



$\mu$   $\mu\mu$  *SAP2000*  
*Version 10*

$\mu$   $\mu$   $\mu$   
 $\mu$

$\mu$   $\mu$

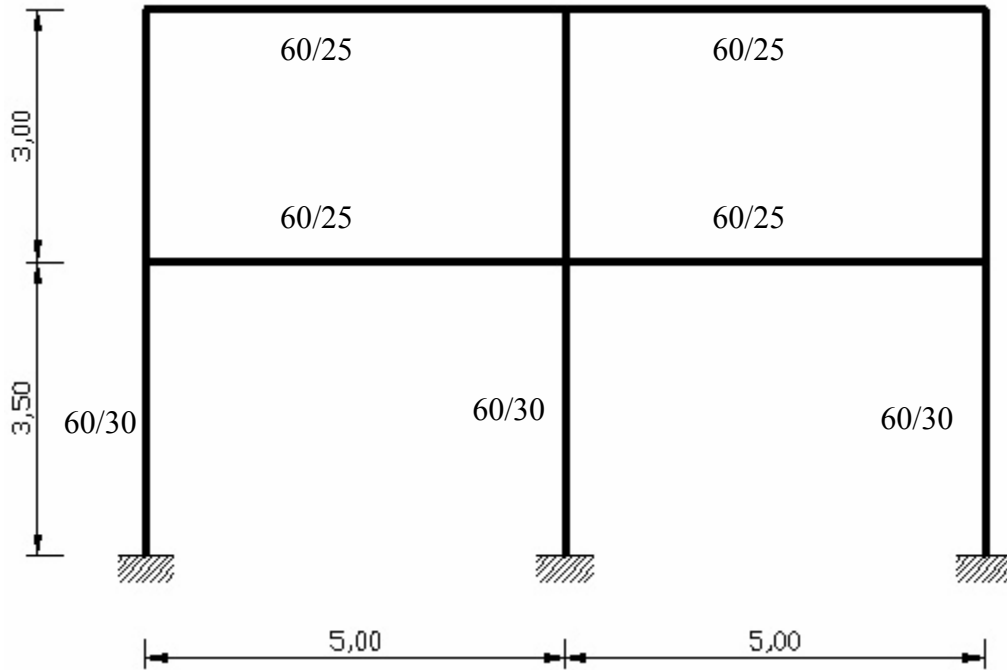
, 2006

μ

μ

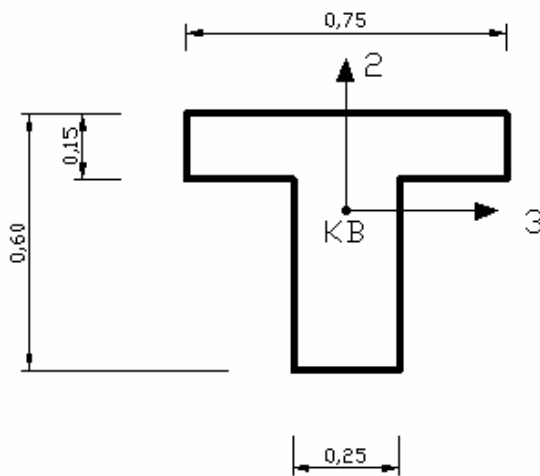
μ

<http://www.eng.ucy.ac.cy/Archimedes/SAPV10.pdf>



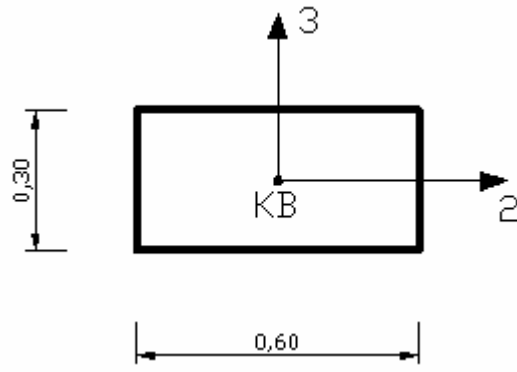
μ 1- μ

: =21 GPa  
 Poisson : =0.2



μ 2- μ

V4 15/3/06



$\mu$  3-  $\mu$

•  
-  $\mu$  :

	<b>5.60 kN/m</b>
$\mu$ 1 :	
$\mu$ 2 :	

- ..... **7.00 kN/m**

•  
- ..... :  $1.35 \times G + 1.5 \times Q$   
- ..... :  $1.0 \times G + 1.0 \times Q$

\_\_\_\_\_ :  
 $\mu$  :  
1.  $\mu\mu$   $\mu$   
2.  $\mu\mu$   $\mu$   $\mu$   
3.

\_\_\_\_\_ (      ) :

•

-  $\mu$   $\mu$   $W_{,G+0,3Q} / g$  :

$W_{,G+0,3Q}$  :  $\mu$   $G + 0,3Q$

-  $\mu$   $\mu$   $\mu$  .

•

-  $\mu$   $(\mu$   $\mu$   $\mu$   $\mu$   $\mu$  ) :

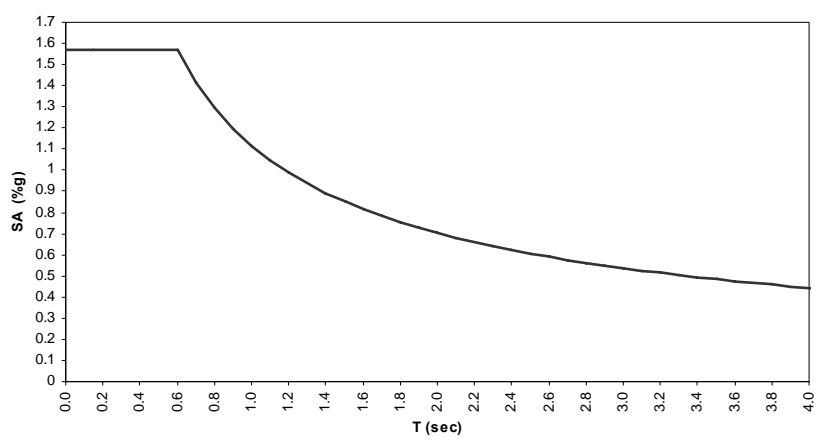
- "constrain"

•

$\mu$   $\mu$   $\mu$  8:

:  
 $g = 0.16g$   
 $= 0.05$   
 $q = 2.5$

EAK2000 SPECTRA



$\mu$  4-  $\mu$   $\mu$

•

-  $1.00 \times G + 0.30 \times Q +$

\_\_\_\_\_ :

-  $\mu$   $\mu$  :

1.  $\mu$

-  $\mu$  :

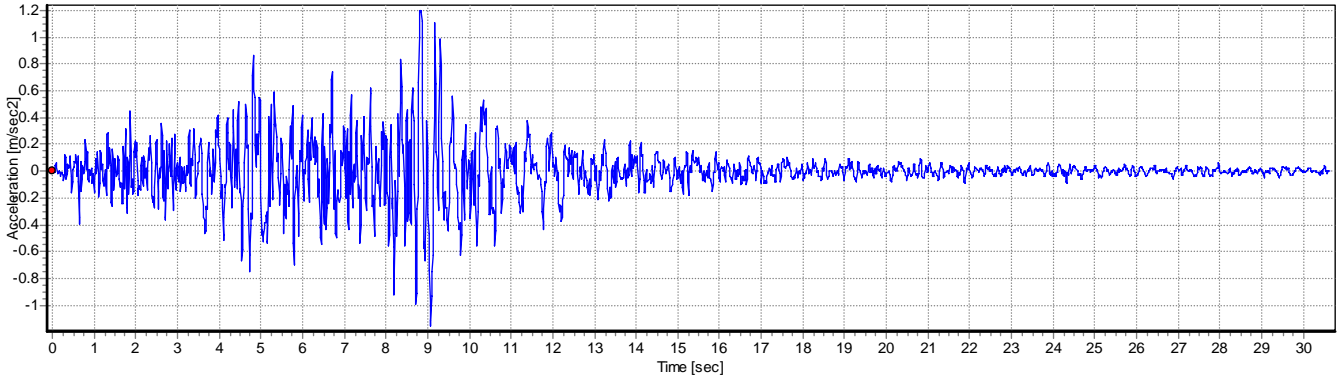
2.  $\mu\mu$  ,  $\mu$   $\mu$  (i)  $\mu$  (ii)

3.  $\mu$   $\mu$  .  $\mu$   $\mu$  .

— μ μ μ .  
 μ μ μ : μ μ

THESSALONIKA EARTHQUAKE

20:03:21, JUNE 20, 1978



— :

1. μμ 8.1 sec.
2. μμ — .
3. μ .
4. μ .



μμ SAP2000 μ  
 μ μ  
 μ μ μ μ μ μ μ S2K ( manual  
 frame1.s2k) μ μ μ μ μ μ μ  
 μ μ μ CD-R μ μ μ μ μ μ  
 μ μ μ μ μ μ μ μ μ μ  
 μ μμ SAP2000.  
 μμ μ μ μ μ *file → Import*

μ :

**SYSTEM**

DOF=UX,UY,UZ,RX,RY,RZ LENGTH=m FORCE=KN PAGE=SECTIONS

**JOINT**

1 X=0 Y=0 Z=0  
 2 X=2 Y=0 Z=0  
 3 X=1 Y=0 Z=0

**RESTRAINT**

ADD=1 DOF=U1,U2,U3,R1,R2,R3  
 ADD=2 DOF=U2,U3

**MATERIAL**

NAME=BETON IDES=N  
 T=0 E=2.8+07 U=0.2

**FRAME SECTION**

NAME=BEAM MAT=BETON SH=R T=.6,.25 A=.15 J=2.30675E-3 I=.0045,7.8125E-4 AS=.125,.125

**FRAME**

1 J=1,3 SEC=BEAM NSEG=4 ANG=0 JREL=R3  
 2 J=3,2 SEC=BEAM NSEG=4 ANG=0

**LOAD**

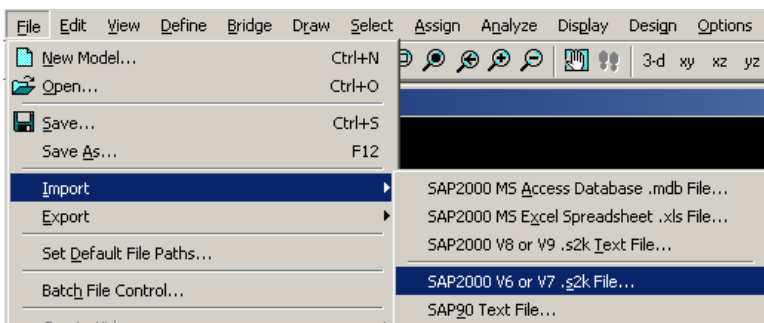
NAME=LOAD1 SW=0  
 TYPE=FORCE  
 ADD=3 UZ=-10  
 NAME=LOAD2 SW=0  
 TYPE=DIST  
 ADD=1 UZ=-5

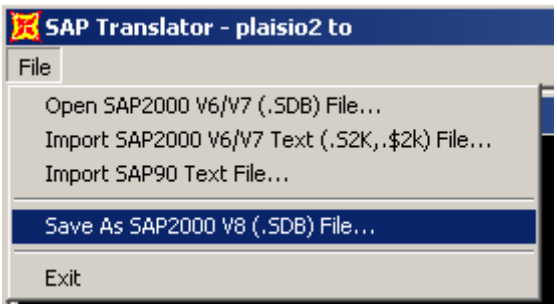
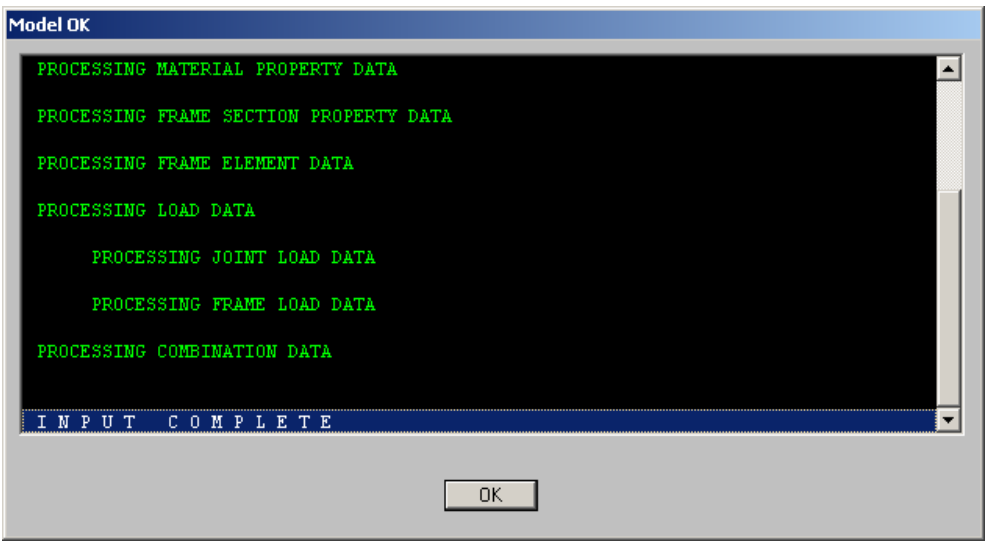
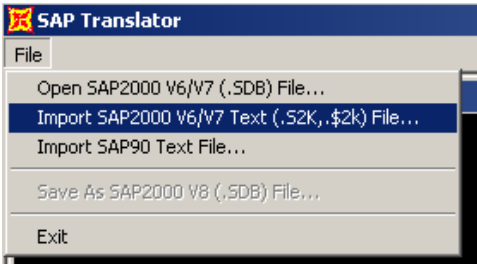
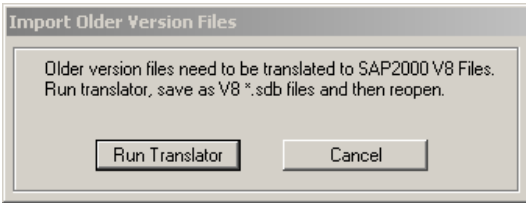
**COMBO**

NAME=ALL  
 LOAD=LOAD1 SF=1  
 LOAD=LOAD2 SF=1

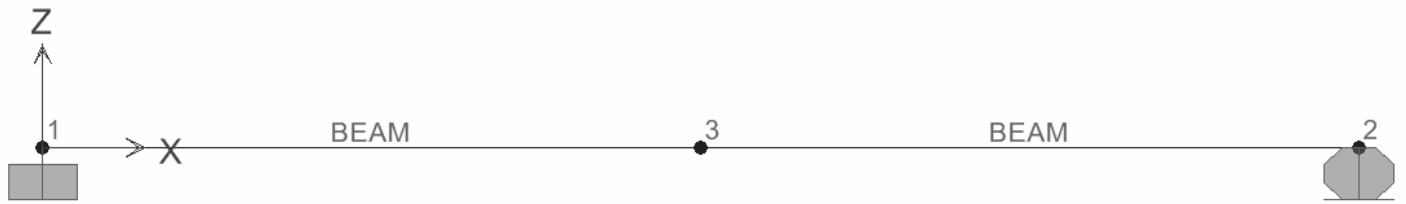
END

μ μ .S2K



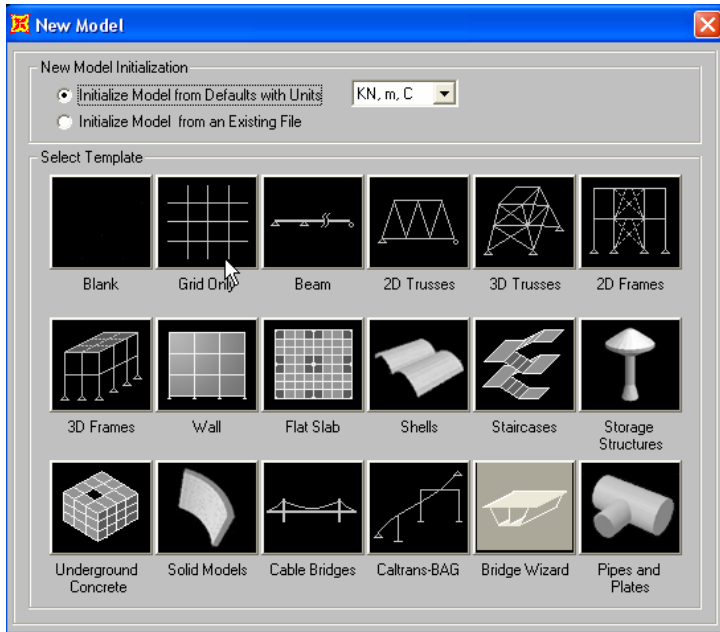


μμ File → Open →



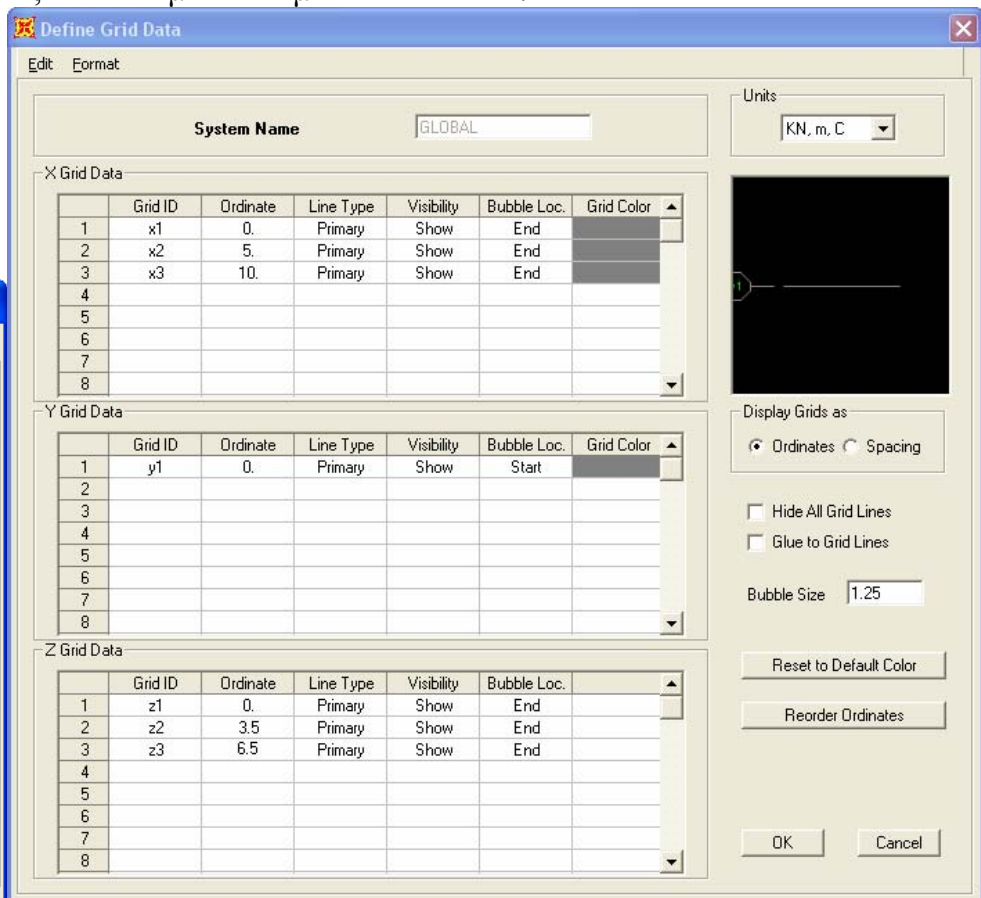
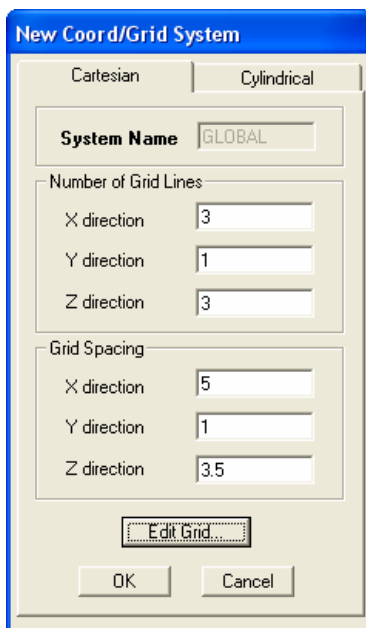


File → New Model

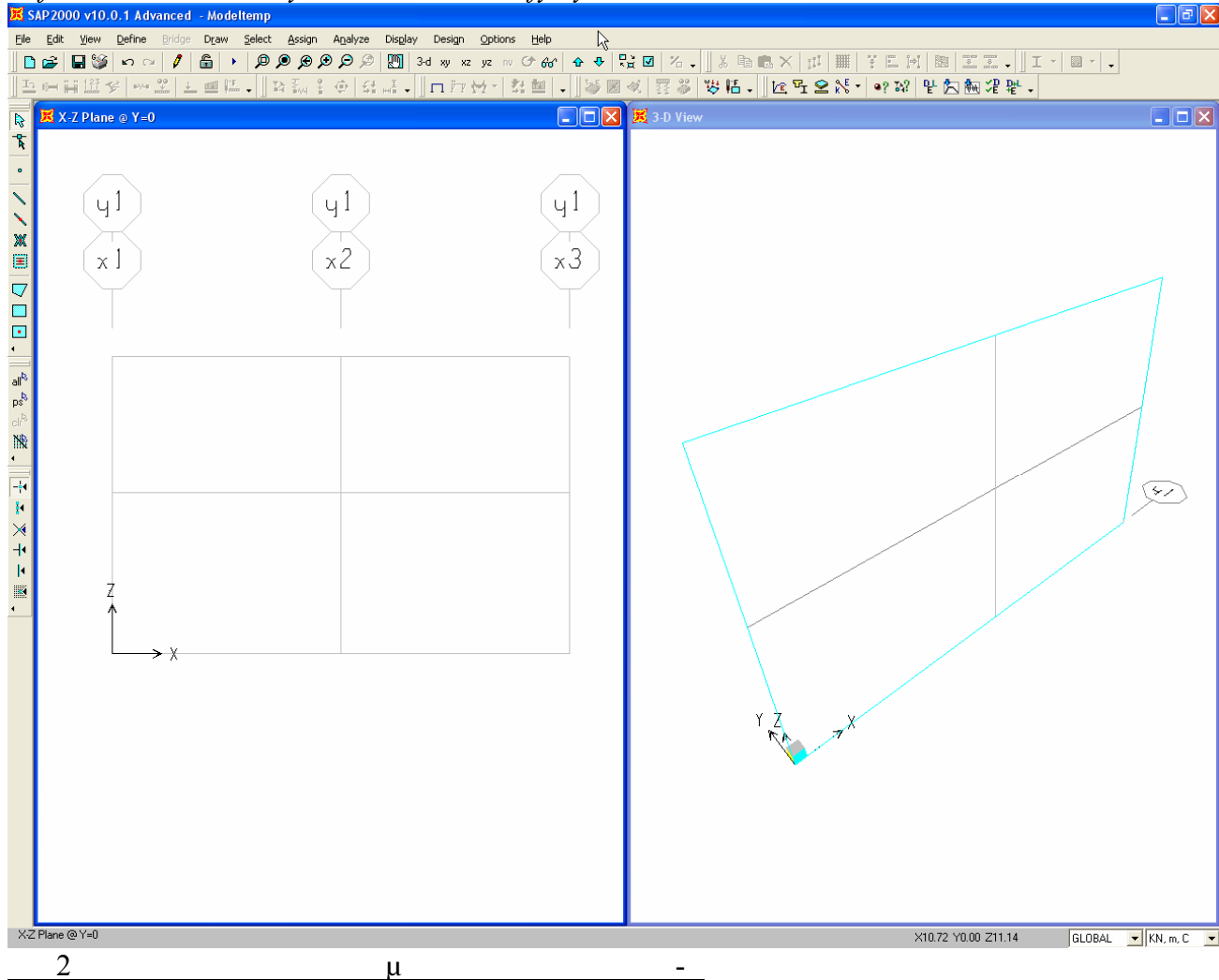


(grid)

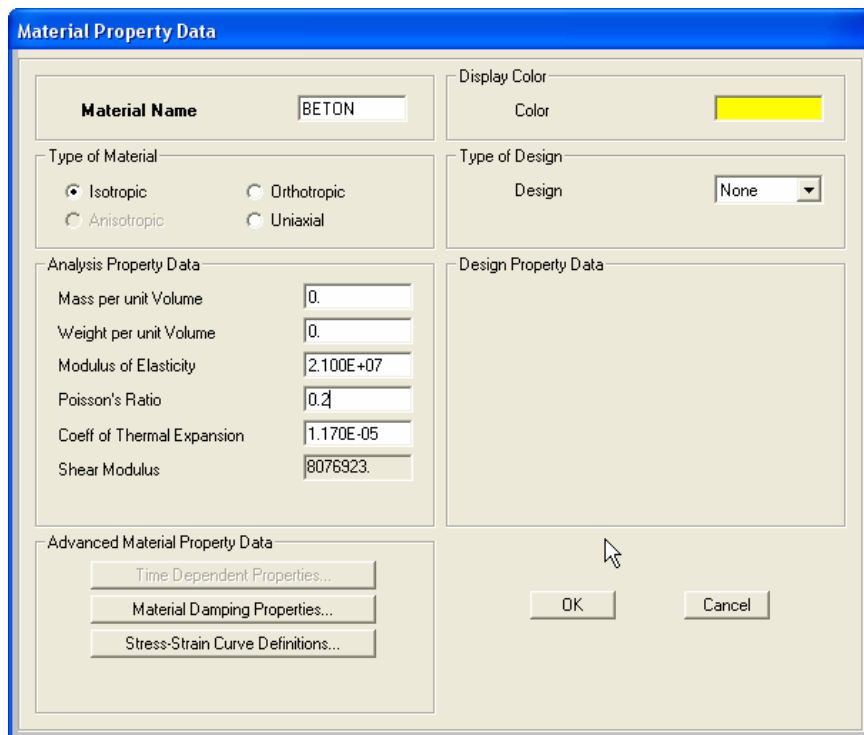
(grid),



Define → Coordinate System/Grid → Modify System

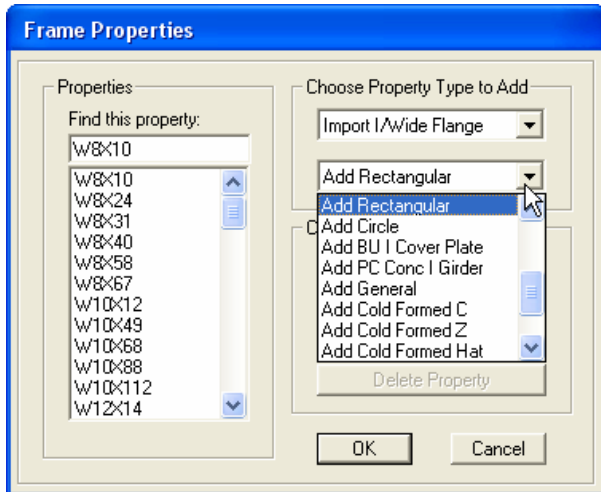


Define → Material → Add new Material



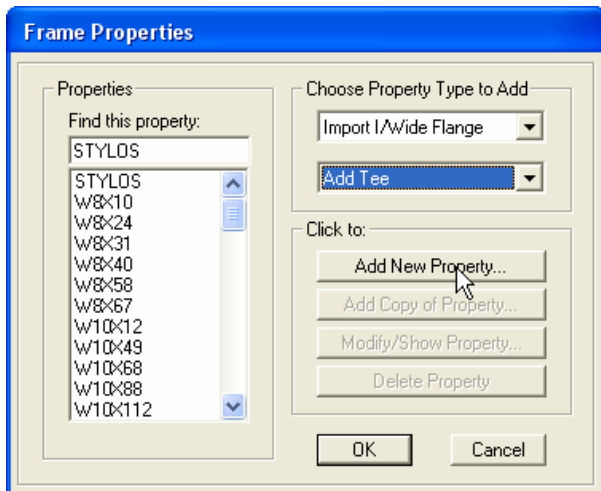
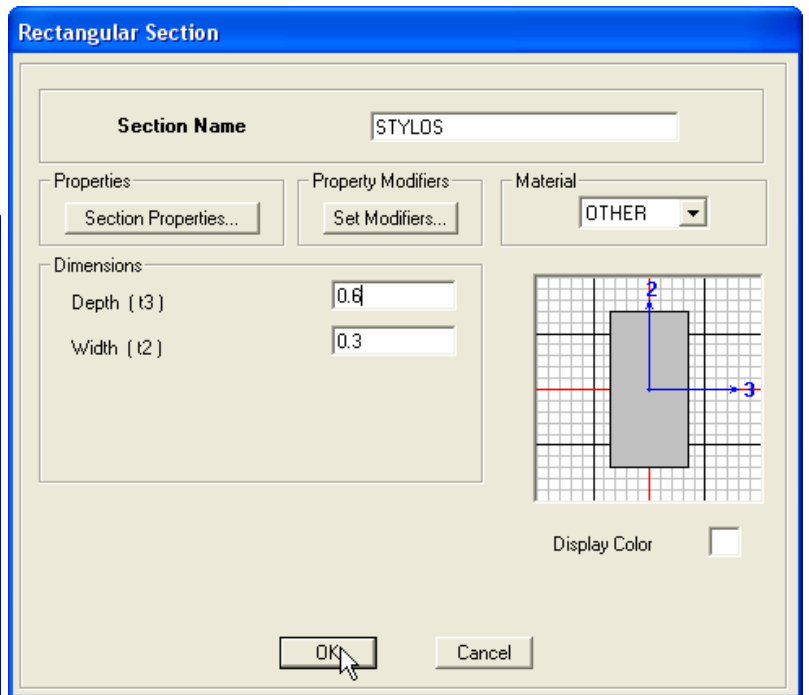
“Type of Design”  
Steel, Concrete  
 $\mu$

Define  $\rightarrow$  Frame sections...



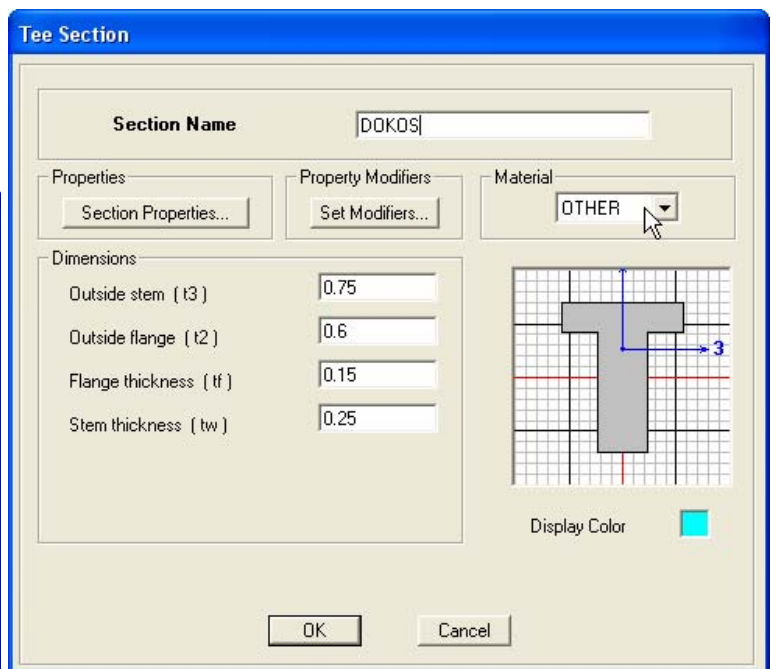
Add New Property

(Material)



Add Tee

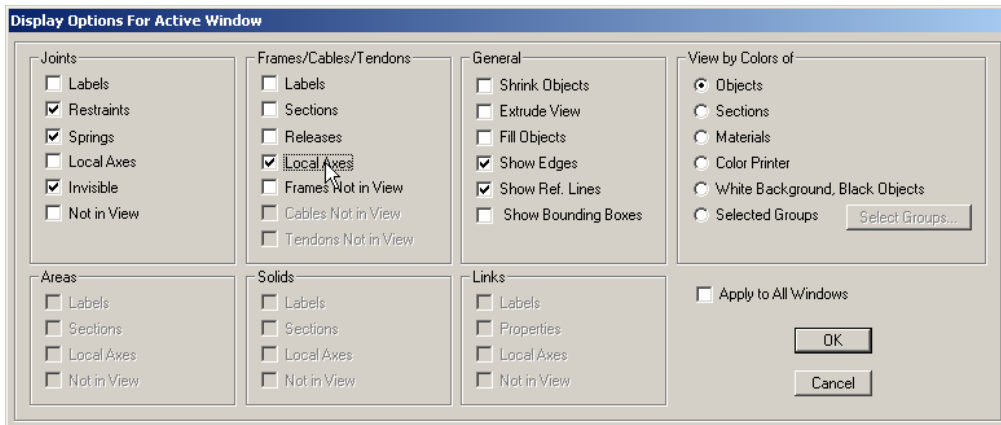
(Material)



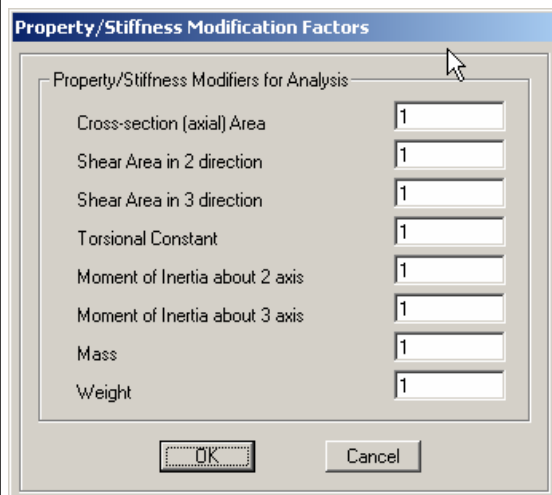
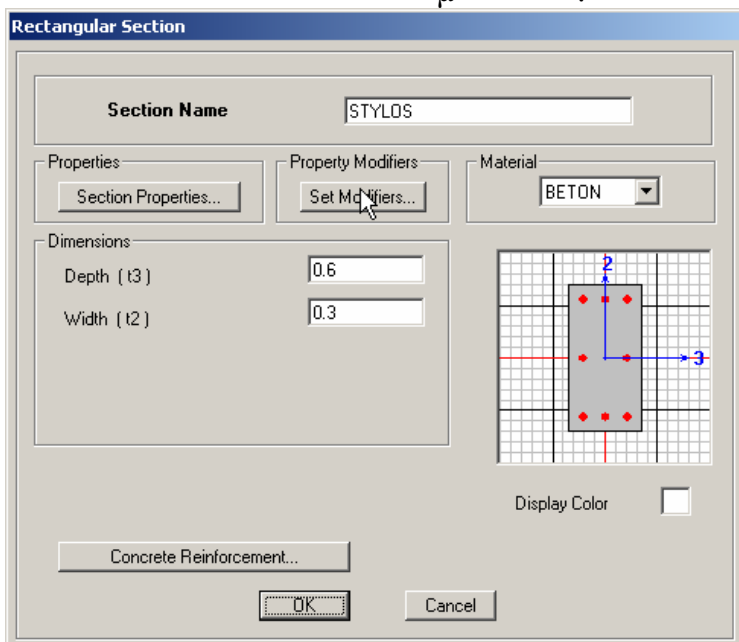
$\mu$

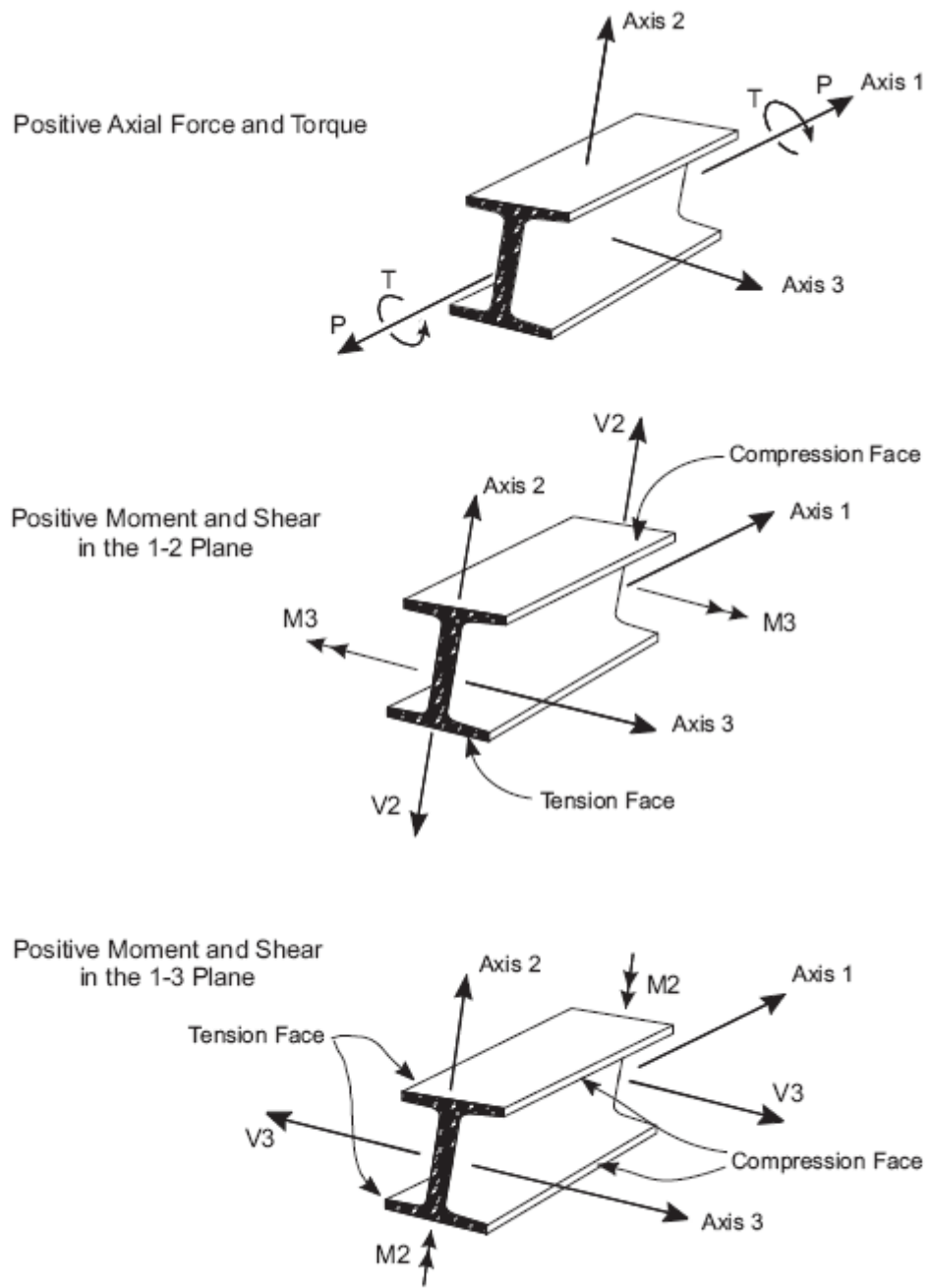
- 1
- 2
- 3

“Local Axes” “Frames” : View → Set Display Options

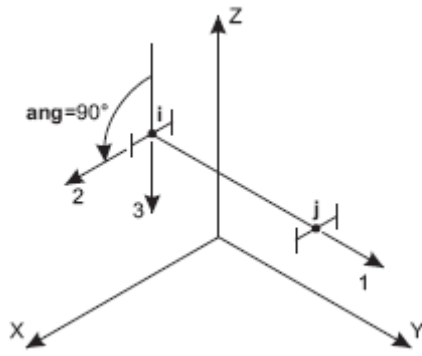


(Set Modifiers)

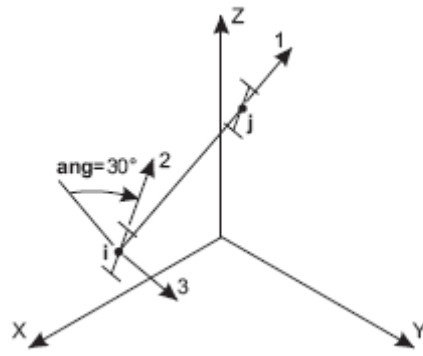




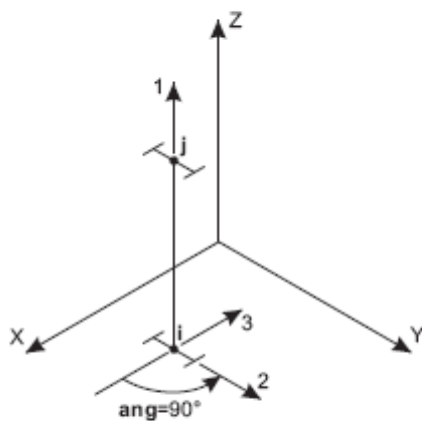
**Figure 11**  
*Frame Element Internal Forces and Moments*



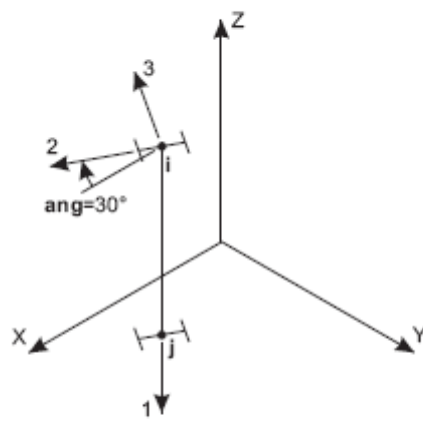
Local 1 Axis is Parallel to +Y Axis  
Local 2 Axis is Rotated 90° from Z-1 Plane



Local 1 Axis is Not Parallel to X, Y, or Z Axes  
Local 2 Axis is Rotated 30° from Z-1 Plane



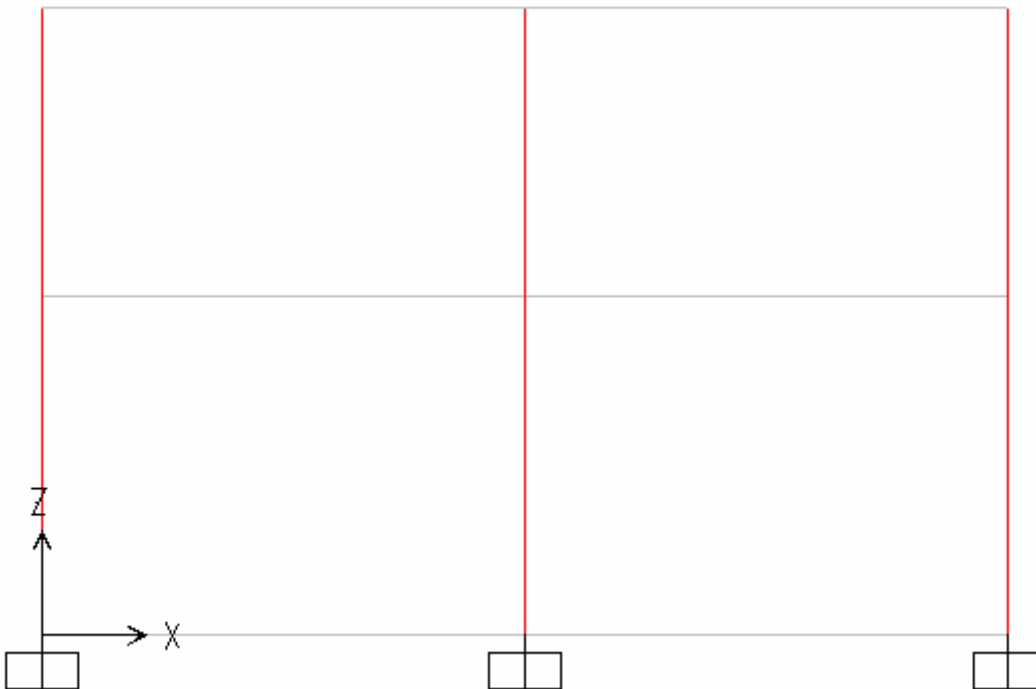
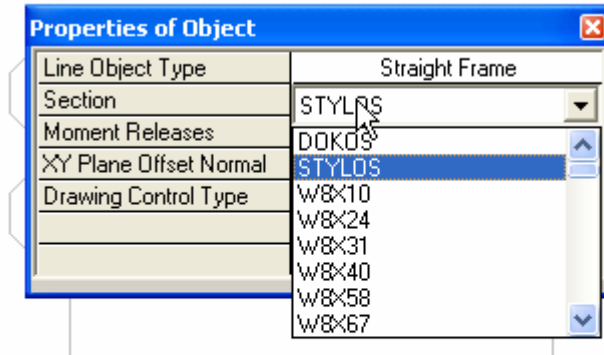
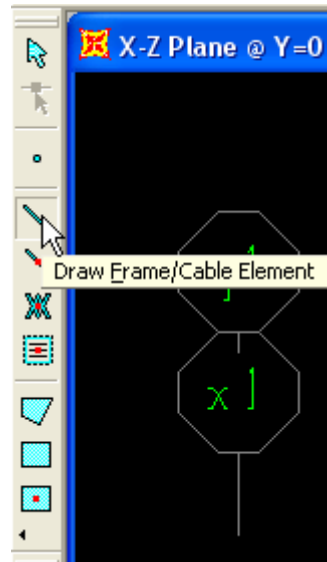
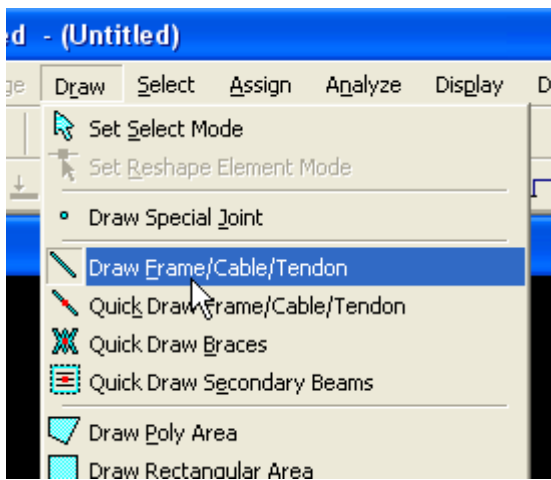
Local 1 Axis is Parallel to +Z Axis  
Local 2 Axis is Rotated 90° from X-1 Plane



Local 1 Axis is Parallel to -Z Axis  
Local 2 Axis is Rotated 30° from X-1 Plane

**Figure 1**  
*The Frame Element Coordinate Angle with Respect to the Default Orientation*

SAP2000





Properties of Object	
Line Object Type	Straight Frame
Section	DOKOS
Moment Releases	Continuous
XY Plane Offset Normal	0.
Drawing Control Type	None <space bar>



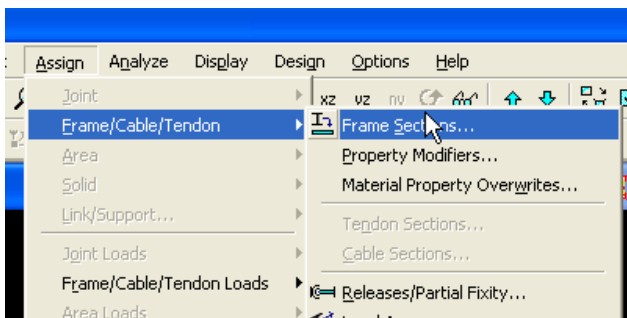
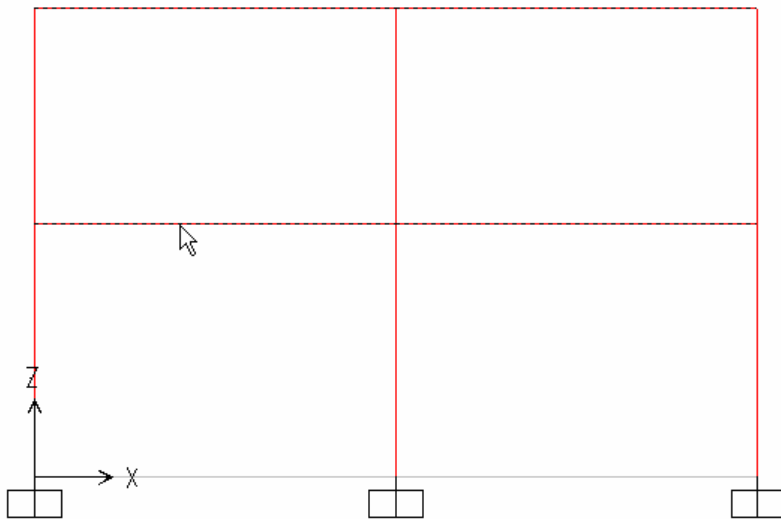
μ

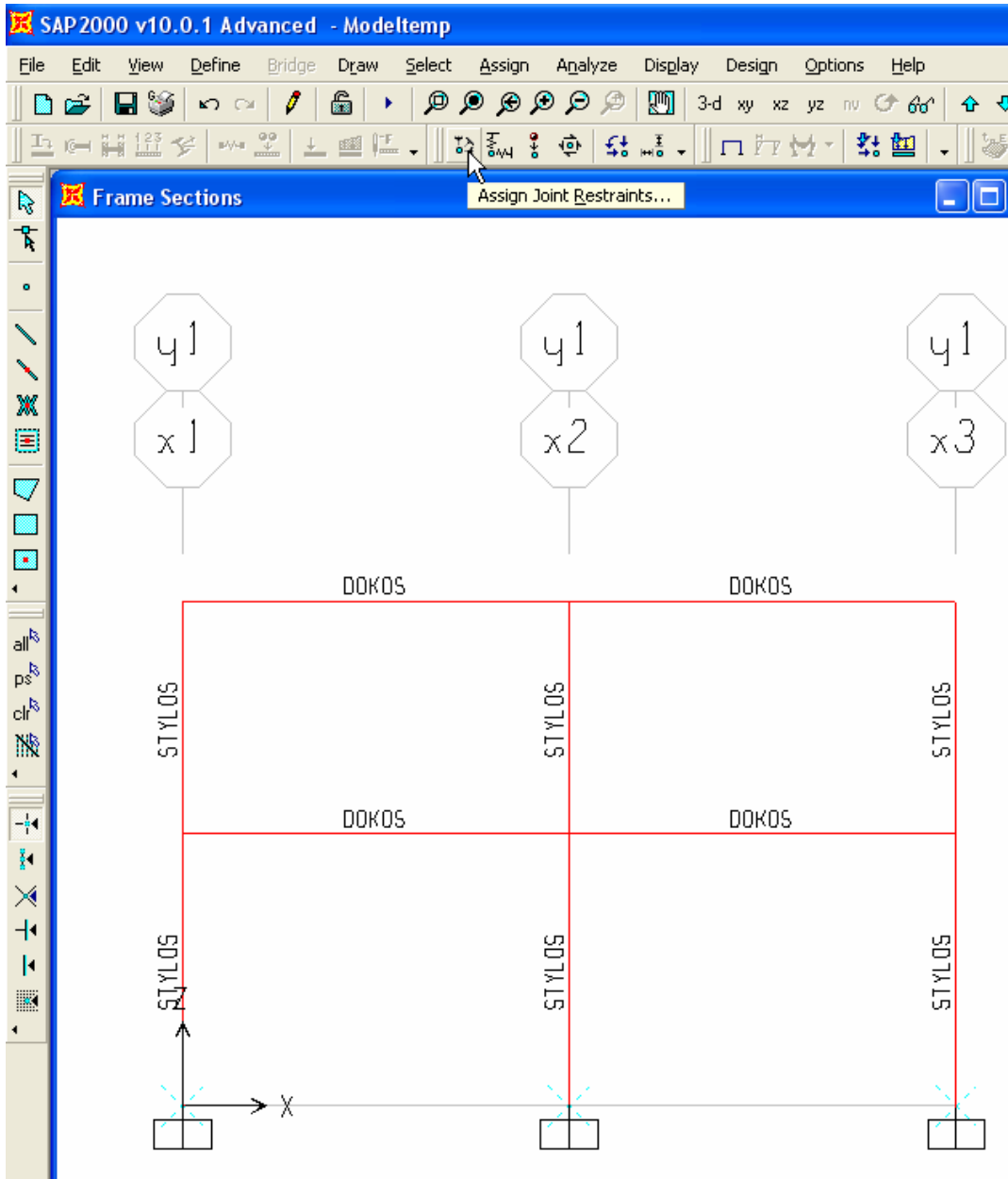
μ

μ

μ

Assign → Frame → Frame Sections...





μ

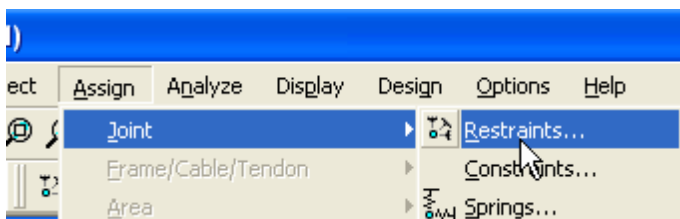
μ ,

μ

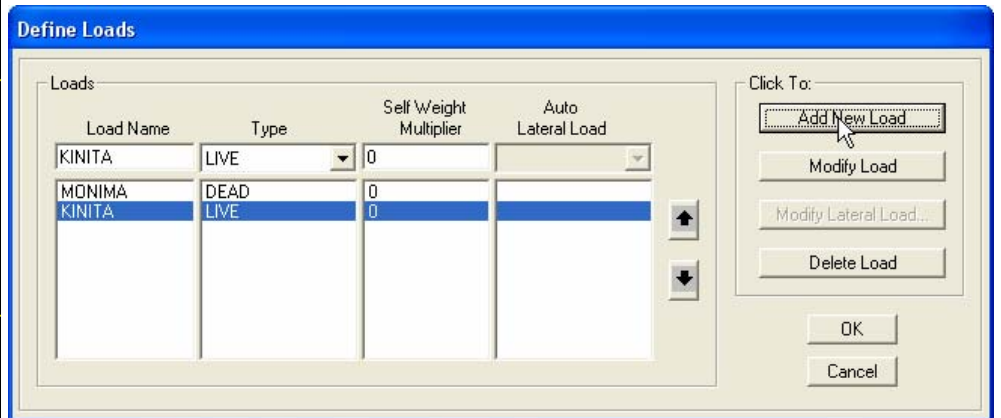
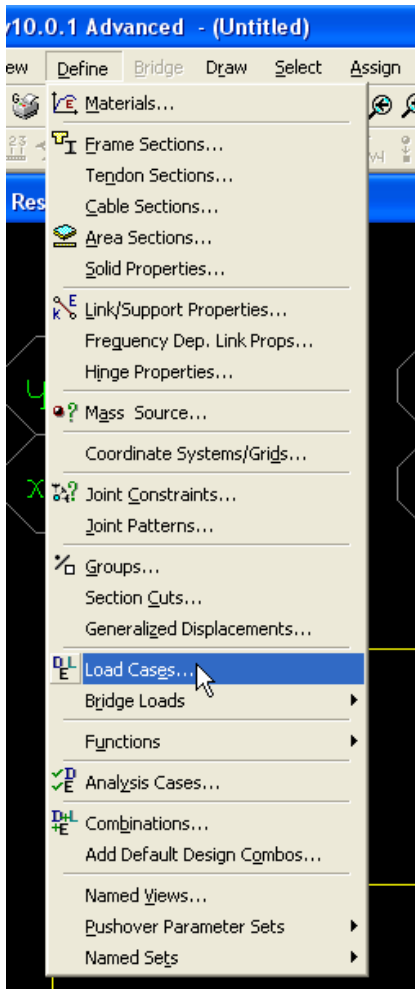
Assign → Joint → Restraints

μ

μ







μ : μ “DEAD” “MONIMA” μ μ “DEAD”. μ μ “DEAD” μ μ μ .

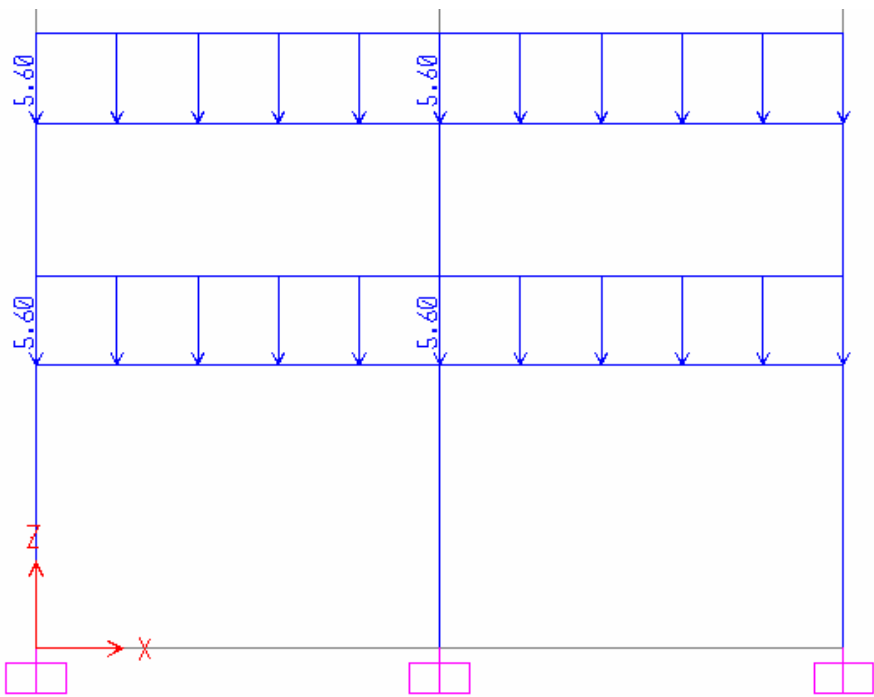
μ

μ μ ,

The screenshot shows the software interface with the following elements:

- Menu Path:** Assign > Frame/Cable/Tendon Loads > Distributed...
- Dialog Box:** Frame Distributed Loads. Load Case Name: MONIMA. Units: KN, m, C. Load Type and Direction: Forces, Direction: Z. Trapezoidal Loads: 1. Distance: 0, Load: 0; 2. Distance: 0.25, Load: 0; 3. Distance: 0.75, Load: 0; 4. Distance: 1, Load: 0. Uniform Load: Load: -5.6.
- Diagram:** A structural frame with three vertical columns labeled 'STYLOS' and two horizontal beams labeled 'DOKOS'. A coordinate system with X and Y axes is shown at the bottom left.

“MONIMA” μ



**Frame Distributed Loads**

Load Case Name:  Units:

Load Type and Direction:  Forces  Moments

Coord Sys:  Direction:

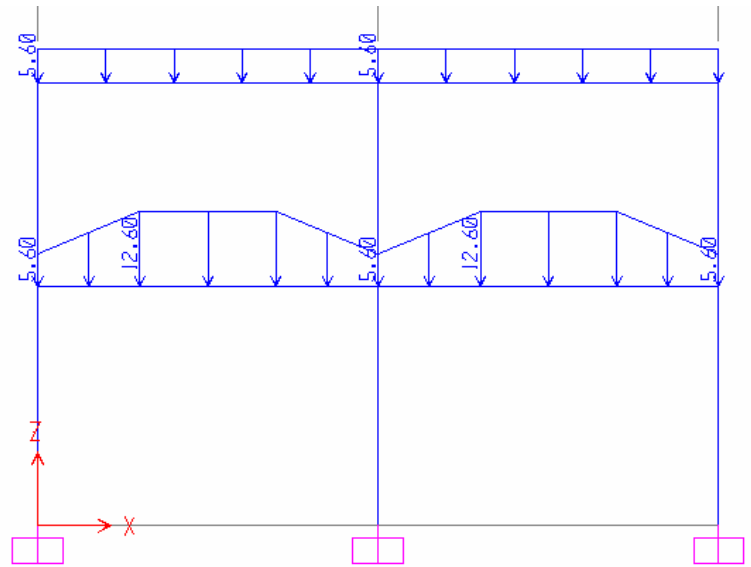
Options:  Add to Existing Loads  Replace Existing Loads  Delete Existing Loads

Trapezoidal Loads:

	1.	2.	3.	4.
Distance	<input type="text" value="0."/>	<input type="text" value="1.5"/>	<input type="text" value="3.5"/>	<input type="text" value="5."/>
Load	<input type="text" value="0."/>	<input type="text" value="-7."/>	<input type="text" value="-7."/>	<input type="text" value="0."/>

Relative Distance from End-I  Absolute Distance from End-I

Uniform Load: Load



**Frame Distributed Loads**

Load Case Name:  Units:

Load Type and Direction:  Forces  Moments

Coord Sys:  Direction:

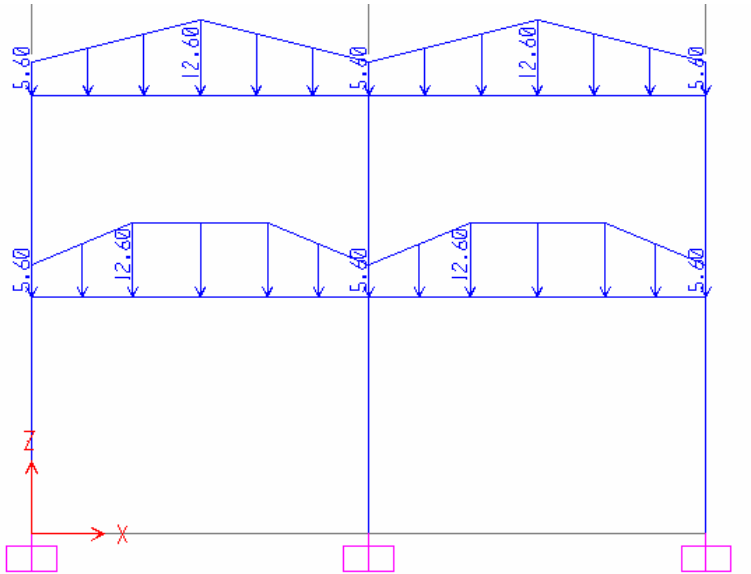
Options:  Add to Existing Loads  Replace Existing Loads  Delete Existing Loads

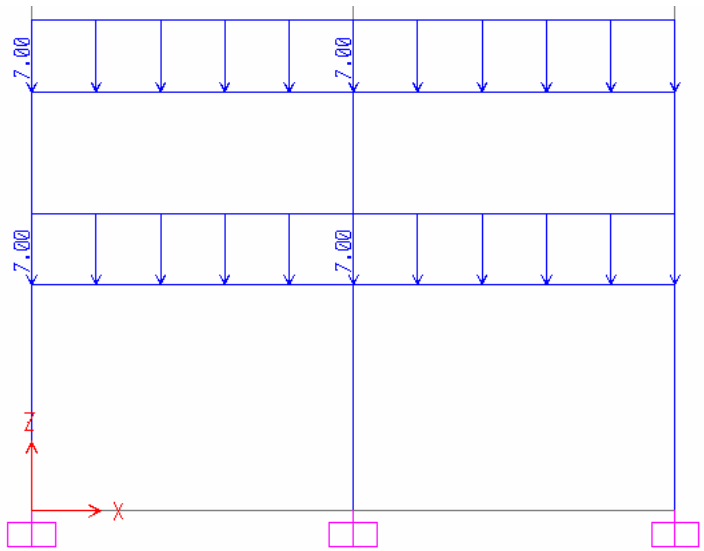
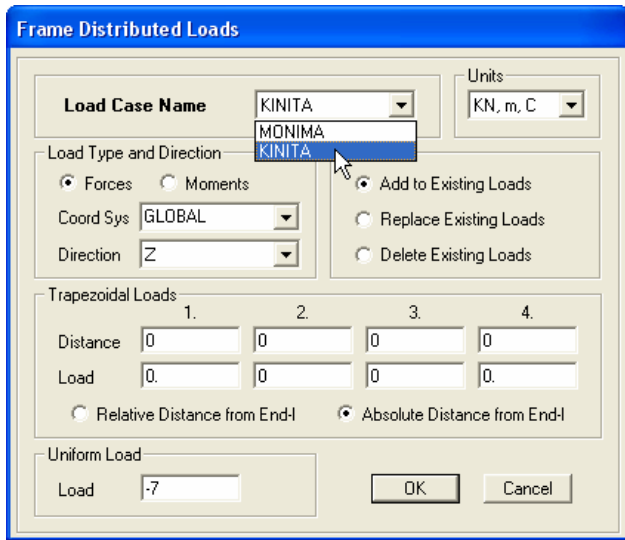
Trapezoidal Loads:

	1.	2.	3.	4.
Distance	<input type="text" value="0."/>	<input type="text" value="2.5"/>	<input type="text" value="2.5"/>	<input type="text" value="5."/>
Load	<input type="text" value="0."/>	<input type="text" value="-7."/>	<input type="text" value="-7."/>	<input type="text" value="0."/>

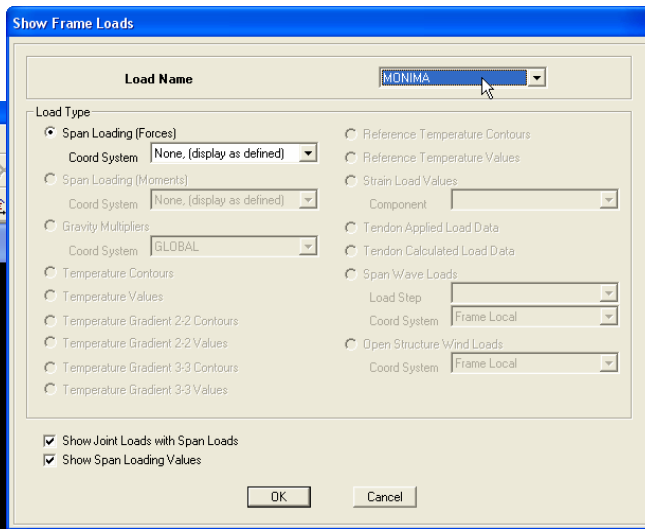
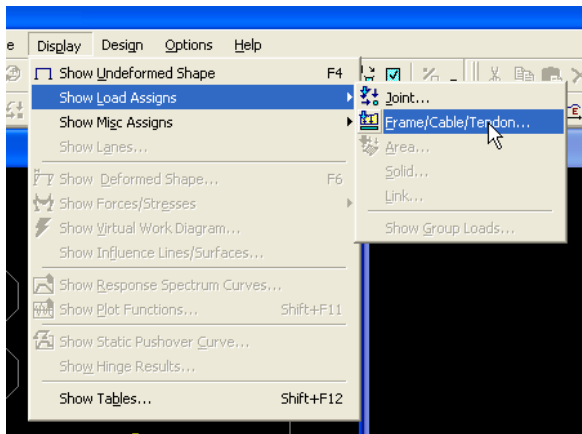
Relative Distance from End-I  Absolute Distance from End-I

Uniform Load: Load



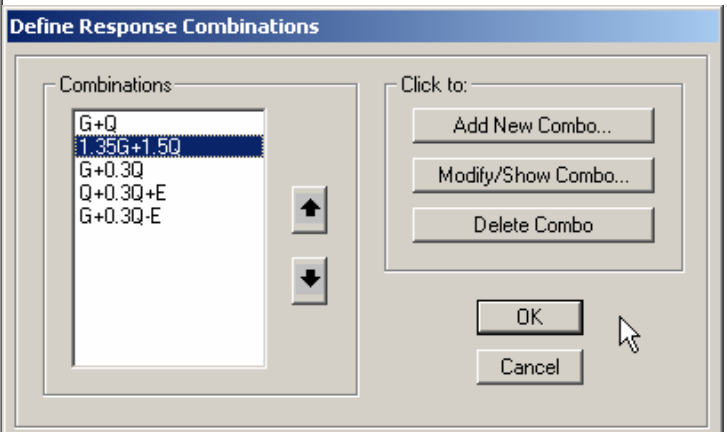
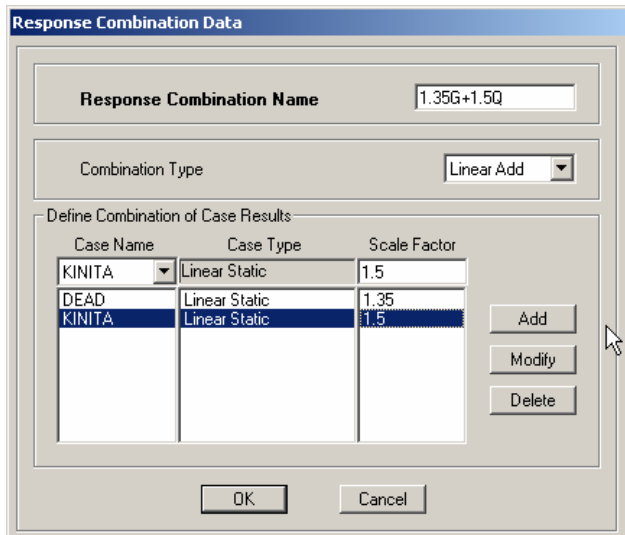


μ .  
μ μ



μ μ

Define → Combinations → Add new Combo

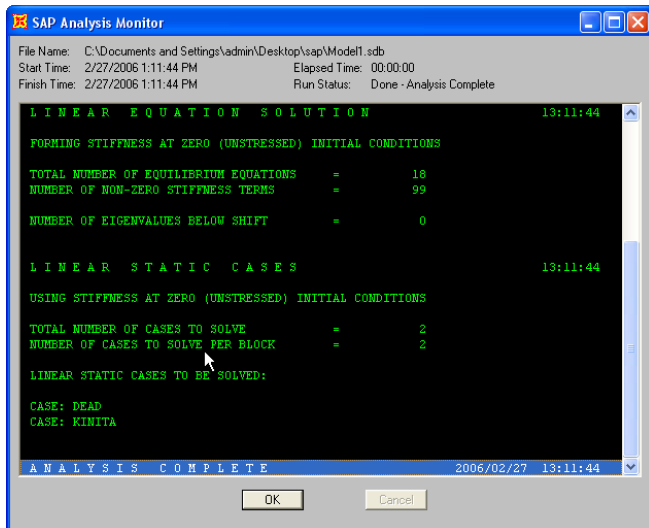
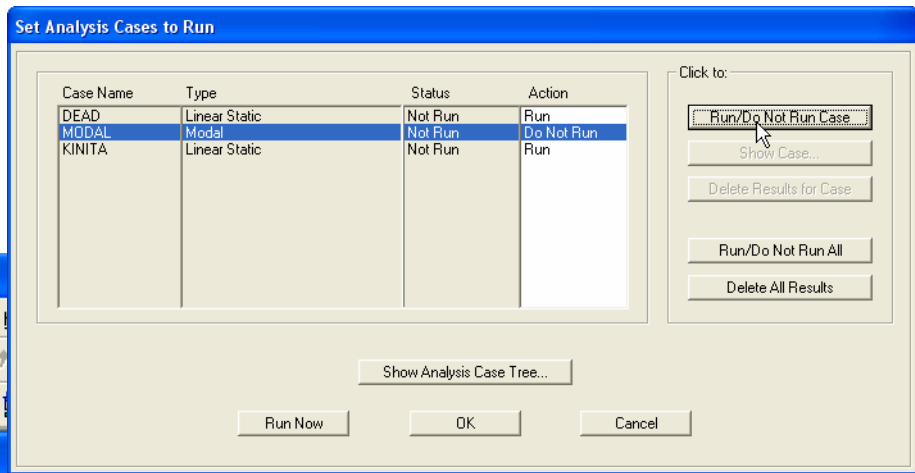
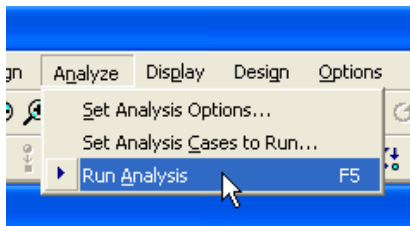
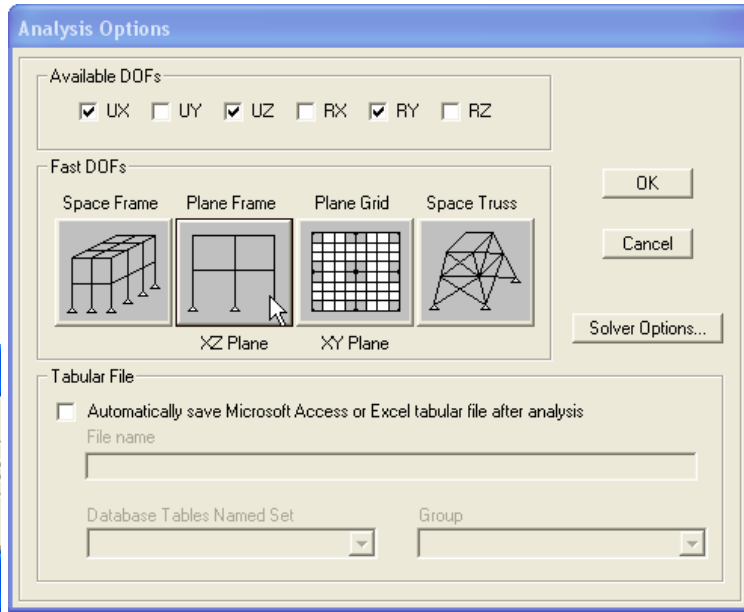
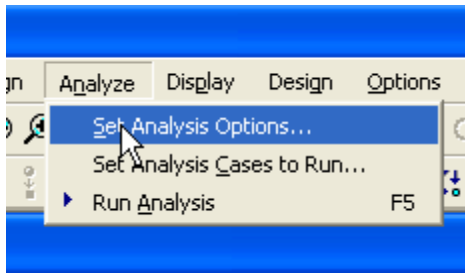


μ

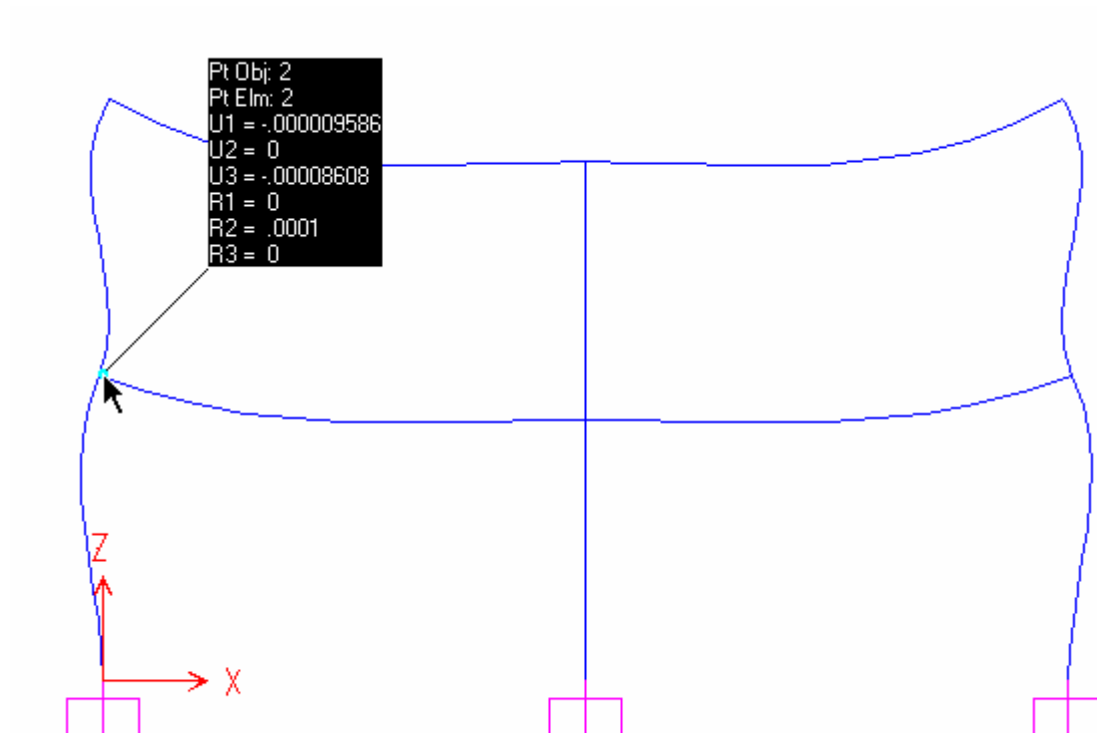
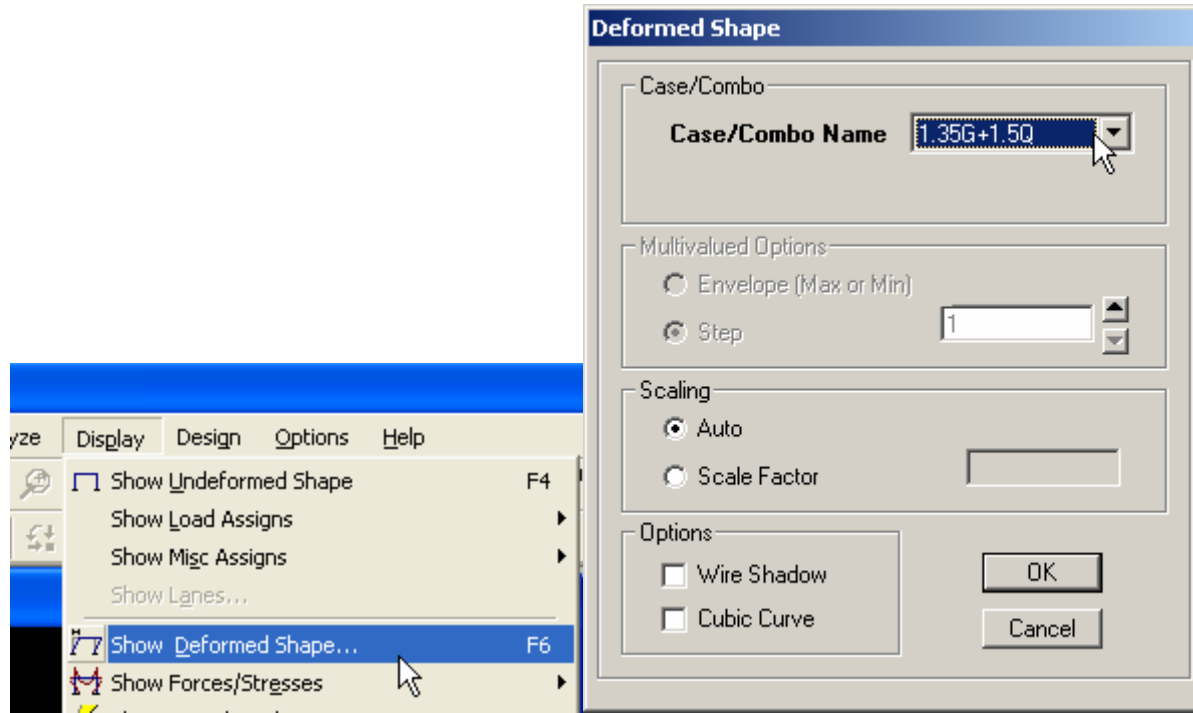
3 μ μ

UX, UZ R

( -



μ



μμ

μ

### Member Force Diagram for Frames

Case/Combo  
**Case/Combo Name** 1.35G+1.5Q

Multivalued Options  
 Envelope (Range)  
 Step 1

Component  
 Axial Force       Torsion  
 Shear 2-2       Moment 2-2  
 Shear 3-3       Moment 3-3

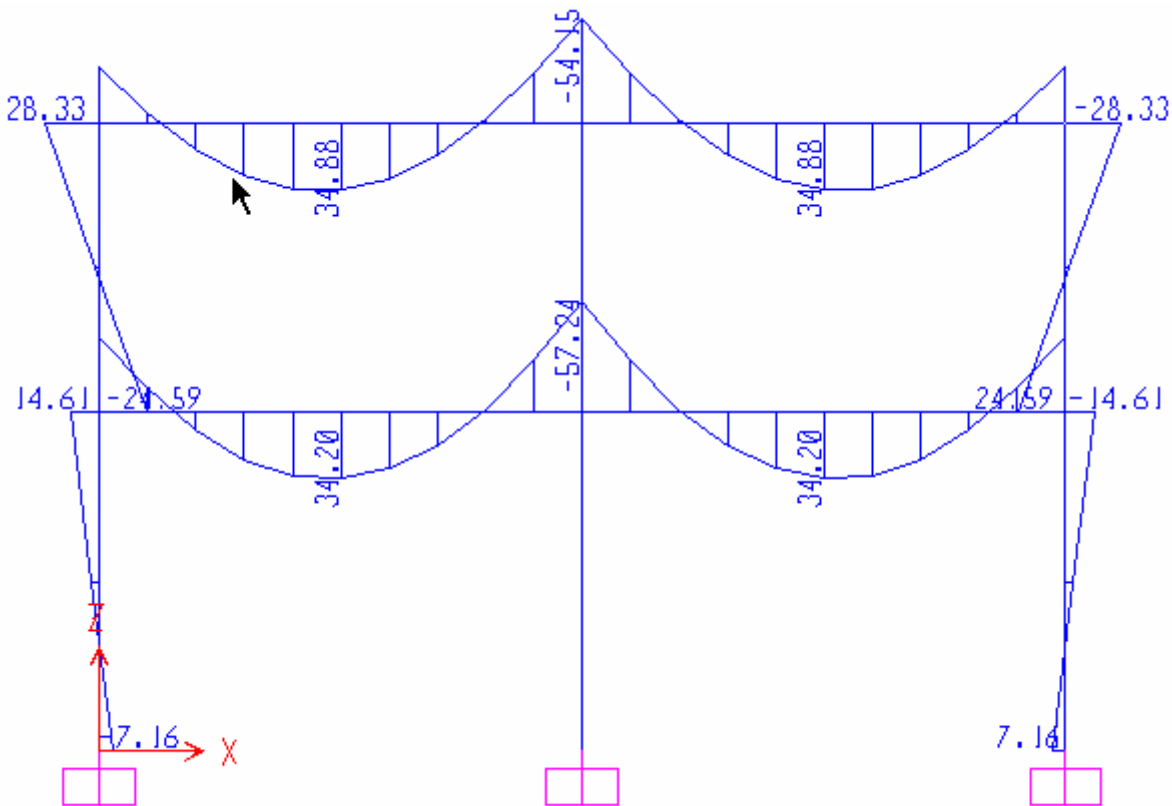
Scaling  
 Auto  
 Scale Factor

Options  
 Fill Diagram  
 Show Values on Diagram  
 Show Deformed Shape

OK Cancel

Display Design Options Help

- Show Undeformed Shape F4
- Show Load Assigns
- Show Misc Assigns
- Show Lanes...
- Show Deformed Shape... F6
- Show Forces/Stresses
  - Joints...
  - Frames/Cables...
- Show Virtual Work Diagram...
- Show Influence Lines/Surfaces...







μ μ

### “End Length Offsets”

( μ μ μ μ )

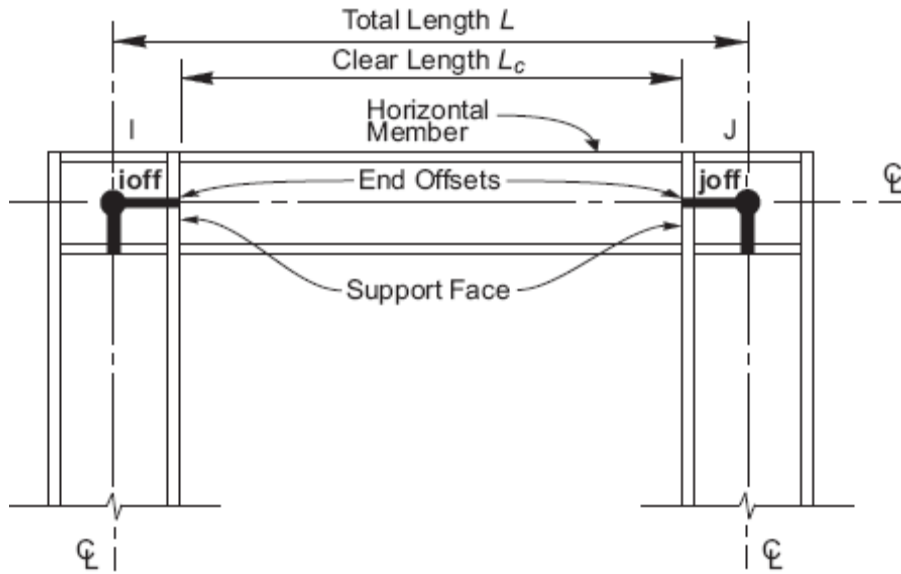
μ . μ μ μ

μ μ  
μ μ  
μ

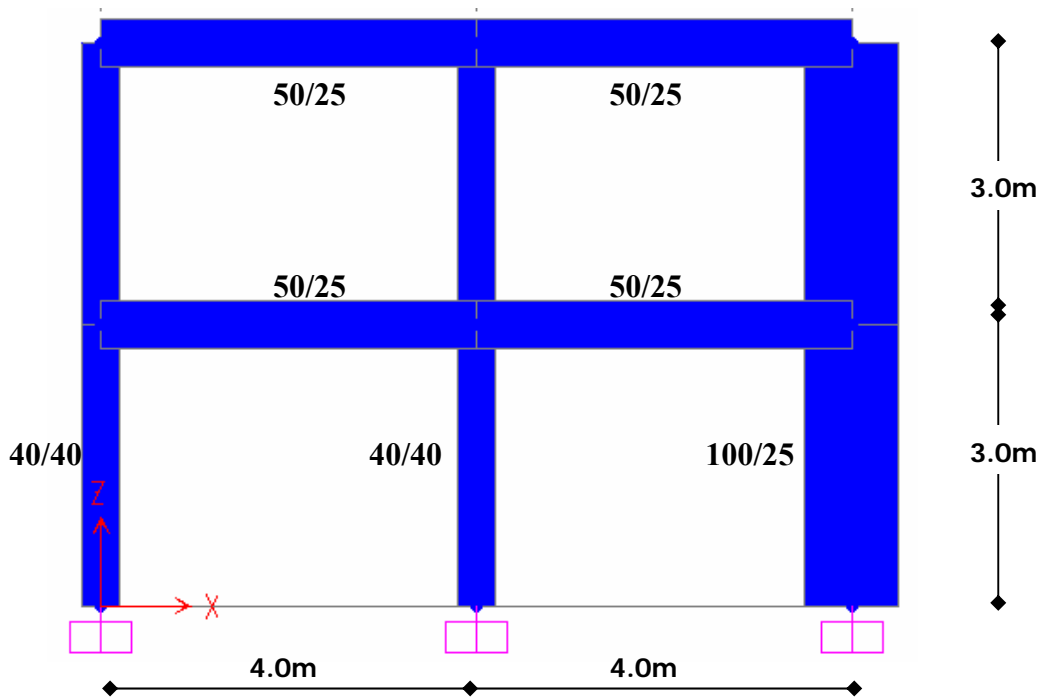
μ μ  
μ μ  
SAP2000

μ μ μ

End Length Offsets



μ μ μ μ μ



μ μ μ μ μ μ μ μ μ μ μ (0.5m)





**Property/Stiffness Modification Factors**

Property/Stiffness Modifiers for Analysis

Cross-section (axial) Area	1
Shear Area in 2 direction	1000
Shear Area in 3 direction	1
Torsional Constant	1
Moment of Inertia about 2 axis	1
Moment of Inertia about 3 axis	1000
Mass	1
Weight	1

OK Cancel

$\mu$   
 $\mu$

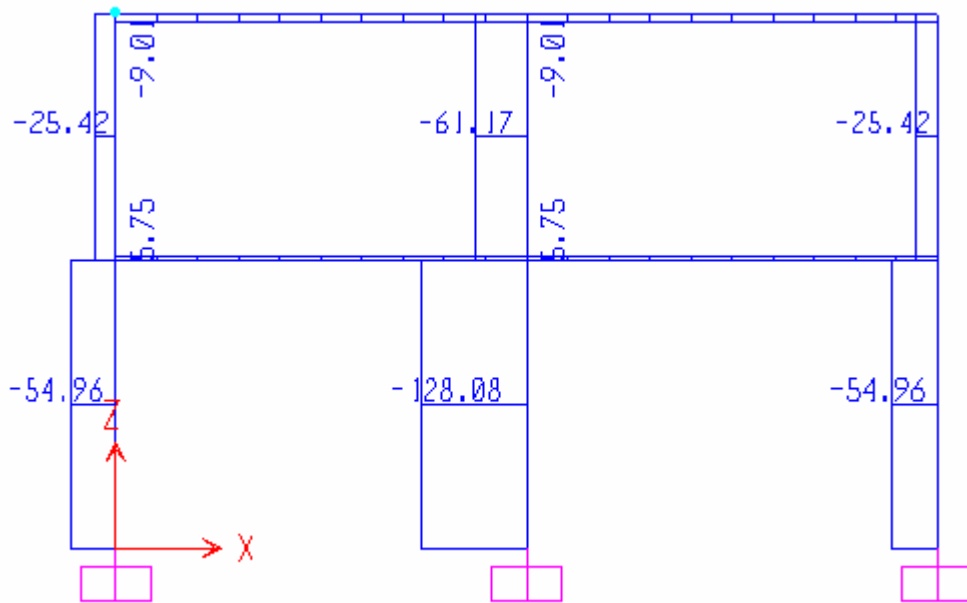
$\mu$

$\mu$

— μ μ

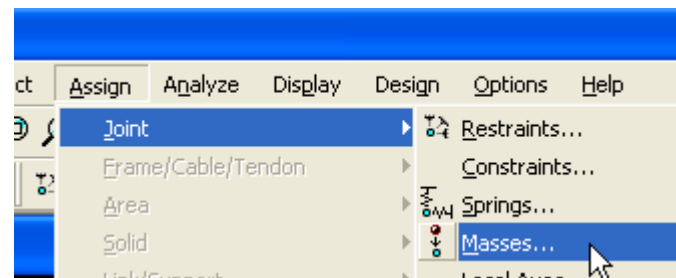
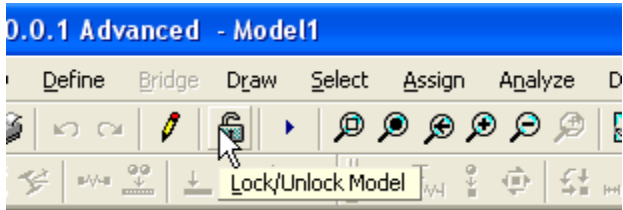
μ

μ G+0.3Q

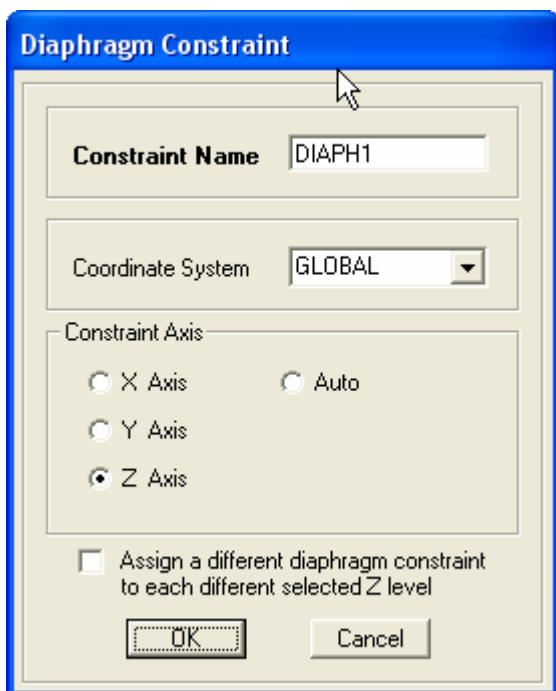
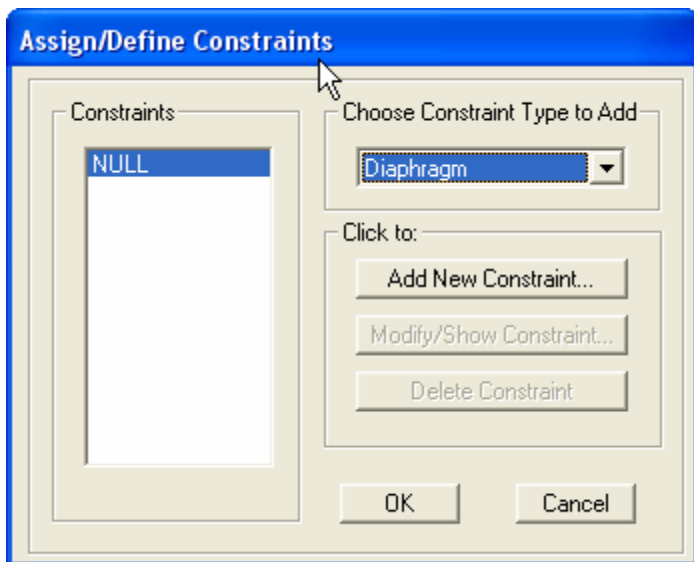


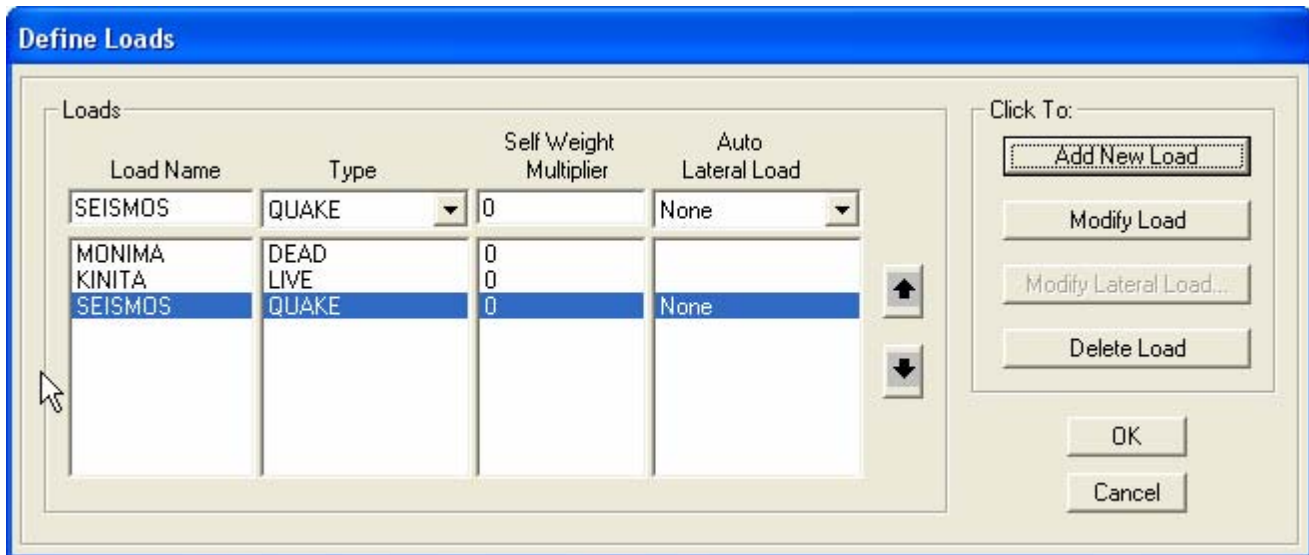
$$2 = (25.42+61.17+25.42)/9.81=11.42 \text{ tons (SI)}$$

$$1 = (54.96+128.08+54.96)/9.81-11.42=12.84 \text{ tons (SI)}$$

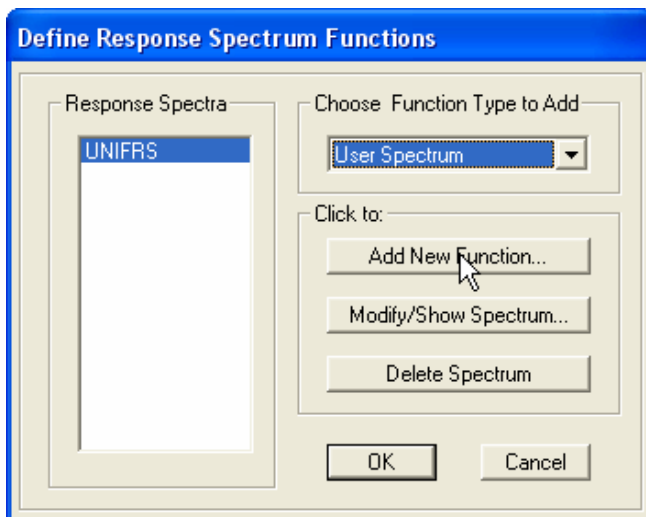
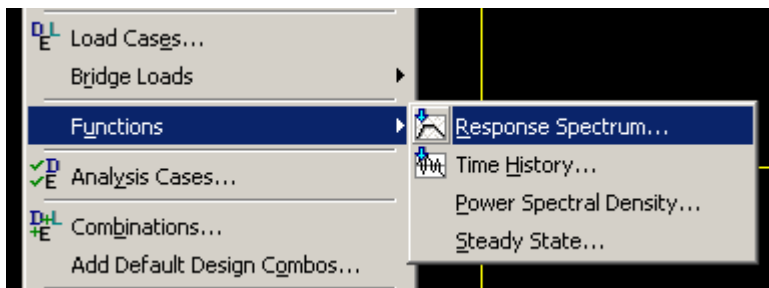


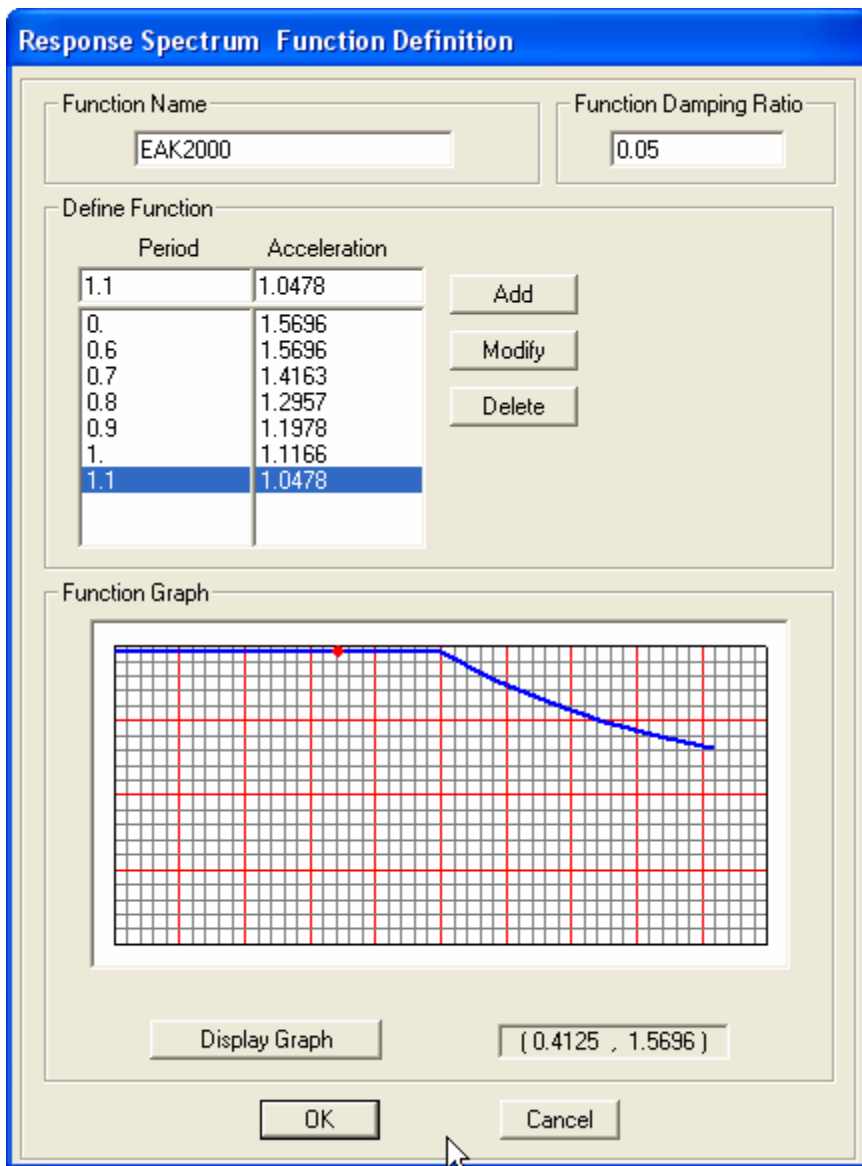




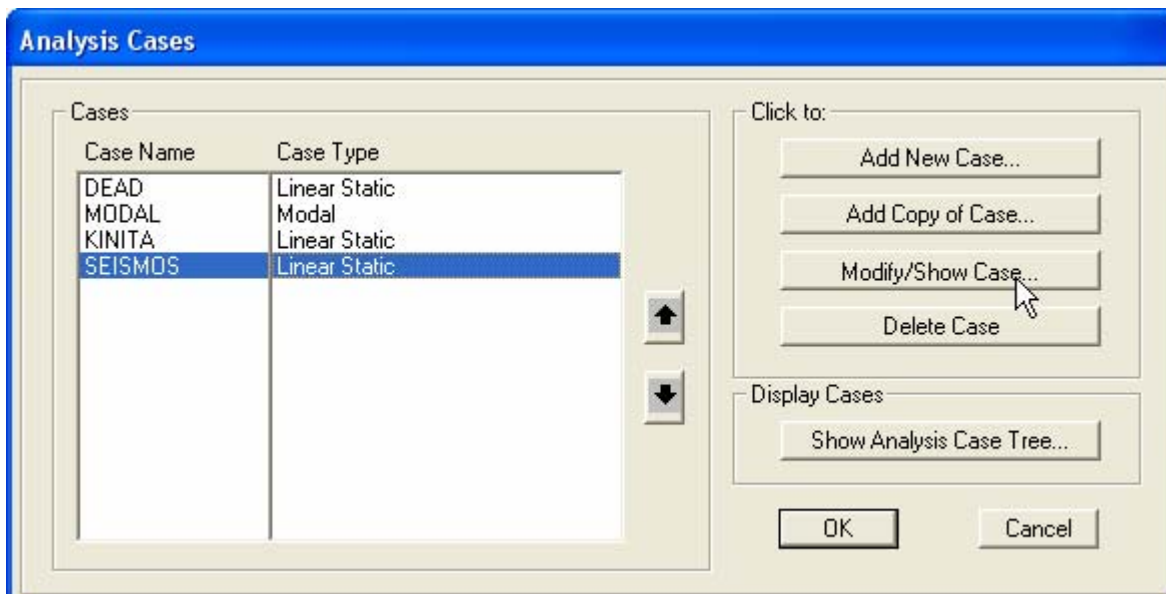
$\mu$  $\mu$  $\mu$  $\mu$  $\mu$  $\mu$ 

Define → Function → Response Spectrum





Define  $\rightarrow$  Analysis Cases



### Analysis Case Data - Response Spectrum

**Analysis Case Name** SEISMOS

**Analysis Case Type** Response Spectrum

**Modal Combination**  
 CQC  SRSS  ABS  GMC  10 Pct  Dbl Sum  
 GMC f1  GMC f2

**Directional Combination**  
 SRSS  ABS  
 Modified SRSS (Chinese)  
 ABS Scale Factor

**Modal Analysis Case**  
 Use Modes from this Modal Analysis Case MODAL

**Diaphragm Eccentricity**  
 Eccentricity Ratio 0.

**Loads Applied**

Load Type	Load Name	Function	Scale Factor
Accel	U1	EAK2000	1.
Accel	U1	EAK2000	1.

Show Advanced Load Parameters

**Other Parameters**  
 Modal Damping

$\mu$   
 Define → Combinations

G+0.3Q+E

G+0.3Q-E

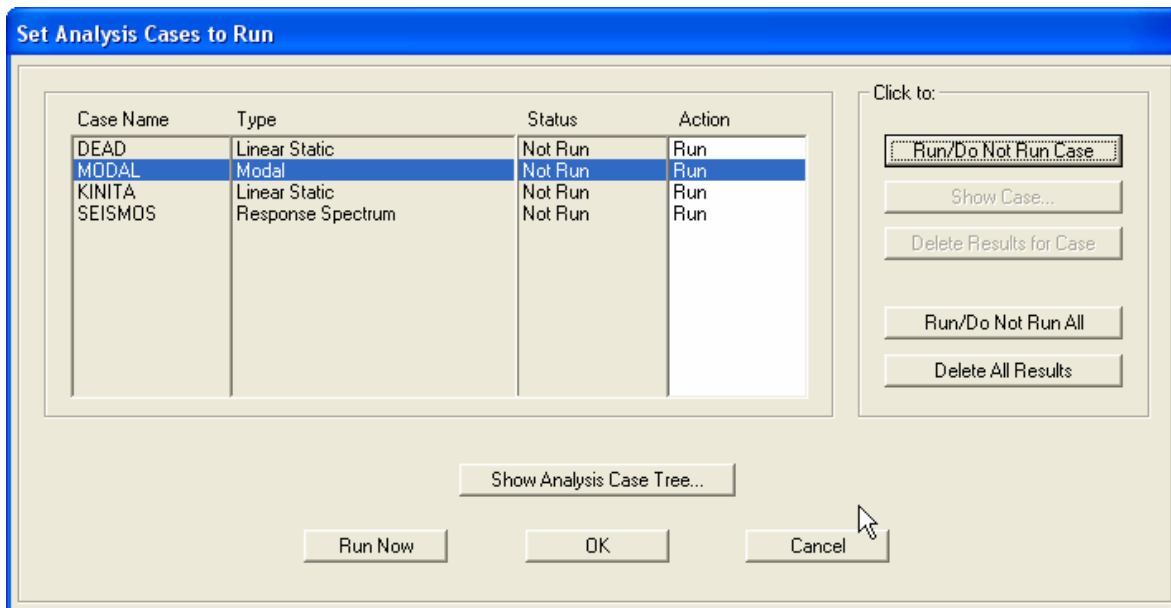
### Response Combination Data

**Response Combination Name** G+0.3Q+E

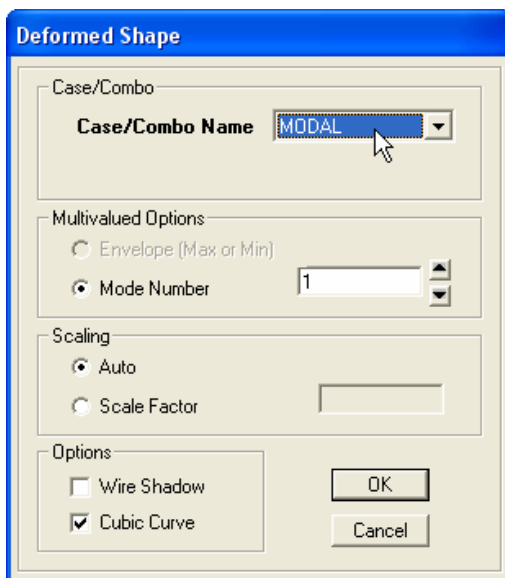
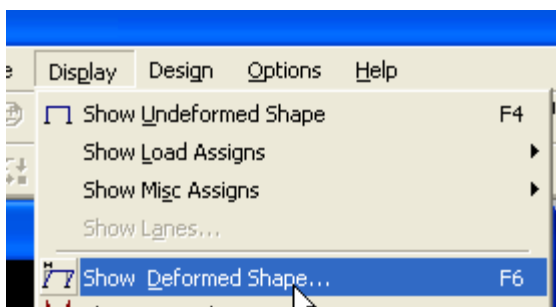
**Combination Type** Linear Add

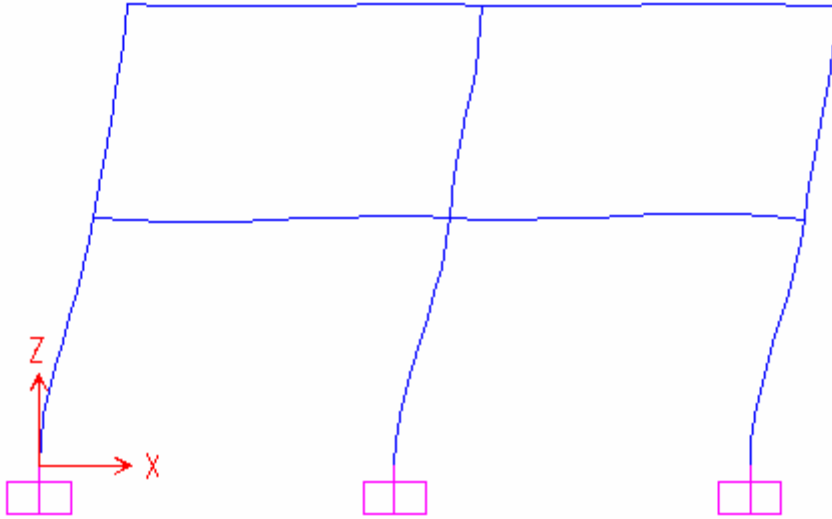
**Define Combination of Case Results**

Case Name	Case Type	Scale Factor
SEISMOS	Response Spectrum	1.
DEAD	Linear Static	1.
KINITA	Linear Static	0.3
SEISMOS	Response Spectrum	1.



μ μ -



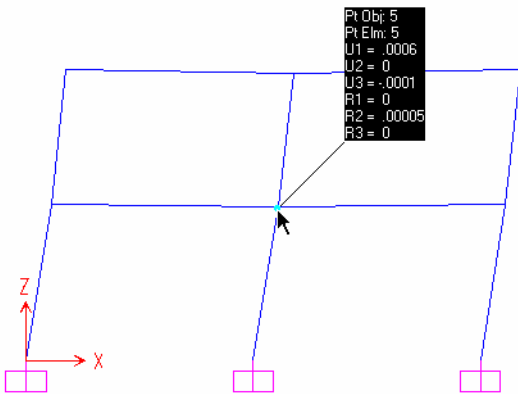


μ μ μ μ μ μ μ

Start Animation ← → GLOBAL KN, m, C

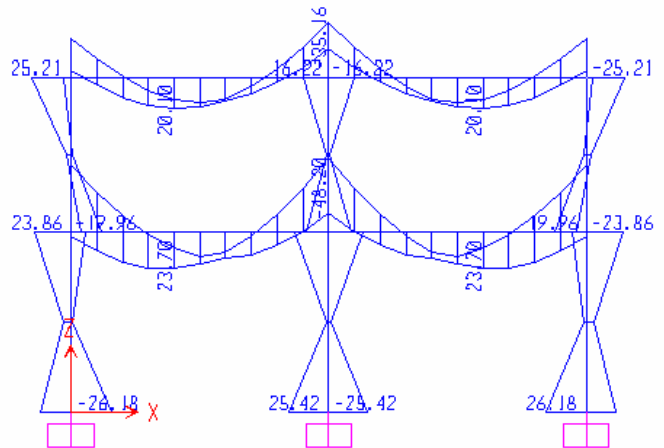
μμ

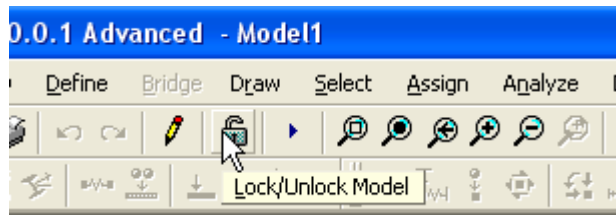
Joint Displacements			
Joint Object	5	Joint Element	5
	1	2	3
Trans	5.513E-04	0.00000	-1.182E-04
Rotn	0.00000	4.930E-05	0.00000



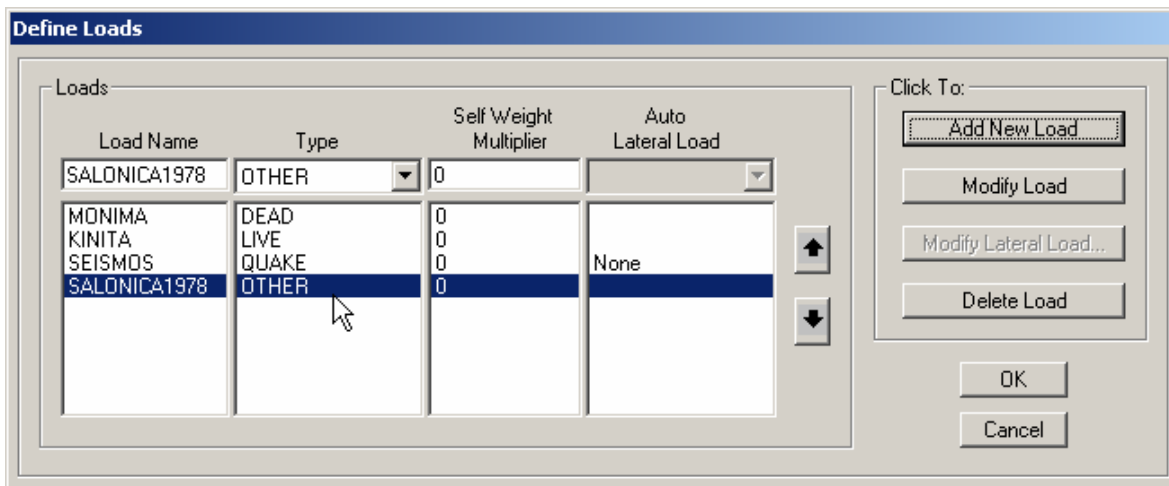
μ

μ G+0.3Q+E

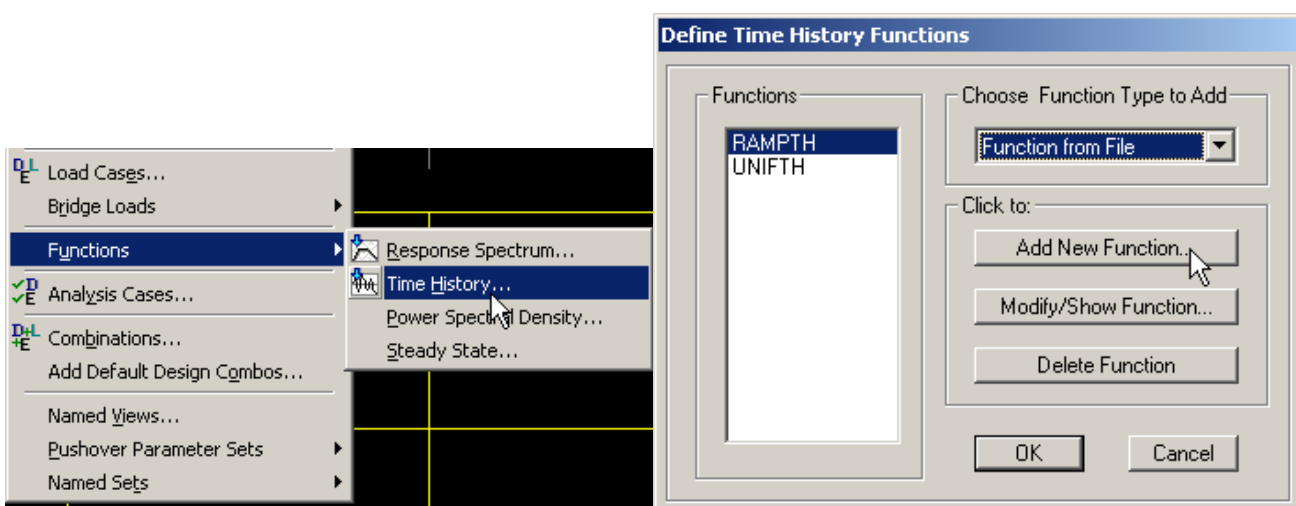


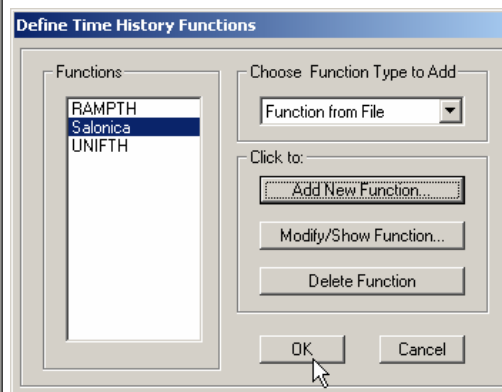
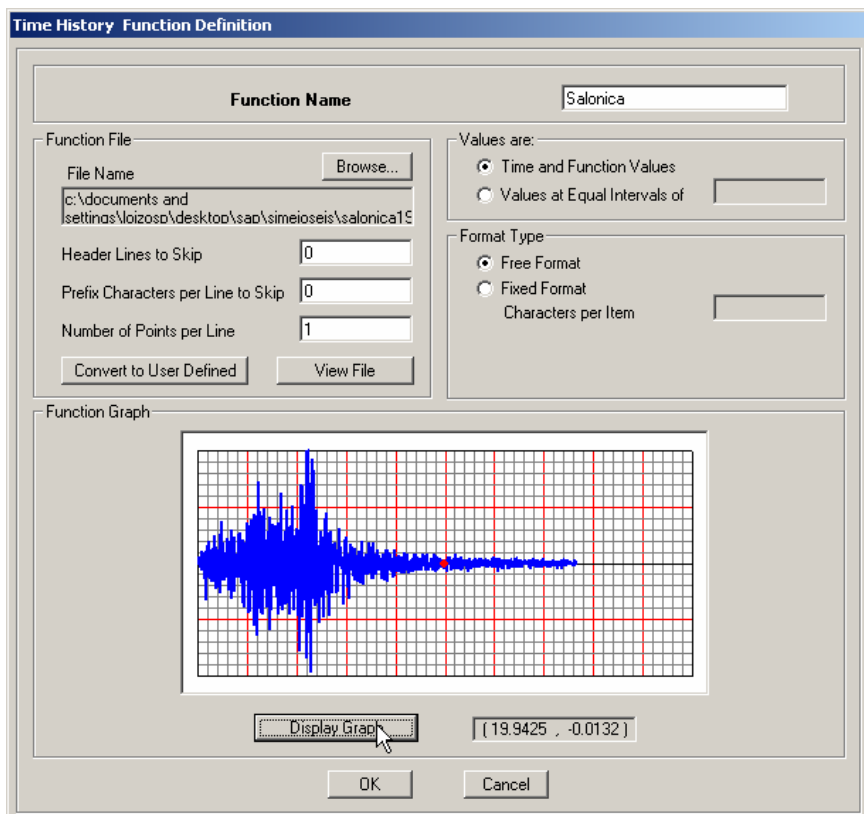


Define → Load Case

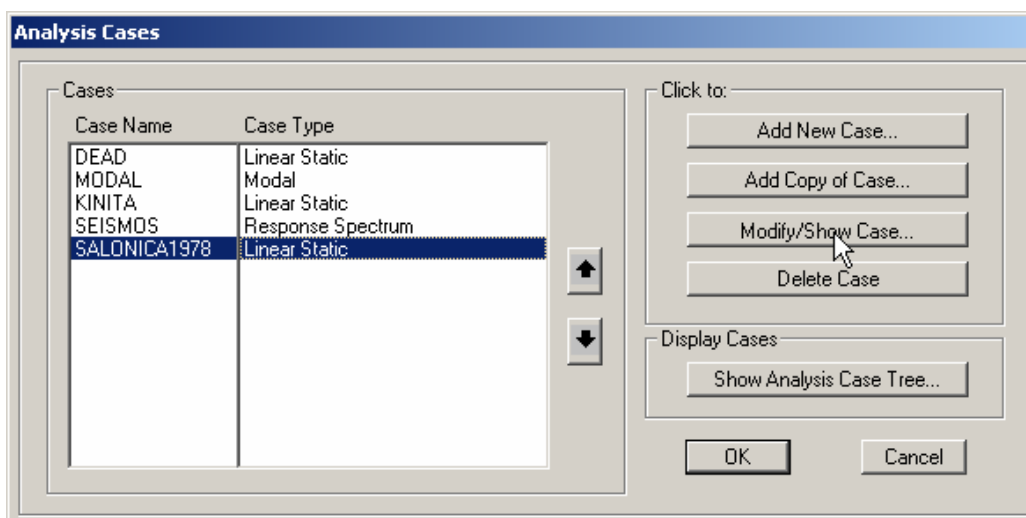


Define → Function → Time History...





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 Define  $\rightarrow$  Analysis Cases



### Analysis Case Data - Linear Modal History

**Analysis Case Name** SALONICA1978

**Analysis Case Type** Time History

**Initial Conditions**

Zero Initial Conditions - Start from Unstressed State

Continue from State at End of Modal History

Important Note: Loads from this previous case are included in the current case

**Modal Analysis Case**

Use Modes from Case MODAL

**Loads Applied**

Load Type	Load Name	Function	Scale Factor
Accel	U1	Salonica	1.
Accel	U1	Salonica	1.

Show Advanced Load Parameters

**Time Step Data**

Number of Output Time Steps

Output Time Step Size

**Other Parameters**

Modal Damping

### Set Analysis Cases to Run

Case Name	Type	Status	Action
DEAD	Linear Static	Not Run	Run
MODAL	Modal	Not Run	Run
KINITA	Linear Static	Not Run	Run
SEISMOS	Response Spectrum	Not Run	Run
SALONICA1978	Linear Modal History	Not Run	Run

Click to:

μ

μ

μ

μ

μ

μ

μ

μμ

μ  
8.1sec

μ

μ

μ

**Member Force Diagram for Frames**

Case/Combo  
**Case/Combo Name** SALONICA1978

Multivalued Options  
 Envelope (Range)  
 Time 8.1

Component  
 Axial Force     Torsion  
 Shear 2-2     Moment 2-2  
 Shear 3-3     Moment 3-3

Scaling  
 Auto  
 Scale Factor

Options  
 Fill Diagram  
 Show Values on Diagram  
 Show Deformed Shape

OK Cancel

**Member Force Diagram for Frames**

Case/Combo  
**Case/Combo Name** SALONICA1978

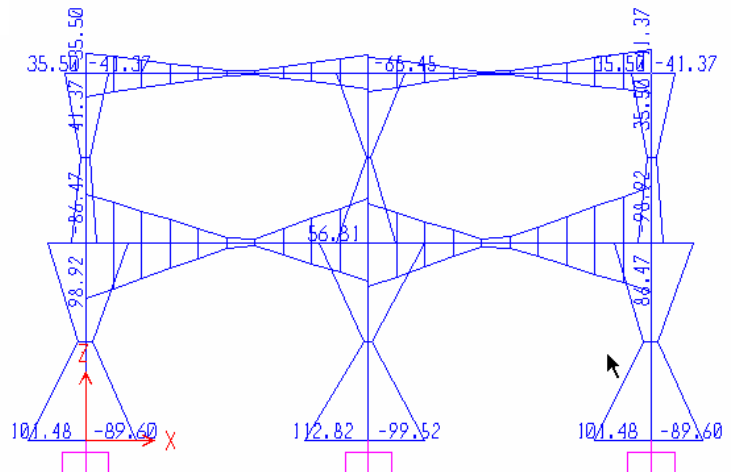
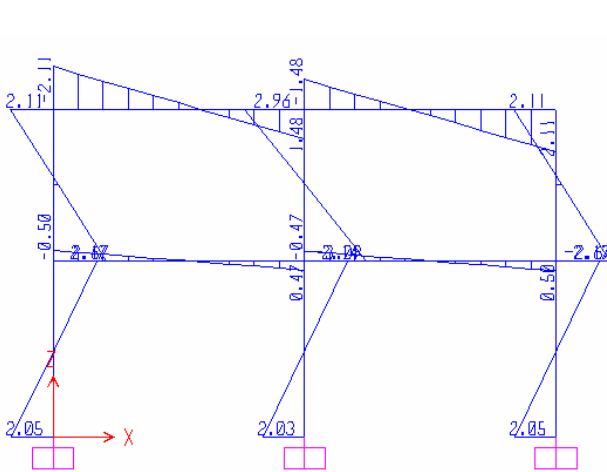
Multivalued Options  
 Envelope (Range)  
 Time 0.1

Component  
 Axial Force     Torsion  
 Shear 2-2     Moment 2-2  
 Shear 3-3     Moment 3-3

Scaling  
 Auto  
 Scale Factor

Options  
 Fill Diagram  
 Show Values on Diagram  
 Show Deformed Shape

OK Cancel



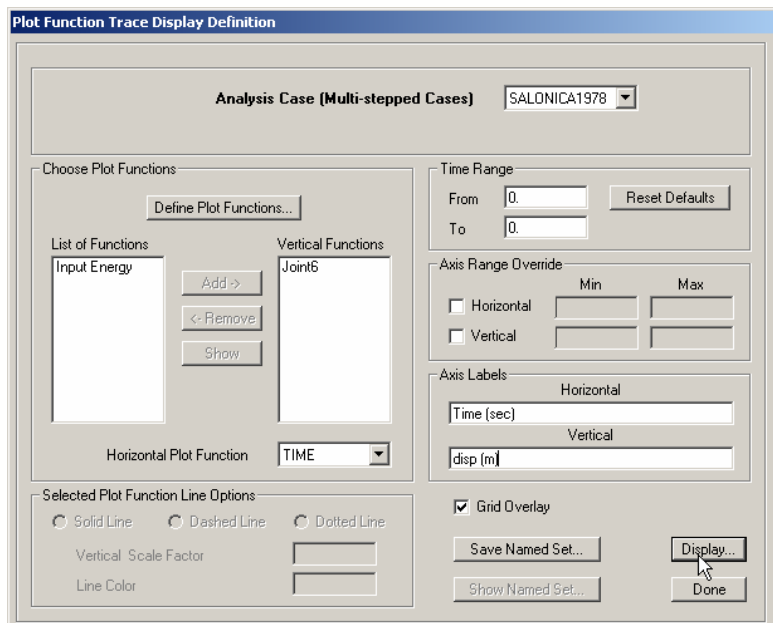
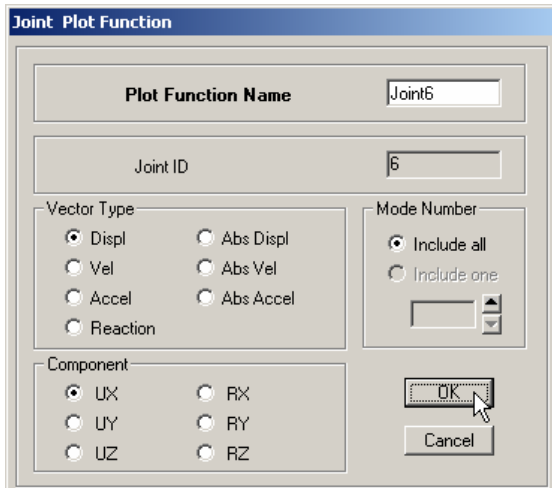
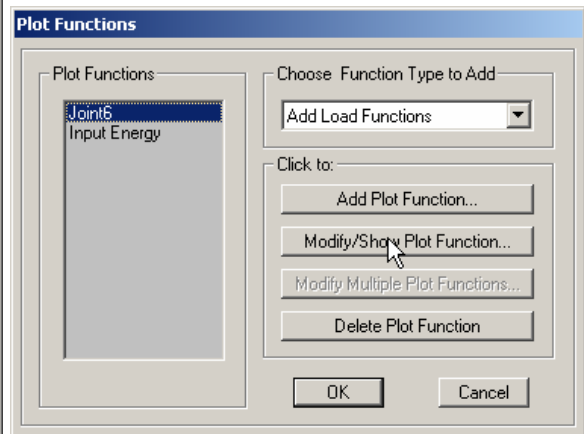
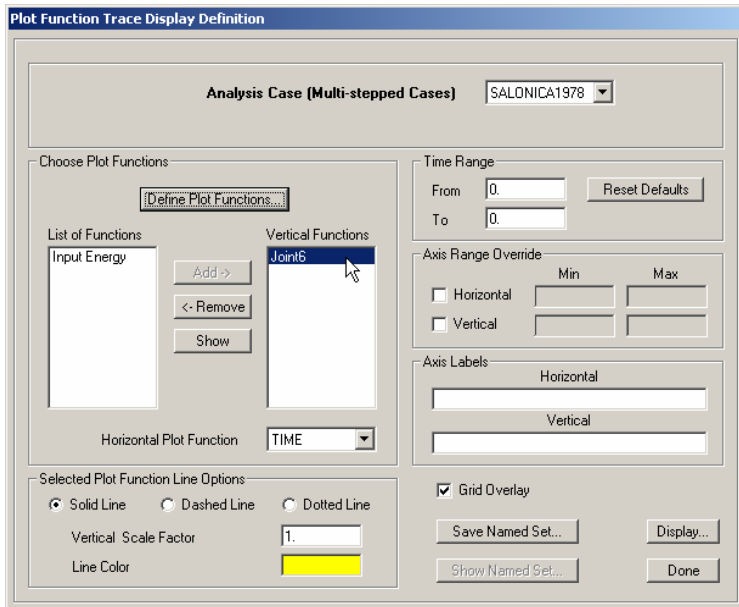
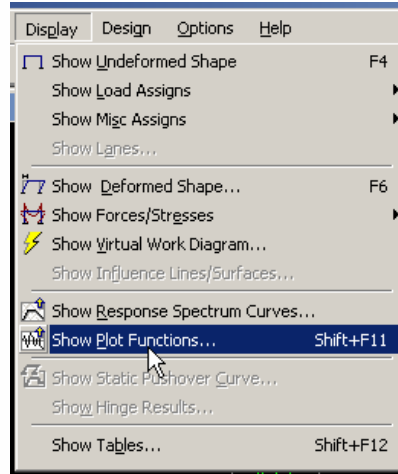
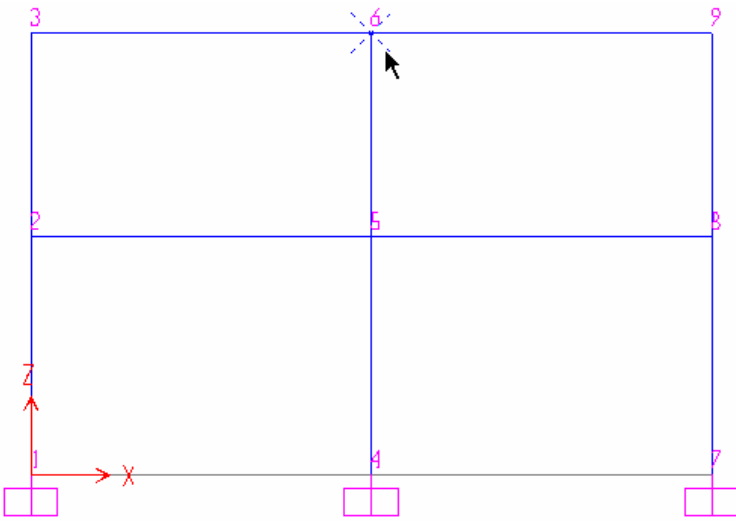
μ

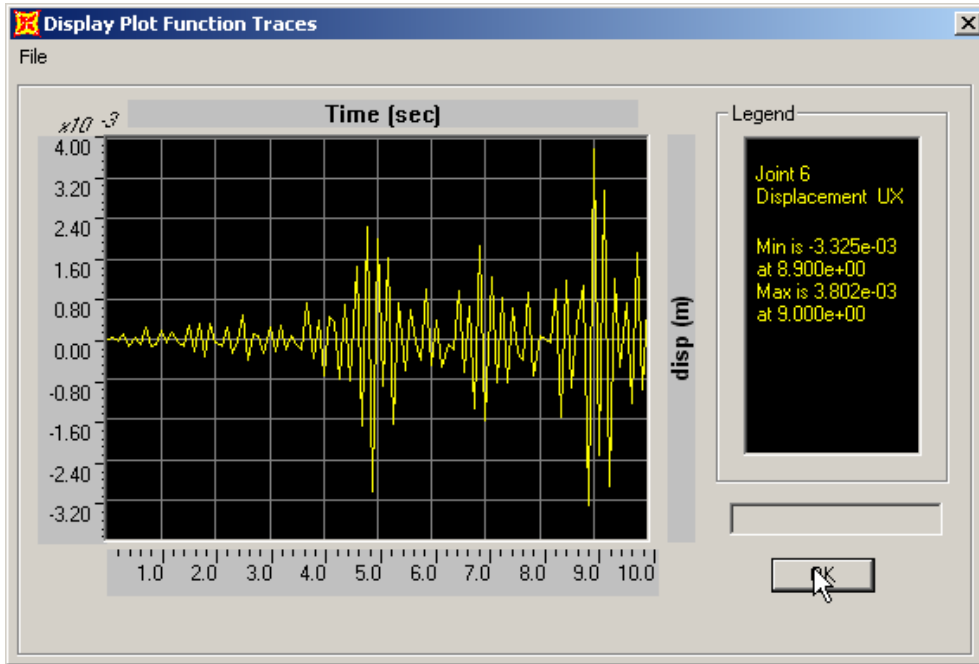
μ

μ

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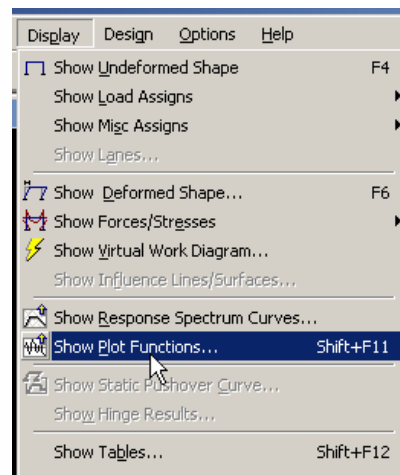
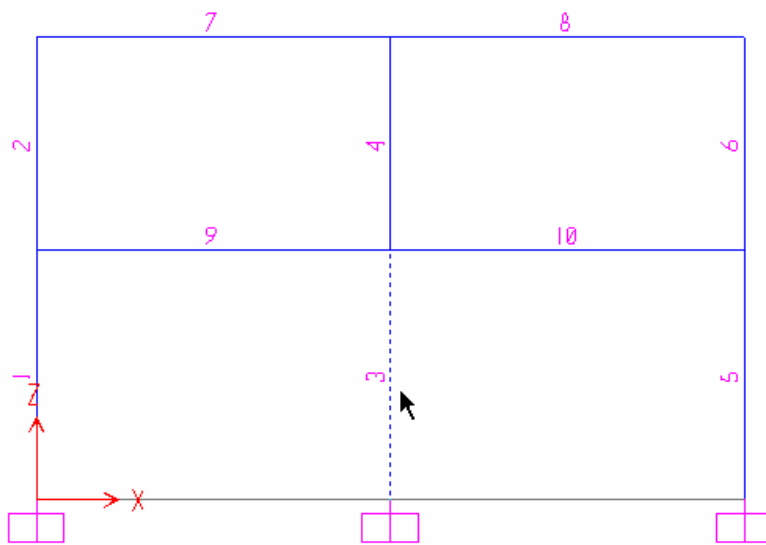
$\mu$

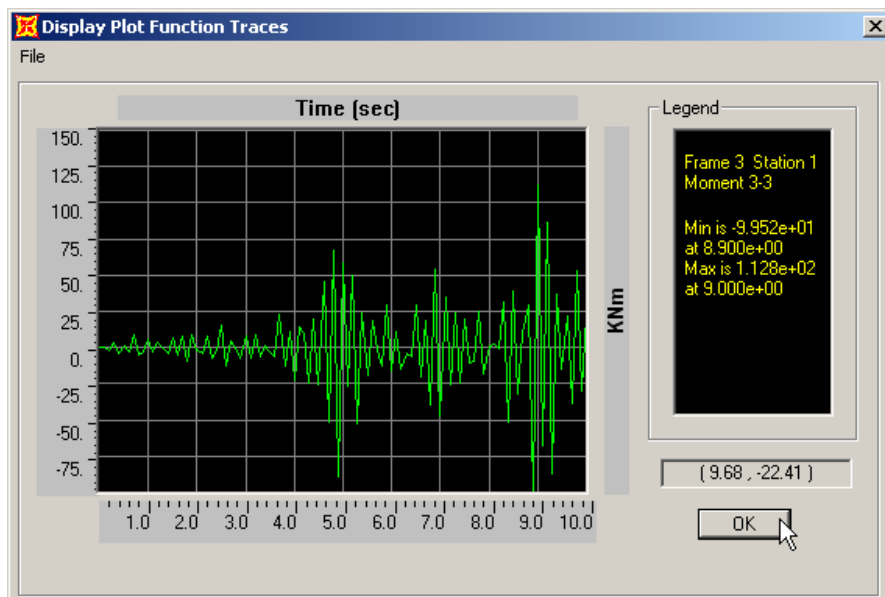
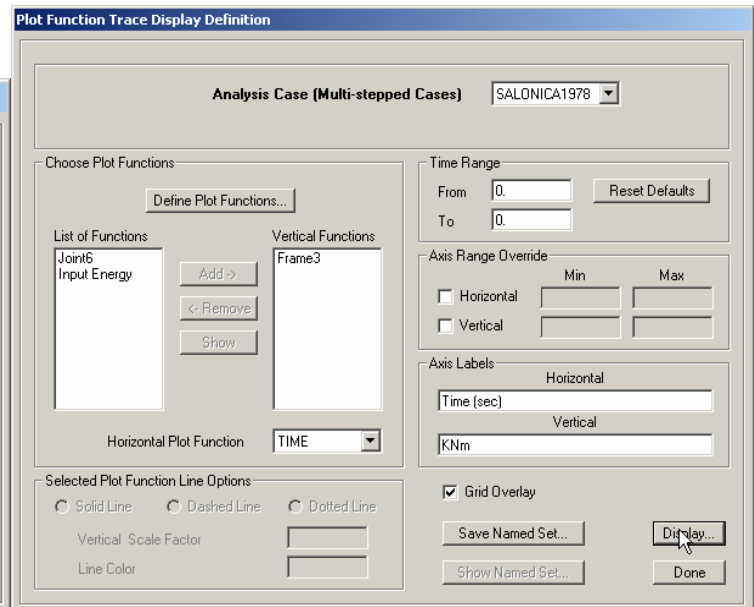
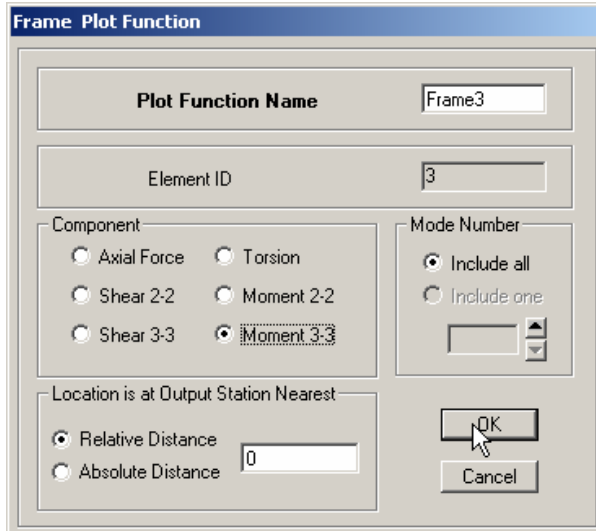
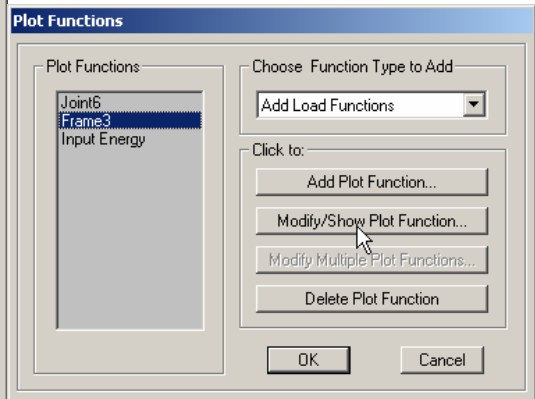
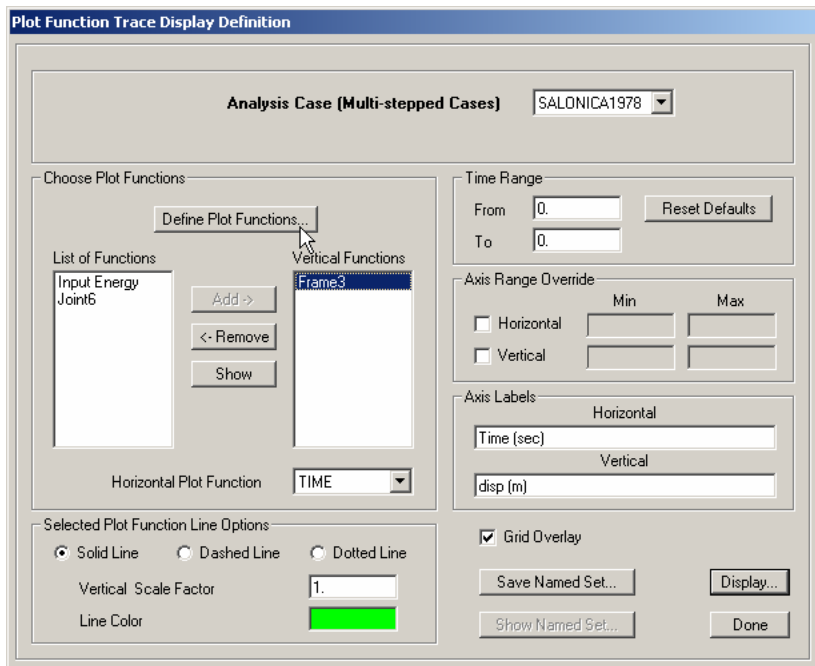




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# μ “Animation”

