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COMPUTER AIDED STRUCTURAL
ENGINEERING (CASE) PROJECT

INSTRUCTION REPORT ITL-92-3

CONCEPT DESIGN EXAMPLE, COMPUTER AIDED
STRUCTURAL MODELING (CASM)

Report 2

SCHEME B

by

David Wickersheimer, Gene McDermott, Carl Roth

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

and

Michael E. Page

Information Technology Laboratory

DEPARTMENT OF THE ARMY
Waterways Experiment Station, Corps of Engineers
3909 Halls Ferry Road, Vicksburg, Mississippi 39180-6199



June 1992

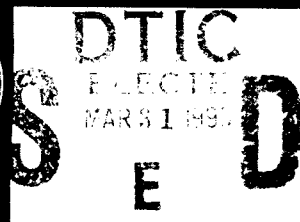
Report 2 of a Series

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93-06501



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B

All Steel, Composite,
Lateral Load Resistance = X Braced Frames

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for

Scheme B

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Preface

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

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

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

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

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

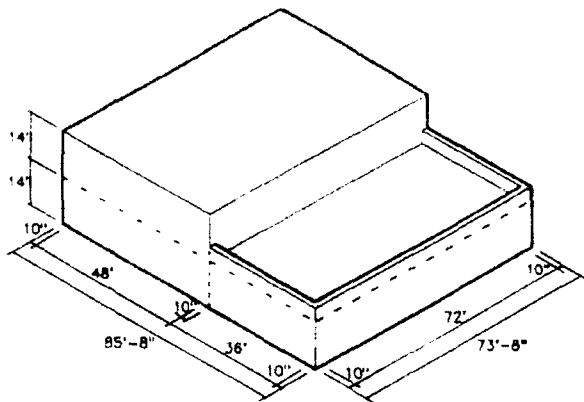
The computer program was written by Messrs. David Wickersheimer, Gene McDermott, and Carl Roth of Wickersheimer Engineers, Inc.

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

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

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

Project Description



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

- (a) Charleston, South Carolina
- (b) Radford AAP, Virginia

Soil conditions are unknown at both sites.

The following project criteria has been established:

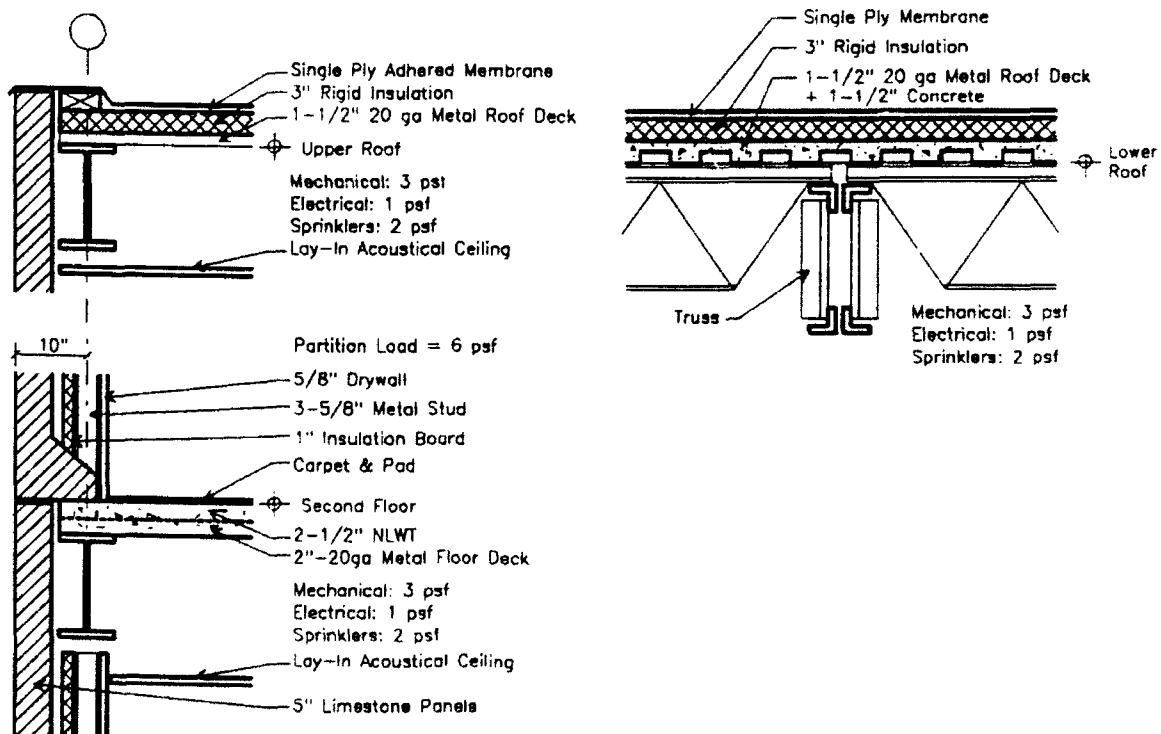
1. The 36' x 72' space on the first level shall be column free for open office planning.
2. The 48' x 72' first and second floor areas shall provide 24' square bays.
3. The first floor shall be a slab on grade with the tops of perimeter continuous wall footings set at 2'-6" below grade. Column footings will be isolated spread footings.
4. The second floor occupancy live loads located on the plan are:

Offices:	50 psf
File Storage:	150 psf
Corridor, Stair & Lobby:	100 psf
5. Structural framing schemes to be designed and compared shall be as follows:

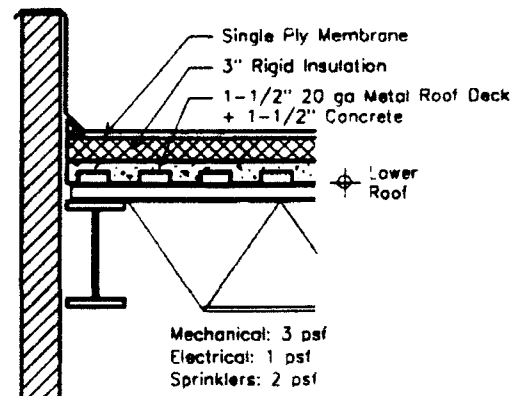
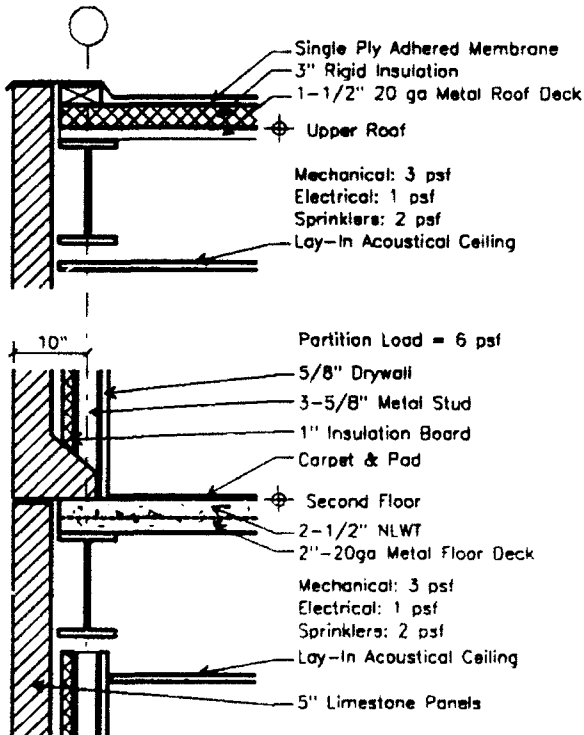
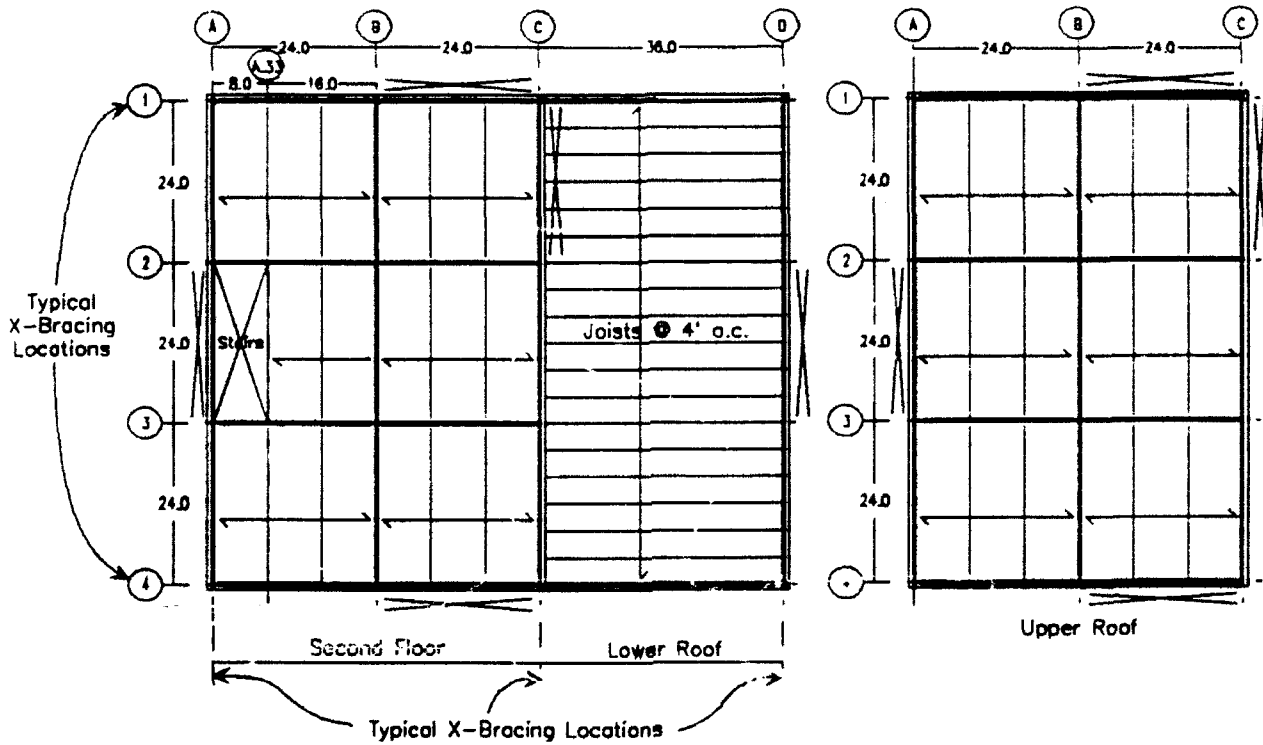
Scheme A: All steel, non-composite,
lateral load resistance = rigid frames.

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

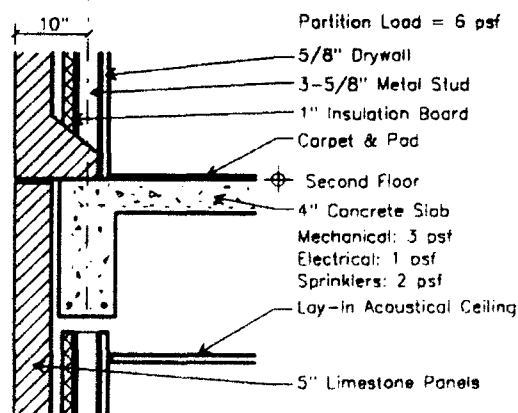
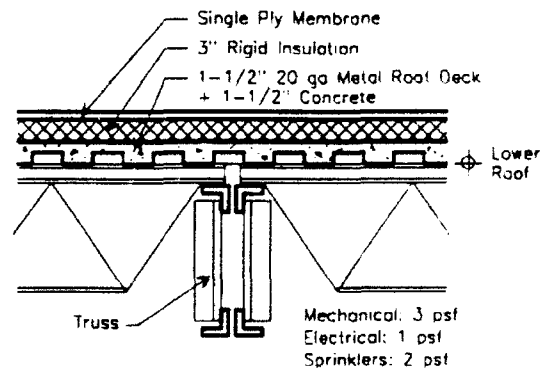
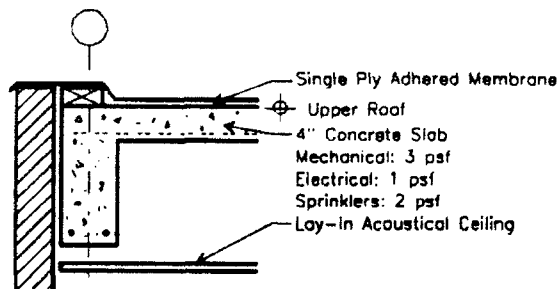
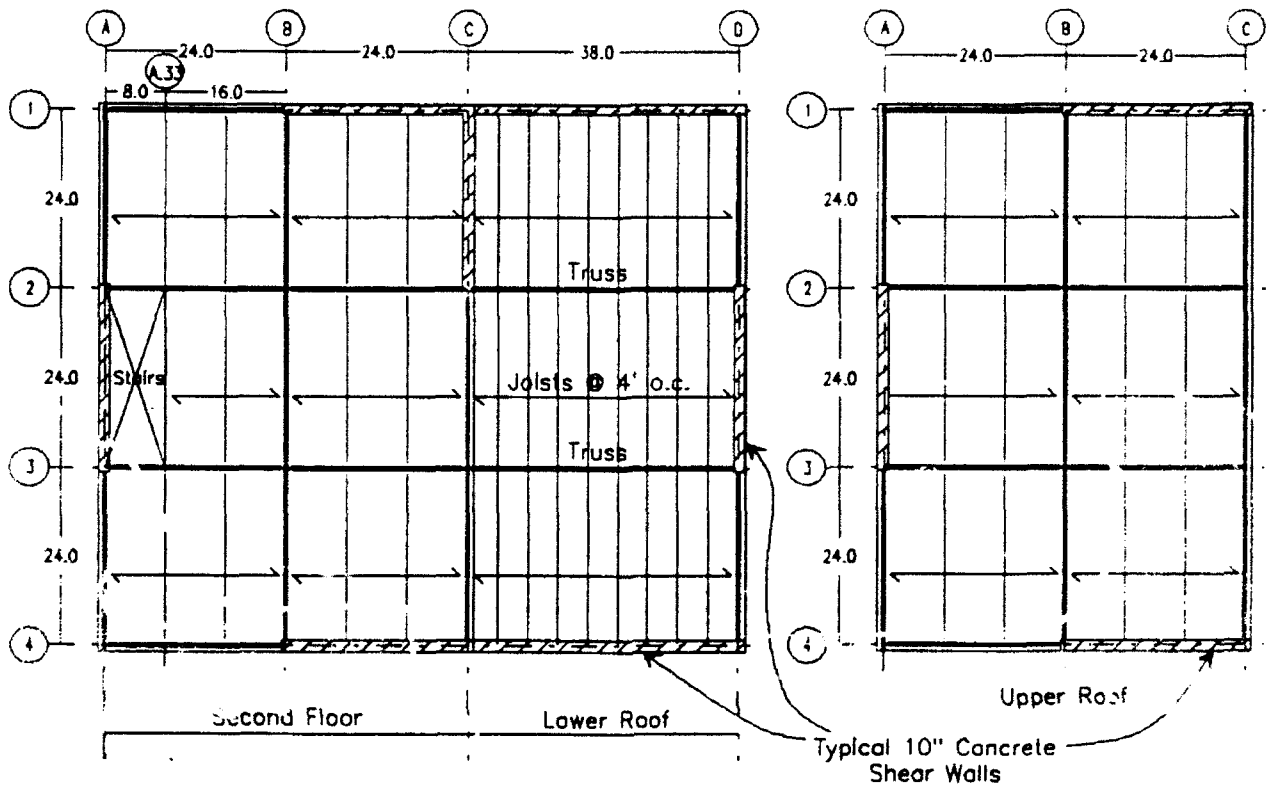
Scheme C: Monolithic concrete for two story portion, steel for lower roof portion,
lateral load resistance = shear walls.



Scheme B



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:

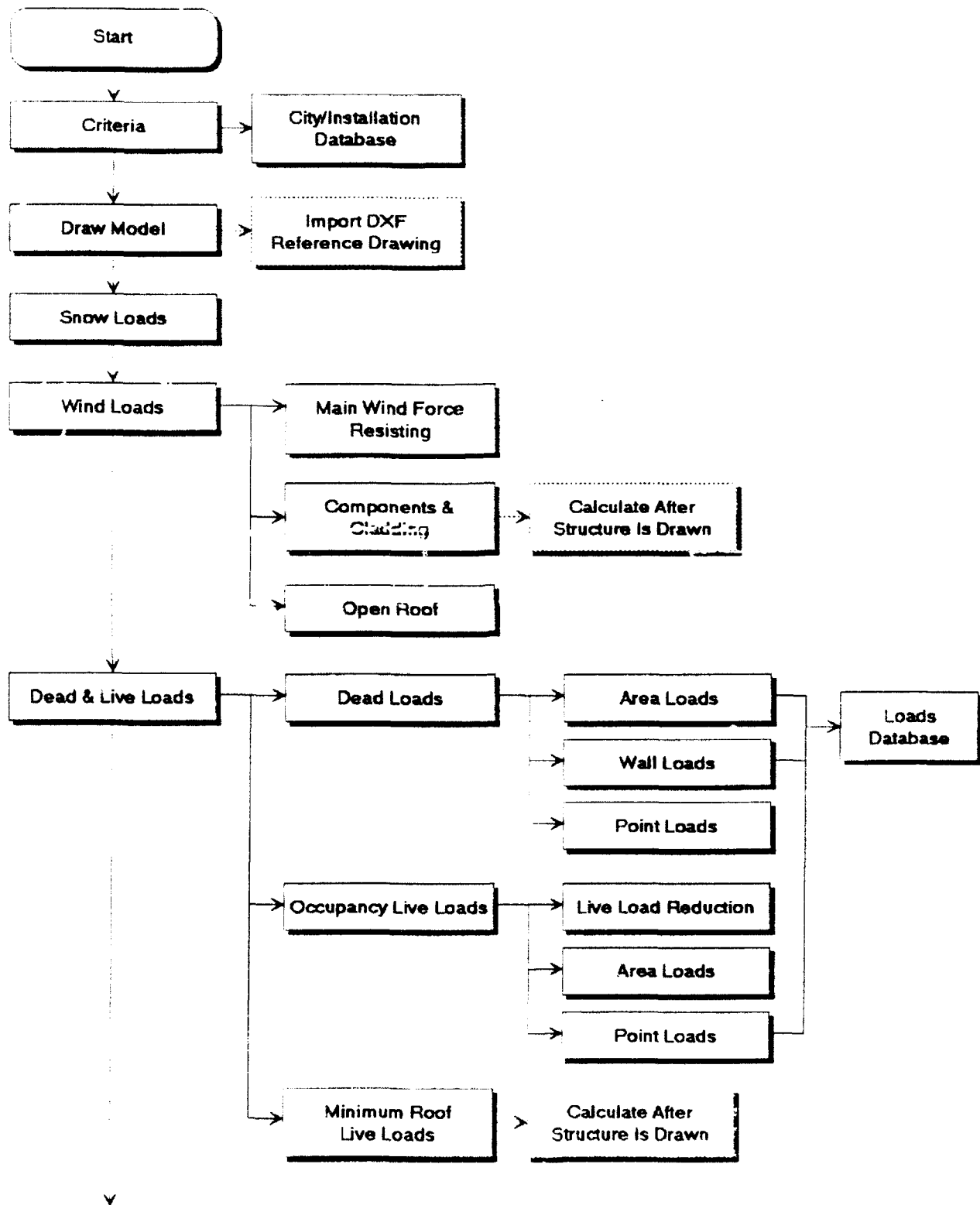
	Importance Category	Exposure Category
Snow:	I	C
Wind:	I	C
Seismic:	IV	

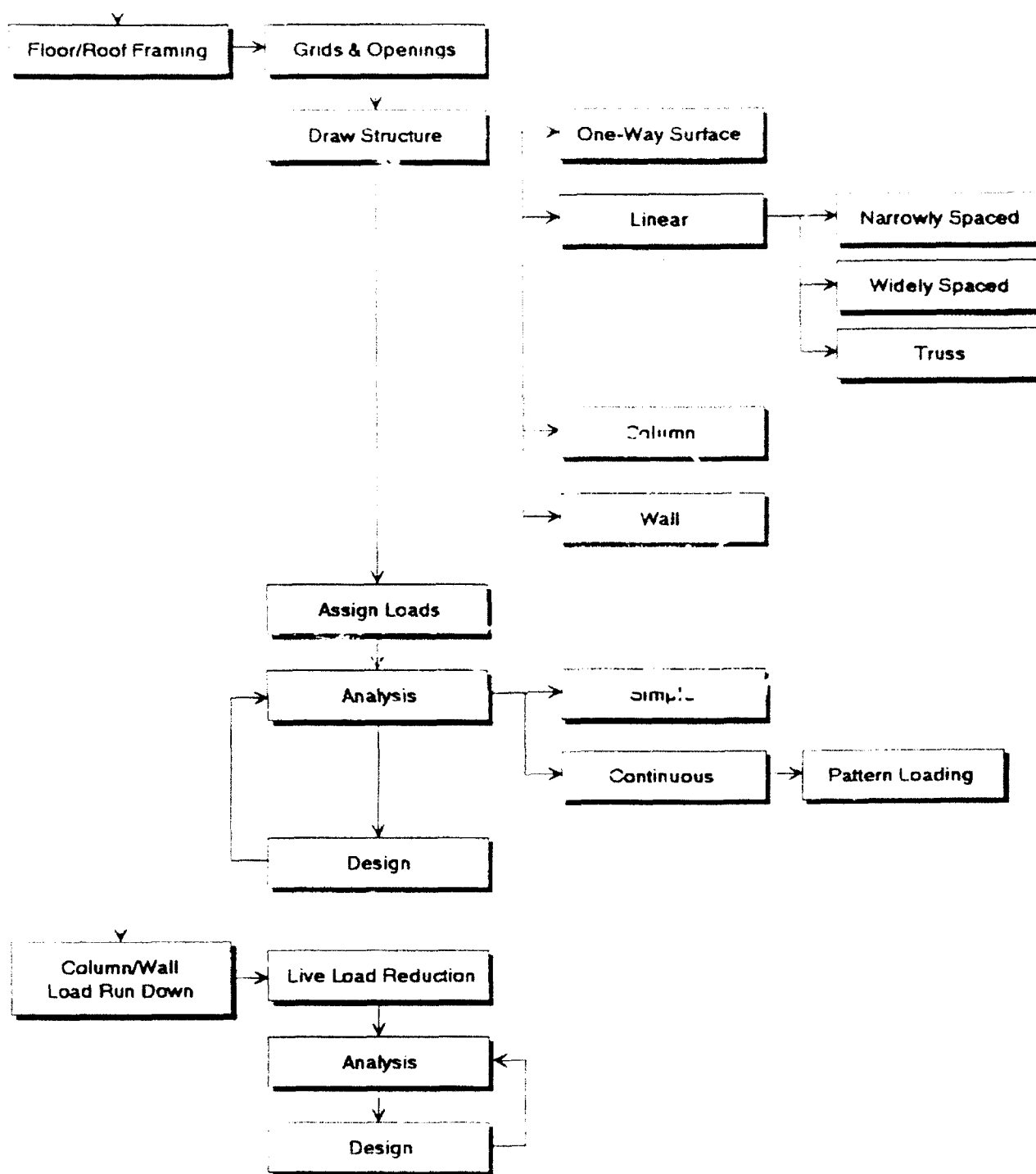
9. Material Assumptions:

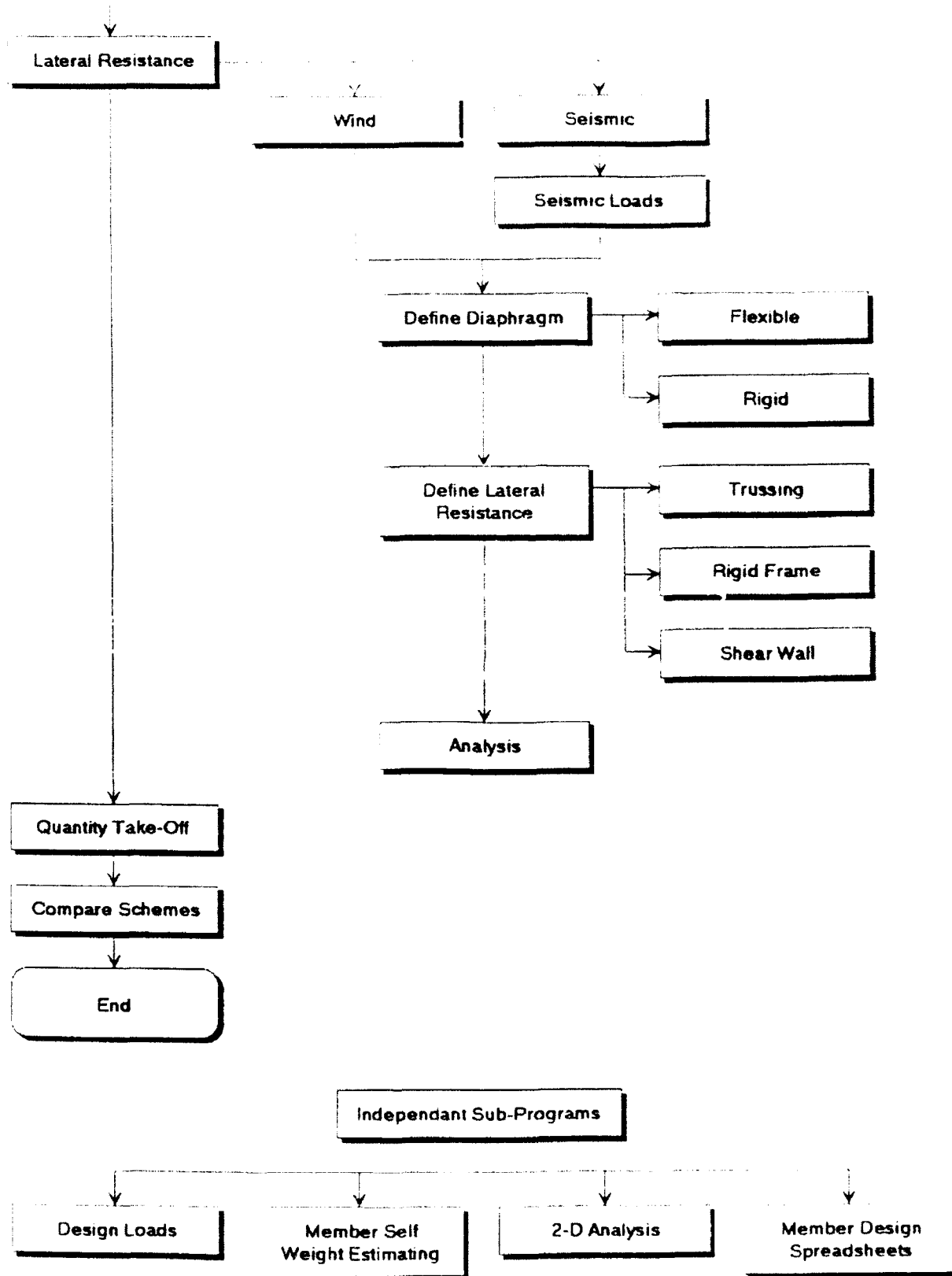
Concrete:	4,000 psi, NLWT
	Steel Reinforcing: Grade 60
Steel:	A36

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

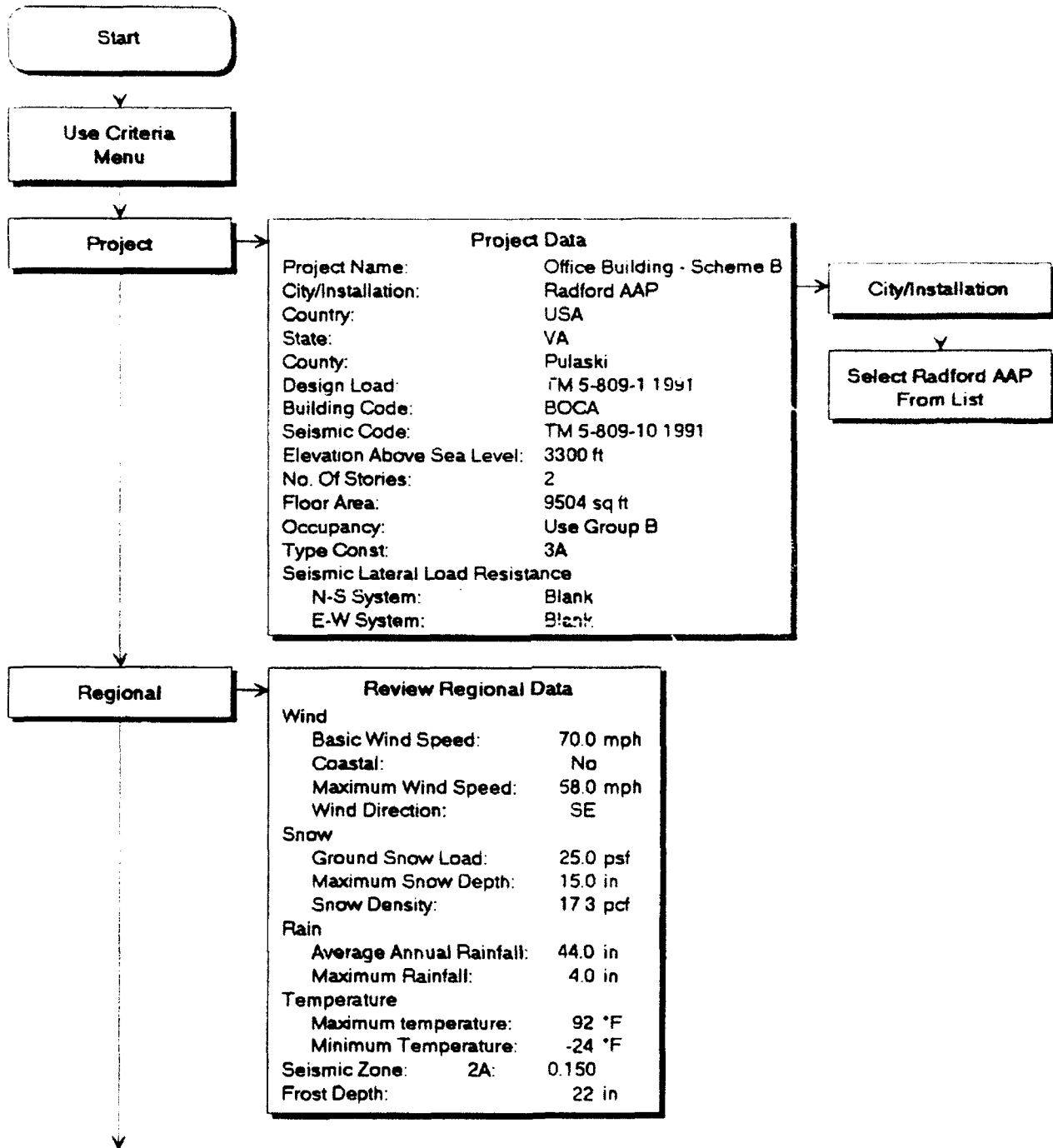
Computer Aided Structural Modeling

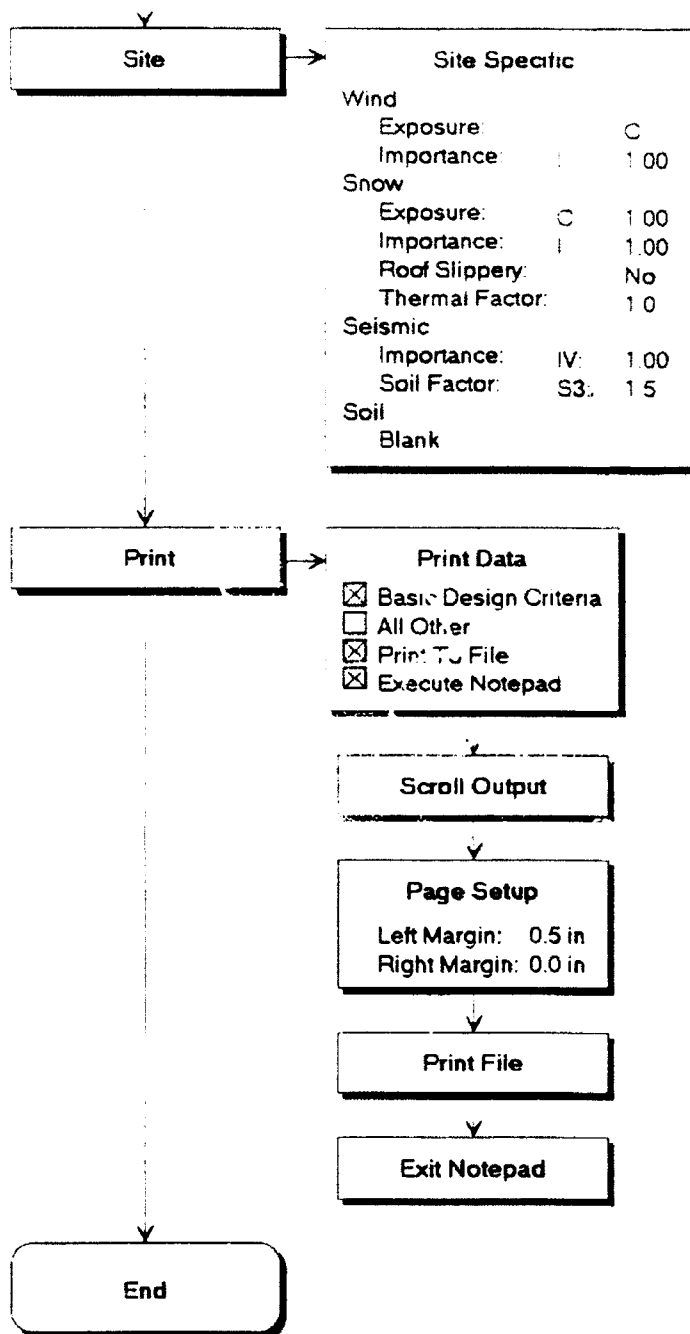






Criteria





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 1991
 Building Code : BOCA
 Seismic Code : TM 5-809-10 1991
 Elevation above sea level : 1300 ft.
 No. of Stories : 2
 Floor Area : 9504 sqft.
 Occupancy : Use Group B
 Type of Construction : 3A
 Seismic Lateral Load Resistance
 N-S System :
 N-S Rw : 0
 E-W System :
 E-W Rw : 0

Regional Data

Wind

Basic Wind Speed : 70.0 mph
 Coastal : No
 Maximum Wind Speed : 58.0 mph
 Wind Direction : SE

Snow

Ground Snow Load : 25.0 psf
 Maximum Snow Depth : 15.0 in.
 Snow Density : 17.3 pcf

Rain

Average Annual Rainfall : 44.0 in.
 Maximum Rainfall : 4.0 in.

Temperature

Maximum Temperature : 92.0 deg F
 Minimum Temperature : -24.0 deg F

Seismic Zone : 2A

0.150

Frost Depth

22 in.

Site Specific Data

Wind

Exposure : C
 Importance : I : 1.00

Snow

Exposure : C : 1.00
 Importance : I : 1.00
 Roof Smooth : No
 Thermal Factor : 1.0

Seismic

Importance : IV : 1.00
 Soil Factor : S3 : 1.5

Notes

Importance Factor for Snow and Wind:

- I All buildings and structures except those listed below.
- II Buildings and structures where primary occupancy is one in which more than 300 people congregate in one area.
- III Buildings and structures designated as essential facilities, including, but not limited to:
 - Hospital and other medical facilities having surgery or emergency treatment areas.
 - Fire or rescue and police stations.
 - Primary communication facilities and disaster operation centers.
 - Power stations and other utilities required in an emergency.
 - Structures having critical national defense capabilities.

Criteria

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

Wind Exposure Category:

Exposure C:

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

Snow Exposure Category:

Exposure C:

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

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

Snow Thermal Factor:

Heated Structure.

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

Importance Factor for Seismic:

I. Essential Facilities

Hospitals and other medical facilities having 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

IV. Standard Occupancy Structure

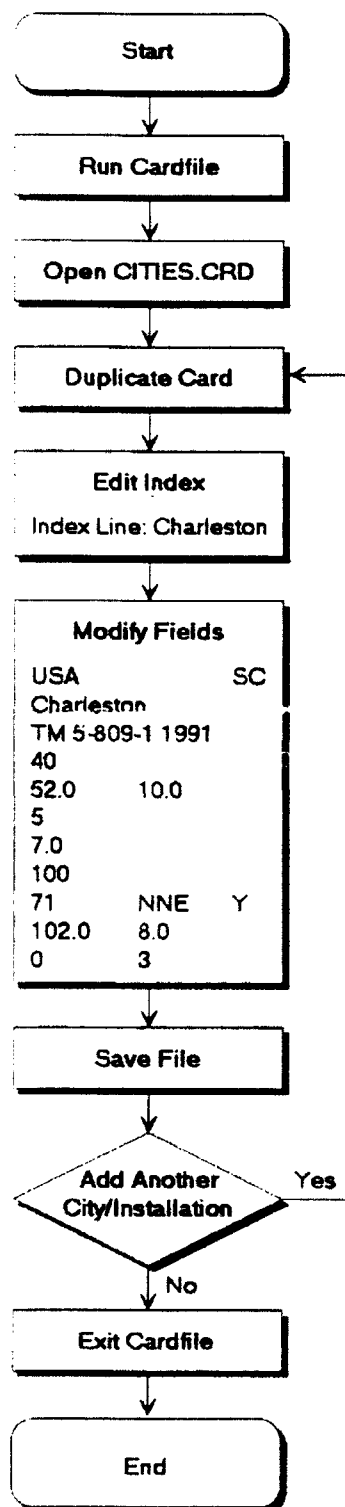
All Structures having occupancies or functions not listed above.

Seismic Soil Factor:

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

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

City/Installation Database



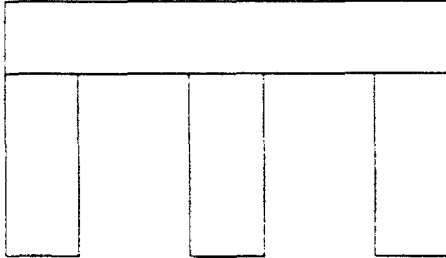
Fields			
Country		State	
County			
Design Load			
Elevation (ft)			
Ave. Rain (in)		Max. Rain (in)	
Ground Snow Load (psf)			
Max. Snow Depth (in)			
Basic Wind Speed (mph)			
Max. Wind Speed (mph)	Wind Direction	Coastal (Y/N)	
Max. Temp. (°F)	Min. Temp. (°F)		
Frost Depth (in)	Seismic Zone		

Modeling Philosophy

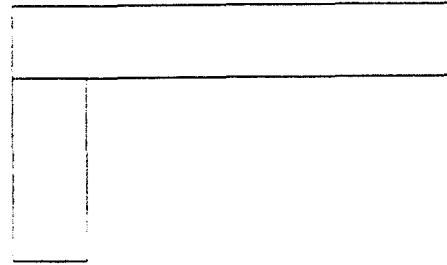
A. Simplify the geometric model

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

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



Extra wings are not necessary



Simplified model

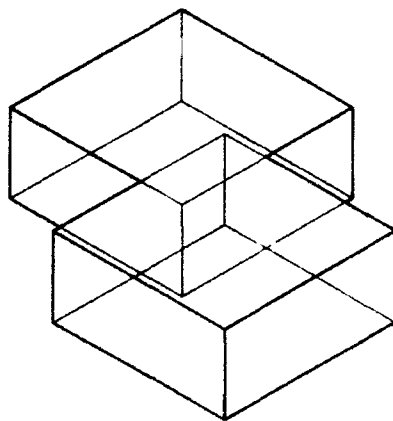
B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

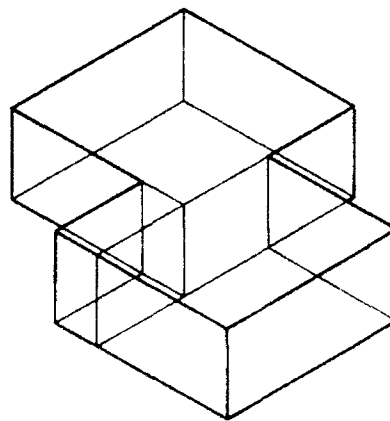
Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

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



Incorrect

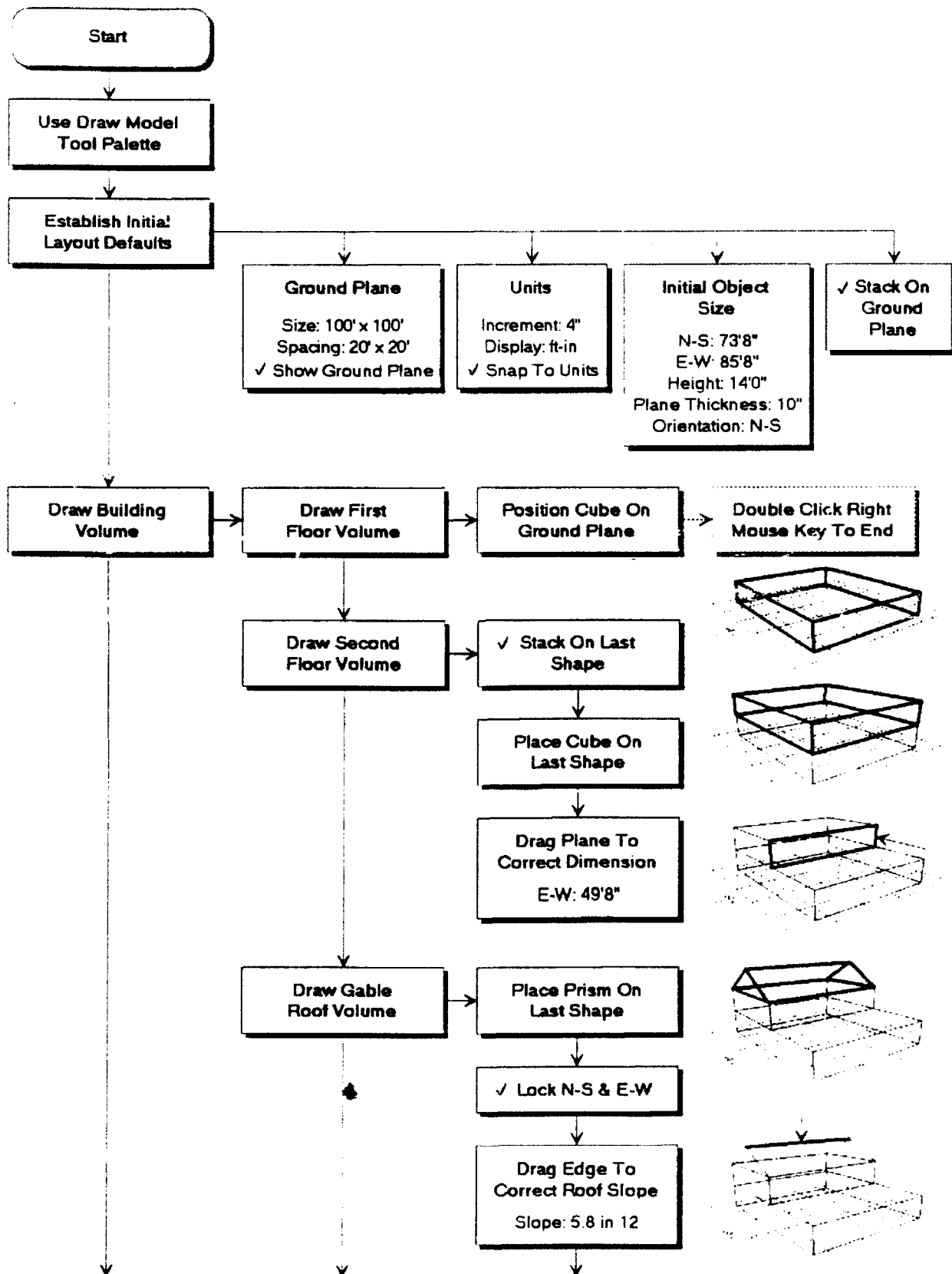


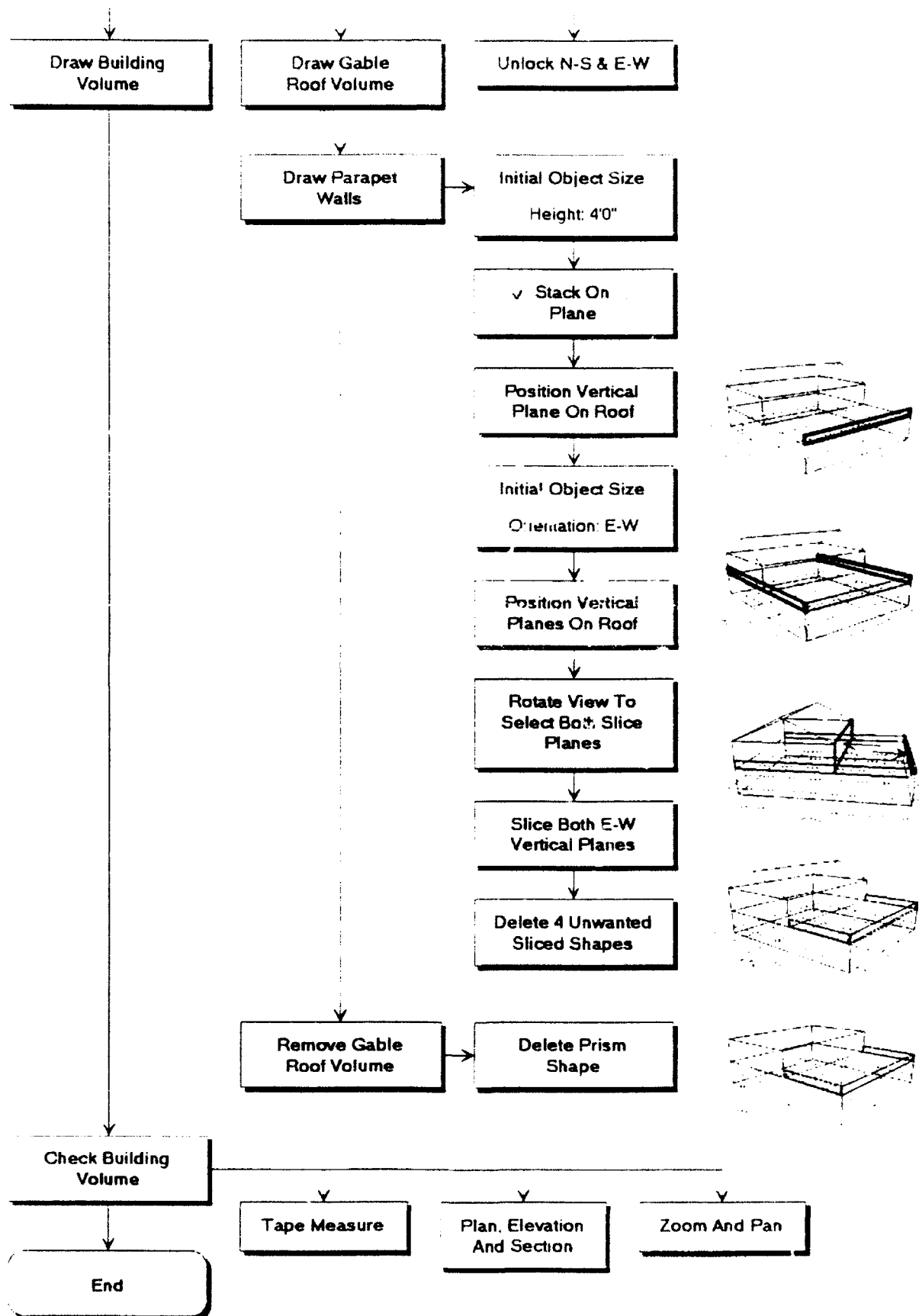
Correct

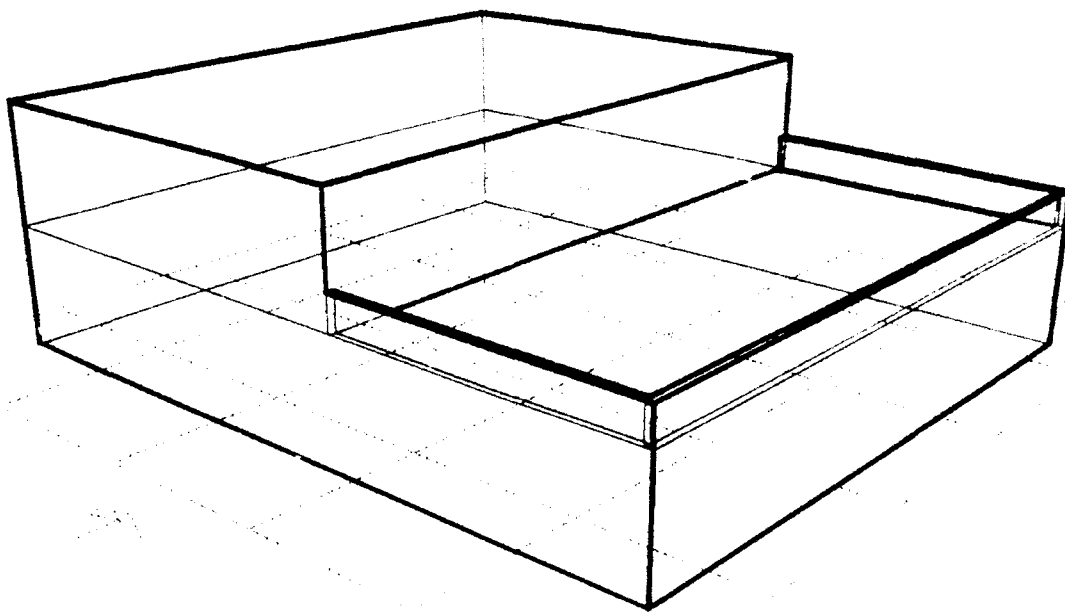
D. Verify the model

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

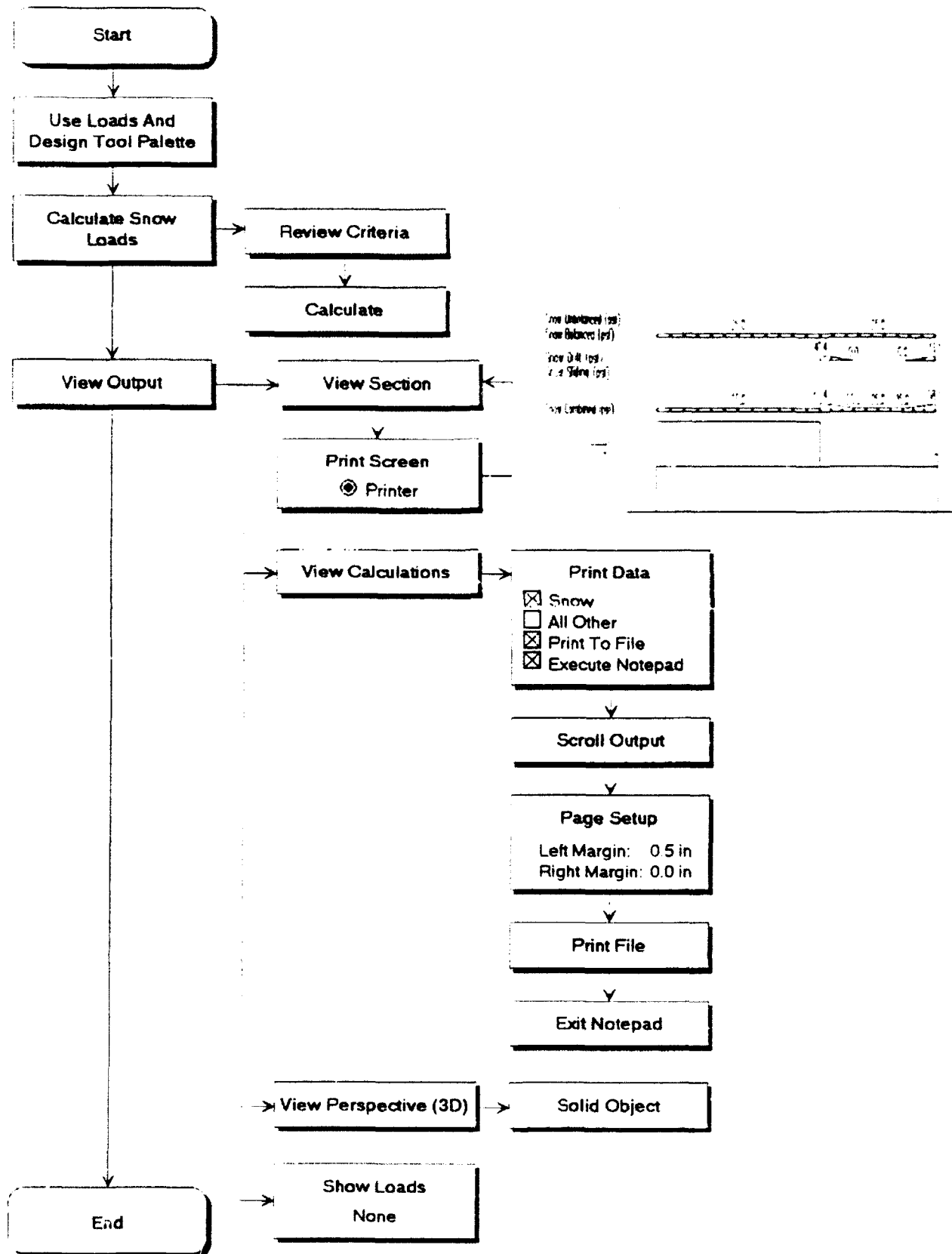
Draw Model







Snow Loads



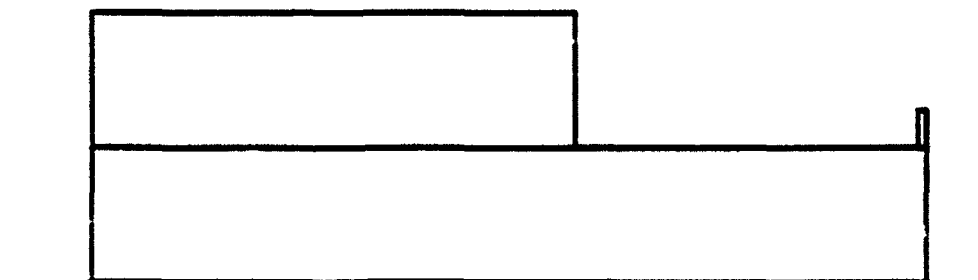
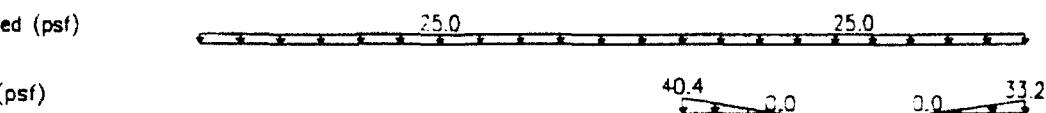
Snow Unbalanced (psf)

Snow Balanced (psf)

Snow Drift (psf)

Snow Sliding (psf)

Snow Combined (psf)



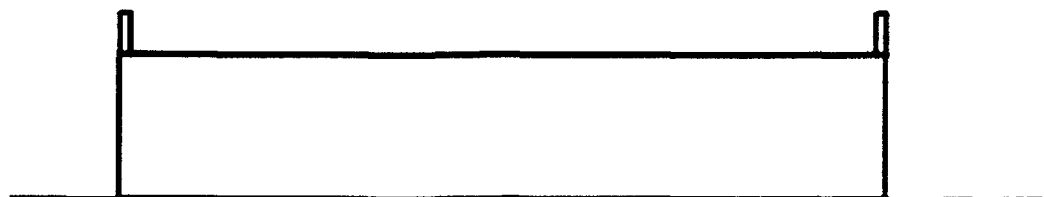
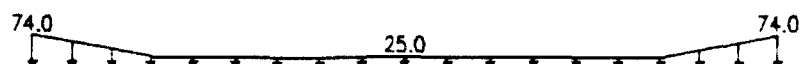
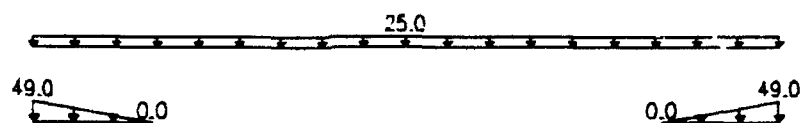
Snow Unbalanced (psf)

Snow Balanced (psf)

Snow Drift (psf)

Snow Sliding (psf)

Snow Combined (psf)



Snow Loads

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

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

Flat Roof Snow Load (Pf)
 $P_f = 0.7 \cdot C_e \cdot C_t \cdot I \cdot P_g$
Snow Exposure Category: C
 $C_e = 1.0$
Heated Structure.
 $C_t = 1.0$
Importance Category: I
 $I = 1.0$
 $P_g = 25.0 \text{ psf}$
 $P_f = 17.50 \text{ psf}$
Roof Slope: 0.00 in 12
 $\theta = 0 \text{ deg}$
Check minimum Pf where $\theta \leq 15 \text{ deg}$
When $P_g > 20.0 \text{ psf}$, min $P_f = 20 \cdot I$
Min $P_f = 20.00 \text{ psf}$
Since $\theta < 1/2 \text{ in/ft}$, 5 psf rain-on-snow surcharge applies.

-----+
| $P_f = 25.00 \text{ psf}$ |
-----+

Sloped Roof Snow Load (Ps)
 $P_s = C_s \cdot P_f$
Roof Slippery: No
 $C_s = 1.00$

-----+
| $P_s = 25.00 \text{ psf}$ |
-----+

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

$P_g = 25.0 \text{ psf}$
Snow Density = 17.25 pcf
 $P_s = 20.00 \text{ psf}$ (rain-on-snow surcharge not included)
 $h_b = P_s / \text{density}$
 $h_b = 1.16 \text{ ft}$
Projection Height = 4.00 ft
 $h_c = \text{height} - h_b$
 $h_c = 2.84 \text{ ft}$
 $h_c / h_b = 2.45 \geq 0.20$ Therefore consider drift load.
Importance Category: I

$I = 1.0$
Snow Exposure Category: C
 $C_e = 1.0$
Separation = 0.00 ft
 $l_u = 35.17 \text{ ft}$
 $h_d = 0.43 \cdot l_u^{1/3} \cdot (P_g + 10)^{1/4 - 1.5}$
 $h_d = 1.93 \text{ ft}$
Width of drift: W = minimum of $4 \cdot h_d$ or $4 \cdot h_c \geq 10 \text{ ft}$
 $w = 4 \cdot h_d = 7.71 \text{ ft}$
 $w = 4 \cdot h_c = 11.36 \text{ ft}$

-----+
| $W = 10.00 \text{ ft}$ |
-----+

$h_d = h_d \cdot (20 - s) / 20 = 1.93 \text{ ft}$
 $h_d \leq h_c$
 $P_d = h_d \cdot \text{density}$

-----+
| $P_d = 33.23 \text{ psf}$ |
-----+

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

$P_g = 25.0 \text{ psf}$
 Snow Density = 17.25 pcf
 $P_s = 20.00 \text{ psf}$ (rain-on-snow surcharge not included)
 $h_b = P_s / \text{density}$
 $h_b = 1.16 \text{ ft}$
 Projection Height = 4.00 ft
 $h_c = \text{height} - h_b$
 $h_c = 2.84 \text{ ft}$
 $h_c / h_b = 2.45 \geq 0.20$ Therefore consider drift load.
 Importance Category: I
 $I = 1.0$
 Snow Exposure Category: C
 $C_e = 1.0$
 Separation = 0.00 ft
 $l_u = 72.00 \text{ ft}$
 $h_d = 0.43 \cdot l_u^{1/3} \cdot (P_g + 10)^{1/4 - 1.5}$
 $h_d = 2.85 \text{ ft}$
 Width of drift: $W = \text{minimum of } 4 \cdot h_d \text{ or } 4 \cdot h_c \geq 10 \text{ ft}$
 $w = 4 \cdot h_d = 11.40 \text{ ft}$
 $w = 4 \cdot h_c = 11.36 \text{ ft}$

+-----+
 | $W = 11.36 \text{ ft}$ |
 +-----+

$h_d = h_d \cdot (20 - s) / 20 = 2.85 \text{ ft}$
 $h_d > h_c$, therefore $h_d = h_c = 2.8 \text{ ft}$
 $h_d = h_d \cdot \text{density}$

+-----+
 | $P_d = 49.00 \text{ psf}$ |
 +-----+

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

$P_g = 25.0 \text{ psf}$
 Snow Density = 17.25 pcf
 $P_s = 20.00 \text{ psf}$ (rain-on-snow surcharge not included)
 $h_b = P_s / \text{density}$
 $h_b = 1.16 \text{ ft}$
 Projection Height = 14.00 ft
 $h_c = \text{height} - h_b$
 $h_c = 12.84 \text{ ft}$
 $h_c / h_b = 11.08 \geq 0.20$ Therefore consider drift load.
 Importance Category: I
 $I = 1.0$
 Snow Exposure Category: C
 $C_e = 1.0$
 Separation = 0.00 ft
 $l_u = 49.67 \text{ ft}$
 $h_d = 0.43 \cdot l_u^{1/3} \cdot (P_g + 10)^{1/4 - 1.5}$
 $h_d = 2.34 \text{ ft}$
 Width of drift: $W = \text{minimum of } 4 \cdot h_d \text{ or } 4 \cdot h_c \geq 10 \text{ ft}$
 $w = 4 \cdot h_d = 9.38 \text{ ft}$
 $w = 4 \cdot h_c = 51.36 \text{ ft}$

+-----+
 | $W = 10.00 \text{ ft}$ |
 +-----+

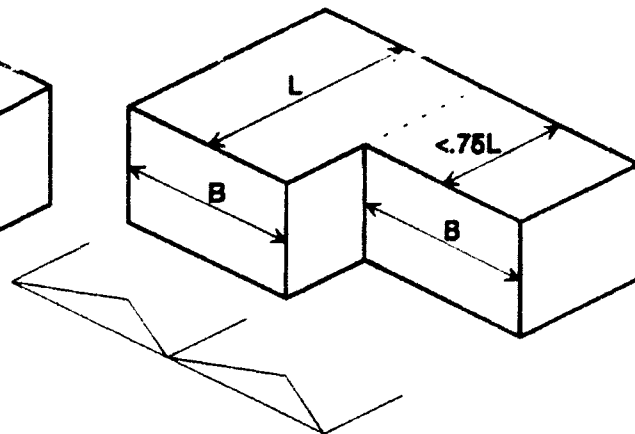
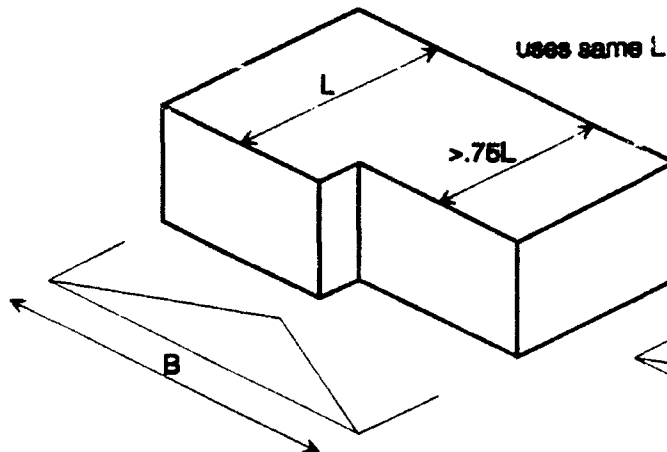
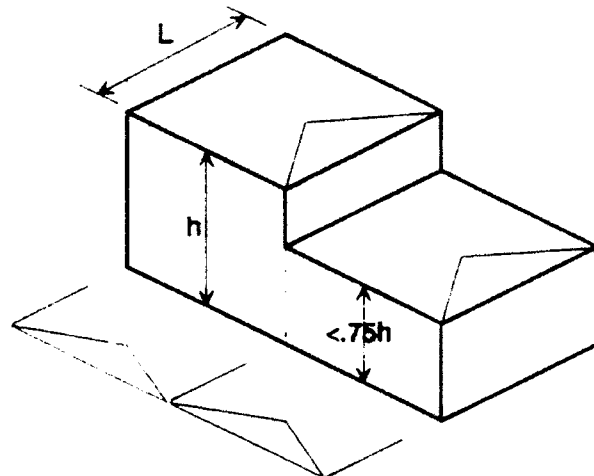
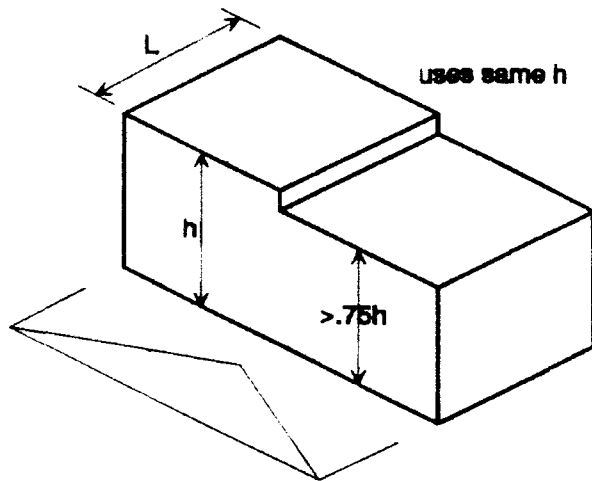
$h_d = h_d \cdot (20 - s) / 20 = 2.34 \text{ ft}$
 $h_d \leq h_c$
 $P_d = h_d \cdot \text{density}$

+-----+
 | $P_d = 40.44 \text{ psf}$ |
 +-----+

Wind Assumptions

Proportions For B/L & h/L

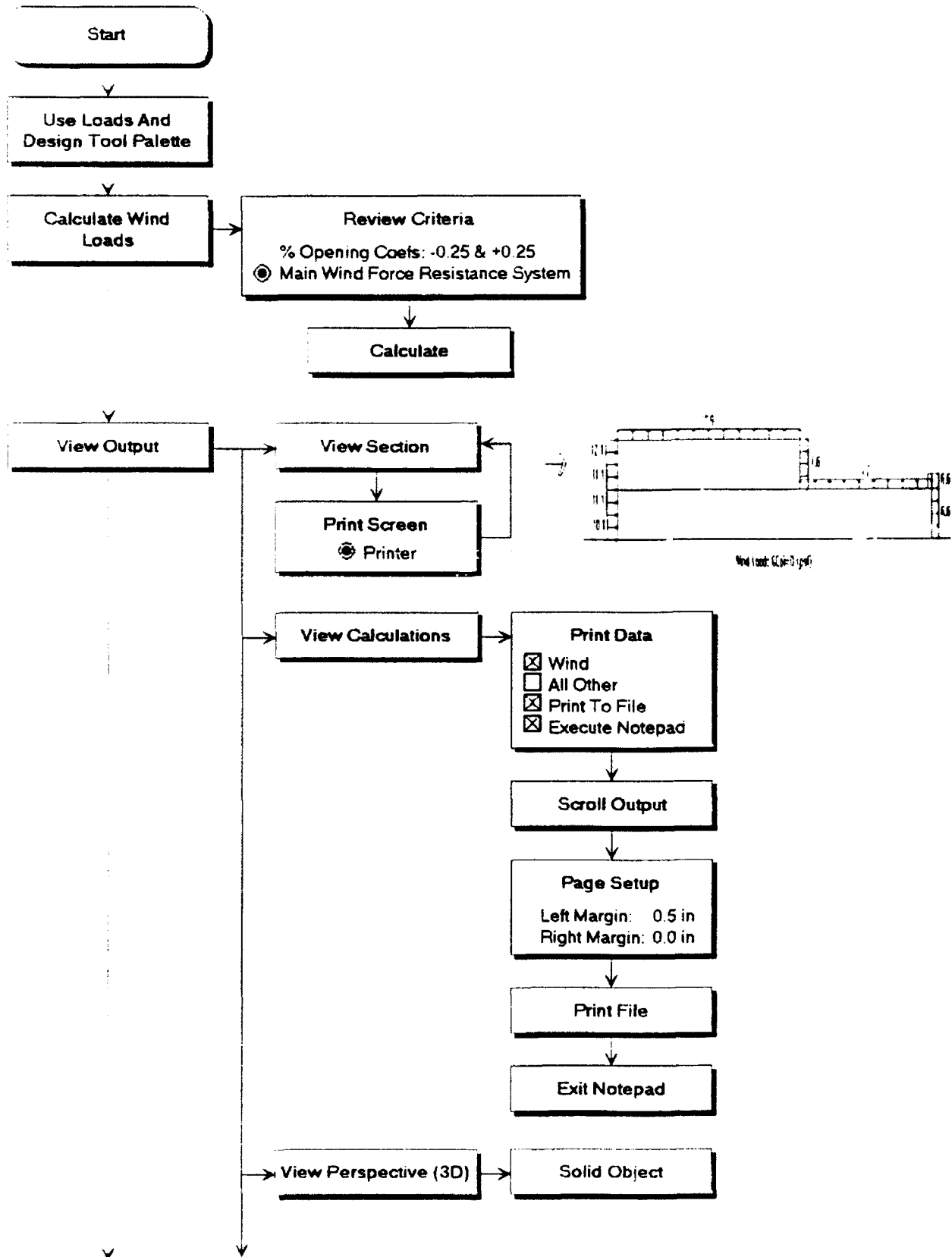
Defaults: Height Ratio: 0.75
Plan Ratio: 0.75



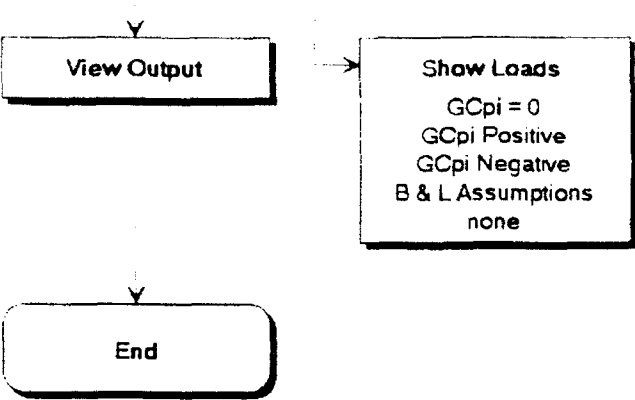
Building Height Maximum 60 Feet

Assumed for components and cladding

Main Wind Force Resisting Loads

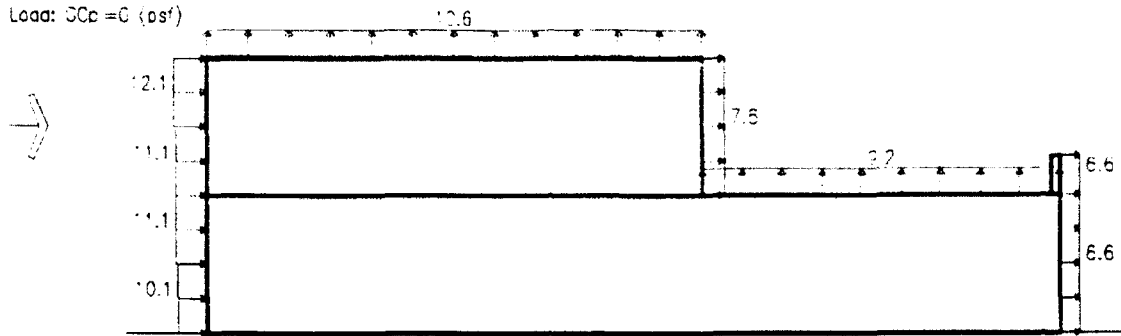


Main Wind Force Resisting Loads

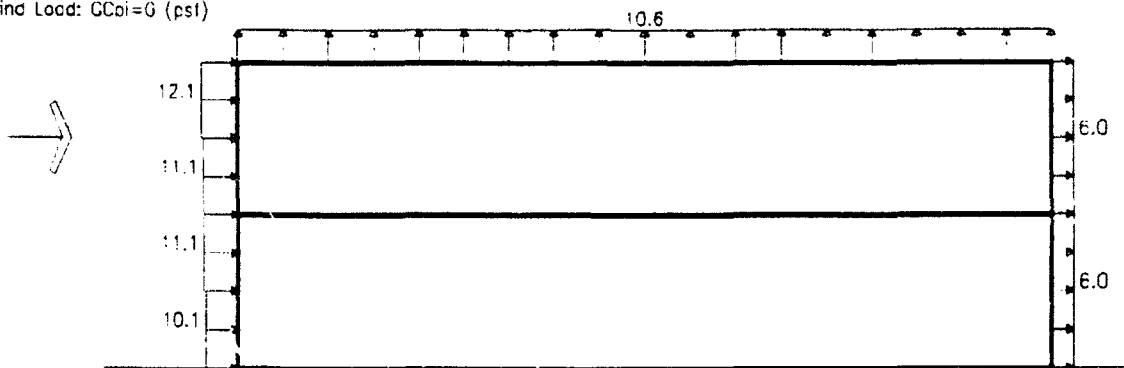


Main Wind Force Resisting Loads

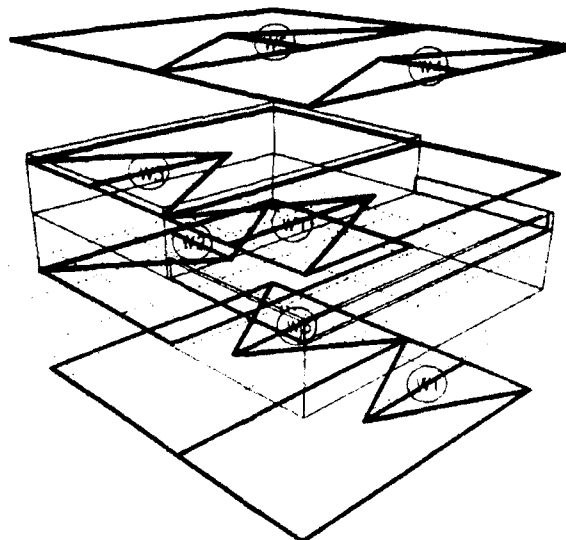
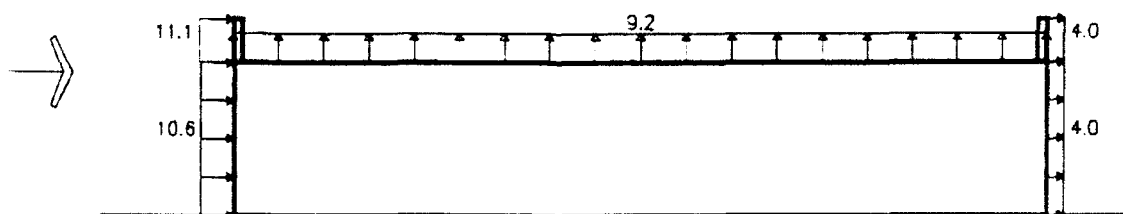
Wind Load: $GCp = 0$ (psf)



Wind Load: $GCp = 0$ (psf)



Wind Load: $GCp = 0$ (psf)



Main Wind Force Resisting Loads

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

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

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

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

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

Parallel to Ridge or Length

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

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

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

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

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

Parallel to Ridge or Length

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

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	49.7	33.7	

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
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

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

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

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

***** 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	22.0	1.32	0.89	11.2	0.80	11.8		
level 3	18.0	1.32	0.84	10.5	0.80	11.1	13.6	8.6
level 2 - 3	16.0	1.32	0.82	10.3	0.80	10.9	13.4	8.4
level 1 - 2	7.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
level 1	0.0	1.32	0.80	10.0	0.80	10.6	13.1	8.1
Leeward Wall	14.0	1.32	0.80	10.0	-0.50	-6.6	-4.1	-9.1
Side Wall	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Roof	14.0	1.32	0.80	10.0	-0.70	-9.2	-6.7	-11.7
Internal	14.0		0.80	10.0		0.0	-2.5	2.5

Main Wind Force Resisting Loads

..... Wind Load - 5

Velocity Factor (mph)	Importance Factor	Exposure Factor	Width	Length	Roof Type
			Perpend. to Wind (ft)	Parallel to Wind (ft)	
33.0	1.00	1	33.7	49.7	

Distance to ocean line ≥ 100 mi. $K_{zt} = 0.56 \leq 5$

..... Main Framing Pressures

Parallel to Ridge or Length

Location	z or h (ft)	Gh	Kz	qz (psf)	Cp	External Pressure P (psf) GCp1=0 -0.25 0.25		

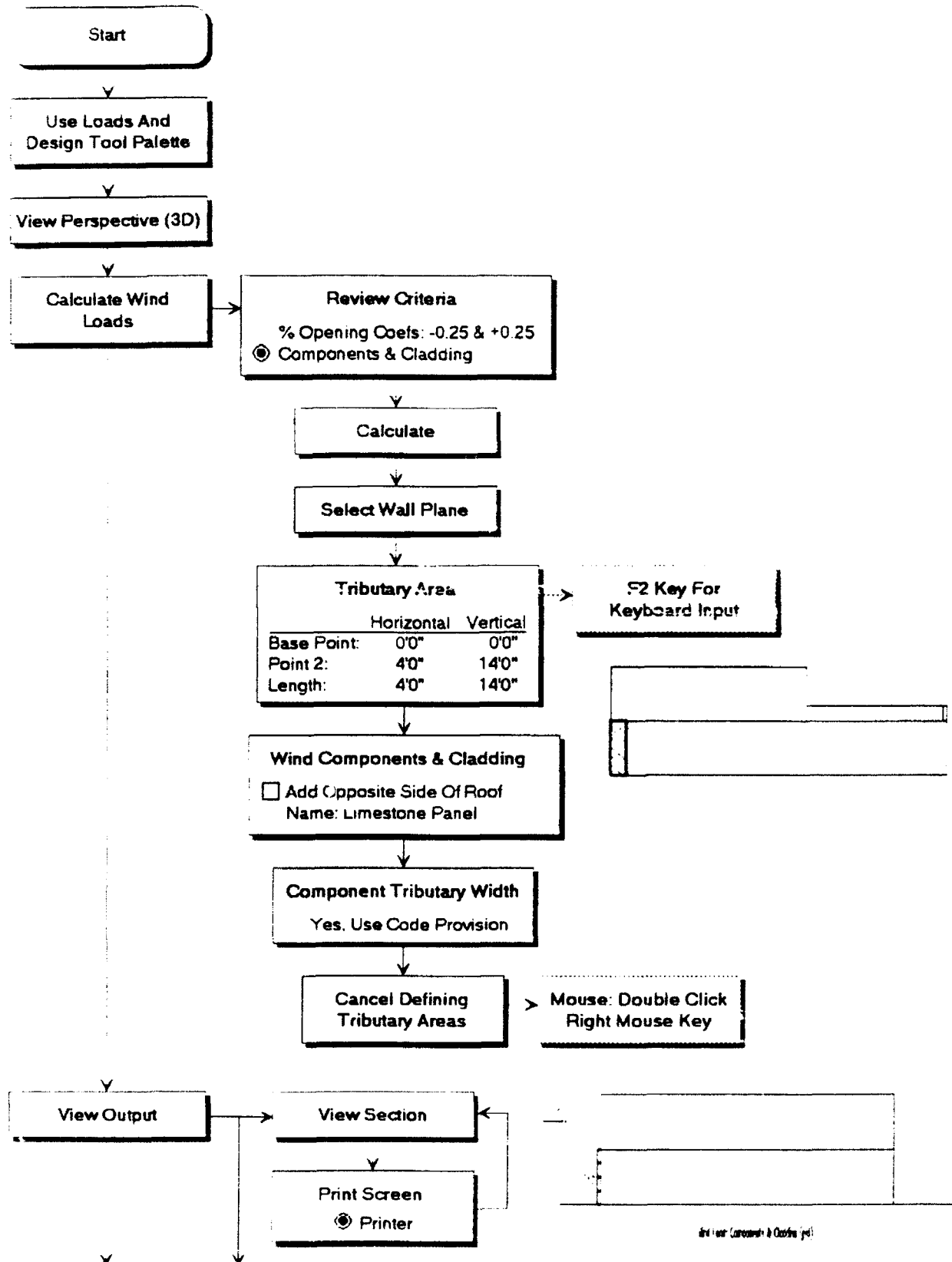
Windward Wall								
Level 2	28.0	1.26	0.96	12.0	0.80	12.1	15.1	9.1
Level 1 - 2	14.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Level 1	0.0	1.26	0.80	10.0	0.80	10.1	13.1	7.1
Leeward Wall	28.0	1.26	0.96	12.0	-0.50	-7.6	-4.6	-10.6
Side Wall	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Roof	28.0	1.26	0.96	12.0	-0.70	-10.6	-7.6	-13.6
Internal	28.0		0.96	12.0		0.0	-3.0	3.0

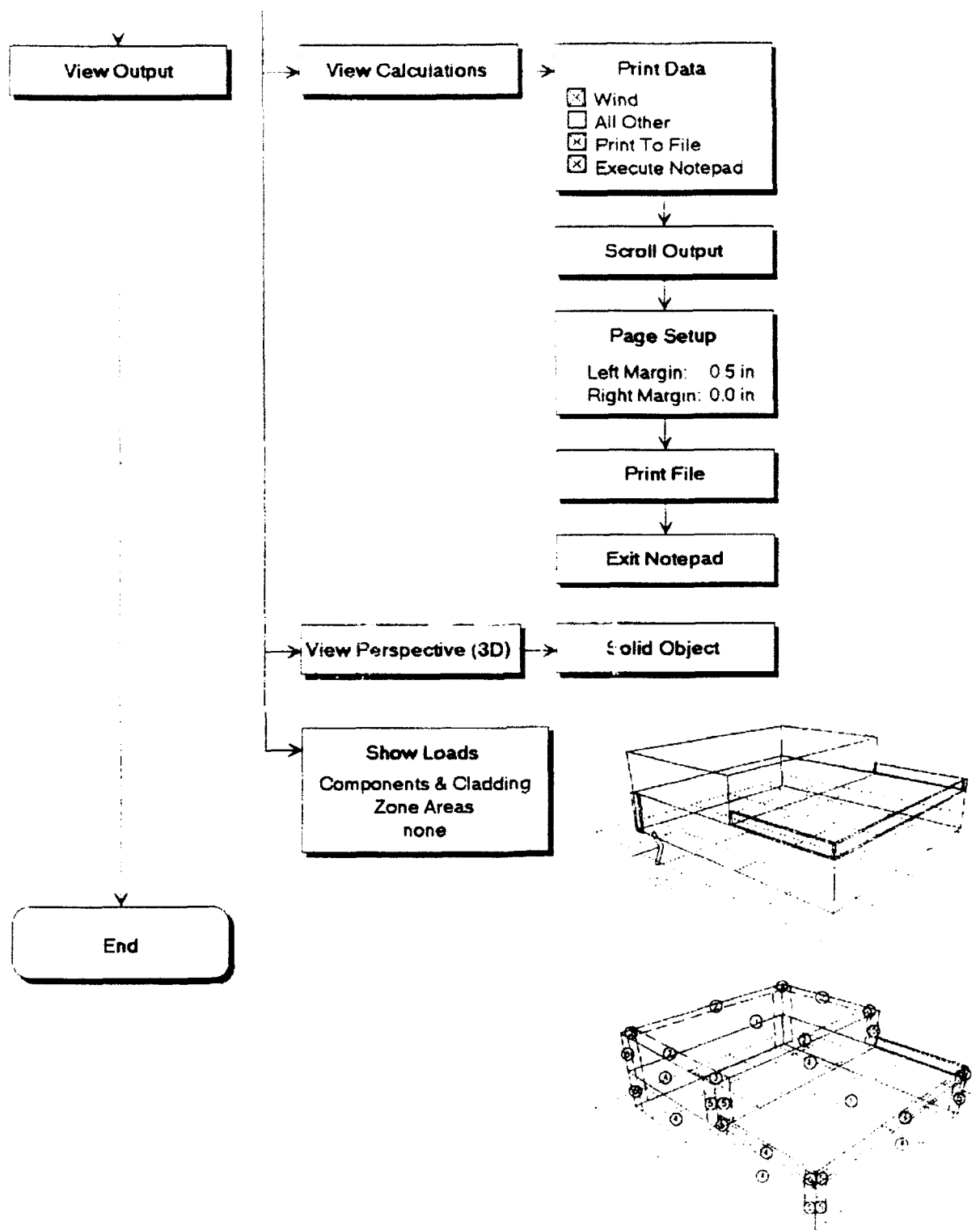
Notes for main framing:

Positive pressures act toward surfaces.

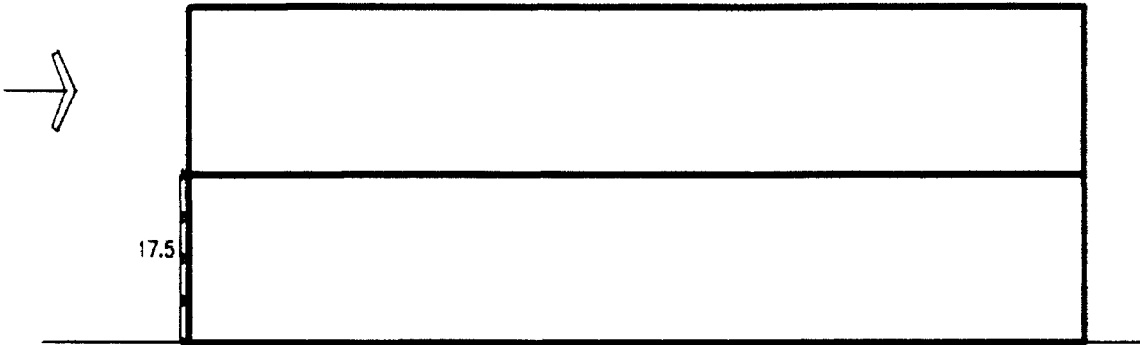
Pressure or suction = $P = qh \cdot Gh \cdot Cp - qh \cdot (GCp1)$

Wind Components & Cladding Loads

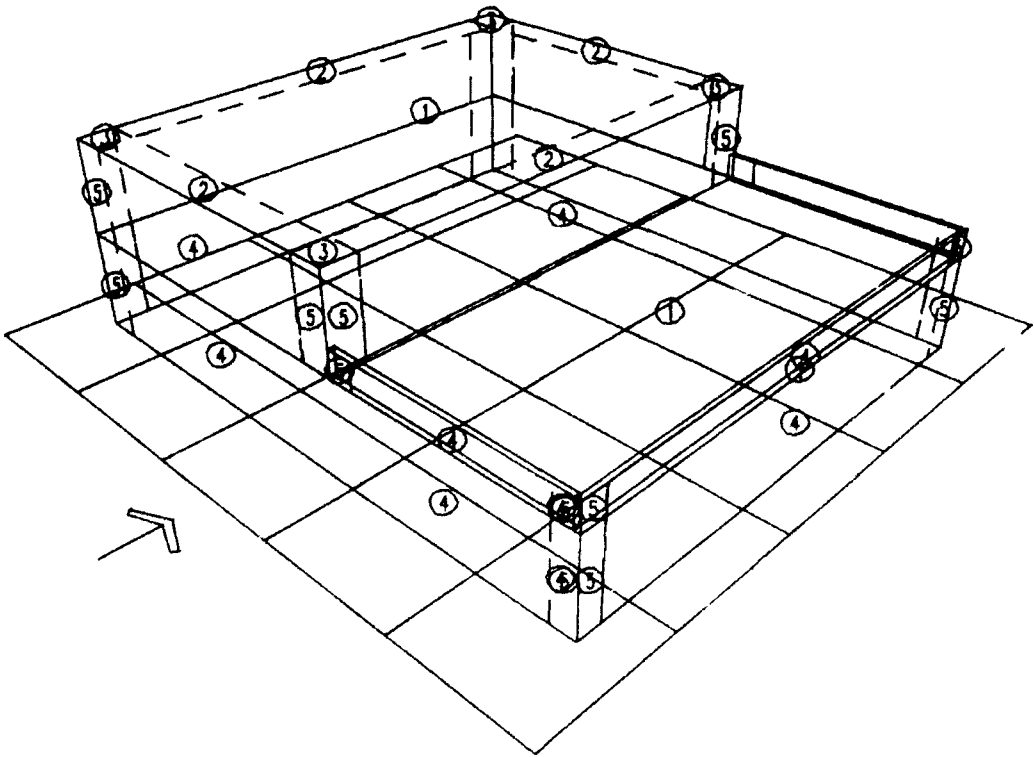
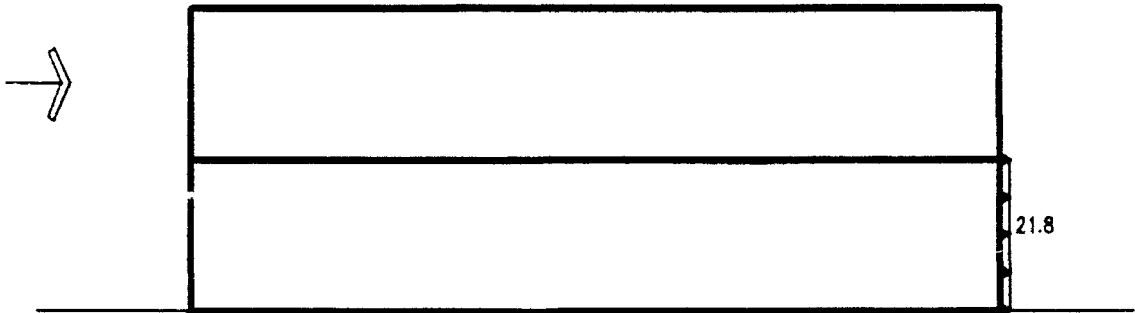




Wind Load: Components & Cladding (psf)



Wind Load: Components & Cladding (psf)



Wind Components & Cladding Loads

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

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

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

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

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

Height <= 60 ft

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

Tributary Area (sf)	Windward				Leeward			
	Zone 4		Zone 5		Zone 4		Zone 5	
	middles		corners		middle		corners	
	GCp	P	GCp	P	GCp	P	GCp	P
Internal		-3.0		-3.0		3.0		3.0
Limestone Panel	4.67 ft x 11.00 ft							
65.3	1.21	17.5	1.21	17.5	-1.31	-18.7	-1.57	-21.0
a = 5.0 ft								

Notes for components and cladding:

P = qh(GCp) - qh(GCp1)

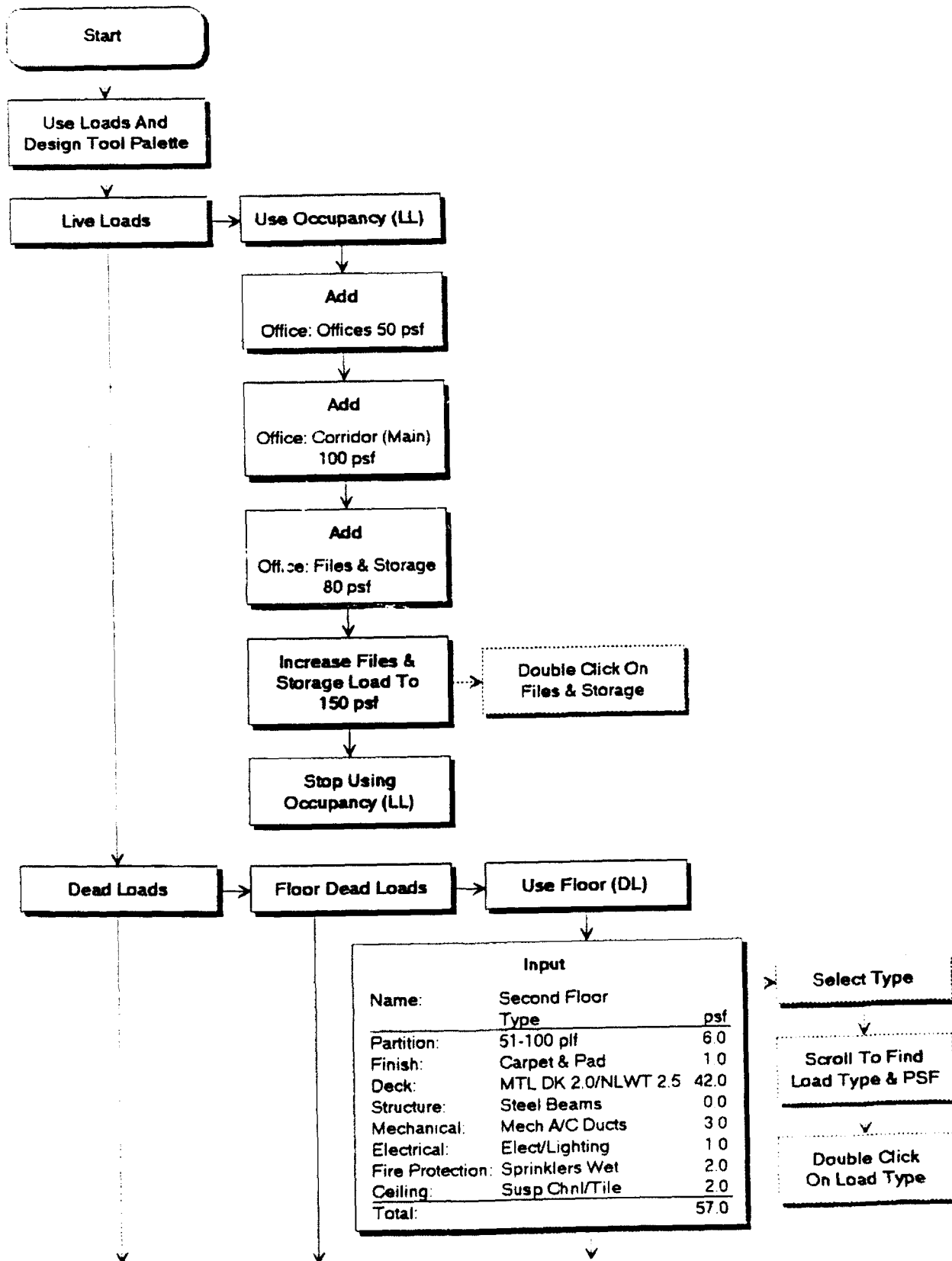
Internal pressures have been included in above values.

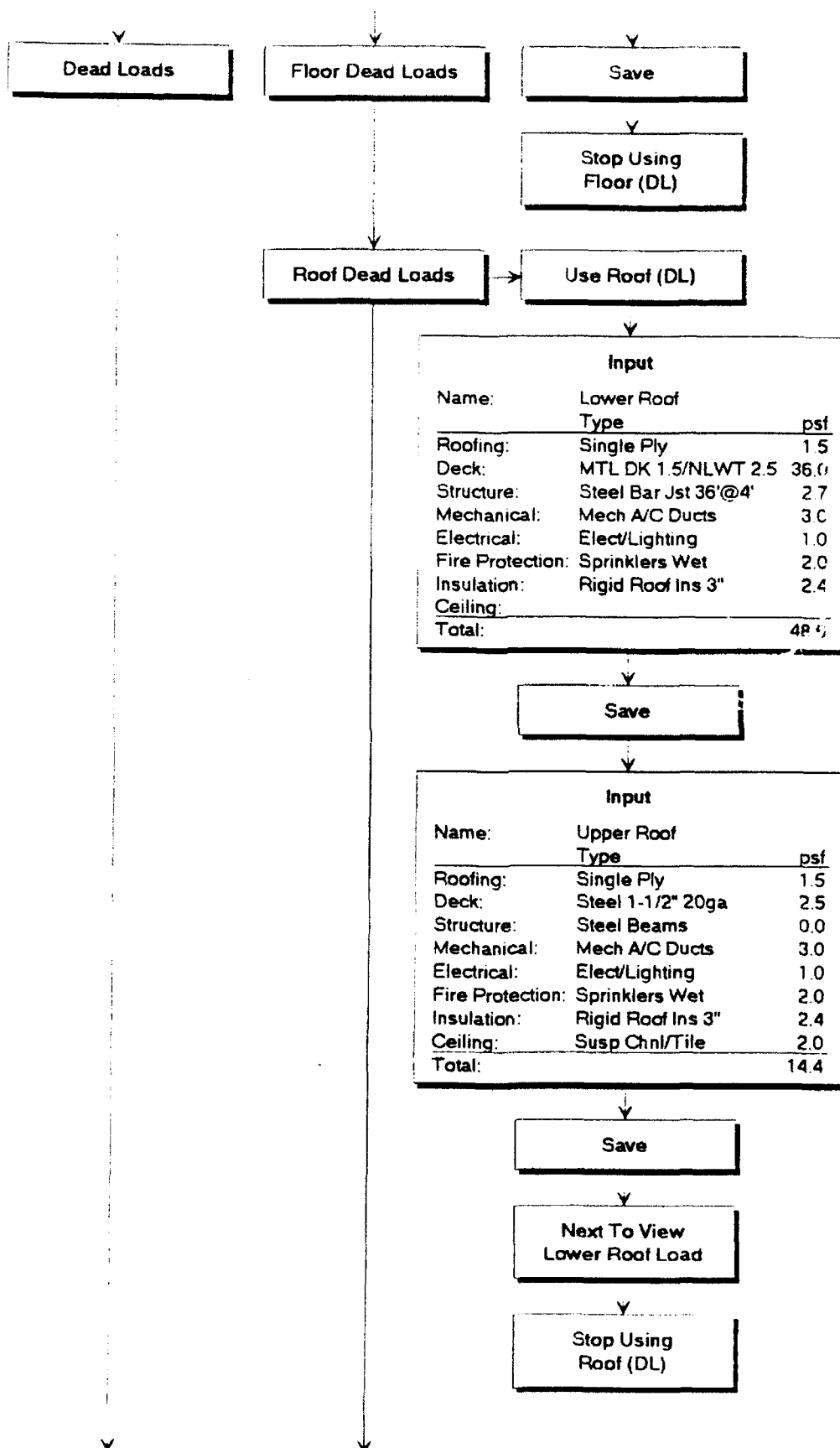
* For roof overhangs: algebraically add this pressure to the above values. P = qh(GCp) = 0.8qh

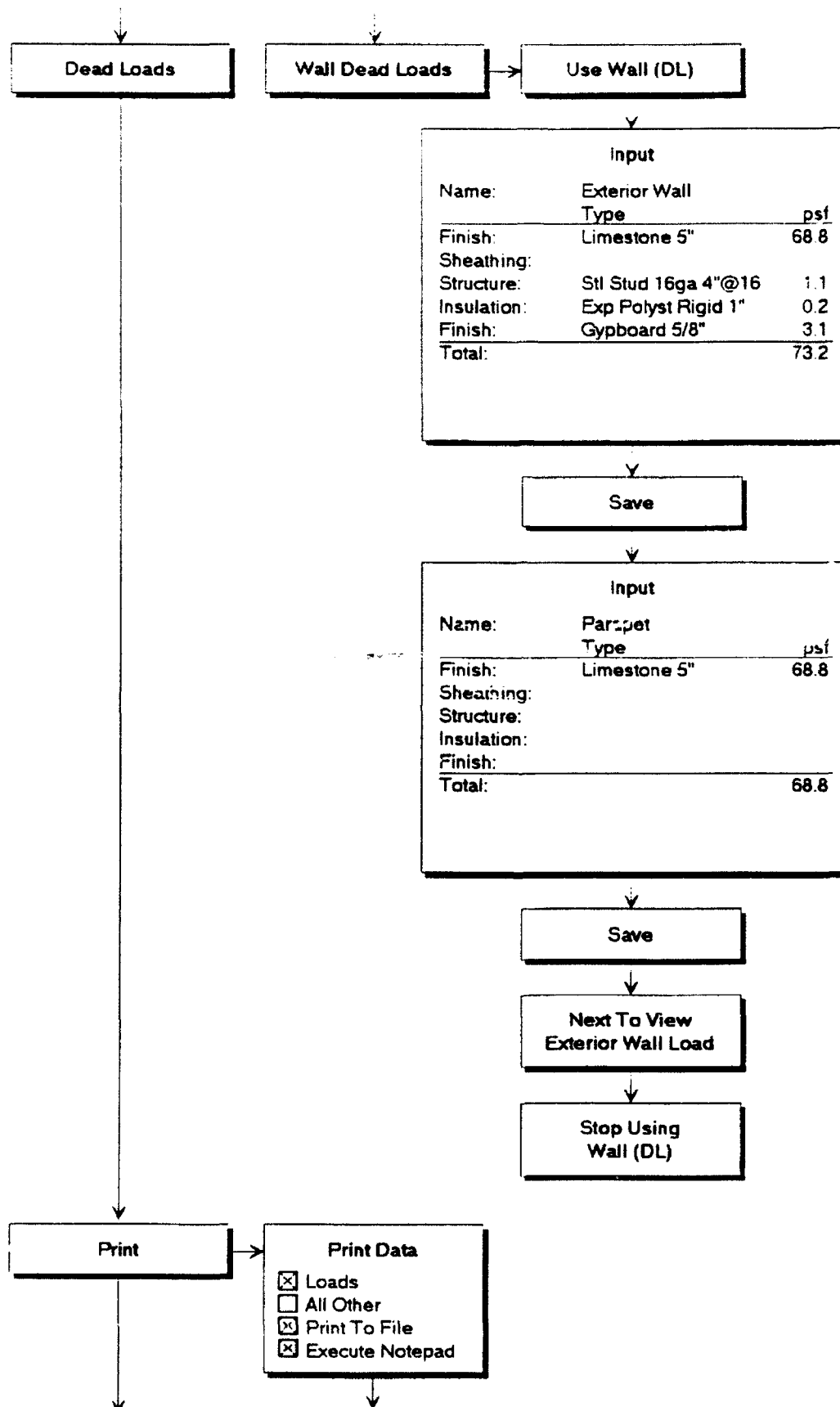
To comply with TM 5-809-1, wall external pressures have not been reduced 10% per ASCE figure 3, note 3.

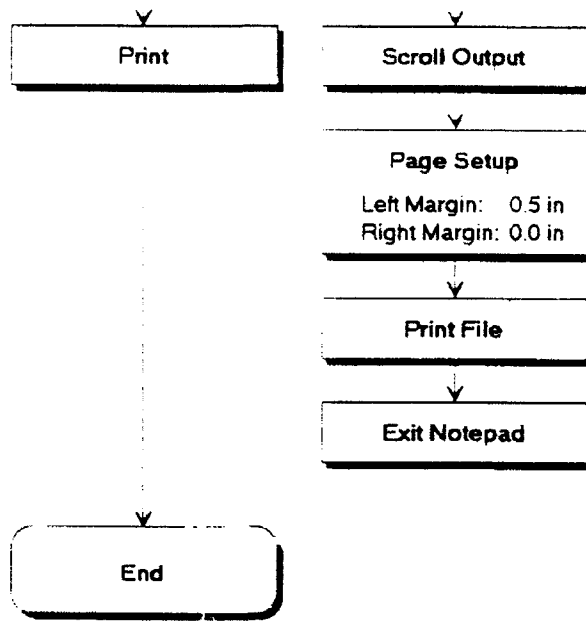
** For a rectangular tributary area, the width of the area need not be less than one-third the length of the area.

Dead & Live Loads









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
Office: Corridor (main)	100
Office: Files & Storage	150a

a. Variable design load. Increase may be necessary.

Notes

Uniformly distributed live loads for supporting members; i.e., two-way slab, beam, girder or columns having an influence area of 400 sq ft or more may be reduced with: $L = L_o[0.25 + (15/\sqrt{A_1})]$

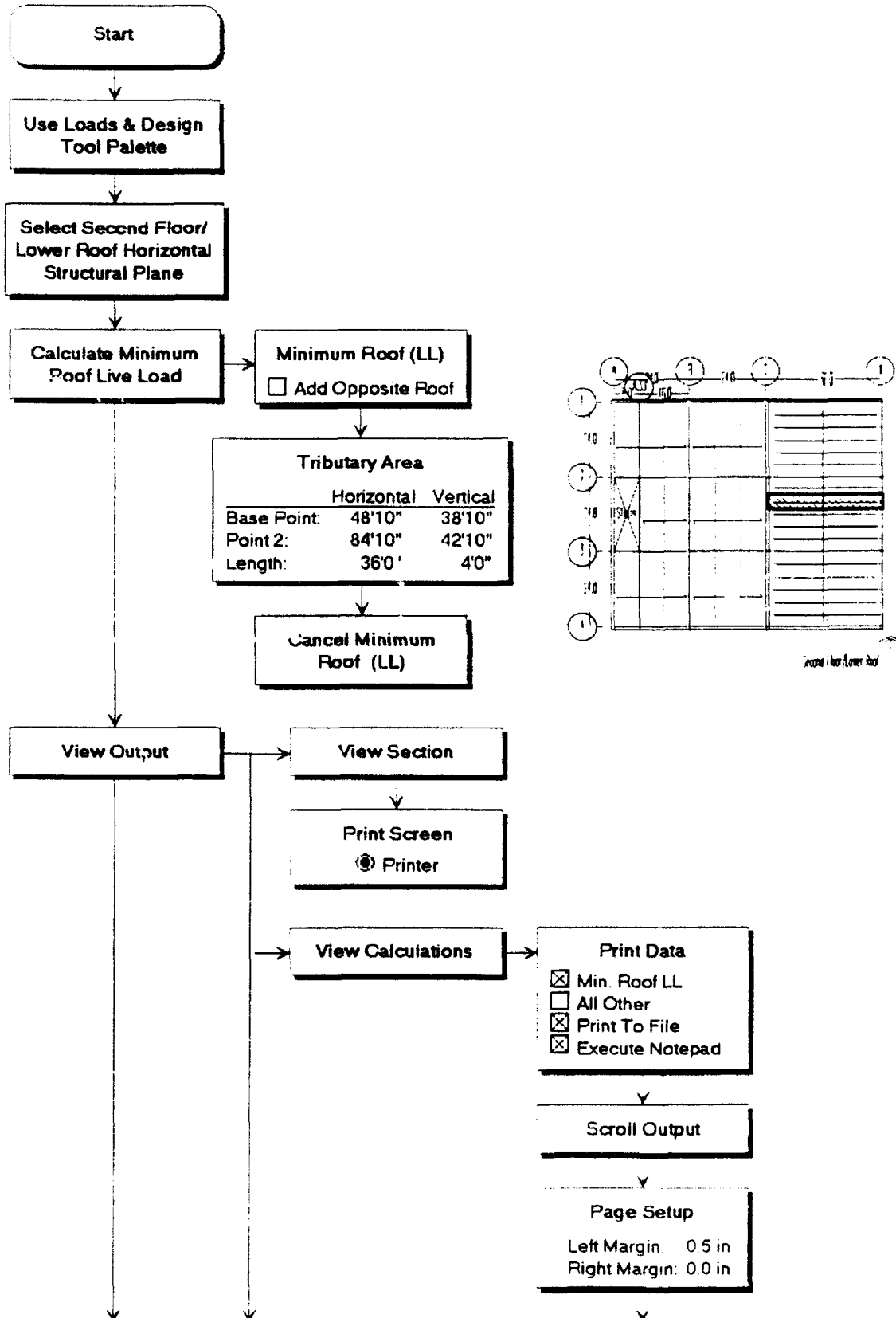
The reduced design live load will not be less than 50% of the unit live load for members supporting one floor, nor less than 10% of the unit live load for members supporting two or more floors.

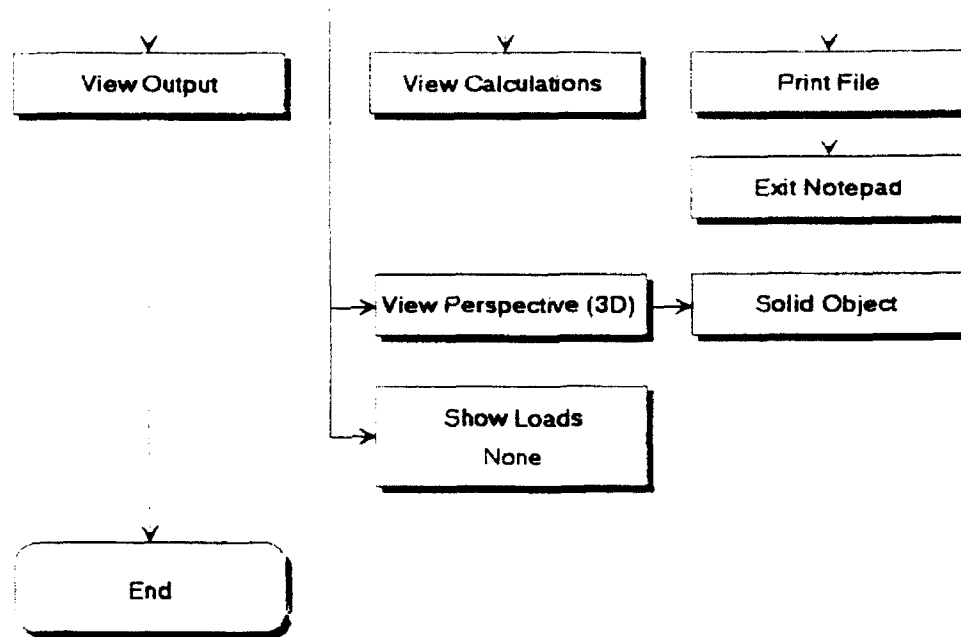
Exceptions: For live loads less than 100 psf, no reduction is permitted for members supporting floor(s) in the following areas:

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

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

Minimum Roof Live Load





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

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

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

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

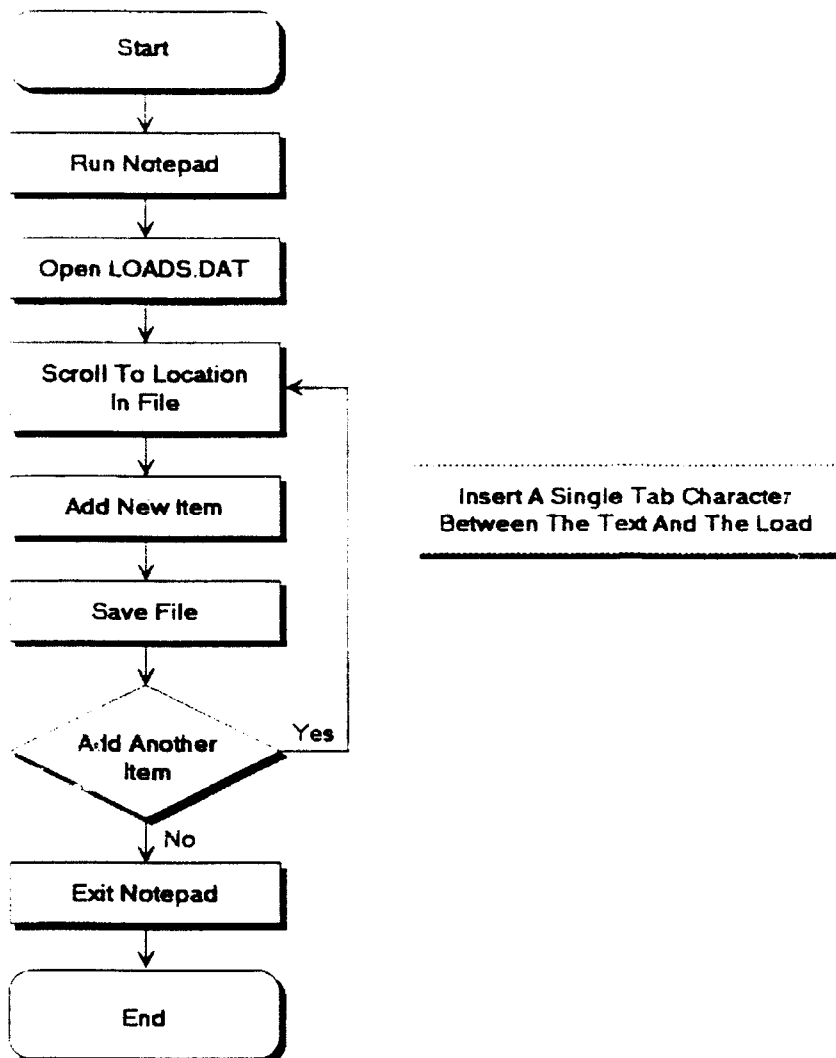
$L_r = 20.00$ psf
 minimum $L_r = 12$ psf

-----+
 | $L_r = 20.00$ psf |
 -----+

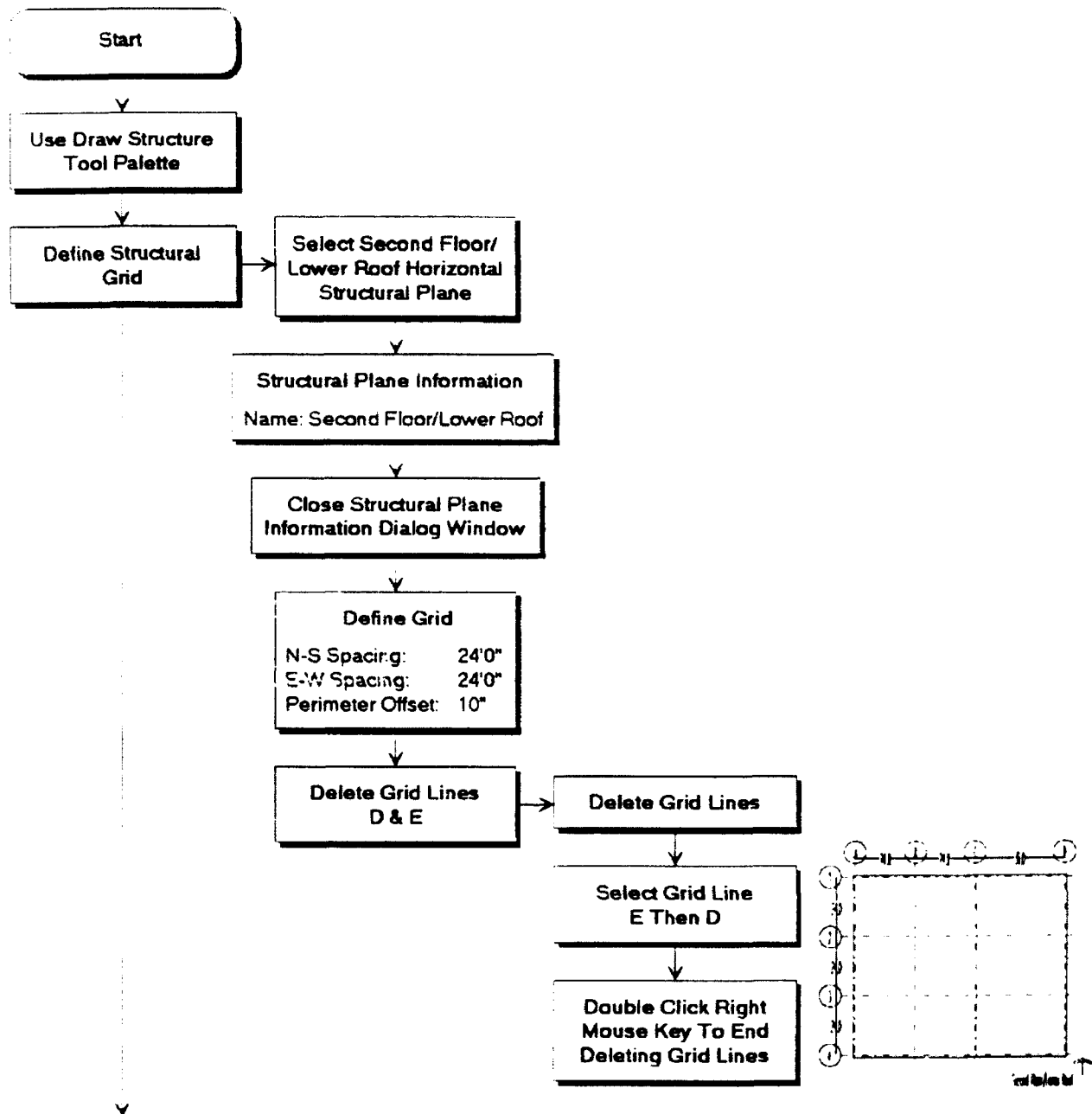
Check minimum roof live load, L_r , against minimum snow design loads.

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 feet square (4 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.

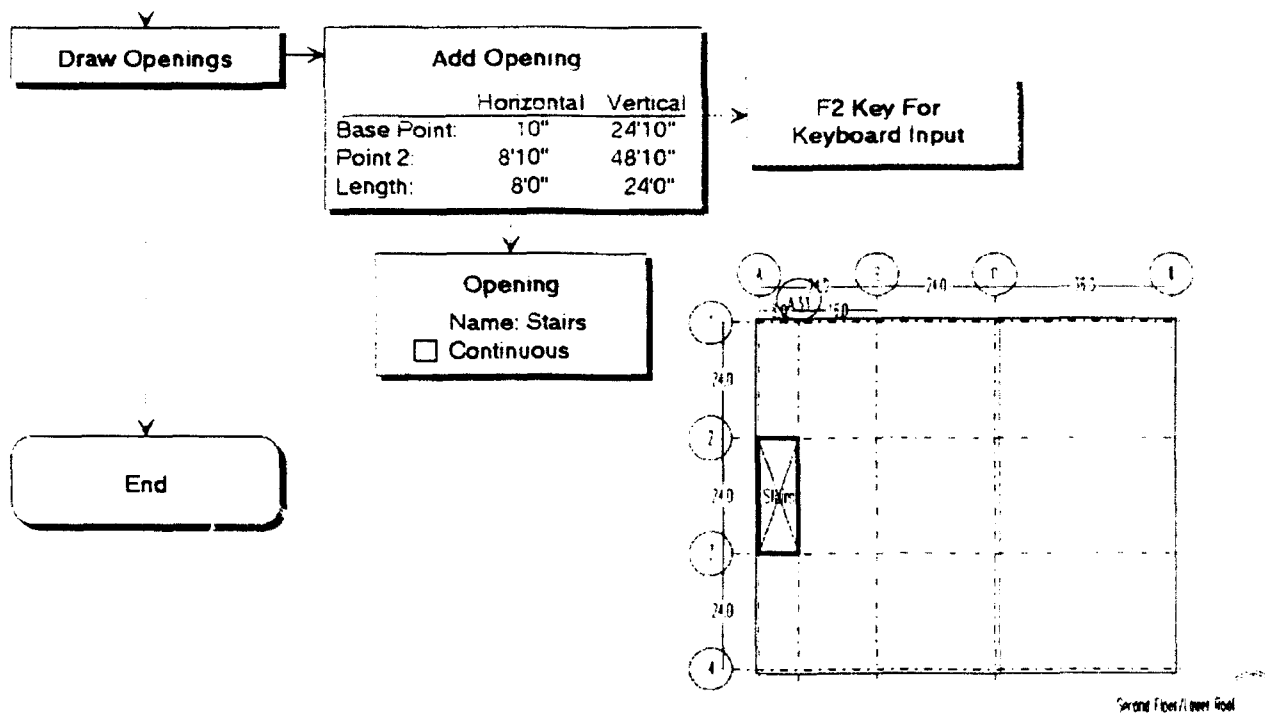
Loads Database



Draw Grid & Openings



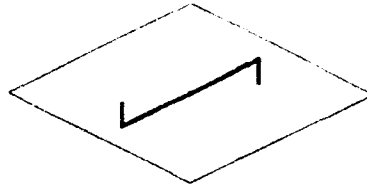
Draw Grid & Openings



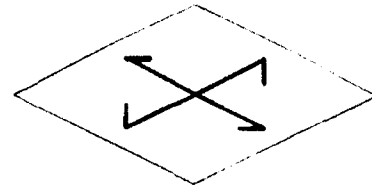
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)



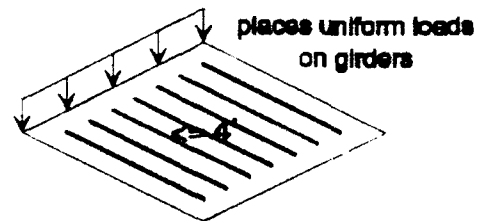
1 way



2 way
(not activated)

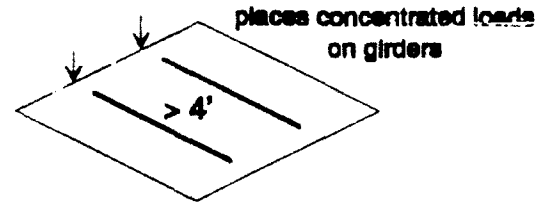
Linear
(horizontal)

Narrowly Spaced
(joists)



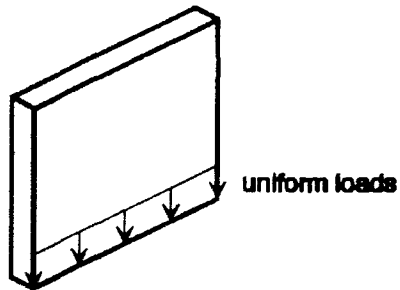
places uniform loads
on girders

Widely Spaced
(beams)



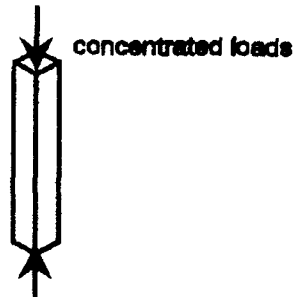
places concentrated loads
on girders

Surface
(vertical)
(planar)



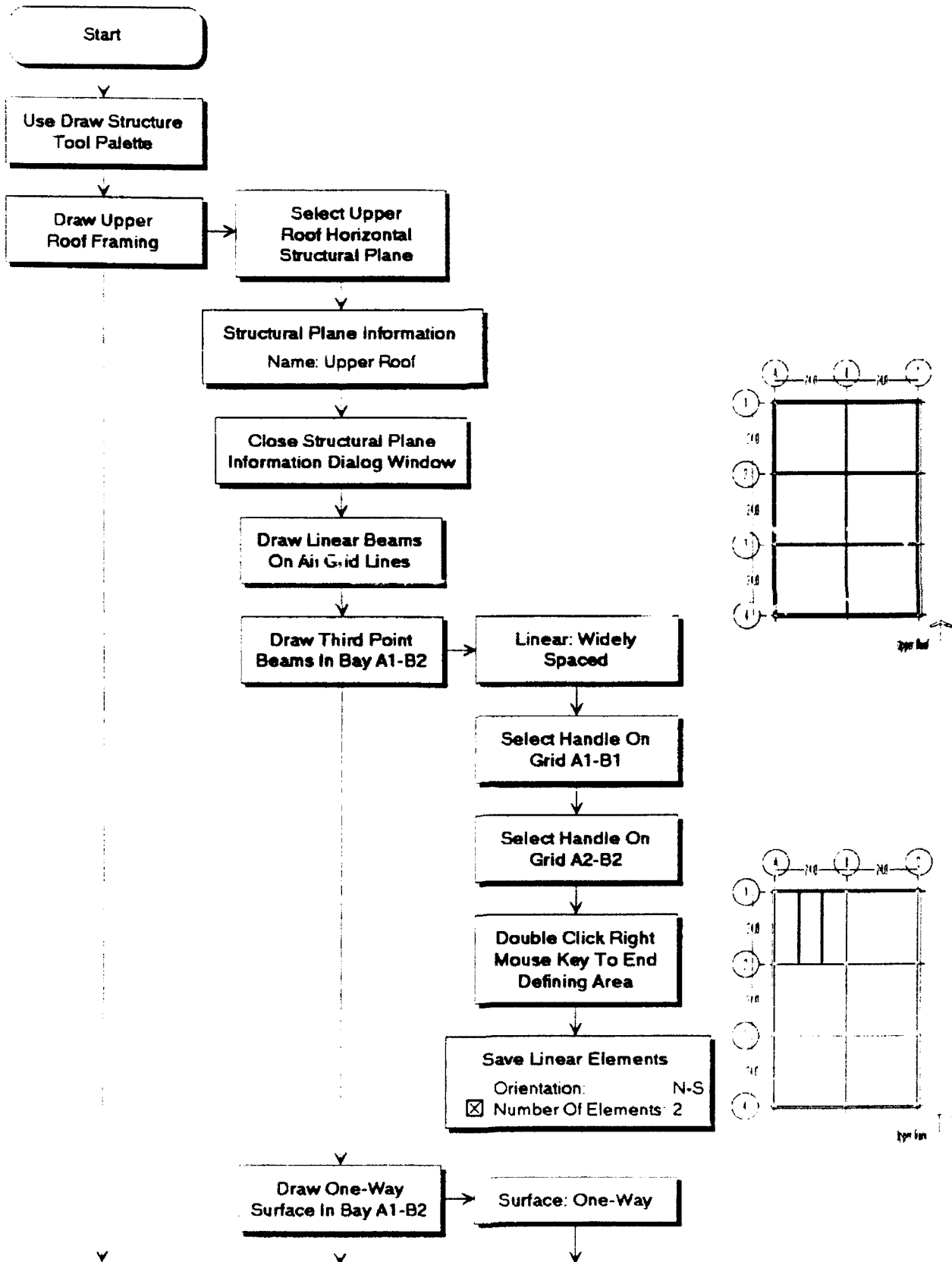
uniform loads

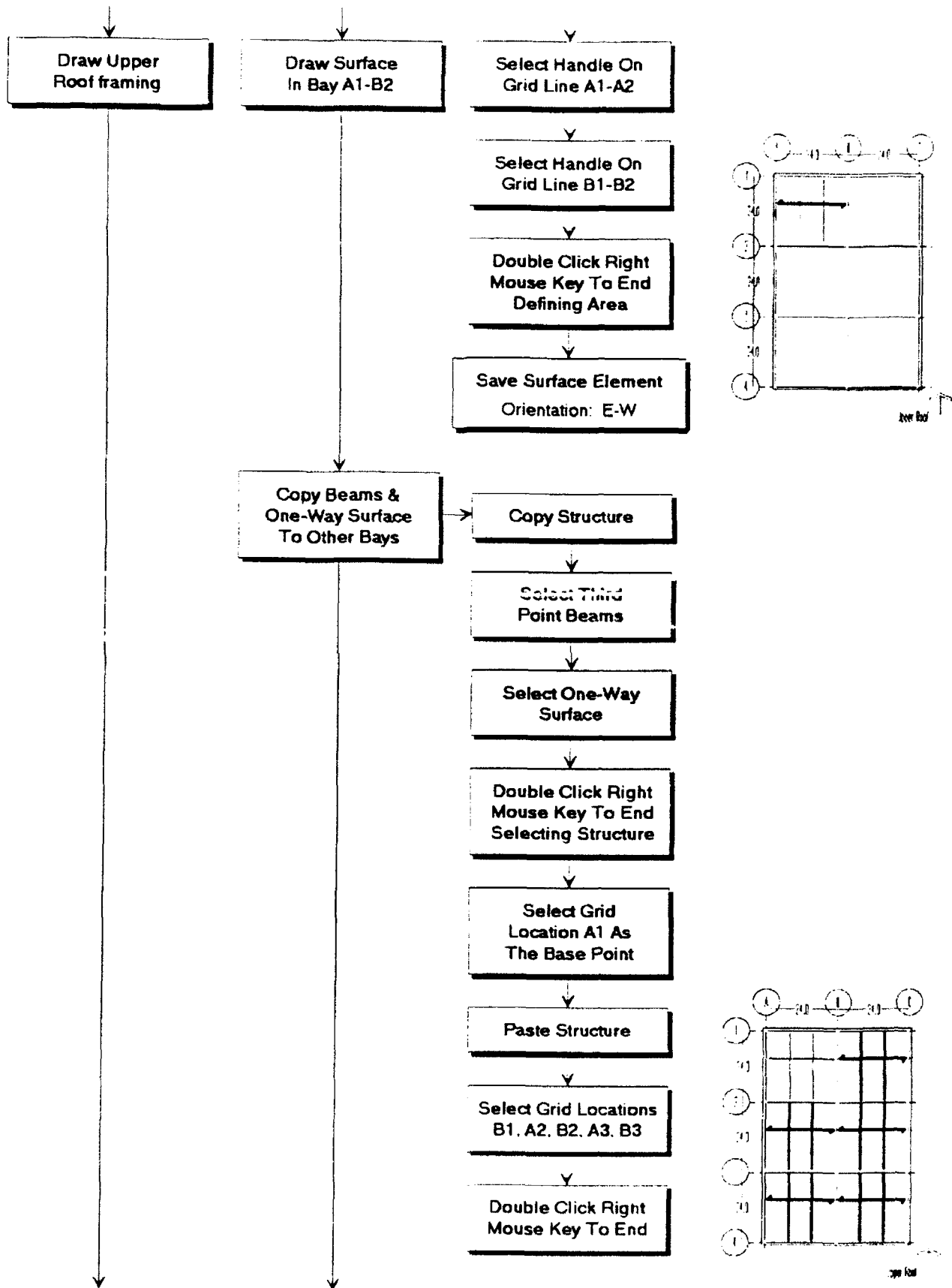
Linear
(vertical)

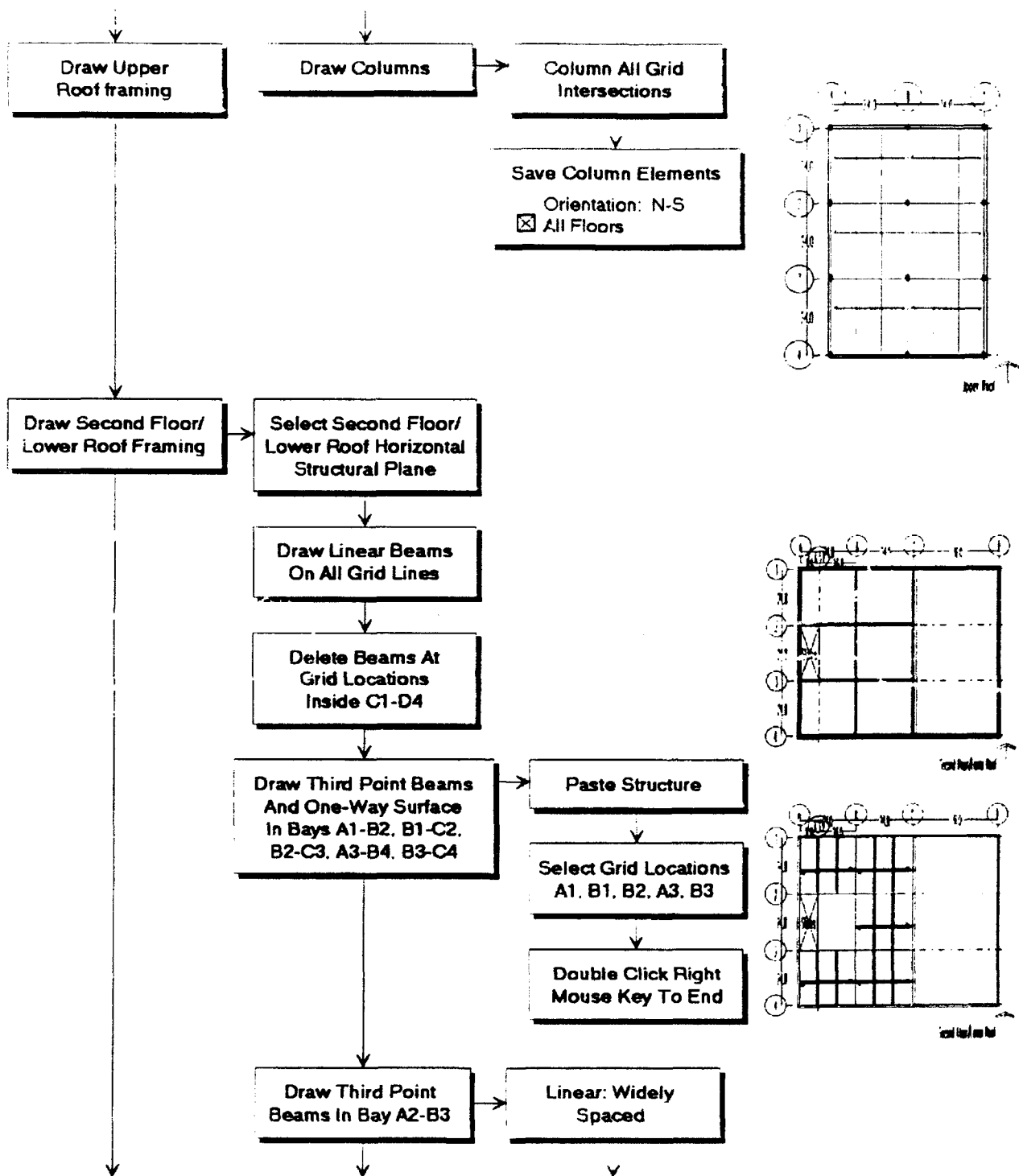


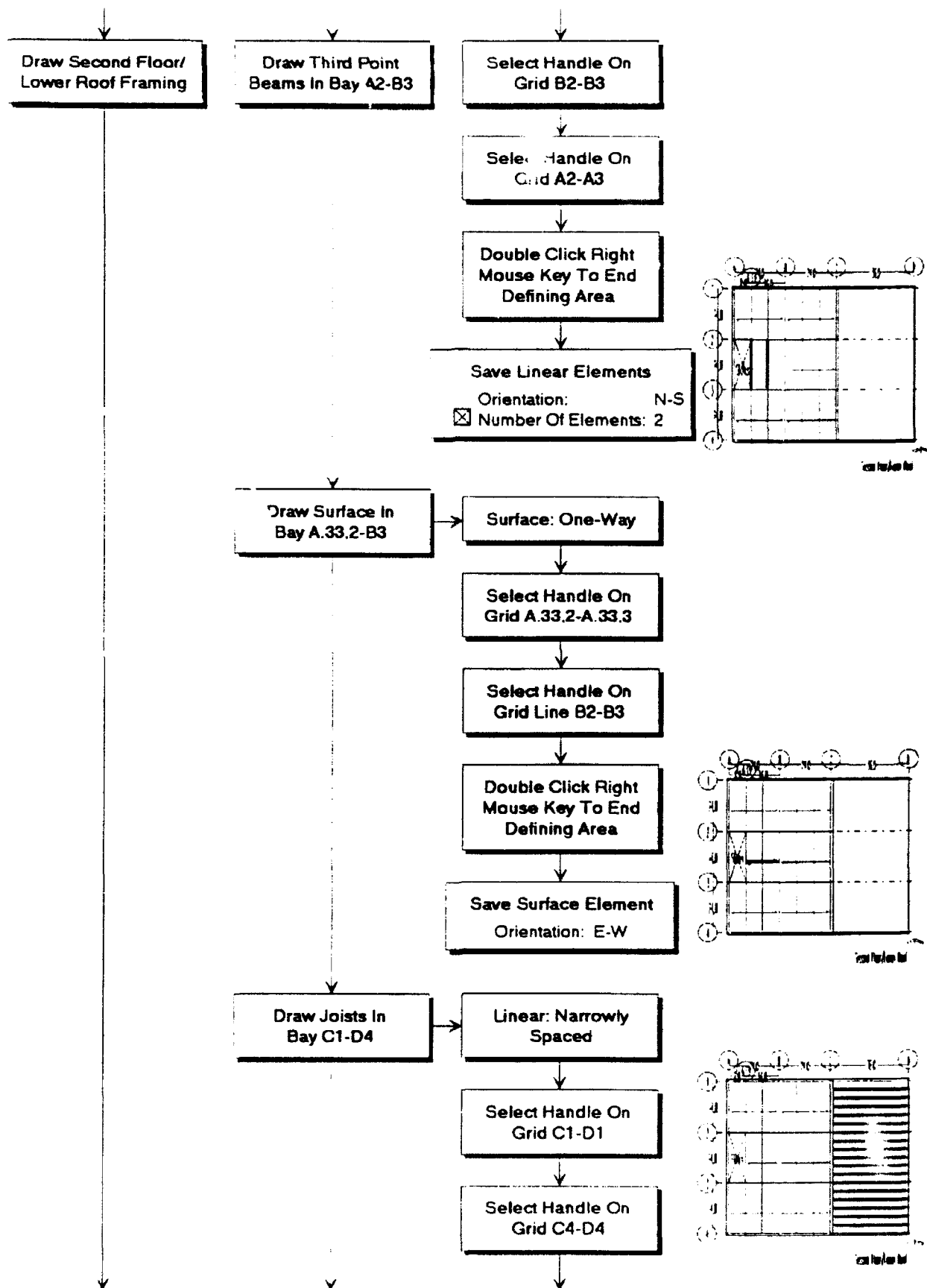
concentrated loads

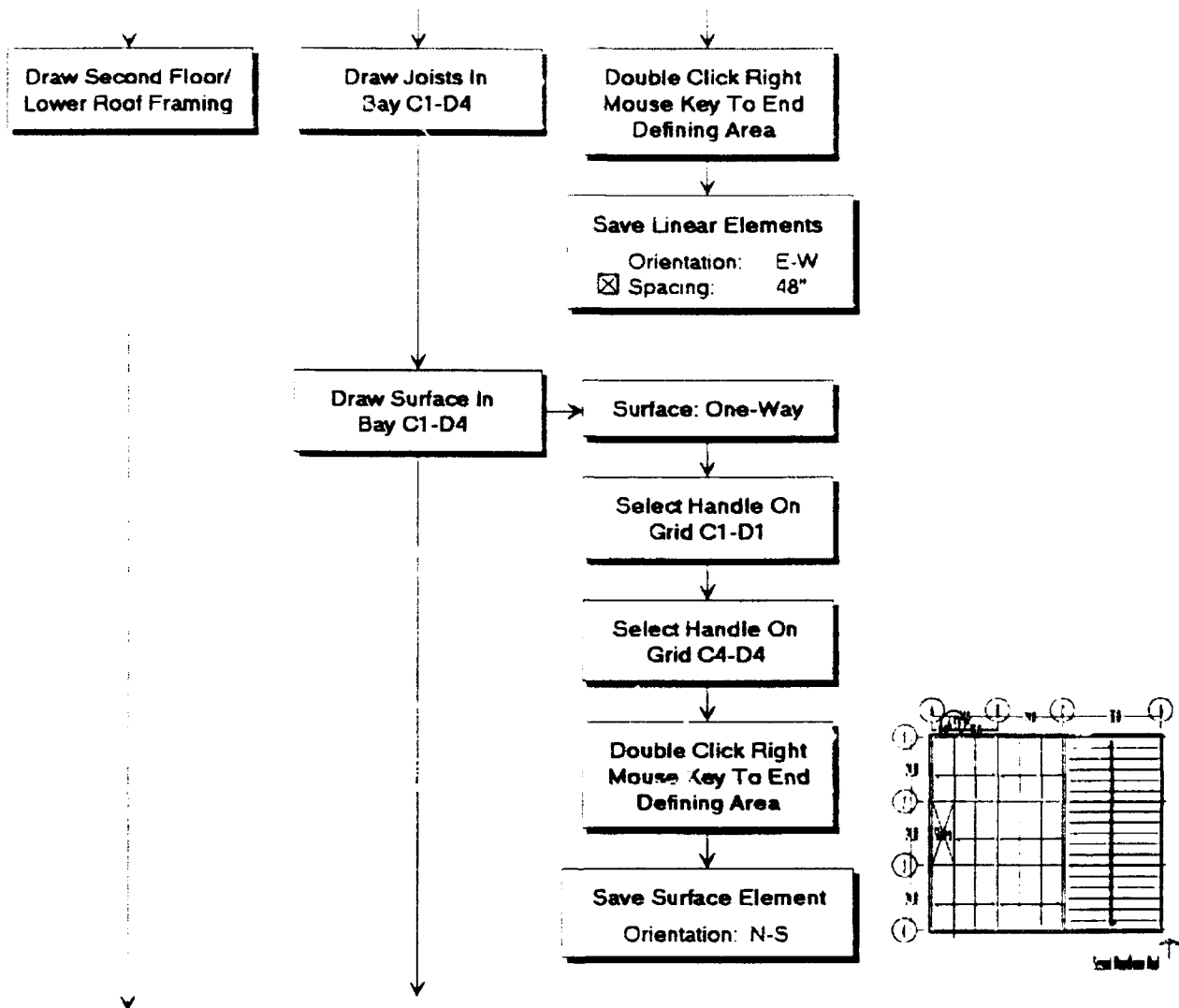
Draw Structure

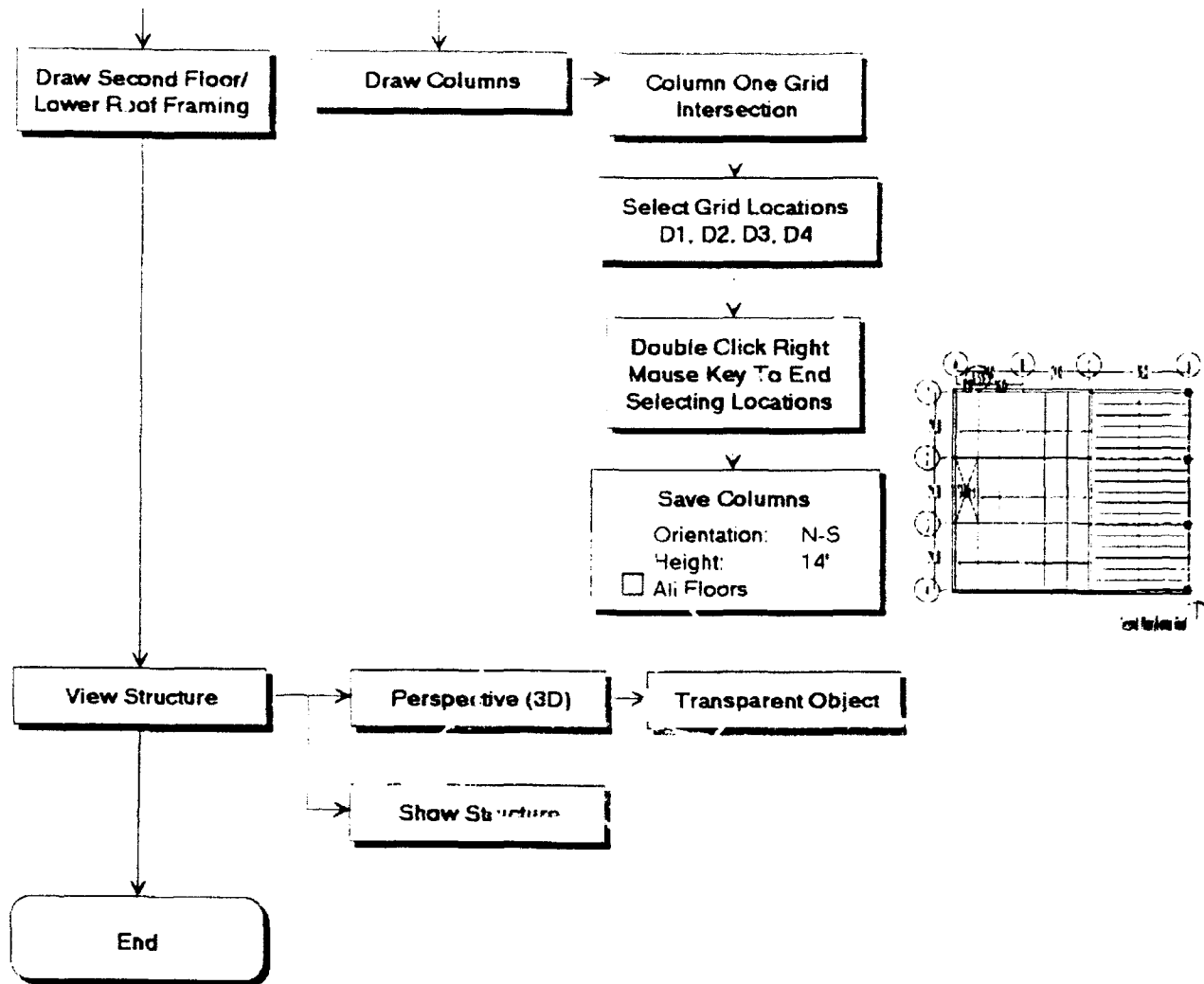


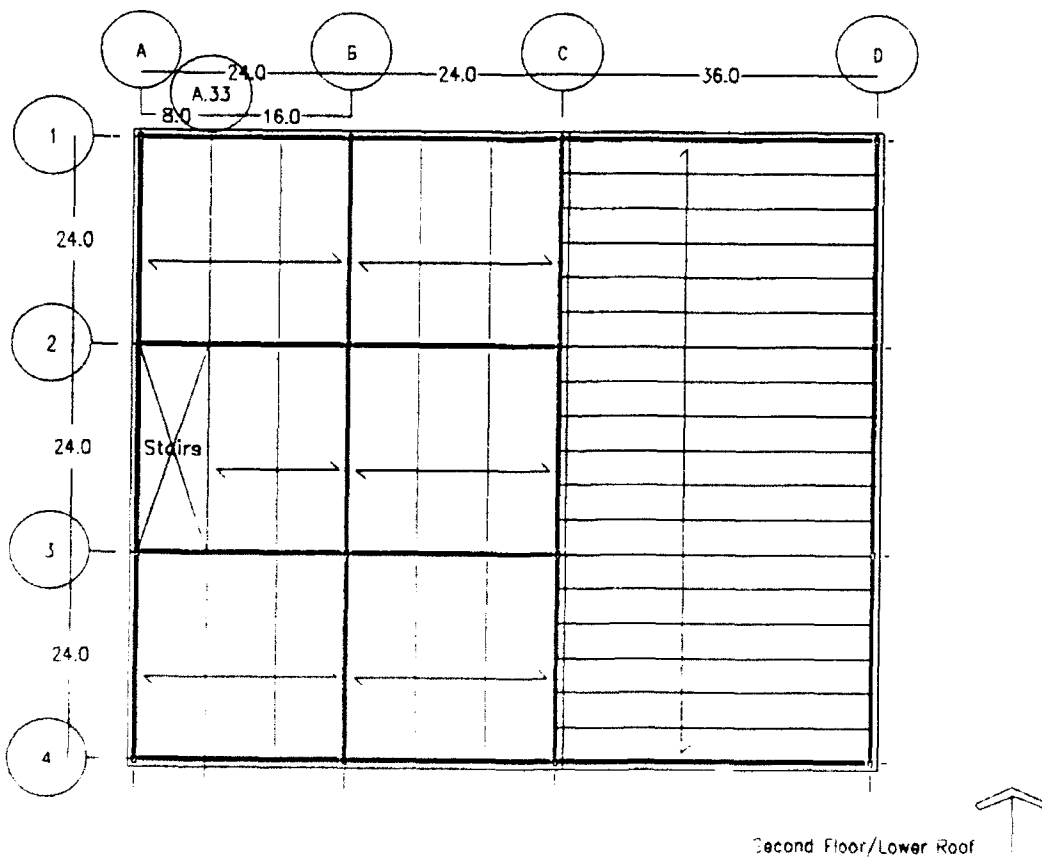
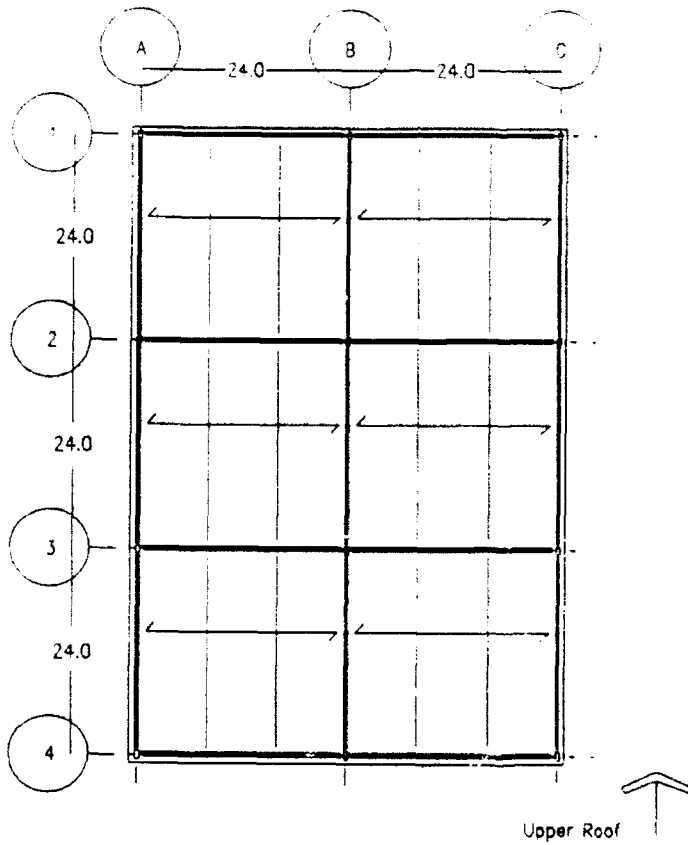


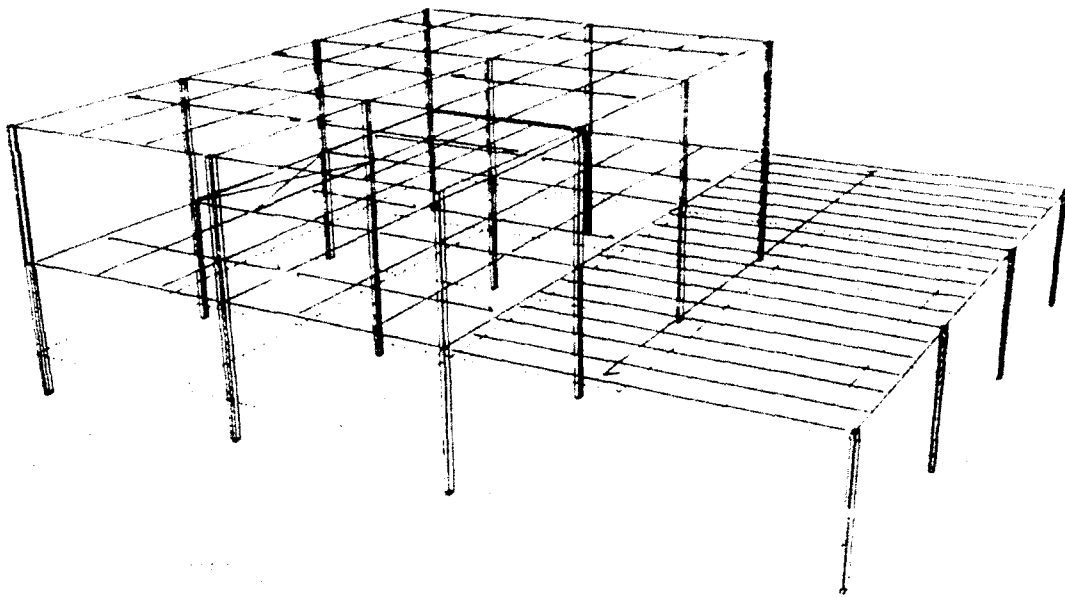




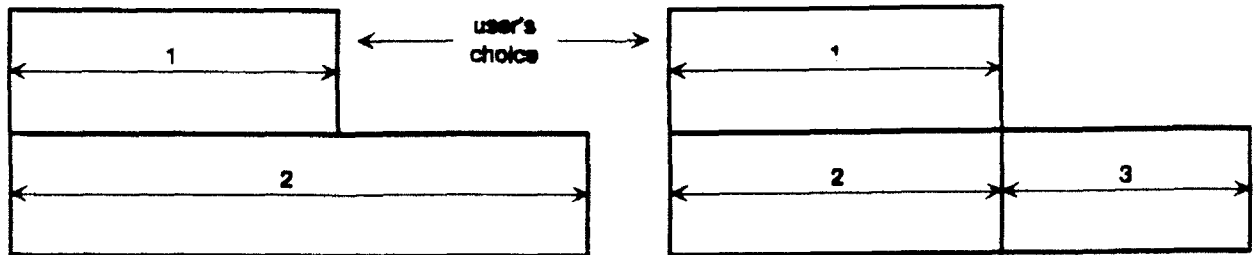
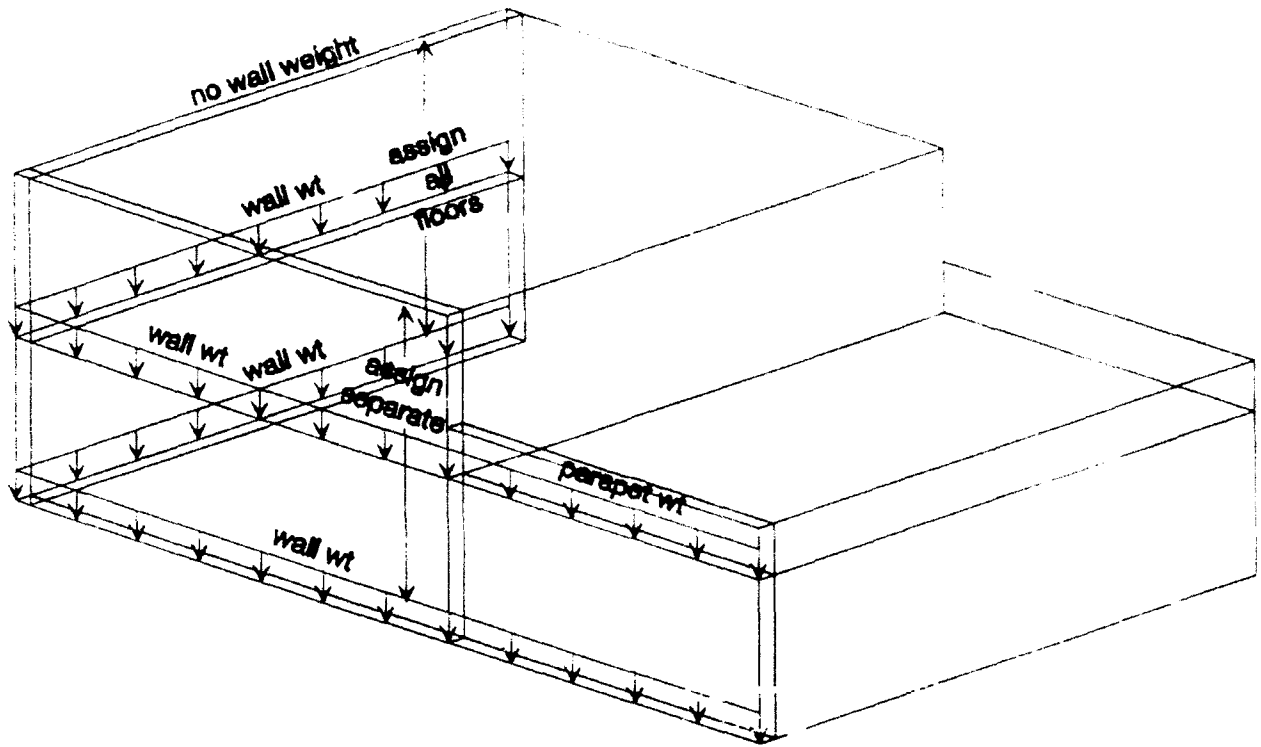






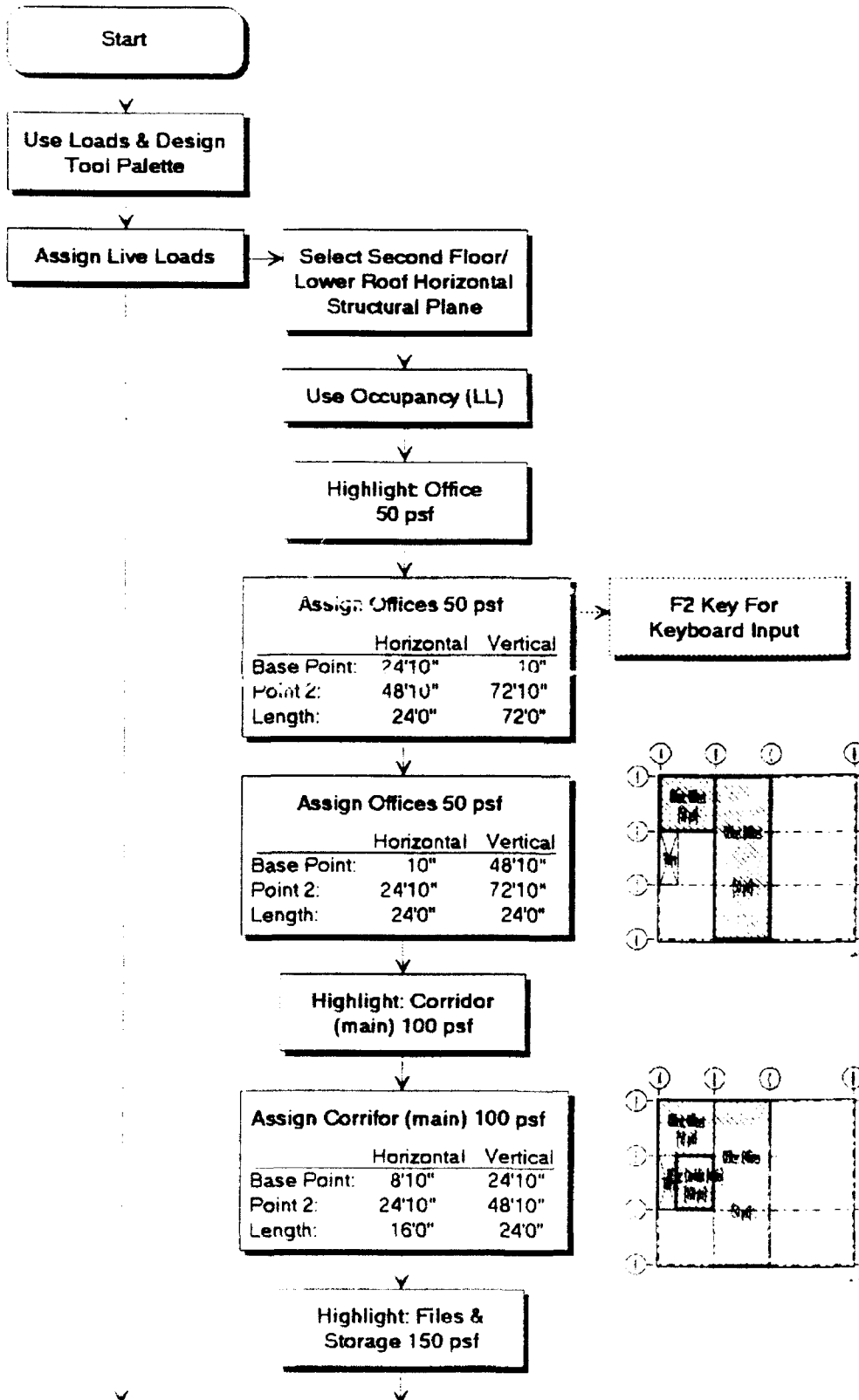


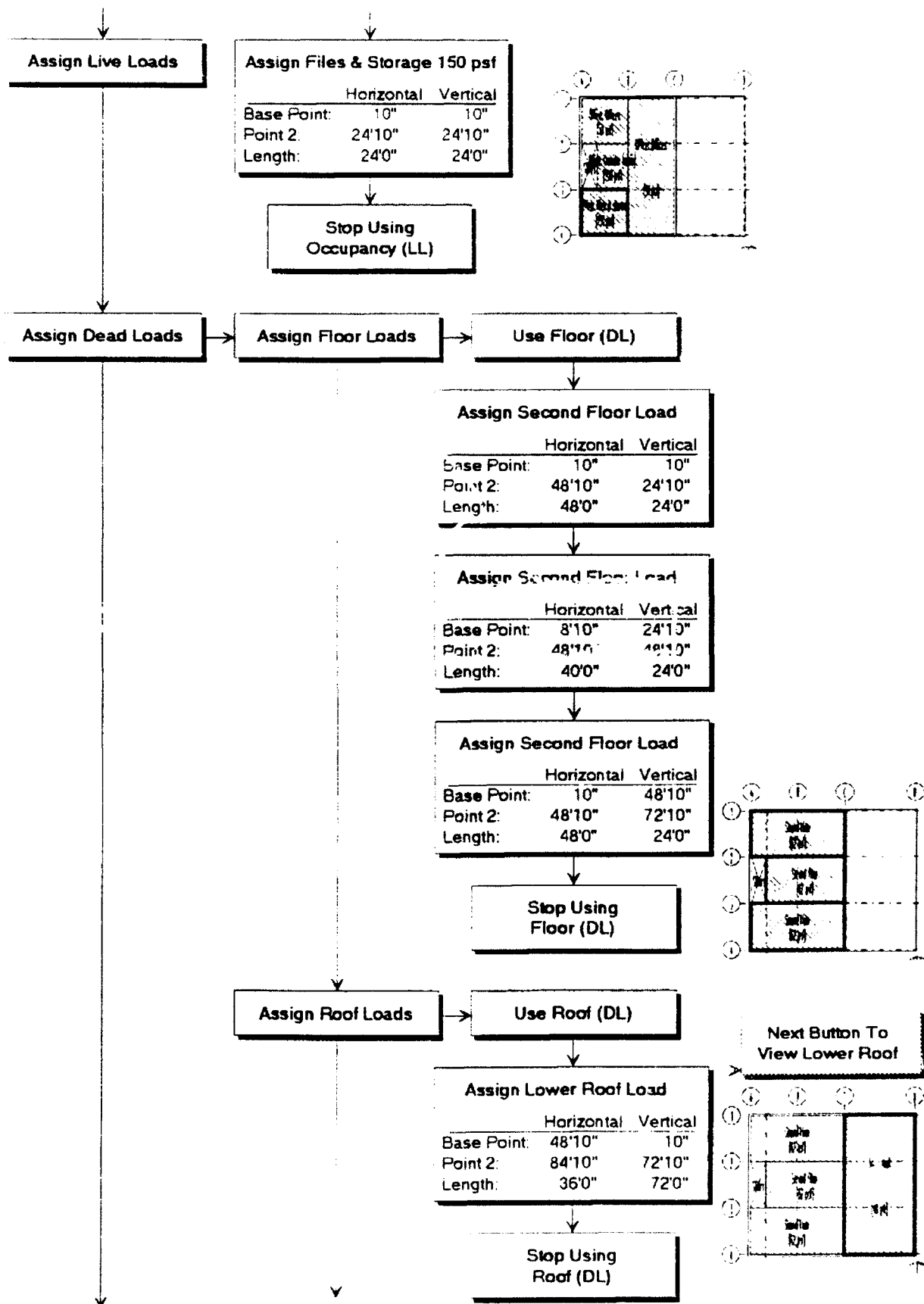
Assign Wall Loads Philosophy

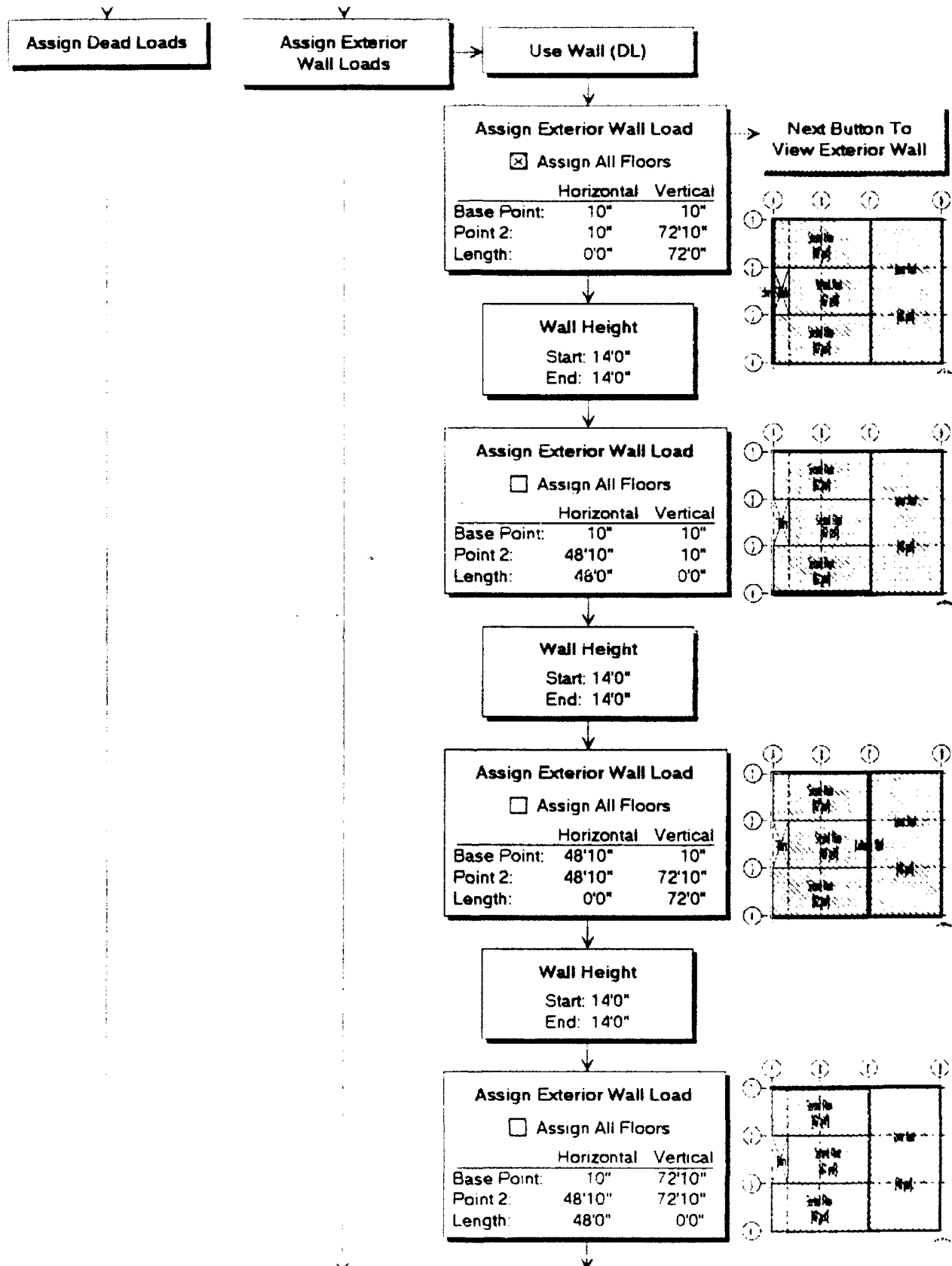


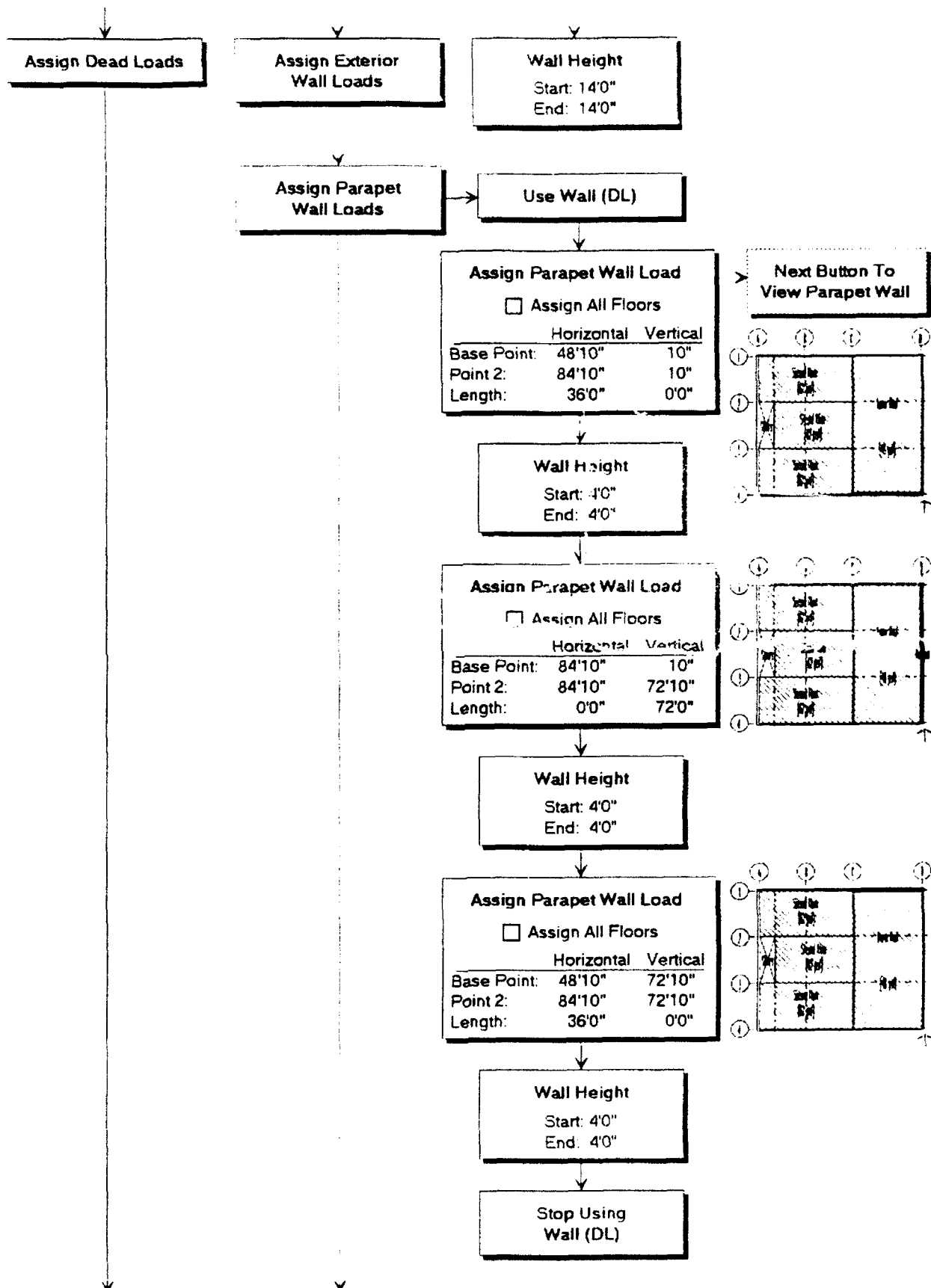
this approach saves memory

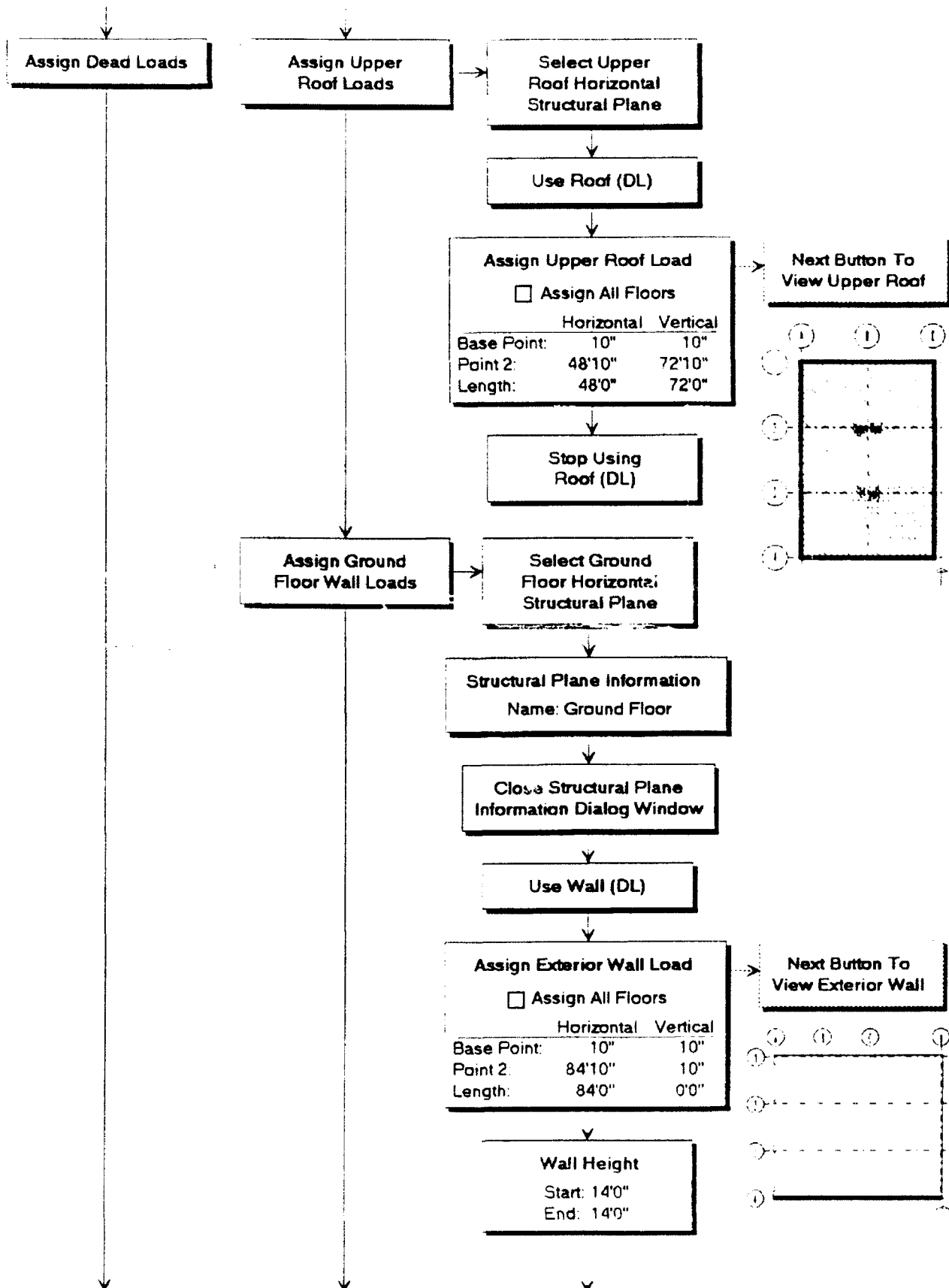
Assign Loads



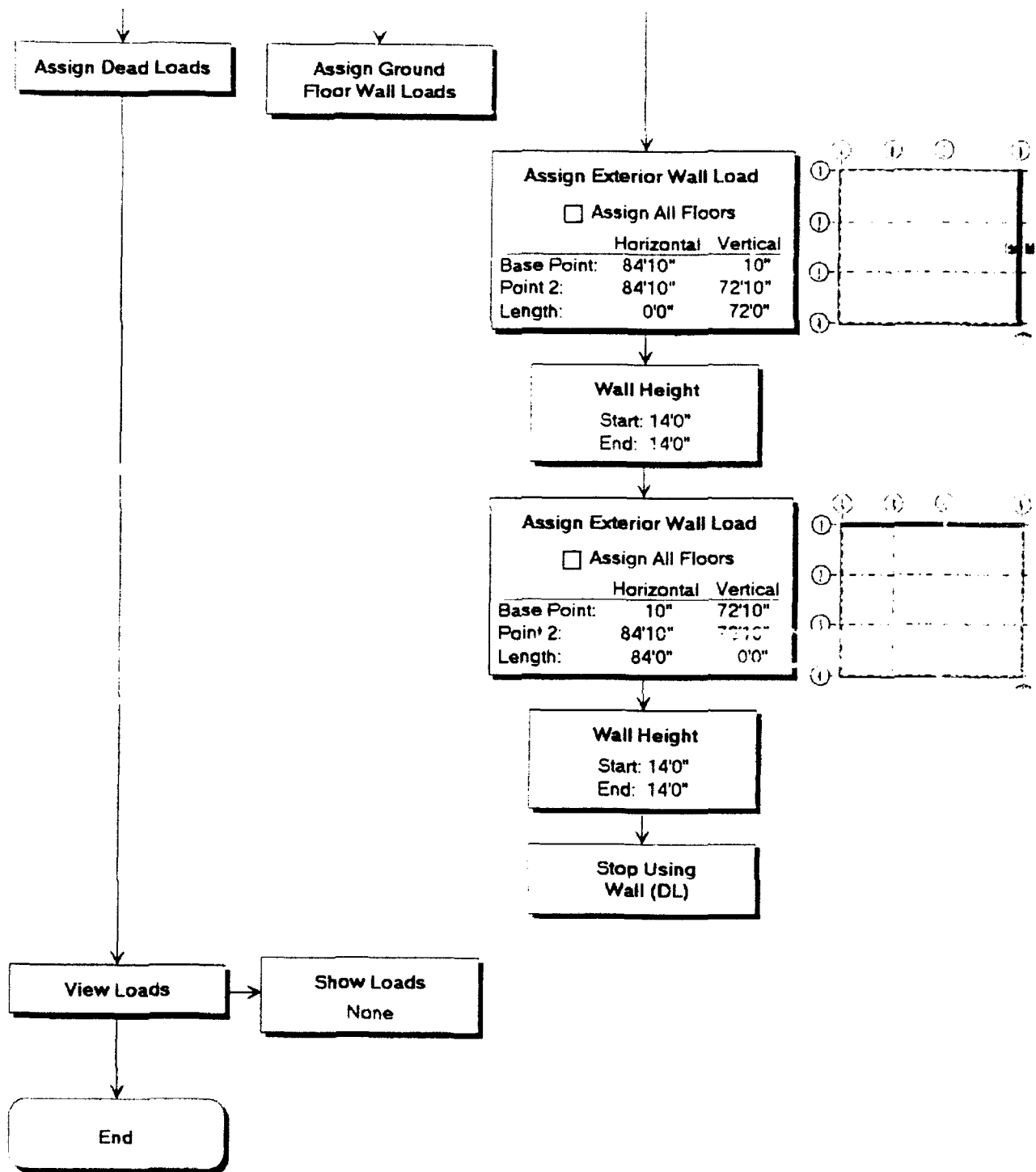


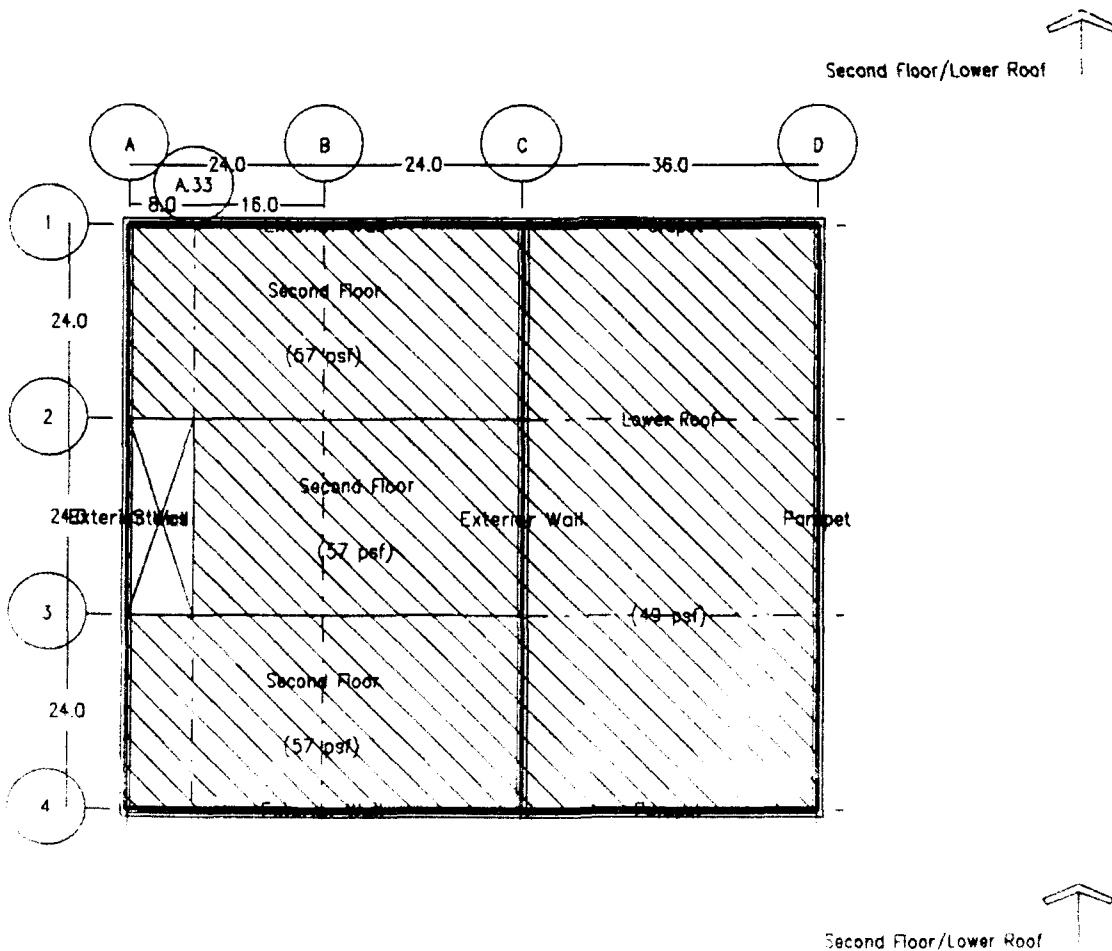
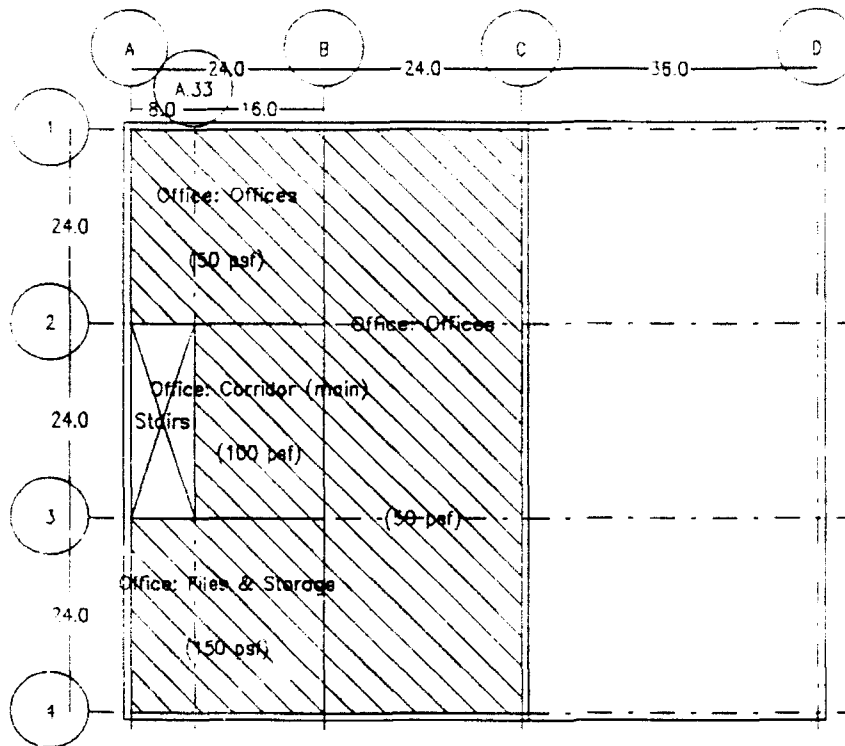




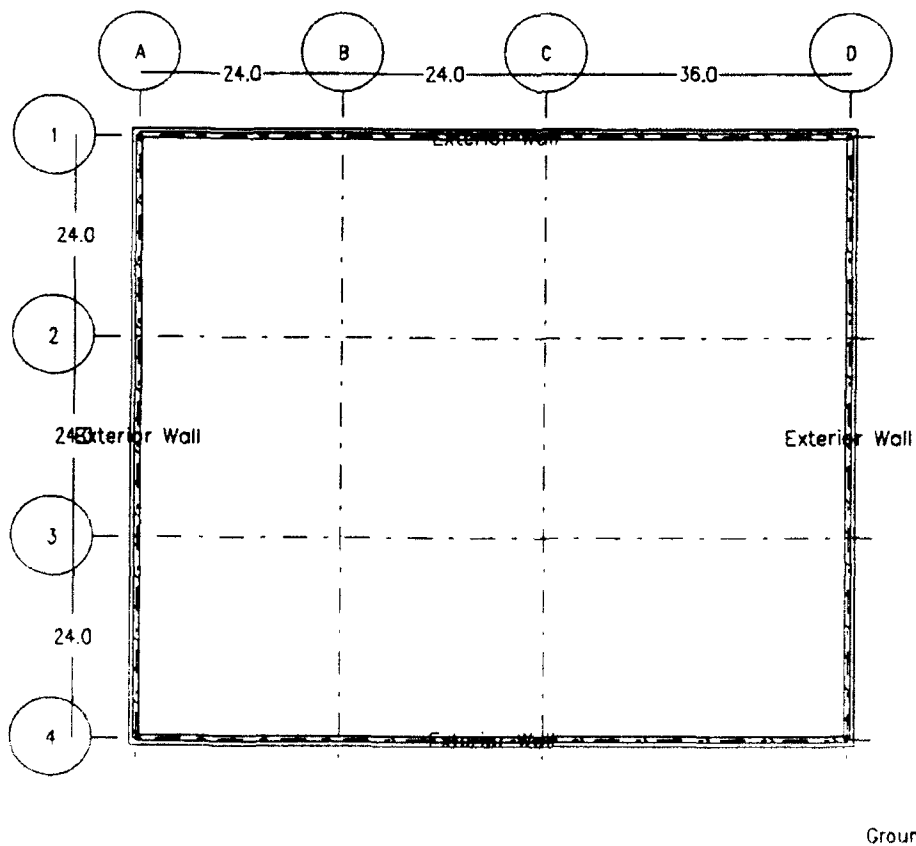
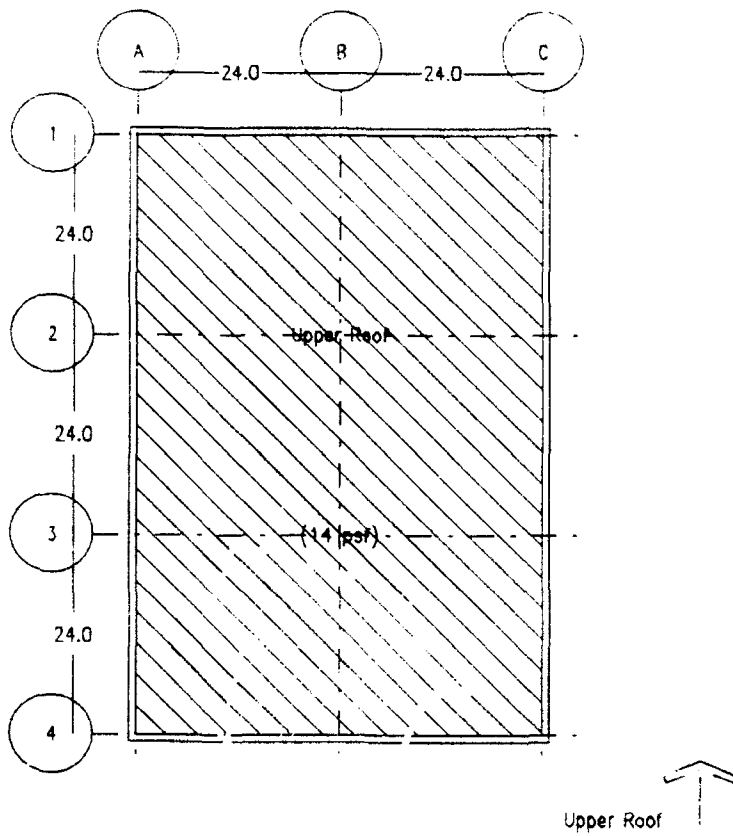


Assign Loads





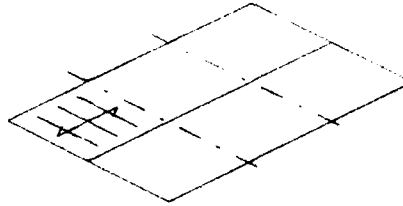
Assign Loads



Analysis & Design Philosophy

Preliminary Analysis

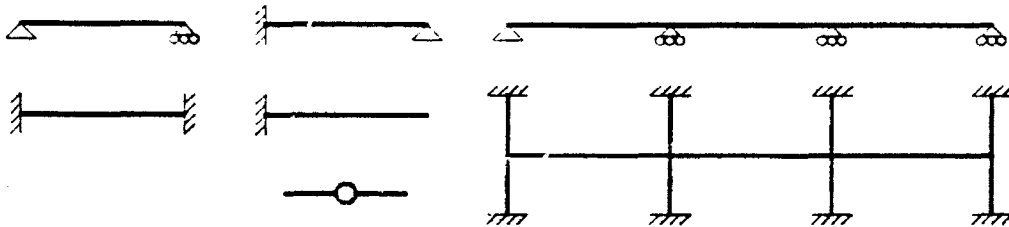
- A. Select:
- * Material
 - * Load Combination
(Live Load Reduction)
 - * Element To Analyze



- B. Review:
- * Attributes
 - * Guidelines



C. Connectivity

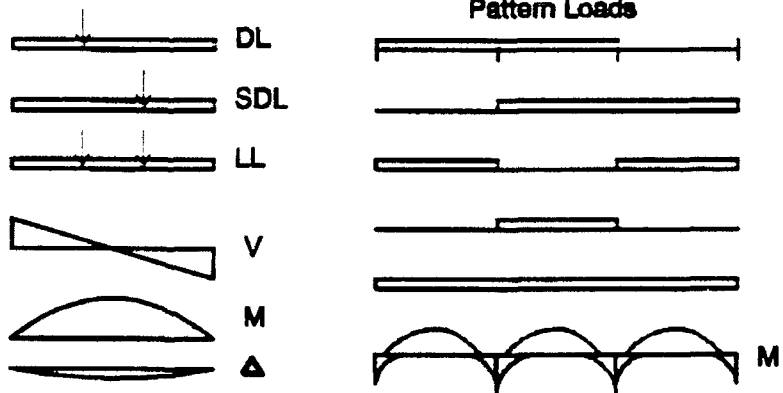


D. Self Weight Estimate

- * Guidelines



- E. Analysis
- * Review Loads
 - * Connectivity



* Analysis Output

$$I = 1$$

$$E = 1$$

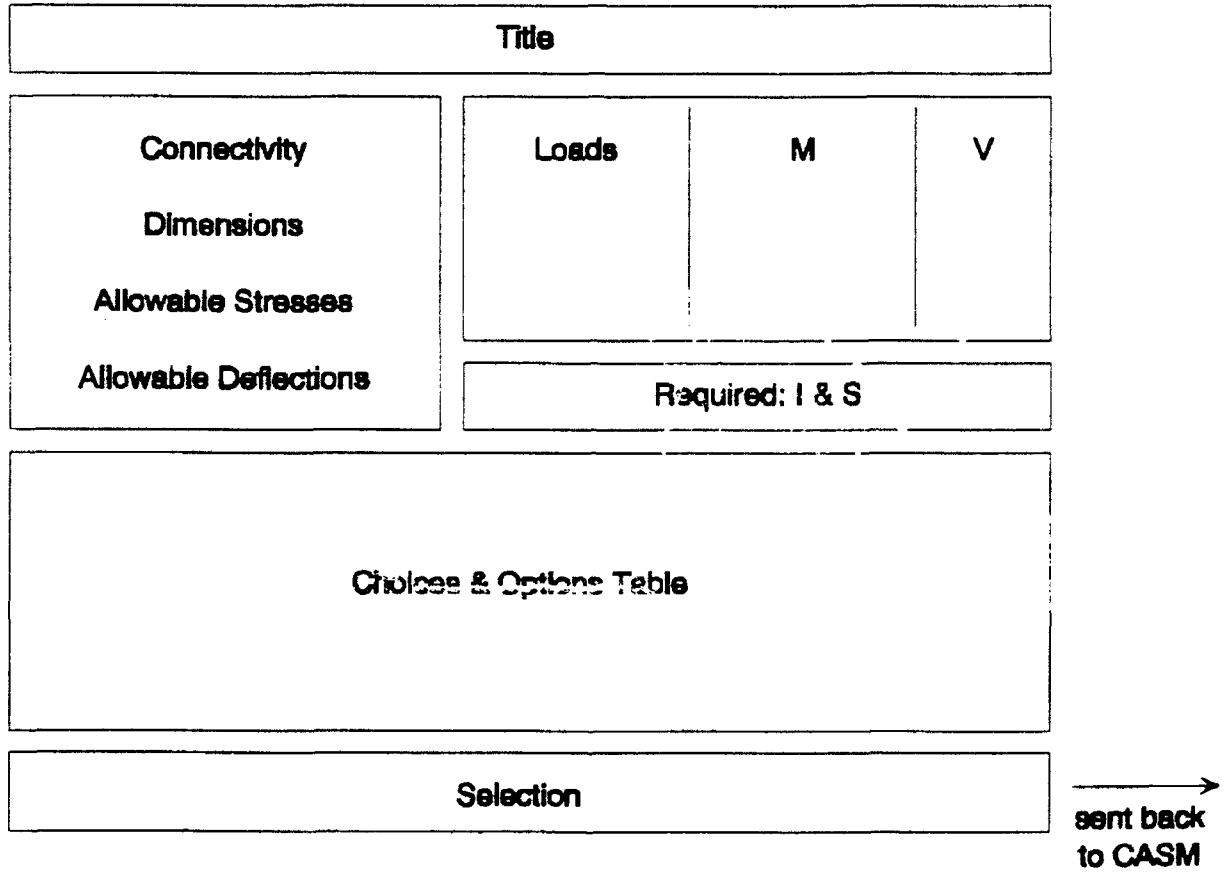
$$A = 1000$$

F. Re-Analysis (with real properties)

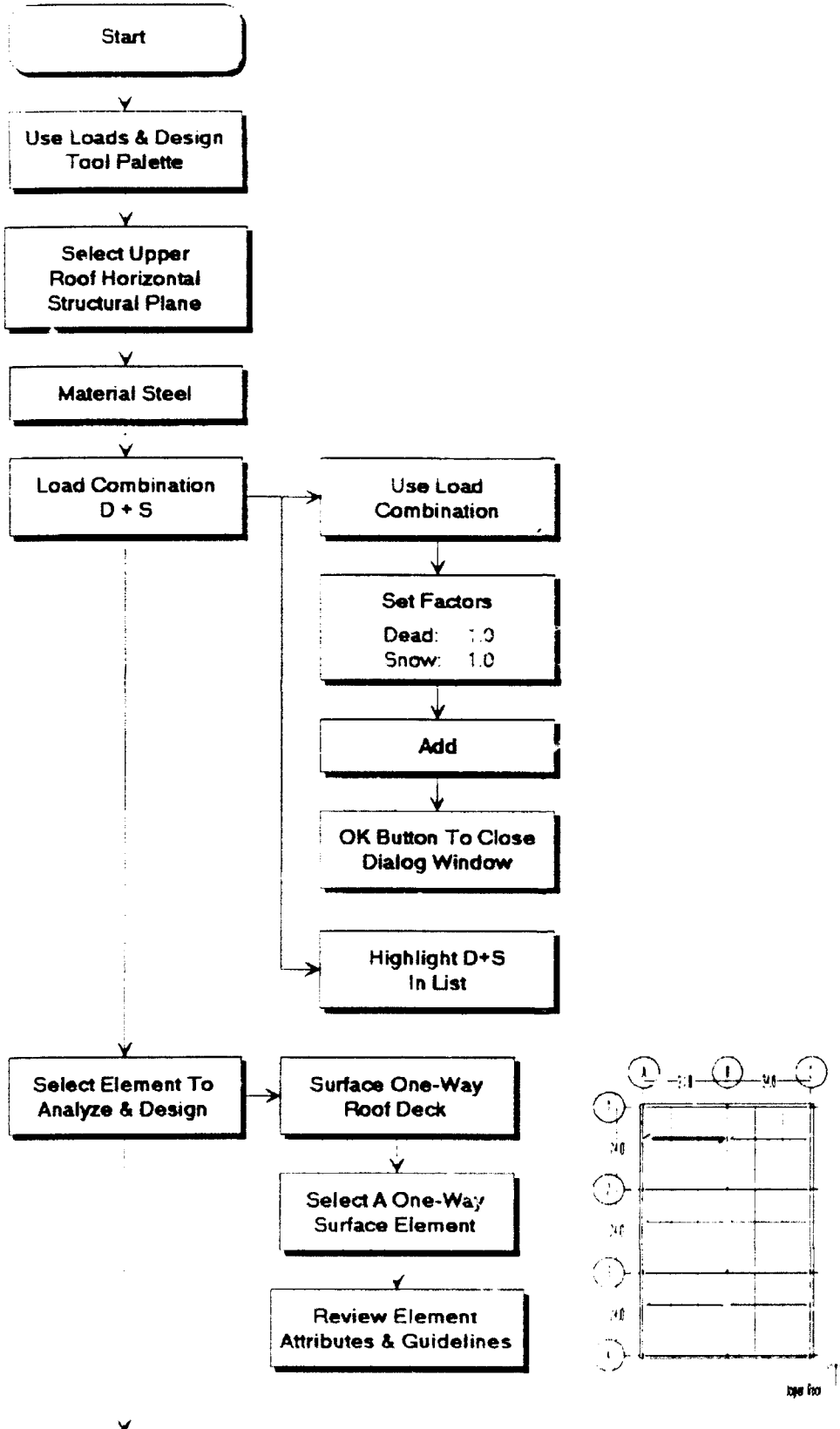
Preliminary Design

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

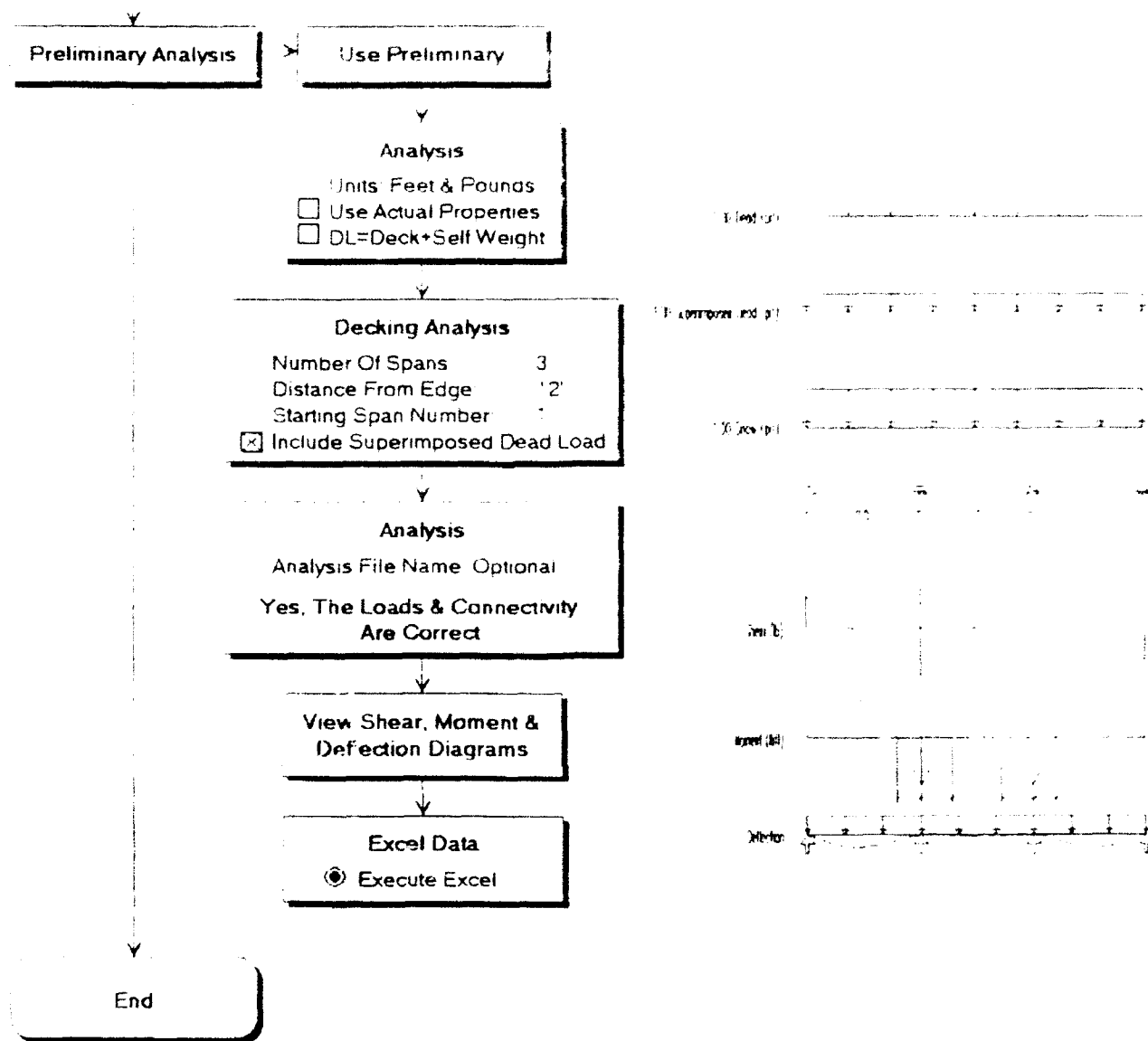
Spreadsheets

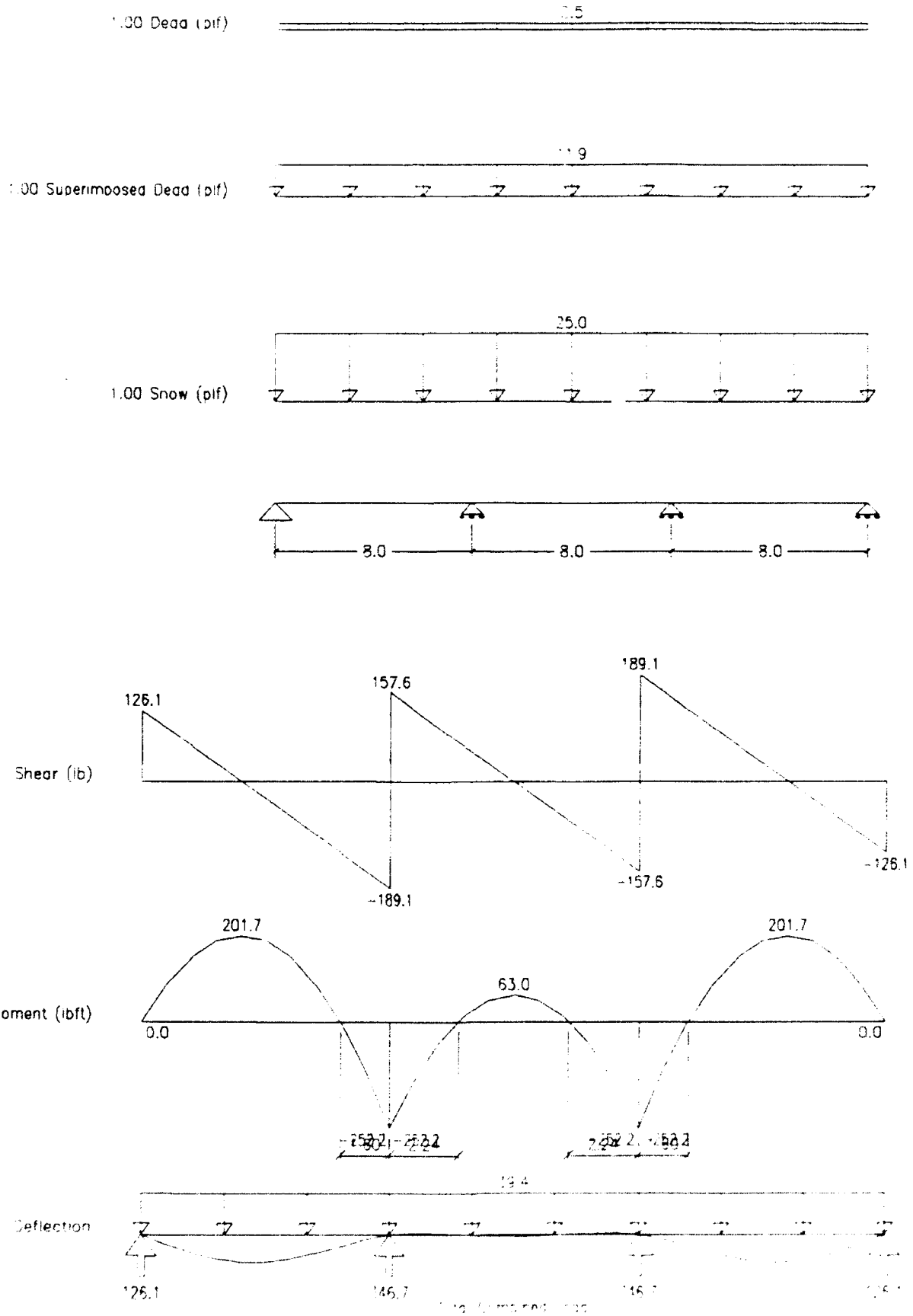


Surface Element Analysis

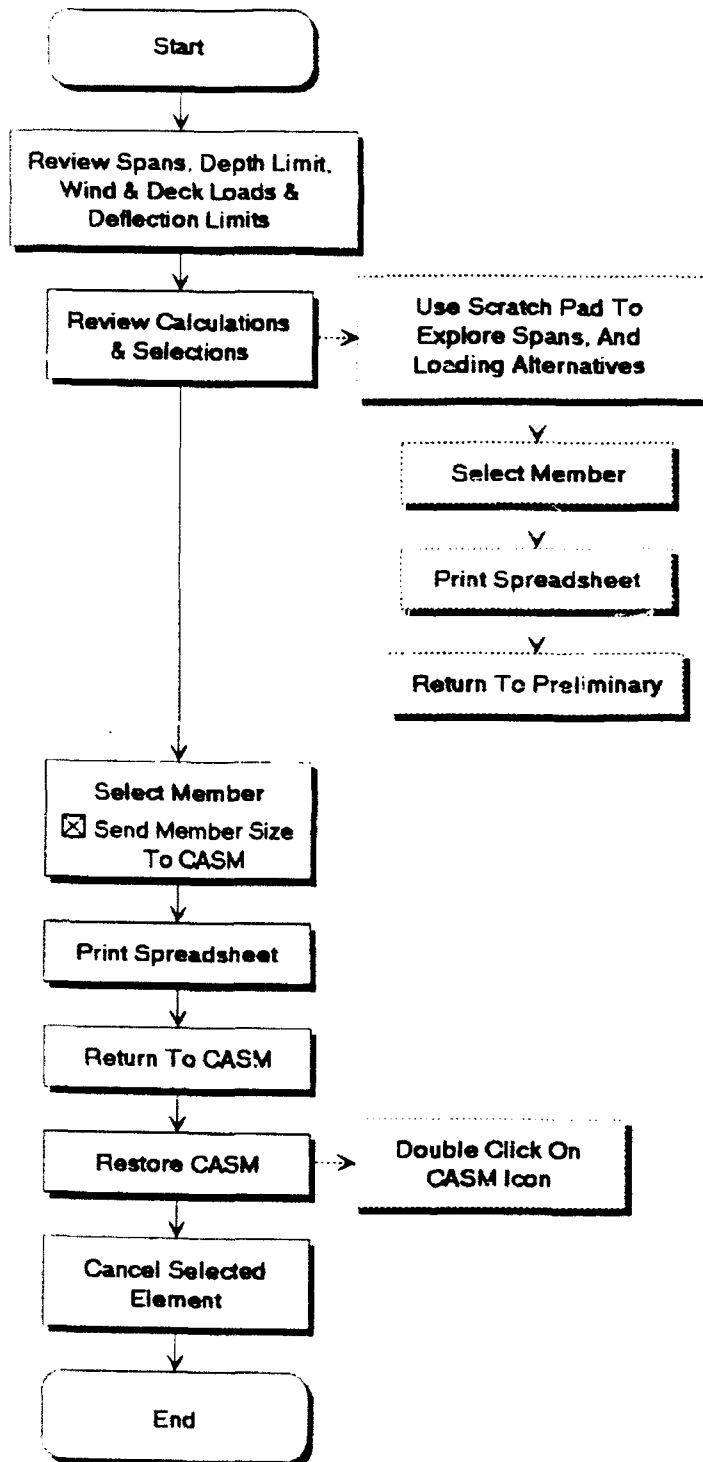


Surface Element Analysis





Steel Roof Deck Design



Steel Deck Selection

STEEL ROOF DECK PRELIMINARY SELECTION

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

Load and Analysis Data:

Method: Analysis		Load Combination: D + S					
Member ID:		Load Type	Factored Moments (lb-ft)			Fact. Reactions	
Connectivity: Beam (Left)			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= 3 in		Live					
Depth Limit= 1.5 in. max		Lmin Roof					
Fy= 33.0 ksi		Snow	160.0	128.0	160.0	120.0	120.0
Fb= 20.0 ksi		Wind					
Fv= 13.2 ksi		Summary	252.2	201.7	252.2	189.1	189.1
E = 29,000 ksi		Load Combinations for roof:					
Live Ld Defl= L/240 =0.53 in		Load Case #1: D + S			Est. Deck Wgt = 0.8 psf		
Total Defl= L/180 =0.40 in		Load Case #2: Deck + Wind			Wind Load = -40.0 psf		
		Load Case #3: Deck + Construction 200# Point Load					

Deck Configuration:

Deck Type: Roof Deck	Cellular: No
-----------------------------	---------------------

Core Load Combinations:

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

Steel Roof Deck Selection Table - Spans = 3

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

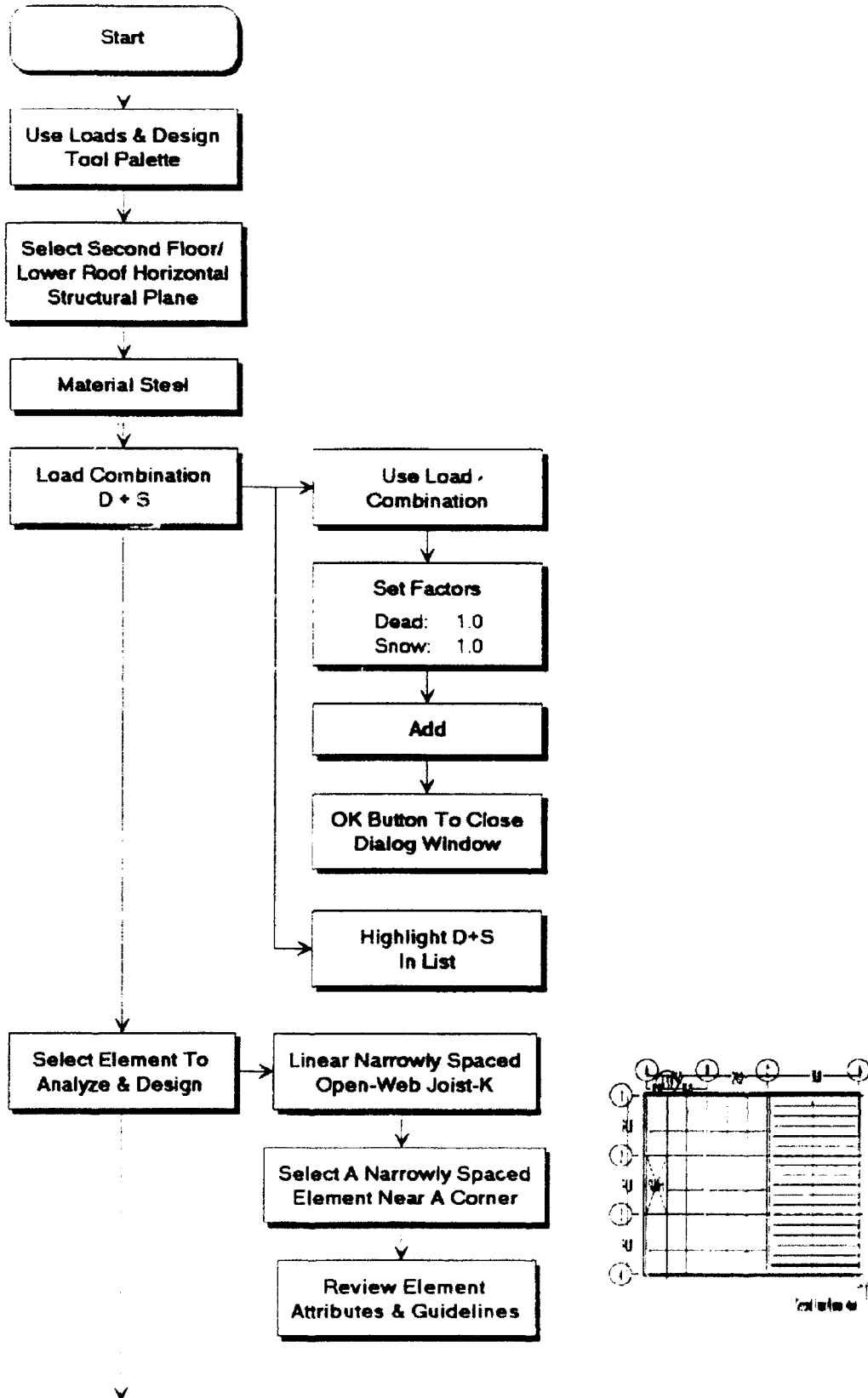
CASM Preliminary Steel Roof Deck Selection:

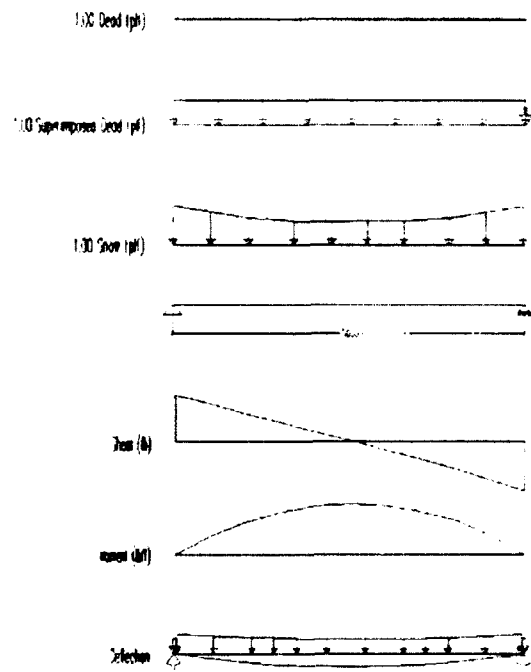
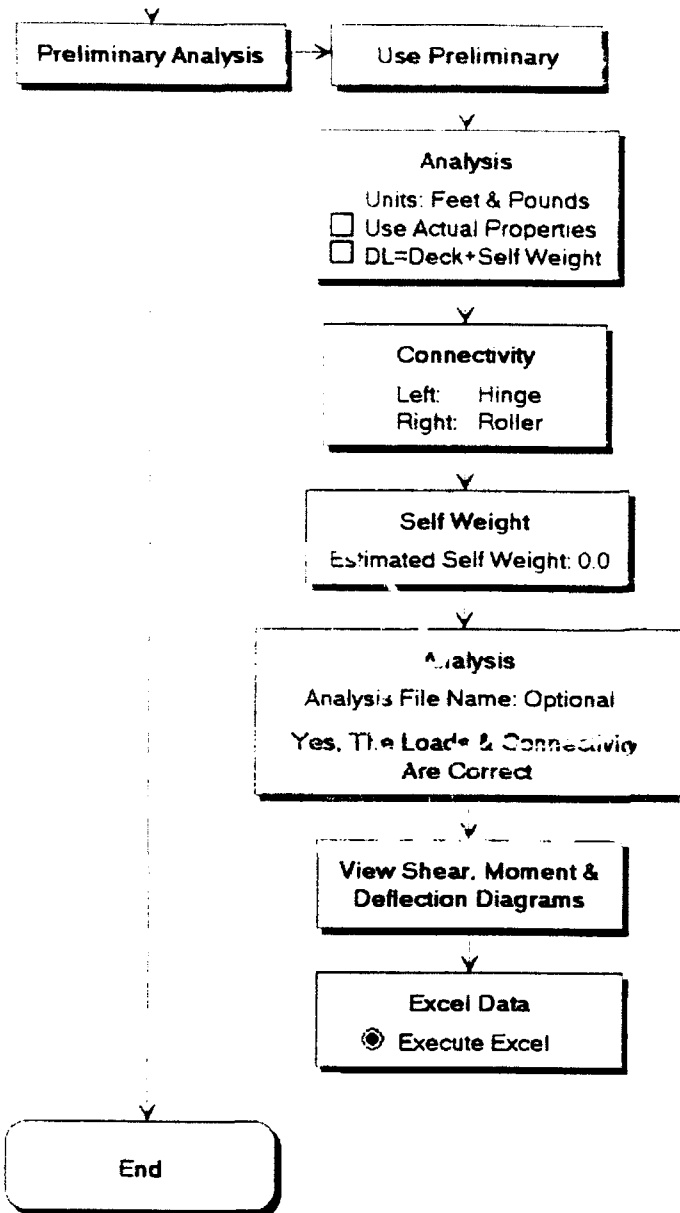
Deck Type: WR 20	Span= 8.0 ft	Depth: 1.5 in	Description: 2-1/2"Rib@6"oc	
Weight: 2.2 psf	Gage: 20	Ix = 0.207	Construction Load Span Limits:	
	Sx+ = 0.237	Sx- = -0.251	1 span: 6'-3"	2+span: 7'-5"

Notes:

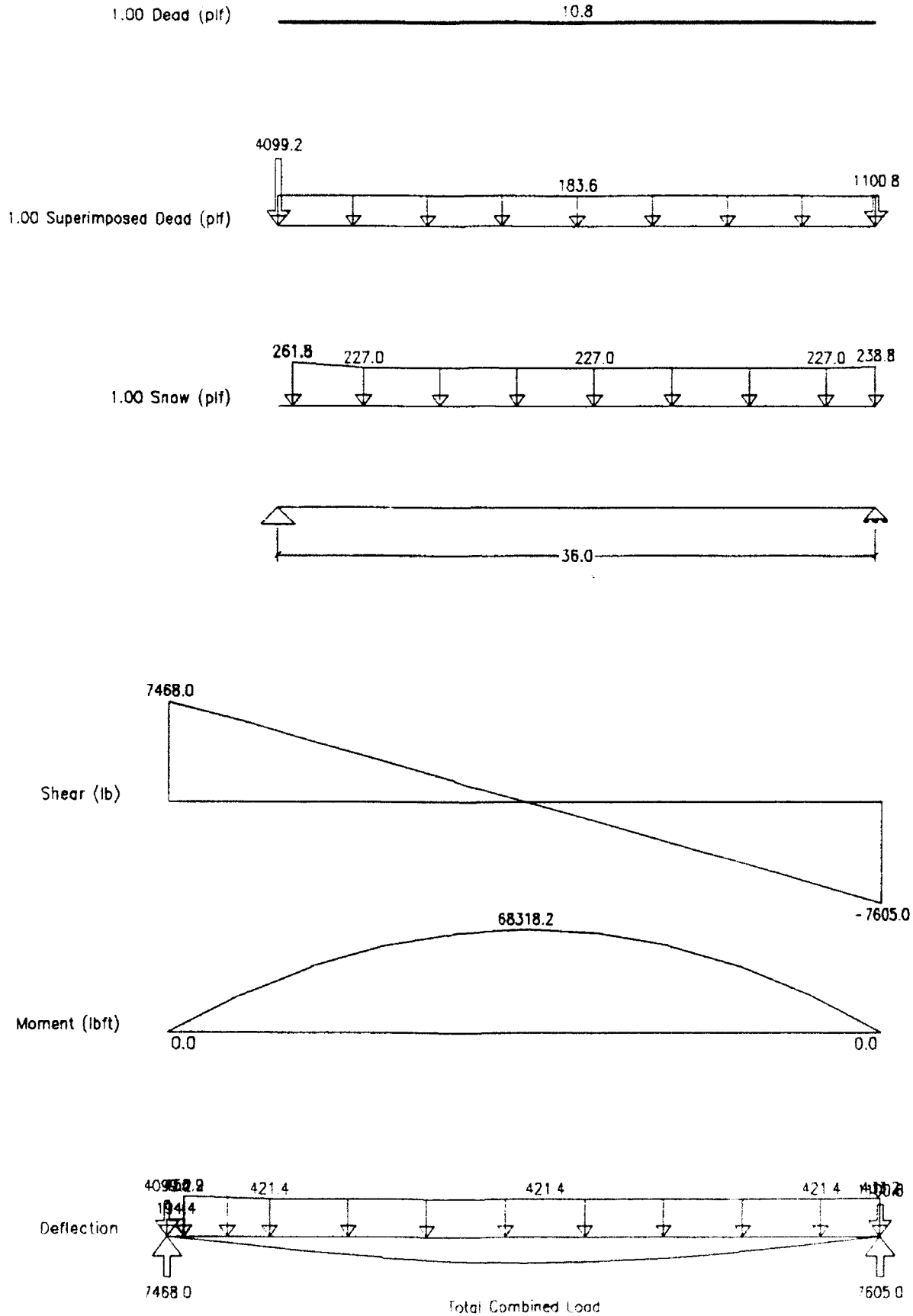
1. Steel roof deck properties from representative manufacturer's data.
2. Design calculations from SDI Design Manual for Roof Deck - 1987.

Narrowly Spaced Element Analysis





Narrowly Spaced Element Analysis



Narrowly Spaced Element Analysis

* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1982 5:20 PM

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

Office Building - Scheme B -- Dead Load

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

MATERIAL TYPES

UNITS: INCHES, POUNDS

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

MEMBER PROPERTIES

UNITS: INCHES

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

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE

UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING POSITION	ENDING POSITION	LOADING POSITION
1	UNIFORM	3.60	-10.00	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	11.660	0.000	19.440	-11.660

JOINT DATA

UNITS: FEET, POUNDS

NODE CODE	NODAL COORDINATES		BOUNDARY CONDITIONS			ELASTIC SUPPORT TYPE
	X	Y	X	Y	Z	
1	11.0	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

ELS	NODE I	NODE J	ELT TYPE	ELS CODE	Y.E.V. TYPE	SAL F12	STIFF K11	CARRY OVER FACTOR
1	1	2	1	1	0	4.00	4.00	0.50
2	2	3	1	1	0	4.00	4.00	0.50
3	3	4	1	1	0	4.00	4.00	0.50
4	4	5	1	1	0	4.00	4.00	0.50
5	5	6	1	1	0	4.00	4.00	0.50
6	6	7	1	1	0	4.00	4.00	0.50
7	7	8	1	1	0	4.00	4.00	0.50
8	8	9	1	1	0	4.00	4.00	0.50
9	9	10	1	1	0	4.00	4.00	0.50
10	10	11	1	1	0	4.00	4.00	0.50

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

JOINT DISPLACEMENTS

UNITS: INCHES, RADIAN AFTER DIVISION BY 85

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	ROTATION
1	0.0000	0.0000	1023308.8534
2	0.0000	-126125410.5597	-2854003.5578
3	0.0000	-242406448.2180	-2394460.6119
4	0.0000	-331872240.8077	-1717239.4287
5	0.0000	-388866240.7806	-894899.4204
6	0.0000	-408146495.2082	0.0000
7	0.0000	-388866240.7806	894899.4204
8	0.0000	-331872240.8077	1717239.4287
9	0.0000	-242406448.2180	2394460.6119
10	0.0000	-126125410.5597	2854003.5578
11	0.0000	0.0000	1023308.8534

MEMBER END FORCES

UNITS: FEET, POUNDS

ELS	AXIAL I	SHEAR I	MOMENT I	SHEAR J	MOMENT J
1	0.000	194.400	0.000	0.000	-155.520
2	0.000	155.520	-429.856	0.000	-116.640
3	0.000	116.640	-1119.744	0.000	-77.760
4	0.000	77.760	-1669.664	0.000	-38.880
5	0.000	38.880	-1749.600	0.000	-0.000
6	0.000	-38.880	-1749.600	0.000	38.880
7	0.000	-116.640	-1669.616	0.000	77.760
8	0.000	-77.760	-1669.664	0.000	116.640
9	0.000	-116.640	-1119.744	0.000	155.520
10	0.000	-155.520	-429.856	0.000	194.400

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

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

PROBLEMS COMPLETED

* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

2-D FRAME ANALYSIS-V 8/77 RUN-Sun Jan 26, 1982 5:20 PM

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

Office Building - Scheme B -- 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	1.0000	0.0000

MEMBER PROPERTIES

UNITS: INCHES

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

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
 UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING POSITION	ENDING POSITION	LOADING POSITION
1	UNIFORM	3.60	-103.60	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	330.400	190.200	0.000	330.400	-190.200

JOINT DATA

UNITS: FEET, POUNDS

NODE CODE	MODAL COORDINATES			MODAL FORCES AND MOMENTS			ELASTIC RESPONSE TYPE
	X	I	T	X	I	T	
1	110	7.00	0.00	0.00	0.00	0.00	0
2	0	10.40	0.00	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0.00	0
4	0	17.40	0.00	0.00	0.00	0.00	0
5	0	21.40	0.00	0.00	0.00	0.00	0
6	0	25.00	0.00	0.00	0.00	0.00	0
7	0	28.40	0.00	0.00	0.00	0.00	0
8	0	32.20	0.00	0.00	0.00	0.00	0
9	0	35.80	0.00	0.00	0.00	0.00	0
10	0	39.40	0.00	0.00	0.00	0.00	0
11	10	43.00	0.00	0.00	0.00	0.00	0

MEMBER DATA

EL	MOCK	MOCK	NET	EL	EL	F.E.F.	REL	STIFF	CARRY OVER
I	J	TYPE	TYPE	CODE	TYPE	TYPE	ELI	ELI	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

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Z-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-51396247.8380
2	0.0000	-2178131846.3768	-40518057.9591
3	0.0000	-4120910034.8538	-40705028.2877
4	0.0000	-5841827800.8764	-28193068.7720
5	0.0000	-6878868090.0484	-15213289.3401
6	0.0000	-6938493450.1321	0.0000
7	0.0000	-6878868090.0484	15213289.3401
8	0.0000	-5841827800.8764	28193068.7720
9	0.0000	-4120910034.8538	40705028.2877
10	0.0000	-2178131846.3768	40518057.9591
11	0.0000	0.0000	51396247.8380

MEMBER END FORCES

UNITS: FEET, POUNDS

EL	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	-1992.880	19035.440
3	0.000	1992.880	-19035.440	0.000	-1521.920	24994.297
4	0.000	1321.920	-24994.297	0.000	-860.960	28553.473
5	0.000	860.960	-28553.473	0.000	-0.000	28743.199
6	0.000	-0.000	-28743.199	0.000	1321.920	24994.297
7	0.000	-860.960	-24994.297	0.000	1992.880	19035.440
8	0.000	-1321.920	-19035.440	0.000	2643.840	10707.552
9	0.000	-1992.880	-10707.552	0.000	3304.800	0.000
10	0.000	-2643.840	-10707.552	0.000	3304.800	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT Z
1	0.000	3304.800	0.000
2	0.000	-0.000	-0.000
3	0.000	-2.000	-0.000
4	0.000	-0.000	-0.000
5	0.000	0.000	0.000
6	0.000	-0.000	-0.000
7	0.000	-0.000	-0.000
8	0.000	0.000	0.000
9	0.000	-0.000	0.000
10	0.000	-0.000	0.000
11	0.000	3304.800	0.000

PROBLEM COMPLETED

 * TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

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

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

Office Building - Schema B -- Snow Load

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

MATERIAL TYPES

UNITS: INCHES, POUNDS

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

MEMBER PROPERTIES

UNITS: INCHES

Narrowly Spaced Element Analysis

ELEMENT TYPE	AXIAL AREA	SHEAR AREA	MOMENT OF INERTIA
1	1.000.0000	3.0000	1.0000

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	RAMP	3.60	-261.49	0.65	-239.25	1.60
1	RAMP	3.60	-261.77	0.63	-261.49	2.85
2	UNIFORM	3.60	-228.99	1.52	3.60	3.60
3	RAMP	3.60	-239.25	0.00	-228.99	1.52
4	UNIFORM	3.60	-228.99	0.00	3.60	3.60
4	RAMP	3.60	-228.99	0.54	-238.84	3.60

FIXED END FORCES IN LOCAL COORDINATES

UNITS: FEET, POUNDS

TYPE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	256.911	211.411	0.000	435.962	-258.310
2	0.000	417.181	248.137	0.000	409.261	-245.865
3	0.000	408.575	245.145	0.000	408.575	-245.145
4	0.000	412.842	248.937	0.000	422.351	-251.899

JOINT DATA

UNITS: FEET, POUNDS

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

MEMBER DATA

ELE	MEMBER	MEMBER	MEMBER	ELE	ELE	ELE	STIFF	CARRY OVER
I	J	TYPE	TYPE	CODE	TYPE	RIJ	EJI	FACTOR
1	1	2	1	1	0	1	4.00	4.00
2	2	3	1	1	0	2	4.00	4.00
3	3	4	1	1	0	3	4.00	4.00
4	4	5	1	1	0	3	4.00	4.00
5	5	6	1	1	0	3	4.00	4.00
6	6	7	1	1	0	3	4.00	4.00
7	7	8	1	1	0	3	4.00	4.00
8	8	9	1	1	0	3	4.00	4.00
9	9	10	1	1	0	3	4.00	4.00
10	10	11	1	1	0	4	4.00	4.00

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

JOINT DISPLACEMENTS

UNITS: INCHES, RADIANS AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	1-ROTATION
1	0.0000	0.0000	-43862352.4687
2	0.0000	-2496833542.0345	-40109090.4609
3	0.0000	-5105261224.3298	-50410811.8458
4	0.0000	-4986465119.9759	-38140140.4944
5	0.0000	-4183902930.3205	-14823555.4926
6	0.0000	-4592913108.3733	14371.4712
7	0.0000	-4182713864.0544	18848625.9098
8	0.0000	-4946403664.1839	36156240.5354
9	0.0000	-5102980232.5319	55406189.4801
10	0.0000	-2497241549.7188	40079484.1562
11	0.0000	0.0000	53847124.5340

MEMBER END FORCES

UNITS: FEET, POUNDS

ELE	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	3968.630	-15.000	0.000	-1275.938	13315.012
2	0.000	3275.836	-13315.012	0.000	-2449.485	23608.730
3	0.000	2449.485	-23608.730	0.000	-1432.338	30956.008
4	0.000	1432.338	-30956.008	0.000	-415.187	35261.547
5	0.000	415.187	-35261.547	0.000	1.943	34825.352
6	0.000	-1.943	-34825.352	0.000	419.112	35347.418
7	0.000	-419.112	-35347.418	0.000	1938.261	25827.744
8	0.000	-1938.261	-25827.744	0.000	2493.411	23566.326
9	0.000	-2493.411	-23566.326	0.000	3270.560	13263.188
10	0.000	-3270.560	-13263.188	0.000	4105.752	0.000

APPLIED JOINT LOADS AND SUPPORT REACTIONS

UNITS: FEET, POUNDS

NODE	FORCE X	FORCE Y	MOMENT X
1	0.000	3968.630	-15.000
2	0.000	-0.000	-0.000
3	0.000	0.000	-0.000
4	0.000	-0.000	-0.000
5	0.000	-0.000	-0.000
6	0.000	-0.000	-0.000
7	0.000	-0.000	0.000
8	0.000	0.000	-0.000
9	0.000	0.000	-0.000
10	0.000	0.000	-0.000
11	0.000	4105.752	0.000

***** PROBLEM COMPLETED *****

* TWO DIMENSIONAL FRAME ANALYSIS PROGRAM *

1-D FRAME ANALYSIS-V 8/77 REV-000 Jan 26, 1992 5:20 PM

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

Office Building - Scheme 2 - Total Col. Spaced Load

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

MATERIAL TYPES

UNITS: INCHES, POUNDS

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

MEMBER PROPERTY

UNITS: INCHES

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

SUMMARY OF IN-SPAN LOADS

POSITIVE IS UPWARD AND COUNTERCLOCKWISE
UNITS: FEET, POUNDS

LOAD SET	LOAD TYPE	SPAN LENGTH	STARTING MAGNITUDE	STARTING POSITION	ENDING MAGNITUDE	ENDING POSITION
1	UNIFORM	3.60	-194.40	0.00	3.60	3.60
1	RAMP	3.60	-261.49	0.65	-219.25	1.60
1	RAMP	3.60	-261.77	0.63	-261.49	2.85
2	UNIFORM	3.60	-194.40	1.52	3.60	3.60
2	UNIFORM	3.60	-228.99	1.52	-228.99	1.52
3	UNIFORM	3.60	-421.39	0.00	3.60	3.60
4	UNIFORM	3.60	-194.40	0.00	3.60	3.60
4	UNIFORM	3.60	-228.99	0.00	3.60	3.60
4	RAMP	3.60	-228.99	0.54	-218.84	3.60

Narrowly Spaced Element Analysis

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	408.831	421.383	0.000	785.902	-468.282
2	0.000	787.111	458.048	0.000	759.181	-755.837
3	0.000	758.495	455.087	0.000	748.495	455.087
4	0.000	742.762	456.909	0.000	772.271	-441.851

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	12.68	0.00	0.00	0.00	0
3	0	14.20	0.00	0.00	0.00	0
4	0	17.88	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	28.68	0.00	0.00	0.00	0
8	0	32.28	0.00	0.00	0.00	0
9	0	35.88	0.00	0.00	0.00	0
10	0	39.48	0.00	0.00	0.00	0
11	10	43.08	0.00	0.00	0.00	0

MEMBER DATA

MEMBER	FROM	TO	TYPE	SL	SL	F.R.F.	REL	TYPE	CARRY OVER
1	J	J	TYPE	CODE	TYPE	TYPE	K/J	K/J	FACTOR
1	1	2	1	1	0	1	4.00	4.00	0.50
2	2	3	1	1	0	2	4.00	4.00	0.50
3	3	4	1	1	0	3	4.00	4.00	0.50
4	4	5	1	1	0	3	4.00	4.00	0.50
5	5	6	1	1	0	3	4.00	4.00	0.50
6	6	7	1	1	0	3	4.00	4.00	0.50
7	7	8	1	1	0	3	4.00	4.00	0.50
8	8	9	1	1	0	3	4.00	4.00	0.50
9	9	10	1	1	0	3	4.00	4.00	0.50
10	10	11	1	1	0	4	4.00	4.00	0.50

***** JOINT DISPLACEMENTS *****

JOINT DISPLACEMENTS

UNITS: INCHES, RADIAN AFTER DIVISION BY EI

JOINT	X-DISPLACEMENT	Y-DISPLACEMENT	Z-ROTATION
1	0.0000	0.0000	-118181809.5601
2	0.0000	-5005080838.9711	-111481152.3776
3	0.0000	-7448377744.2017	-93510700.7454
4	0.0000	-12962145161.4607	-67080457.6951
5	0.0000	-15180235281.1495	-14931744.2734
6	0.0000	-15528353281.7134	14371.4712
7	0.0000	-15179063314.8834	14956824.6805
8	0.0000	-12960103705.4779	67064540.7361
9	0.0000	-9468276752.4037	93506477.7597
10	0.0000	-5002488626.6332	111451545.7129
11	0.0000	0.0000	118066691.2274

MEMBER END FORCES

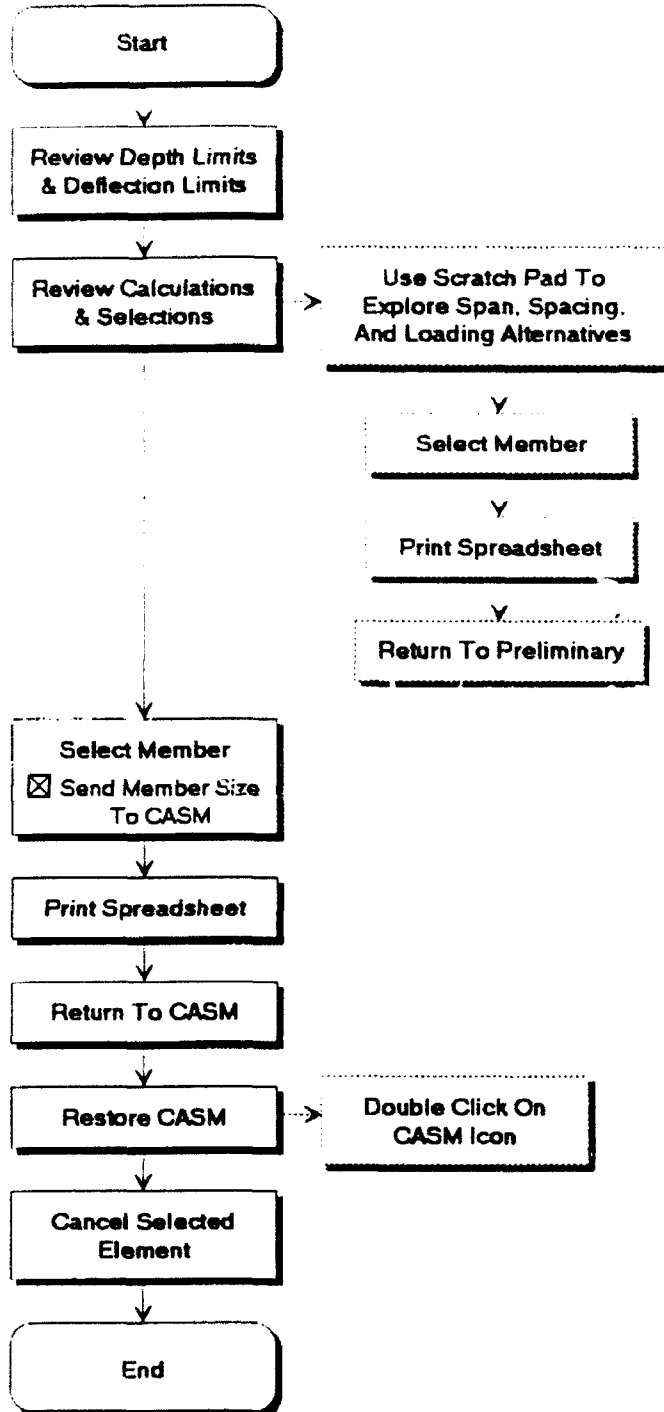
UNITS: FEET, POUNDS

MEM	AXIAL I	SHEAR I	MOMENT I	AXIAL J	SHEAR J	MOMENT J
1	0.000	7468.028	-0.000	0.000	-6075.287	24852.420
2	0.000	6075.287	-24852.420	0.000	-4549.005	43784.121
3	0.000	4549.005	-43784.121	0.000	-3052.016	57409.861
4	0.000	3052.016	-57409.861	0.000	-1515.026	85594.641
5	0.000	1515.026	-85594.641	0.000	1.863	60318.154
6	0.000	-1.863	-60318.154	0.000	1518.952	45540.508
7	0.000	-1518.952	-45540.508	0.000	3035.941	57381.499
8	0.000	-3035.941	-57381.499	0.000	4532.931	43721.727
9	0.000	-4532.931	-43721.727	0.000	6069.920	24800.588
10	0.000	-6069.920	-24800.588	0.000	7464.952	0.000

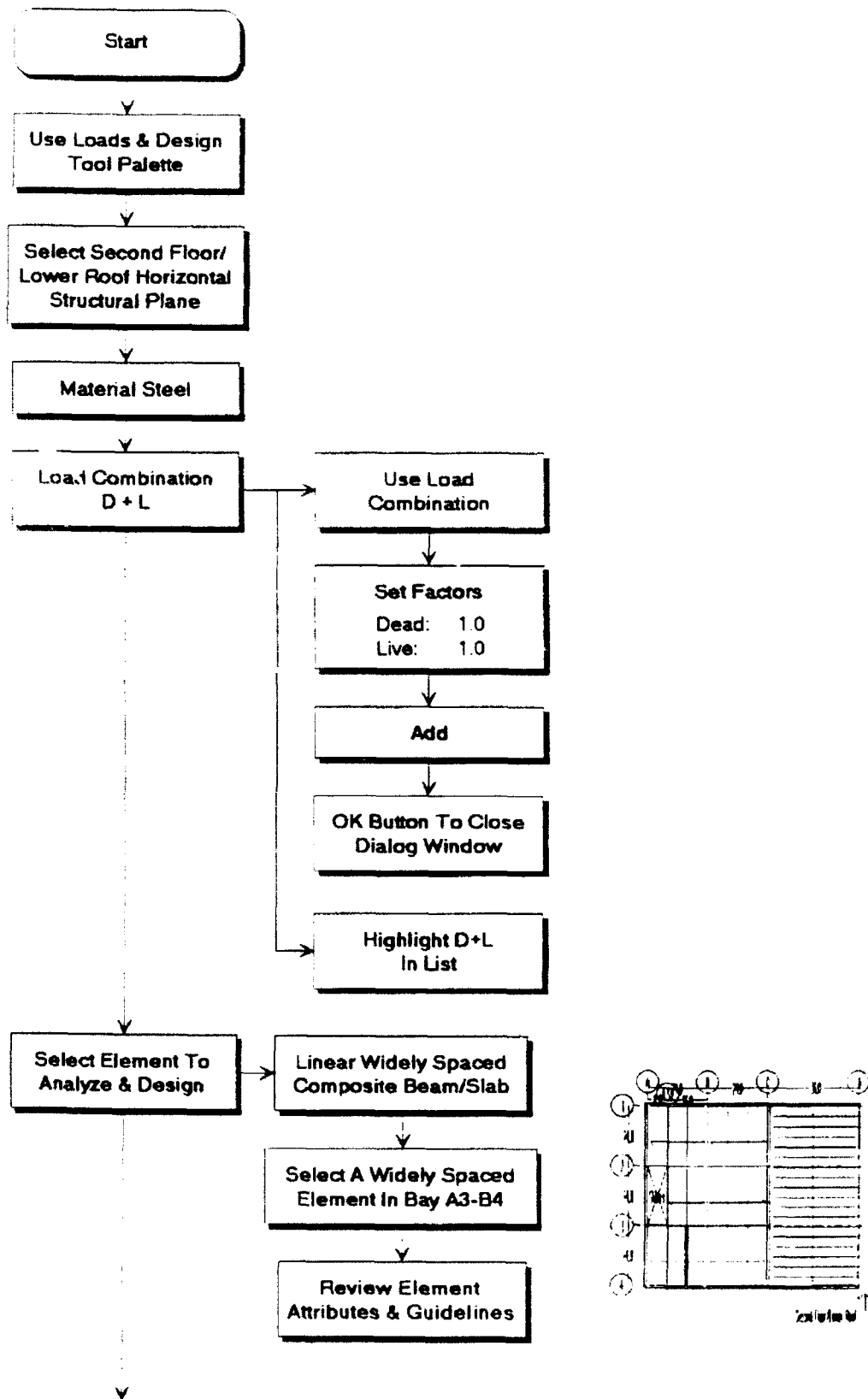
APPLIED JOINT LOADS AND SUPPORT REACTIONS

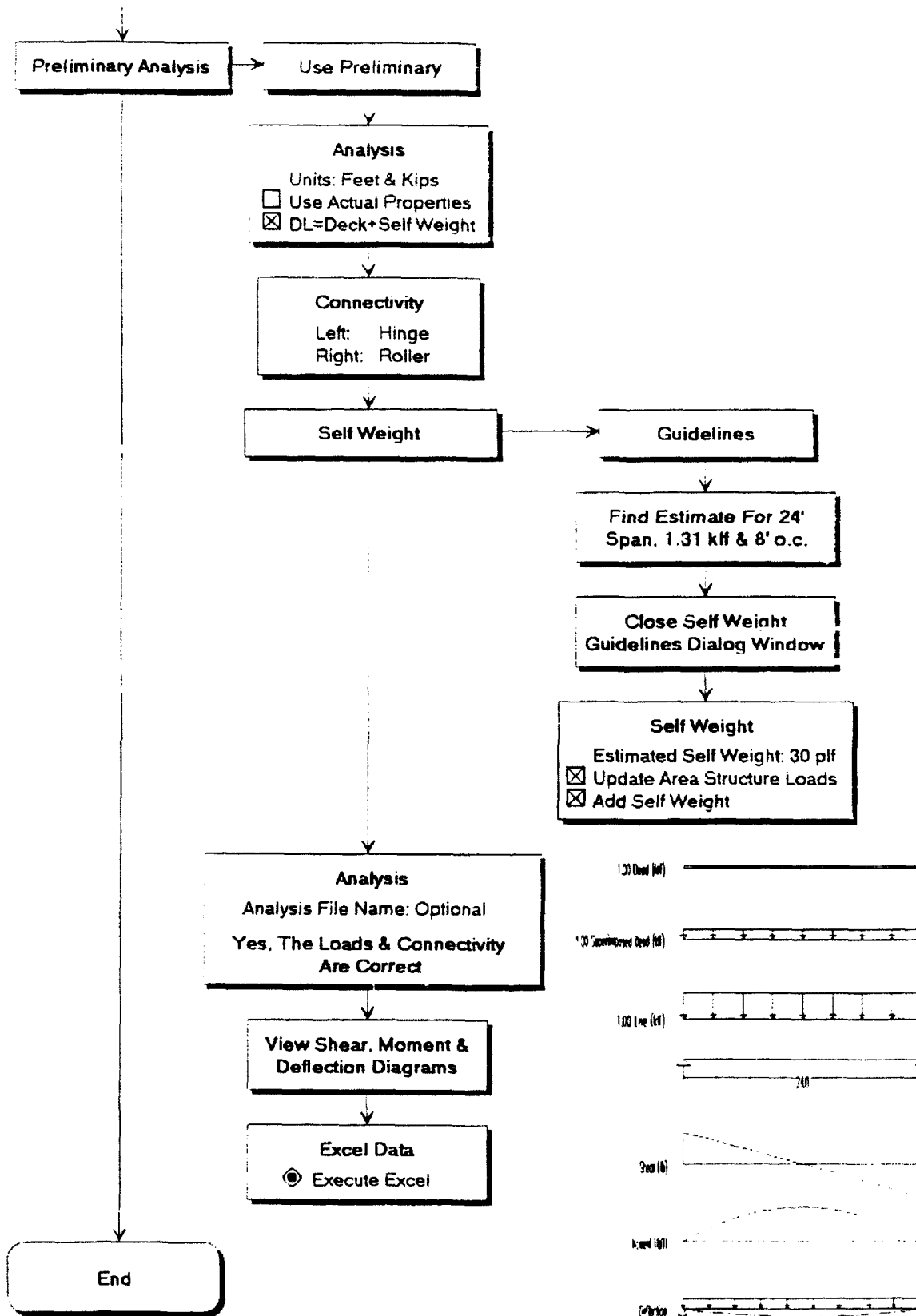
UNITS: FEET, POUNDS

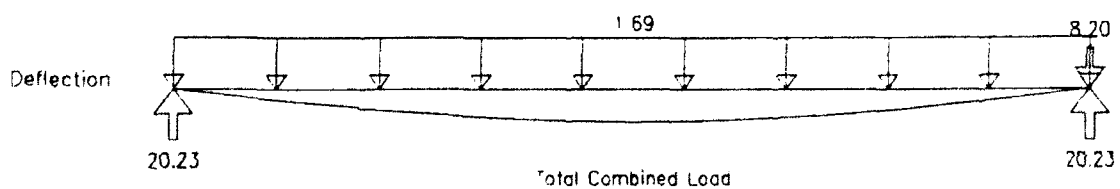
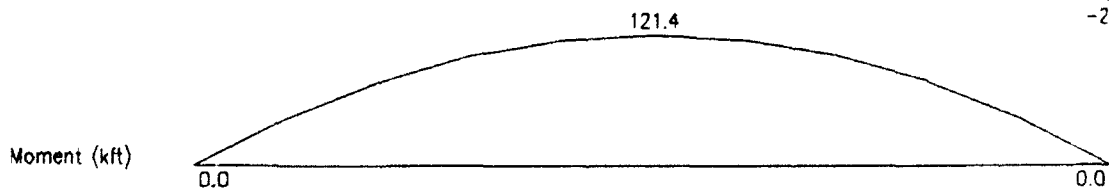
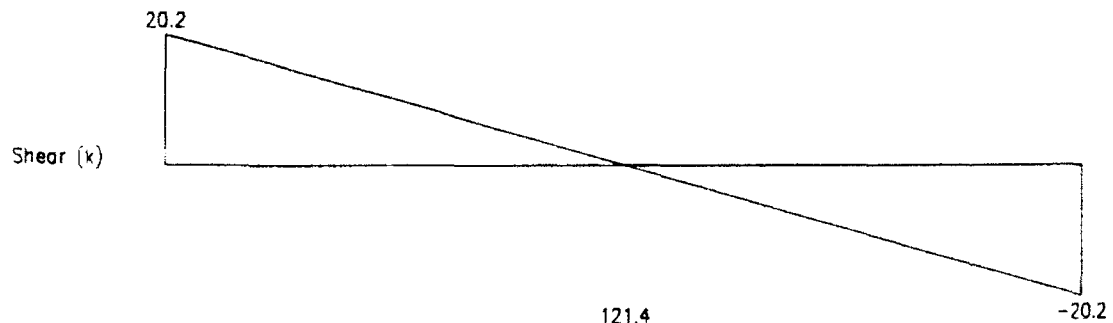
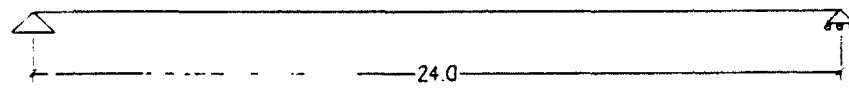
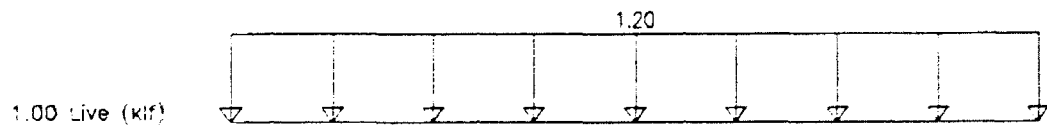
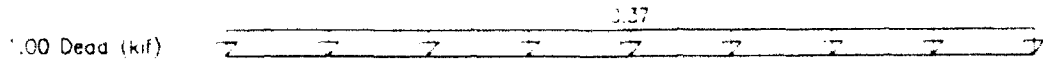
Steel Open-Web Joist Design



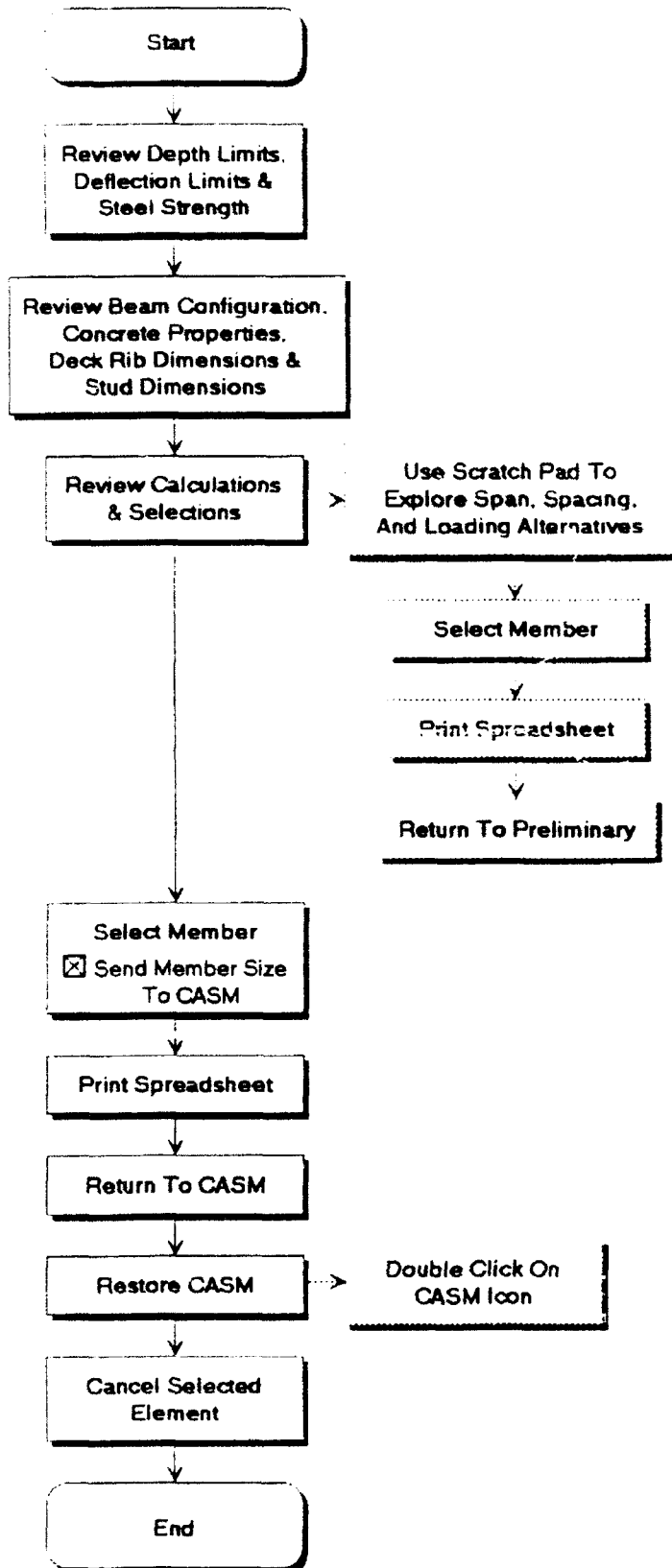
Widely Spaced Element Analysis: Beam







Composite Steel Beam Design



Preliminary Selection

STEEL COMPOSITE BEAM PRELIMINARY SELECTION

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

CASM Load & Analysis Data:

Method: Analysis		Load Combination: D + L					
Member ID:		Load Type	Factored Moments (k-ft)			Fact. Reactions	
Connectivity: Hinge (Left)			Left	Mid	Right	Left(k)	Right(k)
Roller (Right)		Dead		26.4		4.4	4.4
Beam Span: 24.0 ft		Sup Dead		8.6		1.4	1.4
Trib Width= 8.0 ft		Live		86.4		14.4	14.4
Depth Limit= 36.0 in. max		Lmin Roof					
Fy= 36.0 ksi		Snow					
Fb=Fy*0.66= 24.0 ksi		Wind					
Fy * 0.89= 32.0 ksi		Summary		121.4		20.2	20.2
Fv= 14.4 ksi							
Es= 29,000 ksi							

Beam	Composite Properties:
------	-----------------------

Deflection Limits:	Beam Composite Properties:			
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= 2.00 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= 3.5 in		
Str(req)= 61 in^3	Slab ts= 4.00 in	Reduct. Factor= 0.80		
Composite percent= 100 %	Slab bE= 70.5 in	Shear Cap= 10.6 kips		

CASM Beam Selection Table:

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

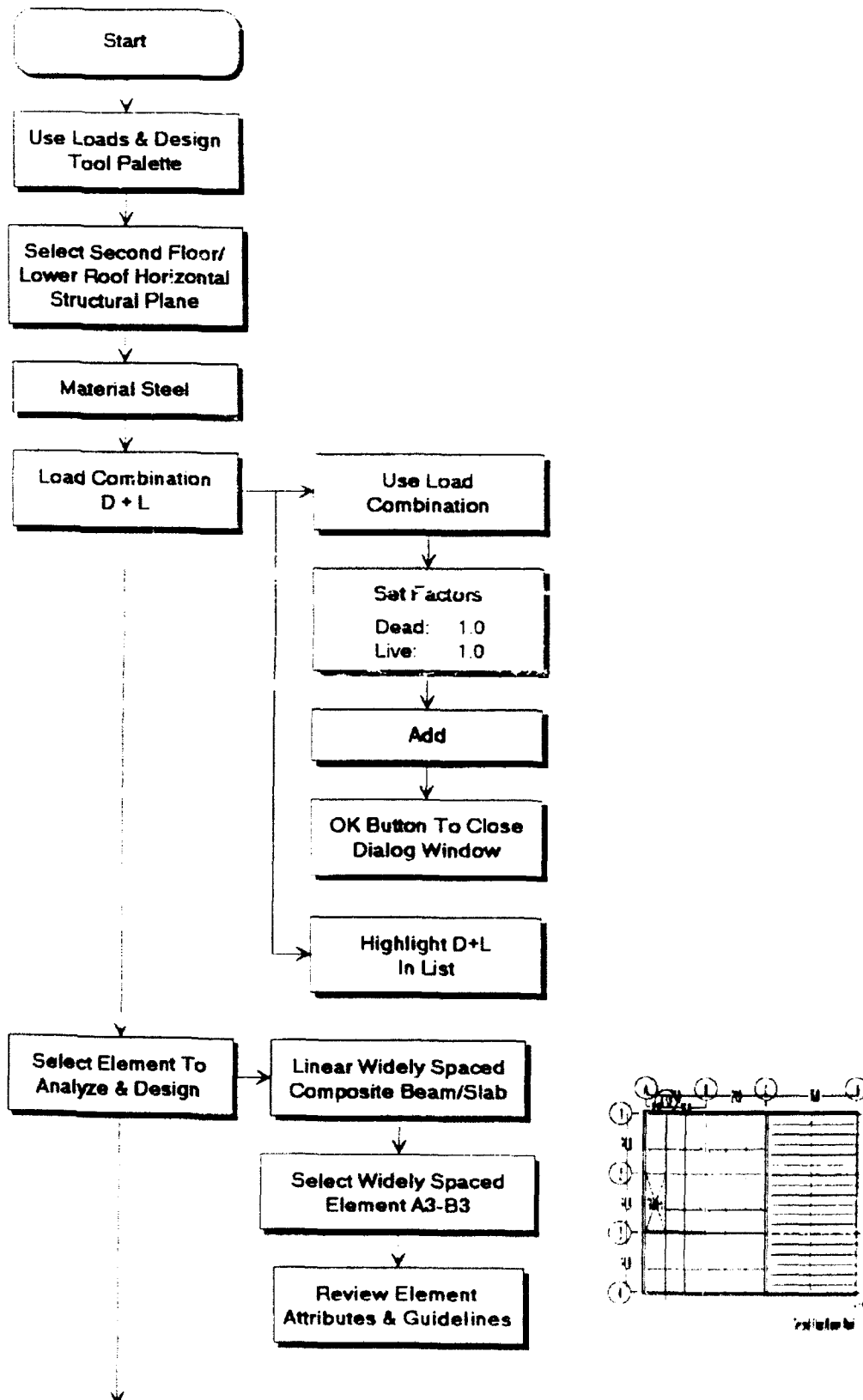
CASM Steel Beam Selection:

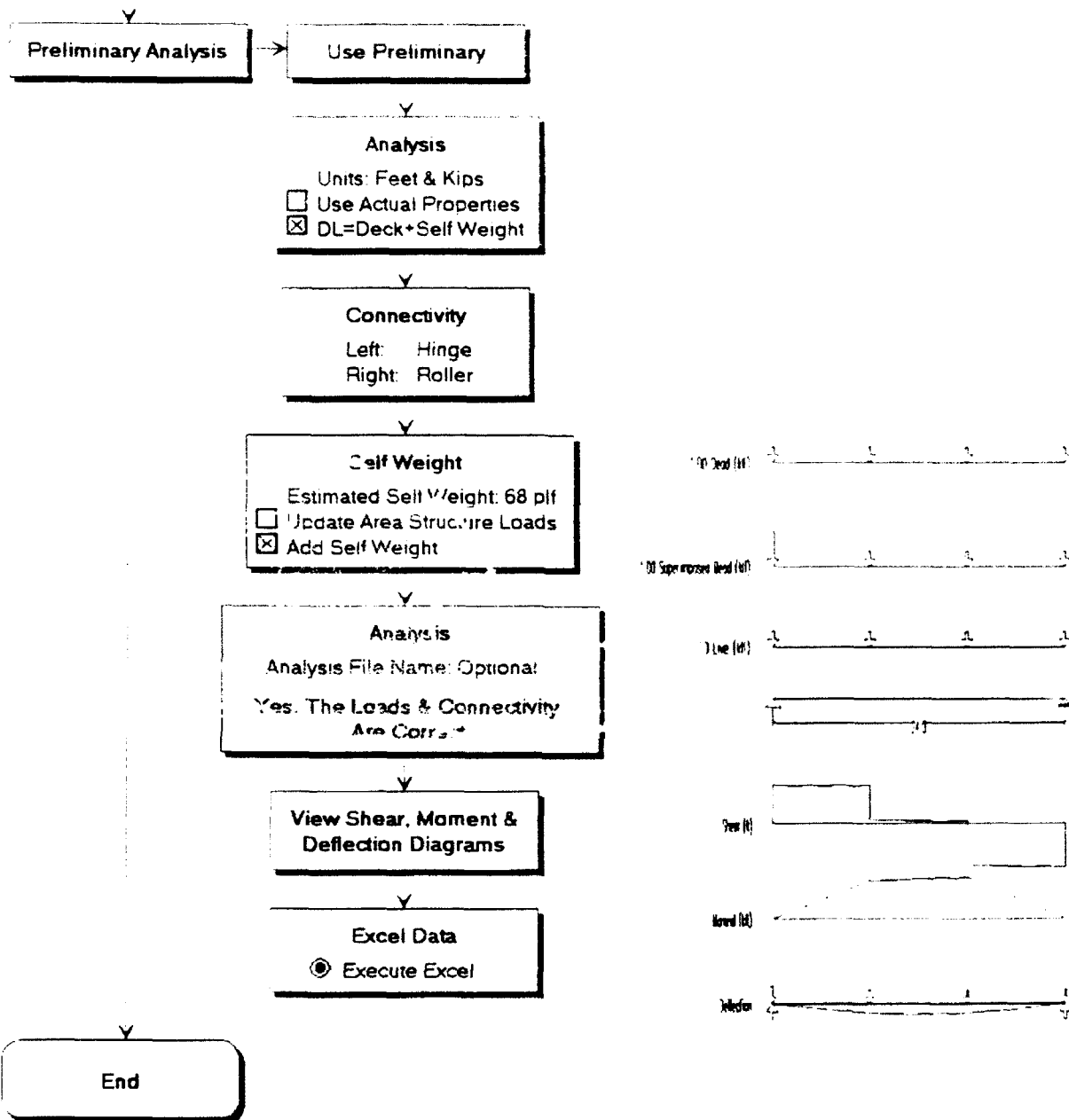
						Live Ld	Total
W 16 x 26	Span= 24.0 ft	Seff(in3)= 60.8	Ieff(in4)= 934	Defl(in)= -0.36		-0.68	
Shores Reqd:	No	Nstuds= 28 (full)	Partial: (100 %)	Nstuds= 28		fv= 5.2ksi	
						Beam Wgt=	0.31 tons

Notes:

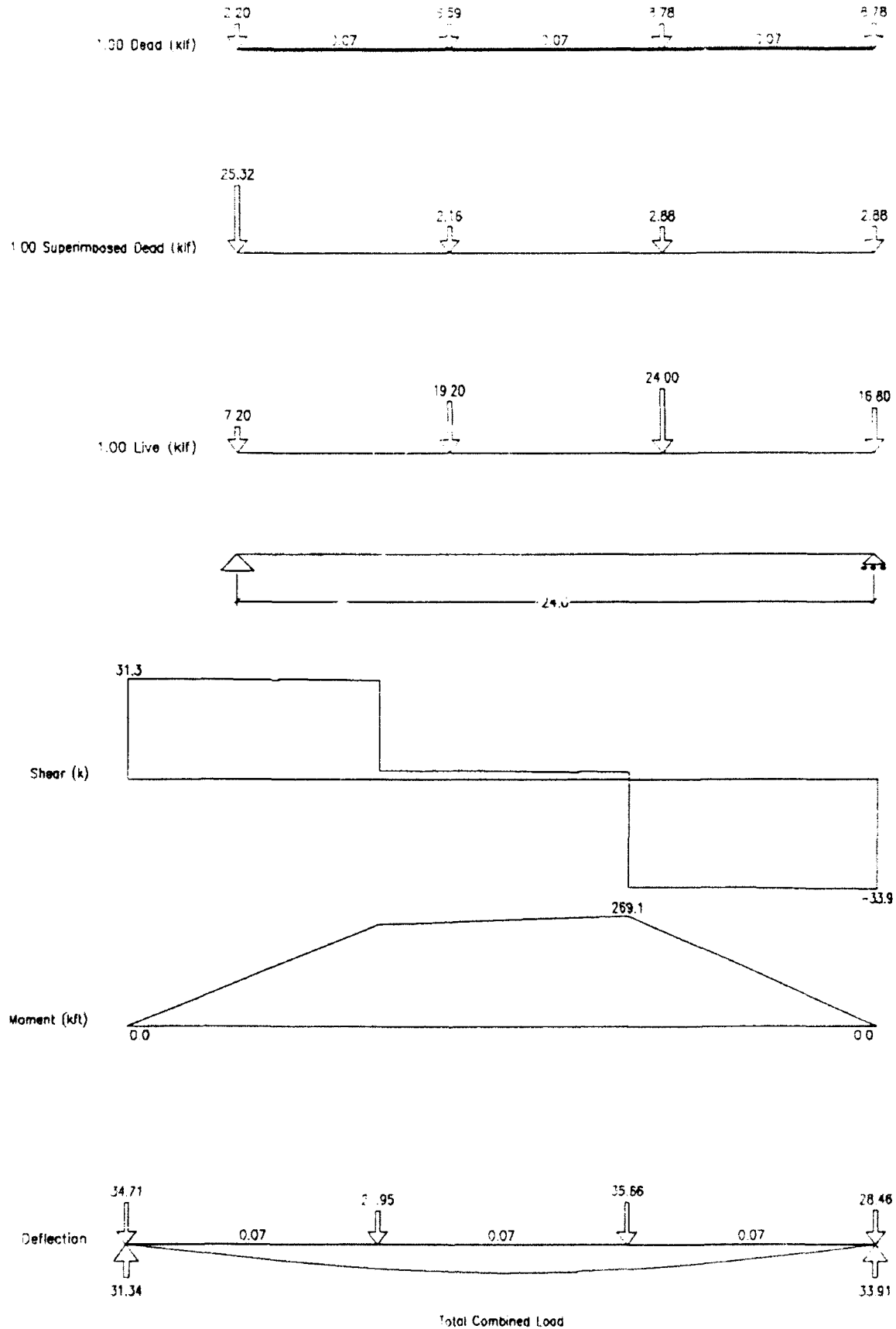
- Steel beam properties and composite beam properties based on ASD - AISC Steel Construction Manual, 9th edition.
- Dead load shear and moment are not modified with changes in slab depth.

Widely Spaced Element Analysis: Girder

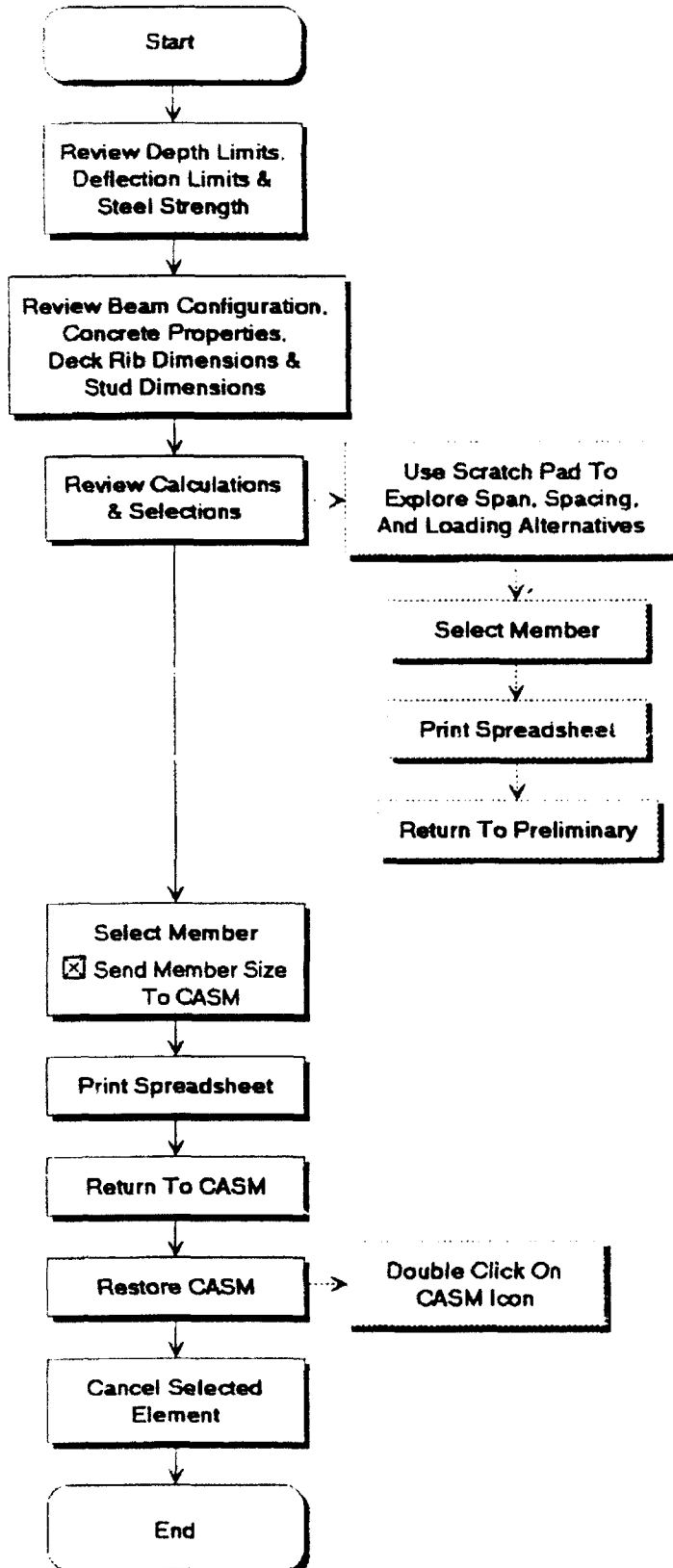




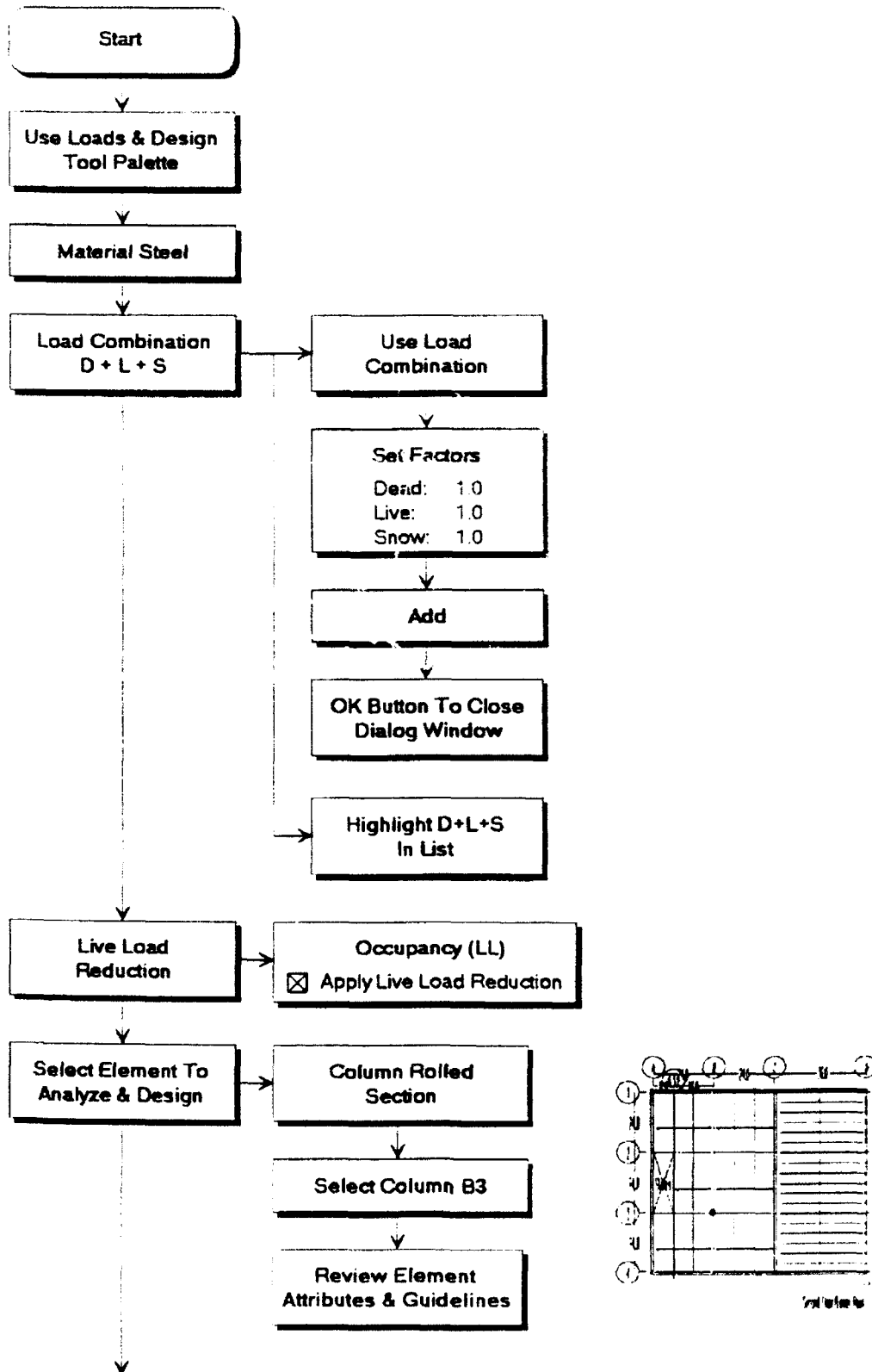
Widely Spaced Element Analysis: Girder

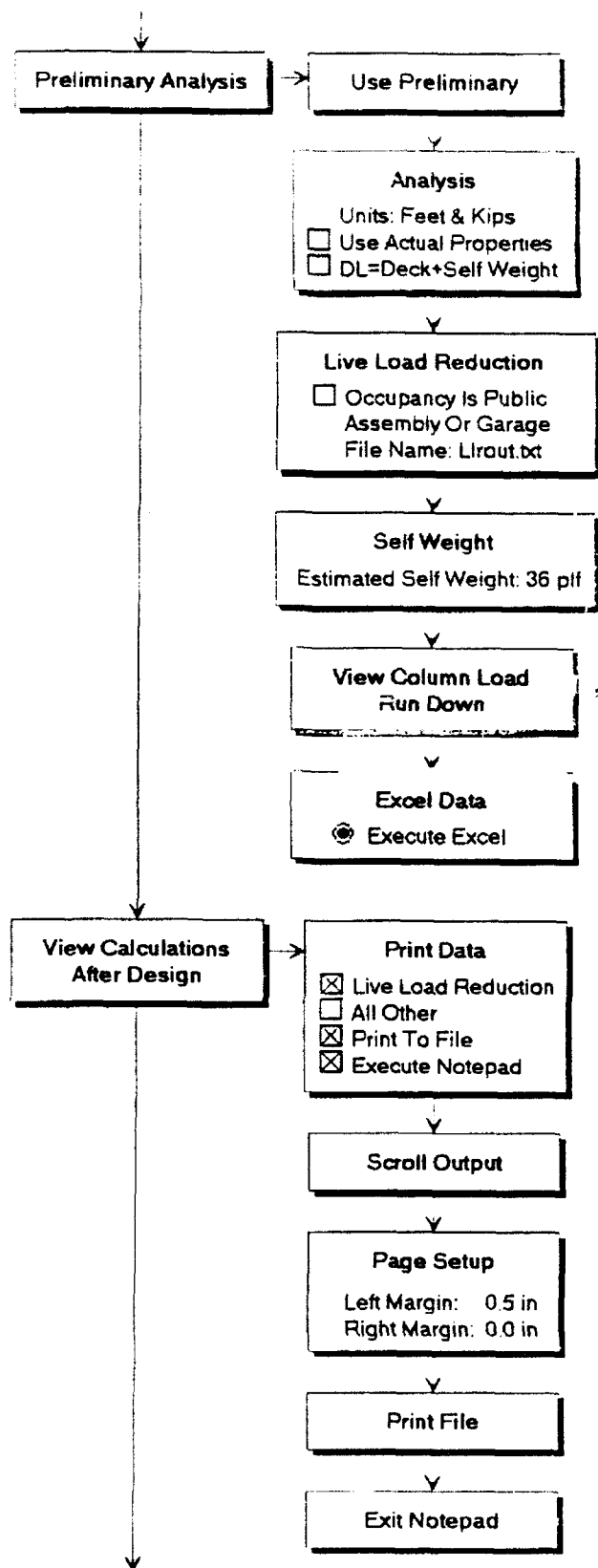


Composite Steel Beam Design

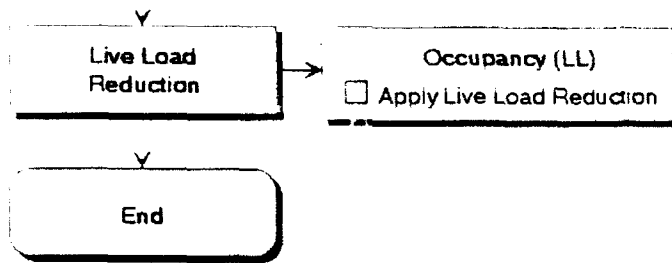


Column Load Run Down

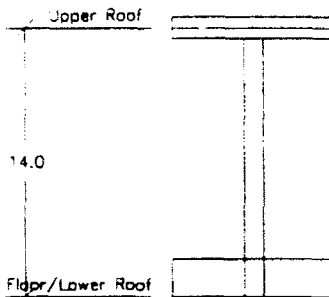
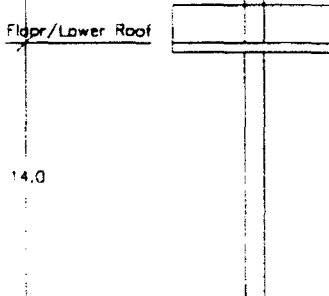




Thickener Feed (Lbs)	70	110	118	75	70	100	105	100	105	100
1st Thickener Feed	578.2	5.5	0.0	0.0	14.4	11.7				
2nd Thickener Feed	578.0	15.9	37.5	0.0	12.7					



Column Load Run Down

		Tributary Area	Self Weight	DL	LR	SLR	W	TL	Sum DL	Sum LR	Sum S	Sum TL
Upper Roof		576.0		9.3	0.0	0.0	14.4	22.7				
14.0			0.5						8.8	0.0	14.4	23.2
Second Floor/Lower Roof		576.0		35.0		37.8	0.0	72.8				
14.0			0.5						44.3	37.8	14.4	96.5

Column B-3 Load Run Down (k)

Column Load Run Down

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

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

Second Floor/Lower Roof
Office: Offices (Lo) : 50.0 psf
Tributary area (TA) : 576.0 sf
Area of influence (Ai) = 4*TA for columns.
Ai = 2304.0 sf
Ai >= 400.0 sf
Lo <= 100.0 psf
 $L = Lo * (0.25 + 15 / \sqrt{Ai})$
L = 28.1 psf
Member supports only one floor.
L >= 0.5*Lo
0.5*Lo = 25.0 psf
+-----+
| L = 28.13 psf |
+-----+

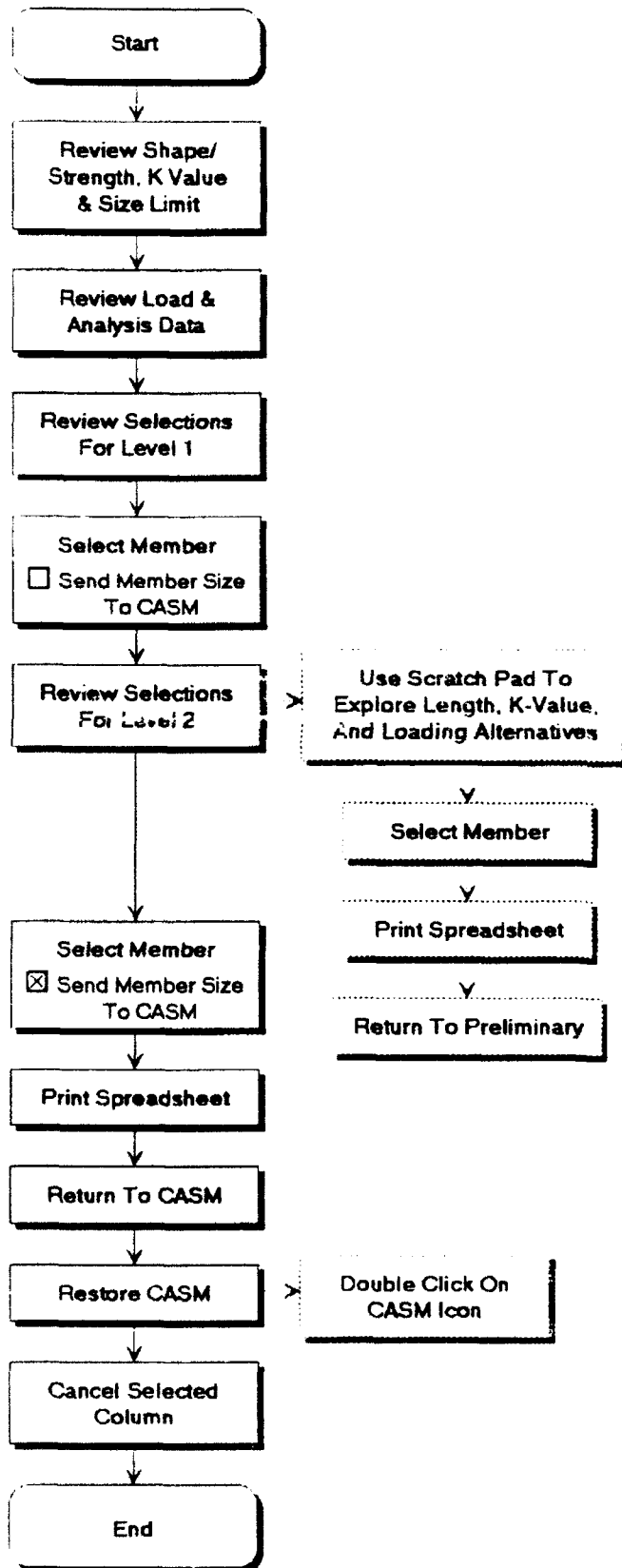
***** Live Load Reduction *****

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

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

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

Steel Column Design



Steel Column Preliminary Selection

STEEL COLUMN PRELIMINARY SELECTION

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

CASM Load & Analysis Data:

Method: Analysis		Load Combination: D + L + S		Steel Fy=		36.0 ksi			
Member ID: B-3		Size Limit=		16.0 in. max		E= 29000 ksi			
Name	Level	Fir to Fir 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			14.4		23.2
Second Floor/L	1	14.0	576	44.3	37.8		14.4		96.5

CASM Column Selection Table

Level: 2		Preq: 23.2 kips			K-value: 1.0			Cc= 126.1	
Col Shape: W		Length: 14.0 ft			kl: 14.0				
Column Size	Depth d(in)	Width bf(in)	Area (sq in)	ry (in)	kl/r	Fa (ksi)	fa (ksi)	Pallow (kip)	Weight (ton)
W 6 x 15	5.99	5.99	4.43	1.46	115.07	10.98	5.24	48.6	0.11
W 5 x 16	5.01	5.00	4.68	1.27	132.28	8.45	4.96	39.6	0.11
W 8 x 18	8.14	5.25	5.26	1.23	136.59	7.78	4.41	40.9	0.13
W 5 x 19	5.15	5.03	5.54	1.28	131.25	8.61	4.19	47.7	0.13
W 8 x 28	8.06	6.54	8.25	1.62	103.70	12.50	2.81	103.2	0.20

CASM Steel Column Selection

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

Total Column Weight: 0.20

Notes:

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

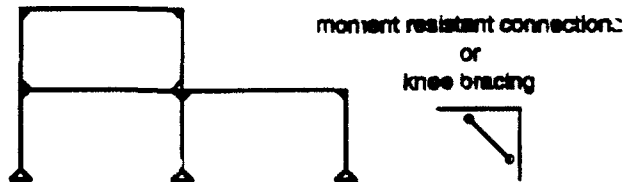
Lateral Resistance Philosophy

Steps Required

1. Create building volume
2. Define a structural grid
3. Layout structural framing on ALL levels
4. Assign gravity load on ALL levels
Calculate wind and/or seismic loads
5. Select a load combination including wind or seismic loads
6. Define N-S & E-W vertical resistance system

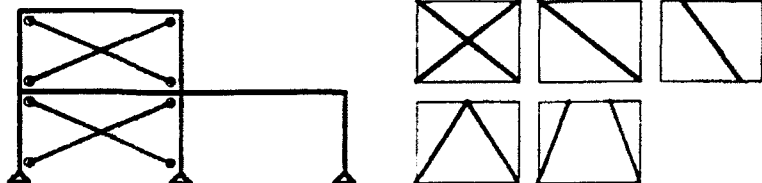
Options:

1. Unbraced Frames

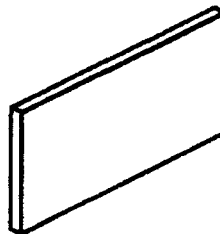


2. Braced Frames

A. Trussing



B. Shear Walls



7. Define horizontal diaphragm systems

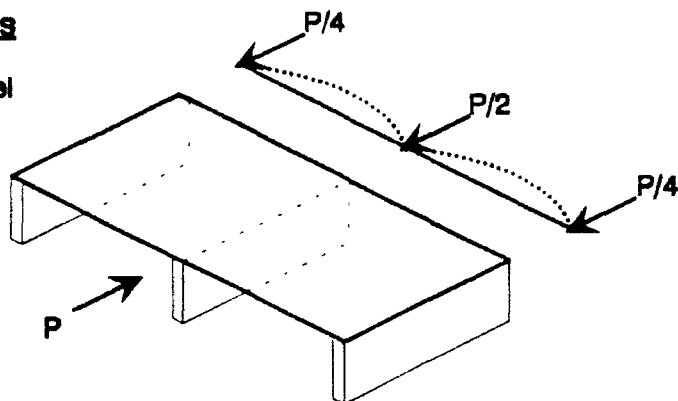
All flexible

All rigid

Floors rigid & roof flexible

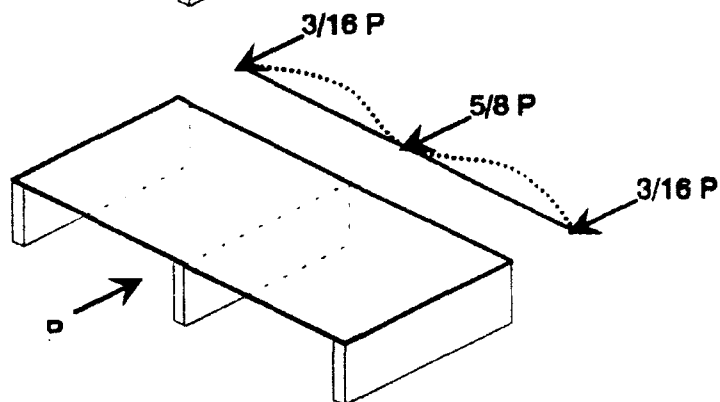
Flexible Diaphragms

Simple Beam Model
(tributary area)



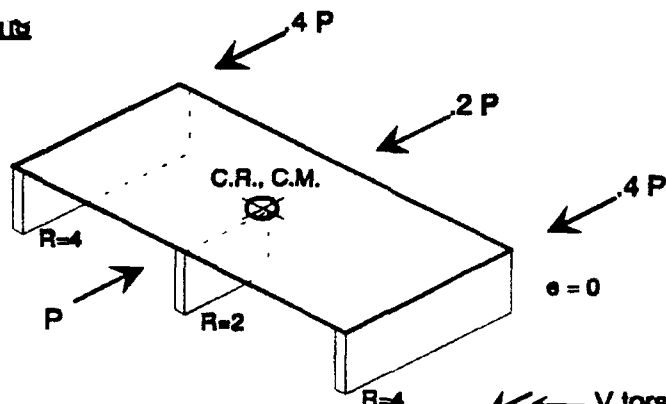
* No Torsion

Continuous Beam Model



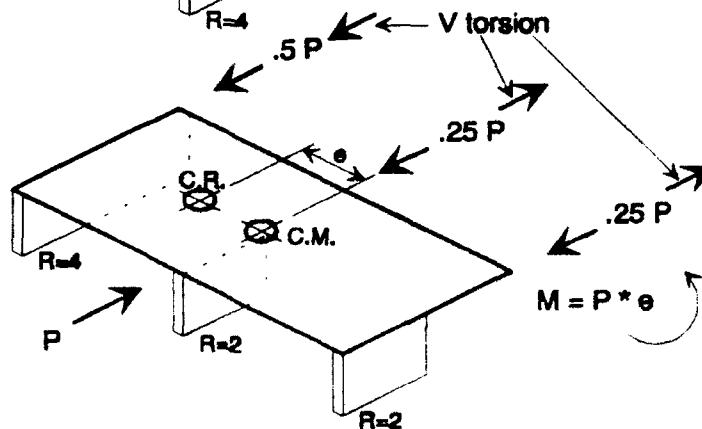
Rigid Diaphragms

Symmetrical

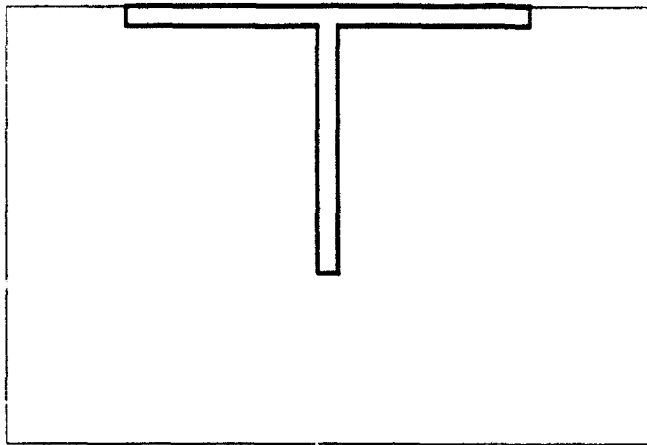


Torsion
(even accidental
minimum required)

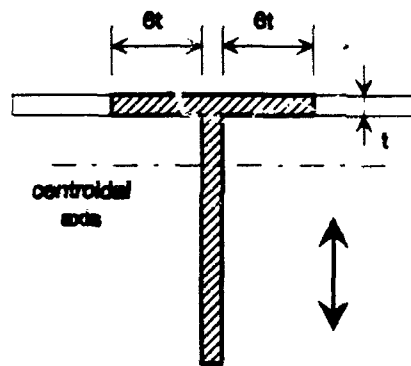
Non-Symmetrical



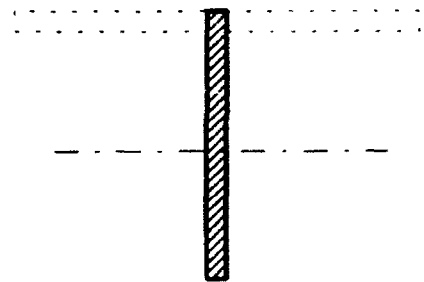
Monolithic Perpendicular Shear Walls



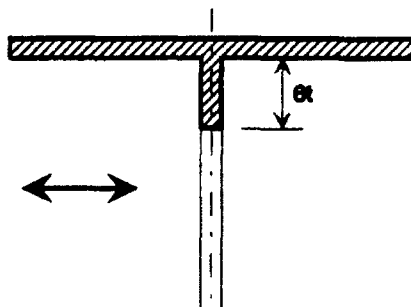
For N-S



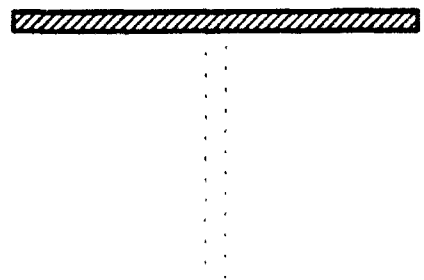
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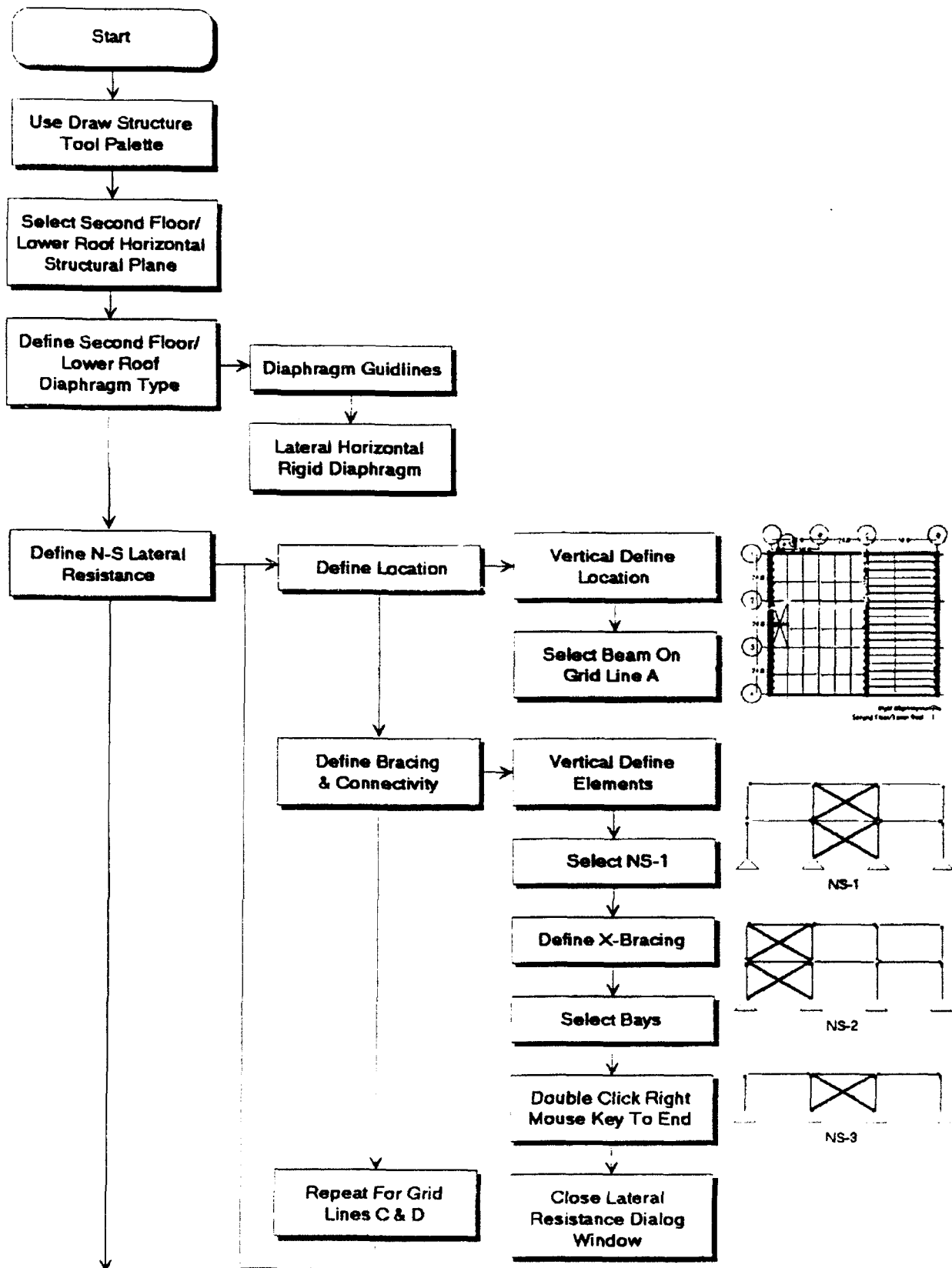
For E-W



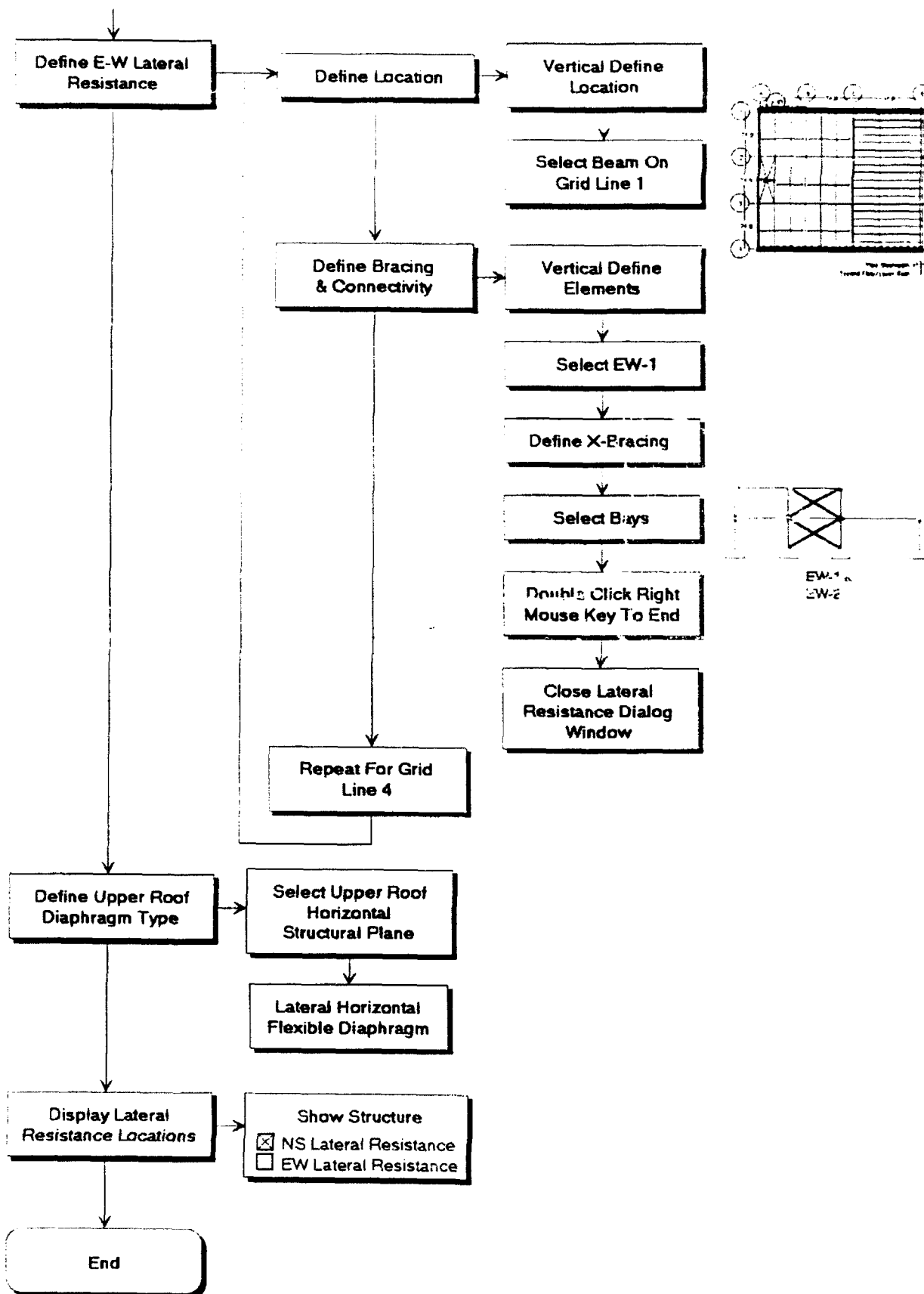
or

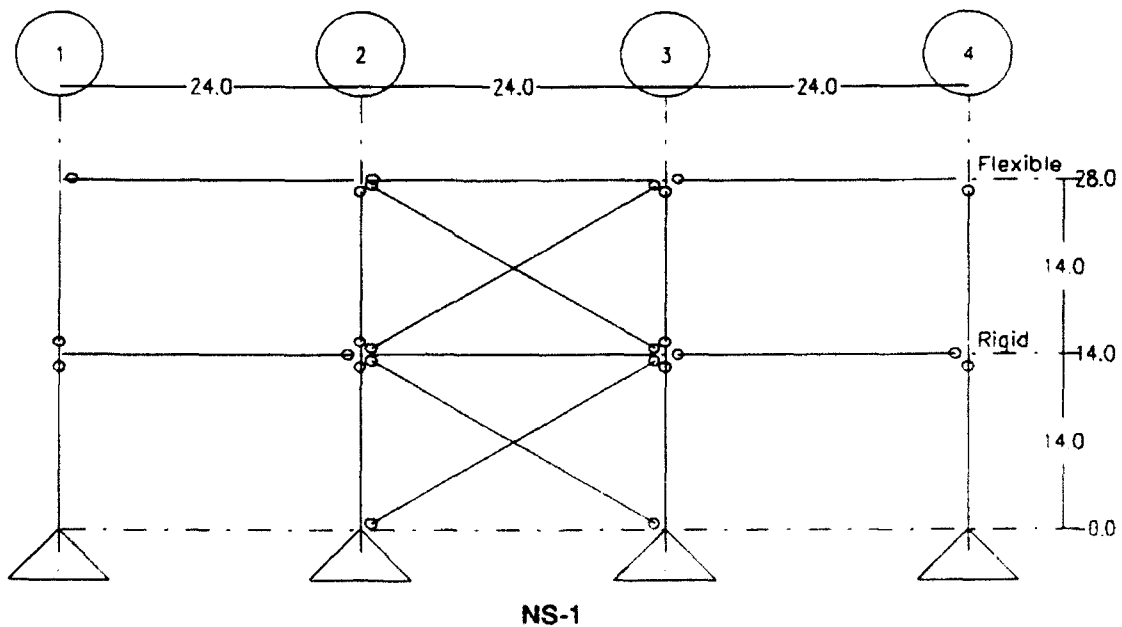
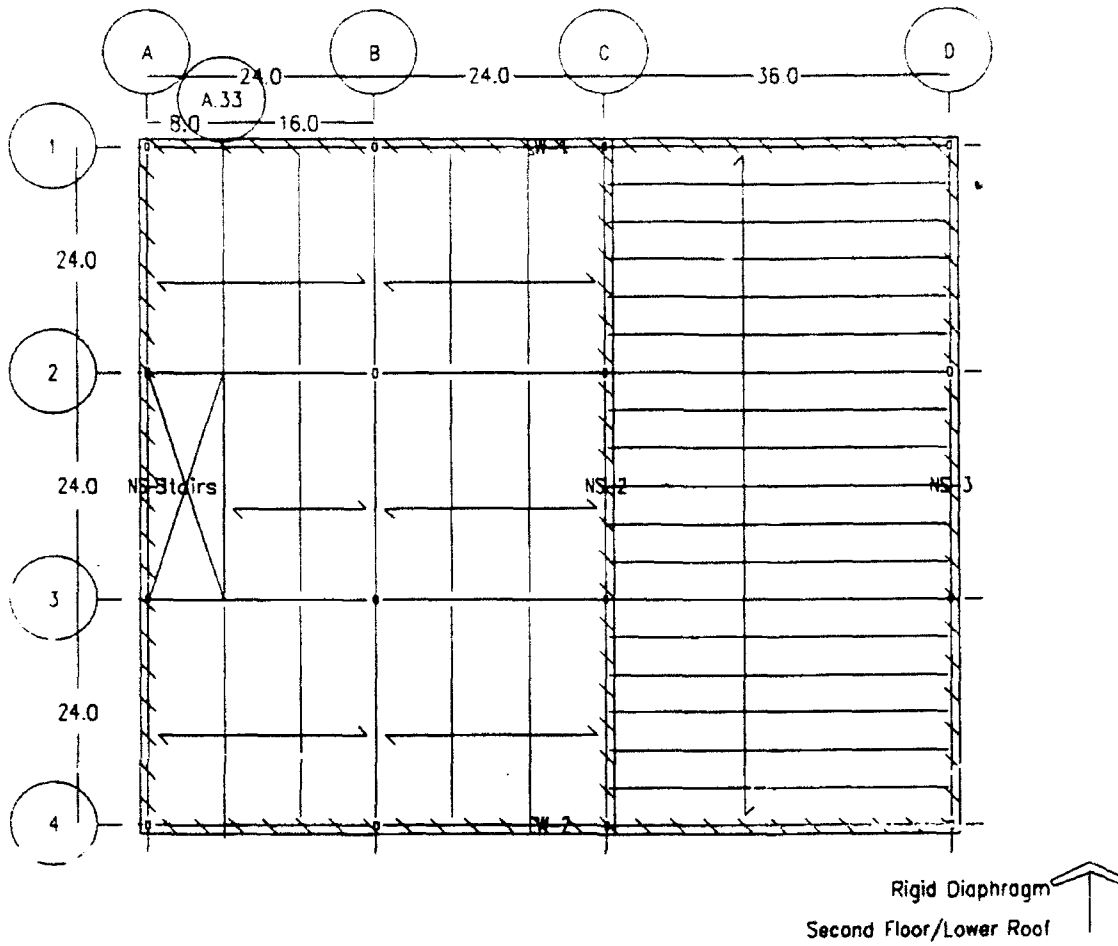


Define Lateral Resistance

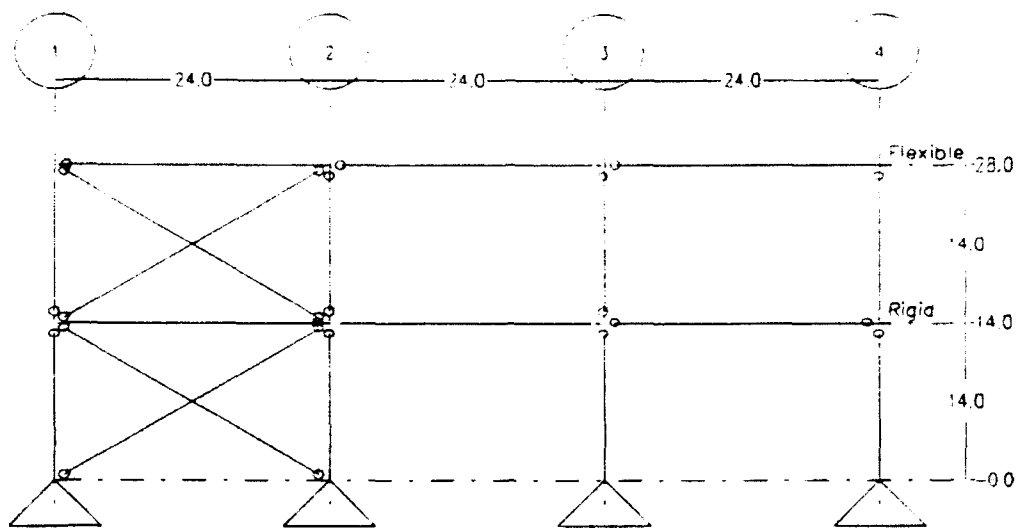


Define Lateral Resistance

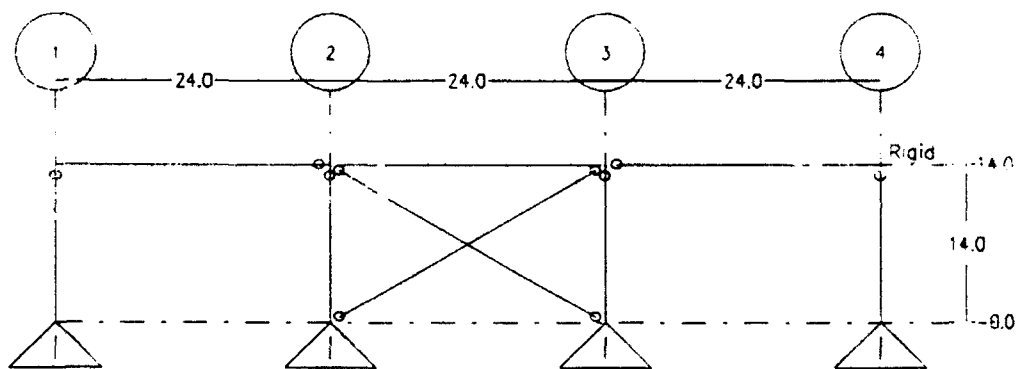




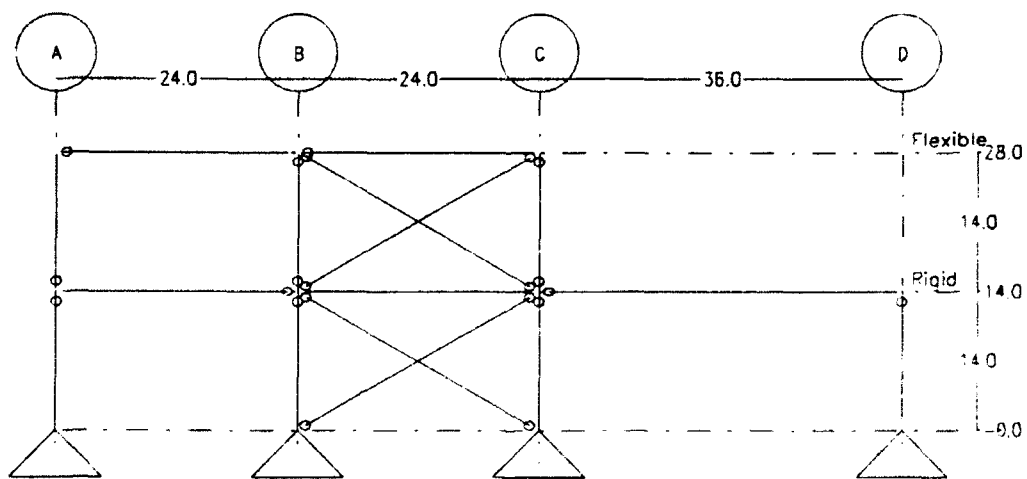
Define Lateral Resistance



NS-2

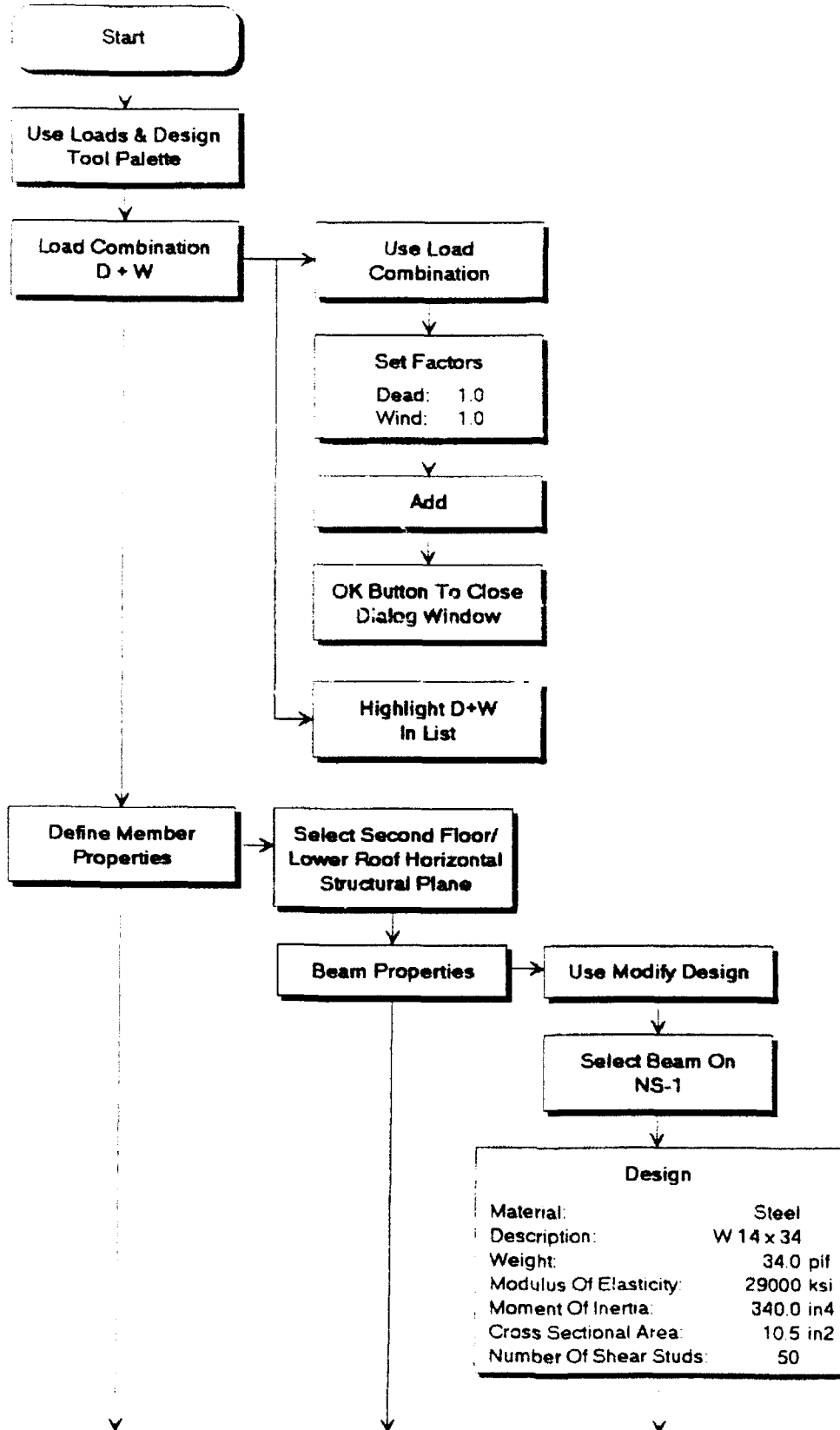


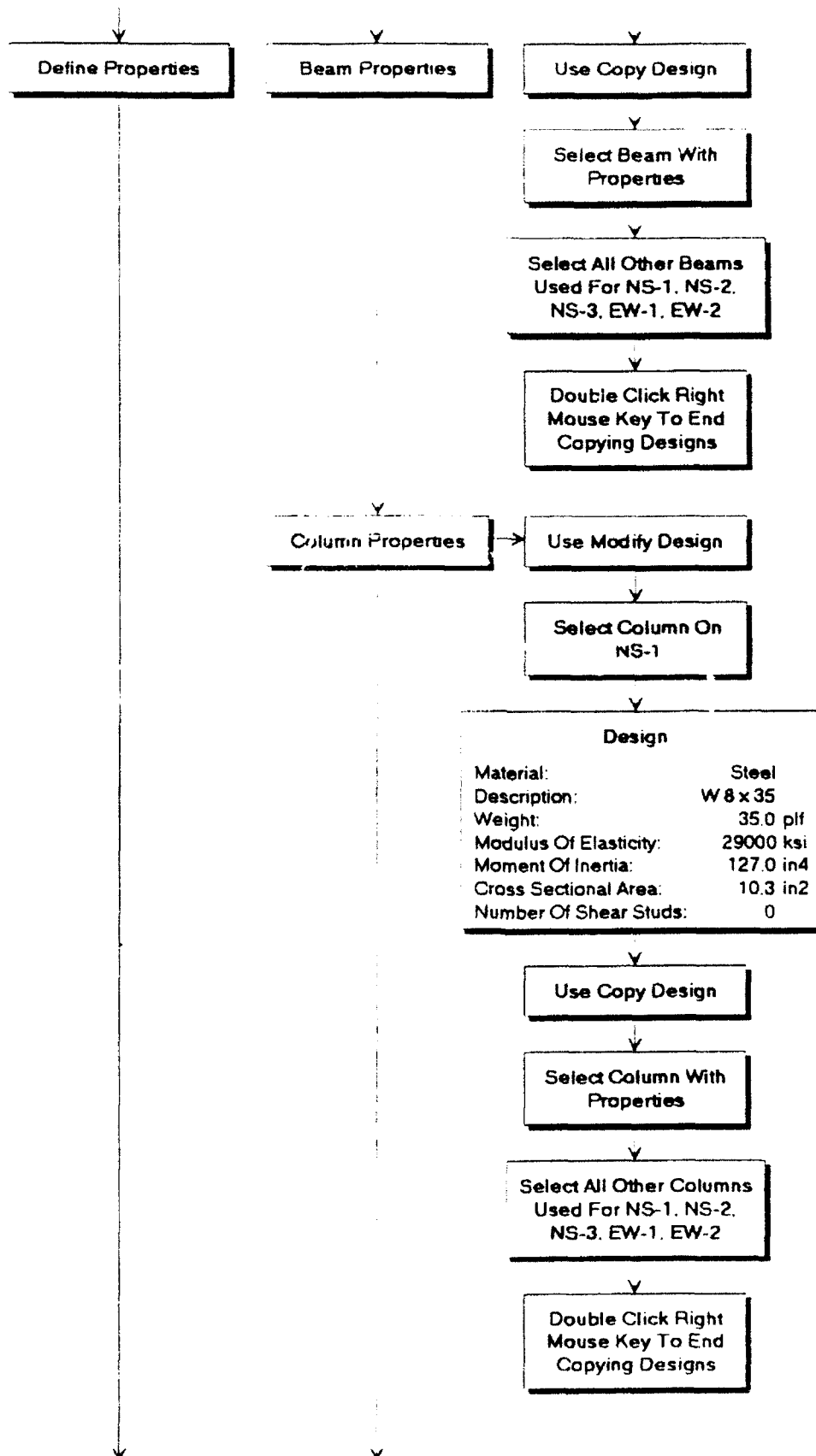
NS-3

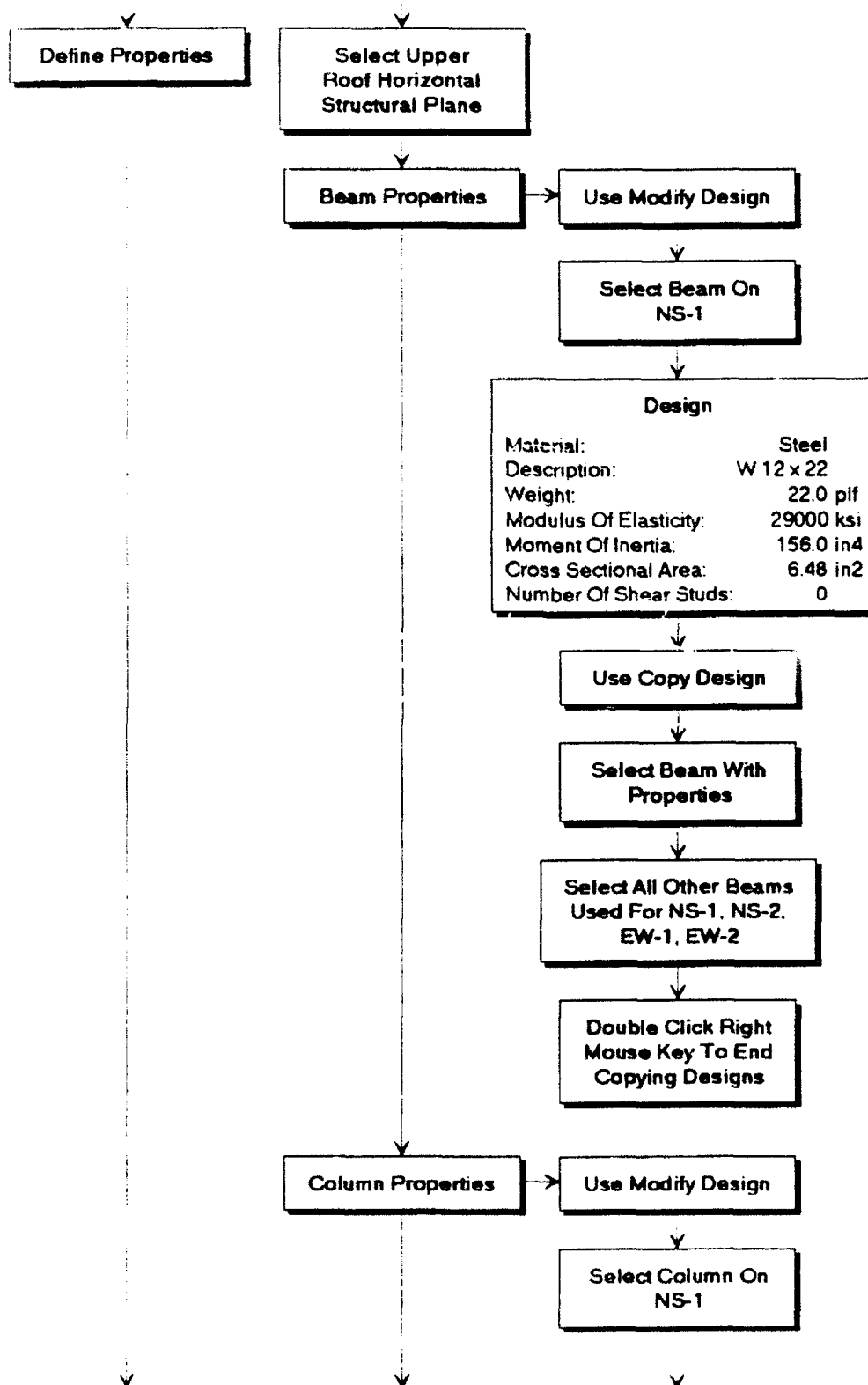


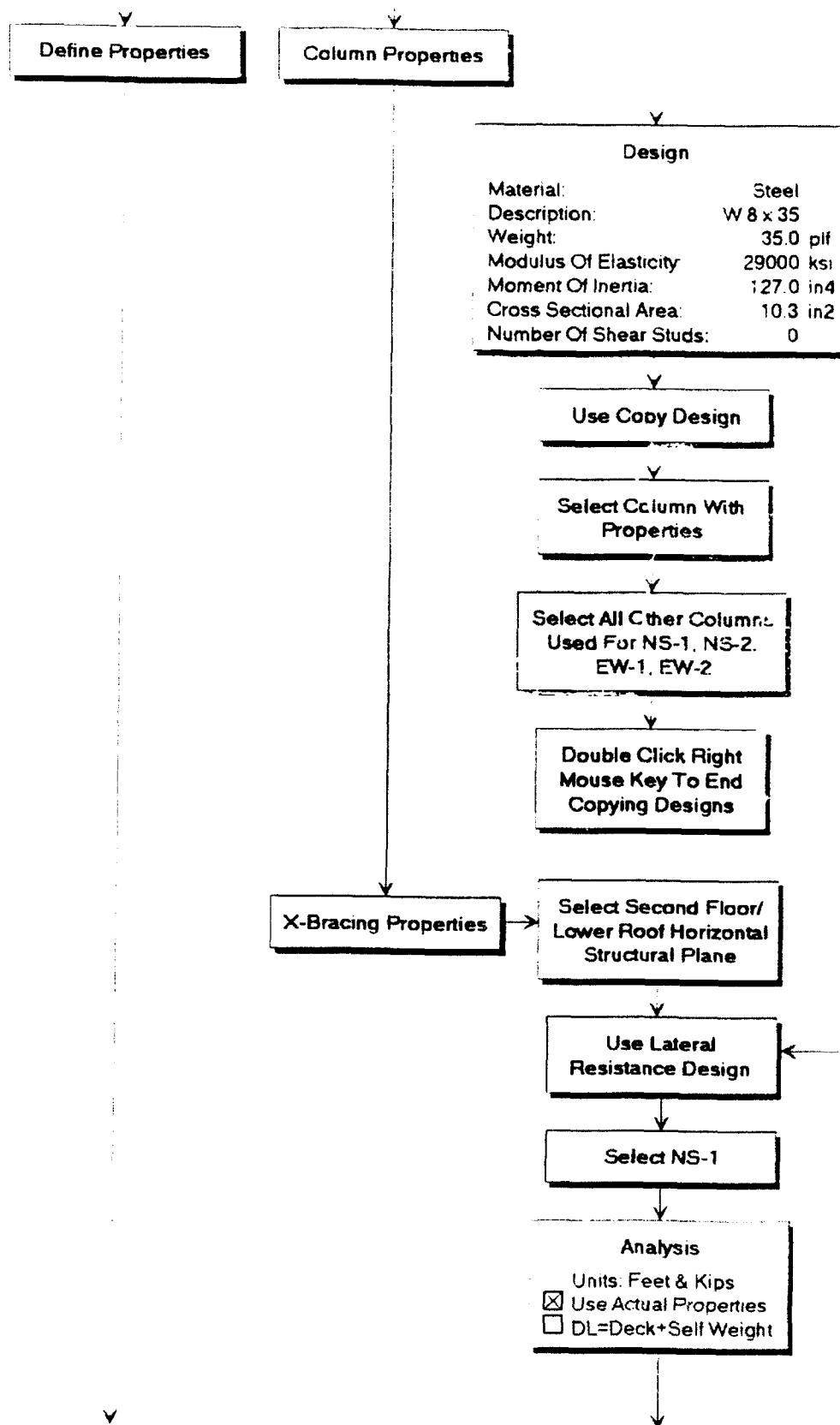
EW-1 & EW-2

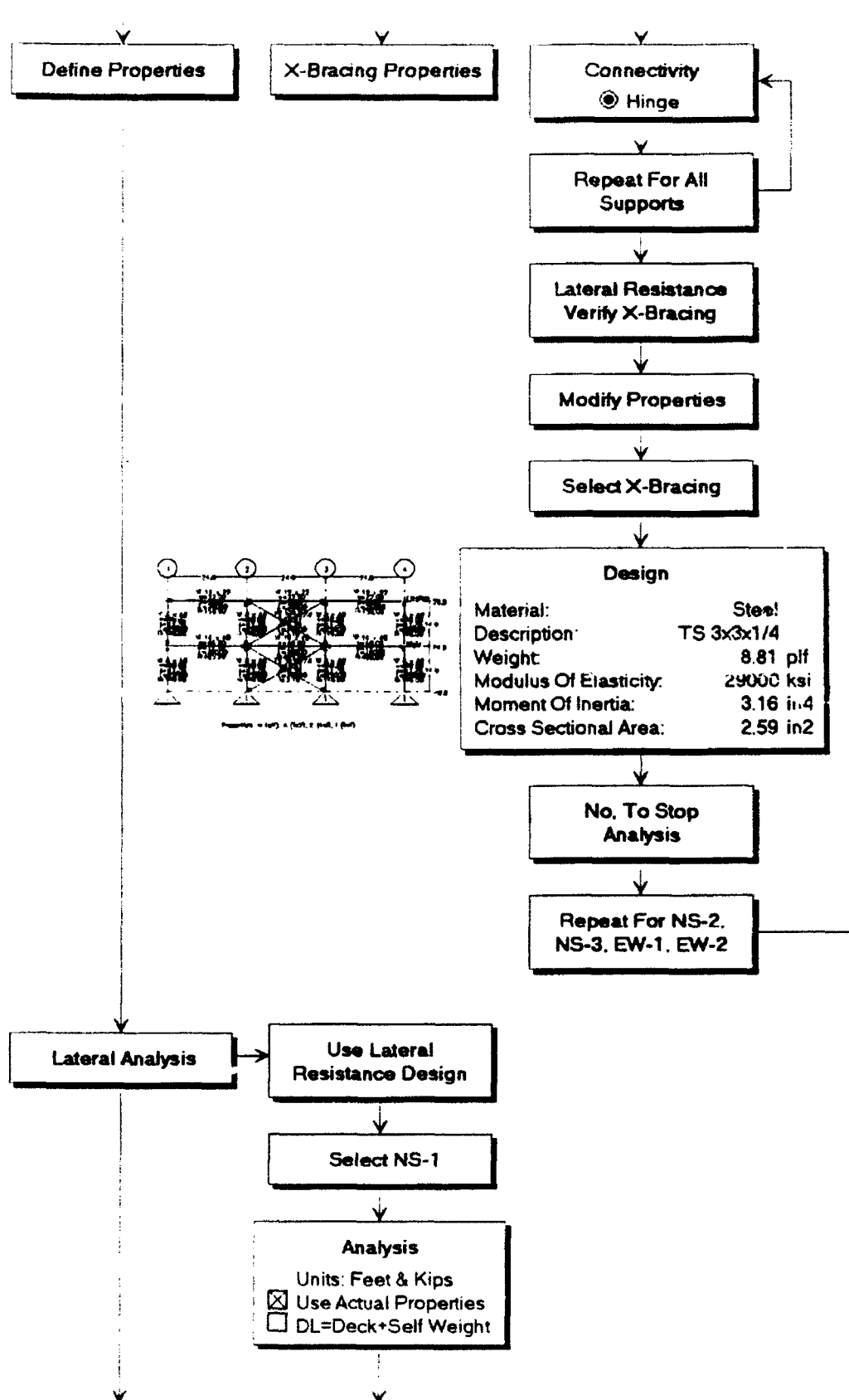
Wind Lateral Analysis

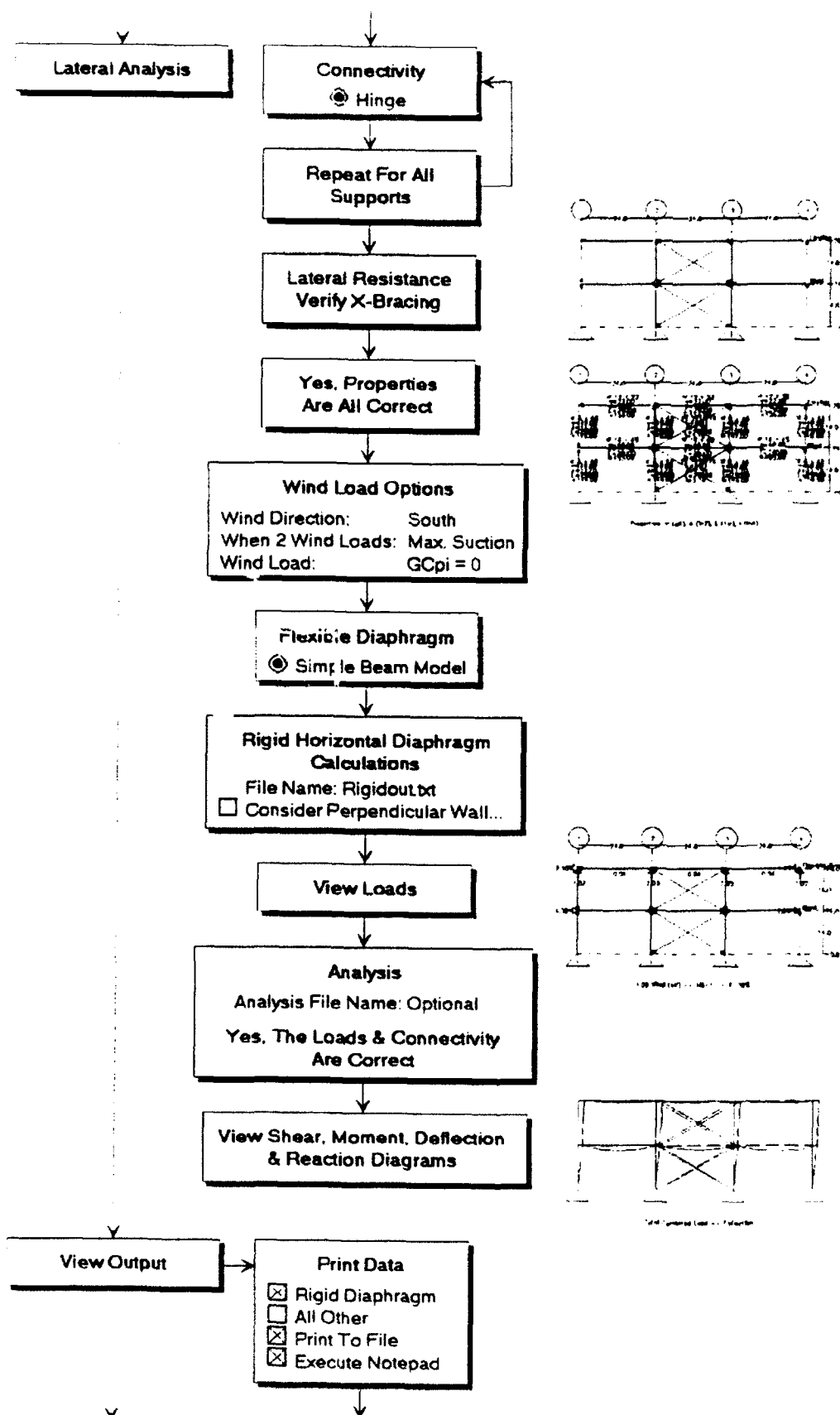


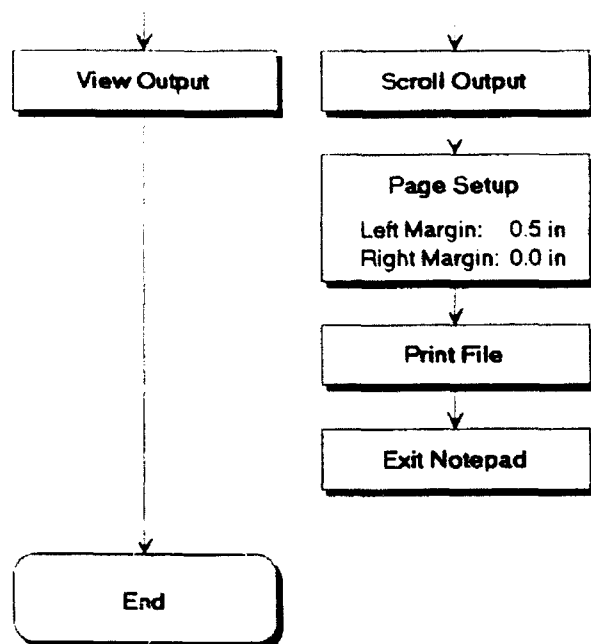


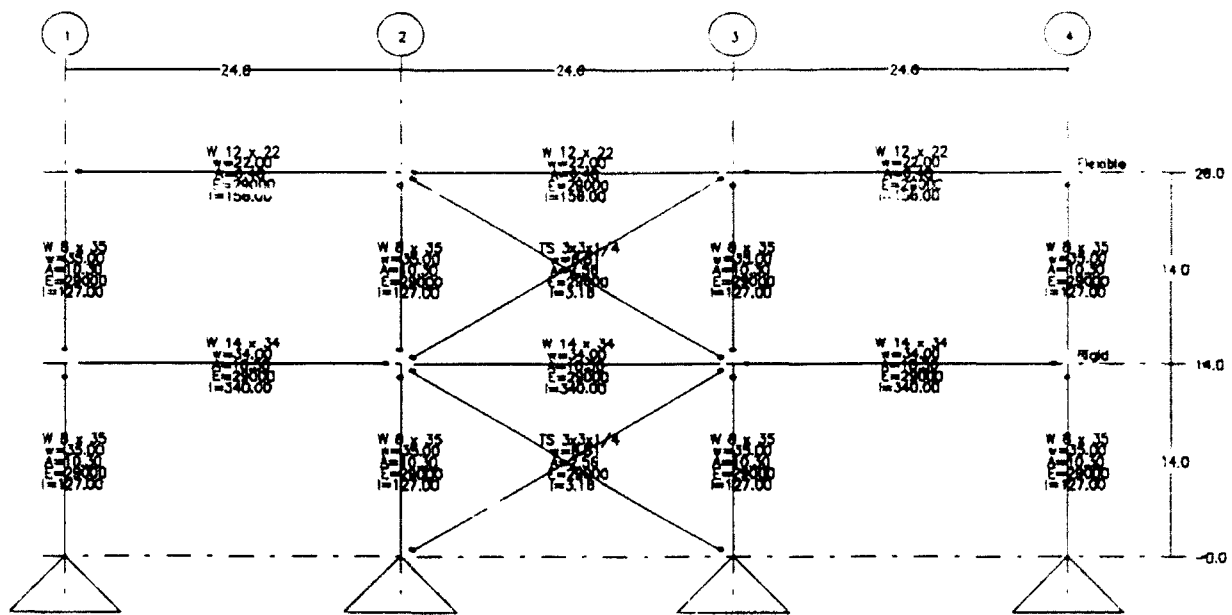




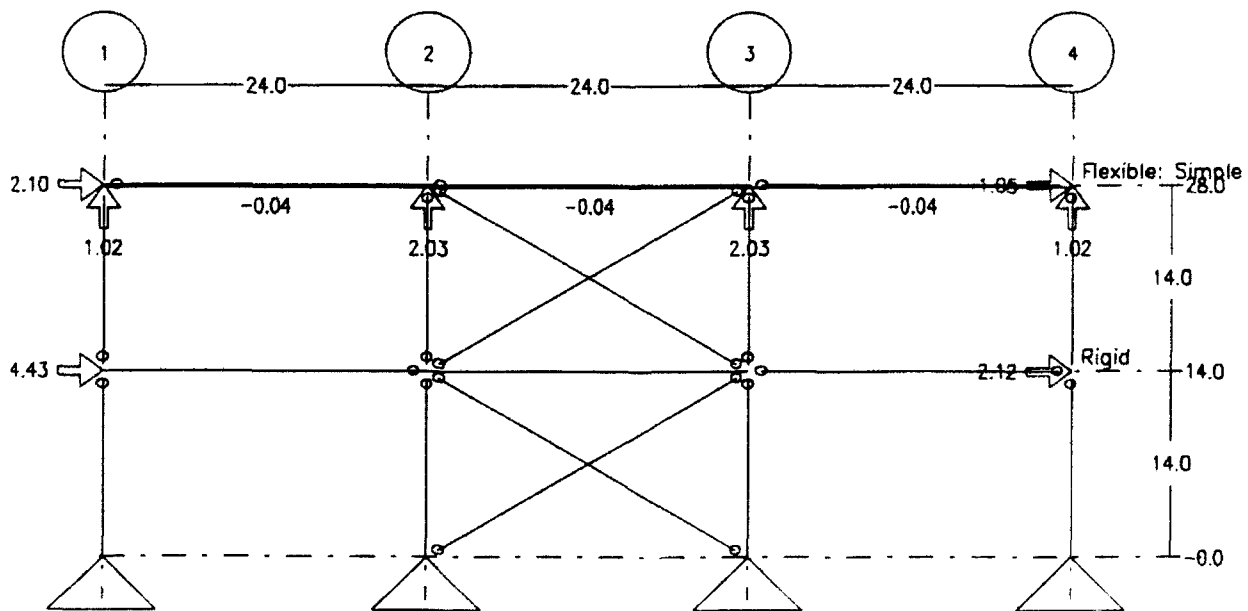






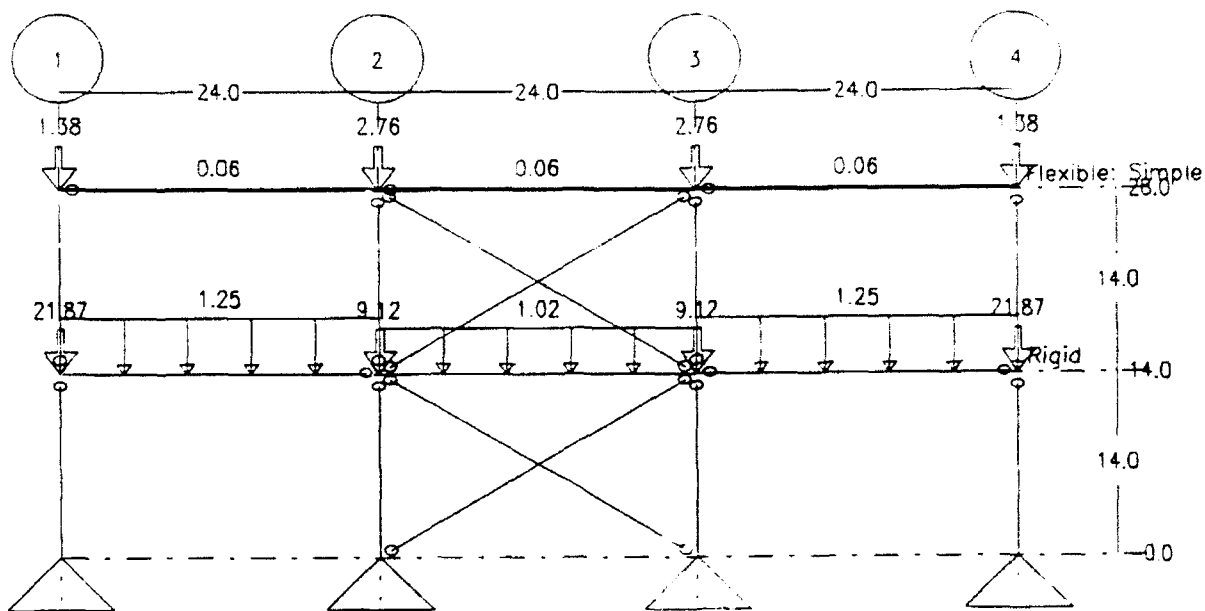


Properties: w (plf), A (in²), E (ksi), I (in⁴)

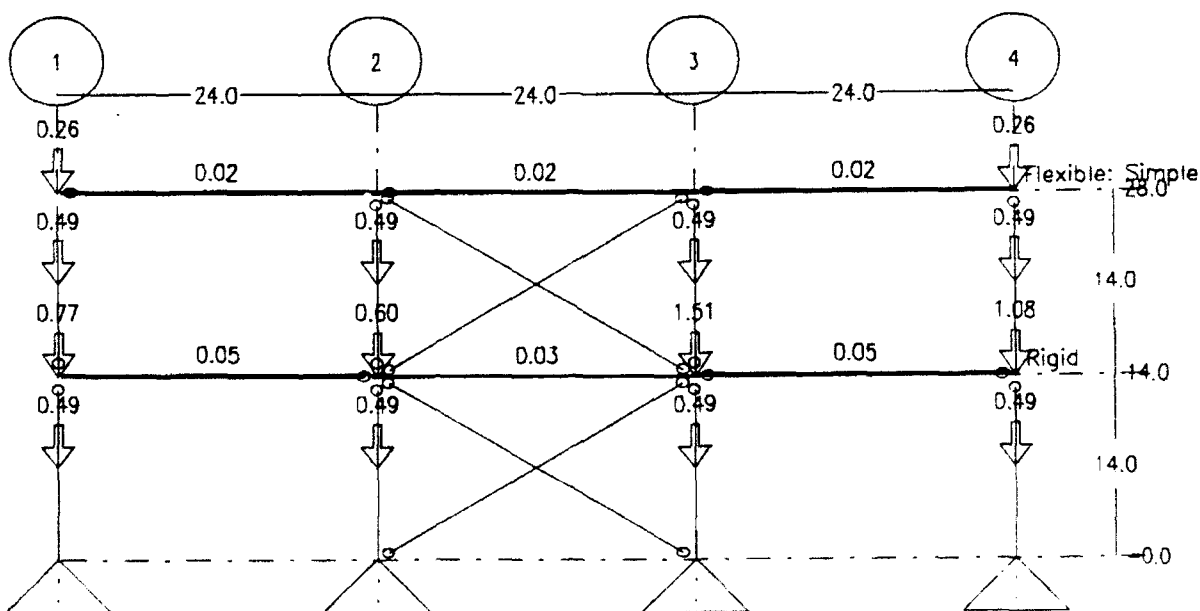


1.00 Wind (klf) -- NS-1 -- F, 36%

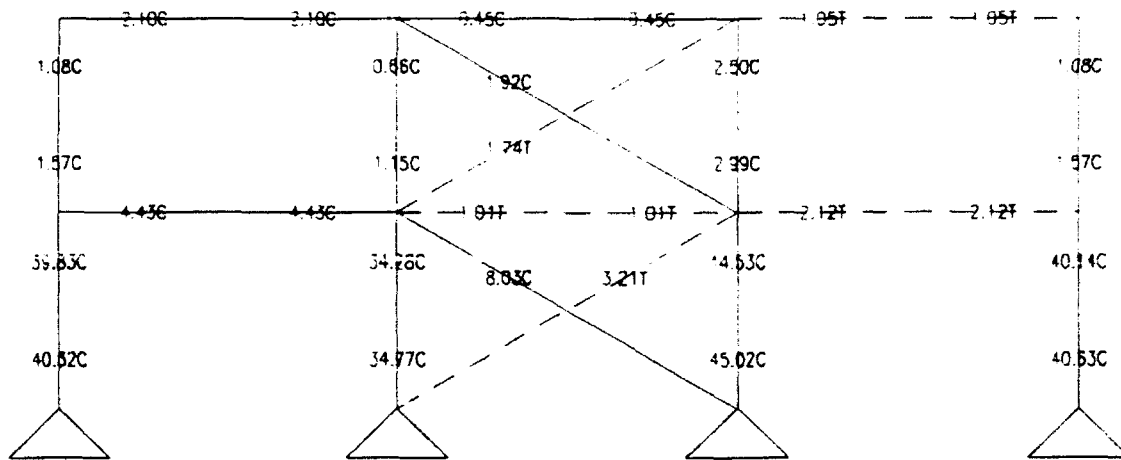
Wind Lateral Analysis



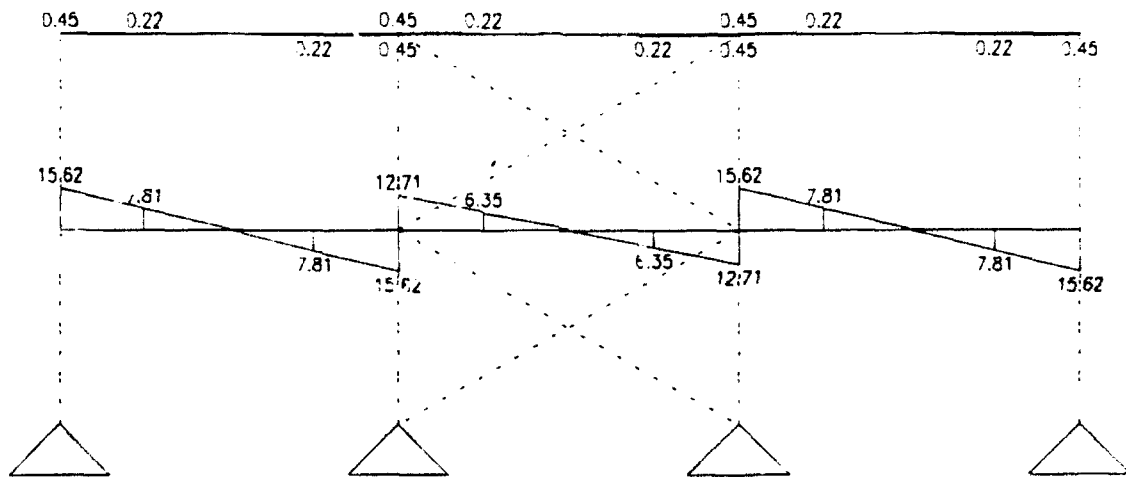
1.00 Superimposed Dead (klf)



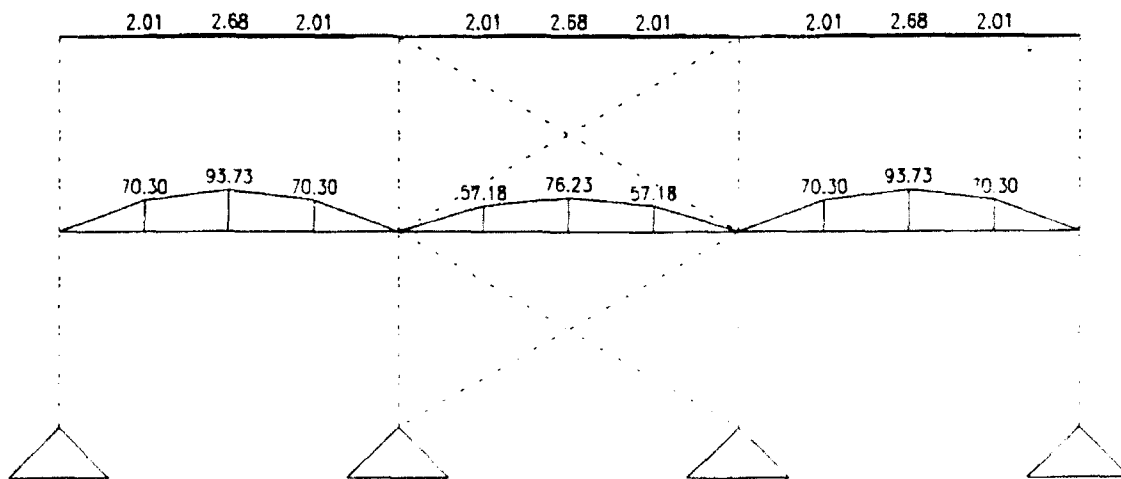
1.00 Dead (klf)



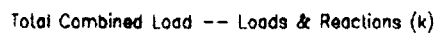
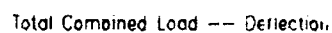
Total Combined Load -- Axial (k)



Total Combined Load -- Shear (k)



Total Combined Load -- Moment (k-ft)



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

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

Center of Rigidity

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

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

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

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

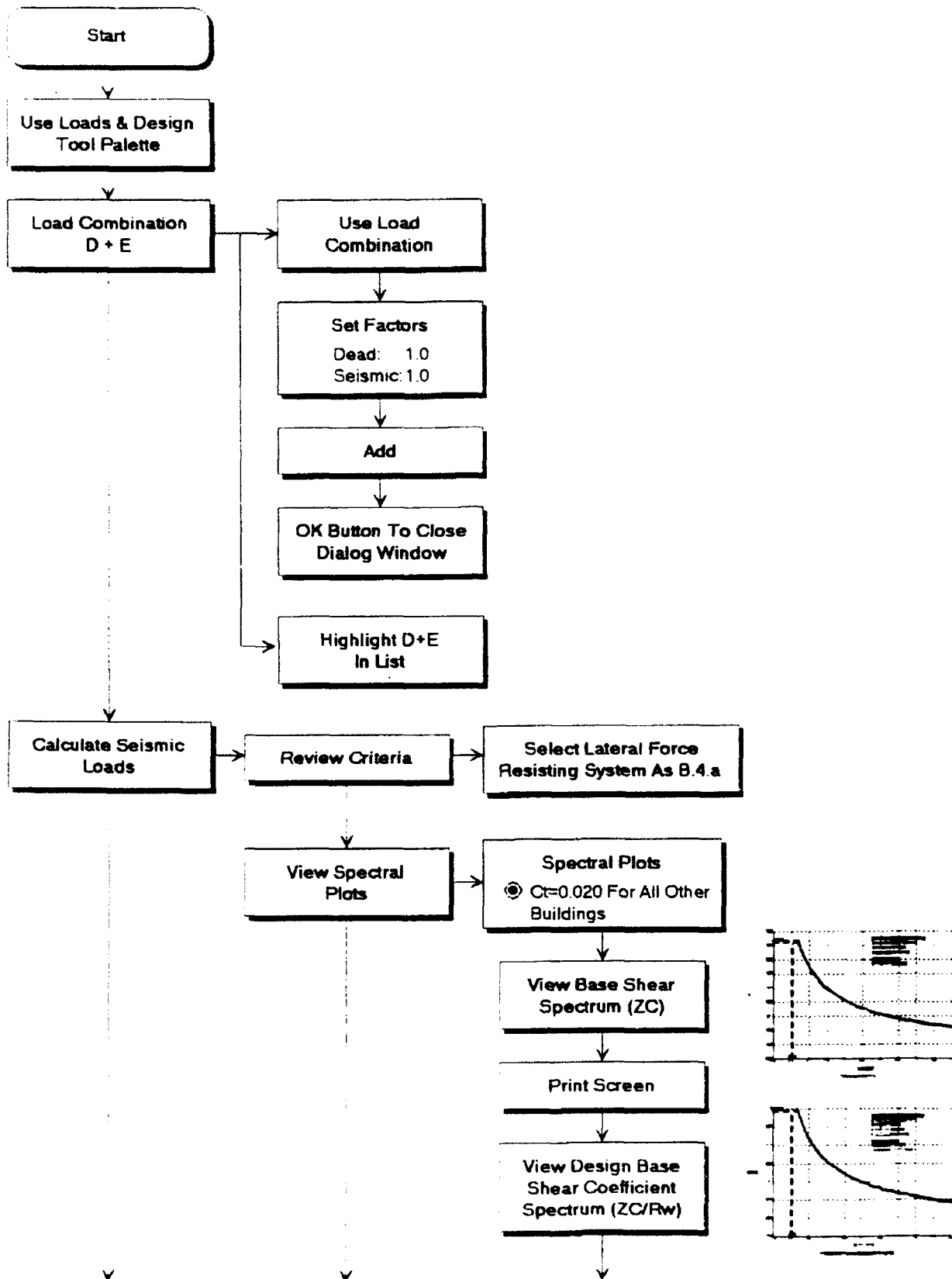
Assumptions used:

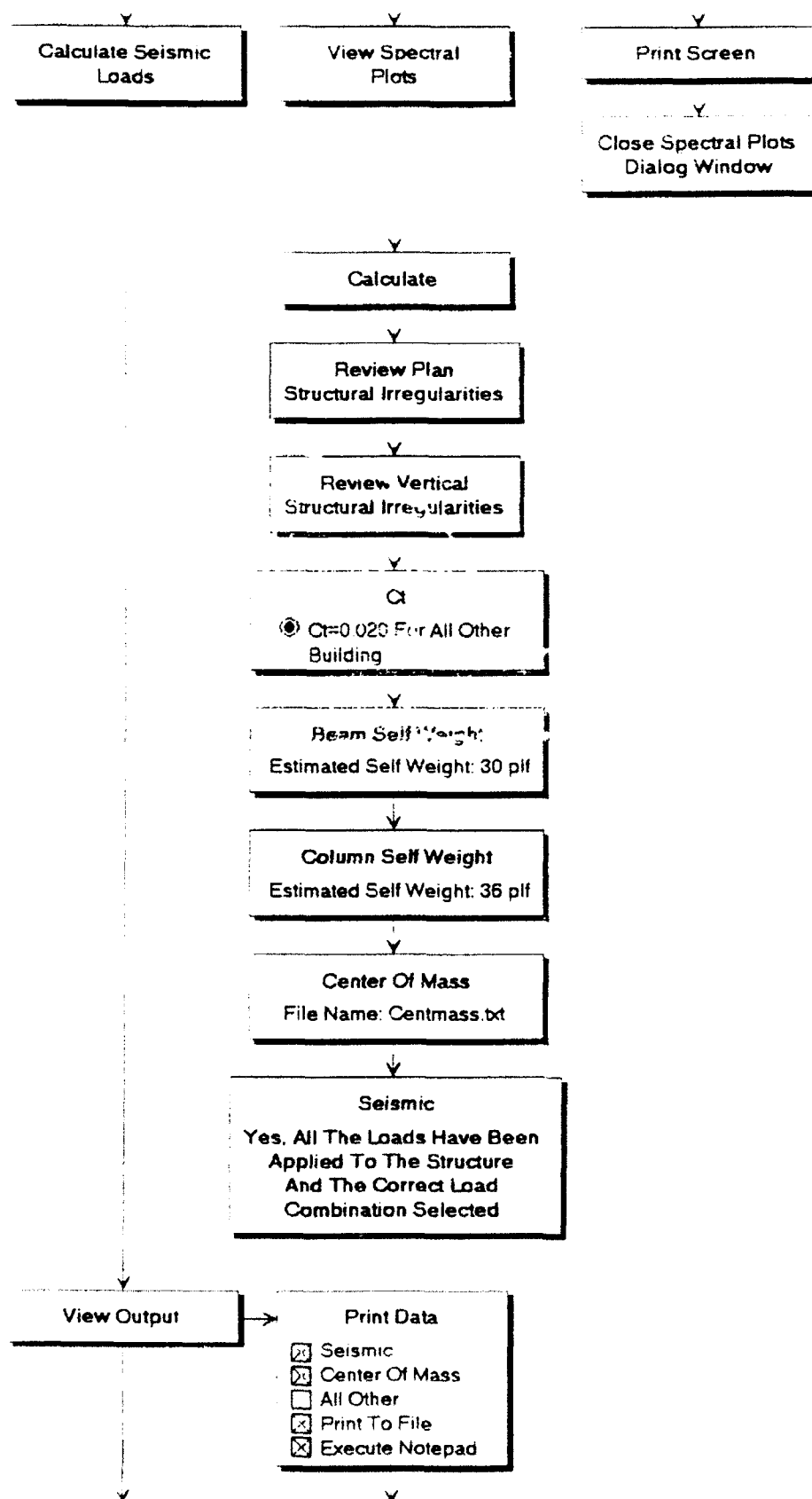
Deflections calculated by applying a 1 kip load.

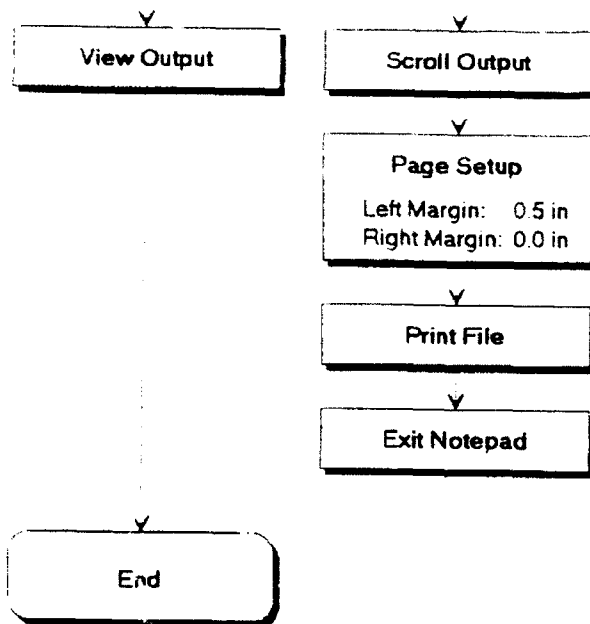
Name	h (ft)	Rigidity	dx (ft)	R*dx	R*dx*dx	R*dx/ sum(R*dx*dx)
NS-1	14.0	305.434	40.8	12447.298	507262.624	0.00705
NS-2	14.0	308.740	7.2	2237.491	16215.477	0.00127
NS-3	14.0	236.080	43.2	10209.807	441545.249	0.00578
EW-1	14.0	308.740	36.0	11114.640	400127.035	0.00630
EW-2	14.0	308.740	36.0	11114.640	400127.035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

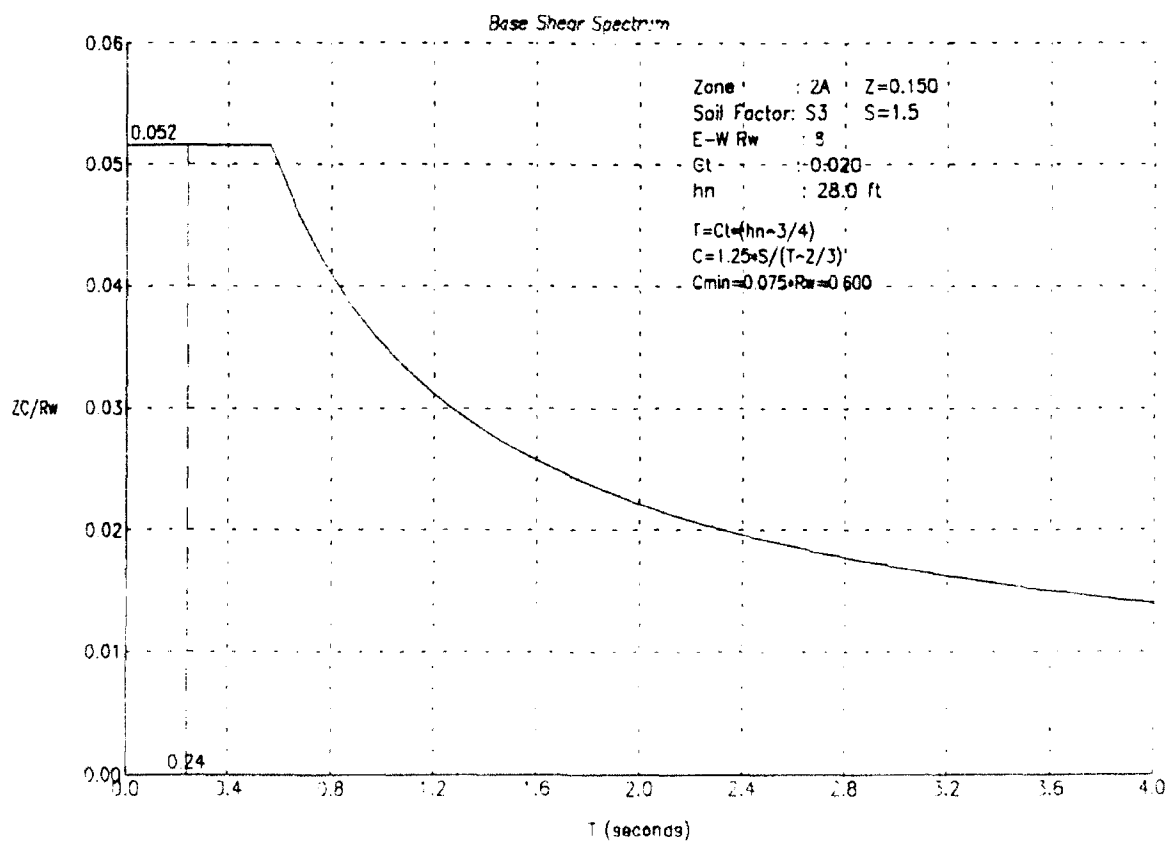
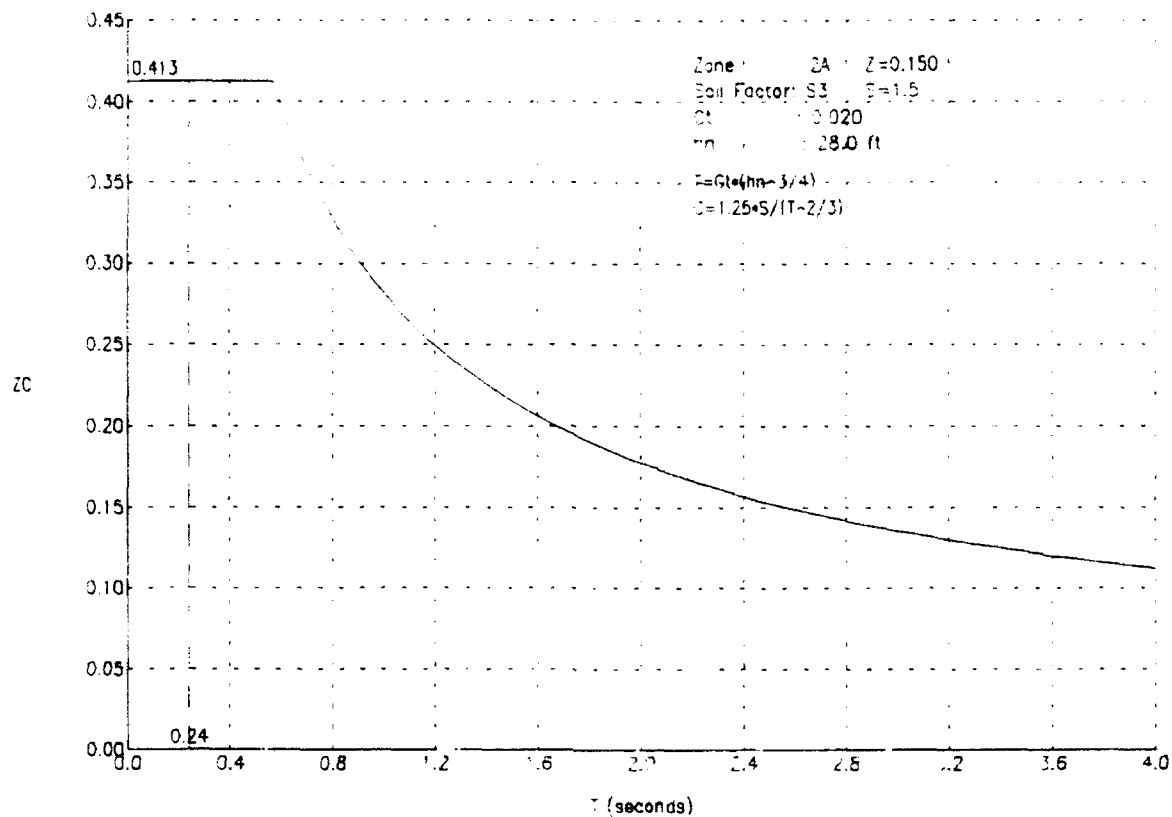
Shear distribution : $F_v = V*R/\text{sum}(R)$
 Torsional moment : $M_t = V*e$
 Torsional component : $F_t = M_t*R*dx/\text{sum}(R*dx*dx)$
 Total shear to element: $F_{\text{total}} = F_v + F_t$

Seismic Loads









Design Base Shear Coefficient Spectrum

Seismic Loads

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

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

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

 Total Building Weight (W) : 858.4 k

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

Zone: 2A: Z = 0.150
 Importance Category: IV: I = 1.00
 Soil Factor: S3: S = 1.5
 System: B4a: R_w = 8
 C_t = 0.020
 h_n = 28.0 ft
 T = C_t*h_n^{3/4} = 0.24 sec
 C = 1.25*S/T^{2/3} = 4.86 > 2.75
 C = 2.75
 C_r = 0.344 > 0.075
 W = 858.4 k
 V = Z_s*C*W/R_w

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

T = 0.24 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)	sum(w*h) (kft)	F (k)	sum(F) V (k)
3	28.0		188		5264	0.359	15.9	
		14.0		188				15.9
2	14.0		670		9385	0.641	28.4	
		14.0		858				44.3
1	0.0							
Sum			858		14649	1.000	44.3	

Level	h (ft)	Floor to Floor h (ft)	w (k)	sum(w) (k)	sum(F) V (k)	OTM (kft)	sum(OTM) (kft)	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 : Sun Jan 26, 1992 6:09 PM

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

 Upper Roof -- 28.00 ft

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

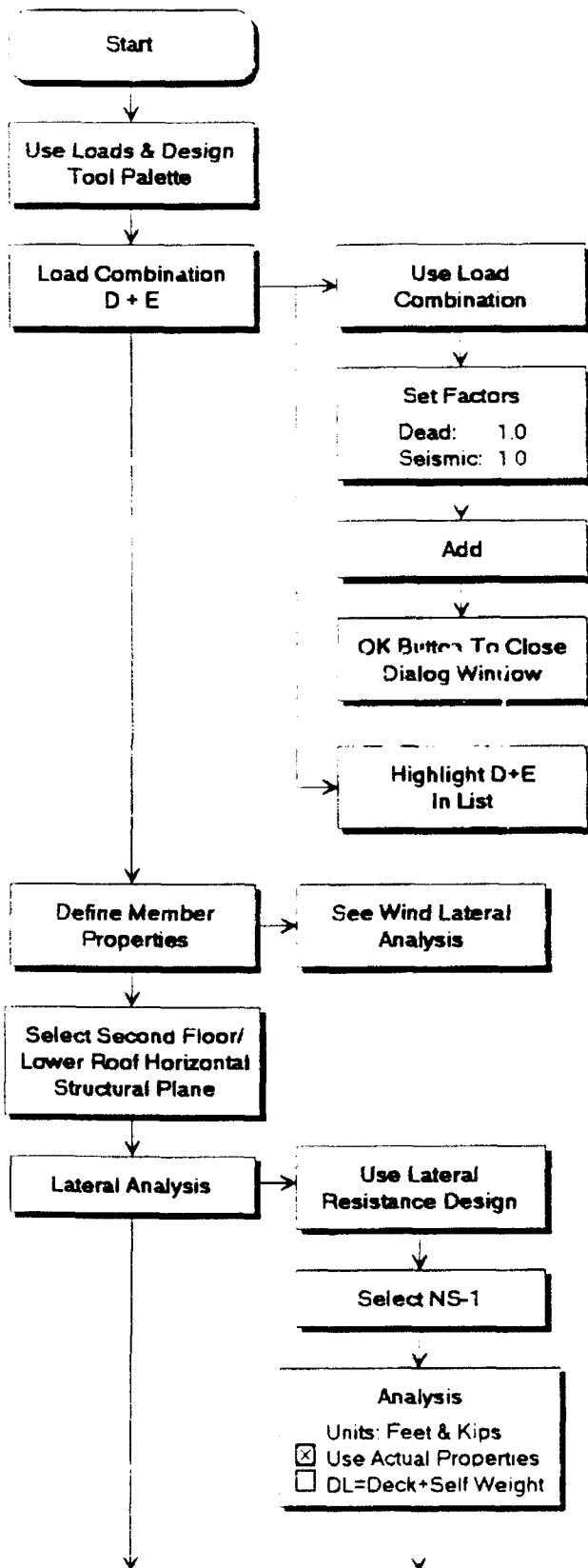
N-S Center Of Mass: 36.83 ft
 E-W Center Of Mass: 24.83 ft

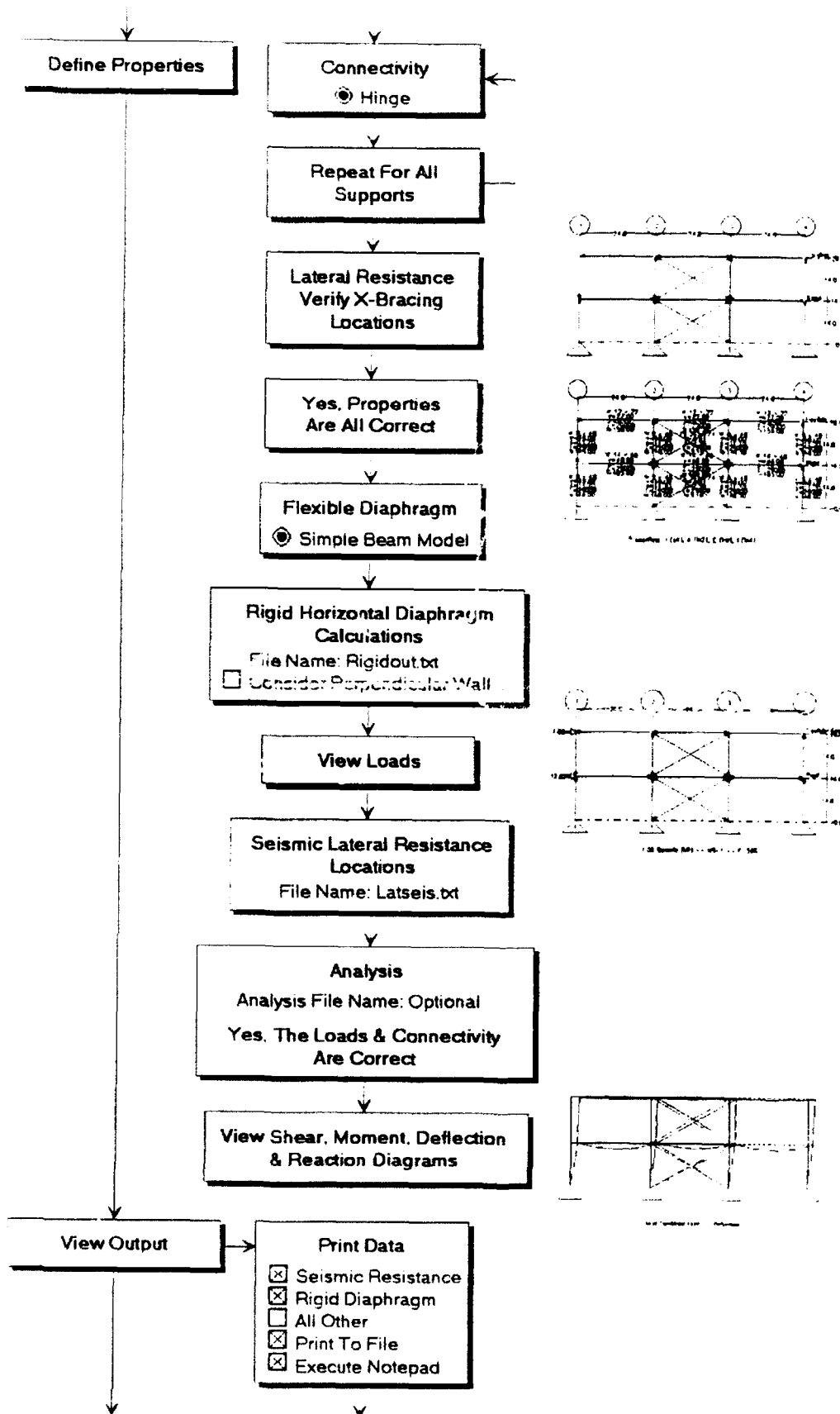
 Second Floor/Lower Roof -- 14.00 ft

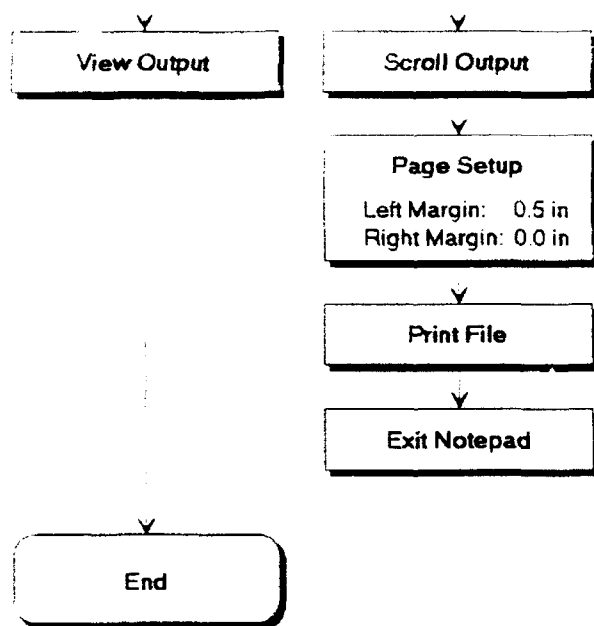
Name	Weight (k)	NS (ft)	NS*Weight (kft)	EW (ft)	EW*Weight (kft)
Second Floor	70.0	12.8	898.1	24.8	1737.9
Second Floor	58.3	36.8	2148.1	28.8	1681.6
Second Floor	70.0	60.8	4257.4	24.8	1737.9
Lower Roof	126.0	36.8	4639.9	66.8	8419.1
Exterior Wall	73.8	36.8	2717.8	0.8	61.5
Exterior Wall	24.6	0.8	20.5	24.8	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

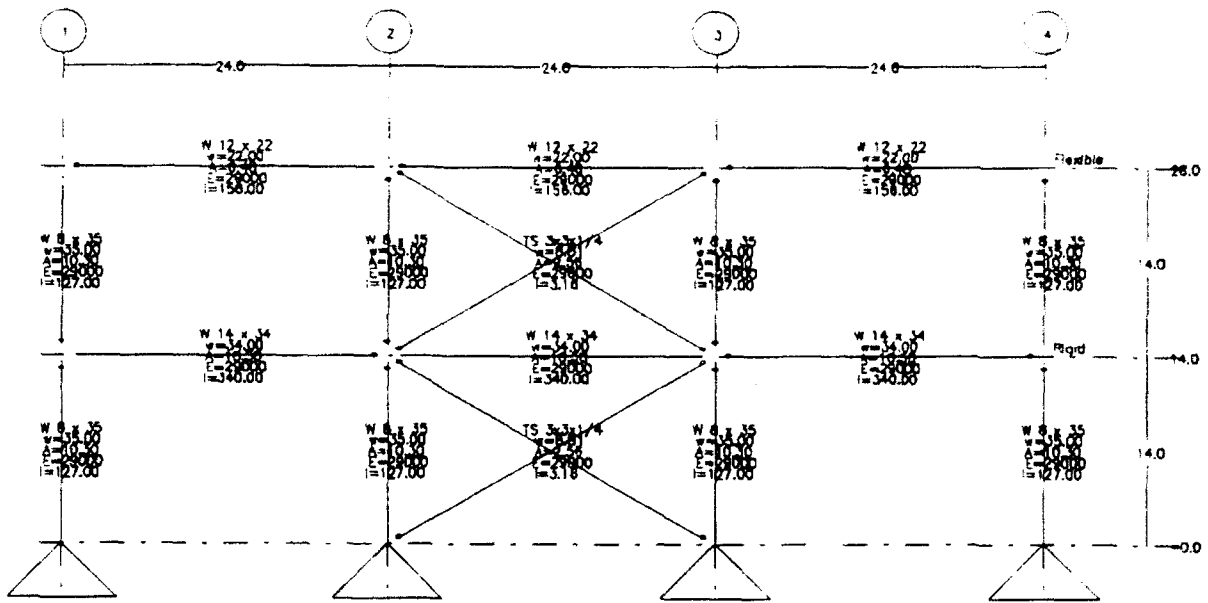
Seismic Lateral Analysis



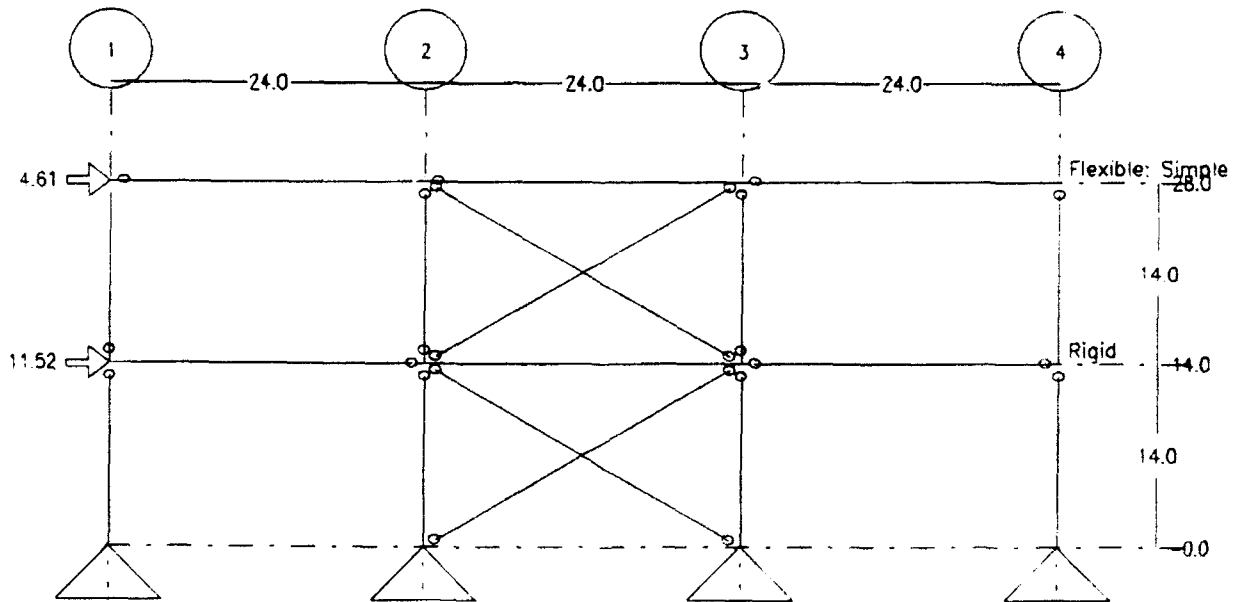




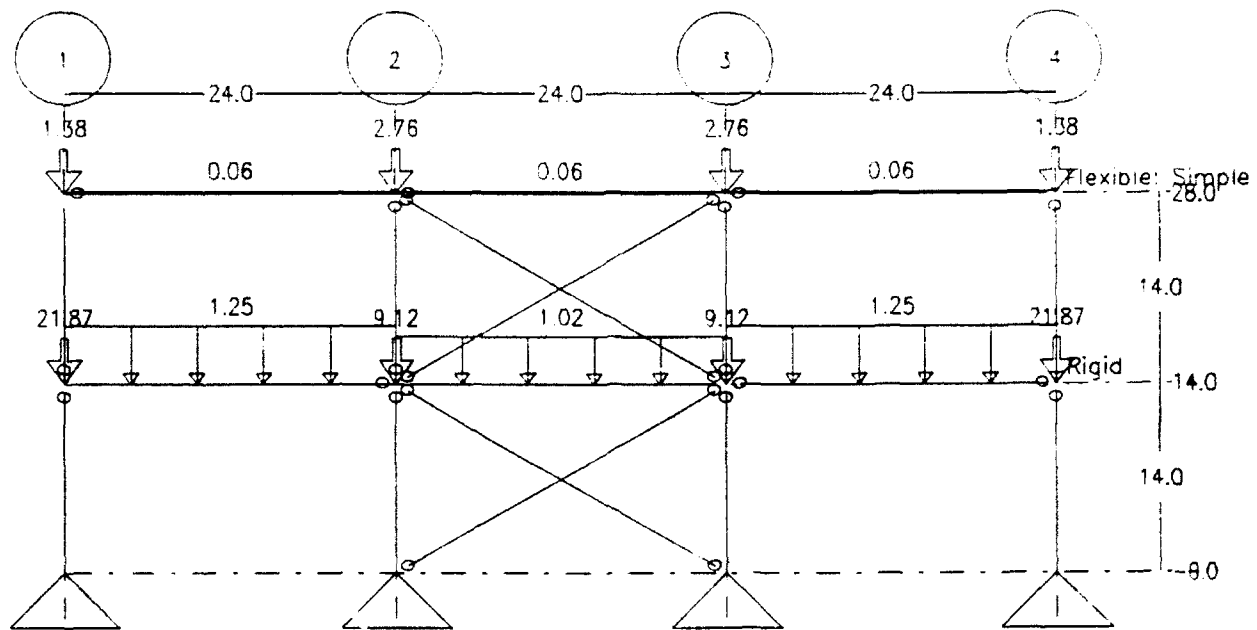
Seismic Lateral Analysis



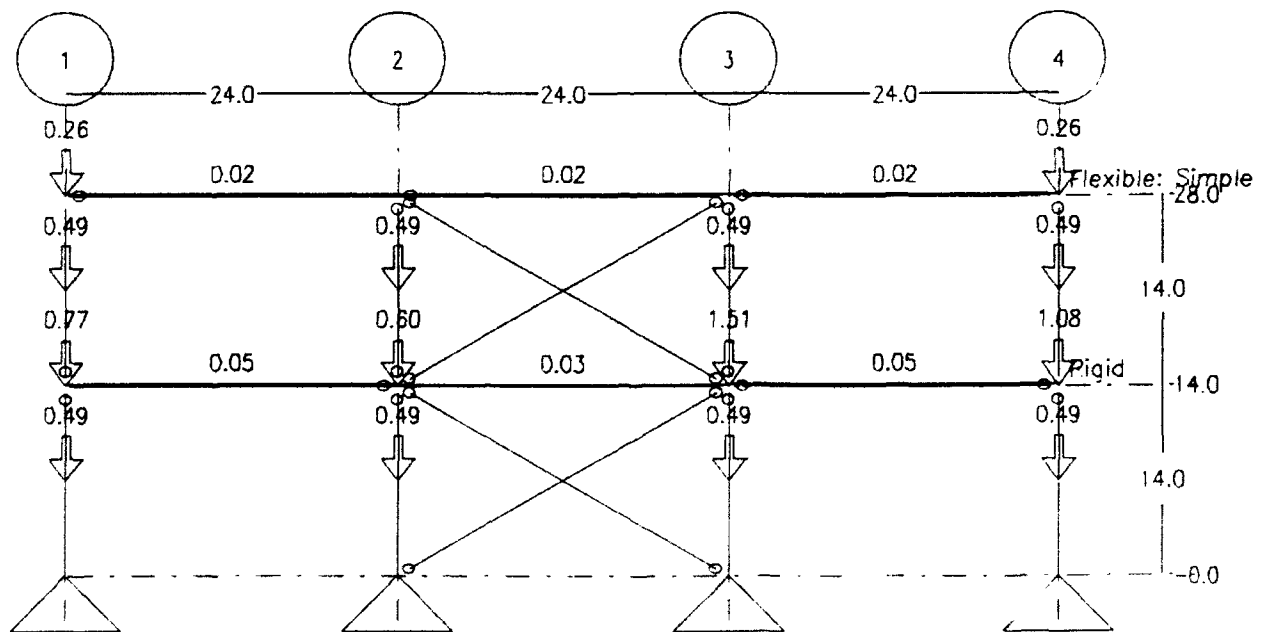
Properties: w (plf), A (in²), E (ksi), I (in⁴)



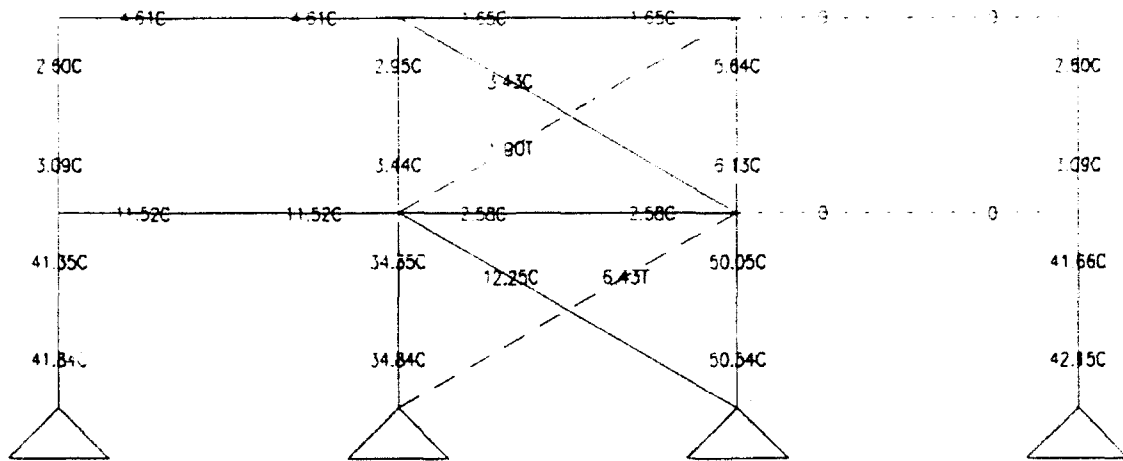
1.00 Seismic (klf) -- NS-1 -- F, 36%



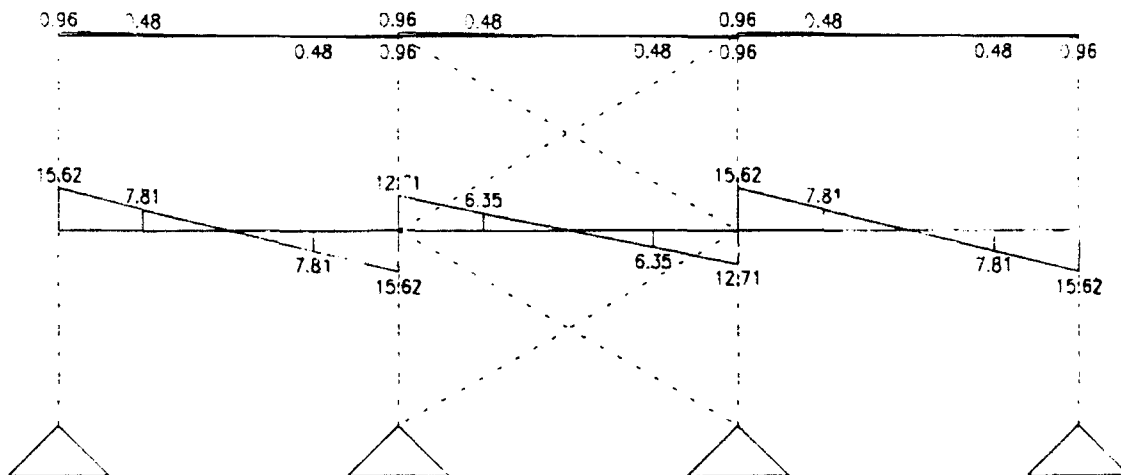
1.00 Superimposed Dead (klf)



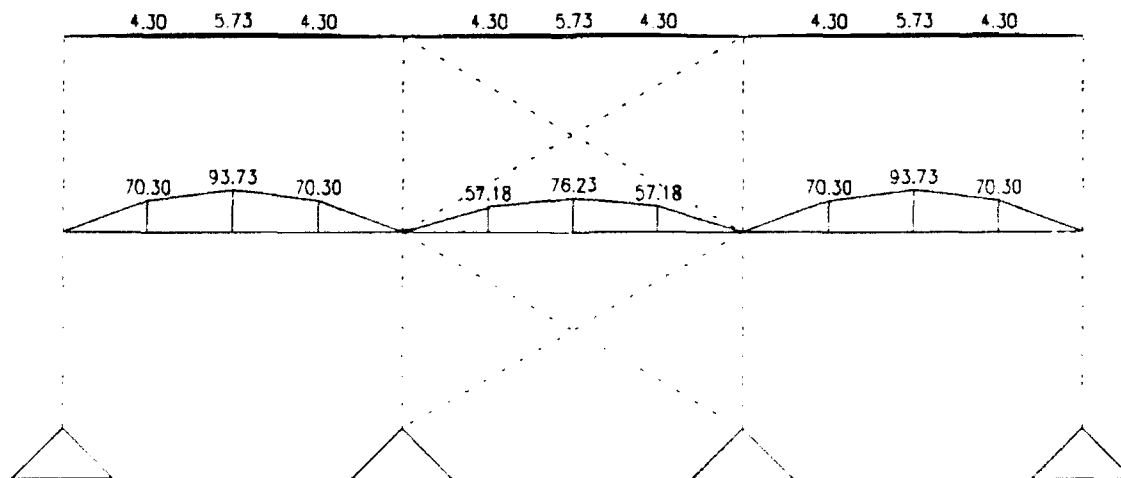
1.00 Dead (klf)



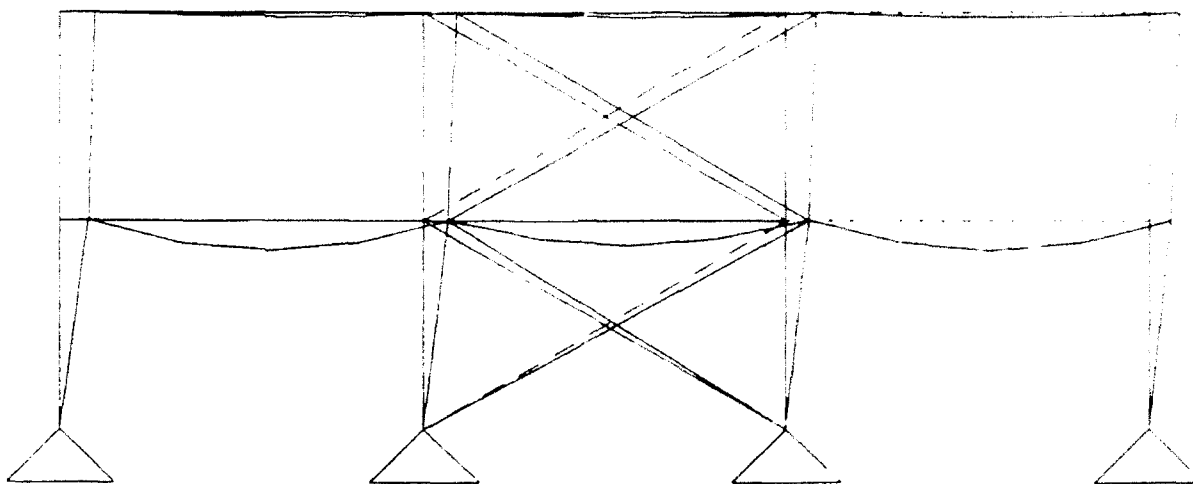
Total Combined Load -- Axial (k)



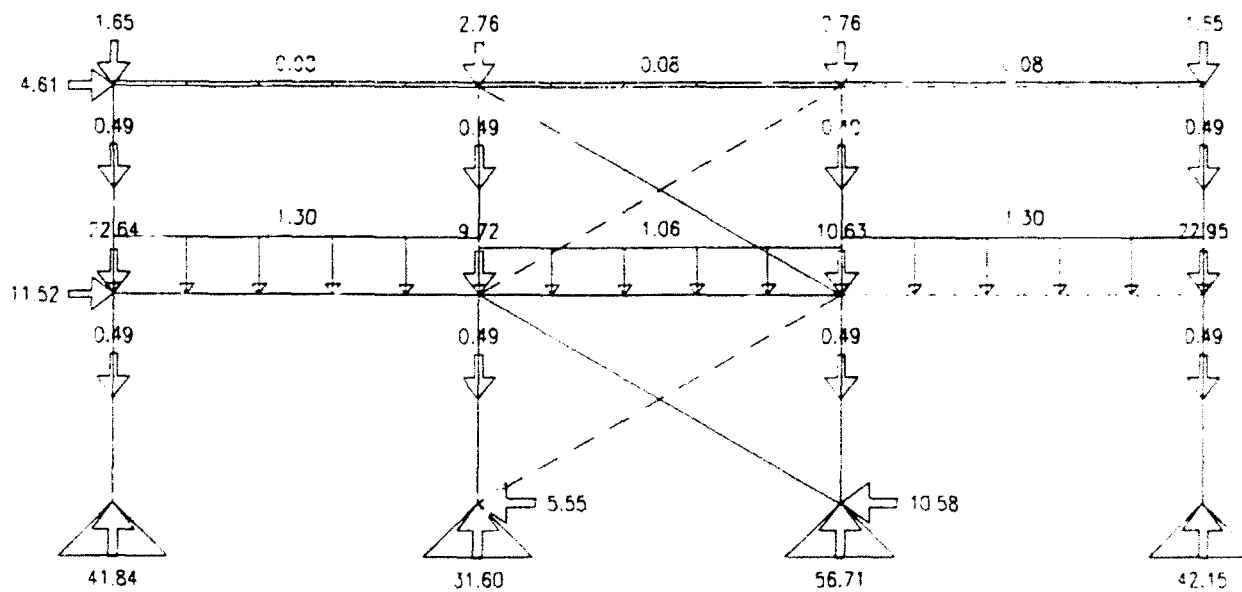
Total Combined Load -- Shear (k)



Total Combined Load -- Moment (kft)



Total Combined Load --- Deflection



Total Combined Load -- Loads & Reactions (k)

Seismic Lateral Analysis

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

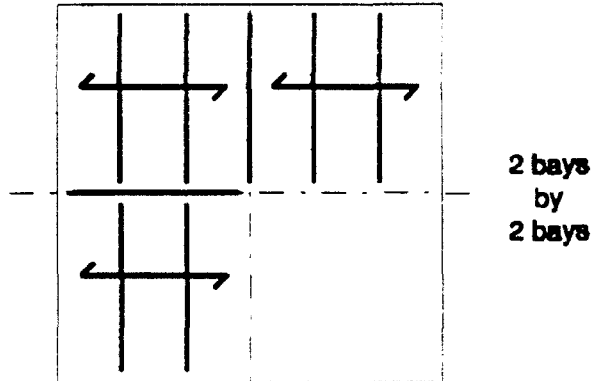
NS-3 -- F, 28%

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

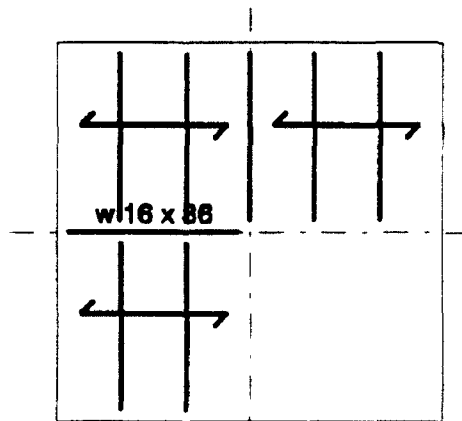
Quantity Take-Off Philosophy

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



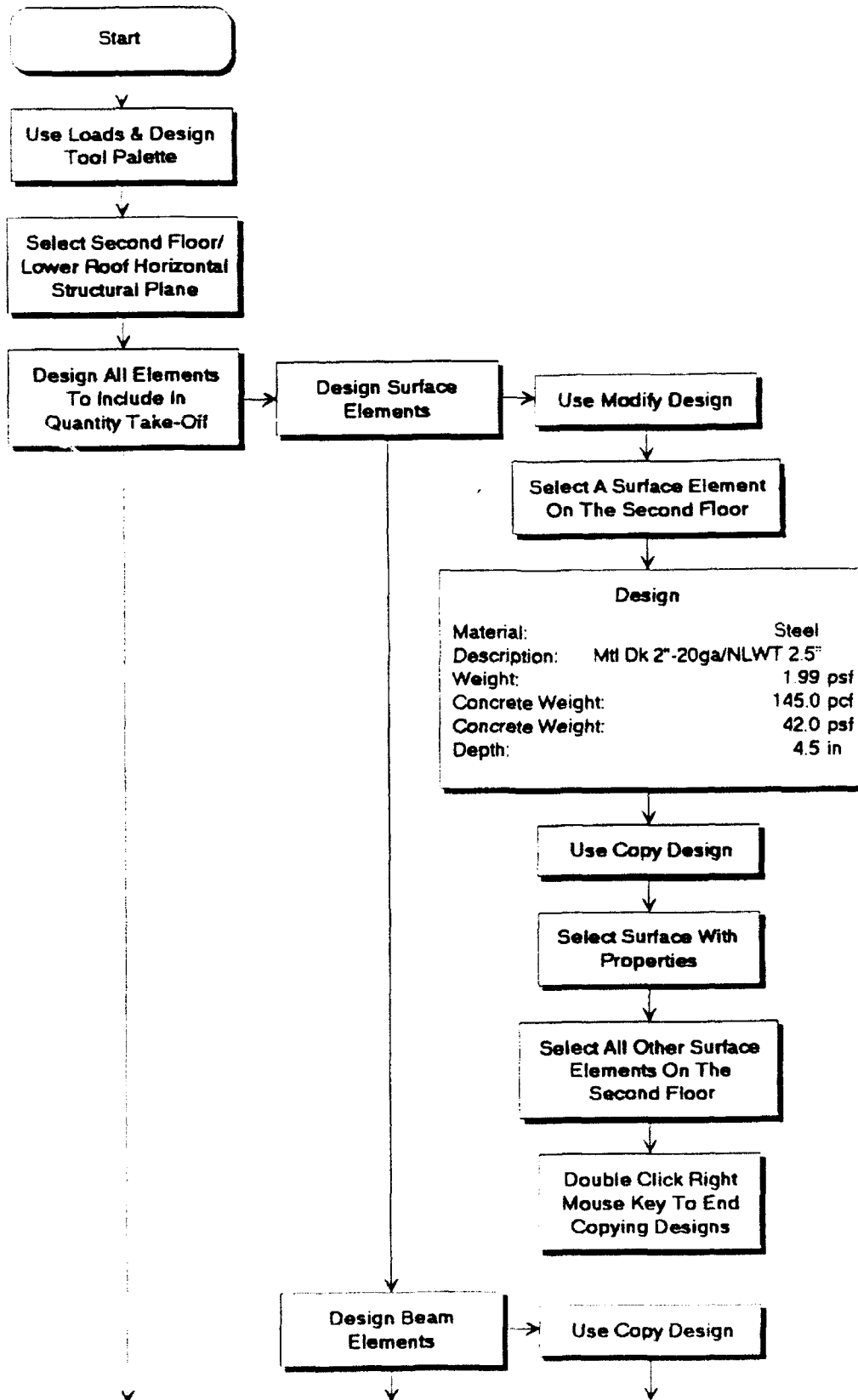
Estimated weights are not used
for quantity take-offs

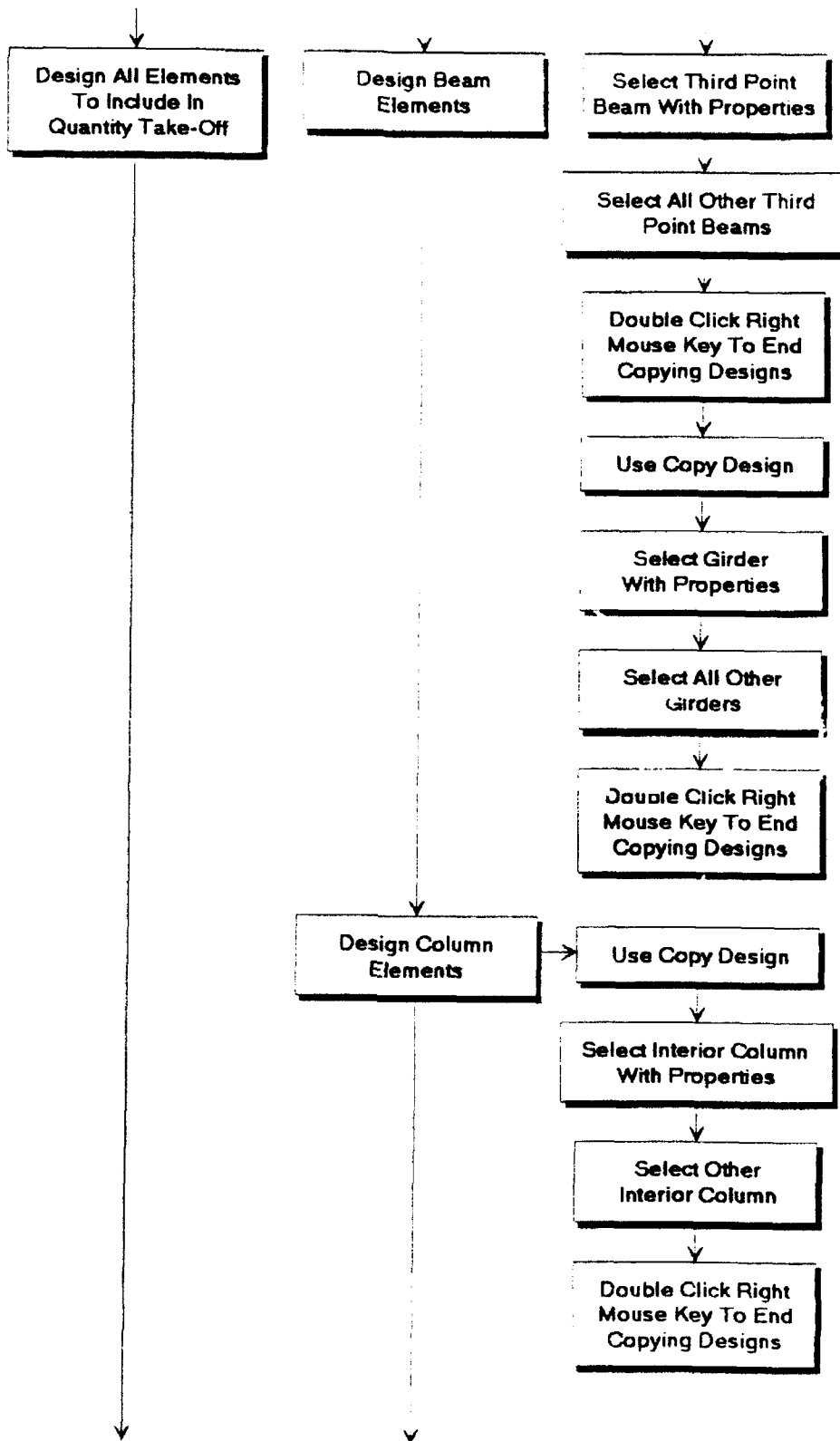
Elements designed by Excel
spreadsheets are used

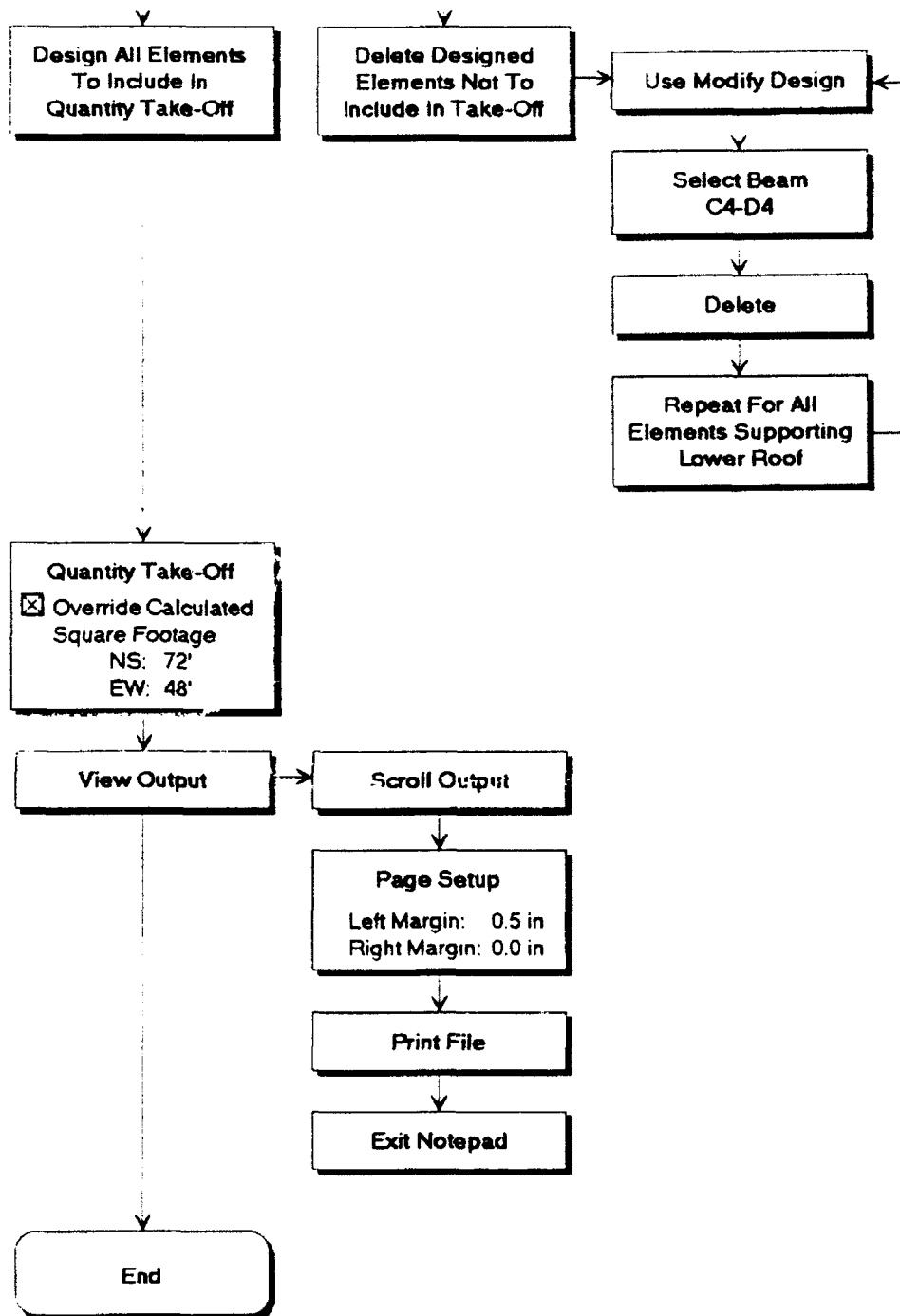
Use Modify Design and Copy Design
to manually enter element sizes

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	2	0
Sum					22320

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

STEEL: Surface Elements

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

Concrete Cubic Yards : 35.0
 Total Weight : 3.2 tons

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.

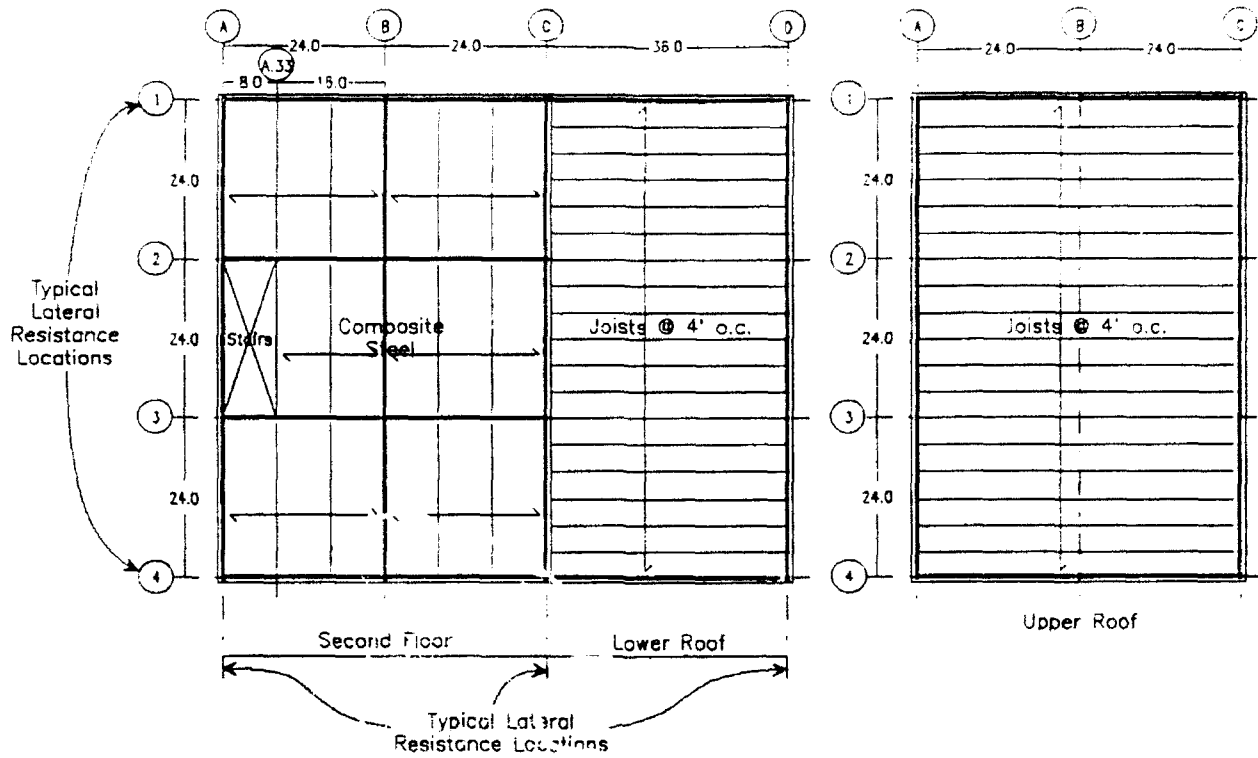
A logical steel framed beam/column solution for "real" consideration would include open web steel joists spanning 48 feet for the upper roof to eliminate a central column in the second floor space. The lower roof would be framed with 36 foot span open web steel joists (without inclusion of custom trusses) 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.

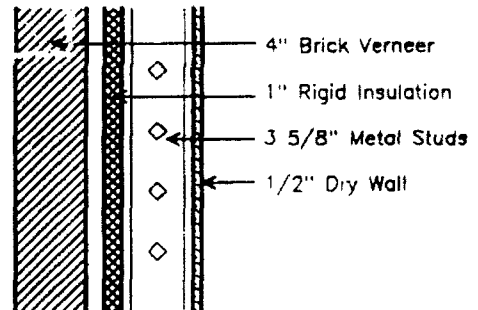
The structural engineers that become proficient with the use of CASM will be able to explore many other ideas to arrive at the most structurally efficient and economical solution for this hypothetical project.

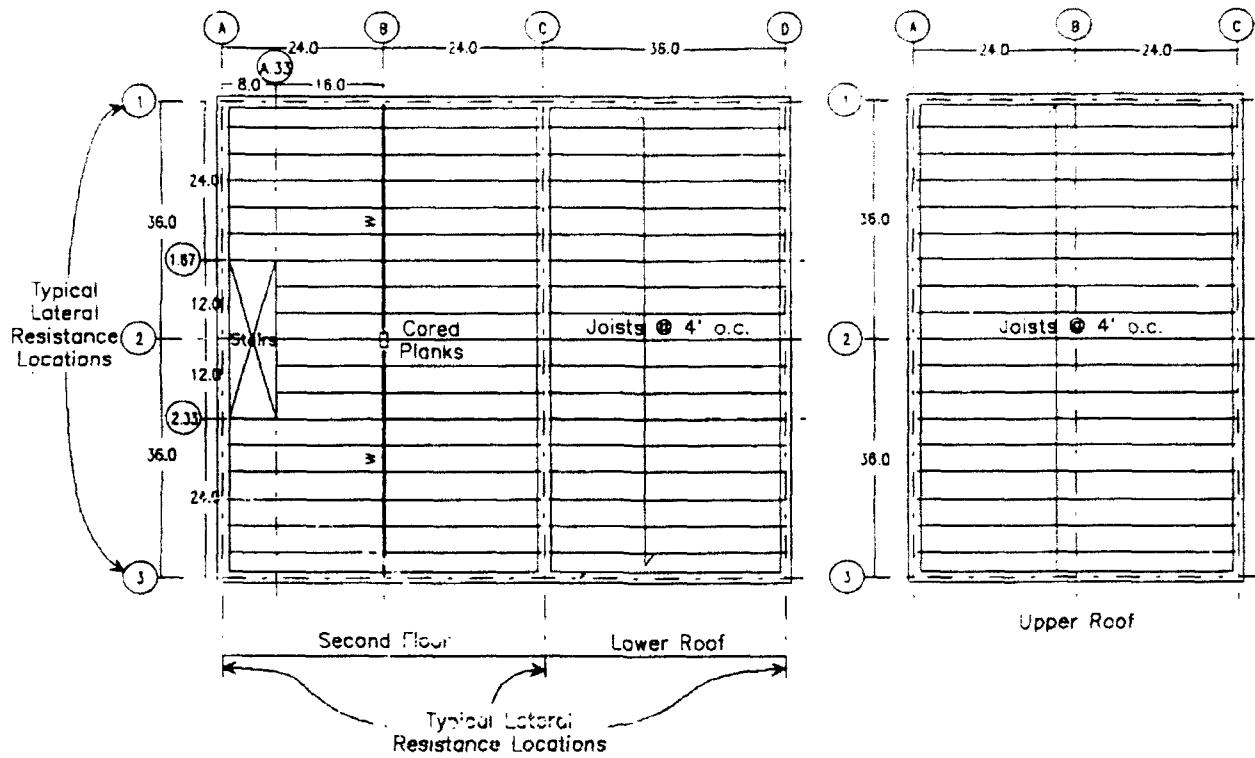
Concluding Remarks



Scheme 1: Moment connections for lateral load resistance

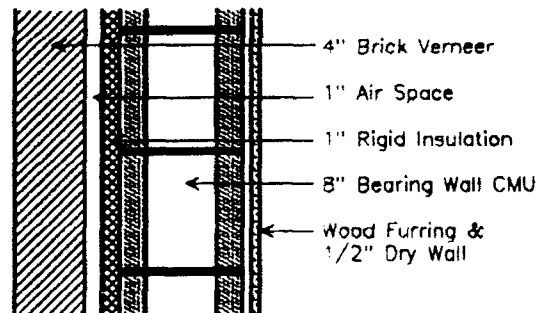
Scheme 2: Trussing for lateral load resistance





Scheme 3: Shear walls for lateral load resistance

8" CMU walls can be used as shear walls



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