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## A Study Related to the Long-Life Housing Infill Part Application Plan

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**PAPER ABSTRACT** In Korea, the Housing Act was revised to oblige constructors to receive a long-life housing certification when constructing joint housing having more than 1,000 units from December 25, 2014. The basic concept of long-life housing is to physically maintain support having high durability, and to easily maintain and manage infill, which is sensitive to social changes and functional changes, through easy replacement and repairs. In order to activate long-life housing, there is a need to develop the connection, which can increase the consistency of infill parts for each area. This study has researched the connection of supports and infills, in order to compose an interface map and has proposed an infill part application plan by analyzing the properties of each connection part.

**KEYWORDS:** Skeleton & Infill System Housing, remodeling, Dual Flooring System, infill products

### 1 Introduction

#### 1. 1 Background and Purpose of Research

Korean joint housing uses the box-frame construction method, due to its low construction cost and heights compared to other construction methods, which results in the security of greater units in the same amount of land. From December 25, 2014, the Housing Act was revised to oblige the construction of joint housing of more than 1,000 units to receive the long-life housing certification, which is expected to change the construction method in the development of future joint housing. The basic concept of long-life housing is to enable easy maintenance and management by allowing easy replacement of infill, which is sensitive to functional change and social changes, and to maintain supports, which have high physical durability, for a long period of time. For longevity of joint housing, the space must be changeable in response to the demands of the residents. However, since the bearing wall performs the role of the column in a box-frame structure, a variable space is difficult for this structure. If long-life housing should be supplied in the future, a structural change of joint housing from the box-frame structure to a ramen structure, which provides easy variable of space, is expected. The infill products currently used in Korea are suitably developed for box-frame structure joint housing. For the longevity of joint housing, there is a need for the development of infill products that can be used on changed structures and changes in the structural system. This study intends to propose an improvement plan needed upon the application of a longevity housing model of a future ramen structure by analyzing the properties of the dual flooring system, which is an architectural element technique applied upon modifying or expanding space, among infill produced used on box-frame structure joint housing.

#### 1. 2 Study Method

Long-life housing is composed of infills, which are variable elements, and skeletons, which are fixed elements. This study has intended to deduce the planned properties of infill that can be used after changing the structure from box-frame to ramen by apprehending the properties of products applied in infill parts currently used in Korea for the development of element techniques, which can be applied in long-life housing. The study method of this study is as follows. First, the infill plan elements of the ramen structure were apprehended for reuse of infill products through literary consideration. Second, a basic plan of a ramen structure long-life housing was conducted for a variation and reuse of space. Third, the occurrence of problems was analyzed by applying the dual flooring system, among existing infill products, on the existing ramen structure floor plan.

## 2 Long-life Housing and Infill System

### 2.1 Long-life Housing

Long-life housing enables the composition of the 'SI housing system', which categorizes the elements composing the housing into the fixing element, i.e., the structure, and the variable element, i.e., the interior material, for the structure to be responsible for the durability and the interior material to be responsible for the variability. Herein, the infill parts respond to the changes in the family members or lifecycles by having variability to provide a residential environment that can maintain a long life which freely changes the interior performance or width (Kim Hong Yong). In order to accommodate the changes in spatial composition, the structural method and resistance of the boundary walls are important. These two elements can accommodate various uses and functions and can enable combined recomposition of the whole, combination of two units as one, or division of one unit as two units as the basic conditions accommodating change in space (Kim, Soo Am). According to Article 21(6) of the Korean Housing Act, long-life housing is defined as housing having easiness of repair and excellent variability, which can easily change the internal structure based on need of the resident and having durability, which can be structurally managed and maintained for a long time. It is understood that long-life housing must be accompanied by the development of architectural element techniques applied upon architectural plans and physical changes that can change spaces in response to the demands of the residents.

### 2.2 Infill System

Infills are physically personal elements and can be installed and changed, and also can be categorized into variable infills, which vary based on the decision of the residents, or fixed infills, which are not based on the decision of the residents (Yi Yong Kyu). The infill connections must be composed to allow easy connection or replacement of parts upon exchange of parts for future repairs or construction of parts. Thus, there is a need to examine the performance needed for the connective parts (Lee Hyun Jae). Housings are composed of parts or materials that have great differences in lengths of lifespans, and the declination of lifespan of parts may influence the lifespan of the entire housing. In addition, is housing is unable to socially accommodate the changes in growth and function of the family, the performance of the housing declines, and thus, in order for a housing to become a long-life housing, its physical lifespan should be prolonged, and a system that can accommodate the demands of the residents, which newly require social functions must be composed. Infill parts of long-life housing must be easily modified upon repairs to compositional materials having variability and require compatibility with other parts.

## 3 Long-life Housing Design Applying the Ramen Structure

### 3.1 Two-Dimensional Design

Long-life housing must be allow easy replacing of equipment and space based on the demands of the residents after construction of the structure for long-term use, and thus, structures and infill components and materials are required to be fixed in a manner of attachment upon replacement and require connective standards. With respect to the structure of joint housing, this study has applied the ramen structure, which is a column structure, and not the existing box-wall construction method, to design long-life housing, and conducted a two-dimensional plan by focusing on spatial use and reuse. The design standards of long-life housing were planned to allow an increase of the width in the column and the two-dimensional unit dimension by 3m with 300 mm increment, in consideration of the connection of infill products and the structure. The two-dimensional prototype was planned by planning the basic grid of a 300mm dual floor panel, and non-specified 100 x 100mm modules were used for any other units.

This study considered the movability of equipment pipes by installing the equipment core between units for variability of space. The equipment core was disposed together with the stairwell for existing joint housing, but this study independently located the equipment core between units in separation with the stairwell for a two-dimensional change within the units. The equipment core located between the units can allow the installation of electrical wiring and equipment wiring, for use as a living room in the early stages, and when dividing the unit, wiring can be additionally installed in the equipment core, to change as a kitchen, which uses water.

**Table 1. Surface plan considering spatial change**

	
<p>Integration of bedroom</p>	<p>Southward kitchen</p>
	
<p>Divided bedroom</p>	<p>Partial lease</p>

### 3. 2 Cross-Sectional Plan

The long-life housing proposed by this study allows change of the interior space in correspondence with the lifestyle of the residents. It was difficult to change the interior space of existing joint housing, once it was installed, because the pipes in the bathroom and kitchen using water were laid underground on a slab.

However, to expand or change space, a change in the equipment facilities is essential, and the structure of the equipment facility, such as the pipes must not be buried underground. The plans of the prototype of this study were performed to allow movement of space on the interior in spaces that use water through cross-sectional planning of dual floor structures. Furthermore, heating facilities were planned through a dry flooring system, and the dry flooring system was planned to allow the installment within the scope of construction of a dual flooring structure. In consideration of the coordination of the structure and infill products on the two-dimensional plan, the 300 mm increment has been set as the basic unit, and the 100 x 100 mm non-standard module was used to supplement any insufficient areas upon installation of the infill products.

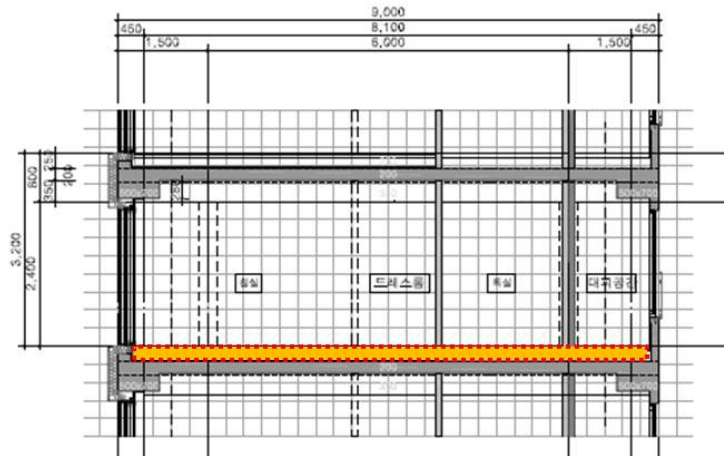


Fig.1. Cross-sectional plan applying a dual flooring system

## 4 Analysis of a Long-Life Housing Plan Applying Infills

### 4. 1 Comparative Analysis of the Composition of Infills

The Korean housing culture involves floor heating, which installs heating pipes above slabs and buries, fixes, and finishes mortar. The floor heating system displays effective heat delivery and heating effect but displays difficult installation of walls and disassembly, and thus, variation of space becomes difficult. In order to change the interior space based on the changing growth of the family, the variation of the flooring system, which compose the housing space within the units should be easy. This study has researched infill products developed with the dry heating system of dual flooring structure. The dual flooring system is a dry heating system, and is used in spaces that require heating, such as bedrooms, living rooms, kitchen, and restaurants, and the products are in parts, which can be installed on-site and can easily be maintained and managed. The components of the two infill products are compared in the table below.

Table 2. Comparison of Components of the Dual Flooring System

Category	Company D	Company H
Components	Magnesium board (top), XL-Pipe, heat exchanger plate, PP panel, felt, magnesium board (bottom), atron, vibration dampener, foil, isopink	Side filler, 8mm pipe, support, heating panel, particle board, glass surface board, support plate, height adjusting bolt, dustproof rubber
Height	100.7mm	110mm
Cross-Section		

## 4. 2 Application and Analysis of Properties of Infill Products

The results of applying the dual flooring system on long-life housing are as shown on Fig. 2. The infill products of Company D are composed of 10 products. The magnesium board of Company D has the function of increasing thermal conduction and is installed on the top and bottom of the PP panel as a 900 x 1,800 board. The PP panel is a plate created to allow installation of heating pipes in the size of 600 x 600 panels. In the case of the infill products of Company D, the sizes between the components of the infill and the parts are different, and thus, difficulty in the reuse of infill products upon remodeling is expected. Particularly with the use of non-standardized panels, the use of irregular parts between connections with walls is used with the use of non-standardized panels. In order to resolve such problems, there is a need to develop problems that consider reuse by standardizing the dimensions of infill parts. This study has applied a 300 mm increment size upon design for conformity with the parts. Since the columns and the interior space are applied to the 300 mm increment size, the conformity between the infill products and the plane could be increased if the basic size unit of infill products could also apply the 300 mm increment size. There are a total of 9 Company H infill products. Company H is composed of a 2,100 x 450 integral buffer material floor heating panel. The floor heating panel is installed with heating pipes. The infill products of Company H are an integrated buffer material type, which allows easy reuse and disassembly. However, must increase conformity with the plane through adjustment of the length and width. The infill products of Company H are characterized by the easiness of detachment due to the integrated infill products. Upon applying the infill products of the two companies on the planes applying the ramen structure, this study has found the need for the development of an integrated and standardized dual flooring system for the reuse of infill products.

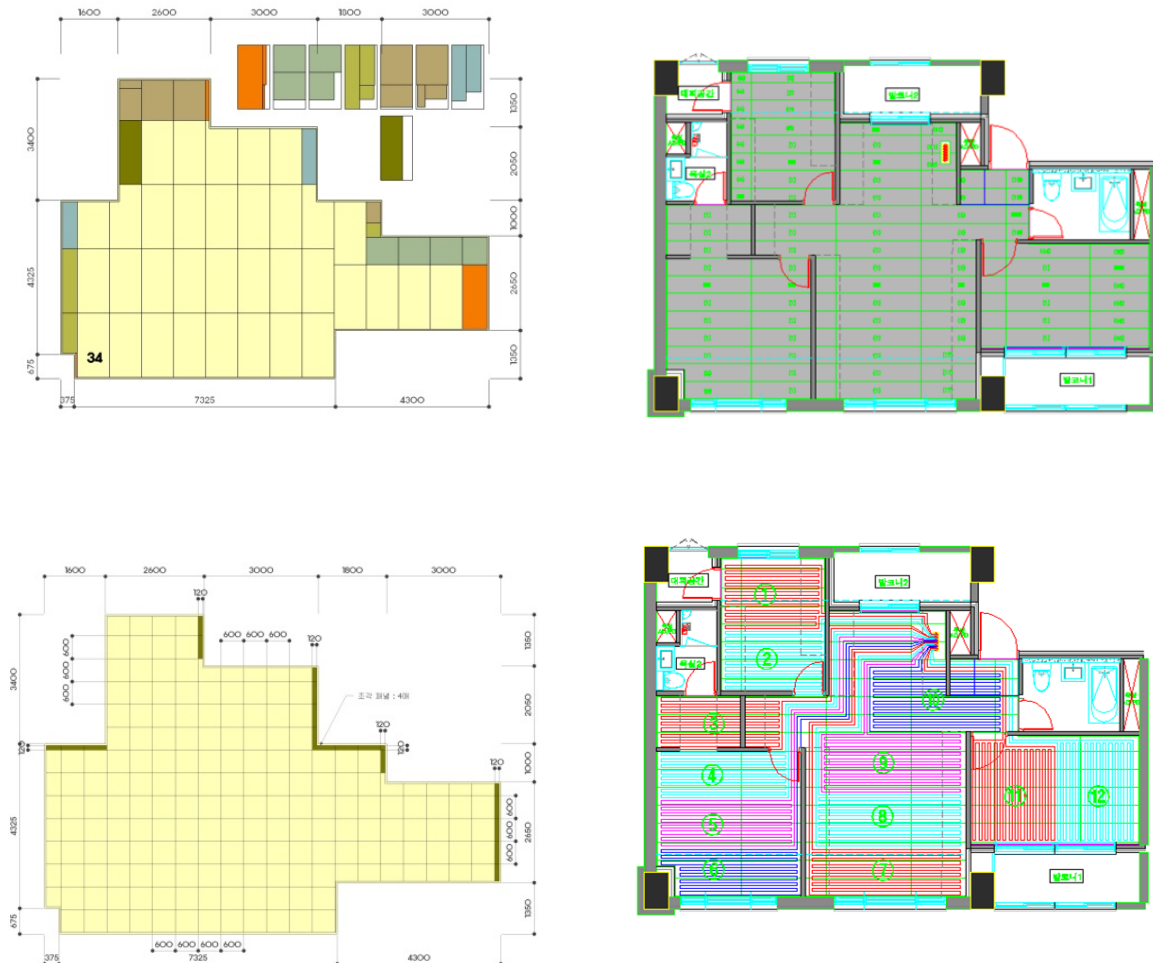


Fig. 2. Dual Flooring System Applying the Ramen Structure Plane

## 5 Conclusion

The long-life housing infill system must allow easy construction and reinstallation based on the demands of the residents. This study has analyzed the problems that occur by applying the dual flooring system on long-life housing planned with the ramen structure. The results of research of this study are concluded as follows.

First, there is a need to set plan standards that consider remodeling in order for easy reconstruction upon changing the interior space. Currently for infill products, reuse is not carried out after on-site installation. Thus, the size of infill products is different for each part. For reuse, the infill products must respond to the size of each space, but mutual compatibility between currently used products is difficult.

Second, there is a need to develop modularized infill products that consider reuse. Currently, there is a modularized dual flooring system developed in Korea for infill products, but there are no products for reuse, thus, there is difficulty in disassembling and reusing upon changing the interior space.

Third, there is a need to develop buffer materials that can maintain the space between the flooring and walls for reuse of the dual floors. For variation of space, dry and standardization is beneficial for reuse. There is a need for buffer materials that can fill the interval between the floor and walls if the dual flooring is modularized.

## 6 Acknowledgments

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