

Exploration on factors of old industrial building renovation and design practice

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Abstract. The value and necessity of the current renovation and reuse of old industrial buildings are obtained by introducing the status quo of China's old industrial buildings and citing the protection methods in the world in each period. Through the field investigation and observation analysis in Guangzhou, China, taking the number of users as the evaluation standard, the influence of the building material, color, number of floor, lighting and greening on the renovation and utilization of old industrial buildings is expounded. Combined with the relevant theory and case analysis, the favorable factors of affecting the old industrial building renovation are obtained to be some of the inspiration and recommendations of the old industrial building renovation and utilization. Finally, according to research conclusion, it is applied to the actual project. Through the project design, the previous research conclusion is further comprehensively used, and the final result is explained with the help of the three-dimensional model.

1. Introduction

With the acceleration of China's industrialization process, industrial manufacturing process has been optimized. Many old buildings have been unable to adapt to the new manufacturing needs, and a large number of industrial plant buildings are left to be idle. Many of these buildings are in the city center area, so a large number of demolitions will cause great harm to the surrounding environment. The construction of these buildings is relatively long with a certain historical and cultural value. Old industrial buildings are not the historical burden of urban development, but the precious heritage. So for many old industrial buildings, China has adopted the way of use of "suppressing the second industry and developing the third industry". Guangzhou area is the first place to carry out this policy in China, so there are a lot of research cases.

Redtory can be considered as the most successful case of many old industrial buildings, not only for the superior geographical location, but also for its own successful renovation and utilization. From the Redtory this representative case study, most of the influencing factors used in the old industrial building renovation can be obtained. The building material, color, number of floor, lighting and greening can influence the result of its use. Through the comparison of these factors, the strategy of the old industrial building renovation is obtained. Lubao Warehouse is a real renovation project. The application of the strategy of the previous Redtory to the Lubao Warehouse is the combination of the theory and practice.

2. The tendency of architectural heritage protection in each period.



Period [↗]	Architect [↗]	Heritage conservation expert [↗]	value orientation [↗]
1850s-1950s [↗]	Aesthetic value , French style restoration [↗]	Historical information authenticity , Italy literature restoration [↗]	Value orientation of cultural elite [↗]
1960s [↗]	“Authenticity” [↗]		The value orientation of cultural masses [↗]
1970s [↗]	Use value、Economic value、Remediation reuse [↗]		
1980s [↗]	Cultural value [↗]		

Figure 1. Characteristics of architectural heritage protection in different periods

The protection of architectural heritage, from the mid 19th century to 1980s, undergoes the change from the authenticity to the culture. As shown in Figure 1, It can be concluded that more than a hundred years ago, people paid more attention to the surface of a building, and the building protection depended on the degree of reduction of historical information. In the 1960s, the preservation of the authenticity of the building was valued by people. After the war, people urgently needed buildings able to be used. The whole community began to cherish buildings of legacy, and people began to actively participate in the protection of architectural heritage. In the 1970s, the world's major economies resumed development, and China also implemented reform and opening up. Economic development had increased the value of land, so the use of the building itself and its subsidiary space and economic value began to be taken seriously. After the 1980s, the world's economic development had greatly improved, and more and more people began to care about the needs of the spirit. Building is the main carrier of human activities and life, so the cultural value of the architectural heritage naturally begins to be taken seriously.

Old industrial buildings in modern times were cheap with rent in the early period of time and are located in the center area of the city. More importantly, the industrial civilization and field memories accumulated behind the old factories and old warehouses can inspire creativity. In addition, as the open and spacious structure of the factories can be divided or combined arbitrarily or can be rearranged, they are favored by creative industry practitioners such as artists[1]. The recycling objects expand from warehouse and light industry factory buildings to heavy industry factory or evenshipyards.[2]The industrial heritages can be recognized and rebuilt by the public, which conforms to the development of the times and demands of people.

3. Reconstruction factor explorations of old industrial buildings

3.1. Research objects and research results

The Redtory, located near the Tianheyuan village of Guangzhou province in China, is the first creative industry center of non-investment property. The predecessor was Guangzhou Ying Jin Food Factory (Guangdong Cannery Factory). Through reconstruction, it has been transformed into a cluster of businesses. The Redtory is the most popular creative industry center in Guangzhou. The reason for choosing the Redtory for the research object is that the application evaluation is good.

As shown in Figure 2-3, the investigation has selected parts of those buildings, streets and facilities. The old warehouse reconstruction clusters studios, but it means nothing without people[3]. The evaluation basis of the investigation is divided into materials, colors, layers, lighting, afforestation, and the evaluation criteria is the number of users. According to the statistics, the successfully reconstructed buildings have the following characteristics. The materials are mostly of red bricks, combing with local glass and wood structures. The colors of those buildings are warm colors such as red and saffron yellow. The number of layer is 1-2 layers of pleasant height. Lighting should be sufficient. There should be good greening around the buildings. The targets of the investigation are mostly successful cases, with the F18 - West and D-1 as the opposite contrastive cases. Because it is an office space, the F-18 west has been making a hesitant for visitors to move by lowering the lighting. The D-1 is a sales

building that is open to the outside world, but because the lighting is not good, it greatly reduces the number of visitors to the store.



Figure 2. Redtory plane and research objectives.

Position	Material	Colour	Storey	Lighting	Green	Function	Popularity
F18-East	Brick	Orange	1	Adequate	Yes	Exhibition	Many
F18-West	Brick	Orange	1	Medium	No	Office	Few
Y-9	Brick, Glass	Tangerine	2	Adequate	Yes	Restaurant	Many
F-3	Brick	Tangerine	2	Adequate	Yes	Restaurant	Many
Train	Steel	Gray	1	Adequate	Yes	Play	Many
Booth	Container	Yellow	1	Adequate	Yes	Service	Many
D-2	Brick	Tangerine	1	Adequate	Yes	Restaurant	Many
D-1	Paint	White	2	Lack	Yes	Sale	Few
D-5	Brick	Tangerine	2	Adequate	Yes	Exhibition	Many
Booth	Steel	Tangerine	1	Adequate	No	Sale	Many
C-1	Steel, Glass	White	1	Adequate	No	Exhibition	Many
A-5	Glass, Wood	Yellow	2	Adequate	Yes	Exhibition	Many

Figure 3. Research target usage evaluation

3.2. Factor analysis of influencing the building use

3.2.1. Materials and architectural improvements. Red bricks are made of yellow clay, red clay and so on, and its rough sense gives off the life of the land. Many famous buildings have used such materials, such as the red house in Morris. Red brick is a kind of all-matched materials, and the combination of red brick and glass will show the coarse of soil and the transparency of the glass. The combination of red bricks and the lumbers can show extremely strong affinity, and the wood grows out of the ground. The concrete will simplify the complex space problem. Metal can enhance the sturdiness and the logicity of the whole space, and it simplifies complex problems. The transparency of glass is almost irreplaceable, and the combination of glass and modern steel structure and concrete can make the interface richer in day-lighting and sight effect

When there is a large scale of solid wall in the construction, mindset shall be transformed to comply with functional needs, and this area shall be differentiated from other areas with material differences [4]. The majority of the research cases are based on red brick and other materials. Y-9 is a dining building located in a narrow street and a bad view. But after reconstruction, part of wall were torn down and replaced by glass, which increased the day-lighting and would widen the negative and narrow street, giving a visual sense of transparency. C – 1, as an exhibition building, is only kept the roof, and is increased steel structure and replaced by large area of curtain wall. It makes the exhibition items take in everything in a glance with a strong sense of openness and landmark. A-5, as an exhibition building, is ordinary in mould, but after modification, transverse wood shutters were added. A layer of bricks were replaced by glass, which makes the whole building facade rich immediately, showing the multiple elements that an exhibition building should have.

3.2.2. Color and architectural improvements. Colors of high chroma look resplendent, and colors of low chroma look simple; and as for the brightness, bright colors appear more resplendent, while dark colors appear simpler. The excitement or stillness caused by these different colors can serve our ill space and environment well[5]. White and black and high chroma colors often give the sense of tension, and grey and low chroma colors the sense of comfort. The sense of excitement or pacification implied by different colors can be very useful for specific space and environment. As for the building with the white wall, it is required to properly manage the internal lighting, to avoid the occurrence of glare from the excessive difference in brightness indoors and outdoors. If it is unpleasant to the eye, people will not see objects in the room clearly, which will significantly influence the behaviors of people in such space.

Color is playing a significant part in human psychology and physiology through visual sense, and has a direct influence on human production and lives[6]. The buildings in the survey are mostly catering and exhibition buildings, and are mostly in orange red, orange yellow and other warm colors, scarcely in other colors. Brick red is used in most catering buildings, e.g. F-3, as the warm color will stimulate the appetite. Other colors can also be used for exhibition/sales buildings, e.g. in C-1, the fresh and elegant white color suggests the attribute of the building. The auxiliary facilities, e.g. the booth, formerly a monitor center, attract many visitors to take photos there, due to striking yellow color of high purity.

3.2.3. Storeys and building renovation. The size of the space will have effect on the behaviors and psychological feelings of people. Attention should be paid to the size of the human body, closely related to the human body, and the details of the building[7]. The reasonable height of the storey will facilitate the applicability of the internal space, and increase the frequency of use. The low single-storey and double storey spaces are the most common, with the highest utilization rate.

The buildings surveyed are all 1/2-storey buildings. For the businesses requiring the building space with large number of users, e.g. catering and exhibition, requiring higher flow rate, the buildings with 1-3 storeys are usually chosen, those with more storeys are used for e-business and office, and the tall water towers and storage buildings can hardly be used, but used for landmark buildings.

3.2.4. lighting and building improvements. The lack of light in the dark space creates insecurity, and there is no one to stay at all. It is only suitable for storage and transportation. The dark space of the old industrial buildings must be strengthened with light treatment, which will reduce the sense of the unknown in the space and strengthen the applicability after opening.

The quality of lighting directly affects the use of buildings, whether it is dining or exhibitions. Buildings that were originally poorly lit could be better used by renovation. F-13 as an exhibition space for sale, because there is skylight lighting, so the indoor lighting is excellent, very attractive to visitors to the room reading and buying books. C-1 originally lighting is not good, but through a large area of glass curtain wall and partial construction of roof lighting wells, indoor lighting is good.

3.2.5. Greening and building renovation. For the environment of the building, the presence of green vegetation not only brings the difference in colors, but also the benefits in the view, temperature, humidity, etc. Although, the application of climbing plants over a wall is not a new trend, the systems and the purpose of using them has changed over the last few decades[8]. Generally, greening at 2 levels is required, i.e. at the eye level and the building level. The eye level is usually 1600mm when you stand, and due to the difference of height inside and outside the room, the eye level when you sit indoors is also about 1600mm, in relation to the ground outdoors. Greening at such level is very critical, for dividing the view, improving the privacy and reducing interference to the view indoors and outdoors. In many occasions there exists an active grey space surrounding the building, and for the issue of sun shading required in Guangzhou, trees of the building level will provide the shade, creating the comfortable environment away from the scorching sun. Greening can also block the sunlight around the building, to prevent the high temperature reflecting on the building walls.

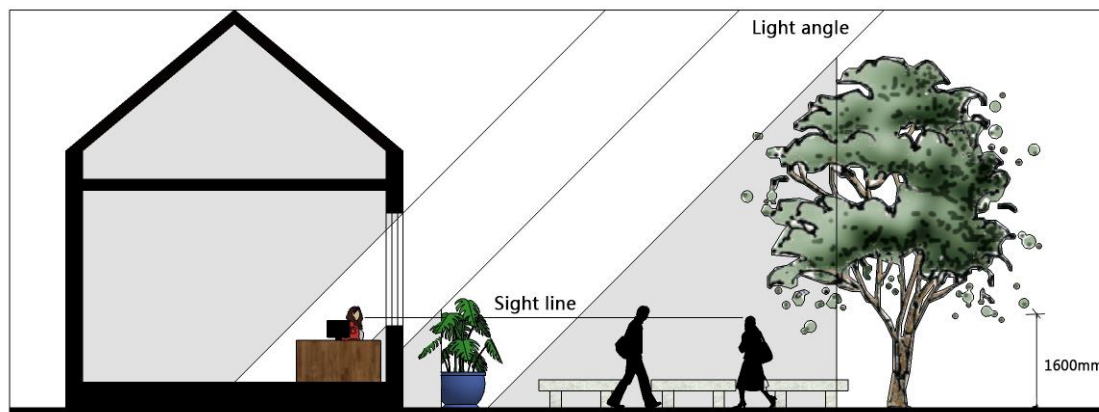


Figure 4. The relationship between greening and architecture

As shown in figure 4, most of the buildings are surrounded with green vegetation of different levels after renovation. Therefore, greening of different levels and layers is a valuable factor in renovation of old industrial buildings.

4. Design practice guided by building renovation factors.

Based on the survey and analysis of the Redtory, we summarized the considerations regarding renovation of old industrial buildings, and such considerations will serve as the useful measures in our actual projects. The design of Lubao Granary Project is a good example. The Project, located in the center of Lubao Town, Sanshui District, Foshan, China, is a project entrusted by the government. It was a granary built at the beginning of the People's Republic of China, with the simple and enclosed architectural style, and now it shall be renovated and reused. We prepared the program as attached with reference to relevant expertise and design practice, in which the following renovations were made based on the original structure and enclosure: As shown in figure 5-6.

4.1. Material.

Change the formerly white mosaic fences to the coarse and wild style stone fences by coating the stone-like paint.

4.2. Colors.

Change the color of the fence from white to yellow, and the roof from grey tiles to orange (with color tile paint).

4.3. Storeys.

Change the monotonous structure of one or two storeys to irregular arrangements by adding members or hollowing.

4.4. Daylighting.

Open the windows in the wall, and the skylight at the roof, to allow entry of more sunlight.

4.5. Greening.

Build a courtyard with the space between two buildings, plant shrubs and trees, and shield the façade with greening.

5. Conclusion

Through the survey and analysis of representative renovation project of Guangzhou Redtory, China, we developed the architectural strategies for innovation of old industrial buildings, focusing on analyzing the effect of materials, colors, storeys, daylighting and greening on use of buildings; and further studied how to utilize such strategies in actual innovation of old industrial buildings, based on the case analysis.



Figure 5. Lubao bin Original form



Figure 6. Lubao bin Original form

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