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# Structural Engineers Association of Colorado Recommendations Relating to IBC 2018 & ASCE 7-16 Wind Load Provisions

The 2018 International Building Code, which has been or will be adopted by many Front Range communities, designates ASCE 7-16 as a referenced standard. IBC 2018 / ASCE 7-16 contain significant changes relative to the wind load provisions of IBC 2015 / ASCE 7-10 that impact the determination of design wind loads in the Front Range region. These changes affect the use of the 2013 Colorado Front Range Gust Map to determine design wind speed and the effect of air density on the calculation of design velocity pressures using ASCE 7. The SEAC Wind Loads Committee will be working toward incorporating the recommendations regarding wind speed into a revised Colorado Front Range Gust Map. This document provides interim recommendations.

## Colorado Front Range Gust Map

The Colorado Front Range Gust Map was first introduced in 2006 for use with ASCE 7-02 and 7-05 and contained 50-year recurrence wind speed contours. The Gust Map was updated in 2013 to be used with ASCE 7-10, which utilized wind maps with recurrence intervals of 700 years (Risk Category II), 1,700 years (Risk Categories III & IV) and 300 years (Risk Category I) in Chapter 26. Changes in ASCE 7-16 that impact use of the 2013 Gust Map include:

- Wind speed map contour changes that reduce design wind speeds in the Front Range area
- Moving the eastern border of the Front Range special wind region further west, potentially leading to further reductions in design wind speed in many Front Range communities
- Adding a new wind speed map for Risk Category IV structures with a 3,000 year recurrence interval

## Colorado Special Wind Region as Defined by IBC 2018 & ASCE 7-16

The boundaries of the Colorado Special Wind Region were changed in IBC 2018/ASCE 7-16 to resolve a graphical inconsistency unintentionally introduced between ASCE 7-93 and ASCE 7-95. This recent revision had the effect of relocating Colorado's Special Wind Region to the west, now excluding significant areas to the east of the foothills that were previously included and including some areas to the west that were previously excluded. This change has varying implications, depending upon location:

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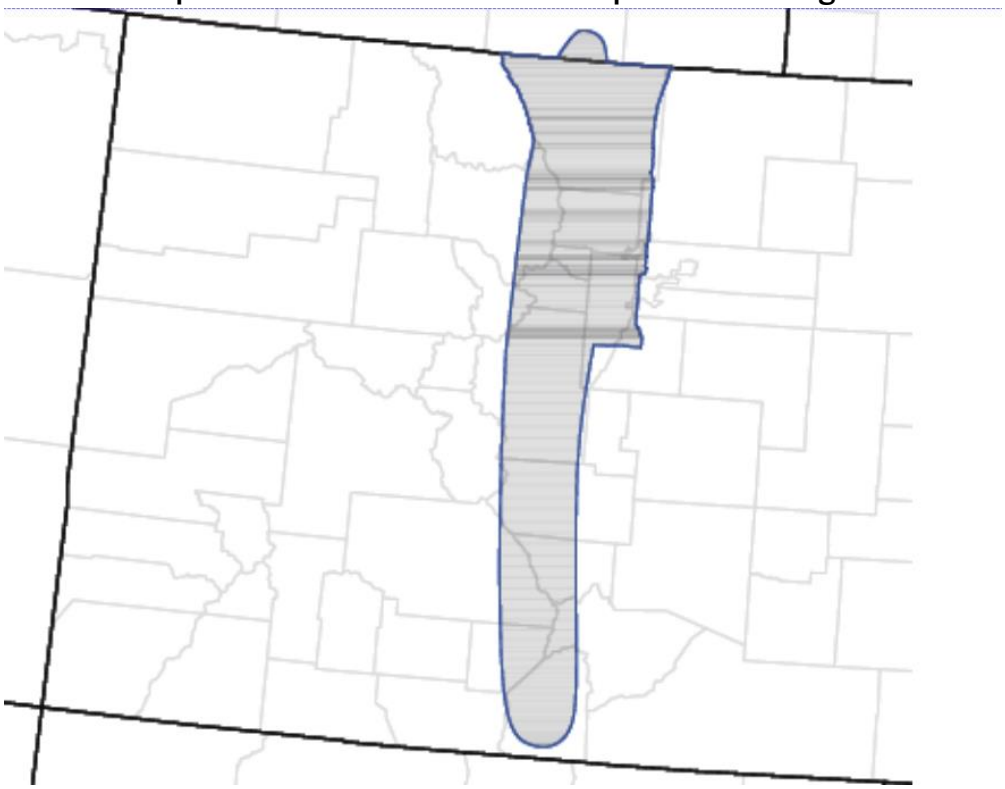
- Significant portions of the eastern boundary of the Special Wind Region from ASCE 7-95 to ASCE 7-10 did not need to be included, according to regional climatic data. Excluding these areas from the Special Wind Region improves and simplifies the specification of wind design criteria for communities in these areas of Colorado.

- The eastern boundary of the new ASCE 7-16 Special Wind Region is too far west, according to regional climatic data. The new boundary runs directly through or just to the west of numerous Front Range Communities with well-documented histories of extraordinary winds. Use of the design wind speeds allowed by the ASCE 7-16 wind contours could result in unconservative designs along the margins of the new special wind region.

ASCE is in the process of revising the Special Wind Region in ASCE 7-22 to conform to the limits of the Colorado Front Range Gust Map. However, the current version of the maps will remain in effect until ASCE 7-22 is published and adopted. In the interim, the following map provides the revised boundaries that are likely to be incorporated into the reference standards in the next code cycle. These boundaries are based on a reconciliation of the ASCE 7-16 boundaries with the 2013 Colorado Front Range Gust Map.

Proposed Boundaries of Colorado Special Wind Region



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### ASCE 7-16 Section 26.9 – Ground Elevation Factor

Section 26.9 adds a ground elevation factor to adjust for air density, $K_e$, to the body of the code. Previously, wind pressures could be reduced as allowed by the authority having jurisdiction using a method in Chapter C27 of the ASCE 7-10 Commentary. This method calculated a reduction to the coefficient in the wind velocity pressure equation that reflects the mass density of air. The new $K_e$ factor is a function of the ground elevation above sea level and has been added to the basic velocity pressure equation in Section 26.10.2. For a ground elevation that is 5,000 feet above sea level, the calculated velocity pressure would be 83% of the calculated velocity pressure at sea level due to the $K_e$ factor. In comparison, the method in the Commentary resulted in a wind pressure at elevation 5,000 feet that was 86% of the sea level wind pressure. As a conservative simplification, Section 26.9 allows the use of $K_e = 1.0$ in all cases.

### IBC 2018 Section 1609.3 – Wind Speed Terminology

The terminology describing wind speeds has struggled to keep up with and convey recent changes to the reference standards for structural design. The Basic Wind Speed, V, in ASCE 7-93 referred to a "fastest mile" speed measured 10 meters above the ground in exposure category C with a return period of 50 years. In ASCE 7-95, the Basic Wind Speed, V, became a "3-second gust" but was otherwise consistent with the prior definition. In ASCE 7-10, the Basic Wind Speed, V, was revised further to represent the design wind speed producing the ultimate factored-level wind pressures associated with Load and Resistance Factor Design (LRFD). The IBC attempted to clarify the issue and ease the transition by introducing the terms $V_{ult}$ for the new ultimate wind pressure and $V_{ASD}$ for the old 50-year return period pressure. The new Allowable Stress Design (ASD) provisions actually used $V_{ult}$ to calculate design pressures, introducing potential confusion. With ASCE 7-10 each geographic location no longer had a single Basic Wind Speed, but multiple Basic Wind Speeds conveyed in multiple maps depending on Risk Category. ASCE 7-16 retained the ASCE 7-10 conventions but added a map for Risk Category IV, and IBC 2018 dropped the $V_{ult}$ term consistent with ASCE 7, while $V_{ASD}$ persists.

Establishing clear and correct criteria for wind design has been a challenge for jurisdictions in Special Wind Regions. For building codes based upon ASCE 7-10 and later, Basic Wind Speeds, V, are ultimate-level speeds that are different for each risk category. Citing the previous 50-year return-period speed or just a single ultimate-level speed is not strictly compatible with current codes, no matter how qualified. Further, jurisdictions that span broad variations in wind climate should provide criteria that vary accordingly. Reference the 2013 Colorado Front Range Gust Map for guidance.

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## Interim Recommendations

The Wind Loads Committee offers the following interim recommendations regarding the above referenced issues.

1. **Design wind speeds for jurisdictions within the limits of the area covered by the 2013 Colorado Front Range Gust Map should continue to be determined using the wind speed contours presented in that report.** The report continues to provide the most accurate and applicable wind design criteria along the Colorado Front Range. The continued use of the 2013 Gust Map contours is justified in accordance with ASCE 7 Section 26.5.3 which allows the use of appropriate regional climatic data to determine design wind speeds. If desired, continuity along the eastern edge of the Front Range can be achieved by interpolating between the 115 mph contour for Risk Category II structures in the 2013 Gust Map and the 110 mph contour in ASCE 7-16.

2. **Special care should be exercised to utilize clear and correct terminology in describing wind speed criteria for design.** The Basic Wind Speed, V, is an ultimate factored-level speed that varies by Risk Category. This is the same as the Ultimate Design Wind Speed, $V_{ult}$, but "Ultimate Design Wind Speed" is no longer a referenced term, and should not be used. The Allowable Stress Design Wind Speed, $V_{ASD}$, may also be provided for reference, context, and for use outside the area of structural design such as roofing, siding and windows.

3. **The boundaries of the Front Range Special Wind Region should be amended from those shown in IBC 2018/ASCE 7-16.** Use of the proposed boundaries shown above provides consistency with the regional climatic data and with in-process revisions to the reference standards in the next code cycle. Communities within the boundaries of the Special Wind Region should take special care in their amendments to strike or amend ***all*** IBC 2018 references that permit use of the wind speed maps in ASCE 7-16; otherwise, use of unconservative wind speeds may be permitted. Sections of IBC 2018 that reference the ASCE 7-16 wind maps (which do not match the 2013 Colorado Front Range Gust Map) include 1609.1.1 and 1609.3.

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4. **Design wind speeds for Risk Category IV structures should be based on the following table:**

**Basic Design Wind Speeds (mph)**

| 50 Yr Gust Speed* (Risk Category II) | 700 Yr Gust Speed (Risk Category II) | 3000 Yr Gust Speed (Risk Category IV) |
|---|---|---|
| 90 | 115 | 125 |
| 100 | 125 | 140 |
| 110 | 140 | 155 |
| 120 | 150 | 170 |
| 130 | 165 | 185 |
| 140 | 175 | 195 |
| 180 | 225 | 255 |

*$V_{ASD}$ (for reference and comparison with ASCE 7-05 and earlier

The 2013 Front Range Gust Map report provides an equation to calculate the rate of change of wind speed as a function of the recurrence interval for the Front Range:

$$F_{rc} = 0.36 + 0.10 \ln(12T)$$

where T is the return period in years and $F_{rc}$ is the ratio of the return period speed at T years to the return period speed at 50 years. Therefore, for T = 3,000 years, $F_{rc}$ = 1.41. The tabulated 3,000 year speeds have been rounded to the nearest 5 mph consistent with ASCE 7 maps.

5. **The ground elevation factor, $K_e$, may be used to reduce wind pressures in accordance with ASCE 7 provisions at the discretion of the designer and subject to the approval of the authority having jurisdiction.** The use of this reduction factor is optional. Reduced wind pressures calculated with this factor are consistent with the reduced pressures previously calculated using ASCE 7-10 Commentary Section C27.3.2, which is consistent with accepted engineering practice in Colorado.

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The above recommendations are strictly advisory in nature and are not a substitute for the designer's engineering knowledge and professional judgment. At this time, the recommendations have not been endorsed by the Structural Engineers Association of Colorado Board of Directors or the General Membership. The recommendations do not supersede local building code regulations and their usage is subject to the approval of the authority having jurisdiction over the work.

Respectfully submitted,
SEAC Wind Loads Committee

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