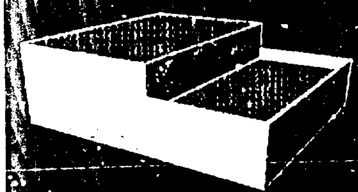
US
of Engineers

COMPUTER AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

INSTRUCTION REPORT ITL-92-3



CONCEPT DESIGN EXAMPLE, COMPUTER AIDED STRUCTURAL MODELING (CASM)

Report 1

SCHEME A

by

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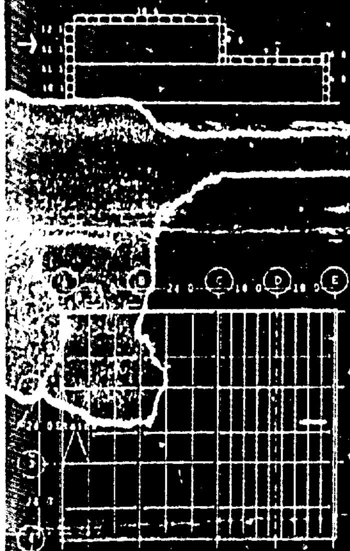

June 1992

Report 1 of a Series

Approved For Public Release; Distribution Is Unlimited

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Washington, DC 20314-1000

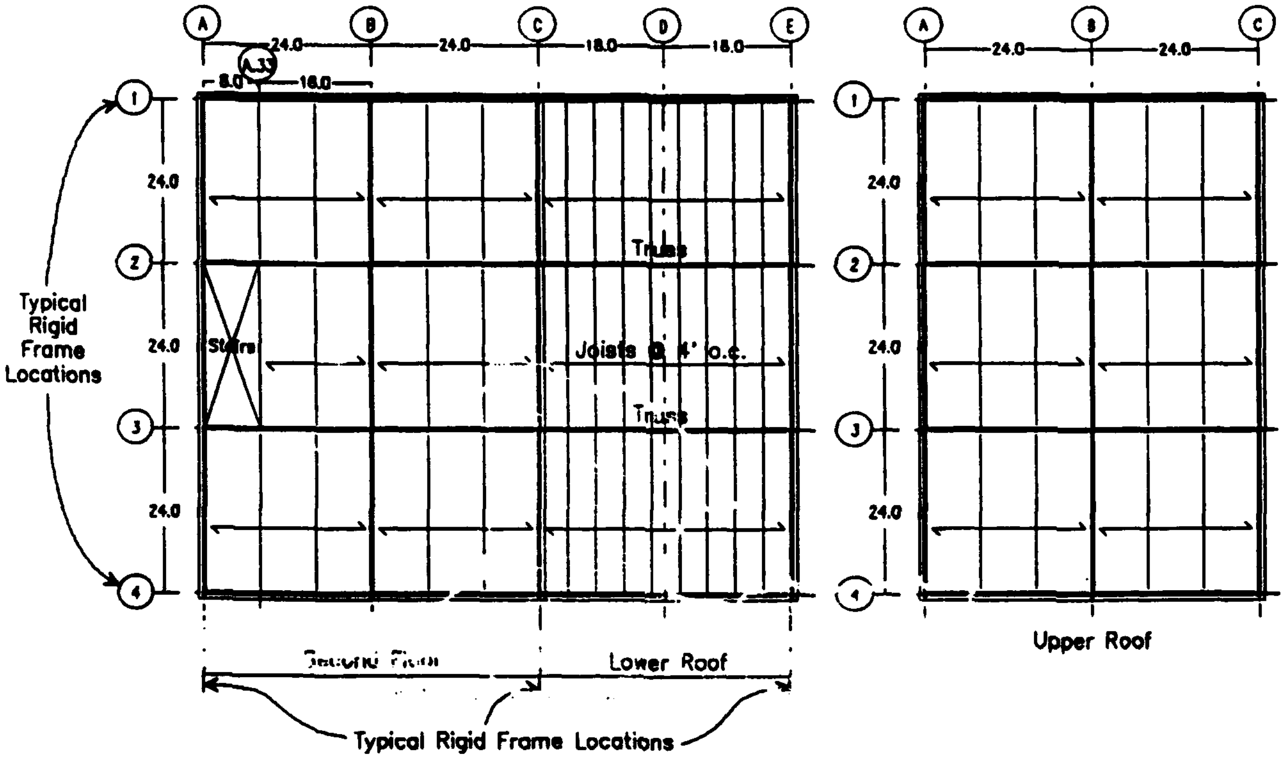
Under Contract No. DACA39-86-C-0024
(RDT&E Program, Work Unit No. AT40-CA-001)

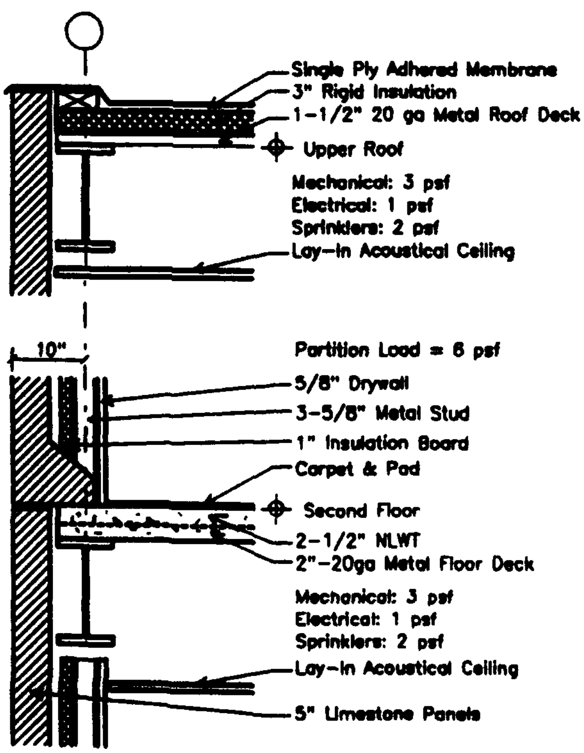
A

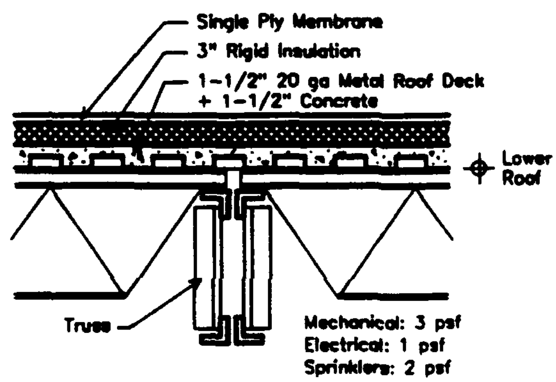
All Steel, Non-Composite,
Lateral Load Resistance = Rigid Frames

Table of Contents
for
Scheme A

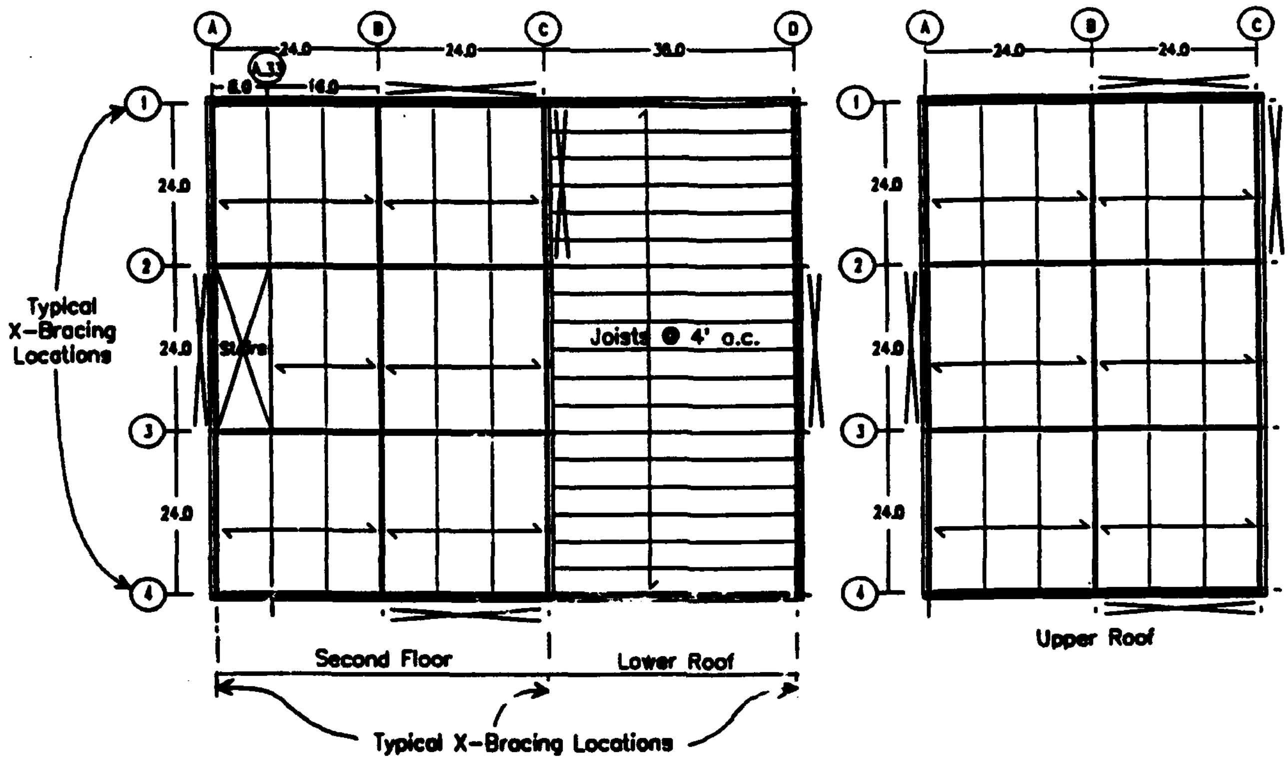
Scheme A


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
Stairs
Truss
Joists @ 4' o.c.
Truss
Lower Roof
Typical Rigid Frame Locations
Upper Roof

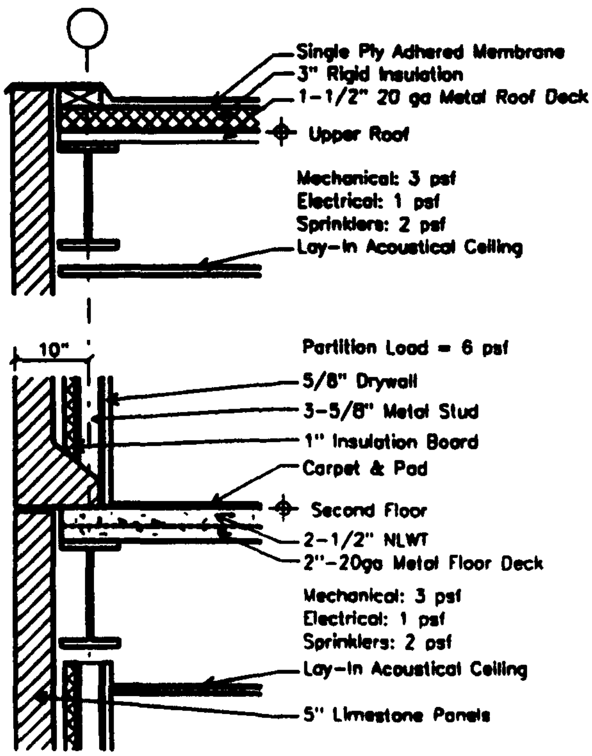

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor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

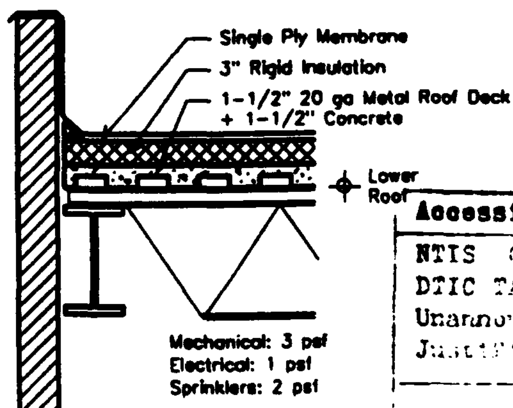
Scheme B



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

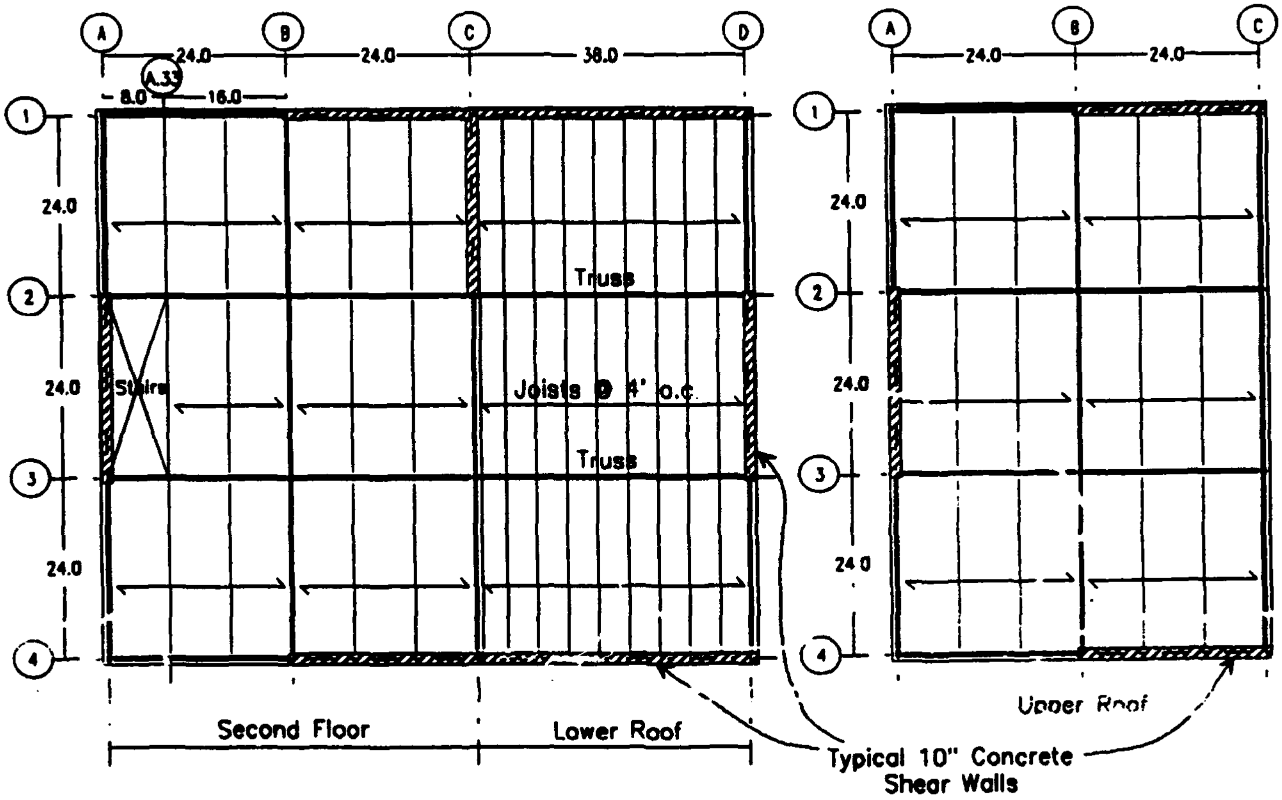


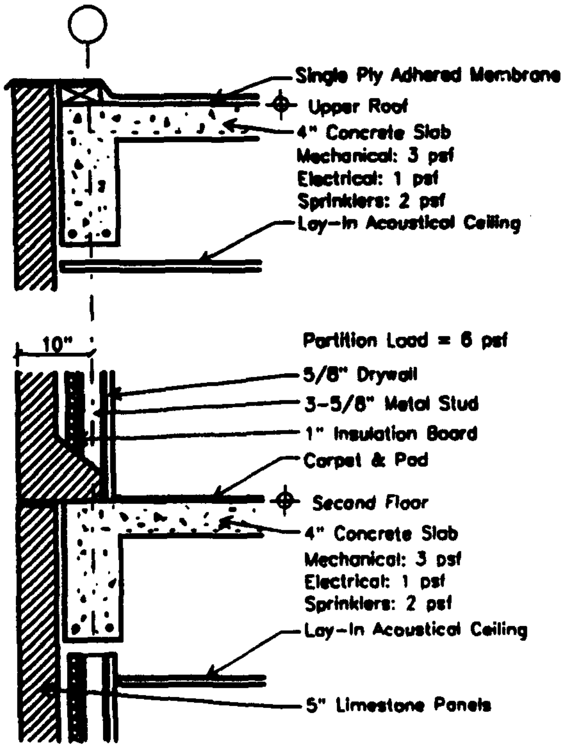
Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
10"
Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad
Second Floor
2-1/2" NLWT
2"-20ga Metal Floor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

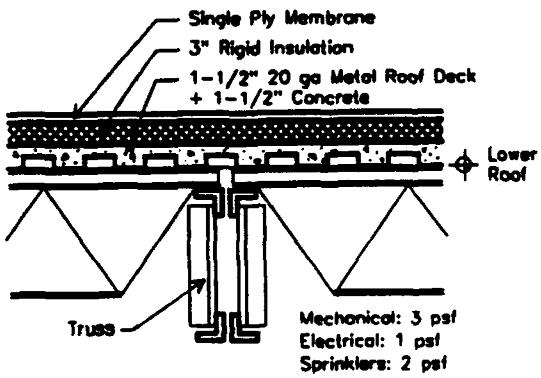


Single Ply Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck
+ 1-1/2" Concrete
Lower Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf

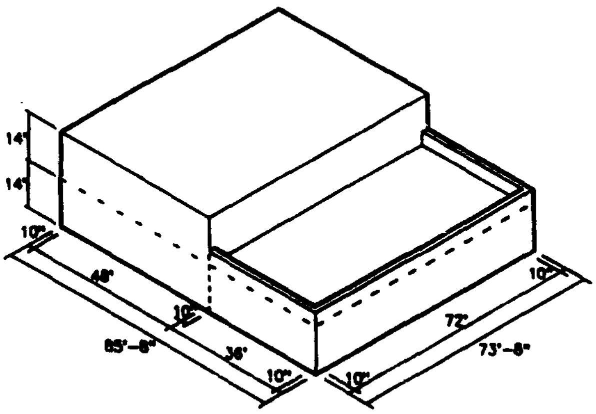
Scheme C


A
B
C
D
24.0
24.0
38.0
8.0
16.0
A.33
1
2
3
4
24.0
24.0
24.0
Truss
Stairs
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

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.

HH

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:

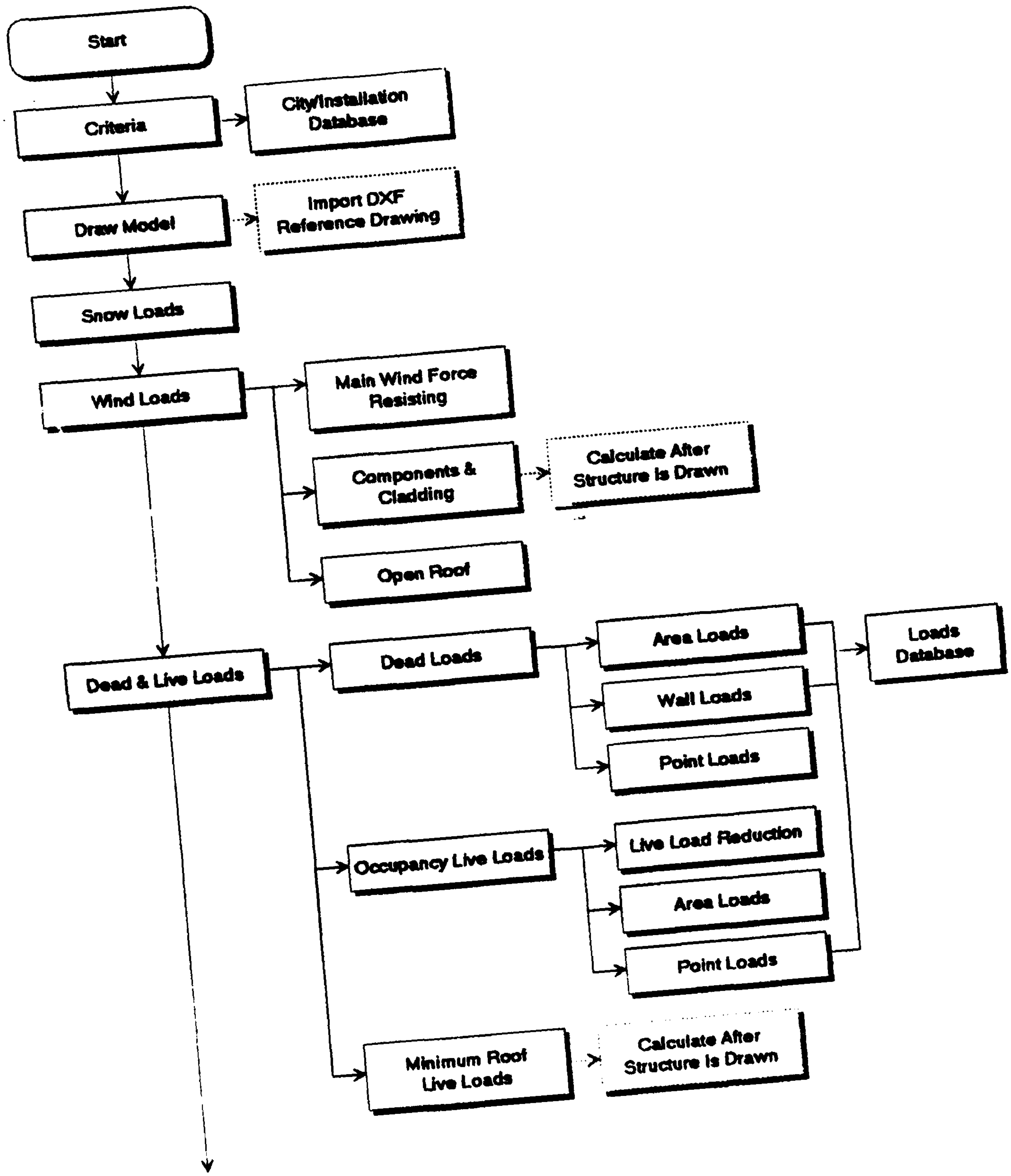
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

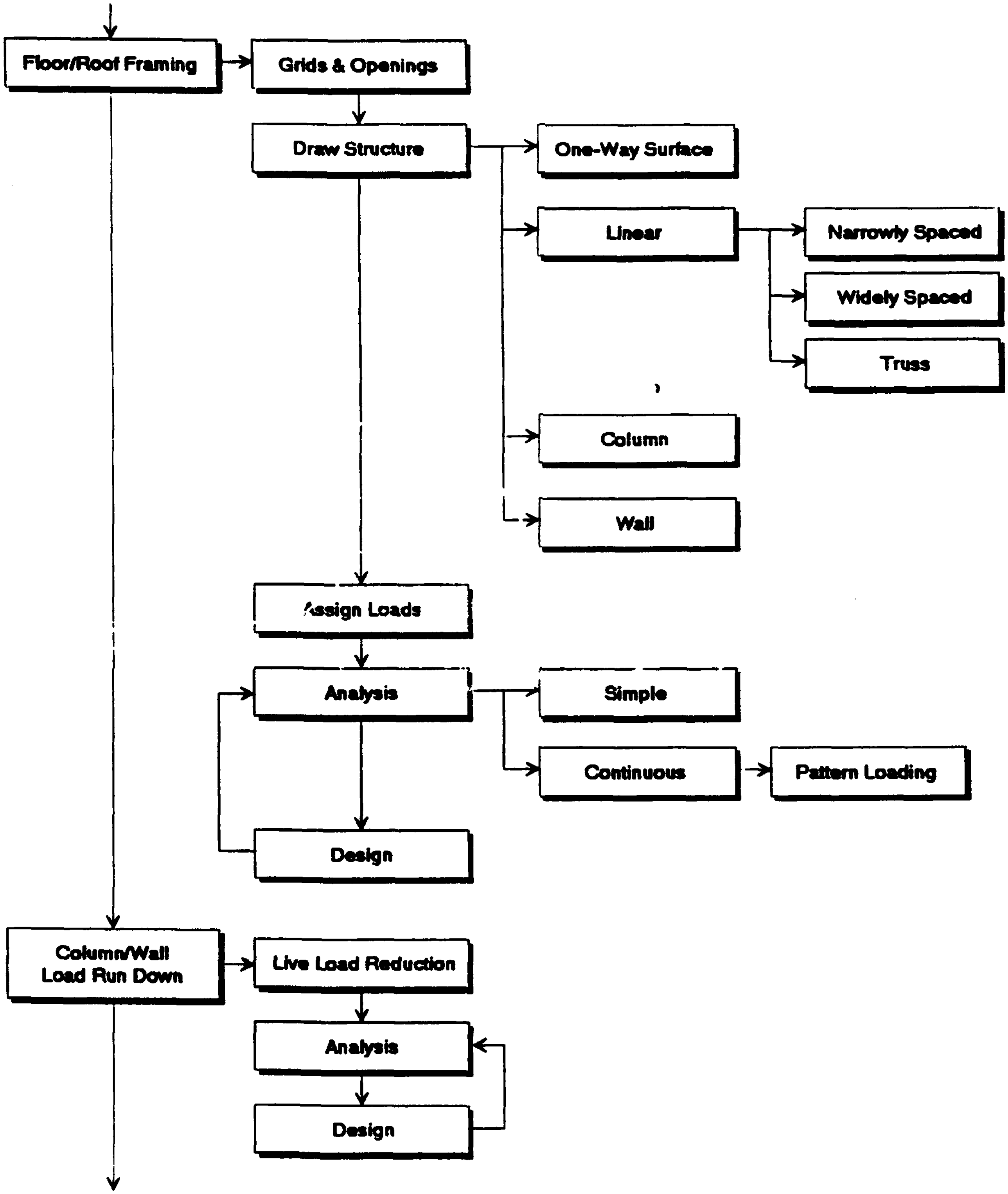
9. Material Assumptions:

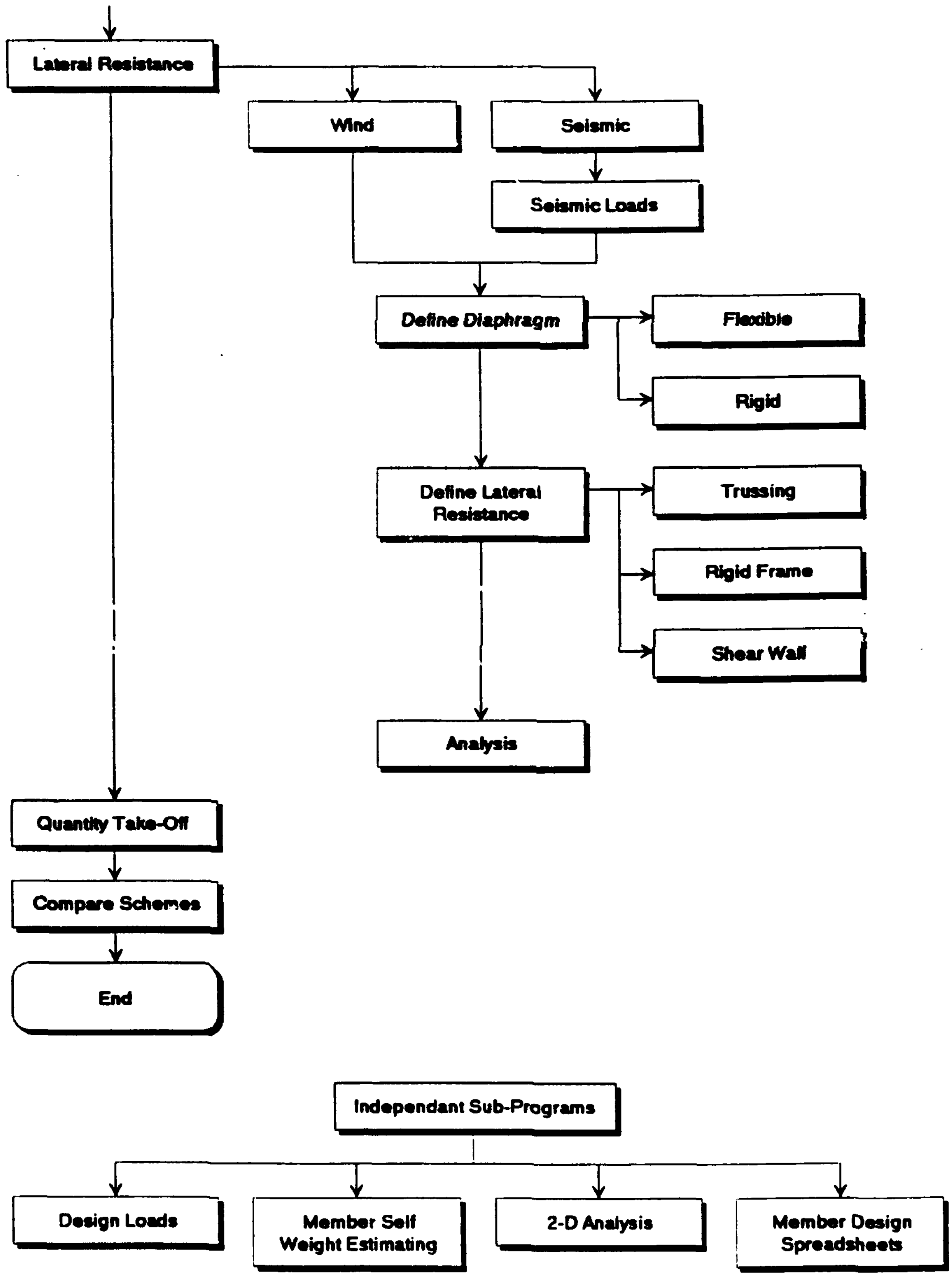
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

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 A
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

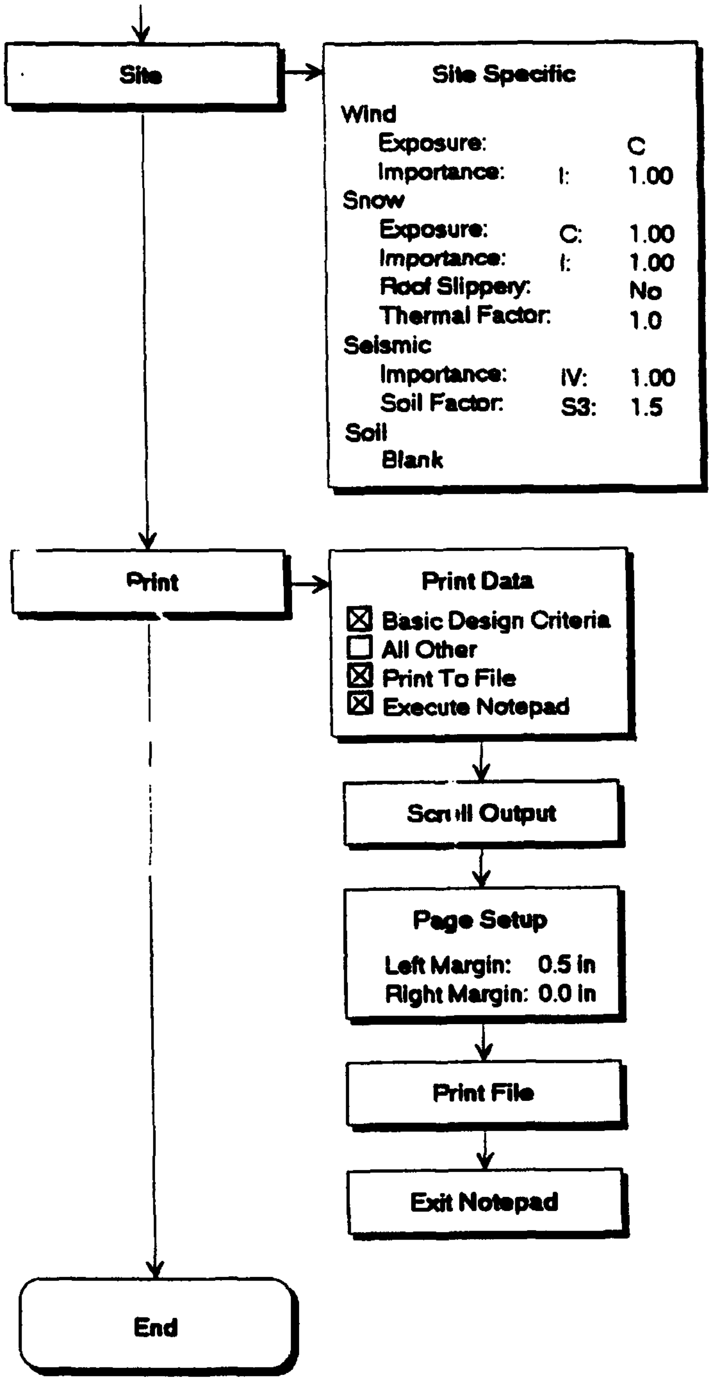
City/Installation

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: I: 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 A
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 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 Slippery	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.

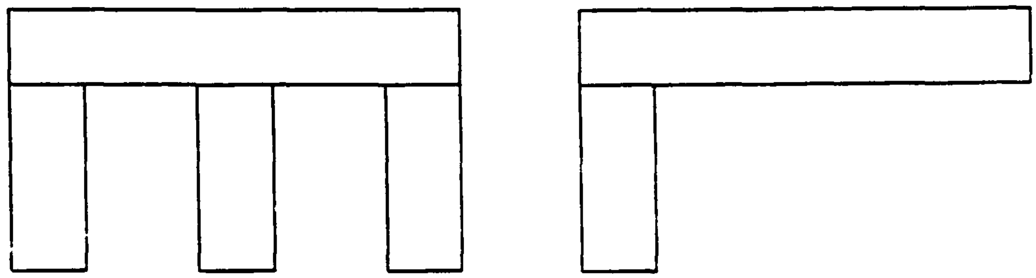
The site factor shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S3 shall be used. Soil profile S4 need not be assumed unless the Building Official determines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

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

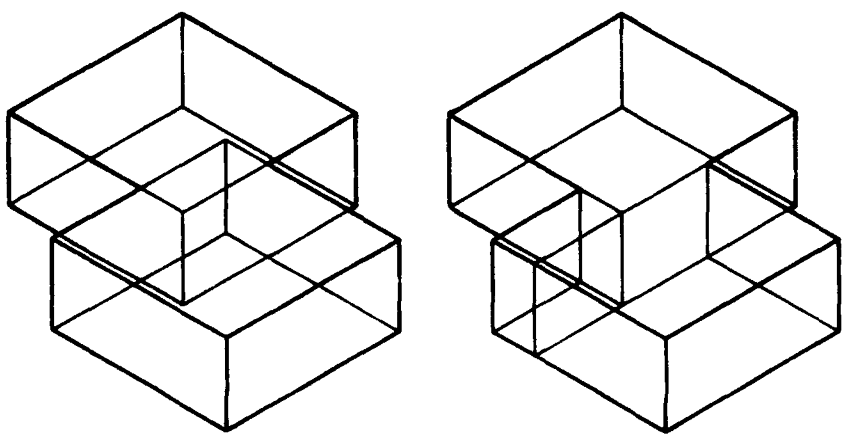
B. Make sure planes are in contact

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

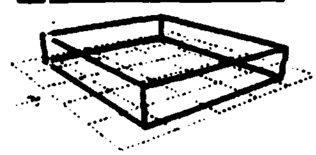
Use Draw Model Tool Palette

Establish Initial Layout Defaults

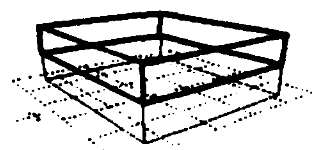
- **Ground Plane**
  Size: 100' x 100'
  Spacing: 20' x 20'
  ✓ Show Ground Plane
- **Units**
  Increment: 4"
  Display: ft-in
  ✓ Snap To Units
- **Initial Object Size**
  N-S: 73'8"
  E-W: 85'8"
  Height: 14'0"
  Plane Thickness: 10"
  Orientation: N-S
- ✓ Stack On Ground Plane

Draw Building Volume

Draw First Floor Volume → Position Cube On Ground Plane → Double Click Right Mouse Key To End



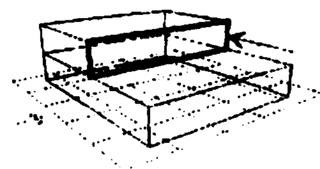
Draw Second Floor Volume → ✓ Stack On Last Shape



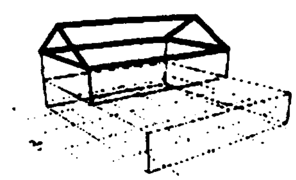
Place Cube On Last Shape

Drag Plane To Correct Dimension

E-W: 49'8"



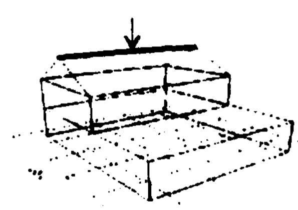
Draw Gable Roof Volume → Place Prism On Last Shape

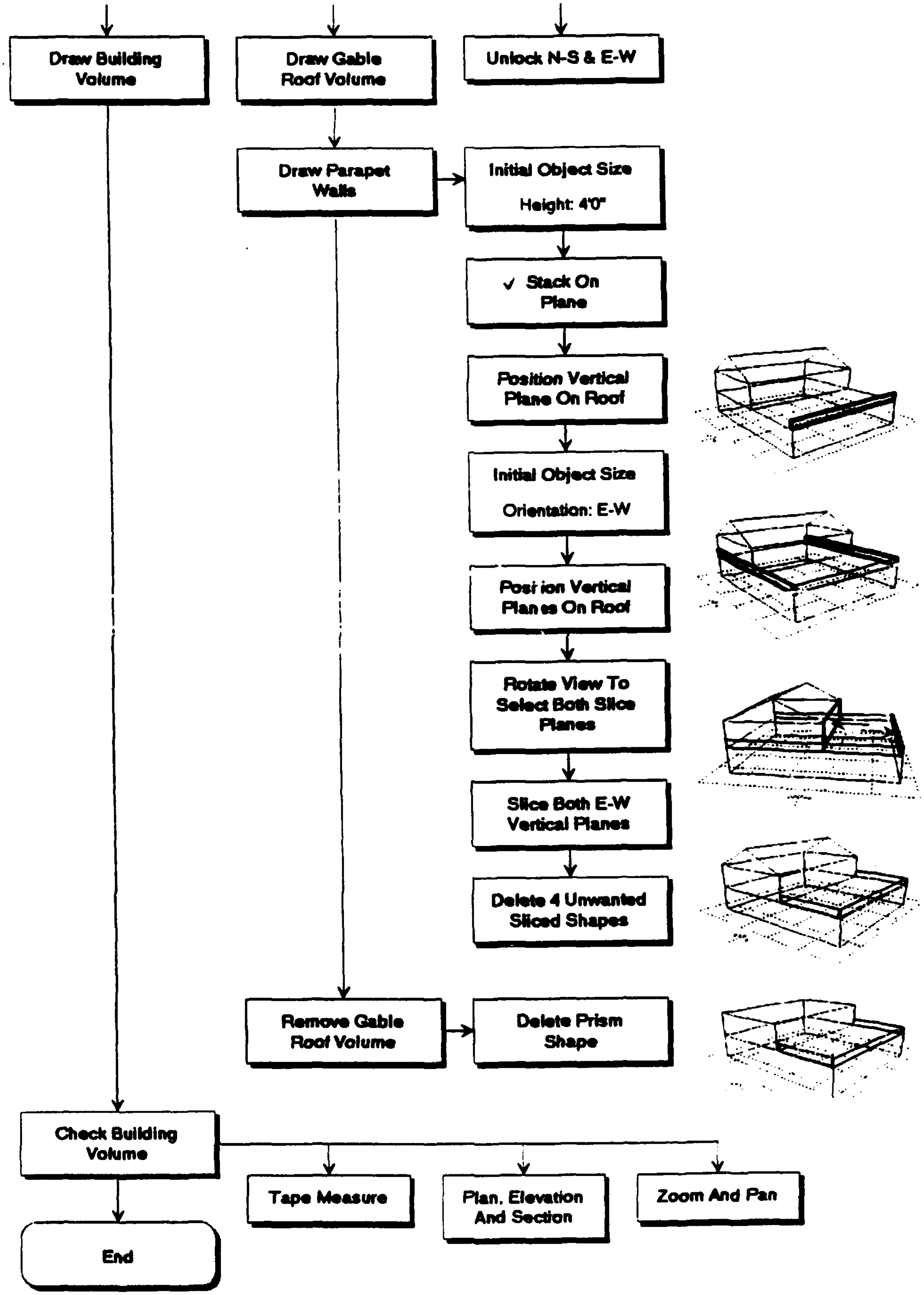


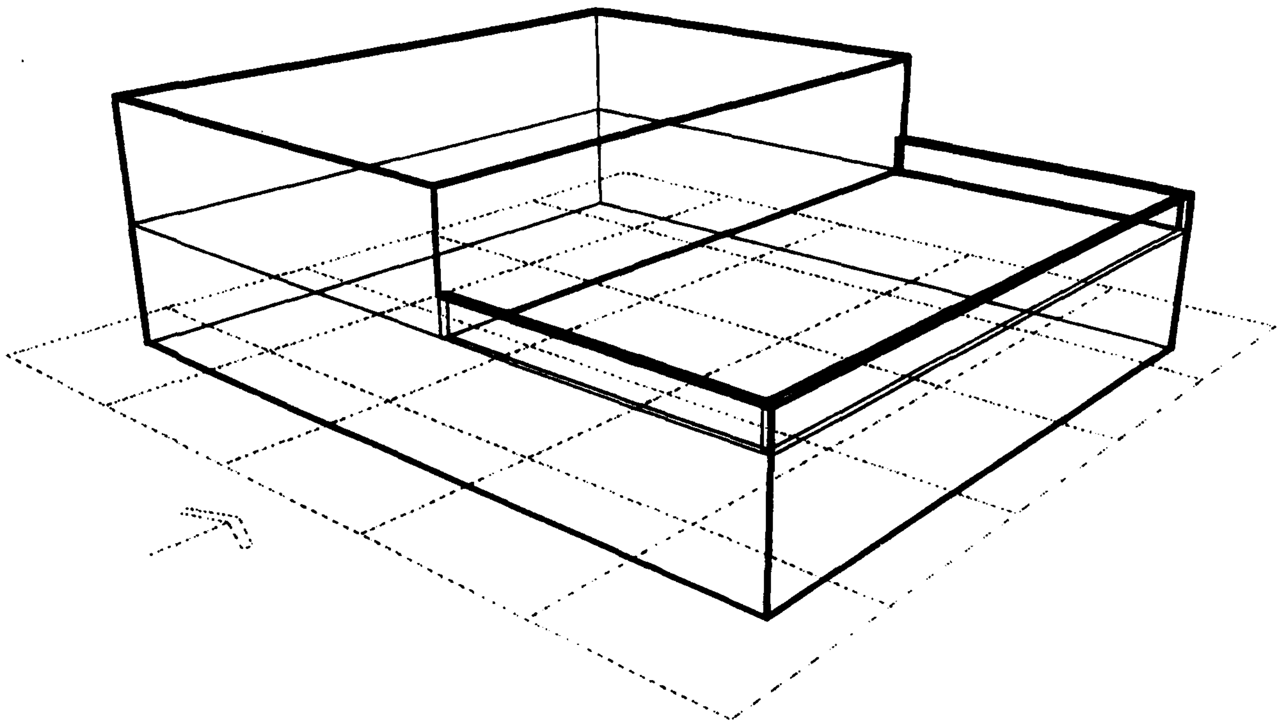
✓ Lock N-S & E-W

Drag Edge To Correct Roof Slope

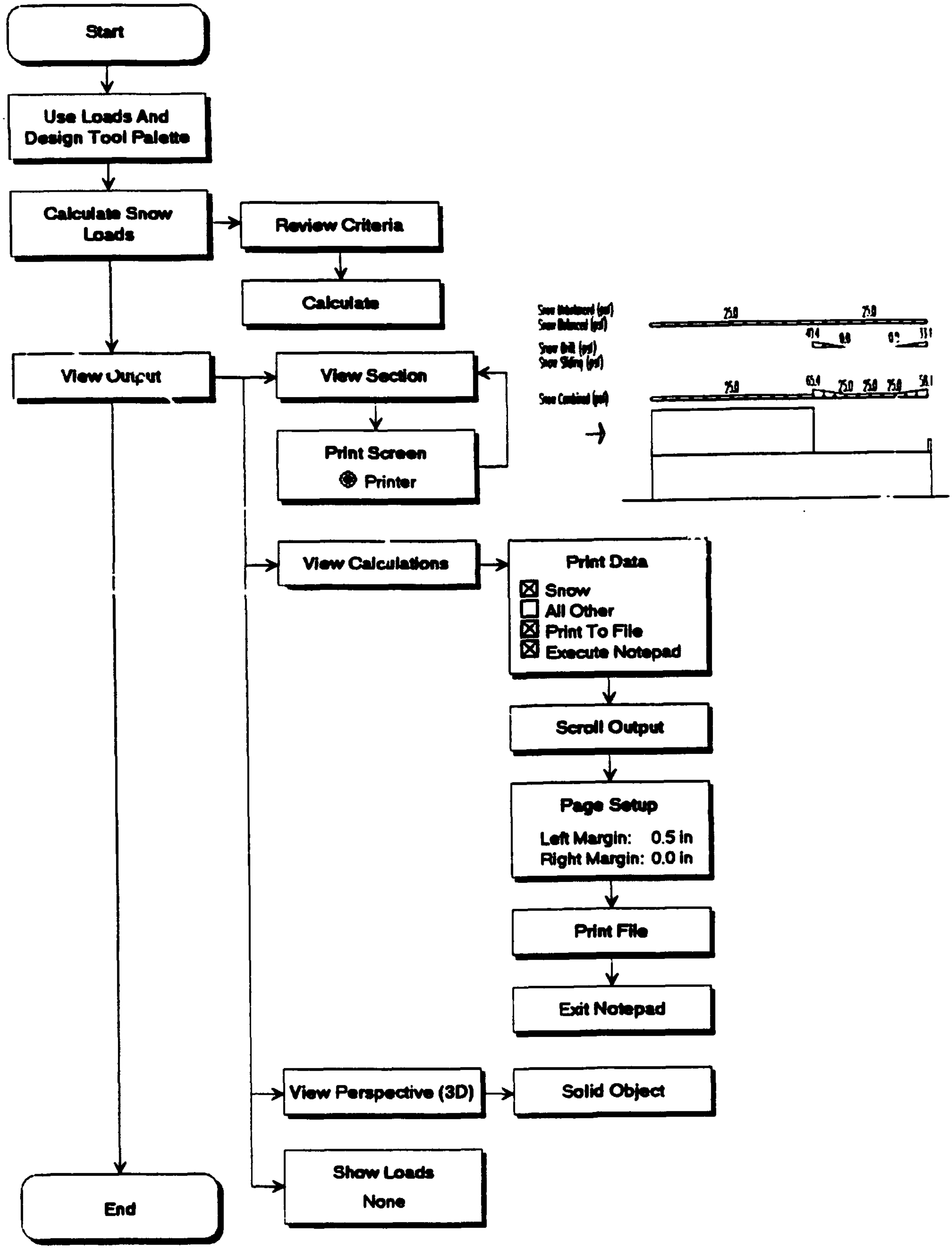
Slope: 5.8 in 12

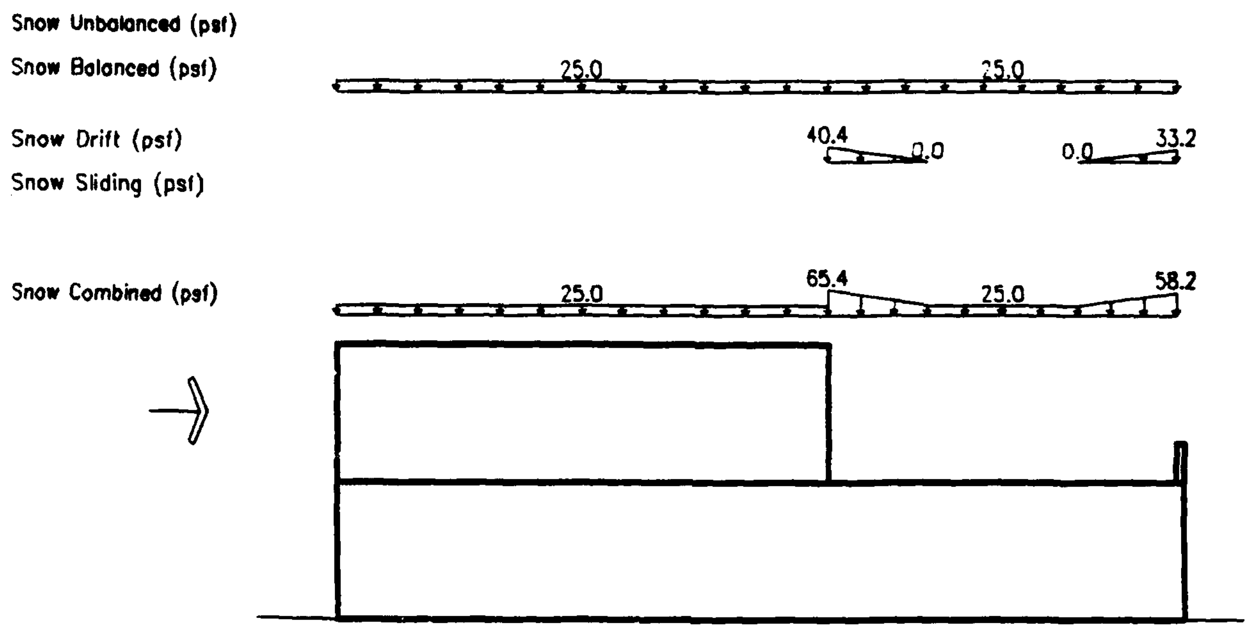


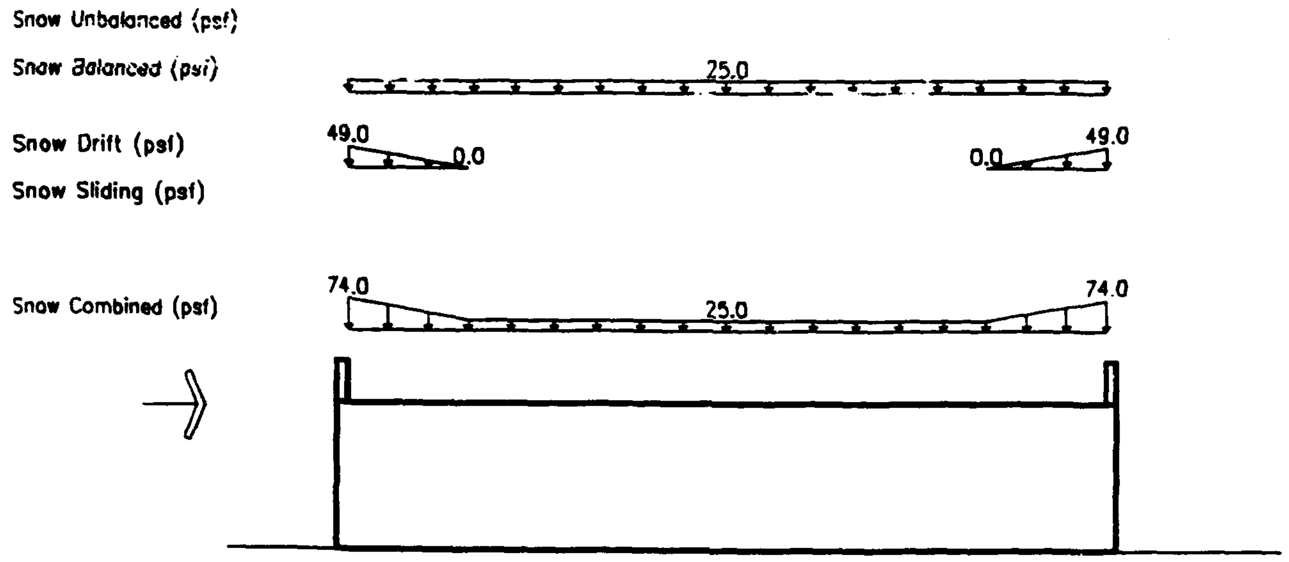

Draw Building Volume
Draw Gable Roof Volume
Unlock N-S & E-W
Draw Parapet Walls
Initial Object Size
Height: 4'0"
✓ Stack On Plane
Position Vertical Plane On Roof
Initial Object Size
Orientation: E-W
Position Vertical Planes On Roof
Rotate View To Select Both Slice Planes
Slice Both E-W Vertical Planes
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 A
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 *************************

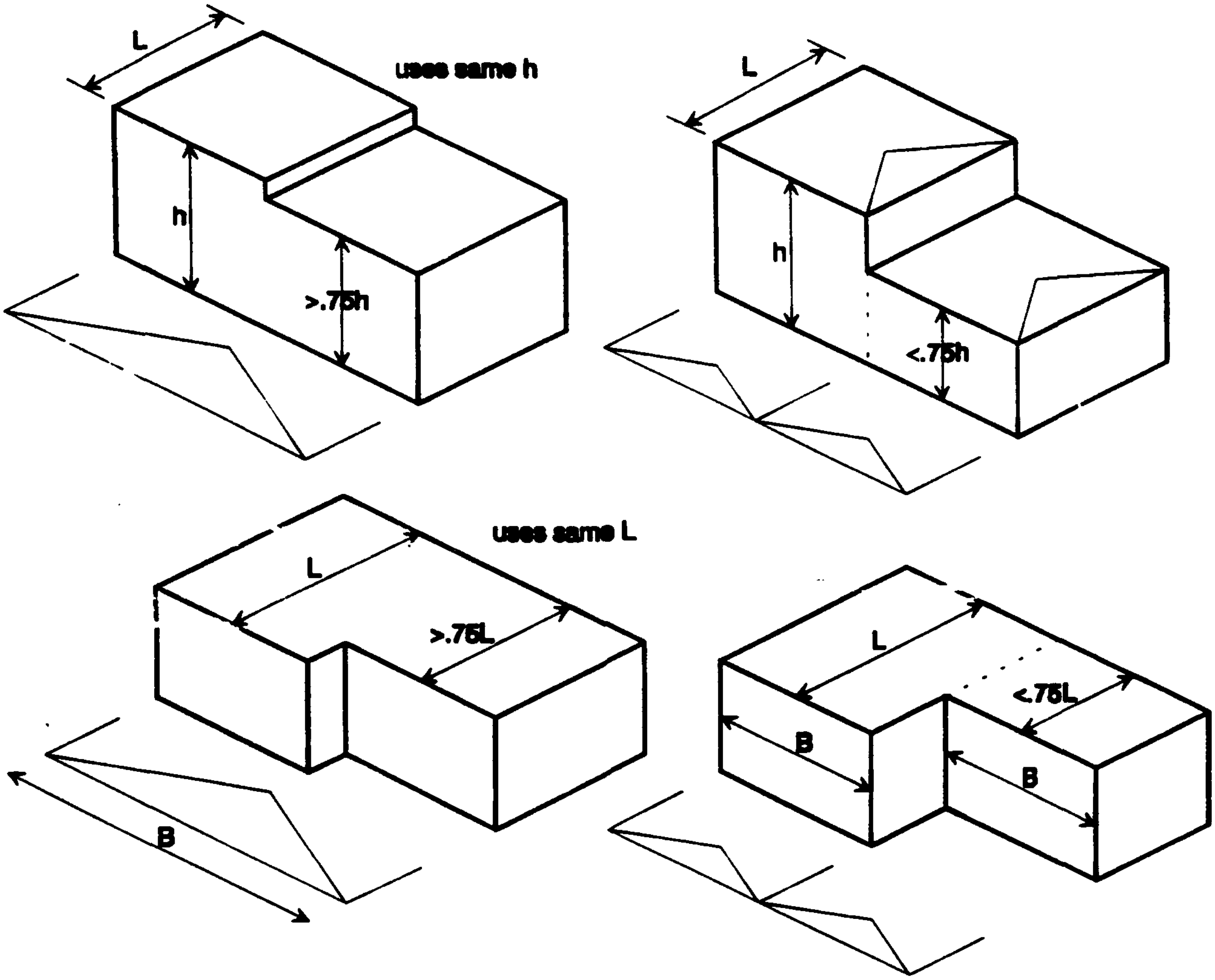
Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 20.00 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.16 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.84 ft
hc/hb = 11.08 >= 0.20  Therefore consider drift load.
Importance Category: I
I  = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 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

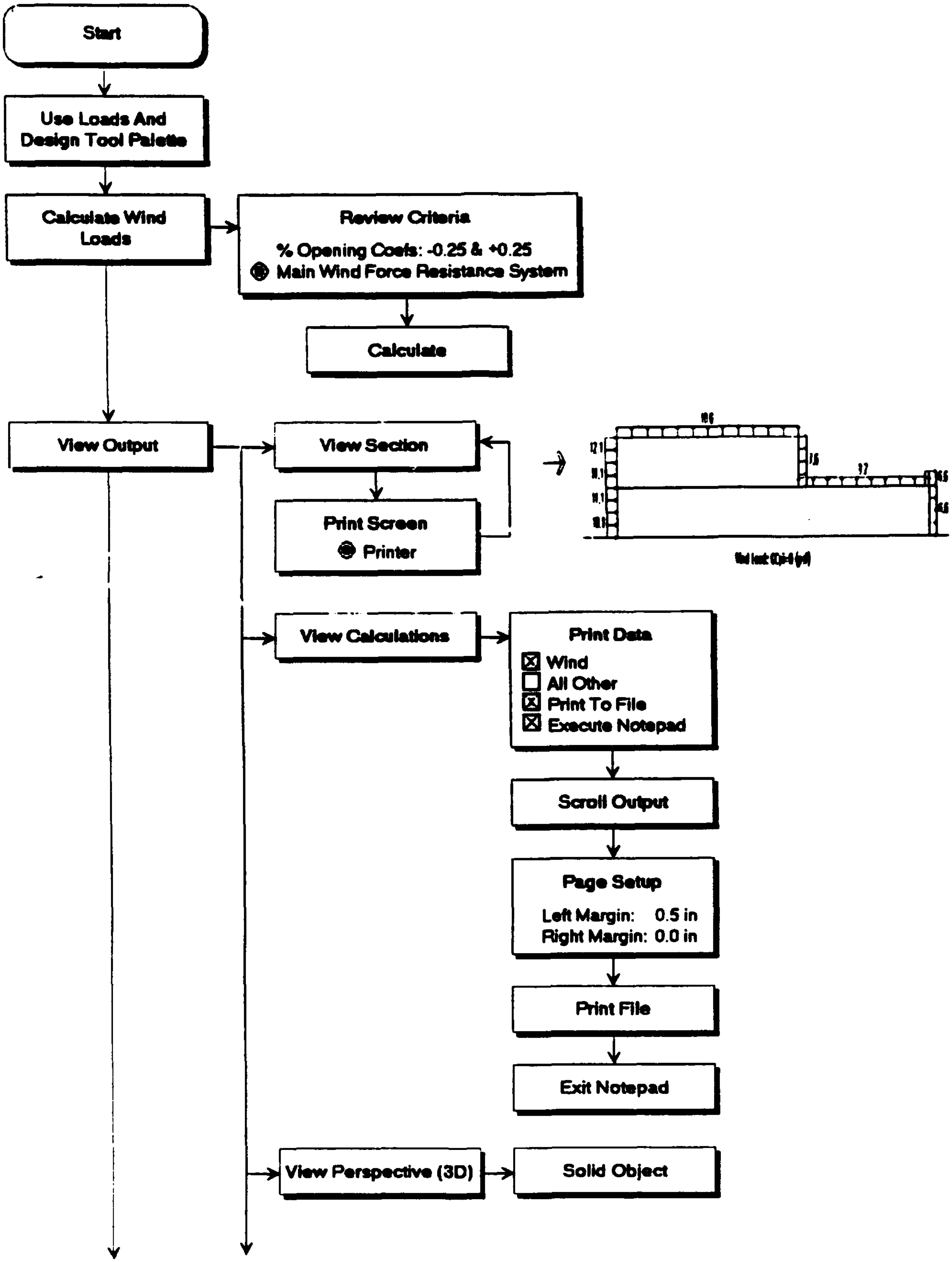
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75

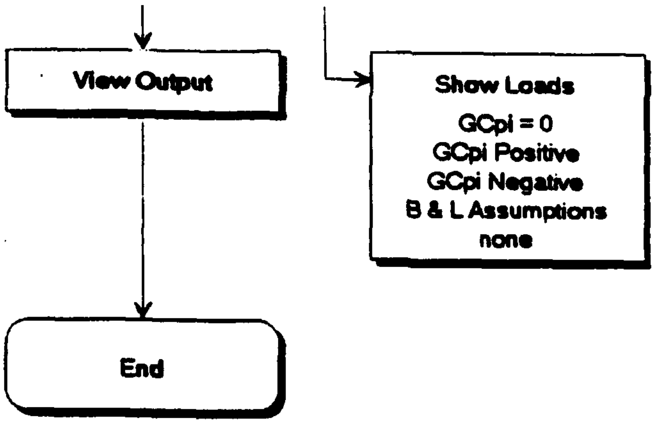


Building Height Maximum 60 Feet

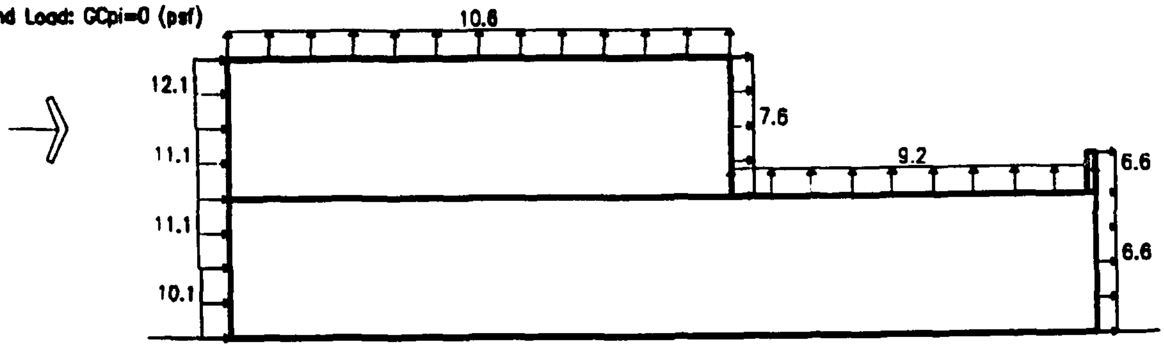
Assumed for components and cladding

Main Wind Force Resisting Loads

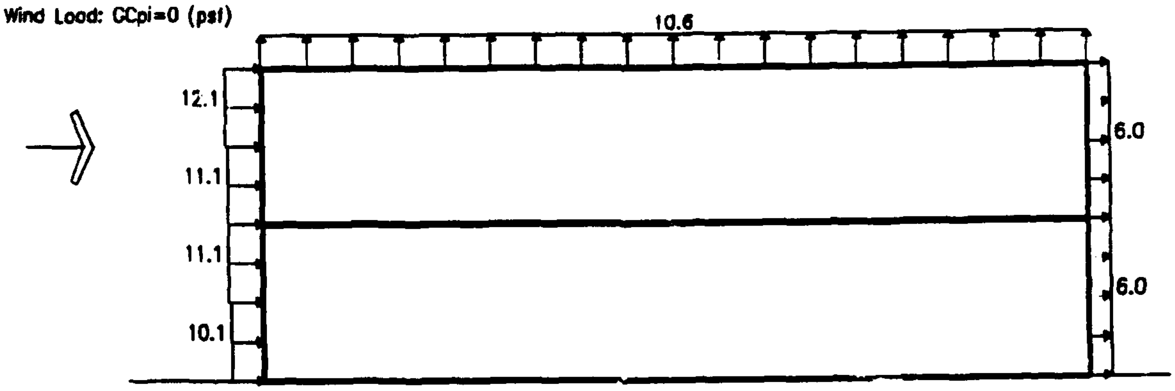



View Output
Show Loads
GCpi = 0
GCpi Positive
GCpi Negative
B & L Assumptions
none
End

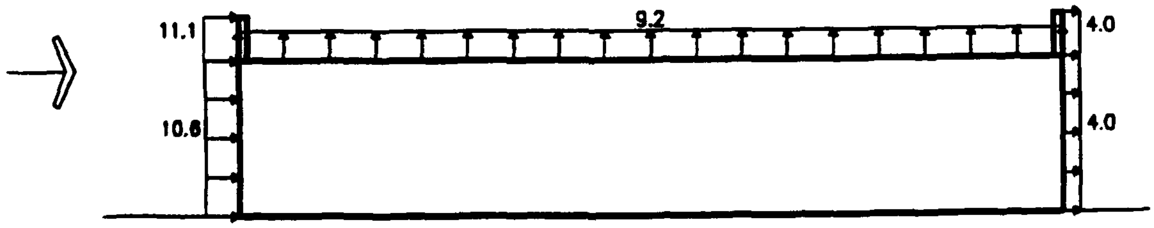
Wind Load: GCpi=0 (psf)

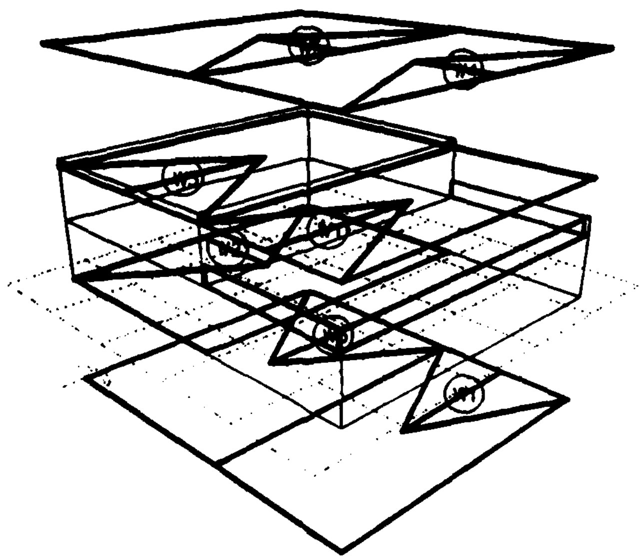


Wind Load: GCpi=0 (psf)



Wind Load: GCpi=0 (psf)





Project : Office Building - Scheme A
Location : Radford AAP
Design Load : TM 5-809-1 1991
Time : Tue Feb 18, 1992 4:16 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 GCpi=0	Pressure P (psf) -0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	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 GCpi=0	Pressure P (psf) -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 GCpi=0	Pressure P (psf) -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 GCpi=0	Pressure P (psf) -0.25	0.25
Windward Wall								
parapet	18.0	1.32	0.84	10.5	0.80	11.1		
level 1	14.0	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 - 5 ******************************

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 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:

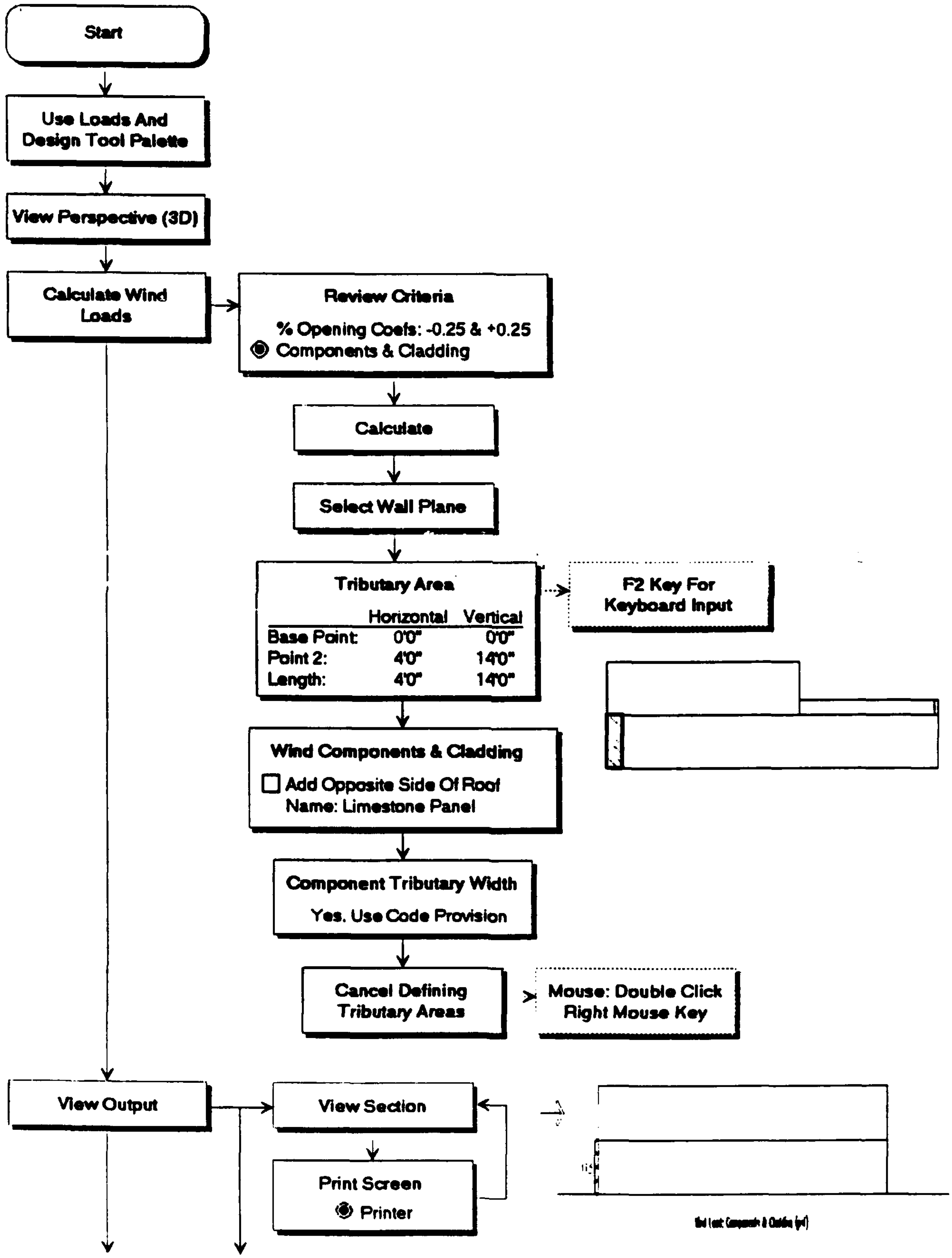
Positive pressures act toward surfaces.

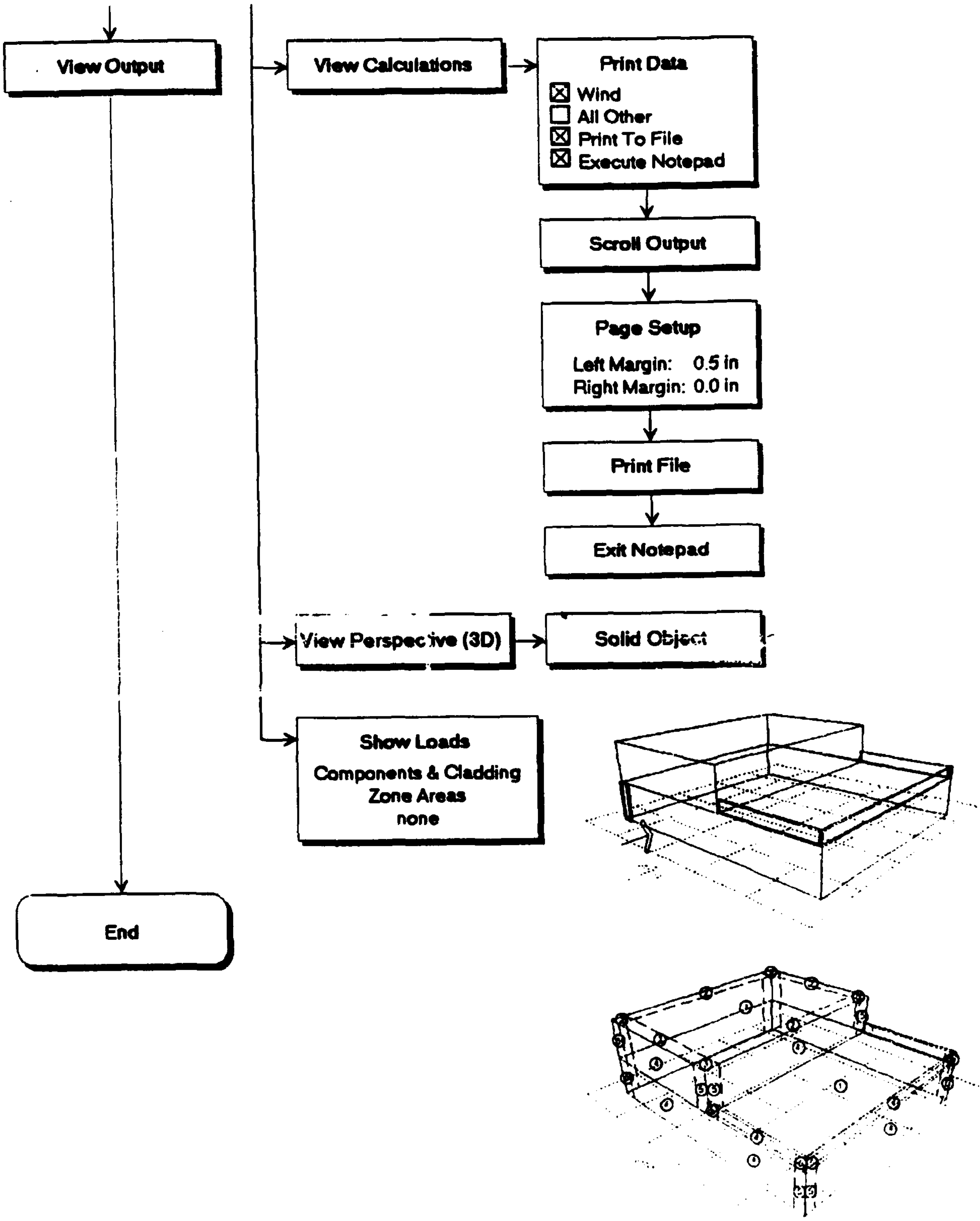
Pressure or suction = P = q*Gh*Cp-qh*(GCpi)

q: qz for windward wall evaluated at height z.

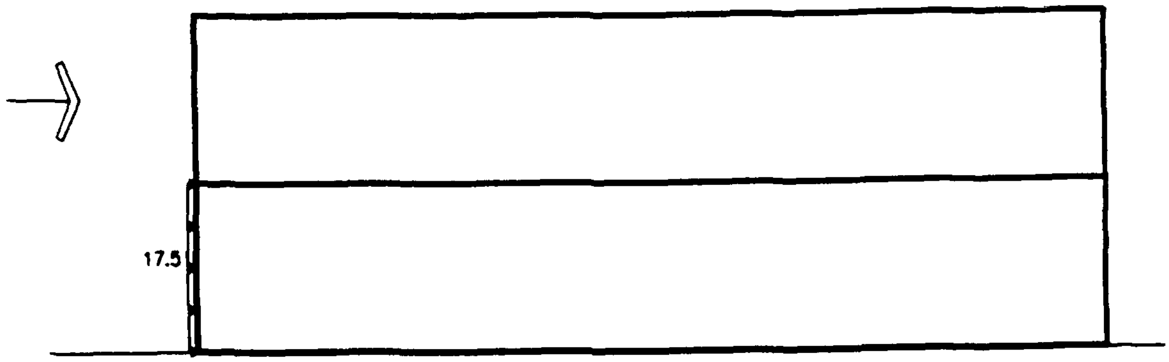
qh for leeward wall, side walls, and roof evaluated at mean roof height.

Wind Components & Cladding Loads

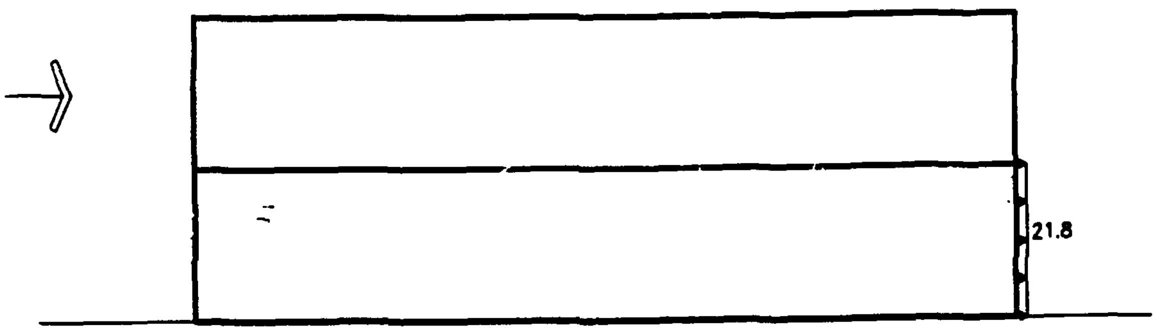


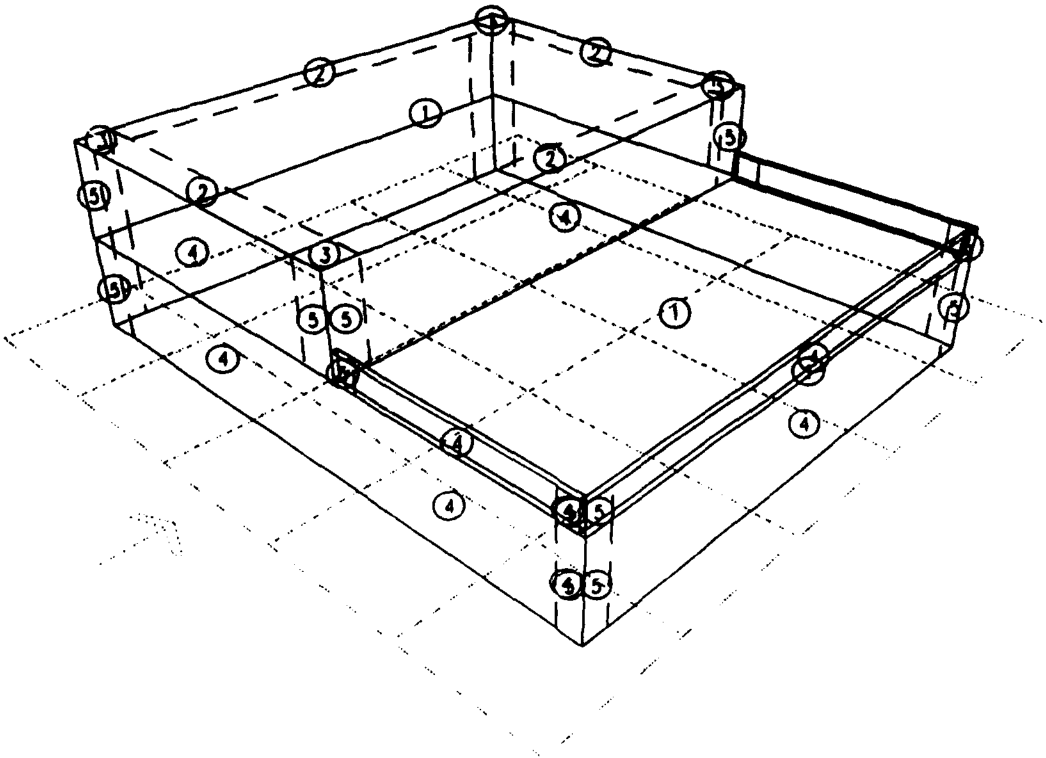

View Output
View Calculations
Print Data
Wind
All Other
Print To File
Execute Notepad
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
View Perspective (3D)
Solid Object
Show Loads
Components & Cladding
Zone Areas
none
End

Wind Load: Components & Cladding (psf)



Wind Load: Components & Cladding (psf)





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

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

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

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

Height <= 60 ft

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

	Walls							
	Windward				Leeward			
Tributary Area (sf)	Zone 4 middles		Zone 5 corners		Zone 4 middles		Zone 5 corners	
	GCp	P	GCp	P	GCp	P	GCp	P
Internal		-3.0		-3.0		3.0		3.0
Limestone Panel 4.[illegible] ft x 1[illegible] ft **								
65.3	1.21	17.5	1.21	[illegible]	[illegible]	[illegible]	-1.57	-21.8
a = 5.0 ft								

Notes for components and cladding:

P = qh(GCp)-qh(GCpi)

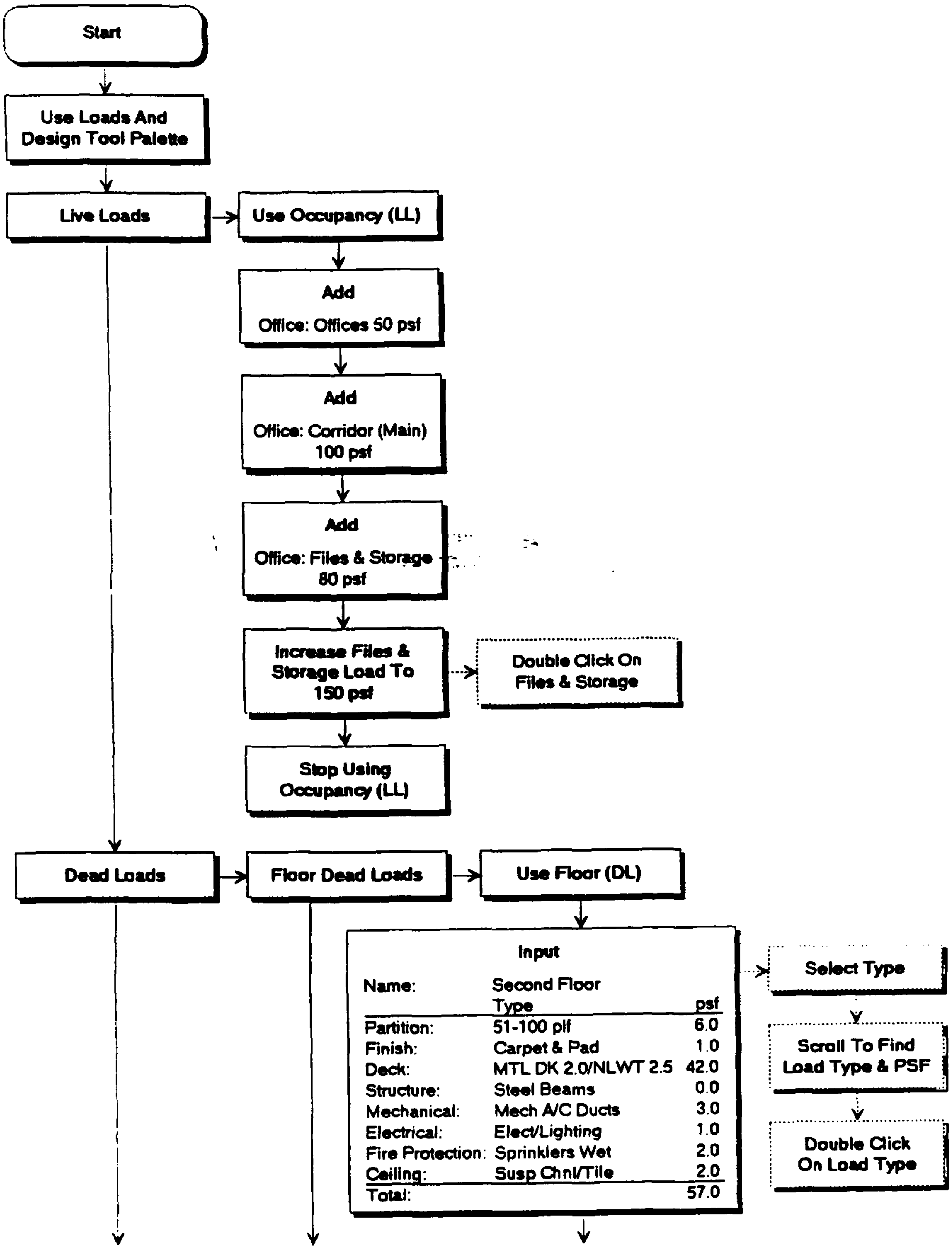
Internal pressures have been included in above values.

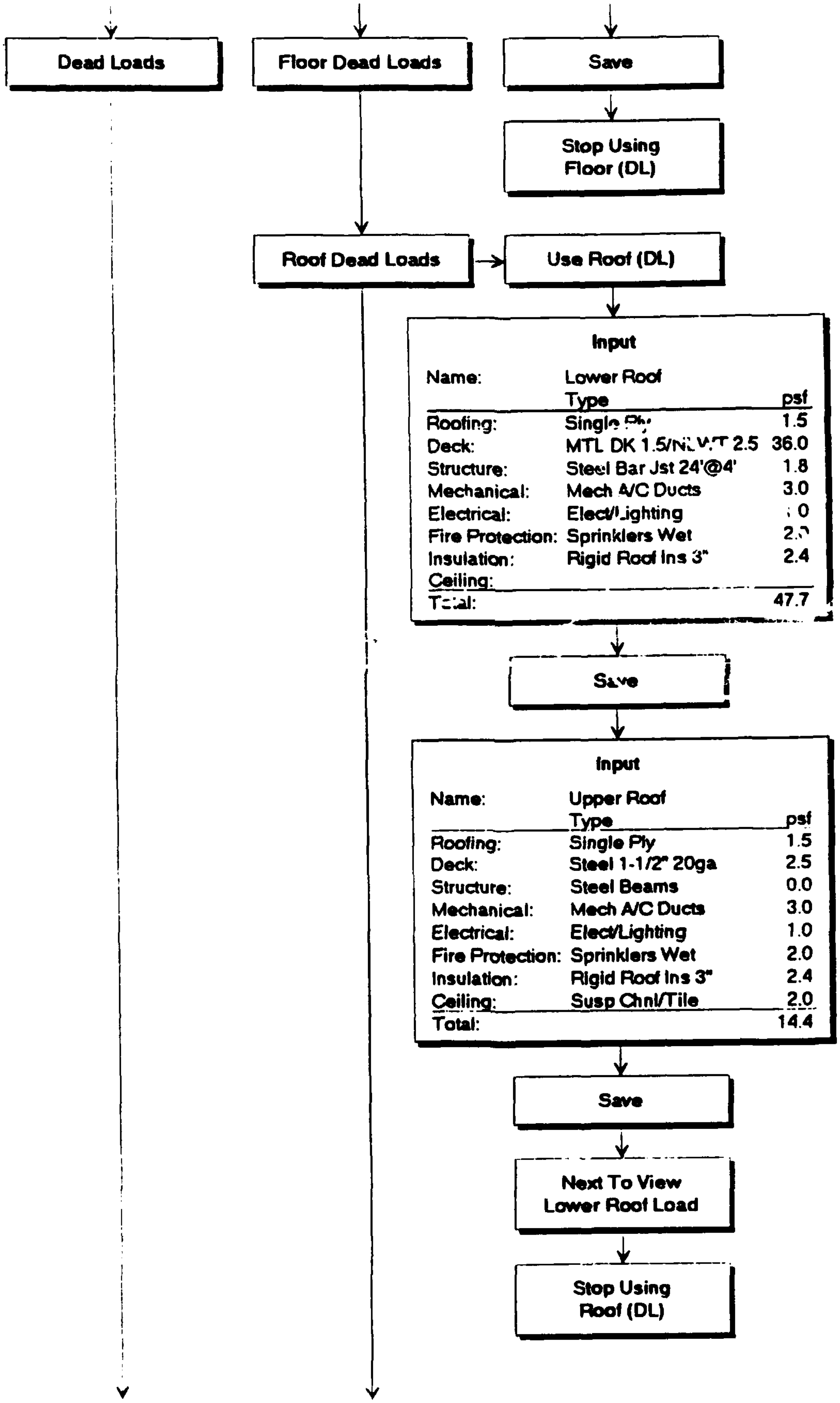
* For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

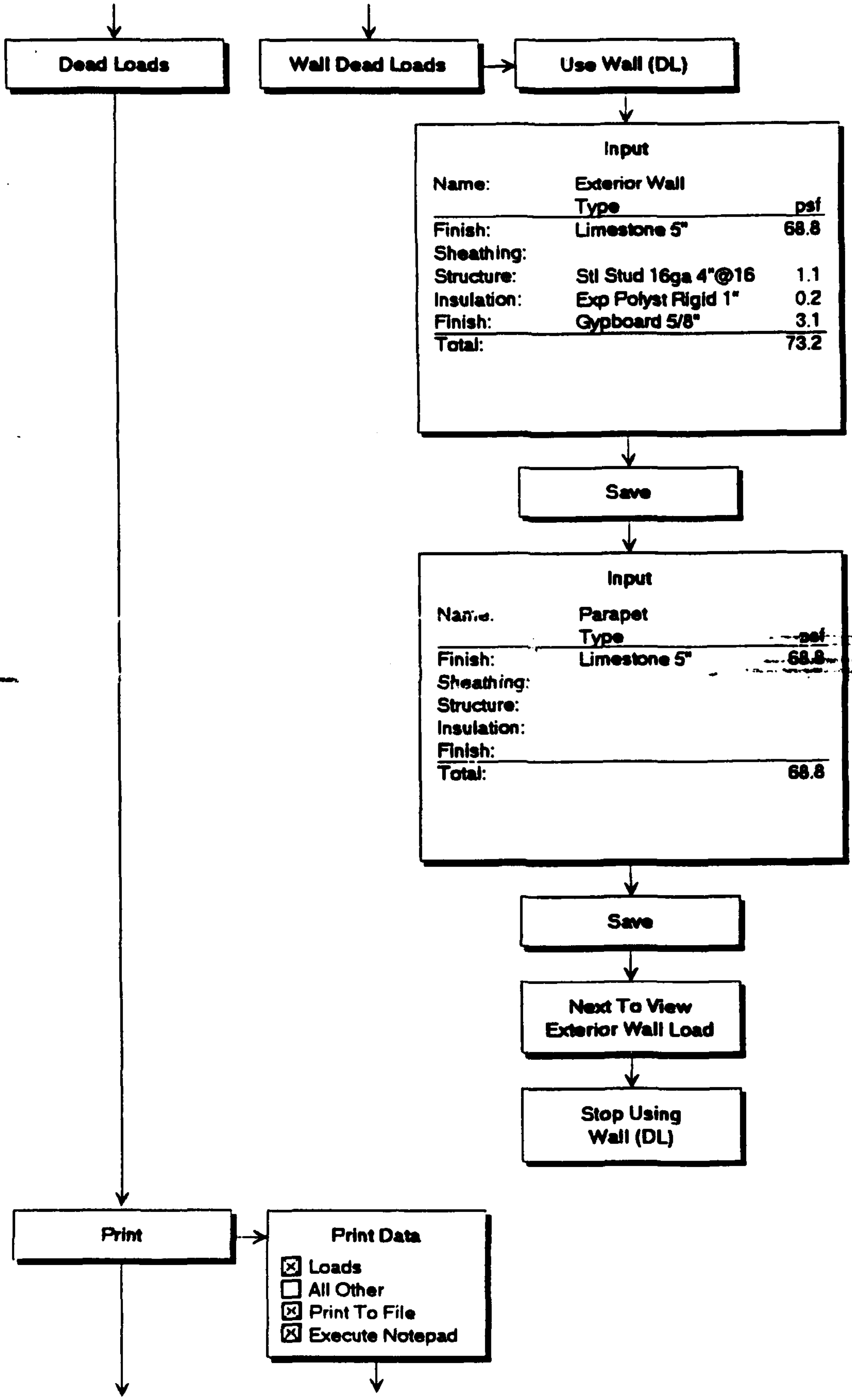
To comply with TM 5-809-1, wall external pressures have not been reduced 10% per ASCE figure 3, note 3.

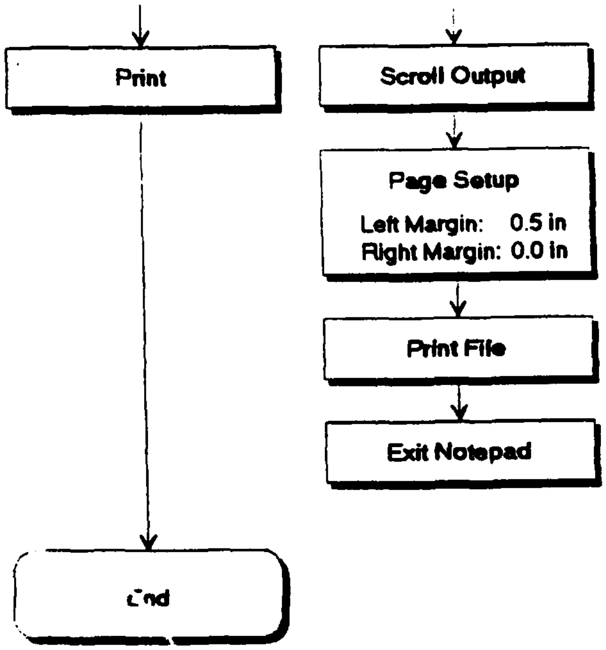
** For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.

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: 1.5
Deck: MTL DK 1.5 36.0
Structure: Steel Bar Jst 24'@4' 1.8
Mechanical: Mech A/C Ducts 3.0
Electrical: 0
Fire Protection: Sprinklers Wet
Insulation: Rigid Roof Ins 3" 2.4
Ceiling:
47.7
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
End
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad

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 24'@4'	1.8
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	:	47.7

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))]

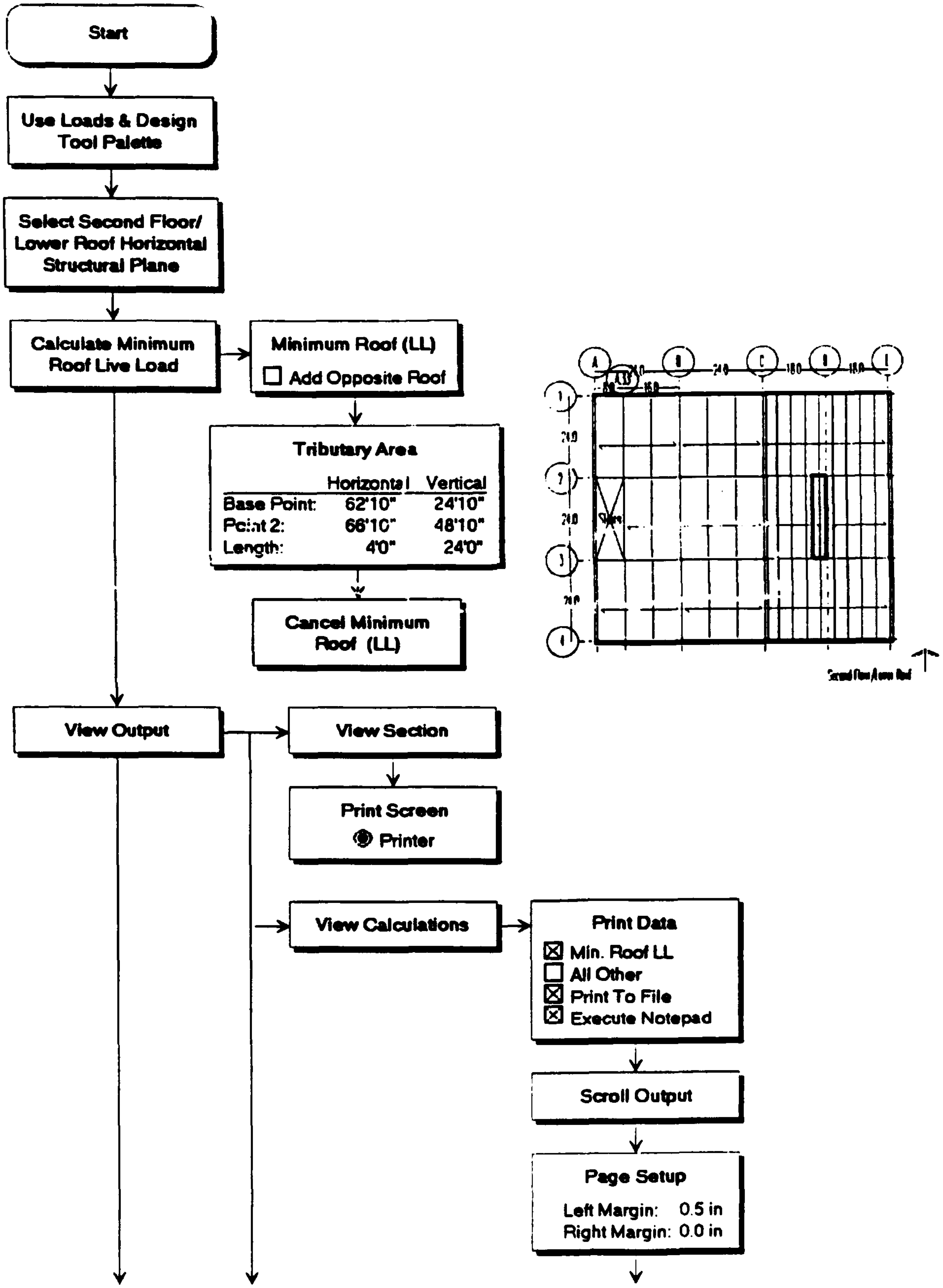
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.

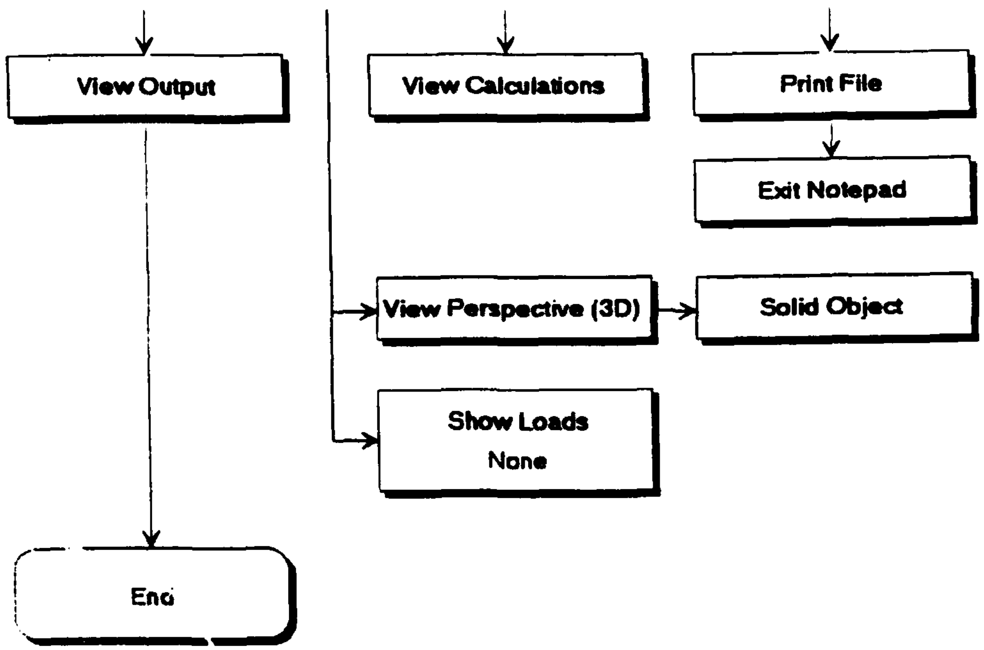
Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

- -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 A
Location    : Radford AAP
Design Load : TM 5-809-1 1991
Time        : Sat Jan 25, 1992  6:16 PM

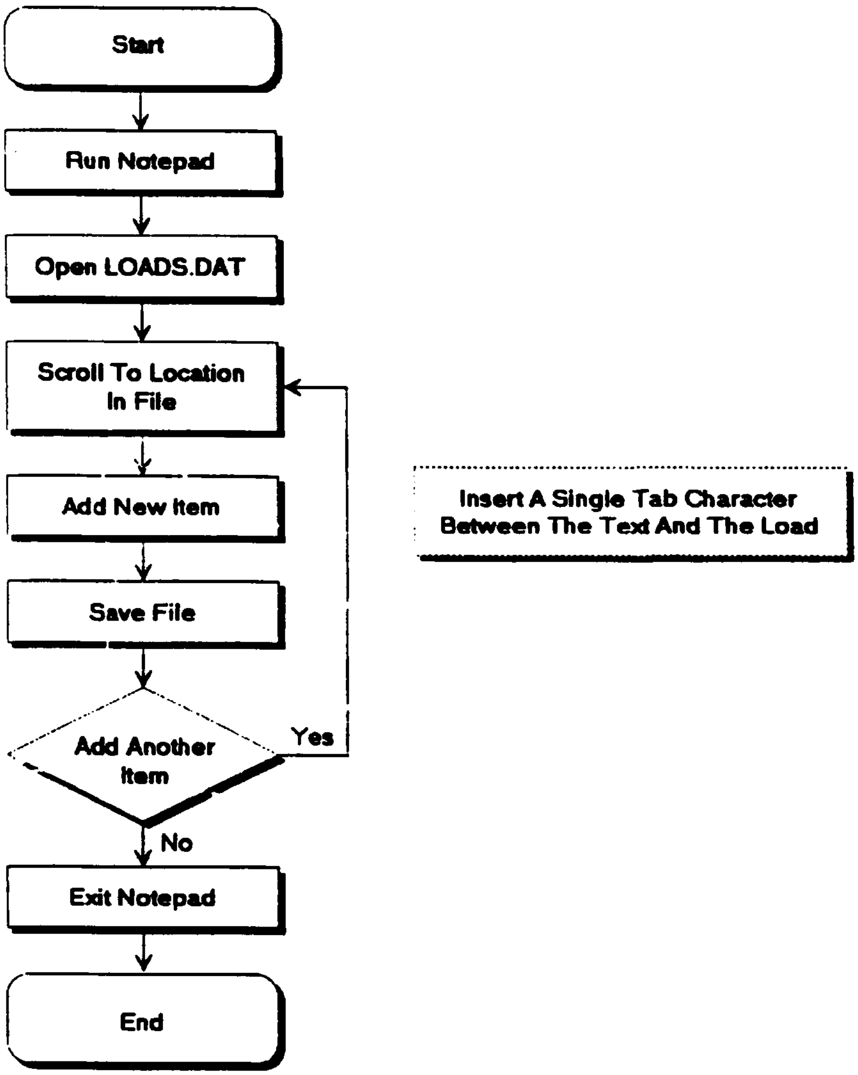
********************** Minimum Roof Live Load (Lr) **********************

Tributary area (At) : 96 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

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/ Lower Roof Horizontal Structural Plane

Structural Plane Information

Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid

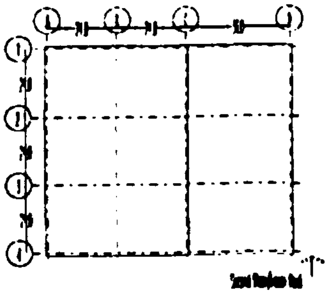
N-S Spacing:	24'0"
E-W Spacing:	24'0"
Perimeter Offset:	10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines

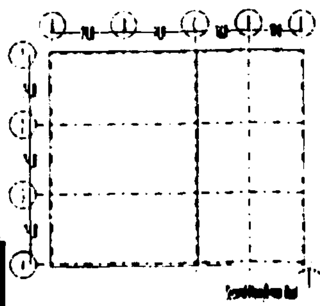


Add Main Grid Line Between C & D

Add Main Grid Line

Select Handle Between C & D

Keep Dimensions To The Left & Right At 18' And Click The Left Mouse Key



Draw Openings

Add Opening

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

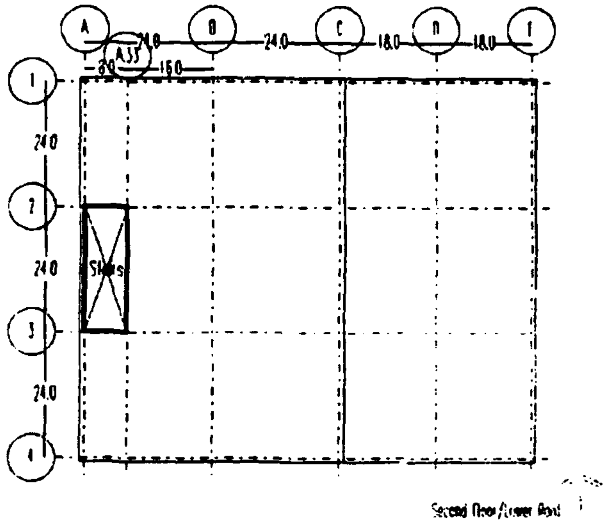
F2 Key For Keyboard Input

Opening

Name: Stairs

☐ Continuous

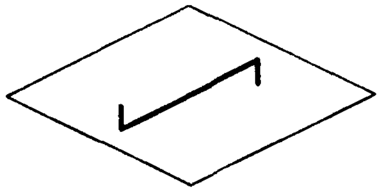
End



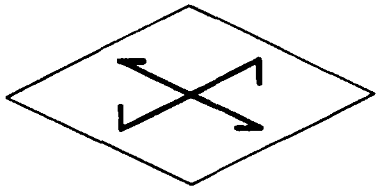
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



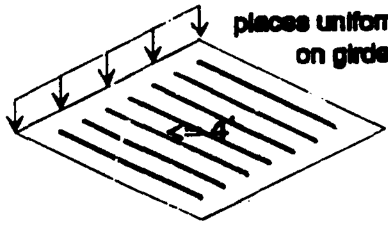
1 way



2 way
(not activated)

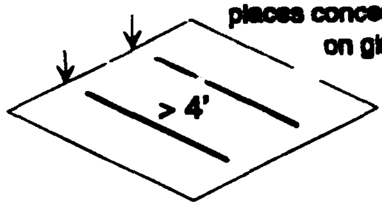
Linear
(horizontal)

Narrowly Spaced
(joists)



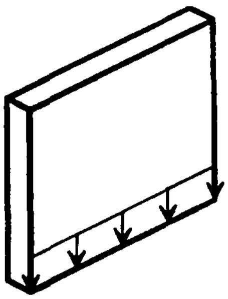
places uniform loads
on girders

Widely Spaced
(beams)



places concentrated loads
on girders

Surface
(vertical)
(planar)



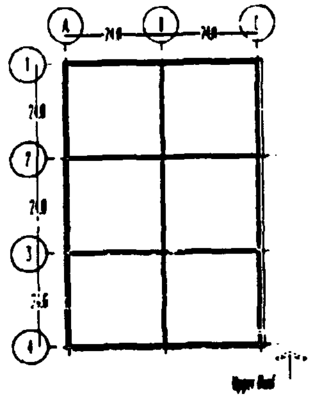
uniform loads

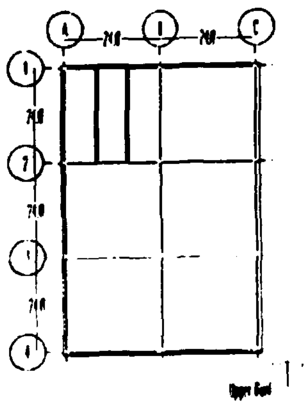
Linear
(vertical)

concentrated loads

Draw Structure

- Start
- Use Draw Structure Tool Palette
- Draw Upper Roof Framing
  - Select Upper Roof Horizontal Structural Plane
  - Structural Plane Information
    Name: Upper Roof
  - Close Structural Plane Information Dialog Window
  - Draw Linear Beams On All Grid Li:ies
  - Draw Third Point Beams In Bay A1-B2
    - Linear: Widely Spaced
    - Select Handle On Grid A1-B1
    - Select Handle On Grid A2-B2
    - Double Click Right Mouse Key To End Defining Area
    - Save Linear Elements
      Orientation: N-S
      ☒ Number Of Elements: 2
  - Draw One-Way Surface In Bay A1-B2
    - Surface: One-Way





Draw Upper Roof framing

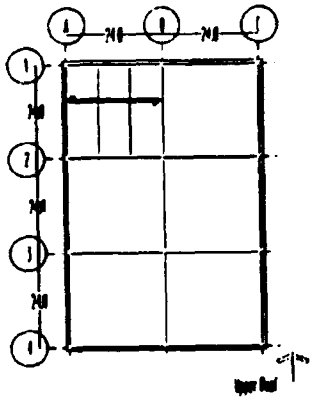
Draw Surface In Bay A1-B2

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

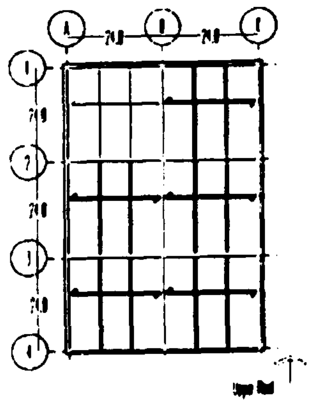
Double Click Right Mouse Key To End Selecting Structure

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

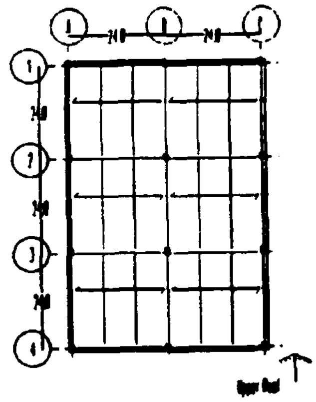


Draw Upper Roof framing

Draw Columns → Column All Grid Intersections → Save Column Elements

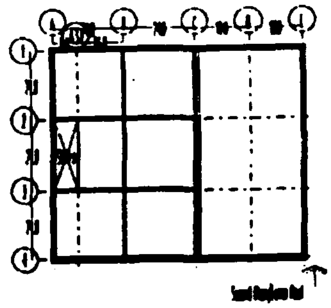
Orientation: N-S

☒ All Floors



Draw Second Floor/ Lower Roof Framing → Select Second Floor/ Lower Roof Horizontal Structural Plane

Draw Linear Beams On All Grid Lines

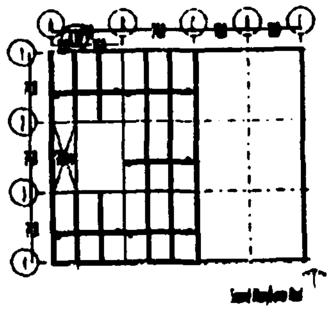


Delete Beams At Grid Locations Inside C1-E4

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

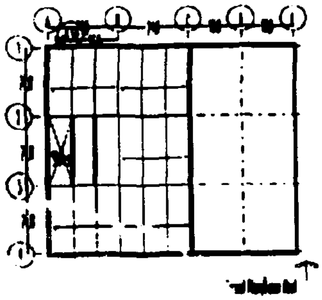
Draw Second Floor/ Lower Roof Framing

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

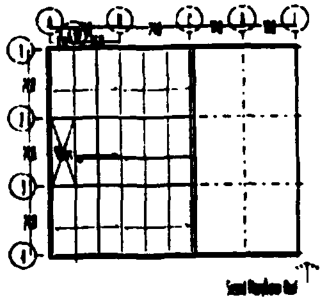
Draw Surface In Bay A.33.2-B3

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

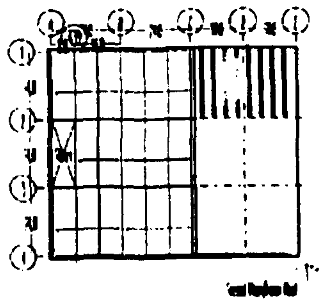


Save Surface Element

Orientation: E-W

Draw Joists In Bay C1-E2

Linear: Narrowly Spaced



Select Handle On Grid C1-C2

Select Handle On Grid E1-E2

Draw Second Floor/
Lower Roof Framing

Draw Joists In
Bay C1-E2

Double Click Right
Mouse Key To End
Defining Area

Save Linear Elements

Orientation: N-S

☒ Spacing: 48"

Draw Surface In
Bay C1-E2

Surface: One-Way

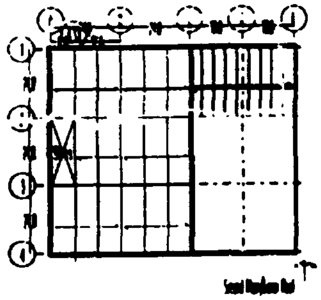
Select Handle On
Grid C1-C2

Select Handle On
Grid E1- E2

Double Click Right
Mouse Key To End
Defining Area

Save Surface Element

Orientation: E-W



Copy Joists &
One-Way Surface
To Other Bays

Copy Structure

Select Joists

Select One-Way
Surface

Double Click Right
Mouse Key To End
Selecting Structure

Select Grid
Location C1 As
The Base Point

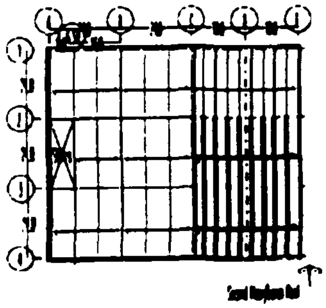
Draw Second Floor/ Lower Roof Framing

Copy Joists & One-Way Surface To Other Bays

Paste Structure

Select Grid Locations C2, C3

Double Click Right Mouse Key To End



Draw Trusses

Linear Truss-Custom

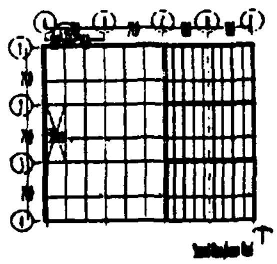
Select Grid Locations C2-D2, D2-E2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: E-W

Truss-Custom
☐ Include Opposite Side Of Roof
Depth Of Support: 3'
Scissors Height: 0'

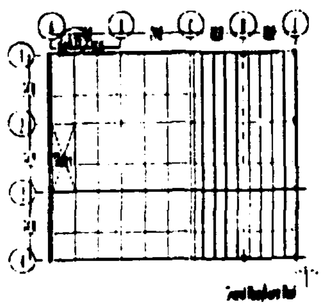
Repeat For Grid Location C3-E3

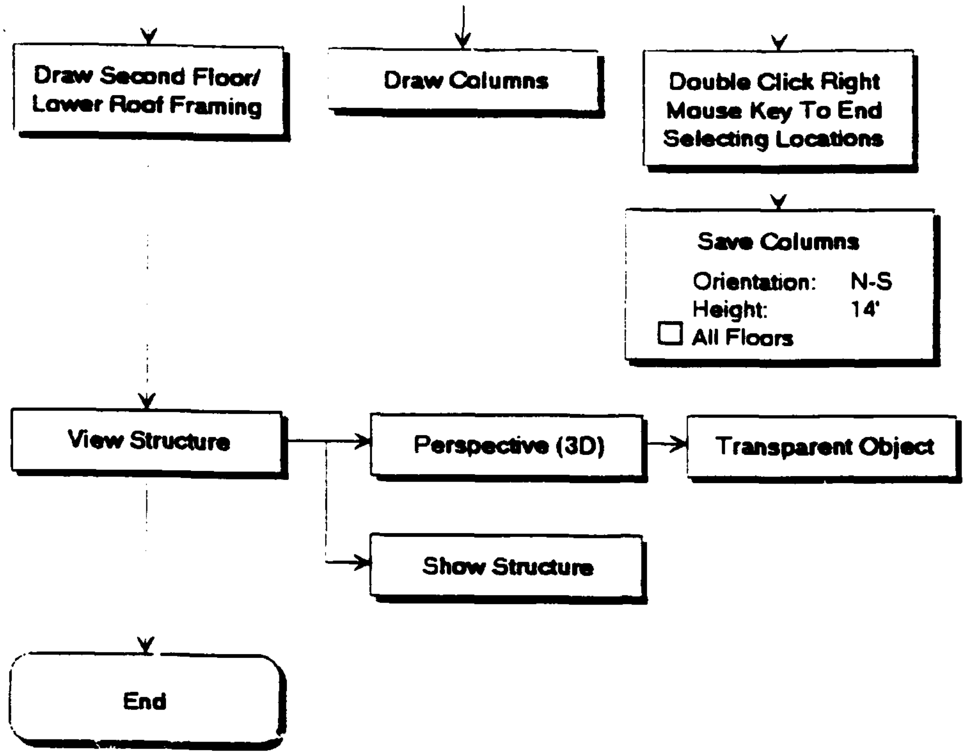


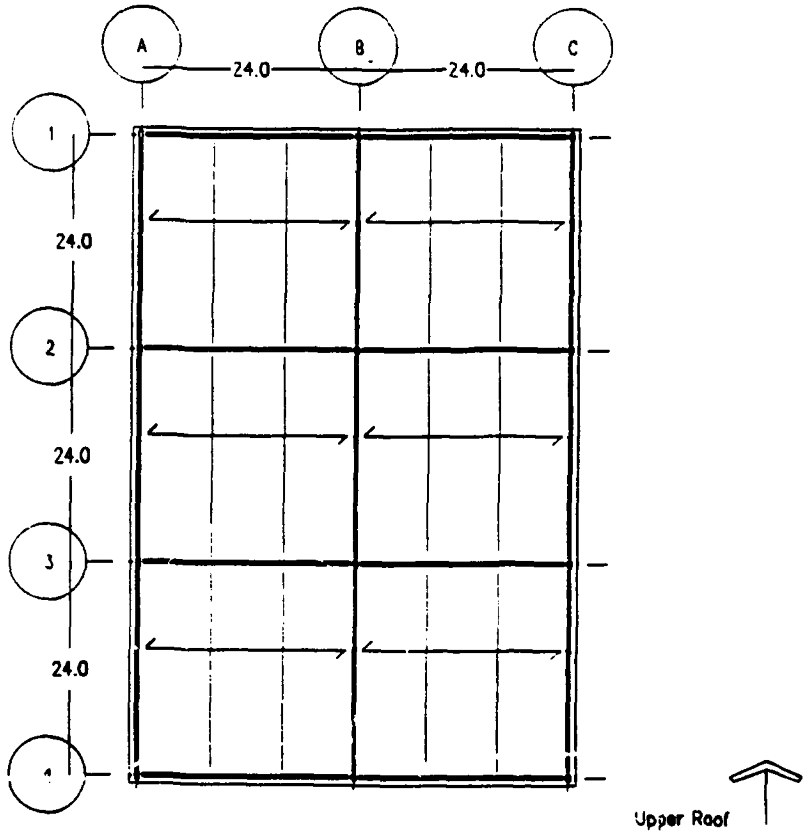
Draw Columns

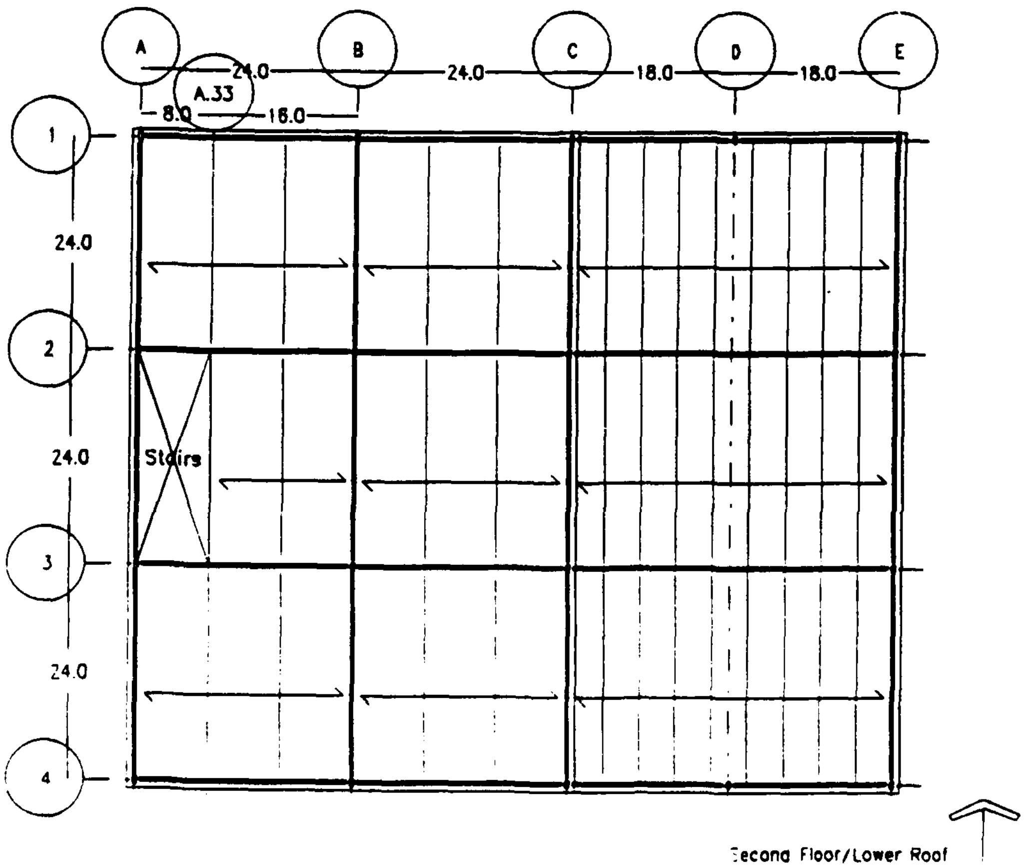
Column One Grid Intersection

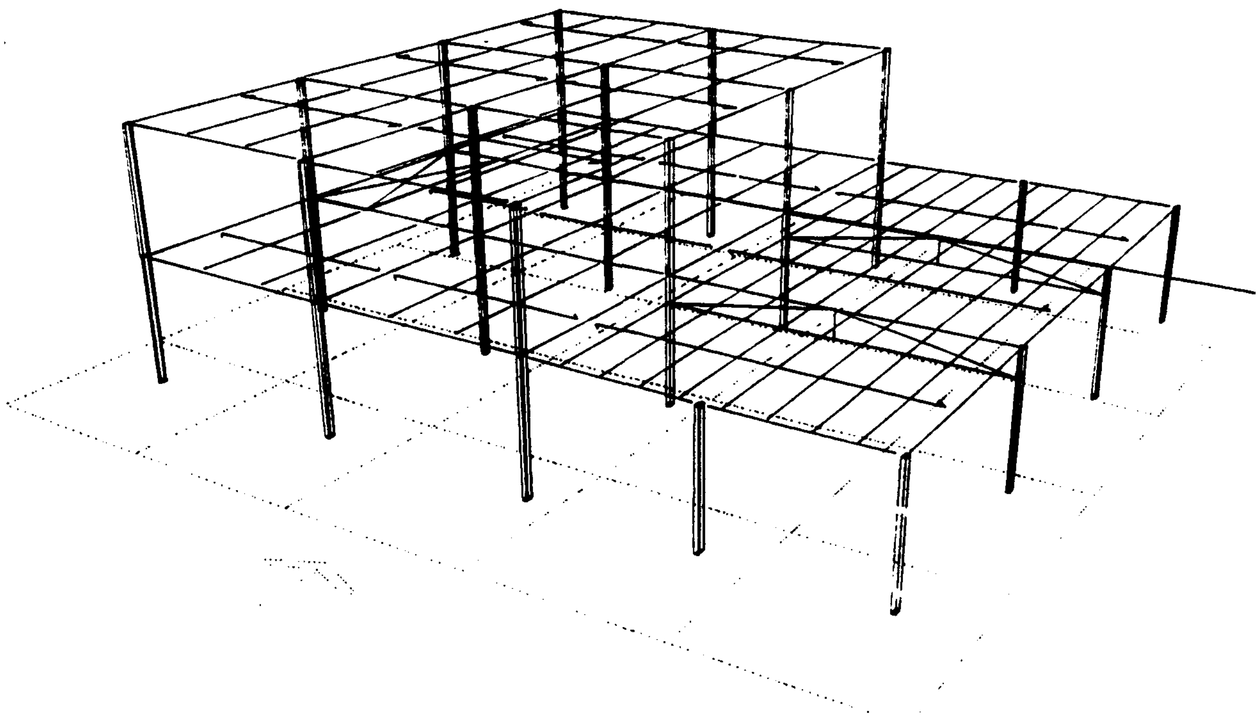
Select Grid Locations D1, E1, E2, E3, D4, E4



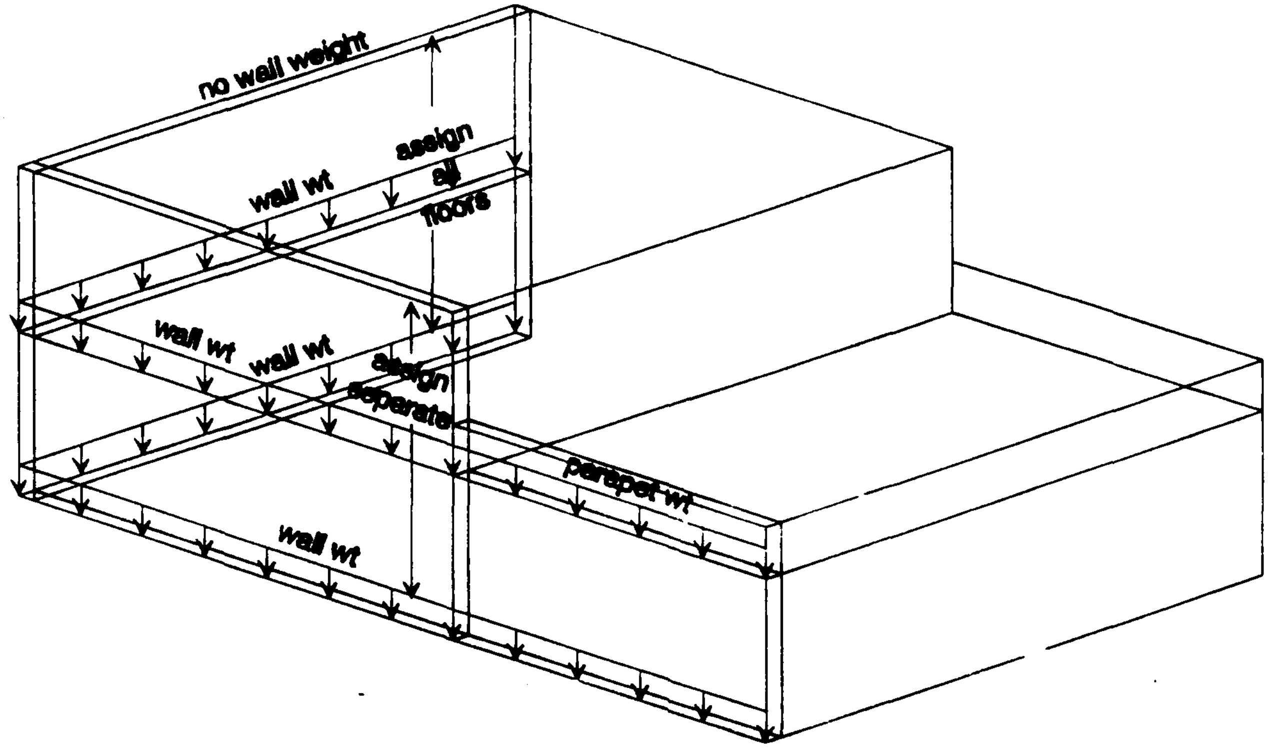

Draw Second Floor/ Lower Roof Framing
Draw Columns
Double Click Right Mouse Key To End Selecting Locations
Save Columns
Orientation: N-S
Height: 14'
All Floors
View Structure
Perspective (3D)
Transparent Object
Show Structure
End

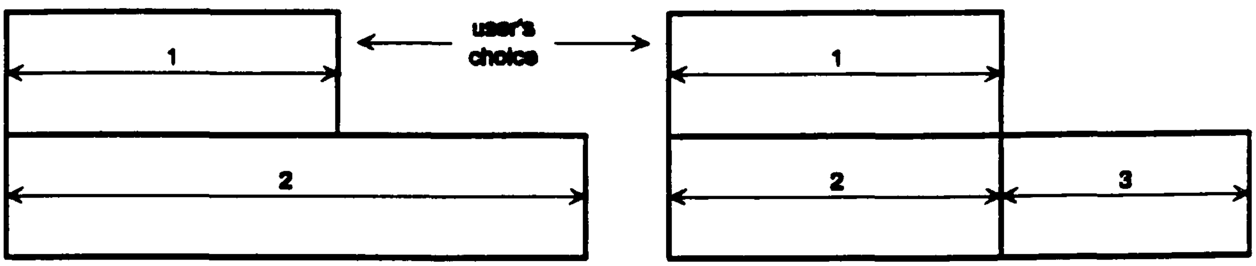

A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof


A
B
C
D
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
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

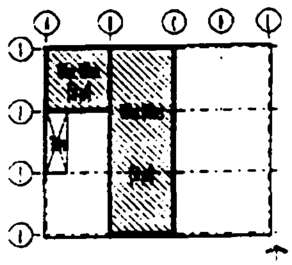
Assign Offices 50 psf

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

F2 Key For Keyboard Input

Assign Offices 50 psf

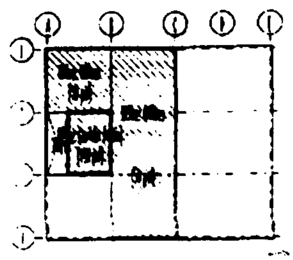
	Horizontal	Vertical
Base Point:	10"	48'10"
Point 2:	24'10"	72'10"
Length:	24'0"	24'0"



Highlight: Corridor (main) 100 psf

Assign Corridor (main) 100 psf

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



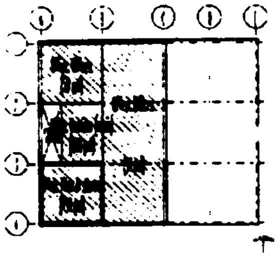
Highlight: Files & Storage 150 psf

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"

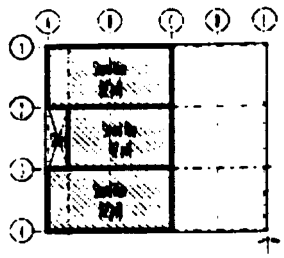
Assign Second Floor Load

	Horizontal	Vertical
Base Point:	8'10"	24'10"
Point 2:	48'10"	48'10"
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)

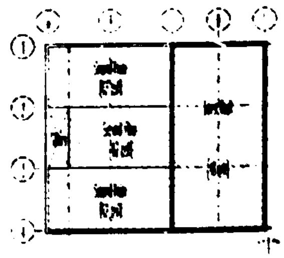


Assign Roof Loads → **Use Roof (DL)**

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

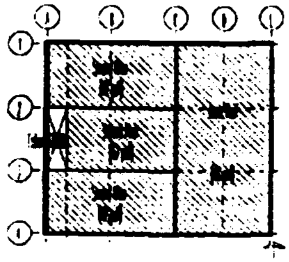
Use Wall (DL)

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



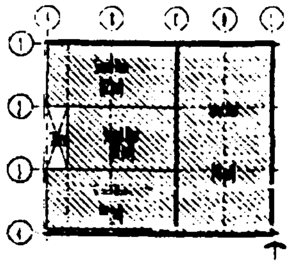
Wall Height

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"



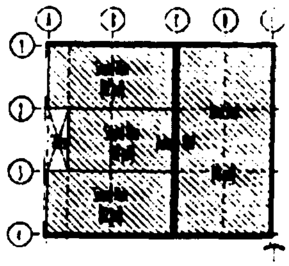
Wall Height

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"



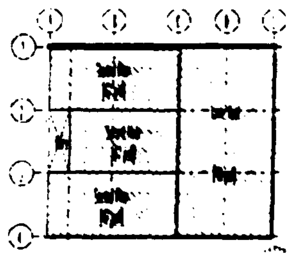
Wall Height

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

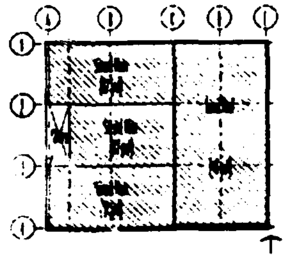
Use Wall (DL)

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

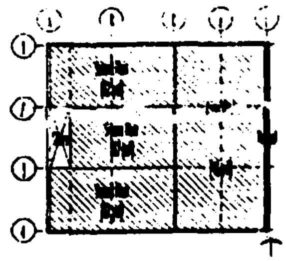


Wall Height
Start: 4'0"
End: 4'0"

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"

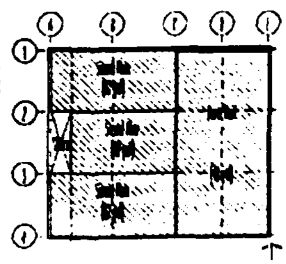


Wall Height
Start: 4'0"
End: 4'0"

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

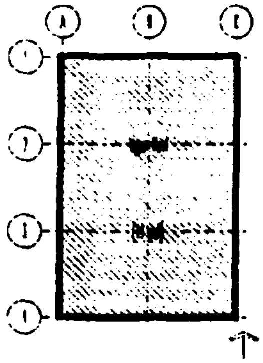
Use Roof (DL)

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

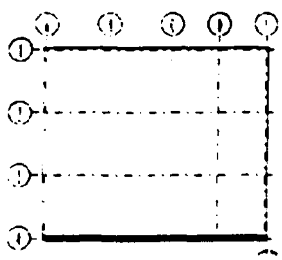
Use Wall (DL)

Assign Exterior Wall Load

☐ Assign All Floors

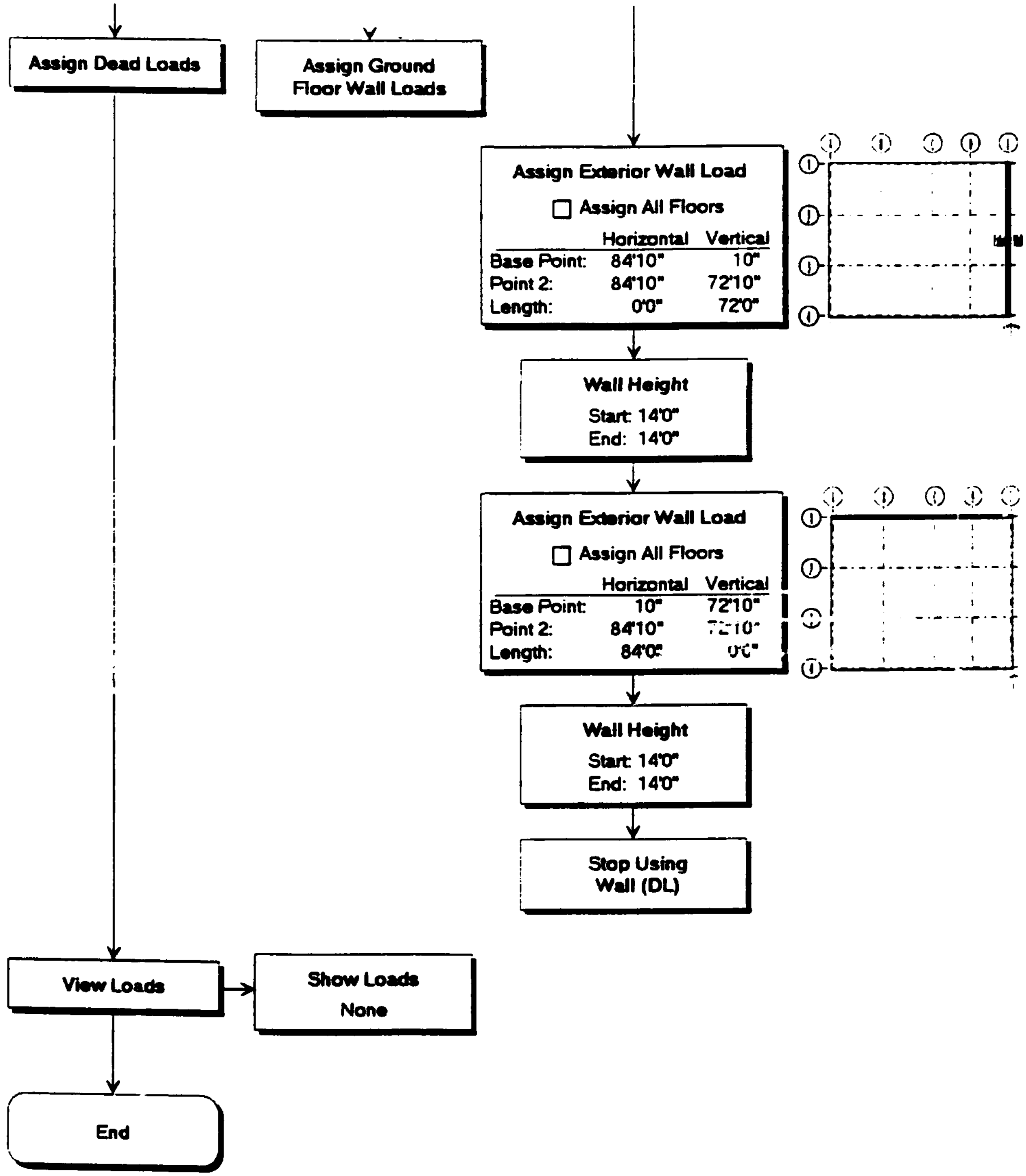
	Horizontal	Vertical
Base Point:	10"	10"
Point 2:	84'10"	10"
Length:	84'0"	0'0"

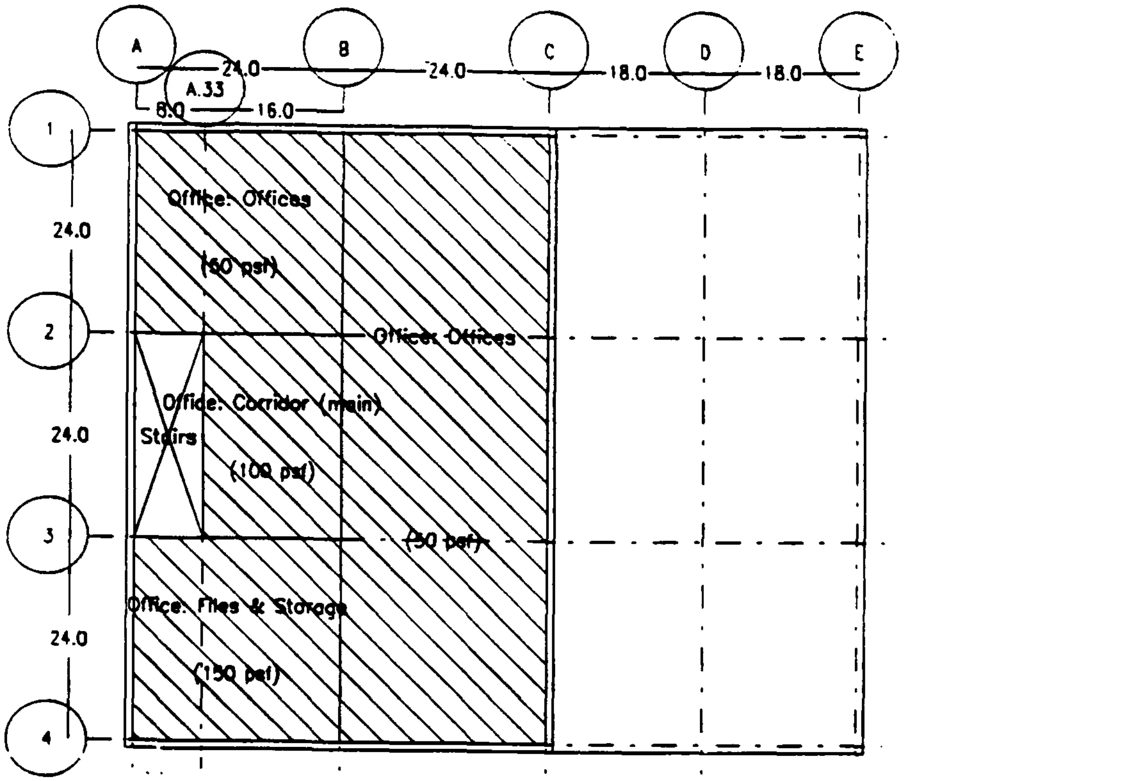
Next Button To View Exterior Wall



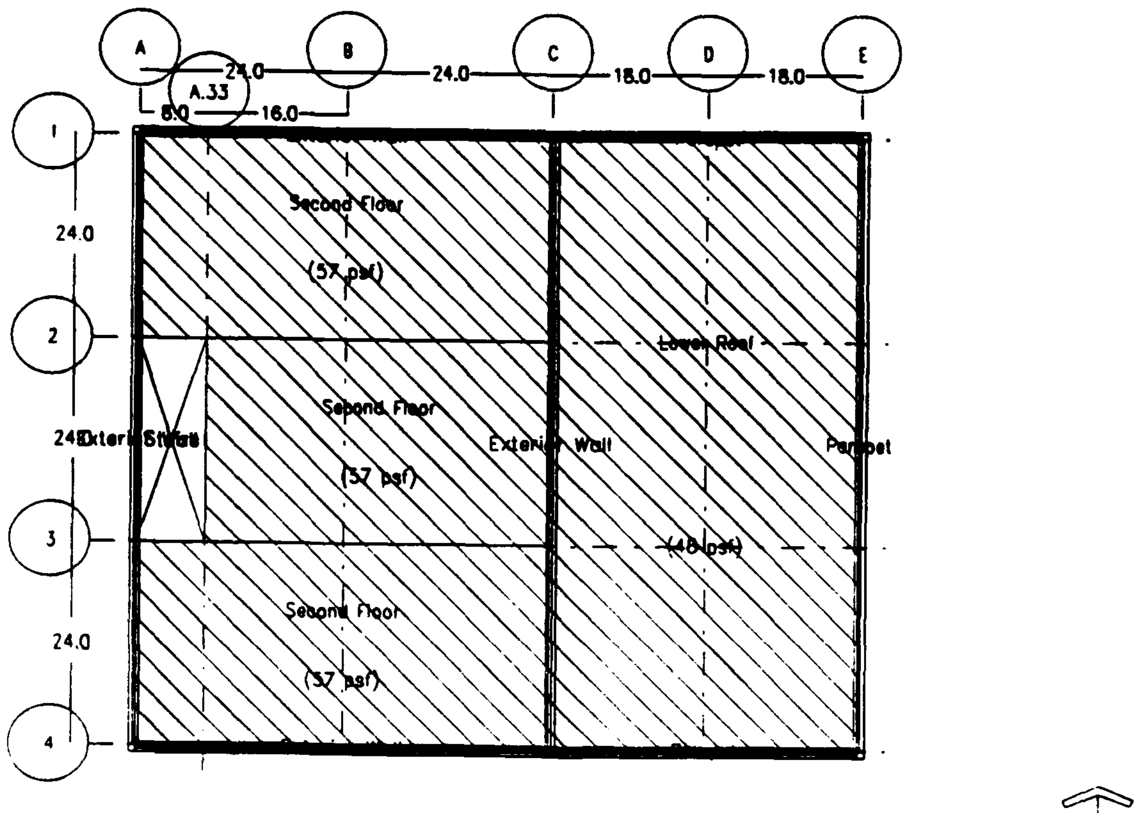
Wall Height

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

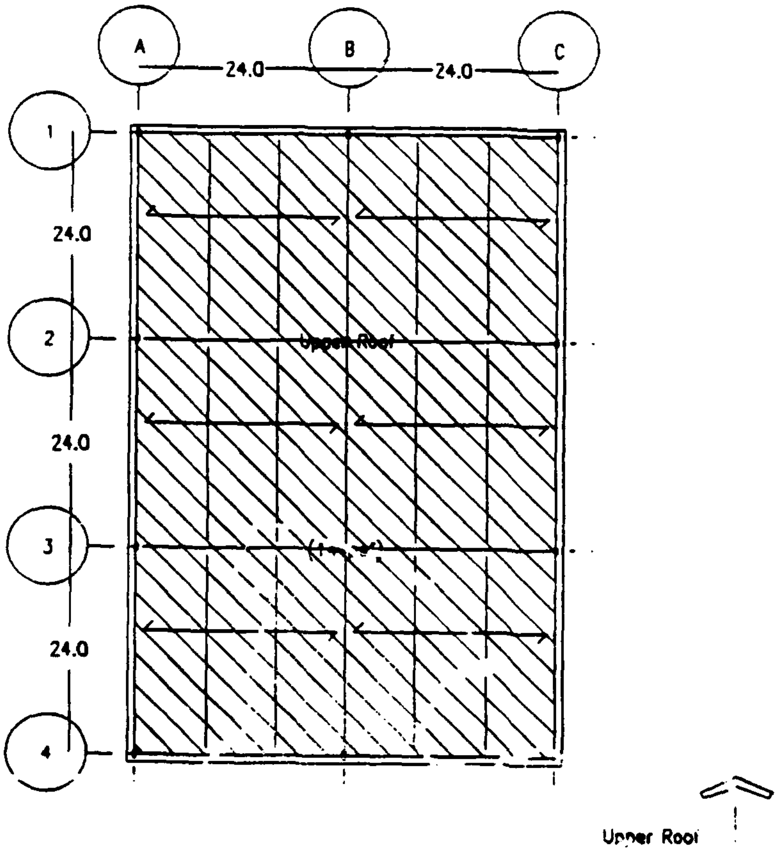

Assign Dead Loads
Assign Ground Floor Wall Loads
Assign Exterior Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 84'10" 10"
Point 2: 84'10" 72'10"
Length: 0'0" 72'0"
Wall Height
Start: 14'0"
End: 14'0"
Assign Exterior Wall Load
Assign All Floors
Horizontal Vertical
Base Point: 10" 72'10"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

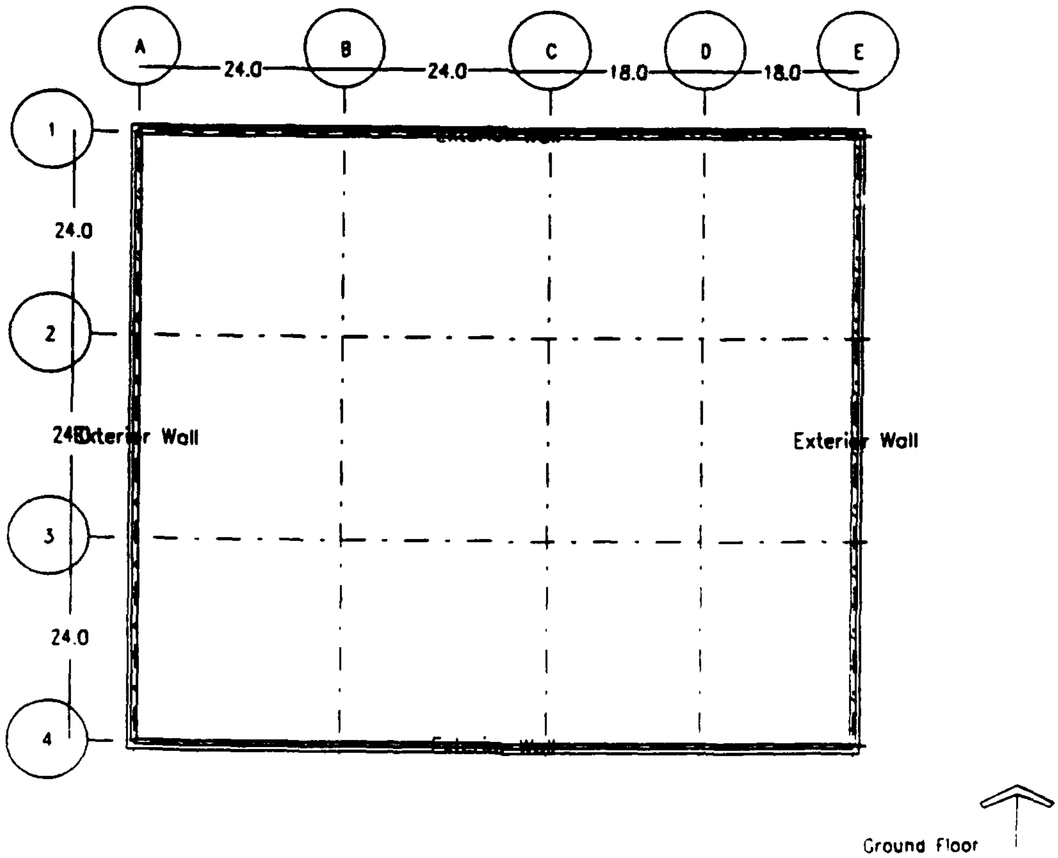


Second Floor/Lower Roof



Second Floor/Lower Roof

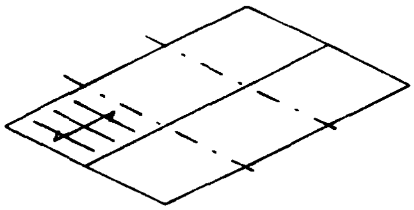

A
B
C
24.0
24.0
1
2
3
4
24.0
24.0
24.0
Upper Roof


A
B
C
D
E
24.0
24.0
18.0
18.0
1
2
3
4
24.0
24.0
24.0
Exterior Wall
Exterior Wall
Exterior Wall
Exterior Wall
Ground Floor

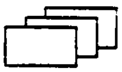
Analysis & Design Philosophy

Preliminary Analysis

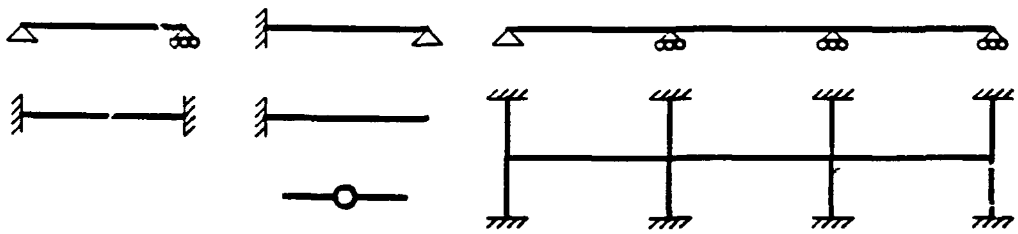
A. Select:
* Material
* Load Combination
  (Live Load Reduction)
* Element To Analyze



B. Review:
* Attributes
* Guidelines



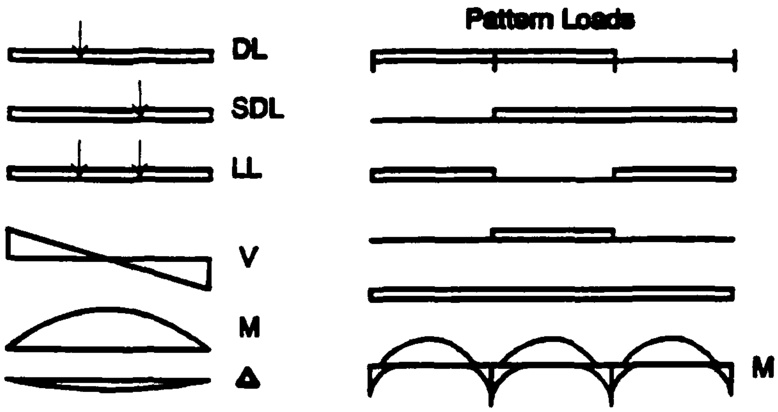
C. Connectivity



D. Self Weight Estimate
* Guidelines

E. Analysis
* Review Loads
* Connectivity

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

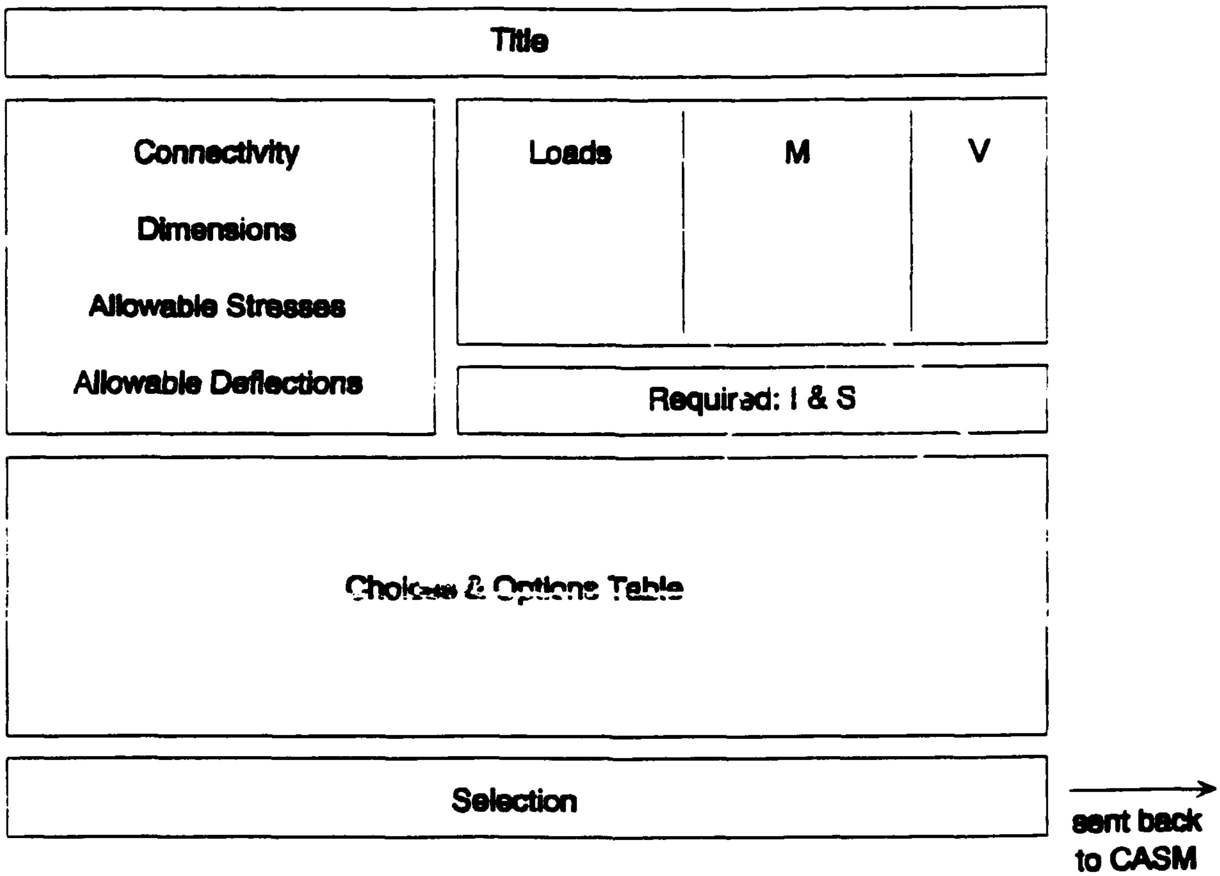


F. Re-Analysis (with real properties)

Preliminary Design

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

Spreadsheets



Surface Element Analysis

Start

Use Loads & Design Tool Palette

Select Upper Roof Horizontal Structural Plane

Material Steel

Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

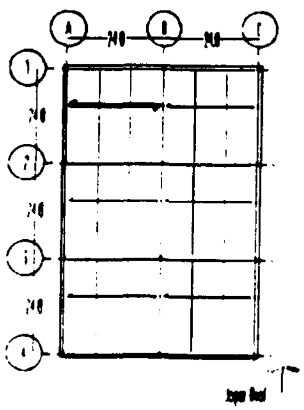
Highlight D+S In List

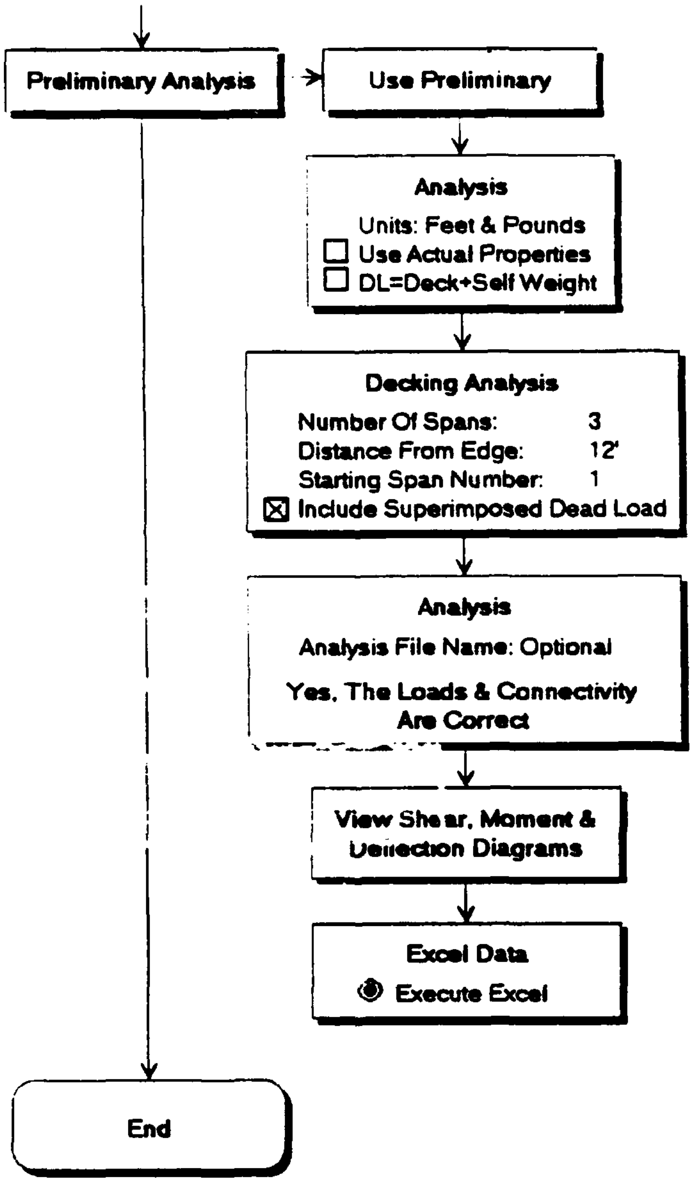
Select Element To Analyze & Design

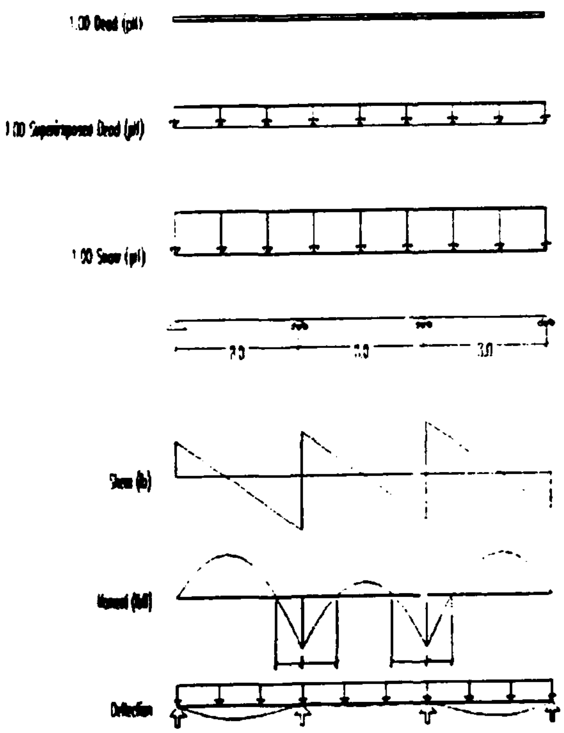
Surface One-Way Roof Deck

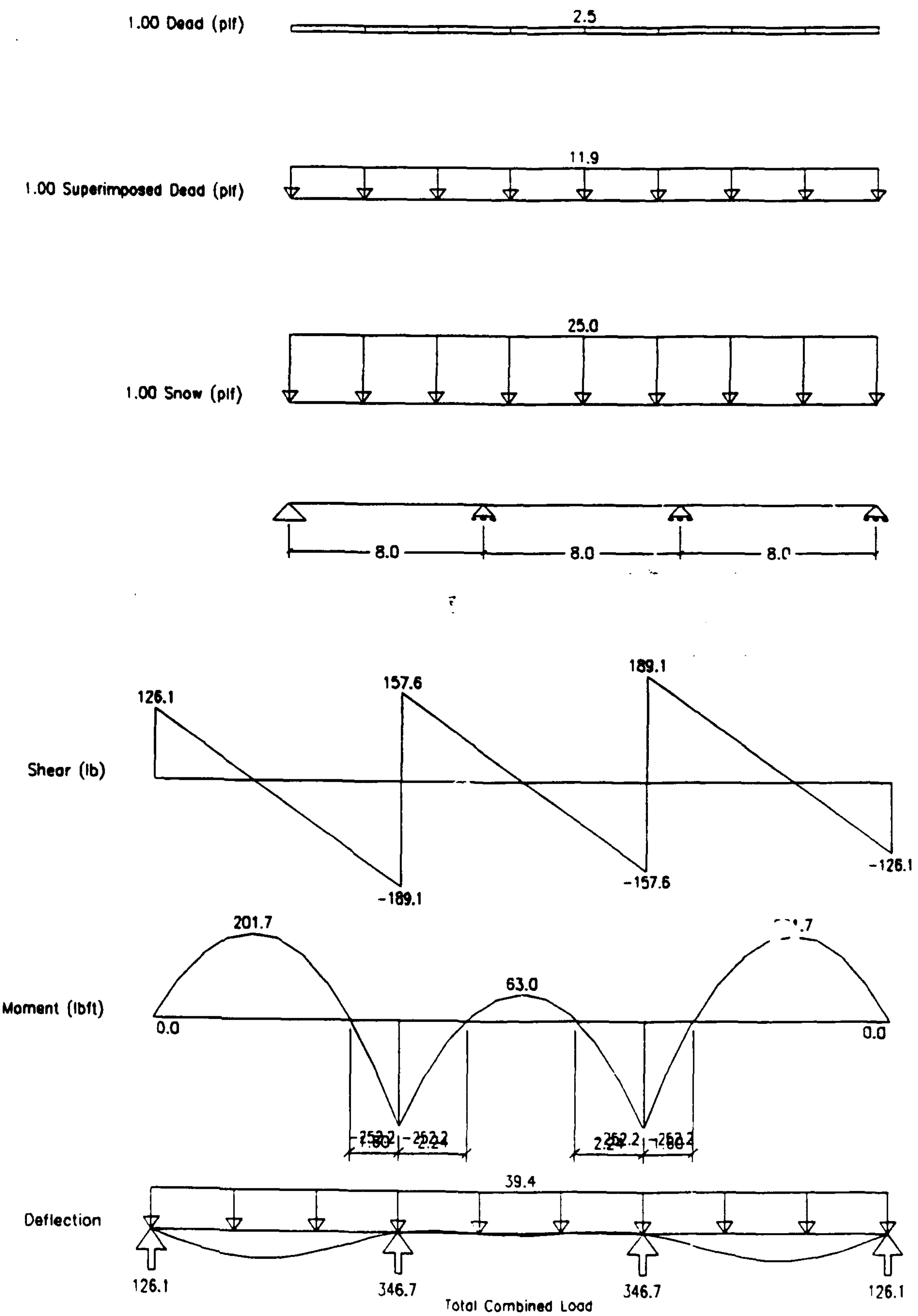
Select A One-Way Surface Element

Review Element Attributes & Guidelines

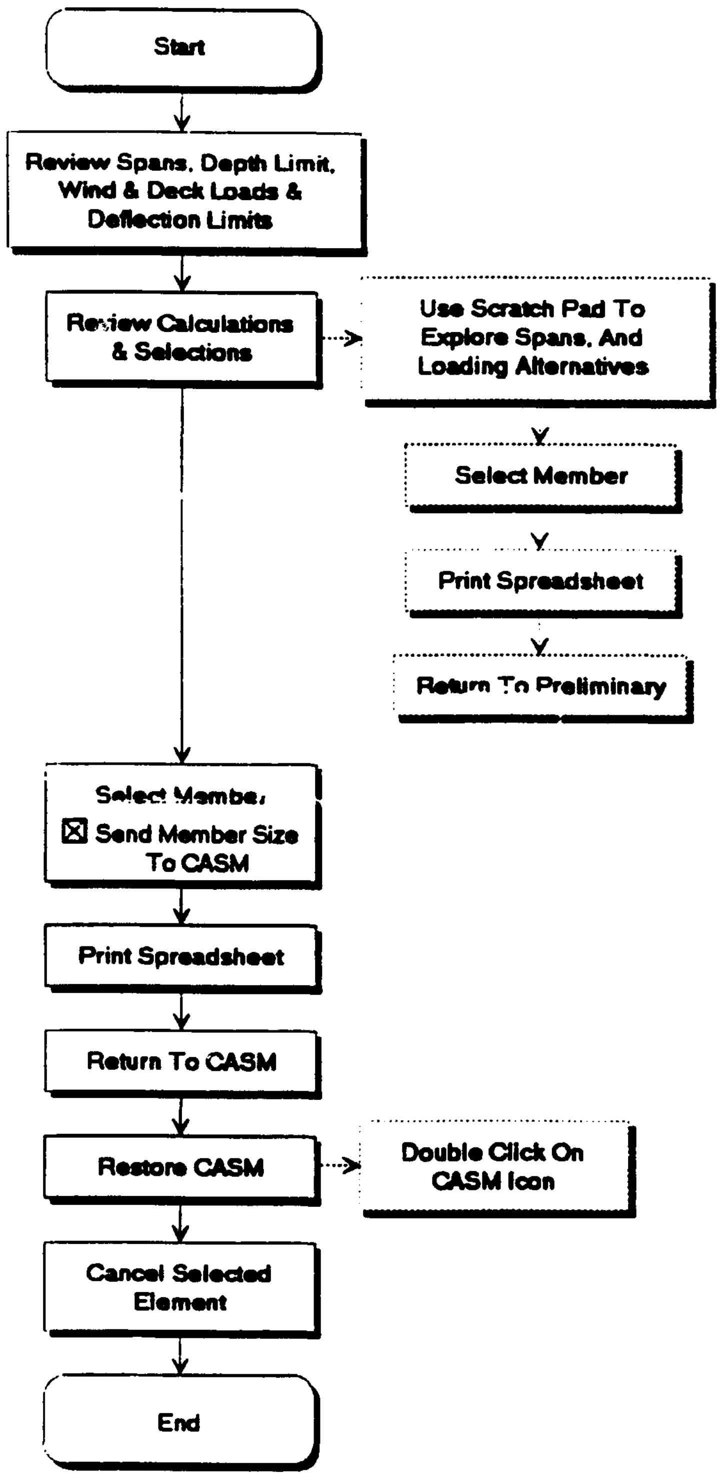



Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Pounds
Use Actual Properties
DL=Deck+Self Weight
Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1
Include Superimposed Dead Load
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End




1.00 Dead (plf)
2.5
11.9
1.00 Superimposed Dead (plf)
25.0
1.00 Snow (plf)
8.0
8.0
Shear (lb)
126.1
157.6
189.1
-189.1
-157.6
-126.1
Moment (lbft)
201.7
63.0
0.0
0.0
Deflection
39.4
126.1
346.7
346.7
126.1
Total Combined Load

Steel Roof Deck Design



Steel Deck Selection

STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme A	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

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Load Combination D + S

Use Load Combination

Set Factors
Dead: 1.0
Snow: 1.0

Add

OK Button To Close Dialog Window

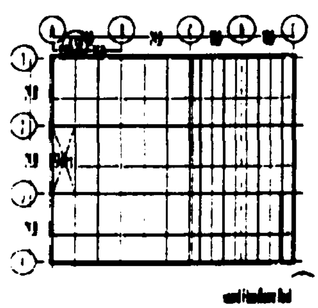
Highlight D+S In List

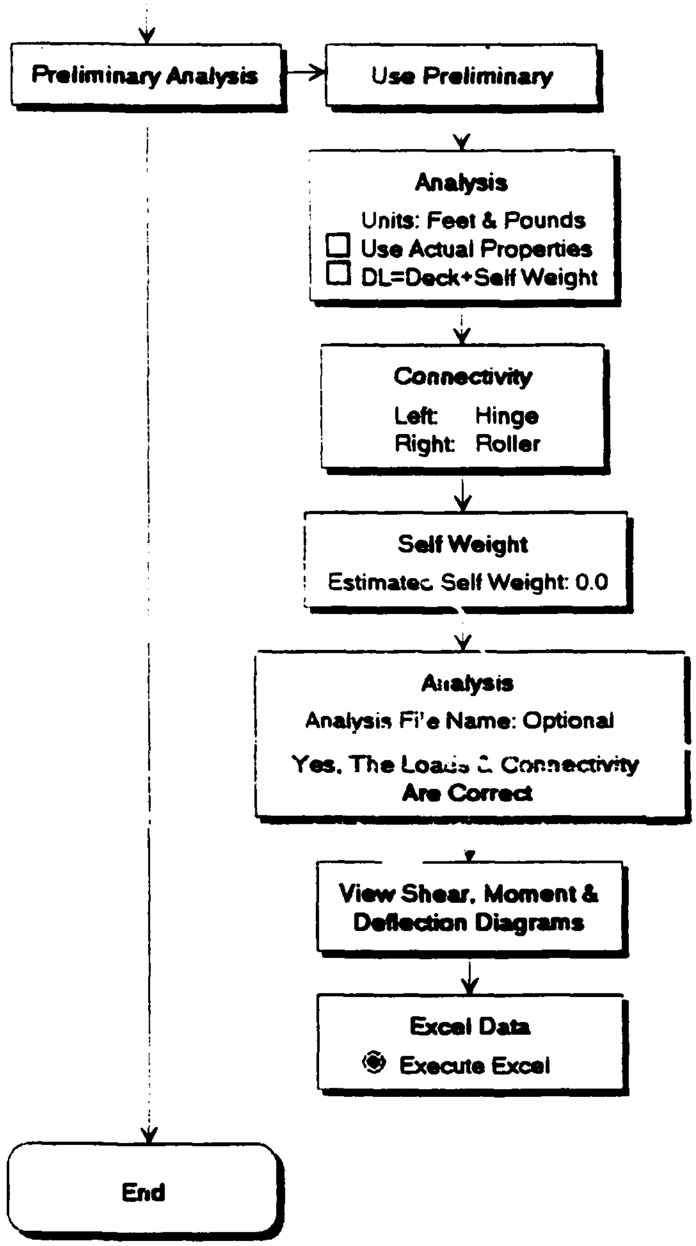
Select Element To Analyze & Design

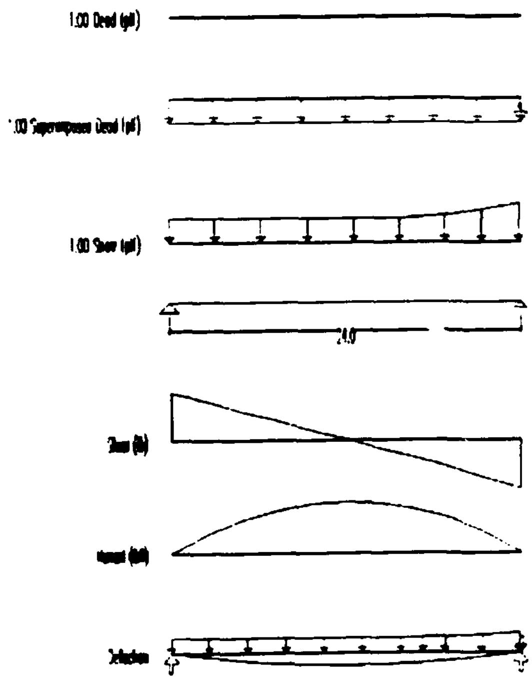
Linear Narrowly Spaced Open-Web Joist-K

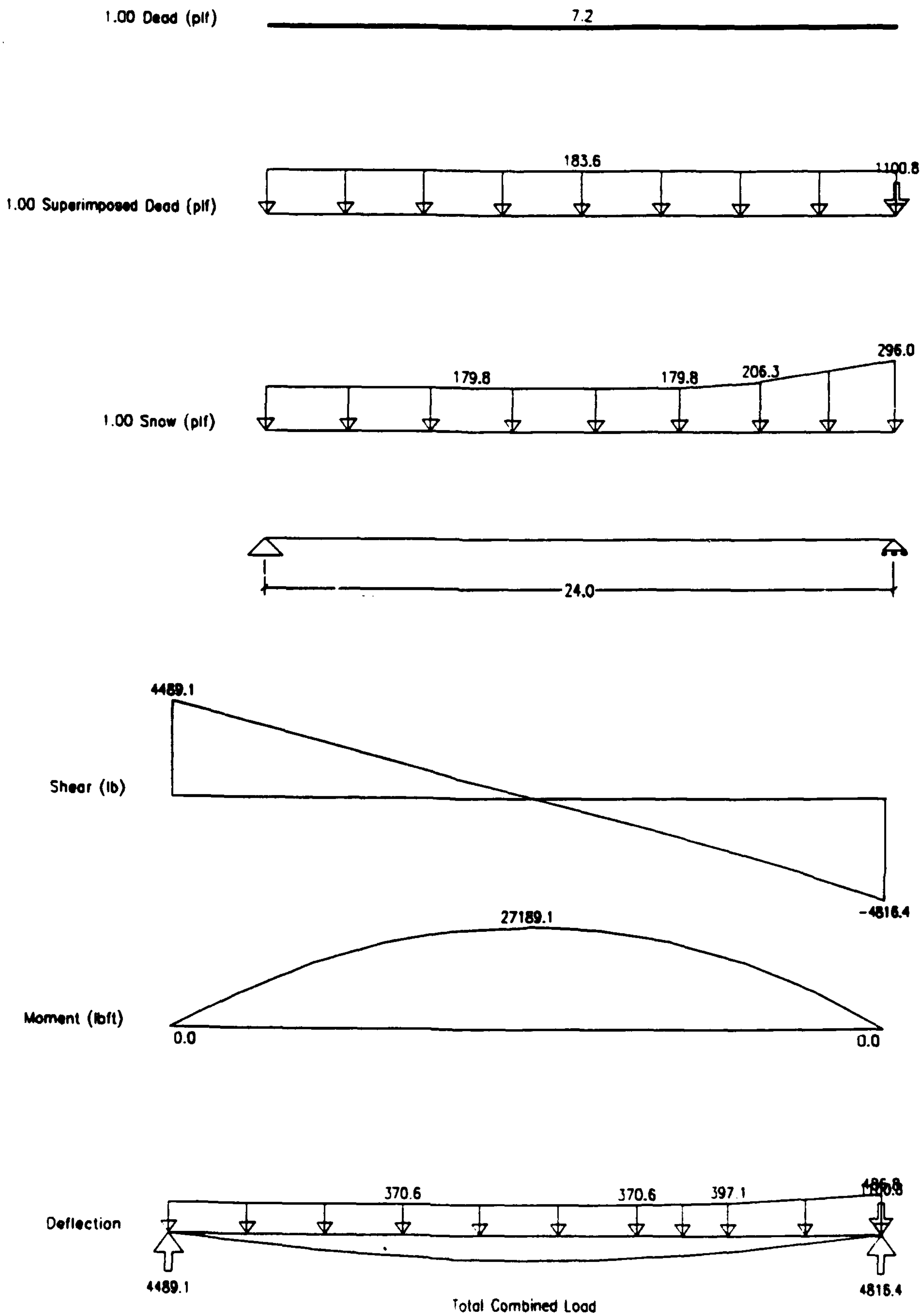
Select A Narrowly Spaced Element Near A Corner

Review Element Attributes & Guidelines




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
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Shear, Moment & Deflection Diagrams
Excel Data
Execute Excel
End




1.00 Dead (plf)
7.2
1.00 Superimposed Dead (plf)
183.6
1100.8
1.00 Snow (plf)
179.8
179.8
206.3
296.0
24.0
Shear (lb)
4489.1
-4816.4
Moment (lbft)
27189.1
0.0
0.0
Deflection
370.6
370.6
397.1
4489.1
4816.4
Total Combined Load

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

2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992 1:10 PM

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

Office Building - Scheme A -- 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	UNIFORM	2.40	-7.20	0.00		2.40

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	8.640	3.456	0.000	8.640	-3.456

JOINT DATA

UNITS: FEET, POUNDS

				BOUNDARY CONDITIONS			
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	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	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

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********************************  O U T P U T  ********************************
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JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-597196.7842
2	0.0000	-16872481.3041	-563753.7643
3	0.0000	-31921840.2654	-472979.8531
4	0.0000	-43703330.4237	-339207.7734
5	0.0000	-51184019.7359	-176770.2401
6	0.0000	-53747710.5762	-0.0000
7	0.0000	-51184019.7359	176770.2401
8	0.0000	-43703330.4237	339207.7734
9	0.0000	-31921840.2654	472979.8531
10	0.0000	-16872481.3041	563753.7643
11	0.0000	0.0000	597196.7842

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	86.400	-0.000	0.000	69.120	186.624
2	0.000	69.120	186.624	0.000	51.840	331.776
3	0.000	51.840	-331.776	0.000	34.560	435.456
4	0.000	34.560	-435.456	0.000	17.280	497.664
5	0.000	[illegible]	[illegible]	0.000	-0.000	518.400
6	0.000	0.000	-518.400	0.000	17.280	497.664
7	0.000	-17.280	-497.664	0.000	34.560	435.456
8	0.000	-34.560	-435.456	0.000	51.840	331.776
9	0.000	-51.840	-331.776	0.000	69.120	186.624
10	0.000	-69.120	-186.624	0.000	86.400	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	86.400	-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	86.400	0.000

PROBLEM COMPLETED

```
*****************************************
* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *
*****************************************
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2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1992 1:10 PM

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

Office Building - Scheme A -- 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     POISSON'S
           MODULUS       RATIO
--------------------------------
   1        1.0000      0.0000


MEMBER PROPERTIES
-----------------
UNITS: INCHES

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


SUMMARY OF IN-SPAN LOADS
------------------------
POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD  LOAD      SPAN   STARTING   STARTING    ENDING     ENDING
 SET  TYPE    LENGTH  MAGNITUDE   POSITION  MAGNITUDE.  POSITION
-----------------------------------------------------------------
  1  UNIFRM     2.40    -183.60      0.00                   2.40


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     220.320     88.128     0.000     220.320    -88.128


JOINT DATA
----------
UNITS: FEET, POUNDS

                                        BOUNDARY CONDITIONS
               NODAL COORDINATES   NODAL FORCES AND MOMENTS    ELASTIC
NODE CODE        X         Y          X         Y         Z   SUPPORT TYPE
--------------------------------------------------------------------------
  1   110      13.00      0.00      0.00      0.00      0.00      0
  2     0      15.40      0.00      0.00      0.00      0.00      0
  3     0      17.80      0.00      0.00      0.00      0.00      0
  4     0      20.20      0.00      0.00      0.00      0.00      0
  5     0      22.60      0.00      0.00      0.00      0.00      0
  6     0      25.00      0.00      0.00      0.00      0.00      0
  7     0      27.40      0.00      0.00      0.00      0.00      0
  8     0      29.80      0.00      0.00      0.00      0.00      0
  9     0      32.20      0.00      0.00      0.00      0.00      0
 10     0      34.60      0.00      0.00      0.00      0.00      0
 11    10      37.00      0.00      0.00      0.00      0.00      0


MEMBER DATA
-----------

ELE  NODE  NODE  MAT  ELE  ELE   F.E.F.     REL      STIFF   CARRY OVER
      I     J   TYPE TYPE  CODE   TYPE      KIJ       KJI      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         -13220516.6600
  2            0.0000      -430240282.2500        -14375721.6235
  3            0.0000      -814006902.7874        -12060906.7858
  4            0.0000     -1116428179.0004         -8640790.6000
  5            0.0000     -1308210000.0929         -4507641.3200
  6            0.0000     -1370560600.2001               -0.0000
  7            0.0000     -1308210000.0929          4507641.3200
  8            0.0000     -1116428179.0004          8640790.6000
  9            0.0000      -814006902.7874         12060906.7858
 10            0.0000      -430240282.2500         14375721.6235
 11            0.0000              0.0000          13220516.6600


MEMBER END FORCES
-----------------
UNITS: FEET, POUNDS

ELE    AXIAL I     SHEAR I    MOMENT I    AXIAL J     SHEAR J    MOMENT J
--------------------------------------------------------------------------
 1      0.000     2203.200       0.000      0.000   -1762.560    4758.912
 2      0.000     1762.560   -4758.912      0.000   -1321.920    8460.288
 3      0.000     1321.920   -8460.288      0.000    -881.280   11104.128
 4      0.000      881.280  -11104.128      0.000    -440.640   12690.432
 5      0.000      440.640  -12690.432      0.000       0.000   13219.201
 6      0.000       -0.000  -13219.201      0.000     440.640   12690.432
 7      0.000     -440.640  -12690.432      0.000     881.280   11104.128
 8      0.000     -881.280  -11104.128      0.000    1321.920    8460.288
 9      0.000    -1321.920   -8460.288      0.000    1762.560    4758.912
10      0.000    -1762.560   -4758.912      0.000    2203.200      -0.000


APPLIED JOINT LOADS AND SUPPORT REACTIONS
-----------------------------------------
UNITS: FEET, POUNDS

NODE       FORCE X          FORCE Y          MOMENT Z
-----------------------------------------------------
  1         0.000          2203.200            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          2203.200           -0.000


**PROBLEM COMPLETED**


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


2-D FRAME ANALYSIS-V 6/77 BMH-Sun Jan 26, 1992  1:10 PM


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


Office Building - Scheme A -- 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  =    3


MATERIAL TYPES
--------------
UNITS: INCHES, POUNDS

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


MEMBER PROPERTIES
-----------------
UNITS: INCHES

ELEMENT        AXIAL          SHEAR       MOMENT OF
 TYPE          AREA           AREA         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	2.40	-179.76	0.00		2.40
2	UNIFRM	2.40	-179.76	0.00		1.32
2	RAMP	2.40	-179.76	1.32	-189.06	2.40
3	RAMP	2.40	-189.06	0.00	-206.35	2.00
3	RAMP	2.40	-206.35	2.00	-213.18	2.40
4	RAMP	2.40	-213.18	0.00	-254.39	2.40
5	RAMP	2.40	-254.39	0.00	-296.00	2.40

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	215.713	86.285	0.000	215.713	-86.285
2	0.000	216.128	86.381	0.000	220.311	-87.387
3	0.000	234.236	94.731	0.000	244.933	-96.788
4	0.000	270.727	110.278	0.000	290.603	-114.254
5	0.000	320.417	130.184	0.000	340.293	-134.138

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	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
[illegible]	0	[illegible]	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	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	2	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	4	4.00	4.00	0.50
10	10	11	1	1	0	5	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	-15477674.9686
2	0.0000	-437429473.1567	-14028130.2757
3	0.0000	-820320035.9028	-12300057.6766
4	0.0000	-1135615012.7337	-8870299.3904
5	0.0000	-1338510783.5772	-4699097.6362
6	0.0000	-1402544784.5933	-128094.6333
7	0.0000	-1339351507.7742	4470667.3991
8	0.0000	-1147071481.9354	8702670.3217
9	0.0000	-841413597.1693	12350723.8440
10	0.0000	-446233743.7972	14866520.1648
11	0.0000	0.0000	15019665.5358

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	2199.320	0.000	0.000	-1760.094	4761.137
2	0.000	1760.094	-4761.137	0.000	-1336.660	8486.852
3	0.000	1336.660	-8486.852	0.000	-905.241	11177.143
4	0.000	905.241	-11177.143	0.000	-473.815	12832.011
5	0.000	473.815	-12832.011	0.000	-42.389	13451.456
6	0.000	42.389	-13451.456	0.000	389.037	13035.477
7	0.000	-389.037	-13035.477	0.000	825.477	11582.273
8	0.000	-825.477	-11582.273	0.000	1304.746	9036.668
9	0.000	-1304.746	-9036.668	0.000	1866.876	5251.558
10	0.000	-1866.876	-5251.558	0.000	2526.785	-0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	2199.320	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	2526.785	-0.000

PROBLEM COMPLETED

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

2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26 1992 1:10 PM

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

Office Building - Scheme A -- Total Combined 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	=	5

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	2.40	-370.56	0.00		2.40
2	UNIFRM	2.40	-190.00	0.00		2.40
2	UNIFRM	2.40	-179.76	0.00		1.32
2	RAMP	2.40	-179.76	1.32	-189.06	2.40
3	UNIFRM	2.40	-190.00	0.00		2.40
3	RAMP	2.40	-189.06	0.00	-206.35	2.00
3	RAMP	2.40	-206.35	2.00	-213.18	2.40
4	UNIFRM	2.40	-190.00	0.00		2.40
4	RAMP	2.40	-213.18	0.00	-254.59	2.40
5	UNIFRM	2.40	-190.00	0.00		2.40
5	RAMP	2.40	-254.59	0.00	-296.00	2.40

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	444.673	177.869	0.000	444.673	-177.869
2	0.000	445.000	176.165	0.000	449.271	-178.971
3	0.000	463.296	186.315	0.000	473.093	-188.372
4	0.000	499.087	201.062	0.000	519.563	-205.030
5	0.000	549.377	221.730	0.000	569.253	-225.714

JOINT DATA

UNITS: FEET, POUNDS

		BOUNDARY CONDITIONS					
		NODAL COORDINATES		NODAL FORCES AND MOMENTS			ELASTIC
NODE	CODE	X	Y	X	Y	Z	SUPPORT TYPE
1	110	13.00	0.00	0.00	0.00	0.00	0
2	0	15.40	0.00	0.00	0.00	0.00	0
3	0	17.80	0.00	0.00	0.00	0.00	0
4	0	20.20	0.00	0.00	0.00	0.00	0
5	0	22.60	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	27.40	0.00	0.00	0.00	0.00	0
8	0	29.80	0.00	0.00	0.00	0.00	0
9	0	32.20	0.00	0.00	0.00	0.00	0
10	0	34.60	0.00	0.00	0.00	0.00	0
11	10	37.00	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	2	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	4	4.00	4.00	0.50
10	10	11	1	1	0	5	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	[illegible]
2	0.0000	[illegible]	[illegible]
3	0.0000	[illegible]	[illegible]
4	0.0000	[illegible]	[illegible]
5	0.0000	[illegible]	[illegible]
6	0.0000	[illegible]	[illegible]
7	0.0000	[illegible]	[illegible]
8	0.0000	[illegible]	[illegible]
9	0.0000	[illegible]	[illegible]
10	0.0000	[illegible]	[illegible]
11	0.0000	0.0000	[illegible]

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	4409.120	0.000	0.000	-3599.774	9706.674
2	0.000	3599.774	-9706.674	0.000	-2710.420	17270.916
3	0.000	2710.420	-17270.916	0.000	-1821.081	22716.727
4	0.000	1821.081	-22716.727	0.000	-931.735	26020.107
5	0.000	931.735	-26020.107	0.000	-42.389	27109.055
6	0.000	42.389	-27109.055	0.000	840.987	26223.574
7	0.000	-840.987	-26223.574	0.000	1741.317	23121.659
8	0.000	-1741.317	-23121.659	0.000	2670.806	17020.732
9	0.000	-2670.806	-17020.732	0.000	3697.756	10197.094
10	0.000	-3697.756	-10197.094	0.000	4816.386	0.000

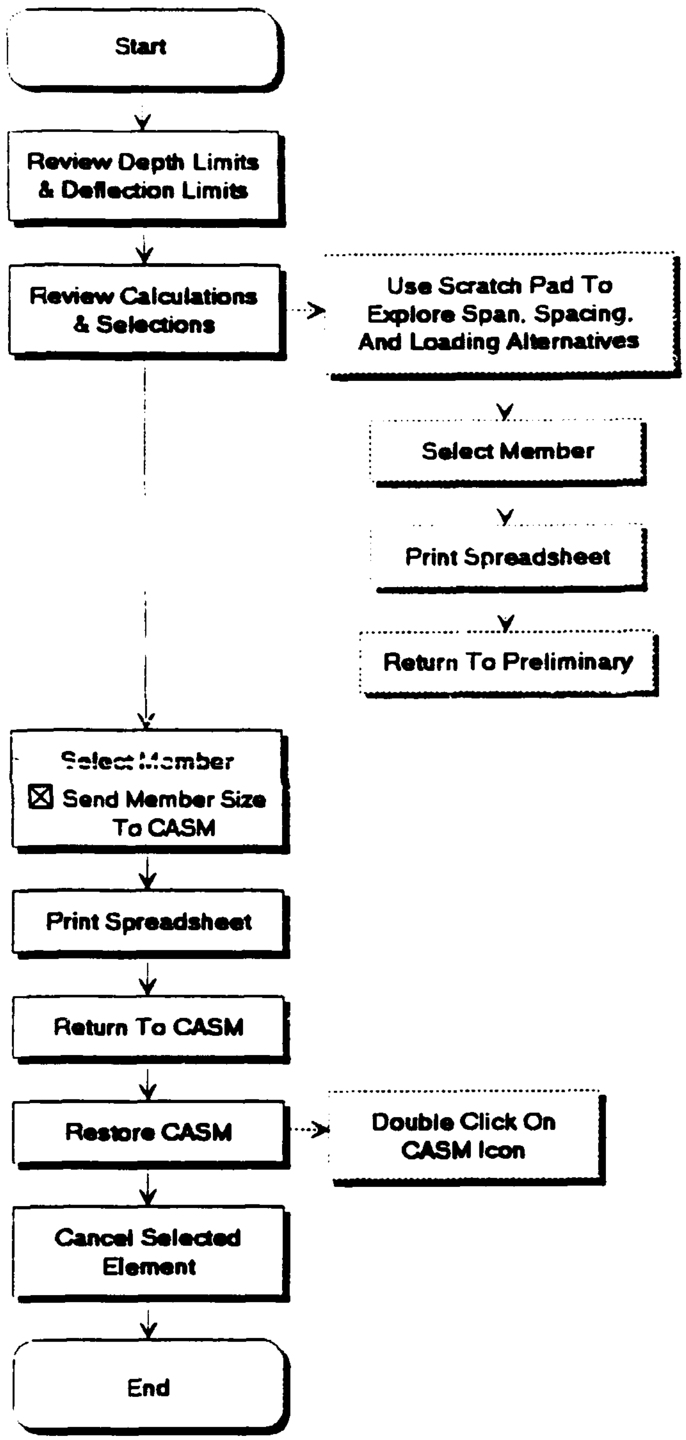
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	4409.120	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	4816.386	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



Barjoist Selection

STEEL BAR JOIST PRELIMINARY SELECTION

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

CASM Load & Analysis Data:

Method: Analysis

Member ID:

Connection: Hinge (Left) Roller (Right)

Span: 24.0 ft

Spacing: 48.0 in

Depth Limit= 24.0 in. max

Fy= 36.0 ksi

Fb= 24.0 ksi

E = 29,000 ksi

Live Defl= L/360= 0.80 in

Total Defl= L/240= 1.20 in

Load Combination: D + S

	Factored Moment (ft-lb)			Factored Reaction	
LoadType	Left	Mid	Right	Left(lb)	Right(lb)
Dead		518		86	86
Sup Dead		13,219		2,203	2,203
Live					
Lmin Roof					
Snow		13,451		2,200	2,527
Wind					
Summary		27,189		4,489	4,816

Moment: (EUL)		Reaction: (EUL)	
Total Ld=	378 plf	Total Ld=	401 plf
Live Ld=	187 plf	Live Ld=	211 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)
20K4	48.0	430	353	30,960	5,160	0.48	0.92	1.9	7.6
18K5	48.0	434	318	31,248	5,208	0.54	1.03	1.9	7.7
22K4	48.0	475	431	34,200	5,700	0.40	0.76	2.0	8.0
16K6	48.0	418	269	30,096	5,016	0.63	1.21	2.0	8.1

CASM Bar Joist Selection:

Joist Size:	20K4	Span:	24.0 ft	Spacing:	48 in	Total Ld:	430 plf	Live Ld:	353 plf
Wgt(tons):	0.09	Mmax:	30,960	Rmax:	5,160	TL defl:	0.92 in	LL defl:	0.48 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

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Load Combination D + L

Use Load Combination

Set Factors

Dead: 1.0

Live: 1.0

Add

OK Button To Close Dialog Window

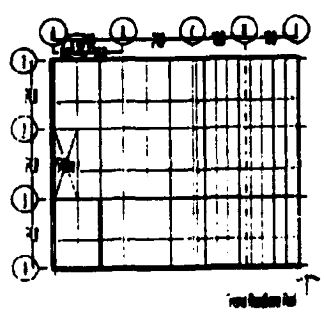
Highlight D+L In List

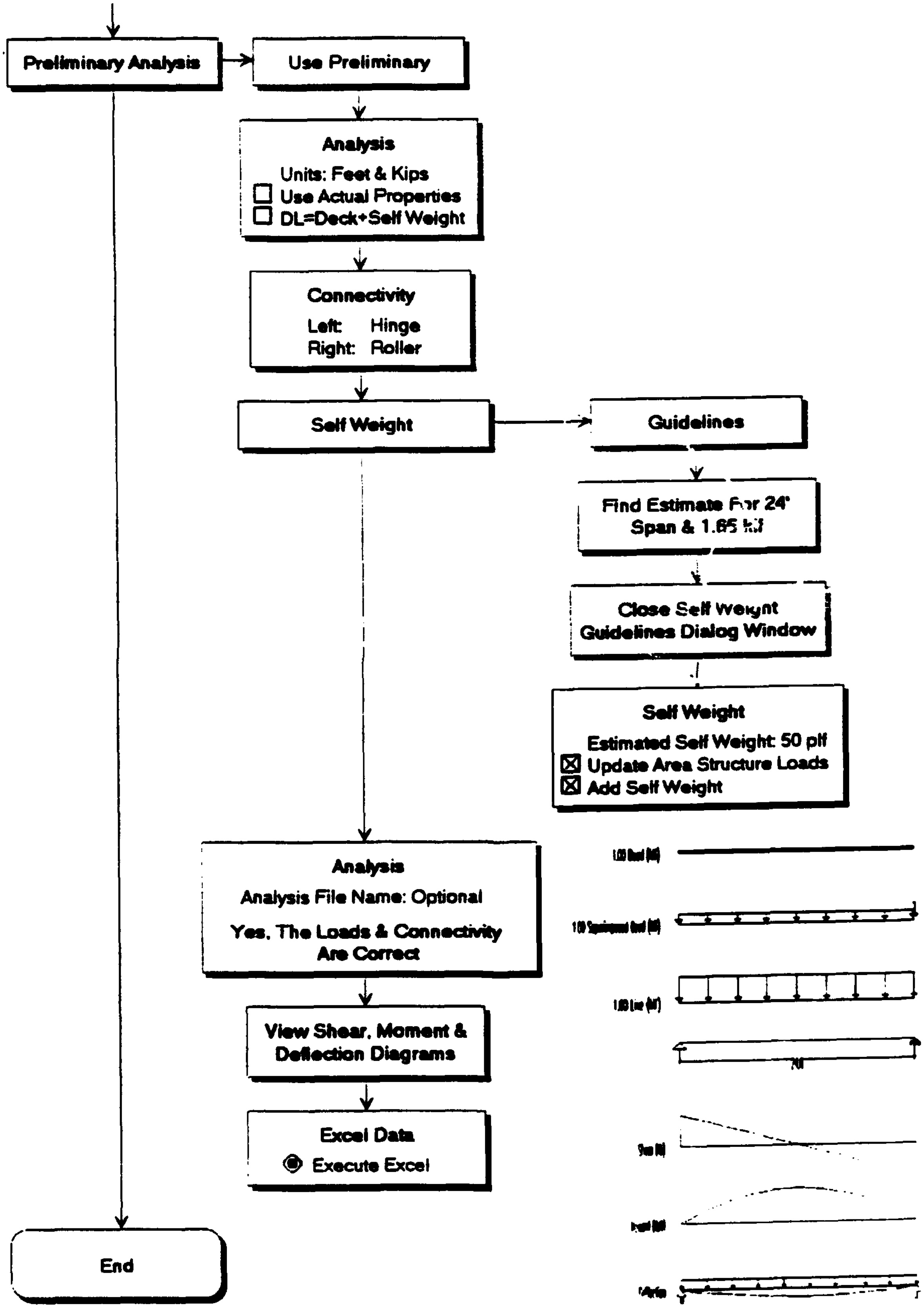
Select Element To Analyze & Design

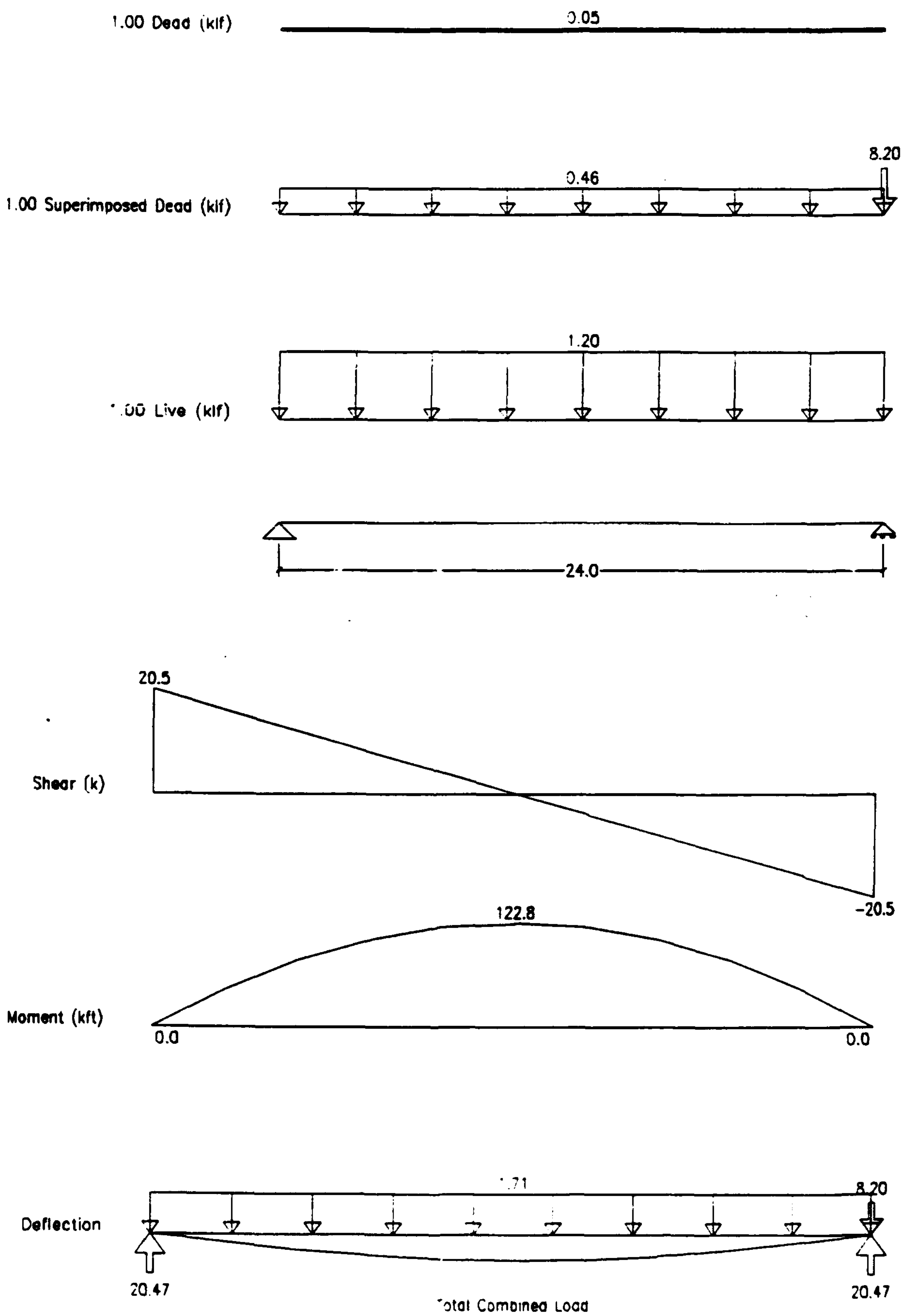
Linear Widely Spaced Rolled Section

Select A Widely Spaced Element In Bay A3-B4

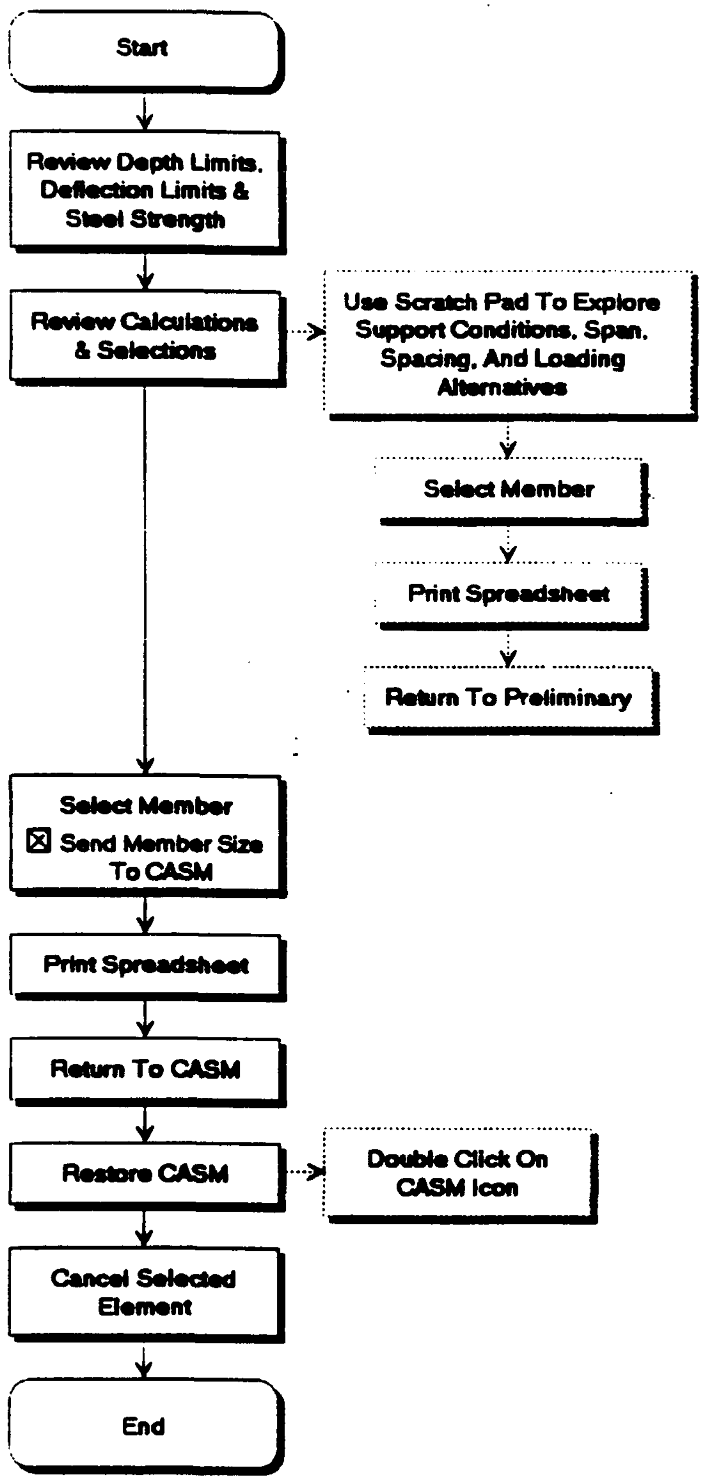
Review Element Attributes & Guidelines




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 & 1.65
Close Self Weight
Guidelines Dialog Window
Self Weight
Estimated Self Weight: 50 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)
0.05
8.20
0.46
1.00 Superimposed Dead (klf)
1.20
.00 Live (klf)
24.0
20.5
Shear (k)
-20.5
122.8
Moment (kft)
0.0
0.0
.71
8.20
Deflection
20.47
20.47
otal Combined Load

Steel Beam Design



Steel Beam Selection

STEEL BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme A Location: Radford AAP	Date: Feb 26, 1992 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=.66*Fy= 24.0 ksi
Fv= 14.4 ksi
E = 29,000 ksi
Live Ld Defl= L/360 =0.80 in
Total Defl= L/240 =1.20 in

Load Combination: D + L

	Factored Moments (k-ft)			Fact. Reactions	
Load Type	Left	Mid	Right	Left(k)	Right(k)
Dead		3.6		0.6	0.6
Sup Dead		32.8		5.5	5.5
Live		86.4		14.4	14.4
Lmin Roof					
Snow					
Wind					
Summary		122.8		20.5	20.5

Max: M= 122.8 k-ft	R= 20.5 kips
Sx(req)= 61.4 in^3	Ix(req)= 386.1 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 14 x 43	13.7	8.00	428	63	-0.72	-1.03	4.9	23.5	1,032
W 12 x 50	12.2	8.08	394	65	-0.78	-1.11	4.5	22.8	1,200
W 16 x 40	16.0	7.00	518	65	-0.60	-0.85	4.2	22.8	960
W 18 x 40	17.9	6.02	612	68	-0.50	-0.72	3.6	21.5	960
W 14 x 48	13.8	8.03	485	70	-0.64	-0.91	4.4	21.0	1,152

CASM Steel Beam Selection:

				Live / Total
W 16 x 40	Span= 24.0 ft	Ix= 518	Sx= 65	Defl(in): -0.60 -0.85
		fv= 4.2	fb= 3.8	Beam Wt(tons)= 0.48

Notes:

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

Widely Spaced Element Analysis: Girder

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Load Combination D + L

Use Load Combination

Set Factors
Dead: 1.0
Live: 1.0

Add

OK Button To Close Dialog Window

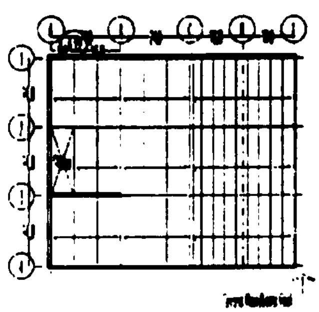
Highlight D+L In List

Select Element To Analyze & Design

Linear Widely Spaced Rolled Section

Select Widely Spaced Element A3-B3

Review Element Attributes & Guidelines



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: 73 plf
☐ Update Area Structure Loads
☒ Add Self Weight

Analysis

Analysis File Name: Optional

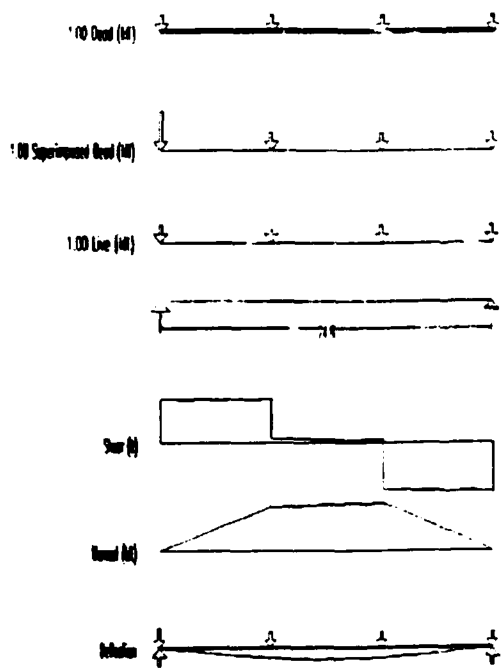
Yes, The Loads & Connectivity Are Correct

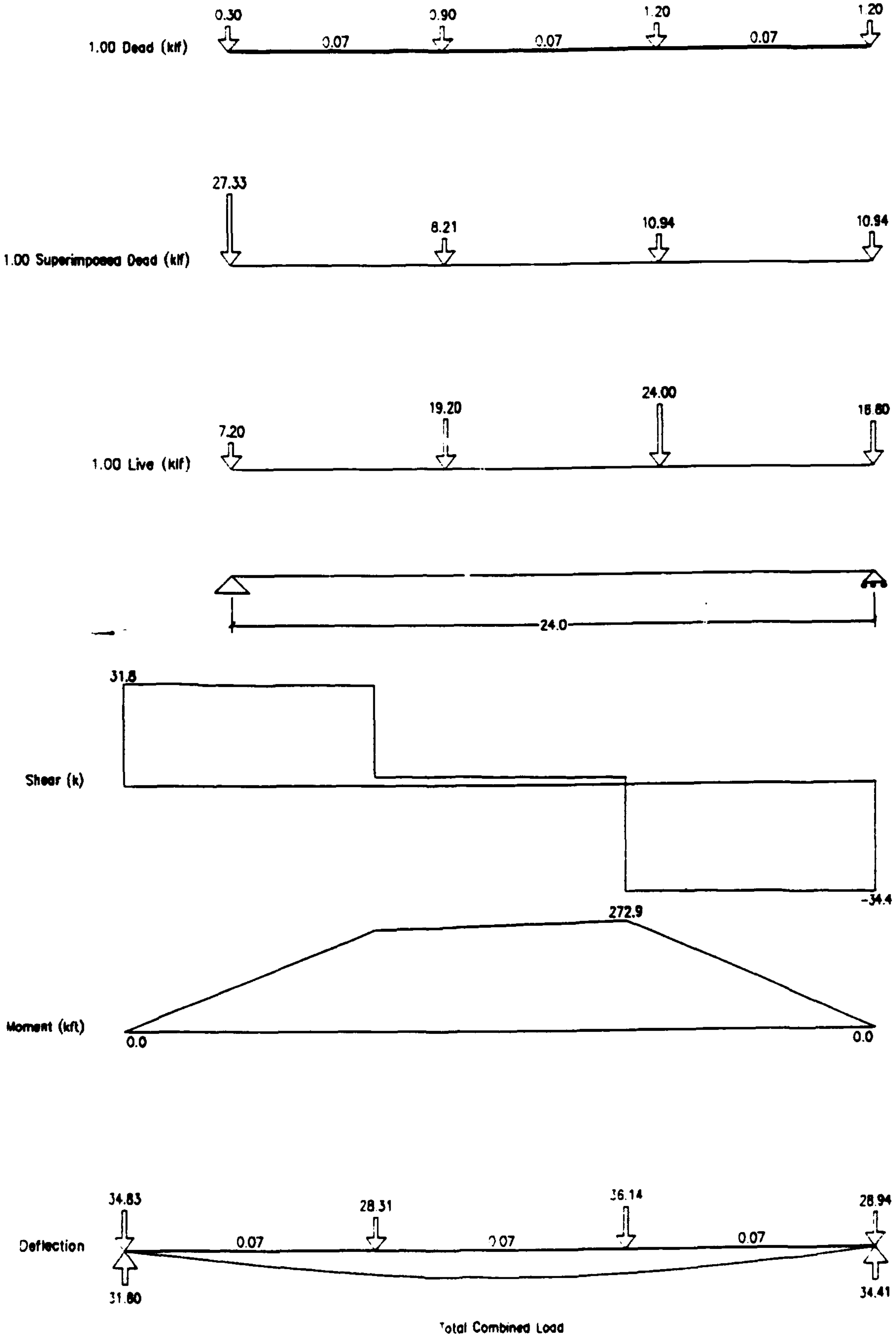
View Shear, Moment & Deflection Diagrams

Excel Data

◉ Execute Excel

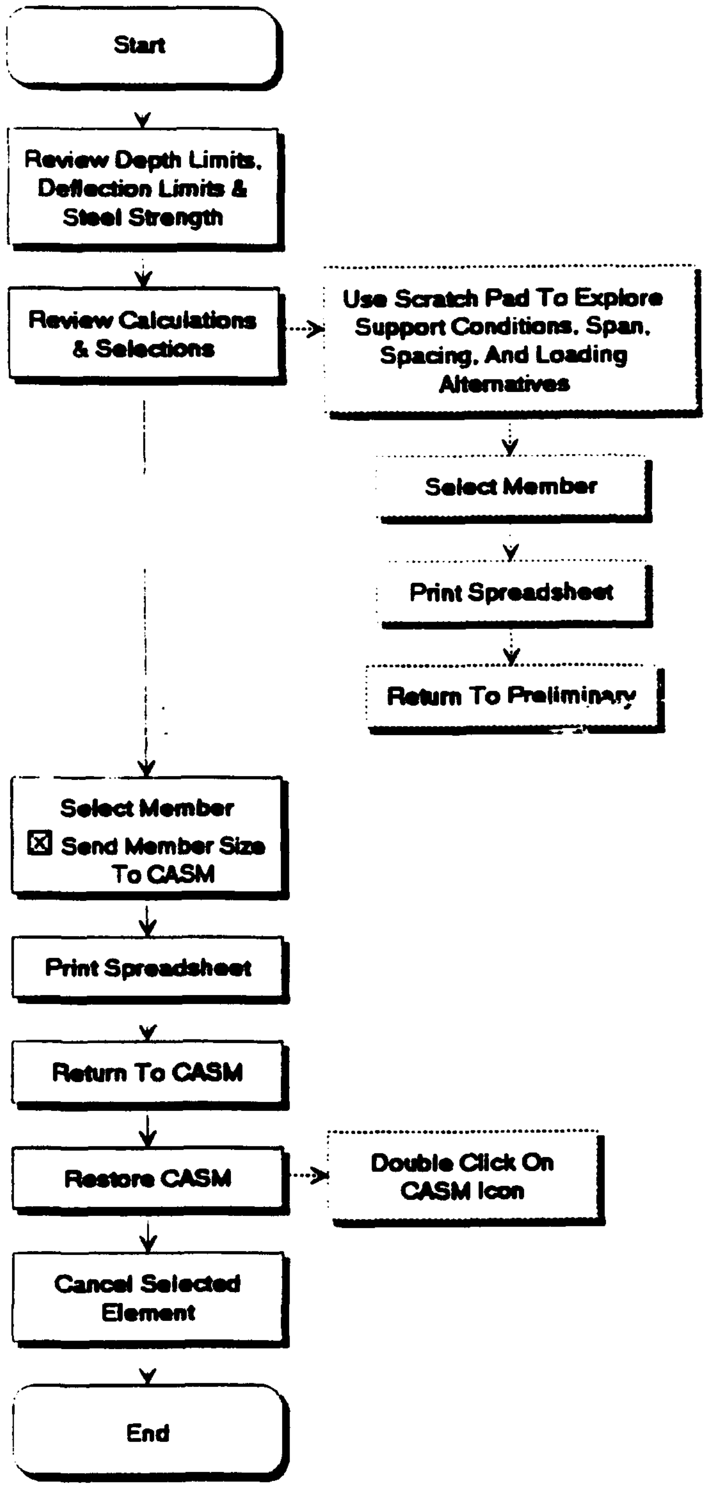
End





0.30
0.90
1.20
1.20
1.00 Dead (klf)
0.07
0.07
0.07
27.33
8.21
10.94
10.94
1.00 Superimposed Dead (klf)
24.00
19.20
7.20
16.80
1.00 Live (klf)
24.0
31.8
Shear (k)
-34.4
272.9
Moment (kft)
0.0
0.0
34.83
28.31
36.14
28.94
Deflection
0.07
0.07
0.07
31.80
34.41
Total Combined Load

Steel Beam Design



Steel Beam Selection

STEEL BEAM PRELIMINARY SELECTION

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

CASM Load & Analysis Data:

Method: Analysis

Load Combination: D + L

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=.66*Fy= 24.0 ksi

Fv= 14.4 ksi

E = 29,000 ksi

Live Ld Defl= L/360 =0.80 in

Total Defl= L/240 =1.20 in

Load Type	Factored Moments (k-ft) Left	Mid	Right	Fact. Reactions Left(k)	Right(k)
Dead		13.7		1.9	2.0
Sup Dead		80.3		9.1	10.0
Live		179.2		20.8	22.4
Lmin Roof					
Snow					
Wind					
Summary		272.9		31.8	34.4

Max: M= 272.9 k-ft	R= 34.4 kips
Sx(req)= 136.5 in^3	Ix(req)= 789.4 in^4

CASM Beam Selection Table:

Beam	Depth d (in)	Width bf (in)	Ix (in^4)	Sx (in^3)	Live Ld Defl (in)	Total Ld Defl (in)	Shear fv (ksi)	Bending fb (ksi)	Beam Wt (lb)
W 21 x 68	21.1	8.27	1,480	140	-0.43	-0.65	3.8	23.4	1,632
W 14 x 90	14.0	14.52	999	143	-0.63	-0.96	5.6	22.9	2,160
W 12 x 106	12.9	12.22	933	145	-0.68	-1.03	4.4	22.6	2,544
W 18 x 76	18.2	11.04	1,330	146	-0.47	-0.72	4.4	22.4	1,824
W 21 x 73	21.2	8.30	1,600	151	-0.39	-0.60	3.6	21.7	1,752

CASM Steel Beam Selection:

				Live / Total
W 21 x 68	Span= 24.0 ft	Ix= 1,480	Sx= 140	Defl(in): -0.43 -0.65
		fv= 3.8	fb= 2.7	Beam Wt(tons)= 0.82

Notes:

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

Truss Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

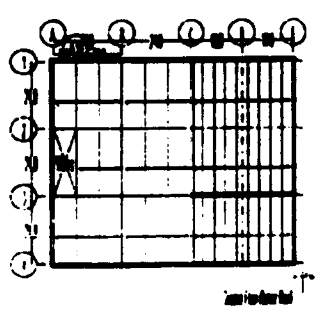
Material Steel

Load Combination D + S

- Use Load Combination
- Set Factors
  Dead: 1.0
  Snow: 1.0
- Add
- OK Button To Close Dialog Window
- Highlight D+S In List

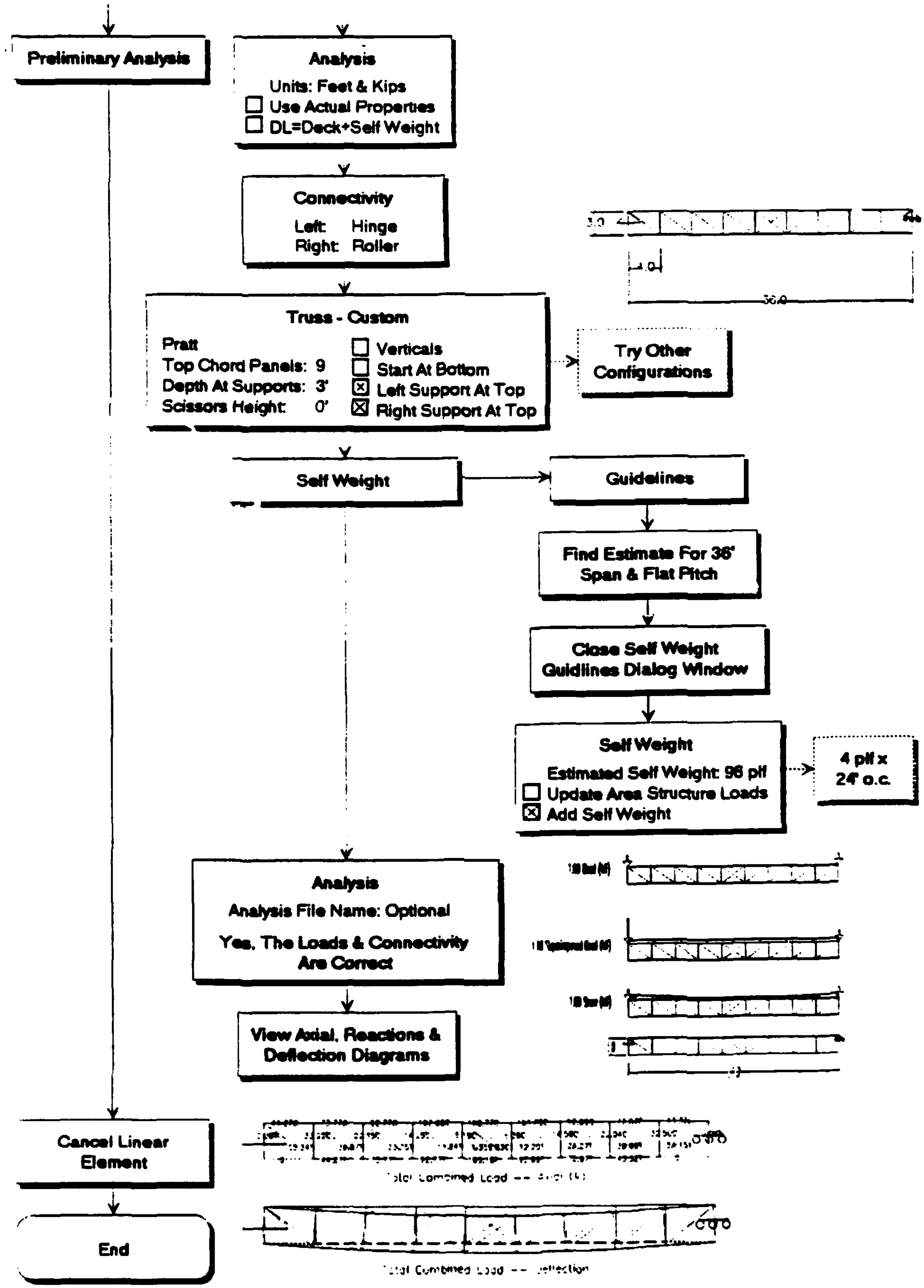
Select Element To Analyze & Design

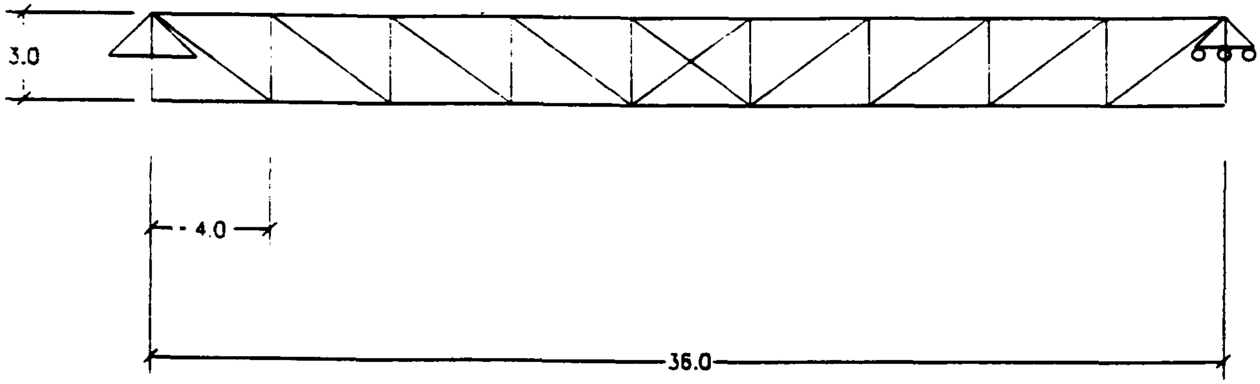
- Linear Truss-Custom
- Select A Truss
- Review Element Attributes & Guidelines

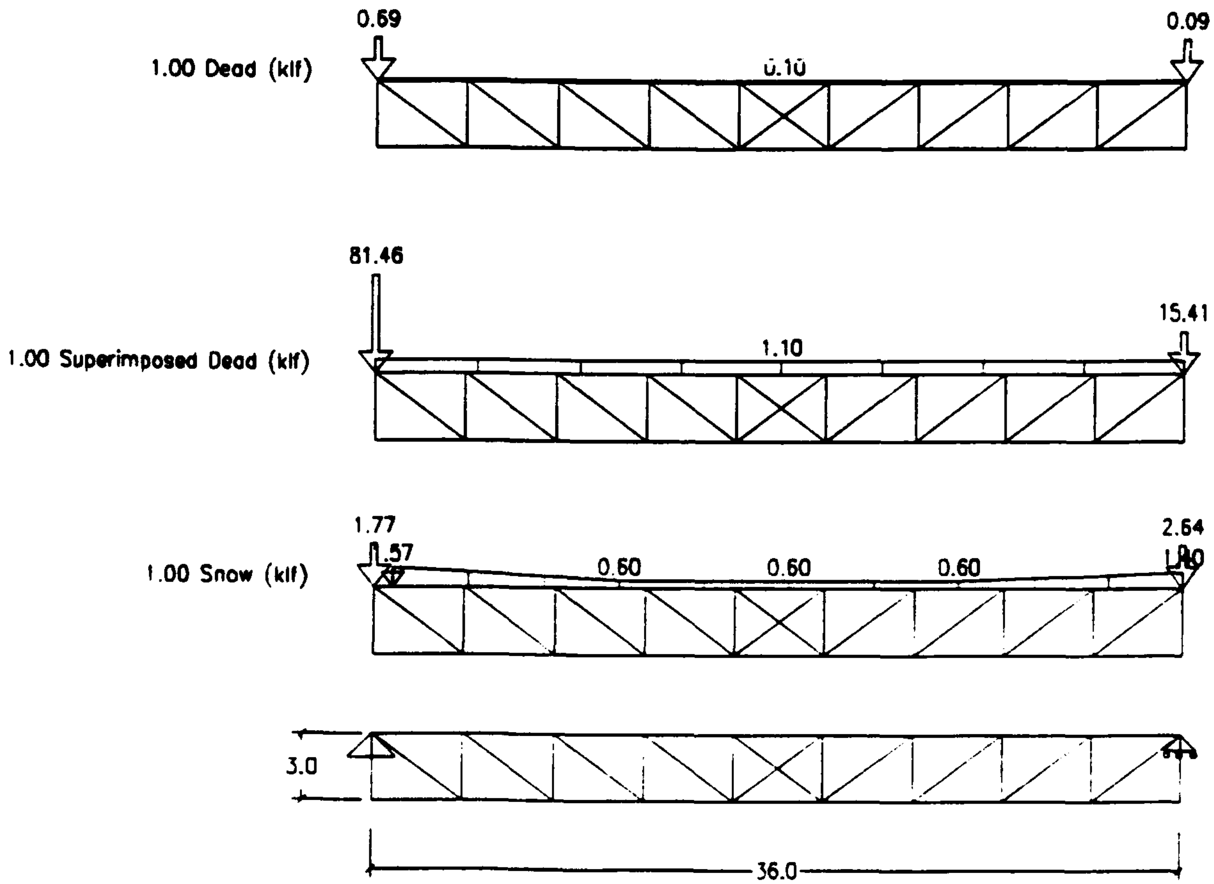


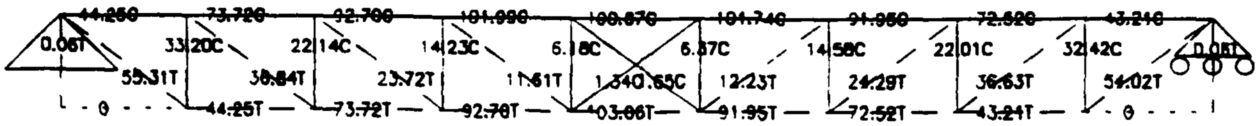
Preliminary Analysis

- Use Preliminary

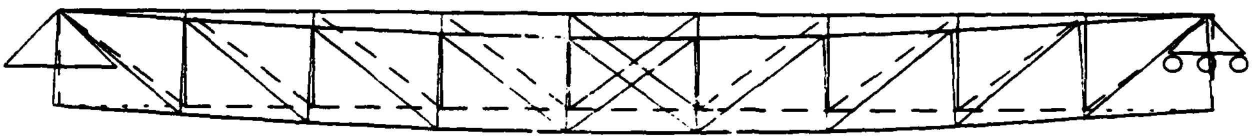

Preliminary Analysis
Analysis
Units: Feet & Kips
Use Actual Properties
DL=Deck+Self Weight
Connectivity
Left: Hinge
Right: Roller
Truss - Custom
Pratt
Top Chord Panels: 9
Depth At Supports: 3'
Scissors Height: 0'
Verticals
Start At Bottom
Left Support At Top
Right Support At Top
Try Other Configurations
Self Weight
Guidelines
Find Estimate For 36' Span & Flat Pitch
Close Self Weight Guidlines Dialog Window
Self Weight
Estimated Self Weight: 98 plf
Update Area Structure Loads
Add Self Weight
4 plf x 24' o.c.
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct
View Axial, Reactions & Deflection Diagrams
Cancel Linear Element
End


3.0
4.0
36.0

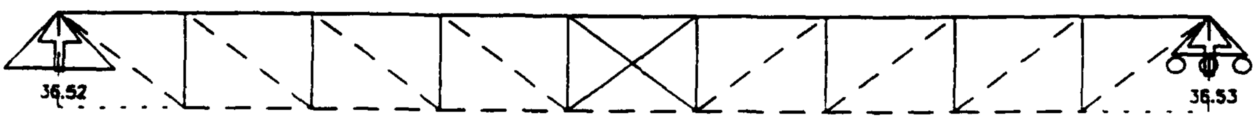

1.00 Dead (klf)
0.69
0.10
0.09
1.00 Superimposed Dead (klf)
81.46
1.10
15.41
1.00 Snow (klf)
1.77
1.57
0.60
0.60
0.60
2.64
3.0
36.0



Total Combined Load -- Axial (k)

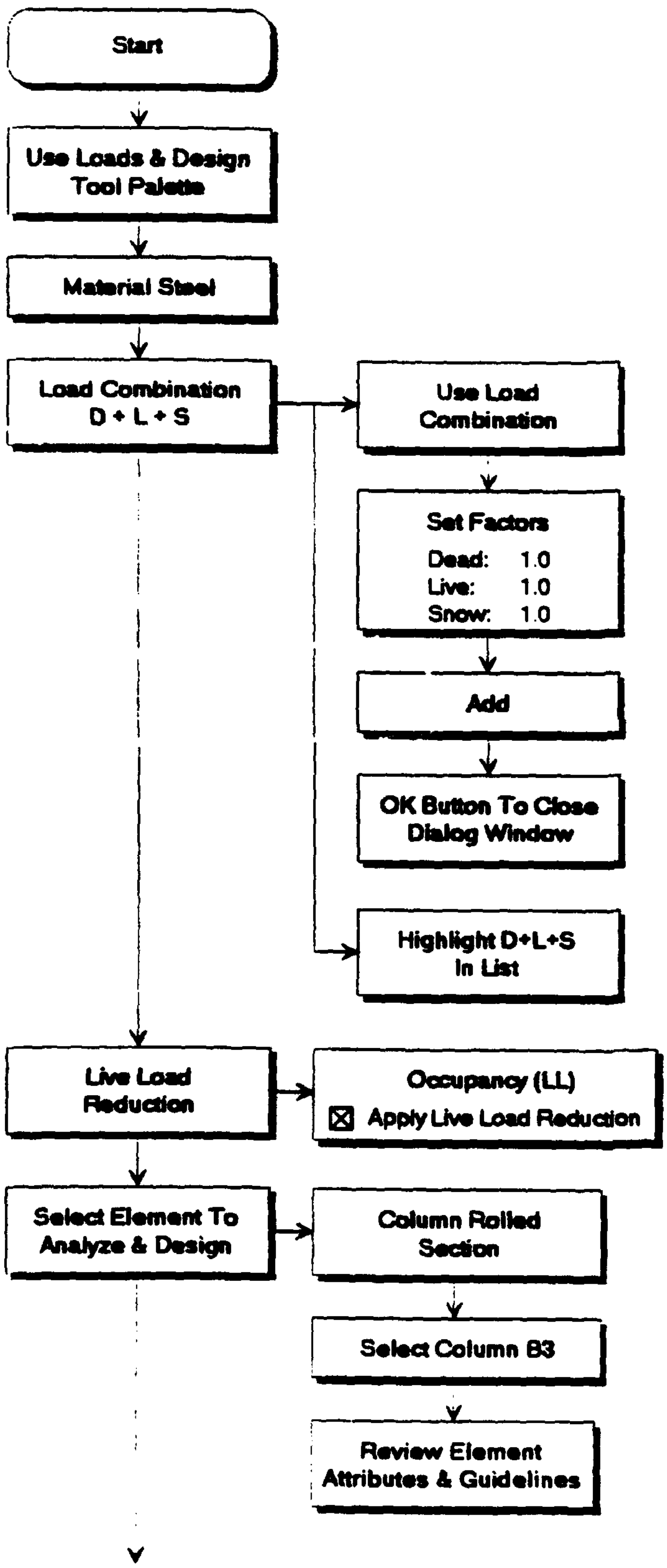


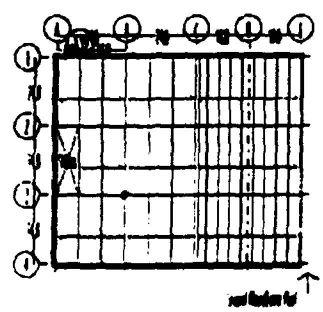
Total Combined Load -- Deflection

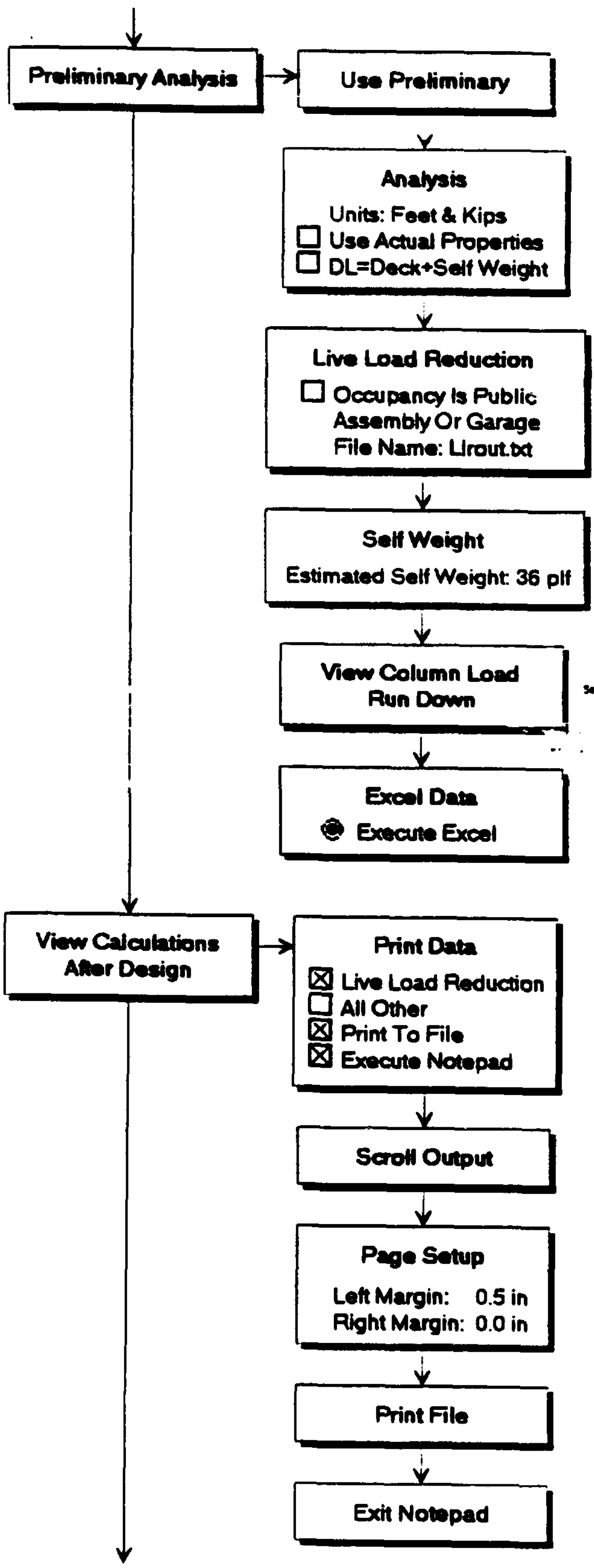


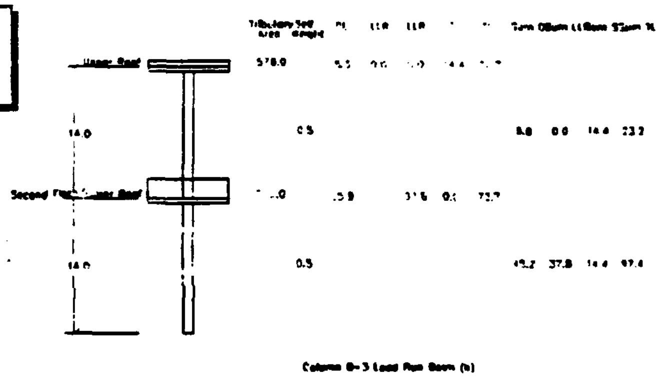
Total Combined Load -- Reactions (k)

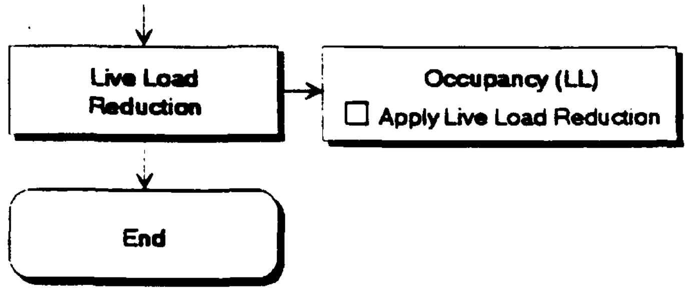
Column Load Run Down

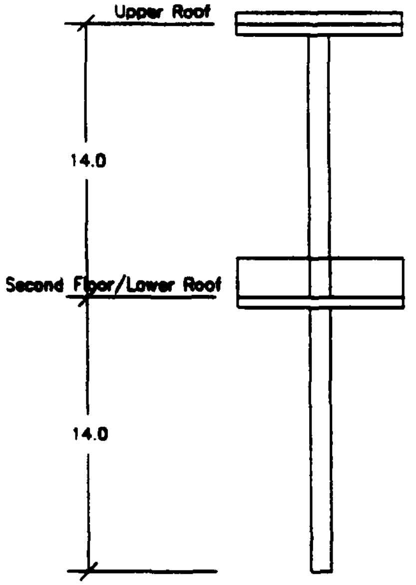





Preliminary Analysis
Use Preliminary
Analysis
Units: Feet & Kips
☐ Use Actual Properties
☐ DL=Deck+Self Weight
Live Load Reduction
☐ Occupancy Is Public Assembly Or Garage
File Name: Llrout.txt
Self Weight
Estimated Self Weight: 36 plf
View Column Load Run Down
Excel Data
Execute Excel
View Calculations 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	LLR	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				
		0.5						8.8	0.0	14.4	23.2
Second Floor/Lower Roof	576.0		36.4		37.8	0.0	74.2				
		0.5						45.7	37.8	14.4	97.9

Column B-3 Load Run Down (k)

```
Project      : Office Building - Scheme A
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) :    50.0 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 = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+-------------------------+
|      L = 28.13 psf      |
+-------------------------+

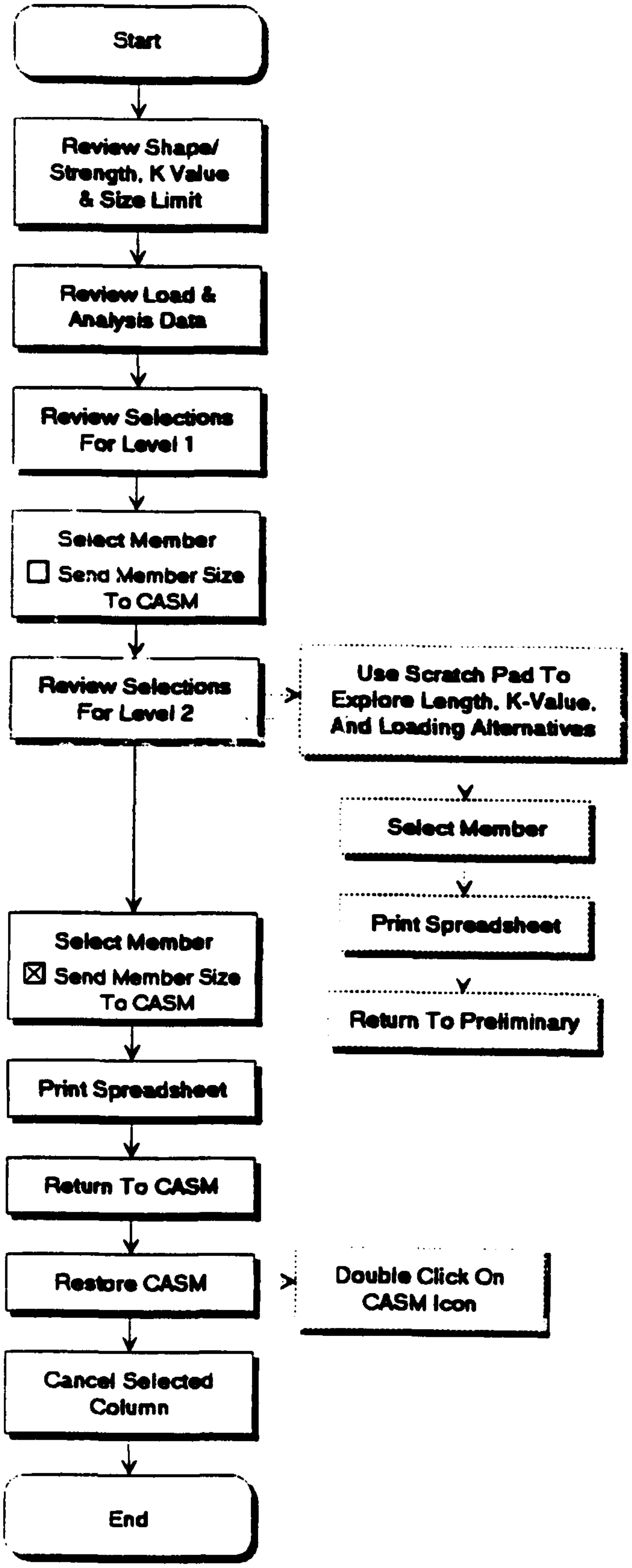
************************** Live Load Reduction **************************

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 A	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	45.7	37.8		14.4		97.9

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

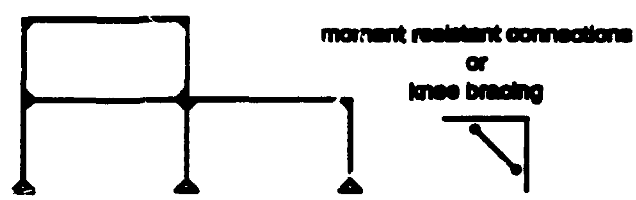
4. Assign gravity load on ALL levels
   Calculate wind and/or seismic loads

5. Select a load combination including wind or seismic loads

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

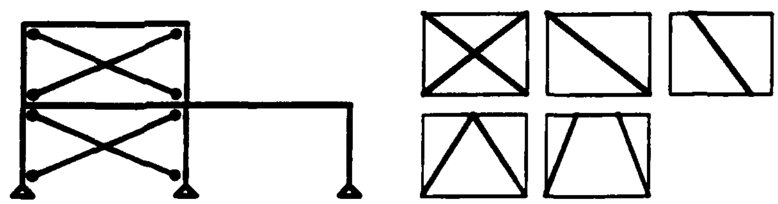
   Options:

   1. Unbraced Frames

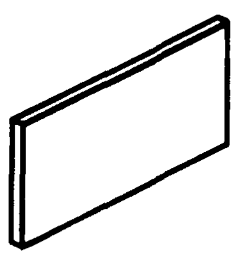


   2. Braced Frames

      A. Trussing



      B. Shear Walls

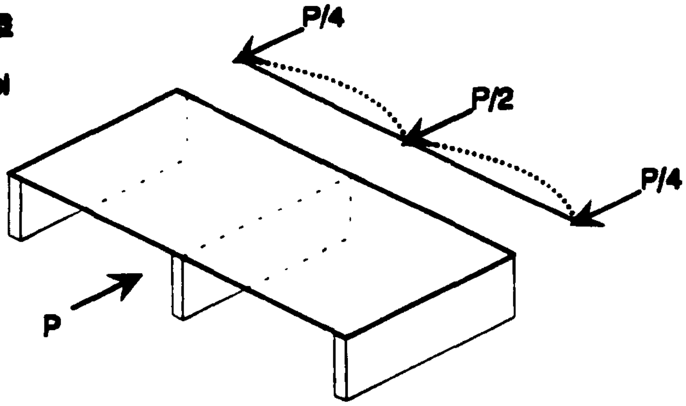


7. Define horizontal diaphragm systems

   All flexible
   All rigid
   Floors rigid & roof flexible

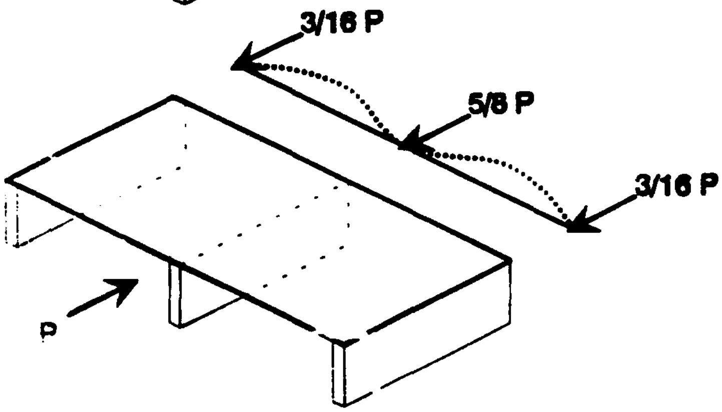
Flexible Diaphragms

Simple Beam Model
(tributary area)



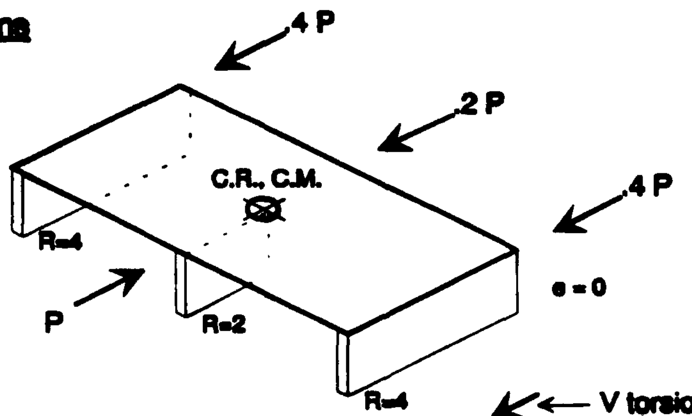
* No Torsion

Continuous Beam Model



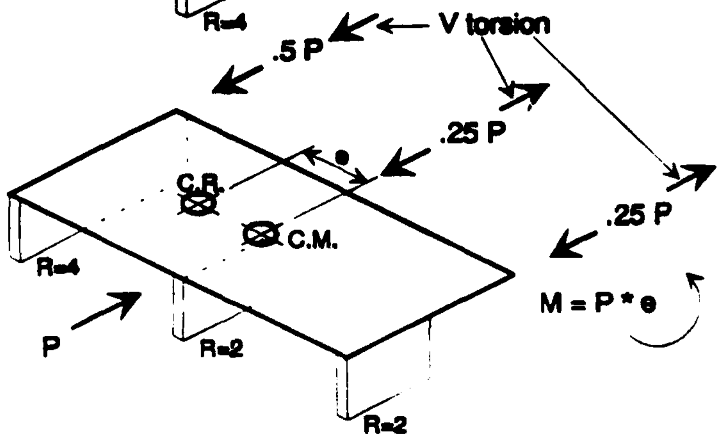
Rigid Diaphragms

Symmetrical

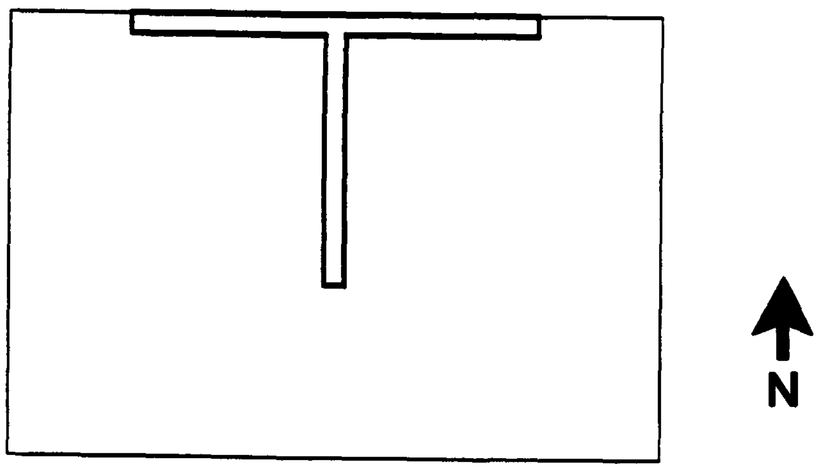


Torsion
(even accidental minimum required)

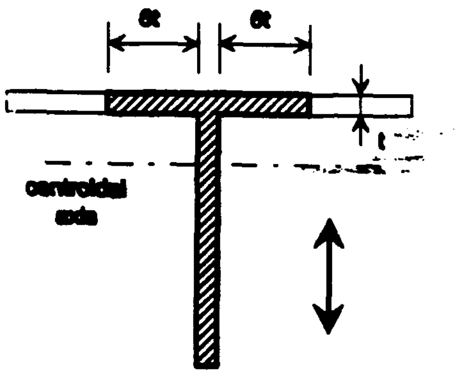
Non-Symmetrical



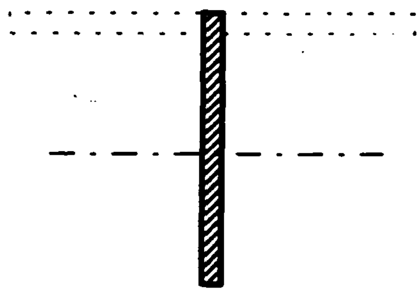
Monolithic Perpendicular Shear Walls



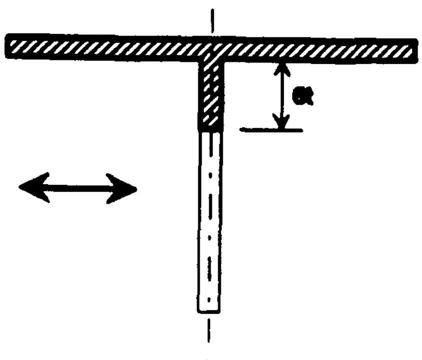
For N-S



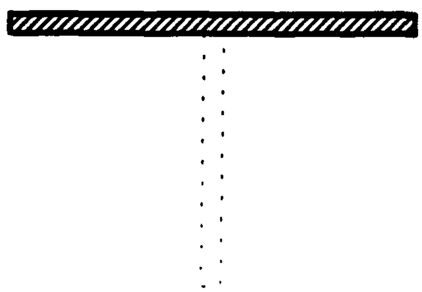
or



For E-W



or



Define Lateral Resistance

Start

Use Draw Structure Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Define Second Floor/ Lower Roof Diaphragm Type

Diaphragm Guidlines

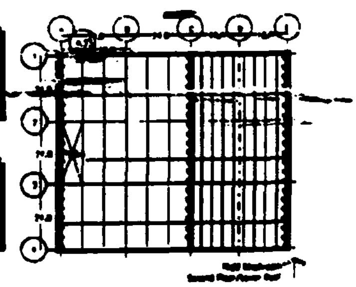
Lateral Horizontal Rigid Diaphragm

Define N-S Lateral Resistance

Define Location

Vertical Define Location

Select Beam On Grid Line A

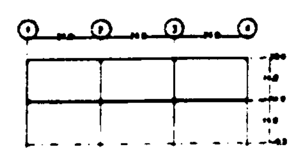


Define Bracing & Connectivity

Vertical Define Elements

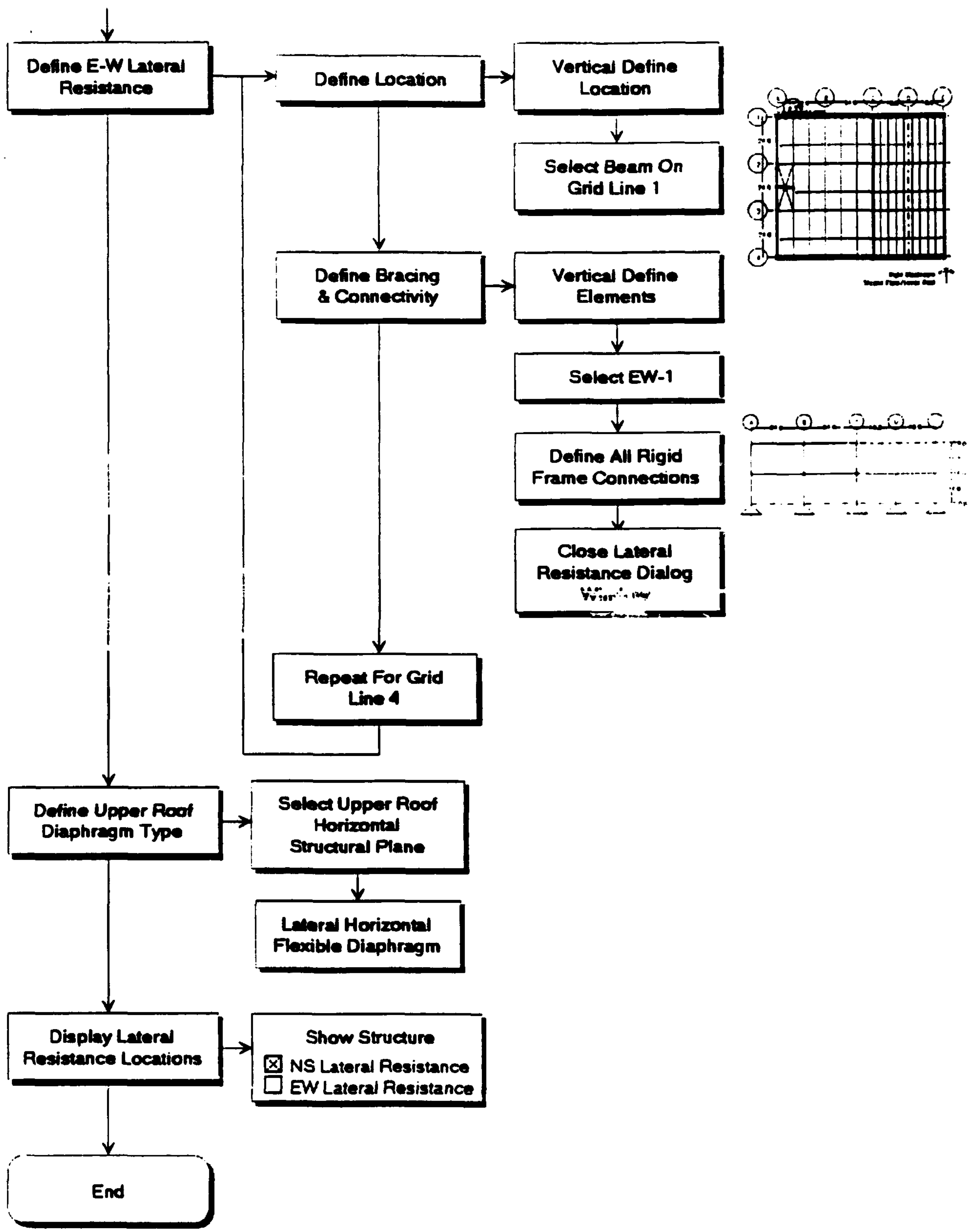
Select NS-1

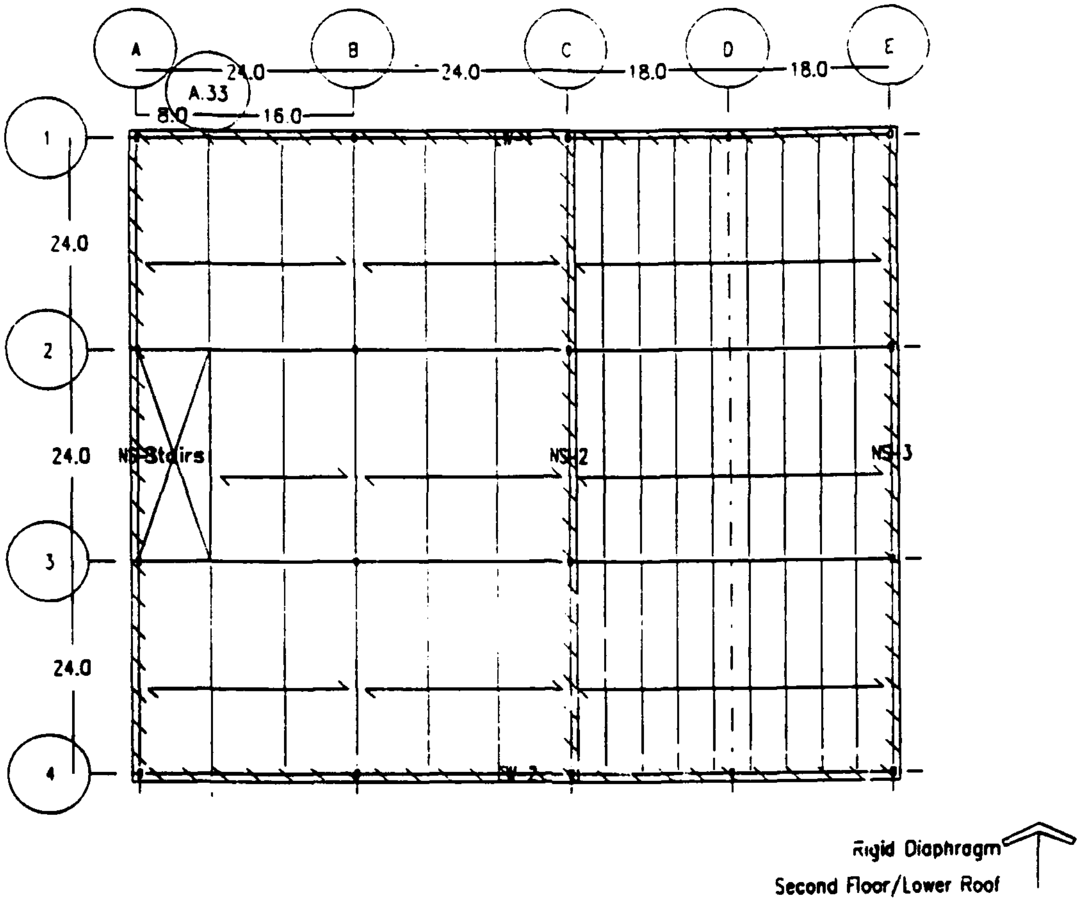
Define All Rigid Frame Connections

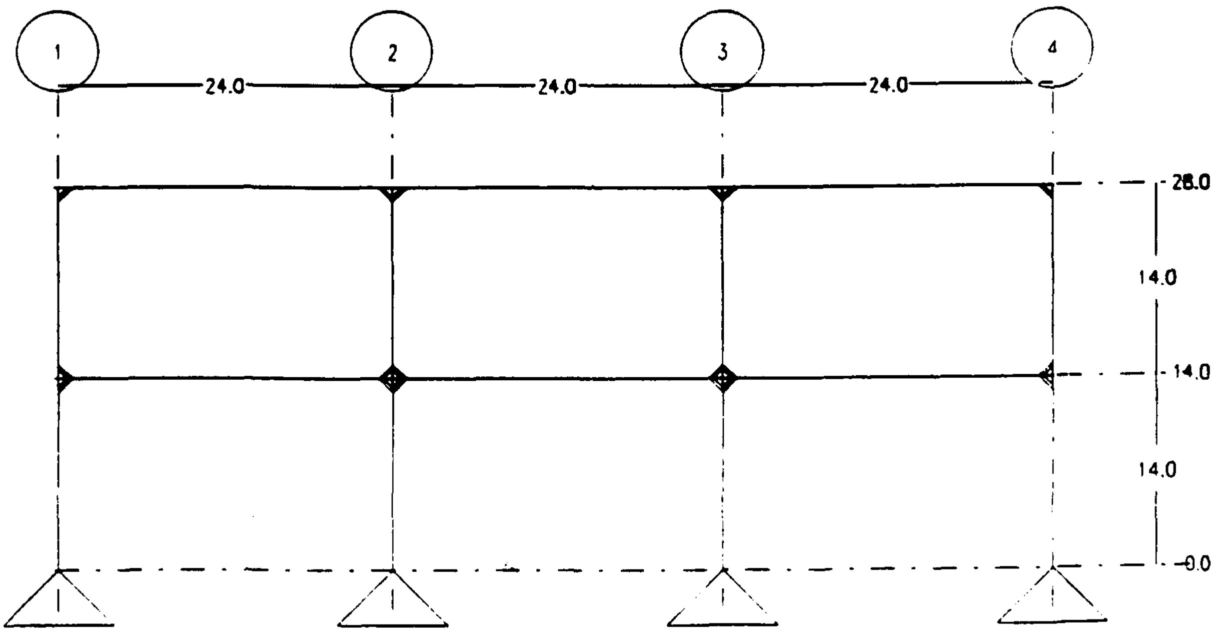


Close Lateral Resistance Dialog Window

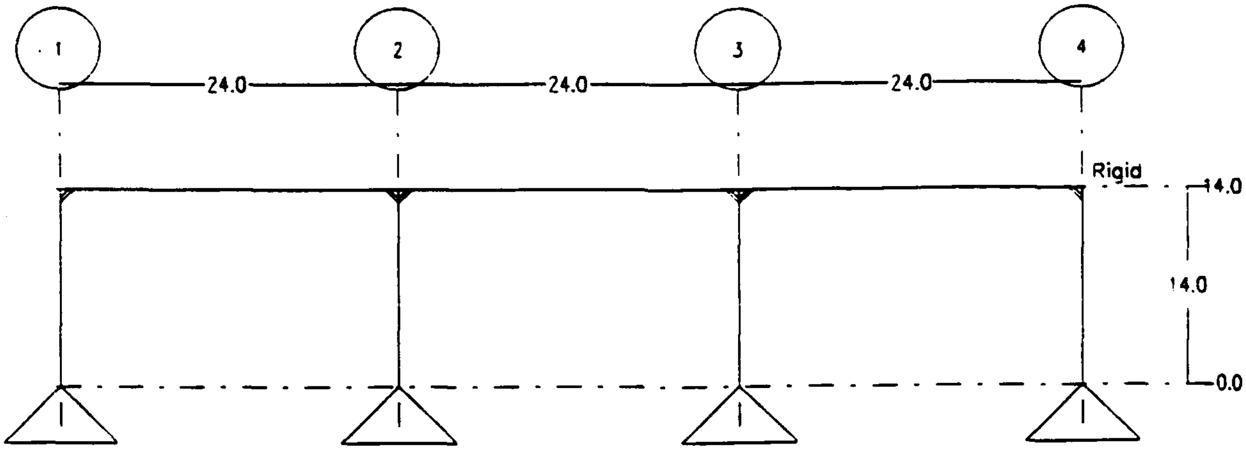
Repeat For Grid Lines C & E


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 All Rigid Frame Connections
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

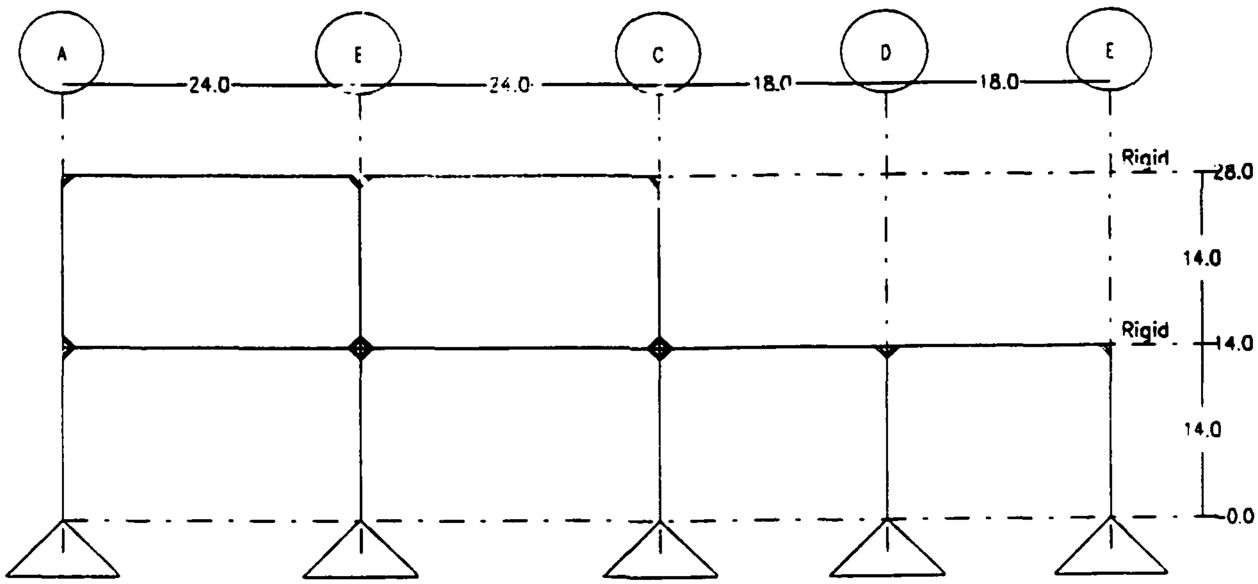

A
B
C
D
E
A.33
24.0
24.0
18.0
18.0
8.0
16.0
1
2
3
4
24.0
24.0
24.0
NS-Stairs
NS-2
NS-3
Rigid Diaphragm
Second Floor/Lower Roof


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

NS-1 & NS-2

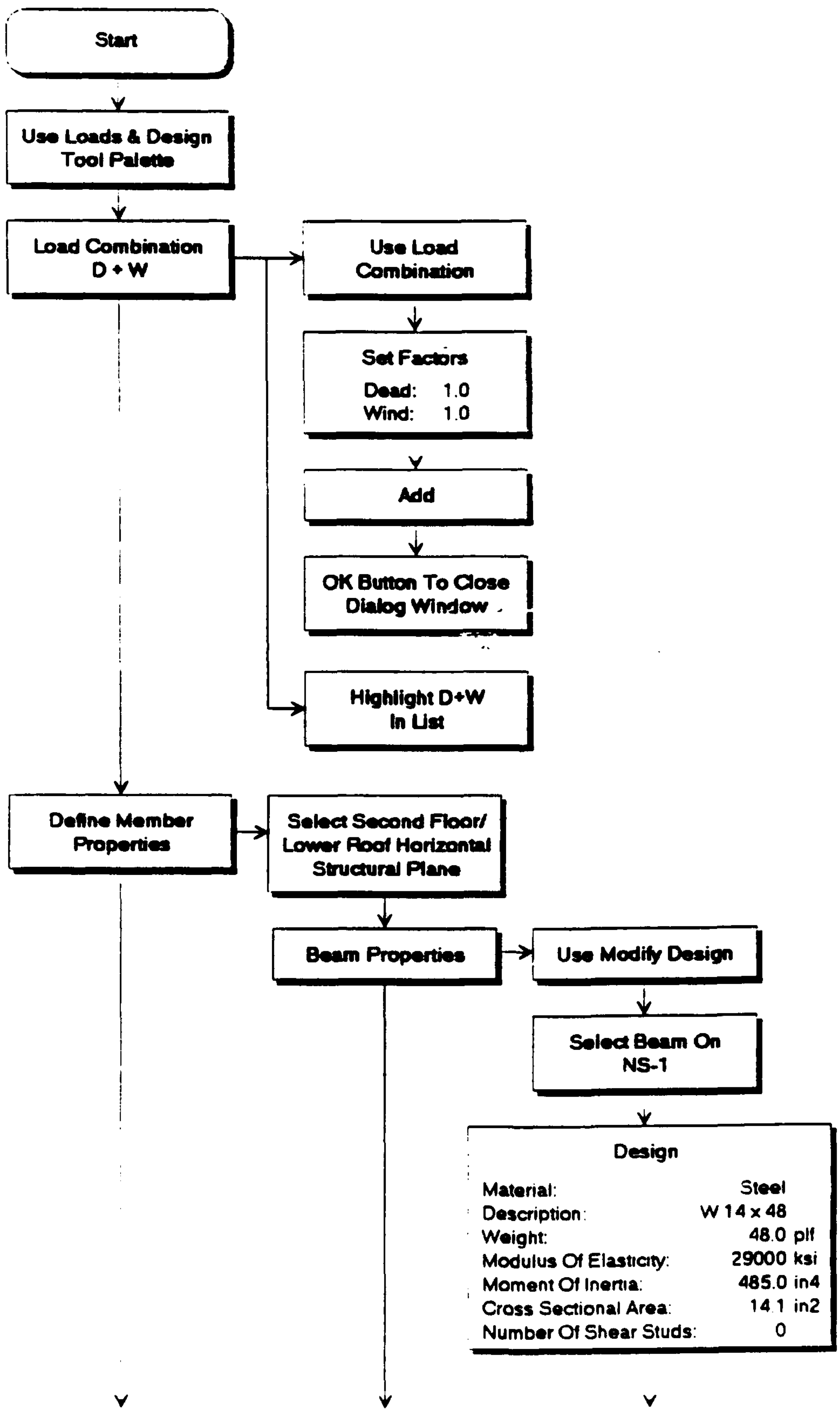

1
2
3
4
24.0
24.0
24.0
Rigid
14.0
14.0
0.0

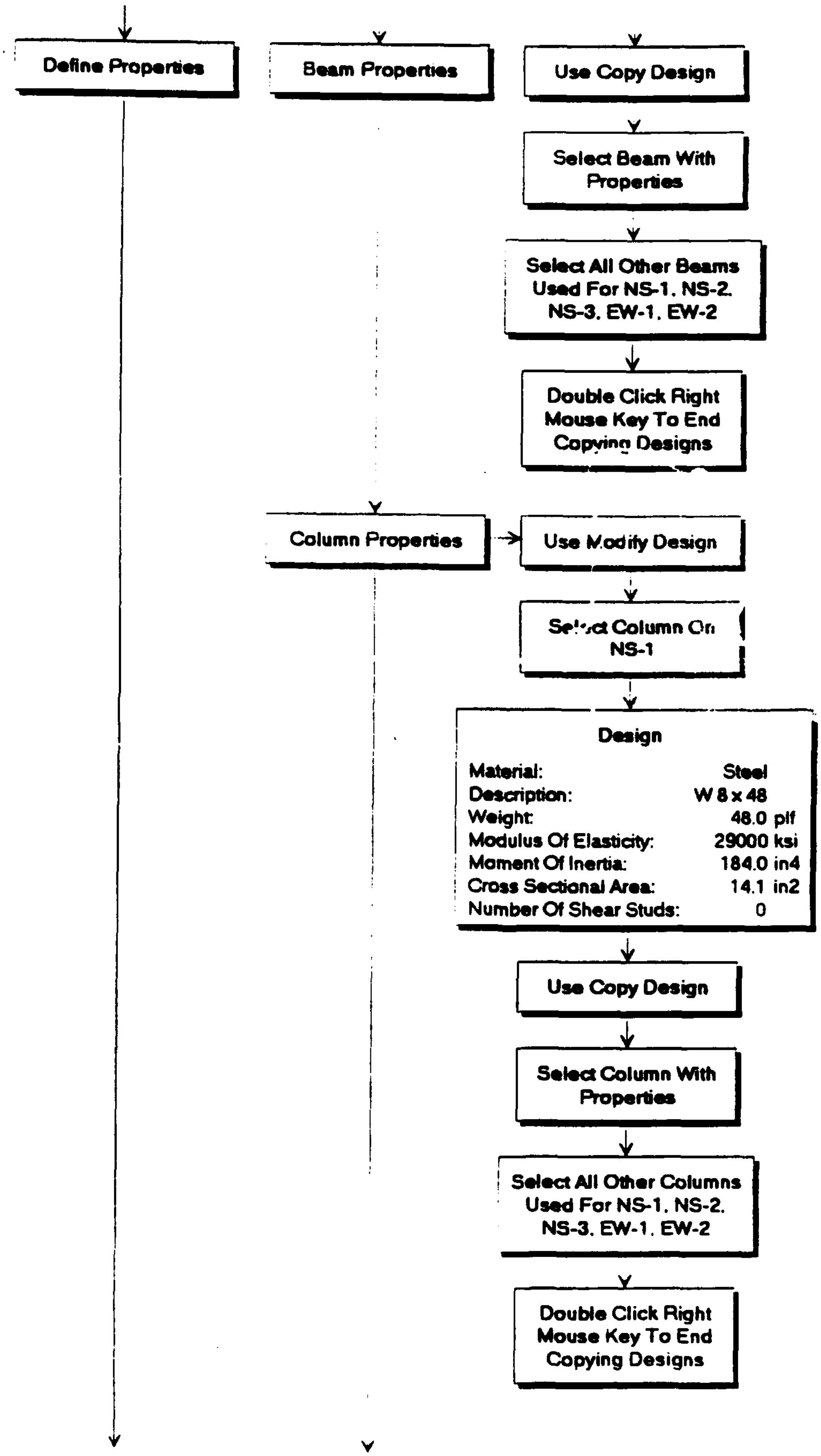
N S-3

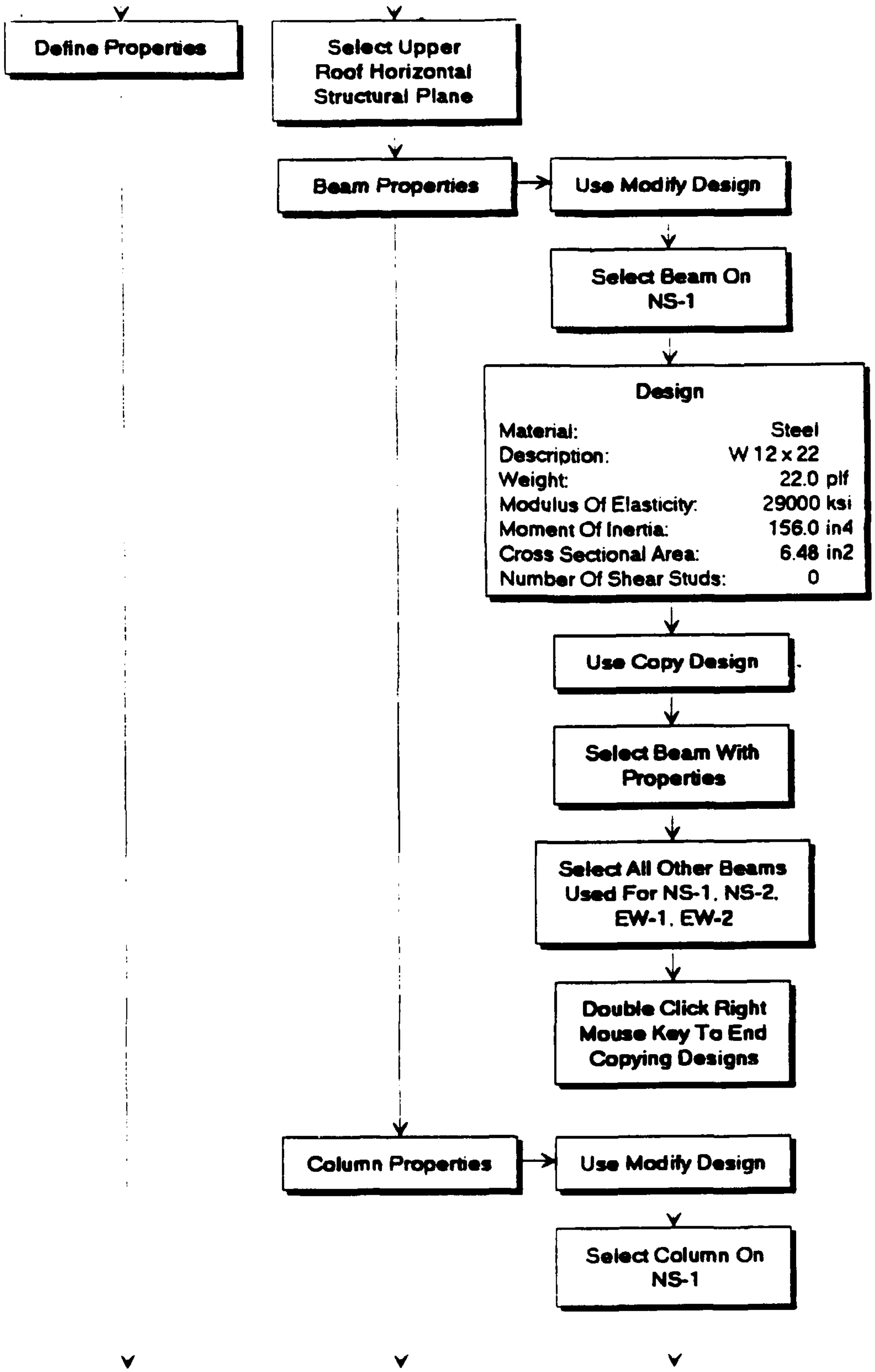

A
E
C
D
E
24.0
24.0
18.0
18.0
Rigid
28.0
14.0
Rigid
14.0
14.0
0.0

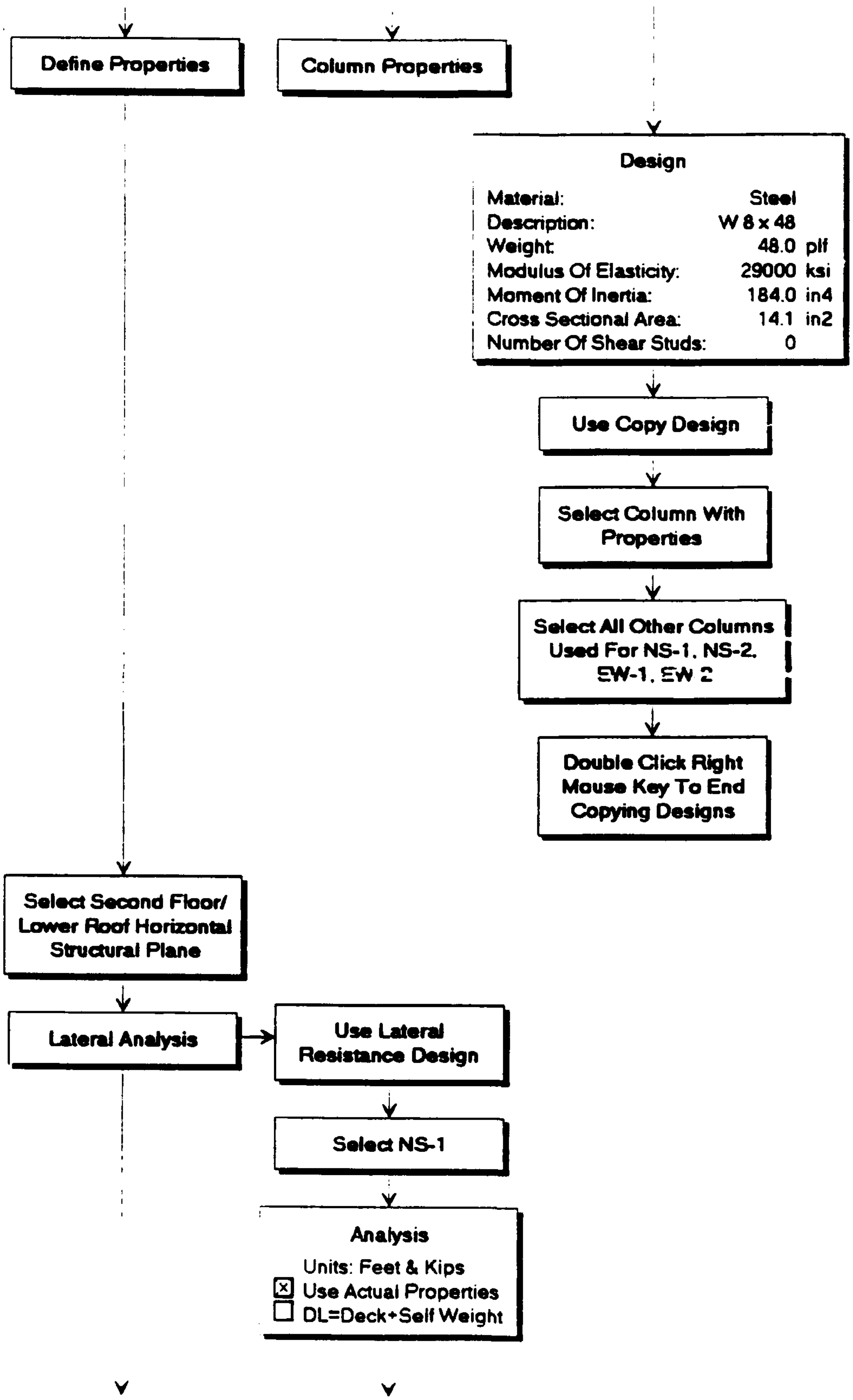
EW-1 & EW-2

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 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 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

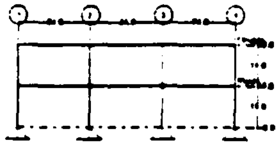

Define Properties
Column Properties
Design
Material: Steel
Description: W 8 x 48
Weight: 48.0 plf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 184.0 in4
Cross Sectional Area: 14.1 in2
Number Of Shear Studs: 0
Use Copy Design
Select Column With Properties
Select All Other Columns Used For NS-1, NS-2, EW-1, EW 2
Double Click Right Mouse Key To End Copying Designs
Select Second Floor/ Lower Roof Horizontal Structural Plane
Lateral Analysis
Use Lateral Resistance Design
Select NS-1
Analysis
Units: Feet & Kips
☒ Use Actual Properties
☐ DL=Deck+Self Weight

Lateral Analysis

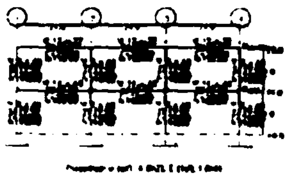
Connectivity
Hinge

Repeat For All Supports

Lateral Resistance
Verify All Rigid Connections



Yes, Properties Are All Correct



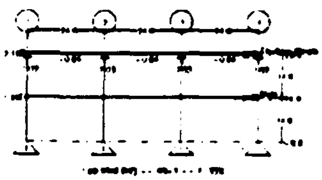
Wind Load Options

Wind Direction:	South
When 2 Wind Loads:	Max. Suction
Wind Load:	GCpi = 0

Flexible Diaphragm
Simple Beam Model

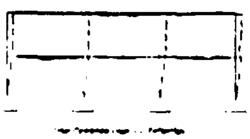
Rigid Horizontal Diaphragm Calculations
File Name: Rigidout.txt
☐ Consider Perpendicular Wall...

View Loads



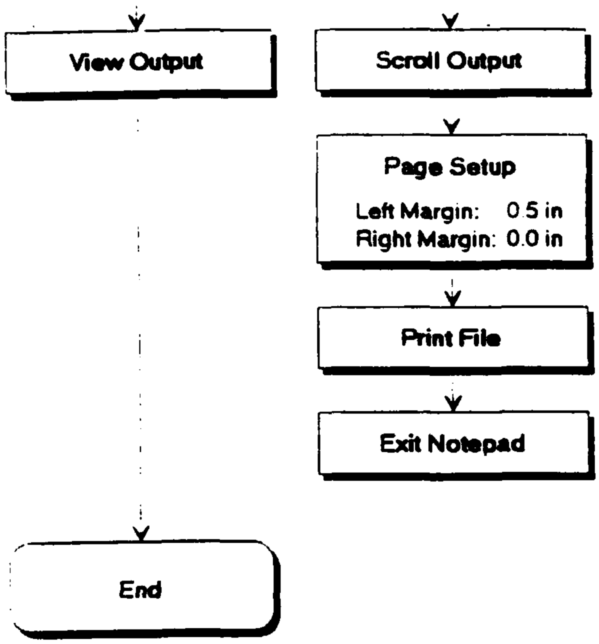
Analysis
Analysis File Name: Optional
Yes, The Loads & Connectivity Are Correct

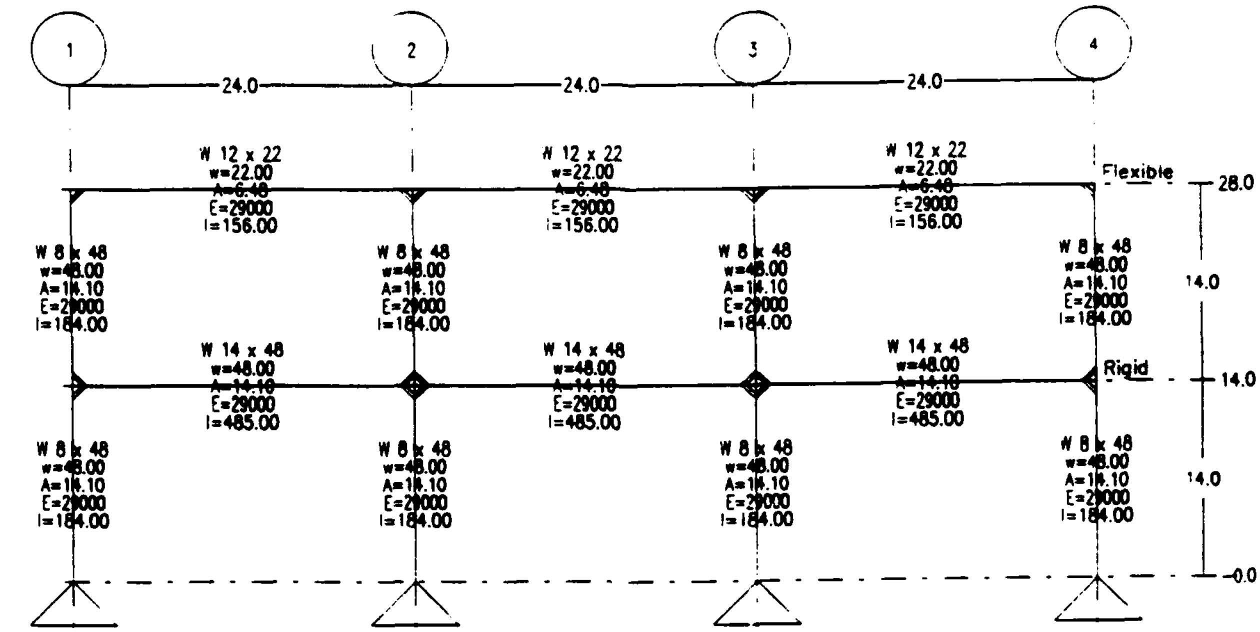
View Shear, Moment, Deflection & Reaction Diagrams



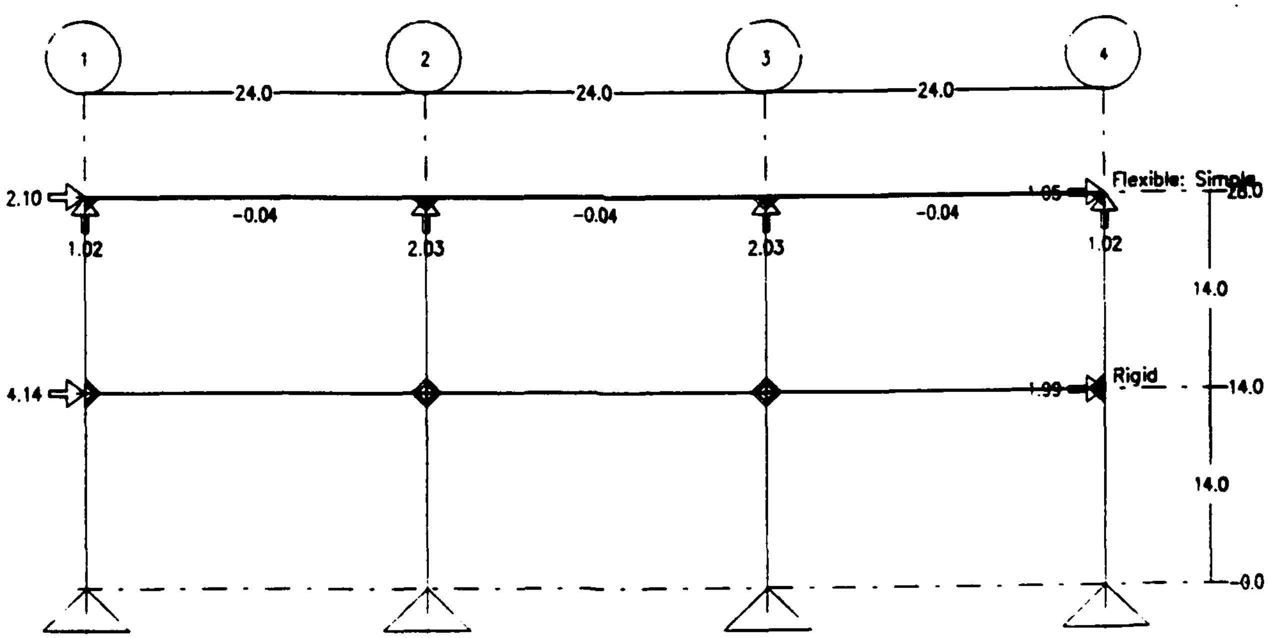
View Output

Print Data
☒ Rigid Diaphragm
☐ All Other
☒ Print To File
☒ Execute Notepad

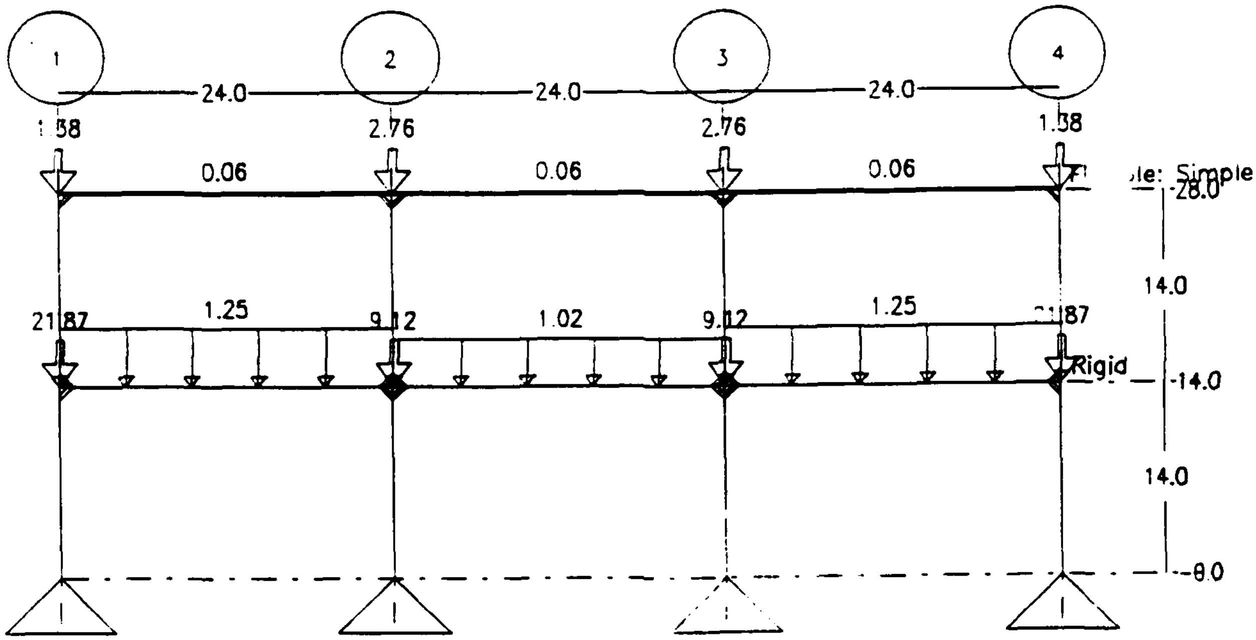

View Output
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



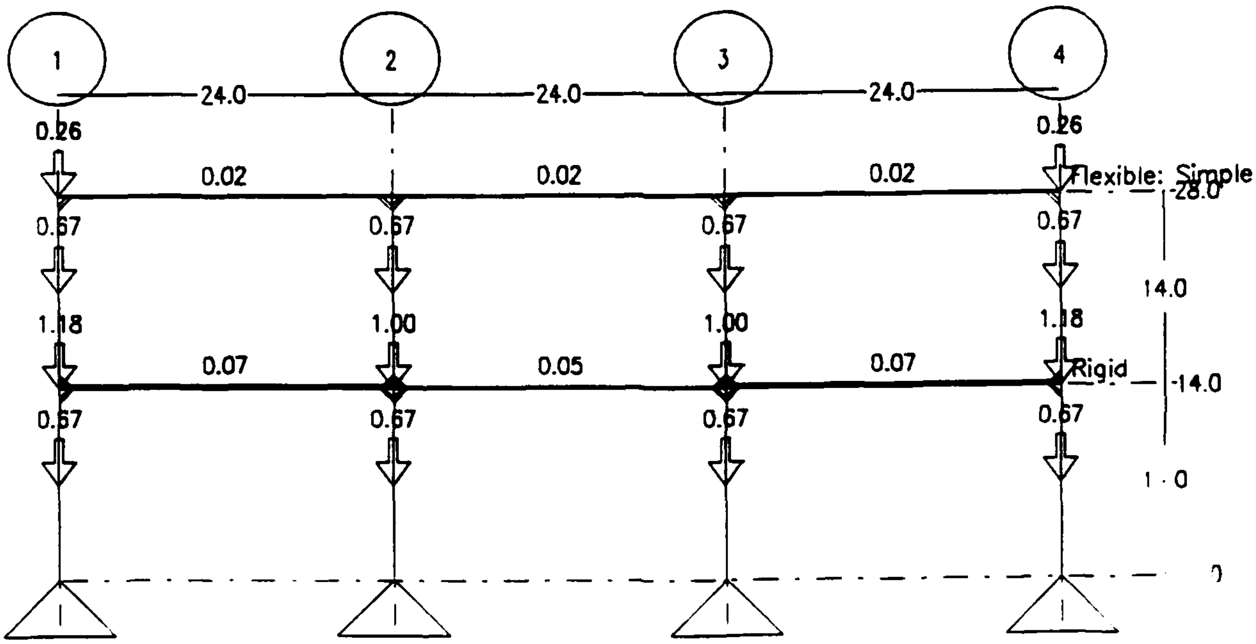
Properties: w (plf), A (in2), E (ksi), I (in4)



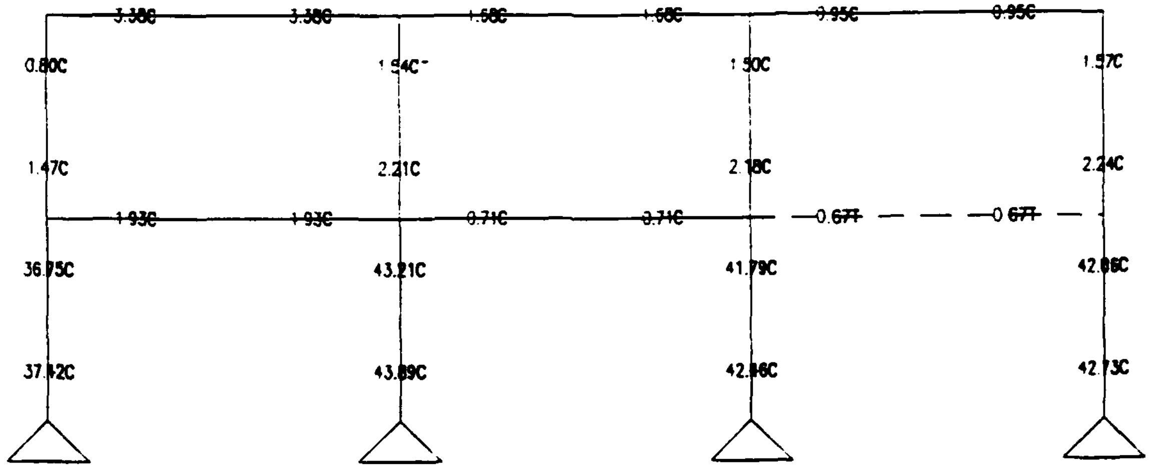
1.00 Wind (klf) -- NS-1 -- F, 32%



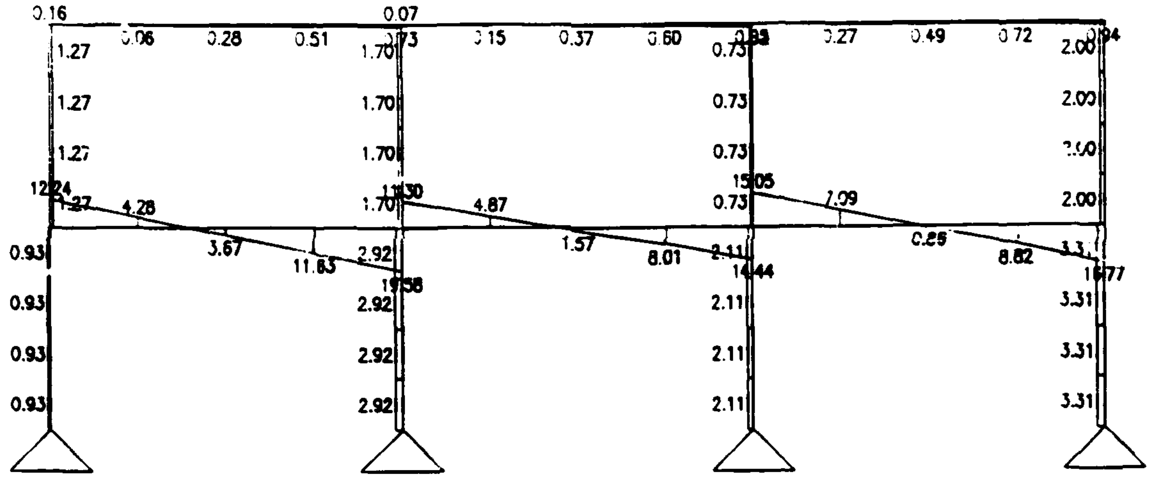
1.00 Superimposed Dead (klf)



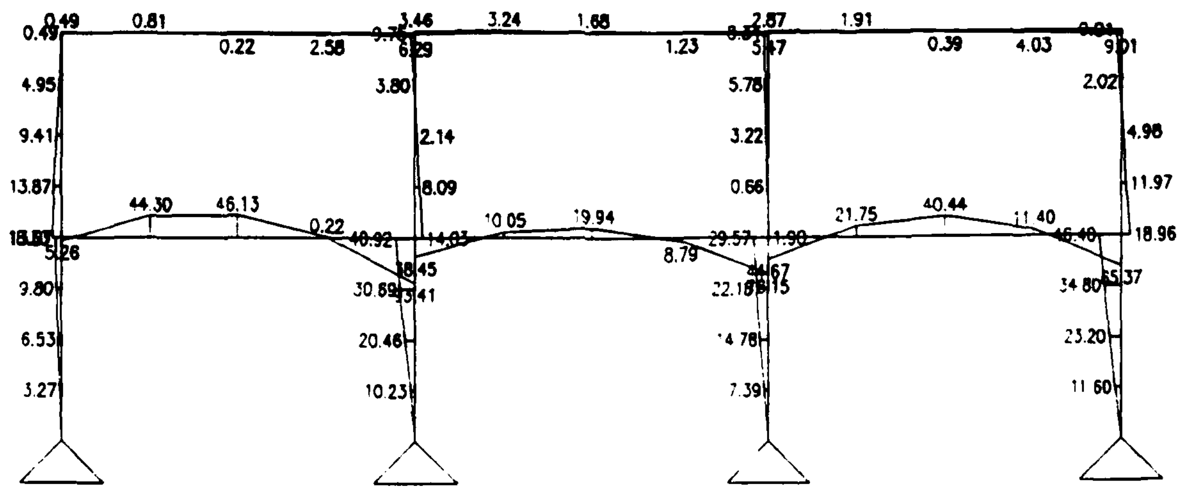
1.00 Dead (klf)



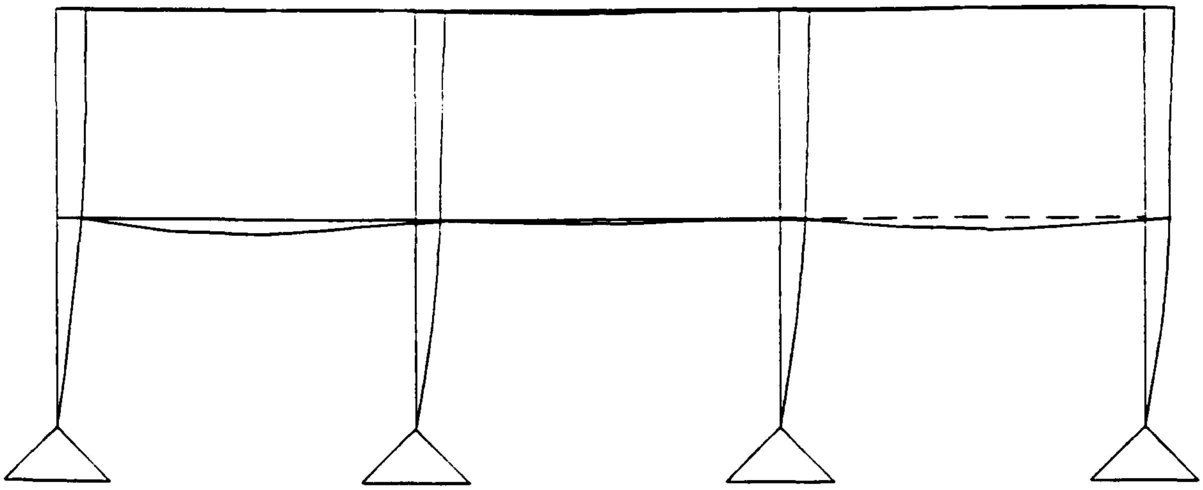
Total Combined Load -- Axial (k)



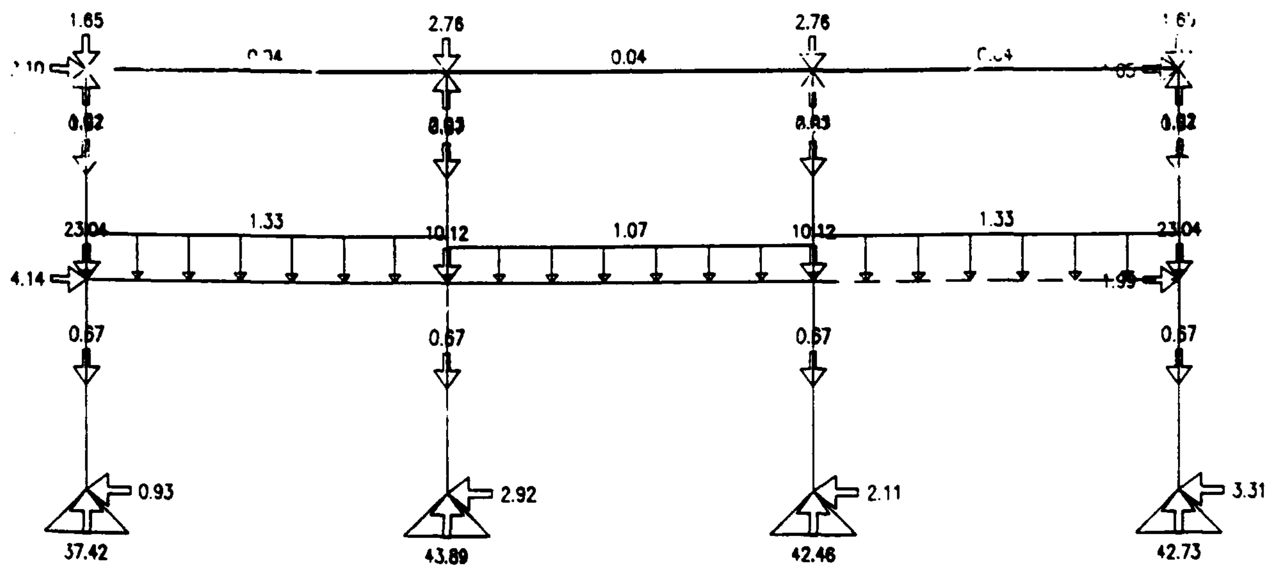
Total Combined Load -- Shear (k)



Total Combined Load -- Moment (kft)



Total Combined Load -- Deflection



Total Combined Load -- Loads & Reactions (k)

Project : Office Building - Scheme A
Location : Radford AAP
Time : Wed Feb 26, 1992 3:56 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	0.101	9.917	32.48%	0.8	8.264
NS-2	14.0	0	0	0.101	9.917	32.48%	48.8	484.294
NS-3	14.0	0	0	0.093	10.697	35.04%	84.8	907.432
Sum					30.531			1399.991

Centroid from lower left = sum(R*x)/sum(R) : 45.85 ft
Maximum dimension : 85.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 3.02 ft
e min = 0.05*max. dimension : 4.28 ft
Eccentricity (e) used for torsional analysis : 3.02 ft
e min considered only for seismic analysis.

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	0.078	12.793	50.00%	72.8	931.750
EW-2	14.0	0	0	0.078	12.793	50.00%	0.8	10.661
Sum					25.586			942.411

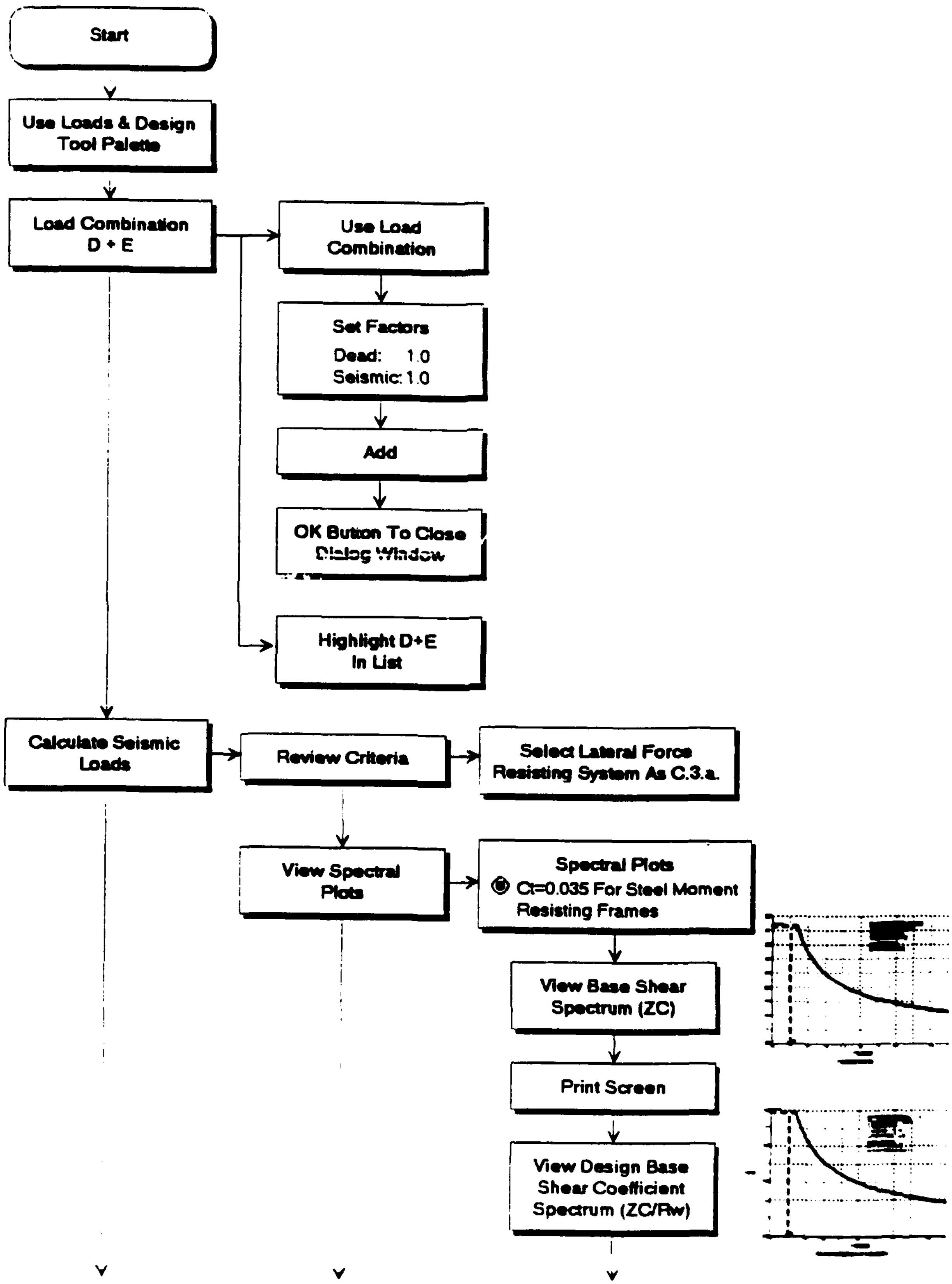
Centroid from lower left = sum(R*x)/sum(R) : 36.83 ft
Maximum dimension : 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 : 0.00 ft
e min = 0.05*max. dimension : 3.68 ft
Eccentricity (e) used for torsional analysis : 0.00 ft
e min considered only for seismic analysis.

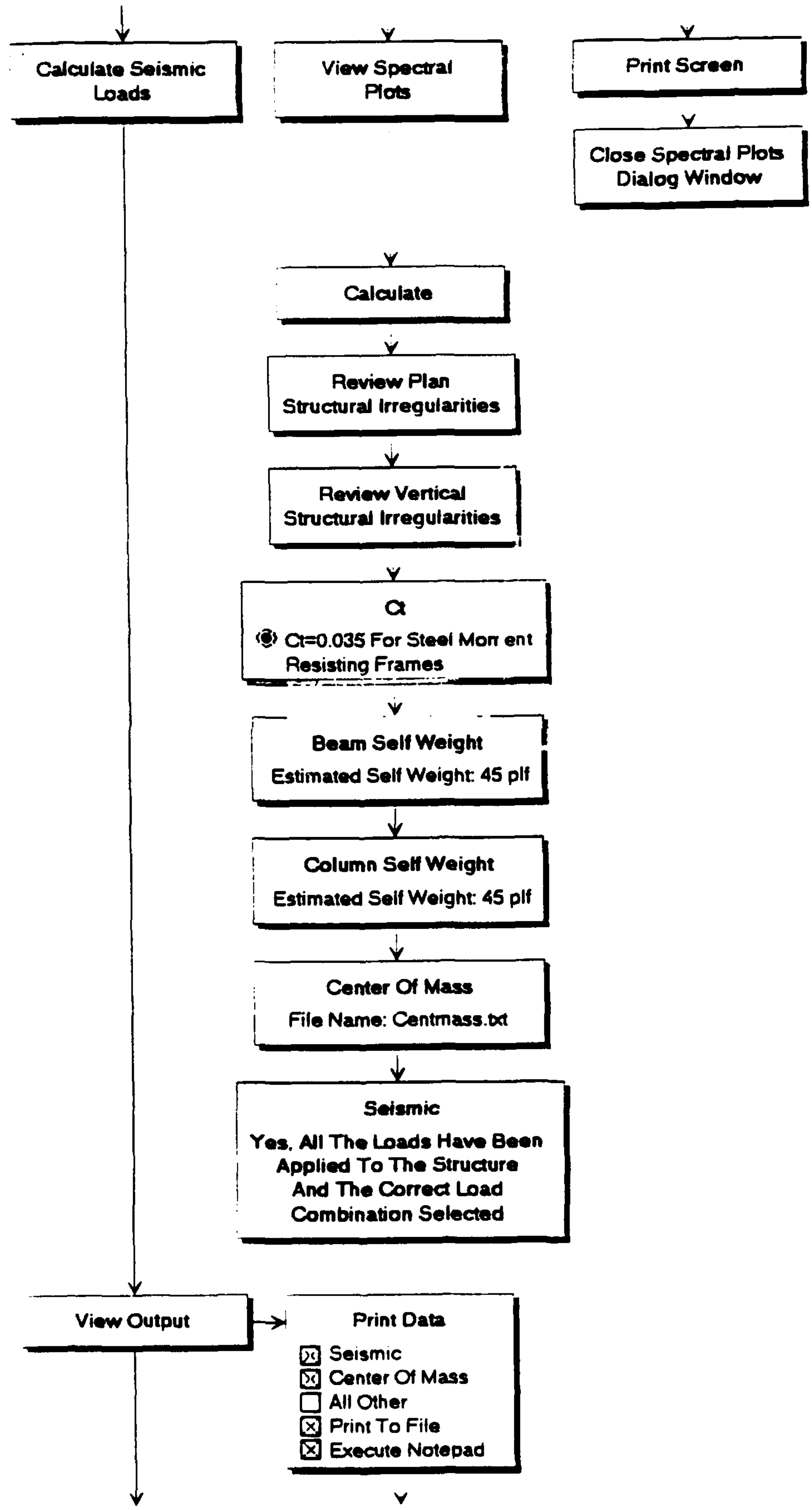
Assumptions used:
Deflections calculated by applying a 1 kip load.

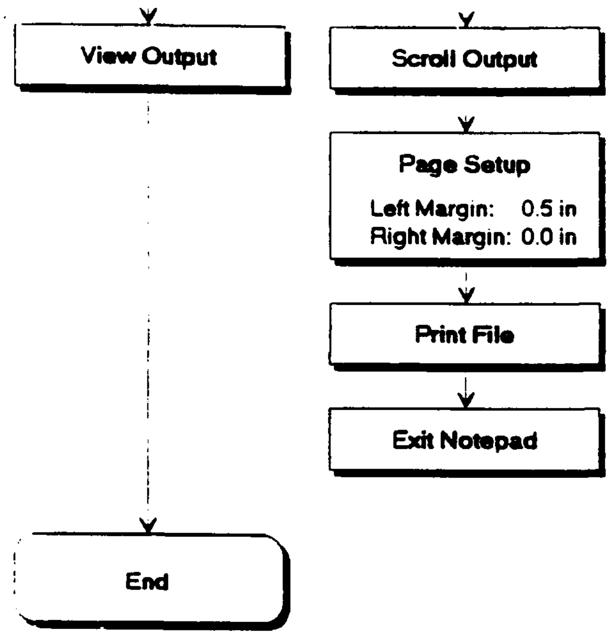
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	9.917	45.0	446.487	20101.310	0.00641
NS-2	14.0	9.917	3.0	29.543	88.007	0.00042
NS-3	14.0	10.697	39.0	416.944	16252.029	0.00599
EW-1	14.0	12.793	36.0	460.545	16579.613	0.00662
EW-2	14.0	12.793	36.0	460.545	16579.613	0.00662
Sum					69600.573	

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=0.035 For Steel Mom ent Resisting Frames
Beam Self Weight
Estimated Self Weight: 45 plf
Column Self Weight
Estimated Self Weight: 45 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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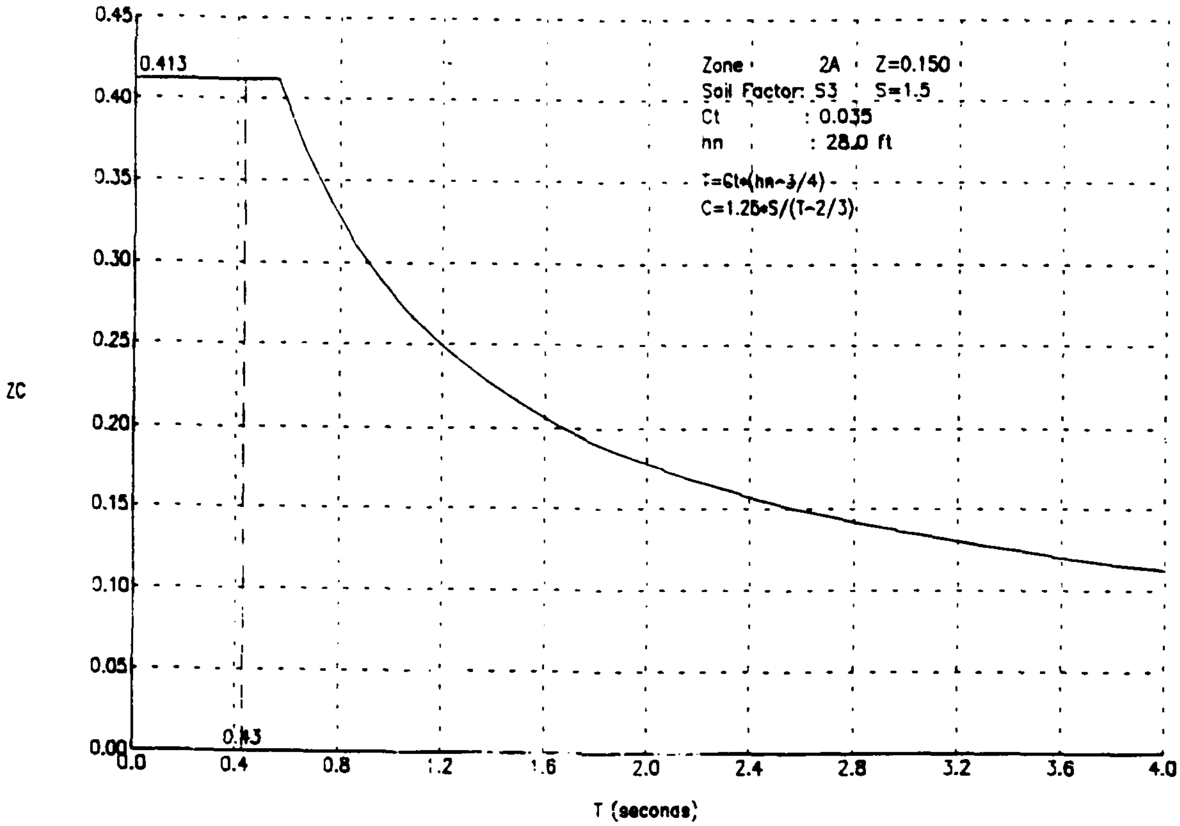
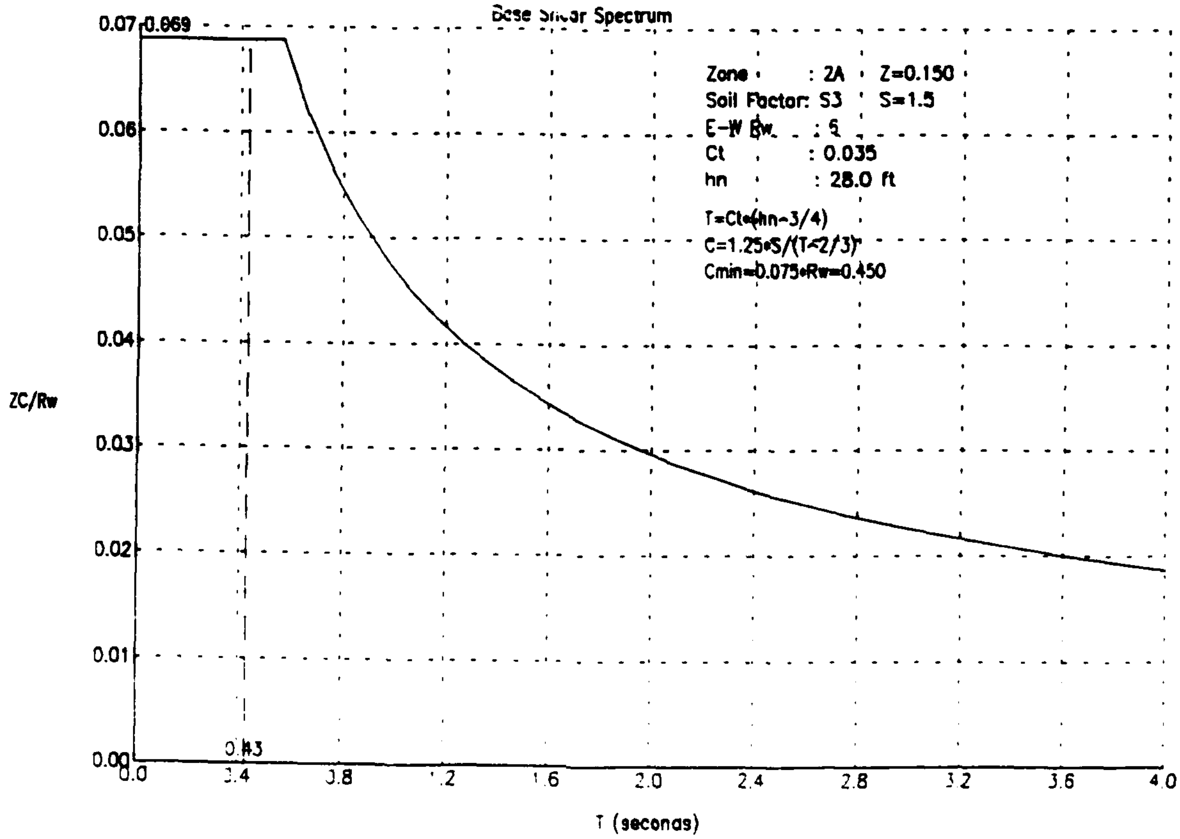


Base Shear Spectrum



Design Base Shear Coefficient Spectrum

```
Project      : Office Building - Scheme A
Location     : Radford AAP
Seismic Code: TM 5-809-10 1991
Time         : Sun Jan 26, 1992  1:40 PM

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

 3. Upper Roof                                   :      194.9 k
 2. Second Floor/Lower Roof                      :      686.9 k
-------------------------------------------------------------------
Total Building Weight (W)                        :      881.7 k

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

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: C3a: Rw = 6
Ct = 0.035
hn = 28.0 ft
T = Ct*hn^3/4 = 0.43 sec
C = 1.25*S/T^2/3 = 3.29 > 2.75
C = 2.75
C/Rw = 0.458 > 0.075
W = 881.7 k
V = Z*I*C*W/Rw
+-----------------------+
|      V = 60.6 k       |
+-----------------------+

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

+-----------------------+
|    V-Ft = 60.6 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		195		5457	0.362	21.9	
		14.0		195				21.9
2	14.0		687		9616	0.638	38.7	
		14.0		882				60.6
1	0.0							
Sum			882		15073	1.000	60.6	

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		195					
		14.0		195	21.9	307		0.113
2	14.0		687				307	
		14.0		882	60.6	849		0.069
1	0.0						1156	
Sum			882			1156		

```
Project     : Office Building - Scheme A
Location    : Radford AAP
Time        : Sun Jan 26, 1992  1:40 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	18.4	36.8	676.3	24.8	455.9
Column Self Weight	3.8	36.8	139.2	24.8	93.9
Sum	194.9		7178.2		4839.6

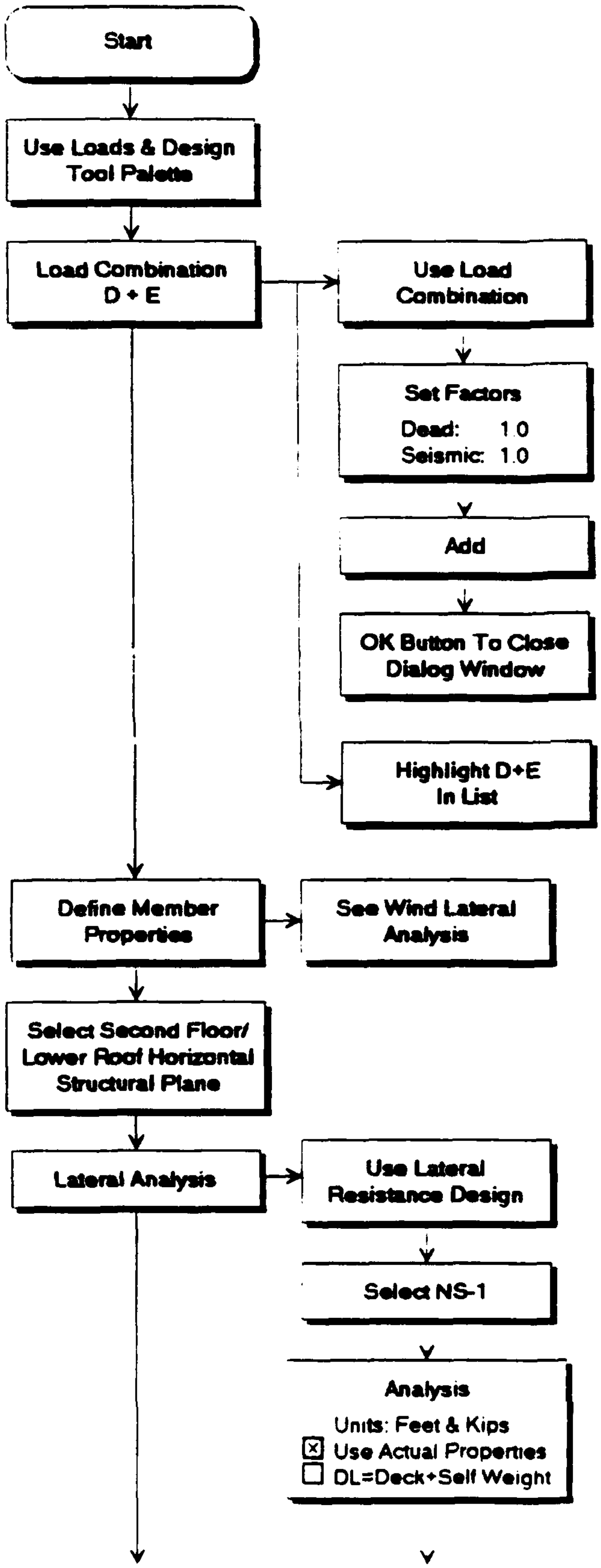
N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 24.83 ft

Second Floor/Lower Roof -- 14.00 ft

Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	72.9	12.8	935.1	24.8	1809.5
Second Floor	60.7	36.8	2236.5	28.8	1750.8
Second Floor	72.9	60.8	4432.6	24.8	1809.5
Lower Roof	123.6	36.8	4554.0	66.8	8263.2
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	24.8	36.8	914.9	36.2	899.9
Column Self Weight	5.7	36.8	208.8	36.2	205.4
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	3.8	36.8	139.2	24.8	93.9
Sum	686.9		25299.0		27738.8

N-S Center Of Mass: 36.83 ft
E-W Center Of Mass: 40.39 ft

Seismic Lateral Analysis



Draw Upper Roof framing

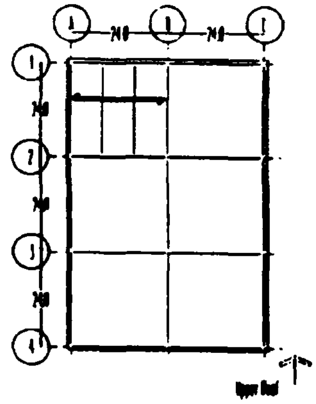
Draw Surface In Bay A1-B2

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

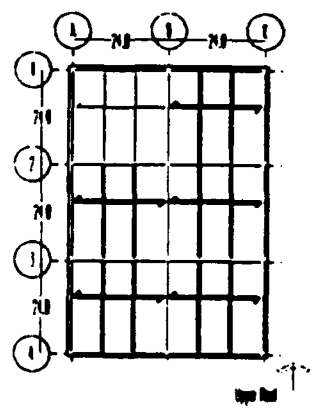
Double Click Right Mouse Key To End Selecting Structure

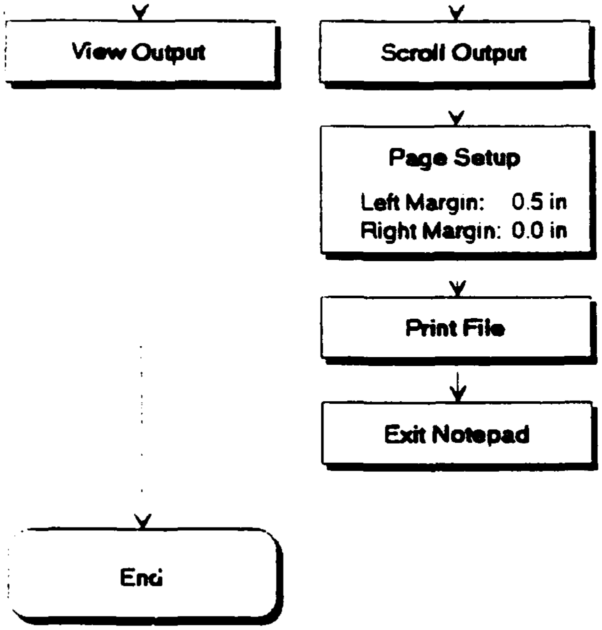
Select Grid Location A1 As The Base Point

Paste Structure

Select Grid Locations B1, A2, B2, A3, B3

Double Click Right Mouse Key To End

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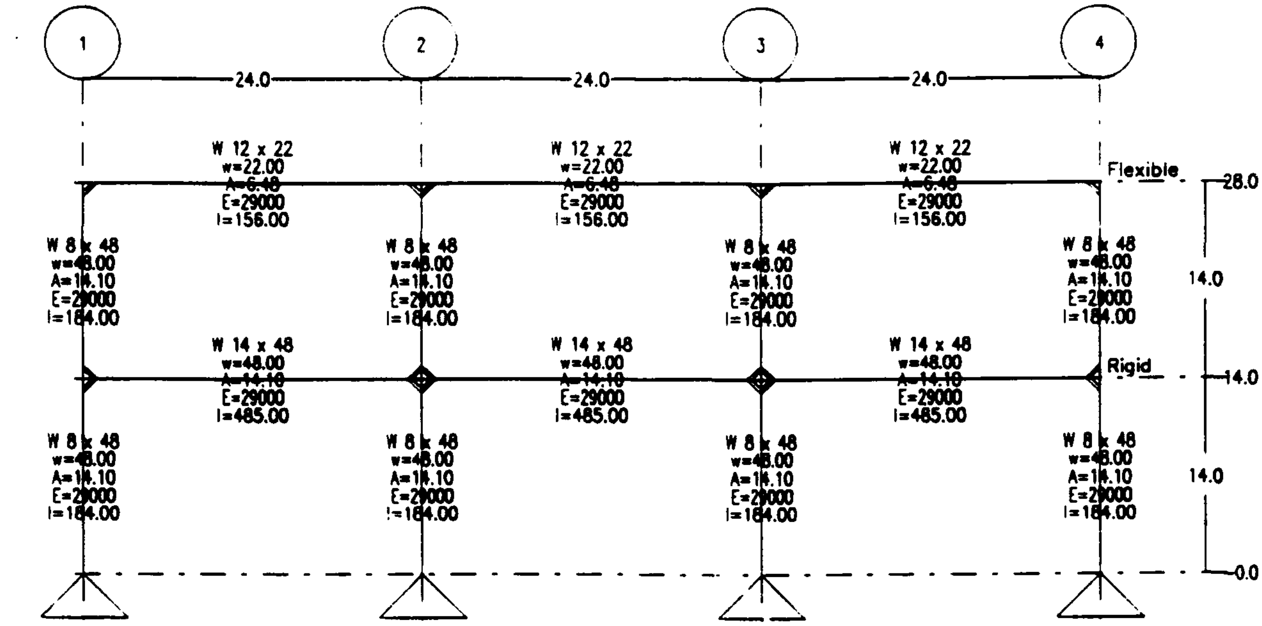
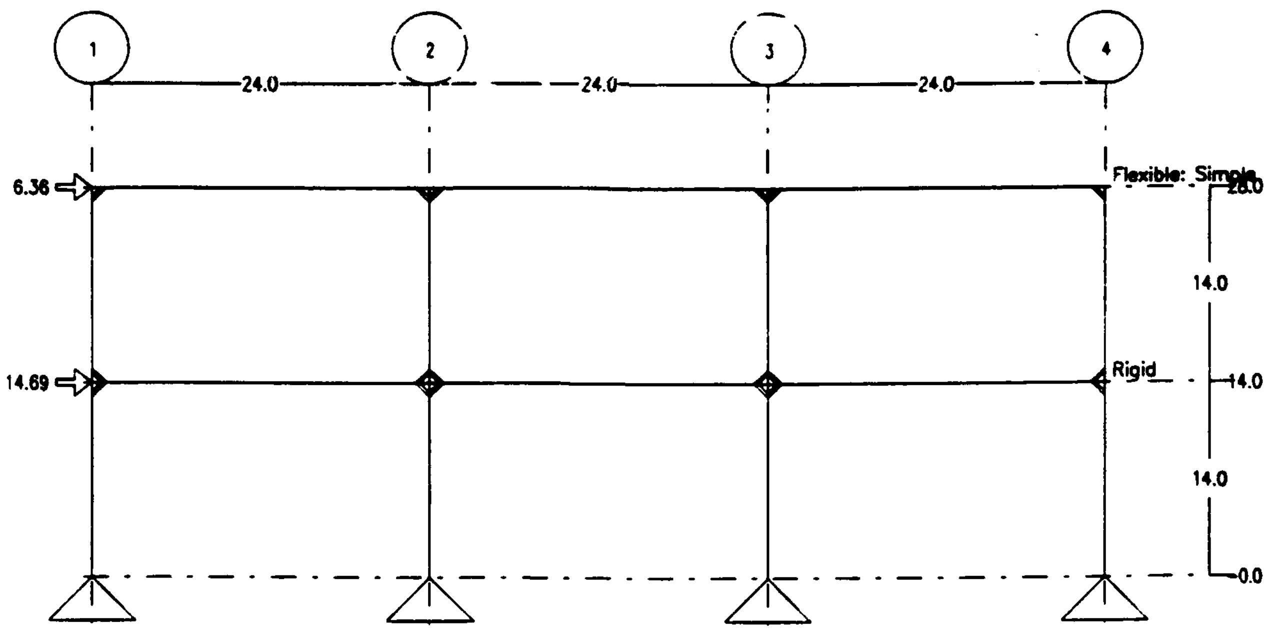
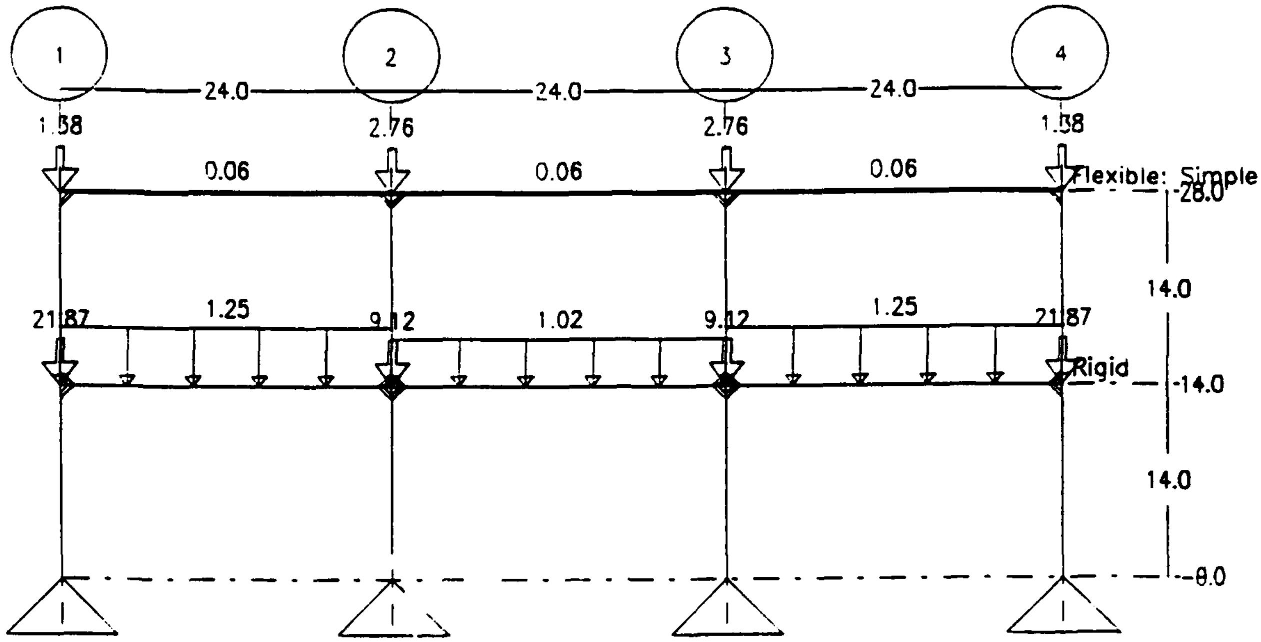
Scroll Output
Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in
Print File
Exit Notepad
End



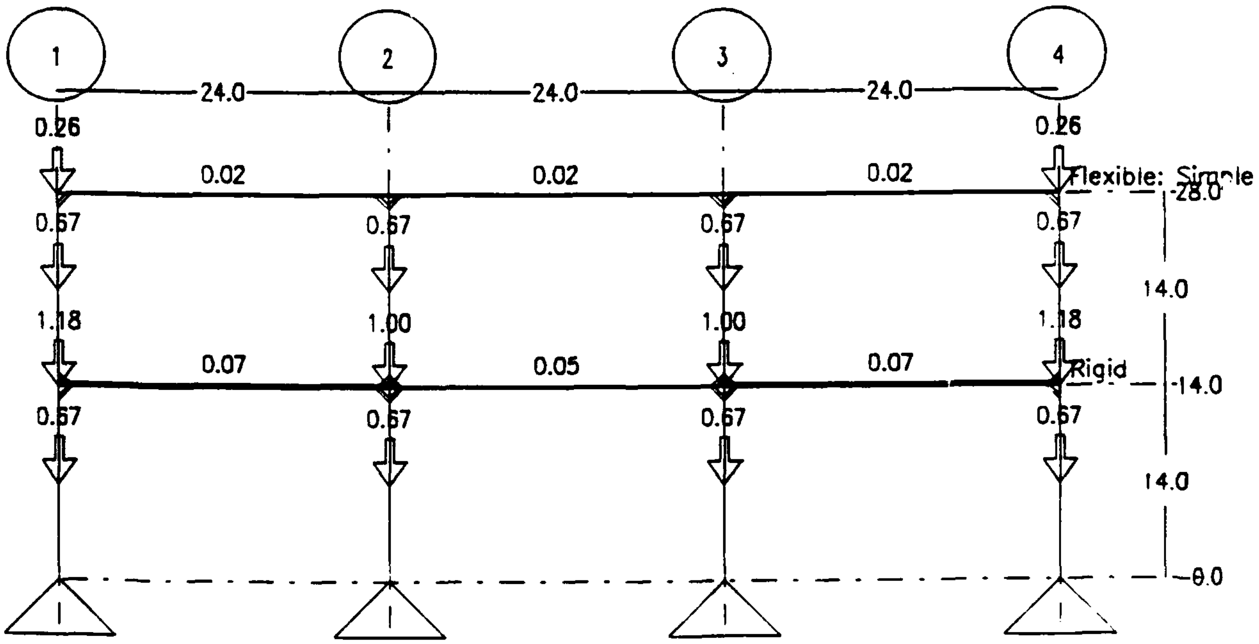
Properties: w (plf), A (in2), E (ksi), I (in4)



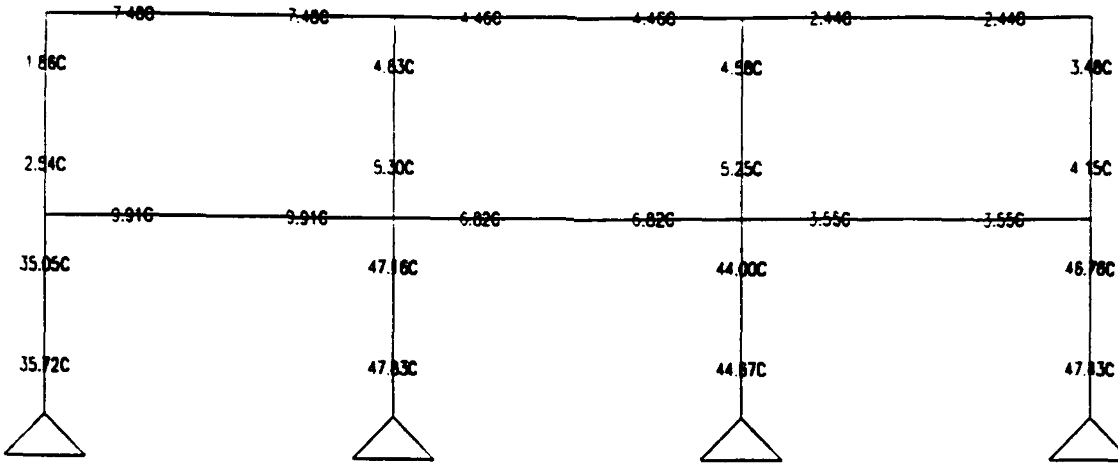
1.00 Seismic (klf) -- NS-1 -- F, 32%



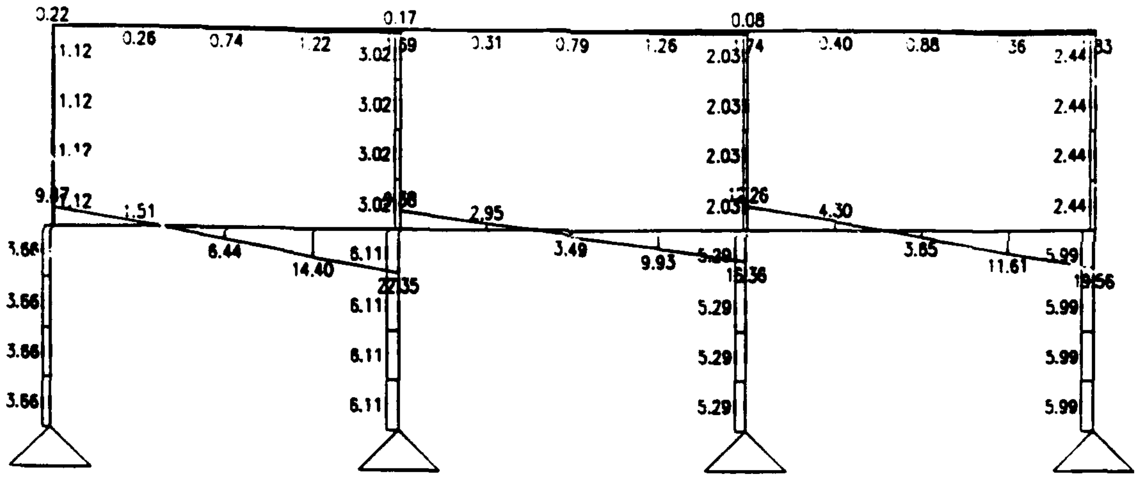
1.00 Superimposed Dead (klf)



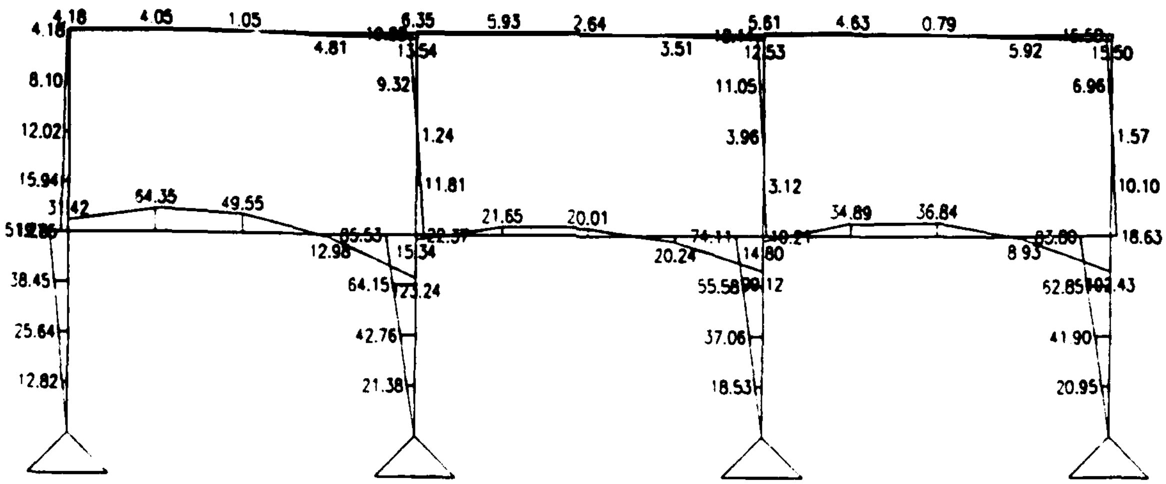
1.00 Dead (klf)



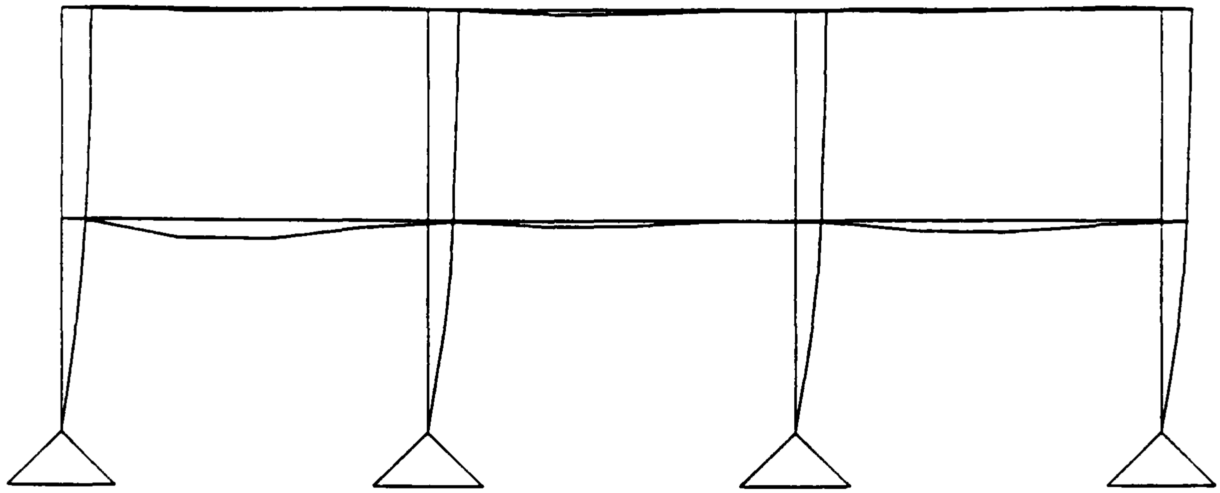
Total Combined Load -- Axial (k)



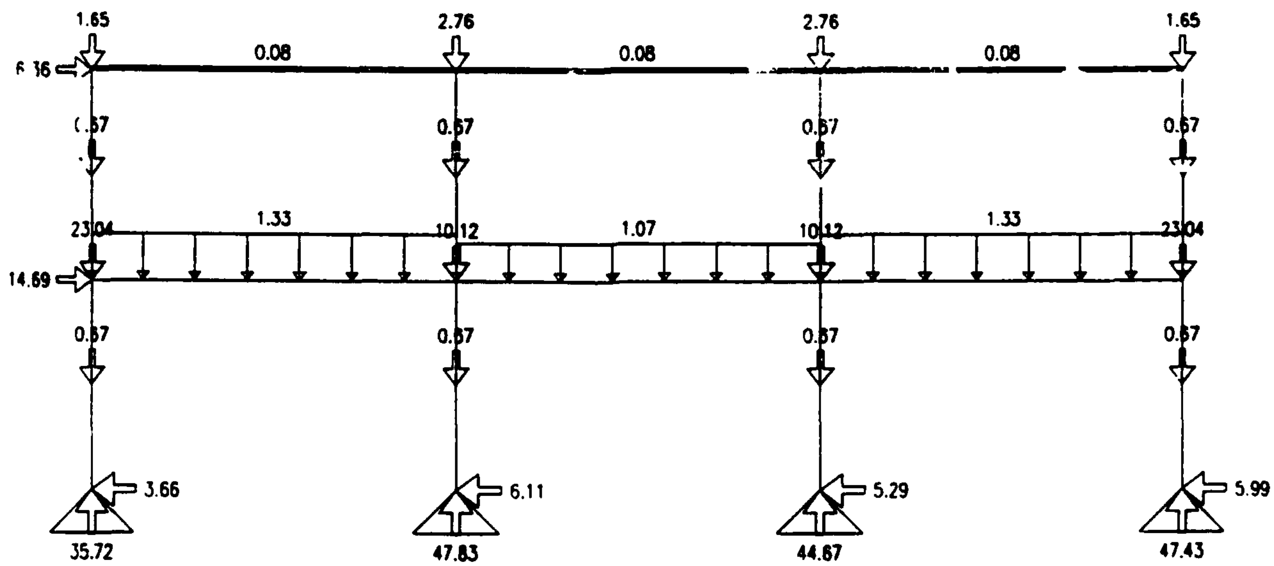
Total Combined Load -- Shear (k)



Total Combined Load -- Moment (kft)



Total Combined Load -- Deflection



Total Combined Load -- Loads & Reactions (k)

Project : Office Building - Scheme A
Location : Radford AAP
Seismic Code: TM 5-809-10 1991
Time : Sun Jan 26, 1992 1:43 PM

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

NS-1 -- F, 32%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

NS-2 -- F, 32%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		21.9			
		14.0		21.9	307	
2	14.0		38.7			307
		14.0		60.6	849	
1	0.0					1156
Sum			60.6		1156	

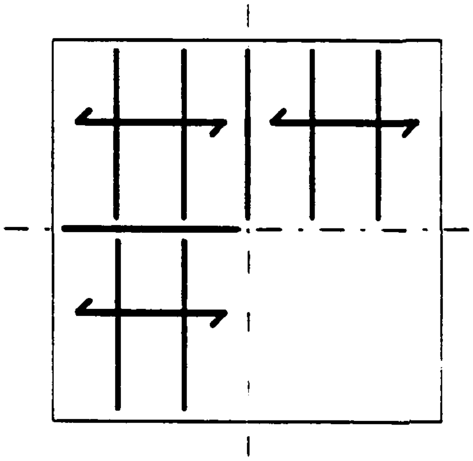
NS-3 -- F, 35%

Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		38.7			
		14.0		38.7	541	
1	0.0					541
Sum			38.7		541	

Quantity Take-Off Philosophy

3 Considerations

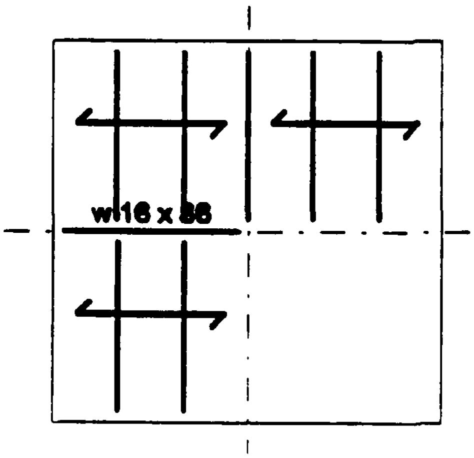
1. One typical interior bay (exterior side bay, corner bay)



2 bays
by
2 bays

2. One typical floor level and roof level

3. The entire building structural system



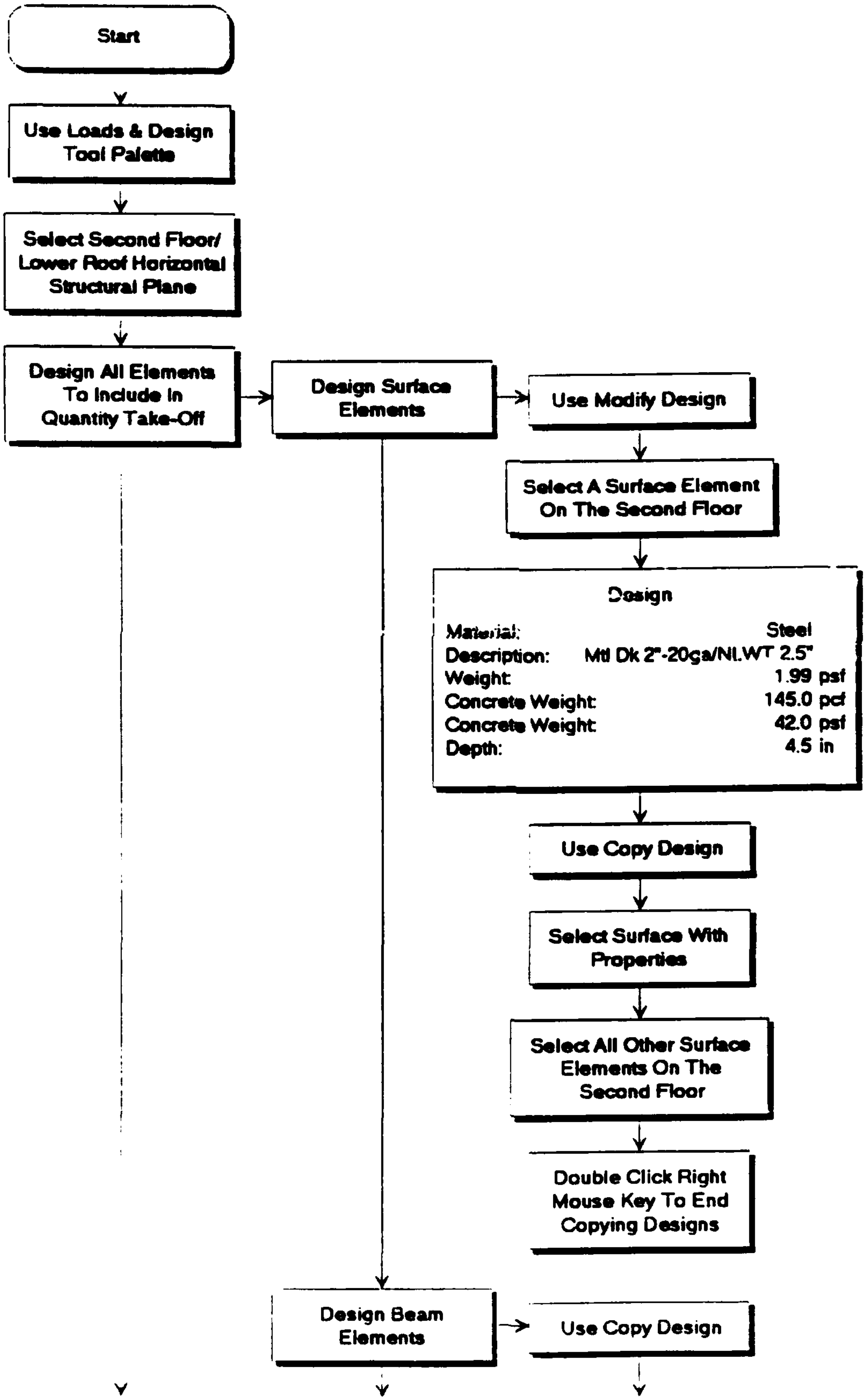
Estimated weights are not used for quantity take-offs

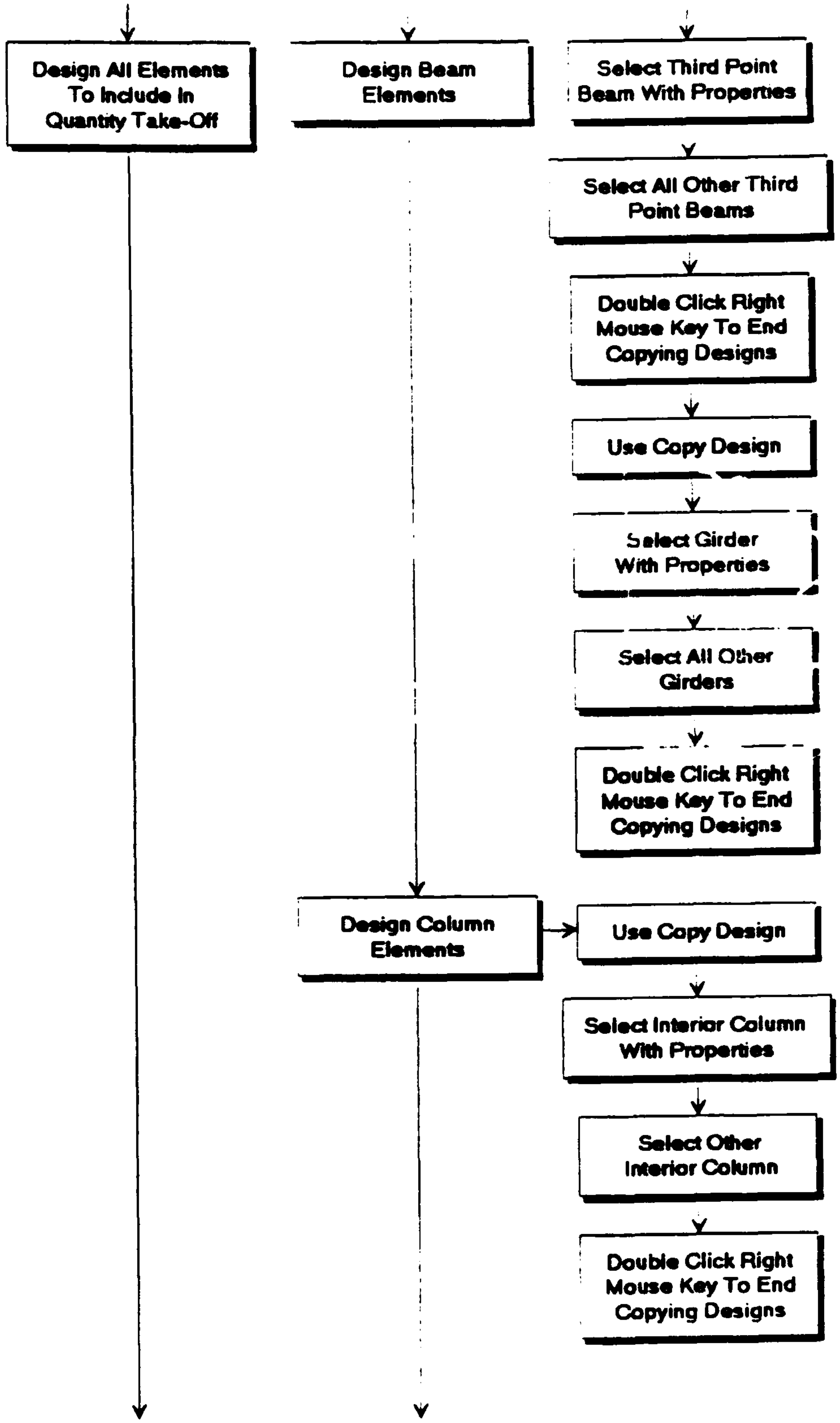
Elements designed by Excel spreadsheets are used

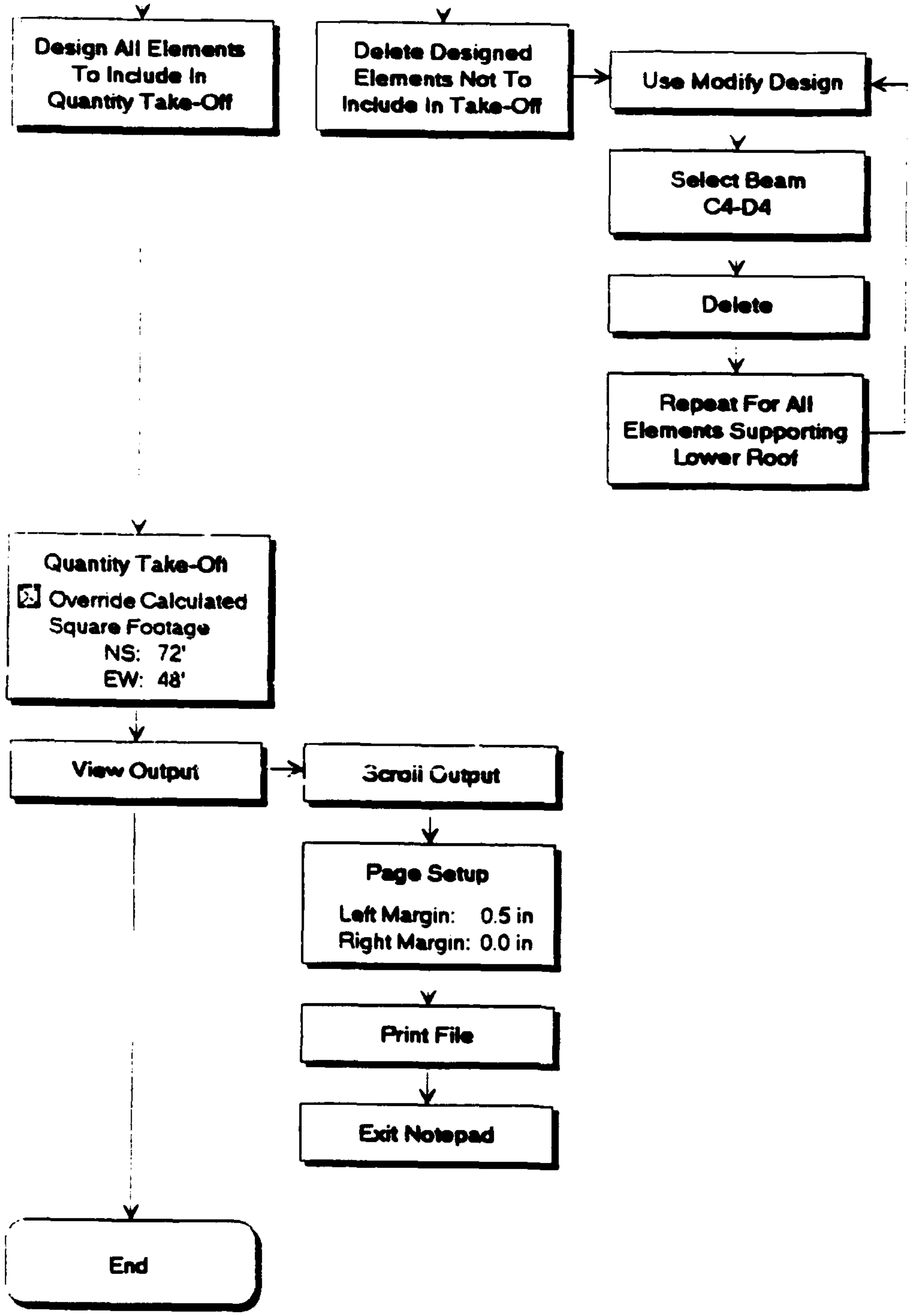
Use Modify Design and Copy Design to manually enter element sizes

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 A
Location : Radford AAP
Time : Sun Jan 26, 1992 1:57 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)
	24.0	0.0	0.0	24	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 48	24.0	48.0	1152.0	10	11520
	18.0	0.0	0.0	4	0
W 21 x 66	24.0	68.0	1632.0	4	6528
W 16 x 40	24.0	40.0	960.0	15	14400
	24.0	0.0	0.0	3	0
Sum					32448

Total Weight : 16.2 tons
Weight Per Square Foot : 9.4 psf

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total Weight (lbs)	Total 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 48	14.0	48.0	672.0	10	6720
W 8 x 28	14.0	28.0	392.0	2	784
	14.0	0.0	0.0	6	0
Sum					7504

Total Weight : 3.8 tons
Weight Per Square Foot : 2.2 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.

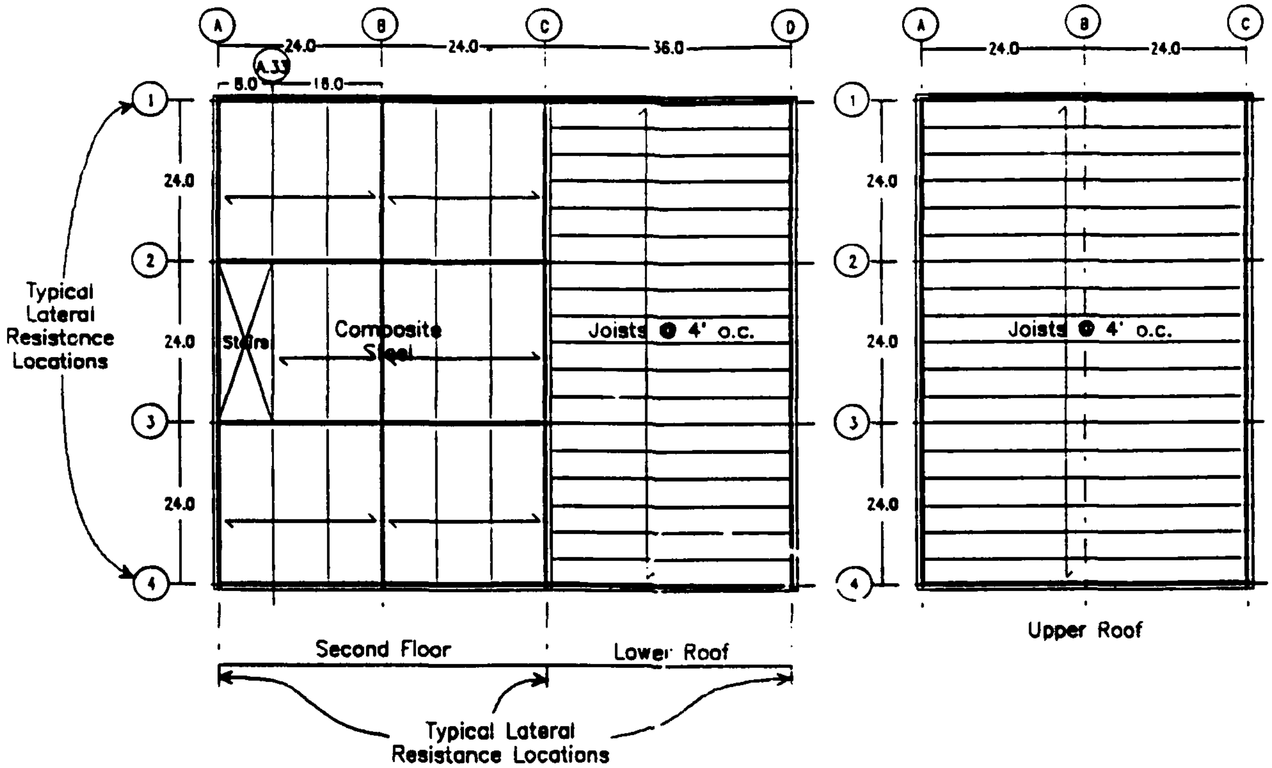
Examples of unlikely components assembled in schemes A, B and C include: (1) concrete as a decking for the low roof, (2) custom made trusses for the low roof framing, (3) prefabricated limestone wall panels mixed with cast-in-place concrete shear walls, and (4) non-composite steel beam framing for the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

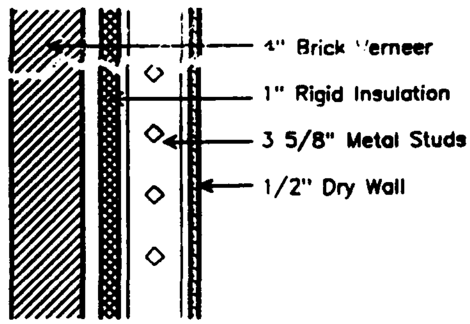
It is unlikely that a reinforced concrete frame would present an economical solution for a 1-2 story office building.

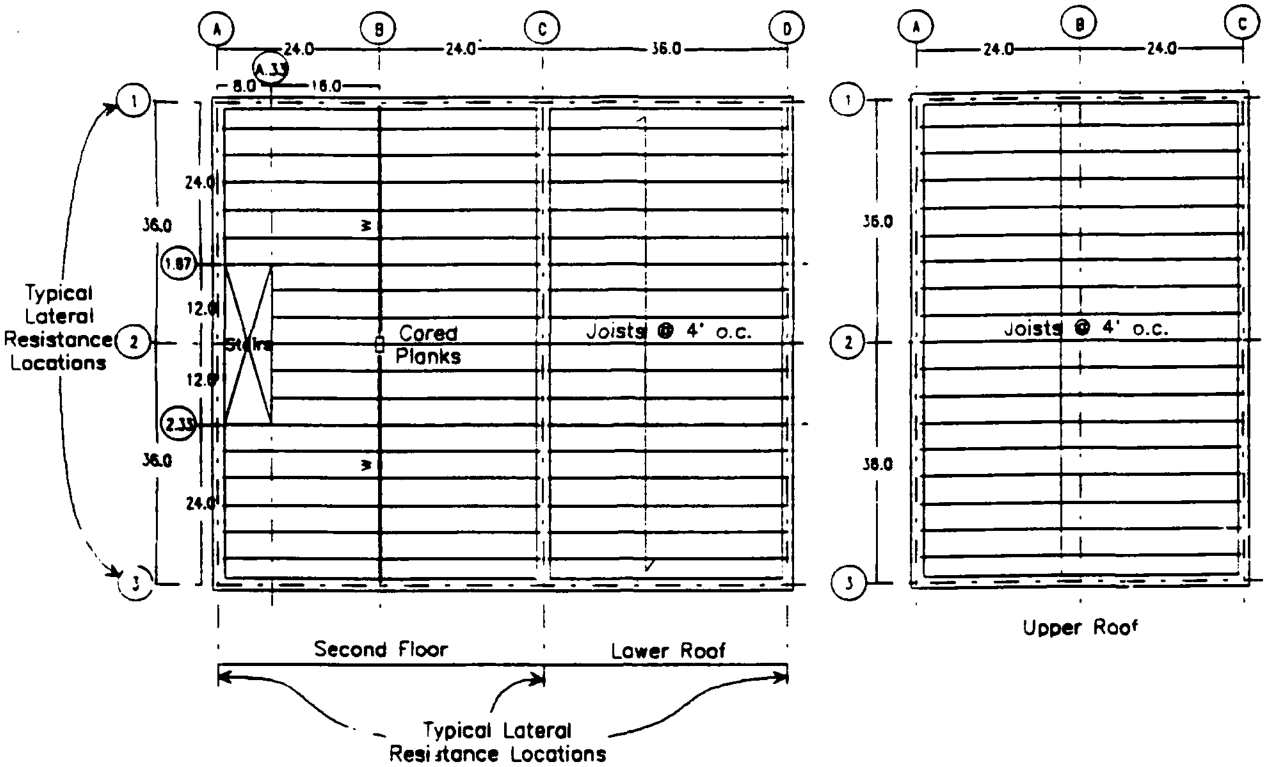
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.



Scheme 1: Moment connections for lateral load resistance

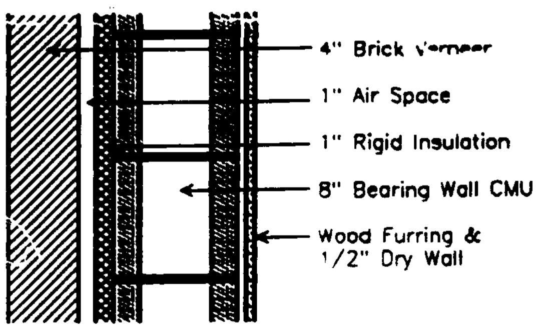
Scheme 2: Trussing for lateral load resistance





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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