THE NEW DRAFT CONCRETE DESIGN CODE

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A new draft New Zealand Standard, DZ 3101: Parts 1 and 2, was published in June, 1978. Part 1 is the "Code of Practice for the Design of Concrete Structures", and Part 2 is a complete commentary on the code.

The scope of this code is wider than was the case in previous New Zealand concrete design codes, because it covers the design, not only of buildings, but also bridges and other engineering structures. It also covers the design of prestressed and partially prestressed structures. Particular attention has been given to producing provisions which would be appropriate for use with modern New Zealand design loading codes, and particularly with NZS 4203:1976, Code of Practice for General Structural Design and Design Loadings for Buildings. This latter code has requirements for seismic design which do not appear in any other design codes in the world - particularly its specific requirements covering the detailed principles of design for many types of ductile structures. The purpose of the material design codes such as the Concrete Design Code, is to provide information on how the requirements of NZS 4203 can be met. In actual design many of the apparently simple requirements in NZS 4203 require complex analysis considerations, resolution of indeterminacies, studies of inelastic response situations and studies of large scale tests of members and assemblies. For example, in the concrete design code, the specific requirement that capacity design principles must be complied with introduces complexities in developing procedures for design that will ensure that the chosen energy dissipating mechanisms will be maintained, without non-ductile failures developing in any part of the structure. The requirement to design for the concurrent effects of simultaneous yielding of members framing into a column or wall from different horizontal directions introduces serious difficulties in framing the provisions of a concrete design code. Further, the loading code has a number of other specific requirements to ensure adequate ductility, such as those governing permissible positions of plastic hinges, restriction on column hinge mechanisms, prevention of failure of beam-column junction zones and the prevention of plastic hinges in such zones, design of ductile coupled shear walls, ductile cantilever shear walls, foundation capacity requirements, restrictions on foundation uplift, etc. Corresponding provisions are required in the material design codes to satisfy all these requirements, and the Committee has endeavoured to satisfy all such provisions in the appropriate chapters of the present draft.

NZS 4203 also has provisions governing the design of small buildings of limited ductility, and special chapters have been provided in this concrete design code to cover the various types of structures which come into this category.

The code is made up of three parts. Parts 1 and 2 contain the "non-seismic" chapters which have been largely based on the American Concrete Institute Building Code Requirements for Reinforced Concrete (ACI 318-71 and 318-77), but with extensive and significant alterations. These alterations include those to suit special New Zealand design requirements, those necessary to give consistency with related New Zealand codes and the New Zealand framework of Model Building Bylaws, the necessity to cover other structures as well as buildings, metric units for all parameters and for all formulae, etc.

Part 1 - General, corresponds to Chapters 1, 2 and 7 of the ACI Code. There are no chapters on materials and workmanship in this New Zealand design code, because there is a separate New Zealand Concrete Construction Code, now being revised, which will cover this subject. However, there will be some unavoidable duplication between Chapter 3 - Details of Reinforcement - of the Concrete Design Code and the corresponding chapter of the Concrete Construction Code. There is very little corresponding to Chapter 1 of the ACI Code in the New Zealand Design Code, because such matters as permits and drawings, inspections and approval of special systems are all covered by other codes or by the building bylaws. Chapter 2 - Definitions, is much expanded from the corresponding ACI sections, and covers the seismic chapters, 15 to 30, as well as the "non-seismic" chapters that correspond to the ACI Code Material.

Part 2 - General Design Requirements, corresponds to chapters 8 to 20 of the ACI Code. Chapter 9, Slab Systems, has been completely rewritten, and some of the other chapters are considerably different from the corresponding ACI Code chapters. Except for a short section in chapter 6, there are no provisions for walls in this part, because it was considered that, in New Zealand design practice, it was not possible to have a structural wall that was not a seismic wall. Walls are covered by Chapter 18 of Part 3.

Part 3 - Additional Requirements for Seismic Design, comprises Chapters 15 to 30 inclusive. These chapters, which add to and modify the requirements of Parts 1 and 2, are all new chapters which are the work of various members of the drafting committee. They are based on recent articles in the literature and recent development work in New Zealand. These chapters cover structures of two different categories - fully ductile structures and structures of limited ductility. Structures of limited ductility are those

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which are covered by the section in NZS 4203 on Small Buildings of Limited Ductility or by corresponding clauses in the appropriate bridge design loading code. All other structures come into the category of fully ductile structures and must comply with the requirements for this category.

Chapter 15 - General Seismic Design Requirements, has a special position in this part, because it governs the use of all the other chapters in part 3. For example, chapter 15 gives cases when some requirements in chapters 16, 19 and 22 need not be satisfied for fully ductile structures.

Although Chapter 26 deals with additional seismic requirements for foundations, most of the seismic foundation design provisions were finally put in Section 15.11 (of Chapter 15), and only a few remaining provisions have been retained in Chapter 26.

Chapters 16-22 inclusive and 26 apply only to fully ductile structures. Chapters 27-30 inclusive apply only to structures of limited ductility, while chapters 23, 24 and 25 apply to all structures.

Appendix B is the only part of this Code which governs the Alternative Design Method (or Working Stress method). All other parts of the Code deal with the Strength Method of design. Chapter 15 prohibits the use of the Alternative Method in all design work covered by Part 3.

Among other topics, Chapter 15 has sections on concurrency effects, P-Δ effects and mechanical energy absorbing devices. The code has endeavoured to simplify the process of determining concurrency effects by providing in most cases for independent uniaxial calculations and combining the resulting vertical forces.

In Chapter 18 (on the design of coupled shear walls), it will be noted that the code makes it mandatory to use diagonal reinforcement in the coupling beams unless the capacity shear in these beams is below a certain value. This is considered to be justified as a result of University of Canterbury tests which showed a vastly improved performance by beams with this pattern of reinforcement.

The section in Chapter 19 on design for shear in plastic hinge regions will be of particular interest.

In Chapter 21 (design of beam-column joints to resist horizontal shear) it will be noted that, here again, the procedure for design for concurrency has been simplified as compared with earlier procedures that have been proposed, in that independant calculations may be made in each direction. The only interaction effect that is required to be taken into account is that the minimum compression load above the joint must be divided into two parts, which are apportioned to the shear mechanisms in each direction. This simplification is based on the results of tests on a 3 dimensional beam-column assembly at the University of Canterbury.

It will also be noted that Chapter 21 makes a distinction between the case where plastic hinges can form immediately adjacent to a joint and the case where all beams at the joint are detailed so that each plastic hinge forms at a distance from the column face. In the latter case the design requirements of the code are less severe.

The 1977 revision of the ACI Code was published while the committee were revising their drafts of the New Zealand code chapters. All technical changes in the 1977 ACI revision were taken into account in preparing the final draft, but in some chapters the 1971 arrangement has been retained, in order to avoid extensive rewriting. Additional recent information on some topics will involve some changes in the final published code. Because it was considered urgent to produce a complete draft code, it was not considered advisable to introduce further delays by rewriting sections of chapters at a late stage of the draft production. Such recent information includes a report by P. M. Ferguson on recent research on bond, development length and splicing of tensile reinforcing bars. This reports that the provisions in the 1977 ACI Code for development length and splicing can be significantly unconservative in cases where small covers or small bar spacing is involved. Another example is the question of requiring ties in composite concrete flexural members. The present draft requires these in bridges regardless of the horizontal shear force level, but requires them in buildings only where the shear stress at the interface is above a certain level. However, a recently completed building is showing signs of separation between the precase elements and the cast-in-situ topping, so it appears that the question of making ties mandatory in all cases will have to be considered.

A great deal of effort went into providing a comprehensive commentary to the Code for Design of Concrete Structures, because the committee wished to provide guidelines without being restrictive. The Commentary not only explains the provisions of the Code, but also suggests approaches for satisfying the Code's intent. Appendix 1 - Method for the Evaluation of Column Action in Multistorey Frames - is a special example of this intention. This appendix was considered necessary because the assessment of the maximum actions on columns resulting from capacity design considerations has not as yet been fully developed. Because of its developmental stage it was not considered suitable as yet for including as a code section.

At the end of some chapters a list of references is provided to assist designers in areas where standard design procedures have not yet been formulated.

Readers are urged to examine the new draft and comment on it as soon as possible. The closing date for comments has now been extended to 1 November, 1978 and any comments which arrive shortly after that date will also be considered. Since there is an urgent need to provide New Zealand engineers with an up to date concrete code, the committee wishes to commence the task of considering comments and producing the final code at the earliest possible date.

It should be noted that it is proposed to include a discussion on the new draft concrete design code on Tuesday 13 February, 1979 at the Society's technical session during the NZIE Conference in Wellington.