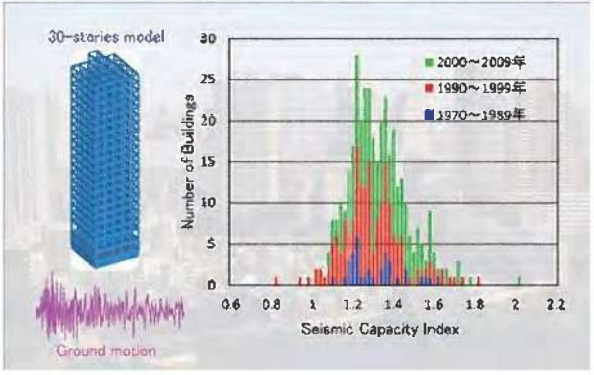
Evaluation of the Seismic Capacity of High-Rise RC Buildings

To date, more than 500 **high-rise RC buildings** have been built in Japan. Typically constructed buildings are demolished in about 30 to 60 years. On the other hand, large buildings, such as high-rise RC buildings, are expected to be used for as long as possible—at least 100 years—for economical and environmental reasons. As a result of such long-term use, it is more likely that these buildings will undergo a large earthquake at some point. Therefore, it is important to enhance **earthquake resistance** by strengthening such buildings.

In this study, we propose a method for expressing the seismic performance of existing high-rise RC buildings using a **seismic capacity index** based on limited published data. As shown in the figure, we can ascertain the percentage of high-seismic-performance buildings versus low-seismic-capacity buildings by analyzing the distribution of seismic capacity indexes across many buildings. Through this analysis, our intention is to highlight the need to enhance earthquake resistance by strengthening buildings.



Analysis model and distribution of seismic capacity indexes of buildings

About Researcher

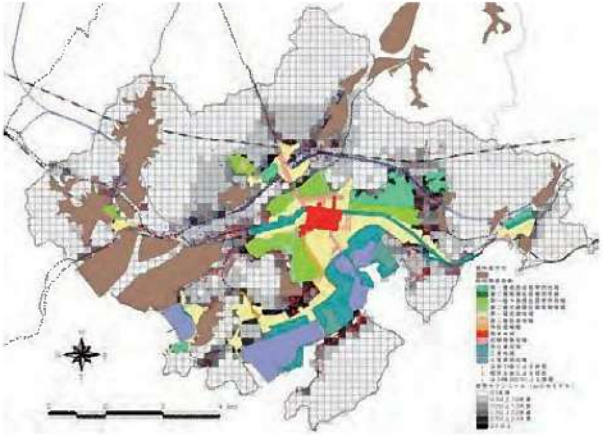
AKITA Tomofusa, Dr.Eng.

Dr.Eng., 2008, Toyohashi University

City Planning and Urban Design Methods for Compact Cities in an Era of Depopulation

This study targets suburban areas and associated city centers during an era of depopulation. We achieved local collaboration by forming a special city planning support organization, studied land use regulations and guidance techniques in suburban areas, and examined **urban regeneration techniques** in city centers. We also demonstrated methods for realizing city planning for entire cities.

Specifically, first we assessed the suburbanization phenomenon from the viewpoint of **land-use** law and clarified and present conditions from the relationship with the hollowing out of city centers. Second, after demonstrating a city planning organization for local collaboration and reviewing its practical effects, we demonstrated an urban regeneration technique for city centers. Third, we demonstrated a technique for supporting the conclusion of formal **agreements** when advancing the city planning enterprise. Fourth, we clarified city planning methods from the viewpoint of reconstruction of the planning units of local cities by municipal mergers or deregulation.



Mesh map of development potential and land use regulations

About Researcher

IKARUGA Shinji, Dr.Eng.

Dr.Eng., 1998, Kyushu University

WEB » http://www.urban.kde.yamaguchi-u.ac.jp/

Evaluation of Seismic Performance of Buildings and Development of New Structural Systems

In Japan, a country known for frequent earthquakes, one important area of performance for buildings is **seismic performance**. In this laboratory, which focuses primarily on reinforced concrete buildings, we study how to make reasonable assessments of the seismic performance of new and existing buildings.

In particular, we continue to develop economical and rational **seismic retrofitting methods** for existing buildings with poor seismic performance, for example steel brace retrofitting, external frame retrofitting, and installation of response control systems using dampers or base isolation. Using experimental laboratory equipment, we conducted **structural experiments** to evaluate the performance of retrofitting methods we have developed.

In addition, we also studied wall-type reinforced concrete buildings, which are primarily used in low-rise housing complexes and which have extremely high earthquake-resistant performance; old brick structures; and new reinforced masonry buildings with high strength.

Laboratory equipment and 1:2.5 scale reinforced concrete frame specimen retrofitted with steel braces

About Researcher

INAI Eiichi, Dr.Eng.

Dr.Eng., 1993, Waseda University

WEB ≫ http://ds22n.cc.yamaguchi-u.ac.jp/~strlab/lab/index.html

Evaluation Methods for a Sustainable Urban Structure

My main research interests are constructing evaluation methods for **sustainable urban structures** and a support system for urban design in regional cities facing serious problems of depopulation, an aging population, and a low birthrate. Therefore, I aim to use GIS to support sustainable **urban planning** based on **spatial statistical evaluation** and forecasts about land use, development activity, environmental burden, and the income and expenditure budget.
Moreover, in urban planning, residents' opinions should be reflected in the plans, for example in how the landscape will be developed and the design of the housing. Therefore, we developed a support tool to enable people to examine both spatial images after the construction work and project evaluation, using a cooperative approach. The support tool is aimed at citizens who can manage their planning area. It was frequently tested in workshops for planning in our previous research projects.

Interactive user interface to visualize the effects of introducing energy-saving and energy-generation technology into a residential area, and a spatial image of the future project site

About Researcher

KOBAYASHI Takeshi, Dr.Eng.

Dr.Eng., 2007, Yamaguchi University

A study on thermal comfort and productivity of zero energy buildings

We study technologies necessary for designing and planning **zero energy buildings** (ZEBs). We are comprehensively investigating technologies for achieving conversion to ZEBs by improving the efficiency of equipment using renewable energy and optimizing operation through load reduction by constructing passive methods such as the improvement of heat insulation performance.

Moreover, in order to achieve a thermal environment that considers the occupants' health and **thermal comfort** first, without their having to endure heat and cold for the sake of energy conservation, we select and operate air-conditioning equipment with the aim of achieving **energy saving** while maintaining it. We will provide zero energy buildings that combine thermal comfort and energy conservation.

The building with which Japan's first ZEB was achieved through renovation. We installed PV panels and solar collectors.

About Researcher

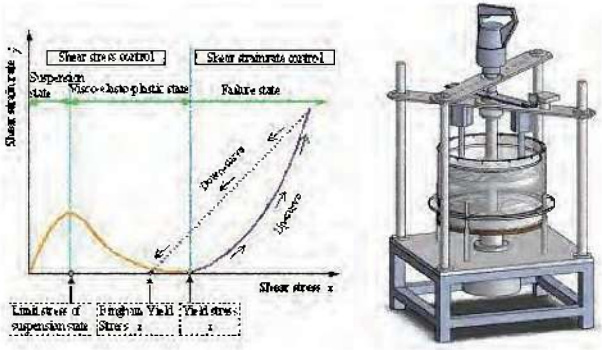
KUWAHARA Ryoichi, Dr. Eng.

Dr. Eng., 2000, Niigata University

Rheological Model and Test Methods for Fresh Concrete

Fresh concrete's properties affect construction efficiency and hardened concrete's quality. Consequently, they need to be evaluated properly, predicted numerically, and optimized according to construction and structural conditions. Hence, one of our research interests is rheology and test methods for **fresh concrete**. We have been involved in the following projects: (1) clarification and **modeling of fresh concrete's rheological properties** by means of a microscopic approach; (2) development of a **rheometer** that can examine the effects of normal stress and measure shear deformation under shear load control in addition to shear flow under deformation rate control; (3) development of a **numerical flow simulation method** that can simulate shear behavior from deformation to flow; (4) development of a **non-destructive method of segregation** of fresh concrete by radial rays; and (5) prediction of the deterioration of hardened concrete due to segregation.

Other research interests include: (a) self-property recovery behavior and improvement technology for fire-damaged concrete, (b) an environmental performance assessment methodology for concrete, and (c) property clarification and development of application technology for geopolymers.



Left: Proposed rheological model. Right: Newly developed rheometer

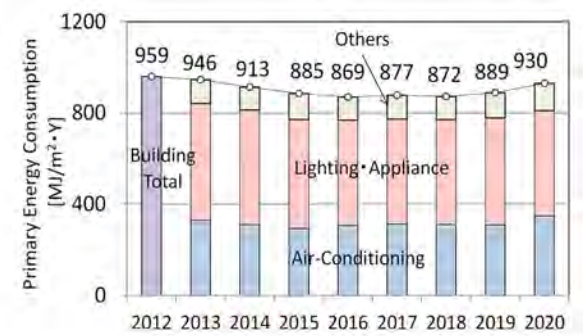
About Researcher

LI Zhuguo, Ph.D.

Ph.D., 2000, Nagoya University

Study for Reduction of Environmental Load and Realization of Comfortable Indoor Environments in Buildings

Human activities bring huge burdens such as waste and CO_2 emissions to the Earth. Buildings are no exception. They consume materials like concrete, steel, fuel, and electricity for construction, and energy and maintenance for operation. Reducing energy consumption or material usage is simply not enough to reduce **environmental loads** if there are not comfortable indoor environments in operating buildings. This way of thinking leads to rationalizing a balance between environmental loads and the indoor environments in buildings. This requires adequate consideration with regard to design assumptions. However, actual **operational conditions** differ usually from the assumptions. This means that the rationalization in the operational phase is necessary to effectively reduce the environmental impact. The purpose of this study is reducing environmental loads and, at the same time, realizing comfortable **indoor environments** in real buildings. Its method contains the rationalization in design and operational phases by means of the combination of prediction, measurement, and operational management.



Energy consumption in buildings changes with social situations like COVID-19. Rationalization requires considerate operational management.

About Researcher

MIURA Katsuhiro, Ph.D.

Ph.D., 2009, Kyoto University

Application of a Biologically Inspired System to Computer Vision

Our research interest lies in how the **human vision system** is realized on several levels, ranging from low to high. We study three vision levels of **brain neuron network models** in the field of biology, low- and high-level functional vision models related to the closing of the eyes in the field of psychology, and **next-generation robots and interfaces** with a hardware vision system and an integrated vision model.

Ongoing research in our laboratory is focused on the following five areas:

1) Human vision realized through computer vision
2) Neuron network vision models in the brain
3) Next-generation vision interfaces
4) Next-generation vision robot with eye movement capability
5) Music information processing applied to vision models

A remote vision system with a three-dimensional vision interface and a vision robot with eye movement capability

About Researcher

MORITA Satoru, Ph.D.

Ph.D., 1993, Hokkaido University

WEB ≫ http://www.vision.kde.yamaguchi-u.ac.jp

Participatory Social Housing Methods around the World

There is a general understanding that Japan is a developed country in terms of architecture. When we look at its planning methods for social housing, however, it seems to be only at a very early stage. The small supply of social housing – less than 4% of the total stock – is still diminishing to prioritize marketization for ownership, while the rich-poor gap is increasing. In addition, the traditional top-down way of supplying causes common problems like deterioration in security. Problems related to post-disaster housing for resettlement are particularly serious. Mass-supplied units are allocated randomly to families, and the single-household elderly often die in units alone because they have been separated from their old neighborhood friends and are reluctant to go out. Participatory social housing needs to be addressed to preserve existing communities and construct new ones.

Our research therefore explores the world's most advanced examples of participatory social housing (such as the cohousing 'People's Plan' in the Philippines, the cooperative housing in Switzerland, and the heritage preservation housing in France) to analyze their methods of architectural and organizational planning in order to realize both quantitatively more and qualitatively better housing for the vulnerable.

The social or ideological contexts are of course different, but the many issues are universal and international learning exchange is worthwhile.

We visit housing designed by people's organizations and conduct housing design workshops in informal settlement areas.
This picture was taken in the Philippines.

About Researcher

SHIRAISHI Rei, Dr.Eng.

Dr.Eng., 2019, Kyushu University

WEB ≫ http://www.urban.kde.yamaguchi-u.ac.jp/

Evaluation and Management Method for Urban Sustainability with a Focus on Urban Design

In order to suggest a better living environment and sustainable urban future, we are interested in **urban design management** that places an emphasis on urban spaces such as architecture, streets, and parks and open spaces. In this work, we are focusing on the following five areas: (1) developing planning methods through spatial analysis from the viewpoint of **TOD (transit-oriented development) and compact city design** in response to the need for a low-carbon society; (2) developing **town management and urban regeneration methods** for sustainable urban growth based on public-private partnerships and citizen participants; (3) predicting and understanding the morphological changes and characteristics of urban spatial structures based on urban planning systems; (4) evaluating and proposing methods for better utilizing urban space such as the areas around train stations, streets, and public spaces to cope with changing social needs; and (5) implementing **smart shrinking management** through the predictive imaging of shrinking cities.

We also promote urban design and management projects in collaboration with local communities and conduct field surveys of foreign cities by studying the unique sustainable forms and types of Asian cities.

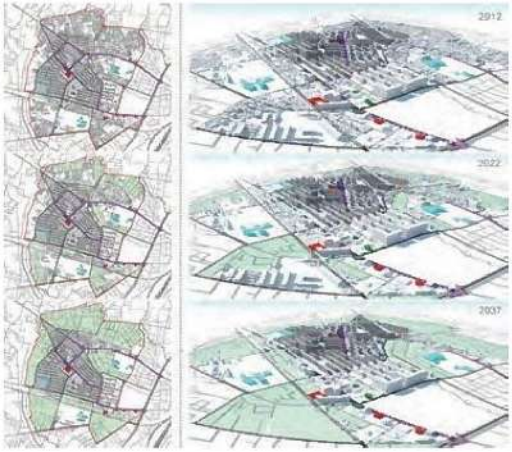


Image of a shrinking city based on population transitions

About Researcher

SONG Junhwan, Ph.D.

Ph.D., 2013, The University of Tokyo

Research on Traditional Folk Houses and Rural Villages

There are various forms of traditional folk houses and rural villages rooted in the natural features and climate of the areas in which they were located in Japan. In addition, traditional habitats that are peculiar to certain areas have been sustained by the wisdom and ingenuity of previous inhabitants.
However, many traditional folk houses and rural villages are facing a crisis as they disappear due to falling population and industrial decline. Therefore, we are now pursuing community development using traditional living environments that are specific to particular regions.
Our research interests are in **spatial composition**, **historical formative processes**, and **traditional dwelling systems** in rural villages as formed by regional customs that reflect local people's lives and livelihoods. Research now underway is focused on the following four areas:

1) Analysis of the spatial composition of traditional rural villages
2) Application of traditional sustainable habitat systems
3) Building of protective systems for cultural scenery
4) Examination of the sustainable value of traditional folk houses in our society

Rethatched roof of a traditional folk house in Yamaguchi prefecture

About Researcher

USHIJIMA Akira, Dr.Eng.

Dr.Eng., 2011, Kyushu University

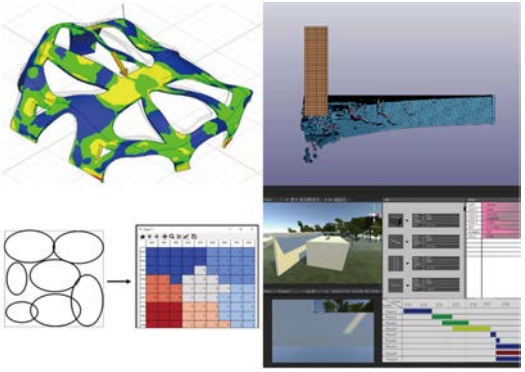
WEB ≫ http://www.nakazono.lab.kde.yamaguchi-u.ac.jp/

Applications of IT & ICT to Structures from Safety and Security to Design and Construction

Recent advances of IT and ICT have been remarkable. We are already receiving many benefits from them, with the things that were science fiction a decade ago but is being real today. They should be actively applied to the design and construction of structures as well. This has been chosen as the theme for our laboratory.

One of our applications of computer-aided engineering (CAE) to the mechanical design of structures is to design **futuristic structures** through repeated modeling, simulation and optimization using IT. Technologies to keep structures **safe and secure against external impacts and explosions** as well as earthquakes are also being studied based on computer simulations.

Furthermore, using artificial intelligence (AI) to assist with **automatically allocating rooms** in a given space and plotting design drawings are being tried. Construction assistance tools have been also developed with which effective information is automatically provided via **assembly in a virtual reality (VR)** space.



Designed futuristic structures / Missile impact simulation // Automatic allocation from an esquisse / Construction simulation tool in VR

About Researcher

YAMADA Kazuhiko, Dr.Eng., P.E.jp

Dr.Eng., 2000, Kyoto University

WEB ≫ https://ds0n.cc.yamaguchi-u.ac.jp/~kansei/