

CODE DEVELOPMENT
NCSEA EXPLAINS THE CODE DEVELOPMENT PROCESSES AND STANDARDS
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I. THE BUILDING CODE REVISION PROCESS

Today, most U.S. communities enforce a building code based on a recent edition of the International Building Code (IBC). The IBC is one of several model code documents published by the International Code Council (ICC). Other model codes published by ICC include the International Residential Code, the International Existing Buildings Code, and the International Performance Code. Several other organizations including NFPA and IAPMO also publish a series of model codes. None of these model codes have any legal standing, unless they are adopted by a state, county, city or other jurisdiction. ICC and the other organizations publish their codes to assist these jurisdictions in the code adoption process and also as a means of fund raising for their organizations.

Some communities adopt the IBC and one or more of its companion codes without modification, while other communities adopt these codes with substantial local amendments and modifications. The local adoption and amendment process can vary substantially from state to state and city to city. Engineers interested in how their local communities adopt a building code should discuss this with their local building official.

Despite the fact that it seems like each edition of the model code is quite different from the prior edition, in reality, the model codes change very little from one edition to the next. This is because the ICC uses the previous edition of its codes as the basis for the next edition and unless someone successfully submits a proposal to change, add or delete something in the code, and it is approved through a formal process, everything stays the same. So what is this formal process?

ICC publishes its codes on a 3-year cycle. At the start of this process ICC places a call for submissions to change its codes. Interested parties can download a proposal submittal form from ICC's website at www.iccsafe.org, fill it out and submit it, electronically, by email. The proposal form is relatively straightforward. It includes information on the name and affiliation (if any) of the person submitting the proposal; the specific code that the person wishes to change; the Section of the code to be changed (added or deleted); the specific proposal in which the text to be changed is typed with additions shown in underline format, deletions in strike-through format and existing text left the same; and then an explanation of the reason the person thinks this change is necessary.

Any person or organization can submit a change, and many take advantage of this opportunity. Usually there are several thousand proposals to change the code each cycle. These proposals range from (a) somewhat trivial requests to edit the way in which requirements are phrased, so as to clarify their intent or meaning, to (b) short but important proposals to adopt new or revised consensus standards (like ASCE 7-10 or ACI 318-11) by reference, (c) proposals to add new technical requirements directly into the body of the code, and (d) proposals to remove existing requirements from the code.

Many code change proposals are submitted for altruistic reasons because a person or group legitimately believes that there are problems with the existing requirements that need to be corrected to avoid safety problems. Others are submitted to allow the use of new techniques, systems and products. Many are also submitted for purely commercial reasons, either to allow the use of one supplier's products or to prohibit the use of a competitor's products. Even the most well-meaning proponents of a code change can inadvertently submit intended improvements to the code that would have unintended consequences and allow inappropriate design and construction. Therefore, the ICC uses a rigorous process to evaluate the merit of proposals, once they are received.

First, ICC staff reviews each proposal for editorial and technical merit and to determine whether the change is being proposed for an appropriate section of the code or conflicts with other code requirements. Often, ICC staff will contact a proponent and suggest changes they believe would improve the proposal. ICC staff develops an opinion as to the merits of the proposal and its likely effect on construction cost and safety. Then it assigns

each proposal to a cognizant ICC code committee, including Administrative, Fire Safety, General, Means of Egress, Structural, Energy Conservation, Existing Buildings, and others. Finally, ICC publishes all proposals received, together with the staff analyses, in a monograph, which can be downloaded from the ICC website.

After publication of the monograph, ICC holds a public hearing to consider the proposals. At the hearing, cognizant ICC committees will review each of the proposals and vote to approve or deny them. As part of this process, proponents and other interested parties are permitted to offer comment on why they believe the proposal is needed or inappropriate. Proponents can propose changes to a proposal at the hearing, in order to improve it or address concerns expressed by others; however, major changes to proposals are not permitted, as the committees do not have adequate time to consider major changes in the brief time allotted each proposal during the hearing. Sometimes, the committee will approve a proposal with modifications they themselves propose. When an ICC committee denies a proposal, it also states the reason for denial, so that the proponent can modify the proposal and resubmit it for future consideration. Following the hearings, ICC publishes the results of the committee actions on its website, so that interested parties who could not attend the hearing can remain informed.

Prior to adoption of a code change proposal, ICC holds a final action hearing, usually in conjunction with an annual meeting. Prior to the final action hearing, proponents and opponents of proposals can challenge the committee actions, asking for disapproval of proposals the committees have approved or asking for reconsideration and approval of proposals the committee has denied. Requests for modification of committee action are voted upon at the final action hearing by the ICC-government members, typically building officials, who are present. Following the final action hearing, ICC staff inserts new language into the code, makes necessary deletions and publishes the new code.

NCSEA and many of our member organizations play an active role in this process through our code committees. Some member organizations (MOs), notably California and Washington, maintain active code committees that develop and submit proposals for consideration by ICC. Since most structural engineering requirements in the code are adopted by reference to the consensus standards, these proposals typically focus on the administrative requirements and the code chapters associated with foundations, quality assurance and existing buildings that are not presently covered by consensus standards. The NCSEA code advisory committee coordinates the efforts of MO committees, tries to develop consensus between the various MOs and submits the proposals on their behalf. In addition, the NCSEA code advisory committee sends delegates to the ICC code hearings to offer public comment on our proposals and those generated by other individuals. The NCSEA

code advisory committee includes several subcommittees, including Existing Buildings, chaired by David Bonowitz; General, chaired by Ed Huston; Seismic, chaired by Kevin Moore; Wind, chaired by Don Scott; and Construction Quality Assurance, chaired by Kirk Harman. We also maintain a subcommittee, chaired by Bill Warren, that works with the ICC Evaluation Service and other evaluation services, to review the submittals made for product evaluation reports. These committees are always looking for active members. Interested engineers should contact the committee chairs.

It is also possible for engineers to serve on the ICC Code Committees. Each committee has a number of seats that are open to the public. Interested engineers can submit their personal nominations for consideration. ICC does not provide travel or time support for committee members; however, NCSEA does provide some expense support for engineers who sit on the ICC committees with NCSEA endorsement. NCSEA endorsement is available to engineers who are interested in serving on an ICC committee if the CAC deems that the engineer has adequate qualifications. NCSEA-endorsed ICC committee members are asked only to perform a diligent and honest evaluation of proposals and have no obligation to support NCSEA proposals. Engineers interested in serving on these committees should monitor the ICC web site for a call for participants and also notify the NCSEA Code Advisory Committee chair so that we can provide endorsement at the appropriate time.

For many years, ICC and its predecessor organizations used an 18-month cycle for this process, with alternate cycles used to publish a new edition of the code (e.g. 2000, 2003, 2006, etc) and the remaining cycles used to publish Supplements to the code. The supplements gave proponents who could not get their proposals into the code a second chance to modify and resubmit their proposals, without having to wait three years. Supplements also provided ICC an opportunity to make emergency changes when an incident, such as an earthquake, hurricane, or other event showed that a major, previously undetected problem with the code needed to be changed on an expedited basis. However, since many communities did not adopt the supplements, most proponents timed their proposals to appear in the cycles that would lead to a new code.

Last year, as a cost-saving measure, ICC elected to abandon the supplement cycles and, instead, go to a three-year cycle. Under this new approach, half of the committees consider their proposals in the first 18 months of the cycle and the remaining half of the committees consider their proposals in the second 18 months of the cycle. Unfortunately for structural engineers, ICC placed the Structural Committee into the first 18-month portion of the cycle. This created several problems. First, when this decision was made, AISC, ASCE and other standards development organizations were working towards publication of 2010 editions of their standards that would not be completed prior to the deadline for submittal and

approval of structural code changes. Thus, it appeared that the 2012 edition of the IBC would not be able to adopt these updated standards. Second, the deadline for submittal of proposals for change was so early that most engineers would not have the opportunity to use the 2009 edition of the codes, and they would have to submit proposals for change before they even knew if there were problems with the prior code. In response to the first problem, ICC provided for administrative adoption of the new consensus standards. This is less than satisfying as it means that it is not possible for either ICC or the public to conduct a thorough technical review of the standards before they are adopted. ICC offered no resolution for the second concern identified above.

NCSEA, ASCE/SEI and the other structural standards development organizations are quite concerned about these new ICC procedures and are working to find a means of more effectively operating in this new paradigm for code development. One option includes the potential publication of a stand-alone structural building code. ASCE/SEI and NCSEA will be hosting a series of meetings over the next year to review how this or other measures can move forward; and I will keep you posted on important developments through NCSEA's Member Organization newsletter, *Structural Connection*.

II. THE STANDARDS DEVELOPMENT PROCESS

Most structural requirements contained in the International Building Code are adopted through reference to ANSI-consensus standards including ACI 318, AISC 360 and ASCE-7. The American National Standards Institute (ANSI) is a non-profit, member-based organization that sets the procedures for developing national consensus standards in the United States. ANSI includes more than 200-distinct organizations that together publish approximately 10,000 standards governing the procedures for design, development, delivery, manufacture and construction of a variety of products and services. Although not all standards developed in the United States are ANSI standards, the ANSI process is the most widely-recognized process in the U.S. ACI, AF&PA, AISC, AISI, ASCE, AWS and TMS all produce ANSI consensus standards.

In order to publish ANSI consensus standards, these organizations adhere to a consistent set of procedures that govern the consensus development process. The intent is to ensure that all interested and affected parties have an opportunity to participate in a standard's development and also to protect the public interest. Each standards development organization (SDO) can develop and maintain its own unique standards development process as long as it abides by the overall rules set by ANSI. The process must conform to basic principles intended to assure that all affected parties have access, that all objections or comments are given appropriate consideration and that a consensus, defined as a majority of participants, agree with all actions.

SDO's empanel committees of volunteers to develop their consensus standards. ANSI rules, which are generally developed around the concept of standards governing products, require that committees have a balance between "producers," "users," and "general interests." The SDO's that develop structural standards have interpreted these requirements in different ways. Some define "users" as design engineers, "producers" as fabricators or contractors, and, "general interests" as researchers and building officials. Regardless, structural standards development committees usually have a healthy mix of designers, contractors, building officials, product developers and researchers/academics. These committees can be quite large, with as many as 100 members, and often have a number of subcommittees or task groups that deal with specific technical areas. Committee members work on a volunteer basis, without payment by the SDO, although some SDO's do reimburse travel costs.

ANSI rules require update or reaffirmation of standards on a periodic basis, typically 5 years. If this does not occur, then a standard becomes outdated and, technically, should not be referenced by the building codes. Thus, the standards committees usually operate on a multi-year, often 5-year, cycle.

At the initiation of update cycles, SDOs empanel a committee or task group by appointing a chair and a secretary. The secretary is usually an SDO employee who is responsible for keeping ANSI-required records. Following appointment of the chair and secretary, the SDO has a public call for volunteers, often through an advertisement on the organization's internet site. The committee chair typically reviews applications received and makes selections, subject to SDO approval. The SDO's primary interest in approving members is to assure that (i) the committee has appropriate balance between producers, users and general interest, (ii) as a whole, the committee has appropriate levels of technical expertise, (iii) volunteers will put in the necessary level of work, and (iv) to the extent possible, that volunteers have demonstrated capability to work within the process without being disruptive. Most committees have two levels of membership: full or voting membership and corresponding. Corresponding members can submit proposals, attend meetings, and make comments on proposals, but they do not have a formal vote. As part of the requirement to achieve balance, most SDOs have adopted rules that prevent voting participation by more than one person from any organization or firm.

Assuming a standard already exists, the committee initiates work by reviewing the existing standard and asking for proposals to revise the standard. Many SDO's have a formal process for soliciting input from the general public, although most proposals for change are initiated by committee members. Committees meet several times per year during the development cycle. At these meetings, members discuss proposals for updating the

standard and receive comments from other members. When the proponent for a change feels that he or she has sufficient support for a proposal, the proponent can forward it to the Secretary for a formal ballot. Typically, written ballots are required. The proposal for change is forwarded to all voting members together with a justification as to why the change is needed and a ballot form. Sometimes proposals are accompanied by extensive supporting documentation, including research reports, design examples, and similar material. Acceptable votes are typically "affirm," "affirm with comment," "oppose" and "abstain." "Affirm with comment" votes are used to suggest relatively minor, often editorial, improvement. Negative or opposition votes must be accompanied by a statement that explains the voter's objections and what actions could be taken by the proponent to address the voter's concerns. For a ballot to be valid, most organizations require that a substantial percentage of their voting members record their votes. These days, most voting is done over the internet.

For a change proposal to be successful it must receive a minimum number of supporting votes and all negative votes must be formally resolved. The percentage of voting members that must vote in support of an action varies, but it is always at least 1/2 of those voting and may be as much as 2/3, with at least 1/2 of the total membership voting in favor. When a negative vote is received, the negative and the voter's comments must be communicated to all voting members, in case this affects their opinion. To resolve the negative vote, the change proponent may take several actions. The proponent can present additional information to the negative voter, to convince them that the change is justified; and, if convinced, the negative voter may withdraw their negative, in writing. The proponent can find the negative vote persuasive and withdraw or revise the proposal, submitting it for re-ballot. The proponent can find the negative vote non-persuasive, present information to the other voting members as to why the comment accompanying the negative is non-persuasive, and ask the committee to affirm this, by written vote, overturning the negative. It is a cumbersome process and can often take 3 or more rounds of voting for a proposal to be successful. In a typical revision cycle, a committee may review and ballot several hundred proposals.

Once committee consensus is achieved, the draft of the new or revised standard must go through a public review process. Typically, SDO's post their draft standards on their internet site and provide a means for the public to provide comment. When public comment is received, the committee must address and resolve the comment. This can be done by finding the comment persuasive and changing the proposed new standard accordingly, by finding the comment non-persuasive, or, in a few cases, by deferring formal action until the next cycle, due to time constraints. All such actions must receive a consensus vote of the committee. The committee secretary must keep records of all committee actions, all ballots and all resolutions. In order to obtain ANSI certification, these records are presented to ANSI

who can audit the process. The SDO must also maintain an appeals process for persons who believe that the SDO's committee has not acted in a fair or appropriate manner.

The ANSI consensus process is intended to assure fairness, as well as open access by all parties who may potentially be affected. Typically, it is only modestly effective in meeting these goals. In order to truly have access, one must be aware of the committee's activities and the appropriate time to provide input; but, often, only committee members know what is happening and when. Anyone can submit proposals to revise a standard; however, unless they have an advocate on the committee, there is limited chance that such proposals will be successful. Also, some committees have a "not-invented-here" attitude and automatically find comments and suggestions that come from outside the committee non-persuasive. Despite these drawbacks, most committees and committee members are well-intentioned and hard-working, and most of our structural standards are excellent, especially when compared with similar design and construction regulation developed in other countries.

Engineers interested in participating on a standards development committee can do so by volunteering. Most SDO's publish the names of standards committee members on their websites and in the front pages of their standards. If you are interested in participating, it helps to contact one of these individuals and express your interest. Most participants start by becoming corresponding members. Corresponding members who are active, knowledgeable and supportive are often elevated to full voting status after a period of time.

Since SDO's do not have organizational representation on their committees, it is important that engineers who get appointed to an SDO committee attempt to coordinate with their colleagues and with their SEA and NCSEA committees. This is the only way that the profession, rather than individuals, can truly have an impact on a standard's contents and requirements.

III. WHY THE CODES ARE SO COMPLEX

If the codes are excessively complex, we cannot blame building officials. The originators of the technical provisions of the building codes are engineers, not building officials. Today's codes are complex, at least in comparison with the design requirements contained in the building codes of the 1970s and earlier; and I believe the complexity can be attributed, in varying degrees, to the drivers discussed below.

Safety and Economy – Most code changes have originated as a result of these twin drivers. Our clients are constantly pushing us to design more economical structures. We respond by trying to find ways to do the same job with less structure and by searching for new systems,

materials and construction techniques. New methods may be developed at Universities, when a researcher determines that a more accurate prediction of structural behavior can be achieved with a new, more complex design formula; and the use of this formula will allow many structures to be designed lighter. Since everyone wants lighter structures, engineers are often eager to incorporate these new formulas into the code. Other times, researchers may determine that design formulas currently present in the code can lead to unsafe structures under certain conditions, and a more complex design formula is needed to assure that we don't have failures. Again, engineers are eager to modify the codes to assure we design safely. Finally, engineers and contractors will often work together to invent new techniques that are on the fringe of acceptability under the codes of the time. Historic examples include the use of higher strength steels, precast concrete, bolting instead of riveting, and welding instead of bolting. Sometimes these innovations are adopted without extensive research and then, later, structures constructed using these new techniques do not perform acceptably, failures occur, and engineers write code changes to improve the performance of structures using these techniques. Each time that the rules for a new system or construction technique are introduced, or existing rules are improved, the code becomes larger. The engineer has more material to be aware of, creating the impression of complexity, even if each individual requirement is, by itself, relatively simple. Essentially, we find ourselves being overwhelmed by the volume of material, as much as by its apparent difficulty.

Prescription – Early code requirements typically limited themselves to specification of minimum loads and maximum permissible stresses and deflections under load and, in some cases, required detailing (e.g., minimum edge distance for bolt or rivet holes). These codes did not tell the engineer how to determine the distribution of forces in a structure under the specified loads or how to calculate deflections. Instead, the authors relied on the universities to instruct us in how to determine these things. Today's codes specify not only required loads and permissible strengths, but also the required analysis techniques and stiffness assumptions. If we could remove this material from the codes, and again rely on universities, text books and design guides to tell us how to do the analysis properly, then the volume of the code would be significantly decreased. Much of this over-prescription has been driven by two things: Distrust by some engineers of the ability of other engineers to do things properly, if the code does not spell out exactly how things should be done, and the strong desire of some building agencies to check every number and assumption in an engineer's calculations against the code. This practice originated in the western United States, predominantly California, where frequent earthquakes sometimes resulted in poor building performance. This, in turn, resulted in perceived pressure on the building agencies to correct the situation. Engineers would then feel compelled to write detailed how-to guides into the codes, to accommodate these building agencies and to exclude the use of engineering judgment.

Rather than permitting rational or reasonable procedures based on engineering mechanics, the requirement to use approved procedures was written into the codes.

Computerization – Early codes were simple because they had to be. Engineers did not have the capability to perform complex analyses. Instead, we tried to design statically determinate structures or, failing this, to use simple methods of analysis, like moment distribution, Williot-Mohr diagrams, and the portal method of frame analysis, all of which were amenable to hand calculations. Appreciating that these approximate techniques were sometimes less than accurate, our permissible stresses incorporated large factors of safety. Today, however, with the advent of the economical desktop computer and the proliferation of analysis and design software, it is no longer important to keep things simple, because few engineers actually do hand calculations anymore. The belief that “everyone will do this calculation on a computer” has allowed code developers to incorporate complex formulas with comfort, knowing nobody will try to run the numbers by hand. Of course, if you are actually reading the code, to figure out what it requires before running to the computer, these formulas will appear hopelessly complex.

Poor Writing and Formatting – In many cases, the code requirements appear more complex than they actually are because of bad writing and formatting. Bad writing and formatting comes in many forms. For example, a design procedure might not be presented in a logical step-by-step order that matches the way an engineer would actually perform the calculation (consider the ASCE 7.05 all heights wind procedure). Another source of complexity is the tendency of code writers to cross-reference between portions of the code, in order to avoid duplicating material. Sometimes persons who wrote the requirements weren't thinking like people who had to implement the requirements. Another contributor to poor wording and formatting is a pedantic requirement to use code-approved language. Thus, the word “engineer” doesn't appear in the code. Instead, we have “design professional” (because, after all, landscape architects may be doing structural design). The codes won't permit use of the word “may” but instead require “shall be permitted to be” (why use one word when 5 can say the same thing?). Finally, code provisions tend to evolve over a period of many years, with minor additions and tweaks made in each successive cycle. I am reminded of a poem I read many years ago, titled the “engineer's lament.” One verse read: “revision 1, add this new piece; revision 2 – improve it; revision 3 – make it just right; revision 4 – remove it.” Code provisions evolve in this same way, except, instead of four revisions, the process may cover decades of revisions, with a few words added to a requirement in each cycle. Code writers are reluctant to undertake a major rewriting effort just to introduce a small “adjustment or tweak” and so, over time, the code becomes unreadable.

The Solution – Unfortunately, I don't have a silver bullet to solve these problems, though I can assure you that those of us who are active in developing code requirements are aware of them and even complain ourselves at times. Personally, I would like to see much of the "how-to" material removed from the code and placed back in text books and design guides. This wouldn't change the way we do our analyses, but it would make the code look a whole lot simpler. Most complex material was placed in the code because of a belief that building agencies and plan checkers needed it. However, when you consider that most calculations are done by computer these days and cannot really be checked in the traditional sense, I doubt that the loss of this material from the code would be a serious problem for anyone. Furthermore, even if the building officials objected, they don't really have the power to prevent it from occurring. Remember that the technical requirements are not in the code anymore, but rather in the standards, and building officials have little control over standards.

Following a talk on this topic that I gave at the National Steel Construction Conference this year, Charlie Carter, who heads AISC's technical activities, asked Jim Malley and I (Jim chairs the AISC TC-9 committee that develops AISC 341 – Seismic Provisions, and I chair the Connection Prequalification committee that develops AISC 358) if we would try to implement this in the next edition of these standards. We agreed. Perhaps there may be some room to do this in ASCE 7 as well.

Another thing that needs to happen, and is happening, is the occasional rewrite of entire code sections, to improve the format and clean up the messes that have accumulated over decades of revision. This is an ongoing process that each of the code and standards development groups undertake. ASCE 7.05 underwent a complete rewrite of the seismic sections that incorporated few technical changes, but greatly improved the writing style and logic of the presentation by moving seldom-used requirements into separate chapters where they could be ignored by most users. The ASCE 7.10 standard did the same thing with the wind requirements. AISC 341-10 underwent a complete rewrite and reorganization, again with few technical changes, intended to simplify the presentation and be more consistent with the format of the main AISC 360 specification. ACI is currently doing a complete reformat of its 318 standard.

Finally, I want to encourage all engineers who are concerned about code complexity, and who genuinely care about the problem, to become part of the solution by actively engaging in the development process. Even if you don't join a committee, you can, as individuals or members of SEA committees, develop proposals for change and provide public comments on changes proposed by others. Remember that we as engineers are the ones who write the codes. If we don't like the way they read, or what they require us to do, we have the power to change them.