NCSEA

National Council of Structural Engineers Associations

As the recovery efforts begin in the communities affected by the Hurricane Ian, Structural Engineers will be called on to assist. As Structural Engineers assist in these efforts, they may be called on by media, community leaders or property owners to provide background on current and future hurricane and high wind design requirements and what our profession is doing to help communities prepare for future events. Following is some background information that was authored and reviewed by the NCSEA Wind Engineering Committee that may be of use to your SEA and its members to assist in forming responses to these types of inquiries.

Structural Engineering for Hurricanes FAQ

What is the relation between hurricane wind speed and building design wind speed? Are ASCE 7 wind loads correlated to hurricane categories 3, 4, or 5?

ASCE 7 *Commentary* Table C26.5-2 provides an approximate relationship between wind speeds in ASCE 7 and Hurricane Categories 1-5.

Table C26.5-2. Approximate Relationship between Wind Speeds in ASCE 7 and Saffir–Simpson Hurricane Wind Scale.

Saffir–Simpson Hurricane Category	Sustained Wind Speed over Water[a]		Gust Wind Speed over Water[b]		Gust Wind Speed over Land[c]	
	mi/h	m/s	mi/h	m/s	mi/h	m/s
1	74–95	33–42	90–116	40–51	81–105	36–47
2	96–110	43–49	117–134	52–59	106–121	48–54
3	111–129	50–57	135–157	60–70	122–142	55–63
4	130–156	58–69	158–190	71–84	143–172	64–76
5	>157	>70	>191	>85	>173	>77

[a] 1 min average wind speed at 33 ft (10 m) above open water.
[b] 3 s gust wind speed at 33 ft (10 m) above open water.
[c] 3 s gust wind speed at 33 ft (10 m) above open ground in Exposure Category C. This column has the same basis (averaging time, height, and exposure) as the basic wind speed from Figure 26.5-1.

Hurricane intensities are reported by the National Hurricane Center according to the Saffir–Simpson Hurricane Wind Scale. This scale is used by hurricane forecasters, local and federal agencies responsible for evacuation of residents, long-range disaster planners, and the news media. The scale contains five (5) categories of hurricanes and distinguishes them based on wind speed intensity.

The wind speeds used in the Saffir–Simpson Hurricane Wind Scale are defined in terms of a sustained wind speed with a *1-min averaging time* at *33 ft* over *open water*. The ASCE 7 standard uses a *3-s gust speed* at *33ft* above *ground in Exposure C* (defined as the basic wind speed and shown in the wind speed maps).

Table C26.5-2 provides the sustained wind speeds of the Saffir–Simpson Hurricane Wind Scale over water, equivalent-intensity gust wind speeds over water, and equivalent-intensity gust wind speeds over land (ASCE 7 equivalent). For a storm of a given intensity, Table C26.5-2 takes into consideration both the reduction in wind speed as the storm moves from over water to over land because of changes in surface roughness and the change in the gust factor as the storm moves from over water to over land.

What is a "hurricane prone region"?

As defined in ASCE 7, hurricane prone regions in the United States and its territories are areas vulnerable to hurricanes. These regions meet one of the following characteristics:

- The US Atlantic Ocean and Gulf of Mexico coasts where the basic wind speed for Risk Category II buildings is greater than 115 mi/h (51.4 m/s); and
- Hawaii, Puerto Rico, Guam, US Virgin Islands, Northern Mariana Islands, and American Samoa.

Do the ASCE 7 Wind Speed Maps include the effects of climate change?

Current versions of ASCE 7 (7-22 and previous) do not consider future conditions, but instead use historical data to generate the wind speed maps in ASCE 7. Most structures have life spans of 50 to 100 years. Climate scientists have reached an overwhelming consensus that hurricane intensities will tend to increase because of climate change. As a result of these two facts, an effort is underway to generate wind loads in ASCE 7-28 that address climate change effects, to ensure buildings and other structures continue to provide low risks of failures over their lives.

Why and how are buildings and structures damaged during hurricanes?

Damage to buildings and structures may result from wind, flood, or a combination of both.

Wind damage to components and cladding, which typically includes roof covering and wall elements, is frequently observed in hurricane events. Damage to components and cladding opens the interior of buildings to water intrusion, and high wind pressures. When hurricane winds are able enter an enclosed building, they cause a rapid increase in roof and wall wind pressures, causing further damage to components and cladding, creating wind-borne debris. Wind-borne debris can cause further damage to unprotected windows in the affected building, as well as nearby buildings. ASCE 7, Chapter 30, provides design guidance for determining wind pressures on component and cladding elements, and identifies critical areas of the roofs (Zones 2 & 3) and walls (Zone 5) where the highest wind pressures occur at building geometry changes.

Flood loads are a significant cause of damage during and after hurricane events. The most common flood loads in a hurricane result from storm surge in *costal high hazard areas*. Buildings or structures subjected to flood loads must resist hydrodynamic loads due to moving water, impact loads from wave action and floating debris impact, along with wind loads. Additional flooding can occur in areas away from the coast during and after a hurricane due to the rainfall associated with the storm. Flood risk and flood categories are currently determined using FEMA Flood Insurance Rate Maps (FIRM), and flood loads are calculated using Chapter 5 of ASCE 7. Additional design requirements are prescribed in the IBC and ASCE 24.

Do all structures in hurricane prone regions have impact-resistant glazing?

ASCE 7 and the International Building Code (IBC) require protection for glazed openings in *wind-borne debris regions*, which are a subset of *hurricane prone regions*. The use of impact-resistant glazing is now common in new construction in many *hurricane prone regions* to mitigate internal pressurization of buildings during hurricane events.

What are wind-borne debris regions?

Wind-Borne Debris Regions include the following locations:

1. Within 1 mile of the mean high-water line where an Exposure D condition exists up wind of the water line and the basic wind speed is equal to or greater than 130mi/h, or

2. In areas where the basic wind speed is equal to or greater than 140 mi/h.

What is impact resistant glazing?

Glazing in buildings requiring protection can either be classified as *impact resistant* or be protected with an *impact-protective system*. *Impact-protective systems* and *impact-resistant glazing* are approved by passing missile and cyclic pressure differential tests in accordance with ASTM E1996.

Does the building code prescribe load amplification factors for structures in Hurricane Prone Regions like it does for buildings in high seismic regions?

No. Seismic provisions envision a design event where the building performs inelastically to dissipate energy. An "omega" factor is applied to critical elements in the system which are not intended to be part of the inelastic performance of the building (cantilever columns, discontinuous walls or frames, drag elements). In contrast, wind provisions of ASCE 7 do not envision a significant inelastic behavior of the building under a design wind event. Thus omega factors are not required for wind design.