Annual Report

Department of

Architecrure and Building Engineering

Tokyo Metropolitan University

2018

STAFFS

Architectural Planning / City Planning

Kenji TAKEMIYA　Professor / Dr. Eng.
Architectural Planning, Facility Planning (Health care, Welfare and Education), Environmental Behavior
Rm.9-869，　+81-42-677-2795　takemiya-kenji@tmu.ac.jp

Tohru YOSHIKAWA　Prof. / Dr.Eng.
City Planning, Spatial Analysis, Geographical Information System
Rm.9-868, +81 426 77 2813 yoshikawa-tohru@tmu.ac.jp

Motoki TORIUMI, Associate Professor /Dr. in France (Urban Studies)
Urbanism in Paris (from the Renaissance to today)
Rm.8-867, +81 426 77 2812,

Masumi MATSUMOTO, Assistant Professor / BHE
Housing Studies, Gerontology, Life History
Rm.9-877, +81 42 677 1111 Ext.4788

Ryo SANUKI, Assistant Professor / Dr. Eng.
Urban Planning / Spatial Analysis, GIS, Public Facility Management
Rm.9-875, +81 426 77 1111 Ext.4786

Architectural Design and History

Masao KOIZUMI　Prof. / Dr. Eng
Design Practice, Architectural Design, Design Methodology
Rm. 27-872, +81 42 677 2817 koizumi@ecomp.metro-u.ac.jp

Katsuhiro KOBAYASHI　Prof. /Dr. Eng.
Theory of Architecture, Architectural Design, Modern and Contemporary Architecture
Rm.9-871 +81-426-77-2816 Ext. 4782

Yukimasa YAMADA Professor / Dr. Eng.
Japanese Architecture, Asian/Islamic Architecture, Cultural Heritage
Rm.9-870, +81 426 77 2815 yyamada@tmu.ac.jp

Jun INOKUMA Assistant Professor /M.Eng.
Architectural Design, Theory of Architectural Design
Rm.9-732,+81 42 677 1111 Ext.478

Akira KINOSHITA　Assistant Prof. / M. Eng.
Theory of Architectural Design, Architectural History, Architectural Design
Rm.9-827 +81-426-77-1111 Ext. 4763

Construction Management and Building Materials

Yoshinori KITSUTAKA Professor / Dr. Eng.
Building Materials, Environmental Materials, Durability Evaluation
Rm.9-775, +81 42 677 2797 kitsu@tmu.ac.jp

Makoto TSUNODA　Prof. / Dr. Eng.
Management and Organization of the Building Process, Building System Design, Durable Building System,
Rm.27-767, +81 42 677 2807

Yoichiro KUNIEDA　Assistant Professor / Dr. Ph.D.
Building Materials, Building demolition, Construction and demolition (C&D) waste recycling
Rm.9-730, +81 42 677 1111 Ext.4726　ykunieda@tmu.ac.jp

Structural Engineering

Kazuhiro KITAYAMA　Prof. / Dr. Eng.
Reinforced Concrete, Seismic Design, Earthquake Engineering, Seismic Retrofit
Rm.9-771, +81-42-677-2802 kitak@tmu.ac.jp

Jiro TAKAGI, Associate Professor / Ph.D.
Structural Design, Steel Structures, Structural System Development
Rm.9-774,+81 42 677 1111 Ext.4798,jtakagi@tmu.ac.jp

Toshikazu KABEYASAWA　Associate Professor / Dr. Eng.
Building Disaster Prevention, Earthquake Engineering, Reinforced Concrete
Rm.9-773, +81 426 77 2800 Ext.4741　tosikazu@tmu.ac.jp

Noriko TAKIYAMA　Associate Professor / Dr. Eng.
Timber Engineering, Dynamics of Structure, Regenerative Preservation of Built Environment
Rm. 9-772, +81 42 677 2801　norikot@tmu.ac.jp

Kazushige YAMAMURA, Assistant Professor / M.Eng.
Structural Engineering, Load and External Force
Rm.41-131, +81 42 677 1111 Ext.469

Environmental Engineering

Nobuyuki SUNAGA　Professor / Ph.D. (Dr. Eng.)
Architectural Environment, Bioclimatic Architecture, Thermal Comfort
Rm.9-768, Tel: +81 42 677 2805, E-mail: sunaga-nobuyuki@tmu.ac.jp

Akihiro NAGATA　Professor / Dr. Eng.
Building Environmental Engineering, Hygrothermal Environment, Building Simulation
Rm.9-769, +81 42 677 2804　ngt@tmu.ac.jp

Masayuki ICHINOSE　Associate Professor / Dr. Eng.
MEP (Mechanical, Electrical and Plumbing), Urban and Architectural Environment, MEP System Development and Commissioning
Rm. 9-770, +81 42 677 1111 Ext.4744　ichinose@tmu.ac.jp

Eiko KUMAKURA　Assistant Prof. / Dr. Eng.
Urban Greenery, Urban Environmental Design
Rm.9-734, +81 42 677 1111 Ext.4732　kumakura@tmu.ac.jp

OVERVIEW OF RESEARCH ACTIVITIES

Architectural Planning / City Planning

Kenji TAKEMIYA

(1) Study on Facility Planning of Medical Facilities

Kenji TAKEMIYA, Takahumi Tsushima, Haruka Asai, Kouki Shimada

1) Research on facility planning of medical centers for dementia

We grasp the nationwide improvement situation of medical centers for dementia, precipitated the major facility types based on the operation form, conducted a visit survey of the pioneering medical centers for dementia and organized the use characteristics of the examination and consultation rooms.

2) Current condition and change of the facility planning of neonatal intensive care units

We did a nationwide questionnaire about the facility improvement of neonatal intensive care units. We also compared the result with the survey at 2005, we clarified the improvement situation in the NICUs. We conducted a visit survey of the pioneering neonatal intensive care unit and organized the use characteristics and clarified an issue of the unit.

3) Utilization analysis of the dedicated space and stairs for staff

These days, the dedicated space for staff located between the wards are enhanced in some hospitals to improve the linkage between staff. We conducted case study in cancer center O. We conducted an observation survey in the dedicated space and stairs for staff, we clarified the use characteristics of them.

(2) Research on care prevention and livelihood support facility for the elderly

Kenji TAKEMIYA, Soe Sokjun, Shihomi Tawara

1) Research on the planning of day service facilities for the elderly with Independence

We did a questionnaire about the facility management and planning of day service (type A) in Tokyo metropolitan. We precipitated the major facility types based on the operation form, conducted a visit survey of the pioneering day service and organized the use characteristics of the activity and communication space.

2) Research on livelihood support facility for the elderly "Ten Million House" in Musashino city

Musashino city has provided places, small facilities, for healthy elderly people, which called "Ten Million House" since 1999. We grasped the usage history and conducted observation survey at the two facilities, clarified the use characteristics of them.

(3) Research on Healthcare Environment and Supporting Environment for Disabled Children

Kenji TAKEMIYA, Miyabi Hasegawa, Bae Minjung

1) We conducted a survey on facility usage related to facility management and planning of after school day service in Tokyo.

2) We carried out a visit survey to the facility practicing the treatment of super-severe children with high medical dependence and support for their families.

(4) Research on change of use characteristic of community center

We selected community centers in Musashino city as pioneering community centers. We conducted simple questionnaire survey and observation survey, which were the same survey at 2008, at the three centers. And we clarified the use characteristics at the present and the changes of them from 2008.

(5) Research on Utilization of Facilities after the Olympic and Paralympic Games

Kenji TAKEMIYA, Naoki Terada

We conducted field survey on the current situation of utilization of the 2012 London Olympic and Paralympic Games facilities.

These studies are to be published in Summaries of Technical Papers of Annual Meeting, AIJ.

Tohru YOSHIKWA

Theoretical Study on Compactness of Cities

Tohru YOSHIKAWA

In Japan, urban policies for compact cities are being conducted considering the decrease in population, the lower birth rates, the aging society and the serious global environmental issues. Considering this situation, the study explored what is the compactness of cities. In this fiscal year, this project developed a method to quantify foot accessibility in consideration of inclination using GIS, and applied it to the area around the Tokyo 2020 Olympic and Paralympic venues.

Development of the evaluation method for the existing building stock on the basis of location

Tohru YOSHIKAWA

It is the problem important to our country, which is leaving for the low birthrate and aging society, to utilize a large quantity of buildings accumulated after the war as effective social property. To this end, methods easy to use for evaluating the existing building stock easily would be effective. Therefore, this study aimed at the development of the method to evaluate existing stock buildings based on the location. In this year, the characteristics of consumer surplus and numbers of visitors as evaluation indexes of social benefit for facilities with distance decay of utilization ratio were analyzed in Tama New Town.

Motoki TORIUMI

Masumi MATSUMOTO

Studies on Sustainable Living of Elderly People in their Local Communities

Masumi MATSUMOTO

This series of studies aims to research on the living environment of elderly people who continue to live in the same community, and to research and develop supporting systems for such people.

1) Research using sensors to monitor elderly people's behaviors in their homes.
2) Research on community salons and support for senior citizen.
3) Research on various community activities for elderly people and their relationship with the professionals working in community comprehensive care centers.

Studies on Regeneration and Revitalization of New Towns

Masumi MATSUMOTO

Tama New Town is the largest new town developed over 40 years ago in Japan. This series

of studies aims to research and develop the methods for regeneration and revitalization of living environment of new towns, mainly exemplified by Tama New Town.
1) Research on housing conditions and lifestyles in Minami-osawa District of Tama New Town.
2) Research on neighboring commercial areas of Tama New Town.
3) Studies on governing body of an old condominium apartment.
4) Studies on community activities initiated by women residing in Tama New Town.

Studies on the Positioning of Interior Design in Housing Design Processes

Masumi MATSUMOTO

Conducted hearings to architects on the design making processes relating to housing designs.

Ryo SANUKI

I am conducting urban planning and urban analysis research using city space analysis method and GIS.

Architectural Design and History

Masao KOIZUMI

(1) Research on Accessibility of Urban and Architectural Space

Masao KOIZUMI

The First Stage of the Research is to analyze the Relationship between Housing and the City. This Research will be generalized into an Analysis of Relation between Architecture and Urban City.

These Researches will cover Areas such as; Type of Connection and Distance between Housing and the City, an Arrangement of Territories, Strength of the Boundary between Different Territories, etc. These Basic analyses will be developed into Research and Practice of a Design Method concerning Accessibility in an Urban Scale.

(2) Research on Housing Transformation Reflecting the Change of Family

Masao KOIZUMI

Today a Family Style has transformed because of an Increase of Divorce and the rapid Progress of the Aging Society. But still most of the Houses are planned for so called “Nuclear Family”.

The Goal of this Research is to develop a Planning Method for Housings and propose a new Typology, through the Analysis of Contemporary Japanese Family and their Life Style. Collective Housing will be a main Target for this Theme.

(3) Research on revitalization of residential suburb

Masao KOIZUMI

Research on lifestyle for next generation in Yokohama area under the keyword such as energy and environment, health and wellness, community.

Katsuhiro KOBAYASHI and Akira KINOSHITA

Analyses on Composition of Modern and Contemporary Architecture

Katsuhiro KOBAYASHI, Akira KINOSHITA

One of the main purposes of architectural design research is to clarify morphological principles that give birth to architectural beauty. For this purpose, it is important and effective to abstract compositional principles and compositional methods from existing architectural works and to examine the design principles. In the academic year of 2018, designs of imaginary architectural drawings, Brutalism architecture movement, were analyzed.

Development of Architectural Design Method

Katsuhiro KOBAYASHI, Akira KINOSHITA

In architectural design research, it is also important to apply design principles and compositional methods abstracted by analyses to actual architectural design works. Thereby theory and practice, in other words, basic research and high-level application would be synthesized. In the academic year of 2018, relations between theory and design practice were pursued through three design works of our master program students.

Research on Design of Architectural Conversion

Katsuhiro KOBAYASHI, Akira KINOSHITA

It is becoming one of the crucial social subjects in the architectural field of Japan to find out various methods to revitalize the existing building stocks. Among these methods, architectural conversion is very useful and important. For more than 10 years, we have made research survey on architectural conversion abroad. In the academic year of 2018, we published research results of our research trip to the cities of Baltic Nations (Tallinn, Riga, Vilnius, Berlin) in 2017, in *Summaries of Technical Papers of Annual Meeting*, A.I.J. We also made a trip to investigate converted buildings in Bangkok, Ayutthaya, Chiang-Mai (Thailand), and Hongkong, Macau for 10 days in December.

Study on Landscape Architecture and City in Early Modern Period

Akira KINOSHITA

In the academic year of 2018, the geometrical composition of Sir John Vanbrugh's architectural works was examined. Vanbrugh's works, especially Blenheim Palace built between 1705-16 has reputation among critics and historians to have dynamic impression. In order to analyze such aspect of the building "motion parallax", a concept of visual effect in the field of cognitive science was referred. As the result of analysis, it was clarified that certain composition creates optical illusion of movement. And the possibility of Vanbrugh's intentional manipulation of dynamic composition was inferred. As the concept of motion parallax is based on the premise of moving viewpoint, it can be closely related to the birth of landscape garden where an observer is required to strolls around the park to appreciate the scenery.

Yukimasa YAMADA

Jun INOKUMA

Construction Management and Building Materials

Yoshinori KITSUTAKA

Fundamental Study on Self-Healing Performance of Heavyweight Concrete Using the Expansive Additive and SCMs

Yoshinori KITSUTAKA

Amid the strong demand for safe containment of radioactive substances, we investigated the heavyweight concrete, which is used for shielding containers and building walls, focusing on its self-healing performance with the aim of preventing leaching of contaminants through cracks. The results revealed that the crack closure due to the products of self-healing is not found at early stages. The addition of an expansive additive and SCMs as fly ash was found to improve self-healing at relatively early stages when compared with the case of no such addition. The addition of above also showed more stable performance in self-healing.

Pull-Out Behavior of Mechanical Anchor Bolts

Yoshinori KITSUTAKA and Yoichiro KUNIEDA

Joints of mechanical anchor bolts are subjected to cyclic dynamic loading under an earthquake, which leads to drop accidents of ceiling members and equipment. To ensure the seismic safety of a structure, it is crucial to grasp the behavior of its joints with anchor bolts during an earthquake. This study reports on pull-out tests by monotonic and cyclic dynamic loading conducted on five types of mechanical anchor bolts to clear the fracture properties and pull-out resistance of joints between concrete and anchor bolts.

Damage Resistance of Gymnasium Flooring Materials Under Dynamic Loading Caused by Wheelchair Sports

Yoshinori KITSUTAKA and Yoichiro KUNIEDA

Wheelchair sports have been attracting attention in recent years in the lead-up to the 2020 Paralympics. However, in addition to reasons such as facilities not being fully accessible to the disabled and the risk of injuring others including the disabled, the use of wheelchairs tends to be denied at many gyms for fear of damaging the gym floor. This study is intended to evaluate the suitability of floor materials for wheelchair sports by conducting drop impact tests simulating wheelchair falls focusing on the bumpers used wheelchair rugby, which are said to be most prone to causing floor damage. The results revealed that damages to floor can be reduced by improving the shape of bumper ends, the damage resistance of single-ply and multi-ply oak with aqueous coating is high, all of the composite floor materials tested caused reductions in the dent depths of both wood floor materials and vinyl floor sheeting, composite floor material C led to nearly no dent in the wood floor material.

Makoto TSUNODA

Studies on Activation Technique of Public Building Stock

Makoto TSUNODA

In Japan, demolition and new construction based on declining in the durability and increased availability of buildings continues to be practiced. This practice is unfavorable from the viewpoint of utilization of the existing building stock. Activation technique is necessary for

leading preservation and improvement of the public property.
In this year, we were clarified repair design content and its examination and decision system of public hall architecture built after the war. From the roles of participate persons who decide the design content of the repair and the conditions that influenced the content determination, the considerations for optimum repair design method were presented. Furthermore, we clarified the decision-making process of repair design in time series and clarified the relationship between the contents of repair design. Based on these findings, we presented the items to be considered when deciding the design content of the renovation in public hall architectural renovations.

Research on the method of renovating detached houses to improve comprehensive performance

Makoto TSUNODA

Housing renovation technology plays an effective role in improving various performances required by residents. However, there are many restrictive refurbishment actions that only improve unit performance, not leading to an increase in the value of existing homes. In order to build used residential market, it is necessary to develop comprehensive renovation technology that can cope with improvement of required performance of various living conditions. This research aims to construct a comprehensive renovation system to support residents from the elucidation of the mutual relationship between the technologies of used housing renovation process.

In this year, focusing on the renovation for the improvement of heat insulation, we explored the possibility of comprehensive repair design about the method of partially improving the heat insulation performance and the method of comprehensively improving other performances. The production processes of thermal insulation repair works were roughly divided into three stages: repair examination stage, diagnosis stage, design and construction stage. Then, in the repair examination stage, the variations of the thermal insulation repair method were grasped from the conditions such as the repair location, repair level, thermal insulation effect, approximate cost, and construction period. At the diagnosis stage, the variations were expanded by taking into account differences in diagnosis contents and judgment methods by the diagnostician. Furthermore, at the design and construction stage, we grasped the feasibility of the thermal insulation repair design's variation such as the concept of thermal insulation division and the possibility of packaging of the builder's organization, elucidation of the production system contributing to the spread promotion of partial thermal insulation repair in detached houses.

Research on How to Configure the Renovation Construction Methods Corresponding to the Building Stock

Makoto TSUNODA

Although we were supported by using the formulas of the various construction system for performance was required in new construction, there is a completely different conditions in terms of new construction and renovation that are present in a pre-existing condition. And that the work of the components to the contents of the construction methods in new construction is not seen to reflect. Therefore, there is some relationship between the role of members in the construction methods and improved performance as a result of each repair. In the renovation, it is considered that the contents of the construction system are particularly reflected in the constituent members to direct.

In this year, we clarified the actual conditions of repair design for vacant stores in the

shopping district. In particular, we found out the building system design according to application functions.

Studies on methodology of the building improvement to be compatible with value of property and utility.

Makoto TSUNODA

It is not unusual for an available building to be removed for some reason. As a removal reason, completion original performance cannot maintain and use of building changes. There are various things in reproduction technique to resolve these situations. So far to improve the property values when we extend the life of an existing building, maintenance and improvement of various performances and addition of the new performance that does not hold it are required. Similarly, to improve the utility value, physical changes of the building it and the function changes such as the usage of building are required. These two value improvement does not become independent each, and renovation program of the building should be drafted after having considered the trade-off of both. Various renovation techniques are seen in today, but the technique that included plural value improvement to advance building renovation of building are the urgent need.

In this year, we clarified the conditions of the regulations in the reform of the exclusive part of the multi-family dwellings with old age and presented the operation system of the dwelling unit reform useful for the future utilization of the multi-family dwellings. First, from the transition of the apartment standard management code prepared by the Ministry of Land, Infrastructure, Transport and Tourism, we have clarified the change in the regulations on housing reform from the time of establishment to the present. Next, it was clarified that the application method and the application period were different according to the contents of the regulations as the actual condition of the dwelling unit reform in the condominium complex for sale. On the other hand, it was shown that complicated procedures were needed for implementation approval in the replacement of plumbing equipment with layout change and piping operation. Furthermore, from the analysis focusing on the difference in the scale of construction based on the detailed reform work history, it was shown that there were many barrier-free and renewal of interior and facilities in dwelling unit reform by residents. It was found that constructions were done in multiple times because it was while living. On the other hand, in dwelling unit reform by the contractor, an overall renovation is carried out the modernization of the living life, and it is desirable to have a flexible operation in which the restriction contents of the present regulations are diversified.

Yoichiro KUNIEDA

Simulation analysis of Debris Generation in Earthquake Disaster

Yoichiro KUNIEDA and Yoshinori KITSUTAKA

Due to the frequency of earthquake disaster in Japan (e.g. Great East Japan Earthquake in 2011), the recovery of debris has a strong demand. In this research, a simulation model which recreates debris generation in dynamic was developed from the demolition impact evaluation model in last year study. The property of debris in the simulation results should decide the recyclability of debris. The finite element method (FEM) was adopted in the model to structurally analyze the impact of earthquakes. Distribution of debris was simulated from the input force estimated from seismic waves for each element. From the previous model, the recovery simulation model was also developed in which an optimal recovery plan can be

recreated by auto-running of debris recovery vehicles with algorithms. Optimal separation in terms of waste treatment cost can be calculated from the threshold of waste purity for recycling use.

GIS application to system analysis of future concrete supply

Yoichiro KUNIEDA and Yoshinori KITSUTAKA

The influence of future population changes on supply chain of ready-mixed concrete mainly used in Japanese concrete construction was studied with the Geographic Information System (GIS) approach. Hokkaido prefecture in which concrete supply between other provinces should be negligible was chosen for case study to estimate the concrete demand from the government report of the population forecast by 2050. The correlation between declining of population and concrete plants were investigated from the business risk of plants evaluated from their concrete supply. The result showed the number of bankrupts for plants would reach a peak due to the temporally demand recovery from the corruption of business rivals. The reduction of the future demand from local area might induce the concentration of plants in urban. The current approach forecasting the supply chain of ready-mixed concrete (e.g. plants number, supply volume) from the business threshold is expected to be adopted as the efficient decision-support tool for stakeholders (e.g. governors, concrete cartel).

Structural Engineering

Kazuhiro KITAYAMA

1. Axial Collapse Mechanism for Reinforced Concrete Corner Column-Beam Joint Failing in Joint Hinging

KITAYAMA Kazuhiro and Jin Kiwoong (Meiji University)

Collapse of buildings is induced by a loss of ability for sustaining vertical loads due to dead and live loads. These vertical loads are carried mainly by columns, which are divided into two portions, i.e., a region along clear height and its upper and lower beam-column joint regions. Collapse of reinforced concrete (R/C) buildings subjected to past earthquakes has occurred in Japan by a sway mechanism in a particular story caused by column shear failure or flexural failure at a top and bottom of columns. There are, however abroad, many buildings suffering from collapse due to a loss of axial load capacity at beam-column joints (Moehle 2003, Park and Mosalam 2013). Those buildings had unconfined beam-column joints without hoops or small column sections, being different from usual buildings in Japan.

However, almost the whole collapse occurred in Japan for a R/C five-story city office building during Kumamoto Earthquake in 2016 due to axial failure at beam-column joints located in a perimeter frame (Mukai 2016), which was designed according to old seismic provisions in Japan. Beam-column joints in the building seemed to fail in joint-hinging prior to axial failure.

A concept of the joint-hinging failure at a R/C beam-column joint was proposed by Shiohara in 2008. While laboratory tests were begun to investigate the mechanism in detail, a process leading to axial failure from joint-hinging failure in a beam-column joint is not studied except for a few studies such as horizontal load reversal tests to plane exterior beam-column subassemblage specimens under varying axial load (Murakami and Maeda et al. 2017). Actual buildings are subjected to three-directional excitations during an earthquake. The sole

experimental study conducted to simulate such actual conditions is the test using a three-dimensional (3D) corner column-beam subassemblage specimen with code-satisfied joint hoops subjected to horizontal bi-directional loads and constant axial load (Katae and Kitayama 2015). In the test, buckling of column longitudinal bars in a beam-column joint region was indicative of joint axial failure. Hassan and Moehle in 2012 and 2013 investigated the limit drift of a R/C frame reaching joint axial failure.

This study, therefore, aims to reveal a series of mechanisms leading to joint axial failure from joint-hinging failure in R/C frames under three-directional earthquake excitations, and estimate the limit drift capacity at joint axial failure for the building. At first, through a literature survey, the manner of joint axial failure was classified into three modes for exterior beam-column joints resulting in joint-hinging failure. At second, three 3D corner column-beam subassemblage specimens were designed to conduct the static test under horizontal bi-directional loads and varying axial load, accompanied by one plane subassemblage specimen for comparison. A compressive axial load ratio in varying column axial loading and an amount of joint lateral hoops were chosen as test parameters. A column-to-beam ultimate flexural capacity ratio was designed to be approximately 1.6 in the tensile loading of the column, and approximately 2.4 or 3.0 in the compressive loading of the column with a compressive axial stress ratio of 0.08 or 0.16 respectively in order to cause joint-hinging failure under the tensile loading of the column. Static loading tests will be carried out in the next academic year.

2. Analytical Study on Joint Hinging Failure for Precast Prestressed Concrete Beam-Column Frame Assembled by Post-Tensioning Unbonded Tendons

KITAYAMA Kazuhiro

Beam-column joints in reinforced concrete (R/C) frames frequently fail in a joint-hinging mechanism under earthquake excitations. Meanwhile, joint-hinging failure of beam-column joints in unbonded PCaPC frames, where post-tensioning tendons without grout mortar pass through beams and beam-column joints, is little investigated in both experimental and analytical study fields. Recent experimental studies conducted at Kitayama Laboratory in TMU showed a possibility of joint-hinging failure for interior beam-column joints (Suzuki and Song et al. 2016), and the occurrence of that for exterior joints (Zou and Kitayama 2017) in unbonded PCaPC frames.

Then, the theory on a joint-hinging mechanism for R/C frames proposed by Kusuhara and Shiohara in 2010 was extended to a beam-column joint in unbonded PCaPC frames. Based on this theory extension, theoretical equations to take an ultimate joint-hinging moment were introduced for interior beam-column joints in unbonded PCaPC frames. Adequacy of the theoretical equations was verified by comparing with test results. In addition, parametric analyses using the theoretical equations were conducted to investigate the influence of several parameters such as the amount of post-tensioning tendons or column longitudinal bars and column axial load on the possibility of joint-hinging failure of unbonded PCaPC joints. Some findings obtained by the study are shown below.

1) Theoretical equations to take an ultimate joint-hinging moment were introduced for unbonded PCaPC interior beam-column joints based on a kinematic model, where an interior beam-column joint panel was divided into four segments along imaginary diagonal sections. The force equilibrium and the inelastic conditions of materials, i.e., concrete compressive failure, tensile yielding in steel bars and an elastic limit stress for post-tensioning tendons were taken into account in the computation.

2) Adequacy of the theoretical equations to estimate an ultimate joint-hinging moment was verified by comparing with recent test results for plane interior beam-column subassemblages

and that with R/C slabs. Results obtained by the computation agreed qualitatively with those by tests. However, an accuracy of the proposed equations can not be verified since beam bending failure due to concrete compression at a beam end proceeded in tests prior to joint-hinging failure. A lateral-load-carrying capacity in a cruciform specimen with slabs was 9 percent greater than that computed by the equations. It seemed that this computational result was consistent with the test result that joint-hinging failure occurred for the specimen after beam bending failure. More verification is needed by new tests in the future.

3) An ultimate joint-hinging moment was calculated by the proposed equations with a variety of the amount of post-tensioning tendons or column longitudinal bars and column axial load, based on properties of test specimens such as beam and column cross-sections, the amount of joint hoops and so on. The amount of post-tensioning tendons provided the greatest influence to the occurrence of joint-hinging failure, comparing with the influence of the amount of column longitudinal bars and column axial load. Unbonded PCaPC beam-column joints failed in joint-hinging in the computation at a column-to-beam ultimate flexural capacity ratio less than values ranging from 1.3 to 1.7 with an increase in the amount of post-tensioning tendons.

3. Evaluation of Tensile Stress of Post-Tensioning Unbonded Tendon for Beam in PCaPC Frame Reaching Ultimate Flexural Capacity

KITAYAMA Kazuhiro and Jin Kiwoong (Meiji University)

Precast prestressed concrete beam-column frames assembled by post-tensioning unbonded tendons (called unbonded PCaPC frames) behave somewhat differently from usual reinforced concrete frames subjected to horizontal loads because strain distribution along the post-tensioning tendon arranged in beams is uniform due to no bond along it. Then, it is hard for the tendon to yield, and peak bending moment of the beam is usually reached by concrete compressive failure at beam ends. For evaluating the peak bending moment of unbonded PCaPC beams, it is necessary to identify a tensile stress of unbonded tendons. It is usual in Japan to use Takemoto's formula proposed in 1984 for this purpose in practical design fields.

Takemoto's formula was, however, based on experimental test results using not unbonded PCaPC beams, but cast-in-place prestressed reinforced concrete beams subjected to anti-symmetric bending moments at both ends. Post-tensioning unbonded tendons for these beams were placed in a curved shape over the member to resist long-term loads such as dead and live loads, and were located only at the top of the critical section at a column face. These properties are quite different from those for unbonded PCaPC beams. From this point of view, it is doubtful whether Takemoto's formula can apply to unbonded PCaPC beams which have straight tendons and constitute moment-resisting frames against earthquake loads.

Therefore, an accuracy of Takemoto's formula to evaluate a tensile stress of unbonded tendons at the peak bending moment was investigated on the basis of recent tests conducted by Kitayama Laboratory at TMU using cruciform unbonded PCaPC beam-column subassemblage specimens, failing in concrete compression at beam ends without yielding of unbonded tendons. Moreover, a new formula to predict a tensile stress of unbonded tendons at the peak bending moment was proposed. A tensile stress increment of the tendon from an initially introduced prestress to the beam was re-evaluated in the study. Beams in five specimens investigated for the study had straight unbonded tendons placed symmetrically at the top and bottom with the same cross-sectional area. A tensile stress of the tendon at the peak bending moment was obtained from an output of strain gauges attached at a surface of the tendon. Concrete compressive strength ranged from 49 to 79 N/mm2 for specimens.

Tensile stress increments of unbonded tendons obtained by the tests were 1.7 times to 7.8 times larger than those evaluated by Takemoto's formula. This indicates that Takemoto's

formula underestimated remarkably an actual stress of the tendons, which makes conservative estimation when computing beam ultimate bending capacity. In contrast, when conducting beam shear design, usage of Takemoto's formula is inappropriate because beam shear force obtained from Takemoto's formula is far less than actual.

Therefore, a new formula to predict a tensile stress increment of unbonded tendons at the peak bending moment was empirically proposed through test results of five specimens with a variation in an initially introduced beam prestress divided by a product of the beam width and effective depth. The larger the value of this prestress level was, the more prematurely concrete compressive failure occurred at a beam end, and the smaller the tensile stress increment became. Peak bending moments computed by using tensile stress increments proposed by the author agreed well with test results of five specimens aforementioned and three specimens tested by other organizations, showing an accuracy of 15 % variation.

4. Hinge Relocation of Beams and Prevention of Joint Hinging Failure in Reinforced Concrete Frame using Partially High-Strengthened Steel Bars

KITAYAMA Kazuhiro, KISHIDA Shinji (Shibaura Institute of Technology) and MURATA Yoshiyuki (NETSUREN Co. Ltd.)

Partially high-strengthened steel (called PHS) bars are made by heat treatment to its limited length. The potential plastic hinge regions of beams in a reinforced concrete (R/C) frame can be located away from the column face (called relocated hinge design) by using PHS bars as beam longitudinal reinforcement which passes through a beam-column joint. Kisida and Fukuyama showed in 2016 that this construction technique was able to mitigate damage to a beam-column joint and prevent it from failing in joint hinging.

In the study in 2017, this construction technique was applied to precast fabrication consisting of R/C beams and columns. For cast-in-place frames using PHS bars, moreover, an effect of slabs on development of the beam hinge relocation and an influence of varying axial load in a column on whole behavior of the frame were also studied by cyclic reversed loading tests. The relocation of potential plastic hinge in beams was designed to be at 400 mm, which was equal to a beam depth, away from the column face. Nevertheless, the relocation of a plastic hinge in beams was not well formed for almost all specimens regardless of precast or cast-in-place concrete and existence or no-existence of slabs, and heavy damage concentrated on a beam-column joint. Only for an exterior beam-column subassemblage specimen with varying column axial load, when lateral load was applied to the direction toward an increasing compressive axial load, a column-to-beam ultimate capacity ratio became large, and joint hinging failure was prevented, forming well the hinge relocation in the beam.

The study in 2017 showed that the original plan to form the beam hinge relocation by using PHS bars as longitudinal reinforcement might not be performed, resulting in damage concentration to a beam-column joint. Therefore, in the 2018 academic year, nine plane beam-column subassemblage specimens were designed and tested on the basis of the assumption that the joint lateral expansion should be prevented in order to keep beam-column joints sound without heavy damage. Among nine specimens, two specimens were made by a precast method (one：interior joint, and one：exterior joint), and seven specimens were a cast-in-place method (three：interior joint, and four：exterior joint). The amount of column longitudinal or intermediate bars and expected location to form the beam plastic hinge, i.e., at 400 mm or 200 mm away from the column face along the beam axis, were chosen as test parameters. Six lateral hoops with a diameter of 6 mm, corresponding to a joint reinforcement ratio of 0.35%, were arranged in a beam-column joint panel. Concrete compressive strength ranged from 31 MPa to 40 MPa.

Test results in 2018, however, was almost identical with those in 2017. It was conceived at first that reducing tensile strain along beam longitudinal bars within a joint was necessary to confine lateral expansion of the joint and prevent joint-hinging failure. To perform this concept, two specimens were expected to form the beam plastic hinges at 200 mm away from the column face by placing the boundary between high and normal strength along a PHS bar at the same location. The lateral-load-carrying capacity, however, was determined for these specimens by joint-hinging failure without development of beam bending capacity at the expected potential hinge region. More research to such an unexpected phenomenon is needed in the future.

5. Earthquake Resistant Performance of Reinforced Concrete Building Damaged by the 2011 East Japan Earthquake under Retrofit Construction

KITAYAMA Kazuhiro

A reinforced concrete (R/C) three-story school building located at Nasu town in Tochigi prefecture, which was under construction for seismic rehabilitation using steel-braced frames, suffered moderate damage under the 2011 East Japan Earthquake. A plan of the building is 108 meter long for the longitudinal direction, and the first term construction for seismic retrofit was completed but the second term construction was not conducted yet when the 2011 Earthquake attacked the building. Damage concentrated on a non-retrofitted area of the building during the earthquake; three R/C columns failed in shear and severe shear cracks classified as Grade 3 were observed for four columns.

Residual seismic capacity after the earthquake was estimated to be 0.77 times the original seismic capacity before the earthquake for the first story in the longitudinal direction. Thus the damage of the building was classified into the moderate level. In contrast, residual seismic capacity limited to a non-retrofitted area of the building was re-estimated to be 0.59 times the original seismic capacity, judging to be the heavy damage level.

Non-linear earthquake response analyses were carried out for spatial moment-resisting frames of the school building subjected to tri-directional earthquake motions to investigate the reason why damages concentrated on a non-retrofitted area of the building. Shear walls with opening in a transverse direction were modeled as not a monolithic wall, but an assembly consisting of a column with a long wing-wall and an isolated column, placing multi-springs at a top and bottom of respective columns. Tri-directional earthquake motions with a peak acceleration of 475 gal in the east-west direction, corresponding to the longitudinal direction of the building, 925 gal in the north-south direction and 229 gal in the vertical direction were input to the building. These earthquake motions were obtained at a Nasu City hall adjacent to the school. At first, the analyses assumed rigid floors.

A Maximum story drift angle of 0.26 % for the third story obtained by the earthquake response analysis was the smallest compared with that of 0.28 % for the first story and 0.34 % for the second story, corresponding to actual slight damages to the third story. Response drift angles for respective floors under uni-directional loading were a little greater than those under tri-directional loading. Response drift angles in the transverse direction were almost equal to or a little greater than those in the longitudinal direction for respective floors. Shear failure of first story columns and damage to boundary columns adjacent to a steel-braced frame were almost traced by the analysis. Shear failure of a column in a retrofitted area, however, occurred in the analysis, which was different from actual minor damage.

Then, in-plane shear distortion of floor slabs was permitted for the second analysis by taking into account shear stiffness of slabs, out-of-plane stiffness of transverse beams and axial stiffness of longitudinal beams. For this shear-deformable floor model, the in-plane shear stiffness of a slab equivalent to one-third the initial in-plane shear stiffness was provided to

consider stiffness degradation due to cracks in the floor slabs. Even for the analysis, column shear failure occurred in a retrofitted area, but this was delayed comparing with that in a non-retrofitted area. A response story drift of columns at the first story in a retrofitted area became smaller than that in a non-retrofitted area, qualitatively reproducing actual damage more precisely than the rigid floor model.

6. Evaluation of R/C Beam Deformation at Peak Lateral Load Capacity and Safety Limit State

KITAYAMA Kazuhiro

Deformation capacity of reinforced concrete (R/C) beams in beam-column moment-resisting frames can be estimated precisely up to yielding of longitudinal reinforcement according to Guidelines for Performance Evaluation of Earthquake Resistant R/C Buildings published by Architectural Institute of Japan in 2004. The proposed method to estimate deformation capacity corresponding to a restorable limit and a safety limit for R/C beams, however, is not verified through laboratory tests. Therefore, three cruciform beam-column subassemblage specimens were tested in 2010 to verify the adequacy of the AIJ method to estimate deformation capacity of R/C beams after beam yielding. Suzuki and Kitayama (2013) proposed a new method to evaluate beam deformation at shell-concrete crushing after flexural yielding, which is one of factors governing a restorable limit state, based on the tests in 2010. Since only a few specimens were tested, it is difficult to say that sufficient research was completed.

Then, the method to predict beam deformation at the peak lateral-load-carrying capacity and reaching safety limit state was re-examined by reversed cyclic loading tests of two cruciform beam-column subassemblage specimens. Bond condition along beam bars within a beam-column joint was chosen as a test parameter by changing beam bar yielding strength from Grade SD345 (normal-strength) to USD590B (high-strength). Concrete compressive strength was 54 MPa.

Beam longitudinal bars yielded at a beam deflection angle of 0.44% or 0.99% for the specimen with normal-strength or high-strength steel bars respectively. For both specimens, the peak lateral-load-carrying capacity was attained by concrete compression failure at beam ends. Although the specimen with high-strength beam bars was given a column-to-beam ultimate capacity ratio of 3.0, which is quite larger than that adopted in practical seismic design of R/C low- to medium-rise buildings, main diagonal cracks in a beam-column joint region widened with an increase in a lateral drift, and the damage to the joint became remarkable. Then, the lateral-load-carrying capacity dropped immediately after the peak without sustaining the beam capacity. A joint shear capacity margin ratio of 1.3 appeared to provide ill effects on shear behavior of the beam-column joint. In contrast, the lateral-load-carrying capacity exceeding the computed ultimate bending capacity of the beams was kept till a story drift angle of 5% for the specimen with normal-strength beam bars.

Beam cover concrete crushed at the ends at a beam deflection angle of 1.3% to 2.3% or 1.4% to 1.8% for the specimen with normal-strength or high-strength longitudinal bars respectively, being almost equivalent to each other. In contrast, a ductility factor when crushing of beam cover concrete occurred was 3.2 to 4.9 for the specimen with normal-strength longitudinal bars, and 1.4 to 1.8 for high-strength longitudinal bars respectively; the former was 2.5 times greater than the latter. Relationship between bond situation along beam bars within a beam-column joint and a beam bar slip, and strain distribution along beam bars when cover concrete crushed at beam ends will be researched in more detail.

7. Earthquake Response Analysis Using Superstructure-Pile-Soil System for Reinforced Concrete Building Retrofitted by Steel-Braced Frames

KITAYAMA Kazuhiro

Many reinforced concrete (R/C) buildings suffered damage under the 2011 East Japan Earthquake though seismic retrofit to those buildings had been already conducted. Among them, there were several R/C buildings which suffered not only minor or moderate damage to the superstructure, but also severe damage to the pile foundation. Therefore, earthquake response analyses were carried out using a superstructure-pile-soil system to a building mentioned below with or without seismic retrofit. A R/C three-story school building located at Ichikai Town in Tochigi prefecture was analyzed, which suffered moderate damage to the superstructure and severe damage to the pile foundation during the 2011 East Japan Earthquake regardless of seismic retrofit by means of steel-braced frames, and eventually was demolished.

For the analysis, the superstructure of the building was represented by a three-dimensional frame model. Several piles under each of footings were lumped into one pile. An earthquake motion was input during major 10 seconds to the building in the longitudinal direction. Earthquake motions at each of soil layers were deduced from the equivalent linear analysis such that an acceleration measured at 112 meters below the ground surface at KiK-net Haga Observatory located 2 km away from the school building was input to the engineering bed-rock, in order to take the magnification to earthquake motions due to soil layers into account. Non-linear earthquake response analysis software SNAP was utilized in the study. Following findings were obtained from the earthquake response analyses.

A response lateral drift obtained by the analysis to the retrofitted building was the largest at the third story among stories of the superstructure, being consistent with actual damage. Bending moment at a top of piles was enhanced by the seismic retrofit to the superstructure, and almost all pile tops failed in flexure for the analysis. Varying axial load of piles under steel-braced frames was quite large. This caused up-lift of steel-braced frames. The analysis was able to trace well actual damage to the building. It was confirmed that enhancement of lateral-load-carrying capacity of the superstructure due to such seismic retrofit caused severe damage to the pile foundation under earthquake excitation.

8. Relationship among Seismic Retrofit, Preservation and Renovation for Reinforced Concrete Modern Architecture in Japan

KITAYAMA Kazuhiro

A first reinforced concrete (R/C) building in Japan was built in 1911, which was designed by Endo Oto. From this, approximately one century has passed. Then, numerous R/C old buildings which seem to be worth being preserved as cultural assets choose the way continuing to be in service. At the time, R/C old buildings which do not satisfy the present building law of Japan should be upgraded in seismic performance by some retrofit methods. Therefore, a methodology for conducting the harmonious combinations among seismic retrofit, architectural design and serviceability without injuring a cultural value of the building was researched through surveying actual renovated R/C buildings (Furuya 2017).

In a study in the 2018 academic year, focusing on the wall-used retrofit, twenty-two buildings were selected from forty-one buildings made by reinforced concrete (R/C) or R/C with steel plates (called SRC in Japan) which were collected by Furuya. These buildings were renovated to be preserved as cultural assets and enhance its seismic performance by retrofit. Buildings retrofitted by the base isolation system or the vibration control system were omitted in the study.

Installation of R/C shear walls was able to mitigate an ill influence on cultural assets if a location and a shape of installed walls were carefully considered. However, this technique is not

reversible to an original design of the building because installed shear walls were unified to the building using post-installed anchors drilled into the original concrete. If a retrofit technique that an existent opening of a shear wall is embedded by reinforced concrete is used, the embedded wall can be obviously distinguished from an original body of the building by contriving surface finish to the embedded wall. Then, cultural assets can be preserved to some extent by using the technique for a retrofit of buildings.

Jiro TAKAGI

Toshikazu KABEYASAWA

A study on the relaxation length of slab reinforcement in the static loading test on the sub assemblage reinforced concrete frames

Based on the assembled reinforced concrete frame specimen with slabs in last year, the static loading test is carried out on a similar assembled reinforced concrete frame specimen in which the stiffness of the orthogonal beam increases. It examines the difference of the deformation that the slab width effective to the strength of the beam section become full span between those tests. It also pointed out that the stiffness of the orthogonal beam affected this deformation in the end section. It was clarified that the yield drift can be evaluated with the conventional formula for the degrading stiffness factor when the full width slab contributed on the strength of the beams.

Post-earthquake damage observation after 2016 Kumamoto Earthquake

A school building designed by old seismic standard shows the beam side sway mechanism in the 2016 Kumamoto earthquake. The static loading analysis and earthquake response analysis is carried out in order to evaluate the mechanism. The shear failure of short columns occurs in the conventional analytical model, but it proposed a new assumption that make the strength of beams become weaker than that of connecting columns, and this model can explain the observed damage analytically. (Insufficient fixing of the transverse reinforcement of wall to the column, amplification of the effective slab width)

An experimental study on the damming effect caused by the waterborne debris

The hydrodynamic load on the scaled reinforced concrete four-story moment resisting frame with waterborne debris is evaluated from the hydrodynamic tests. It verified that the integral value of wave pressure on members is identical with the wave load recorded with the water-proof load cells. It was pointed out that the drag force in calculation underestimates the wave load on the moment resisting frame in the test. The wave load on the specimen with waterborne debris is different from the simple drag force in calculation due to the difference of water height and flow velocity between the front of the specimen and waterborne debris.

Hearing survey on existing tsunami evacuation facilities

It conducted a hearing survey on the existing tsunami evacuation facilities, and examined the problems in the construction of the current tsunami evacuation facilities. It conducted interviews with two local governments, they construct tsunami evacuation facilities in areas with low inundation depth away from the coast. A new construction towers are often used as evacuation facilities near the coast. The formulation of a practical tsunami load for medium design inundation depth is required.

Restoring Force Estimation of Fitting-Type Joint of Japanese Traditional Wooden Structure

Noriko TAKIYAMA

According to regional characteristics and cultural differences, there are various specifications in SASHIGAMOI joint in Japan. In the limit strength calculation which is one of calculation methods used in the seismic performance evaluation of traditional wooden residents, the shear forces of all earthquake resistant elements are simply added and the restoring force is given for each seismic element without considering the different detail of SASHIGAMOI joint. In past study, to figure out the fracture mode and the restoring force characteristic, we per-formed cyclic loading test on 4 specimens with same external dimension method but different joint shape. Moreover, we also aimed to construct the evaluation formula to estimate the restoring force and compare with results of experiment. In this study, to simulate the experiment, we modeled the specimens, and compared the results of simulation with the experiment to investigate the accuracy of the simulation.

Verification Experiment on Reinforcement Method by Aramid Fiber Sheet for Column Base of Existing Wooden House

Noriko TAKIYAMA

High-performance aramid fiber sheets are a new class of composite materials made up of weaved polyamide fibers. In this study, the seismic performance and failure behavior of timber column–ground sill joints reinforced with aramid fiber sheets were investigated. In a past study, we conducted many bending tests under cyclic loading for three column–ground sill specimens. After reinforcing the specimens with aramid fiber sheets, the joint strength improved but was dependent on the method of attaching the sheet. It was found that the seismic property is unstable because of many failure mode. So, we proposed an improvement in the method of attaching the fiber sheet to the joint. Then, we used vertical splitting sheet, to stabilize the failure mode and to improve deformation performance. Therefore, we could control the failure of column-ground sill joints. In this year, we conduct the loading test of full-scale frame, to understand seismic property of frame.

Seismic Property of Traditional Wooden House in IPDGHB, Fukushima

Noriko TAKIYAMA

The Ouchi-Juku and Maesawa district of the inland Fukushima prefecture, which was registered as an IPDGHB (Important Preservation District for Groups of Historic Buildings), contains many traditional thatched houses. A low-five-intensity earthquake on the Japanese seven-stage seismic scale was recorded near these preservation district; nevertheless, none of the thatched houses suffered any damage. Hence, it is very important to understand their construction and structural characteristics. The purpose of this study was to analyze the structural and vibration characteristics of a thatched house in Ouchi-Juku and Maesawa district. From this year, we also investigate the mud-wall townhouses in Kitakata city.

Environmental Engineering

Nobuyuki SUNAGA

Research on Comfortable Bioclimatic Architecture

For the benefit of preserving global environment, the effective use of energy consumed in architecture and the utilization of natural energy are indispensable factors for architectural design. Furthermore to popularize Zero Energy Building (ZEB) and Bioclimatic Architecture (BA) which is designed by considering energy conservation, natural energy utilization and comfortable environment, it is necessary to clarify the actual performance of ZEB and BA. We have been engaged in the research of these themes, and, in recent years, we concentrate on building stock improvement and residents' energy-saving awareness and behavior.
In this academic year (2018/04 – 2019/03), we mainly carried out following studies and activities.

1. Relationship between Thermal Insulation Performance and Life Quality [Collaboration with Project Researcher Hiroko Onodera]

When the thermal insulation performance of residence leaps to the highest level, it is considered the comfortableness of residents is improved and the residents' behavior and awareness will be changed. This research examines the effect of high level thermal insulation by actual measurement, evaluating experiment, questionnaire survey and Web survey, collaborating with Asahi Kasei Construction Materials Corporation.
In this academic year, we clarified as followings;
1. The high thermal insulation house has good thermal comfort in all rooms and it leads the residents do not feel house works lazy and so on.
2. The evaluation of lighting environment is getting higher to the increase in its thermal insulation level.
3. The bathroom and dressing room in high thermal insulation house has little heat stress for human body, and in the case of low thermal insulation house, it is necessary to improve thermal performance at first.

2. Refinement of residential building on the theme of environmental performance improvement [Collaboration with Project Researcher Hiroko Onodera]

We have been studying about this theme, for example, Insulated Door at Inside of Window (IDiW), a Japanese wooden house refine project 2011 and so on. In this academic year, we made a questionnaire survey for the residents' awareness for thermal performance improvement of detached house. The results shows like as;
1. The reason not to improve the house is "the residents like (choose) to endure the coldness and hotness rather than to pay the cost for improvement".
2. The recognition of the thermal performance improvement is not so high, but some people have interest in it.
We also carried out a field measurement about the partial thermal insulation improvement of wooden detached house, and showed the effect of thermal performance improvement.

3. Improvement of Thermal Performance of Apartment House in Asia [Collaboration with Assistant Professor Eiko Kumakura and Project Researcher Hiroko Onodera]

In Asia, the construction of apartment houses is processing at a fast pace and there is growing anxiety of the increase of energy consumption, but there are small number of study

about the thermal environment and energy consumption of apartment house in hot and humid region. So we have been conducting the indoor climate measurement and the questionnaire survey for apartment house in Asia since 2014. In the last academic year we had the budget by Housing Research Foundation JUSOKEN, and we surveyed at Okinawa prefecture and Kochi prefecture in Japan, which climate is hot and humid in summer (Japanese climate zone XIII and VII). In this academic year we analyze the data with the result of past surveys and the results are published in the Journal of the Housing Research Foundation "Jusoken". We had a comment by the referee that the data and results of our survey are precious.

4. **Improvement of Air-conditioning System of Art Museum's Repository**

In this research we are examining the detailed distribution of thermal environment in the repository of K MUSEUM for the improvement of air-conditioning system, in cooperation with MAYEKAWA Associates, Architects & Engineers. It is required to keep constant temperature and humidity in the repository of museum, but it is difficult because there are many storage furniture and boxes of fine art which disturb the air movement by air-conditioner. In this year we carried out the summer measurement in the condition of after improvement and clarified the thermal and air environment are improved before repair work. We also carried out a detailed CFD analysis and examine the effect of thermal insulation and so on.

5. **Improvement of Thermal Environment at the Outside Space of Architecture and Urban Quarter** [Collaboration with Assistant Professor Eiko Kumakura]

We presented the results of last year analysis about the thermal environment of Marathon course area at the 2020 Tokyo Olympics and got the best poster award of Japan Heat-Island Society and also a master course student got the Student Encouragement Prize of Architectural Institute of Japan. In this academic year, we examined about the thermal environment of newly announced Marathon course.

About the effect of greening to urban area, we compared the condition and policy in Singapore and Tokyo. It is clear there are many sky-terrace greening in Singapore and is different from Tokyo where the greening is mainly on the ground.

6. **Lighting Environment of greening open space in urban area**

In recent years the open space in urban area is planted by trees and flowers, and then the appeal of the open space is improved. But in the nighttime there are worries that the user feel frightening to the shadow by plants. In this study we clarified the actual lighting condition of a greening open space and the impression of people about it by the field measurement and the experiment using subject.

7. **Other outcome, social contribution and award**

1) N. Sunaga is played as the President of Japan Solar Energy Society and as a member of committee in AIJ and so on.

2) N. Sunaga is played as a member of committees of Tokyo Metropolitan Government, Mizuho town in Tokyo and Environmentally Symbiotic Housing Promotion Council.

3) We, Mr. Shimon Okazaki and others, were given the best poster award of the annual meeting of Japan Heat-Island Society.

4) Mr. Shimon Okazaki, received the Student Encouragement Prize of Architectural Institute of Japan, 2018.

5) Mr. Ryo Meshino received the Student Encouragement Prize 2017 of Japan Solar Energy Society in May, 2018. And it is decided Mr. Keisuke Chiba and Miss Miyu Banzai will receive

the same prize of 2018 (in May, 2019).
6) Miss. Kanako Itoh was given the commendation of graduation thesis by the Dept. of Architecture and Building Engineering, TMU. And she also received the Student Encouragement Prize of Society of Heating, Air-conditioning and Sanitary Engineers of Japan, 2018.

Akihiro NAGATA

A Study on the Evaluation Method of Thermal Performance for Combination of Glazing and Shading Devices

Akihiro NAGATA

The heat transfer from window affects indoor environment. It is important to evaluate the characteristics. In the case of window with shading devices such as screens, curtains, and Venetian blinds, thermal properties are affected by ventilation between the cavity, which is formed between the glazing surface and the shading device, and the room.

There are many studies about the heat transfer from the window with internal blinds. In some previous studies the calculation model is presented based on the assumption that the ventilation was occurred by the stack effect depending on thermally-driven pressure. However, the model could not describe well our previous experiment results probably because the shape of blinds effects the airflow and thermal properties. There are also the studies on predicting the convective heat transfer coefficient from the viewpoint of temperature difference between the glazing surface or the blinds surface and air by experimental and numerical study. However, these research has focused mainly on the window which has a relatively narrow cavity.

To reveal the airflow and thermal properties of the window which has a relatively wide cavity, we conducted Particle Image Velocimetry (PIV) and Computational Fluid Dynamics (CFD) analysis. The analyses were made with the window with internal blinds of which cavity was 130mm width and in a total of 24 cases (3 slat angle of Venetian blinds and 8 patterns of temperature condition). The experimental apparatus consists of a glass pane, a Venetian blinds and an aluminum panel. The glass and blinds were heated by energization to simulate absorption of solar radiation and the aluminum panel was heated or cooled by a chilling unit. CFD modelling was made to reproduce the experimental setup. Results are given in the form of airflow velocity, airflow rate, and convective heat transfer. Comparison of PIV and CFD results shows the following:

1) The airflow vector map from CFD results were in almost good agreement with PIV. The CFD model described here could be used for predicting the airflow properties of the window with relatively wide cavity. In CFD, the airflow snaking through the blinds slats was observed.

2) The larger the temperature difference between the glass or the blinds and the cavity, the larger the airflow velocity, airflow rate, and convective heat transfer. For the maximum vertical airflow velocity of the cavity, CFD results were slightly larger than those of experiment. However, the thickness of velocity boundary layer in experiment is larger than CFD, which indicates that diffusivity is higher in the experiments. Consequently, the airflow rate in CFD was slightly smaller than those in experiment.

3) Blinds slat angle does not significantly affect the velocity, airflow rate and convective heat transfer both in experiment and CFD.

A Study on the Performance of Shut-Off and Induction of Heat and Air Flow of Air Curtain
Akihiro NAGATA

Masayuki ICHINOSE

Eiko KUMAKURA

The Influence of Skycourt Greenery on the Thermal Environment and Its Psychological Effects

Recently, greenery building has been developing all over the world. There are several typologies of greenery space positions in buildings. This study investigated the typologies of greenery buildings and compared their features between Tokyo and Singapore based on each city's regulations. The results found that the ratio of greenery on buildings in Singapore was higher than on those in Tokyo. This is because skycourt greenery is used on buildings in Singapore. Using thermal simulation, eye-tracking glasses and VR images, the influence of skycourt greenery on the thermal environment and its psychological effects were evaluated. Although trees in the open area were effective for shade in regard to solar radiation, they reduced the score for the area's feeling of openness from the results of the SD method on high-ceilinged buildings.

The Thermal Environment of the Tokyo 2020 Olympics Marathon Course

The thermal environment of the marathon course at the Tokyo 2020 Olympics venue has been measured since 2014. This year, 13 districts were selected to simulate the impact of countermeasures for the thermal environment. The most challenging environment for runners was found to be in front of the Imperial Palace. The MRT there increased to 49.3 degrees Celsius. The MRT for spectators along the course differed by a maximum of 9 degrees Celsius depending on their position, even though they were on the same street and block. Based on these simulation results, a countermeasure map considering the duration of stay of spectators and the shaded area by the building along the street was proposed. For part of the street, the effects of shading devices, such as membrane structures and trees along the street, were calculated. They were found to decrease the MRT by 8 to 10 degrees Celsius.

LIST OF RESEARCH ACTIVITIES

Architectural Plannning / City Planning

Kenji TAKEMIYA

1. Refereed Papers

Minjung Bae, Kenji Takemiya, Yuki Fujiwara
Usefulness of the new layout at center K, Comparative analysis of actual facility usage in the transition from a facility for children with motional disabilities to a medical-type facility for children with disabilities, J. Archit. Plan. AIJ. Vol.83 No.752, 1865-1875, Oct. 2018

Ayumi Mineno, Kenji Takemiya, Minjung Bae
"Questionnair research to clarify utilization of users' place and furniture in dayservice centers for childeren with severe motor and intellectual disabilities"
AIJ J. Technol. Des. Vol. 24, No.58, 1161-1166, Oct., 2018

Yoki Kamitomo, Kenji Takemiya
Study on the planning methods used against the growth and change of hospital architecture
AIJ J. Technol. Des. Vol. 25, No.59, 281-286, Feb., 2019

2. Proceedings of Oral Presentations

Minjung Bae, Kenji Takemiya, Yuki Kamioka
Characteristics of utilization of new facility type for children and adults with severe disabili ties -Case study on day care and respite care center U-
ISAIA 2018, The 12th International Symposium on Architectural Interchanges in Asia, Proceedings of the 12th ISAIA, pp.457-462, Pyeongchang, KOREA, October 23-26, 2018

Kenji Takemiya, Tatsuo Ishibashi, Shigeki Nakayama
Emergency Medical System and facility planning in the U.S.A., Emergency Medical System and facility planning method in the foreign countries Part.1
Summaries of technical papers of annual meeting E-1, AIJ, pp.325-326, 2018 (in Japanese)

Koki Shimada, Eri Nagata, Kenji Takemiya
A stusy on the overall using state of facilities, A study on actural conditions of space-use in kindergarten based on continued research for 3 years (Part1)
Summaries of technical papers of annual meeting E-1, AIJ, pp.39-40, 2018 (in Japanese)

Eri Nagata, Kenji Takemiya
A Study on using state of facilities focusing on an individual,A Study on actual conditions of space-use in kindergarten based on continued research for 3 years (Part2)
Summaries of technical papers of annual meeting E-1, AIJ, pp.41-42, 2018 (in Japanese)

Seo Seokjun, Kenji Takemiya
Analysis of the current state of facility management and planning of day service (type A) in Tokyo
Summaries of technical papers of annual meeting E-1, AIJ, pp.161-162, 2018 (in Japanese)

Takahumi Tsushima, Minjung Bae, Takemiya Kenji, Yuki Fujiwara
Analysis on characteristic of the children in the facility K -Comparative study of actual facility usage in the transition from a facility for children with motional disabilities to a medical, type facility for children with disabilities Part 1
Summaries of technical papers of annual meeting E-1, AIJ, pp.334-335, 2018 (in Japanese)

Minjung Bae, Takemiya Kenji, Yuki Fujiwara
Analysis on used place of the children and nurses in the facility K , Comparative study of actual facility usage in the transition from a facility for children with motional disabilities to a medical-type facility for children with disabilities Part 2
Summaries of technical papers of annual meeting E-1, AIJ, pp.335-336, 2018 (in Japanese)

Akari Hashimoto, Kenji Takemiya
Study on facility management and planning of nursery school in the 3 wards in central Tokyo
Summaries of technical papers of annual meeting E-1, AIJ, pp.9-10, 2018 (in Japanese)

Miyoko Tomosada, Kenji Takemiya
Consideration of furniture placement by childcare person and behavior of children, Case study of O certified centers for early childhood education and care
Summaries of technical papers of annual meeting E-1, AIJ, pp.47-48, 2018 (in Japanese)

Hikaru Abe, Kenji Takemiya
"Current conditions of service and facility planning of day care unit for psychiatric patients - Study on improvement of living environment in day care units for psychiatric patients Part 1 -"
Summaries of technical papers of annual meeting E-1, AIJ, pp.129-130, 2018 (in Japanese)

Yuna Sugino, Kenji Takemiya
Study on operating system for terminal and bereavement care and actual utilization of its space: Case study on the various care homes away from home
Summaries of technical papers of annual meeting E-1, AIJ, pp.289-290, 2018 (in Japanese)

Takumi Nakama, Kenichi Kbayashi, Ruka Kosuge, Kenji Takemiya
"The classification of management and details of community-based integrated wards, Study on the classification of management and facility planning of community-based integrated wards, part 1"
Summaries of technical papers of annual meeting E-1, AIJ, pp.295-296, 2018 (in Japanese)

Kenichi Kbayashi, Takumi Nakama, Ruka Kosuge, Kenji Takemiya
"The utilization of space and facility planning of community-based integrated wards, Study on the classification of management and facility planning of community-based integrated wards, part 2"

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TohruYOSHIKAWA

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Motoki TORIUMI

Masumi MATSUMOTO

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Ryo SANUKI

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Masao KOIZUMI

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KatsuhiroKOBAYASHI

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YoshinoriKITSUTAKA

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Makoto TSUNODA

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