

Impact of C&C loads due to ASCE/SEI 7-16

Overview

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SBCA

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Introduction

- The draft version of ASCE/SEI 7-16 includes significant changes regarding Components & Cladding (C&C) wind loads on roofs which will affect a wide range of roof products/applications, including:
 - Rake connections
 - Roof sheathing suction loads/connections
 - Rafter spans
 - Roof framing capacity
 - Solar panel attachments
- These changes will impact prescriptive requirements in the 2018 International Residential Code (IRC) and International Building Code (IBC), as well as American Wood Council's Wood Frame Construction Manual (WFCM) and Special Design Provisions for Wind (SDPWS).

Introduction

- Scope of changes:
 - Impacts ASCE 7, Chapter 30 Parts 1 & 2 (low rise, enclosed/partially enclosed, $h \leq 60$ ft)
 - Impacts roof design (not wall)
 - Separates provisions for gable and hip roofs (different figures for each)
 - Increases number of zones and modifies zone locations
 - Only changes one of 3 values (GC_p) used to calculate C&C pressure:
 $p = q_h [(GC_p) - (GC_{pi})]$. q_h & GC_{pi} do not change.
 - Because both the zones and slope ranges for gable roofs changed in ASCE/SEI 7-16 (4 instead of 3), the net difference is difficult to compare.

Key Definitions

- **AUTHORITY HAVING JURISDICTION (AHJ):** ([IBC Section 104.1](#))
The building code official authorized and directed to enforce the provisions of a building code who also has the authority to render interpretations of this code and to adopt policies and procedures in order to clarify the application of its provisions.
- **BUILDING DESIGNER:** (*ANSI/TPI 1* Section 2.2)
The owner of the building or the person that contracts with the owner for the design of the framing structural system and/or who is responsible for the preparation of the construction documents. When mandated by the legal requirements, the Building Designer shall be a registered design professional.
- **BUILDING, ENCLOSED:** (ASCE/SEI 7-10, revised in 7-16)
A building that does not comply with the requirements for open or partially enclosed buildings.
- **BUILDING, LOW-RISE:** (ASCE/SEI 7-10, same at 7-16)
Enclosed or partially enclosed buildings that comply with the following conditions:
 1. Mean roof height h less than or equal to 60 ft (18 m) and
 2. Mean roof height h does not exceed least horizontal dimension.

Key Definitions

- **BUILDING, PARTIALLY ENCLOSED:** (ASCE/SEI 7-10, same at 7-16)
A building that complies with both of the following conditions:
 1. The total area of openings in a wall that receives positive external pressure exceeds the sum of the areas of openings in the balance of the building envelope (walls and roof) by more than 10% and
 2. The total area of openings in a wall that receives positive external pressure exceeds 4 ft² (0.37 m²) or 1% of the area of that wall, whichever is smaller, and the percentage of openings in the balance of the building envelope does not exceed 20%.
- **COMPONENT AND CLADDING WIND LOADS (C&C):** (ASCE/SEI 7-10, similar at 7-16)
26.1.2.2 Components and Cladding. Wind loads on components and cladding on all buildings and other structures shall be designed using one of the following procedures:
 1. Analytical procedures provided in Parts 1 through 6, as appropriate, of Chapter 30; and
 2. Wind tunnel procedure as specified in Chapter 31.

Key Definitions

- **DESIGN PRESSURE, P:** (ASCE/SEI 7-10, same at 7-16)
Equivalent static pressure to be used in the determination of wind loads for buildings
- **EAVE HEIGHT, h_e :** (ASCE/SEI 7-10, same at 7-16)
The distance from the ground surface adjacent to the building to the roof eave line at a particular wall. If the height of the eave varies along the wall, the average height shall be used.
- **EFFECTIVE WIND AREA, A:** (ASCE/SEI 7-10, similar at 7-16)
The area used to determine (GC_p). For component and cladding elements, the effective wind area (in Figs. 30.4-1 through 30.4-7, 30.5-1, 30.6-1, and 30.8-1 through 30.8-3) is the span length multiplied by an effective width that need not be less than one-third the span length. For cladding fasteners, the effective wind area shall not be greater than the area that is tributary to an individual fastener.
- **MEAN ROOF HEIGHT, h:**
The average of the roof eave height and the height to the highest point on the roof surface, except that, for roof angles of less than or equal to 10° , the mean roof height is permitted to be taken as the roof eave height.

Background

- Each new edition of ASCE 7 has seen changes to the wind provisions.
- While some changes have been editorial, others have been substantive, for example in the 2010 edition:
 - Wind speed maps changed to include strength-level basis of design
 - Exposure D in hurricane prone regions
 - Windborne debris regions were recalibrated
 - Minimum pressure reduced
 - Simplified method for enclosed simple diaphragm buildings ≤ 160 ft,
 - Exceptions to wind torsion cases
 - Wind tunnel procedure limitations

Application

- In the draft version of ASCE/SEI 7-16, the low-rise roof provisions have been significantly revised.
- C&C wind loads impact a wide range of applications: fasteners, structural members that are not part of the MWFRS, etc.
- The following four tables illustrate the percentage of difference in the minimum net pressure (minimum of 16 psf) at the stated slope conditions.

The following parameters are used in all cases:

Mean roof Height (h)	25 ft
Wind speed (V_{ult})	170 mph
Directionality Factor (K_d)	0.85
Exposure Category	B
Topographic Factor (K_{zt})	1.00
Velocity pressure exposure coefficient (K_z)	0.70
Building Category	Enclosed
Velocity pressure at MRH (q_h)	44.02
Internal Pressure coefficient ($GC_{pi} \pm$) $p=q_h[(GC_p)-(GC_{pi})]$	0.18

Application

- Note that the zone designation is not the same for each slope group.
 - Since the zone designations are not the same between the two editions of ASCE/SEI 7, where possible, values for ASCE/SEI 7-10 have been determined as best as possible to reflect the zones used in ASCE/SEI 7-16.
 - When values are missing in the ASCE/SEI 7-16 figures, appropriate values have been entered in the calculations used to produce the tables.

Application

	Zone	7-16 Min. Net Pressure	7-10 Min. Net Pressure	Difference	% Difference
ROOF	1	-47.54	-51.94	4.40	-8%
	1	-82.76	-51.94	-30.81	59%
	2	-109.17	-87.16	-22.01	25%
	3	-148.79	-131.18	-17.61	13%
	All	16.00	16.00	0	0%
OVERHANG	1	-82.76	-82.76	n/a	n/a
	1	-82.76	-82.76	0	0%
	2	-109.17	-148.79	-26.41	32%
	3	-148.79	-82.76	0	0%

Table 1: Slope 4.76 degrees (1:12 pitch)

Application

	Zone	7-16 Min. Net Pressure	7-10 Min. Net Pressure	Difference	% Difference
ROOF	1	-95.96	-47.54	-48.42	102%
	2e	-95.96	-82.76	-13.21	16%
	2n	-139.99	-82.76	-57.23	69%
	2r	-139.99	-82.76	-57.23	69%
	3e	-139.99	-122.38	-17.61	14%
	3r	-166.40	-122.38	-44.02	36%
	All	22.89	16.00	6.89	43%
OVERHANG	1	-117.97	-	-	-
	2e	-117.97	-104.77	-13.21	13%
	2n	-162.00	-104.77	-57.23	55%
	2r	-162.00	-104.77	-57.23	55%
	3e	-188.41	-170.80	-17.61	10%
	3r	-214.82	-170.80	-44.02	26%

Table 2: Slope 9.46 degrees (2:12 pitch)

Application

	Zone	7-16 Min. Net Pressure	7-10 Min. Net Pressure	Difference	% Difference
ROOF	1	-73.95	-47.54	-26.41	56%
	2e	-73.95	-82.76	8.80	-11%
	2n	-117.97	-82.76	-35.22	43%
	2r	-117.97	-82.76	-35.22	43%
	3e	-117.97	-122.38	4.40	-4%
	3r	-166.40	-122.38	-44.02	36%
	All	22.89	22.89	0.00	0%
OVERHANG	1	-95.96	-	-	-
	2e	-95.96	-104.77	8.80	-8%
	2n	-139.99	-104.77	-35.22	34%
	2r	-139.99	-104.77	-35.22	34%
	3e	-166.40	-170.80	4.40	-3%
	3r	-214.82	-170.80	-44.02	26%

Table 3: Slope 22.62 degrees (5:12 pitch)

Application

	Zone	7-16 Min. Net Pressure	7-10 Min. Net Pressure	Difference	% Difference
ROOF	1	-87.16	-51.94	-35.22	68%
	2e	-87.16	-60.75	-26.41	44%
	2n	-95.96	-60.75	-35.22	58%
	2r	-87.16	-60.75	-26.41	44%
	3e	-148.79	-60.75	-88.04	145%
	3r	-95.96	-60.75	-35.22	58%
	All	31.69	31.69	0.00	0%
OVERHANG	1	-104.77	-	-	-
	2e	-104.77	-95.96	-8.80	09%
	2n	-131.18	-95.96	-35.22	37%
	2r	-104.77	-95.96	-8.80	09%
	3e	-184.01	-95.96	-88.04	92%
	3r	-131.18	-95.96	-35.22	37%

Table 4: Slope 33.69 degrees (8:12 pitch)

Conclusion

- Since this SBCA Research Report is based on a draft version of ASCE/SEI 7-16, none of the results should be used for any design purposes.
- It is intended to be illustrative of the proposed changes to ASCE/SEI-7.

References

- *ANSI/AWC National Design Specification (NDS) for Wood Construction*; American Wood Council; 2015.
- *ANSI/TPI 1 – National Design Standard for Metal Plate Connected Wood Truss Construction*; Truss Plate Institute; 2007.
- *ASCE/SEI 7 – Minimum Design Loads for Buildings and Other Structures*; American Society of Civil Engineers and the Structural Engineering Institute; 2010 3rd printing & 2016 (draft).
- *International Building Code*; International Code Council; 2015.
- *International Residential Code*; International Code Council; 2015.