03/08/00
Island.

Concrete for Asia (Part II)

by Asitha Jayawardena

(Continued from last week)

Asian Concrete Model Code

The objective of the model code is to establish, in an Asian context, the most common ground to work with structural concrete with a view to obtaining high performance in design, construction and maintenance.

It is a performance-based code rather than a prescriptive one, and consists of 3 parts:

* Part One: Design (pre-construction stage).

*Part Two: Materials & Construction (construction stage)

* Part Three: Maintenance (post-construction stage).

Code documentation is presented at three different levels:

* Level One provides the framework and the basic concepts for performance-based design of all concrete structures.

* Level Two gives the specifications required to meet the performance-based objectives.

* Level Three includes practical design guidelines, necessary formulae and country-specific examples considering the local conditions in a country in which the model code is to be applied; it should however conform to Level One and Two documents.

Model code committees have drafted Level One and Two documents. Each member country should draft the Level Three document applicable to the local conditions.

Level One and Two documents with their corresponding parts (ie Part One, Two and Three) are contained in one volume. Level Three document will come as a separate volume.

Part One: Design

The concept of performance-based design is similar to the limit state design practised currently. However, the former describes the required performance in rather non-engineering terms while the latter prescribes the limit state in engineering terms.

The required performance of the structure being designed is clearly described in a three-fold presentation.

* Serviceability: Ability of a structure or a structural element to provide adequate services or functionality in use, and not to cause an unpleasant environment under the effects of the considered actions.

* Restorability (reparability): Ability of a structure or a structural element to be repaired physically and economically when damaged under the effects of the considered actions.

* Safety: Ability of a structure or a structural element to ensure that no harm would come to either the users of the structure or the people near it under any action; this is the most important performance.

The performance required is qualitative. Therefore, to explicitly express the required level of performance, the Performance Index (PI) is introduced. Thus the level of performance required from a structure or a structural element, i.e. PI (required), can be compared with the level of performance possessed by that structure or structural element, i.e. PI (possessed).

For example, under safety, PI (required) is the maximum bending moment acting on a structural element; PI (possessed) is the bending strength of this element. PI (required) should be less than PI (possessed).

Under aesthetics, PI (required) is the limit of crack width against unpleasant appearance; PI (possessed) is the maximum crackwidth caused by the actions considered. PI (required) should be greater than PI (possessed).

Performance index can be used for .s

* Examination of the required performance: whether a structure or a structural element satisfies the required performance or not.

* Evaluation of the performance possessed by a structure or a structural element: how good is the performance it possesses, and usually given as a ratio.

Level One document describes the basic concepts of design such as general principles, requirements, materials, actions, analyses, examination of performance and evaluation of performance.

Level Two document specifies, for all required performances, the performance indices together with the actions to be considered: Actions in normal use, wind actions, seismic actions and environmental actions.

Level Three document contains complete processes for the examination of each required performance. Like a design manual, it provides design equations and details, and in fact, without it, an actual design cannot be done. It should be prepared only for a particular type of structure, or for a particular region or country. Moreover, different types of structures may need different codes. For example, in Japan, codes for buildings and bridges are completely different. To tackle this problem, two Level Three documents can be prepared: one for buildings, the other for bridges.

Part Two: Materials and Constructions

Since the model code could be applicable to any Asian country or region regardless of the environmental conditions, type of available resources (material and human), and level of available technology, Part Two was drafted with the following considerations: performance-based, user-friendly, national application document friendly (i.e. current code adopted), and environment-friendly.

Two aspects of materials are evaluated:

* Durability: performance in resisting chemical, physical, mechanical and biological attack (both individual and combined).

* Structural: mechanical properties such as strength and modulus of elasticity.

Level One and Two documents consists of essential requirements, formwork, reinforcement, concrete and pre-stressed concrete. They provide a series of minimum requirements for performance of construction materials, standard of workmanship, measures of quality control and construction records that may be achieved on site to ensure that all requirements in design are achieved.

An advantage in adopting the performance-based design concept is that the newly developed technology and a wide range of materials (especially recycled and waste materials) can be applied to concrete structures relatively easily.

Part Three: Maintenances

This part was drafted by compiling various methods for maintaining completed structures. The methods are catergorised into preventive and corrective maintenance. It discusses the basis of maintenance, inspection, deterioration mechanism and its prevention, evaluation and decision making, remedial actions, and records.

Future Work

The concept of a permanent body responsible for the model code has been already discussed. In fact the constitution was approved in 1999 but more details should be discussed. This proposed committee can be named Asian Model Code Committee, and should perhaps

comprise an advisory committee, an organising committee and several task groups.

Copies of the model code were sent to various leading Asian institutes related to concrete; some have already sent their comments. Two common suggestions are:

* Combine Level One and Two documents.

* Improve the coordination among the three parts (i.e. Part One, Two and Three) by inserting a common document at the beginning of each part.

The committee has already made available several examples of Level Three document; however, the participating countries should prepare their own. Two types should be considered. The first is the document meant for application to a particular region or country, considering the local conditions. Because it is meant for practical use, it should be prepared by practising engineers. eg: Design and construction of concrete structures in country X, and design of concrete buildings for seismic actions in region Y.

The second is the document containing the latest technological achievements. Since it will indicate the future directions for the design of concrete structures, it should be prepared by academics and researchers eg: Design of concrete structures for environmental actions with long term performance indices, and design of buildings and bridge concrete structures for seismic actions with non-linear dynamic analysis.

Coordination will be necessary with ISO/TC 71, which is an international body taking care of codes for design and construction of concrete structures. Currently, it is preparing two draft codes based on the limit state design: one to provide the basis for design; the other for simplified design of buildings. The former is similar to Level One and Two documents; the latter, Level Three document. Moreover, the contents of the ISO code are not in conflict with the model code. More countries participating in the model code should become voting members of ISO/TC 71 to explain the model code to ISO members; thus more contents of the model code can be included in the ISO code.

Comparison

ACI standard is adopted in North America; AS in Australia; and BS in Britain. They reflect the local factors (such as climate, environment, availability of resources, concrete technology) in the region or the country. On the other hand ACMC is expected to be widely adopted by Asian countries; therefore, it will reflect the diverse local conditions found throughout Asia.

ACI 318 is a material and structural design code; AS 1379 is a material code. However ACMC will cover structural design, materials and construction, and maintenance; therefore, it is more complex. It is intended to be a unified code for Asia; so it obviates the need for its users to refer to other sources.

A commentary provides the background information to clauses, and explains their application. American and Australian standards have separate publications for this purpose, published as "Commentary" and "Supplement" respectively. In ACMC, however, the commentary is an in-built feature.

Implementation

The ultimate goal of implementation of the model code is high performance of structural concrete in strength, serviceability and durability.

Implementation should be done in two stages: adopting it as the national code, and then implementing it in professional practices. The progress however will depend on individual countries. The model code has unified the current practical standards with an academic background to iron out various differences; therefore, adopting it as the national code of a particular member country is less complicated. However, the local conditions and the legal aspects are different in various countries. The code may be made part of the regulations or may be incorporated in the jurisdiction process as legally binding in a city or municipality.

The promotion strategy should be developed by identifying target users, producing a commentary, organising workshops, seminars and symposia, publishing technical papers, and starting a web site.

Further Improvement

For further improvement of the code, engineering institutes and societies in Asia should take the lead. It is achievable through feedback from the industrial practices and structural performance of concrete in professional practice by means of assessment and evaluation. From time to time, research and development in materials, structures and technologies can be accommodated in the code.