AD-A264 760

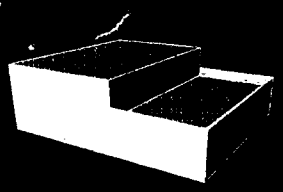
COMPUTER AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

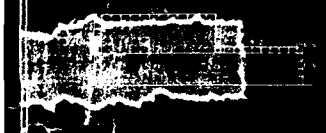
INSTRUCTION REPORT ITL-92-3

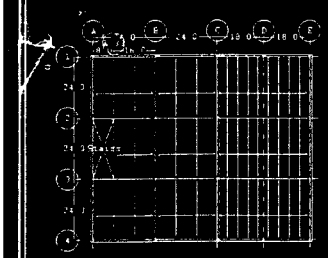
CONCEPT DESIGN EXAMPLE, COMPUTER AIDED STRUCTURAL MODELING (CASM)

Report 2

SCHEME B







by

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DEPARTMENT OF THE ARMY
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B

All Steel, Composite,

Lateral Load Resistance = X Braced Frames

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for
Scheme B

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Preface

This manual presents a detailed design example emphasizing major capabilities of the Computer Aided Structural Modeling (CASM) computer program which is a program designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics.

Funds for the development of this program were provided to the Information Technology Laboratory (ITL), US Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, US Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

Funds for publication of this report were provided to ITL under the RDT&E Program and CASE Project.

Specifications for the program were provided by members of the Building Systems Task Group of the CASE Project. The following were members of the task group during this phase of program development:

Mr. Dan Reynolds, US Army Engineer (USAE) District, Sacramento (Chairman)
Ms. Anjana Chudgar, USAE Division, Ohio River
Mr. Pete Rossbach, USAE District, Baltimore
Mr. Gary Close, USAE District, Savannah
Mr. Dave Smith, USAE District, Omaha
Mr. Mark Burkholder, USAE District, Tulsa
Mr. Jerry Maurseth, USAE District, Portland
Mr. Young Hsu, USAE District, Memphis
Mr. Michael Pace, WES

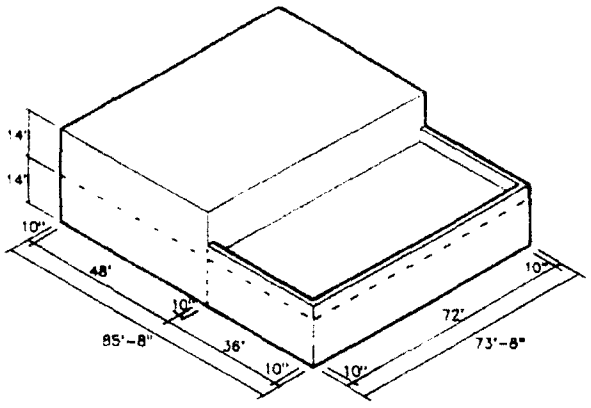
The computer program was written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

This report was written by Messrs. Wickersheimer, McDermott, and Roth and Mr. Michael E. Pace, Computer-Aided Engineering Division (CAED), ITL, WES.

The work was monitored at WES by Mr. Pace, under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; and Dr. N. Radhakrishnan, Director, ITL. Mr. Charlie Gutberlet is the HQUSACE Technical Monitor.

During publication of this report, Dr. Robert W. Whalin was Director of WES. COL Leonard G. Hassell, EN, was Commander and Deputy Director.

Project Description



This 1 and 2 story project is to provide approximately 9,500 gross square feet of office space for one of two possible sites:

(a) Charleston, South Carolina

(b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

1. The 36' x 72' space on the first level shall be column free for open office planning.

2. The 48' x 72' first and second floor areas shall provide 24' square bays.

3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.

4. The second floor occupancy live loads located on the plan are:

Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf

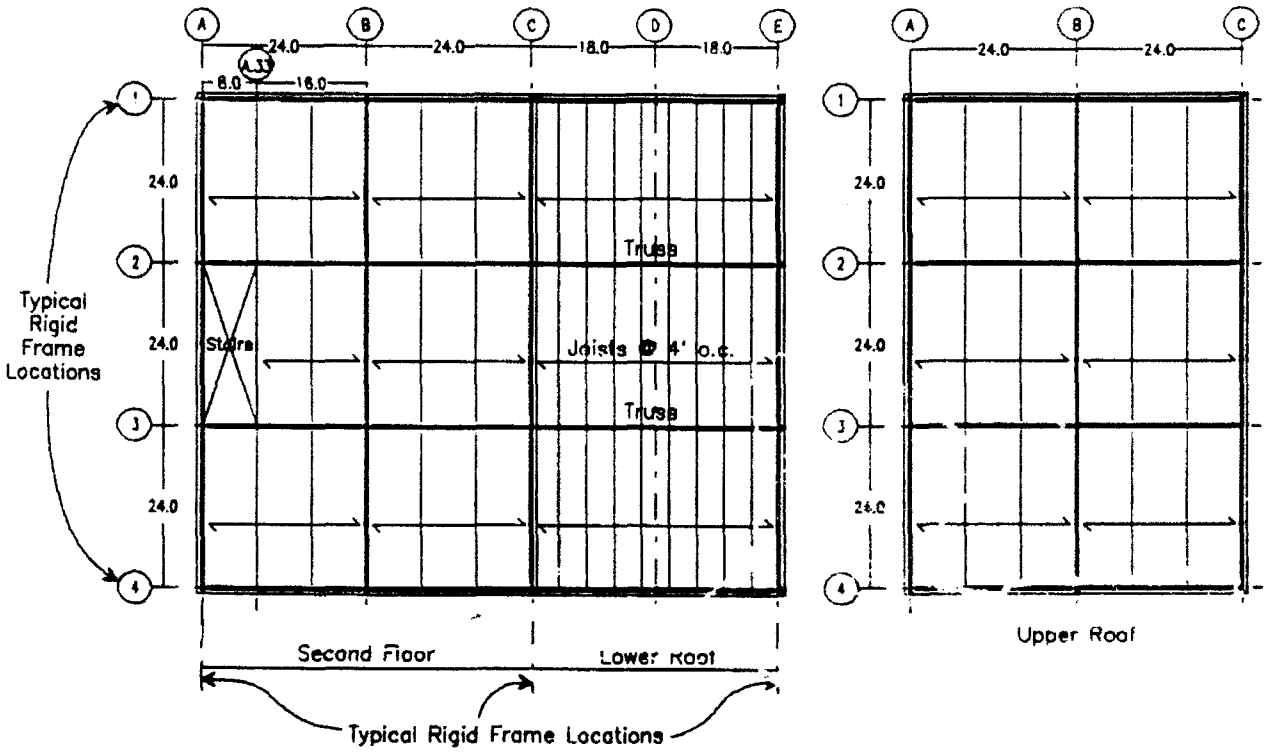
5. Structural framing schemes to be designed and compared shall be as follows:

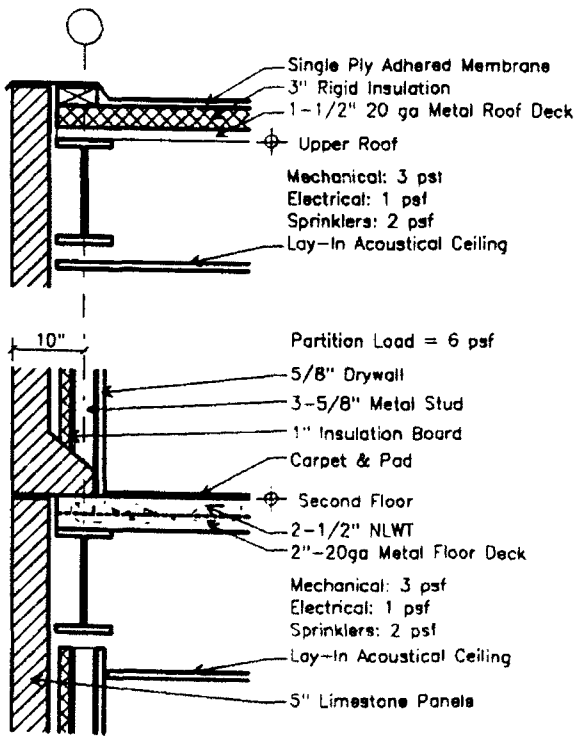
Scheme A: All steel, non-composite,
lateral load resistance = rigid frames.

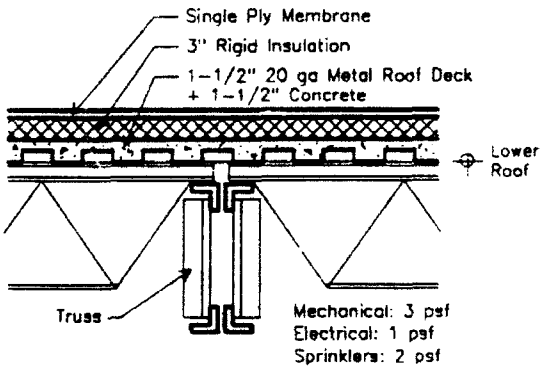
Scheme B: All steel, composite,
lateral load resistance = X braced frames.

Scheme C: Monolithic concrete for two story portion, steel for lower roof portion,
lateral load resistance = shear walls.

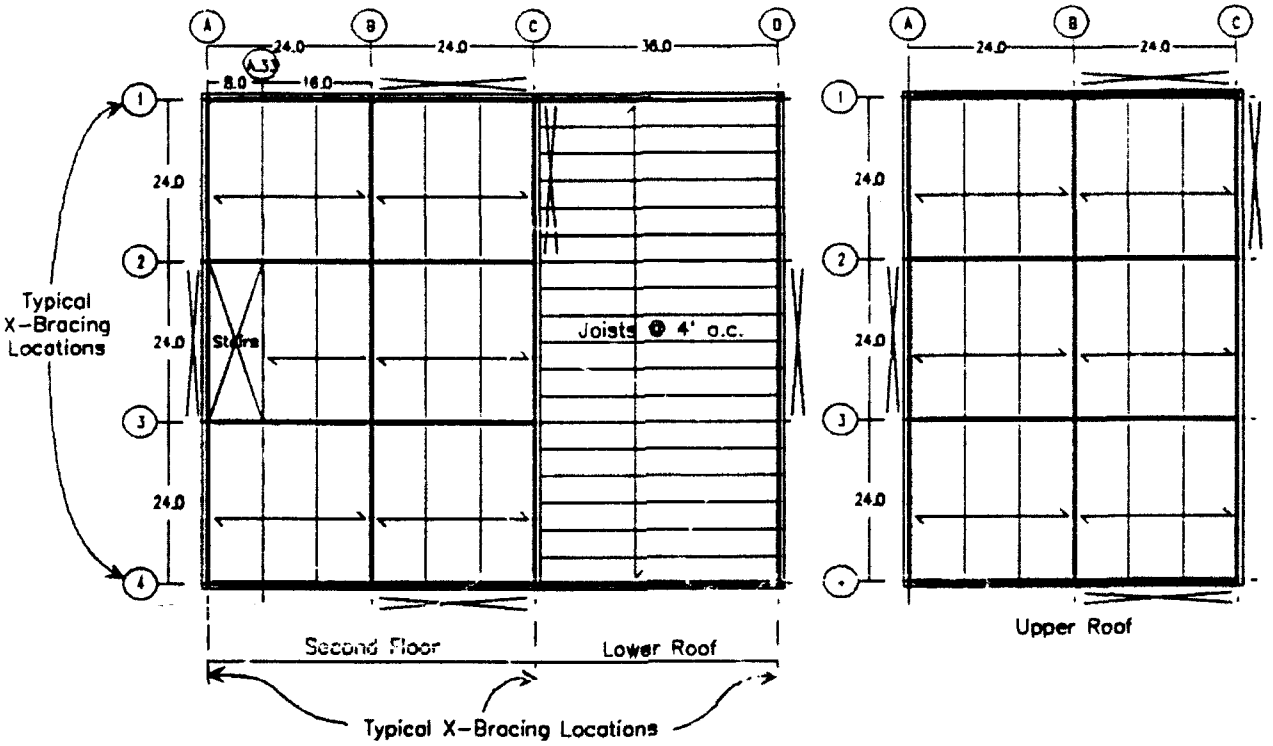
Scheme A

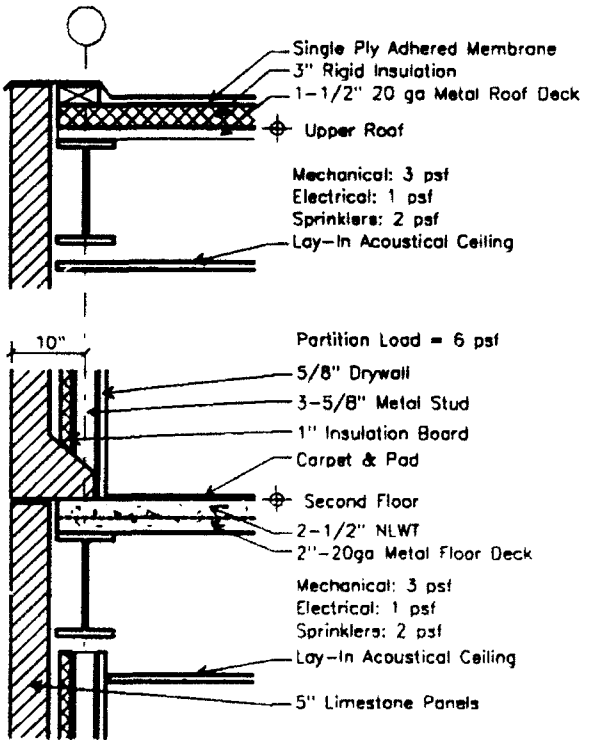

A
B
C
D
E
24.0
24.0
18.0
18.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical Rigid Frame Locations
Store
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Typical Rigid Frame Locations
Upper Roof

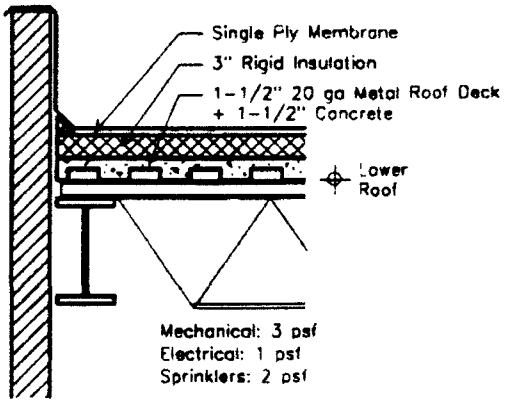

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

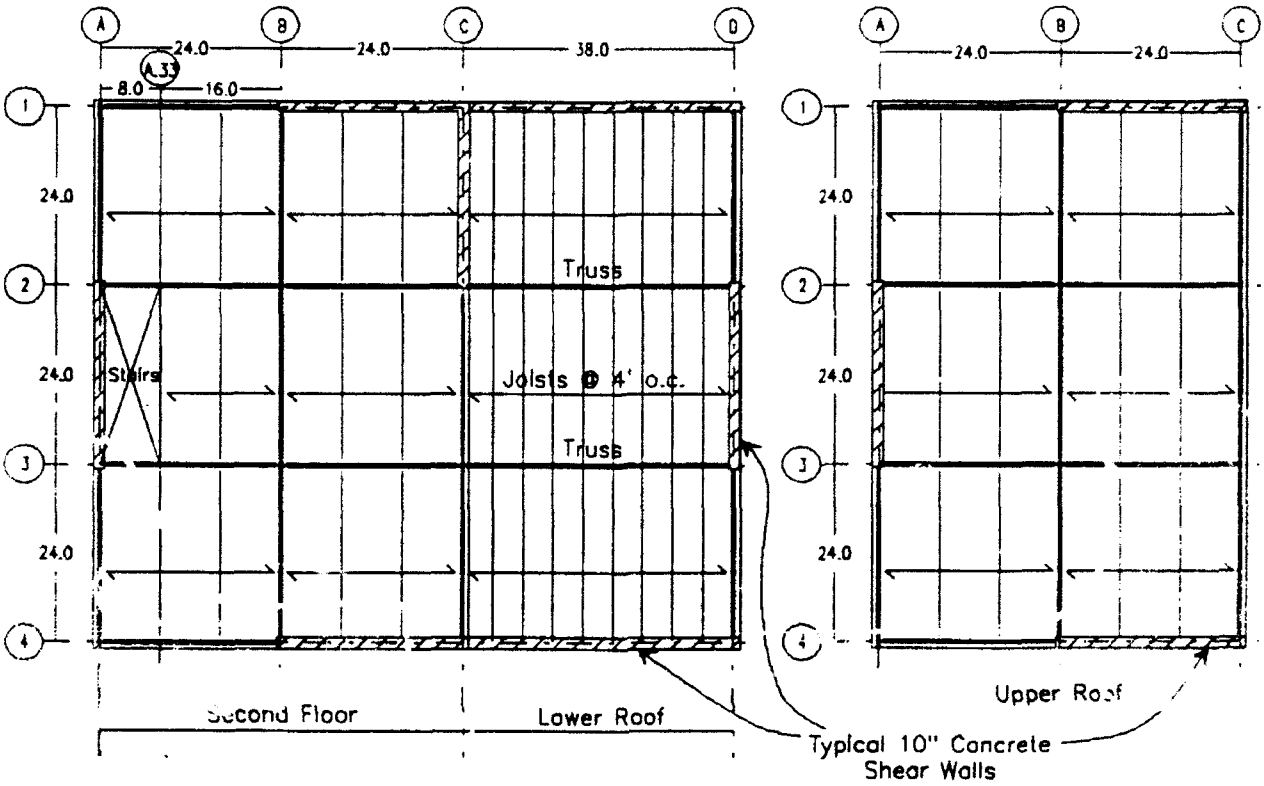
Scheme B

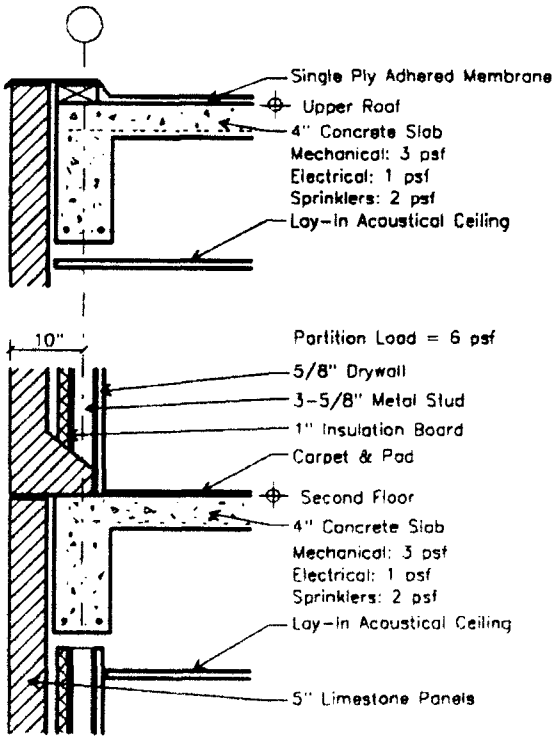

A
B
C
D
24.0
24.0
36.0
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Typical
X-Bracing
Locations
Store
Joists @ 4' o.c.
Second Floor
Lower Roof
Typical X-Bracing Locations
Upper Roof

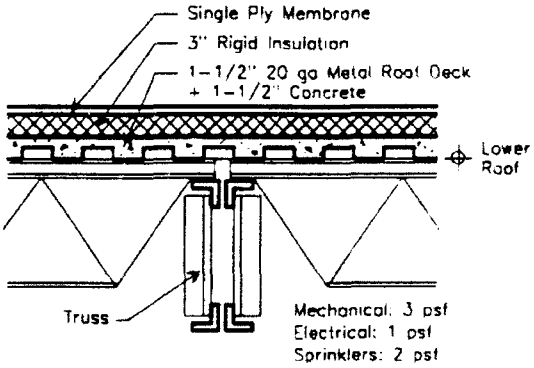

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower
Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

Scheme C


A
B
C
D
24.0
24.0
38.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Stairs
Truss
Joists @ 4' o.c.
Truss
Second Floor
Lower Roof
Upper Roof
Typical 10" Concrete Shear Walls


Single Ply Adhered Membrane
Upper Roof
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
4" Concrete Slab
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Truss
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

6. The typical exterior envelope consists of 5" limestone panels, 1" rigid insulation, 3-5/8" metal studs, and 5/8" drywall.

7. Window and door openings are uniformly distributed to all elevations.

8. Load Assumptions:

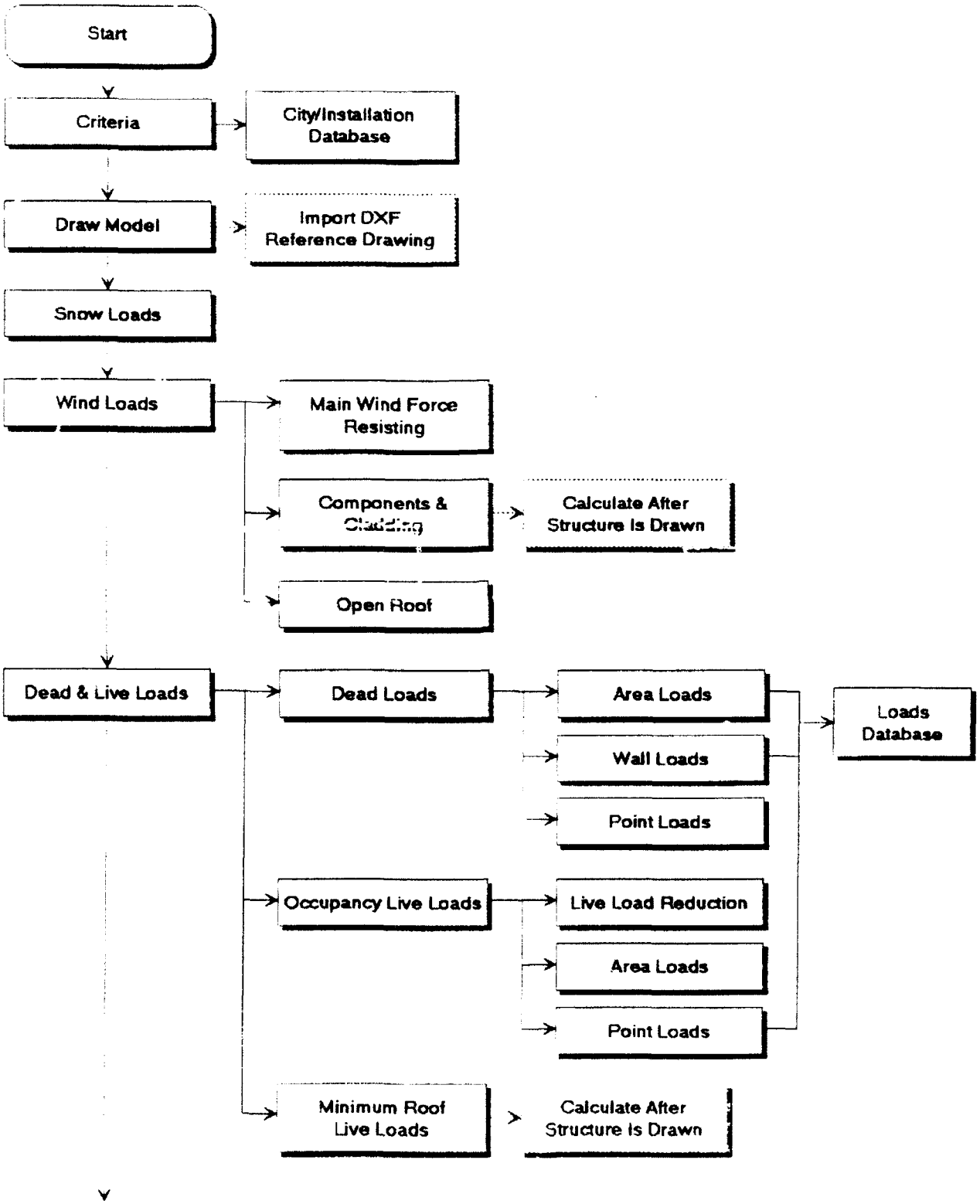
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

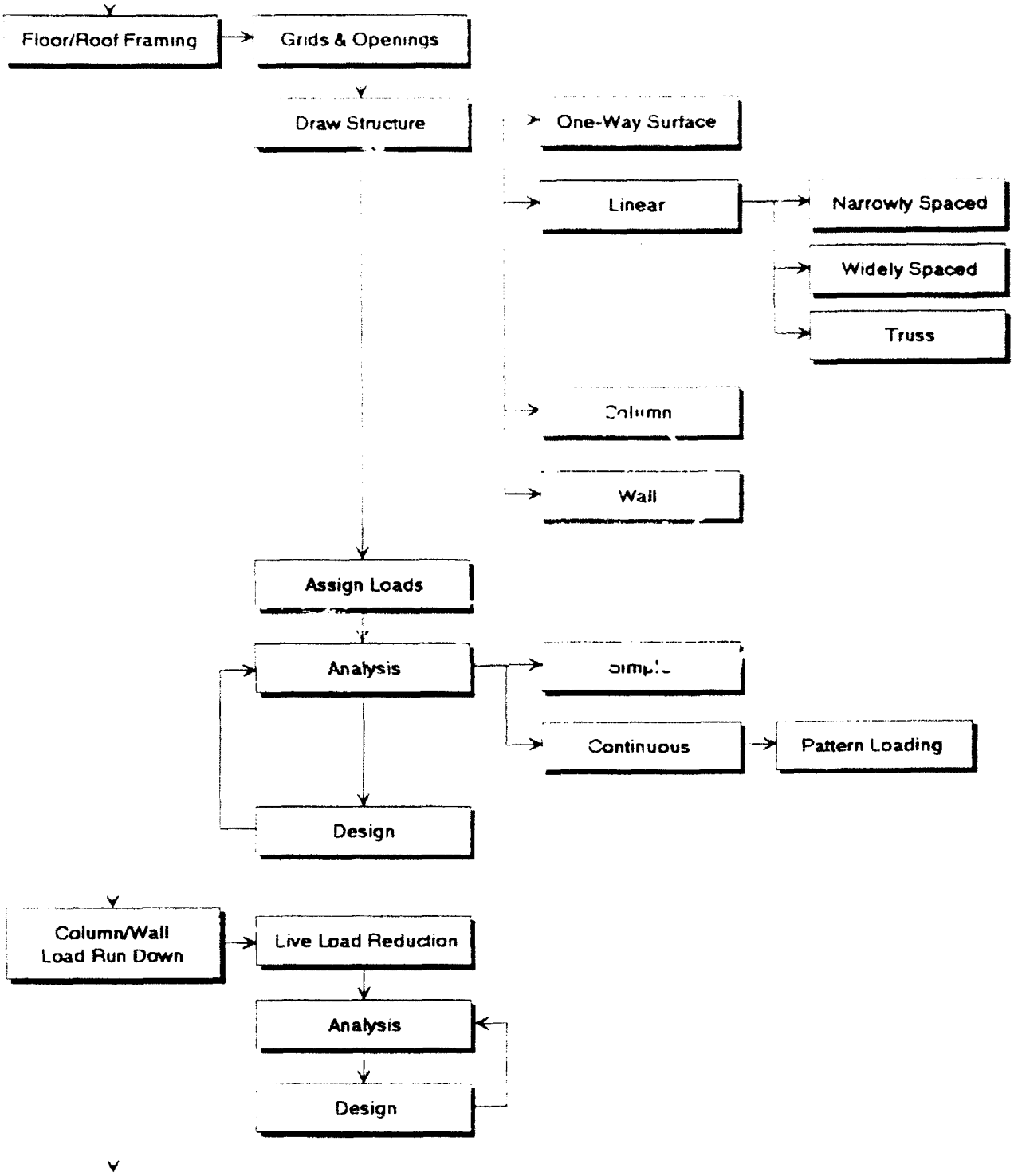
9. Material Assumptions:

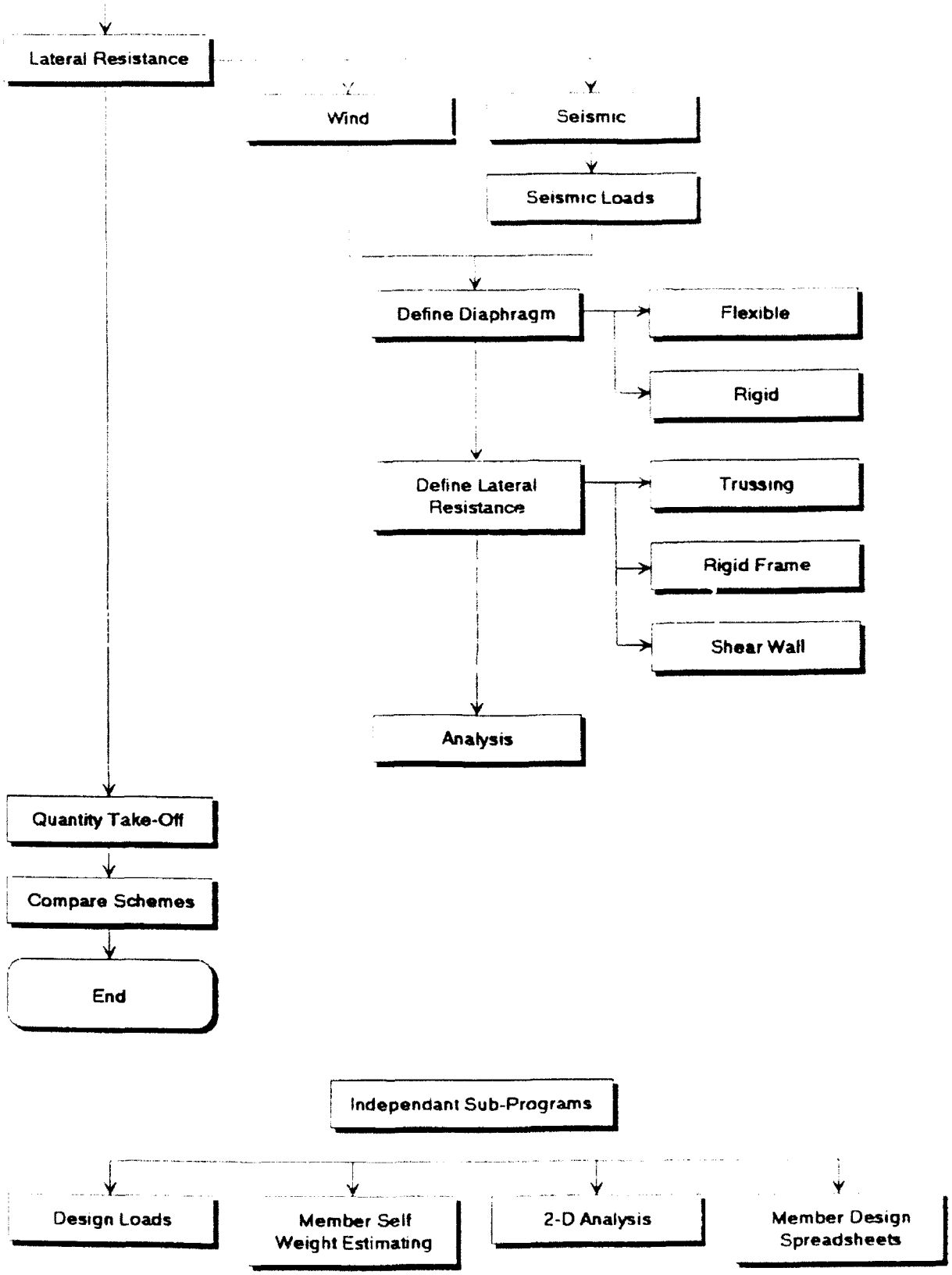
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

10. Fire resistance rating shall be achieved by a wet sprinkler system.

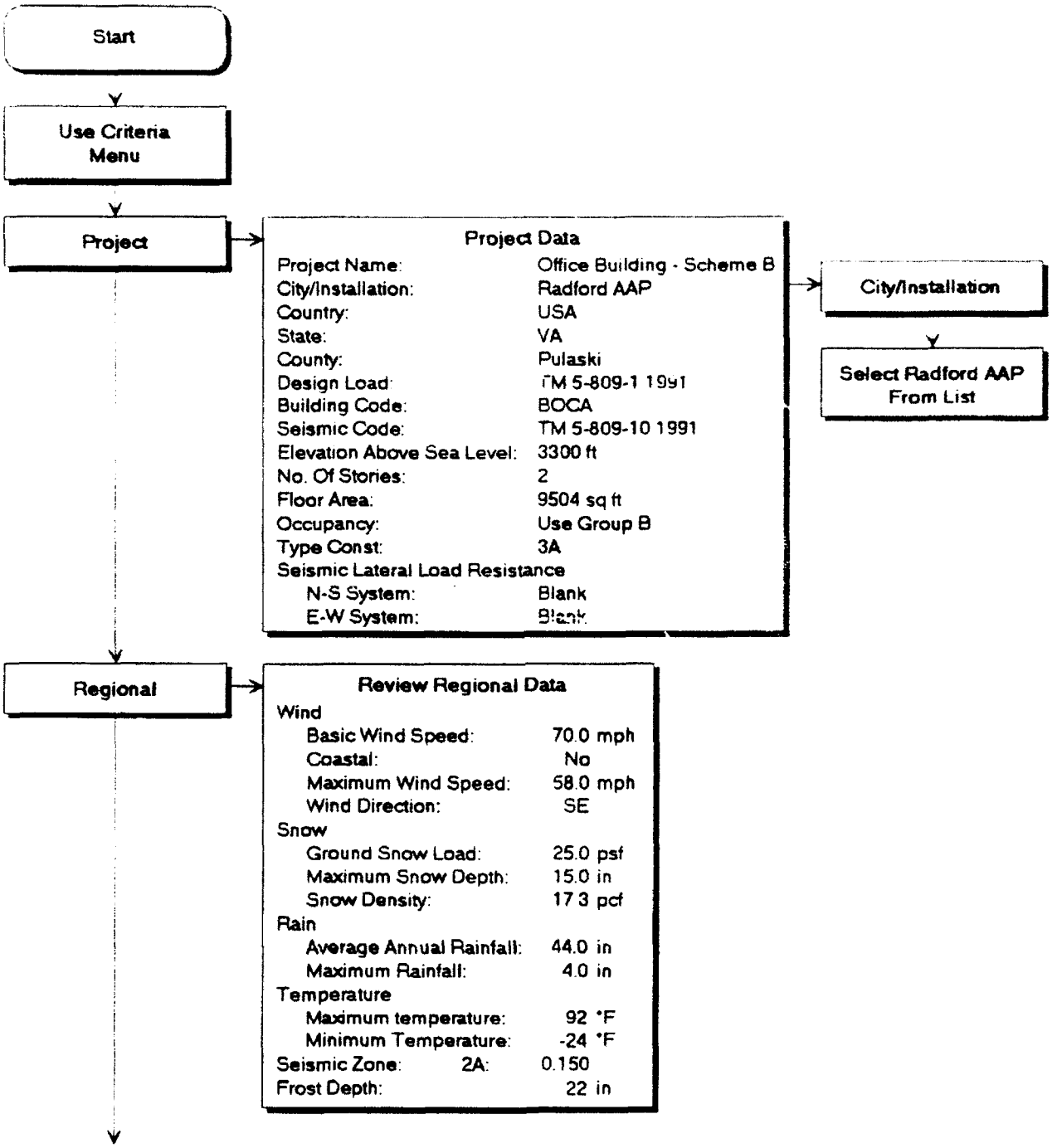
Computer Aided Structural Modeling

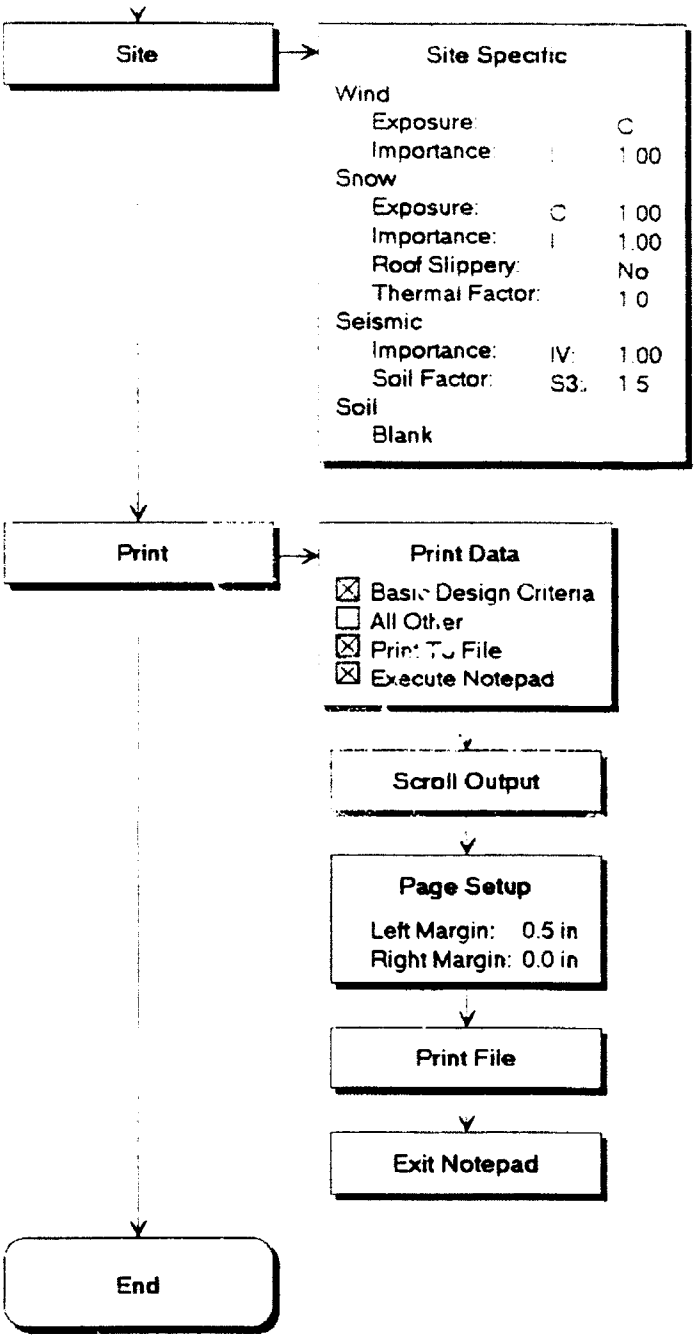



Floor/Roof Framing
Grids & Openings
Draw Structure
One-Way Surface
Linear
Narrowly Spaced
Widely Spaced
Truss
Column
Wall
Assign Loads
Analysis
Simple
Continuous
Pattern Loading
Design
Column/Wall
Load Run Down
Live Load Reduction
Analysis
Design


Lateral Resistance
Wind
Seismic
Seismic Loads
Define Diaphragm
Flexible
Rigid
Define Lateral Resistance
Trussing
Rigid Frame
Shear Wall
Analysis
Quantity Take-Off
Compare Schemes
End
Independant Sub-Programs
Design Loads
Member Self Weight Estimating
2-D Analysis
Member Design Spreadsheets

Criteria


Start
Use Criteria Menu
Project
Project Data
Project Name: Office Building - Scheme B
City/Installation: Radford AAP
Country: USA
State: VA
County: Pulaski
Design Load: TM 5-809-1 1991
Building Code: BOCA
Seismic Code: TM 5-809-10 1991
Elevation Above Sea Level: 3300 ft
No. Of Stories: 2
Floor Area: 9504 sq ft
Occupancy: Use Group B
Type Const: 3A
Seismic Lateral Load Resistance
N-S System: Blank
E-W System: Blank
City/Installation
Select Radford AAP From List
Regional
Review Regional Data
Wind
Basic Wind Speed: 70.0 mph
Coastal: No
Maximum Wind Speed: 58.0 mph
Wind Direction: SE
Snow
Ground Snow Load: 25.0 psf
Maximum Snow Depth: 15.0 in
Snow Density: 17 3 pcf
Rain
Average Annual Rainfall: 44.0 in
Maximum Rainfall: 4.0 in
Temperature
Maximum temperature: 92 °F
Minimum Temperature: -24 °F
Seismic Zone: 2A: 0.150
Frost Depth: 22 in


Site
Site Specific
Wind
Exposure: C
Importance: 1.00
Snow
Exposure: C 1.00
Importance: I 1.00
Roof Slippery: No
Thermal Factor: 1.0
Seismic
Importance: IV: 1.00
Soil Factor: S3: 1.5
Soil
Blank
Print
Print Data
Basic Design Criteria
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Basic Design Criteria

Project Data

Project Name	: Office Building - Scheme B
City/Installation	: Radford AAP
Country	: USA
State	: VA
County	: Pulaski
Design Load	: TM 5-809-1 1991
Building Code	: BOCA
Seismic Code	: TM 5-809-10 1991
Elevation above sea level	: 1300 ft.
No. of Stories	: 2
Floor Area	: 9504 sqft.
Occupancy	: Use Group B
Type of Construction	: 3A
Seismic Lateral Load Resistance	
N-S System	:
N-S Rw	: 0
E-W System	:
E-W Rw	: 0

Regional Data

Wind	
Basic Wind Speed	: 70.0 mph
Coastal	: No
Maximum Wind Speed	: 58.0 mph
Wind Direction	: SE
Snow	
Ground Snow Load	: 25.0 psf
Maximum Snow Depth	: 15.0 in.
Snow Density	: 17.3 pcf
Rain	
Average Annual Rainfall	: 44.0 in.
Maximum Rainfall	: 4.0 in.
Temperature	
Maximum Temperature	: 92.0 deg F
Minimum Temperature	: -24.0 deg F
Seismic Zone : 2A	: 0.150
Frost Depth	: 22 in.

Site Specific Data

Wind	
Exposure	: C
Importance : I	: 1.00
Snow	
Exposure : C	: 1.00
Importance : I	: 1.00
Roof Smooth	: No
Thermal Factor	: 1.0
Seismic	
Importance : IV	: 1.00
Soil Factor : S3	: 1.5

Notes

Importance Factor for Snow and Wind:

I All buildings and structures except those listed below.

II Buildings and structures where primary occupancy is one in which more than 300 people congregate in one area.

III Buildings and structures designated as essential facilities, including, but not limited to:

Hospital and other medical facilities having surgery or emergency treatment areas.

Fire or rescue and police stations.

Primary communication facilities and disaster operation centers.

Power stations and other utilities required in an emergency.

Structures having critical national defense capabilities.

IV Buildings and structures that represent a low hazard to human life in the event of failure, such as agricultural buildings, certain temporary facilities, and minor storage facilities.

Wind Exposure Category:

Exposure C:

Open terrain with scattered obstructions having heights generally less than 30 ft.

Snow Exposure Category:

Exposure C:

Locations in which snow removal by wind cannot be relied on to reduce roof loads because of terrain, higher structures, or several trees nearby.

* The conditions discussed should be representative of those that are likely to exist during the life of the structure. Roofs that contain several large pieces of mechanical equipment or other obstructions do not qualify for siting category A.

Snow Thermal Factor:

Heated Structure.

* These conditions should be representative of those that are likely to exist during the life of the structure.

Importance Factor for Seismic:

I. Essential Facilities

Hospitals and other medical facilities having surgury and emergency treatment areas.

Fire and police stations.

Tanks or other structures containing, housing or supporting water or other fire-suppression materials or equipment required for the protection of essential or hazardous facilities, or special occupancy structures.

Emergency vehicle shelters and garages.

Structures and equipment in emergency preparedness centers.

Stand-by power generating equipment for essential facilities.

Structures and equipment in communication centers and other facilities required for emergency response.

II. Hazardous Facilities

Structures housing, supporting or containing sufficient quantities of toxic or explosive substances to be dangerous to the safety of the general public if released.

III. Special Occupancy Structure

Covered structures whose primary occupancy is public assembly - capacity more than 300 persons.

Buildings for schools (through secondary) or day-care centers - capacity more than 250 students.

Buildings for colleges or adult education schools - capacity more than 500 students.

Medical facilities with 50 or more resident incapacitated patients, but not included above.

Jails and detention facilities.

All structures with occupancy more than 5000 persons.

Structures and equipment in power generating stations and other public utility facilities not included above, and required for

IV. Standard Occupancy Structure

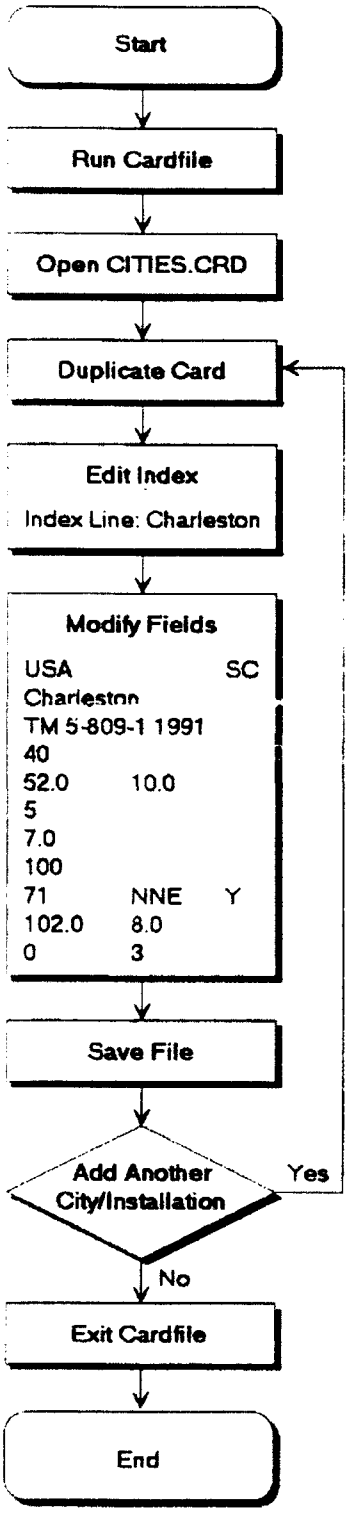
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

S3: A soil profile 70 feet or more in depth and containing more than 20 feet of soft to medium stiff clay but not more than 40 feet of soft clay.

The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines that soil profile S4 may be present at the site, or in the event that soil profile S4 is established by geotechnical data.

City/Installation Database



Fields

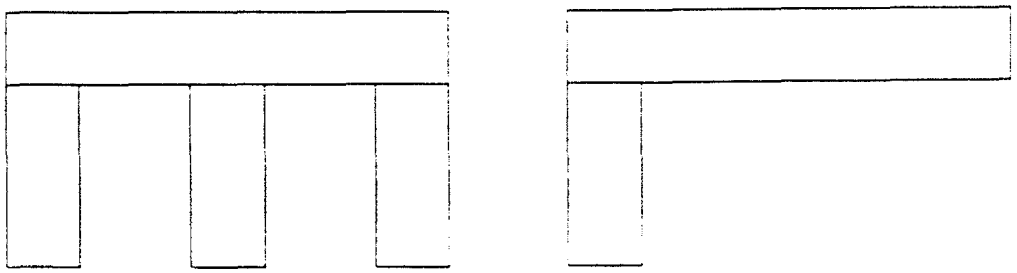
Country		State
County		
Design Load		
Elevation (ft)		
Ave. Rain (in)	Max. Rain (in)	
Ground Snow Load (psf)		
Max. Snow Depth (in)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (in)	Seismic Zone	

Modeling Philosophy

A. Simplify the geometric model

For buildings with repetitive wings, only one wing needs to be modeled.

Insignificant portions such as chimneys, dormers, and small projections, should not be modeled.



Extra wings are not necessary Simplified model

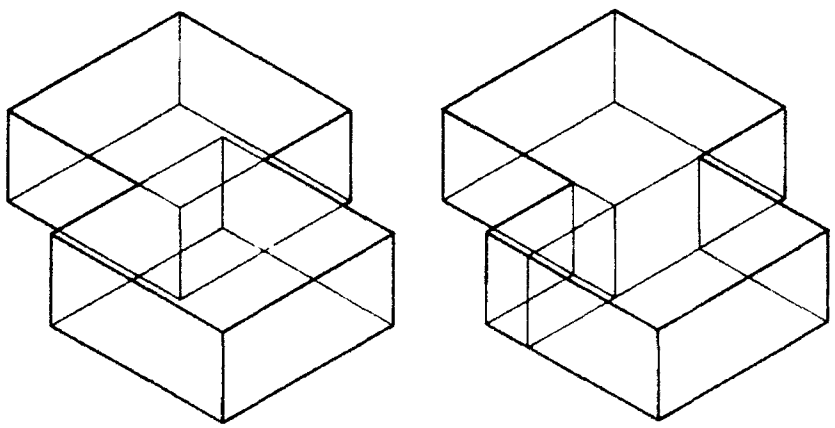
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

When modeling parapet walls, make sure the corners do not intersect.

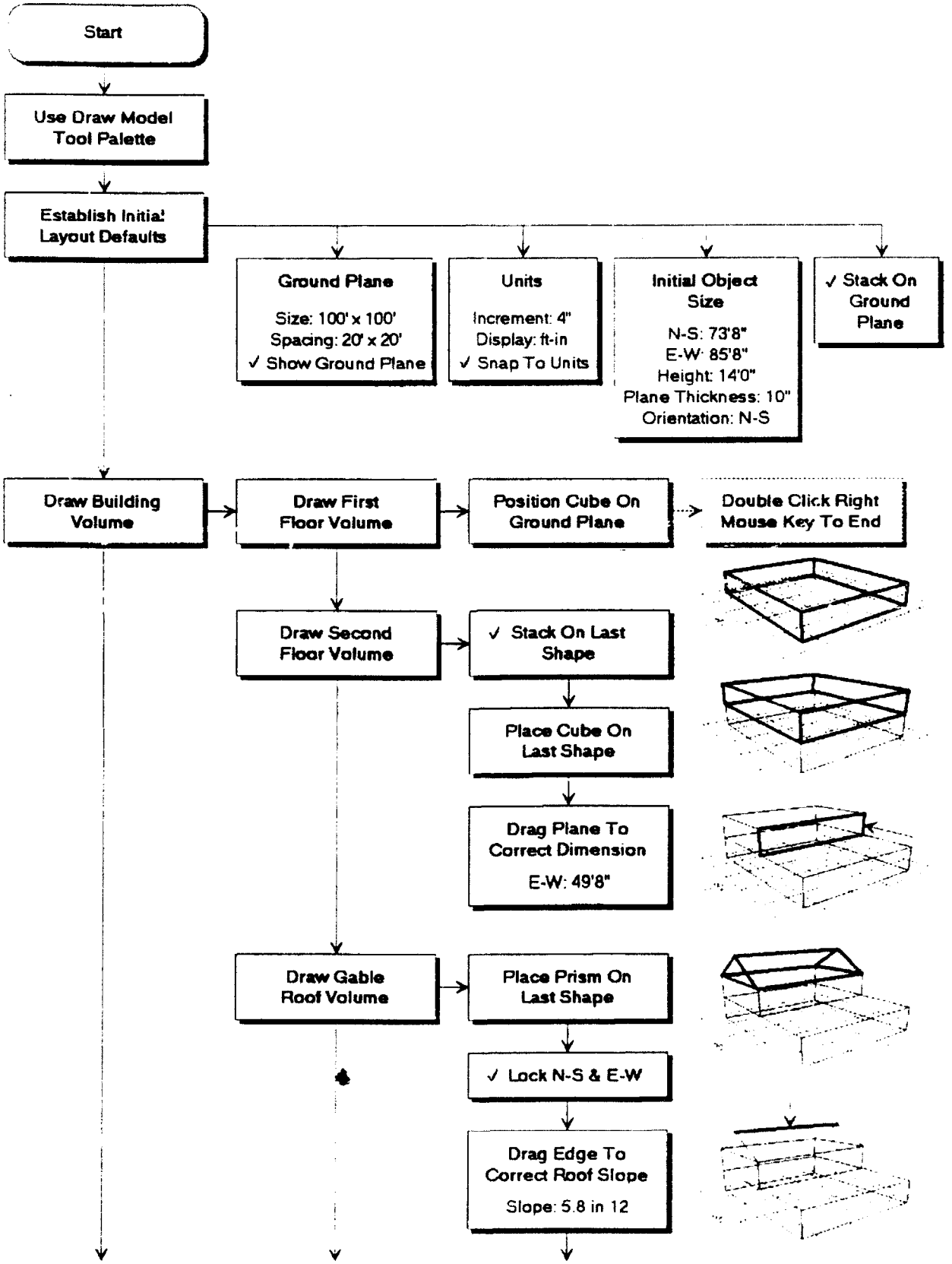


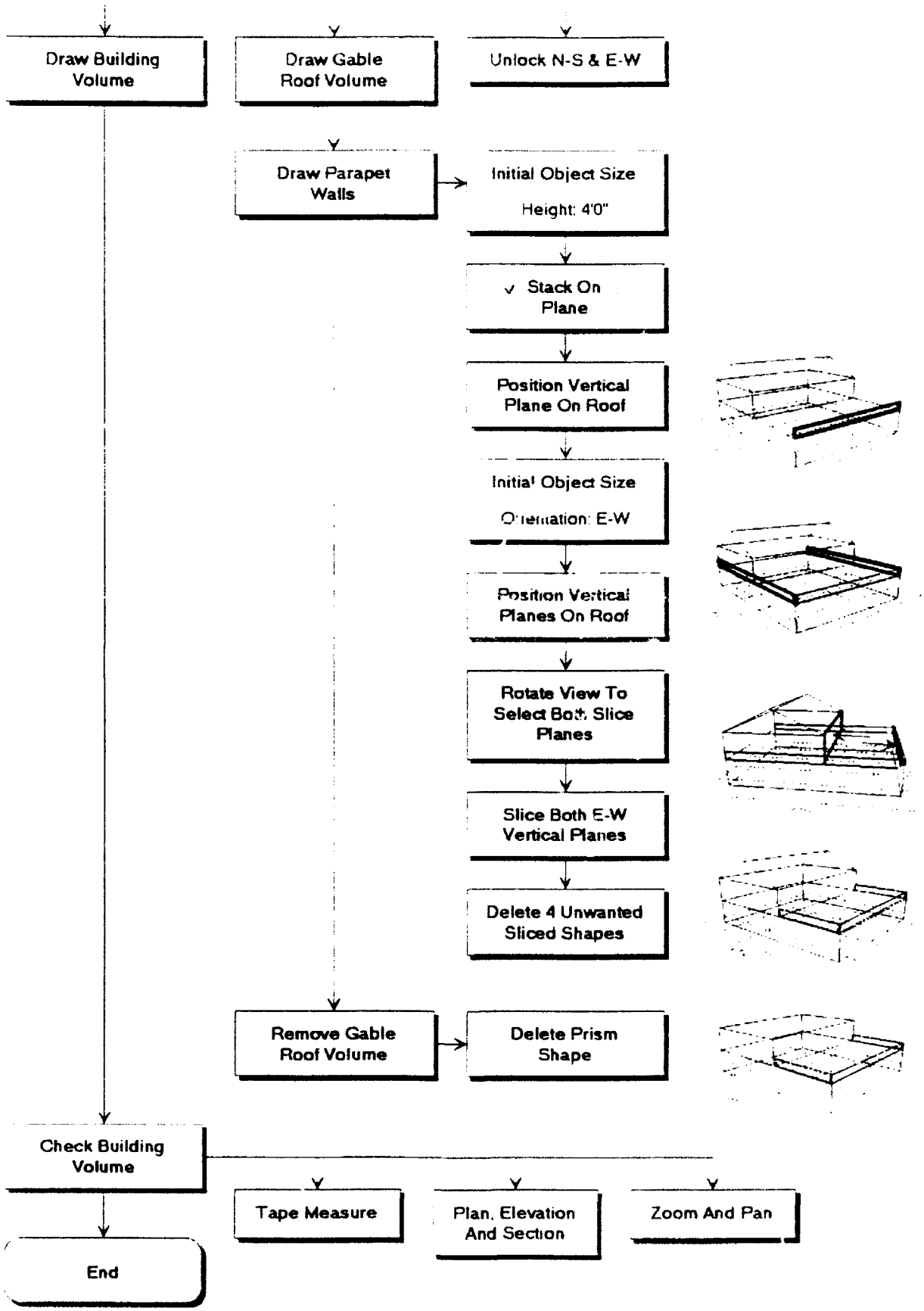
Incorrect Correct

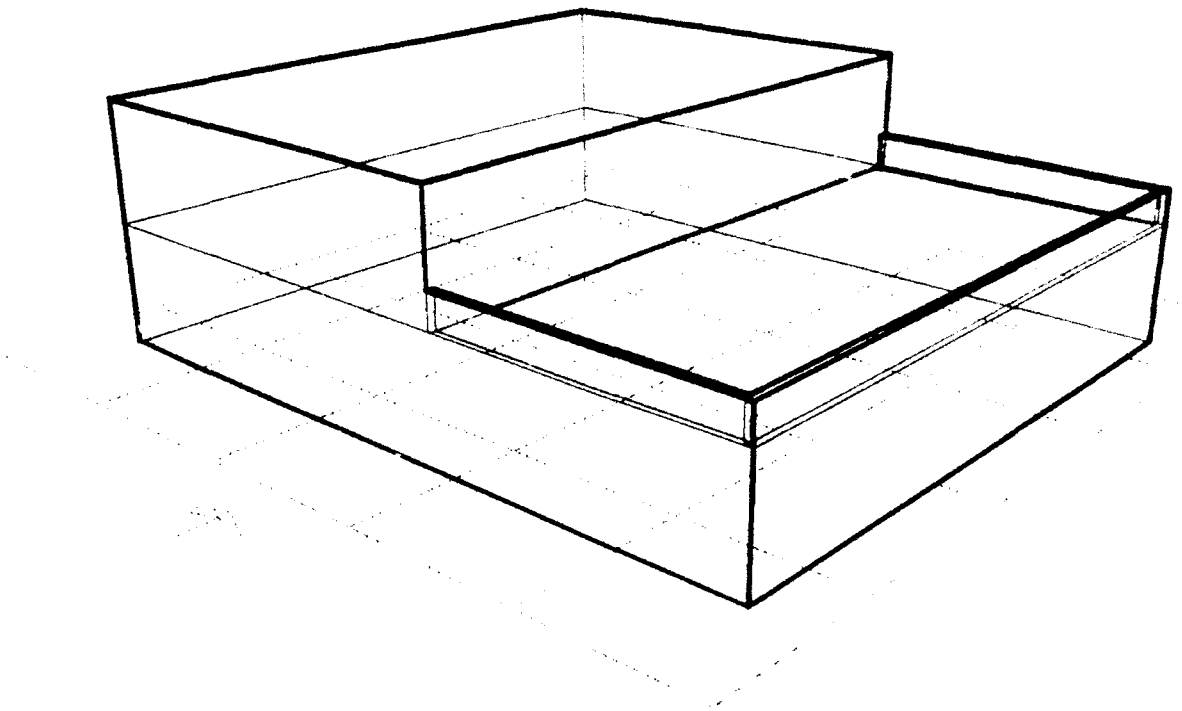
D. Verify the model

Use the Tape Measure command, zoom in on a plan, elevation and 3-D views to verify the model.

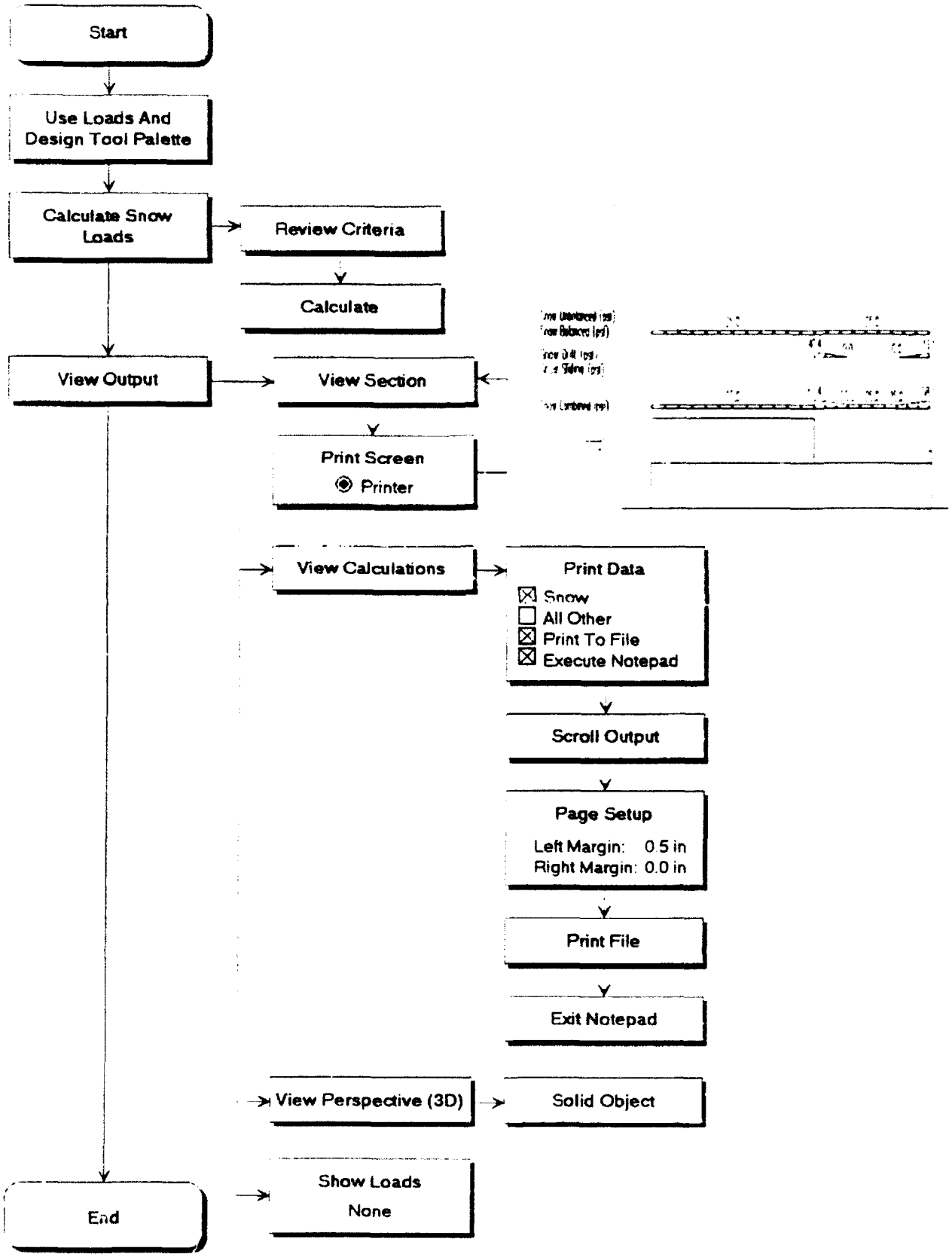
Draw Model

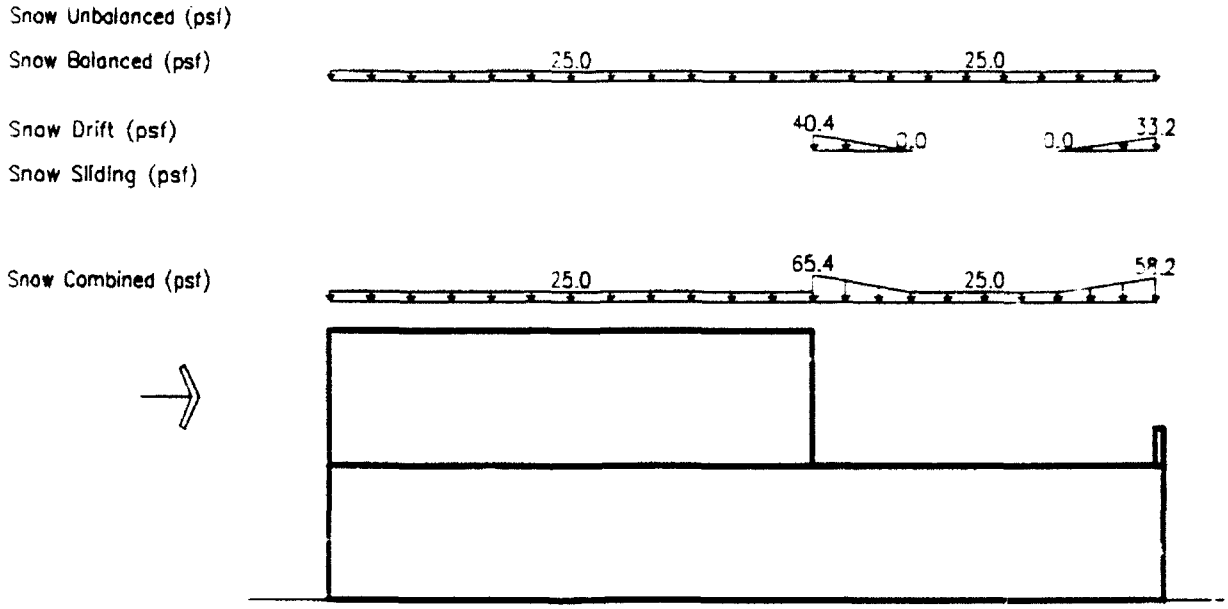

Start
Use Draw Model Tool Palette
Establish Initial Layout Defaults
Ground Plane
Size: 100' x 100'
Spacing: 20' x 20'
✓ Show Ground Plane
Units
Increment: 4"
Display: ft-in
✓ Snap To Units
Initial Object Size
N-S: 73'8"
E-W: 85'8"
Height: 14'0"
Plane Thickness: 10"
Orientation: N-S
✓ Stack On Ground Plane
Draw Building Volume
Draw First Floor Volume
Position Cube On Ground Plane
Double Click Right Mouse Key To End
Draw Second Floor Volume
✓ Stack On Last Shape
Place Cube On Last Shape
Drag Plane To Correct Dimension
E-W: 49'8"
Draw Gable Roof Volume
Place Prism On Last Shape
✓ Lock N-S & E-W
Drag Edge To Correct Roof Slope
Slope: 5.8 in 12

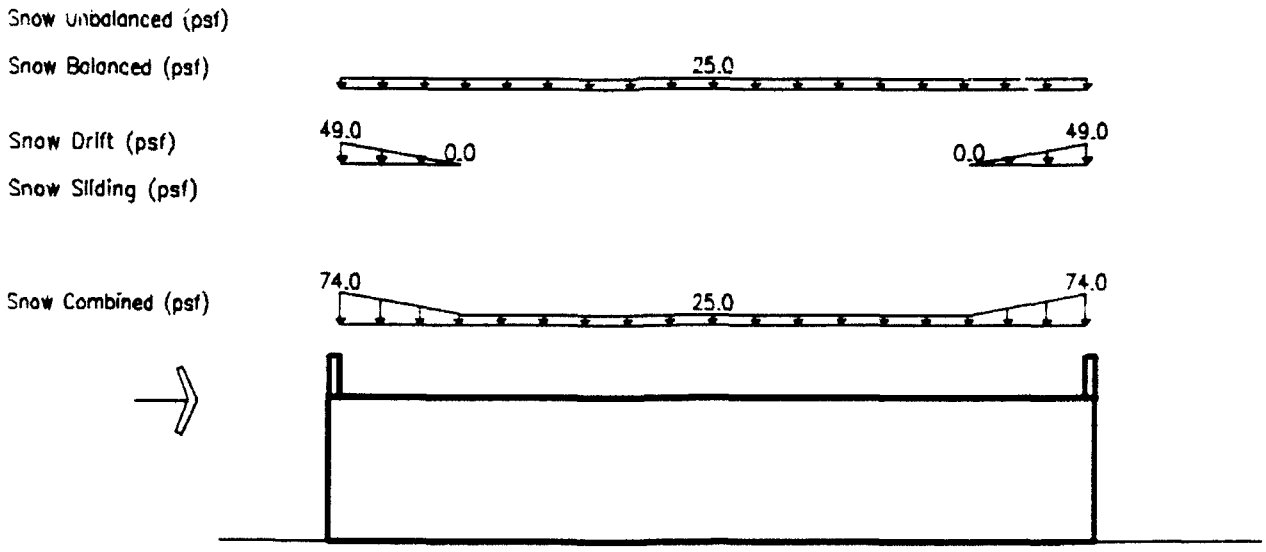

Draw Building Volume
Draw Gable Roof Volume
Unlock N-S & E-W
Draw Parapet Walls
Initial Object Size
Height: 4'0"
Stack On Plane
Position Vertical Plane On Roof
Initial Object Size
Orientation: E-W
Position Vertical Planes On Roof
Rotate View To Select Both Slice Planes
Slice Both E-W Vertical Planes
Delete 4 Unwanted Sliced Shapes
Remove Gable Roof Volume
Delete Prism Shape
Check Building Volume
Tape Measure
Plan, Elevation And Section
Zoom And Pan
End



Snow Loads


Start
Use Loads And Design Tool Palette
Calculate Snow Loads
Review Criteria
Calculate
View Output
View Section
Print Screen
Printer
View Calculations
Print Data
Snow
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End


Snow Unbalanced (psf)
Snow Balanced (psf)
25.0
25.0
Snow Drift (psf)
40.4
0.0
0.0
33.2
Snow Sliding (psf)
Snow Combined (psf)
25.0
65.4
25.0
58.2


Snow Unbalanced (psf)
Snow Balanced (psf)
25.0
Snow Drift (psf)
49.0
0.0
0.0
49.0
Snow Sliding (psf)
Snow Combined (psf)
74.0
25.0
74.0

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1991
Time         : Sat Jan 25, 1992  5:40 PM

******************* Flat/Lean-To Roof Snow Load Design *******************

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*Ct*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I  = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20*I
Min Pf = 20.00 psf
Since theta < 1/2 in/ft, 5 psf rain-on-snow surcharge applies.
+------------------------+
|     Pf = 25.00 psf     |
+------------------------+

Sloped Roof Snow Load (Ps)
Ps = Cs*Pf
Roof Slippery: No
Cs = 1.00
+------------------------+
|     Ps = 25.00 psf     |
+------------------------+

************************* Drift Snow Load Design *************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 20.00 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.16 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.84 ft
hc/hb = 2.45 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 35.17 ft
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 1.93 ft
Width of drift: W = minimum of 4*hd or 4*hc >= 10 ft
w = 4*hd = 7.71 ft
w = 4*hc = 11.36 ft
+------------------------+
|      W = 10.00 ft      |
+------------------------+

hd = hd*(20-s)/20 = 1.93 ft
hd <= hc
Pd = hd*density
+------------------------+
|     Pd = 33.23 psf     |
+------------------------+
```

```
************************ Drift Snow Load Design ************************

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 20.00 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.16 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.84 ft
hc/hb = 2.45 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 72.00 ft
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.85 ft
Width of drift: W = minimum of 4*hd or 4*hc >= 10 ft
w = 4*hd = 11.40 ft
w = 4*hc = 11.36 ft
+-------------------------+
|      W = 11.36 ft       |
+-------------------------+

hd = hd*(20-s)/20 = 2.85 ft
hd > hc, therefore hd = hc = 2.84 ft
Pd = hd*density
+-------------------------+
|     Pd = 49.00 psf      |
+-------------------------+

************************ Drift Snow Load Design ************************

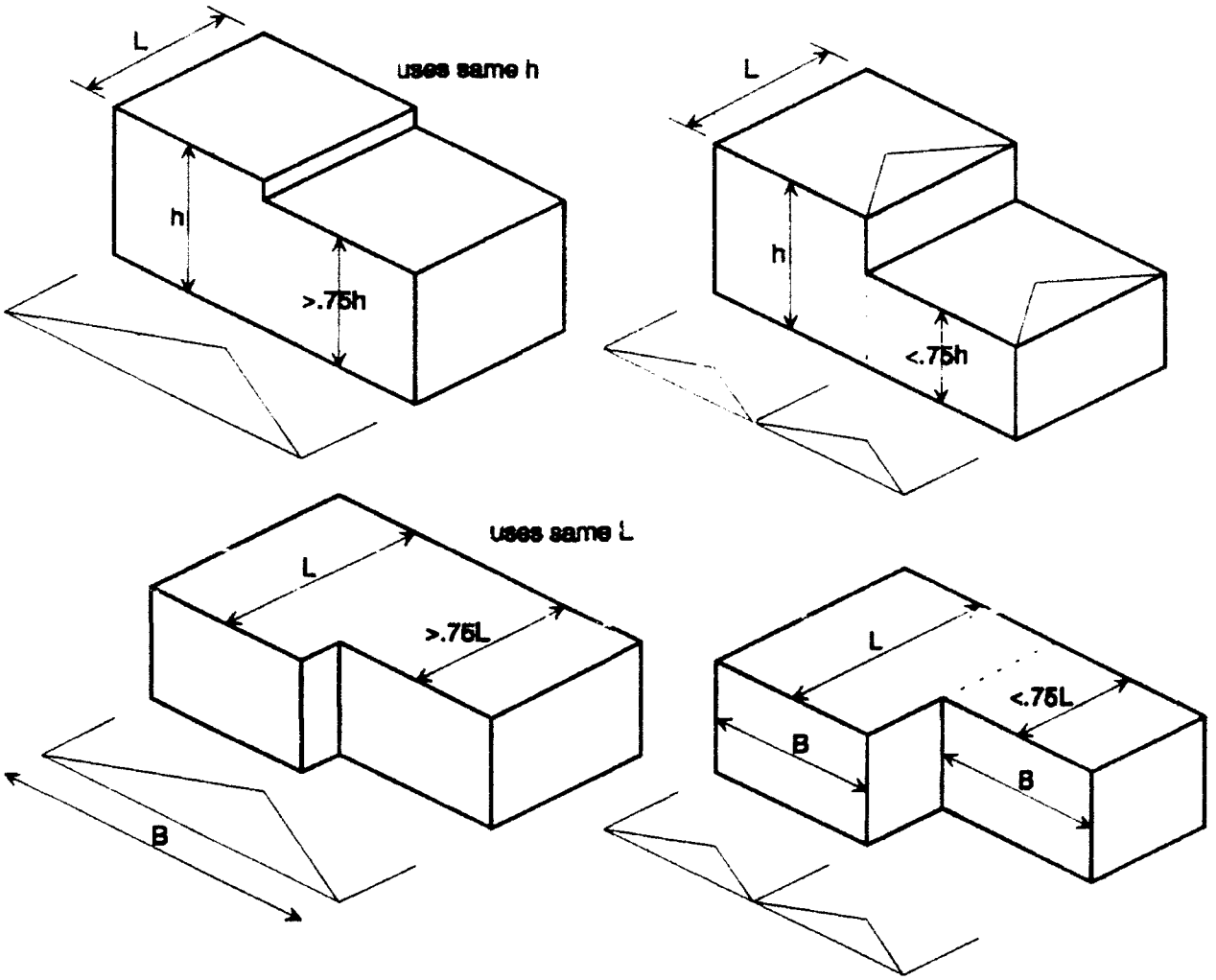
Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 20.00 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.16 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.84 ft
hc/hb = 11.08 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
hd = 0.43*lu^1/3*(Pg+10)^1/4-1.5
hd = 2.34 ft
Width of drift: W = minimum of 4*hd or 4*hc >= 10 ft
w = 4*hd = 9.38 ft
w = 4*hc = 51.36 ft
+-------------------------+
|      W = 10.00 ft       |
+-------------------------+

hd = hd*(20-s)/20 = 2.34 ft
hd <= hc
Pd = hd*density
+-------------------------+
|     Pd = 40.44 psf      |
+-------------------------+
```

Wind Assumptions

Proportions For B/L & h/L

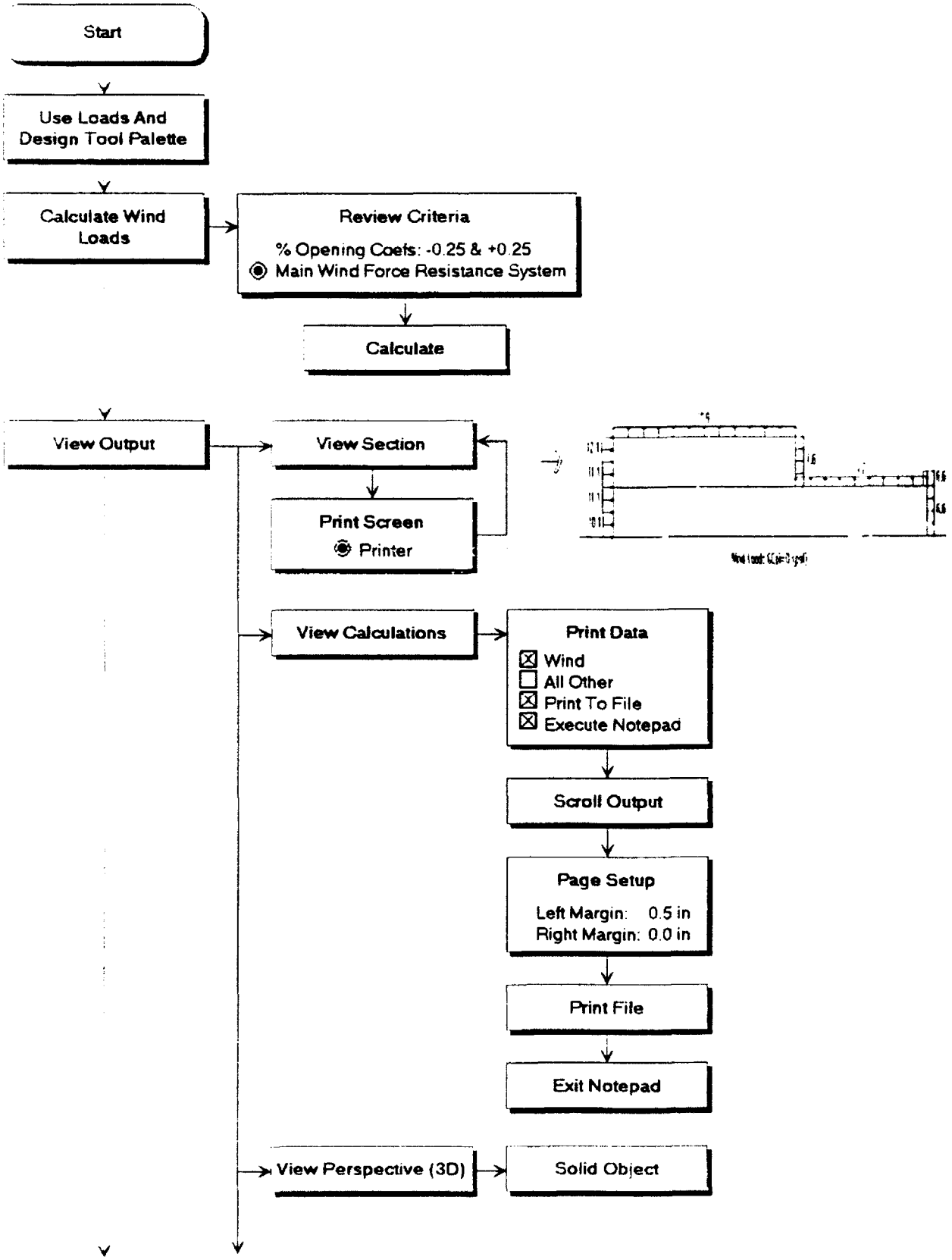
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

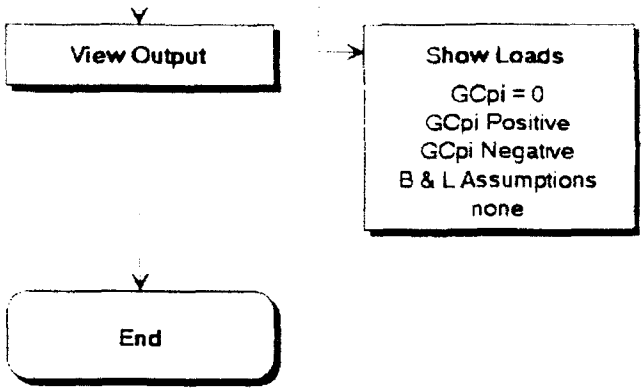


Building Height Maximum 60 Feet

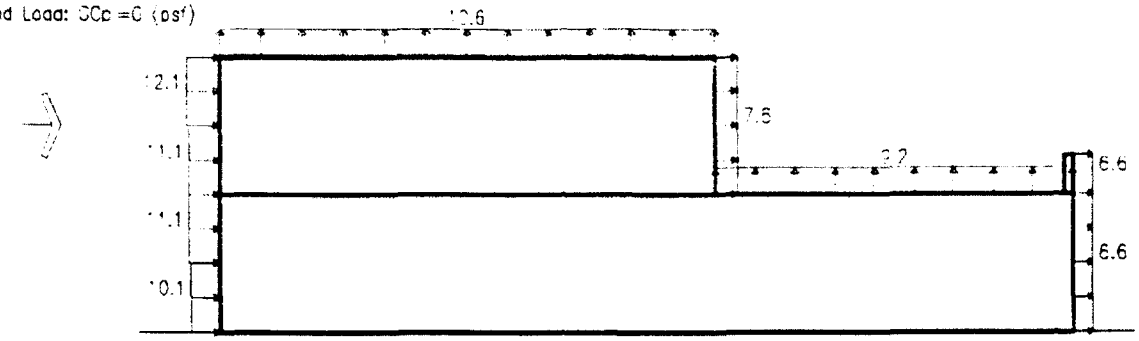
Assumed for components and cladding

Main Wind Force Resisting Loads

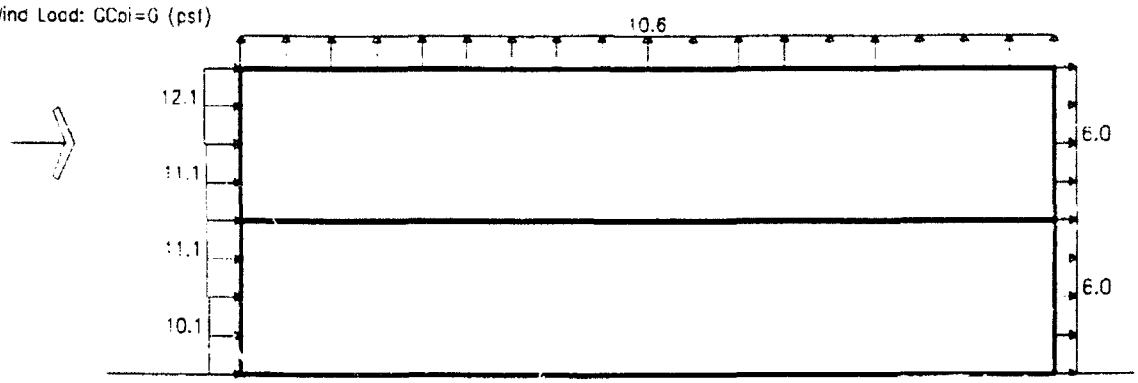



View Output
Show Loads
GCpi = 0
GCpi Positive
GCpi Negative
B & L Assumptions
none
End

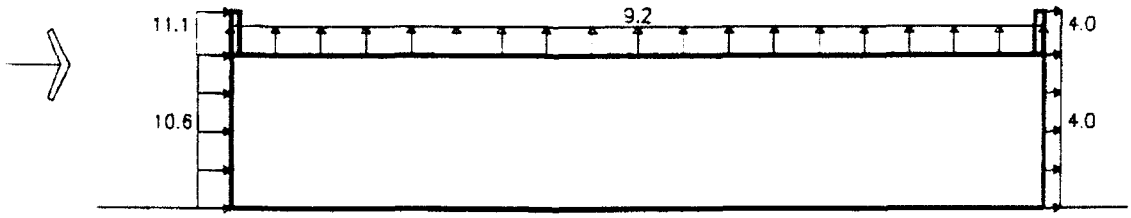
Wind Load: GCpi=0 (psf)

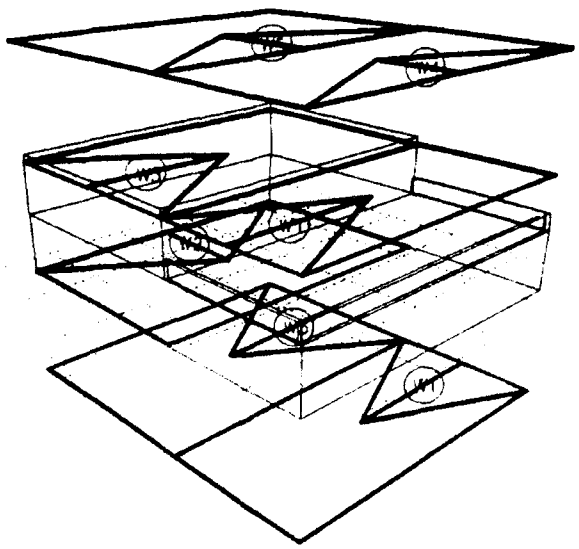


Wind Load: GCpi=0 (psf)



Wind Load: GCpi=0 (psf)





Project : Office Building - Scheme B
Location : Radford AAP
Design Load : TM 5-809-1 1991
Time : Sat Jan 25, 1992 5:46 PM

********** Wind Load - 1 **********

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	36.0	73.7	

Distance to ocean line >= 100 mi. h/d = 0.39 <= 5

********** Main Framing Pressures **********

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	22.0	1.32	0.89	11.2	0.30	11.8		
level 3	18.0	1.32	0.84	10.5	0.80	11.1	13.6	8.6
level 2 - 3	16.0	1.32	0.82	10.3	0.80	10.9	13.4	8.4
level 1 - 2	7.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.30	-4.0	-1.5	-6.5
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

********** Wind Load - 2 **********

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	49.7	

Distance to ocean line >= 100 mi. h/d = 0.56 <= 5

********** Main Framing Pressures **********

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

********** Wind Load - 3 **********

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	49.7	73.7	

Distance to ocean line >= 100 mi. h/d = 0.56 <= 5

********** Main Framing Pressures **********

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 3	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1	14.1	8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0	-3.0	-9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

********** Wind Load - 4 **********

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
70.0	1.00	C	73.7	36.0	

Distance to ocean line >= 100 mi. h/d = 0.39 <= 5

********** Main Framing Pressures **********

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	22.0	1.32	0.89	11.2	0.80	11.8		
level 3	18.0	1.32	0.84	10.5	0.80	11.1	13.6	8.6
level 2 - 3	16.0	1.32	0.82	10.3	0.80	10.9	13.4	8.4
level 1 - 2	7.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.50	-6.6	-4.1	-9.1
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

********** Wind Load - [illegible] **********

Velocity (mph)	Importance Factor	Exposure	Width Perpend. to Wind (ft)	Length Parallel to Wind (ft)	Roof Type
[illegible]	1.00	[illegible]	[illegible]	[illegible]	

Distance to ocean line >= 100 mi. [illegible]d = 0.56 <= 5

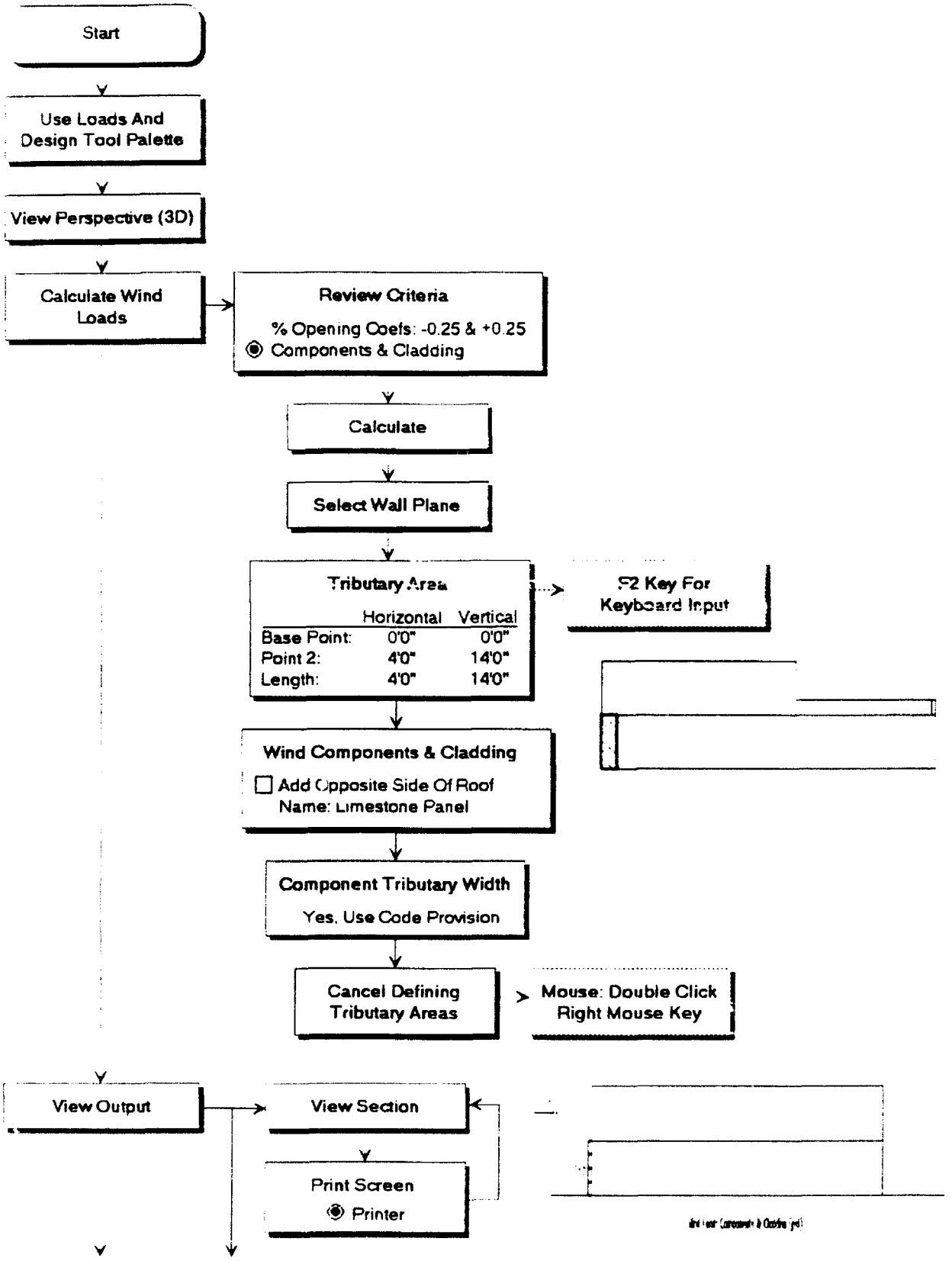
********** Main Framing Pressures **********

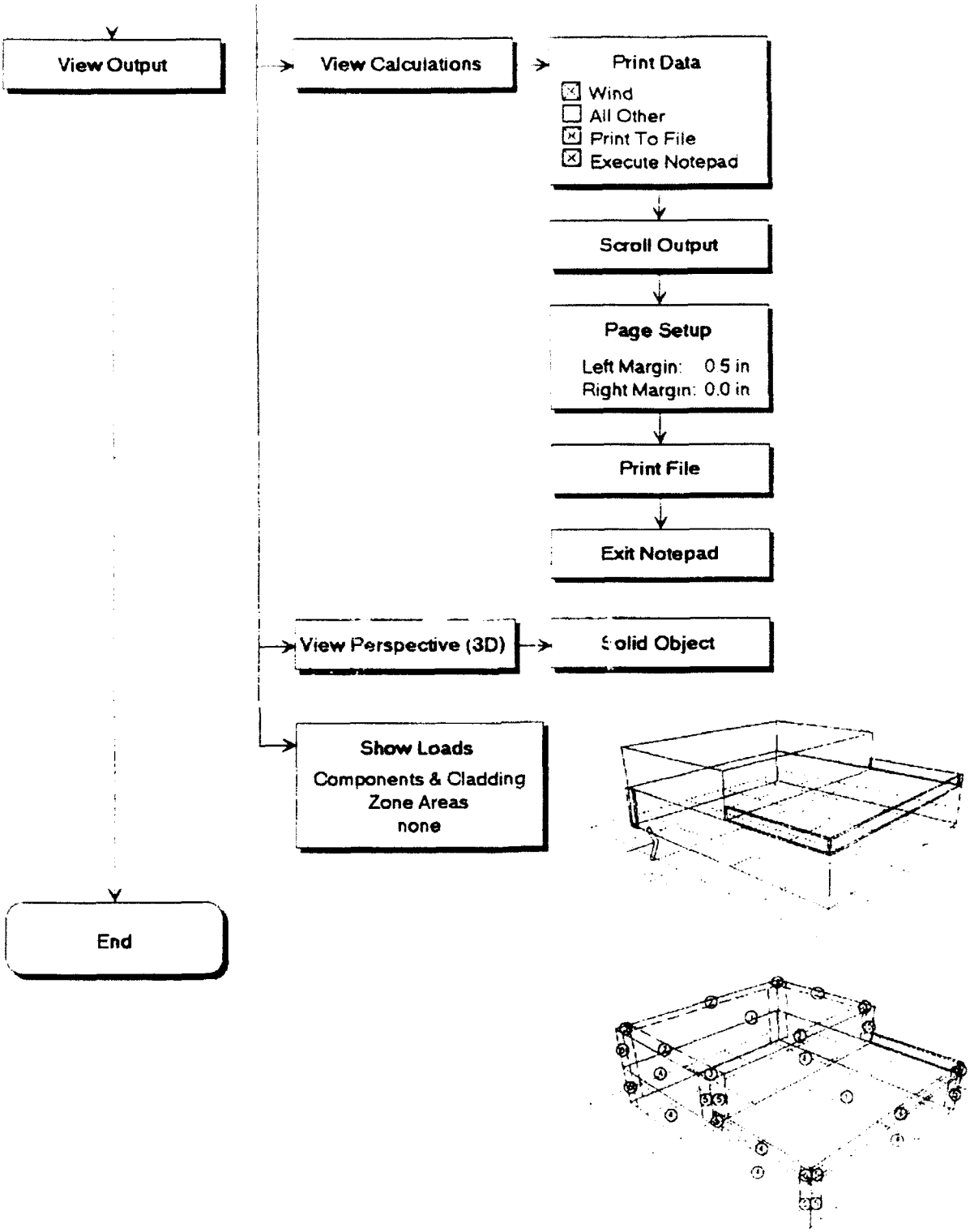
Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
level 2	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
level 1 - 2	14.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

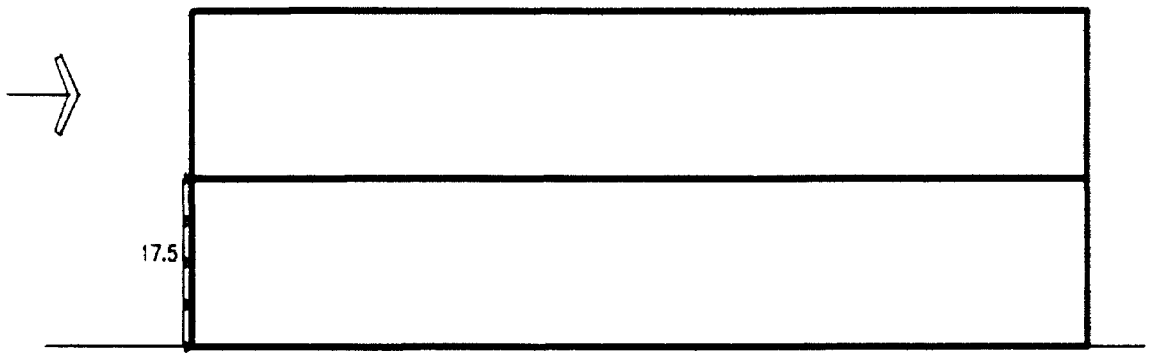
Notes for main framing:
Positive pressures act toward surfaces.
Pressure or suction = P = qh*Gh*Cp-qh*(GCpi)

Wind Components & Cladding Loads

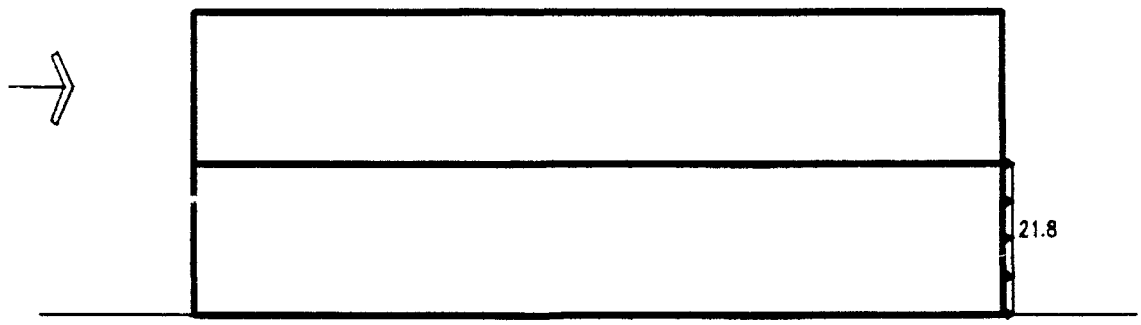


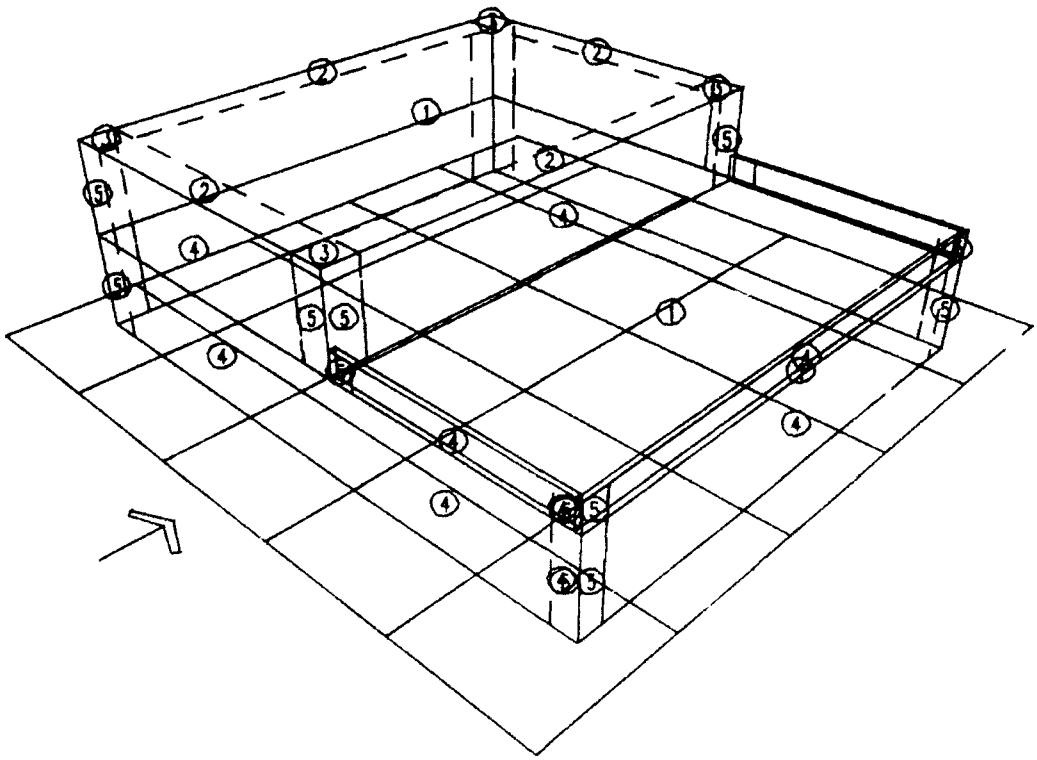

View Output
View Calculations
Print Data
Wind
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
Components & Cladding
Zone Areas
none
End

Wind Load: Components & Cladding (psf)



Wind Load: Components & Cladding (psf)





```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1991
Time         : Sat Jan 25, 1992  5:49 PM

******************************** Wind Load ********************************

Velocity  Importance  Exposure   Width     Length                Roof Type
            Factor               Perpend.  Parallel
                                 to Wind   to Wind
  (mph)                            (ft)      (ft)
-------------------------------------------------------------------------------
   70.0      1.00         C       49.7      73.7

Distance to ocean line >= 100 mi.   h/d = 0.56 <= 5

 Height      Kh       qh        GCpi
  (ft)               (psf)
---------------------------------------------
  28.0      0.96     12.0    -0.25  0.25

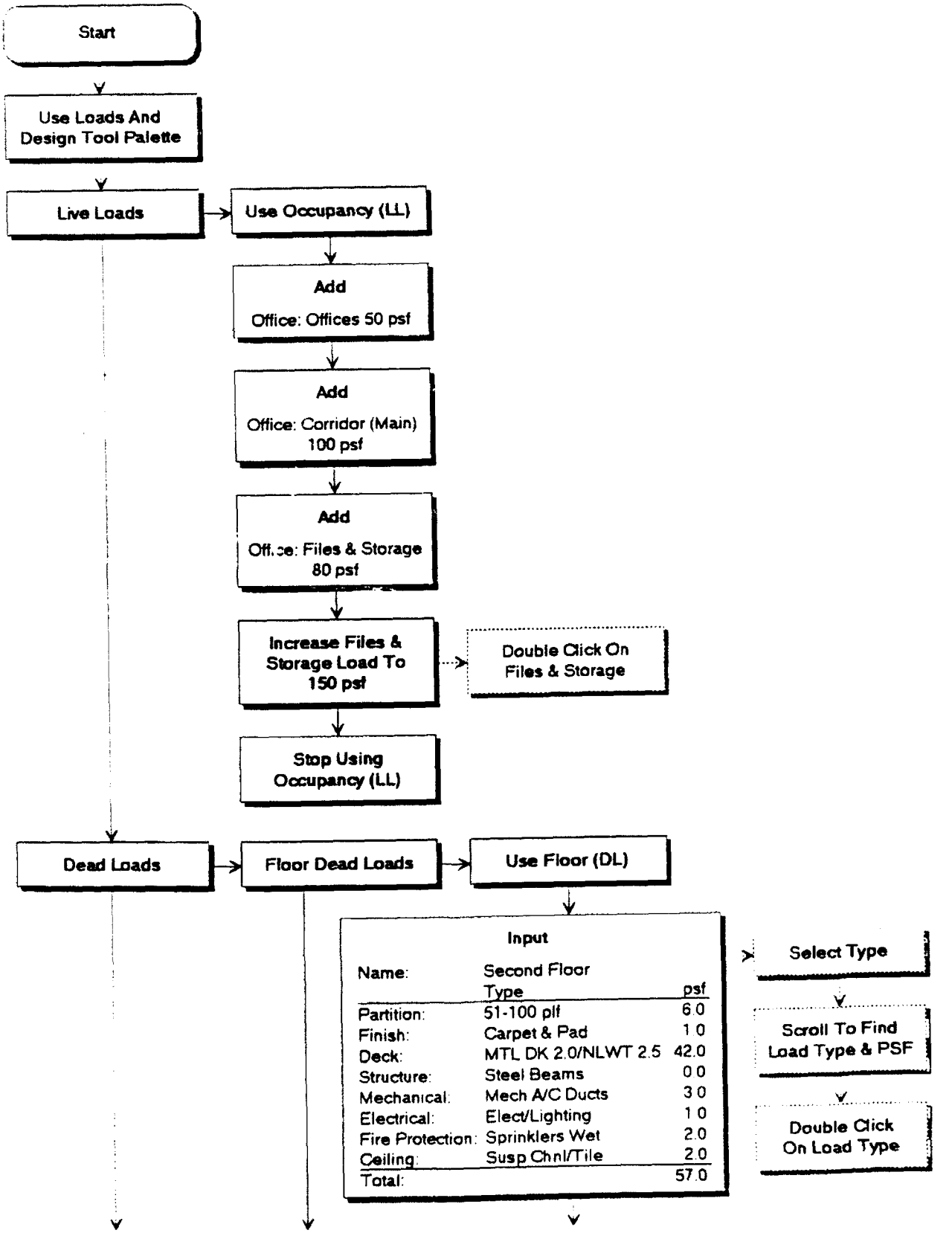
Height <= 60 ft

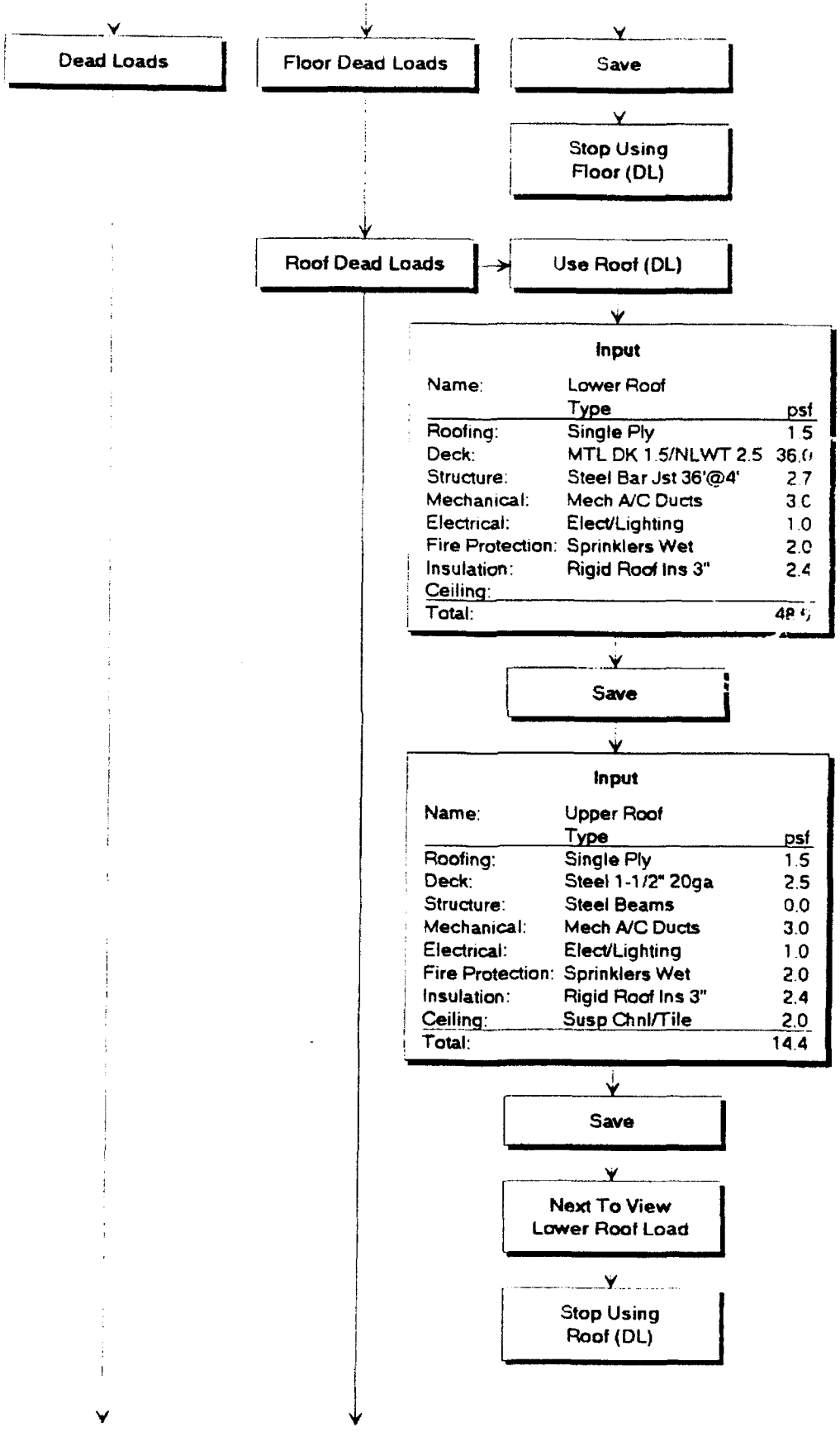
******************* Component/Cladding Pressures (psf) ********************

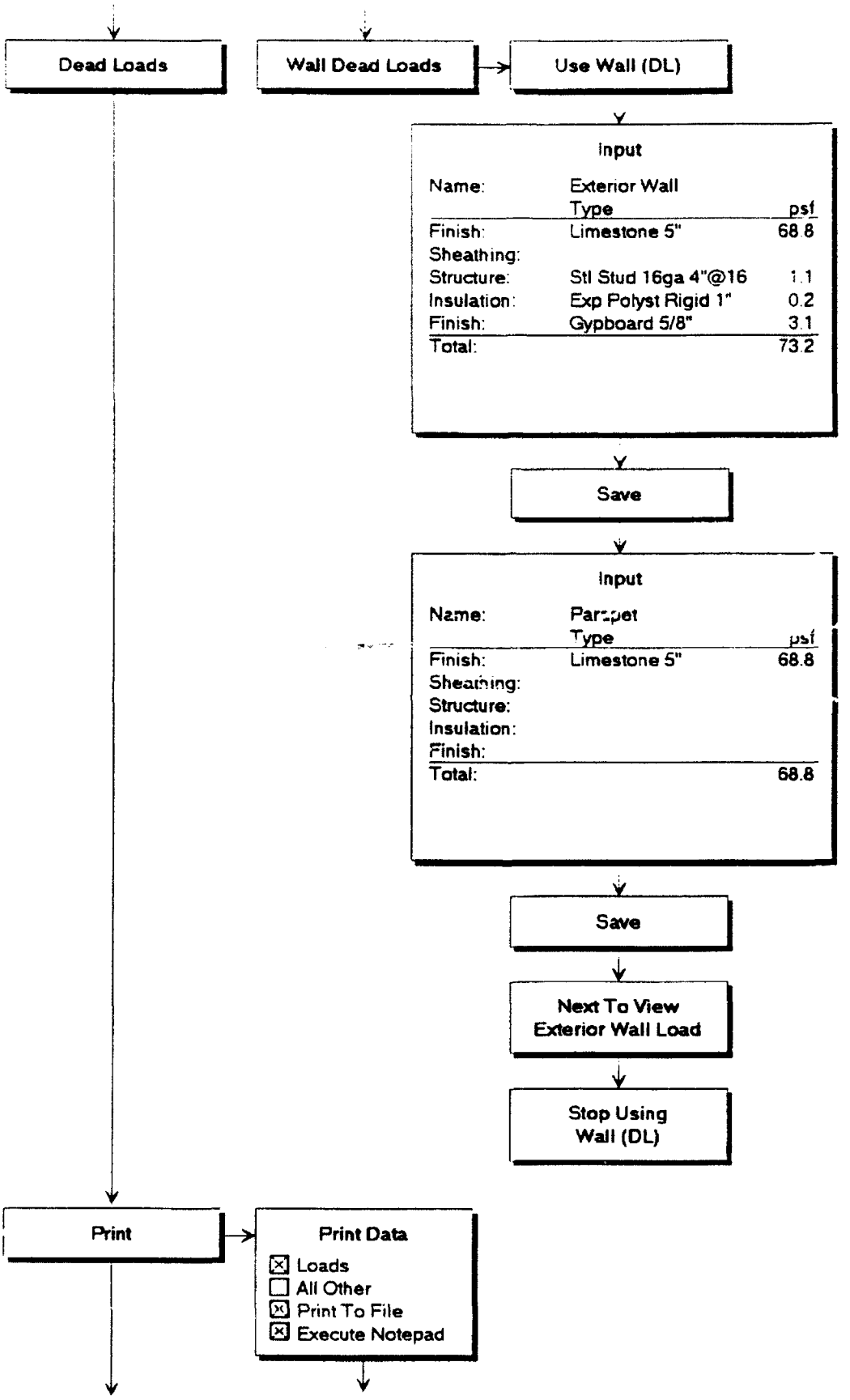
           ----------------------- -----Walls-----------------------------
                     Windward                          Leeward
Tributary     Zone 4           Zone 5           Zone 4           Zone 5
Area (sf)     middles          corners          middles          corners
            GCp      P       GCp      P       GCp      P       GCp      P
           ---------------------------------------------------------------
Internal           -3.0             -3.0              3.0              3.0
Limestone Panel  4.67 ft x 11.00 ft **
  65.3      1.21   17.5      1.21   17.5     -1.31  -18.7     -1.57  -11.0
      a = 5.0 ft

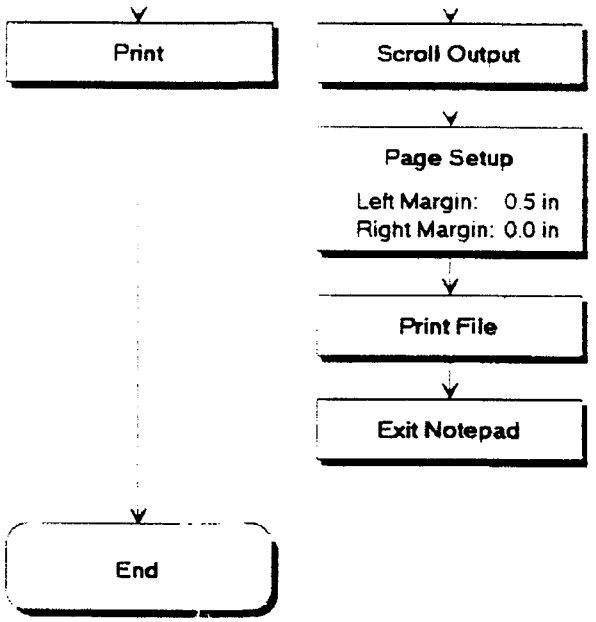
Notes for components and cladding:
   P = qh(GCp)-qh(GCpi)
   Internal pressures have been included in above values.
   *  For roof overhangs: algebraically add this pressure
      to the above values.  P = qh(GCp) = 0.8qh
   To comply with TM 5-809-1, wall external pressures
   have not been reduced 10% per ASCE figure 3, note 3.
   ** For a rectangular tributary area, the width of the area
      need not be less than one-third the length of the area.
```

Dead & Live Loads




Dead Loads
Floor Dead Loads
Save
Stop Using Floor (DL)
Roof Dead Loads
Use Roof (DL)
Input
Name: Lower Roof
Type psf
Roofing: Single Ply 1.5
Deck: MTL DK 1.5/NLWT 2.5 36.0
Structure: Steel Bar Jst 36'@4' 2.7
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling:
Total:
Save
Input
Name: Upper Roof
Type psf
Roofing: Single Ply 1.5
Deck: Steel 1-1/2" 20ga 2.5
Structure: Steel Beams 0.0
Mechanical: Mech A/C Ducts 3.0
Electrical: Elect/Lighting 1.0
Fire Protection: Sprinklers Wet 2.0
Insulation: Rigid Roof Ins 3" 2.4
Ceiling: Susp Chnl/Tile 2.0
Total: 14.4
Save
Next To View Lower Roof Load
Stop Using Roof (DL)


Dead Loads
Wall Dead Loads
Use Wall (DL)
Input
Name: Exterior Wall
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure: Stl Stud 16ga 4"@16 1.1
Insulation: Exp Polyst Rigid 1" 0.2
Finish: Gypboard 5/8" 3.1
Total: 73.2
Save
Input
Name: Parapet
Type psf
Finish: Limestone 5" 68.8
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8
Save
Next To View Exterior Wall Load
Stop Using Wall (DL)
Print
Print Data
Loads
All Other
Print To File
Execute Notepad


Print
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Loads

Floor Dead Loads

Name : Second Floor

	Type	psf
Partition	: 51-100 plf	6.0
Finish	: Carpet & Pad	1.0
Deck	: MTL DK 2.0/NLWT 2.5	42.0
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Ceiling	: Susp Chnl/Tile	2.0
Total	:	57.0

Roof Dead Loads

Name : Lower Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: MTL DK 1.5/NLWT 2.5	36.0
Structure	: Steel Bar Jst 36'@4'	2.7
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	:	0.0
Total	:	48.6

Name : Upper Roof

	Type	psf
Roofing	: Single Ply	1.5
Deck	: Steel 1-1/2" 20ga	2.5
Structure	: Steel Beams	0.0
Mechanical	: Mech A/C Ducts	3.0
Electrical	: Elect/Lighting	1.0
Fire Protection	: Sprinklers Wet	2.0
Insulation	: Rigid Roof Ins 3"	2.4
Ceiling	: Susp Chnl/Tile	2.0
Total	:	14.4

Wall Dead Loads

Name : Exterior Wall

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	: Stl Stud 16ga 4"@16	1.1
Insulation	: Exp Polysty Rigid 1"	0.2
Finish	: Gypboard 5/8"	3.1
Total	:	73.2

Name : Parapet

	Type	psf
Finish	: Limestone 5"	68.8
Sheathing	:	0.0
Structure	:	0.0
Insulation	:	0.0
Finish	:	0.0
Total	:	68.8

Occupancy Live Loads

Name	psf
Office: Offices	50
Office: Corridor (main)	100
Office: Files & Storage	150a

a. Variable design load. Increase may be necessary.

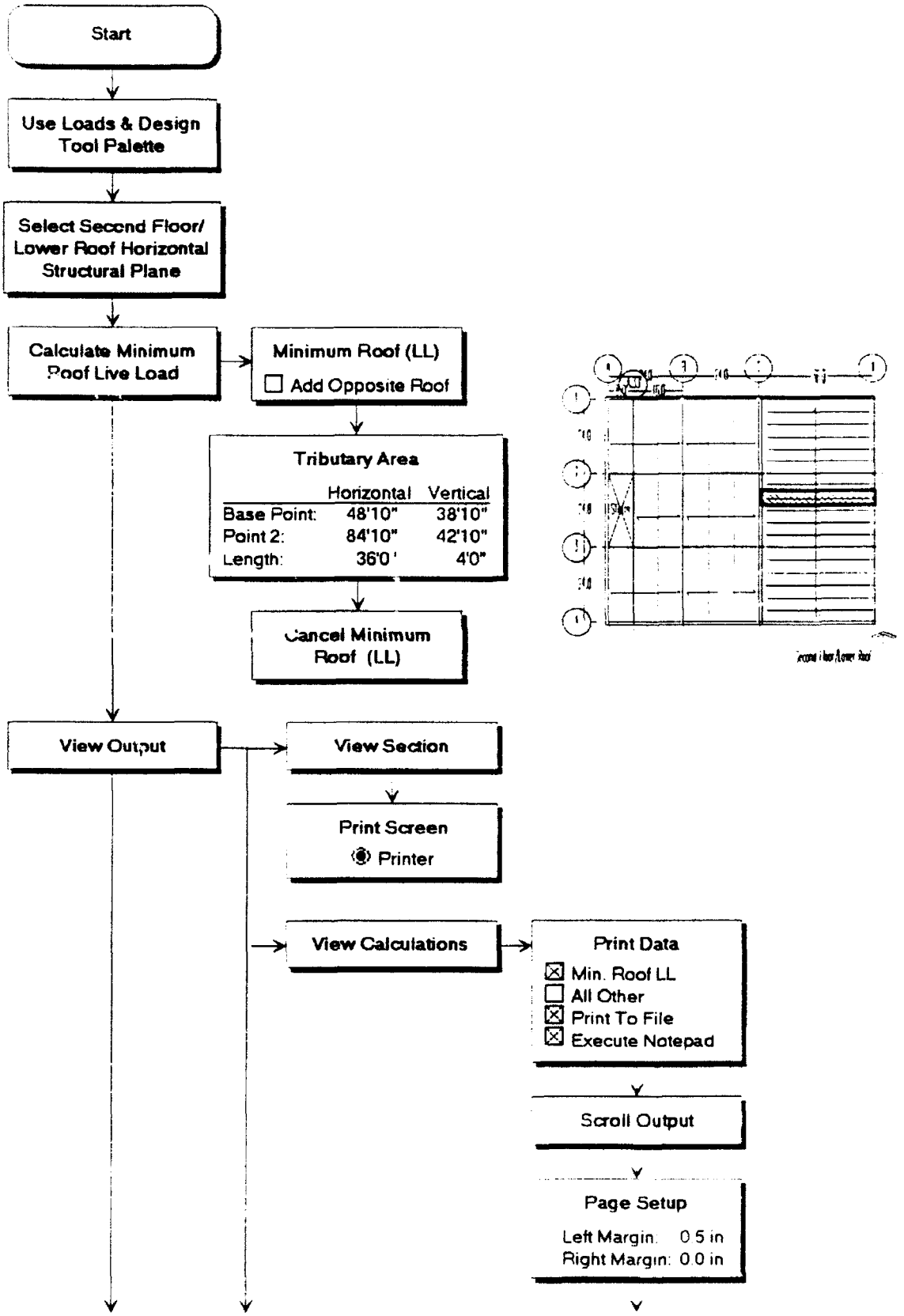
Notes

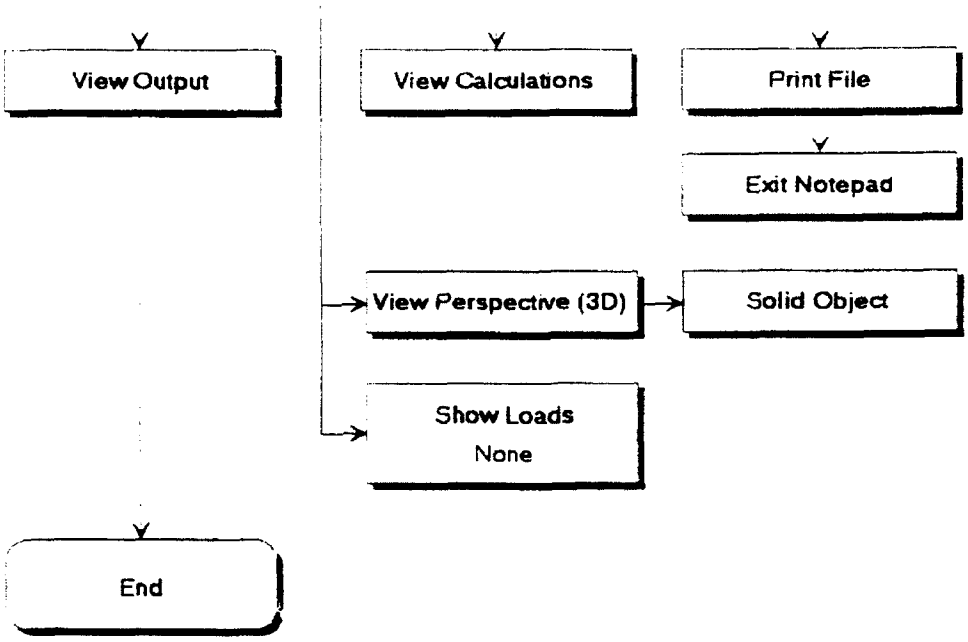
Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400 sq ft or more may be reduced with: L = Lo*[0.25+(15/sqrt(Ai))]
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.
Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- public assembly
- garages (except where 2 or more floors are supported)
- one-way slab floor

For live loads greater than 100 psf and for garages used for passenger cars only, no reduction is permitted for members supporting one floor; however, where two or more floors are supported, a 20% reduction is permitted.

Minimum Roof Live Load




View Output
View Calculations
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
None
End

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1991
Time         : Sun Jan 26, 1992  4:25 PM

********************** Minimum Roof Live Load (Lr) **********************

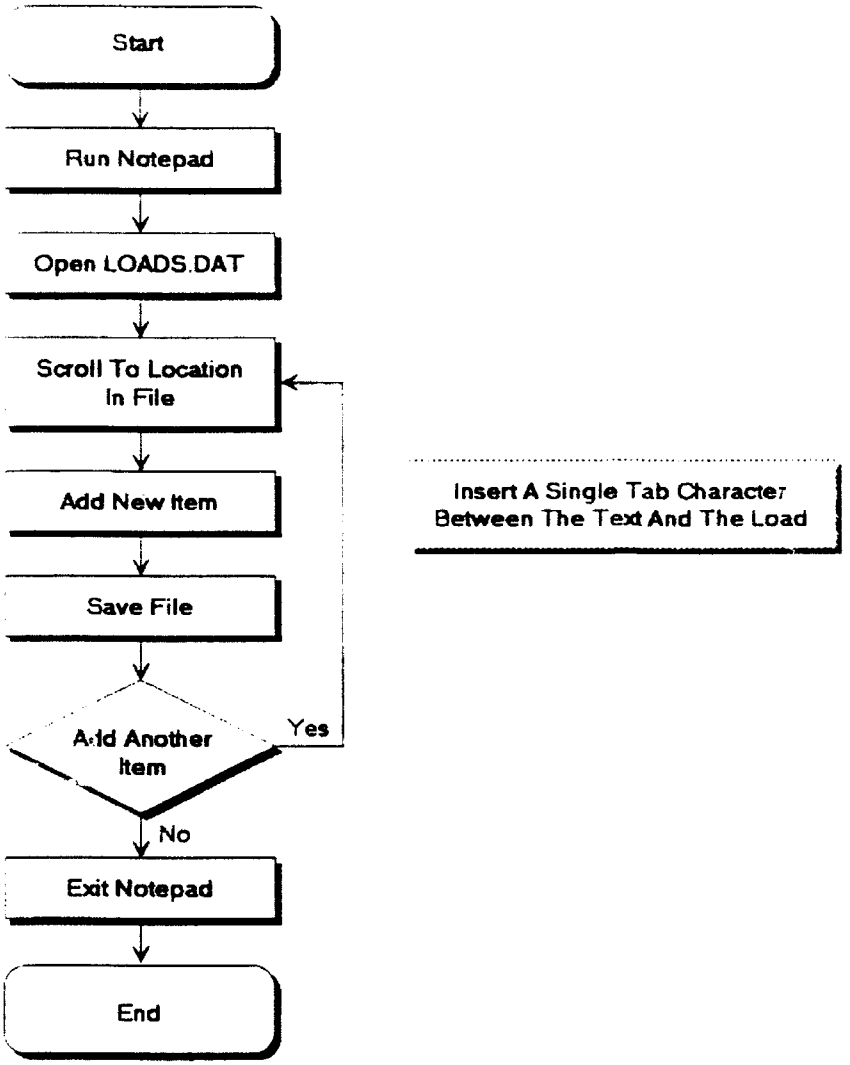
Tributary area (At) : 144 sf
Roof slope     (F)  : 0.00 in 12

Lr = 20*R1*R2 >= 12
At <= 200        R1 = 1.00
F <= 4           R2 = 1.00
Lr = 20.00 psf
minimum Lr = 12 psf
+-------------------------+
!     Lr = 20.00 psf      !
+-------------------------+
```

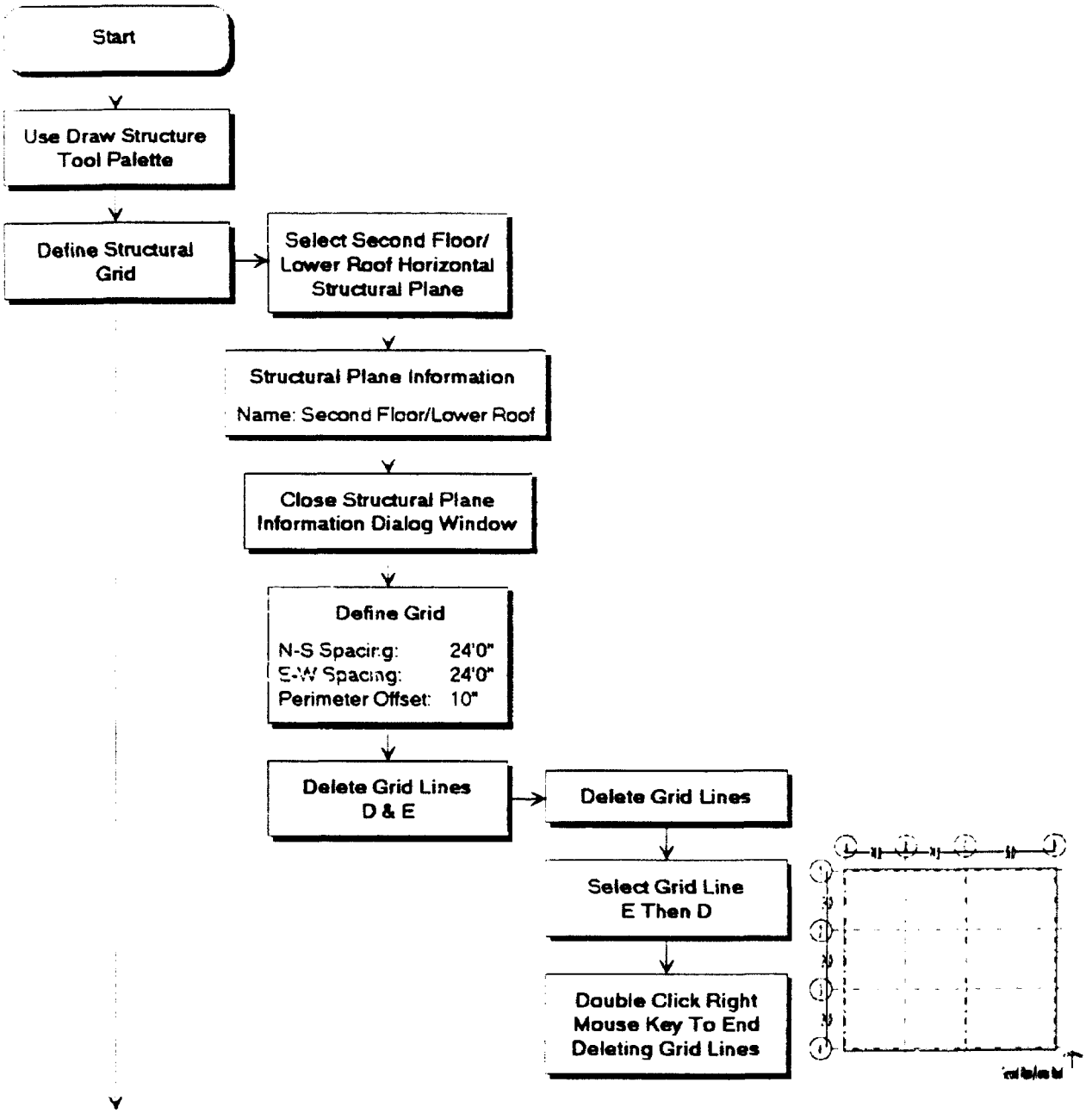
Check minimum roof live load, Lr, against minimum snow design loads.

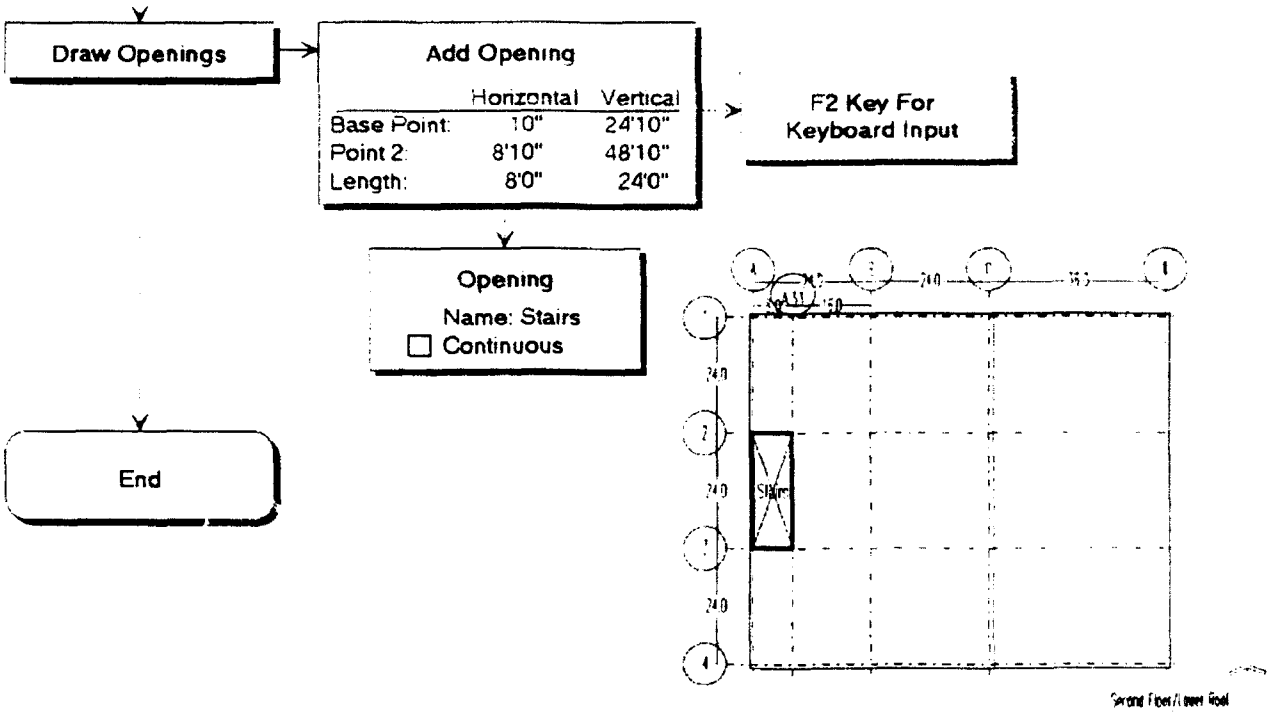
Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2 feet square (4 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Loads Database



Draw Grid & Openings

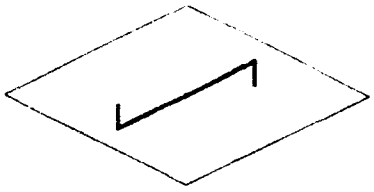



Draw Openings
Add Opening
Horizontal Vertical
Base Point: 10" 24'10"
Point 2: 8'10" 48'10"
Length: 8'0" 24'0"
F2 Key For Keyboard Input
Opening
Name: Stairs
Continuous
End

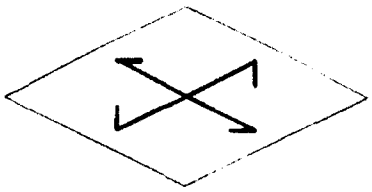
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



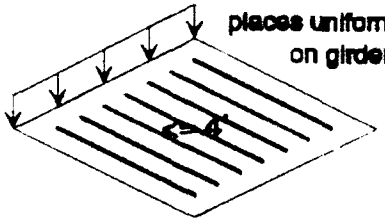
1 way



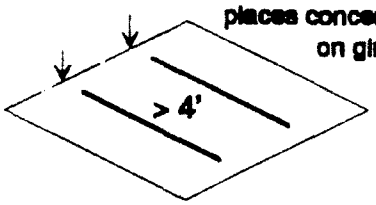
2 way
(not activated)

Linear
(horizontal)

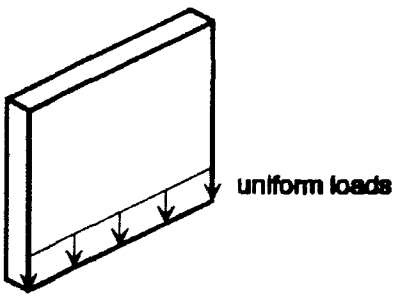
Narrowly Spaced
(joists)



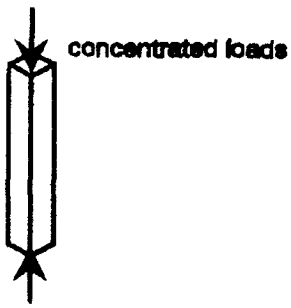
Widely Spaced
(beams)



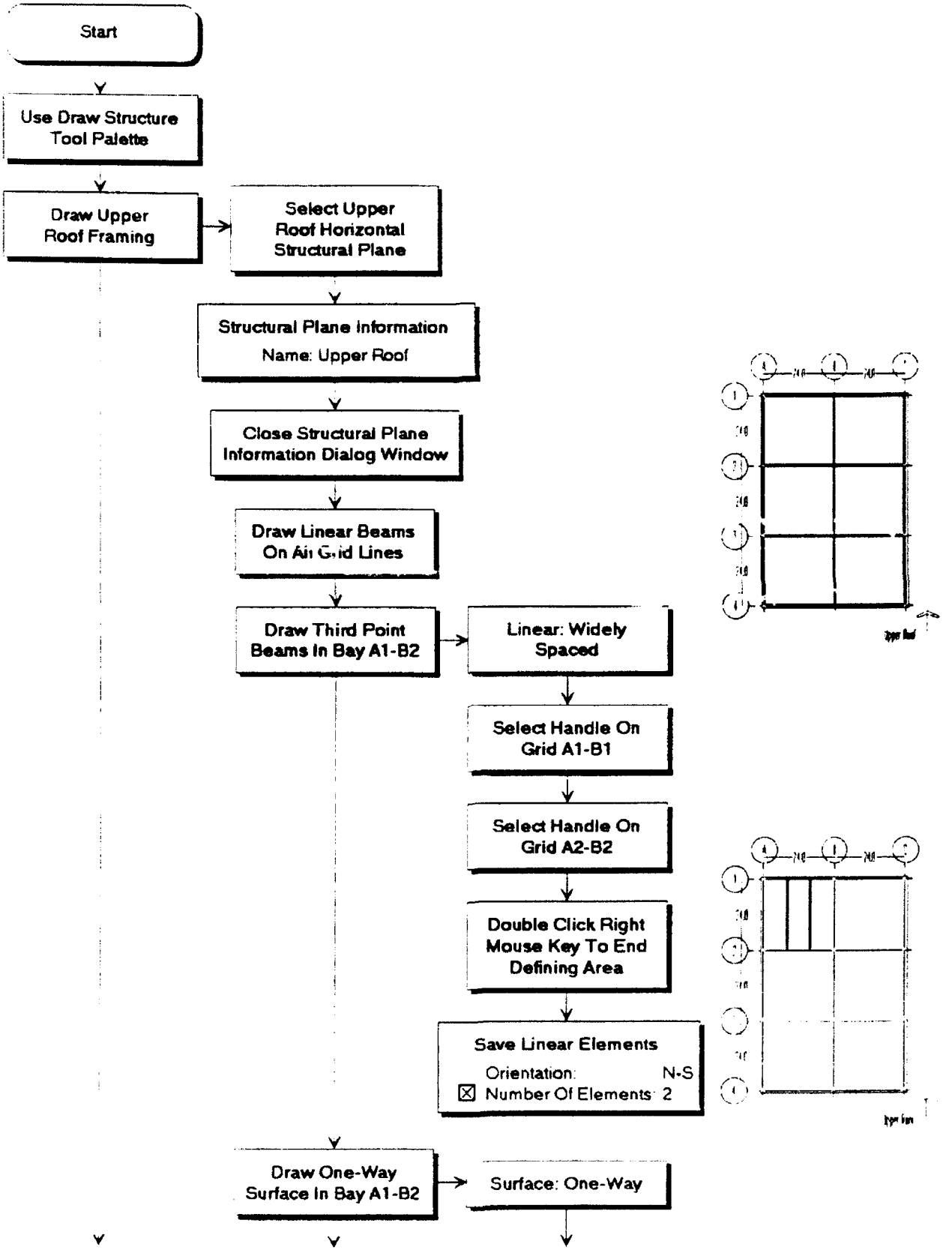
Surface
(vertical)
(planar)

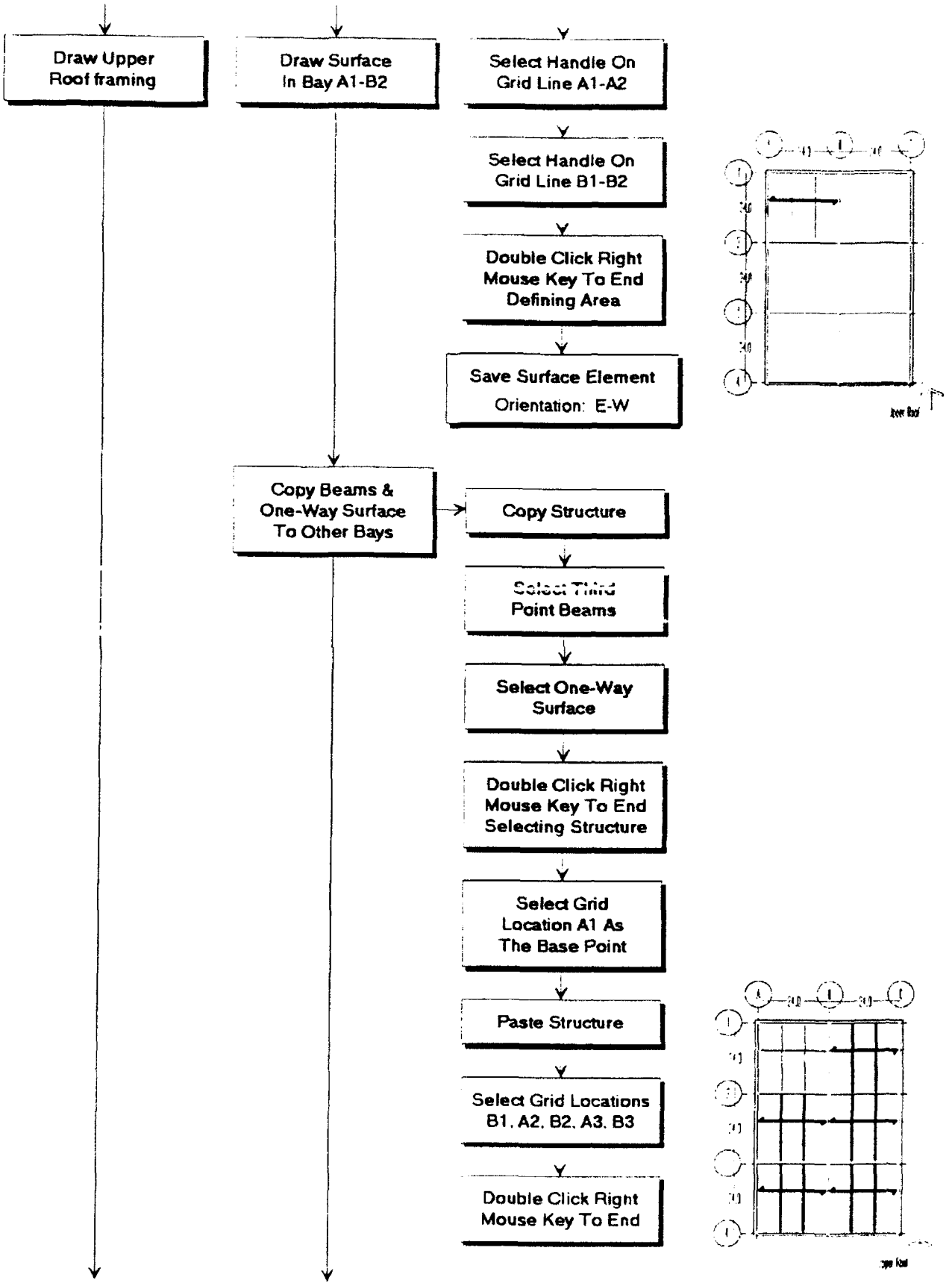


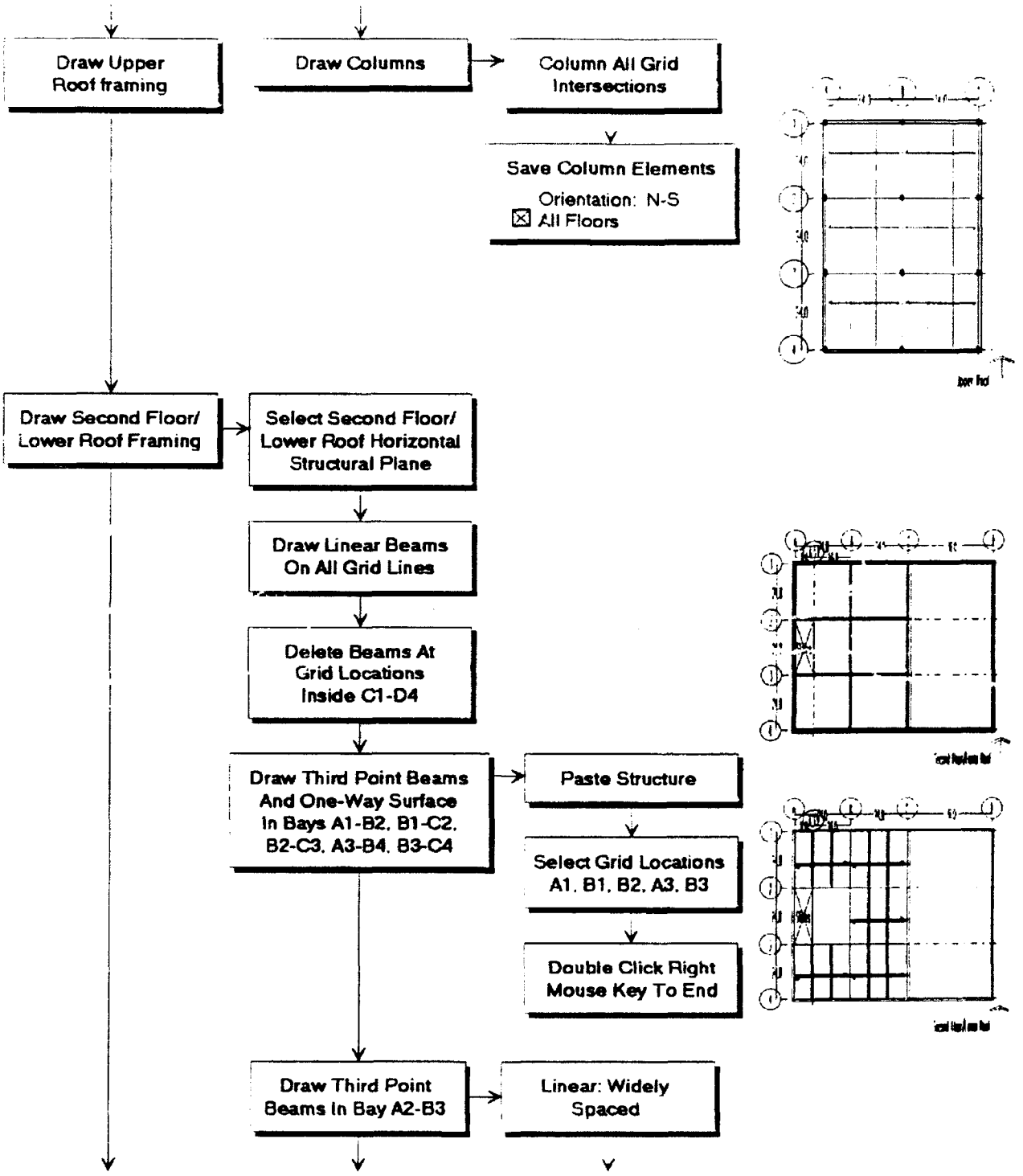
Linear
(vertical)

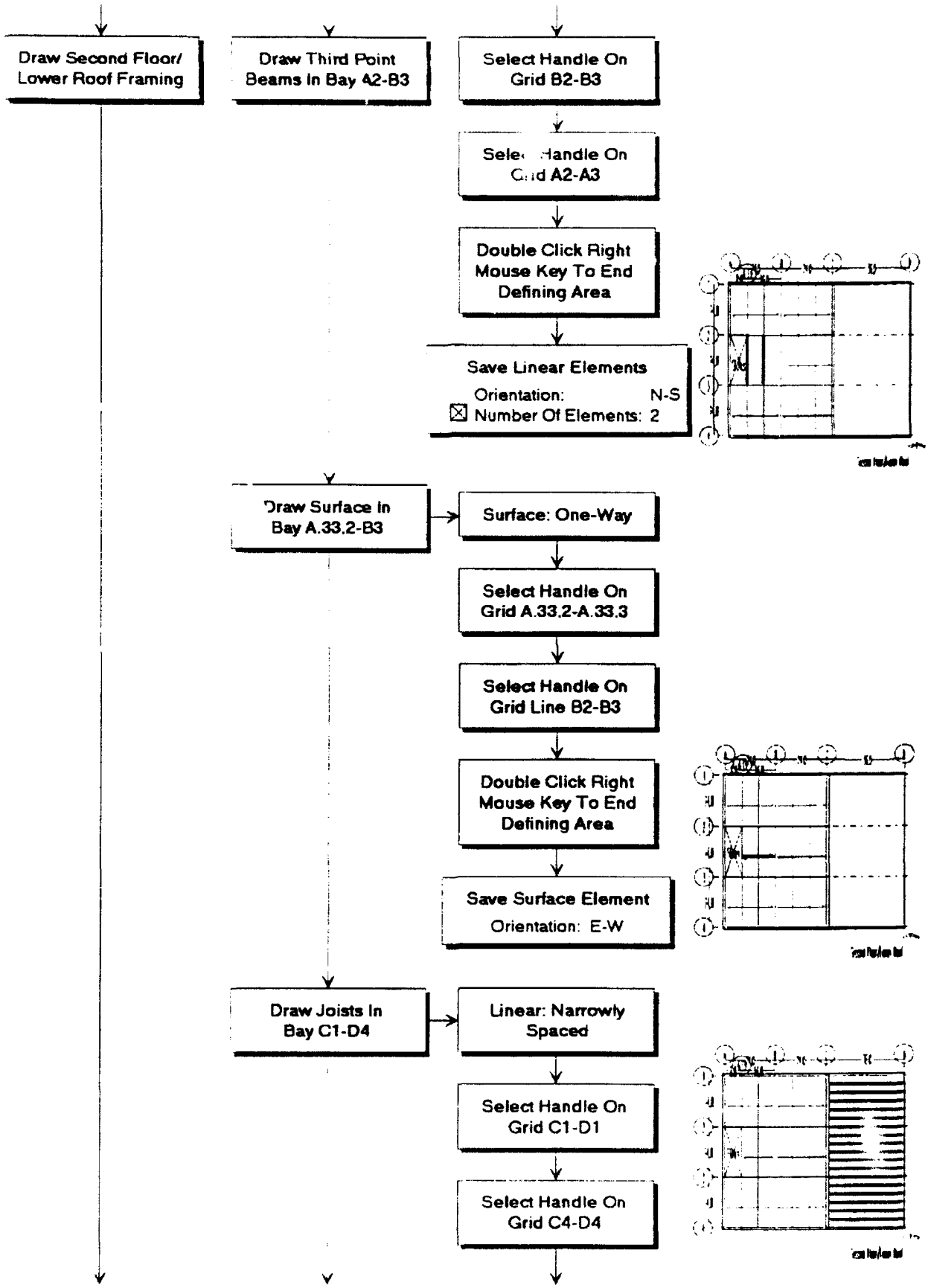


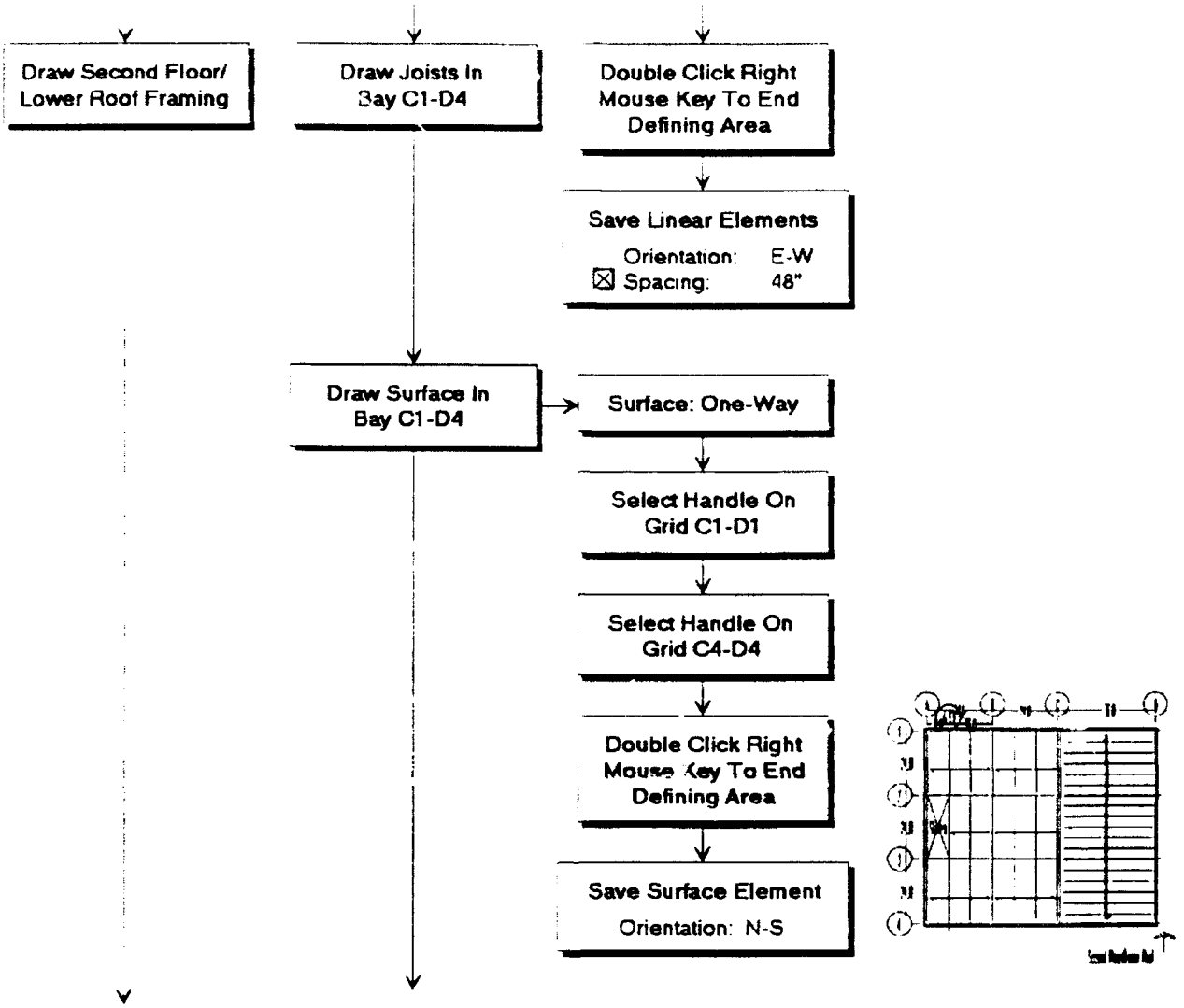
Draw Structure

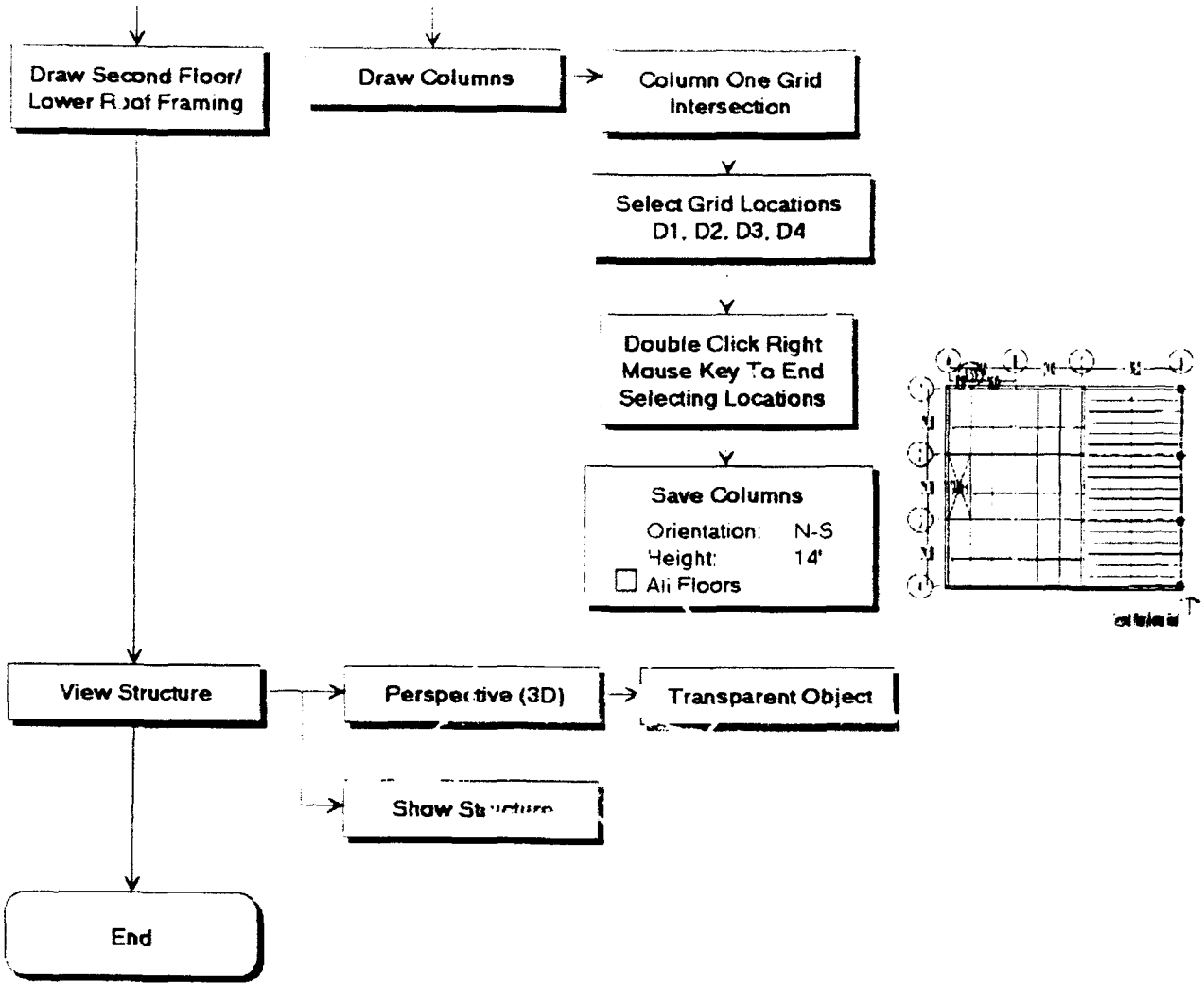


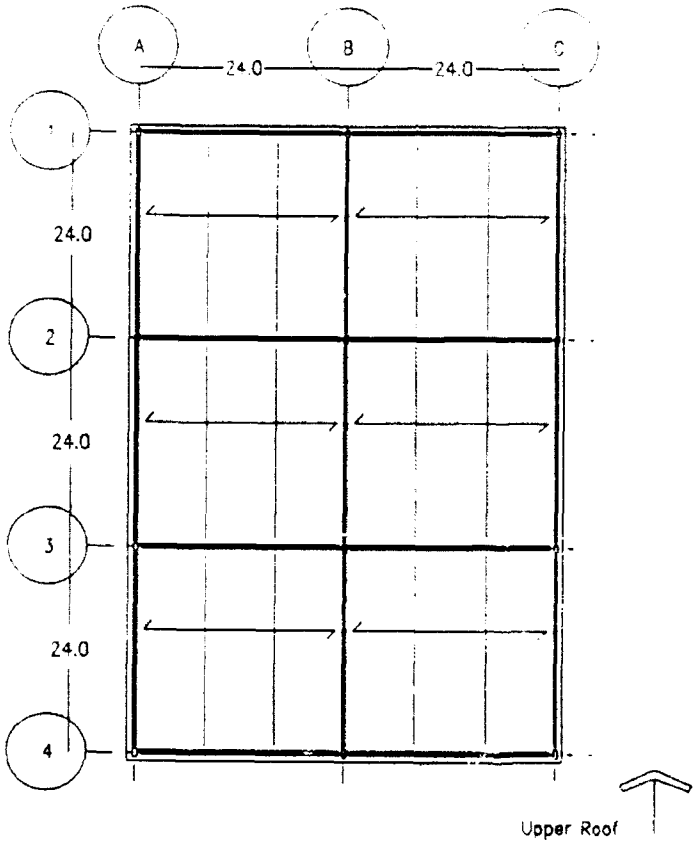

Draw Upper Roof framing
Draw Surface In Bay A1-B2
Select Handle On Grid Line A1-A2
Select Handle On Grid Line B1-B2
Double Click Right Mouse Key To End Defining Area
Save Surface Element
Orientation: E-W
Copy Beams & One-Way Surface To Other Bays
Copy Structure
Select Third Point Beams
Select One-Way Surface
Double Click Right Mouse Key To End Selecting Structure
Select Grid Location A1 As The Base Point
Paste Structure
Select Grid Locations B1, A2, B2, A3, B3
Double Click Right Mouse Key To End

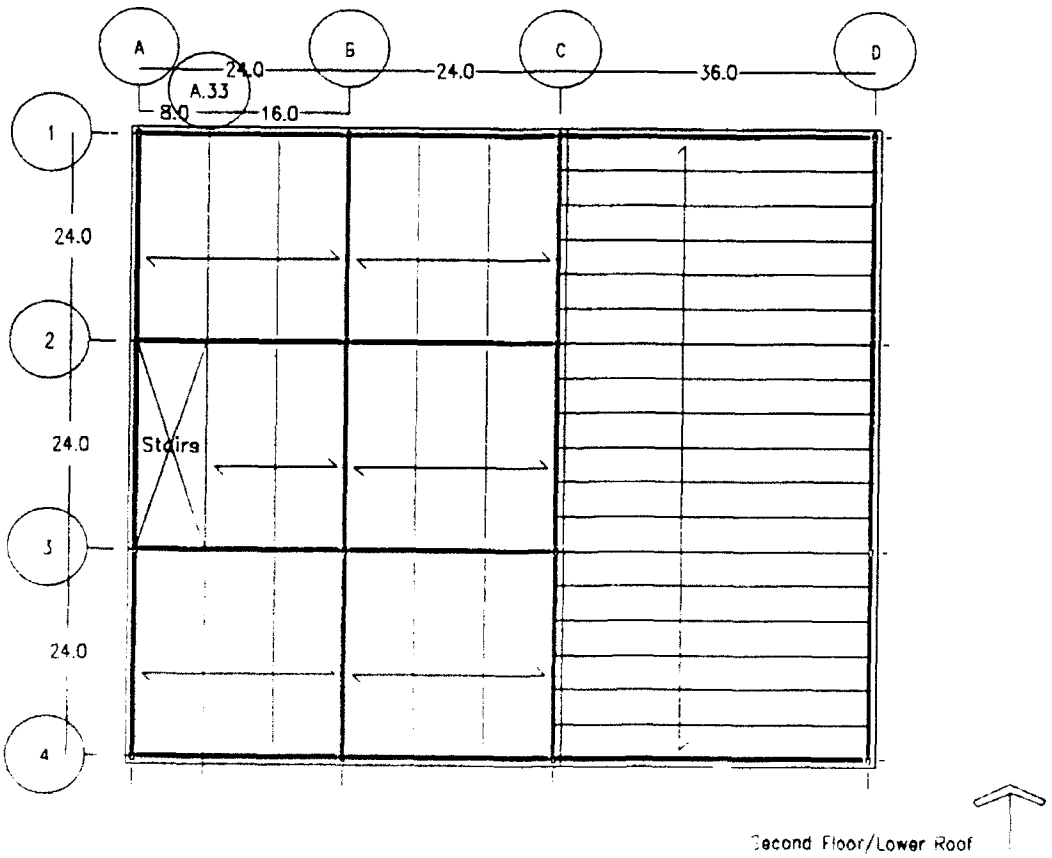

Draw Upper Roof framing
Draw Columns
Column All Grid Intersections
Save Column Elements
Orientation: N-S
☒ All Floors
Draw Second Floor/ Lower Roof Framing
Select Second Floor/ Lower Roof Horizontal Structural Plane
Draw Linear Beams On All Grid Lines
Delete Beams At Grid Locations Inside C1-D4
Draw Third Point Beams And One-Way Surface In Bays A1-B2, B1-C2, B2-C3, A3-B4, B3-C4
Paste Structure
Select Grid Locations A1, B1, B2, A3, B3
Double Click Right Mouse Key To End
Draw Third Point Beams In Bay A2-B3
Linear: Widely Spaced

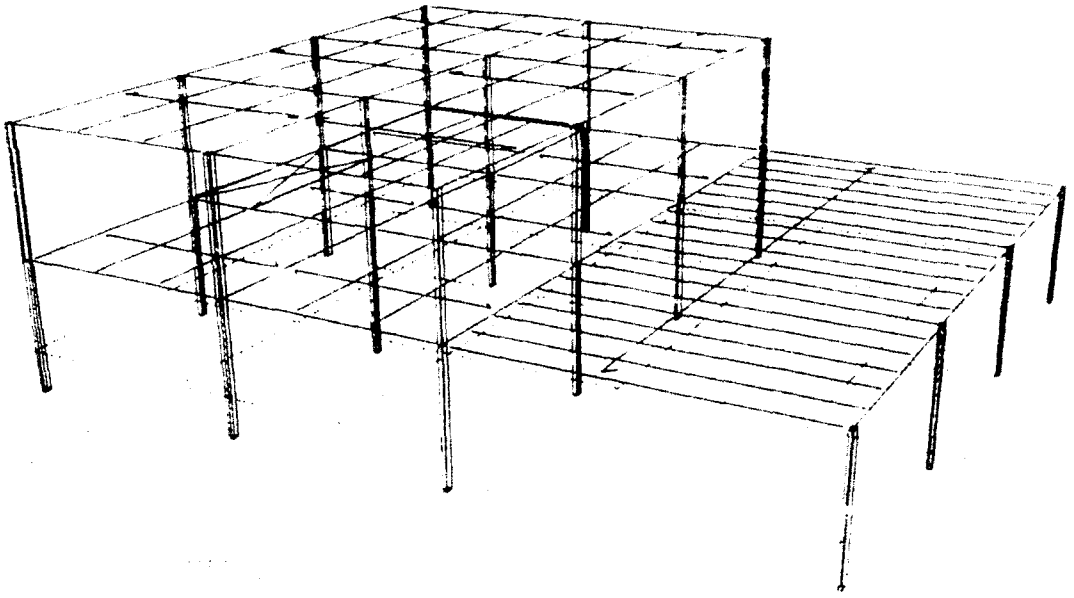

Draw Second Floor/ Lower Roof Framing
Draw Third Point Beams In Bay A2-B3
Select Handle On Grid B2-B3
Select Handle On Grid A2-A3
Double Click Right Mouse Key To End Defining Area
Save Linear Elements
Orientation: N-S
Number Of Elements: 2
Draw Surface In Bay A.33.2-B3
Surface: One-Way
Select Handle On Grid A.33.2-A.33.3
Select Handle On Grid Line B2-B3
Double Click Right Mouse Key To End Defining Area
Save Surface Element
Orientation: E-W
Draw Joists In Bay C1-D4
Linear: Narrowly Spaced
Select Handle On Grid C1-D1
Select Handle On Grid C4-D4


Draw Second Floor/ Lower Roof Framing
Draw Joists In Bay C1-D4
Double Click Right Mouse Key To End Defining Area
Save Linear Elements
Orientation: E-W
☒ Spacing: 48"
Draw Surface In Bay C1-D4
Surface: One-Way
Select Handle On Grid C1-D1
Select Handle On Grid C4-D4
Double Click Right Mouse Key To End Defining Area
Save Surface Element
Orientation: N-S

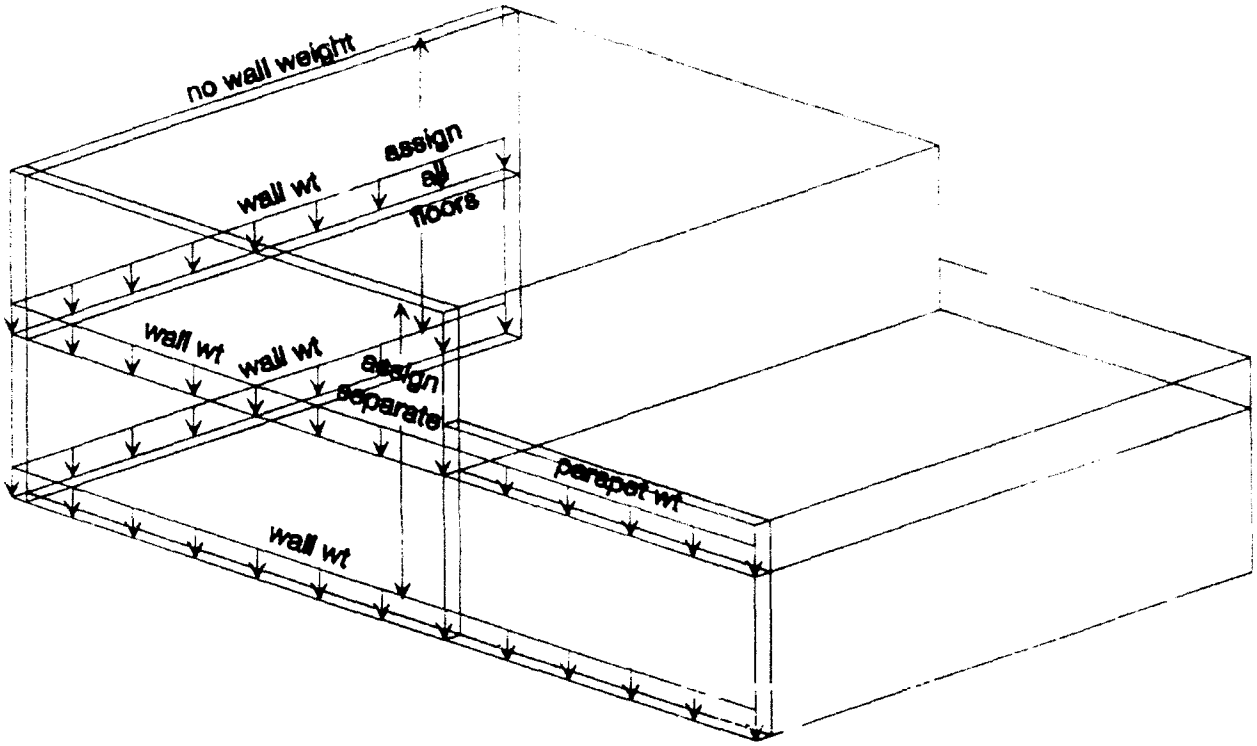

Draw Second Floor/
Lower Roof Framing
Draw Columns
Column One Grid
Intersection
Select Grid Locations
D1, D2, D3, D4
Double Click Right
Mouse Key To End
Selecting Locations
Save Columns
Orientation: N-S
Height: 14'
All Floors
View Structure
Perspective (3D)
Transparent Object
Show Structure
End

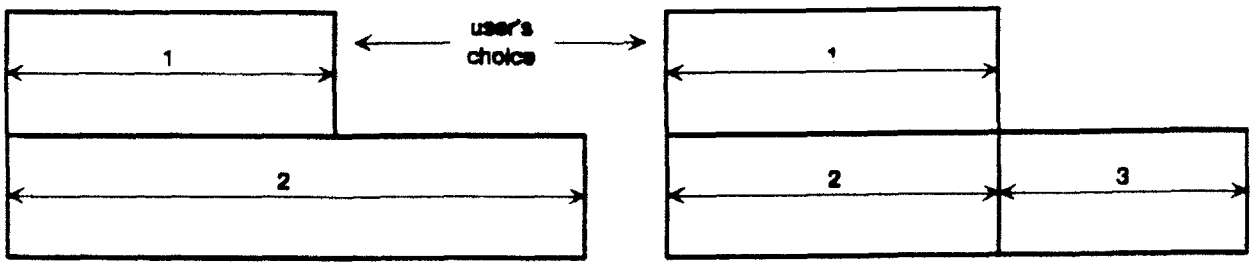

A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof


A
B
C
D
24.0
24.0
36.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
Stairs
Second Floor/Lower Roof



Assign Wall Loads Philosophy





this appproach saves memory

Assign Loads

Start

Use Loads & Design Tool Palette

Assign Live Loads → Select Second Floor/ Lower Roof Horizontal Structural Plane

Use Occupancy (LL)

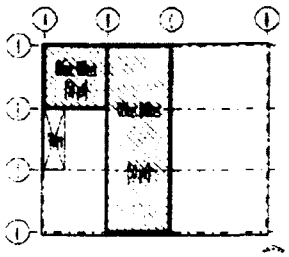
Highlight: Office 50 psf

Assign Offices 50 psf → F2 Key For Keyboard Input

	Horizontal	Vertical
Base Point:	24'10"	10"
Point 2:	48'10"	72'10"
Length:	24'0"	72'0"

Assign Offices 50 psf

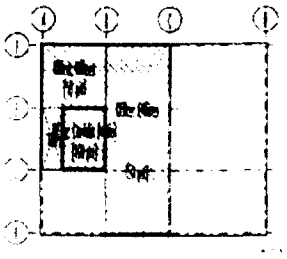
	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	24'10"	72'10"
Length:	24'0"	24'0"



Highlight: Corridor (main) 100 psf

Assign Corrifor (main) 100 psf

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	24'10"	48'10"
Length:	16'0"	24'0"



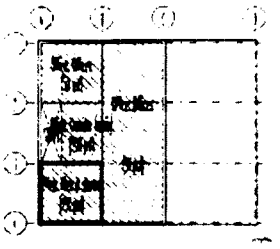
Highlight: Files & Storage 150 psf

Assign Live Loads

Assign Files & Storage 150 psf

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	24'10"	24'10"
Length:	24'0"	24'0"

Stop Using Occupancy (LL)



Assign Dead Loads → **Assign Floor Loads** → **Use Floor (DL)**

Assign Second Floor Load

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	24'10"
Length:	48'0"	24'0"

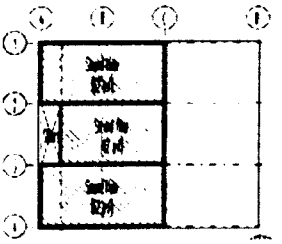
Assign Second Floor Load

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	[illegible]	[illegible]
Length:	40'0"	24'0"

Assign Second Floor Load

	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	48'10"	72'10"
Length:	48'0"	24'0"

Stop Using Floor (DL)

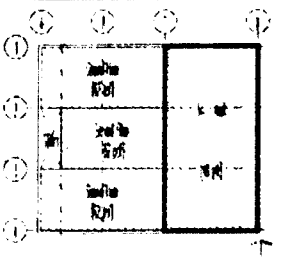


Assign Roof Loads → **Use Roof (DL)**

Next Button To View Lower Roof

Assign Lower Roof Load

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	84'10"	72'10"
Length:	36'0"	72'0"



Stop Using Roof (DL)

Assign Dead Loads

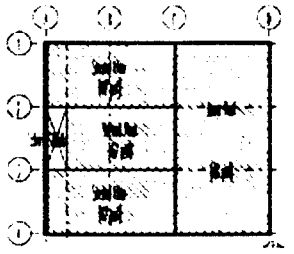
Assign Exterior Wall Loads → **Use Wall (DL)**

Assign Exterior Wall Load

☒ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	10"	72'10"
Length:	0'0"	72'0"

→ **Next Button To View Exterior Wall**



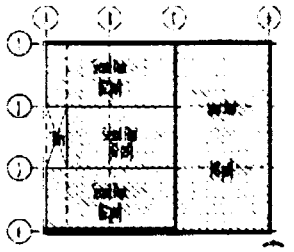
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	48'10"	10"
Length:	48'0"	0'0"



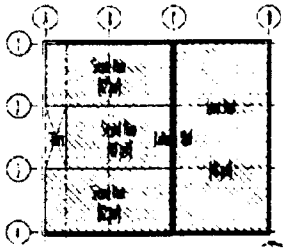
Wall Height

Start: 14'0"
End: 14'0"

Assign Exterior Wall Load

☐ Assign All Floors

	Horizontal	Vertical
Base Point:	48'10"	10"
Point 2:	48'10"	72'10"
Length:	0'0"	72'0"



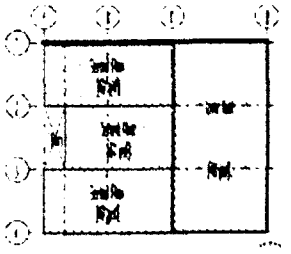
Wall Height

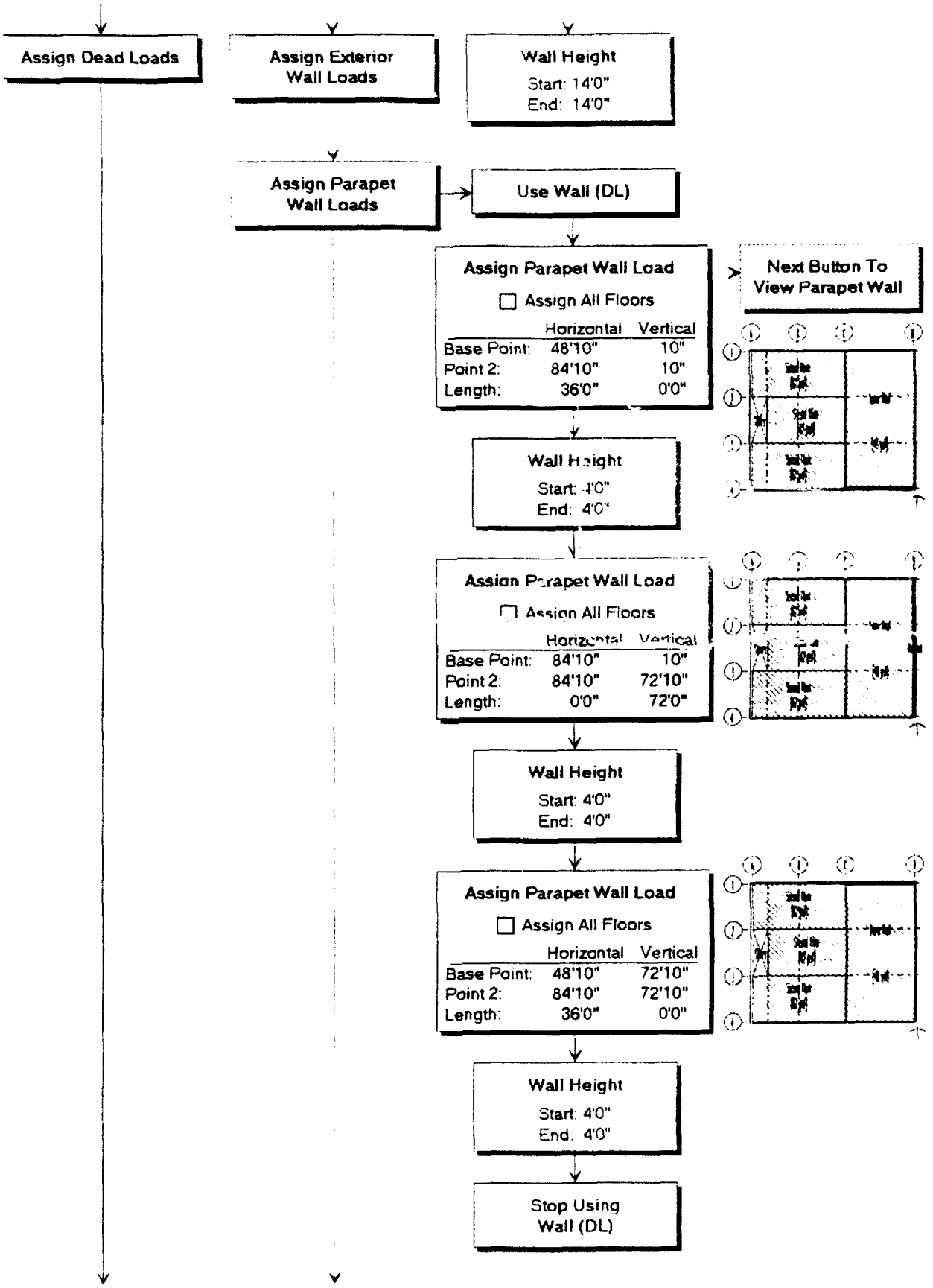
Start: 14'0"
End: 14'0"

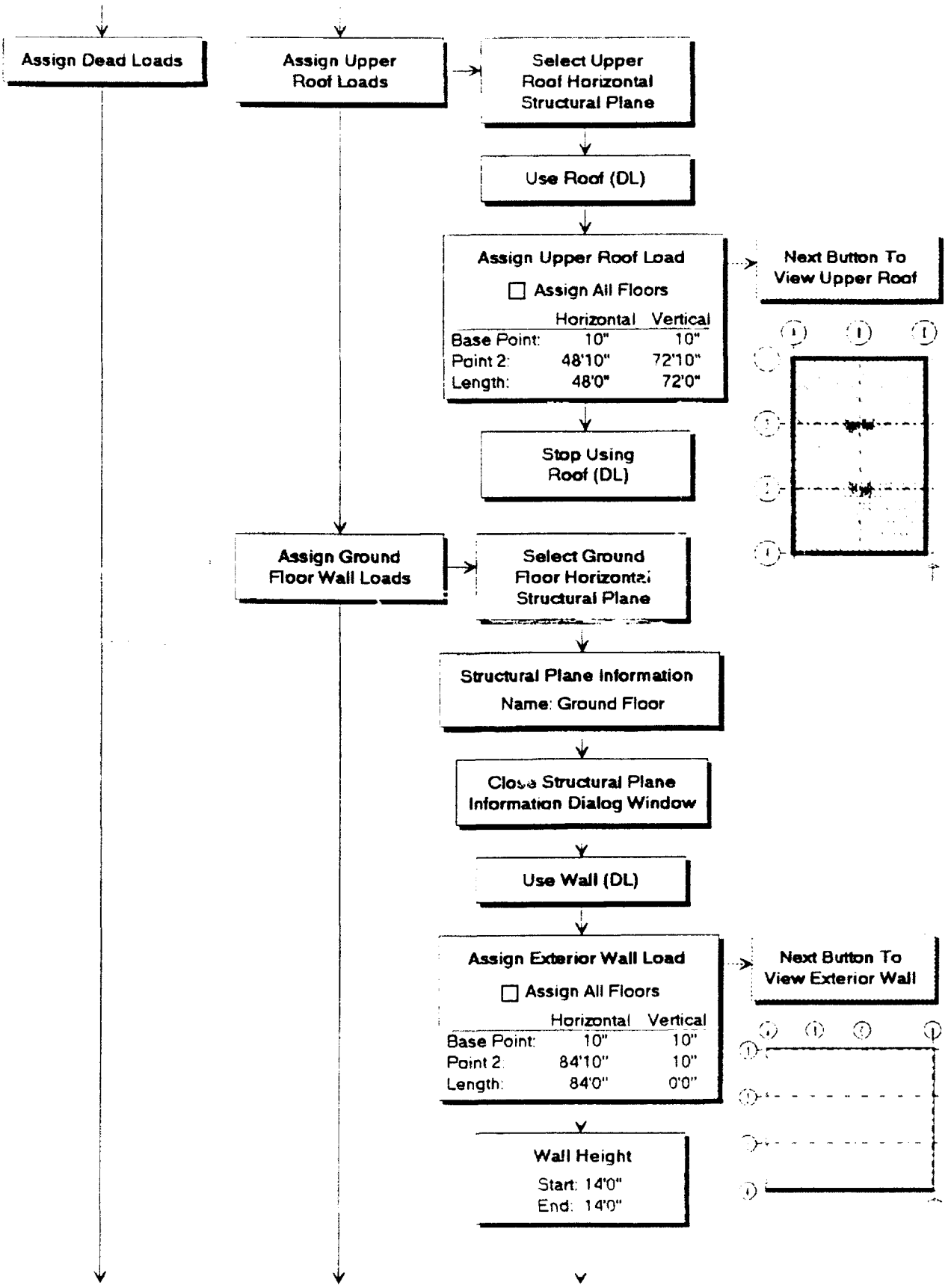
Assign Exterior Wall Load

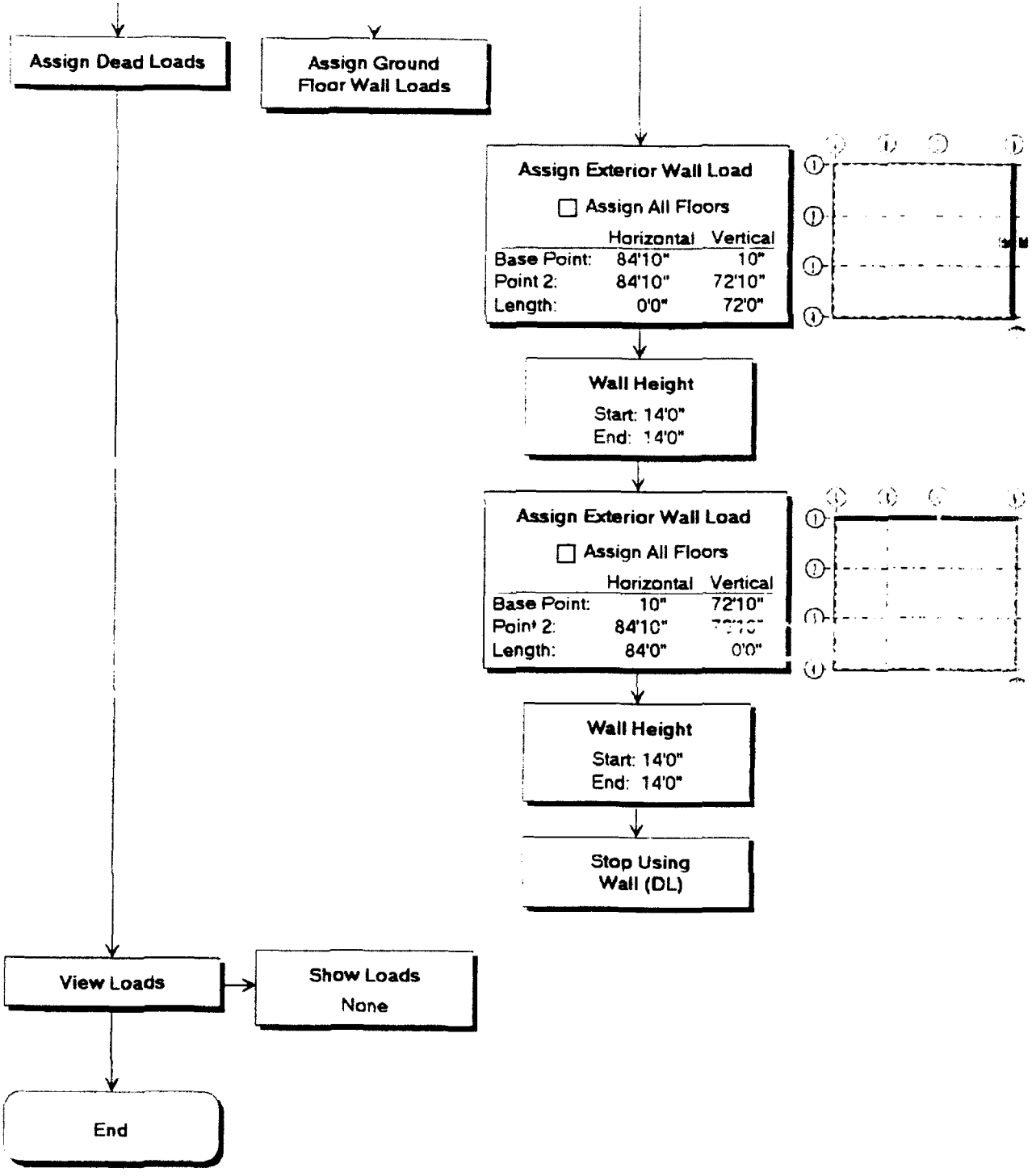
☐ Assign All Floors

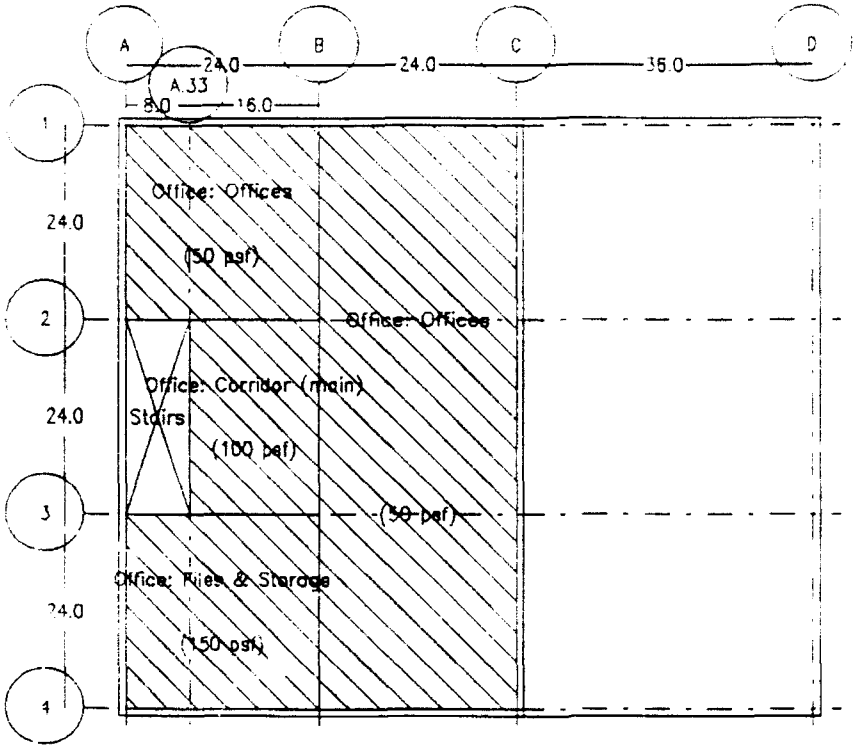
	Horizontal	Vertical
Base Point:	10"	72'10"
Point 2:	48'10"	72'10"
Length:	48'0"	0'0"



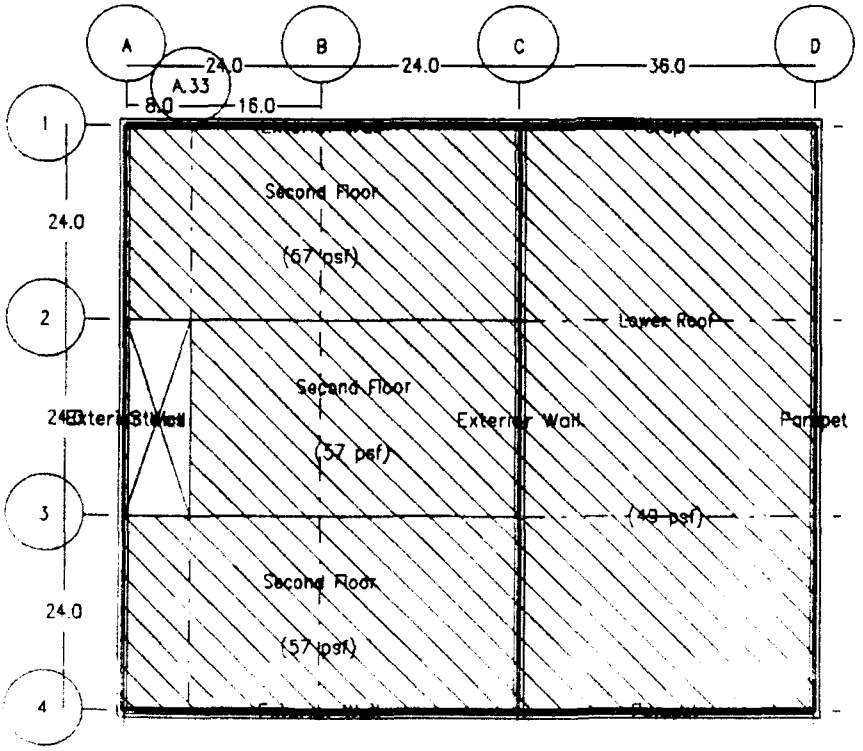

Assign Dead Loads
Assign Exterior Wall Loads
Wall Height
Start: 14'0"
End: 14'0"
Assign Parapet Wall Loads
Use Wall (DL)
Assign Parapet Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 48'10" 10"
Point 2: 84'10" 10"
Length: 36'0" 0'0"
Next Button To View Parapet Wall
Wall Height
Start: 4'0"
End: 4'0"
Assign Parapet Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 84'10" 10"
Point 2: 84'10" 72'10"
Length: 0'0" 72'0"
Wall Height
Start: 4'0"
End: 4'0"
Assign Parapet Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 48'10" 72'10"
Point 2: 84'10" 72'10"
Length: 36'0" 0'0"
Wall Height
Start: 4'0"
End: 4'0"
Stop Using Wall (DL)


Assign Dead Loads
Assign Upper Roof Loads
Select Upper Roof Horizontal Structural Plane
Use Roof (DL)
Assign Upper Roof Load
Assign All Floors
Horizontal Vertical
Base Point: 10" 10"
Point 2: 48'10" 72'10"
Length: 48'0" 72'0"
Next Button To View Upper Roof
Stop Using Roof (DL)
Assign Ground Floor Wall Loads
Select Ground Floor Horizontal Structural Plane
Structural Plane Information
Name: Ground Floor
Close Structural Plane Information Dialog Window
Use Wall (DL)
Assign Exterior Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 10" 10"
Point 2: 84'10" 10"
Length: 84'0" 0'0"
Next Button To View Exterior Wall
Wall Height
Start: 14'0"
End: 14'0"

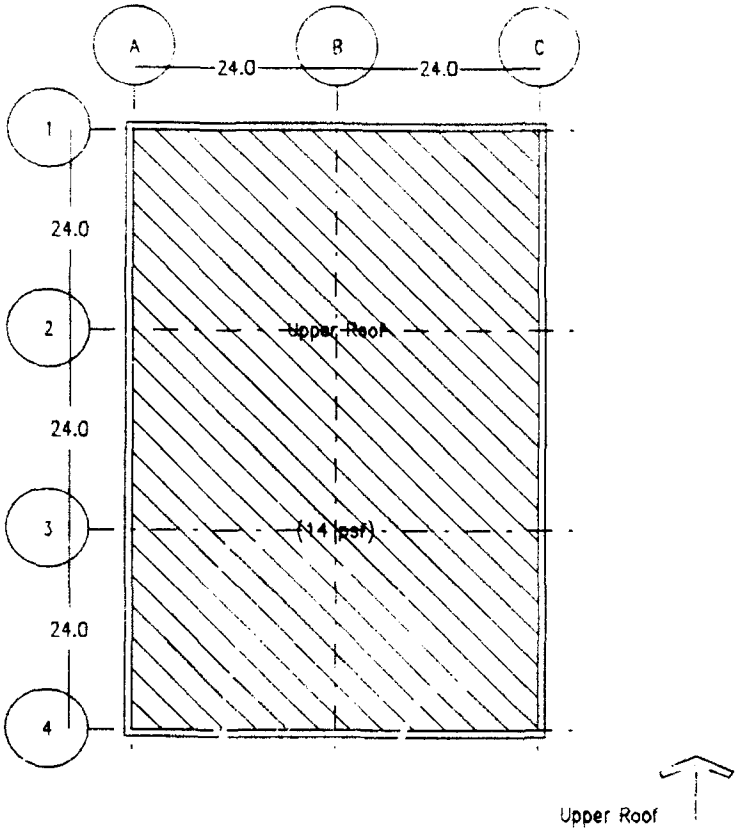

Assign Dead Loads
Assign Ground Floor Wall Loads
Assign Exterior Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 84'10" 10"
Point 2: 84'10" 72'10"
Length: 0'0" 72'0"
Wall Height
Start: 14'0"
End: 14'0"
Assign Exterior Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 10" 72'10"
Point 2: 84'10"
Length: 84'0" 0'0"
Wall Height
Start: 14'0"
End: 14'0"
Stop Using Wall (DL)
View Loads
Show Loads
None
End

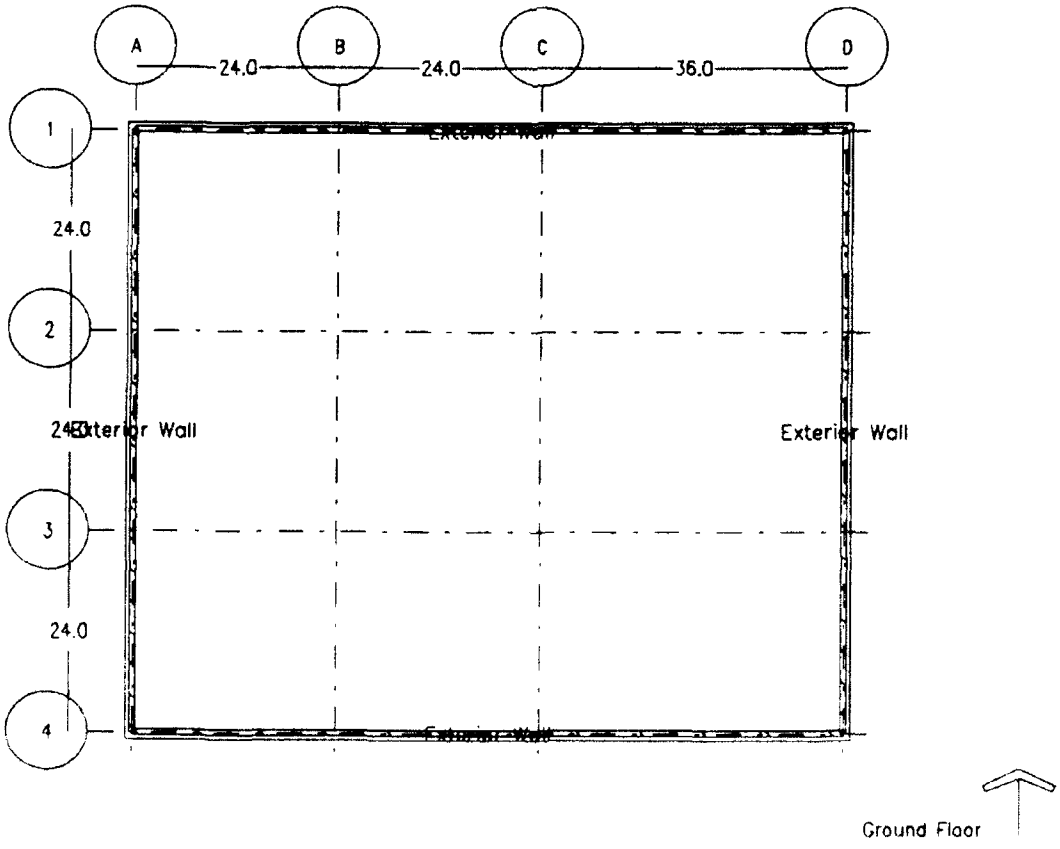


Second Floor/Lower Roof



Second Floor/Lower Roof

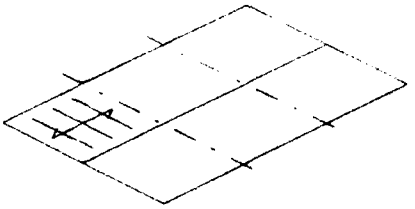

A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof
(14 psf)
Upper Roof


A
B
C
D
24.0
24.0
36.0
1
2
3
4
24.0
24.0
24.0
Exterior Wall
Exterior Wall
Ground Floor

Analysis & Design Philosophy

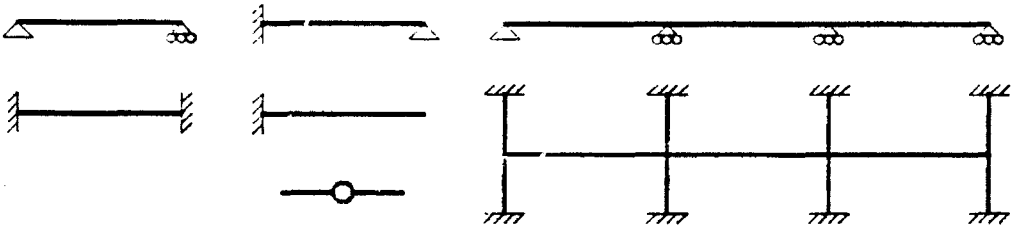
Preliminary Analysis

A. Select:
* Material
* Load Combination
  (Live Load Reduction)
* Element To Analyze

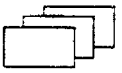


B. Review:
* Attributes
* Guidelines

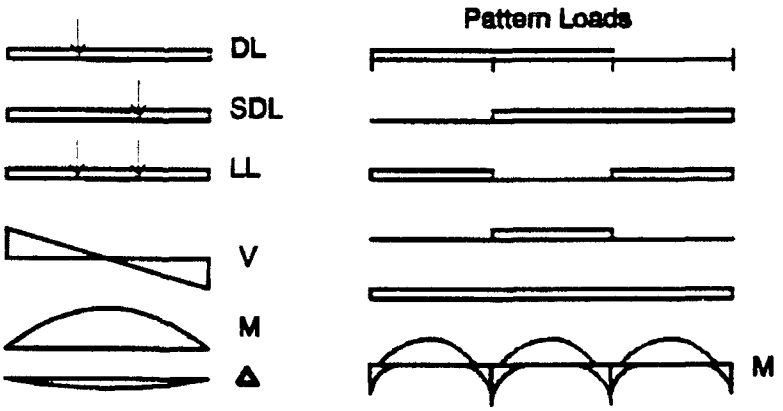
C. Connectivity



D. Self Weight Estimate * Guidelines



E. Analysis
* Review Loads
* Connectivity



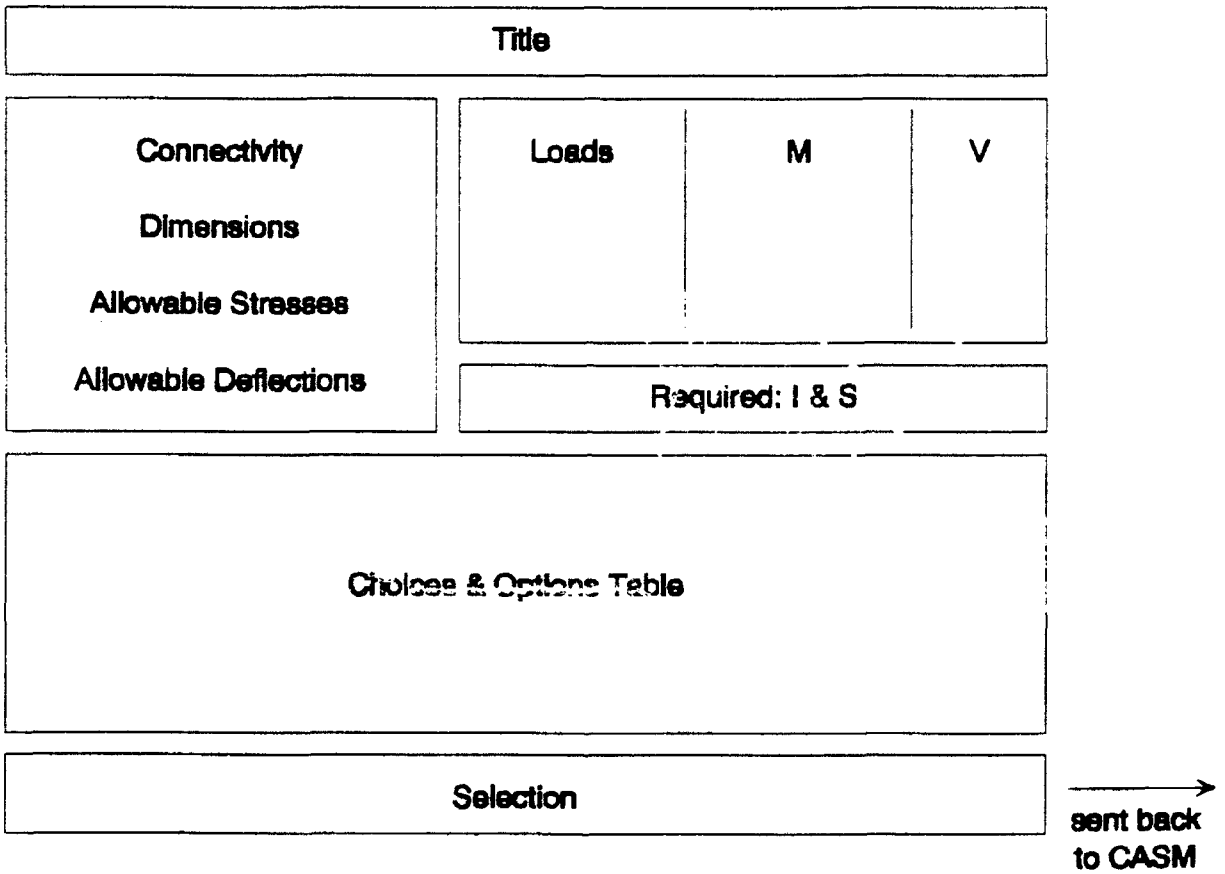
* Analysis Output
  I = 1
  E = 1
  A = 1000

F. Re-Analysis (with real properties)

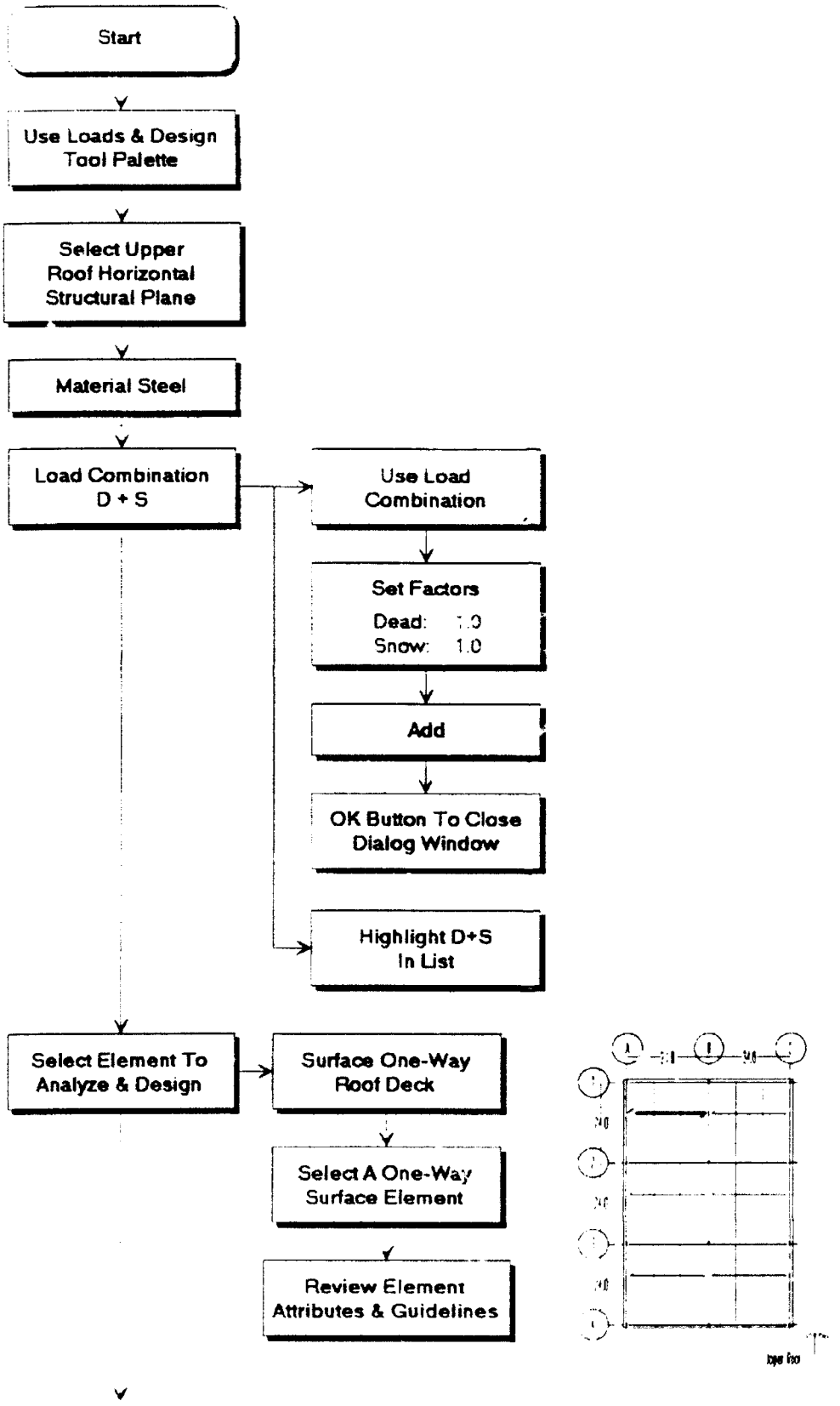
Preliminary Design

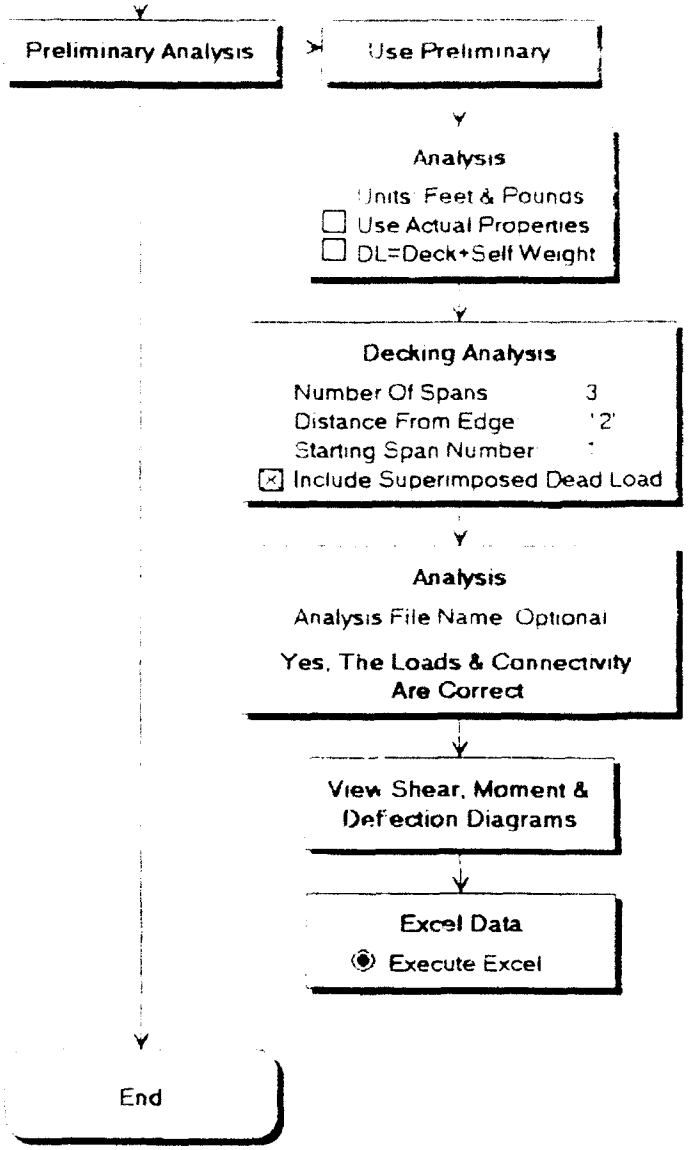
* Maximum V's, M's, R's, etc. sent to Excel

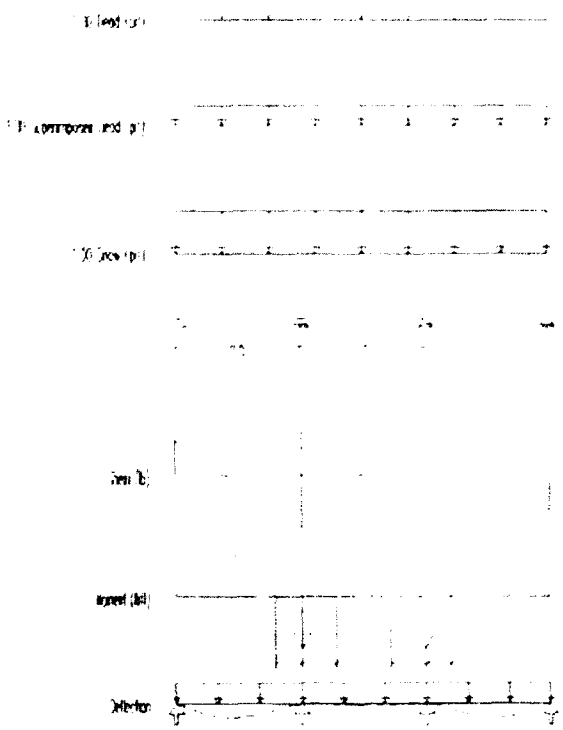
Spreadsheets

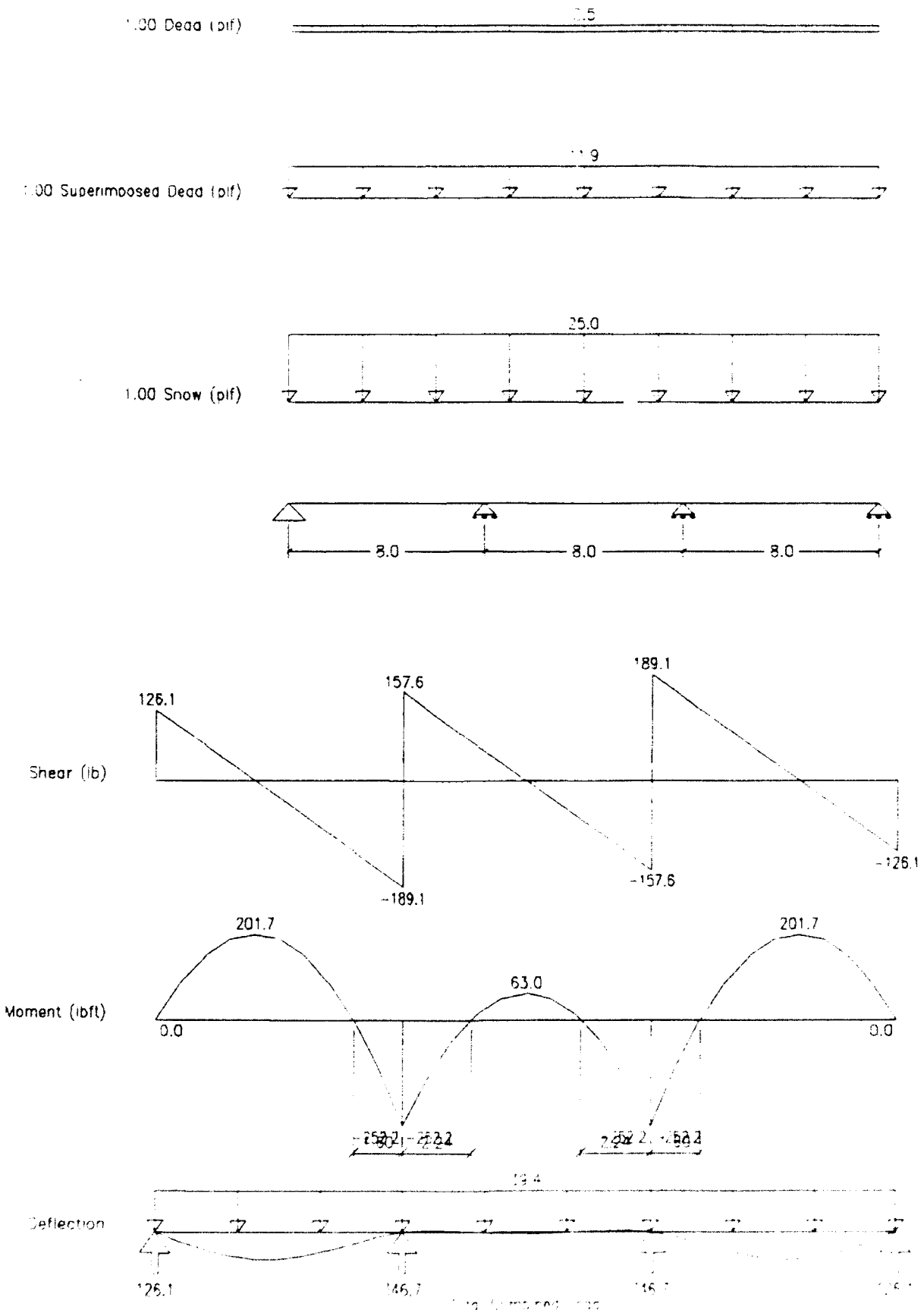


Surface Element Analysis

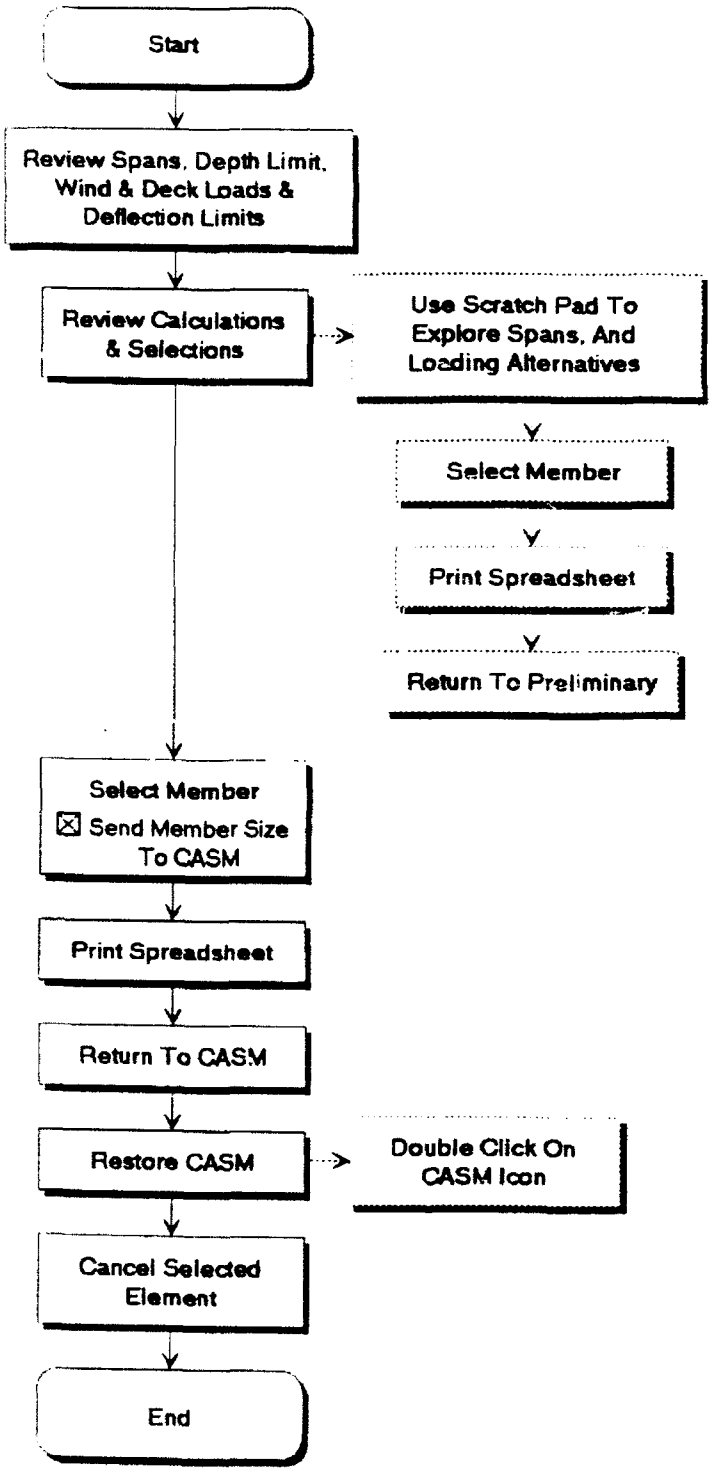



Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Use Actual Properties
DL=Deck+Self Weight
Decking Analysis
Number Of Spans 3
Distance From Edge '2'
Starting Span Number
Include Superimposed Dead Load
Analysis
Analysis File Name Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End




1.00 Dead (plf)
1.00 Superimposed Dead (plf)
25.0
1.00 Snow (plf)
8.0
8.0
8.0
Shear (lb)
126.1
157.6
189.1
-189.1
-157.6
-126.1
Moment (lbft)
201.7
63.0
201.7
0.0
0.0
Deflection
126.1

Steel Roof Deck Design



Steel Deck Selection

STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date:** Feb 26, 1992
Location: Radford AAP	**Engr:**

Load and Analysis Data:

Method: Analysis

Member ID:

Connectivity: Beam (Left)

Beam (Right)

Deck Span: 8 ft

Trib Width= 3 in

Depth Limit= 1.5 in. max

Fy= 33.0 ksi

Fb= 20.0 ksi

Fv= 13.2 ksi

E = 29,000 ksi

Live Ld Defl= L/240 =0.53 in

Total Defl= L/180 =0.40 in

Load Combination: D + S

Load Type	Factored Moments (lb-ft) Left	Mid	Right	Fact. Reactions Left(lb)	Right(lb)
Deck	16.0	12.8	16.0	12.0	12.0
Sup Dead	76.2	60.9	76.2	57.1	57.1
Live					
Lmin Roof					
Snow	160.0	128.0	160.0	120.0	120.0
Wind					
Summary	252.2	201.7	252.2	189.1	189.1

Load Combinations for roof:

Load Case #1:	D + S	Est. Deck Wgt =	0.8 psf
Load Case #2:	Deck + Wind	Wind Load =	-40.0 psf
Load Case #3:	Deck + Construction 200# Point Load		

Deck Configuration:

Deck Type: Roof Deck Cellular: No

Code Load Combinations:

	Case	Load (psf)	Fb Factor	M+ (f-lb)	M- (f-lb)	S+ (in.3)	S- (in.3)	Ix (in.4)
Number of spans = 3	# 1		1.00	201.7	92.2	0.121	0.055	0.0001
	# 2	-39.2	1.33	293.5	-235.8	0.132	-0.106	0.1650
	# 3	0.8	1.33	284.1	-133.1	0.128	-0.060	
Maximums:				293.5	-235.8	0.132	-0.106	0.1650

Steel Roof Deck Selection Table - Spans = 3

Deck Type	Gage	Depth (in)	Sx+ (in.^3)	Sx- (in.^3)	Ix (in.^4)	Dk wgt (psf)	Const Span Limit 1 Span	2+Span
WR 20	20	1.5	0.237	-0.251	0.207	2.2	6'-3"	7'-5"
IR18	18	1.5	0.204	-0.211	0.222	2.8	6'-2"	7'-4"
NR18	18	1.5	0.176	-0.182	0.203	2.9	5'-11"	6'-11"
WR18	18	1.5	0.322	-0.331	0.298	2.9	7'-6"	8'-10"

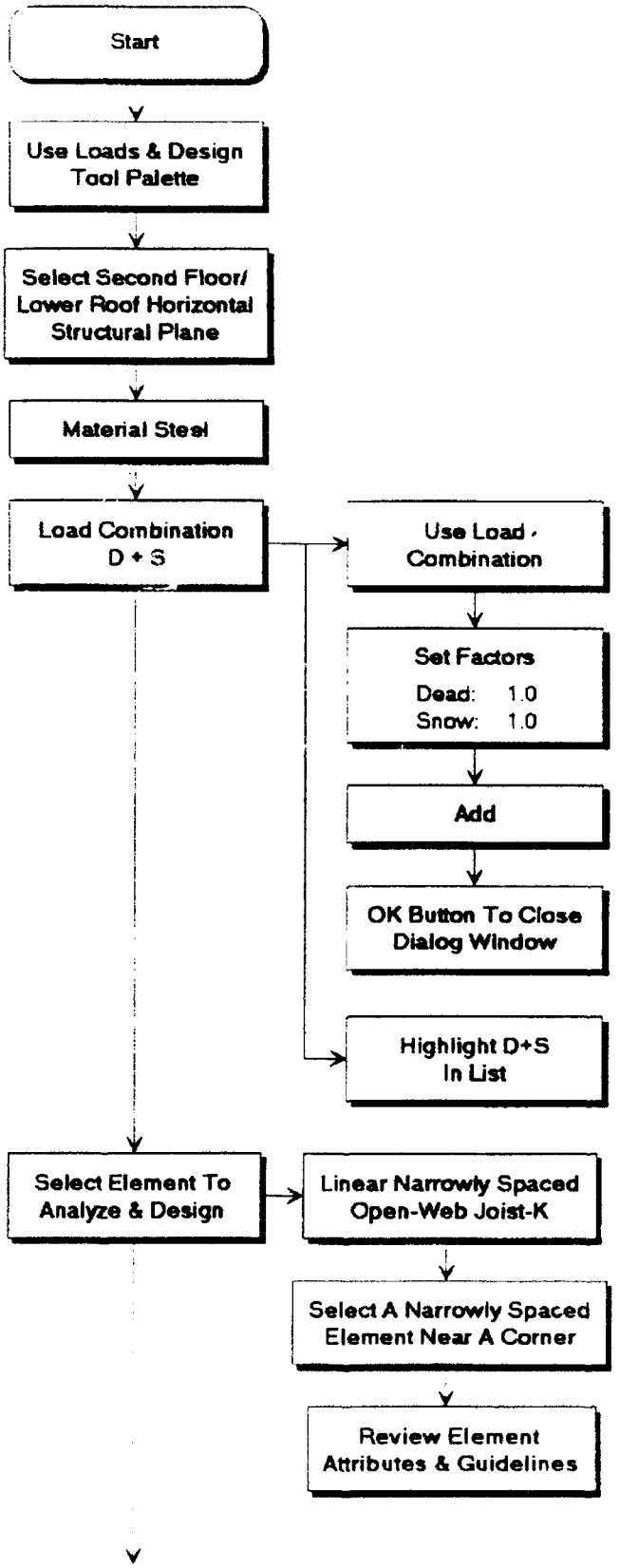
CASM Preliminary Steel Roof Deck Selection:

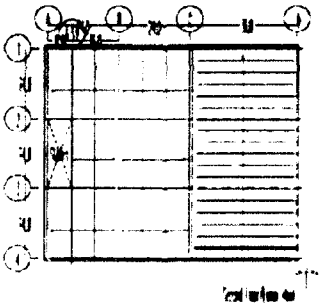
Deck Type: **WR 20**	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc
Weight: 2.2 psf	Gage: 20	Ix = 0.207	Construction Load Span Limits:
	Sx+ = 0.237	Sx- = -0.251	1 span: 6'-3" 2+span: 7'-5"

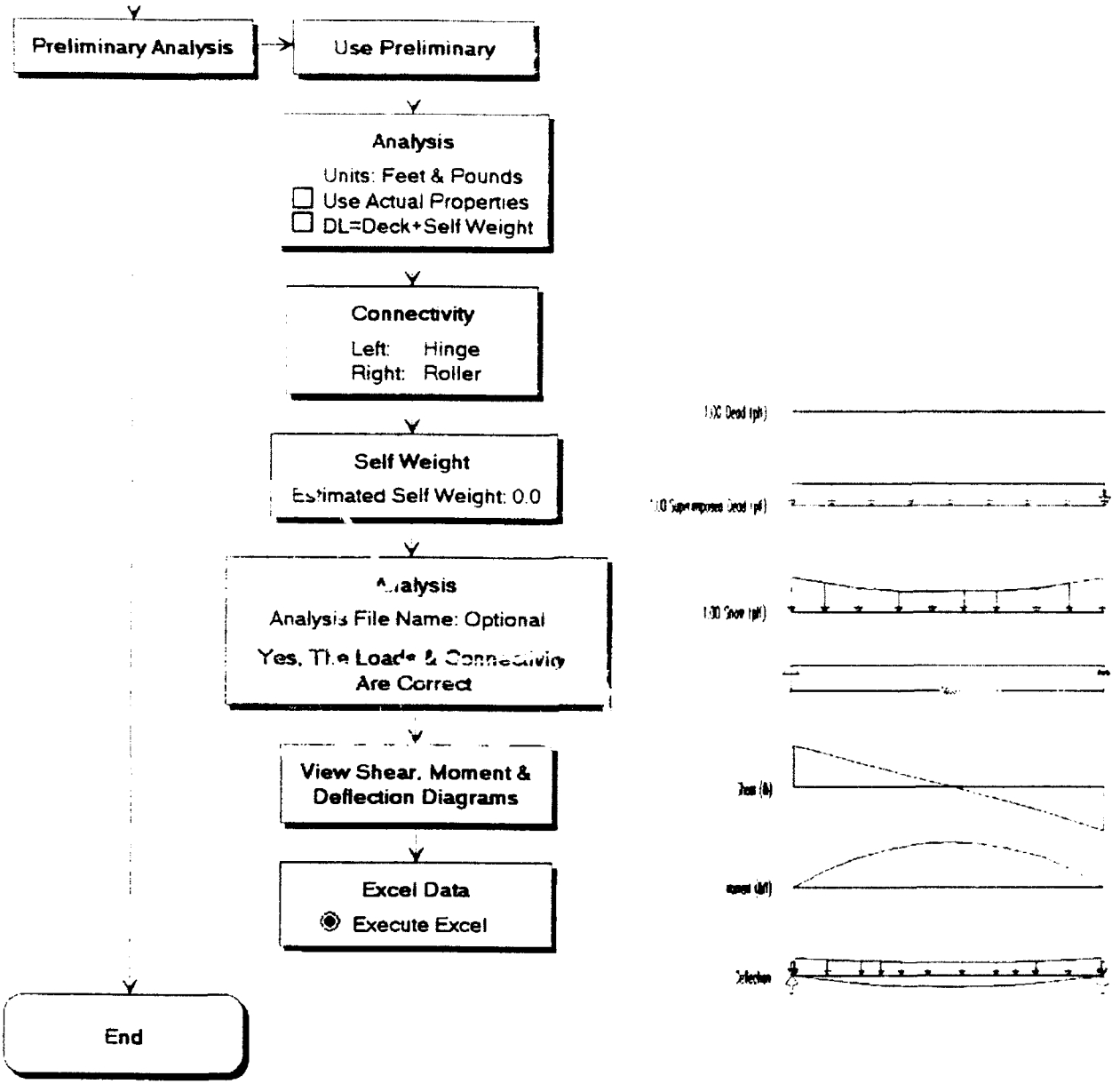
Notes:

1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

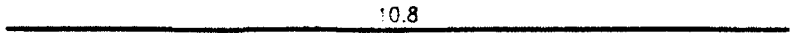
Narrowly Spaced Element Analysis



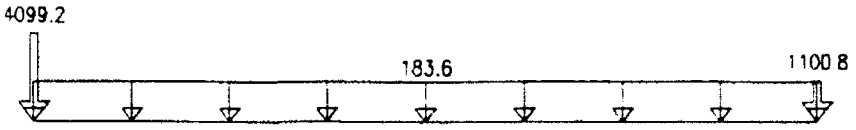



Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Estimated Self Weight: 0.0
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End

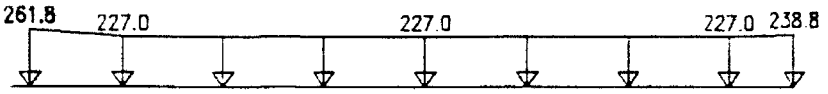
1.00 Dead (plf)

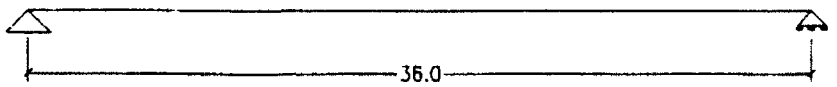


1.00 Superimposed Dead (plf)

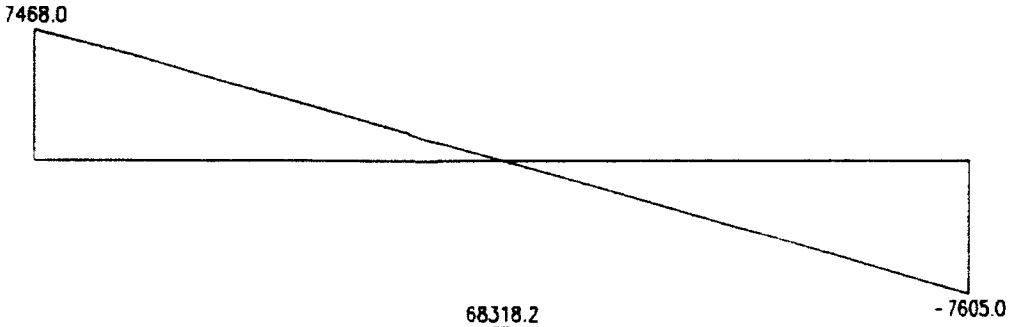


1.00 Snow (plf)

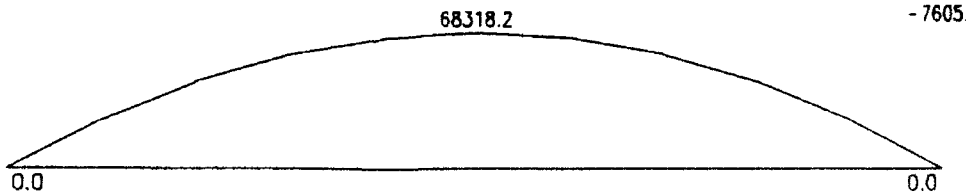




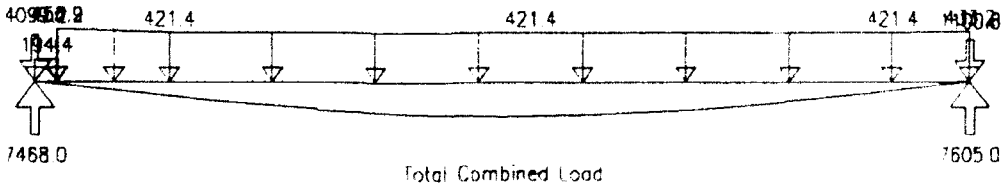
Shear (lb)



Moment (lbft)



Deflection



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****************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****************************************


2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992  5:20 PM


********************************** I N P U T **********************************


Office Building - Scheme B -- Dead Load


      NUMBER OF ELEMENTS                  =    10
      NUMBER OF NODAL POINTS              =    11
      NUMBER OF MATERIALS                 =     1
      NUMBER OF ELEMENT TYPES             =     1
      NUMBER OF ELASTIC SUPPORT TYPES     =     0
      NUMBER OF FIXED END FORCE TYPES     =     1
```

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE

UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	3.60	-10.80	0.00		3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	19.440	11.664	0.000	19.440	-11.664

JOINT DATA

UNITS: FEET, POUNDS

		NODAL COORDINATES		BOUNDARY CONDITIONS: NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.60	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL RIJ	STIFF RJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	4.00	0.50
9	9	10	1	1	0	1	4.00	4.00	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

```
********************************** O U T P U T **********************************
```

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	3023308.8534
2	0.0000	-128125410.5587	-2854003.5574
3	0.0000	-242406485.2180	-2394460.6119
4	0.0000	-331872240.8077	-1717239.4287
5	0.0000	-388886240.7806	-494899.6206
6	0.0000	-408146695.2082	0.0000
	0.0000	-388886240.7806	494899.6206
8	0.0000	-331872240.8077	1717239.4287
9	0.0000	-242406485.2180	2394460.6119
10	0.0000	-128125410.5587	2854003.5574
11	0.0000	0.0000	3023308.8534

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	194.400	0.000	0.000	-155.520	629.856
2	0.000	155.520	-426.856	0.000	-116.640	1119.744
3	0.000	116.640	-1119.744	0.000	-77.760	1469.664
4	0.000	77.760	-1469.664	0.000	-38.880	1679.616
5	0.000	[illegible]	[illegible]	[illegible]	-0.000	1749.600
6	[illegible]	[illegible]	-1749.600	0.000	38.880	1679.616
7	0.000	-38.880	-1679.616	0.000	77.760	1469.664
8	0.000	-77.760	-1469.664	0.000	116.640	1119.744
9	0.000	-116.640	-1119.744	0.000	155.520	629.856
10	0.000	-155.520	-629.856	0.000	194.400	-0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	194.400	-0.000
2	0.000	-0.000	-0.000
3	0.000	0.000	-0.000
4	0.000	0.000	-0.000
5	0.000	-0.000	-0.000
6	0.000	-0.000	-0.000
7	0.000	-0.000	-0.000
8	0.000	0.000	0.000
9	0.000	-0.000	0.000
10	0.000	0.000	-0.000
11	0.000	194.400	-0.000

```
**PROBLEMS COMPLETED**


****************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****************************************


2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992  5:20 PM


********************************** I N P U T **********************************


Office Building - Scheme B -- Superimposed Dead Load
```

```
NUMBER OF ELEMENTS                  =   10
NUMBER OF NODAL POINTS              =   11
NUMBER OF MATERIALS                 =    1
NUMBER OF ELEMENT TYPES             =    1
NUMBER OF ELASTIC SUPPORT TYPES     =    0
NUMBER OF FIXED END FORCE TYPES     =    1
```

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFRM	3.60	-183.60	0.00		3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	330.480	198.288	0.000	330.480	-198.288

JOINT DATA

UNITS: FEET, POUNDS

NODE	CODE	NODAL COORDINATES X	NODAL COORDINATES Y	BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS X	Y	M	ELASTIC SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.40	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL KIJ	STIFF KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	1	4.00	4.00	0.50
3	3	4	1	1	0	1	4.00	4.00	0.50
4	4	5	1	1	0	1	4.00	4.00	0.50
5	5	6	1	1	0	1	4.00	4.00	0.50
6	6	7	1	1	0	1	4.00	4.00	0.50
7	7	8	1	1	0	1	4.00	4.00	0.50
8	8	9	1	1	0	1	4.00	[illegible]	0.50
9	9	10	1	1	0	1	4.00	[illegible]	0.50
10	10	11	1	1	0	1	4.00	4.00	0.50

********** O U T P U T **********

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	51396247.8380
2	0.0000	-2178131646.3764	48516057.9591
3	0.0000	-4120910034.6538	40705828.2877
4	0.0000	-5641027800.6764	29193068.7720
5	0.0000	-6607666090.0464	15213289.3601
6	0.0000	-6938693450.1321	0.0000
7	0.0000	-6607666090.0464	-15213289.3601
8	0.0000	-5641027800.6764	-29193068.7720
9	0.0000	-4120910034.6538	-40705828.2877
10	0.0000	-2178131646.3764	-48516057.9591
11	0.0000	0.0000	-51396247.8380

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3304.800	0.000	0.000	-2643.840	10707.552
2	0.000	2643.840	-10707.552	0.000	-1982.880	19035.648
3	0.000	1982.880	-19035.648	0.000	-1321.920	24984.287
4	0.000	1321.920	-24984.287	0.000	-660.960	28553.473
5	0.000	660.960	-28553.473	0.000	-0.000	29743.199
6	0.000	-0.000	-29743.199	0.000	660.960	28553.473
7	0.000	-660.960	-28553.473	0.000	1321.920	24984.287
8	0.000	-1321.920	-24984.287	0.000	1982.880	19035.648
9	0.000	-1982.880	-19035.648	0.000	2643.840	10707.552
10	0.000	-2643.840	-10707.552	0.000	3304.800	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3304.800	0.000
2	0.000	-0.000	-0.000
3	0.000	0.000	-0.000
4	0.000	-0.000	-0.000
5	0.000	0.000	0.000
6	0.000	-0.000	-0.000
7	0.000	-0.000	-0.000
8	0.000	0.000	0.000
9	0.000	-0.000	0.000
10	0.000	-0.000	0.000
11	0.000	3304.800	0.000

PROBLEM COMPLETED

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*****************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
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2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992 5:20 PM

********** I N P U T **********

Office Building - Scheme B -- Snow Load

```
NUMBER OF ELEMENTS                  =   10
NUMBER OF NODAL POINTS              =   11
NUMBER OF MATERIALS                 =    1
NUMBER OF ELEMENT TYPES             =    1
NUMBER OF ELASTIC SUPPORT TYPES     =    0
NUMBER OF FIXED END FORCE TYPES     =    4
```

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	RAMP	3.60	-261.49	0.65	-239.25	1.60
1	RAMP	3.60	-261.77	0.83	-241.49	0.85
2	UNIFORM	3.60	-226.99	1.52		3.60
2	RAMP	3.60	-239.25	0.00	-226.99	1.52
3	UNIFORM	3.60	-226.99	0.00		3.60
4	UNIFORM	3.60	-226.99	0.00		3.56
4	RAMP	3.60	-226.99	0.56	-238.84	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	256.911	211.411	0.000	435.982	-259.310
2	0.000	417.181	248.117	0.000	409.261	-245.865
3	0.000	408.575	245.145	0.000	408.575	-245.145
4	0.000	412.842	248.957	0.000	422.351	-251.899

JOINT DATA

UNITS: FEET, POUNDS

NODE	CODE	NODAL COORDINATES X	NODAL COORDINATES Y	BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS X	Y	M	ELASTIC SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.40	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	[illegible]	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	REL RIJ	STIFF RJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

********** O U T P U T **********

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-43682352.8687
2	0.0000	-2698833582.0345	-60109090.8609
3	0.0000	-5105261224.3298	-50410411.8458
4	0.0000	-4966465119.9759	-38140148.8944
5	0.0000	-4183902930.3205	-18823555.6928
6	0.0000	-3592913108.3733	14371.6712
7	0.0000	-4162713964.0544	18849635.9098
8	0.0000	-4966403864.1939	36156240.5354
9	0.0000	-5102980232.5319	50406188.8801
10	0.0000	-2697241549.7188	50679484.1962
11	0.0000	0.0000	43647124.5340

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3966.830	-0.000	0.000	-3275.938	13313.012
2	0.000	3275.938	-13313.012	0.000	-2449.485	23408.730
3	0.000	2449.485	-23408.730	0.000	-1632.336	30956.008
4	0.000	1632.336	-30956.008	0.000	-815.187	35361.547
5	0.000	815.187	-35361.547	0.000	1.963	36825.352
6	0.000	-1.963	-36825.352	0.000	819.112	35347.418
7	0.000	-819.112	-35347.418	0.000	1638.261	30927.746
8	0.000	-1638.261	-30927.746	0.000	2453.411	23566.336
9	0.000	-2453.411	-23566.336	0.000	3270.560	13263.188
10	0.000	-3270.560	-13263.188	0.000	4105.752	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3966.830	-0.000
2	0.000	-0.000	-0.000
3	0.000	0.000	-0.000
4	0.000	-0.000	-0.000
5	0.000	-0.000	-0.000
6	0.000	-0.000	-0.000
7	0.000	-0.000	0.000
8	0.000	0.000	-0.000
9	0.000	0.000	-0.000
10	0.000	0.000	-0.000
11	0.000	4105.752	0.000

PROBLEMS COMPLETED

********** **
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
****

2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992 5:20 PM

********** I N P U T **********

Office Building - Scheme B -- Total Co Based Loads

NUMBER OF ELEMENTS	=	10
NUMBER OF NODAL POINTS	=	11
NUMBER OF MATERIALS	=	1
NUMBER OF ELEMENT TYPES	=	1
NUMBER OF ELASTIC SUPPORT TYPES	=	0
NUMBER OF FIXED END FORCE TYPES	=	4

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1000.0000	0.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFORM	3.60	-194.40	0.00		3.60
1	RAMP	3.60	-261.49	0.65	-239.25	1.60
1	RAMP	3.60	-261.77	0.83	-241.49	0.85
2	UNIFORM	3.60	-194.40	0.00		3.60
2	UNIFORM	3.60	-226.99	1.52		3.60
2	RAMP	3.60	-239.25	0.00	-226.99	1.52
3	UNIFORM	3.60	-421.39	0.00		3.60
4	UNIFORM	3.60	-194.40	0.00		3.60
4	UNIFORM	3.60	-226.99	0.00		3.56
4	RAMP	3.60	-226.99	0.56	-238.84	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	606.631	421.363	0.000	795.902	-469.262
2	0.000	757.111	456.049	0.000	759.161	-755.837
3	0.000	758.495	455.097	0.000	758.495	455.097
4	0.000	762.762	456.909	0.000	772.271	-461.851

JOINT DATA

UNITS: FEET, POUNDS

NODE	CODE	NODAL COORDINATES X	Y	BOUNDARY CONDITIONS NODAL FORCES AND MOMENTS X	Y	Z	ELASTIC SUPPORT TYPE
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.66	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.80	0.00	0.00	0.00	0.00	0
5	0	21.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.60	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.40	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

ELE	NODE I	NODE J	MAT TYPE	ELE TYPE	ELE CODE	F.E.F. TYPE	KEL KIJ	TYPE KJI	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

********** O U T P U T **********

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-118101809.5601
2	0.0000	-5005080858.8711	-111401152.3776
3	0.0000	-14488777746.2017	-63510700.7454
4	0.0000	-12962165161.4607	-67030437.0951
5	0.0000	-15180253261.1495	-14931744.2734
6	0.0000	-15338353261.7124	14371.6712
7	0.0000	-15179064314.8834	34956824.5805
8	0.0000	-12960103705.6779	67064548.7361
9	0.0000	-9466276752.4037	93506477.7597
10	0.0000	-5003498826.6532	111451545.7129
11	0.0000	0.0000	118066651.2274

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	7468.030	-0.000	0.000	-6075.297	24652.420
2	0.000	6075.297	-24652.420	0.000	-4549.005	43764.121
3	0.000	4549.005	-43764.121	0.000	-3032.016	57409.961
4	0.000	3032.016	-57409.961	0.000	-1515.026	65594.641
5	0.000	1515.026	-65594.641	0.000	1.863	68318.158
6	0.000	-1.863	-68318.158	0.000	1518.952	65580.508
7	0.000	-1518.952	-65580.508	0.000	3035.941	57381.499
8	0.000	-3035.941	-57381.499	0.000	4552.931	43721.727
9	0.000	-4552.931	-43721.727	0.000	6069.920	24600.598
10	0.000	-6069.920	-24600.598	0.000	7804.952	0.000

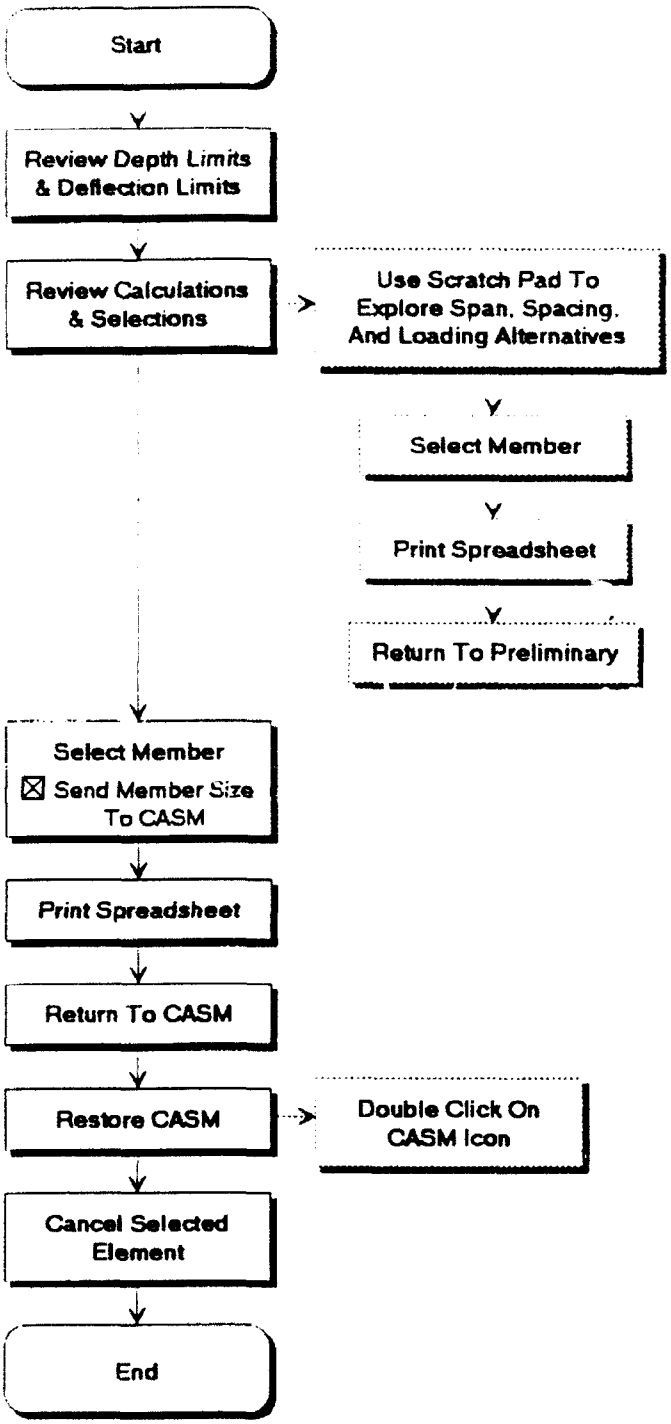
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	7468.030	0.000
2	0.000	0.000	0.000
3	0.000	0.000	0.000
4	0.000	0.000	0.000
5	0.000	0.000	0.000
6	0.000	0.000	0.000
7	0.000	0.000	0.000
8	0.000	0.000	0.000
9	0.000	0.000	0.000
10	0.000	0.000	0.000
11	0.000	7804.952	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



Barjoist Selection

STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date:** Feb 26, 1992
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis

Load Combination: D + S

Member ID:	
Connection:	Hinge (Left)
	Roller (Right)
Span:	36.0 ft
Spacing:	48.0 in
Depth Limit=	36.0 in. max
Fy=	36.0 ksi
Fb=	24.0 ksi
E =	29,000 ksi
Live Defl=	L/360= 1.20 in
Total Defl=	L/240= 1.80 in

	Factored Moment (ft-lb)			Factored Reaction	
LoadType	Left	Mid	Right	Left(lb)	Right(lb)
Dead		1,750		194	194
Sup Dead		29,743		3,305	3,305
Live					
Lmin Roof					
Snow		36,825		3,969	4,106
Wind					
Summary		68,318		7,468	7,605

Moment: (EUL)		Reaction: (EUL)	
Total Ld=	422 plf	Total Ld=	422 plf
Live Ld=	227 plf	Live Ld=	228 plf

CASM Joist Selection Table: (joist capacities)

Joist Size	Spacing (in)	Total Ld(plf)	Live Ld(plf)	Mmax (ftlb)	Rmax (lb)	Live Ld Defl(in)	Total Ld Defl(in)	Joist Weight (psf)	Joist Weight (plf)
28K9	48.0	442	332	71,604	7,956	0.83	1.53	3.3	13.0
24K10	48.0	447	283	72,414	8,046	0.96	1.79	3.3	13.1
30K8	48.0	436	353	70,632	7,848	0.78	1.45	3.3	13.2
30K9	48.0	475	383	76,950	8,550	0.72	1.33	3.4	13.4

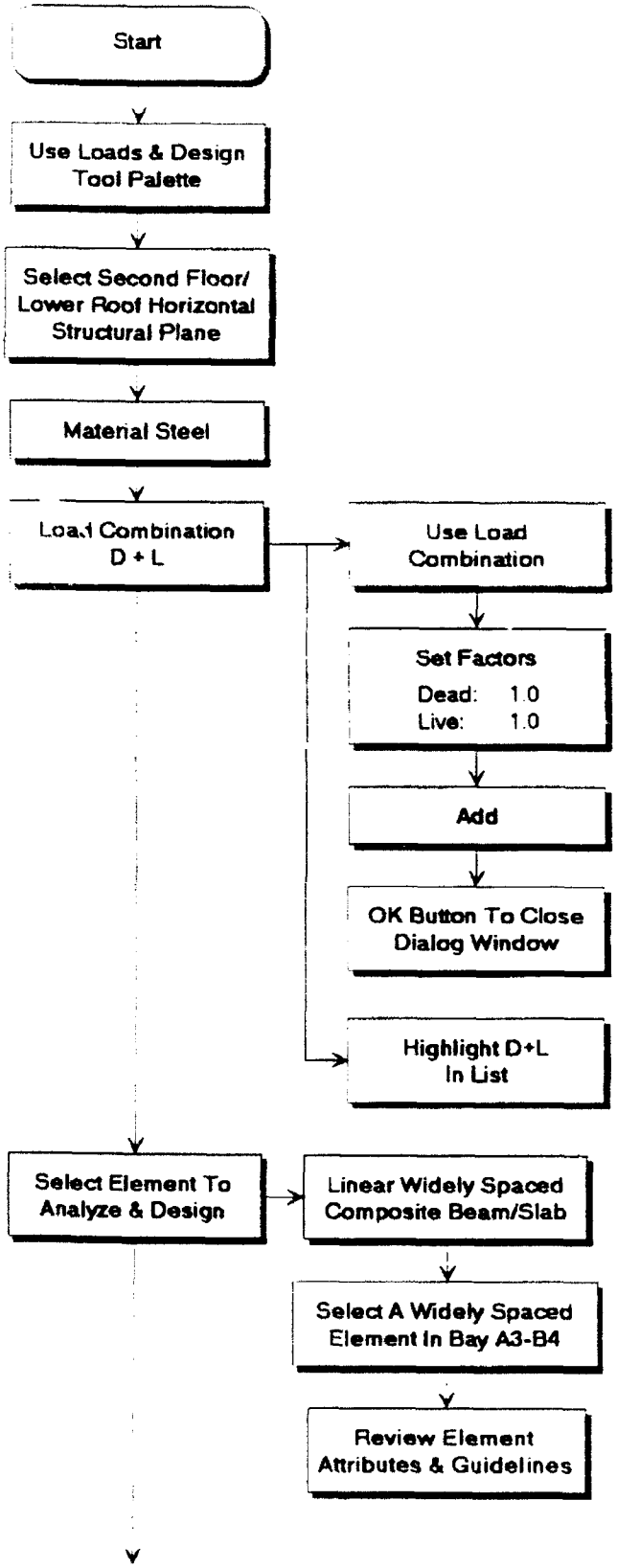
CASM Bar Joist Selection:

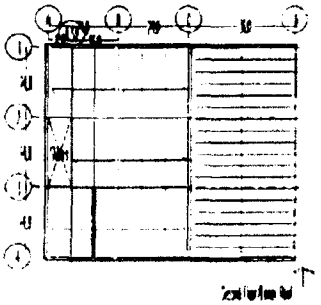
Joist Size:	28K9	Span:	36.0 ft	Spacing:	48 in	Total Ld:	442 plf	Live Ld:	332 plf
Wgt(tons):	0.23	Mmax:	71,604	Rmax:	7,956	TL defl:	1.53 in	LL defl:	0.83 in

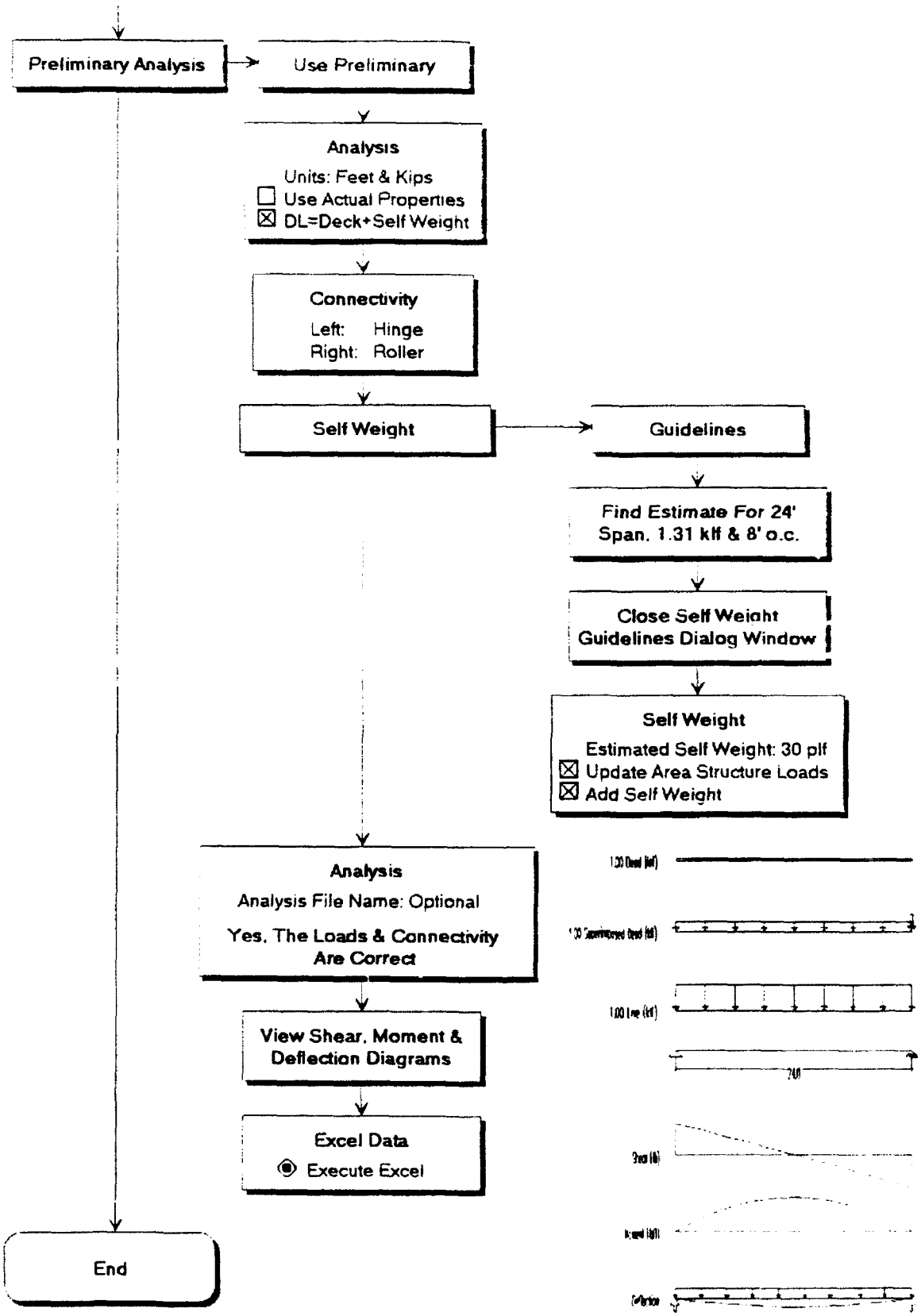
NOTES:

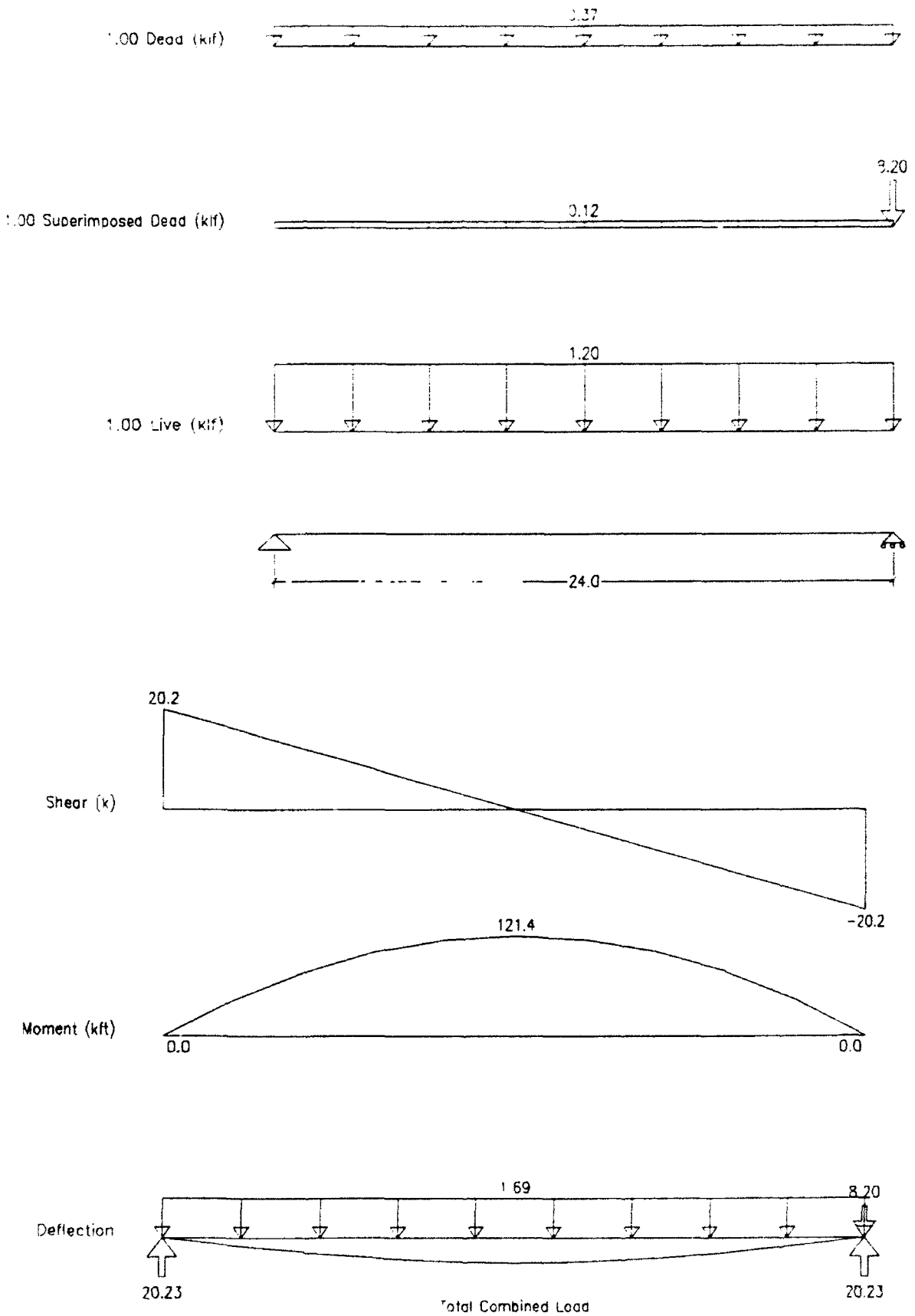
1. Bar joist selections based on 1988 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.
2. Approximate moment of inertia of the joist in inches^4 is:
   Ij = 26.767 (WLL) (L^3) (10^-6), where WLL = Live Load value in table;
   where L = Span - 0.33 in feet

Widely Spaced Element Analysis: Beam

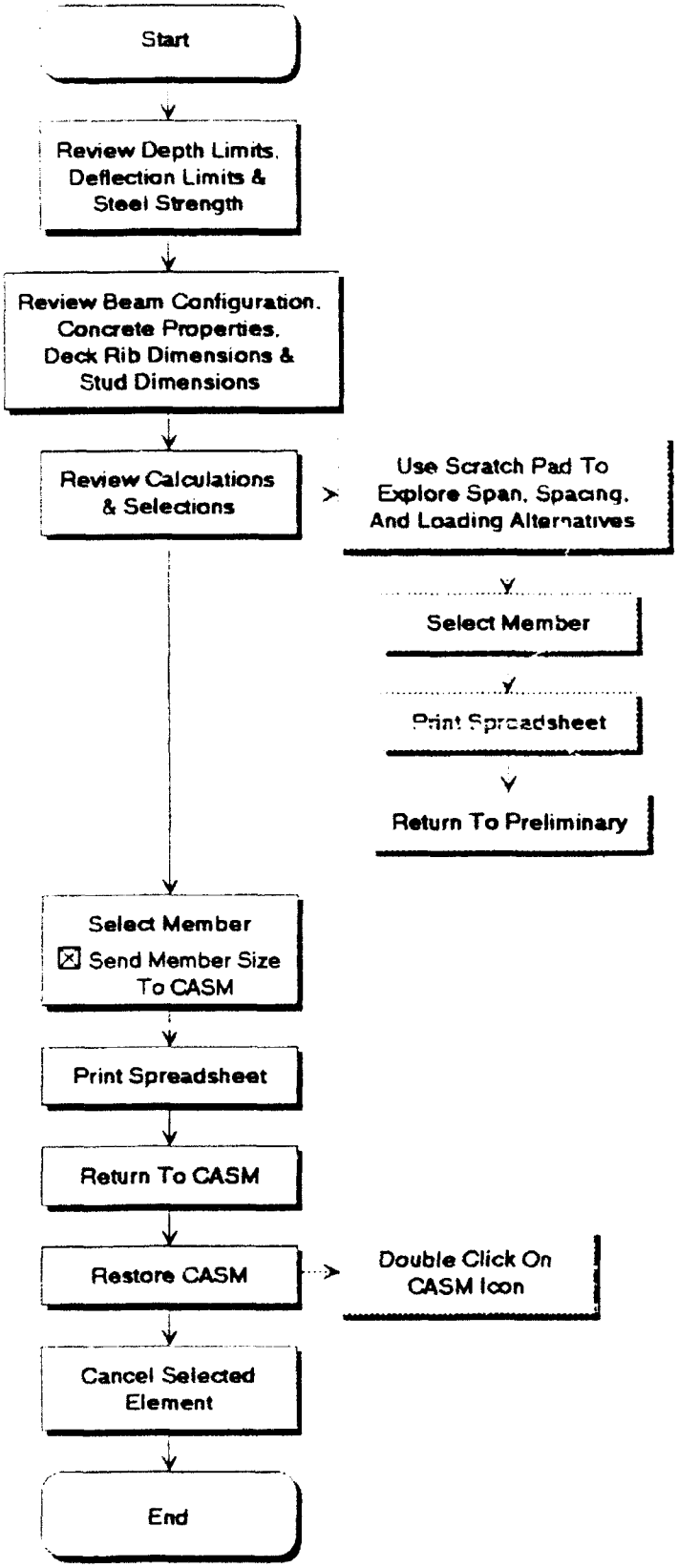





Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Kips
☐ Use Actual Properties
☒ DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Guidelines
Find Estimate For 24' Span, 1.31 klf & 8' o.c.
Close Self Weight Guidelines Dialog Window
Self Weight
Estimated Self Weight: 30 plf
☒ Update Area Structure Loads
☒ Add Self Weight
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End


1.00 Dead (klf)
0.37
1.00 Superimposed Dead (klf)
0.12
8.20
1.00 Live (klf)
1.20
24.0
Shear (k)
20.2
-20.2
Moment (kft)
121.4
0.0
0.0
Deflection
1.69
8.20
20.23
20.23
Total Combined Load

Composite Steel Beam Design



Preliminary Selection

STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date:** Feb 26, 1992
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis
Member ID:
Connectivity: Hinge (Left)
Roller (Right)
Beam Span: 24.0 ft
Trib Width= 8.0 ft
Depth Limit= 36.0 in. max
Fy= 36.0 ksi
Fb=Fy*0.66= 24.0 ksi
Fy * 0.89= 32.0 ksi
Fv= 14.4 ksi
Es= 29,000 ksi

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		26.4		4.4	4.4
Sup Dead		8.6		1.4	1.4
Live		86.4		14.4	14.4
Lmin Roof					
Snow					
Wind					
Summary		121.4		20.2	20.2

Deflection Limits:

Live Load= L/360 =0.80 in
Total Load= L/240 =1.20 in

Reqd Section Properties:

Ss(req)= 23 in^3
Str(req)= 61 in^3
Composite percent= 100 %

Beam Composite Properties:

f'c= 4.0 ksi
.45f'c= 1.8 ksi
Wc= 145 pcf
Ltwt conc coef= 1.0
Ec= 3,644 ksi
n= 8.0
Slab ts= 4.00 in
Slab bE= 70.5 in

Rib Spacing= 6.00 in
Rib Width= 2.50 in
Rib Height= 2.00 in
Studs/rib= 1
Stud Diameter= 0.75 in
Stud Length= 3.5 in
Reduct. Factor= 0.80
Shear Cap= 10.6 kips

CASM Beam Selection Table:

Beam Size	Ss in^3	Dead Ld Defl(in)	Seff in^3	Conc fc (psi)	Steel fs (psi)	Ieff in^4	L + SD Defl(in)	# of Studs	Min % Comp.
W 16 x 26	38.4	-0.31	60.8	0.66	23.98	934	-0.36	28	99
W 14 x 30	42.0	-0.32	64.9	0.70	22.46	878	-0.39	32	67
W 10 x 39	42.1	-0.45	67.2	0.89	21.67	661	-0.51	40	55
W 8 x 48	43.3	-0.51	72.9	0.99	19.99	607	-0.56	48	40
W 12 x 35	45.6	-0.33	70.1	0.74	20.78	848	-0.40	36	40

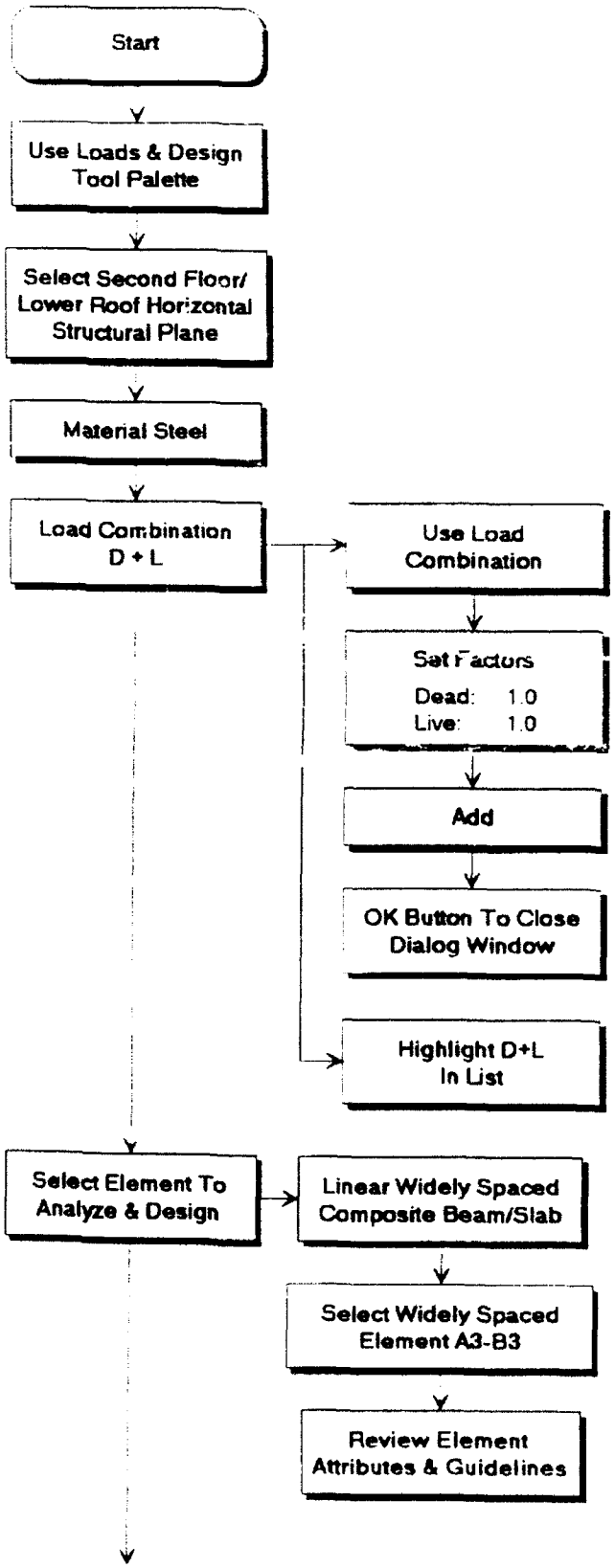
CASM Steel Beam Selection:

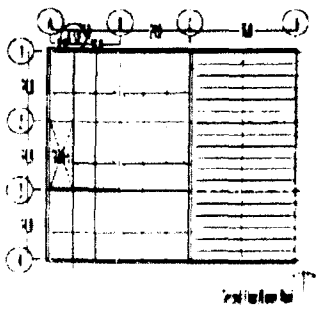
							Live Ld	Total
W 16 x 26	Span= 24.0 ft	Seff(in3)= 60.8	Ieff(in4)= 934	Defl(in)=	-0.36	-0.68		
Shores Reqd: No	Nstuds= 28 (full)	Partial: (100 %)	Nstuds= 28	fv= 5.2ksi				
			Beam Wgt= 0.31 tons					

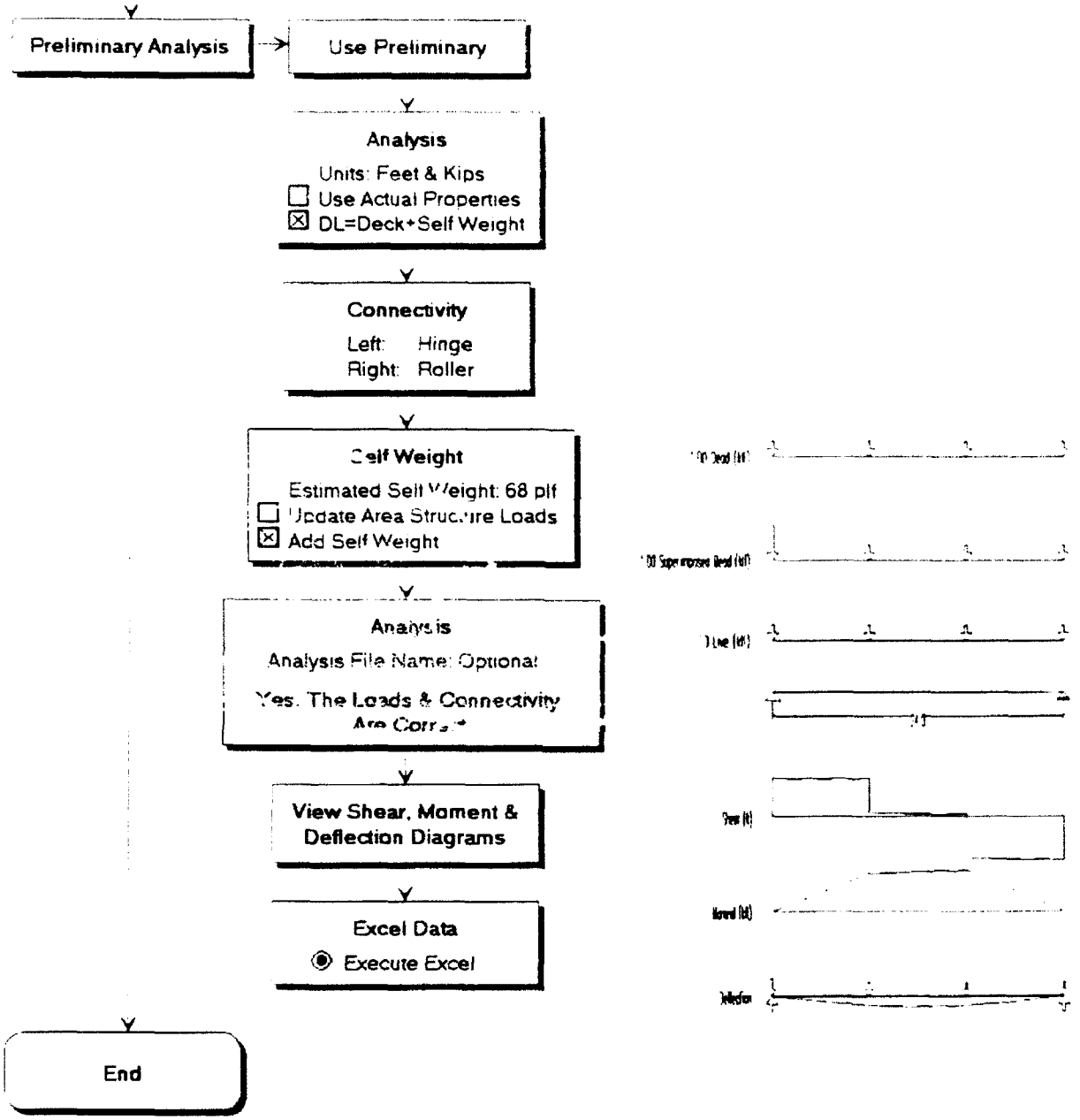
Notes:

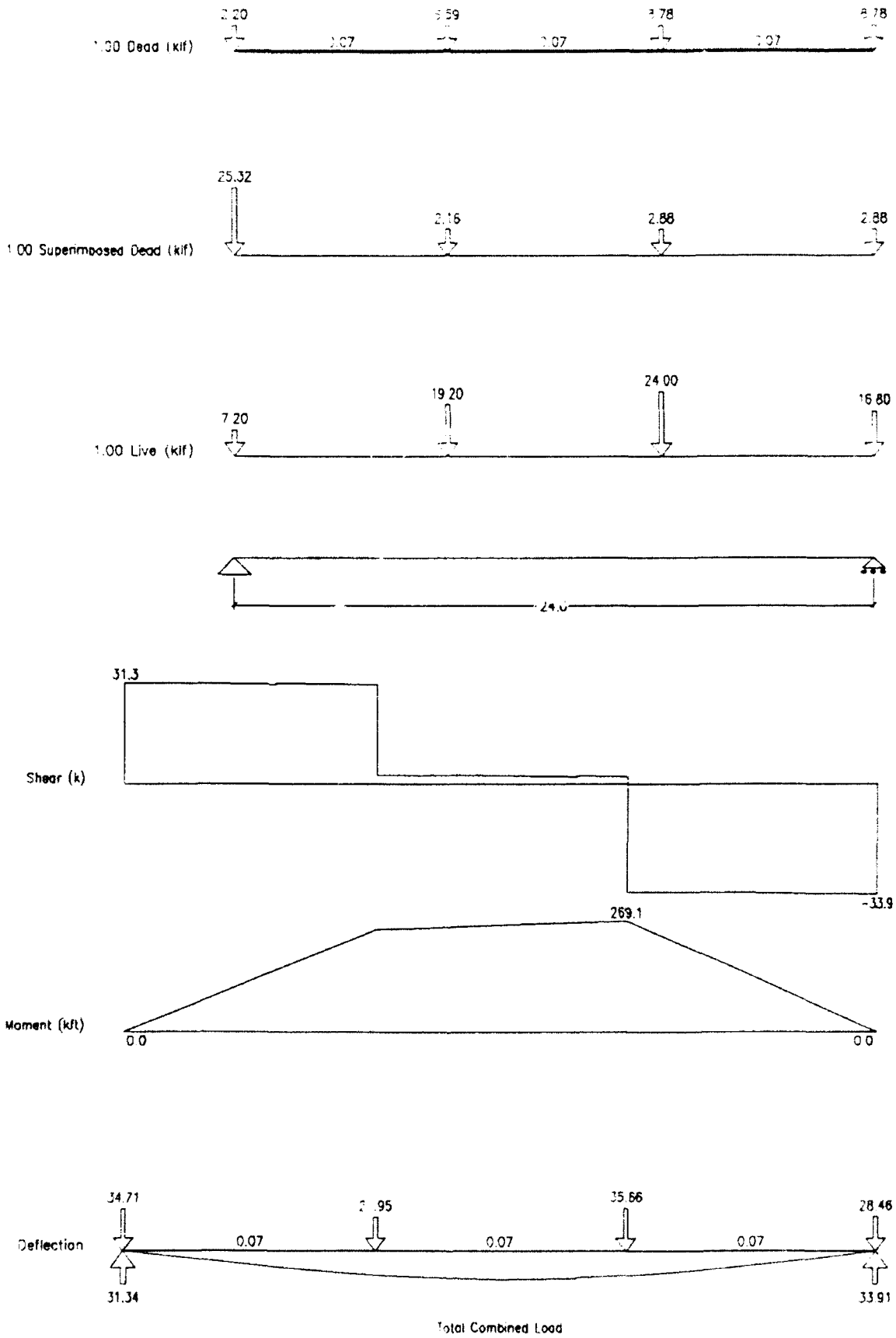
1. Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
2. Dead load shear and moment are not modified with changes in slab depth.

Widely Spaced Element Analysis: Girder

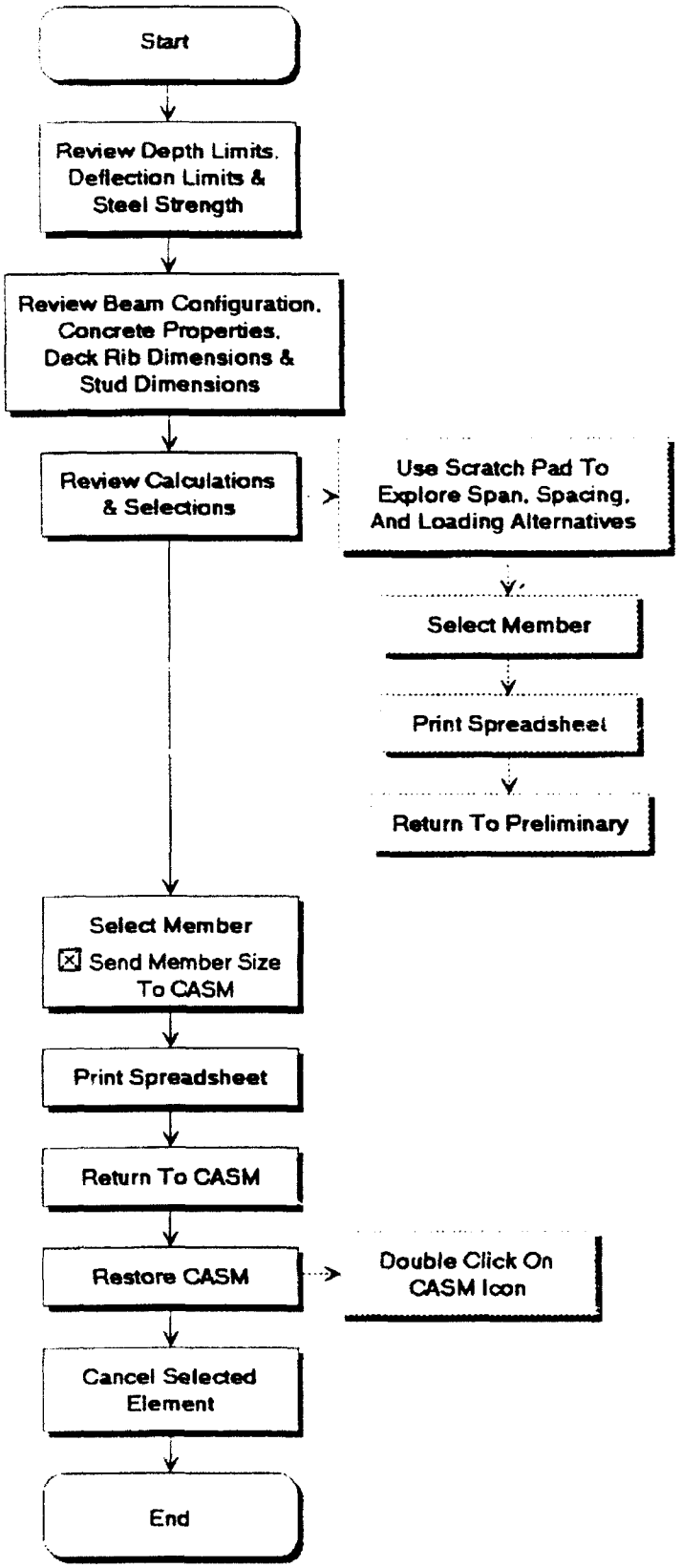





Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Self Weight
Estimated Self Weight: 68 plf
Update Area Structure Loads
Add Self Weight
Analysis
Analysis File Name: Optional
Yes. The Loads & Connectivity
View Shear, Moment &
Deflection Diagrams
Excel Data
Execute Excel
End


1.00 Dead (klf)
25.32
2.16
2.88
2.88
1.00 Superimposed Dead (klf)
7.20
19.20
24.00
16.80
1.00 Live (klf)
24.0
31.3
Shear (k)
-33.9
269.1
Moment (kft)
0.0
0.0
34.71
35.66
28.46
Deflection
0.07
0.07
0.07
31.34
33.91
Total Combined Load

Composite Steel Beam Design



Preliminary Selection

STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date:** Feb 26, 1992
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis

Member ID:

Connectivity: Hinge (Left)
Roller (Right)

Beam Span: 24.0 ft
Trib Width= 24.0 ft
Depth Limit= 36.0 in. max
Fy= 36.0 ksi
Fb=Fy*0.66= 24.0 ksi
Fy * 0.89= 32.0 ksi
Fv= 14.4 ksi
Es= 29,000 ksi

Load Combination: D + L

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		68.8		8.1	8.9
Sup Dead		21.1		2.4	2.6
Live		179.2		20.8	22.4
Lmin Roof					
Snow					
Wind					
Summary		269.1		31.3	33.9

Deflection Limits:

Live Load= L/360 =0.80 in
Total Load= L/240 =1.20 in

Reqd Section Properties:

Ss(req)= 57 in^3
Str(req)= 135 in^3
Composite percent= 100 %

Girder Composite Properties:

f'c= 4.0 ksi
.45f'c= 1.8 ksi
Wc= 145 pcf
Ltwt conc coef= 1.0
Ec= 3,644 ksi
n= 8.0
Slab ts= 4.00 in
Slab bE= 70.5 in

Rib Spacing= 6.00 in
Rib Width= 2.50 in
Rib Height= 2.00 in
Studs/rib= 1
Stud Diameter= 0.75 in
Stud Length= 3.5 in
Reduct. Factor= 0.56
Shear Cap= 7.5 kips

CASM Beam Selection Table:

Beam Size	Ss in^3	Dead Ld Defl(in)	Seff in^3	Conc fc (psi)	Steel fs (psi)	Ieff in^4	L + SD Defl(in)	# of Studs	Min % Comp.
W 21 x 50	94.5	-0.25	141.0	0.68	22.91	2,661	-0.27	72	74
W 12 x 72	97.4	-0.41	141.0	0.99	22.90	1,569	-0.45	94	73
W 18 x 55	98.3	-0.27	142.3	0.73	22.69	2,337	-0.30	78	68
W 10 x 88	98.5	-0.45	151.5	1.09	21.31	1,456	-0.48	94	46
W 14 x 68	103.0	-0.34	147.0	0.88	21.96	1,860	-0.38	94	51

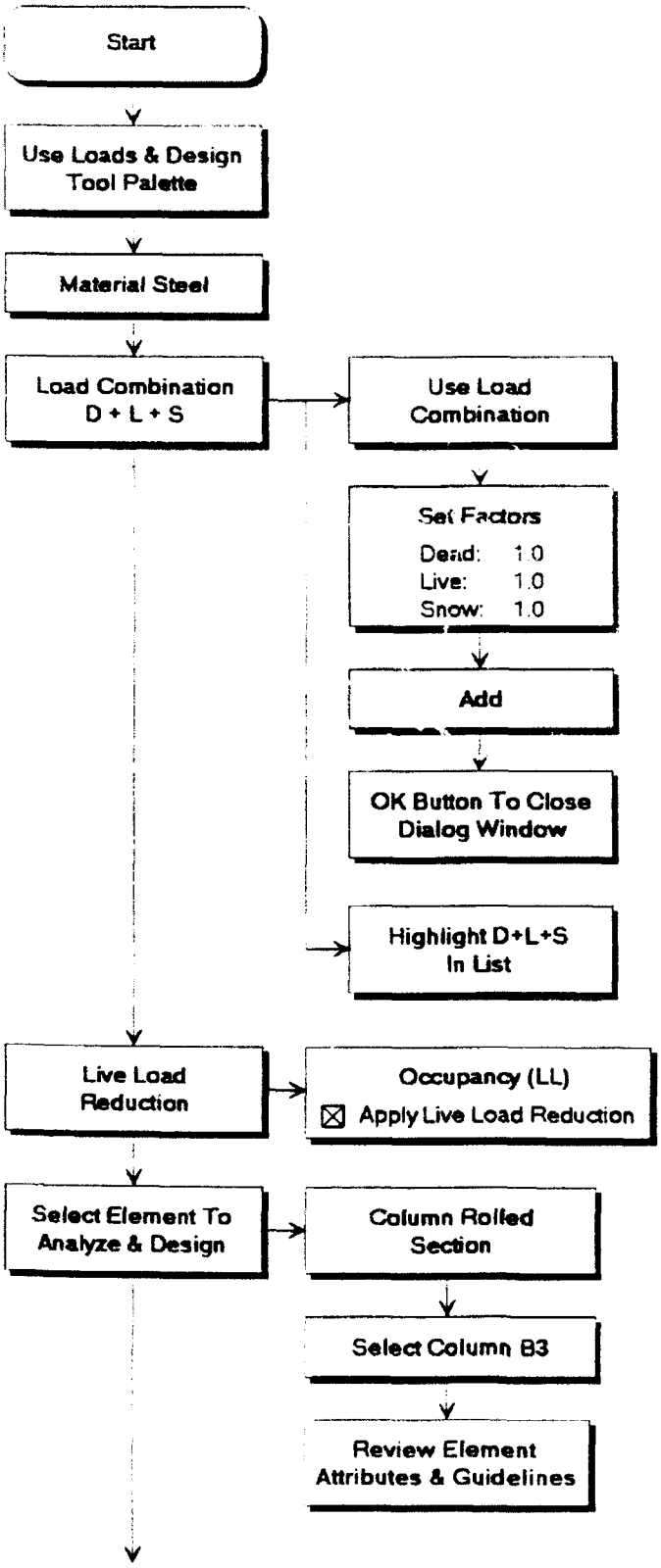
CASM Steel Beam Selection:

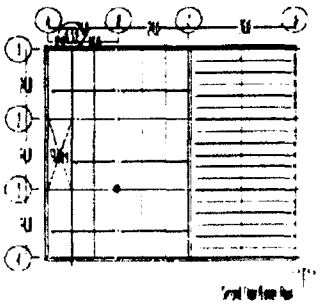
						Live Ld	Total
W 21 x 50	Span= 24.0 ft	Seff(in3)= 141.0	eff(in4)= 2,661	Defl(in)=		-0.27	-0.51
Shores Reqd: No	Nstuds= 72 (full)	Partial: (100 %)	Nstuds= 72			fv=	4.3ksi
			Beam Wgt=	0.60	tons		

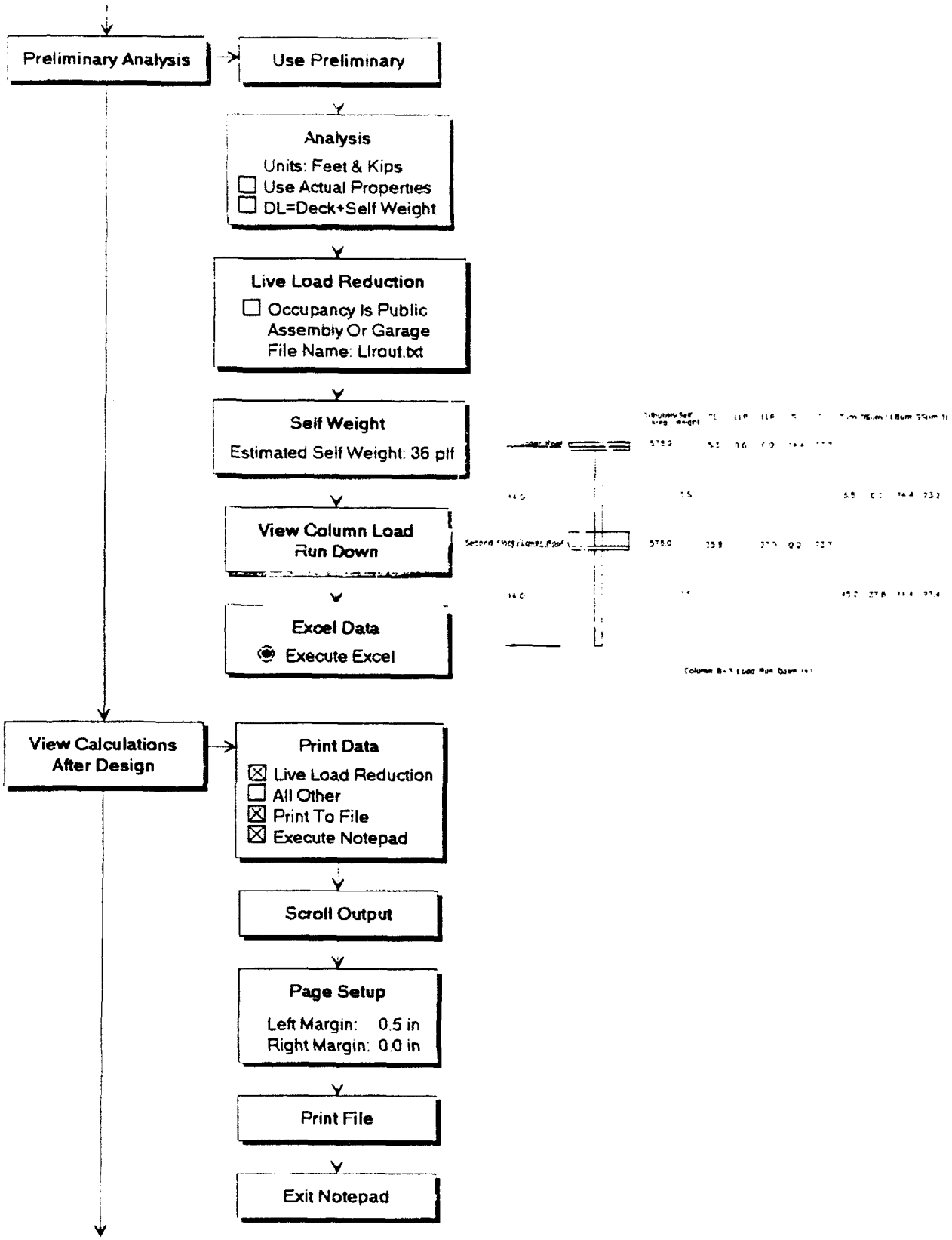
Notes:

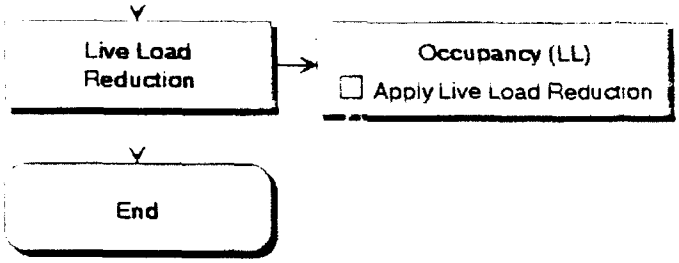
1. Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
2. Dead load shear and moment are not modified with changes in slab depth.

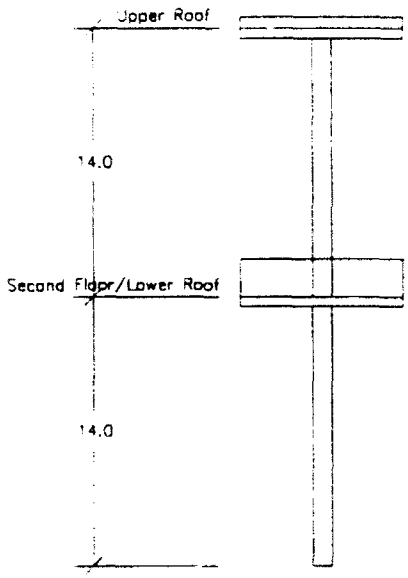
Column Load Run Down






Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight
Live Load Reduction
Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Self Weight
Estimated Self Weight: 36 plf
View Column Load Run Down
Excel Data
Execute Excel
View Calculations After Design
Print Data
Live Load Reduction
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad


Live Load Reduction
Occupancy (LL)
Apply Live Load Reduction
End



	Tributary Area	Self Weight	DL	LR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
Upper Roof	576.0		8.3	0.0	0.0	14.4	22.7				
14.0		0.5						8.8	0.0	14.4	23.2
Second Floor/Lower Roof	576.0		35.0		37.8	0.0	72.8				
14.0		0.5						44.3	37.8	14.4	96.5

Column B–3 Load Run Down (k)

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Design Load  : TM 5-809-1 1991
Time         : Sun Jan 26, 1992  1:13 PM

************************** Live Load Reduction **************************

Second Floor/Lower Roof
Office: Offices                    (Lo) :   [illegible] psf
Tributary area                     (TA) :   576.0 sf
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sf
Ai >= 400.0 sf
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+----------------------+
|     L = 28.13 psf    |
+----------------------+

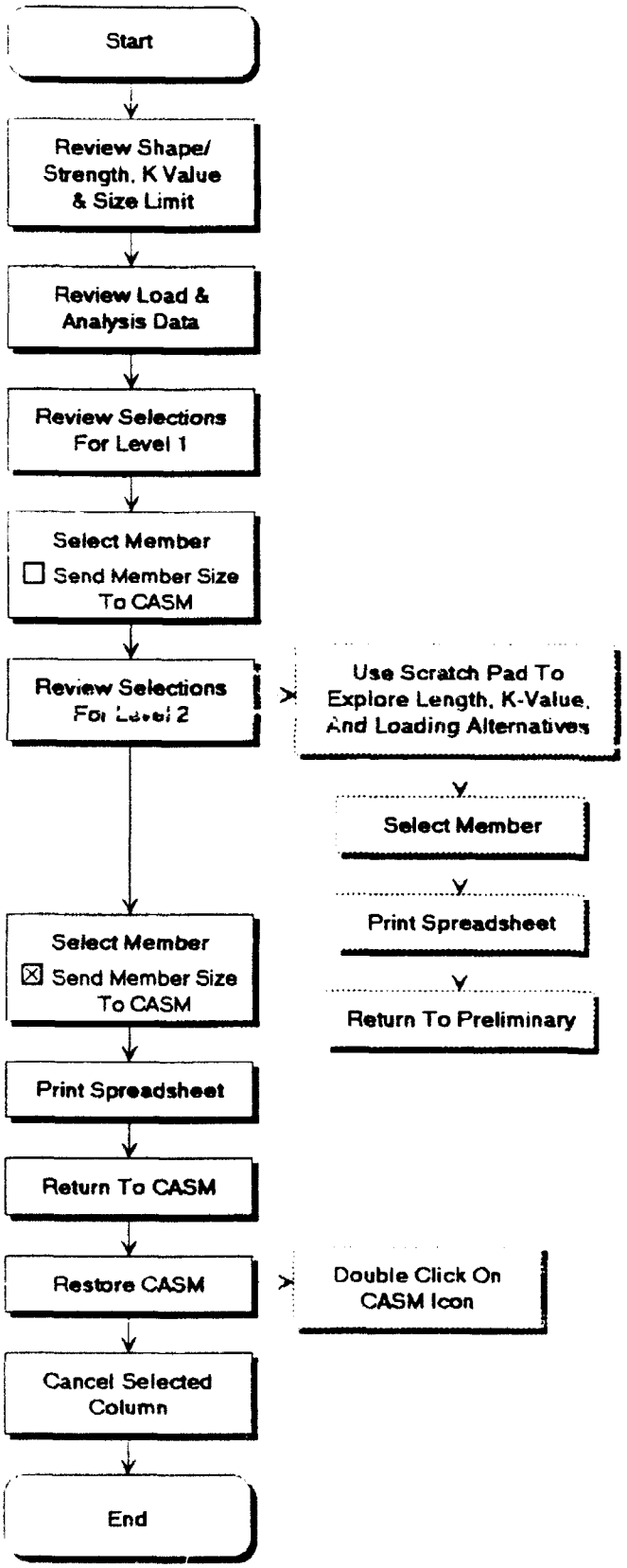
************************** Live Load Reduction **************************

Second Floor/Lower Roof
Office: Corridor (main)            (Lo) :  100.0 psf
Tributary area                     (TA) :  576.0 sf
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sf
Ai >= 400.0 sf
Lo <= 100.0 psf
L = Lo*[0.25+15/sqrt(Ai)]
L = 56.3 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 50.0 psf
+----------------------+
|     L = 56.25 psf    |
+----------------------+

************************** Live Load Reduction **************************

Second Floor/Lower Roof
Office: Files & Storage            (Lo) :  150.0 psf
Tributary area                     (TA) :  576.0 sf
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sf
Ai >= 400.0 sf
Lo > 100.0 psf
Member supports only one floor.
No live load reduction taken.
L = Lo
+----------------------+
|     L = 150.00 psf   |
+----------------------+
```

Steel Column Design



Steel Column Preliminary Selection

STEEL COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme B	**Date:** Feb 26, 1992
Location: Radford AAP	**Engr:**

CASM Load & Analysis Data:

Method: Analysis Load Combination: D + L + S Steel Fy= 36.0 ksi
Member ID: B-3 Size Limit= 16.0 in. max E= 29000 ksi

Name	Level	Flr to Flr Ht	Trib Area	Floor Level Load Totals (kips) Dead	Live	Lmin	Snow	Wind	Load Totals
	6								
	5								
	4								
	3								
Upper Roof	2	14.0	576	8.8			14.4		23.2
Second Floor/L	1	14.0	576	44.3	37.8		14.4		96.5

CASM Column Selection Table

Level: 2 Preq: 23.2 kips K-value: 1.0 Cc= 126.1
Col Shape: W Length: 14.0 ft kl: 14.0

Column Size	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	fa (ksi)	Pallow (kip)	Weight (ton)
W 6 x 15	5.99	5.99	4.43	1.46	115.07	10.98	5.24	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.96	39.6	0.11
W 8 x 18	8.14	5.25	5.26	1.23	136.59	7.78	4.41	40.9	0.13
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	4.19	47.7	0.13
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.81	103.2	0.20

CASM Steel Column Selection

Column Size	Level	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	Pallow (kip)	Weight (ton)
W 8 x 28	2	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20
W 8 x 28	1	8.06	6.54	8.25	1.62	103.70	12.50	103.2	0.20

Total Column Weight: 0.20

Notes:

1. Steel column properties from ASD - AISC Steel Construction Manual, 9th edition

Lateral Resistance Philosophy

Steps Required

1. Create building volume

2. Define a structural grid

3. Layout structural framing on ALL levels

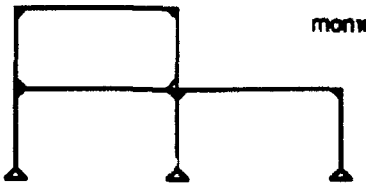
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads

5. Select a load combination including wind or seismic loads

6. Define N-S & E-W vertical resistance system

   Options:

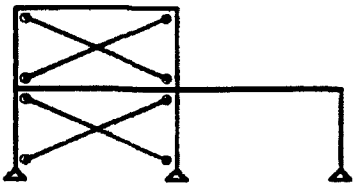
   1. Unbraced Frames

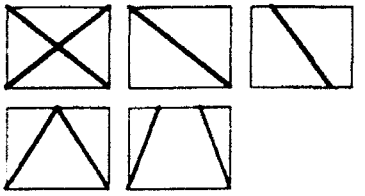


moment resistant connections
or
knee bracing

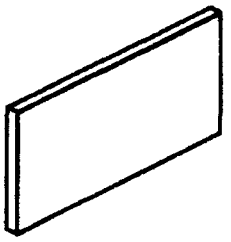
   2. Braced Frames

      A. Trussing





      B. Shear Walls

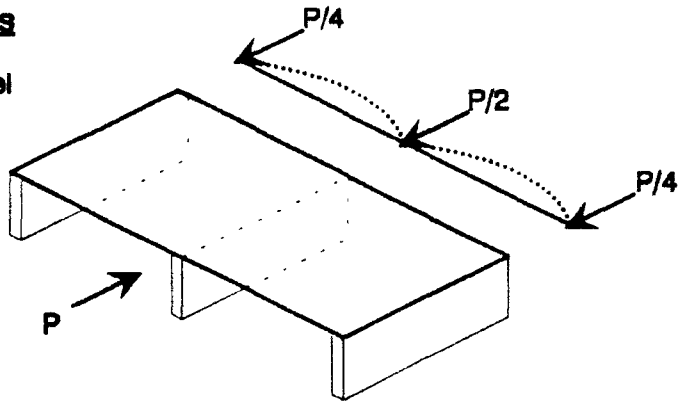


7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

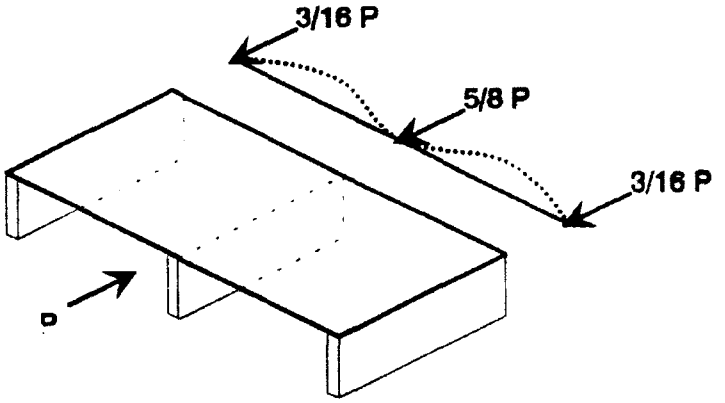
Flexible Diaphragms

Simple Beam Model
(tributary area)



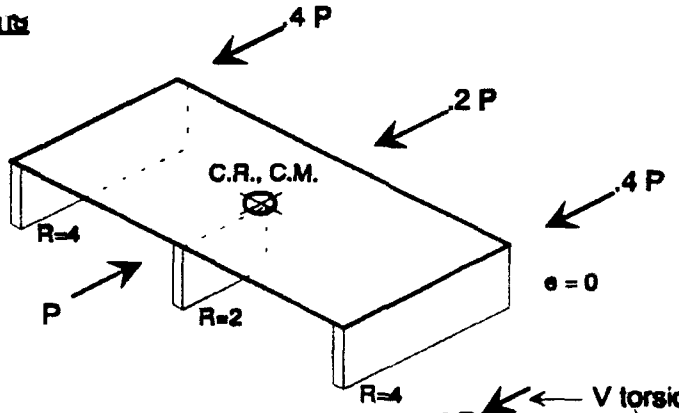
* No Torsion

Continuous Beam Model



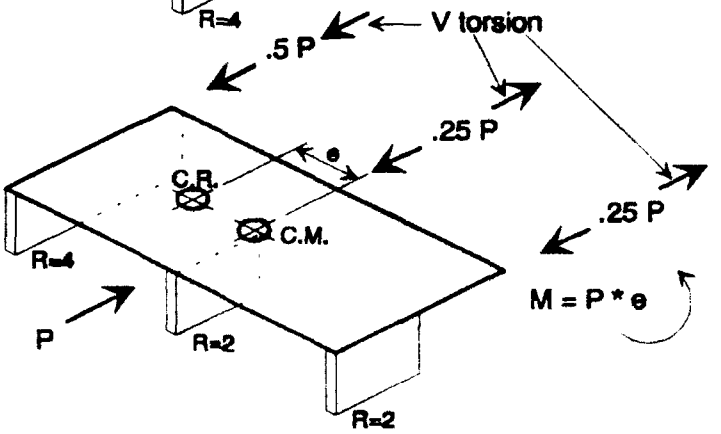
Rigid Diaphragms

Symmetrical

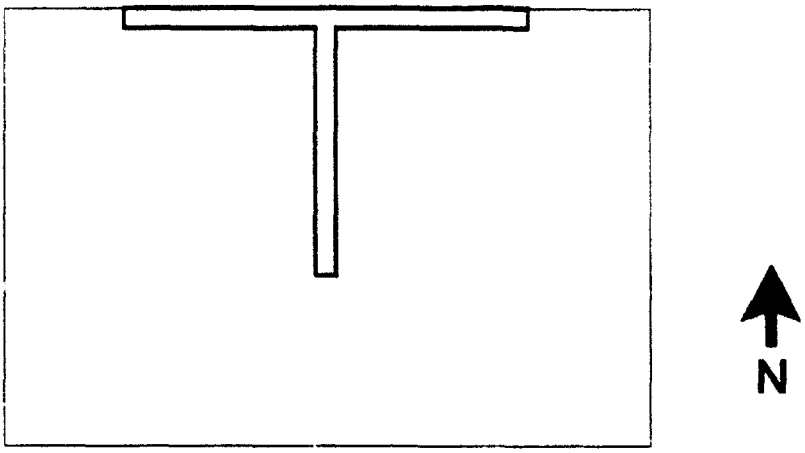


Torsion
(even accidental minimum required)

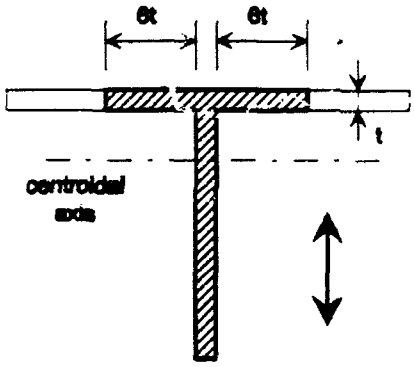
Non-Symmetrical



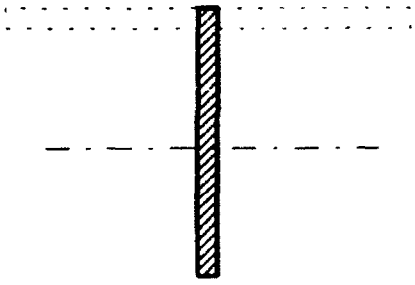
Monolithic Perpendicular Shear Walls



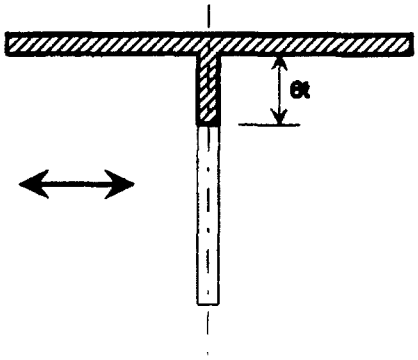
For N-S



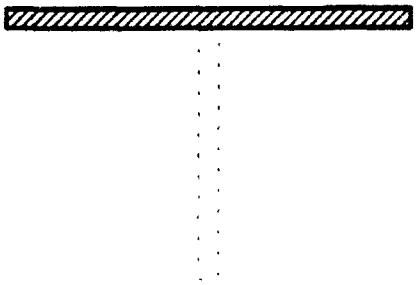
or



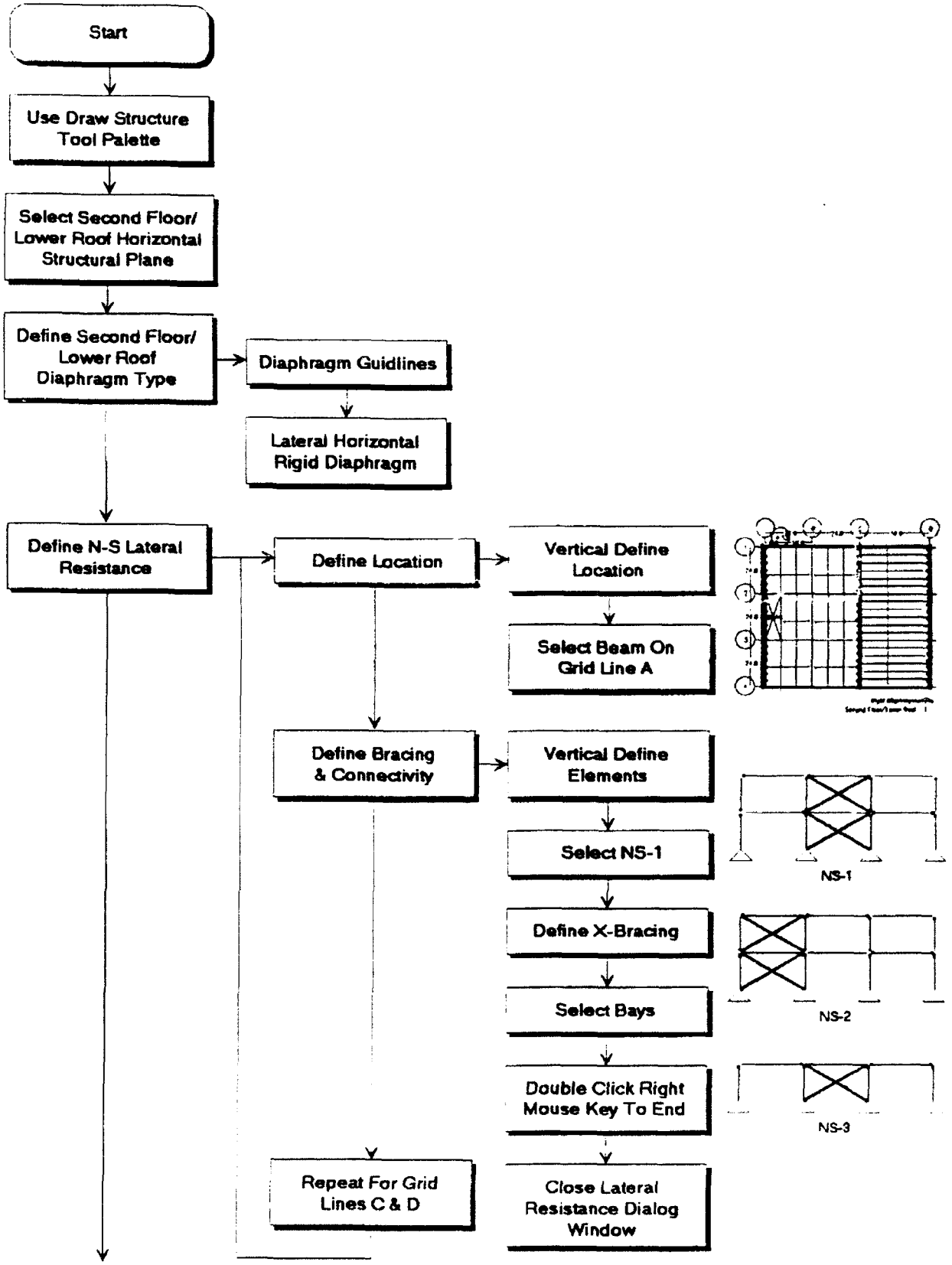
For E-W

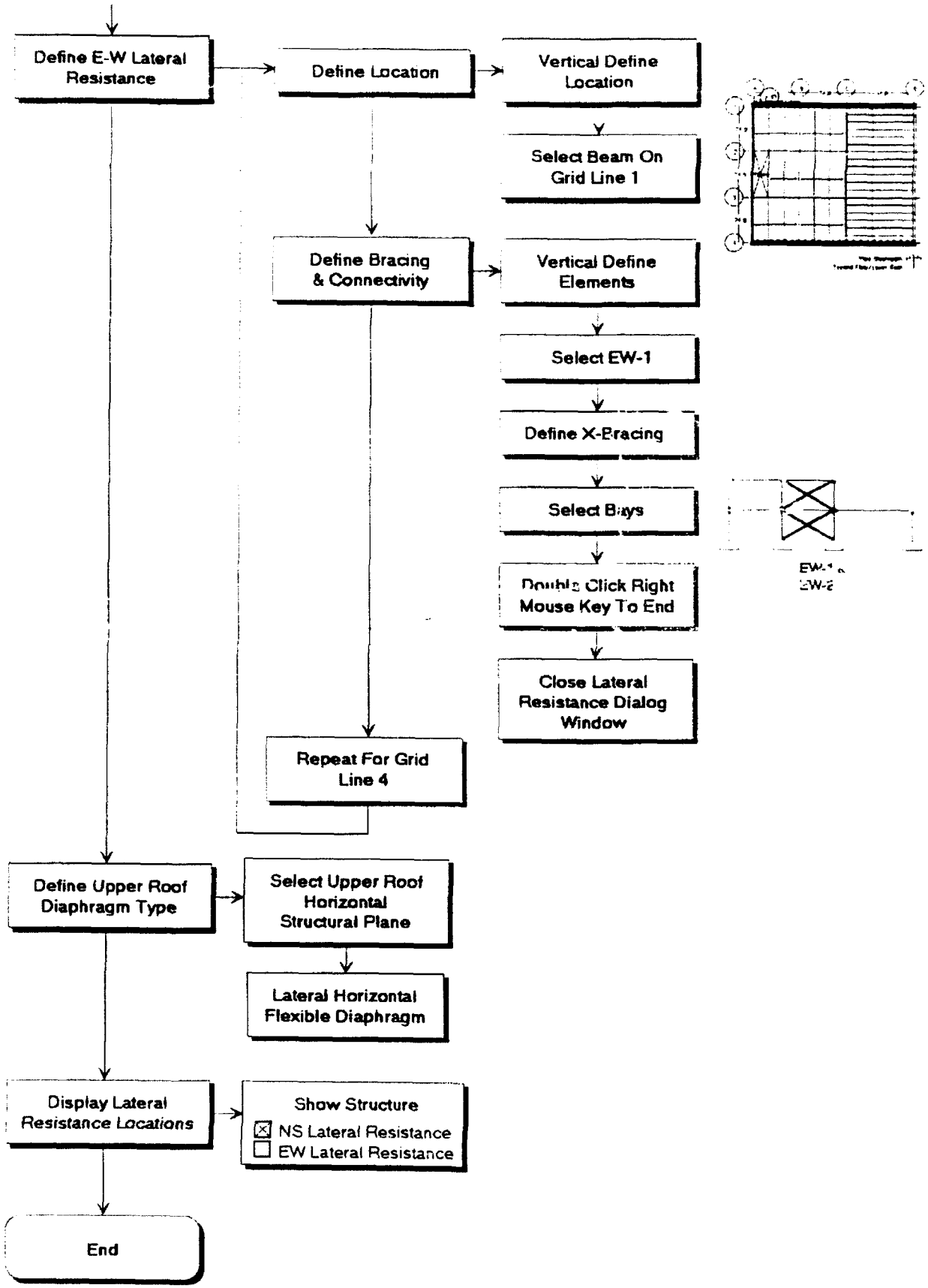


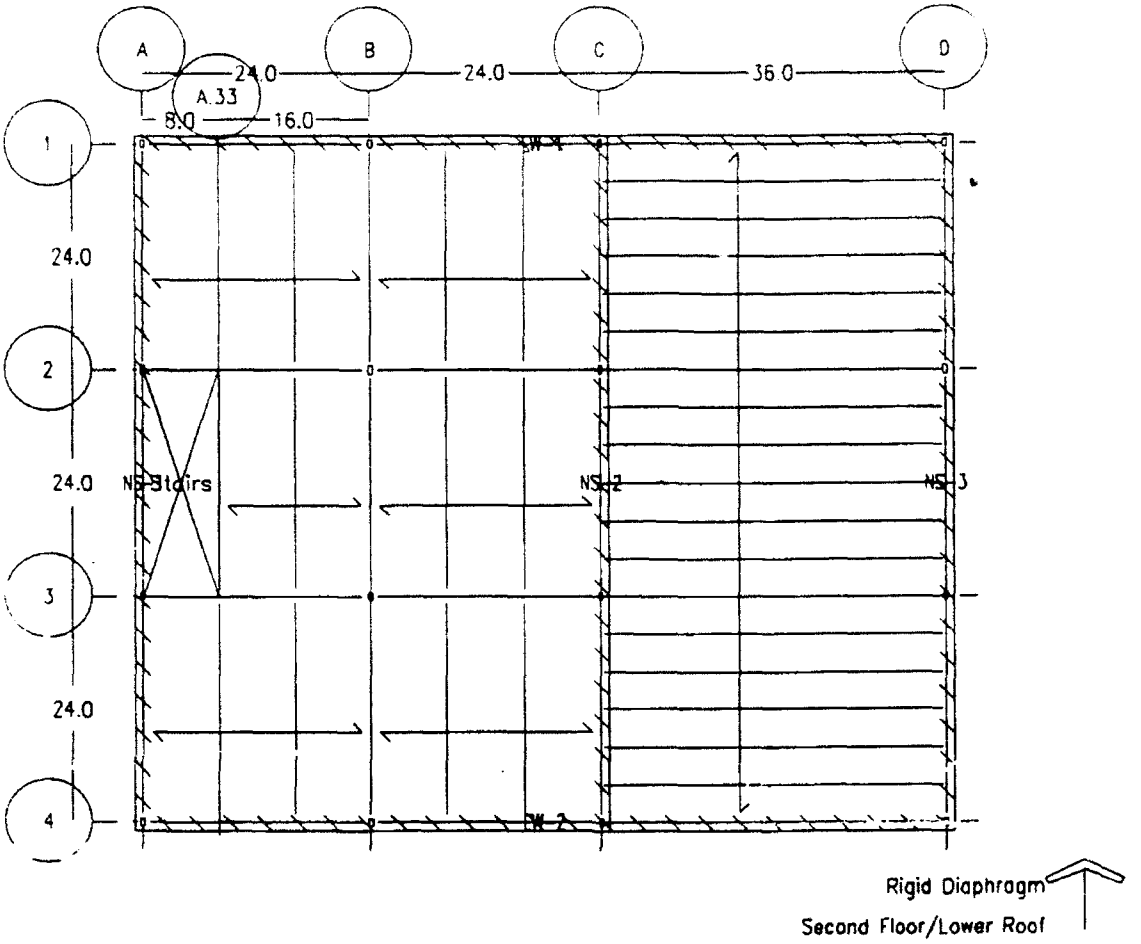
or

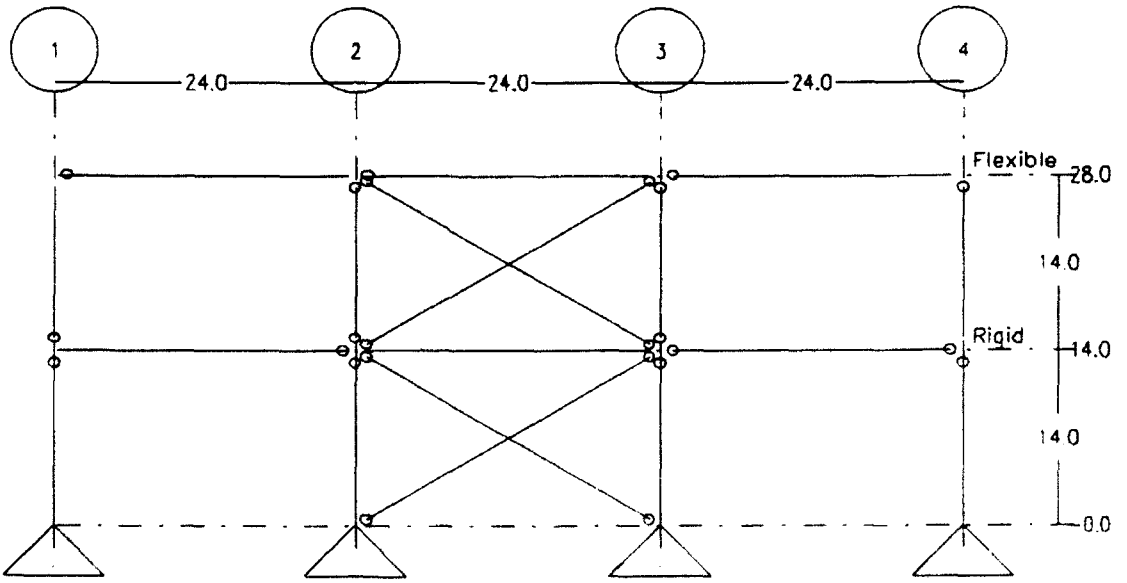


Define Lateral Resistance

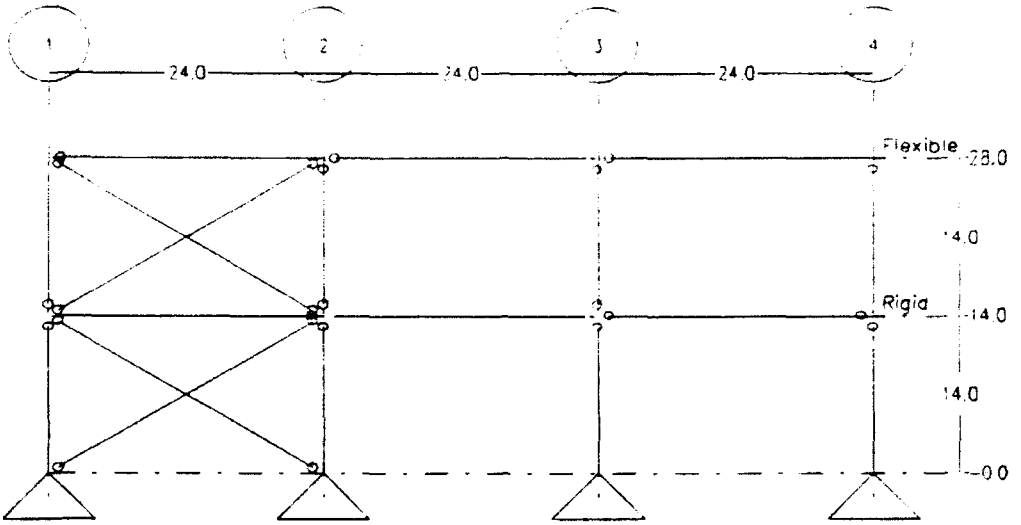



Define E-W Lateral Resistance
Define Location
Vertical Define Location
Select Beam On Grid Line 1
Define Bracing & Connectivity
Vertical Define Elements
Select EW-1
Define X-Bracing
Select Bays
Double Click Right Mouse Key To End
Close Lateral Resistance Dialog Window
Repeat For Grid Line 4
Define Upper Roof Diaphragm Type
Select Upper Roof Horizontal Structural Plane
Lateral Horizontal Flexible Diaphragm
Display Lateral Resistance Locations
Show Structure
NS Lateral Resistance
EW Lateral Resistance
End

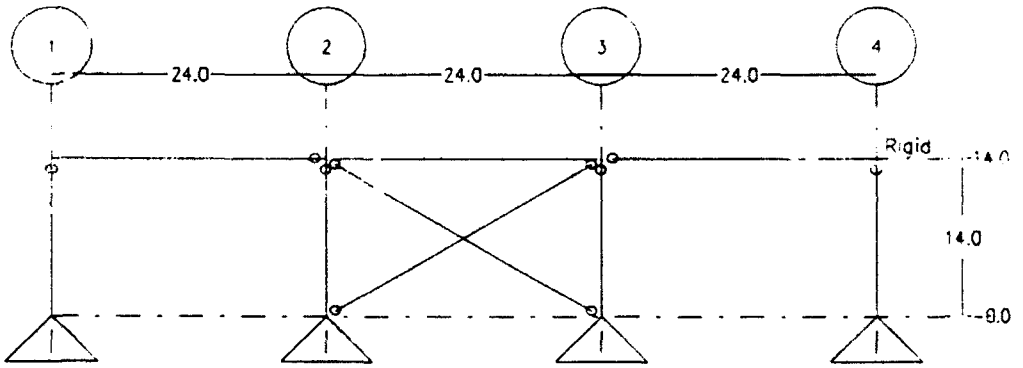

A
B
C
D
24.0
24.0
36.0
A.33
8.0
16.0
1
2
3
4
24.0
24.0
24.0
NS-Stairs
NS-2
NS-3
Rigid Diaphragm
Second Floor/Lower Roof


1
2
3
4
24.0
24.0
24.0
Flexible
Rigid
28.0
14.0
14.0
14.0
0.0

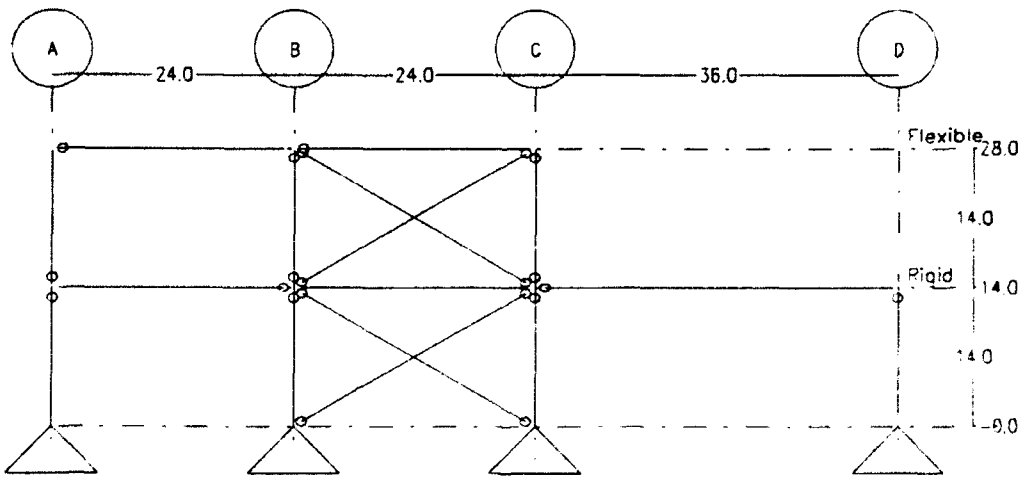
NS-1



NS-2

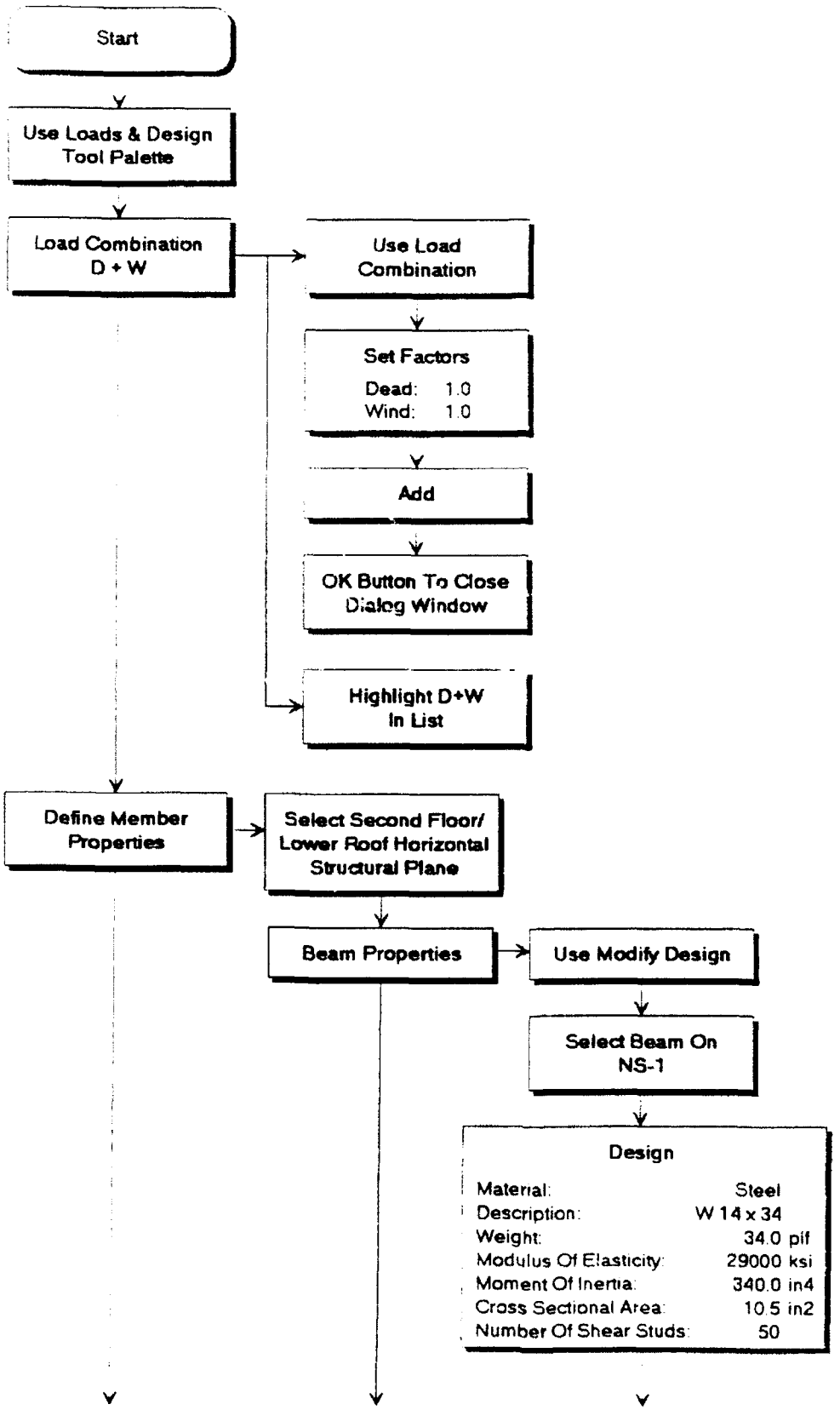


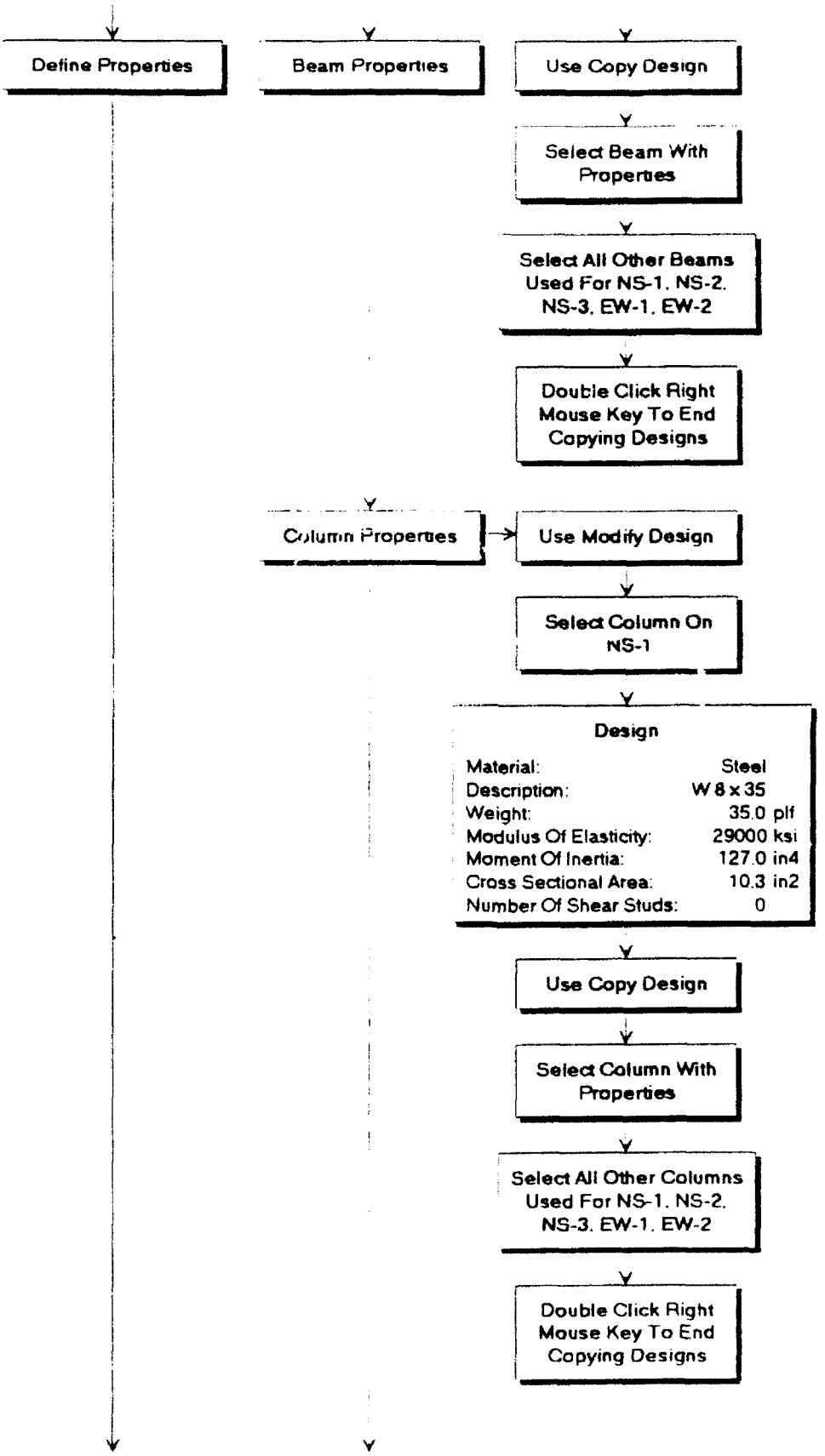
NS-3

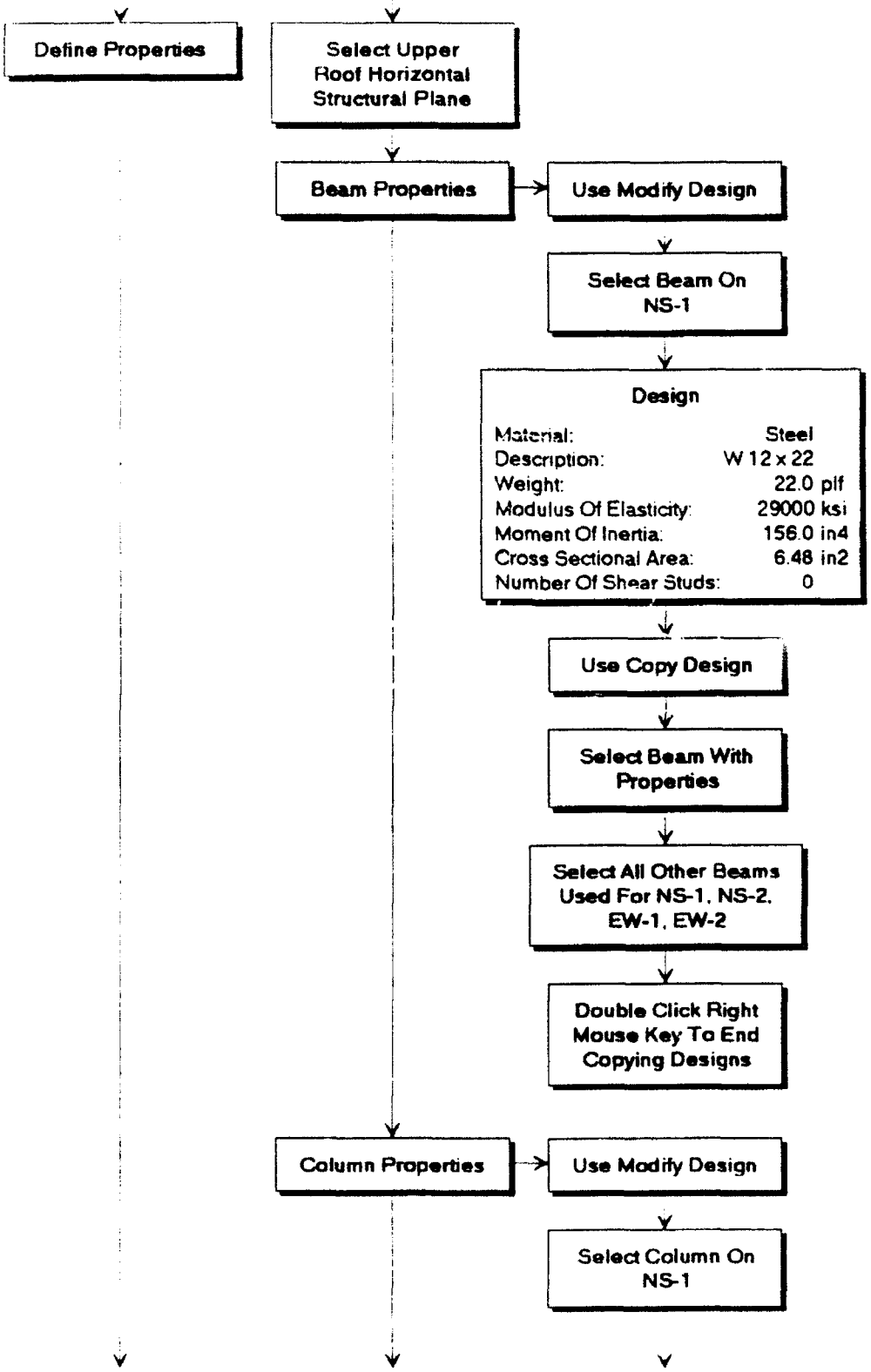


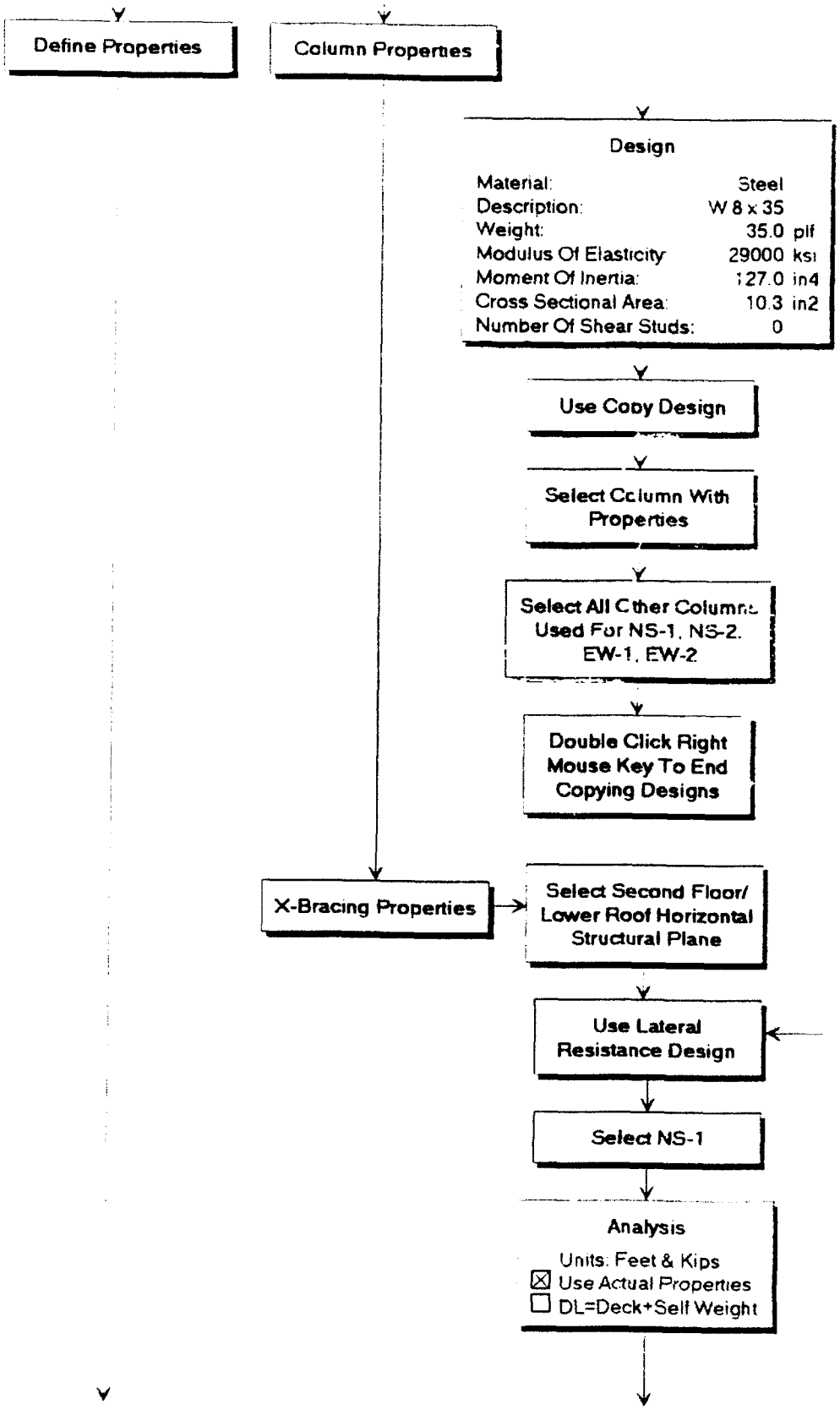
EW-1 & EW-2

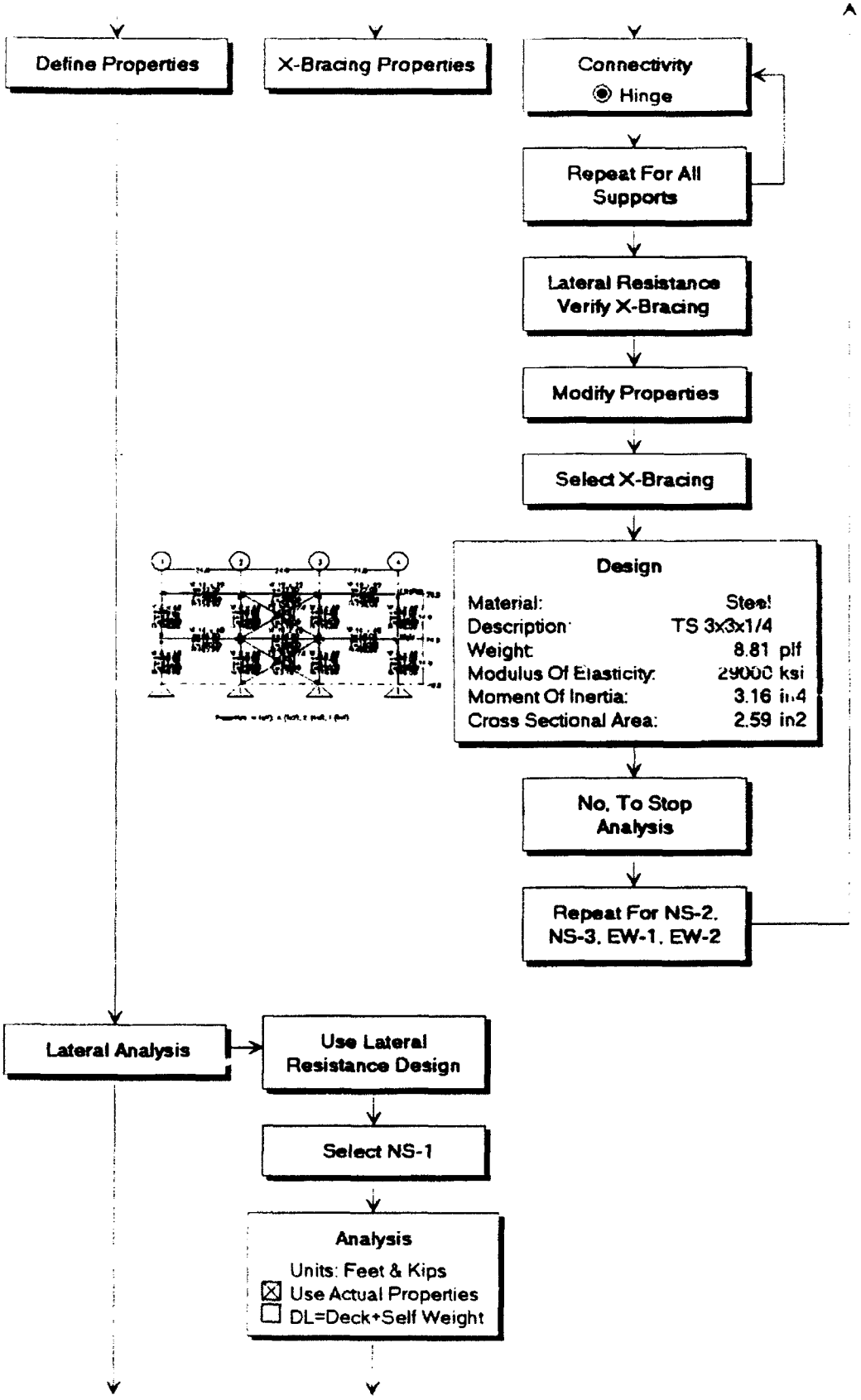
Wind Lateral Analysis

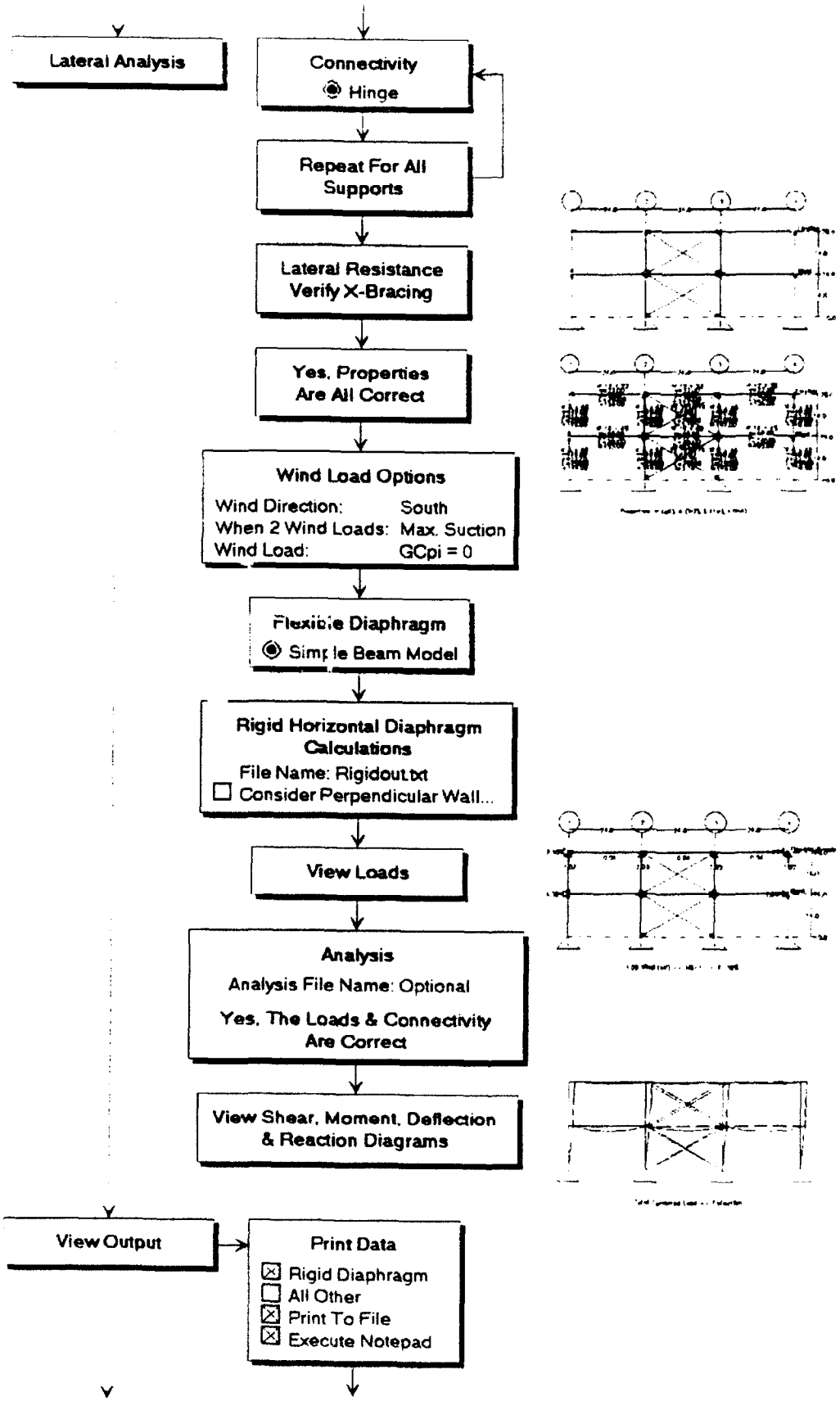


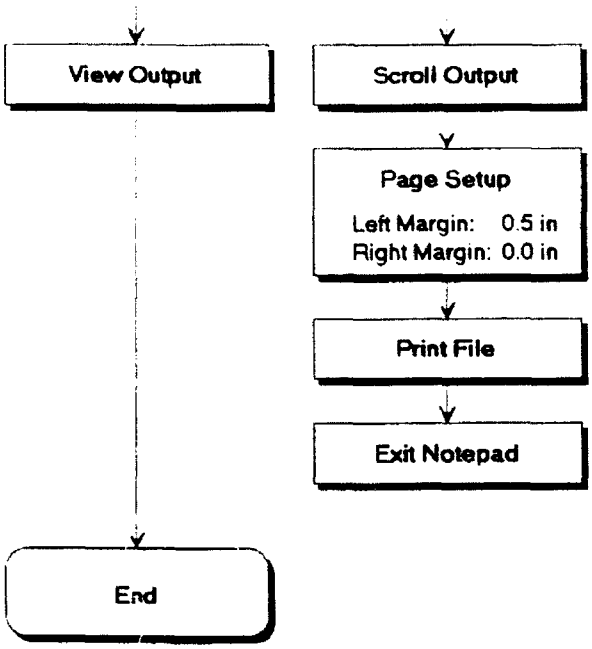

Define Properties
Beam Properties
Use Copy Design
Select Beam With Properties
Select All Other Beams Used For NS-1, NS-2, NS-3, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Column Properties
Use Modify Design
Select Column On NS-1
Design
Material: Steel
Description: W 8 x 35
Weight: 35.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 127.0 in4
Cross Sectional Area: 10.3 in2
Number Of Shear Studs: 0
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, NS-3, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs


Define Properties
Select Upper Roof Horizontal Structural Plane
Beam Properties
Use Modify Design
Select Beam On NS-1
Design
Material: Steel
Description: W 12 x 22
Weight: 22.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 156.0 in4
Cross Sectional Area: 6.48 in2
Number Of Shear Studs: 0
Use Copy Design
Select Beam With Properties
Select All Other Beams Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
Column Properties
Use Modify Design
Select Column On NS-1


Define Properties
Column Properties
Design
Material: Steel
Description: W 8 x 35
Weight: 35.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 127.0 in4
Cross Sectional Area: 10.3 in2
Number Of Shear Studs: 0
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, EW-1, EW-2
Double Click Right Mouse Key To End Copying Designs
X-Bracing Properties
Select Second Floor/ Lower Roof Horizontal Structural Plane
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight


Define Properties
X-Bracing Properties
Connectivity
Hinge
Repeat For All Supports
Lateral Resistance Verify X-Bracing
Modify Properties
Select X-Bracing
Design
Material: Steel
Description: TS 3x3x1/4
Weight: 8.81 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 3.16 in4
Cross Sectional Area: 2.59 in2
No. To Stop Analysis
Repeat For NS-2, NS-3, EW-1, EW-2
Lateral Analysis
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight


Lateral Analysis
Connectivity
Hinge
Repeat For All Supports
Lateral Resistance Verify X-Bracing
Yes, Properties Are All Correct
Wind Load Options
Wind Direction: South
When 2 Wind Loads: Max. Suction
Wind Load: GCpi = 0
Flexible Diaphragm
Simple Beam Model
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
Consider Perpendicular Wall...
View Loads
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment, Deflection & Reaction Diagrams
View Output
Print Data
Rigid Diaphragm
All Other
Print To File
Execute Notepad


View Output
Scroll Output
Page Setup
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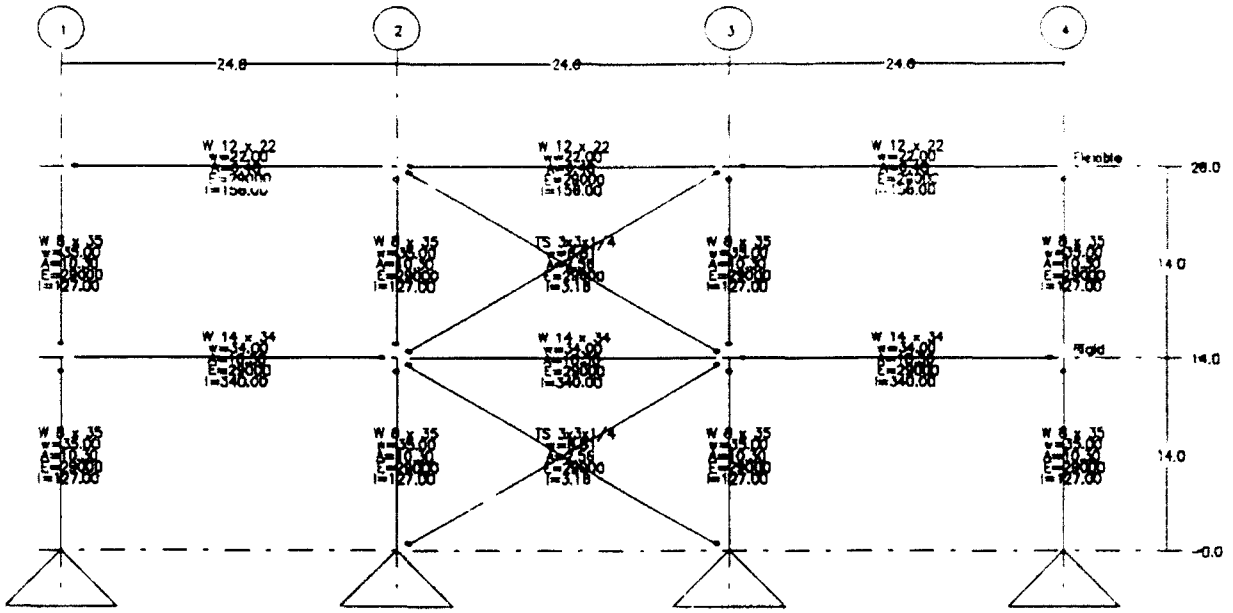
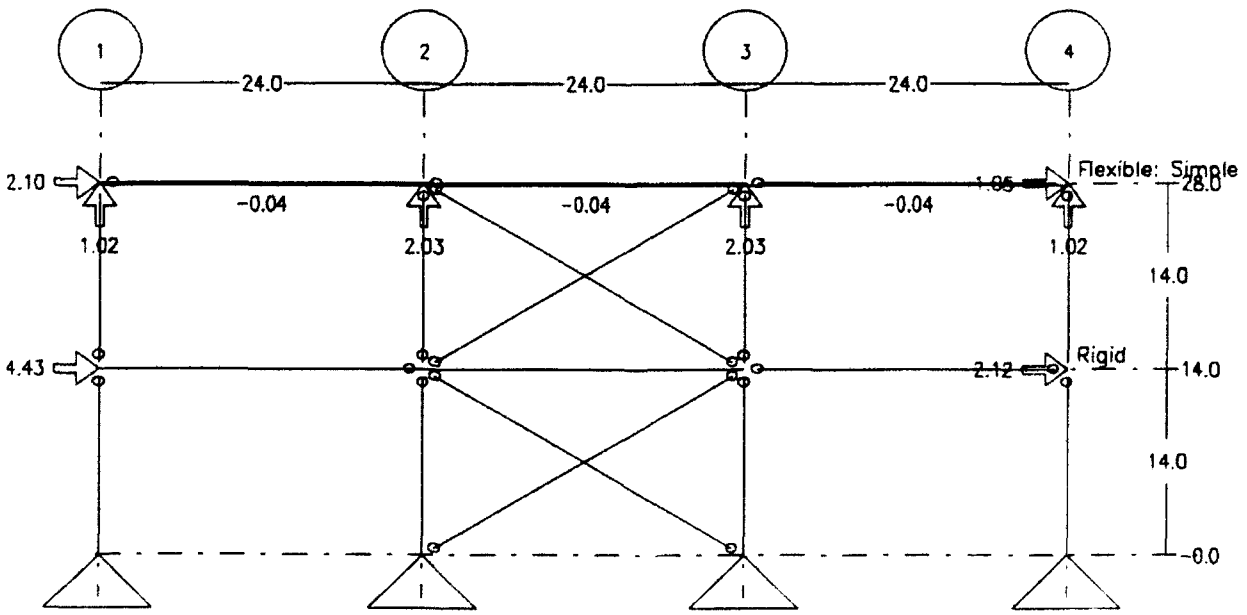
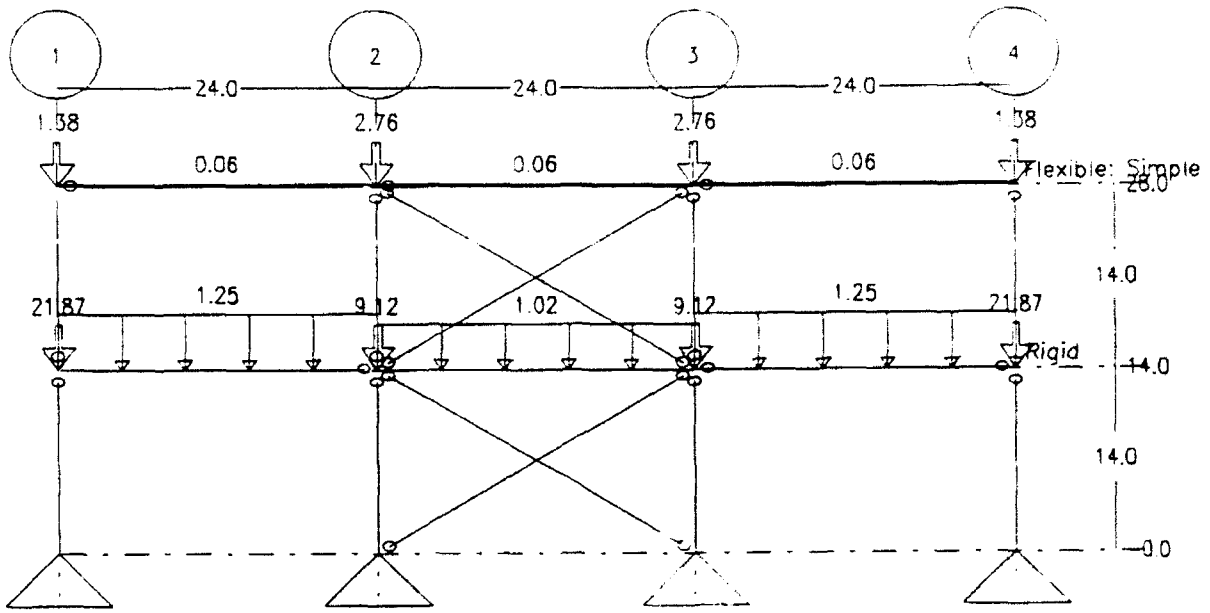
Right Margin: 0.0 in
Print File
Exit Notepad
End



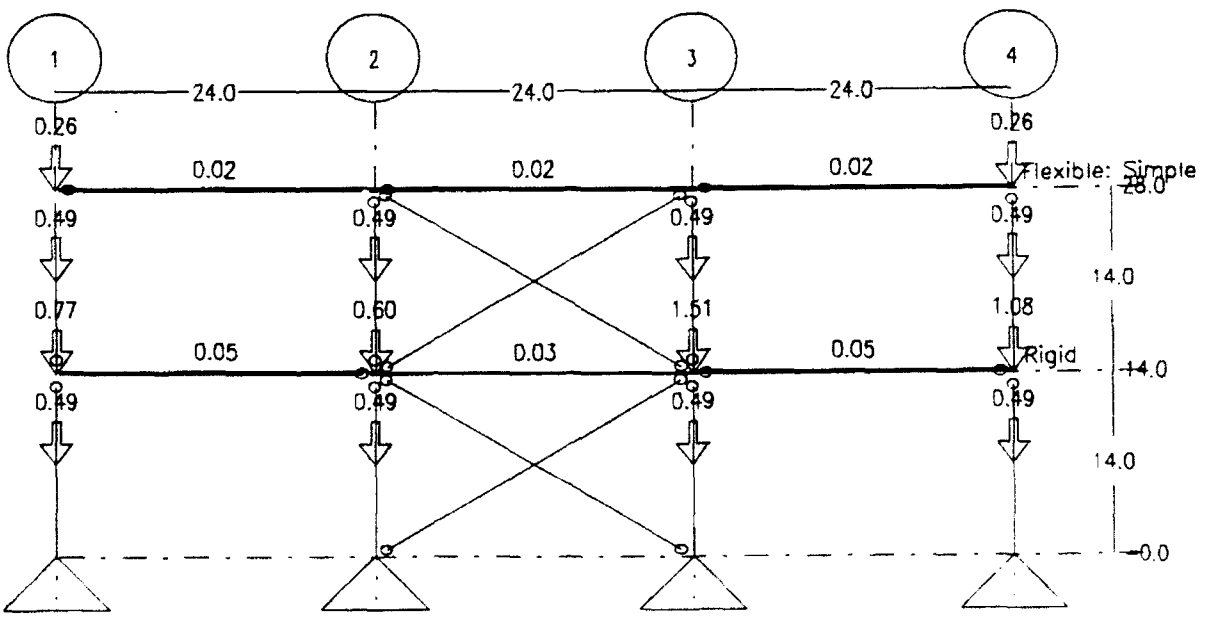
Properties: w (plf), A (in2), E (ksi), I (in4)



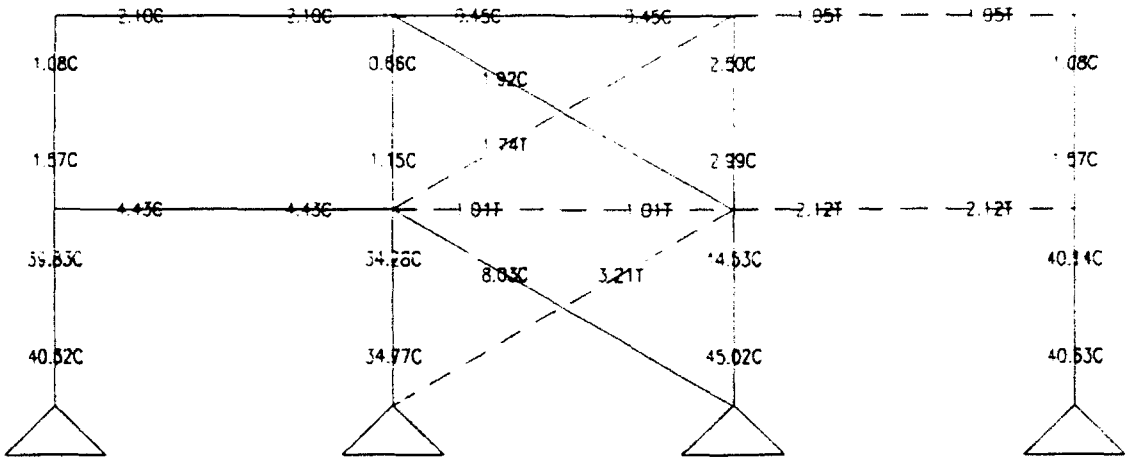
1.00 Wind (klf) -- NS-1 -- F, 36%



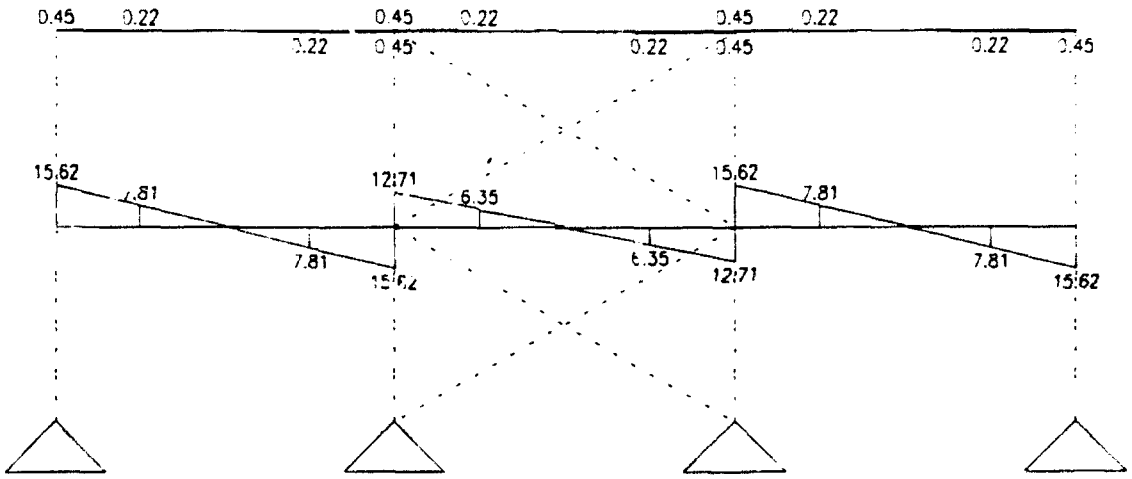
1.00 Superimposed Dead (klf)



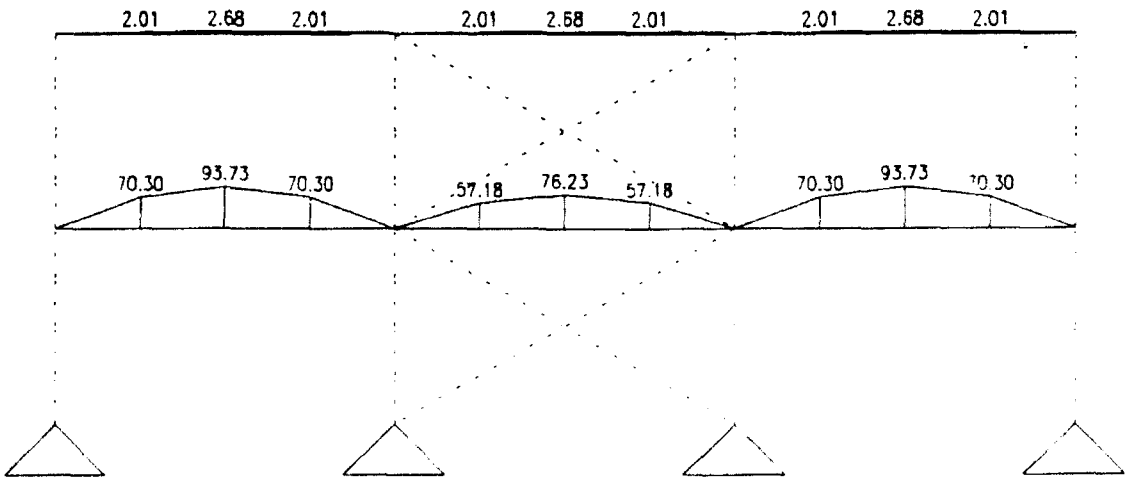
1.00 Dead (klf)



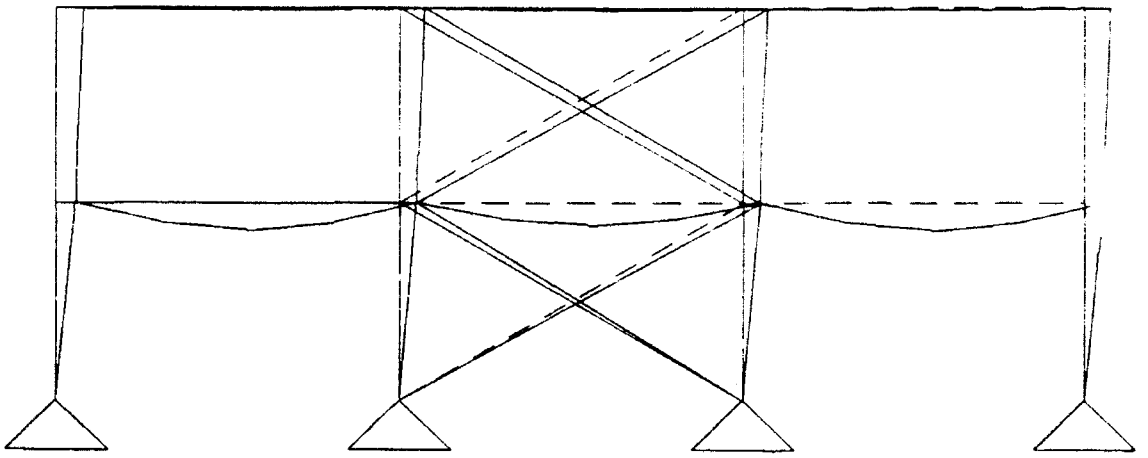
Total Combined Load -- Axial (k)



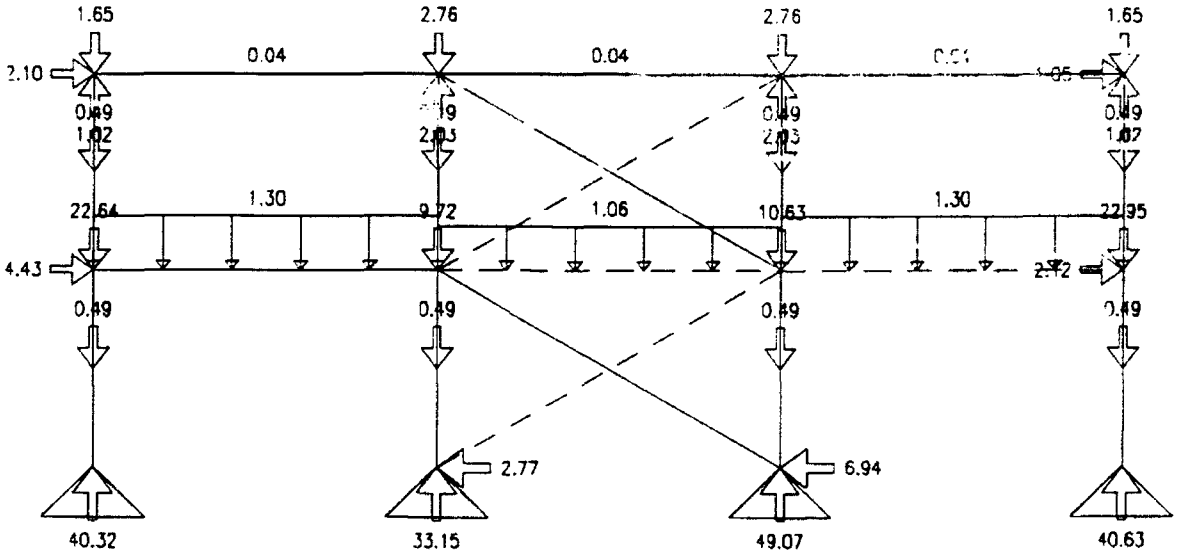
Total Combined Load -- Shear (k)



Total Combined Load -- Moment (kft)



Total Combined Load -- Deflection



Total Combined Load -- Loads & Reactions (k)

Project : Office Building - Scheme B
Location : Radford AAP
Time : Sun Jan 26, 1992 6:10 PM

********** Rigid Horizontal Diaphragm Calculations **********

Center of Rigidity

Name	h (ft)	I (ft^4)	Av (ft^2)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
NS-1	14.0	0	0	0.003	305.434	35.92%	0.8	254.528
NS-2	14.0	0	0	0.003	308.740	36.31%	48.8	15076.803
NS-3	14.0	0	0	0.004	236.080	27.77%	84.8	20027.483
Sum					850.254			35358.814

Centroid from lower left = sum(R*x)/sum(R) : 41.59 ft
Center of mass from lower left : 40.73 ft
Eccentricity (e) : 0.85 ft
Maximum dimension : 85.67 ft
e min = 0.05*max. dimension : 4.28 ft
Eccentricity (e) used for torsional analysis : 4.28 ft

Name	h (ft)	I (ft^4)	Av (ft^2)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	14.0	0	0	0.003	308.740	50.00%	72.8	22486.563
EW-2	14.0	0	0	0.003	308.740	50.00%	0.8	257.283
Sum					617.480			22743.846

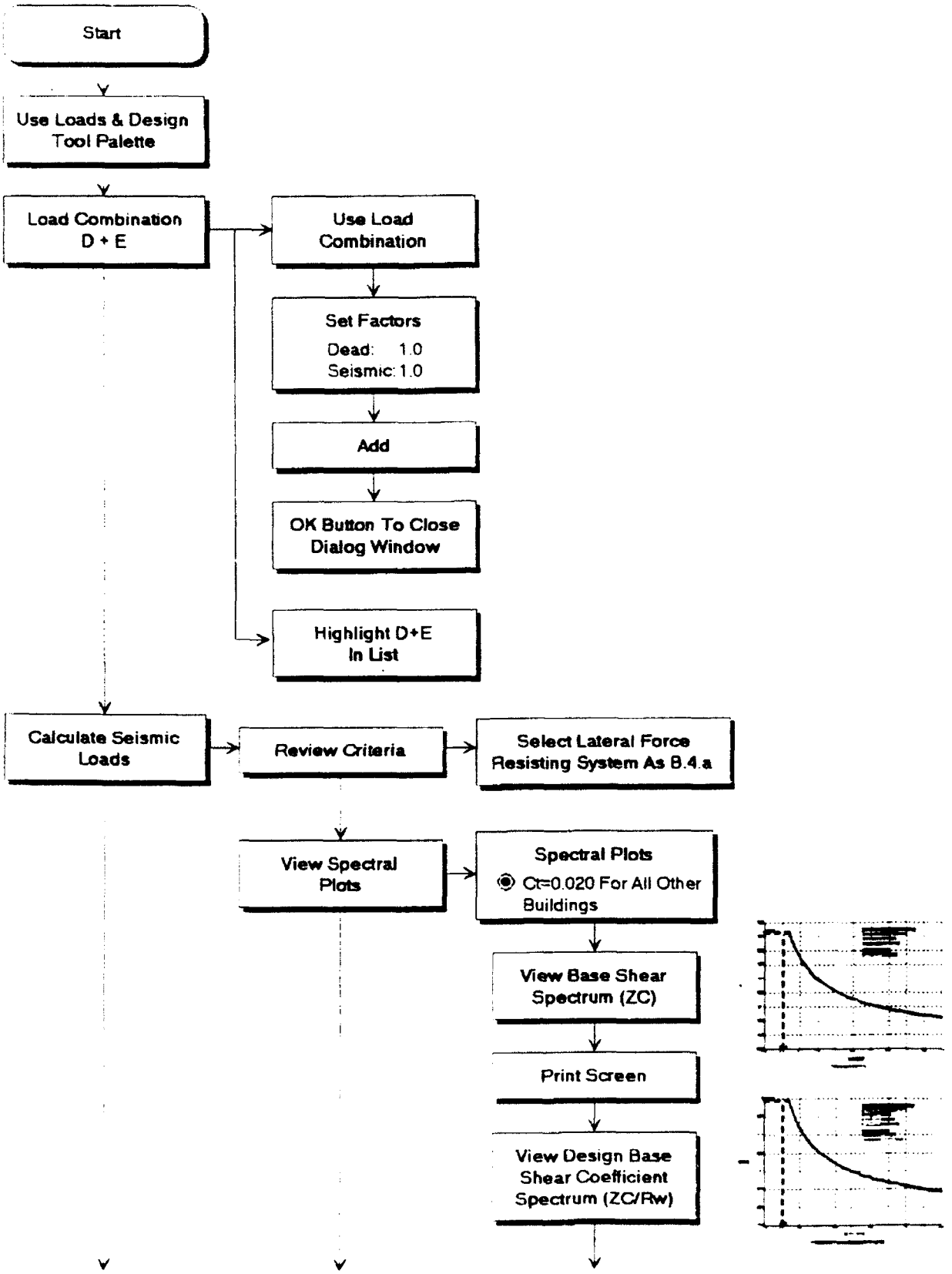
Centroid from lower left = sum(R*x)/sum(R) : 36.83 ft
Center of mass from lower left : 36.83 ft
Eccentricity (e) : 0.00 ft
Maximum dimension : 73.67 ft
e min = 0.05*max. dimension : 3.68 ft
Eccentricity (e) used for torsional analysis : 3.68 ft

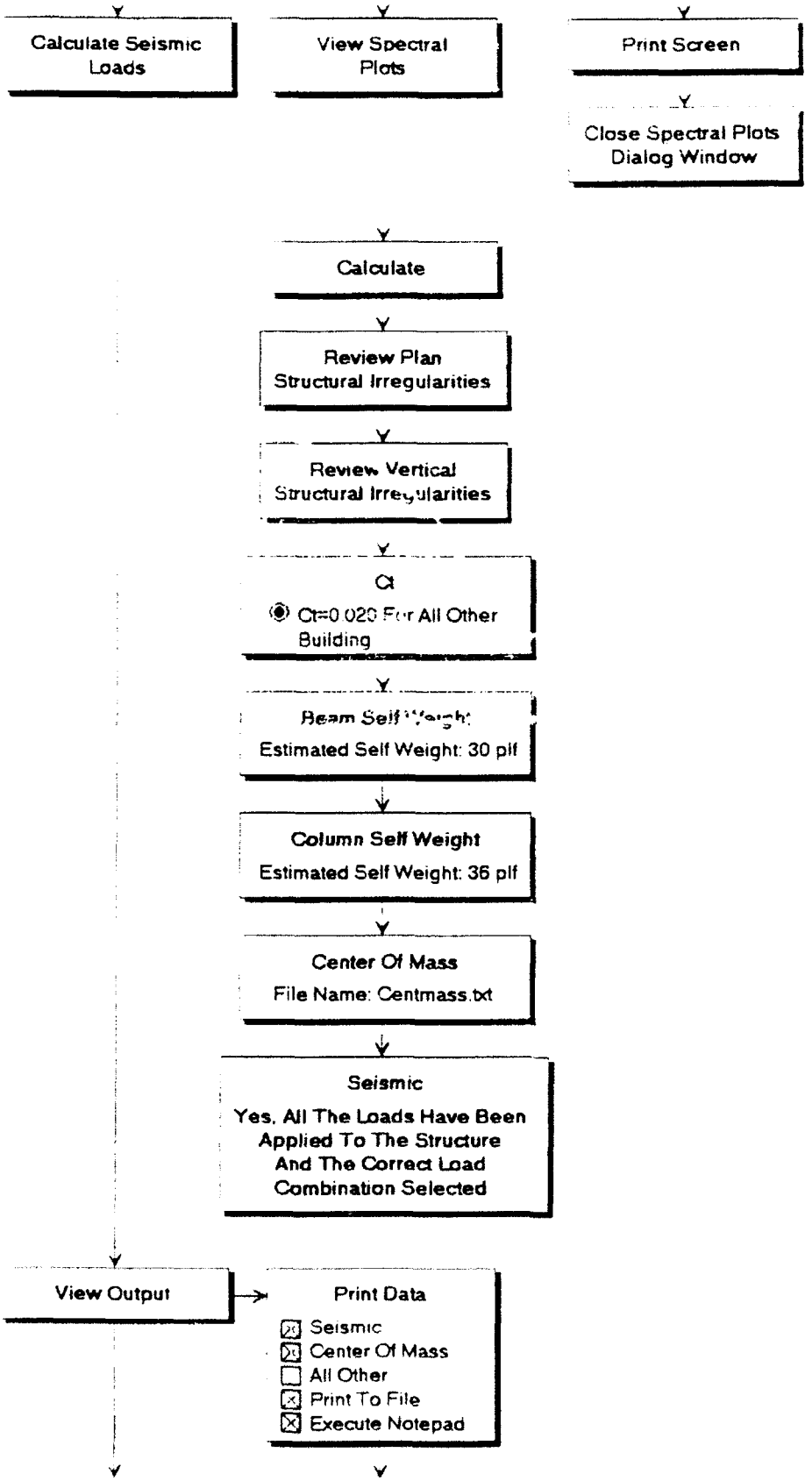
Assumptions used:
Deflections calculated by applying a 1 kip load.

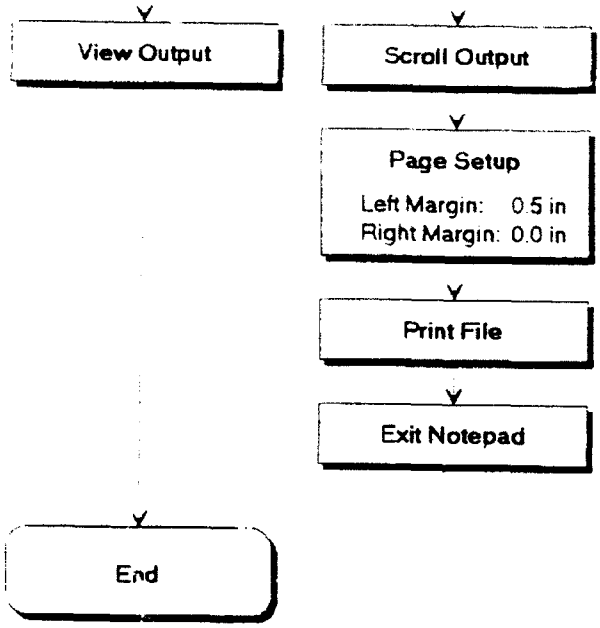
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	305.434	40.8	12447.298	507262.624	0.00705
NS-2	14.0	308.740	7.2	2237.491	16215.477	0.00127
NS-3	14.0	236.080	43.2	10209.807	441545.249	0.00578
EW-1	14.0	308.740	36.0	11114.640	400127.035	0.00630
EW-2	14.0	308.740	36.0	11114.640	400127.035	0.00630
Sum					1765277.419	

Shear distribution : Fv = V*R/sum(R)
Torsional moment : Mt = V*e
Torsional component : Ft = Mt*R*dx/sum(R*dx*dx)
Total shear to element: Ftotal = Fv + Ft

Seismic Loads




Calculate Seismic Loads
View Spectral Plots
Print Screen
Close Spectral Plots Dialog Window
Calculate
Review Plan Structural Irregularities
Review Vertical Structural Irregularities
Ct
Ct=0.020 For All Other Building
Beam Self Weight
Estimated Self Weight: 30 plf
Column Self Weight
Estimated Self Weight: 36 plf
Center Of Mass
File Name: Centmass.txt
Seismic
Yes, All The Loads Have Been Applied To The Structure And The Correct Load Combination Selected
View Output
Print Data
Seismic
Center Of Mass
All Other
Print To File
Execute Notepad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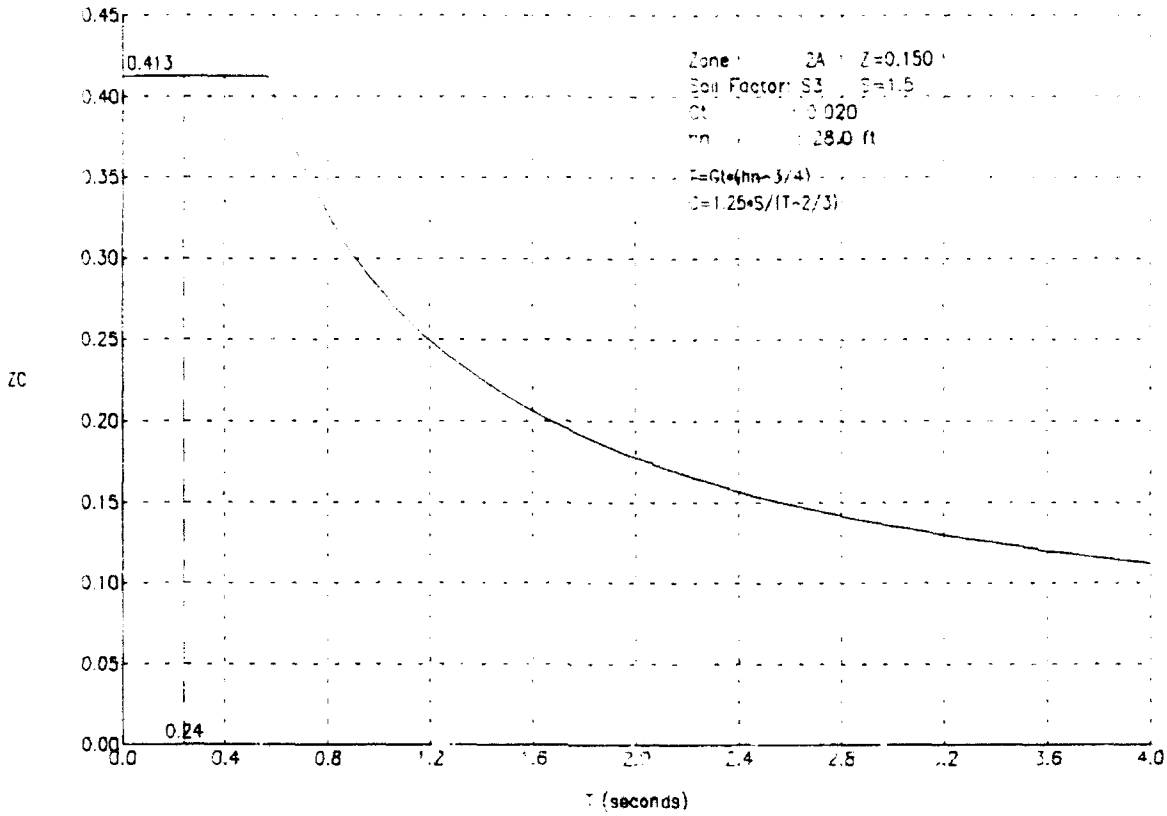
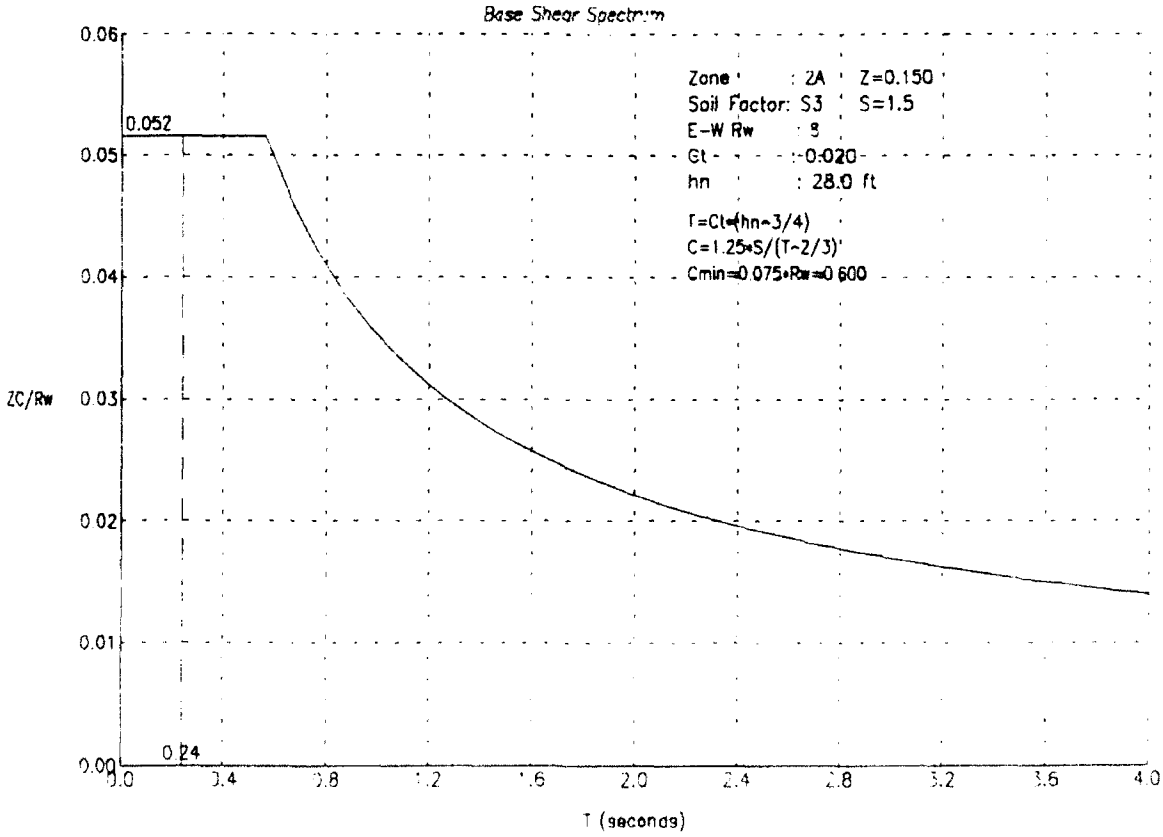


Base Shear Spectrum



Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme B
Location     : Radford AAP
Seismic Code: TM 5-809-10 1991
Time         : Sun Jan 26, 1992  6:09 PM

*************************** Seismic Analysis ****************************

 3. Upper Roof                              :    188.0 k
 2. Second Floor/Lower Roof                 :    670.3 k
-------------------------------------------------------
Total Building Weight (W)                   :    858.4 k

**************************** N - S and E - W ****************************

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: B4a: Rw = 8
Ct = 0.020
hn = 28.0 ft
T = Ct*hn^3/4 = 0.24 sec
C = 1.25*S/T^2/3 = 4.86 > 2.75
C = 2.75
C/Rw = 0.344 > 0.075
W = 858.4 k
V = Z*I*C*W/Rw
+-----------------------+
|       V = 44.3 k      |
+-----------------------+

T = 0.7 sec
+-----------------------+
|       Ft = 0.0 k      |
+-----------------------+

+-----------------------+
|     V-Ft = 44.3 k     |
+-----------------------+
```

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	w*h (kft)	w*h/ sum(w*h)	F (k)	sum(F) V (k)
						Ft =	0.0	
3	28.0		188		5264	0.359	15.9	
		14.0		188				15.9
2	14.0		670		9385	0.641	28.4	
		14.0		858				44.3
1	0.0							
Sum			858		14649	1.000	44.3	

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)	Ft+sum(F)/ sum(w)
3	28.0		188					
		14.0		188	15.9	223		0.085
2	14.0		670				223	
		14.0		858	44.3	620		0.052
1	0.0						842	
Sum			858			842		

Project : Office Building - Scheme B
Location : Radford AAP
Time : Sun Jan 26, 1992 6:09 PM

********** Center Of Mass **********

Upper Roof -- 28.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Exterior Wall	36.9	36.8	1358.9	0.8	30.7
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Upper Roof	49.8	36.8	1833.1	24.8	1235.9
Beam Self Weight	12.2	36.8	450.8	24.8	304.0
Column Self Weight	3.0	36.8	111.4	24.8	75.1
Sum	188.0		6924.9		4668.8

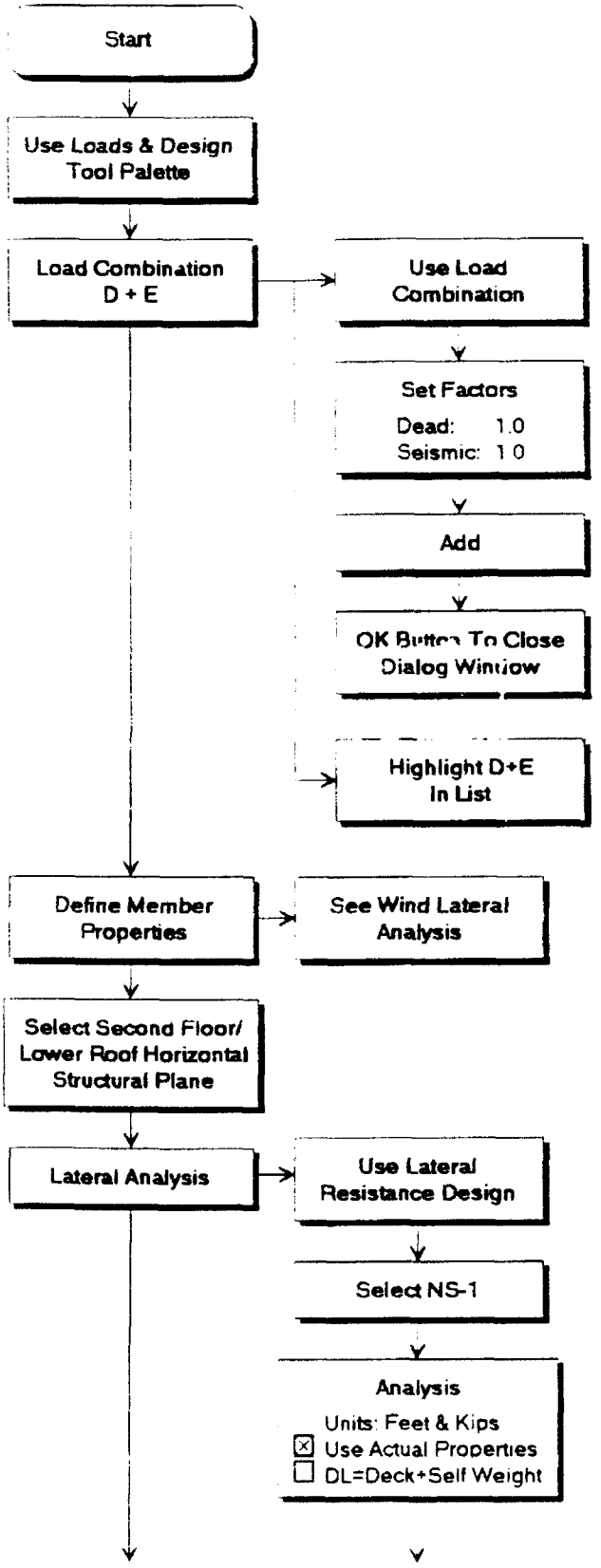
N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 24.83 ft

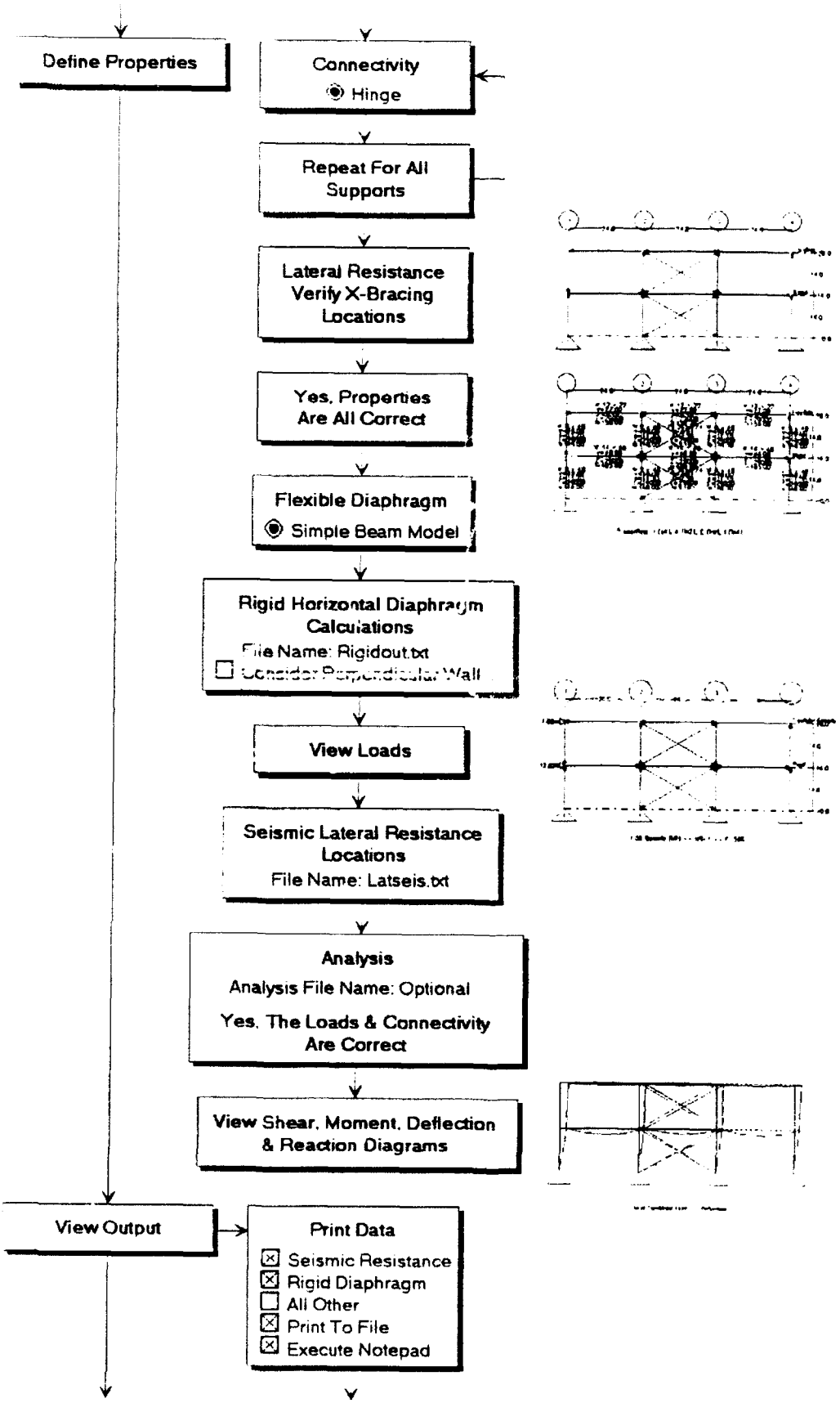
Second Floor/Lower Roof -- 14.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	70.0	12.8	898.1	24.8	1737.9
Second Floor	58.3	36.8	2148.1	28.8	1681.6
Second Floor	70.0	60.8	4257.4	24.8	1737.5
Lower Roof	126.0	36.8	4639.9	66.8	8419.1
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8	610.8
Exterior Wall	36.9	36.8	1358.9	48.8	1801.6
Exterior Wall	24.6	72.8	1791.4	24.8	610.8
Parapet	9.9	0.8	8.3	66.8	662.1
Parapet	19.8	36.8	729.8	84.8	1680.9
Parapet	9.9	72.8	721.6	66.8	662.1
Beam Self Weight	16.6	36.8	610.0	36.2	599.9
Column Self Weight	4.0	36.8	148.5	36.2	146.1
Exterior Wall	43.0	0.8	35.9	42.8	1843.6
Exterior Wall	36.9	36.8	1358.9	84.8	3129.7
Exterior Wall	43.0	72.8	3134.9	42.8	1843.6
Column Self Weight	3.0	36.8	111.4	24.8	75.1
Sum	670.3		24691.2		27304.4

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 40.73 ft

Seismic Lateral Analysis




Define Properties
Connectivity
Hinge
Repeat For All Supports
Lateral Resistance Verify X-Bracing Locations
Yes, Properties Are All Correct
Flexible Diaphragm
Simple Beam Model
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
Consider Perpendicular Wall
View Loads
Seismic Lateral Resistance Locations
File Name: Latseis.txt
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment, Deflection & Reaction Diagrams
View Output
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All Other
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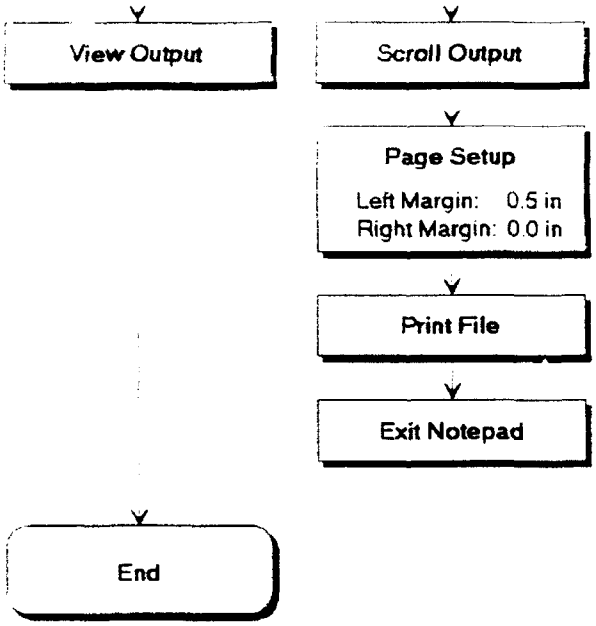
Execute Notepad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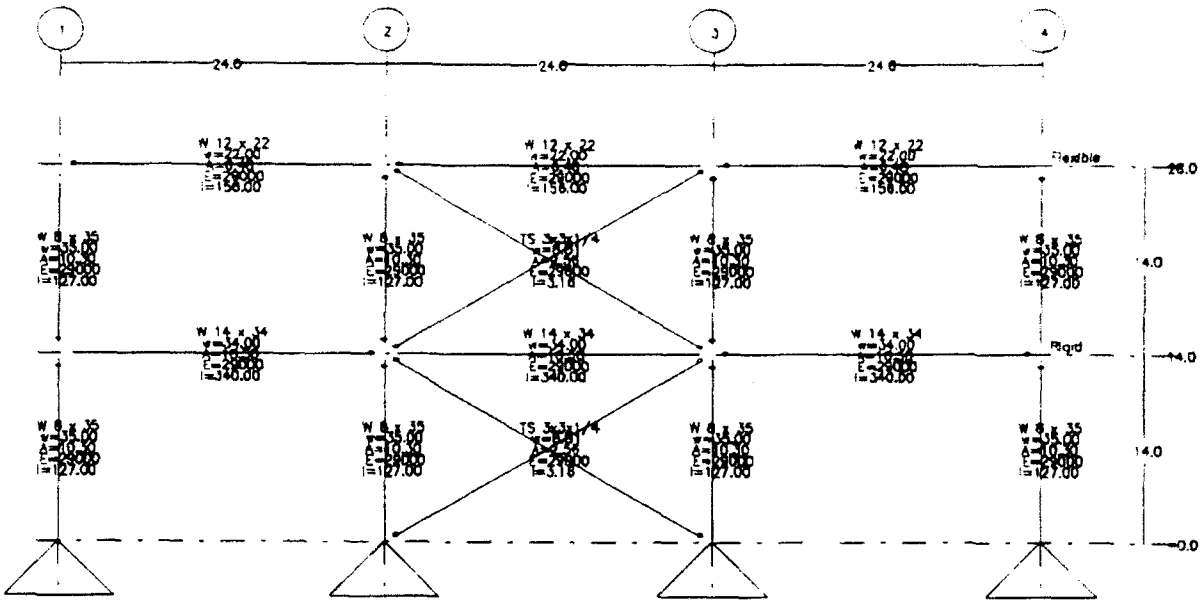
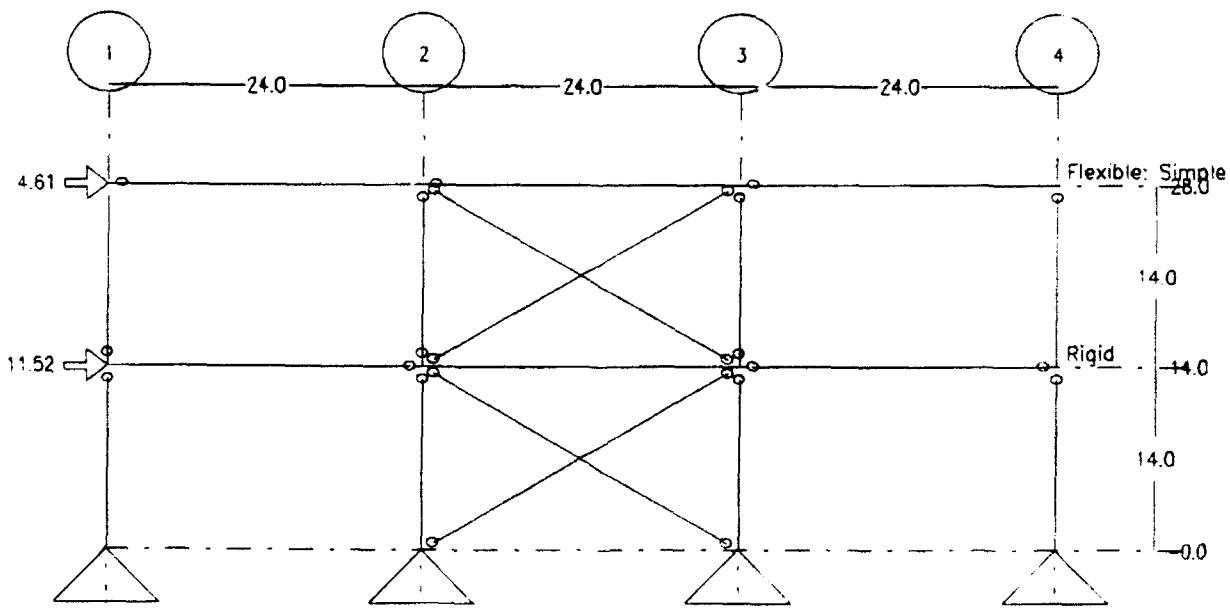
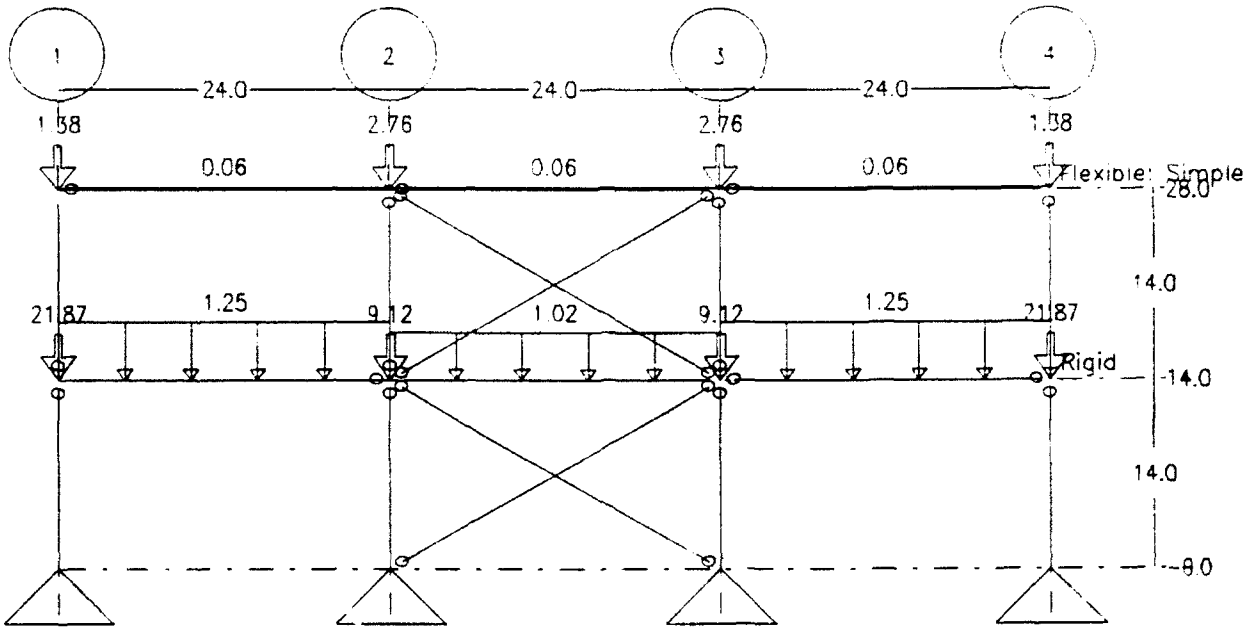


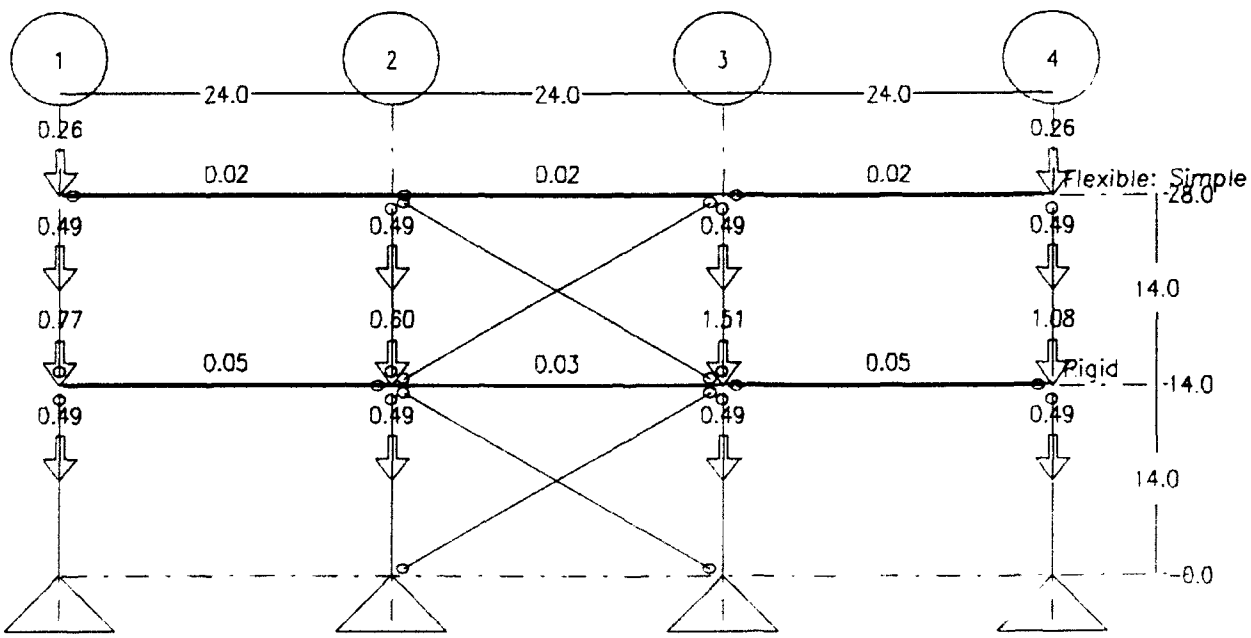
Properties: w (plf), A*(in2), E (ksi), I (in4)



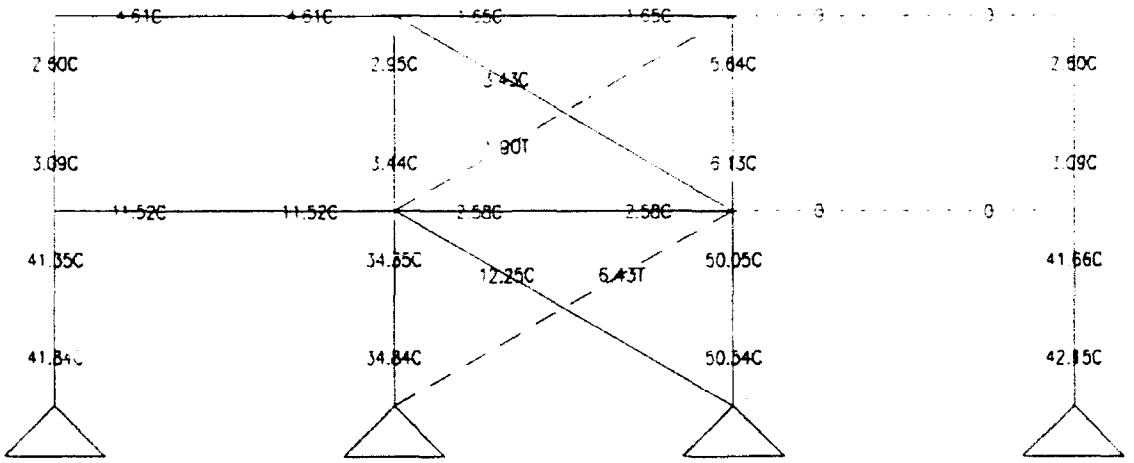
1.00 Seismic (klf) -- NS-1 -- F, 36%



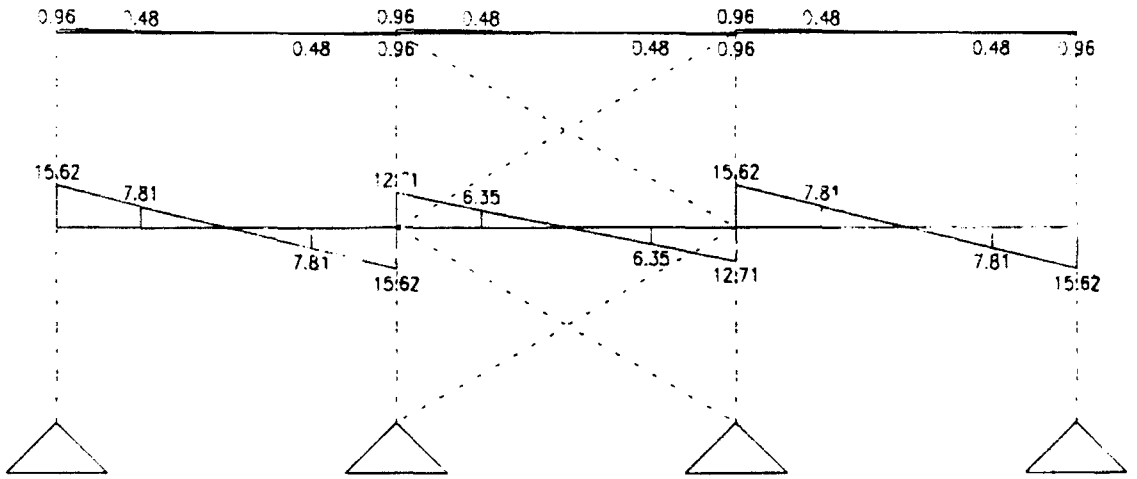
1.00 Superimposed Dead (klf)



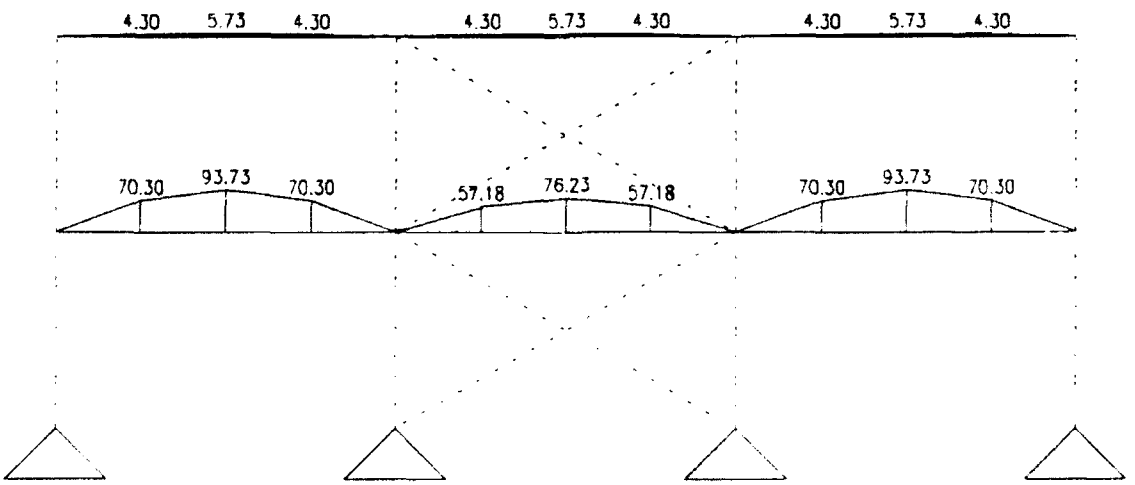
1.00 Dead (klf)



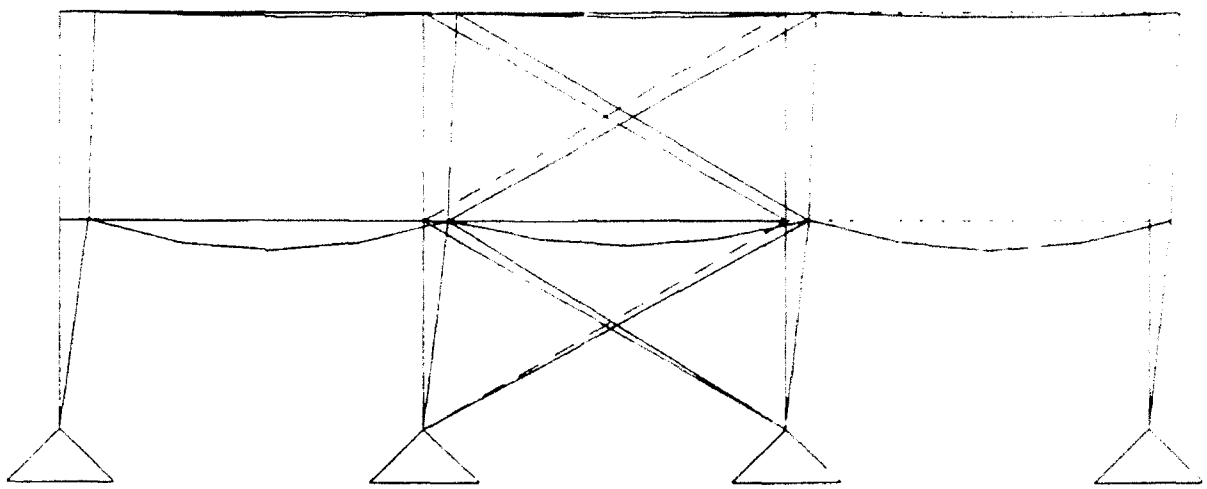
Total Combined Load -- Axial (k)



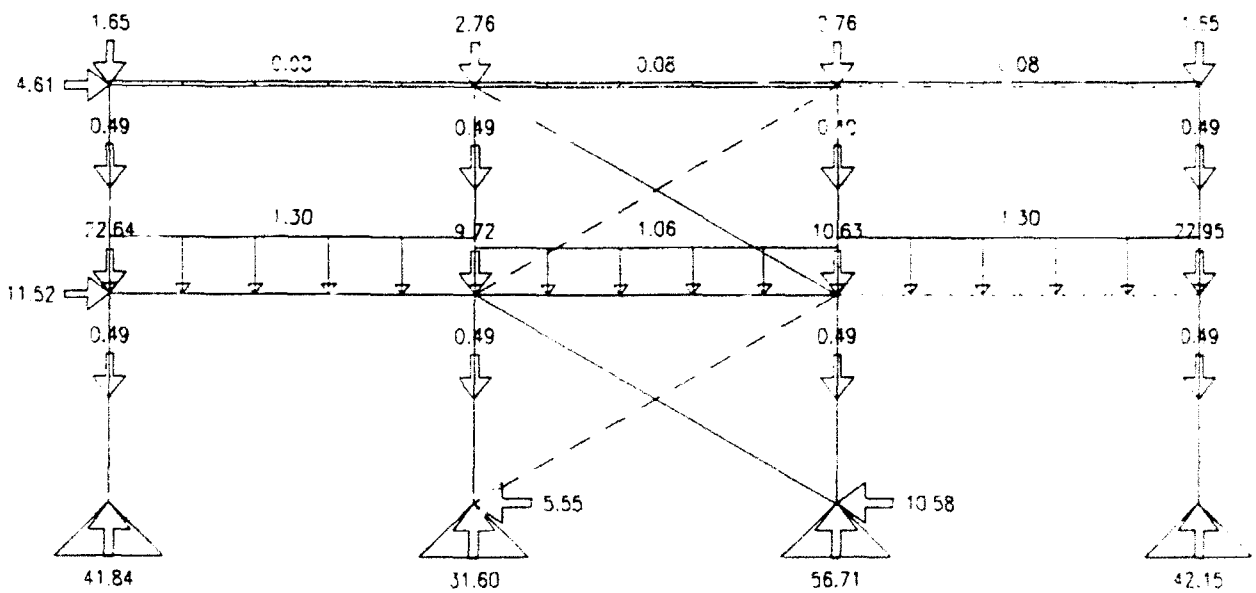
Total Combined Load -- Shear (k)



Total Combined Load -- Moment (kft)



Total Combined Load -- Deflection



Total Combined Load -- Loads & Reactions (k)

Project : Office Building - Scheme B
Location : Radford AAP
Seismic Code: TM 5-809-10 1991
Time : Sun Jan 26, 1992 6:12 PM

********** Seismic Lateral Resistance Locations **********

NS-1 -- F, 36%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

NS-2 -- F, 36%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

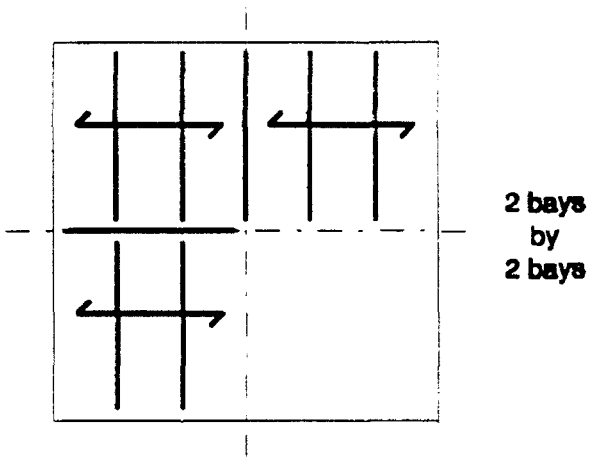
NS-3 -- F, 28%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		28.4			
		14.0		28.4	397	
1	0.0					397
Sum			28.4		397	

Quantity Take-Off Philosophy

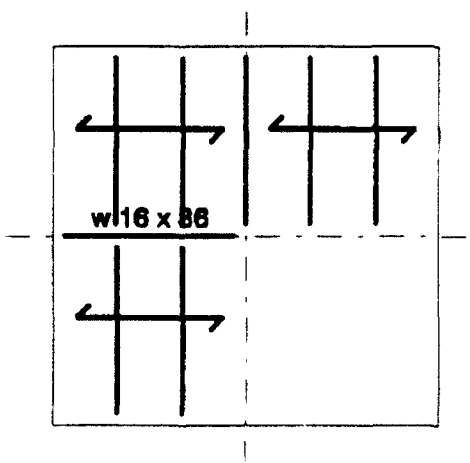
3 Considerations

1. One typical interior bay (exterior side bay, corner bay)



2. One typical floor level and roof level

3. The entire building structural system



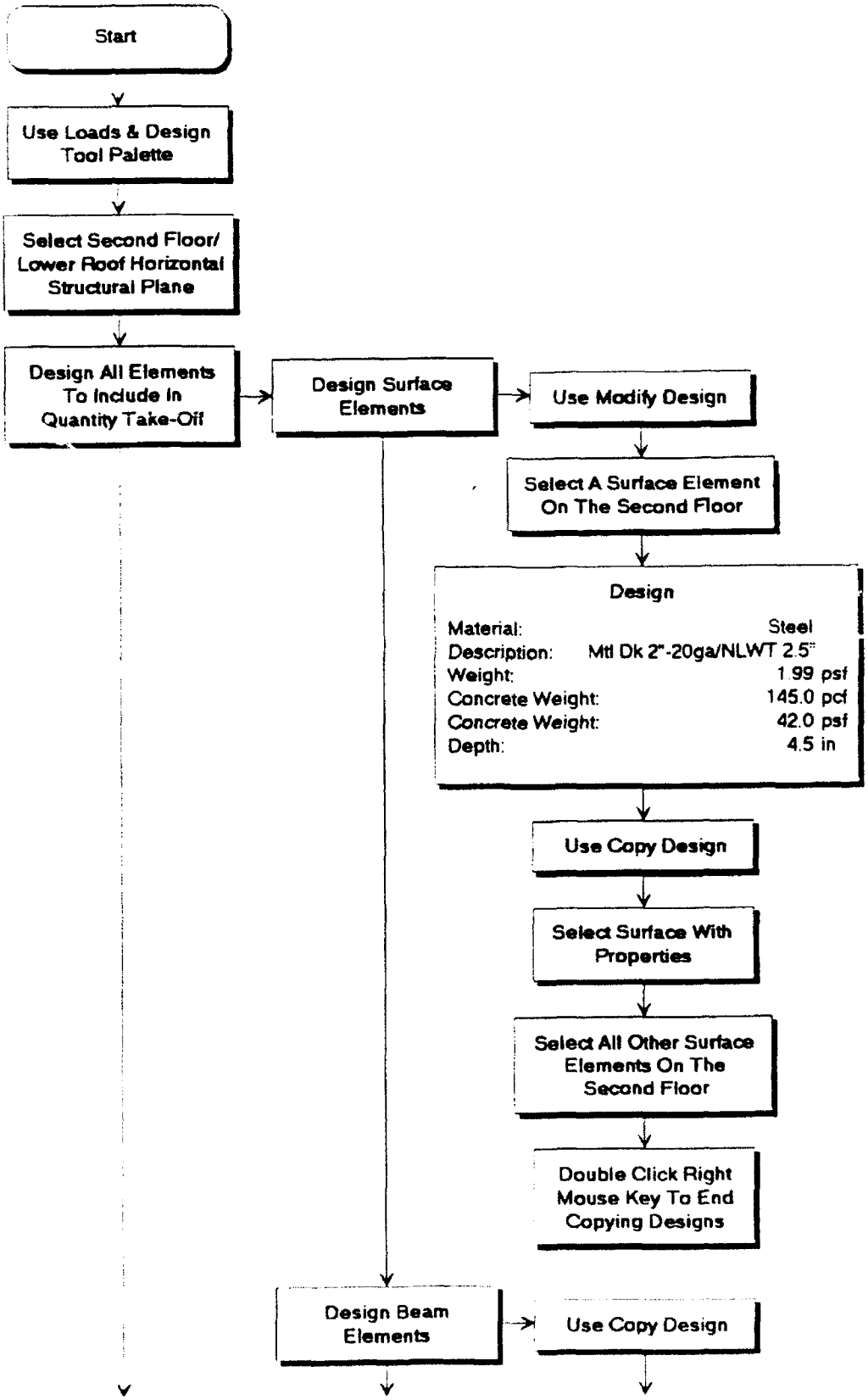
Estimated weights are not used for quantity take-offs

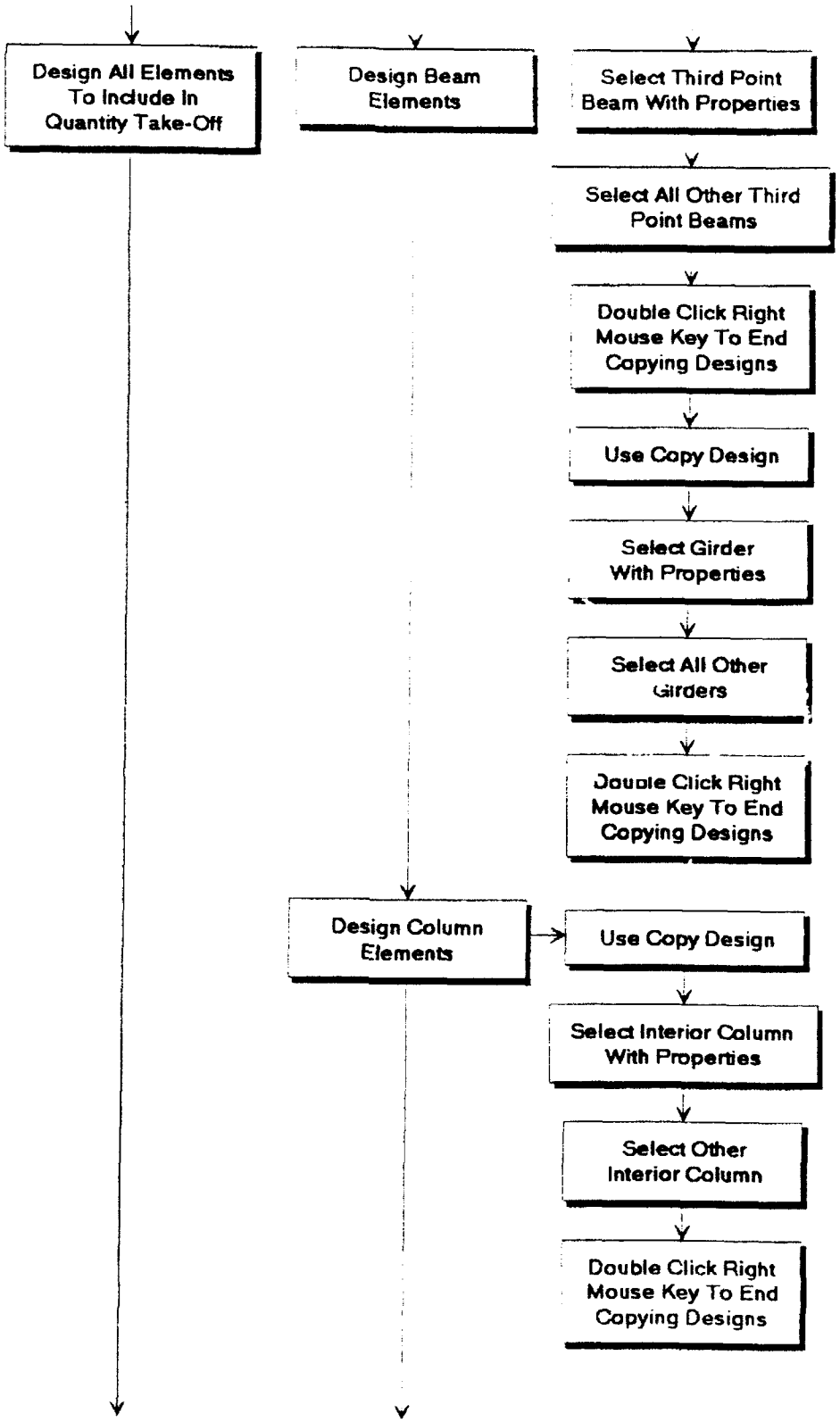
Elements designed by Excel spreadsheets are used

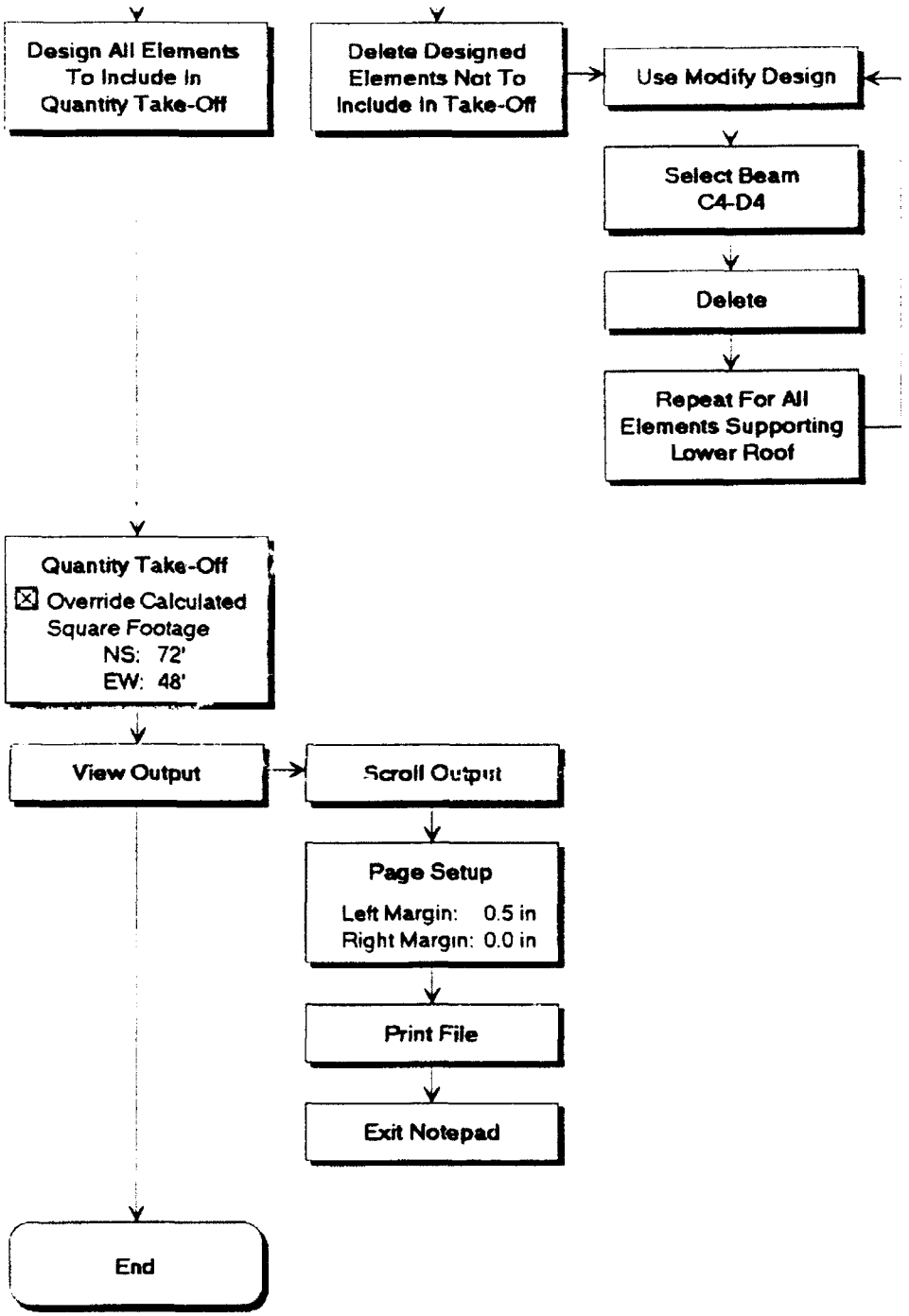
Use Modify Design and Copy Design to manually enter element sizes

Calculated square footage can be overridden

Quantity Take-Off




Design All Elements To Include In Quantity Take-Off
Design Beam Elements
Select Third Point Beam With Properties
Select All Other Third Point Beams
Double Click Right Mouse Key To End Copying Designs
Use Copy Design
Select Girder With Properties
Select All Other Girders
Double Click Right Mouse Key To End Copying Designs
Design Column Elements
Use Copy Design
Select Interior Column With Properties
Select Other Interior Column
Double Click Right Mouse Key To End Copying Designs


Design All Elements To Include In Quantity Take-Off
Delete Designed Elements Not To Include In Take-Off
Use Modify Design
Select Beam C4-D4
Delete
Repeat For All Elements Supporting Lower Roof
Quantity Take-Off
☒ Override Calculated Square Footage
NS: 72'
EW: 48'
View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End

Project : Office Building - Scheme B
Location : Radford AAP
Time : Sun Jan 26, 1992 6:30 PM

********** Quantity Take-off **********

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

STEEL: Narrowly Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
	36.0	0.0	0.0	17	0
Sum					0

Total Weight : 0.0 tons
Weight Per Square Foot : 0.0 psf

STEEL: Widely Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 14 x 34 (50)	24.0	34.0	816.0	10	8160
	36.0	0.0	0.0	2	0
W 21 x 50 (72)	24.0	50.0	1200.0	4	4800
W 16 x 26 (28)	24.0	26.0	624.0	15	9360
	24.0	0.0	0.0	2	0
Sum					22320

Total Weight : 11.2 tons
Weight Per Square Foot : 6.5 psf
Number of Shear Studs : 1208

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total (lbs)	Weight Conc (lbs)
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	2880	2.0	145.0	42.0	5731	120960
Mtl Dk 2"-20ga/NLWT 2.5"	4.5	384	2.0	145.0	42.0	764	16128
	0.0	2592	0.0	0.0	0.0	0	0
Sum						6495	137088

Concrete Cubic Yards : 35.0
Total Weight : 3.2 tons

STEEL: Column Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 8 x 35	14.0	35.0	490.0	10	4900
W 8 x 28	14.0	28.0	392.0	2	784
	14.0	0.0	0.0	4	0
Sum					5684

Total Weight : 2.8 tons
Weight Per Square Foot : 1.6 psf

Concluding Remarks

Schemes A, B and C were developed to permit exploration and instruction of the broadest possible range of CASM capabilities. The schemes should not be viewed as completely logical structural framing solutions to the given design parameters, nor as necessarily economical. Each of the three schemes contain a variety of elements, which if properly combined and interchanged might produce "real" schemes for consideration at a 35% review.

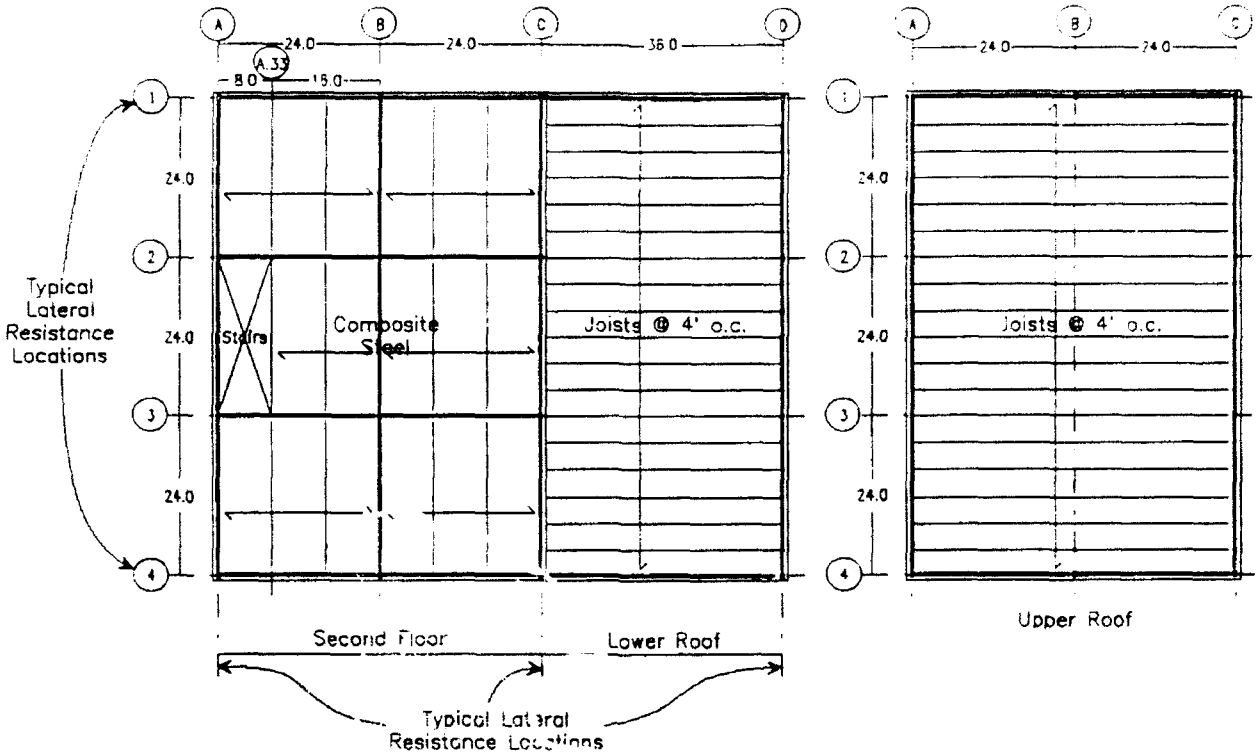
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the second floor.

A logical **steel framed beam/column** solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) as in scheme B. Both roofs would be sheathed with a metal roof deck without concrete and both would become flexible diaphragms. The second floor would be framed with composite steel beams as in scheme B and remain a rigid diaphragm. Two lateral load resistance system options could be compared. One scheme could include a moment resistant frame approach similar to scheme A, while a second approach might incorporate trussing similar to scheme B. The non-loadbearing exterior envelope is open to a variety of possibilities. The Architects will likely dictate the aesthetic expression. The foundation system would be a combination of isolated and linear spread footings.

A third logical solution would be a **masonry bearing wall** system to support the steel open-web joist roof planes described above. The second floor plane might be constructed of pre-cast pre-stressed hollow cored planks, which would also bear on the walls and a central steel girder line. Some of these walls could become shear walls for lateral load resistance. Thus the exterior envelope and the interior partition provide a structural function, eliminating costly moment connections and columns within the exterior wall layout. Footings are now all linear spread footings with only one isolated footing.

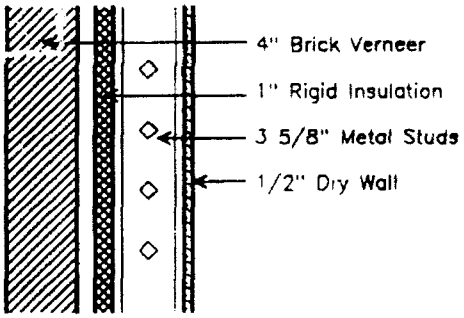
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

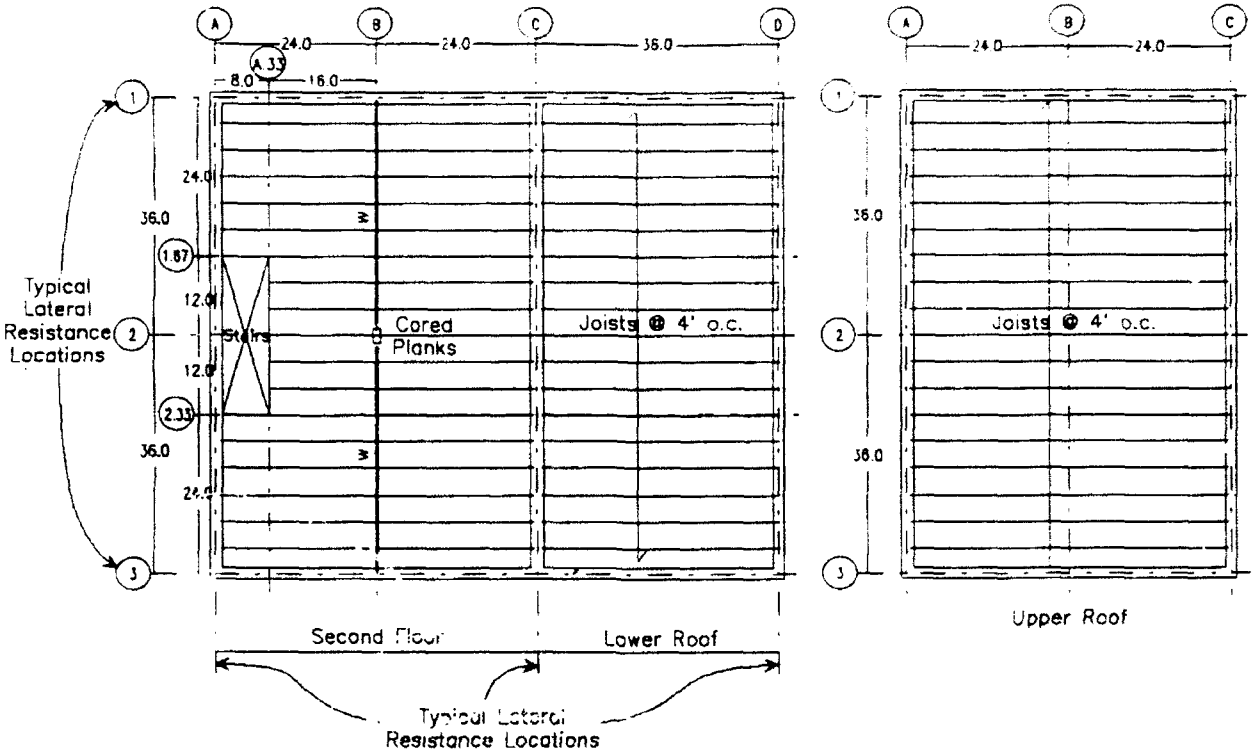
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

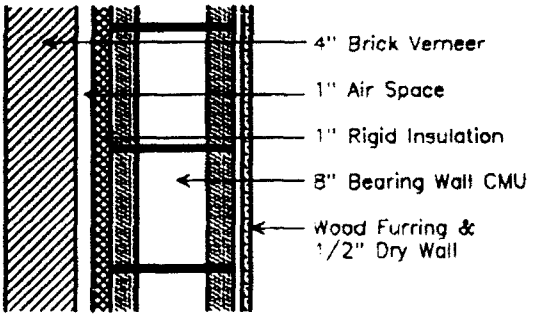
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



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13. ABSTRACT *(Maximum 200 words)*

This is one in a series of three manuals designed to instruct in the use of the Computer Aided Structural Modeling (CASM) computer program. The manuals are composed of flowcharts which show step-by-step procedures for executing a broad range of CASM capabilities. CASM is a computer program designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional (3-D) interactive graphics. This manual contains one of three different framing schemes for the same 1-2 story office building. The examples contain a complete range of capabilities to permit framing comparisons, including 3-D geometry modeling, criteria specifications, development of loads (snow, wind, seismic, dead, and live), drawing structural elements, preliminary analysis and design of structural elements, and quantity take-offs.

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