# Improvement of Urban Housing Blocks in China: The Comparative Cases of Design Optimisation

Ali Cheshmehzangi
*The University of Nottingham Ningbo China, Ningbo, China*

ABSTRACT: In China, urban housing is the most significant part of housing sector. In recent years, the large-scale housing developments and gated housing community blocks have become key urban landscapes and housing provisions in major medium scale and large scale cities in China. The design and masterplanning of such housing developments are not necessarily sustainable. Therefore, this study evaluates key issues and potentials of urban housing blocks (or small residential districts) in China and proposes for their improvement through optimised design and planning.

This study is based on design improvement of urban housing blocks in the City of Ningbo, China. This study is undertaken as part of a research-informed teaching exercise, assessing several urban housing blocks and improving their design through evaluation of four key aspects of: a) environmental performance; b) green infrastructure; c) urban form and layout; and d) building orientation. In this study, the author will elaborate, in particular, on the importance of urban pattern and layout. The study will conclude on methods and implementation strategies for urban housing design improvement and optimisation in the context of China.

This research study is part of an on-going EPSRC-DfID funded research programme, under the 'Energy and International Development' scheme. The project is titled 'Energy and Low-Income Housing in Tropical Housing' and has a huge scope of housing and community analysis in both rural and urban areas of China, Thailand, Tanzania and Uganda. The focus of this research paper is on China's urban housing.

Key words: Urban Housing, Urban Block, Ningbo, China.

## 1 INTRODUCTION

### 1.1 *Urban Housing Blocks in China*

Urban housing is a major field in the sector of housing in a rapidly-urbanising context like China. Unlike many European countries and some other Asian countries, China's urban housing are currently built in the form of mid to high rise [tower] blocks. In the past few years, most of these blocks are developed with low density, higher buildings and less surface coverage of the urban blocks.

Although the most common practice of housing development appears in large scale blocks, there still remain many smaller housing developments that are as small as 100m x 200m in size. A typical two hectares urban block is still a fairly large scale in comparison to a more compact typology of urban housing in other contexts.

In the past two decades, many Chinese cities have undergone the whole process of becoming reshaped, redeveloped and restructured. Majority of this reshaping process has been the renewal of old urban fabric, particularly the urban housing. The transition of two to four storey housing towards six to eight storey housing has already taken place and is towards new mid-to-high rise developments, most of which are gated and at a large scale (Galvez & Cheshmehzangi, 2015).

In here, this study aims to identify lacking elements in China's urban housing developments and later examine ways of achieving design optimisation. This study is undertaken as a research study with a group of 20 undergraduate students with requirements of analysis, simulation and design development of selected urban housing blocks in the City of Ningbo, China.

### 1.2 *Context of Study: Issues and Challenges*

In our previous studies (Cheshmehzangi & Butters, 2015; Galvez & Cheshmehzangi, 2015), we have studied different typologies of urban housing in China. Based on thorough comparative analysis of 'Surface Coverage (SC)' and 'Floor Area Ratio (FAR)', we have identified a medium SC and medium to high FAR for most Chinese urban housing blocks. A typical high-rise housing block has a significantly low SC which is very much similar to the European cases, while its FAR is beyond 2.5 and sometimes reaches 4.0, which is not necessarily efficient both environmentally and socially. Consequently, low dense and [previously known as] affordable housing typologies are subject to demolition and replacement by new mid to high rise housing developments. Apart from the three urban issues of 'limited-time land ownership', 'rapid growth' and 'large gated communities' (Cheshmehzangi & Butters, 2015), China's urban housing faces the following key design challenges:

- Housing development at masterplan level, which reduces the role of architects at detailed design stage and as a result diminishes the quality of housing design;
- Lack of detailed analysis for environmental performance, greenery and landscaping, which often leads towards generic (but yet beautifully designed) green spaces and lack of consideration for urban ecology and the city landscape at a larger scale;
- Lack of integration and connectivity between the urban blocks, which results in development of large scale gated communities and encourages car use and diversity of building heights, orientation and block patterns.

By considering the three above design challenges, several housing blocks were studied across the City of Ningbo for the purpose of identifying what can possibly lead towards strategic plans for design and planning optimisation of Chinese urban housing blocks.


Figure 1. An example of studied area in the City of Ningbo with a total area of approximately 1.5 $km^2$ (Source: Baidu maps)

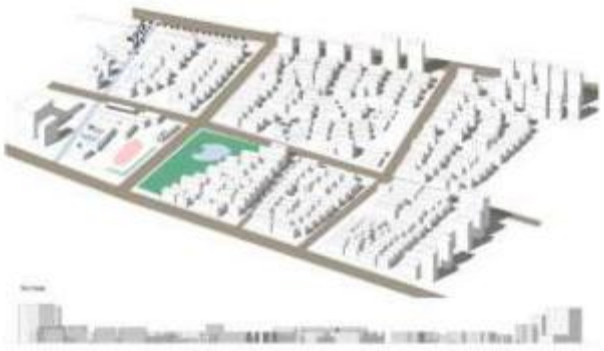


Figure 2. A 3D model and sectional study of the area for simulation studies (Source: IDB reports, Spring 2015)

The overall approach to this comparative study includes: 1) a thorough analysis of an area of around 1.5km2 in the City of Ningbo (figure 1) with a minimum of 70% built environment (urban blocks mixed of housing and other uses), with an adequate mixture of land-uses, such as, residential, commercial, public realms and green spaces; 2) Detailed measurements of the urban features, roads, blocks and buildings as well as ratio of the built and green environments, clear understanding of land-uses, building heights, density, circulation and any environmental features/elements for the selected urban areas (figure 2); 3) Detailed analysis of housing urban blocks based on their current conditions; and 4) Proposal for design modifications and optimisation to initiate comprehensive design strategies based on the above.

## 2 CASE STUDIES OF URBAN HOUSING IN THE CITY OF NINGBO, CHINA

### 2.1 *The Key Aspects of Assessment*

The assessment of selected housing blocks and improving their design is developed through evaluation of four key aspects of: a) environmental performance; b) green infrastructure; c) urban form and layout; and d) building orientation. At a later design improvement stage, the four aspects are integrated in an effective way. The importance of urban pattern and layout is embedded in all four aspects. Each aspect reflects on deficiencies of urban housing and planning that impacts how the city performs at a larger scale.

### 2.2 *Assessment of Environmental Performance*

At first, each of the selected housing blocks were assessed environmentally based on how they perform with their current design and layout (figure 3). This includes evaluation of insolation/lighting, overshadowing, and wind direction. By doing so, we assess basic – but yet important – condition of how housing blocks are designed with their impacts on one another, and how they environmentally perform according to issues of lighting, overshadowing and wind.

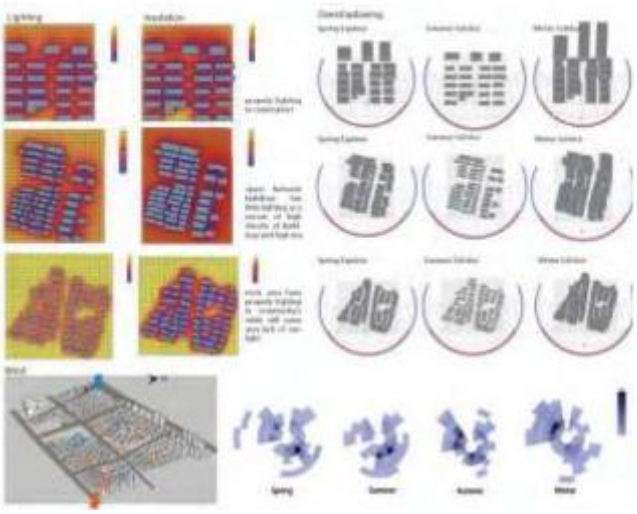


Figure 3. Environmental analysis of three selected urban housing blocks in one selected area (Source: IDB reports, Spring 2015)

Although Eco-Tect and CFD simulations often do not provide detailed data at a larger scale, they can be used for an overall understanding of how the urban housing blocks are performing and how they may improve if to be redesigned or if a similar masterplan is happening at another site with a similar situation.

### 2.3 *Assessment of Green Infrastructure of the urban blocks*

As part of this assessment, two elements of green (and blue) spaces (figure 4) and mobility pattern (figure 5) of each site were studied at both macro and meso scales.
The availability of green and blue spaces alone does not represent much of data. However, by assessing them we can identify cooling performances at both city scale (macro level) and an urban block or building scale (meso or micro level).

Figure 4. Assessment of available green and blue spaces in a selected urban area (Source: IDB reports, Spring 2015)

At macro scale, we can identify possibilities and potentials for urban cooling corridors, urban canyons, urban cool islands and green corridors (mainly ecological). Also at meso and micro scale we can assess micro-climate performance of urban blocks or units and suggest for design optimisation at a more implementable scenario.


Figure 5. Assessment of mobility pattern in a selected urban area (Source: IDB reports, Spring 2015)

In addition, assessment of mobility pattern enables us to evaluate network of connections and modes of

movement in and about urban blocks. Such assessment identifies opportunities for social dimension of green spaces and integration of the built and green for a better performance of movement, walkability and social activities.

## 2.4 *Assessment of Urban Form and Layout*

Lack of integration between urban blocks remains a major challenge of urban housing in China. While each block can develop differently and become an urban enclave, multiplying this to the city level would result in a mixed of city landscapes, images, and urban patterns (figure 6).

Figure 6. Assessment of urban form and layout in a selected urban area (Source: IDB reports, Spring 2015)

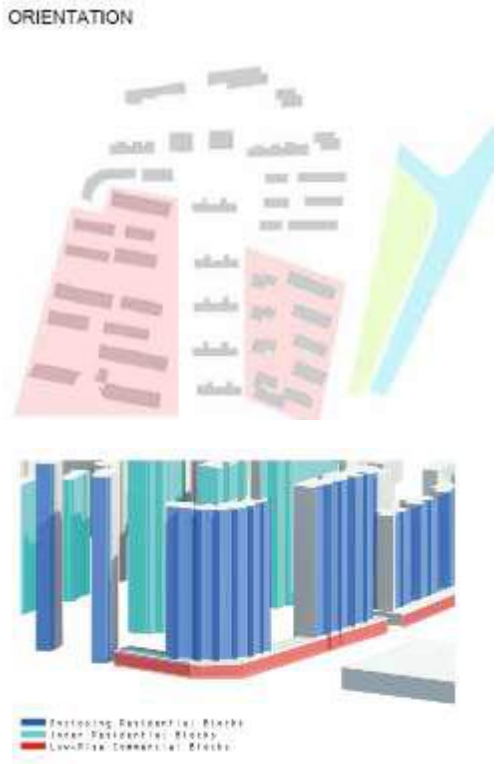
A variable urban pattern does not necessarily harm the city infrastructure or image as it develops diversity, but it would change the city when it leads to development of urban enclaves and large-scale (masterplan level) housing developments.


Figure 7. Assessment of grain study and density in a selected urban area (Source: IDB reports, Spring 2015)

By doing such assessment, we can identify few very important elements of: urban grain, density, land-use and typology of urban blocks (figure 7).

## 2.5 *Assessment of Building Orientation*

While majority of houses are built with North-to-South facades, some housing blocks are built with larger footprints resulting in having many individual residential units with one-sided ventilation, west or east orientations only and some units with inner facades and less access to direct light.




Figures 8 & 9. Assessment of building orientations in a selected urban area (Source: IDB reports, Spring 2015)

Building orientation has significant impact on maximising or minimising lighting surface and solar gain, wind flow and ventilation for indoor spaces and cross ventilation for double-sided units. These represent key aspects of building performance for carbon emission reduction and energy efficient strategies for operational energy (figures 8 & 9). Design, being precursor to energy solutions here, can have a major impact on how residential units perform at micro scale and also how urban blocks perform at meso scale.

## 3 COMPARATIVE ANALYSIS OF SELECTED CASES

### 3.1 *Improvement of Urban Housing Blocks*

Further to assessment studies in the previous section, the collated information is used for development of potential [re]design strategies of the studied urban housing blocks. This includes a comprehensive approach to combine the four main studied elements to optimise the housing blocks if they were to be redesigned. The process is undertaken by evaluation of existing conditions of the housing blocks and proposals to improve the environmental performance, green infrastructure, layout and orientation of buildings (figure 10).

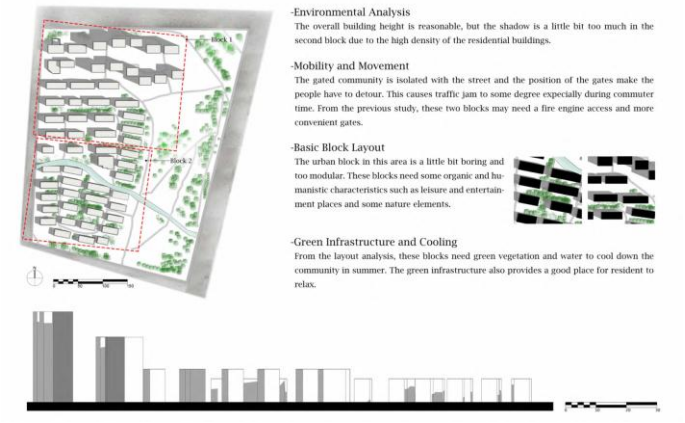



Figure 10. Existing situation of a large scale housing block in Ningbo (Source: IDB reports, Spring 2015)

As part of this design teaching exercise, same FAR is achieved for each of the improved/re-designed cases with revision of SC and density. Based on LSE Citiesi/EIFER studies (2014), a FAR of 1.5 to 2.5 is as efficient as any higher FAR; therefore, to achieve this, each revised case maintains a reasonable FAR and density, while an emphasis is given to orientation, layout and spatial configuration of the blocks. Based on simulation of lighting, overshadowing and the wind environment, the overall urban layout and spatial configuration of each block is modeled and evaluated. An example is shown below in figure11.

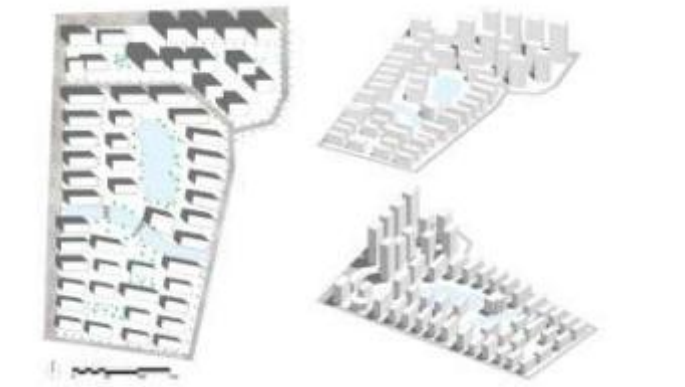


Figure 11. Proposal of new design layout based on assessment of environmental performance, green and blue spaces, pattern and layout (including density, height and configuration), and orientation (Source: IDB reports, Spring 2015)

Also based on the layout design optimisation, an emphasis is given to orientation, heights and space-building ratio of each studied block. Considering the re-arrangement of spaces, the green and blue spaces are integrated as part of improving the cooling performance. As such, this improvement finds a better balance of spatial usage and green and grey ratio and integrates the two as part of re-planning the block layout.

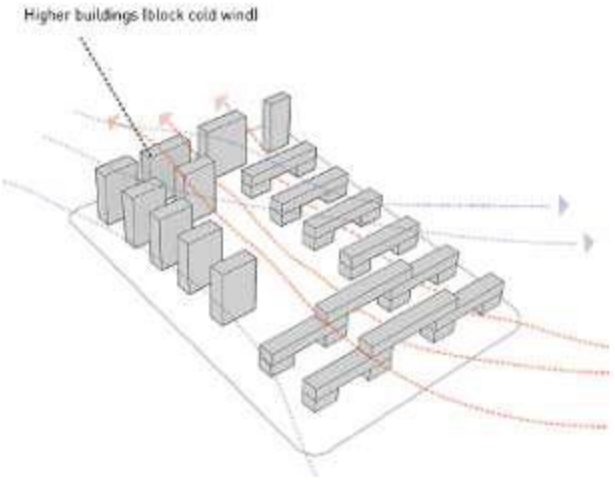



Figure 12. An example of orientation and layout of a re-modeled case (Source: IDB reports, Spring 2015)

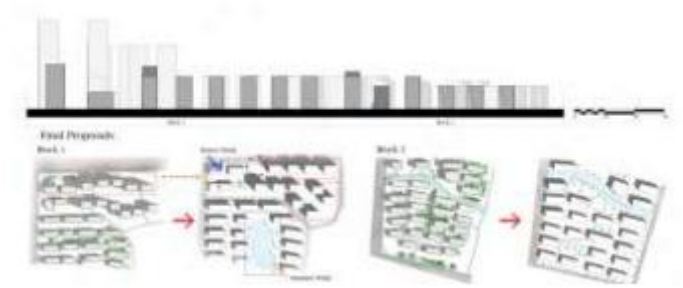


Figure 13. An example of proposal in section and plan (Source: IDB reports, Spring 2015)

By considering the climatic conditions (cold winter and hot and humid summer) of Ningbo, the new block layout is aimed to block cold wind in winter (from North-West) and allow a better wind flow in summer (from South-East) for a better cooling performance (figures 12 and 13).

### 3.2 *Discussions: Towards Design Optimisation*

Here we have two design optimisation challenges; 1) It is almost impossible to find optimised solutions at an urban scale while implementation takes place at a smaller scale; and 2) detailed design optimisation lacks careful architectural input and analysis with a longer timeframe, which requires a more comprehensive approach than what currently exists in practice. In this study, the emphasis has been on potential improvement scenarios for existing blocks while the real scenario remains in hands of mass housing and large scale development projects. A pro-developer planning approach to urban housing has a negative impact on quality and efficiency of housing developments. Such negative impacts include: fast pace of development, low-quality design consideration, generic masterplanning and lack of detailed design.

As part of this design teaching exercise, one can argue the effectiveness of design strategies for the existing contexts while planning the new is often easier and with a higher potential of better planning and design. However, the city is comprised of districts and communities where housing provision appears in various typologies, heights and characteristics. The concern about current homogenization of urban housing in China is an alerting matter that suggests reduction of architects' role in the sector. As a result, the approach undertaken in this study and as part of the teaching exercise was to re-promote the value of architecture and detailed design for urban housing blocks in China.

### 3.3 *Conclusions*

This paper proposes improvement of urban housing blocks through integrated consideration of four key aspects of: a) environmental performance; b) green infrastructure; c) urban form and layout; and d) building orientation. These aspects may appear general and simple at a drawing board, but are certainly very crucial and effective at the implementation stage. The lack of housing development control and deficiency of planning regulations has resulted in dispersed and endless large-scale housing developments, cities with many enclave residential communities (i.e. gated communities) and large numbers of housing provision that are not socially viable (e.g. due to high density, poor urban layout and lack of connection to the context) and are not environmentally efficient (e.g. large grain of building blocks with provision of several units at each floor, higher dependency on air conditioning for heating and cooling, and lack of consideration of sound material use and facades).

This study is based on a research-informed teaching exercise with a focus on methods of urban housing design improvement and optimisation in the context of China. A step-by-step approach to such optimisation methods includes assessment of scale, context and climatic condition of each studied case. By integrating the four key aspects of the study, a holistic framework is developed to enhance efficiency of urban housing and their design at a pre-design stage. The practical implications of such methods, however, require careful reconsideration of planning regulations on urban housing, review of urban block sizes and their integration at a larger scale (i.e. at meso or even macro scales). With such planning and design thinking approach, there remains an opportunity to improve urban housing in China and promote new housing typologies that are vernacular and context-specific, performative and sustainable. Some of these can currently occur at an urban block scale for faster implementation and noticeable success stories. Nevertheless, a successful practical implementation requires comprehensiveness at both planning and pre-design stages while policy changes require reflecting on the urban housing challenges that are addressed in this study.

### 3.4 *References*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