11 REFLECTION

1.RELEVANCE

Scientific relevance

Researches on the recycling of waste building materials have been studied for a long time, and there are many related research results, but these studies have not yet been able to be applied widely. And there are fewer projects that involve these materials to the regeneration of public spaces. Due to the current techniques of recycling, building materials cannot yet use a large number of secondary materials, so using secondary materials to regenerate public spaces and build sustainable public spaces has great potential.

The waste materials generated by the building demolition and the materials required for the construction of public spaces are listed separately, and the reusability of various materials is studied, so as to select building materials that can be recycled for public space regeneration. Besides, learn the amount of waste materials that can be applied in the production process of recycled materials.

Use flexible grid and modular design to regenerate public spaces to form flexible, sustainable public spaces to face future changes. Combining these modules with sponge city technology allows them to have flexibility in adapting to climate changes and responding to natural disasters caused by rain.
Study how to rely on existing urban waste management facilities to form a collaborative circular construction network.

Societal relevance

The new workers' estate is a type of residential area with Chinese characteristics. This type of residential area, which was built in the 1950s-1990s, still accounts for a large proportion of Shanghai' s residential areas. However, after nearly 30-70 years of development, the quality of building and public spaces of most new workers' estates are running down, and a large number of social problems have arisen. Due to property rights, it is difficult to regenerate. In this research, the new workers' estate was selected as the research object to regenerate the urban area with low living quality while maintaining the identity and urban context inheritance of such a particular type of housing.

In addition to the renewal of buildings, the regeneration of public space is relatively significant. People are now pursuing the improvement of the living environment. Public space that cannot meet the demand of living quality will lead to the replacement of original residents by less affluent residents, which will accelerate the decay of the estates, resulting in a larger number of demolition and new construction. Through the regeneration of public space, it can reduce future regeneration demand.

Meanwhile, the regeneration of public space solves social problems and makes the neighborhood more livable, vibrant, and aesthetically pleasing.

The problem of aging is particularly serious in the new workers' estates. Therefore, during the renewal process, special attention is paid to the experience of the elderly, to adapt to the living habits of the elderly, and to meet the needs of the elderly. But the design is not just for the elderly, the estate is still a mixed community, so we must also pay attention to how to allow different users to share space reasonably.

Through the research, learn how to balance the social resource among different stakeholders, to make the urban development more sustainable, the developer can always get their profits, and the residents can always find their best place to live.

2.METHODOLOGY

Methodology framework

The geo-deisign framework in essence is a platform for multidisciplinary collaborative research, at the same time, it provides a clear process for research questions. In this study, borrowing from this framework's method of analyzing problems, to study the current situation (what is the current context, how does the context operate, and how is the current context), and the changing situation after adding Circular Construction concept (what is the new concept, what happens with the application of new concepts, and how will these changes happen). Under the guidance of this methodology framework, the new workers' estates regeneration problem in Shanghai was analyzed.

Inductive

The research adopts the inductive method, starting from three different new workers' estates and researching three different regeneration strategies, then applying these strategies to various types of new workers' estates respectively, so as to predict the flow direction and amount of the entire circular construction network. Using this method helps me have a detailed understanding of material types, material production and consumption, and regeneration strategies at the beginning of the study so that the establishment of the network is more scientific.

Case study and literature review

Although many cases mention the application of circular construction technology in the design process, most of the examples do not describe in detail how to apply and which materials use these technologies. Therefore, the method of reusing materials, public space regeneration design can be learned from the case study. But most of the specific recycling methods come from papers of construction technology. How to connect the circulation technology with the space design lacks relevant cases.

3.PROBLEMS AND DIFFICULTIES

Research content

The research object, content, and method changed a lot during the process of research.

The initial research object was the large number of high-rise buildings in Shanghai. However, after research, the number of high-rise buildings that are badly in need of being demolished or renovated is not large, so the research is lack of generality. Therefore, to study the history of Shanghai's urban development, select a building type that is currently undergoing a preliminary transformation. It has a significant demand for regeneration shortly in the future, produces a large amount of waste while has few related studies. The new research object is the new workers' estate with a history of 30-70 years in Shanghai.

The original research content is to evaluate the new workers' estates in Shanghai, select different types of communities, and propose different regeneration strategies according to their current conditions. That is to say, based on the analysis and indicators, the decision is made as to which estates need to be demolished, which need to be refurbished, and which only need to be maintained. In other words, we know which communities will generate waste building materials, which communities require additional building materials, and the amount of materials generated and needed. According to their different regeneration conditions, different material flows will be formed, which combine with the city's infrastructure to create a circular construction network. On this basis, select cases to design the public space at the estate scale.

Due to the lack of data, technology, and knowledge, the research methods of the above research content are difficult to realize, and the research methods have changed. Directly select three cases, corresponding to three different regeneration methods. Starting with the regeneration of neighborhood-scale public spaces, learn the types of materials involved, and calculate the flow of materials. And on this basis, to build the circular construction network.

Data

The main reason for the change in the research content is insufficient data. It is hard to find accurate building age data for each community. At the same time, the assessment of the current status of the community needs to be supported by a large number of subjective and objective data contains building structure safety, environment, and facility use status, vacancy rate, land property rights, and land ownership. These data are difficult to obtain or replaced by other indicators. It is a process that requires multi-disciplinary collaboration. This evaluation cannot be completed in this study. Therefore, instead of classification, directly selecting representative cases, after the government has completed the overall assessment, they will be completely demolished or partially regenerated.

Techniques

In the entire project's research process, circular construction technology is essential. Through a literature review of a large number of methods for recycling various materials, the material's reusability, and the ratio of raw materials and secondary materials in new materials are summarized. Because the data is very different in different papers, the average of various data is selected as the result, so the calculation results cannot fully guarantee the scientificity.

At the same time, there are many methods of recycling, and some methods are too elaborate and small scale (such as some recycled street furniture), which is difficult to be applied on a large scale under the current situation. There is no in-depth research on this part of recycling technology.

Besides, the current circular construction techniques' primary material recycle process is mainly based on the re-production of the same type of materials, which is not innovative enough.

Fieldwork and investigation

Although many cases mention the application of circular Through the survey, I have an overall understanding of residential areas such as new workers' estate and investigated the problems of public space, the ownership of property rights, the user's demand for space, and the user's views on circular construction. And in the process of investigation, only the regeneration projects carried out can be investigated, but the specific amount of materials consumed during the transformation process cannot be known.

Due to the behavioral characteristics of people returning to their hometowns during the Chinese New Year, Shanghai, as a city with a large external population, will significantly reduce the number of people who can conduct investigations during this time, so the field trip arrangements are advanced before P2. At this stage, the research object is not precisely the same as the final design sites.

One of the final selected cases did not carry out a field investigation, and the results of the online investigation are not ideal, only get a general understanding of the community environment and surrounding facilities. The rest of the information is obtained through online materials.

Zoom in cases

Corresponding to the three regeneration methods, three cases were selected. Since demolition is equivalent to designing a new community, no in-depth design of this kind of example is done. The key research case is the case of refurbishment. In this case, there are partial demolition or reconstruction of buildings, which produce waste materials. At the same time, the regeneration of public spaces requires materials. On-site reuse and off-site recycling can occur at the same time. It is the more complicated one in the three regeneration process.

However, the transformation of the other type of maintain category requires more research. At present, only a micro-regeneration strategy is given for this type of estates and no more in-depth study. The fundamental difference between these two types of regeneration is whether there is on-site reuse. The impact of this difference on the spacial design and the large-scale circular network needs further research.

4.MODULARITY AND GENERALIZATION

The concept of modularity comes from the strategy proposed in the research process to reduce the materials consumed in future regeneration, improve the reusability of materials, and carry out a reversible design. The application of modular materials facilitates the application of modules directly to other locations or sites in the future regeneration process, reducing the in-between process of dismantling and reprocessing. Therefore, the design flexibility is guaranteed. The modularity usually means prefabricated industrial production, reducing material consumption, improving construction efficiency, and reducing pollution. At the same time, the combination of modules creates more possibilities for public spaces.

Another advantage of modularity is its ease of generalization. The same modules can be used in different scenarios, and various types of residential communities can divide the public space into flexible grids and apply these modules according to functional requirements. Therefore, this type of design can be more easily to be widely used.

There are also disadvantages of modularity.

- From the perspective of flexibility, the products used in modular grids and modules should be processed specially. It means that most of the current materials need to be remanufactured for recycling. And the secondary products must be processed according to the module, which makes them not as flexible as the common ones. If the modulus is different, the material cannot be applied. To complete the modularization of all products requires a long time and also requires some additional processing.

- The modules cannot fully match the sites without modular design. The new workers' estates are all old urban area which are not designed by modulus. Therefore, when the modules are applied, there will be remaining space that cannot be covered.

- The unification of modulus is a difficult thing. The most suitable modulus at this stage may change in the future. From this perspective, the module's ability to adapt to future changes is weak.

- The size of a single module limits the space. To obtain more space, there is a need to combine multiple modules, and the combined space may be larger than the required space, resulting in waste of space.

- The design is not fully context or user specific, which could cause spatial monotony.

While compared to reusing the products directly, the advantages of modularity, such as its speed of construction, ease of generalization, and sustainability over a longer period of time, make it still a potential design method. Based on the premise that before the completion of large-scale modular production, circular technology will not undergo a tremendous change, modularity is a potential design method to achieve this longer-term sustainable development.

The thesis design is an experimental research using this concept. It supplies a framework and guideline of applying circular construction to public space design. The basic public spacial regeneration is made as a basis, and more design possibilities could be developed further by designers and residents.

In the application process, the diversity of a single module and the combination of multiple modules should be continuously developed to form different spatial experiences in similar spatial forms to avoid the monotony of public spaces. At the same time, combined with the modularity of the building, unify the modules and make a coordinated development.

5.CIRCULAR CONSTRUCTION NETWORK

The application of circular construction to urban regeneration requires not only material research and spatial design at the micro-level but also relies on the Circular Construction Network at the urban or even regional scale to achieve this process. The circular use of building materials is a complex process, including demolition, separation, collection, reprocessing, storage, transportation, and reconstruction. Therefore, it is necessary to rely on this network for centralized processing and distribution of various resources.

Although the evaluation method mentioned above cannot be fully implemented in this study, it is still an indispensable step in the construction of this network. In the form of strategy, this can be described as the surveys and investigations required by each stakeholder to complete this step, which, as a result, shows how new workers' estates should be classified. After completing this classification, we can know the direction of material flow (where waste materials come from and where secondary materials are used). Combined with the calculation of small-scale material recycling applications, and the area of various types of new workers' estates, the number of materials participating in this circular construction network can be roughly obtained.

The next step is to learn how this network works and how to distribute it in urban areas. First, learn the existing formal or informal waste collection and processing infrastructure, and select functional nodes according to the importance of the area and their identity function in the city. These nodes serve as main demolition, separation, collection, reprocessing, and storage functions. At the same time, new nodes are added according to the predicted material flow. According to the principle of local priority, roughly draw the flow map of this network. To find the proper location for bio-based material production, look into the potential of different typologies of the landscape.

Analyze the different stakeholders participating in the network and let them collaborate to make the network more efficient. Build a collaborative online platform for the information of material flow. By using the techniques of material passport, building ID, and BIM system, the collaborative platform can have a more accurate judgment of the material offer and demands. The center of the platform can also be a real place for trading headquarter and stakeholder meetings as a knowledge hub.

Through the above steps, the establishment of a collaborative circular construction network can make the entire design and research framework more complete and more implementable in the future.

While, the current research is based on several cases and shows the implementation of the ideas of circular construction network, but it still needs further researches to promote its practical application.

- According to the guideline, all new workers' estates that are planned to be regenerated need to be evaluated and decisions made to form the network for supply and demands.

- The choice of construction industry node simplifies the actual situation, unable to obtain specific flow data, and takes distance as the evaluation standard. In practical applications, the connections between various nodes are more complicated, and the benefit relationships between different links also need more detailed research.

- The infrastructure selected as transformation nodes needs a more comprehensive feasibility study to determine whether it is truly practicable.

- There are more nodes in the actual network than mapped points.

- The relationship between stakeholders is more complicated.

- Collaboration at different scales also requires a more specific management system.

- The actual project construction order is also affected by more factors.

- The laws and regulations regarding circular construction also need to be improved.