

Research on Residential Block Fabric: A Case Study of Hangzhou West Area

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Abstract—Residential block construction of big cities in China began in the 1950s, and four models had far-reaching influence on modern residential block in its development process, including unit compound and residential district in 1950s to 1980s, and gated community and open community in 1990s to now. Based on analysis of the four models' fabric, the article takes residential blocks in Hangzhou west area as an example and carries on the studies from urban structure level and block spacial level, mainly including urban road network, land use, community function, road organization, public space and building fabric. At last, the article puts forward "Semi-open Sub-community" strategy to improve the current fabric.

Keywords—Hangzhou West Area, residential block model, residential block fabric, "Semi-open Sub-community" strategy.

I. THE RESIDENTIAL BLOCK EVOLUTION IN CHINA

A. Unit Compound and Residential District in 1950s to 1980s

1. Unit Compound

IN the period of planned economic system, unit compound is the basic economic unit and social administrative organization form [1]. The earliest unit compound took place in the first 5-year economic planning and served people who were working and living in the unit. Its scale was determined by unit that it belonged to, and it was enclosed by walls and gates. It characterized itself by axial symmetry in space and centralized its public facilities such as education, rear service, commerce and culture facilities. Neighbors were arrayed symmetrically on both sides of the spatial axle. Each neighbor covered an area of 1-2 hectares in arrangement of standing-in line form and around-street form. Most buildings were low-rise high [1] (Fig. 1).

Unit compounds absorb the spatial idea of Neighborhood Unit in layout [2]. The conception of Job-house balance was of great insignificant but around-streetform produced a lot of building facing the east or west, leading to many kinds of disturbance in living problems like sun-shine, ventilation and street-noise. When it was past the 1980s, unit compounds fell into a decline with the development of residential industry.

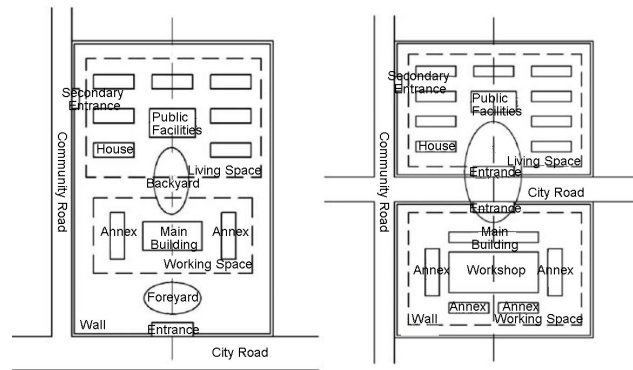


Fig. 1 Basic spacial model of Unit compounds
Data source: Zhang Yan, 2009 [1]

2. Residential District

Residential district took its root in the Residential District Theory of Soviet Union in 1957, developed itself in imitation of Neighborhood Unit in 1960s, based the scale of residential district's population and land use on the proportion of children between 7-12 years old and influence of this method lasts till now [3]. As the residential system reform, paid land use system reform and the experimental work of residential district began to take effect from 1980s, the residential district model grew mature. Residential district is with 5000-15000 residents and an area of 10 to 20 hectares¹. It is very suitable for a hierarchical structure of three levels of "district-group-building" with four residential groups surrounding one garden in the center. Its road network take principles of "accessible but not direct" in circuit mode linking each groups. One group is with 500 households governed by residential committee². Residential group takes form of many kinds such as around-street mode, standing-in line mode, point-group mode and mixed mode, breaking through standing-in line mode dominated situation previously. The residential building is designed on standard and consists of sorts of house types. During this time, the high-rise buildings sprung up in order to economize land use [4]. Otherwise, the scale of public service facilities are decided by the "index of per thousand"³ involving eight categories namely educational

¹Residential district scale=population scale* the area of land use per person, according to Temporary Regulations for Quota Index of urban planning (1980), the indicator of residential land is 14.5 to 22 square meters. Based on the data, it can be known the residential district is of 7 to 22 hectares.

²Residential committee: it refers to basic organization of mass which conducts the residential self-management, self-education and self-service in China. Its scale is 100-700 households.

³Index of per thousand: it refers to index for the public facilities on residential district level put forward by National Architecture Department in

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facility, health care facility, culture and sports facility, commercial facility, finance and telecommunication facility, community service facility, municipal facility, administrative and other facility. The distribution of such facilities is influenced by serve radius and service targets (Fig. 2).



Fig. 2 Hongmeixi village in Changzhou
Data source: Zhu Yi, 2006 [5]

B. Gated Community⁴ and Open Community in 1990s to Now

1. Gated Community

As estate-development is taking the lead in the building construction, residential district model has gradually developed into gated community, which is the widely-adopted space organization form and developing standard from 1990s[6]. The main distinctions between the residential district and gated community lie in three aspects as below.



Fig. 3 Chunyuan community in Kunming
Data source: LvJunhua, 2003[4]

First is the larger scale. Property developers gain the right of newly-develop land use by payment, establish gated community bounded by urban arterial roads which distance is 400-500 meters, and thus the scale of gated community is about 10 to 50 hectares.

Second is the enclosure feature. In order to avoid outside people's interference in environment and use of facilities,

1980. It is used in residential district design to guarantee the amount of public facilities per thousand people need.

⁴ The gated community: America was the first to build the gated community and spread all over the world rapidly. It is the American socialist Edward J. Blakely and Mary Gail Snyder who firstly put forward the conception of Gated Community in 1997, referring to those residential districts which are not accessible by setting wall or fence to privatize their space.

developers build up walls and guarding bars to put the community gated with few monitored exits [7].

Third is the new hierarchical structure. As regulations for urban newly-built residential communities instituted in 1994 by National Architectural Department, property management is marked by law. Compared with residential committee, property management can have the whole community under control, thus resulting in "community-courtyard-building" structure (Fig. 3). Out of being restricted by group scale, new structure has more freedom to distribute buildings and public space.

Promoting living quality to some extent by letting community residents enjoy their facilities and space alone make gated community welcomed. It covered a proportion of 80% in city renewal and community construction from the year 2000 to 2007. However, due to the problems of social segregation, spatial fragmentation and public space's privatization caused by enclosure [8], it results in low-efficiency and segregation of urban space, public facilities and the society, awarded as "Megablock" by international academic world.

2. Open Community

The conception of the open community took shape in the late 1990s, and till now it is on the stage of exploration. Compared with gated community, open community characterizes itself with being open, aiming at integrating residential area into city. Road network layout of open community is free and open community often adopts means of opening road network, public space, commercial facilities and enclosing residential units to guarantee the privacy and popularity (Fig. 4). In addition, some scholars advocate small scale and high-density road in residential community [9], [10], and suitable mixed function like business and service within residential unit [5]. These bring advantages in developing open community theory.



Fig. 4 Sijihuacheng community in Guangzhou
Data source: Wang Hongwei, 2012 [11]

C. Summary

Chinese modern residential block evolution has passed changes from closeness to openness, large scale to small scale, and organization from group to courtyard. Other changes have taken place in freer road network, better public facilities, more variable modes of building combination and gradual enhancement in floor area ratio.

II. GENERAL SITUATION OF RESIDENTIAL BLOCK IN HANGZHOU WEST AREA

Neighboring Zijingang River on the west, Yuhangtang River on the north, Xueyuan Road on the east, Tianmushan Road on the south, residential blocks in study area is with many service facilities developed since 1980s. The blocks are composed of Wenxin, Gudang and Cuiyuan sub-district, including 24 communities with an total area of about 9.8 square kilometers and resident population of more than 200000 (Fig. 5).

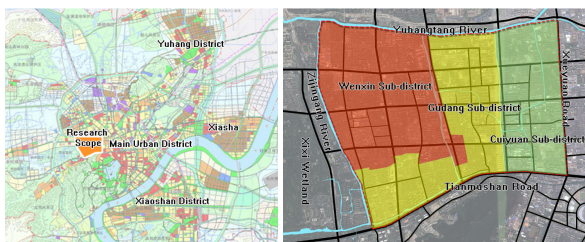


Fig. 5 Location of Site

III. URBAN STRUCTURE LEVEL STUDY

A. Urban Road Network

1. Density and Scale

The density of express way, trunk road, secondary trunk road and branch road of cities with a population of over 2 million should reach 0.4-0.5, 0.8-1.2, 1.2-1.4, 3-4km/km² (regulated by code for transport planning and urban road GB50220-95), so the index of urban road network should be like Table I. By the statistics in Table I, urban road density and scale of study area are suitable.

TABLE I
URBAN ROAD NETWORK INDEX

Item	Large city standard		Study area	
	Arterial road	Branch road	Arterial road	Branch road
Road density(km/km ²)	2-2.6	3-4	2.56	3.75
Road scale	1:1.5		1:1.46	

2. Structure and Formation

Study area is divided into evenly distributed “chessboard” block with an area of about 50-60 hectares by grid roads between which the distance is 600-1100 meters. Compared with urban arterial roads, branch roads show features of free layout and uneven distribution, and have some end roads (Fig. 6). Further, Figs. 10 and 11 show another problem that branch roads mainly locate in business service land when residential land is in lack of it. This contributes to form many gated communities each with a boundary length of 300-600 meters and an area of about 10-30 hectares in study area.

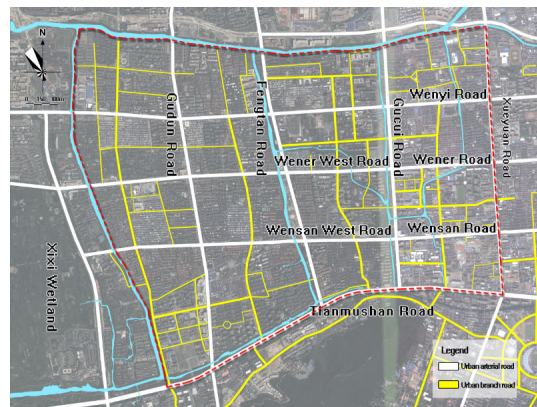


Fig. 6 Urban road network

B. Land Use Status

1. Urban Construction Land Use

Study area covers an area of 982.25 hectares including urban construction land 963.49 hectares, water land 17.03 hectares and idle land 1.73 hectares (Fig.7). And urban construction land mainly comprises residence land 562.40 hectares, public management and public service land 127.73 hectares, business service land 77.11 hectares, street and traffic land 135.05 hectares and green space and square land 55.29 hectares.

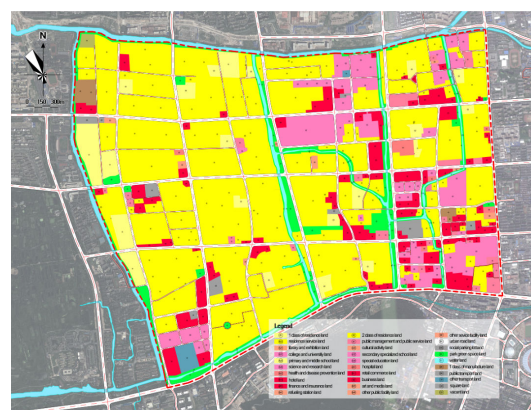


Fig. 7 Land use status

Compared with city standard (regulated by code for classification of urban land use and planning standards of development land GB50137-2011), Table II mainly tells us 3 things: First, street and traffic land (S) is suitable; Secondly, the indicator of residence land (R) and public management and public service land (A) is over-high while manufacture land (M) is too little, this is because study area is Hangzhou's residential district and old education center, and the current scientific research and education land still accounts for 11% of urban construction land; Thirdly, green space and square land (G) is too little, including park green space land 53.22 hectares and square land 2.06 hectares. The per capita park green space is lower than 2.66 square meters while Hangzhou green space system planning (2002-2020) requires it to reach 12 square meters in 2010.

TABLE II
URBAN CONSTRUCTION LAND USE STRUCTURE

Land use	City standard (%)	Study area (%)
R	25.0-40.0	58.4
A	5.0-8.0	13.3
M	15.0-30.0	0.6
S	10.0-25.0	14.0
G	10.0-15.0	5.7

2. Kindergarten, Primary and Middle School Layout

When service radius considered as 300 meters (regulated by code for Urban Residential Areas Planning GB50180-93-2002), kindergartens are scarce in the west side of study area (Fig. 8). Furthermore, service area of kindergartens is overlapping because basic facilities like kindergarten are independently established in gated community.

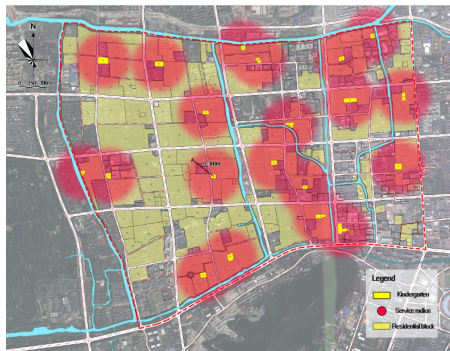


Fig. 8 Kindergarten layout

When service radius respectively considered as 500 and 1000 meters (regulated by code for Urban Residential Areas Planning GB50180-93-2002), primary and middle school layout has similar problems as kindergarten: inadequate facilities and overlapping service area, especially primary schools which have a large service vacuum zone with a total number of 12 (Fig. 9). The main reason is that the government is lack of control over private primary school's construction which is led by market and this contributes to unreasonable overall layout of public and private primary schools.

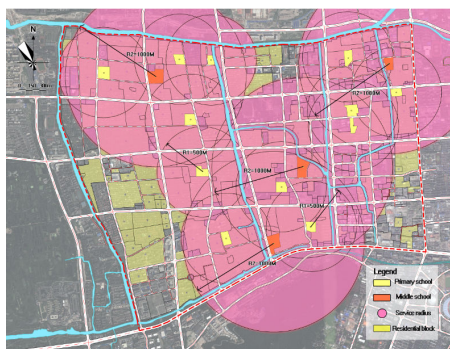


Fig. 9 Primary and middle school layout

3. Park Green Space Layout

The study area has 11 pieces of park green space (not including waterfront green space) and 3 pieces of them have an area over 1 hectare per piece. When service radius respectively considered as 300, 500 and 1000 meters (refer to related content from code for Urban Residential Areas Planning GB50180-93-2002 and standard for classification of urban green space CJJ/T85-2002) (Table III), serious shortage of park green space can be seen (Fig. 10).

TABLE III
DEFINITION OF PARK GREEN SPACE SERVICE RADIUS

Park green space scale(hectare)	Service radius(meter)
<0.4	300
0.4-1.0	500
≥1.0	1000

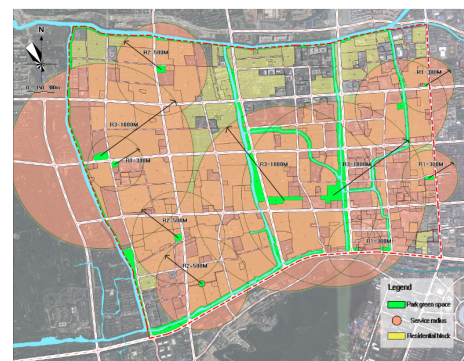


Fig. 10 Park green space layout

C. Summary

In study area, overall index of urban road network is suitable but branch road is in shortage in residential district. In land use structure, the quantity and area of park green space are obviously inadequate, and kindergarten, primary and middle schools have a service vacuum zone in the west due to inefficient distribution.

IV. BLOCK SPATIAL LEVEL STUDY

The article selects 4 residential blocks including 8 communities to do deep analysis: Representing basic facilities well-supplied residential blocks, case 1 is surrounded by Gucui road, Wener road, Xueyuan road and Yuhangtang river, covers an area of 119.29 hectares, includes 4 Cuiyuan communities with 39408 residents in 15275 households and was mainly built in 1990s (Fig. 11); Representing pure residential blocks with few basic facilities, case 2 is surrounded by Wenyixi road, Gudun road, Wensanxi road and Lianhuagang river, covers an area of 98.94 hectares, includes Jingzhou, Dejie, Jinle and Xiangzhang communities with about 32000 residents in 11173 households and was mainly built in 2000s (Fig. 12).

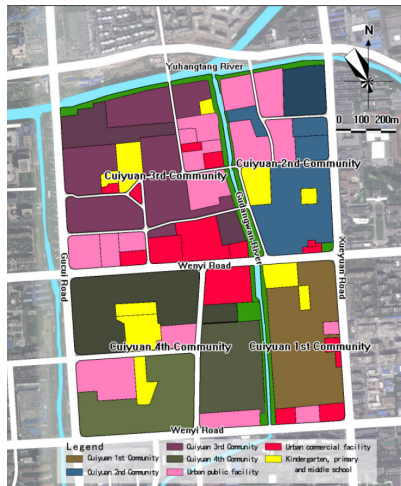


Fig. 11 Case 1: Block composition



Fig. 13 Case 1: Public service facility layout

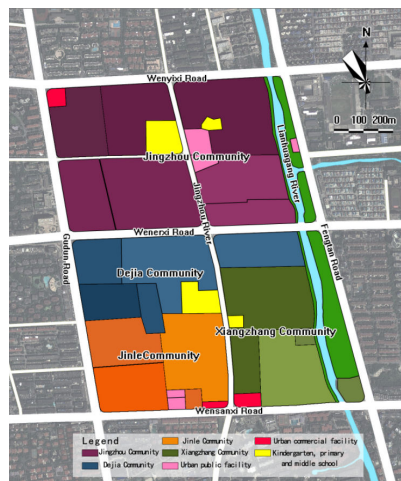


Fig. 12 Case 2: Block composition

A. Case 1: 4 Cuiyuan Communities

1. Mixed Functions

According to related requirements of public service facilities⁵, facilities in Case 1 are sorted in many categories and well-equipped, including 8 kinds namely educational facility (kindergarten, primary and middle school), health care facility (hospital and community clinic), culture and sports facility (activity center and committee for the olds), commercial facility (supermarket, fair, restaurant and shop), finance and telecommunication facility (bank and post-office), community service facility (community service center, residential committee, nursing home and estate management department), municipal facility (bus stop, car park, garbage collection and garbage transfer station), administrative and other facility (sub-district office, police office and sanitation office) (Fig. 13).

⁵More details can be seen in the table of the public facilities allocation in Code for Urban Residential Areas Planning GB50180-93-2002

Commercial facilities are distributed by streets in spotted and linear form. Other public service facilities usually have concentrated and de-concentrated layout, and it improves efficiency and enlarges service area of these facilities. In the meanwhile, as some urban branch roads are free from semi-open communities including Cuiyuan 2nd, 3rd and 4th communities, public service facilities have been making themselves integrated into the residential blocks. All of these represent a residential picture in mixed-function form.

2. Road Organization

Fig. 14 shows three different kinds of inner roads in case 1: First are enclosed roads in urban villages such as Songjiang village and Gudangwan village. Road system is usually in state of chaos and organized by grid and end roads; The second are semi-open roads in sub-communities such as Cuiyuan 2nd and 3rd sub-communities. Their main roads connect with urban road system and present in irregular grid form while their minor roads in fish-bone or lasso shaped are closed to the outside; The third are enclosed roads in sub-communities such as Cuiyuan 1st, 4th and 5th sub-communities. Main roads of this kind are in circular or semi-circular shape, and minor roads connect with them in fish-bone or lasso shape.

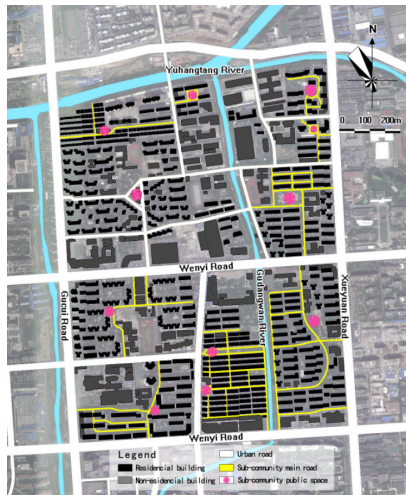


Fig. 14 Case 1: Road and public space organization



Fig. 15 Case 1: Building fabric

3. Public Space

As Fig. 14 shows, public space in urban villages is usually compactly placed at the entrance or inside. Meanwhile, public spaces in sub-communities generally exist in concentrated and de-concentrated form: concentrated green space and public facilities are in the center beside main roads while group green space is scattered inside every residential group.

4. Building Fabric

As Fig. 15 shows, building fabric can be sorted into three kinds: The first is compactly combined fabric in urban villages, whose structure is unranked. Three-story-high buildings are strictly uniform in standing-in-line form and they are in high density of 40% with floor area ratio of 1.2; the second is residential group fabric in sub-communities, such as Cuiyuan 1st, 2nd and 3rd sub-communities. In order to match their circular or semi-circular shaped main roads, sub-communities are divided into residential groups whose scale is 1-3 hectares for each. Point-group form and mismatching standing-in-line form rich building fabric's variety which is determined by standing-in-line form. Most buildings are six-story-high and they reach a density of 25-30% with floor area ratio of 1.5-1.8; the third is residential neighbor fabric in sub-communities, such as Cuiyuan 4th and 5th sub-communities. The organization form is similar to residential group fabric, but it takes the scale of 1-2 hectares as its residential unit which is surrounded by standing-in-line, point-group and around-street shaped buildings. Most buildings are six-story-high and they reach a density of 25-30% with floor area ratio of 1.5-2.0.

B. Case 2: Dezhou, Jingjia, Jinle and Xiangzhang Communities

1. Single Function

Main kinds of public service facilities in case 2 are as below: educational facility (kindergarten, primary and middle school), health care facility (hospital and community clinic), culture and sports facility (activity center and committee for the olds), commercial facility (fair, restaurant and shop), finance and telecommunication facility (bank and post-office), community service facility (residential committee, estate management department and rescue station), municipal facility (car park and garbage collection), administrative and other facility (sub-district office and administration center of Xihu District) (Fig. 16). The problems lie in the scarcity of facilities in amount and lack of diversity, except for commercial facilities which forms are rich.

Because there are many gated sub-communities in case 2, public service facility layout presents distinctive features of externality and internality: Externality refers to facilities placed along the urban arterial roads including line shaped commercial facilities and point shaped facilities like schools, hospitals, banks, and administration offices; Internality refers to the independence and closeness in arrangement and management of other public facilities. In order to cover as large area as they can, these facilities generally locate in or near sub-communities' center. All of these contribute to problems of efficiency and amount lack, presenting single-function form of gated sub-communities.



Fig. 16 Case 2: Public service facility layout

2. Road Organization

Fig. 17 shows two kinds of inner roads in case 2: The first are enclosed roads in urban villages such as Luojiashuang east village and Wulian east village. Road system is unranked and organized by grid and end roads; the second are enclosed roads in sub-communities which are dominant in inner-road proportion. Main roads of this kind are circular or semi-circular shaped and minor roads connect with them in fish-bone or lasso shape.



Fig. 17 Case 2: Road and public space organization

3. Public Space

As Fig.17 shows, public space in urban villages is in serious shortage, with patches of green space scattered among buildings. Meanwhile, public spaces in sub-communities generally exist in concentrated and de-concentrated form: concentrated green space is in center of the sub-community and group green space is scattered inside every residential group.

4. Building fabric

As Fig. 18 shows, building fabric can be sorted into two kinds: The first is compactly combined fabric in urban villages, which is almost the same as that in case 1; the second is residential group fabric in sub-communities. Sub-communities consist of residential groups with an area of 1-2 hectares for each. Standing-in-line form is in a dominant position while some sub-communities enrich themselves by point-group and mismatching standing-in-line arrangement, such as Zigui, Langui and Dejia sub-communities. Most buildings are six-story-high and they reach a density of 20-35% with floor area ratio of 1.0-2.0.



Fig. 18 Case 2: Building fabric

C. Summary

From analysis of the two cases, residential blocks built in 1990s and 2000s of Hangzhou west area shows following features in block special fabric: The first are urban villages which are relatively separated from city. Their public service facilities are simple and road system is organized by grid and end road but not in a systematic manner. Meanwhile, standing-in-line building fabric is excessively monotonous and intensive, and public space is in shortage especially residential group's green space; the second are gated sub-communities which cover most land of study area and are completely separated from city. Their public service facilities are inefficiently distributed and utilized with low sharing and road system is organized by circular (or semicircular) main roads and fishbone shaped (or lasso shaped) minor roads. Point-group form, mismatching standing-in-line form and around-street form rich building fabric's variety which is determined by standing-in-line form. In addition, public space distribution is under the organization of concentration and deconcentration; the third are semi-open sub-communities which are relatively integrated with city. Fabric of this kind is similar to gated sub-community, except for diverse variety, even distribution and high efficiency of public service facilities.

V.CONCLUSION AND SUGGESTION

Urban villages are intermediate products with the rapid expansion of city in China, and they would be digested and replaced with city's natural growth and update. So the article doesn't do further research on urban village's development. However, gated communities have many distinct disadvantages on the whole, such as they decrease urban branch road's density and lose efficiency on public service facilities' distribution. In the meanwhile, various planning means such as improving utilization efficiency of public space by classification can also produce negative impact on city when the residential community is gated, and thus the article puts forward "Semi-open Sub-community" Strategy at last, in order to solve the problems reflected by current fabric of residential district in Hangzhou west area. Central ideas of the strategy include "opening sub-communities, gating residential groups, downscaling sub-communities and densifying road network".

A. Open Sub-Communities and Gate Residential Groups

Based on the analysis above, the root problem of gated community is gated main roads in sub-community. Opening sub-communities' main roads is the key to open sub-communities, because integrating main roads into urban road system can not only densify urban branch roads and improve utilization efficiency of public facilities and public space, but also can increase sub-communities' popularity. However, some measures to decrease interference from outside vehicles are in urgent need, such as taking circular main road, narrowing roadway and weaving pedestrian and vehicle to slow traffic, making a card door in every residential group to improve residents' privacy and security. In addition, public management and public service facilities in urban level should be distributed by city and district government and established by sub-district government, to avoid problems such as private and public primary schools have an inefficient layout.

B. Downscale Sub-Communities and Densify Road Network

According to the requirement of branch road span of large cities in China (namely 150-200 meters), the article suggests that the basic unit of new established residential sub-communities should be residential group, with side length of about 150-200 meters and scale of 2-4 hectares. The road network should be classified to main roads in grid, circle or semi-circle shape and minor roads in fish-bone or lasso shape. To improve present gated sub-communities, it is recommended that the structure is a priority to be retained, the near-term emphasis is to open main roads in sub-communities and avoid excessive impact from outside vehicles, and the long-term emphasis is to share and distribute public facilities and public space reasonably step by step.

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