241894.88	41631.69	305	270	
22	RFL	C7	306	DEAD	0	-20788.04	221.23	-1775.49	-1413.81	-226778.08	28442.57	306	0	
23	RFL	C7	306	DEAD	135	-20301.43	221.23	-1775.49	-1413.81	12912.54	-1423.17	306	135	
24	RFL	C7	306	DEAD	270	-19814.82	221.23	-1775.49	-1413.81	252603.17	-31288.9	306	270	
25	RFL	C8	296	DEAD	0	-16751.76	-6.25	1066.8	-1413.81	152513.85	-915.17	296	0	
26	RFL	C8	296	DEAD	150	-16211.09	-6.25	1066.8	-1413.81	-7506.04	22.44	296	150	
27	RFL	C8	296	DEAD	300	-15670.41	-6.25	1066.8	-1413.81	-167525.92	960.06	296	300	
28	RFL	C9	307	DEAD	0	-20763.59	-230.11	-1966.59	-1413.81	-251494.88	-29683.15	307	0	

Output axial load for column

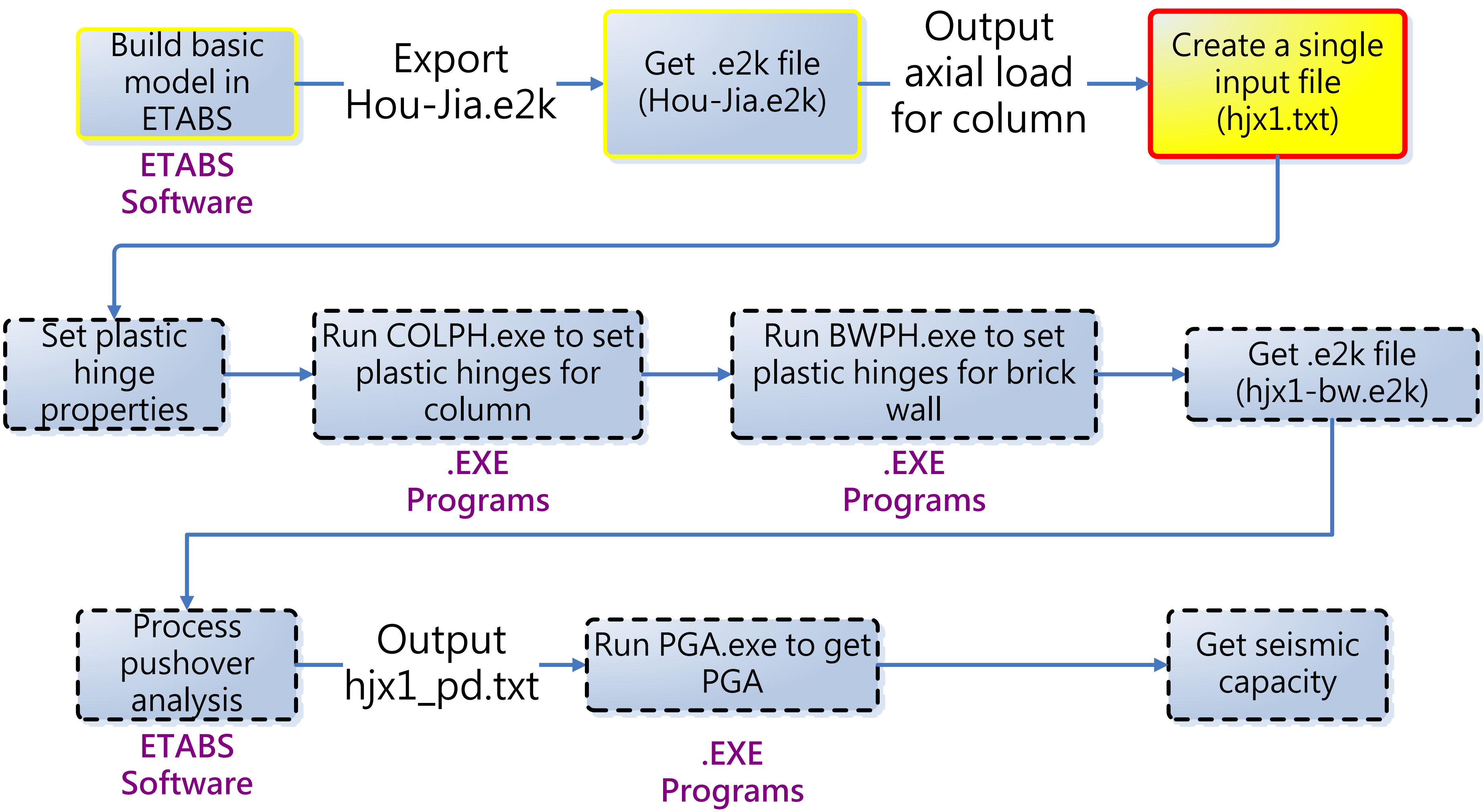
hjx1 - 記事本

檔案(F) 編輯(E) 格式(O) 檢視(V) 說明(H)

3FL	C3	315	-11087.96
2FL	C3	0	-18456.19
2FL	C3	157.5	-17888.49
2FL	C3	315	-17320.78
RFL	C4	0	-10136.28
RFL	C4	152.5	-9586.59
RFL	C4	305	-9036.91
3FL	C4	0	-21293.03
3FL	C4	152.5	-20743.35
3FL	C4	305	-20193.66
2FL	C4	0	-32285.33
2FL	C4	152.5	-31735.65
2FL	C4	305	-31185.96
RFL	C5	0	-13194.78
RFL	C5	150	-12654.11
RFL	C5	300	-12113.43
3FL	C5	0	-28306.43
3FL	C5	150	-27765.76
3FL	C5	300	-27225.08
2FL	C5	0	-43320.3
2FL	C5	150	-42779.63
2FL	C5	300	-42238.95
RFL	C6	0	-19818.3
RFL	C6	135	-19331.69
RFL	C6	270	-18845.08
3FL	C6	0	-42024.01
3FL	C6	135	-41537.4

RFL	C5	0	-13194.78
RFL	C5	150	-12654.11
RFL	C5	300	-12113.43
3FL	C5	0	-28306.43
3FL	C5	150	-27765.76
3FL	C5	300	-27225.08
2FL	C5	0	-43320.3
2FL	C5	150	-42779.63
2FL	C5	300	-42238.95

Flowchart (3/9)



Create a single input file (hjx1.txt)

- Building Properties
- Site Spectrum Parameter
- Brick Wall Properties
- Column Properties
- Beam Properties
- Column Data
- Beam Data
- Axial Load
- Column Section Properties

Building Properties (3 Lines)

$ Weight	Height
488420	360
488420	720
422588	1080

Weight：weight of lump mass
Height：height of lump mass

Site Spectrum Parameter (1 Line)

$ S_DS   S_D1

0.7   0.52

The site is in East area of Tainan city, and the site class is normal site.

S_{DS}：the site-adjusted spectral response accelerations at short periods

S_{D1}：the site-adjusted spectral response accelerations at 1.0 second

Brick Wall Properties (2 Lines)

$ Name	width	height	thick	f_mc	f_bc	P	Bond	Confinement
BW1	218	90	24	210	150	0	3	2

Name : name of brick wall
Width : width of brick wall
Height : height of brick wall
Thick : thickness of brick wall
f_mc : compression strength of mortar
f_bc : compression strength of brick
P : axial load applied in brick wall

Bond:
1 is English bond
2 is French bond
3 is Type III bond
4 is Stretching bond

Confinement:
4 is 4-sides confined
3 is 3-sided confined
2 is window sill

Material List

Compression strength of concrete	$f_c' = 160\text{kgf/cm}^2$
Yield strength of longitudinal steel	$f_y = 2800\text{kgf/cm}^2$
Yield strength of transverse steel	$f_y = 2800\text{kgf/cm}^2$
Compression strength of brick	$f_{bc} = 150\text{kgf/cm}^2$
Split strength of brick	$f_{bt} = 33\text{kgf/cm}^2$
Compression strength of mortar	$f_{mc} = 210\text{kgf/cm}^2$
Split strength of mortar	$f_{tm} = 21\text{kgf/cm}^2$
Split strength of interface of brick and mortar	$f_{mbt} = 2.04\text{kgf/cm}^2$

Column Properties (4 Lines)

$ Name	f_cp	f_yl	f_yt	cover	hoop	spacing	num_hoop	TR
C1L	160	2800	2800	4	3	25	2	0

Name: name of column

f_cp: f'_c

f_yl: f_{yl}

f_yt: fyt

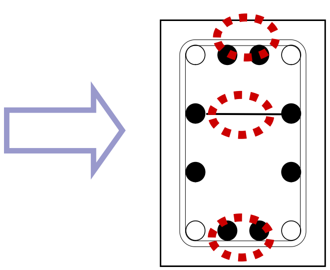
cover: thickness of coverage

hoop: size number of stirrup

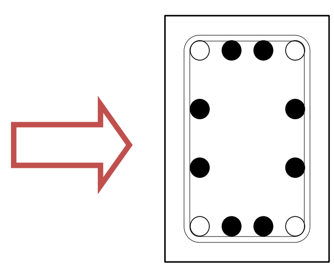
Spacing: spacing of stirrup

num_hoop: number of stirrup for shear resistance

TR: confinement quality



Num hoop=3



Beam Properties (12 Lines)

$ Name1	L	f_cp	f_yl	f_yt	cover	hoop	spacing	num_hoop	TR
B1D_333	333	160	2800	2800	4	3	25	2	0

Name：Name of Beam

L：effective length

f_cp：f'_c

f_yl：f_{yl}

TR: confinement quality

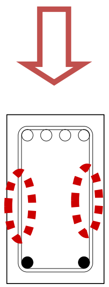
f_yt：f_{yt}

cover： thickness of coverage

hoop： size number of stirrup

spacing： spacing of stirrup

num_hoop： number of stirrup for shear resistance



Column Data (47x3=141 Lines)

Long Column

$ Name	story	section	shape	Height	L	fromBtm
C1	2FL	C3	C3	360	315	0

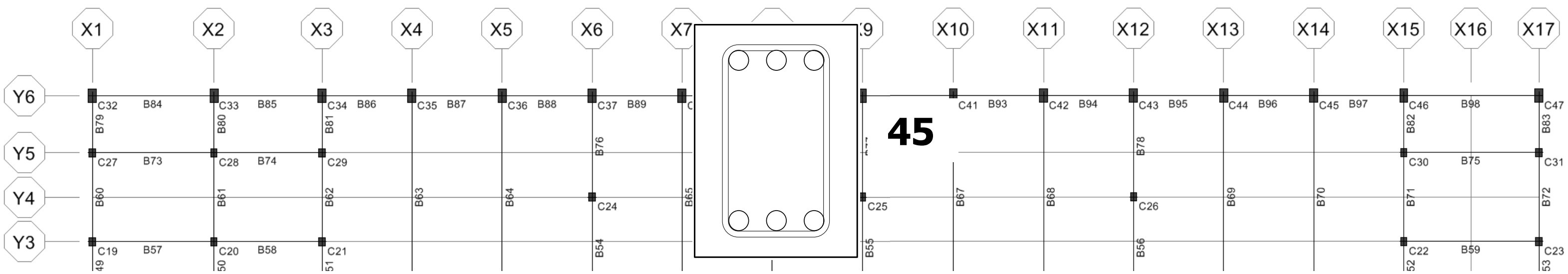
Name ：name of column
Story ：name of story
Section ：name of column section
Shape ：name of column section

Height：height of floor
L：effective length of column
fromBtm：height of window sill

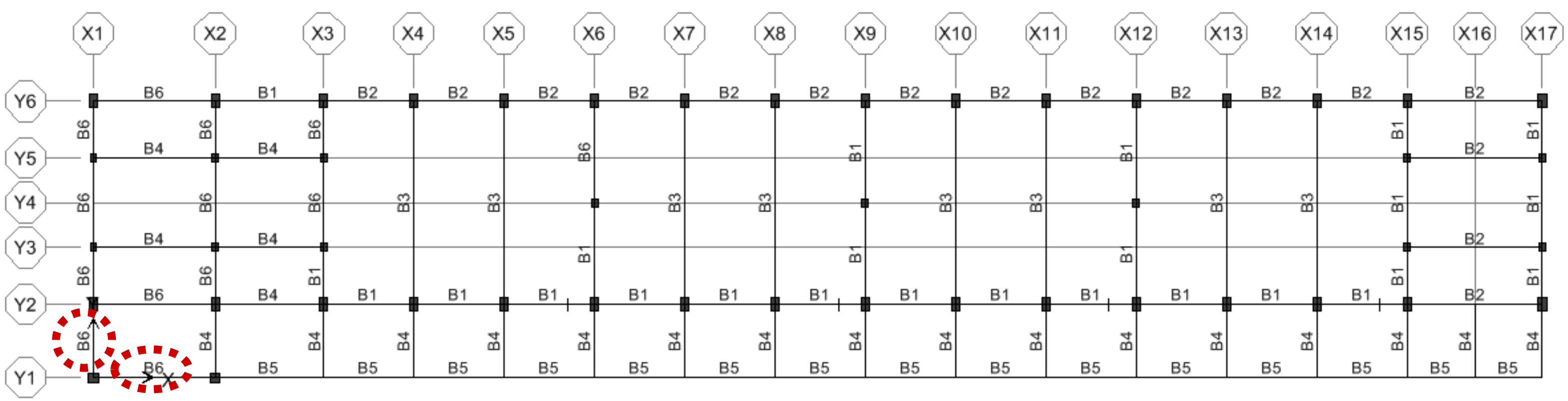
Column Data (47x3=141 Lines)

Long Column

$ Name	story	section	shape	Height	L	fromBtm
C1	2FL	C3	C3	360	315	0



360-45=315



Column Data (47x3=141 Lines)

Short Column

$ Name	story	section	shape	Height	L	fromBtm
C6	2FL	C1S	C1S	360	180	90

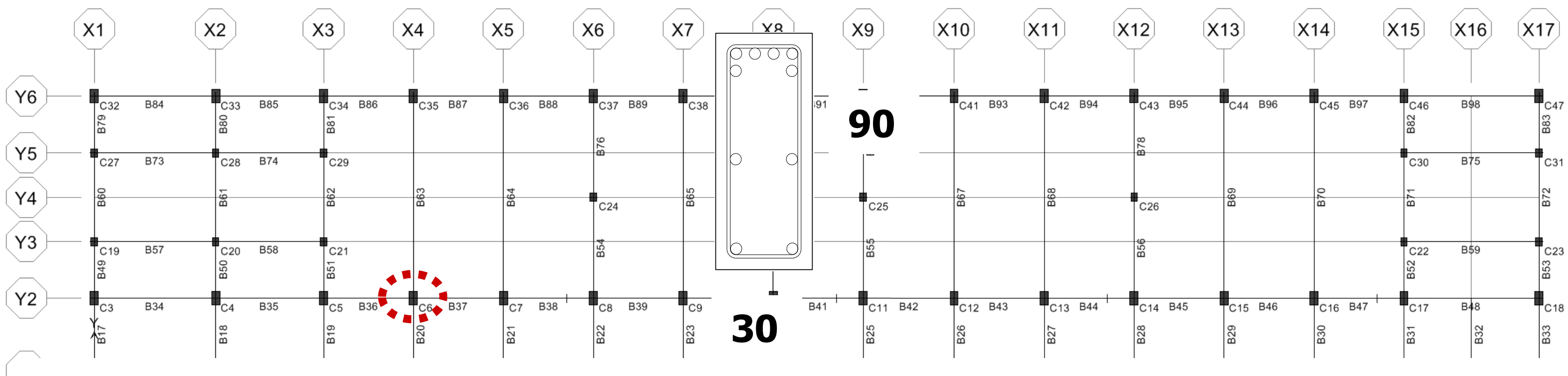
Name ：name of column
Story ：name of story
Section ：name of column section
Shape ：name of column section

Height：height of floor
L：effective length of column
fromBtm：height of window sill

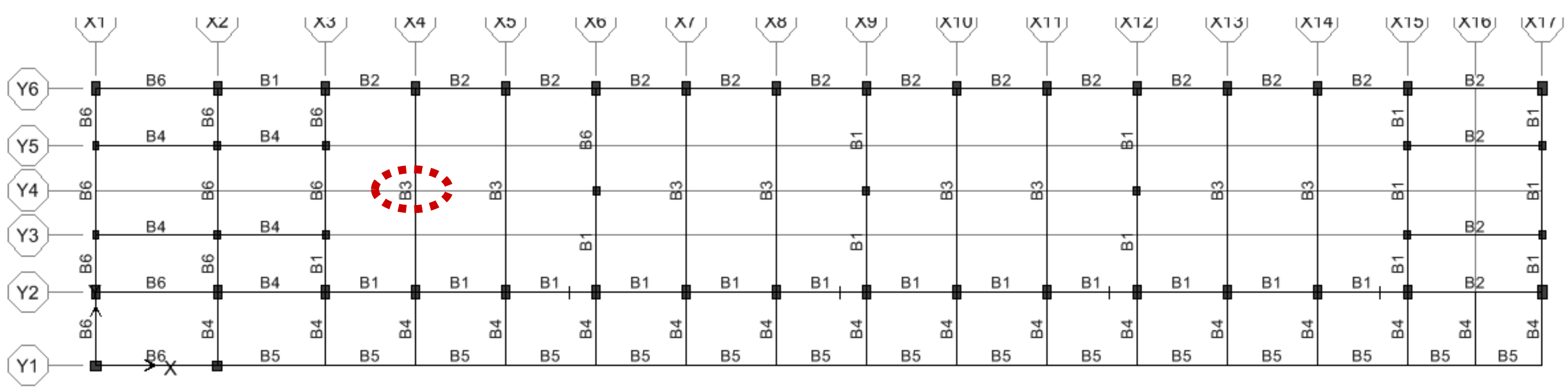
Column Data (47x3=141 Lines)

Short column

$ Name	story	section	shape	Height	L	fromBtm
C6	2FL	C1S	C1S	360	180	90



360—90-90=180



Beam Data (116 Lines)

$ Name	story	section
B1	2FL	B6S_450

Name：name of beam

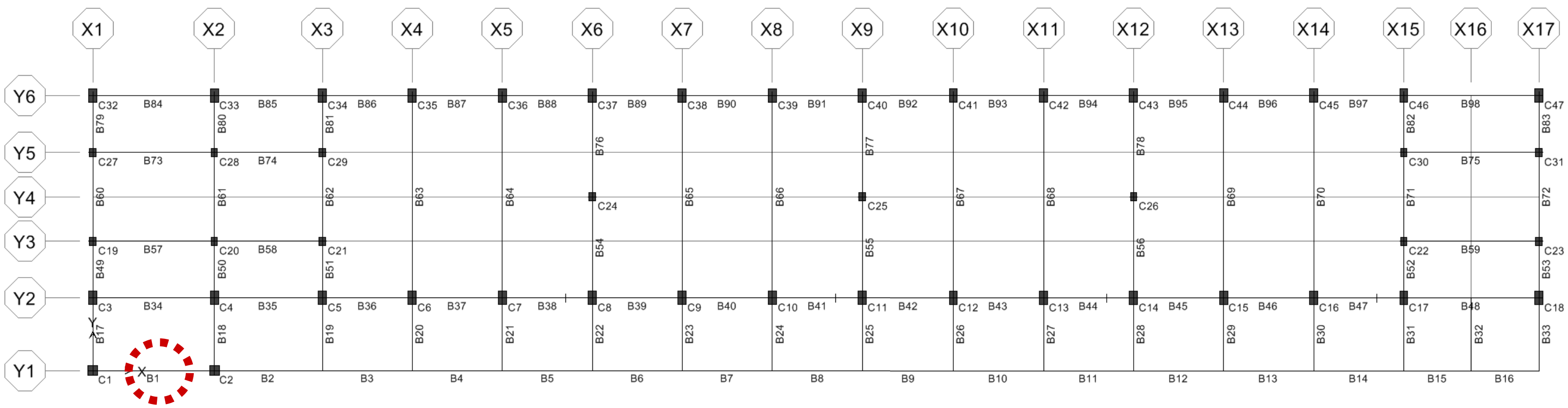
story：name of story

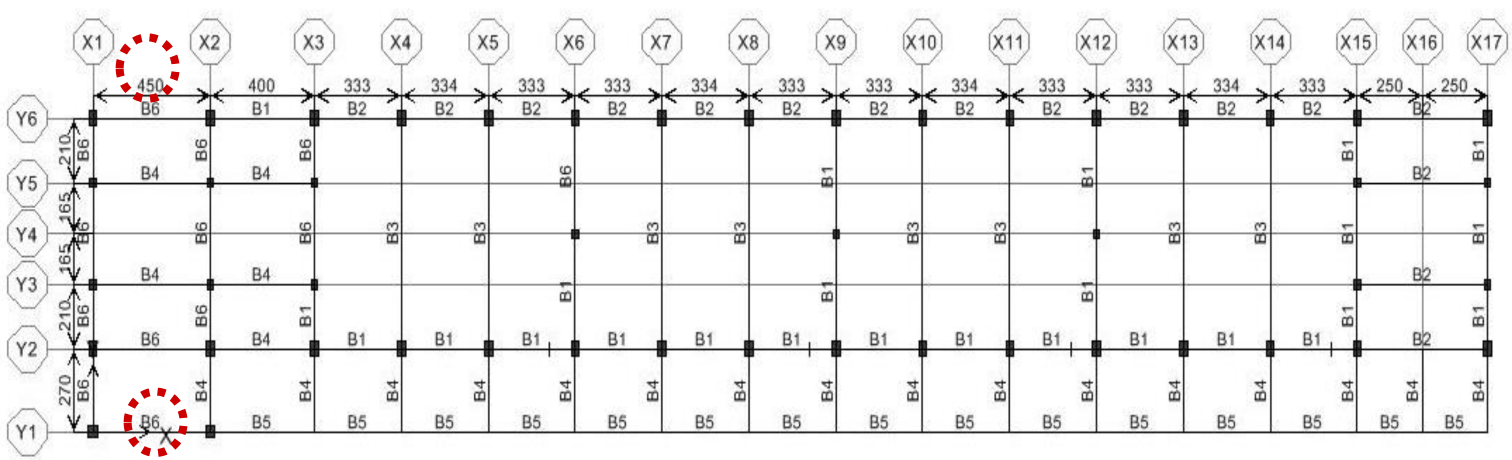
section：name of beam section (Name in BEAM DATA)

Beam Data (116 Lines)

$ Name story section

B1 2FL B6S 450





Axial Load (47x3x3=423 Lines)

$ Story	Column	Loc	P
RFL	C1	0	-3932.74

Story：name of story

Column：name of column

Loc：position of axial load at column

P：axial load

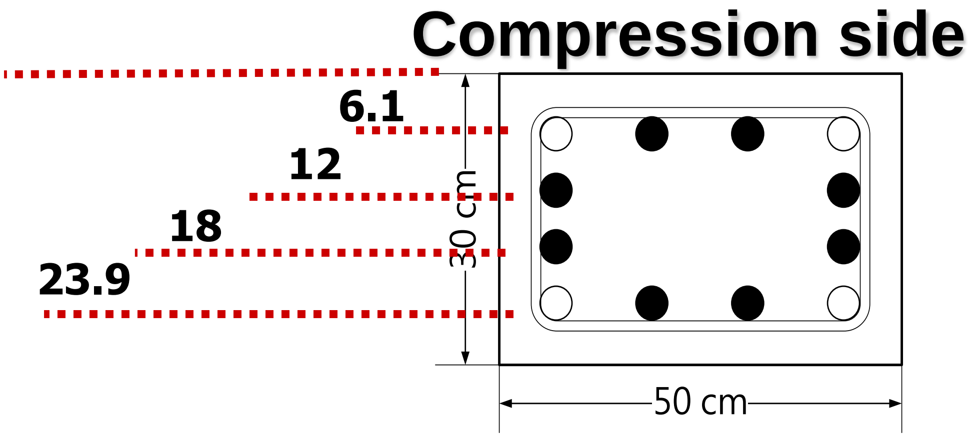
Column Forces

1 of 564 Reload Apply

Story	Column	Unique Name	Load Case/Combo	Station cm	P kgf
RFL	C1	291	DEAD	0	-3932.74
RFL	C1	291	DEAD	157.5	-3442.24
RFL	C1	291	DEAD	315	-2951.74
RFL	C2	292	DEAD	0	-8162.75
RFL	C2	292	DEAD	152.5	-7687.82
RFL	C2	292	DEAD	305	-7212.89
RFL	C3	293	DEAD	0	-5971.66

Column Section Properties (4 groups)

C1L						Name of column section
30	50					depth and width of column
6.1	2800	7	6	6	7	distance from compression side, f_y
12	2800	6			6	
18	2800	6			6	
23.9	2800	7	6	6	7	



4(Cover)+1(＃3)+2.2/2(＃7)=6.1

(30-6.1×2)/3≒5.9，6.1+5.9=12

12+5.9 ≒ 18

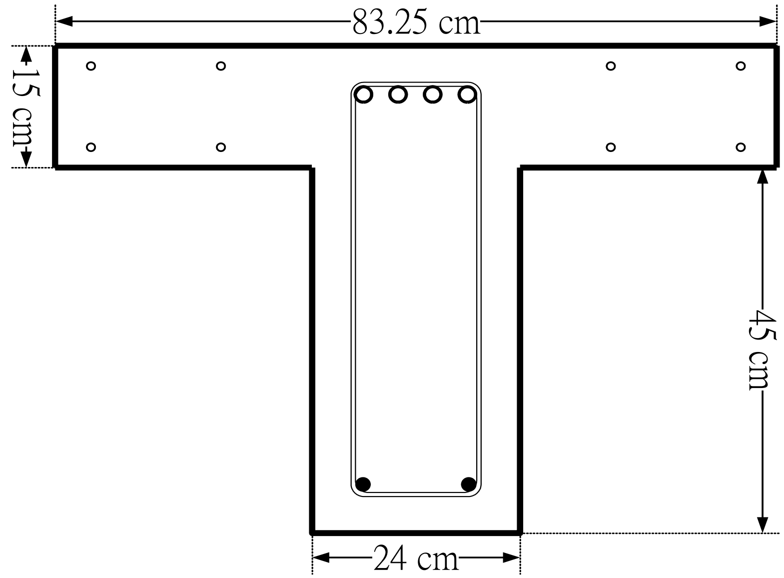
30-6.1=23.9

Beam Section Properties (12x2=24 groups) (1/3)

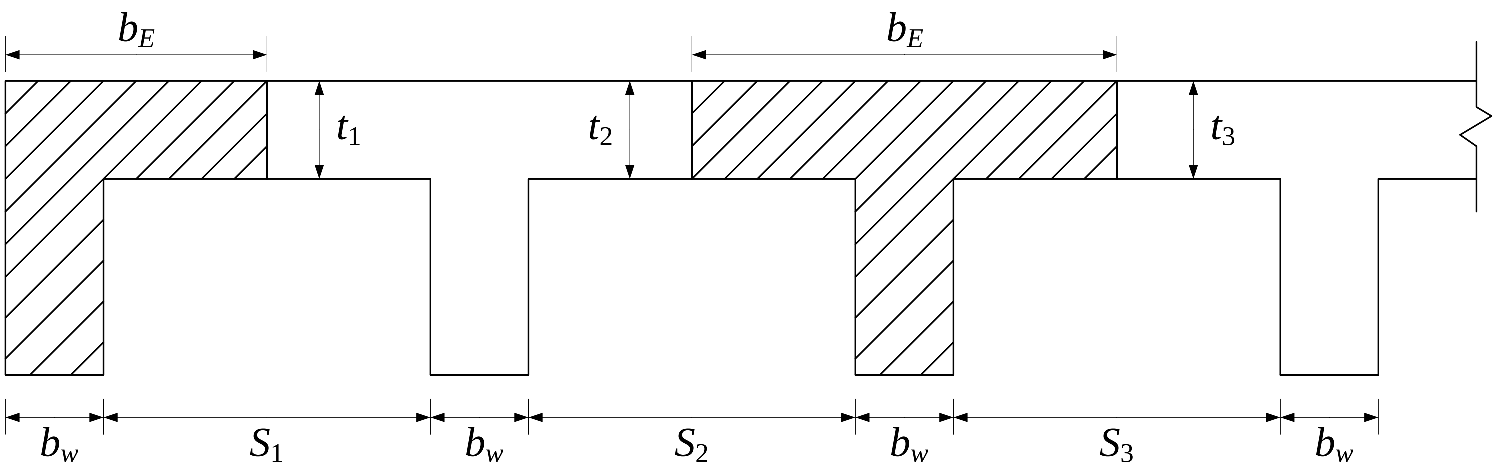
B1D_333

15	83.25	60			24
2.5	2800	3	3	3	3
6	2800	6	6	6	6
12.5	2800	3	3	3	3
54	2800	5			5

Compression side



Beam Section Properties (12x2=24 groups) (1/3)



T Shape beam 雙翼T型梁$: b_E = \min(L/4, b_w + 8t_2 + 8t_3, b_w + \frac{S_2}{2} + \frac{S_3}{2})$

L Shape beam 單翼T型梁$: b_E = \min(b_w + \frac{L}{12}, b_w + 6t_1, b_w + \frac{S_1}{2})$

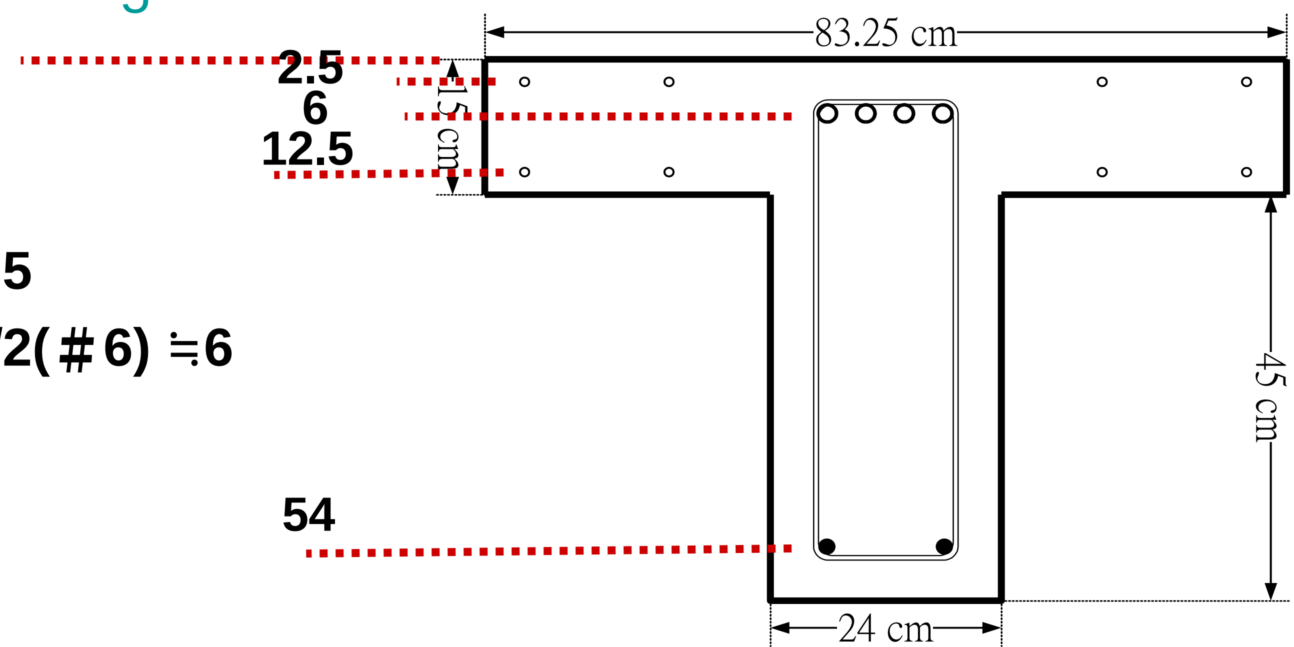
在此為雙翼T型梁, $t_2 = t_3 = 15cm \quad b_E = 333/4 = 83.25$

Beam Section Properties (12x2=24 groups) (2/3)

B1D_333

15	83.25	60			24
2.5	2800	3	3	3	3
6	2800	6	6	6	6
12.5	2800	3	3	3	3
54	2800	5			5

Compression side



2(Cover)+1/2(＃3)=2.5

4(Cover)+1(＃3)+1.9/2(＃6) ≒6

15-2.5=12.5

60-6=54

Contents in hjx1.txt

$ BUILDING PROPERTIES

$ SITE SPECTRUM PARAMETER

$ BRICK WALL PROPERTIES

$ COLUMN PROPERTIES

$ BEAM PROPERTIES

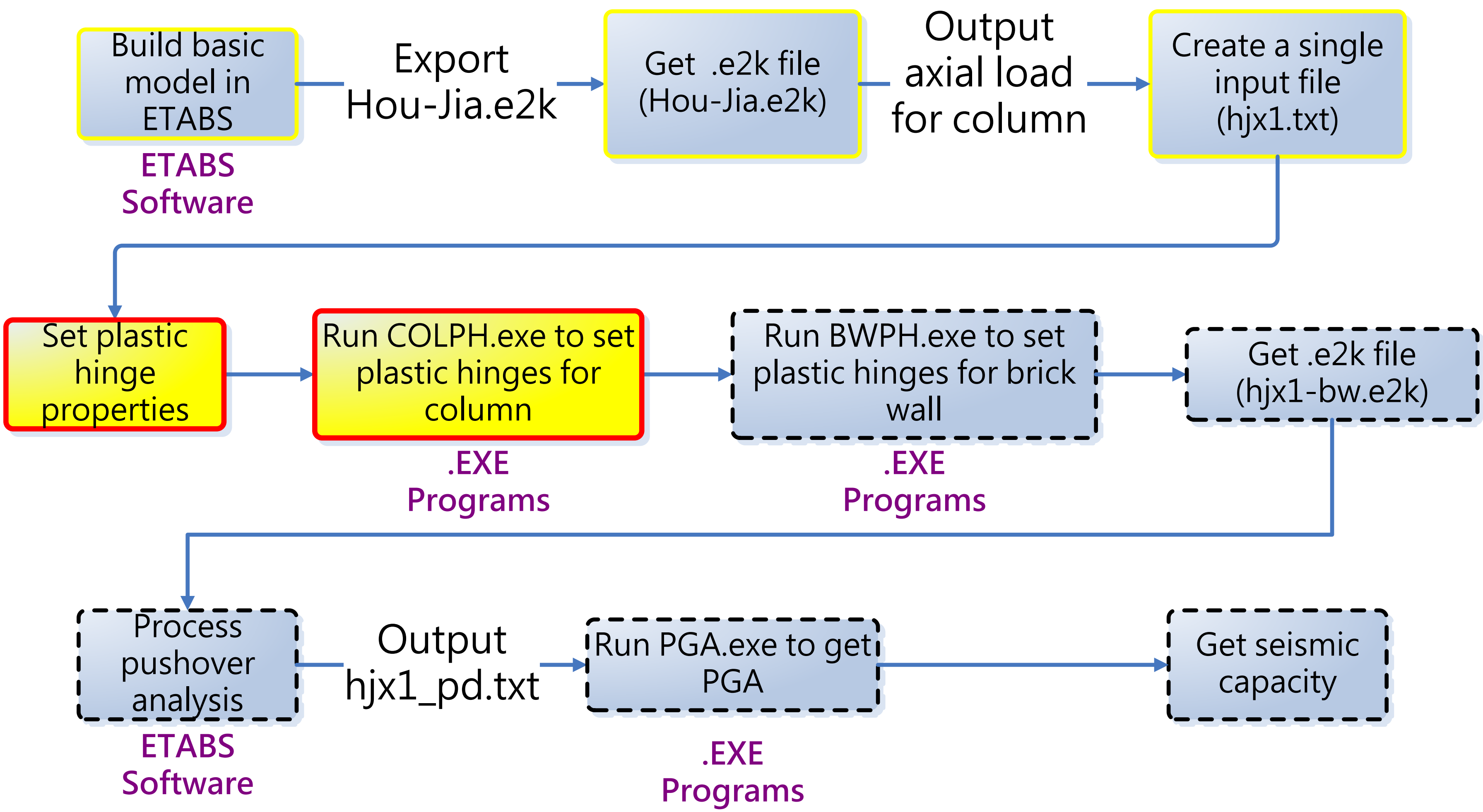
$ COLUMN DATA

$ BEAM DATA

$ AXIAL LOAD

$ COLUMN SECTION PROPERTIES

Flowchart (4/9)



Run COLPH.exe

- Run COLPH.exe
- Output for the X direction or Y direction of the nonlinear hinges of columns?(X:X-direction; Y:Y-direction) ? (X/Y): X
- Do you want to include the nonlinear hinges of beams ? (Y/N): Y
- Please enter the name of the single input file (*.txt): hjx1
- Please enter the name of the ETABS model file (*.e2k): Hou-Jia
- Please enter the name of the ouput file after computing (*.e2k): hjx1-colph

Run COLPH.exe

C:\Example\ColPH.exe

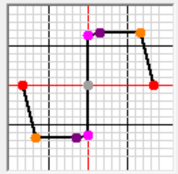
```
請問輸出爲X方向還是Y方向之非線性鉸 (X:X方向； Y:Y方向) ? (X/Y)
[Output for the X direction or Y direction of the nonlinear hinges of columns?
(X:X-direction； Y:Y-direction) ? (X/Y)]
 : x
是否考慮梁之非線性鉸 ? (Y/N)
[Do you want to include the nonlinear hinges of beams ? (Y/N)]
 : y
請輸入輔助程式共用輸入檔檔名 (*.txt)
[Please enter the name of the single input file  (*.txt)]
 : hjx1
請輸入 ETABS 結構模型檔檔名 (*.e2k)
[Please enter the name of the ETABS model file (*.e2k)]
 : Hou-Jia
請輸入完成梁、柱非線性鉸計算後之 ETABS 結構模型檔檔名 (*.e2k)
[Please enter the name of the ouput file after computing (*.e2k)]
 : hjx1_colph
>> 輔助程式共用輸入檔讀取中...
>> Reading the single input file...
>> 輔助程式共用輸入檔讀取完畢...
>> Finish reading the single input file...
>> 梁非線性鉸計算中...
>> Computing the nonlinear hinges of beams...
>> 梁非線性鉸計算完成...
>> Finish computing the nonlinear hinges of beams...
>> 柱非線性鉸計算中...
>> Computing the nonlinear hinges of columns...
>> 柱非線性鉸計算完成...
>> Finish computing the nonlinear hinges of columns...
>> COLPH程式計算完畢!!!
>> Done!
```

Check hinge properties for column (C5)

Hinge Property Data for 2FLC5F - Moment M3

Displacement Control Parameters

Point	Moment/SF	Rotation/SF
E-	0	-0.026166
D-	-1	-0.02105
C-	-1	-0.004527
B-	-0.95	0
A	0	0
B	0.95	0
C	1	0.004527
D	1	0.02105
E	0	0.026166



Symmetric

Type
- (•) Moment - Rotation
- ( ) Moment - Curvature
  - Hinge Length [ ] cm
  - [ ] Relative Length

Hysteresis Type and Parameters

Hysteresis: Isotropic

No Parameters Are Required For This Hysteresis Type

Load Carrying Capacity Beyond Point E
- (•) Drops To Zero
- ( ) Is Extrapolated

Scaling for Moment and Rotation

		Positive	Negative	
[ ] Use Yield Moment	Moment SF	1352800	1352800	kgf-cm
[ ] Use Yield Rotation (Steel Objects Only)	Rotation SF	1	1	

Acceptance Criteria (Plastic Rotation/SF)

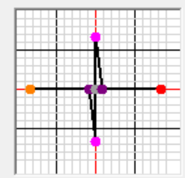
	Positive	Negative
Immediate Occupancy	100	-100
Life Safety	200	-200
Collapse Prevention	300	-300

[ ] Show Acceptance Criteria on Plot

Hinge Property Data for 2FLC5V - Shear V2

Displacement Control Parameters

Point	Force/SF	Disp/SF
E-	0	-0.27438
D-	0	-0.27438
C-	0	-0.027438
B-	-1	0
A	0	0
B	1	0
C	0	0.027438
D	0	0.27438
E	0	0.27438



Symmetric

Type
- (•) Force - Displacement
- ( ) Stress - Strain
  - Hinge Length [ ] cm
  - [ ] Relative Length

Hysteresis Type and Parameters

Hysteresis: Isotropic

No Parameters Are Required For This Hysteresis Type

Load Carrying Capacity Beyond Point E
- (•) Drops To Zero
- ( ) Is Extrapolated

Scaling for Force and Disp

		Positive	Negative	
[ ] Use Yield Force	Force SF	16510.6	16510.6	kgf
[ ] Use Yield Disp (Steel Objects Only)	Disp SF	300	300	cm

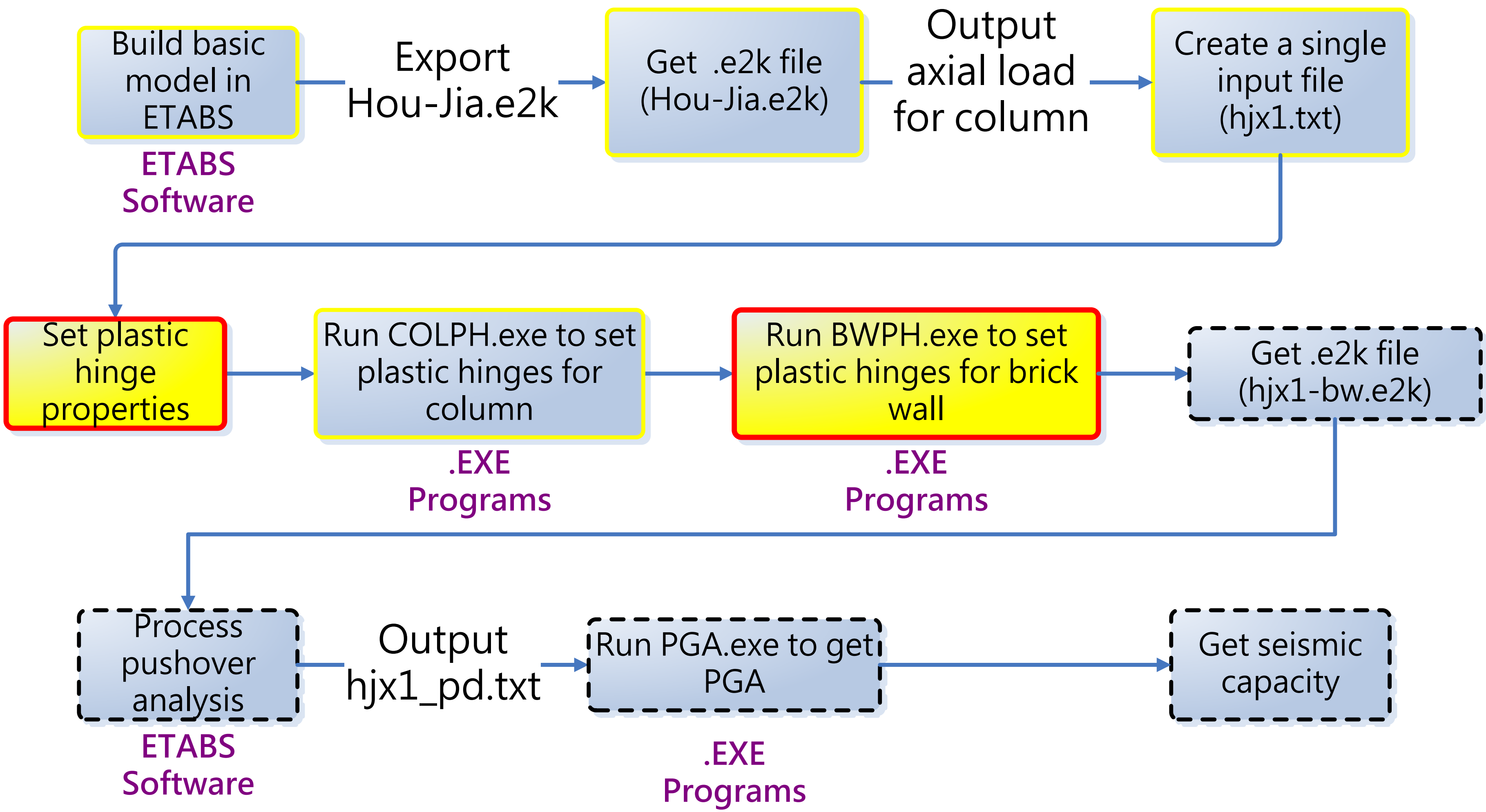
Acceptance Criteria (Plastic Disp/SF)

	Positive	Negative
Immediate Occupancy	100	-100
Life Safety	200	-200
Collapse Prevention	300	-300

[ ] Show Acceptance Criteria on Plot

OK Cancel

Flowchart (5/9)



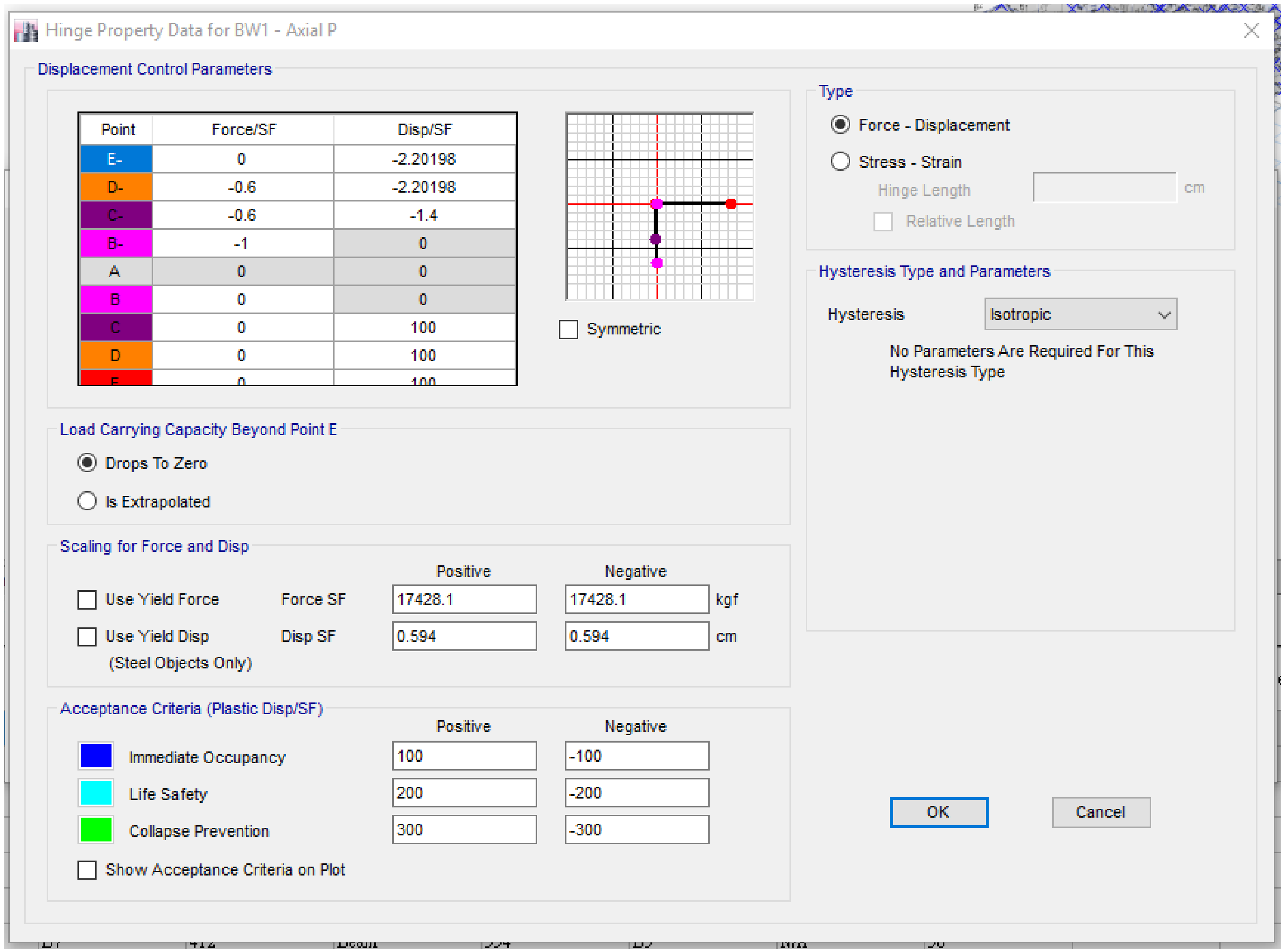
Run BWPH.exe

- Run BWPH.exe
- Please enter the name of the single input file (*.txt): hjx1
- Please enter the name of the ETABS model file (*.e2k): hjx1-colph
- Please enter the name of the ouput file after computing (*.e2k): hjx1-bwph
- Draw equivalent truss with plastic hinges for brick wall in ETABS

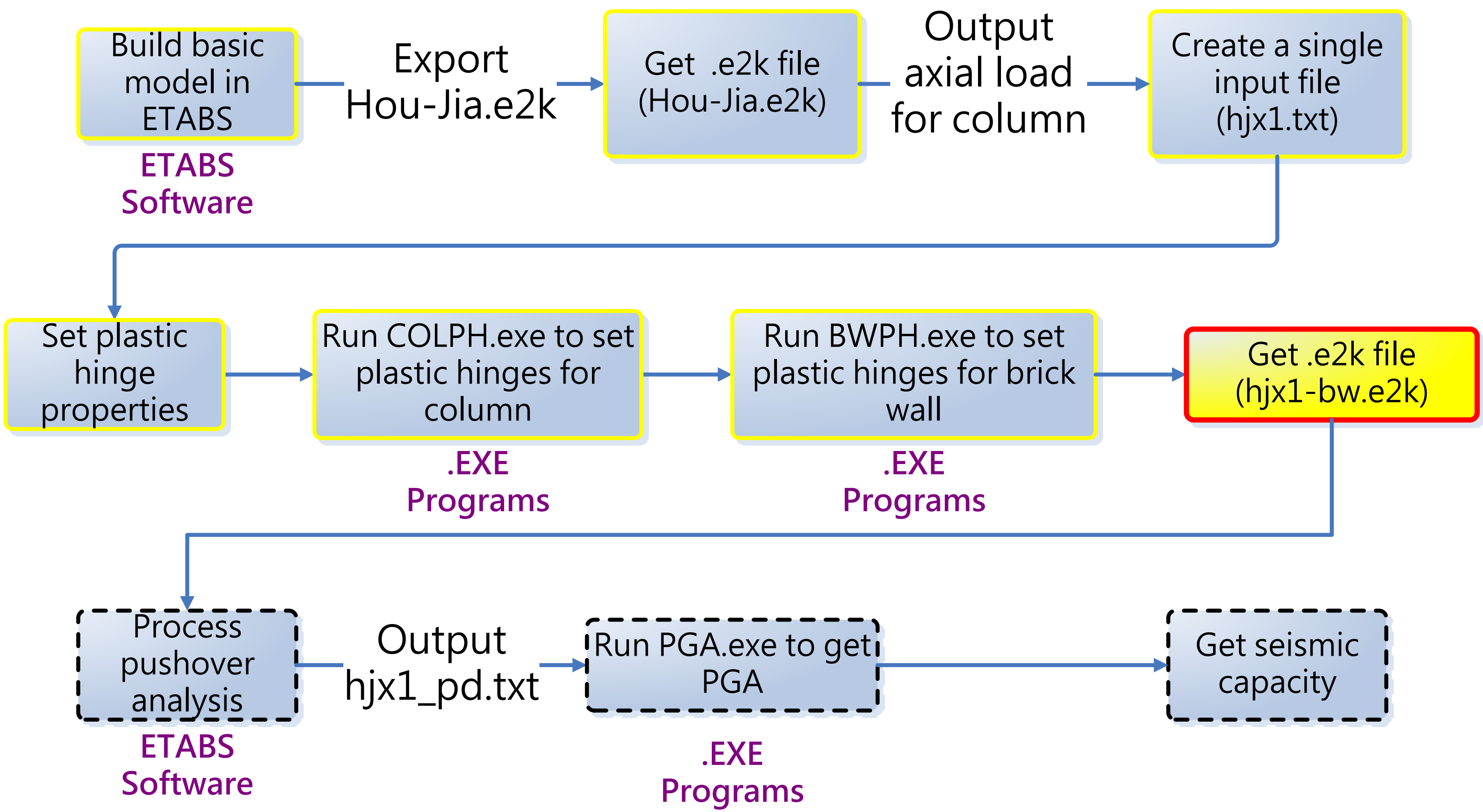
Run BWPH.exe

```
C:\Example\BWPH.exe
*         建議請至鋼筋混凝土結構耐震詳評討論區討論          *
*                http://pushover.ncree.org                    *
*                                                             *
***************************************************************



 請輸入輔助程式共用輸入檔檔名 (*.txt)
 [Please enter the name of the single input file (*.txt)]
  : hjx1
 請輸入 ETABS 結構模型檔檔名 (*.e2k)
 [Please enter the name of the ETABS model file (*.e2k)]
  : hjx1_colph
 請輸入完成磚牆等值斜撐非線性鉸計算後之 ETABS 結構模型檔檔名 (*.e2k)
 [Please enter the name of the ouput file after computing (*.e2k)]
  : hjx1_bwph
>> 輔助程式共用輸入檔讀取中...
>> Reading the single input file...
>> 輔助程式共用輸入檔讀取完畢...
>> Finish reading the single input file...
>> BWPH程式計算中...
>> Computing with BWPH program...
>> BWPH程式計算完畢!!!
>> Done!
```

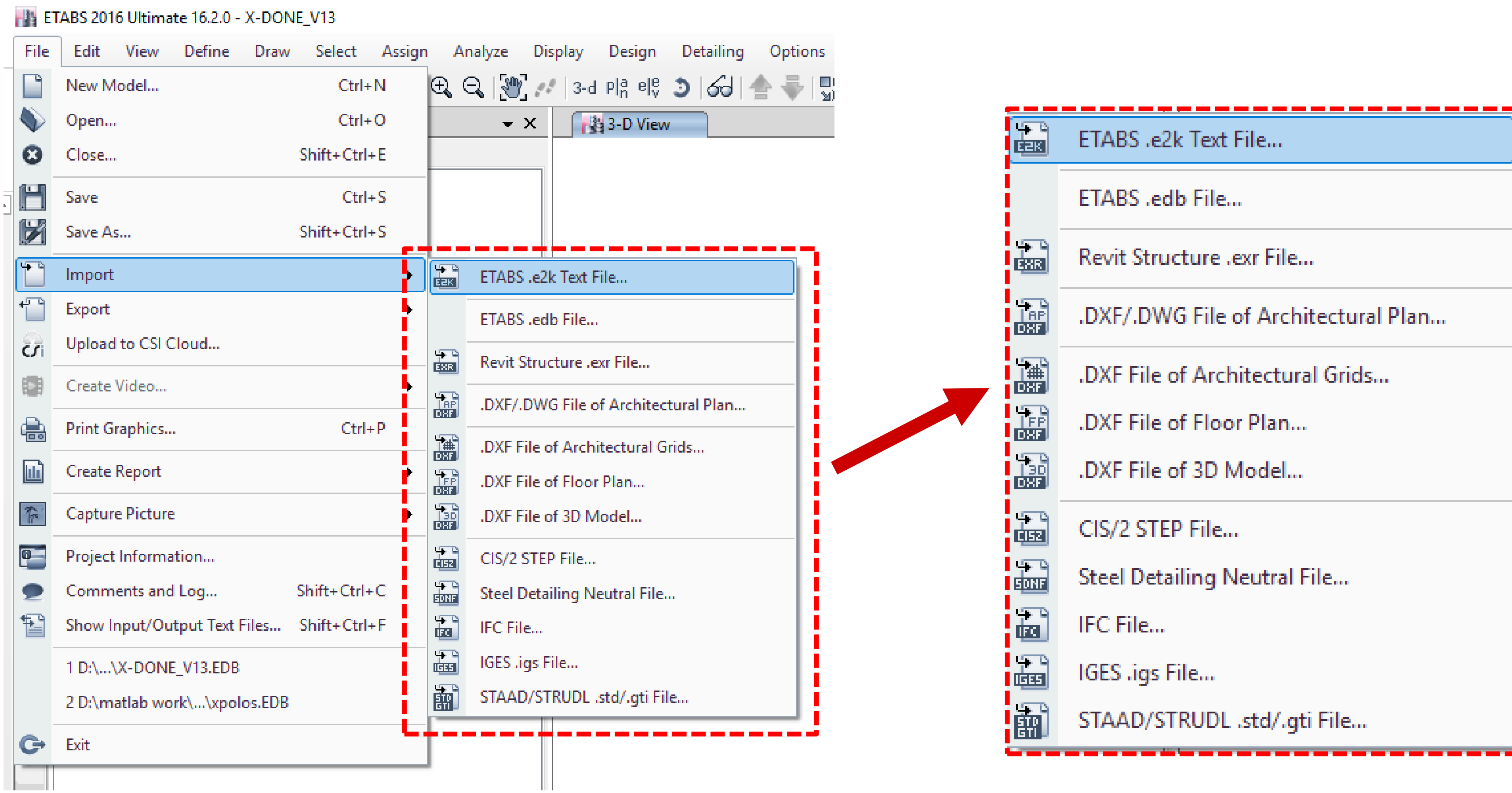
Check hinge properties for brick wall (BW2)



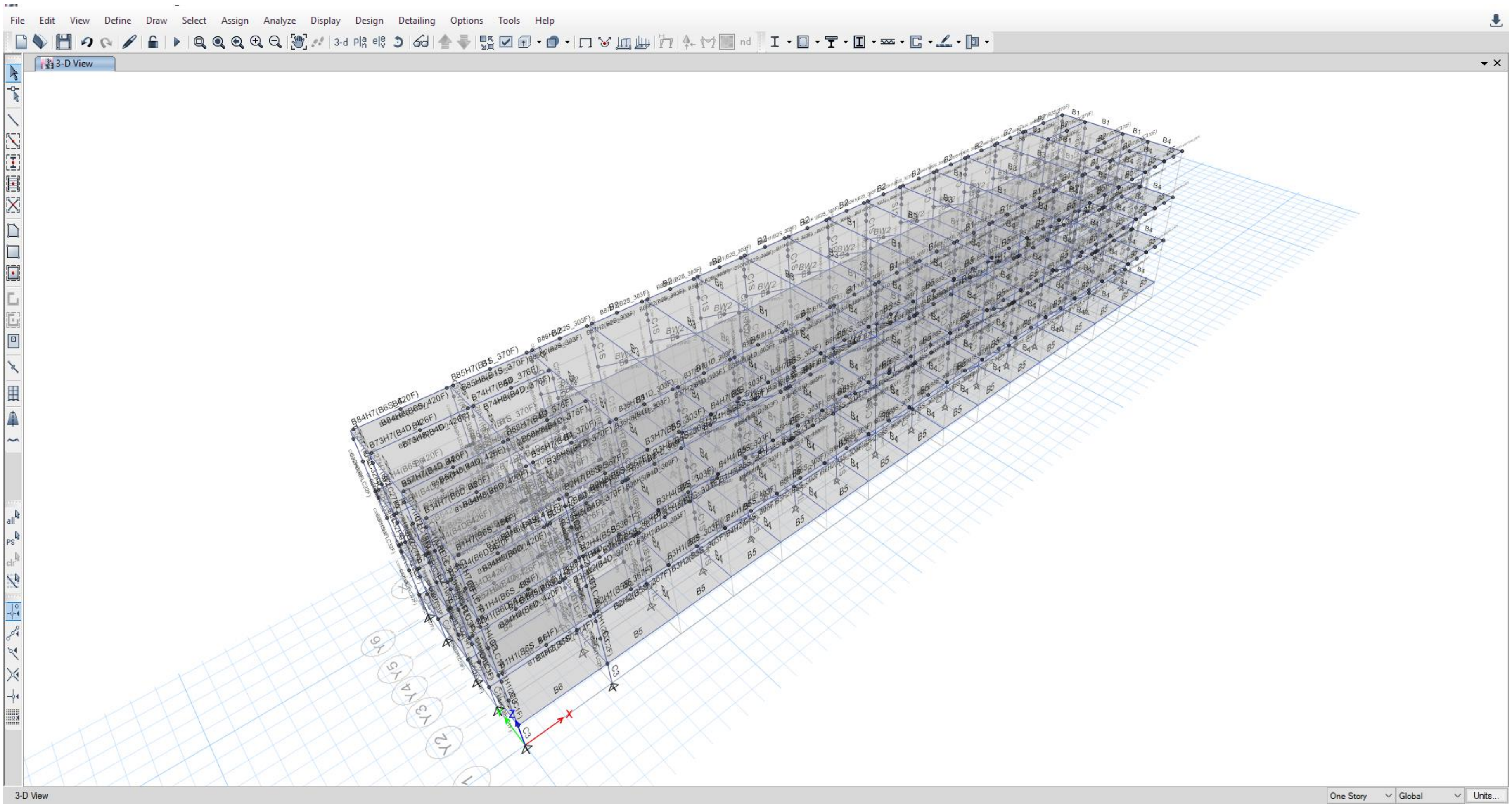
Flowchart (6/9)



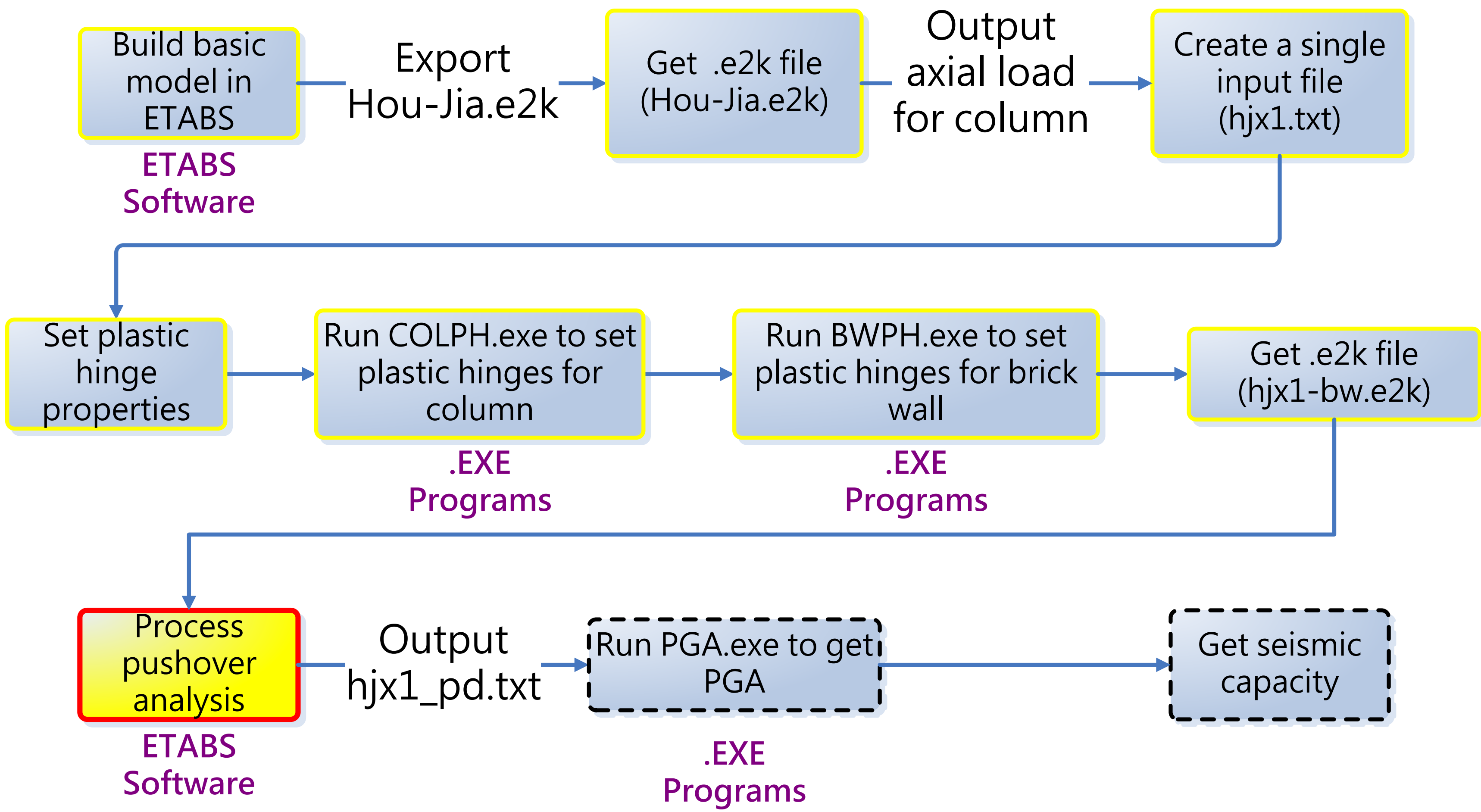
Import .e2k file



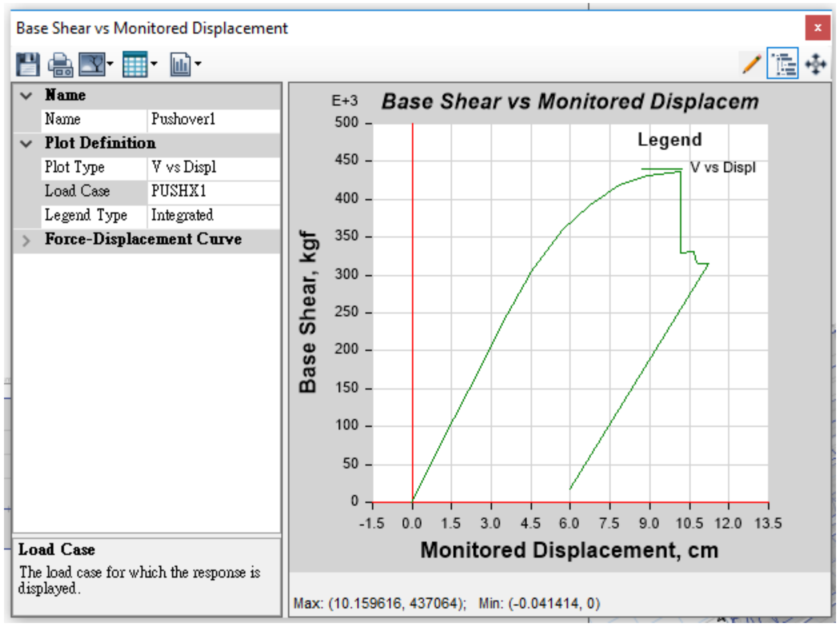
hjx1-bw.e2k

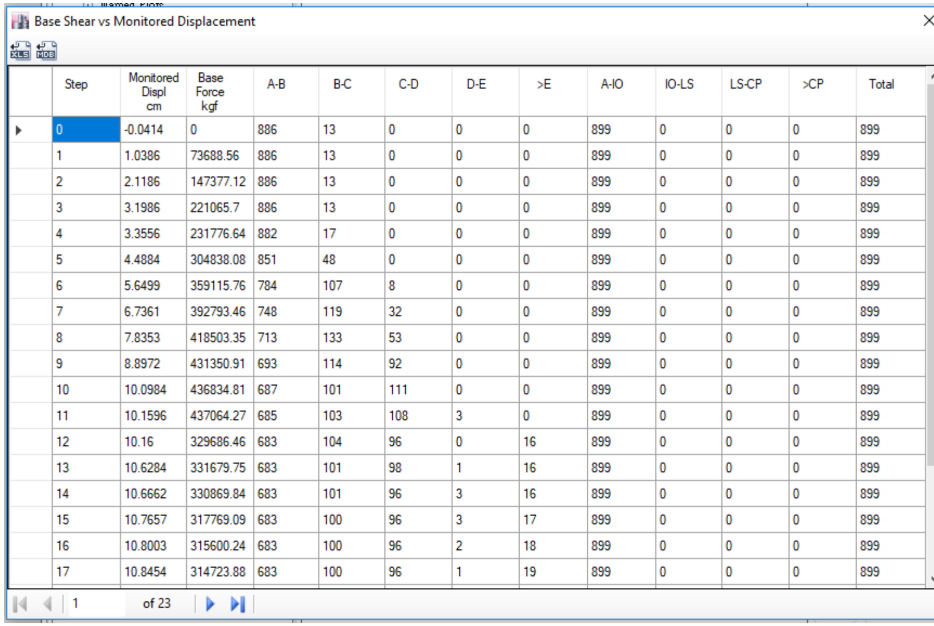

File Edit View Define Draw Select Assign Analyze Display Design Detailing Options Tools Help
3-D View
3-D View
One Story
Global
Units...

Flowchart (7/9)



Output data of base shear and roof displacement from ETABS




Base Shear vs Monitored Displacement

Step	Monitored Displ cm	Base Force kgf	A-B	B-C	C-D	D-E	>E	A-IO	IO-LS	LS-CP	>CP	Total
0	-0.0414	0	886	13	0	0	0	899	0	0	0	899
1	1.0386	73688.56	886	13	0	0	0	899	0	0	0	899
2	2.1186	147377.12	886	13	0	0	0	899	0	0	0	899
3	3.1986	221065.7	886	13	0	0	0	899	0	0	0	899
4	3.3556	231776.64	882	17	0	0	0	899	0	0	0	899
5	4.4884	304838.08	851	48	0	0	0	899	0	0	0	899
6	5.6499	359115.76	784	107	8	0	0	899	0	0	0	899
7	6.7361	392793.46	748	119	32	0	0	899	0	0	0	899
8	7.8353	418503.35	713	133	53	0	0	899	0	0	0	899
9	8.8972	431350.91	693	114	92	0	0	899	0	0	0	899
10	10.0984	436834.81	687	101	111	0	0	899	0	0	0	899
11	10.1596	437064.27	685	103	108	3	0	899	0	0	0	899
12	10.16	329686.46	683	104	96	0	16	899	0	0	0	899
13	10.6284	331679.75	683	101	98	1	16	899	0	0	0	899
14	10.6662	330869.84	683	101	96	3	16	899	0	0	0	899
15	10.7657	317769.09	683	100	96	3	17	899	0	0	0	899
16	10.8003	315600.24	683	100	96	2	18	899	0	0	0	899
17	10.8454	314723.88	683	100	96	1	19	899	0	0	0	899

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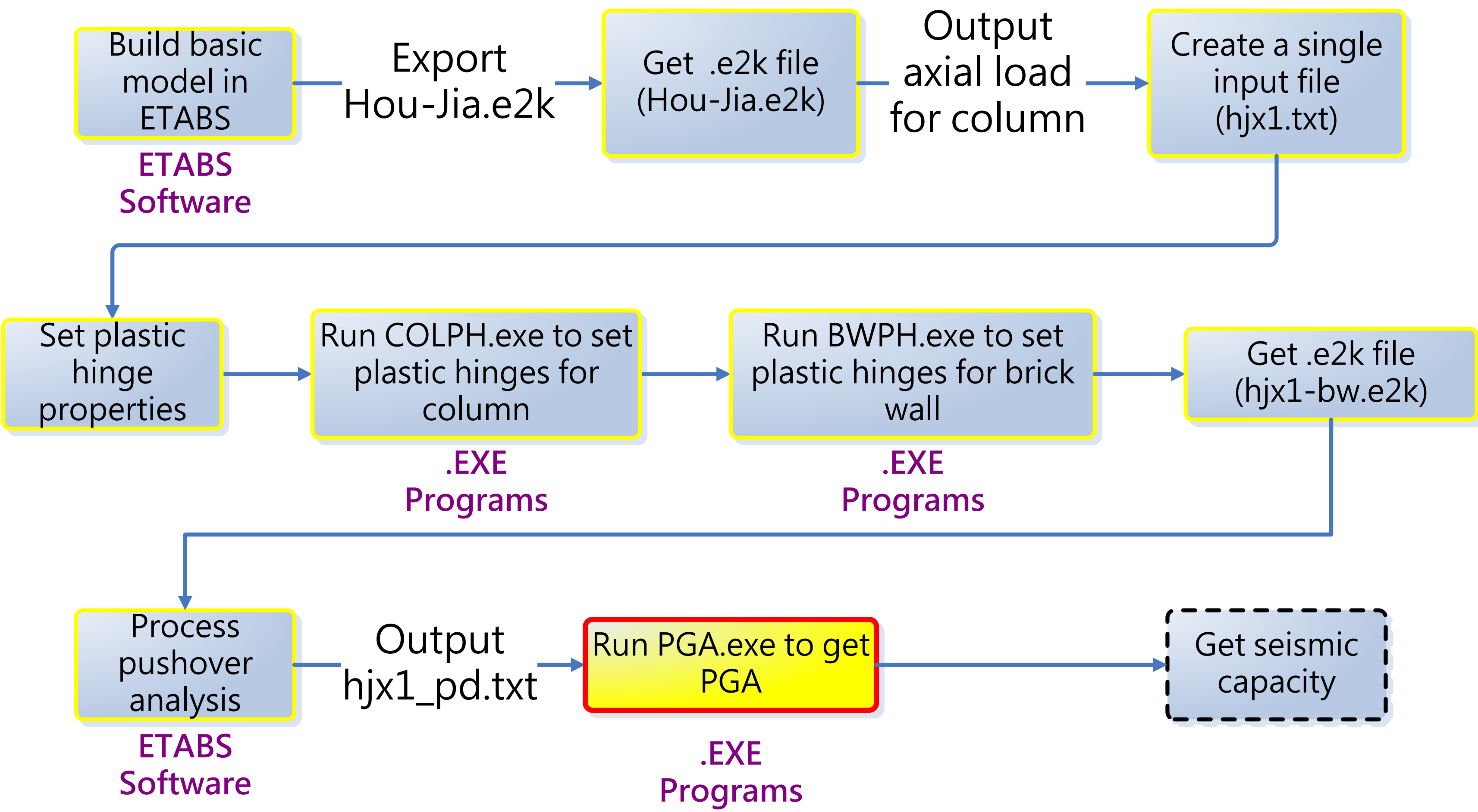
Flowchart (8/9)



Run PGA.exe

- Run PGA.exe
- Please enter cofficient k (For old school building, k = 0.33): 0.33
- Please enter the name of the single input file (*.txt): hjx1
- Please enter the P-D curve from [1] User-defined, or [2] ETABS, or [3] MIDAS: 2
- Please enter the filename of P-D curve form ETABS (*.txt): hjx1_pd
- Do you want to include the Sa-Sd curve computed by ETABS ? (Y/N): N
- Please enter the name of the ouput file after computing (*.e2k): hjx1_pga

PGA.exe

C:\Example\pga.exe

```
請輸入阻尼修正係數 k (既有校舍建築 k 可設爲 0.33)
[Please enter cofficient k (For old school building, k = 0.33)]
: 0.33
請輸入輔助程式共用輸入檔檔名 (*.txt)
[Please enter the name of the single input file (*.txt)]
: hjx1
請輸入 [1] 自行定義，或 [2] ETABS定義，或 [3] MIDAS定義之 P-D 曲線檔
[Please enter the P-D curve from [1] User-defined, or [2] ETABS, or [3] MIDAS]
: 2
請輸入 ETABS 定義之 P-D 曲線檔檔名 (*.txt)
[Please enter the filename of P-D curve form ETABS (*.txt)]
: hjx1_pd
是否輸入 ETABS 所計算之 Sa-Sd 曲線檔 ? (Y/N)
[Do you want to include the Sa-Sd curve computed by ETABS ? (Y/N)]
: N
請輸入完成性能目標地表加速度計算之文字檔檔名 (*.txt)
[Please enter the name of the ouput file after computing (*.e2k)]
: hjx1_pga
>> 輔助程式共用輸入檔讀取中...
>> Reading the single input file...
>> 輔助程式共用輸入檔讀取完畢...
>> Finish reading the single input file...
>> PGA程式計算中...
>> Computing with PGA program...
>> PGA程式計算完畢!!!
>> Done!
```

PGA.exe

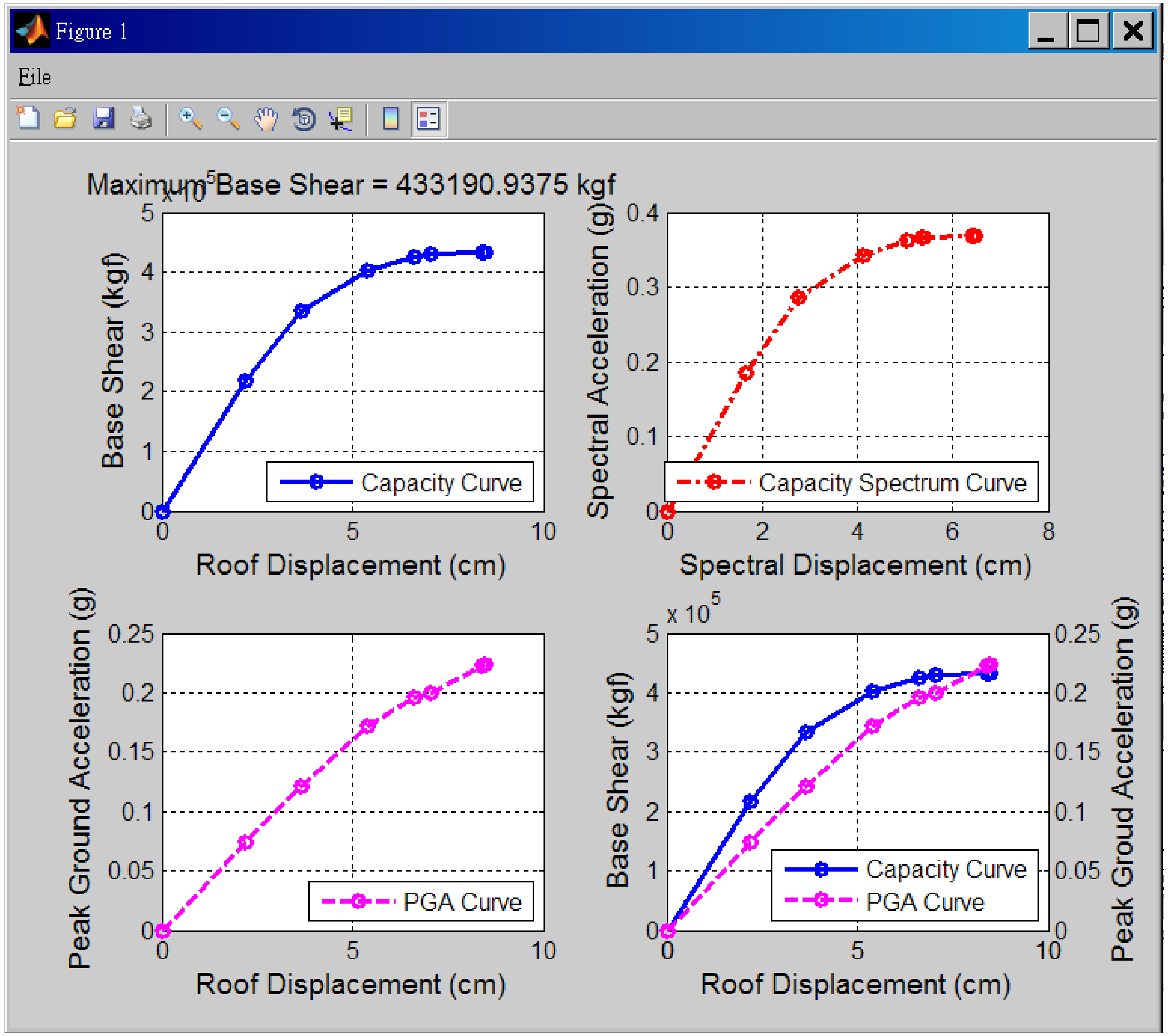
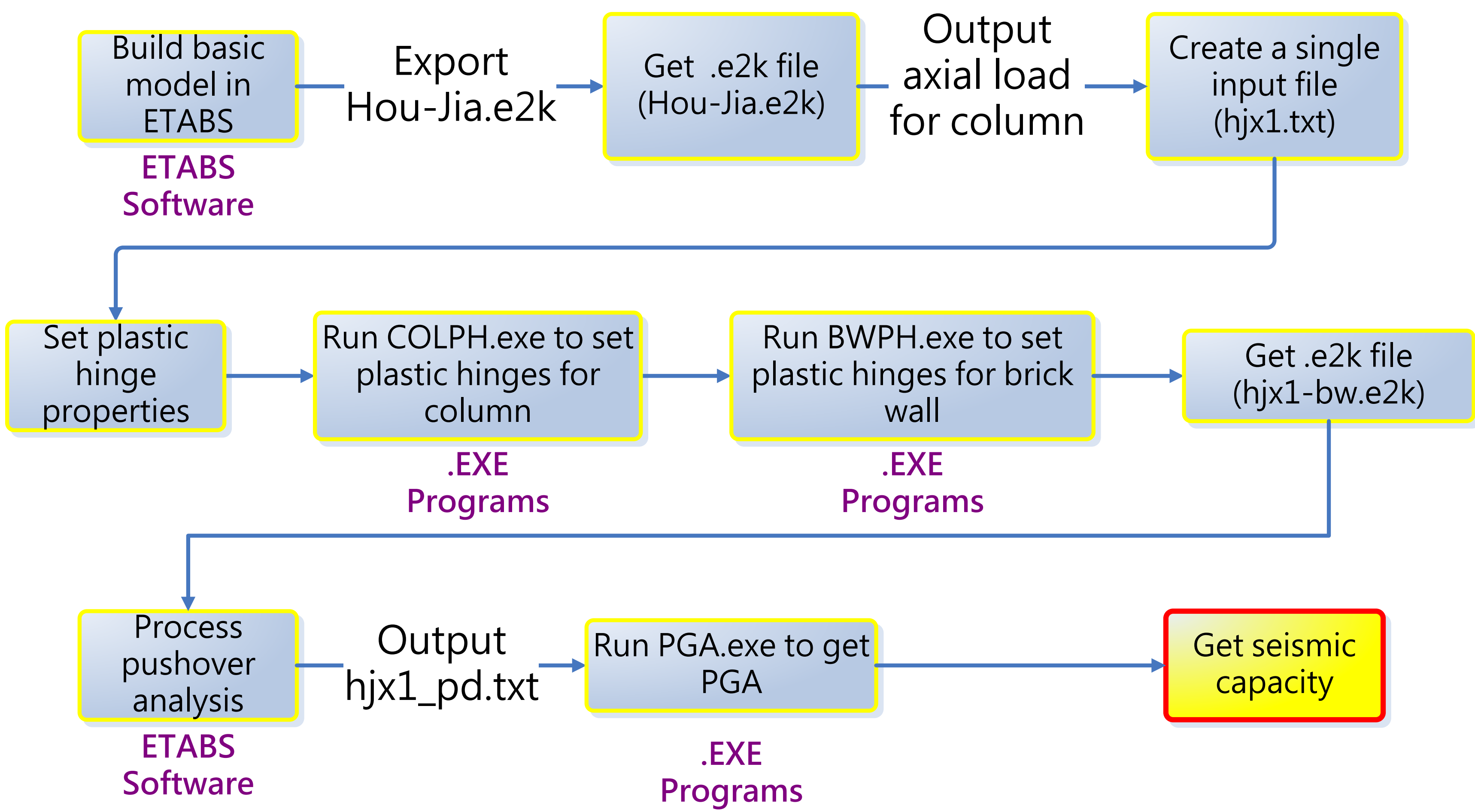


Figure 1
File
Maximum Base Shear = 433190.9375 kgf
x 10^5
Base Shear (kgf)
Roof Displacement (cm)
Capacity Curve
Spectral Acceleration (g)
Spectral Displacement (cm)
Capacity Spectrum Curve
Peak Ground Acceleration (g)
PGA Curve
Peak Groud Acceleration (g)

Flowchart (9/9)



Performance point criteria

The design spectral response acceleration in the design level with a return period of 475 years,

	A_p		A_T
$I = 1.25$ (for normal purpose school building)	V_{max}	$D_R^T = 2.0\%$	$0.4S_{DS}$
$I = 1.5$ (for emergency purpose school building)	$0.80V_{max}$	$D_R^T = 1.0\%$	$0.4S_{DS}$

hjx1_pga.txt

$	PGA	DATA									
$S_a	S_d	A_e	BETA_0	BETA_eq	T_e	T_0	B_s	B_1	Force	Disp.	A_p
0	0.015838	0	0	0.05	0	0	0	0	0	0.0208	0
0.185812	1.67038	0.153716	0	0.05	0.601473	0.742857	1	1	217769	2.1937	0.074325
0.284913	2.77112	0.41279	0.029069	0.059593	0.625628	0.753737	1.06331	1.04796	333915	3.6393	0.121181
0.342799	4.11674	0.835121	0.116851	0.088561	0.695188	0.781281	1.2545	1.1928	401756	5.4065	0.172017
0.362878	5.03846	1.16034	0.171429	0.106572	0.747505	0.790554	1.34774	1.26643	425288	6.617	0.195626
0.366302	5.35781	1.27677	0.191698	0.11326	0.767219	0.790707	1.3658	1.28315	429301	7.0364	0.200118
0.36642	5.377	1.2838	0.19302	0.113697	0.768468	0.790717	1.36698	1.28424	429439	7.0616	0.200355
0.369568	6.40472	1.662	0.257397	0.134941	0.835119	0.791176	1.42434	1.33735	433129	8.4113	0.222251
0.369621	6.45909	1.68209	0.260461	0.135952	0.838595	0.791197	1.42707	1.33988	433191	8.4827	0.22363

Thank You for Your Attention!