

Furniture Innovative Design with Earthquake Self-rescue Function: From Furniture Form and Structure Perspective

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Abstract: Firstly, the background of earthquake disasters occurred recently and the necessity of furniture design with earthquake emergency self-rescue function were analyzed. Then the research situation on furniture design with earthquake emergency self-rescue function were summarized, and the rethinking on functional design of furniture, especially design on form and structure, were conducted based on analysis of theoretical basis of furniture design with earthquake emergency self-rescue function. Finally, bedside tables were designed as demonstration, which provides a new approach to furniture design with earthquake emergency self-rescue function.

Keywords: earthquake, emergency self-rescue function, furniture design

1. Introduction

Located in the junction of Circum-Pacific seismic belt and Eurasia seismic zone, China is one of the countries which are suffering mostly from earthquakes. Wenchuan M8.0 earthquake in 2008, Yushu M7.1 earthquake in 2010, Ya'an M7.0 earthquake in 2013 and Kangding M6.3 earthquake in 2014, all the above earthquakes reminds us the urgency to take measures to preventing disasters and reducing damages.

With the increasing urbanization nowadays, it is hard for the modern megalopolis to cope with the occurrence of earthquakes [1]. In recent years, though the fast development in science and technology has achieved, the earthquake is still one of the most dangerous natural disasters to human being. Earthquake disaster is emergent, unpredictable and high-frequency with secondary earthquake disaster, which could cause a tremendous impact to the society. In

order to reduce the damage caused by the earthquake, people have taken some measures on active prevention measures, such as earthquake disaster reduction architectures. However, less concern on indoor furniture has been expressed. Earthquake emergency self-rescue function should be taken into account while designing furniture that used heavily, which can play an important role in saving lives in the critical moment.

2. The importance and research status of furniture design with earthquake emergency self-rescue function

2.1 The importance of furniture design with earthquake emergency self-rescue function

The work of preventing disasters and reducing damages in our country is now mainly focused on improving anti-seismic grade of architectures, which is based on the situation of house collapsing in destructive earthquakes. For one thing, in accordance with the related norms, the new-built ferroconcrete buildings can resist a certain level of earthquake, but the living conditions of majority of crowds in the current China are still need to be improved. Large number of brick-concrete structure houses and brick & timber structure houses exists in various regions, and tile-roofed houses and keekwilee-houses also can be seen in mass rural areas. The load bearing wall, internal-external wall and corner wall will be collapsed and destroyed when earthquake occurred under the non-standard foundation and irregular construction model of these types of buildings [2]. In the earthquake, the mountain and rural areas with economy-backward and inaccessible traffic are affected mostly where usually

damaged severely and it will take a long waiting period for rescuing.

According to the vice director of Japan Kobe Disaster Prevention Science and Technology Museum, self-rescue is 70%, mutual help is 20%, and public assistance is 10% in the escape and rescue behaviors after earthquakes [3]. Self-rescue is the most effective way in the economy-backward mountain areas after earthquake. Therefore, the effectiveness of furniture is available shown at this circumstance. Furniture design aiming at the form and structure make them be earthquake-resistance to protect people temporarily, increase the time of humanity in accordance with the variation of catastrophe time dimension and space dimension, and enhance the efficiency of escape.

For another, according to the statistics of happened earthquakes in our country, the medium-small earthquakes took up more than 80% [4]. The house will not be collapsed by the medium-small earthquakes, but the indoor furniture by which the people would likely get hurt will be toppled down due to the easily cracked materials. When the earthquake occurs, finding a nearby shelter becomes the best choice for most people indoor. At this point, the importance of self-rescue function furniture has come into effect; they not only have an effective protection for people indoor, but also have a certain work on comforting them.

2.2 The research status of furniture design with earthquake emergency self-rescue function

Japan is famous for frequent earthquakes. According to the statistics, in the every five earthquakes, there is one happened around Japan. Hundreds of all kinds of earthquakes occurred every year which form the unique

catastrophe culture in Japan. Earthquake prevention and reaction has become the most important part in Japanese citizen's daily life. Through the comprehensive construction, the disaster prevention and rescue system of Japanese city has become the leading position of the world, and it also becomes the model to the other countries [5]. Japanese government has invested lots of manpower and financial resources into development and research of disaster prevention and reduction products due to the frequent disasters and painful lessons.

Japan has developed a variety of earthquake prevention and disaster resistance products, for instance, indoor emergency multi-functional scaffold, emergency kit, raincoat, gloves and GPS [6]. Anti-seismic desk has also been invented, as well as the pad pasting called splash prevention pad that can be pasted on the glass cabinet door for preventing people get hurt from the splashed glass[3], other products like the furniture fixed chain link type, ribbon type fall prevention products, vibration isolation that prevent furniture from sliding[5]. In recent years, with the development of economy, people have turned their attention to the consideration of environment and safety as well as the awareness on the importance of earthquake prevention and reduction. It is necessary to design furniture with functions of earthquake emergency self-rescue which fit the general people of our country based on the enlightenment from Japanese disaster culture and earthquake prevention and disaster reduction present situation of China. Meanwhile, it is necessary to taking the reference on the achievements that Japan has made and combining with our nation conditions.

At present, there are some design schemes and products about furniture with functions on anti-seismic and disaster rescue. For one thing,

there are very few types of furniture including beds and cabinets. For another, most of the schemes and products were only concerned about the protection to the user, however, some tools and food supply which should be useful in post-quake self-rescue were neglected and it could result in troubles for the victims because of the long-time waiting for the help from relief workers [7]. Thus, it is not only saving the cost, but also improving the design efficiency through redesigning the furniture and adding the emergency self-rescue function into furniture.

3. The theory basis of earthquake emergency self-rescue

3.1 Golden 12S

There is a saying called 12 seconds opportunity for self-rescuing in earthquake psychology, which means after the earthquake, it will be short time for people to find a self-rescue opportunity in 12 seconds. Therefore, it is crucial that finding a shelter within golden 12 seconds, that means furniture would be one of the best choices for being shelters in such a short distance around people.

3.2 The innovative design on form and structure of furniture

The so-called form is the objects that people can see and feel from design science viewpoint. There are four basic elements, point, line, surface and shape, which are consisted of the form of furniture, starting from the basic forms to the changeful forms in furniture design. The structure of furniture is a certain combination and connection among the used materials and components and also a structural system according to a certain using function. The stability and pressure resistance depends on the form of furniture, for instance, the shape of

triangle possesses the character of stability which will not easily be collapsed during the violent shaking. The shape of arc can develop a buffer action when bearing the exerting vertical acting force to reduce the direct harm given by heavy objects to people.

The damage caused by earthquake is commonly within seconds, therefore, the design of furniture structure should cope with people's reaction and their demands during refuge, for example, the easy pull and push door which is convenient for escaping when disaster happens [3]. The steady structure, which plays an important role in the usage, and safe is the fundamental requirement to all furniture, as well as one of the most important ways to make improvement and innovation to the target of earthquake prevention and disaster reduction [8]. No matter the design for furniture form or structure, the combination that with other earthquake defensive products should be concerned, such as the food and medical kit, torch, whistle. The furniture that equipped with the function of earthquake emergency self-rescue can become the effective tool during the earthquake, and how to design the furniture form and structure should be concerned extensively.

4. The design ideas of earthquake emergency self-rescue bedside table

The design principles as shelters that the bedside tables required are analyzed, and in accordance with the analysis of earthquake and the comparison to the furniture that used in the past, as well as the earthquakes usually happened at night. As for the bedside table, it's connected with the bed and positioned around the corner, which the safe triangle area formed. The bedside table should have the function of storage. When earthquake happened, the rolling

door will be opened through pressing the switch on. The design of the bedside table is formed in the shape of arc, structured by the steel frame, as well as the safe frame installed inside which ensuring the safety.

Except the design of beside table itself, the matched design also should be taken into concern. Such as the storage space which can store the supplies for the usual life as well as the disaster. Meanwhile, some clothes or cotton fiber could be stored inside to warm people after the earthquake. The earthquake alarm is installed on the headboard which can wake up the sleepy people to self-rescue in emergency circumstances. The bedside table is connected to the bed, and there could be more bedside tables available to protect more family members.



Fig1. Bedside table beside bed

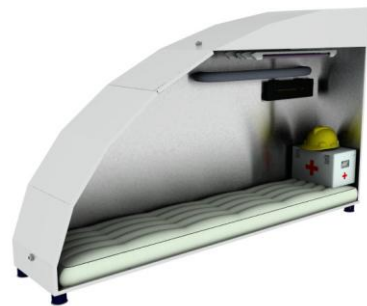


Fig2. Bedside table with earthquake self-rescue function

5. Design analysis of earthquake emergency self-rescue bedside table

5.1 Arc-shaped structure design

This bedside table is designed into arc shape, which is different from the common ones in our daily life, but length is as same as the length of the normal bed. Bedside table designed like this way is mainly concerned about the urgent situation that people will get panic and slow reaction when earthquake happened, especially for those who are in sleep. In this way, people can react quickly to elude inside of bedside table to avoid the panic and save themselves.

Moreover, the arc shape design can have buffer action against the exerting vertical acting force to avoid hurting people by the heavy objects, and the bedside table is located at the corner of the wall, where is more safe than other place when earthquake occurred. This bedside table is not only a place for protecting people themselves, but also a place for rescuing themselves when disaster happened.

5.2 The design of double layer energy-consumption protection frame for earthquake reduction

The design of this bedside table takes a measure of double layer energy-consumption protection frame for earthquake reduction. Energy absorption frame placed in external which can defend most of the impact energy, and the safety frame in internal also called safe house, which plays a part in fundamental protection. The double layer structure can strengthen the bedside table. There is a crash pad installed in the arc-shaped storage box up the bedside table, which can ensure the security of people inside and increase the safety performance of bedside table from buffering the dropped objects. The rolling door is designed as the bedside table door, and the switch is installed inside, the door

will upspring when the switch was turned on. People can escape through the door after the earthquake.

5.3 The design of assorted safe emergency kit

Except the form and structure of bedside table designed, the built-in self-rescue tool was also been taken into concerned and some of them have been taken the advantage of the Japanese earthquake emergency self-rescue products, there are as follows:

Emergency light, power supplied by batteries, lighting and comforting people in earthquake. Safety grab bar, which installed on the side plate of bedside table, prevent people from hurting by shaking. Radio and beeper, which is convenient for people to acquire the information and ask for help under the ruins by using the golden 72 hours rescue time principle. Helmet can defend the head when earthquake happened. People can prepare some first-aid kit, water, concentrated food, whistle, manual type flashlight, medicine, rope and all kinds of escape tools into the bedside table. Cushion, which can be installed on the top and at the bottom into bedside table, plays a part in buffering and comforting to people. Damping spring device, installed at the bottom of bedside table, which can reduce the shaking given by earthquake, and ensure the stability.

6. CONCLUSIONS

The earthquake emergency bedside table can be used in every family of earthquake-prone countries, especially in those located above the seismic zone, it can play an important role in decoration and it also has the functions which cannot be neglected. The appearance design of bedside table has broken the traditional appearance used to be. For one thing, the shape of bedside is full of beauty and enjoyment, as

well as expanding the space of storage, for another, the special structure and form enable it to be functioned in emergency self-rescue when earthquake happened, which can assure the safety and comfort people.

The meaning of anti-seismic and disaster relief furniture is anti-seismic and disaster relief [7], the design of bedside table has made the disaster refuge and disaster rescue come true, which makes a great meaning in ensuring people's life and relieving people's pain, reducing nation's financial loss. It is necessary to take disaster emergency self-rescue function into concern of the furniture design in the future.

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