

**Supplemental Design Examples
for the**

**SNOW LOAD ANALYSIS
FOR WASHINGTON**

Second Edition

Using SEI/ASCE 7-05 criteria



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SNOW LOAD MANUAL ATTACHMENT

USER NOTES

The design examples within this attachment are intended to supplement the previously published Snow Load Analysis for Washington, Second Edition, published by the Structural Engineers Association of Washington, Copyright 1995 (Snow Load Manual) and the previous supplemental design example problems based on SEI/ASCE 7-02. The examples within this attachment are not intended to change the original example design problem objectives or assumptions. The original design examples are on pages 33 to 44 within the Snow Load Manual, Part III.

The original design examples utilized the design criteria given within the 1994 Uniform Building Code (94 UBC), Appendix Chapter 16, STRUCTURAL FORCES, Division I – SNOW LOAD DESIGN. The changes within Appendix Chapter 16 from the 1994 to the 1997 editions of the uniform codes were trivial. Thus, the original design examples were relevant through the use of the 1997 Uniform Building Code (97 UBC).

The attached design examples (new examples) follow the original design examples with respect to example number, page number, location within the State, ground elevation, structure type and geometry. The new examples have been designed using the criteria set forth in Chapter 7, Snow Loads, of SEI/ASCE 7-05, the American Society of Civil Engineers Standard, Minimum Design Loads for Buildings and Other Structures. Please note that new examples that have changed from SEI/ASCE 7-02 to SEI/ASCE 7-05 are so noted in the new example Table of Contents. Also, note that the new examples refer to the Washington State Nonresidential Energy Code, or NREC. The current edition of the NREC is available on-line under wabo.org and following the leads.

There are some inequalities with respect to the change from the 94-97 UBC to the SEI/ASCE 7-02 and -05 documents. There are several and it is not the intent of this attachment to cover them all. Of note, however, are:

- There are no SEI/ASCE 7-02 / 05 companion code provisions to 94 UBC 1638.3.2 / 97 UBC 1641.3.2, Unbalanced Snow Loads, Gable Roofs with Nonparallel Ridge Lines or 94 UBC 1645 / 97 UBC 1648 Vertical Obstructions. The design professional should use his or her judgment with regard to application of these sections to a structure designed under SEI/ASCE 7-05 criteria.
- There were no 94 UBC / 97 UBC companion code provisions to SEI/ASCE 7-02 / 05 Section 7.3.2 Thermal Factors, Section 7.5.1 Partial Loading Continuous Beam Systems and Section 7.6.4 Unbalanced Snow Loads for Dome Roofs. Again, there are other differences but these are notable.
- There are many 94 UBC / 97 UBC to SEI/ASCE 7-02 / 05 companion code provisions that have changed in application limits, values and ranges. Many, but not all, of these changes will be demonstrated within the new examples.

With regard to the design items that are within the SEI/ASCE 7-02 / 05, Section 7.5 Partial Loading has no new example within this attachment. This section along with companion Figure 7-4, is left to the designer to apply to his or her specific project and specific conditions. The wording and intent of the application of this section is clear and straightforward. However, the results and issues that arise from the application of the section can be varied and often material specific. Some, but not all, of the issues that the designer should consider and investigate when applying SEI/ASCE 7-02 / 05 Section 7.5 were (most will be obvious):

- The impact of differing spans along the same beam line.
- The impact of differing tributary loading areas to the same beam line.
- The obvious impact of changing positive/negative moment locations along the beam line.
- The differing responses of pinned versus fixed beam/column and column/footing connections.
- The impact of differing eccentricities on slender columns.
- Any combination of the above and others not mentioned.

(Checked 10-25-08 J.A.T.C.E.)

The user of the Snow Load Manual should review the text on page 33 of the manual. The statements made with regard to methodology and purposes are valid for this attachment. Specific emphasis should be paid to the references made to locally established minimum design snow loads. Of specific interest in the State of Washington, the snow storms of the winter of 1996-97 have resulted in the establishment of some extremely variable snow load minimums within the same general geographic area. Please note that the local Building Officials ARE empowered to establish the design snow loads within their enforcement area under RCW 19.27. In any case, call the local jurisdiction.

DISCLAIMER

While considerable care has gone into reading and interpreting the data available from the **National Weather Service** and the **Soil Conservation Service**, the stations are widely spaced, and the period of data collection at specific stations varies from continuous records back into the 1890's to only a few years of data. Additionally, **NWS** data for the most part consists only of snow depth information which must be converted into snow load information by means of a snow depth-to-load conversion relationship. Extrapolations must then be made to infer, from these few points, a value for the snow load at every point in the State. These difficulties must be taken into account when using the values presented in this Snow Load Manual. Designers cannot rely solely on the data contained herein, but must also attempt to obtain local data for the site under consideration

The recommendations and information presented in the Snow Load Manual and this attachment are to be used only as a guide and design aid for the Building Officials and the experienced designer. Users of the Snow Load Manual and this attachment should be aware of the limitations of these design examples. They are primarily intended to illustrate the use of the SEI/ASCE 7-02/05 Chapter 7 Snow Loads design provisions and are not to be considered the best or only way to handle a particular type of snow loading. Again, RCW 19.27 empowers the local Building Official to establish the design snow loads for their jurisdictional area. Therefore, design snow loads to be used should be no less than those established by the local Building Official having jurisdiction over a given site.

While the **Snow Load Committee** has endeavored to present accurate guidelines for snow load design based on the data available, neither the **Snow Load Committee** nor the **Structural Engineers Association of Washington** will accept liability for the use of the information provided herein.

SNOW LOAD MANUAL ATTACHMENT
TABLE OF CONTENTS

The design examples within this attachment are intended to supplement the previously published **Snow Load Analysis for Washington**, Second Edition, published by the Structural Engineers Association of Washington, Copyright 1995.

Relative to the original design examples on pages 33 to 44 of the Snow Load Manual, Design Example No. 1 and Design Example No. 2 have not been redone. Methods shown in these examples remain valid for this attachment.

Also relative to the original design examples, Design Example No. 11, referencing 94 UBC Appendix Section 1638.3.2 and 97 UBC Appendix Section 1641.3.2 Multiple Gable Roofs with Non-parallel Ridge Lines, has not been redone since there is no companion code provision within SEI/ASCE 7-02 / 05. As stated previously in the attachment user notes, the designer should use their best professional judgment with regard to application of this provision as well as 94 UBC Appendix Section 1645 and 97 UBC Appendix Section 1648 Vertical Obstructions to a structure designed under the provisions of SEI/ASCE 7-02 / 05.

Relative to the new design examples for the change from the 94 / 97 UBC to the SEI/ASCE 7-02 / 05, Design Example No. 7.2 is new and is meant to illustrate SEI/ASCE 7-02 / 05 Section 7.6.4 Unbalanced Snow Loads for Dome Roofs. Also new for the UBC to SEI/ASCE change, Design Example No. 12.1 is new and is meant to illustrate SEI/ASCE 7-02 / 05 Section 7.3.4 Minimum Values of Pf for Low-Slope Roofs and Section 7.10 Rain-on-Snow Surcharge Load.

Relative to the new design examples for the change from SEI/ASCE 7-02 to 7-05, Design Example No. 3.2 is new and is meant to illustrate the variability of the changed SEI/ASCE 7-05 Section 7.6.1 Unbalanced Snow Loads for Hip and Gable Roofs. Further, Design Examples 3.1, 9.1 and 10.1 have been reworked relative to changed SEI/ASCE 7-05 Section 7.6.1. Also, Design Example 12.1 is reworked relative to changed SEI/ASCE 7-05 Section 7.10 Rain on Snow Surcharge Load.

Please note that several editorial changes have been made to correct errata and clarify items on the previously published SEI/ASCE 7-02 Design Examples. These changes have not been “marked” and do not change the design examples with respect to procedures and results.

Also within the Design Examples following a statement or an equation, there are references made to the specific location within SEI/ASCE 7-02 / 05 justifying the statement or equation. These references are as follows: (E X-X) refers to equation X-X, (T X-X) refers to Table X-X, (F X-X) refers to Figure X-X and (S X.X.X) refers to Section X.X.X.

<u>DESIGN EXAMPLE.....</u>	<u>STATUS.....</u>	<u>PAGE</u>
Design Example No. 3.1.....	Changed SEI/ASCE 7-02 to 7-05.....	36.1
Design Example No. 3.2.....	New SEI/ASCE 7-02 to 7-05.....	36.2
Design Example No. 4.1.....	No Change SEI/ASCE 7-02 to 7-05.....	37.1.1 and 37.1.2
Design Example No. 5.1.....	No Change SEI/ASCE 7-02 to 7-05.....	38.1
Design Example No. 6.1.....	No Change SEI/ASCE 7-02 to 7-05.....	39.1
Design Example No. 7.1.....	No Change SEI/ASCE 7-02 to 7-05.....	40.1
Design Example No. 7.2.....	No Change SEI/ASCE 7-02 to 7-05.....	40.2
Design Example No. 8.1.....	No Change SEI/ASCE 7-02 to 7-05.....	41.1.1 and 41.1.2
Design Example No. 9.1.....	Changed SEI/ASCE 7-02 to 7-05.....	42.1.1 and 42.1.2
Design Example No. 10.1.....	Changed SEI/ASCE 7-02 to 7-05.....	43.1.1 and 43.1.2
Design Example No. 11.1.....	For Reference 97 UBC App Section 1641.3.2.....	44.1
Design Example No. 12.1.....	Changed SEI/ASCE 7-02 to 7-05.....	45.1

(Checked 10-25-08 J.A.T.C.E.)

Design Example No. 3.1

Location: Chewelah, Stevens County
 Elevation: 1167'

Building Type: Industrial UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Sheltered UBC C_e=.9 (Original Problem Design Criteria)
 Ground Snow Load: P_g = 50.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-05

$$P_f = 0.7C_e C_t I P_g \quad (E 7-1)$$

$$C_e = 1.2 \text{ Terrain Category B and Sheltered} \quad (T 7-2)$$

$$C_t = 1.1 \text{ Note: Minimum } C_t = 1.0. \text{ Stevens County is in Washington State NREC Climate Zone 2.}$$

With gable shape shown, this would imply a "Roof over Attic" with a corresponding minimum R value of R-38. Thus C_t=1.1. (T 7-3)

$$I = 1.0 \text{ Building Category II} \quad (T 7-4)$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.2 \times 1.1 \times 1.0 \times 50 \text{ psf} = 46.2 \text{ psf}$$

$$P_s = C_s P_f \quad (E 7-2)$$

C_s = 0.86 Reference F 7-2b for C_t=1.1 and a 4:12 slope. A standing seam metal roof covering is assumed for this industrial application and thus, "unobstructed, slippery surface". (S 7.4.2)

$$P_s = C_s P_f = 0.86 \times 46.2 \text{ psf} = 39.7 \text{ psf} \quad (\text{Use } 40.0 \text{ psf})$$

For Unbalanced Snow Load

$$\text{Slope } 4:12 = 18.4^\circ < 70^\circ \quad (S 7.6.1)$$

AND

$$\text{Slope } 4:12 = 18.4^\circ > 2.38^\circ \text{ OR } (70/W) + 0.5 = (70/31) + 0.5 = 2.76^\circ \quad (S 7.6.1)$$

Therefore, unbalanced snow load must be considered.

$$W = L_u = 31' > 20' \quad (S 7.1 \text{ for definition of } W \text{ \& F 7-5 / S 7.6.1 for solution for } W < 20')$$

$$\text{Windward} = 0.3 P_s = 0.3 \times 40 \text{ psf} = 12 \text{ psf} \quad (S 7.6.1)$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 = 0.43 \times \sqrt[3]{31} \times \sqrt[4]{50 + 10} - 1.5 = 2.26' \quad (F 7-9 \text{ \& equation})$$

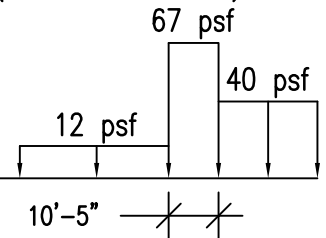
$$\text{Density } \gamma = 0.13 P_g + 14.0 = (0.13 \times 50 \text{ psf}) + 14.0 = 20.5 \text{ pcf} < 30 \text{ pcf} \quad (E 7-3)$$

$$\text{Surcharge Width} = (8/3) \times h_d \times \sqrt{S} = (8/3) \times 2.26' \times \sqrt{3} = 10.4' \quad (F 7-5 \text{ \& S 7.6.1})$$

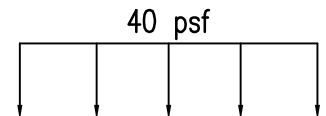
$$\text{Surcharge Magnitude} = h_d \times \gamma / \sqrt{S} = 2.26' \times 20.5 \text{ pcf} / \sqrt{3} = 27 \text{ psf} \quad (F 7-5 \text{ \& S 7.6.1})$$

Unbalanced Snow Load

SEE SEI/ASCE 7-05
 FIGURE 7-5 PAGE 89



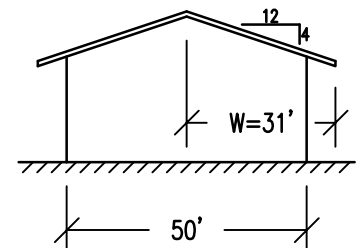
Balanced Snow Load



Note: S = roof slope run for a rise of one.

$$\frac{12}{4} = \frac{3}{1} \Rightarrow S = 3$$

Note: 2P_f at overhangs not applicable because roof is not "warm roof" and under-insulated.



Design Example No. 3.2

Location: Chewelah, Stevens County
 Elevation: 1167'

Building Type: Industrial UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Sheltered UBC C_e=.9 (Original Problem Design Criteria)
 Ground Snow Load: P_g=50.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-05

$$P_f = 0.7C_e C_t I P_g \quad (E 7-1)$$

$$C_e = 1.2 \text{ Terrain Category B and Sheltered} \quad (T 7-2)$$

$$C_t = 1.1 \text{ Note: Minimum } C_t = 1.0. \text{ Stevens County is in Washington State NREC Climate Zone 2.}$$

With gable shape shown, this would imply a "Roof over Attic" with a corresponding minimum R value of R-38. Thus C_t=1.1. (T 7-3)

$$I = 1.0 \text{ Building Category II} \quad (T 7-4)$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.2 \times 1.1 \times 1.0 \times 50 \text{ psf} = 46.2 \text{ psf}$$

$$P_s = C_s P_f \quad (E 7-2)$$

C_s=0.45 Reference F 7-2b for C_t=1.1 and a 12:12 slope. A standing seam metal roof covering is assumed for this industrial application and thus, "unobstructed, slippery surface". (S 7.4.2)

$$P_s = C_s P_f = 0.45 \times 46.2 \text{ psf} = 20.8 \text{ psf} \quad (\text{Use } 21.0 \text{ psf})$$

For Unbalanced Snow Load

$$\text{Slope } 12:12 = 45^\circ < 70^\circ \quad (S 7.6.1)$$

AND

$$\text{Slope } 12:12 = 45^\circ > 2.38^\circ \text{ OR } (70/W) + 0.5 = (70/31) + 0.5 = 2.76^\circ \quad (S 7.6.1)$$

Therefore, unbalanced snow load must be considered.

$$W = L_u = 31' > 20' \quad (S 7.1 \text{ for definition of } W \text{ \& } F 7-5 / S 7.6.1 \text{ for solution for } W < 20')$$

$$\text{Windward} = 0.3 P_s = 0.3 \times 20.8 \text{ psf} = 6 \text{ psf} \quad (S 7.6.1)$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 = 0.43 \times \sqrt[3]{31} \times \sqrt[4]{50 + 10} - 1.5 = 2.26' \quad (F 7-9 \text{ \& } \text{equation})$$

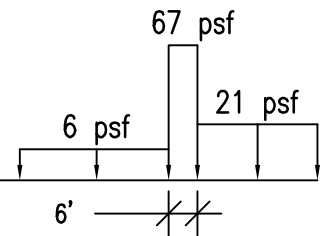
$$\text{Density } \gamma = 0.13 P_g + 14.0 = (0.13 \times 50 \text{ psf}) + 14.0 = 20.5 \text{ pcf} < 30 \text{ pcf} \quad (E 7-3)$$

$$\text{Surcharge Width} = (8/3) \times h_d \times \sqrt{S} = (8/3) \times 2.26' \times \sqrt{1} = 6.0' \quad (F 7-5 \text{ \& } S 7.6.1)$$

$$\text{Surcharge Magnitude} = h_d \times \gamma / \sqrt{S} = 2.26' \times 20.5 \text{ pcf} / \sqrt{1} = 46 \text{ psf} \quad (F 7-5 \text{ \& } S 7.6.1)$$

Unbalanced Snow Load

SEE SEI/ASCE 7-05
 FIGURE 7-5 PAGE 89



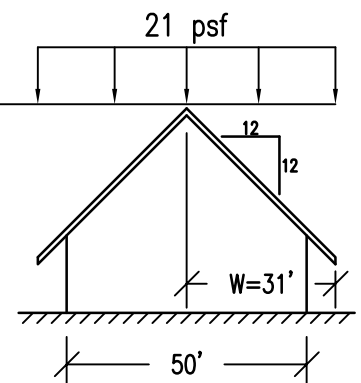
Balanced Snow Load

Note: S = roof slope run for a rise of one.

$$\frac{12}{12} = \frac{1}{1} \Rightarrow S = 1$$

Note: 2P_f at overhangs not applicable because roof is not "warm roof" and under-insulated.

36.2



(CHECKED 10-25-08 J.A.T.C.E.)

Design Example No. 4.1

Location: Medical Lake, Spokane County
Elevation: 2420'

Building Type: Office/Warehouse UBC I=1.0 (Original Problem Design Criteria)
Building Exposure: Open UBC C_e=.6 (Original Problem Design Criteria)
Ground Snow Load: P_g=36.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 0.9 \text{ Terrain Category C and Fully Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.0 \quad (\text{T 7-3})$$

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 0.9 \times 1.0 \times 1.0 \times 36 \text{ psf} = 22.7 \text{ psf} \quad (\text{Use } 23 \text{ psf})$$

For Snow Density and Uniform Snow Geometry

$$\text{Density} = \gamma = 0.13P_g + 14.0 = (0.13 \times 36 \text{ psf}) + 14.0 = 18.7 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-3})$$

$$\text{Uniform snow depth} = h_b = P_f / \gamma = 22.7 \text{ psf} / 18.7 \text{ pcf} = 1.21' \quad (\text{S 7.7.1 and F 7-8})$$

$$\text{Parapet height} = 4'$$

$$\text{Available depth} = h_c = \text{Parapet height} - h_b = 4' - 1.21' = 2.79' \quad (\text{S 7.7.1 and F 7-8})$$

$$h_c / h_b = 2.79' / 1.21' = 2.31 > 0.2 \quad (\text{S 7.7.1})$$

Therefore, snow drift analysis is required.

Drifted Snow at East & West Parapet

$$L_u = 40' \text{ Total upwind building length to projection} \quad (\text{S 7.8})$$

$$\text{Roof projection/parapet drift} = 0.75h_d \quad (\text{S 7.8})$$

$$\text{Parapet } h_d = 0.75[0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5] \quad (\text{F 7-9 with given equation})$$

$$= 0.75[0.43 \times \sqrt[3]{40} \times \sqrt[4]{36 + 10} - 1.5] = 0.75[2.33'] = 1.75' \quad (\text{Use for } h_d)$$

$$h_d < h_c = 1.75' < 2.79' \text{ Use } h_d \text{ for drift intensity and width.}$$

$$\text{Drift width} = w = 4h_d = 4 \times 1.75' = 7' \quad (\text{S 7.7.1 and F 7-8})$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 1.75' \times 18.7 \text{ pcf} = 32.7 \text{ psf} \quad (\text{Use } 33 \text{ psf over } P_f = 23 \text{ psf})$$

Drifted Snow at North & South Parapet

$$L_u = 100' \text{ Total upwind building length to projection} \quad (\text{S 7.8})$$

$$\text{Roof projection/parapet drift} = 0.75h_d \quad (\text{S 7.8})$$

$$\text{Parapet } h_d = 0.75[0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5] \quad (\text{F 7-9 with given equation})$$

$$= 0.75[0.43 \times \sqrt[3]{100} \times \sqrt[4]{36 + 10} - 1.5] = 0.75[3.70'] = 2.77' \quad (\text{Use for } h_d)$$

$$h_d < h_c = 2.77' < 2.79' \text{ Use } h_d \text{ for drift intensity and width.}$$

$$\text{Drift width} = w = 4h_d = 4 \times 2.77' = 11.1' \quad (\text{S 7.7.1 and F 7-8})$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 2.77' \times 18.7 \text{ pcf} = 51.8 \text{ psf} \quad (\text{Use } 52 \text{ psf over } P_f = 23 \text{ psf})$$

Continued

Design Example No. 4.1 Continued

Location: Medical Lake, Spokane County
 Elevation: 2420'

Building Type: Office/Warehouse UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Open UBC C_e=.6 (Original Problem Design Criteria)
 Ground Snow Load: P_g = 36.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7C_eC_tI P_g = 0.7 \times 0.9 \times 1.0 \times 1.0 \times 36 \text{ psf} = 22.7 \text{ psf} \quad (\text{Use } 23 \text{ psf})$$

Drifted Snow at East & West Parapet

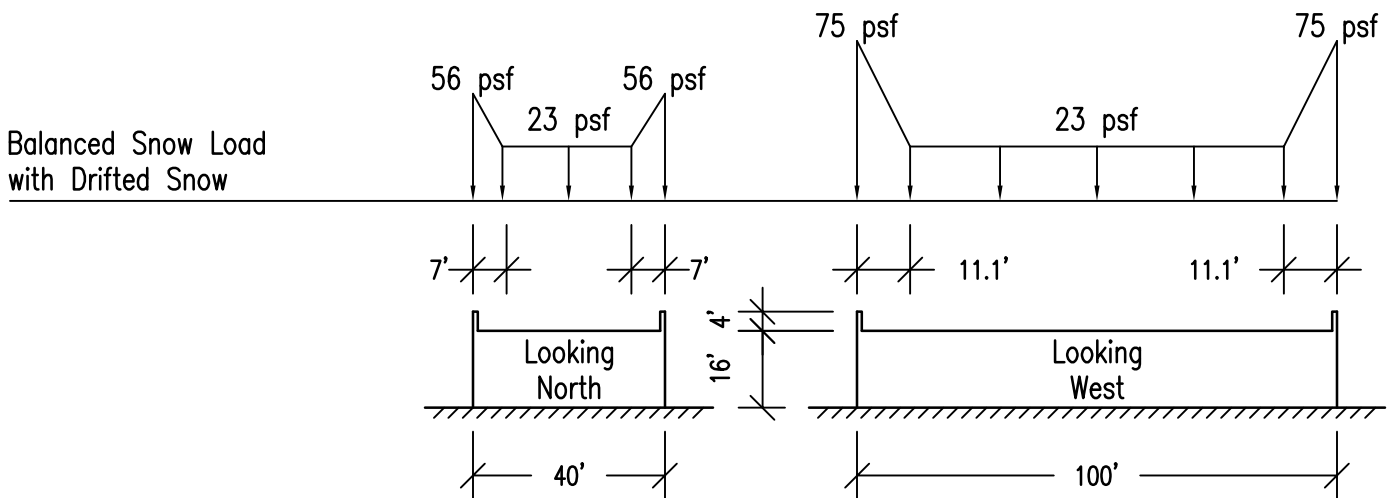
$$\text{Drift width} = w = 4h_d = 4 \times 1.75' = 7' \quad (\text{S } 7.7.1 \text{ and F } 7-8)$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 1.75' \times 18.7 \text{ pcf} = 32.7 \text{ psf} \quad (\text{Use } 33 \text{ psf over } P_f = 23 \text{ psf})$$

Drifted Snow at North & South Parapet

$$\text{Drift width} = w = 4h_d = 4 \times 2.77' = 11.1' \quad (\text{S } 7.7.1 \text{ and F } 7-8)$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 2.77' \times 18.7 \text{ pcf} = 51.8 \text{ psf} \quad (\text{Use } 52 \text{ psf over } P_f = 23 \text{ psf})$$



Design Example No. 5.1

Location: Lake Cushman, Mason County
 Elevation: 733'

Building Type: Single family residence UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Heavy forest UBC C_e=.9 (Original Problem Design Criteria)
 Roof Type: Metal roofing (Under-insulated assumed)
 Ground Snow Load: P_g =114.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7 C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.2 \text{ Terrain Category B and Sheltered} \quad (\text{T 7-2})$$

C_t = 1.0 Note: For this example, the roof is assumed to be unventilated with R-19 insulation with the text of Section 7.4.1 to be correct. Thus C_t taken as 1.0. (T 7-4)

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-3})$$

$$P_f = 0.7 C_e C_t I P_g = 0.7 \times 1.2 \times 1.0 \times 1.0 \times 114 \text{ psf} = 95.8 \text{ psf}$$

$$P_s = C_s P_f \quad (\text{E 7-2})$$

C_s = 0.94 Reference F 7-2a for C_t = 1.0. The roof is assumed unventilated with R-19 insulation. Thus, the solid line of F 7-2a is used. (S 7.4.1)

$$P_s = C_s P_f = 0.94 \times 95.8 \text{ psf} = 90.1 \text{ psf} \quad (\text{Use } 90.0 \text{ psf})$$

For Snow Load Along Eaves

Structure meets the "under-insulated" criteria of Section 7.4.5 and thus the special snow loads along the lower eaves must be considered (by code, other than lower eaves need not be considered).

$$\text{Lower eave} = 2P_f = 2 \times 95.8 \text{ psf} = 191.6 \text{ psf} \quad (\text{Use } 192.0 \text{ psf})$$

$$\text{Upper and gable eaves} = 0 \text{ psf}$$

Snow Load Along Lower Eave

192 psf

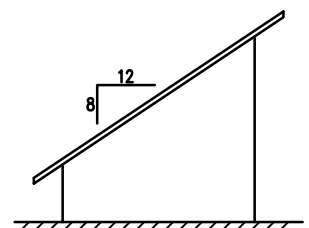


Balanced Snow Load

90 psf



**UNIFORM AND EAVE LOADS
ARE NOT CONCURRENT**



Design Example No. 6.1

Location: Wenatchee, Chelan County
 Elevation: 780'

Building Type: Industrial UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: City UBC C_e=.7 (Original Problem Design Criteria)
 Ground Snow Load: R_s = 22.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

C_t = 1.1 Note: For this problem, assume these structures are cold storage or controlled atmosphere storage and thus kept just above freezing. (T 7-3)

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.1 \times 1.0 \times 22 \text{ psf} = 16.9 \text{ psf} \quad (\text{Use } 17.0 \text{ psf})$$

$$P_s = C_s P_f \quad (\text{E 7-2})$$

C_s = 1.0 For multiple folded plate, sawtooth and barrel vault roofs, C_s = 1.0 regardless of roof slopes, roof coverings or warm/cold conditions present. (S 7.4.4)

$$P_s = C_s P_f = 1.0 \times 17.0 \text{ psf} = 17 \text{ psf} \quad (\text{Use } 17 \text{ psf})$$

For Unbalanced Snow Load

$$\alpha = \tan^{-1} 8/25 = 17.74^\circ > 3/8":12" = 1.79^\circ \quad (\text{S 7.6.3})$$

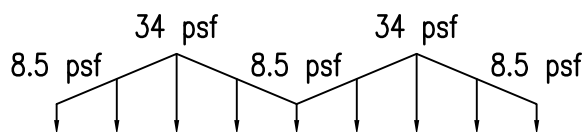
Therefore, unbalanced snow load must be considered.

$$\text{Ridge or crown} = 0.5P_f = 0.5 \times 17 \text{ psf} = 8.5 \text{ psf} \quad (\text{S 7.6.3})$$

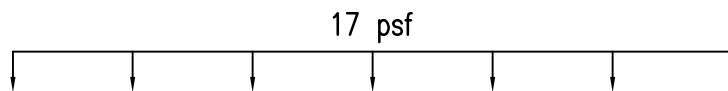
$$\text{Valley} = 2P_f / C_e = 2 \times 17 / 1.0 = 34 \text{ psf} \quad (\text{S 7.6.3})$$

Note: Valley snow depth does not exceed horizontal projection of snow depth at ridge or crown.

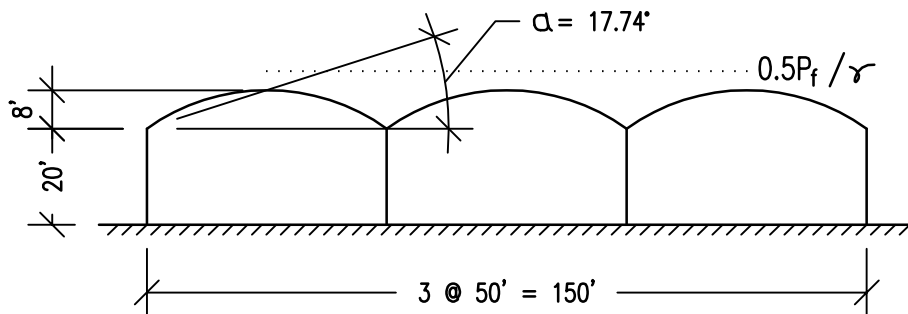
Unbalanced Snow Load



Balanced Snow Load



**SEE DESIGN EXAMPLES
 7.1 AND 7.2 FOR
 UNBALANCED LOADING
 AT OUTBOARD
 BARREL SECTIONS**



Design Example No. 7.1

Location: Republic, Ferry County
 Elevation: 2600'

Building Type: Industrial UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Forested UBC C_e=.9 (Original Problem Design Criteria)
 Roof Type: Bituminous mop down
 Ground Snow Load: P_g =54.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7 C_e C_t I P_g \quad (E 7-1)$$

$$C_e = 1.2 \text{ Terrain Category B and Sheltered} \quad (T 7-2)$$

$$C_t = 1.2 \text{ Note: For this problem, assume this structure is un-heated dry storage.} \quad (T 7-3)$$

$$I = 1.0 \text{ Building Category II} \quad (T 7-4)$$

$$P_f = 0.7 C_e C_t I P_g = 0.7 \times 1.2 \times 1.2 \times 1.0 \times 54 \text{ psf} = 54.4 \text{ psf}$$

$$P_s = C_s P_f \quad (E 7-2)$$

C_s =Varies For un-heated structure with C_t=1.2, use figure 7-2c. With bituminous roof covering assumed, use dashed line for unobstructed slippery surfaces. C_s varies from 1.0 @ 15° to 0.0 @ 70°, linearly. Note break points @ 30° and eaves on balanced and unbalanced loading diagrams F 7-3, Case 2. (S 7.4 and 7.4.3)

$$P_s = C_s P_f = 1.0 \times 54.4 \text{ psf} = 54.4 \text{ psf for } 0^\circ \text{ to } 15^\circ \quad (\text{Use } 54 \text{ psf})$$

$$P_s = C_s P_f = 0.71 \times 54.4 \text{ psf} = 38.6 \text{ psf @ } 30^\circ \text{ point} \quad (\text{Use } 39 \text{ psf})$$

$$P_s = C_s P_f = 0.53 \times 54.4 \text{ psf} = 28.8 \text{ psf @ } 40^\circ \text{ point} \quad (\text{Use } 29 \text{ psf})$$

For Unbalanced Snow Load

$$\alpha = \tan^{-1} 12/30 = 21.7^\circ > 10^\circ$$

AND

$$\alpha = \tan^{-1} 12/30 = 21.7^\circ < 70^\circ \quad (\text{S 7.6.2})$$

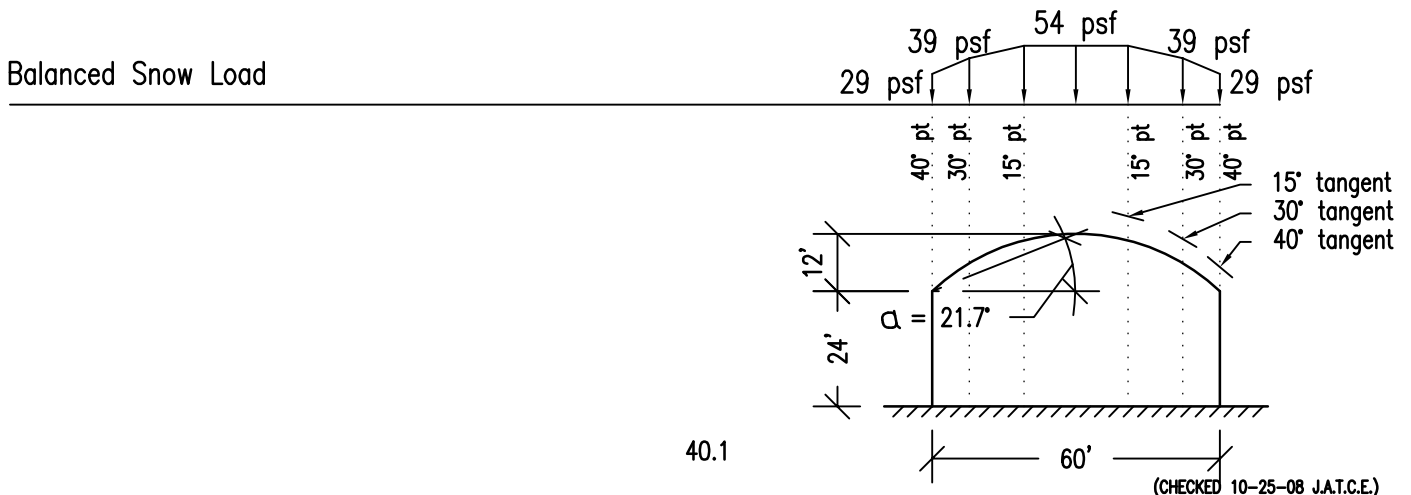
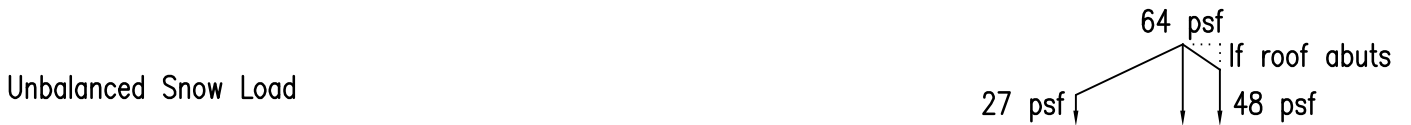
Therefore, unbalanced snow load must be considered.

$$\text{Ridge or crown} = 0.5 P_f = 0.5 \times 54.4 \text{ psf} = 27.2 \text{ psf} \quad (\text{Use } 27 \text{ psf}) \quad (\text{F 7-3 Case 2})$$

$$30^\circ \text{ point} = 2 P_f C_s / C_e = 2 \times 54.4 \text{ psf} \times 0.71 / 1.2 = 64.4 \text{ psf} \quad (\text{Use } 64 \text{ psf}) \quad (\text{F 7-3 Case 2})$$

$$\text{Eaves (40')} = 2 P_f C_s / C_e = 2 \times 54.4 \text{ psf} \times 0.53 / 1.2 = 48.1 \text{ psf} \quad (\text{Use } 48 \text{ psf}) \quad (\text{F 7-3 Case 2})$$

If roof abuts, note horizontal dotted line @ 30° point. (F 7-3 Case 2 and Case 3)



Design Example No. 7.2

Location: Republic, Ferry County
 Elevation: 2600'

Building Type: Residence UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: Forested UBC C_e=.9 (Original Problem Design Criteria)
 Roof Type: Hemispherical dome with wood shake roof
 Ground Snow Load: R_g =54.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$P_f = 0.7C_e C_t I R_g$ (E 7-1)

$C_e = 1.2$ Terrain Category B and Sheltered (T 7-2)

$C_t = 1.0$ Unventilated roof with R>30 (S 7.4.1 and T 7-3)

I = 1.0 Building Category II (T 7-4)

$P_f = 0.7C_e C_t I R_g = 0.7 \times 1.2 \times 1.0 \times 1.0 \times 54 \text{ psf} = 45.4 \text{ psf}$

$P_s = C_s P_f$ (E 7-2)

$C_s = \text{Varies}$ For unventilated roofs with R>30 and $C_t = 1.0$, use figure 7-2a. With wood shake roof covering assumed, use solid line for All Other Roofs. C_s varies from 1.0 @ 30° to 0.0 @ 70°, linearly.

Note break points @ 30° and 70° on balanced and unbalanced loading diagrams F 7-3, Case 3.

$P_s = C_s P_f = 1.0 \times 45.4 \text{ psf} = 45.4 \text{ psf}$ for 0° to 30° (Use 45 psf)

$P_s = C_s P_f = 0.0 \times 45.4 \text{ psf} = 0.0 \text{ psf}$ @ 70° point (Use 0 psf)

Portions of roof with slope > 70° shall be considered free of snow. (S7.6.2)

For Unbalanced Snow Load

$\alpha = \tan^{-1} 30/30 = 45^\circ > 10^\circ$

AND

$\alpha = \tan^{-1} 30/30 = 45^\circ < 70^\circ$ (S 7.6.2 and S 7.6.4)

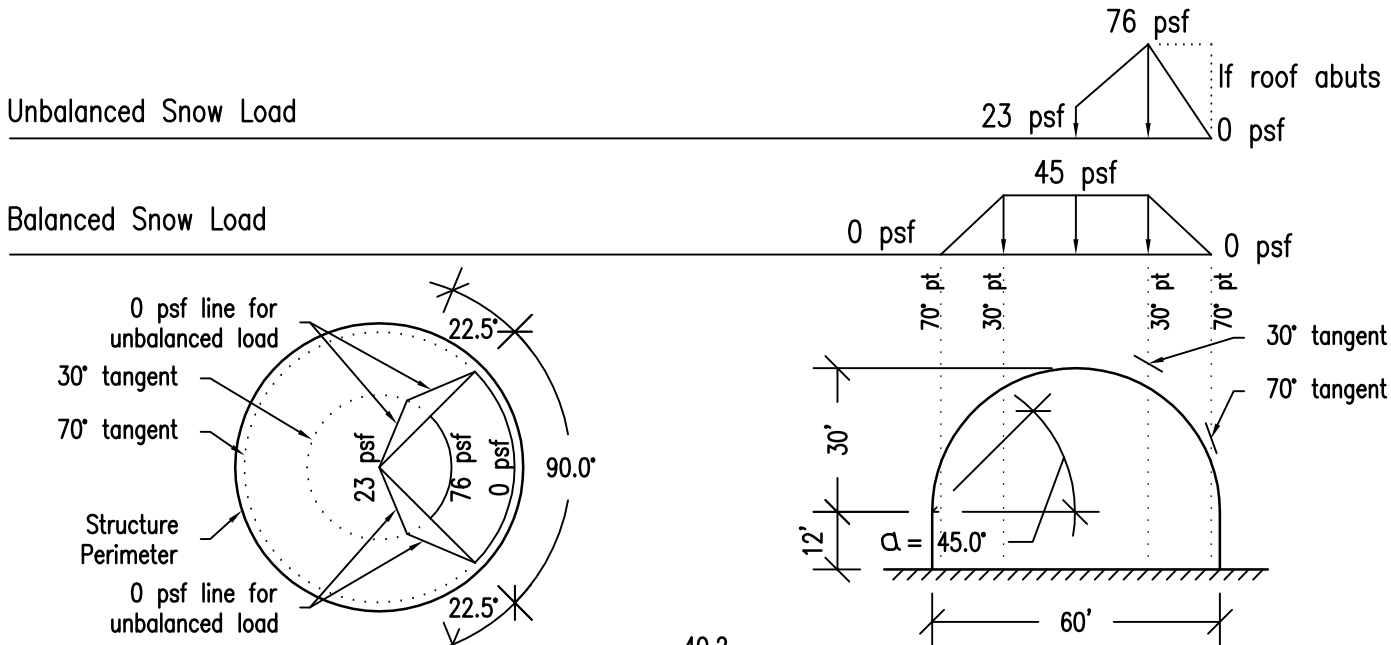
Therefore, unbalanced snow load must be considered.

Ridge or crown = $0.5P_f = 0.5 \times 45.4 \text{ psf} = 22.7 \text{ psf}$ (Use 23 psf) (F 7-3 Case 3)

30° point = $2P_f C_s / C_e = 2 \times 45.4 \text{ psf} \times 1.0 / 1.2 = 75.7 \text{ psf}$ (Use 76 psf) (F 7-3 Case 3)

70° point = 0 psf (Use 0 psf) (F 7-3 Case 3)

Reference S 7.6.4 for application area of unbalanced snow load on domed roof structures. (See plan below)



Design Example No. 8.1

Location: Entiat, Chelan County
Elevation: 800'

Building Type: Commercial UBC I=1.0 (Original Problem Design Criteria)
Building Exposure: City UBC C_e=.7 (Original Problem Design Criteria)
Ground Snow Load: P_g=40.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.0 \quad (\text{T 7-3})$$

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.0 \times 1.0 \times 40 \text{ psf} = 28.0 \text{ psf} \quad (\text{Use } 28 \text{ psf})$$

For Snow Density and Uniform Snow Geometry

$$\text{Density} = \gamma = 0.13P_g + 14.0 = (0.13 \times 40 \text{ psf}) + 14.0 = 19.2 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-3})$$

$$\text{Uniform snow depth} = h_b = P_f / \gamma = 28.0 \text{ psf} / 19.2 \text{ pcf} = 1.46' \quad (\text{S 7.7.1 and F 7-8})$$

$$\text{Difference in roof heights} = 14'$$

$$\text{Available depth} = h_c = \text{Roof difference} - h_b = 14' - 1.46' = 12.54' \quad (\text{S 7.7.1 and F 7-8})$$

$$h_c / h_b = 12.54' / 1.46' = 8.59 > 0.2 \quad (\text{S 7.7.1})$$

Therefore, snow drift analysis is required.

Drifted Snow to Lower Roof – Leeward Condition

$$L_u = 60' \text{ Total upwind building length to lower roof} \quad (\text{S 7.7.1})$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 \quad (\text{F 7-9 with given equation})$$

$$= 0.43 \times \sqrt[3]{60} \times \sqrt[4]{40 + 10} - 1.5 = 2.98' \quad (\text{Use } 3' \text{ for application})$$

$$h_d < h_c = 2.98' < 12.54' \text{ Use } h_d \text{ for drift intensity and width.}$$

$$\text{Drift width} = w = 4h_d = 4 \times 3' = 12' \quad (\text{S 7.7.1 and F 7-8})$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 3' \times 19.2 \text{ pcf} = 57.6 \text{ psf} \quad (\text{Use } 58 \text{ psf over } P_f = 28 \text{ psf})$$

Drifted Snow to Lower Roof – Windward Condition

$$L_u = 30' \text{ Total upwind building length to lower roof} \quad (\text{S 7.7.1})$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 \quad (\text{F 7-9 with given equation})$$

$$= 0.43 \times \sqrt[3]{30} \times \sqrt[4]{40 + 10} - 1.5 = 2.06'$$

$$\text{Windward drift depth} = 0.75h_d = 0.75 \times 2.06' = 1.54' \quad (\text{S 7.7.1})$$

Windward drifting conditions do not govern lower roof snow load design.

Continued

Design Example No. 8.1 Continued

Location: Entiat, Chelan County
 Elevation: 800'

Building Type: Commercial UBC I=1.0 (Original Problem Design Criteria)
 Building Exposure: City UBC C =.7 (Original Problem Design Criteria)
 Ground Snow Load: $P_g = 40.0$ psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-02 & 7-05

$$P_f = 0.7C_eC_tI P_g = 0.7 \times 1.0 \times 1.0 \times 1.0 \times 40 \text{ psf} = 28.0 \text{ psf} \quad (\text{Use } 28 \text{ psf})$$

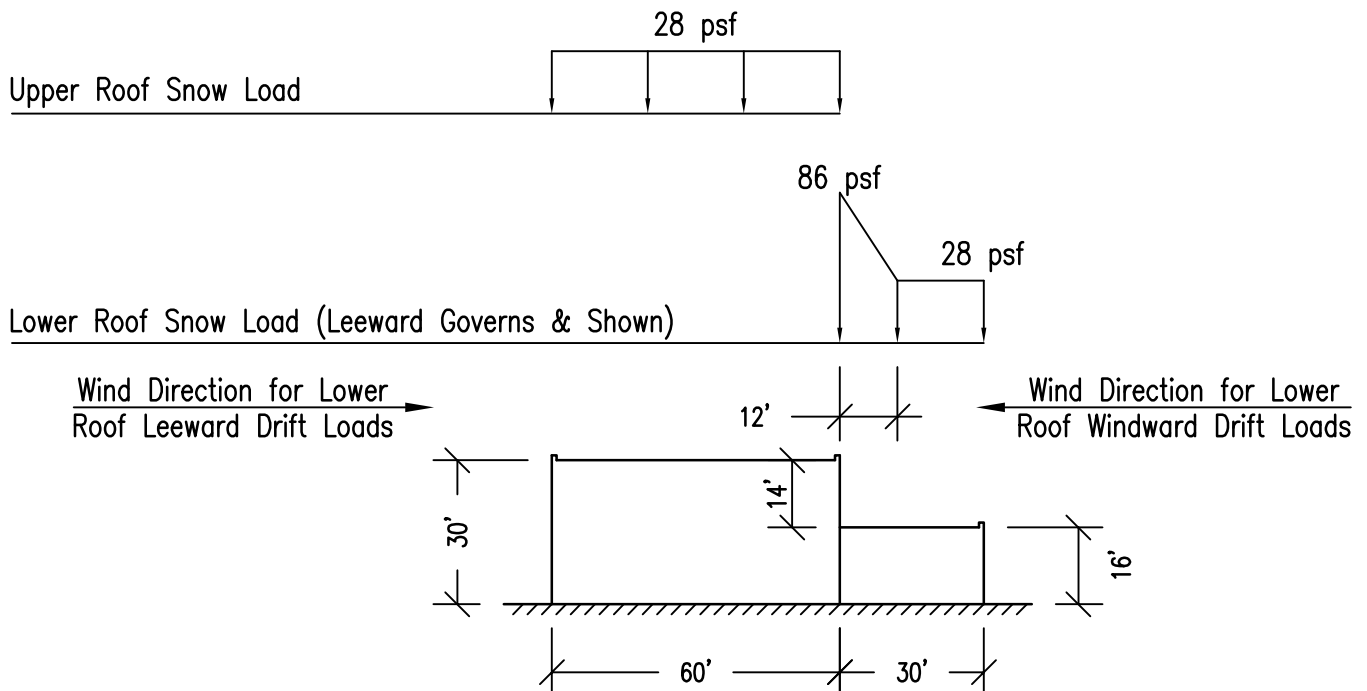
Drifted Snow to Lower Roof – Leeward Condition

$$\text{Drift width} = w = 4h_d = 4 \times 3' = 12' \quad (\text{S } 7.7.1 \text{ and F } 7-8)$$

$$\text{Drift intensity} = P_d = h_d \times \gamma = 3' \times 19.2 \text{ pcf} = 57.6 \text{ psf} \quad (\text{Use } 58 \text{ psf over } P_f = 28 \text{ psf})$$

Drifted Snow to Lower Roof – Windward Condition

Windward drifting conditions do not govern lower roof snow load design.



Design Example No. 9.1

Location: Twisp, Okanogan County
Elevation: 1614'

Building Type: Commercial UBC I=1.0 (Both) (Original Problem Design Criteria)
Building Exposure: City UBC C_e=.7 (Both) (Original Problem Design Criteria)
Ground Snow Load: P_g=64.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-05

For Upper Roof

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.1 \text{ Washington State NREC Climate Zone 2 with R-38 in "Roof over attic"} \quad (\text{T 7-3})$$

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.1 \times 1.0 \times 64 \text{ psf} = 49.3 \text{ psf} \quad (\text{Use 49 psf})$$

$$P_s = C_s P_f \quad (\text{E 7-2})$$

C_s=1.0 Reference F 7-2b for C_t=1.1. Asphalt shingles assumed for this commercial application and thus, use solid line for "All Other Surfaces". (S 7.4 and 7.4.2)

$$P_s = C_s P_f = 1.0 \times 49.0 \text{ psf} = 49.0 \text{ psf}$$

For Unbalanced Snow Load

$$\text{Slope } 3:12 = 14.0^\circ < 70^\circ \quad (\text{S 7.6.1})$$

AND

$$\text{Slope } 3:12 = 14.0^\circ > 2.38^\circ \text{ OR } (70/W) + 0.5 = (70/24) + 0.5 = 3.42^\circ \quad (\text{S 7.6.1})$$

Therefore, unbalanced snow load must be considered.

$$W = L_u = 24' > 20' \quad (\text{S 7.1 for definition of } W \text{ \& F 7-5 / S 7.6.1 for solution for } W < 20')$$

$$\text{Windward} = 0.3 P_s = 0.3 \times 49 \text{ psf} = 14.7 \text{ psf} \quad (\text{Use 15 psf}) \quad (\text{S 7.6.1})$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 = 0.43 \times \sqrt[3]{24} \times \sqrt[4]{64 + 10} - 1.5 = 2.14' \quad (\text{F 7-9 \& equation})$$

$$\text{Density} = \gamma = 0.13 P_g + 14.0 = (0.13 \times 64 \text{ psf}) + 14.0 = 22.3 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-3})$$

$$\text{Surcharge Width} = (8/3) \times h_d \times \sqrt{S} = (8/3) \times 2.14' \times \sqrt{4} = 11.4' \quad (\text{F 7-5 \& S 7.6.1})$$

$$\text{Surcharge Magnitude} = h_d \times \gamma / \sqrt{S} = 2.14' \times 22.3 \text{ pcf} / \sqrt{4} = 24 \text{ psf} \quad (\text{F 7-5 \& S 7.6.1})$$

For Lower Roof

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.0 \text{ Washington State NREC Climate Zone 2 with R-30 in "Unventilated space"} \quad (\text{S 7.4.1 and T 7-3})$$

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.0 \times 1.0 \times 64 \text{ psf} = 44.8 \text{ psf} \quad (\text{Use 45 psf})$$

For Snow Density and Uniform Snow Geometry

$$\text{Density} = \gamma = 0.13 P_g + 14.0 = (0.13 \times 64 \text{ psf}) + 14.0 = 22.3 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-3})$$

$$\text{Uniform snow depth} = h_b = P_f / \gamma = 44.8 \text{ psf} / 22.3 \text{ pcf} = 2.01' \quad (\text{S 7.7.1 and F 7-8})$$

Difference in roof heights = 8'

$$\text{Available depth} = h_c = \text{Roof difference} - h_b = 8' - 2.01' = 5.99' \quad (\text{S 7.7.1 and F 7-8})$$

$$h_c / h_b = 5.99' / 2.01' = 2.98 > 0.2 \quad (\text{S 7.7.1})$$

Therefore, snow drift analysis is required.

Continued

Design Example No. 9.1 Continued

Location: Twisp, Okanogan County
 Elevation: 1614'

Building Type: Commercial UBC I=1.0 (Both) (Original Problem Design Criteria)
 Building Exposure: City UBC C_e=.7 (Both) (Original Problem Design Criteria)
 Ground Snow Load: P_g = 64.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

Drifted Snow to Lower Roof – Leeward Condition Not Considering Separation

L_u = 48' Total upwind building length to lower roof (S 7.7.1)

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 \quad (\text{F 7-9 with given equation})$$

$$= 0.43 \times \sqrt[3]{48} \times \sqrt[4]{64 + 10} - 1.5 = 3.08' \quad (\text{Use } 3' \text{ for application})$$

h_d < h_c = 3.08' < 5.99' Use h_d for drift intensity and width.

Drift width = w = 4h_d = 4 × 3' = 12' (S 7.7.1 and F 7-8)

Drift intensity = P_d = h_d × γ = 3' × 22.3 pcf = 66.9 psf (Use 70 psf) (S 7.7.1)

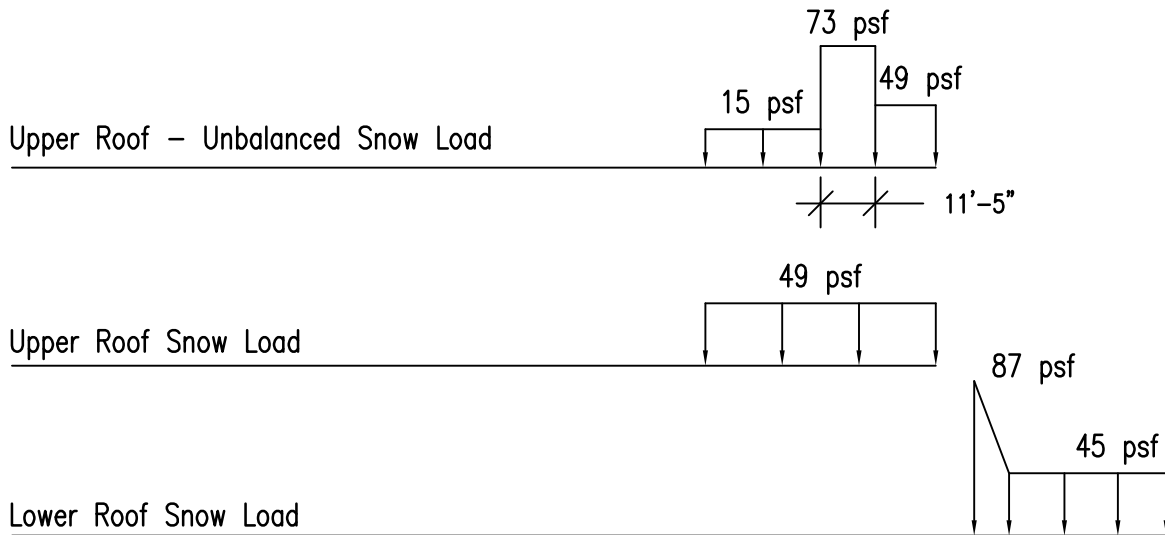
Drifted Snow to Lower Roof – Separated Condition

Separation factor = (20-s)/20 = (20-8)/20 = 0.6 (S 7.7.2)

Therefore

Separated drift intensity = P_d = 0.6 × 70 psf = 42 psf (Use 42 psf over P_f = 45 psf)

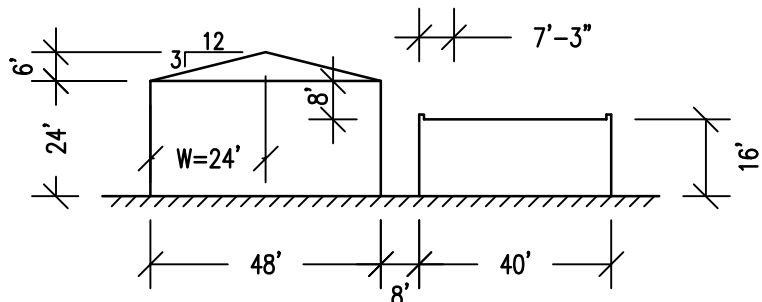
Separated drift width = w = 0.6 × 12' = 7.2'



Note: S = roof slope run for a rise of one.

$$3 \frac{12}{12} = 1 \frac{4}{4} \Rightarrow S = 4$$

Note: May argue for sliding snow. However, with 8' separation, sliding snow seems unlikely.



Design Example No. 10.1

Location: North Bend, King County
Elevation: 442'

Building Type: Fire Station UBC I=1.15 (Original Problem Design Criteria)
Building Exposure: City UBC C_e=.7 (Original Problem Design Criteria)
Ground Snow Load: P_g=33.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

By SEI/ASCE 7-05

For Upper Roof

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.1 \text{ Washington State NREC Climate Zone 1 with R-30 in "Roof over attic"} \quad (\text{T 7-3})$$

$$I = 1.2 \text{ Building Category IV} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.1 \times 1.2 \times 33 \text{ psf} = 30.49 \text{ psf} \quad (\text{Use 30 psf})$$

$$P_s = C_s P_f \quad (\text{E 7-2})$$

C_s=1.0 Reference F 7-2b for C_t=1.1. Membrane with mineral granule surface assumed for this commercial application and thus, use solid line for "All Other Surfaces". (S 7.4 and 7.4.2)

$$P_s = C_s P_f = 1.0 \times 30.0 \text{ psf} = 30.0 \text{ psf}$$

For Unbalanced Snow Load

$$\text{Slope } 4:12 = 18.4^\circ < 70^\circ \quad (\text{S 7.6.1})$$

AND

$$\text{Slope } 4:12 = 18.4^\circ > 2.38^\circ \text{ OR } (70/W) + 0.5 = (70/32.5) + 0.5 = 2.65^\circ \quad (\text{S 7.6.1})$$

Therefore, unbalanced snow load must be considered.

$$W = L_u = 32.5' > 20' \quad (\text{S 7.1 for definition of } W \text{ \& F 7-5 / S 7.6.1 for solution for } W < 20')$$

$$\text{Windward} = 0.3 P_s = 0.3 \times 30 \text{ psf} = 9 \text{ psf} \quad (\text{S 7.6.1})$$

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 = 0.43 \times \sqrt[3]{32} \times \sqrt[4]{33 + 10} - 1.5 = 2.00' \quad (\text{F 7-9 \& equation})$$

$$\text{Density} = \gamma = 0.13 P_g + 14.0 = (0.13 \times 33 \text{ psf}) + 14.0 = 18.3 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-3})$$

$$\text{Surcharge Width} = (8/3) \times h_d \times \sqrt{S} = (8/3) \times 2.00' \times \sqrt{3} = 9.2' \quad (\text{F 7-5 \& S 7.6.1})$$

$$\text{Surcharge Magnitude} = h_d \times \gamma / \sqrt{S} = 2.00' \times 18.3 \text{ pcf} / \sqrt{3} = 21 \text{ psf} \quad (\text{F 7-5 \& S 7.6.1})$$

For Lower Roof

$$P_f = 0.7C_e C_t I P_g \quad (\text{E 7.1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.0 \text{ Washington State NREC Climate Zone 1 with R-21 in "Unventilated space"} \quad (\text{S 7.4.1 and T 7-3})$$

$$I = 1.2 \text{ Building Category IV} \quad (\text{T 7-4})$$

$$P_f = 0.7C_e C_t I P_g = 0.7 \times 1.0 \times 1.0 \times 1.2 \times 33 \text{ psf} = 27.7 \text{ psf} \quad (\text{Use 28 psf})$$

For Snow Density and Uniform Snow Geometry

$$\text{Density} = \gamma = 0.13 P_g + 14.0 = (0.13 \times 33 \text{ psf}) + 14.0 = 18.3 \text{ pcf} < 30 \text{ pcf} \quad (\text{E 7-4})$$

$$\text{Uniform snow depth} = h_b = P_f / \gamma = 27.7 \text{ psf} / 18.3 \text{ pcf} = 1.51' \quad (\text{S 7.7.1 and F 7-8})$$

Difference in roof heights = 8'

$$\text{Available depth} = h_c = \text{Roof difference} - h_b = 8' - 1.51' = 6.49' \quad (\text{S 7.7.1 and F 7-8})$$

$$h_c / h_b = 6.49' / 1.51' = 4.30 > 0.2 \quad (\text{S 7.7.1})$$

Therefore, snow drift analysis is required.

Continued

Design Example No. 10.1 Continued

Location: North Bend, King County
 Elevation: 442'

Building Type: Fire Station UBC I=1.15 (Original Problem Design Criteria)
 Building Exposure: City UBC C_e=.7 (Original Problem Design Criteria)
 Ground Snow Load: P_g = 33.0 psf Reference Appendix A (SEAW 2nd "Snow Load Analysis")

Drifted Snow to Lower Roof – Leeward Condition

L_u = 65' Total upwind building length to lower roof (S 7.7.1)

$$h_d = 0.43 \times \sqrt[3]{L_u} \times \sqrt[4]{P_g + 10} - 1.5 \quad (\text{F 7-9 with given equation})$$

$$= 0.43 \times \sqrt[3]{65} \times \sqrt[4]{33 + 10} - 1.5 = 2.93' \quad (\text{Use 2.9' for application})$$

h_d < h_c = 2.93' < 6.49' Use h_d for drift intensity and width.

Drift width = w = 4h_d = 4 x 2.9' = 11.6' (S 7.7.1 and F 7-8)

Drift intensity = P_d = h_d x 18.3 pcf = 2.9' x 18.3 pcf = 53.07 psf (Use 53 psf over P_f = 28 psf)

Sliding Snow to Lower Roof

Upper roof slope = 4:12 > 2:12 for "non-slippery" surfaces (S 7.9)

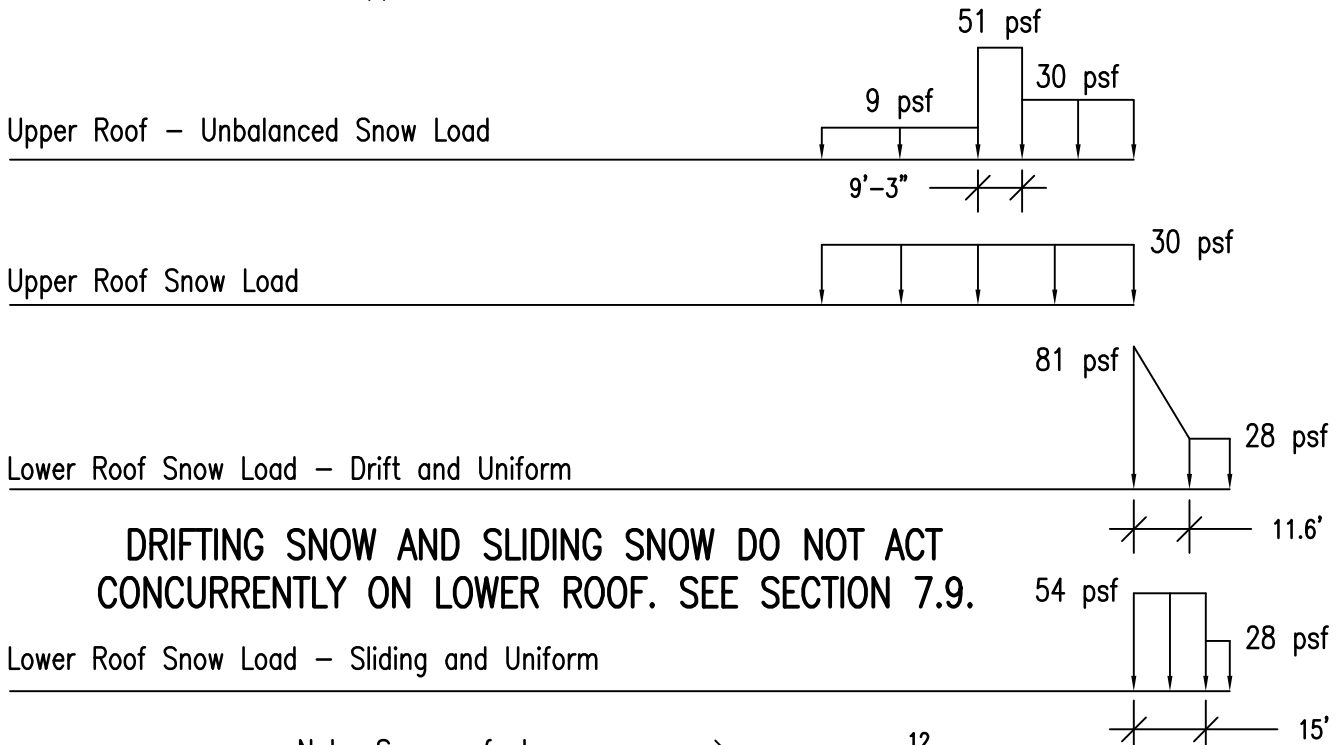
Therefore, sliding snow from upper roof to lower must be considered.

Sliding snow = 0.4P_fW = 0.4 x 30 psf x 32.5' = 390 plf of eave length (S 7.9)

Distributed distance = 15' (S 7.9)

Sliding snow intensity = 0.4P_fW/15' = 26 psf (Use 26 psf over P_f = 28 psf)

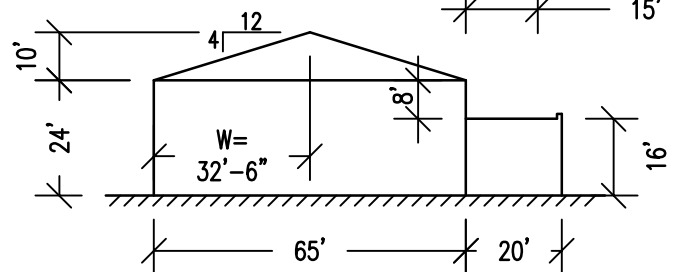
Note the use of P_f from upper roof, not P_s.



**DRIFTING SNOW AND SLIDING SNOW DO NOT ACT
 CONCURRENTLY ON LOWER ROOF. SEE SECTION 7.9.**

Note: S = roof slope run
 for a rise of one.

$$4 \frac{12}{12} = 1 \frac{3}{3} \Rightarrow S = 3$$



Design Example No. 11.1

1641.3.2 With nonparallel ridge lines. Structural members at roof valleys for multiple-gable roofs having intersecting ridge lines in areas where P_g is greater than 70 psf (3352 N/m²) and where the slope is 3 units vertical in 12 units horizontal (16.7% slope) or greater shall be designed for P_f times C_v and the distribution of loads is as shown in Figures A-16-12 and A-16-13 where C_v shall be determined from Figure A-16-11.

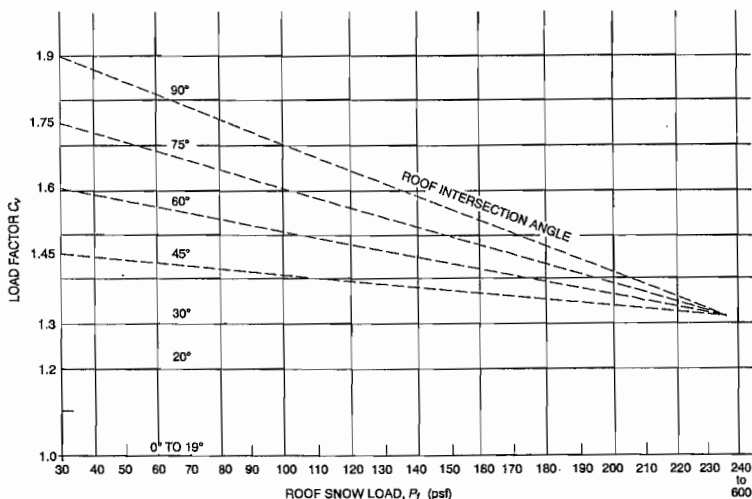
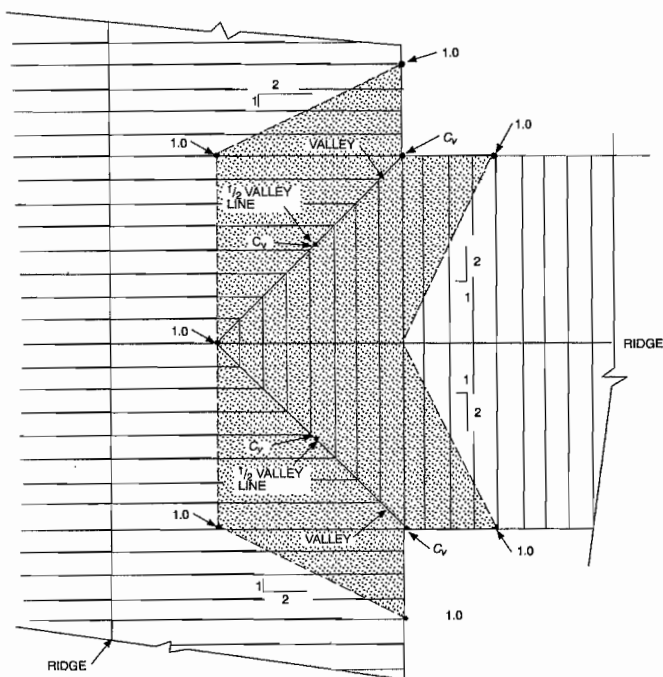
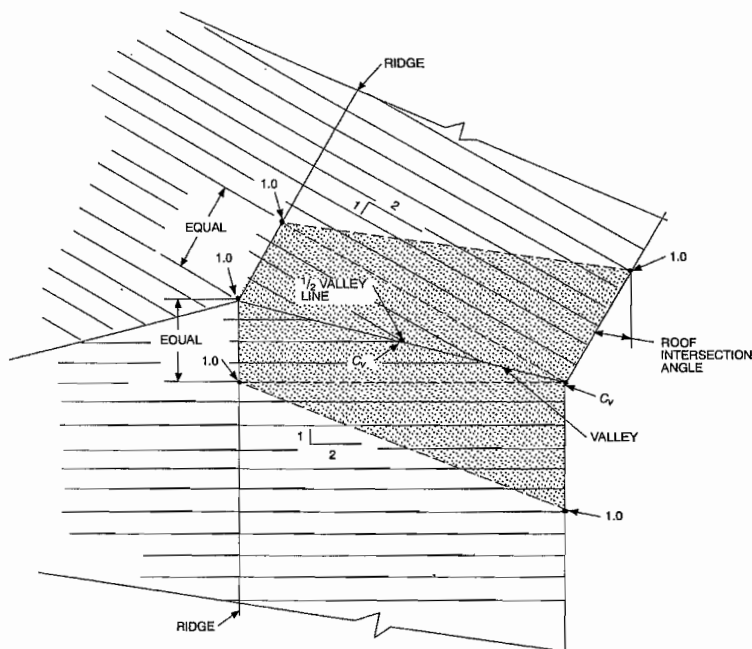


FIGURE A-16-11—VALLEY COEFFICIENT, C_v



- DENOTES INCREASED LOAD AREA:
1. Load is constant on lines connecting points noted 1.0.
 2. Load is constant on lines connecting points noted C_v .
 3. Load varies linearly between 1.0 and C_v .

FIGURE A-16-12—VALLEY DESIGN COEFFICIENTS, C_v



- DENOTES INCREASED LOAD AREA:
1. Load is constant on lines connecting points noted 1.0.
 2. Load is constant on lines connecting points noted C_v .
 3. Load varies linearly between 1.0 and C_v .

FIGURE A-16-13—VALLEY DESIGN COEFFICIENTS, C_v

RELEVANT 1997 UNIFORM BUILDING CODE SECTIONS REPRODUCED ABOVE. NEITHER SEI/ASCE 7-02 NOR 7-05 CONTAINS A COMPANION CODE SECTION FOR THIS CONDITION. NUMEROUS REPORTS OF THIS CONDITION OCCURRING AND CAUSING PROBLEMS IN BOTH HIGH SNOW LOAD AND LOW SNOW LOAD AREAS HAVE BEEN VOICED. THE DESIGNER SHOULD USE HIS/HER JUDGMENT AS TO THE USE OF THIS DESIGN CONDITION.

Design Example No. 12.1

Location: Yakima, Yakima County
Elevation: 1066'

Building Type: Industrial UBC I=1.0 (Original Problem Design Criteria)
Building Exposure: City UBC C_e=.7 (Original Problem Design Criteria)
Ground Snow Load: P_g = (Elevation) x (Isobar) = 1066' x 0.018 = 19.2 psf
Reference SEAW 2nd "Snow Load Analysis"

By SEI/ASCE 7-05

$$P_f = 0.7 C_e C_t I P_g \quad (\text{E 7-1})$$

$$C_e = 1.0 \text{ Terrain Category B and Partially Exposed} \quad (\text{T 7-2})$$

$$C_t = 1.0 \text{ Washington State NREC Climate Zone 1 with R-30 in "Unventilated Roof"} \quad (\text{T 7-3})$$

$$I = 1.0 \text{ Building Category II} \quad (\text{T 7-4})$$

$$P_f = 0.7 C_e C_t I P_g = 0.7 \times 1.0 \times 1.0 \times 1.0 \times 19.2 \text{ psf} = 13.44 \text{ psf}$$

For Minimum Values of P_f for Low-Slope Roofs

$$\text{Slope } 3/8:12 = 1.79^\circ < (70/W) + 0.5 = (70/40) + 0.5 = 2.25^\circ \quad (\text{S 7.3.4})$$

Therefore, minimum values for P_f shall apply. (S 7.3)

$$P_g < 20 \text{ psf}$$

$$P_f = I P_g = 1.0 \times 19.2 \text{ psf} = 19.2 \text{ psf} \quad (\text{Use } 19 \text{ psf}) \quad (\text{S 7.3})$$

For Unbalanced Snow Load

$$\text{Slope } 3/8:12 = 1.79^\circ < 70^\circ \quad (\text{S 7.6.1})$$

BUT

$$\text{Slope } 3/8:12 = 1.79^\circ < 2.38^\circ \text{ OR } (70/W) + 0.5 = (70/40) + 0.5 = 2.25^\circ \quad (\text{S 7.6.1})$$

Therefore, unbalanced snow load need not be considered.

For Rain-on-Snow Surcharge Load

$$P_g = 19.2 \text{ psf} < 20 \text{ psf} \quad (\text{S 7.10})$$

BUT

$$\text{Slope } 3/8:12 = 1.79^\circ > W/50 = 40/50 = 0.8^\circ \quad (\text{S 7.10})$$

Therefore, 5 psf rain-on-snow surcharge need not be applied to established design snow loads. (S 7.10)

Balanced Snow Load

