A study on green buildings

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Green building is sustainable building, the practice of creating structures that aim to reduce their impact on the environment. Every action taken under this practice, from construction to operation to maintenance, is designed to ensure the efficient use of natural resources such as energy, water and other materials. This paper takes green building as the theme, briefly describes the emergence and meaning of green building, summarizes the general situation of the development of green building, and finally proves the influence of building materials and building systems on green building through two experiments.

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1 Introduction

1.1 Current situation of green buildings

The 1960s saw the emergence of the new concept of "ecological architecture". American and Italian architect Paolo Sprelli first referred to ecology and architecture as "eco-architecture", which is the germ of the concept of green building. In the 1970s, due to the energy crisis, an architectural festival was also put on the agenda. Low energy consumption buildings have emerged in various countries, and the trend of "energy saving buildings" has been formed in various countries. In the 1980s, the energy-saving building system gradually improved and began to be applied. Since then, some European countries began to put forward the concept of "sustainable building", Japan began to put forward "environmental symbiotic building", and North American countries put more emphasis on "green building". Since "green" has become synonymous with environmental protection around the world, most countries in the Americas, Australia and East Asia use "green building" as a general term for ecological, environmentally friendly and sustainable buildings. It was not until 1992, at the United Nations Conference on Environment and Development, that the concept of "green building" was first articulated. (Green building workshop/Comparison of major green building evaluation systems in the world,2020).

Green buildings in the 21st century are different from energy-saving and ecological buildings in the past in terms of environmental protection. It is no longer an imagination, but a philosophy of environmental life. It has completely changed the scale of the earth and shaped the entire architectural culture from the aspects of global warming, ozone layer destruction, tropical rain forest depletion, resource shortage and biodiversity environment.

1.2 Design requirements for green buildings

After decades of practice, green building has gradually formed some important design concepts, principles and methods. In general, green building design is a kind of architectural development concept controlled by ecological ethics and ecological aesthetics. Green building design should follow the following principles in practice.

1.2.1 Principle of harmony

Due to the influence of human behavior, buildings have practical effects of consumption, interference and influence in their space selection, construction process, and the whole life process of use and demolition.

1.2.2 Principle of appropriateness

Any regional planning, urban construction or individual construction projects must be based on analysis and evaluation of specific local conditions.These include regional climate characteristics, geography, local culture and customs, and building mechanism characteristics, which are conducive to the environmental sustainability of energy distribution and environmental sustainability.And the strength and durability of local building materials and the influence of various local restrictions.

The principle of appropriateness refers to the construction site selection, planning and design based on the safety and health of the building in accordance with the ecological system, the efficient use of land, and the cultural characteristics and economic attributes. It is the condition and fundamental principle that must be followed by the construction and use of green buildings.

1.2.3 Sustainability principle

As a new architectural design style, green building design is a new architectural concept which takes sustainable development as its guidance and is different from the traditional architectural concept. Reducing energy consumption should be paid attention to, make full use of various advanced technologies for fine design, and improve the environmental, economic and social benefits of buildings to a great extent.

1.3 Design principles of green buildings

(1) The whole life cycle of buildings should be paid attention to. From building design to building construction, commissioning, building renovation and building demolition, these contents together constitute the whole life cycle of the building. From the perspective of building materials, the development, transportation and processing of building raw materials, as well as the collection, recycling and disposal of construction waste after demolition, should be integrated into the whole life cycle of the building.

Therefore, engineers should pay attention to the whole life cycle of the building, not only consider the environmental factors of construction and use in the process of building design, but also fully control and reduce the impact of construction on the surrounding environment. At the same time, it also includes reducing the negative impacts of building abandonment and demolition on the surrounding environment. e

(2) Make full use of the surrounding natural conditions and maximize the protection of the ecological environment. The architectural design should maximize the use of various natural conditions around the construction site, including geographical conditions, water system and various plants, in order to maintain the cultural nature of the building environment and the integrity of the natural landscape; In addition, in the process of architectural design, the coordination between the climate characteristics and the scale of the building environment and the surrounding environment should be considered, so as to control and reduce the negative impact on the surrounding natural environment and reduce the damage to the surrounding natural ecological environment.

(3) A safe and comfortable living environment should be established. The design of green building should fully consider the needs of users and design a safe and comfortable living environment. It mainly includes improving the environmental quality of indoor environment, controlling and reducing environmental pollution, and comprehensively improving people's working and living standards in the built environment.

(4) Improve the utilization efficiency of natural resources. Firstly, in the design and management of green buildings, the most reasonable construction technology, construction materials and products should be selected as far as possible to fully optimize various resources. Second, efforts

to reduce the consumption of various natural resources, improve the utilization rate of energy and construction raw materials; Finally, various measures should be taken to make the building conform to the development of the surrounding environment in order to extend the service life of the building. (Construction network/Research on key points of green building design, 2021).

1.3.1 Comfort principle

When engineers want to meet the requirements of comfort, energy consumption will often become the contradiction between comfort requirements, resource occupation and energy consumption in building construction, use and maintenance management. The emphasis on the comfort principle in green buildings is not based on sacrificing the comfort of buildings, but on meeting the comfort requirements of human habitation. The performance of heat storage and insulation materials is used to improve the thermal insulation performance of maintenance structures. Solar energy is used for heating in winter and cooling in summer. Sunshade facilities are used to prevent overheating in summer and ultimately improve the comfort of the indoor environment.

1.4 Natural ventilation

In order to achieve the water-saving goal of green buildings, it is necessary to improve the utilization rate of water resources, namely the reuse of waste water and rainwater, improve the water environment system from the original "supply and discharge" mode, increase the necessary storage and treatment facilities, and form a water resources recycling mode of "supply and discharge, storage, treatment and reuse".

Building plans for communities need to consider tap water, sewage, stormwater, and possibly the introduction, delivery, discharge and treatment of direct drinking water, municipal reclaimed water, groundwater and surface water. Rainwater collection, utilization and discharge are closely related to green building planning. For example, the footprint of the roof, green space, roads, etc. in the built-up area and their surface paving materials directly affect stormwater runoff and infiltration. If the aim is to increase stormwater penetration, it is necessary to select pavement materials with good water permeability, such as pavements and plazas, to improve the green matrix and increase its water storage. Green roofs will also store some rainwater and reduce runoff from roof stormwater.

Sewage and rainwater generally rely on gravity to transport water flow, so the design of sewage pipes should be in accordance with the elevation design of the site. Green space can accumulate rainwater, increase rainwater penetration, and intercept rainwater pollutants. Therefore, the terrain of green space in green buildings should be designed to be lower than roads and squares in order to better play the function and comprehensive benefits of green space.

Sewage and stormwater pipes outside the building also need to be aligned with the site road plan to facilitate pipe excavation and future maintenance. Stormwater runoff from roads and parking lots is of poor quality, so appropriate pollution interception measures such as low potential green spaces and ecological retention systems should be considered when collecting stormwater.

1.5 Wind environment

To create a good ventilation and convection environment, the establishment of natural air circulation system is an important embodiment of green design principles. Here, the optimization of natural ventilation design is often neglected. Especially in residential areas, developers tend to pursue higher building density and floor area ratio to obtain higher economic benefits, and the building spacing can only meet the minimum sunshine spacing required by the code.

For buildings with high ventilation requirements, each building should have a certain windward side. The wind shadow behind the building is about three times the height of the building and far greater than the distance from the sun. If the buildings are placed in the same row only considering the sunshine distance, the buildings behind will not have a direct windward side, which is very unfavorable to the ventilation of the buildings behind. However, if engineers only pursue the distance between wind and shadow, it will contradict the principle of protecting land. Engineers should make reasonable choices in the design process.

It is of practical significance to solve the problem of natural ventilation of buildings in cold winter and hot summer areas to reduce the power consumption of air conditioning. The maximum natural ventilation can be achieved through the architectural shape design, orientation, and layout of the building group according to the local wind rose. The height, length and depth of buildings have a great impact on natural ventilation, and the reasonable arrangement of trees can also be used to strengthen the natural ventilation of buildings. A simple rectangular body with its long doors and windows facing the dominant wind direction in summer as much as possible has better ventilation effect. When the building plane is "concave" or "L" shaped, its notch should face the dominant wind direction in summer as much as possible; The plane depth of the building should not be too deep, which is conducive to the formation of ventilation. In general, when the plane depth is not more than 5 times of the clear height of the floor, a better ventilation effect can be obtained; For buildings with unilateral ventilation, the depth should not exceed 2.5 times of the clear height.

A-type buildings are conducive to natural ventilation, the smallest shape coefficient, and easy to meet various energy-saving indicators. In summer, the main rooms are placed on the windward side and the auxiliary rooms are placed on the leeward side. Corridor building depth is large, saving land, but only one side of the room towards the good, not easy to organize indoor ventilation, is not conducive to heat dissipation. The relative arrangement of doors and Windows can make ventilation line short and straight, reduce the detour of airflow and resistance, ensure wind speed. If the internal corridor building has a long corridor, ventilation vents can be set at appropriate parts in the middle or stairwells can be used to form ventilation to improve the ventilation effect.

1.6 Definition of green building

In the world, green building fully embodies the basic concept of "energy saving, resource saving, environmental protection and people-oriented", and has become the mainstream direction of the development of architecture in the world. (Hua Tian, Wenxue Zhao/Talking about green building design, Shanxi architecture, 2010).

2 Assessment tools

The global green building assessment system mainly includes the Green Building Assessment standard GD50378-2014, the United States Green Building Assessment System (LEED), the United Kingdom Green Building Assessment System (BREEAM), the Japan Building Integrated Environmental Performance Assessment System (CASBEE) and the France Green Building Assessment System (HQE). In addition, there are the German Eco-building guide DGNB, the Australian Building Environment Assessment agency NABERS, and the Canadian GB Tool Assessment System.

2.1 Evaluation criteria

These evaluation systems include six main indicators, namely:

1) Outdoor environment;

2) Energy conservation and energy utilization;

3) Water saving and water resources utilization;

4) Saving materials and utilizing material resources;

5) Indoor environment quality;

6) Operation management (residential buildings), comprehensive performance of the whole life cycle (public buildings).

The specific indicators in the main indicators are divided into three categories: control items, general items, and preferences. Green building is rated as necessary project, among which the control project is green building; The preferred scheme is mainly aimed at the projects with high difficulty and high index requirements. For the same object, the corresponding index requirements of control item, general item and preference item can be put forward according to the needs and possibilities. (Four lines of Youjia digital energy efficiency/Analysis of green building scoring and evaluation suggestions, 2022).

2.2 BREEAM（UK）

BREEAM is the world's first green building assessment system, which was developed by the Architectural Institute of the United Kingdom in 1990. This certificate is authoritative in the United Kingdom due to the Building Research Establishment (hence the name, BRE). BREEAM system: It covers the range from the main energy source of the building to the ecological value of the site, including many aspects of social and economic sustainability.

The BREEAM Assessment standard comprehensively assesses the procurement, design, construction and operation of a project to ensure that each stage meets the target performance requirements. The assessment process is carried out by independent and chartered assessors and is assessed and certified according to grades of Qualified, good, very good, excellent.

BREEAM results are scored according to the weight of each part. The scoring results are divided into five levels, namely:

- Pass ≥ 30%.
- Good ≥ 45%.
- Very good ≥ 55%.
- Excellent ≥ 70%.
- Outstanding ≥ 85%.

BREEAM goals： Reduce the impact of buildings on the environment.

BREEAM evaluation object： New and existing buildings.

BREEAM evaluation content：

1) core performance factors.

2) design and Implementation.

3) Management and operation.

BREEAM advocates the standard of "health and comfort" in the living environment, and carries out strict evaluation from ten indicators such as energy, health and livability, innovation, land ecology, materials, management, pollution, traffic, waste treatment and water. Each sub-category will analyze the factors that have the greatest impact on the built environment, including low-carbon design, energy conservation and emission reduction, design durability, resilient cities, climate change factors, ecological values and conservation of species diversity. Under each sub-item, the project will receive a corresponding evaluation score, and the final total score of the project determines the project's rating. (Four lines of Youjia digital energy efficiency/Analysis of green building scoring and evaluation suggestions, 2022).

2.3 LEED (USA)

LEED was developed by the United States Green Building Council (USGBC) in 1996. LEED is a performance standard that emphasizes the "greening" of a building in terms of its overall and integrated performance. LEED rarely sets hard targets, which can complement each other through relevant adjustments, so that users can build green buildings according to the technical and economic conditions of the area. LEED is a voluntary assessment system standard.

Figure 1. LEED certification level.

LEED is the most widely used green building system in the world in part because it can be regionally adapted while still providing a powerful global standard.

2.3.1 LEED certification evaluation elements

Sustainable sites (14 points):

- Sustainable site assessment includes soil and water conservation and surface sedimentation control during construction; Reasonable tenant design and construction guidelines.

Water efficiency in buildings (5 points):

- In the part of building water saving, LEED-CS (New building core and exterior system) divides water saving into three sub items: "reducing landscape water consumption, using advanced science and technology to save water and reducing general daily water". Rainwater recovery technology and reclaimed water reuse technology can be adopted.

Energy & atmosphere (17 points):

- Firstly, the minimum energy consumption standard must be met in the construction process. ASHRAE standard has a clear explanation of the minimum energy consumption in the construction process. LEED also refers to this energy consumption standard to determine whether the energy consumption meets the energy consumption standard required by LEED.

The main technical measures adopted are not to use refrigerants containing Freon; Double layer Low-E glass; Optimize the thermal insulation and shading system; Passive design; Install household metering system; Select energy-saving air conditioner; Install solar, wind and other renewable energy systems.

Materials & Resources (13 points):

- In view of the actual situation of building material waste, the scoring point of material and resource utilization was added in the LEED certification process. This scoring point aims to promote the rational use of resources in the construction process, try to use recyclable materials, and reflect it in the LEED certification process in the form of bonus points. In the material and resource assessment, the following items are mainly referred to: storage and collection of recyclable items, management of construction waste, resource reuse, recycled components, and utilization rate of local materials.

Indoor environmental quality (15 points):

- Indoor ambient air quality monitoring is mainly to monitor the indoor environmental quality of the completed buildings. In this implementation process, the following items are considered: minimum indoor environmental quality requirements, smoking environmental control, fresh air monitoring, strengthening ventilation, construction indoor air environmental quality management, application of low volatile materials, use and control of indoor chemicals, control lability of the system, thermal comfort, natural lighting and field of vision distribution. The technical measures adopted include the installation of fresh air monitoring system; Independent exhaust system shall be adopted in the storage and use area of hazardous gas or chemical products;

Innovation & design process (5 points):

Design innovation refers to the addition of reasonable, groundbreaking design concepts that are of great benefit to energy conservation and environmental protection in the process of building design, which can obtain additional innovation scores. (Four lines of Youjia digital energy efficiency/Analysis of green building scoring and evaluation suggestions, 2022).

2.4 Evaluation standard for green buildings (gb50378-2014) (China)

The evaluation standard for green buildings (GB / t50378-2014) is revised on the basis of the original national standard evaluation standard for green buildings (GB / t50378-2006) and had been implemented as of January 1, 2015. The original evaluation standard for green buildings (GB / t50378-2006) had been abolished at the same time. The evaluation standard for green buildings (gb50378-2006) is a Chinese green building evaluation standard issued by the Ministry of construction and jointly edited by China Academy of Building Sciences and Shanghai Academy of Building Sciences.

In August 2003, nine research institutes, including Tsinghua University and China Academy of Architectural Sciences, jointly launched the Green Olympic Building Evaluation System in mainland China, which is the first official green building evaluation system in China and the first "green standard" tailored for the construction of Beijing Olympic venues. According to the concept of green building and the specific requirements of Olympic building, the specific research content is to formulate the "green" standard of Olympic building and park construction, and to research and develop scientific and operational evaluation methods. (Four lines of Youjia digital energy efficiency/Analysis of green building scoring and evaluation suggestions, 2022).

2.5 Difference between standards

In the following 60 years, the standard has been revised many times, and the thermal performance requirements of building envelope in the code have been continuously improved. In addition, the 2006 code introduced the "carbon dioxide emission rate per square meter of floor area" (DER) index, which takes into account the impact of other thermal factors (such as building air tightness, electrical efficiency, etc.) on energy consumption. The UK's Green Building Assessment system BREEAM and its residential assessment version Eco-House are not mandatory regulations. In 2006, the UK government published Guidelines for Sustainable Housing. The code is similar to the BREEAM assessment system. However, the assessment content is more detailed and comprehensive, and the criteria are more stringent. Government-issued "energy performance certificates" have been in place in the UK since late 2007, and a new plan issued by the UK government requires all new homes to achieve zero carbon dioxide emissions by around 2016.

The development of green building evaluation system in developed countries provides experience for our green building development. The above "Green Olympic building evaluation system" refers to the CASBEE evaluation system in Japan.

3 Life cycle assessment

Life cycle assessment (LCA) is defined as the statistics and analysis of environmental emission indicators generated in the whole life cycle of a product, process or industry. The international general standards ISO14040 environmental management - life cycle assessment - Principles and framework and ISO14044 environmental management - life cycle assessment - Requirements and guidelines define the unified principles, framework and requirements of life cycle assessment.

The calculation results of building life cycle assessment are expressed by seven environmental emission indicators generated per year per unit building area, namely building LCA indicators, which are defined as the sum of environmental emission indicators generated in construction stage (c), operation stage (U) and demolition / recycling (EOL), namely:

- Life cycle assessment index (LCA) = environmental index in construction stage (c) + environmental index in operation stage (U) + environmental index in demolition stage (EOL)

Figure 2.LCA process.

3.1 Core contents of LCA calculation in each stage of construction product life cycle

1) Construction phase (c)

Due to the large difference in the quantities of various building materials, DGNB defines the simplified algorithm in the construction stage, ignores the materials with less use and less impact on the calculation results, and only counts the types of materials constituting the main part of the building:

- Materials for exterior wall structure and construction of each floor (including doors and windows).
- Roof structure and materials for each layer.
- Floor structure and materials for each floor.
- Materials for construction of foundation cushion and each layer of bottom plate.
- Bearing structure foundation.
- Materials for interior wall and each floor (including indoor support column).
- Building cold and heat source equipment and ventilation and air conditioning terminal equipment.

2) Operation phase

DGNB defines the service life of buildings in the operation stage as 50 years. The LCA indicators in the operation stage include building material replacement (U1) and building energy consumption (U2). Building energy consumption (U2) is the most important part of LCA analysis. The calculation of building energy consumption specified by DGNB shall meet the provisions of German standard din18599 (i.e. the calculation method of energy consumption of German energy certificate).

3) Demolition phase (EOL)

The calculation of LCA indicators in the demolition stage requires that the quantities of waste and recycled materials should be matched with the corresponding LCA data to summarize the environmental emission indicators of all building materials and components.

4) Building LCA database

The calculation of the above stages requires the use of a unified building LCA database in line with the local actual situation. At present, there are several building LCA databases that comply with DGNB building life cycle assessment:

- Oekobau, Germany Dat database.
- EU ESUCO database.
- CSUCO database customized by DGNB for China.
- Individual products can use the LCA data in the product EPD evaluation report.

3.2 Energy consumption assessment

Energy consumption refers to the energy consumed in production and life. Per capita energy consumption is an important indicator to measure a country's economic development and people's living standard. The more energy consumed per capita, the larger the GDP, the richer the society. In developed countries, changes in energy consumption intensity are closely related to the process of industrialization. With the economic growth, the energy consumption in the early and middle stages of industrialization showed a slow upward trend. When the economic development enters the post-industrial stage, the economic growth mode changes significantly, and the energy consumption intensity begins to decline.

3.3 Energy system

Many different buildings in the world need to consume hundreds of millions of CNY of energy, such as water, electricity and natural gas, every year to power various equipment systems that ensure the safety, service and quality of human existence. In order to control this part of energy consumption more rationally, it is necessary to deploy different energy systems in the building system.

3.3.1 PV system

The solar power generation system is composed of solar cells, solar controllers and batteries. If engineers want to make the output power of solar power generation system is AC 220 V or 110 V, engineers also need to configure inverter.

3.3.2 Heat Pump system

Heat pump is a kind of special equipment that transfers heat from low temperature end to high temperature end, which is a new energy saving device. It is composed of evaporator, air compressor, condenser and other parts, using a small amount of working energy, in the way of absorption and compression, to gather the low temperature and scattered heat in a specific environment, making it a useful heat energy. Although a certain amount of energy is consumed in this process, the new heat energy obtained is half or twice as much as that consumed. In 1824, French engineer Carnot put forward the famous Carnot cycle principle,which laid the theoretical foundation of heat pump. It was only after the world energy crisis in the 1970s that heat pumps developed. At present, heat pump is mainly used for indoor heating and air conditioning system of families, hotels and shops. In industry, it is mainly used for drying wood, food and paper. In agriculture and animal husbandry, it is used for drying grain, cotton, wool and tea. In addition to heating, the heat pump can also be used for cooling, air conditioning, food freezing and ice making in summer. Germany also produces a large number of absorption type small heat pumps, which can save 30% - 45% of energy than ordinary boilers for heating. It is very suitable for household use and is called "mass heat pump".

3.3.3 Geothermal system

Geothermal energy is the natural heat extracted from the earth's crust. This energy comes from the lava inside the earth and exists in the form of heat. It is the energy that causes volcanic eruptions and earthquakes.

The temperature inside the earth can be as high as 7000 ℃, while at depths of 80 to 100 km miles, the temperature will drop to 650-1200 ℃. Through the flow of groundwater and the flow of lava to the earth's crust 1 to 5 kilometers above the ground, heat can be transferred to a place closer to the ground. Hot lava heats nearby groundwater, which eventually seeps out of the ground. The simplest and most cost-effective way to use geothermal energy is to directly use these heat sources and extract their energy.

3.4 Analysis of building energy consumption

In terms of energy structure, building energy consumption mainly includes electricity, coal, fuel oil, gas, etc. For the analysis of building energy consumption, starting from the overall building energy consumption, the composition of various energy consumption is counted by means of measurement or collection, and the proportion of various energy in the total energy consumption is determined to analyze the rationality of energy structure distribution. In addition, an important way to determine whether the building energy consumption is reasonable is to make a horizontal comparison with the energy consumption of similar buildings. On the basis of the overall comparison of differences, engineers can gradually understand the energy consumption of various energy consuming equipment through the analysis of the micro level, so as to find out the problem. (Baidu Wenku/Building energy consumption analysis and evaluation method, 2022).

4 Green materials in buildings

4.1 Green building materials

Green building materials refer to non-toxic, non-polluting and non-radioactive building materials produced using clean production technologies, with no or less natural resources and energy, as well as large amounts of industrial, agricultural or municipal solid waste. After reaching the end of its service life, it can be recycled, which is beneficial to environmental protection and human health.

The definition of green building materials focuses on the four links of raw material adoption, product manufacturing, use and waste disposal, to achieve the two goals of minimizing the earth's environmental load and benefiting human health, so as to achieve the four goals of "health, environmental protection, safety and quality".

4.2 Characteristics of green building materials

- The raw materials used in the production of green building materials are waste less, the main raw materials use the least disposable resources, and will not cause damage to the environment or ecology in the process of raw materials collection.

- The waste water, waste residue and waste gas produced in the production of green building materials meet the requirements of environmental protection. At the same time, the energy consumption during production and processing is as little as possible. The production of high-energy materials does not meet the requirements of green buildings.

- Green building materials have complete functions in the process of use (such as heat insulation, sound insulation, service life, etc.), and have the characteristics of health, hygiene, safety, no harmful gas, no harmful radioactivity, etc.

- Green building materials discarded at the end of their service life will not cause secondary pollution, and can also be reused.

4.3 Types of green building materials

"Green building materials" mainly include fiber reinforced gypsum board, ceramics, glass, pipes, composite flooring, carpet, paint, wallpaper, etc.

Wall material has the functions of bearing, isolation, sun shading, rain prevention, wind resistance, heat insulation, sound insulation, sound absorption, light insulation and so on. Green wall decoration includes straw wallpaper, hemp wallpaper, thick yarn wall cloth and other products. Green pipeline includes plastic - metal composite pipe, biological latex paint, green carpet, green lighting system, LED energy-saving lamp, diatom mud and so on.

Building insulation systems and materials have good fire insulation performance, as well as sintered hollow products, aerated concrete products, multifunctional composite integrated wall materials, integrated roof, low radiation coated glass, broken bridge insulation doors and Windows, shading system, high performance concrete and other green building materials, high strength steel, etc.

Non-clay bricks, blocks and building panels made of silicic materials such as concrete, cement and sand are also green building materials, as are some industrial waste such as fly ash, coal gangue and slag, or construction waste after pressing, sintering and autoclaving.

4.4 Production process of green building materials

- High-performance traditional building materials produced at the cost of relatively low resource and energy consumption and environmental pollution, such as high-quality cement produced by modern advanced processes and technologies.

- it has high efficiency and excellent material properties, can reduce the consumption of materials, such as high performance cement concrete and lightweight high strength concrete.

- Building materials with the function of improving indoor ecological environment and health care, such as multifunctional glass, ceramics and coatings used for antibacterial, deodorant, temperature and humidity regulation and shielding harmful rays.

- Construction materials that can use large amounts of industrial wastes, such as cement materials for purifying sewage and curing toxic and harmful industrial wastes, or cement components such as slag, fly ash, silica fume and zeolite that have been recycled and treated with high performance.

4.5 Application of wall building materials

In the aspect of wall environmental protection materials, the most commonly used materials are fly ash, slag ash and hollow concrete. Among them, fly ash is mainly coal cinder discharged by some enterprises, which can be used after simple treatment and processing, which can reduce environmental pollution to a certain extent. Slag ash is mainly used to make building bricks from the waste produced in the process of steel processing. This kind of building material is not only energy saving and environmental protection, but also high quality and low price, which is expected to create big economic benefits.

The final hollow block concrete is also a green material. It is mainly made of waste materials such as fly ash, stone powder and cement. This green material has certain advantages in the extraction and is widely used in the construction of China. Price favorable, sound insulation effect is strong.

4.6 Application of concrete building materials

With the application of green building materials, the shortage of concrete building materials has been reasonably solved. Cement is mixed with green concrete for a more scientific and environmentally friendly processing material. Therefore, the research and development of this type of high performance concrete should be strengthened. With the help of this modern technology, it can not only reduce the cracking of the material, but also show the durability of the material. In addition, adding industrial waste can also reduce the use of clinker cement, taking advantage of this positive advantage, so that it can more effectively play the characteristics of concrete, thereby reducing environmental pollution.

At the same time, commercial concrete should be actively promoted. Due to the waste of too much manpower and material resources in the past construction process, ordinary concrete is still unable to actively supervise the production of quality problems. Therefore, commercial concrete should be continuously promoted to reduce the impact on the environment and air. However, the current price problem still hinders the good promotion of commercial concrete. Therefore, it is necessary to constantly innovate technology to reduce costs.

4.7 Application of green roof materials

In the process of building a roof, it is also very important to choose the right material.More green building materials have been successfully developed and promoted and the green environmental protection of roofing materials has been highly valued by people. As the roof material, the engineer should first ensure that it has a strong thermal insulation effect, can automatically adjust the indoor temperature, and ensure people's daily life.

In addition, green roofs should effectively absorb harmful gases, maintain soil and water conservation, and play their role in storing rainwater. Based on these effects, it can prolong the service life of buildings and effectively improve the urban environment. Of course, the development of this technology also requires it to actively adopt some waterproof technology.

4.8 Application of green waterproof coating

With the promotion and research and development of green materials, they occupy certain advantages in 2022 market. With the help of science and technology, the environmental protection standards have been comprehensively improved and have been widely used in the market. Green paint is also a waterproof material. Its waterproof type is mainly solvent-based, but the material contains certain harmful substances such as xylene, soluble heavy metals and free formaldehyde. These substances will not only pollute the environment to a certain extent, but also threaten people's lives.

There are also some low-toxic product materials on the market, which have certain advantages in the waterproof coating market. At present, most of the waterproof coatings adopt the hot-melt method, but this kind of coating does not have environmental protection properties. Therefore, with the continuous progress of science and technology and the continuous development of society, the development of building materials that are both environmentally friendly and waterproof can make this project move towards a sustainable development direction. (China report hall/Future trend of environmental protection market: in 2022, the environmental protection market will accelerate its release, 2022).

5 Analysis on recycling of waste building materials

At present, the whole world is advocating the idea of low-carbon economy. In the construction industry, the effective recycling of waste building materials from the demolition of old buildings can effectively promote the country's protection of the ecological environment and avoid waste of resources and energy. It can make corresponding contributions to the response to global warming, the realization of energy conservation, emission reduction and consumption reduction around the world. This paper expounds the significance of the recycling of waste building materials, and puts forward measures and suggestions for the recycling of waste building materials according to the current situation of recycling and utilization of waste building materials in the world. Actively respond to the concept of low-carbon economy, and promote the rapid development of the world's waste building materials recycling industry.

5.1 Significance of recycling waste building materials

The recycling of waste building materials has a profound impact on people's production and life. With the progress and development of society, people have produced and consumed a large number of building products. People's continuous absorption of resources leads to a large consumption of resources and energy, resulting in a gradual decline in the comprehensive utilization rate of resources. The building materials industry has become an important pillar industry for the development of the world economy. It has made significant contributions to improving the quality of life of the people, expanding industrial and agricultural production, developing national defense, and promoting the progress of social civilization. However, the production of building materials does not happen overnight. It needs a process. From the extraction of raw materials to preparation and processing, it will consume a lot of energy, discharge a lot of waste, and cause environmental pollution. For example, in the production process of building materials, some coal resources and natural gas will be consumed, and a large amount of carbon dioxide gas will be emitted during the processing of building materials, causing certain environmental pollution, which is not conducive to the development of global warming and low-carbon economy. According to the survey and analysis, China's cement output has reached 2.5 billion tons per year, and it is showing an upward trend year by year. In addition to the production of cement, construction materials such as architectural glass, asphalt, wood, masonry, and rebar need to be produced to meet the growing construction industry and provide raw materials for the construction industry. It is conceivable that the production process of building materials will have a huge impact on China's ecological environment. The production of building materials will directly cause environmental pollution, waste and depletion of resources and energy. If the construction waste generated after the demolition of old buildings is not recycled, these waste resources will be discharged into nature, and some toxic and harmful gases will be discharged into the air, which will change the environment and cause harm. Therefore, it is necessary to effectively recycle the waste building materials from the demolition of old buildings, in order to reduce the large amount of energy and resources consumed by the building materials industry in the process of collection, extraction, production and transportation, reduce the cost in the production process of new building materials, and reduce construction costs. The discharge of garbage into nature promotes the construction of a resource-saving and environment-friendly society, avoids waste of resources, actively responds to the slogans of energy conservation, emission reduction, and consumption reduction, and realizes low-carbon economic development.

5.2 Recycling of waste steel

Among building materials, the utilization rate of steel is very high. The scrap steel has good bearing capacity, and the recycling and utilization have achieved good energy saving and emission reduction effects. The recycled waste building materials can be used as raw materials for steel production, reducing the use of ore resources and improving the utilization rate of steel resources. In the steel recycling process, the steel recycling mechanism can be established and improved through the standardization of modern technology. Strengthen the training of employees in the steel recycling industry, and strengthen the publicity of the recycling of steel materials, so that people realize the necessity of steel recycling, thereby promoting the development of the recycling industry. The government can invest in the steel recycling industry through different channels, increase support for the steel industry, and recycle and process waste steel to form a certain steel industry chain, realize the effective allocation of resources, and ensure the recycling of steel. Establish and improve the supervision mechanism for scrap steel recycling, set up scrap steel recycling stations near the construction site, and conduct certain tests on scrap steel recycling to ensure that scrap steel that can be recycled can be recycled smoothly, using qualified products, and unqualified products will not be approved.

5.3 Recycling of waste wood

The construction industry often uses a lot of wood. A large amount of wood is used every year, resulting in a global shortage of wood resources. Therefore, in the recycling and utilization of waste wood, it is necessary to improve the utilization rate of wood, alleviate the shortage of wood resources, and continuously realize the sustainable development of resources. There is no certain institutionalization and scale of wood recycling, the wood recycling rate is not high, there is no fixed wood recycling site, and there are defects in wood recycling management. In order to manage the recycling of wood, government departments need to establish and improve the recycling mechanism, strictly control the management of waste wood, organically unify the collection, screening and classification of wood, and form an industrial chain of wood recycling. After the waste wood is processed, it can be made into wood-based panels for building materials.

5.4 Recycling of waste glass

When buildings are demolished, large amounts of waste glass are produced. Through relevant analysis, a large amount of waste glass will be produced every year in the world. In the process of waste glass recycling, different types of waste glass can be recycled through garbage sorting and recycling, and then processed into various murals or billboards. The waste glass is heated at high temperature through processing to make glass cloth. Glass can also be rolled into marble slabs with mechanical equipment. Waste glass has many uses and can be reused as building materials.

5.5 Recycling of waste concrete

Concrete is a very common type of waste building materials and is an indispensable material in construction. Depending on the useful life of the concrete, the waste concrete can be recycled, then the concrete is rolled and then modified according to the exterior dimensions to support a material with a concrete component that can be mixed with cement and then used for building or road paving.

The recycling method of waste concrete is to crush the waste concrete and replace the aggregate of fresh concrete with traditional mineral materials.

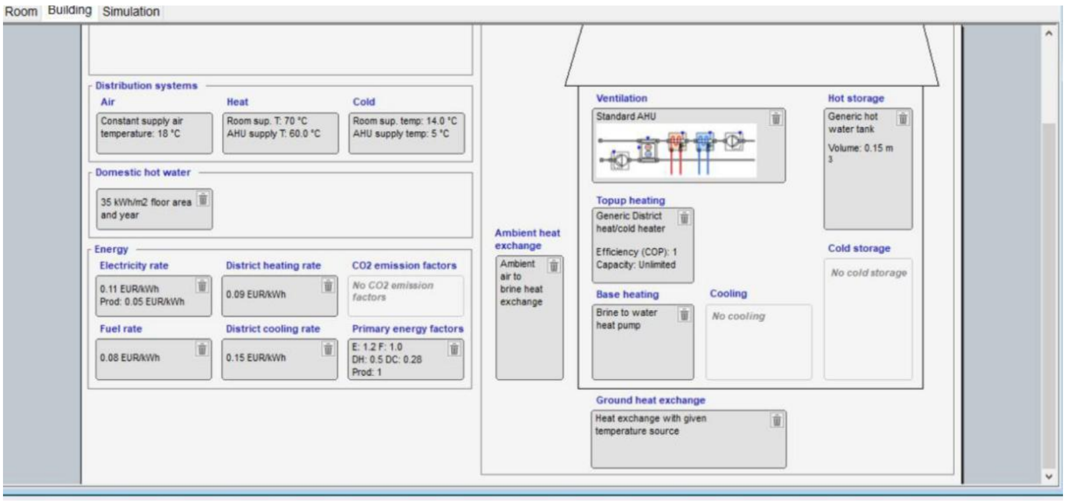
The most common recycling method of waste concrete is to crush, screen, classify and mix waste concrete blocks according to a certain proportion, as the aggregate of fresh concrete, which is called recycled aggregate, and the concrete prepared with recycled aggregate is called recycled concrete. Referred to as recycled concrete. Depending on the combination of aggregates, recycled concrete can be divided into the following types: All aggregates are recycled aggregates; Coarse aggregates are recycled aggregates, fine aggregates are natural sand; Coarse aggregates are natural gravel or pebbles, fine aggregates Regenerated aggregate; regenerated aggregate replaces part of coarse aggregate or fine aggregate. Recycled concrete technology can not only solve the environmental pollution caused by waste concrete, but also save mine resources and reduce engineering costs to a certain extent. Since the properties of waste concrete are different from natural aggregates, it is necessary to conduct special research on the mix ratio design of recycled concrete according to the characteristics of waste concrete. Recycled concrete technology has significant social, economic and environmental benefits and meets the requirements of sustainable development. It is one of the main ways to develop green concrete. (Baidu Wenku/Recycling and performance analysis of waste concrete,2022).

6 Case study

This experiment is mainly a comparative experiment conducted by ESBO software. First, we assume the use system of buildings. The first building uses heat pump + geothermal system, and the second building uses PV panels. After the deployment of other systems is consistent, zero energy consumption can be calculated, and the cost recovery time can be obtained. After comparison, the results can be obtained.

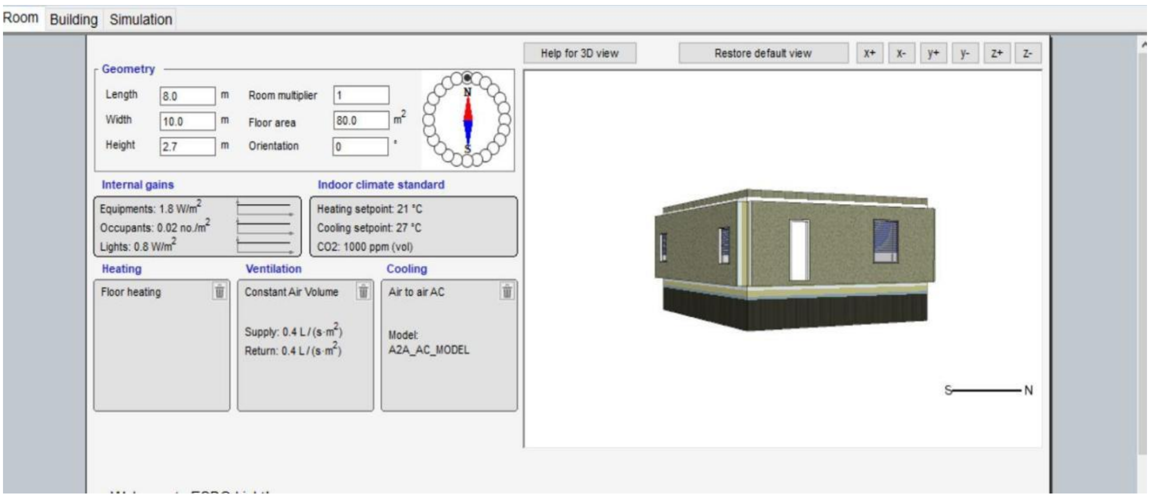
6.1 Energy Consumption (ESBO)

Figure 3. The equipment of building module in ESBO.



The equipment used in this figure is the combination of heat pump and geothermal energy. The working principle of heat pump and geothermal energy is divided into two types. The first is that in winter, cold water will enter the ground for the first cycle. When it reaches the bottom of the pipeline, it will absorb heat, and then it will enter the heat pump along the pipeline for heat conduction and use, and finally, recycling . The second is in summer. First, heat transfer and heat absorption are carried out in the heat pump, and then the first cycle is carried out when the heat just enters the pipe. The heat will be discharged, and the heat will be recovered. These are two different seasons. There are many more values in this picture. The first one is the constant temperature air supply temperature. I set it at 18 ℃, because it will make people feel the most comfortable temperature. The second is that the room temperature of the thermal system can be regulated at 70 ℃ and AHU at 60 ℃. Finally, the room temperature of the cooling system is regulated at 14 ℃ and AHU at 5 ℃. The domestic water consumption is 35kwh / m2 per year. Next is the energy module, which is adjusted according to Finnish standards. A heat exchanger is placed in the middle.

Figure 4. The design of room module in ESBO.



6.1.1 Result

From the following figure, we can see that the buildings using HP + geothermal system will take 15 years from negative to positive at the beginning.

HP+Geothermal system

Figure 5. HP+Geothermal system pay back time.

Cash flow				
Year				
n	CF	NPV 1%	IRR over	ROI
1	-80500			
2	6439	-74124.75	-92%	8.00%
3	6439	-67812.63	-67%	16.00%
4	6439	-61563.00	-48%	24.00%
5	6439	-55375.24	-34%	32.00%
6	6439	-49248.76	-24%	39.99%
7	6439	-43182.93	-18%	47.99%
8	6439	-37177.16	-13%	55.99%
9	6439	-31230.85	-9%	63.99%
10	6439	-25343.41	-6%	71.99%
11	6439	-19514.27	-4%	79.99%
12	6439	-13742.84	-2%	87.99%
13	6439	-8028.56	-1%	95.99%
14	6439	-2370.85	1%	103.98%
15	6439	3230.84	2%	111.98%
16	6439	8777.07	2%	119.98%
17	6439	14268.39	3%	127.98%
18	6439	19705.34	4%	135.98%
19	6439	25088.45	4%	143.98%
20	6439	30418.27	5%	151.98%
21	6439	35695.32	5%	159.98%
22	6439	40920.11	5%	167.97%
23	6439	46093.18	6%	175.97%
24	6439	51215.03	6%	183.97%
25	6439	56286.17	6%	191.97%

From the following figure, we can see that the buildings using PV panel will take 12 years from negative to positive at the beginning.
PV system

Figure 6. PV system pay back time.

Cash flow		PV		
Year				
n	CF	NPV 1%	IRR over	ROI
0	-16300			
1	1553	-14762.38	-90%	9.53%
2	1553	-13239.98	-64%	19.06%
3	1553	-11732.65	-44%	28.58%
4	1553	-10240.25	-30%	38.11%
5	1553	-8762.62	-21%	47.64%
6	1553	-7299.63	-14%	57.17%
7	1553	-5851.11	-9%	66.69%
8	1553	-4416.94	-6%	76.22%
9	1553	-2996.97	-3%	85.75%
10	1553	-1591.06	-1%	95.28%
11	1553	-199.07	1%	104.80%
12	1553	1179.14	2%	114.33%
13	1553	2543.70	3%	123.86%
14	1553	3894.75	4%	133.39%
15	1553	5232.43	5%	142.91%
16	1553	6556.86	5%	152.44%
17	1553	7868.18	6%	161.97%
18	1553	9166.51	6%	171.50%
19	1553	10451.99	7%	181.02%
20	1553	11724.74	7%	190.55%
21	1553	12984.89	7%	200.08%
22	1553	14232.57	8%	209.61%
23	1553	15467.89	8%	219.13%

Through comparison, engineer can know that the buildings using PV panel have a relatively short cost recovery time, so engineer conclude that PV panel is a suitable system.

6.2 LCA

The influencing factors of building construction carbon emission mainly include two aspects: the carbon emission factors in the transportation process and the carbon emission factors in the construction site.

1) Factors of carbon emission during transportation

During construction, the transportation of building materials and equipment will cause carbon dioxide emission, which is generally related to transportation mode, transportation distance, transportation efficiency, driver operation level, etc.

Generally, there are four transportation modes of building materials: highway, railway, sea transportation and air transportation. The carbon emissions caused by sea transportation and railway transportation are less. Sea transportation and railway transportation are more effective ways to reduce emissions. According to statistics, highway transportation accounts for 80%-90%, and railway transportation, sea transportation and air transportation account for 10-20% in total. Therefore, railway or sea transportation should be used as far as possible in long-distance transportation to reduce emissions.

2) Average transportation distance

Material suppliers should be selected nearby for project construction. Shortening the transportation distance can greatly reduce the carbon emissions during transportation.

3) Transport efficiency

The transportation efficiency of vehicles is not only linked to the cost and progress of the construction enterprise, but also related to the consumption of gasoline and transportation carbon emissions. High transportation efficiency can not only enable building materials and equipment to enter the site on time, but also save unnecessary waste and unnecessary carbon emissions.

4) Operating level

According to the survey, the fuel consumption of vehicles driven by drivers with different operating levels varies by 7% -25%, resulting in a large difference in transportation carbon emissions.

5) Factors affecting carbon emission at construction site

The main source of construction carbon emission is the carbon dioxide emission at the construction site. The carbon emission at the construction site is mainly caused by the carbon emission during the construction process, the carbon emission caused by the office work of the management personnel and the life of the workers.

6) Selection of construction machinery

At the construction site, the carbon emission of construction equipment accounts for more than 90% of the total emission of the construction site, and the construction life and lighting only account for about 10%. The energy-efficient construction equipment is more than the general equipment. The work efficiency is about 5% higher, and the carbon emission is about 25% lower than that of general equipment. The use of energy-saving machinery and equipment is more important. For example, frequency conversion energy-saving elevators reduce the emission by 20% compared with ordinary elevators.

7) Construction living and office lighting

Figure 7. Carbon emission saved in 2017. (IHS Markit. 2017.)

Carbon Emissions Saved in 2017

Company Name	CO2e (Mt)	Share of LED Lighting Total Saving	Coal Plants	Share of World's Entire Footprint (CO2e)
Nichia	56	10%	16	0.15%
Cree	48	8%	14	0.13%
Lumileds	39	7%	11	0.11%
Seoul Semiconductor	33	6%	9	0.09%
MLS	28	5%	8	0.07%
Samsung Electronics	23	4%	7	0.06%
LG Innotek	22	4%	6	0.06%
Osram Opto	19	3%	5	0.05%
Everlight	15	3%	4	0.04%
Nationstar	13	2%	4	0.04%
Other	273	48%	78	0.7%
Total	**570**	**100%**	**163**	**1.5%**

Source: IHS Markit

According to statistics, under the same conditions, the carbon emission caused by the use of LED lamps is only 20% of that of incandescent lamps, accounting for only 30% of that caused by the use of fluorescent lamps, which shows that there is a huge potential for emission reduction of construction, living and office lighting. In addition, the strength and time of Rooms shall be effectively treated, and different lighting levels can be divided according to needs.

8) Construction management

Different construction schemes mean different selection and allocation of construction machinery and equipment, and different construction technologies and methods in the same construction process, so the carbon emissions from building construction must be very different. Different levels of construction governance, different levels of on-site aging, and different levels of construction governance

The project with higher management level has reasonable and compact process arrangement, less idling, less opportunity to occupy mobile time, and less repetition and redundant process. Therefore, the carbon emission from construction is also reasonably manipulated.

9) Thermal insulation performance of temporary rooms

At the construction site, attention should be paid to maintaining the thermal insulation and heat preservation performance of the temporary rooms used for buildings, living and office. Good thermal insulation materials should be used. Good thermal insulation and heat preservation performance will reduce the use of air conditioning and heating equipment, so as to reduce the energy consumption outside the construction10% energy consumption, thereby reducing carbon dioxide emissions.

10) Waste carbon emission

The disposal of construction waste will also produce carbon dioxide emissions. The transportation of waste will also produce carbon dioxide emissions. Incineration or landfill will also produce carbon dioxide emissions. Therefore, it is necessary to reduce waste and improve the reuse and recycling of waste.

11) Energy efficiency

Energy use efficiency is related to energy quality and workers' operating skills. Generally, energy can not achieve the use effect under the ideal condition, and there will always be some losses. For example, due to mechanical wear and tear, it will take more energy to start mechanical equipment than under the ideal condition

12) Wear degree of construction machinery

The construction machinery will be worn out and the efficiency will be reduced in the process of production and use. If the equipment is not repaired, updated and upgraded in time, it may seriously affect the production and use efficiency. Equipment wear is divided into type wear and intangible wear. Shaped wear refers to wear, deformation and damage caused by equipment entities. This reduces the productivity of the equipment, causes frequent failures, repeated startup, and increases the fuel consumption or power consumption. Therefore, it also increases the carbon dioxide emission.

13) Low carbon technology measures for building construction

In order to reduce environmental pollution and effectively reduce energy consumption, it is necessary to continuously improve the traditional building construction technology in the construction process, so as to achieve the goal of reducing carbon emissions and realizing low-carbon buildings. Low carbon construction should not only stay in the concept, but should become the consensus of the society. The construction industry has been in a period of rapid development, which requires the support of energy supply. High building energy consumption will directly affect the healthy progress of the construction industry and the national economy. In the current situation of energy shortage and severe environmental pollution, it is necessary to pay enough attention to building construction technology, and constantly promote the promotion and popularization of building energy-saving technology in order to achieve good energy-saving effect, environmental effect and social effect

14) Construction scheme optimization

The formulation of the construction scheme is critical. In the bidding process, an advanced and reasonable construction scheme is a key stage for the construction enterprise to show its technical ability, governance ability and comprehensive strength to the bidding unit. A good construction scheme is easier to win the bid. In the construction stage, it is advanced A reasonable construction scheme is also an important foundation for shortening the construction period, reducing costs, ensuring quality, and energy conservation and emission reduction.

15) Strengthen mechanical equipment management

During construction, strictly control the mobilization of equipment to prevent obsolete mechanical equipment with backward technical performance, low efficiency and high energy consumption from entering the construction site; Respect the construction site environment, carry out construction in combination with the climate, and save resources and energy Implement scientific management, reasonably allocate and use

Transform and eliminate high energy consuming equipment with various mechanical equipment in the production line, implement the planned maintenance and repair system of mechanical equipment, ensure the good technical status of mechanical equipment, prevent high energy consumption caused by defective operation of mechanical equipment, and reduce carbon dioxide emission. Reasonably match the equipment to realize economic operation. Electric equipment with appropriate rated power shall be selected to avoid waste and motor damage caused by improper power; Select the appropriate transformer capacity. If the transformer capacity is too large or too small, the cost will increase and the transformer load will be large and burned out; Strictly control the mechanical equipment and lighting equipment on the site, so that they can be used and opened immediately to prevent no-load operation.

16) Use local materials

During the transportation phase of materials, a large amount of carbon dioxide will be generated. Transportation carbon emission has a great relationship with transportation distance, transportation mode and other factors. Excessive use of foreign main materials not only increases the cost, but also increases the transportation carbon emission. Therefore, unless otherwise required by the owner, using local building materials will save energy and reduce emissions.

17) Implement assembly construction

Assembly construction is to carry out assembly operation on the construction site after standardized production of building commodities and accessories. Assembly construction can reduce complicated on-site processing, reduce costs and reduce construction carbon emissions. Therefore, the assembly construction method can combine various production factors, reduce intermediate links and optimize resource allocation.

18) Improve energy efficiency

The two major goals of construction energy conservation are to minimize energy consumption and maximize benefits. Therefore, new energy utilization technologies should be continuously developed and promoted in the process of building construction. At present, renewable resources have become a new development direction. In order to reduce building energy consumption and pollution, it is necessary to continuously promote the overall system concept of energy-saving buildings, comprehensively consider the transmission and distribution pipes, heat sources and building systems, improve building maintenance by selecting available renewable energy sources, reduce heat loss of transmission and distribution pipes, and improve energy utilization by making full use of natural resources, In the selection of construction machinery, we should focus on the construction machinery with matching power and load, so as to effectively avoid the overload operation of low-power mechanical equipment or low-load operation of high-power mechanical equipment. In addition, the construction scheme can be optimized to avoid the unmanned operation of mechanical equipment by improving the utilization rate of mechanical equipment.

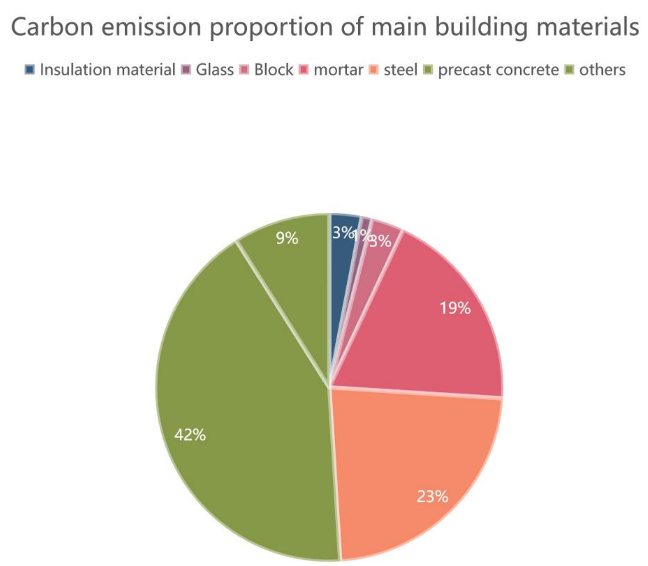
19) Utilization of low carbon environmental protection materials

Low carbon building materials are characterized by low energy consumption, low emissions and low pollution. It is best to recycle them. In building construction, low-carbon building materials can be adopted to increase the strength of the wall to prolong the service life of the external wall. In addition, it can achieve a good waterproof and thermal insulation effect. However, due to the impact of the economy, there is a severe lack of relevant standards in the selection of materials in the construction process, which makes the waste of construction materials serious. In order to effectively reduce the construction waste brought to the construction site by the use of excessive building materials, it is necessary to increase the promotion and utilization of energy-saving technology in the construction process. Advanced building energy-saving technologies such as natural ventilation and lighting systems, heat preservation and energy conservation systems, independent temperature and humidity control systems, and waste classification and recycling systems can be widely used in building construction to achieve the goal of low carbon or even zero carbon in building construction, so as to build a high standard low-carbon building.

To sum up, it is of great significance to apply the concept of low-carbon energy conservation to building construction. We should fully realize the importance of low-carbon environmental protection in construction, adopt low-carbon new technologies, new processes, new construction methods and new materials in engineering practice, realize the sustainable progress of construction projects, and make unremitting efforts to realize energy conservation, intelligence and low-carbon of buildings! (China carbon emissions trading network/Evaluation system of green buildings around the world, 2017).

6.2.1 Result of LCA

Figure 8. Carbon emission proportion of main building materials. (One Click LCA)

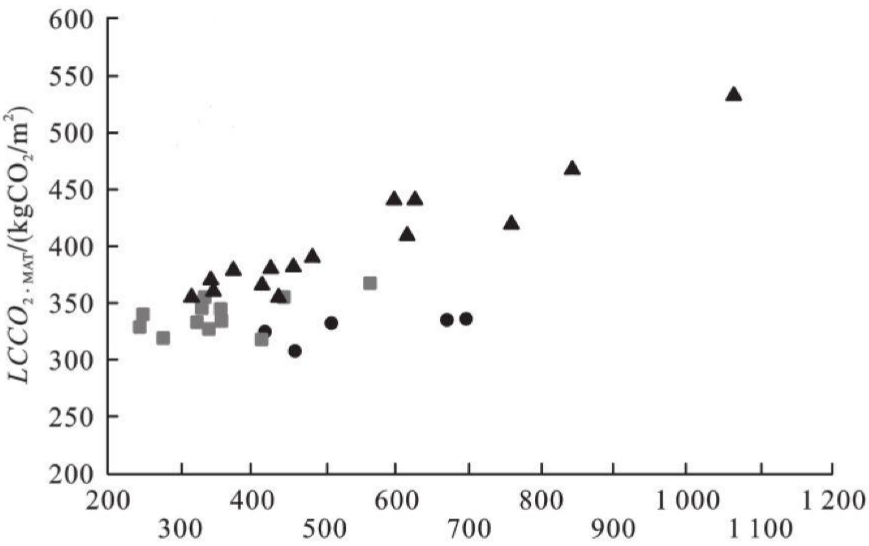


Taking a residential building as an example, this thesis collects a large number of engineering data through investigation and research, selects all reinforced concrete structures as samples, obtains relevant data through the bill of quantities and construction drawings, and calculates the CO2 equivalent emission data in each stage of the life cycle of building materials; The carbon emissions generated by the transportation of building materials are less than 5% of the carbon emissions in the life cycle of building materials; Through calculation, the carbon emissions of the building materials in the life cycle can be obtained. The building area of each residential building corresponds to lcco2.mr (Life cycle carbon emissions of buildings). With the increase of the building area, the carbon emissions increase significantly; If the building floors are divided into three groups: 5-10 floors, 11-20 floors and 21-35 floors, analyze the corresponding relationship between the area of the building standard floor and lcco2.mat under different floors, as shown in Fig. 8. It can be seen from the figure that when the area of the standard layer is fixed, the carbon emission increases with the increase of the number of layers; When the number of layers is in the same group, with the increase of the standard layer area, the carbon emission also increases.

Information in the figure

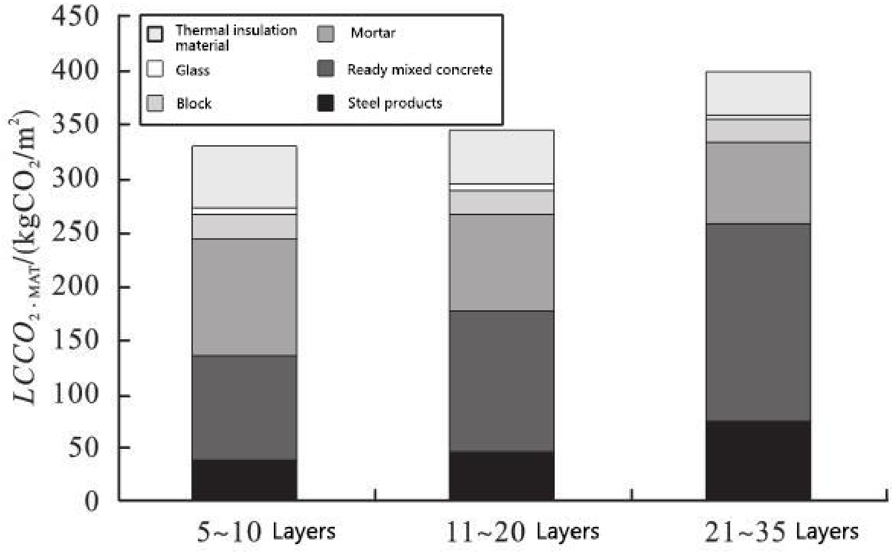
- The x-axis is the area of the standard layer.
- Circular（5th-10th floor）Square（11th-20th floor）Triangle（21th-35th floor）

Figure 9. PV Analysis of standard floor area and carbon emission under different floors.



Six main building materials such as concrete, steel, mortar, block, thermal insulation material and glass are selected for accounting. If the standard floor area is also divided into three groups: 200 ~ 350 m2, 350 ~ 600 m2 and 600 ~ 1200 m2, the emission situation of each building material under different floors and standard floor area is analyzed respectively (the average value of each group is taken), as shown in Fig. 9. It can be seen from the figure that steel, ready mixed concrete and mortar have the largest carbon emissions, accounting for more than 80% of the carbon emissions of all accounting materials on average. Among them, with the increase of the number of floors and the area of standard floors, the carbon emissions of steel and ready mixed concrete per unit building area increased significantly.

Figure 10. Carbon emission analysis of various building materials at different floors.


Thermal insulation material
Glass
Block
Mortar
Ready mixed concrete
Steel products
$LCCO_{2 \cdot MAT}/(kgCO_2/m^2)$
450
400
350
300
250
200
150
100
50
0
5~10 Layers
11~20 Layers
21~35 Layers

7 Conclusion

In 2022, people pay more and more attention to the application of green building materials with the continuous enhancement of the concept of ecology and green environmental protection. The construction industry is closely related to people's life, so it is of great significance to actively use green building materials. The use of green building materials not only saves energy, but also helps to build a conservation oriented society. Therefore, we should strengthen the promotion and research and development of green building materials, and make important contributions to the healthy development of the construction industry.

At present, the human survival crisis, such as the sharp increase of population, serious desertification of land, frequent natural disasters, greenhouse effect and the gradual depletion of fresh water resources, has deteriorated sharply. The emergence of green buildings is the inevitable result of the development of architectural design. The title 24 report in California is a good example. What exactly is the report? In essence, this is the report on the ownership of residential buildings established by the California Building Commission in 1978. This is part of the organization's efforts to reduce energy consumption in the state, especially in residential and non residential buildings. From the data of these surveys, it can be seen that the world has been making efforts for "green building" between 2010 and 2022, and has also improved it. Many people don't have a clear understanding of "green building", but the current emphasis on health and the increase in green awareness show that the development trend of green building is getting faster and faster. Through this thesis, we can make it more integrated into internationalization.

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