学 位 論 文 内 容 の 要 旨

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学 位 論 文 題 名

A Case Study on Environmental Design Methods toward the Lifecycle Carbon Reduction of Residential Buildings in Severe Cold Regions in China

(中国における寒冷地住宅の脱炭素化に向けた環境設計手法に関する事例研究)

According to data from the Global Carbon Project, China's carbon dioxide emissions in 2018 were 10.1 billion tons, ranking first in the world, accounting for 27.6% of global carbon dioxide emissions; according to data from the 2022 China Building Energy Consumption and Carbon Emissions Research Report, In 2020, the total carbon emissions from the entire construction process nationwide were 5.08 billion tCO_2, accounting for 50.9% of the national carbon emissions. In order to achieve the goal of peaking carbon dioxide emissions before 2030 and achieving carbon neutrality before 2060, the construction industry will become a key emission reduction target in China.

The demand for cooling and heating due to extreme weather has increased global carbon dioxide emissions by approximately 60 metric tons, accounting for approximately one-fifth of the total increase in global carbon dioxide emissions. Moreover, China has a large geographical span, and the dominant influencing factors of building carbon emissions are closely related to climate and environment. Therefore, research on building emission reduction should be conducted by region.

This article selects residential buildings in severe cold areas as the research object. It takes the temperature changes, building structure changes and external thermal performance changes in the severe cold areas over the past 20 years as the main variable parameters, and conducts research based on the landforms and climate characteristics of the severe cold areas.

The main contents of the research are as follows:

Chapter 1,explains the research background, purpose and significance of the paper. At the same time, the research methods and technical routes of the paper are clearly given.

Chapter 2,explains the selection of simulation software and formulas and the analysis methods used. This paper briefly explains the reasons for choosing DesignBuilder software for carbon emission simulation, and introduces the data models involved later. It also introduces the calculation method of climate change tendency rate and the application of orthogonal analysis method.

Chapter 3,introduces the project overview and sets the model parameters based on the selection of residential buildings for model construction. And conduct carbon emission simulations for the building in three selected areas.

Chapter 4 describes the impact of temperature changes on carbon dioxide emissions over the past 20 years.

This chapter selects three cities in severe cold areas: Changchun City in Jilin Province, Shenyang City in Liaoning Province, and Datong City in Shanxi Province. Based on data from NASA's Goddard Earth Science Center, we analyzed the average temperatures in Changchun, Shenyang, and Datong

over the past 20 years, as well as the average temperatures in spring, summer, and winter. Based on the temperature data of various places in the past 20 years, DesignBuilder software was used to conduct carbon dioxide simulations to compare the impact of temperature changes in the past 20 years on spring, summer, autumn, winter and annual carbon dioxide emissions.

Chapter 5,describes the impact of changes in building structure on carbon dioxide emissions throughout the building's life cycle.

This chapter selects the original building structure - reinforced concrete structure and the new building structure - wooden structure to compare the carbon dioxide emissions in the entire life cycle, and uses the inventory analysis method to analyze the material production stage, material transportation stage, building construction stage, and building operation throughout the building life cycle. During the building disassembly stage, carbon dioxide emissions are calculated and the carbon dioxide emission reduction rates are compared.

Chapter 6, describes the impact of changes in building envelope on building carbon dioxide emissions.

This chapter studies the impact of changes on building carbon dioxide emissions from three aspects: exterior walls, exterior windows, and roofs. Analyze the impact of individual changes in exterior walls on building carbon dioxide emissions in severe cold areas, the impact of individual changes in exterior windows on building carbon dioxide emissions in severe cold areas, and the impact of individual changes in roofs on building carbon dioxide emissions in severe cold areas. DesignBuilder software was used to simulate the impact of simultaneous changes in the three factors of exterior walls, exterior windows, and roofs on building carbon dioxide emissions, and the optimal design plans for Changchun, Shenyang, and Datong were selected based on the orthogonal analysis method.

Chapter 7,Conclusion and Prospect.