Research on Land Utilization Intensity Control and Urban Design Fusion Mechanism Based on Spatial Hierarchy Coupling Model

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Abstract

Under the work of vigorously promoting the "whole cover" regulatory plan across the country, urban design also desiderates the regulatory plan of land use intensity. And of which urban design conducts fusion influencing mechanism in three levels under the engineering of fusion compilation system. This paper put forward the control of land use intensity and the fusion compilation of urban design in hierarchical regulatory plan. Through analysis on the spatial level of regulatory plan compilation in various cities, the content and scale of regulatory plan system engineering were shown. As to coupling and relevancy of the division of compilation spatial level, based on the coupling model of spatial level and the fully grasp of the connotation of spatial level system engineering, this paper presented the framework of coupling model with the consistency of its principle, scale and content. Moreover, this paper conducted the research on influencing factors of the control of land use intensity and the fusion mechanism of urban design in hierarchy. Its mechanism avoided the control and guidance of comprehensive urban design mainly on macro space, which was difficult to achieve the practical requirement in urban design.

Keywords: land use intensity, urban design, regulatory plan, spatial system engineering, fusion mechanism

1 Introduction

Regulatory plan played an important role in the urban planning system in our country. Since the eighties, the system of regulatory was gradually perfect and its law status was continuously improved. In addition, control strengthened and effect improved. Regulatory plan mainly experienced these stages, such as the theoretical research and technology exploration stage, generalization and legislation stage, continuous revolution and exploration stage, and rethink and perfect stage. In recent years, with the implementation of The Compilation and Approval of Regulatory Plan in City and Town, the compiling work of "whole" regulatory was vigorously promoted across the country. New ideas and methods of regulatory compilation of "total constraint, hierarchical control, and partition balance" had been put forward to adapt to the city's own characteristics in these cities, such as Beijing, Shanghai, Guangzhou, Wuhan, Nanjing, Jinan, etc.

The core content of regulatory is to control the land use intensity. There are many influencing factors in land use intensity, including society, economy, policy, etc, but these factors concern more about the "quantity" control of indicators to land development, and give less guidance to the "quality" of the urban space environment. While urban design is one of the important means to guarantee the "quality" of the urban space environment, therefore, to organically integrate the idea and method of urban design into the whole cover regulatory system can both enhance the basis of the control of land use intensity in regulatory phase and effectively guide the construction of the "quality" of the urban space environment. Therefore, how to make the illegal file of urban design influence the legal file of regulatory has become the focus issue in the academic circle. We need to explore the theoretical practice foundation on the blending of the control of land use intensity and urban design in the process of the whole cover hierarchical compilation, and the space coupling and technical system of fusion compilation, and to clear the influence mechanism and contents and compilation contents of the control of land use intensity and fusion compilation of urban design, so as to guide the index control of land use intensity.

2 Study of the Blending Between the Control of Land Use Intensity and Urban Design in Regulatory

2.1. STUDY OF THE CONTROL OF LAND USE INTENSITY IN REGULATORY

In recent years, there were many studies on the control of land use intensity at home, mainly focused in three aspects. In the first aspect, Huang Minghua [1], Xian Baoning [2], Duan Zhaoguang [3], et al studied the connotation of land use intensity (Table 1); in the second aspect, Xu Fang [4], Wang Yang [5], Liu Da, Wei Dong, [6][7], Liu Huijun [8]

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et al studied the control method of hierarchical land development intensity, thus to ensure the rationality of plot ratio index; in the third aspect, Ding Liang [9], Xu Zhidong [10], Yao Deming, et al [11] analyzed the influencing factors of land use intensity, established comprehensive model and the corresponding index system, and put forward the related suggestions.

Thus we can see:

(1) hierarchical control is suitable for the current regulatory compilation system, each city or region was divided into different levels according to its own characteristics, of which the majority of cities divided regulatory compilation into three levels: section–management unit–plot (as shown in Figure 1);

(2) the influencing factors closely related to land use intensity were selected to construct the related model by corresponding methods;

(3) in the formulation of land use intensity index, more attention was paid to the combination of" qualitative "and" quantitative ".

TABLE1 The plot ratio index chart of regulatory in three levels

Spatial hierarchy	Main indicators of land use intensity		Index connotation
Section	Regulatory plot ratio	Average plot ratio	Description of district land use intensity on average
Management unit		Benchmark plot ratio	Description of unit land use intensity on average
Plot		Plot ratio	Description of land use intensity in specific plot

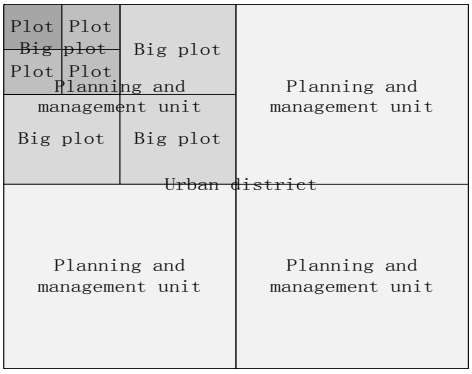


FIGURE1 Diagram of hierarchical control division

2.2. STUDY OF THE THEORY AND PRACTICE OF URBAN DESIGN IN REGULATORY

There were many studies about urban design in regulatory phase in our country, which can be divided into four phases according to the development course of urban design and the analysis and summary of regional planning experience: signal form method, control element method, intention design method, and study of independent urban design. Urban design is an indispensable component of the urban planning compilation system in our country. On the premise of "control and guide", Liu Lei built the framework of urban design theory and method in regulatory aspect mainly focused on the study of the leading index in regulatory, and perfected the theoretical system of urban design in regulatory phase [12]. Urban design compilation system was corresponded to the system of overall planning (macro)–regulatory (meso)–construction plan (micro) hierarchically and step by step by Xie Lingshu, thus to strengthen the operability of urban design [13].

2.3 RESEARCH OF THE BLENDING BETWEEN THE CONTROL OF LAND USE INTENSITY AND URBAN DESIGN IN REGULATORY

2.3.1 Study of Compiling Technique

There were many studies about regulatory plan of urban design integration, on the whole, mainly set from the following two aspects:

First, study of on blending between urban design and regulatory compilation system. Xu Zhenmin, Liu Jian, et al reconstructed and perfected the control index closely related to urban space environment from the perspective of urban design, and proposed to throughout the urban design idea to the whole regulatory compilation process, thus strengthened the ability of regulatory indicators implementation [14,15]. Wang Pingping optimized the content of regulatory results from the perspective of urban design, through the contrast and analysis between the optimization results and the traditional results, and put forward the content optimization system on the technical methods [16]. Jin Guangjun, et al put forward a set of optimized regulation compilation thoughts (“control area”, “construction content”, ”control type”) based on the perspective of urban design, and explored a set of optimized index system, thus enhanced the maneuverability and actionability of regulatory [17].

Second, study of land use intensity guided by urban design. Wang Jiangguo, et al constructed the dynamic decision-making model of land use intensity under the intervention of urban design by using computer programming tools. The conception and intention of urban design was implanted into the parameter of computer programming system, and through parameter to adjust and control the positive decision of intervention in land use, thus provided basis for the objectivity, rationality, flexibility, of land use intensity [18]. Huang Minghua, et al proposed to build hierarchical model of land use intensity based on the relationship of "map" "bottom", and impact factors was selected and GIS overlay analysis was used to build "figure"– benchmark model and "bottom"–correction model; finally got hierarchical model of land use intensity through "figure" and "bottom" superposition [19]. Gao Jie, et al explored the new thought made by land use intensity from the perspective of urban design, selected the impact factors of urban design, and set up multi-factor comprehensive evaluation system, thus got the control model of land use intensity, and effectively guided and perfect the index made by land use intensity [20].

Through the above review, we can got that the organic integration between regulatory plan and urban design enriched and perfected the regulatory plan index system,

thus achieved the goal of reasonable control of the urban space; second, the active intervention of urban design on formulation and control of land use intensity is the important factors that affect the control of land use intensity and an important means of urban space environment building.

2.3.2 Research of Content Index

The content of regulatory plan is mainly centered on "qualitative, positioning, and quantitative, delimit", thus there are rationality and implementation demand in corresponding stage of urban design. It mainly translated the research essence of urban design content into the elements and indexes of each regulatory, then concretely implemented to the corresponding level of regulatory plan.

The majority of regulatory plan compilation content is closely connected and intertwined with urban design (as shown in Figure 2. The in-depth research of urban design content and method in regulatory is benefit to control the "quantity" in land use intensity, thus to have a better guidance of "quality" in urban space form.

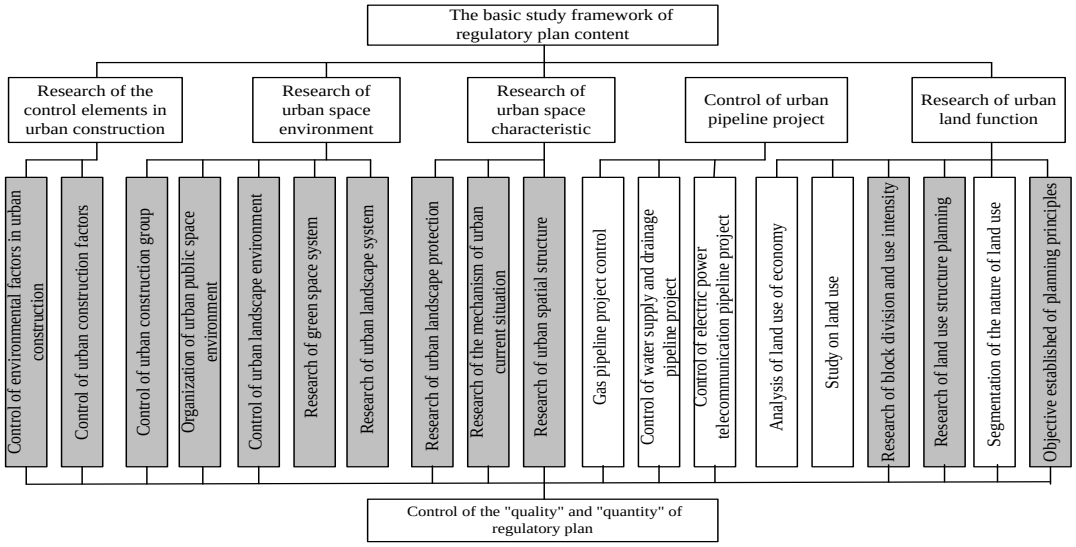


FIGURE 2 Diagram of the relationship between regulatory content and urban design content

The prescriptive index in regulatory plan (land use intensity index, etc) is closely connected with urban space environment. The prescriptive index and leading index in regulatory plan are closely related to the content of urban design in nature (as shown in Figure 3).

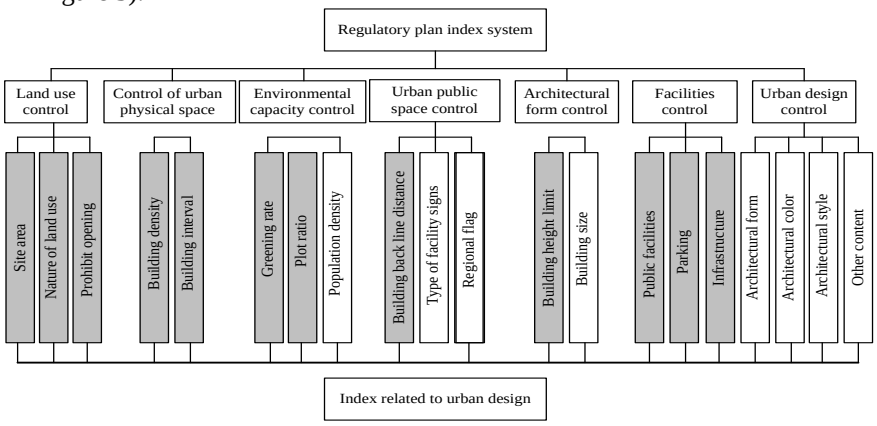


FIGURE 3 Diagram of the relationship between regulatory plan index system and urban design
(the plastered index in figure was the prescriptive index of regulatory plan)

2.3.3 Summary

From the above research review, we can see that land use intensity index in regulatory phases actively guided by urban design has been recognized by the current academic circles, but mostly from block level. However, researches of land use intensity content and method influenced by urban design under a complete coverage of regulatory plan (section, management unit, plot) are less, which need to be further studied to build the blending planning compilation system in urban design and hierarchical regulatory plan based on the technical platform of regulatory plan whole cover. Thus it is quite necessary and practical to clear the blending mechanism and content of land use intensity and urban design in three dimensional administrative levels of regulatory plan.

3 Systems of Land Use Intensity Control and Urban Design Blending Compilation Technology

3.1 COUPLING OF SPECIAL LEVEL SYSTEM

3.1.1 Analysis of special level system of regulatory planning compilation

Statistics of special level, scale and primary task these three aspects of regulatory plan has been carried out in cities like Beijing, Shanghai, Guangzhou, Wuhan, etc (Table 2).

TABLE 2 Regulatory compilation special level system in domestic major cities

Name	Spatial hierarchy	Division scale	Task
Beijing	District	10-20km2	To decompose the total main control Construction in new city
	Block	New block: 2-4km2 Old block: 0. 8-1. 5km2	To decompose the total district to block and to coordinate the configuration, urban design of all kinds of facilities from a certain range
	Plot	—	Clear land property
Shanghai	Compilation unit	Inner ring: 1-3km2 Outer ring: 3-5km2	To decompose the main index of center city
	Neighborhood	—	To decompose the total district to block
	Plot	—	To carry out the planning control index of compilation unit and clear land property
Guangzhou	Development unit	5km2	To decompose the main index of center city
	Plot	New block: 0. 8-1km2 Old city: 0. 2-0. 3km2	To carry out the unit planning control index and clear land property
Wuhan	Compilation unit of regulatory planning	20-50km2	To decompose the main total construction of master planning
	Management unit of regulatory planning	—	To decompose the total compilation unit to management unit
	Plot	—	To carry out the management unit planning control index and clear land property
Nanjing	Compilation unit of regulatory planning	4-20km2	To decompose the main total construction of master planning
	Plan unit	New block: 0. 8-1km2 Old city: 0. 2-0. 3km2	To decompose the total compilation unit To plan unit
	Plot	—	To carry out the plan unit planning control index and clear land property
Jinan	District	4-15km2	From a certain range to coordinate between all kinds of facilities in the neighborhood configuration, urban design
	Neighborhood	New block: 0. 5-1km2 Old city: 0. 3-0. 5km2	To clear land property
	Plot	—	To clear land property
Chengdu	Outline plan	5km2	To coordinate the configuration of all kinds of facilities from a certain range
	detailed plan	—	To clear land property

Through the statistical analysis of special level division content of regulatory phase in the domestic major cities, we can see the division principle of special level system, controlling content and scale in regulatory phase (as shown in Table 3).

TABLE 3 The division principle, scale and planning content of regulatory planning special level

Level	Division principle	Division content	Scale
District	To be in line with the current planning design standards and the administrative management system; the regional location of district in the city; to use natural barrier as boundaries; the main traffic artery; the property of land use function in different areas; with appropriate population capacity.	To implement and deepen the overall urban planning, to specially plan the control content, and mainly controls the leading function, total land use and population scale, planning of land use control and unit division.	10-30km2
Management unit	Road traffic boundary; different planning district and planning compilation body; to use administrative street or community; independence of the dominant function; to use natural barrier as boundaries; the nature of land use as well as the inner link; reasonable service radius of public facilities; the intrinsic relevance and unity of urban functions; appropriate scale of land use;	Mainly to make sure the total amount of construction unit and the dominant function, target and positioning, three control facilities, landscape system, population scale, land use control planning, special control guidance, land division.	2-4km2
Plot	Try to keep a single nature; to respect the plot of the existing land use rights and property rights boundary; to divide block according to the development way and management change, to further restructure in the planning and implementation; suggested at least one side of each plot be adjacent to city road.	To determine various kinds of control index and instructional index.	0. 3-0. 5km2

3.1.2 Analysis on Spatial Level Division System of Urban Design

In this paper, the compilation content of urban design was corresponded to the spatial level of regulatory plan hierarchically to clear the division principle and planning content of each level (as shown in Table 4). That can not only guarantee the urban design could better in line with regulatory plan compilation system, but also gave full play to its special function.

TABLE 4 Division principle and planning content table of each level in urban design

Level	Division principle	Planning content
District	To keep the features of city image; to keep the perfect of the planning system structure	Overall layout framework of urban space; macro orientation and spatial development policy; urban image; combination of the overall environment planning and public policy.
Management Unit	To keep the characteristics of spatial morphology; to keep the perfection of space landscape, traffic organization, public space.	Space form layout; the core control principle closely related to land use intensity of urban design; framework of the city key partition space, and to put forward the assumption of space form and the feature localization for node.
Plot	To keep the perfect of environment landscape elements; to keep the characteristics of the architectural elements.	To keep close contact with the key development projects partially; control elements and quantitative indicators

3.1.3 Coupling of regulatory plan and the special level of urban design

We need to butt joint the division principle and content of both compilation spatial level based on the full master of regulatory spatial level system. Then we analyze the coupling and relevance of both spatial division, and to put forward the consistent coupling framework of in spatial division principle, scale and planning content (as shown in Figure 4).

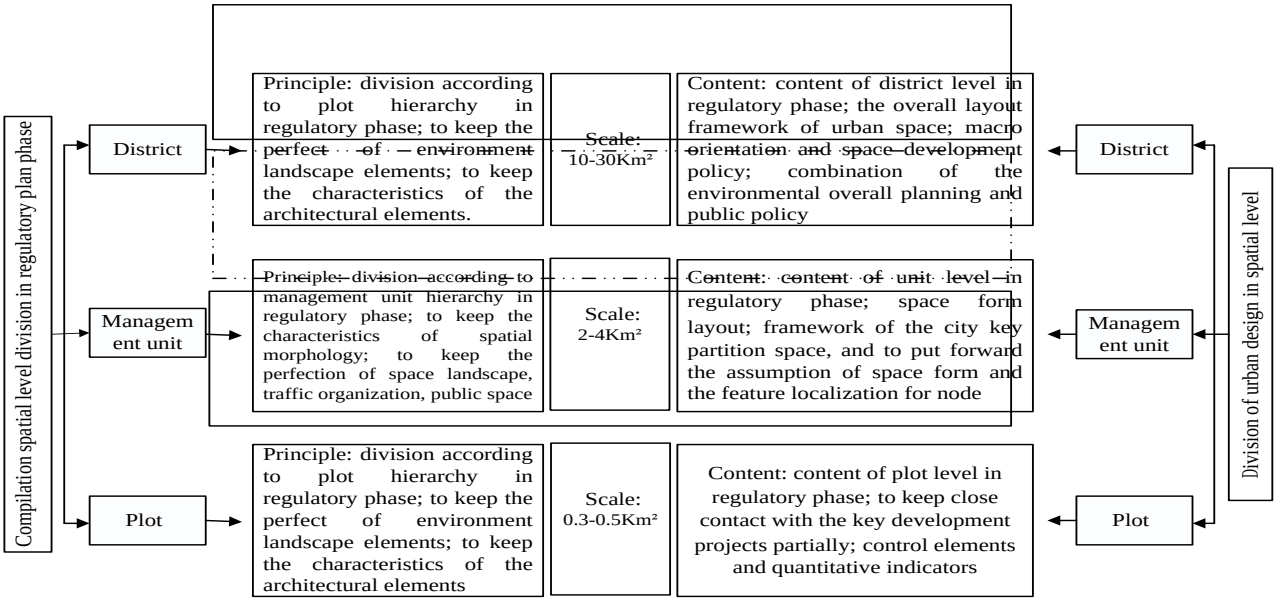


FIGURE 4 Coupling diagram of regulatory and urban design special level

3.2 FRAMEWORK INTEGRATION OF URBAN DESIGN AND HIERARCHICAL CONTROL COMPILATION CONTENT

Through the analysis and research of the coupling of regulatory plan and urban design spatial level system, the framework of interactive feedback relations between the compilation content of urban design and regulatory plan was established based on the regulatory plan compilation system platform of "total constraints, hierarchical control, partition balance" (as shown in Figure 5).

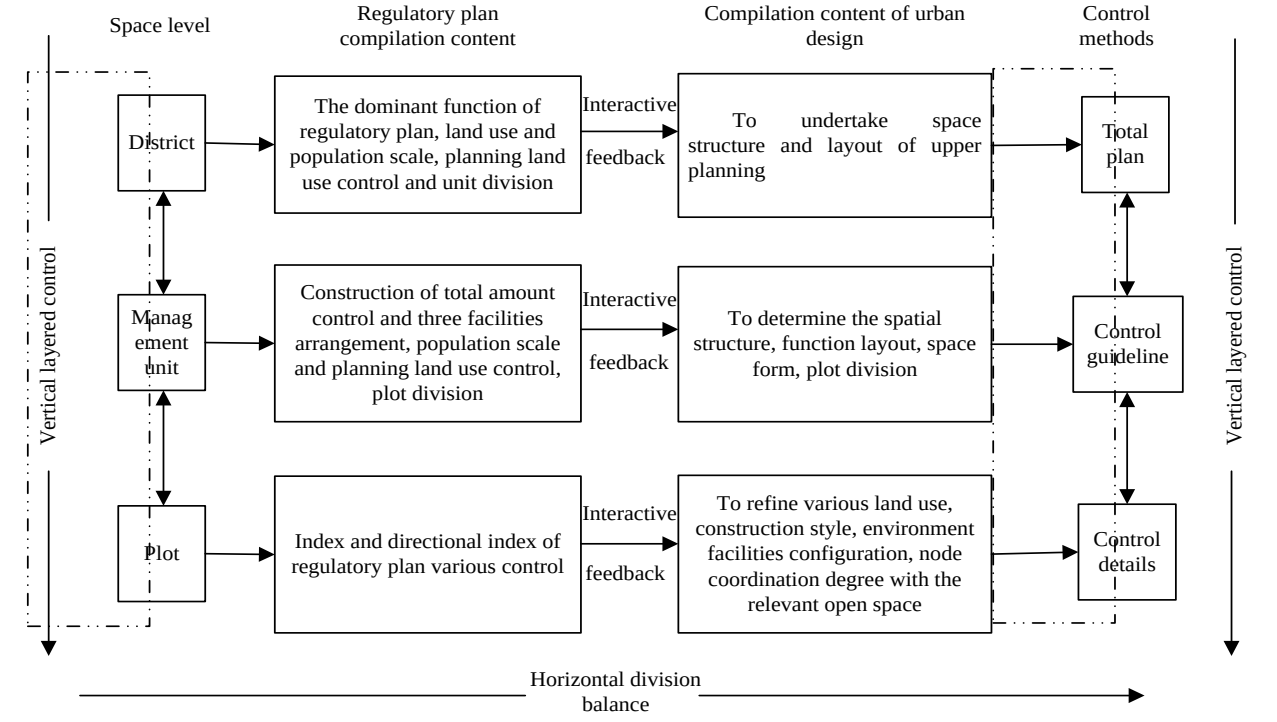
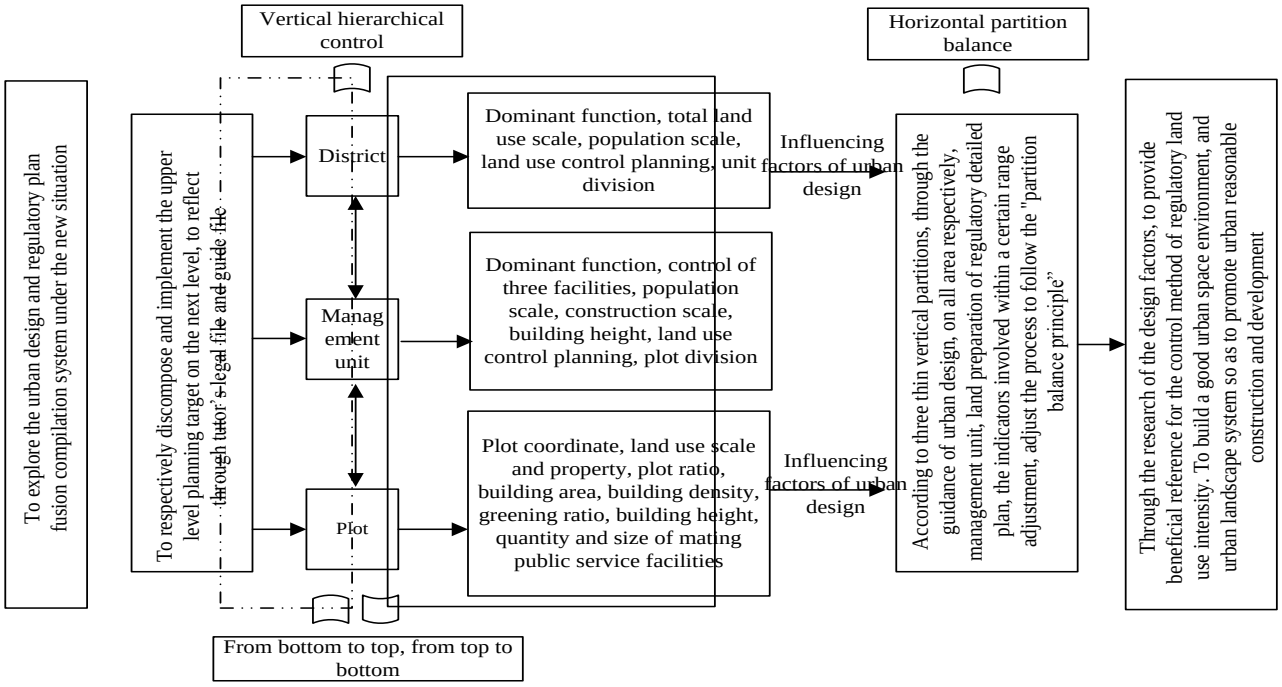


FIGURE 5 Framework of interactive feedback between the compilation content of urban design and regulatory plan

3.3 COMPILING TECHNIQUE SYSTEM OF LAND USE INTENSITY CONTROL INTEGRATED BY URBAN DESIGN

Through relationship carding of interactive feedback between the compilation content of urban design and regulatory plan, the control methods of land use intensity suitable for our current hierarchical control was discussed, which was based on total amount control of forward urban, hierarchical control as the main content, the goal to promote urban development.

The system of the control of land use intensity was proposed from "urban design guidance, total constraint, vertical hierarchical control, and horizontal partition balance" these four aspects, on which the system mainly focused (as shown in Figure 6).



FUGURE 6 Figure of compiling system of land use intensity control integrated by urban design

"Urban design guidance" means to make the urban design idea and method through out the whole process of regulatory compilation system.

"Total constraint" means to discompose the overall index layer upon layer based on grasping the control of coordination between the overall and local, each level has the corresponding total constraints. Total constraint is mainly on the quantitative implementation of those core objectives, like city scale, urban space form, function structure, nature, etc.

"Vertical layered control" means to discompose and implement the planning and requirements of the above one level to the next level. Hierarchical control includes district, management unit and plot three spatial levels, which emphasizes on the feedback of two-way hierarchical mechanism from top-down passing and bottom-up adjustment, at the same time stresses the interaction mechanisms of all levels should be considered in district-unit-plot division. In "top-down" control, district level mainly in line with total plan and complete the corresponding total constraints index. The index of land use intensity is determined follow the overall requirements of plot index. The "bottom-up" control acts on "plot" through the details of the current situation.

"Horizontal partition balance" means to adjust the index involved in district, management unit, plot three levels within a reasonable range, thus to keep balance of each area in the process of adjusting.

4 The Influencing Mechanism and Factors of the Control of Land Use Intensity and Urban Design Blending

4.1 THE INFLUENCING MECHANISM OF THE CONTROL OF LAND USE INTENSITY AND URBAN DESIGN BLENDING IN HIERARCHY

The influence of urban design to land use intensity is throughout the whole process of land use planning. Under the regulatory hierarchical control, their integration mechanisms mainly showed vertical stratification relay feedback mechanism and transverse partition balance guidance mechanism, and determined the land use intensity index step by step under the vertical and horizontal two-way mechanism (as shown in Figure 7).

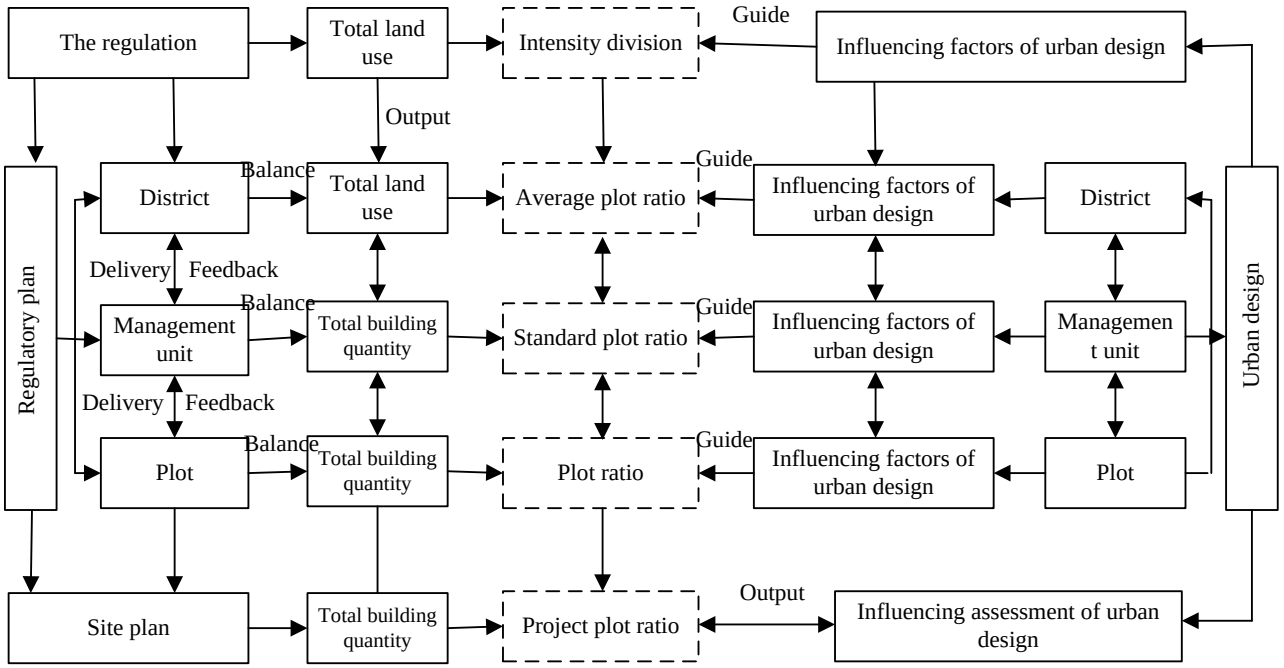


FIGURE 7 The influencing mechanism figure of land use intensity and urban design blending

4.1.1 The influencing mechanism of district level blending

The amounts of district was determined by total plan, while the content and method of urban design has the characteristics of elastic, especially on the guidance and constraint of urban space structure, function partition, ecological system, etc. To a certain extent, it affects the determination of total amount of district, thus affects the average plot ratio of district.

4.1.2 The influencing mechanism of management unit level

The determined total amount of district needs to be allocated reasonably under the level of regulatory management unit, thus the influence of urban design on land use intensity can extend to the management unit level. Urban design affects the differences in mechanism, which causes the transverse difference in space bearing capacity of each management unit. While the total amount allocation of each management unit construction should fully consider the space bearing capacity of the corresponding management unit. The total amount of construction allocated by each management unit directly determines the standard plot ratio of that management unit.

4.1.3 The influencing mechanism of plot level

People's requirements are not only limited to the basic satisfaction of living needs, instead, rise to the demand for environmental quality. The determination of plot level, plot ratio also influenced by urban design, the urban design factor which is closely related to land use intensity will decide the foundation of land use intensity of that plot.

4.2 THE INFLUENCING FACTORS OF THE CONTROL OF LAND USE INTENSITY AND URBAN DESIGN BLENDING IN HIERARCHY

In the process of compiling, we considered both the city overall goal and the structure in plot level, and the research and guidance of urban space and morphology in unit level, thus ensured the operability of plot level, which effectively guided the control of land use intensity in plot level. The framework of "plot–strategic grasp, compilation unit–space design, plot–action arrangement" of urban design that influenced the control of land use intensity has been put forward (as shown in Figure 8).

4.2.1 The influencing factor of plot level blending--strategic grasp

The overall city objective: to combine with the characteristics of urban integral pattern, and to ensure determine the overall goal; the overall urban space structure: to combine with the natural landscape, history and culture context, urban texture, and the overall city function structure, to determine the overall urban space structure as well as the spatial distribution structure of all levels; the city space form: to determine the overall image and features of urban skyline according to land use structure, function division, building partition, etc, to put forward suggestions of the urban stereo shape design and city height partition; the system and partition of urban color: to determine the overall city tone and partition (including key area) according to the overall city landscape, function structure, folk customs.

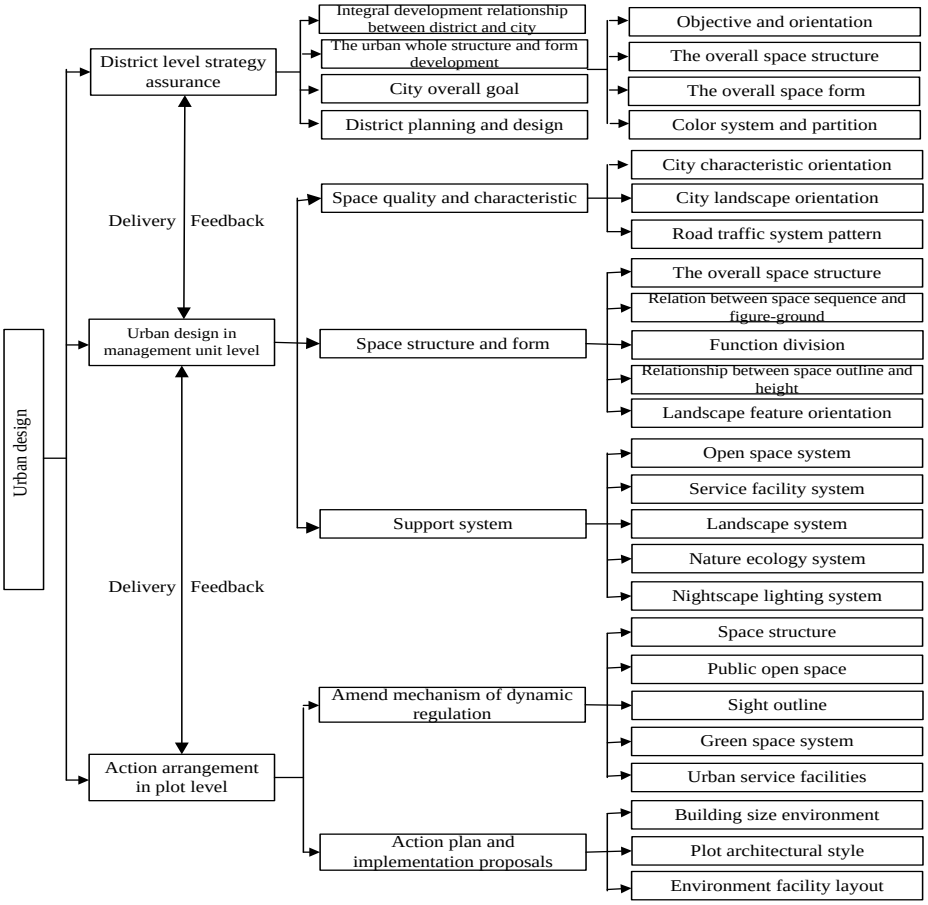


FIGURE 8 The influencing factor figure of urban design in each regulatory level

4.2.2 The influencing factor of management unit level – space design

The localization of city features: to combine with the present district situation, spatial structure, landscape structure, etc according to the requirement of district to unit layout, to determine the unit positioning and spatial form pattern, and to formulate the goal of unit urban design; the orientation of city landscape: to combine with the current requirement of unit construction according to the upper plan requirement, and to determine the feature and partition of urban landscape; the spatial landscape pattern: to determine the main landscape axis, important landscape nodes of unit level according to the localization of city features, the current environment situation and the requirement of geological conditions, and to build a complete ecological pattern of landscape; the localization of landscape features: to mine unit internal unique landscape elements according to district spatial landscape pattern, to put forward the requirement of key area spatial layout and morphology; the service facility system: to make an overall design idea to the city important service facility (including public service facility and municipal infrastructure); the pattern of road traffic system: to put forward the overall idea and guidance to the facility layout of unit rail traffic, city road traffic, pedestrian traffic (including slow traffic) and main traffic; the control of height: to combine with the landscape according to the urban design requirement, so as to determine the control of unit building height, and to shape the space outline of rich modality; to confirm key urban design area.

4.2.3 The influencing factor of plot level – action arrangement

The plot special structure: to study the planar characteistics and vertical form of plot according to the unit spatial structure and layout, and to determine spatial structure and form, function partition and walking system of big plot; public open space: to put forward the relevant control and guidance requirement to the form and scale of open space; public green system: to carry out the overall design concept of urban green space landscape (park green space, green buffer, etc), urban night scene, important environmental facilities, etc, according to landscape spatial pattern and land use planning; construction type environment: to put forward the design requirements for construction group of spatial organization, architectural style, architectural form, architectural color, etc; plot architectural style: to put forward the guide requirements of plot structure size, shape, color design according to the requirement of the big plots to small plot; environment facilities configuration: to carry on reasonable arrangement and layout to the pavement within the plot, landscape sketch, sculpture, etc, to put forward corresponding guiding opinions to the sketch form, shape, color, etc; the coordinate degree with the adjacent open space nodes; to put forward the requirements of important plot design.

5 Conclusion

This paper mainly focused on the problems and plight of the control of land use intensity and urban design fusion in hierarchical regulatory plan in our country. Through the analysis of the related theory and practice, this paper further analyzed the inner link between urban design and the control of regulatory land use intensity, which constructed the blending compilation system of both spatial level divisions in the consistent of principle, content, scale. It exploratory put forward the land use intensity control system of "urban design guidance, total constraint, longitudinal hierarchical control, horizontal partition balance", and also further discussed the influencing mechanism and factors of land use intensity and urban design in the hierarchical fusion.

The fusion of land use intensity control and urban design in hierarchical regulatory plan avoided the control and guidance mainly carried on macro space of overall urban design, which was difficult to achieve the actual requirement in urban construction practice, and the overall coverage of the city could not be realized in site plan phase. It played an essential role in the urban planning system. It not only helps to shape the urban space form, but also effectively guide the development and construction of urban land. It is the beneficial supplement of regulatory management.

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