INTERNATIONAL TECHNICAL STANDARDS IN THE FIELD OF CONCRETE

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***ABSTRACT*:** At present in Japan, we are facing an unprecedented period of change in terms of both political and economic systems and industrial structure. Furthermore, with the internationalization of the WTO (World Trade Organization) and ISO (International Organization for Standardization), together with a major revision of the JIS (Japan Industrial Standard) accreditation system, it is impossible to ignore the massive wave of change that is sweeping the world with regard to quality assurance standards for structures, products and materials.

This paper presents the state of internationalization and quality assurance from the perspective of the development of international standards for design methods for concrete structures, firstly looking at the state of stipulation of ISO and European standards (EN) in the field of concrete. We will then take a look at Basic Principles of Design for Civil Engineering and Building which was released by the Ministry of Land, Infrastructure and Transport and which aims to standardize and unified design standards for civil engineering and building, which is an example of the way that Japan has enthusiastically embraced for the adoption of international standards.

Through the discussion, it is found that there are increased calls for quality assurance for structures with the internationalization of construction activities. Even in the area of research and technological development, with the increasing internationalization, the time has come to think seriously about how the aims of research and technological development are set, how it is carried out and how the results are released. At the same time, the Basic Principles of Design for Civil Engineering and Building stipulated by the Ministry of Land, Infrastructure and Transport are expected to be an effective base from which to work on the international standardization of design methods for structures. Furthermore, activities such as those of the Special ISO Committee within the Japan Society of Civil Engineers also play an important role in establishing appropriate conformity assessment systems that are able to cope with internationalization.

KEYWORDS: ISO, European standard, Basic Principles of Design, Special ISO Committee in JSCE

1. INTRODUCTION

We are facing an unprecedented period of change in terms of both political and economic systems and industrial structure. Furthermore, with the internationalization of the WTO (World Trade Organization) and ISO (International Organization for Standardization), together with a major revision of the JIS (Japan Industrial Standard) accreditation system in Japan, it is impossible to ignore the massive wave of change that is sweeping the world with regard to quality assurance standards for structures, products and materials.

Typical examples of certification activities include ISO9000 (Quality Management Systems) and ISO14000 (Environmental Management

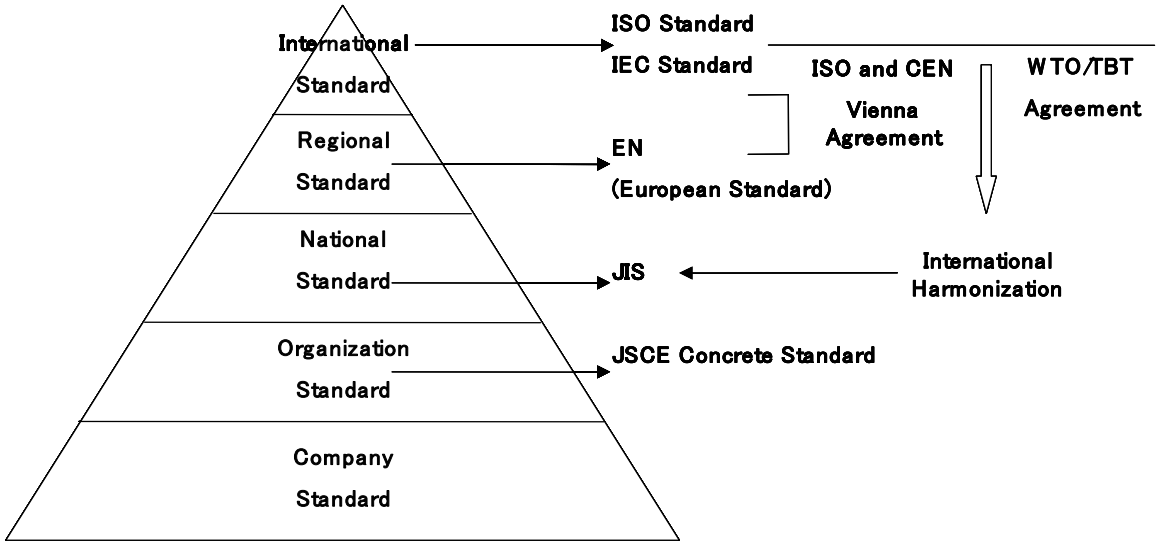

Figure 1 Hierarchy of Standards and International Harmonization

Systems). From the perspective of quality assurance for structures and products, etc., the acquisition of ISO9000 certificate is proceeding throughout the world in major construction companies and now even among medium-sized construction companies. Furthermore, the trend toward the acquisition is also spreading among construction consultants and various material manufacturers (Tsuji, 1999 and 2003).

In this paper, we will consider the present state of this internationalization and quality assurance from the perspective of the development of international standards for design methods for concrete structures, firstly looking at the state of stipulation of ISO and European standards (EN) in the field of concrete. We will then take a look at Basic Principles of Design for Civil Engineering and Building which was released by the Ministry of Land, Infrastructure and Transport and which aims to standardize and unified design standards for civil engineering and building, and activities of the Special ISO Committee within JSCE (Japan Society of Civil Engineers) which are examples of the way that Japan has enthusiastically embraced for the adoption of international standards.

2. THE WTO'S TBT AGREEMENT AND AGREEMENT ON GOVERNMENT PROCUREMENT

Within the hierarchy of the various standards, as we can see from Figure 1, international standards, such as those of the ISO and IEC (International Electrotechnical Commission), are beginning to have a major impact on national standards such as JIS as well as other standards of lesser importance. This has been largely on account of the influence of the WTO, which was inaugurated when GATT was dissolved on January 1, 1995. In other words, with the inauguration of the WTO, among the agreements was the so-called TBT Agreement (Agreement on Technical Barriers to Trade) and the Agreement on Government Procurement found in WTO Annex 4 that came into force in January 1996.

Under these agreements, where there are ISO and IEC standards with the same content as national standards or organization standards which are lower ranking than ISO standards or IEC standards, must

observe such international standards. This is called international harmonization and it is gradually having a significant impact on the technical standards system of every country.

3. INTERNATIONAL HARMONIZATION

International harmonization of approximately 2,000 JIS and ISO standards, etc. was carried out at great time and expense during the period between FY1995 and FY1998 in Japan. JIS, which has a long history and was firmly rooted in Japanese traditional practices, has undergone many amendments throughout the years, meaning that an extraordinary effort was required in order to be able to harmonize it with ISO standards, etc. In fact, there are many JIS that it was just not possible to harmonize and which must be dealt with sometime in the future.

The international harmonization of organization standards, such as the Standard Specification for Concrete Structures of the JSCE is much more difficult than the harmonization of JIS. Furthermore, with regard to the fields of civil engineering and building in particular, it will be necessary to harmonize the Standard Specification for Concrete Structures which is a system standard that is an accumulation of the results of research and technological development regarding concrete engineering with ISO standards that will be determined in the future. Consequently, this will have a major impact on future research and technological development, design, construction and maintenance in Japan.

4. ISO/TC71 TECHNICAL COMMITTEES

Technical committees and subcommittees consisting of participating members and observing members are created in order to stipulate and amend ISO standards. There are many technical committees related to construction materials and design methods. Of these, technical committees directly related to RC structures include TC17, TC59, TC98, and more importantly TC71. Japanese deliberative organizations correspond to the various technical committees. These deliberative organizations serve as a service window to the ISO.

Participating members have the right to vote in technical committees and subcommittees. On the other hand, they are also required to reply to enquiries from committees and to attend meetings as frequently as possible. Japan became actively involved as a participating member, rather than merely an observing member, in TC71, which deals with concrete, reinforced concrete and prestressed concrete, fairly late in the activities during October 1994. In many cases, Japan is still involved in technical committees as an observing member in order to obtain ISO information.

ISO/TC71 was established in 1949 and although it stipulated firstly ISO1920 in 1976, and stipulated 19 testing methods for concrete materials and quality. Since the 5th general meeting held in Vienna in June 1987, the US has taken the reins, with the committee being dormant until the 6th general meeting held in San Francisco in August 1995. Since that time, although SC2 (Rules for the Design of Concrete Structures, secretariat by the UK) has not yet to be reactivated, SC3 (The Production and Control of Concrete, secretariat by Norway) was reactivated in June 1998.

Currently, in TC71 there are six subcommittees, as can be seen in Table 1. At the 6th general meeting, the creation of two new subcommittees (SC4 and SC5) was permitted. At the 8th general meeting held in Tokyo in 2000, SC2 was suspended and abolished.

Table 1 Structure of the ISO / TC71 Technical Committee

Technical Committee 71(TC71)	Concrete, reinforced concrete and pre-stressed concrete. (Overseen by the US)	WG for Handling JCI ISO/TC71
Sub-Committee 1 (SC1)	Test Methods for Concrete. (Overseen by Israel)	WG1
Sub-Committee 2 (SC2)	Rules for the Design of Concrete Structures. (Overseen by the UK) —> Abolished	—
Sub-Committee 3 (SC3)	Production of Concrete and Execution of Concrete Structures (Overseen by Norway)	WG1
Sub-Committee 4 (SC4)	Performance Requirements for Concrete Structures. (Overseen by the US)	WG2
Sub-Committee 5 (SC5)	Simplified Design Standard for Concrete Structures. (Overseen by Colombia)	
Sub-Committee 6 (SC6)	Non-traditional Reinforcing Materials for Concrete Structures. (Overseen by Japan)	WG3
Sub-Committee 7(SC7)	Maintenance and Repair of Concrete Structures (Overseen by Korea)	WG4

At the 7th general meeting held in Bogota, Colombia in 1998, it was decided to establish SC6, which, from the time that it commenced operation in September 2000, has been overseen by Japan and has as its main aim the establishment of standards regarding the quality of continuous fabric strengthening materials other than steel materials, and testing methods. At the 11th general meeting held in Sydney in July 2003, it was decided to establish SC7.

The domestic deliberative organization for TC71 is the Japan Concrete Institute (JCI). JCI's domestic committee is actively engaged in dealing with ISO/TC71. As we can see from Table 1, within JCI, Subcommittee 1 (SC1) and Subcommittee 3 (SC3) are handled by Working Group 1 (WG1), SC4 and SC5 are by WG2, SC7 is by WG4, SC6, which is overseen by Japan is handled by WG3. In each of these working groups, the work of collating the views of industry, the government and academia into a single response is in many cases extremely difficult. The deliberation and adjustment activities being carried out in JCI domestic committees in response to ISO/TC71 are increasing as the emphasis in ISO draft standards regarding concrete changes from standards regarding testing methods to standards regarding products and quality, and then to standards regarding quality control and quality assurance and to those regarding compliance.

5. ISO 2394 — THE KEY STANDARD FOR CONSTRUCTION DESIGN

As we have already mentioned, as the establishment of international standards in the field of construction is strongly influenced by differences in local climate, culture and history, the task of harmonization is extremely difficult. However, ISO/TC98 (Bases for Design of Structures) stipulated ISO2394 (General Principles on Reliability for Structures) in 1986. The second revision of this standard was carried out in June 1998 and determines principles for the assessment of the reliability of structures with regard to loads and actions based on limit states design methods.

ISO2394 is an important ISO standard that

Table 2 ISO/DIS19338
(Performance and Assessment Requirements for Acceptance of National Standards on Structural Concrete)

Chapter	Title
1	Scope
2	Normative References
3	Terms and Definitions
4	General Requirements
5	Performance Requirements
6	Loadings and Actions
7	Assessment
8	Construction and Quality Control
9	National Standards Deemed to Satisfy
Annex A(informative)	Conformity with this International Standards

details the basic concepts concerning the design of various structures, including concrete structures. This shows the framework and foundational design concepts followed when establishing individual ISO standards, such as those for concrete structures, steel structures, soil structures and geotechnical structures, etc. Based on the limit states design method, whereby limit states are classified under ultimate limit states and serviceability limit states, a design method based on probability or partial safety coefficients is used. In this way, ISO2394 reveals design concepts that contribute to proper reliability for building and civil engineering structures in general and as a haven for standards and regulations stipulated in various countries.

ISO2394 contains general principles concerning the evaluation of reliability of structures with regard to various loads and gives consideration to the performance of structures with regard to their reliability during the period in which such structures will be in use. It can also be applied with regard to entire structures or parts of structures during construction, or to existing structures. Structures and each part of those structures must maintain adequate reliability and, in addition to requirements for serviceability limits and ultimate limits, must be sufficiently robust. The probability formula and partial coefficient are used in order to verify the reliability of such matters. Calculation models include the action model, the structure model and the durability model.

6. ISO STANDARDS REGARDING THE DESIGN OF CONCRETE STRUCTURES

With the aim of covering the standards for the design of concrete structures established by each country, an ISO draft standard entitled Performance Requirements for Structural Concrete was revealed at the 7th TC71 general meeting held in Bogota, Colombia in September 1998 by the US, which was overseeing SC4. Of the previously mentioned limit states design contained in ISO2394, this performance standard utilized the partial safety coefficient.

The chapter titles of ISO/DIS19338 are shown in Table 2. The whole document consists of approximately 15 pages. Under Chapter 4 General Requirements, limit states are defined and the partial safety coefficient method using load coefficients and

Table 3 Eurocodes (European Structural Standards)

EN1990	Eurocode	: Basis of Structural Design
EN1991	Eurocode1	: Actions on Structures
EN1992	Eurocode2	: Design of Concrete Structures
EN1993	Eurocode3	: Design of Steel Structures
EN1994	Eurocode4	: Design of Composite Steel and Concrete Structures
EN1995	Eurocode5	: Design of Timber Structures
EN1996	Eurocode6	: Design of Masonry Structures
EN1997	Eurocode7	: Geotechnical Design
EN1998	Eurocode8	: Design of Structures for Earthquake Resistance
EN1999	Eurocode9	: Design of Aluminum Structures

durability reduction coefficients is used. By contrast, the material coefficient proposed by the Europeans was adopted. In Chapter 6 Loadings and Actions, although it states that the loads on structures should be clearly determined, it does not, in fact, mention detailed methods for determining such loads. Chapter 7. Assessment mentions basic principles regarding cross-sectional strength and the calculation of various kinds of durability.

Chapter 9. National Standards Deemed to Satisfy contains a list of the standards of each country which satisfy this standard and seeks to put the draft international standard to the vote in ISO/TC71. The Chairman of SC4 approved of and proposed the inclusion of the ACI 318 and ACI 343 standard, Eurocode2 and the Concrete Specification of the Japan Society of Civil Engineers, the reinforced concrete structure calculation standard and prestressed concrete design construction specification of the Architectural Institute of Japan. After final draft voting, ISO/FDIS19338 was gotten approval at October 2003 and ISO19338 was published at December 2003.

7. THE VIENNA AGREEMENT BETWEEN EN AND ISO STANDARDS

When stipulating and amending ISO standards and IEC standards, we must focus on the European Standards (EN), the draft standards (prEN), and the provisional European Prestandards (ENV) that are being stipulated by the EU's European Committee for Standardization (CEN) and European Committee for Electrotechnical Standardization (CENELEC). In order to avoid duplicating the work involved in the stipulation of standards, both the ISO and the CEN exchange information with each other right from the stipulation stage and in 1991 concluded the Vienna Agreement, or more properly the Agreement regarding Technical Cooperation between the ISO and the CEN. Through the signing of this agreement, these organizations agree to communicate with each other during the process of standard stipulation and cooperate with each other in meetings. It is also permitted for technical activities in CEN, etc. to be transferred as they are to the technical activities of the ISO.

8. EUROCODES

The stipulation of European standards by CEN is now in its final stages. The TC250 (Structural Eurocodes) were established within the CEN in 1990 and the stipulation of the so-called Eurocodes is carried out within the TC250 (See Table 3). Standards have been stipulated for the design of concrete structures by SC2 (EN1992, Eurocode 2), the design of steel structures by SC3 (EN1993,

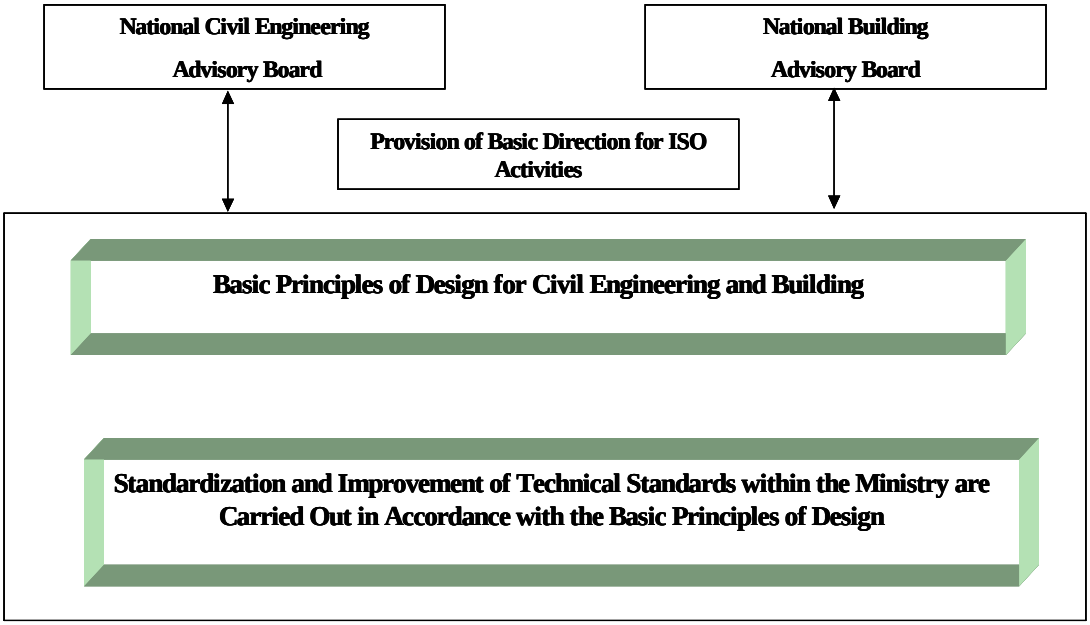

Figure 2 The Position of Basic Principles of Design for Civil Engineering and Building

Eurocode 3), and the design of composite steel and concrete structures by SC4 (EN1994, Eurocode 4).

The basic principle behind the stipulation of these Eurocodes is based on the concepts contained in the previously mentioned ISO2394. In EN1991-1 (Basic Principles and Loads and Actions in the Design of Structures), the main emphasis is on design methods using partial safety coefficients in the limit states design method.

9. FROM EN TO ISO STANDARDS

European Standards (EN) have passed through the ENV and prEN stages and are now in the final stages of stipulation. It is expected that ISO technical committees and subcommittees will again be reactivated and, in accordance with the Vienna Agreement, EN, ENV, prEN will be submitted as ISO draft standards, which will then be quickly adopted as ISO standards after parallel voting system between ISO and CEN.

Under the Agreement on Technical Barriers to Trade and the Agreement on Government Procurement, the task of the international harmonization of JIS and organization standards, which have many system standards, still remains.

10. THE UNIFICATION OF BASIC PRINCIPLES OF DESIGN

The stipulation of international standards in the ISO and the internationalization of standards in Europe and the US is actively proceeding even at this time. In Japan, measures are also being taken in response to these situations, with the Special ISO Committee being established in the Japan Society of Civil Engineers at the request of the Ministry of Construction, the Ministry of Transport and the Ministry of Agriculture, Forestry and Fisheries of that time. In order to properly correspond to the ISO, it is essential for opinions from Japan to be presented and acknowledged in the various technical committees stipulating ISO standards. However, the very nature of construction in Japan prevents the presentation of a single unified opinion as civil engineering and building are completely separated.

Table 4 Chapter Headings from the Basic Principles of Design for Civil Engineering and Building

1. General 1.1 Scope 1.2 The Basics of Design 2. Limit State 2.1 General 2.2 Ultimate Limit State 2.3 Serviceability Limit State 2.4 Restorability Limit State	3. Actions 3.1 Definitions 3.2 Classification of Actions 3.3 Handling Various Actions 3.4 Combination of Actions 4. Seismic Design 4.1 Seismic Performance 4.2 Methods of Clarifying Seismic Performance 5. Verification Method of Performance

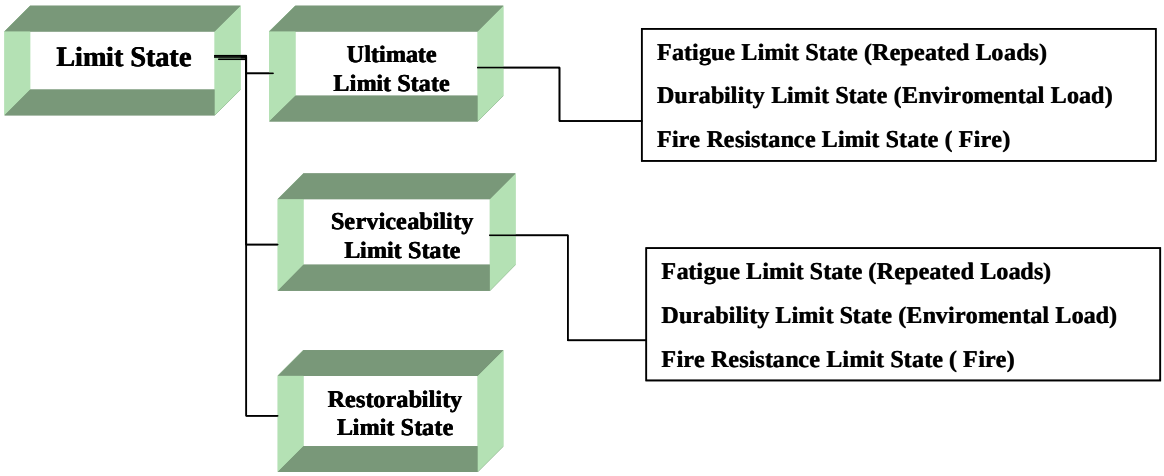

Figure 3 Limit States Considered in Basic Principles of Design for Civil Engineering and Building

At the request of the Special ISO Committee, the Basic Principles of Design for Civil Engineering and Building Investigation Committee was established in December 1998 within the Ministry of Construction. The committee deliberated on fundamental matters regarding design, ranging from basic requirements, limit states, actions (loads), and assurance methods, such as the partial safety coefficient method, etc., and matters that are common to both fields, such as steel and concrete. The Ministry of Land, Infrastructure and Transport released Basic Principles of Design for Civil Engineering and Building in October 2002. In the future, the Ministry will prepare and amend other technical standards concerning other areas of design under its jurisdiction in keeping with the concepts embodied in these basic principles(Matsumoto,2002). The position of the Basic Principles of Design for Civil Engineering and Building is shown in Figure 2, with chapter headings are listed in Table 4.

As we can see from Figure 3 and Figure 4, these basic principles of design are essentially in harmony with the previously mentioned ISO2394 (General Principles on Reliability for Structures) and the Eurocodes (European Structural Standards) being stipulated by the CEN. Therefore, when ISO2394 is amended or other ISO standards are stipulated, Japan, as a nation subject to earthquakes, is able to make a strong case as it puts forward proposals reflecting the

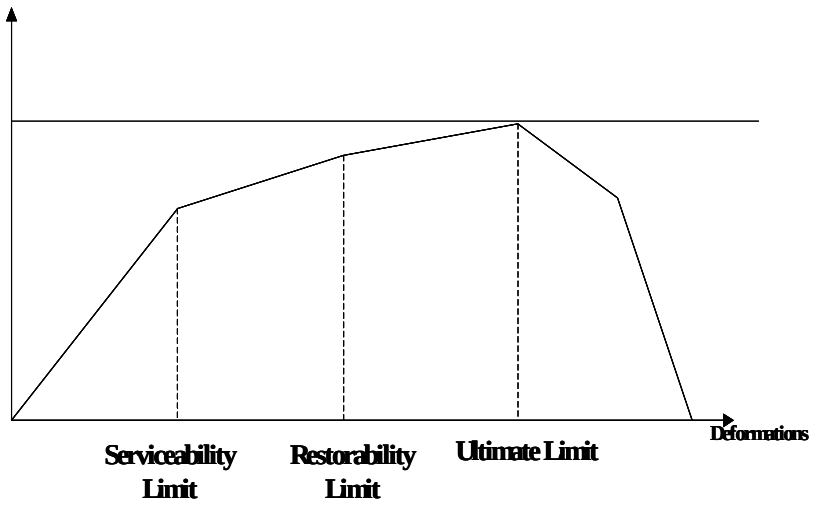

Figure 4 Image of Various Limit States

nature of the country.

11. THE ACTIVITIES OF THE SPECIAL ISO COMMITTEE IN JSCE

The Special ISO Committee was established within JSCE for a period of three years from 1997 as an organization that would act as a single source of information in the fields of civil engineering while collaborating in the deliberation of individual standards. The term of this special committee was extended, then the committee was moved to the Technical Promotion Organization within JSCE after being made an independent organization, in which the Special ISO Committee still functions as today. The Special ISO Committee consists of representatives from universities, domestic organizations deliberating on the ISO, representatives of organizations using technical standards, and representatives of standing committees within JSCE related to the ISO, etc.

The committee carried out mainly the following activities during the period between FY1997 and FY2001 at the request of the Ministry of Construction, the Ministry of Transport, and the Ministry of Agriculture Forestry and Fisheries, and during the period since FY2002 for the Ministry of Land, Infrastructure and Transport, and the Ministry of Agriculture Forestry and Fisheries.

1) The consideration of basic policies for ISO activities in field related to civil engineering.
2) The coordination of domestic deliberation in the fields of civil engineering and the submittal of opinions from all perspectives.
3) The collection of information concerning the ISO and the CEN for fields related to civil engineering that will form the foundation for Japan's response to those organizations, and the collation and provision of such information.
4) An outline of direct activities (domestic deliberation organizations) and detailed activities carried out by the committee when new technical committees and subcommittees are established within the ISO that it is thought will have a major influence on civil engineering structures.

12. CONCLUSION

With the internationalization of construction activities, there are increased calls for quality assurance for structures, including concrete structures. Even in the area of research and

technological development, with the increasing internationalization, the time has come to think seriously about how the aims of research and technological development are set, how it is carried out and how the results are released. At the same time, the Basic Principles of Design for Civil Engineering and Building stipulated by the Ministry of Land, Infrastructure and Transport are expected to be an effective base from which to work on the international standardization of design methods for structures. Furthermore, activities such as those of the Special ISO Committee within JSCE also play an important role in establishing appropriate conformity assessment systems that are able to cope with internationalization.

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