Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte
Band: 81 (1999)

Artikel: Concrete model code for Asia: report of the working group on materials and construction
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DOI: https://doi.org/10.5169/seals-61421

Concrete Model Code for Asia : Report of the Working Group on Materials and Construction

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Summary

This paper summarizes the activities of a working group for materials and construction set up under the International Committee on "Concrete Model Code for Asia". The activities commenced from the survey on situation of construction industry, concrete technology and concrete code in many countries in Asia. Then, discussion on the proper characteristics of the Model Code for Asia, the drafting of a framework and the drawing up of a tentative draft of the Model Code was conducted. Considering the features on which special cares should be taken in making an unified model code in the region, the Model Code was characterized by the conceptual phrases and divided into 6 chapters, and the table of contents of each chapter was arranged in similar manner except for Chapter 1 General and Chapter 2 Basic Requirements. The code was drafted into 3 levels of document. Level 1 document provides all essential requirements for each chapter whereas detail explanations are provided as commentary in Level 2 document. Level 3 document will be show examples of code application.

1. Introduction

1.1 Background

Concrete has been playing and will do a major role as an essential material for construction in Asia. As the global environmental problems and economic crisis come into Asian concern, it is inevitable to reduce the exploitation of natural resources, reduce the disposal of waste from

removed structures and reduce the cost from repair and maintenance of the infrastructures. While concrete is an excellent material considered useful for structures, it has a disadvantageous point of difficult recyclability and not being maintenance-free. It is, therefore, necessary to build concrete structures with high durability. With the recent active inter-activity in construction industries in Asia as a background, Japan Concrete Institute set up a Research Committee on "Concrete Model Code for Asia" in 1992 to study the present situation of construction industry, concrete technology and code used in different countries, and to carry out some preliminary groundwork towards the establishment of the Code [1]. After two years of the survey on the above subjects, a framework of Concrete Model Code for Asia was proposed in Tokyo in April 1994 by the committee. Then in December 1994 during the Bangkok meeting, three working groups namely Design WG, Materials & Construction WG and Maintenance & Management WG were formed. The firstly formed working group on materials and construction first consisted of ten members from Australia, Indonesia, Japan, Philippine, Sri Lanka and Thailand. The working group has been discussing on policy, basic idea, format, etc. of the Code as well as drafting and revising the Code since then. During drafting and revision, comments were also obtained from respondents from China, India, Singapore, etc.

1.2 Performance-Based Concept of the Code

The changes in the codes from prescriptive specifications to performance-based provisions are currently proceeded around the world. This concept is adopted to the model code for Asia too [2,3,4]. According to the performance-based code, the concrete structure are supposed to be designed based on required performance of the concrete structure throughout the service life. The structure and components are designed to fulfill their functions with respect to load carrying capacity, stability, serviceability and durability throughout their design life. The materials are evaluated by the resisting performance to the chemical, physical, mechanical, biological attacks as well as their combination attack regarding the durability, and are evaluated by mechanical properties such as strength and the modulus of elasticity relevant to the stress in structural aspect. In regard of the durability of concrete, there seem to be few properties recognized as performance or few test methods are established as standards for the recognized performance, and so such specifications as water to cement ratio, cement content, etc. are adopted as indexes of resistant properties at present. Since the water to cement ratio that develop the identical resistant property varies with the proportion of the ingredients, types of cement and admixtures used, specifying water to cement ratio may not lead to the concrete as required in the performance-based code. Accordingly, the performance-based model code requires to make close connections between actions and concrete resistant properties and to prescribe the resisting performance according to the required life. On the other hand, concrete cover is determined taking both the environmental conditions and the resisting performance of concrete into consideration. It is determined depending on not only the durability but also the fire resistance, the safe transmission of bond forces, the adequate compaction of concrete, etc.

2. Activities of WG on Materials and Construction

2.1 Survey on Concrete in Asia

Investigations in Asian countries were made by asking each member in the member countries to prepare a report. The reports included both the state of code and standard specification relating to concrete works used in the country and the circumstances of construction industries such as the share in GDP or GNP of construction, the cement production and consumption, the materials used, the role of professional bodies, the consultants and contractors and the automation. According to the reports received from the members from different countries, the followings are clarified as features on which special cares should be taken in making an unified model code in the region.

- Most countries have, in general, adopted the available codes such as British and ACI codes with certain modifications to suit the local conditions.
- There are wide differences in the climatic and environmental conditions.
- There are wide differences in the construction industry, level of technologies, labor circumstance and types of materials.

Due to the mentioned differences among Asian countries, it was decided that the code would comprise of 3 document levels. Level 1 is the main text which includes the fundamental provisions prescribing only the performance and functional requirements. Level 2 is the descriptive details of the main text in commentary form. Level 3 is the example of adoption of the model code to national code, depending on situation of each country.

2.2 Format of Part 2: Materials and Construction

The Model Code for materials and construction was divided into 5 chapters; 1) General, 2) Essential Requirements, 3) Formwork, 4) Reinforcement, 5) Concrete 6) Prestressed Concrete. Each table of contents for Chapter 3, 4, 5 and 6 were arranged to have the similar composition as listed below.

1. Scope
2. Basic requirements
3. Materials
4. Workmanship
5. Quality control and assurance
6. Records

2.3 Progress of Drafting Part 2 : Materials and Construction

The first draft of "Chapter 4 Concrete" was presented at Jakarta meeting in March 1996 by Thailand group and a discussion was held focusing on performance-based provision. The revised Chapter 4 and the first drafts of "Chapter 2 Formwork" and "Chapter 3 Reinforcement" were circulated at Dalian meeting in October 1996. Many arguments were presented about the meaning of "Model" and a discussion was held about the format of the code. At the Hyderabad meeting in March 1997, the first draft of Chapter 5 Prestressed Concrete was circulated together with the first revision of Chapter 2, 3 and the second revision of Chapter 4. At the Haki meeting in August 1997, the revised versions of Chapter 3, 4, 5 and 6 were discussed for preparation of

the final revision ready for the working group meeting in EASEC-6, Taipei whereas Chapter 1 and 2 were assigned to be drafted. At EASEC-6, Taipei in January 1998, the level 1 and level 2 drafts were proposed and discussed. It was proposed that the test methods should be included and some example of level 3 document should be given in the next meeting in Singapore. In August 1998, the meeting in Singapore was held at the National University of Singapore. The revised level 1 and level 2 drafts including the test methods were discussed. It was proposed here that the level 3 document be introduced at the IABSE Colloqium, Phuket, Thailand in March 1999.

3. Content of Draft of Model Code for Asia

The draft of "Materials and Construction" in Model Code for Asia is briefly introduced below. The introduced draft includes provisions for materials, workmanship, quality control and assurance and records of works for formwork, reinforcement, concrete and prestressed concrete. All 3 levels of document consist of the same chapters and subtitles.

Chapter 1 General

This chapter gives the scope of the code which states the attempts to introduce a guideline for being adopted to establish the national code based on local condition of each country in Asia. The content of this chapter also includes definitions of terms, notations and units used in the model code.

1.1 Scope
1.2 Definition
1.3 Notation
1.4 Units

Chapter 2 Essential Requirements

This chapter explains the basic requirements for materials, construction team and workmanship, quality control and assurance and records.

2.1 General
2.2 Materials
2.3 Construction Team and Workmanship
2.4 Quality Control and Assurance
2.5 Records

Chapter 3 Formwork

3.1 Scope
3.2 Basic requirements for formwork
3.3 Materials
3.4 Design of formwork
    3.4.1 Loads in formwork design
    3.4.2 Deformation
3.5 Workmanship
    3.5.1 Erection of formwork
    3.5.2 Formwork removal
3.6 Quality control and assurance
3.7 Records

Chapter 4 Reinforcement

4.1 Scope
4.2 Basic requirements for reinforcement
4.3 Materials
    4.3.1 General
    4.3.2 Material properties

4.3.2.1 Characteristic strength
4.3.2.2 Partial safety factor for strength γ_m
4.3.2.3 Stress-strain relationship
4.4 Workmanship
4.4.1 Transportation and storage
4.4.2 Fabrication
4.4.2.1 Cutting and bending
4.4.2.2 Welding
4.4.3 Developments
4.4.4 Laps and joints
4.4.5 Placing
4.5 Surface condition
4.6 Quality control and assurance
4.7 Records

Chapter 5 Concrete
5.1 Scope
5.2 Basic requirements for concrete
5.2.1 Quality of concrete
5.2.2 Workmanship
5.3 Materials
5.3.1 Cement
5.3.2 Aggregates
5.3.2.1 Coarse aggregate
5.3.2.2 Fine aggregate
5.3.3 Admixtures
5.3.3.1 Mineral admixtures
5.3.2.2 Chemical admixture
5.3.4 Mixing water
5.3.5 Mix proportions
5.4 Workmanship
5.4.1 Batching and mixing
5.4.2 Transporting
5.4.3 Placing
5.4.4 Compacting
5.4.5 Surface finishing
5.4.6 Curing
5.5 Quality control and assurance
5.5.1 Quality control at batching and mixing plant
5.5.2 Quality control at construction site
5.5.3 Quality control and inspection of hardened concrete
5.6 Records

Chapter 6 Prestressed Concrete
6.1 Scope
6.2 Basic requirements for prestressed concrete
6.2.1 Design assumptions
6.2.2 Loss of prestress
6.3 Materials
6.3.1 Concrete
6.3.2 Prestressing steel
6.3.3 Anchorage and coupling
6.3.4 Reinforcement
6.3.5 Grout
6.4 Workmanship
6.4.1 Tendon placing
6.4.2 Concrete placement
6.4.3 Curing
6.4.4 Stressing operation
6.4.5 Form removal and reshoring
6.4.6 Grouting
6.5 Quality control and assurance

6.5.1 Quality control and inspection during concrete casting
6.5.2 Quality control and inspection during prestressing transfer
6.5.3 Quality control and inspection during transportation and erection
6.6 Records

4. Concluding Remarks

The unsettled subjects are still left regarding some standard test methods for the materials and some quantified specification of the performance of concrete for level 3 document.

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