Status of Building Codes in New Jersey and New York: The Future of Resilience in a Post-Sandy Environment

Sandy devastated properties in several states, but primarily in New York and New Jersey. Now, as storm victims and other stakeholders repair and rebuild communities, many challenges remain. Questions loom about whether to rebuild certain properties at all, as well as how to elevate, repair and/or rebuild other properties to reduce vulnerability to future storms. As often happens in a post-disaster environment, there will be pressure to simply build back what was damaged or destroyed because devastated individuals, families and communities will understandably push to recover as quickly as possible. However, we must not lose sight of the opportunities afforded by these repair and rebuilding activities to strengthen and protect properties to prevent owners from being victimized by future storms.

The Insurance Institute for Business & Home Safety (IBHS) has examined building codes currently being used in New York and New Jersey. As a result of this analysis, IBHS provides the following critical information and suggestions to help increase building resilience for future storms.

QUICK LINKS

Q. What building codes currently apply in New York and what did they use before?

A. New York State uses the 2006 edition of the International Building Code (IBC), the 2006 International Residential Code (IRC) and the 2006 International Existing Building Code (IEBC) for all construction within the state. However, New York City follows the 2008 City of New York Building Code, which is based on the 2003 edition of the IBC and applies to both non-residential and residential construction. The first modern building code in New York State was the New York Uniform Fire Prevention and Building Code, which took effect Jan.1, 1984. Prior to that adoption, the city used the 1968 Building Code of New York.

Q. What building codes currently apply in New Jersey and what did they use before?

A. New Jersey uses the 2009 edition of the IBC, the 2009 IRC and the 2009 IEBC for all construction within the state. Prior to adoption of the 2000 editions of the IBC and IRC on May 5, 2003, the State of New Jersey used various editions of the Building Officials & Code Administrators International (BOCA) National Building Code (BNBC). The 1975 edition of the BNBC was the first to be adopted and became effective Jan.1, 1977. The last edition of the BNBC used prior to the adoption of the I-Codes was the 1996 edition, which took effect July 6, 1998. Prior to adoption of the IRC, New Jersey used various editions of the Council of American Building Officials (CABO) one- and two-family dwelling code starting with the 1983 edition effective July 1, 1985 through the 1995 edition effective July 6, 1998.

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Q. How can destruction caused by Sandy be explained in the context of New York and New Jersey building codes?

A. The vast majority of damage caused by Sandy was due to storm surge and flooding at levels not seen in these areas since coastal development occurred. Three critical elements of building construction influence how a building fares in storm surge and flooding: 1) elevation of habitable spaces and utilities; 2) type of foundations used, and 3) use of flood-resistant materials in vulnerable areas. Elevation is typically not addressed in model building codes, except by reference to local elevation requirements. Floodplain management guidelines are usually tied to base flood elevations (BFEs) specified by the Federal Emergency Management Agency (FEMA) through maps that are part of the National Flood Insurance Program (NFIP). The specified BFEs are then adopted by local communities.

The international codes (IBC and IRC) do contain a number of provisions related to flood-resistant design. A summary of these provisions is available at http://www.fema.gov/building-science/building-code-resources. However, the IRC and IBC do not include maps providing elevation requirements.

Common practice in the United States is to set BFEs at a level corresponding to a 1-in-100 chance that a flood/surge event equal to or exceeding that level will occur in any given year. Some communities adopt design flood elevations (DFEs) that include "freeboard," which is additional height above the BFE required for the lowest habitable floor and utilities. One exception, where building codes do address additional elevation, is for commercial buildings that are designed using the American Society of Civil Engineering (ASCE) Standard 24. The 2013 and later editions of the IBC and IRC do reference ASCE 24 for foundation design and flood levels.

ASCE 24 requires one foot of freeboard above BFE for commercial buildings and it is it is the only example of a national building standard to do so. IBHS recommends ASCE 24 should be used for design of foundations in any coastal areas, and notes it is becoming more widely used throughout coastal regions of the U.S. In addition to specific design guidance, the ASCE standard requires open foundations in areas subject to surge with possible wave action. Another excellent resource for design of coastal structures is FEMA's Coastal Construction Manual.

The NFIP, with its specification of BFE requirements for new construction, is relatively new when compared to the age of many buildings located along New York and New Jersey waterfronts. Furthermore, early BFEs did not account for wave action; BFE values were raised in the 1980s when wave action was included. Older properties have been grandfathered into the NFIP program and they frequently have lowest habitable floors and utilities below the BFE. Consequently, when a flood event occurs that is anywhere close to the BFE, these older buildings suffer tremendous damage and disruption for occupants – as was the case with Sandy. If the flood provisions of the IRC and IBC were adopted, New York and New Jersey coastal properties built after adoption of the 2003 or later editions of the I-Codes would have been designed with ASCE 24 foundation requirements.

Q. Since older building codes have not really addressed elevation and flooding issues and newer codes just reference local minimum elevation requirements, what can New York and New Jersey property owners do to reduce coastal property vulnerability to flood and surge damage?

A. If property owners have opportunities to elevate existing properties or to rebuild, they should elevate as much as practical above the BFE. If new advisory flood elevations are issued by FEMA, properties should be built above the advisory flood elevations, regardless of whether the community broadly adopts these elevation levels. It is important to remember that building to a flood elevation that has a 1-in-100 chance of being met or exceeded each year means that there is a 40% chance that the property will be flooded at least once during a 50-year period. IBHS recommends building to a flood elevation corresponding to a 1-in-500 chance of being met or exceeded annually; this means that, in a 50–year period, the chance of that property being flooded is 10% rather than 40%. If information on the 1-in-500 chance flood elevation is not available, IBHS recommends elevating the lowest habitable floor and utilities at least three feet above BFE or advisory BFE.

Q. In 2011, New England was hit by a storm that dumped lots of water and caused significant inland flooding, but had relatively low wind speeds. In 2012, Sandy did not have particularly high winds, but caused extensive damage from storm surge and flooding. Why should areas of New York and New Jersey be concerned about wind damage?

A. Each storm has its own signature in the form of wind field structure and characteristics. Coastal areas of New York and New Jersey have experienced high winds from hurricanes in the past. It is only a matter of time before another hurricane with stronger winds strikes the area. Densely developed parts of both New York and New Jersey are located in areas highly vulnerable to tropical storm or higher wind speeds. Older buildings and roofing systems are particularly vulnerable to wind and wind-driven, water-related damage.

Q. Do modern building codes include provisions that reduce wind damage vulnerability?

A. Modern building codes do contain guidance that can be very useful in designing and constructing buildings to resist high winds. Key elements of modern building codes that address enhanced resistance to high winds are:

- adequate specification of wind loads;
- requirements for wind-rated roof covers;
- requirements for protection of openings (windows and doors) from wind pressure and windborne debris; and,
- engineering-based design requirements leading to robust continuous load paths that tie all parts of a building together and anchor roof structure to walls and walls to foundations.

However, because building codes represent minimum legal standards for designing and constructing buildings, wind-related building requirements scale with design wind speed for particular areas. This means that certain protective features or requirements are only triggered when design wind speeds exceed certain levels. Geographical boundaries in coastal areas of New York and New Jersey associated with these triggers have changed over time, and will change again as 2012 editions of IBC and IRC model building codes are implemented.

Q. How have these building code provisions and triggers changed over time in the New York and New Jersey areas affected by Sandy?

A. Wind load provisions in building codes are relatively new when compared with fire protection requirements. Furthermore, the codes treat residential and commercial buildings separately, so it makes sense to look at each separately.

Residential: Prior to the 1990s, single-family homes were generally built throughout the U.S. using conventional construction techniques, except in a few areas, such as South Florida, coastal Texas, and the Outer Banks of North Carolina. Conventional construction implies that homes were built using techniques passed down as younger builders and contractors learned from older, more experienced builders and contractors. If designers were involved, wind load guidance available to them before the latter part of the 1980s was pretty simplistic – and the loads used to design cladding systems, which included the outer walls and roof of buildings – were much lower than those included in modern building codes and standards.

The 1988 edition of the American National Standard Institute (ANSI) A-58.1 – the precursor to the American Society of Civil Engineers Standard 7 (ASCE 7) – represented a major step forward in wind load provisions for design of buildings and other structures. In essence, the 1988 edition, represented the codification of significant research on wind loads, and produced design loads for building cladding elements similar to those in today's codes. Also, it was during the late 1980s that the Southern Building Code Congress International (SBC) began to develop and promote a prescriptive standard (SSTD 10) that provided solid engineering based guidance for use in building hurricane-resistant residential buildings. SSTD 10 was adopted by some coastal communities in the Southeast, where SBC codes were typically adopted if a community used one of the national model building codes. Some prescriptive requirements in SSTD 10 did also appear in the Council of American Building Officials (CABO) one- and two-family residential code that was used more broadly across the U.S.

Aside from some local adoptions of SSTD 10 and the CABO code, the most far-reaching guidance on design of residential buildings for hurricane winds came when the three major model building code associations joined together to form the International Code Council and produced inaugural 2000 editions of the IBC and IRC.

The 2000 IRC represented the first model building code to require opening protection, including pressure and impact protection requirements, for windows and doors, or design for a higher internal pressure. This would apply to buildings built in areas within a mile of the coast, where the design wind speed was greater than or equal to 110 mph, or in all areas where the design wind speed was greater than 120 mph.

Implication for Future Storms: If the 2006-2009 editions were followed without modifications in New York, opening protection would have been required for buildings built within one mile of most of the New Jersey coast, and within one mile of the coast of Long Island for many of the boroughs of New York City, to a point about two-thirds of the way east along Long Island where the 120 mph contour crosses and opening protection would be required everywhere.

In the 2006 edition of the IRC, the option to design for increased internal pressure instead of protecting the openings was removed. This removal was due to the recognition that most people shelter at home during a hurricane and the consequences of breaching the building envelope by breaking open a window or door was far too great for residential properties.

In addition to the opening protection requirements, the 2000 IRC and later editions also put limits on where conventional construction was allowed and defined areas where engineering-based residential design is required, such as that pioneered in SSTD 10 and developed more fully for wood frame construction in the American Forest and Paper Association's Wood Frame Construction Manual. Other building material trade groups, including those focused on light metal frame and masonry, have also developed their own engineering-based guides for residential builders.

Implication for Future Storms: In the 2000 and 2003 editions of the IRC, the threshold for engineering-based design was set at a design wind speed of 110 mph or higher. Adopting these provisions would have required new homes built in the seaward halves of New Jersey coastal counties and most of Long Island to be designed and built using engineering-based requirements. In the 2006 edition of the IRC, the trigger was reduced to areas with a design wind speed of 100 mph or higher. This was due to the recognition of roof spans becoming larger, and that conventional construction techniques could be woefully inadequate in many cases – unless roof-to-wall anchorage and wall bracing requirements were improved. If the 2006 and 2009 thresholds were adopted, this would have resulted in engineering-based residential construction being built throughout much of New Jersey and all of Long Island and New York City boroughs. The load and resistance issues that spurred this change were addressed in the 2012 edition of the IRC and the design wind speed threshold for engineered design has been adjusted upward.

Starting with the 2003 IRC, the code requires shingles to be wind-rated. IBHS field and laboratory research has shown that this change is reducing the amount of wind damage to shingle roofs, especially when the wind speeds in the event are below the design wind speeds.

Commercial: Commercial construction has benefitted from more attention by design professionals. Furthermore, when it comes to commercial buildings, both the Building Officials Code Administrators International (BOCA) codes used throughout most of New England before the advent of the ICC and the International Codes have used ASCE 7 as the basis for their wind load guidance. As a result, with the exception of improvements in design wind load guidance for parapets and signs, and introduction of windborne debris protection requirements based on the same wind speed thresholds described above, designers of commercial buildings and multi-family housing have been using very similar load information for some time.

Implication for Future Storms: Because structural systems are designed using engineering principles, most of these buildings tend to remain structurally sound in windstorms; their greatest problems tend to be related to roofing and wall cladding water intrusion and component failures. The main exception is older, lightweight commercial buildings designed using something known as a "1/3 stress increase." For a number of years, material standards reduced their safety factors for wind design because it was assumed that winds would impact the building only for short periods of time compared to loads imposed by constant forces, such as the weight of building elements or building contents. While wood clearly exhibits improved bending resistance and structural properties for short duration loads as compared with longer duration loads, the same is not true for most other materials.

Both Residential and Commercial: Finally, the design wind speed maps in the 2000 through 2009 editions of the IBC and IRC were based on hurricane risk models developed in the early 1990s and used to produce the design wind speed map first published in the 1998 edition of ASCE 7. Considerable research has been conducted in intervening years to improve modeling of hurricane risks. Results of that research have been adopted in design wind speed maps contained in the 2010 edition of ASCE 7, which form the basis of the wind load provisions in the 2012 IBC and 2012 IRC. The result is that the 2012 IRC and 2012 IBC will no longer require opening protection (i.e., windborne debris protection for windows and doors) along the New Jersey Coast. These model codes will still require opening protection within a mile of the coast for the eastern half of Long Island. The 2012 IRC will not require engineered design for one- and two-family residential construction along the New York and New Jersey Coasts.

Q. What is the practical implication of this history of codes for the wind resistance of residential buildings in areas affected by Sandy?

A. The majority of single-family residential buildings built along the coasts of New Jersey and New York are likely to have been built according to older, conventional construction practices. This means few buildings will have the kind of essential, complete load path that would be developed using engineering-based residential construction. These areas border where the building code would require engineering-based, high-wind construction. The fact that New Jersey has had a strong building code system – including adoption of modern building codes without amendments, as well as training and certification of building officials, and licensing of contractors – means that buildings are more likely to adhere to code requirements and be better built than in most other areas of the country. When it comes to wind resistance and windstorm damage, older homes would be more vulnerable than newer ones built after adoption of the IRC. Because New York City did not adopt the opening protection requirements, newer homes built along the New York coast would not be as well protected as newer homes built along the New Jersey shore.

Q. What is the practical implication of this history of codes for the wind resistance of commercial buildings in the areas affected by Sandy?

A. Code wind provisions for commercial buildings have not really changed that much since the 1990s editions of the BOCA code adopted ASCE 7 as the basis for wind provisions; that has continued with refinements as various editions of the IBC have been adopted. The main change in building performance is likely to be for lightweight commercial or industrial buildings built in recent years when the one third stress increase was eliminated from design calculations for many materials. Consequently, newer metal buildings should perform better than older ones.

Q. If New York and New Jersey homeowners want to improve wind resistance of their homes, what can they do?

A. The best advice is to move beyond the code's minimum requirements. Stepping up to minimal engineering-based hurricane design guidance that produces robust continuous load paths would provide substantial well-proven increases in wind resistance for the home, while likely adding only 1% to 2% to the cost of a typical house. In New York and New Jersey, this would mean designing using guidance available in various engineering-based guides for a design wind speed of 110 mph when using the 2006 or 2009 IRC.

One possible way to approach reducing windstorm risks including hurricane risks would be to consider the tiered approach in the IBHS FORTIFIED Home™ Program. This program is applicable to both new and existing homes and provides levels of wind resistance at several price points. For all homes, getting the roof right is extremely important; that is why the roof is the focus of the first level in the FORTIFIED Program. For older homes, protecting openings is the next most accessible step–up, since protective systems can be installed without major disruptions to the home. Wind pressures that build up inside a home because a window is broken or a door is blown open can nearly double the forces trying to rip off a roof or tear off exterior walls.

Q. If New York and New Jersey commercial property owners wanted to improve the wind resistance of their buildings, what can they do?

A. Since commercial buildings receive substantially more design professional attention than residential buildings, the best ways to increase wind resistance are to increase design wind speed and pay close attention to critical connections and roofing details. Designers should select wind-rated products and systems and insist on high wind–rated, well attached roofing with special attention to flashing anchorage. For commercial-residential structures, such as condominiums or apartments, attention should be paid to selecting windows and sliding glass doors that are resistant to water intrusion. Debris impact-resistant products are available for both doors and windows, and would provide additional security, as well as protection from windborne debris during a hurricane. The IBHS FORTIFIED for Safer Business™ design guidelines can provide overall guidance for designers trying to achieve a more resilient building.

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