CHAPTER 7
SNOW LOADS

7.1 DEFINITIONS AND SYMBOLS

7.1.1 Definitions

DRIFT: The accumulation of wind-driven snow that results in a local surcharge load on the roof structure at locations such as a parapet or roof step.

FLAT ROOF SNOW LOAD: Uniform load for flat roofs.

FREEZER BUILDINGS: Buildings in which the inside temperature is kept at or below freezing. Buildings with an air space between the roof insulation layer above and a ceiling of the freezer area below are not considered freezer buildings.

GROUND SNOW LOAD: The site-specific weight of the accumulated snow at the ground level used to develop roof snow loads on the structure. It generally has a 50-year mean recurrence interval.

MINIMUM SNOW LOAD: Snow load on low sloped roofs, including the roof snow load immediately after a single snow storm without wind.

PONDING: Refer to definitions in Chapter 8, Rain Loads

PONDING INSTABILITY: Refer to definitions in Chapter 8, Rain Loads.

R-VALUE: A measure of the resistance to heat flow through a roof component or assembly per unit area.

SLIPPERY SURFACE: Membranes with a smooth surface, e.g., glass, metal, or rubber. Membranes with an embedded aggregate or mineral granule surface are not considered a slippery surface.

SLOPED ROOF SNOW LOAD: Uniform load on horizontal projection of a sloped roof, also known as the balanced load.

VENTILATED ROOF: Roof that allows exterior air to naturally circulate between the roof surface above and the insulation layer below. The exterior air commonly flows from the eave to the ridge.

7.1.2 Symbols

C_e = exposure factor as determined from Table 7.3-1.
C_s = slope factor as determined from Fig. 7.4-1.
C_t = thermal factor as determined from Table 7.3-2.
h = vertical separation distance in feet (m) between the edge of a higher roof including any parapet and the edge of a lower adjacent roof excluding any parapet.
h_b = height of balanced snow load determined by dividing p_s by γ, in ft (m).
h_c = clear height from top of balanced snow load to (1) closest point on adjacent upper roof, (2) top of parapet, or (3) top of a projection on the roof, in ft (m).
h_d = height of snow drift, in ft (m).
h_{d1} or h_{d2} = heights of snow drifts, in ft (m), where two intersecting snow drifts can form.
h_o = height of obstruction above the surface of the roof, in ft (m).
I_s = importance factor as prescribed in Section 7.3.3.
l_u = length of the roof upwind of the drift, in ft (m).
p_d = maximum intensity of drift surcharge load, in lb/ft^2 (kN/m^2).
p_f = snow load on flat roofs ("flat"= roof *slope* $\leq 5°$), in lb/ft^2 (kN/m^2).
p_g = ground snow load as determined from Fig. 7.2-1 and Table 7.2-1; or a site-specific analysis, in lb/ft^2 (kN/m^2).
p_m = minimum snow load for low-slope roofs, in lb/ft^2 (kN/m^2).
p_s = sloped roof (balanced) snow load, in lb/ft^2 (kN/m^2).
s = horizontal separation distance in ft (m) between the edges of two adjacent buildings.
S = roof slope run for a rise of one.
w = width of snow drift, in ft (m).
w_1 or w_2 = widths of snow drifts, in ft (m), where two intersecting snow drifts can form.
W = horizontal distance from eave to ridge, in ft (m).
γ = snow density, in lb/ft^3 (kN/m^3), as determined from Eq. (7.7-1).

θ = roof slope on the leeward side, in degrees.

7.2 GROUND SNOW LOADS, p_g

Ground snow loads, p_g, to be used in the determination of design snow loads for roofs shall be as set forth in Fig. 7.2-1 for the contiguous United States and Table 7.2-1 for Alaska. Site-specific case studies shall be made to determine ground snow loads in areas designated CS in Fig. 7.2-1 (see also Tables 7.2-2 through 7.2-8). Ground snow loads for sites at elevations above the limits indicated in Fig. 7.2-1 and for all sites within the CS areas shall be approved by the Authority Having Jurisdiction. Ground snow load determination for such sites shall be based on an extreme value statistical analysis of data available in the vicinity of the site using a value with a 2% annual probability of being exceeded (50-year mean recurrence interval).

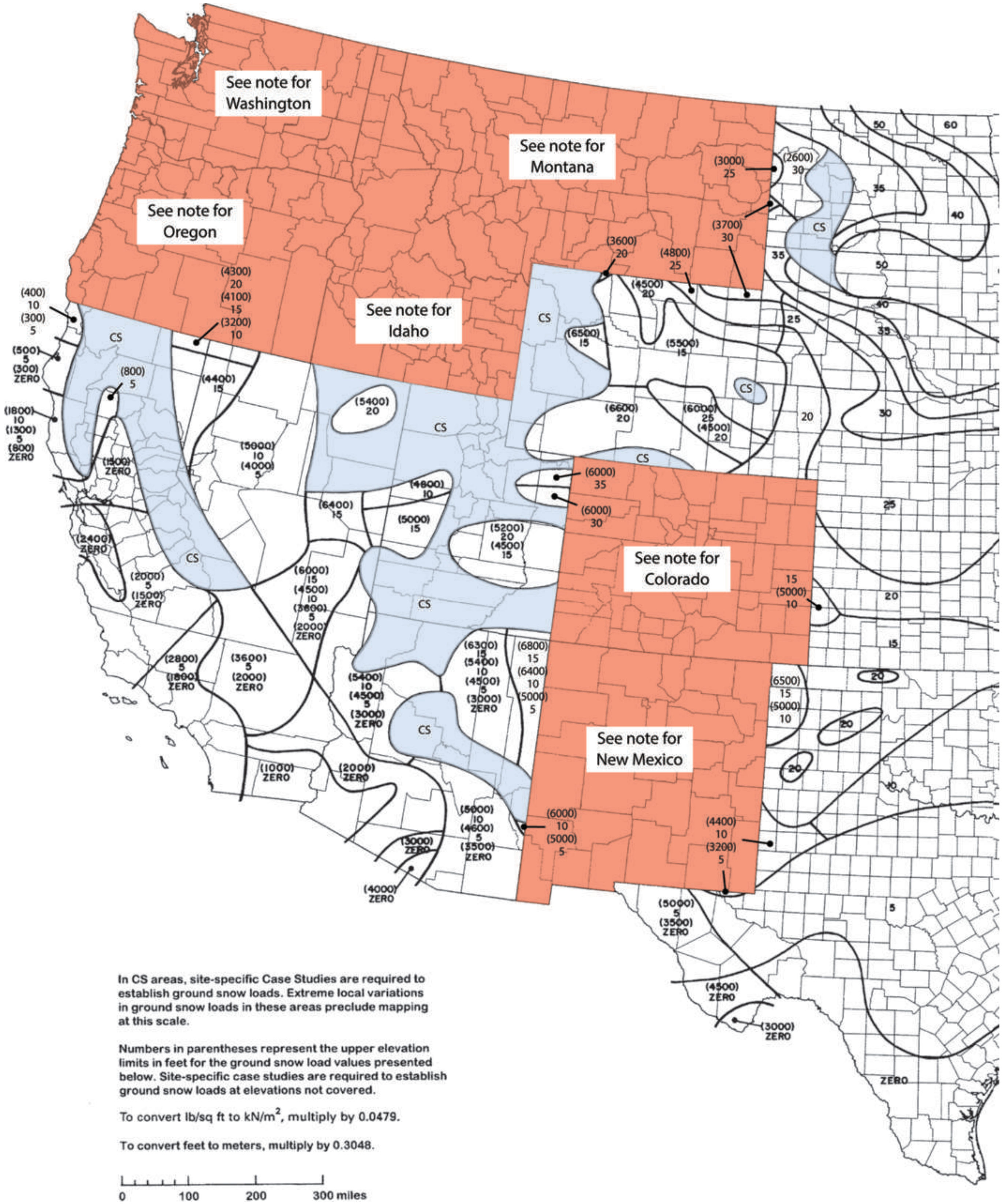
Snow loads are zero for Hawaii, except in mountainous regions as determined by the Authority Having Jurisdiction.

The importance factor times the ground snow load, $I_s p_g$, shall be used as the balanced snow load for snow accumulation surfaces, such as decks, balconies, and other near-ground level surfaces or roofs of subterranean spaces, whose height above the ground surface is less than the depth of the ground snow, h_g ($h_g = p_g/\gamma$).

7.3 FLAT ROOF SNOW LOADS, p_f

The flat roof snow load, p_f, shall be calculated in lb/ft^2 (kN/m^2) using the following formula:

$$p_f = 0.7 C_e C_t I_s p_g \qquad (7.3\text{-}1)$$



Note: See Table 7.2-2 for Colorado; see Table 7.2-3 for Idaho; see Table 7.2-4 for Montana; see Table 7.2-5 for Washington; see Table 7.2-6 for New Mexico; see Table 7.2-7 for Oregon; see Table 7.2-8 for New Hampshire.

FIGURE 7.2-1 Ground Snow Loads, p_g, for the United States (lb/ft^2)

7.3.1 Exposure Factor, C_e. The value for C_e shall be determined from Table 7.3-1.

7.3.2 Thermal Factor, C_t. The value for C_t shall be determined from Table 7.3-2.

7.3.3 Importance Factor, I_s. The value for I_s shall be determined from Table 1.5-2 based on the Risk Category from Table 1.5-1.

7.3.4 Minimum Snow Load for Low-Slope Roofs, p_m. A minimum roof snow load, p_m, shall only apply to monoslope,

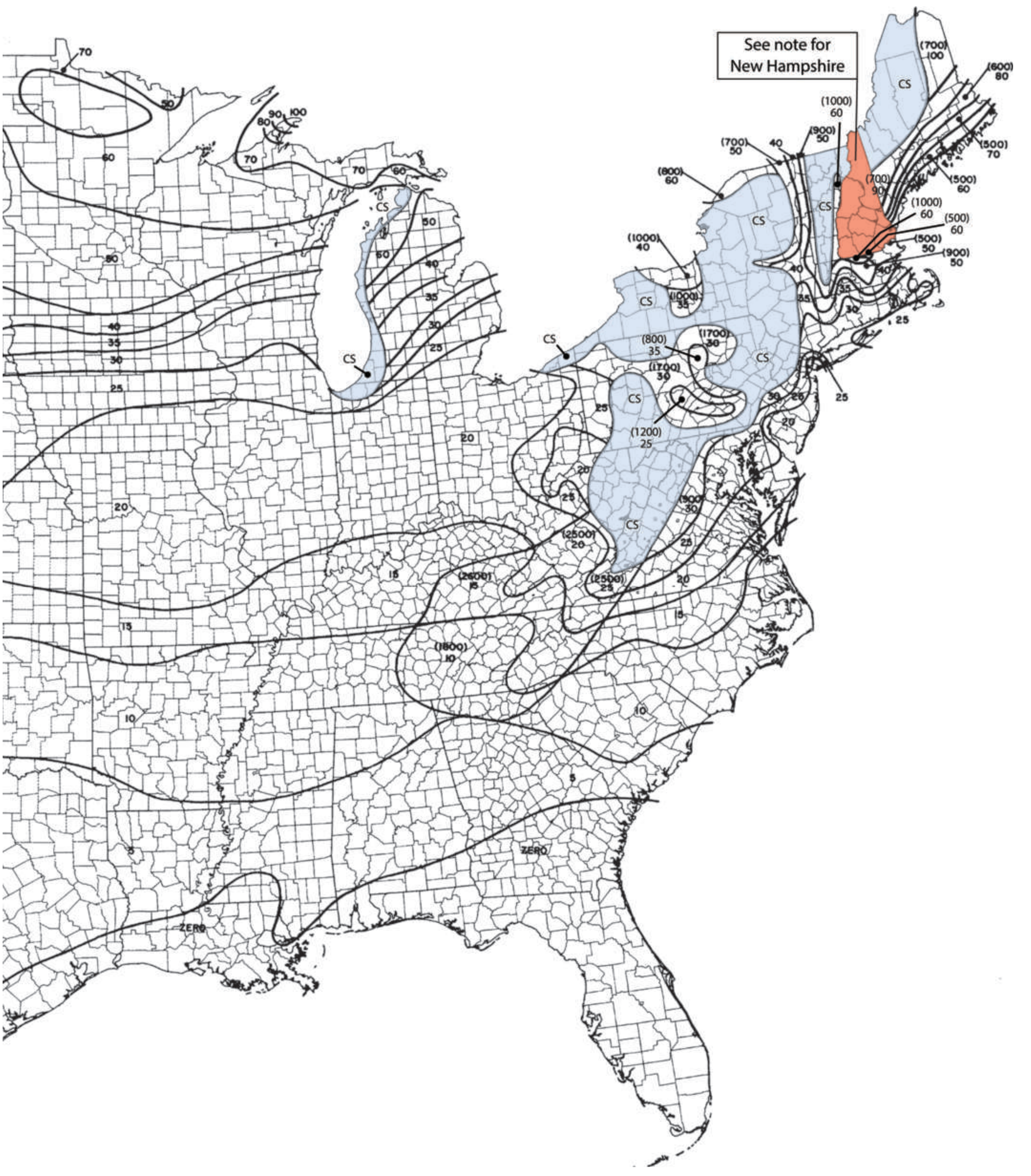


FIGURE 7.2-1 (*Continued*)

hip, and gable roofs with slopes less than 15° and to curved roofs where the vertical angle from the eaves to the crown is less than 10°. The minimum roof snow load for low-slope roofs shall be obtained using the following formula:

Where p_g is 20 lb/ft^2 (0.96 kN/m^2) or less:

$$p_m = I_s p_g \quad (\text{Importance Factor times } p_g)$$

Where p_g exceeds 20 lb/ft^2 (0.96 kN/m^2):

$$p_m = 20(I_s) \quad (20\ \text{lb/ft}^2 \text{ times Importance Factor})$$

$$p_m = 0.96(I_s)\,(0.96\ \text{kN/m}^2 \text{ times Importance Factor})$$

This minimum roof snow load is a separate uniform load case. It need not be used in determining or in combination with drift, sliding, unbalanced, or partial loads.

Table 7.2-1 Ground Snow Loads, p_g, for Alaskan Locations

Location	p_g lb/ft²	p_g kN/m²	Location	p_g lb/ft²	p_g kN/m²	Location	p_g lb/ft²	p_g kN/m²
Adak	30	1.4	Galena	60	2.9	Petersburg	150	7.2
Anchorage	50	2.4	Gulkana	70	3.4	St. Paul	40	1.9
Angoon	70	3.4	Homer	40	1.9	Seward	50	2.4
Barrow	25	1.2	Juneau	60	2.9	Shemya	25	1.2
Barter	35	1.7	Kenai	70	3.4	Sitka	50	2.4
Bethel	40	1.9	Kodiak	30	1.4	Talkeetna	120	5.8
Big Delta	50	2.4	Kotzebue	60	2.9	Unalakleet	50	2.4
Cold Bay	25	1.2	McGrath	70	3.4	Valdez	160	7.7
Cordova	100	4.8	Nenana	80	3.8	Whittier	300	14.4
Fairbanks	60	2.9	Nome	70	3.4	Wrangell	60	2.9
Fort Yukon	60	2.9	Palmer	50	2.4	Yakutat	150	7.2

7.4 SLOPED ROOF SNOW LOADS, p_s

Snow loads acting on a sloping surface shall be assumed to act on the horizontal projection of that surface. The sloped roof (balanced) snow load, p_s, shall be obtained by multiplying the flat roof snow load, p_f, by the roof slope factor, C_s:

$$p_s = C_s p_f \qquad (7.4\text{-}1)$$

Values of C_s for warm roofs, cold roofs, curved roofs, and multiple roofs are determined from Sections 7.4.1 through 7.4.4. The thermal factor, C_t, from Table 7.3-2 determines if a roof is "cold" or "warm." "Slippery surface" values shall be used only where the roof's surface is unobstructed and sufficient space is available below the eaves to accept all the sliding snow. A roof shall be considered unobstructed if no objects exist on it that prevent snow on it from sliding. Roof areas with snow retention devices shall not be considered unobstructed. Slippery surfaces shall include metal, slate, glass, and bituminous, rubber, and plastic membranes with a smooth surface. Membranes with an embedded aggregate or mineral granule surface shall not be considered smooth. Asphalt shingles, wood shingles, and shakes shall not be considered slippery.

7.4.1 Warm Roof Slope Factor, C_s. For warm roofs ($C_t \le 1.0$ as determined from Table 7.3-2) with an unobstructed slippery surface that allows snow to slide off the eaves, the roof slope factor C_s shall be determined using the dashed line in Fig. 7.4-1a, provided that for nonventilated warm roofs, their thermal resistance (R-value) equals or exceeds 30 ft² hr°F/Btu (5.3°C m²/W) and for warm ventilated roofs, their R-value equals or exceeds 20 ft² hr°F/Btu (3.5°C m²/W). Exterior air shall be able to circulate freely under a ventilated roof from its eaves to its ridge. For warm roofs that do not meet the aforementioned conditions, the solid line in Fig. 7.4-1a shall be used to determine the roof slope factor C_s.

7.4.2 Cold Roof Slope Factor, C_s. Cold roofs are those with a $C_t > 1.0$ as determined from Table 7.3-2. For cold roofs with $C_t = 1.1$ and an unobstructed slippery surface that allows snow to slide off the eaves, the roof slope factor C_s shall be determined using the dashed line in Fig. 7.4-1b. For all other cold roofs with $C_t = 1.1$, the solid line in Fig. 7.4-1b shall be used to determine the roof slope factor C_s. For cold roofs with $C_t = 1.2$ or larger and an unobstructed slippery surface that allows snow to slide off the eaves, the roof slope factor C_s shall be determined using the dashed line on Fig. 7.4-1c. For all other cold roofs with $C_t = 1.2$ or larger, the solid line in Fig. 7.4-1c shall be used to determine the roof slope factor C_s.

7.4.3 Roof Slope Factor for Curved Roofs. Portions of curved roofs that have a slope exceeding 70° shall be considered free of snow load (i.e., $C_s = 0$). Balanced loads shall be determined from the balanced load diagrams in Fig. 7.4-2 with C_s determined from the appropriate curve in Fig. 7.4-1.

7.4.4 Roof Slope Factor for Multiple Folded Plate, Sawtooth, and Barrel Vault Roofs. Multiple folded plate, sawtooth, or barrel vault roofs shall have a $C_s = 1.0$, with no reduction in snow load because of slope (i.e., $p_s = p_f$).

7.4.5 Ice Dams and Icicles along Eaves. Two types of warm roofs that drain water over their eaves shall be capable of sustaining a uniformly distributed load of $2p_f$ on all overhanging portions: those that are unventilated and have an R-value less than 30 ft² hr°F/Btu (5.3°C m²/W) and those that are ventilated and have an R-value less than 20 ft² hr°F/Btu (3.5°C m²/W). The load on the overhang shall be based upon the flat roof snow load for the heated portion of the roof upslope of the exterior wall. No other loads except dead loads shall be present on the roof when this uniformly distributed load is applied.

7.4.6 Sloped Roof Snow Loads for Air-Supported Structures. Roof snow loading for air-supported structures with vinyl coated exterior fabric shall be as shown in Fig. 7.4-3.

7.5 PARTIAL LOADING

The effect of having selected spans loaded with the balanced snow load and remaining spans loaded with half the balanced snow load shall be investigated as follows:

7.5.1 Continuous Beam Systems. Continuous beam systems shall be investigated for the effects of the three loadings shown in Fig. 7.5-1:

Case 1: Full balanced snow load on either exterior span and half the balanced snow load on all other spans.
Case 2: Half the balanced snow load on either exterior span and full balanced snow load on all other spans.
Case 3: All possible combinations of full balanced snow load on any two adjacent spans and half the balanced snow load on all other spans. For this case, there will be (n–1) possible combinations where n equals the number of spans in the continuous beam system.

If a cantilever is present in any of the above cases, it shall be considered to be a span.

Table 7.2-2 Ground Snow Loads for Selected Locations in Colorado

City/Town	County	Ground Snow Load (lb/ft^2)	Elevation (ft)
East of I-25 and under 4,500 ft		30	<4,500
Alamosa	Alamosa	25	7,540
Aspen	Pitkin	75	7,890
Aurora	Arapahoe	40	5,400
Beaver Creek	Eagle	75	8,080
Boulder	Boulder	40	5,330
Breckenridge	Summit	80	9,600
Brighton	Adams	35	4,980
Buena Vista	Chaffee	35	7,960
Cañon City	Fremont	35	5,350
Castle Rock	Douglas	45	6,220
Central City	Gilpin	85	8,510
Colorado Springs	El Paso	45	6,010
Copper Mountain	Summit	80	9,700
Cortez	Montezuma	30	6,190
Craig	Moffat	30	6,200
Creede	Mineral	65	8,800
Cripple Creek	Teller	70	9,490
Delta	Delta	25	4,960
Denver	Denver	35	5,280
Durango	La Plata	55	6,530
Eagle	Eagle	45	6,600
Estes Park	Larimer	65	7,250
Fairplay	Park	55	9,950
Fort Collins	Larimer	35	5,000
Georgetown	Clear Creek	60	8,520
Glenwood Springs	Garfield	40	5,760
Golden	Jefferson	40	5,670
Granby	Grand	55	7,980
Grand Junction	Mesa	25	4,590
Greeley	Weld	30	4,680
Gunnison	Gunnison	45	7,700
Keystone	Summit	70	9,170
Leadville	Lake	75	10,160
Longmont	Boulder	35	4,980
Meeker	Rio Blanco	40	6,240
Montrose	Montrose	25	5,810
Mount Crested Butte	Gunnison	155	9,900
Pagosa Springs	Archuleta	75	7,130
Paonia	Delta	35	5,680
Pueblo	Pueblo	30	4,690
Rifle	Garfield	40	5,350
Salida	Chaffee	45	7,080
Snowmass Village	Pitkin	90	8,210
Steamboat Springs	Routt	85	6,730
Telluride	San Miguel	75	8,790
Trinidad	Las Animas	45	6,030
Vail	Eagle	90	8,190
Vail Mountain	Eagle	175	10,300
Winter Park	Grand	100	9,050

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in Colorado, see *Colorado Design Snow Loads 2016*, Structural Engineers Association of Colorado, http://seacolorado.org, for ground snow loads.

Table 7.2-3 Ground Snow Loads for Selected Locations in Idaho

City/Town	County	Ground Snow Load (lb/ft^2)	Elevation (ft)
American Falls	Power	24	4,406
Ammon	Bonneville	24	4,718
Blackfoot	Bingham	28	4,498
Bogus Basin Lodge	Ada	137	6,176
Boise	Ada	15	2,681
Brundage Mtn. Lodge	Valley	207	6,038
Buhl	Twin Falls	28	3,769
Burley	Cassia	19	4,159
Caldwell	Canyon	18	2,376
Chubbuck	Bannock	31	4,467
Coeur d'Alene	Kootenai	43	2,189
Eagle	Ada	18	2,566
Emmett	Gem	15	2,363
Fruitland	Payette	18	2,226
Garden City	Ada	15	2,673
Gooding	Gooding	27	3,571
Grangeville	Idaho	18	3,400
Hailey	Blaine	82	5,323
Hayden	Kootenai	62	2,287
Heyburn	Minidoka	19	4,146
Homedale	Owyhee	16	2,231
Idaho Falls	Bonneville	23	4,725
Jerome	Jerome	12	3,764
Ketchum	Blaine	92	5,846
Kimberly	Twin Falls	14	3,924
Kuna	Ada	14	2,693
Lewiston	Nez Perce	10	994
McCall	Valley	157	5,012
Meridian	Ada	16	2,605
Middleton	Canyon	18	2,400
Montpelier	Bear Lake	45	5,986
Moscow	Latah	38	2,580
Mountain Home	Elmore	15	2,563
Nampa	Canyon	15	2,517
Orofino	Clearwater	19	1,017
Payette	Payette	17	2,148
Pocatello	Bannock	31	4,463
Post Falls	Kootenai	72	2,183
Preston	Franklin	79	4,715
Rathdrum	Kootenai	87	2,211
Rexburg	Madison	50	4,863
Rigby	Jefferson	32	4,851
Rupert	Minidoka	18	4,154
St. Anthony	Fremont	37	4,963
Salmon	Lemhi	15	3,943
Sandpoint	Bonner	56	2,101
Schweitzer Basin Lodge	Bonner	243	4,175
Shelley	Bingham	35	4,629
Silver Mt. Lodge	Shoshone	173	5,040
Soda Springs	Caribou	70	5,769
Star	Ada	16	2,471
Sun Valley Mt. Baldy	Blaine	197	9,000
Twin Falls	Twin Falls	15	3,734
Weiser	Washington	17	2,129
Wendell	Gooding	20	3,433

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in Idaho, see Al Hatailah, Godfrey, Nielsen and Sack (2015). "Ground Snow Loads for Idaho," Dept. of Civil Engineering, Univ. of Idaho, Moscow, ID, http://www.lib.uidaho.edu/digital/idahosnow/ for ground snow load values.

Table 7.2-4 Ground Snow Loads for Selected Locations in Montana

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Anaconda	Deer Lodge	47	5,676
Baker	Fallon	46	2,966
Belgrade	Gallatin	33	4,446
Big Mt. Resort	Flathead	94	4,464
Big Timber	Sweet Grass	37	4,200
Billings	Yellowstone	29	3,242
Boulder	Jefferson	74	4,948
Bozeman	Gallatin	40	4,823
Butte	Silver Bow	36	5,824
Chinook	Blaine	61	2,418
Choteau	Teton	19	3,799
Colstrip	Rosebud	18	3,232
Columbia Falls	Flathead	71	3,015
Columbus	Stillwater	41	3,599
Conrad	Pondera	16	3,520
Cut Bank	Glacier	17	3,793
Deer Lodge	Powell	27	4,593
Dillon	Beaverhead	23	5,125
East Helena	Lewis and Clark	28	3,904
Forsyth	Rosebud	20	2,510
Fort Benton	Chouteau	29	2,713
Glasgow	Valley	24	2,146
Glendive	Dawson	16	2,067
Great Falls	Cascade	32	3,399
Hamilton	Ravalli	43	3,619
Hardin	Big Horn	15	2,904
Havre	Hill	49	2,500
Helena	Lewis and Clark	27	4,013
Kalispell	Flathead	56	2,992
Laurel	Yellowstone	36	3,356
Lewis Hgts.	Fergus	50	3,914
Libby	Lincoln	76	2,198
Livingston	Park	33	4,544
Malta	Phillips	30	2,284
Manhattan	Gallatin	21	4,242
Miles City	Custer	25	2,362
Missoula	Missoula	34	3,245
Plentywood	Sheridan	73	2,080
Polson	Lake	63	2,999
Red Lodge	Carbon	109	5,610
Ronan	Lake	50	3,077
Roundup	Musselshell	21	3,209
Shelby	Toole	28	3,301
Sidney	Richland	27	1,969
Stevensville	Ravalli	48	3,399
Thompson Falls	Sanders	51	2,507
Three Forks	Gallatin	22	4,085
Townsend	Broadwater	11	3,868
W. Yellowstone	Gallatin	122	6,713
Whitefish	Flathead	67	2,999
Wolf Point	Roosevelt	24	2,057

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in Montana, see Theisen, G. P., M. J. Keller, J. E. Stephens, F. F. Videon, and J. P. Schilke. (2004). "Snow Loads for Structural Design in Montana," Dept. of Civil Engineering, Bozeman, MT, http://www.coe.montana.edu/snowload/ for ground snow load values.

Table 7.2-5 Ground Snow Loads for Selected Locations in Washington

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Arlington	Snohomish	17	120
Auburn	King	20	85
Bainbridge Island	Kitsap	15	100
Bellevue	King	20	100
Bellingham	Watcom	15	100
Bonney Lake	Pierce	18	40
Bothell	King	20	90
Bremerton	Kitsap	15	100
Burien	King	16	325
Covington	King	20	85
Crystal Mt.	Pierce	438	4,380
Des Moines	King	18	370
Edmonds	Snohomish	20	350
Ellensburg	Kittitas	34	1,540
Everett	Snohomish	15	110
Federal Way	King	20	85
Issaquah	King	20	100
Kenmore	King	20	90
Kennewick	Benton	15	400
Kent	King	20	50
Kirkland	King	20	180
Lacey	Thurston	15	200
Lake Stevens	Snohomish	15	250
Lakewood	Pierce	15	235
Longview	Cowlitz	18	21
Lynnwood	Snohomish	22	435
Maple Valley	King	23	440
Marysville	Snohomish	16	20
Mercer Island	King	16	320
Mt. Baker	Whatcom	588	4,200
Mt. Spokane	Spokane	151	5,800
Mt. Vernon	Skagit	15	180
Oak Harbor	Island	17	120
Olympia	Thurston	15	130
Pasco	Franklin	15	383
Pullman	Whitman	30	2,400
Puyallup	Pierce	18	40
Redmond	King	20	120
Renton	King	20	15
Richland	Benton	15	359
Sammamish	King	28	520
SeaTac	King	22	440
Seattle	King	20	350
Shoreline	King	22	450
Snoqualmie Pass	Kittitas	433	3,000
Spokane	Spokane	39	2,000
Spokane Valley	Spokane	39	2,000
Stevens Pass	Chelan	400	4,060
Tacoma	Pierce	21	380
Tukwila	King	16	325
Univ. Place	Pierce	20	400
Vancouver	Clark	20	150
Walla Walla	Walla Walla	18	1,000
Wenatchee	Chelan	22	780
White Pass	Yakima	244	4,720
Yakima	Yakima	19	1,066

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in Washington, see Structural Engineers Association of Washington (1995). "Snow Load Analysis for Washington," Seattle, WA, www.seaw.org, for ground snow load values.

Table 7.2-6 Ground Snow Loads for Selected Locations in New Mexico

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Alamogordo	Otero	4	4,300
Albuquerque	Bernalillo	18	5,000
Artesia	Eddy	10	3,400
Aztec	San Juan	10	5,600
Bloomfield	San Juan	9	5,500
Carlsbad	Eddy	10	3,100
Clovis	Curry	10	4,300
Corrales	Sandoval	9	5,000
Deming	Luna	8	4,300
Espanola	Rio Arriba	10	5,600
Farmington	San Juan	10	5,300
Gallup	McKinley	13	6,500
Grants	Cibola	16	6,450
Hobbs	Lea	10	3,600
Jemez	Sandoval	18	6,200
Las Cruces	Dona Ana	9	3,900
Las Vegas	San Miguel	22	6,400
Los Alamos	Los Alamos	30	7,300
Los Lunas	Valencia	6	4,900
Portales	Roosevelt	9	4,000
Red Rock	Grant	4	6,800
Roswell	Chaves	14	3,600
Ruidoso	Lincoln	25	6,700
Santa Fe	Santa Fe	15	7,000
Shiprock	San Juan	9	4,900
Socorro	Socorro	13	4,600
Zuni	McKinley	14	6,300

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in New Mexico, see Maji, A. K. (1999). "Ground Snow Load Database for New Mexico," Dept. of Civil Engineering, University of New Mexico, Albuquerque, NM, http://www.seanm.org/files/snowload.pdf for ground snow load values.

Partial load provisions need not be applied to structural members that span perpendicular to the ridgeline in gable roofs with slopes between ½ on 12 (2.38°) and 7 on 12 (30.3°).

7.5.2 Other Structural Systems. Areas sustaining only half the balanced snow load shall be chosen so as to produce the greatest effects on members being analyzed.

7.6 UNBALANCED ROOF SNOW LOADS

Balanced and unbalanced loads shall be analyzed separately. Winds from all directions shall be accounted for when establishing unbalanced loads.

7.6.1 Unbalanced Snow Loads for Hip and Gable Roofs. For hip and gable roofs with a slope exceeding 7 on 12 (30.2°) or with a slope less than ½ on 12 (2.38°), unbalanced snow loads are not required to be applied. Roofs with an eave to ridge distance, W, of 20 ft (6.1 m) or less that have simply supported prismatic members spanning from ridge to eave shall be designed to resist an unbalanced uniform snow load on the leeward side equal to Ip_g. For these roofs, the windward side shall be unloaded. For all other gable roofs, the unbalanced load shall consist of $0.3p_s$ on the

Table 7.2-7 Ground Snow Loads for Selected Locations in Oregon

City/Town	County	Ground Snow Load (lb/ft²)	Elevation (ft)
Antelope	Wasco	17	2,840
Ashland	Jackson	13	1,990
Astoria	Clatsop	11	10
Baker City	Baker	17	3,450
Bandon	Coos	0	20
Bend	Deschutes	20	3,660
Black Butte	Deschutes	19	970
Bonneville Dam	Hood River	44	60
Brookings	Curry	1	50
Burns	Harney	20	4,140
Corvallis	Benton	14	230
Crater Lake	Klamath	461	6,470
Crescent Lake	Klamath	154	4,760
Dallas	Polk	20	290
Detroit	Marion	78	1,730
Diamond Lake	Klamath	10	4,160
Enterprise	Wallowa	26	3,280
Eugene	Lane	12	360
Forest Grove	Washington	17	180
Fossil	Wheeler	21	2,650
Government Camp	Clackamas	321	3,980
Grants Pass	Josephine	6	920
Heppner	Morrow	17	1,880
Hood River	Hood River	43	500
John Day	Baker	8	500
Joseph	Wallowa	16	4,020
Klamath Falls	Klamath	23	4,100
La Grande	Union	15	2,750
Lakeview	Lake	47	4,780
Madras	Jefferson	17	2,440
Medford	Jackson	4	1,460
Mitchell	Wheeler	46	3,980
Newport	Lincoln	2	140
North Bend	Coos	2	10
Ontario	Malheur	15	2,140
Parkdale	Hood River	79	1,720
Pendleton	Umatilla	30	1,040
Portland	Multnomah	11	30
Prineville	Crook	15	2,840
Redmond	Deschutes	16	3,060
Roseburg	Douglas	7	420
Salem	Marion	9	200
Santiam Pass	Linn	481	4,750
Seaside	Clatsop	3	10
Sisters	Deschutes	30	3,180
The Dalles	Wasco	24	100
Troutdale	Multnomah	12	30
Vale	Malheur	17	2,240
Vernonia	Columbia	35	840
Zig Zag	Clackamas	70	1,440

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. For locations where there is substantial change in altitude over the jurisdiction, the load applies at and below the cited elevation, with a tolerance of 100 ft (30 m).
3. For other locations in Oregon, see "Snow Load Analysis for Oregon," 4th Ed., November 2013, Structural Engineers Association of Oregon and the PRISM Climate Group of Oregon State University, http://snowload.seao.org/lookup.html, for ground snow load values.

Table 7.2-8 Ground Snow Loads for Selected Locations in New Hampshire

Town	County	Ground Snow Load (lb/ft²)	Elevation (ft.)	Town	County	Ground Snow Load (lb/ft²)	Elevation (ft.)
Amherst	Hillsborough	70	600	Keene	Cheshire	70	900
Atkinson	Rockingham	55	400	Laconia	Belknap	80	900
Barrington	Strafford	70	500	Lebanon	Grafton	80	1,200
Bedford	Hillsborough	70	700	Litchfield	Hillsborough	60	250
Belmont	Belknap	80	900	Londonderry	Rockingham	65	500
Berlin	Coos	100	1,600	Manchester	Hillsborough	70	500
Bow	Merrimack	75	800	Merrimack	Hillsborough	60	400
Claremont	Sullivan	85	1,100	Milford	Hillsborough	70	600
Concord	Merrimack	70	600	Nashua	Hillsborough	60	400
Conway	Carroll	95	900	Newmarket	Rockingham	50	200
Derry	Rockingham	65	600	Newport	Sullivan	85	1,200
Dover	Strafford	60	200	Pelham	Hillsborough	55	400
Durham	Strafford	55	150	Pembroke	Merrimack	70	700
Epping	Rockingham	55	300	Plaistow	Rockingham	55	300
Exeter	Rockingham	50	200	Plymouth	Grafton	75	900
Farmington	Strafford	85	800	Portsmouth	Rockingham	50	100
Franklin	Merrimack	75	700	Raymond	Rockingham	60	500
Gilford	Belknap	90	1,200	Rochester	Strafford	70	500
Goffstown	Hillsborough	75	800	Salem	Rockingham	55	300
Hampstead	Rockingham	55	300	Seabrook	Rockingham	50	100
Hampton	Rockingham	50	150	Somersworth	Strafford	60	250
Hanover	Grafton	75	1,300	Stratham	Rockingham	50	150
Hollis	Hillsborough	60	500	Swanzey	Cheshire	65	800
Hooksett	Merrimack	70	600	Weare	Hillsborough	80	900
Hudson	Hillsborough	60	400	Windham	Rockingham	60	400

Note: To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

1. Statutory requirements of the Authority Having Jurisdiction are not included in this state ground snow load table.
2. These loads only apply at the elevation listed. For lower elevations, the ground snow load shall be decreased by 2.1 lb/ft² for every 100 ft of elevation difference (0.32 kN/m² for every 100 m of elevation difference). For higher elevation up to an elevation of 2,500 ft, the ground snow load shall be increased at the same rate. Ground snow loads calculated for a site-specific elevation different than that listed in the table should be rounded to the nearest 5 lb/ft² (0.25 kN/m²)
3. For other locations in New Hampshire, see Tobiasson, W., Buska, J., Greatorex, A., Tirey, J., Fisher, J., and Johnson, S., (2002). "Ground snow loads for New Hampshire." U.S. Army Corps of Engineers, Engineering Research and Development Center (ERDC), Cold Regions Research and Engineering Laboratory (CRREL) Technical Report ERDL/CRREL TR-02-6. Hanover, NH, http://www.senh.org/public-links or http://www.erdc.usace.army.mil/Locations/ColdRegionsResearchandEngineeringLaboratory/Publications.aspx, for ground snow load values.

windward side, p_s on the leeward side plus a rectangular surcharge with magnitude $h_d\gamma/\sqrt{S}$ and horizontal extent from the ridge $8h_d\sqrt{S}/3$ where h_d is the drift height from Fig. 7.6-1 with l_u equal to the eave to ridge distance for the windward portion of the roof, W. For W less than 20 ft (6.1 m), use $W = l_u = 20$ ft (6.1 m) in Fig. 7.6-1. Balanced and unbalanced loading diagrams are presented in Fig. 7.6-2.

Table 7.3-1 Exposure Factor, C_e

Surface Roughness Category	Exposure of Roof[a]: Fully Exposed	Partially Exposed	Sheltered
B (see Section 26.7)	0.9	1.0	1.2
C (see Section 26.7)	0.9	1.0	1.1
D (see Section 26.7)	0.8	0.9	1.0
Above the tree line in windswept mountainous areas	0.7	0.8	NA
In Alaska, in areas where trees do not exist within a 2-mi (3-km) radius of the site	0.7	0.8	NA

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 Exposure Category in Section 26.7 are heights above the ground.

Table 7.3-2 Thermal Factor, C_t

Thermal Condition[a]	C_t
All structures except as indicated below	1.0
Structures kept just above freezing and others with cold, ventilated roofs in which the thermal resistance (R-value) between the ventilated space and the heated space exceeds $25°F \times h \times ft^2/Btu$ ($4.4\ K \times m^2/W$)	1.1
Unheated and open air structures	1.2
Freezer building	1.3
Continuously heated greenhouses[b] with a roof having a thermal resistance (R-value) less than $2.0°F \times h \times ft^2/Btu$ ($0.4\ K \times m^2/W$)	0.85

[a]These conditions shall be representative of the anticipated conditions during winters for the life of the structure.

[b]Greenhouses with a constantly maintained interior temperature of 50°F (10°C) or more at any point 3 ft (0.9 m) above the floor level during winters and having either a maintenance attendant on duty at all times or a temperature alarm system to provide warning in the event of a heating failure.

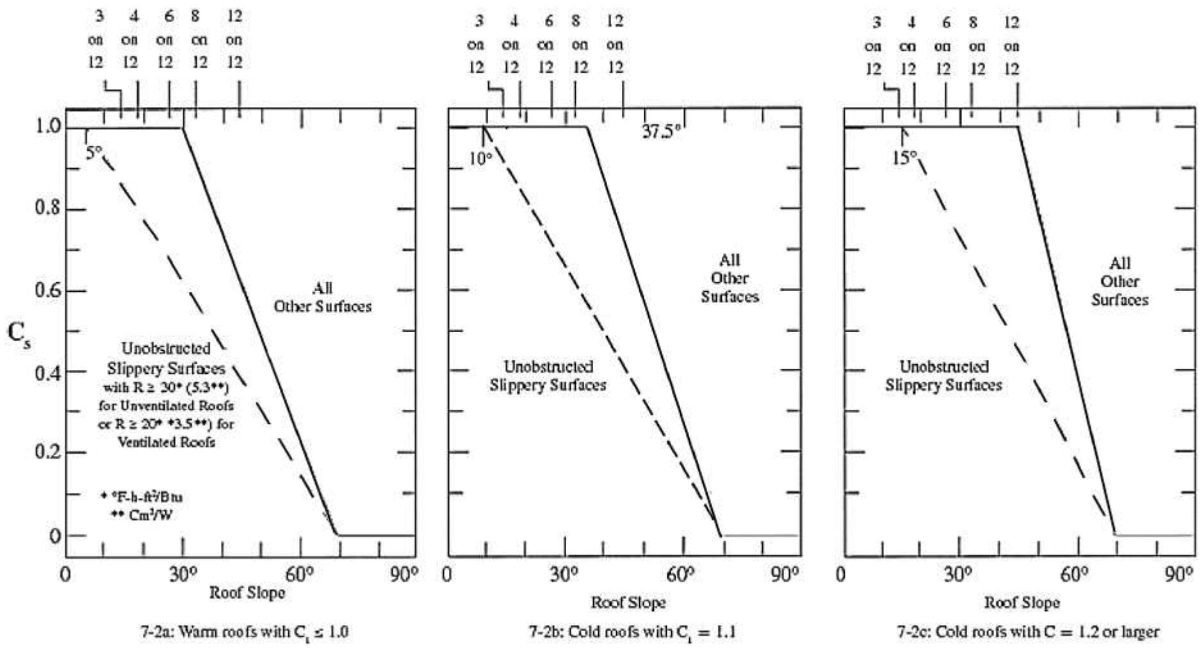


FIGURE 7.4-1 Graphs for Determining Roof Slope Factor, C_s, for Warm and Cold Roofs (See Table 7.3-2 for C_t Definitions)

7.6.2 Unbalanced Snow Loads for Curved Roofs. Portions of curved roofs that have a slope exceeding 70° shall be considered free of snow load. If the slope of a straight line from the eaves (or the 70° point, if present) to the crown is less than 10° or greater than 60°, unbalanced snow loads shall not be taken into account.

Unbalanced loads shall be determined according to the loading diagrams in Fig. 7.4-2. In all cases, the windward side shall be considered free of snow. If the ground or another roof abuts a Case II or Case III (see Fig. 7.4-2) curved roof at or within 3 ft (0.9 m) of its eaves, the snow load shall not be decreased between the 30° point and the eaves but shall remain constant at the 30° point value. This distribution is shown as a dashed line in Fig. 7.4-2.

7.6.3 Unbalanced Snow Loads for Multiple Folded Plate, Sawtooth, and Barrel Vault Roofs. Unbalanced loads shall be applied to folded plate, sawtooth, and barrel-vaulted multiple roofs with a slope exceeding 3/8 in. on 12 (1.79°). According to Section 7.4.4, $C_s = 1.0$ for such roofs, and the balanced snow load equals p_f. The unbalanced snow load shall increase from one-half the balanced load at the ridge or crown (i.e., $0.5p_f$) to two times the balanced load given in Section 7.4.4 divided by C_e at the valley (i.e., $2p_f/C_e$). Balanced and unbalanced loading diagrams for a sawtooth roof are presented in Fig. 7.6-3. However, the snow surface above the valley shall not be at an elevation higher than the snow above the ridge. Snow depths shall be determined by dividing the snow load by the density of that snow from Eq. (7.7-1), which is in Section 7.7.1.

7.6.4 Unbalanced Snow Loads for Dome Roofs. Unbalanced snow loads shall be applied to domes and similar rounded structures. Snow loads, determined in the same manner as for curved roofs in Section 7.6.2, shall be applied to the downwind 90° sector in plan view. At both edges of this sector, the load shall decrease linearly to zero over sectors of 22.5° each. There shall be no snow load on the remaining 225° upwind sector.

7.7 DRIFTS ON LOWER ROOFS (AERODYNAMIC SHADE)

Roofs shall be designed to sustain localized loads from snowdrifts that form in the wind shadow of (1) higher portions of the same structure and (2) adjacent structures and terrain features.

7.7.1 Lower Roof of a Structure. Snow that forms drifts comes from a higher roof or, with the wind from the opposite direction, from the roof on which the drift is located. These two kinds of drifts ("leeward" and "windward," respectively) are shown in Fig. 7.7-1. The geometry of the surcharge load due to snow drifting shall be approximated by a triangle, as shown in Fig. 7.7-2. Drift loads shall be superimposed on the balanced snow load. If h_c/h_b is less than 0.2, drift loads are not required to be applied.

For leeward drifts, the drift height h_d shall be determined directly from Fig. 7.6-1 using the length of the upper roof and the Snow Importance Factor from Table 1.5-2. However, the drift height need not be taken as larger than 60% of the length of the lower level roof. For windward drifts, the drift height shall be determined by substituting the length of the lower roof for l_u in Fig. 7.6-1 and using three-quarters of h_d as determined from Fig. 7.6-1 as the drift height. The larger of these two heights shall be used in design. If this height is equal to or less than h_c, the drift width, w, shall equal $4h_d$ and the drift height shall equal h_d. If this height exceeds h_c, the drift width, w, shall equal $4h_d^2/h_c$ and the drift height shall equal h_c. However, the drift width, w, shall not be greater than $8h_c$. If the drift width, w, exceeds the width of the lower roof, the drift shall taper linearly to zero at the far end of the lower level roof. The maximum intensity of the drift surcharge load, p_d, equals $h_d\gamma$ where snow density, γ, is defined in Eq. (7.7-1):

$$\gamma = 0.13p_g + 14 \text{ but not more than } 30 \text{ lb/ft}^3 \qquad (7.7\text{-}1)$$

$$\gamma = 0.426p_g + 2.2, \text{ but not more than } 4.7 \text{ kN/m}^3 \qquad (7.7\text{-}1.\text{si})$$

This density shall also be used to determine h_b by dividing p_s by γ (in SI: also multiply by 102 to get the depth in m).

7.7.2 Adjacent Structures. If the horizontal separation distance between adjacent structures, s, is less than 20 ft (6.1 m) and less than six times the vertical separation distance ($s < 6h$),

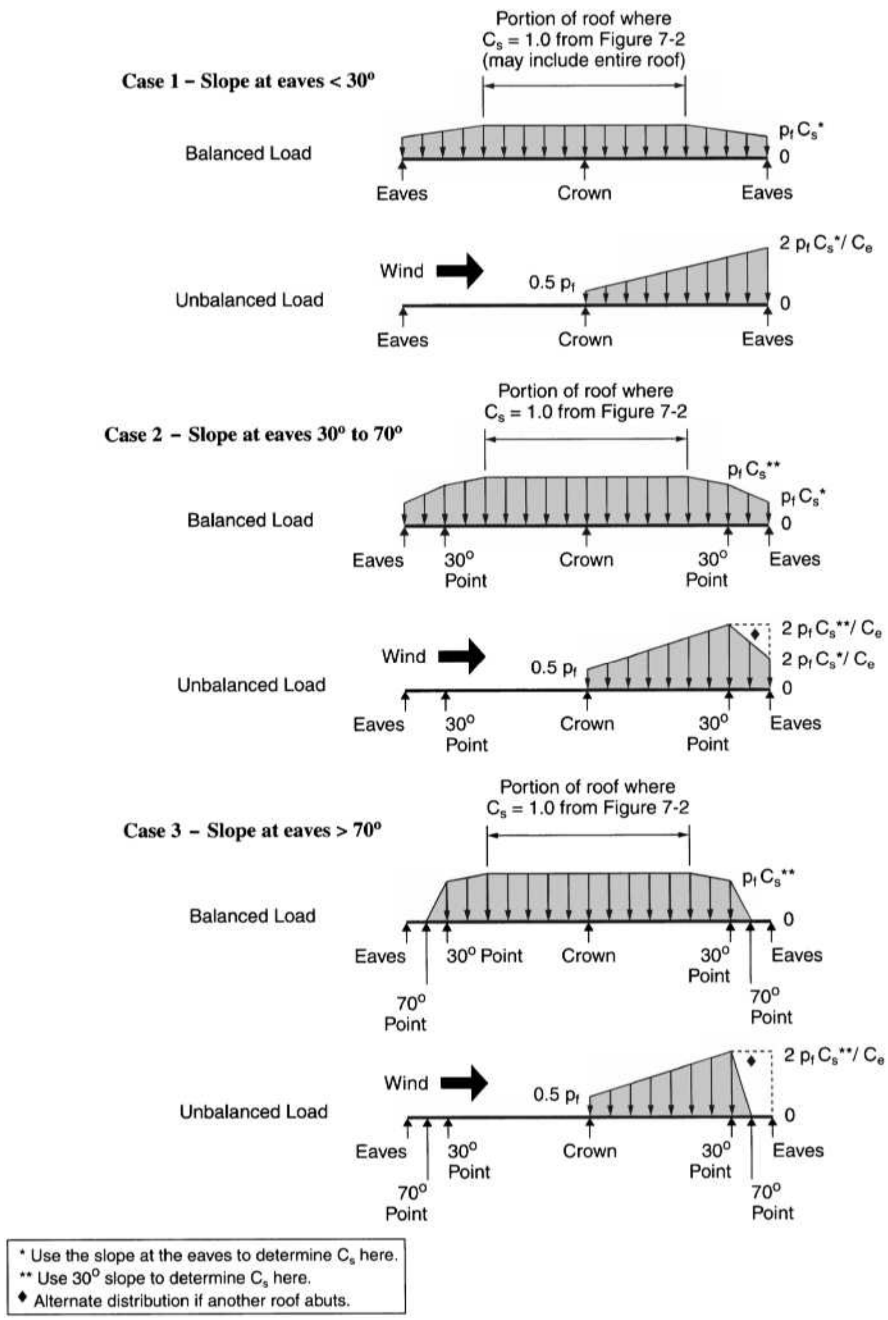


FIGURE 7.4-2 Balanced and Unbalanced Loads for Curved Roofs

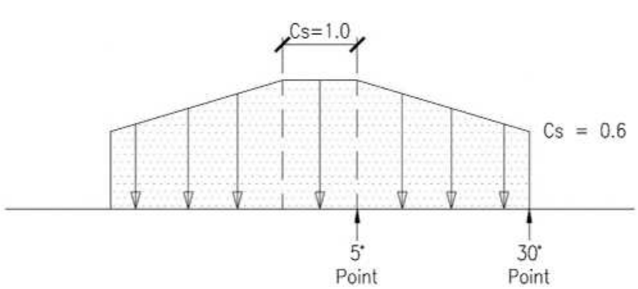
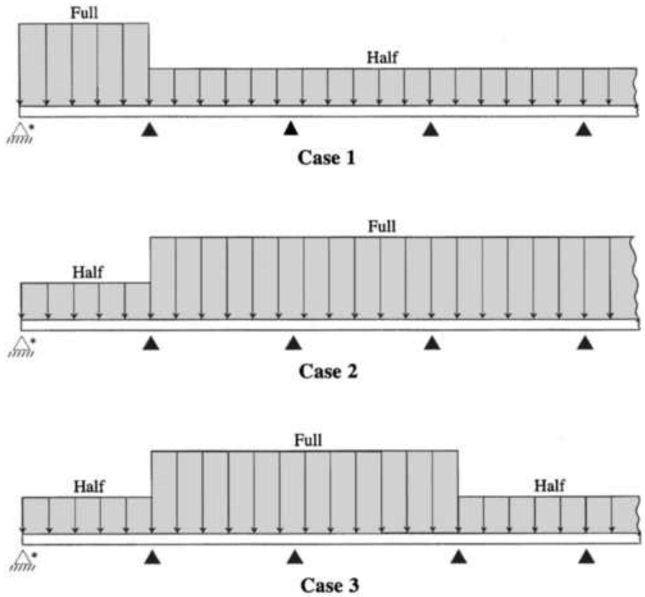


FIGURE 7.4-3 Sloped Roof Snow Load for Air-Supported Structures

then the requirements for the leeward drift of Section 7.7.1 shall be used to determine the drift load on the lower structure. The height of the snow drift shall be the smaller of h_d, based upon the length of the adjacent higher structure, and $(6h - s)/6$. The horizontal extent of the drift shall be the smaller of $6h_d$ or $(6h - s)$.

For windward drifts, the requirements of Section 7.7.1 shall be used. The resulting drift is permitted to be truncated.

7.7.3 Intersecting Drifts at Low Roofs. At reentrant corners and parapet wall corners, the provisions in Section 7.7.1 shall be used to determine the individual snow drift geometry. Where the two snowdrifts intersect, the larger snowdrift shall govern, as



* The left supports are dashed since they would not exist when a cantilever is present.

FIGURE 7.5-1 Partial Loading Diagrams for Continuous Beams

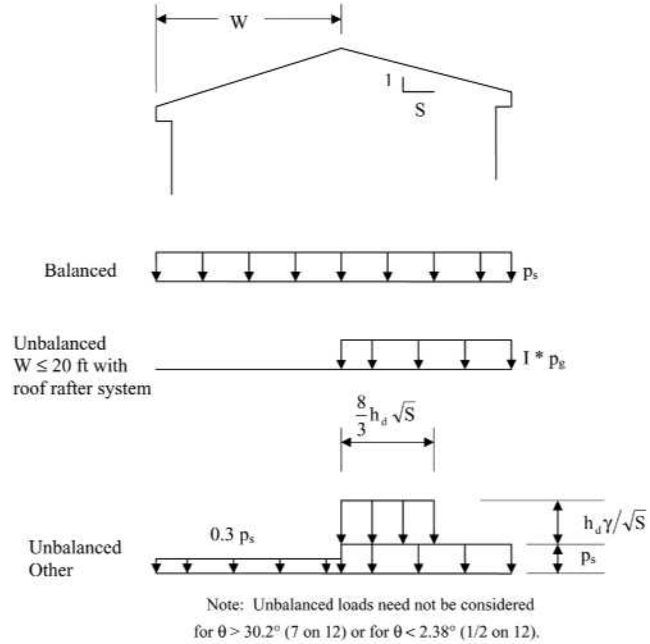
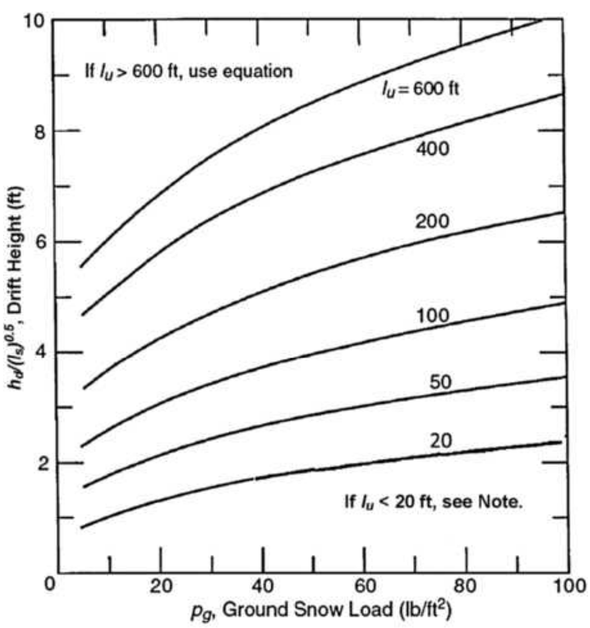


FIGURE 7.6-2 Balanced and Unbalanced Snow Loads for Hip and Gable Roofs



$$\frac{h_d}{\sqrt{I_s}} = \left(0.43\sqrt[3]{l_u}\,\sqrt[4]{p_g + 10}\right) - 1.5$$

Notes: If $l_u < 20$ ft, use $l_u = 20$ ft, except h_d for this small fetch case need not be taken greater than $\sqrt{(I_s p_g l_u/4\gamma)}$ where l_u is the actual fetch distance, not the minimum fetch of 20 ft.

To convert lb/ft^2 to kN/m^2, multiply by 0.0479. To convert feet to meters, multiply by 0.3048.

FIGURE 7.6-1 Graph and Equation for Determining Drift Height, h_d

shown in Fig. 7.7-3. Intersecting snowdrift loads shall be considered to occur concurrently, except that the two drift loads need not be superimposed.

For leeward intersecting snowdrifts at reentrant corners, the length of the upper roof applicable for each snowdrift shall be used with l_u parallel to w_1 for the first drift and l_u parallel to w_2 for the second drift. For windward snowdrifts, the lengths of the lower roof shall be used for l_u.

7.8 ROOF PROJECTIONS AND PARAPETS

The method in Section 7.7.1 shall be used to calculate drift loads on all sides of roof projections and at parapet walls. The height of such drifts shall be taken as three-quarters the drift height from Fig. 7.6-1 (i.e., $0.75h_d$). For parapet walls, l_u shall be taken equal to the length of the roof upwind of the wall. For roof projections, l_u shall be taken equal to the greater of the length of the roof upwind or downwind of the projection.

EXCEPTION: Drift loads shall not be required where the side of the roof projection is less than 15 ft (4.6 m) or the clear distance between the height of the balanced snow load, h_b, and the bottom of the projection (including horizontal supports) is at least 2 ft (0.61 m).

7.9 SLIDING SNOW

The load caused by snow sliding off a sloped roof onto a lower roof shall be determined for slippery upper roofs with slopes greater than ¼ on 12, and for other (i.e., nonslippery) upper roofs with slopes greater than 2 on 12. The total sliding load per unit length of eave shall be $0.4p_f W$, where W is the horizontal distance from the eave to ridge for the sloped upper roof. The sliding load shall be distributed uniformly on the lower roof over a distance of 15 ft (4.6 m) from the upper roof eave. If the width of the lower roof is less than 15 ft (4.6 m), the sliding load shall be reduced proportionally.

The sliding snow load shall not be further reduced unless a portion of the snow on the upper roof is blocked from sliding onto the lower roof by snow already on the lower roof.

For separated structures, sliding loads shall be considered when $h/s > 1$ and $s < 15$ ft ($s < 4.6$ m). The horizontal extent

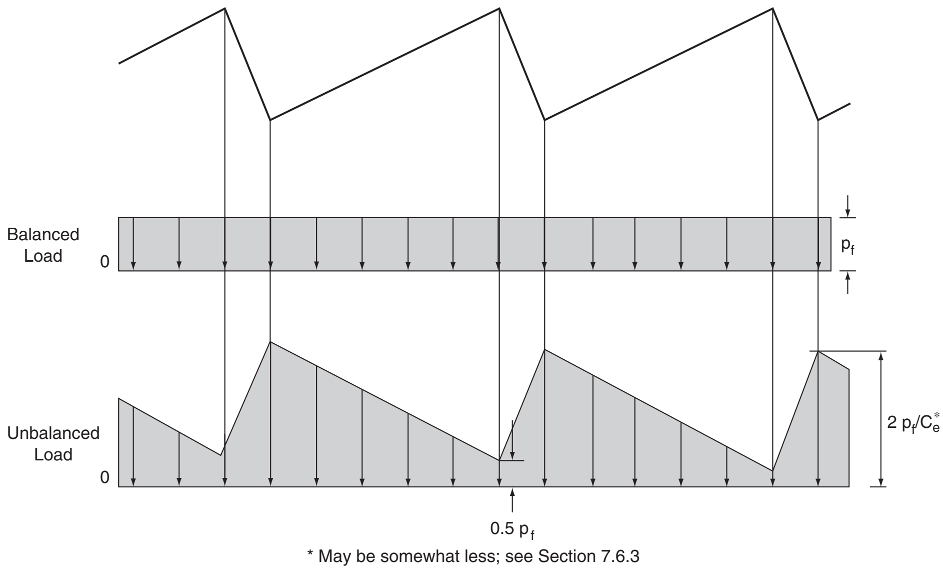


FIGURE 7.6-3 Balanced and Unbalanced Snow Loads for a Sawtooth Roof

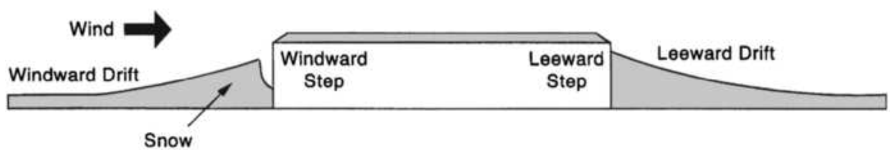


FIGURE 7.7-1 Drifts Formed at Windward and Leeward Steps

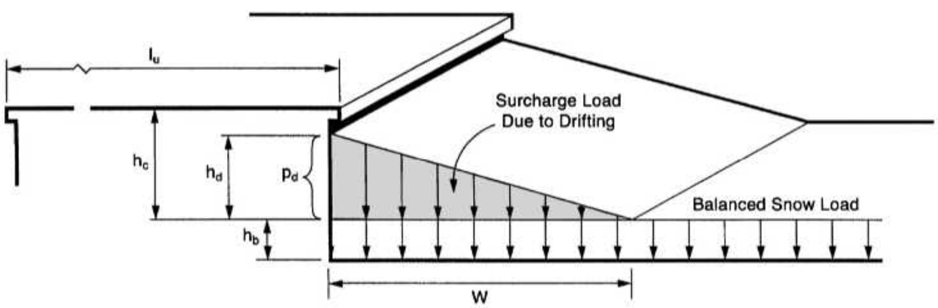


FIGURE 7.7-2 Configuration of Snowdrifts on Lower Roofs

of the sliding load on the lower roof shall be $15 - s$ with s in feet ($4.6 - s$ with s in meters), and the load per unit length shall be $0.4 p_f W(15 - s)/15$ with s in feet ($0.4 p_f W(4.6 - s)/4.6$ with s in meters).

Sliding loads shall be superimposed on the balanced snow load and need not be used in combination with drift, unbalanced, partial, or rain-on-snow loads.

7.10 RAIN-ON-SNOW SURCHARGE LOAD

For locations where p_g is 20 lb/ft^2 (0.96 kN/m^2) or less, but not zero, all roofs with slopes (in degrees) less than $W/50$ with W in ft (in SI: $W/15.2$ with W in m) shall include a 5 lb/ft^2 (0.24 kN/m^2) rain-on-snow surcharge load. This additional load applies only to the sloped roof (balanced) load case and need not be used in combination with drift, sliding, unbalanced, minimum, or partial loads.

7.11 PONDING INSTABILITY

Susceptible bays shall be designed to preclude ponding instability. Roof deflections caused by full snow loads shall be evaluated when determining the likelihood of ponding instability (see Section 8.4).

7.12 EXISTING ROOFS

Existing roofs shall be evaluated for increased snow loads caused by additions or alterations. Owners or agents for owners

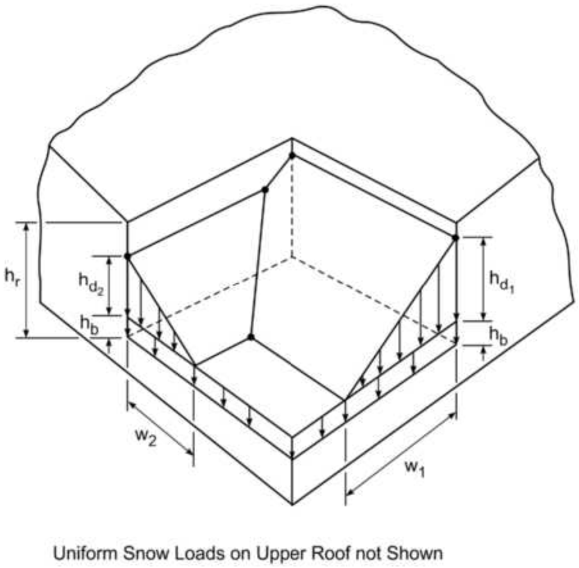


FIGURE 7.7-3 Configuration of Intersecting Snowdrifts at Lower Roof

of an existing lower roof shall be advised of the potential for increased snow loads where a higher roof is constructed within 20 ft (6.1 m). See footnote to Table 7.3-1 and Section 7.7.2.

7.13 SNOW ON OPEN-FRAME EQUIPMENT STRUCTURES

Open-frame equipment structures shall be designed for snow loads in accordance with Sections 7.13.1 through 7.13.4. The thermal factor, $C_t = 1.2$, shall be used in determination of snow loads for unheated open-frame equipment structures.

7.13.1 Snow at Top Level. Flat roof snow loads (p_f) and drift loads shall be applied at the top level of the structure where there is flooring or elements that can retain snow. Open frame members with a width of more than 8 in. (200 mm) shall be considered snow retaining surfaces. The top level shall be designed for snowdrifts in accordance with Sections 7.7 and 7.9 where there are wind walls or equivalent obstructions.

7.13.2 Snow at Levels below the Top Level. At all levels with flooring (grating, checkered plate, etc.) located below a level with

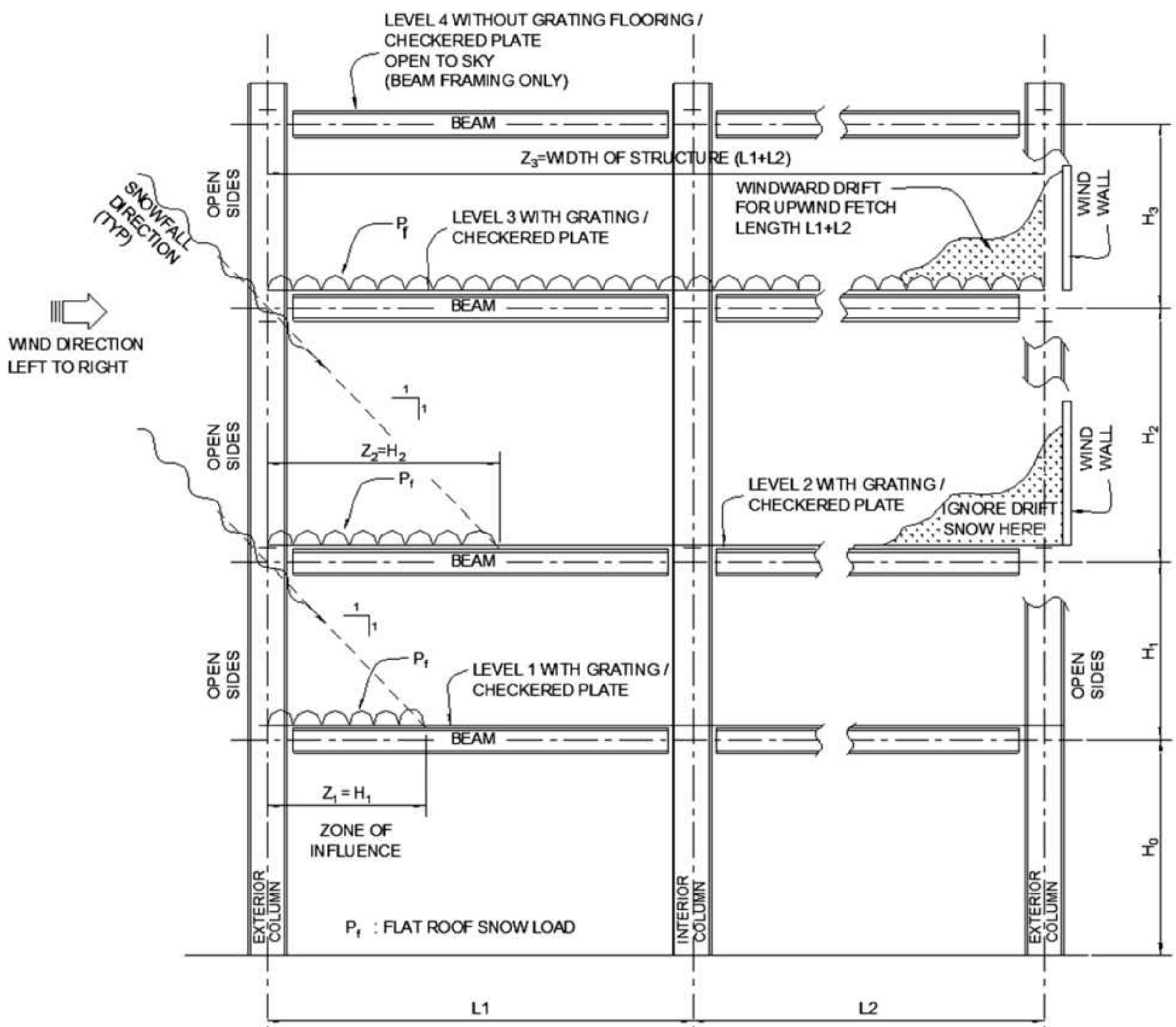
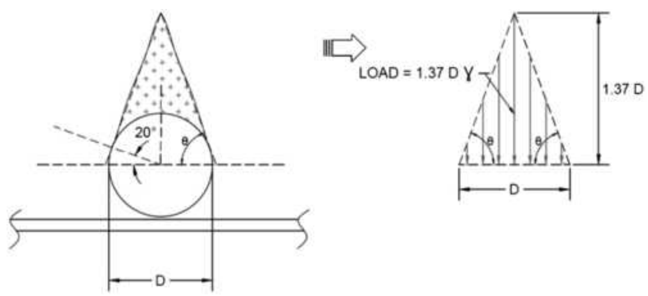
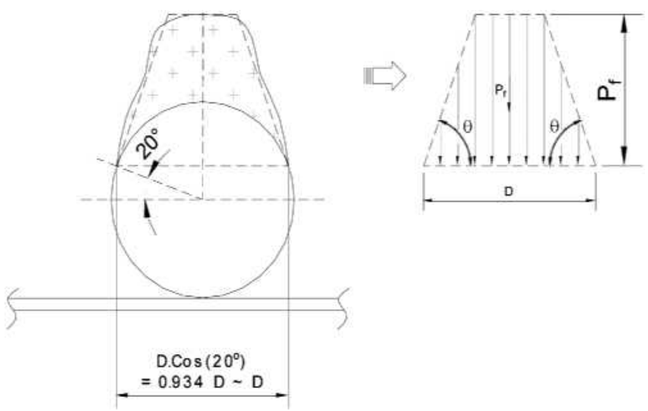


FIGURE 7.13-1 Open-Frame Equipment Structures



Note: *D*, pipe diameter $+2x$ insulation thickness (as applicable); P_f, flat roof snow load; θ, assumed angle of repose = 70°

FIGURE 7.13-2a Snow Load on Individual Pipes and Cable Trays with Diameter or Width Less Than or Equal to $0.73p_f/\gamma$



Note: *D*, pipe diameter $+2x$ insulation thickness (as applicable); P_f, flat roof snow load; θ, assumed angle of repose = 70°

FIGURE 7.13-2b Snow Load on Individual Pipes and Cable Trays with Diameter or Width Greater Than $0.73p_f/\gamma$

flooring, the flat roof snow load shall be applied over a portion of that flooring level near any open edge in accordance with Fig. 7.13-1. The flat roof snow load shall extend from the upwind edge of the flooring a horizontal distance equal to the vertical difference in elevation between the level in question and the next floor above.

7.13.3 Snow Loads on Pipes and Cable Trays. Individual pipes and cable trays with a diameter (pipe) or width (tray) less than or equal to $0.73p_f/\gamma$ shall be designed for a triangular snow load in accordance with Fig. 7.13-2a. Individual pipes and cable trays with a diameter (pipe) or width (tray) greater than $0.73p_f/\gamma$ shall be designed for a trapezoidal snow load in accordance with Fig. 7.13-2b. Snow loads on pipes are not required to be considered if the wintertime external surface temperature of the pipe is greater than 45°F (7.2°C).

Where the spacing between multiple adjacent pipes or cable trays at the same elevations is less than the height of the flat roof snow load (p_f/γ), an additional uniform cornice load of p_f shall be applied in the spaces between the pipes or cable trays, as shown in Fig. 7.13-3. For $S_p \geq h$, the additional cornice loads need not be applied.

7.13.4 Snow Loads on Equipment and Equipment Platforms. Snow loads on the structure shall include snow accumulation on equipment and equipment platforms that can retain snow. Snow accumulation need not be considered on equipment with a wintertime external surface temperature greater than 45°F (7.2°C).

7.14 CONSENSUS STANDARDS AND OTHER REFERENCED DOCUMENTS

No consensus standards and other documents that shall be considered part of this standard are referenced in this chapter.

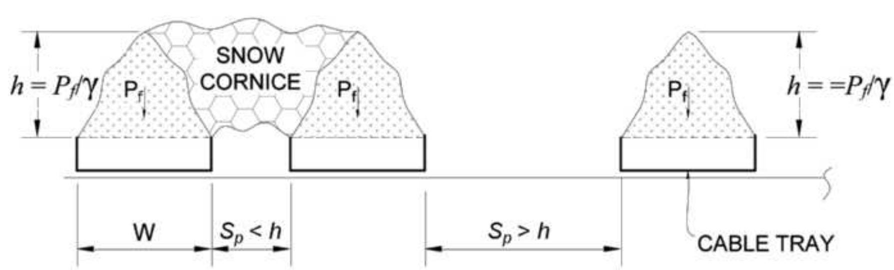


FIGURE 7.13-3 Snow Load on Multiple Cable Trays/Pipes at Same Elevation