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The ACI 318 Code Process

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Summary

After providing a brief history of the origin and development of the ACI Building Code, this paper presents a general overview of the process by which the code is revised and modified. In addition, significant changes introduced into the most recent revision, ACI 318-95, are summarized. The status of the current work of Committee 318, which is expected to lead to ACI 318-99, is briefly reviewed.

1. Brief History

The origins of the ACI Building Code (1)* go back to the early 1900s, to efforts of the National Association of Cement Users. The NACU was a society organized in 1905 (2) to deal with problems arising from the use of concrete. A code for reinforced concrete by the committee on Laws and Ordinances of the NACU appeared in 1907. This code apparently was the forerunner of the First Standard Building Regulations, which was adopted by the NACU in 1910.

However, another group known as the Joint Committee on Reinforced Concrete had been formed in 1904. This committee consisted of representatives of four major societies, all of whom were interested in the control of concrete construction. These societies were the American Society for Testing Materials, American Society of Civil Engineers, American Railway Engineering and Maintenance Association (which later became the American Railway Engineering Association), and the Association of American Portland Cement Manufacturers (which later became the Portland Cement Association). The first report of the JCRC on regulations for concrete was issued in 1910. A final report was issued in 1917.

In July, 1913, the name of the NACU was changed to the American Concrete Institute, to recognize the breadth of the aims and interests of the society. A revision of the First Standard Building Regulations was also issued in 1917, which was known as the ACI Code.

* Numbers in parenthesis refer to references listed in Section 7

Differences between the JCRC regulations and the ACI Code were a source of controversy among many engineers who felt there should be more uniform standardization of concrete practices. In subsequent years, a second and third Joint Committee were formed, each of which produced a final report in 1925 and 1940, respectively. However, ACI was also continuing to work on its document, resulting in regulations referred to as the 1925 and 1936 ACI Codes. The 1936 ACI Code was developed by Committee 501, because it was also referred to as ACI 501-36. Committee 501 was apparently organized in 1929, and later became Committee 318. The first code produced by Committee 318 was known as the Building Code Requirements for Reinforced Concrete (ACI 318-41).

Since that time the ACI Code, or rather the ACI Building Code as it has come to be known, has been updated on a regular basis, in 1947, 1951, 1956, 1963, 1971 and thereafter on a six year cycle, although there have been minor mid-cycle revisions in the recent intervals. A very interesting point of view on the development of the ACI Building Code during this period of time may be found in an interview of Chester P. Siess presented by Nancy L. Galvin (3). The informality that characterized the development of the ACI Building Code has been largely supplanted by more rigorous procedures now required with the emphasis on standardization. These procedures are discussed in this paper.

The current ACI Building Code is ACI 318-95 (4). The next code is expected to be published late this year, as ACI 318-99 (5). Thereafter, the code is expected to be revised in three year intervals. This change in procedure recently came about as a result of a merging of three separate model code groups in the United States into the International Code Council. The ICC intends to publish a single model building code, to be known as the International Building Code, in the year 2000, and every three years thereafter. The publication of the ACI Building Code will then always precede the IBC by a year. It is anticipated that the ACI Building Code will be adopted by reference in the IBC.

2. Current Mission and Organization

Committee 318 is a Technical Committee of ACI. As such it falls under the jurisdiction of the Technical Activities Committee, which is the final authority on technical issues in all publications. The mission of Committee 318 - Standard Building Code - is to develop and maintain standard building code requirements for plain and reinforced concrete (6). As a committee that produces standards, prescribed document adoption procedure set forth in the Technical Committee Manual (7) must be followed. This procedure will be reviewed in the next section. The work of Committee 318 is carried out in a Main Committee and Subcommittees.

Following the completion of a major revision of the code, i.e. the completion of a code cycle, the membership of Committee 318 has usually been discharged. A new chairman is appointed, although in infrequent circumstances the chairman of the committee during the last cycle has been reappointed. The incoming chairman makes recommendations to the TAC for reconstituting the committee.

Committee 318 has four classifications of membership, as follows: a. Active, b. Subcommittee, c. Consulting and d. Liaison. Only Active members have the privilege and obligation of voting on matters before the Main Committee. Subcommittees are made up of Active members of the Main Committee as well as other members who represent technical committees that cover issues

related to a particular subcommittee or who provide special expertise for the subcommittee. These members vote only on matters before the subcommittee. The Consulting member classification is for persons with special expertise or a long time association with Committee 318. Liaison membership is a special classification for representatives of other organizations to provide such groups with current information about developments within Committee 318.

Committees such as 318 that produce standards are required to have balance in their voting membership, in order to ensure fairness and balance among affected interests. To achieve balance, members are classified as Producer, User, or General Interest. A producer interest is an organization or an individual that produces or sells materials, products, or systems covered in the committee mission. A member who represents a producer interest is classified as a Producer. A member who is a User represents an organization that purchases or uses materials, products, or systems covered in the committee mission. A member in the General Interest classification is anyone who is not classified as a Producer or User. For example, an employee of a government agency or a university is classified as General Interest. Balance is considered to be met in a committee when the combined number of voting members classified as User and General Interest equal or exceed the number of voting members classified as Producer, and each producer interest has no more than one voting member.

After the work on ACI 318-95 was completed, about one-half of the previous Active membership was reappointed for work on the next code cycle. With the addition of new members, the membership of the Main Committee consisted of 19 engineers or architects, 7 academic persons, 5 contractors, 5 persons from industry, and 4 persons from government.

Eight of the ten Subcommittees of Committee 318 are responsible for specific sections of the ACI Building Code. These 8 subcommittees are listed below:

Subcommittees of ACI Committee 318

318-A	General, Concrete, and Construction
318-B	Reinforcement and Development
318-C	Safety, Serviceability, and Analysis
318-D	Flexure and Axial Loads
318-E	Shear and Torsion
318-F	Two-Way Slabs
318-G	Precast and Prestressed Concrete
318-H	Seismic Provisions

The two remaining subcommittees are Metrication and Editorial. In addition to a code in English units, ACI 318 produces a document entirely in S.I. units. The Metrication subcommittee makes recommendations to the Main committee for issues that arise concerning the metrication of the code. The Editorial subcommittee seeks to maintain uniformity of style in the code.

3. The Adoption Procedure

Changes in or additions to the ACI Building Code are proposed as a result of new research and new or improved technology. The performance of existing structures, particularly in view of unexpected distress or catastrophic failure, provides impetus for change in code provisions.

While many of the changes originate with members of Committee 318, other ACI committees are encouraged to propose changes as well. For that matter, a change proposed by any interested party is considered.

To facilitate consideration, Committee 318 requires that each proposed revision or new inclusion cover only one subject and include the Section or Sections of the ACI 318 Code that are affected, a complete description with proposed wording where possible, and the reason for the change. The proposed wording should be the precise language that is desired for incorporation as well as the existing language that should be removed. Major reasons for changes include:

- Correcting shortcomings in the present code for those cases where the code does not provide adequate safety or serviceability
- Reducing cost of construction while maintaining public safety and serviceability
- Reducing design costs while retaining adequate public safety and serviceability
- Simplifying design or construction procedures
- Clarifying provisions where ambiguity has been found in application

Finally, the proposal should include all of the supporting material for the change. If the proposed change will result in revision to design procedures, one or more examples should be included that show how the change affects design practice.

Requests for a proposed revision from the public at large and the ACI membership should be sent to the Chairman of ACI Committee 318, with copies to the Secretary of ACI 318 and the ACI Director of Engineering. The Chairman assigns each revision to a lead Subcommittee, and notifies other concerned Subcommittees. If a proposed revision originates in a Subcommittee or an ACI committee designated for liaison with the concerned Subcommittee, the revision is submitted to the Subcommittee Chairman, with copies to the Chairman and Secretary of ACI 318 and the ACI Director of Engineering.

After review and discussion, the lead Subcommittee either declines to consider the proposal or accepts the proposal for further action. If declined, the reasons must be reported in the minutes of a Subcommittee meeting, after which the Secretary of ACI 318 informs the proponent as well as the Chairman of ACI 318 and the Director of Engineering. If accepted, the lead Subcommittee Chairman assigns a Change Submittal Number which is used for subsequent processing.

After due consideration, a final Subcommittee vote is taken, which may either be oral at a Subcommittee meeting or written. Negative votes must be accompanied by a reason. If the revision is not approved, it may be discussed and further revised in the Subcommittee as needed, and then reballoted. If and when the revision is approved, the Change Submittal is moved to the Main Committee for action, along with a summary of the results of the action.

The lead Subcommittee chairman, or his or her delegate, presents the Change Submittal to the Main Committee. After presentation and discussion including further revision, if agreed to,the Subcommittee Chairman may move the item for Main Committee ballot, or take the item back to the Subcommittee for further consideration. If balloted in the Main Committee, the goal is to

obtain practically unanimous approval. The ACI standardization procedure require approval by at least two-thirds of the Yes and No votes but not less than 50% of the eligible votes.

After an item is successfully balloted in the Main Committee, the Chairman and Secretary of ACI 318 submit the action to the Technical Activities Committee for further steps in the standardization process. If the TAC proposes any editorial changes as a result of its review, they are referred back to the lead Subcommittee Chairman for concurrence or comment. Proposed substantive changes are also referred back to the lead Subcommittee, if necessary, and to the Main Committee for appropriate action.

Following TAC approval, the document is submitted to the Standards Board for verification that all of ACI's standardization procedures have been followed. The document is then published for public review and for discussion for three months. ACI members as well as the public at large may suggest revisions. After publication, the revisions are presented by Committee 318 for oral discussion at an annual or fall ACI convention.

In accord with its normal procedure, Committee 318 will review all comments and suggested revisions, including further revision and approval of amendments to the document, and the Chairman of Committee 318 will then write a closure statement that is reviewed by the committee. TAC further reviews the public comments, amendments and closure statement, and after agreement forwards the closure to the Standards Board. Upon approval of the Standards Board, the closure statement and any revisions are published, and the document is submitted to the entire voting membership of ACI, The document must receive a two-thirds affirmative vote of all ballots marked Yes or No. If approved, the document becomes an official ACI standard upon certification of the results of the letter ballot.

4. Incorporation Into Legally Binding Building Codes

The provisions in the ACI Building Code are not legally binding until they are incorporated in the building code of a local jurisdiction, such as a city or municipality. However, since the building code of a local jurisdiction generally covers all aspects of construction, and since the local jurisdiction may not have the capability to maintain a code and assure its rigor, the local jurisdiction usually joins an agency that produces a model building code.

In recent years, there have been three recognized agencies in the United States that have produced a model building code, each intended for use in a certain geographical area in the United States. These agencies have incorporated the provisions of the ACI Building Code in their code either by reference or by transcription. The agency that incorporated the provisons by transcription has, over time, also made some changes in the document. ACI Committee 318 has sought recently to minimize these differences, to facilitate the adoption of the ACI Building Code by reference in the International Building Code or IBC 2000 referred to earlier in this paper.

5. Future Directions

There were a number of significant changes in ACI 318-95 (4). These included a change in the title of the document, from "Building Code Requirements for Reinforced Concrete" to "Building

Code Requirements for Structural Concrete," to reflect the incorporation of a new chapter on "Structural Plain Concrete" in the code. Other notable changes include the modification and expansion of design provisions for slender columns, major revision of the design provisions for torsion which apply equally to non prestressed as well as prestressed concrete, simplification of the calculation of development length for deformed bars in tension, and a substantial expansion of provisions on precast concrete incorporating detailed requirements for structural integrity. In addition, a new Appendix B on "Unified Provisions for Reinforced and Prestressed Concrete Flexural Members" was introduced into the code, allowing heavily reinforced beams to be used with a reduced capacity reduction factor based on the net tensile strain in the extreme tension steel. This new provision also provides a smooth transition in flexural strength of columns as axial load decreases to zero. A new Appendix C on "Alternative Load and Strength Reduction Factors" was provided for the design of mixed concrete and steel systems.

Changes that are in the process of being incorporated into ACI 318-99 are limited as a result of the reduction in the code cycle from 6 to 4 years. Further, the decision to make this change was taken after the completion of the code cycle leading to ACI 318-95, thus reducing the time that would otherwise have been available for processing.

There will be extensive revisions in Chapter 21 of ACI 318-99 (8), Special Provisions for Seismic Design. These revisions were brought forward as a result of the 1994 Northridge earthquake in California, and are expected to include the following:

- New detailing provisions for structural diaphragms
- Provisions for walls that relate requirements more directly to displacement demands
- Revisions in requirements for transverse reinforcement for columns
- Introduction of requirements for diagonally-reinforced coupling beams
- Allowing the use of high-performance mechanical splices in yielding regions.

In recent years, Committee 318 has been developing a new chapter on fastenings to concrete. As of the time that this paper is written, however, it is uncertain whether this chapter will be included.

6. Concluding Remarks

Over the last three or four code cycles, the ACI Building Code has become more voluminous and complex. This has been a rather natural process, as a result of incorporation of extensive research on the behavior and strength of structural concrete members into the code. The advancement of technology based on research, along with the demand for structures that are both safe and economical, has led to many significant improvements in building codes, largely based on strength design procedures. While some improvements have been simplifications, most have been complications because dealing with so-called disturbed regions in concrete structures invariably requires very specific and detailed requirements. As a consequence, the code has become more difficult and time consuming to use in the design process.

Further, while serviceability and durability have received more attention in recent codes, there is growing recognition that volume changes and environmental factors have more influence on life than strength requirements, provided of course that an adequate level of safety is provided by the structure. In ACI 318-89, construction requirements relating to durability were placed in a separate Chapter 4 of the code. Controversy continues about some of these provisions, along with the realization that minimum requirements, as given in a code, can never provide full protection in all circumstances.

Another factor affecting the code is that the process of adoption has become more stringent, to assure opportunity for all interested parties to provide comment and proposals. At the same time, the ability to make revisions has become cumbersome and time consuming as a result of providing due process to all comments.

Finally, there is increasing need that a building code have worldwide applicability. While some people have interpreted this as competition for a code that would have preference over other codes, it is the view of the author that any code which can be shown to provide safe, serviceable and durable designs should be permitted for use by engineers with familiarity and understanding of the applicability of that document.

7. References

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