EVOLUTION OF CODES IN THE USA

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Abstract: While harmonization of structural design codes in Europe has been a detailed and organized process about to culminate in 2010 after 25 years of work, significant similar changes in American codes occurred in the late 1990s and early 2000s through a completely different process. These changes included (1) the imposition of a single national code, where there had been three regional codes before, (2) the formal separation between the load and resistance side of the codes into a national load code and a series of material codes, (3) the development and rapid adoption of ultimate strength design approaches for materials such as wood and masonry which had had only allowable strength design standards until recently, (4) the extensive editorial reorganization and changes in several codes, and (5) extensive attempts at streamlining the inclusions of the latest research results into the codes. The paper first traces the development of design codes in the USA to provide a context for these recent developments. It then describes the regulatory environment that led to the adoption of a unified design code, including the selection between two competitive alternatives, the rationale behind some apparent random unification efforts, and the adoption process by the individual jurisdictions. Finally, this paper describes the new building code regulatory landscape and the first attempts at generating performance-based design guidelines, in the form of seismic provisions for tall buildings in high seismic zones.

1. Background to Development of Codes in the USA

To comprehend the somewhat chaotic manner by which building codes are developed in the United States, it is necessary to begin some 220 years ago or so with the ratification of the Bill of Rights to the US Constitution. At that time there was a great concern, bordering on fear, of establishing too strong of a national, centralized authority and so the 10th Amendment of the US Constitution clarified that powers not specifically granted to the Federal Government nor prohibited to the states by the Constitution are the dominion of the states or the people themselves. As a result, the power to regulate design and construction of buildings has been left to the government of individual states, cities and towns.

Over time individual cities developed and promulgated building codes with the impetus usually being a major fire (1886 Chicago Fire) or natural disaster (1906 San Franciso Earthquake). Along this same time, insurance as a business began to come of age and the recognized need to provide for greater public safety and less payouts of insurance led to the founding in 1915 of the Building Officials and Codes Administrators, International (BOCA) and their subsequent issuing the first "model" building code which was based on a document used by insurance companies at the time.

Over time, two other model code organizations were established in the United States: (a) the Southern Building Code Congress International and (b) the International Conference of Building Officials. Each covered a distinct portion of the US based upon their membership, which consisted of the various jurisdictional building code departments (Figure 1.) It should be emphasized that all three were private corporations.

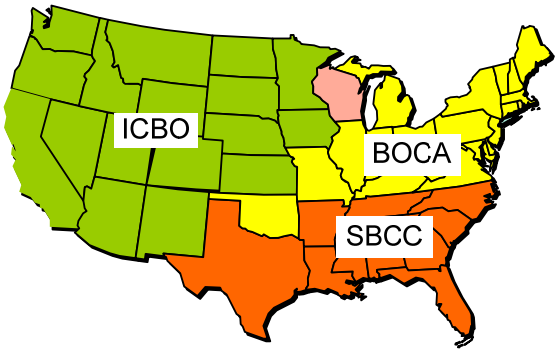

Figure 1. Applicability of building codes by region - pre-IBC.

Over the years each of these three organizations developed their own unique but similar processes for updating their model building codes. These codes cover not just structural design but also plumbing, electrical, residential, fire codes, and other design issues. The discussion herein is equally applicable to each of these, but only details related to structural design will be emphasized. Each organization published a new edition of their model codes every three years, and the decision would then need to be made by each state or jurisdiction as to whether or not they wished to adopt it and update their own building code. It is this process at the state or local level whereby a building code in the US actually becomes law. The majority of states in the US do have building codes that are promulgated by their state legislatures; however, the applicability of those codes to the various jurisdictions within a state varies widely. Often large cities, such as Chicago, New Orleans or New York, have their own building code that may or may not be consistent with the state building code. In addition, it is common for the final adoption authority to be left to an individual township

or county. Hence, it is not uncommon for large, typically rural, areas of a state to have no building code at all.

2. CODES AND STANDARDS

When discussing building regulations in the United States it is important to recognize the differences but symbiotic relationship between codes and standards. Often used interchangeably, the two types of documents actually serve quite distinct purposes. A building code is the term referring to the legally adopted document by a jurisdiction for the purpose of regulating a portion of the design and construction industry – in short, it is the law and hence must be adopted through the appropriate legislative process. The provisions of building codes strive to address all aspects of the process including such areas as the approval process, the contents of the construction drawings, site preparation, loads, design, plumbing, mechanical, and electrical plans. Conversely, standards provide in-depth provisions on a relatively small portion of the design and construction process. Because of the depth and expertise provided by the standard it is common for building codes to adopt standards by reference in which case the use of the standard is legally required. It is this "adoption by reference" that causes standard developing organizations (SDO's) such as American Society of Civil Engineers (ASCE) to work closely with the developers of model codes. If a SDO's standard is adopted by reference into the "model" code, there is a strong likelihood that this adoption will remain when the model is used by a jurisdiction to prepare their legally binding building code.

Another important distinction between codes and standards is the manner in which they are developed. When a jurisdiction adopts or updates their building code they are essentially writing a law. Although the precise process varies by individual state or jurisdiction the steps are generally the same: a draft is prepared normally by a department within the government, the draft is accepted, reviewed and voted upon by a committee within the legislature, the committee approved version of the law is then submitted to the legislative branches for deliberation, and upon approval by the legislature, a final law is presented to the executive such as the governor for final approval. Although typically not as controversial as many pieces of legislation, because the building code affects a substantial portion of a jurisdiction's economy, it is open to the same influences from lobbyists and special interests as any other piece of legislation.

By comparison, the development of standards tends to be a much more ordered and transparent process. The majority of standards used within the design and construction industry in the US are developed by organizations whose process for developing the standards has been reviewed and accredited by the American National Standards Organization (ANSI). The details of this process are discussed later in this paper. In addition to serving as the accrediting body for standards developers in the US, ANSI also serves as the US's member body to the International Standards Organization (ISO) and as such is known internationally. In this capacity ANSI generally serves as the gateway and coordinator for other US organizations to be involved on ISO committees.

Between the standards developed by private SDO's and the actual law written by a government entity lay two private organizations which bridge the gap by developing

"model" building codes – the International Code Council (ICC) and the National Fire Protection Association (NFPA). The documents that each produce, NFPA 5000 and the International Building Code, are intended to serve as a first draft of the law and hence the documents address all the necessary portions of a complete building code. It is quite common in the governmental adoption process for modifications to be introduced to reflect local practices. These "local amendments" tend to be primarily oriented towards the administrative aspects of building regulation rather than the technical provisions.

3. THE INTERNATIONAL BUILDING CODE (IBC)

For much of the 20th century there were three predominant model building code organizations in the US. The three organizations and the names of their model building codes are shown in Table 1:

Table 1 – Code-writing organizations in the USA

Organization	**Title of Building Code**	**Commonly name for the code:**
Building Officials and Code Administrators, International	Basic National Building Code	"BOCA" or "the BOCA code"
Southern Building Code Congress, International	Standard Building Code	the "Southern Building Code"
International Congress of Building Officials	Uniform Building Code	the "UBC"

From a purely a structural engineering perspective, each of these organizations tended to focus upon the predominant natural hazards in their geographic areas. In looking at Figure 1 it comes as no surprise that ICBO focused upon earthquakes, SBC developed a base of regulations for addressing the effects of hurricanes, and BOCA emphasized both snow and wind issues. Although the codes developed these particular strengths, there were also innumerable areas where they overlapped to the point where in effect there were three organizations developing model codes which truly could be used as the draft for any building code in the country.

The duplication and inefficiencies in this arrangement were apparent. Each organization conducted annual processes to produce an annual supplement and every three years a new edition of the model code, integrating each annual supplement, was published. For standard-writing organizations like ASCE, this arrangement required participation in three nearly identical processes. For a structural engineer practicing nationally this arrangement led to the possibility of having to comply with distinctly different structural requirements for the exact same structure for the exact same loads depending purely upon the jurisdiction in which the structure was sited.

As the quality and breadth of the three model codes grew through the 70's and 80's the duplication became more and more apparent. Individuals wishing to introduce new ideas, products or standards were having to attend 6 or more meetings each year essentially bringing forward the exact same arguments and rational in front of three different audiences. Designers were constantly attempting to discern which provisions applied in which locality. Building owners operating nationally were constantly attempting to understand which provisions applied in which areas. Over time many voices were calling for the creation of a single model building code or at the very least consistency between their provisions as expressed in ASCE's Policy 340- Uniformity of Building Codes, first adopted by ASCE in 1989, which stated:

> *The American Society of Civil Engineers (ASCE) actively encourages the model building code groups and government agencies to develop uniformity among the codes in their technical provisions, format and use of standards. All government jurisdictions and agencies, federal, state and local are encouraged to adopt codes promulgated by one of the three model code groups -BOCA, ICBO and SBCCI- without technical modification. The three model code groups are encouraged to adopt by reference only those standards developed and maintained through a nationally recognized consensus process such as ANSI or ASTM.*

By the early 1990's the situation in the US was truly chaotic – there were three private organizations each developing their own building code. There was a fourth lesser know organization called the Council of American Building Officials, CABO, promulgating the CABO One and Two Family Dwelling Code which was often adopted by reference into one of the three model building codes. Even though the Federal Government did not issue a national building code, various branches of the government had their own regulations. For instance, the US Department of Commerce issued their own set of regulations called the Minimum Property Standards to apply to residential construction where public monies are involved. The Department of Housing and Urban Development, HUD, issued requirements applicable to manufactured housing, each branch of the military had their own building regulations, and the General Services Administration had their own building requirements.

Two significant events occurred in the early 1990's to begin bringing order to this chaos – first, in 1993, the Office of Management and Budget (OMB) of the Executive Branch of the Federal Government issued OMB Circular A-119 directing that the federal government shall rely upon building codes and standards promulgated by the private sector and only develop their own requirements for subjects for which no private standard or code exists. While certainly it took time for the effect of this Order to be felt throughout the federal government, it helped bring additional pressure for the second event, the incorporation in 1994 of the International Code Council by the three existing code groups .

The effort to merge the three model code organizations into one was not simple or expeditious. Each organization had its own staff of between 150 and 250 people in its own headquarters building. Each organization had its own magazine, its own publications department, its own membership department, its own continuing education department, and its own culture, reputation, idiosyncrasies and way of operating. The task of transitioning

the three organizations together into a single, viable entity fell primarily to the three CEO's, John Traw of ICBO, Paul Heilstedt of BOCA, and Bill Tangye of SBCCI. While the process was not deviod of difficulties, these three men deserve much credit for establishing a process and organization to better provide for the safety of the citizens of the US.

The work to blend the provisions of the three legacy codes (BOCA, SBC and the UBC) into a single book began in earnest in 1998 with the formation of drafting committees for each of the major subject areas of the code. Each drafting committee consisted of 3 member representatives appointed by each legacy organization. One of the first decisions to be faced was the general organization of the document – BOCA and SBC were organized in a single book consisting of approximately 30 chapters. The UBC on the other hand was organized into three volumes designated as Parts 1, 2 and 3, and although collectively it contained approximately the same number of chapters as the other two codes the chapters were not divided sequentially into the three volumes. By a vote of 6 to 3 the organization by sequential chapters was adopted for the IBC.

A Structural Committee was assigned the task of drafting chapters 16 through 26 which cover the major structural topics. This division of subject matter made it relatively straight forward for other organizations to assist in the drafting process by volunteering to prepare a first draft for the Structural Committee's consideration. With lead drafting organizations in place the process for preparing the first edition of the IBC proceeded in a manner similar to many volunteer committee efforts. A first draft was assembled and distributed to all interested parties. A meeting of the committee was held, usually with 30 or 40 interested individuals observing, and the draft was presented by the lead author. Because of the volume of work to be accomplished and decisions to be made questions and discussion was limited to the nine committee members and lead author however during the breaks and between the meetings all interested parties were afforded the opportunity to contribute, comment or question the contents of the draft.

By mid-1999, a complete final first draft of the IBC was assembled and ready to be processed through the new procedures of the ICC. Complete details of the ICC's development process, after a final draft is published and available to any and all interested persons, may be found at www.iccsafe.org and is briefly presented here:

- Approximately 3 months after publication are given for anyone to submit a proposed modification. The change must be in legislative format, using strike-out and underline to show proposed deletions and additions to the existing text, respectively.
- Approximately 6 weeks after the deadline for submissions, the ICC staff issues a monograph containing all proposed changes, organized by section so that everyone has an opportunity to review them.
- Approximately 6 weeks after the monograph is issued, an open hearing is held and everyone has the opportunity to testify either in support or in opposition on every code change that has been proposed. At the conclusion of receiving testimony on a particular proposed code change, the committee openly deliberates and makes one of three formal recommendations: recommend for approval as submitted, approval as modified or disapproval.

- Approximately 2 weeks after the hearings the ICC staff publishes a complete summary of all of the committee's recommendations.
- Approximately four weeks after this is the deadline for anyone to submit a challenge to the committee's recommendation. Normally challenges are submitted by proponents who felt that the committee erred in recommending disapproval, by opponents who felt that the committee erred by recommending approval, or by another interested party who feels that a modification to proposed code change is needed.
- The ICC acts upon the recommendation of the committees at the annual Final Action Hearings (FAH). The agenda for the FAH consists of two parts – a consent agenda that is acted upon en masse and an individual change agenda. Code changes whose recommendations are not challenged comprise the consent agenda and those that receive challenges make up the individual change agenda

A typical hearing by the Structural Committee will last 3 to 4 days for 12 to 16 hours each day. The agenda for the hearing is the monograph so that individuals have an approximate idea when their particular change will be heard – however the committee doesn't wait, if a proponent is not ready to testify when his/her change is called, the committee will act on the proposed change without his/her testimony and quite likely with the testimony of others in opposition to the change. Testimony is presented at open microphones and, now, simultaneously broadcast over the internet. Testimony in favor of the change is first presented, followed by those in opposition, followed by rebuttal, and then re-rebuttal. During their deliberations the committee may ask questions of either the proponents or opponents which depending upon the question and answer may necessitate a reopening of formal testimony. The testimony and committee deliberation usually takes 15 minutes for a single change; for a controversial or complex change, it may take an hour or more.

At the FAH testimony is once again presented by the proponents and opponents this time to the entire assembled membership of the ICC. The recommendation by the committee is the standing motion and upon the conclusion of the testimony, led by an independent moderator, votes are taken to determine the final dispensation of the proposed change. In recognition of the expertise of the members of the subject committee it takes a 75% majority to overturn the committee's recommendation – a high threshold, but one that is crossed on occasion. For the formal processing of the first edition of the IBC, issued in 2000, over 2,000 individual code changes were processed and the audience for both the committee hearings and the FAH numbered well into the thousands and were conducted over two 2-week periods. As one could well imagine, this process does not lend itself to in-depth discussion of highly technical issues and this recognition among the membership of the ICC has led them to every increasingly reply upon standards and the experts involved in those standard development processes. This reliance led to the rule by the ICC that any standard being proposed for adoption by reference into any of its codes must be promulgated under an ANSI accredited organization or one that uses a similar process.

4. THE IBC vs. NFPA COMPETITION

In 2000, it seemed that after years of effort on the part of a tremendous number of individuals and organizations, the US finally had a single model building. However, the process of bringing the three legacy code organizations together affected more than just those three organizations. Within the US, the vast majority of standards are produced by private organizations, each of which must do so under their own individual business model. Often that business model includes the generation of revenue through the sale of the published standards, the sale of associated guides, and the conduct of related continuing education courses. As a result these organizations work extremely hard to position themselves as the definitive source of information in a particular area and attract to their activities the preeminent experts in the particular field. One of the more subject specific and dominant organizations is the National Fire Protection Association (NFPA). With over 400 standards in print, a dedicated staff of over 300, and annual revenues in excess of $20 million dollars, NFPA is unquestionably one of the world's leading sources of knowledge on protecting society from the effects of fire. When the original ICC code was being developed, it also included other typical codes such as the plumbing code, electrical code, existing building code, and a "fire and life safety" code. This last item was not received well by NFPA and no agreement could be reached as to how NFPA and the announced IBC code would co-exist. Over the objections of many in the design and construction industries, NFPA decided that they would compete directly with the ICC/IBC by creating their own model building code, subsequently designated as NFPA 5000; this threatened to reverse progress by going from a single model building code to two. To the authors' knowledge only two jurisdictions in the US have used NFPA 5000 as the basis of their building code – the City of Phoenix, Arizona and the City of Pasadena, Texas. In effect, the competition between NFPA and the ICC building code is over, with the market having chosen the IBC. Over time, the ICC and NFPA also arrived at an agreement regarding the fire and life safety code with the ICC dropping the use of the term "life-safety" and instead promulgating the International Fire Code which adopts NFPA 101 for the majority of its technical provisions.

5. THE USA STANDARDS DEVELOPMENT PROCESS (ANSI)

In the US standards for use with the building codes are developed by independent, private nonprofit organizations. The reasons for this approach are many and varied depending upon which standard is being discussed but in general the primary reason is the fundamental belief that the private sector can produce better standards, in a more timely manner, that the government. Because of the importance and affect that standards can have upon commercial interests and markets, standards for adoption by reference into the model building codes must be developed under an American National Standards Institute (ANSI) accredited or similar, process. Because of the difficulty determining what the term "or similar" means,from a practical perspective, all standards referenced in the model building codes are developed under a process accredited by ANSI. ANSI provides for two methods of developing standards – the committee method and the canvas method.

An organization that is accredited by ANSI to develop standards means that the organization (a) is a member of ANSI; (b) has a set of rules and procedures for developing

their standards; (c) is regularly audited by ANSI to ensure that they are following their processes; and (d) has a process to regularly maintain their standards. Although the process that each organization follows may be different, there are certain fundamental tenets that ANSI expects will be embedded in every organizations process. Those tenets are: openness, balance, and due process. "Openness" means that anyone may participate in the organizations process. For some organizations that is embodied by allowing any interested party to participate as a member of a standards committee. For other organizations "openness" means that anyone may submit a proposal or a comment for the standards committee's consideration. Regardless of how it is specifically embodied, every process must be open for anyone to participate. This doesn't mean that it has to be easy, convenient or free for someone to participate – only that there is a mechanism by which they the opportunity to participate.

"Balance" means that the process may not be dominated by a particular interest. Within ANSI's Essential Requirements, this is expressed through the establishment of three membership categories (consumer, producer, and general interest) along with the requirement that each category constitute between 20 and 40 percent of the committee membership. Depending upon the particular standard the definition of each of the categories can vary however in general within the US the following are used:

- A "consumer" is an owner or representative of an owner, such as an engineer or an architect
- A "producer" is a material producer, product manufacturer or contractor
- A "general interest" individual is someone without a direct monetary interest in the building process being standardized such as someone who does research in the particular area.

In addition to these three general categories some standards developing organizations also seek to maintain balance within these major categories themselves or seek to ensure a geographical balance due to regional differences in practice. Generally these subcategories for balance are applied on an ad-hoc basis within an individual standards committee unless they are explicitly required within the processes of an organization.

The requirement for "due process" necessitates that a standards developing organization have their rules and processes written down and made available to all participants, a requirement easily achieved via the organizations website. Participants are expected to comply with the processes of an organization and the organization is expected to adhere to them as well. The written processes of an organization must also contain procedures for how an individual might appeal if they believe that the processes were not followed. Appeals may only be made on procedural grounds and generally there must be two levels of appeal available within the organization with the final level of appeal being to ANSI itself.

A standard developed by an ANSI accredited standards developing organization receives a designation from that organization, e.g. ACI 318, AISC 360, or ASCE 7. These standards may then be further processed as "American National Standards" by following the specific steps delineated by ANSI, which in general simply consists of conducting a public review period through ANSI's announcement procedures. ANSI Standards are labeled as such, carry the ANSI logo on their cover, and include "ANSI" in their designation, e.g.

ASCE/ANSI 28. The term "ANSI standard" is one that is commonly used, often times improperly. An "ANSI-standard" is a standard that is developed by a committee that is actually a part of ANSI. There are very, very few of these committees that produce standards for adoption into the model building codes as private nonprofit organizations have assumed responsibility for nearly all of those standards (see Chapter 37 of the IBC or Chapter 23 of ASCE 7.)

6. THE FUTURE

The future of the code development process in the US will depend heavily upon the fortunes and leadership of the International Code Council (ICC). As the IBC has become the defacto single model building code in the US upon which nearly every building code is based, they have in essence developed a monopoly. This is a concept that runs counter to the core of many American's belief systems. Therefore in order for this approach to thrive into the future ICC is going to need to generally do two things – first, it will need to aware of potential legal challenges, and, secondly, the ICC will need to provide a strong infrastructure for their development process.

The legal challenges to the IBC may come on several fronts. First, as the only model building code in the US, they will need to continue to justify the value of this monopoly in terms of public safety and improvement of commerce. This argument can be easily made. In addition, because the ICC encourages states to use their model code as the basis for the state law, it is possible that they might lose the copyright of their code on the legal grounds of the written law needing to be available at no charge to the public. The 10th Circuit Court has already ruled on a case of this nature that the Supreme Court decided not to hear and hence the finding remains the law in the 10th Circuit Court's jurisdiction. Although this case, Veeck v. SBCCI, applied only to the Southern Building Code its application to all of the I-Codes is evident. How this ruling may be extended in the future to primary, secondary and tertiary standards that are adopted by reference into the building codes is an issue that all standards organizations are contemplating.

In a very real sense, the success of the IBC is heavily dependent upon the individual industries, organizations, individuals and private firms that choose to participate in their process. Without groups such as these actively proposing revisions to the IBC or developing new standards for adoption by reference, the technical provisions of the IBC could soon grow stale and therefore the technical credibility of the code itself. Preventing this erosion will require that the leadership of the ICC maintain true involvement of these groups in their processes, valuing their input, and involving them in the decision making process. Recent steps by the ICC to unilaterally shorten the development process of the structural provisions of the IBC by 18 months and thereby severely affecting the schedules and future revenues of many standards developing organizations caused widespread displeasure in the structural engineering community and may yet have substantial repercussions.

At this stage of development, many of the material organizations are trying to streamline and homogenize their design provisions. Notable among those are the efforts of the

American Institute of Steel Construction (AISC) which has synthesized all its requirements into four, non-overlapping documents: a Specification for regular buildings, a set of Seismic Provisions, a Nuclear Structures code, and a fabrication and erection guide. ACI is in the process of completely reorganizing its main design document, an effort that is expected to be completed around 2014. Similar efforts are underway in the wood, masonry, cold-formed and stainless steel industries.

Within ASCE there are a number of standards in various stages of development which may be of interest. Many of these may ultimately be championed for adoption by reference into the model building codes, and include:.

- *Blast Resistant Design and Construction*: Literally since September 11th, ASCE has been working to produce a standard on blast resistant design and construction. This standard is nearing committee consensus and may be complete by the end of 2010 for publication in 2011.
- *Progressive collapse*: A draft standard has been under way within ASCE for several years on progressive collapse. With the issuance in 2008 of the Unified Facilities Criteria guidance by the Federal Government the urgency for a standard has diminished and hence it is difficult to estimate when formal guidance by ASCE may be produced.
- *Terrorism*: Although no specific standard is being developed to mitigate terrorism there have been a number of changes introduced into various I-codes as a direct result of the September 11th attacks. The majority of these changes have been coordinated by a committee supported by NIST – the changes and their status may be viewed at http://wtc.nist.gov/NIBS_MMC/CodeChangeProposals.htm
- *Simplification*: One of the on going challenges within the code and standards environment of the US is the desire for simplification – the oft heard lament is that the provisions of the building codes and the various reference standards have become too complex. These concerns unfortunately run directly counter to the continual, but quieter, effort to optimize structural systems and provide the most cost effective structure to the owner. These conflicting pressures will be a major force in shaping the codes and standards in the coming decades.
- *FRP standard*: ASCE, in cooperation with the American Composite Manufacturers Association (ACMA), is in the process of completing the first draft of an LRFD-based design standard for pultruded fiber-reinforced plastic structural members. The draft is scheduled to be turned over to the standards committee by the end of 2010 with the hope for a formal consensus standard to be published by the end of 2011.

7. PERFORMANCE-BASED DESIGN

Over the last 10 to 15 years the topic of performance-based design (PBD) has been the subject of many research projects, workshops and conferences in the USA and abroad (for example, ACI SP-240, 2008). As with many other structural engineering issues, much of the impetus has come from seismic design needs and the design of unusual structures. At the application level, there have been a few buildings designed using this approach, but it remains the province of a few, high-level design firms. In the seismic context, PBD *explicitly evaluates how a building is likely to perform, given the potential hazard it is*

likely to experience, considering uncertainties inherent in the quantification of potential hazard and uncertainties in assessment of the actual building response. It permits design of new buildings or upgrade of existing buildings with a realistic understanding of the risk of casualties, occupancy interruption, and economic loss that may occur as a result of future earthquakes (FEMA 445, 2006). This is a definition that will be very hard to fulfill except with extensive experimental and analytical work, and that will remain outside of common practice for many years to come.

From the code standpoint, performance-based design has been implemented in the USA only by the cities of San Francisco (SFO AB-83) and Los Angeles (LATBDC, 2007) with respect to design of tall structures. Before the recession hit in 2008, there were over 25 building over 40 stories planned for downtown Los Angeles. Most of them were of mixed use, with parking at the bottom, followed by retail space at the lower levels, office, and condos or hotels at the top. Many of these building were originally conceived with innovative structural systems that would be required by a legalistic reading of the existing code to provide a primary lateral load resisting system to take 100% of the lateral loads, and a backup system capable of resisting 25% of the same load. In order to avoid this onerous requirement, many designers decided to attempt to use PBD; however, as no code contemplated it, the local jurisdictions (cities of Los Angeles and San Francisco) were forced to develop their own regulations. These regulations intend to address thorny design issues such as (a) the return period of design ground motions: (b) number, types, and scaling of ground motions; (c) influence of foundation and soil-structure interaction; and (d) and modeling and acceptance criteria.

The development of performance-based design in the USA will need to be tied to some basic expertise by the designer (such as registration as a structural engineer), tradeoffs between prescriptive and performance-based criteria, and discussions between architect, owners, and engineers as to the merit of suing this approach for individual projects.

8. CONCLUSION

This paper briefly describes the historical development of building codes in the USA, discusses current code development procedures and projects some future developments.

REFERENCES

1. ACI 240, 2006, SP-240: Performance-Based Design of Concrete Buildings for Wind Loads (J. Bracci, ed.), ACI, Farmington Hills (CD format).
2. LATBDC, 2005, An Alternative Procedure for the Seismic Analyses and Design of Tall Buildings Located in the Los Angeles Region, Los Angeles Tall Building Design Council, Los Angeles, CA.
3. SFO AB-83, 2007. Recommended Administrative Bulletin on the Review and Design of Tall Buildings Using Non-Prescriptive Procedures, Structural Engineers Association of Northern California, Sacramento
4. FEMA 445, 2006. Next Generation Performance-Based Seismic Design Guidelines, FEMA 445, Washington, D.C.
5. OMB, 1993, OMB Circular A-119 d http://www.whitehouse.gov/omb/circulars/