Calculating Wind Loads on Buildings Using the Envelope Procedure of ASCE 7-22 Code

An Online Continuing Education Course for Engineers

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Introduction

Structures must be built to withstand wind loads prescribed by the code, as must their constituent parts. To ensure the safety and stability of structures against wind forces, the fundamental component of structural engineering known as wind load cannot be ignored, which is the force that the wind exerts on a structure (Fig. 1).

ASCE 7 offers techniques for determining the design wind pressure depending on two types of applications: components and claddings (C&C) or the main wind force-resisting system (MWFRS). Given that the most recent version of ASCE7-22 is consistent with the International Building Code (IBC), which takes into account the most recent developments and structural engineering research, wind load analysis will be utilized to ensure the safety and longevity of buildings even in the face of severe wind conditions.

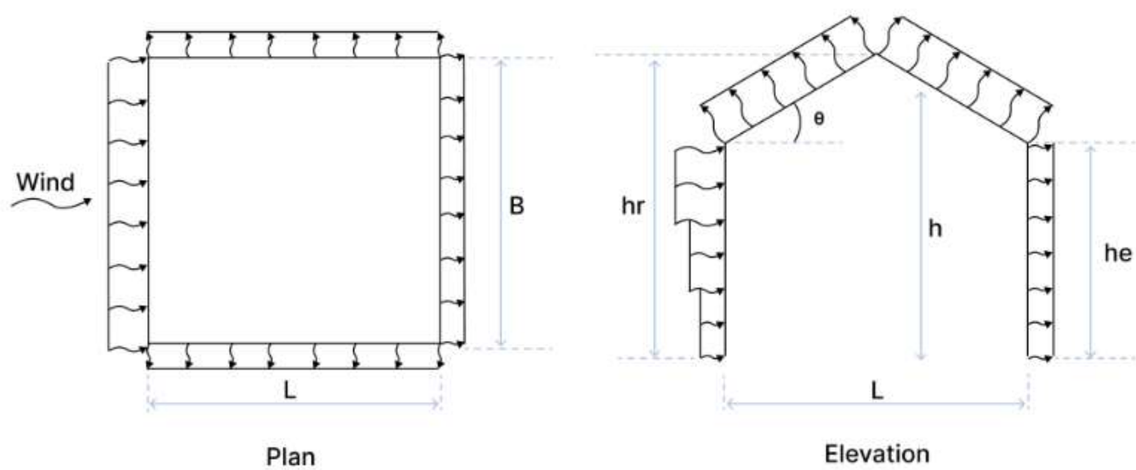


Figure 1: Wind loads exerted on a structure by the wind

<u>Importance of wind load checks</u>

Lightweight structures like steel and timber structures are more likely to fail under wind impacts due to their small weights compared to concrete ones; hence, it is more important to calculate wind load combinations and check their efficiency and stability to resist.

This course gives enough information about how wind loads are calculated using the envelope procedure of ASCE 7-22 Code to enable the professional engineer to correctly understand the standard's wind load requirements. The examples extensively reference sections of the standard as well as its figures and tables. A copy of the ASCE 7-22 Code is required in order to work with these courses and follow the examples.

Highlights of the Major Modifications to ASCE 7-22's Wind Load Provisions

ASCE/SEI 7-22, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures* (commonly referred to as ASCE 7-22), developed and published by the American Society of Civil Engineers (ASCE) and Structural Engineering Institute (SEI), will be the primary reference standard for structural loads in the 2024 *International Building Code, 2024 International Residential Code, and the 8th Edition (2023) Florida Building Code*. The standard specifies minimum structural design loads and other criteria for the design of buildings and other structures for dead, live, soil, flood, tsunami, snow, rain, atmospheric ice, earthquake, wind, and tornado loads. It also provides criteria on how to assess load combinations.

This overview highlights a few of the key significant changes to the wind loading design provisions contained in ASCE 7-22, as compared to the previous version (ASCE 7-16), that will affect building design. The topics in this overview include:

- ♣ Changes to the basic wind speed maps
- ♣ Change to the Wind-borne Debris Region (WBDR)
- ♣ Changes to the component and cladding external pressure coefficients (GCp) for roofs of buildings with roof slopes greater than 7°

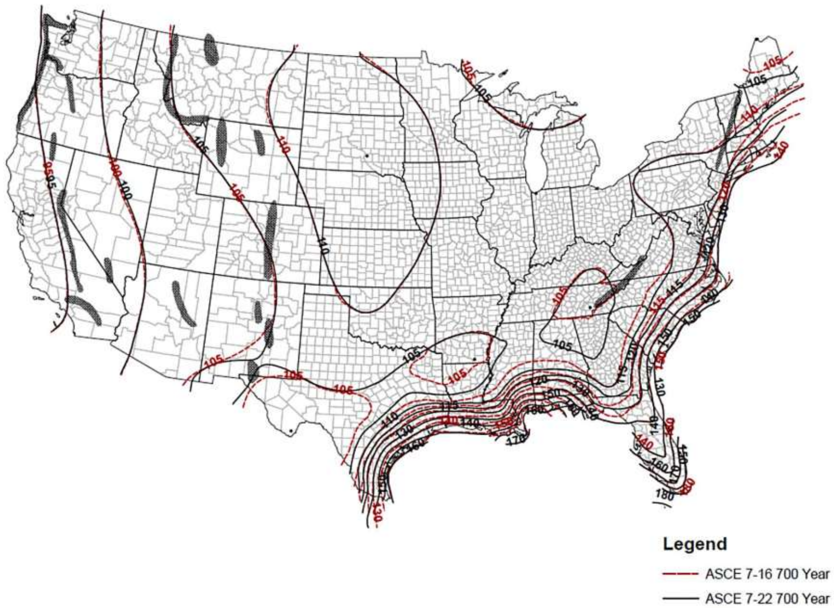
Changes to the Basic Wind Speed Maps

The basic wind speed maps in ASCE 7-22 have been revised primarily in hurricane-prone regions. These changes are the result of ongoing improvements to the hurricane simulation model that is used to develop the wind speeds in hurricane-prone regions. The changes also include better wind speed estimates in the areas where hurricane wind speeds transition to non-hurricane wind speeds adjacent to the hurricane-prone coast.

Summary of changes to basic wind speeds in hurricane-prone regions:

- ♣ Decreases along the North Atlantic coast
- ♣ Minor adjustments in the Carolinas and Virginia
- ♣ Increases along the Florida panhandle and Big Bend areas
- ♣ Slight decreases along the coastal areas of Alabama, Mississippi, and Louisiana
- ♣ Increases along the coastal areas of Texas

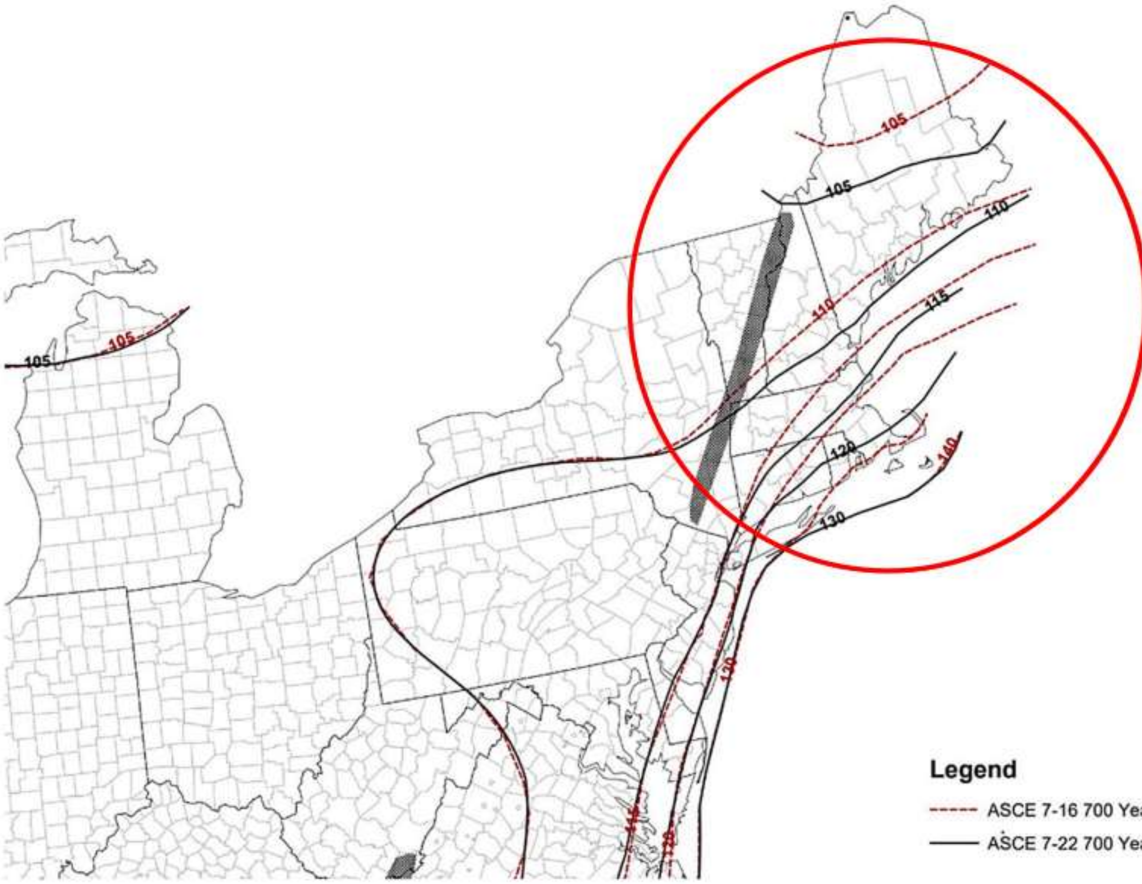
Figure 2 illustrates the changes to the basic wind speeds for Risk Category II buildings and structures in ASCE 7-22. The red dashed contours are the ASCE 7-16 Risk Category II wind speeds. The black contours are the ASCE 7-22 Risk Category II wind speeds. Similar adjustments occur for the Risk Category I, III, and IV maps.



(Source: Adapted from Figure 26.5-1B of ASCE 7-16 and Figure 26.5-1B of ASCE 7-22 with permission)

Figure 2: Comparison of basic wind speeds for Risk Category II buildings and structures in ASCE 7-16 and ASCE 7-22

Figure 3 provides a more detailed view of the changes along the North Atlantic coast. Basic wind speeds for the North Atlantic region have been decreasing from previous versions for the last three editions of ASCE 7. While wind speed contours have generally moved closer to the coast, reflecting slightly lower wind speeds, the shift of the 130 miles-per-hour (mph) contour completely off the coast is notable. (The 130 mph Risk Category II wind speed is the trigger in the *International Residential Code* for the *Wind Design Required Region* and one of the triggers for the *Wind-borne Debris Region*. The North Atlantic is now completely out of both regions, and conventional construction as permitted in the *International Residential Code* will be permitted throughout the area.)



(Source: Adapted from Figure 26.5-1B of ASCE 7-16 and Figure 26.5-1B of ASCE 7-22 with permission)

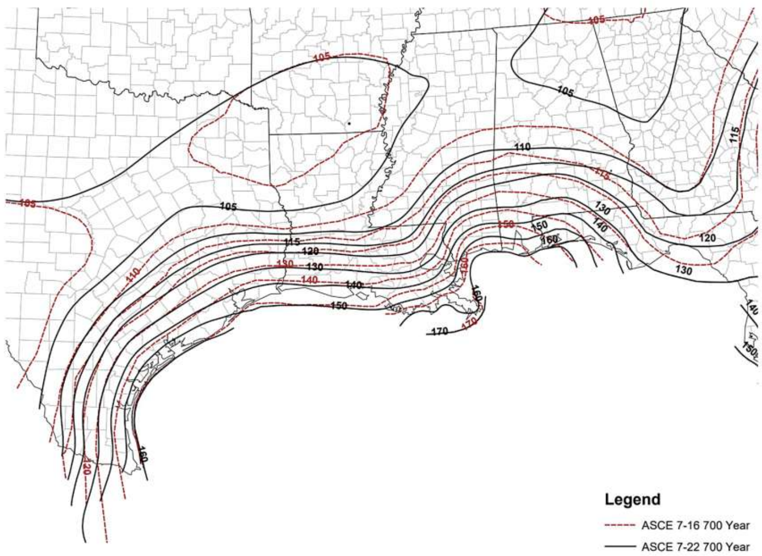
Figure 3: Basic wind speed changes along the North Atlantic coast for Risk Category II buildings and structures

Figure 4 provides a more detailed view of the changes along the Gulf Coast. Along the South Texas coast, basic wind speeds have increased by approximately 10 mph. Further inland, 130 mph or less wind speeds are slightly lower.

Along the coastal areas of Louisiana, Mississippi, and Alabama, wind speeds have generally decreased for most areas. The decrease is more significant in some areas than others. For example, the ASCE 7-16 Risk Category II wind speed for Mobile, Alabama, is 154 mph. In ASCE 7-22, the Risk Category II wind speed is 146 mph (approximately a 5% decrease). For Gulf Shores, Alabama, the wind speed is essentially the same in ASCE 7-22 as it is in ASCE 7-16.

In the Florida panhandle area, wind speeds have increased in some areas of the western part of the panhandle. For example, the ASCE 7-16 Risk Category II wind speed for Destin, Florida, is 142 mph. In

ASCE 7-22, the Risk Category II wind speed is 152 mph (approximately a 7% increase). In the Big Bend area of Florida (an informal region of Florida generally stretching from the Apalachicola River to the St. Johns River), the wind speeds have increased from ASCE 7-16, but are essentially the same as they were in ASCE 7-10. (While the 7th Edition (2020) *Florida Building Code* did adopt ASCE 7-16, it did not adopt the ASCE 7-16 Risk Category II basic wind speed map and maintained the ASCE 7-10 Risk Category II basic wind speed map.)



(Source: Adapted from Figure 26.5-1B of ASCE 7-16 and Figure 26.5-1B of ASCE 7-22 with permission)

Figure 4: Basic wind speed changes along the Gulf coast for Risk Category II buildings and structures

Changes to the Wind-borne Debris Region

As with ASCE 7-16, areas within hurricane-prone regions where the basic wind speed is 140 mph or greater are included in the WBDR unconditionally. However, the location of the WBDR has undergone a small but significant change in hurricane-prone regions where the basic wind speed is less than 140 mph but greater than or equal to 130 mph. The locations where the WBDR applies have been revised as follows:

ASCE 7-22

26.12.3.1 Wind-Borne Debris Regions. Glazed openings shall be protected in accordance with Section 26.12.3.2 in the following locations:

- Within 1 mi (1.6 km) of the ~~coastal~~ mean high water line where an Exposure D condition exists upwind of the water line and the basic wind speed is equal to or greater than 130 mi/hr (58 m/s), or
- In areas where the basic wind speed is equal to or greater than 140 mi/h (63 m/s).

The term "coastal mean high-water line" is not d... d, and its interpr... has varied across jurisdictions in the hurricane-prone region d... he new criteria in ASCE 7-22 delete the word "coasta..." ...ondition exist upwind of the water l... body of water (located in hurricane... n 130 mph and less than 140 m... urricane-prone regions, Exposure D a... 000 feet or 20 times the height of... e Panama City area of Florida, where...

For area A, bui... where the basic wind speed is e... er, for area B, the initial point to m... in ASCE 7-16 and earlier editions. ... B), any building located within 1 ... ter surface that prevails for at leas...

To view the remainder of the course material and to take the quiz for PDH credit, you must purchase the course.

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