Building Codes

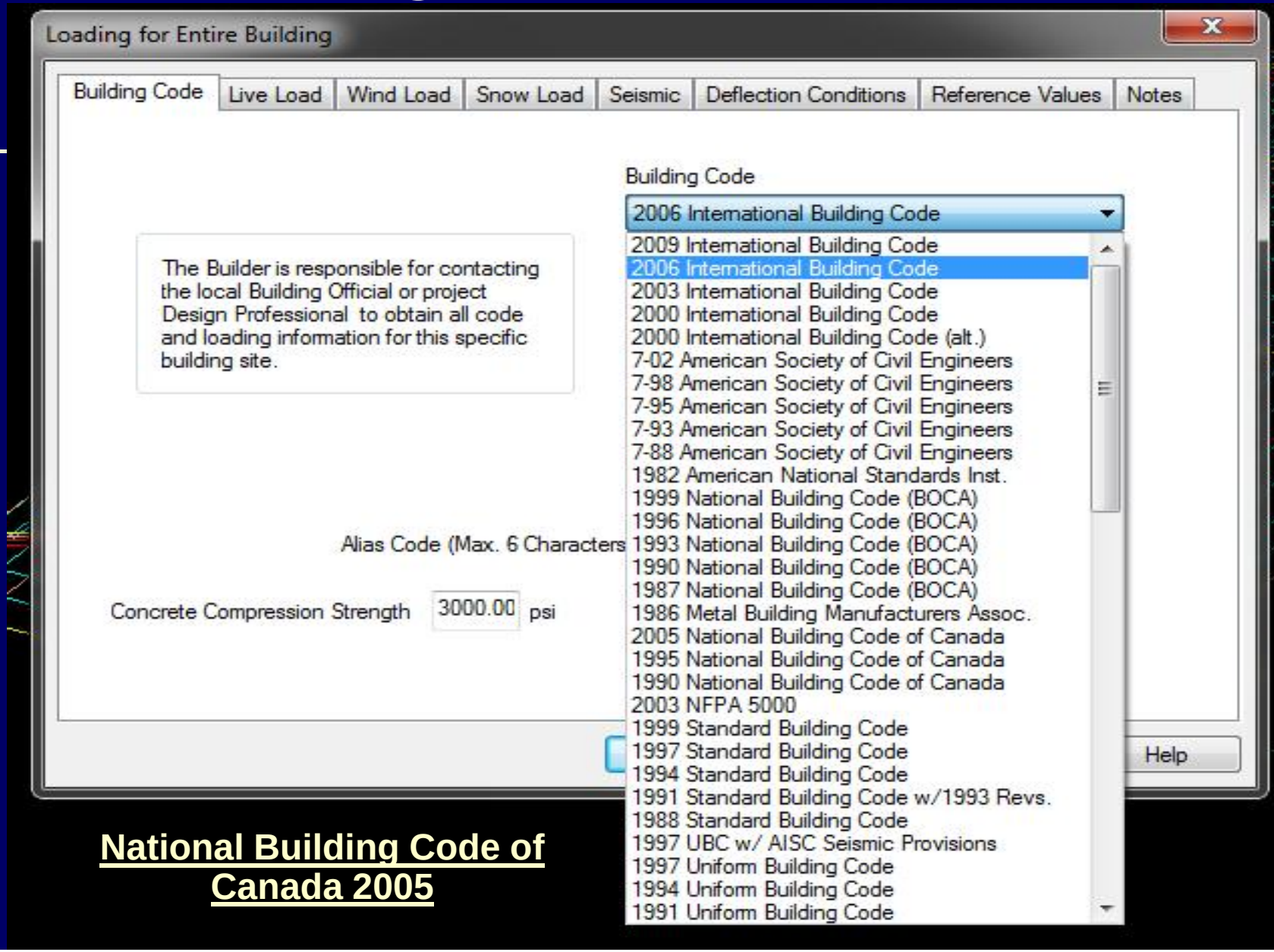
Builder Responsibilities

- Load & Code Data
  - Supplied by the Builder
  - Verify with Engineer of Record
- Pursue most accurate data
  - Assures the most accurate design
  - Assures the most competitive (*$$*) design and pricing
  - Verify with Building Department
- Make VP aware of changing codes!

Model Building Codes

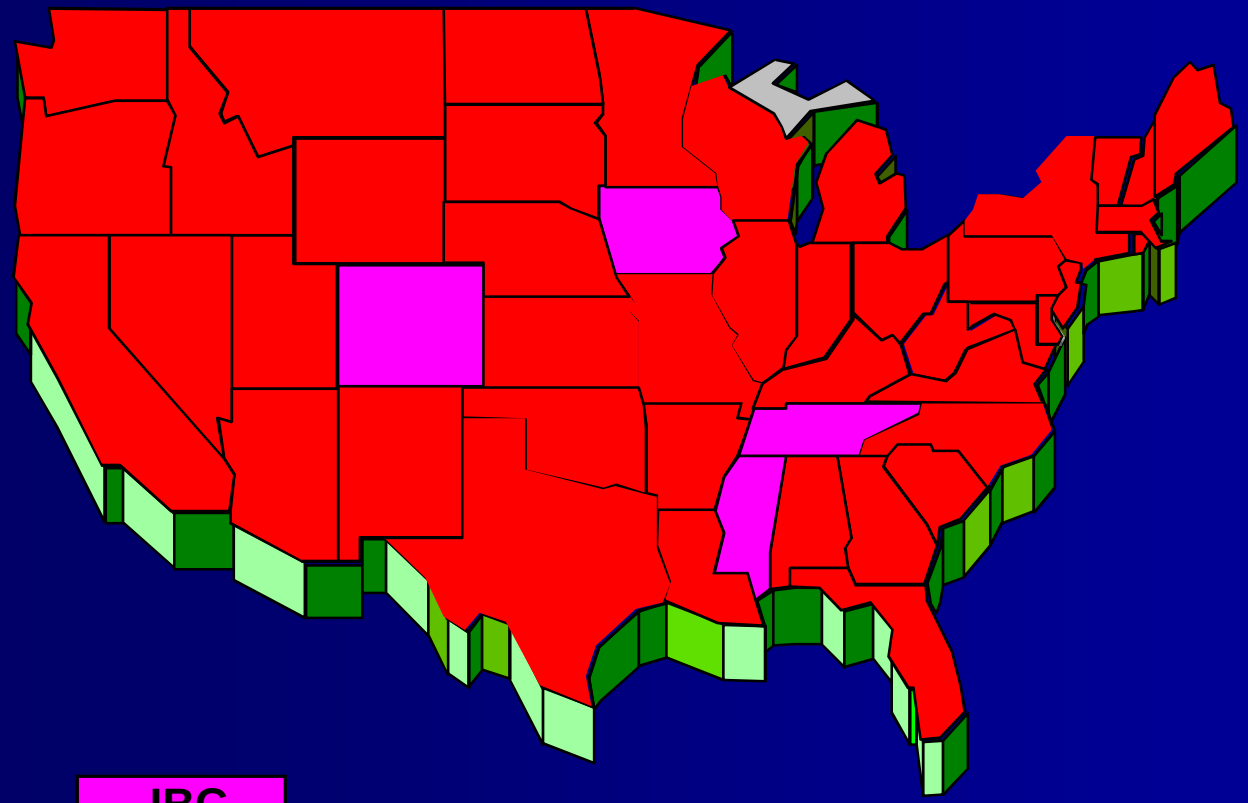
- International Building Code (IBC)
  - International Code Council (ICC)
- Uniform Building Code (UBC)
  - International Conference of Building Officials (ICBO)
- Basic Building Code (BBC)
  - Building Officials and Code Administrators (BOCA)
- Standard Building Code (SBC)
  - Southern Building Code Congress International (SBCCI)

Building Code Screen



National Building Code of Canada 2005

Areas of Influence



- Alaska

Hawaii

IBC State

IBC Local

State Adoption shown

Standards and Specifications

- Metal Building Systems Manual
  - Published by Metal Building Manufacturers Association (MBMA)
- Manual of Steel Construction
  - By American Institute of Steel Construction (AISC)
- Cold-Formed Steel Design Manual
  - By American Iron And Steel Institute (AISI)

Load Combinations

- Building codes specify how loads are applied to buildings
- And how they are to be combined
  - For determination of critical loading conditions

Building Use

- Building Use Categories are numbered “1” through “4”
- Definitions and severity vary according to Building Code
- “Importance Factors” are determined by Building Use Categories
- Higher “Importance” means stronger building
- Can affect the price (*$$*) by 10% or more

Building Use Category

- The USE CATEGORY represents the level of hazard to human life in the event of failure.
- More severe category results in increased design loads (and building price *$$*)

STANDARD		I	$
SPECIAL	>300 people (school, church, jail) petrochemical, waste water treatment...	II	$$
EMERGENCY	Hospital, police, power, fire station...	III	$$$
LOW HAZARD	Agriculture, temporary...	IV	

Importance Factors

Load Type	Standard Occ.	Special Occ.	Essential Occ.
Snow	1.0	1.1	1.2
Wind	1.0	1.15	1.15
Seismic	1.0	1.25	1.5

Snow Exposure Factor
Fully Exposed = 0.90
Partially Exposed = 1.0
Sheltered = 1.1

Thermal Factor
Ct = 0.85 (heated, green house)
Ct = 1.0 (heated)
Ct = 1.1 (just above freezing)
Ct = 1.2 (unheated)

Ground Snow (Pg)
Roof Snow = Pg x Snow Exp. Factor

Load Type Definitions

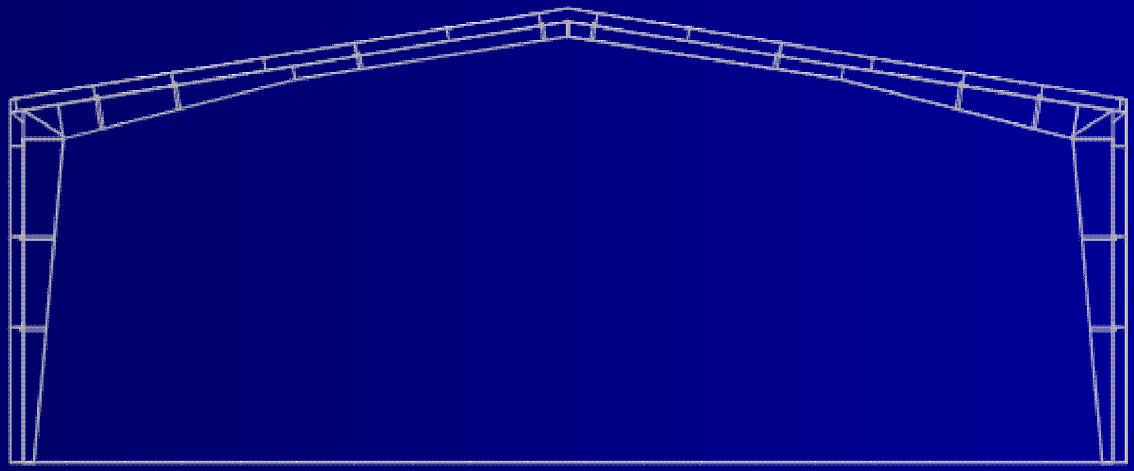
- Dead Load
- Roof Live Load
- Wind Load
- Roof Snow Load
- Partial Span Snow Loads
- Collateral Load
- Seismic Load
- Alternate Span Live Loads

Load Definitions

D1. Notations

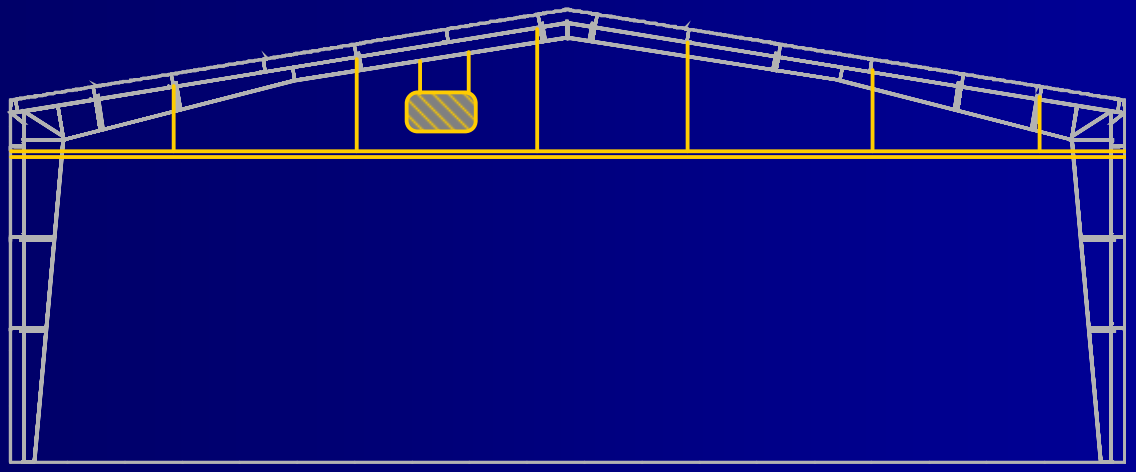
D	= dead load of steel framing system furnished by BlueScope (actual steel weight), crane runway systems, and dead weight of floor systems
C_g, C_u	= user specified collateral load including dead weight of ceilings, sprinklers, permanent equipment, piping, ductwork, HVAC systems, etc.
D_c	= dead weight of the crane system: runway, bridge and trolley, as applicable (see D5)
D_p	= dead weight of partitions
L_c	= live load due to crane lifted loads
L_r	= roof live load due to use & occupancy
L_F	=uniform floor live load due to use and occupancy
S	= uniformly distributed snow load (see D3)
S_d	= drifting snow load
S_p	= partial loading snow
S_r	= rain-on-snow surcharge snow load
S_s	= sliding snow load
S_u	= unbalanced roof snow load
R	= rain accumulation load (not rain on snow surcharge)
W	= wind load
Q_E	= earthquake load, base shear (V) or component force (F_p)
S_{DS}	= seismic spectral response acceleration parameter at short periods
ρ	= redundancy coefficient (=1.3, except where specific condition satisfied use 1.0)
Ω_o	= overstrength factor (between 2.0 and 3.0, except 1.25 for cantilevered systems)

Load Types - Dead



Dead Load = the weight of the building materials (Includes Panel, Purlin and Frame weights)

Load Types - Collateral

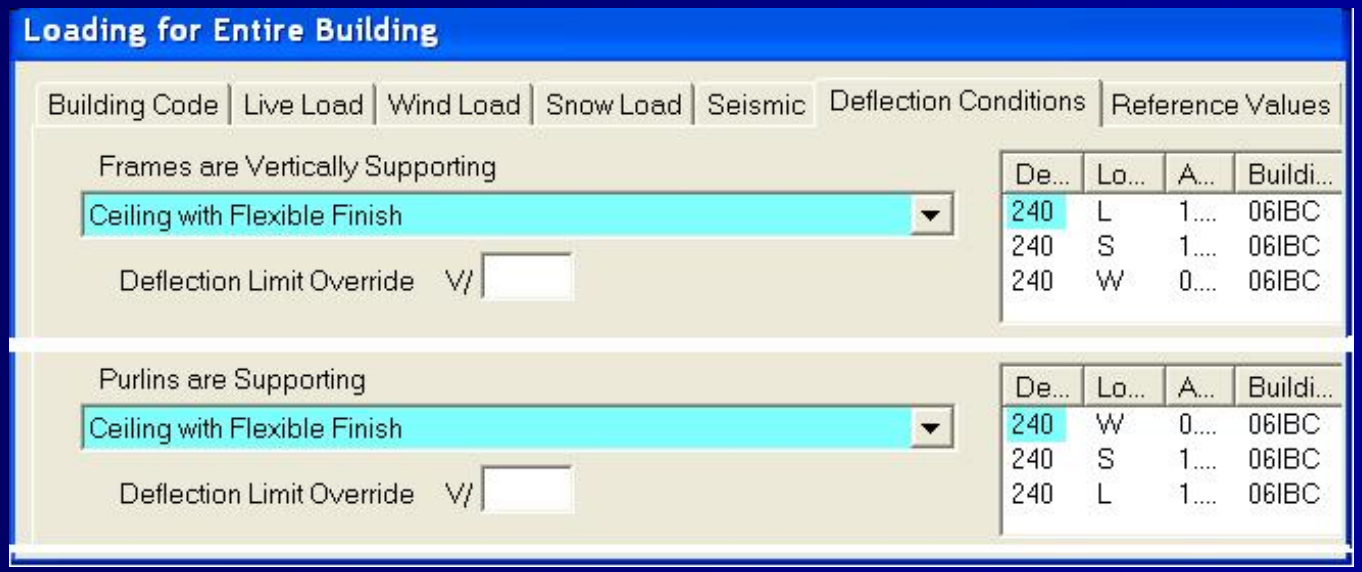


Collateral Load = additional dead loads
(ceilings, mechanical equipment - current & future)

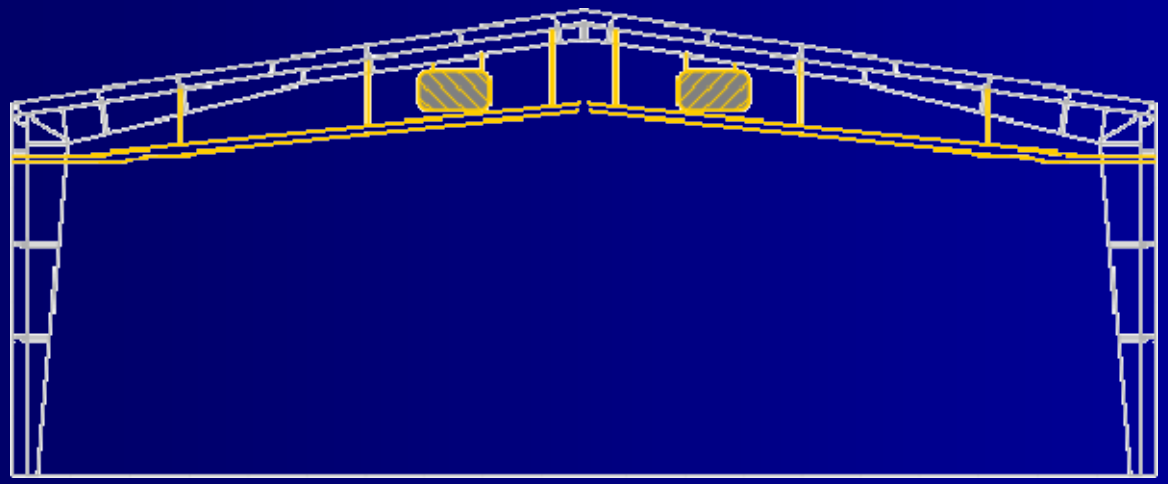
Load Types - Collateral

Vertical Deflection Limits for Flexible Ceilings

Select “Ceiling with Flexible Finish” in VP Command’s Deflection Condition screen as shown.
The system will design frames and purlins for the required deflections.



Load Types - Collateral

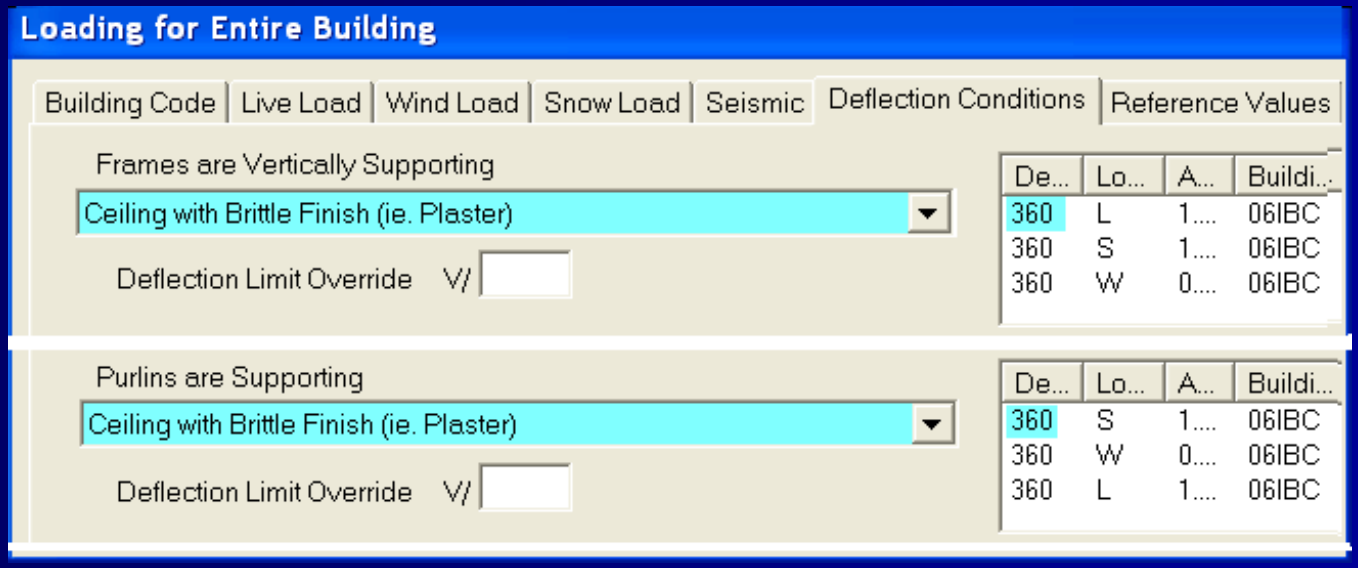


Collateral Load = Vaulted Ceiling (Plaster)

Load Types - Collateral

Vertical Deflection Limits - Vaulted Ceiling (Plaster)

Select “Ceiling with Flexible Finish” in VP Command’s Deflection Condition screen as shown.
The system will design frames and purlins for the required deflections.



Load Types - Collateral

- Collateral Loads are a form of dead load on the roof or floor of a building. These loads are usually estimated with the help of the Architect or Engineer of Record, and represent the weight of items such as ceilings and mechanical equipment supported by the building.
- Collateral Loads may represent both current and future loads.

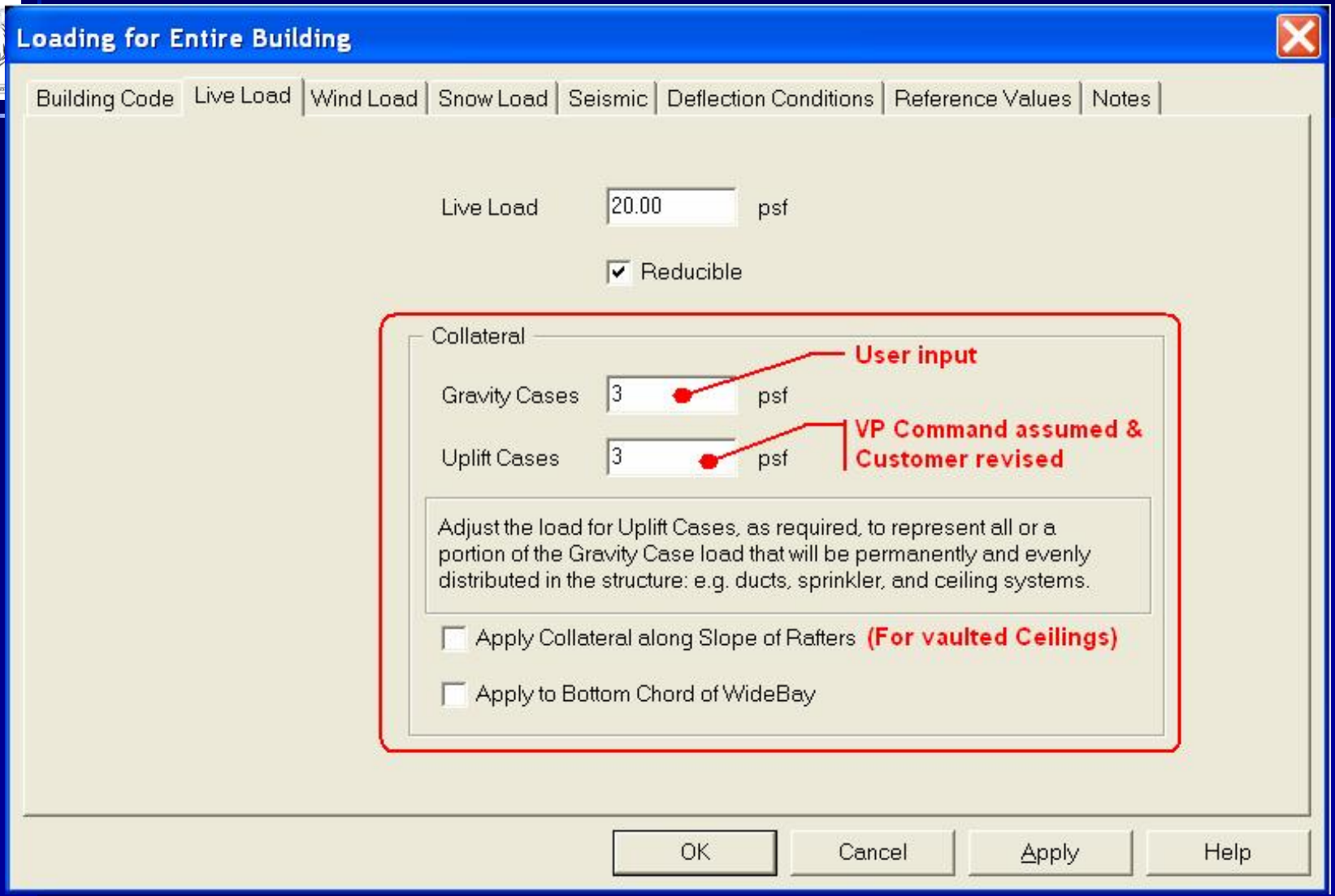
Collateral Loading- Sprinkler*

Table 1 - Typical Sprinkler Pipe Loadings

Pipe Diameter	Pipe + Water Wt/ft	Hanger Load 5' Spacing	Hanger Load 10' Spacing	Hanger Load 15' Spacing
	lbs/ft	lbs	lbs	lbs
2"	5.1	25.5	51.0	76.5
3"	10.8	54.0	108.0	162.0
4"	16.3	81.5	163.0	244.5
5"	23.3	116.5	233.0	349.5
6"	31.5	157.5	315.0	472.5
8"	50.2	251.0	502.0	753.0
10"	74.6	373.0	746.0	1119.0
12"	98.6	493.0	986.0	1479.0

*

Collateral Load Screen



Collateral Load Screen

- Input the Collateral Gravity loads. VPC assumes the Uplift loads = Gravity loads
- Read the “lit-up” message and revise Uplift accordingly.

Collateral Load Input
Ex 1 - Flexible Ceiling

- Collateral load is entered for a Flexible Drop Ceiling, lighting, sprinklers and ducts for an office building.
- Gravity Cases: the user inputs a value of 3 psf.
- Uplift Cases: VPC assumes this entire amount is a permanent, uniformly distributed load similar to dead load on the building, and fills in a value of 3 psf.

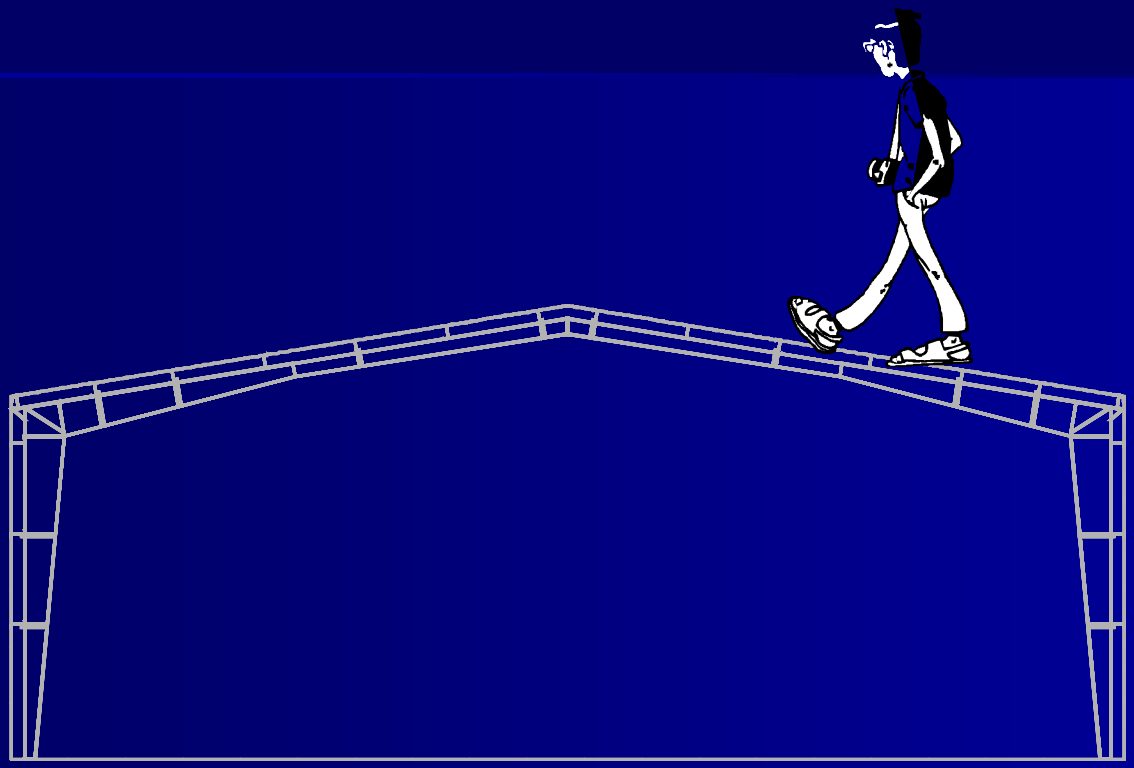
Collateral Load Input
Ex 2 – Current & Future Collateral

- Collateral load of 5 psf is required for a warehouse that includes sprinklers, lighting and ducts. The owner is unsure of the future building use and wants to design for worst case collateral of 8 psf.
- Gravity Case value of 8 psf is input and VPC assumes that entire amount is a permanent, uniformly distributed load.
- Since only 5 psf is guaranteed to be always in place AND evenly distributed over the floor plan of the building, the user must revise the “Uplift Case” field from 8 psf to 5 psf.
- VPC will then design for worst case gravity and uplift combinations

Live Load vs. Snow Load

- Clear distinction between Live and Snow Loads
- "Live Load" is a "Service Load"
  - A temporary load for erection
  - Independent of project site location

Load Types - Live



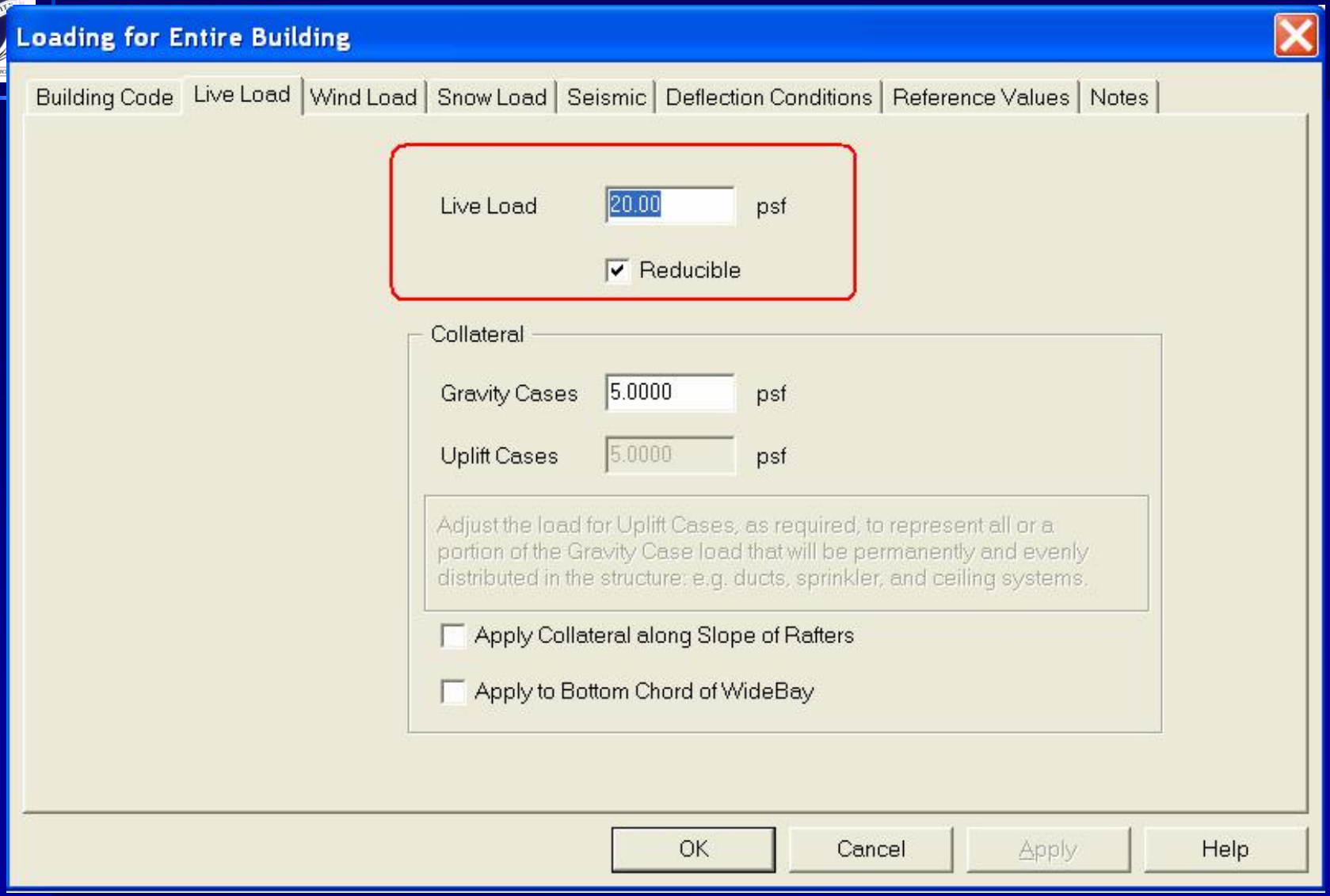
Roof Live Load = Temporary applied loads

Live Load Reduction

Tributary Loaded Area	Minimum Roof Live Load
0-200 sq. ft.	20 psf *
201-600 sq. ft.	16 psf *
Over 600 sq. ft.	12 psf *

* Varies with Roof pitch

Live Load Screen

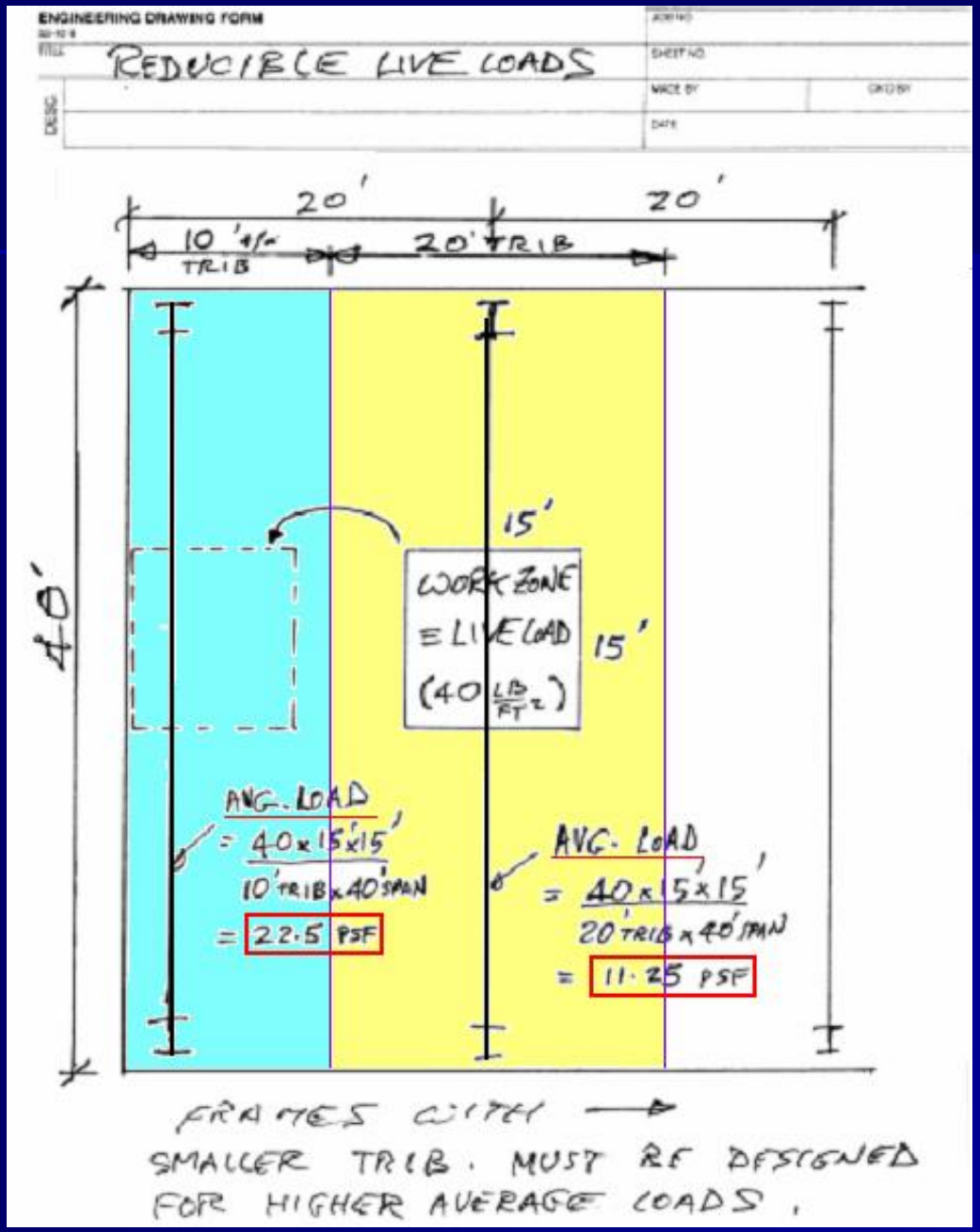


Live Load Input Screen

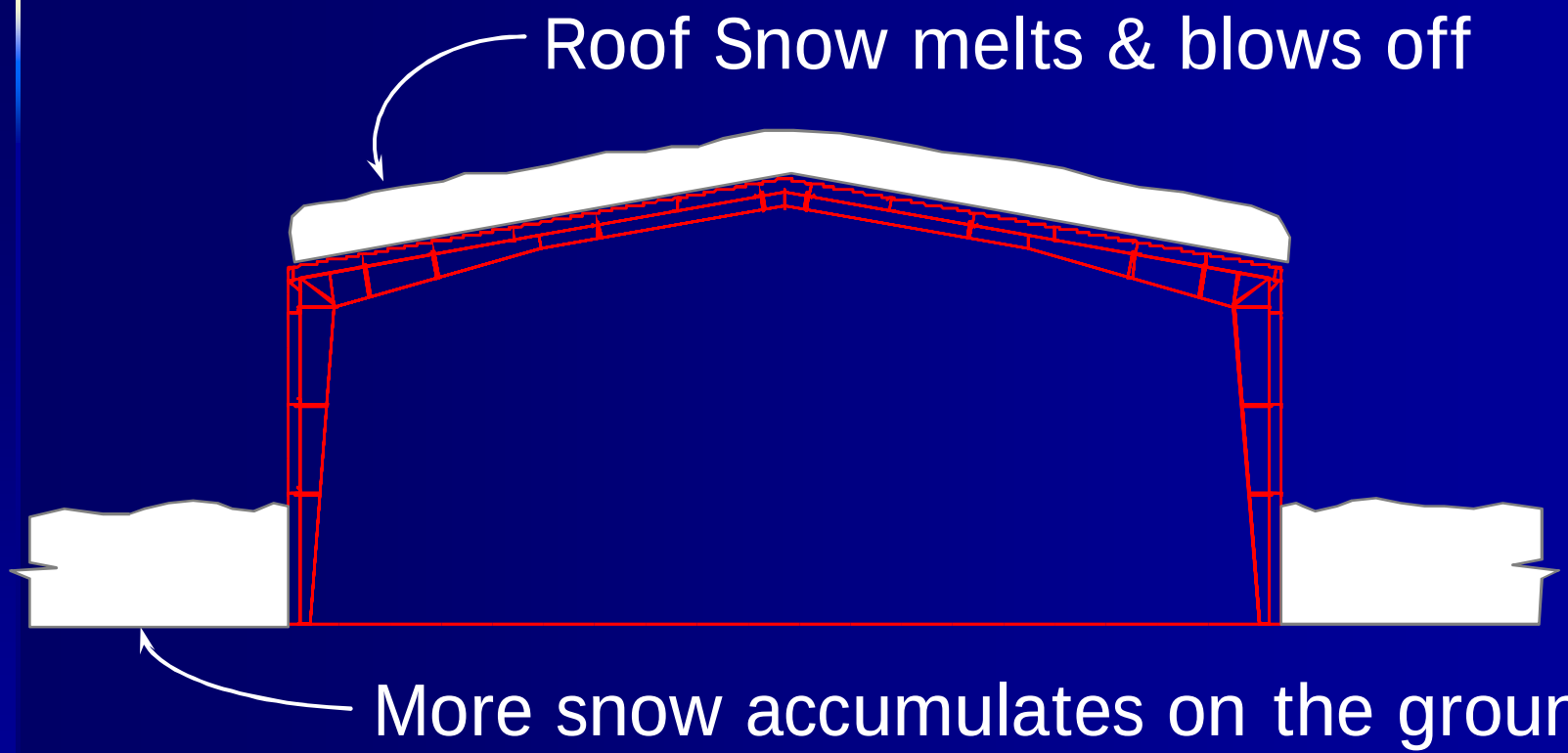
- Input the required Live Load. Reducible live loads may be used if allowed by specs or building officials.
- Enter the maximum roof live load required by the IBC code of 20 psf (VPC will reduce to a minimum of 12 psf where applicable - See IBC 1607.11)

Note: If the State or County or City requires a Minimum Roof Load (this can be a Snow Load or Live load), then input the minimum into the Live Load field in VPCommand.

Why Reducible ?



Snow Load



Roof Snow is less than Ground Snow

Snow

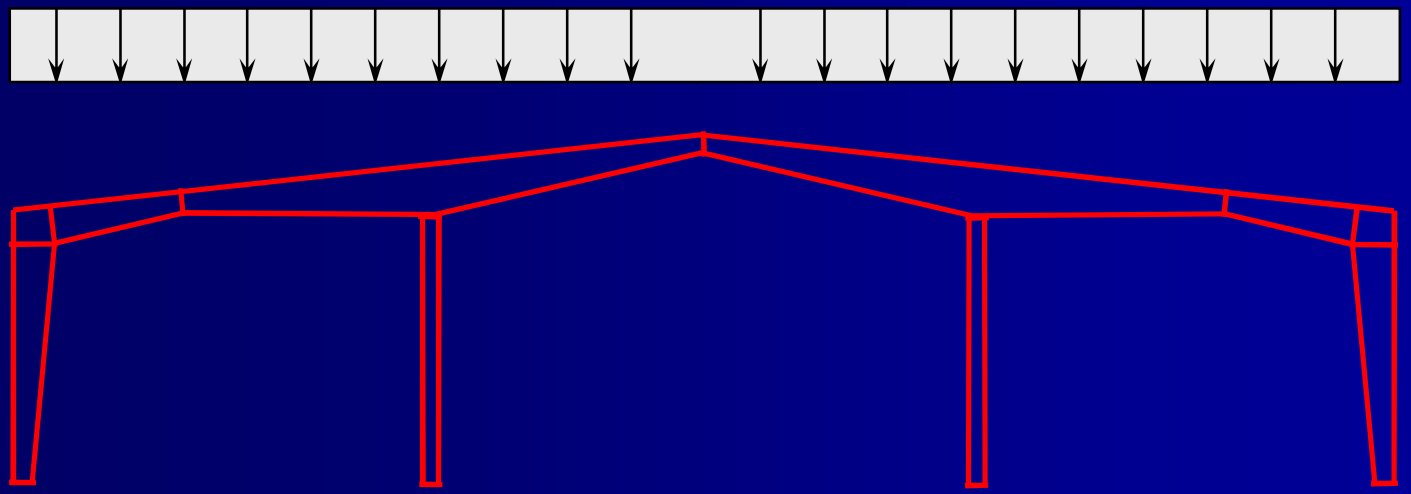
Some Love Snow!


02/06/2010

Snow Load

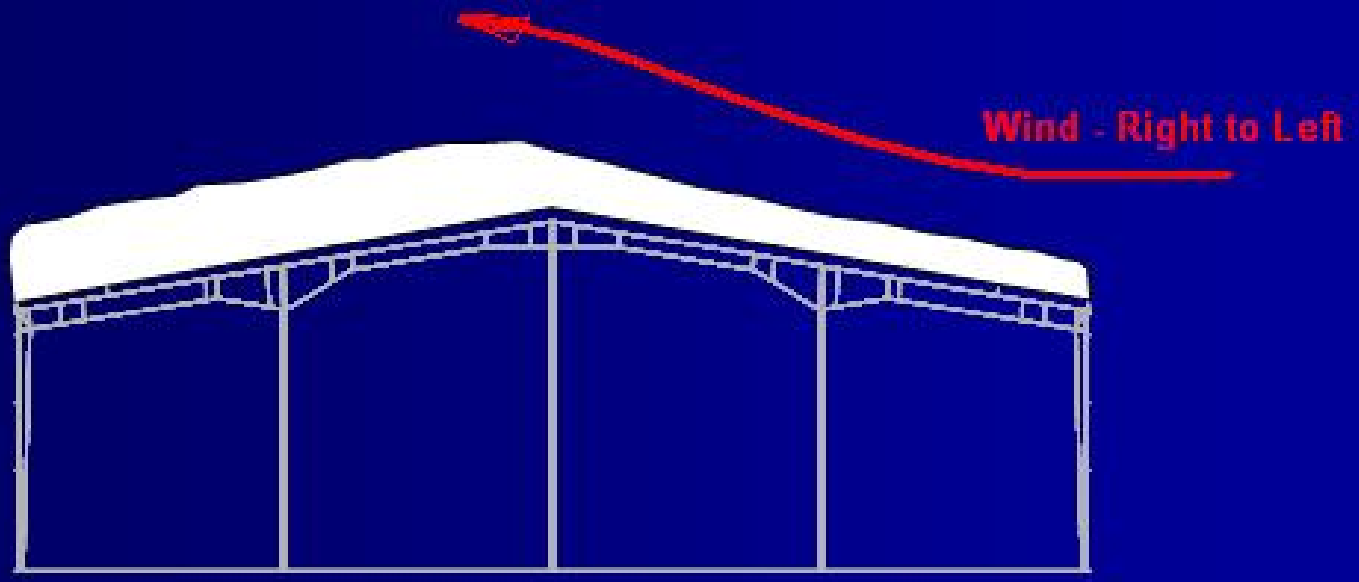
Case I: Balanced Snow Load

Dead + Collateral + Snow Load



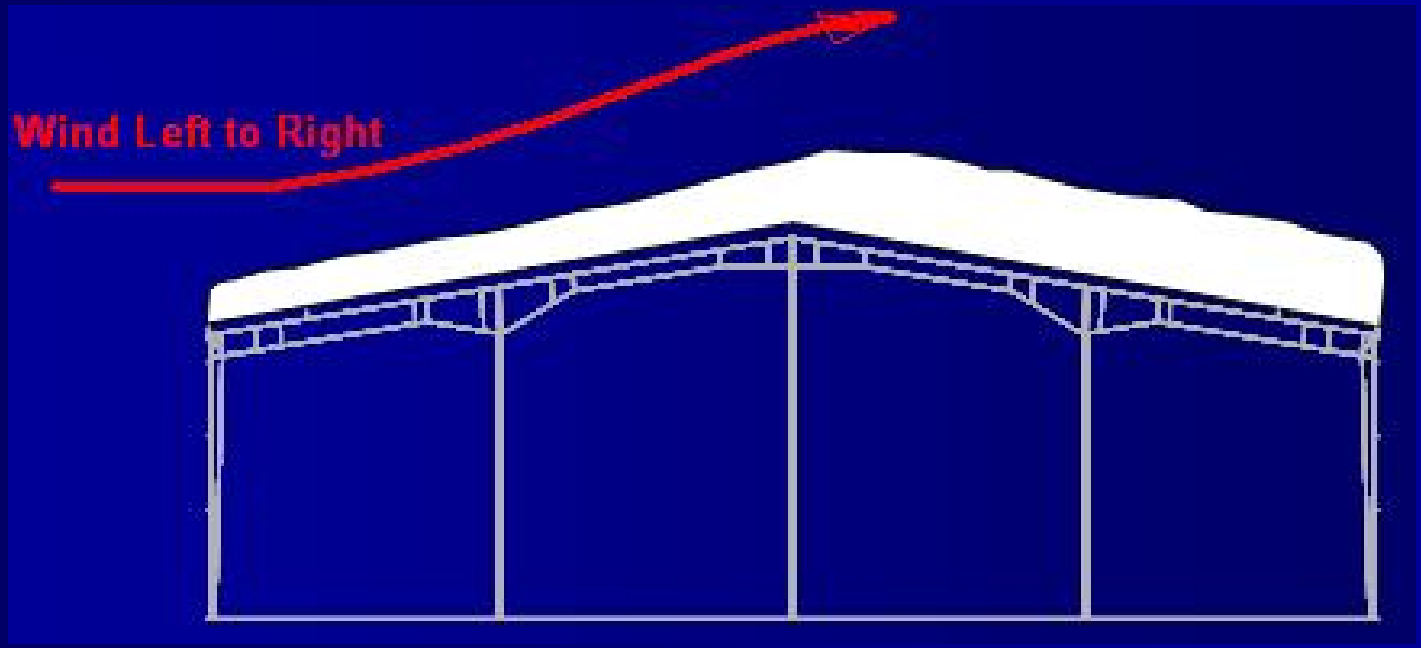
Snow Load

Case II: Unbalanced Snow Left = *US1



Snow Load

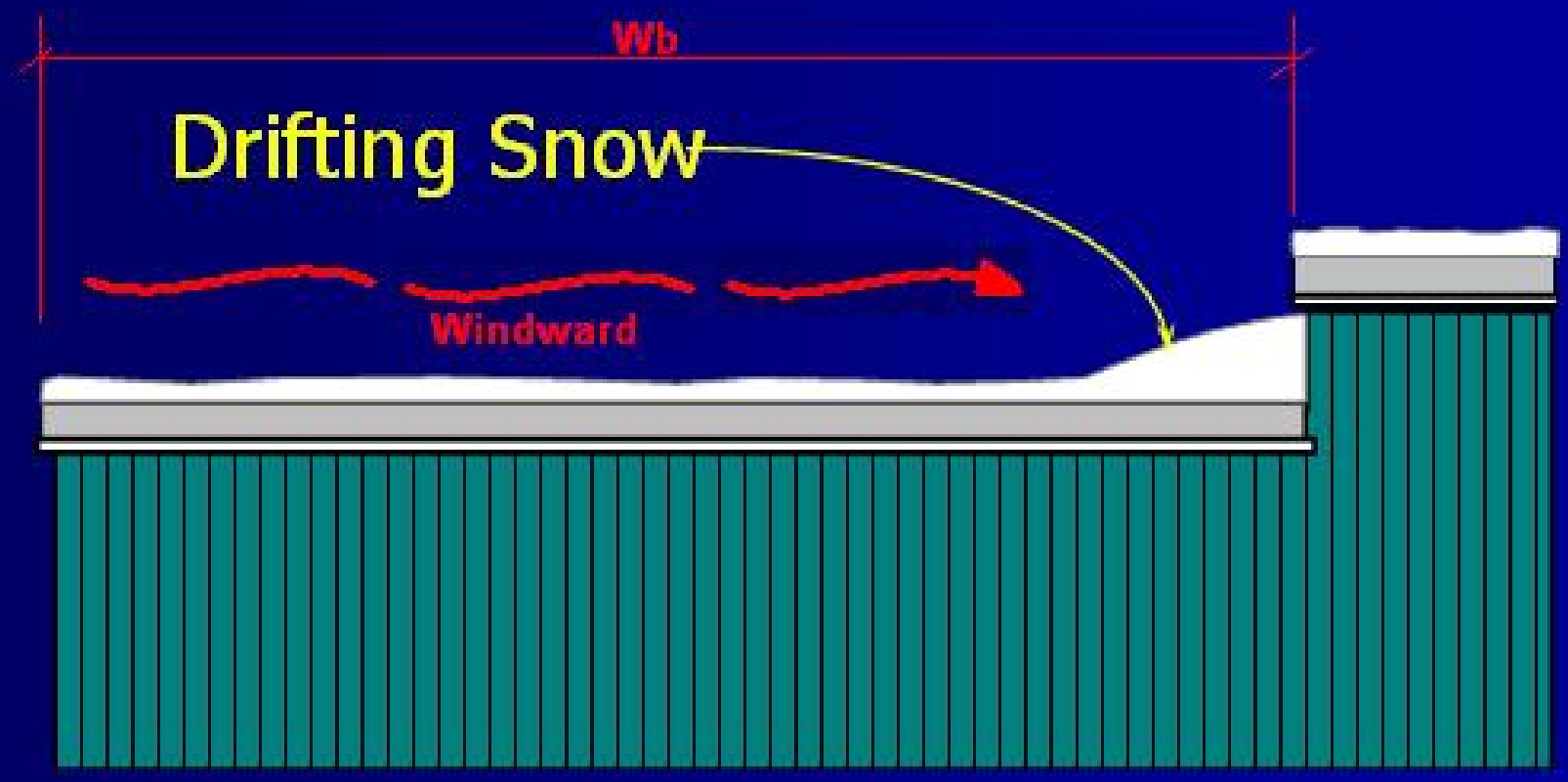
Case III: Unbalanced Snow Right = US1*



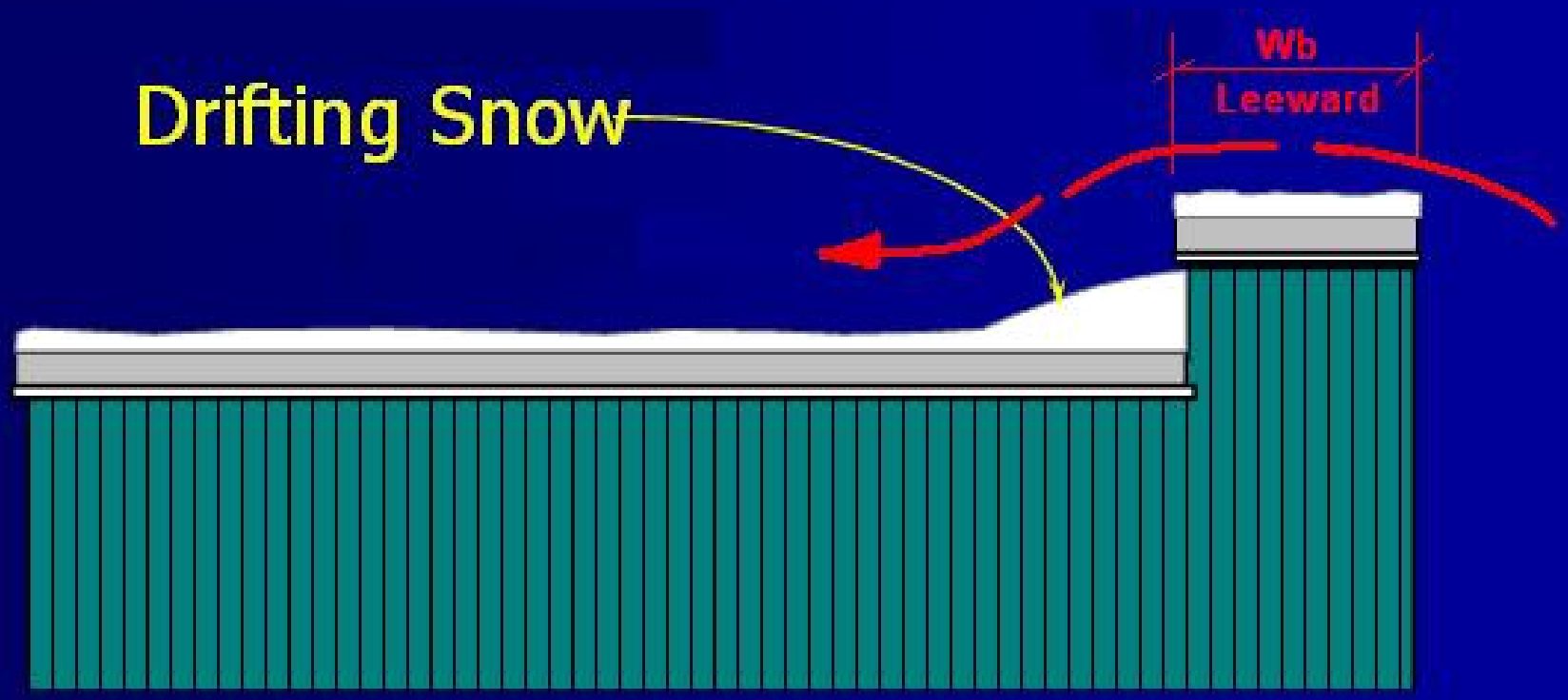
Unbalanced Snow

Watch for Snow Build Up at Walls

Snow Build-Up



Snow Build-Up



Sliding Snow

Sliding Snow

OOPS!

Watch out for those Existing or Future Buildings

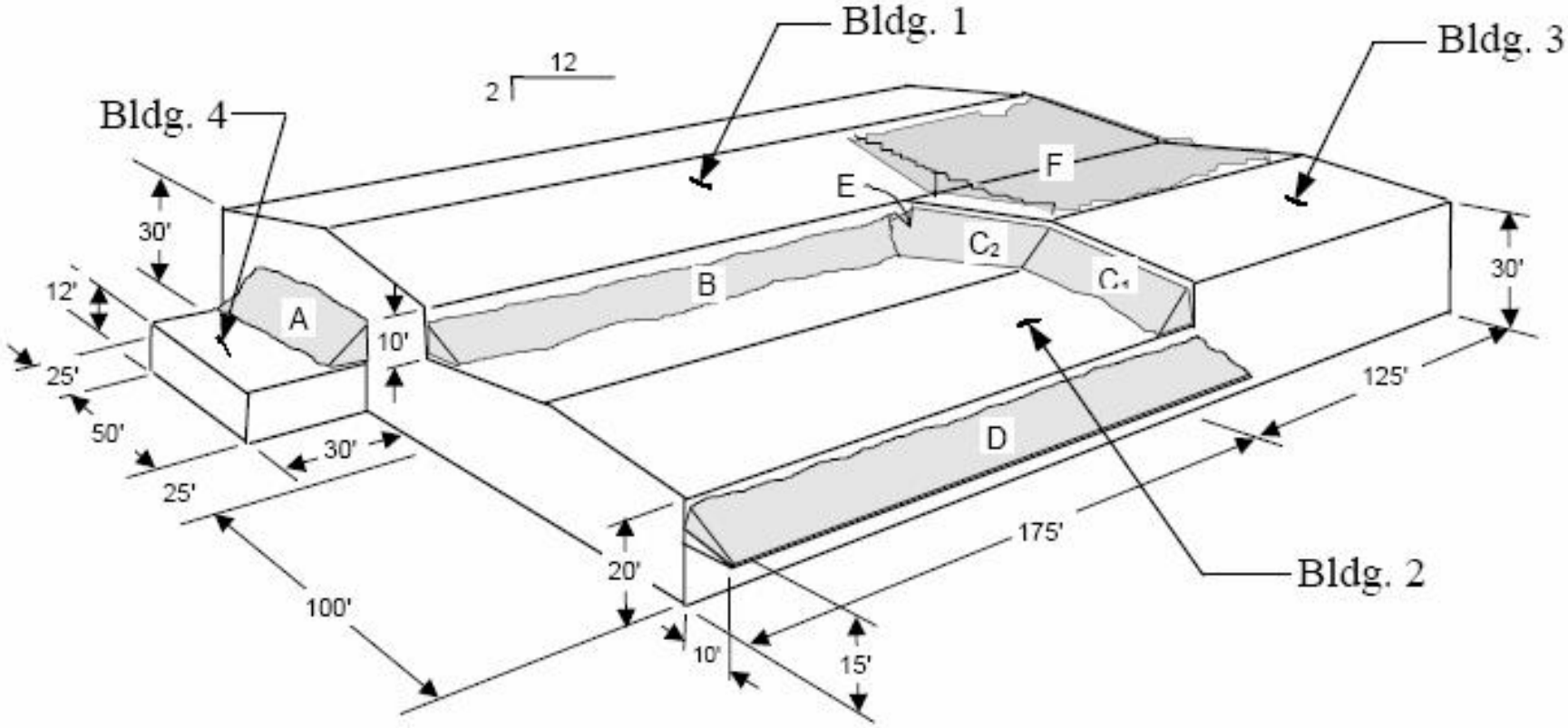


Figure 1.5.14(c)-1
Building Geometry and Drift Locations

Watch out for those Existing Buildings

- The Building Code does not "*KNOW*" actual ground conditions. For instance, are you building within 20' of an existing building? Do you know of a future building that will sit beside this one?
- Existing or Future building dimensions must be clearly defined for purposes of determining Code Required snow Drift and Unbalanced loads

New Building placed beside Existing w/o re-engineering

Snow Guards (Not By VP)

Snow Guards
“Obstructed Roof”

Without Snow Guards

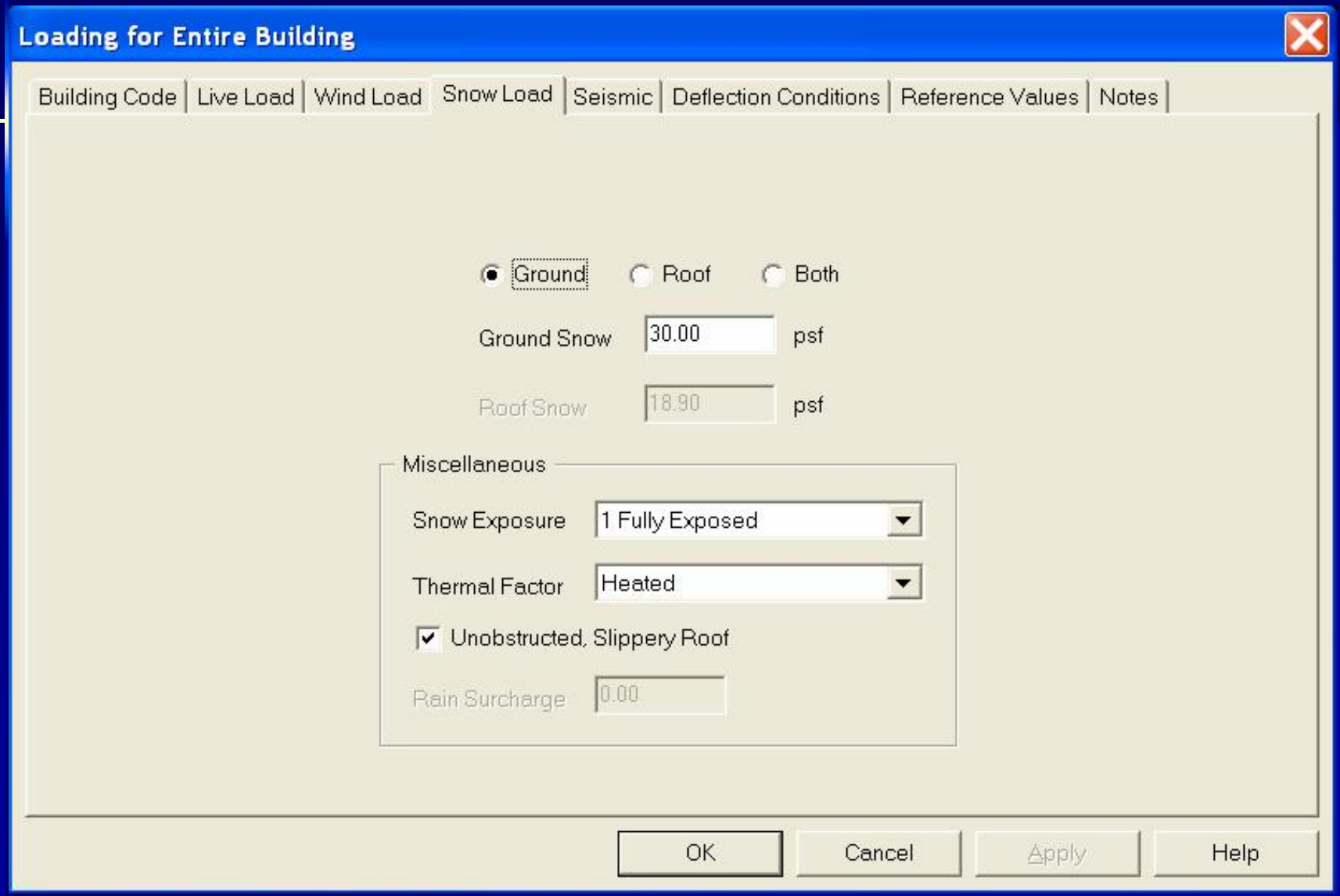
With Snow Guards

Photo from:
http://www.metalroofsnowguards.com/

Snow Guards (Not By VP)

Snow-damaged Gutter

Snow Load Screen



Snow Load Input Screen

- For Ground Snow, input the larger of the values shown on the attached IBC Snow Map or the value shown under the Reference Values tab.
- Use the drop down menu to input Thermal Factor.

Note: If the State or County or City requires a Minimum Roof Load (this can be a Snow Load or Live load), then input the minimum into the Live Load field in VPCommand.

Snow Load Input Screen

- Input the Snow Exposure as defined below (VPC will generate the appropriate coefficients):
  - Snow Exposure 1 – Fully Exposed
  - Snow Exposure 2 - Partial Exposed
  - Snow Exposure 3 – Sheltered

TABLE 7-2 EXPOSURE FACTOR, C_e

Terrain Category (Wind Exposure)	1 – Fully Exposed	2 – Exposure of Roof[a] Partially Exposed	3 – Sheltered
B (see Section 6.5.6)	0.9	1.0	1.2
C (see Section 6.5.6)	0.9	1.0	1.1
D (see Section 6.5.6)	0.8	0.9	1.0
Above the treeline in windswept mountainous areas.	0.7	0.8	N/A
In Alaska, in areas where trees do not exist within a 2-mile (3 km) radius of the site.	0.7	0.8	N/A

Increasing Wind Exposure

Decreasing Snow Coefficients

Decreasing Snow Coefficients

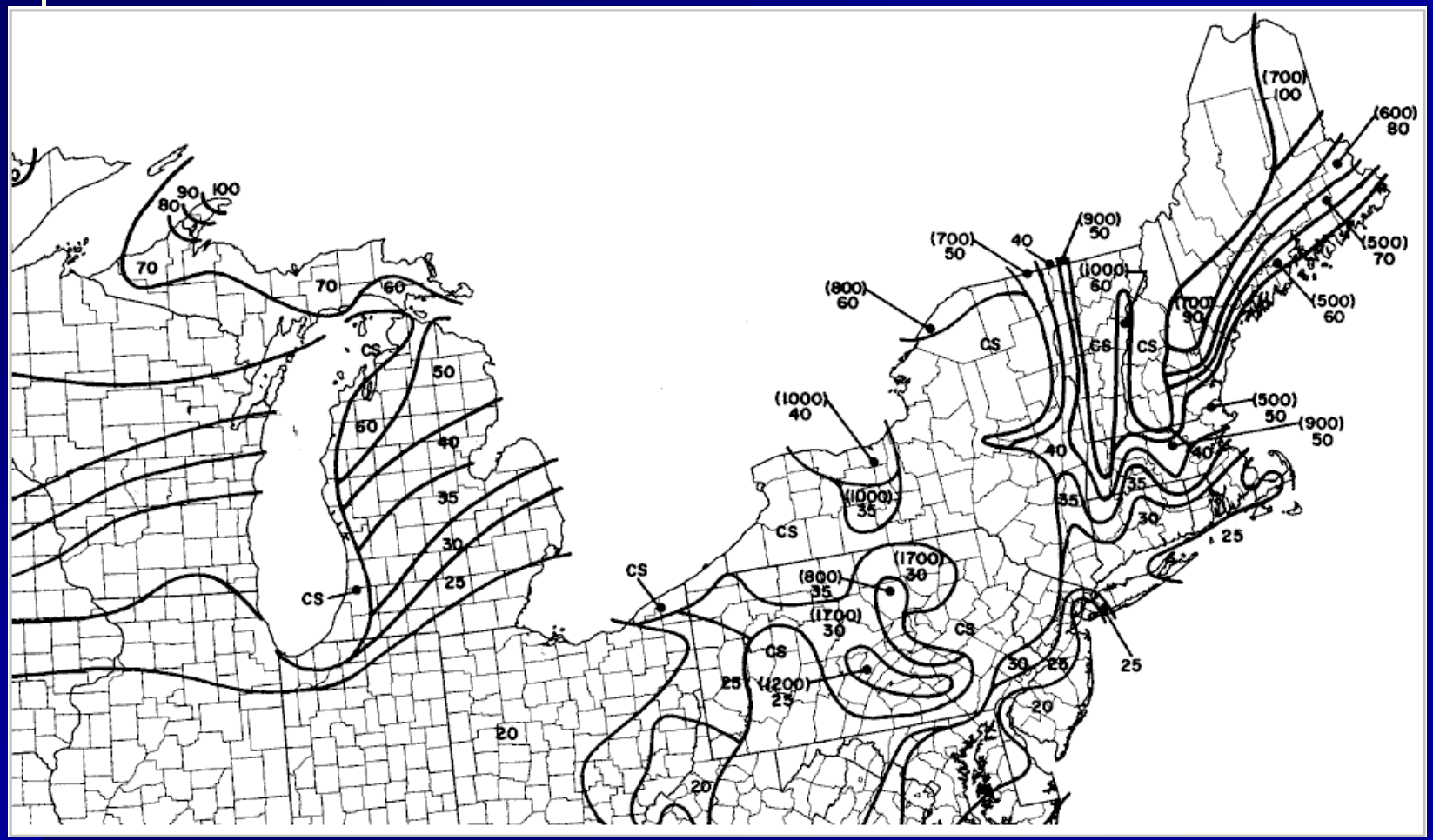
Decreasing Snow Coefficients

The terrain category and roof exposure condition chosen shall be representative of the anticipated conditions during the life of the structure. An exposure factor shall be determined for each roof of a structure.

[a] Definitions: Partially Exposed: All roofs except as indicated in the following text. Fully Exposed: Roofs exposed on all sides with no shelter[b] afforded by terrain, higher structures, or trees. Roofs that contain several large pieces of mechanical equipment, parapets that extend above the height of the balanced snow load (h_b), or other obstructions are not in this category. Sheltered: Roofs located tight in among conifers that qualify as obstructions.

[b] Obstructions within a distance of $10h_o$ provide "shelter," where h_o is the height of the obstruction above the roof level. If the only obstructions are a few deciduous trees that are leafless in winter, the "fully exposed" category shall be used. Note that these are heights above the roof. Heights used to establish the terrain category in Section 6.5.3 are heights above the ground.

Snow Map [Ground Snow]



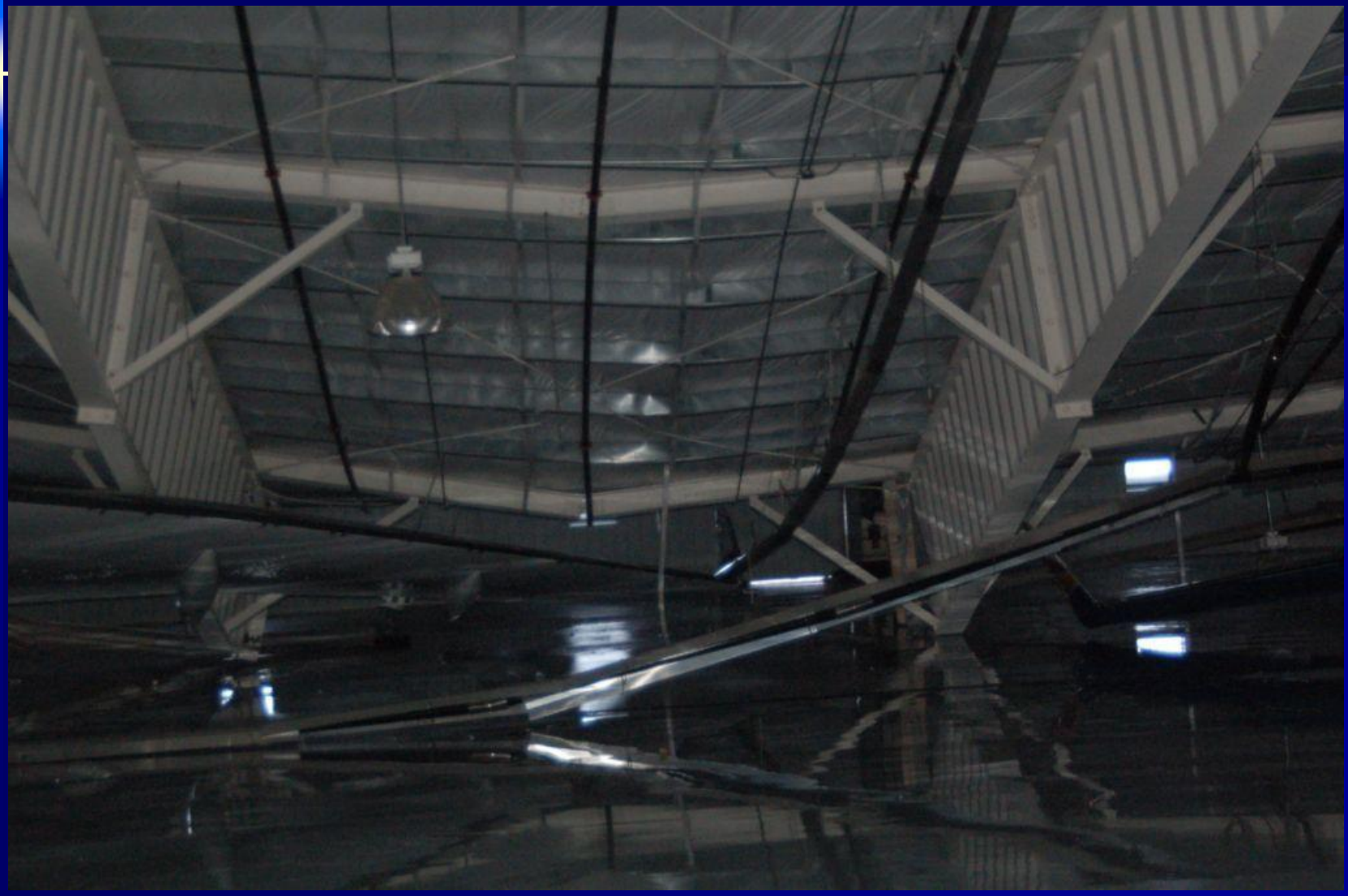
Check local requirements!

Washington D.C. February 2010 (the following is not a VP building)

Washington D.C. February 2010 (the following is not a VP building)

Washington D.C. February 2010

Washington D.C. February 2010



Washington D.C. February 2010

Washington D.C. February 2010

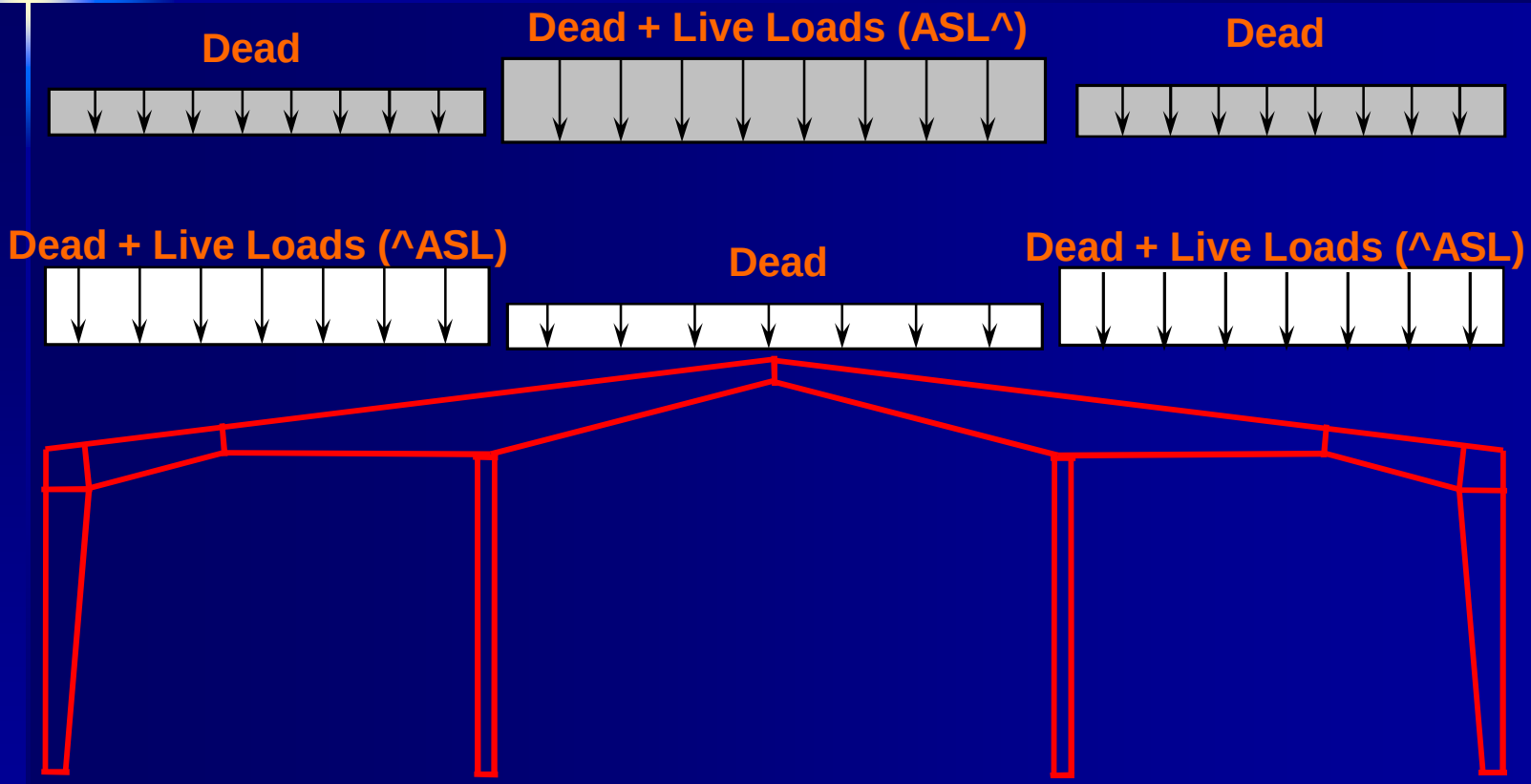
Washington D.C. February 2010

Washington D.C. February 2010

Washington D.C. February 2010

Alternate Span Live Loading

Continuous Rafter Loading Only

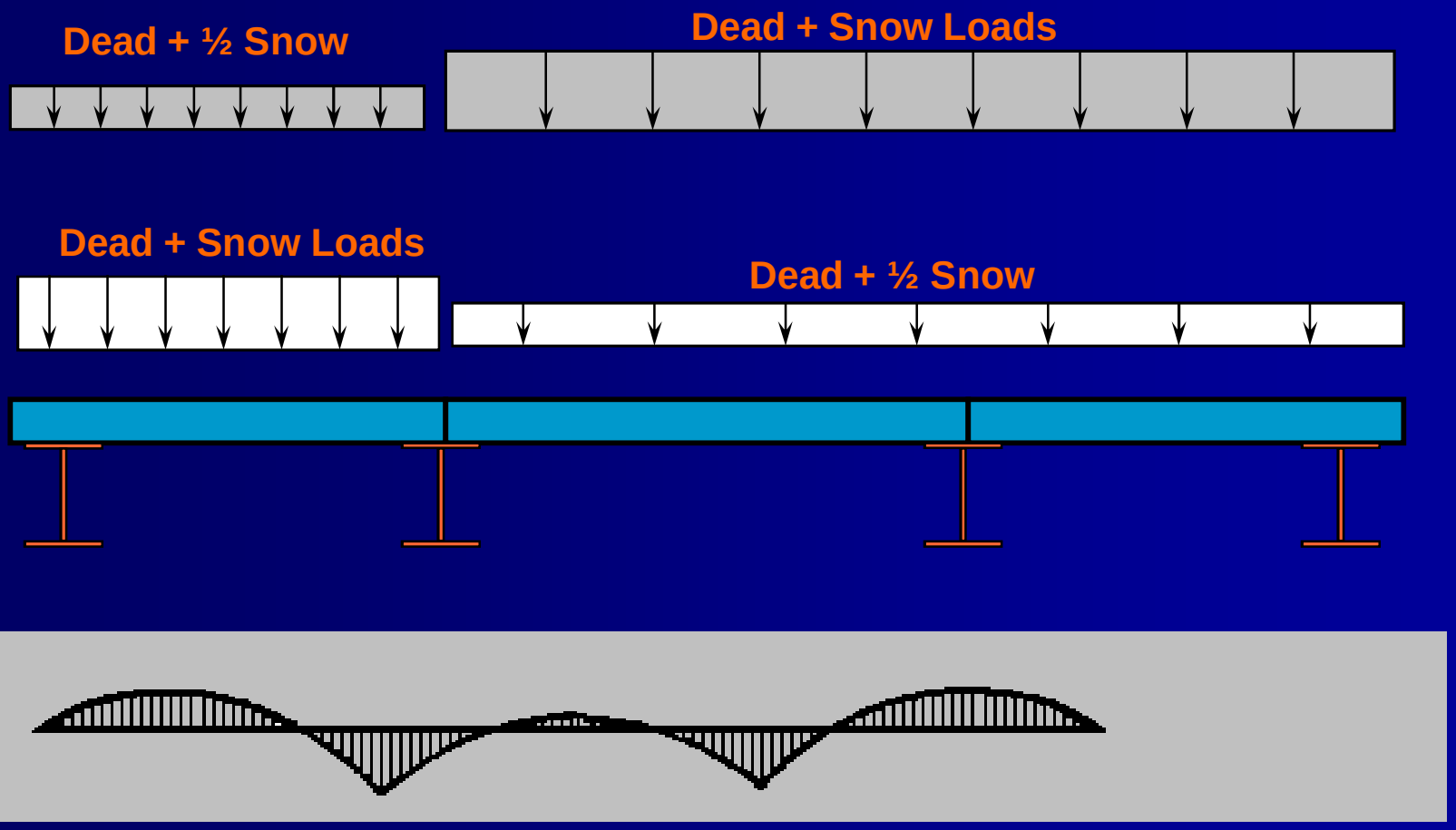


Partial Span Snow Loading

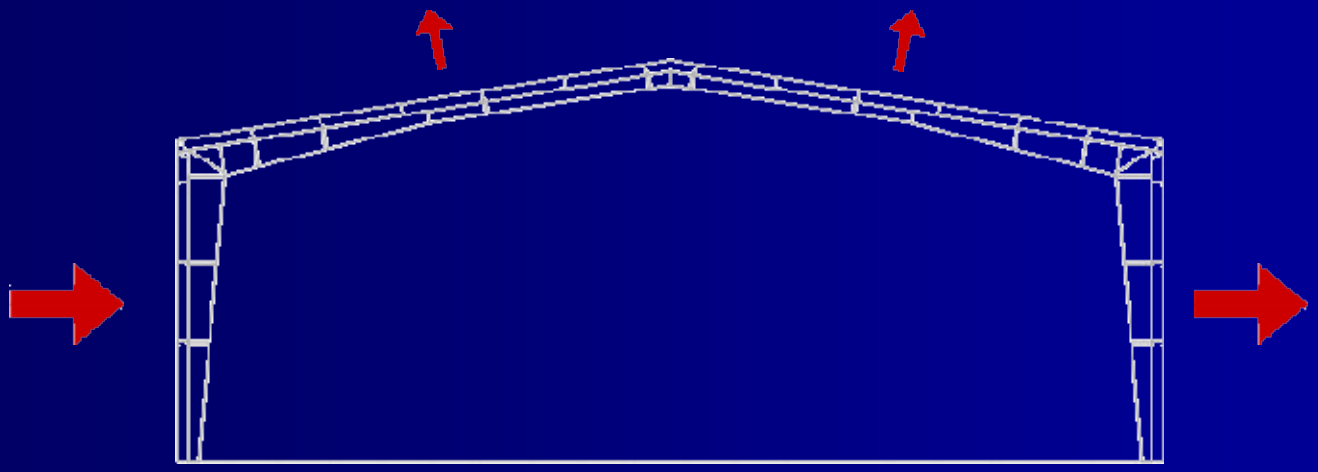
Continuous Secondary Only

Case 1 (PH1)

Case 2 (PF1)



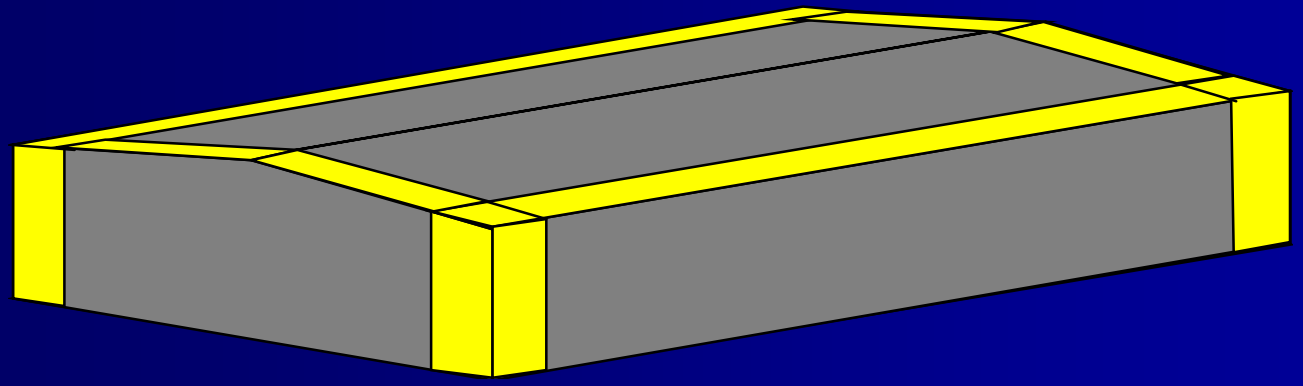
Load Types



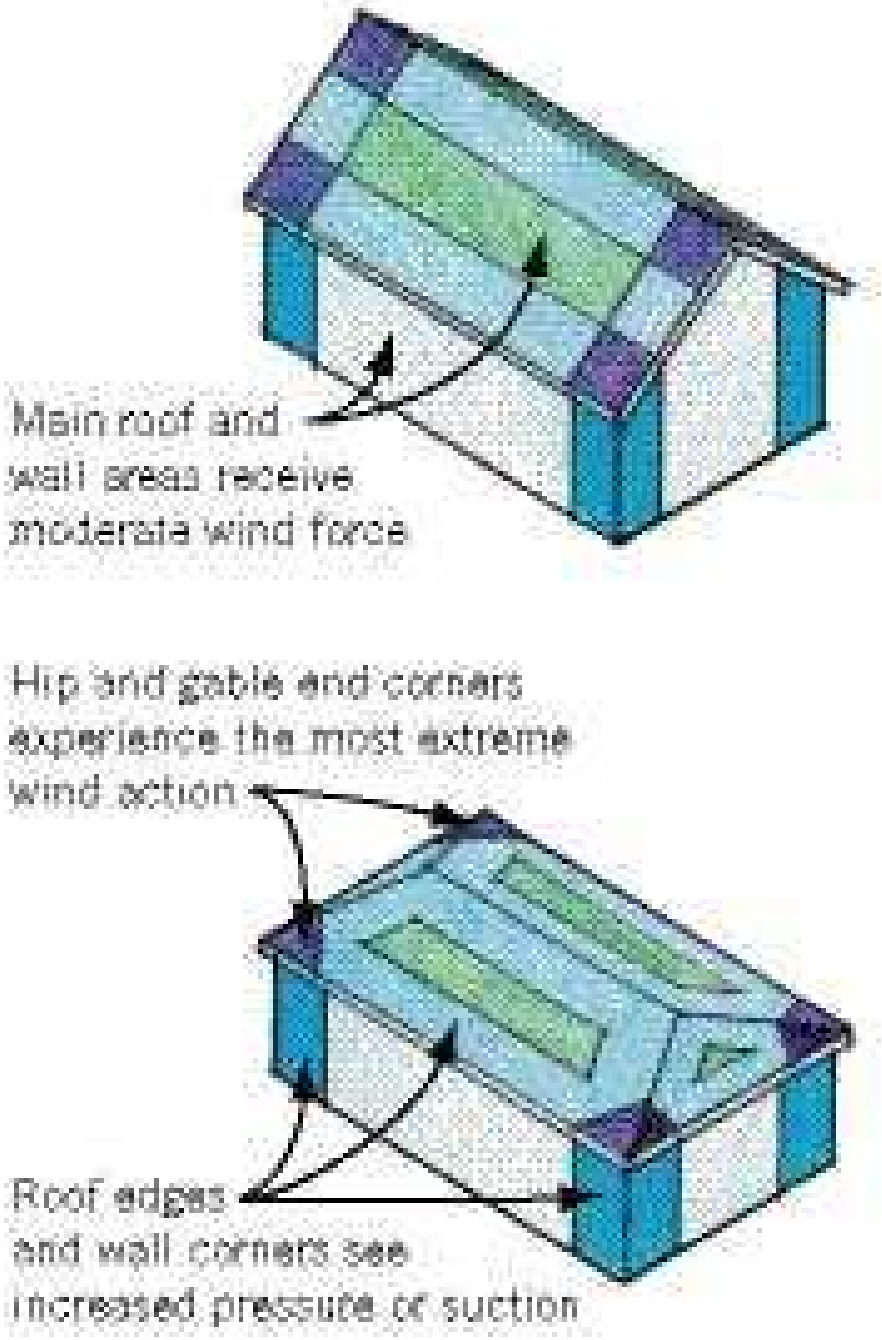
Wind Load = Wind pressure and suction

Wind Loads

Wind pressure has a greater effect on the “EDGE ZONES” of the building.



Wind Load is normally expressed in miles per hour


Main roof and
wall areas receive
moderate wind force
Hip and gable end corners
experience the most extreme
wind action
Roof edges
and wall corners see
increased pressure or suction

Wind Exposure

- Wind loads are rated according to the building's EXPOSURE to wind.

Wind Exposure “D”

- Represents Flat, unobstructed areas exposed to wind flowing over open water (excluding shore-lines in hurricane prone regions) for a distance of at least 1 mi.
- Exposure “D” produces the most severe wind loading and therefore, the most costly (*$$*) building design of all exposures. Verify with Local Building Official that this is truly required.
- Shorelines in Exposure D include inland waterways, the Great Lakes and coastal areas of California, Oregon, Washington and Alaska.

Wind Exposure “D” $$$

Wind Exposure “C”

- Represents Open terrain with scattered obstructions having heights generally less than 30 ft.
- This category includes flat open country, grasslands and shorelines in hurricane prone regions.
- Exposure “C” produces the 2nd most severe wind loading and is a more costly requirement than Exposure “B”. Verify with Local Building Official whether Exposure “B” would not be acceptable

Wind Exposure “C” $$

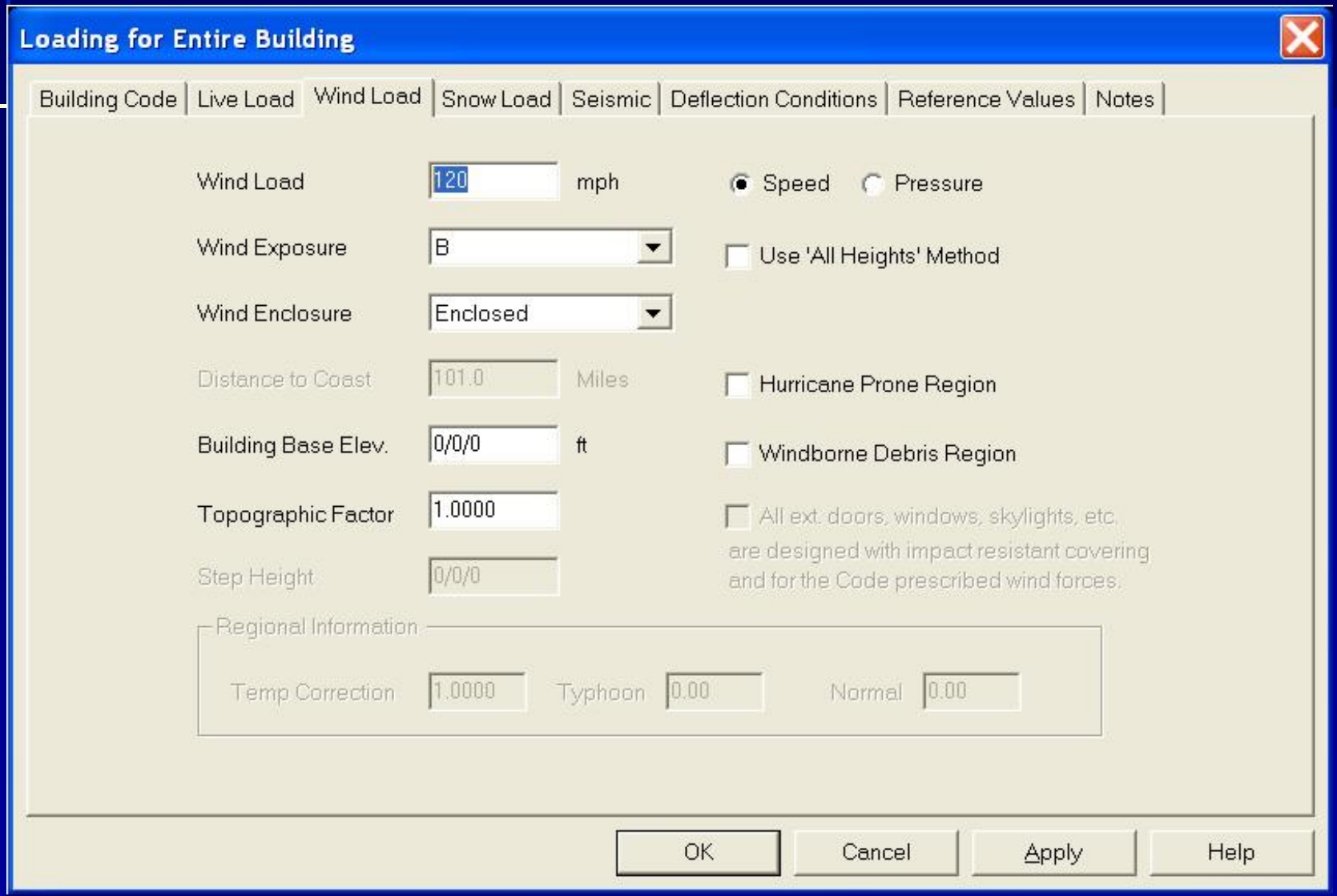
Wind Exposure “B”

- Represents Urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of single-family dwellings or larger.
- Most areas in the US may qualify for Exposure “B” wind loading. Verify with Local Building Official and use Exposure “B” when applicable to produce most cost (*$$*) effective designs.

Wind Exposure “B” $

When the Wind “blows harder” than the Code Specified

Wind Load Screen



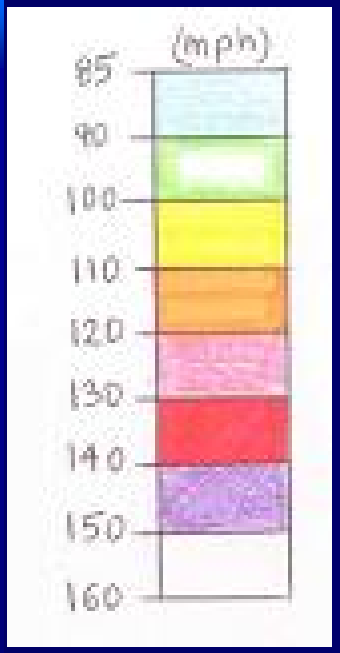
Wind Load Screen Input

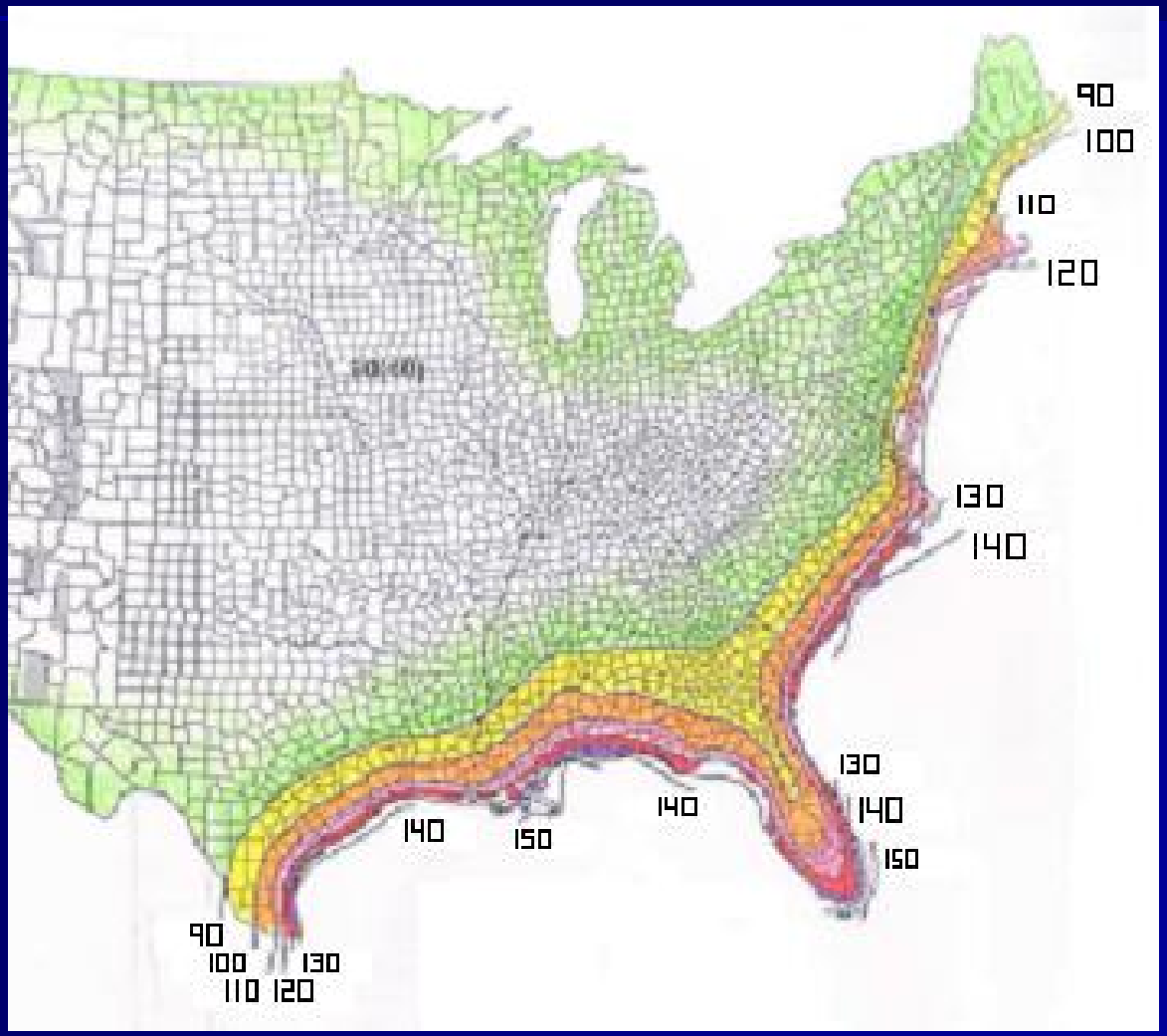
- The Wind load in miles per hour.
- Determine what the building Wind Exposure is. The typical definitions are B, C or D with the least cost impact derived from “B” (=$) and the most from “D” (=$$$).
- Determine the Wind Enclosure per the attached definitions. The most severe designs result from Partially Enclosed buildings.
- Enter 1 for Topographic Factor if the building is located in a flat area. Contact a VP Engineer for the appropriate factor if the building is sitting on or near a hill, ridge, or escarpment.

Wind Load Screen Input

- If the building is located on the Atlantic Ocean or Gulf of Mexico, and the basic wind load is greater than 90 mph, then you are in a Hurricane Prone region.
- Wind-borne Debris Regions: areas within Hurricane Prone Regions located within 1 mile of the coastal mean high water line where wind speed ≥ 110 mph and in Hawaii
- Wind-borne Debris Regions: areas within Hurricane Prone Regions when the wind speed ≥ 120 mph
- Glazing in Wind-borne Debris Regions shall be impact resisting or be covered by impact resisting material per ASTM or other approved test methods

Wind Map (IBC-ASCE 7)



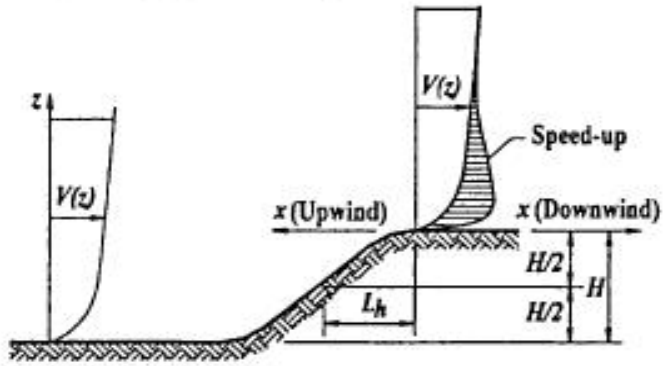


Not a very common occurrence – Ex. Hawaii

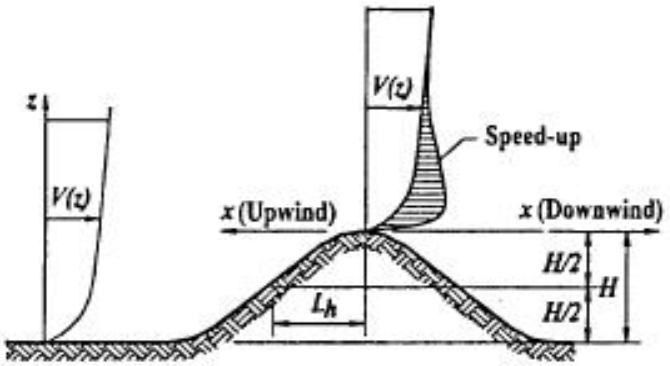
Topographic Factor, K_{zt}

Figure 6-2

EXPANDED CHART



ESCARPMENT



2-D RIDGE OR 3-D AXISYMMETRICAL HILL

Topographic Multipliers for Exposure C

H/L_h	K_1 Multiplier			x/L_h	K_2 Multiplier		z/L_h	K_3 Multiplier		
	2-D Ridge	2-D Escarp.	3-D Axisym. Hill		2-D Escarp.	All Other Cases		2-D Ridge	2-D Escarp.	3-D Axisym. Hill

Wind Enclosure

- Open – Each wall having at least 80% open
- Partially Enclosed (PENC)
  - Total area of openings in a wall exceeds the sum of the areas of openings in the balance of the building envelope by more than 10%
  - Percentage of openings in the balance of the building envelope does not exceed 20%.
- Enclosed – Buildings not Open or PENC
- Consult with VP's Estimating Department if there are permanent openings (exposed to wind) in your walls or roofs.

Wind Enclosure

Loads and Codes / Wind Load – Wind Enclosure: Three new wind enclosures were added to VPCommand.

The Free Roof options use coefficients from ASCE7-05 figures 6-18A and 6-18B for the main wind force resisting parts of the structure and figures 6-19A and 6-19B for component and cladding. Load and design of troughed free roofs ASCE7-05 figures 6-18C, 6-18D, and 6-19C are not included at this time.

- Free Roof – Clear
- Free Roof – Clear/Obstructed
- Open – All Heights Method

Free Roof – Clear option will only use the "Clear Wind Flow" coefficients from the referenced figures

Free Roof – Clear/Obstructed will use a combination of "Clear Wind Flow" and "Obstructed Wind Flow" coefficients in order to produce the worst case of the 2 coefficients.

A building is considered **OBSTRUCTED** and should use the Clear/Obstructed option when more than 50% of the open walls will be obstructed with objects inside the building. If less than a 50% obstruction will be caused by objects inside the building the Clear option should be used.

Building Enclosure

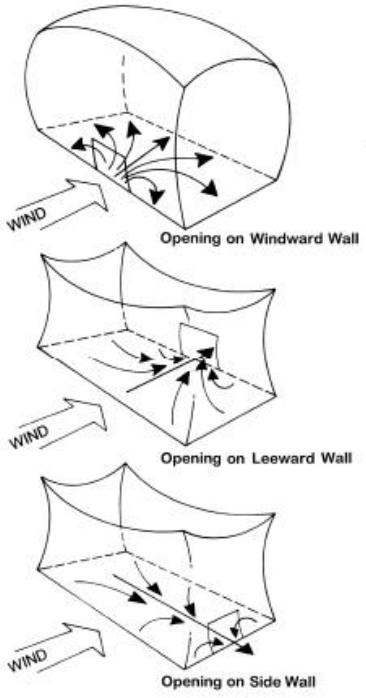


Figure 7.2.3(b)
Influences of Openings on Internal Pressure

Wind Speed - Height

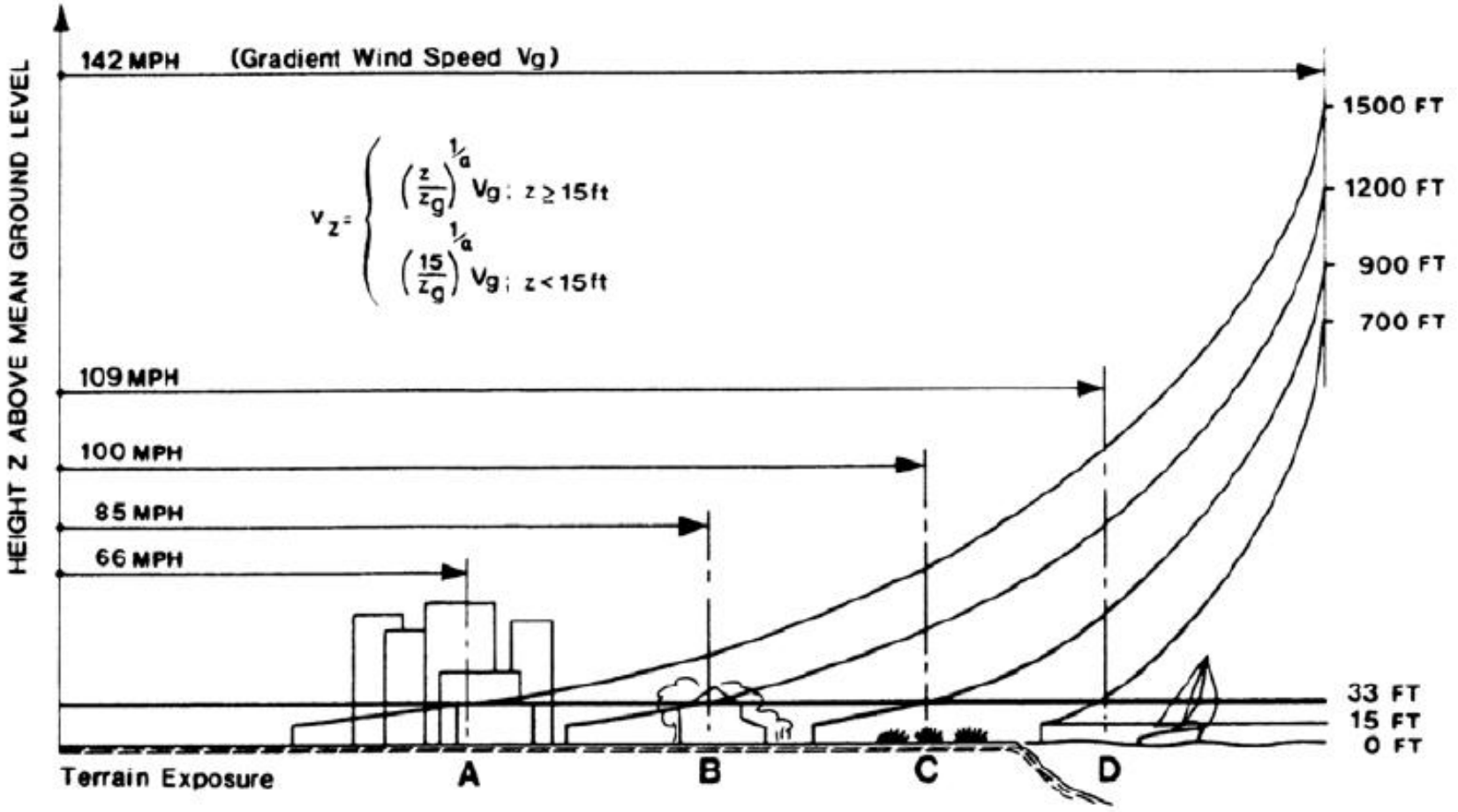
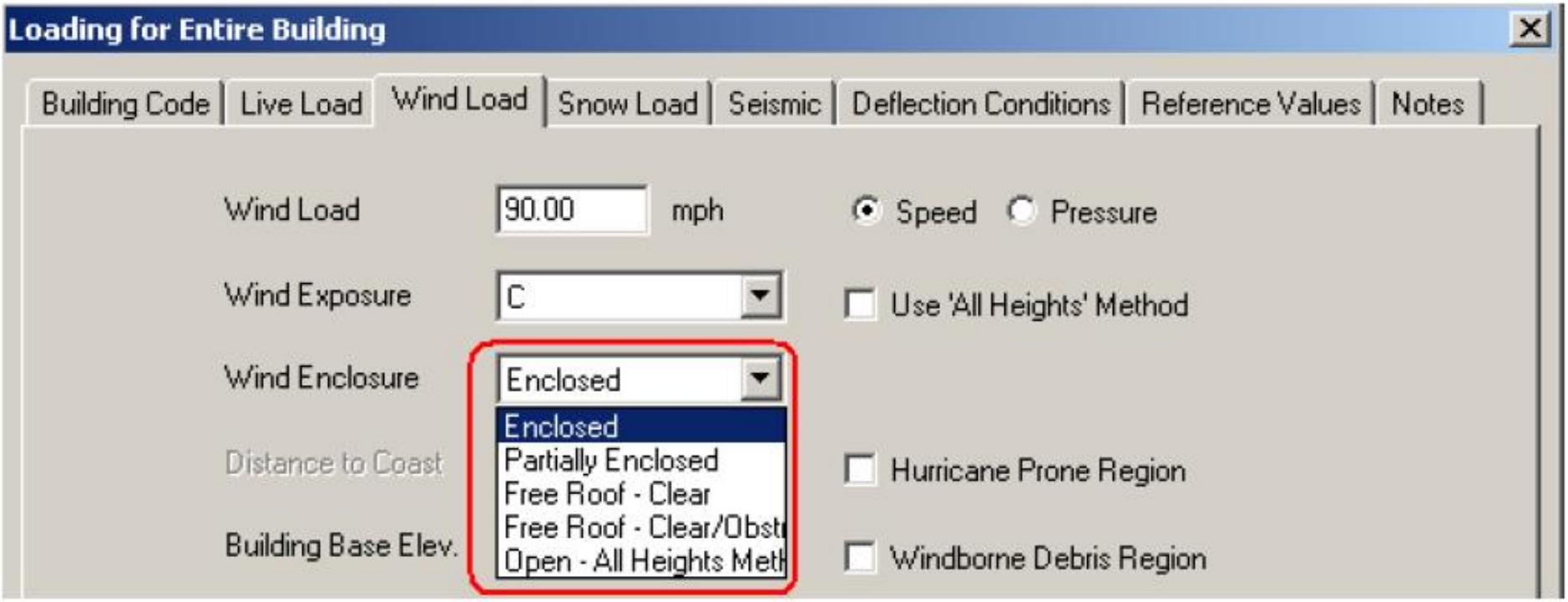


Figure A7.2.1(a)
Mean Wind Speed Variation With Height

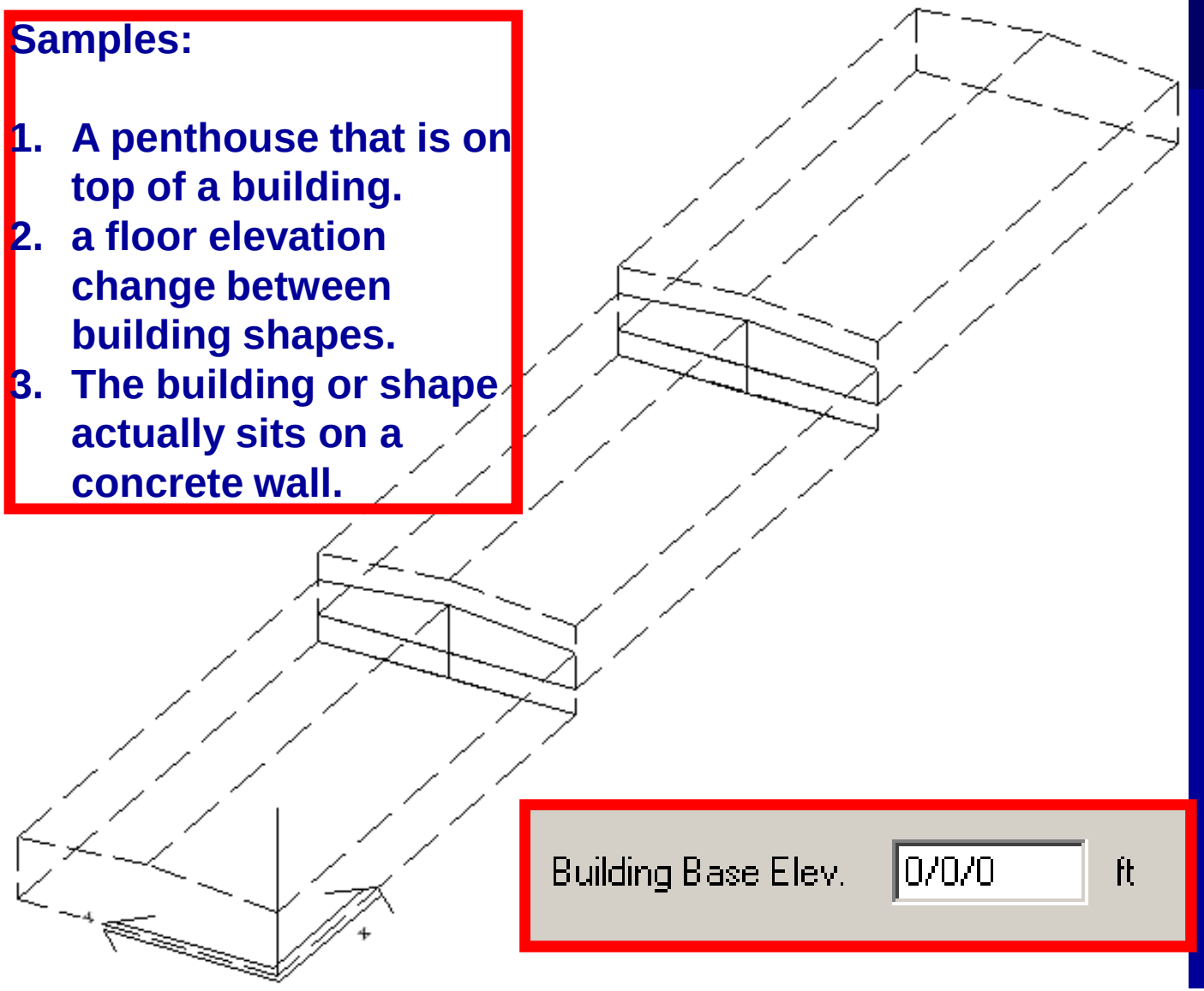
Wind Enclosure



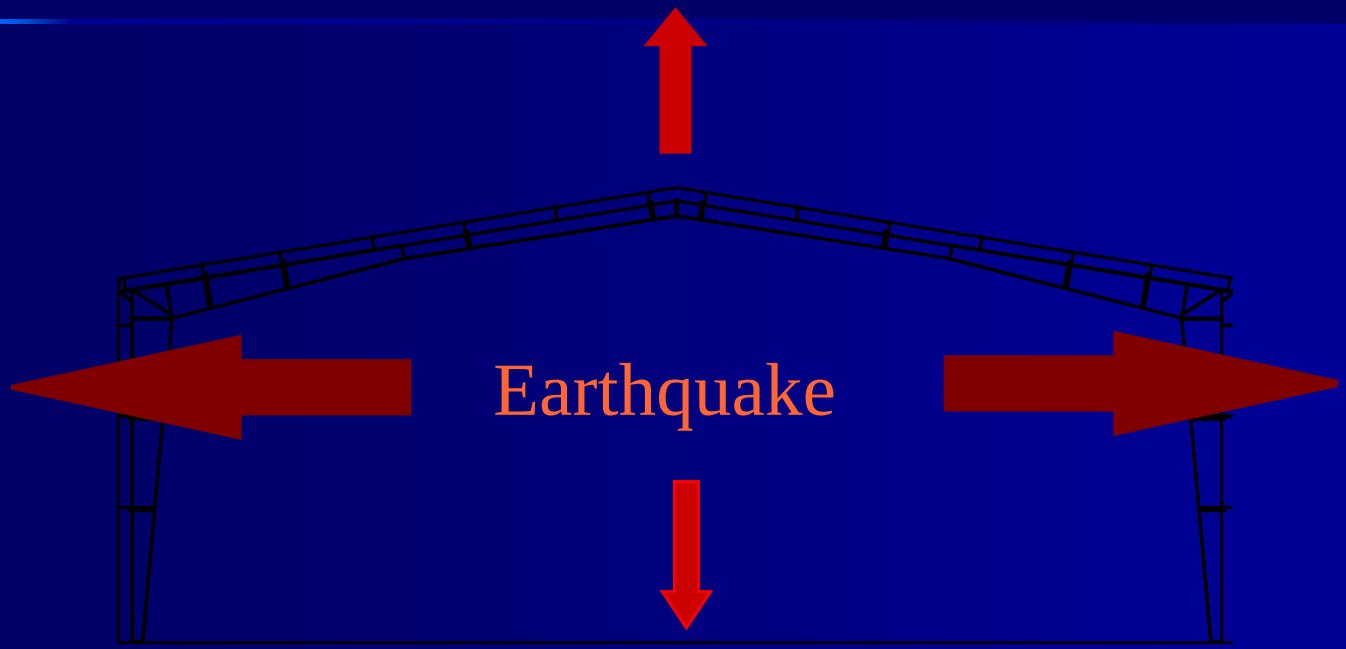
Building Base Elevation Change

Samples:

1. **A penthouse that is on top of a building.**
2. **a floor elevation change between building shapes.**
3. **The building or shape actually sits on a concrete wall.**



Load Types



Seismic Load = Horizontal & Vertical loads due to earthquake

Seismic

- Two site specific parameters called Ss and S1 are required to determine the seismic loading on a building.

Ss – is the chance that the building will be subject to a seismic event

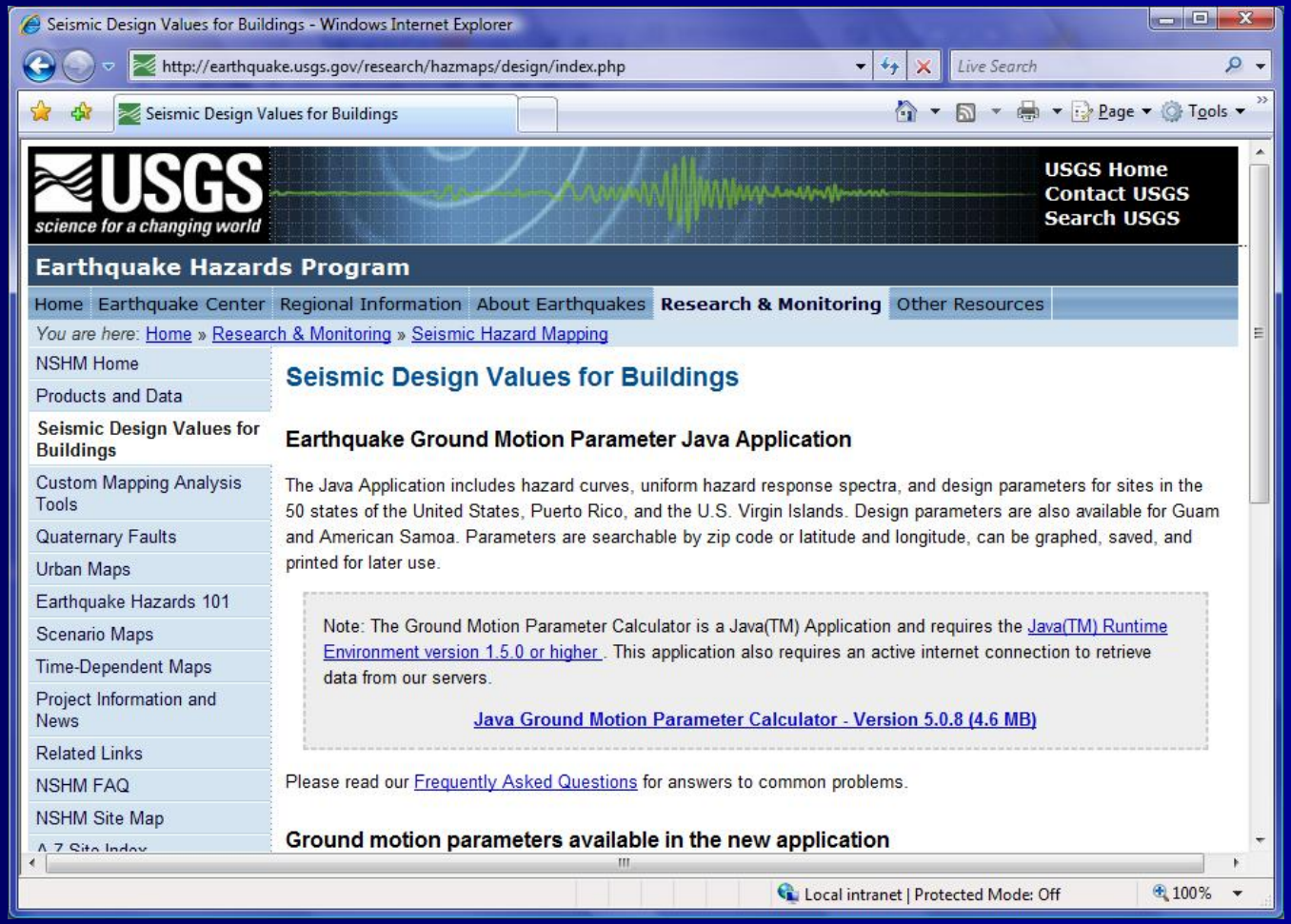
S1 – is the height of the ground motion caused by the seismic event

- These values are determined by the US Geological Society

Seismic

- *CAUTION*: Ss and S1 values may vary significantly within a given zip code, so it's recommended that you use the site coordinates (Longitude/Latitude) to determine Ss and S1 more precisely.
- One way to determine site coordinates is to use Google/Maps/ web site, enter the job site address, or if not available, one that's close by. Click on Search Maps, then zoom and center the actual job site on the map. Now click on "Link to this Page" and locate the coordinates in the address bar of your browser.

Seismic


Seismic Design Values for Buildings - Windows Internet Explorer
http://earthquake.usgs.gov/research/hazmaps/design/index.php
Live Search
Seismic Design Values for Buildings
Page
Tools
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science for a changing world
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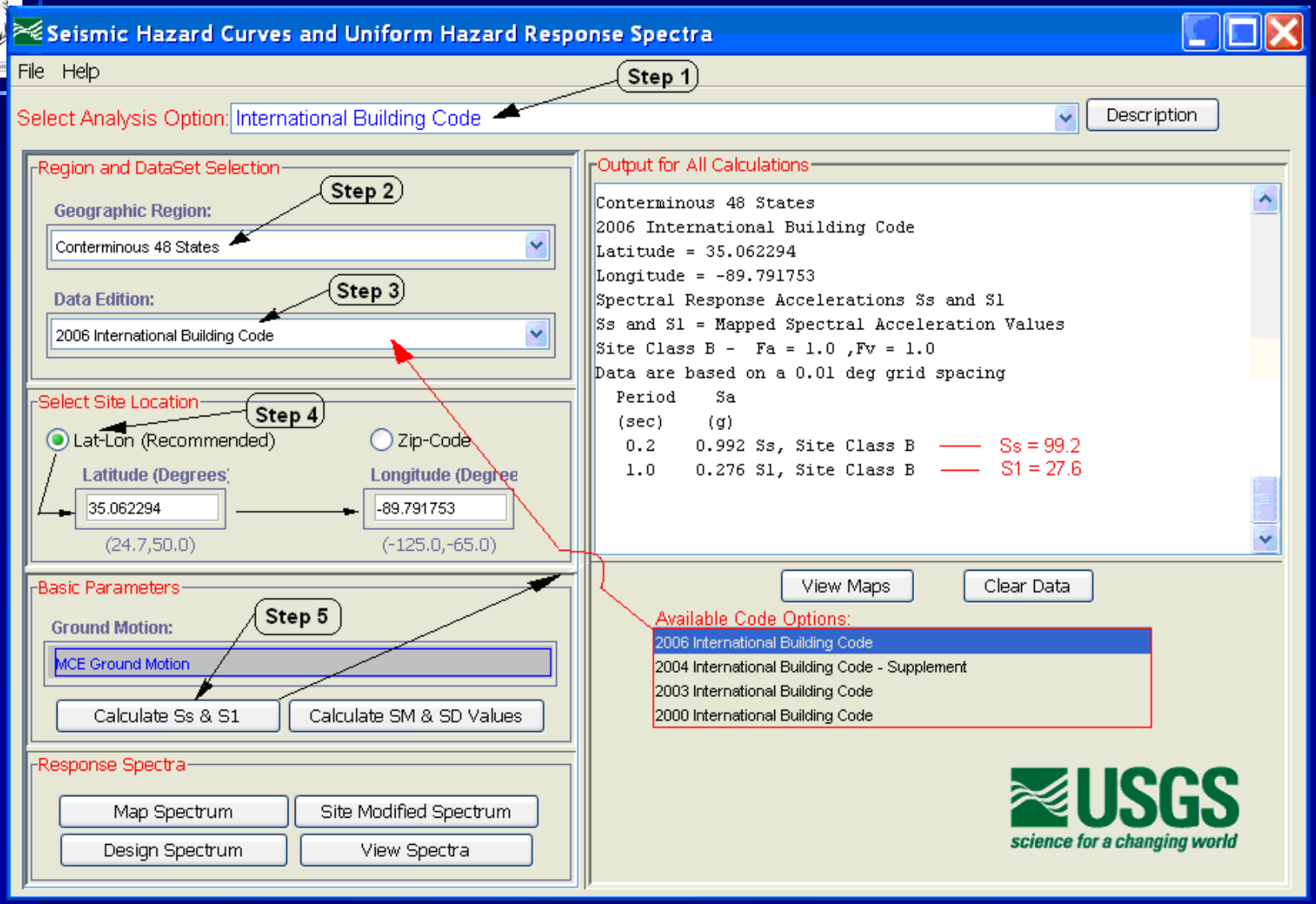
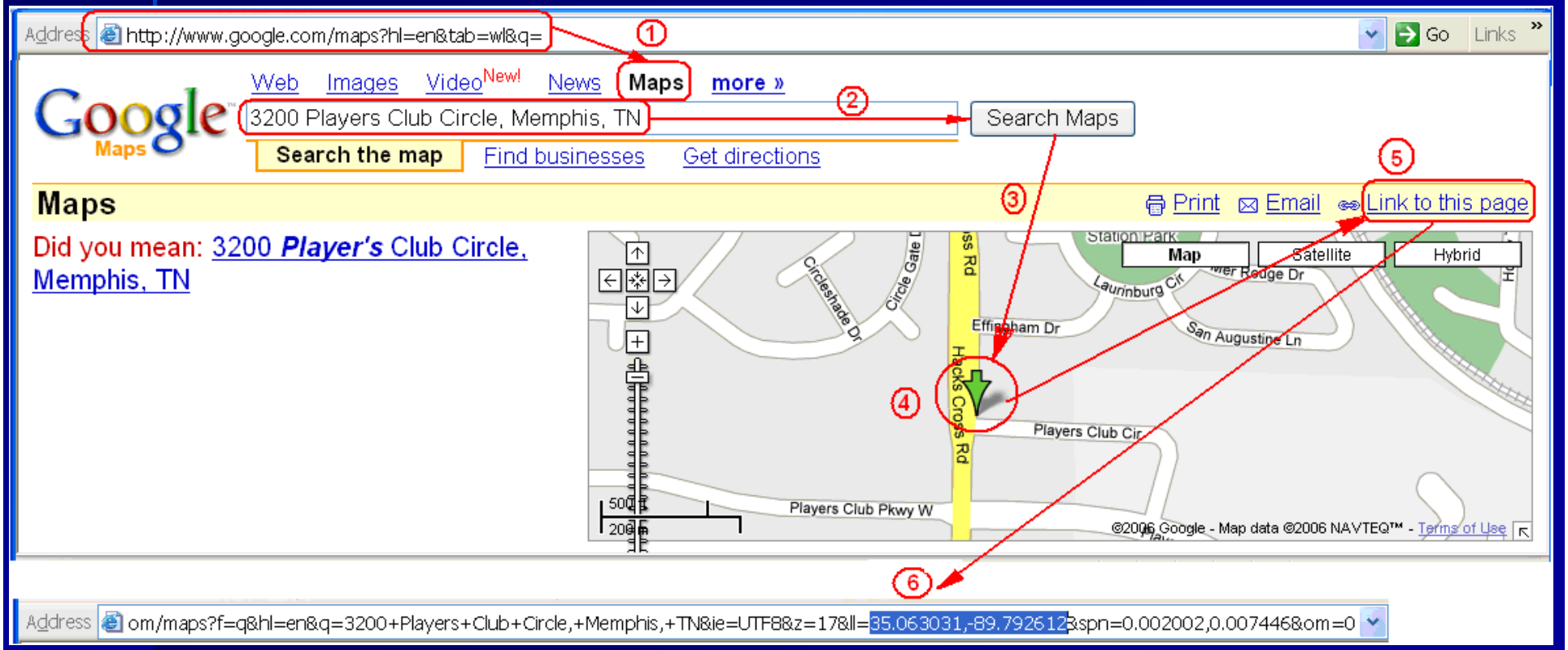
NSHM Home
Products and Data
Seismic Design Values for Buildings
Custom Mapping Analysis Tools
Quaternary Faults
Urban Maps
Earthquake Hazards 101
Scenario Maps
Time-Dependent Maps
Project Information and News
Related Links
NSHM FAQ
NSHM Site Map
Seismic Design Values for Buildings
Earthquake Ground Motion Parameter Java Application
The Java Application includes hazard curves, uniform hazard response spectra, and design parameters for sites in the 50 states of the United States, Puerto Rico, and the U.S. Virgin Islands. Design parameters are also available for Guam and American Samoa. Parameters are searchable by zip code or latitude and longitude, can be graphed, saved, and printed for later use.
Note: The Ground Motion Parameter Calculator is a Java(TM) Application and requires the Java(TM) Runtime Environment version 1.5.0 or higher. This application also requires an active internet connection to retrieve data from our servers.
Java Ground Motion Parameter Calculator - Version 5.0.8 (4.6 MB)
Please read our Frequently Asked Questions for answers to common problems.
Ground motion parameters available in the new application
Local intranet | Protected Mode: Off
100%

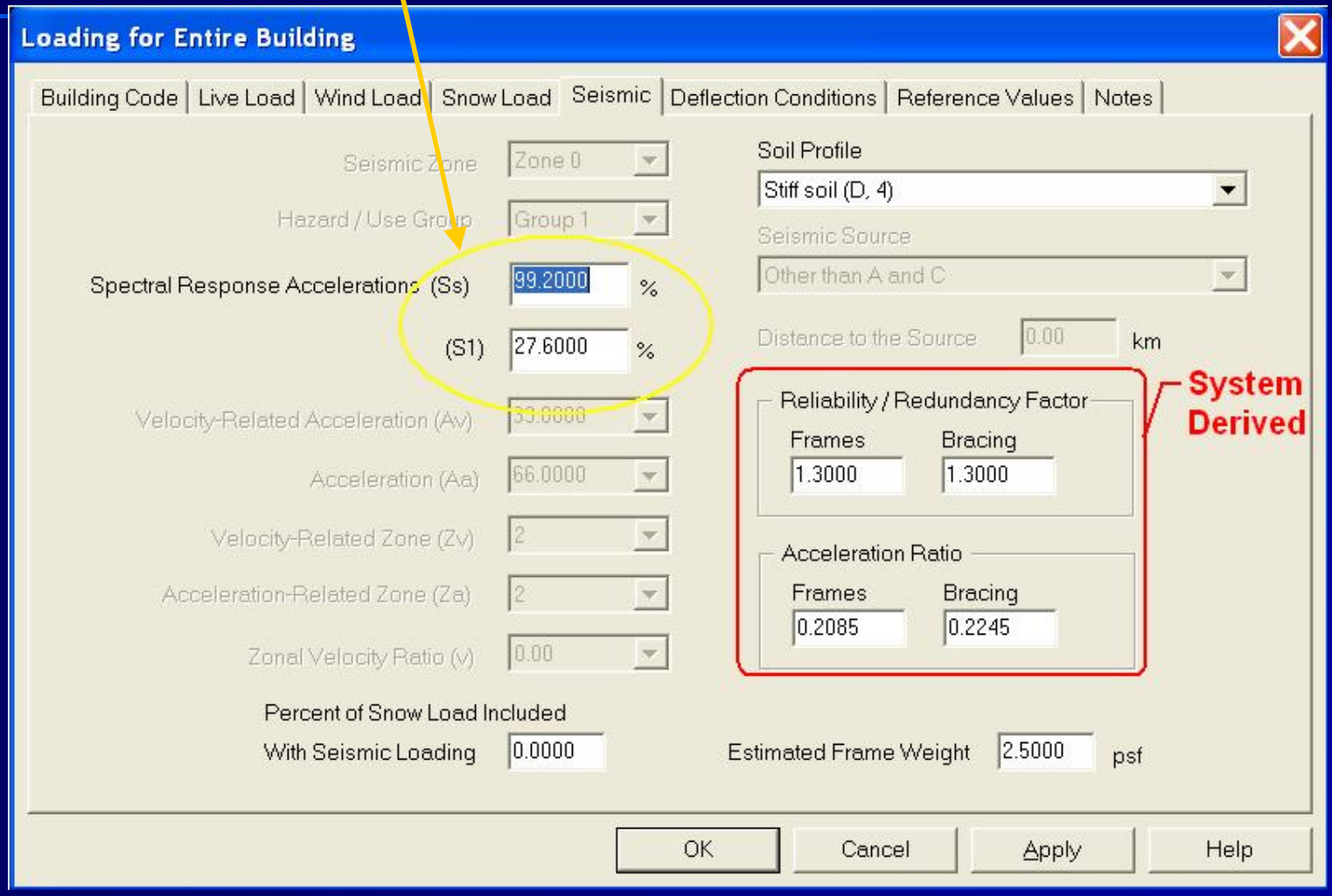
Seismic Calculator



Seismic - Site Coordinates



S_S Always Larger



Soil Profile

- A classification assigned to a site based on the types of soil present and their engineering properties
- Applies to the upper 100 ft. of the soil

Site Class	Description
A	Hard rock
B	Rock
C	Very dense soil or soft rock
D	Stiff soil
E	Soil
F	Vulnerable soils (clays…)

VPC Default

$

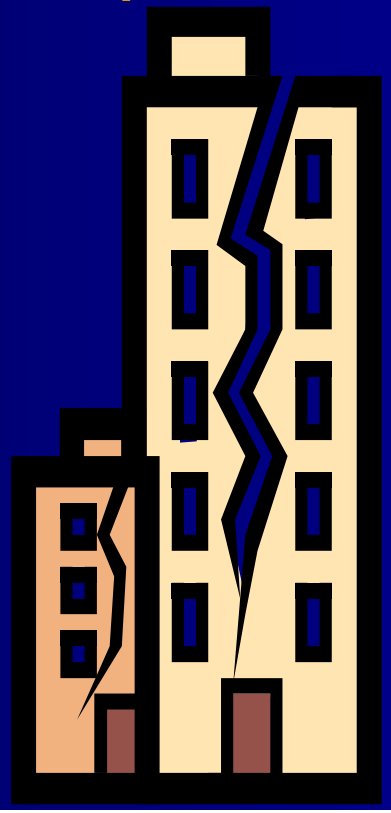
$$$

Soil Profile

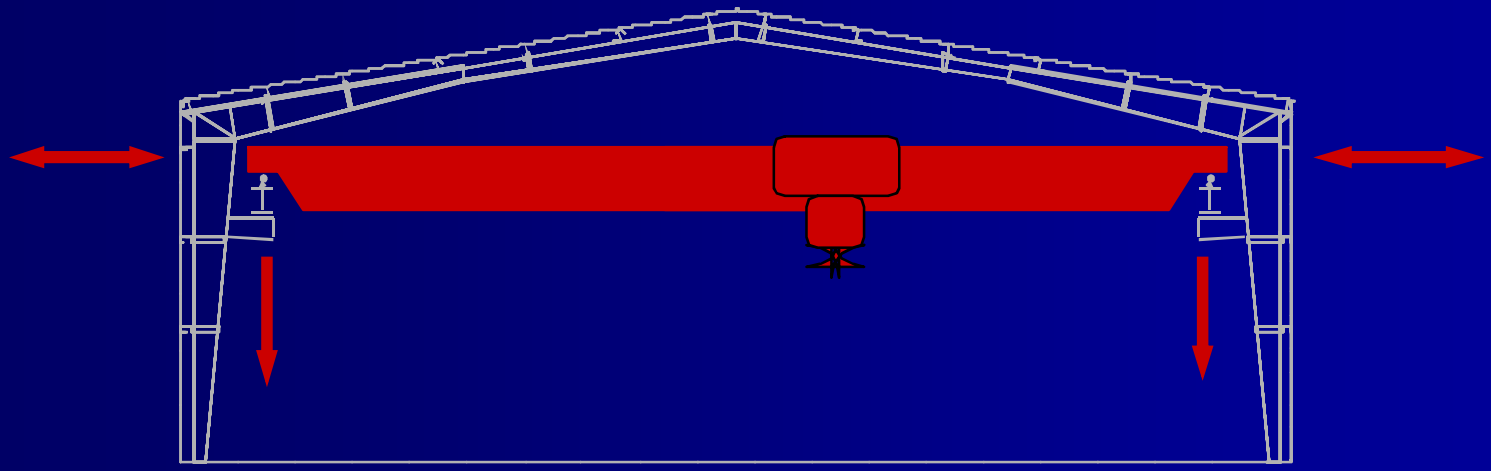
- Seismic loading can be significantly impacted by the selection of soil type.
- Major projects usually have soils reports.
- Engineer of Record should be pressed for accurate information for these projects.

Seismic

- Pay special attention to the weight of your materials (masonry walls in particular).

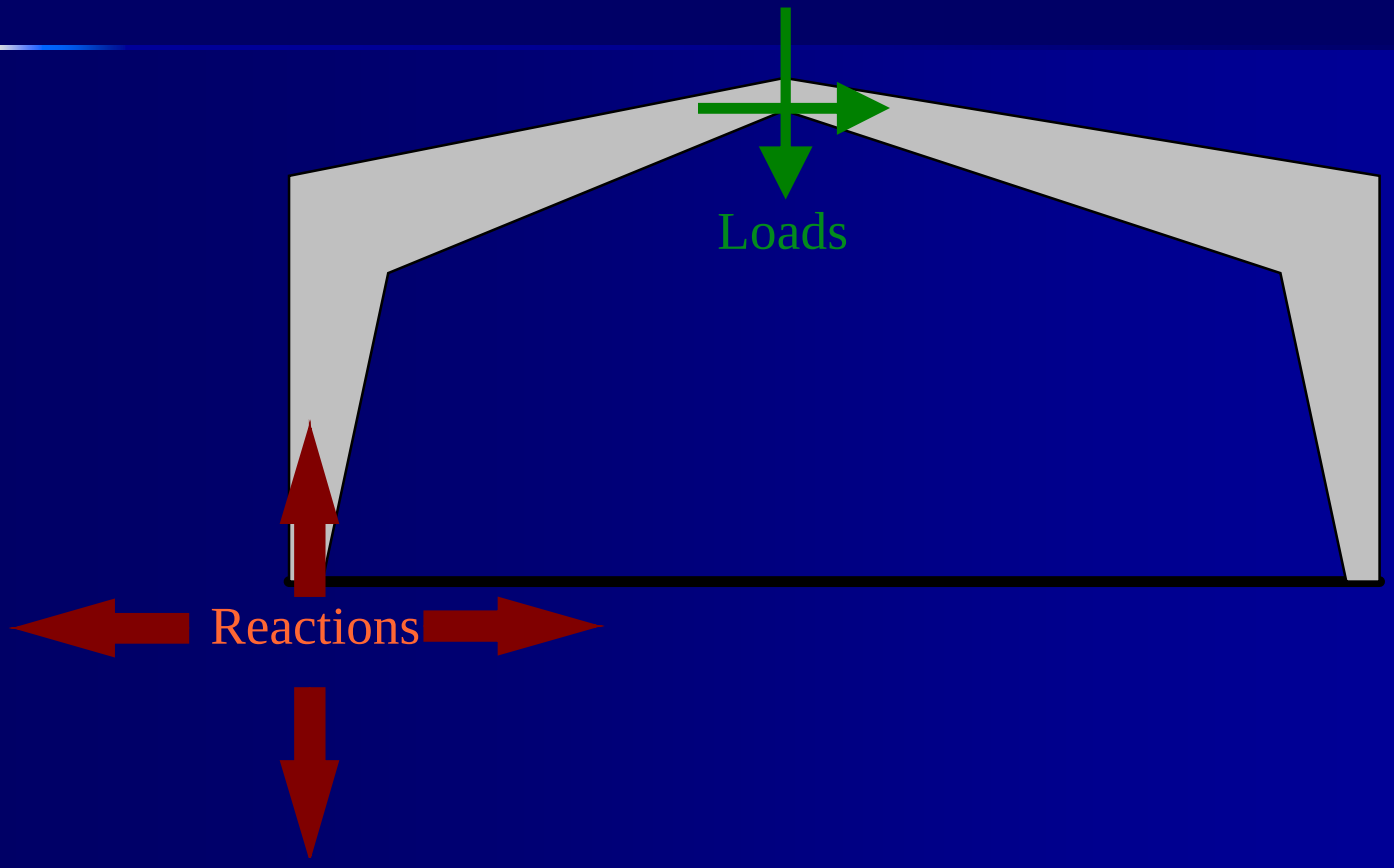


Load Types



Auxiliary Live Load = Dynamic loads

Loads to the Foundation



Loads In = Reactions Out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