OB PROTOTYPE DESIGN FOR FLEXIBILITY AND MAINTAINABILITY IN SHORT-TERM SOCIAL HOUSING

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Summary

This paper intends to present the implementation results in a research project that applies ‘open building (OB)’ concepts in developing an 'OB prototype design' for social housing, to be adopted by local governments in Taiwan when planning their own short-term social housings. The developed OB prototype is designed for 'flexibility' and 'maintainability' in order for the developed social housings to be sustainable. The proposed OB prototype design adopts several major design concepts: (1) flexible I-shape ‘support’ expandable to respond to different site conditions and project requirements of social housing projects; (2) open horizontal and vertical distribution of wires and pipes for easy maintenance; (3) wet zones in housing units adjoining public corridor for easy access; (4) three types of modular housing units (1BR, 2BR, 3BR) flexibly arranged in housing zones; and (5) integrated OB remodelling system for interior layout flexibility. The proposed OB prototype design offers planning flexibility for local governments and layout flexibility for tenants. It also results in high level of building maintainability for facility maintenance crew.

Keywords: open building, support, wet zone, pipe distribution, infill systems

1 Introduction

'Open building', a concept or approach featuring a support-infill two-stage building delivery process, aims to produce buildings with maximal capacity for accommodating the diverse needs of different householders over time (Habraken, 1976; Kendall and Teicher, 2000). Social housings are typically for short-term rental and have the characteristics of diverse tenants needs and high turn-over rate. They are therefore expected to benefit from the ‘open building’ concept, if implemented properly.

The Architectural and Building Research Institute of the Ministry of Interior in Taiwan has been supporting open building research projects over the years (Lin et al., 2009; Tu ad Wei, 2007; Wei et al., 2007), and has collaborated with the authors to apply open building concepts in developing the ‘OB prototype design’ for social housing, to be adopted by local governments when planning their own short-term social housings (Tu et al., 2012). This paper intends to present the results of this OB implementation and localization effort.

2 The OB prototype design for social housing

Several design concepts were adopted to develop the OB prototype design for social housing in Taiwan. To simulate and demonstrate how the developed OB prototype design can be applied in a realistic social housing project, the DLD site (area 2,600 m^2), an existing social housing estate in Taipei City, is used as a case for OB exercise.

- **Flexible I-shape 'support' expandable to fit in different sites and project needs**: a beam-column framing structural system, an optimal layout of basement parking (max. parking spaces), and an I-shape floor plate for housing units on the upper floors of the building are overlaid and integrated to form an I-shape framework of 'support' (Fig 1; 26 m long and wide, floor area 500 m^2). This prototype is expandable in one direction to respond to different site conditions and project requirements. The service core is placed on the central 840 cm * 755 cm square of the I-shape floor plate, with two expandable 'housing zones' placed on both sides. Fig 2 shows the social housing design schemes of applying the I-shape 'support' framework to the DLD site.
- **Open horizontal and vertical distribution of wires & pipes for easy maintenance**: The wires/pipes of power, telecommunication, and sprinkler systems are distributed horizontally in the ceiling cavity above public corridor from service core to housing units (Fig. 3a). In addition, the pipes of plumbing system are distributed horizontally in the double deck space below wet spaces (Fig. 3b) to and from the vertical shaft allocated one in every 840 cm * 795 cm housing square. Both distribution routes are accessible from public corridor and thus facilitate future maintenance.
- **Wet Zones in Housing Units adjoining public corridor for easy access**: A wet zone, housing the lobbies, kitchens, and bathrooms, is placed within each housing unit adjoining public corridor. Various horizontal wires and pipes are fed into the wet zones, allowing shorter wire/pipe distribution and easy access from the corridor.
- **Three types of modular housing units flexibly arranged in housing zones**: Three types of modular housing units, which can be flexibly accommodated on the 'housing zones' of a typical I-shape floor plate, were offered to meet diverse tenant needs: (1) Type-8P (1BR, 27 m^2), occupying half a 'housing square' (420 cm * 660 cm); (2) Type-16P (2BR, 55 m^2); and (3) Type-24P (3BR, 80 m^2).
- **Integrated OB remodelling system (IOBRS) for interior layout flexibility**: The IOBRS consists of three components: (1) trenched floor (Fig. 4a), configured around the perimeter of the unit for distributing wires and pipes; (2) raised floor (Fig. 4b; 10 cm thick), consisting of wood flooring, cement board, concrete blocks, softwood bed, and waterproof membrane (under wet spaces); (3) demountable partition (Fig. 4b; 10 cm thick), consisting of light gauge steel C-channel, calcium silicate board, and fiberglass. Where a partition intersects trenched floor, the pipes/wires rise into the bottom of the partition and are redistributed to certain equipment or outlets.

3 Design for flexibility and maintainability

3.1 Planning flexibility for local governments

On a typical I-shape floor plate, the OB prototype design is able to produce 14 possible unit type combination schemes (Tab. 1), offering planning flexibility for local governments to meet the diverse requirements in various social housing development projects. The results of unit type combination scheme 1 and 11 are shown in Fig. 5.

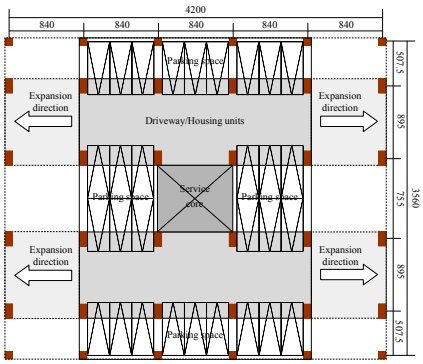
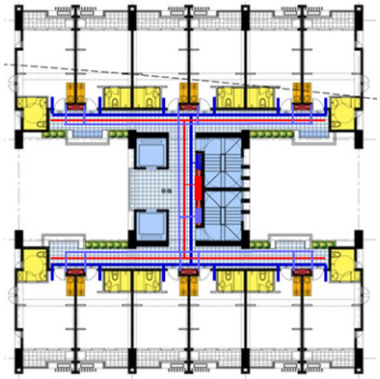
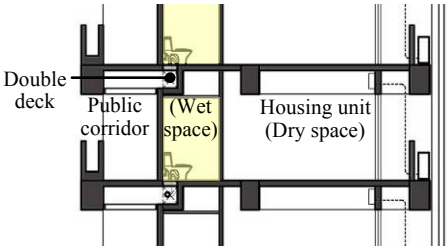


Fig. 1 *The proposed I-shape framework of 'support' for social housing.*



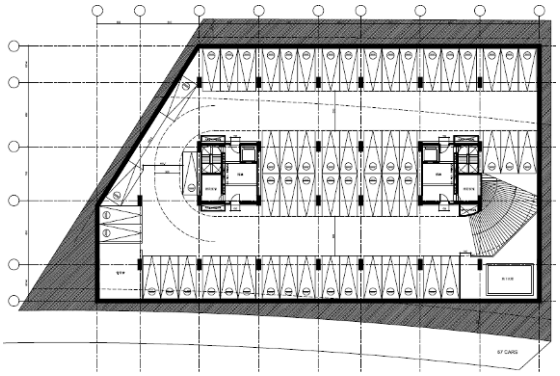
(a) The I-shape support and the wire/pipe distribution routes from the central service core to housing units.



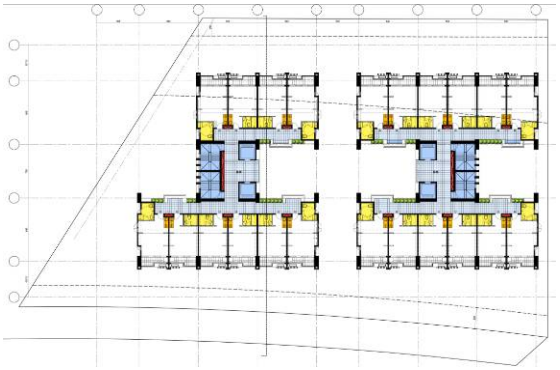
(b) The section indicating the horizontal distribution space below wet spaces allocated for maintenance.

Fig. 2 *The typical I-shape support and floor plate and the pipe distribution routes.*

(a) Ground floor plan

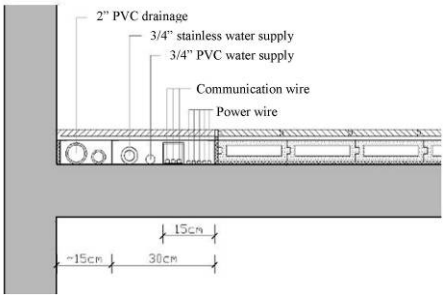


(b) B1 floor plan

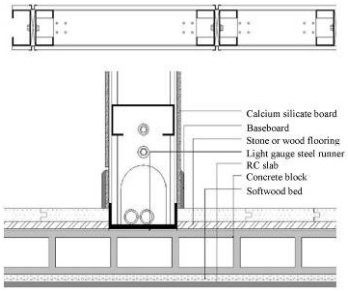


(c) Typical floor plan

Fig. 3 *The resulting design schemes of adopting the OB prototype design on DLD site.*



(a) Section of the 'trench floor' housing pipes/wires.



(b) Plan and section of the 'partition' & 'floor' systems.

Fig. 4 *The components of the integrated open building interior remodelling system: trench floor, demountable partition and floor sub-systems.*

3.2 Interior layout flexibility for tenants

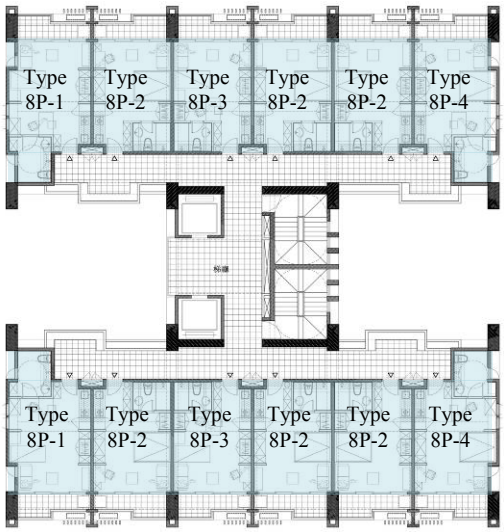
For each unit type, multiple interior layouts are designed and provided to meet tenants' diverse needs. For example, two different interior layouts are provided for each unit type in combination scheme 11 (Fig. 5). When moving in, tenants can choose from the interior layouts available and that best suit their needs. When necessary, local governments can further upgrade the units to a higher standard by using the integrated OB interior remodelling system, designed to provide layout flexibility and facilitate interior remodelling construction.

3.3 Accessibility for maintenance crew

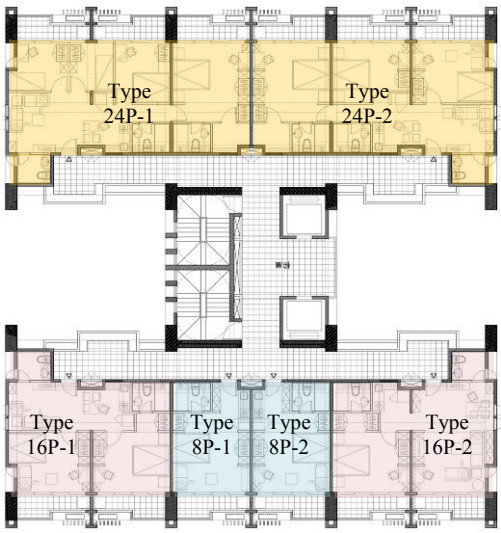
During the occupancy phase, the 'accessible' wire and pipe distribution concept adopted allows the facility maintenance crew to easily access and maintain the wire and pipes of the wet spaces of housing units from the public corridor.

Tab. 1 *14 possible combination schemes*

Scheme	Type-8P	Type-16P	Type-24P	Total
1	12	-	-	12
2	6	-	-	6
3	4	-	-	4
4	10	1	-	11
5	8	2	-	10
6	6	3	-	9
7	4	4	-	8
8	5	2	1	8
9	3	3	1	7
10	1	4	1	6
11	2	2	2	6
12	-	3	2	5
13	1	1	3	5
14	3	-	3	6



(a) Scheme-1: 12 Type-8P units.



(b) Scheme-11: 2×8P, 2×16P, and 2×24P.

Fig. 5 *The combination schemes for the numbers of unit of various unit types on a typical I-shape floor plate.*

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