Building regulation in the United States began in the late 1800s when major cities began to adopt and enforce building codes in response to the large conflagrations that frequently occurred in these densely populated urban areas. The early building codes were intended primarily to reduce the fire risk but, over time, their scope was broadened to address many other issues deemed important to protecting public health, safety, and welfare — including natural hazards like earthquakes — and they became known as "model" building codes since they could be tailored to reflect community concerns before they were adopted.

Building codes generally are intended to be applied by architects and engineers but also are used for various purposes by safety inspectors, environmental scientists, real estate developers, contractors and subcontractors, manufacturers of building products and materials, insurance companies, facility managers, tenants, and others.

Today, most U.S. communities formally adopt a building code and have a system in place for building regulation, but this was and still is not always the case. In fact, some rural areas in America still have not adopted a building code and, in these areas, it is legal to design and construct structures using any standards deemed appropriate by the designers and builders. Further, not all codes enforced at the local level will result in adequate earthquake-resistant design and construction. Some communities in the central and eastern United States, for example, are at significant risk of experiencing damaging earthquakes but do not acknowledge this risk and, consequently, have not adopted adequate seismic design and construction requirements into their local building codes. As a result, although the cost of incorporating appropriate seismic resistance into new construction is small, many buildings continue to be constructed without adequate protection, leaving people in these communities at considerable risk.
1.1 Model Building Codes

By the mid-1900s, three organizations were publishing model building codes for adoption by U.S. communities and each represented a major geographic region:

- The Building Officials and Code Administrators International (BOCAI) published the *National Building Code* that served as the basis for most building regulation in the northeastern and central states.

- The Southern Building Code Congress International (SBCCI) published the *Standard Building Code* that was commonly adopted throughout the southeastern part of the country.

- The International Conference of Building Officials (ICBO) published the *Uniform Building Code* that was commonly adopted in the western United States.

Each of the three building codes tended to develop particular strengths in certain areas. The *National Building Code* was heavily influenced by the major cities in the northeastern and central states and developed strong provisions on fire resistance and urban construction. The *Standard Building Code* was influenced primarily by building interests in the southeastern states where hurricanes were a common hazard and consequently developed advanced wind design requirements. The *Uniform Building Code*, reflecting the interest of the western states, became a leader in the development and adoption of earthquake design provisions.

The three organizations continued to issue their model codes for more than 50 years, typically publishing revised and updated editions every three years. All three used a similar process that began with a public call for proposals for change. Anyone could respond to these public calls and submit a proposal to change the code. Typical code changes involved the prohibition of certain types of construction or the introduction of requirements governing the design of other types of construction. These proposals generally were made by proponents of building products and construction processes as well as by individual building officials and design professionals and associations representing these interests. Code change proposals often were made in response to observations that some types of construction performed poorly in certain events (e.g., fires or earthquakes) or situations (e.g., in areas of very heavy snow) and that changes in design or construction were needed to improve performance. Once proposals were submitted, the model code organization would hold a series of hearings to obtain public input on the validity of the proposals and the organization’s membership would then vote to either reject or accept the proposals, sometimes modifying the original proposal in the process.
In the late 1990s, the three original code development organizations (BOCAI, ICBO, and SBCCI) agreed to merge into a single organization called the International Code Council (ICC) and, in 2000, published a single series of model building codes called the International or I-Codes. The I-Codes are intended to be nationally and internationally applicable and include:

- The International Building Code (IBC) that addresses almost all types of buildings including residential, commercial, institutional, government, and industrial structures;
- The International Residential Code (IRC) that addresses one- and two-family dwellings; and
- The International Existing Buildings Code (IEBC) that addresses existing buildings.

The ICC publishes new editions of these codes every three years (i.e., 2000, 2003, 2006, 2009, 2012). Currently, all 50 states and most U.S. communities have adopted building codes based on the I-Codes. Depending on the state and its specific regulations, some adopt the codes verbatim while others modify or adopt only portions of the model codes. The development and widespread adoption of the I-Codes is beneficial in that it has created a more uniform regulatory environment in which design professionals and contractors need to become familiar with only a single set of requirements regardless of where they are practicing.

### 1.2 Consensus Standards

As the model building codes were evolving, various industries (e.g., concrete, masonry, steel, wood) established professional associations to develop technical criteria for the design and construction of structures using each industry’s specialized materials and systems. Eventually, the industry associations began issuing their guidance documents in the form of industry standards developed following rigorous consensus procedures promulgated by the American National Standards Institute (ANSI) and the model code organizations began adopting those documents into their codes by reference. The industry consensus standards typically are revised and updated every five years.

Among the more important consensus standards presently referenced by the building codes are the following:

- *Minimum Design Loads for Buildings and Other Structures, ASCE/SEI 7*, published by the Structural Engineering Institute of the American Society of Civil Engineers;
1.3 Code Adoption and Enforcement

Building codes are adopted by state and local governments to protect the health, safety, and welfare of the public by establishing minimum acceptable design and construction requirements intended to provide safe and reliable buildings and structures. These codes affect all aspects of building construction including structural stability, fire resistance, means of egress, ventilation, plumbing and electrical systems, and even energy efficiency. Once adopted by a state or local government, the building code becomes law and is typically enforced by a government official. This official generally is identified as the Chief Building Official but he or she may have another title such as Fire Marshall or Clerk. Collectively, the people empowered to enforce the requirements of a building code are identified in the codes as the Authority Having Jurisdiction (AHJ).

In communities that have adopted a building code, it is illegal to construct a structure unless the AHJ issues a building permit. Before issuing the permit, the AHJ typically will review the design documents to ensure that they were prepared by an appropriately qualified and licensed (generally by the state) professional and that they conform, in a general sense, to the technical requirements of the building code. Once the AHJ is satisfied that a design conforms to the applicable requirements and appropriate fees are paid, the AHJ issues a permit for construction, a document commonly referred to as the “building permit” that generally is posted at the construction site.

During the construction period, the AHJ requires a series of inspections to ensure that the design is being properly executed by the builders. These inspections may
be directly performed by the AHJ or the AHJ’s staff, by private individuals or firms with the appropriate qualifications, or by a combination of the two. When an inspection is performed, the conformance of the construction with the design and code requirements is documented by a series of reports and/or by the inspector’s signature on the building permit. If an inspector finds that the construction does not conform in some way to the code requirements, the builder must correct this situation before a sign-off is given. Upon completion of construction and submittal of documentation by the builder of evidence that the building has passed all required inspections, the AHJ will issue an “occupancy permit” that allows the structure to be open to the public. If a building is occupied without this permit, the AHJ can require that other law enforcement officials vacate the premises and lock it. Even after an occupancy permit has been issued for a structure, the AHJ can revoke the permit if there is reason to believe that the structure has become unsafe in some way. It is not uncommon for this to occur after a fire, earthquake, hurricane, or other event that causes extreme damage to buildings and structures. This also can occur if a building’s occupants allow its various systems to deteriorate to a point at which the structure is no longer safe for use.

1.4 The NEHRP and the NEHRP Recommended Seismic Provisions

Even though the largest earthquakes affecting the United States actually occurred in the central states, most 20th century U.S. earthquakes struck in the western states – primarily Alaska, California, and Washington – and most Americans think of earthquakes as a West Coast problem. As a result, the development of seismic requirements for building codes occurred primarily in the western states, notably California. These earthquake design requirements initially were developed by volunteers from the Structural Engineers Association of California (SEAOC) in cooperation with ICBO. These initial requirements appeared as a non-mandatory appendix in the 1927 Uniform Building Code. Over the years, as more earthquakes occurred in western states, SEAOC worked with its sister associations in other states, most notably Washington, to refine and improve these regulations and eventually they were moved into the body of the code and became mandatory.

During the early years of seismic code provision development, the principal basis for code changes was observation of the performance of actual buildings in earthquakes. When an earthquake occurred, engineers and building officials would survey the damage and, when certain types of construction performed poorly, they would develop code changes to address the observed problems. Noteworthy code changes resulted after earthquakes that occurred in Long Beach, California,
in 1933; Olympia, Washington, in 1949; Kern County, California, in 1952; and
Prince William Sound, Alaska, in 1964. By 1970, many West Coast engineers and
building officials believed they had developed a building code capable of pro-
viding buildings with superior earthquake performance. However, in 1971, a
magnitude 6.6 earthquake occurred in Sylmar, California, a community located in
the San Fernando Valley just north of Los Angeles, and resulted in extensive dam-
age to many modern code-conforming structures and the collapse of some such
structures.

This earthquake made it clear that the building code needed significant improve-
ment, but the involved engineers and building officials concluded they did not
have the resources to address the problem adequately on a volunteer basis. Several
things occurred in response to this need. First, SEAOC formed a nonprofit entity
— the Applied Technology Council (ATC) — to seek the funding needed to assemble
the best available talent to research problems with the building code requirements
and to develop recommendations for improving those requirements.

At about the same time, Congress passed the Earthquake Hazards Reduction Act
of 1977 (Public Law 95-124) that established the National Earthquake Hazards
Reduction Program (NEHRP). Under the NEHRP, four federal agencies — the Fed-
eral Emergency Management Agency (FEMA), the National Institute of Standards
and Technology (NIST), the National Science Foundation (NSF), and the United
States Geological Survey (USGS) — were authorized and provided with dedicated
funding to develop effective ways to mitigate earthquake risks to the national
economy and the life safety of building occupants. The NEHRP has been reau-
thorized periodically since that time, and it has funded and continues to support
many important initiatives involving basic research and the application of this re-
search in ways that will foster broad-scale mitigation of earthquake risks. Figure 1
identifies some of the many activities conducted under the NEHRP and the agency
primarily responsible for each.

Under the NEHRP, the USGS focuses on identification of the level of earthquake
hazard throughout the United States. As part of this effort, USGS operates a
network of strong-ground-motion instruments that record the effects of earth-
quakes at sites that range from a few to hundreds of kilometers from the event’s
geographic origin. These data permit the USGS to identify the likely intensity of
future earthquakes throughout the United States and to develop the national seis-
mic hazard maps that serve as the basis for the design maps incorporated into the
NEHRP Recommended Seismic Provisions and building codes and standards.
NSF fosters technological leadership by sponsoring basic research and the development of new generations of scientists and engineers. Over the years it has sponsored a broad range of earthquake engineering research including field investigations of damage caused by earthquakes and laboratory and analytical research performed by individual students and their professors. NSF also originally funded national earthquake engineering research centers to conduct fundamental research focused on mitigating U.S. earthquake hazards. Much of this research is reflected in requirements contained in today’s building codes. One of the early research programs sponsored by NSF under the NEHRP was the development by ATC of a guidance document containing recommendations for next-generation seismic building code requirements. Published in 1978, this document, *Tentative Provisions for the Development of Seismic Regulations for Buildings*, acknowledged that the new concepts and procedures presented should be evaluated in comparative designs to test their workability, practicability, enforceability, and cost impact before they were considered for code adoption. Later, FEMA took over this initiative and funded the BSSC to conduct this comparative design effort, which resulted in consensus-approved modifications to the original document.
amended seismic design procedures then served as the basis for the initial edition of the *NEHRP Recommended Seismic Provisions* and, hence, the procedures reflected in today’s building codes.

NIST conducts research and development work and also supports public/private partnerships that perform such work with the goal of improving the technological competitiveness of the United States. It has sponsored and participated in research that led to development of some of the seismic-resistant technologies reflected in the current model building codes. In the 2004 reauthorization of the NEHRP program, NIST was identified as the lead NEHRP agency with responsibility for coordinating the activities of the four NEHRP agencies and for establishing an advisory committee to assess scientific and engineering trends, program effectiveness, and program management.

FEMA provides public and individual assistance after an earthquake disaster occurs, speeding community recovery and minimizing the disaster’s impact on the nation as a whole. Under the NEHRP, it sponsors the development of tools and practices that will encourage the development of a more earthquake-resistant nation. It is in this role that, in the early 1980s, FEMA funded the development of a resource document that would serve as the basis for future seismic regulations in building codes. This effort resulted in the 1985 edition of the *NEHRP Recommended Provisions*. As noted above, the first edition of the *Provisions* reflected the results of a series of trial designs conducted to test the ATC report and was presented in a format that could be directly adopted by building codes. FEMA has continued to sponsor regular updating of the *Provisions* since 1985 (initially a new edition was published every three years but now every five years).

The first building code adoption of the *Provisions* occurred in 1992 when both BOCAI and SBCCI adopted seismic provisions in their buildings codes based on the 1991 edition of the *Provisions*. In 1998, the Structural Engineering Institute of the American Society of Civil Engineers adopted the 1997 edition of the *Provisions* almost verbatim into the ASCE/SEI 7 standard. Two years later, the 2000 *International Building Code* also adopted seismic provisions based on the 1997 *Provisions* and, since that time, both the IBC and ASCE/SEI 7 standard have continued to base their seismic design criteria on the recommendations contained in the latest edition of the *Provisions*.

A key step in this process occurred in 1990 when Executive Order 12699, *Seismic Safety of Federal and Federally Assisted or Regulated New Building Construction*, was issued. This executive order required all new federally owned, leased, regulated, or funded structures to be constructed using building codes that contained suitable seismic standards and charged the Interagency Committee on Seismic Safety in Construction (ICSSC) to identify appropriate standards for
seismic safety in building construction. The ICSSC identified the Provisions as the appropriate reference standard, thus providing a great incentive for the model code development organizations to adopt the Provisions as the basis for their seismic requirements so that new construction involving federal money could use their model building codes.