Committee report　Technical committee on technological standards of concrete and its use

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Abstract: The committee has aimed to investigate Japanese industrial standards (JIS) and other international standards, such as ISO and EN, that are related to concrete materials and structures, organize the relationships with the contents prescribed in specifications and guidelines that use (cite, follow, etc.) the various test methods, and propose methods for using information related to technical standards of concrete, such as test methods, quality specifications and criteria for use. In practice, the committee has a) organized the historical background and circumstances of the establishment of standards on quality and test methods and the relationships between relevant standards, b) surveyed the circumstances of establishing and/or revising specifications, etc. related to concrete and reinforced concrete structures and organized the bases of citing and following the contents of JIS, etc., and c) proposed a framework and model for using the results of the aforementioned two activities.

Keywords: Specification, test method, quality standard, strength, mix proportion, corrosion induced by chloride ion, frost damage, cracks, maintenance, carbonation

1. Introduction

Technical standards related to concrete require engineers to not only follow the values and methods prescribed in the standards but also to understand the significance and basis (origin) of each regulation because this leads to securing the quality and performances of concrete and serves as the basis of further research and development. The "study committee on interpretation of quality standards and testing methods related to concrete (TC-095A)", which acted in 2010 to 2011, mainly investigated JIS A 5308 (ready mixed concrete) and test methods and quality standards related to its materials, analyzed and organized the circumstances and basis of their establishment and revision, the relationship with international standards (ISO, EN and ASTM), and the utilization states, and proposed and summarized points needing improvement (a symposium held in November 2011).

The study committee on methods for using information about technological standards of concrete (hereinafter referred to as the "committee") expanded the scope of survey and research and has surveyed JIS and international standards that were not included in the scope of TC-095A, organized the relationship with contents prescribed in specifications that use the standards, and investigated construction of methods for using information related to technical standards (test methods, quality standards and criteria for use) of concrete. In concrete terms, the committee has 1) expanded the scope of survey from TC-095A and organized the

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historical background (such as circumstances of the establishment) of quality standards such as JIS and test methods related to concrete in general and the relationships between relevant standards, 2) surveyed the circumstances of establishing and/or revising specifications, etc. related to concrete and reinforced concrete structures and comprehensively organized the concepts of citing and following the contents of JIS, etc., and 3) proposed a framework and model for using the results of the aforementioned two activities.

The constitution of the committee (Chairman: Tanano) is shown in Table-1. Working Group 1 (Chief: Hamasaki) conducted surveys and investigations related to the former of the aforementioned topics in the first year and, in the second year, summarized matters related to strength, maintenance and carbonation based on the results of the first year. Working Group 2 (Chief: Koga) conducted surveys and investigations related to the latter topic in the first year and, in the second year, summarized matters related to mix proportion, salt damage, frost damage and cracks due to drying and autogeneous shrinkage based on the results of the first year.

Table-1 Constitution of the committee

Chairman: Hiroyuki Tanano (Building Research Institute)
Chief: Hitoshi Hamasaki (Shibaura Institute of Technology)
Chief: Hirohisa Koga (Public Works Research Institute)
WG1 - Working Group for Test Methods Research
Chief: Hitoshi Hamasaki (Shibaura Institute of Technology)
Secretary: Atsushi Ueno (Tokyo Metropolitan University)
Member: Katsuyoshi Ariki (Urban Renaissance Agency)
Member: Shigeki Seko (Aichi Institute of Technology)
Member: Norikiyo Nakamura (Japan Testing Center for Construction Materials)
Member: Naoki Nagamoto (Sumitomo Mitsui Construction Co., Ltd.)
Member: Sohei Nishio (Railway Technical Research Institute)
Member: Yasuyuki Hirose (Nippon Expressway Research Institute Co., Ltd.)
Member: Tetsurou Matsushita (Takenaka Corporation)
Member: Hiroyuki Miyauchi (Building Research Institute)
Member: Satoshi Watanabe (Taisei Corporation)
WG2 - Working Group for Standards Research
Chief: Hirohisa Koga (Public Works Research Institute)
Secretary: Tadatsugu Kage (National Institute for Land and Infrastructure Management)
Member: Atsushi Ueno (Tokyo Metropolitan University)
Member: Shinichiro Okazaki (Port and Airport Research Institute)
Member: Satoru Kobayashi (Kajima Corporation)
Member: Hiromitsu Koyama (BASF Japan Ltd.)
Member: Hirokazu Tanaka (Shimizu Corporation)
Member: Madoka Taniguchi (Northern Regional Building Research Institute)
Member: Satoru Nogami (Japan Cement Association)

2. Examination and tests during mix design and construction and standards

2.1 Mix proportion of fresh concrete

Regulations on mix proportion, which determines the properties of fresh concrete, were surveyed in the following documents, etc.

(1) Japanese Architectural Standard Specification for Reinforced Concrete Work JASS 5 published by Architectural Institute of Japan

The "Japanese Architectural Standard Specification for Reinforced Concrete Work (JASS5)" [1] requires concrete 1) to have workability that is easy to transport, place, compact and finish and conduct other works that involve transporting and changing the shape of the concrete, and 2) to have comprehensive properties that maintain the concrete to be uniform even during and after the works, ensure certain placement within formwork and around reinforcing steel, and develop little bleeding and separation of materials. It prescribes values such as minimum cement content to be 270kg/m^3 for ordinary concrete and 290kg/m^3 upon usinghigh range water reducer with AE agent.

(2) Standard Specifications for Concrete Structures "Materials and Construction" published by Japan Society of Civil Engineers

Standard Specifications for Concrete Structures "Materials and Construction" (hereinafter referred to as "Standard Specifications of JSCE") prescribes that workability is the properties of fresh concrete that show the degree of easiness of transporting, placing, compacting, finishing, etc. Of the workability, the properties of concrete that allow the concrete to fill compactly throughout the form including cover sections and corners without undergoing segregation of materials are defined as filling ability, which is determined by the balance between fluidity and material separation resistance. To ensure resistance to segregation, it states that the cement content (powder content) needs to exceed a certain value, at least 270kg/m^3 for the concrete with aggregates whose maximum size is 20 or 25 mm and desirably 300kg/m^3 or more.

(3) Tests on segregation resistance

The segregation resistance of fresh concrete is judged by [1] a slump test, [2] from the flowing states during a slump flow test, or [3] from the distribution states of coarse aggregates in a specimen in a state of rest. Evaluation by these methods contains subjectivity of the person who performs the test. Various test methods have been proposed to secure universality of test results, but there has been no testing method established. For example, the Recommendation for practice of mix design of concrete [2] of Architectural Institute of Japan proposes inserting the cylinder penetration tester shown in Fig.-1 into a specimen for 10 seconds and measuring the amount of mortar that flows into the cylinder.

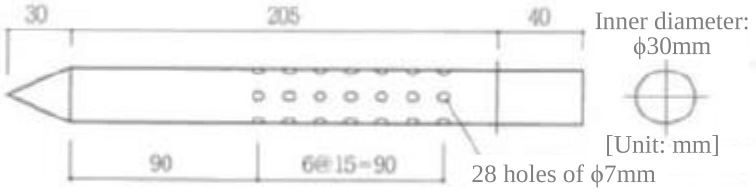

Fig.-1 Cylinder penetration tester [1]

2.2 Examination and tests of concrete strength

Generally, strength of concrete signifies compressive strength; and the strength of concrete is controlled by examining and checking in compression. The committee also focused on strengths other than compressive strength and surveyed their test methods and transitions of the methods, compared test methods when there are two or more methods, and surveyed evaluation methods of test results and reflection of the results in mix design.

Strengths surveyed were bending strength, tensile strength, shear strength and bond strength as well as compressive strength. For compressive strength, bending strength and tensile strength, detailed JIS test methods and changes of the methods have been summarized in a past committee report [3)]. This time, the committee organized relationships with other test standards and surveyed how test values obtained by strength tests are used as technical standards in various kinds of specifications and design guidelines. As an example of survey results, relational expressions between tensile strength and compressive strength are compared in Fig.-2. In general, tensile strength is not considered for designing reinforced concrete structure, but limit is frequently imposed on tensile strength for designing prestressed concrete to control tensile cracks. The figure compares the Standard Specifications of JSCE [4)], Explanation of technical standards for prestressed concrete construction and design and calculation examples (The Building Center of Japan) [5)], AASHTO LRFD (USA) [6)], fib bulletin 70 (fib) [7)] and BPEL 91 (France) [8)]. For example for concrete of design standard strength of 40 N/mm^2, the tensile strength value in the standards of Japan is about 2.7N/mm^2 but is larger in the American and European standards with 3.0 N/mm^2 in BPEL91, 3.9 N/mm^2 in AASHTO and 3.5 N/mm^2 in fib. However, these values were calculated from the relational expressions for estimating tensile strength from compressive strength, and the effects of the values on design of a structure should vary by each structure.

Test methods for shear strength and bond strength have not been standardized, and the committee compared test methods that have been proposed.

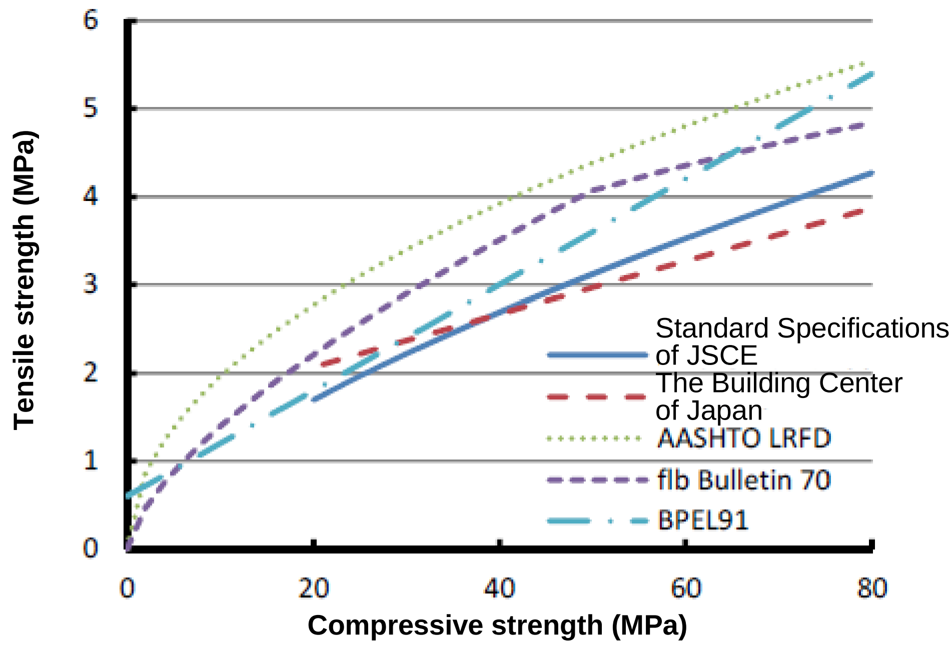

Fig.-2 Comparison of relational expressions between tensile strength and compressive strength in and outside Japan

2.3 Examination and tests of durability on deterioration caused by carbonation

The resistance of concrete against carbonation is an important factor for diagnosing the durability of a reinforced concrete structure. Resistance against carbonation is commonly evaluated by accelerated carbonation test. However, there are still many unclear points in the relationship between the progress of carbonation in accelerated test and under actual environment. Thus the test is recognized as a mere relative method of evaluation.

Method of accelerated carbonation test is prescribed in JIS A 1153 (Method of accelerated carbonation test for concrete), which was established in 2003 and revised in 2012. Accelerated carbonation test had been widely performed by a number of institutes even before the establishment of the JIS standards. The test conditions (20°C, 60% R.H. and CO_2 concentration of 5%) in JIS A 1153 were likely to have been decided by referring to the Recommendations for high durability design and construction practice of reinforced concrete of AIJ, which was issued in 1991 [9].

ISO/DIS 1920-12 is now being proposed, and DIS finished voting in March 2015. Table-2 shows a comparison between JIS A 1153 and ISO/DIS 1920-12. The conditions of curing differ between JIS and ISO/DIS, and thus the degree of dryness is predicted to affect test results. Conditions of acceleration also differ. ISO establishes different thermal and humidity condition compared with JIS and sets a high-temperature environment. The CO_2 concentration is also lower in ISO than in JIS.

In various kinds of technical guidelines, results of accelerated carbonation test are deemed to not directly predict the progress of carbonation. The committee has studied references on the relationship between carbonation rate coefficients obtained via acceleration test and outdoor-exposure test aiming to provide reference information.

Table 2-Comparison of accelerated carbonation test methods

Item	JIS A 1153	ISD/DIS 1920-12
Shape and dimensions of specimen	Square pillar 100 × 100 × 400 mm	Square pillar 100 × 100 × 400 mm
Curing conditions (wet curing)	Wet curing in water or at least 95% R.H. at 20°C until 4-week age	Wet curing in water at 20°C until 4-week age
Curing conditions (dry conditions)	Leave it to stand still at 20±2°C in 60±5% R.H. from 4-week to 8-week age. Seal the four sides other than the test surface at 7 or 8-week age	Leave it to stand still at 18~29°C in 50~70% R.H. over 14 days. Then seal the four sides other than the test surface.
Accelerated conditions	Period of acceleration: 1, 4, 8, 13, 26 weeks Temperature: 20±2°C Relative humidity: 60±5% CO_2 concentration: 5±0.2%	Period of acceleration: 56, 63, 70 days ○General environment: Temperature: 22±2°C Relative humidity: 55±5% CO_2 concentration: 3±0.5% ○High-temperature environment: Temperature: 27±2°C Relative humidity: 65±5% CO_2 concentration: 3±0.5%
Depth of carbonation testing method	Spray phenolphthalein over the cracked surface. Measure the colored depth using vernier calipers	Spray phenolphthalein over the cracked surface. Measure the colored depth using slide gauge. Spray again 30 min later if coloring is insufficient.

2.4 Examination and tests for corrosion induced initial salt content in fresh concrete

The committee surveyed quality control and test method for the measurement of initial salt content in fresh concrete and transitions of the methods. Regulations on initial salt content in countries outside Japan were also comparatively investigated.

(1) Circumstances of regulations on initial salt content in Japan

Chloride ions (initial chloride ions) in fresh concrete derived from aggregates, chemical admixtures, cement and/or mixing water and are strictly controlled to prevent corrosion of steel in reinforced concrete structure.

Until the 1970's, NaCl in sea sand was the main source. Therefore, the amount of chlorides in sea sand was regulated. After the Ministry of Construction issued the notification on "chloride total quantity limit in concrete" (1986), all materials of concrete (cement, admixture, chemical admixture and mixing water) are in the scope of regulation.

The chloride total quantity limit (notification by the Ministry of Construction) prescribes standard values of Cl^- content in fresh concrete to not exceed 0.30kg/m^3 or 0.60kg/m^3 depending on the types of structures.

For buildings, the notification issued in 1977 on use of fine aggregates containing salt in concrete prescribes NaCl content to not exceed 0.04% of the weight of fine aggregate. This is roughly equivalent to a Cl^- content of 0.30kg per 1m^3 of concrete when calculated by considering the salt contents in cement and mixing water [10]. Assuming that rust preventives are used, the limit of NaCl content may be mitigated to not exceed 0.1%, which is equivalent to 0.60 kg per 1m^3 of concrete.

For civil engineering structures, the conventional chloride quantity limit (Cl^- content not exceeding 0.60kg/m^3) has been judged to be appropriate via comprehensive investigation of experimental results conducted in Public Works Research Institute and other institutes in Japan, standards, studies, calculations and actual chloride contents in ready mixed concrete. Provided, the limit is 0.30kg/m^3 or less for prestressed concrete of pretension type, in which the steels are under high stress, and for cases of performing autoclave curing [11)].

(2) Specifications on initial salt content in other countries

ACI 318 prescribes the maximum amount of chloride ions in hardened concrete. The soluble salt content is to be measured based on the test method specified in ASTMC 1218. The specified limit are the same as those in ACI 318-83 and are shown in Table-3. According to a trial calculation mentioned in Reference 11), 0.15% per unit mass of cement corresponds to 0.45kg/m^3 in concrete. This value shows the quantity of soluble chloride ion and is more moderate than the limit in Japan. On the other hand, ACI 318 limits the maximum water cement ratio at 0.40% in areas where salt is supplied, which is stricter than the regulations in Japan.

EN 206 (Table-4) prescribes different values for maximum chloride ion content depending on type of concrete such as plain concrete, reinforced and prestressed concrete. The value differs by cement content, but the limit for reinforced concrete is about 0.60kg or less per 1m^3 of concrete.

(3) Summary of initial salt content

In Japan, the 1986 version of JIS A 5308 prescribes that the chloride ion content can be increased up to 0.60kg/m^3 upon obtaining approval of the owner, but in practice the actual salt content in almost all products is limited to below 0.30kg/m^3, requiring a value slightly lower compared to regulations in other countries.

The limit on the initial quantity of chloride ions is possible to be mitigated depending on the purpose of concrete and the environment to which the structure is exposed, but the mix proportions and environmental conditions need to be clarified to do so.

Table-3 Maximum chloride quantity limits for protecting steels from corrosion (ACI 318-11)

Environmental conditions	Maximum water cement ratio	Minimum strength (N/mm^2)	Maximum quantity of soluble Cl^- (wt% vs C)	
			RC	PC
C0	N/A	ca. 17	1.00	0.06
C1	N/A	ca. 17	0.30	0.06
C2	0.40	ca. 34	0.15	0.06

C0: Dry environment or environment protected from moisture
C1: Exposed to moisture but no supply of salt
C2: With supply of salt from the ambient

Table-4 Upper limit of chloride ion content in concrete (EN 206:2013)

Purpose	Salt content Class	Maximum quantity of Cl^- (wt% to C)
No reinforcing bars or steel	Cl 1.00	1.00

Reinforced concrete	Cl 0.20	0.20
	Cl 0.40	0.40
Prestressed concrete (steels in direct contact with concrete)	Cl 0.10	0.10
	Cl 0.20	0.20

2.5 Examination and tests of frost damage

The committee compared the concept for ensuring resistance against freezing and thawing and the actual specifications for achieving the resistance among various standards. Representative standards are exemplified below.

(1) JASS 5 (2009 version)

The air content in ordinary concrete that uses air-entraining agent or high-performance air-entraining agent is prescribed to be 4.5% in "5.8 Air Content" in Section 5 "Mix Proportioning" if not otherwise specified. For sections subjected to severe freezing and thawing and where sufficient measures such as finishing cannot be taken, Section 26 "Concrete Subjected to Freezing and Thawing" is applied. In the section, deterioration forms or causes and measures for preventing frost damage are organized as shown in Table-5 [1)].

Unless specified, the durability design strength of concrete is 27 N/mm^2 for planned service period of a standard class, which is 3 N/mm^2 larger than in ordinary case. The relative dynamic modulus of elasticity is to be at least 85% after 300 cycles of freezing and thawing test of the JIS A 1148 A method. Concrete is to be air-entraining concrete and is to have air content of at least 4%. Provided, the air content can be reduced to 3% for quality standard strength exceeding 36 N/mm^2. For frost damage predicted on a horizontal surface, bleeding is to not exceed 0.3cm^3/cm^2, but there are special notes about whether the limitation is imposed or not.

Table-5 Relationship between deterioration forms/causes and measures of frost damage

Deterioration form or cause	Measure for preventing frost damage						
	Lowering water cement ratio (strength increase)	Ensuring air content	Limiting aggregates	Reducing bleeding	Surface finishing	Curing	Details (reducing water content)
Expansion of tissue	○	◎	○	○	○	○	◎
Scaling	◎	○	○	*	○	◎	◎
Pop-outs	–	–	◎	—	○	–	◎
Direct freezing pressure	–	–	–	–	–	–	◎

Notes: ◎: very effective, ○: effective, –: no effect, [*]: very effective on horizontal surface

(2) Standard Specifications of JSCE

Since the 2012 version, the Standard Specifications of JSCE prescribes the durability against frost damage to be checked separately for internal damage and surface damage [12)]. However, only policies have been decided to use the amount of scaling for examining internal damage, and there have been no quantitative examination method established. On the other hand, internal damage is to be checked by using the relative dynamic modulus of elasticity determined by freezing and thawing test of the JIS A 1148 A method as an index and calculating the resistance depending on climatic conditions, thinness of the section and exposure state of the structure. Within air content range of 4% to 7%, water cement ratio values that satisfy relative dynamic modulus of elasticity are shown as standards, and thus the resistance against frost damage can be checked from the table of mix proportion. For marine concrete, the Standard Specifications recommends to regulate the maximum water cement ratio at 45% to 50% and increase the air content to 4.5% to 6.0% depending on the maximum size of coarse aggregates and the location of the structure (exposed to marine atmosphere, located in splash zone or located in tidal zone) in its section for Materials and Construction of special concrete [13)].

(3) Comparison of methods for securing resistance to frost damage

Both JASS 5 of the Architectural Institute of Japan and the Standard Specifications of Japan Society of Civil Engineers requires lowering of the water cement ratio and securing air content for areas where concrete is subjected to severe freezing and thawing. However, the reasons and methods for the regulations differ slightly between the two. JASS 5 considers that securing air content is effective for preventing expansion of tissue, while the Standard Specifications of JSCE requires considering scaling in areas subjected to sea water.

Outside Japan, the concept for securing resistance against frost damage differs among standards. For example, ASTM C94/C94M changes the recommended air content value depending on environmental condition. EN206: 2013 prescribes a constant minimum air content of 4.0% and to change the maximum water cement ratio.

The standards of the Architectural Institute of Japan and Japan Society of Civil Engineers state various specifications as described above; but in practice, resistance against frost damage is deemed to be secured just by using ready mixed concrete of air content of 4.5%.

3. Methods for inspecting newly built and existing structures and standards

3.1 Examination and inspection of compressive strength of concrete in structure

Methods and concepts of examination and inspection (inspection of structural concrete strength) for checking whether the concrete placed as a structure has manifested strength as designed or not differ by field. The committee organized inspection of structural concrete strength in JASS 5 and the Standard Specifications of JSCE.

In the field of architecture, Article 74 in Enforcement Ordinance of Construction Standard Law stipulates that structural concrete strength must satisfy the safety standards in relation to specified design strength; and the evaluation methods are prescribed as follows in a related notice. The mean strength of a specimen of 28-day age cured underwater at job site must be the specified design strength or larger, or the mean compressive strength of a core specimen or a similar specimen of 28-day age cured (sealed curing at job site is assumed) must be at least 7/10 of the specified design strength and the strength must not fall below the specified design strength at the age of 91 days. This is because it considers increases in strength after 28 days of age and the strength of specimen cured underwater at job site is larger than the strength of the structure. Based on the regulation, JASS 5 (1997 version) mentioned to calculate the difference ΔF in strength between a core specimen or specimen cured sealed at job site and a specimen cured underwater at job site, set a correction value T for temperature during curing, and assess the strength by adding ΔF and T to the specified design strength. However, in the revision in 2009, the difference in strength between a standard cured specimen of 28-day age and structural concrete strength at the age of 91 days is put as structural strength correction value (${}_{28}S_{91}$), and the sum of the S value and specified design strength is to be evaluated. In this way, concrete is checked in the field of architecture for manifestation of required strength by considering curing conditions after concrete placement, such as temperature during curing. Fig.-3 is a schematic diagram of strength correction value between the strength of concrete in structure and the strength of specimen for controlling compressive strength stated in JASS 5 (1999 and 2009 versions).

On the other hand in the field of civil engineering, the Standard Specifications of JSCE gives material factor that considers change from characteristic material strength value and difference from structural body. The design strength used for designing concrete is the value determined by dividing the specified design strength by material factor and includes the effects of differences in materials and curing in the design. The compressive strength of concrete in structure that is appropriately cured is expected to be larger than the strength of a standard cured specimen of 28-day age. Therefore, ordinary structures are controlled by checking the compressive strength of standard cured specimen of 28-day age. The Standard Specifications also mentions that concrete in structure needs not to be inspected as long as receiving inspection is properly performed and shows satisfactory results.

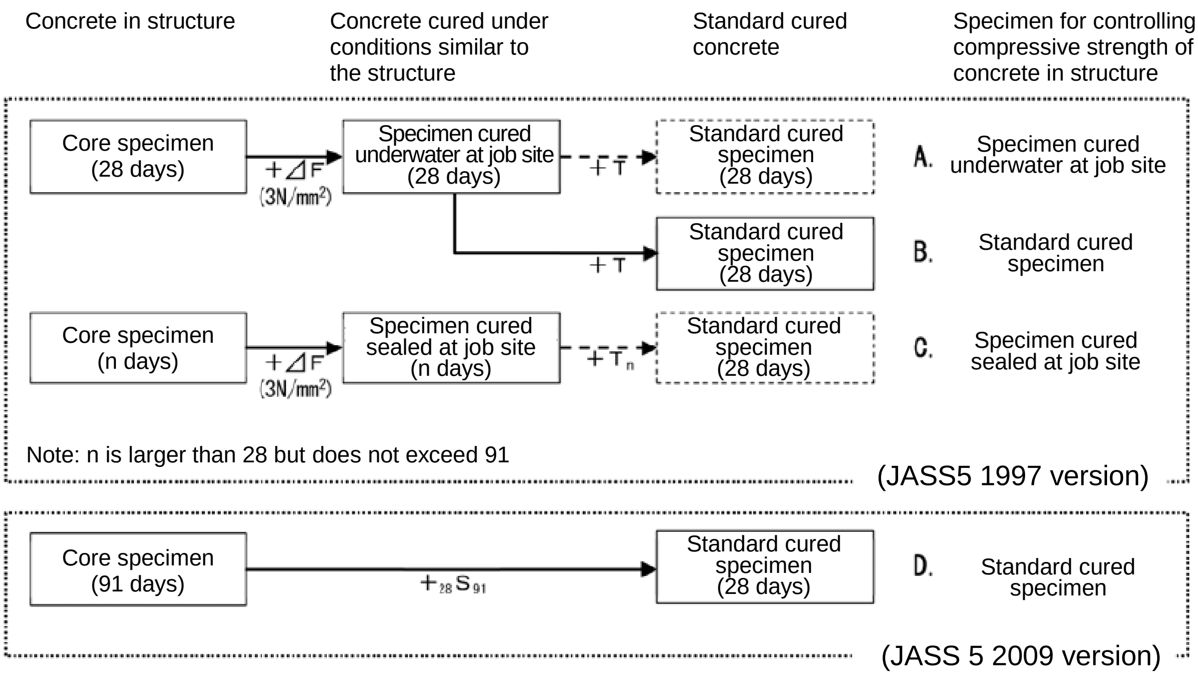

Fig.-3 Concept of strength correction value between concrete in structure and specimen for controlling compressive strength in JASS 5

The concept and methods of compressive strength inspection for concrete in structure differ between fields of architecture and civil engineering in this manner. In the field of civil engineering, compressive strength tests other than JIS, etc., such as nondestructive test and small-diameter core, are also used to control concrete in structure. In such a case, the strength control aims not at quantitatively determining the structural concrete strength but at checking that appropriate concrete has been placed and has been properly cured. The committee also organized such test methods other than JIS, etc. for overview, actual states of implementation and issues for implementing the methods.

3.2 Inspection of initial cracks on newly built structure

The committee surveyed and investigated the allowable crack width of a structure and inspection methods. Cracks on concrete lead to lowered durability by corrosion of steel, reduced water tightness, air tightness and other performances, and deteriorate the appearance. Therefore, allowable crack width and preventive measures for crack occurrence and extension are stated in various specifications, design and construction guidelines, etc. Crack width is prescribed to be measured by using crack scale, magnifying glass, microscope, etc.; but no standards state an inspection method in detail, and there has been no standardized method established.

Most crack scales that are widely used for measuring crack width are graduated in 0.05 mm. In crack scales on the market, the precision of the scale is about ±0.02mm in resin film scales and about ±0.05mm in stainless steel scales. The precision varies by printing skill, and the precision is not examined.

In inspection of an actual structure, the maximum crack width is widely used as an index. However, it is very difficult to determine the point of the largest width when the crack is long. Because the points to measure crack width or spacing are not clearly determined, measurement relies on the skills and experience of the person who performs the measurement. When part of crack has a chip, maximum crack width is possible to be measured large at the point, which may result in excessive repairing. In such a case, it is important to note not only the maximum value but also the distribution of crack width throughout the crack.

Future issues toward standardization of crack inspection method will include controlling the quality of crack scale, determining spacing of measurement and the number of points to measure, and organizing ways of expressing representative values.

3.3 Inspection of carbonation depth

Depth of carbonation is one of most important inspection items for evaluating the durability of an existing structure. Methods widely used in Japan for inspecting carbonation depth of an existing structure include JIS A 1152 (Method for measuring carbonation depth of concrete), which was established in 2002 and revised in 2011, and NDIS 3419 (Method of test for neutralization depth of concrete in structures with drilling powder), which was established in 1996 and revised in 2011. In recent years, drilled powder is increasingly used to minimize damage to a structure.

Before the JIS and NDIS were established, RILEM CPC18 (1988), Recommendations for high durability design and construction practice of reinforced concrete described above [9], and Japan Highway Public Corporation standard (JHS311, 1992) were proposed among others. Methods have also been proposed that use electron probe micro-analysis (EPMA), thermogravimetric-differential thermal analysis (TG-DTA) or X-ray analysis but have not been standardized.

All of currently standardized methods use alcohol solution of phenolphthalein as the indicator. A difference to RILEM CPC18, which was also an issue questioned when revising JIS, is how to deal with unstable coloring by phenolphthalein. In the old JIS version, the coloring was to be judged immediately after spraying, but the revised version in 2011 prescribes to leave the specimen over a period of several minutes to about 3 days. RILEM CPC18 states to leave the specimen for 24 hours after spraying. The time necessary for the color to stabilize cannot be determined as a universal rule because it is affected by the states and dryness of the specimen, but it certainly requires some time to stabilize. As an example, difference in the color between immediately and in 24 hours after spraying phenolphthalein is shown in Photo-1.

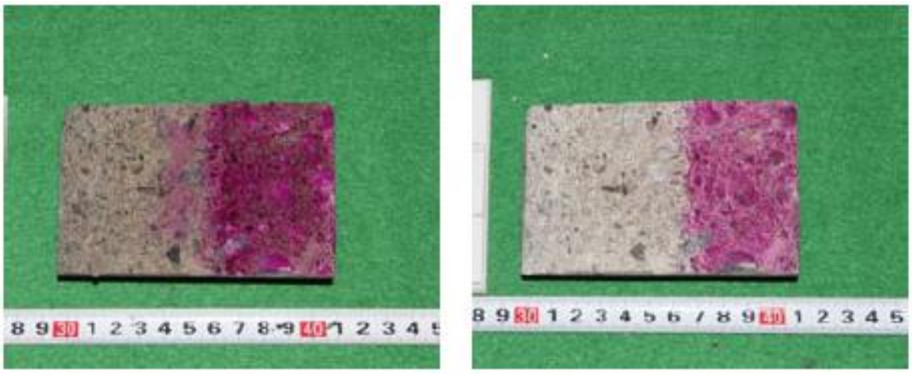

Photo-1 Difference in phenolphthalein coloring by time
(Left: immediately after spraying, right: 24 hours after spraying)

4. Investigation on methods for using technological information

One of the objectives of the committee was to construct a method for using information about technical standards of concrete. Technical standards include relevant laws, which must be obeyed, standards and criteria, which prescribe the quality of materials and test methods, and specifications and related guidelines, which states the actual methods of use. There are also studies and reports, which form the bases for preparing technical standards. Therefore, the committee focused on studies and reports, which will possibly be used as bases for preparing technical standards, and investigated use of information related to the studies and reports that have been investigated by Japan Concrete Institute (JCI).

JCI started establishing study committees in 1969, and since then 156 committees have been established to organize precious studies on civil engineering, architecture and materials conducted by researchers and engineers, and accumulated knowledge. The massive knowledge has been widely referred to not only for preparing JCI standards and guidelines but also for formulating and revising JIS standards and investigating technical standards of other related associations. However, most of the information is available only in hard copies besides few exceptions, and old reports and their contents are hardly available. This has impeded full utilization of the precious technical references accumulated. To facilitate use of the technical references and investigate use of information in the future, the committee constructed a database of the index information contained in the reports prepared by these study committees on a trial basis and investigated it as a proposal of information use in the future.

As mentioned above, there have been 150 study and technical committees in JCI that prepared reports. Of the reports, the committee obtained 125 committee reports (hard copies) and digitalized the information (index information) that shows the contents of the reports such as the title, table of contents and forewords. Based on the index information, keywords were added to enable keyword and field searches. Keywords that show the field of study were those used for classifying paper submitted to the annual conference of JCI. For keywords for showing the contents of the study, members of the committee read the index information and selected and added keywords that directly expressed the contents. By summarizing these, a database consisting 125 reports was constructed.

The constructed database is scheduled to be distributed as a content of the report of this committee in the form of CD-ROM. The committee also considers publishing it on the web jointly with the computerization committee is an effective way for using information.

5. Summary

The study committee on methods for using information about technological standards of concrete aimed to survey Japanese industrial standards and international standards, such as ISO and EN, organize the relationships with the contents prescribed in specifications and guidelines that use the standards in and outside Japan, and propose methods for using information related to technical standards of concrete, such as test method, quality standards and criteria for use. Over a period of 2 years, the committee has conducted surveys and investigations on the following topics. The committee has:

a) organized the historical background and circumstances of the establishment of quality standards such as JIS and test method and the relationships between relevant standards,
b) surveyed the circumstances of establishing and/or revising specifications, etc. related to concrete and reinforced concrete structures and organized the bases of citing and following the contents of JIS, etc., and
c) proposed a framework and model for using the results of the aforementioned two activities.

Many researchers and engineers have used and cited provisions in technical standards and specifications related to concrete structure without full understanding of the significance and basis (origin). It is not rare that the provisions are modified. We would appreciate if the results of the committee were used for applying, citing or modifying regulations of various kinds.

The method for using information proposed this time involved only digitalizing part of existing study committee reports so far. We expect it would be a help for a JCI member having an easy access to precious study results in the past.

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