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Urban design based on public safety—Discussion on safety-based urban design

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Abstract Because of public safety problems in construction of urban surroundings, this paper expounds the necessity of the study on public safety-based urban design in perspective of modern city. It brings forward the concept of safety-based urban design and attempts to explore the basic connotation and contents with framework for studies.

Keywords urban public safety, urban design, safety-based urban design

1 Introduction

Today, urban safety faces a more complex and urgent situation. On one hand, in the global range, such traditional safety problems as disasters including traffic accidents, flood, water logging and earthquake as well as crimes of public security still exist, whereas nontraditional security problems assault cities, including terrorist attack and new pandemic disease disasters represented by SARS, and eco-environmental safety. On the other hand, with social transformation and high-speed urbanization progress, population, architecture, production and wealth are gradually concentrated in the cities of China, whereas relatively weak urban infrastructure safety, increasing potential safety hazards in the public space and continuous occurrence of new social contradictions have all greatly increased the risk level of safety in cities that face many challenges. The buildup of safe cities not only has become a major topic of global concern but also is the basic goal of and important guarantee for the strategy of realizing sustainable development and establishing a harmonious socialist society of China as well as the overall strategic issue significant to harmonious development of the society and the economy of our country.

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2 Urban planning and public safety

Aiming at urban safety problems, corresponding theoretical discussion and planning preparation have been carried out in the field of urban planning of China in terms of general planning, district planning, and special planning from such aspects as industrial hazard sources, public places, public infrastructures, natural disasters, road traffic, terrorist attack, and vandalism as well as outbreak of events concerning public health [1].

As a whole, as far as space is concerned, urban safety planning, through the prearrangement of urban land use, coordinates the relationship among various urban components and improves the relationship among urban society, economy, and space, protecting the urban environment and citizens from the harm of various safety threats. It is a distribution process of urban space and relevant resources based on safety, with the systematic establishment of its main content, objective, scope, and methods still in exploration stage. As far as technology is concerned, improving the urban public safety level from the planning and design of physical space environment is a major content and research orientation of urban safety planning. As a major field of people sensing and experiencing urban space quality, the relatively microcosmic and specific urban space (especially public space) is crucial to the recognition and feeling of general urban safety. The safety quality of urban space involves many factors including people's psychology and behaviors, society, history, culture, and nature, with rather complicate relationship and function mechanism with urban space environment. The rigid means of urban public safety planning can only relatively control the "safety baseline" of space design and the construction, while lacking effective countermeasures to relatively soft psychological and behavioral safety and incapable of meeting overall demands of public safety of urban space. Moreover, urban safety planning pays more attention to satisfying safety demands in terms of engineering function intensification, with angle of view being rather singular and specific design methods being relatively program oriented, incapable of fully exerting an

active role of spatial structure and environmental landscape factor in the quality of space safety, and being hard to cope with specific environmental background of versatile space and various safety requirements or coordinating such space factors as function, structure, and form to realize the comprehensive performance of space safety. Besides, realizing internal perfection of building safety design, the former safety planning (mainly disaster-prevention planning) ignored the public space outside the building, lacking overall control over urban space environment in each hierarchy and incapable of forming a complete and safe public space system.

In addition, in the stage of implementing administration and control, there are no corresponding technical means and administrative and control media of how to coordinate the specific requirements of urban public safety planning and safety requirements of buildings and sites as well as how to carry out the structural outline of safety planning in the specific safety construction of a three-dimensional urban space environment. Therefore, further improvement is required for urban safety planning in terms of the content, theory, and method.

3 Urban design and public safety

Design of the built environment of cities and towns as well as creating places is the basic contents of urban design [2]. Quality of public safety of space environment is the basic goal of and the major factor deciding the success of urban design.

In fact, the field of urban design has long been paying attention to the safety of urban space environment. Historically, urban design based on military requirements has improved military defense capability from city site selection, city form, road organization and design of city walls and city gates. Both palaces representing power and urban streets emphasized the safety precautions against behaviors of destruction and attack. Through urban infrastructure construction and reconstruction of district living environment, the urban design, paying attention to improving living environment, improved hygienic quality of space environment, restrained, and alleviated the pandemic disasters that had ever brought great hit to the urban public safety. In addition, avoidance from flood, earthquake, and other disasters in time of urban construction site selection, fire isolation belt formed by streets, firewalls and water systems within the streets, setup of firefighting facilities, and improvement of the form and layout of urban streets and squares from the angle of safety refuge reflected the consideration of safety against disasters. For example, geometrical layout form as well as broad and straight streets adopted in Paris reconstruction plan directed by Hausmann not only embodied the magnificent aesthetic principle but also took military

defense into consideration. During the reconstruction of Catania after the city was razed to ground by the earthquake in 1693, broad and straight roads in radioactive form and the space mode of oversized square as central refuge place were adopted, providing space guarantee for people's quick escape and safety refuge. After Lisbon, Portugal, suffered great damage from the earthquake on November 1, 1755, a series of reconstruction principles were determined in the urban design, including connecting urban public squares by straight streets to maintain orthogonal block form as well as limiting building height not higher than street width so as to ensure postearthquake evacuation passages [3].

4 Concept and connotation of safety-based urban design

With the overall optimization of urban space environmental quality as the objective, modern urban design, although covering safety quality of space environment, is deficient in design principles, strategies, and methods for safety. For example, overall consideration of and comprehensive countermeasures to disaster prevention, disaster reduction, safety refuge, and safety defense as well as psychological and behavioral safety are absent from specific space environmental design and project design. Innovations of theories, methods, and technical means are required for the current construction of the urban public safety planning system. It is very necessary to introduce the angle of view and content of urban design to the urban space safety planning. Therefore, urban design should take active care of the safety property of urban space environment, take urban public space as main objective, carry out comprehensive design of and research into urban space environmental safety, and explore ideas and methods of urban design based on urban public safety so as to make it the connection and transition between urban safety planning and building safety design as well as guide and control the whole process of design, decision making, and implementation of urban space safety, improving the planning system of urban public safety in terms of the theory, method, and implementation. The urban design based on public safety is hereby temporally called "safety-based urban design." As a whole, safety-based urban design cares about actual spatial safety experience and safety quality. The basic connotation refers to the design and organization of exterior space of cities and physical environment carried out for the purpose of realizing urban public safety, which is the specification and visualization of urban safety planning content and the process of "shape forming" of the structural outline of urban safety planning in the specific urban physical space as well as provides research framework and methods of practice for specific space safety design.

5 Content of safety-based urban design

With people's safety as the main objective, safety-based urban design is concerned with the safety problems in physical space environment. Public safety factors of urban space include people's psychological sense of safety, no damage from environmental disturbance when people are conducting normal behaviors and activities, and noninvasion from such act of destruction as crime and natural disasters. Impact and interference of these factors from overall design of space environment collectively consist of the basic contents of the safety-based urban design.

5.1 Psychological safety

According to the model put forward by Maslow, people's requirements has hierarchical relationship from the most fundamental needs of life to the most abstract aesthetic needs. Once the basic physiological needs are satisfied, people will turn to seek physiological and psychological safety. The physiological sense of safety is related to the needs of life to a great extent. While the psychological sense of safety is mainly and closely related to the society in which people realize self-values and physiological mechanism. According to environmental stress theory, people acquire a sense of control over and predictive judgment of space environment through cognition of environmental stimuli and then evaluate the environment as being threatening or unsafe through the cognitive process. The cognition is surely related to the individual's psychological factors (intelligence, knowledge, experience, and motive) and also affected by such social and natural environmental factors as status of social security, occurrence or frequency of natural disasters, and corresponding treatment measures and effectiveness as the result of coactions of many factors.

With regard to specific spatial environment, factors influencing people's psychological sense of safety are mainly related to people's privacy level in the space environment and control degree of it [4]. Among them, privacy level is related to the protection degree that people sense in the space, whereas the control degree is directly connected with people's capability of avoiding and improving factors of threat. Many scholars, including Lang, held the view that safety requirements mainly include requirements for avoidance from threats and harm, keeping self safety and personal privacy as well as orientation in the environment. Lynch has also pointed out that a chaotic space image lacking personality will always cause difficulties to people's spatial orientation, resulting in environmental fear and psychological uneasiness, whereas a desirable environmental image with "legibility" can reduce the possibility of labyrinth or wilderment, give space users a psychological sense of safety, and help them to establish psychological harmonious relationship with the outside world [5]. It is obvious

that environmental identifiability and "readability" of urban image are important factors of psychological sense of safety. Besides, the study of urban social geography has indicated the relationship between spatial layout and composition mode of urban psychological safety and environmental quality. Excessively dense and old buildings, lack of and poor-quality public space (especially space for public entertainment), excessively large traffic flow of roads, dirty and chaotic environment, and overflow of uncivilized behaviors will all cause the feeling of destruction of social order and weak sense of control over the space, with a rather big impact on psychological safety cognition [6]. The researchers in Ohio, America, has also proved the active influence of such environmental factors as identifiable marks, definite space boundary, reasonable road system, and sufficient lighting on the formation of the sense of safety [7].

For the purpose of interfering in people's psychological safety from urban design, organization and arrangement of spatial form and environmental factors can be used to enhance the identifiability as well as territoriality, control, and ownership of spatial places so as to further improve the psychological sense of the places. In the mean time, it should be noted that psychological sense of safety comes from people's general cognition of the factors probably threatening their safety, which requires space environment not only to be capable of providing safety guarantee for people's normal activities but also to be capable of protecting them from invasion by such external threatening factors as crime, terrorist attack, and natural disasters, which will inevitably involve other aspects of safety-based urban design.

5.2 Behavioral safety

Urban space environment has a close relationship with safety of people's behaviors and activities. Some factors of urban space may hurt people and even endanger their life when they are engaged in such behaviors and activities as walking, sitting, lying, and viewing. For example, excessively smooth surface of ground pavement materials of urban public squares (especially in rainy days) is inclined to cause pedestrians (especially the old) to fall over and hurt themselves; changes of height difference of sidewalks, paths, and square grounds are abrupt, and space arrangement and material arrangement lack necessary allusion and direction; lack of lighting or unreasonable design at space-changing places disturbs people's judgment of space environment; angles of some parterres, chairs, and other street furniture are too sharp, being inclined to cause second hurt after people fall over; waterside space lacks handrails and other facilities preventing people from falling into water. Aiming at the above-mentioned safety factors, behavioral safety design, taking environmental behavior science and ergonomics as foundation, eliminates potential accidents that can

endanger behavioral safety according to the relationship among people's living and behavioral habits, accident occurrence regularity, and space environment. It mainly covers such contents as walking environment design, preventing falling and dropping in daily pedestrian safety as well as space environmental improvement, preventing collision of falling objects from high altitude and occurrence of falling into water, and dropping and other accidents in waterside and mountainous regions [8].

In addition, traffic safety of pedestrians associated with automobiles is also a major content of behavioral safety design. Urban design should improve form, structure, function type, and road-surrounding environmental landscape of the road system; reasonably locate entrances and exits of buildings and their sites for the purpose of safety; and satisfy such safety requirements as visible scope within the line of sight by organizing environmental factors including pavement, lighting, signal, and planting so as to reduce adverse impact on safety judgment of drivers and pedestrians. For many years, in the field of urban design, separating pedestrian and vehicle under the precondition of walking safety have been extensively taken, such as street motor vehicles in exterior and pedestrian streets (such as commercial pedestrian streets) in interior, and establishing pedestrian linkage by vertical traffic means including pedestrian bridges and street-crossing subways. As for pedestrian safety under the status of coexistence of pedestrians and vehicles, many scholars have attempted to improve the safety of walking space through design of and control over street form and environment. Thanks to a great deal of investigation and study, they have found that, under the status of coexistence of pedestrians and vehicles, reasonable street design can greatly improve pedestrian safety and create walking space full of energy. For example, Jacobs and Buchanan et al. have discovered that, compared with closed expressways, compound avenues with many intersections and sidewalk configuration are not dangerous, with accident rate and accident loss degree obviously decreased. In the 1970s, concept of "shared streets" following pedestrian and vehicle sharing principle was first put forward in Holland, under the precondition of ensuring pedestrian priority; having traffic calming measures; redesign of the form factors of bending, straightness, and width of streets; natural barriers including trees and flower pools; and color and texture of road surface pavement so as to urge drivers to concentrate and reduce vehicle speed to avoid occurrence of accidents. This concept of "shared streets" was then carried out in Germany, Britain, Japan, and other countries, with remarkable achievements made (see Figs. 1 and 2) [9].

5.3 Defense for safety

Such design takes people's inappropriate behaviors as objects, mainly including such disruptive and behaviors of

attack as crime and terrorist attacks that may happen in urban space environment. In view of crime prevention and control in urban space, modern urban design is carried out in terms of design of physical space environment. Some famous scholars have put forward important theories, ideas, and practice results. Among them, Jacobs published *The Death and Life of Great American Cities* in 1961. In this book, Jacobs clarified the impact of urban space on the criminal behavior mode and emphasized protection of citizens' safety by the clear division of public and private areas as well as eyes on the streets and other natural surveillance [10]. In *Defensible Space: Crime Prevention Through Urban Design* in 1972, Newman explicitly put forward the urban design strategy of defensible space theory responding to crime problems and emphasized integration of four factors of territoriality, natural surveillance, image, and milieu [11]. Later, famous American contemporary criminologist Jeffery analyzed the interactive relationship among criminal behaviors, interpersonal relationship, social criteria, and space environment and then put forward the concept of Crime Prevention through Environmental Design (CPTED). Hillier, Clarke, and others continuously supplemented and deepened the research into this aspect.

Among the above-mentioned studies, Jeffery's achievements are more remarkable. After dozens of years of development and amalgamation, comprehensive CPTED strategy has become an important theory and design idea of using environmental design to prevent criminal behaviors as well as using urban design means to interfere in space safety. It has been extensively applied to the practice in the U.S.A., the U.K., Canada, and Australia. UN-Habitat, AIA, British Home Office, and other institutions have specified, in their action plans and planning design guidance, the strategy of using CPTED methods to prevent and eliminate crimes in urban planning and design (see Fig. 3) [12]. In the 1980s, Toronto, Canada, began to devote itself to improving urban public security from urban planning. The design strategy, represented by "Planning for a Safer City" guidelines, mainly emphasizes visibility and surveillance of people in the space and spatial identifiability, being acclaimed as the best practice by International Centre for the Prevention of Crime and Organization for Economic Cooperation and Development (OECD) [13]. Almost at the same time, British planners and designers carried out large quantities of practices and researches with urban public spaces as an object, including squares, parking lots, and traffic stations. Until April 2004, *Safer Places: The Planning System and Crime Prevention* was issued by the Office of the Deputy Prime Minister of the U.K., with directive achievements made, having established the basic framework of space planning and urban design aiming at crime prevention from access and movement, structure, surveillance, ownership, physical protection, activity, management, and maintenance [14].

Systematic research aiming at terrorist attacks, mainly

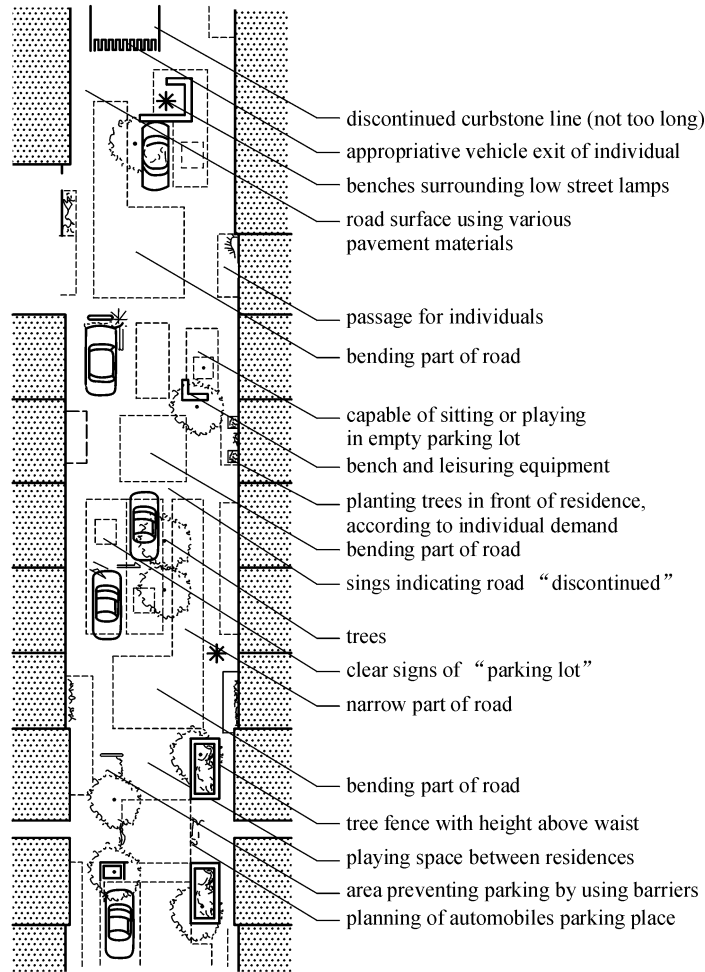


Fig. 1 Measures to enhance road safety under status of coexistence of pedestrians and vehicles in Ref. [9], p152

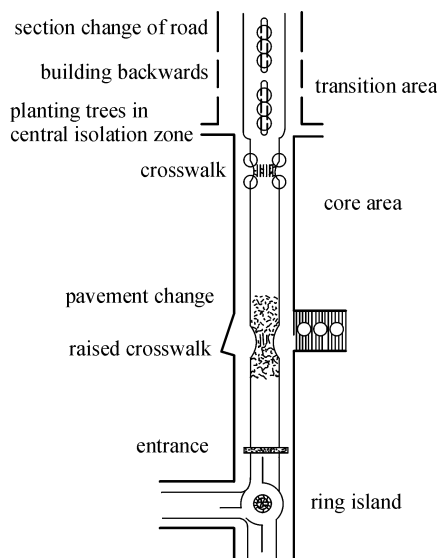


Fig. 2 Measures to enhance road safety of shared streets in Ref. [9], p155

started from the work in the field of urban planning and design of the United States after the 9·11 Terrorist Attack, mostly concentrates in the reflection of urban design guidance and architectural design of high-density urban form, spatial pattern, urban public space, and large activity place [15]. *The National Capital Urban Design and Security Plan* with the White House as core implemented from October 2002 to November 2004, in America, organically integrated spatial safety planning, safety facility, and optimization of urban daily space environment through urban design with automobile bomb terrorist attacks as the main target, with the specific strategy thereof including forming building safety buffer area by integrating building back-off and public space; setting physical barriers by integrating such street furnishings as parterres and lamp posts; providing line of sight monitoring by integrating architectural layout, facade design, and spatial form; removing roads that can probably be utilized by terrorists; and improving control over road entrances and exits by integrating structural form of roads and site design as well as dividing defense spatial hierarchy by integrating

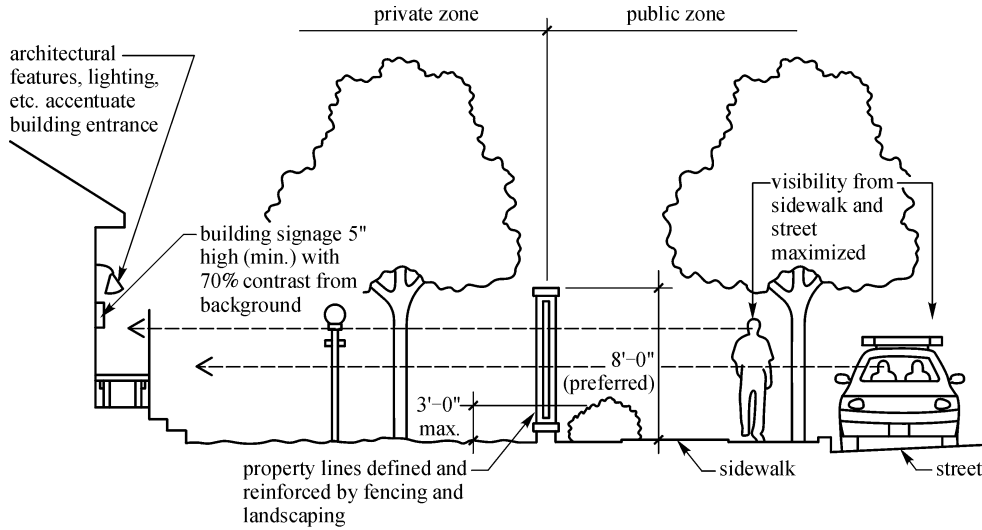


Fig. 3 Section design of streets based on consideration of crime prevention in Ref. [12], p476

spatial landscape requirements. The research mainly concentrates on districts, blocks, and sections (see Fig. 4) [16].

To sum up, in terms of urban design, the design of defense for safety, mainly starting from such characteristics as the type, implementation process, and methods of criminal behavior and terrorist attack, integrating defense space and the basic principle of CPTED, through the overall design of factors including architectural layout, spatial form, road structure, planting, lighting, and environmental facilities as well as such safeguard technology and equipment as camera and closed-circuit television, advances monitoring capability of line of sight, improves public activity level in the whole day, and promotes the sense of place cognition so as to bring convenience to safe management and maintenance, thus protecting target to be attacked from the physical space and improving the possibility of discovering crime and terrorist attacks.

5.4 Safety against disaster

Urban physical space environment is closely related with natural disasters. On one hand, the negative impact of urban space environment on the safe operation of nature, ecological system, and geological system will induce urban natural disasters as well as high urbanization and dense urban spatial form will always have an amplifying and cumulative effect on the damage degree of natural disasters. On the other hand, urban space environment is the material basis for implementing disaster-avoiding and disaster-mitigating measures as well as conducting disaster prevention and disaster relief. Design of site selection, function, composition, and form of space environmental system factors (roads, infrastructures, open space, architecture, and so on) will directly influence the resistance capability of space environment to natural disasters. In recent years, elimination of disaster vulnerability of built environment, creation of disaster-preventive space,

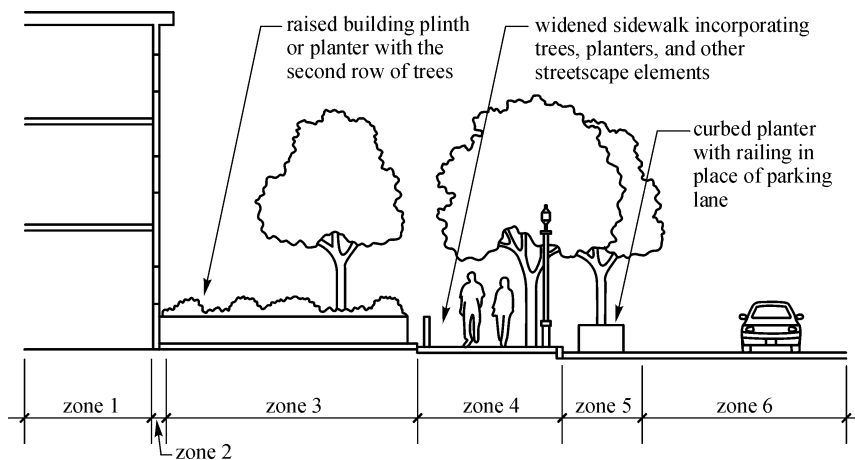


Fig. 4 Example of streets design preventing terrorist attack of automobile bomb in Ref. [12], p477

enhancement of disaster-preventive capability, and reduction of disaster risks in terms of space planning and design have attracted extensive attention in the field of international disaster prevention and mitigation as well as become one of the major research orientations [17]. As an important means and medium of interfering and controlling urban built environment, urban design determines the basic form of framework and specific design strategy of space environment as well as directly influences the capability of disaster prevention and resistance of urban space. As a result, urban design should improve the overall quality of urban disaster-preventive space under the general framework of disaster prevention and mitigation planning, at various levels of general, district, section, and building site of cities as well as from the angle of organization and design of spatial shape and environmental factors, with its main contents roughly as follows:

- Reducing the adverse impact on natural environment and system, promoting normal energy recycling and safe operation of natural system as well as eliminating the possibility of disaster formation through organizing and arranging such factors as site selection, function, use, relation, density and form of urban space environment and construction projects to coordinate with natural environment.
- Integrating reasonable layout of building density and spatial form with land use and site selection of construction so as to effectively avoid factors causing disasters.
- Forming a disaster isolation belt as well as a multicore and decentralized disaster-preventive spatial pattern through providing such natural open space of urban public green space and water in interspaces and such artificial public space of squares and streets so as to restrain disaster deterioration.
- Optimizing the positions and forms of refuge and rescue roads, refuge space, and entrances and exits through providing sound back-off distance and spatial layout and integrating overall design of environmental landscapes so as to improve the disaster-prevention space system meeting such requirements as safety refuge and disaster relief in terms of spatial form.

Former practices were mostly targeted at certain special disaster. For example, in the Downtown Development and Redevelopment Plan of Hilo, Hawaii, in 1974 and 1985,

aiming at tsunami and potential flood disaster, besides establishment of safe area according to the range of affected area in history, a series of measures were taken in urban design and architectural design, such as selecting the sites of buildings and infrastructures at places of relatively high altitude and providing sufficient back-off distance among buildings to avoid flood-prone area; encouraging raised ground-floor of buildings; paying attention to layout and form design of planting, ditches, slopes, and waterside terraces so as to decelerate water flow; and enlarging as much as possible building interval and building walls of certain angles so as to influence and steer water flow direction as well as block force of water flow by walls, reinforced platforms and waterside terraces. In addition, parking buildings was built in central area, providing a parking lot and functioning as a barrier preventing ocean waves from entering inland built areas as well (see Fig. 5) [18]. In recent years, with the increasing attention to comprehensive spatial disaster-prevention concept based on multidisasters, comprehensive space design and research have been carried out in the urban design practice in Europe, America, and Japan aiming at common requirements of ordinary natural disasters in cities. For example, in terms of the urban design of the district level, Western countries, represented by the U.K., always use such open spaces as urban parks, avenues, public green space, and waters and rivers to build public disaster-prevention space systems meeting safety requirements of multidisasters. Japan endeavors to emphasize the optimization of spatial layout form of district and the improvement the overall disaster-prevention capability through enlarging building interval, forming fire isolation belt by plants of rather desirable flame-resistance, and optimizing site selection and form design of the open spaces from the angle of safe refuge in sections and districts level (see Fig. 6) [19].

6 Conclusions

As a whole, safety-based urban design put forward in this paper is associated with urban design and research with urban space public safety as the main target. With the construction of sustainable and safe urban space

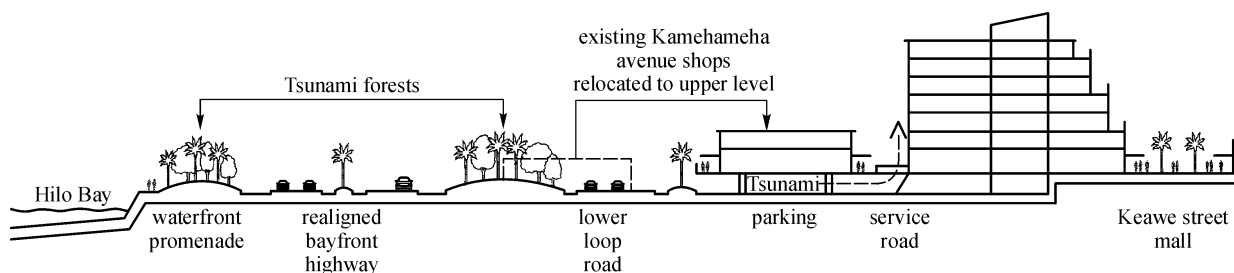


Fig. 5 Section example of urban design for redevelopment of Hilo, Hawaii in Ref. [12], p171

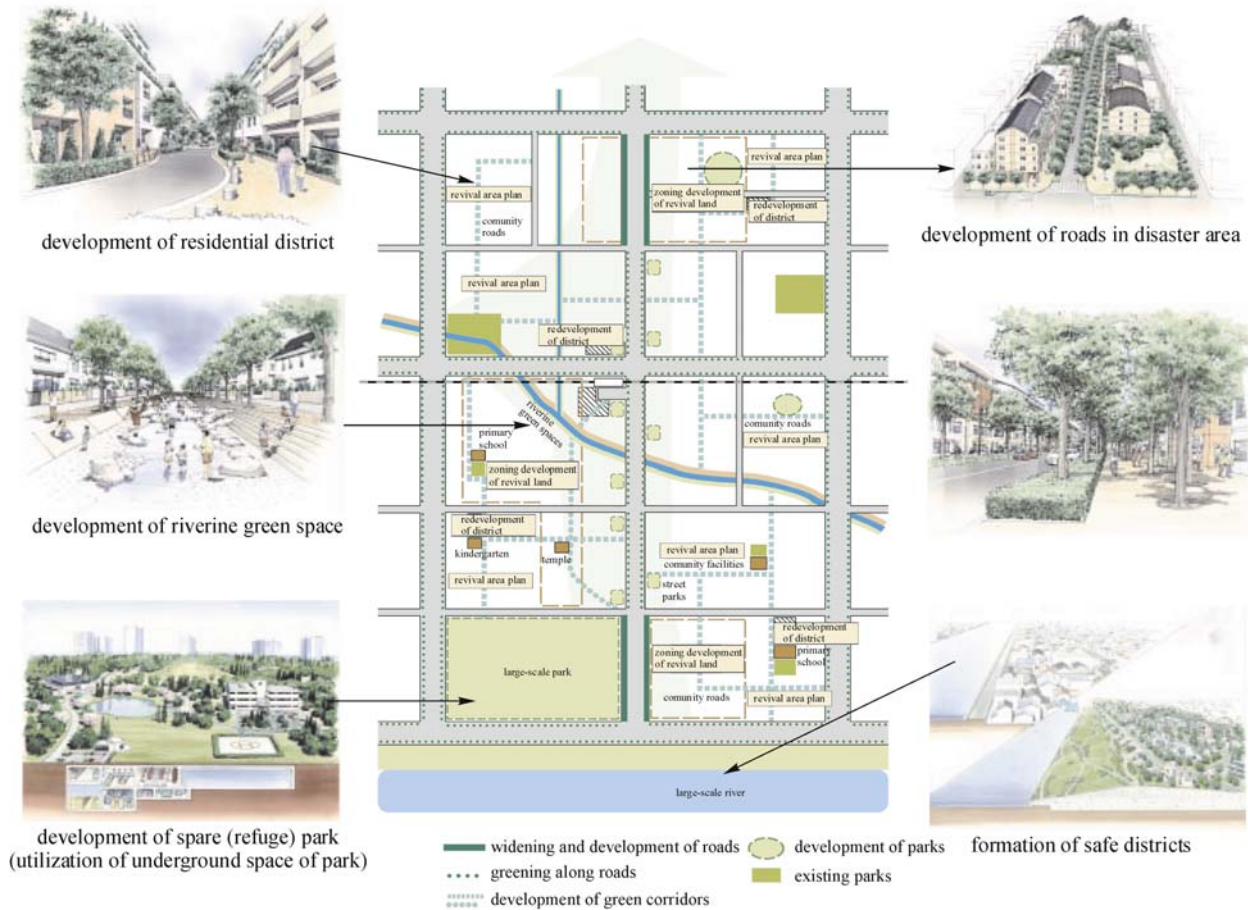


Fig. 6 Design and image of disaster-preventive green corridor in “Grand Design for Recovery after an Earthquake” in Tokyo, Japan [19]

environment as the objective, safety-based urban design covers the criteria on physiology, psychology, and behaviors as well as such factors as urban ecological environment, society, and culture. There are many relevant sciences and theories, including not only basic theories on safety science, disaster science, and ecology but also such urban science as urban geography and urban sociology as well as such relevant theories on urban planning and urban design and architecture such as environmental psychology, environmental behaviors, and disaster-prevention space. Safety-based urban design is a comprehensive space design established on the interdisciplinary platform. Moreover, with multiple value goals, urban design based on public safety must improve space safety quality while giving attention to such inherent pursuits of urban design as function, access, convenience, comfort, and public activity. A safe, coordinative, orderly, and versatile urban space environment can be built only by integrating improving space safety quality with other property and goals.

Urban safety has always been the basic requirement of urban existence and development. Facing the increasingly complicated urban public safety problem, the author puts

forward the concept of “safety-based urban design” from the angle of view of urban design as well as attempts to probe the basic direction and possible fields of theoretical research, aiming at deepening, improving, and expanding relevant contents of urban design, on one hand, and attempting to put forward new research approaches and methods of planning, design, administration, and control of urban public safety to meet increasing urgent requirements of urban safety construction on the other hand.

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