Committee Report : JCI- TC122A

Technical Committee on Historiography and Organization of Researches in Concrete Technology

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Abstract

The objective of the Committee is to review landmark studies in the fields of materials and structure in concrete engineering. The Committee has not only studied references, but also interviewed persons who were involved in leading studies in each field to organize backgrounds of the studies, reasons to start the studies, and research processes, which do not appear in papers. So far the Committee has interviewed 13 precursors as of March 2014. This report summarizes the circumstances of the Committee in deciding interviews.

Keywords: Landmark, concrete engineering, cement chemistry, materials, structure, precursor

1. Introduction

Concrete engineering is expected to further develop under new boundary conditions of mitigating environmental load, disaster prevention, and development of new materials. Understanding the correct history of studies in this field and achievements by precursors is important, as well as learning their attitudes toward studies and methodology based on the social background at that time. The Committee traces landmark studies in detail by interviewing persons involved, mainly aiming to organize their attitudes toward studies, methodology for achieving the goals, and their views of life, which do not directly appear in papers.

The period of activity of the Committee is 2 years from April 2012 to March 2014. The members of the Committee are shown in **Table 1**.

Table 1: Committee Members

Chair	**Kei-ichi Imamoto**	**Tokyo Univ. of Science**
Co-Chair	**Tetsuya Ishida**	**Tokyo Univ.**
Advisor	**Toshiharu Kishi**	**Tokyo Univ.**
Secretary	**Manabu Kanematsu**	**Tokyo Univ. of Science**
Secretary	**Tuyoshi Saito**	**Niigata Univ.**
Secretary	**Shigehiko Saito**	**Yamanashi Univ.**
Secretary	**Akira Hosoda**	**Yokohama National Univ.**
Secretary	**Ippei Maruyama**	**Nagoya Univ.**
Secretary	**Takashi Ymamoto**	**Kyoto Univ.**
Member	**Masami Ishikawa**	**Tohoku Gakuin Univ.**
Member	**Ichiro Iwaki**	**Nihon Univ.**
Member	**Masahiro Ouchi**	**Kochi Univ. of Technology**
Member	**Yoshimori Kubo**	**Kanazawa Univ.**
Member	**Isao Kurashige**	**Central Research Institute of Electric Power Industry**
Member	**Yuya Sakai**	**Tokyo Univ.**
Member	**Takahiro Sagawa**	**Nippon Steel & Sumikin Cement Co.,Ltd.**
Member	**Yasushi Tanaka**	**Nagaoka Univ. of Technology**
Member	**Masaki Tamura**	**Kogakuin Univ.**
Member	**Tomoya Nishiwaki**	**Tohoku Univ.**
Member	**Yukio Hama**	**Muroran Institute of Technology**
Member	**Kazuhiko Hayashi**	**Yokohama National Univ.**
Member	**Takeshi Maki**	**Saitama Univ.**
Member	**Naoki Mishima**	**Mie Univ.**
Member	**Shingo Miyazawa**	**Ashikaga Institute of Technology**
Member	**Takeshi Watanabe**	**Tokushima Univ.**
Member	**Kenzo Watanabe**	**Kajima Corporation**
Communication Member	**Kenichiro Nakarai**	**Hiroshima Univ.**

2. Overview of activities

2.1 The interviews

(1) Professor Yasuo Tanigawa

Already in the late 1980's, reduced durability of reinforced concrete structures surfaced as a social problem. Tanigawa et al. pointed out that many such problems can be prevented by strictly controlling casting, and advocated the idea of "construction design" as a radical solution. In a series of studies, they investigated the material properties (rheological properties) of fresh concrete while simultaneously developing a method of assessing casting performance (numerical analysis and theoretical analysis). Among their achievements, one that should be especially mentioned is the development and application of the flow analysis method that used a personal computer, the implementation of which had just begun. Later in the early 1990's, high workable concrete and high strength concrete were developed, further attracting people's attention to Tanigawa's study. We interviewed Dr. Tanigawa, asked him about motivations that led to the studies and hardships he confronted at that time, and summarized his story (Reporter: Naoki Mishima).

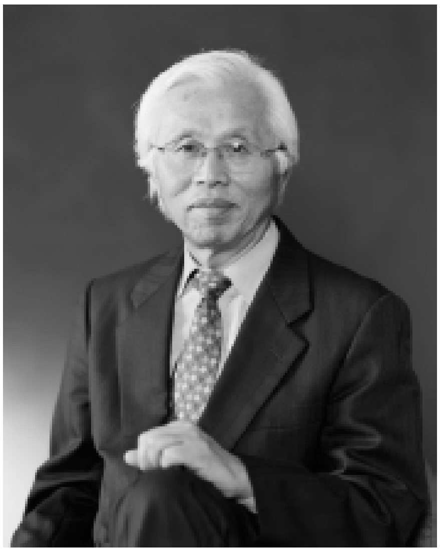

Photo 1: Professor Yasuo Tanigawa

(2) Professor Yoshio Kakuta

In the Standard Specifications for Concrete Structures 1986 of the Japan Society of Civil Engineers, the limit state design method, which was devised in Europe, was implemented, as well as several design formulas developed based on study results in Japan. We interviewed Professor Yoshio Kakuta, who constructed one of the formulas, i.e., the equation for flexural crack width. The interview turned out to be very valuable, and yielded information about the substantial content of the discussions made during and after the introduction of the limit state design method, and his principles as a scientist.

Instructed by Professor Hideo Yokomichi, who was the Prof. Kakauta's supervisor, Prof. Kakuta designed Kamihimekawahashi Bridge when he was a first-grade graduate school student. His design was based on the so-called three-type precast concrete (PC), or precast reinforced concrete (PRC) for controlling cracks. He said that he could freely design the bridge because there were no design rules at that time, such as those on allowable stress of deformed bars, allowable crack width, and fatigue of reinforcing bars. Because PC steels increase the ultimate strength, he reduced the amount of deformed bars by the increase of PC steels. This was calculating the cumulative strength, i.e., incorporating the idea of ultimate strength design. While the idea of seeing allowable crack width as a function of cover depth is an original Japanese idea, we learned how Prof. Kakuta devised a model of the idea in the design of the bridge from the interview. We all felt the originality of a scientist who has always thought freely and creatively.

During the process of introducing the limit state design method, Prof. Kakuta and other young researchers claimed not to imitate or follow Europe and America in the Subcommittee on Strength Design (later Subcommittee on Limit State Design), and systematically challenged them in establishing original Japanese equations and standards. Prof. Kakuta had an "ambition" to publish a paper(s) that would be a model for constructing future design equations, and submitted a paper on punching shearing stress. He included data with standard deviations, aiming to present data that was likely easy to be included in specifications. He said he does not know whether the paper acted as a trigger or not, but many other original Japanese design equations were subsequently proposed, such as that on shear strength by Prof. Okamura et al., fatigue strength of deformed bars, and shear fatigue strength.

The concept of time was incorporated in the durability check (steel corrosion) in the Standard Specifications for Concrete Structures 1999. That was an idea of Prof. Kakuta. The concept of "Optimum design" was popular once, and it eliminates all unnecessary items and results in the least durable structure among allowable designs. The need for incorporating the concept of time was proposed by Prof. Kakuta when Prof. Okamura was Chair of the then Committee for Revising Standard Specifications. Prof. Okamura decided to incorporate at least one equation that has a time-dependent term, and equations for checking carbonization and salt damage were adopted and are also included in the current specifications.

"I want young people to take the plunge, have a wide viewpoint, and think flexibly". This is a message to today's young people from Prof. Kakuta, who has always undertaken studies on advanced and original design methods (Reporter: Akira Hosoda).

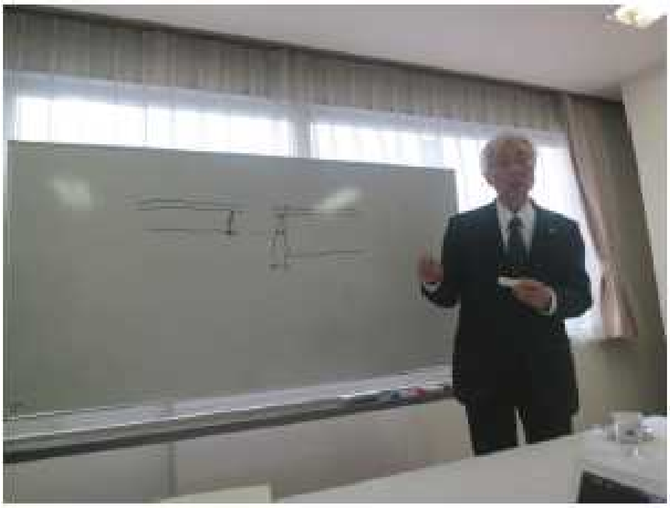

Photo 2: Professor Yoshio Kakuta
(explaining allowable crack width)

(3) Professor Shoji Ikeda

“I like to think things from zero. I also like to confront difficulties finding solutions. When I confront a difficulty, I think day and night. And I always find an answer”. These were the words we heard at the interview with Professor Shoji Ikeda. From the interview, we constructed a profound profile of Prof. Ikeda, who made remarkable achievements in the establishment of seismic design methods for civil engineering structures, reduction of allowable shear strength, development of composite structures, etc., and is playing an active part in formulating design standards of the performance creation type, and drafting Rule 17 Articles for Prevention and Mitigation of Great Disasters.

Prof. Ikeda should be called a “philosopher”. The English terms “subjective” and “objective” are translated into Japanese as “shukan-teki” and “kyakkan-teki”, but according to him, the translations are not appropriate because their concepts are different from the English words. The difference may disturb Japanese people when they engage in international work, and thus, harmful translations should be revised. It is inconsistent that the affix “sub”, which means “a lower level or position”, was translated into “shu”, which means “a higher level or position” in Japanese. Design needs philosophy; and because the concepts of “subject” and “object” play important roles in philosophy, they must be correctly understood. This and other philosophical ideas of Prof. Ikeda related to design are clearly stated in the “Standards for Design and Construction of Concrete Structures” (Japan Prestressed Concrete Institute) of the performance creation type.

He asked us to refer to references for revising the Standard Specifications for Concrete

Structures in 1980 (complete library) for the circumstances of reducing the allowable shear strength level, which was called "a decisive by Ikeda" by Professor Okamura, and the circumstances are described in the references in detail. At that time, commonly used reinforcing bars were round SR24, which had low allowable strength and crack dispersiveness. However, as use of deformed bars, which have high adhesiveness and strength, became more widespread, concrete became more prone to dispersed cracks and diagonal cracks. We formed a good picture of Prof. Ikeda, who is always strict in his thinking about design standards for ensuring the usability of structures based on actual phenomena.

In formulation of the ultimate strength design method, Prof. Ikeda was in charge of seismic design. He thought, thought and thought, and found answers. He found that until that time, seismic design was deemed to be an act of resisting an earthquake that occurs in an unpredictable region at an unpredictable time. He investigated the performance required for structures along the time axis including after an earthquake, and constructed a framework of giving deformation performance to structures depending on their importance. "I think it was the first performance-based design", he said.

He talked about diverse philosophical issues ranging from design methods for concrete structures to beauty, the dynamism of "Makura no Soshi", Adam Smith, Keynes, prevention of disaster due to tsunami, and the Board of Audit (Reporter: Akira Hosoda).

Photo 3: Together with Professor Shoji Ikeda

(4) Professor Fuminori Tomosawa

Since the finite element method was first adopted for designing aircraft, numerical analysis technologies using computers for structural design have rapidly advanced, and are now an indispensable area of study. On the other hand, modeling changes in material properties and deterioration as numerical models, and using them for maintenance, are widely used today in the plant industry for aging management, and their importance is being recognized also in the concrete industry. Compared to plants, concrete structures are subject to complex environmental external forces, which is a possible reason for the delay in the generalization of the method. Recently, its use for future prediction is being investigated in combination with monitoring technologies.

An indispensable technology with such a background is methods for expressing time-historical changes of material properties in a numerical analysis manner. In kinetic problems of materials, the first problem in concrete is the problem of the speed of hydration reaction. So far, hydration reaction models have been developed in the USA, Netherlands, Switzerland, and Japan, and various applications are being investigated.

As described in Section (7), Professor Renichi Kondo, a cement chemist, was the first in the world to analyze the process of hydration reaction of cement precisely. On the other hand, in the field of architecture, industrialized houses were developed and constructed to meet the social demand of supplying a large number of houses. Against such a background, Prof. Tomosawa decided to work on determining the phenomena of assessing the strength of precast elements by numerical calculations, investigated the process of hydration reaction of cement during steam curing from his original approach, and succeeded in reproducing the process by using an un-reacted nuclear model. He also proposed a method for predicting strength by assuming that the theory of gel-space ratio, which was applied to hardening of mortar by Powers, can be applied to concrete undergoing hydration. The attempt was nothing but the fundamental skeleton of a numerical prediction method in current material engineering, and it was a world-first landmark study that showed that a problem in cement chemistry can contribute to concrete engineering via numerical analysis.

Prof. Tomosawa has also been deeply involved in social issues of the time since around 1987 when he started to work as a professor at the University of Tokyo. One of the issues is the problem of durability, and he has been engaged in the project from the viewpoint of improving the durability of buildings by revising the comprehensive technological development project and JASS5. Especially, based on the experience of the concrete crisis and the Great Hanshin Earthquake disaster, he has discussed with a number of structural engineers and acted beyond the regional boundaries of concrete engineering and building material science, aiming to respond to social issues as a building material scientist. In a comprehensive technological development project for byproducts, he investigated various standards concerning the quality of recycled aggregates, but also faced a social problem of the investigatory results not leading to widespread use of the technology at a practical level. From the viewpoint of users, no one wants goods of bad quality, and the quality gradually deteriorates as the material is recycled repeatedly. He felt that these are big issues, and from this viewpoint, he thought that aggregates should be recycled in a manner whereby concrete of the original quality is produced, and not in a manner of cascade recycling. He grasped the idea that complete recycling is needed, which recovers cement materials and aggregates with the qualities of virgin materials, and has shown ways leading to several technical solutions.

Against such a background, we interviewed Professor Tomosawa, and listened to his historical descriptions, his research philosophy, and what came out of it. We also listened to his social contributions while he worked for the Building Research Institute and the University of Tokyo, and future topics in concrete engineering Reporters: Ippei Maruyama, Manabu Kanematsu, and Masaki Tamura).

Photo 4: Professor Fuminori Tomosawa

(5) Mr. Toshio Hirose

The construction of concrete dams in Japan started with the Nunobiki Gohonmatsu Dam in 1900. For the next 30 years or so, small-scale dams of heights of around 30 m were mainly built. After WWII, large dams were rapidly constructed to meet the increasing demands for power supply, flood control and agricultural water reserve that accompanied revitalization of social economy. Many dams were built including the 157-m tall Okutadami Dam in 1961. However, in the 1970s, the national budget for dam construction fluctuated sharply in response to business fluctuations, and rational construction of concrete dams was in high demand. The former Ministry of Construction established a committee consisting of experts in concrete dams to investigate and develop new construction methods. Extensive knowledge, technology development and strategies that cover a wide range of concrete materials, manufacturing, transportation and construction machines, construction plans and economy were required to develop new construction methods. The person who played a central role in the R&D project was Dr. Toshio Hirose, who was a chief engineer of the Ministry of Construction.

As the first step in rational dam construction, Dr. Hirose calculated the costs in each and every process from excavation to construction. The cost for transporting concrete was found to be conspicuously large. He proposed the roller compacted dam-concrete method (RCD method), which rationally builds a dam by reducing the unit cement content, transporting concrete on dump trucks, spreading the concrete with bulldozers, compacting it with vibratory rollers, and repeating these procedures until the dam reaches the predetermined height. However, the method received cold reactions and was sometimes called "borokon (poor concrete)", and ignored. Dr. Hirose promoted its development by asking Professor Kokubu for guidance, and getting the Board of Audit and engineers of general construction companies involved. To use the RCD method in a dam under construction, he begged and persuaded people involved to use the method, saying "it is for the development of dam technologies in Japan". In Shimajigawa Dam, rational construction using the RCD method was executed for the first time in the world. After a number of works, the RCD method is today established as a standard method for building a large concrete dam.

Besides the development of the RCD method, he has also proposed many activities for improving dam technologies in Japan, and promoted the establishment of the certification system for chief management engineers for dam construction. In the interview, he also talked about how technologies should be, how infrastructure should be developed, and his ways of thinking as a civil engineer, providing us with a lot of large-scale and precious information (Reporter: Kenzo Watanabe).

Photo 5: Dr. Toshio Hirose (explaining the RCD method)

(6) Professor Tada-aki Tanabe

Establishment of the Committee on Thermal Stress of Massive Concrete Structures (chair: Professor Tada-aki Tanabe, hereinafter referred to as the "Committee") in August 1981 was a turning point of studies on thermal stress of massive concrete structures. Today, the temperature and stress values in a concrete structure can be calculated in advance by the finite element method, and even the probability of crack development can also be predicted. The technology of controlling thermal cracks advanced rapidly with the establishment of the Committee. It is no exaggeration to say that it is one of the most advanced fields of study in the world today. The level of technology related to thermal stress before 1981 can be estimated from the statement on "massive concrete structures" in the Standard Specifications for Concrete Structures 1980. It says, "A massive concrete structure should be cast by minimizing temperature rises after placing, and so as to not develop cracks", which is no more than a qualitative statement. In the revised Specification in 1886, the following results of the Committee were fully incorporated, showing the very important roles of Prof. Tanabe and the Committee in the development of technologies in this field. In the interview, Prof.Tanabe talked about his then desire to control cracks in important structures such as nuclear power plants by using any means necessary. The desire bore fruit in the Specification of 1986.

The landmarks set by Prof. Tanabe and the Committee in the field of thermal stress of massive concrete structures are the following two:

1) First, the finite element method was introduced to calculate thermal stress. In other words, a series of analytical technologies was established, which solves temperature rises due to heat generation from the hydration process as a problem of non-steady heat conduction, and then as a problem of initial stress that assumes the process of generating thermal stress that accompanies changes in the elastic modulus of concrete as successive elasticity problems.

2) The other is the development of the Compensation Plane Method (CP method), which is a simple analytical method for thermal stress based on the beam theory. The CP method assumes that an entire concrete structure is like a beam, and is a simplified method for calculating thermal stress. The precision compares favorably with the finite element method. Obviously, the above technology of thermal stress analysis, which is based on the finite element method, was indispensable for the development of the CP method. The most important points in the studies on the CP method were 1) constraints were clearly separated into "external constraint" and "internal constraint", and 2) equations for calculating the "strain

component" were derived for each kind of constraint. The concept of "constraint" on volume change of concrete was already mentioned in the report of the ACI207 Committee in 1973, which also defined external and internal constraints. However, the strain component in the calculation formula for external constraint stress included internal constraint strain, and there was no equation that appropriately reflected the concept of external constraint.

It goes without saying that Prof. Tanabe worked energetically to elucidate basic problems, such as the mechanism of thermal stress generation, before these study results were achieved. In the interview, he told us about his episodes while he was still a student, what triggered studies on thermal stress, difficulties in research, and many other stories. We received very precious advice for young researchers who will play important roles in the future. Please look forward to the final report of this Committee (Reporter: Masami Ishikawa).

Photo 6: Professor Tada-aki Tanabe (explaining the CP method)

(7) Professor Masaki Daimon, Professor Seishi Goto, and Professor Kiyoshi Asaga

In terms of the position of "cement chemistry" in Japan and past developments in "cement chemistry" in Japan, Japan has followed its own path different from European and American countries. This is at least partly because "cement chemistry" has developed as a field of pure "science" in America and particularly in Europe, while it has been a field of "engineering" in Japan. Therefore, the academic frameworks of "cement chemistry" in Japan focus mainly on explaining hydration reaction by velocity theory, rather than explaining hydration of cement compounds and cement hydrates in terms of equilibrium or chemical analysis of structures and properties of hydrate structures. Cement chemistry has been used mostly as a basis for discussing, estimating and assessing pore structure characteristics, strength, and durability of concrete rather than cement itself.

In the 2000s, the design system for concrete structures shifted from that based on specifications to one based on performance codes and performance verification, requiring the performances of a concrete structure, such as strength, durability and dimension stability, to be quantitatively determined along the time axis at a high precision. This has further highlighted the importance of "cement chemistry" as a "basis". Moreover, gossip on highly precise prediction of ion movements, which are closely related to the durability of concrete, and recent problems of concrete shrinkage have promoted attempts to understand cement hydrates from an equilibrium point of view and chemically analyze the structures and properties of calcium silicate hydrate (C-S-H) and other hydrates, resulting not only in recognition of the latest studies in Europe but also in re-acknowledgment of "cement chemistry", which was once active in Japan, particularly studies in the 1960s and 1970s.

Against such a background, we interviewed three professors (Professor Masaki Daimon, Professor Seishi Goto, and Professor Kiyoshi Asaga) who studied in the laboratory of Professor Kondo of the Department of Inorganic Materials, Tokyo Institute of Technology, and listened to their wide-ranging stories about motive and background in cement chemistry research at that time, their ideas on C-S-H structures, and the induction and acceleration periods in the hydration reaction of cement (Reporter: Tsuyoshi Saito).

Photo 7: Professor Masaki Daimon, Professor Seishi Goto, and Professor Kiyoshi Asaga

(8) Professor Koichi Maekawa

Professor Koichi Maekawa has developed generalized constitutive laws of reinforced concrete, a method of nonlinear structural analysis, self-compacting concrete, and a multi-scale and comprehensive system of analysis that directly connects the thermal physics of materials, which determines microscopic phenomena, with macroscopic structural responses. We interviewed this world-leading concrete scientist.

In the interview, Prof. Maekawa spoke about episodes with persons whom he has met in his research life and who have affected his studies and life philosophy, the study philosophy he cultivated based on encounters and landmark studies from his viewpoint, rather than about his own landmark studies, which are many. The story told by Prof. Maekawa, who has great knowledge of the history of concrete science and technology development in and outside Japan, focused mainly on "persons", and consisted of points that the Committee wants to convey to young-generation researchers and engineers via this activity. Here, we outline the interview only briefly due to space limitations.

Prof. Maekawa's studies are characterized by reproducing the behavior of a concrete structure by grasping the essence of a phenomenon, performing sometimes venturesome modeling (simplification), combining the parts, and reconstructing the entire system. According to him, the roots of his research style lie in Professor Hajime Okamura, Prof. Okamura's teacher Professor Masatane Kokubu, Professor P.M. Ferguson (USA), Professor M.P. Collins (Canada) whom Prof. Maekawa met at international symposiums, and Dr. V. Cervenka (Czech Republic). Prof. Maekawa spoke about many episodes with these and other persons whom Prof. Maekawa respects and who have influenced him because they have (had) both the technical knowledge (of basic theories and numerical analysis) as well as a practical sense to "feel" what reinforced concrete is (engineering sense to find an answer without performing calculation), attitudes to do what they should do regardless of whether they can or cannot, and attitudes to deny even their past studies for the advancement of science.

He mentioned Professor Okamura and Professor Kiyoshi Muto as persons whom he respects for their ways of living as researchers and engineers. They both continued to study, move and act even after they retired from the University of Tokyo, and he said he felt in high spirits. He cited Zeami's words from Fushikaden to describe his way of living, and said "Even when I get old and have lost my leaves, I want to be like an old leafless tree. I want to live with a flower that makes me dance even if I don't have the energy of young actors". These words convincingly reflected the daily life of Prof. Maekawa, who still spends hours and hours enthusiastically over programming and numerical analysis (Reporter: Testsuya Ishida).

Photo 8: Professor Koichi Maekawa (reviewing his notebook)

(9) Professor Eiichi Tazawa

Autogenous shrinkage of concrete attributable to the hydration reaction of cement has been reported since the first study by H.E. Davis in 1940. Because the shrinkage is as small as 100 × 10-6 a year, it was not much investigated thereafter. Therefore, “autogenous shrinkage” was not mentioned in textbooks of concrete or in publications by the society until recently. It has long been common sense that “shrinkage does not occur as long as it does not dry”.

However, at the Annual Meeting of Cement and Concrete Engineering in 1991, Dr. Eiichi Tazawa (Hiroshima University at that time) published that autogenous shrinkage increases more conspicuously by reducing the binder ratio, and can be a major cause of cracks in high strength concrete. Subsequent studies showed that the effects of autogenous shrinkage cannot be ignored even in ordinary concrete, and its importance is widely recognized today.

Studies on autogenous shrinkage became frequent in and outside Japan in the late 1990s. In 1994, the Japan Concrete Institute established the Committee on Autogenous Shrinkage (chair: Dr. Eiichi Tazawa) to study terminology, testing methods, generation mechanism, and prediction methods. The world's first international conference on autogenous shrinkage was also held this year sponsored by JCI. In the Standard Specifications for Concrete Structures, the revision in 1996 first mentioned autogenous shrinkage as a phenomenon to be noted. Later revisions include design values for shrinkage strain, assessment of autogenous shrinkage as a driving force of thermal stress, and incorporation into structural design. Investigation is also being undertaken on assessing the effects of autogenous shrinkage on the shear strength of reinforced concrete elements. Cement and admixtures are also being actively developed from the viewpoint of reducing autogenous shrinkage. This history of concrete technology makes us recognize the importance of autogenous shrinkage anew, which was suggested by Dr. Eiichi Tazawa almost a quarter of a century ago.

In the interview, Dr. Tazawa talked about the circumstances in which studies on autogenous shrinkage began, and the attitudes toward and philosophy of such studies. We also asked about research themes at the Massachusetts Institute of Technology, memories of them, and research and development of new materials and technologies by Dr. Tazawa when he worked for Taisei Corporation. We listened to his precious stories on pioneering studies particularly on inflating agent, resin-impregnated concrete, and double mixing (Reporter: Shingo Miyazawa).

Photo 9: Interview with Professor Eiichi Tazawa (right)

(10) Professor Hirozo Mihashi

We received Emeritus Professor Hirozo Mihashi of Tohoku University, and listened to his diverse stories of studies in his field, such as concrete cracks and fracture mechanics, as well as the launching of the Journal of Advanced Concrete Technology (ACT) of JCI for which Prof. Mihashi made great efforts, and has acquired a strong position today. We also heard his ideas on globalization of concrete studies in Japan, and the circumstances up to the present.

In concrete, cracks are a typical, old and new issue. In many cases concrete is used combined with reinforcing bars, and thus structural tensile strength is not required for concrete. On the other hand, today, environmental aspects are attracting attention, increasingly highlighting the problem of durability. Crack control is still an urgent topic of study. Prof. Mihashi studied in a laboratory working on the structural mechanics of buildings, and since then has investigated cracks and tensile behaviors of concrete. He introduced the concept of fracture mechanics, which was developed for uniform materials such as metals, into concrete, which is not uniform, and has consistently studied all mechanical aspects ranging from fine cracks around aggregates to structural behaviors. After he moved to the laboratory of building materials, he always tackled the problem of cracks from his broad viewpoint while making free use of new ideas, developed fiber-reinforced cement materials, and introduced the concept of intelligent materials that have the ability of self-recovery.

The need for globalization has long been advocated, and Prof. Mihashi has endeavored to increase the range of JCI in conveying messages to the international community, such as by starting ACT and expanding it until it was highly acclaimed and had a high impact. He has also hosted international conferences and been involved in ISO/TC98 as a representative of Japan. He also talked about his experiences of studying in the Swiss Federal Institute of Technology in Lausanne and Delft University of Technology (Netherlands), and related precious stories on the importance of dispatching information and strategies from Japan to the international community (Reporter: Tomoya Nishiwaki).

Photo 10: Interview with Professor Hirozo Mihashi

(11) Professor Hajime Okamura

Professor Hajime Okamura has made world-leading contributions to studies of constitutive laws of reinforced concrete and self-compacting concrete, etc., and has played a leading role in the establishment of the limit state design method in Japan. We interviewed Prof. Okamura, who explained his studies from his graduation thesis to current ones as the chair executive of Kochi University of Technology, and his ideas on education, humanities, and management using a Power Point file which Okamura himself spent 20 hours or more to prepare.

His explanations of his study methods were highly meaningful, and included many lessons from Professor Masatane Kokubu and Professor P.M. Ferguson (Texas University), who were Okamura's professors and indispensable for forming his academic background. He found that almost all studies in the past had a determined range of application and had not been generalized, such as the formula for calculating crack width, the fatigue strength of deformed bars, and the relationship between local bond strength and local slip. His studies are characterized by strategically collecting a number of datasets in order to “convert quantity into quality”, i.e., summarizing study results in a single picture for generalization. He stressed that it is important to produce study results of high quality rather than producing quick results, and mentioned the posture of Ferguson who prepared large specimens, measured the strength and diameters of all reinforcing bars used, and even determined the position of the cover after fracture. He said that his two teachers had 80% in common, the 80% being the requirements of a great professor, and the remaining 20% being individuality. Prof. Okamura talked about his teachers with profound respect.

Prof. Okamura also talked about the establishment of Japan ACI, which was a predecessor organization to JCI, active participation and contributions to international conferences, and respect for Professor Kokubu, who made great efforts for Japan to host international conferences. He then told us about his experiences in international conferences. According to him, the presence of a researcher increases by the strategy of continuously attending the same conference. He has attended CEB since he was young together with Professor Yoshio Ozaka as a representative of Japan, and there he gained a grasp on the latest trends in design standards. In IABSE, he got hold of the latest trends in studies. In the interview, he focused not so much on practical things, but on how he achieved communication with scientists all over the world. We felt that this communication with first-class, renowned scientists is the basis of Prof. Okamura's greatness.

The interview made all seven of us, most of who are in the academic world, think more deeply about how a scholar should be, and how to systematically research, educate and contribute to society in today’s world in which everything is increasingly subdivided (Reporter: Akira Hosoda).

Photo 11: Professor Hajime Okamura