Research and Practice of China Indemnificatory Housing Sustainable Construction & Standardization, Industrialization Construction

Liu Dongwei
China Institute of Building Standard Design & Research
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I. The sustainable construction issue faced by China public rental housing under massive construction
Sustainable construction issue that the indemnificatory housing construction faces

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1. Major problems to be solved for public rental housing

At present, under the overall housing security objective of “everyone has his home to live” during the “12th five-year” plan, the housing supply system integrating commercial house market and security house has come into being gradually. The public rental housing construction has become the big issue in the work of various levels of local government departments. The large-scale construction period is coming. All local government issued relevant measures in succession recently to greatly promote the public rental housing construction. The public rental housing has entered the large-scale construction period. However, the lack of complete and perfect industrialized technology system and construction technology brings about a series of problems to be solved for the public rental housing.
Construction issue that the indemnificatory housing construction faces

I. The construction issue faced by China public rental housing under massive construction

1. Major problems to be solved for public rental housing

Specifically as follows:

(1) The quality cannot be guaranteed due to the lack of complete technology support. Although the public rental housing construction is valued highly by the government, the technology system has not been established completely, and the targeted design technology is still immature. It cannot provide technology support for high quality public rental housing construction. It also brings about a series of problems for design, construction as well as management and maintenance. The problems of standardization and building system are still the key problems hindering the development of housing construction in China.

(2) The outdated housing construction method leads to the poor overall quality. The demand is large and construction period is short for public rental housing construction in China, and at present, the quality is low, integration degree is low and the complete technological control measures are lacked. The building components are few in type, poor in quality and low in performance in China, and we still have not formed the components and parts production and supply yet. Therefore, the productivity is impacted and the production costs cannot be reduced.

(3) The environmental and energy saving problems caused by public rental housing construction are prominent. The long construction period, unfavorable endurance, uneasy maintenance and replacement, high maintenance costs and decoration of the indemnificatory housing can not guarantee the living quality, and also cause vast waste of resources. For the large-scale of construction, we should consider the requirements of sustainable development for public rental housing, carry out provincial and local material saving, environmental and cost-efficiency principles, and implement various technological measures of energy saving and emission reduction. How to construct, maintain and reconstruct public rental housing at low costs is a new issue that the architects face.
Traditional design and construction methods seriously restrict the efficient and quality construction of indemnificatory housing

In the current stage, the housing industrialization level in China is low, and the outdated housing design and construction method cannot adapt to the demand of large-scale construction. Especially the public rental housing construction, which has small floorage and one-step facilities and still need to depend on the government for post maintenance, brought about a series of problems to be solved.

<table>
<thead>
<tr>
<th></th>
<th>Design</th>
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<tbody>
<tr>
<td>1</td>
<td>- Due to the small floorage of the public rental housing, the design cannot fully meet the basic requirements for living, energy conservation and environmental production.</td>
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<td></td>
<td>- The public rental housing requires the facilities completed at one step. The traditional design methods, regardless of components, equipment, pipeline standardization, industrialization and integration cannot realize the favorable living quality, and cause loopholes for post maintenance.</td>
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<tr>
<td>2</td>
<td>Construction</td>
<td>At present, the extensive (massive wet construction) construction method is still the primary, which has low productivity, long construction period, large materials consumption, and out-of-control quality and costs, and causes tremendous waste of resources and energies</td>
</tr>
<tr>
<td>3</td>
<td>Integration</td>
<td>It lacks complete housing industrialization technology integration system, and it is difficult to realize the sustainable development of indemnificatory housing construction</td>
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Technical transformation and innovation promotes "everyone has his own house to live"
The public housing “standardized design and industrialized construction” led by government has become the international mainstream.

Foreign public housing construction experiences
The foreign public housing increases rapidly due to the massive construction requirements. In order to simplify the on-situ construction and improve the construction quality and efficiency, they realize the mass production mode of standardized design, prefabricated construction and industrialized components, form the completed nationwide general standard design and construction system, and establish complete housing components certification system.
The public housing “standardized design and industrialized construction” led by government has become the international mainstream

Public housing construction experiences in Hong Kong
In order to rapidly solve the living problems, accelerate the construction speed of public housing, reduce the costs and effectively control the building quality, only a few plans are regarded as the standard mode for public housing in Hong Kong in every development stage. The prefabricated panel, standard kitchen components and sizing furniture are adopted to realize the standard design and industrialized construction.

House type

<table>
<thead>
<tr>
<th>Prefabricated panel</th>
<th>Sizing furniture</th>
<th>Kitchen components</th>
</tr>
</thead>
</table>
The public housing “standardized design and industrialized construction” led by government has become the international mainstream

- The public rental housing is a kind of small-area suites led by the government, which is in favor of the implementation of series design, standard components application and industrialized construction. The standardized and industrialized production mode of housing industrialization is incomparably superior to improve housing quality, increase construction efficiency and reduce resource waste. At present, the demand of urban public housing is still large, and the public rental housing construction will keep rapid development.

- As the house of the government to meet the demand of middle and low income people, the public housing has the nature of public goods, and the target constructing quality public rental housing fully according to the market operation cannot be realized. Many domestic designers lack the research of public rental housing design and construction, and have many blind points in the basic knowledge of the public housing. Adding the misunderstanding of the design technology, the various problems brought about by the design institute of the public rental housing are prominent. The key issue of standardized and industrialized design restricts the long-term development of the public rental housing in China.

- Generally, the existing problems lie in the lack of complete construction design ideas and construction technology guarantee system. The public leasing house constructed by traditional methods have problems to be solved in aspects of quality control and post operation and maintenance guarantee. The design method and construction technology innovation is urgent. The establishment of complete public rental housing standard system admits no delay. The standard can help improve the construction level, and realize the overall sustainable housing guarantee objective of “everyone has his house to live”.
II. Public rental housing adopts standard design, industrialized construction ideas and overall solution
II. Public rental housing adopts standard design, industrialized construction ideas and overall solution

- The public rental housing construction in China can only adopt the industrialized method. However, compared with the advanced countries, the housing industrialization in China is still far lower. The housing construction is basically the intensive type, and the traditional outdated technologies are still in use massively. The housing construction industrialization is lagged behind. The housing components general utilization degree is low, the matching ability and universality is poor, and the housing components still fail to form the matching series.

- The housing industrialization adopted standard design and component construction, as the main line, shall be systematic and integrated product architecture; on the basis of standard system, make the housing in components, i.e. divide the housing into different modules and constitute a system.

- The standard design and component construction idea refers to the housing construction with standard and integrated production and social supply by complete technology. The four features are specifically: first is the standard and modularized design, and the standard design creates preconditions for factory and intensive production of batch sizing products; the second is application of industrialized building system, which forms new building system so as to guarantee the housing buildings acquire safe, environmental and energy-saving quality; the third is supply of general housing components. The main components are generated by standard production, and all parts of the internal decoration have the general components; the fourth is the on-situ construction tries to adopt assembled and integrated operation, mainly the dry construction, which helps the accurate control over the quality of the buildings.
1. Design measure—Change traditional design method, organically implement standard design

- Change the traditional design method, and organically implement the standard design to meet the requirements for high quality living and industrial construction.

2. Construction measure —transfer from extensive construction mode, and implement industrialized construction technology step by step

- Implement industrialized construction technology step by step, and construct the sustainable construction method of “good quality, improved efficiency, economical cost and environmental protection”.

3. Integration measure —establish complete technology system

- Construct the complete industrialized technology integration system through technological transformation and innovation, and improve the housing industrialization level.
Technological innovation ——Standard design

Realize standard design and industrialized construction by technological transformation and innovation

———Core idea of Excellent Design Scheme of Public Rental Housing

Dominant ideas

Meet the high quality living requirements of “intensive area, complete function, perfect facility and flexible space” and create preconditions for industrialized construction

Specific connotation

Standard design: building standardization — Suite standardization— Component standardization
Building standardization: modular design, combination to realize diversified layout

Technical transformation and innovation promotes “everyone has his own house to live”
Component standardization

**Kitchen system**

- The design of integrated kitchen makes the space more compact, quality is more reliable and function is more complete.
- Dry construction shortens the construction period.
- Suitable for the requirements of massive and rapid construction of indemnificatory housing.

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Technical transformation and innovation promotes "everyone has his own house to live"
Component standardization

- **Bathroom accessories**
  - Bathroom quality is more reliable
  - Dry construction shortens the construction period
  - Suitable for the requirements of massive and rapid construction of indemnificatory housing

<table>
<thead>
<tr>
<th>Traditional bathroom accessories</th>
<th>Integrated bathroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable quality</td>
<td>Unified quality</td>
</tr>
<tr>
<td>Technical workers have different levels</td>
<td>Scale production, refined processing</td>
</tr>
<tr>
<td>Long construction period</td>
<td>Fast installation</td>
</tr>
<tr>
<td>6 types of work 7-day construction</td>
<td>2 worker finished within 4h</td>
</tr>
<tr>
<td>Limited service life</td>
<td>Durable</td>
</tr>
<tr>
<td>5-8 years are one reconstruction period</td>
<td>Removable 20-year service warranty</td>
</tr>
</tbody>
</table>

**Technical transformation and innovation promotes “everyone has his own house to live”**
III. Technological transformation and innovation of construction projects with standard design in Beijing
The pilot project in Beijing locates at Huangzhuang Town, Daxing District, Beijing, about 1000m far from Yihezhuang Station of Daxing subway line with complete surrounding supporting facilities. The total land scale of the project is approximately 15800 square meters, with total building area about 20400 square meters, including 5000m² public rental housing comprised of two public rental buildings and two small and medium-sized commercial residences, covering 168 households.

During the “12th five-year plan”, the public rental housing enters the large-scale construction period, as the chief editorial unit, the China Institute of Building Standard & Research takes charge of the formulation and compilation of the Standards for Public Rental Housing Construction as well as a series of supporting technology research on public rental housing construction. Particularly, according to the requirements of the 12th five-year plan science and technology support program, Summit – Guanghe Yuanzhu Project is the demonstration project of the Research on New Industrialized Construction System and Key Technology Standards of Indemnificatory Housing, which is the subject of the national 12th five-year plan science and technology support program. This pilot project is organized by China Institute of Building Standard & Research, and the participants are domestic and foreign research institutes, design institutions and real estate development enterprises including Summit Real Estate, ICHIURa Housing & Planning associates, Beijing SBS, Beijing Boloni, Cozy, and Beijing Jian Wang Design.

Aiming at the public housing construction subject in China, referring to the international public housing advanced ideas, this project studies the industrialized production and construction mode of public rental housing under background of massive construction, develops the supportive integration technology with characteristic of public rental housing and operability and explores the overall technical solution for public rental housing in the new sage of China so as to guarantee the living quality, improve lifecycle of house and realize sustainable residence.
Overall Objective and Current Status

Technological transformation and innovation of construction project with standard design

The project has convenient traffic conditions. The south sixth ring is on its south and JINGKAI Highway is on its east. The block is about 1000m far from Yihezhuang Station of Daxing subway line with complete surrounding supporting facilities, including schools, hospitals and supermarkets. The Linxiao Road on its east is an urban road with 30m wide. The surrounding environment is mature, and Linxiao Road is the mature urban commercial road; the road on its south is expanding, which will become the main road connecting the east and west. The land is in the shape of a triangle, which is 109m wide from south to north and 155m long from east to west. The land is flat. The total land scale of the project is approximately 15800 square meters, with total building area about 20400 square meters, including 5000m² public rental housing comprised of two public rental buildings and two small and medium-sized commercial residences, covering 168 households.

Under the grand objective of housing guarantee during the “12th five-year plan”, the public rental housing enters the large-scale construction period. As the chief editorial unit, the China Institute of Building Standard & Research while formulating the Standards for Public Rental Housing Construction, is conducting the support technology research and development of public rental housing construction. Beijing Daxing project is its pilot project. This pilot project is organized by China Institute of Building Standard & Research, and the participants are domestic and foreign research institutes, universities and real estate development enterprises including Summit Real Estate, ICHIJUra Housing & Planning associates, Beijing SBS, Beijing Boloni, Cozy, and Beijing Jian Wang Design. Aiming at the public housing construction subject in China, referring to the international public housing advanced ideas, the Summit – Daxing project studies the industrialized production and construction mode of public rental housing under background of massive construction, develops the supportive integration technology with characteristic of public rental housing and operability and explores the overall technical solution for public rental housing in the new sage of China.
Overall Objective and Current Status

Technological transformation and innovation of construction project with standard design

Technical transformation and innovation promotes “everyone has his own house to live”
Overall Objective and Current Status

Technological transformation and innovation of construction project with standard design

Technical transformation and innovation promotes “everyone has his own house to live”
Overall Objective and Current Status

Technological transformation and innovation of standard construction project

Standard series suite design of public rental housing

The suite design of the public rental housing shall meet the functional requirements of middle and low income residents for core family living, and realize long-term function optimization in a smaller area and scale. The standard series suite function design is the systematic frame comprised of hallway function module unit, LDK function module unit, multipurpose bedroom function module unit, integrated bathroom function module unit, integrated kitchen function module unit, and system storage function module unit. Combining the lease nature, endurance, economical efficiency and applicability of the public rental housing, it can not only realize the compact plane space layout for multiple living style, but also emphasize on convenience for necessary reconstruction and maintenance management so as to prolong the lifecycle of the living function and improve the long-term value as social assets.

Public rental housing T4 Unit plan
1. The overall unit is structured in appearance and favorable in energy saving property.
2. The indoor walls are design as lightweight walls, which can be reconstructed by users due to different requirements.
3. Standard integrated bathroom and integrated kitchen

The bathroom space is intensive for the convenience of partial structure plate lowering and drainage of the same floor.
The indoor walls are design as lightweight walls, which can be reconstructed by users due to different requirements.
The overall unit is structured in appearance and favorable in energy saving property.

The elevator space is reserved for the convenience of the aged and the mobility impaired.
Drainage of the same floor, intensive pipeline in outdoor space, easy to repair and maintain.
The combination of balcony and bay-window makes the structure neat, façade more ordered, and the space extension increased.
A House type (two and a half bedrooms) of the public rental housing

1. The overall unit is structured in appearance and favorable in energy saving property.
2. The indoor walls are designed as lightweight walls, which can be reconstructed by users due to different requirements.
3. The 60m² space creates two and a half bedrooms. The space is extending and flexible.
4. Standard integrated bathroom and kitchen

Increase the storage space and set storage space to meet the living needs.

The LDK system makes the kitchen and the living room more reasonable and compact, and the space is efficiently used. While working in the kitchen, people can not only communicate with people in the dining room and living room, but also take care of the family and children.

The bedroom separation and integration system can adjust the internal spatial arrangement to show the flexibility according to the family structure change.

Living balcony: meet the daily function for drying

Open kitchen integrates the kitchen and dining table in the limited small house, and creates the open and communicable dining room – kitchen relation; and meanwhile creates the possibility of independent kitchen.

Independent hallway system with storage and shoe changing design creates the atmosphere of returning home.

The separated bathroom system has intensive pipelines, and adopts overall bathroom technology. Dry and wet separation and intensive space eradicates water leakage and saves costs.

Analysis of public rental housing T4 A House Type

Product type and house type design
Technological transformation and innovation of standard construction project

Overall Objective and Current Status

Analysis to house type A, B and C of gallery-type public rental

<table>
<thead>
<tr>
<th>House Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>A 40 Type</td>
<td>1. The overall unit is structured in appearance and favorable in energy saving property.</td>
</tr>
<tr>
<td>B 50 Type</td>
<td>2. The indoor walls are design as lightweight walls, which can be reconstructed by users due to different requirements.</td>
</tr>
<tr>
<td>C 60 Type</td>
<td>3. The push-pull indoor separation system makes the rooms divided or integrated freely and the space flexible.</td>
</tr>
<tr>
<td></td>
<td>4. Standard integrated bathroom and kitchen</td>
</tr>
<tr>
<td></td>
<td>5. The extended gallery has small residential pool area</td>
</tr>
</tbody>
</table>

Product type and house type design 4-10
Technological transformation and innovation of standard construction project

Independent hallway system
- Create the layering sense of the space, and the atmosphere of returning home
- Increase storage room to meet the living demand of shoes and clothes changing

Product type and house type design 4-15

Technical transformation and innovation promotes “everyone has his own house to live”
LDK living room, dining room and kitchen system

- The humanized living room is another key point of integrated housing function use and distribution. It provides the life style with man-made elements, integrates the family service spaces and maximize the life.
Overall Objective and Current Status

Technological transformation and innovation of standard construction project

Integrated bathroom system
- Improve the service efficiency of each space
- Compact house type suitable for multiple family members
- Dry-wet separation layout saves construction costs

Product type and house type design 4-17
Overall Objective and Current Status

Technological transformation and innovation of standard construction project

Industrialization and technology integration of fully decorated finished public rental houses
The SI house, through the separation of S (Skelton) and I (Infill) makes the structure endurable, indoor space flexible and infill renewable, and is extensively practiced in housing construction for its low energy consumption, high quality and long service life.

Integrated construction technology of industrialized production mode in two stages

<table>
<thead>
<tr>
<th>Stage 1</th>
<th>Stage 2</th>
</tr>
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<tbody>
<tr>
<td>A. Structure system, including 1 Wall; 2 Floor slabs; 3. Balcony, beam, pillar, and stairs</td>
<td>C. Inner room system, including 1 partition wall; 2 inner walls; 3 floor and ceiling</td>
</tr>
<tr>
<td>B. Maintenance system, including 1 interior decoration; 2 insulating layer; 3 windows, doors, roof, etc.</td>
<td>D. Facility system, including 1 integrated bathroom; 2 integrated kitchens; 3 Pipeline systems, etc.</td>
</tr>
</tbody>
</table>

100-year wall structure

Indoor area: secondary wall and basic facilities

Skelton (structure and containment) (Skelton usable for over 100 years)

Infill (interior decoration and facility pipelines) (changing the house pattern freely)
## Overall Objective and Current Status

### Technological transformation and innovation of standard construction project

#### Integrated bathroom

- Processed in factory by overall compression molding with high fineness
- Efficient and fast on-situ installation; each set of integrated bathroom can be installed in 6 hours, as 24 times faster as the traditional decoration
- The dry construction is not impacted by seasons, and with no noise and construction waste
- Professional waterproof structure, the waterproof edge prevents from leakage
- Need no special maintenance work
- The access hole is equipped, and is easy to repair

#### Integrated kitchen

It is a new kitchen type systematically matching the cabinets, kitchen utensils and appliances. It is more beautiful, neater, safer and more convenient to use through overall configuration, overall design and overall construction and decoration.

- Interior decoration components industrialization
- building technology

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Technical transformation and innovation promotes “everyone has his own house to live”
General design for the adaptability for family full life cycle and for the aged

1. Install handrails as required, such as in the restroom, bathroom and hallway
2. No ground level difference inside the room, such as the entrance of house gate and the bathroom entrance
3. Inner door opening direction, for instance the bathroom door shall be opened outward or be sliding door
4. The effective opening of the bathroom door shall be larger than 750mm
5. Adopt non-slip surface materials especially in hallway, bathroom and kitchen
6. Proper height of sockets and switches

Large balcony scheme; Furniture partition scheme; separate house into two independent residents
At present, the demand for public rental housing is still large, and the public rental housing construction will keep rapid development. Facing the demand of large-scale construction, the public rental housing constructed by traditional methods face great challenges in aspects of quality control and guarantee, cost control, as well as operation and maintenance guarantee due to lack of complete construction technology standard and guarantee system.

The indemnificatory housing is a kind of small-area suites led by the government, which is in favor of the implementation of series design, standard components application and industrialized construction. The standardized and industrialized production mode of housing industrialization is incomparably superior to improve housing quality, increase construction efficiency and reduce resource waste. It can improve the quality and efficiency of building construction, improve the performance, reduce resource waste so as to realize the overall sustainable housing security objective of “every one has his own house to live”

Industrialized residence and housing industrialization integration technology – Standards & Specifications – Technology research & development – overall solution of demonstration projects
Currently, the indemnificatory housing construction is in the large-scale intensive construction period, and it is urgent to implement standard methods for design and construction.

We propose the following five suggestions hence:

1. Ideological understanding: pay high attention to the standardization of indemnificatory housing construction
2. Technical policy: actively promote the standard design of indemnificatory housing
3. Technical support: designedly implement the industrialization construction technology and complete the technology integration system
4. Industrial development: establish certification system for indemnificatory housing components as soon as possible
5. Demonstrative method: Organize and implement some demonstration projects with standard design to accumulate practical experiences.

We believe only by accelerating the implementation and promotion of the standard methods can we improve the quality and efficiency of indemnificatory housing construction, truly realize sustainable development overall objective of “everyone has his house to live”, and benefit the citizens, the society and the country.
Thanks for Your Attention