CRMC Coastal Hazard App - Wind Speed

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Background

RI CRMC has developed a coastal hazard worksheet and viewer (Figure 1) as part of its permitting process for structures and infrastructure in coastal areas of the state. The steps required in the application are summarized below.

STEP 1. PROJECT DESIGN LIFE
STEP 2. SITE ASSESSMENT
STEP 3. STORMTOOLS DESIGN ELEVATION(SDE)
STEP 4. SHORELINE CHANGE
STEP 5A. OTHER SITE CONSIDERATIONS: CERI
STEP 5B. OTHER SITE CONSIDERATIONS: SLAMM
STEP 5C. OTHER SITE CONSIDERATIONS: WIND (to be added)
STEP 6. LARGE PROJECTS
STEP 7. DESIGN EVALUATIONS

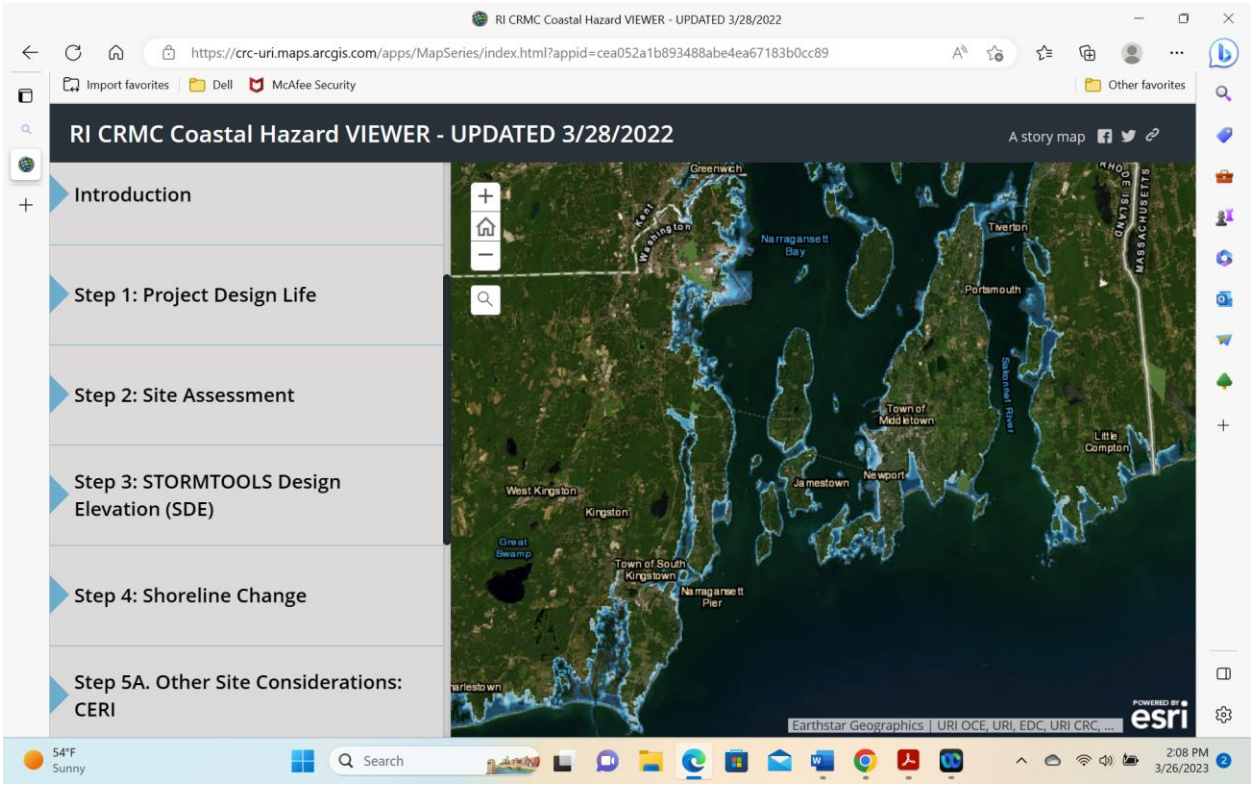
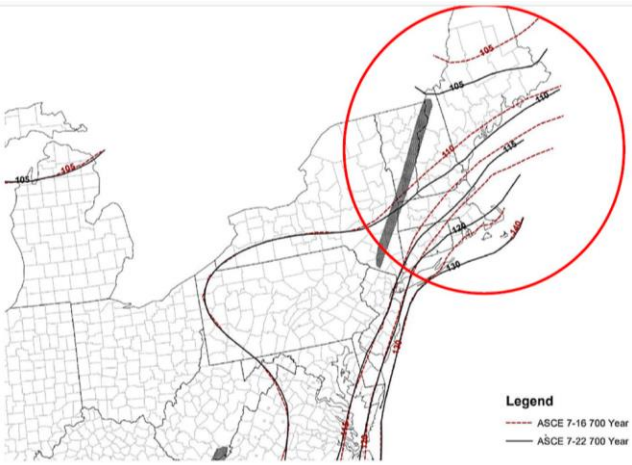


Figure 1 RI CRMC Coastal Hazard Viewer ([RI CRMC Coastal Hazard VIEWER - UPDATED 3/28/2022 (arcgis.com)])

The overarching goal of the coastal hazard worksheet/viewer is to have the applicant clearly understand the risks inherent to the project they are proposing. It starts with setting the design life for the project of interest and then requests information on the site, including flooding (considering the effects of sea level rise) via STORMTOOLS Design Elevation (Base Flood Elevation) maps, estimates of how shoreline erosion will impact the site, assessment of the risk level (damage to the structure for the design life from STORMTOOLS Coastal Environmental Risk Index (CERI), and an understanding of the implications of sea level rise on marsh migration, if this is relevant at the site.

One thing missing from the coastal hazard viewer is any sense of the design wind conditions at the site. These are of course closely linked to storm risk since they are dominated by tropical storms and hurricanes. They are also dependent on the type of structure. The design winds in the state vary widely with the transition between open water (Block and RI Sound and Narragansett Bay) and nearby coastal areas. The American Society of Civil Engineers (ASCE) has developed maps of the design wind speeds for the US that allows one to estimate wind conditions as part of the design guidance for structures and infrastructure. The standard is routinely updated to consider the most recent changes, in both structure design and changes in the probability of wind speeds with climate change. Figure 2 shows the wind speed contour maps for a residential structure (Risk Category II) in New England area from the 2016 (ASCE 7-16) (black line) and 2022 (ASCE 7-22) (red dashed line) standards. These standards are currently embedded in the building codes for most states and communities in the US, including RI (Chapter 16: Structural Design, 2019 Rhode Island Building Code | UpCodes).



(Source: Adapted from Figure 26.5-1B of ASCE 7-16 and Figure 26.5-1B of ASCE 7-22 with permission)
Figure 2: Basic wind speed changes along the North-Atlantic coast for Risk Category II buildings and structures

Figure 2 Basic wind speed changes along the North Atlantic coast for Risk Category II buildings and structures in ASCE 7-16 and ASCE 7-22. (https://www.fema.gov/sites/default/files/documents/fema_asce-7-22-wind-highlights_fact-sheet_2022.pdf).

Given the widespread use of these standards, ASCE has developed an online hazard tool

(https://asce7hazardtool.online/). The hazard tool considers all hazards at the site, including wind, flooding, earth quake, tsunami, snow, ice, rain, etc. The output of the viewer is shown in Figure 3 for the Ocean Mist, 895 Matunuck Beach Road, Wakefield, RI, assuming that the structure is equivalent to a residential structure (Risk Category II). The insert is the wind speed (mph) vs return period. The value predicted by the online tool is 124 mph (700 yr MRI). For risk category I (low hazard to humans, such as a warehouse) the wind speed is 118 mph (300 yr MRI). For risk category III (heightened risk to people) the value is 133 mph (1700 yr MRI), and for category IV (extensive risk to humans, such as a hospital or fire and police stations) (139 mph) (3,000 yr MRI).

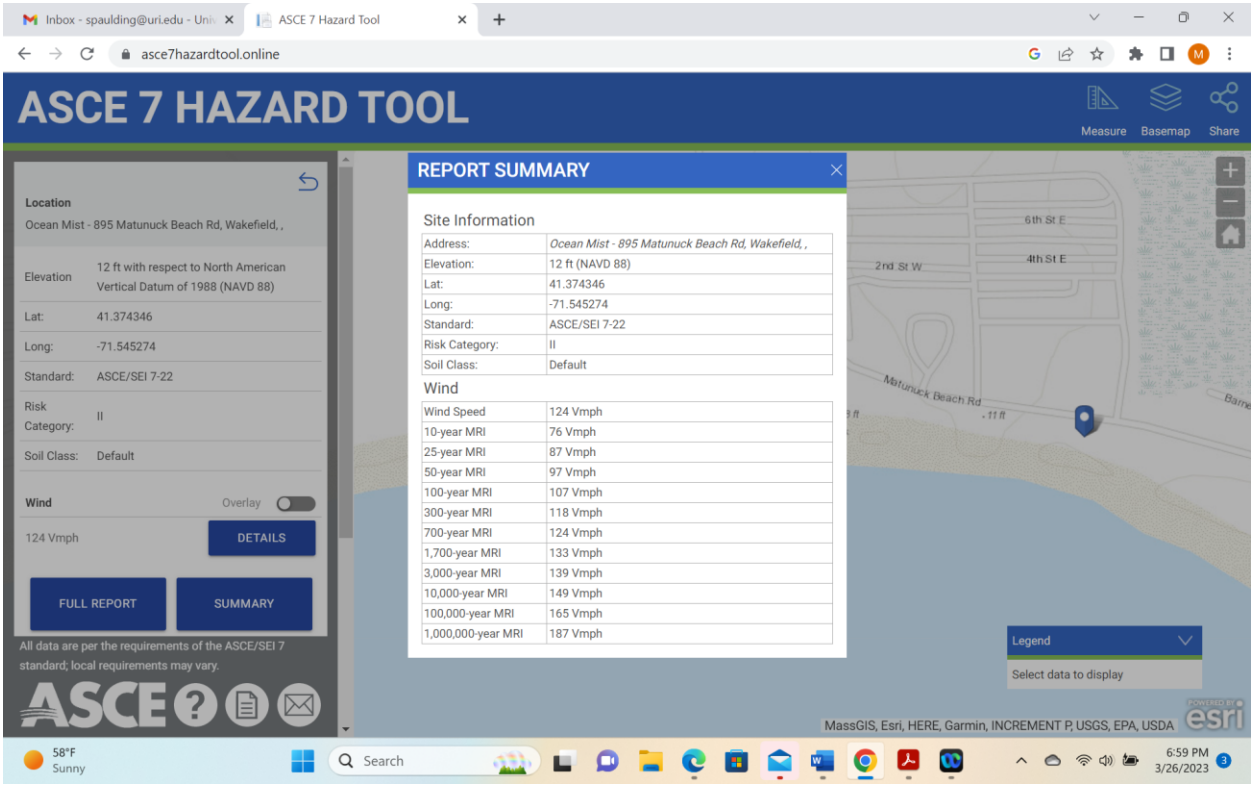


Figure 3 ASCE Hazard tool showing wind speed vs return period at the location of the Ocean Mist, Matunuck, RI (https://asce7hazardtool.online/).

It is recommended that provision for estimating the design winds at site of the permit application be added to the current CRMC Coastal Hazard Application. A summary of this step is provided below.

Method for Wind Estimates

STEP 5C OTHER CONSIDERATIONS: WIND

- Access ASCE7 online hazard tool (https://asce7hazardtool.online). (Figure 4)
- Specify the location of the structure (using one of the following approaches: address, latitude/longitude, or find on map).
- Select risk category of structure (I, II, III, or IV), (e.g. residential structure is Risk Category II) (explanation of risk categories are provided at https://www.engineeringexpress.com/wiki/asce-risk-categories-explained/).
- Select measurements (customary are English units, mph).
- Select wind load type, and then select view results.
- Select summary of results. The result is shown in the form of a table (highlighted here for illustration by number highlighted in the red circle).
- The design wind speed is 124 mph. (Figure 5 for the Ocean Mist example).

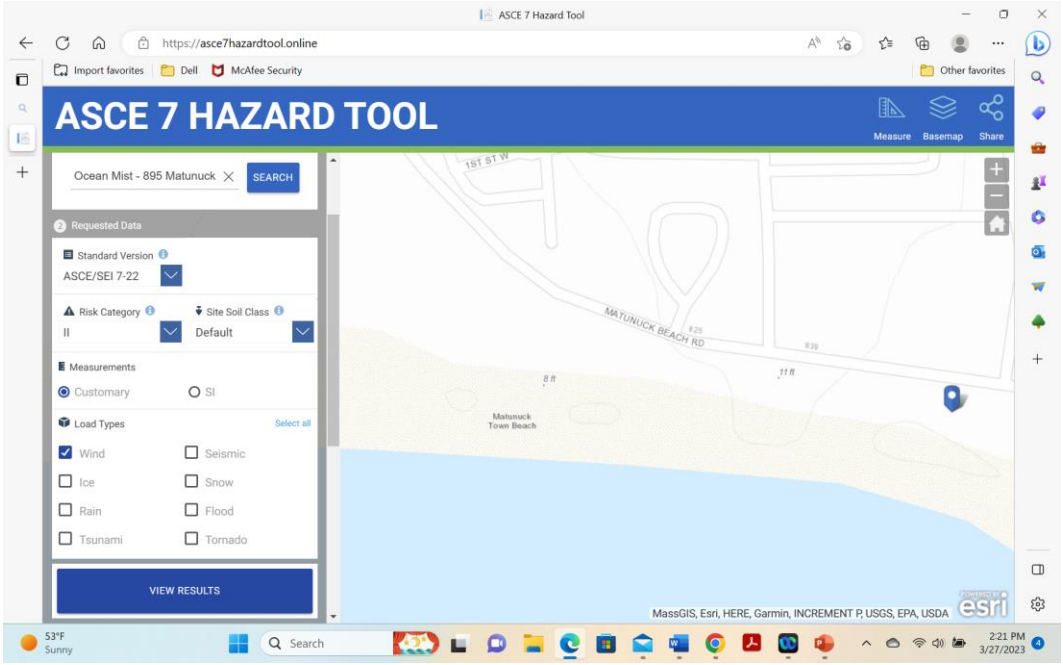


Figure 4 ASCE Hazard Tool showing menu at the location of the Ocean Mist, Matunuck, RI (https://asce7hazardtool.online/).

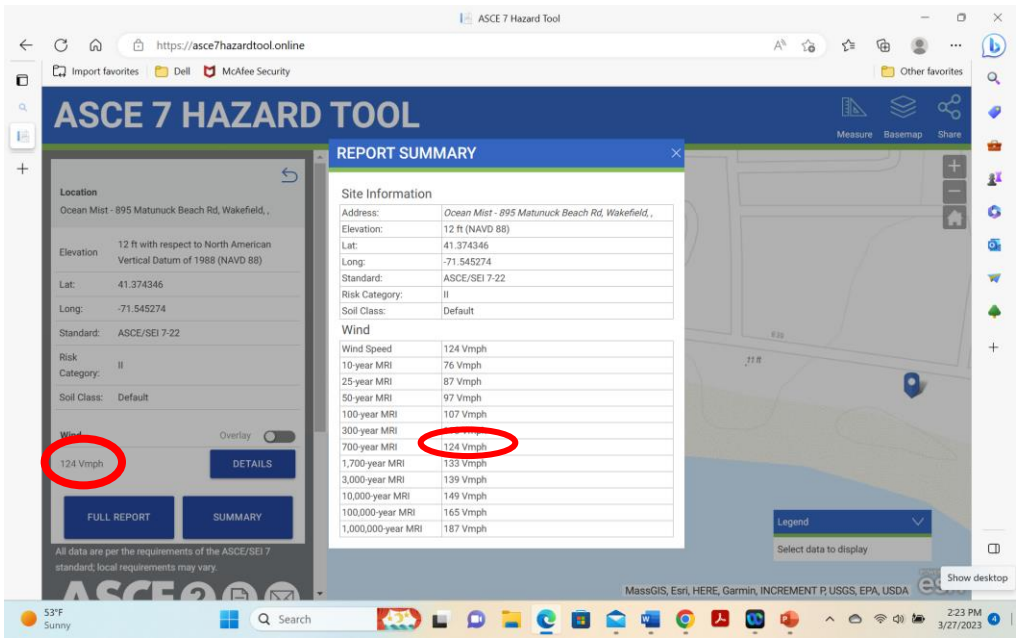


Figure 5 ASCE Hazard tool showing summary of results at the location of the Ocean Mist, Matunuck, RI (https://asce7hazardtool.online/).

Some important attributes of this approach:

1. The approach documents another important variable that is closely associated with storm surge and flooding events in the coastal zone and associated with the design of structures and infrastructure.

2. Uses state of the art methods and standards to determine wind speed for the location of individual structures. ASCE standards are currently embedded in the RI Building Code (Chapter 16: Structural Design, 2019 Rhode Island Building Code | UpCodes). Access to ASCE Hazard tool is ***free*** and covers the entire US. The tool is routinely updated (5 yr cycle) to address impacts of climate change.

3. First Street Foundation (FSF) has recently (March 2023) introduced a wind hazard tool for the US (Wind Factor - First Street Foundation). They claim that the tool has been designed to calculate the likelihood and intensity of a severe wind event impacting any property over the next 30 years. Wind Factor scores consider a property's risk from hurricane, tornado, or severe storms today and 30 years into the future. The FSF method has no regulatory standing in the state but potential users might assume that it does.

I was requested to review the summary report on this project by Alex Kuffner, ProJo environmental journalist, while it was embargoed. Once the embargo was lifted (February 28, 2023) access to the Wind risk tool became publicly available via the web site. To evaluate the FSF estimates, I applied the method for my home address (1674B Ministerial Road, South Kingstown, RI). The risk level for wind was 104 mph for current conditions, increasing to 116 mph in 30 yrs (Figure 6). This is for 1 in 3000 yr storm event (Figure 6). It is not clear why FSF has selected this return period as it corresponds to ASCE Risk Category IV.

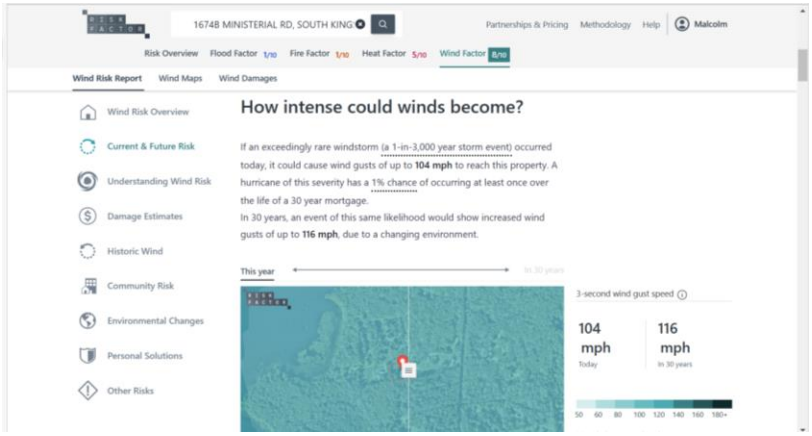


Figure 6 First Street Foundation (FSF) wind risk level at 1674B Ministerial Road, Wakefield, RI. (1674B MINISTERIAL RD, SOUTH KINGSTOWN, RI 02879 Wind Factor™ | Risk Factor).

For comparison the ASCE Hazard Tool shows a wind speed of 123 mph for 700 yr return period (design winds) and 138 mph for 3000 yr return period (see return period table in Figure 7). The FSF method substantially underestimates the current risk (24.6%) and the future risk (15.9%). It would be a serious underestimate of the risk if applicants thought the most recent predictions offered by FSF were used.

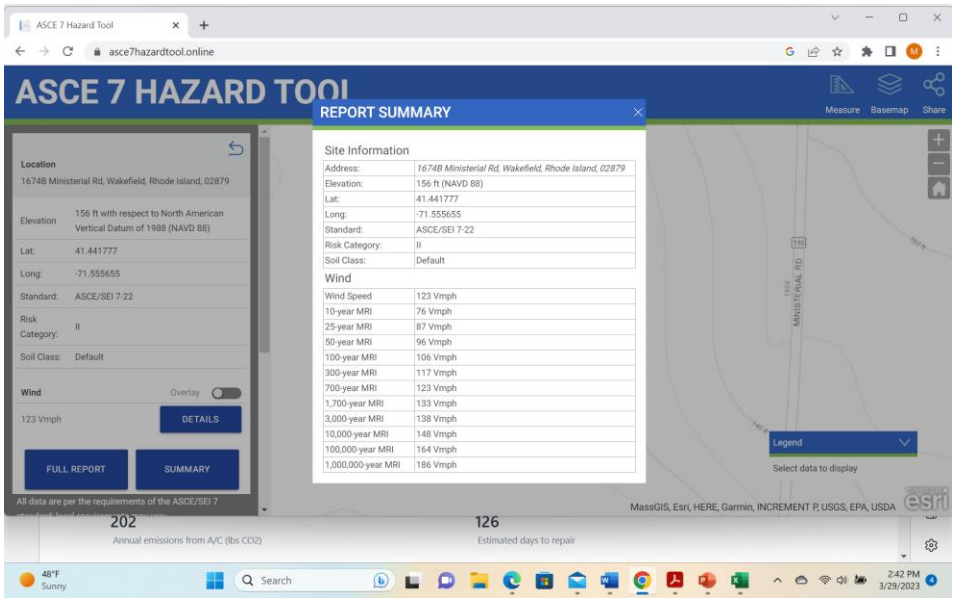


Figure 7 Wind design speeds for Risk Category II structure at 1674B Ministerial Road, South Kingstown, RI (https://asce7hazardtool.online/).

References

ASCE/SEI 7-22 Minimum Design Loads and Associated Criteria for Buildings and Other Structures. Standards Committee of the Codes and Standards Activity Division of the Structural Engineering Institute of ASCE. (https://www.asce.org/publications-and-news/civil-engineering-source/article/2021/12/02/updated-asce-7-22-standard-now-available).

ASCE Hazard Tool (https://asce7hazardtool.online/)

CRMC Coastal Hazard Viewer (RI CRMC Coastal Hazard VIEWER - UPDATED 3/28/2022 (arcgis.com))

First Street Foundation (FSF) Wind Factor (Wind Factor - First Street Foundation)

ASCE/SEI 7-22
Minimum Design Loads and Associated Criteria for Buildings and Other Structures,

Abstract
Prepared by the Minimum Design Loads and Associated Criteria for Buildings and Other Structures Standards Committee of the Codes and Standards Activity Division of the Structural Engineering Institute of ASCE

Minimum Design Loads and Associated Criteria for Buildings and Other Structures, ASCE/SEI 7-22, provides the most up-to-date and coordinated loading provisions for general structural design. This standard prescribes design loads for all hazards including dead, live, soil, flood, tsunami, snow, rain, atmospheric ice, seismic, wind, and fire, as well as how to evaluate load combinations. The 2022 edition of ASCE 7, which supersedes ASCE 7-16, coordinates with the most current structural material standards including those from ACI, AISC, AISI, AWC, and TMS.

Significant technical changes include the following: new target reliability tables for tsunami and extraordinary loads; new alternative method for loads from water in soil; terminology change from guardrail system to guard system; new provisions for emergency vehicle loads; updated tsunami data for Hawaii and many populous locations in California, coordinated with the state agencies; new tsunami provisions for above-ground horizontal pipelines; revised ground snow loads to reflect more recent snow load data and reliability-targeted values; revised method for estimating drifts to include a wind parameter; design rain load revisions to explicitly consider a ponding head; new risk-targeted atmospheric ice load data for the continental United States and Alaska; multi-period response spectrum data that eliminates need for Fa and Fv coefficients; new lateral force resisting systems such as steel and concrete coupled composite plate shear walls, reinforced concrete ductile coupled shear walls, cross-laminated timber shear walls, and concrete tabletop structures; new provisions for rigid wall, flexible diaphragm buildings (big box stores/warehouses); new and updated provisions for supported and interconnected (coupled) nonbuilding structures; new wind provisions for MWFRS and C&C of elevated buildings; new chapter of tornado provisions; new long return period hazard maps for wind and tornado; and digital data available for all hazards at ASCE Hazard Tool (https://asce7hazardtool.online/).

In addition to the technical changes, the 2022 edition of ASCE 7 provisions are accompanied by detailed commentary with explanatory and supplementary information developed to assist users of the standard, including design practitioners, building code committees, and regulatory authorities.

Standard ASCE/SEI 7 is an integral part of building codes in the United States and around the globe and is adopted by reference into the International Building Code, International Existing Building Code, International Residential Code, and NFPA 5000 Building Construction and Safety Code. Structural engineers, architects, and those engaged in preparing and administering local building codes will find the structural load requirements essential to their practice.