Application of Green Building Materials in Exhibition Hall Building with Low Carbon Concept

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Abstract — In this paper, for the problem of energy wasting and greenhouse effect caused by global warming, we introduced the concept of low-carbon design to promote the people’s cognition and practice of low-carbon environmental protection, displayed the advantages of exhibition hall built with green building materials of the concept of low-carbon design with entity images of low-carbon and energy saving exhibition hall, established a design model of building exhibition hall by analyzing the data from index selection system of low-carbon building’s technology planning scheme, finally to achieve the goal of providing a more far-reaching and extensive power for the future scientific and reasonable low-carbon exhibition design.

Keywords - Low-Carbon concept; Green building materials; Exhibition hall building

I. INTRODUCTION

With the arrival of the new era, new materials and construction techniques are constantly mature. A large number of green and environmentally display materials provide more ideas and stage for people to practice the sustainable development of the pavilion space, this not only guides the new green ecological aesthetics in the pavilion space, but also increases more power for people to enjoy low-carbon Pavilion space. On the one hand, the development of the industry has provided a very rich source of research materials for the majority of researchers, on the other hand, the research of the design methods, ideas, methods and techniques of the green Pavilion for the vast number of researchers are also presented [1]. Figure 1 a-c shows several green materials in the modern life.

(a) Green building materials (b) Green decoration materials
(c) Green waterproof Material

Figure 1. Several kinds of green materials in modern life

With the development of the convention and exhibition industry, especially the successful hosting of the World Expo. Display design, especially the exhibition design, has a larger and larger developing space, and become more and more potential all over the world. And the low-carbon design, as one of the important research directions and factors, has achieved remarkable progress in both theoretical research and practical application. As the arrival of the era of future generations, the low-carbon design represents the design trend of the most promising green and environmental protection action in a new historical period. Because the world’s energy consumption is growing, the concept of low carbon has caused the universal resonance and consensus of the whole mankind and the whole society, people are beginning to realize the importance, feasibility and necessity of low-carbon economy, low-carbon culture, low-carbon design, and low-carbon production.In this series of the coming of future generations era with low-carbon reform, committing to the organic combination of exhibition design and low-carbon design will become a big development trend of the development of the world’s exhibition industry [2].

II. SIGNIFICANCE AND METHODS OF RESEARCH

A. The Significance of Research

The research value and significance of low-carbon design are the major theoretical changes in the development of human society and economy. Its sustainable development prospects can make all professions and trades, especially the design industry be full of life, and always maintain the industry’s freshness and frontier. Many domestic and
foremost scholars in the field have begun to discuss and explore the problems of the green ecology, environmental technology, recycling, and sustainable development, in order to create a livable environment for life, and realize the harmony of man and nature. This is considered as the core to put forward the “humanitarian nature”, “natural ecology”, “view of humanized nature”, “system view” with the theories and concepts of innovation. The sustainable development of the “low carbon” concept provides an important research direction and learning foundation on the subjects of our study, design concept and instance operation[3]. On the concept of low carbon, green environmental protection and harmony, which carry the new humanistic care and humanistic ideal, it should become the basic quality that every person has and become the most basic values of life. For the designer, it is the foundation of the cultural position and attitude towards life, low-carbon design reflects exactly what they need to have a very important professional quality. Technology, craftwork, skill and materials are not simply a simple tool to use, and the promotion of production technology and material technology will not provide the new technology and new materials used in the exhibition venue to create the use of new technology. If the low-carbon environmental protection idea and technology application is integrated into the life, and become a life style, his research will play a more profound and lasting effect. This is also the historic breakthrough significance of low-carbon design for the research of the era of future generations [4].

B. 2.2 Methods of Research

This article sets out from the subject orientation, theoretical construction, results and other factors, and comprehensives social, economic, cultural and other conditions, to establish the basic understanding of the multimedia display technology through the preliminary research. Besides it contact concrete theory and reality through the case analysis method, so as to summarize and sum up the systematic and theoretical research system in a better way.

III. THE CONCEPT AND SUSTAINABLE DEVELOPMENT OF LOW-CARBON DESIGN

A. The Concept of Low-Carbon Design

The design ideas and technical support of “Zero carbon” museum come from the construction of the world’s first zero carbon dioxide emissions in the world’s first zero carbon dioxide emissions in BEDZED London. “Zero carbon” museum chose to use local products, and realized the Chinese’s first zero carbon building with the climate characteristics of Shanghai where the World Expo was held [5]. The venues are located in the north of the city’s best practice area, and connected by two zero-carbon emission venue from the front and rear, as shown in Figure 2.

Figure 2. Impression drawing of london zero-carbon museum on shanghai world expo in 2010 source: world expo museum

“Zero carbon” achieves the ventilation, refrigeration, heat, dampness, humidity and other conditions in the venue through the recycling use of solar energy, heat energy, wind energy and water, to meet the needs of the habitat. The electric energy consumed by the pavilion is supplied by its own solar panel. South of the pavilion is a large area in the use of transparent glass. Glass-sun room absorbs from sunlight heat and converts it to indoor heat. The north exhibition building provides a natural lighting for the interior by diffuse solar light, and cultivat green vegetation using the solar light on the roof of the building [6]. On the roof, the solar water heater can be placed, so the solar energy can be converted into heat energy, which is used to supply the required energy consumption. In the era of low-carbon economy, low-carbon design is the overall trend of the current development of the industry.

Consumers’ demands for low-carbon civilization draw understanding of the social responsibility and occupation moral of the designer, and make it into a low-carbon awareness in the design work. Chinese design puts the idea of low-carbon culture into the traditional thought, that helps to release the design from high-carbon bonds, and make new interpretation of tradition on the basis of inheriting the fine tradition, to transform the traditional culture resources into cultural capital. That will not only continue the glory of the traditional, but also be an excellent Chinese traditional design, which are pushed to modern world and influence the world, so as to create another “rare sign of optimism”, a “Chinese model” of low carbon design [7].

B. Sustainable Development of Low-Carbon Design

The sustainable development of low-carbon design is a major change in the development of human society theory, and also a historical breakthrough in the study of ecological theory. Around the green ecological environment, sustainable development and other related issues, domestic and foreign experts and scholars have carried on many aspects of the research, and with putting it as a core concept, carried out a series of new theoretical concepts like “natural ecology”, “humanitarian view of nature”, “view of humanized nature”, “system view” and so on. This study provides an important theoretical basis and subject research direction for exhibition design, the sustainable development of low-carbon design, and the research on exhibition design with low-carbon design concept. People pay attention to the low-carbon design and its sustainable development, because the deterioration of ecological environment is more and more serious. The serious pollution of the environment, soil erosion, global warming, dust storms and other abnormal phenomena, have threatened the existence of human beings...
IV. EXHIBITION DESIGN OF LOW-CARBON CONCEPT

A. Significance of Low-Carbon Design in Exhibition Design

The fusion of low-carbon design and exhibition design makes the exhibition Industry oriented and green. This will also become the new era of the development of the industry culture to show the development of the thrust force. Low-carbon concept and design achieve the delivery of the latest information, to display the latest achievements, exchange of new materials, exhibition and other purposes by holding various types of meetings, exhibitions and exchanges at home and abroad, so as to promote benign-circle development of the tourism industry, catering industry, transportation and other related industries. The living space of human beings is essentially divided into two major environments, which are natural environment and artificial environment. The natural beauty of the natural ecological environment like nature itself lets us be free to learn and enjoy with highest quality. And artificial environment is the carrier of elements in the exhibitions. In all ages, these two kinds of different environmental beauty, show harmonious development and complement for each other in the form of forming, this is also the spirit of the green low-carbon concept in the showing of the exhibition activities. However, since the beginning of the industrial revolution, industrial production has blindly expanding investment, which made a sudden deterioration to the harmonious coexistence situation of two kinds of environment in the past. In the process of claiming and consuming resources from the natural ecological environment without thinking about the consequences, a series of consequences such as the industrial harm, the ecological destruction, the excessive exploitation of resources, the population’ rapid growth and so on, make the human need to look at the past, backing to the most basic survival position [10]. Green low-carbon movement has come into being, which is a low-carbon design in the design industry. Under the background of new knowledge culture and culture, One movement committing to changing the ecological environment and create a new concept of postmodernism design has spread in the world wide. The significance and goal of low-carbon design is to solve the the relationship among human, environment and science, it’s an effective measure to ensure the protection of the green environment. In many fields, low-carbon and design are closely related, we should combine the two concepts, and deep understand each concept. Recognizing the seriousness of the ecological crisis or not is one of the important reasons which restrict the design industry, that also will have a great effect on the production and life of the future. Low-carbon, environmental protection ideas can provide a lot of information for our design, including the transformation of the way of communication, design connotation of the rich and diverse materials, etc. these are all new energy for our cultural ideas [11].

B. Development of Low-Carbon Design in Exhibition Design

The problem of low-carbon design in exhibition design is still a form of expression, low-carbon should have a corresponding impact on various levels of the design. Many facts have proved that, in spite of the beauty and low-carbon environment protection is not a natural combination, but the combination of the two must be coordinated. Low-carbon technology to develop to a deeper level is very necessary, this is the effective path to get rid of high energy consumption and waste. But at present, there are some problems such as technology and capital investment limitations, and the most essential is that the low-carbon design cost is still very expensive, this has raised a lot of questions about whether it has the meaning of development. However, some of the low-carbon display technologies have been used in the whole point of view, low-carbon, energy saving and environmental protection material, still can get a good effect in reducing cost and material consumption situation [12], as shown in Fig. (3) a-b.

Figure 3. Exhibition hall design of low-carbon and energy saving concept.

(a) rattan pavilion under low-carbon design

(b) large sports venues of low-carbon design

In fact, many of the techniques used in the design of the exhibition are obvious to us, such as solar energy
technology, geothermal systems, cogeneration systems, biomass energy systems, efficient cooling technology and small-scale wind power technology, etc. However, the integration of these systems, the promotion of the use and maintenance are very complex and sophisticated needs, we need to spend more time and money, this has also been one of the reasons for that the low-carbon exhibition industry cannot be promoted. Through the analysis of the development of low-carbon design in the convention and exhibition industry, we can understand that low-carbon design is not the use of low-carbon materials. Some designers understand the design scheme of the puzzle game, then borrow all around, graft and transplant, but not to consider the conservation of environmental protection and rational use from the essence of the development of the technology. In fact, some energy-saving environmental protection and low-carbon design is not complicated, as long as we make the full investigation, accumulat experience through the practice, and exert the advantages of the designer, we can totally make a contribution to the reform and development of the low carbon from the traditional design mode, this just requires coordination and cooperation among various industries in various fields [13].

V. THE CONCEPT AND TECHNOLOGY ANALYSIS OF GREEN EXHIBITION HALL DESIGN

A. Selection Index System of Low-Carbon Pavilion Scheme.

According to the actual situation of the options, we can initially determine the index selection system of the following low-carbon building's technology planning scheme. It’s divided into two major criteria of low-carbon index and economic index. The two layer rule includes the total energy consumption, total emissions, renewable energy replacement rate, rational use of resources, environmental protection, environmental coordination, initial investment, full life cycle cost and net present value [14], as shown in Figure 4. And the calorific value and carbon emissions of all kinds of energy are shown in Table 1.

![Figure 4. The index selection system of low-carbon building’s technology planning scheme.](image)

<table>
<thead>
<tr>
<th>Energy category</th>
<th>Unit</th>
<th>Calorific value (kcal/unit)</th>
<th>Heating value conversion unit (TJ)</th>
<th>Carbon emission coefficient (T-C/TJ)</th>
<th>Carbon oxidation rate</th>
<th>CO₂ emissions (kg-CO₂/unit)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>Kg</td>
<td>7000</td>
<td>0.0000029302</td>
<td>29.45</td>
<td>0.99</td>
<td>3.16</td>
</tr>
<tr>
<td>Coal gas</td>
<td>m³</td>
<td>7000</td>
<td>0.000002093</td>
<td>13</td>
<td>0.99</td>
<td>0.998</td>
</tr>
<tr>
<td>Crude oil</td>
<td>L</td>
<td>9000</td>
<td>0.000031764</td>
<td>20</td>
<td>0.99</td>
<td>2.735</td>
</tr>
<tr>
<td>Liquefied petroleum</td>
<td>m³</td>
<td>8000</td>
<td>2.78E-05</td>
<td>20</td>
<td>0.99</td>
<td>1.734</td>
</tr>
<tr>
<td>Kerosene</td>
<td>L</td>
<td>8500</td>
<td>0.0000035581</td>
<td>19.6</td>
<td>0.99</td>
<td>2.532</td>
</tr>
<tr>
<td>Diesel engine</td>
<td>L</td>
<td>8000</td>
<td>3.68E-05</td>
<td>20.2</td>
<td>0.99</td>
<td>2.701</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>L</td>
<td>9200</td>
<td>3.85E-05</td>
<td>23.7</td>
<td>0.99</td>
<td>3.31</td>
</tr>
<tr>
<td>Gas</td>
<td>m³</td>
<td>8000</td>
<td>3.73E-05</td>
<td>15.3</td>
<td>0.995</td>
<td>2.04</td>
</tr>
<tr>
<td>Gasoline</td>
<td>L</td>
<td>7800</td>
<td>3.27E-05</td>
<td>18.9</td>
<td>0.99</td>
<td>2.24</td>
</tr>
<tr>
<td>Electric</td>
<td>kWh</td>
<td></td>
<td></td>
<td></td>
<td>0.95</td>
<td></td>
</tr>
</tbody>
</table>

Note: Heat transfer unit: 1 kcal=4.186J
Data in the table from ‘IPCC Guidelines for National Greenhouse Gas Inventors’

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In the actual operation, according to the specific circumstances of the project appropriate increasing or decrease will be made. Total energy consumption (C1) is mainly refers to the energy consumption of the project, including the power consumption of cold water, power consumption of air conditioning, refrigeration, heating gas consumption, living hot water consumption and energy consumption converted into standard coal measure. Total emissions (C2) uses the total energy consumption as the benchmark data, to convert into emissions. Renewable energy replacement rate (C3) refers to the proportion of renewable energy in the energy supply structure. Renewable energy refers to resources that can be continuously regenerated, inexhaustible, and inexhaustible in nature, it’s harmless or a little harmful to the environment, and the resources are widely distributed, they are suitable for local development use, including solar energy, shallow geothermal energy etc. Reasonable utilization of resources (C4) has been using resources in the use of natural resources in the proportion of the amount smoked, including water resources, land resources, mineral resources, etc. Environmental protection (C5) and environmental coordination (C6) stress the harmony and sustainable development of the project and the environment. Initial investment (C7) usually contains the computer room equipment, pipe network cost, room construction costs, distribution costs, gas interface, etc. The life cycle cost (C8) is the sum of the cost of the system's equipment manufacturing to the final scrap, the cost is mainly composed of the initial investment, annual operating expenses, and the economic life of the equipment. Depreciation charge, etc. To the project’s energy plan, the life cycle cost can be written to the following formula:

\[
LCC = P + A(P/A, i, n) - R(F/P, i, n)
\]

\[
= P + A\left(\frac{1-(1+i)^{-n}}{i(1+i)^n} \right) - R(1+i)^{-n}
\]

In the formula, \(LCC\) is the life cycle cost; \(P\) is the initial investment of plan (million); \(A\) is the annual operating cost (million/a); \(N\) is the economic life (a); \(i\) is the discount rate, take 10%; \(R\) is the residual value of scheme(yuan). Net present value (C9) is gained by using the amount of capital inflows that occur during the whole life cycle of the technical scheme to minus the net cash flow from the amount of outflow, and at a certain discount rate, the present value of the investment is reduced to the investment at the beginning, finally, the algebraic sum of the value added of the technical scheme is put into the evaluation of the evaluation method. If the net present value is greater than zero, the scheme is feasible, and the greater the net present value is, the better the scheme is, and the better the investment benefit is. Dynamic investment recovery period (C10) puts the net cash flow of the investment projects in the present value of the benchmark yield, and then calculate the payback period, which is the fundamental difference between the recovery period and static investment period. Dynamic payback period is the year when the net present value is zero [15].

**B. Energy Structure Optimization of Single Scheme**

We suppose that a scheme uses two techniques, assumed to be \(A\) technology and \(B\) technology, which respectively consumt electricity and gas. One of the objectives of the scheme is to minimize the volatility of the price and the price of electricity. The price of electricity and gas are respectively \(p_1\), \(p_2\), \(A\), \(B\), and the power consumption of the technology (especially from the external power consumption) and gas consumption are \(x_1\) and \(x_2\). Then the target can be expressed as the minimum variance of \(x_1p_1 + x_2p_2\), here \(p_1\) and \(p_2\) are considered as random variables. According to the probability theory, we can get the formula:

\[
E(x_1p_1 + x_2p_2) = x_1E(p_1) + x_2E(p_2)
\]

\[
D(x_1p_1 + x_2p_2) = E(x_1p_1 + x_2p_2 - E(x_1p_1 + x_2p_2))^2
\]

\[
= E(p_1)^2 + E(p_2)^2 + 2COV(p_1, p_2)
\]

The mathematical model of the scheme is expressed as:

\[
\text{min} f(x) = D(p_1)x_1^2 + D(p_2)x_2^2 + 2COV(p_1, p_2)x_1x_2
\]

\[
\text{min} f(x) = 0.095x_1 + 0.28x_2
\]

\[
\text{min} f(x) = 0.78Ix_1 + 1.86x_2
\]

In the formula, \(x_1\) is the project from the external access to the amount of electricity, the unit is MWh; \(x_2\) is natural gas consumption for the project, the unit is thousand m³; \(f_1(x)\) is the variance of the scheme cost with the change of the power consumption, the consumption of gas and the price of electricity and gas, this formula shows that the scheme of scientific energy should be the minimum, which is the least of the power consumption, the consumption of gas and electricity, this is the most stable of the scheme. \(f_2(x)\) is the scheme’s cost generated by the direct consumption of energy with the unit of million yuan, while the price unit of electricity is yuan, the gas’s price is 2.8 yuan/m³.

\[
f_3(x) = 0.95x_1 + 0.28x_2
\]

\[
f_4(x) = 0.78Ix_1 + 1.86x_2
\]

VI. CONCLUSION

Low-carbon design and its sustainable development have become a major theme in today’s society. So far the discussion, that low-carbon design has brought new opportunities and new development to the convention and exhibition design, is not enough, but its impact is very prominent. It helps to optimize the design space, reduce design costs, change the design concept, and expand the service population, and make the display design more quickly and more convenient. Low-carbon concept will dominate the future of people’s life concept, and also become an important direction in the construction of social economy.

**REFERENCES**


