Renewal Design of Vacant Space and Concrete Framed Girder-Column Structures in Shopping Malls under the Rise of Vacancy Rate during the COVID-19 Epidemic -A case study in Fuzhou, China

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ABSTRACT
Reinforce Concrete Framed girder-column structures is an important supporting system in concrete facilities apart from shear wall system. When necessary reinforcement is being conducted in response to increased loading, evaluation of influence on the seismic-resistance performance exerted by corresponding alterations is of vital significance in determining proper approach to strengthening the structures.
During the epidemic, the vacancy rate of urban shopping malls has raised significantly. Taking the renewal and reconstruction of local vacant space in Yongjia shopping mall, Fuzhou, China as an example, this study is aimed to find out the way to reactive shopping malls in the post-pandemic period. On-site observation and interviews with relevant personnel have been implemented to establish the site model. Findings include the importance of the fully integrated environment of both online and offline and the importance of integrating online shopping into commercial buildings for the city. The study concludes that the solution is to combine the 'online space' such as live broadcast space into the vacant space in the deprived shopping mall. Moreover, this project illustrates a combination of traditional and contemporary seismic reinforcement approaches in real concrete frame structure reinforcement project.

Keywords: *concrete frame; girder-column; seismic resistant; pandemic cities; mall design*

1. INTRODUCTION

Reinforced Concrete Framed (RCF) structure is an important branch of building support system where horizontal girder (major beam supporting extended beams) and vertical columns are connected to form a compound transferring loads into rigid foundation. Devastating intensity of seismic activities and lethal dagame imposed on buildings (as is the case in Wenchuan, China, 2008) facilitate the regulation on the safety of concrete structure to revise in the realm of seismic design[1], thereby proposing new requirement towards conventional concrete frame girder-column structures.

Research on concrete frame strengthening is being conducted since last century. An approach to strengthen concrete frame is to modify the structural character. In 1977[2], precast concrete frames were proposed for mass application due to ductility. Lv et al.[3] discussed a prefabricated frame pattern that exhibited better ductility and resistance compared with conventional structures which were built and constructed on spot.

Since the epidemic of COVID-19 has been continuously outbreaking for one year and a half, the impact on retail business has become long-term trend in China. Many brands have reduced their expenditure of opening stores, increased the online channels, and reduced the layout of physical stores, which has increased the risk of vacancy rate in shopping centers and consequently increased the downward pressure on rental income. This phenomenon has led people to think about the re-layout of vacant space in shopping malls under the urban epidemic. In order to alleviate the rise of store vacancy rate in shopping centers after the epidemic, improve the seismic capacity of shopping centers and improve the economic level of shopping centers, the authors take Yongjia shopping center in Fuzhou, Fujian, China as the research object, and finds out the factors

affecting the development of shopping centers after the epidemic by means of online inquiry, on-site observation and investigation, and inquiry of tourists and shopkeepers, For the development countermeasures of shopping centers in the post epidemic period and the causes of building collapse, online spaces based on covid-2019 coronavirus disease epidemic space, such as live broadcasting space and vacant mall space, are studied. The authors hope to provide innovative ideas and effective experience for the renewal and transformation of vacant space in shopping malls.

2. ANALYZE THE FACTORS AFFECTING THE DEVELOPMENT OF SHOPPING CENTERS IN THE POST-EPIDEMIC PERIOD

2.1. The proportion of online consumption has increased

Table 1 monthly growth rate of online physical retail sales from 2019 to 2020

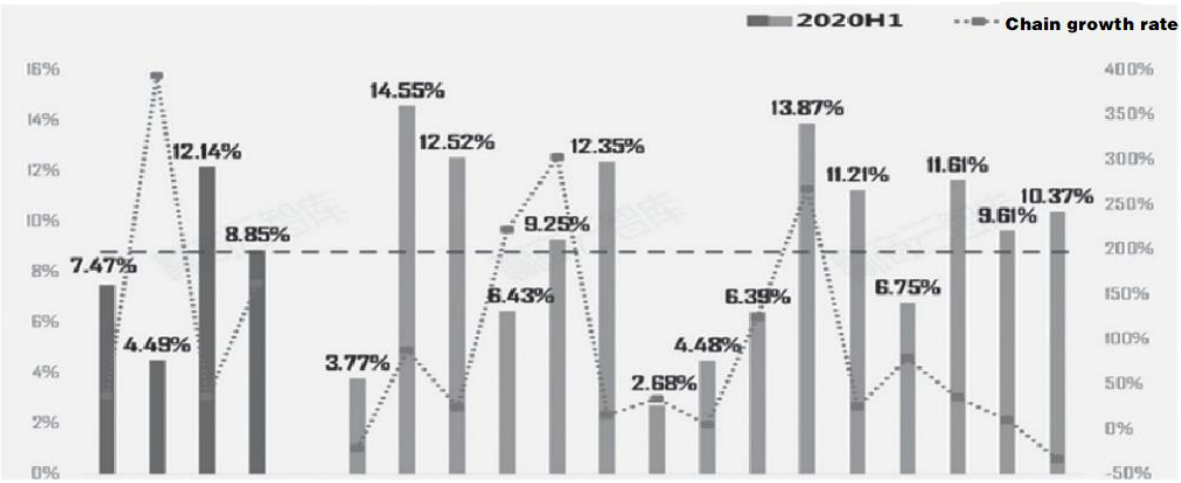
January to February 2019	19.50%	January to February 2020	3%
March 2019	23.50%	March 2020	10.70%
April 2019	25.80%	April 2020	16.20%
May 2019	19.90%	May 2020	22%
June 2019	21.20%	June 2020	25.20%
July 2019	16.70%	July 2020	24.50%
August 2019	20.10%	August 2020	16.50%
September 2019	18.40%	September 2020	11.70%
October 2019	14.60%		
November 2019	19.10%		
December 2019	17.90%		

Data source: China Business Information Center

During the epidemic, people chose to stay at home, which promoted the online reconstruction of many scene activities. The rapid online of entertainment, shopping and diet, have changed people's consumption concept and have changed many people's consumption mode to online. According to the data of China Business Information Center, the retail sales of online physical goods in the first three quarters reached 6647.7 billion yuan, a year-on-year increase of 15.3%, accounting for 24.3% of the total retail sales of social consumer goods, an increase of 4.4% over 2019 before the outbreak, and this consumption transfer behavior is irreversible. The monthly growth rate of online physical retail sales from 2019 to 2020 is shown in Table 1, according to an average of 30 days[4].

2.2. The vacancy rate of shops in shopping centers has increased

Affected by the COVID-19 epidemic, in order to avoid contact and group aggregation, online shopping has become our main shopping mode, and has also formed new consumption habits. The formation of new consumption habits has also led to a rapid rise in the vacancy rate of shops in shopping centers. In the first half of 2019, more than 1000 large-scale commercial facilities have been opened in 19 first and second tier cities across the country, and nearly 66000 shops (closed and opened) have been adjusted, which is far more than before. The overall rental situation of the shopping center was poor. The average vacancy rate increased by nearly 46.3% month on month, and the vacancy rate reached 8.88%. Among them, the vacancy rate of 1/3 of large commercial facilities exceeded 10%, and the operation continued to be under pressure,as shown in figure 1[5].



X: vacancy rate **Y:** percentage

Figure 1. Average vacancy rate of shopping centers in first-tier and second-tier cities in China in 2020

2.3. Change of people's concept in the post epidemic era: People's health awareness is stronger

Tencent news network reported novel coronavirus pneumonia epidemic in March 18, 2021, the cumulative diagnosis consists 102450 people, of which 4849 people died[6]. The epidemic has undoubtedly posed a threat to peoples' health and life safety, and it also sounded the alarm of health and epidemic prevention. The masses are more clearly aware that protection should start from themselves. Paying attention to eating habits, washing hands and disinfecting frequently, increasing the length of exercise, and maintaining their own health have become a topic of attention.

3. DEVELOPMENT COUNTERMEASURES OF SHOPPING CENTERS IN THE POST EPIDEMIC PERIOD

3.1. Meeting health needs and preferably achieving the effect of publicity and education

People's health awareness and protection needs have been greatly improved in this epidemic, and their awareness and demand for health, medical and pharmaceutical products have been further strengthened. The health industry will become the focus of people's attention[7]. Shopping malls can further improve the proportion of life health care, medical and health brands and peripheral products, and can place some self-service medical and health product vending machines. Medical single rooms can also be placed in the idle space in the mall (such as underground parking lot or some large mobile space) to facilitate the storage of relevant medical devices. In addition, some epidemic prevention public activities can be carried out in some non-enclosed spaces, or some performances can be held outdoors to make up for the losses caused by cinemas and children's activity space.

3.2. Encourage the combination of online and offline shopping

On March 13, 2020, China's national development and Reform Commission and other 23 departments jointly issued the implementation opinions on promoting consumption expansion and quality improvement and accelerating the formation of a strong domestic market, which clearly proposed to encourage the development of new consumption modes such as the combination online and offline. It is suggested that the stores in the mall adopt live broadcasting to alleviate the losses of the stores, and provide online purchase and pick-up services on the same day in combination with third-party distribution resources[8].

3.3. Optimizing space layout and shaping diversified commercial space

In the post epidemic period, it is necessary to provide people with more safe and healthy commercial space to meet consumer demand. Designers need to pay special attention to the outdoor of commercial space and increase the ventilation of indoor space. Ventilation measures shall be taken for leisure and entertainment spaces such as cinemas, cafes or libraries. The traditional closed design shopping mall needs to add open commercial blocks to realize the integration of closed and open space in the whole commercial space. For example, the seats can be arranged in places where people do not travel frequently outdoors in restaurants. The open commercial block is the best carrier for the shopping mall to meet people's requirements of improving the ventilation environment. It can also give consumers more leisure experience content and give consumers the reason to "walk at ease".

4. DESIGN AND RESEARCH ON THE VACANT SPACE OF YONGJIA SHOPPING MALL, FUZHOU, FUJIAN, CHINA

4.1. Project background

4.1.1. Geographical location and surrounding environment.

The project is located in Fuzhou City, the capital city of Fujian Province, China. There is Fuzhou University Town in the West and a residential community in the East. Citizen can take Fuzhou Metro Line 2 directly to the mall, as shown in figure 2.

Fuzhou Yongjia shopping mall is located in residential areas, near schools and business districts. Different groups of people can be selected for investigation, and the problem of rising vacancy rate during the epidemic is significant, so Yongjia shopping mall is selected as the research object. Through on-site investigation, the author asks different groups (such as consumers and businesses) to understand the vacancy rate of the shopping center, and analyzes and designs it.

Figure 2. District Analysis

4.1.2. Samples of Field Research.

The sample of field research is mainly college students from the University Town, followed by residents living nearby, and then people who come from other areas by subway and other means of transportation.

4.1.3. Reasons for the generation of vacant space in shopping malls and types of vacant space

From the perspective of the service population, college students in the University Town stayed at home for online classes during the epidemic, which reduced the number of main service populations. Jewelry stores, cosmetics counters, electronic products stores, bars and other places serving college students chose to close the stores.

From the perspective of store location, stores located in more remote areas of shopping malls have to choose to close due to the reduction of traffic.

4.2. Investigation and analysis of regional current situation

4.2.1. Analyze the vacant space at this stage by observing the site.

Because the novel coronavirus pneumonia has weakened, most shops have been reopened, but there are still lots of vacant space in shopping malls.

There are still different types of vacant spaces, but they have a common feature: they are all distributed in remote locations of shopping malls. The types of shops include bars, cosmetics counters, electronic products stores, etc as shown in figure 3, 4, 5.

Figure 3. Overview of Bar.

Figure 4. Overview of Counter.

Figure 5. Overview of electronic stores.

4.2.2. Understanding the shopping mall expected by the masses by asking the masses in the site

The objects of inquiry are adults with thinking abilities. The author interviewed from the perspectives of customers and businesses and got ideas from different perspectives.

The first person interviewed was a mother of two children who lives near the mall and often brings her children to the mall. Due to the impact of the epidemic, the original children's playground in the mall was closed. The children could not go out during the epidemic and stayed at home every day. She hopes to form a public space that can meet children's playful needs, enhance children's awareness of epidemic prevention and play the role of education and publicity, so that children can join the epidemic prevention team together.

The second person interviewed was a salesperson of a remote store in the mall. During the epidemic, there were very few customers, resulting in poor business. The boss finally chose to compromise and closed the store, and made a huge loss. She hopes that the layout of the store can be diversified, combined with some online consumption methods, and has the ability to attract customers.

4.2.3. The problems of vacant space in shopping malls.

There are three main problems within vacant space so that they are still not open. The first is the health problem of public space. In the post epidemic period, the health problem of public space is the main problem to be solved. The vacant stores in Yongjia shopping mall are in direct contact with the outside world without isolation and protection measures. Secondly, vacant spaces are located in remote places of shopping malls and lack the ability to attract customers. Without customer consumption, the store can not drive the economy, which will only lead to an increase in the vacancy rate in remote areas of the shopping center. The third problem is that the advantage of online shopping was not utilized during the epidemic period, and the stores did not operate in a combination of online and offline. If there is no online shopping to drive the economy, the offline passenger flow is difficult for the shopkeeper to bear the store rent, increasing the risk of store closure.

4.3. Concepts and ideas

Shopping online is a popular consumption mode in the epidemic, and live broadcasting is an important way to publicize products online. The design is mainly aimed at the renewal and reconstruction of the vacant store space in the mall: the "online space" required for the packaging of online live broadcasting and takeout products is combined with the offline space, so that the stores in the mall can also alleviate the rent by means of live broadcasting and takeout during the epidemic, so as to successfully overcome the crisis of customs clearance stores. In addition, we must pay attention to hygiene and health in shopping malls, and self-service devices that can place sanitary instruments are at the door of some stores. The authors hope that the design can provide a scheme for the shopping center and optimize the vacant space here.

4.3.1. New store form formed by the combination of online and offline.

The space is mainly divided into two areas. According to the situation of the store, 10-20% of the space is allocated to arrange the "online space" required for online live broadcasting and takeout product packaging, and the remaining 80-90% is used for daily store function layout. In order to attract customers, some on-site activities can be held in the "online space", such as the "transformation of plain people" at the cosmetics counter, which can play a publicity role and increase the number of customers through live broadcasting, according to figure 4.

4.3.2. Establishing activity space connecting indoor and outdoor.

The vacant space of indoor shops near the outdoor in the mall can connect the outdoor space,

Figure 6. Analysis diagram online live broadcasting space.

Figure 7. Analysis diagram of offline space.

achieve the connection between indoor and outdoor space, and increase the ventilation of the space. Some anti epidemic activities were organized in the outdoor space to solve the problem of closing the indoor activity area of the mall, which also attracted customers to a certain extent, as shown in figure 5.

Figure 8. Effect picture:The left is the activity space connecting indoor and outdoor.

5. ADVANCEMENT OF MATERIAL ALSO PROMOTES CONCRETE STRUCTURE'S ABILITY AGAINST SEISMIC ACTIVITIES BY ADOPTING CUTTING-EDGE COMPOSITES

Sarah et al.[9] conducted a scaled experiment of a sprayable ductile concrete infills and concluded potential of this material. Jianwei Zhang et al. examined in their experiment a recycled aggregate concrete (RAC) wall and concluded new RAC material "significantly improved and the concrete damage was reduced"[10]. These research and experiment constitute current efforts on concrete frame structure against seismic activities.

In real practice, methods are adopted as a combined result of economic, construction safety reasons. Given this, overall structures of the building is not overturned; instead, a reinforcement based on original structures while keeping the existing intact is considered.

For girder previously damaged and fractured under loading, fractured concrete should be cleaned until the structures is solid and stable before new concrete is poured. If the internal reinforcement is exposed, anti-corrosion treatment must be carried out before other reinforcement.

Column is the critical structural support in sustaining major gravitational loadings and transferring them into foundation. In many earthquakes, column failure is investigated responsible for the majority of building collapses. Under seismic activities where horizontal movement of the foundation impose shear force to the system, columns are directly influenced. If one column fails to sustain the shear force, a shift of movement will occur, causing redistribution of loads on the remaining columns, and excessive loadings caused by gravity results in more columns to fail, which inevitably will bring the failure of the entire floor, and structures above them will shift and collapse.

Beside numerical improvement of seismic performance, this example also illustrates current trends of concrete structure reinforcement against seismic activities: the reinforcement plan alters the loading structures by mostly adhering the existing structures and specifically strengthening critical area to reach maximum effect. This approach manages to reduce the exerted influence or damage on existing structures to an acceptable minimum, as direct alteration to existing structures during the reinforcement project is reduced.

6. CONCLUSION

In this paper, an offline store Yongjia Shopping Mall in Fujian, China is analyzed. To cope with the receding offline business activities due to prolonged COVID pandemic, this paper proposes a conceptual design scheme aiming to create a more economical and practical shopping space and qualitative feasibility analysis. Though comparing and integrating online spaces into offline shopping area, the scheme adopts stall elements to create space atmosphere, hence achieving the design concept "space-time tunnel". Based on current research and comparison with the original design, the new scheme is expected to optimize the vacant space available while abiding by current pandemic prevention regulations to public facilities, thereby promoting individual economy of mobile cities under post-pandemic circumstances.

However, it should be stressed that the current design is only conceptual and qualitative, no quantitative simulation or on-site experiment is yet conducted to verify if the scheme can be effective in real practice. Filed research of similar design for other shops should be considered in the future. Furthermore, the scheme omits analysis on structure safety that might be influenced and altered during and after renewal operation. Given the fact that researched shopping mall is located in seismic-active region, further investigation of building structure and simulation on seismic-resistance performance after alteration is needed in order to conduct structural inspection that if the alteration scheme could abide by relevant construction code.

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