ASCE 7-22 Changes to Component and Cladding Wind Provisions

By William L. Coulbourne, P.E., F.ASCE, F.SEI, and Philip Line, P.E.

Revised Component and Cladding (C&C) wind load provisions in ASCE 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, produce in most cases either the same or slightly lower pressures than would occur under the prior edition while also preserving the extensive wind tunnel testing basis of the ASCE 7-16 C&C wind provisions.

The C&C wind load provisions adopted for ASCE 7-16 introduced several changes that increased the C&C wind pressures in some roof zones of flat, gable, and hip roofs. Roof zones were added, usually increasing the number of zones from 3 to 6. There were some zones where the effective wind areas (EWA) were reduced to less than 10 square feet, thus increasing the C&C pressures. Hip roofs had two sets of graphs for EWA vs. (GC_p) pressure coefficients, one for $h/B \geq 0.8$ and one for $h/B \leq 0.5$, with interpolation required between these two h/B values. Finally, for hip roofs with a slope between 27° and 45°, determining the (GC_p) value required using an equation that used the roof slope. While based on wind tunnel testing, the determination of (GC_p) coefficients became more complicated in ASCE 7-16, and an increase in some pressures based on small EWA was not supported by the 'science' of load sharing between the C&C elements.

The primary changes to ASCE 7-22 Chapter 30 C&C wind loads provisions are:

1) Reduced the number of roof zones on both gable and hip roofs to three
2) Changed the EWA vs. (GC_p) graphs such that the smallest EWA is not less than 10 square feet
3) Minimized the number of greatest EWAs to either 100, 200, or 300 square feet
4) Eliminated the need to determine h/B ratios for hip roofs (i.e., h/B is the ratio of roof height to least horizontal dimension)
5) Eliminated the equations for hip roofs of 27° to 45° to a simple set of graphs for only 45° and an interpolation formula that can be used to determine (GC_p) coefficients for roof slopes that vary from 27° to 45°
6) Eliminated the graphs for roof overhangs on gable roofs with slopes greater than 7° and all hip roofs with a formula that adds

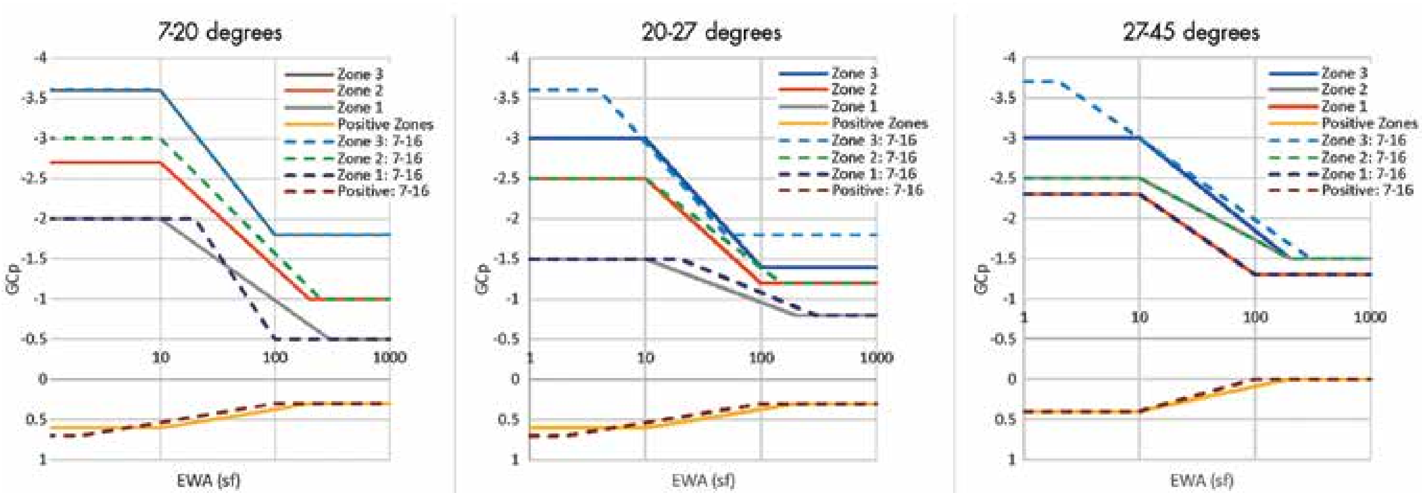

Figure 1. Gable roof EWA and (GC_p) comparisons.

Table of C&C pressure comparison for four roof cases.

Roof Shape	Slope (degrees)	Zone	EWA (ft^2)	ASCE 7-16 (GC_p)	ASCE 7-22 (GC_p)	ASCE 7-16 C&C Pressure (psf)	ASCE 7-22 C&C Pressure (psf)
Gable	25	3	4	-3.6	-3.0	-59.7	-50.2
Gable	40	3	100	-1.5	-1.3	-26.5	-23.4
Hip	25	3	100	-1.23	-1.0	-22.3	-18.6
Hip	35	3	20	-2.53	-1.82	-42.8	-31.6
Hip	45	3	3	-3.6	-2.4	-59.7	-40.8

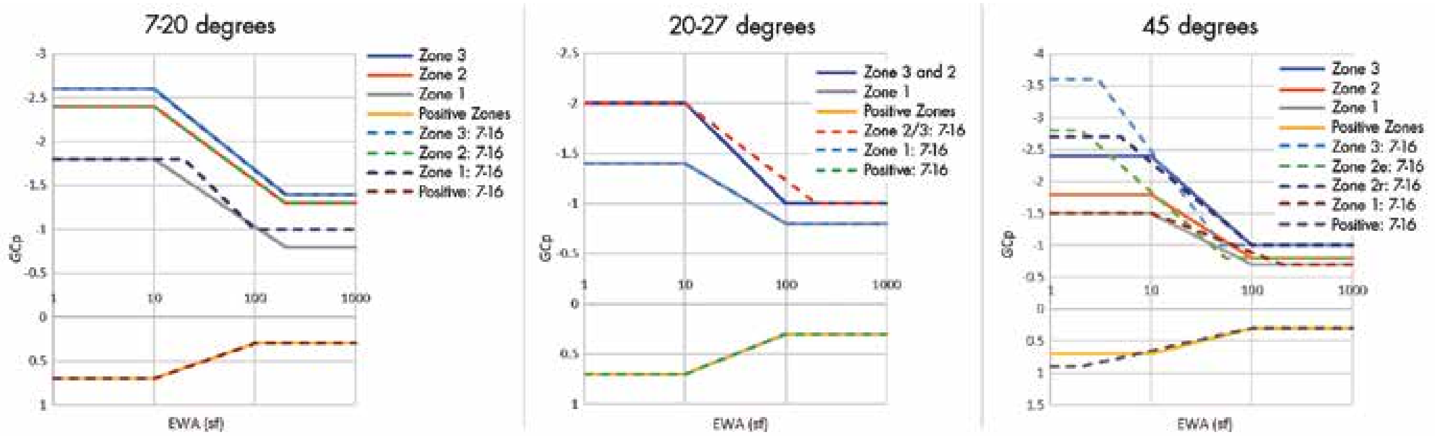

Figure 2. Hip roof EWA and (GC_p) comparisons.

the (GC_p) for the upper roof surface to the (GC_p) for the wall surface adjusted for the applicable EWA

7) Modified the (GC_p) equations in the Chapter 30 commentary to match the chapter changes

The changes in EWAs and the reduction in roof zones are best represented by comparing the ASCE 7-16 and ASCE 7-22 roof GC_p graphs. *Figure 1* illustrates the comparisons in gable roof EWAs and (GC_p) values. ASCE 7-22 is shown in solid lines; ASCE 7-16 is shown in dashed lines. While there are some changes in EWAs, the basic tenet in developing C&C wind load updates was to preserve the wind tunnel testing basis used for the ASCE 7-16 standard. Raw wind tunnel results were used to construct graphs to meet practitioner use objectives while preserving the integrity of the extensive wind tunnel results.

Figure 2 illustrates the comparisons in hip roof EWAs and (GC_p) values. For ASCE 7-22, it was found unnecessary to vary the (GC_p) with h/B values, simplifying the presentation of values. The graph for the 45° hip roof compares the ASCE 7-16 values for 45° using the required equations with the proposed (GC_p) values for 45° for ASCE 7-22.

The following example illustrates the differences in C&C pressures between ASCE 7-16 and ASCE 7-22. The example location is Kansas City, MO, with a 110-mph design wind speed; the mean roof height is 20 feet; the exposure is Exposure B; the internal pressure is characterized

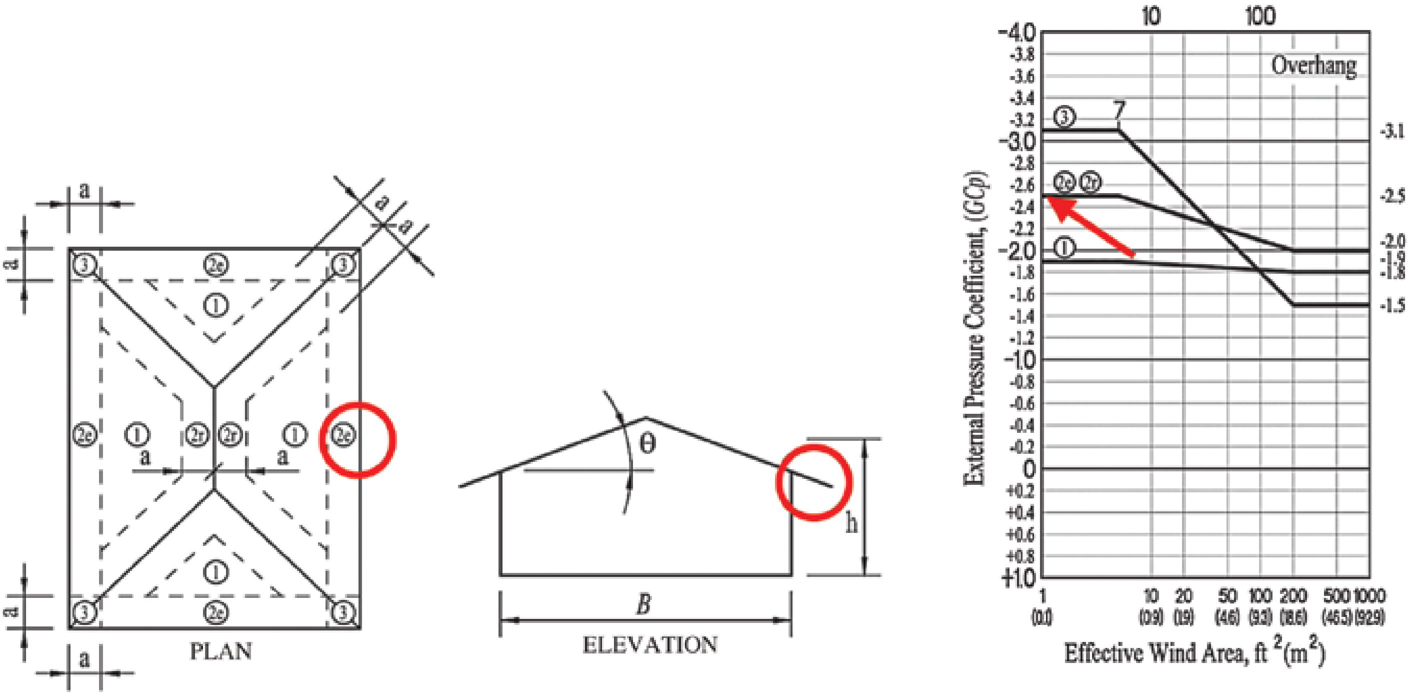

Figure 3. Roof overhang for Zone 2e, extracted from ASCE 7-16 Figure 30.3-2G.

as a partially open building; the site elevation is 897 feet. The resulting C&C pressures are shown in the *Table* (*page 16*) for a velocity pressure of 15.8 psf. For those coefficients that could not be read from the graphs, the equations in the ASCE 7-22 commentary were used.

The ASCE 7-16 (GC_p) coefficient for a hip roof Zone 3 location (no overhang) with a 35° slope and an EWA of 20 square feet is determined from the equation (GC_p) = 1.25-0.108*θ = -2.53. In ASCE 7-22, the (GC_p) value for a 35° slope is interpolated between the (GC_p) value for 27° and 45°. The (GC_p) value for 27° and EWA of 20 square feet is -3.00+1.00logA = -1.7 and the value for 45° and EWA of 20 square feet is -3.80+1.40logA = -1.98. These two values must then be interpolated using the formula shown in Figure 30.3-2G. The interpolation formula for this example is: (1.98-1.7)*(35°-27°)/(45°-27°)+1.7 = 1.82.

Determining (GC_p) coefficients for roof overhangs in ASCE 7-16 required reading a different graph (or using a different set of equations) than was required for the main roof. For example, the overhang (GC_p) coefficients for a hip roof with a slope of 20° – 27° are shown in *Figure 3* (*Figure 30.3-2G from ASCE 7-16*). Zone 2e (zone along the eave) with EWA of 10 square feet or less has a coefficient of -2.5. This coefficient includes pressure contributions from the overhang's upper and lower surfaces.

ASCE 7-22 has simplified this process by simply adding the roof surface coefficient to the wall surface coefficient at a point of interest on the overhang. The process is shown in *Figure 4* (*Figure 30.7-1 in ASCE 7-22*).

Using the ASCE 7-22 process yields a (GC_p) coefficient for the same Zone 2 as shown above of -2.0 (*Figure 30.3-2F from ASCE 7-22*) for the roof surface contribution and +1.0 (*Figure 30.3-1 from ASCE 7-22*) for the wall surface contribution for a total of -3.0 coefficient. The theory is that positive wall pressure washes up the wall and strikes the underside of the soffit, adding to the uplift pressure on the top of the roof surface.

Conclusion

The C&C (GC_p) coefficients developed for ASCE 7-22 are typically either the same as ASCE 7-16 or slightly lower (*Table*). Thus, the required design pressures for C&C are slightly reduced. Since the basic results found in the wind tunnel studies that support the coefficients did not change from ASCE 7-16 to ASCE 7-22, the coefficient results are not expected to change dramatically. The reductions, where they occur, primarily result from the simplification methods and increased EWA basis described in this article. The authors hope that the practice finds these simplifications for determining C&C wind pressures helpful.▪

William Coulbourne is a Structural Engineering consultant with Coulbourne Consulting, Churchton, MD.

Philip Line is Vice President of Codes & Regulations for the American Wood Council, Leesburg, VA.

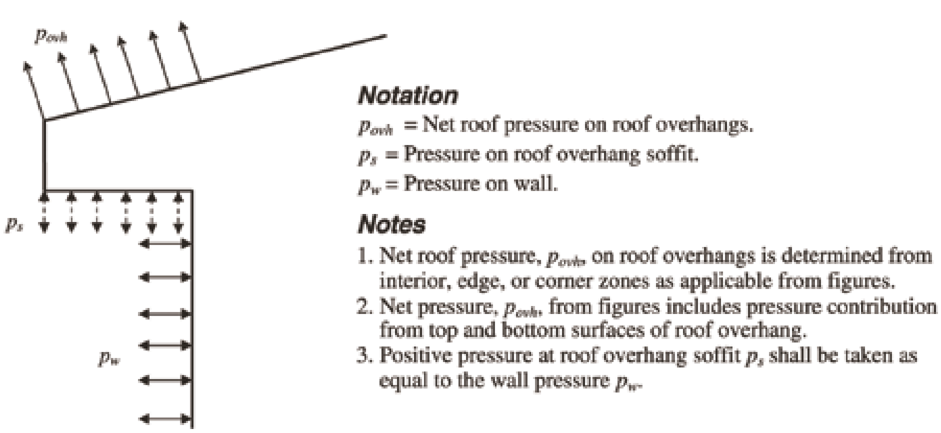

Figure 4. C&C wind Loading on overhangs, Figure 30.7-1 in ASCE 7-22.