Research on the Teaching Reform of "Building Construction" Course in the Network Information Age: Green Low Carbon Transformation as the Center

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Abstract: The highly developed network information technology makes it possible for us to learn more about the latest foreword knowledge at the first time. Achieving carbon peaking and carbon neutralization is the only way for China to promote high-quality development in the new development stage. As the highland of talent training in the construction industry, colleges and universities should coordinate the construction of carbon neutral related courses to provide solid support for talents in the construction field to achieve the ambitious goal of carbon peak and carbon neutral. As the core course of the architecture major, "Building construction" combines carbon peaking and carbon neutralization to reform the teaching content of building materials, building modules, building energy conservation, building doors and windows, etc.

1 INTRODUCTION

The construction industry is a pillar industry in China and one of the industries with the highest carbon emissions. Computer information technology analysis results In 2018, the carbon emissions of the whole process of building operation in China's urban and rural construction accounted for 51.3% of the national total. In order to achieve the goal of carbon peaking and carbon neutralization in the field of urban and rural construction, it is necessary to continuously promote innovation in all aspects based on the management of the whole construction process, so as to make the whole construction process green, intelligent and sustainable. The Implementation Plan for Carbon Peak in Urban and Rural Construction issued in June 2022, the main goal of which is to control the peak carbon emissions in urban and rural construction by 2030, and strive to achieve green and low-carbon transformation in urban and rural construction mode and modernization of carbon emission governance in urban and rural construction by 2060, The full text of the Plan can be viewed through the network information platform (Fig 1).

As a basic course and a technical course in the undergraduate education system of architecture specialty, the content of "Building construction" course is closely related to the diversification of architectural technology, construction technology, material technology and various systematic design methods. However, in the past, the teaching content of "Building construction" was mainly based on traditional construction methods and building materials, and there were few new materials and technologies related to green and low carbon. Therefore, this paper will make full use of the cutting-edge direction of the network new media to compare the latest national green and low-carbon norms, procedures and standards with the relevant content of the current "Building construction" textbook, supplement and improve the teaching content of the "Building construction" course, so that the teaching content of the "Building construction" course is closer to the requirements of today's green and low-carbon development (JIN, 2017).

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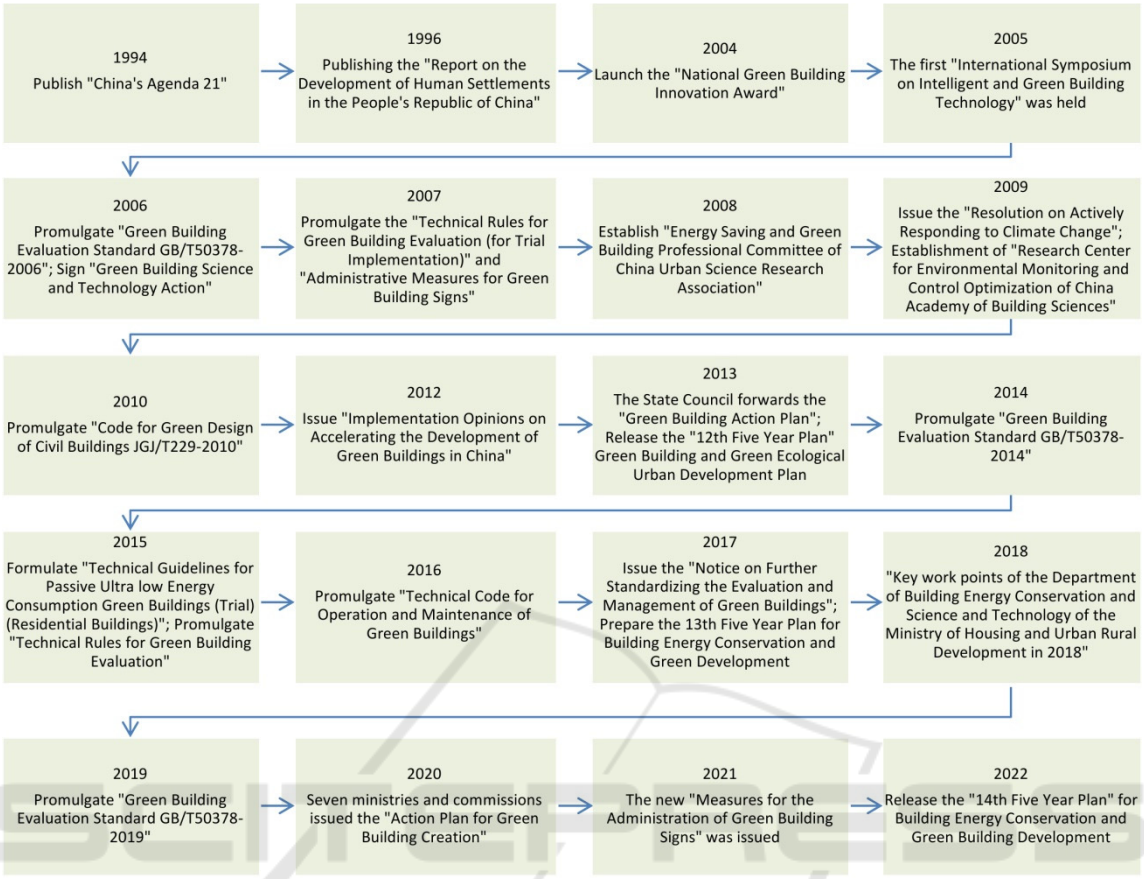


Figure 1: Development history of green buildings in China.

2 RESEARCH PURPOSE AND METHOD

In order to thoroughly implement the decision and deployment of the CPC Central Committee and the State Council on carbon peaking and carbon neutralization, and make the teaching content of the "Building construction" course more close to the requirements of green and low-carbon development in today's society, on the premise of collecting and sorting out relevant green and low-carbon documents, norms, procedures and standards through various online and offline methods, consult the shortcomings of the current "Building construction" teaching materials and deepen and supplement them, Put forward reasonable suggestions for the teaching reform of "Building construction" course of architectural specialty in colleges and universities (Table 1).

Table 1: Current green low carbon related specifications

Serial No	Specification name	Revision
1	Design standard for energy efficiency of public buildings (GB50189-2015)	2015
2	Design Standard for energy efficiency of residential buildings in severe cold and cold zones (JGJ 26-2018)	2018
3	Assessment standard for green building (GB/T50378-2019)	2019
4	Standard for Building Carbon emission calculation (GB/T 51366-2019)	2019
5	General code for energy efficiency and renewable energy application in buildings (GB55015-2021)	2021

3 REQUIREMENTS FOR GREEN AND LOW-CARBON DEVELOPMENT IN URBAN AND RURAL CONSTRUCTION

3.1 Long Term Development Requirements of Green and Low-Carbon

Carry out digital review of construction drawings based on network information technology, and supervise the sustainable development of green and sustainable building design. All new buildings in domestic cities and towns will be constructed according to the green building design standards by 2025. The buildings that meet the green building standards will reach more than 30%, and all new public construction projects invested by the government will reach the standard of one star green building or above (MOC & MSA, 2019). By 2030, the energy efficiency rate of new residential buildings in severe cold and cold regions will increase from 75% to 83%; The energy efficiency rate of new residential buildings in other climate zones has increased from 65% to 75%; The energy efficiency rate of new public buildings has increased from the current 72% to 78%. We will promote the large-scale development of low-carbon buildings, and encourage all regions to actively build zero carbon buildings and near zero energy consumption buildings. By 2030, all public buildings in key cities above prefecture level will be renovated, and the energy saving rate will be increased by more than 20% on the original basis (MOC & MSA, 2022).

3.2 Green and Low-Carbon Development Requirements at this Stage

From April 2022, the energy consumption of new residential buildings will be reduced by 30% on the original basis, that is, the energy efficiency rate of residential buildings in severe cold and cold regions will increase from 65% to 75%, and that of residential buildings in other climatic regions will increase from 50% to 65%; The energy consumption of new public buildings is reduced by 20% on the original basis, that is, the energy saving rate is increased from 65% to 72%. It also requires that the carbon emissions of new buildings be reduced by 40% on the original basis and reported to the competent department platform through network information technology. The calculation method of total carbon emissions (CM) in the whole phase of building operation is:

$$CM = \frac{[\sum_{i=1}^{n}(EiEFi) - Cp)]y}{A}$$

Where Ei is the energy consumption of class i of buildings; EFi is the carbon emission factor of class i energy; i is the type of terminal energy consumed by buildings; Cp is the annual carbon reduction of building green space carbon sink system; y is the design life of the building; A is the building area (MOC & MSA, 2019).

4 TEACHING CONTENT REFORM OF "BUILDING CONSTRUCTION" COURSE

4.1 Teaching Content Reform of Building Materials

Building materials are the main contributors to carbon emissions in the construction industry. According to statistics, 41.3% of the carbon emissions in the production stage of building materials account for the total life cycle carbon emissions of buildings. In addition, the proportion of carbon emissions during the transportation of building materials will be higher. Therefore, reasonable selection of building materials in architectural design will play an absolute role in reducing carbon emissions in the construction industry (Table 2).

Table 2: Carbon Emission Factors of Main Building Materials.

Category of building materials	Carbon emission factor
Ordinary Portland cement	735kg CO_2e/t
Concrete brick	336 kg CO_2e/m^3
Autoclaved fly ash brick	341 kg CO_2e/m^3
Fired fly ash solid brick	134 kg CO_2e/m^3
Shale solid brick	292 kg CO_2e/m^3
Shale hollow brick	204 kg CO_2e/m^3
Gangue solid brick	22.8kg CO_2e/m^3
Coal gangue hollow brick	16.0kg CO_2e/m^3
C30 concrete	295 kg CO_2e/m^3
Clay	2.69 kg CO_2e/t
Lime production (market average)	1190 kg CO_2e/t
Steelmaking pig iron	1700 kg CO_2e/t
Natural gypsum	32.8 kg CO_2e/t

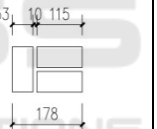
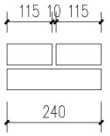
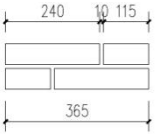
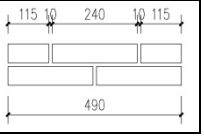
Cast pig iron	2280 kg CO_2e/t
sand (f=1.6~3.0)	2.51 kg CO_2e/t
Ordinary carbon steel	2050 kg CO_2e/t
Polyvinyl chloride (market average)	7300kg CO_2e/t
Rock wool board	1980kg CO_2e/t
Polystyrene foam board	5020kg CO_2e/t
Plastic steel window	121kg CO_2e/m^2
Aluminum plate with	28500kg CO_2e/t
Universal wood	178 kg CO_2e/m^3
Plywood	487 kg CO_2e/m^3
Particleboard	336 kg CO_2e/m^3

At present, the building structure design in the "Building construction" textbooks used in China is all around traditional building materials, but from the perspective of carbon peaking, carbon neutralization and the use of network information technology, more materials with low carbon emission factors are selected. For example, the traditional method of flat roof slope making layer in roof construction is to use expanded perlite, but the carbon emission factor of expanded perlite has reached 2880kgCO_2e/t. The materials of slope making layer should be changed to light aggregate concrete, vermiculite cement mortar, slag cement mortar and other materials with low carbon emission factors according to the requirements of building roof use, so as to reduce carbon emissions (MOC & MSA, 2019).

4.2 Teaching Content Reform of Building Module and Wall

In order to make building materials universal and improve production efficiency, China has stipulated a unified modular series for building materials. In a large number of architectural designs, the opening, depth and door and window dimensions of buildings must be coordinated according to this module. In order to achieve the ambitious goal of carbon peaking and carbon neutralization, the country has formulated a forward-looking policy of reducing the proportion of building materials consumed at the construction site by 2030 by 20% on the basis of 2020, and comprehensively promoting green building materials on projects that meet the StarCraft green building standards by 2030, And use network information technology to supervise at any time. Although the thickness of common brick walls is included in the teaching material of "Building construction" currently used in China, it is not expanded and extended by combining wall materials and modulus. In the selection of masonry bricks, the building materials with low carbon emission factors and the carbon emission factors in the transportation process of building materials should be considered first. Therefore, the coal gangue porous bricks and hollow bricks with low carbon emission factors produced locally should be selected as far as possible through network information technology; In addition, considering the loss rate of building materials, the door and window buttresses, walls between doors and windows, molding pilasters, etc. shall be designed in combination with the brick modulus as much as possible in the architectural design. For example, walls with a length of less than 1 m shall be 120 mm, 180 mm, 250 mm, 370 mm, 500 mm, 680 mm, 750 mm and other dimensions to avoid wasting materials and labor caused by brick cutting during construction (Table 3).

Table 3: Standard Brick Laying Method.

name	Wall thicness	legend
6 thick wall	1/4 brick wall	
12 thick wall	1/2 brick wall	
18 thick wall	3/4 brick wall	
24 thick wall	1 brick wall	
37 thick wall	3/2 brick wall	
49 thick wall	2 brick wall	

4.3 Teaching Content Reform of Building Energy Conservation

China's building energy conservation started in the 1980s, but China has always attached importance to the development of building energy conservation, and has successively issued and updated the design standards for building energy conservation in

various climatic regions, promoting the healthy and rapid development of China's building energy conservation field. Proper thermal insulation materials for buildings can effectively improve energy efficiency and promote green, sustainable and low-carbon development. In order to protect the ecological environment and cope with climate change, implement the decision-making and deployment of carbon peaking and carbon neutralization, improve the efficiency of energy resource utilization, promote the use of renewable energy, promote low-carbon development, create a good indoor space environment, and meet the needs of high-quality development of the whole society, the country has continued to pay attention to building energy conservation design, successively issued building energy conservation design standards, green building evaluation standards, building carbon emission calculation standards As of now, the average energy efficiency rate of residential buildings and public buildings in severe cold and cold regions in China needs to reach 75% and 72% respectively, according to the general specifications and regulations for building energy efficiency and renewable energy utilization (MOC & MSA, 2015; Fig 2).

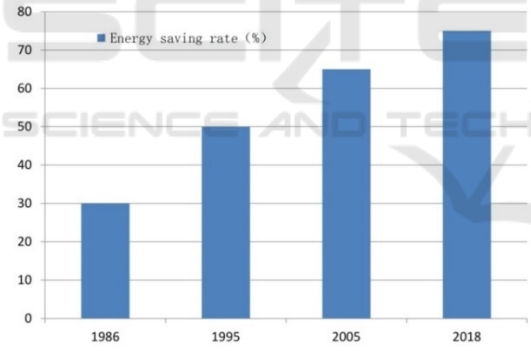


Figure 2: Evolution of China's civil building energy efficiency rate.

At present, the content of "Building construction" textbooks used in China involves little in building energy conservation, especially in the current society where the national policy on carbon peaking, carbon neutralization and deployment is only reflected in the wall and roof chapters of "Building construction" textbooks. The energy saving rate of civil buildings is mainly achieved through the improvement of the thermal insulation function of the building envelope. Therefore, it is necessary to add this part to the teaching content of "Building structure", and pay attention to relevant foreword knowledge through network information technology at any time.

4.4 Teaching Content Reform of Doors and Windows

Doors and windows are part of the building envelope, and also an important link to ensure building energy conservation, which needs to meet many relevant indicators. At present, the content of "Building construction" textbook used in China has supplemented the content of energy conservation of doors and windows, but the length is only one and a half pages, without detailed description. The current national codes and regulations describe the energy conservation of windows and doors in residential buildings, public buildings and industrial buildings in more detail, such as the area ratio of windows to walls, the area of roof skylights, and the thermal performance of windows and doors, which should be deepened in combination with the relevant computer software for building energy conservation design. (Table 4)Extend this aspect for the green and low carbon transformation of the construction industry to lay the foundation for the realization of green and low carbon national policies as soon as possible (MOC, 2018).

Table 4: Requirements for window wall ratio of residential buildings.

orientation	Window wall area ratio				
	Frigid region	Cold region	Hot summer and cold winter area	Hot summer and warm winter areas	Moderate Zone A
north	≤0.25	≤0.30	≤0.40	≤0.40	≤0.40
East, West	≤0.30	≤0.35	≤0.35	≤0.30	≤0.35
south	≤0.45	≤0.50	≤0.45	≤0.40	≤0.50

5 CONCLUSIONS

Carbon peaking and carbon neutralization have become the key direction of national development and the strategic goal of green and low-carbon transformation of the construction industry. In today's society with highly developed network information technology, we should learn more about the latest foreword knowledge at the first time to enrich the teaching content. As the highland of talent training in the construction industry, colleges and universities should closely follow the national guidelines and policies, coordinate the construction of relevant courses, provide solid support for building professionals to achieve the ambitious goal of carbon peaking, carbon neutralization, and provide constructive suggestions for other colleges and universities to reform the "building structure" curriculum.

By analyzing the teaching content of the course "Building construction", the following aspects should be reformed. 1) For the selection of building materials, try to choose materials with low carbon emission factor and produced in local or surrounding cities; 2) The building is designed according to the modulus to reduce the material loss rate and reduce carbon emissions; 3) In combination with the requirements of the current national energy conservation rate standard, building energy conservation design runs through most chapters of the "building construction" curriculum; 4) Improve the performance of building doors and windows, and make the weak links of the exterior enclosure structure meet the current standard requirements.

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