Journal of World Architecture

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Table of Contents

1 **Reform and Practice of the Core Curriculum of Civil Engineering and Architecture Based on the "1+X" System**
Yajuan Liu

5 **Analysis of Several Problems in the Construction of Sponge City**
Wei Li

10 **Discussion on the Improvement of Technical Safety Scheme Compilation for Hazardous and Ultrahazardous Projects**
Yi Gong, Bingyang Yang

20 **Beautification of Chinese Architectural Images in the New Media Age**
Shan Huang, Tingyu Liu, Jinni Bai

28 **Dilemma in the Development of Modern Timber Architecture and Its Countermeasures**
Liang Pan

37 **Study on Safety Distance between Expressway Tunnel and Interchange under Multi Tunnel**
Yaoping Luo, Yun Wan

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Reform and Practice of the Core Curriculum of *Civil Engineering and Architecture* Based on the "1+X" System

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Abstract: The "1+X" system has a great impact on the development of vocational education. Based on this system, it is imperative to carry out the reform and practice of the core curriculum of *Civil Engineering and Architecture*. Several vocational colleges have made attempts in the reform and practice of the curriculum, but the effect is not ideal. Under the influence of various factors, such as the lack of experience, there are also several problems in the reform and practice of the curriculum. Among them, the most apparent problems are as follows: the curriculum reform is not synchronized with the development of teaching materials, the pertinence of practical teaching is lacking, and the guidance provided for professional certificate examinations is not well-established. This paper specifically analyzes the problems existing in the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system, and then puts forward effective strategies for these problems.

Keywords: "1+X" system; Civil engineering and architecture; Curriculum reform

Online publication: January 12, 2022

1. Introduction

Under the background of vocational education reform, the maturity of the teaching concept of *Civil Engineering and Architecture* has improved, and the reform and practice of its core curriculum has gained much attention. After the "1+X" system was introduced, the curriculum reform and practice based on this system has become the main choice. More and more vocational colleges are making attempts at this level, but the actual effect is not ideal. It is an indisputable fact that there are some problems in its curriculum reform and practice. Considering the obvious restrictive effects of various problems, it is of great significance to explore effective strategies for the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system.

2. Reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system

The reform and practice trend of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system is apparent. It is directly related to the value of specific curriculum reform and practice [1]. On the one hand, the reform and practice of the core curriculum of civil engineering and architecture under the "1+X" system can greatly improve the innovation and effectiveness of the course teaching as well as the

quality of professional teaching. On the other hand, it can deepen students' understanding of professional knowledge and help students better improve their basic professional skills as well as obtain professional certificates, so as to promote better development. This indicates that whether from the perspective of vocational education development and curriculum reform, or from the perspective of students' growth and development, it is necessary to actively carry out corresponding curriculum reform and practice under the "1+X" system. For vocational colleges and civil architecture teachers, they also need to think more deeply about the reform and practice of its core curriculum.

3. Problems existing in the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system

3.1. Unsynchronized curriculum reform with textbook development

In the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system, many vocational colleges are not keeping up with the development of school-based teaching materials, resulting in an asynchrony in the curriculum reform with the development of teaching materials [2]. Generally speaking, as long as curriculum reform is involved, it needs to be adjusted at the teaching level. In addition to selecting innovative teaching methods, it is also important to introduce new teaching contents. At this stage, the teaching of civil engineering and architecture in vocational education is highly dependent on the teaching materials, in which the content framework of the teaching materials determines the knowledge framework in the curriculum teaching. However, theoretical knowledge accounts for a large proportion in many teaching materials. Teaching based on the inherent curriculum teaching does not provide effective support for the reform and practice of its core curriculum under the "1+X" system. At the same time, it does not provide sufficient support for the cultivation and improvement of students' professional skills. In the specific curriculum reform and practice, as the development of teaching materials is not synchronous in practice, the continuous use of previous teaching materials is not conducive to the reform and practice of the curriculum.

3.2. Lacking pertinence in practical teaching

In the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system, the lack of pertinence in practical teaching is also a problem. Since the "1+X" system emphasizes more on the cultivation of students' professional skills, it has become a goal for students to obtain relevant certificates of civil engineering based on the cultivation of professional skills. In this case, practical teaching has become the main form of teaching. Most vocational colleges are also driving the reform and practice of its core curriculum around practical teaching activities. Through analyzing the curriculum reform and practice of *Civil Engineering and Architecture* in several vocational colleges, it has been ascertained that although the importance of practical teaching is increasing, the pertinence of practical teaching is obviously lacking, which makes practical teaching a mere form. In the long run, it will be difficult to make a confounding breakthrough in the curriculum reform and practice.

3.3. Inadequate guidance in professional certificate examinations

In the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system, the problem of inadequate guidance in certificate examinations is also apparent. Under the "1+X" system, it is necessary to help students obtain as many certificates as possible throughout the course. However, from the perspective of its curriculum reform and practice, many vocational colleges and teachers have not been guiding students properly in preparing for these certificate examinations. It is extremely difficult for students to obtain multilevel certificates, such as in Building Information Modeling (BIM). The

acquisition of these certificates requires students to put in a lot of effort, and it is also inseparable from the guidance provided in curriculum teaching. However, in the specific reform and practice of the core curriculum, the guidance provided for these examinations is not properly established, which makes it difficult for many students to obtain the relevant certificates; thus, the effect of the curriculum reform and practice under the "1+X" system is naturally below par.

4. Strategies for the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system

4.1. Developing school-based teaching materials that are in line with the curriculum reform and practical needs

In the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system, vocational colleges should develop school-based teaching materials in line with the needs of curriculum reform and practice [3]. For example, a vocational college in Xi'an has made attempts for the reform and practice in the teaching of many professional courses, such as in *Civil Engineering and Architecture*. With the reform and practice of the core curriculum of *Civil Engineering and Architecture*, the vocational college has also upgraded its school-based teaching materials. In the new materials, there is a high proportion of contents related to the vocational skills examination, including personnel cost, data processing, construction supervision, and building information modeling (BIM). With the development of school-based teaching materials, the explanation of theoretical knowledge in the curriculum reform and practice links better with practical teaching. Therefore, other vocational colleges also need to actively participate in the development of school-based teaching materials along with the curriculum reform and practice.

4.2. Improving the pertinence of practical teaching from the perspective of applied talent training

It is also very important to improve the pertinence of practical teaching in the core curriculum of civil engineering courses from the perspective of applied talent training. It is an important matter which should not be disregarded in the curriculum reform and practice. For example, some vocational colleges are trying to cooperate with enterprises in the reform and practice of the core curriculum of *Civil Engineering and Architecture*, in order to create a link between professional course teaching inside the school and practical teaching outside the school. Under the "1+X" system, considering the high demand of students for professional certificates, different students have different needs for different professional certificates. Therefore, in the selection of off-campus practical teaching bases and students' practical teaching posts, schools need to communicate with the students to promote the curriculum reform and better highlight the practical value by improving the pertinence of practical teaching.

4.3. Strengthening the guidance in professional certificate examinations

In the reform and practice of the core curriculum of *Civil Engineering and Architecture*, it is imperative to strengthen the guidance in relevant professional certificate examinations. In the specific curriculum reform and practice, professional curriculum teachers should communicate with the students in an in-depth manner about relevant professional certificate examinations and help students to meet their needs in preparing for various certificate examinations. In addition to explaining course knowledge in classroom teaching and cultivating students' professional skills in practical teaching, teachers should also regularly carry out teaching activities that are related to relevant professional certificate examinations in the overall teaching process. By interpreting specific tested points, professional knowledge, and skill requirements in these certificate examinations, students would be able to understand and learn about the difficulty and

requirements of the corresponding certificates, thus lowering the perceived difficulty of the students in face with these examinations. Strengthening guidance in these examinations is an effective way in the curriculum reform and practice.

5. Conclusion

More attention should be paid to the reform and practice of the core curriculum of *Civil Engineering and Architecture* under the "1+X" system. Vocational colleges should provide guidance, while teachers should also actively try to do so. It has to be acknowledged that the corresponding curriculum reform and practice as well as the value of concrete efforts are not simple; in addition, the influence of a variety of factors also easily leads to certain problems. Therefore, vocational colleges and professional teachers should analyze the specific curriculum reform and practice as well as make targeted adjustments based on the results, thus providing more support for the curriculum reform and practice under the "1+X" system.

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Analysis of Several Problems in the Construction of Sponge City

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Abstract: Sponge city refers to a new urban construction concept used to solve urban flood disasters and water ecological problems. It is important for the construction of ecological civilization. It plays an important role in the green development and livability of the city. In the construction of a sponge city, it is necessary to make special urban planning and improve the top-level design. In recent years, China has developed a number of sponge city pilot projects. The numerous experiments act as important references for the urban construction in China. This paper mainly analyzes the requirements for the construction of sponge city and discusses several problems as well as solutions in the construction.

Keywords: Sponge city; Construction problems; Solution strategies

Online publication: January 12, 2022

1. Introduction

The construction of sponge city plays an important role in urban water conservation and flood disaster prevention in China. It is an important way to solve urban water ecological problems. The construction of sponge city is conducive to reducing the impact on the ecological environment in urban construction and development as well as promoting a green, innovative, and coordinated development of the city. It is also an important channel for the construction of social ecological civilization in China. In recent years, China has developed a number of pilot projects and made some achievements from them. With these pilot projects, several problems in the construction of sponge city have surfaced. The analysis of these problems is conducive to the construction and development of sponge city.

2. Key points in the planning and construction of sponge cities

From 2015 to 2016, the list of sponge cities in China has been published. There are two batches of sponge cities. Thirty cities have been selected as pilot units for the construction, with an investment of more than 400 billion yuan [1]. The development of these pilot sponge cities provides an effective reference for the construction of sponge cities in China and a reproducible construction template for the construction of other sponge cities. Through the construction of the first and second batch of pilot sponge cities, it can be concluded that the construction of sponge cities plays an important role in the improvement of urban hydrological environment as well as the prevention and treatment of flood and waterlogging disasters, affirming the feasibility of the construction of sponge cities in China, and highlighting the problems that need to be paid attention to in the construction of sponge cities, which play important roles in the construction of sponge cities and the promotion of sponge cities in China (**Table 1** and **Table 2**).

Table 1. First batch of sponge cities in China

City	Annual river runoff control
Baicheng	70% to 85%
Qian'an	75% to 85%
Jinan	75% to 85%
Hebi	80% to 85%
Xixian New Area	70% to 85%
Zhenjiang	70% to 85%
Pingxiang	70% to 85%
Chizhou	80% to 85%
Wuhan	80% to 85%
Changde	70% to 85%
Chongqing	70% to 85%
Suining	70% to 85%

Table 2. Second batch of sponge cities in China

City	Annual river runoff control
Beijing	70% to 85%
Tianjin	70% to 85%
Dalian	80% to 85%
Qingdao	80% to 85%
Xining	60% to 85%
Guyuan	60% to 85%
Qingyang	70% to 85%
Yuxi	70% to 85%
Shanghai	75% to 85%
Ningbo	75% to 85%
Fuzhou	75% to 85%
Shenzhen	85% to 90%
Zhuhai	85% to 90%
Sanya	85% to 90%

2.1. Formulating scientific urban planning

According to the relevant regulations on sponge city planning issued by the Ministry of Housing and Urban-Rural Development, it is necessary to clarify diversified contents, such as condition assessment, construction objectives, construction ideas, and control requirements, before the construction. It is not only necessary to have macro-overall planning, but also specific qualitative and quantitative data analysis to promote the implementation of various control indicators [2].

2.2. Playing an exemplary and guiding role

In the construction of sponge city, it is necessary to perform well in project demonstration and promotion as well as strictly implement institutionalization, localization, and standardized application. For pilot areas, it is important to clarify the objectives and problem orientation, prepare scientific and systematic schemes as well as implementation plans, encourage design methods and technological innovation, improve the

project quality, and publicize well. This would ensure the project quality and improve the satisfaction of the people [3].

2.3. Building a complete urban planning policy

In order to promote the scientificity of sponge city planning, it is necessary to build a scientific, comprehensive, and long-term management and control mechanism. At present, the construction of sponge city is in the primary stage and the relevant legal system is still incomplete; in addition, the sustainable and long-term development concept, which is required to further improve the relevant laws and regulations as well as build city planning systems, has not been formed. It is necessary to build a diversified sponge city construction system, including project initiation, construction drawings, operation, and management, as well as integrate the construction and management of sponge city into the normal management of the city.

3. Problems and countermeasures in the construction of sponge city

The construction of sponge city in China is still in the primary construction stage. The construction ideas and methods are relatively backward, resulting in many problems in the construction of sponge city. There are many problems in policy construction, urban transformation, and rainwater runoff pollution control, which affect the improvement and continuous promotion of the construction. Therefore, it is necessary to analyze and investigate the problems in the construction of sponge city as well as work out corresponding countermeasures for them.

Table 3. Analysis of the problems in the construction of sponge city

Problem	Countermeasures
Imperfect policies and insufficient standardization	Formulate standardization programs, promote multisectoral cooperation, and strengthen policy guidance from both macro and micro aspects.
Difficult urban transformation	Increase publicity and enhance people's support for urban transformation; improve construction, strengthen construction management, improve management efficiency, and strengthen cost control.
Rainwater runover pollution	Formulate rainwater runoff pollution targets and explore new technical forms.

3.1. Imperfect policies and insufficient standardization

The construction of sponge city in China is still in its infancy, lacking in technology and experience. It is difficult to formulate a scientific sponge city planning in a short time. Therefore, in order to ensure the scientificity of sponge city planning, there are many departments involved in the construction, including the cooperation of multiple departments, such as urban planning, garden construction, and water supply and drainage [4]. In the construction of sponge city, some urban areas only formulate preliminary guidance schemes from the macro perspective. However, due to the large pilot area and complex construction projects, it is impossible to effectively guide the planning projects. Although some cities have set up special plans for the construction of sponge city, they have not coordinated the development from the overall plan, resulting in contradictions and conflicts in the implementation; in addition, it is difficult for follow-up departments to coordinate and build.

In view of this condition, each sponge city needs to plan well from the macro and micro levels in consideration of the specific situation of the city. Firstly, the macro development strategy is formulated from the macro level in line with the national guidance requirements for the construction and the specific planning of the city. The specific plan for the construction is formulated through the exchange with foreign

experts and the reference of relevant literatures [5]. Secondly, from the micro level, it is necessary to carry out the overall construction planning step by step in consideration of the specific characteristics of the city, formulate special construction guidance according to the operation requirements of each step, clarify the responsibilities of various departments, manage the division of labor well, give full play to the joint force of various departments, and improve the construction effect of sponge city.

3.2. Difficulty in transformation

The reconstruction of sponge city is based on traditional old urban areas. The infrastructure construction facilities such as water supply and drainage as well as greening and rainwater resources collection in the old urban area cannot meet the development needs of modern cities. In the construction of sponge city, pipe network reconstruction needs to be carried out again, in which it involves land acquisition, demolition, and other activities. The project scale is large, and the construction period is long, so there are many difficulties in the construction [6]. In addition, the degree of participation among the residents is low, so it is difficult to implement the comprehensive participation and supervision mechanism of the masses, resulting in many management loopholes.

The reconstruction of sponge city is difficult, which is a problem in all urban construction. Therefore, it is necessary to explore an effective model to provide large-scale replication for the reconstruction of sponge city. On this basis, reasonable solution strategies have been explored while taking into account of the specific situation of the city [7]. First, the publicity of sponge city should be strengthened to ensure that the residents realize the significance of the construction and its value to the long-term development of the city, promote their participation, win the support of the public, and ensure a smooth progress in the effort of land acquisition and demolition. Second, the construction period is long. In that way, sectional construction can be adopted. Different construction sections can be set according to the overall planning. The construction of the next section can be carried out after the construction of one section has been completed and has passed the inspection, which will not only reduce the pressure of project management, but also weaken the impact on the residents' lives [8]. In addition, the original pipeline shall be used as much as possible in the planning to reduce the construction burden and avoid material waste.

3.3. Control of rainwater runover pollution

The main problems to be solved in the construction of sponge city include urban waterlogging and rainwater runoff pollution. However, from the construction, most cities do not pay attention to urban runoff pollution and neglect the water treatment system [9]. As a result, the idea of pollution is not included in the construction of sponge city. Therefore, it is necessary to control rainwater runoff pollution in future development.

In the construction of sponge city, it is important to reasonably plan the objectives of rainwater runoff control, which can be carried out from four aspects: total runoff, runoff peak, runoff pollution, and resource utilization. From the review of foreign literatures, the total annual runoff of green land needs to be controlled between 80% and 85%, but there are many factors affecting runoff discharge, including opening intensity, soil properties, vegetation coverage, and other factors. It is necessary to explore new technical forms as support and determine the final implementation scheme in consideration of the local economic situation [10].

4. Conclusion

In conclusion, in the construction of sponge city, it is necessary to ensure the scientificity of urban planning, improve the top-level design of urban planning, promote the smooth development of sponge city planning

in China, build macro and micro urban management systems as well as standardized sponge city construction standards, improve the construction effect of sponge city according to the specific situation of the city, solve various problems in the construction of sponge city, and improve China's water ecological environment.

Disclosure statement

The author declares that there is no conflict of interest.

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Discussion on the Improvement of Technical Safety Scheme Compilation for Hazardous and Ultrahazardous Projects

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Abstract: This paper reviews the summary and analysis of special technical safety schemes for hazardous and ultrahazardous activities, supported by housing scaffolding, installation, and dismantling of outer wall attached tower crane, deep foundation pit with supporting structure, municipal bridge box girder formwork support, as well as grooved Larsen steel sheet pile, which are commonly seen in recent years, so as to enhance the pertinence, rationality, and economy of the special program to strengthen safety.

Keywords: Hazardous and ultrahazardous; Scheme; Compilation; Improvement

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1. Introduction

China's gross domestic product (GDP) increased by nearly eighty times, from US $1,958.66 billion in 1981 to US $15.69 trillion in 2020. The construction industry has also developed rapidly. Especially in the past decade, due to industrial transformation, market expansion, and new business growth, safety management has been heavily emphasized. The construction industry is a high-risk industry. In order to protect people's lives and property safety, the state has issued a series of laws and regulations to give clear definitions and technical management requirements for hazardous and ultrahazardous activities in construction projects. From document No. 87 of the General Office of the Ministry of Housing and Urban-Rural Development (2009) to order No. 37 of the Ministry of Housing and Urban-Rural Development (2018), order No. 393 of the State Council, order No. 279 of the State Council, document No. 31 of the General Office of the Ministry of Housing and Urban-Rural Development (2018), document No. 343 of the Office of the Department of Housing and Urban-Rural Development of Hubei Province (2018], and document No. 7 of Wuhan Urban and Rural Construction Bureau (2012), the state has revised the Security Law several times; the construction enterprise has also formulated and implemented a strict management system; the overall security situation has been effectively controlled. The flow of talents in construction enterprises is frequent, and the refinement deficiencies as well as contradictions in the preparation of special technical safety schemes for hazardous and ultrahazardous divisional and subdivisional projects are becoming more apparent.

2. Deficiency analysis and compilation improvement suggestions of special scheme for scaffold

Scaffolding here mainly refers to the floor type and cantilever scaffold of civil buildings as well as falsework.

2.1. Floor-type scaffold

At present, the floor-type scaffold is mainly used in buildings with a height of less than 50 meters: low rise, small high-rise, or podium of high-rise buildings. The main deficiencies of the special scheme are reflected in three aspects.

2.1.1. Lacking detail in the preparation of the basic treatment scheme

Most of the floor-type scaffold are located on the relatively soft backfill soil; the compaction requirements of the backfill are vague, and the label, width, and drainage organization of the backfill concrete foundation are unclear [1].

The compactness requirements shall be specified in the preparation and lifting of the scheme, and the plan details of each building or special parts and the section diagram of specific construction methods of the foundation shall be drawn. Only in this way can the construction be guided, the inspection be measured, the safety be guaranteed, and the measurement be based.

2.1.2. Rough content in scheme preparation

In order to avoid management inspection, the prepared scheme covers the small with the large and disregards the economy. In order to meet the requirements of national, industrial, and local government laws and regulations as well as the management inspection, the scheme preparation is represented by the working condition of the floor-type scaffold with higher height, and then it is stipulated that floor-type scaffold with a lower height shall implement the working condition scheme of the floor-type scaffold with a higher height. Although the plan is formulated and the plan itself is safe, the implementation is all empty talk. Due to the great difference in the actual investment in erection span, step distance, and foundation treatment of 10 meters, 20 meters and 30 meters floor-type scaffold, it is difficult for subcontractors and operators to implement this scheme. As a result, there is no scheme construction but an increase in potential safety hazards.

Therefore, in the preparation of the scheme, safety check calculation should be carried out one by one according to the required height of the scaffold erection with reasonable span and step distance. After comparative analysis, the conclusions that can be merged should be summarized, and detailed drawings should be provided to clarify specific individual buildings or areas, so as to implement the scheme and ensure safety [2].

2.1.3. Working conditions differ from the actual construction conditions

It is mainly reflected in single multistorey public buildings and commercial podium buildings of group buildings. As the column spacing and storey height of the buildings are generally large, even if the wall connecting parts are set according to the “three steps and three spans” safety calculation software, the design dimensions of the column spacing and the storey height still do not meet the calculation conditions of the safety software. This is the common in-current design.

Therefore, after the safety check is passed, the prepared plan should be formulated according to the specific building or area and environmental conditions; the corresponding frame floor should be added with

holding columns and upper floor beams, slabs, and other implementable parts. Measures such as adding wall fittings or ground bracings and drawing plans should be included to mark them.

2.2. Cantilever scaffold

The cantilever scaffold is an outer frame scheme widely used in high-rise buildings. The scheme basically meets the requirements of the height limit of the cantilever layer height of the frame body of 18 meters, and its safety has greatly improved. The main deficiencies of the special scheme are reflected in two aspects.

2.2.1. Lacking detail in construction scheme drawings

The safety checking calculation of the scheme can be guaranteed, but there is a lack of detailed construction scheme drawings. There are great differences in terms of the structural components among different types of architectural plane designs. The design layout of the fire evacuation ladder, elevator shaft, and pipe space in the building plane design layout is different, and the structural design of the column grid, column section size, shear wall, and corner on the structural plane is different. This has a great impact on the layout of steel beams supported by the cantilever scaffold [3]. It is not enough only to safely check the layout dimensions of the steel beam supported by the cantilever scaffold, the calculation parameters of the section, the length dimensions of the steel beam components, and the layout diagram.

Therefore, based on the parameters of safety calculation, it is necessary to supplement the layout drawing of cantilever scaffold supporting steel beam of specific building design type, clarify the plane size and section as well as the length size of steel beam components, and to be more detailed on the evacuation ladder, elevator shaft, pipe, corner, and other key parts. In this way, the construction preparation will be more sufficient, the construction guidance will be more specific, the assembly and disassembly will be more convenient, and the safety will be more guaranteed.

2.2.2 Neglecting the systematicness of the scheme

The influence of vertical transportation (tower crane and passengers-goods elevator) layout on the external frame is easily neglected. The outer scaffold mainly provides safety protection for high-altitude operation and operation platform for exterior facade decoration. The preparation and implementation of the outer frame scheme is easily neglected in the preparation of the outer frame before the vertical transportation layout. In this way, when installing vertical transportation equipment, the erected and closed frame needs to be disassembled and reinforced. At this time, not only will the investment be higher, but the stability of the outer frame will also be tested.

Therefore, the space requirements for the layout, installation, and use of vertical transportation equipment should be fully considered when preparing the special plan for outer scaffold; in addition, the treatment and strengthening measures within the scope of vertical transportation equipment should be specified on the elevation of outer scaffold erection, so as to minimize the impact on the safety and stability of the outer frame when installing vertical transportation equipment as well as to save investment [4].

2.3. Falsework

The hazardous and super-hazardous schemes of falsework mainly include co-construction of house construction, apartment building, BCD business building, basement, and high-rise podiums formwork support scheme. The common features of these buildings are high storey height, large bay, deep beam, thick plate, primary and secondary beams, staggered arrangement of shear walls, and atrium in the building.

At present, the safety checking calculation with the help of software is basically not a problem for the calculation. The deficiencies in the aforementioned housing construction scheme for falsework are discussed below.

2.3.1. Neglecting the construction operation space

The support frame does not leave 250-300 mm space for template installation, dismantling, and reinforcement on the outer surface of the beam, column, and shear wall, especially for deep beam and high fat column. The space distance is insufficient when workers install, reinforce, and dismantle the template. This requires that on the basis of safe working conditions, the parameters of the opposite rod should be adjusted reasonably, the need for appropriate operating space should be fully considered, and the parameters of safe working conditions as well as secondary safety hazards due to insufficient operating space should be avoided.

2.3.2. Neglecting the safety check calculation for the side formwork of deep beam and high fat column

During the safety check calculation of falsework, it is mainly for the frame body. It seems that the side template of deep beam and high fat column has no direct relationship with the support. In fact, if there is a weak point at the side mold of the tall formwork, it will cause overall harm to the safety of the support system. Therefore, when examining the drawing design and scheme, it is necessary to be strict and carry out scheme design as well as safety checking calculation for the side template of deep beam and high fat column to ensure a perfect overall scheme.

2.3.3. Insufficient overall planning and selection as well as lacking local enhancement schemes

Due to the characteristics of high building floor height, large spaces, deep beam, thick plate, and staggered arrangement of primary and secondary beams and shear walls, it is appropriate to carry out safety checking calculation on various support methods and layout parameters of primary and secondary beams as well as plate template supports on the same floor or construction section on the same floor, so that the vertical and horizontal parameters of primary and secondary beams and plates can be the same or meet the multiple levels on the basis of safety. For example, the plate vertical bar is 900 x 900 mm, the longitudinal spacing of the main beam vertical bar is 300 / 450 mm, the secondary beam is 450 / 600mm, etc. In that way, the plate, main beam, and secondary beam vertical bars are in the multiple level in the longitudinal or transverse direction, the horizontal bars can be smoothly connected into a straight line in the multiple level spacing, and part vertical rods that do not have a single horizontal rod (longitudinal or transverse) connected to the whole within the multiple stage spacing can be reinforced with eight struts; Then, in the same layer or construction section, the frame can be connected as a whole to enhance the integrity and stability of the frame (as shown in **Figure 1**).

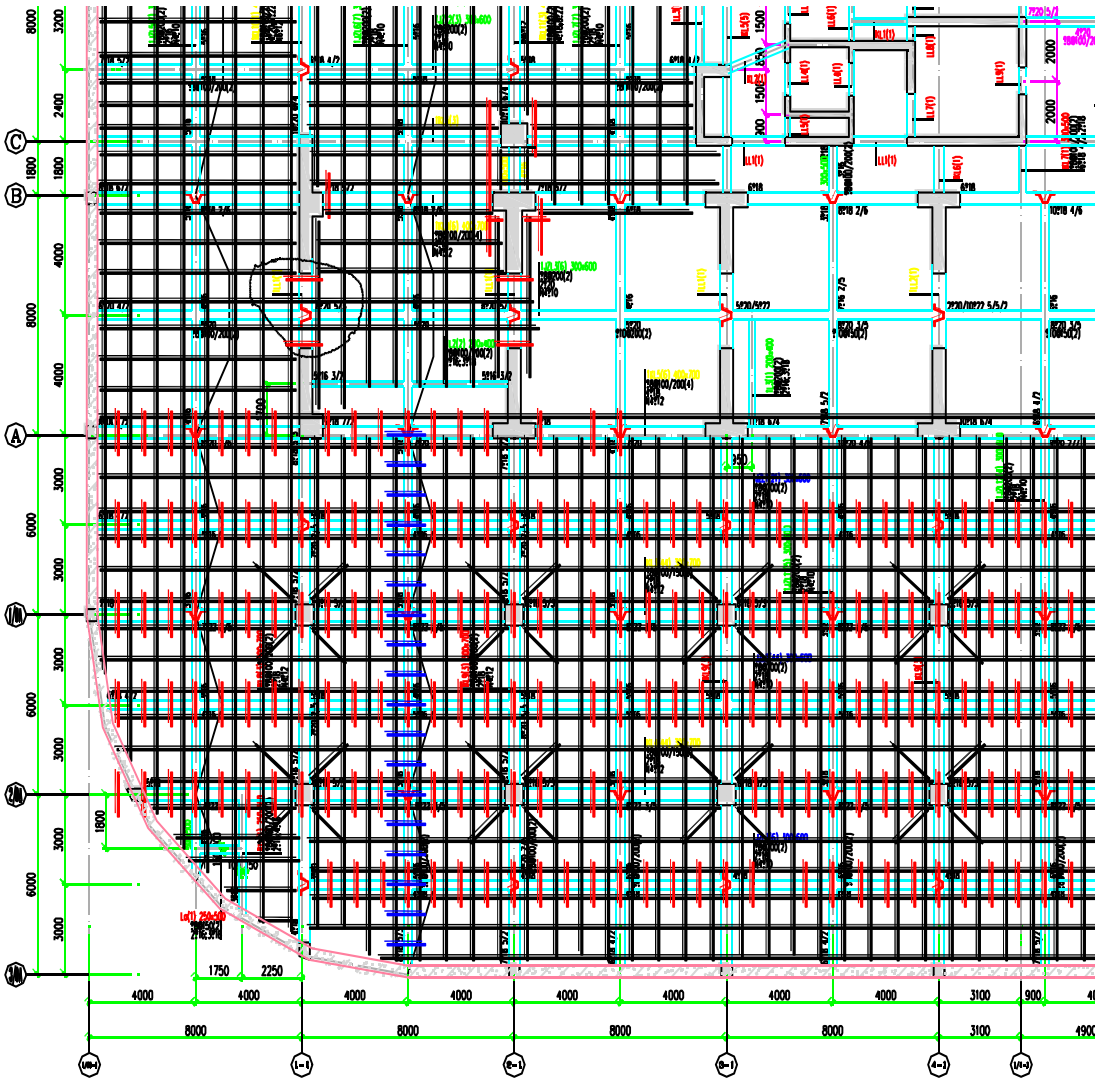

Figure 1. A construction drawing of the full framing layout adjusted according to safety check conditions (example)

The lack of local reinforcement scheme is mainly when high-rise buildings are constructed. The ground pump and distributing rod scheme is adopted for concrete pouring of high-rise buildings. The test shows that 2 kN resistance increases at each 90° elbow of the pump pipe, and its reaction force is transmitted to the falsework support system, causing damage to the stability of the falsework support [5]. Therefore, in the scheme, reinforcement measures should be taken for the bottom support frame of the material distributor boom, and reinforcement measures or reduction of resistance measures should be taken for the pump pipe at the horizontal and vertical turning parts.

2.3.4. Emphasizing on the densification of upright tubes, while neglecting the adjustment of horizontal pole spacing in the design of beam height support scheme

In this case, there is a high possibility of having too dense upright tubes, which would be difficult for construction operation, especially for the support of deep beams. The is due to the insufficient analysis of the software calculation results. In case of nonconformity, it is easy to simply judge that the bearing capacity of the upright tubes is insufficient, and the influence on the horizontal spacing of the high-formwork supports as well as the overall stability parameter i (radius of gyration) of the frame is not deep. At the same time, it is too inertial to think that the step distance of the upright pole is 1800 mm. In fact, for the height of Chinese people, the step distance of 1650-1700 mm is more convenient to fasten bolts. Therefore, the

results should be deeply analyzed when setting the scheme parameters, and a safe, economic, and convenient construction scheme should be given priority.

3. Deficiency analysis and compilation improvement suggestions of special scheme for outer wall attached tower crane

Tower cranes are the main mode of vertical transportation in the construction of high-rise and super-high structures in housing construction. There are several deficiencies in the preparation of the special scheme for outer wall attached tower cranes.

3.1. Emphasizing on the coverage radius and demolition space requirements, while neglecting the impact on essential building components

High-rise and super high-rise buildings basically have one or more basements, the red line of ground buildings is less than the outdoor side line of the basement, and there are many podium structures. In this way, the outer wall attached tower crane basically passes through the basement and podium structures. Due to the neglect of the impact of tower crane crossing on important building components, the main beams of basement and podium are often cut off during crossing, which has an adverse impact on the main structure in addition to creating potential safety hazards. Therefore, in the layout of tower cranes, the main structural members of the corresponding crossing area should be carefully checked and avoided; otherwise, BIM technology should be used for collision inspection.

3.2. Emphasizing on the space requirements for tower arm removal, while neglecting the requirements for safety and environmental conditions for wall connecting points removal

It is easy to arrange the connecting points at the smooth front gable area in the layout of the wall fittings. There are no protruding components, such as canopy, and it is far away from the opening for workers to enter and exit. When removing the connecting points, there is no safety platform at high places or environmental conditions for better erection of safety platform. Therefore, when setting wall connecting points, it is necessary to consider the safety requirements and environmental conditions for the next demolition or the conditions to facilitate the formulation of safety measures.

3.3. Emphasizing on anti-collision in the final use state, while neglecting the use collision in the gradual lifting process

The construction schedule is often different from the actual progress, which means that the lifting section and supporting wall formulated in the scheme are different from the actual progress requirements, so that the installation progress, sequence, as well as horizontal and vertical distance of adjacent tower cranes are different in the process of lifting section, or the independent height behind the supporting wall is greater than the limit height in technical documents.

Therefore, it is necessary to reasonably implement the plan and organization, dynamically monitor the construction process, as well as timely adjust the construction progress or increase the supporting wall measures.

4. Deficiency analysis and compilation improvement suggestions of scheme for deep foundation pit with supporting structure

Deep foundation pit construction is a divisional project with great impact of safety accidents, in which the deep foundation pit with supporting structure is more dangerous.

4.1. Unclear description of the features captured in the project profile

In many schemes, the project overview of deep foundation pit is copied from the general design of construction organization, and the hydrogeological introduction is copied from the text description of geological exploration report. The general introduction of targeted deep foundation pit design scheme is less, and the geological and hydrological parameters required by the scheme are simple. The expression of the later lacks substantive bedding and support for the deep foundation pit. This is also a large program with little substantive content.

4.2. Unclear key processes

The scheme describes the construction of conventional construction support piles, mixing piles, and horizontal support beams in detail; however, the key processes of drainage, earthwork excavation, and horizontal support beam demolition are unclear.

4.2.1. Deep well dewatering scheme

In the deep well dewatering scheme, the hole forming process is more detailed, but there are few schemes and preventive measures on how to prevent blind wells, control water level, and backfilling the well hole. In drainage, the discharge direction of deep well drainage, the number of wells, the acceptance of peripheral municipal pipe network, the slope and section size of pit top drainage ditch, as well as the measures to prevent leakage are rarely involved.

4.2.2. Earth excavation scheme

In the earth excavation scheme, the dewatering effect, ramp construction, protection of horizontal support beam and the dewatering well pipe in the pit, layout description, and drawings of foundation pit monitoring points are insufficient, and some even omit the process of deep well dewatering directly in the process flow and schedule.

4.2.3. Foundation pit with more than two layers of horizontal support beams

For foundation pit with more than two layers of horizontal support beams, the key points of operation and control for the transformation of force transmission system before the removal of horizontal support beams are not clear.

4.3. Weakening of traditional on-site inspection, dangerous situation judgment, and disposal scheme

In terms of foundation pit monitoring, the scheme focuses on the monitoring scheme of technical means and weakens the traditional on-site inspection, dangerous situation judgment, and disposal scheme. According to practical experience, the traditional on-site inspection, dangerous situation judgment, and disposal scheme are more timely than the monitoring scheme of technical means, which can make comprehensive judgment and quick response better in combination with specific engineering site environment.

Due to the complexity, unpredictability, professionalism, technical content, and high construction practice requirements of deep foundation pit construction, in-depth study and practice summary are the main ways to improve.

5. Deficiency analysis and compilation improvement suggestions of special schemes for municipal bridges

The special scheme for municipal bridges mainly discusses the special scheme for municipal concrete cast-in-situ box girder support. Its deficiency is similar to the deficiency of the formwork support scheme of high space, large span, as well as beam and slab in the room. The lack of pertinence and rationality leads to poor enforceability and economy, resulting in increased safety risk.

5.1. Insufficient scheme refinement

The construction load of cast-in-situ box girder has several section characteristics: near the support, outside the cantilever plate, standard section web and bridge plate, middle transverse beam, prestressed anchor, and tensioned serrated block. In scheme planning, the feature block is not fine; in addition, the multi-scheme comparison and selection are insufficient, leading to a waste of turnover materials or insufficient local safety degree. Moreover, the scheme is difficult to be implemented. Therefore, it is necessary to deeply study the drawings, accurately analyze the live load of the block, compare and select multiple schemes, as well as make overall planning.

5.2. The preloading and measurement are not in strict accordance with the requirements of the specifications and regulations in actual construction

The design of the elastic compression deformation of the formwork support material, the clearance of the rod assembly, the compression deformation of the foundation, and the suboptimal or missing foundation, especially the cast-in-situ box girder with high height and large load, greatly influence the safety. If there is sufficient estimation and calculation for the above situation during scheme preparation, there will be more instructive data, and corresponding remedial measures can be taken. Although the construction specifications and corresponding regulations have the requirements of preloading the formwork support on the construction site, the preloading and measurement are not in strict accordance with the requirements of the specifications and regulations in the actual construction. Therefore, it is advisable to seriously extract the above parameters required by the technology and calculate them as well as to take appropriate measures to avoid the above errors in the construction scheme, thus avoiding the adjustment of the frame body after preloading, the instability of extra-standard deformation, and extraction in the construction of concrete.

6. Deficiency analysis and compilation improvement suggestions of Larsen steel sheet pile supporting scheme for municipal trenches

The Larsen steel sheet pile supporting scheme has been adopted for many projects with support requirements in municipal trenches. From the approved schemes, there are some deficiencies.

6.1. Failure of the self-gravity drainage trench in preparing specific measures according to the depth, soil, and hydrological conditions

The gravity drainage trench flows with the help of hydraulic gradient, so the mileage length is long. Therefore, the trench depth shows a gradual trend with a continuous change in the depth. There are great differences in the soil and hydrological conditions. At the same time, there are also differences in the construction environment around the trench in the city.

Therefore, before preparing the plan, it is necessary to carefully study the drawings, geological exploration data, site survey, and historical data investigation. If necessary, supplementary geological survey and field environmental measurement should be conducted. During preparation, different sections

should be divided according to different characteristic conditions; then, corresponding measures and schemes should be formulated.

6.2. Lacking detail in the preparation of the scheme and weak guidance

It is difficult to press the Larsen steel sheet pile into clay with a depth of 5 meters and a foundation bearing capacity of more than 20 tons in accordance with the working conditions of the scheme. On site, Larsen steel sheet pile is often excavated to an appropriate depth before construction, and then horizontal support is effectuated while excavating. Good retaining pressure can be obtained only when the soil wall is closely adhered to. In this way, a layer of earthwork is excavated first, and then pile pressing changes the scheme design condition. At this time, the preparation scheme would be predictable, so the filler at the back of Larsen steel sheet pile should be compacted before excavation and after the installation of horizontal support. In this way, it can avoid the sliding of the back wall and the destruction of the surrounding buildings under the influence of external environment when the trench earthwork continues to construct. There are also some super-deep trenches that use holes in the construction of Larsen steel sheet pile first, and there will also be loose adhesion or soft soil on the back wall between the lead hole and the Larsen steel sheet pile, so measures should be assumed in the preparation of the scheme. When the anchorage depth of Larsen steel sheet pile is insufficient, a plan should be formulated during preparation. If the number of layers of intermediate horizontal support or the foot support at the bottom of the trench increase, the construction section should be as short as possible, the process connection should be close, and the patrol inspection of the trench as well as the surrounding environment should be strengthened.

7. Conclusion

From the review of the scheme, this paper discusses several deficiencies and suggestions that need to be supplemented and improved based on personal experience. When preparing the scheme, “safety first” is affirmative; the rationality, operability, and economy of the scheme greatly affect its safety. At the same time, scheme preparation and construction operation support each other and have their own emphasis on safety control. Construction operation is much more complex for safety management compared to scheme preparation. Studies on this are still insufficient; therefore, it would be beneficial for other researchers or experts to contribute their experience to fortify this research.

Disclosure statement

The authors declare that there is no conflict of interest.

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Beautification of Chinese Architectural Images in the New Media Age

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Abstract: From the perspective of communication science, the communication of architectural images in the new media age has an obvious beautifying trend. Due to the differences in politics, economics, and cultural environment between China and western countries, the beautification of architectural images in China is a unique phenomenon. This study classifies the beautification of Chinese architectural images into different types in terms of image communication: audience orientation, time orientation, space orientation, and cultural orientation. By investigating and analyzing relevant cases, this study explores the beautification of Chinese architectural images in the new media age and puts forward thoughts and evaluation, aiming to better comprehend the relationship between beautification and architectural communication.

Keywords: Beautification; Chinese architectural image; New media age; Image communication

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1. Introduction

In the context of new media age, the communication of architecture can be understood as the last step to be considered in the design process. The content, media, and effect of communication influence the entire architectural environment directly or indirectly, leading to a series of hot topics represented by online well-known architectures, which reflect a unique phenomenon with characteristics of the times in the communication process of architecture. A representative trend among these is the beautification of architectural images. Due to its remarkable effect on communication, the discussion on its social, cultural, and practical significance is still worthwhile despite this trend being lesser known. Therefore, proceeding with the comparison of ideology and cultural environment between China and the west, this paper discusses the phenomenon from different communication orientations and attempts to provide different perspectives of the design and communication processes of architecture by exploring the beautification of architectural images.

2. Beautification of images

2.1. Definition

In *Wandering in the Beauty*, Zong Baihua said, "Beauty mediates contradictions and draws in harmony." In Chinese, beautification is translated as "mei yan hua," in which "mei" means beautifying, "yan" refers to appearance, and "hua" equates to the suffix "-tion," which is defined as the action or a state of being. Therefore, the phrase "mei yan hua" (beautification) has a deep implication of "the alteration of appearance

to achieve harmony in the form." There are various media subjects of beauty, among which image, one of the most widely communicated media, has expected research value. In the semiotic sense, an image is a systematic form of rules and symbols. It is a symbol indicating the object under some common characteristics between itself and the object expressed by it. The purpose of beautification is to create an ideal image by improving the harmony of the image itself through editing, which can be understood as a self-display and management strategy of impression [1].

2.2. Analysis of the beautification of non-architectural images

With the development of image editing, the change of media, and the increasing pursuit of beauty among people, beautification of images is increasingly common [2]. Especially the ones on social media, such as MeituPic, a Chinese beauty camera application, which has attracted wide attention in recent years. In a survey, the consensus of the respondents points to the development trend of today's society whereby their attention is on pursuing beauty. In this era of "appearance anxiety," opportunities tend to favor those with a better appearance. Hence, people receive attention and praise from others by posting beauty-filtered photos on social platforms to meet their social needs. In Owen Goffman's impression management theory, people's daily social communication is comparable to a stage performance [3]. Everyone is trying their best to keep their image consistent with the current social situation to ensure that other people respond to them. This phenomenon reflects the noticeable beautifying trend in the new media age.

2.3. Analysis of the beautification of architectural images

Architecture and architectural images exist intertextually [4]. Architectural images have unique characteristics compared with those of other areas. For example, in architectural photography, tilt-shift lens and high-definition cameras are usually used to capture the light influence on certain architectures. Furthermore, some architectural photographers have attempted to communicate tactile and auditory information through visual languages, such as through light, color, and composition. Accordingly, it is worthwhile to learn this separately. However, unlike documentary photography, the beautification of architectural images has artistic or other purposes. Therefore, the academic world in the new media age generally calls it "conceptual photography." Architectural images are part of a form of media art.

Although globalization has brought about strong homogenization in modern media, the fundamental differences between China and the west in ideology and cultural environment still contribute to their distinctions in the beautification of architectural images. Therefore, combing the differences is beneficial to understand the beautification of Chinese architectural images. At the same time, exploring the beautification of architectural images with Chinese characteristics may play a positive role in the regression of the sense of place and belonging.

3. Differences between China and the west

3.1. Differences between Chinese and western built environments

Just as Cheng Taining, an academician, argued that civilizations seek common ground and cultures raise differences [5], the differences in cultural landscapes lead to the differences between Chinese and Western architectural environments.

First, from the perspective of history, western architecture focused on the physical form and spatial expressions, whose prototype was a complex space overlaid by multiple structural units. The construction of traditional western architecture appeared as three-dimensional vertical expansion, showed the spatial

pattern of concentration, and attached great importance to the rational beauty of form, which includes the structure, shape, decoration, and volume of the building, having a strong sense of sculpture and tension. However, traditional Chinese architecture focused on the artistic prospect of space. Its prototype and unit were represented by "jian" (a surface surrounded by four columns). By repeatedly juxtaposing them, the architecture presents a two-dimensional horizontal linear and longitudinal advancement. It emphasizes practice and spatial sequence as well as stresses the effect of axial symmetry and depth [6].

From the perspective of modern architecture, as Arata Isozaki had mentioned, after the 1950s, various architectural forms in the world have been consumed by China. The development of local Chinese architecture has seen a strong influence through internationalization. It is on a tough road, on which traditional Chinese architectural forms attempt to be modern, while western architectural forms are being nationalized [7].

3.2. Differences between Chinese and Western architectural images

As a medium to spread ideas, architectural images reflect the differences between Chinese and Western architecture and architectural media accordingly. Due to the well-developed political and economic situations, architectural images in western countries can meet the needs of consumers and participate in the process of consumption [8]. As opposed in China, where political and economic development is insufficient, this orientation is still in its infancy. The Chinese ideology and construction environment have shaped a unique urban and architectural culture [9]. In the new media age, the openness and sharing of a wide range of public audiences are promoted. Therefore, architectural images tend to reflect the characteristics of the society. Architectural images shoulder the role of cultural inheritance, especially those cities and architectures that reflect the historical features and living habits of the Chinese. Moreover, with the trend of internationalization, Chinese architectural images are still influenced by western ones, making them a mixture of both sides.

With the arrival of the new media age and the formation of the "architecture-architect-architectural image(beautified)-market" system, the differences between Chinese and western beautification of architectural images come from the differences between architecture and architectural images. To sum up, the beautification of Chinese architectural images reflects the mixed characteristics of Chinese architectural forms, the initial elements of catering to consumer needs, as well as the attributes of inheriting Chinese urban and architectural culture, which integrates Chinese aspects on the basis of the west.

4. Beautification of Chinese architectural images

In the new media age, as the mainstream communication medium, the internet promotes architectural communication. As a result, many architectural media have moved from traditional to online ones.

Compared with traditional media, the public hopes to seek a more powerful expression, so visualized expression has become the new trend in architectural communication. The beautification of Chinese architectural images is classified and expounded according to different communication directions: audience orientation, time orientation, space orientation, and culture orientation.

4.1. Audience orientation

On May 10, 2015, "Yitiao" uploaded a video on its WeChat official account with the headline of "The Loneliest Library in China." It was popular on the internet and received 600 million views across the network (**Figure 1**). The video showed a library facing the sea and standing alone on an empty beach as if it was the end of time. As a result, many tourists visited the library, with the highest daily flow of more than 3,000 people, far more than the library can contain. Sharon Zukin, an American professor of sociology,

argued that urban changes should take politics, economics, society, and culture into account along with capital, property, media preferences, and consumer preferences.

Figure 1. Library facing the sea (from a website)

Figure 2. Inside the Dune Art Museum (from Mafengwol, a website)

The library in China represents a successful case of image communication in the new media age. Based on communication data, design information, and field investigation, an elaboration on the audience orientation will be discussed in consideration of this seaside library. In this case, four types of audiences are included in image communication: investors, developers, consumers, and architects.

As far as investors are concerned, this project has become famous throughout the internet due to the widespread architectural photography images. These images have attracted many tourists and brought substantial sales records to Anaya Real Estate, its developer, who managed to realize the online-to-offline (O2O) mode of cultural real estate. Since then, the developer has continuously cooperated with domestic star architectural firms to create distinctive complementary buildings, including Anaya Auditorium, Dune Art Museum (**Figure 2**), Anaya Art Center, etc. [10]. For consumers, attracted by the lonely, genuine, meditative, and mysterious atmosphere of the sea conveyed by the images, urban youth visit the library to pursue the psychological demand of "a slow life." At the same time, Anaya's tourism real estate development provides cultural, leisure, and living facilities, which meet the cultural demands of the urban middle class and personalize its spatial image in the process of social media communication. Visitors consider these images as a label of a "beautiful life," while architects drive architectural designs into the professional field. Differing from the emphasis on the lonely atmosphere on social media, architects make serious, orthodox, and academic discussions about this seaside library. They ponder about the relationship between two-dimensional architectural images and architectural designs from the architectural perspective of site, space, structure, section, material, etc.

4.2. Time orientation

In the era of picture-reading nowadays, architectural photography shapes people's understanding of architecture. When people do not have the opportunity to experience on-site architecture, images become the best medium to reflect the relationship among architectural space, light and shadow, scale, color, as well as texture. Moreover, the beautification of architectural images is widely found in exhibitions, announcements of new works, travel guides, and printed publications. Therefore, architectural photography has increasingly become an active embellishing method for architectural communication.

The beautification of architectural photography includes two stages: shooting and effect. The shooting stage focuses on the equipment, light, composition, color, and other aspects. For example, photographers primarily use large and medium format cameras, consider the relationship between height, angle, distance,

and the characteristics of the architecture, as well as take into account of the use of light, color control, and indoor light. The post-processing in photography is equally important, such as Photoshop, Lightroom, and other software to adjust the highlight and shadows or exposure value, saturation, clarity, perspective, and other elements [11]. For the later stage, architectural photography is not only the visual expression of the architectural form and environment, facade, interior space, as well as internal and external decoration, but also the process of recreating, integrating the views and emotions of the photographer, as well as displaying the cognitive concept of the photographer to the world. Taking the urban photography in Chongqing with cyberpunk style as an example, the time-oriented beautification of architectural photography is elaborated.

With the rapid development of Chongqing, modern skyscrapers, colorful neon lights, and magical urban structures with a strong sense of space create a city that is full of futuristic cyberpunk style, becoming the preferred location of photographers (**Figure 3** and **Figure 4**). A series of photographs of Chongqing have won much attention on the internet, making Chongqing an online celebrity city. Photographers tend to focus on Chongqing's urban rail transit, such as viaducts, tunnels, cableways, bridges, and skyscrapers. They usually use sizeable wide-angle lens to shoot in a low angle or shoot perspective in an elevation angle or use a wide-angle lens in an elevation angle. Splicing, symmetry, contrast, reconstruction, and other techniques strengthen the visual impression of conflict aesthetics in the scene composition [12]. In post-processing, in terms of hue, the colors are adjusted uniformly, focusing on improving the blue and purple saturation as well as the overall picture brightness and lighting brightness. Geometric neon light effects of different shapes are drawn to enhance the sense of science and technology. The technological and futuristic elements of urban space are reflected with a sense of fiasco, such as dislocation stretching and dynamic blurring [13], thus subverting the audience's cognition of architectural images in the objective real-life world and presenting the concept of urban dystopia.

Figure 3. Raffles City Chongqing
(a shot by AKA_SK8Simon)

Figure 4. Nearby Chongqing Liberation Monument
(a shot by Marcelo)

4.3. Spatial orientation

Those who perceive architectural images are also users of architecture to a certain extent. In that case, architectural design is influenced by images, which illustrate and reconstruct architectural design. For example, in an actual project, the interior of the minaret and the spiral staircase of the Yangtze River Art Museum convey the commemorative atmosphere of the "anchor point" of the architecture through photography filled with a sense of light, creating a sense of place. In the design of Nestle's Sense Cafe in Beijing, the red ribbon is a "soft intervention" in the courtyard. The photos enhance the color of the ribbon, breaking through a series of boundary relations of the old city. Other than that, the glass facade of Depot Boijmans Van Beuningen is made of reflective mirrored panels, which emphasize the visual effect of the

art warehouse and its surroundings. Taking Mulan Prairie House as an example, this paper further looks into the beautification of architectural images with spatial orientation.

Mulan Prairie House was one of the most reported architectures in 2017. The articles attached with the architectural photographs of this architecture have been read 100 million times on the internet, making it an excellent sample for studying the beautification of architectural photography images (**Figure 5**). The simplified form of the architecture, the unique environment with mountains and grasslands as the background, as well as the graphic materials create a photogenic scene to stimulate images visually. Mulan Prairie House is located in the northeast of Hebei Province, connected with the Inner Mongolia grassland. The effect image is detached, enjoying the grassland with blue sky and white clouds with its unique location. The architecture prioritizes the form, imitating the Mongolian yurt, whose image expression is simple and easy to perceive. Zhang Haiao, an architect, introduced mirrors, glass, aluminum, and other materials unrelated to the main structure but have a strong sense in pictures to enhance the visual effect of the interior and exterior space. For example, outside the architecture, the quaint tea room is wrapped in mirrored metal panels, and a rectangular volume that extends from the yurt is wrapped in rubble veneers.

Figure 5. Mulan Prairie House (shots by Su Shengliang, from https://www.gooood.cn)

The process from drawing to architecture and then from the architecture to the image completes the "design – construction – use" routine or the so-called "production and consumption" of the architecture loop [14]. When images are the mainstream of presentation, image consumption and architectural design are equally important in this process. Therefore, in a space where the beauty of images is prioritized, the viewer may not be bothered even if the space is uncomfortable, non-durable, non-functional, or impractical. Image hides a series of information of the architecture, such as the location, material, function, etc. Visual effect has become the critical consideration in design.

4.4. Cultural orientation

Architectures and cities grow from status symbols to stories, images, and network traffic. Architectural design is for the minority, but it is open to the public. Traditional two-dimensional architectural drawings limit architecture to professionals, but beautified architectural images in picture books and photographic images circulate architecture's cultural, historical, social, regional, and national characteristics in a way that is more acceptable to the public. Drawing Changsha Taiping Street is taken as an example to explore the positive effects of architectural paintings on architecture, city, and culture.

Drawing Changsha Taiping Street adopts the form of an architectural picture book and takes historical events as well as current narration as spatial clues. Moreover, with the urban renewal of Chaozong Street, the most representative historical and cultural blocks in Changsha have been captured, highly reflecting the food and entertainment culture [15] (**Figure 6**). The team profoundly excavates the gene of the city itself, uses its social, historical, and cultural resources, as well as visualizes the vivid scenes of streets and corners of Changsha to help the public understand the participation of the architectural space in urban development.

Figure 6. Drawing Changsha Taiping Street

As a new cultural communication medium, Drawing Changsha Taiping Street is a reproduction of Changsha's history, existing space, and market culture as well as a reminder of history and urban space to awaken citizens' cultural identity in urban historical blocks. Drawing Changsha Taiping Street promotes the protection and development of culture by cultural communication rather than the previous economy-oriented model, which is also a new strategy to explore the revival of urban historical blocks in the new media age. Architecture picture books are stories with historical value, artistic value, technical value, and social thinking. They integrate architectural and environmental information as well as the image content of urban culture and record them into books through painting to attract the public to "taste" the cities and architectures beyond the inherent standards.

5. Conclusion

In conclusion, the impetus for the beautification of Chinese architectural images comes from various sources, with multiple influencing factors from different directions. On the whole, in the age of new media, the communication of Chinese architectural images plays a critical role in the judgment of architectural design, architectural influence, architects themselves, and also the entire architectural environment. Although the beautification of images has brought more attention to the communication of architecture, the impact of values and judgment guidance behind the communication still requires further discussion.

Disclosure statement

The authors declare that there is no conflict of interest.

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Dilemma in the Development of Modern Timber Architecture and Its Countermeasures

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Abstract: Under the context that "peak carbon emissions" and "carbon neutrality" are included in the overall plan for the construction of ecological civilization in China, this paper discusses the value of modern timber architecture as a form of low-carbon and environmental protection movement in the whole life cycle of the construction field. It mainly analyzes the reasons for the limited resources, misunderstandings of inherent concepts, the high cost of comprehensive construction, and the shortage of professionals. Based on that, several countermeasures have been proposed, such as perfecting relevant norms and policies, strengthening technology research and development as well as demonstration guidance, moderately developing forest resources, applying digital construction operation and maintenance technology, as well as cultivating compound professionals, all of which provide a reference for the development of ecological benefits in China's construction industry.

Keywords: Beautification; Modern timber architecture; Ecological benefits; Dilemma; Countermeasures

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1. Introduction

The terms "peak carbon emissions" and "carbon neutrality" appeared for the first time in the government work report of the National People's Congress in 2021, with a commitment to hit peak carbon emissions before 2030 and attain carbon neutrality before 2060 [1]. In the midst of implementing energy conservation and emission reduction in the construction industry, the Ministry of Housing and Urban-Rural Development issued the *Calculation Standard for Architecture's Carbon Emissions*, which clearly defined the carbon emissions of buildings, calculation boundaries, carbon emission factors, the carbon sinks of buildings, global warming potential, etc., among which the carbon emissions of buildings include the sum of greenhouse gas emissions generated by buildings during production and transportation, construction and demolition, as well as the operational stages of related building materials [2]. With the enforcement of the concept of green ecology in the construction industry and the proposal of the concepts of ecological city and landscape garden city, modern timber structure architecture with green environmental protection, comfort, and livability as the starting point would bring great ecological and economic benefits. Modern timber architecture refers to the construction in which the main structural components are made of standardized synthetic timber or engineering timber products, and the connecting nodes of components are connected by metal connectors. Amidst the implementation of "carbon neutrality" and green development in the construction industry, modern timber architecture has important practical significance for sustainable green development in the construction field.

2. Application value of modern timber architecture

2.1. Promoting the transformation and upgrading of the construction industry

The construction industry has always been a large energy consumption industry. According to the *Chinese Buildings' Energy Consumption Research Report 2020* issued by China Association of Building Energy Efficiency, the total energy consumption in the whole process of construction in China in 2018 was 21.47 tce, accounting for 46.5% of China's total energy consumption; the total carbon emissions were 49.3-ton CO_2, accounting for 51.3% of China's carbon emissions [3]. Among many building materials, timber, boasting as the only natural renewable material, also known as "negative carbon" material, has certain characteristics, which include carbon fixation and energy conservation. Timber architectures have the advantage of storing carbon dioxide in nature. Research has shown that 100 m^2 of these architectures can store about 10 tons to 30 tons of carbon dioxide [4]. In addition, from the perspective of the mechanical properties of materials, the strength-to-weight ratio of timber is much better than that of steel and concrete, indicating that compared with the other two materials, timber can meet the strength requirements with a smaller cross-sectional area and greatly reduce the dead weight of the structure. In light of the structure of buildings, compared with steel and concrete structures, the energy consumption of timber in the process of material production and processing as well as the carbon emissions after production are lower. Research has shown that carbon emissions in the production stage can be reduced by 48.9%~94.7%; from the analysis of carbon emissions in the whole life cycle of buildings, 8.6%~13.7% of carbon dioxide emissions can be saved [5], which embodies excellent environmental protection advantages and is conducive to reducing carbon emissions in the construction industry. **Table 1** shows the impact of the life cycle of main building materials on the environment [6].

In recent years, prefabricated buildings have been widely used in the construction industry because of their advantages, which include industrialization, standardization, high efficiency, and green construction. Timber serves as a natural prefabricated architectural form, and thus the implementation of prefabricated timber architecture is of practical significance to the industrialization of the construction industry. Prefabricated timber architecture is prefabricated in factories and then transported to the site for assembly [6], which saves on on-site labor costs and resources, is convenient for construction, is conducive to improving the industrialization level of the construction industry, as well as effectively promotes the transformation and upgrading of the construction industry.

Table 1. Impact of the life cycle of main building materials on the environment

Category	Water pollution	Greenhouse effect	Air pollution index energy	Solid waste	Energy consumption
Timber	1	1	1	1	1
Cement	120	1.47	1.44	1.37	1.9
Steel	0.9	1.88	1.69	1.95	1.5

2.2. Improving the green business and living environment

Modern timber architecture has flexible structural style, and its design conforms to the original demand for space, which creates more possibilities for the function of space without destroying harmony, but rather boasting the "walking" architecture. The low-carbon attribute of timber architecture can also be effectively combined with the green business in this region, which is in line with the current concept of green economic development and promotes the cultivation of new economic business. With the development of social economy, more and more high-rise buildings with steel and concrete structures are merging in cities. People get in touch with nature and relax through tourism. This has given birth to the vigorous development of

new business services, such as cultural tourism and forest health care. The ecological label of timber architecture has made it more preferable in the construction of tourist areas, forest areas, and rural towns. These timber architectures are integrated with cultural tourism at scenic spots and characteristic towns to create original ecological buildings. In forest areas, living in harmony with the forest is a style that would not destroy or affect the existing forest landscape, but rather it highlights the natural beauty of timber structures along with the poetic and picturesque scenery among mountains, rivers, and vegetation. The setting of the timber house as the form, the flowers and grass as mediums, and human care as the principle form new artistic and cultural artistic conception. Along this line, timber architecture with strong local flavor will become a new form and choice of rural tourism, which would assist rural revitalization [7-9]. On the other hand, modern timber architecture with beautiful, practical, and rich cultural characteristics can be applied to urban ecological landscapes, forming a harmonious unity between the natural environment and the living environment, thus meeting the requirements of national forest city construction [10].

2.3. Enhancing the overall performance of buildings

Earthquakes pose huge damages to the production and life of society, such as social disorders and major losses in terms of personnel and properties. Therefore, earthquake resistance has always been a key research topic in the field of civil and architectural engineering. Engineering experiments have shown that the heavier the dead weight of a building in the event of earthquakes, the more severe the shaking intensity will be. Compared with steel and concrete materials, timber has a lighter dead weight. Research has shown that the dead weight of reinforced concrete buildings is about 5 times that of timber structures under the same volume. Besides, the deformation property of timber can be utilized, as timber has high toughness and elasticity, is capable of absorbing part of the energy generated by earthquakes, and has strong resistance to instantaneous impact load as well as periodic fatigue damage, indicating that the whole building would shake more without collapsing during an earthquake [11]. In view of the good seismic performance of timber, most architectures in Japan are mainly timber structures. Modern timber structures have been used for several reconstruction projects after Wenchuan earthquake in China as exemplified by Xiang'e Primary School in the suburb of Dujiangyan, where its buildings are now made from timber structures.

Thermal insulation is an important part of building energy conservation. Timber is a natural thermal insulation material. Research has shown that the thermal insulation performance of timber is 400 times that of steel and 16 times that of concrete. The thermal insulation performance of a timber wall with thickness of 150 mm is equivalent to that of a 610 mm brick wall. Under the same building area, timber architectures can save more than 40% of energy compared with brick-concrete buildings [12].

3. Problems existing in the popularization of modern timber architecture

3.1. Limited resources

Timber architecture occupies an important position in the architectural history of China. Traditional timber architecture came about during the Qin and Han Dynasties, flourished during the Tang and Song Dynasties, and reached its peak during the Ming and Qing Dynasties. Due to frequent social wars, social system changes, and the reduction of timber volume in modern China, timber architecture has declined. In the 1970s, in consideration of the shortage of forest resources in China, the policy of replacing timber with steel and plastic was put forward. In the 1980s, the utilization of timber structures for housing construction was stopped as domestic forest resources were almost exhausted [13,14]. Since then, reinforced concrete buildings and reinforced structure buildings, which are more suitable for social and economic development, have become common building structures. At the same time, with the slow development of timber architecture, the research progress of new technologies related to timber architecture is delayed, and the

corresponding technical specifications and standards are not comprehensive enough, thus limiting the applicability of the whole modern timber architecture.

3.2. Misunderstandings of inherent concepts

Due to the low proportion of timber architectures in China over the past 30 years, most of the timber architectures that can be seen are timber dwellings in villages, which leads to prejudice and misunderstandings toward timber architecture. Most people think that timber architecture is still the same as ancient timber architecture, and they mistakenly equate timber structures with traditional timber structures, with little understanding about the concept of modern timber structures. Wang Ruisheng and Chen Youliang compared modern timber architecture with traditional timber architecture, as shown in **Table 2** [15]. It can be concluded that modern timber architecture is different from traditional timber architecture in terms of raw materials, processing methods, and construction methods, of which modern timber architecture can better adapt to the needs of contemporary social development and reflect the development level of today's social productive forces.

Table2. Comparison between traditional timber architecture and modern timber architecture

Category	Traditional timber architecture	Modern timber architecture
Building materials	Natural timber	Engineering timber, artificial timber
Processing method	Natural air drying	Modern advanced industrial technology treatment
Structure type	Beam lifting type, bucket piercing type, dense beam flat top type	Ordinary timber structure, glued timber structure, light timber structure
Connection mode	Mortise-tenon connection, bucket-arch connection	Notch and tooth connection, bolt connection and nail connection, tooth-plate connection
Number of cycles	Disposable	6~7 times
Industrial paradigm	Relies on resources and production factors	Relies on innovation and technological progress

Another inherent concept of timber is that timber is a combustible material, and timber-constructed houses are prone to fire. Many magnificent ancient timber buildings in history were destroyed by fire; in addition, the safety of houses built with timber cannot be guaranteed. Moreover, the low durability of timber-constructed houses, the long-term influence of weather and environment, the aging and decay of timber components, as well as the alarming erosion by termites are all common views about timber architecture.

3.3. High comprehensive construction cost

At present, China's timber construction market is still in the early stage of development; not only the market acceptance is low with limited application, but the development planning of each timber construction enterprise is also different with uneven quality of engineering timber products in the market. At present, most timber materials in China are imported from abroad, even if only some materials or components are processed abroad, the construction cost of timber houses excluding land costs would reach 4,000-6,000 yuan per square meter [16]. In addition, most modern timber structure architectures are concentrated in tourist spots or towns and other areas, in which the transportation and labor costs are relatively high; meanwhile, the overall maintenance cost and other costs of completed timber structures ensue a higher comprehensive cost than that of other structural forms.

3.4. Shortage of professionals

The lack of professional personnel training also indirectly limits the development and application of modern timber architecture. Since the 1970s, the education, training, and scientific research of timber architectural technology in relevant construction engineering courses in Chinese colleges and universities have stopped. As a result, the overall technical level of modern timber architecture in China is behind that of developed countries, such as Japan and Canada. In recent years, several colleges and universities have resumed the undergraduate elective course of timber architectural technology, some of which have resumed the postgraduate training in timber structures; however, the research and education of modern timber architectural technology in China as a whole is still lacking [17].

Another limiting factor that affects the training of modern timber architecture professionals is the classification of its specialty. At present, timber architecture belongs to a branch of timber science and engineering in colleges and universities. This leads to the emphasis on materials courses in the training system of modern timber architecture majors, while the teaching of engineering technology related courses is relatively lacking, which results in the inability of talents to directly engage in the construction of timber architecture and develop competence for on-site engineering positions.

4. Countermeasures and suggestions

4.1. Perfecting relevant policies and norms

The development of modern timber structures cannot be separated from the promotion of policies and the perfection of norms. Under the new historical background, in recent years, China has issued a number of policies and norms to promote the development of modern timber architecture and ensuring a sustainable development. In 2015, the *Action Plan for Promoting the Production and Application of Green Building Materials*, which was jointly issued by the Ministry of Industry and Information Technology and the Ministry of Housing and Urban-Rural Development, advocated the construction of urban timber structures and the application of timber structures in tourist resorts. In 2016, *Several Opinions on Further Strengthening the Management of Urban Planning and Construction* by the State Council stated that 30% of new houses would be built in the next decade to advocate the development of modern timber architecture [16]. In 2017, the General Office of the People's Government of Linsheng Province issued the *Guiding Opinions on Promoting the Development of Timber Structure Construction Industrialization*. In June the same year, the *Technical Standard for Prefabricated Timber Structure Architecture* was implemented (GB/T51233-2016); in August 2018, the *Timber Structure Design Standard* (GB50005-2017) was carried out; in November 2020, the *Technical Standard for On-Site Inspection of Timber Structures* (JGJ/T488-2020) issued by the Ministry of Housing and Urban-Rural Development was put into effect. The *General Code for Timber Structure* (GB55005-2021), a national compulsory engineering construction code, was issued by the Ministry of Housing and Urban-Rural Development and was scheduled to be officially implemented from January 1, 2021. The implementation of this code broke through the bottleneck of the low-rise construction of timber structure, which ensued its expansion to middle and high-rise buildings as well as long-span structures [18]. The introduction and support of the above policies have promoted and would further promote the development and technological innovation of modern timber architecture in China.

4.2. Strengthening technology research and development as well as demonstration guidance

It is universally acknowledged that timber architecture has defects and deficiencies in fire prevention, earthquake prevention, moth prevention, and land possession, but these problems are no longer challenging in view of continuous technological progress and innovation. At present, the technical problems of timber

architecture in earthquake prevention, fire prevention and flame retardant, durability modification, damage detection, and others have been tackled; in addition, green, efficient technologies with improved durability, such as lateral force-resisting systems, performance fire protection designs, and "zero-hazard" timber with high temperature modifications, have been innovated [18]. The timber components of modern timber architecture have undergone flame retardant, anti-corrosion, insect-proof treatment, and other processes, thus improving the firmness and durability. At the same time, timber components that have been treated with modern technology have optimized anti-sinking stress, anti-drying, and anti-aging as well as significantly improved stability. In addition, with regard to the flammability of timber architecture, modern timber structures are treated with water-based flame retardant treatment agent, which has carbonization effect. When these timber components encounter fire, a carbonized layer would be formed on the surface, and the low conductivity of these timber components would effectively prevent the flame from spreading inwards, thus ensuring that the whole structure would not be seriously damaged due to the spread of fire for a long period [12].

In today's construction, dominated by concrete and steel structures, in addition to some ancient timber architectures, it seems that people have ignored the existence of timber architecture; hence, modern timber architecture is even less known. Therefore, on the one hand, it is necessary to strengthen the publicity of modern timber architecture, such as actively carrying out various seminars and theme exhibitions related to modern timber architecture, sharing new technologies and achievements, as well as strengthening exchanges within the industry; on the other hand, combined with the rapid advancement of prefabricated architecture in China in recent years, the use of prefabricated timber structure plays a demonstrated and guiding role. It is necessary to design and construct distinctive modern prefabricated timber architecture, so that people can personally understand the advantages of modern timber structures.

4.3. Moderately developing forest resources

After years of forest cultivation, the forest area in China is increasing year by year, ranking the fifth in the world. It is certain that everyone has the responsibility to protect forest resources and prevent these resources from being wantonly destroyed. China has also formulated relevant regulations for the protection of forest resources. It has been pointed out that the regulation aims to protect natural forests, prohibit logging, and encourage the use of artificial fast-growing forests. China has been exporting a large number of multilayer glued laminated timbers and laminated veneer timbers to foreign timber markets every year. With the development and improvement of gluing technology, it is foreseeable that logs will be inevitably replaced by manpower as timber product materials in the near future, which would break people's original concept of timber. There are three main kinds of conglomerate timbers in the market: (1) glued laminated timber (GLT) is a high-quality, beautiful, and degradable engineering composite material, which is made from small-sized solid timbers arranged along the grain direction and bonded with cold-curing adhesive; as glued timber can be made into long-span curved beams, it is widely used in the construction of stadiums and large public buildings; (2) cross-laminated timber (CLT) is a new type of timber building material, and it uses kiln-dried Chinese fir (spruce or fir) finger joints; upon sorting and cutting into timber squares, they are orthogonally superimposed, glued, and formed with high-strength materials, and then prefabricated into the required material volume, whose strength can replace concrete materials; experimental research has shown that timber structures with cross-laminated timber as the main material have good seismic performance; (3) laminated veneer lumber (LVL) is a kind of veneer made of log timber by rotary cutting or planning; after drying, gluing, and other processes, it is formed by assembling billets along the grain, and then hot pressing and gluing; it has the material characteristics of good stability, high strength, high toughness, and accurate specifications; the strength and toughness of LVL are about 3 times higher than those of solid timber [16].

In addition, studies have shown that there is a limit for the ability of trees to absorb carbon dioxide. With the growth of trees, the ability of trees to absorb carbon dioxide becomes weaker after the timber stage. Therefore, reasonable planning and development of forestry resources, moderate deforestation of timber, timely cultivation of new saplings, and cultivation of trees at multiple varieties, levels, and ages in forest areas are the key to realizing sustainable recycling of timber resources and reducing the dependence on imported timber, thus reducing costs [19].

4.4. Applying digital construction operation and maintenance technology

In recent years, through the implementation and practice of new concepts and technologies, such as building information modeling (BIM), digital twin, intelligent construction, as well as intelligent operation and maintenance in the construction industry, the application of information technology has shown positive effect in reducing the overall construction, operation, and maintenance costs of buildings. Based on the digital building lifecycle approach, digital twin is used to map virtual space to physical space. In the construction as well as the operation and maintenance of modern timber architecture, the data information platform is used to realize the integration of physical geometric model, physical numerical model, digital twin simulation, as well as the operation and maintenance model. The comprehensive cost of modern timber architecture is reduced by means of parametric design, structural analysis simulation, construction application simulation, and information facilities management.

In addition, through the data information platform and intelligent sensing equipment, the staged health inspection of modern timber architecture can be carried out, the performance value of timber structure can be analyzed by data feedback, and its hidden danger points can be predicted, thus further ensuring the safety of modern timber architecture and preventing the occurrence of multiple disasters.

4.5. Cultivating compound professionals

First of all, enterprises and schools should actively join hands. Enterprises can use their own resources to provide funds, technical equipment, and projects, while schools can make use of their own professional teaching teams, teaching level, and scientific research strength. The two sides ought to carry out regional school-enterprise cooperation, actively expand cross-regional cooperation forms, build a modern "apprenticeship system," as well as innovate vocational education and certification of courses related to modern timber architecture by means of online and offline hybrid teaching, so as to deliver timber structure professionals and technical talents for the construction industry.

Secondly, the interdisciplinary system of timber architecture specialty should be constructed. With the transformation and upgrading of the construction industry, the application of new materials, BIM, machine learning, intelligent construction, and others become increasingly close to the extent of merging. In order to meet the needs of talents in the industry, the combination of cross-disciplinary and multi-disciplinary is implemented to train talents with compound skills. At the same time, college teachers should also learn and practice in enterprises, understand the actual needs and new development trends of the industry, update their teaching contents, as well as clarify the personnel training objectives.

5. Conclusion

The development and application of modern timber architecture is of great significance to the sustainable development of the construction industry, the reduction of carbon emissions, as well as the transformation and upgrading of the industry, which is helpful for China to realize the reform of hitting "peak carbon emissions" and attaining "carbon neutrality." It is imperative to make good use of modern timber structures, take action according to one's ability in consideration of the current social development status and demand,

assume “precision and quality” as the construction purpose, as well as create characteristic architectures with a sense of commitment, in order to maximize the social and ecological benefits of modern timber architecture.

There are several problems in the popularization and application of modern timber architecture, such as limited resources, poor public acceptance, high comprehensive construction cost, and shortage of professional talents. The applicable scope of modern timber architecture can be expanded through policy support and improvement of norms and standards; in addition, it is necessary to strengthen technology research and development as well as demonstration guidance, in order to create modern structural construction formats and related derivative industries with regional characteristics. Developing forest resources moderately is a must to realize the sustainable recycling of timber resources. Moreover, it is essential to promote the application of digital construction as well as operation and maintenance in modern timber architecture, thereby reducing the comprehensive construction cost. In order to promote a sustainable development of modern timber architecture in China, it is imperative to add modern timber architecture courses and train up talents with compound skill level to engage in related industries.

Disclosure statement

The author declares that there is no conflict of interest.

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Study on Safety Distance between Expressway Tunnel and Interchange under Multi Tunnel

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Abstract: The net distance between the Xuetangwan interchange and the Huangshi tunnel exit of the Kaiyun expressway (Jiangkou-Yunyang-Longgang section) is used as an example in this paper. This paper analyses the problems in the safety distance between expressway tunnel and interchange under multi tunnel, and proposes safety distance measures between expressway tunnel and interchange under multi tunnel, based on the current safety distance standard between expressway tunnel and interchange under multi tunnel.

Keywords: Expressway tunnel; Interchange; Safety distance; Improvement measures

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1. Introduction

Although China's regulations on highway design do not put forward clear and specific parametric design requirements for the distance between tunnel and interchange, they generally adopt the design specifications of exit guide signs as requirements. If it cannot be met, the setting can be applied to solve the warning display scheme, but the minimum value of safety distance when conditions are limited is not provided. Due to the unclear relevant regulations, road designers face many puzzles, which indirectly leads to the short design distance between many tunnels and overpasses, which is not conducive to the safe driving of vehicles [1]. The number of lanes outside the tunnel must vary at least 10 seconds from the tunnel entrance, according to the tunnel regulation. As a result, vehicles outside the tunnel must be able to change lanes safely in less than 10 seconds, and the distance between the tunnel and the interchange must at least match this standard [2]. At the same time, this paper focuses on the standard of safety distance between expressway tunnel and interchange under multi tunnel because research on the safety distance between tunnel and interchange has major theoretical significance in China's road engineering design.

2. Study on safety distance between expressway tunnel and interchange under multiple tunnels

Kaizhou-Yunyang expressway (Jiangkou-Yunyang-Longgang section) is a part of the newly added encryption network planned for Chongqing expressway to realize "free inside, connected outside and interconnection." After the completion of the project, to the south, the expressway interconnection between Yunyang and Lichuan and Enshi will be implemented. To the north, Kaiyunwu expressway can be connected with Yinbai expressway to form a new northbound channel and improve the overall traffic efficiency of the road network. At the same time, it will open up a large vertical channel for Yunyang. This

will improve its regional advantages, and boost the development of poverty alleviation and rural revitalization in Yunyang.

3. Analysis of factors affecting the spacing between tunnel and interchange

3.1. Speed

Speed is one of the most important factors. On one hand, the higher the speed, the longer it takes to complete lane change or deceleration. On the other hand, the higher the speed, the more easily the driver's psychology is stimulated and affected, which increases the possibility of causing driver tension and anxiety. As a result, the response time for lane changes or deceleration behavior increases, influencing the distance to the vehicle indirectly. Besides that, vehicle speed has a significant impact on the interchange distance between Huangshi tunnel and Xuetangwan junction interchange. According to the study perspective, several definitions of vehicle speed exist. Design speed refers to the maximum speed that can be maintained only under the control of road design characteristics under good road, traffic, weather, and other conditions. Driving speed refers to the maximum speed that can be maintained only under the control of road design characteristics under good road, traffic, weather, and other conditions.

Generally, it refers to the speed limit of local design sections. The driving speed refers to the statistical value of the representative vehicle speed observed at the characteristic points of the road section when the vehicles are unobstructed and the weather conditions are good. The driving speed is a dynamic speed value, and 85% of the driving speed is commonly used as the alternative value of the driving speed at home and abroad. The estimated speed is the highest "safe" speed that the driver can expect under certain road conditions and driving environment. In this case, the vehicle is not or almost not affected by other vehicles while driving. Speed limit refers to the management speed of vehicles on the road set by the road traffic administration in order to completely show road traffic efficiency while ensuring vehicle safety. Several popular expressway design speed criteria are primarily concerned while assessing the safety distance between Huangshi tunnel and Xuetangwan junction interchange: 120 km/h, 100 km/h, and 80 km/h [3]. When investigating the distance, however, it is necessary to examine the connection between the design speed, driving speed, predicted speed, and speed limit in order to pick the appropriate speed for the study.

3.2. Response characteristics of the driver

In the process of driving, the driver's response to the action continuously according to the driving environment (including people, vehicles, road conditions, weather, etc.) is called the driver's response. The driver's response is divided into simple responses and complex responses. Simple response generally means that the stimulus source to stimulate the driver is relatively simple. The driver can respond directly without too much thinking and judgment, which is action. Complex response generally means that the driver needs to think and judge to a certain extent in order to receive complex and multifaceted stimuli and make corresponding operational response. For example, the driver's lane change behavior will cause complex reactions, because the driver's lane change will consider a variety of factors, including vehicle speed, traffic volume, road conditions, traffic sign information and traffic organization mode. The standard to measure the driver's reaction characteristics can be expressed as reaction time [4]. At the same time, the length of reaction time is also related to the driver's physical condition, psychological state, surrounding environment and other factors. For example, the reaction time of people of different ages is different. The reaction time of women is slightly longer than that of men, and the reaction speed becomes slower when excited. Therefore, the driver's response characteristics have a great impact on driving safety. The distance design between Huangshi tunnel and Zuetangwan hub interchange should take into account the response characteristics of most people and try to meet the needs of most drivers for safe driving.

3.3. Traffic flow

The traffic demand is predicted before the site selection, design and construction of Huangshi tunnel and Xuetangwan junction interchange, and the road parameters are reasonably designed by estimating the traffic flow after the completion and operation of the project. The design length of Huangshi tunnel and Xuetangwan junction interchange is also affected by traffic volume, because the ratio of traffic volume to road length (traffic density) can be used as the measurement standard of traffic volume [5]. After predicting the future traffic volume of the road through road congestion and vehicle freedom index, if the design section is too short, it will cause excessive traffic density and congestion, while if the design section is too long, it will increase the project construction and operation costs. Therefore, if the section length between Huangshi tunnel and Xuetangwan junction interchange is reasonably designed according to the traffic flow, the traffic flow in the section can be evenly distributed and effectively buffer the traffic flow [6].

3.4. Setting of traffic signs

If the driver does not find the warning sign of elevated off ramp in time during driving, he will miss the ramp and can only go to the next exit on the closed expressway or turn around at the toll station. Or if the driver does not find the exit ramp warning sign, he may find the exit when approaching the ramp and forcibly change lanes to catch the exit ramp, which is extremely likely to cause traffic accidents. Therefore, the export guide sign should be set up before the exit of the Xuetangwan junction interchange, which reminds drivers to adjust ahead of time, so as to predict the location of the next exit.

4. Spacing setting measures between expressway tunnel and interchange

4.1. Measures for handling traffic safety facilities

An overpass exit warning sign shall be set at an appropriate position in front of the entrance of Huangshi tunnel to remind drivers to get close to the overpass exit and remind vehicles leaving the main road to change lanes in advance. The communication vehicles in the left lane can change lanes to the right lane by placing a solid line on the right side of the dotted line on the left side of a specified stretch of the tunnel. The length of the left dotted line and the right solid line is mostly controlled by the distance travelled by a vehicle while waiting in the outside lane for insertion, as well as the distance travelled when modifying speed and position [7]. The distance while changing is determined by the distance that may be inserted and the reaction time when the vehicle changes lanes. Xuetangwan junction interchange, particularly ramp A1, will be equipped with colour anti-skid vibration signs at the entry and departure sections of Huangshi tunnel (or deceleration vibration signs).

While drawing the driver's attention, the marking also serves as an anti-skid and deceleration feature, allowing the car to lower speed and safely enter and depart the tunnel. To eliminate the hidden threat of traffic accidents caused by Huangshi tunnel's inaccurate up and down speed limits, complete speed limit signs will be installed in the Xuetangwan junction interchange region. Perfect traffic guidance signs must be organised in the Xuetangwan transfer area (with monitoring facilities) to improve the consistency and accuracy of sign setting, advance notice, and multiple notices at an appropriate distance before the information point (or accident point), so that drivers and passengers can accurately and timely understand traffic information and road condition information and achieve the goal of active guidance. To lessen the loss of life and property caused by traffic accidents, it is vital to strengthen the level of protection provided by railings in the region. A guiding anti-collision pad must be installed at the triangular end of the main line outlet. A deceleration indication line shall be set 300m before the starting point of the extended Lane transition section in the tunnel and extended to the exit. At the starting point of the transition from the tunnel interchange exit to the deceleration lane, 2km, 1km, 500m and 0m exit guidance signs shall be installed, and internal luminous photoelectric signs shall be adopted to ensure the safety of the tunnel. The export

notification symbol matches the ground export notification text, as shown in **Figure 1**.

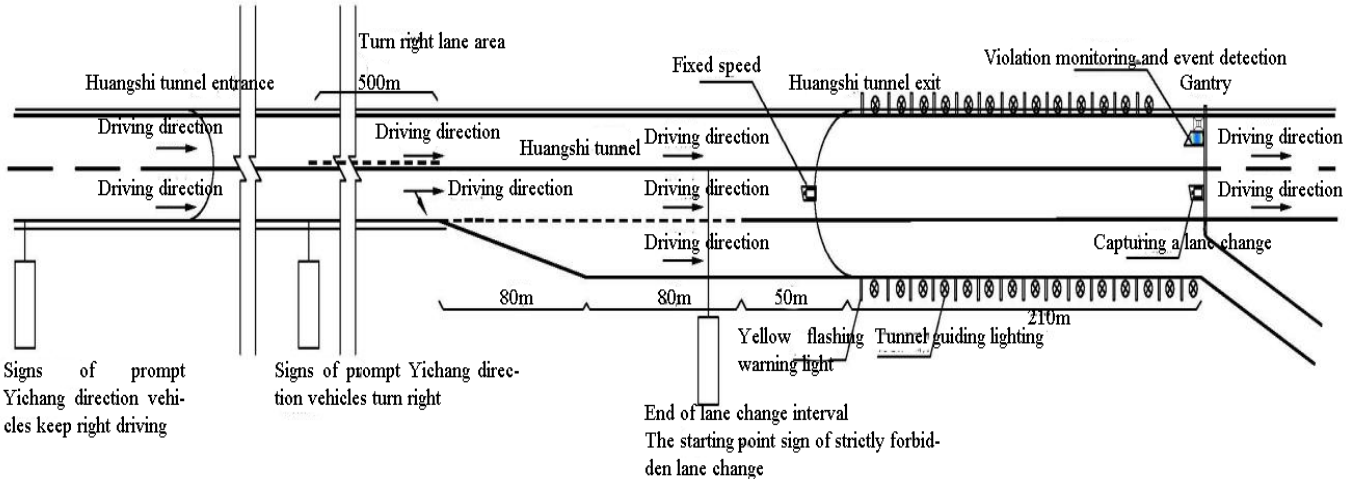

Figure 1. Layout of traffic facilities

4.2. Disposal measures for tunnel structures

The tunnel structure treatment measures consider extending the deceleration lane into the tunnel and widening the tunnel entrance. The length of the extension line is mainly determined according to the lane change distance and immutable lane distance of the vehicle. The lane change distance of the vehicle mainly includes the right turn distance determined by the driver and the lateral driving distance of the vehicle [8]. The deceleration lane is extended by comprehensively considering the specification requirements of the deceleration lane, the distance of the lane-changing vehicle, the distance between the deceleration lanes, and the constant lane 50m away from the opening.

4.3. Traffic monitoring measures

The first is the local speed limit. An inter-district speed limit is installed at Xuetangwan junction interchange to ensure that vehicles in the area travel at the required speed and reduce the risk of accidents. The second is the violation detection of the accident risk department. The traffic accidents in this area are reduced by installing constant speed measurement and violation monitoring facilities at the exit of Huangshi tunnel. The take off ramp intersection of Xuetangwan junction interchange is supplemented by lane change violation monitoring facilities to capture illegal lane change vehicles and reduce traffic accidents caused by random lane change.

4.3.1. Accident detection

By installing an accident detection surveillance camera at the junction of the Xuetangwan interchange exit ramp, traffic accidents in the area can be identified in time, and treatment and rescue can be carried out in time.

4.3.2. Danger warning

In order to improve drivers' safety awareness and reduce potential safety hazards, yellow lights and other warning facilities are installed between Xuetangwan interchange exit and Huangshi tunnel exit in cooperation with traffic safety facilities. The information prompt is improved, combined with traffic signs, and portal signs are set at the interchange entrance of the hub to provide complete traffic information for drivers.

4.3.3. Disposal of tunnel

Lights by strengthening the lighting of the tunnel entrance section and the lighting of the tunnel lane change section, the brightness of the light inside and outside the tunnel is gradually changed to improve the safety of tunnel lane change. The illumination brightness and layout length of the guiding section of Huangshi tunnel should be appropriately increased (the layout length should be from the exit of Huangshi tunnel to the exit ramp of Xuetangwan interchange) to provide the best driving conditions for drivers. When driving at night, the traffic accident time is reduced due to poor vision at the exit of Huangshi tunnel.

According to the specification, we can formulate the lighting enhancement scheme at the exit of Huangshi tunnel, and appropriately increase the parameter value to reduce the traffic accidents caused by the black hole effect.

5. Conclusions

It is necessary to ensure the safe operation of Xuetangwan hub interchange and Huangshi tunnel of Kaiyun Expressway (Jiangkou-Yunyang-Longgang section), give full play to the safe and smooth operation of the expressway, and conduct a safety assessment on the sections closely connected with the tunnel interchange. Starting with engineering and management technology, we will carry out comprehensive safety improvement of expressway tunnels, strengthen monitoring and management, improve safety facilities and other measures to ensure the safety of Kaiyun expressway.

Disclosure statement

The author declares no conflict of interest.

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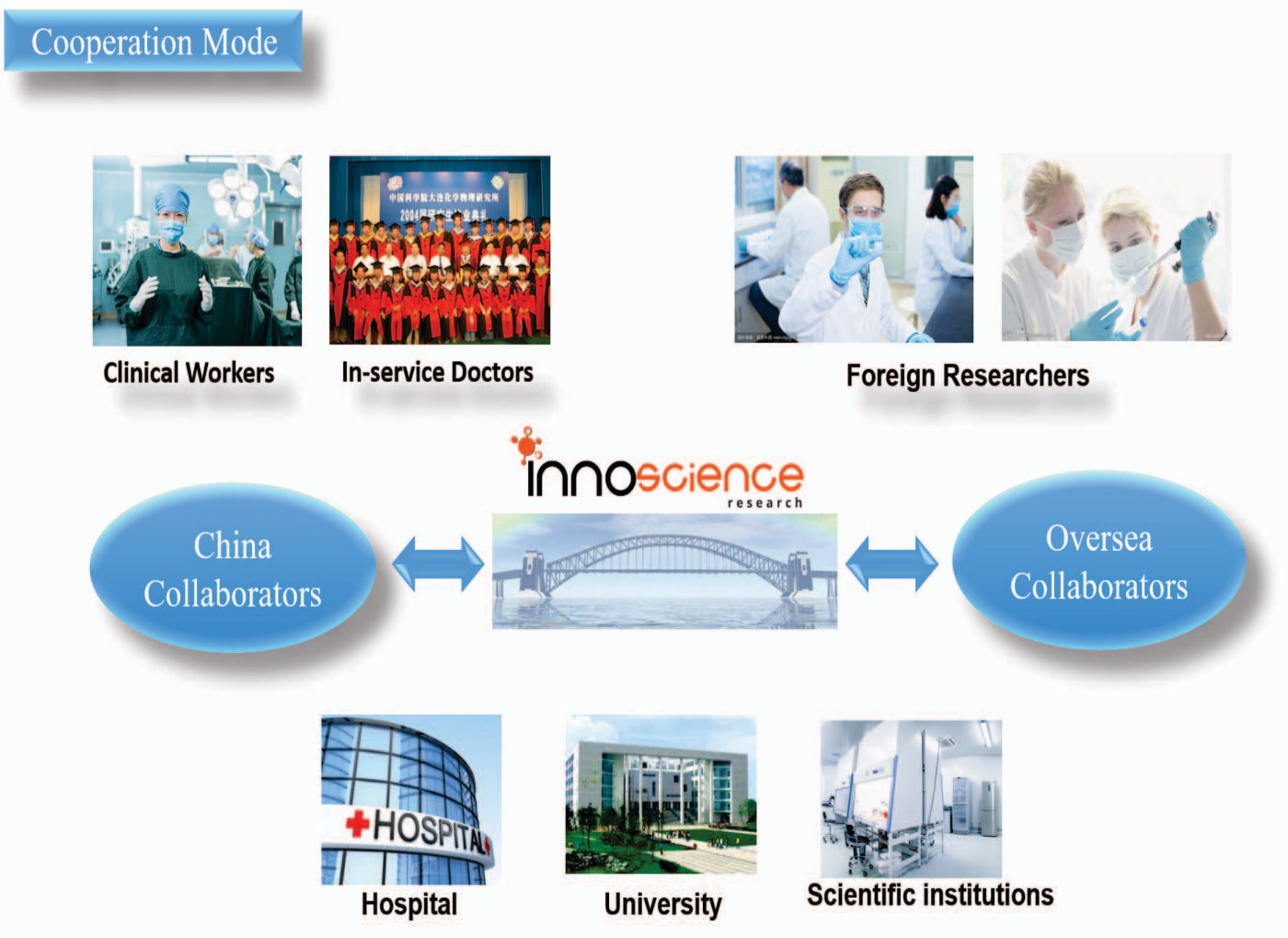

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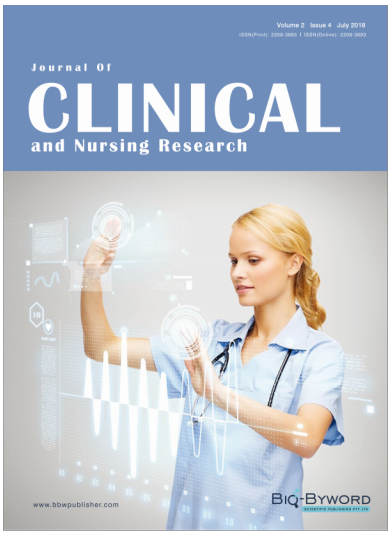

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