Computer-Aided Structural Engineering (CASE) Project

Computer-Aided Structural Modeling (CASM)

Version 6.00

Report 4
Scheme B

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

Approved For Public Release; Distribution Is Unlimited

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Prepared for Headquarters, U.S. Army Corps of Engineers
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by David Wickersheimer, Carl Roth, Gene McDermott
Wickersheimer Engineers, Inc.
821 South Neil Street
Champaign, IL 61820

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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.

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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.
Scheme A

Typical Rigid Frame Locations

Second Floor  Lower Roof

Typical Rigid Frame Locations

Single Ply Adhered Membrane
3" Rigid Insulation
1-1/2" 20 ga Metal Roof Deck

Upper Roof
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling

Partition Load = 6 psf
5/8" Drywall
3-5/8" Metal Stud
1" Insulation Board
Carpet & Pad

Second Floor
2-1/2" NLWT
2"-20ga Metal Floor Deck
Mechanical: 3 psf
Electrical: 1 psf
Sprinklers: 2 psf
Lay-In Acoustical Ceiling
5" Limestone Panels
**Scheme B**

![Diagram of Scheme B]

- **Typical X-Bracing Locations**
- **Second Floor**
- **Lower Roof**
- **Upper Roof**

**Details:**
- **Single Ply Adhered Membrane**
- **3" Rigid Insulation**
- **1-1/2" 20 ga Metal Roof Deck**
- **Upper Roof**
- **Mechanical:** 3 psf
- **Electrical:** 1 psf
- **Sprinklers:** 2 psf
- **Lay-In Acoustical Ceiling**

**Partition Load = 6 psf**
- **5/8" Drywall**
- **3-5/8" Metal Stud**
- **1" Insulation Board**
- **Carpet & Pad**
- **Second Floor**
- **2-1/2" NLWT**
- **2"-20ga Metal Floor Deck**
- **Mechanical:** 3 psf
- **Electrical:** 1 psf
- **Sprinklers:** 2 psf
- **Lay-In Acoustical Ceiling**
- **5" Limestone Panels**
Scheme C

- Second Floor
- Lower Roof
- Upper Roof
- Typical 10" Concrete Shear Walls

- Single Ply Adhered Membrane
- Upper Roof
- 4" Concrete Slab
  - Mechanical: 3 psf
  - Electrical: 1 psf
  - Sprinklers: 2 psf
- Lay-In Acoustical Ceiling

- Partition Load = 6 psf
- 5/8" Drywall
- 3-5/8" Metal Stud
- 1" Insulation Board
- Carpet & Pad

- Second Floor
- 4" Concrete Slab
  - Mechanical: 3 psf
  - Electrical: 1 psf
  - Sprinklers: 2 psf
- Lay-In Acoustical Ceiling

- 5" Limestone Panels

- Single Ply Membrane
- 3" Rigid Insulation
- 1-1/2" 20 ga Metal Roof Deck
- 1-1/2" Concrete
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:

<table>
<thead>
<tr>
<th>Importance Category</th>
<th>Exposure Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snow: I</td>
<td>C</td>
</tr>
<tr>
<td>Wind: I</td>
<td>C</td>
</tr>
<tr>
<td>Seismic: IV</td>
<td></td>
</tr>
</tbody>
</table>

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

Start

Criteria

City/Installation Database

Draw Model

Import DXF Reference Drawing

Snow Loads

Wind Loads

Main Wind Force Resisting

Components & Cladding

Calculate After Structure Is Drawn

Open Roof

Dead & Live Loads

Dead Loads

Area Loads

Wall Loads

Point Loads

Occupancy Live Loads

Live Load Reduction

Area Loads

Point Loads

Minimum Roof Live Loads

Calculate During Analysis

Loads Database
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 sq ft
- Occupancy: Use Group B
- Type Const: 3A
- Seismic Lateral Load Resistance:
  - N-S System: Blank
  - E-W System: Blank

Review Regional Data
- Wind:
  - Basic Wind Speed: 70.0 mph
  - Coastal: No
  - Maximum Wind Speed: 58.0 mph
  - Wind Direction: SE
- Snow:
  - Ground Snow Load: 25.0 psf
  - Maximum Snow Depth: 15.0 in
  - Snow Density: 17.3 pcf
- Rain:
  - Average Annual Rainfall: 44.0 in
  - Maximum Rainfall: 4.0 in
- Temperature:
  - Maximum temperature: 92 °F
  - Minimum Temperature: -24 °F
- Seismic Zone: 2A: 0.150
- Frost Depth: 22 in
Criteria

Site

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

Print

Print Data
☑ Basic Design Criteria
☐ All Other
☐ Print To File
☐ Execute Notepad

Scroll Output

Page Setup
Left Margin: 0.5 in
Right Margin: 0.0 in

Print File

Exit Notepad

End
Basic Design Criteria

Project Data
Project Name : Office Building - Scheme B
City/Installation : Radford AAF
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 :
E-W System :
E-W Rw :

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 psf
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
Frost Depth : 22 in

Site Specific Data
Wind
Exposure :
Importance : I
Importance : 1.00
Snow
Exposure : C
Importance : I
Importance : 1.00
Roof Slippery : No
Thermal Factor : 1.0
Seismic
Importance : IV
Soil Factor : S3

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

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

Wind Exposure Category:

Exposure C:
Open terrain with scattered obstructions having heights generally less than 30.0 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

Start

Run Cardfile

Open CITIES.CRD

Duplicate Card

Edit Index
Index Line: Charleston

Modify Fields
USA   SC
Charleston
TM 5-809-1 1992
40
52.0 10.0
5
7.0
100
71    NNE    Y
102.0 8.0
0
3

Save File

Add Another City/Installation

Yes

No

Exit Cardfile

End

Fields

<table>
<thead>
<tr>
<th>Country</th>
<th>State</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>County</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Load</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elevation (ft)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ave. Rain (In)</td>
<td>Max. Rain (In)</td>
<td></td>
</tr>
<tr>
<td>Ground Snow Load (psf)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Snow Depth (In)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Basic Wind Speed (mph)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. Wind Speed (mph)</td>
<td>Wind Direction</td>
<td>Coastal (Y/N)</td>
</tr>
<tr>
<td>Max. Temp. (*F)</td>
<td>Min. Temp. (*F)</td>
<td></td>
</tr>
<tr>
<td>Frost Depth (in)</td>
<td>Seismic Zone</td>
<td></td>
</tr>
</tbody>
</table>
**Modeling Philosophy**

A. Simplify the geometric model

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

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

Extra wings are not necessary

Simplified model

B. Make sure planes are in contact

A gap between adjoining shapes will make the surfaces exterior.

Use the Stack options to accurately place adjoining shapes.

C. Do not intersect shapes

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

Incorrect

Correct

D. Verify the model

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

Start

Use Draw Model Tool Palette

Establish Initial Layout Defaults

Ground Plane
- Size: 100' x 100'
- Spacing: 20' x 20'
- Show Ground Plane

Units
- Increment: 4'
- Display: US ft-lin
- Snap To Units

Initial Shape Size
- N-S: 738'
- E-W: 858'
- Height: 140'
- Plane Thickness: 10'
- Orientation: N-S

✓ Stack On Ground Plane

Draw Building Volume

Draw First Floor Volume

Position Cube On Ground Plane

Double Click Right Mouse Key To End

✓ Stack On Last Shape

Place Cube On Last Shape

Drag Plane To Correct Dimension
- E-W: 498'

Draw Second Floor Volume

Draw Gable Roof Volume

Place Prism On Last Shape

✓ Lock N-S & E-W

Drag Edge To Correct Roof Slope
- Slope: 5.8 in 12

Draw Second Floor Volume

Place Cube On Last Shape

Drag Plane To Correct Dimension
- E-W: 498'

Draw Gable Roof Volume

Place Prism On Last Shape

✓ Lock N-S & E-W

Drag Edge To Correct Roof Slope
- Slope: 5.8 in 12
Snow Loads

Start

Use Loads And Design Tool Palette

Calculate Snow Loads

Review Criteria

Calculate

View Output

View Section

Print Screen ( Printer

Print Calculations

View Perspective (3D)

Show Loads

None

Print Data

- Snow
- All Other
- Print To File
- Execute Notepad

Scroll Output

Page Setup

Left Margin: 0.5 in
Right Margin: 0.0 in

Print File

Exit Notepad

Solid Object
Snow Loads
Snow Loads

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

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

Flat Roof Snow Load (Pf)
Pf = 0.7*Ce*CT*I*Pg
Snow Exposure Category: C
Ce = 1.0
Heated Structure.
Ct = 1.0
Importance Category: I
I = 1.0
Pg = 25.0 psf
Pf = 17.50 psf
Roof Slope: 0.00 in 12
Theta = 0 deg
Since theta < 0.5 in/ft, 5.0 psf rain-on-snow surcharge applies.
Pf = 22.50 psf
Check minimum Pf where theta <= 15 deg
When Pg > 20.0 psf, min Pf = 20.0*I
Min Pf = 20.00 psf

---------------------
Pf = 22.50 psf
---------------------

Sloped Roof Snow Load (Ps)
Ps = Cm*Pf
Roof Slippery: No
Cm = 1.00

---------------------
Ps = 22.50 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 = 2.99 >= 0.20 Therefore consider drift load.
Importance Category: I
I = 1.0
Snow Exposure Category: C
Ce = 1.0
Separation = 0.00 ft
lu = 84.83 ft
Minimum lu = 25.0 ft <= lu
hd = 0.43*lu^-1/3*(Pg*10)^1/4-1.5
hd = 3.10 ft
Width of drift: W = minimum of 4*hd or 4*hc
w = 4*hd = 12.38 ft
w = 4*hc = 11.94 ft

---------------------
W = 11.94 ft
---------------------

hd = hd*20.0-3/20.0 = 3.10 ft
hd > hc, therefore hd = hc = 2.99 ft
Pd = hd*density
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 <= 1u
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

hd = hd*(20.0-a)/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 = 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 = 49.67 ft
Minimum lu = 25.0 ft <= 1u
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

hd = hd*(20.0-a)/20.0 = 2.34 ft
hd <= hc
Snow Loads

\[ F_d = h \cdot d \cdot \text{density} \]

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>( F_d = 40.44 \text{ psf} )</td>
<td></td>
</tr>
</tbody>
</table>
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

Start

Use Loads And Design Tool Palette

Calculate Wind Loads

Review Criteria
% Opening Coefs: -0.25 & +0.25
Main Wind Force Resistance System

Calculate

View Output

View Section

Print Screen

View Calculations

Print Data
- Wind Main Force Resist.
- All Other
- Print To File
- Execute Notepad

Scroll Output

Page Setup
- Left Margin: 0.5 in
- Right Margin: 0.0 in

Print File

Exit Notepad

View Perspective (3D)

Solid Object
Main Wind Force Resisting Loads

View Output

Show Loads
- GCpl = 0
- GCpl Positive
- GCpl Negative
- B & L Assumptions
  - none

End
Main Wind Force Resisting Loads

Wind Loads: GCpl=0 (psf)

Wind Loads: GCpl=0 (psf)

Wind Loads: GCpl=0 (psf)
## Wind Load - 1

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Importance Factor</th>
<th>Exposure</th>
<th>Width to Wind (ft)</th>
<th>Length to Wind (ft)</th>
<th>Roof Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mph)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>70.0</td>
<td>1.00</td>
<td>C</td>
<td>73.7</td>
<td>49.7</td>
<td></td>
</tr>
</tbody>
</table>

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

## Main Framing Pressures

### Parallel to Ridge or Length

<table>
<thead>
<tr>
<th>Location</th>
<th>$z$ or $h$ (ft)</th>
<th>$Gh$</th>
<th>$K_z$</th>
<th>$q_z$ (psf)</th>
<th>$C_p$</th>
<th>External Pressure $P$ (psf)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0.96</td>
<td>12.0</td>
<td>0.80</td>
<td>12.1</td>
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Distance to ocean line $\geq 100$ mi $h/d = 0.56 \leq 5$

## Wind Load - 2

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Importance Factor</th>
<th>Exposure</th>
<th>Width to Wind (ft)</th>
<th>Length to Wind (ft)</th>
<th>Roof Type</th>
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</thead>
<tbody>
<tr>
<td>(mph)</td>
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<td>1.00</td>
<td>C</td>
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<td>73.7</td>
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Distance to ocean line $\geq 100$ mi $h/d = 0.56 \leq 5$

### Main Framing Pressures

### Parallel to Ridge or Length

<table>
<thead>
<tr>
<th>Location</th>
<th>$z$ or $h$ (ft)</th>
<th>$Gh$</th>
<th>$K_z$</th>
<th>$q_z$ (psf)</th>
<th>$C_p$</th>
<th>External Pressure $P$ (psf)</th>
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<tbody>
<tr>
<td>Windward Wall</td>
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<td>21.0</td>
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<td>0.88</td>
<td>11.0</td>
<td>0.80</td>
<td>11.1</td>
</tr>
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<td>0.80</td>
<td>10.0</td>
<td>0.80</td>
<td>10.1</td>
</tr>
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<td>0.80</td>
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<td>0.80</td>
<td>10.1</td>
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<tr>
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<td>-10.6</td>
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### Wind Load - 2

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Importance Factor</th>
<th>Exposure</th>
<th>Width to Wind (ft)</th>
<th>Length to Wind (ft)</th>
<th>Roof Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mph)</td>
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<td>70.0</td>
<td>1.00</td>
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</tr>
</tbody>
</table>

Distance to ocean line $\geq 100$ mi $h/d = 0.56 \leq 5$
Main Wind Force Resisting Loads

<table>
<thead>
<tr>
<th>Velocity Importance Factor</th>
<th>Exposure</th>
<th>Width Perpend. to Wind (ft)</th>
<th>Length Parallel to Wind (ft)</th>
<th>Roof Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>(mph)</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>1.00</td>
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<tr>
<td></td>
<td>C</td>
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<tr>
<td></td>
<td>11.1</td>
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<td></td>
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<tr>
<td>Distance to ocean line &gt;= 100 mi</td>
<td>h/d = 0.39 &lt;= 5</td>
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</table>

Main Framing Pressures

<table>
<thead>
<tr>
<th>Location</th>
<th>z or h (ft)</th>
<th>Gh (psf)</th>
<th>Kz (psf)</th>
<th>qz (psf)</th>
<th>Cp</th>
<th>External Pressure P (psf)</th>
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</thead>
<tbody>
<tr>
<td>Windward Wall</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Perpendicular</td>
<td>16.0</td>
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<td>0.84</td>
<td>10.5</td>
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<tr>
<td>Level 1</td>
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<td>1.32</td>
<td>0.80</td>
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<tr>
<td>Level 1</td>
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<td>0.80</td>
<td>10.0</td>
<td>0.80</td>
<td>10.6</td>
</tr>
<tr>
<td>Leeward Wall</td>
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<td>0.80</td>
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<tr>
<td>Side Wall</td>
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<td>Roof</td>
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<td>-9.2</td>
</tr>
<tr>
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<td>14.0</td>
<td>0.80</td>
<td>10.0</td>
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<table>
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<tr>
<th>Location</th>
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<th>Kz (psf)</th>
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<td>10.1</td>
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<tr>
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<td>12.0</td>
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<td>-3.0</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Location</th>
<th>z or h (ft)</th>
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<th>Kz (psf)</th>
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<tr>
<td>Windward Wall</td>
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<tr>
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<td>0.80</td>
<td>10.1</td>
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<td>10.0</td>
<td>0.80</td>
<td>10.1</td>
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Distance to ocean line >= 100 mi | h/d = 0.39 <= 5 | 0.39
Main Wind Force Resisting Loads

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

Parallel to Ridge or Length

<table>
<thead>
<tr>
<th>Location</th>
<th>z or h (ft)</th>
<th>Gk</th>
<th>Kz</th>
<th>qz (psf)</th>
<th>Cp</th>
<th>External Pressure P (psf)</th>
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<th>0.25</th>
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<td>Parapet</td>
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<td>13.1</td>
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<td>13.1</td>
<td>8.1</td>
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<td></td>
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<tr>
<td>Side Wall</td>
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<td>0.80</td>
<td>10.6</td>
<td>-9.2</td>
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<td>-11.7</td>
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<tr>
<td>Overhang **</td>
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<td>8.0</td>
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<td></td>
<td>0.0</td>
<td>-2.5</td>
<td>2.5</td>
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</tbody>
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Notes for main framing:
Positive pressures act toward surfaces.
Pressure or suction = \( P = q^*Gh^*Cp = q^*h^*(GCpi) \)
\( q^* \): qz for windward wall evaluated at height z.
\( q^* \): qh for leeward wall, side walls, and roof evaluated at mean roof height.
** For roof overhangs: algebraically add this pressure to the above values. \( P = q^*h^*(GCpi) = 0.8qh^* \)

Internal Pressure Coefficients for Buildings, GCpi:

<table>
<thead>
<tr>
<th>Condition</th>
<th>GCpi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition I</td>
<td>All conditions except as noted under condition II.</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition II</td>
<td>Buildings in which both of the following are met:</td>
</tr>
<tr>
<td>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</td>
<td>-0.25</td>
</tr>
<tr>
<td>2. Percentage of openings in any one of the remaining walls or roof do not exceed 20%.</td>
<td></td>
</tr>
</tbody>
</table>

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

Start

Use Loads And Design Tool Palette

View Perspective (3D)

Calculate Wind Loads

Review Criteria
- % Opening Coefs: -0.25 & +0.25
- Components & Cladding

Calculate

Select Wall Plane

Tributary Area

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Point: 0'0&quot; 0'0&quot;</td>
<td></td>
</tr>
<tr>
<td>Point 2: 4'0&quot; 14'0&quot;</td>
<td></td>
</tr>
<tr>
<td>Length: 4'0&quot; 14'0&quot;</td>
<td></td>
</tr>
</tbody>
</table>

Wind Components & Cladding

- Add Opposite Side Of Roof
- Name: Limestone Panel

Component Tributary Width

Yes, Use Code Provision

Cancel Defining Tributary Areas

Mouse: Double Click Right Mouse Key

View Output

View Section

Print Screen

© Printer

Wind Load: Components & Cladding (pdf)
Wind Components & Cladding Loads

Wind Loads: Components & Cladding (psf)

Wind Loads: Components & Cladding (psf)
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 --------------------------------------------------

<table>
<thead>
<tr>
<th>Velocity</th>
<th>Importance Factor</th>
<th>Exposure</th>
<th>Width Perpendicular to Wind (ft)</th>
<th>Length Parallel to Wind (ft)</th>
<th>Roof Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>70.0</td>
<td>1.00</td>
<td>C</td>
<td>49.7</td>
<td>73.7</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Height (ft)</th>
<th>Kh</th>
<th>qh (psf)</th>
<th>GCpi</th>
</tr>
</thead>
<tbody>
<tr>
<td>28.0</td>
<td>0.96</td>
<td>12.0</td>
<td>-0.25 0.25</td>
</tr>
</tbody>
</table>

Height <= 60.0 ft

-------------------------------------------------- Component/Cladding Pressures (psf) --------------------------------------------------

<table>
<thead>
<tr>
<th>Tributary</th>
<th>Zone 4</th>
<th>Zone 5</th>
<th>Zone 4</th>
<th>Zone 5</th>
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<tbody>
<tr>
<td>Area (sf)</td>
<td>middle</td>
<td>corner</td>
<td>middle</td>
<td>corner</td>
</tr>
<tr>
<td></td>
<td>GCpi</td>
<td>P</td>
<td>GCpi</td>
<td>P</td>
</tr>
<tr>
<td>Internal</td>
<td>-3.0</td>
<td>-3.0</td>
<td>3.0</td>
<td>3.0</td>
</tr>
<tr>
<td>Limestone Panel</td>
<td>4.67 ft x 14.00 ft **</td>
<td>65.3</td>
<td>1.21</td>
<td>17.5</td>
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<tr>
<td>a = 5.0 ft</td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes for components and cladding:
P = qh(GCpi) - qh(GCpi)

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, GCpi:

<table>
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<tr>
<th>Condition</th>
<th>GCpi</th>
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</thead>
<tbody>
<tr>
<td>Condition I All conditions except as noted under condition II.</td>
<td>+0.25</td>
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<tr>
<td></td>
<td>-0.25</td>
</tr>
<tr>
<td>Condition II Buildings in which both of the following are met:</td>
<td>+0.75</td>
</tr>
<tr>
<td>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</td>
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(1) Values are to be used with qz or qf 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.
Dead & Live Loads

Start

Use Loads And Design Tool Palette

Live Loads

Use Occupancy (LL)

Add
Office: Offices 50 psf

Add
Corridor: First Floor 100 psf

Change Corridor: First Floor to Corridor: Main

Double Click On Corridor: First Floor

Add
Files: Letter 80 psf

Change Files: Letter To Files & Storage 150 psf

Double Click On Files: Letter

Stop Using Occupancy (LL)
Dead & Live Loads

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

Input
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

Select Type
Button

Scroll To Find Load Type & PSF

Double Click On Load Type

Stop Using Floor (DL)

Roof Dead Loads → Use Roof (DL)

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

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

Dead Loads → Roof Dead Loads → Select Lower Roof Load → Stop Using Roof (DL) → Wall Dead Loads → Use Wall (DL) →

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

Input
Name: Parapet
Type: Limestone 5" 68.8
Finish:
Sheathing:
Structure:
Insulation:
Finish:
Total: 68.8

Select Exterior Wall Load → Stop Using Wall (DL)

Print
Print Data
☐ Dead and Live Loads
☐ All Other
☐ Print To File
☐ Execute Notepad
Scroll Output
Dead & Live Loads

- Print
  - Page Setup
    - Left Margin: 0.5 in
    - Right Margin: 0.0 in
  - Print File
  - Exit Notepad
- End
# Dead & Live Loads

## Floor Dead Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Partition</td>
<td>51-100 plf</td>
<td>6.0</td>
</tr>
<tr>
<td>Finish</td>
<td>Carpet &amp; Pad</td>
<td>1.0</td>
</tr>
<tr>
<td>Deck</td>
<td>MTL DK 2.0/NLWT 2.5</td>
<td>42.0</td>
</tr>
<tr>
<td>Structure</td>
<td>Steel Beams</td>
<td>0.0</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Mech A/C Ducts</td>
<td>3.0</td>
</tr>
<tr>
<td>Electrical</td>
<td>Elect/Lighting</td>
<td>1.0</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Sprinklers Wet</td>
<td>2.0</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Susp Chnl/Tile</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>57.0</td>
</tr>
</tbody>
</table>

## Roof Dead Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing</td>
<td>Single Ply</td>
<td>1.5</td>
</tr>
<tr>
<td>Deck</td>
<td>MTL DK 1.5/NLWT 2.5</td>
<td>36.0</td>
</tr>
<tr>
<td>Structure</td>
<td>Steel Bar Jst 36'64'</td>
<td>2.7</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Mech A/C Ducts</td>
<td>3.0</td>
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<tr>
<td>Electrical</td>
<td>Elect/Lighting</td>
<td>1.0</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Sprinklers Wet</td>
<td>2.0</td>
</tr>
<tr>
<td>Insulation</td>
<td>Rigid Roof Ins 3&quot;</td>
<td>2.4</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Susp Chnl/Tile</td>
<td>0.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>48.6</td>
</tr>
</tbody>
</table>

## Upper Roof

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing</td>
<td>Single Ply</td>
<td>1.5</td>
</tr>
<tr>
<td>Deck</td>
<td>Steel 1-1/2&quot; 20ga</td>
<td>2.5</td>
</tr>
<tr>
<td>Structure</td>
<td>Steel Beams</td>
<td>0.0</td>
</tr>
<tr>
<td>Mechanical</td>
<td>Mech A/C Ducts</td>
<td>3.0</td>
</tr>
<tr>
<td>Electrical</td>
<td>Elect/Lighting</td>
<td>1.0</td>
</tr>
<tr>
<td>Fire Protection</td>
<td>Sprinklers Wet</td>
<td>2.0</td>
</tr>
<tr>
<td>Insulation</td>
<td>Rigid Roof Ins 3&quot;</td>
<td>2.4</td>
</tr>
<tr>
<td>Ceiling</td>
<td>Susp Chnl/Tile</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>14.4</td>
</tr>
</tbody>
</table>

## Wall Dead Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish</td>
<td>Limestone 5&quot;</td>
<td>68.8</td>
</tr>
<tr>
<td>Sheathing</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Structure</td>
<td>Stl Stud 16ga 4&quot;816</td>
<td>1.1</td>
</tr>
<tr>
<td>Insulation</td>
<td>Exp Polysty Rigid 1&quot;</td>
<td>0.2</td>
</tr>
<tr>
<td>Finish</td>
<td>Gypboard 5/8&quot;</td>
<td>3.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>73.2</td>
</tr>
</tbody>
</table>
Dead & Live Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>psf</th>
</tr>
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<tbody>
<tr>
<td>Finish</td>
<td>Limestone 5&quot;</td>
<td>68.8</td>
</tr>
<tr>
<td>Sheathing</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Structure</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Insulation</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Finish</td>
<td></td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>68.8</td>
</tr>
</tbody>
</table>

Occupancy Live Loads

<table>
<thead>
<tr>
<th>Name</th>
<th>psf</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offices</td>
<td>50</td>
</tr>
<tr>
<td>Corridor: Main</td>
<td>100</td>
</tr>
<tr>
<td>Files &amp; Storage</td>
<td>150</td>
</tr>
</tbody>
</table>

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:

\[ L = L_0 \times \left(0.25 + \frac{15}{\text{sqrt}(A_1)}\right) \]

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**

1. **Start**
2. **Run Notepad**
3. **Open LOADS.DAT**
4. **Scroll To Location In File**
5. **Add New Item**
6. **Save File**
7. **Add Another Item**
   - **Yes**
   - **No**
   - **Exit Notepad**
8. **End**

*Insert A Single Tab Character Between The Text And The Load*
Draw Grid & Openings

Start

Use Draw Structure Tool Palette

Define Structural Grid

Select Second Floor/Lower Roof Horizontal Structural Plane

Structural Plane Information
Name: Second Floor/Lower Roof

Close Structural Plane Information Dialog Window

Define Grid
N-S Spacing: 240"
E-W Spacing: 240"
Perimeter Offset: 10"

Delete Grid Lines D & E

Delete Grid Lines

Select Grid Line E Then D

Double Click Right Mouse Key To End Deleting Grid Lines
Draw Grid & Openings

- Draw Openings
  - Add Opening
    - Horizontal: 10" 24'-10"
    - Vertical: 8'-10" 48'-10"
    - Length: 8'-0" 24'-0"
  - Opening Name: Stairs
  - Continuous

- F2 Key For Keyboard Input

End
Draw Structure Philosophy

Structure Hierarchy

Surface/Deck
(horizontal)

1 way

2 way
(not activated)

Linear
(horizonal)

Narrowly Spaced
(joists)

places uniform loads on girders

Widely Spaced
(beams)

places concentrated loads on girders

Surface
(vertical)
(planar)

uniform loads

Linear
(vertical)

concentrated loads
Draw Structure

Start

Use Draw Structure Tool Palette

Draw Upper Roof Framing

Select Upper Roof Horizontal Structural Plane

Structural Plane Information
Name: Upper Roof

Close Structural Plane Information Dialog Window

Draw Linear Beams On All Grid Lines

Draw Third Point Beams In Bay A1-B2

Linear: Widely Spaced

Select Handle On Grid A1-B1

Select Handle On Grid A2-B2

Double Click Right Mouse Key To End Defining Area

Save Linear Elements
Orientation: N-S
Number Of Elements: 2
Draw Surface

Upper Roof
Draw Structure

- Draw Upper Roof framing
- Copy Beams & One-Way Surface To Other Bays
- Copy Structure
  - Select Third Point Beams
  - Select One-Way Surface
  - Double Click Right Mouse Key To End Selecting Structure
  - Select Grid Location A1 As The Base Point
  - Paste Structure
  - Select Grid Locations B1, A2, B2, A3, B3
  - Double Click Right Mouse Key To End
- Draw Columns
- Column All Grid Intersections
  - Save Column Elements
    - Orientation: N-S
    - All Floors
- Draw Second Floor/ Lower Roof Framing
  - Select Second Floor/ Lower Roof Horizontal Structural Plane
  - Draw Linear Beams On All Grid Lines
Draw Second Floor/ Lower Roof Framing

Draw Surface In Bay A33,2-B3

Double Click Right Mouse Key To End Defining Area

Save Surface Element Orientation: E-W

Draw Joists In Bay C1-D4

Linear: Narrowly Spaced

Select Handle On Grid C1-D1

Select Handle On Grid C4-D4

Double Click Right Mouse Key To End Defining Area

Save Linear Elements Orientation: N-S

Spacing: 48"

Draw Surface

Draw Columns

Column One Grid Intersection

Select Grid Locations D1, D2, D3, D4

Double Click Right Mouse Key To End Selecting Locations

Save Columns Orientation: N-S

Height: 14'

☐ All Floors
Draw Structure
Assign Wall Loads Philosophy

1

user's choice

2

this approach saves memory
Assign Loads

Start

Use Loads & Design Tool Palette

Assign Live Loads

Select Second Floor/Lower Roof Horizontal Structural Plane

Use Occupancy (LL)

Highlight: Offices 50 psf

Assign Offices 50 psf

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

Snap To Grid

F2 Key For Keyboard Input

Assign Offices 50 psf

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

Highlight: Corridor: Main 100 psf

Assign Corridor: Main 100 psf

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

Highlight: Files & Storage 150 psf
Assign Loads

Assign Live Loads ➔ Assign Files & Storage 150 psf

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Point: 10&quot;</td>
<td>10&quot;</td>
</tr>
<tr>
<td>Point 2: 24'10&quot;</td>
<td>24'10&quot;</td>
</tr>
<tr>
<td>Length: 24'0&quot;</td>
<td>24'0&quot;</td>
</tr>
</tbody>
</table>

Stop Using Occupancy (LL)

Assign Dead Loads ➔ Assign Floor Loads ➔ Use Floor (DL)

Assign Second Floor Load

- Assign All Floors

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Point: 10&quot;</td>
<td>10&quot;</td>
</tr>
<tr>
<td>Point 2: 48'10&quot;</td>
<td>24'10&quot;</td>
</tr>
<tr>
<td>Length: 48'0&quot;</td>
<td>24'0&quot;</td>
</tr>
</tbody>
</table>

Assign Second Floor Load

- Assign All Floors

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Point: 8'10&quot;</td>
<td>24'10&quot;</td>
</tr>
<tr>
<td>Point 2: 48'10&quot;</td>
<td>48'10&quot;</td>
</tr>
<tr>
<td>Length: 40'0&quot;</td>
<td>24'0&quot;</td>
</tr>
</tbody>
</table>

Assign Second Floor Load

- Assign All Floors

<table>
<thead>
<tr>
<th>Horizontal</th>
<th>Vertical</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Point: 10&quot;</td>
<td>48'10&quot;</td>
</tr>
<tr>
<td>Point 2: 48'10&quot;</td>
<td>72'10&quot;</td>
</tr>
<tr>
<td>Length: 48'0&quot;</td>
<td>24'0&quot;</td>
</tr>
</tbody>
</table>

Stop Using Floor (DL)
Assign Loads

Assign Dead Loads

Assign Roof Loads

Use Roof (DL)

Assign Lower Roof Load

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

Stop Using Roof (DL)

Assign Exterior Wall Loads

Use Wall (DL)

Assign Exterior Wall Load

Assign All Floors

Horizontal: 10"  10"
Point 2: 10"  72'10"
Length: 00"  72'0"

Wall Height
Start: 140'
End: 140'

Assign Exterior Wall Load

Assign All Floors

Horizontal: 10"  10"
Point 2: 48'10"  10"
Length: 48'0"  00"

Wall Height
Start: 140'
End: 140'

Assign Exterior Wall Load

Assign All Floors

Horizontal: 48'10"  10"
Point 2: 48'10"  72'10"
Length: 00"  72'0"
Assign Loads

1. Assign Dead Loads
2. Assign Ground Floor Wall Loads
3. Close Structural Plane Information Dialog Window
4. Use Wall (DL)
   - Assign Exterior Wall Load
     - Assign All Floors
     - Horizontal: 10°, Vertical: 10°
     - Base Point: 10°, Point 2: 84°10′, Length: 84°0′
     - Wall Height: Start: 140°, End: 140°
   - Assign Exterior Wall Load
     - Assign All Floors
     - Horizontal: 10°, Vertical: 10°
     - Base Point: 84°10′, Point 2: 84°10′, Length: 0°, 72°0′
     - Wall Height: Start: 140°, End: 140°
   - Assign Exterior Wall Load
     - Assign All Floors
     - Horizontal: 72°10′, Vertical: 10°
     - Base Point: 10°, Point 2: 84°10′, Length: 84°0′
     - Wall Height: Start: 140°, End: 140°
5. Stop Using Wall (DL)
Assign Loads

View Loads → Show Loads
None

End
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

<table>
<thead>
<tr>
<th>Connectivity</th>
<th>Loads</th>
<th>M</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable Stresses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allowable Deflections</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Required: I &amp; S</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Choices & Options Table

Selection

sent back to CASM
Surface Element Analysis

Start

Use Loads & Design Tool Palette

Select Upper Roof Horizontal Structural Plane

Material Steel

Select Element To Analyze & Design

Surface One-Way Roof Deck

Select A One-Way Surface Element

Review Element Attributes & Guidelines

Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis
Units: Feet & Pounds

Decking Analysis
Number Of Spans: 3
Distance From Edge: 12'
Starting Span Number: 1

Snow Load Options
- Combined Snow Loads

Minimum Roof (LL)
Surface Element Analysis

Preliminary Analysis

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

View Shear, Moment & Deflection Diagrams

Excel Data
- Execute Excel

End
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

Lr = 20*R1*R2 >= 12
At <= 200    R1 = 1.00
F <= 4       R2 = 1.00
Lr = 20.00 psf
Minimum Lr = 12.0 psf

---

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

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

Start

Review Spans, Depth Limit, Wind & Deck Loads & Deflection Limits

Review Calculations & Selections → Use Scratch Pad To Explore Spans, And Loading Alternatives

Select Member

Print Spreadsheet

Return To Preliminary

Select Member

Send Member Size To CASM

Print Spreadsheet

Return To CASM

Cancel Selected Element

End
STEEL ROOF DECK PRELIMINARY SELECTION

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

Load and Analysis Data:

<table>
<thead>
<tr>
<th>Method: Analysis</th>
<th>Load Combination: D + S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member ID:</td>
<td></td>
</tr>
<tr>
<td>Connectivity:</td>
<td></td>
</tr>
<tr>
<td>Beam (Left)</td>
<td>Deck 16.0</td>
</tr>
<tr>
<td>Beam (Right)</td>
<td>Deck 12.8</td>
</tr>
<tr>
<td>Deck Span:</td>
<td>Sup Dead 76.2</td>
</tr>
<tr>
<td>Trib Width=</td>
<td>Live 60.9</td>
</tr>
<tr>
<td>Depth Limit=</td>
<td>Lmin Roof 76.2</td>
</tr>
<tr>
<td>Fy=</td>
<td>Snow 144.0</td>
</tr>
<tr>
<td>Fb=</td>
<td>Wind 115.2</td>
</tr>
<tr>
<td>Fv=</td>
<td>Summary 236.2</td>
</tr>
<tr>
<td>E =</td>
<td></td>
</tr>
<tr>
<td>Live Ld Defl=</td>
<td>=0.40 in</td>
</tr>
<tr>
<td>Total Defl=</td>
<td>=0.53 in</td>
</tr>
</tbody>
</table>

Load Combinations for roof:

Load Case #1: D + S  Est. Deck Wgt = 2.0 psf
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:

<table>
<thead>
<tr>
<th>Case</th>
<th>Load (psf)</th>
<th>Fb Factor</th>
<th>M+ (f-lb)</th>
<th>M- (f-lb)</th>
<th>S+ (in.3)</th>
<th>S- (in.3)</th>
<th>lx (in.4)</th>
</tr>
</thead>
<tbody>
<tr>
<td># 1</td>
<td>1.00</td>
<td>188.9</td>
<td>92.2</td>
<td>0.113</td>
<td>0.055</td>
<td>0.1531</td>
<td></td>
</tr>
<tr>
<td># 2</td>
<td>-28.0</td>
<td>209.7</td>
<td>-168.4</td>
<td>0.095</td>
<td>-0.076</td>
<td>0.1263</td>
<td></td>
</tr>
<tr>
<td># 3</td>
<td>2.0</td>
<td>332.0</td>
<td>-183.0</td>
<td>0.150</td>
<td>-0.083</td>
<td>0.1716</td>
<td></td>
</tr>
</tbody>
</table>

Maximums:

332.0 -183.0 0.150 -0.083 0.1716

Steel Roof Deck Selection Table - Spans = 3

<table>
<thead>
<tr>
<th>Deck Type</th>
<th>Gage</th>
<th>Depth (in)</th>
<th>Sx+ (in.3)</th>
<th>Sx- (in.3)</th>
<th>lx (in.4)</th>
<th>Dk wgt (psf)</th>
<th>Const Span Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>WR 20</td>
<td>20</td>
<td>1.5</td>
<td>0.232</td>
<td>-0.245</td>
<td>0.210</td>
<td>2.1</td>
<td>6'-3&quot; 7'-5&quot;</td>
</tr>
<tr>
<td>IR 18</td>
<td>18</td>
<td>1.5</td>
<td>0.189</td>
<td>-0.194</td>
<td>0.206</td>
<td>2.7</td>
<td>6'-2&quot; 7'-4&quot;</td>
</tr>
<tr>
<td>WR 18</td>
<td>18</td>
<td>1.5</td>
<td>0.316</td>
<td>-0.325</td>
<td>0.290</td>
<td>2.8</td>
<td>7'-6&quot; 8'-10&quot;</td>
</tr>
<tr>
<td>NR 18</td>
<td>18</td>
<td>1.5</td>
<td>0.163</td>
<td>-0.168</td>
<td>0.188</td>
<td>2.8</td>
<td>5'-11&quot; 6'-11&quot;</td>
</tr>
</tbody>
</table>

CASM Preliminary Steel Roof Deck Selection:

<table>
<thead>
<tr>
<th>Deck Type: WR 20</th>
<th>Span= 8.0 ft</th>
<th>Depth: 1.5 in</th>
<th>Description: 2-1/2&quot;Rlb@6&quot;oc</th>
</tr>
</thead>
</table>
| Weight: 2.1 psf   | Gage: 20      | lx = 0.21     | Construction Load Span Limits:
|                   |               | Sx+ = 0.232   | 1 span: 6'-3" 2+span: 7'-5" |
|                   |               | Sx- = -0.245  |                             |

Notes:

1. Steel roof deck properties from representative manufacturer's data.
Narrowly Spaced Element Analysis

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Select Element To Analyze & Design

Linear Narrowly Spaced Open-Web Joists-K

Select A Narrowly Spaced Element Near A Corner

Review Element Attributes & Guidelines

Compare Min. Roof LL & Snow Loads

Use Compare Min. Roof LL & Snow Loads

Analysis
Units: Feet & Pounds

Connectivity
Left: Hinge
Right: Roller

Snow Load Options
- Combined Snow Loads
- Minimum Roof (LL)
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

\[ L_r = 20 \times R_1 \times R_2 \geq 12 \]
At \leq 200 \quad R_1 = 1.00
F \leq 4 \quad R_2 = 1.00
L_r = 20.00 \text{ psf}

Minimum Lr = 12.0 psf

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

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 ft square (4.0 sqft) will be included. The concentrated load will be located so as to produce the maximum stress in the member.
Office Building - Subcase B - 1.00 Dead Load

**INPUT**

**OUTPUT**

**JOINT DISPLACEMENTS**

**MEMBER END FORCES**

**APPLIED JOINT LOADS AND SUPPORT REACTIONS**

**MEMBER DATA**

**BOUNDARY CONDITIONS**

**PROBLEMS COMPLETE**
**Narrowly Spaced Element Analysis**

**Material Types**

- **Material Young's Modulus**
  - 1 1000.000 0.0000

**Member Properties**

- **Element Type**
  - 1 1000.000 0.0000 1.0000

**Summary of In-Plane Loads**

- **Positive**
  - Z-Plane Shear and Counterclockwise
  - **Units**: Kips
  - **Load Load Shear Starting Starting Ending Ending**
  - **Type**: Length, Moment, Position, Positive, Negative
  - 1 3.60 -15.34 0.00 3.60

**Fixed End Forces in Local Coordinates**

- **Units**: Kips
- **Type**: Axial, Shear, Moment, X, Y
- 1 0.000 330.480 194.880 0.000 330.480 -194.880

**Joint Data**

- **Units**: Kips
- **Node Code**: X, Y

**Boundary Conditions**

- **Modal Coordinates**: Modal Forces and Moments, Elastic
- **Support Type**: 1, 0, 0, 0, 0, 0, 0

**Member Data**

- **Element Type**: Node Code, Modal Force, Modal Moment, Elastic Stiffness, Over

**Joint Displacements**

- **Units**: Inches

**Material Types**

- **Material Young's Modulus**
  - 1 1000.000 0.0000

---

**Shell Element Analysis**

- **Units**: Inches

**Applied Joint Loads and Support Reactions**

- **Units**: Kips

**Nodes**

- **Node Code**: X, Y

**Support Type**: 1, 0, 0, 0, 0, 0, 0

---

**Program Completed**

- **Output**

**Frame Analysis**

- **Units**: Inches

**Office Building - Frame Analysis**

- **Units**: Inches

**Material Types**

- **Material Young's Modulus**
  - 1 1000.000 0.0000
### Narrowly Spaced Element Analysis

#### Summary of 2-Star Loads

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Span</th>
<th>Starting Position</th>
<th>Ending Position</th>
<th>Magnitude (kip)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.40</td>
<td>-225.80</td>
<td></td>
<td>8.83</td>
</tr>
<tr>
<td>2</td>
<td>3.40</td>
<td>-227.70</td>
<td></td>
<td>8.83</td>
</tr>
<tr>
<td>3</td>
<td>3.40</td>
<td>-228.39</td>
<td></td>
<td>8.83</td>
</tr>
<tr>
<td>4</td>
<td>3.40</td>
<td>-227.70</td>
<td></td>
<td>8.83</td>
</tr>
<tr>
<td>5</td>
<td>3.40</td>
<td>-227.70</td>
<td></td>
<td>8.83</td>
</tr>
</tbody>
</table>

#### Applied Joint Loads and Support Reactions

<table>
<thead>
<tr>
<th>Node</th>
<th>Force X</th>
<th>Force Y</th>
<th>Moment Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>2</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>3</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>4</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

#### Joint Data

<table>
<thead>
<tr>
<th>Node Code</th>
<th>Modal Coordinates</th>
<th>Modal Forces and Moments</th>
<th>Elastic Constants</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>150</td>
<td>0.00 0.00 0.00 0.00 0.00</td>
<td>X Y Z</td>
</tr>
<tr>
<td>2</td>
<td>150</td>
<td>0.00 0.00 0.00 0.00 0.00</td>
<td>X Y Z</td>
</tr>
<tr>
<td>3</td>
<td>150</td>
<td>0.00 0.00 0.00 0.00 0.00</td>
<td>X Y Z</td>
</tr>
</tbody>
</table>

#### Member Data

<table>
<thead>
<tr>
<th>Member Code</th>
<th>Element Type Code</th>
<th>E-Modulus</th>
<th>P.Y. Factor</th>
<th>Dundas Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1 2 1 1 0 1</td>
<td>4.00</td>
<td>4.00</td>
<td>0.50</td>
</tr>
<tr>
<td>2</td>
<td>1 2 1 1 0 1</td>
<td>4.00</td>
<td>4.00</td>
<td>0.50</td>
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</tbody>
</table>

#### Member End Forces

<table>
<thead>
<tr>
<th>Member Code</th>
<th>X-Displacement</th>
<th>Y-Displacement</th>
<th>X-Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.000</td>
<td>-262730.751</td>
<td>-3777.335</td>
</tr>
<tr>
<td>2</td>
<td>0.000</td>
<td>-486259.132</td>
<td>-4846.134</td>
</tr>
<tr>
<td>3</td>
<td>0.000</td>
<td>-604341.473</td>
<td>-5455.909</td>
</tr>
<tr>
<td>4</td>
<td>0.000</td>
<td>-728462.945</td>
<td>-72.947</td>
</tr>
<tr>
<td>5</td>
<td>0.000</td>
<td>-852281.493</td>
<td>3104.574</td>
</tr>
<tr>
<td>6</td>
<td>0.000</td>
<td>-976308.502</td>
<td>3487.646</td>
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</table>

#### Joint Displacements

<table>
<thead>
<tr>
<th>Joint</th>
<th>X-Displacement</th>
<th>Y-Displacement</th>
<th>Z-Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.000</td>
<td>-262730.751</td>
<td>-3777.335</td>
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</table>
Narrowly Spaced Element Analysis

<table>
<thead>
<tr>
<th>LOAD</th>
<th>LOAD</th>
<th>MEMBER</th>
<th>STARTING</th>
<th>STARTING</th>
<th>ENDING</th>
<th>ENDING</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>BEAM</th>
<th>TYP</th>
<th>LENGTH</th>
<th>SECTION</th>
<th>POSITION</th>
<th>MAGNITUDE</th>
<th>POSIT ION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| 1 | UTMN | 3.60 | 184.40 | 0.00 | 1255.80 | 2.40 |
| 2 | UTMN | 3.60 | 184.40 | 0.00 | 1255.80 | 2.40 |
| 3 | UTMN | 3.60 | 184.40 | 0.00 | 1255.80 | 2.40 |
| 4 | UTMN | 3.60 | 184.40 | 0.00 | 1255.80 | 2.40 |
| 5 | RAMP | 3.60 | 243.99 | 0.00 | 292.21 | 2.40 |
| 6 | RAMP | 3.60 | 243.99 | 0.00 | 292.21 | 2.40 |

APPLIED JOINT LOADS AND SUPPORT REACTIONS

<table>
<thead>
<tr>
<th>TYPE</th>
<th>AXIAL</th>
<th>SEEN</th>
<th>IMOMENT</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
<td>Z</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

JOINT DATA

<table>
<thead>
<tr>
<th>UNIT</th>
<th>PRET. FORC</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

BENDING AND DEFORMATIONS

<table>
<thead>
<tr>
<th>JOINT</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

MEMBER DATA

<table>
<thead>
<tr>
<th>ELB</th>
<th>MOV</th>
<th>HOC</th>
<th>BAR</th>
<th>REL.</th>
<th>F.R.</th>
<th>REL.</th>
<th>UNIT</th>
<th>CARRY OVER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>

J Most DISPLACEMENTS

<table>
<thead>
<tr>
<th>JOINT</th>
<th>X-DEPLACEMENT</th>
<th>Y-DEPLACEMENT</th>
<th>Z-ROTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

MEMBER END FORCES

<table>
<thead>
<tr>
<th>ELB</th>
<th>AXIAL</th>
<th>SEEN</th>
<th>IMOMENT</th>
<th>X</th>
<th>Y</th>
<th>Z</th>
<th>SUPPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

94
Steel Open-Web Joist Design

Start

Review Depth Limits & Deflection Limits

Review Calculations & Selections

Use Scratch Pad To Explore Span, Spacing, And Loading Alternatives

Select Member

Print Spreadsheet

Return To Preliminary

Select Member

Send Member Size To CASM

Print Spreadsheet

Return To CASM

Cancel Selected Element

End
STEEL BAR JOIST PRELIMINARY SELECTION

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

CASM Load & Analysis Data:

<table>
<thead>
<tr>
<th>Connection</th>
<th>Member ID</th>
<th>Load Type</th>
<th>Factored Moment (ft-lb)</th>
<th>Factored Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roller (Left)</td>
<td>Hinge</td>
<td>Dead</td>
<td>Left 1,170</td>
<td>Mid 194</td>
</tr>
<tr>
<td>Span: 36.0 ft</td>
<td>Sup Dead</td>
<td>329,743</td>
<td>3,305</td>
<td>3,305</td>
</tr>
<tr>
<td>Spacing: 48.0 in</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Depth Limit= 30.0 in. max</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fy= 50.0 ksi</td>
<td>Lmin Roof</td>
<td>35,517</td>
<td>3,817</td>
<td>4,121</td>
</tr>
<tr>
<td>Fb= 30.0 ksi</td>
<td>Wind</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E = 29,000 ksi</td>
<td></td>
<td>67,010</td>
<td>7,316</td>
<td>7,620</td>
</tr>
</tbody>
</table>

Summary: Load Combination D + S

Live Defl= L/360= 1.20 in  Moment = 414 plf
Total Defl= L/240= 1.80 in  EUL: Live Load = 219 plf

Ponding Check: NO

CASM Joist Selection Table: (joist capacities)

<table>
<thead>
<tr>
<th>J o i s t  S i z e</th>
<th>S p a c i n g  (i n)</th>
<th>T o t a l  L d (p f f)</th>
<th>L i v e  L d (p f f)</th>
<th>M m a x  (t f l b)</th>
<th>R m a x  (l b)</th>
<th>L i v e  L d  D e f l (i n)</th>
<th>T o t a l  L d  D e f l (i n)</th>
<th>P o n d i n g</th>
<th>J f t  W g t  (p f f)</th>
</tr>
</thead>
<tbody>
<tr>
<td>28K9</td>
<td>48.0</td>
<td>442</td>
<td>332</td>
<td>71,604</td>
<td>7,956</td>
<td>0.83</td>
<td>1.54</td>
<td>13.0</td>
<td></td>
</tr>
<tr>
<td>24K10</td>
<td>48.0</td>
<td>447</td>
<td>283</td>
<td>72,414</td>
<td>8,046</td>
<td>0.97</td>
<td>1.79</td>
<td>13.1</td>
<td></td>
</tr>
<tr>
<td>30K8</td>
<td>48.0</td>
<td>436</td>
<td>353</td>
<td>70,632</td>
<td>7,848</td>
<td>0.78</td>
<td>1.45</td>
<td>13.2</td>
<td></td>
</tr>
<tr>
<td>30K9</td>
<td>48.0</td>
<td>475</td>
<td>383</td>
<td>76,950</td>
<td>8,550</td>
<td>0.72</td>
<td>1.34</td>
<td>13.4</td>
<td></td>
</tr>
</tbody>
</table>

CASM Bar Joist Selection:

<table>
<thead>
<tr>
<th>J o i s t  S i z e</th>
<th>J o i s t  S i z e 28K9</th>
<th>S p a n  36.0 ft</th>
<th>T L d e f l  1.54 in</th>
<th>L L d e f l  0.83 in</th>
<th>W g t (t o n s) 0.23</th>
<th>M m a x  71,604</th>
<th>R m a x  7,956</th>
<th>T o t a l  L d  442 plf</th>
<th>L i v e  L d  332 plf</th>
</tr>
</thead>
</table>

NOTES:

1. Bar joist selections based on 1993 SJI Load Tables.
   Edit spreadsheet stajstk.xls to revise selection table.

2. Approximate moment of inertia of the joist in inches^4 is:
   \[ I = 26.767 \times (WLL) \times (L^3) \times (10^{-6}) , \] where WLL = Live Load value in table;
   where L = Span - 0.33 in feet

3. 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.
   a. 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.
   b. 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

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Select Element To Analyze & Design

Linear Widely Spaced Composite Beam/Slab

Select A Widely Spaced Element In Bay A3-B4

Review Element Attributes & Guidelines

Load Combination D + L

Use Load Combination

Set Factors
Dead: 1.0
Live: 1.0

Add

OK Button To Close Dialog Window

Highlight D+L In List
Widely Spaced Element Analysis: Beam

1.00 Dead (kif)

1.00 Superimposed Dead (kif)

1.00 Live (kif)

Shear (k)

Moment (ft-k)

Deflection

Total Combined Load: D + L
**Composite Steel Beam Design**

1. **Start**
2. Review Depth Limits, Deflection Limits & Steel Strength
3. Review Beam Configuration, Concrete Properties, Deck Rib Dimensions & Stud Dimensions
4. Review Calculations & Selections
5. Use Scratch Pad To Explore Span, Spacing, And Loading Alternatives
   - Select Member
   - Print Spreadsheet
   - Return To Preliminary
6. Select Member
   - Send Member Size To CASM
7. Print Spreadsheet
8. Return To CASM
9. Cancel Selected Element
10. End
## Composite Steel Beam Design

### STEEL COMPOSITE BEAM PRELIMINARY SELECTION

<table>
<thead>
<tr>
<th>Project: Office Building - Scheme B</th>
<th>Date: Sep 01, 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Radford AAP</td>
<td>Engr:</td>
</tr>
</tbody>
</table>

### CASM Load & Analysis Data:

<table>
<thead>
<tr>
<th>Method: Analysis</th>
<th>Load Combination: D + L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Member ID:</td>
<td></td>
</tr>
<tr>
<td>Connectivity:</td>
<td></td>
</tr>
<tr>
<td>Hinge (Left)</td>
<td></td>
</tr>
<tr>
<td>Roller (Right)</td>
<td></td>
</tr>
<tr>
<td>Beam Span:</td>
<td>24.0 ft</td>
</tr>
<tr>
<td>Trib Width=</td>
<td>8.0 ft</td>
</tr>
<tr>
<td>Depth Limit=</td>
<td>36.0 in. max</td>
</tr>
<tr>
<td>Fy=</td>
<td>36.0 ksi</td>
</tr>
<tr>
<td>Fb= Fy*0.66=</td>
<td>24.0 ksi</td>
</tr>
<tr>
<td>Fy*0.89=</td>
<td>32.0 ksi</td>
</tr>
<tr>
<td>Fv=</td>
<td>14.4 ksi</td>
</tr>
<tr>
<td>Es=</td>
<td>29,000 ksi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Load Type</th>
<th>Factored Moments (k-ft)</th>
<th>Fact. Reactions</th>
<th>Left(k)</th>
<th>Right(k)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left</td>
<td>Mid</td>
<td>Right</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load Type</td>
<td>Left</td>
<td>Mid</td>
<td>Right</td>
<td>Left(k)</td>
</tr>
<tr>
<td>Dead</td>
<td>26.4</td>
<td>4.4</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Sup Dead</td>
<td>8.6</td>
<td>1.4</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>Live</td>
<td>86.4</td>
<td>14.4</td>
<td>14.4</td>
<td></td>
</tr>
<tr>
<td>Lmin Roof</td>
<td>Snow</td>
<td>Wind</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>121.4</td>
<td>20.2</td>
<td>20.2</td>
<td></td>
</tr>
</tbody>
</table>

### Composite Properties:

<table>
<thead>
<tr>
<th>Composite Properties</th>
<th>Beam</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### CASM Beam Selection Table:

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

### CASM Steel Beam Selection:

<table>
<thead>
<tr>
<th>Beam Wgt=</th>
<th>0.31 tons</th>
</tr>
</thead>
</table>

### Notes:

2. Dead load shear and moment are not modified with changes in slab depth.
Widely Spaced Element Analysis: Girder

Start

Use Loads & Design Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Material Steel

Select Element To Analyze & Design → Linear Widely Spaced Composite Beam/Slab

Select Widely Spaced Element A3-B3

Review Element Attributes & Guidelines

Load Combination D + L

Use Load Combination

Set Factors
Dead: 1.0
Live: 1.0

Add

OK Button To Close Dialog Window

Highlight D+L In List
Widely Spaced Element Analysis: Girder

1.00 Dead (kif)

1.00 Superimposed Dead (kif)

1.00 Live (kif)

Shear (k)

Moment (ft-k)

Deflection

Total Combined Load: D + L
Composite Steel Beam Design

Start

Review Depth Limits, Deflection Limits & Steel Strength

Review Beam Configuration, Concrete Properties, Deck Rib Dimensions & Stud Dimensions

Review Calculations & Selections

Use Scratch Pad To Explore Span, Spacing, And Loading Alternatives

Select Member

Print Spreadsheet

Return To Preliminary

Select Member

Send Member Size To CASM

Print Spreadsheet

Return To CASM

Cancel Selected Element

End


## Composite Steel Beam Design

### STEEL COMPOSITE BEAM PRELIMINARY SELECTION

<table>
<thead>
<tr>
<th>Project: Office Building - Scheme B</th>
<th>Date: Sep 01, 1994</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location: Radford AAP</td>
<td>Engr:</td>
</tr>
</tbody>
</table>

### CASM Load & Analysis Data:

**Method**: Analysis

<table>
<thead>
<tr>
<th>Load Combination: D + L</th>
<th>Factored Moments (k-ft)</th>
<th>Fact. Reactions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Mid</td>
</tr>
<tr>
<td>Roller (Right)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beam Span</td>
<td>24.0 ft</td>
<td></td>
</tr>
<tr>
<td>Trib Width</td>
<td>12.0 ft</td>
<td></td>
</tr>
<tr>
<td>Depth Limit</td>
<td>36.0 in. max</td>
<td></td>
</tr>
<tr>
<td>Fy</td>
<td>36.0 ksi</td>
<td></td>
</tr>
<tr>
<td>Fy * 0.89</td>
<td>32.0 ksi</td>
<td></td>
</tr>
<tr>
<td>Fv</td>
<td>14.4 ksi</td>
<td></td>
</tr>
<tr>
<td>Es</td>
<td>29,000 ksi</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>269.1</td>
<td>31.3</td>
</tr>
</tbody>
</table>

### Composite Properties:

<table>
<thead>
<tr>
<th>Composite:</th>
<th>Spandrel Girder</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>f’c</td>
<td>4.0 ksi</td>
</tr>
<tr>
<td>Rib Spacing</td>
<td>6.00 in</td>
</tr>
<tr>
<td>.45f’c</td>
<td>1.8 ksi</td>
</tr>
<tr>
<td>Rib Width</td>
<td>2.50 in</td>
</tr>
<tr>
<td>Wc</td>
<td>145pcf</td>
</tr>
<tr>
<td>Rib Height</td>
<td>1.50 in</td>
</tr>
<tr>
<td>Ltwt conc coef</td>
<td>1.0</td>
</tr>
<tr>
<td>Studs/rib</td>
<td>1</td>
</tr>
<tr>
<td>Ec</td>
<td>3,644 ksi</td>
</tr>
<tr>
<td>Stud Diameter</td>
<td>0.75 in</td>
</tr>
<tr>
<td>n</td>
<td>8.0</td>
</tr>
<tr>
<td>Stud Length</td>
<td>4.0 in</td>
</tr>
<tr>
<td>Slab ts</td>
<td>5.50 in</td>
</tr>
<tr>
<td>Reduct. Factor</td>
<td>1.00</td>
</tr>
<tr>
<td>Composite percent</td>
<td>100 %</td>
</tr>
<tr>
<td>Slab bE</td>
<td>36.0 in</td>
</tr>
<tr>
<td>Shear Cap</td>
<td>13.3 kips</td>
</tr>
</tbody>
</table>

### Deflection Limits:

<table>
<thead>
<tr>
<th>Live Load</th>
<th>L/360 =0.80 in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Load</td>
<td>L/240 =1.20 in</td>
</tr>
</tbody>
</table>

### Reqd Section Properties:

| Ss (req) | 57 in^3       |
| Str (req) | 135 in^3     |

### CASM Beam Selection Table:

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

### CASM Steel Beam Selection:

<table>
<thead>
<tr>
<th>Live Ld</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 21 x 50</td>
<td></td>
</tr>
<tr>
<td>Span</td>
<td>24.0 ft</td>
</tr>
<tr>
<td>Seff (in^3)</td>
<td>145.4</td>
</tr>
<tr>
<td>eff (in^4)</td>
<td>2,746</td>
</tr>
<tr>
<td>Defl (in)</td>
<td>-0.26</td>
</tr>
<tr>
<td>Nstuds</td>
<td>40 (full)</td>
</tr>
<tr>
<td>Nstuds</td>
<td>40</td>
</tr>
<tr>
<td>Beam Wgt</td>
<td>0.60 tons</td>
</tr>
</tbody>
</table>

### Notes:


2. Dead load shear and moment are not modified with changes in slab depth.
Column Load Run Down

1. Start
2. Use Loads & Design Tool Palette
3. Material Steel
4. Live Load Reduction
   - Occupancy (LL)
     - ☑ Apply Live Load Reduction
5. Select Element To Analyze & Design
6. Column Rolled Section
7. Select Column B3
8. Review Element Attributes & Guidelines
9. Compare Min. Roof LL & Snow Loads
10. Use Compare Min. Roof LL & Snow Loads
11. Analysis
   - Units: Feet & Pounds
12. Snow Load Options
   - ☑ Combined Snow Loads
13. Minimum Roof (LL)
14. Column Analysis
   - ☑ Tributary Area
15. Compare Min. Roof LL & Snow Loads
Column Load Run Down

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

2. **Preliminary Analysis**
   - Use Preliminary
     - Analysis
       - Units: Feet & Pounds
       - Load Combination: D+L+S
       - Use Actual Properties
       - DL=Deck+Self Weight
       - Apply Live Load Reduction
     - Live Load Reduction
       - Occupancy Is Public Assembly Or Garage
       - File Name: Lirout.txt
     - Snow Load Options
       - Combined Snow Loads
     - Column Analysis
       - Tributary Area
     - Column Self Weight
       - Estimated Self Weight: 36 psi
Preliminary Analysis

View Column Load Run Down

Excel Data
 Execute Excel

View Calculations After Design

Print Data
 Live Load Reduction
 All Other
 Print To File
 Execute Notepad

Scroll Output

Page Setup
 Left Margin: 0.5 In
 Right Margin: 0.0 In

Print File

Exit Notepad

Live Load Reduction

Occupancy (LL)
 Apply Live Load Reduction

End
### Column Load Run Down

<table>
<thead>
<tr>
<th>Tributary Area</th>
<th>Lr</th>
<th>S</th>
<th>Sum Lr</th>
<th>Sum S</th>
</tr>
</thead>
<tbody>
<tr>
<td>576.0</td>
<td>7.2</td>
<td>13.0</td>
<td>7.2</td>
<td>13.0</td>
</tr>
</tbody>
</table>

#### 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

\[
Lr = 20 \times R1 \times R2 \geq 12
\]

\[
200 < At < 600 \quad R1 = 1.2 - 0.001 \times At \\
R1 = 0.624
\]

\[
F \leq 4
\]

\[
R2 = 1.00
\]

\[
Lr = 12.48 \text{ psf}
\]

Minimum Lr = 12.0 psf

---

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

Additionally, for the design of secondary members such as roof decking and rafters, a concentrated live load with 250 lbs uniformly distributed over an area of 2.0 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

<table>
<thead>
<tr>
<th></th>
<th>Tributary Area</th>
<th>Self Weight</th>
<th>DL</th>
<th>LLR</th>
<th>LLR</th>
<th>S</th>
<th>TL</th>
<th>Sum DL</th>
<th>Sum LLR</th>
<th>Sum S</th>
<th>Sum TL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Roof</td>
<td>576.0</td>
<td>8.3</td>
<td>0.0</td>
<td>0.0</td>
<td>13.0</td>
<td>21.3</td>
<td>8.6</td>
<td>0.0</td>
<td>13.0</td>
<td>21.8</td>
<td></td>
</tr>
<tr>
<td>140°</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second Floor/Lower Roof</td>
<td>576.0</td>
<td>35.0</td>
<td>37.8</td>
<td>0.0</td>
<td>72.8</td>
<td></td>
<td></td>
<td>44.3</td>
<td>37.8</td>
<td>13.0</td>
<td>95.1</td>
</tr>
<tr>
<td>140°</td>
<td></td>
<td>0.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Column B-3 Load Run Down (k)

---

**Project** : Office Building - Scheme B  
**Location** : Radford AAF  
**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 (Al) = 4*TA for columns.  
Al = 2304.0 sqft  
Lo ≥ 400.0 sqft  
Lo ≤ 100.0 psf  
L = Lo*[0.25+15/sqrt(Al)]  
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

Start

Review Shape/ Strength, K Value & Size Limit

Review Load & Analysis Data

Review Selections For Level 1

Select Member

☐ Send Member Size To CASM

Review Selections For Level 2

Use Scratch Pad To Explore Length, K-Value, And Loading Alternatives

Select Member

Print Spreadsheet

Return To Preliminary

Select Member

☐ Send Member Size To CASM

Print Spreadsheet

Return To CASM

Cancel Selected Column

End
### STEEL COLUMN PRELIMINARY SELECTION

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

**CASM Load & Analysis Data:**

<table>
<thead>
<tr>
<th>Name</th>
<th>Level</th>
<th>Flr to Flr Ht</th>
<th>Trib Area</th>
<th>Floor Level Load Totals (kips)</th>
<th>Load Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upper Roof</td>
<td>2</td>
<td>14.0</td>
<td>576</td>
<td>8.8</td>
<td>13.0</td>
</tr>
<tr>
<td>Second Floor/L1</td>
<td>1</td>
<td>14.0</td>
<td>576</td>
<td>44.3</td>
<td>37.8</td>
</tr>
</tbody>
</table>

**CASM Column Selection Table**

<table>
<thead>
<tr>
<th>Level</th>
<th>Col Shape: W</th>
<th>Preq: 21.76 kips</th>
<th>K-value: 1.0</th>
<th>Cc= 126.1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Column Size</td>
<td>Width length: 14.0 ft</td>
<td>K: 14.0</td>
<td>Pallow (kip)</td>
</tr>
<tr>
<td></td>
<td>Depth d(in)</td>
<td>Width d(in)</td>
<td>Area (sq in)</td>
<td>ry (in)</td>
</tr>
<tr>
<td>W 6 x 15</td>
<td>5.99</td>
<td>5.99</td>
<td>4.43</td>
<td>1.46</td>
</tr>
<tr>
<td>W 5 x 16</td>
<td>5.01</td>
<td>5.00</td>
<td>4.68</td>
<td>1.27</td>
</tr>
<tr>
<td>W 5 x 19</td>
<td>5.15</td>
<td>5.03</td>
<td>5.54</td>
<td>1.28</td>
</tr>
<tr>
<td>W 6 x 20</td>
<td>6.20</td>
<td>6.02</td>
<td>5.87</td>
<td>1.50</td>
</tr>
<tr>
<td>W 8 x 28</td>
<td>8.06</td>
<td>6.54</td>
<td>8.25</td>
<td>1.62</td>
</tr>
</tbody>
</table>

**CASM Steel Column Selection**

<table>
<thead>
<tr>
<th>Column Size</th>
<th>Level</th>
<th>Depth d(in)</th>
<th>Width d(in)</th>
<th>Area (sq in)</th>
<th>ry (in)</th>
<th>kl/r</th>
<th>Fa (ksi)</th>
<th>Pallow (kip)</th>
<th>Weight (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W 8 x 28</td>
<td>2</td>
<td>8.06</td>
<td>6.54</td>
<td>8.25</td>
<td>1.62</td>
<td>103.70</td>
<td>12.50</td>
<td>103.2</td>
<td>0.20</td>
</tr>
<tr>
<td>W 8 x 28</td>
<td>1</td>
<td>8.06</td>
<td>6.54</td>
<td>8.25</td>
<td>1.62</td>
<td>103.70</td>
<td>12.50</td>
<td>103.2</td>
<td>0.20</td>
</tr>
</tbody>
</table>

**Notes:**
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)

- P/4
- P/2
- P/4
- 3/16 P
- *No Torsion*

Continuous Beam Model

- 5/8 P
- 3/16 P

**Rigid Diaphragms**

Symmetrical

- 4 P
- 2 P
- 0.4 P
- e = 0
- V torsion
- M = P * e

Non-Symmetrical

- 0.5 P

Torsion (even accidental minimum required)
Monolithic Perpendicular Shear Walls

For N-S

For E-W

or

or
Define Lateral Resistance

Start

Use Draw Structure Tool Palette

Select Second Floor/ Lower Roof Horizontal Structural Plane

Define Second Floor/ Lower Roof Diaphragm Type

Diaphragm Guidelines

Lateral Horizontal Rigid Diaphragm

Define N-S Lateral Resistance

Define Location

Vertical Define Location

Select Beam On Grid Line A

Define Bracing & Connectivity

Vertical Define Elements

Select NS-1

Define X-Bracing

Select Bays

Double Click Right Mouse Key To End

Repeat For Grid Lines C & D

Close Lateral Resistance Dialog Window
Define Lateral Resistance

1. Define E-W Lateral Resistance
   - Define Location
     - Vertical Define Location
       - Select Beam On Grid Line 1
       - Define Bracing & Connectivity
         - Vertical Elements
           - Select EW-1
             - Define X-Bracing
               - Select Bays
                 - Double Click Right Mouse Key To End
                   - Close Lateral Resistance Dialog Window
         - Repeat For Grid Line 4

2. Define Upper Roof Diaphragm Type
   - Select Upper Roof Horizontal Structural Plane
     - Lateral Horizontal Flexible Diaphragm

3. Display Lateral Resistance Locations
   - Show Structure
     - NS Lateral Resistance
     - EW Lateral Resistance

End
Wind Lateral Analysis

Start

Use Loads & Design Tool Palette

Define Member Properties

Select Second Floor/Lower Roof Horizontal Structural Plane

Beam Properties

Use Modify Design

Select Beam On NS-1

Design

Material: Steel
Description: W 14 x 34
Weight: 34.0 psf
Modulus Of Elasticity: 29000 ksi
Moment Of Inertia: 340.0 in4
Cross Sectional Area: 10.5 in2
Number Of Shear Studs: 50

Select From Database

Use Copy Design

Select Beam With Properties

Select All Other Beams Used For NS-1, NS-2, NS-3, EW-1, EW-2

Double Click Right Mouse Key To End Copying Designs

Column Properties

Use Modify Design
Wind Lateral Analysis

Define Member Properties -> Beam Properties -> Select Beam With Properties -> Select All Other Beams Used For NS-1, NS-2, EW-1, EW-2 -> Double Click Right Mouse Key To End Copying Designs

Column Properties -> Use Modify Design -> Select Column On NS-1

Design
- Material: Steel
- Description: W 8 x 35
- Weight: 35.0 plf
- Modulus Of Elasticity: 29000 ksi
- Moment Of Inertia: 127.0 in^4
- Cross Sectional Area: 10.3 in^2
- Number Of Shear Studs: 0

Use Copy Design -> Select Column With Properties -> Select All Other Columns Used For NS-1, NS-2, EW-1, EW-2 -> Double Click Right Mouse Key To End Copying Designs
Wind Lateral Analysis

Show Structure
- Design Sizes

Select Second Floor/
Lower Roof Horizontal
Structural Plane

Load Combination
D + W

Use Load Combination

Set Factors
Dead: 1.0
Wind: 1.0

Add

OK Button To Close
Dialog Window

Highlight D+W
In List

Lateral Analysis

Use Lateral Resistance Design

Select NS-1

Analysis
Units: Feet & Pounds
Load Combination: D+W
☐ Use Actual Properties
☐ DL=Deck+Self Weight

Connectivity
☐ Hinge

Repeat For All Supports
Wind Lateral Analysis

Lateral Analysis

Lateral Resistance
Verify X-Bracing

Yes, Properties
Are All Correct

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

Flexible Diaphragm
Simple Beam Model

Rigid Horizontal Diaphragm
Calculations
File Name: Rigidout.txt
Enter Deflections At Each Level

View Loads

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

View Shear, Moment, Deflection & Reaction Diagrams

View Output

Print Data
- Rigid Diaphragm
- All Other
- Print To File
- Execute Notepad

Scroll Output
Wind Lateral Analysis
Wind Lateral Analysis

Properties: w (pft), A (in²), E (kips), l (in)

1.00 Win (kft) - 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)
### Rigid Horizontal Diaphragm Calculations

#### Center of Rigidity

<table>
<thead>
<tr>
<th>Name</th>
<th>h (ft)</th>
<th>I (ft^4)</th>
<th>Av (sqft)</th>
<th>Deflection Rigidity (in)</th>
<th>R/sum(R)</th>
<th>x (ft)</th>
<th>R*x</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-1</td>
<td>14.0</td>
<td>0</td>
<td>0</td>
<td>3.274</td>
<td>0.305</td>
<td>35.92%</td>
<td>0.8</td>
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<td>NS-2</td>
<td>14.0</td>
<td>0</td>
<td>0</td>
<td>3.239</td>
<td>0.309</td>
<td>36.31%</td>
<td>48.8</td>
</tr>
<tr>
<td>NS-3</td>
<td>14.0</td>
<td>0</td>
<td>0</td>
<td>4.236</td>
<td>0.236</td>
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<td>84.8</td>
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<td>0.850</td>
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<td></td>
<td>35.359</td>
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</table>

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

#### EW Section

<table>
<thead>
<tr>
<th>Name</th>
<th>h (ft)</th>
<th>I (ft^4)</th>
<th>Av (sqft)</th>
<th>Deflection Rigidity (in)</th>
<th>R/sum(R)</th>
<th>x (ft)</th>
<th>R*x</th>
</tr>
</thead>
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<tr>
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<td>0</td>
<td>0</td>
<td>3.239</td>
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<td>0.8</td>
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Centroid from lower left = sum(R*x)/sum(R) = 36.83 ft
Maximum rigid diaphragm dimension = 73.67 ft
Eccentricity (e) = centroid-(max dimension)/2 = 0.00 ft

**Assumptions used:**
Deflections calculated by applying a 1000 k load.

<table>
<thead>
<tr>
<th>Name</th>
<th>h (ft)</th>
<th>Rigidity</th>
<th>dx (ft)</th>
<th>R*dx</th>
<th>R<em>dx</em>dx</th>
<th>R<em>dx/sum(R</em>dx*dx)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NS-1</td>
<td>14.0</td>
<td>0.305</td>
<td>40.8</td>
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<td>36.0</td>
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<td>0.309</td>
<td>36.0</td>
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<td>400.127</td>
<td>0.00630</td>
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<td>Sum</td>
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<td></td>
<td></td>
<td>1765.277</td>
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</tr>
</tbody>
</table>

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

Start

Use Loads & Design Tool Palette

Load Combination D + E

Use Load Combination

Set Factors
Dead: 1.0
Seismic: 1.0

Add

OK Button To Close Dialog Window

Highlight D+E In List

Calculate Seismic Loads

Review Criteria

Select Lateral Force Resisting System As B.4.a

View Spectral Plots

Spectral Plots
Ø Ct=0.020 For All Other Buildings Both Directions

View Base Shear Spectrum (ZC)

Print Screen

View Design Base Shear Coefficient Spectrum (ZC/Rw)
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
   2. Second Floor/Lower Roof

Total Building Weight (W): 858.4 k

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

Zone: 2A: Z = 0.150
Importance Category: IV: I = 1.00
Soil Factor: S3: S = 1.5
System: B4a: Rw = 8
Ct = 0.020
hn = 28.0 ft
T = Ct*hn^3/4 = 0.243 sec
C = 1.25*S/T^2/3 = 4.82 > 2.75
C = 2.75
C/Rw = 0.344 > 0.075
W = 858.4 k
V = 2*I*C*W/Rw
   1. V = 44.3 k
   
T < 0.7 sec

   1. Ft = 0.0 k
   

   1. V-Ft = 44.3 k
   

<table>
<thead>
<tr>
<th>Level</th>
<th>h (ft)</th>
<th>Floor to</th>
<th>w (k)</th>
<th>sum(w) (k)</th>
<th>w*h (kft)</th>
<th>sum(w*h)</th>
<th>F (k)</th>
<th>sum(F) (k)</th>
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<td>14.0</td>
<td>188</td>
<td>188</td>
<td>5264</td>
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<tr>
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<td>14.0</td>
<td>14.0</td>
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<td>858</td>
<td>9385</td>
<td>0.641</td>
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<td>0.0</td>
<td></td>
<td></td>
<td>858</td>
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<td></td>
<td></td>
<td></td>
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</tbody>
</table>

Sum: 858

<table>
<thead>
<tr>
<th>Level</th>
<th>h (ft)</th>
<th>Floor to</th>
<th>w (k)</th>
<th>sum(w) (k)</th>
<th>V (k)</th>
<th>OTM (kft)</th>
<th>sum(OTM) (kft)</th>
<th>Ft+sum(F)/sum(w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>28.0</td>
<td>14.0</td>
<td>188</td>
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<td></td>
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Sum: 858

154
### Upper Roof — 28.00 ft

<table>
<thead>
<tr>
<th>Name</th>
<th>Weight (k)</th>
<th>NS (ft)</th>
<th>NS*Weight (kft)</th>
<th>EW (ft)</th>
<th>EW*Weight (kft)</th>
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<tbody>
<tr>
<td>Exterior Wall</td>
<td>36.9</td>
<td>36.8</td>
<td>1358.9</td>
<td>0.8</td>
<td>30.7</td>
</tr>
<tr>
<td>Exterior Wall</td>
<td>24.6</td>
<td>0.6</td>
<td>20.5</td>
<td>24.8</td>
<td>610.8</td>
</tr>
<tr>
<td>Exterior Wall</td>
<td>36.9</td>
<td>36.8</td>
<td>1358.9</td>
<td>48.8</td>
<td>1801.6</td>
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<tr>
<td>Exterior Wall</td>
<td>24.6</td>
<td>72.8</td>
<td>1791.4</td>
<td>24.8</td>
<td>630.8</td>
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<tr>
<td>Upper Roof</td>
<td>49.8</td>
<td>36.8</td>
<td>1833.1</td>
<td>24.8</td>
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<tr>
<td>Beam Self Weight</td>
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<td>450.8</td>
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<td></td>
<td><strong>4668.8</strong></td>
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</table>

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

### Second Floor/Lower Roof — 14.00 ft

<table>
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<tr>
<th>Name</th>
<th>Weight (k)</th>
<th>NS (ft)</th>
<th>NS*Weight (kft)</th>
<th>EW (ft)</th>
<th>EW*Weight (kft)</th>
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<tr>
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<td>896.1</td>
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<td>4639.9</td>
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<td>8419.1</td>
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<td>61.5</td>
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<td>0.8</td>
<td>20.5</td>
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<td>610.8</td>
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<tr>
<td>Exterior Wall</td>
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<td>36.8</td>
<td>1358.9</td>
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<td>1801.6</td>
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<td>1791.4</td>
<td>24.8</td>
<td>610.8</td>
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<tr>
<td>Parapet</td>
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</tr>
</tbody>
</table>

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

Start

Use Loads & Design Tool Palette

Define Member Properties

See Wind Lateral Analysis

Select Second Floor/Lower Roof Horizontal Structural Plane

Compare Wind & Seismic Loads

Use Compare Wind & Seismic: N-S Building Levels

Compare Wind & Seismic

Load Combination D+E

Use Load Combination

Set Factors
Dead: 1.0
Seismic: 1.0

Add

OK Button To Close Dialog Window

Highlight D+E In List

Lateral Analysis

Use Lateral Resistance Design
Seismic Lateral Analysis

1. Lateral Analysis
2. Select NS-1
   - Analysis
     - Units: Feet & Kips
     - Load Combination: D+E
     - Use Actual Properties
     - DL=Deck+Self Weight
   - Connectivity
     - Hinge
   - Repeat For All Supports
   - Lateral Resistance
     - Verify X-Bracing Locations
   - Yes, Properties Are All Correct
   - Flexible Diaphragm
     - Simple Beam Model
   - Rigid Horizontal Diaphragm Calculations
     - File Name: RigidOut.txt
     - Enter Deflections At Each Level
   - View Loads
   - Seismic Lateral Resistance Locations
     - File Name: LatSeis.txt
   - Analysis
     - Analysis File Name: Optional
     - Yes, The Loads & Connectivity Are Correct
Seismic Lateral Analysis

Wind
Windward + Leeward

Seismic

6.31  15.90

17.81  28.35

24.11  44.26

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

Properties: w (lb/ft), A (in²), E (ksi), I (in⁴)

---

161
Seismic Lateral Analysis

1.00 Dead (kfl) - NS-1

Total Combined Load: D + E - Axial (k)
Seismic Lateral Analysis

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

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

Total Combined Load: D + E -- Deflection
Seismic Lateral Analysis

Project: Office Building - Scheme B
Location: Radford AAP
Seismic Code: TM 5-09-10 1991
Time: Sun Jan 26, 1992 6:12 PM

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

<table>
<thead>
<tr>
<th>Level</th>
<th>h (ft)</th>
<th>Floor h</th>
<th>F (k)</th>
<th>V (k)</th>
<th>OTM (kft)</th>
<th>sum(OTM) (kft)</th>
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</thead>
<tbody>
<tr>
<td>3</td>
<td>28.0</td>
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<tr>
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<table>
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<tr>
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<th>h (ft)</th>
<th>Floor h</th>
<th>F (k)</th>
<th>V (k)</th>
<th>OTM (kft)</th>
<th>sum(OTM) (kft)</th>
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<tbody>
<tr>
<td>3</td>
<td>28.0</td>
<td>14.0</td>
<td>15.9</td>
<td>15.9</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>14.0</td>
<td>14.0</td>
<td>28.4</td>
<td>15.9</td>
<td>223</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
<td>14.0</td>
<td>44.3</td>
<td>223</td>
<td>620</td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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Seismic Lateral Analysis

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<th>V (k)</th>
<th>OTM (kft)</th>
<th>sum(OTM) (kft)</th>
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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

Start

Use Loads & Design Tool Palette

Select Second Floor/Lower Roof Horizontal Structural Plane

Design All Elements To Include In Quantity Take-Off

Design Surface Elements

Use Modify Design

Select A Surface Element On The Second Floor

Design

- Material: Steel
- Description: Mtl Dk 2"-20ga/NLWT 2.5"
- Weight: 1.99 psf
- Concrete Weight: 145.0 pcf
- Concrete Weight: 42.0 psf
- Depth: 4.5 in

Use Copy Design

Select Surface With Properties

Select All Other Surface Elements On The Second Floor

Double Click Right Mouse Key To End Copying Designs

Design Beam Elements

Use Copy Design
Design All Elements To Include In Quantity Take-Off

Design Beam Elements

Select Third Point Beam With Properties

Select All Other Third Point Beams

Double Click Right Mouse Key To End Copying Designs

Use Copy Design

Select Girder With Properties

Select All Other Girders

Double Click Right Mouse Key To End Copying Designs

Use Copy Design

Select Interior Column With Properties

Select Other Interior Column

Double Click Right Mouse Key To End Copying Designs
Project: Office Building - Scheme B
Location: Radford AAF
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

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<tr>
<th>Description</th>
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<th>Weight/Element</th>
<th>Total Weight</th>
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<tbody>
<tr>
<td></td>
<td>(ft)</td>
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<td>(lbs)</td>
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<tr>
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<td>(lbs)</td>
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<tr>
<td>36.0</td>
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Sum: 0

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

STEEL: Widely Spaced Elements

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<td>(plf)</td>
<td>(lbs)</td>
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<tr>
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<td></td>
<td>(lbs)</td>
<td></td>
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<tr>
<td>W 14 x 34 (50)</td>
<td>24.0</td>
<td>34.0</td>
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<tr>
<td></td>
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<td>W 21 x 50 (72)</td>
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<td>50.0</td>
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<td>W 16 x 26 (28)</td>
<td>24.0</td>
<td>26.0</td>
<td>624.0</td>
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Sum: 22320

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

STEEL: Surface Elements

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<tr>
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<th>Total Depth</th>
<th>Area</th>
<th>Weight</th>
<th>Weight</th>
<th>Total Weight</th>
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<td></td>
<td>(in)</td>
<td>(sqft)</td>
<td>(psf)</td>
<td>(pcf)</td>
<td>(lbs)</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mt1 Dk 2&quot;-20ga/NLWT 2.5&quot;</td>
<td>4.5</td>
<td>2880</td>
<td>2.0</td>
<td>145.0</td>
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<td>Mt1 Dk 2&quot;-20ga/NLWT 2.5&quot;</td>
<td>4.5</td>
<td>384</td>
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<td>145.0</td>
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Sum: 6495 137088

Concrete Cubic Yards: 35.0
Total Weight: 3.2 tons
### STEEL: Column Elements

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<tr>
<td>W 8 x 35</td>
<td>490.0</td>
<td>4900</td>
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<td>W 8 x 28</td>
<td>392.0</td>
<td>784</td>
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<td>0</td>
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<tr>
<td>Sum</td>
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<td>5684</td>
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**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
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.
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.
<table>
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<td>Technical Report K-78-1 List of Computer Programs for Computer-Aided</td>
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<td>Interactive Graphics for Analysis of Plane Frame Structures</td>
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<td>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</td>
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<td>Jan 1987</td>
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<td>Sliding Stability of Concrete Structures (CSLIDE)</td>
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<td>Criteria Specifications for and Validation of a Computer Program for the Design or Investigation of Horizontally Framed Miter Gates (CMITER)</td>
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| Technical Report ITL-90-3 | Investigation and Design of U-Frame Structures Using Program CUFRBC  
  Volume A: Program Criteria and Documentation  
  Volume B: User's Guide for Basins  
| Instruction Report ITL-92-3 | Concept Design Example, Computer Aided Structural Modeling (CASM):  
  Report 1: Scheme A  
  Report 2: Scheme B  
  Report 3: Scheme C | Jun 1992 |
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<td>Comparison of Barge Impact Experimental and Finite Element Results for the Lower Miter Gate of Lock and Dam 26</td>
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<td>Technical Report ITL-95-8</td>
<td>Constitutive Modeling of Concrete for Massive Concrete Structures, A Simplified Overview</td>
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| Instruction Report ITL-96-2 | Computer-Aided Structural Modeling (CASM), Version 6.00  
Report 1: Tutorial Guide  
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Report 4: Scheme B  
Report 5: Scheme C | Jun 1996 |