Building Codes Basics

Building codes and standards are crucial to protecting homes in the event of a natural hazard. Only about a third of the jurisdictions in the U.S. that are at risk of one or more hazards have adopted the latest natural hazard-resistant codes. This is particularly important for the Residential Code, as residential buildings account for over 80% of disaster-related damage. By adopting and implementing the latest natural hazard-resistant building codes, your home will be able to better withstand more extreme weather conditions and natural hazards.

There have been numerous examples of homes or communities that were designed and built to the latest building codes that have not only survived a significant natural disaster but were able to continue their intended function, helping their community quickly recover and remain resilient. Some of these examples are detailed below.

How Building Codes Have Changed the Lives of U.S. Virgin Island Residents

In 1995, within two weeks, the U.S. Virgin Islands (USVI) were hit by Hurricane Luis and Hurricane Marilyn. Hurricane Luis caused $300 million worth of damage, while Hurricane Marilyn caused even more of an impact. Marilyn was responsible for eight deaths and the loss or damage of 21,000 homes, including 75% of the residences on St. Thomas. As a result, USVI damage estimates from Hurricane Marilyn were $2.1 billion.

Hurricane Luis Damage	Hurricane Marilyn Damage
$300 million	**$2.1 billion**

Through FEMA's Hazard Mitigation Grant Program, just over $30 million was granted to the USVI to provide the territory with resources for design, construction, construction management oversight, and quality assurance and quality control of mitigation projects. The grant also funded a vital part of the region's post-disaster mitigation plan — the Home Protection Roofing Program (HPRP). One of the key components of the HPRP was to address the issue of poorly attached roofs which could easily be torn from houses by high winds.

A little over 20 years later, in 2017, Hurricanes Irma and Maria struck the USVI. In the wake of those storms, a FEMA Mitigation Assessment Team was deployed to investigate damage. One of their goals was to assess a sample of St. Thomas HPRP homes to determine how the replacement roofs fared.

The result: no structural damage to those roofs was observed. Prior to 1995 and Hurricane Marilyn, the code provisions for wind resistance were weak, but following FEMA's post-storm recommendation, USVI adopted the 1994 Uniform Building Code, which provided significantly more wind resistance requirements. As a result, although Hurricanes Irma and Maria were more severe than Hurricane Marilyn, structures that were repaired or constructed to the 1994 codes showed far less roof damage.

Figure 1. USVI home built using 1994 code

Figure 2. USVI home built using pre-1994 code

The Role of Florida's Building Codes in 2018 Hurricane Michael

The State of Florida first adopted a statewide minimum building code in 1974. However, that code allowed local governments to adopt one of four different codes that they could amend and enforce as they saw fit. When Hurricane Andrew struck south Florida in 1992, it broke all records for insured losses and became Florida's worst insurance crisis in history. It quickly became obvious that Florida's building code system was not adequate and that improvements were needed for the entire state.[1]

In its report, *Building Performance: Hurricane Andrew in Florida, Observations, Recommendations and Technical Guidance* (FIA-22)[2], FEMA recommended improvements to the Florida Building Code. In 1996, Florida appointed a Building Code Study Commission that ultimately recommended "strengthened compliance through greater predictability and accountability in the building code system." The recommendations included "a streamlined uniform family of codes, strengthened administration and enforcement of codes and enhanced compliance with codes through education, training and discipline." In 1998, the legislature adopted the Commission's recommendations, and in 2002, the Florida Building Code was formally adopted, superseding all previous codes.[3]

While buildings constructed to the new Florida Building Code have generally performed well, there still exists a significant population of older buildings constructed prior to 2002 that remain at risk. The vastly different performance by these two sets of buildings was clearly highlighted in 2018 when Hurricane Michael struck the Florida panhandle. Hurricane Michael made landfall at Mexico Beach, a gulf-front community made up of mostly older homes.

The newer homes that were built after the new code took effect performed relatively well, while the majority of older homes were destroyed. One beach-front home performed extremely well and was the subject of numerous reports. This home, nicknamed the Sand Palace, was actually built to higher criteria that was called for in the Florida Building Code.[4] Some of these higher criteria included:

- The concrete support pilings were embedded to 40 feet.

1 Overview of the Florida Building Code (floridahousing.org)
2 FIA 22, Mitigation Assessment Team Report: Hurricane Andrew in Florida (fema.gov)
3 Overview of the Florida Building Code (floridahousing.org)
4 How One House Survived Devastating Hurricane Michael (Architizer Journal)

- The use of a construction technique, insulated concrete forms, that is stronger that normal construction materials.[5]
- Roof overhangs were kept to a minimum to prevent wind uplift.
- A hip roof was used to provide better wind protection.

The Sand Palace's owner estimated that the cost of these additional steps added 15 to 20% to the cost of the home's structural system, which would be less than 10% of the overall cost, but that it more than made up for that cost in only having to do minimal repairs.

Figure 3. Remaining slab of a non-elevated structure from Hurricane Michael

Building Code Lessons From the 1994 Northridge Earthquake

At 4:30 a.m. on January 17, 1994, the M6.7 Northridge struck in the San Fernando Valley, roughly 20 miles northwest of downtown Los Angeles. Although the duration was only 10 to 20 seconds, the ground motions included a reading of 1.82g, the highest ever recorded in an urban area in North America, and the MMI was IX (violent). The earthquake resulted in around 60 fatalities, and damage estimates were as high as $50 billion.

One of the critical building code lessons to come out of the earthquake was the unacceptable performance of steel moment resisting frame construction. Up until then, this type of construction was assumed to be one of the best seismic-performing systems. Once the extent of the problem became known, the earthquake engineering community faced a very real crisis. The building code for this type of construction had just been invalidated, and engineers had little idea of how safe existing buildings were or how to repair damaged buildings.

5 Hurricane proof homes, tornado resistant homes (floridagreenconstruction.com)

In conferring with several industry experts, FEMA determined that the first need was for guidance on how to repair damaged buildings. This work was completed in less than one year, and its product, the *Interim Guidelines for Steel Moment Resisting Frame Construction* (FEMA 267), became the *de facto* standard for repairing this type of construction.

FEMA then contracted the second phase of the project: to research and develop final design criteria documents for new and existing steel moment frame buildings for use by the nation's model building codes and standards. This initiative was groundbreaking in that it was the first FEMA project to effectively combine academic research and the earthquake engineering design community on a scale never before attempted. The project also required close coordination with the steel and welding manufacturing industries who ultimately provided steel columns and beams for project research and testing purposes.

The final products included technical guidance for new construction (FEMA 350), upgrade guidance for existing buildings (FEMA 351), evaluation and repair guidance for damaged build ings (FEMA 352), a technical specifications/quality control guidance document (FEMA 353), a non-technical guidance document for building owners and local officials (FEMA 354) and a series of background papers (FEMA 355CD).

As a result of this effort, the nation's model code organizations and industry standards groups used these findings to improve their codes and standards for this type of construction. FEMA has been widely recognized for its role in organizing and leading the solution to what was a serious problem for the nation's building codes and standards.

Figure 4. Damage from Northridge Earthquake

Building Codes Benefit All

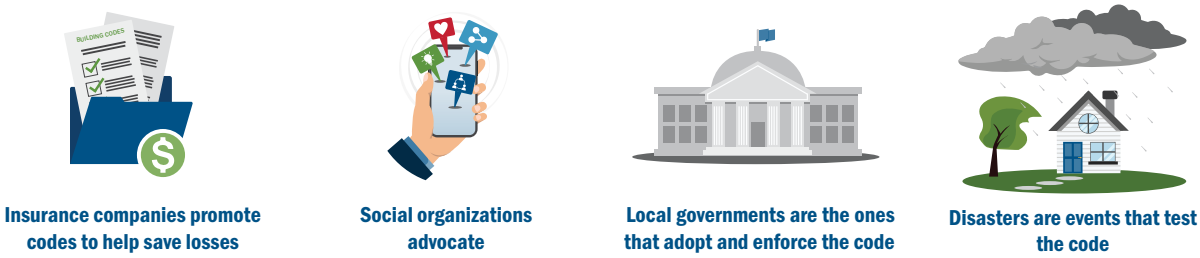

Figure 5. Four factors of modern building codes

Building codes are intended to benefit everyone and are available to be used worldwide. However, many individuals do not understand the importance of having a home designed and constructed using up-to-date building codes. Learning more about the building codes in your community is the first step to creating a world with safe and resilient homes. If your area has not adopted the latest natural hazard-resistant building codes and standards, it is important to encourage their adoption and implementation to reduce the future risk of life and property.

How Strong is Your Building Code?

Find the current codes adopted in your area using the Inspect to Protect tool.

Fast Facts

- Flooding is the most common natural hazard—90% of natural disasters are flood events, and flood risk exists in every county in the nation.
- A 2019 study by the National Institute of Building Sciences found that adopting the latest building codes saves $11 per $1 invested (NIBS, 2019).
- The Earthquake Hazards Reduction Act of 1977 established the need for creating and promoting model building codes to make buildings more resilient against natural hazards.
- Since 2000, states and communities across the country that have adopted the consensus model codes have saved and estimated $32 billion in building damage, according to FEMA's Building Codes Save study (2020).
- Between 2010 and 2020, the National Weather Service reported a ten-year average of 94 tornado-related fatalities.
- The Natural Hazard Mitigation Saves Study determined that about 1,600 people experience nonfatal injuries for every one fatality caused by natural hazards.