



Computer-Aided Structural Engineering (CASE) Project

Version 6.00

by *David Wickersheimer, Carl Roth, Gene McDermott*
Wickersheimer Engineers, Inc.

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Prepared for Headquarters, U.S. Army Corps of Engineers

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Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 4 Scheme B

by David Wickersheimer, Carl Roth, Gene McDermott

Wickersheimer Engineers, Inc.
821 South Neil Street
Champaign, IL 61820

Report 4 of a series

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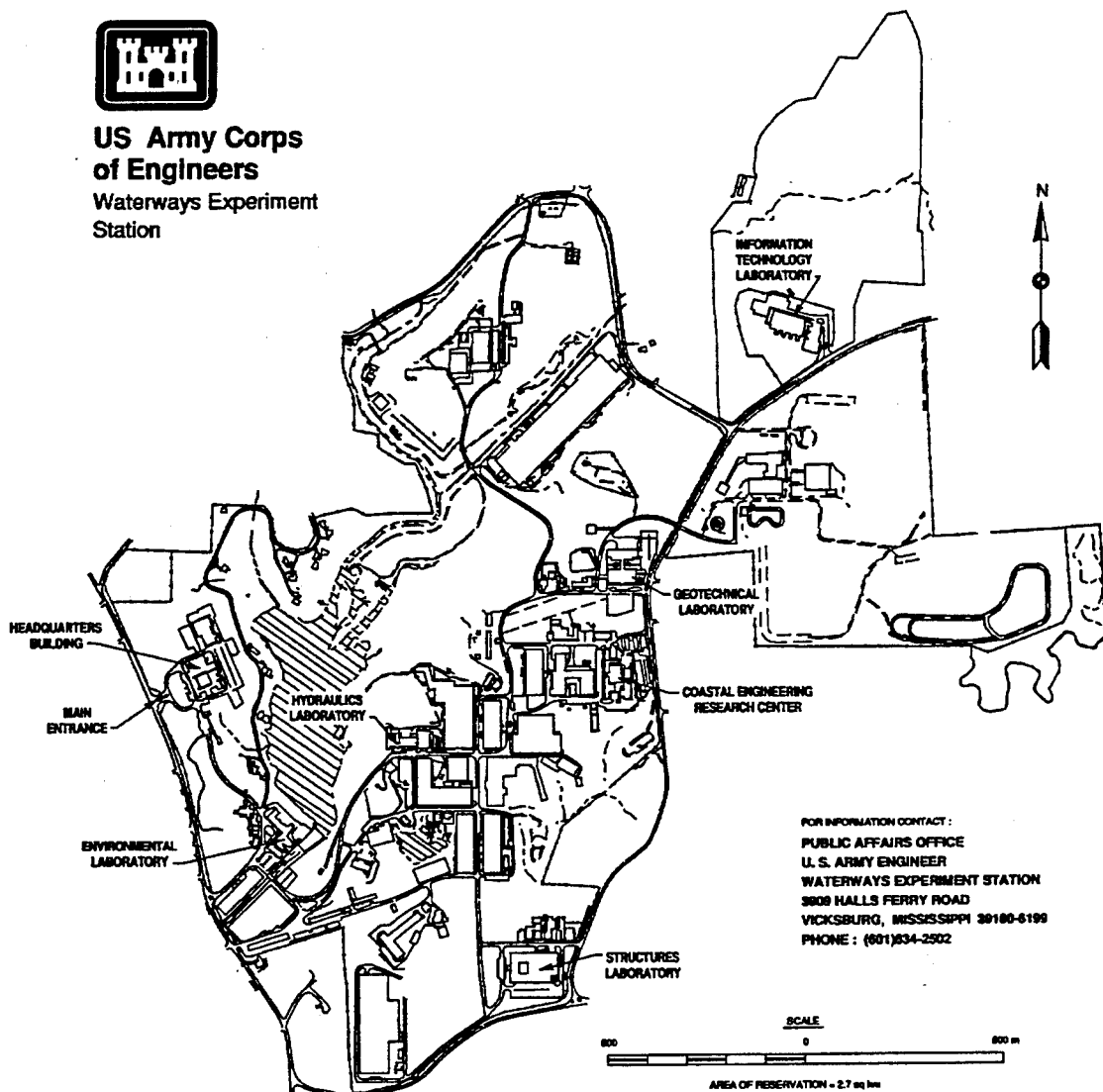
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PREFACE

This report describes the computer program CASM, which is designed to aid the structural engineer in the preliminary design and evaluation of structural building systems by the use of three-dimensional interactive graphics, to describe the structural framing scheme for X-braced frames that are all steel, composite, with lateral load resistance. Funds for the development of this program and publication of this user's guide were provided to the Information Technology Laboratory (ITL), U.S. Army Engineer Waterways Experiment Station (WES), Vicksburg, MS, by the Directorate of Military Programs, Headquarters, U.S. Army Corps of Engineers (HQUSACE), under the Research, Development, Test, and Evaluation (RDT&E) program. The work was accomplished under Work Unit No. AT40-CA-001 entitled "CASE (Computer Aided Structural Engineering) Building Systems." The work was performed by members of Wickersheimer Engineers, Inc., of Champaign, IL, under Contract No. DACA39-86-C-0024.

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

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The work was monitored at WES by Mr. Michael E. Pace and Mr. Chris Merrill, Computer-Aided Engineering Division (CAED), under the general supervision of Mr. H. Wayne Jones, Chief, Scientific and Engineering Applications Center; Dr. Reed Mosher, Chief, CAED; Mr. Timothy Ables, Assistant Director, ITL; and Dr. N. Radhakrishnan, Director, ITL. Mr. Donald Dressler was the original HQUSACE point of contact, and Mr. Charlie Gutberlet is the present technical monitor.

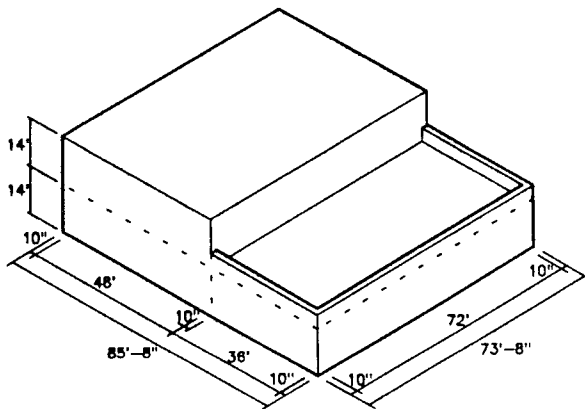
Dr. Robert W. Whalin is Director of WES. COL Bruce K. Howard, EN, is Commander.

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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:

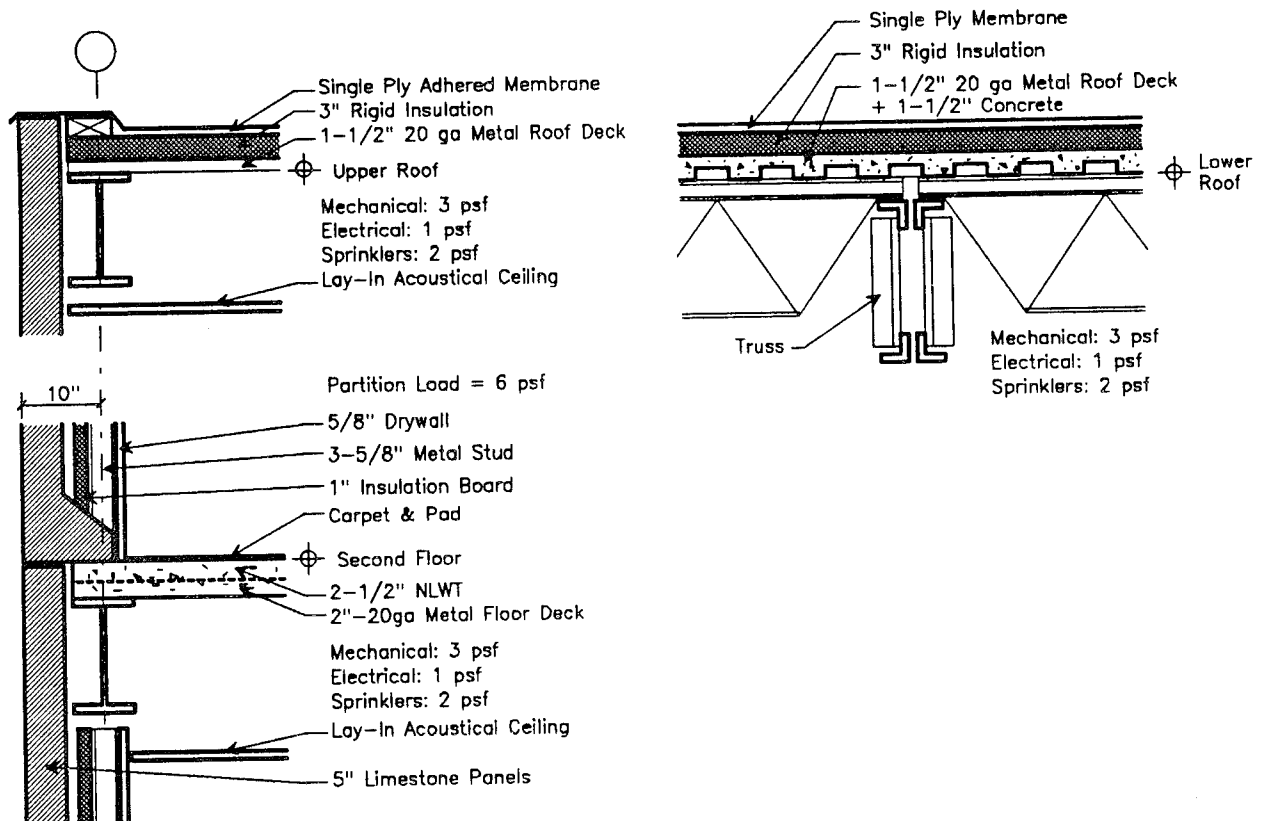
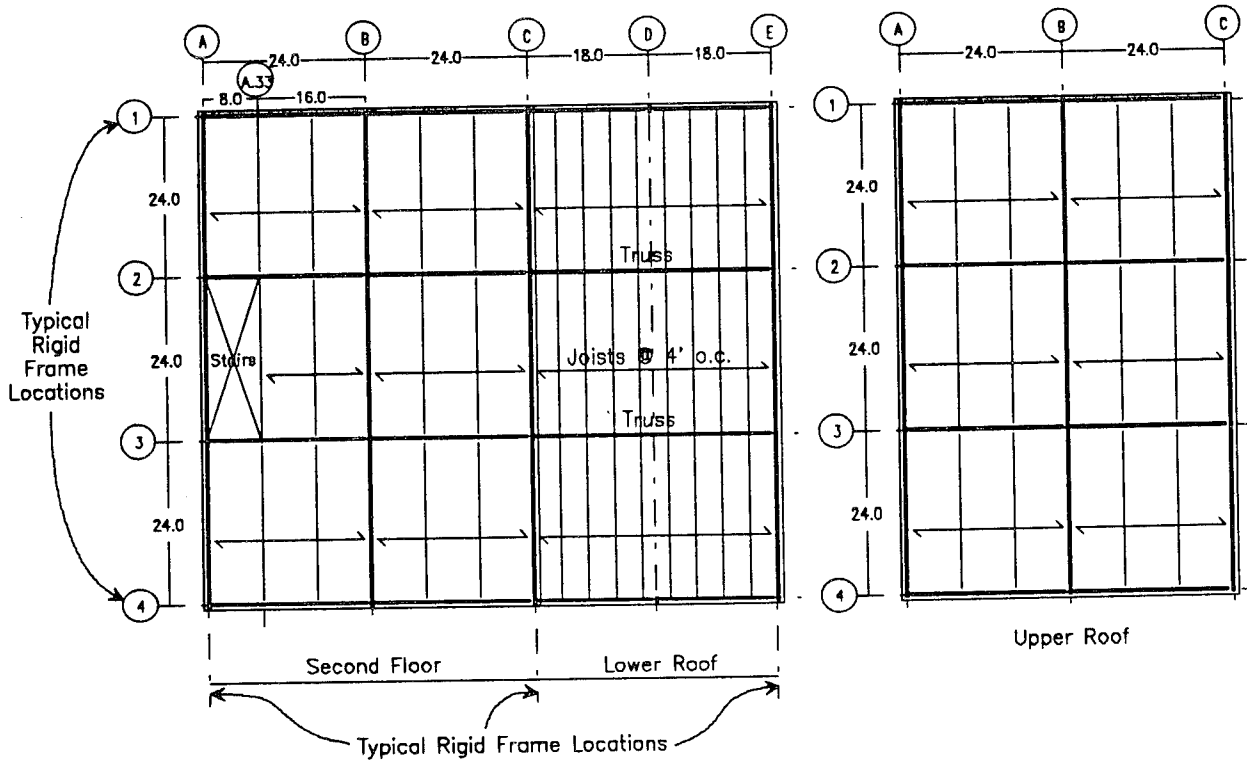
Scheme A: All steel, non-composite,
lateral load resistance = rigid frames.

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

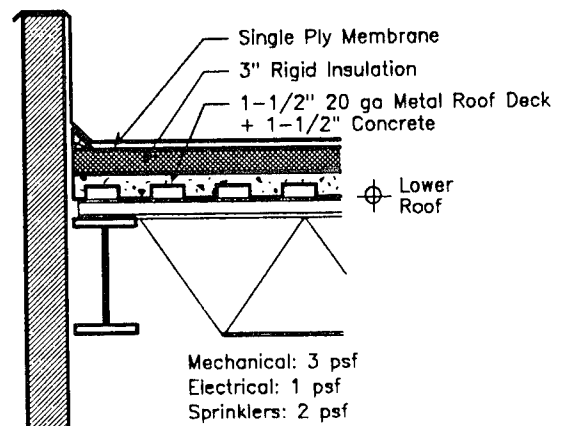
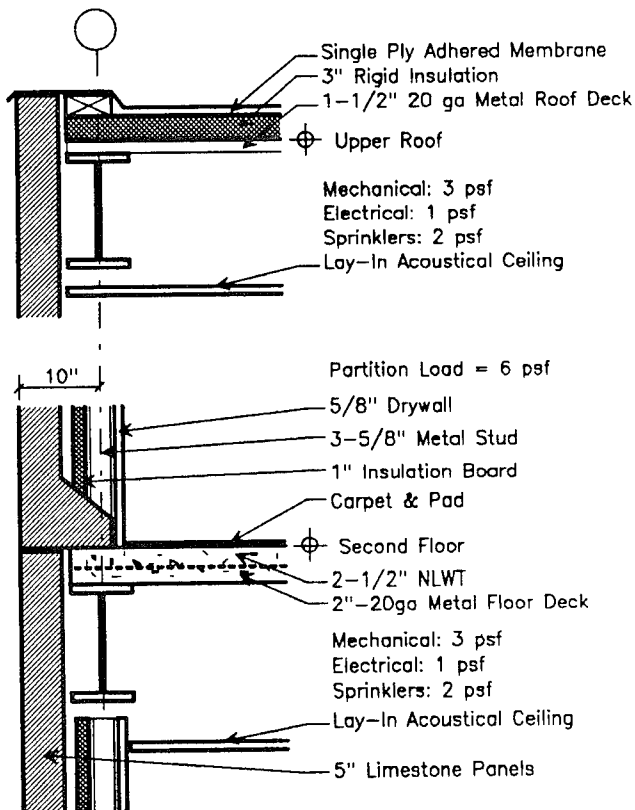
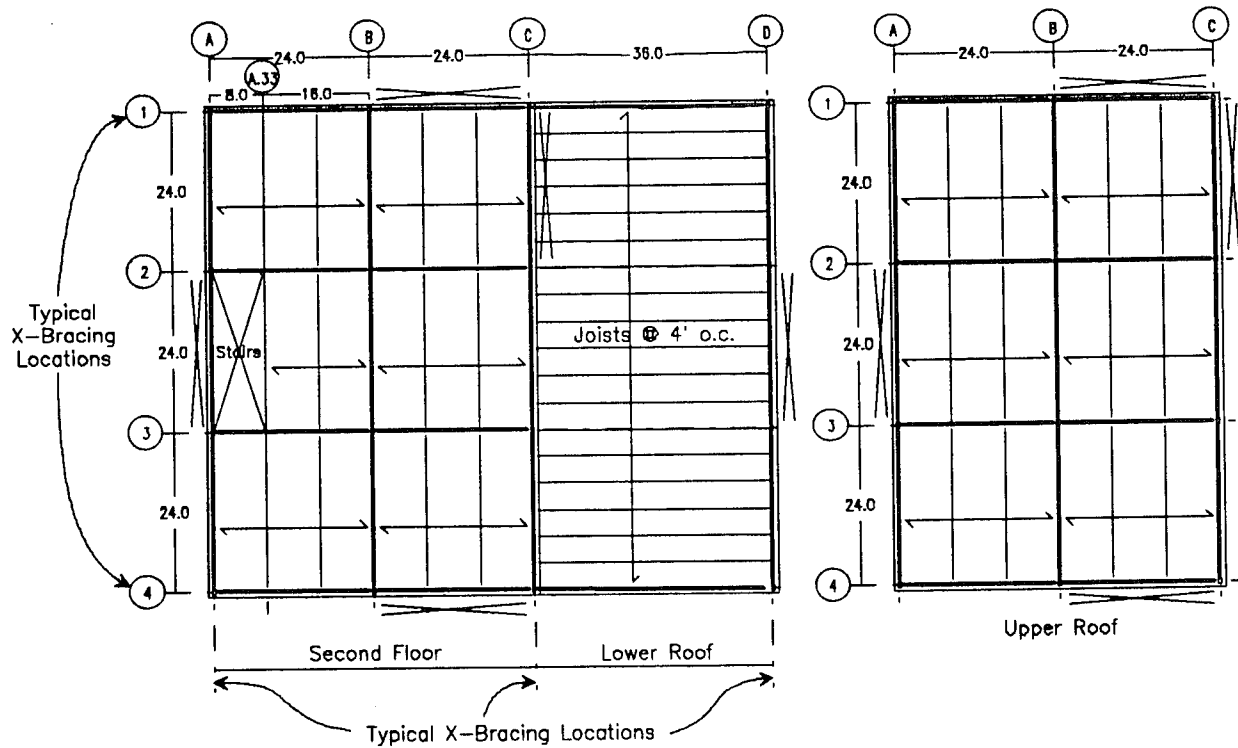
Scheme C: Monolithic concrete for two story portion, steel for lower roof portion,
lateral load resistance = shear walls.

Project Description

Scheme A

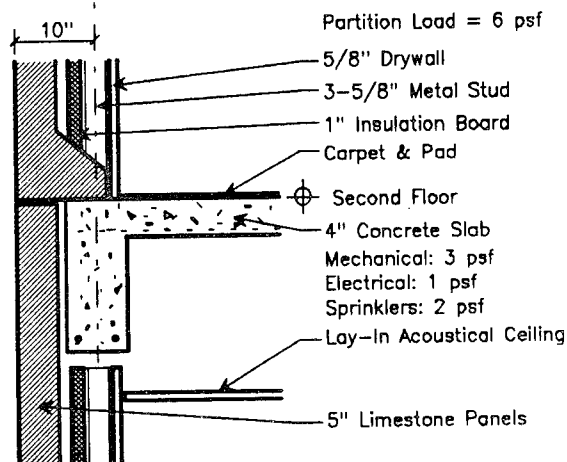
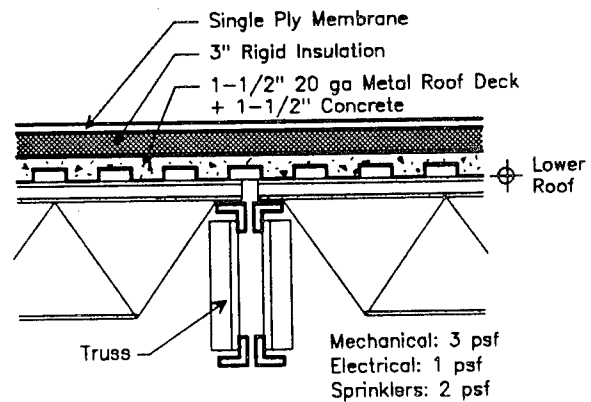
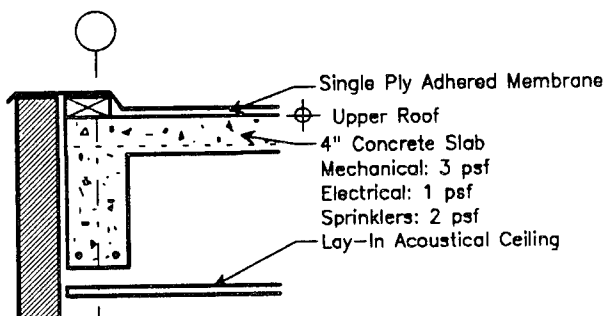
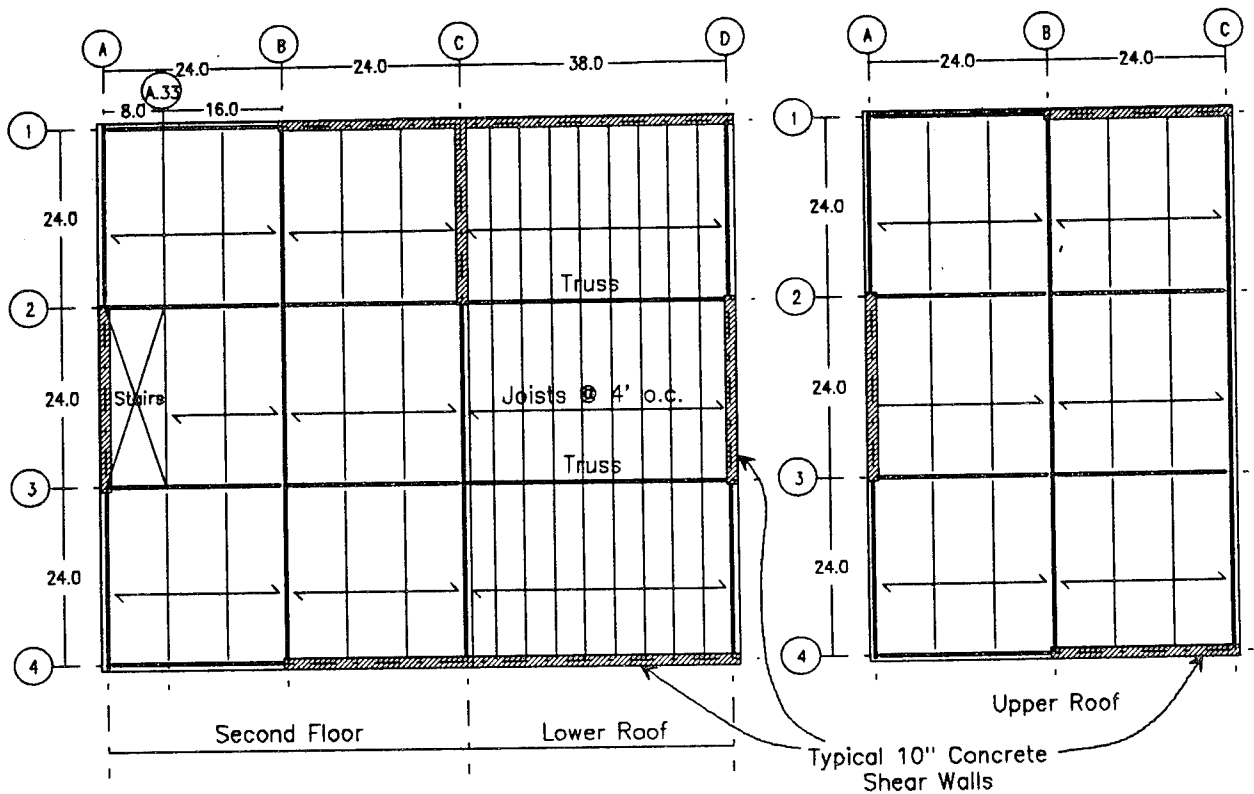


Scheme B



Project Description

Scheme C



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:

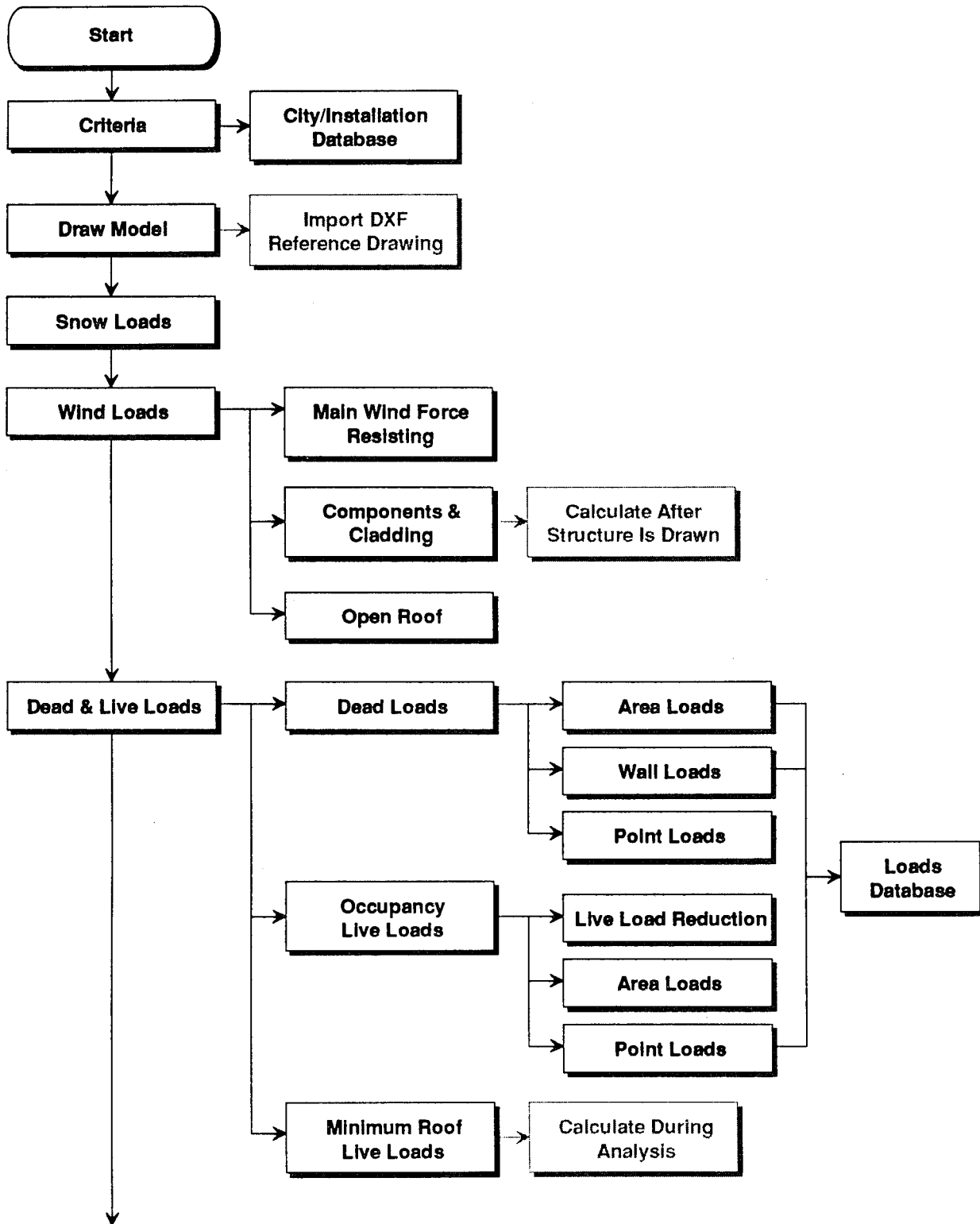
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

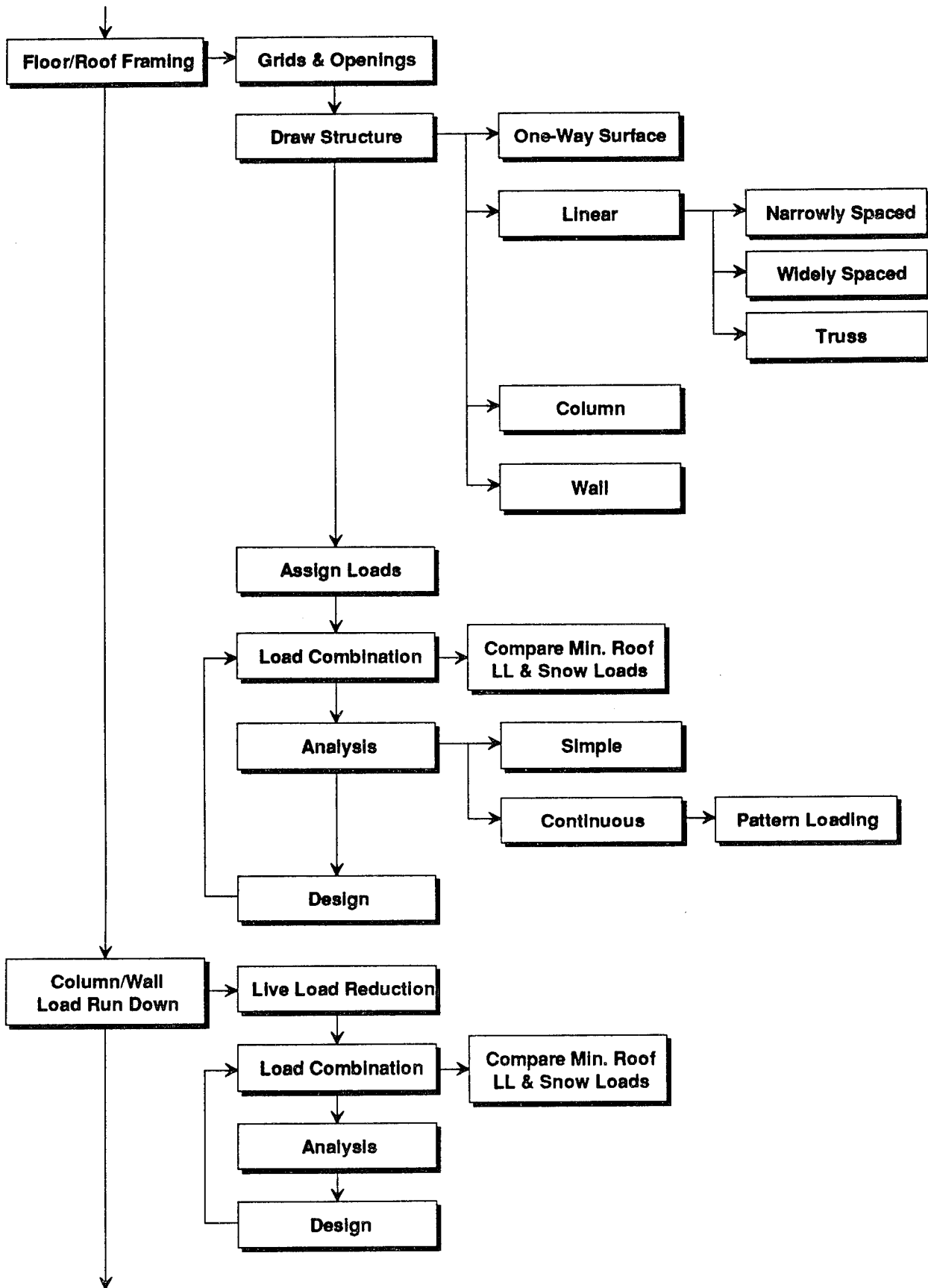
9. Material Assumptions:

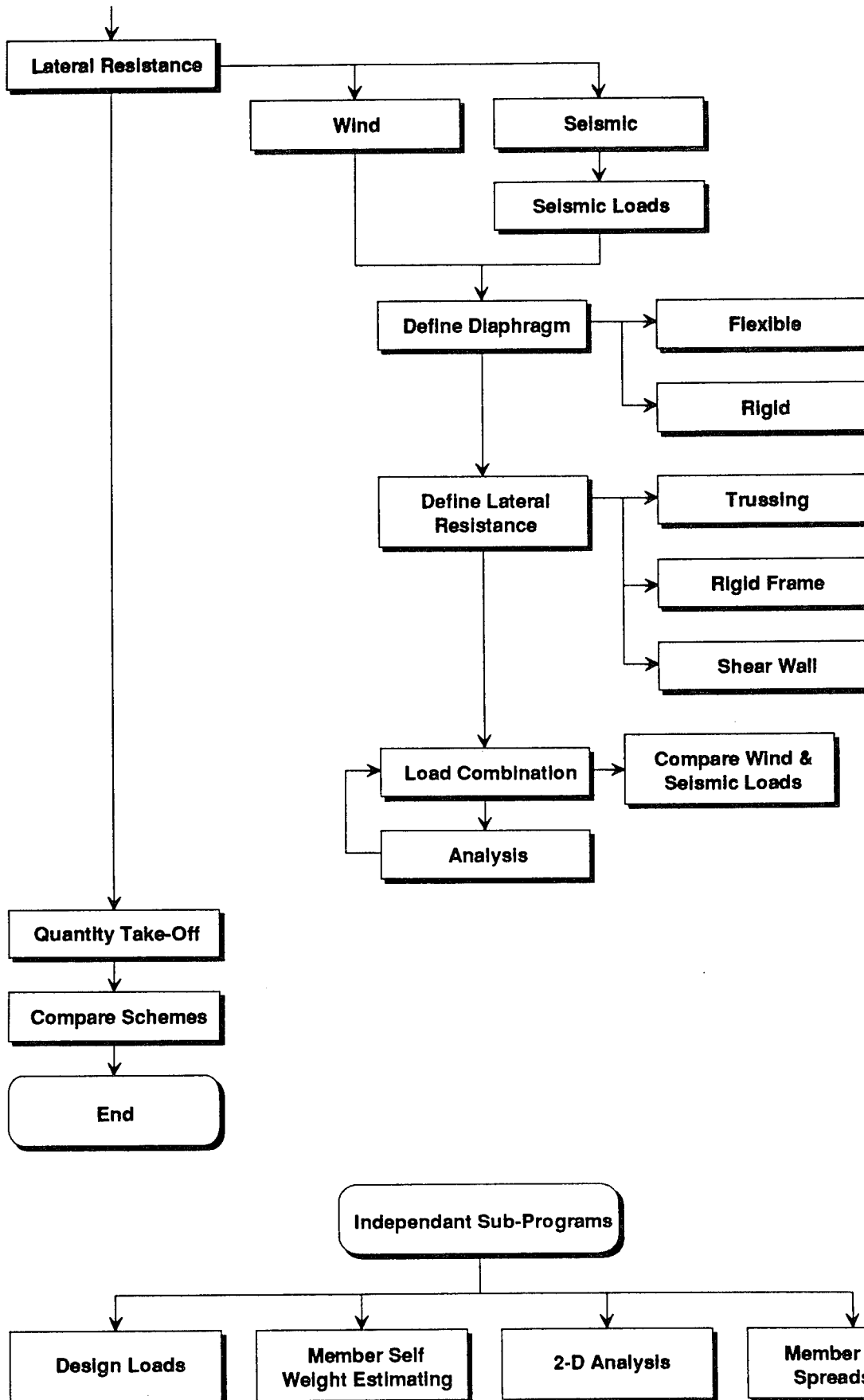
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

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

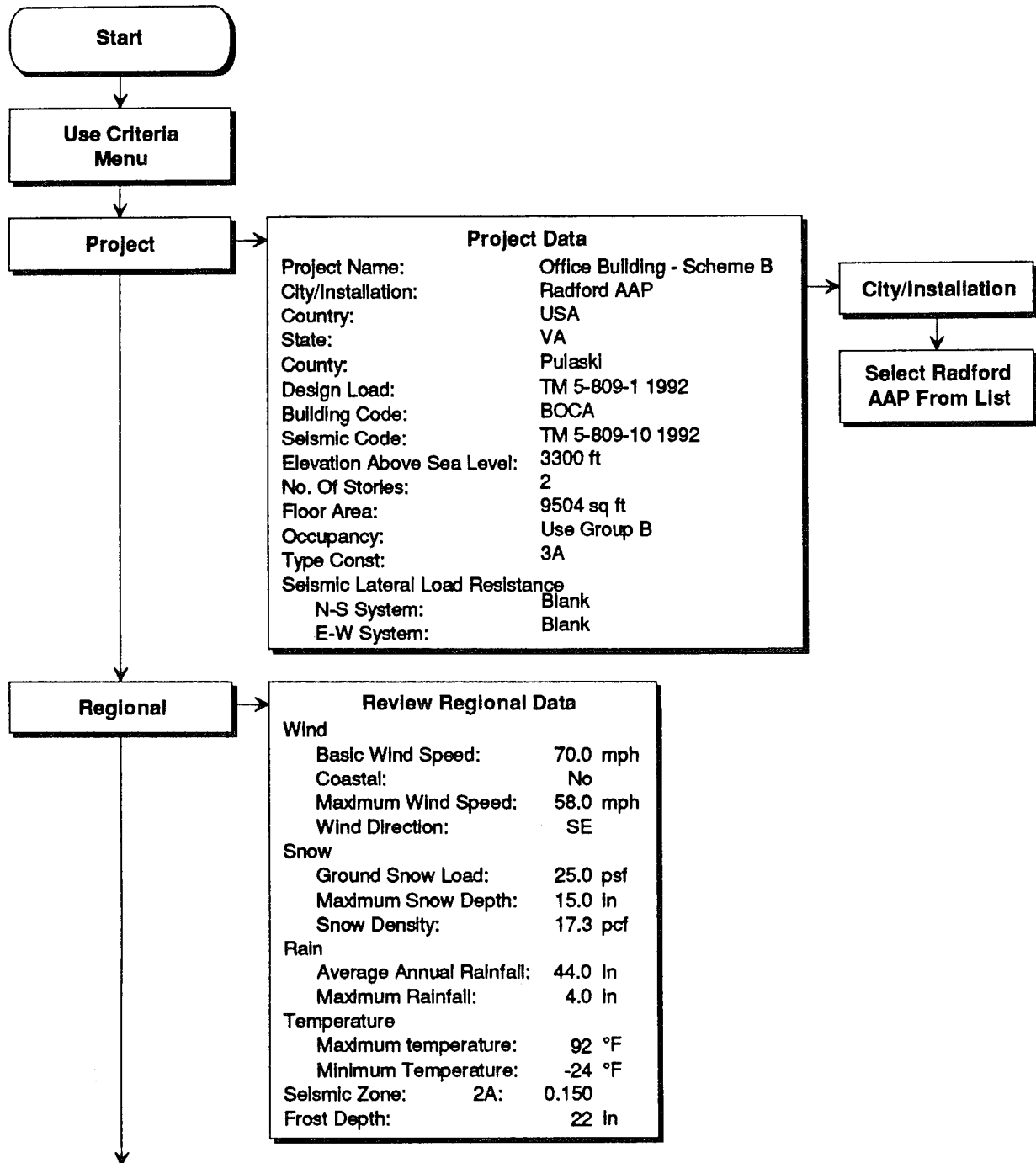
Computer Aided Structural Modeling

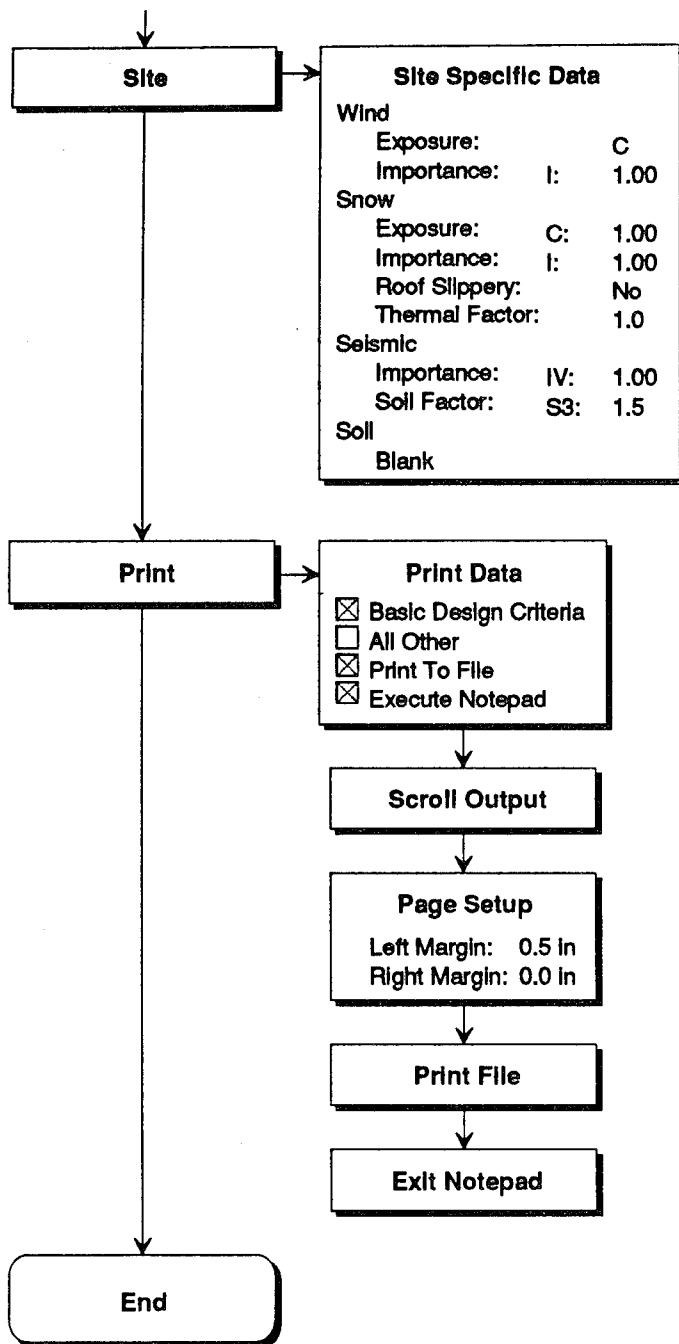






Criteria





Basic Design Criteria

Project Data

Project Name : Office Building - Scheme B
 City/Installation : Radford AAP
 Country : USA
 State : VA
 County : Pulaski
 Design Load : TM 5-809-1 1992
 Building Code : BOCA
 Seismic Code : TM 5-809-10 1992
 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 From Map : 70.0 mph
 Calculated Wind Speed : 0.0 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 °F
 Minimum Temperature : -24.0 °F

Seismic Zone : 2A

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.

Criteria

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 30.0 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 surgery 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 continued operation.

IV. Standard Occupancy Structure

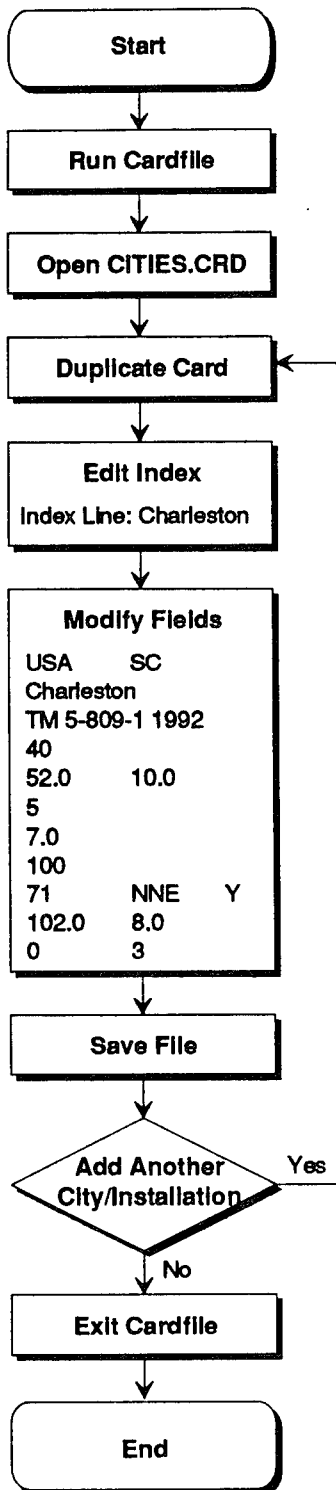
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

- S3: A soil profile 70.0 ft or more in depth and containing more than 20.0 ft of soft to medium stiff clay but not more than 40.0 ft of soft clay.

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

City/Installation Database



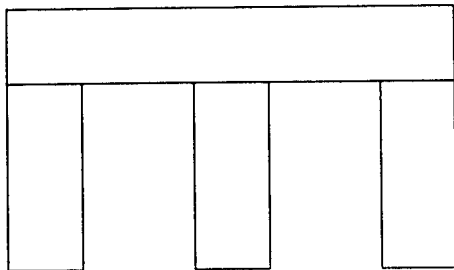
Fields		
Country	State	Metric
County		
Design Load		
Elevation (ft)		
Ave. Rain (In)	Max. Rain (In)	
Ground Snow Load (psf)		
Max. Snow Depth (In)		
Basic Wind Speed (mph)		
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)
Max. Temp. (°F)	Min. Temp. (°F)	
Frost Depth (In)	Seismic Zone	

Modeling Philosophy

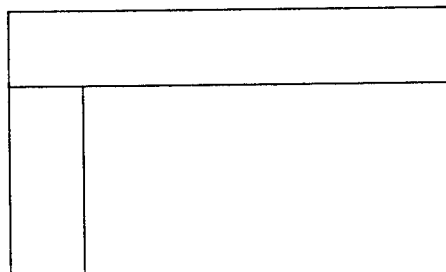
A. Simplify the geometric model

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

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



Extra wings are not necessary



Simplified model

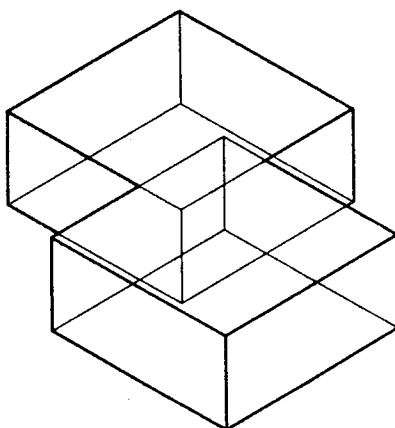
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

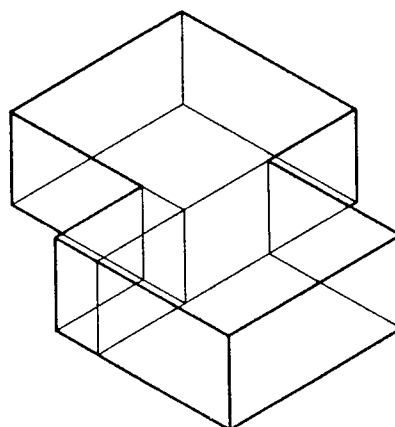
Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

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



Incorrect

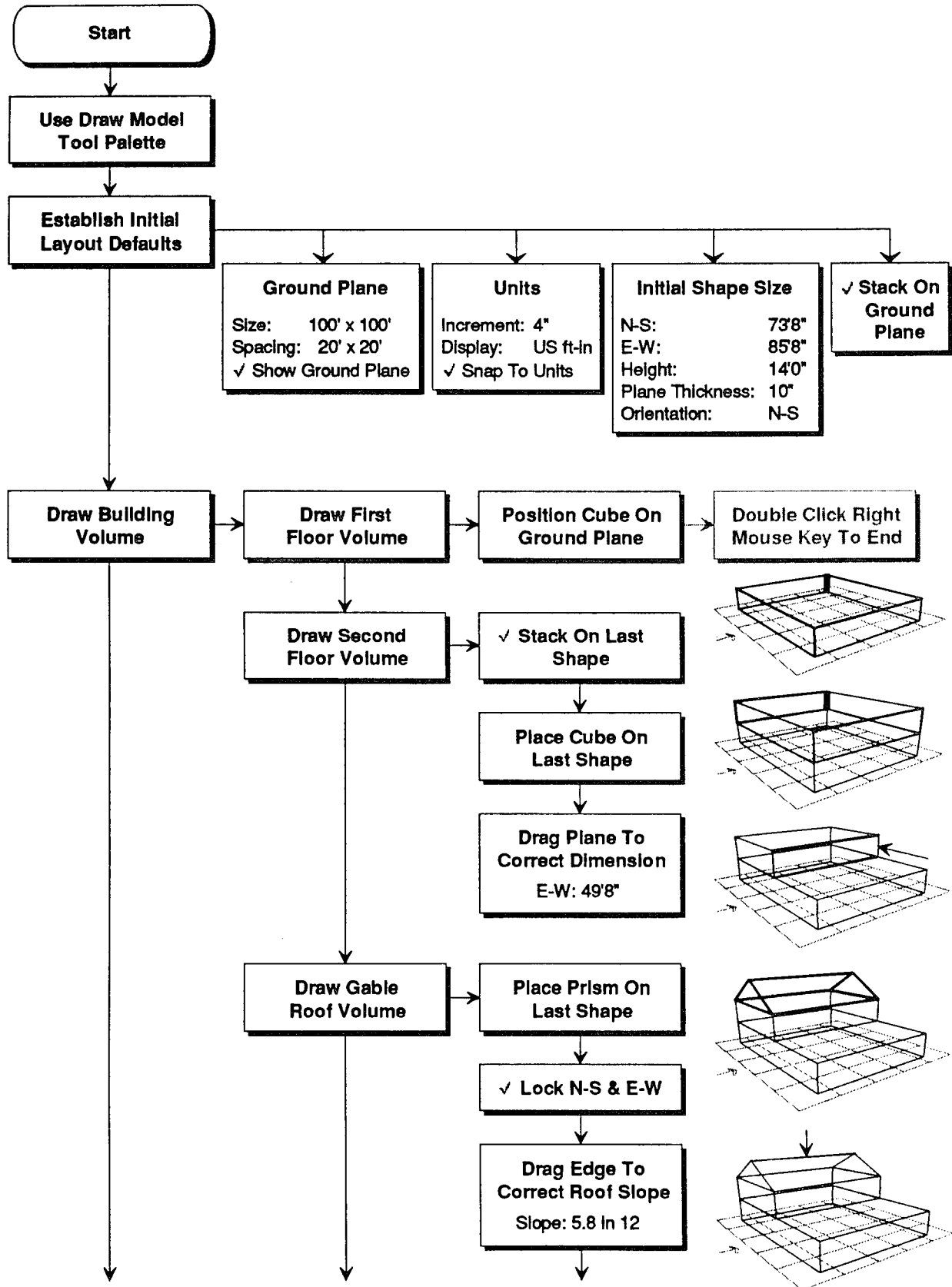


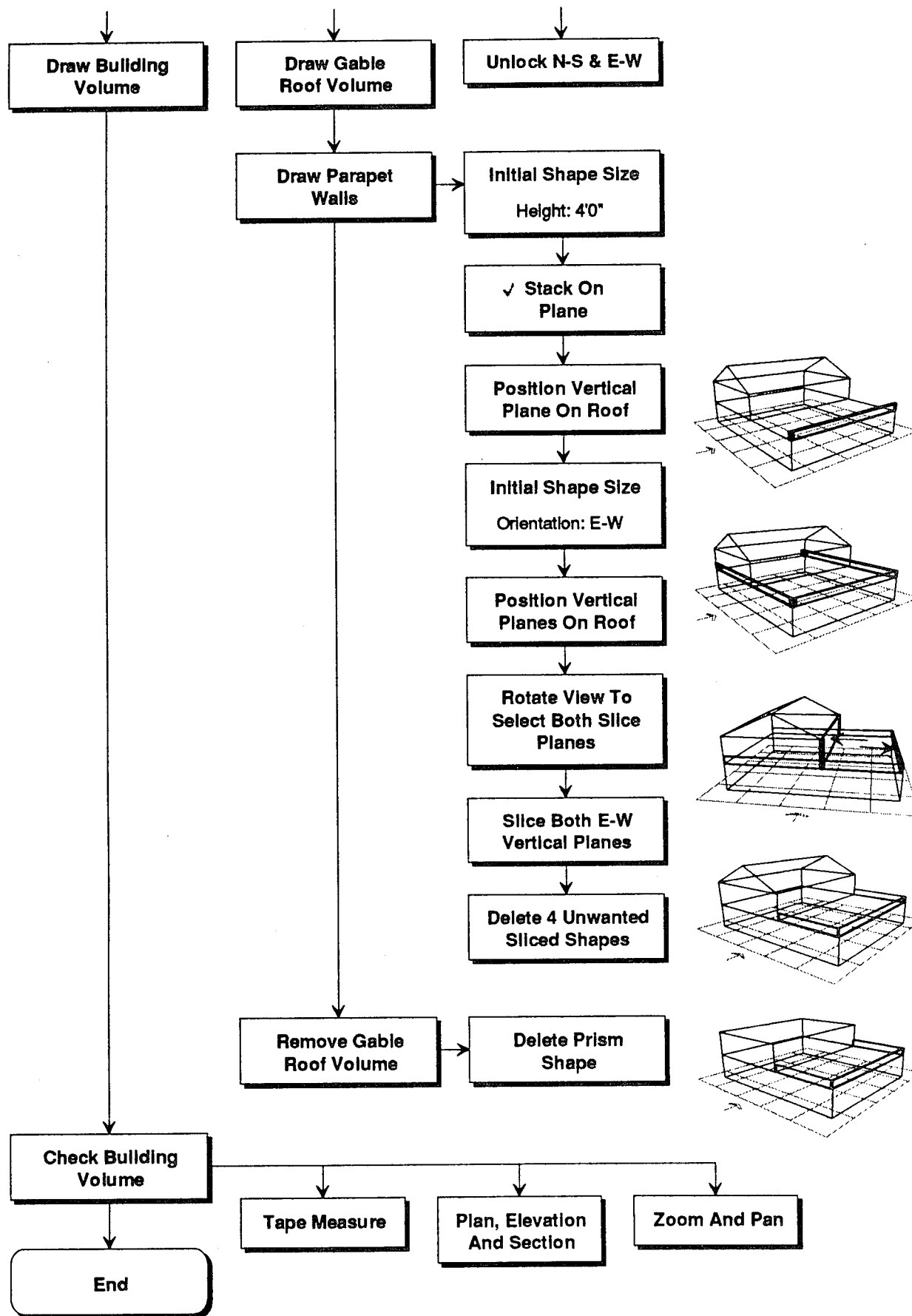
Correct

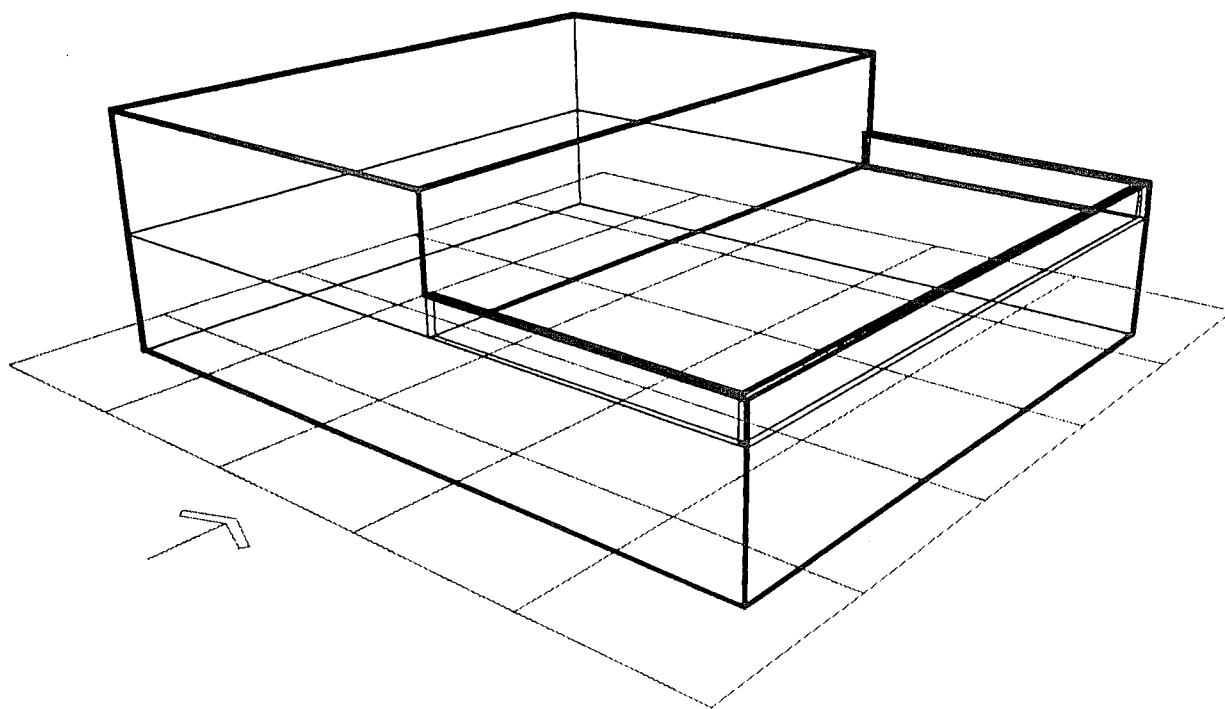
D. Verify the model

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

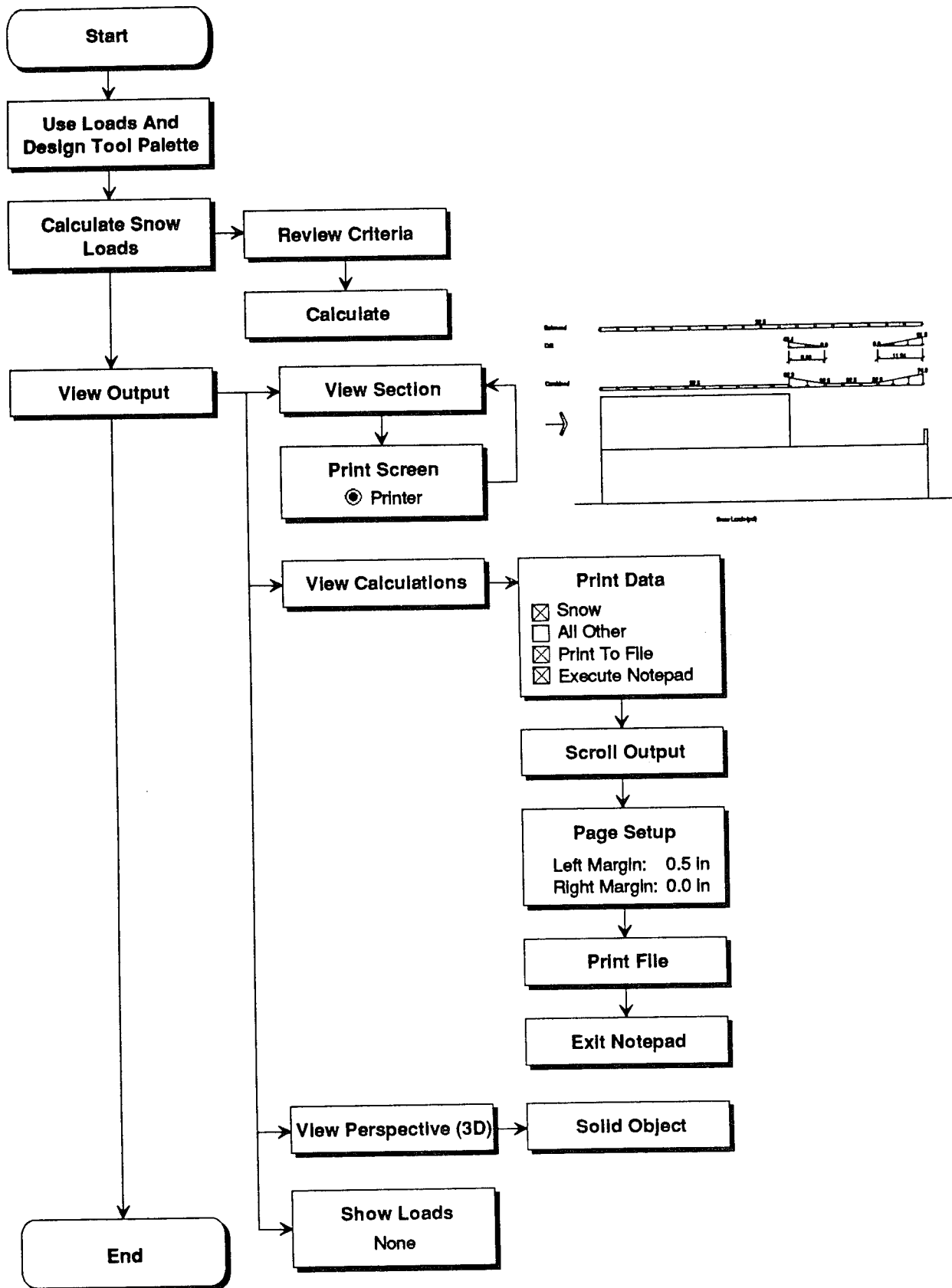
Draw Model



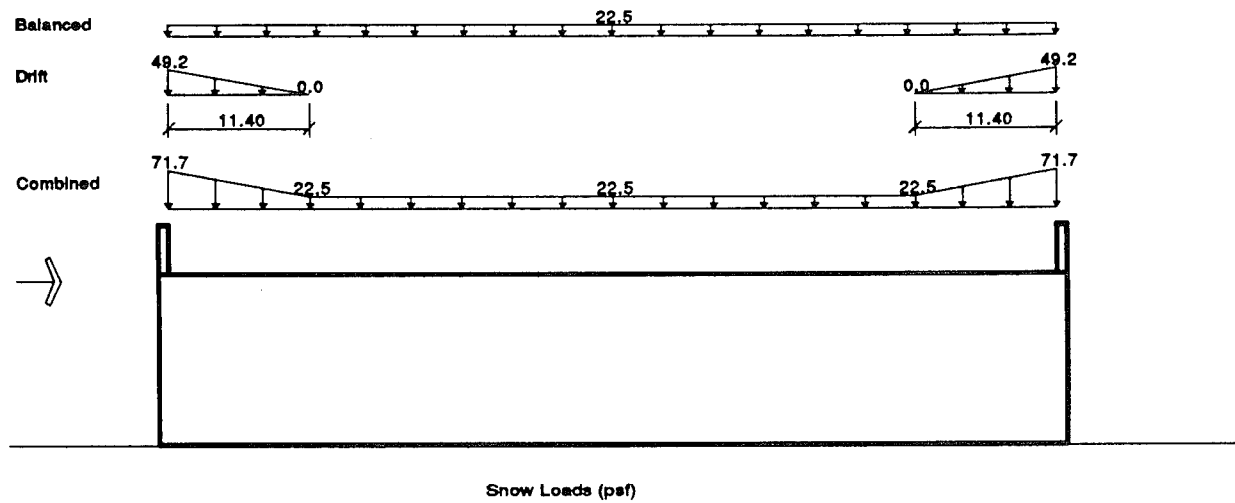
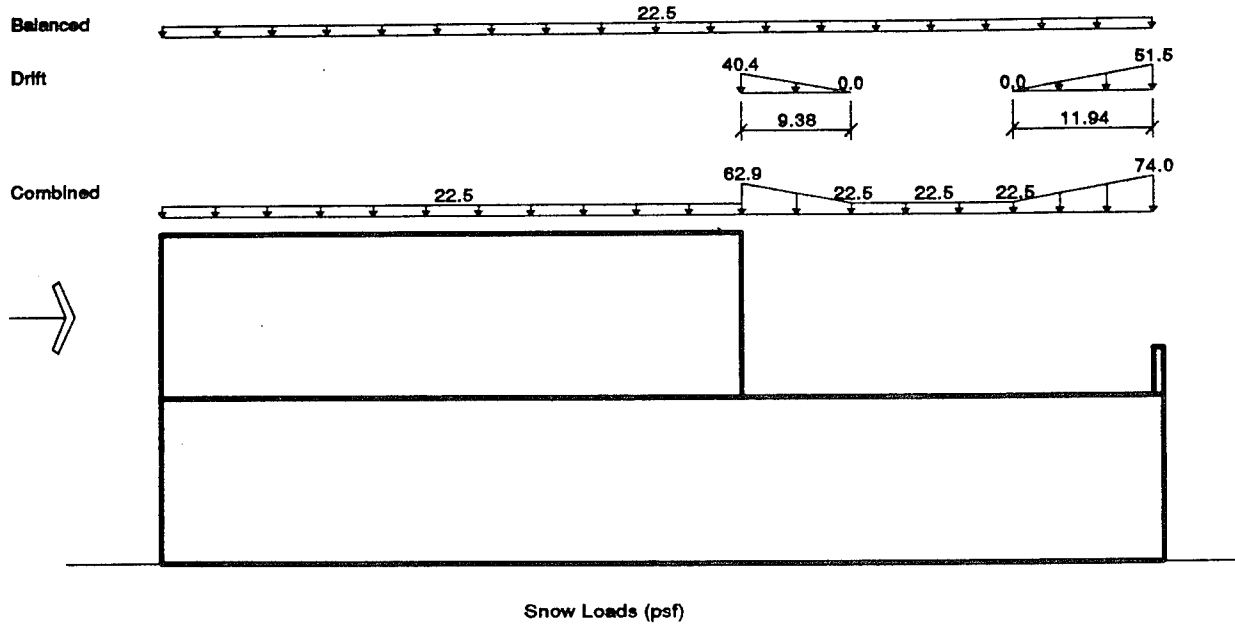




Snow Loads



Snow Loads



Snow Loads

Project : Office Building - Scheme B
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Tue Aug 30, 1994 11:39 AM

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

Flat Roof Snow Load (Pf)

$P_f = 0.7 \cdot C_e \cdot C_t \cdot I \cdot P_g$

Snow Exposure Category: C

$C_e = 1.0$

Heated Structure.

$C_t = 1.0$

Importance Category: I

$I = 1.0$

$P_g = 25.0$ psf

$P_f = 17.50$ psf

Roof Slope: 0.00 in 12

$\theta = 0$ deg

Since $\theta < 0.5$ in/ft, 5.0 psf rain-on-snow surcharge applies.

$P_f = 22.50$ psf

Check minimum P_f where $\theta \leq 15$ deg

When $P_g > 20.0$ psf, $\min P_f = 20.0 \cdot I$

$\min P_f = 20.00$ psf

```
+-----+  
|       $P_f = 22.50$  psf      |  
+-----+
```

Sloped Roof Snow Load (Ps)

$P_s = C_s \cdot P_f$

Roof Slippery: No

$C_s = 1.00$

```
+-----+  
|       $P_s = 22.50$  psf      |  
+-----+
```

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

$P_g = 25.0$ psf

Snow Density = 17.25 pcf

$P_s = 17.50$ psf (rain-on-snow surcharge not included)

$h_b = P_s / \text{density}$

$h_b = 1.01$ ft

Projection Height = 4.00 ft

$h_c = \text{height} - h_b$

$h_c = 2.99$ ft

$h_c / h_b = 2.94 \geq 0.20$ Therefore consider drift load.

Importance Category: I

$I = 1.0$

Snow Exposure Category: C

$C_e = 1.0$

Separation = 0.00 ft

$l_u = 84.83$ ft

Minimum $l_u = 25.0$ ft $\leq l_u$

$h_d = 0.43 \cdot l_u^{1/3} \cdot (P_g + 10)^{1/4 - 1.5}$

$h_d = 3.10$ ft

Width of drift: $W = \text{minimum of } 4 \cdot h_d \text{ or } 4 \cdot h_c$

$w = 4 \cdot h_d = 12.38$ ft

$w = 4 \cdot h_c = 11.94$ ft

```
+-----+  
|       $W = 11.94$  ft      |  
+-----+
```

$h_d = h_d \cdot (20.0 - s) / 20.0 = 3.10$ ft

$h_d > h_c$, therefore $h_d = h_c = 2.99$ ft

$P_d = h_d \cdot \text{density}$

```

+-----+
|      Pd = 51.50 psf      |
+-----+

```

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

```

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 4.00 ft
hc = height-hb
hc = 2.99 ft
hc/hb = 2.94 >= 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
Minimum lu = 25.0 ft <= lu
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
w = 4*hd = 11.40 ft
w = 4*hc = 11.94 ft

```

```

+-----+
|      W = 11.40 ft      |
+-----+

```

```

hd = hd*(20.0-s)/20.0 = 2.85 ft
hd <= hc
Pd = hd*density

```

```

+-----+
|      Pd = 49.18 psf    |
+-----+

```

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

```

Pg = 25.0 psf
Snow Density = 17.25 pcf
Ps = 17.50 psf (rain-on-snow surcharge not included)
hb = Ps/density
hb = 1.01 ft
Projection Height = 14.00 ft
hc = height-hb
hc = 12.99 ft
hc/hb = 12.80 >= 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
Minimum lu = 25.0 ft <= lu
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
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft

```

```

Importance Category: I
I = 1.0

```

```

Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 49.67 ft
Minimum lu = 25.0 ft <= lu
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
w = 4*hd = 9.38 ft
w = 4*hc = 51.94 ft

```

```

+-----+
|      W = 9.38 ft      |
+-----+

```

```

hd = hd*(20.0-s)/20.0 = 2.34 ft
hd <= hc

```

Snow Loads

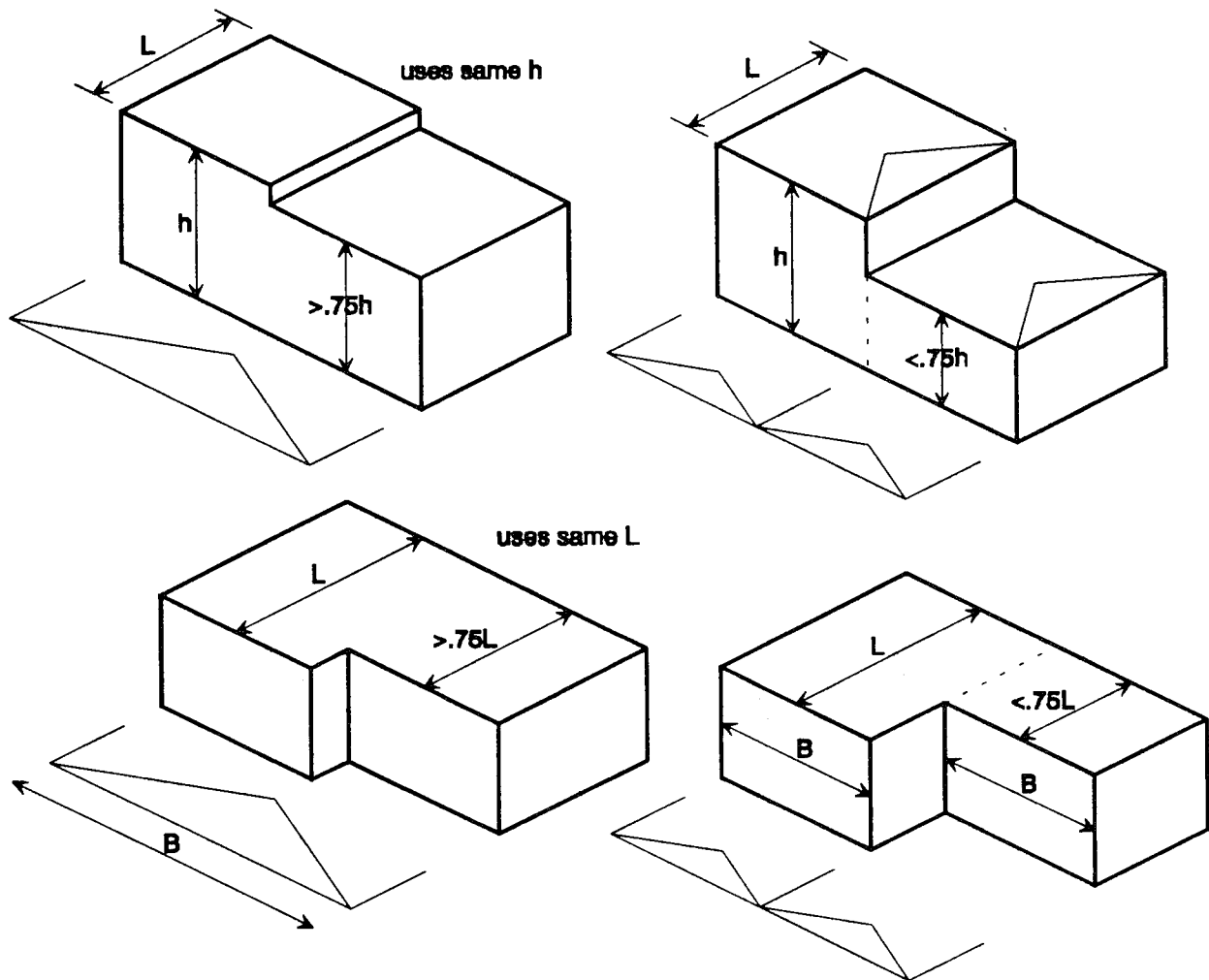
$$p_d = h_d \cdot \text{density}$$

$p_d = 40.44 \text{ psf}$

Wind Assumptions

Proportions For B/L & h/L

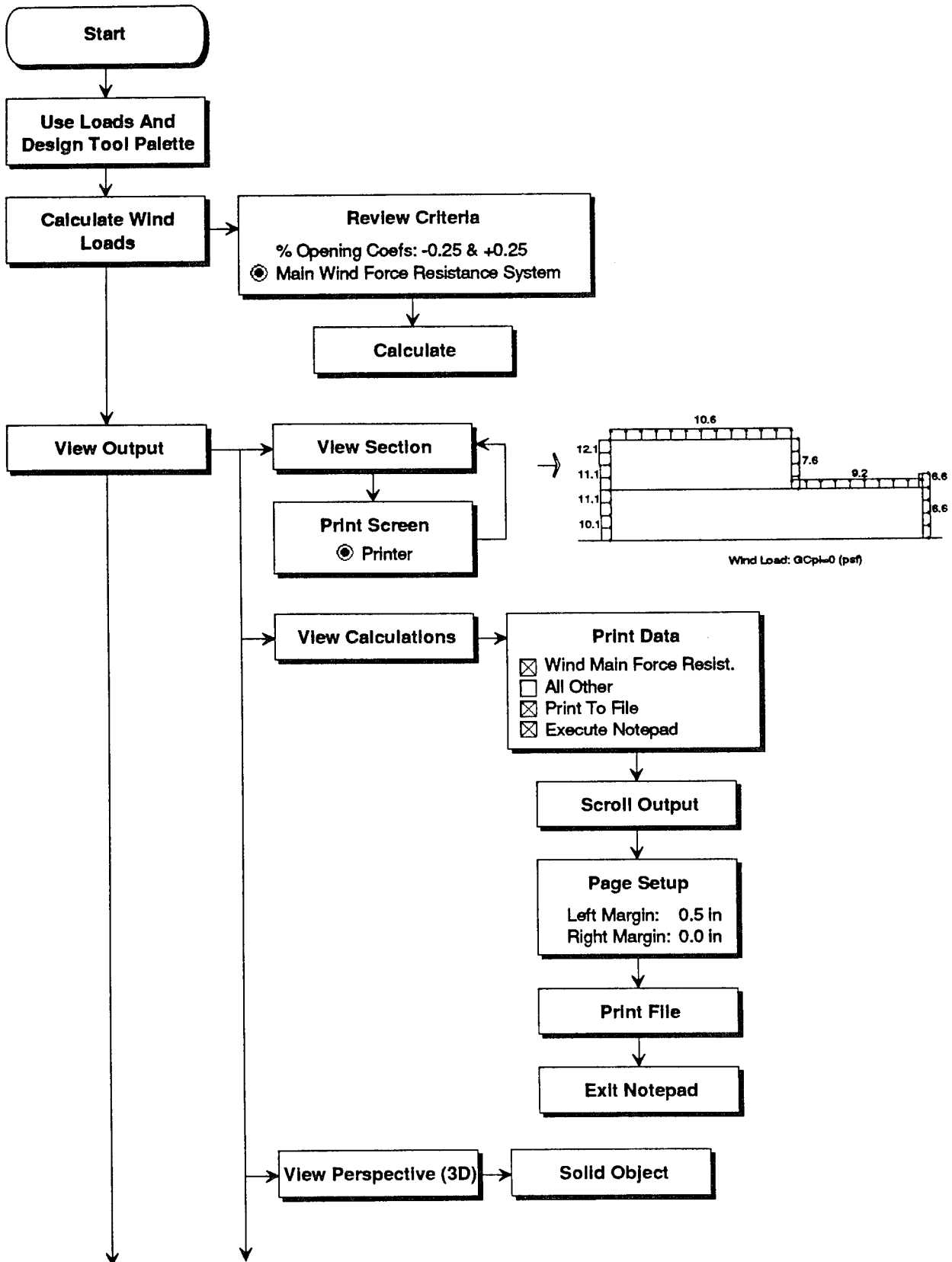
Defaults:	Height Ratio:	0.75
	Plan Ratio:	0.75



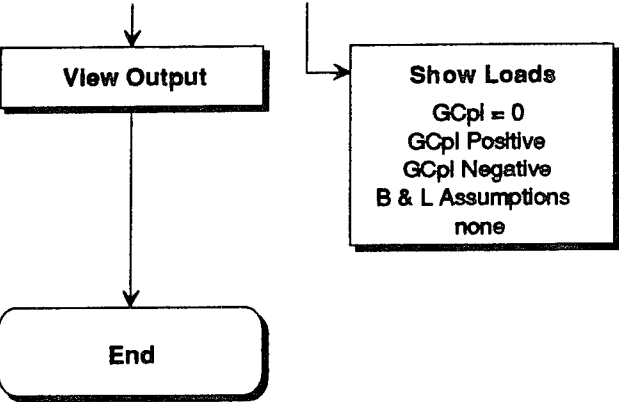
Building Height Maximum 60 Feet

Assumed for components and cladding

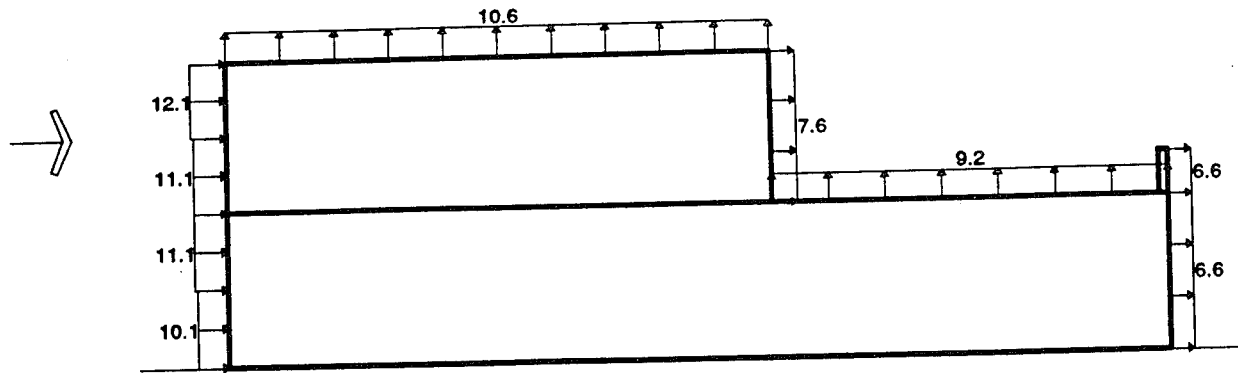
Main Wind Force Resisting Loads



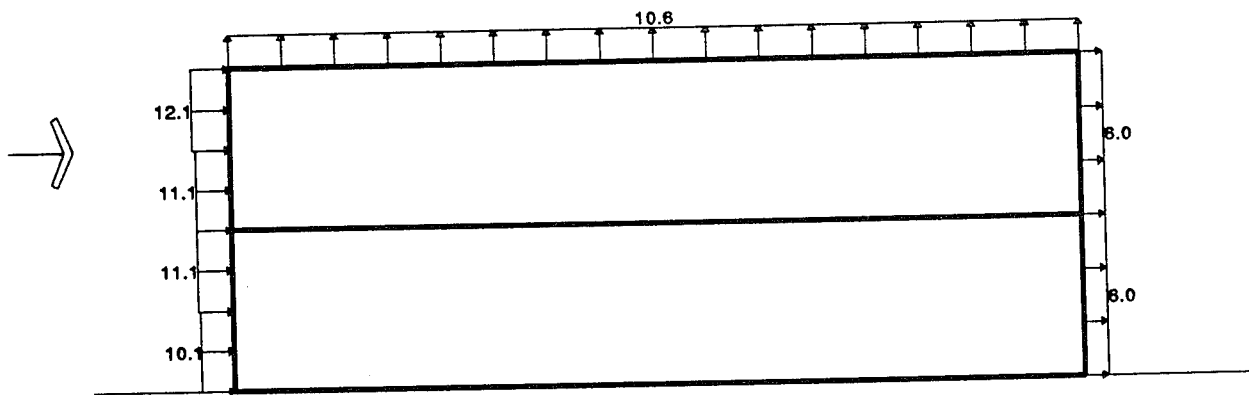
Main Wind Force Resisting Loads



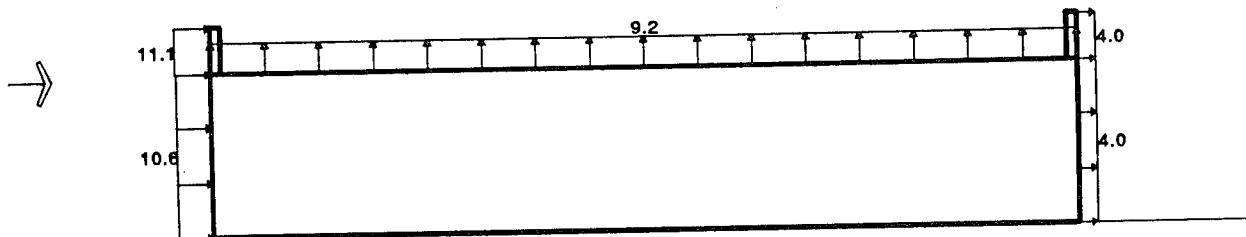
Main Wind Force Resisting Loads



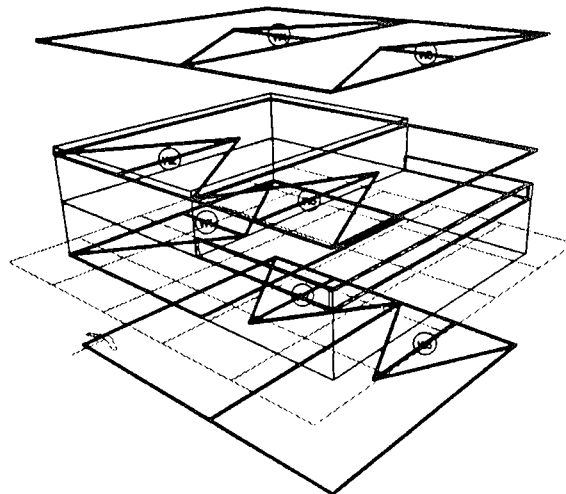
Wind Loads: $GC_{pi}=0$ (psf)



Wind Loads: $GC_{pi}=0$ (psf)



Wind Loads: $GC_{pi}=0$ (psf)



Main Wind Force Resisting Loads

Project : Office Building - Scheme B
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Mon Aug 29, 1994 4:13 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	73.7	49.7	

Distance to ocean line ≥ 100 mi $h/d = 0.56 \leq 5$

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

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0 -0.25 0.25
Windward Wall						
level 3	28.0	1.26	0.96	12.0	0.80	12.1 15.1 9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1 14.1 8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1 13.1 7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1 13.1 7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6 -4.6 -10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6 -7.6 -13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6 -7.6 -13.6
Overhang **	28.0		0.96	12.0	0.80	9.6
Internal	28.0		0.96	12.0		0.0 -3.0 3.0

***** 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	49.7	73.7	

Distance to ocean line ≥ 100 mi $h/d = 0.56 \leq 5$

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

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0 -0.25 0.25
Windward Wall						
level 3	28.0	1.26	0.96	12.0	0.80	12.1 15.1 9.1
level 2 - 3	21.0	1.26	0.88	11.0	0.80	11.1 14.1 8.1
level 1 - 2	7.0	1.26	0.80	10.0	0.80	10.1 13.1 7.1
level 1	0.0	1.26	0.80	10.0	0.80	10.1 13.1 7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.40	-6.0 -3.0 -9.0
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6 -7.6 -13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6 -7.6 -13.6
Overhang **	28.0		0.96	12.0	0.80	9.6
Internal	28.0		0.96	12.0		0.0 -3.0 3.0

Main Wind Force Resisting Loads

***** 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	73.7	36.0	

Distance to ocean line ≥ 100 mi $h/d = 0.39 \leq 5$

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

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0	-0.25	0.25
Windward Wall								
parapet	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
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

***** 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	49.7	

Distance to ocean line ≥ 100 mi $h/d = 0.56 \leq 5$

***** 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
Overhang **	28.0		0.96	12.0	0.80	9.6		
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

***** 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	36.0	73.7	

Distance to ocean line ≥ 100 mi $h/d = 0.39 \leq 5$

Main Wind Force Resisting Loads

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

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCpi=0 -0.25 0.25		
Windward Wall								
parapet	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
Overhang **	14.0		0.80	10.0	0.80	8.0		
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Notes for main framing:

Positive pressures act toward surfaces.

Pressure or suction = $P = q \cdot Gh \cdot Cp - qh \cdot (GCpi)$

q: qz for windward wall evaluated at height z.

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

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

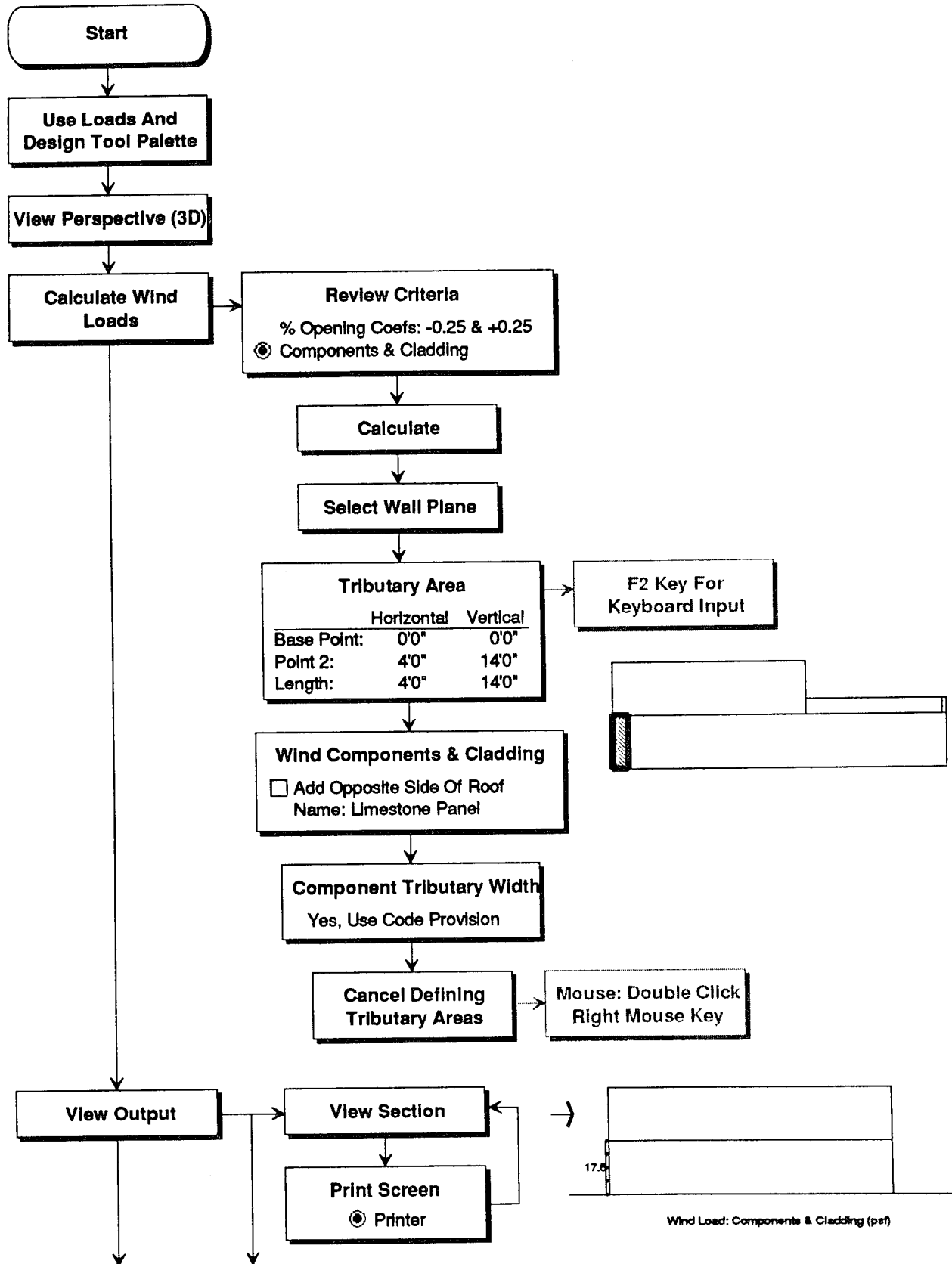
Internal Pressure Coefficients for Buildings, GCpi:

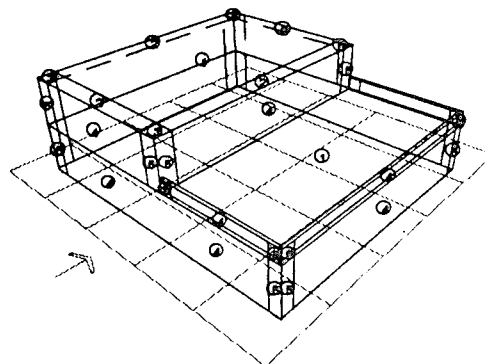
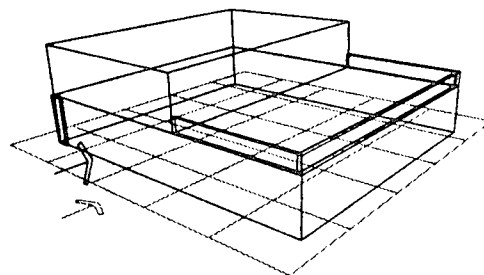
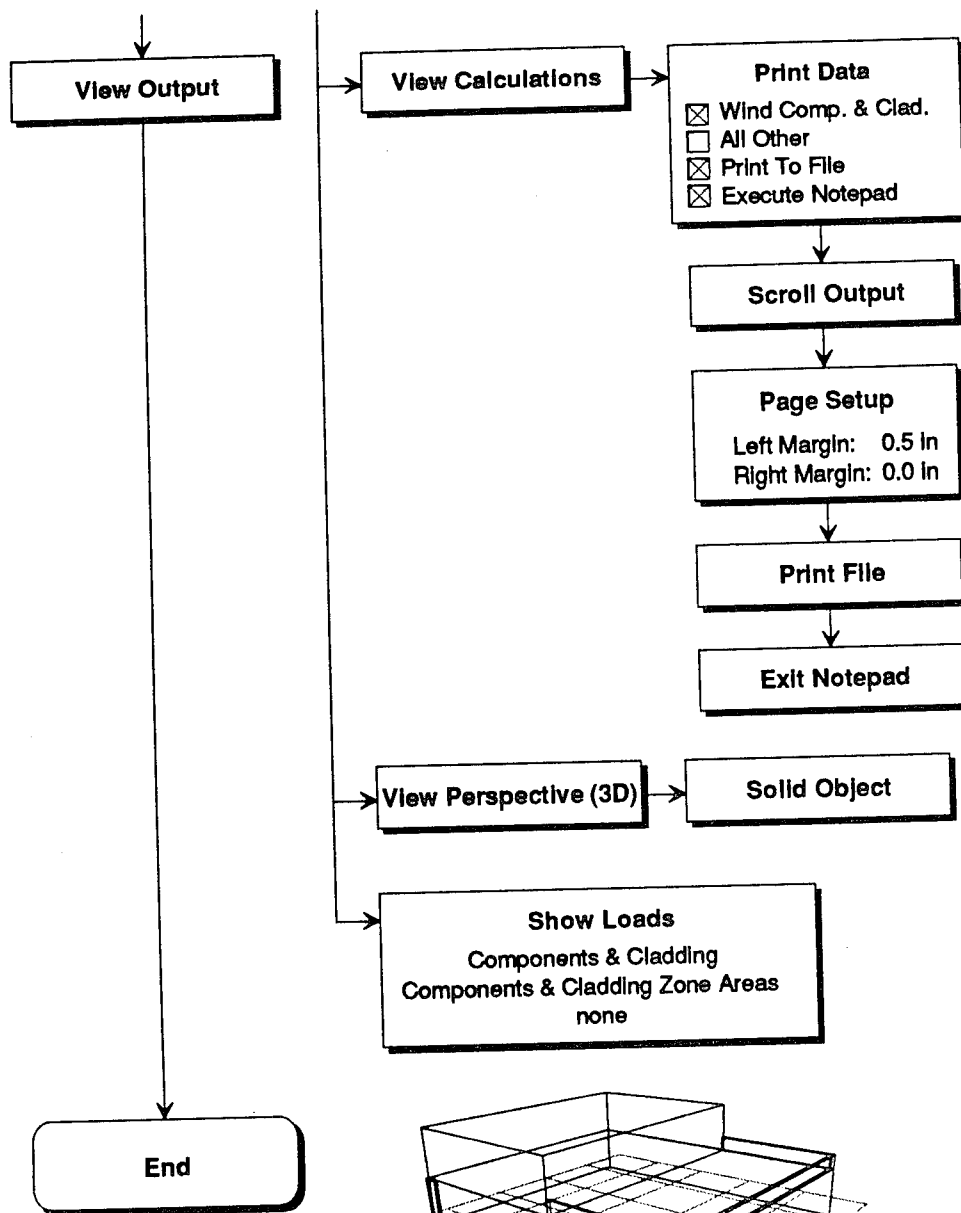
	Condition	GCpi
Condition I	All conditions except as noted under condition II.	+0.25 -0.25
Condition II	Buildings in which both of the following are met:	+0.75
	1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and	-0.25
	2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	

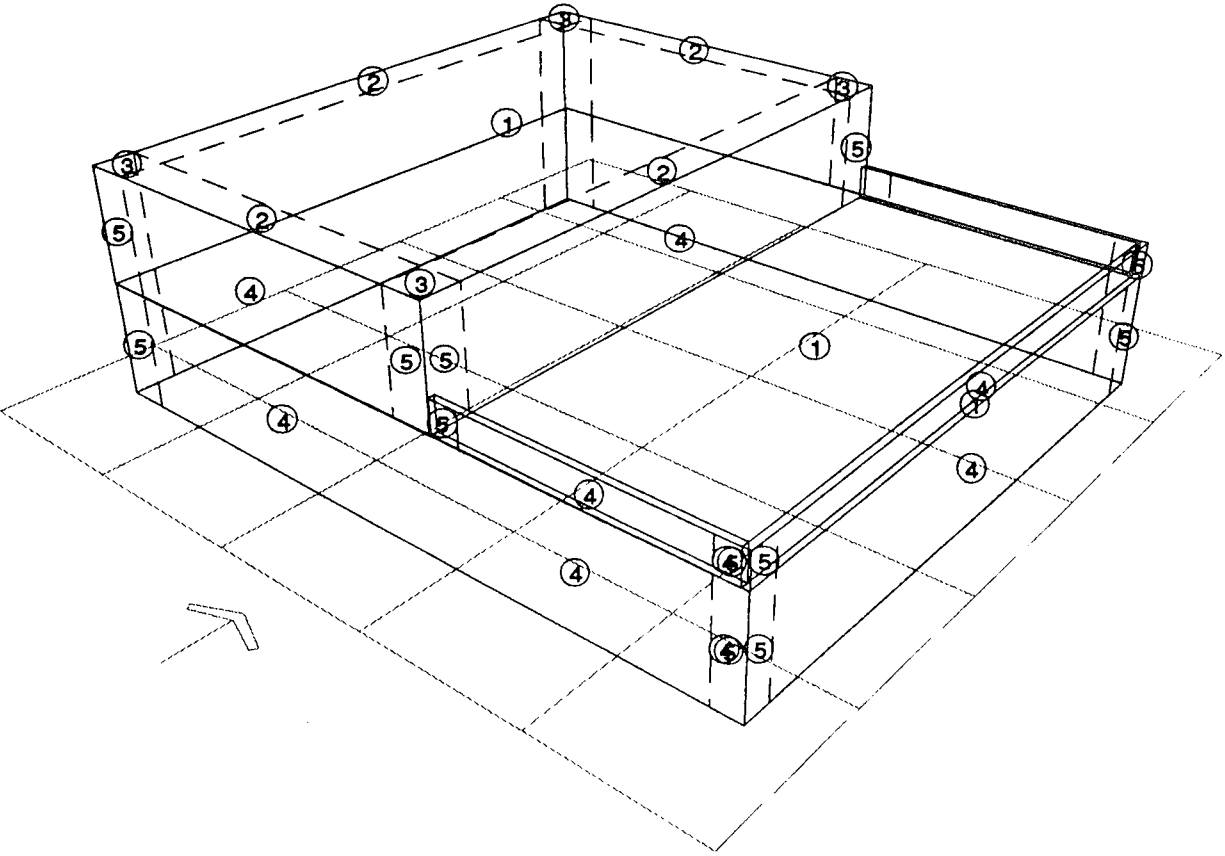
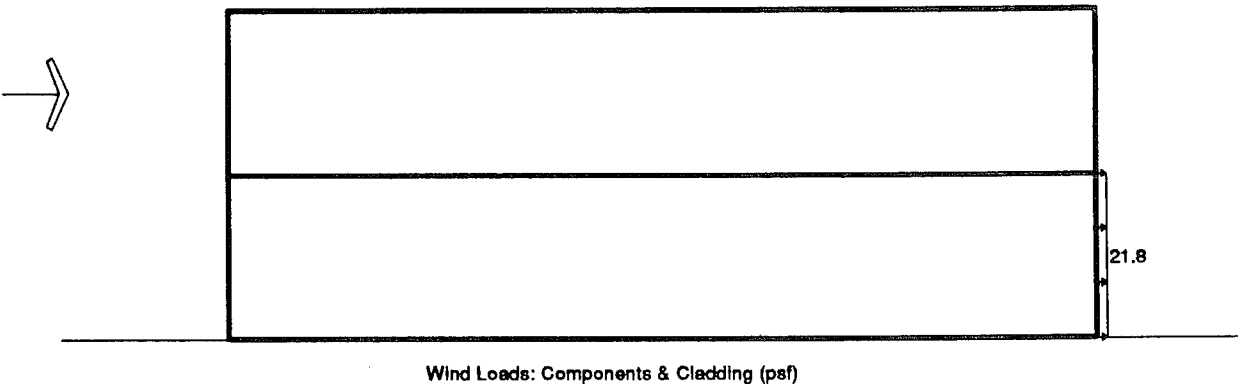
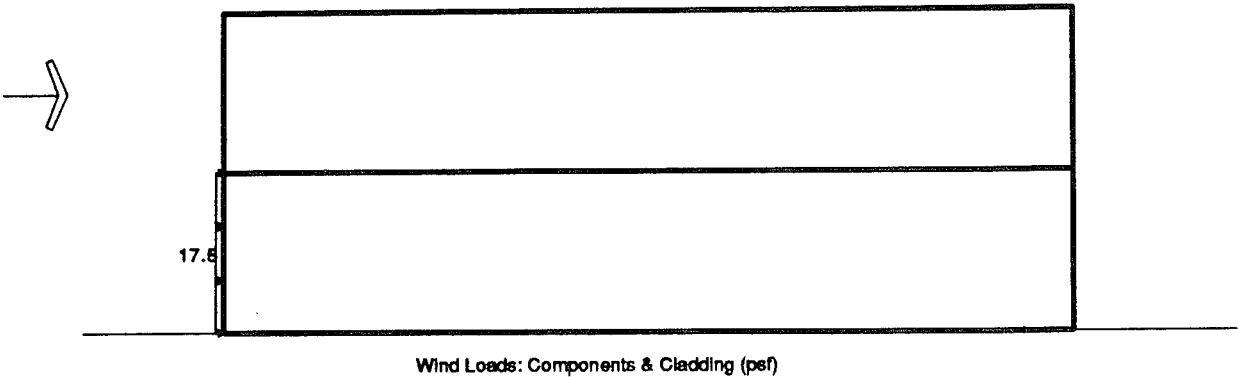
Notes:

- (1) Values are to be used with qz or qh as specified in Table 4.
- (2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
- (3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCpi applied simultaneously to all surfaces, and a negative value of GCpi applied to all surfaces.
- (4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Wind Components & Cladding Loads







Wind Components & Cladding Loads

Project : Office Building - Scheme B
 Location : Radford AAP
 Design Load : TM 5-809-1 1992
 Time : Mon Aug 29, 1994 4:32 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 $h/d = 0.56 \leq 5$

Height (ft)	Kh	qh (psf)	GCp1
28.0	0.96	12.0	-0.25 0.25

Height ≤ 60.0 ft

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

-----Walls-----							
Tributary Area (sf)	Windward				Leeward		
	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	4.67 ft x 14.00 ft **						
65.3	1.21	17.5	1.21	17.5	-1.31	-18.7	-1.57 -21.8
a = 5.0 ft							

Notes for components and cladding:

$$P = qh(GCp) - qh(GCp1)$$

Internal pressures have been included in above values.

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.

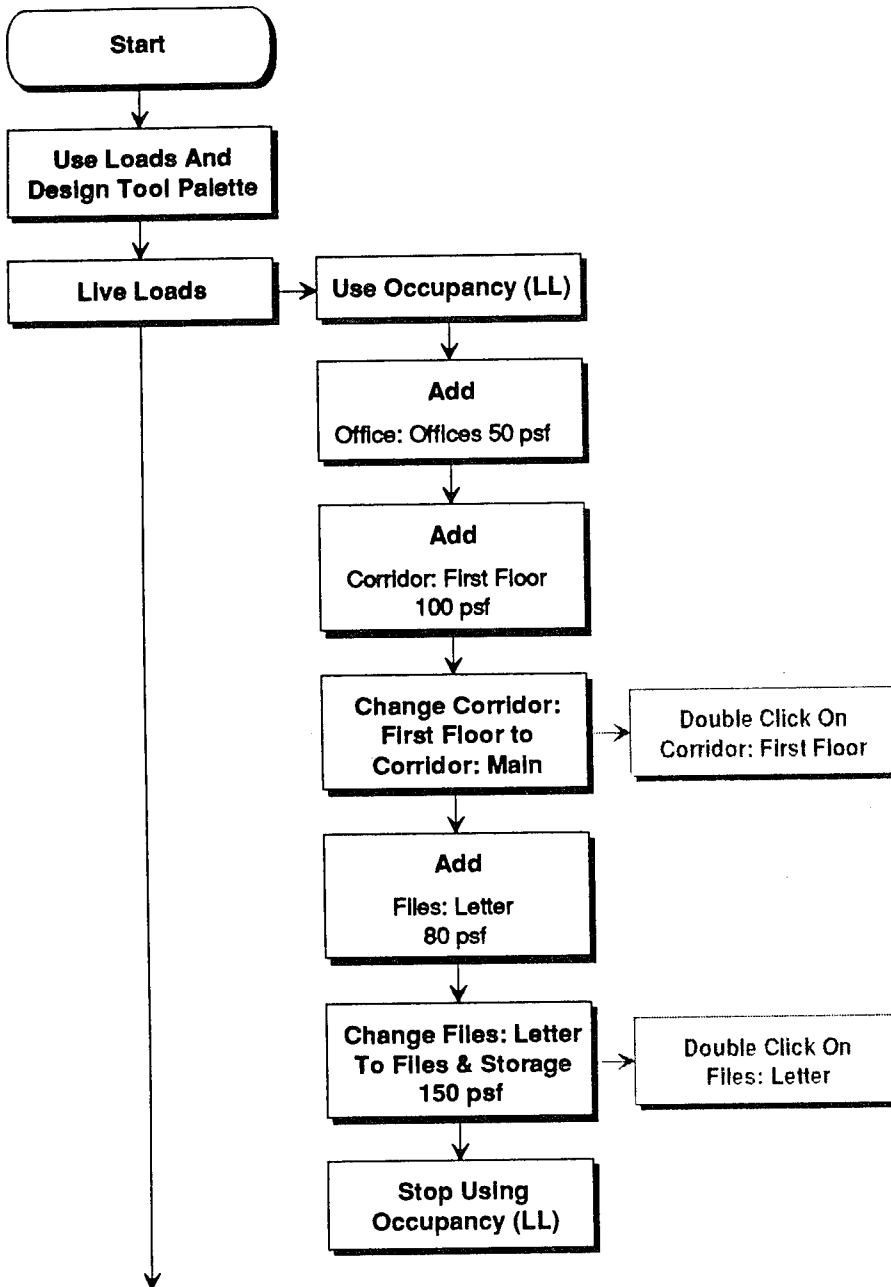
Internal Pressure Coefficients for Buildings, GCp1:

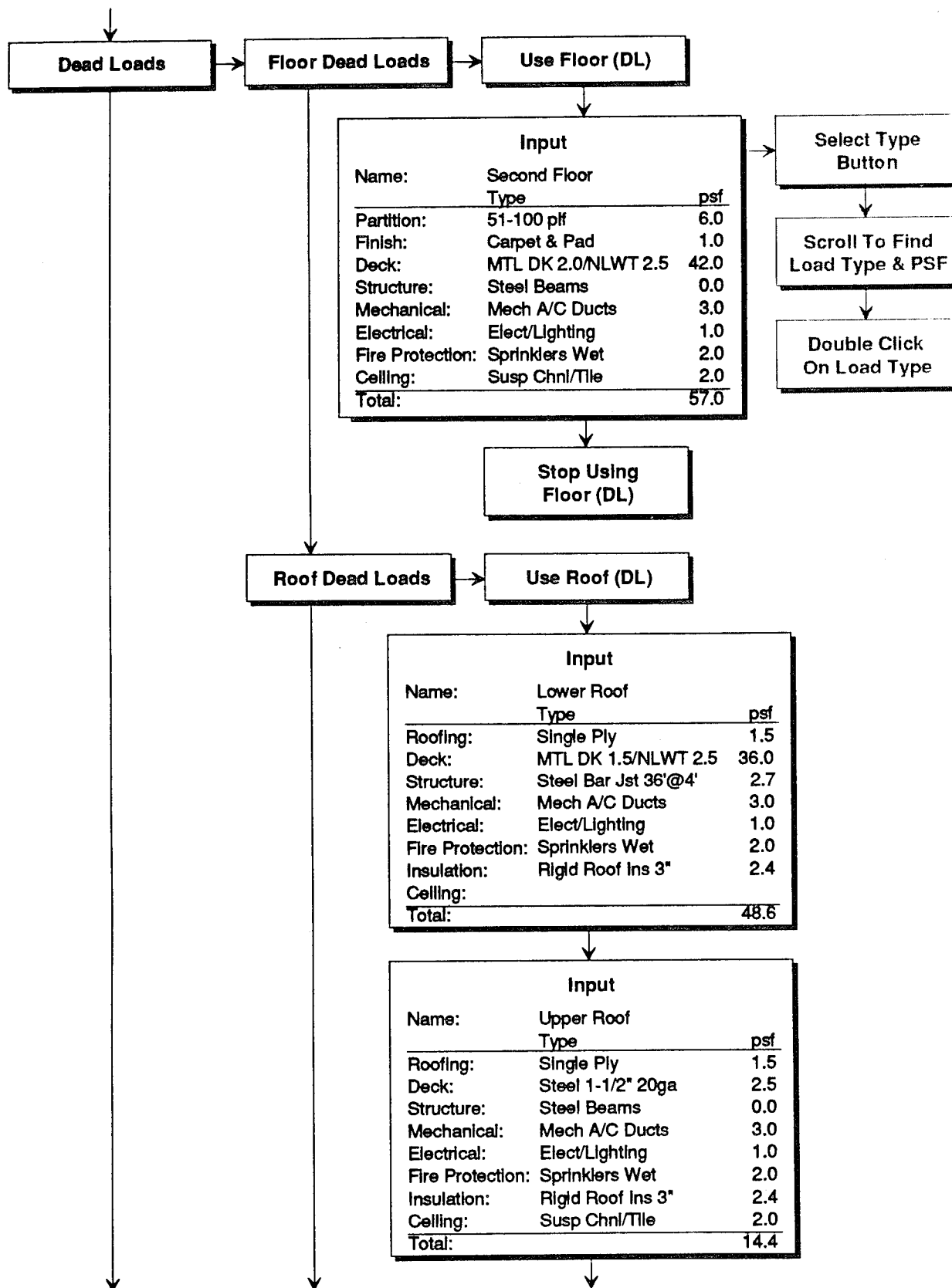
Condition	GCp1
Condition I All conditions except as noted under condition II.	+0.25 -0.25
Condition II Buildings in which both of the following are met:	+0.75
1. Percentage of openings in one wall exceeds the sum of the percentages of openings in the remaining walls and roof surfaces by 5% or more, and	-0.25
2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.	

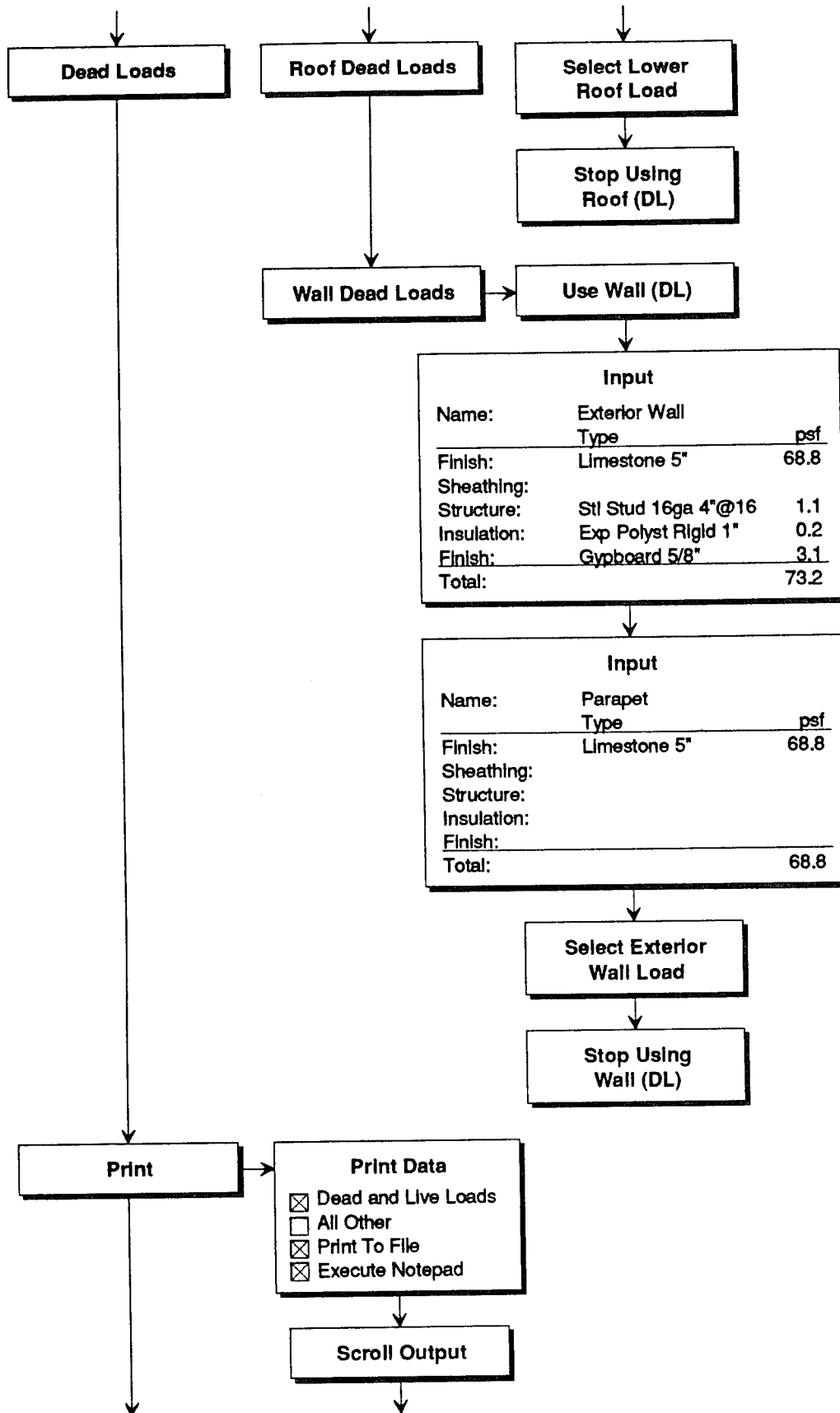
Notes:

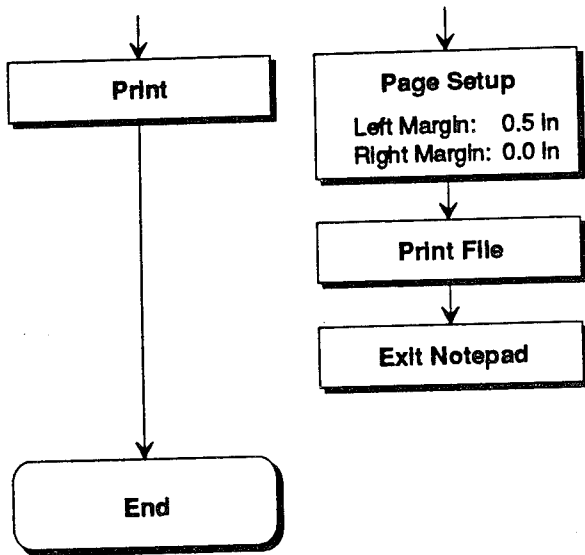
- (1) Values are to be used with qz or qh as specified in Table 4.
- (2) Plus and minus signs signify pressures acting toward and away from the surfaces, respectively.
- (3) To ascertain the critical load requirements for the appropriate condition, two cases shall be considered: a positive value of GCp1 applied simultaneously to all surfaces, and a negative value of GCp1 applied to all surfaces.
- (4) Percentage of openings in a wall or roof surface is given by ratio of area of openings to gross area for the wall or roof surface considered.

Dead & Live Loads









Loads

Floor Dead Loads

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

Roof Dead Loads

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

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

Wall Dead Loads

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

Dead & Live Loads

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
Corridor: Main	100
Files & Storage	150 a

- a. These design loads are extremely variable. The design load will be increased when data is available.

Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400.0 sqft or more may be reduced with: $L = L_o[0.25 + (15/\sqrt{A_i})]$

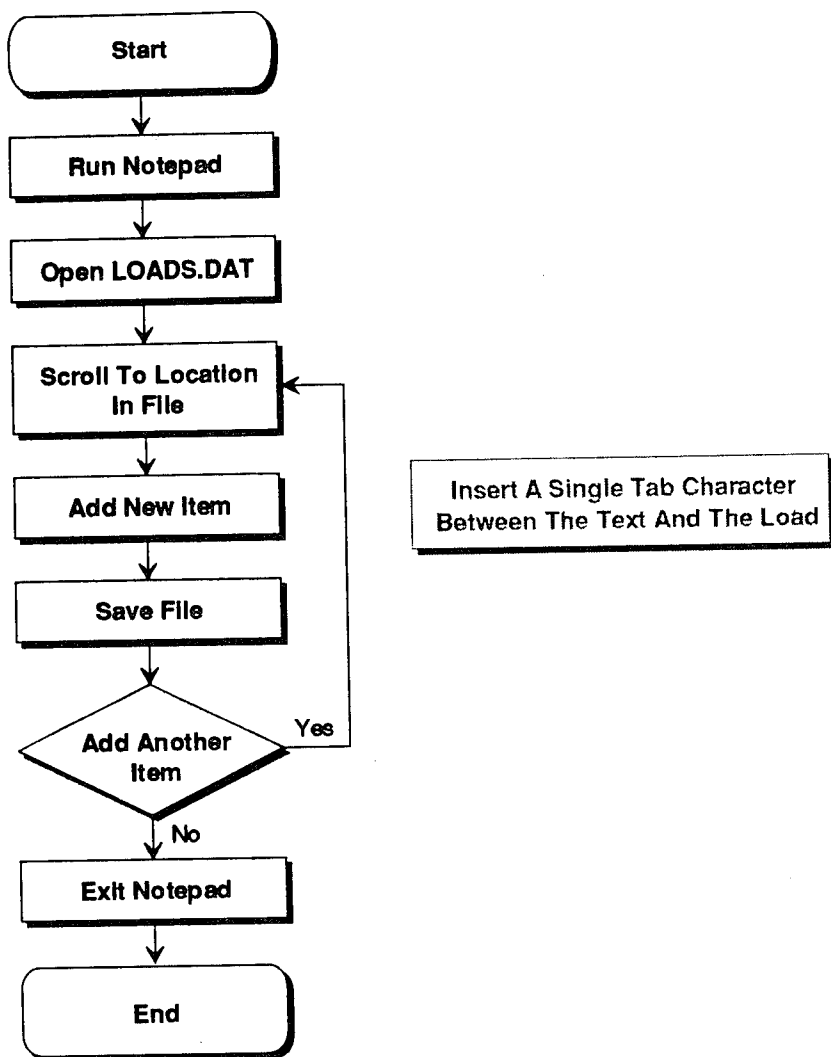
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 40% of the unit live load for members supporting two or more floors.

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

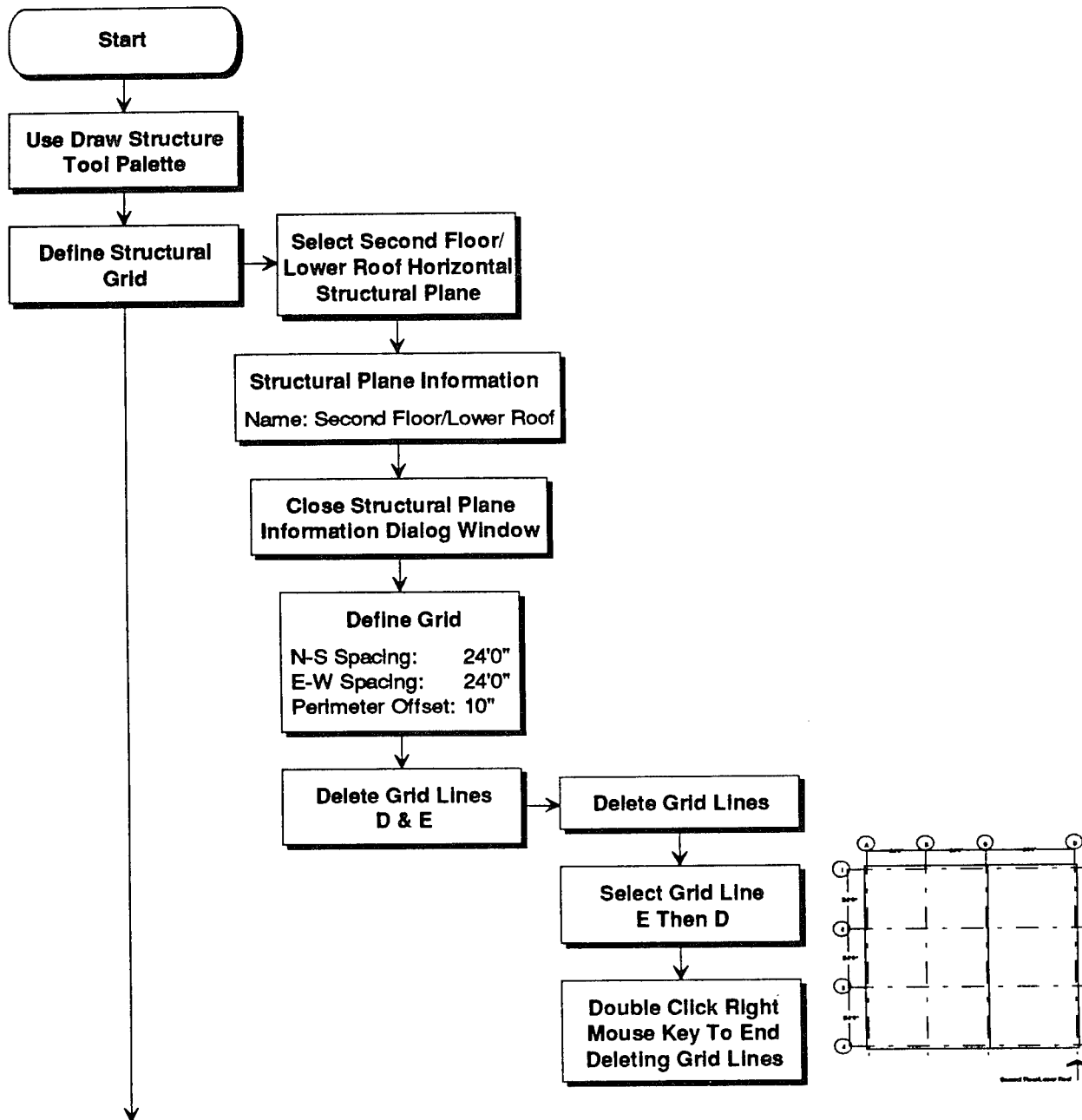
- public assembly
- garages [except where 2 or more floors are supported]
- one-way slab floor

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.

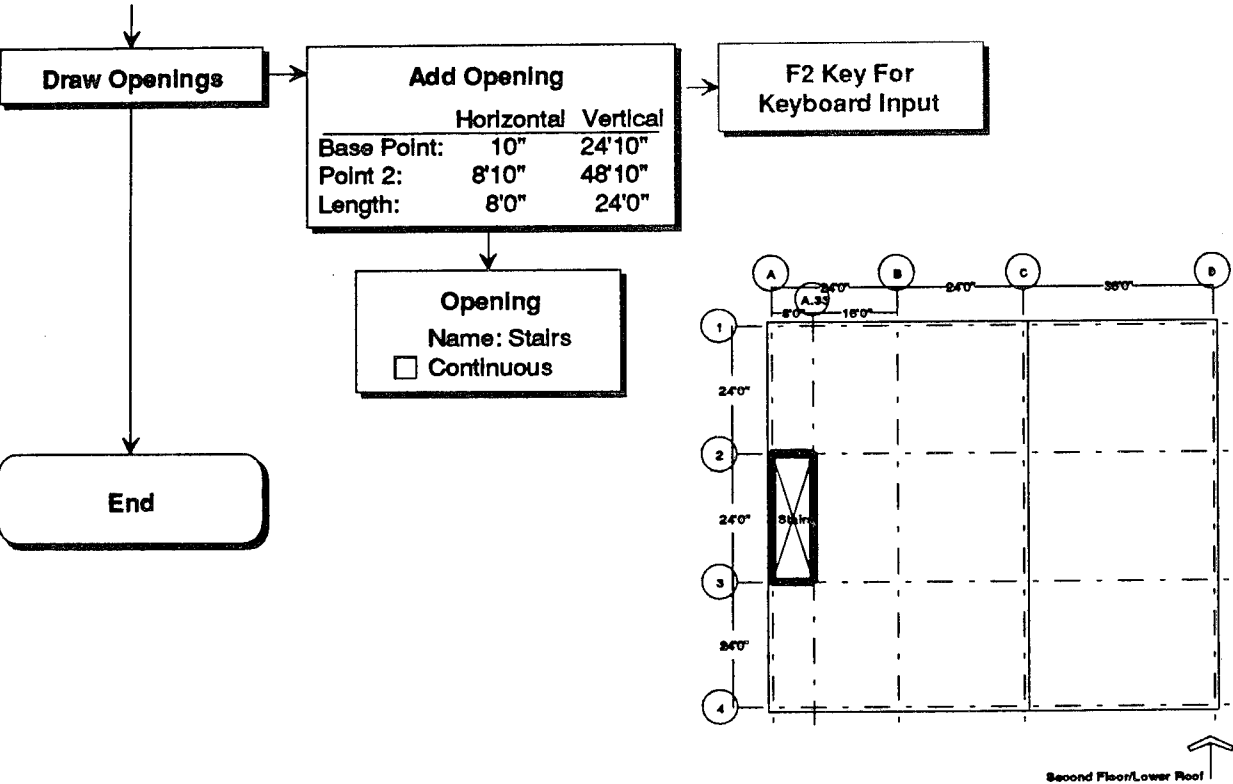
Loads Database



Draw Grid & Openings



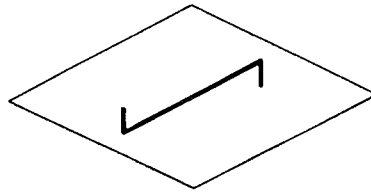
Draw Grid & Openings



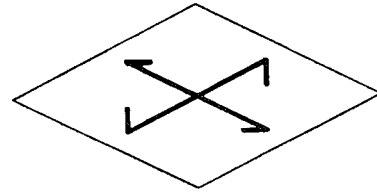
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



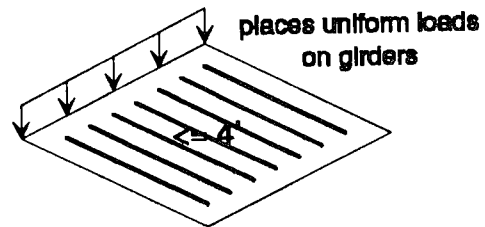
1 way



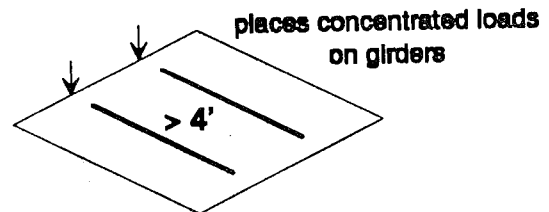
2 way
(not activated)

Linear
(horizontal)

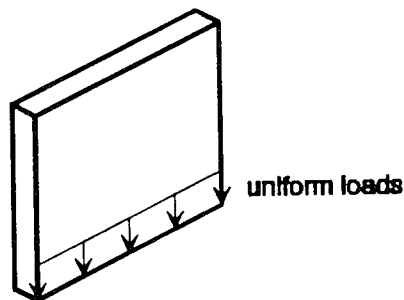
Narrowly Spaced
(joists)



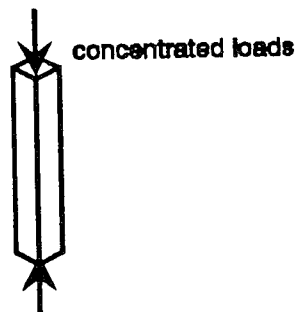
Widely Spaced
(beams)



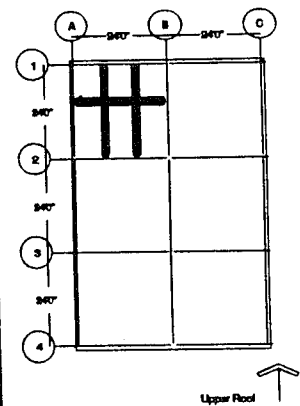
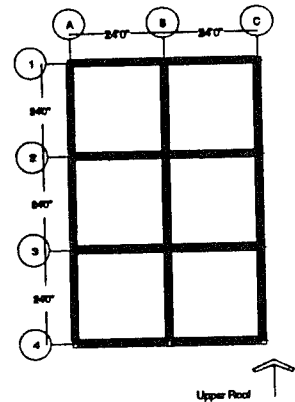
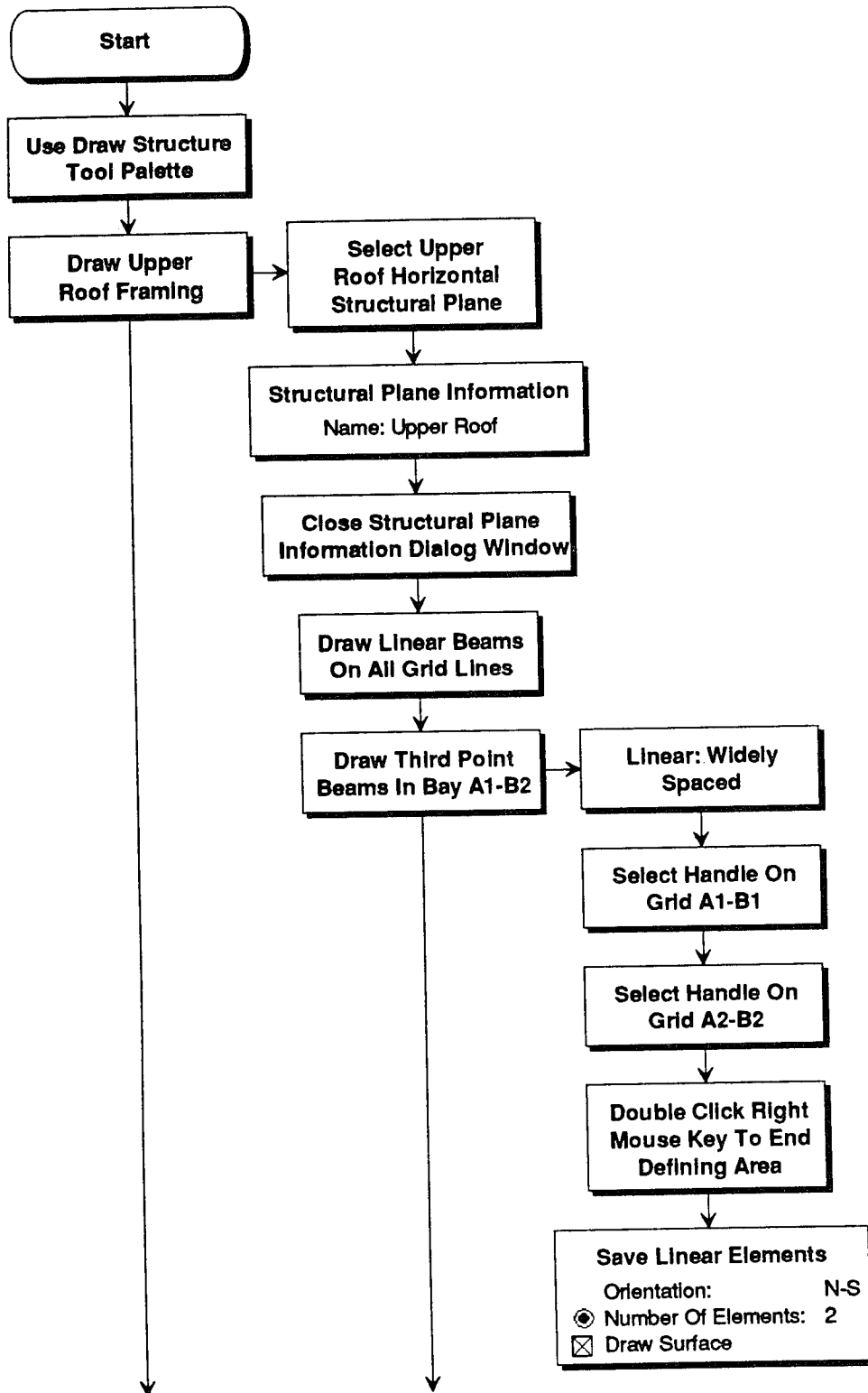
Surface
(vertical)
(planar)



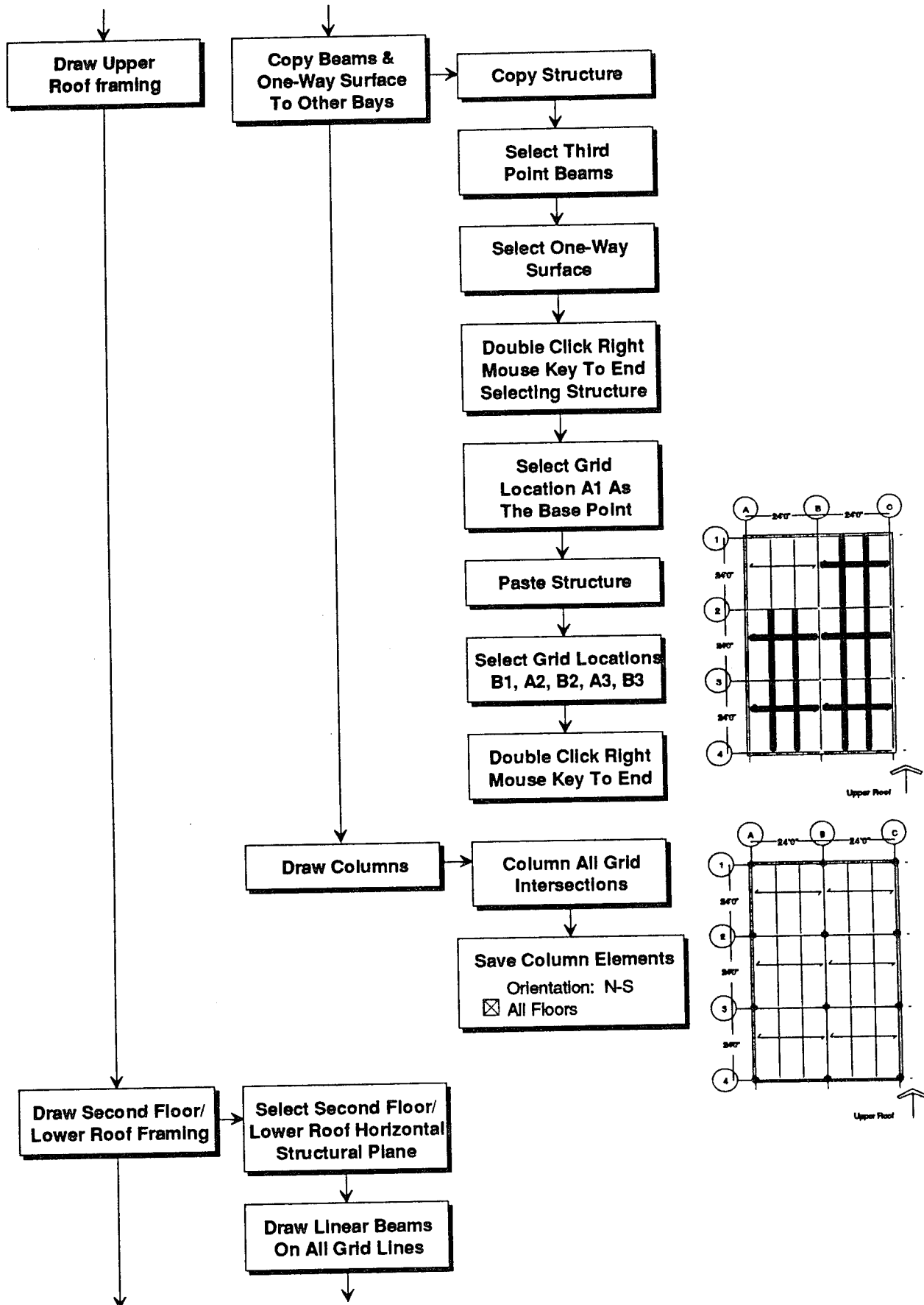
Linear
(vertical)

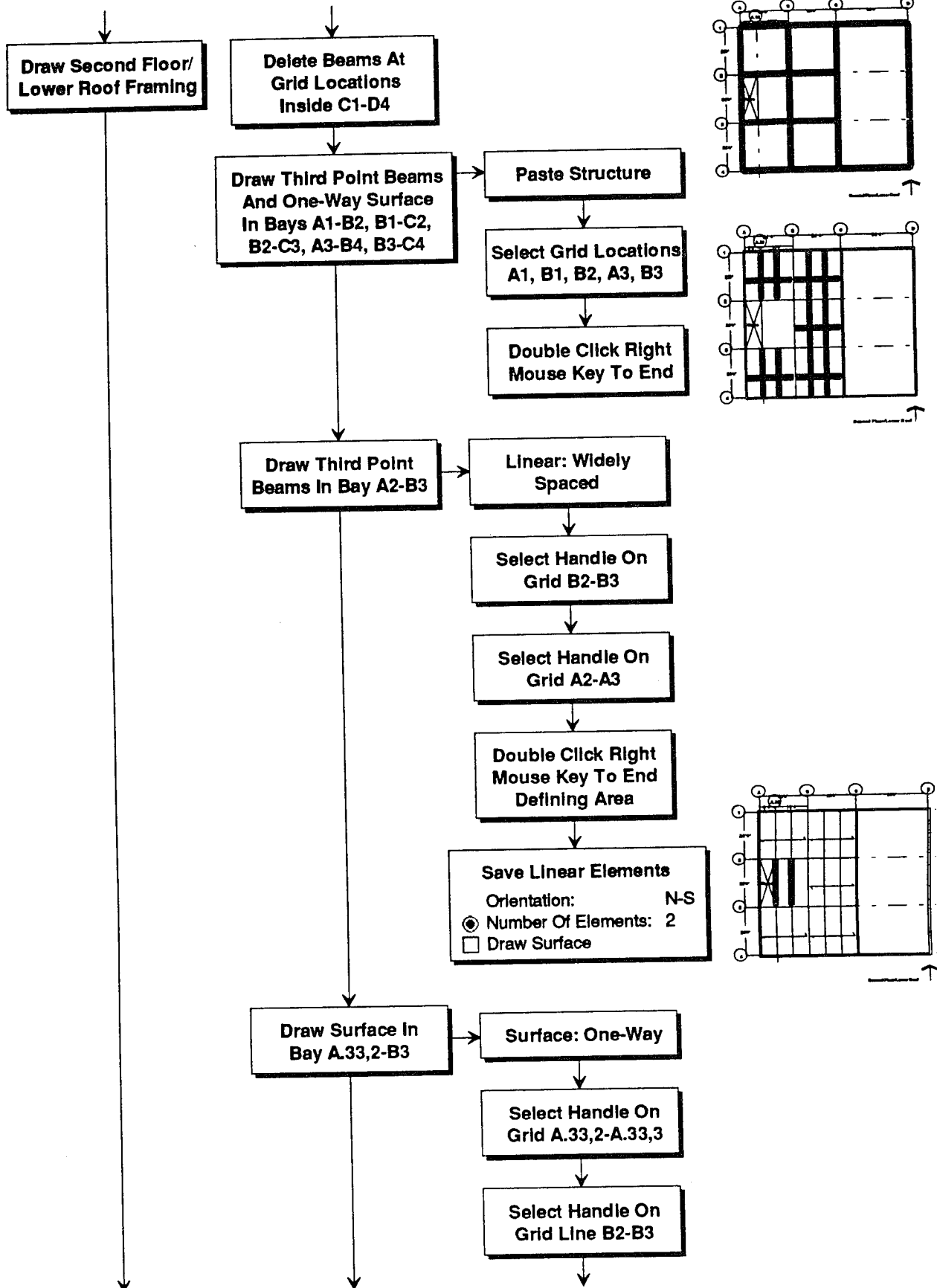


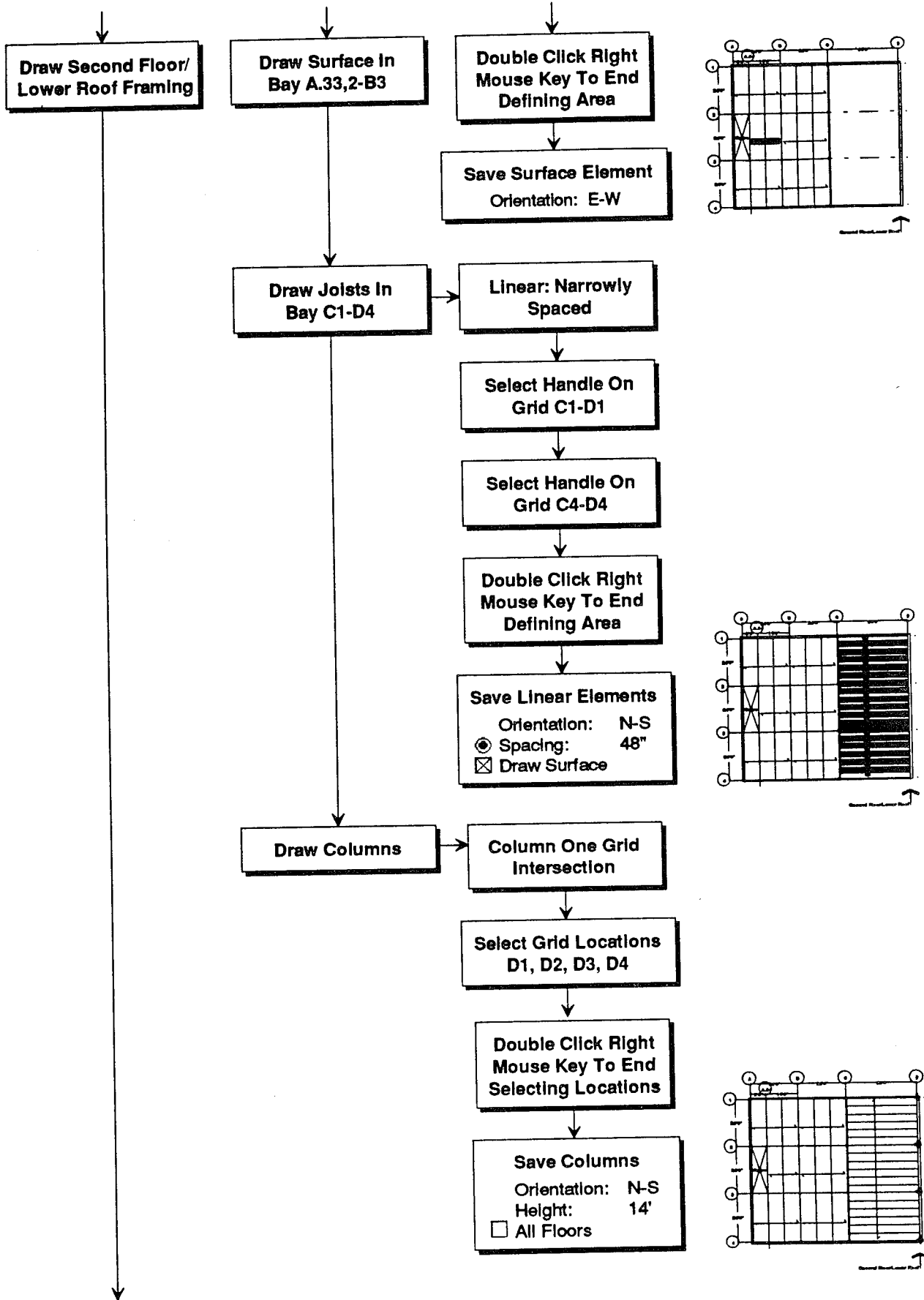
Draw Structure

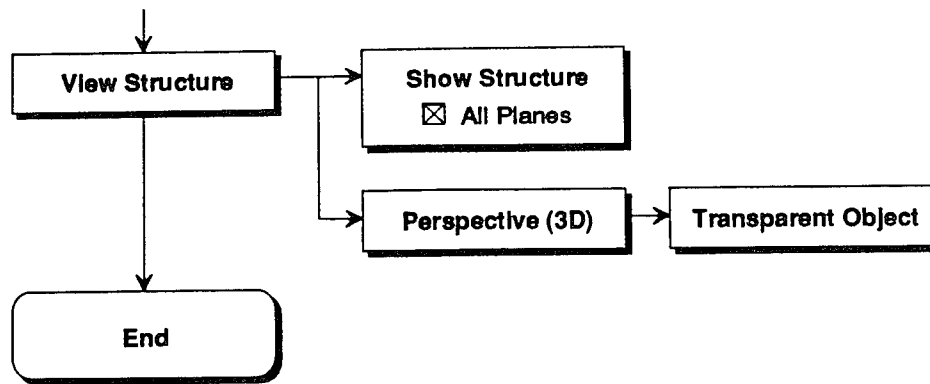


Draw Structure

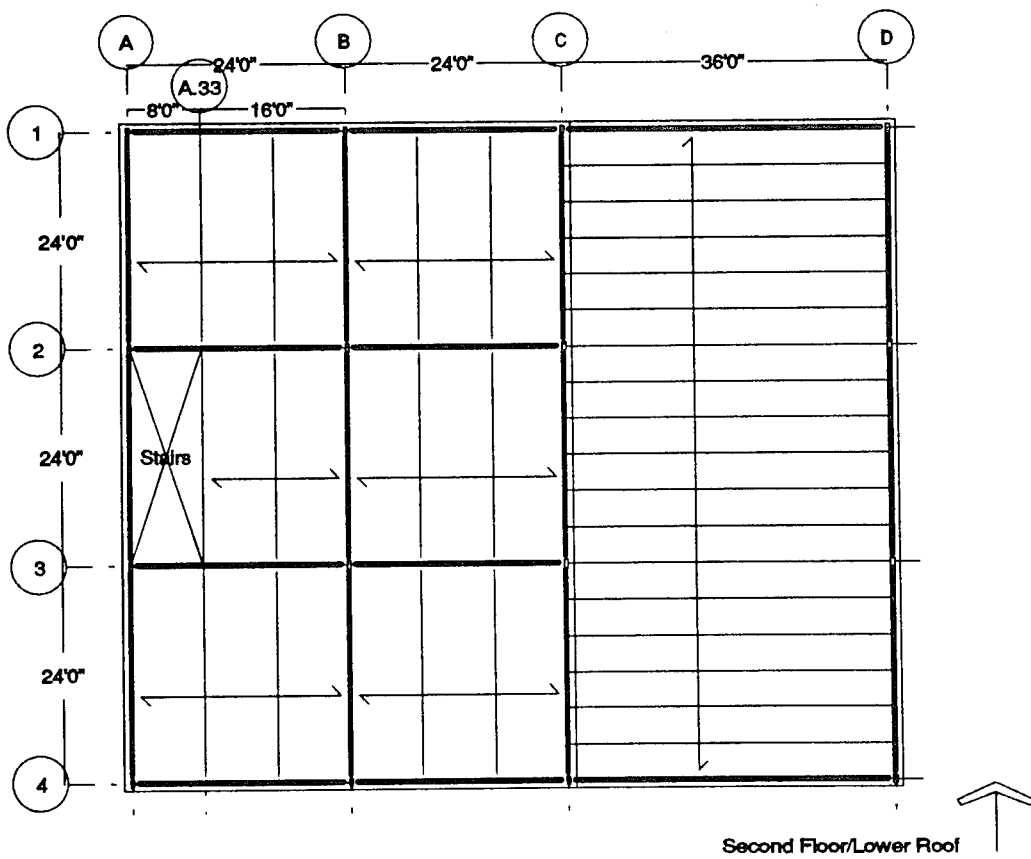
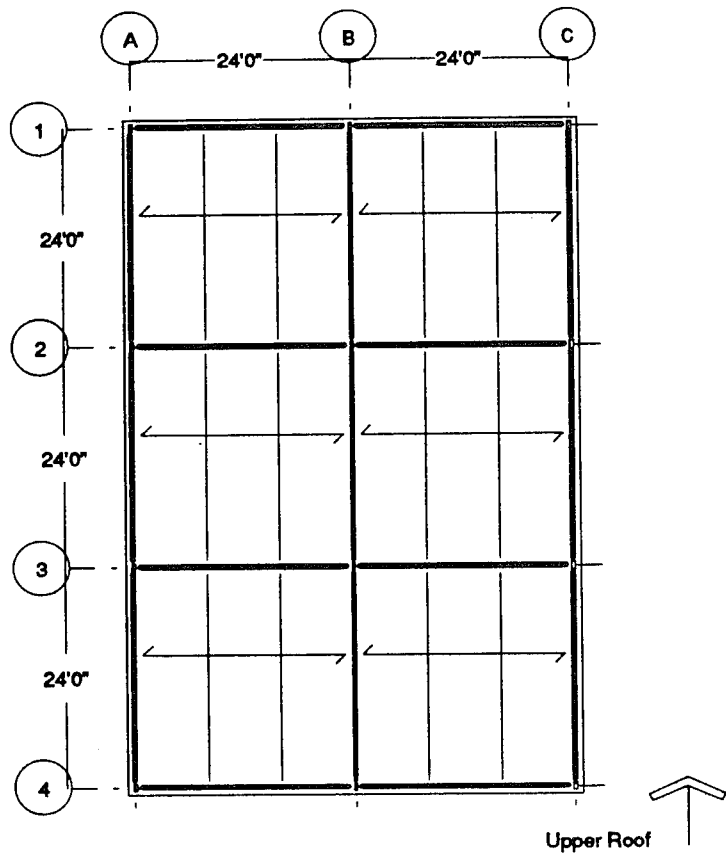


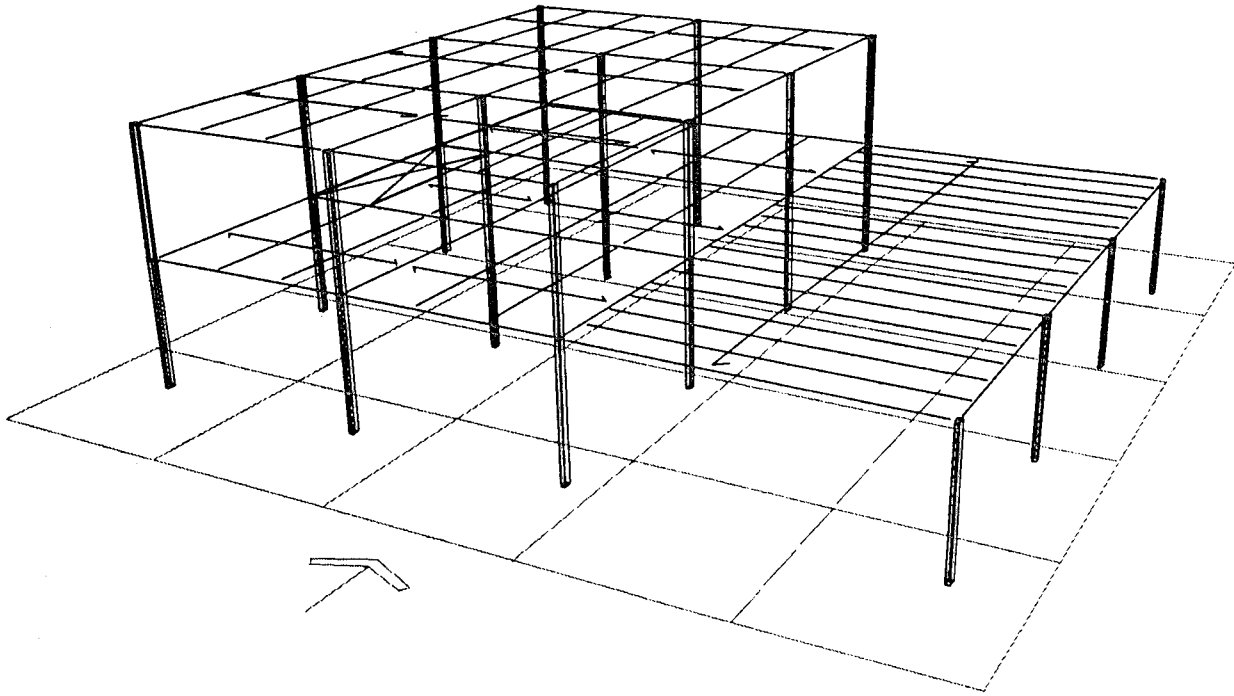




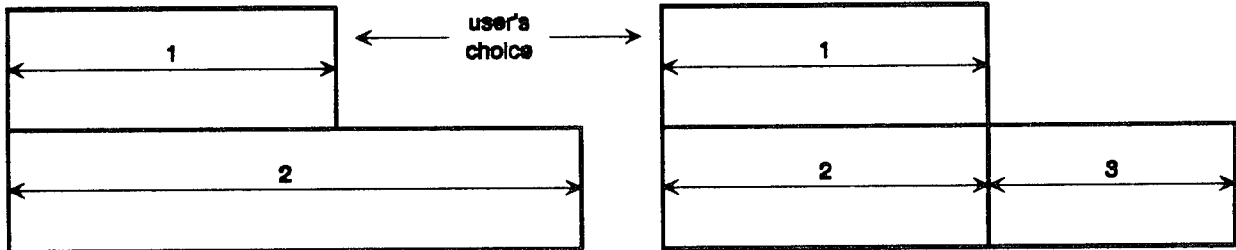
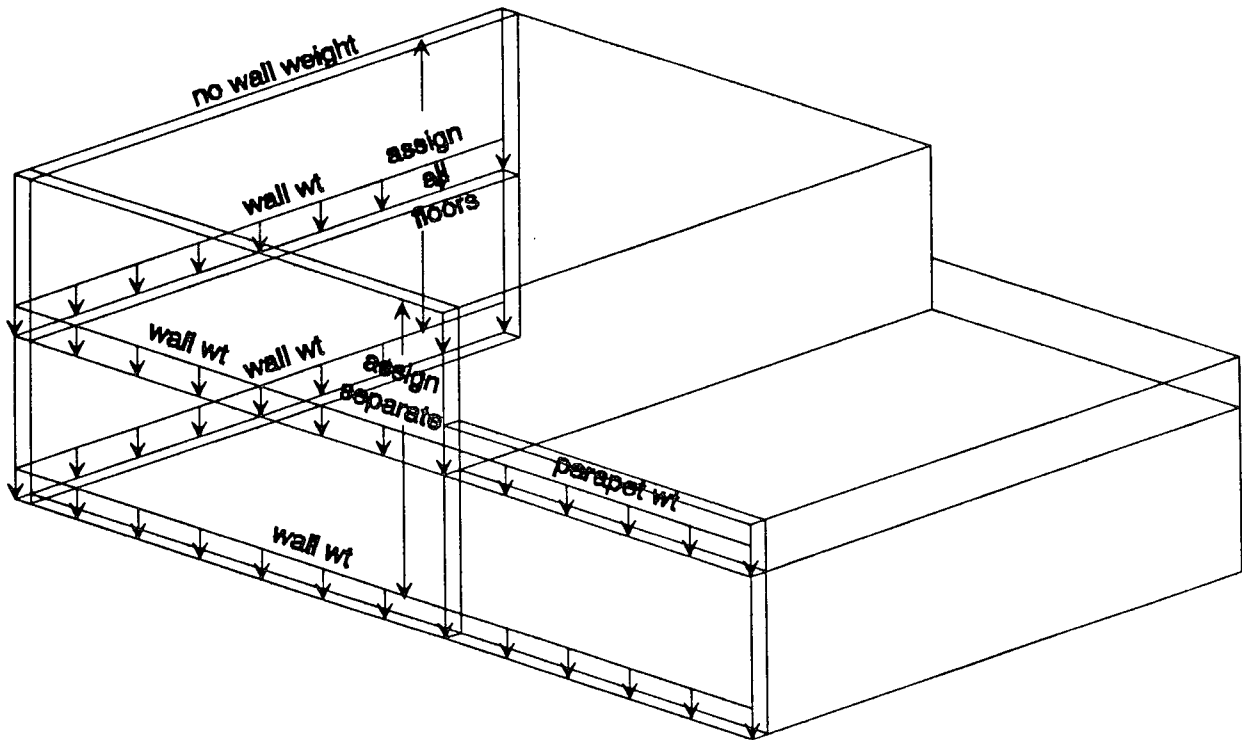


Draw Structure



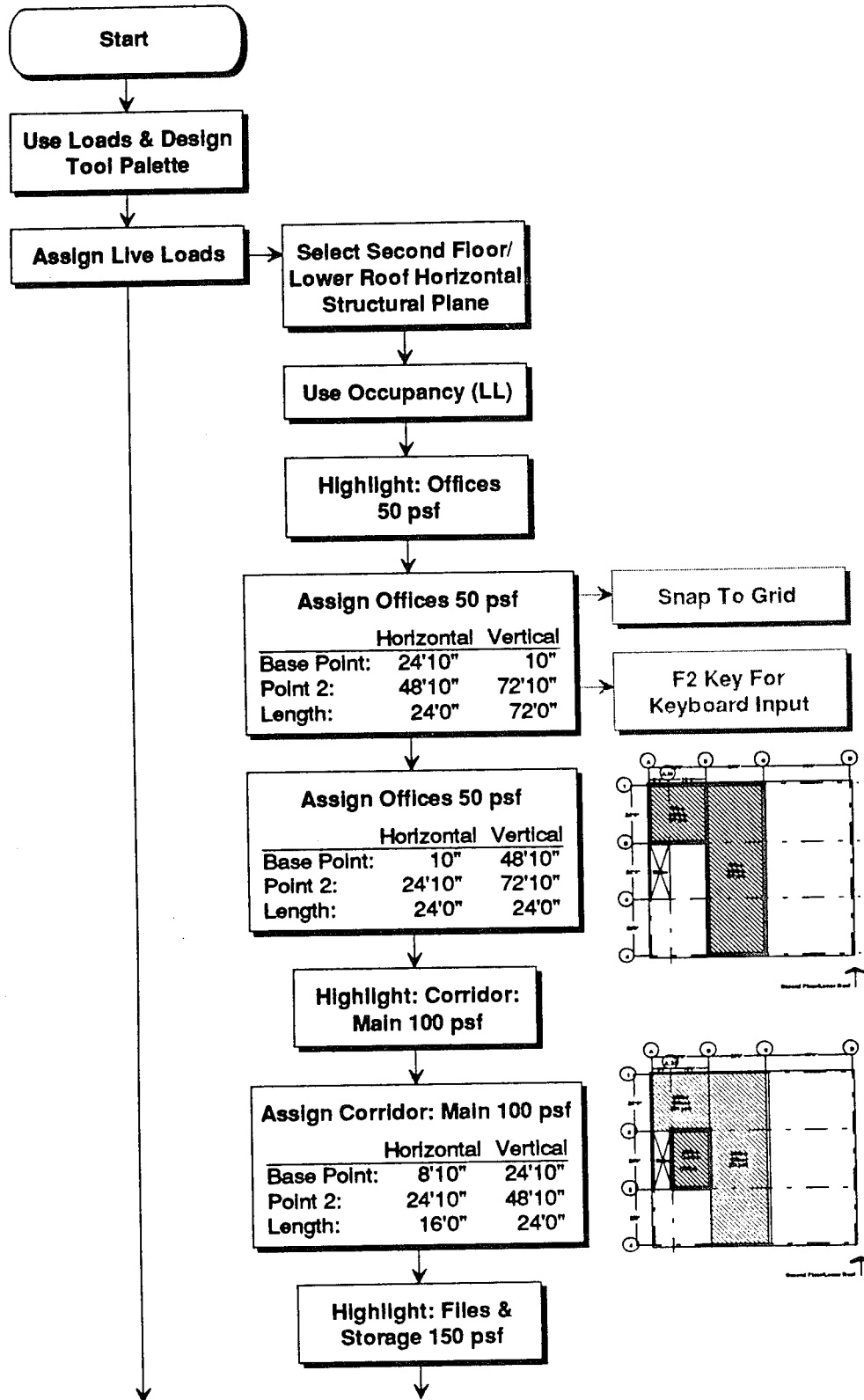


Assign Wall Loads Philosophy

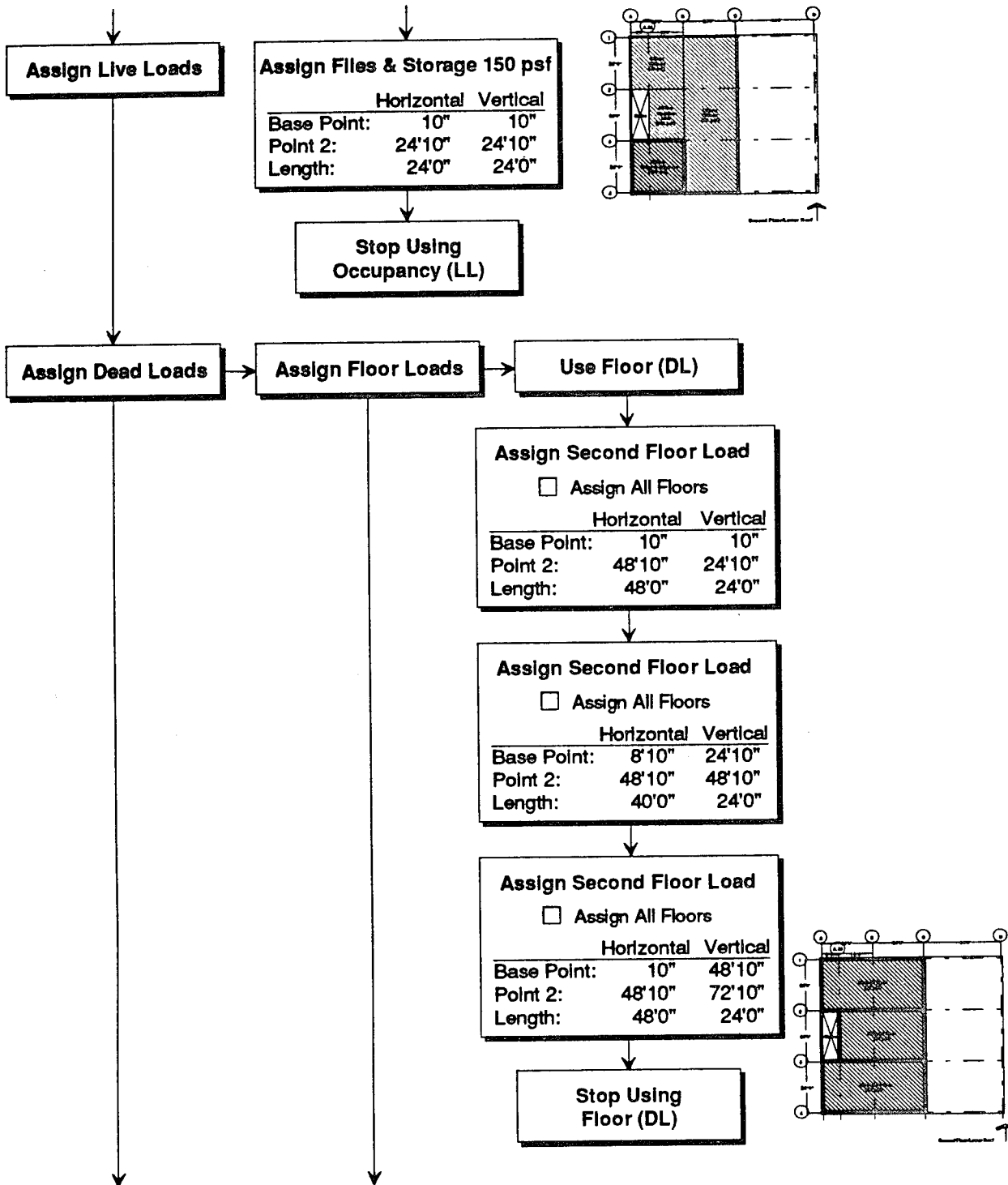


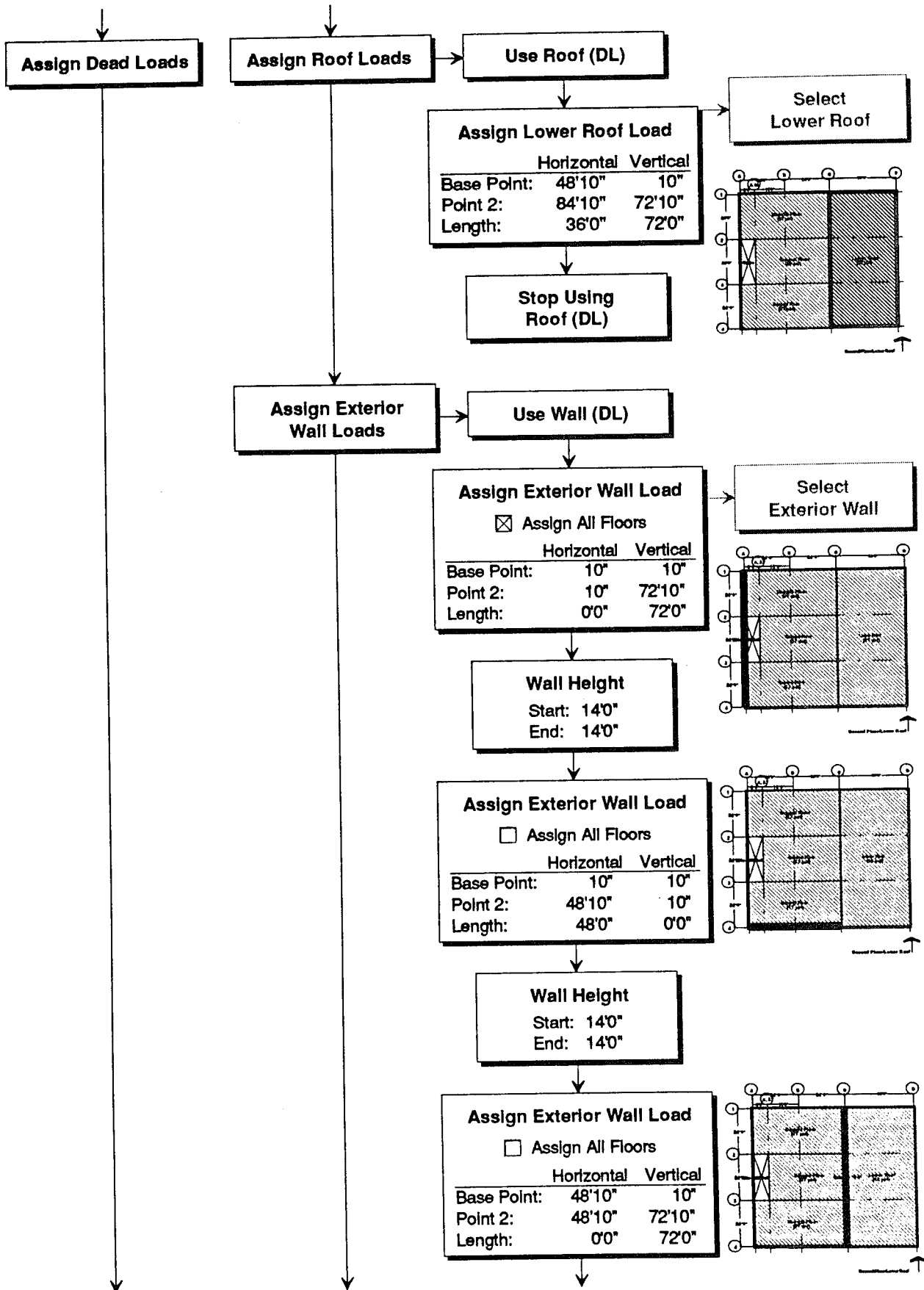
this approach saves memory

Assign Loads

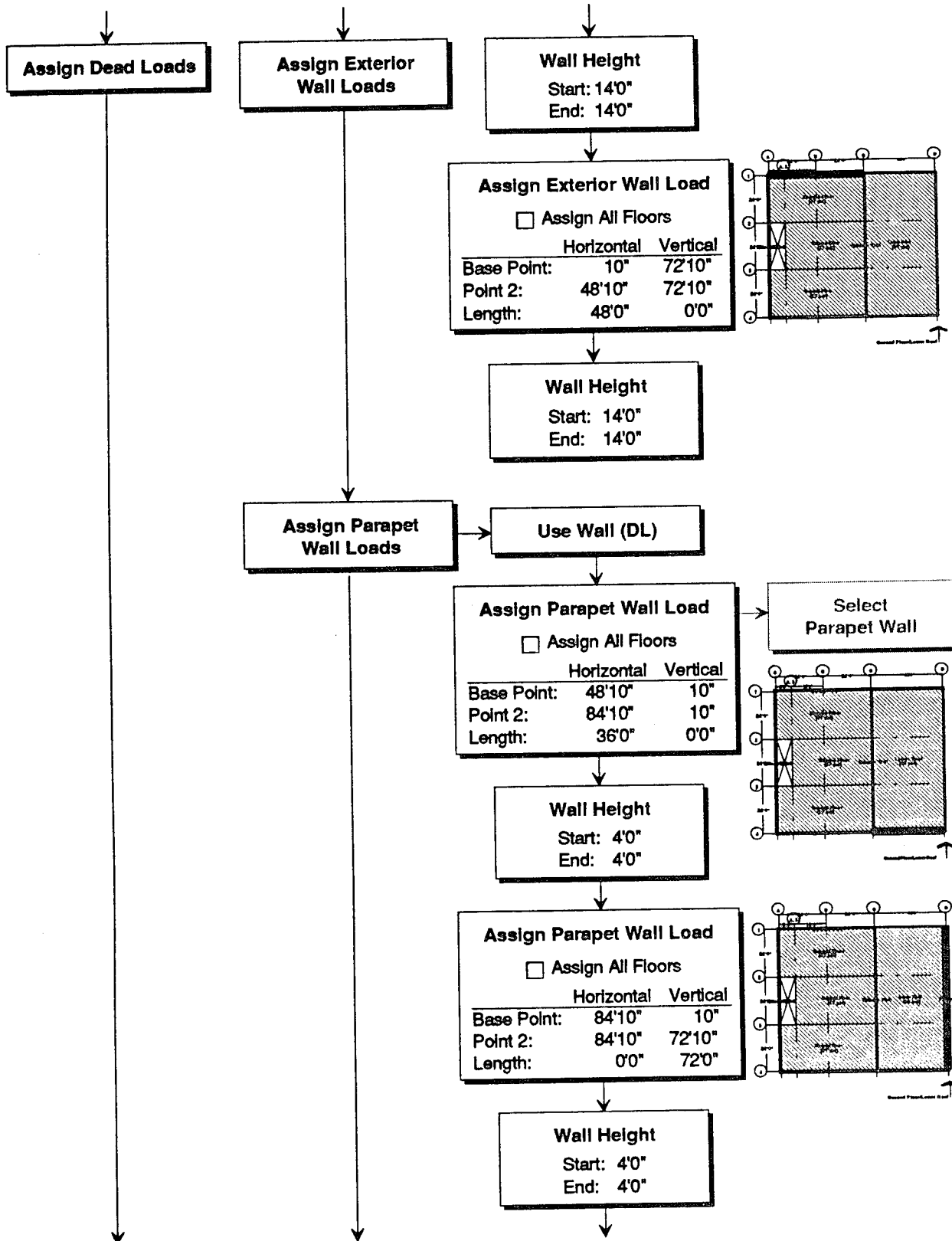


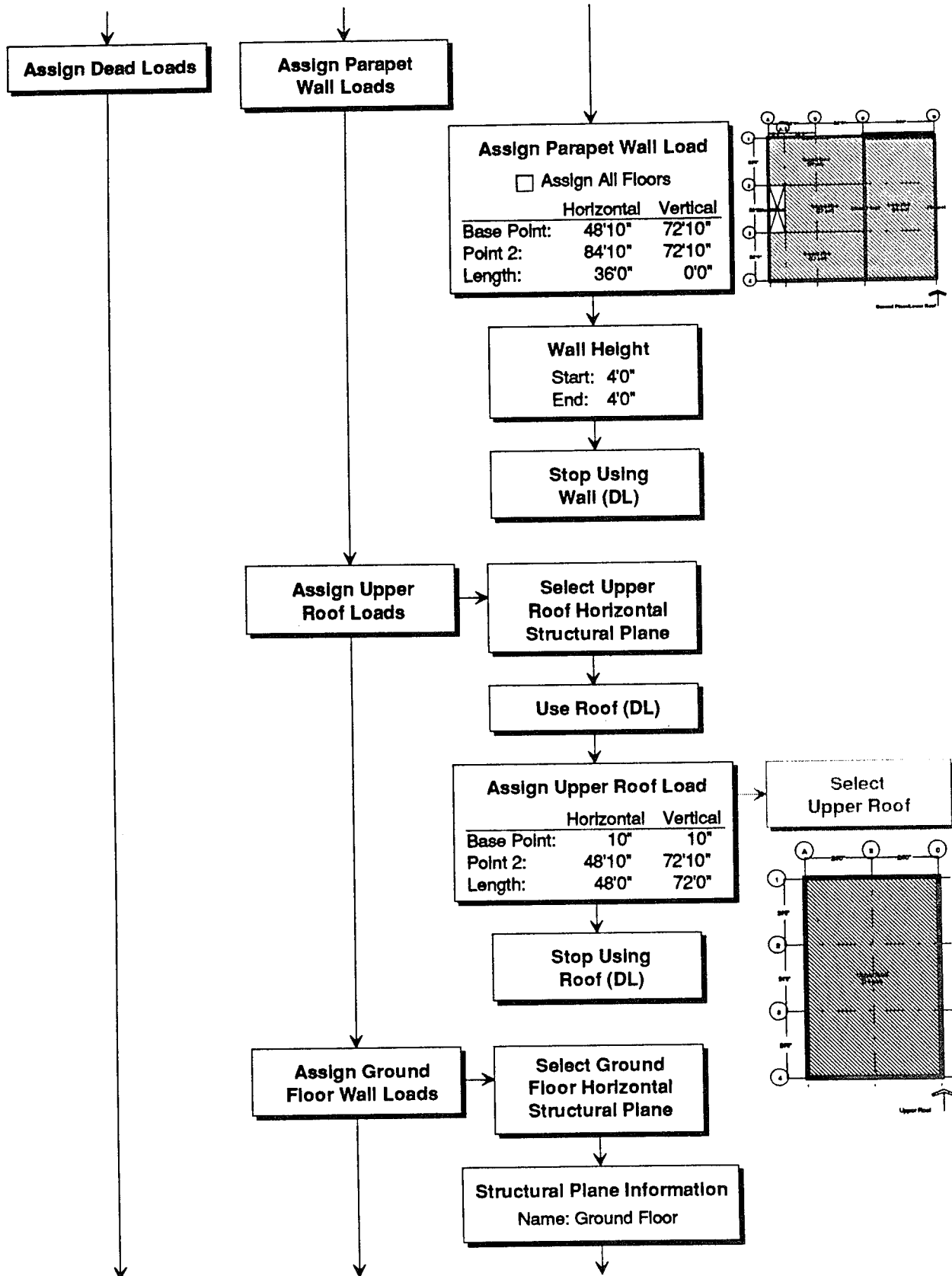
Assign Loads



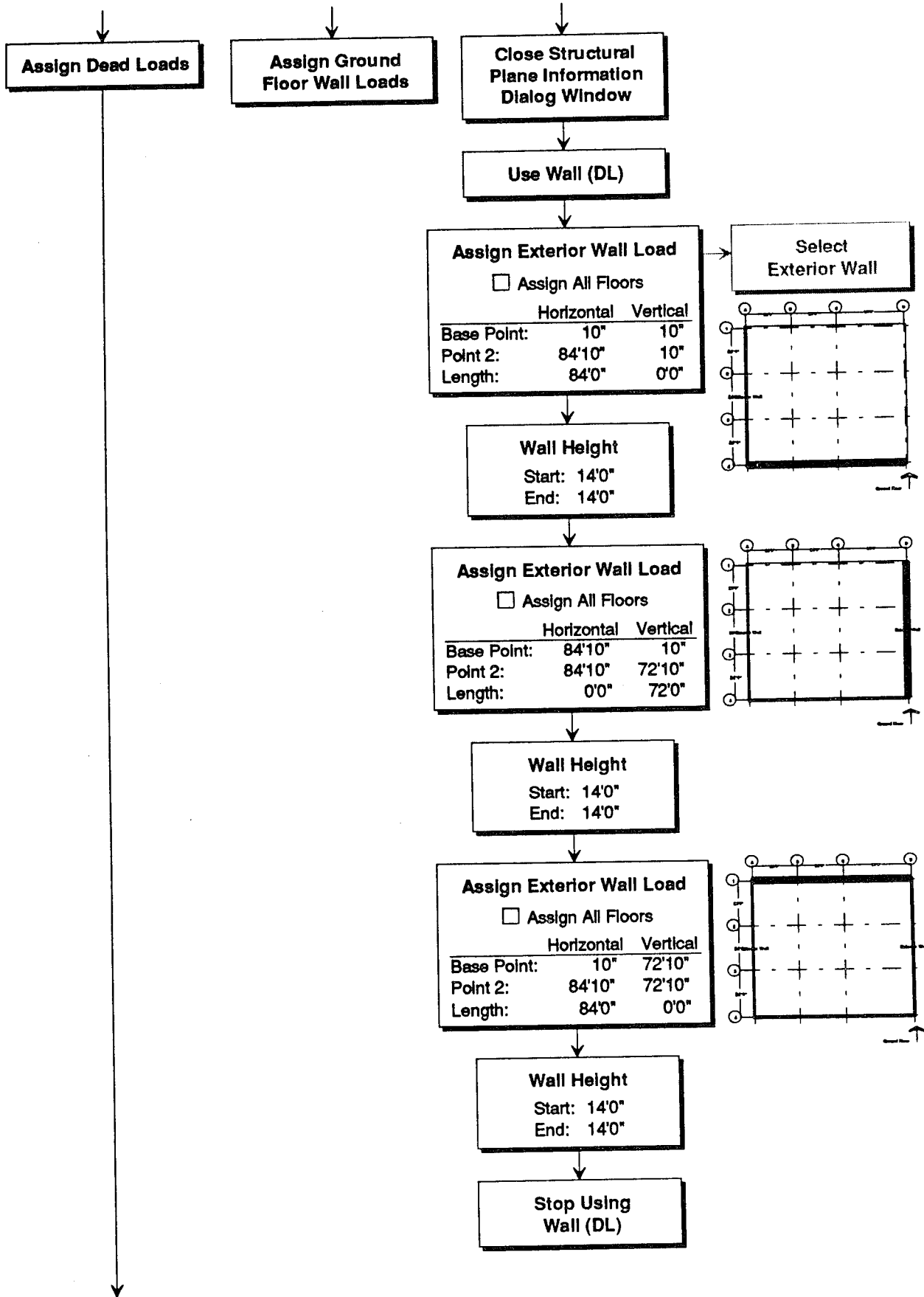


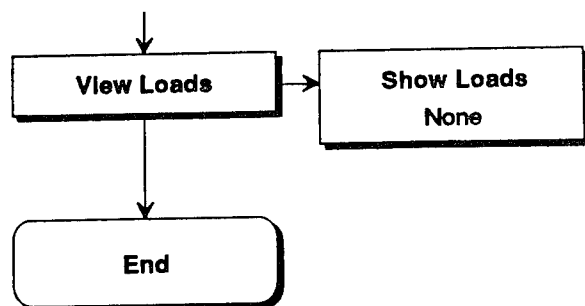
Assign Loads



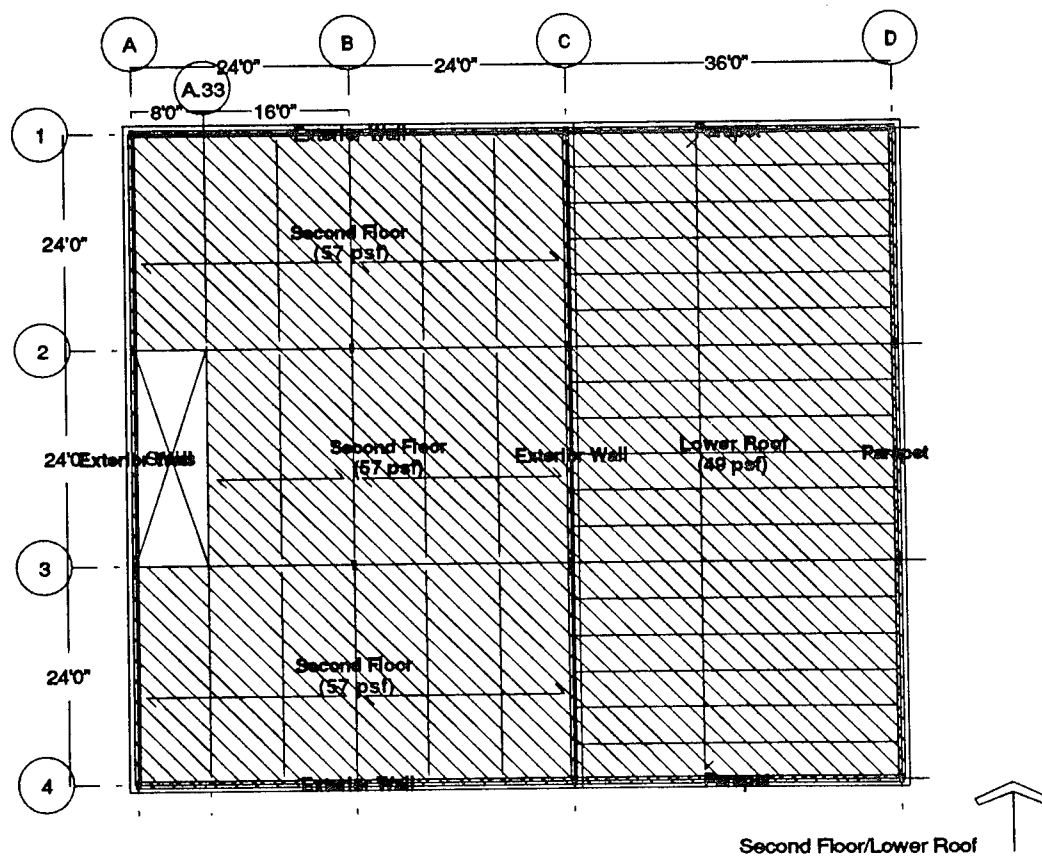
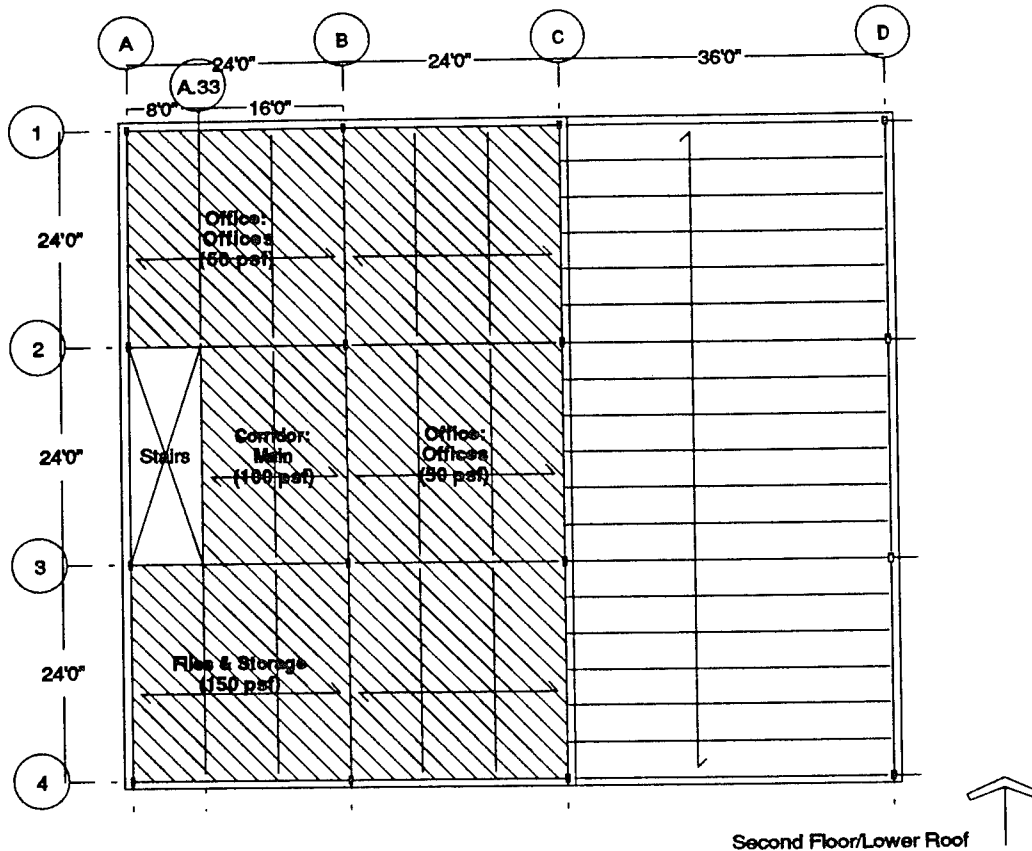


Assign Loads

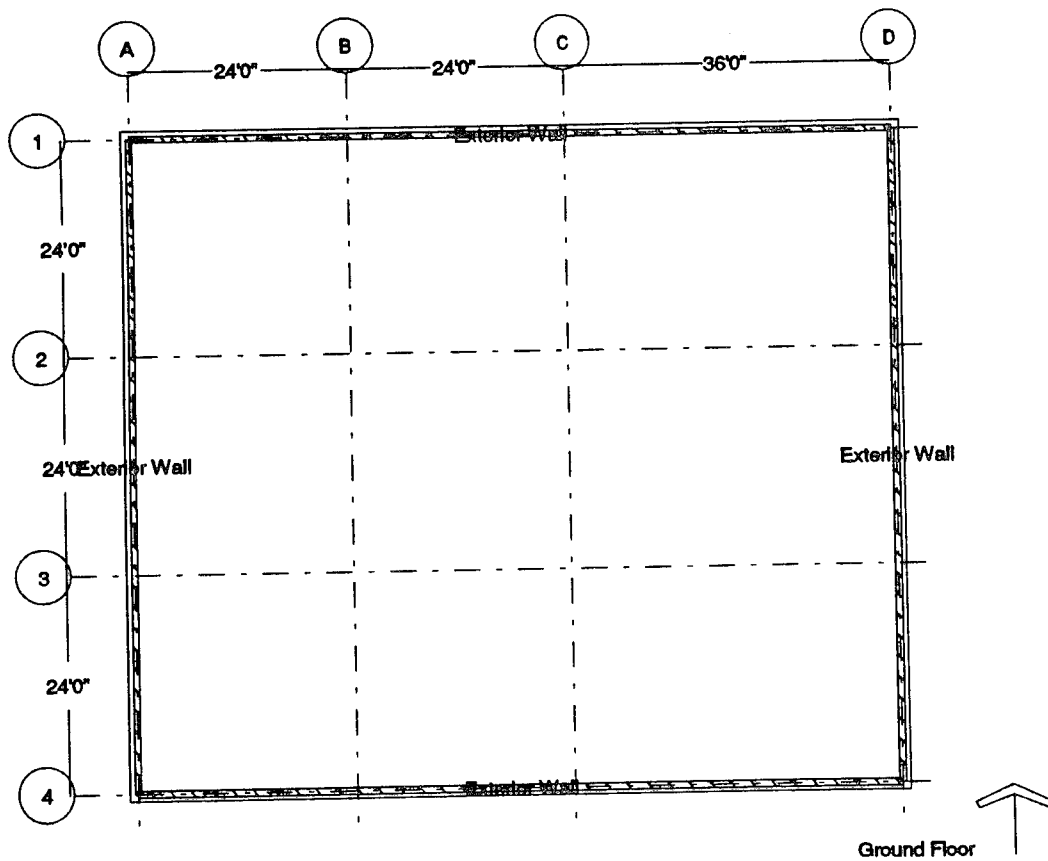
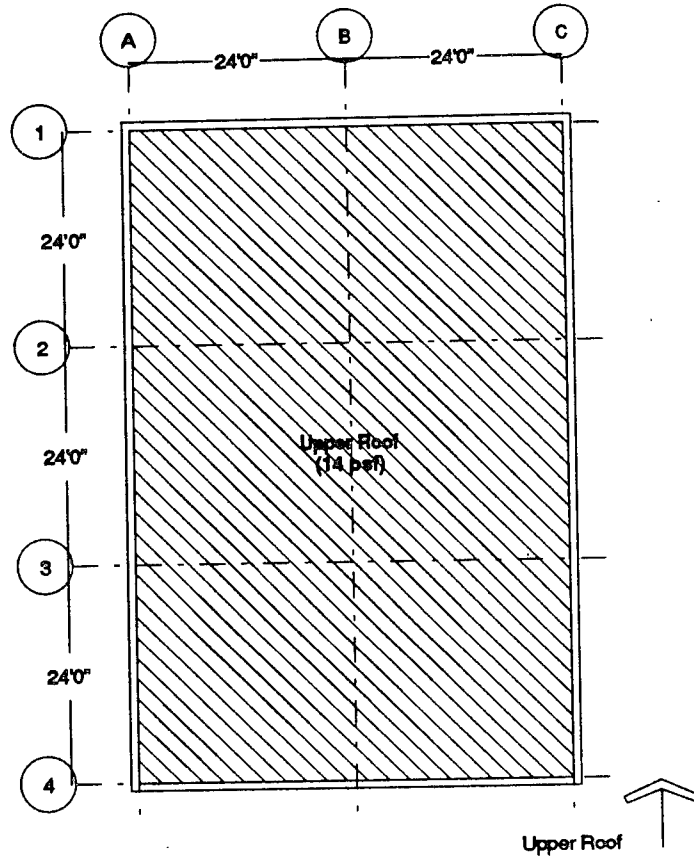




Assign Loads



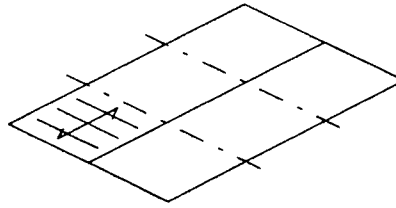
Assign Loads



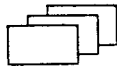
Analysis & Design Philosophy

Preliminary Analysis

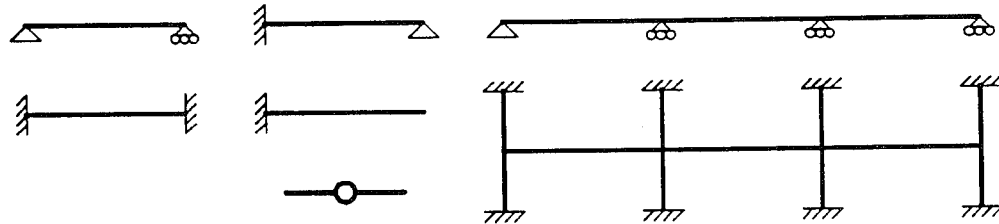
- A. Select:
- * Material
 - * Load Combination
(Live Load Reduction)
 - * Element To Analyze



- B. Review:
- * Attributes
 - * Guidelines



C. Connectivity



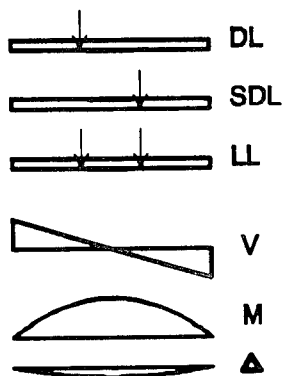
- D. Self Weight Estimate
- * Guidelines



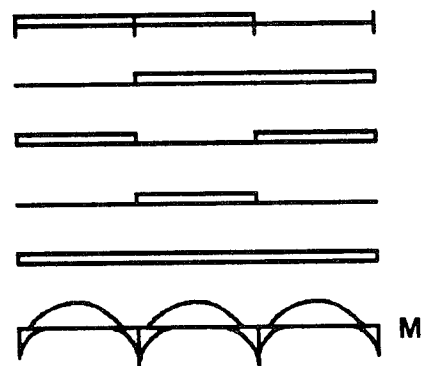
- E. Analysis
- * Review Loads
 - * Connectivity

* Analysis Output

$I = 1$
 $E = 1$
 $A = 1000$



Pattern Loads



- F. Re-Analysis (with real properties)

Preliminary Design

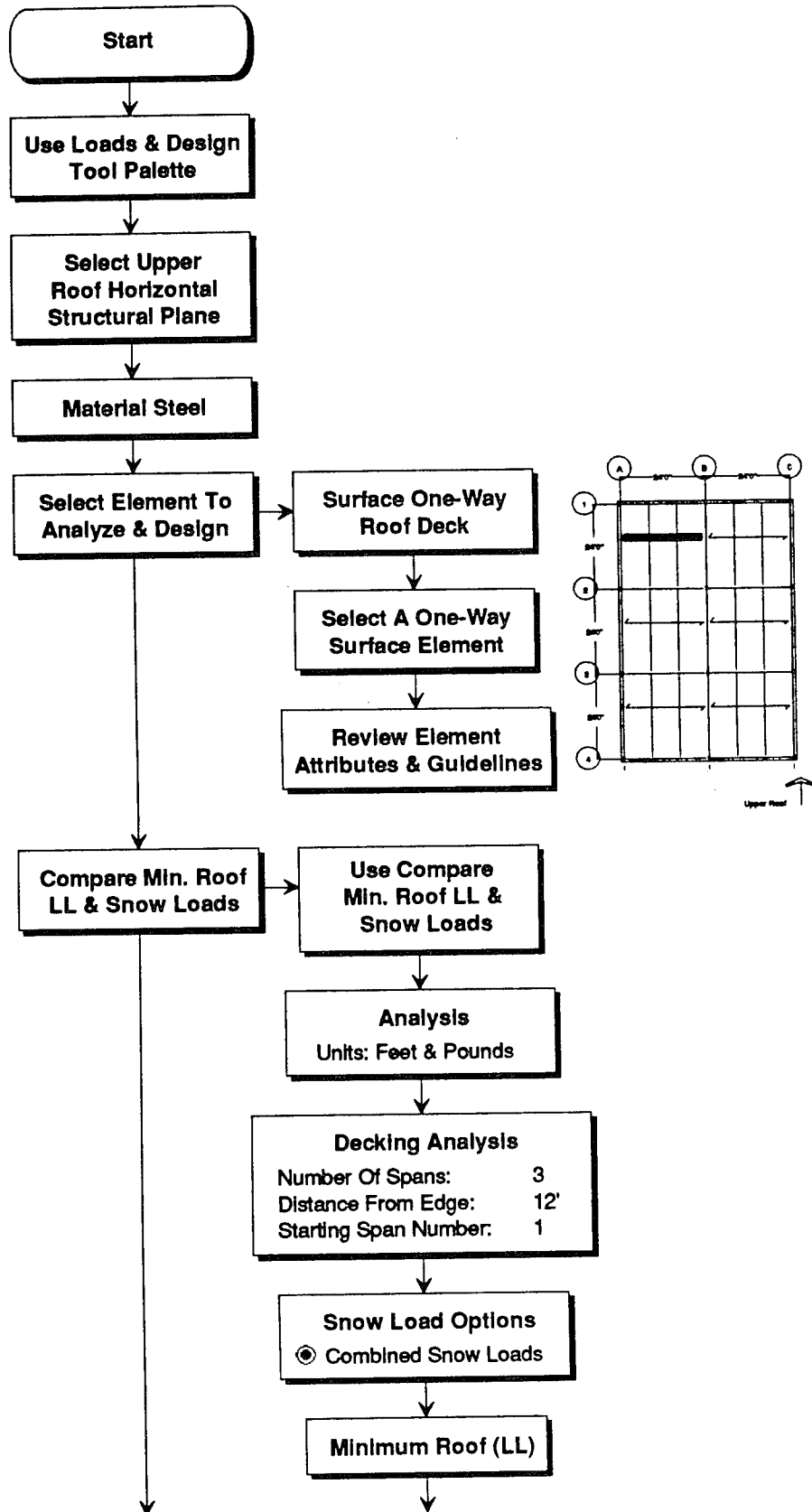
* Maximum V's, M's, R's, etc. sent to Excel

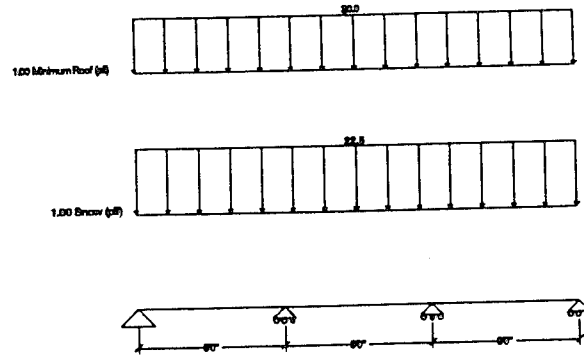
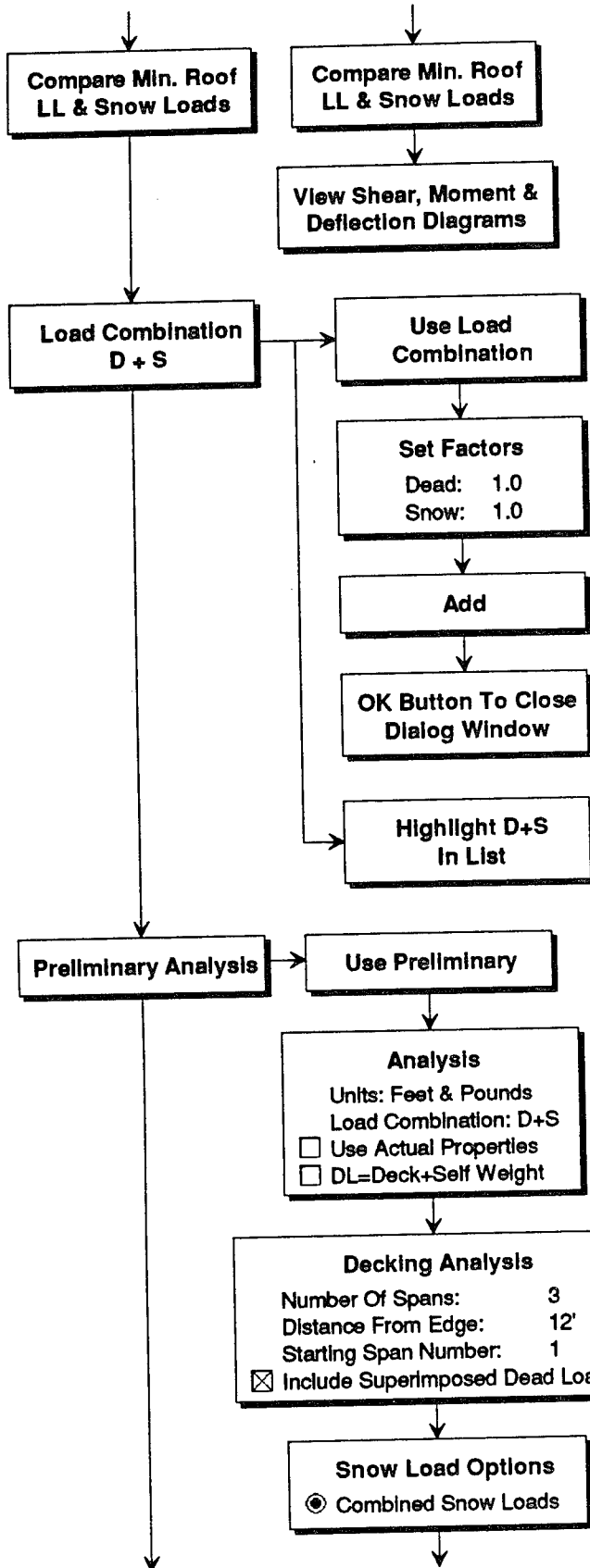
Spreadsheets

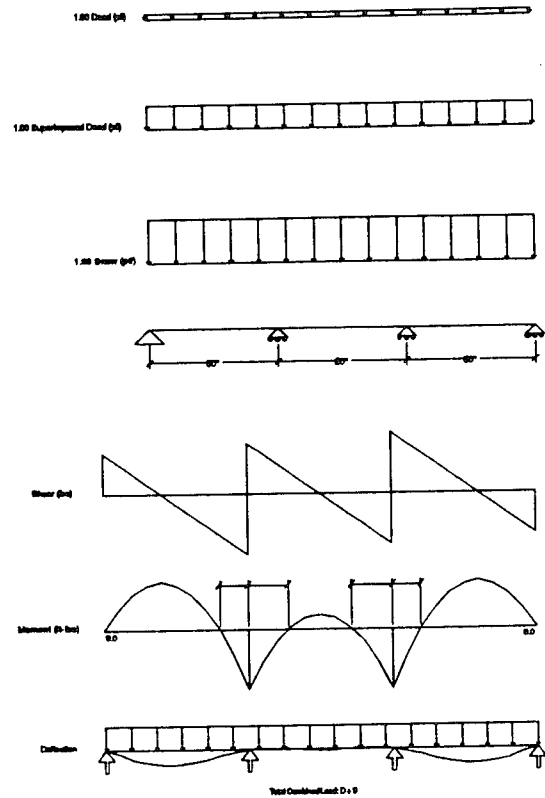
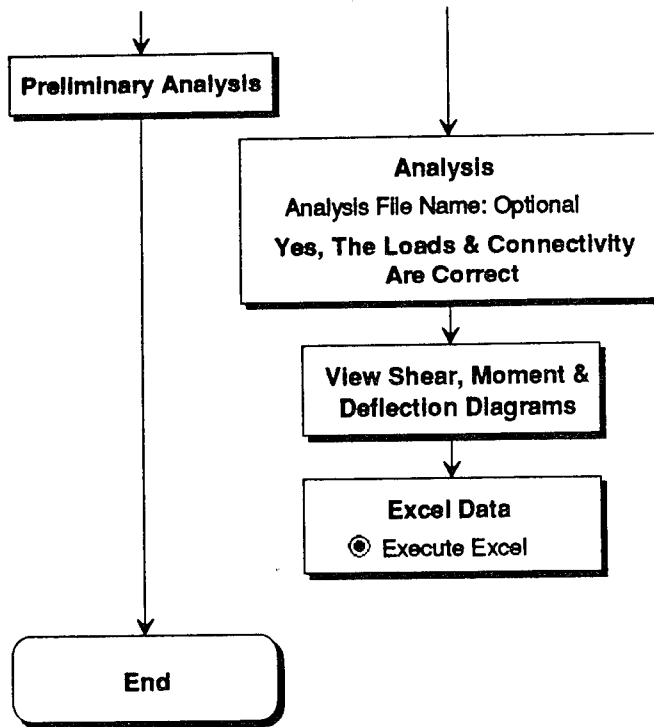
Title			
Connectivity Dimensions Allowable Stresses Allowable Deflections	Loads	M	V
	Required: I & S		
	Choices & Options Table		
	Selection		

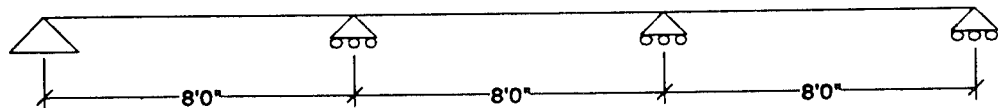
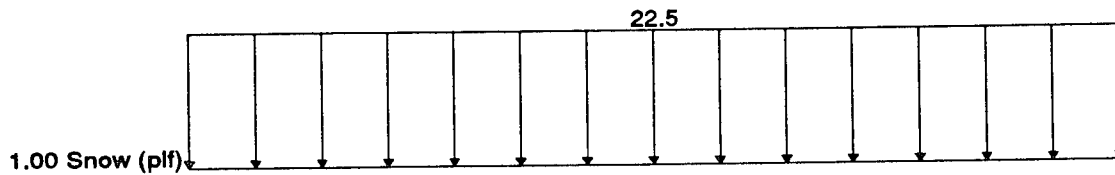
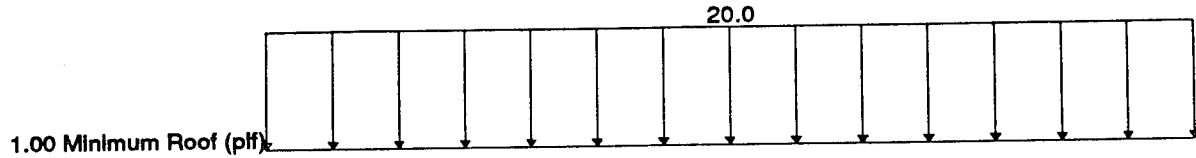
→
sent back
to CASM

Surface Element Analysis









Project : Office Building - Scheme B
 Location : Radford AAP
 Design Load : TM 5-809-1 1992
 Time : Tue Aug 30, 1994 12:08 PM

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

Tributary Area (At) : 24.0 sqft
 Roof Slope (F) : 0.00 in 12

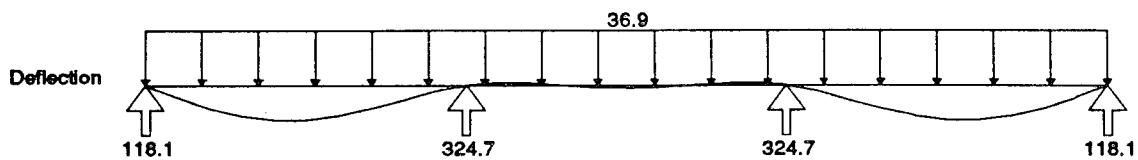
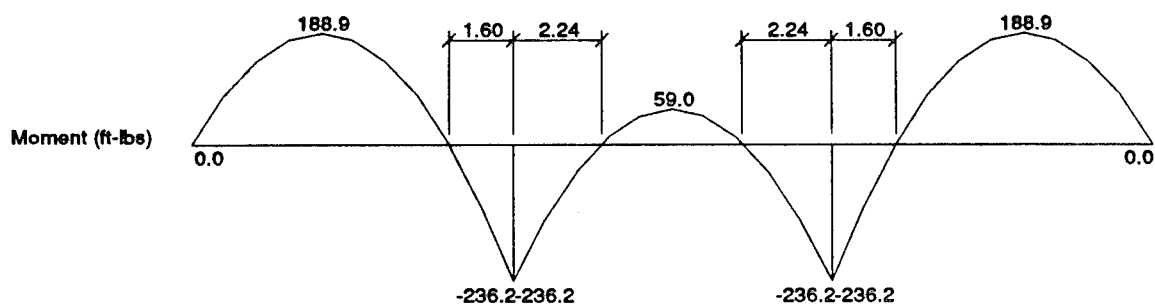
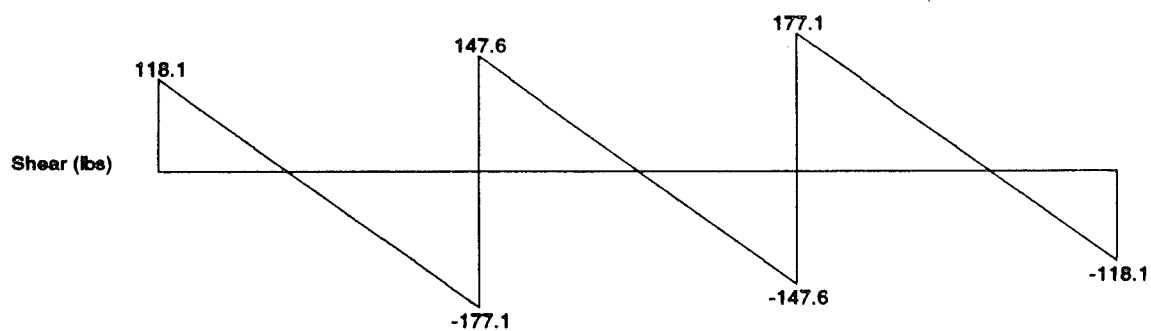
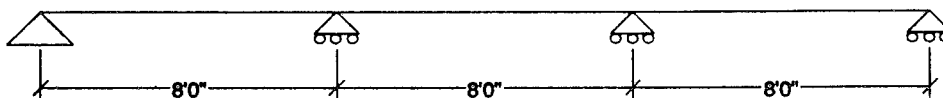
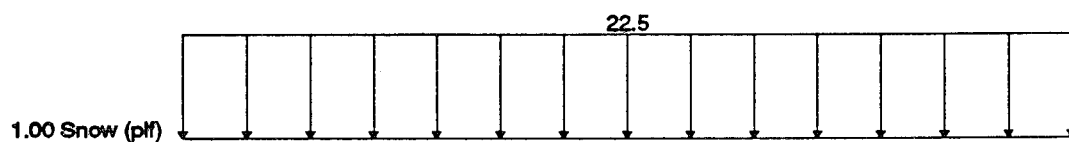
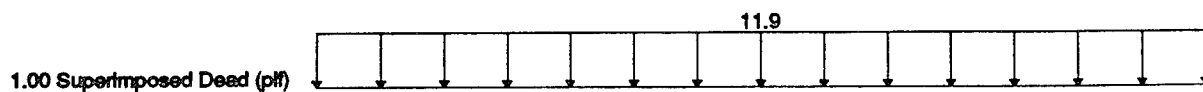
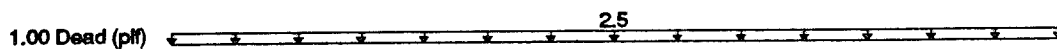
$L_r = 20 \cdot R_1 \cdot R_2 \geq 12$
 At ≤ 200 $R_1 = 1.00$
 F ≤ 4 $R_2 = 1.00$
 $L_r = 20.00$ psf
 Minimum $L_r = 12.0$ psf

+-----+
 | Lr = 20.00 psf |
 +-----+

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

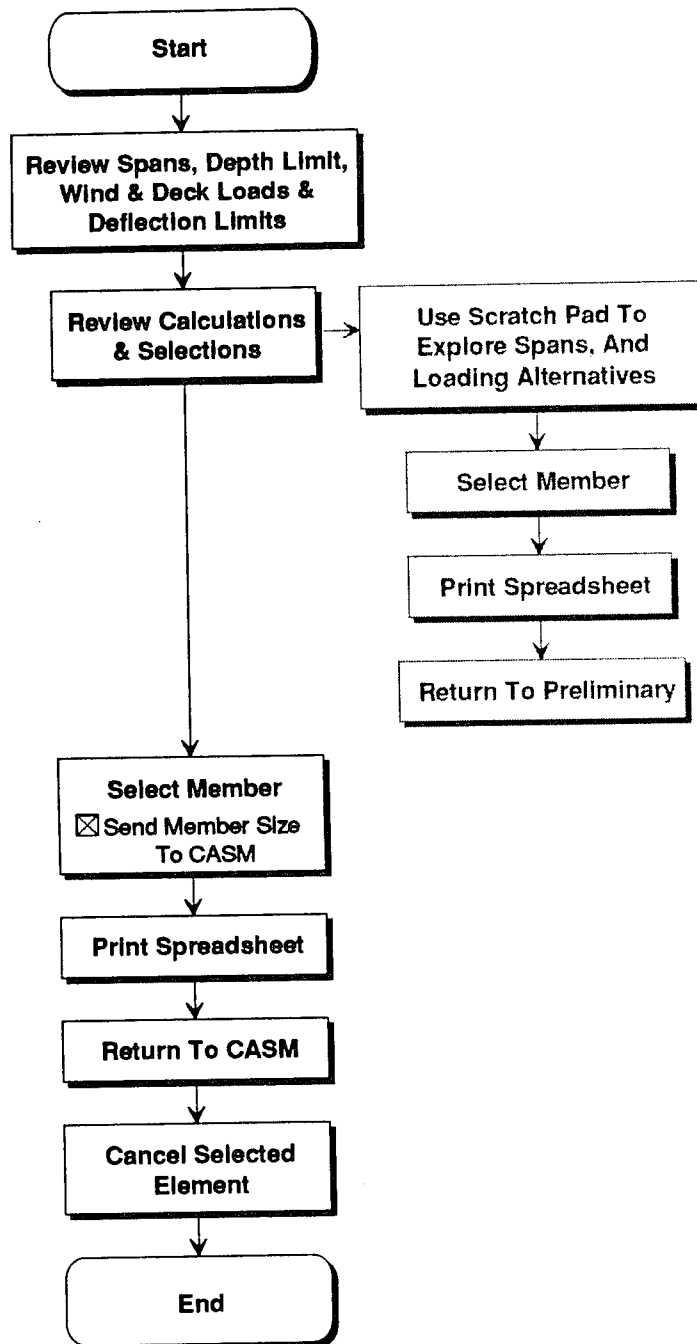
Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Surface Element Analysis



Total Combined Load: D + S

Steel Roof Deck Design



STEEL ROOF DECK PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Aug 31, 1994
Location: Radford AAP	Engr:

Load and Analysis Data:

Method: Analysis	Load Combination: D + S					
Member ID:		Factored Moments (lb-ft)			Fact. Reactions	
Connectivity: Beam (Left)		Load Type	Left	Mid	Right	Left(lb) Right(lb)
Beam (Right)		Deck	16.0	12.8	16.0	12.0 12.0
Deck Span: 8 ft		Sup Dead	76.2	60.9	76.2	57.1 57.1
Trib Width= 12 in		Live				
Depth Limit= 1.5 in. max		Lmin Roof				
Fy= 33.0 ksi		Snow	144.0	115.2	144.0	108.0 108.0
Fb= 20.0 ksi		Wind				
Fv= 13.2 ksi		Summary	236.2	188.9	236.2	177.1 177.1
E = 29,000 ksi		Load Combinations for roof:				
Live Ld Defl= L/240 =0.40 in		Load Case #1: D + S	Est. Deck Wgt = 2.0 psf			
Total Defl= L/180 =0.53 in		Load Case #2: Deck + Wind	Wind Load = -30.0 psf			
		Load Case #3: Deck + Construction 200# Point Load				

Deck Configuration:

Deck Type: Roof Deck

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	188.9	92.2	0.113	0.055	0.1531
	# 2	-28.0	1.33	209.7	-168.4	0.095	-0.076	0.1263
	# 3	2.0	1.33	332.0	-183.0	0.150	-0.083	0.1716
Maximums:				332.0	-183.0	0.150	-0.083	0.1716

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	0.232	-0.245	0.210	2.1	6'-3"	7'-5"
IR18	18	1.5	0.189	-0.194	0.206	2.7	6'-2"	7'-4"
WR18	18	1.5	0.316	-0.325	0.290	2.8	7'-6"	8'-10"
NR18	18	1.5	0.163	-0.168	0.188	2.8	5'-11"	6'-11"

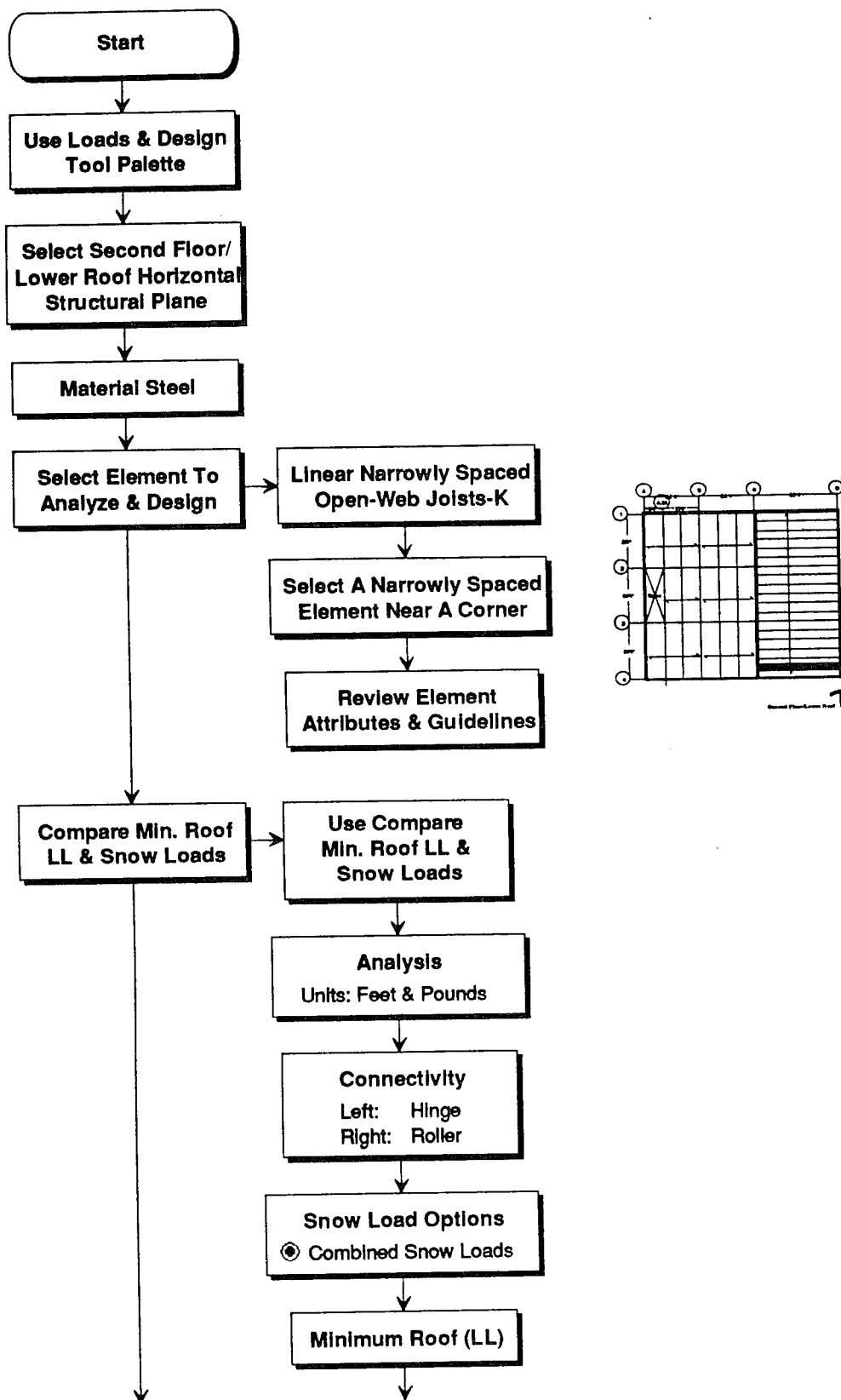
CASM Preliminary Steel Roof Deck Selection:

Deck Type: WR 20	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc	
Weight: 2.1 psf	Gage: 20	Ix = 0.21	Construction Load Span Limits:	
	Sx+ = 0.232	Sx- = -0.245	1 span: 6'-3"	2+span: 7'-5"

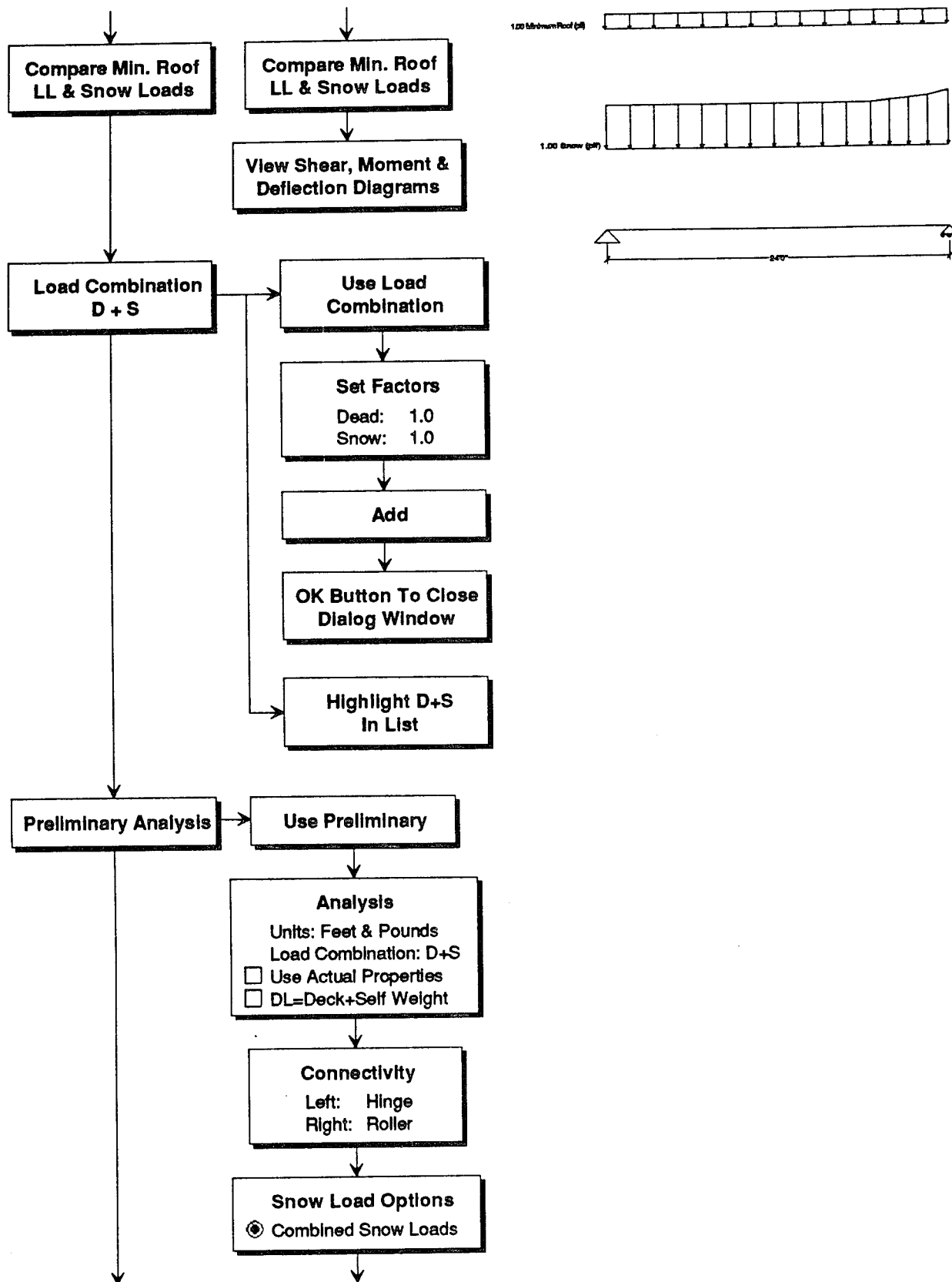
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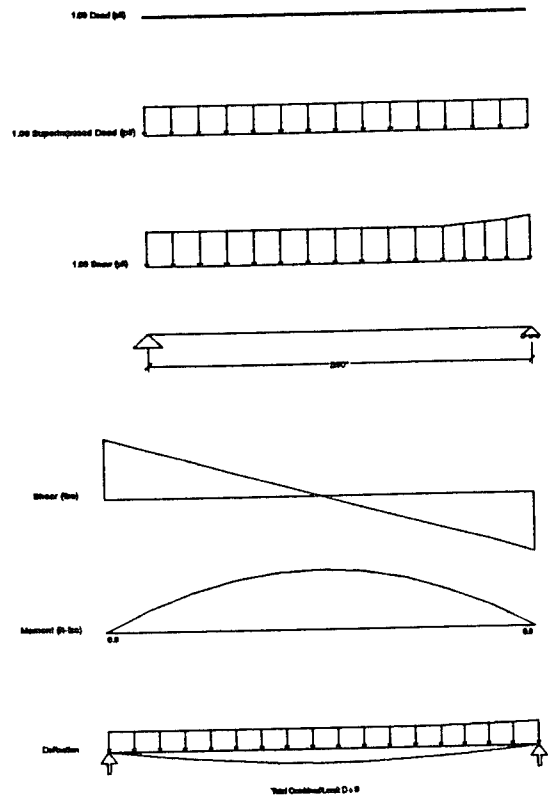
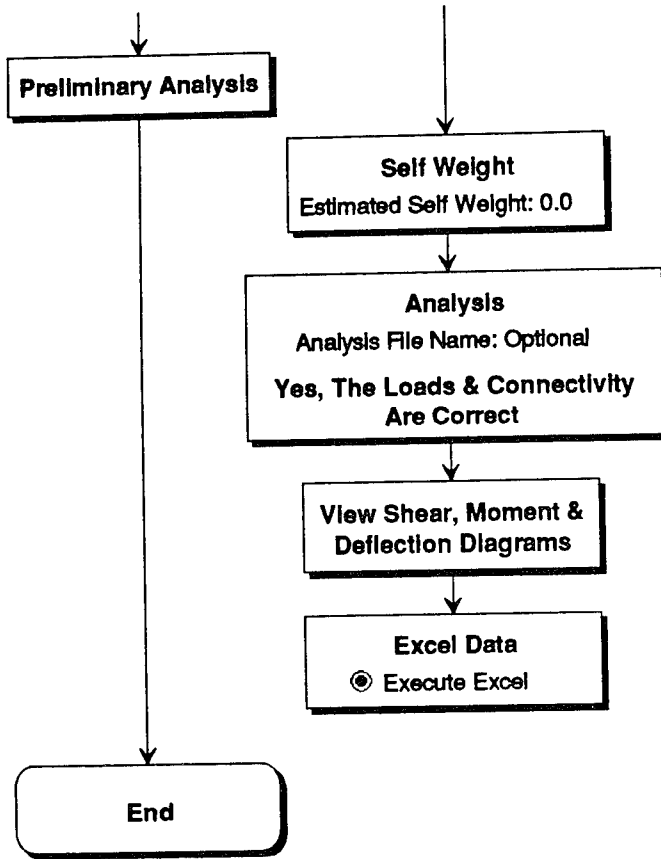
1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

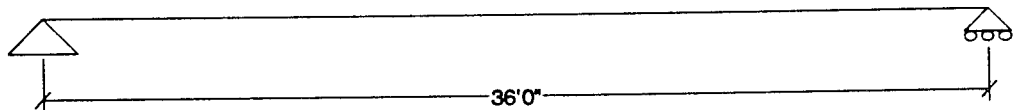
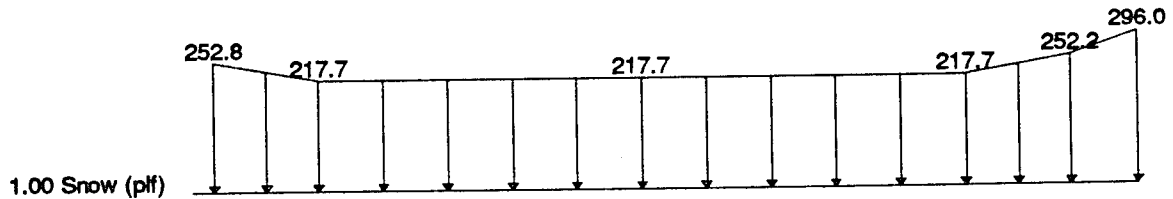
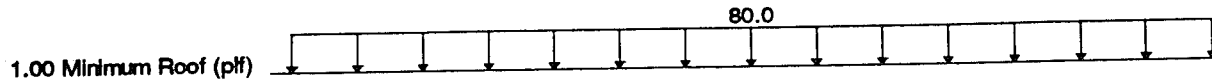
Narrowly Spaced Element Analysis



Narrowly Spaced Element Analysis







Project : Office Building - Scheme B
 Location : Radford AAP
 Design Load : TM 5-809-1 1992
 Time : Wed Aug 31, 1994 4:45 PM

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

Tributary Area (At) : 144.0 sqft
 Roof Slope (F) : 0.00 in 12

$L_r = 20 \cdot R_1 \cdot R_2 \geq 12$
 At ≤ 200 $R_1 = 1.00$
 F ≤ 4 $R_2 = 1.00$
 $L_r = 20.00$ psf
 Minimum $L_r = 12.0$ psf

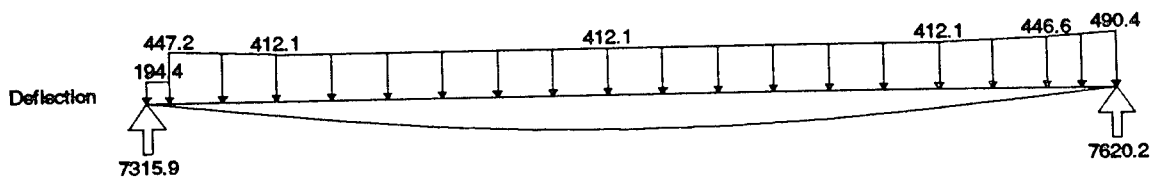
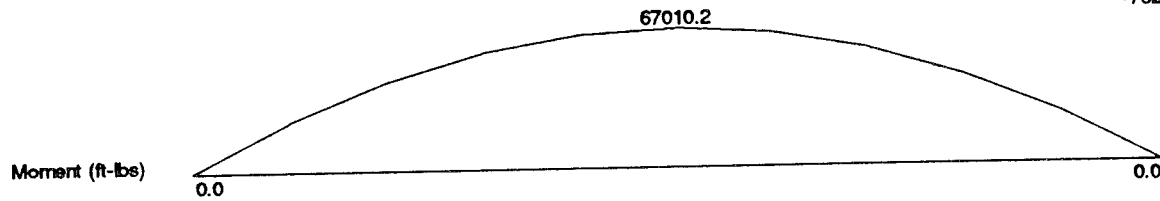
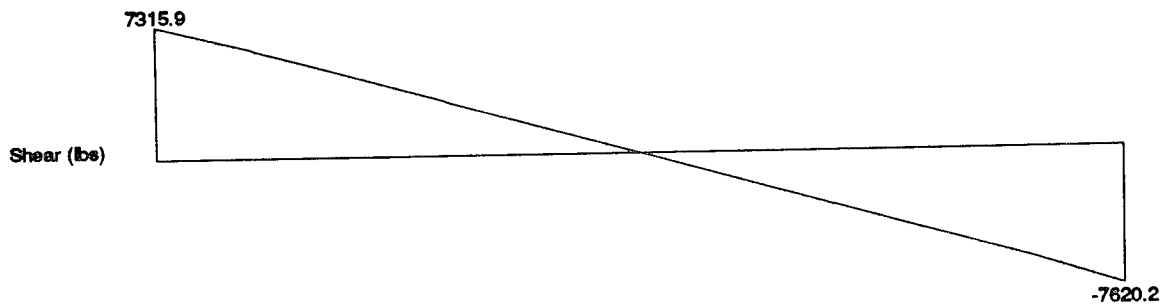
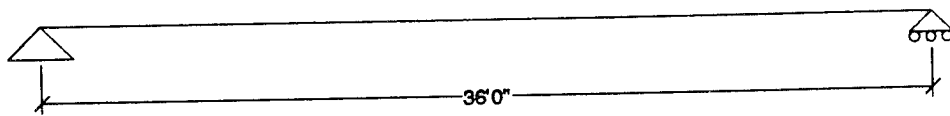
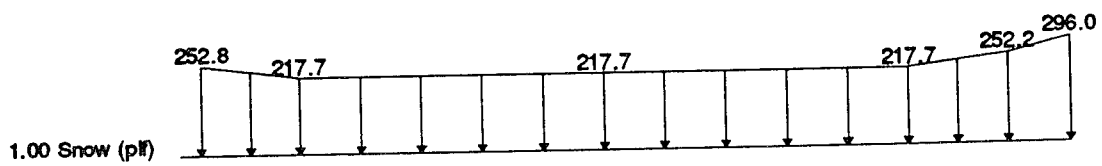
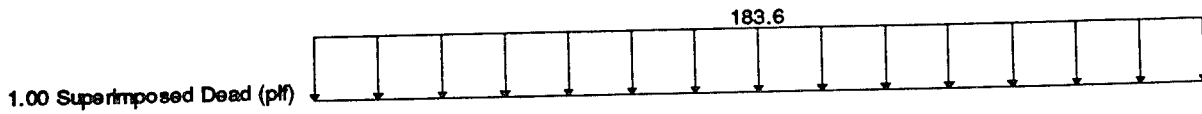
```

+-----+
|  Lr = 20.00 psf  |
+-----+
  
```

Check minimum roof live load, L_r , 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 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Narrowly Spaced Element Analysis



Total Combined Load: D + S

Narrowly Spaced Element Analysis

 * TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1984 4:52 PM

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

Office Building - Scheme B -- 1.00 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	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

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

SUMMARY OF IM-BEAM LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE

UNITS: FEET, POUNDS

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

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

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

JOINT DATA

UNITS: FEET, POUNDS

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

MEMBER DATA

ELE I	MOCK I	MOCK J	MAT TYPE	ELE TYPE	ELE CODE	P.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

***** 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	-3023.3089
2	0.0000	-128125.4106	-2854.0036
3	0.0000	-242406.4852	-2394.4606
4	0.0000	-331872.2408	-1717.2394
5	0.0000	-388686.2608	-894.8994
6	0.0000	-408146.6952	0.0000
7	0.0000	-388686.2608	894.8994
8	0.0000	-331872.2408	1717.2394
9	0.0000	-242406.4852	2394.4606
10	0.0000	-128125.4106	2854.0036
11	0.0000	0.0000	3023.3089

MEMBER END FORCES

UNITS: FEET, POUNDS

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

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

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

PROBLEMS COMPLETED

 * TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1984 4:52 PM

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

Office Building - Scheme B -- 1.00 Superimposed Dead Load

Narrowly Spaced Element Analysis

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	1000.0000	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-BEAM LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
 UNITS: FEET, POUNDS

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

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

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

JOINT DATA

UNITS: FEET, POUNDS

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

MEMBER DATA

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

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

JOINT DISPLACEMENTS

UNITS: INCHES, RADIAN AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-51396.2478
2	0.0000	-2178131.8664	-48518.0580
3	0.0000	-4120910.0347	-40705.8283
4	0.0000	-5641827.8007	-29193.0688
5	0.0000	-6607666.0900	-15213.2894
6	0.0000	-6938493.4581	0.0000
7	0.0000	-6607666.0900	15213.2894
8	0.0000	-5641827.8007	29193.0688
9	0.0000	-4120910.0347	40705.8283
10	0.0000	-2178131.8664	48518.0580
11	0.0000	0.0000	51396.2478

MEMBER END FORCES

UNITS: FEET, POUNDS

ELK	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3304.800	0.000	0.000	-2643.840	10707.552
2	0.000	2643.840	-10707.552	0.000	-1982.880	19035.647
3	0.000	1982.880	-19035.647	0.000	-1321.920	24984.287
4	0.000	1321.920	-24984.287	0.000	-660.960	28553.471
5	0.000	660.960	-28553.471	0.000	0.000	29743.199
6	0.000	0.000	-29743.199	0.000	660.960	28553.471
7	0.000	-660.960	-28553.471	0.000	1321.920	24984.287
8	0.000	-1321.920	-24984.287	0.000	1982.880	19035.647
9	0.000	-1982.880	-19035.647	0.000	2643.840	10707.552
10	0.000	-2643.840	-10707.552	0.000	3304.800	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

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

PROBLEMS COMPLETED

 * TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994 4:52 PM

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

Office Building - Scheme B -- 1.00 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 = 5

MATERIAL TYPES

UNITS: INCHES, POUNDS

MATERIAL	YOUNG'S MODULUS	POISSON'S RATIO
1	1000.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

Narrowly Spaced Element Analysis

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

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	RAMP	3.60	-252.80	0.83	-228.38	3.60
2	UNIFORM	3.60	-217.70	1.21		3.60
2	RAMP	3.60	-228.38	0.00	-217.70	1.21
3	UNIFORM	3.60	-217.70	0.00		3.60
4	UNIFORM	3.60	-217.70	0.00	0.66	0.66
4	RAMP	3.60	-217.70	0.66	-243.05	3.60
5	RAMP	3.60	-243.05	0.00	-252.21	1.06
5	RAMP	3.60	-252.21	1.06	-296.00	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	247.449	203.538	0.000	418.190	-249.101
2	0.000	398.004	236.933	0.000	392.173	-235.464
3	0.000	391.856	235.114	0.000	391.856	-235.114
4	0.000	400.216	242.714	0.000	420.750	-249.112
5	0.000	459.218	280.691	0.000	499.447	-293.057

JOINT DATA

UNITS: FEET, POUNDS

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

MEMBER DATA

ELM	MODE I	MODE J	MAT TYPE	ELM TYPE	P.E.T. CODE	REL 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	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	4	4.00	4.00	0.50
10	10	11	1	1	0	5	4.00	4.00	0.50

***** OUTPUT *****

JOINT DISPLACEMENTS

UNITS: INCHES, RADIAN AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-61411.3760
2	0.0000	-2602732.7518	-57975.3350
3	0.0000	-4924253.1523	-48646.1547
4	0.0000	-6742314.4791	-34910.9089
5	0.0000	-7898171.3665	-18232.3078
6	0.0000	-8296262.9413	-72.9476
7	0.0000	-7904212.4932	18104.5754
8	0.0000	-6752827.4745	34837.6646
9	0.0000	-4936099.5002	48663.7239
10	0.0000	-2611231.5820	58116.2957
11	0.0000	0.0000	61647.5956

MEMBER END FORCES

UNITS: FEET, POUNDS

ELM	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3816.687	0.000	0.000	-3151.048	12803.693
2	0.000	3151.048	-12803.693	0.000	-2360.871	22716.119
3	0.000	2360.871	-22716.119	0.000	-1577.158	29804.571
4	0.000	1577.158	-29804.571	0.000	-793.445	34071.657
5	0.000	793.445	-34071.657	0.000	-9.732	35517.376
6	0.000	9.732	-35517.376	0.000	773.981	34141.729
7	0.000	-773.981	-34141.729	0.000	1557.694	29944.715
8	0.000	-1557.694	-29944.715	0.000	2341.406	22926.335
9	0.000	-2341.406	-22926.335	0.000	3162.373	13050.094
10	0.000	-3162.373	-13050.094	0.000	4121.038	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3816.687	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	4121.038	0.000

PROBLEMS COMPLETED

* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Wed Aug 31, 1994 4:52 PM

***** INPUT *****

Office Building - Scheme B -- Total Combined Load: D + S

NUMBER OF ELEMENTS = 10
NUMBER OF MODAL 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	1000.0000	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

Narrowly Spaced Element Analysis

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFORM	3.60	-194.40	0.00		3.60
1	RAMP	3.60	-252.80	0.83	-228.38	3.60
2	UNIFORM	3.60	-194.40	0.00		3.60
2	UNIFORM	3.60	-217.70	1.21		3.60
2	RAMP	3.60	-228.38	0.00	-217.70	1.21
3	UNIFORM	3.60	-412.10	0.00		3.60
4	UNIFORM	3.60	-194.40	0.00		3.60
4	UNIFORM	3.60	-217.70	0.00		0.66
4	RAMP	3.60	-217.70	0.66	-243.05	3.60
5	UNIFORM	3.60	-194.40	0.00		3.60
5	RAMP	3.60	-243.05	0.00	-252.21	1.06
5	RAMP	3.60	-252.21	1.06	-296.00	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	597.369	413.490	0.000	768.110	-459.053
2	0.000	747.924	446.885	0.000	742.093	-445.416
3	0.000	741.776	445.066	0.000	741.776	-445.066
4	0.000	750.136	452.666	0.000	770.670	-459.064
5	0.000	809.138	490.643	0.000	849.367	-503.009

JOINT DATA

UNITS: FEET, POUNDS

NODE CODE	MODAL COORDINATES		BOUNDARY CONDITIONS				ELASTIC SUPPORT TYPE
	X	Y	X	Y	Z		
1	11.0	7.00	0.00	0.00	0.00	0	0
2	0	10.60	0.00	0.00	0.00	0	0
3	0	14.20	0.00	0.00	0.00	0	0
4	0	17.80	0.00	0.00	0.00	0	0
5	0	21.40	0.00	0.00	0.00	0	0
6	0	25.00	0.00	0.00	0.00	0	0
7	0	28.60	0.00	0.00	0.00	0	0
8	0	32.20	0.00	0.00	0.00	0	0
9	0	35.80	0.00	0.00	0.00	0	0
10	0	39.40	0.00	0.00	0.00	0	0
11	10	43.00	0.00	0.00	0.00	0	0

MEMBER DATA

MEMBER I	MEMBER J	MAT TYPE	MEMBER TYPE	MEMBER CODE	P.R.F. TYPE	REL. KIJ	STIFF. KIJ	CARRY OVER FACTOR
1	1	2	1	1	0	1	4.00	0.50
2	2	3	1	1	0	2	4.00	0.50
3	3	4	1	1	0	3	4.00	0.50
4	4	5	1	1	0	3	4.00	0.50
5	5	6	1	1	0	3	4.00	0.50
6	6	7	1	1	0	3	4.00	0.50
7	7	8	1	1	0	3	4.00	0.50
8	8	9	1	1	0	3	4.00	0.50
9	9	10	1	1	0	4	4.00	0.50
10	10	11	1	1	0	5	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	-115830.9327
2	0.0000	-4908990.0288	-109347.3965
3	0.0000	-9287569.6722	-91764.4436
4	0.0000	-12716014.5206	-65821.2171
5	0.0000	-14894523.7173	-34340.4966
6	0.0000	-15642903.0947	-72.9476
7	0.0000	-14900564.8441	34212.7641
8	0.0000	-12726527.5160	65747.9728
9	0.0000	-9299416.0201	91764.0128
10	0.0000	-4917488.8589	109488.3572
11	0.0000	0.0000	116067.1523

MEMBER END FORCES

UNITS: FEET, POUNDS

MEMBER	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	7315.886	0.000	0.000	-5950.408	24141.100
2	0.000	5950.408	-24141.100	0.000	-4460.391	42871.510
3	0.000	4460.391	-42871.510	0.000	-2976.838	56258.522
4	0.000	2976.838	-56258.522	0.000	-1493.285	64304.744

5	0.000	1493.285	-64304.744	0.000	-9.732	67010.175
6	0.000	9.732	-67010.175	0.000	1473.821	64374.816
7	0.000	-1473.821	-64374.816	0.000	2957.374	56398.666
8	0.000	-2957.374	-56398.666	0.000	4440.926	43081.727
9	0.000	-4440.926	-43081.727	0.000	5961.733	24387.502
10	0.000	-5961.733	-24387.502	0.000	7620.238	0.000

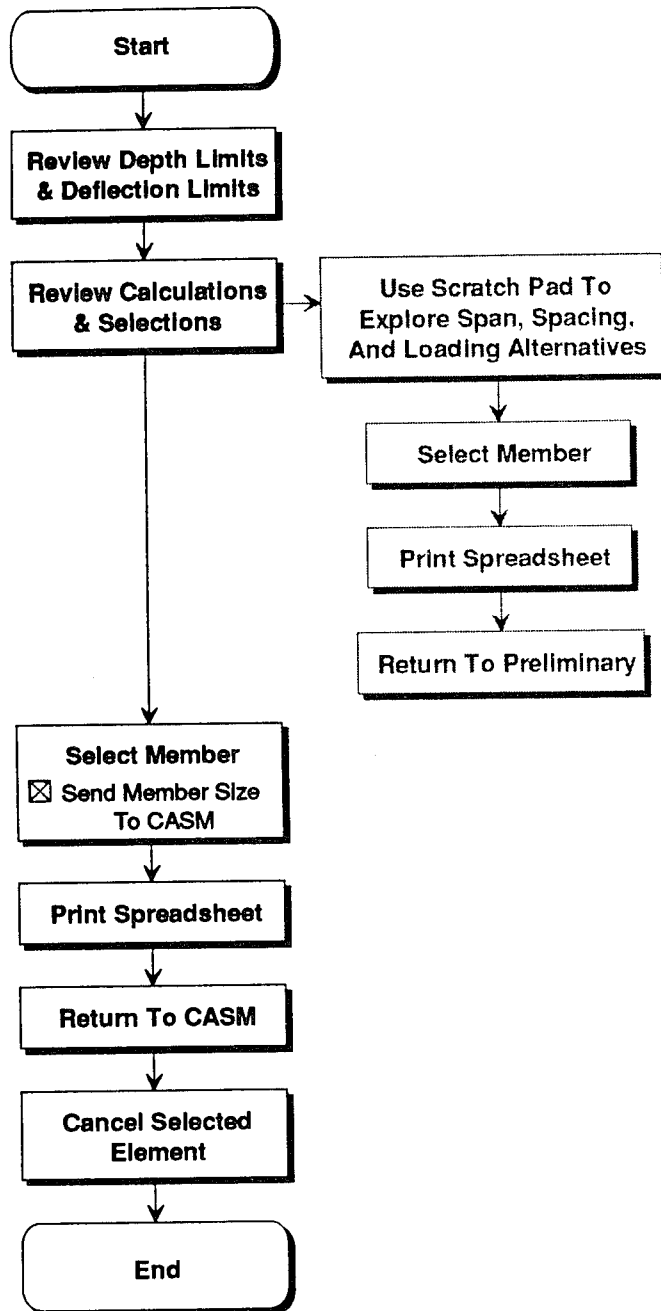
APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT X
1	0.000	7315.886	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	7620.238	0.000

PROBLEMS COMPLETED

Steel Open-Web Joist Design



STEEL BAR JOIST PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Sep 01, 1994
Location: Radford AAP	Engr:

CASM Load & Analysis Data:

Method: Analysis		Load Combination D + S					
Member ID:		LoadType	Factored Moment (ft-lb)			Factored Reaction	
Connection:			Left	Mid	Right	Left(lb)	Right(lb)
	Hinge (Left)	Dead		1,750		194	194
	Roller (Right)	Sup Dead		29,743		3,305	3,305
Span:	36.0 ft	Live					
Spacing:	48.0 in	Lmin Roof					
Depth Limit=	30.0 in. max	Snow		35,517		3,817	4,121
Fy=	50.0 ksi	Wind					
Fb=	30.0 ksi						
E =	29,000 ksi	Summary		67,010		7,316	7,620
Live Defl=	L/360= 1.20 in	Moment	Total Ld= 414 plf		Reaction	Total Ld= 423 plf	
Total Defl=	L/240= 1.80 in	EUL:	Live Ld= 219 plf		EUL:	Live Ld= 229 plf	
Ponding Check: NO							

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)	Ponding	Jst Wgt (plf)
28K9	48.0	442	332	71,604	7,956	0.83	1.54		13.0
24K10	48.0	447	283	72,414	8,046	0.97	1.79		13.1
30K8	48.0	436	353	70,632	7,848	0.78	1.45		13.2
30K9	48.0	475	383	76,950	8,550	0.72	1.34		13.4

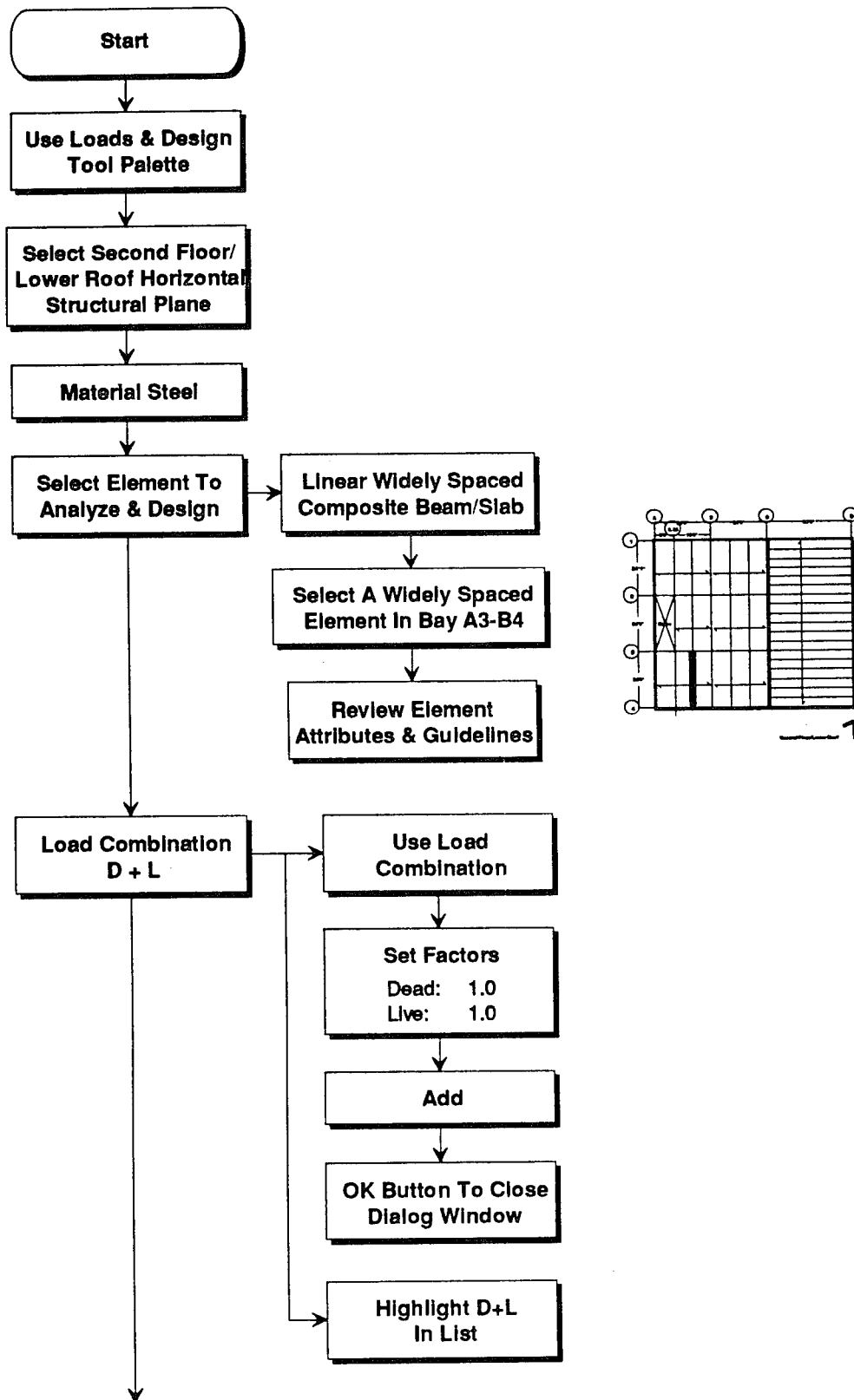
CASM Bar Joist Selection:

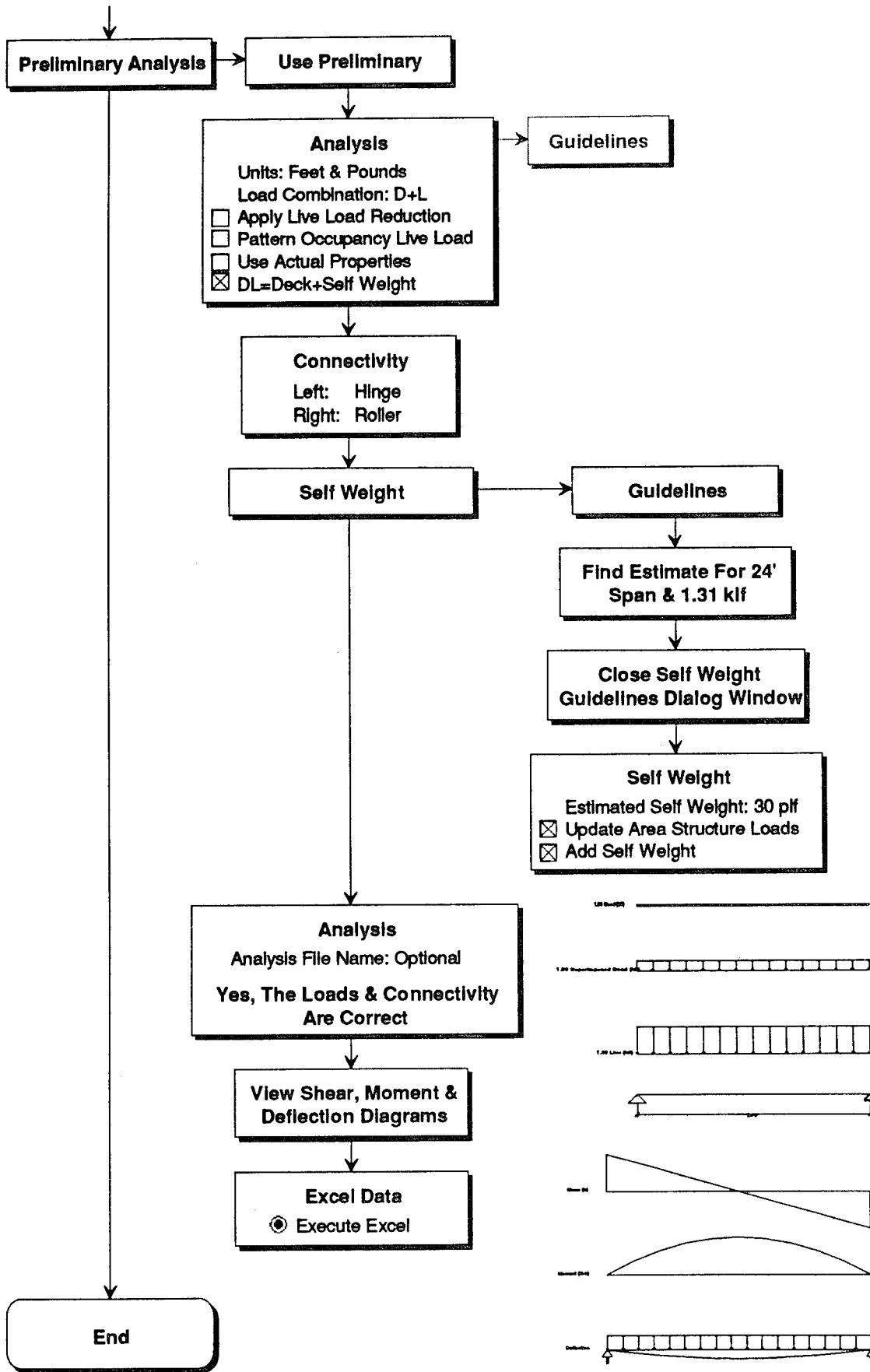
Joist Size: 28K9	Span: 36.0 ft	Spacing: 48 in	TL defl: 1.54 in	LL defl: 0.83 in
Wgt(tons): 0.23	Mmax: 71,604	Rmax: 7,956	Total Ld: 442 plf	Live Ld: 332 plf

NOTES:

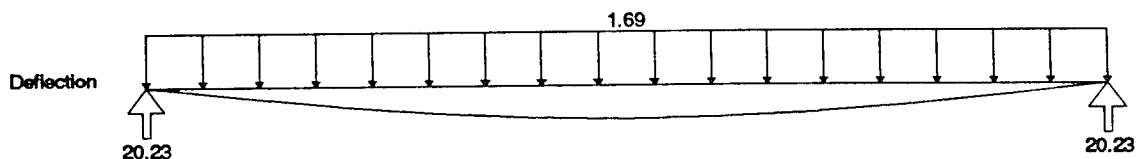
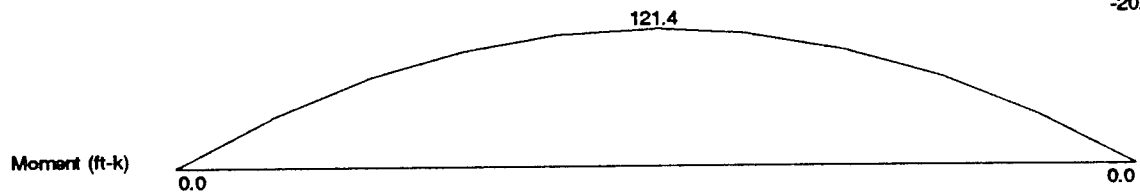
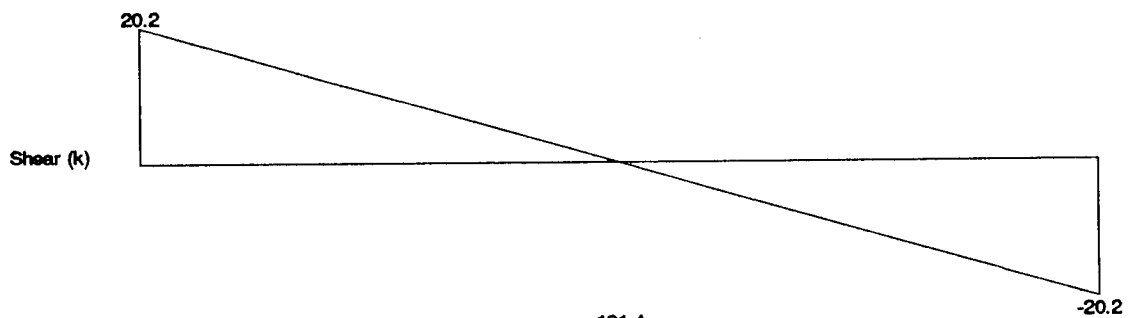
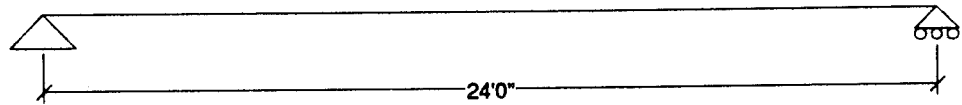
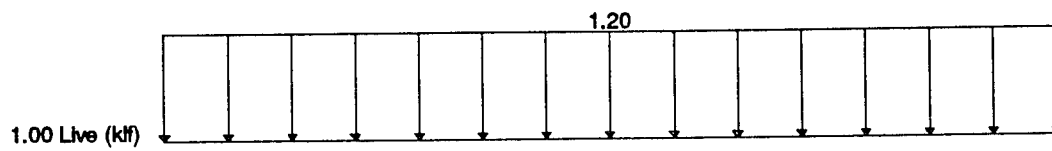
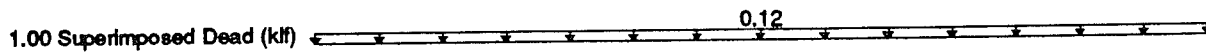
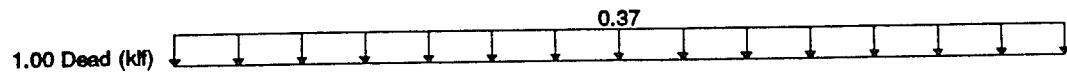
- Bar joist selections based on 1993 SJI Load Tables.
Edit spreadsheet stjstk.xls to revise selection table.
- Approximate moment of inertia of the joist in inches⁴ is:
 $I_j = 26.767 (WLL) (L^3) (10^{-6})$, where WLL = Live Load value in table;
where L = Span - 0.33 in feet
- Ponding check based on SJI Technical Digest. Refer to AISC Commentary section K2 for charts for Stress Constant U and Flexibility Constant C for joists bearing on beams.
 - For joists bearing on steel beams, Cs must be greater than Csreq. This is not an automatic selection. Beam size and/or joist size may need to be increased.
 - For joists bearing on walls, the ponding load includes dead load plus percentage of live load, plus computed ponding load. Selection is based on greatest load.

Widely Spaced Element Analysis: Beam



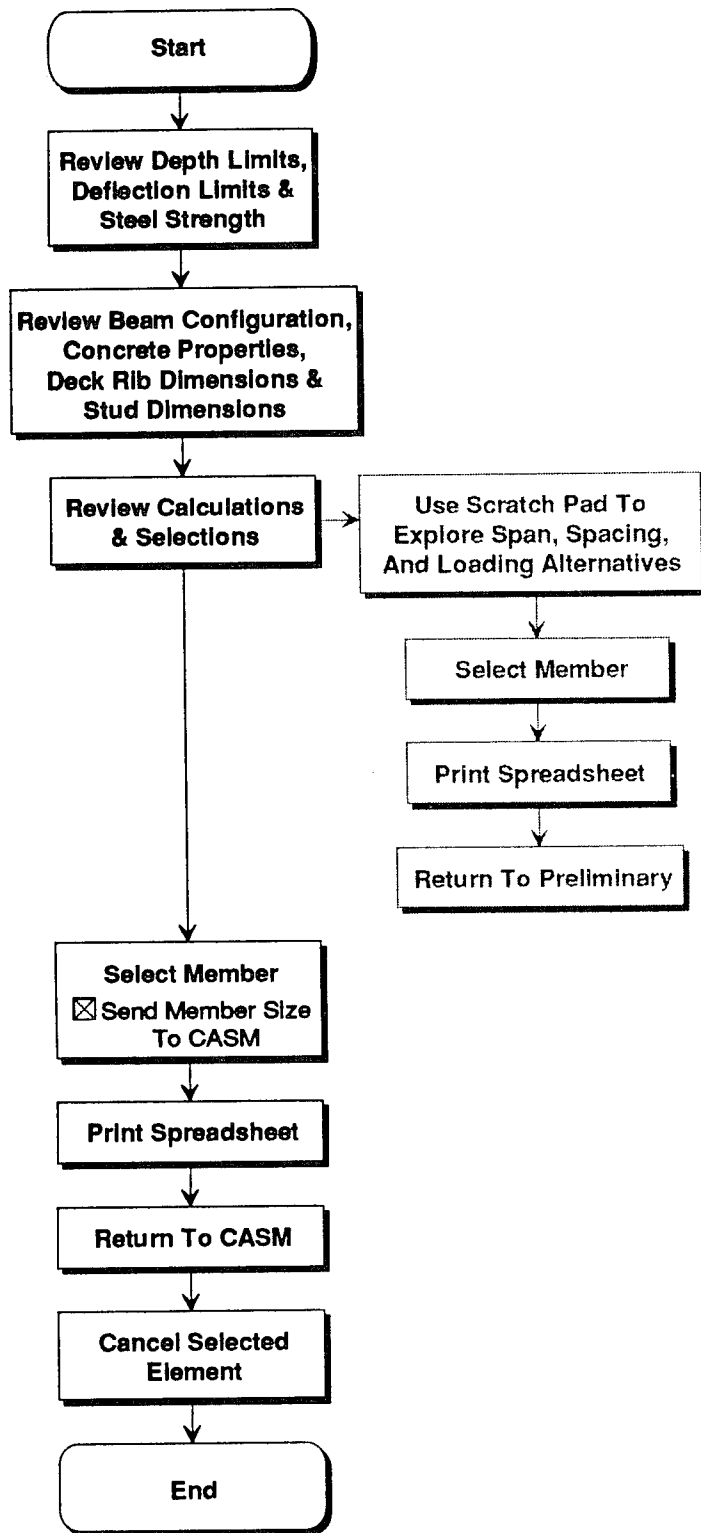


Widely Spaced Element Analysis: Beam



Total Combined Load: D + L

Composite Steel Beam Design



STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Sep 01, 1994
Location: Radford AAP	Engr:

CASM Load & Analysis Data:

Method: Analysis		Load Combination: D + L				
Member ID:		Factored Moments (k-ft)			Fact. Reactions	
Connectivity: Hinge (Left)					Left(k)	Right(k)
Roller (Right)		Load Type	Left	Mid	Right	
Beam Span: 24.0 ft		Dead		26.4		4.4 4.4
Trib Width= 8.0 ft		Sup Dead		8.6		1.4 1.4
Depth Limit= 36.0 in. max		Live		86.4		14.4 14.4
Fy= 36.0 ksi		Lmin Roof				
Fb=Fy*0.66= 24.0 ksi		Snow				
Fy * 0.89= 32.0 ksi		Wind				
Fv= 14.4 ksi		Summary		121.4		20.2 20.2
Es= 29,000 ksi						
Deflection Limits:		Composite Properties:			Beam	
Live Load= L/360 =0.80 in		f'c= 4.0 ksi		Rib Spacing= 6.00 in		
Total Load= L/240 =1.20 in		.45f'c= 1.8 ksi		Rib Width= 2.50 in		
		Wc= 145 pcf		Rib Height= 1.50 in		
		Ltwt conc coef= 1.0		Studs/rib= 1		
Reqd Section Properties:		Ec= 3,644 ksi		Stud Diameter= 0.75 in		
Ss(req)= 23 in^3		n= 8.0		Stud Length= 4.0 in		
Str(req)= 61 in^3		Slab ts= 5.50 in		Reduct. Factor= 1.00		
Composite percent= 100 %		Slab bE= 72.0 in		Shear Cap= 13.3 kips		

CASM Beam Selection Table:

Beam Size	Ss in ³	Dead Ld Defl(in)	Seff in ³	Conc fc (psi)	Steel fs (psi)	leff in ⁴	L + SD Defl(in)	# of Studs	Min % Comp.
W 8 x 35	31.2	-0.74	63.7	0.83	22.87	634	-0.54	28	82
W 10 x 30	32.4	-0.55	62.0	0.70	23.48	760	-0.45	24	91
W 10 x 33	35.0	-0.55	65.8	0.72	22.14	754	-0.45	28	70
W 14 x 26	35.3	-0.38	63.3	0.56	23.00	987	-0.34	22	82
W 8 x 40	35.5	-0.65	71.6	0.78	20.33	708	-0.48	32	49

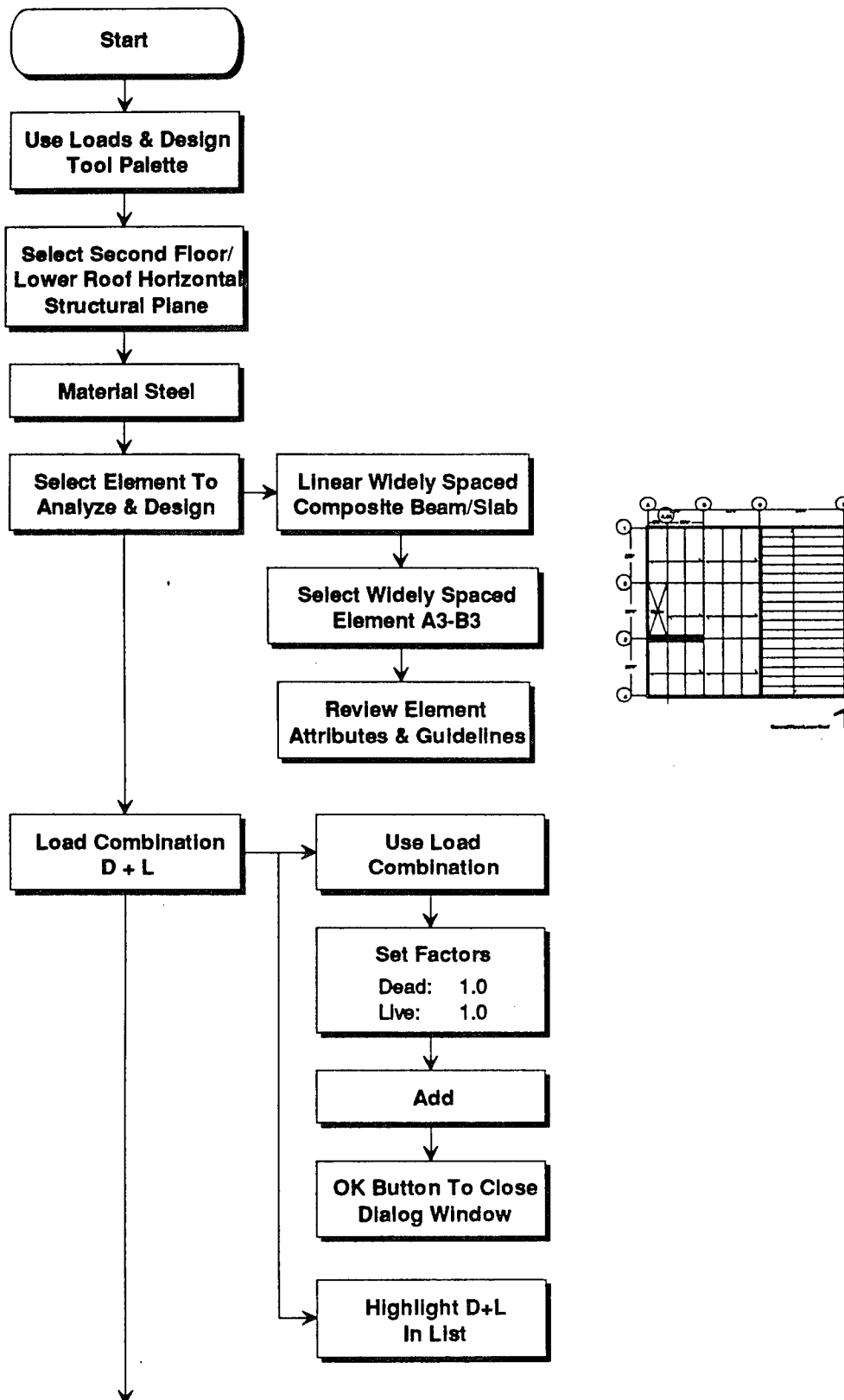
CASM Steel Beam Selection:

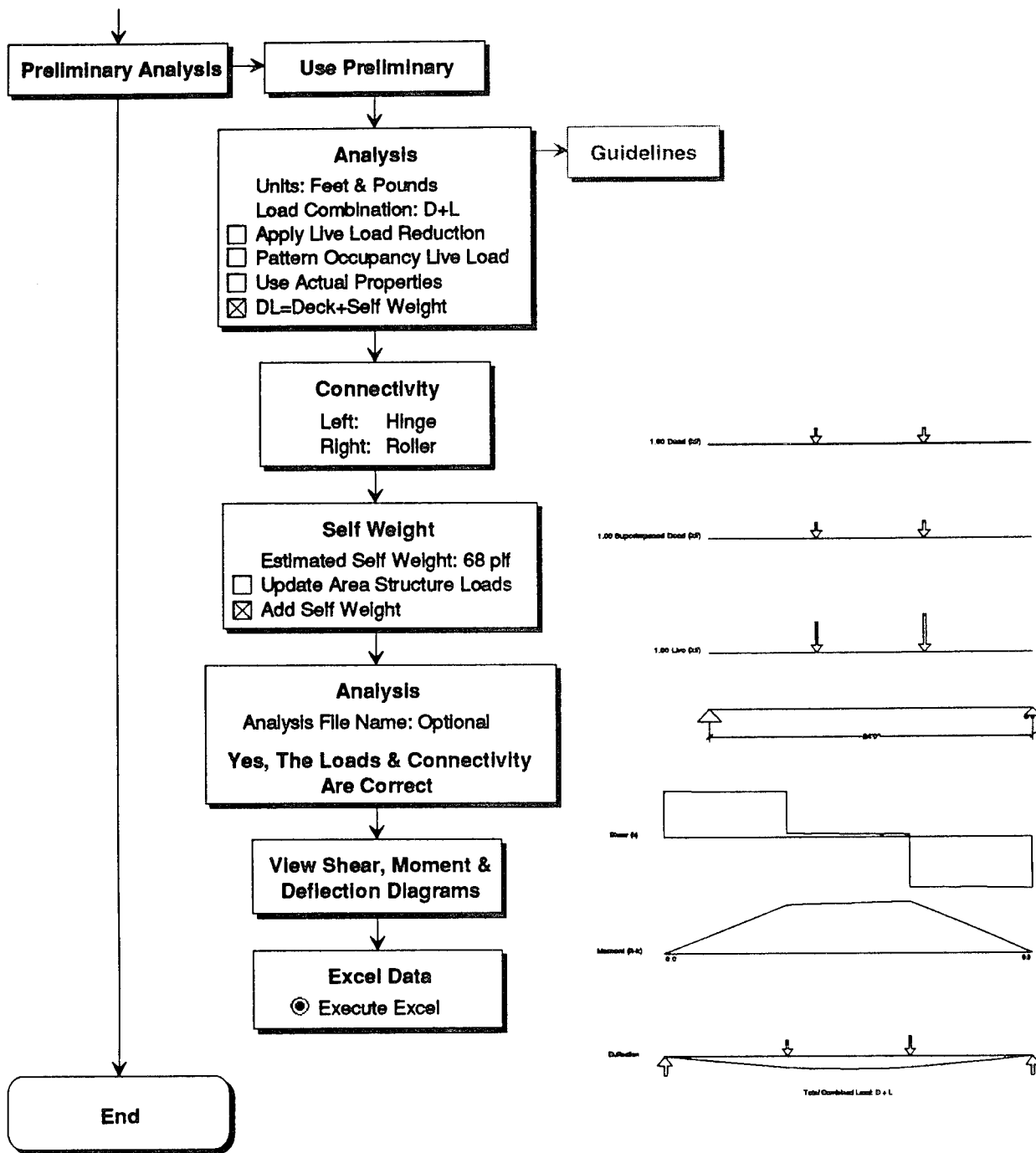
	Span=	Seff(in3)=	leff(in4)=	Defl(in)=	Live Ld	Total
W 14 x 26	24.0 ft	63.3	987	-0.34	-0.73	
Shores Req'd:	No	Nstuds= 22 (full)	Partial: (100 %)	Nstuds= 22	fv= 5.7ksi	
				Beam Wgt=	0.31 tons	

Notes:

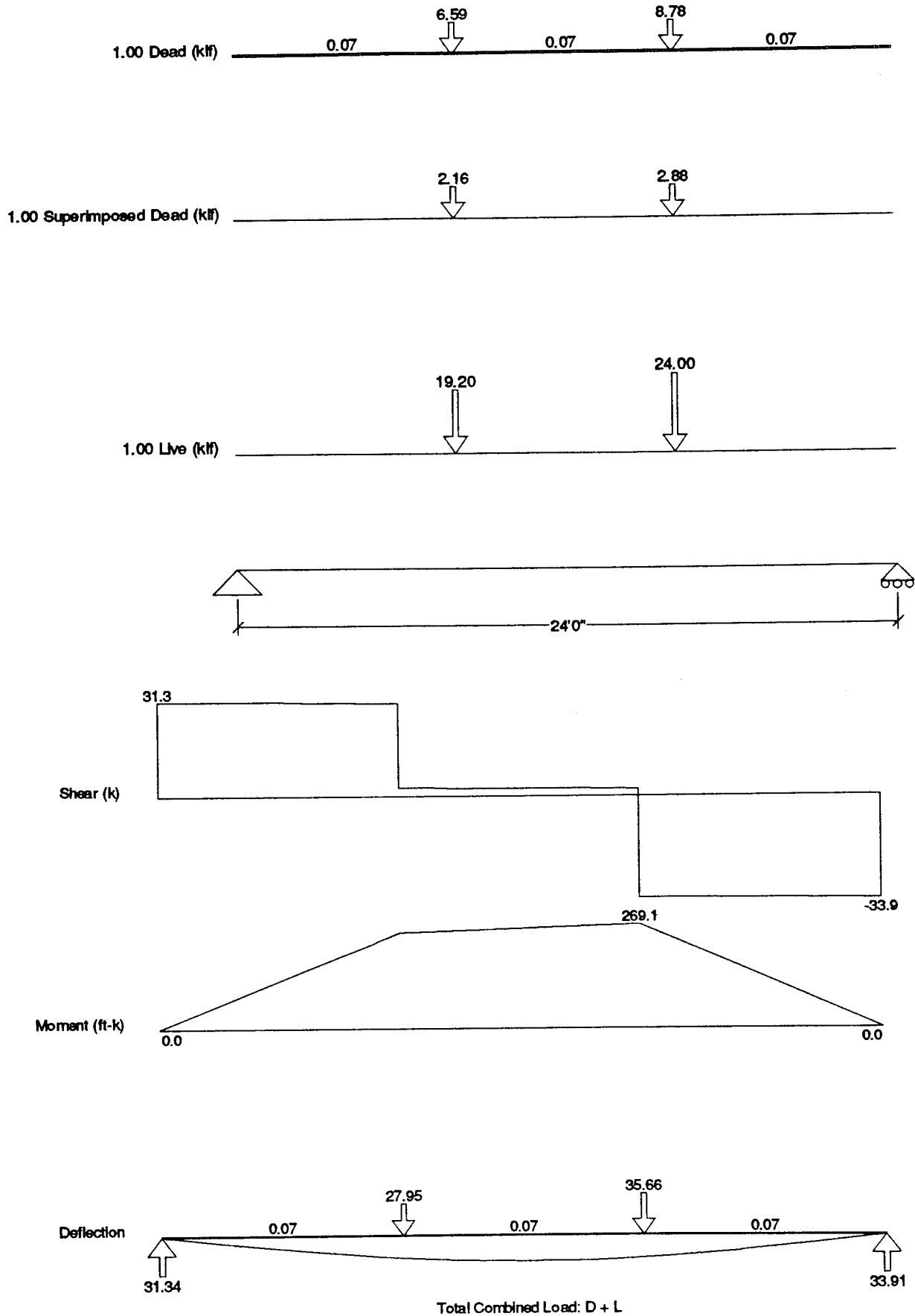
- Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
- Dead load shear and moment are not modified with changes in slab depth.

Widely Spaced Element Analysis: Girder

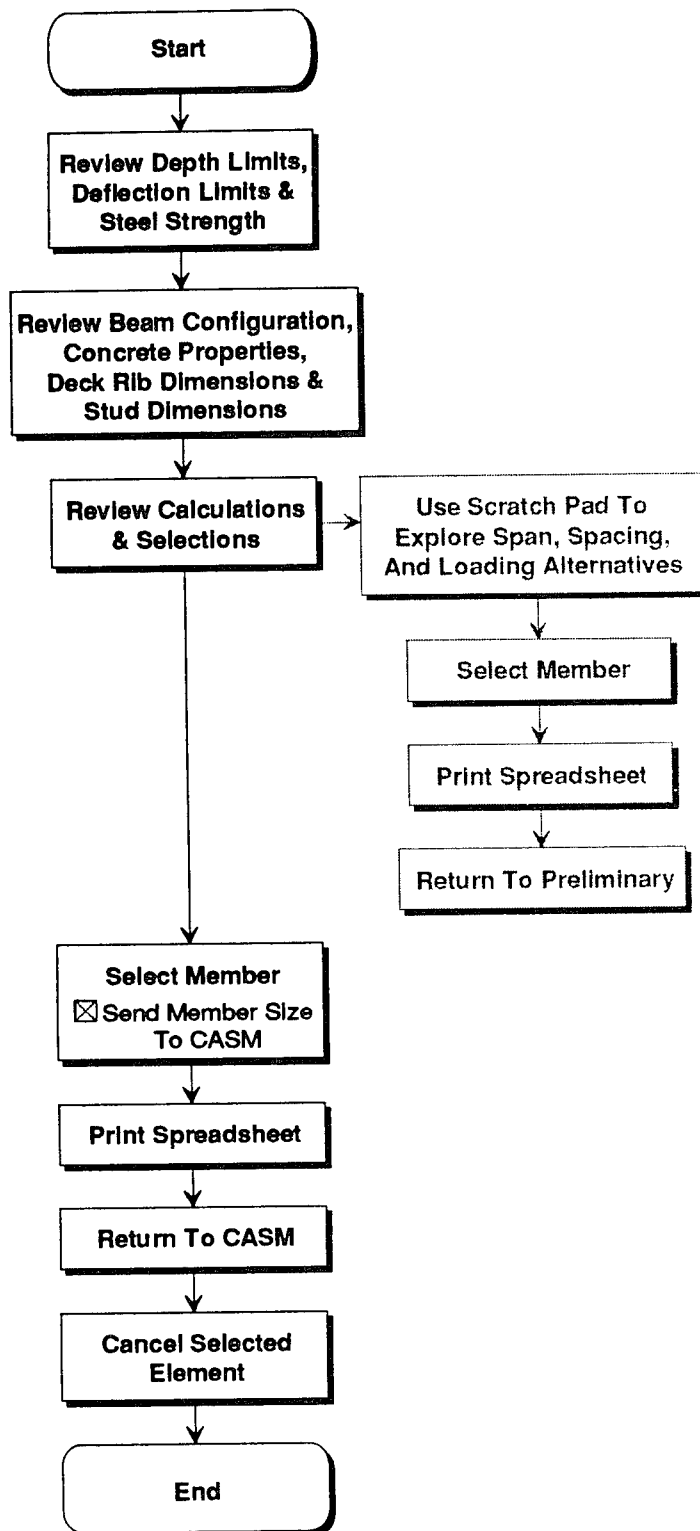




Widely Spaced Element Analysis: Girder



Composite Steel Beam Design



STEEL COMPOSITE BEAM PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Sep 01, 1994
Location: Radford AAP	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= 12.0 ft	
Depth Limit= 36.0 in. max	
Fy= 36.0 ksi	
Fb=Fy*0.66= 24.0 ksi	
Fy * 0.89= 32.0 ksi	
Fv= 14.4 ksi	
Es= 29,000 ksi	
Deflection Limits:	
Live Load= L/360 = 0.80 in	
Total Load= L/240 = 1.20 in	
Reqd Section Properties:	
Ss(req)= 57 in ³	
Str(req)= 135 in ³	
Composite percent= 100 %	
	Factored Moments (k-ft)
	Left Mid Right
	Dead 68.8
	Sup Dead 21.1
	Live 179.2
	Lmin Roof
	Snow
	Wind
	Summary 269.1
	Fact. Reactions
	Left(k) Right(k)
	8.1 8.9
	2.4 2.6
	20.8 22.4
	31.3 33.9
	Composite Properties:
	Spandrel Girder
	f'c= 4.0 ksi
	.45f'c= 1.8 ksi
	Wc= 145 pcf
	Lwt conc coef= 1.0
	Ec= 3,644 ksi
	n= 8.0
	Slab ts= 5.50 in
	Slab bE= 36.0 in
	Rib Spacing= 6.00 in
	Rib Width= 2.50 in
	Rib Height= 1.50 in
	Studs/rib= 1
	Stud Diameter= 0.75 in
	Stud Length= 4.0 in
	Reduct. Factor= 1.00
	Shear Cap= 13.3 kips

CASM Beam Selection Table:

Beam Size	Ss in ³	Dead Ld Defl(in)	Seff in ³	Conc fc (psi)	Steel fs (psi)	leff in ⁴	L + SD Defl(in)	# of Studs	Min % Comp.
W 10 x 77	85.9	-0.53	141.1	1.37	22.88	1,386	-0.51	50	78
W 14 x 61	92.2	-0.38	138.4	1.10	23.33	1,787	-0.39	50	84
W 16 x 57	92.2	-0.32	141.5	0.99	22.81	2,121	-0.33	46	74
W 21 x 50	94.5	-0.25	145.4	0.82	22.20	2,746	-0.26	40	62
W 12 x 72	97.4	-0.41	148.7	1.16	21.72	1,678	-0.42	50	52

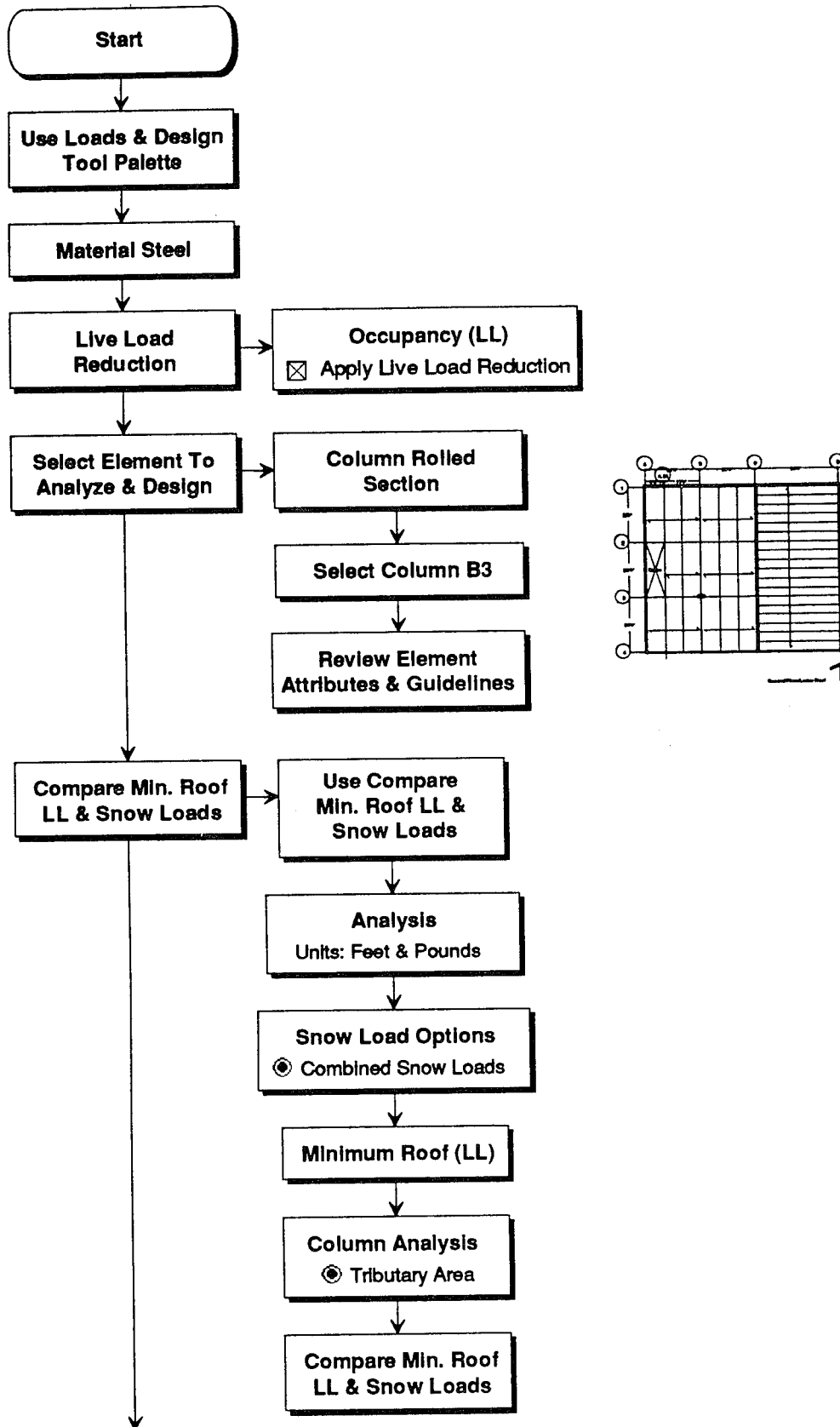
CASM Steel Beam Selection:

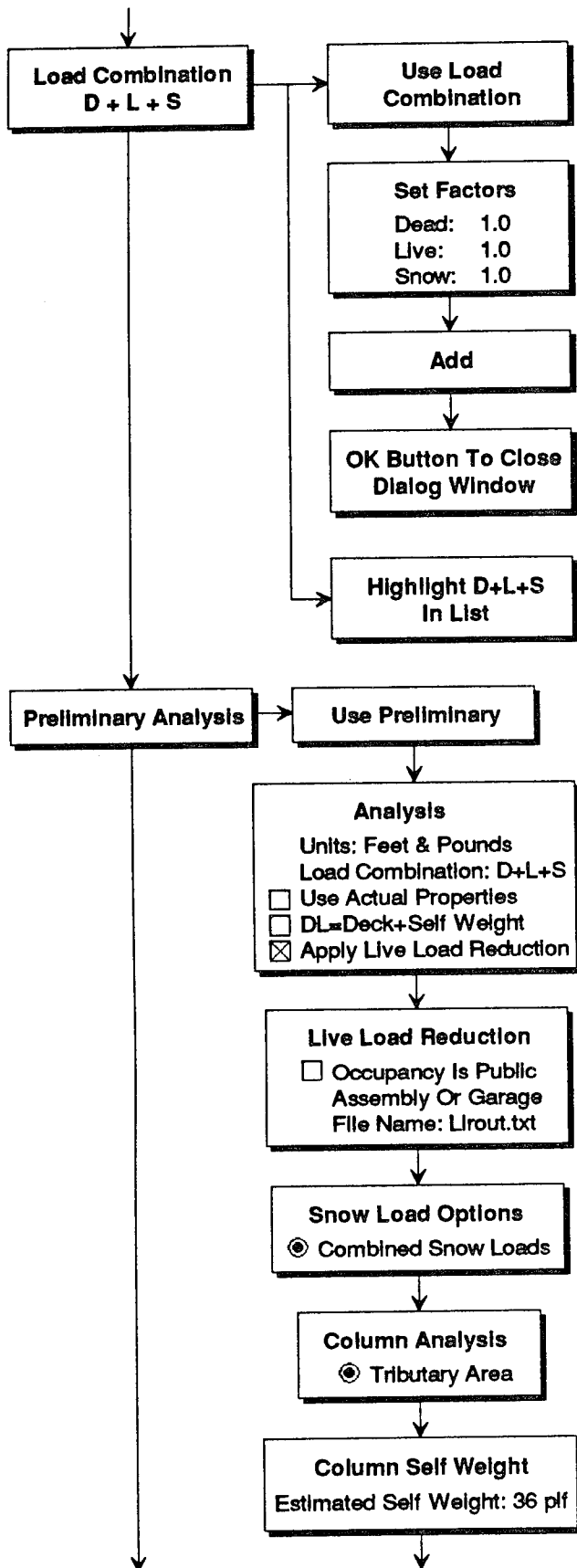
	Span=	Seff(in ³)=	leff(in ⁴)=	Defl(in)=	Live Ld	Total
W 21 x 50	24.0 ft	145.4	2,746	-0.26	-0.50	
Shores Req'd:	No	Nstuds= 40 (full)	Partial: (100 %)	Nstuds= 40	fv= 4.3ksi	
				Beam Wgt=	0.60 tons	

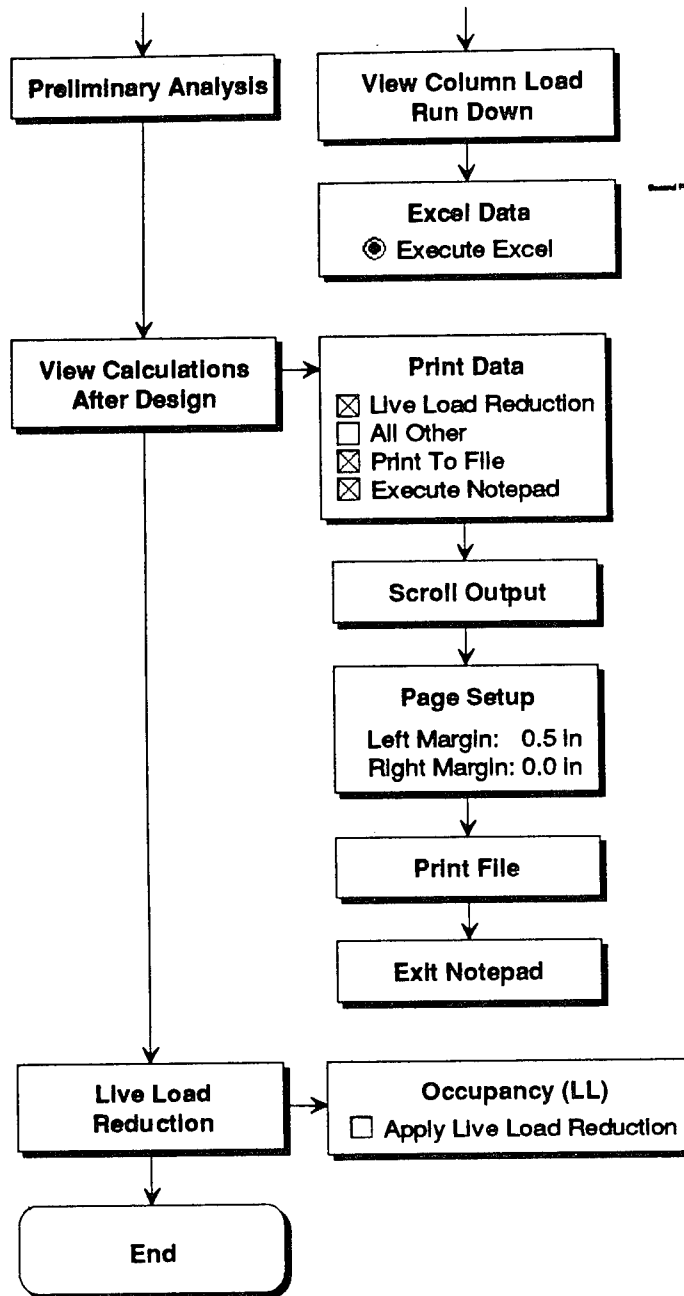
Notes:

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

Column Load Run Down







tributary Area	Self Weight	DL	SLR	LLR	S	TL	Sum DL	Sum LLR	Sum S	Sum TL
2550	0.5	0.5	0.5	10.5	21.5					
							0.5	0.5	10.5	21.5
5750	0.5	0.5	0.5	10.5	21.5					
							48.7	27.8	10.5	87.0

Column 04 Load Run Down 04

Column Load Run Down

Column Load Run Down

	Tributary Area	Lr	S	Sum Lr	Sum S
Upper Roof	576.0	7.2	13.0		
140"				7.2	13.0
Second Floor/Lower Roof	576.0	0.0	0.0		
140"				7.2	13.0

Column B-3 Load Run Down (k)

Project : Office Building - Scheme B
 Location : Radford AAP
 Design Load : TM 5-809-1 1992
 Time : Thu Sep 01, 1994 10:36 AM

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

Tributary Area (At) : 576.0 sqft
 Roof Slope (F) : 0.00 in 12

$L_r = 20 \cdot R_1 \cdot R_2 \geq 12$
 $200 < At < 600 \quad R_1 = 1.2 - 0.001 \cdot At$
 $R_1 = 0.624$
 $F \leq 4 \quad R_2 = 1.00$
 $L_r = 12.48 \text{ psf}$
 Minimum $L_r = 12.0 \text{ psf}$

+-----+
 | Lr = 12.48 psf |
 +-----+

Check minimum roof live load, L_r , 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 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

Column Load Run Down

	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	13.0	21.3				
14'0"		0.5						8.8	0.0	13.0	21.8
Second Floor/Lower Roof	576.0		35.0		37.8	0.0	72.8				
14'0"		0.5						44.3	37.8	13.0	95.1

Column B-3 Load Run Down (k)

Project : Office Building - Scheme B
Location : Radford AAP
Design Load : TM 5-809-1 1992
Time : Thu Sep 01, 1994 10:40 AM

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

Second Floor/Lower Roof
Office: Offices (Lo) : 50.0 psf
Tributary area (TA) : 576.0 sqft
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sqft
Ai >= 400.0 sqft
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

Corridor: Main (Lo) : 100.0 psf

Tributary area (TA) : 576.0 sqft

Area of influence (Ai) = 4*TA for columns.

Ai = 2304.0 sqft

Ai >= 400.0 sqft

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

Files & Storage (Lo) : 150.0 psf

Tributary area (TA) : 576.0 sqft

Area of influence (Ai) = 4*TA for columns.

Ai = 2304.0 sqft

Ai >= 400.0 sqft

Lo > 100.0 psf

Member supports only one floor.

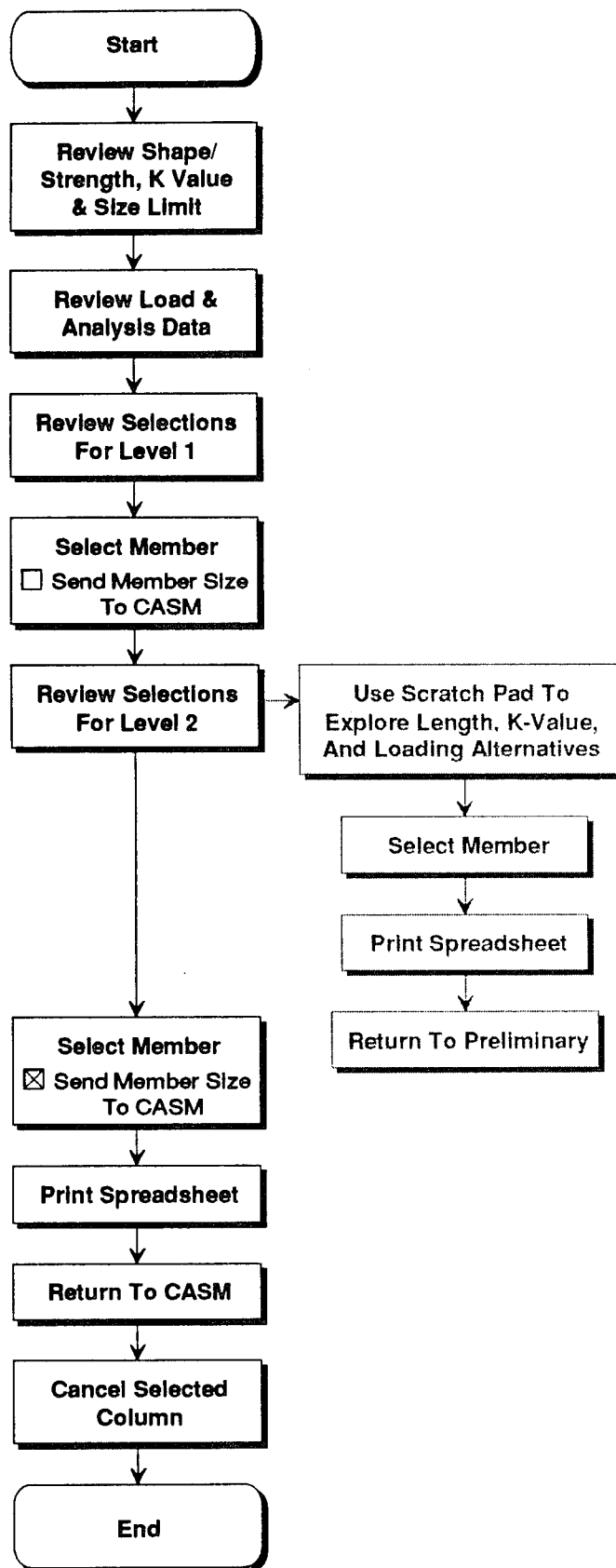
No live load reduction taken.

L = Lo

L = 150.00 psf

Column Load Run Down

Steel Column Design



STEEL COLUMN PRELIMINARY SELECTION

Project: Office Building - Scheme B	Date: Sep 01, 1994
Location: Radford AAP	Engr:

CASM Load & Analysis Data:

CASM Load & Analysis Data:

Method: Analysis		Load Combination: D + L + S		Steel Fy= 36.0 ksi					
Member ID: B-3		Size Limit= 10.0 in. max		E= 29000 ksi					
Name	Level	Flr to Flr Ht	Trib Area	Floor Level Load Totals (kips)					Load Totals
				Dead	Live	Lmin	Snow	Wind	
Upper Roof	6								
	5								
	4								
	3								
	2	14.0	576	8.8			13.0		21.8
Second Floor/L	1	14.0	576	44.3	37.8		13.0		95.1

CASM Column Selection Table

CASM Column Selection Table									
Level: 2		Preq: 21.76 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	4.91	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.65	39.6	0.11
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	3.93	47.7	0.13
W 6 x 20	6.20	6.02	5.87	1.50	112.00	11.40	3.71	66.9	0.14
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.64	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: 0.39

Notes:

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

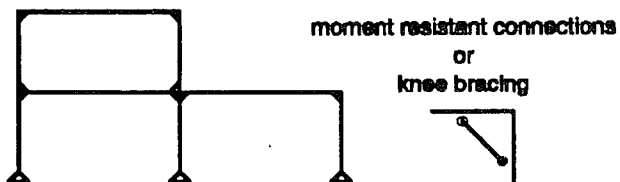
Lateral Resistance Philosophy

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

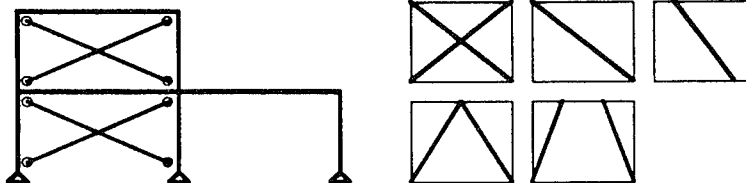
Options:

1. Unbraced Frames

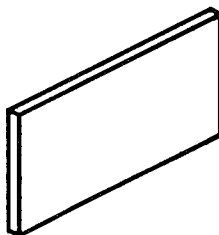


2. Braced Frames

A. Trussing



B. Shear Walls



7. Define horizontal diaphragm systems

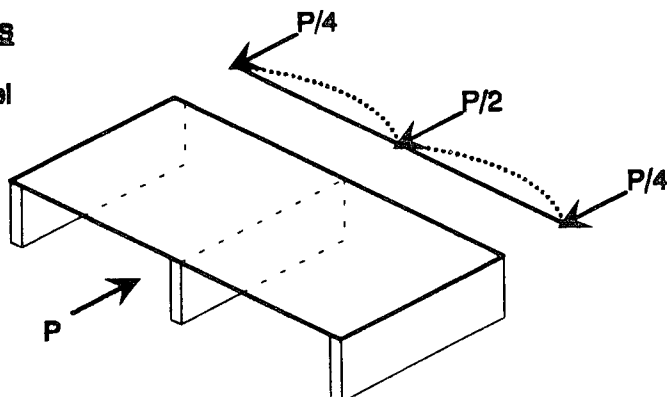
All flexible

All rigid

Floors rigid & roof flexible

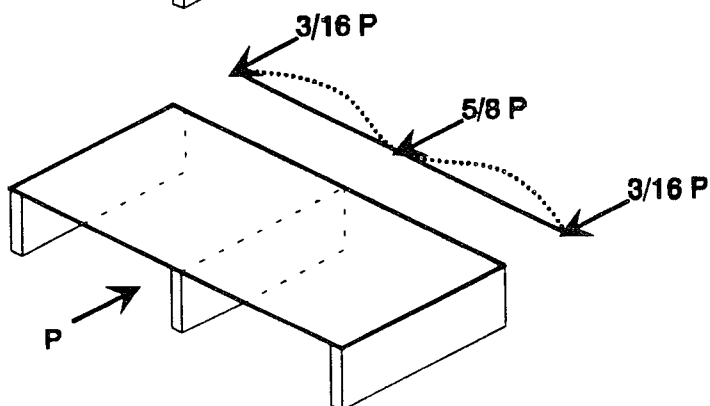
Flexible Diaphragms

Simple Beam Model
(tributary area)



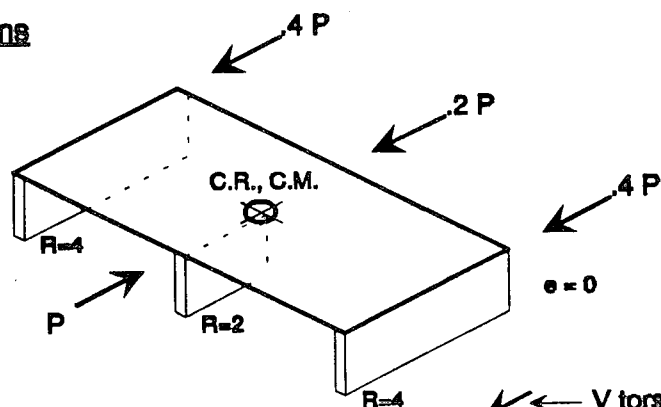
* No Torsion

Continuous Beam Model



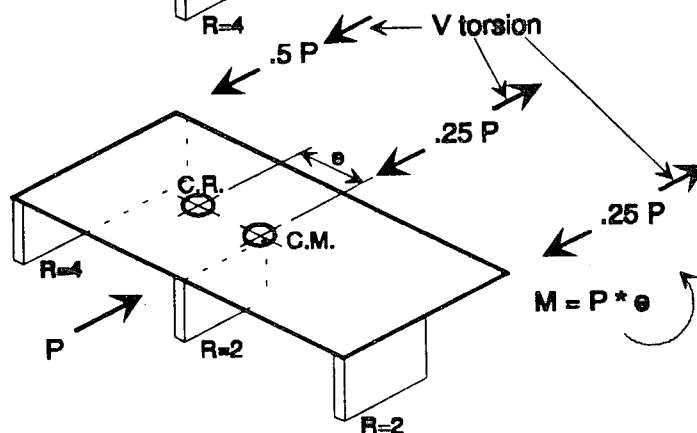
Rigid Diaphragms

Symmetrical

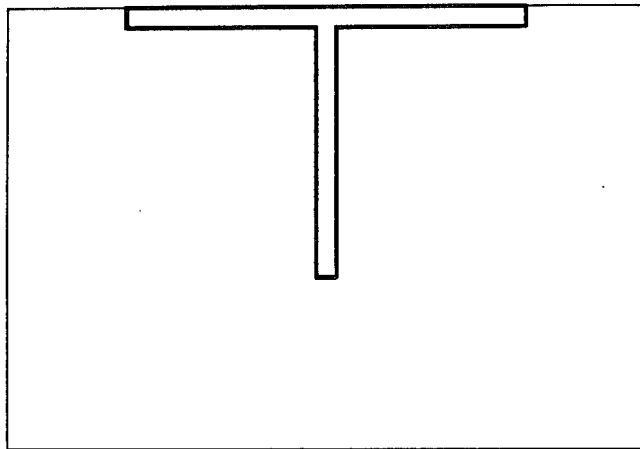


Torsion
(even accidental
minimum required)

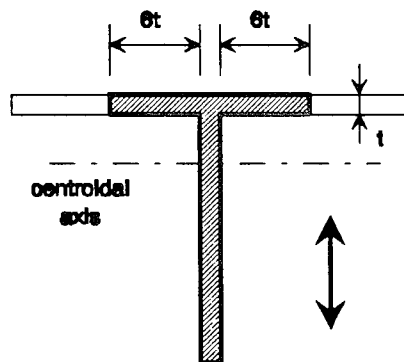
Non-Symmetrical



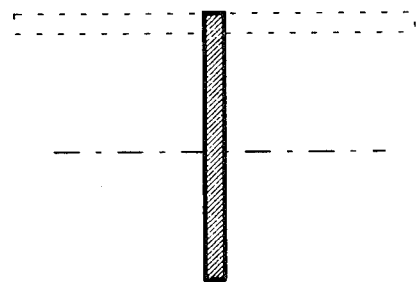
Monolithic Perpendicular Shear Walls



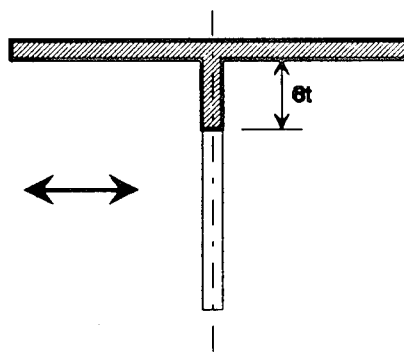
For N-S



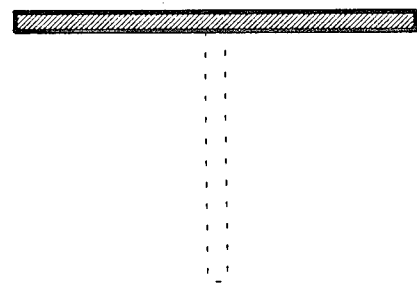
or



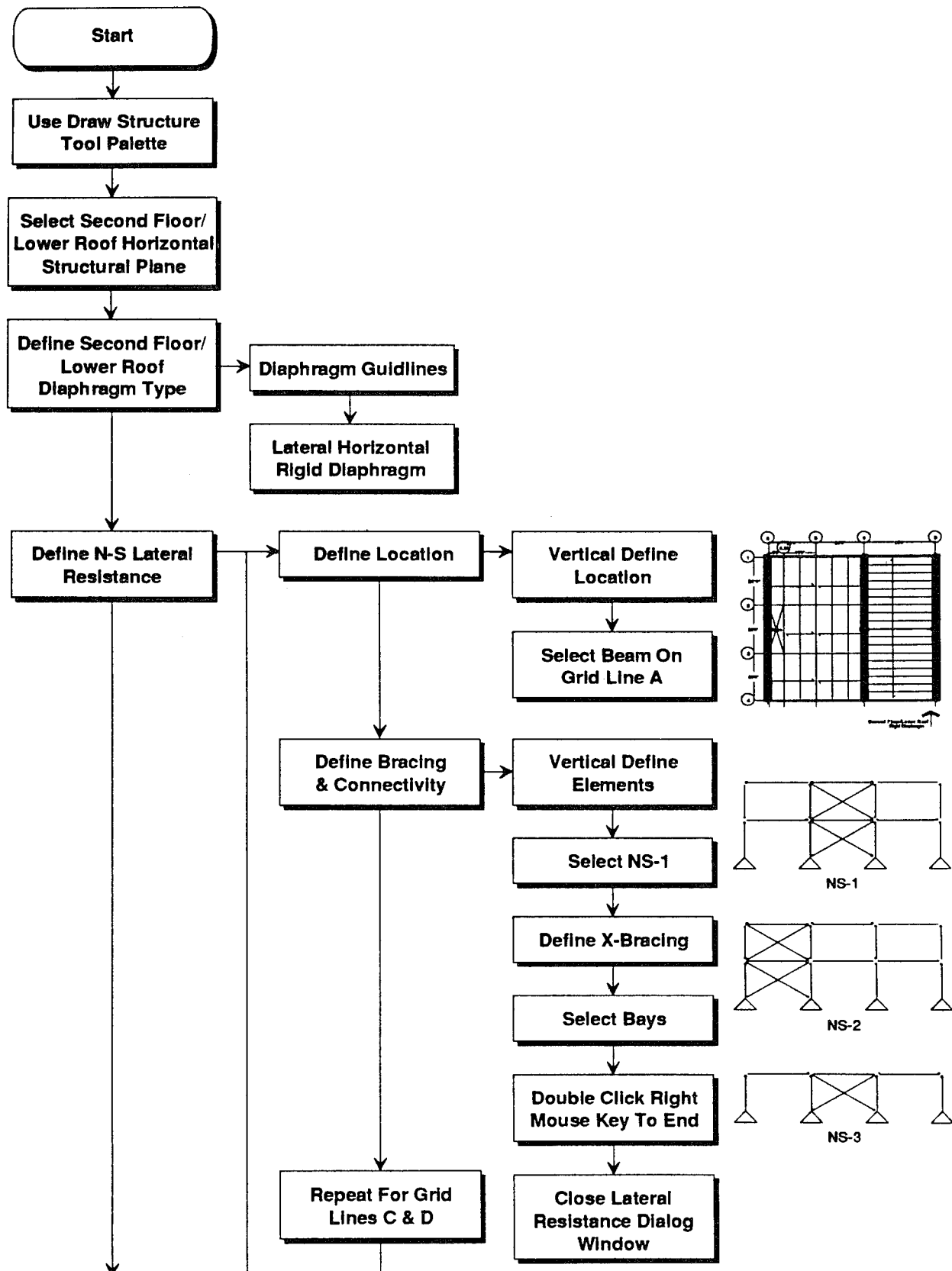
For E-W



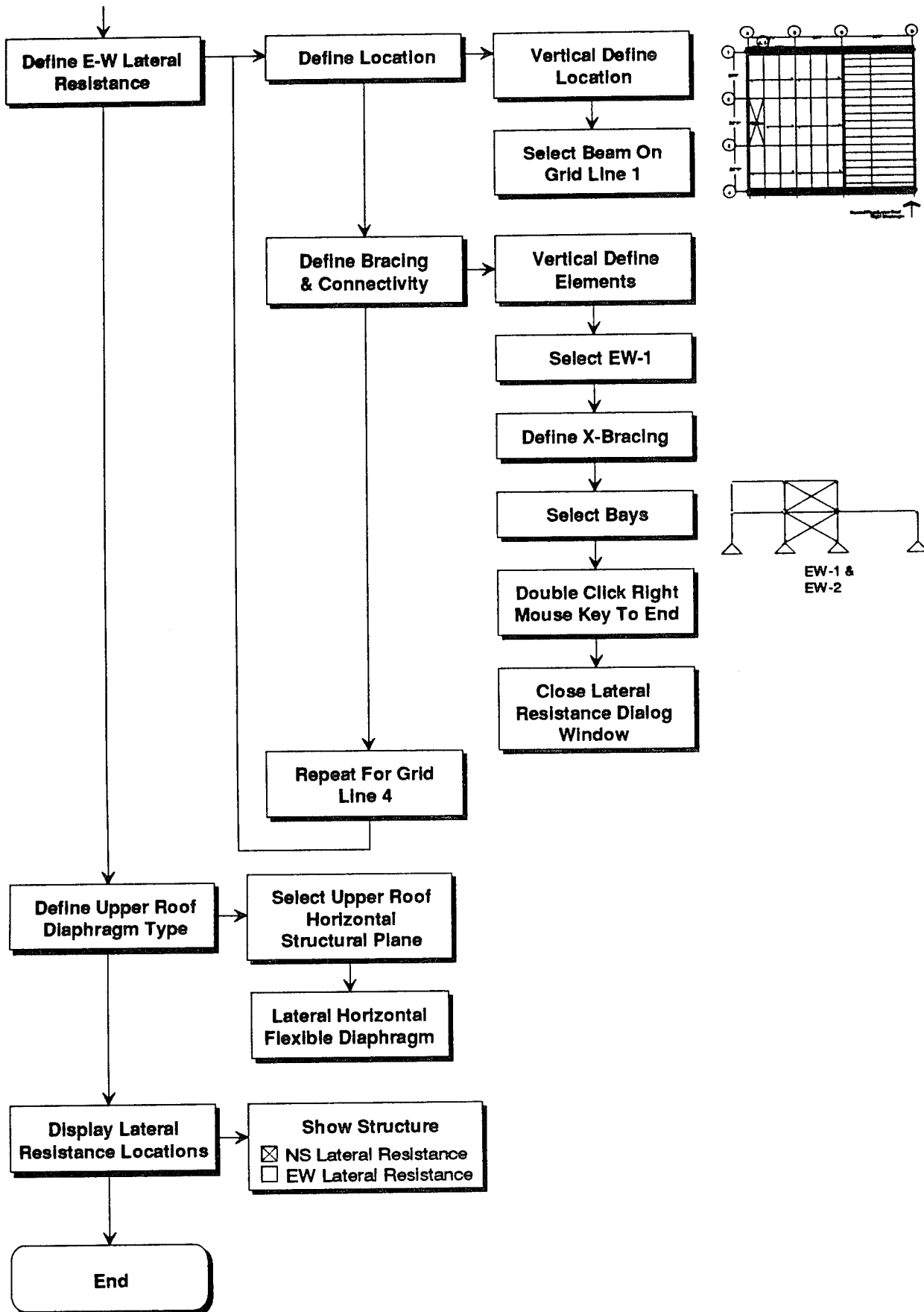
or

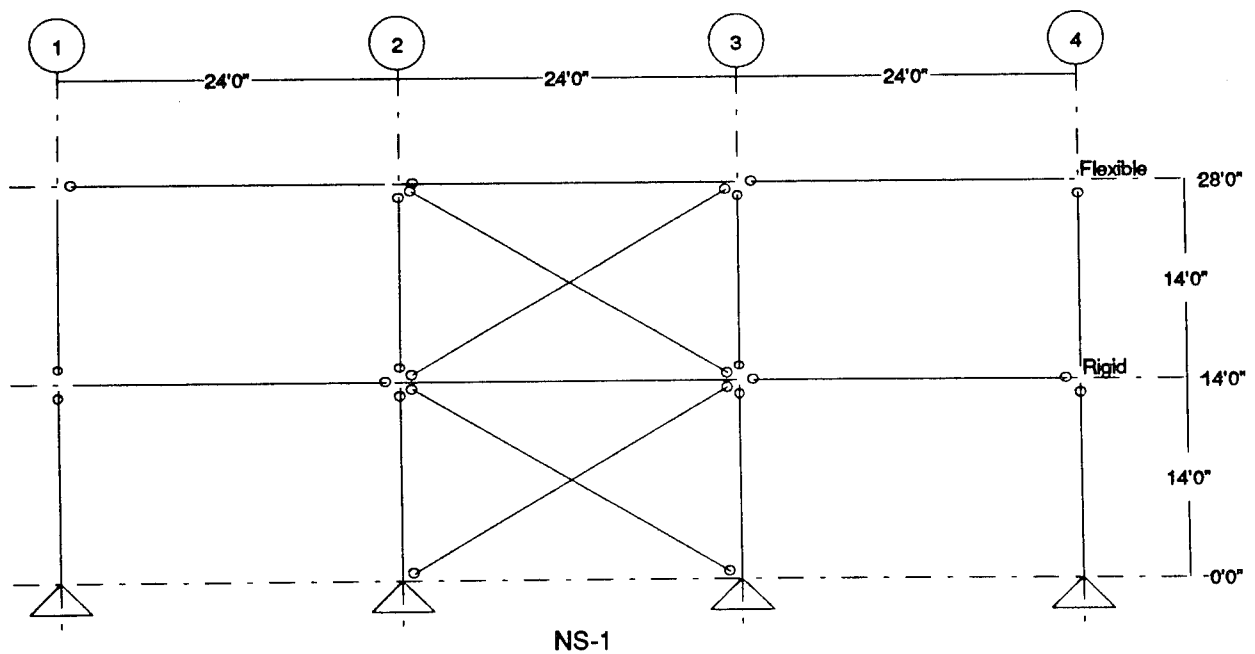
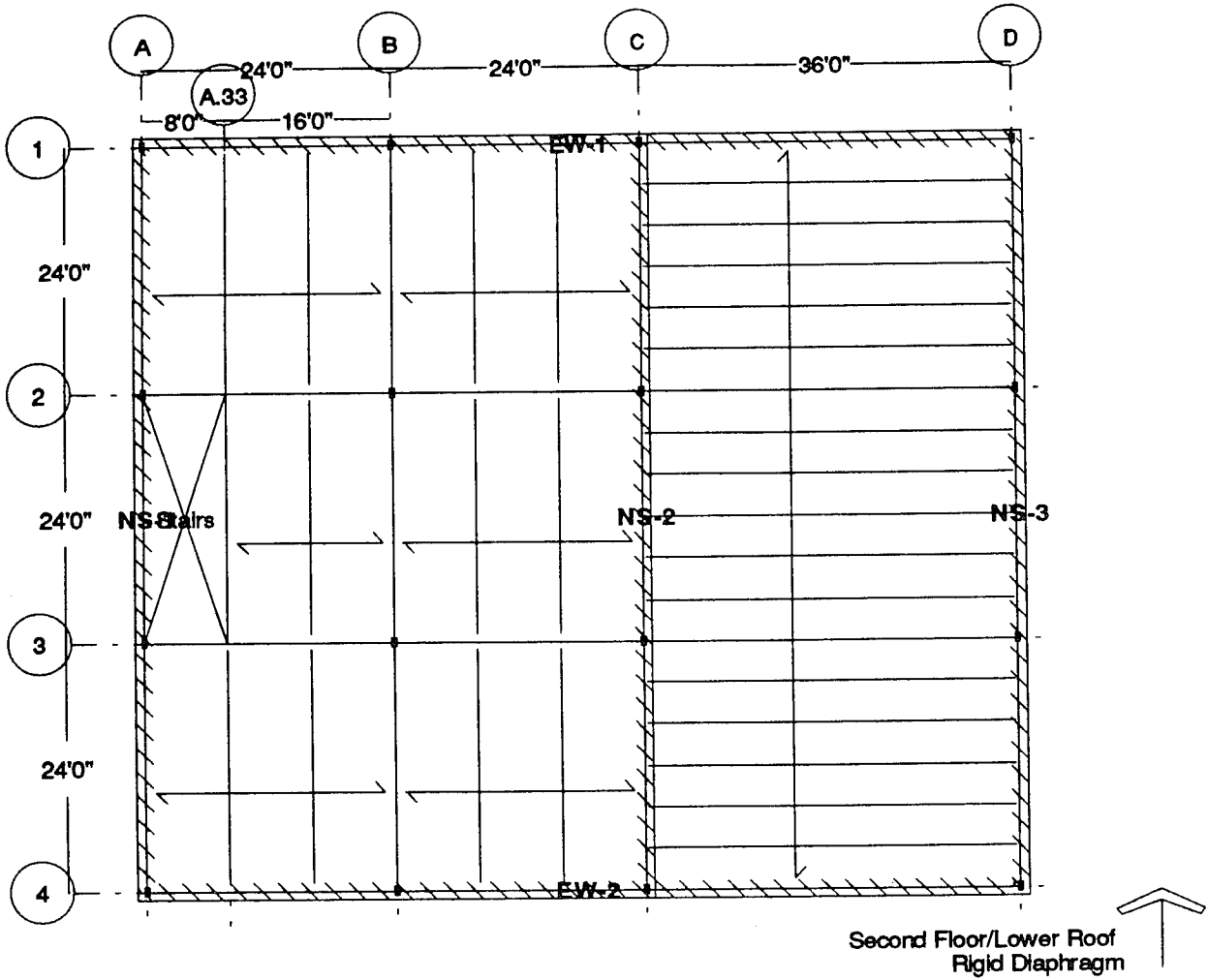


Define Lateral Resistance

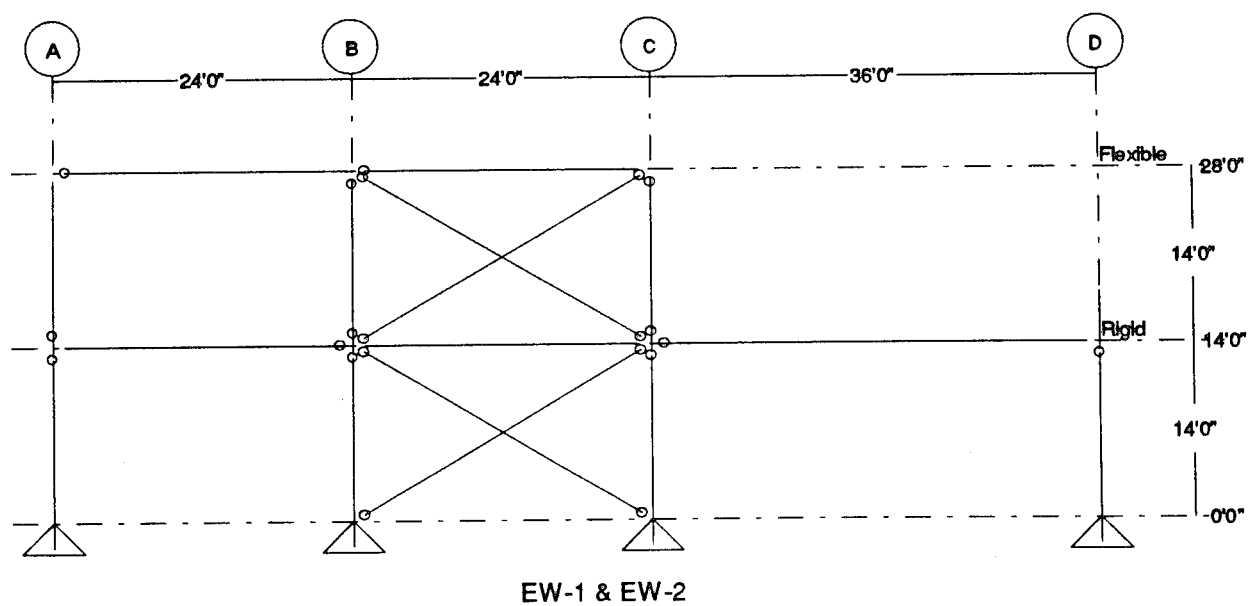
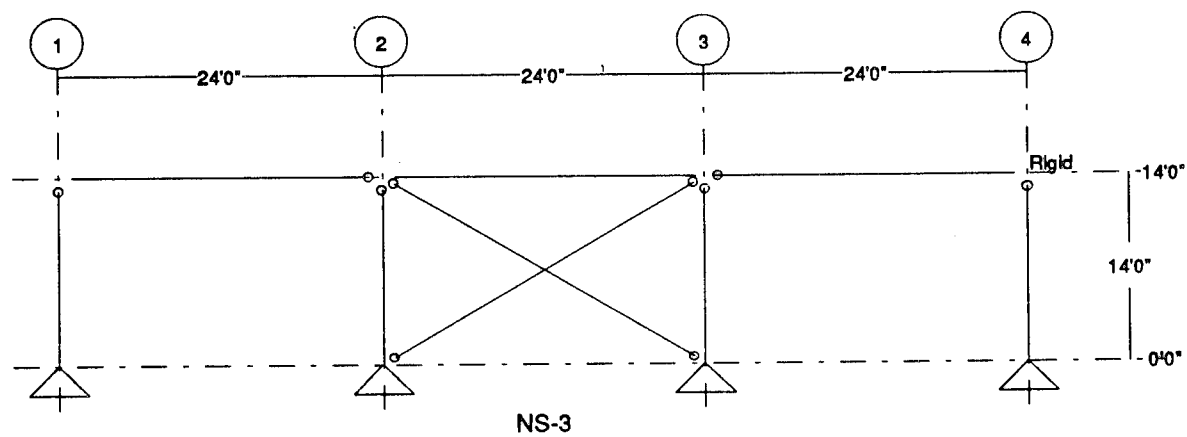
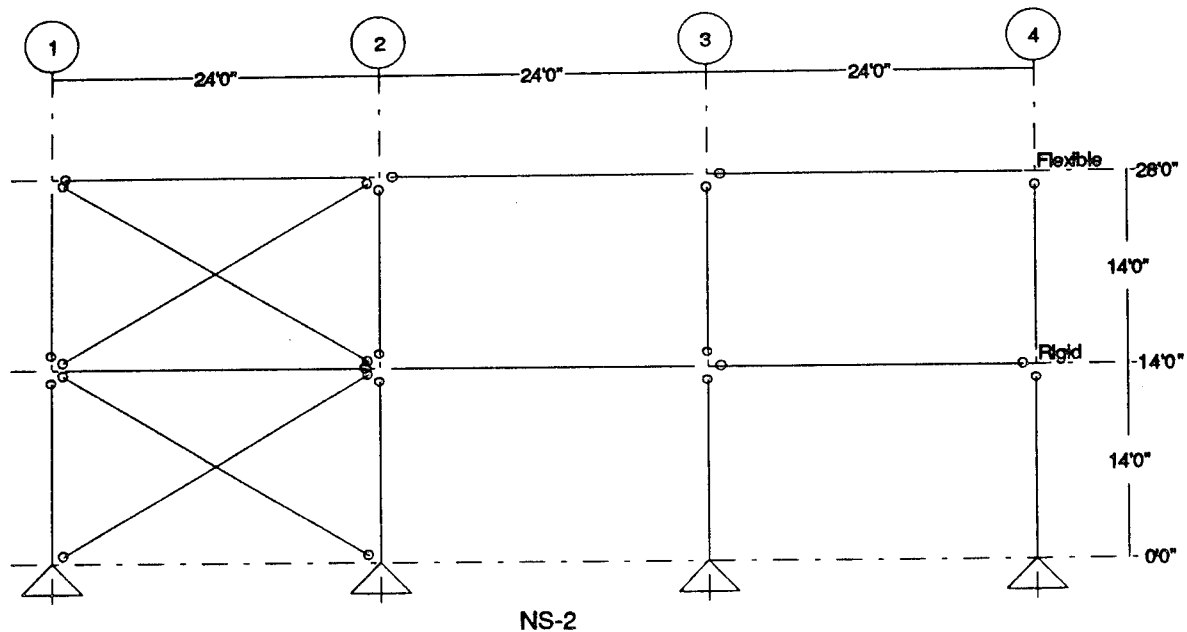


Define Lateral Resistance

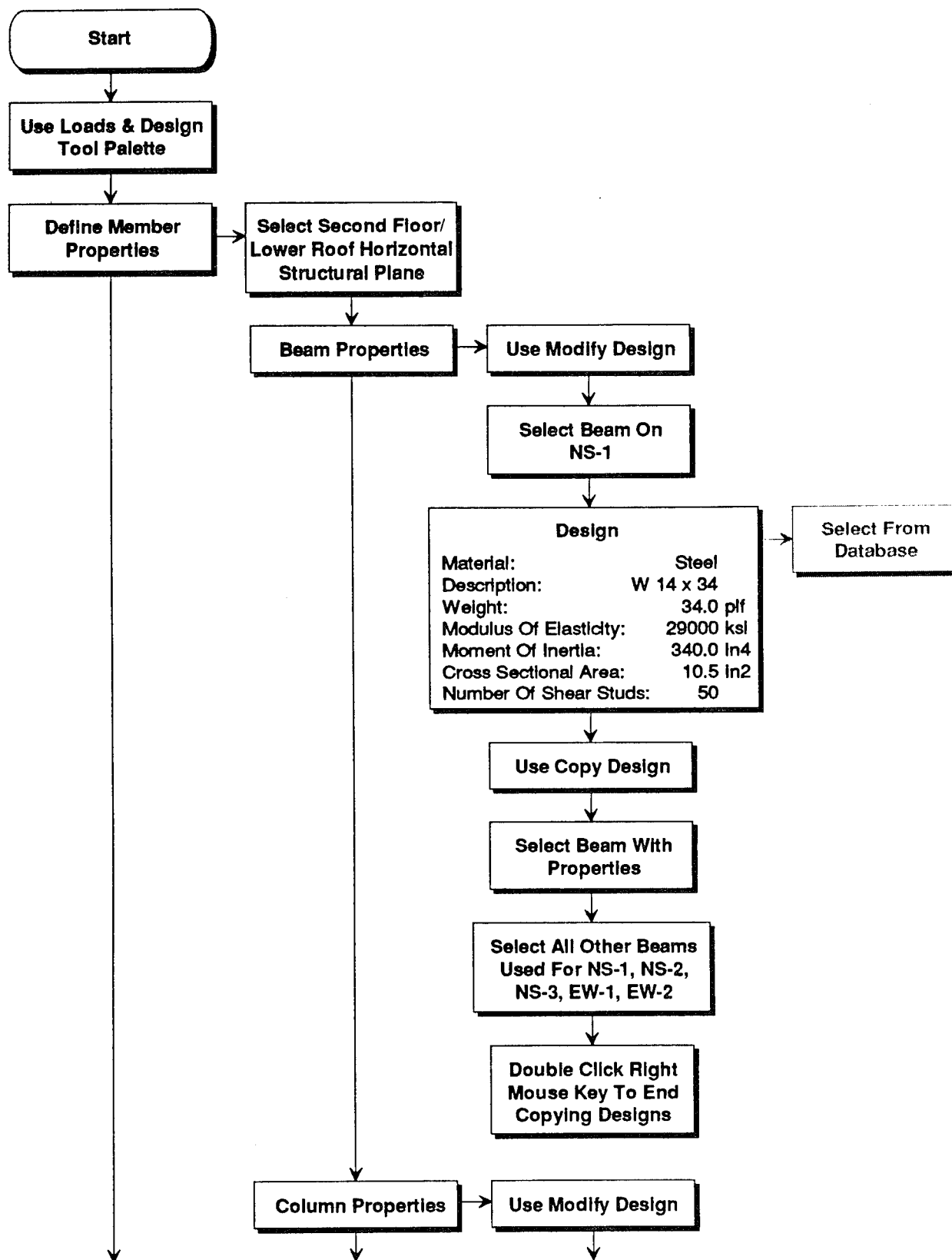


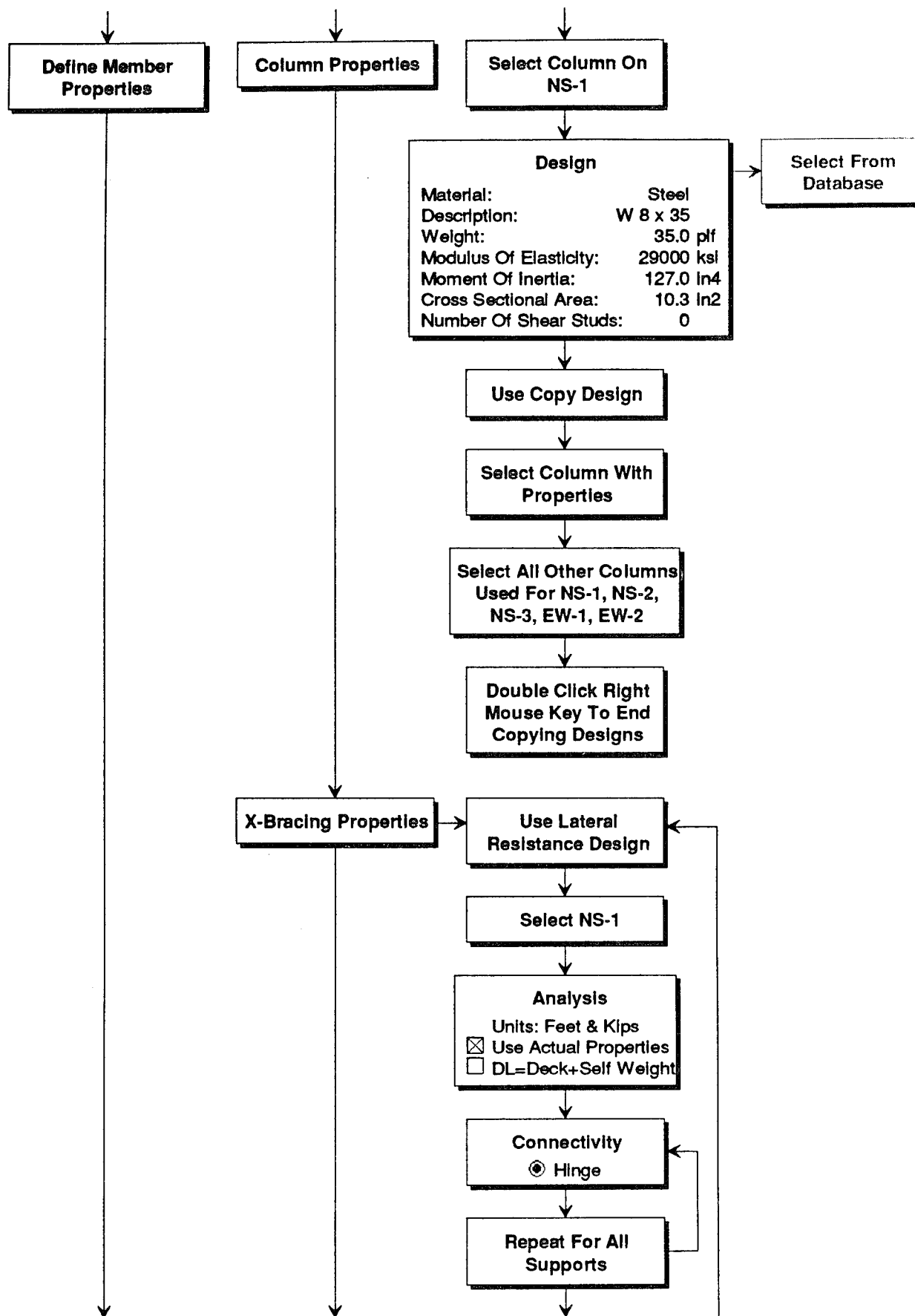


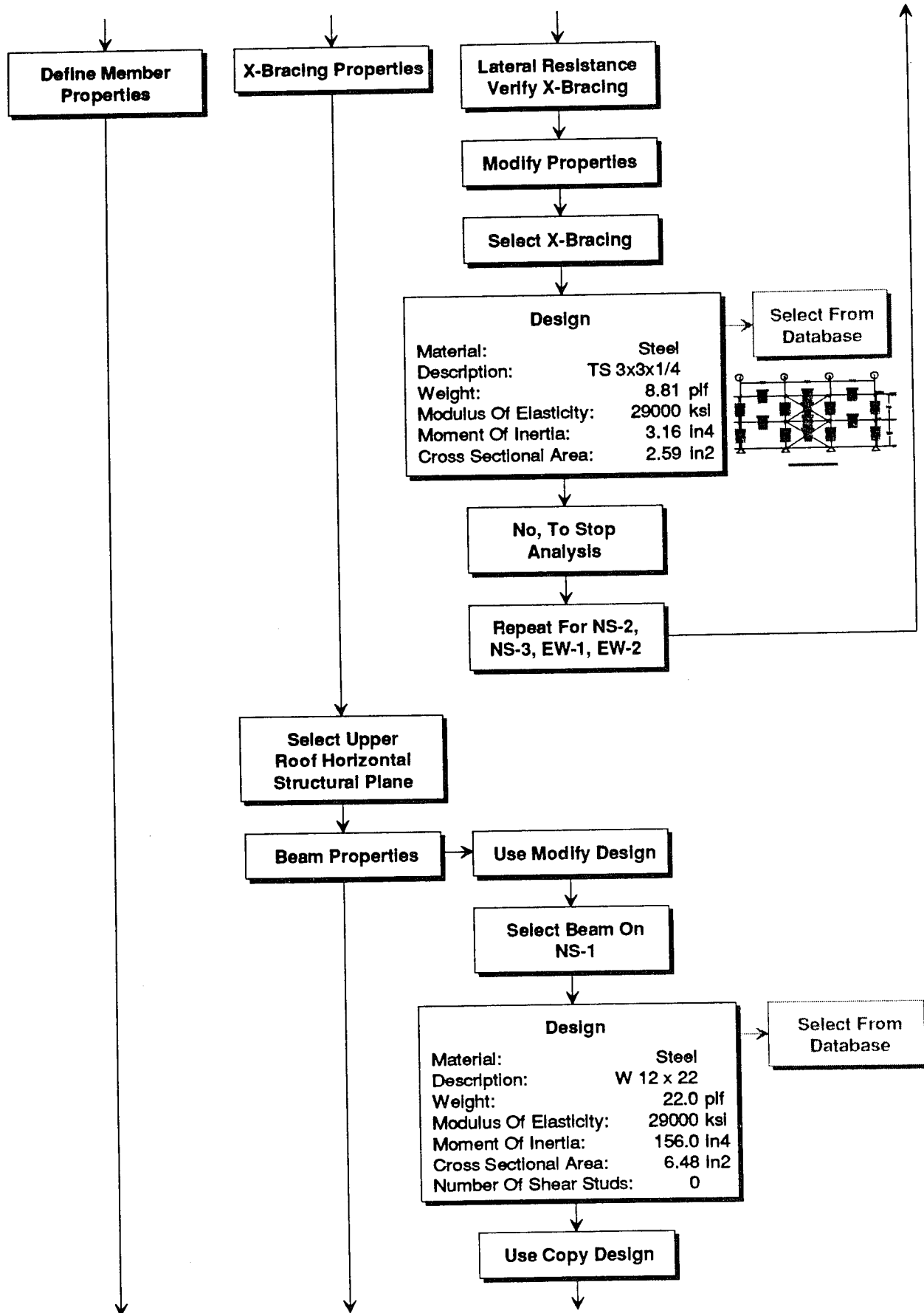
Define Lateral Resistance

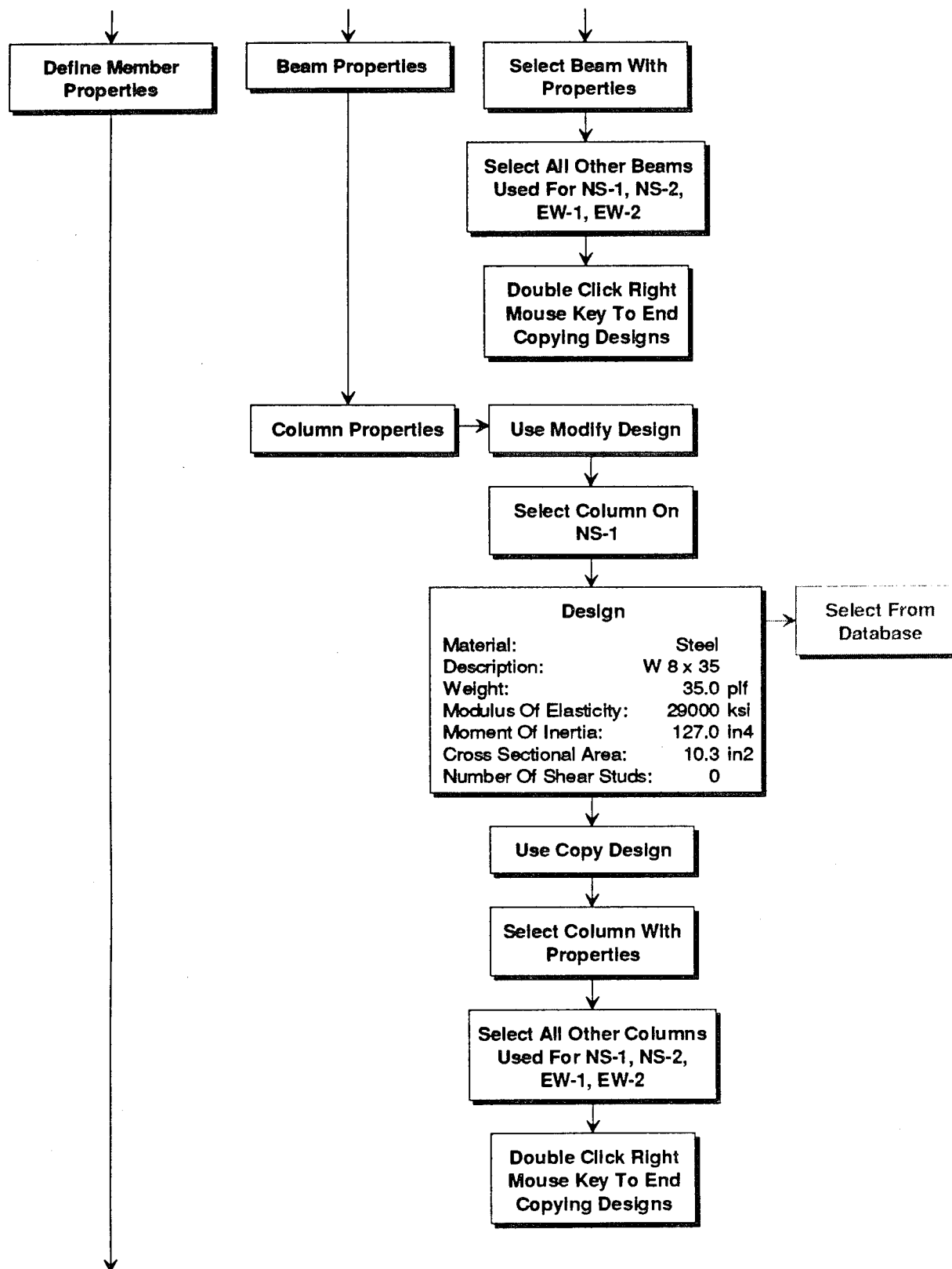


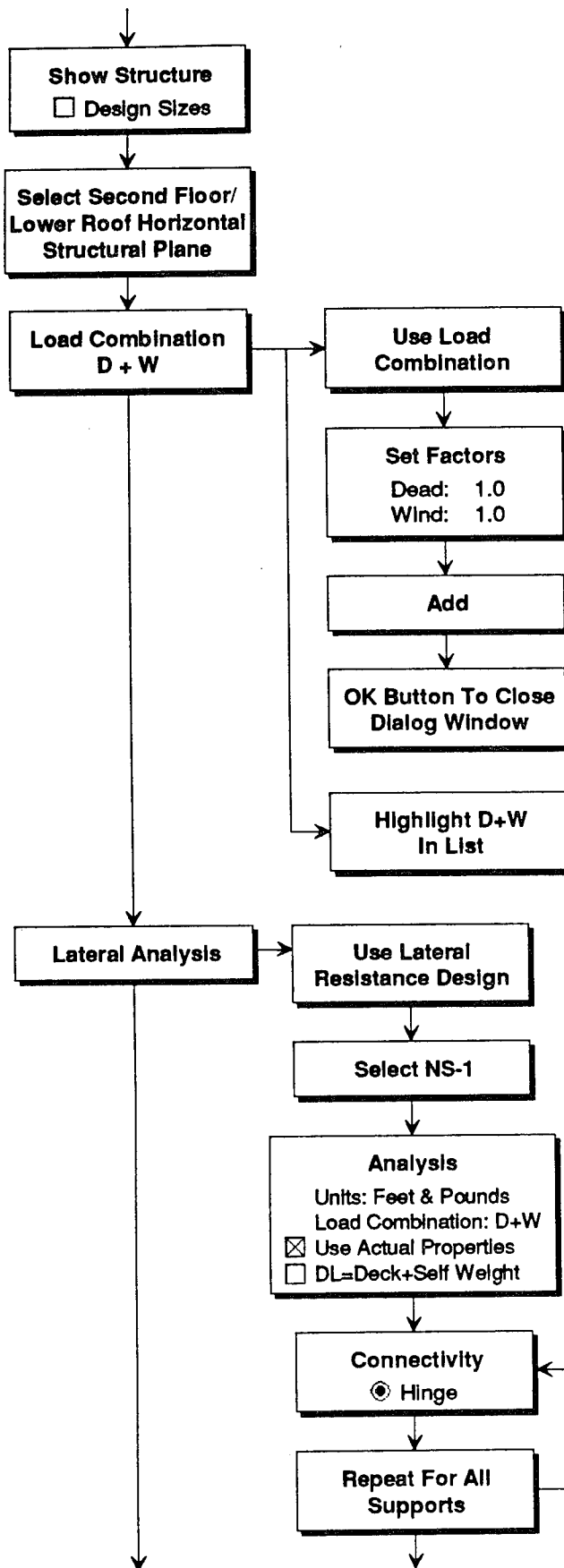
Wind Lateral Analysis

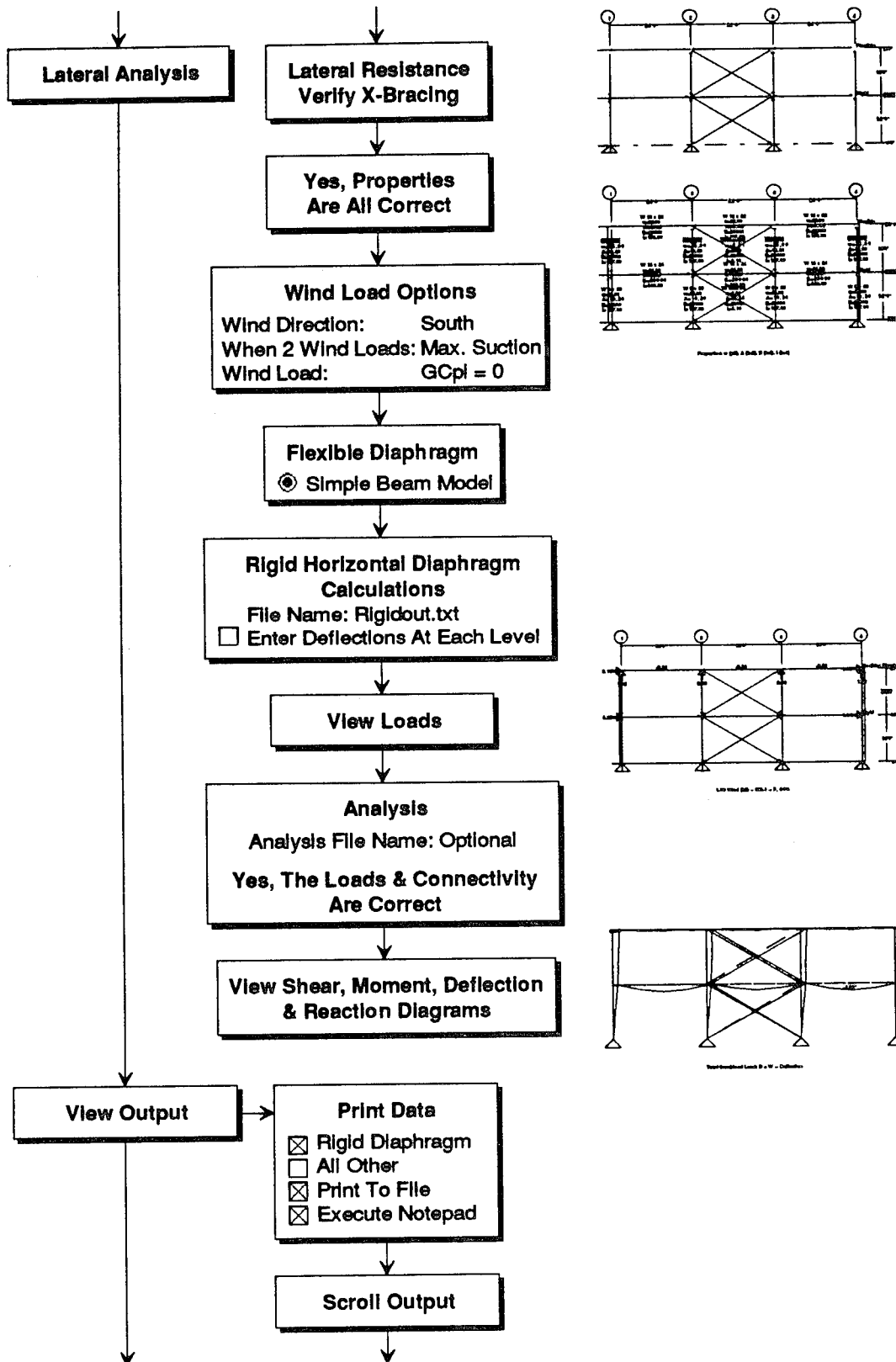


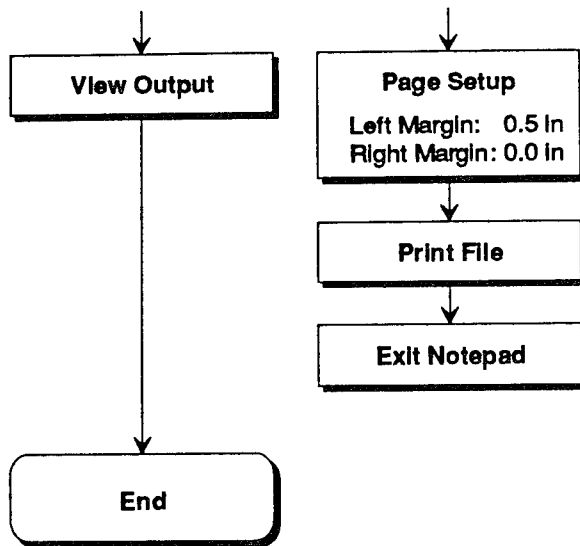


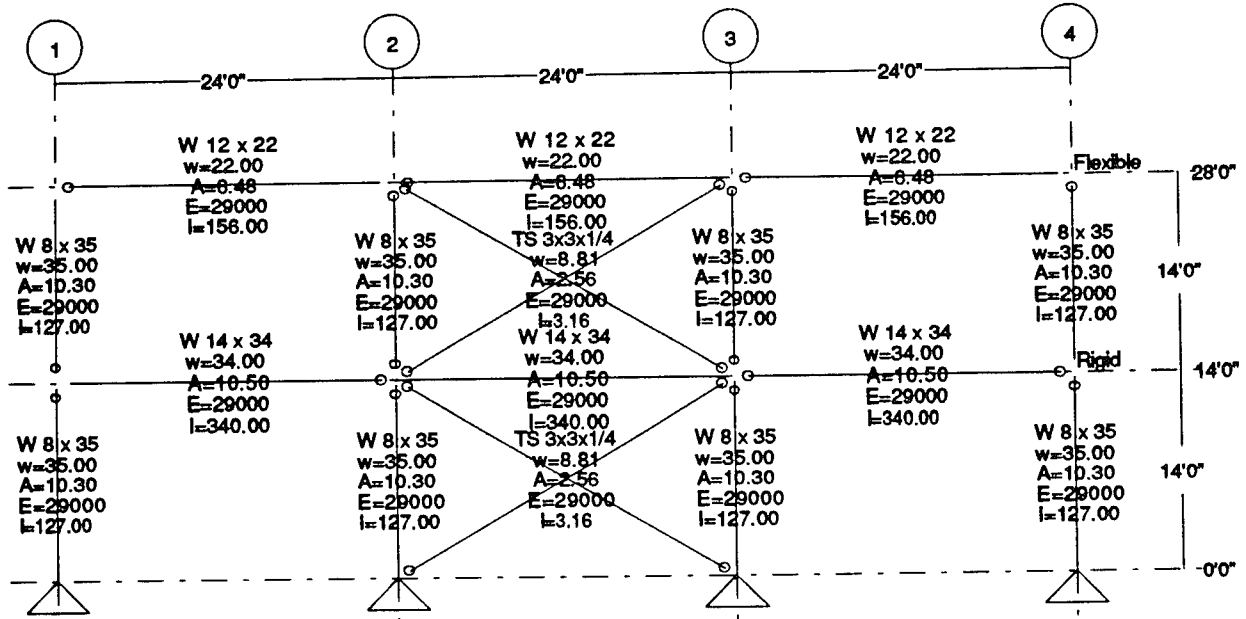




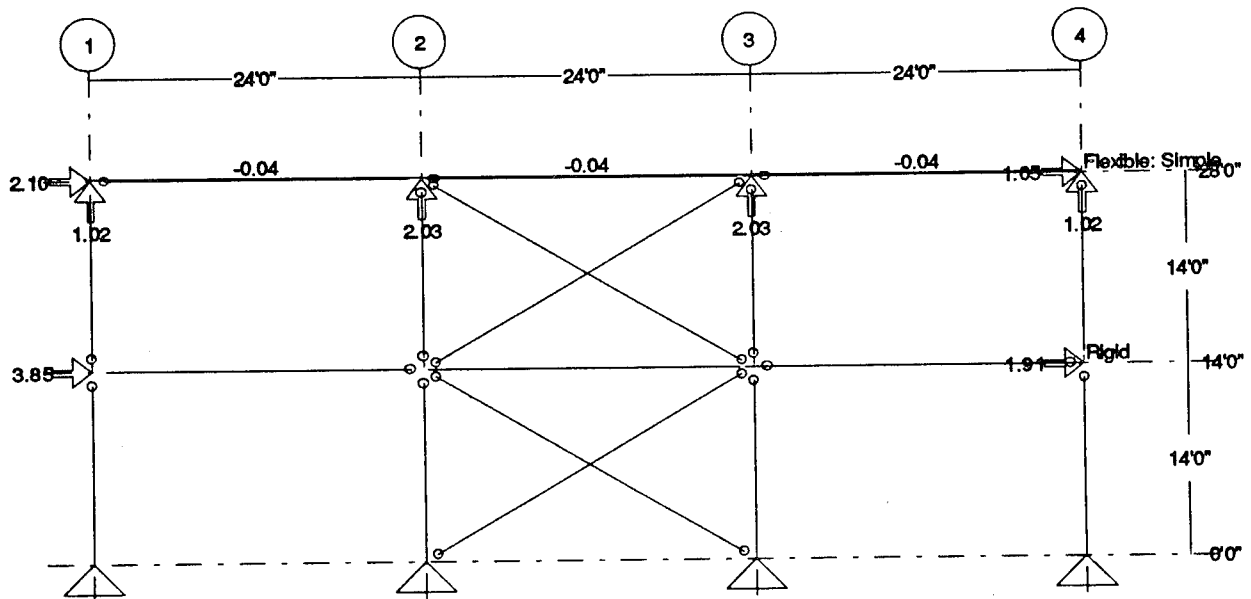






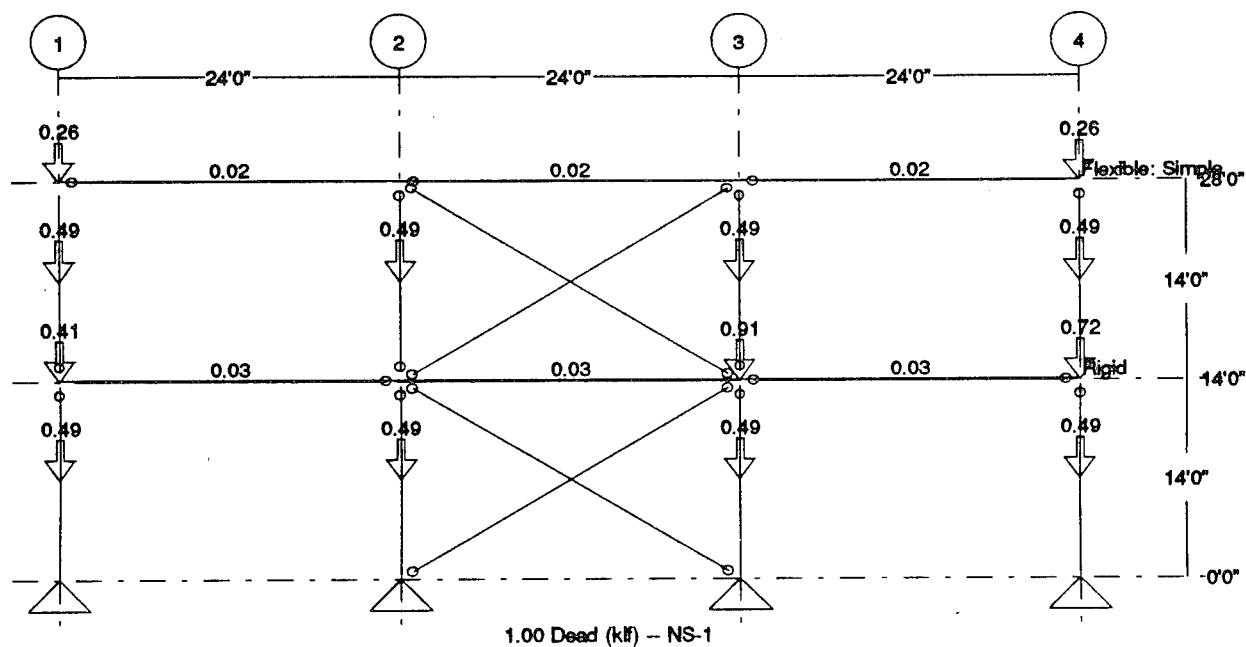
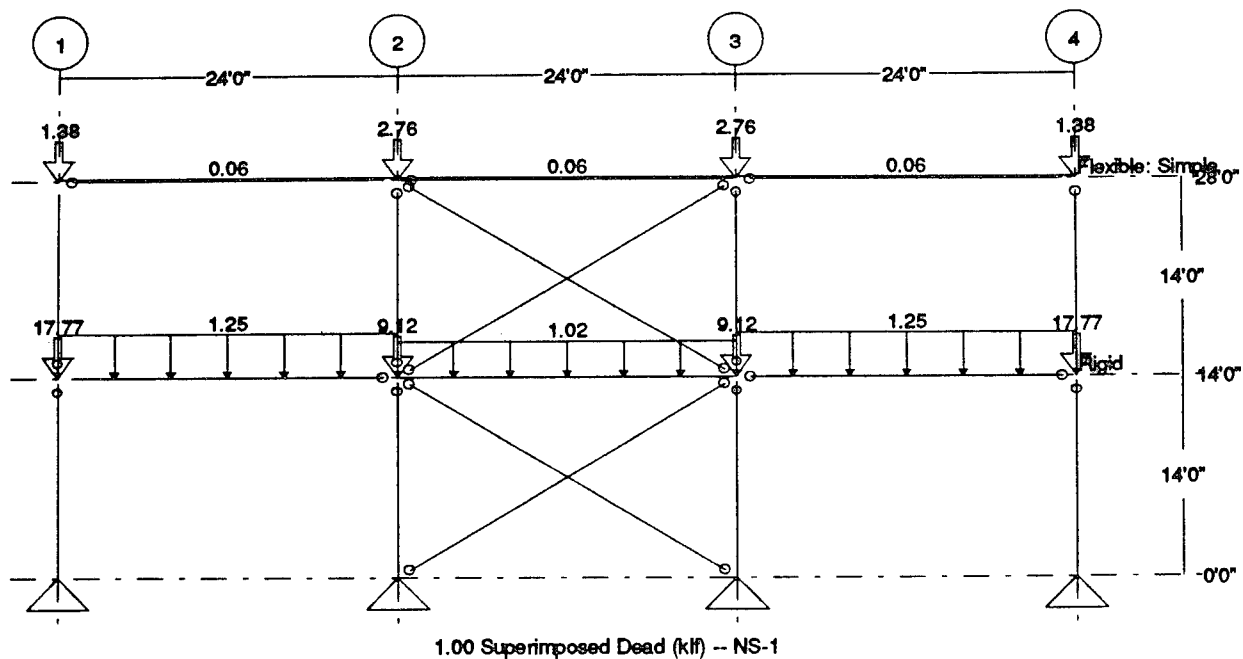


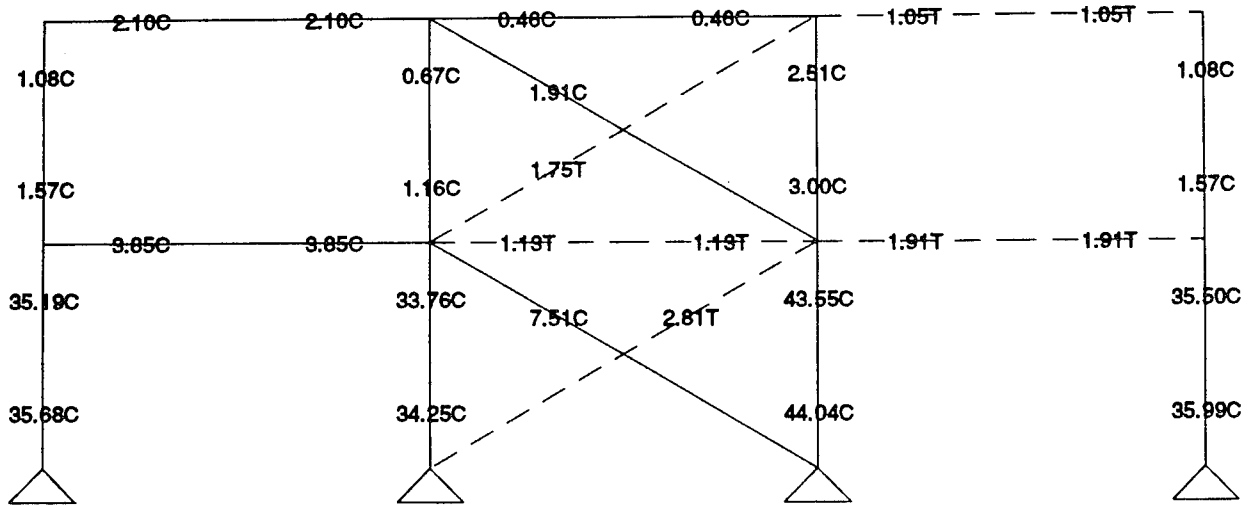
Properties: w (plf), A (in²), E (ksi), I (in⁴)



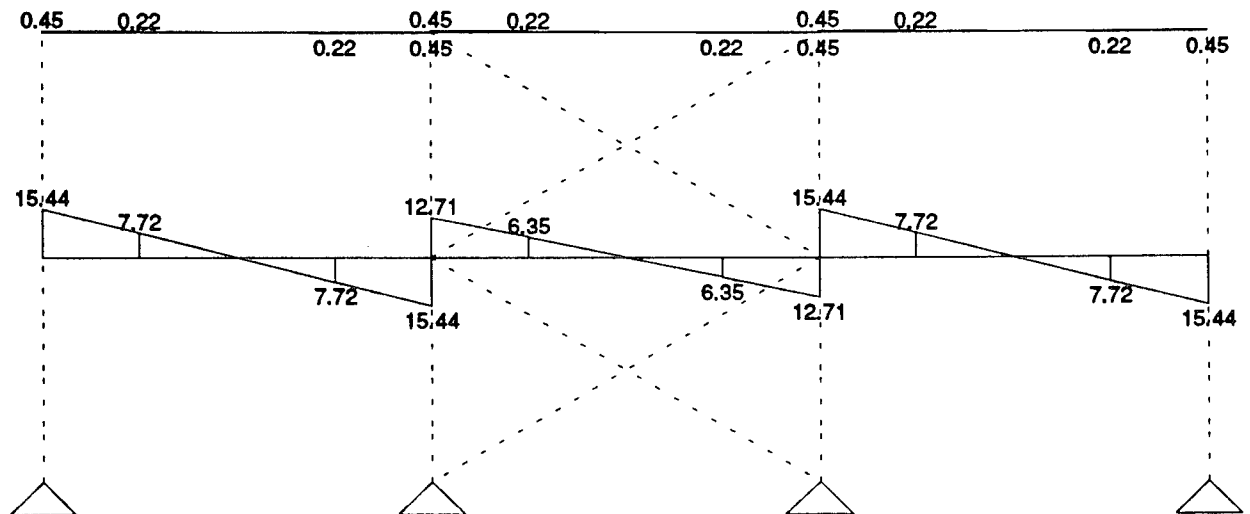
1.00 Wind (klf) - NS-1 - F, 36%

Wind Lateral Analysis

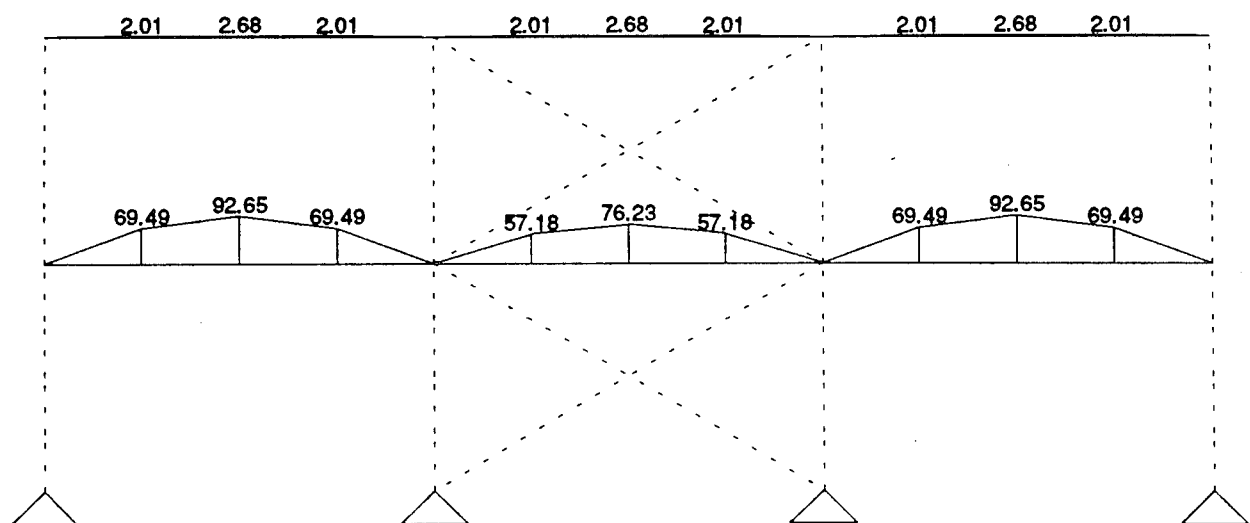




Total Combined Load: D + W -- Axial (k)

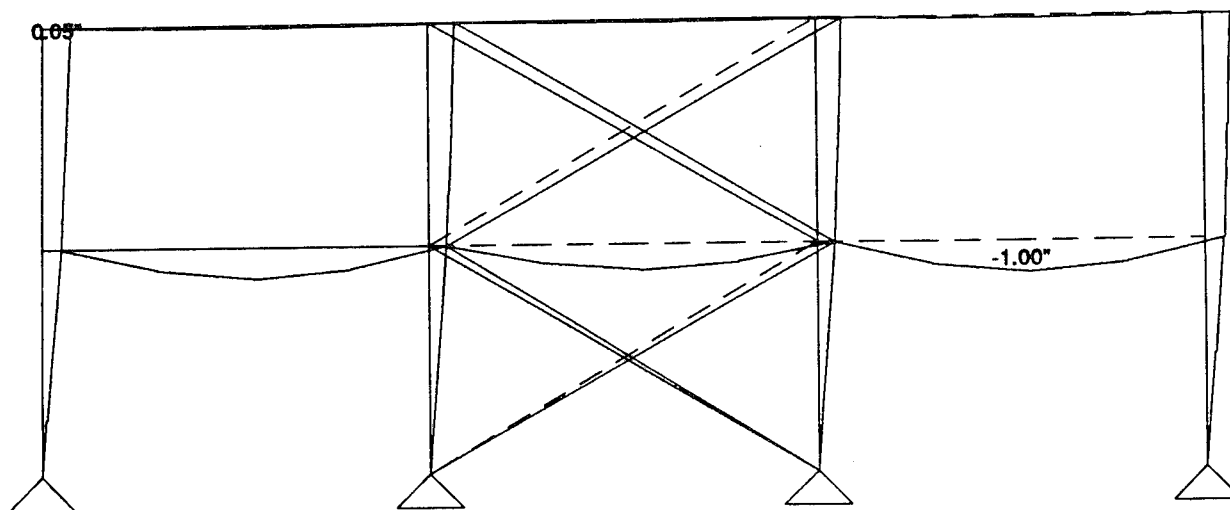


Total Combined Load: D + W -- Shear (k)

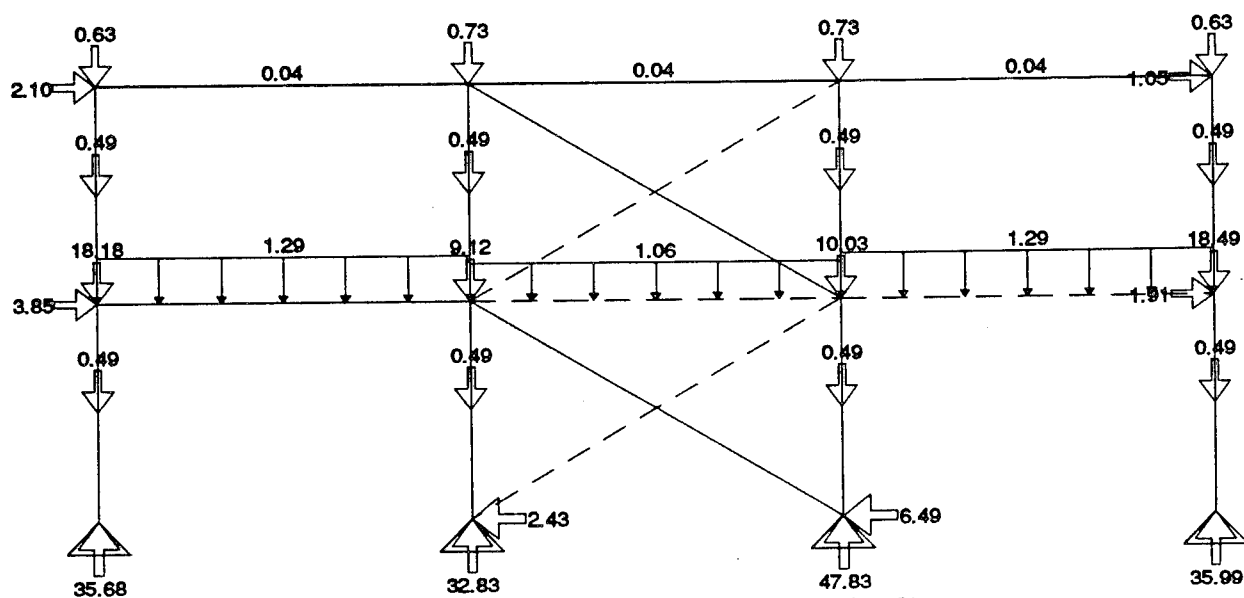


Total Combined Load: D + W -- Moment (ft-k)

Wind Lateral Analysis



Total Combined Load: D + W -- Deflection



Total Combined Load: D + W -- Loads & Reactions (k)

Project : Office Building - Scheme B
 Location : Radford AAP
 Time : Thu Sep 01, 1994 11:17 AM

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

Center of Rigidity

Name	h (ft)	I (ft ⁴)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
NS-1	14.0	0	0	3.274	0.305	35.92%	0.8	0.255
NS-2	14.0	0	0	3.239	0.309	36.31%	48.8	15.077
NS-3	14.0	0	0	4.236	0.236	27.77%	84.8	20.027
Sum					0.850			35.359

Centroid from lower left = $\text{sum}(R*x)/\text{sum}(R)$: 41.59 ft
 Maximum rigid diaphragm dimension : 85.67 ft
 Eccentricity (e) = $\text{centroid} - (\text{max dimension})/2$: 1.25 ft

Name	h (ft)	I (ft ⁴)	Av (sqft)	Deflection (in)	Rigidity	R/ sum(R)	x (ft)	R*x
EW-1	14.0	0	0	3.239	0.309	50.00%	72.8	22.487
EW-2	14.0	0	0	3.239	0.309	50.00%	0.8	0.257
Sum					0.617			22.744

Centroid from lower left = $\text{sum}(R*x)/\text{sum}(R)$: 36.83 ft
 Maximum rigid diaphragm dimension : 73.67 ft
 Eccentricity (e) = $\text{centroid} - (\text{max dimension})/2$: 0.00 ft

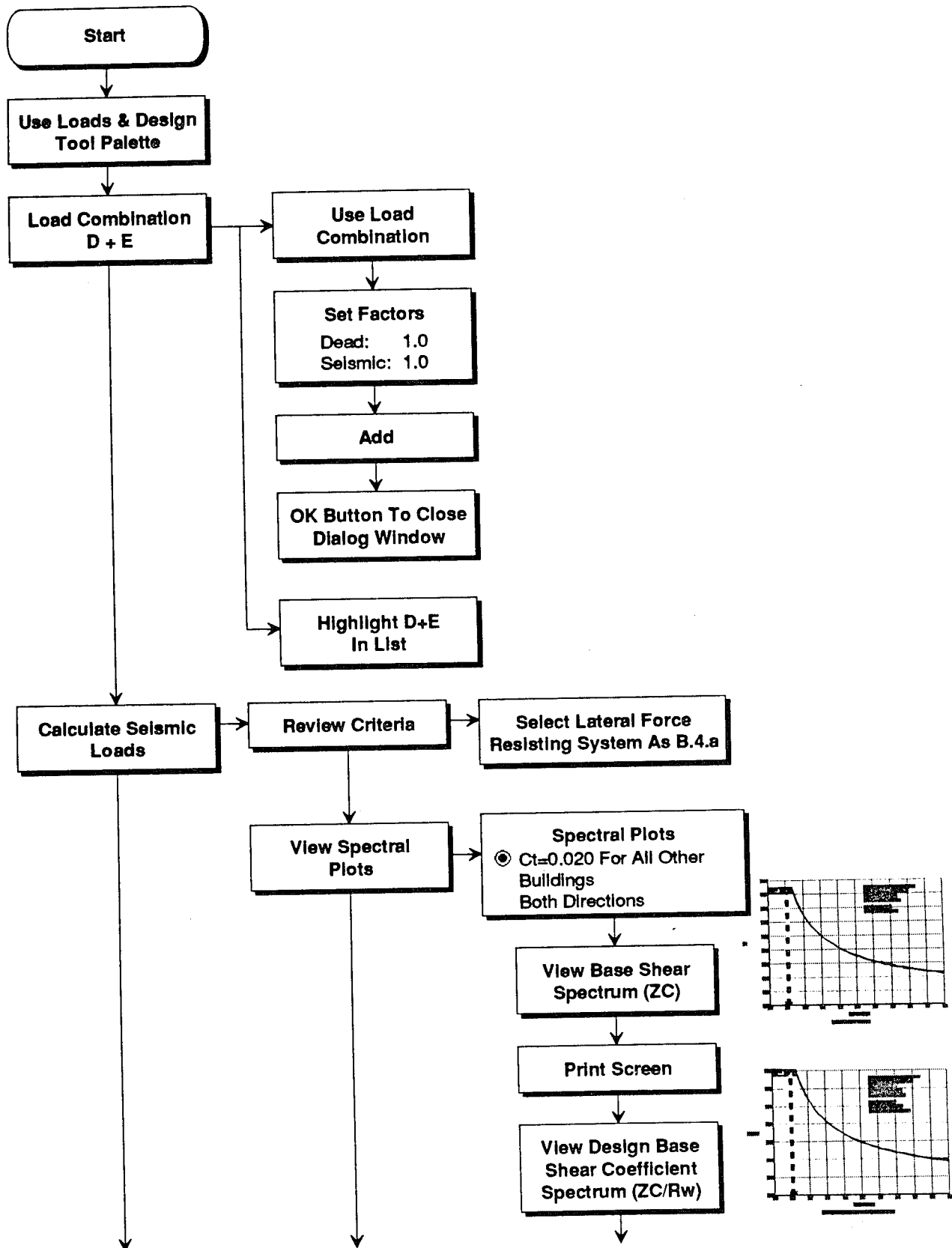
Assumptions used:

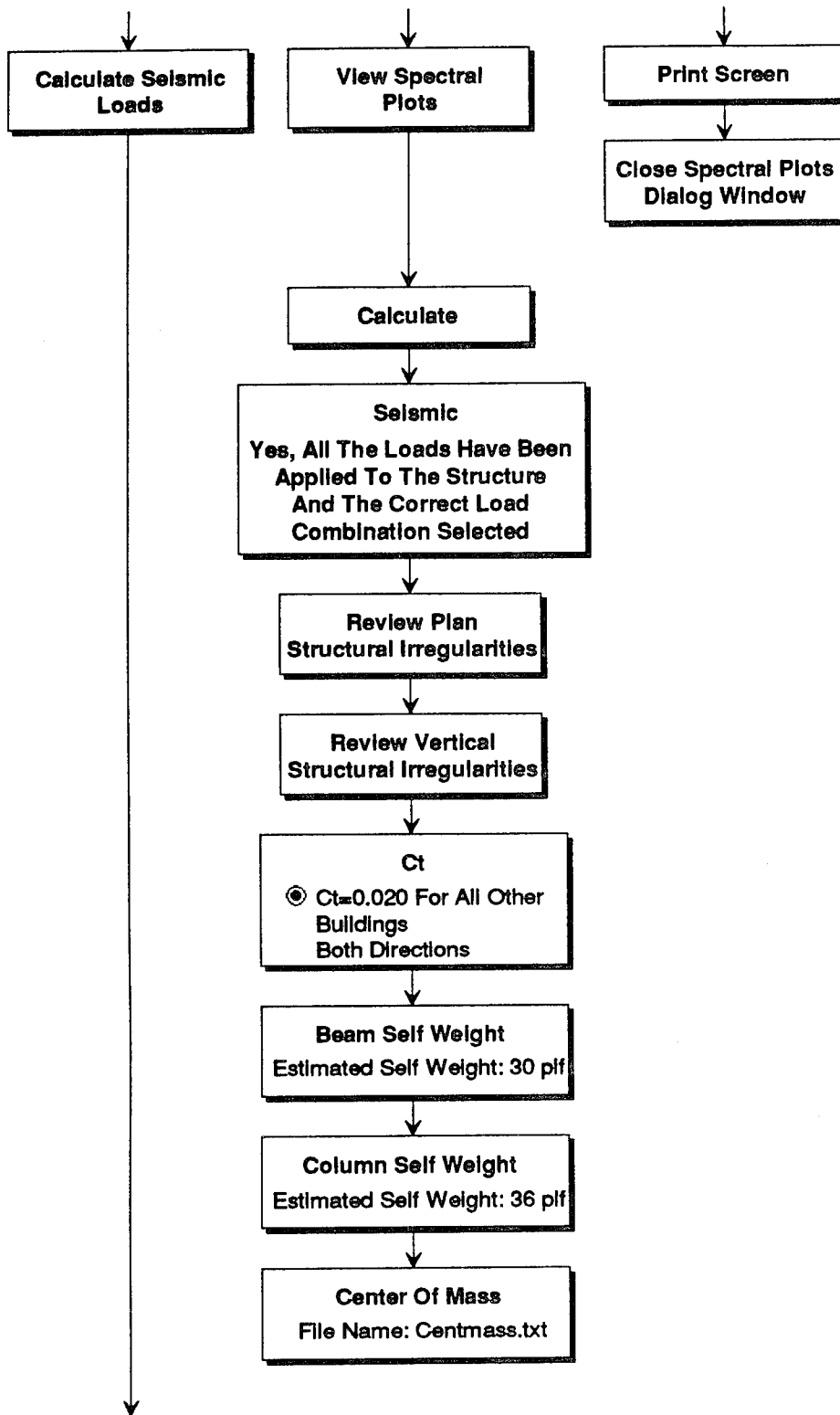
Deflections calculated by applying a 1000 k load.

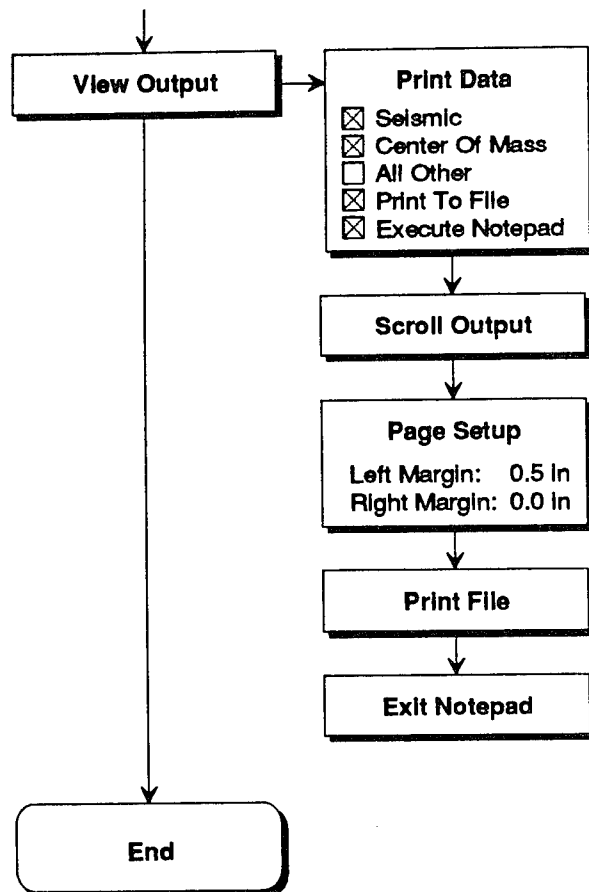
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	0.305	40.8	12.447	507.263	0.00705
NS-2	14.0	0.309	7.2	2.237	16.215	0.00127
NS-3	14.0	0.236	43.2	10.210	441.545	0.00578
EW-1	14.0	0.309	36.0	11.115	400.127	0.00630
EW-2	14.0	0.309	36.0	11.115	400.127	0.00630
Sum					1765.277	

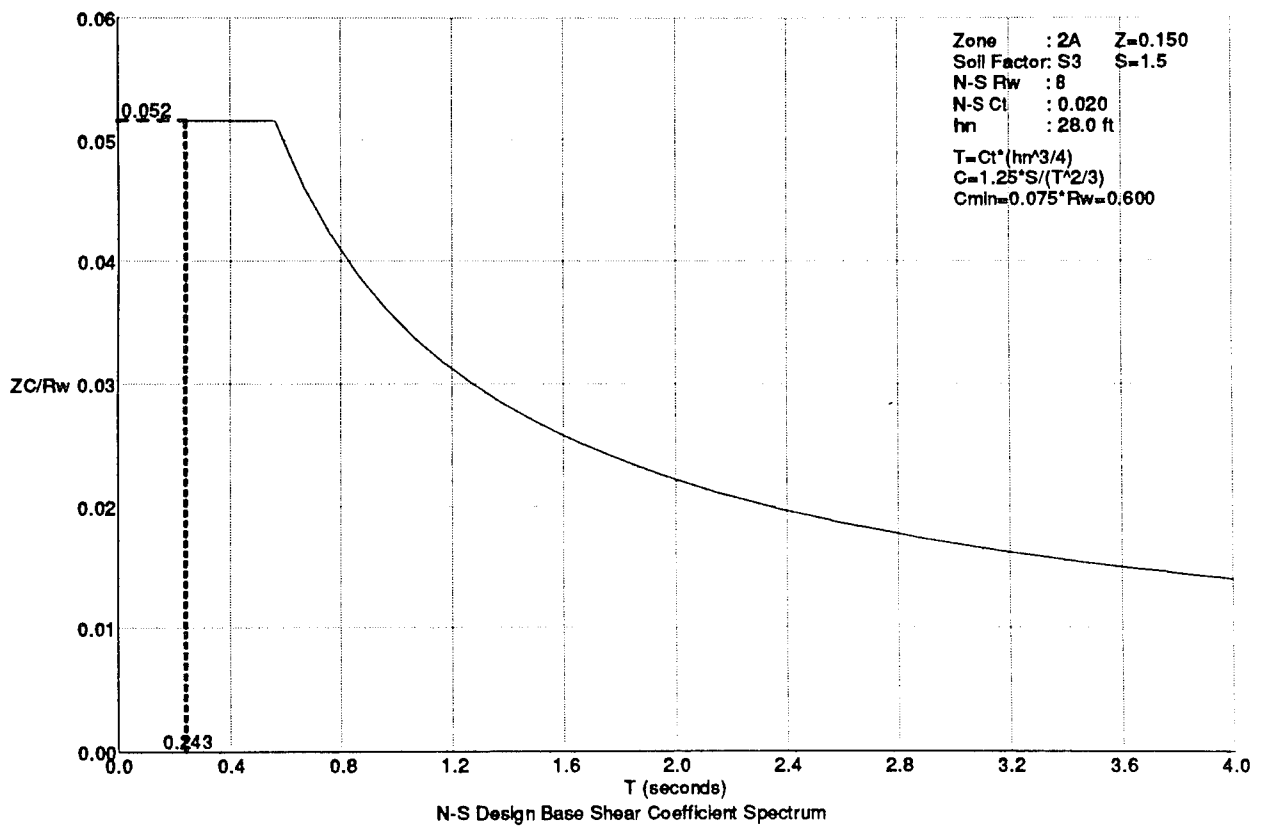
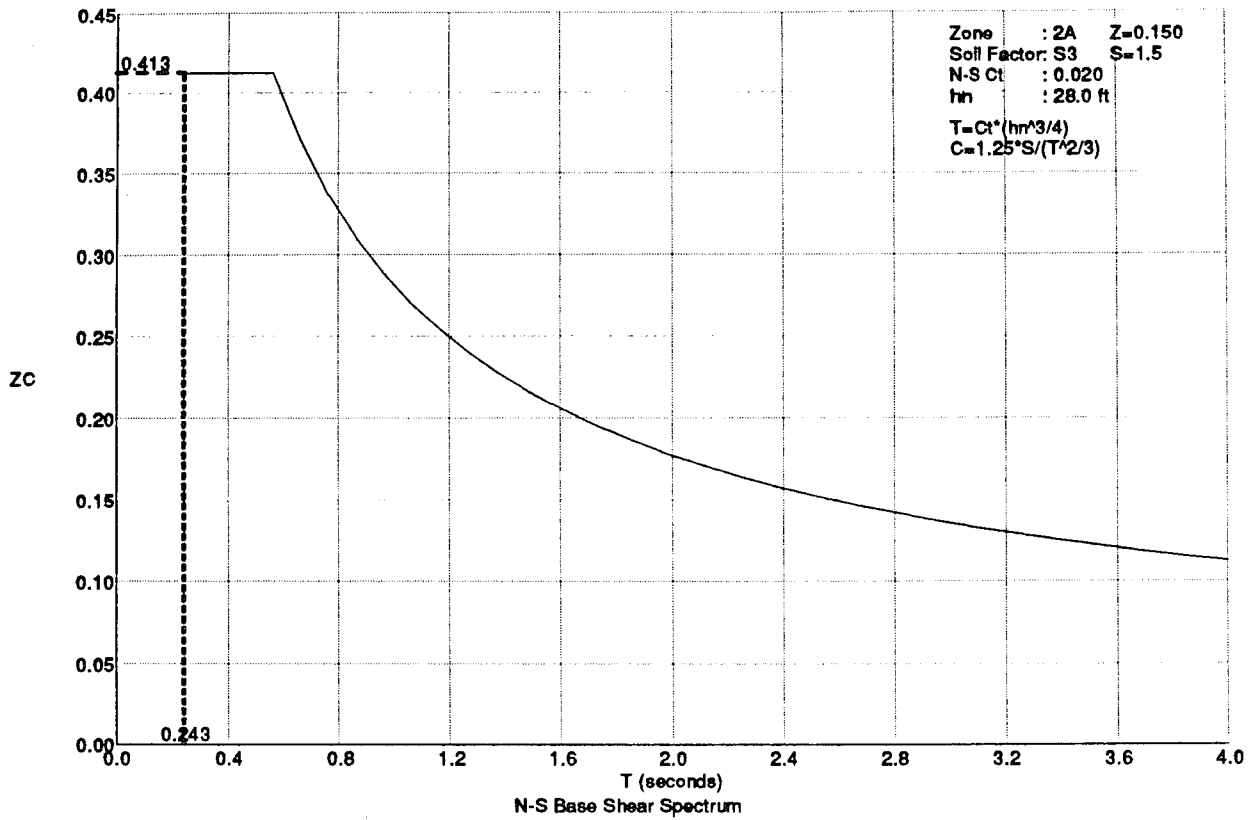
Shear distribution : $F_v = V*R/\text{sum}(R)$
 Torsional moment : $M_t = V*e$
 Torsional component : $F_t = M_t*R*dx/\text{sum}(R*dx*dx)$
 Total shear to element: $F_{\text{total}} = F_v + F_t$

Seismic Loads









Seismic Loads

Project : Office Building - Scheme B
 Location : Radford AAP
 Seismic Code: TM 5-809-10 1992
 Time : Thu Sep 01, 1994 12:13 PM

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

3. Upper Roof : 188.0 k
 2. Second Floor/Lower Roof : 670.3 k

Total Building Weight (W) : 858.4 k

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

Zone: 2A: Z = 0.150
 Importance Category: IV: I = 1.00
 Soil Factor: S3: S = 1.5
 System: B4a: R_w = 8
 C_t = 0.020
 h_n = 28.0 ft
 $T = C_t \cdot h_n^{3/4} = 0.243 \text{ sec}$
 $C = 1.25 \cdot S / T^{2/3} = 4.82 > 2.75$
 $C = 2.75$
 $C / R_w = 0.344 > 0.075$
 $W = 858.4 \text{ k}$
 $V = Z \cdot I \cdot C \cdot W / R_w$

+-----+
 | V = 44.3 k |
 +-----+

T < 0.7 sec

+-----+
 | F_t = 0.0 k |
 +-----+

+-----+
 | V - F_t = 44.3 k |
 +-----+

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

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

Project : Office Building - Scheme B
 Location : Radford AAP
 Time : Thu Sep 01, 1994 12:13 PM

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

Upper Roof -- 28.00 ft

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

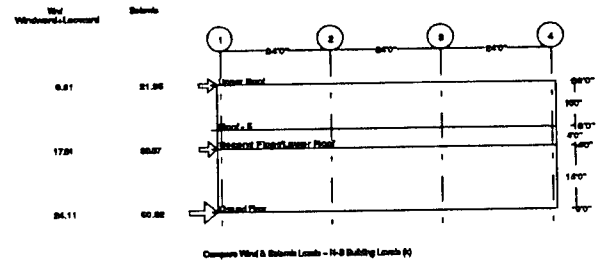
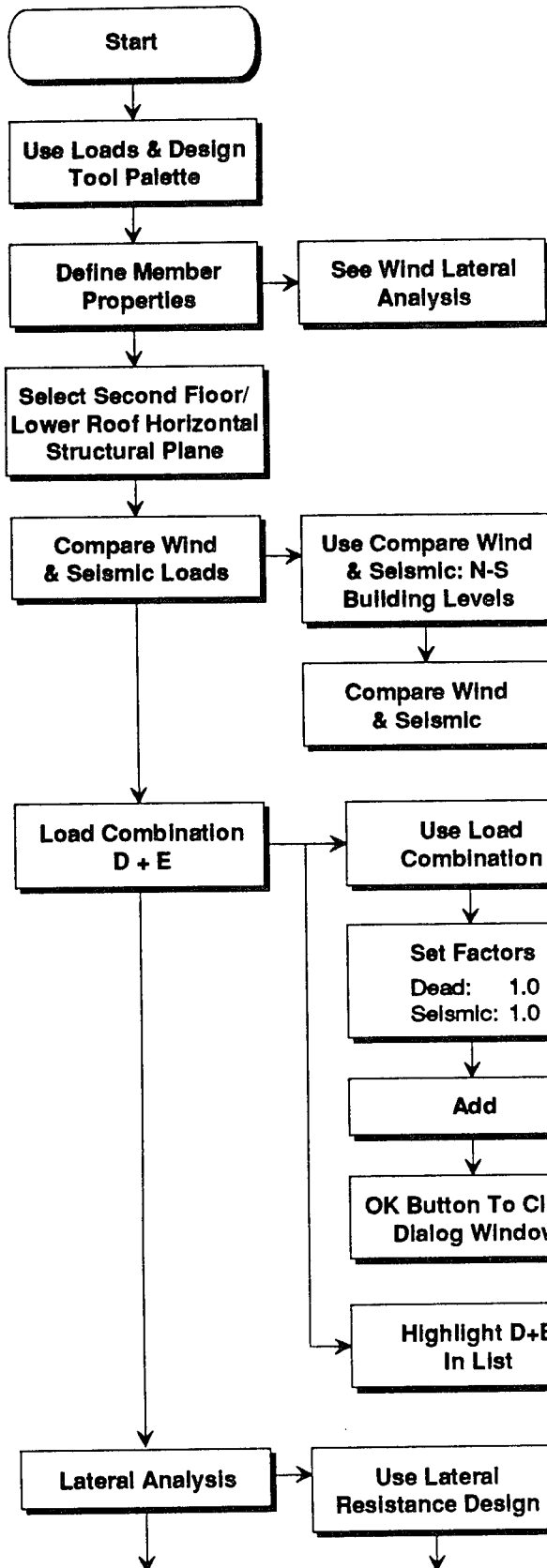
N-S Center Of Mass: 36.83 ft
 E-W Center Of Mass: 24.83 ft

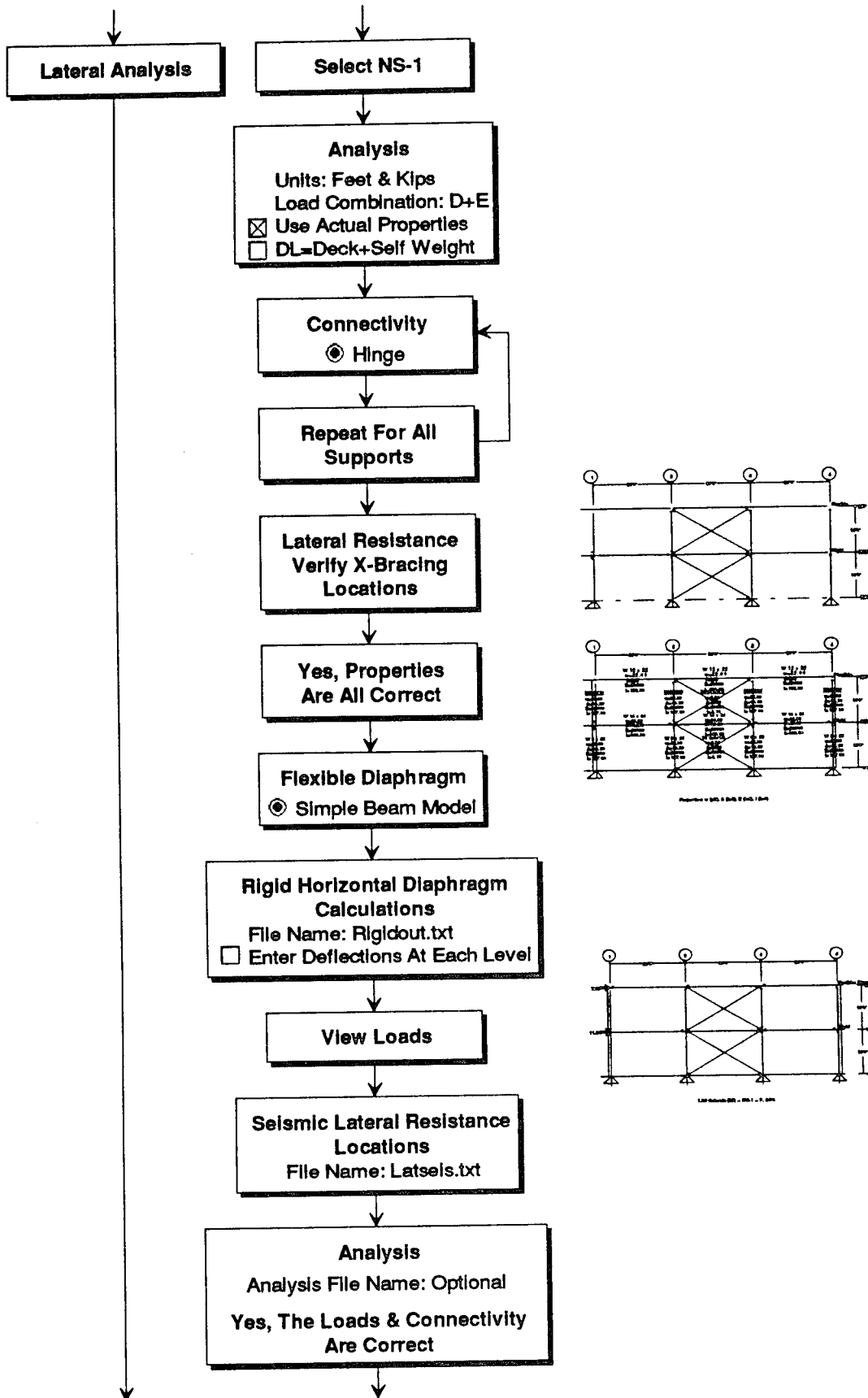
Second Floor/Lower Roof -- 14.00 ft

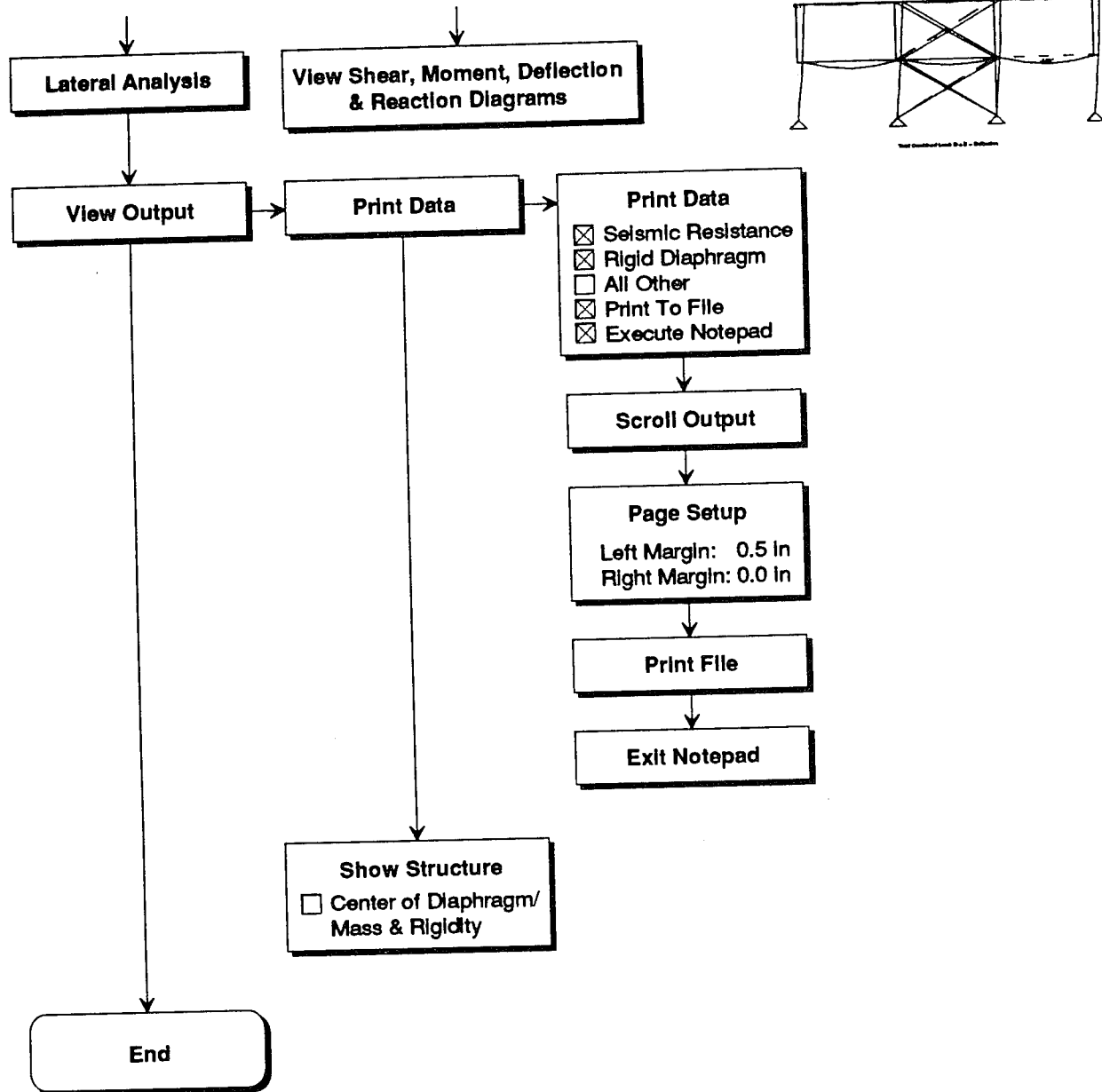
Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	70.0	12.8	898.1	24.8	1737.9
Second Floor	58.3	36.8	2148.1	28.8	1681.6
Second Floor	70.0	60.8	4257.4	24.8	1737.9
Lower Roof	126.0	36.8	4639.9	66.8	8419.1
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8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

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

Seismic Lateral Analysis

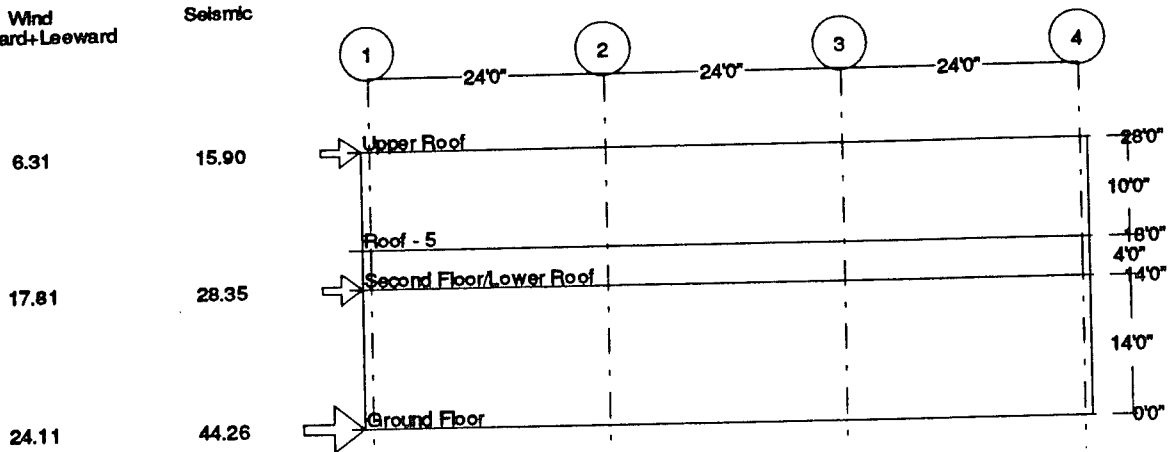




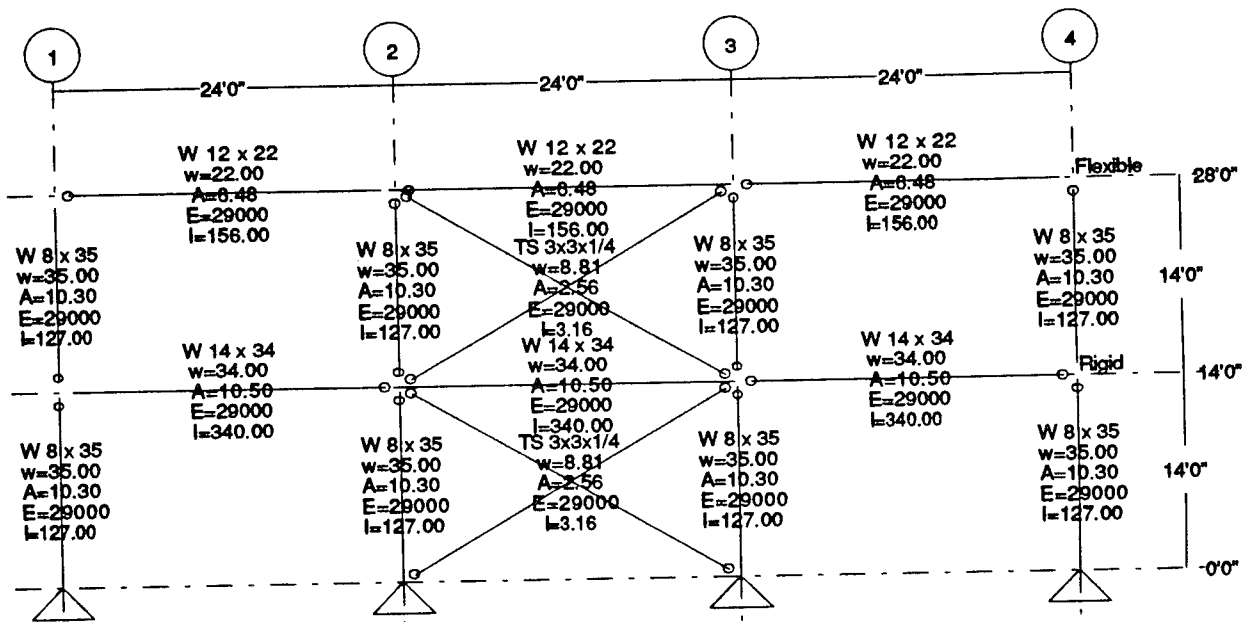


Wind
Windward+Leeward

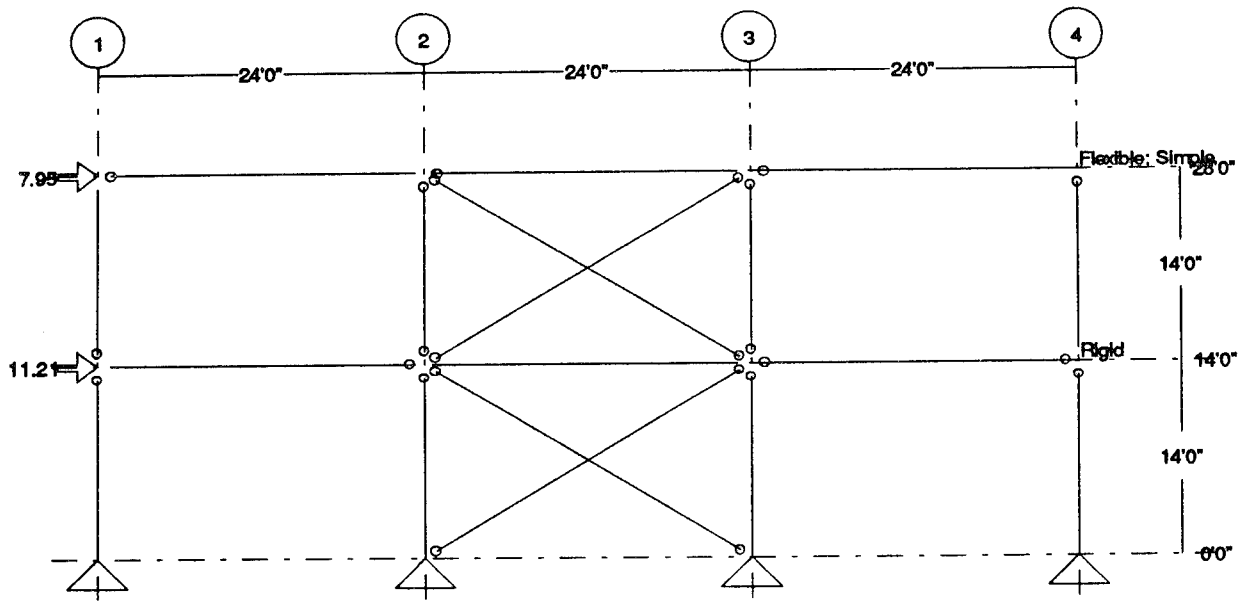
Seismic



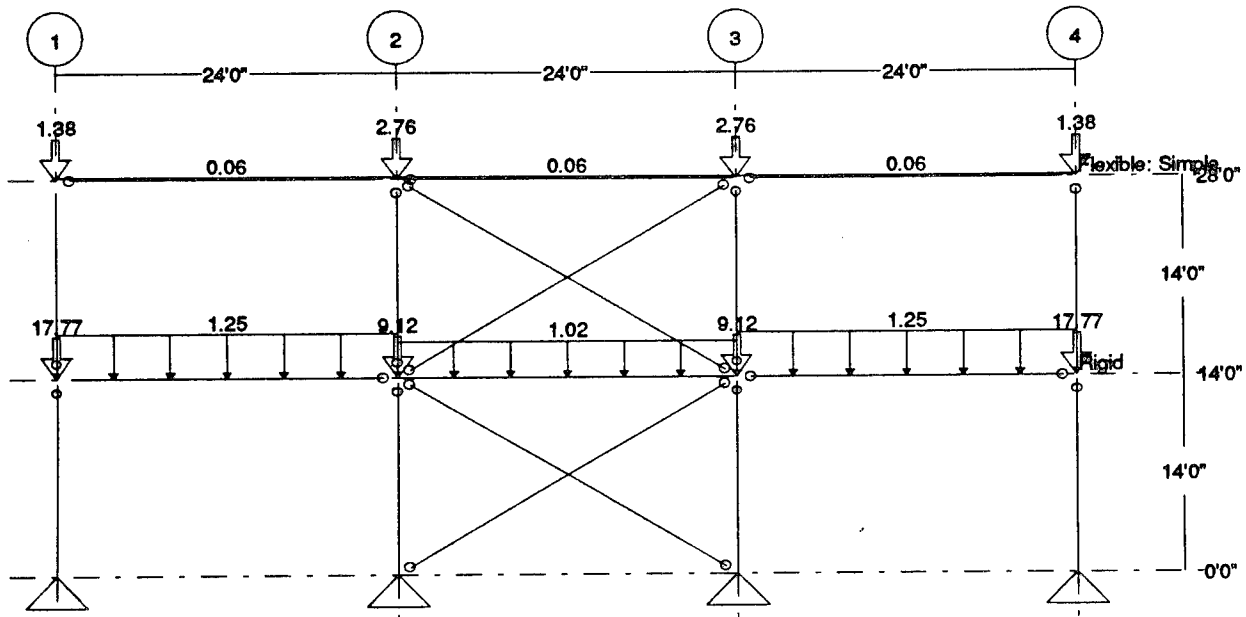
Compare Wind & Seismic Loads -- N-S Building Levels (k)



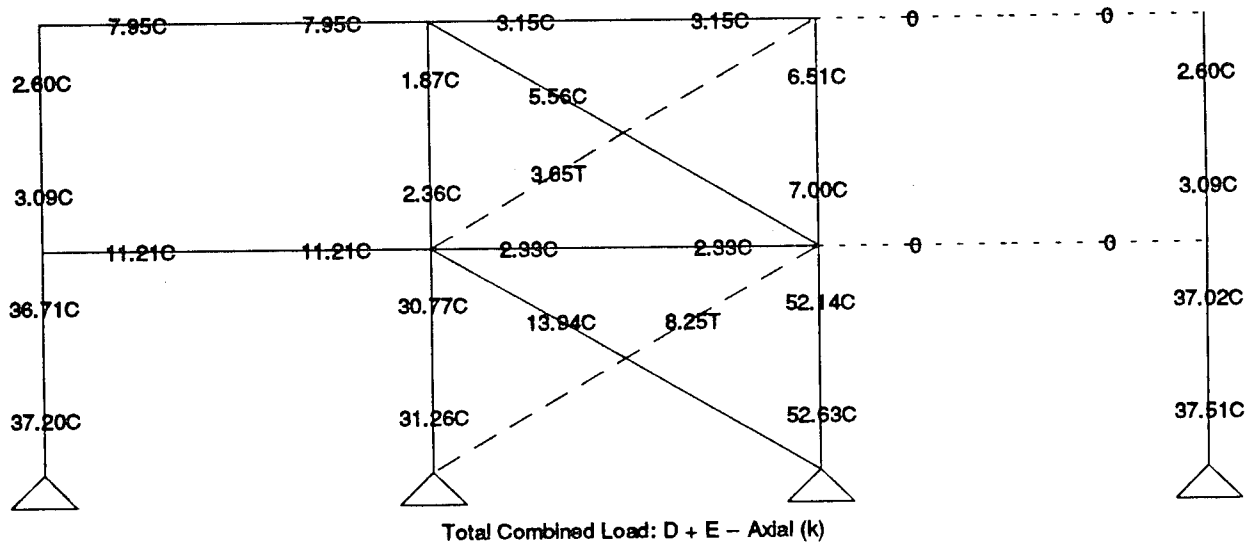
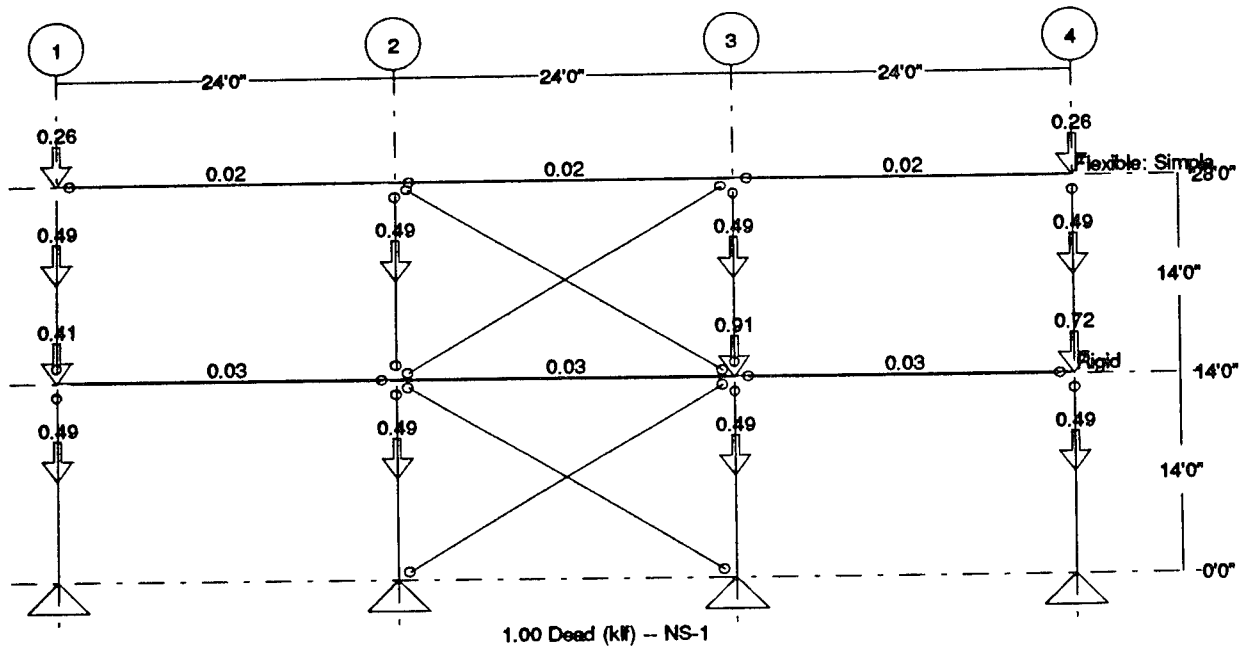
Seismic Lateral Analysis



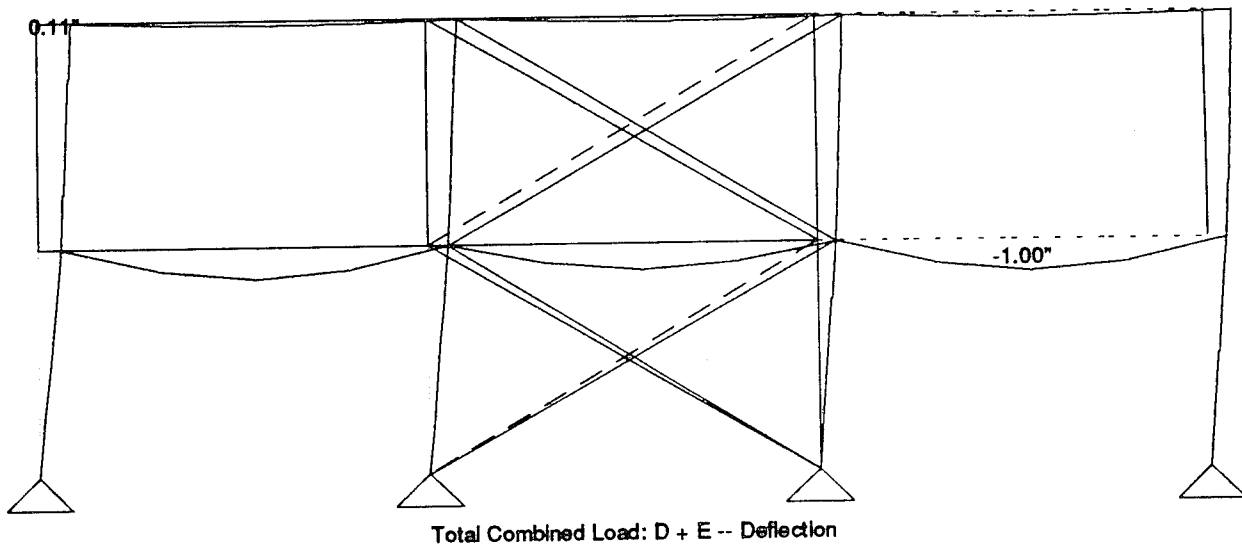
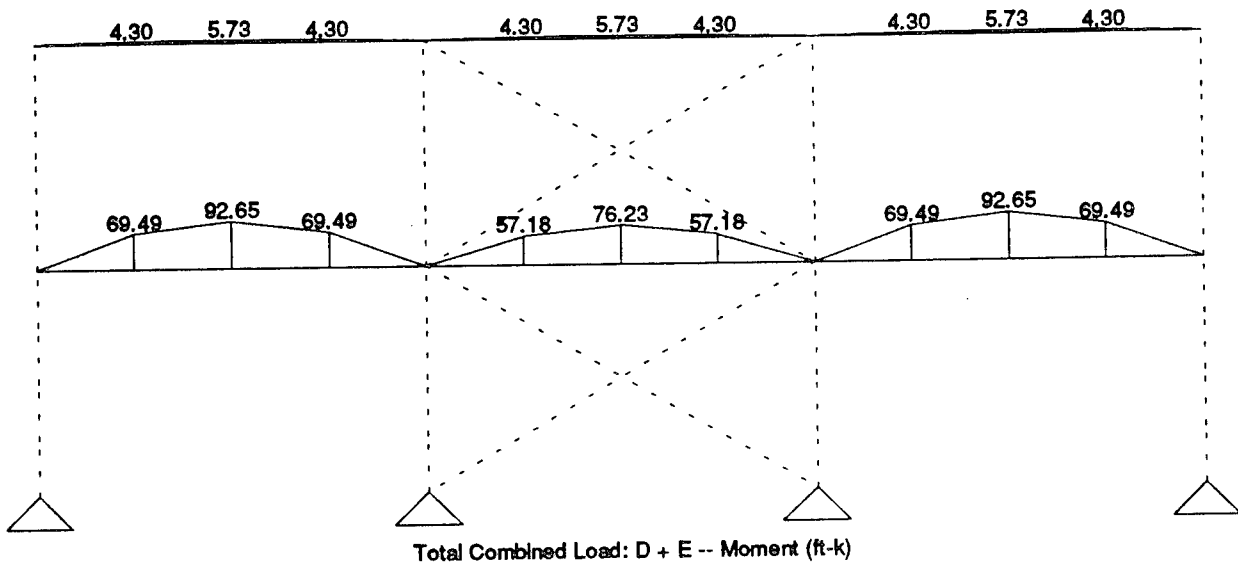
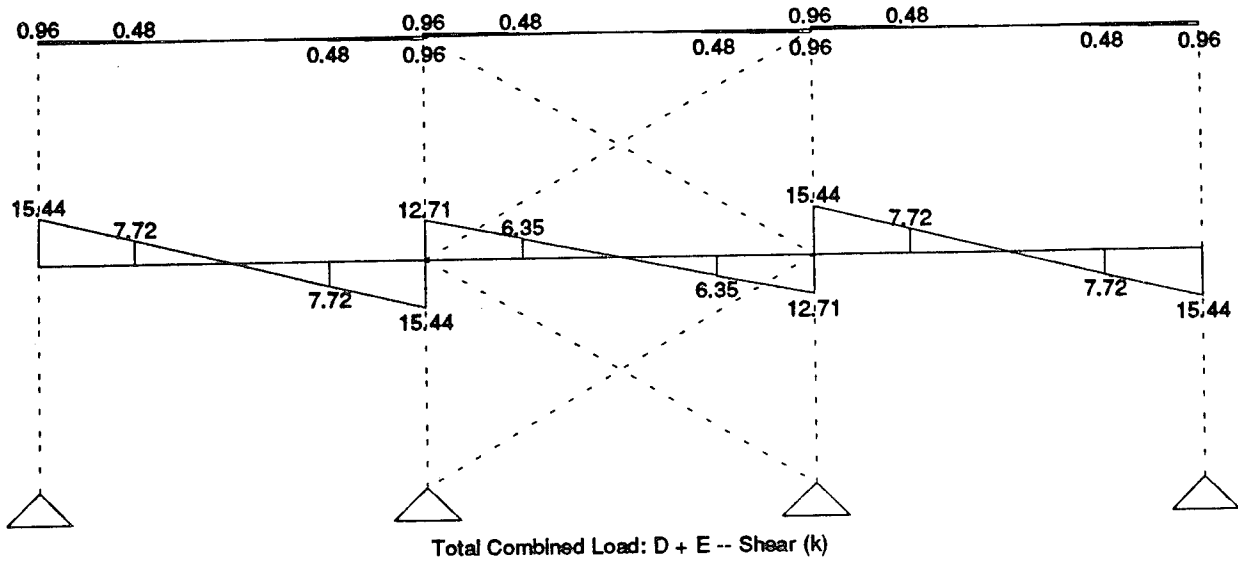
1.00 Seismic (klf) -- NS-1 -- F, 36%

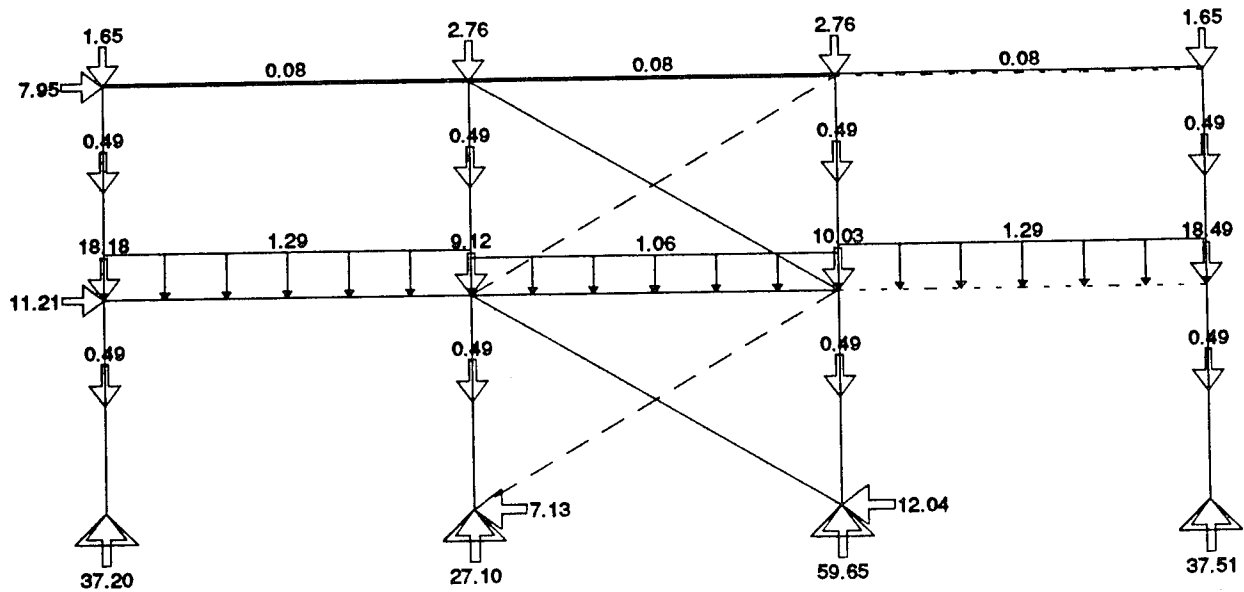


1.00 Superimposed Dead (klf) -- NS-1



Seismic Lateral Analysis





Total Combined Load: D + E -- Loads & Reactions (k)

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

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

NS-1 -- F, 36%						
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

NS-2 -- F, 36%						
Level	h (ft)	Floor to Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
3	28.0		15.9			
		14.0		15.9	223	
2	14.0		28.4			223
		14.0		44.3	620	
1	0.0					842
Sum			44.3		842	

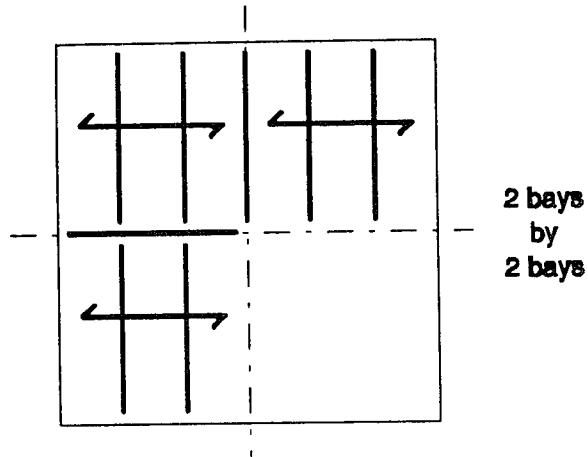
Seismic Lateral Analysis

NS-3 -- F, 28%						
Level	Floor to h (ft)	Floor h (ft)	F (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)
2	14.0		28.4			
		14.0		28.4	397	
1	0.0					397
Sum			28.4		397	

Quantity Take-Off Philosophy

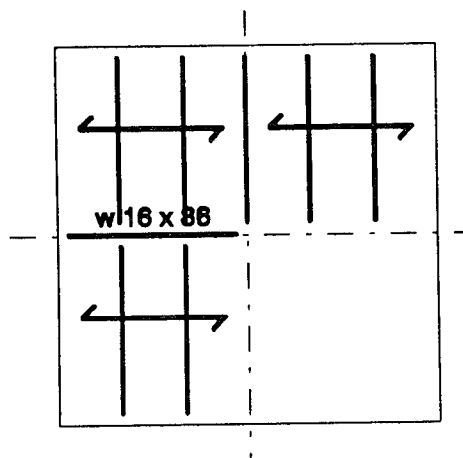
3 Considerations

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



2. One typical floor level and roof level

3. The entire building structural system



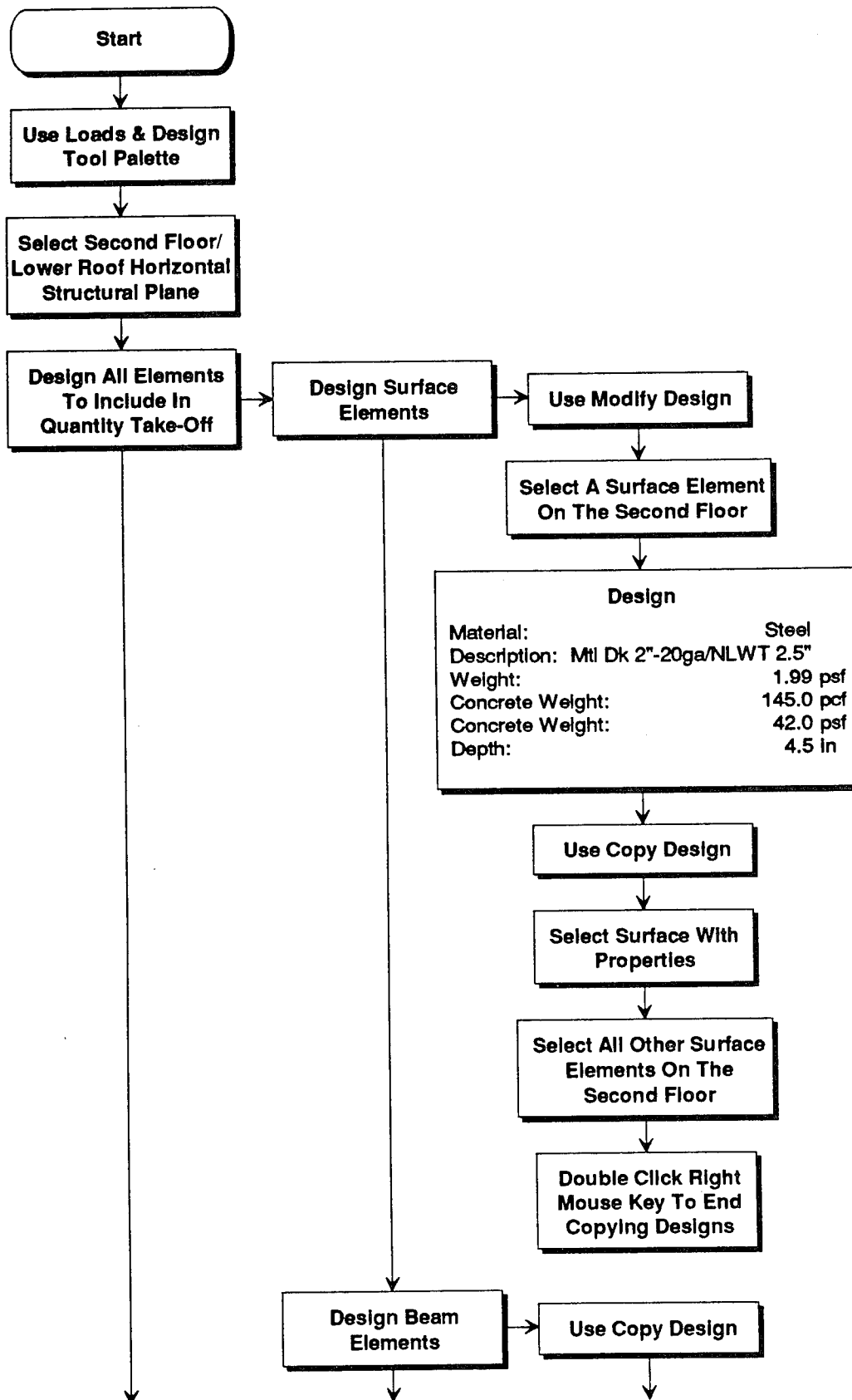
Estimated weights are not used
for quantity take-offs

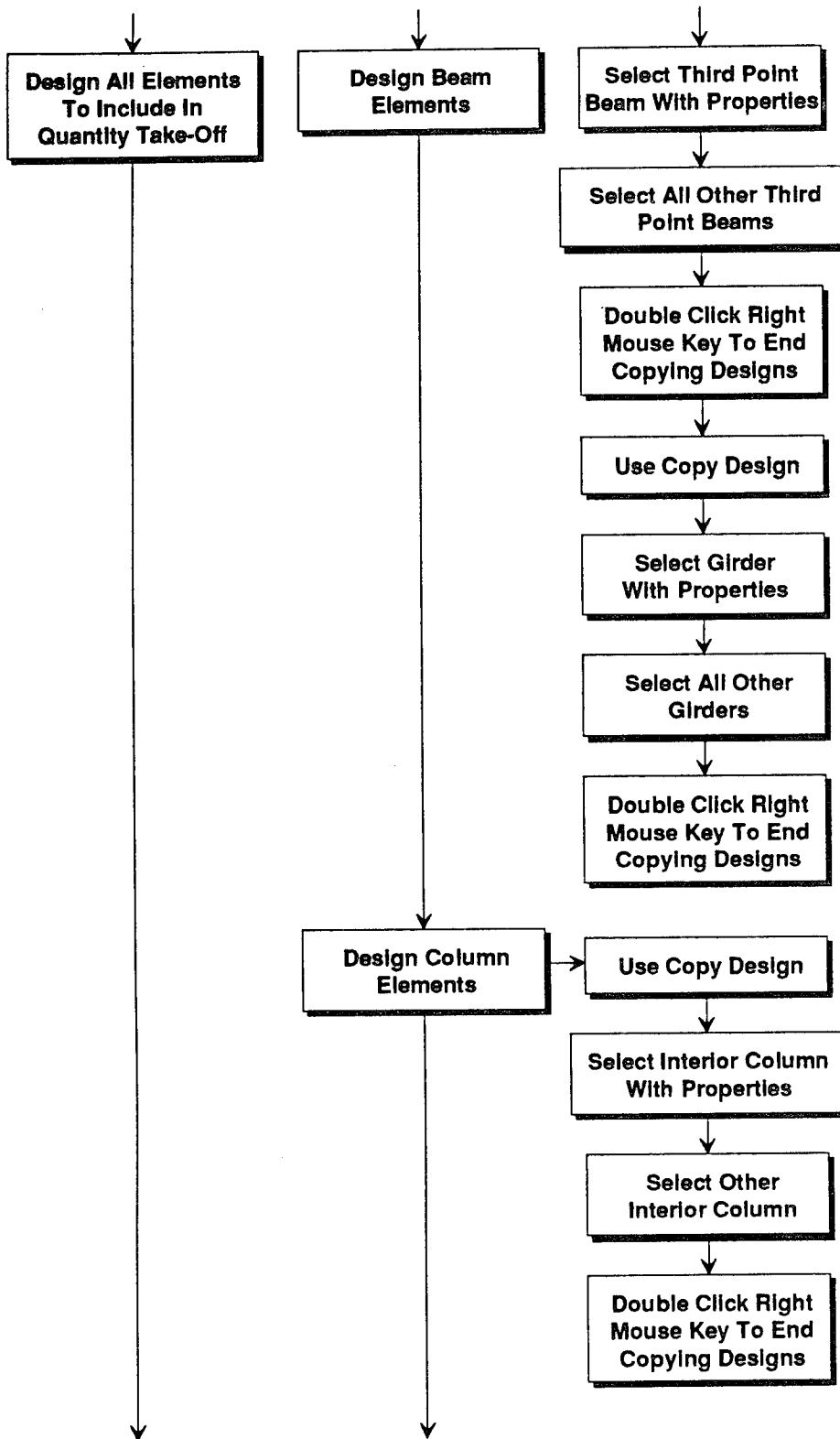
Elements designed by Excel
spreadsheets are used

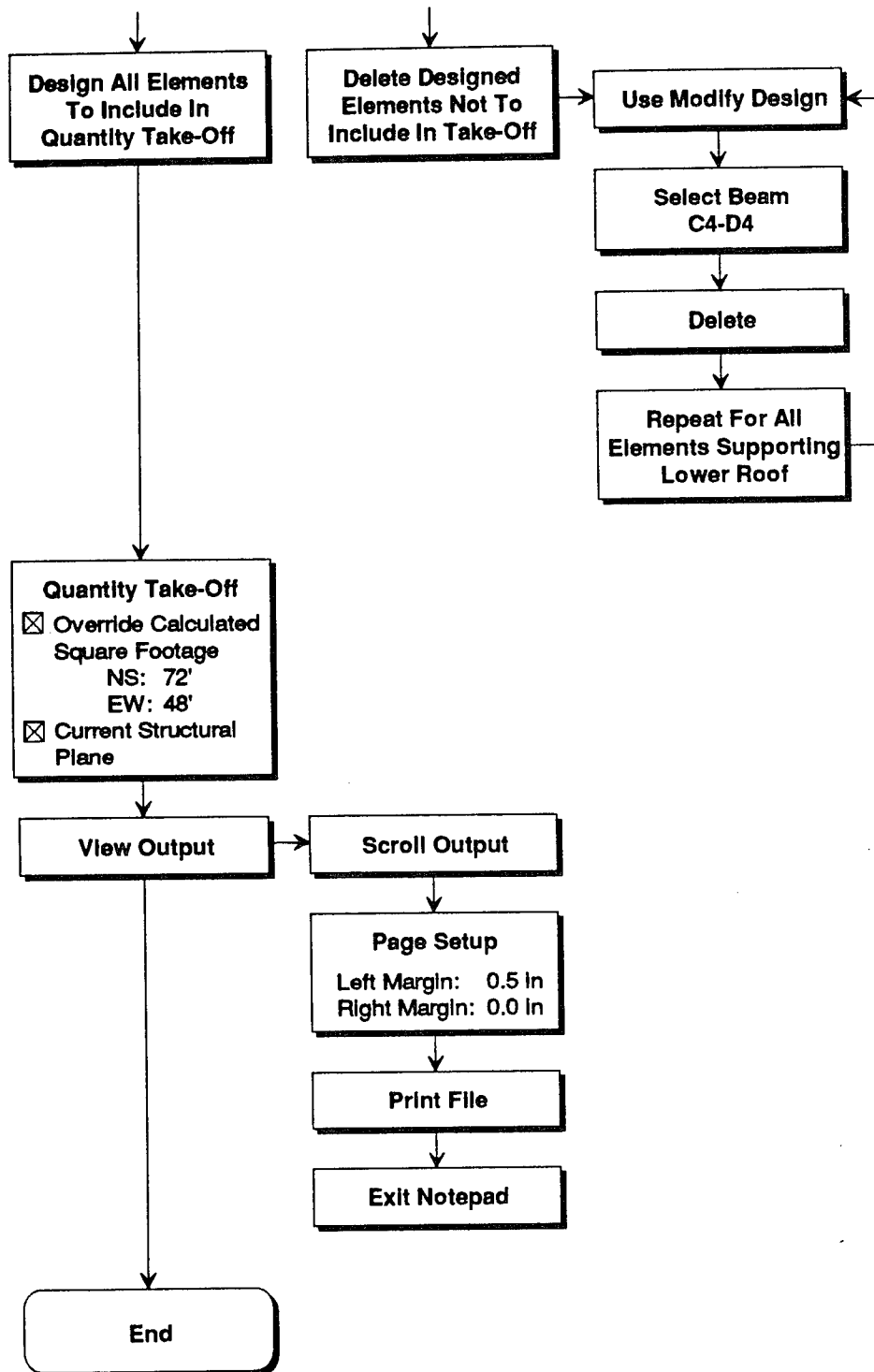
Use Modify Design and Copy Design
to manually enter element sizes

Calculated square footage
can be overridden

Quantity Take-Off







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

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

Second Floor/Lower Roof

Plan Area: 72.0 ft x 48.0 ft: 3456.0 sqft

STEEL: Narrowly Spaced Elements

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

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

STEEL: Widely Spaced Elements

Description	Length (ft)	Weight (plf)	Weight/ Element (lbs)	No.	Total Weight (lbs)
W 14 x 34 (50)	24.0	34.0	816.0	10	8160
	36.0	0.0	0.0	2	0
W 21 x 50 (72)	24.0	50.0	1200.0	4	4800
W 16 x 26 (28)	24.0	26.0	624.0	15	9360
	24.0	0.0	0.0	3	0
Sum					22320

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

STEEL: Surface Elements

Description	Total Depth (in)	Area (sqft)	Weight (psf)	Conc Weight (pcf)	Conc Weight (psf)	Total Weight (lbs)	Weight Conc (lbs)
Mt1 Dk 2"-20ga/NLWT 2.5"	4.5	2880	2.0	145.0	42.0	5731	120960
Mt1 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

Quantity Take-Off

STEEL: Column Elements

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

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

Concluding Remarks

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

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

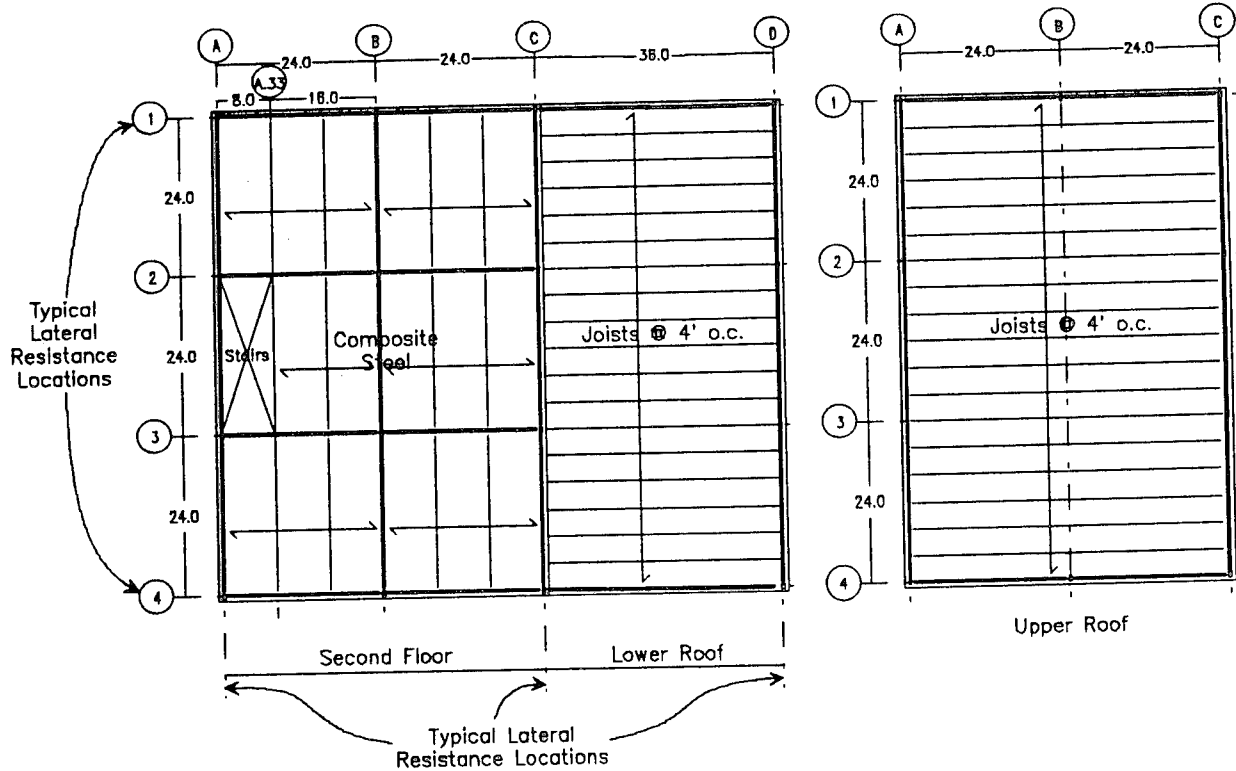
A logical steel framed beam/column solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses)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

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

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

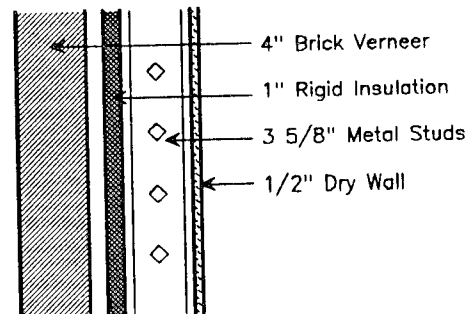
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.

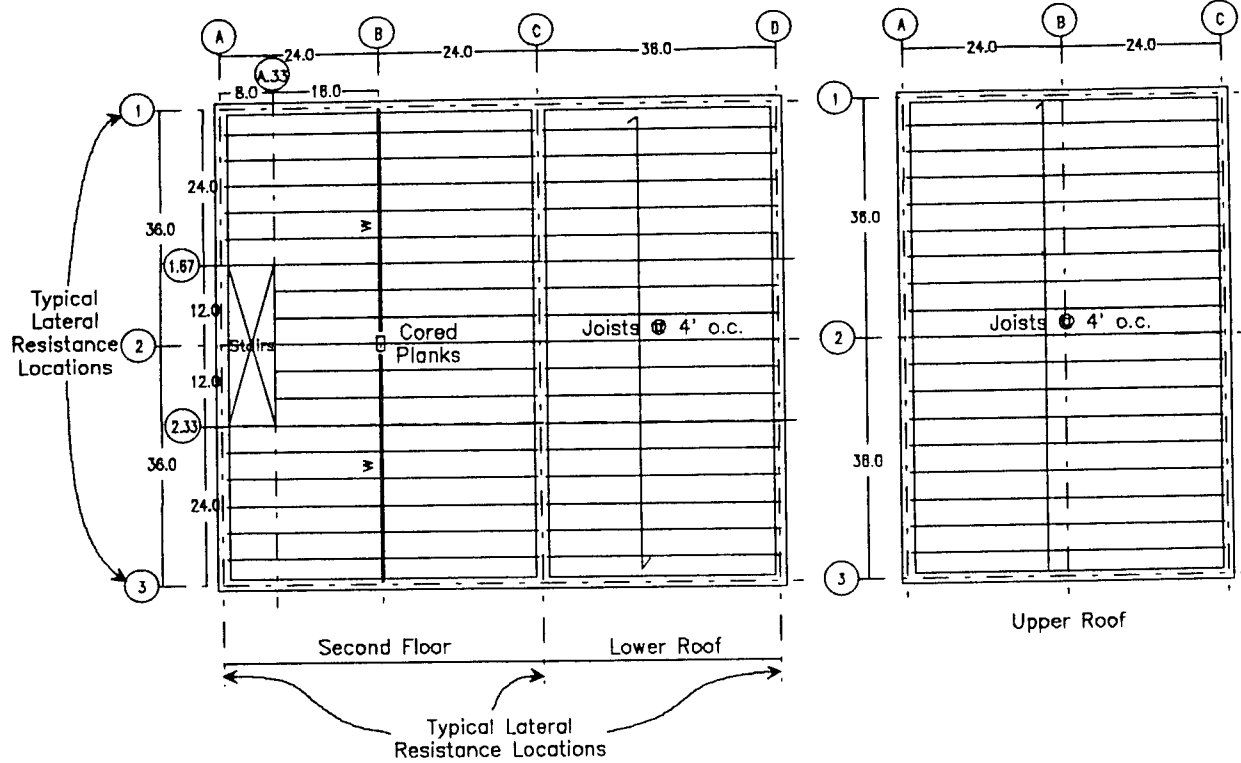
Concluding Remarks



Scheme 1: Moment connections for lateral load resistance

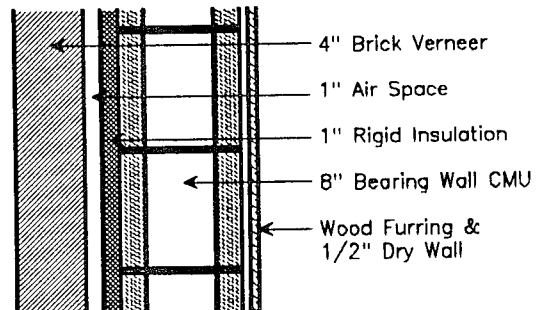
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



REPORT DOCUMENTATION PAGE

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OMB No. 0704-0188

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1.AGENCY USE ONLY (Leave blank)		2.REPORT DATE June 1996	3.REPORT TYPE AND DATES COVERED Report 4 of a series	
4.TITLE AND SUBTITLE Computer-Aided Structural Modeling (CASM), Version 6.00; Report 4: Scheme B			5.FUNDING NUMBERS Contract No. DACA39-86-C-0024 Work Unit No. AT40-CA-001	
6.AUTHOR(S) David Wickersheimer, Carl Roth, Gene McDermott				
7.PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Wickersheimer Engineers, Inc., 821 South Neil Street, Champaign, IL 61820			8.PERFORMING ORGANIZATION REPORT NUMBER	
9.SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army Corps of Engineers, Washington, DC 20314-1000; U.S. Army Engineer Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199			10.SPONSORING/MONITORING AGENCY REPORT NUMBER Instruction Report ITL-96-2	
11.SUPPLEMENTARY NOTES Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161.				
12a.DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b.DISTRIBUTION CODE	
13.ABSTRACT (Maximum 200 words) The Computer-Aided Structural Modeling (CASM) computer program is 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. CASM allows the structural engineer to quickly evaluate various framing alternatives in order to make more informed decisions in the initial structural evaluation process. The program was developed by the Information Technology Laboratory in conjunction with the Computer-Aided Structural Engineering (CASE) Project, Building Systems Task Group. This release of the CASM is designed to aid the user with design criteria, building loads, and structural framing and design. The various parts of the program are summarized below. a. Basic design criteria. The user can enter information directly or retrieve information from a user-definable database. The design criteria include information about the project, regional design information, and site-specific design information. b. Building geometry. The user can assemble the building shape using 3-D primitives (cubes, prisms, spheres, cylinders, etc.) in an easy manner using pull-down menus, icons, and a mouse. (Continued)				
14.SUBJECT TERMS Building systems Computer-Aided Structural Engineering (CASE) Computer programs			15.NUMBER OF PAGES 192 16.PRICE CODE	
17.SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18.SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19.SECURITY CLASSIFICATION OF ABSTRACT	20.LIMITATION OF ABSTRACT	

13. (Concluded).

c. Dead and live loads. The user can select and construct dead and live loads from several user-definable menus of building materials and load conditions. These loads can then be applied to any desired area of the building volume.

d. Snow and wind loads. These loads are automatically calculated in 3-D using information from the basic design criteria database. Wind loads are also calculated for components and cladding and open roof structures. These loads are calculated in accordance with TM 5-809-1.

e. Seismic loads. These loads are calculated based on the equivalent static force method presented in TM 5-809-10.

f. Structural layout. The engineer can easily and rapidly experiment with various framing schemes inside the defined building volume. Beams, girders, joists, girts, columns, walls, and custom trusses are some of the structural elements that can be modeled.

g. Member analysis and preliminary sizing. The user can apply loads to the building geometry from a list of user-defined load cases. The shear, moment, and deflection of selected members may be calculated for various loading conditions (including pattern loads) and connectivity (including continuous beams). The design of a member is performed using a spreadsheet.

Data from the various investigated framing schemes can be edited and printed by CASM and used as justification in a design document.

This report describes the structural framing scheme for X-braced frames that are all steel, composite, with lateral load resistance.

WATERWAYS EXPERIMENT STATION REPORTS PUBLISHED UNDER THE COMPUTER-AIDED STRUCTURAL ENGINEERING (CASE) PROJECT

	Title	Date
Technical Report K-78-1	List of Computer Programs for Computer-Aided Structural Engineering	Feb 1978
Instruction Report O-79-2	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Mar 1979
Technical Report K-80-1	Survey of Bridge-Oriented Design Software	Jan 1980
Technical Report K-80-2	Evaluation of Computer Programs for the Design/Analysis of Highway and Railway Bridges	Jan 1980
Instruction Report K-80-1	User's Guide: Computer Program for Design/Review of Curvilinear Conduits/Culverts (CURCON)	Feb 1980
Instruction Report K-80-3	A Three-Dimensional Finite Element Data Edit Program	Mar 1980
Instruction Report K-80-4	A Three-Dimensional Stability Analysis/Design Program (3DSAD) Report 1: General Geometry Module Report 3: General Analysis Module (CGAM) Report 4: Special-Purpose Modules for Dams (CDAMS)	Jun 1980 Jun 1982 Aug 1983
Instruction Report K-80-6	Basic User's Guide: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Instruction Report K-80-7	User's Reference Manual: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Dec 1980
Technical Report K-80-4	Documentation of Finite Element Analyses Report 1: Longview Outlet Works Conduit Report 2: Anchored Wall Monolith, Bay Springs Lock	Dec 1980 Dec 1980
Technical Report K-80-5	Basic Pile Group Behavior	Dec 1980
Instruction Report K-81-2	User's Guide: Computer Program for Design and Analysis of Sheet Pile Walls by Classical Methods (CSHTWAL) Report 1: Computational Processes Report 2: Interactive Graphics Options	Feb 1981 Mar 1981
Instruction Report K-81-3	Validation Report: Computer Program for Design and Analysis of Inverted-T Retaining Walls and Floodwalls (TWDA)	Feb 1981
Instruction Report K-81-4	User's Guide: Computer Program for Design and Analysis of Cast-in-Place Tunnel Linings (NEWTUN)	Mar 1981
Instruction Report K-81-6	User's Guide: Computer Program for Optimum Nonlinear Dynamic Design of Reinforced Concrete Slabs Under Blast Loading (CBARCS)	Mar 1981
Instruction Report K-81-7	User's Guide: Computer Program for Design or Investigation of Orthogonal Culverts (CORTCUL)	Mar 1981
Instruction Report K-81-9	User's Guide: Computer Program for Three-Dimensional Analysis of Building Systems (CTABS80)	Aug 1981
Technical Report K-81-2	Theoretical Basis for CTABS80: A Computer Program for Three-Dimensional Analysis of Building Systems	Sep 1981
Instruction Report K-82-6	User's Guide: Computer Program for Analysis of Beam-Column Structures with Nonlinear Supports (CBEAMC)	Jun 1982

(Continued)

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	Title	Date
Instruction Report K-82-7	User's Guide: Computer Program for Bearing Capacity Analysis of Shallow Foundations (CBEAR)	Jun 1982
Instruction Report K-83-1	User's Guide: Computer Program with Interactive Graphics for Analysis of Plane Frame Structures (CFRAME)	Jan 1983
Instruction Report K-83-2	User's Guide: Computer Program for Generation of Engineering Geometry (SKETCH)	Jun 1983
Instruction Report K-83-5	User's Guide: Computer Program to Calculate Shear, Moment, and Thrust (CSMT) from Stress Results of a Two-Dimensional Finite Element Analysis	Jul 1983
Technical Report K-83-1	Basic Pile Group Behavior	Sep 1983
Technical Report K-83-3	Reference Manual: Computer Graphics Program for Generation of Engineering Geometry (SKETCH)	Sep 1983
Technical Report K-83-4	Case Study of Six Major General-Purpose Finite Element Programs	Oct 1983
Instruction Report K-84-2	User's Guide: Computer Program for Optimum Dynamic Design of Nonlinear Metal Plates Under Blast Loading (CSDOOR)	Jan 1984
Instruction Report K-84-7	User's Guide: Computer Program for Determining Induced Stresses and Consolidation Settlements (CSETT)	Aug 1984
Instruction Report K-84-8	Seepage Analysis of Confined Flow Problems by the Method of Fragments (CFRAG)	Sep 1984
Instruction Report K-84-11	User's Guide for Computer Program CGFAG, Concrete General Flexure Analysis with Graphics	Sep 1984
Technical Report K-84-3	Computer-Aided Drafting and Design for Corps Structural Engineers	Oct 1984
Technical Report ATC-86-5	Decision Logic Table Formulation of ACI 318-77, Building Code Requirements for Reinforced Concrete for Automated Constraint Processing, Volumes I and II	Jun 1986
Technical Report ITL-87-2	A Case Committee Study of Finite Element Analysis of Concrete Flat Slabs	Jan 1987
Instruction Report ITL-87-1	User's Guide: Computer Program for Two-Dimensional Analysis of U-Frame Structures (CUFRAM)	Apr 1987
Instruction Report ITL-87-2	User's Guide: For Concrete Strength Investigation and Design (CASTR) in Accordance with ACI 318-83	May 1987
Technical Report ITL-87-6	Finite-Element Method Package for Solving Steady-State Seepage Problems	May 1987
Instruction Report ITL-87-3	User's Guide: A Three Dimensional Stability Analysis/Design Program (3DSAD) Module	Jun 1987
	Report 1: Revision 1: General Geometry	Jun 1987
	Report 2: General Loads Module	Sep 1989
	Report 6: Free-Body Module	Sep 1989

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(Continued)

	Title	Date
Instruction Report ITL-87-4	User's Guide: 2-D Frame Analysis Link Program (LINK2D)	Jun 1987
Technical Report ITL-87-4	Finite Element Studies of a Horizontally Framed Miter Gate Report 1: Initial and Refined Finite Element Models (Phases A, B, and C), Volumes I and II Report 2: Simplified Frame Model (Phase D) Report 3: Alternate Configuration Miter Gate Finite Element Studies—Open Section Report 4: Alternate Configuration Miter Gate Finite Element Studies—Closed Sections Report 5: Alternate Configuration Miter Gate Finite Element Studies—Additional Closed Sections Report 6: Elastic Buckling of Girders in Horizontally Framed Miter Gates Report 7: Application and Summary	Aug 1987
Instruction Report GL-87-1	User's Guide: UTEXAS2 Slope-Stability Package; Volume I, User's Manual	Aug 1987
Instruction Report ITL-87-5	Sliding Stability of Concrete Structures (CSLIDE)	Oct 1987
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