

ETABS

Three Dimensional
Static and Dynamic
Analysis and Design
of Buildings



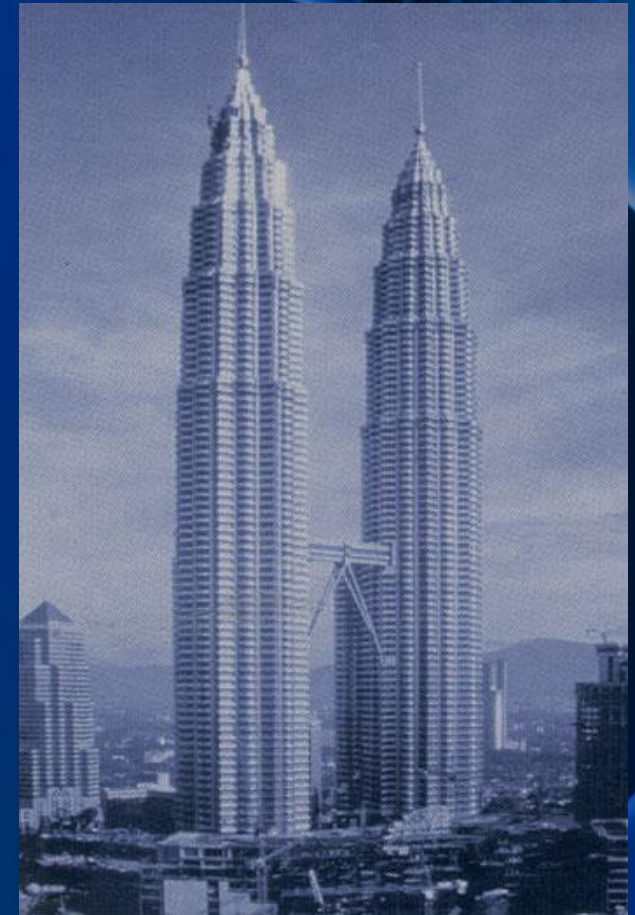
ETABS

**The Most Comprehensive Software for the
Modeling, Analysis and Design of
Buildings**

Key Features

Key Features

- Fully integrated interface within Windows 95/98/NT/2000
- Optimized for modeling of multistory buildings
- 3D perspective, plan, elevation, developed elevation, and custom views
- 3D model generation using plans and elevations
- CAD drawing/editing for fast, intuitive framing layout

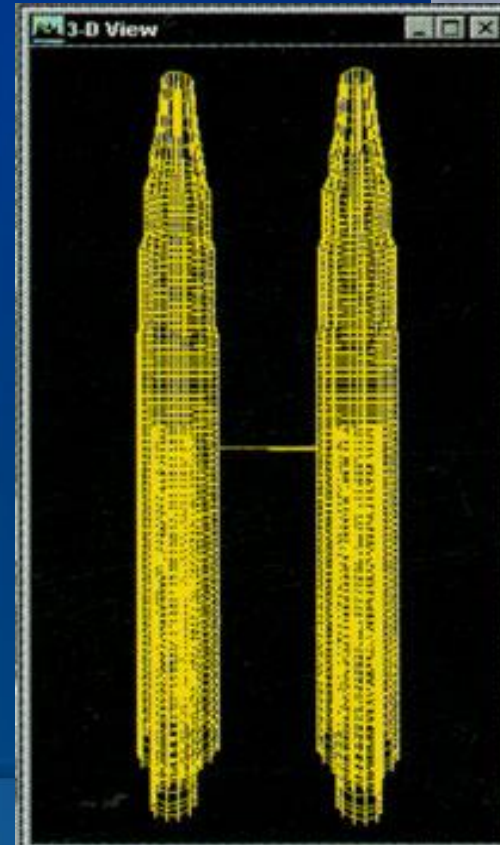


- **Extensive Analysis Capabilities**
 - *Linear Static Analysis*
 - *Linear Dynamic Analysis*
 - *Static and Dynamic P-Delta Analysis*
 - *Static Non-Linear Analysis*
 - *Dynamic Non-Linear Analysis*
 - *Pushover Analysis*
 - *Multiple Response Spectrum Analysis*
 - *Multiple Time History Analysis*
 - *Construction sequence loading analysis*

Key Features

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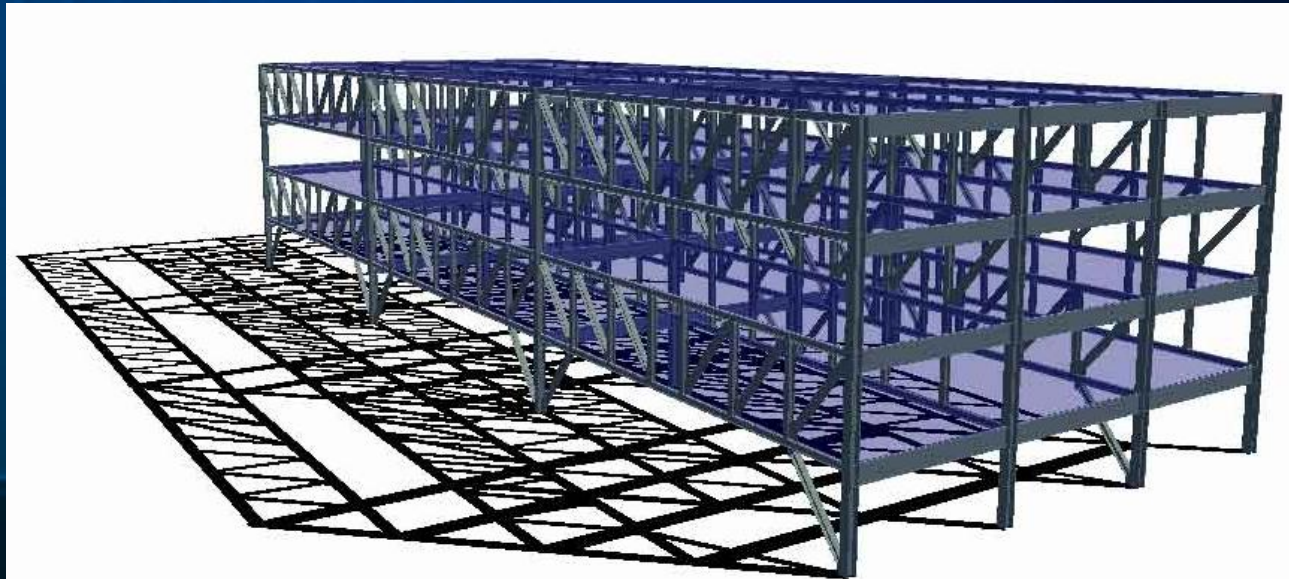
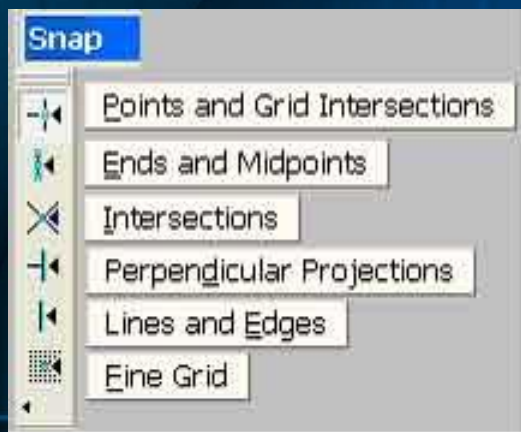
- **Fast generation of model using the concept of similar stories**
- **Automated templates for typical structures**
- **Easy editing with move, merge, mirror and replicate**



Key Features

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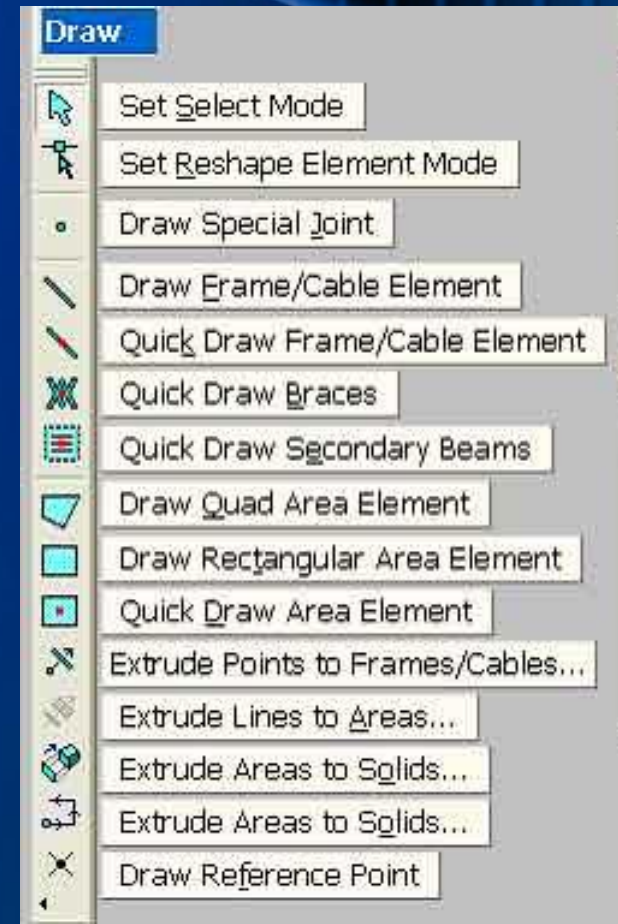
- **Multiple views in 3D perspective with zooming and snapping**
- **Onscreen assignment of properties, loading and supports**
- **Powerful grouping, selection and Display options**
- **Cut, copy and paste options**



Key Features

- **Unlimited levels of undo and redo**
- **Cut/Paste geometry to and from spreadsheets**
- **Import and export of .DXF file for model geometry**
- **Detailed context-sensitive online help**
- **Analysis integrated with post-processing and design**

Key Features



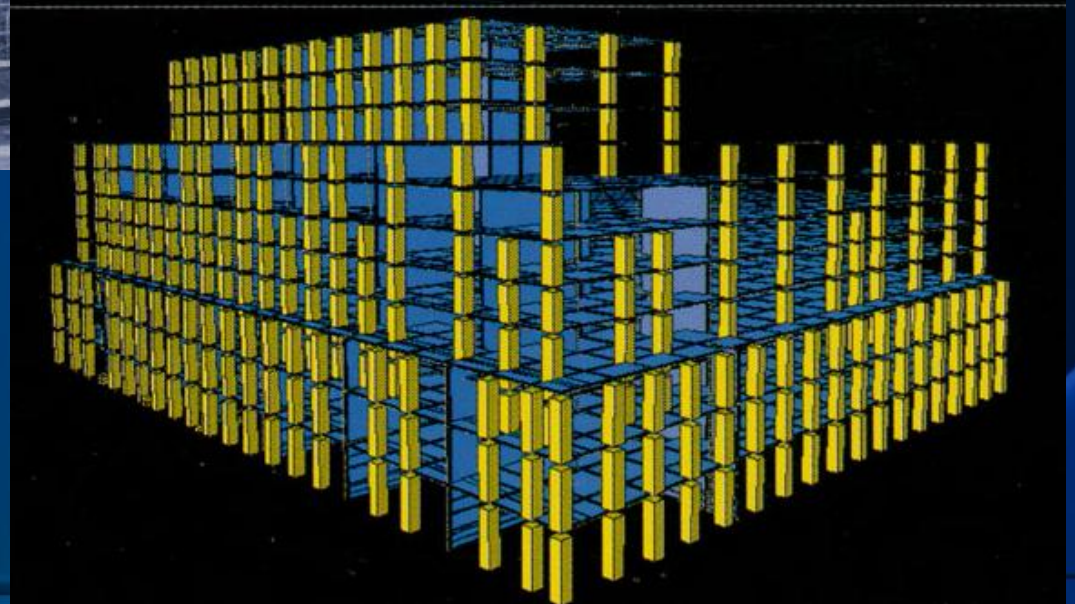
The image features a blue background with a perspective grid of green lines. Two lines of 3D, yellow, blocky text are arranged diagonally from the top-left towards the bottom-right. The top line reads "Interactive Model Creation" and the bottom line reads "Fully Graphical Interface".

Interactive Model Creation

Fully Graphical Interface

Realistic Modeling

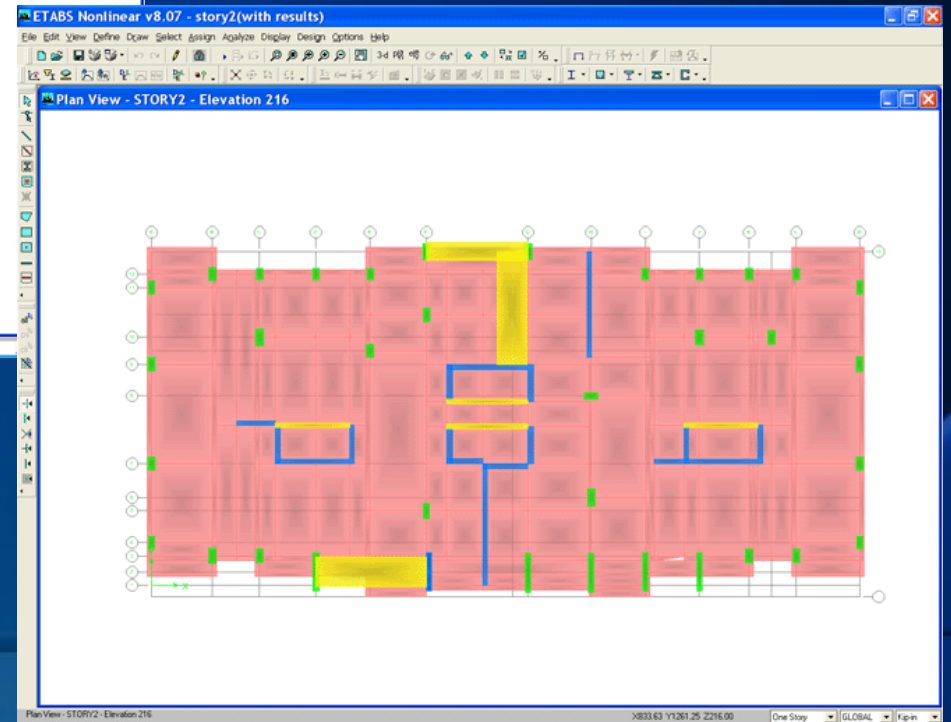
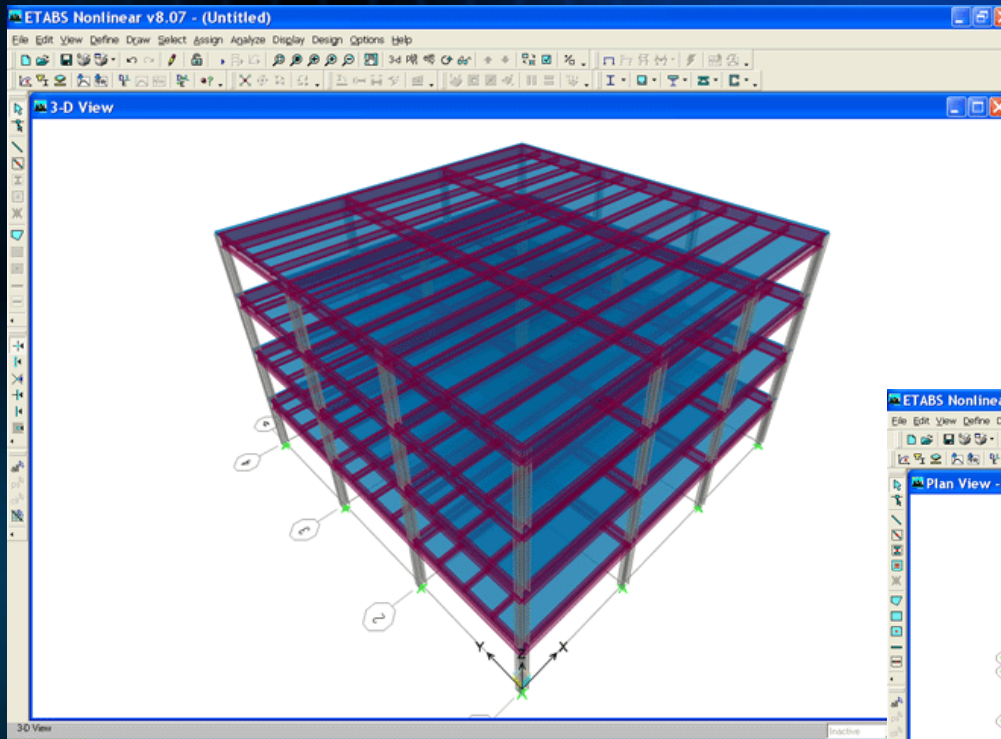
Interactive
Modeling



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Interactive
Modeling

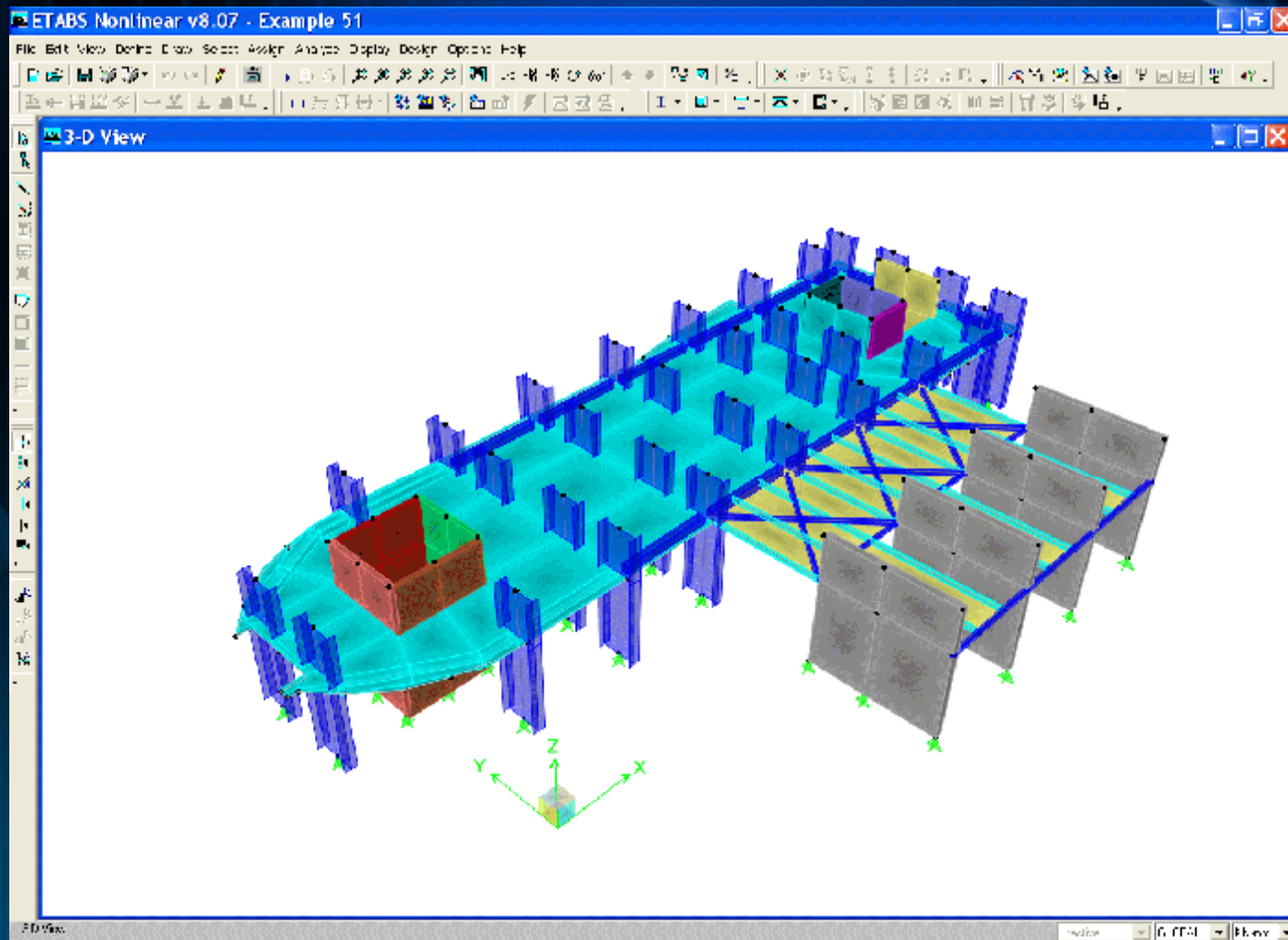
Powerful Viewing Options



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Interactive
Modeling

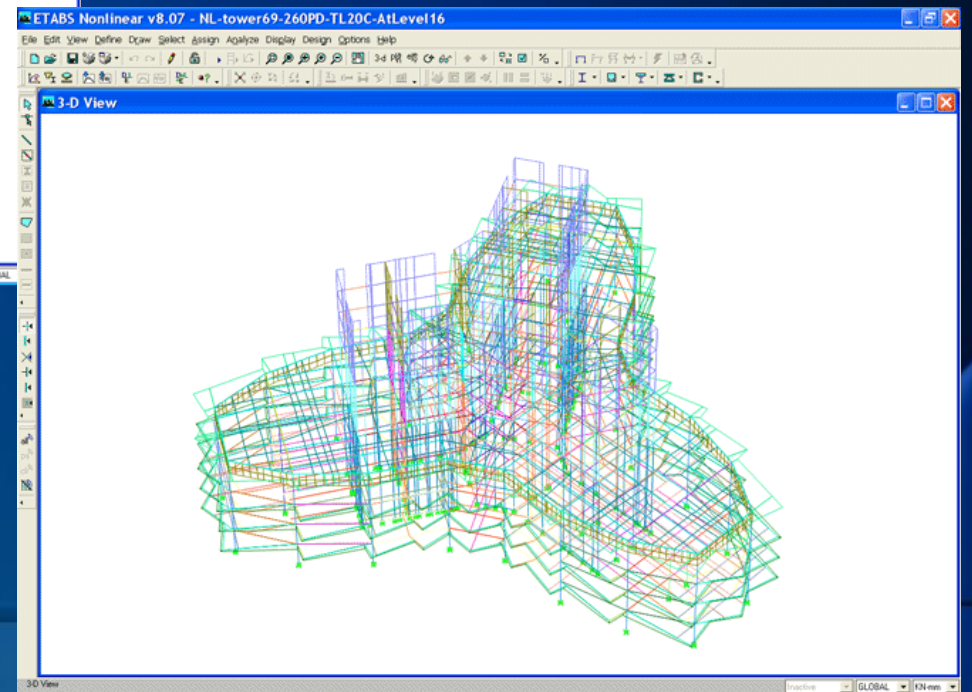
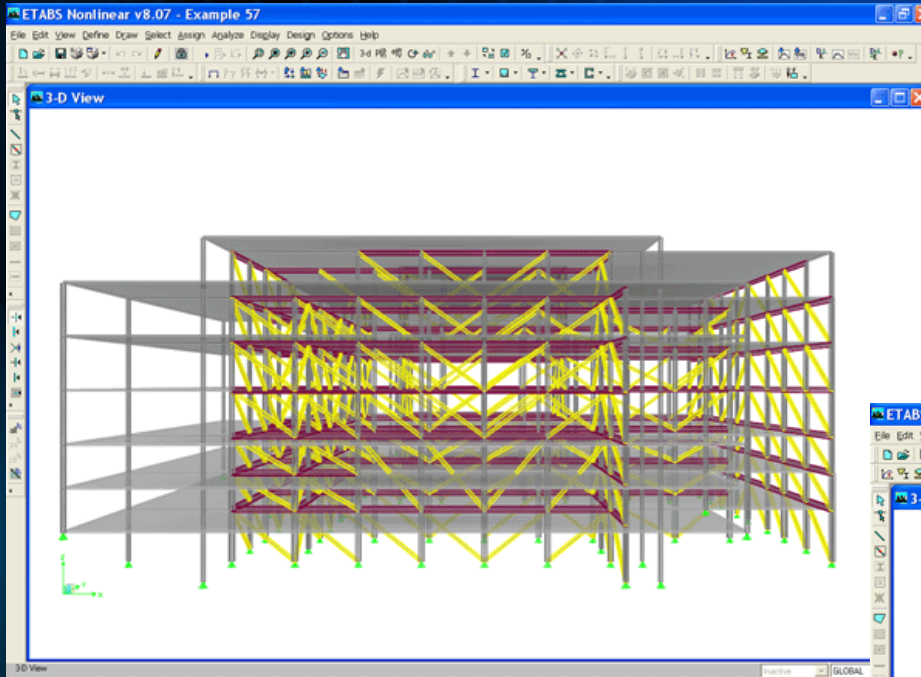
Powerful Viewing Options



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Interactive
Modeling

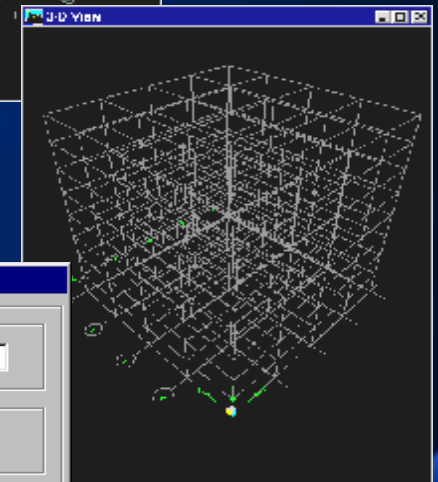
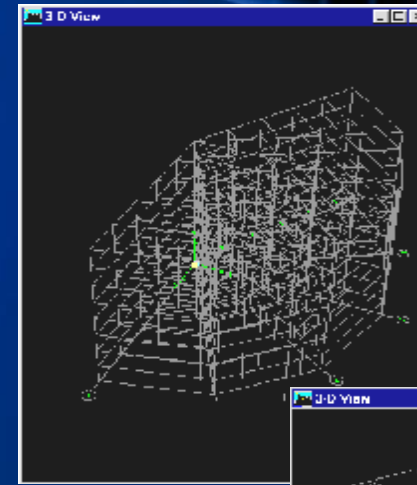
Powerful Viewing Options



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Flexible Grid Systems

- Convenient dividing and meshing of design objects
- Multiple simultaneous rectangular and cylindrical grid systems
- Accurate dimensioning with guidelines and snapping
- Quick-draw options to create objects with one mouse click



Coordinate System Definition

System: CSYS2

Cartesian Cylindrical

Number of Grid Lines:

X Direction: 4

Y Direction: 4

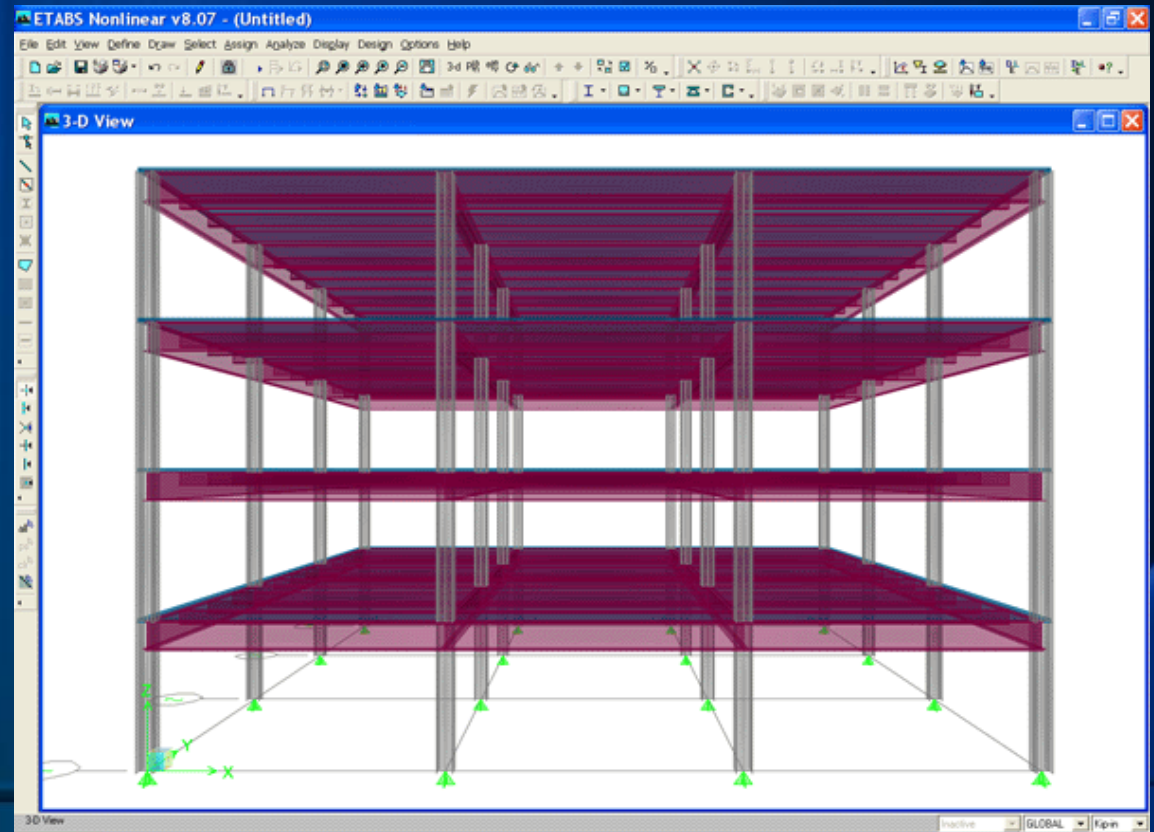
Grid Spacing:

X Direction: 288

Y Direction: 288

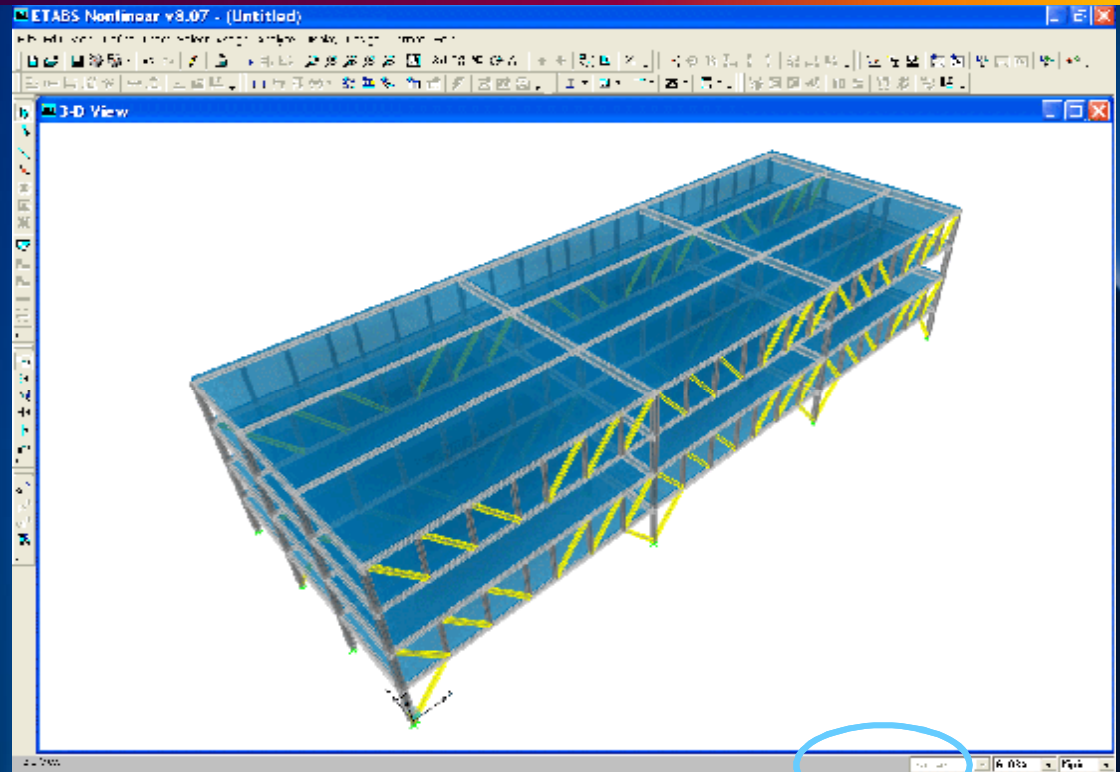
Parametric Templates

- Automated model generation for typical structures using powerful templates
 - *Steel Deck*
 - *Flat Slab*
 - *Two-way Slab*
 - *Waffle Slab*
 - *Ribbed Slab*



"Similar " Story Concept

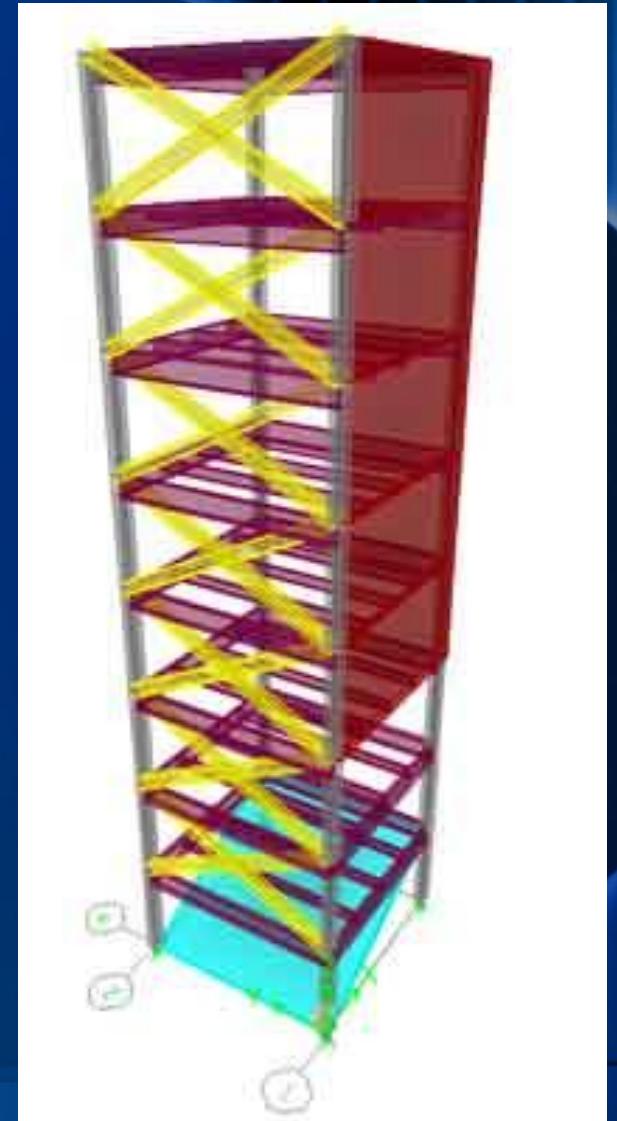
- Time saving Story definitions using the concept of similar Stories
- Common labeling of Objects between similar Stories



Story Data

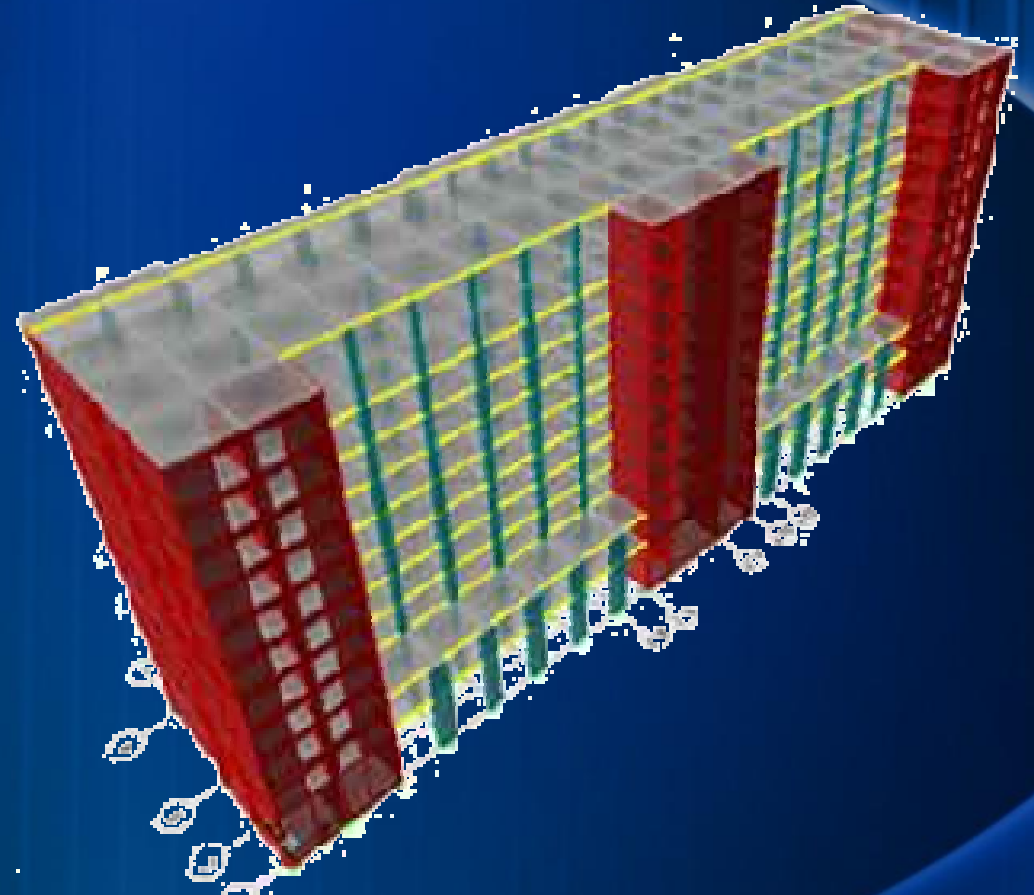
	Label	Height	Elevation	Similar To
9	STORY8	144.	1152.	NONE
8	STORY7	144.	1008.	STORY8
7	STORY6	144.	864.	STORY8
6	STORY5	144.	720.	STORY8

- **Area objects for**
 - *Walls, Slabs/Decks, Opening, Springs, Mass, Loads*
- **Line objects for**
 - *Columns, Beams, Braces, Links, Springs, Mass, Loads*
- **Point objects for**
 - *Supports, Springs, Mass, Loads*



Rigid Diaphragm Concept

- **Define Rigid Diaphragms to effectively model floor slabs and to constrain deformations**



Extensive Section Database

Interactive
Modeling

- **Built-in database of steel sections**

c:\computers and structures\etabs nonl

Section Type:

Section Labels

- W44X285
- W44X248
- W44X224
- W44X198
- W40X328
- W40X298
- W40X268
- W40X244
- W40X221
- W40X192
- W40X165
- W40X142
- W40X117
- W40X99
- W40X86
- W40X74
- W40X62
- W40X54
- W40X46
- W40X38
- W40X30
- W40X22
- W40X14
- W40X11
- W40X9
- W40X7
- W40X5
- W40X3
- W40X1

I/Wide Flange Section

Section Name:

Extract Data from Section Property File

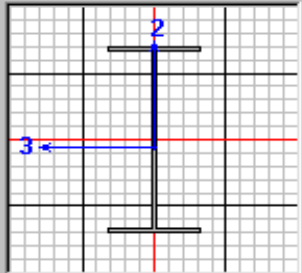
Properties:

Material:

Dimensions

Outside height (t3)	<input type="text" value="3.1833"/>
Top flange width (t2)	<input type="text" value="1.4758"/>
Top flange thickness (tf)	<input type="text" value="0.0692"/>
Web thickness (tw)	<input type="text" value="0.0592"/>
Bottom flange width (t2b)	<input type="text" value="1.4758"/>
Bottom flange thickness (tfb)	<input type="text" value="0.0692"/>

Display Color:

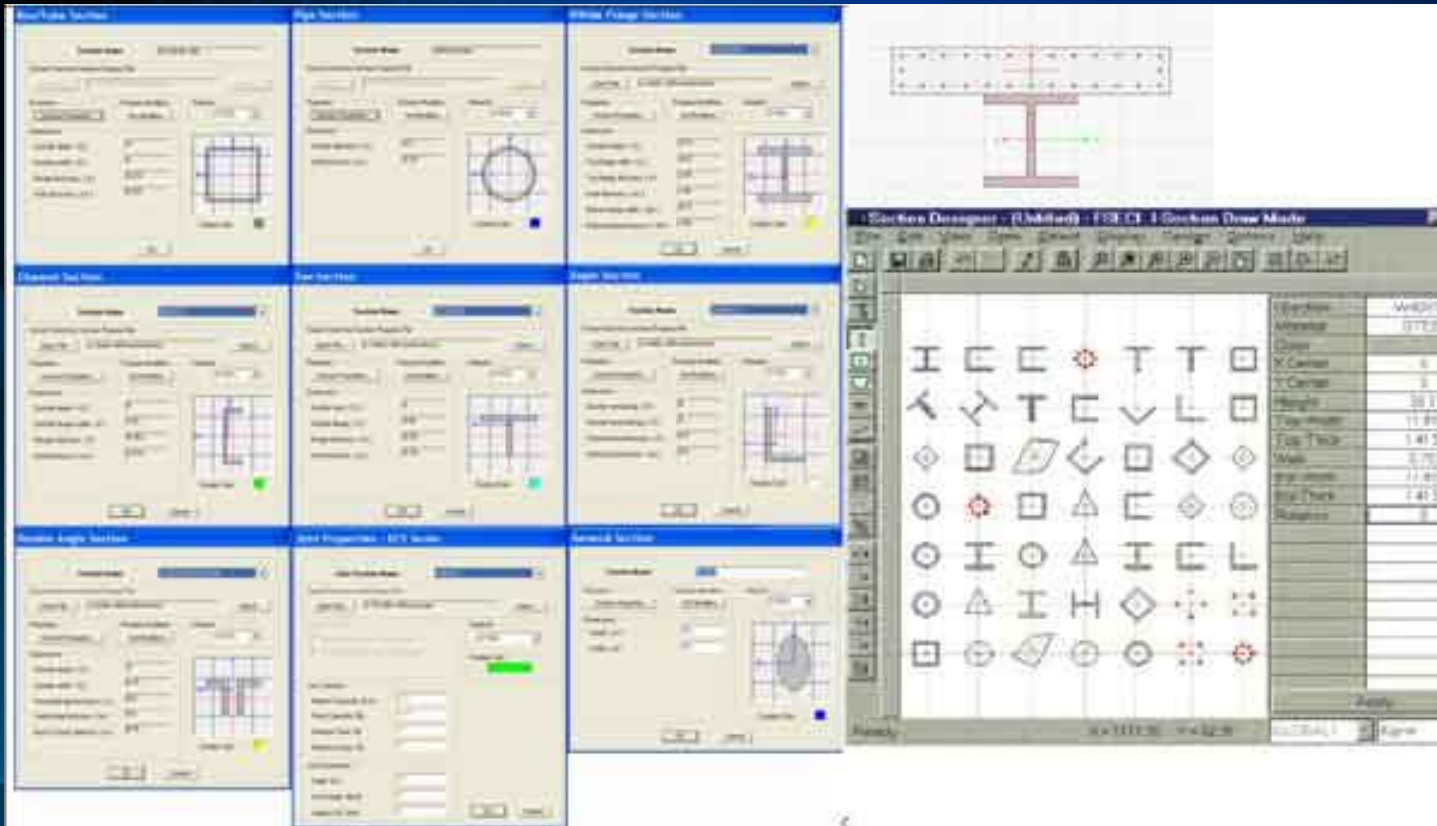


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Interactive
Modeling

Powerful Section Designer

- **Graphical Section Designer for defining custom sections**

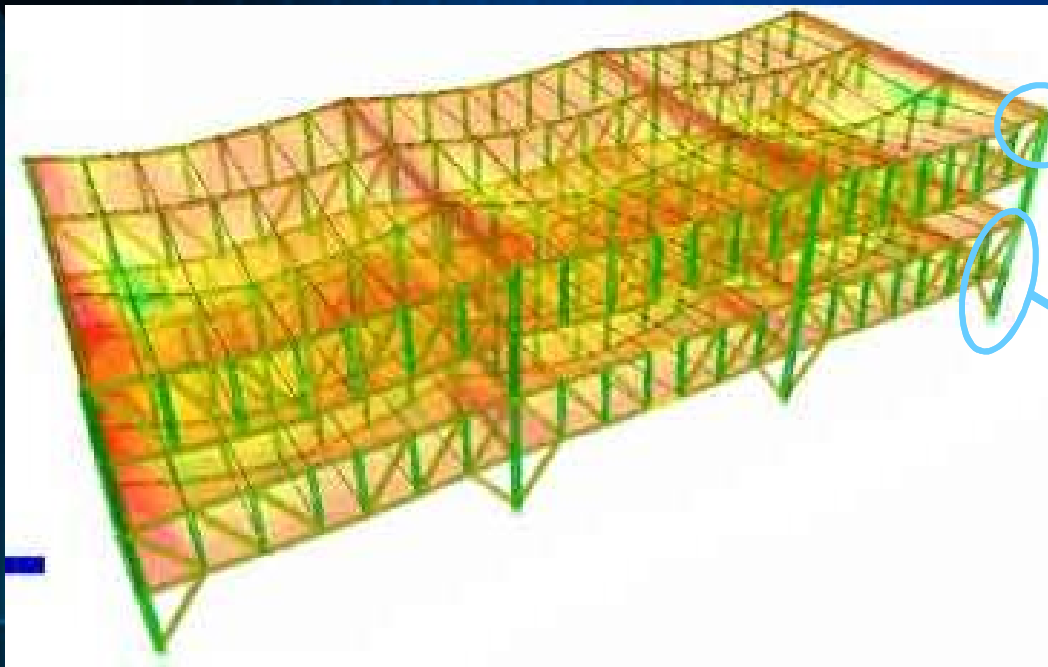


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Feedback and Information

Interactive Modeling

- Right button click for element or design information
- Customized display of parameters and attributes



Point Information

Location | Assignments | Loads

Identification

Label: 19

Story: STORY8

X	816.
Y	-6.
Delta Z	0.
Connectivity	
Area	F18
Area	F19

Line Information

Location | Assignments | Loads

Identification

Label: C4

Story: STORY8

Line Type: [C]

Design Procedure: [C]

Section Property	CSEC1
Releases	None
Partial Fixity Springs	None
End Length Offsets	Automatic
End I Length Offset	0.
End J Length Offset	0.
Rigid Zone Factor	0.
Joint Offsets	None
Min. Number Stations	3
Local axis 2 Angle	Default
Property Modifiers	None
Link Properties	None
Nonlinear Hinges	None
Pier	No
Spandrel	No
Line Springs	None
Line Mass	None

Building Loads

Interactive Modeling

- No limit on number of independent load cases
- Gravity loads specified as point, line or area loads
- Wind and Seismic Load Generator for several codes

Define Static Load Case Names

Load	Type	Self Weight Multiplier	Auto Lateral Load
WINDY	WIND	0	ASCE 7-88
DEAD	DEAD	1	
LIVE	LIVE	0	
SUPERDL	SUPER DEAD	0	
WINDX	WIND	0	ASCE 7-88
WINDY	WIND	0	ASCE 7-88
EQX	QUAKE	0	UBC 97 Isolated
EQY	QUAKE	0	UBC 97 Isolated
SNOW	SNOW	1	

Click To:

Add New Load

Modify Load

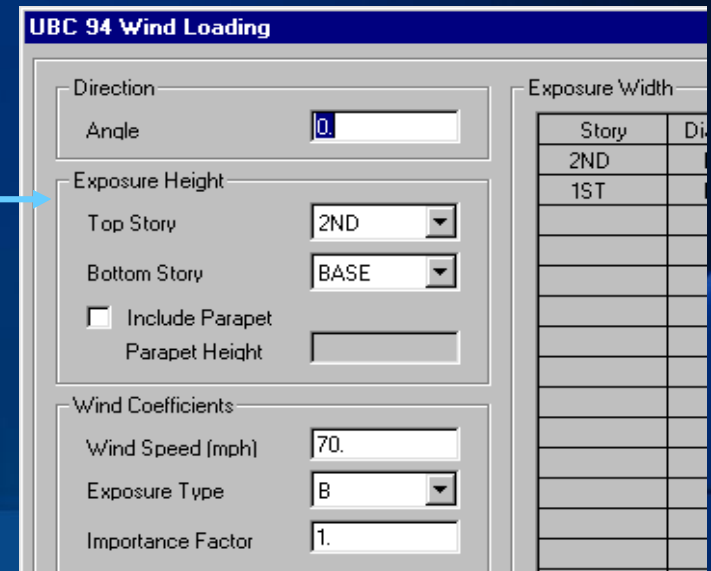
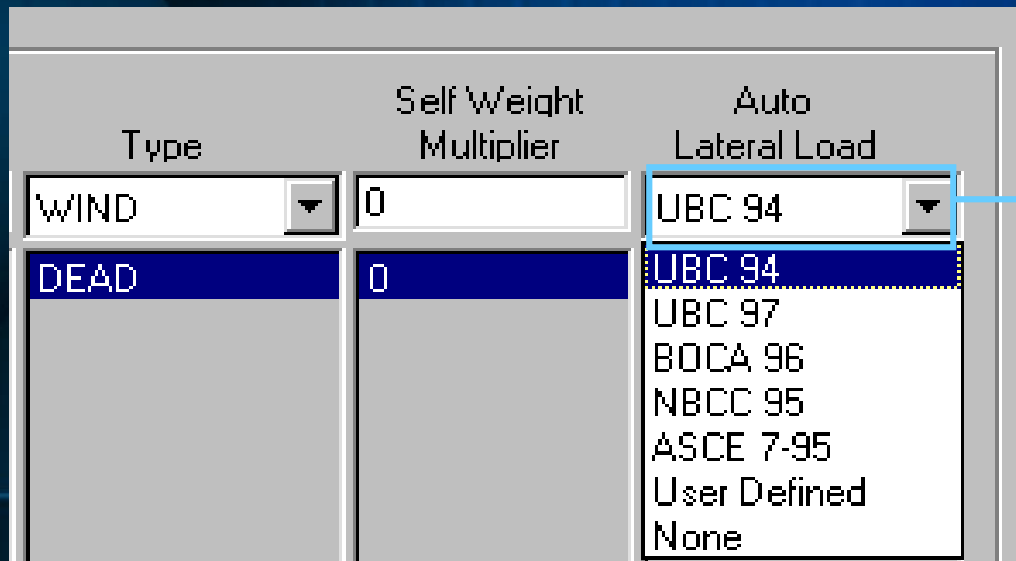
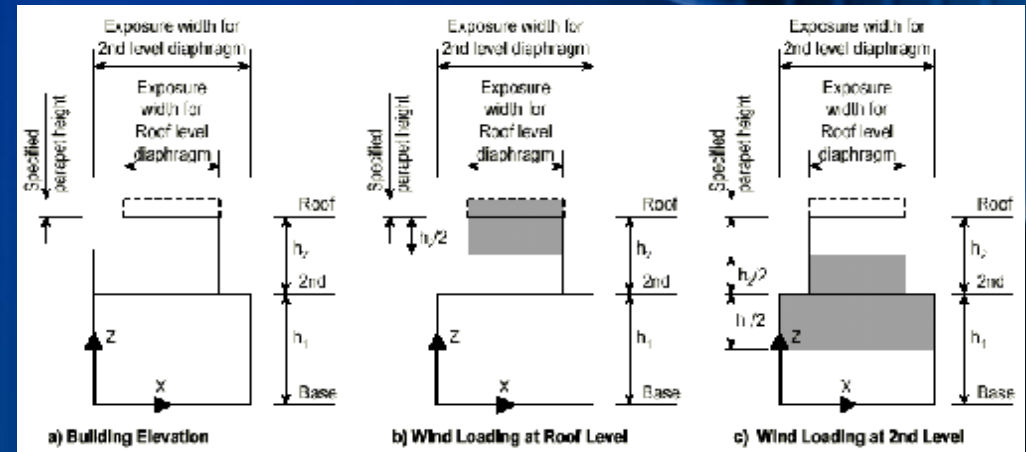
Modify Lateral Load...

Delete Load

OK

Cancel

- Automatic wind load generation
 - *UBC, BOCA, ASCE, NBCC*



- **Automatic Seismic Load Generation**
– *UBC, BOCA, NBCC*

Type	Self Weight Multiplier	Auto Lateral Load
QUAKE	0	UBC 94
QUAKE	0	UBC 94
		UBC 97
		UBC 97 Isolated
		BOCA 96
		NBCC 95
		IBC 2000
		NEHRP 97
		User Defined

1994 UBC Seismic Loading

Directional Data

Direction and Eccentricity

X Dir Y Dir

X Dir + Eccen Y Y Dir + Eccen X

X Dir - Eccen Y Y Dir - Eccen X

% Eccen (all Diaphragms)

Override Eccentricities

Time Period

Method A Ct =

Program Calculated Ct =

User Defined T =

Story Range

Top Story

Bottom Story

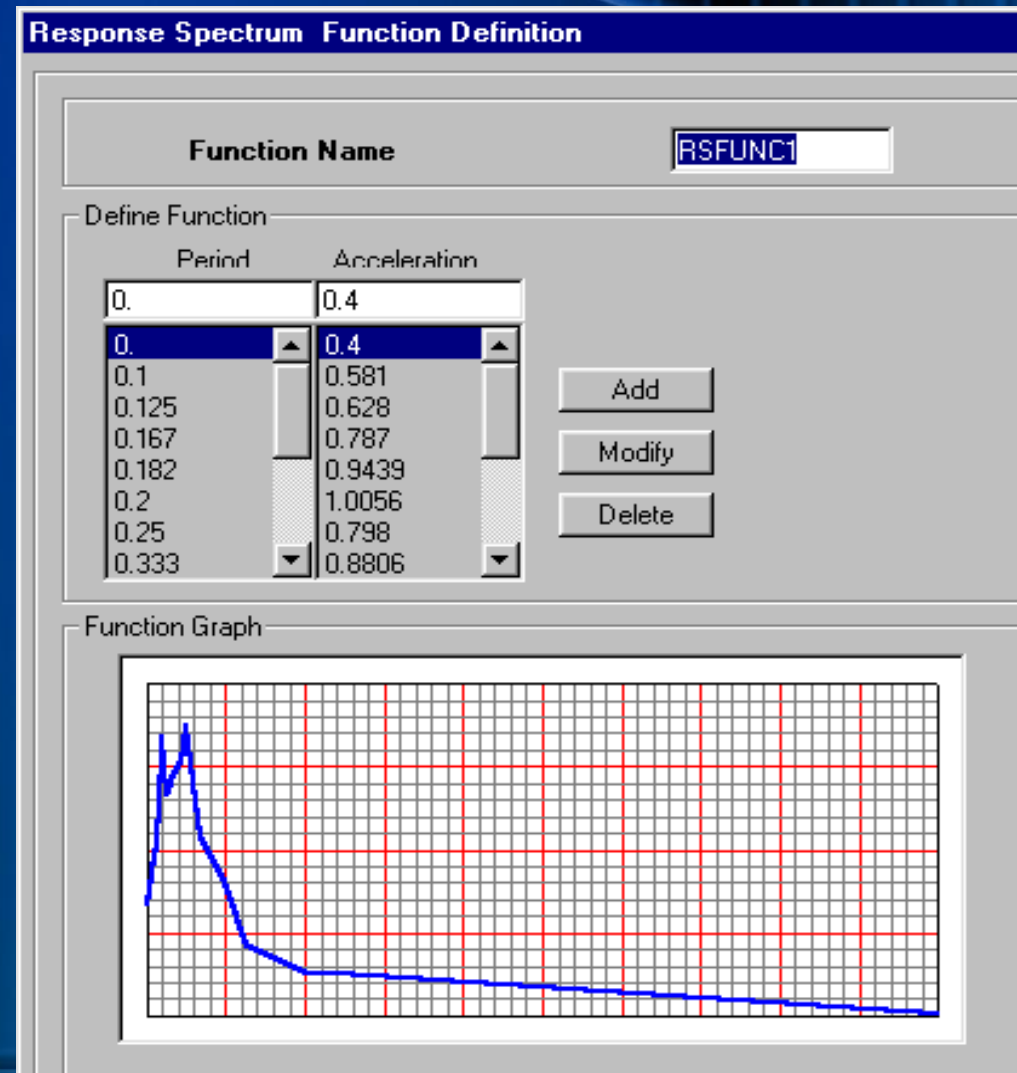
Factors

Numerical Coefficient, R_w

Building Loads

Interactive Modeling

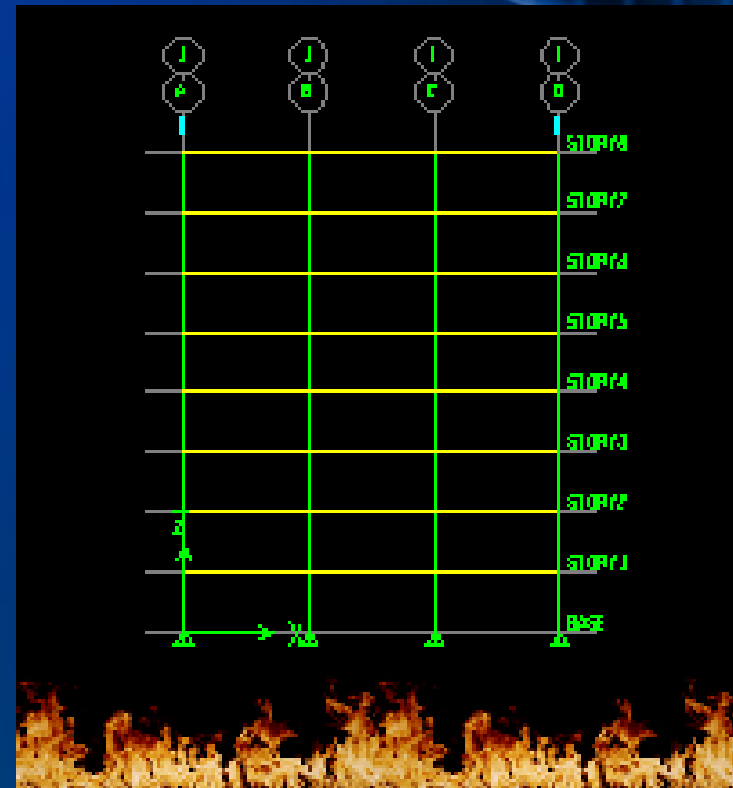
- Built-in response spectrum and time history input
- User-defined response spectrum functions
- User defined time history functions



Building Loads

Interactive Modeling

- Temperature and thermal-gradient loads
- Algebraic, absolute, SRSS, and enveloping load combination
- Mass directly specified or calculated from gravity load





Modeling Elements

Beams, Columns, Walls, Slabs ...

Powerful Object Based Elements

- **Area objects**

- *Walls*
- *Slabs/Decks*
- *Opening*
- *Mass*
- *Loads*

- **Lines objects**

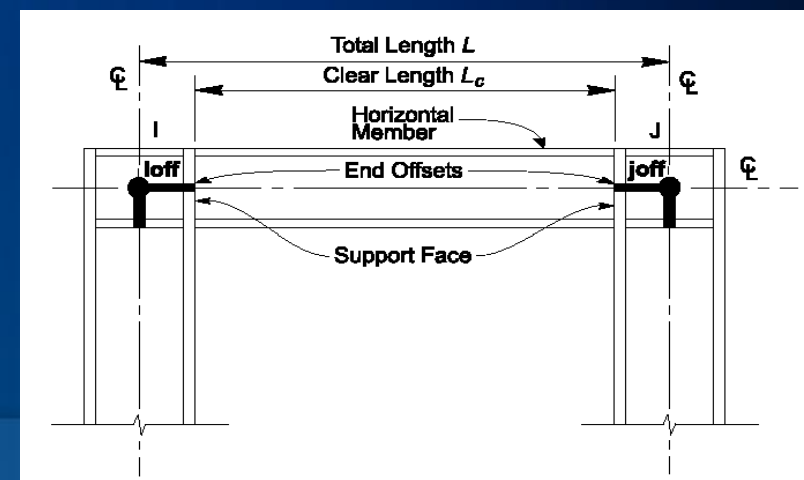
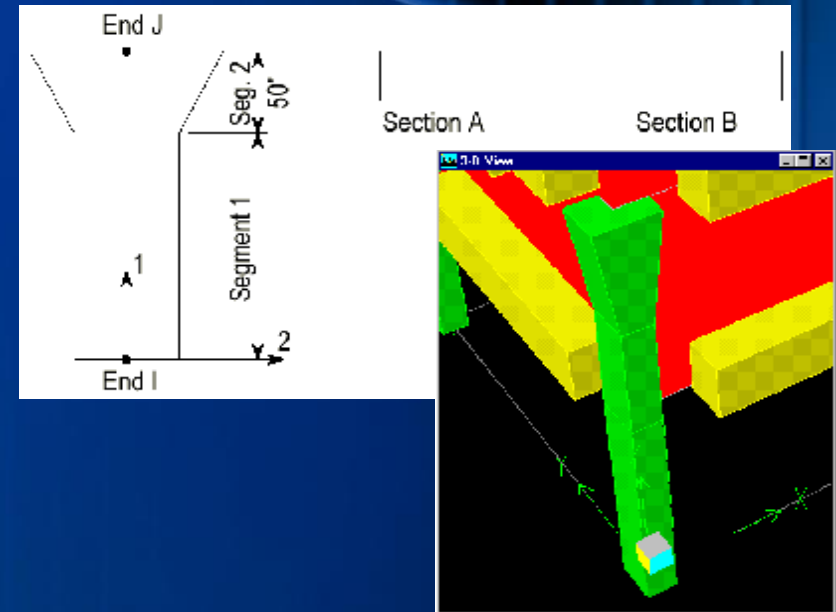
- *Columns*
- *Beams*
- *Braces*
- *Links*
- *Springs*
- *Mass*
- *Loads*
- *Plastic Hinge*
- *Non-linear Link*

- **Point objects**

- *Supports*
- *Springs*
- *Mass*
- *Loads*

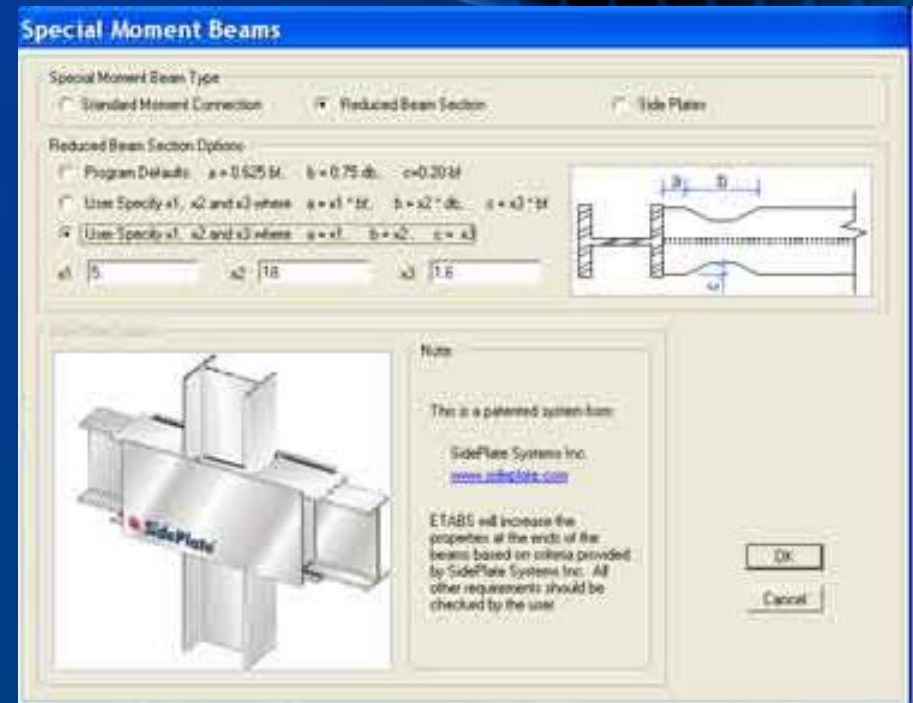
Beam, Column and Brace Elements

- Axial, bending, torsional and shear deformations
- Multiple non-prismatic segments over element length
- Ends offset from reference nodes in any direction
- Automated evaluation of offsets for joint size



Beam, Column and Brace Elements

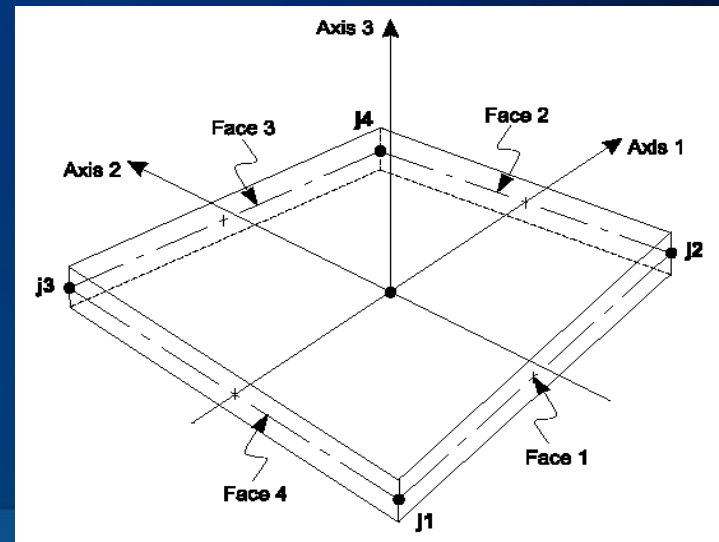
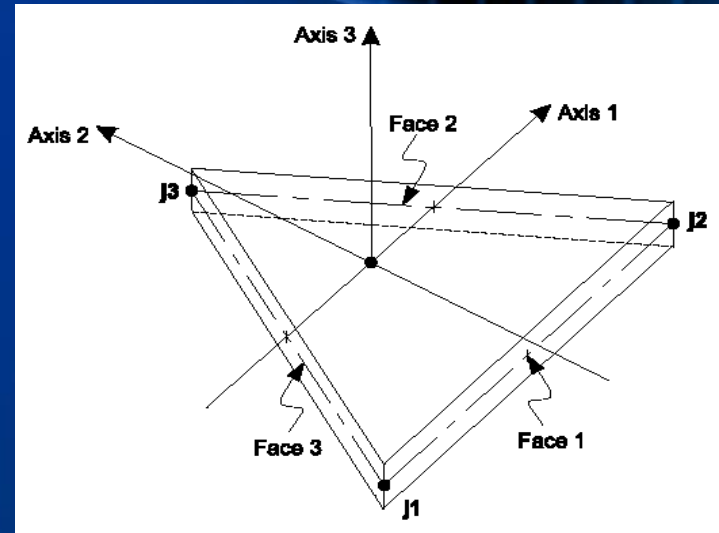
- Moment and shear releases and partial-fixity
- Point, uniform and trapezoidal loading in any direction
- Temperature and thermal-gradient loading



Wall, Slab, Deck Elements

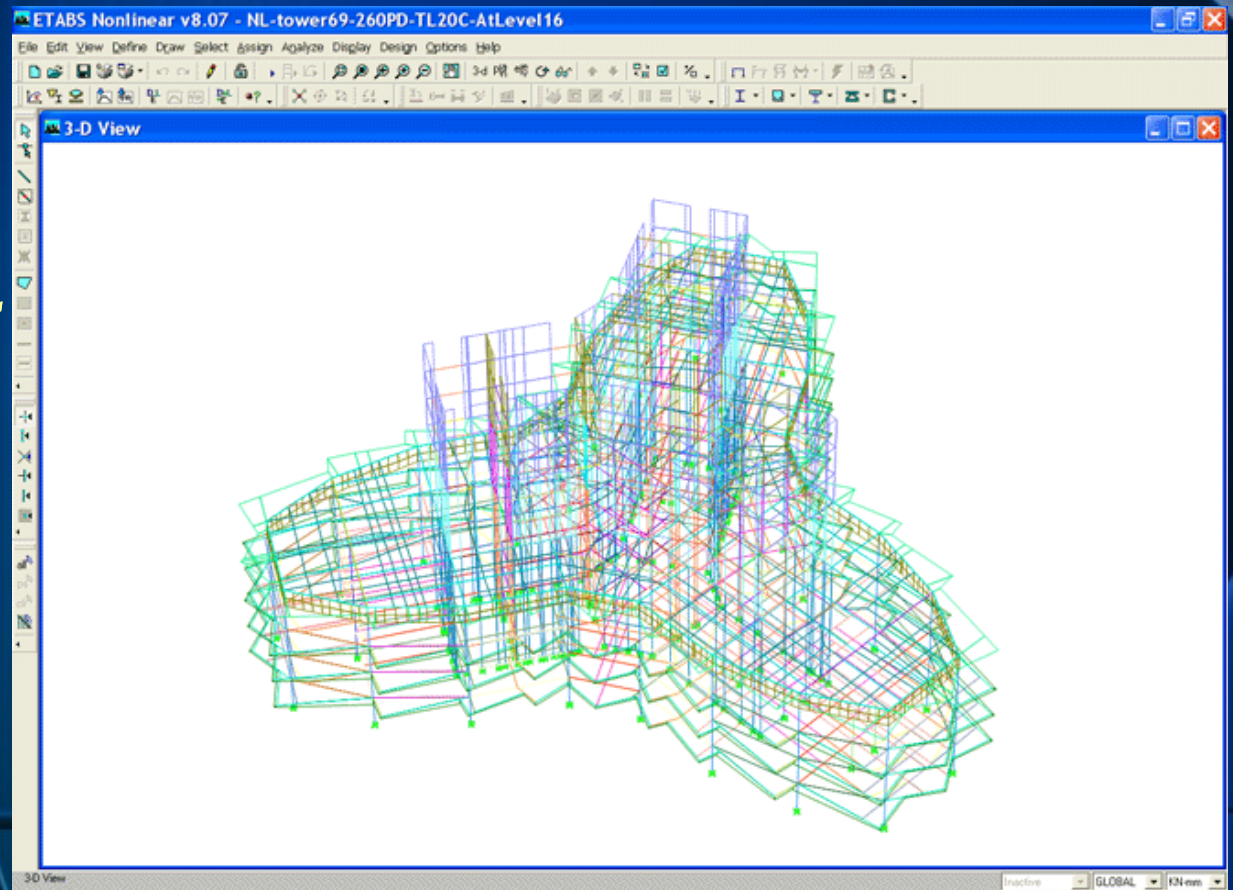
Modeling Elements

- Shell, plate or membrane action
- General quadrilateral or triangular element
- Six degree of freedom per joint
- Uniform load in any direction
- Temperature and thermal-gradient loading

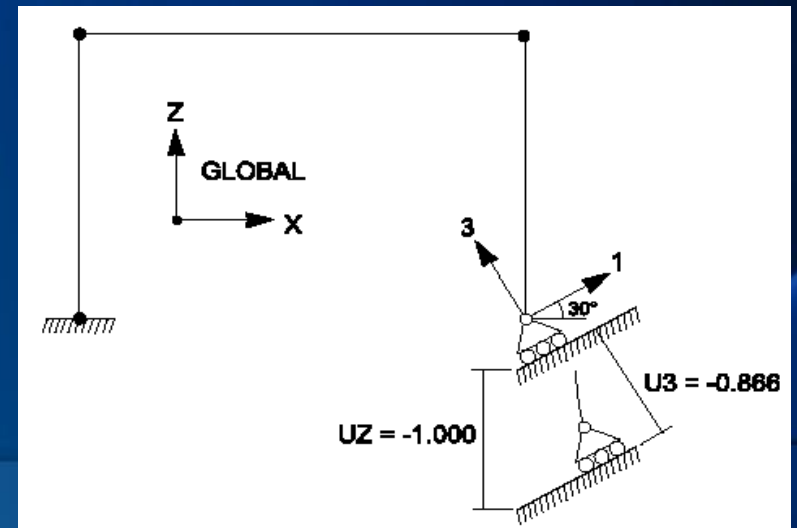
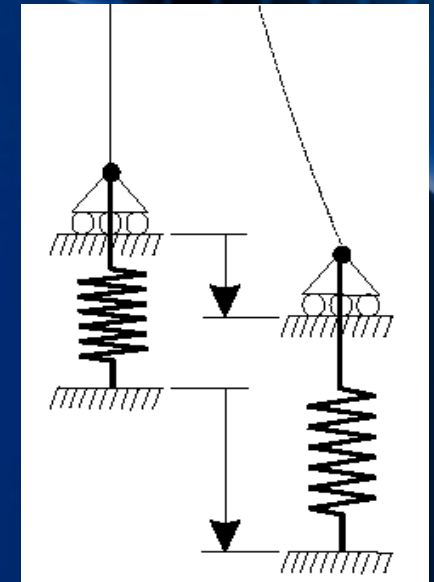


Wall, Slab and Deck Elements

- Use these Elements to Model
 - *Shear Walls*
 - *Bearing Walls*
 - *Wall Panels*
 - *Concrete Slabs*
 - *Diaphragms*
 - *Metal Decks*



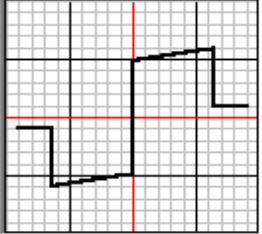
- For modeling of Support
- Coupled or uncoupled grounded springs
- Force loads
- Ground-displacement loads
- Inclined Supports



Plastic Hinge Element

- Used as Spring, Link, Panel zone or inside Frame Elements
- Axial, flexural, shear and torsional behavior
- Axial-load/ biaxial-moment interaction
- Multilinear behavior including softening
- Tabulated and Graphical display of hinge status

Point	Force/SF	Disp/SF
E-	-.2	-8
D-	-.2	-6
C-	-1.25	-6
B-	-1	-1
A	0	0
B	1.	1.
C	1.25	6.
D	0.2	6.
E	0.2	0



Hinge is Rigid Plastic
 Symmetric

Scaling for Force and Disp

	Positive	Negative
<input checked="" type="checkbox"/> Use Yield Force Force SF	<input type="text"/>	<input type="text"/>
<input checked="" type="checkbox"/> Use Yield Disp Disp SF	<input type="text"/>	<input type="text"/>

Acceptance Criteria (Plastic Disp/SF)

	Positive	Negative
Immediate Occupancy	<input type="text" value="2."/>	<input type="text"/>
Life Safety	<input type="text" value="4."/>	<input type="text"/>
Collapse Prevention	<input type="text" value="6."/>	<input type="text"/>

Type

Force - Displacement
 Stress - Strain

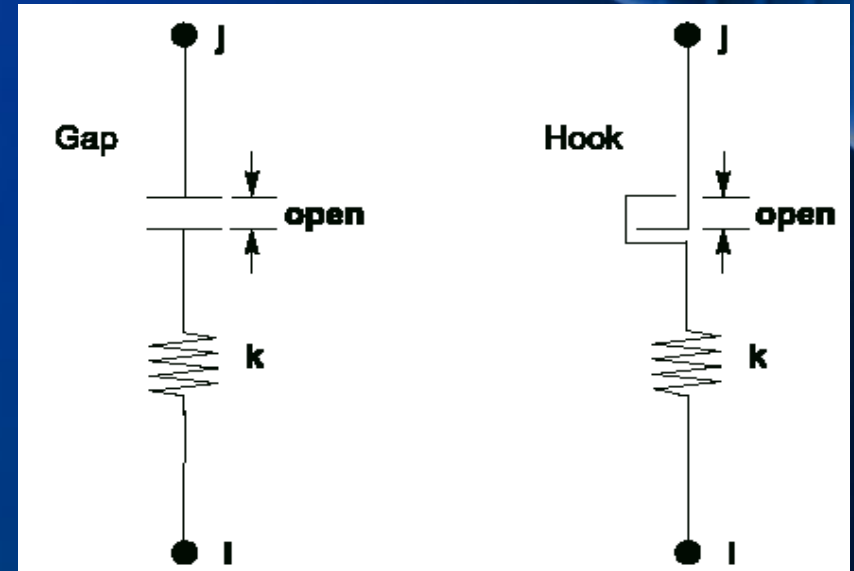
Hinge Length

Relative Length

Nonlinear Link Elements

Modeling Elements

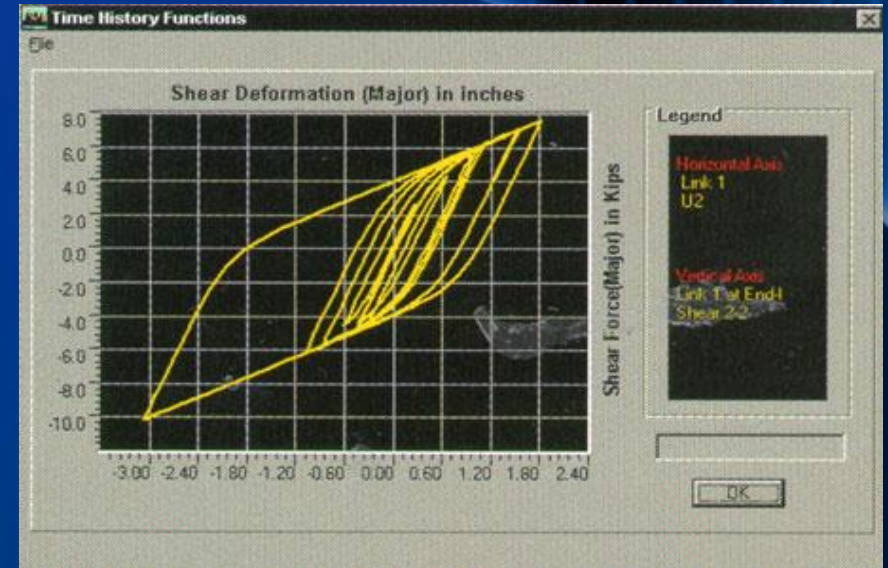
- Used with the **Dynamic Nonlinear Analysis** option
- Used as **Link, Spring or as Panel zone**
- **Viscous damper with nonlinear exponent on velocity term**
- **Gap (compression only) and Hook (tension only)**



Nonlinear Link Elements

Modeling Elements

- **Uniaxial plasticity (all 6 degree of freedom)**
- **Base isolator with biaxial-plasticity behavior**
- **Base isolator with friction and/or pendulum behavior**
- **Force or displacement vs. time plots**
- **Force vs. deformation plots**



Analysis Options

$$[K - \Omega^2 M] \Phi = 0$$

$$Ku(t) + M \ddot{u}(t) = r(t) = p \cos(\nu t)$$

Analysis Options

Main Analysis Options

- Linear Static Analysis
- Linear Dynamic Analysis
- Static and Dynamic P-Delta Analysis
- Static Non-Linear Analysis



Main Analysis Options

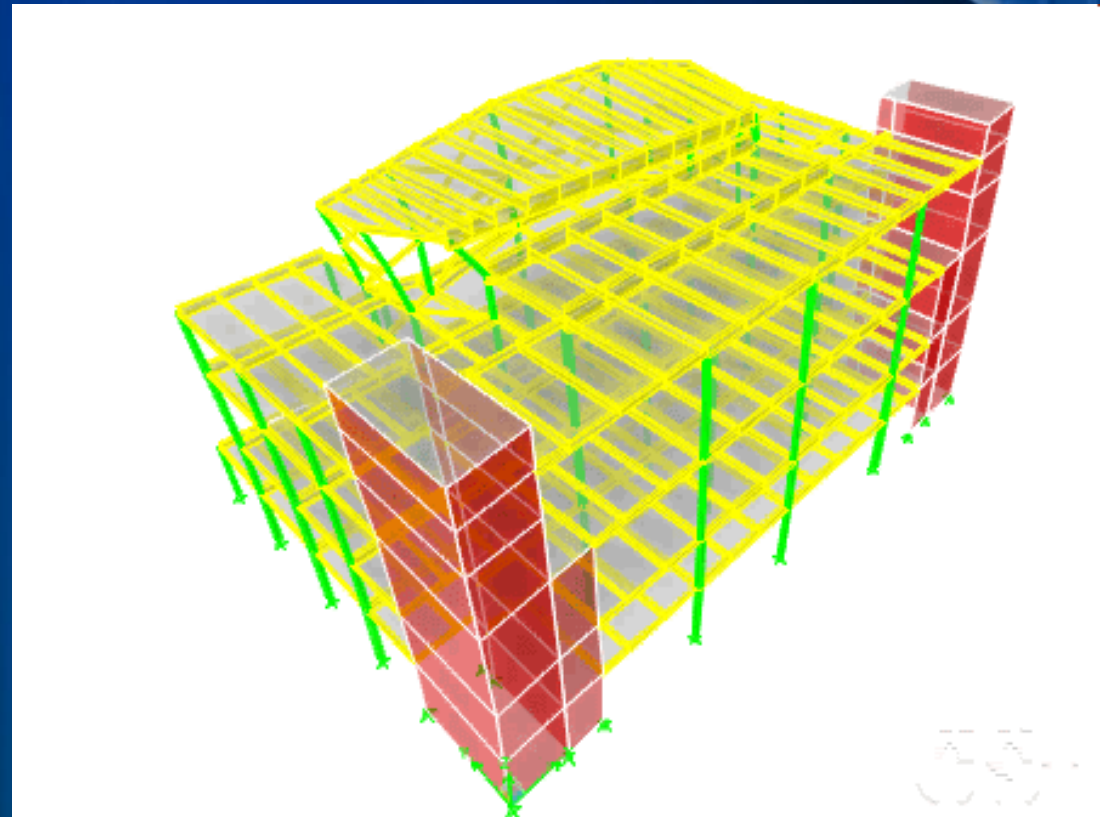
- Dynamic Non-Linear Analysis
- Pushover Analysis
- Multiple Response Spectrum Analysis
- Multiple Time History Analysis
- Construction sequence loading analysis



Special Analysis Options

Analysis Options

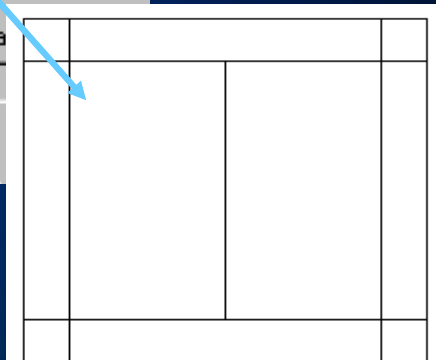
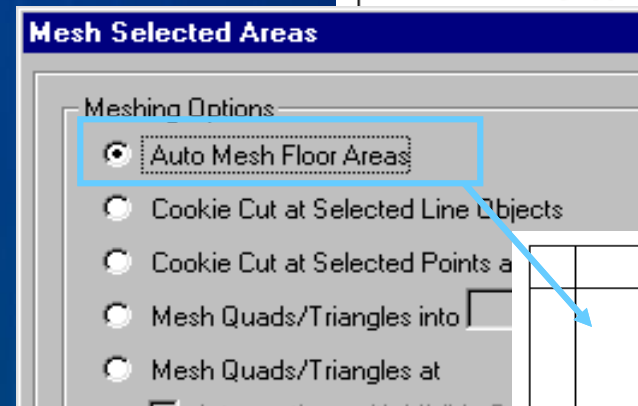
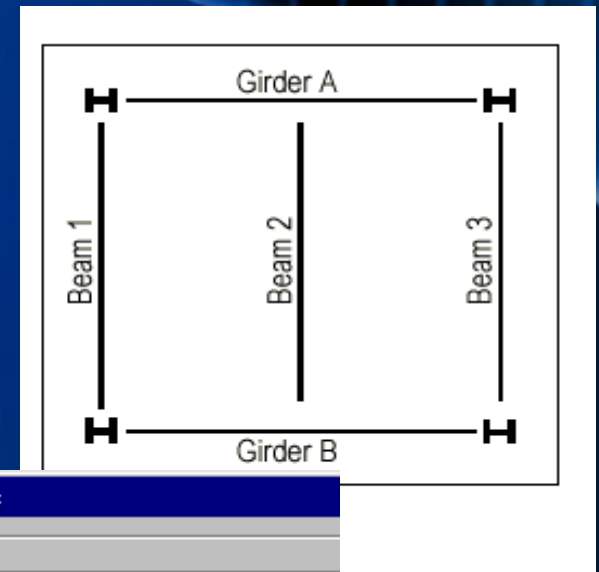
- **Explicit Panel-zone deformations**
- **Automatic tributary-area calculations for Live-Load reduction factors**
- **Construction sequence loading analysis**
- **Automated center of rigidity calculations**



Special Analysis Options

Analysis Options

- Automatic transfer of loads on decks/slabs to beams and walls
- Automatic meshing of frame members into analysis elements
- Automatic meshing of decks/slabs for flexible diaphragm analysis

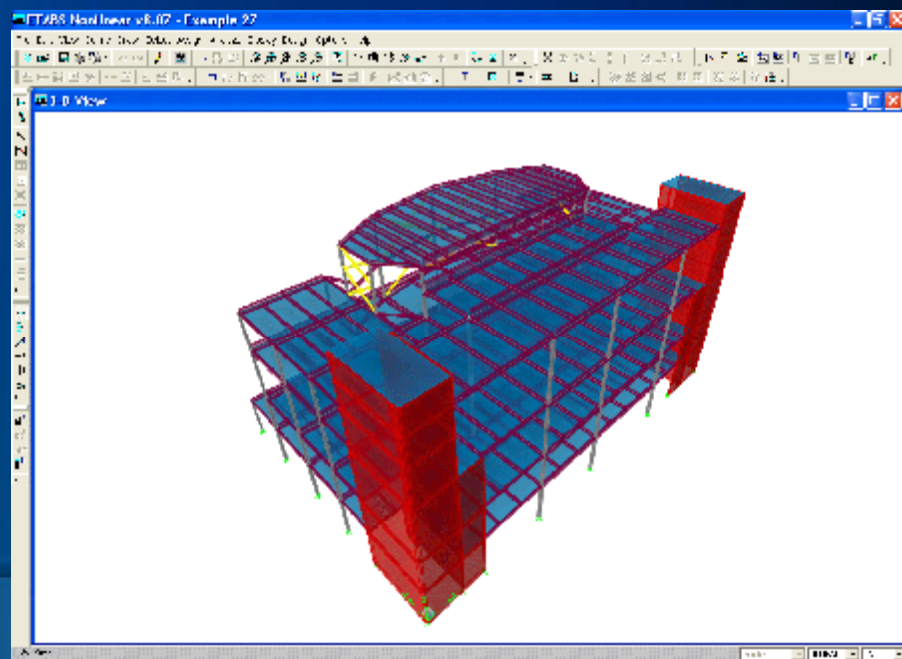
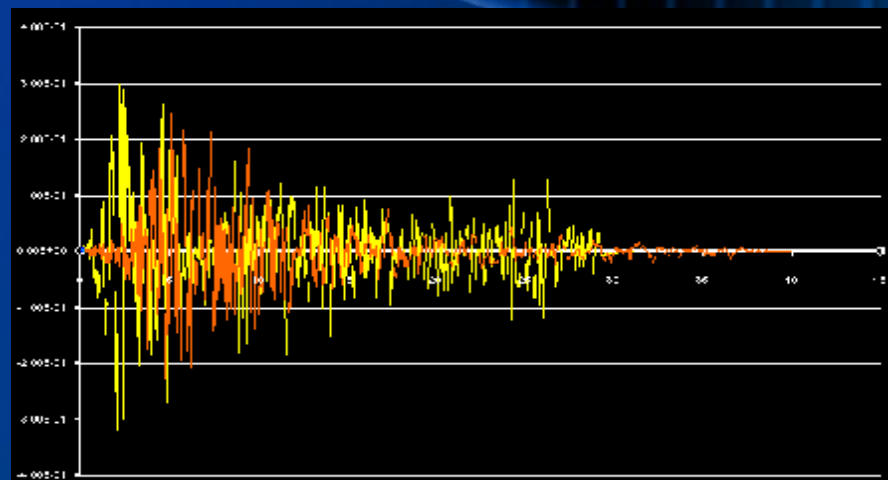


c) ETABS Automatic Floor Meshing

Dynamic Analysis Options

Analysis Options

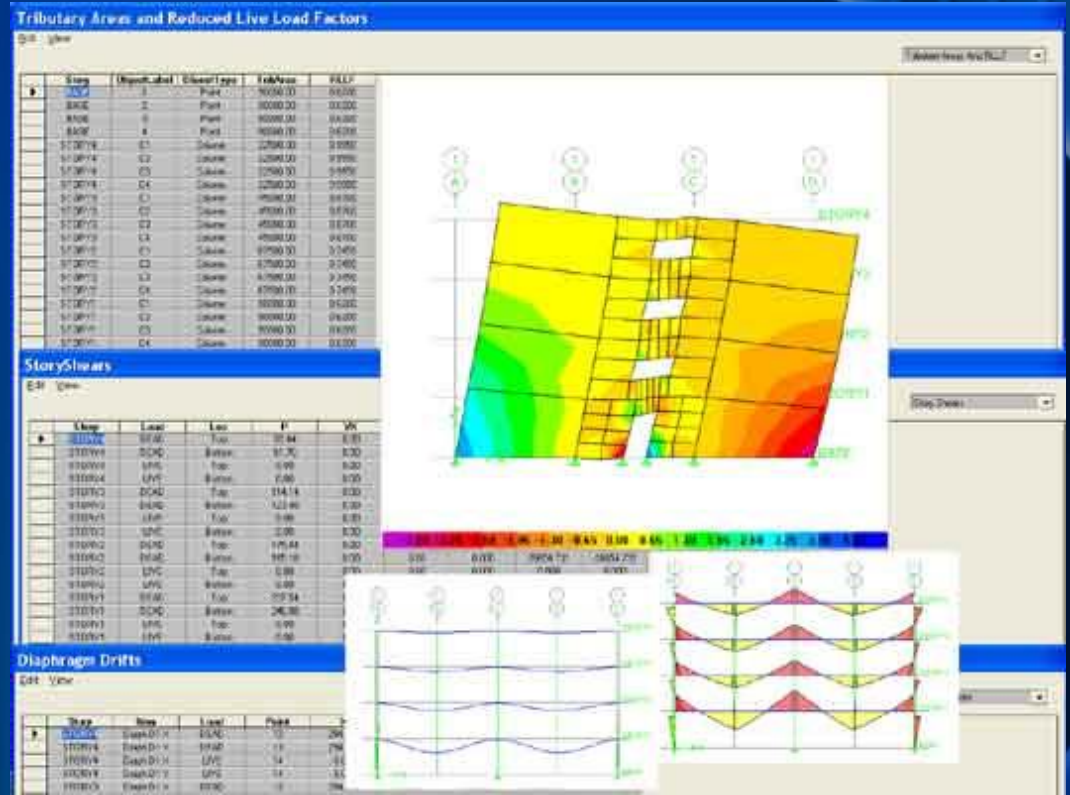
- **Static and dynamic response combinations by ABS or SRSS method**
- **Eigen and load-dependent Ritz vector determination**
- **Model combination by SRSS, CQC or GMC (Gupta) method**
- **Combination of three direction by ABS or SRSS method**



Dynamic Analysis Options

Analysis Options

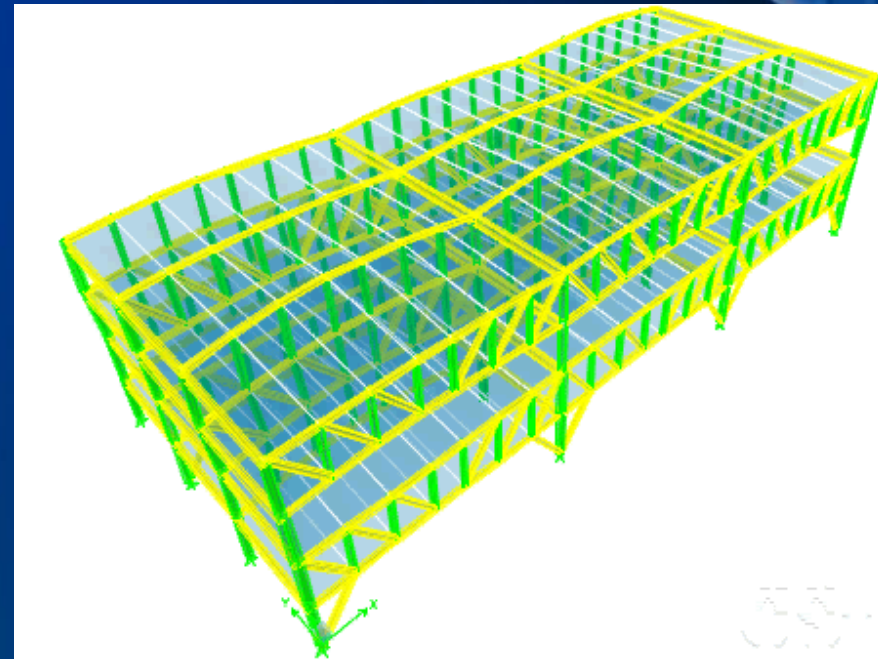
- Multiple Response Spectrum cases
- Multiple Time history cases
- Sequential Time History cases
- Seismic acceleration or displacement excitation
- Wind-load forcing functions
- Transient or steady-state excitation
- Envelope or step-by-step design for Time-History loads



Non-Linear Analysis Options

- **Static Nonlinear Analysis**
 - *Large displacement option*
 - *Sequential loading option*
- **Dynamic Nonlinear Analysis Options**

The nonlinear dynamic analysis option extends the capabilities of the Linear Time History option by allowing for nonlinearity in predefined nonlinear element



Static Pushover Analysis

Analysis Options

- **Considers FEMA 273, ATC-40 provisions**
- **Automated force-deformation relations for steel and concrete hinges**
- **Modal uniform, or user-defined lateral load patterns**
- **Start from applied gravity load**
- **Capacity Spectrum conversions**
- **Effective damping calculation**
- **Demand Spectrum comparisons**
- **Performance point calculation**
- **Summary reports including plastic-hinge deformations**

Static Pushover Analysis

Analysis Options

PUSHOVER CURVE - CASE PUSH1

File

Spectral Displacement

Cursor Location: (7.692E-01 , 1.659E-01)
Performance Point (V,D): (493.488 , 0.167)
Performance Point (Sa,Sd): (0.144 , 0.134)
Performance Point (Teff,#eff): (1.940 , 0.170)

Static Pushover Case PUSH1

Plot Type

- Resultant Base Reaction vs Monitored Displacement
- Capacity Spectrum Color █

Demand Spectrum

Seismic Coefficient Ca: 0.4
Seismic Coefficient Cv: 0.4

Show Family of Demand Spectra Color █

Damping Ratios: 0.05 0.1 0.15 0.2

Show Single Demand Spectrum (Variable Damping) Color █

Show Constant Period Lines at 0.5 1. 1.5 2. Color █

Damping Parameters

Inherent + Additional Damping: 0.05

Structural Behavior Type: A B C User Modify/Show

Override Axis Labels/Range Display Done Reset Default Colors

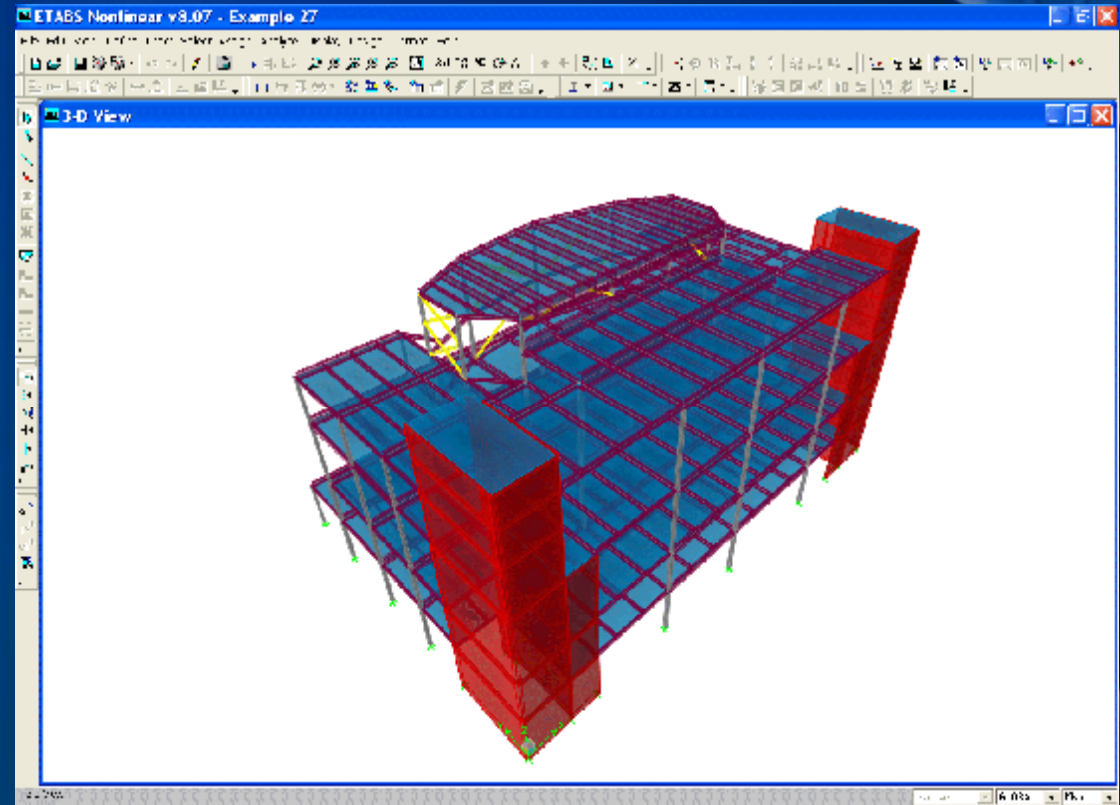


Viewing Results

Analysis Results

Analysis Results

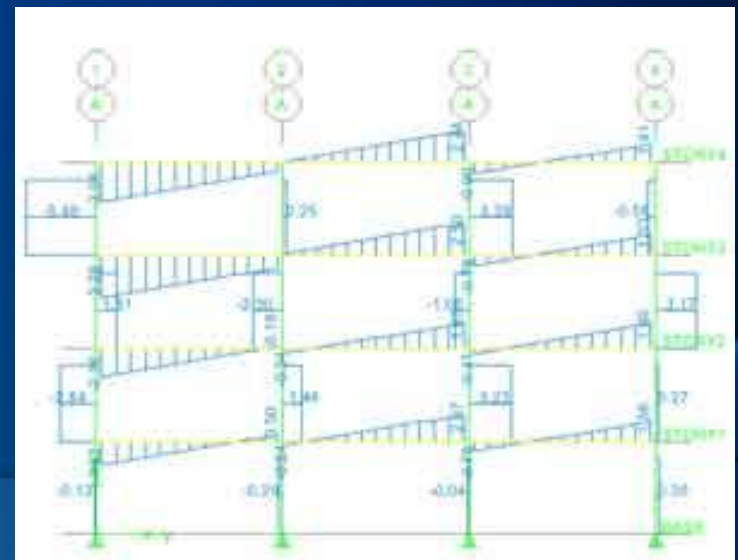
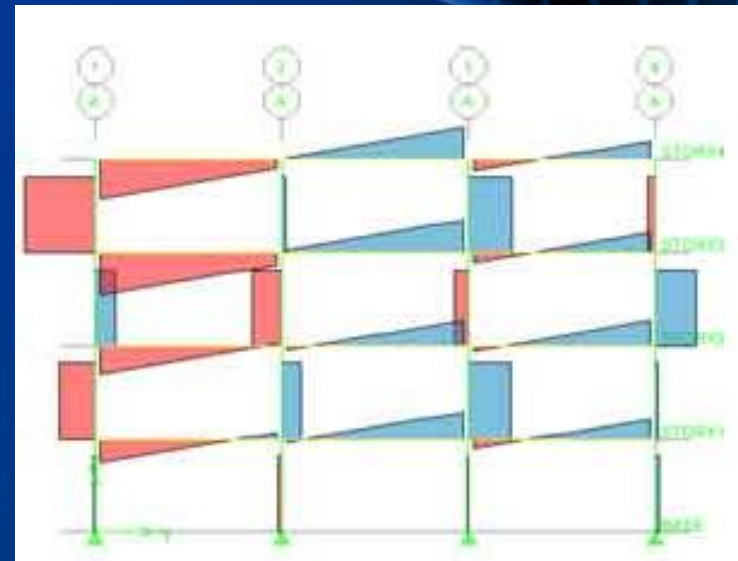
- Deformed and Un-deformed geometry in 3D perspective
- Animation of deformed shapes



Analysis Results

- Bending-Moment and Shear-Force diagrams for Frames
- Instantaneous on-screen results output with right-button click on element
- Integrated-force diagrams for Wall Piers and Spandrels

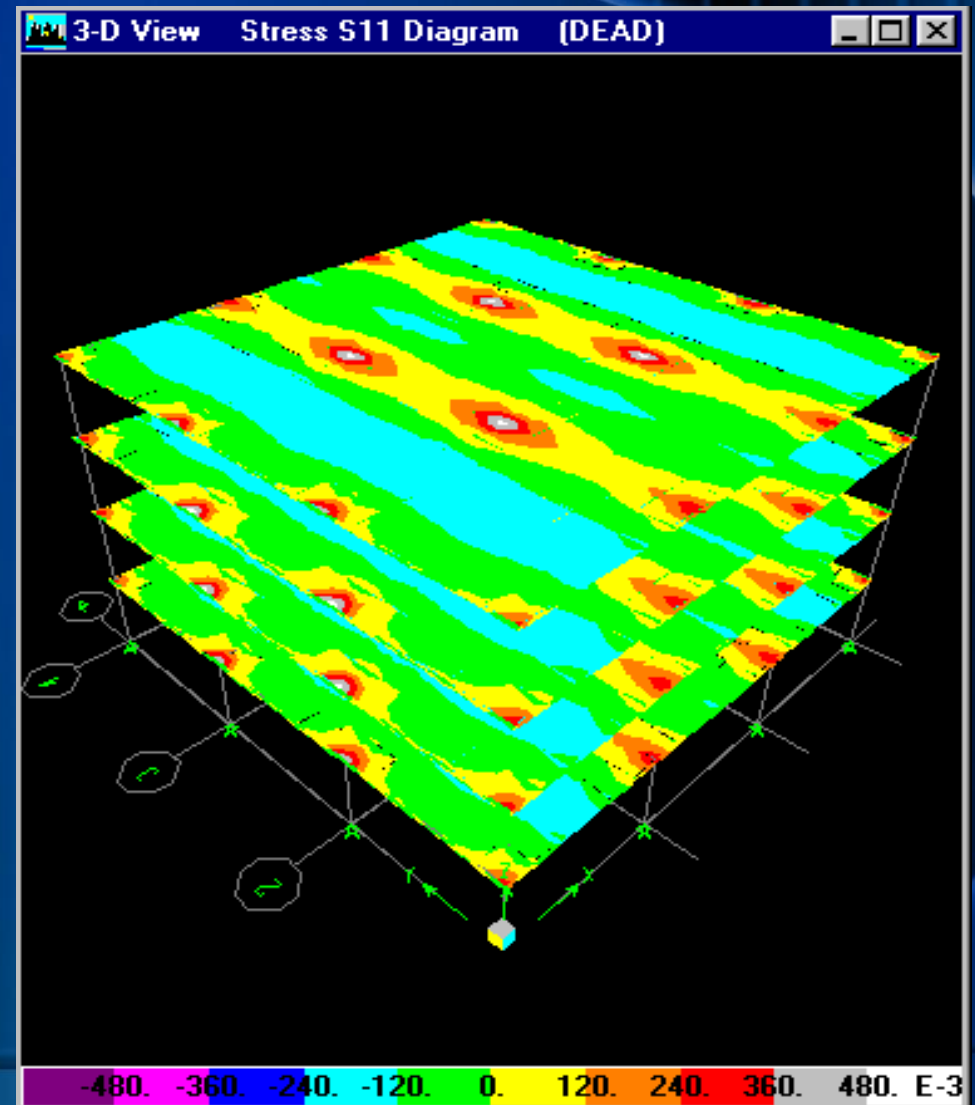
Analysis Results



Analysis Results

Analysis Results

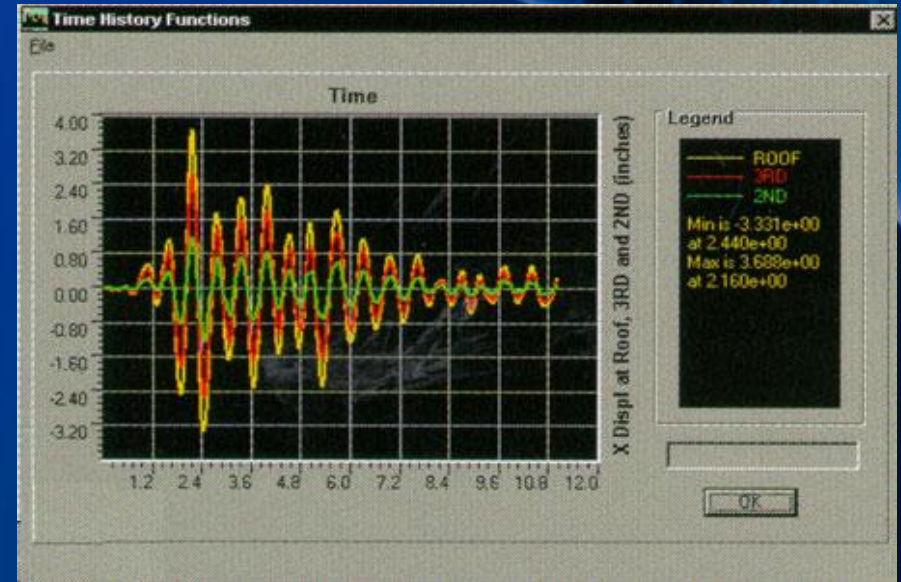
- Loading diagrams
- Stress contours for shells
- Interactive Section-force results using Groups



Dynamic Analysis Results

Analysis Results

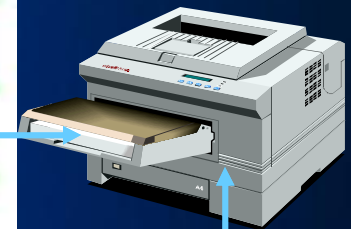
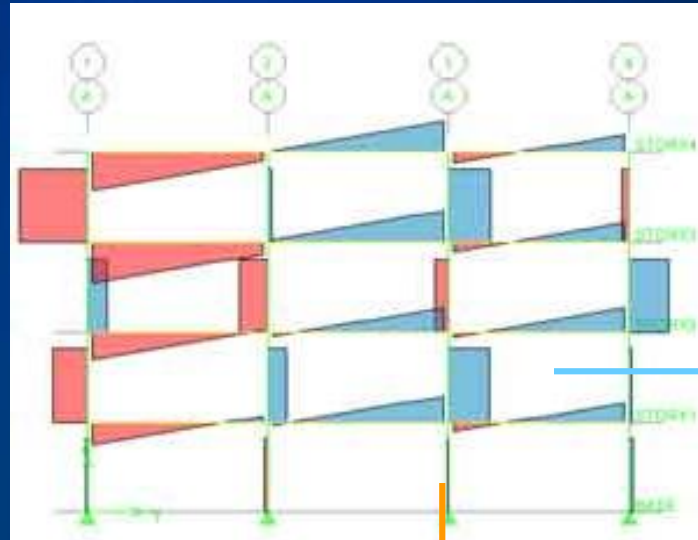
- Time-History deformed shapes as real time AVI file
- Displays of nodal and element time-history records
- Time History displays of function vs. time or function vs. function
- Response spectrum curves for any joint from Time History response



Analysis Output

Analysis Results

- Selective or complete tabulated output for all output quantities
- Graphics output to screen, printer, DXF file, or Windows Metafile
- Tabulated output to screen, printer, or Access Database



Beam Forces
Edit View

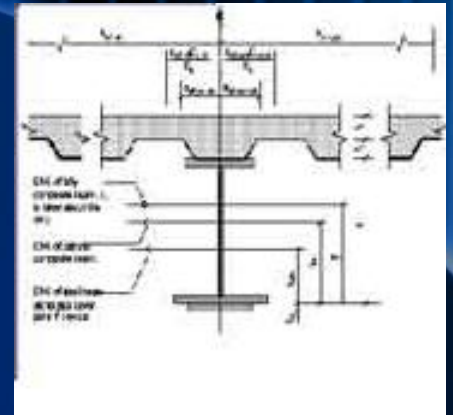
	Story	Beam	Load	Loc	P	V2
▶	STORY4	B1	DEAD	12	0	-9.919177
	STORY4	B1	DEAD	30	0	-9.469206
	STORY4	B1	DEAD	48	0	-9.019235
	STORY4	B1	DEAD	48	0	-5.107079
	STORY4	B1	DEAD	72	0	-4.507117
	STORY4	B1	DEAD	96	0	-3.907155
	STORY4	B1	DEAD	96	0	-1.694391



Fully Integrated Element Design

Member Design

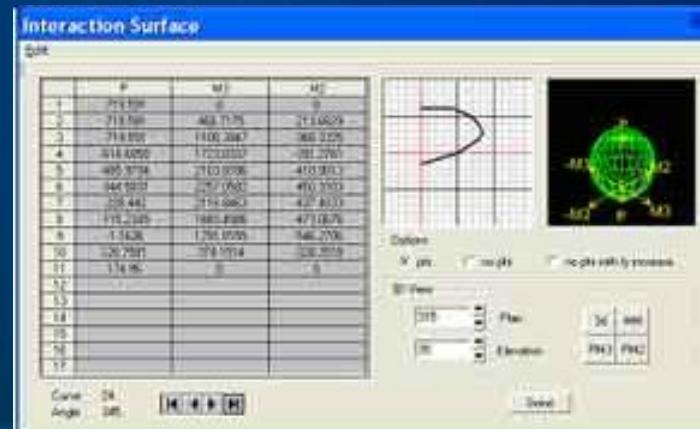
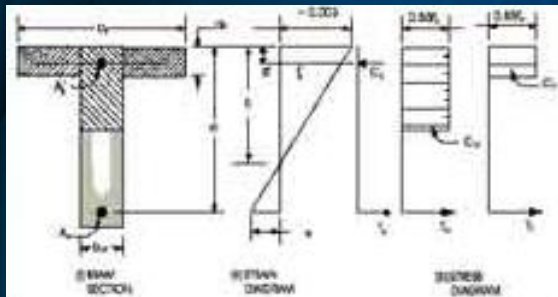
- Design of Steel Beams, and Columns
- Design of Concrete Beams and Columns
- Design of Composite Beams
- Design of Concrete Shear Walls



Pier Design Overwrites - Uniform Rei...

<input type="checkbox"/> Design this Pier	Yes
<input type="checkbox"/> LL Reduction Factor	0.4
<input type="checkbox"/> Design is Seismic	Yes
<input type="checkbox"/> Pier Section Type	Uniform Reinforcing
<input type="checkbox"/> Edge Bar Name	#7
<input type="checkbox"/> Edge Bar Spacing	12
<input type="checkbox"/> End/Corner Bar Name	#9
<input type="checkbox"/> Clear Cover	1
<input type="checkbox"/> Material	CONC
<input type="checkbox"/> Check/Design Reinforcing	Design

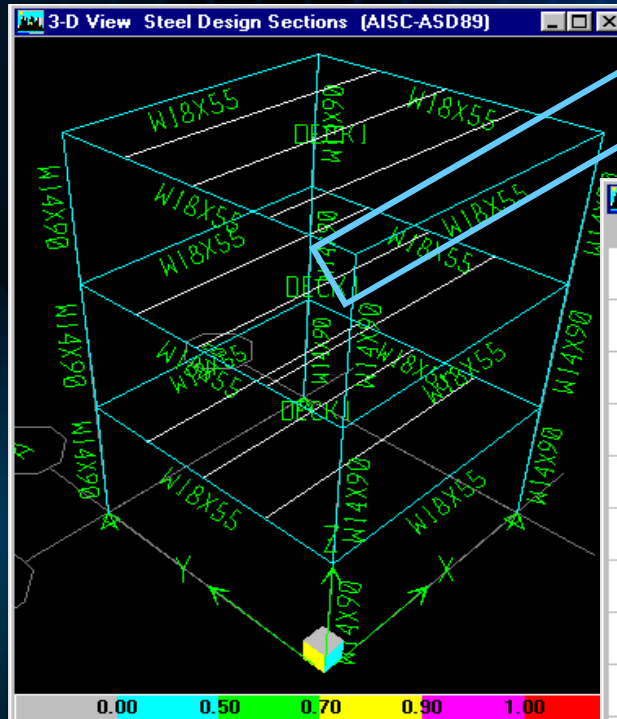
OK Cancel



Steel Frame Design

Member Design

Design Output



Analysis Model

Steel Stress Check Information AISC-ASD89

File

AISC-ASD89 STEEL SECTION CHECK Units: Kip-in
 Level: STORY3 Element: B3 Station Loc: 144.000 Section I
 Element Type: Moment Resisting Classification: Compact

L=288.000
 A=16.200 i22=44.900 i33=890.000
 s22=11.926 s33=98.288 r22=1.665 r33=7.412
 E=29000.000 Fy=36.000
 RLLF=0.947 EQF=1.000

P-M33-M22 Demand/Capacity Ratio is 0.302 = 0.000 + 0.302

STRESS CHECK FORCES & MOMENTS						
Combo	DSTL2	P	M33	M22	U2	U3
		0.000	706.294	0.000	-3.209	0.000

AXIAL FORCE & BIAXIAL MOMENT DESIGN (BENDING)							
		Fa	Fa	Ft			
		Stress	Allowable	Allowable			
Axial		0.000	18.926	21.600			
		Fb	Fb	Fe	Cm	K	L
		Stress	Allowable	Allowable	Factor	Factor	Factor
Major Bending		7.186	23.760	110.726	1.000	1.000	0.945
Minor Bending		0.000	27.000	79.839	1.000	1.000	0.250

SHEAR DESIGN			
	Fv	Fv	Stress

Steel Frame Design

Member Design

- Fully integrated steel frame design
- AISC-ASD, AISC-LRFD, UBC, Canadian and Euro codes
- Design for static and dynamic loads
- Graphical display of stress ratios
- Interactive design and review
- Summary and detailed reports including database formats

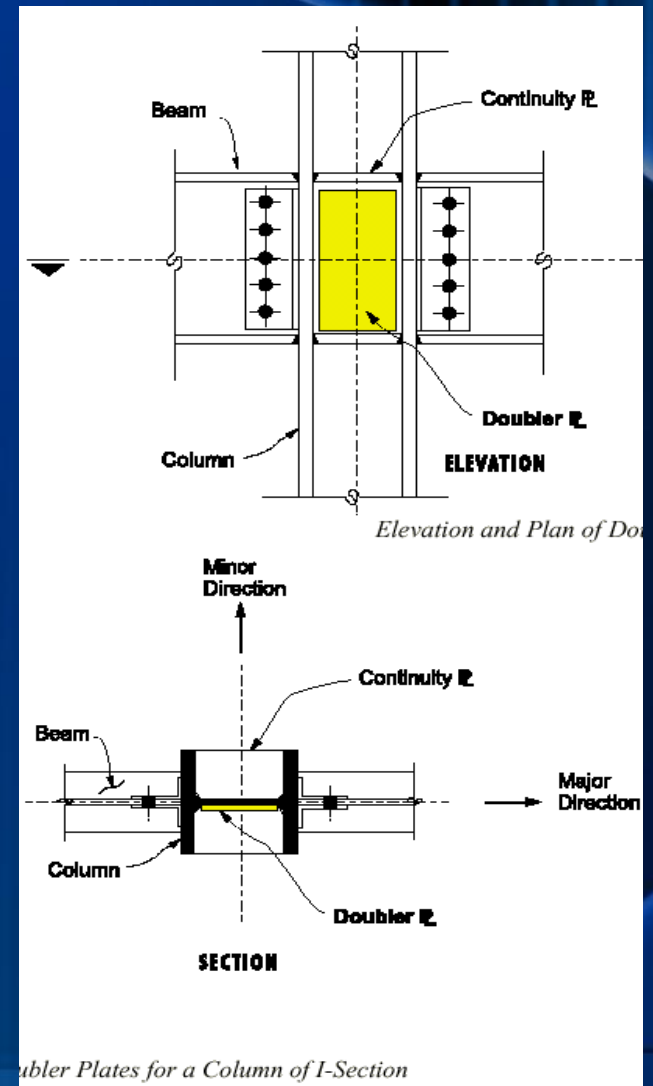
Steel Frame Design Overwrites

Current Design Section	W10x50
Element Type	Moment Frame
Live Load Reduction Factor	1
Unbraced Length Ratio (Major)	0.9452
Unbraced Length Ratio (Minor, LTB)	0.9452
Effective Length Factor (K Major)	1
Effective Length Factor (K Minor)	1
Moment Coefficient (C _m Major)	0.95
Moment Coefficient (C _m Minor)	0.95
Bending Coefficient (C _b)	1
NonSway Moment Factor (B1 Major)	1
NonSway Moment Factor (B1 Minor)	1
Sway Moment Factor (B2 Major)	1
Sway Moment Factor (B2 Minor)	1
Yield stress, F _y	0
Compressive Capacity, φ _c P _n	0
Tensile Capacity, φ _t P _n	0
Major Bending Capacity, φ _b M _n	0
Minor Bending Capacity, φ _b M _n	0
Major Shear Capacity, φ _v V _n	0
Minor Shear Capacity, φ _v V _n	0

Steel Frame Design

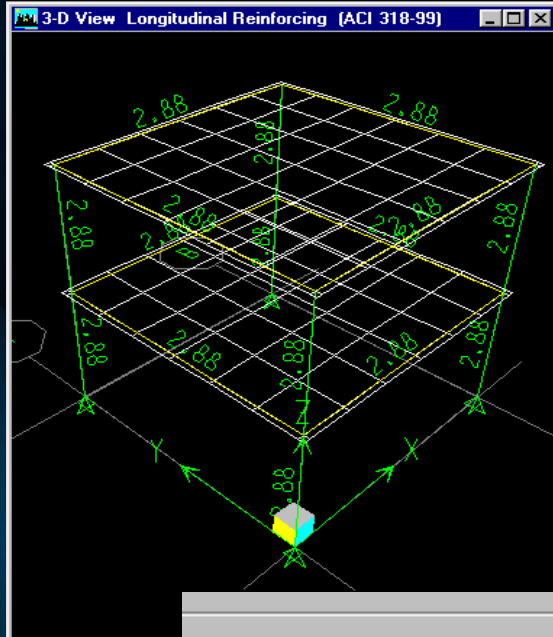
Member Design

- Optimizations for strength and lateral drift
- Seismic design of special moment-resisting frames
- Seismic design of concentric and eccentric braced frames
- Check of panel zones for stiffener and continuity plates



Concrete Frame Design

Member Design



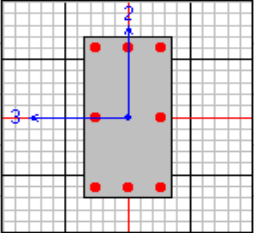
Concrete Design Information ACI 318-99

File

ACI 318-99 COLUMN SECTION DESIGN Type: Sway Special Units: Kip-in

Level: STORY2 Element: C2
 Station Loc 120.000
 Section ID CSEC1
 Combo ID DCON2

L=144.000
 B=12.000 D=24.000 dc=1.500
 E=3600.000 fy=60.000 fc=4.000 Light Wt. Shr. Fac.=1.000
 RLLF=0.995 EQF=1.000



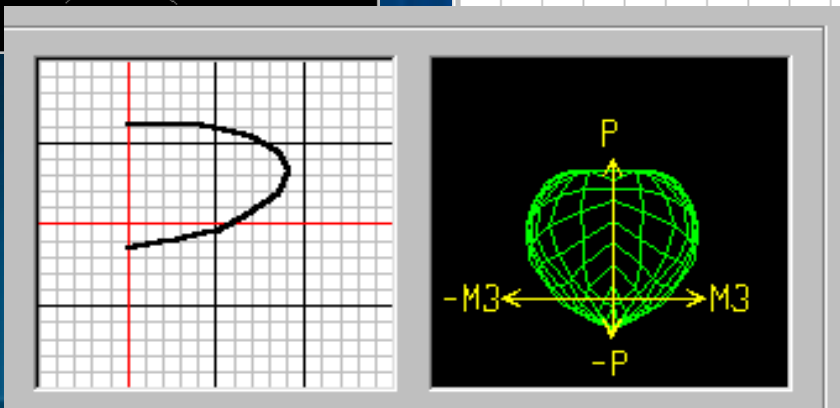
AXIAL FORCE & BIAxIAL MOMENT DESIGN FOR PU, M2, M3

Rebar Area	Design Pu	Design M2	Design M3	Minimum M2	Minimum M3
2.880	43.730	369.087	-667.306	41.981	57.723

LOAD FACTORS

Cm	Delta_ns	Delta_s	K	L
Factor	Factor	Factor	Factor	Length
0.400	1.000	1.000	1.000	120.000
0.400	1.000	1.000	1.000	120.000

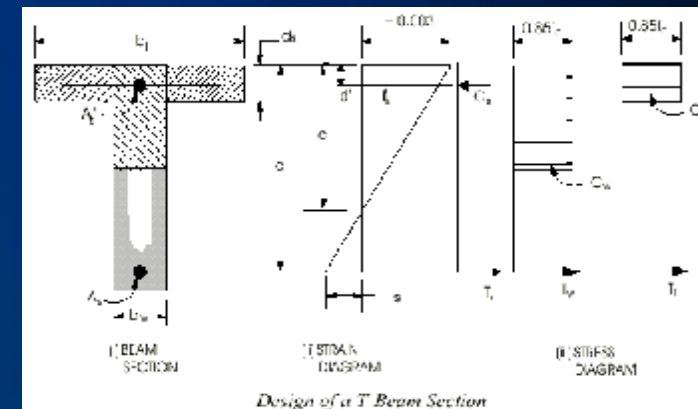
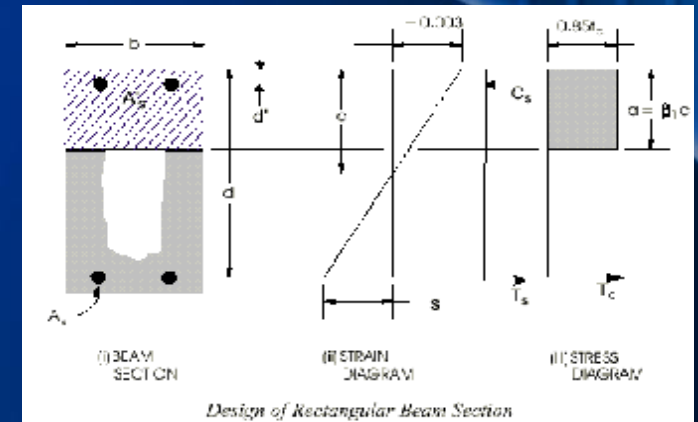
Design Rebar	Shear Vu	Shear phi*Uc	Shear phi*Us	Shear Up
0.032	36.452	0.000	36.452	36.452
0.068	36.445	0.000	36.445	36.445



Concrete Frame Design

Member Design

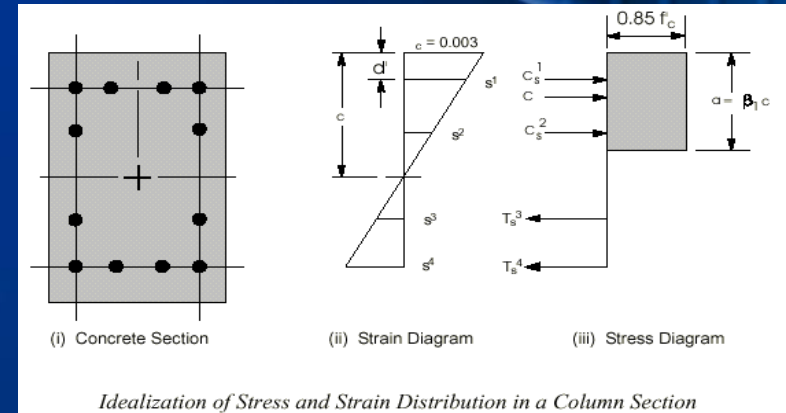
- Fully integrated concrete frame design
- ACI, UBC, Canadian and Euro codes
- Design for static and dynamic loads
- Seismic design of intermediate/special moment-resisting frames
- Seismic design of beam/column joints
- Seismic check for strong-column/weak-beam design



Concrete Frame Design

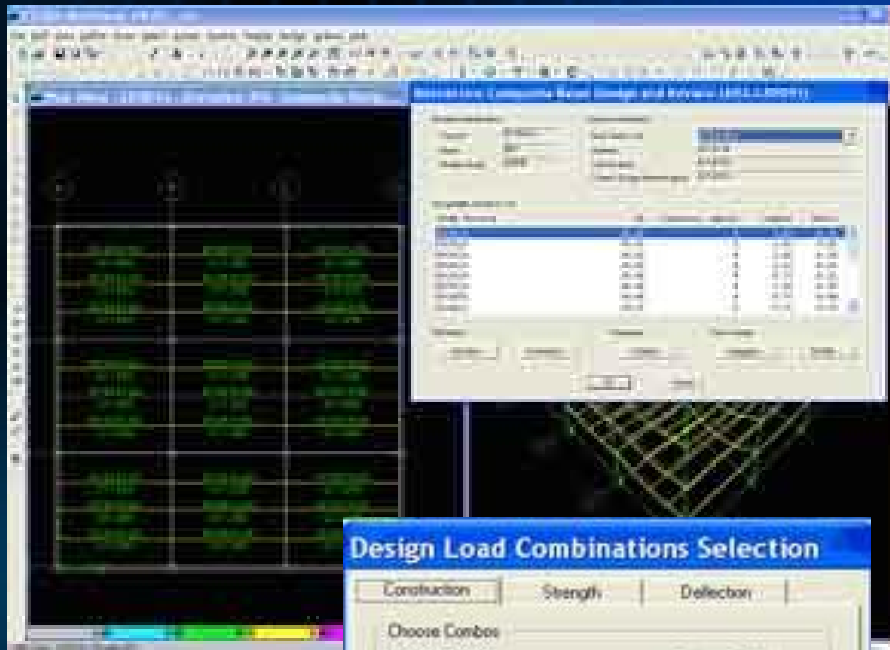
Member Design

- Graphical Section Designer for concrete rebar location
- Biaxial-moment/ axial-load interaction diagrams
- Graphical display of reinforcement and stress ratios
- Interactive design and review
- Summary and detail reports including database formats



Composite Beam Design

Member
Design

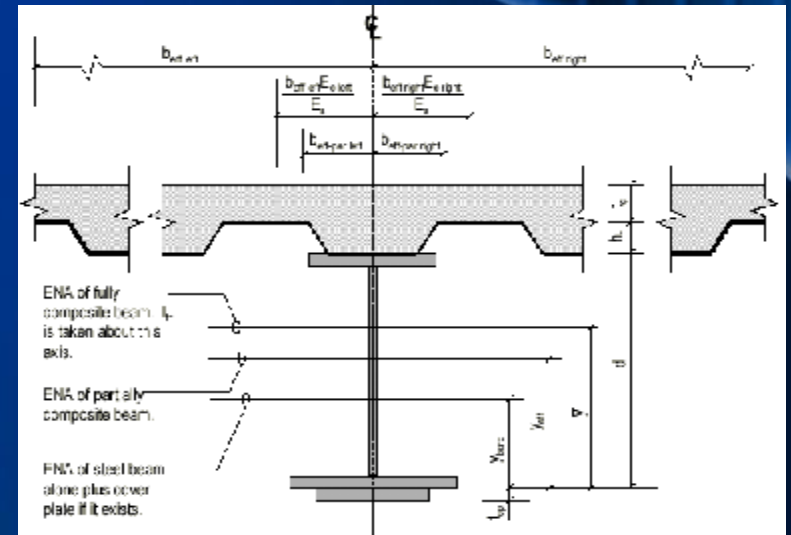


ETABS

Composite Beam Design

Member Design

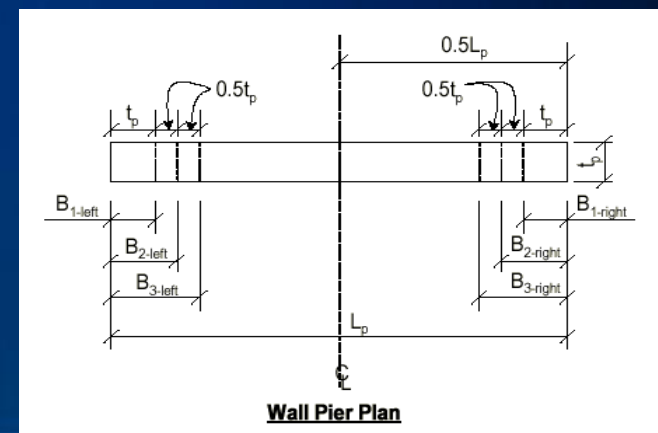
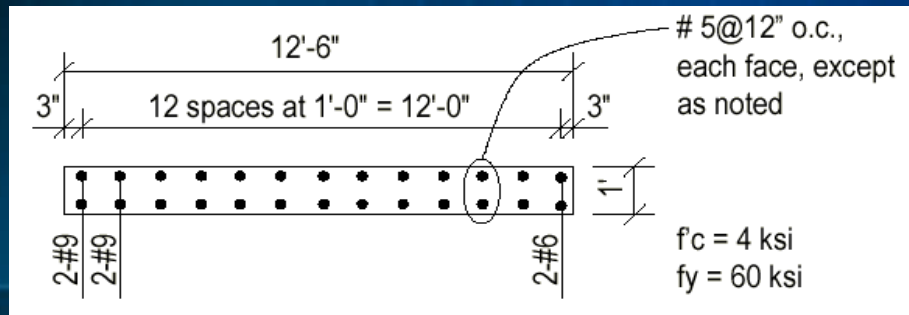
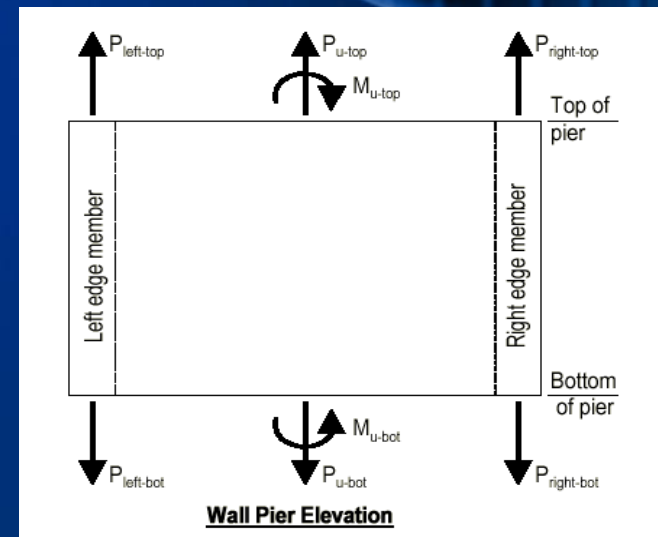
- AISC-ASD and AISC-LRFD Specifications
- Automatic calculation of effective slab widths
- Numerous user-specified constraints
- Shored and un-shored design
- Optimal design for strength and deflections
- Camber calculation
- Floor Vibration analysis



Concrete Shear Wall Design

Member Design

- Fully integrated wall pier and spandrel design
- ACI, UBC and Canadian Codes
- Design for static and dynamic loads
- Automatic integration of forces for piers and spandrel

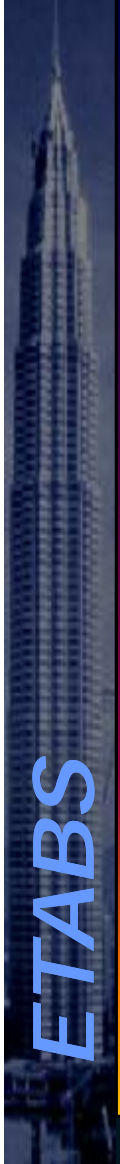


Concrete Shear Wall Design

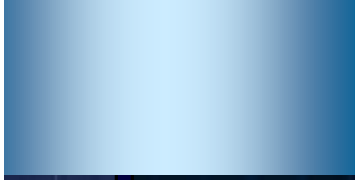
Member
Design

- 2D wall pier design and boundary-member checks
- 2D wall spandrel design
- 3D wall pier check for provided reinforcement
- Graphical Section Designer for concrete rebar location
- Graphical display of reinforcement and stress ratios
- Interactive design and review
- Summary and detailed reports including database formats

ETABS



ETABS



ETABS

V7 – Non Linear

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Buildings**