

**Department of
Architecture and Building Engineering in 2013**

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Overview of Research Activities

ARCHITECTURAL PLANNING / CITY PLANNING

Tohru YOSHIKAWA

Development of Methods for Analyzing Network of Community Facilities

Tohru YOSHIKAWA and Ryo SANUKI

In Japan, reconstruction of community facilities network is demanded by social informatization, aging and maturation. To provide theoretical models and examples of the reconstruction planning, convenience of community facilities and their most suitable placement were analyzed. During this year, the analysis of location optimization of residents and facilities in the long term during which the age structure of population change was conducted.

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, a theoretical study was conducted on a new evaluation index for facilities with distance decay of utilization ratio using the logit model.

Masumi MATSUMOTO

Studies on Regeneration and Revitalization of New Towns

Masumi MATSUMOTO

Tama New Town is the largest New Town in Japan developed for 30 years since its first construction. This series of studies aims to research and develop the methods for regeneration and revitalization of living environment of New Towns, taking its main examples in Tama New Town.

1. Research on housing conditions and lifestyles in Suwa-Nagayama District of Tama New Town and proposal on its renovation
2. Research on neighboring commercial areas of Tama New Town
3. Studies on women's local activities in Tama New Town

Studies on Sustainable Living of Elderly People in their Home Town

Masumi MATSUMOTO

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

1. Research on using sensors of elderly people's behavior in their own house
2. Research on the senior citizen support places
3. Community activities for the elderly people and their relationships with the professionals working in community comprehensive care centers

Ryo SANUKI

Development of a space for continued residence that connects suburban buildings and local communities

Ryo SANUKI and Tohru YOSHIKAWA

We studied a mechanism for supporting people's continued residence in a suburban area southwest of the capital, mainly Tama area, using knowledge of architectural planning, city planning and architecture facilities. Our major themes and achievements are: (1) The convenience of living in a ultra-tall housing complex in a suburban area of Tokyo was evaluated by surveying the walking distance area and the residents' moving up/down through the building. (2) The space configuration of the stores and parking in large shopping facilities near a large city was analyzed with a focus on the transportation and the distance from the train stations. (3) The relation between the noises and odors in residential areas and space configuration elements such as building structure was clarified. (4) The public bath facilities and their actual use in Tama New Town were surveyed. (5) A model for analyzing the site location conditions of food facilities where people can have a meal or take out food was proposed. (6) By using

geographical information systems, it was quantified how the accessibility to the local stores and other facilities changed as a result of the appearance of new stores or the disappearance of existing stores.

Application to the public facilities management of the geographical information system

Ryo SANUKI, Sangjun YI and Hiroki TSUTSUMI (Maebashi Institute of Technology)

In the field of the public facilities management, the construction of the database of the facilities that the local government holds is an important problem. If there is the address information of the building for the database, the spatial grasp of facilities by using a geographical information system (GIS) is enabled. Through the argument with the plural local governments, we studied to push forward “the visualization” of such data.

Accessibility to Medical Care in Case of Major Disasters

Ryo SANUKI, Toshiro KUMAKAWA (National Institute of Public Health), Eiji SATOH (Utsunomiya Univ.), Tohru YOSHIKAWA

It has become evident that the accumulated plans based on the concept in risk management including disaster prevention, disaster reduction and disaster preparation were not enough to prepare for major disasters. Therefore, reconsidering these issues from a viewpoint in crisis management will surely become very significant in the future.

The accessibility to various local facilities decreases in the event of a disaster and its degree increases as the scale of disaster becomes larger. Furthermore, the limited supply of service can easily cause a situation in which not all consumers can receive the service. Especially for the local facilities where the high demand rises in case of emergency, it is important to consider the scale of its impact and have ways to assess the degree of changes and their locations. In this study, the changes in accessibility are examined with a focus on access to medical facilities in the event of a disaster.

Evaluation of the location potential of the commercial facilities as the place of refuge

Ryo SANUKI, Eiji SATOH (Utsunomiya Univ.), Tohru YOSHIKAWA, Norio MAKI (Kyoto Univ.)

The purpose of the study is to analyze the effect of establishing places of refuge in commercial facilities in addition to public facilities. To this end, the differences in accessibility to the places of refuge were analyzed in whole Kii Peninsula and Matsuzaka City among various cases with facilities providing food. The analysis in Kii Peninsula shows that supermarkets would be most useful. The analysis in Matsuzaka City shows that the facilities providing food would be useful in increasing robustness as well as decreasing the refuge distance, but less effective than refuge buildings in the coast in case of tsunami.

Development of a Community Workshop Program for Post-disaster Life-continuity for Condominium Dwellers

Taro ICHIKO and Ryo SANUKI

Condominium dwellers have some special agenda for post-disaster restore. It's more troublesome for refugee life caused of lifeline stooping than detached dwellers. There are some early projects in Tokyo about community workshops for post-disaster recovery. So we researched impacts of The great east Japan Earthquake in Tama-New town. And a community workshop for post-disaster life-continuity were developed and evaluated. Finally, needs and programs about community workshops for post-disaster life-continuity for condominium dwellers were discussed.

ARCHITECTURAL DESIGN AND HISTORY

Katsuhiko KOBAYASHI, Akira KINOSHITA and Sho KADONO

Analyses on Composition of Modern and Contemporary Architecture

Katsuhiko KOBAYASHI and 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 2013, design of recent high-rise buildings, architectural works of Herzog & De Meuron and so on were analyzed. Parts of these studies were and are to be published in Summaries of Technical Papers of Annual Meeting, A.I.J.

Development of Architectural Design Method

Katsuhiko KOBAYASHI and Akira KINOSHITA

In architectural design research, it is also important to apply design principles and compositional methods abstracted by analyses to actual architectural design work. Thereby theory and practice, in other words, basic research and high-level application would be synthesized. In the academic year of 2013, relation between theory and design practice were pursued through four design works of master program students.

Research on Design of Architectural Conversion and High-rise Buildings

Katsuhiko KOBAYASHI, Akira KINOSHITA and Sho KADONO

It is becoming one of the most important and social subject in architectural field of Japan to find out and create various methods to revitalize the existing building stocks. Among these methods, architectural conversion is very useful and important. For these several years, we have made research survey on architectural conversion and high-rise buildings as well. In the academic year of 2013, we made investigation on converted buildings and high-rise buildings in Moscow, Beijing, Xian, Taipei, Taizhong, and Kaohsiung. Parts of these studies are to be published in Summaries of Technical Papers of Annual Meeting, A.I.J.

Study on English Baroque Architecture

Akira KINOSHITA

Christopher Wren, Nicholas Hawksmoor, John Vanbrugh are so called "English Baroque Architects". Largely affected by continental classical style, they invented unique architectural style by manipulating original design vocabulary. Especially Vanbrugh's design is characteristic. His usage of medieval elements for the elevation and the arrangement of the plans created unique architectural style. In the academic year of 2013, the interrelations between planning and elevation, pastoral and sublime motives seen in the Seaton Delaval, one of the Vanbrugh's most controversial country houses, are examined.

Yukimasa YAMADA

Studies on the Architectural History of Catholic Churches in the Northern Vietnam

Yukimasa YAMADA and Tomoharu KATANO (Japanese Association Conservation of Architectural Monuments)

Christianity in Vietnam, since its introduction early in the sixteenth century, has been evolving and expanding to an indigenous culture among the society, convention and thoughts different from European countries. We are focusing attention on three Catholic dioceses that have been played most important rolls in the history and culture of Christianity in the Northern Vietnam, Bui-Chu diocese, Thai-Binh diocese and Phat-Diem diocese. Collaborating with the administration office of each diocese, we attempt to conduct surveys and analysis of existing historical churches, and to show their architectural features and the process of their transition. And also, we try to build up the multi-directionally-operated Database System, through sharing information with religious communities and their supporters for the preservation and activation of culture and tradition in the Northern Vietnamese Christianity. In this fiscal year, we tried to focus on non-wooden churches, and also discussed their construction and distribution in the Vietnamese historical architecture.

Surveys and Studies on the Preservation of Traditional Villages and Vernacular Architecture in Asia and Japan

Yukimasa YAMADA, Hiromichi TOMODA (ShowaWomen Univ.) and Satoshi ONO (Yokohama National Univ.)

Since a number of traditional villages and vernacular architecture with historical and cultural values have been disappearing rapidly in the Asian countries, their preservation is an urgent issue. Making surveys and studies from this point of view, in this year, we have conducted a series of surveys and analysis on traditional villages and houses in Vietnam. In this fiscal year, we made two reports on architectural features of traditional houses in Tien Giang, and Dong Nai provinces. Besides, we have submitted two papers on earthen buildings and thatched folk houses in the northern Japan to the international conference concerning conservation of vernacular architecture held in the northern Portugal.

Studies on Historical Roles and Activities of Foreign Architects in Modern Japan

Yukimasa YAMADA

Many foreign architects coming to Japan since the Meiji era have influenced in some ways and contributed to the development of the modern Japanese architecture. The architects such as Josiah Conder, Hermann Ende and

Wilhelm Bockmann called as “oyatoi-gaikokujin” (hired foreigners) in the early Meiji played a different historical role from the later architects such as William Merrell Vories and Antonin Raymond, who stayed longer and worked continuously in the period between the late Meiji and the prewar period. It is contemplated that the latter architects had set a current closely related with the contemporary architectural society. In this fiscal year, we described the historical background and the formative process of Lake Chuzenji cottage area since the Meiji to the prewar period, and also discussed the relationship between H. Hunter as a client and A. Raymond as an architect, reciting their activities in that time.

Masao KOIZUMI

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.

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.

CONSTRUCTION MANAGEMENT AND BUILDING MATERIALS

Yoshinori KITSUTAKA and Koichi MATSUZAWA

Integrity Evaluation of Corroded Reinforcing Bar Used for Reinforced Concrete Structures

Yoshinori KITSUTAKA and Koichi MATSUZAWA

This study aims to investigate the changes in the mechanical properties of deformed reinforcing bars of different types and sizes when they are corroded. As a reinforcing bar is corroded and the cross-sectional area is reduced, the yield point linearly decreases. The rate of such reduction is common to all types, being independent of the strength and diameter of the bar. Also the apparent Young’s modulus linearly decreases as corrosion proceeds.

Evaluation method of the degradation for reinforced concrete structures using digital X-rays pictures

Yoshinori KITSUTAKA and Koichi MATSUZAWA

This study focused on the X-ray observation technique for the three dimensional evaluation of the corrosion on reinforcement surface in concrete. The corroded reinforcement was embedded in concrete and the thickness distribution of corrosion for circumferential direction on reinforcement surface was measured by the three dimensional X-ray irradiation apparatus. Corrosion accelerated test was performed for the reinforced concrete specimen with a crack by the salt spray testing machine and the degree of corrosion on reinforcement of reinforced concrete specimen was evaluated. Visualization method for the corrosion of reinforcement surface in concrete is proposed.

Influence of Age and Cure on Fracture Properties of Concrete Subjected to High Temperature Heating

Koichi MATSUZAWA and Yoshinori KITSUTAKA

Concrete structures, which serve various purposes, are subjected to a number of deteriorative factors during their service life. Because strength decreases, as for the concrete affected by the high temperature heating, it is expected that the cracking becomes easy to occur. When investigating cracking, however, it is considered important to evaluate not only crack propagation properties but also crack initiation. In this research, the influence of age and cure on fracture properties of concrete subjected to the effect of high temperature heating up to 800C.

Influence of High Temperature Heating on Pull-Out Strength of Mechanical Anchor Bolt embedded in Concrete

Koichi MATSUZAWA and Yoshinori KITSUTAKA

It is surface layer that the part affected by high temperature heating the most when concrete structure is subjected to fire accident. In the surface layer, anchor bolts are used to fix equipment or for seismic strengthening. In this research, the effect of high temperature heating on pull-out strength of mechanical anchor bolt embedded in concrete was investigated.

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 paid our attention to the partial conversion of the surplus classroom in the elementary and junior high school and found out the design condition in each part from characteristics of the existing school. Particularly, we considered the contents of the space change by the section design in the conversion. The methodology of the section design on the basis of floor changing can be classified into rise technique by the method of construction of the floor and the air conditioner setting method of the ceiling. And we showed the space that we could secure after the conversion using the technique.

Organization of Subcontractor for Stock Housing

Makoto TSUNODA

Contents of improvement, such as reform, were diversified in requirement of residents. Therefore, the details of construction and its cost were complicated. As regards realization stock-based societies, the productive organization of effective utilization for stock housing, especially contribute to residential requirement were in urgent need. And it was necessary to creating the local housing construction network owing to sustainable improvement.

In this year, we clarified the duties activity for the resident in the areas of the house improvement company. The cooperation with other builder was required to support current a variety of reform needs. And we showed that the existence of the builder who had duties contents not to be seen in the conventional new house production organization was indispensable. In addition, the continuous tied with the resident are useful to enhance the coherence to the area. Furthermore, we showed that the network between the builders who always functioned as advisers of refurbishment service were necessary.

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 focused on renovation of exterior wall in the office building and represented the combination of exterior wall members serving as improvement of the main performance criteria such as exterior design and quake resistance, insulation characteristics. And we showed that the influence of exterior design according to the shape and the installation members of improving performance were different.

Studies on Management Technique in the Renovation Process of the Apartment House

Makoto TSUNODA

The apartment houses of our country have to work on the earthquake-resistant improvement immediately for safety. However, the consensus building of inhabitants is necessary to plan performance improvement such as the seismic rehabilitation because of existing plural owners. As a result, the renovation on the condition called “while living” is carried out. In the process of the renovation, management techniques including design and execution of work different from new construction are necessary. However, there are many individual solutions under the

present conditions, so the universal methodology is urgent business.

In this year, we grasped the matter which had an influence on the progress of the seismic rehabilitation of apartment houses. And we showed the business contents and the flow carried out by a renovation designer, and clarified the correspondence method to influence matters by the business contents. Furthermore, we arranged in detail that the whole of the accompaniment contents by renovators whom business contents and procedures were hard to assume. Particularly, we extracted five accompaniment contents among the business contents which renovator performed, and we examined the association with the influence matter. As a result, we were able to classify the accompaniment contents roughly into “required accompaniment contents” and “accompaniment contents to occur by an influence matter”.

Furthermore, we clarified various construction influence to occur by the condition called “while living” and showed rational design and control, construction management technique demanded in the construction site. In addition, we stated clearly the measure of a builder and a designer who solved influence to give to residents in “renovation while living”. And we clarified the correspondences of the construction influence relating to residents in “renovation while living” and each construction-related subject, according to construction manager, designer, and resident. Furthermore, we unified design and control and construction management technique and we showed the main point to push forward “renovation while living” smoothly.

Tomoyuki GONDO

Conventional Housing System in Asian Areas

Tomoyuki GONDO, Hirotake KANISAWA (Shibaura Institute of Technology), and Yongsun KIM (the Univ. of Tokyo)

This study focuses on the housing system in several Asian countries, such as Korea, Vietnam, and Thailand among others. In Korea, from the middle of 2000s, new type of wooden houses increased which combines contemporary technologies and planning with Korean traditional design, “Hanok”. As a representative case of new Hanok, this study focuses on actual situations of wooden construction system in recent Korea, such as government, carpenters, and lumber supply.

As for Vietnam and Thailand, Southern East Asia region have potential of growing housing market. However, Japanese housing companies don't succeed in exporting their products and services. From interviews with Japanese and local companies, this study capture problems and tactics for increasing exports from Japanese housing industry.

Technological Developments of Japanese Prefabricated House in Early Stage

Tomoyuki GONDO, Shuichi MATSUMURA (the Univ. of Tokyo), Kouichi SATO (A/E WORKS), Yoshiro MORITA (Tokyo Polytechnic Univ.) and Toru EGUCHI (Yokohama National Univ.)

Major prefabricated houses manufacturers started their business around 1960s, and nowadays they became world class large housing companies. This study clarifies 9 major prefabricated houses manufacturers' developments at early stage by interviews with their in-house engineers and architectural designers as well as analysis of relating documents.

Sangjun YI

IMPROVING THE EFFICIENCY OF PUBLIC FACILITIES MANAGEMENT

Sangjun Yi

In Japan, many infrastructural works were constructed during the period of rapid economic growth following the Second World War. Today, the cost of repairing, improving, and maintaining those facilities is on the rise. Public facilities of the municipality face a similar situation. However, although many municipalities realize the need for public facilities management, they hesitate to take concrete steps toward a solution because of their fear of increasing costs, a lack of know-how, and an uncertainty about what to change. Another problem is that in many municipalities, maintenance and management is not the concern of the entire organization but rather the responsibility of the building repair department. This study showed that all of the public facility activities, such as planning, operation, and maintenance efficiency, are included in public facility management, and the cause of the municipality's mismanagement was not only related to technology and fiscal conditions but also to the municipality's structural organization. Moreover, the purpose of this study is to explain the current state of the municipality's organizational structure and its approach to public facility management and to identify the organizational structures and management processes that are most efficient.

STRUCTURAL ENGINEERING

Manabu YOSHIMURA

Seismic Performance Evaluation of Building Designed by Chinese Building Codes]

Manabu YOSHIMURA

The human losses by the 2008 Sichuan Earthquake in China are caused by mostly building damages while those by the 2011 East Japan Earthquake are primarily by not the same but tsunami. Such difference is thought to be due to the difference in the seismic performance of buildings in both countries. Thus it was attempted to survey the Chinese building codes and evaluate the seismic performance of five-story RC office building designed by the Chinese codes. The pushover and dynamic analyses widely used in Japan were applied. The studies have revealed the followings.

1. The design lateral loads specified by the Chinese codes are 0.0354 and 0.0313 in terms of base-shear coefficient for both directions that are much smaller than the value in Japan or 0.2.
2. But the lateral load capacity derived from the pushover analysis is about 0.1, around three times as much as the design level. This strength increase is because in China, (1) material strength used in design is about 30% smaller than the one used in the lateral strength computation in Japan, (2) the design moment in China is prescribed to be about 20% larger over the moment computed in considering the vertical and lateral loads, (3) the amount of reinforcement is partly determined by the minimum requirement, and (4) in the design of this buildings the dimensions and reinforcement of members are rendered uniform thorough the entire stories.
3. The story drift computed for this building for the level 2 ground motions in Japan does not remain within 1%, even exceeds 2% in some cases

Changing of Building Mechanism Produced by Considering Strength Deterioration of Columns

Manabu YOSHIMURA

The current pushover analysis available in design does not consider the strength deterioration of columns (the Deterioration). But when old buildings are concerned, columns tend to fail in shear, resulting in the Deterioration. Then it was studied if building mechanism may be affected by considering and not considering the Deterioration. The three-story RC building was analyzed. The studies have revealed that if the Deterioration is not considered, the second- and third-stories mechanism results while if it is considered, the first story mechanism does. The reason of such difference is as follows. At early stages yielding hinges appear in the second- and third-stories for both cases. However, at later stage while for the case without considering the Deterioration the second- and third-stories mechanism is reached, for the case with considering it some first-story columns fail in shear thus losing the strength, leading to the yielding at the top and bottom of the remaining first-story columns that results in the first story mechanism. One must note that considering the Deterioration or not can affect the building mechanism.

Kazuhiro KITAYAMA

Seismic Performance and Different Limit States for Prestressed Reinforced Concrete Cruciform Beam-Column-Slab Subassemblage Forming Beam Yield Mechanism

Kazuhiro KITAYAMA and Toshiki ENDO

An ultimate objective of this study is to propose estimation method which can evaluate easily deformation capacity at different limit states with good accuracy for prestressed reinforced concrete (PRC) flexural beams, eventually aiming to formulate a performance-based seismic design methodology for PRC buildings.

Actual buildings have both slabs and transverse beams. Therefore, two beam-column-slab subassemblage specimens with transverse beams and a plane beam-column subassemblage specimen for comparison were tested in 2012 under static load reversals to investigate hysteretic characteristics and the process of damage for PRC beams with slabs. In tests, lateral force capacity attained to the peak for all specimens at or after yielding of post-tensioning tendons, after beam longitudinal bars yielded. Lateral force capacity descended sharply after the peak capacity due to buckling and rupture of beam longitudinal bars, accompanying with concrete severe crushing at beam ends. Concluding remarks drawn from the study are as follows.

1. Slab effective width on beam bending moment capacity exceeded 0.1 times the beam span length at a story drift angle of 0.15 % approximately with beam bar yielding, and the width reached 0.2 times the beam span length before lateral force capacity attained to the peak.
2. Residual tensile force in a post-tensioning tendon became larger than the initial tensile load introduced into the post-tensioning tendon under construction of the specimen, and increased with the increase in a beam deflection for the beam with a contribution ratio of post-tensioning tendons to ultimate flexural capacity for

a PRC beam section of 0.5. In contrast, residual tensile force in a post-tensioning tendon decreased for the beam with a contribution ratio of post-tensioning tendons to ultimate flexural capacity for a PRC beam section of 0.75. Residual tensile force in a post-tensioning tendon ranged from 0.85 times to 1.29 times the initial tensile load at a beam deflection angle of 1.5 %.

3. Residual beam deflection and residual crack width after unloading from peak strength were not influenced by existence of slabs.
4. For a T-shaped beam whose ultimate flexural capacity subjected to tension at a top fiber in the section was larger than that subjected to tension at a bottom fiber, core concrete at the bottom of a beam section crushed prematurely, and eventually buckling and rupture of beam longitudinal bars were induced.
5. A service limit state in PRC beams with slabs was attained due to a residual crack width of 0.2 mm or slight yielding of beam bars at a beam deflection angle of 0.15 % to 0.53 %. A first restorable limit state was attained due to elastic limitations of post-tensioning tendons or a residual crack width of 1.0 mm at a beam deflection angle of 0.24 % to 0.90 %. A second restorable limit state was attained due to a residual deflection angle of 0.5 % or slight yielding of post-tensioning tendons or a residual crack width of 2.0 mm at a beam deflection angle of 0.69 % to 1.69 %. A safety limit state, finally, was attained due to core concrete crushing or rupture of beam bars at a beam deflection angle of 2.66 % to 4.36 %.

Failure Mechanism in Reinforced Concrete Beam-Column Joint Subjected to Tri-Directional Loading

Kazuhiro KITAYAMA and Toshiki ENDO

Shiohara, a professor at the University of Tokyo, indicated from analytical and experimental studies that when an ultimate flexural capacity in a reinforced concrete (R/C) column section is close to that in a R/C beam section at a central node of a beam-column joint, a beam-column joint tends to fail, regardless of designing to provide sufficiently redundant capacity to prevent joint shear failure, due to a concentration of damage prior to developing an ultimate flexural capacity in a beam critical section.

Recent experimental studies to verify such a new failure mechanism proposed by Shiohara have been usually conducted by using plain interior and exterior beam-column subassembly specimens. There are few tests, however, to use three-dimensional beam-column subassemblages with orthogonal beams to each other which frame into a column such as a corner joint. For corner columns in actual R/C buildings, a loss of capacity to sustain column axial load resulting from severe damage to a corner joint led to partial story collapse by some earthquakes, for example, Guam Island Earthquake in 1993. An ultimate flexural capacity of a corner column frequently decreases during an earthquake because an axial load to a corner column cyclically increases and decreases by change of direction of lateral loads induced by earthquake excitations. Therefore, it is of great importance to investigate earthquake resistant performance for a corner beam-column joint subjected to tri-directional earthquake loading.

Failure mechanism of a corner joint was studied in this research by testing two three-dimensional beam-column subassembly specimens, which consist of a corner column and orthogonal beams to each other cut from a R/C frame, under tri-directional load reversals. The ratio of ultimate flexural strength of a column section to that of a beam section was varied in the test from 1.4 to 2.3 by changing the magnitude of column axial load in compression. A plain corner joint specimen was also tested for comparison. General findings taken from the study are summarized as follows.

1. Although a joint shear redundancy ratio of 1.6 to a joint shear strength estimated by AIJ provisions was provided to corner column-beam subassembly specimens to prevent joint shear failure, a beam-column joint region failed severely subjected to column axial load and bi-lateral load reversals after beam, column longitudinal bars and joint hoops yielded.
2. Peak story shear force under bi-lateral loading was 0.74 times the ultimate flexural capacity of a beam computed by a section analysis for a corner column-beam subassembly specimen with a column/beam flexural strength ratio of 1.4. This means that beams for the specimen did not develop fully their flexural performance. In contrast, peak story shear force under bi-lateral loading almost attained to the ultimate beam flexural capacity for a corner column-beam subassembly specimen with a column/beam flexural strength ratio of 2.3, whereas lateral-load carrying capacity descended severely after the peak capacity due to severe damage in a joint region.
3. Fatter hysteresis loops were observed under bi-lateral loading for a corner column-beam subassembly specimen with a column/beam flexural strength ratio of 2.3 than that of 1.4, showing a more amount of energy dissipation.

Failure Mechanism in Reinforced Concrete Cruciform Beam-Column Joint

Kazuhiro KITAYAMA

Static loading tests to five reinforced concrete (R/C) cruciform beam-column subassembly specimens were carried out in 2011 to verify adequacy of a failure mechanics model for a beam-column joint proposed newly by Shiohara at the University of Tokyo. Test parameters were as follows; a ratio of ultimate flexural capacity of a column section to that of a beam section ranging from 1.2 to 1.8, column axial load in tension and compression, beam axial load (absence or compression force which was induced by an unbonded post-tensioning tendon passing through a center of the beam section) and an aspect ratio of a height to a depth of a beam-column joint panel. After beam and column longitudinal bars and joint hoops yielded, a beam-column joint panel eventually failed for all specimens. Conclusions obtained by the study were summarized as follows.

1. A peak story shear force obtained for all specimens was larger than a story shear force at an ultimate flexural capacity of a beam section computed by quick estimation formula. On the other hand, a peak story shear force in the tests was 0.92 to 0.86 times that predicted by a Shiohara and Kusuhara's joint failure model except for the interior joint with beam axial compression load, where a peak story shear force predicted by a Shiohara and Kusuhara's model agreed well with that by the test.
2. Deformation component due to a joint panel rotation, which was calculated on the basis of the nine degree-of-freedom model for joint failure proposed by Shiohara, shared 35 % to 50 % of a total story drift. In contrast, contribution of joint shear distortion to a story drift was less than 10 % of a total story drift. Beam axial compression load contributed to suppression of a joint panel rotation.

Earthquake Resistant Performance in Precast Prestressed Concrete Frame Assembled by Post-Tensioning Unbonded Tendons

Kazuhiro KITAYAMA, Yuji TAJIMA (Asiss Corporation) and Kiyomi KANEMOTO (Shimz Corporation)

It is very effective for sustaining civil infrastructure to lengthen a respective building life. Rational building construction and rehabilitation method for existing buildings are, moreover, required for conservation of global environment and a society with an aging population and a low birthrate. It is a promising construction method to build moment resisting frames for resolving such problems that precast concrete beams and columns are connected by post-tensioning unbonded tendons which pass through these precast concrete members (called as PCaPC frame) from following reasons; first, damaged beams or columns due to earthquakes can be replaced by new ones, second, there is no need to inject grout mortar into a sheath tube where post-tensioning tendons run through, and third, a damage-control is possible such that a damage concentrates on the end of a beam and a column.

Therefore, earthquake resistant performance in a PCaPC frame was studied through laboratory tests to investigate following two subjects; first, an effect of a length of post-tensioning tendons which are anchored within a precast concrete beam on mechanical behavior during earthquakes, and second, shear strength for a beam-column joint panel in a PCaPC frame assembled by post-tensioning unbonded tendons.

Two exterior column-beam subassembly specimens, which were designed to develop beam failure mechanism, were tested for the first subject. Post-tensioning unbonded tendons for one specimen were anchored within beam core concrete at a distance of a beam-depth apart from a column face, whereas post-tensioning unbonded tendons for another specimen passed through the whole beam, and were anchored at the outside of beam end by a nut.

Two interior and one exterior column-beam subassembly specimens, which were designed to fail in shear in a beam-column joint, were tested for the second subject. An existence or absence of bond along a post-tensioning tendon, and configuration of a subassembly, i.e., an interior joint or an exterior joint, were chosen as a test parameter. A ratio of ultimate flexural capacity of a column section to that of a beam section was decided to be 1.7 to 4.8 to prevent a joint panel from failing in bending moment.

Following findings were obtained from a test for the first subject.

1. Both exterior column-beam subassembly specimens reached a peak strength due to concrete compressive failure at a beam end after a strain of post-tensioning unbonded tendons exceeded the elastic limit strain. Short post-tensioning tendons anchored within beam core concrete yielded at a story drift angle of 1.5 %, which was smaller than that of 2.3 % for a specimen with long post-tensioning tendons.
2. Hysteresis loops depicted an origin-oriented shape for a specimen with long post-tensioning tendons. In contrast, hysteresis loops showed a pinching converted-S shape for a specimen with short post-tensioning tendons after a story drift angle of 3 %. This was caused after yielding of tendons by alternate opening and closing of the interface between a beam and a column during which a beam was not able to resist bending moment nor shear force.
3. Damage concentrated finally on the interface between a beam and a column regardless of a length of post-tensioning tendons. Many flexural and shear cracks, however, occurred in a beam with short post-tensioning tendons. Width of a flexural crack at a location of anchorage plates for tendons within a beam was largest

among cracks, but smaller than 0.2 mm.

Following findings were obtained from a test for the second subject.

4. A beam-column joint panel for all specimens failed in shear judging from such facts that post-tensioning tendons did not yield, column longitudinal bars yielded at a large drift after the peak strength, and concrete compressive failure was remarkable along a diagonal strut within a joint.
5. Shear strength of a beam-column joint in a PCaPC frame can be estimated conservatively by AIJ provisions for ultimate shear strength of R/C beam-column joints regardless of bonded or unbonded tendons and an interior or exterior joint panel.
6. A peak story shear force for a cruciform beam-column subassembly with unbonded tendons was 0.9 times that with bonded tendons. This was caused by the reduction of shear strength for a joint with unbonded tendons.

Earthquake Resistant Performance in Precast Prestressed Concrete Frame with Slabs Assembled by Post-Tensioning Unbonded Tendons

Kazuhiro KITAYAMA, Kiwoong Jin, Yuji TAJIMA (Asiss Corporation) and Kiyomi KANEMOTO (Shimz Corporation)

For an above-mentioned study, static loading tests were conducted using plain PCaPC beam-column subassembly specimens. Actual buildings, however, have both slabs and transverse beams, which causes complicate behavior under earthquake motions. Therefore, three-dimensional PCaPC beam-column subassembly specimens with slabs and transverse beams were tested under reversed cyclic loading. A plain exterior beam-column subassembly specimen, whose post-tensioning unbonded tendons were anchored within beam core concrete at a distance of twice a beam-depth apart from a column face, was also tested to compare with past test results. Test results will be investigated in detail.

Seismic Behavior and Damage of Reinforced Concrete School Building by the 2011 East Japan Earthquake

Kazuhiro KITAYAMA and Toshiki ENDO

A reason why a reinforced concrete (R/C) four-story class-room building with a penthouse suffered moderate damage by the 2011 East Japan Earthquake was studied by seismic performance evaluation and non-linear earthquake response analysis to a multi-degree of freedom system.

The class-room building, which is located on the Hoshakuji-plateau at an eastern suburb area of Utsunomiya City in Tochigi prefecture, was designed according to old seismic code and constructed in 1979. The building is supported by PC pile foundations with a length of 21 m. A representative span length in a longitudinal direction is 8.7 m. A typical column has width of 600 mm and depth of 700 mm to a longitudinal loading direction, reinforced by plain-bar-hoops with a diameter of 13 mm spaced at 100 mm on centers whose shear reinforcement ratio is 0.44 %. The building had not been retrofitted at the 2011 Earthquake although the seismic capacity indices I_s for the first to third stories in a longitudinal direction did not satisfy a required value of 0.70 as mentioned later.

Damage to short columns with a shear span ratio of 2.3 was pronounced in a north frame, where one column in the first story, two columns in the second story, and one column in the third story failed in shear. Shear cracks classified as Grade 2 or 3 occurred for other columns in the whole north frame. Minor shear and flexural cracks occurred for long columns in a south frame. Shear walls without boundary columns with a width of 120 mm in a longitudinal direction failed in shear in the first and second stories and suffered severe shear cracks of Grade 3 in the third story.

Residual seismic capacity of the building after the earthquake was estimated to be 0.74 times the seismic capacity before the earthquake for the second story in a longitudinal direction, whereas that for the first and third stories was larger than that for the second story, i.e., 0.86 times and 0.84 times the original capacity respectively. Damage to the fourth story was very slight. Thus the damage of the building was classified into the moderate level at the second story in a longitudinal direction.

The seismic capacity evaluation of the building according to the second level procedure in "Standards for seismic performance evaluation of existing reinforced concrete buildings," which was issued from Japan Building Disaster Prevention Association (JBDPA) in 2001, was carried out by using an available computer software called "RC Shindan 2001 Vr2". Concrete compressive strength which was obtained by a cylinder test using drilled cores from the building ranged from 28.1 MPa to 35.6 MPa. Concrete compressive strength of 26 MPa was adopted for the seismic capacity evaluation. The structural design index, SD, and the time index, T, was evaluated to be 0.93 and 0.99 respectively.

The seismic capacity index I_s in a longitudinal direction for the building was 0.69 for the first story, 0.54 for the second story, 0.63 for the third story, which were less than the standard requirement of 0.70, and 0.98 for the fourth story. The seismic capacity index I_s for the second story was smallest among stories. The seismic capacity

index I_s in a transverse direction ranged from 1.52 to 2.66, indicating sufficient lateral load carrying capacity due to many shear walls.

Non-linear earthquake response analyses to a multi-degree of freedom system were carried out by inputting earthquake accelerations in a east-west direction measured on the ground surface at Utsunomiya, Mohka, Haga and Mashiko observatories. A critical viscous damping ratio of 3 % was assumed to be proportional to the instantaneous stiffness of the building. A tri-linear envelope curve was provided to the hysteresis model for each stories with yield strength equal to the lateral story capacity obtained by the seismic capacity evaluation above-mentioned. The origin-oriented model was used for hysteresis rules for the first and second stories, providing a yield story drift angle of 0.4 % which corresponds to the ductility index F of 1.0. In contrast, Takeda model was used for hysteresis rules for the third and fourth stories, providing a yield story drift angle of 0.67 % which corresponds to the ductility index F of 1.27. A natural period of the multi-degree of freedom system was 0.28 second.

A response story drift angle for the third story was largest among stories to all earthquake motions, which attained to 3 % to the Haga motion with a largest peak ground acceleration. A response story drift angle for the third story increased to the Haga and Mashiko motions due to yielding of the inelastic spring at the third story. Whereas actual damage to the building was remarkable for the second story, a response story drift angle for the second story was smaller than that for the third story. A response story drift angle for the second story to the Haga and Mashiko motions attained to 0.6 %, which exceeds 0.4 % that is considered as a drift angle where common R/C columns fail in shear during earthquake excitations. This result obtained by earthquake response analyses is consistent with the occurrence of shear failure of second story columns.

Research on Building Vibration Measurement System Using Small Electro Accelerometers

Kazuhiro KITAYAMA and Kazushige YAMAMURA

This research is a fundamental study to exhibit distinctly an effect of seismic retrofit to an existing building by measuring vibration characteristics of the building before and after seismic retrofit. Small electrical accelerometers are developed by applying new technology of a micro electro mechanical system which is abbreviated as MEMS to measure a micro-tremor and a strong motion induced by earthquakes of a building. The MEMS type accelerometers used in the study are made by Fuji Electric Co. Ltd., and have a high resolution of 0.02 gal to a horizontal motion and 0.07 gal to a vertical motion.

Therefore, an observation system was constructed by using some MEMS type accelerometers placed in a building, and effectiveness of a big data correcting system through the internet was investigated. For this purpose, one MEMS type accelerometer was placed on the ninth floor of a 9-story reinforced concrete building at Tokyo Metropolitan University and another on the first floor of a testing laboratory adjacent to the 9-story building, which is regarded as equivalent to the free ground surface to measure tri-directional micro-tremors and earthquake strong motions. Then, elementary investigation such as an analysis to take a natural period of the building was carried out using the observation system.

Estimation of Earthquake Resistant Performance for Prestressed Reinforced Concrete Beams in Frame Forming Beam Yield Mechanism

Kazuhiro KITAYAMA

Deformation capacity at peak flexural strength for a prestressed reinforced concrete (PRC) beam in moment-resisting frames forming beam yield mechanism can be estimated by a simple formula proposed by Kishimoto at Osaka University. The Kishimoto's proposal was derived from a regression analysis based on parametric studies by section analyses assuming that plane sections remain to be plane. The proposed method, however, is not verified through laboratory tests using beam-column subassemblage specimens.

Therefore, past tests conducted by Tokyo Metropolitan University for 21 PRC beam-column subassemblage specimens, i.e., 17 plain interior beam-column specimens, 2 plain exterior beam-column specimens and 2 interior beam-column specimens with slabs and transverse beams, were used to verify accuracy of PRC beam deformation capacity estimated by the Kishimoto's proposal at peak flexural strength. Computed deformations of 72 data among 80 data obtained from 40 beams under positive and negative loading respectively underestimated test results. Since an average ratio of a estimated deformation to a deformation obtained by the test was 0.64, and the standard deviation was 0.33, the accuracy of beam deformation capacity estimated by the Kishimoto's proposal at peak flexural strength was inferior. This great discrepancy between computed and tested deformations may be attributed to some uncertain factors involved within the Kishimoto's proposal such as the strain compatibility factor F proposed by Muguruma which can be used to consider indirectly bond action along post-tensioning tendons and a beam hinge length which is arbitrarily determined by users.

Jiro TAKAGI and Toshiki ENDO

Experimental Performance Evaluation of Splice Joints for Timber Structures using Steel Pipes and High-strength Bolts

Jiro TAKAGI and Toshiki ENDO

A splice joint system for timber members was proposed and its performance was evaluated experimentally. The joints are composed of a steel plate and high-strength bolts. Bending moments in the timber members are converted to coupled bearing forces in the bolted connections between the steel and timber. The bearing strength of each bolt is enhanced through the use of doubly placed steel pipe sleeves. Experiments for the connections and splice joints were conducted. The bolt connections were found to have sufficient bearing strength to allow for yielding of the steel plates as the primary failure mechanism of the splice joints. It was also found that the bending stiffness and strength of the splice joints are equivalent to that of the timber members.

Seismic Performance Evaluation of Existing Wall-type Precast Reinforced Concrete Residential Buildings

Jiro TAKAGI and Toshiki ENDO

A significant number of wall-type precast reinforced concrete (WPC) residential buildings exist in Japan that were constructed more than 30 years ago but maintain good structural quality and seismic strength. In order to utilize this building stock, structural renovation is needed such as opening shear walls and addition of elevators, and seismic performance of pre and post renovation is to be evaluated. In authors' previous research, static pushover analysis models were created for standard existing WPC residential buildings under seismic load in the transverse direction. In this research, the models were extended for load in the longitudinal direction. The maximum base shear coefficient, which is defined as the ratio of lateral force to the building weight, is 0.81, and the preliminary failure mechanism is beam yielding, in addition to a limited number of beam shear failures, shear cracking of walls, and bearing failure of the vertical joints. The maximum strength and the failure mechanism calculated using an existing simple seismic performance evaluation method reasonably agreed with that obtained by the models.

Seismic Reinforcement of Existing Japanese Wooden Houses using External Galvanized Thin Steel Plates

Jiro TAKAGI and Toshiki ENDO

There are approximately 24.5 million wooden houses in Japan and roughly 40 percent of them are considered to have inadequate seismic-resisting capacity. Therefore, seismic strengthening of these wooden houses is an urgent task. However, it has not been quickly done for various reasons, including cost and inconvenience during the reinforcing work. Residents typically spend their money on improvements that more directly affect their daily housing environment (such as interior renovation, equipment renewal, and placement of thermal insulation) rather than on strengthening against extremely rare events such as large earthquakes. Considering this tendency of residents, a new approach to developing a seismic strengthening method for wooden houses is needed.

The seismic reinforcement method developed in this research uses galvanized thin steel plates as both shear walls and the new exterior architectural finish. The existing finish is not removed and the space between the new and existing finishes is used for thermal insulation, which is generally insufficiently installed in old Japanese wooden houses. Because galvanized steel plates are aesthetic and durable, they are commonly used in modern Japanese buildings on roofs and walls. Residents could feel a physical change through the reinforcement, covering existing exterior walls with steel plates. Also, this exterior reinforcement can be installed with only outdoor work, thereby reducing inconvenience for residents since they would not be required to temporarily move out during construction. Durability of the exterior is enhanced, and the reinforcing work can be done efficiently since perfect water protection is not required for the new finish. In this method, the entire exterior surface would function as shear walls and thus the pull-out force induced by seismic lateral load would be significantly reduced as compared with a typical reinforcement scheme of adding braces in selected frames. Consequently, reinforcing details of anchors to the foundations would be less difficult.

In order to attach the exterior galvanized thin steel plates to the houses, new wooden beams are placed next to the existing beams. In this research, steel connections between the existing and new beams are developed, which contain a gap for the existing finish between the two beams. The thin steel plates are screwed to the new beams and the connecting vertical members.

The seismic-resisting performance of the shear walls with thin steel plates is experimentally verified both for the frames and connections. It is confirmed that the performance is high enough for bracing general wooden houses.

Seismic Performance Evaluation of Multi-story Buildings composed of Shipping Containers

Jiro TAKAGI and Toshiki ENDO

The seismic response behavior of five-story buildings, which are composed of shipping containers for their structures, was evaluated analytically. During shipping, containers are tightened each other at their cast corners with unique connecting gears. Various benefits can be obtained by applying this connecting and stacking system of containers to building structures, such as rapid construction time, low cost and reuse potential. The nonlinear analytical models included the contact and friction behavior between the connecting gears and cast corners. Under multiple earthquake ground motions normalized to a maximum velocity of 500mm/sec, major structural damage was not found, suggesting that the use of shipping containers to create building structures is feasible.

Noriko TAKIYAMA

Structural Properties and Seismic Performance Evaluation of Unique Wooden Frame Using Oblique Nuki

Noriko TAKIYAMA, Yasuhiro HAYASHI (Kyoto Univ.)

The 1927 Kita-Tango Earthquake (M7.3) occurred at the foot of Tango Peninsula in northern Kyoto, more than 5 thousand houses collapsed because of the shallow hypocenter. There is Ine district at Tango Peninsula, which was registered as IPDGH (Important Preservation District for Groups of Historic Buildings) in 2005. The intensity of 6 on the Japanese seven-stage seismic scale was recorded near Ine; nevertheless, we were unable to find documents recording damage to any boat houses. Hence, it is very important that we understand the structural characteristics of boat house construction. So, we evaluated seismic performance for traditional wooden frame with oblique nuki of boat house in Ine, Kyoto. First, we investigate existing boat houses to understand structural characteristics and the details of wooden frame construction using the oblique nuki form of joints. Next, we conducted cyclic loading test and understand seismic characteristics of frame with oblique nuki. Based on the experimental result, we simulate roughly by simple method. Furthermore, we estimate yield base shear coefficient as indicator of seismic resistance on an existing boat house as an example.

Research on Out-of-plane Vibration Characteristics of Reinforced Masonry Walls

Noriko TAKIYAMA, Yasuhiro HAYASHI (Kyoto Univ.)

Recently, many self-governing bodies and groups tried to preserve or restore historic masonry constructions as symbol of local history and culture. But, these masonry walls don't generally reinforce, and seismic performance is not clear. In past paper, we have conducted microtremor measurement for masonry walls of historic constructions before and/or after reinforcement by steel frame or RC shear walls. Therefore, out-of-plane vibration characteristics of masonry walls were clarified. Furthermore, we were modeling masonry wall with beam elements and conducted eigenvalue analysis to understand the change of vibration characteristics following reinforcement; such as moment of second order of steel, thickness of RC walls etc.

Kiwoong JIN

Seismic Capacity Evaluation of RC Frame with URM Infill Wall

Kiwoong JIN, Yoshiaki NAKANO (The Univ. of Tokyo), and Ho CHOI (The Univ. of Tokyo)

In parts of the world where earthquakes frequently occur, damaged RC buildings often have unreinforced masonry (URM) infill wall, and the seismic capacity evaluation of URM infill wall built in boundary RC frame is necessary. In this study, the failure mechanism and lateral load bearing capacity of RC frame with URM infill wall along with the lateral drift angle are experimentally investigated from cyclic loading tests, and the seismic performance evaluation focused on the backbone curve is also discussed.

ENVIRONMENTAL ENGINEERING

Nobuyuki SUNAGA

Research on Comfortable Bioclimatic Architecture

Nobuyuki SUNAGA

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 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 BA and to establish evaluation methods which are simple and widely acceptable for the public. We have been engaged in the research of these themes, and, in recent years, we give high priority to improve building stocks.

In this academic year, we mainly carried out following studies and activities.

1. Environmentally Friendly School (Eco-School)
 - (a) Performance of Cool/Heat Pit; we have been measured and examined the thermal performance of four Eco-Schools which have different heat/cool pits (CHP). In this year we clarified the influence of length and shape of beams in pit to the CHP performance by measurement results and CFD analysis.
 - (b) Energy Consumption and Architectural Standard of High Schools in Tokyo; as a part of Leading Project of our university, "Constriction Technologies Accelerating the Environmental Load-Reduction for the Society that Utilizes Metropolitan Building Stock", we are studying about the effective energy conservation methods for high schools in Tokyo. In this year we clarified the influence of plan and established year of school building to the energy consumption. And also we showed the necessity of much role for architectural specification for the New Tokyo Energy Efficiency Specifications 2014.
2. Development of Insulated Door at Inside of Window (IDiW)

From 2008 we have been showing the high thermal performance of IDiW, that is the insulated doors installed at the inside of windows. In this year we examined the thermal and lighting performance of Taiko-Shoji with new translucent heat insulation material. The idea for this new Taiko-Shoji will apply for a patent.
3. Effect of Home Energy Management System (HEMS)

We have been studying the effect of HEMS on the energy conservation in detached houses with PV system by filed measurement and questionnaire survey, collaborating with a house maker from 2010. In this academic year, we carried out 14 times questionnaires for 76 families to study about the recommendation extent of energy saving action and life-style for each family. We are examining about the energy saving actions which have little stress and easy continuation.
4. Long-life, Environmental Friendly House by Tokyo Metropolitan Government

We have started a research about high performance detached houses designed by TMG's project, named "Log life, Environmental Friendly House". We installed thermometers into 12 houses and start to check the data collected by HEMS.
5. Refinement of Japanese Wooden House

We are studying about the energy and thermal performance of a Japanese wooden house refined in 2011 (built in 1983). In this refinement, new thermal insulation methods are adopted and several IDiW, above mentioned, were installed. A PV system of 3.2 kW was newly installed, too. In second year, the energy consumption of this house was about 6,000 kWh and the power generation by PV was about 4,400 kWh, therefore the solar power rate is about 74
6. Effect of Thermal Insulation/ Strategies for Disasters for RC Apartment House in TAMA NEW TOWN

We started a research about the effect of out-side thermal insulation for RC apartment houses in TAMA NEW TOWN. In this year, we clarified the effect of thermal insulation (thick outside insulation and evacuated glass for windowpane) at the surface temperature and vertical temperature difference of room from monitoring and questionnaire results of 10 buildings, 146 families. We also examined it from the viewpoints of strategies for disasters and smart city.
7. Active Energy-Saving Control System for Air-conditioning Utilizing Adjustment Behavior of Occupants

A new energy-saving control system for Air-conditioning has been developed. This system is able to install to the existing small and medium-sized building and to reduce the room conditioning deterioration by energy-saving action. This system utilizes SaaS-type BEMS to manage and operate the equipment remotely via Internet and is characterized by sensing occupants' on/off operation onto the air-conditioning. In this year we monitored an office in mid-size building in Tokyo and analyzed the effect of this system.
8. Other outcome
 - (a) N. Sunaga joined a workshop held at Paris-East University in October 2013 and did a presentation titled by "Scientific analysis and technical solutions for energy conservation of building stock -Key findings of TMU Lead Project-".
 - (b) N. Sunaga was invited from The School of Civil Engineering and Architecture, Zhejiang Sci-Tech University in China and gave a lecture titled by "Save the Earth! Make ZEB Come True!", and also discussed about the international exchange program. Agreement between both universities will be signed at April in 2014.
 - (c) N. Sunaga joined Smart-Life Symposium held at Yonago City in Shimane prefecture at January 2014 and did a presentation titled by "Necessity for Smart Town - Thorough Energy Saving -".
 - (d) N. Sunaga is the chair of the 4th filed "Innovative Bioclimatic Architecture" of GRE2014(Grand Renewal Energy 2014)international conference which will be held at Tokyo Big Site in July. We submit

5 papers to the conference.

- (e) N. Sunaga is working by the Vice-president of Japan Solar Energy Society and the chairman of Thermal Environment Committee of Architectural Institute of Japan.

Akihiro NAGATA

Effect of Chairs on the Thermal Sensation When Seated

Akihiro NAGATA

Although people spend a significant amount of time sitting chairs in buildings, few studies explicitly address the effect of chairs on thermal sensation. There are several effects of chairs on thermal sensation such as the heat conduction via contact body parts, the radiation shielding by a chair and the change of the heat convection characteristics. In this study, we have investigated the effects of chairs on thermal sensation by votes, skin temperature and heat flux of the research participants. We have also developed simulated soft thighs for a simple estimation.

Thermal and Anti-Dew Performance Performance of the Window

Akihiro NAGATA

The thermal performance of the window vary a great deal depending on shading devices. In this study, a simple model considering vertical temperature distribution in a tall frame cavity have been proposed for evaluating thermal and anti-dew performance of the window.

Masayuki ICHINOSE

Development and verification of radiative cooling and heating system assisted by a slight air flow

Masayuki ICHINOSE, Nobutaka FUKUDOME, Kitaro MIZUIDE (Nikkensekai Co., Ltd.), Kazuki YAMADA (TONETS Corp.)

This is a project for head-office building newly planned. The characteristic of this system is that radiative cooling and heating panel is equipped in overall ceiling and ventilation air is flowed intentionally to enhance thermal comfort. For high efficiency of the air conditioning system, the temperature of circulating water is moderate and Desiccant air handling unit is installed. As the preliminary study, we built the mock-up of the office space and subject test for thermal comfort was conducted.

Study on the actual environmental performance of commercial and office buildings in Asian cities

Masayuki ICHINOSE, Ngyuen DONG GIANG, Nobutaka FUKUDOME, Wong NYUK HIEN (National University of Singapore), Pattaranan TAKKANON (Kasetsart University)

Most of the operating commercial and office buildings may often have some problems concerning about indoor climate and energy consumption, because actual performance of this kind of buildings are often different from assumed performance. For example, excessive capacity of HVAC system that includes chiller, pump, pipe, fan, duct and coil may cause low system performance and unadequate indoor climate. The most important point is that actual performance of these buildings should be clarified, improved and verified by the observational study.

Retro-reflecting window film with spectral selectivity against near-infrared solar radiation for improving thermal environment of inside and outside buildings

Masayuki ICHINOSE, Takashi INOUE (Tokyo University of Science), Wong NYUK HIEN (National University of Singapore)

Solar heat shielding against solar radiation over the entire building envelope is one of the most effective measures for achieving air-conditioning energy savings and preventing heat-island phenomena in warmer climate regions. In this paper, we propose a new heat-shielding film, which possesses a retro-reflective property and a wavelength-selection property, while having the same degree of transparency as transparent glass. It is comparatively easy to apply the film proposed herein to a wide variety of buildings and architecture, including new and existing buildings. The proposed film embodies an innovative heat-shielding technique that makes it possible to effectively return solar radiation toward the sky, while minimizing the secondary effects to other buildings, to the ground, and so on. In order to verify these effects, several aspects of quantitative evaluation are demonstrated.

Investigation of practical calculation model for solar heat and light considering spectral characteristics of solar and building facade

Masayuki ICHINOSE

This research suggest practical and accurate calculation model. This model reflect spectral characteristics of solar and building facades by using color temperature of black body for visible radiation and two wave-bands including Ultra violet and visible and Near infrared for overall solar heat radiation. Approximate method of color temperature and two wave-bands are verified in the various conditions of solar altitude and climate. This study is based on the long-term spectral solar irradiance data that is separated to direct and diffuse components.

Development of integration of Building Information Modeling and architectural environmental simulation

Masayuki ICHINOSE

Integrated scheme for HVAC design including heat load simulation, studying system and stream of air was investigated and verified. This scheme includes the process that convert from building model described by International Foundation Classes to elements for the architectural environmental simulation including heat load and Computation Fluid Dynamics. In this process, the versatile method is found out and the desired elements supposed for integrating with the architectural environmental simulation.

Eiko KUMAKURA

Comparison of UV Radiation Shading Effect by Trees on Urban Street Using Simulation tool

Eiko Kumakura, Kazuaki Nakaohkubo(Saga University)and Akira Hoyano(The Open University of Japan)

This study is the effect analysis on ultraviolet radiation environments in the summer in actual urban street for various tree planting types using a numerical simulation tool previously developed. As an index of UV environment, in order to evaluate UV radiation received by the human body in an urban street, we used UV scalar luminance after considering the weighting factor for the surface area of the human body. We planted several types of trees different tree crown shapes and planting position for the street to compare the effects. Simulation results showed that diurnal variations of UV scalar luminance for the tree planting types are different from the direction of human and sky view factor.

Organization of Environmental Data in Coastal Communities Affected by Tsunami and Creating Digital Archives

Eiko Kumakura, Akinobu Murakami(University of Tsukuba), Jan Halatsch(SmarterBetterCities), Antje Kunze(SmarterBetterCities)

CityEngine software was used to derive environmental data and to reproduce the outdoor living space of the coastal community of Iwanuma City in Miyagi Prefecture which was destroyed in the Great East Japan earthquake and tsunami. Working together with the Zurich-based SmarterBetterCities software developer, six communities representing more than 500 buildings were reproduced and typologies for coastal regional residences, outdoor structures and trees (igune, small stand of trees around a house) were created, based on satellite imagery, local surveys and interview-based studies with victims in coastal communities carried out by joint research staff. In the next year, interview-based studies are planned that would use the 3D data that has been created to derive information useful to disaster victims for living in the new disaster-prevention-oriented housing, including ways of utilizing outdoor space.

Development of the landscape design support tool considering micro climate

Eiko Kumakura, Akinobu Murakami(University of Tsukuba) and Shunsaku Miyagi(Nara Women's University)

Solar shading effect of trees is an important factor in passive architecture. This paper discusses about evaluation of planting design by using a thermal simulation tool from the viewpoint of landscape architecture. Tree positions and paved surface materials influence not only the outdoor thermal environment of residential housing, but also the indoor environment by using direct gain system, window opening behavior, etc. Therefore, the effects of trees in several evaluations (e.g., the radiation temperature of outdoor living spaces and the amount of incident solar radiation on the outside walls of the housing) made with a landscape early design process are considered in the practical passive design project. As a result, the use of the simulation tools is expanded not only for visualizing materials, but also for their use as design support.

List of Research Activities

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Tohru YOSHIKAWA

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Katsuhiro KOBAYASHI

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Yukimasa YAMADA

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Sangjun YI

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The Public Facility Problem of the Local Government and the Solution Strategy, Sakura city, Sakura city hall, 2013.5.24

The Introduction of Facility Stock and The Present Condition of Japan, KFMA Annual Seminar., Daewoo Corporation PRUGIO Valley(South Korea), 2013.5.20

The Introduction of Facility Stock and The Present Condition of Japan, International Seminar of Dankook Univ., SungNam city(South Korea), 2013.5.22

The Public Facility Management of the Local Government and the Solution Strategy , Nippon Omni-Management Association, Local Government General Fair, Tokyo Bigsight, 2013.5.15

The Public Facility Management of the Local Government, UCHIDA YOKO Co., LTD., Tokyo Ubiquitous hall CANVAS, 2013.5.11

STRUCTURAL ENGINEERING

Manabu YOSHIMURA

1. Refereed Papers

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Kazuhiro KITAYAMA

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3-3 Manuals / Reviews

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Noriko TAKIYAMA

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Kazushige YAMAMURA

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Kiwoong JIN

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Nobuyuki SUNAGA

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3. Others

3-4 Works / Products, etc.

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Akihiro NAGATA

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Masayuki ICHINOSE

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3. Others

3-2 Research Reports

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Masayuki Ichinose: Actual performance of building facade transmitting heat and light selectively, JCRE Forum, July 2013 (Nominated lecture)

Masayuki Ichinose: Technology and utilization of building system simulation considering operation, JABMEE, Sep. 2013 (Nominated lecture)

Masayuki Ichinose: Evaluation of optical characteristics of solar shielding blind and film, Technical information organization, Sep. 2013 (Nominated lecture)

Tomoaki Takase, Takashi Inoue, Masayuki Ichinose, et.al: Commissioning for system performance of Marunouchi Park Building and Mitsubishi Ichigokan, JABMEE, pp.34-30, Sep. 2013

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Eiko KUMAKURA

1. Refereed Papers

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