Research and Development Project (FY2008-2010)

# Development of Planning and Management Technologies for the Ultra-long-life Houses


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October, 2008

# 1. Introduction

## 1.1. Social Background

With regard to houses, two of the challenges Japan faces are as follow:

- **"Short life" of houses.** According to the data of houses lost by disaster, demolition and/or natural collapse, the "average life span" of houses in Japan is estimated to be approximately 30 years at present. This is significantly shorter than that of the West.
- **High initial price of newly-built houses.** The initial price of newly-built houses – including their land prices – is said to be 20-30 percent higher than that of the West.

If houses were durable for a much longer term, for 200 years for example, it will not only alleviate the financial burden of the residents, but also reduce industrial wastes.

To overcome the challenges mentioned above and improve the housing conditions in Japan, it is necessary to stop demolishing houses shortly after they are built.

## 1.2. Aim and Purpose

'Development of Planning and Management Technologies for the Ultra-long-life Houses', a three-year project starting this fiscal year, is aimed to promote the "longevity" of newly-built and existing houses throughout research and development of:

- Planning and management system;
- Advanced technologies for check and retrofit;
- Health monitoring for houses;
- Site and infrastructure management;
- Wooden detached houses.

These researches and developments will focus on hardware and software technologies to help ultra-long-life houses be social assets for generations.

## 1.3. Organizational Framework

The project will be carried out with the help of private, academic and public sectors so that the outcomes can be facilitated to apply to government policies and business activities, etc. A study panel will be held several times each fiscal year in order to receive advices from academic experts, etc. The first study panel was held on 10th October, 2008, and the second study panel will be held on 24th February, 2009.

# 2. Outline

## 2.1. Planning and Management System

### 2.1.1. Target Performance Level of Newly-built Ultra-long-life Houses

The target performance level of newly-built ultra-long-life houses (apartments and detached houses) will be developed. In addition to the standard for the house itself, the comprehensive criteria (e.g. seismic safety, conditions of the location, residential environment, and maintenance techniques at a district level) will also be the agenda.

### 2.1.2. Design, Construction and Management Techniques for Newly-built Houses to Embody the Target Performance Level

Design, construction and management techniques to embody the target performance level of newly-built apartments will be developed.

### 2.1.3. Supply Methods for Ultra-long-life Houses

The following promotion measures will be researched and developed in terms of software:

- Measures to promote supply methods suitable for newly-built ultra-long-life houses (apartments); such as lease-hold method
- Measures to promote renovation of existing houses that are appropriate for their performance level
- Measures to secure appropriate maintenances to last for a long term after their construction

## 2.2. Advanced Technologies for Evaluation and Retrofitting

### 2.2.1. Target Performance Level for Improving Longevity of Existing Houses

As the retrofitting techniques need to be appropriate for the performance level and specifications of the existing houses, the target performance level of retrofitting of existing houses (apartments and detached houses) will be considered by grasping the average performance level and specifications of houses built in each period.

### 2.2.2. Design, Construction and Management Techniques for Existing Houses to Embody the Target Performance Level

The evaluation techniques for retrofitting technologies that embody the target performance level and the criteria of specifications after retrofitting will be developed.

### 2.2.3. Advanced Techniques to Diagnose and Evaluate Existing Houses

The following techniques will be developed to promote retrofitting of existing apartments:

- Deterioration diagnosis techniques for existing houses (e.g. endoscopes and robots that support visual inspection, destructive and non-destructive testing methods)
- Evaluation techniques for durability

### 2.2.4. Cost-benefit Evaluation Method for Retrofitting

In consideration of the amount of houses supplied in each period, the average performance level and specifications of existing apartments and wooden detached houses will be put in order by their housing types (e.g. construction period, and structural form).

Then, the cost-benefit evaluation method for standard performance-improving retrofitting techniques will be developed.

### 2.2.5. Technologies to Improve Performance Based on the Evaluation of Performance Level

Standard techniques to improve performance of existing houses will be developed as a package. Each package will be appropriate for each housing type (e.g. construction period, and structural form).

## 2.3. Health Monitoring for Houses

### 2.3.1. Techniques to Assess the Soundness of Houses

Focusing on health monitoring system that uses information and communication technology, a survey of measurement, communication and analysis techniques (system techniques) such as sensor network will be conducted. We expect to apply health monitoring technologies to houses (mainly to re-enforced concrete apartments) in order to assess their soundness.

### 2.3.2. Diagnostic Technologies

To sophisticate the maintenance/management techniques of the ultra-long-life houses, a prototype for health monitoring system will be developed by clarifying the technical requirements for a simple but accurate monitoring system. This new diagnostic technology for houses is expected to be an alternative, or at least a complementary method for visual inspection by engineers.

### 2.3.3. Maintenance/Management Technologies Using Health Monitoring System

Techniques to apply health monitoring system will be developed with regard to:

- how to introduce the system;
- how to acquire and analyze data;
- how to judge the necessity for further investigations.

These techniques will be adaptable for houses with:

- different forms and sizes;
- different target performance levels of maintenance/management;
- different types of maintenance/management.

### 2.3.4. Technologies to Functionary Recover Deteriorated Structure and Damaged Parts

Technologies to evaluate the possibility of functional recovery will be developed with regard to:

- how to identify deteriorated/damaged parts using health monitoring system;
- how to repair/renovate deteriorated/damaged parts.

## 2.4. Housing Site and Infrastructure Management

### 2.4.1. Target Performance Level of Housing Sites

The target performance level and indicators for site planning, ground safety and infrastructure management that support ultra-long-life houses will be developed in terms of disaster prevention, long-term maintenance, updating, universal design and regional identity.

### 2.4.2. Seismic Safety of Houses Sites

Advanced technologies to improve seismic safety of housing sites will be developed by conducting an experiment to see how well injecting micro-bubble water into the ground mitigates liquefaction.

To contribute to sustainable development, the main focus will be on the improvement of existing housing sites rather than the development of new housing sites as Japan is said to face depopulation in the near future.

Technologies that are harmless to humans and the environment, space-saving and cost-saving are prioritized.

### 2.4.3. Updatable Space for Pipes and Wire Equipments

Prototypical design of advanced storage infrastructure for service equipments (e.g. water pipes, sewerage, electric and telecommunication wires) will be developed in order to facilitate smarter and easier renewal and updating.

# 3. Members of the Study Panel

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| Chair: | FUKAO Seiichi, | Professor, Department of Architecture,<br>Graduate School of Urban and Environmental Science,<br>Tokyo Metropolitan University |
| Committee: | IGARASHI Ken, | Visiting Professor, Research Institute,<br>Faculty of Science and Engineering,<br>Waseda University |
| | KOBAYASHI Hideki, | Professor, Department of Architecture and Urban Science,<br>Graduate School of Engineering,<br>University of Chiba |
| | KOMATSU Yukio, | Professor, Department of Architecture,<br>Faculty of Creation Science and Engineering,<br>Faculty of Science and Engineering,<br>Waseda University |
| | OHASHI Yoshimitsu, | Professor, Department of Architecture,<br>Faculty of Engineering,<br>Musashi Institute of Technology |
| | SAITO Hiroko, | Professor, Department of Real Estate,<br>Faculty of Real Estate,<br>Meikai University |
| | SUEMASA Naoaki, | Professor, Department of Urban Engineering,<br>Faculty of Engineering,<br>Musashi Institute of Technology |
| | MATSUMURA Shuichi, | Professor, Department of Architecture,<br>Graduate School of Engineering,<br>University of Tokyo |
| | MINAMI Issei, | Professor, Department of Architecture,<br>Faculty of Engineering,<br>Shibaura Institute of Technology |
| | MITA Akira, | Professor, Department of System Design Engineering,<br>Faculty of Science and Engineering,<br>Keio University |
| | YASHIRO Tomoya, | Vice Director/Professor,<br>Institute of Industrial Science,<br>University of Tokyo |

(Committees are in alphabetical order)

Secretariat: National Institute for Land and Infrastructure Management(NILIM)
a member of Ministry of Land, Infrastructure, Transport and Tourism(MLIT)