Design Strategies for Activating Public Housing Stock
Learned through the Development of an Elevator Addition System

Kozo KADOWAKI, M. Eng. [1]
Seiichi FUKAO, Dr. Eng. [2]
Shinji YAMAZAKI, Dr. Eng. [2]
Katsuhiro KOBAYASHI, Dr. Eng. [2]
Makoto TSUNODA, Dr. Eng. [3]
Susumu MINAMI, Dr. Eng. [4]
Hitoshi OGAWA, M. Eng. [5]
Kenichi TAHARA, M. Eng. [5]

[1] Assistant Professor, Department of Architecture and Building Engineering, Tokyo Metropolitan University, 1-1, Minami-osawa, Hachioji-shi, Tokyo 192-0397, JAPAN, kkad@tmu.ac.jp
[2] Professor, Department of Architecture and Building Engineering, Tokyo Metropolitan University
[3] Associate Professor, Department of Architecture and Building Engineering, Tokyo Metropolitan University
[4] Assistant Professor, Department of Architecture and Building Engineering, Tokyo Metropolitan University
[5] Doctoral Student, Department of Architecture and Building Engineering, Tokyo Metropolitan University

Keywords: Mass-housing, Aged Residential Building, Barrier Free, Elevator Addition

Abstract
Various government authorities and public corporations built a huge number of dwellings for rent to accommodate the high concentrations of population in urban areas in the mass-housing era between 1955 and 1973 in Japan. These are four- or five-story reinforced concrete buildings; however, they only have stairway access. Housing estates that have a large number of elderly people urgently require the addition of elevators to make access more convenient. This paper presents the development of a new elevator addition system for such deteriorating aged residential buildings. Furthermore, we discussed some design strategies to bear in maind when activating aged housing stock learned from the development, to put it concretely, to increase the various value of a dwelling, to give flexibility to the system design, and to increase diversity in the housing estate.

1. Background and Objectives
In Japan, there is a huge volume of public residential buildings for rent built in the mass-housing era between 1955 and 1973. They were built on a massive scale in the same estate in a short period, to supply the dwellings more efficiently to reconstruct war-damaged cities and to accommodate the high concentrations of population in urban areas. Today, 30 years or more have passed since they were built, and some problems are now arising in such old housing estates.
One of the most serious problems is the rapid increase in the numbers of elderly people. However, most of the aged public residential buildings only have stairway access though they are four or five stories high. The objective of this paper is to develop a new technology to add elevators to aged residential buildings to facilitate access. Furthermore, we consider some design strategies to bear in mind when activating the aged housing stock obtained through this development.

Fig. 1 Housing Estate Built in the Mass-housing Era

Fig. 2 Residential Building with Added Elevator Towers

Fig. 3 Residential Building with Added Access Corridors

2. Review of Existing Elevator Addition Technologies and Set Goal of Development

Some technologies for adding elevators to aged residential buildings built in the mass-housing era (Kadowaki et al. 2005) already exist. One solution is the addition of an elevator tower to each staircase of the building. This method requires no repair to the existing building. However, it does not achieve barrier free access to the dwelling because the elevator car has to stop at the landings of stairways, so that the residents have to go up or down half the story height on foot.

A recent alternative is to add access corridors and an elevator tower to the building to achieve barrier free access. This method requires changing the position of the entry to the dwelling unit, followed by drastic change to the existing structural frame and interior layout, so that the residents have to move during the renovation work. It constitutes an obstacle to renovating the residential buildings, which are located in a small housing estate or in a housing estate in urban areas, by reason of the difficulties to secure substitute addresses. The higher cost of renovation and the longer term required for the residents' consensus caused by the entire building renovation are also obstacles.

Based on such review of the existing methods, we set the goals for the development method as follows:

1) To achieve barrier free access to the dwelling.
2) To make it possible to renovate each staircase (not the entire building) to facilitate obtaining the residents' consensus.
3) To reduce the renovation cost.
4) To make the additional part as a self-standing structure that will not incur structural loads on the existing building.
5) To facilitate renovation work that does not compel residents to move.

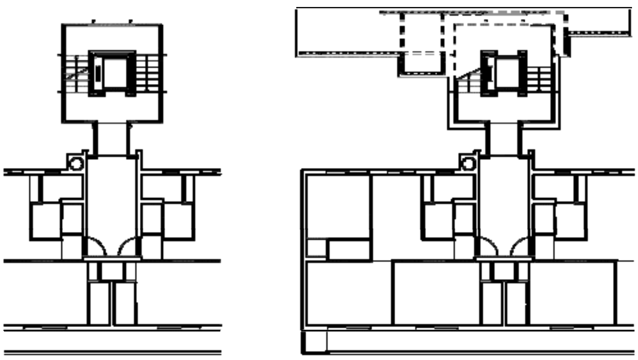

Fig. 4 Typical Floor Plan and Ground Floor Plan of the Experimental Elevator Addition System

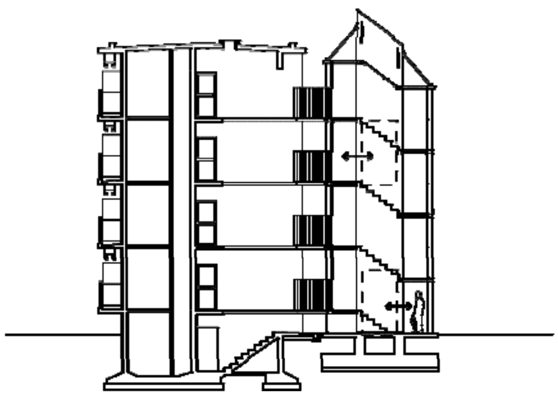

Fig. 5 Cross-section of the Experimental Elevator Addition System

3. Developed Elevator Addition System

3.1 Setup of the System

We developed a new elevator addition system which achieves the set five goals. Furthermore, we designed the system in detail and constructed it experimentally to verify its feasibility. Partial floor plans and a cross-section of the experimental elevator addition system are shown in Fig. 4 and 5.

The developed system consists of three main parts: elevator/stair tower unit, connection unit, and approach lobby unit. The elevator addition process is as follows: firstly, the elevator/stair tower unit, consisting of an elevator shaft and stairs installed in a spiral design encircling the shaft, is installed on the outside of the existing staircase. Next, the existing stairs are removed and the elevator/stair tower unit and the existing building are connected via the connection unit, which consists of new floors installed in the vacant stairwell and bridges. As the occasion demands, the approach lobby unit is built at the same time as constructing the unit. Let us now look at each unit in detail.

3.2. Elevator/Stair Tower Unit

The elevator/stair tower unit, which is the main part of this system, is designed to be compatible with a compact elevator to reduce the renovation cost in consideration of the limited number of the serving dwelling units and infrequency of use.

We determined the smallest elevator car size as being within the limit of accommodating one wheel chair user and one aide, and adopted the elevator with front and rear opening to facilitate a wheel chair user’s access without installing a long ramp in place of the ground floor steps. Miniaturizing the elevator with front and rear opening is also effective because it does not compel the wheel chair user to turn around when getting in and out.

On the other hand, miniaturizing of the elevator causes structural instability of the narrow elevator shaft in an earthquake. We solved this problem with the use of slender tension rods around the elevator shaft which tie the trussed cantilevers from the top of the shaft and the foundation as shown in Fig. 7 in order to bear horizontal load.

The stairs and landings encircling the shaft are hung from the rods without supports to avoid an oppressive view from the dwelling and to give a lighter impression of the elevator shaft.

It should also be added as a device of the elevator/stair tower unit that we reduce the use of steel in quantity to reduce cost, for example, by using the stringers both as braces of the elevator shaft.

3.3 Connection Unit

The connection unit consists of the new floor slabs installed in place of the removed concrete stairs of the existing building, and the bridges between the elevator/shaft unit and the existing building. The

Fig. 6 Experimental Elevator Addition System

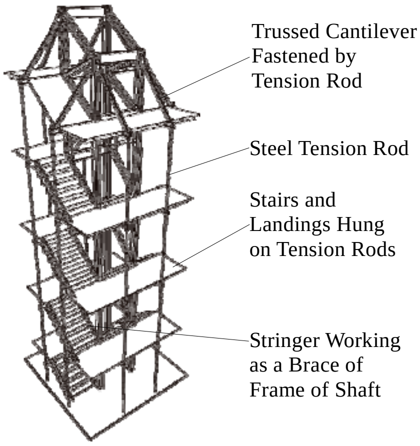

Fig. 7 Structural System of Elevator/Stair Tower Unit

Fig. 8 New Floor Installed in Vacant Stairwell

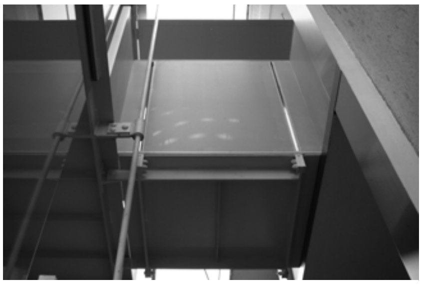

Fig. 9 Connecting Bridge

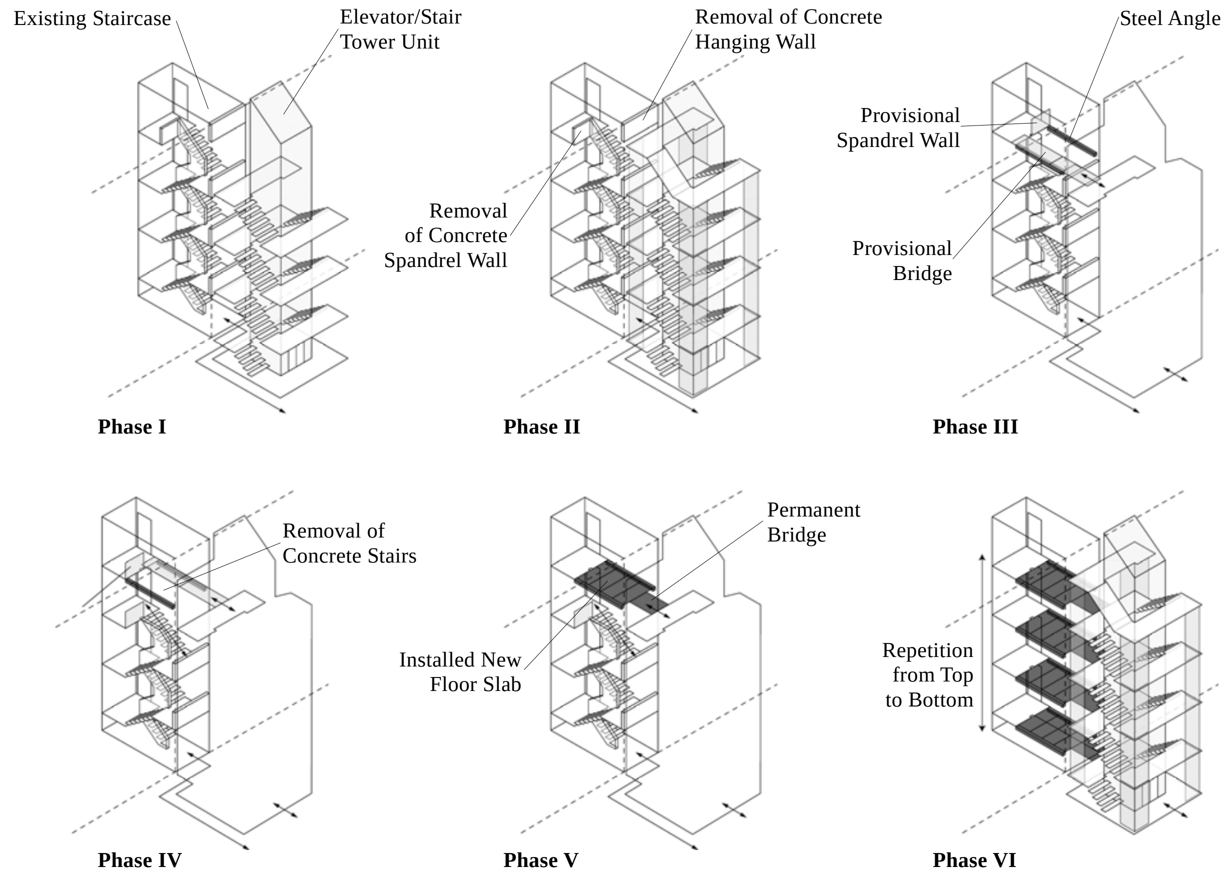

Fig. 10 Renovation Process

new floor is built from the pre-stressed concrete panels supported by steel angles attached to the concrete walls of the vacant stairwell. The bridge is built from the steel plate with ribs. The bridge works as an expansion joint between the elevator/stair tower unit and the new floor in an earthquake because the elevator/stair tower unit and the existing building are different in their shaking motions.

We designed this connection unit to be compatible with facilitating renovation work that does not compel residents to move. The renovation process is shown in Fig. 10.

Firstly, the elevator/stair tower unit is installed on the outside of the existing staircase at intervals of about 1500mm as a passage to allow the residents to use the existing stairs. The connecting work begins from the top floor. The spandrel wall on the top floor of the staircase is removed, and a provisional bridge connects the existing building and the elevator/stair tower unit after attaching steel angles. The provisional bridge allows the residents of the top floor to use the elevator/stair tower unit to access the dwelling, while the residents of the lower floors can use the existing stairs. Then, it becomes possible to remove the existing stairs between the top floor and the right lower floor. After the removal, the new floor slab is installed; the permanent bridge connects it to the elevator/stair tower unit instead of the provisional bridge. When installing the new floor, the residents

Fig. 11 Approach Lobby Unit

Fig. 12 Interior View of Approach Lobby Unit

of the said floor cannot access the dwelling; however, the installation work per floor is finished within two days. The connecting work is completed by repeating this process from the top floor to the ground floor.

3.4 Approach Lobby Unit

We designed this system to be able to add an approach lobby unit to add greater value than achieving barrier free access to the dwelling. The approach unit lobby is able to be designed relatively freely; in the case of the experimental construction, we designed it as a steel structure in the same way as other units. The approach unit allows the equipping of an automatically lockable lobby to increase security.

4. Design Strategies in Activating Aged Housing Stock

In the preceding chapter, we saw the details of the developed system. In this chapter, we will refer to some important points which are required when activating aged housing stock.

1) To Increase the Various Values of a Dwelling

We designed the system not only to increase accessibility to the dwelling, but also to increase various values accompanied by elevator addition.

What we must refer to at first is that we intended to enrich the communal area, for example, new entrance porches for each dwelling generated on the additional floors in the stairwell. This space is well-lighted because of the miniaturized elevator shaft, and it will make the residents' use more active. The approach lobby unit is also designed based on the same concept.

The second point we intended is to increase security. Not only the automatically lockable lobby, but also the lighting equipped with the new stairs, which makes the elevator/stair tower unit look like an illumination tower at night, are considerations for security for the sidewalks in the housing estate which are liable to be in poor light.

The third point is consideration for the scenery of the housing estate developed in the mass-housing era, which were planned with extensive greenery with wide open spaces. The slender elevator/stair tower unit, which provides a lighter impression, is designed not to spoil the beauty.

2) To Give Flexibility to the System Design

We completed this elevator addition method as a "system" to cope with the largeness in quantity of the residential buildings built in the mass-housing era; however, we also regarded it as important to leave some non-systematized parts, or in other words "the parts that added flexibility in designing", to address various problems under a variety of circumstances surrounding housing estates. For example, the exterior facing around the elevator/stair tower unit is placed as a non-systematized part because of the influence of the exterior looking onto the scenery of the housing estate.

In the experimental construction, we used glass panels for exterior facing; use of glass panels is undesirable from the structural viewpoint because of their heaviness, however, a structure, which can stand the weight, secures the use of other materials.

The approach lobby unit is also placed as a non-systematized part. Moreover, the elevator/stair tower unit should be provided for flexibility in extending the elevator shaft according to certain modules to accommodate a larger elevator car.

3) To Increase Diversity in the Housing Estate

Most problems arising in a housing estate constructed in the mass-housing era are caused by the uniform and monotonous design of dwellings. Housing supply on a massive scale in the same estate in a short period brought homogenization of the family type and the strata of residents, and it is bringing a rapid increase in the number of aged residents and stagnation of community. When activating such building stock, it is important to increase diversity in the housing estate.

The developed elevator addition system, which is able to be applied to each staircase, is favorable to accommodate various types of residents to increase diversity. From this viewpoint, it is also desirable to add the elevators around the housing estate though they are usually clustered from the point of view of construction efficiency.

5. Conclusion

In this paper, we presented a new elevator addition system for aged residential buildings constructed in the mass housing era, and have discussed some viewpoints regarded as important when renovating deteriorating housing estates. As we mentioned, the circumstances surrounding the housing estate are various; it is also desirable that the activation methods are many and diverse, that is, accumulation of such development is important to realize sustainability in these housing estates.

This paper is a conflation, revision, and expansion if two earlier studies, Ogawa et al. 2005 and Ogawa et al. 2006.

Acknowledgement

This development was supported in part by the “Construction Technology Research and Development Subside Program” subsidized by the Ministry of Land, Infrastructure and Transport of Japan.

This research was conducted as part of the 21st Century COE Program of Tokyo Metropolitan University “Development of Technologies for Activation and Renewal of Building Stocks in Megalopolis” subsidized by Ministry of Education, Culture, Sports, Science and Technology of Japan.

References

Kadowaki, K., S. Fukao, and T. Arahira. 2005. Regeneration of Public Residential Buildings for Rent in Japan. *Open House International* 30, no. 2: 49-58

Ogawa, H., S. Fukao, and K. Kadowaki. 2005. Actual Conditions of Elevator Addition to the Aged Public Housing in Japan and a Proposal of an Alternative Method. Paper Presented at the 2005 World Sustainable Building Conference, September 27-29, in Tokyo, Japan.

Ogawa, H., S. Fukao, S. Yamazaki, K. Kobayashi, K. Kadowaki, and S. Minami. 2006. Development of a New Elevator System for Aged Residential Buildings. Paper Presented at the Joint CIB, Tensinet, IASS International Conference on Adaptability in Design and Construction, July 3-5, in Eindhoven, The Netherlands