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Research on Integrating the Green and Low-Carbon Concept into the Entire Process of Construction Engineering

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Abstract: In the context of the dual carbon strategy and the transformation of the building sector, the industry has become more and more energy consuming and emitting. The integration of green and low carbon principles into the whole life cycle of a building project is a necessary requirement for industrial development. In this paper, the core nature of green and low carbon concept is defined, and the standards for the division of project process are set up. It systematically analyses the gaps in the implementation of these principles at key stages–planning, design, construction, operation and maintenance, and outlines the basic principles for their integration. Targeted optimization approaches are proposed in three dimensions: enhancing standard systems, applying low carbon technologies, and setting up sustainable governance mechanisms. The purpose of this research is to reduce energy consumption and emissions in building projects, and to provide theoretical and practical advice for the construction industry to develop green, low carbon and high quality.

Keywords: Green and low-carbon concept; Construction engineering; Full-process integration; Low-carbon management and control

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1. Introduction

The building sector, as an important pillar of the national economy, is also an important sector of social energy use and carbon emissions. The traditional broad development pattern influences the efficiency of environmental protection and the overall development of low carbon economy. As the demand for ecological civilization continues to increase, the traditional way of building, which is characterized by high energy consumption, material use, and emissions are no longer able to meet the needs of modern green development. A green, low carbon concept that focuses on energy efficiency, pollution reduction, carbon reduction, and resource recovery needs to be integrated into all phases of building projects: planning, designing, building, operating and decommissioning. At present, the construction industry in China is confronted with the practical challenges of low carbon transformation, such as a lack of concept awareness, low carbon technology deployment, and a weak regulatory framework. The systematic exploration of implementation pathways to integrate green and low carbon principles throughout the life cycle of the building is of great practical value in increasing the efficiency of

the industry and achieving a profound green transformation.

2. Overview of the green and low-carbon concept and its application throughout the entire construction project process

2.1. Core concepts and developmental essentials of the green and low-carbon philosophy

Green and low carbon idea is based on eco-environment, which is based on the principles of energy-saving, pollution-reducing, carbon-reducing, resource-recycling, and human-nature living harmoniously. It stands for a modern concept of development that combines the economy, society, and ecology of building projects. This is a complete rejection of the conventional thinking of building, which puts size above ecology, and uses of resources rather than efficiency. It calls for the minimization of non-renewable resources over the whole life cycle of a building, strict control over the release of hazardous materials like building rubbish, waste, and sewage, and making full use of the nature of the site to create harmony with the environment.

The Green and Low Carbon Concept goes further than local energy efficiency improvements at different stages of construction; it stresses a systemic, integrated low carbon approach across the whole life cycle of a building. It attaches great importance to the wide use of innovative low carbon materials, energy efficient and green building technologies, as well as to enhance the recovery and recovery of building debris and local ecology. A key element of this approach is to strike an accurate balance between real building requirements and environmental load potential of an area [1].

2.2. Division of the full process stages in construction projects and their work characteristics

The whole course of building works is a system of engineering work with complicated architecture and closely linked stages. Once a full process has taken place from start to finish, there are 4 key phases: planning and design, site building, post work and maintenance, and finally removal. The phases are interconnected and together form the whole life cycle of a building. In each phase, the concrete goals, the building goals, the specifications, and the administrative procedures are set out, covering many different areas of expertise including project exploration, concept design, site building, operational and maintenance management, with the involvement of many parties and the complexity of the process.

Being a basic and leading stage in a project, it decides the whole space arrangement, the standard of energy use, and the ecology base. The building stage is the key point in the concentration of energy use and CO_2 emissions, in which the choice of materials, design methods, and the running and maintaining of facilities have a significant effect on the total low carbon performance. Running and maintaining is the most prolonged period of time and has a close relationship with the use of long-term power and day-to-day management.

2.3. The value and role of integrating green and low-carbon concepts into construction projects

Integrating a green and low carbon approach across the whole building cycle can effectively reduce the amount of energy and natural resources consumed at the start of the project, dramatically reduce the amount of polluting substances (such as exhaust, sewage, and solid waste) from the building and operating stages, significantly reducing the impact on the environment and pressure resulting from large building operations, constantly improving the environment and the environment, keeping the environment in and around the city and its environs in line with the state’s environmental and sustainability strategies, and laying the groundwork for a more environmentally friendly development of the building sector.

At the same time, an in-depth combination of green and low carbon policies will spur the construction industry to innovate technology and improve the way it develops, thus contributing to a more extensive use of low carbon construction materials, smart architectural devices and energy efficient architecture in the entire sector, thus improving the whole architecture and conventional patterns of development in the building sector.

3. Existing issues in integrating the green and low-carbon philosophy throughout the entire construction project process

3.1. Insufficient integration of low-carbon thinking in early-stage planning and design

The initial planning and design stage is the foundation and key phase of the project, which is crucial to the determination of the whole low carbon performance of the building. At present, however, the majority of architects are still constrained by the conventional model of architecture, which gives priority to the aesthetics of the architecture, the internal function layout, and the initial cost of the project, and the lack of focus on the essential aspects of the concept of "green" and "low carbon", "energy efficiency" and "environmental compatibility.

Part of the structure's general design is short of a system, low carbon comprehensive planning. The energy efficiency of structures. For example, natural illumination, ventilation, and heat preservation, is lacking in science and rationality, and the use of renewables, such as geothermal and solar energy, is a major problem. There are still no uniform, detailed, workable, low carbon design standards in the building sector. The absence of systematic vocational education on low carbon design has led to a wide gap in the concept of low carbon design, theory and practice [2].

3.2. Lagging application of low-carbon technologies and materials during the construction phase

The existing building sites are mostly based on conventional large-scale operating models, and different low carbon building techniques are not widely promoted and used in the sector. Modern low carbon technologies like pre-fabricated structures, green cast-in-situ technology, and energy efficient external walls are still not being used. The normal use of power in large machines on building sites is insufficient because of the widespread use of obsolete and high energy consuming installations, which results in considerable energy wastage in the course of the operation. The environmental management measures to deal with building dust, noise and waste water are not sufficiently precise or standardized.

Overall, the uptake of low carbon and environmentally friendly construction materials in the market is still low. The majority of building suppliers continue to favor conventional, energy-intensive, high-pollution materials. Because of the high price of the market, the lack of knowledge of the industry, and the lack of the supply system, the low carbon substitutes, and the energy efficiency of the insulating materials are difficult to achieve wide acceptance. Front line builders often lack sufficient low carbon expertise, and there are no standards for low carbon building practices.

3.3. The post-operation and maintenance low-carbon management system is inadequate

Once completed and formally put into service, the construction and maintenance work are carried out over an extended period of time with significant overall power consumption. But at present, the majority of civilian and public buildings do not have an integrated, systemic low carbon operating system, and routine maintenance is still based on the conventional, widespread management methods. Interior systems such as water and power, HVAC, and common illumination are short of smart energy saving management solutions. All kinds of machinery and electric installations work in long periods of high load, resulting in considerable energy wastage. The real-time monitoring of power use and the Dynamic Smart Regulating System by means of Intelligent Monitoring Platforms have not yet been implemented.

The demand of specialized managerial personnel in low carbon operation and maintenance has been obvious. The current O.M. staff often lacks the professional low carbon management knowledge and the energy saving operation technique. Their day-to-day O&M activities are mainly concerned with troubleshooting and fundamental maintenance of construction facilities, with no regard for saving energy, reducing costs, or conventional low carbon management.

4. Principles for integrating the green and low-carbon concept into the entire process of construction engineering implementation

4.1. Principle of synergy between energy conservation, environmental protection, and engineering quality

A green, low carbon concept has been incorporated into the whole building process. First of all, we must insist on the harmonious development of energy-saving, environment, and project quality. It is not acceptable to intentionally compromise the design safety criteria, routine functionality, or the minimum requirements for the whole building in order to achieve the goal of reducing CO_2 emissions and energy efficiency. The basic premise of a building project is that it is safe and reliable in structure, adherence to quality criteria, and overall functionality. In all cases where low carbon technologies are used, the choice of new construction materials and the planning and design proposals are to be followed with strict priority so as to secure the quality of the project in a balanced manner.

During the planning, design, and execution stages of a building project, it is crucial to strike a good balance between strict environmental and building quality standards. Preference shall be given to the selection of building materials which are energy-efficient, low carbon, and high performance, as well as active use of modern building technologies which comply with the goals of reducing pollution and reducing carbon emissions, whilst guaranteeing the quality of the building [3].

4.2. Principle of comprehensive coordination and phased implementation adaptation

In order to incorporate a green and low carbon idea into a building project, it is crucial that the basic principle of a holistic approach is followed through the whole process, accompanied by accurate, gradual implementation. This calls for comprehensive top-level planning for the full life cycle of a building project, setting up a single low carbon development concept, and aligning low carbon development goals, execution techniques, and full process control requirements for all phases, from planning, design, building, operating and maintaining. The aim is to create a coherent, seamless, low carbon growth regime, which avoids fragmentation of processes and disconnected low carbon standards at the various stages of building.

Based on a single, integrated programming framework, differentiated and workable low carbon delivery measures are required to take into account the specificities, key goals, and actual developmental requirements of every stage. In the planning and design stages, it is important to put in place a comprehensive low carbon strategy at the source; in the building stage, there is a need to impose stringent requirements on low carbon building technology and choice of materials; and in the operational and maintenance stages, it is important to emphasize day-to-day energy saving and efficient energy management.

4.3. Principle of balancing technological innovation and cost control

Effective deployment of green and low carbon ideas depends to a large extent on the strong backing of new technologies, materials and facilities. We must continue to insist on technological innovation, actively use advanced low carbon technologies like smart building technology, fully utilizing renewables and extensive use of recycled building materials. In the sector, we need to step up our efforts to invest more in low carbon technologies and speed up the commercialization of research results. Through technology innovation, it is possible to tackle the underlying problems of high-energy-use and carbon-emitting buildings and to provide a sound technical basis for incorporating low carbon technologies across the whole life cycle of a project.

At the same time, adequate control of total civil works costs must be guaranteed, with full account being taken of the up-front cost of low carbon and new construction materials and of their long-term energy savings, and of preventing over-investing in blindly pursuing developments which might lead to significant additional costs for the project. By using large scale industrial use and standardization, we can decrease the use cost of low carbon construction materials and advanced techniques.

5. Strategies for integrating the green and low-carbon philosophy into the entire process of construction engineering optimization

5.1. Improve the low-carbon planning and design standard system for construction projects

In view of the present state of development of the building sector and the overall objectives of CCS, the relevant industrial bodies shall further elaborate industrial norms and professional norms for environmental and low carbon planning and design. This involves specifying measurable low carbon performance targets for different architectural styles and regions, as well as specifying the concrete design requirements for space distribution, energy efficient structures, use of renewables, and environmental conservation in the region. These measures will give architects a clear, standardized, and direct application of professional standards, which will govern the whole profession of low carbon design at an institutional level.

Develop a dedicated low carbon architecture design appraisal system that integrates the basic quantity of green and low carbon practices into the main evaluation standards of construction planning and design projects. Design proposals which do not comply with low carbon building criteria or do not incorporate low carbon concepts are not eligible for approval. Regular enhancement of CPD, systematic dissemination of advanced low carbon design ideas, expertise and practice in the field. Bring in examples of low carbon design examples to learn and learn from, so as to enhance the whole expertise of the design group in low carbon planning and design, and to build a strong base for low carbon growth from the start.

5.2. Promoting low-carbon building materials, energy-saving processes, and intelligent construction technologies

Continuous efforts will be made to promote the development of green, low carbon construction materials in the field of R&D, innovation, and marketing. We will launch a specific industrial support policy to lower the cost of using recycled aggregate construction materials, energy saving insulating materials, and environmental protection construction materials. Priority will be given to construction contractors to adopt low carbon and environmentally friendly construction materials as a priority so as to progressively substitute conventional high energy and high pollution materials, thus raising the total acceptance ratio of low carbon construction materials in construction projects. At the same time, we will set up a low carbon tracking monitoring system for construction materials, which will prevent high pollution and high energy consumption from entering the building market.

We will push forward energy saving and environmental protection technologies like pre-fabricated structures, modular structures, and green cast-in-situ technologies, and progressively eliminate obsolete, energy-intensive, and high-pollution conventional, large-scale building processes. Full implementation of Smart Building Solutions–BIM techniques, Intelligent Surveillance Devices on Building Sites, and Automatic Saving Machines will enable real time control of energy use, dust contamination and building debris during building operations [4].

5.3. Establishing a low-carbon operation and long-term management mechanism for the entire building life cycle

Speed up the construction of a comprehensive smart low carbon operating and maintaining management platform, integration of all kinds of machinery, electric power, HVAC, and public lighting. This makes it possible to monitor the power consumption in real time, to make smart statistics, and to automatically regulate the running of devices, so as to help identify possible energy wastage hazards in a timely manner, and to make scientific optimization of the operating methods of machinery and electronics, so as to decrease the total amount of operating power at the source. Set up a dedicated low carbon operating and maintaining management group, carry out technical training on a periodic basis, improve the energy-saving and low carbon management ability of maintenance staff.

Develop an integrated, full cycle, standard low carbon regulation framework for building projects, with clear definition of low carbon obligations for all interested parties–project owners, builders, operators and maintenance managers, then set

up an overall assessment system that encompasses the whole life cycle from design and building to long-term operating and maintaining. Enhance the security management and recovery system of old building materials and building waste, fully push forward the reuse of building resources in a comprehensive way, and enhance regular supervision and on-the-spot checks. This would build a structured, sustainable, and efficient low carbon management framework, which would make sure that green and low carbon policies are consistently applied across all phases of building projects.

6. Epilogue

Integrating both green and low carbon technologies into the whole building process is a necessary way for the building sector to adapt itself to the wider environmental progress, and to realize the transition of industry. The article looks at the inherent link of green and low carbon ideas and the whole life cycle of building, analyses the actual problems of applying them through planning, design, building, operating and maintaining stages, and outlines three key delivery principles: combining EE and QA, realizing a holistic approach to adaptive integration, and combining technology and cost effectiveness. In addition, the document suggests optimization strategies focusing on improving standard frameworks, promoting low carbon technologies, and setting up integrated life cycle management mechanisms.

Disclosure statement

The author declares no conflict of interest.

References

[1] Faizan S, Sinem M, 2022, Shared Transformational Leadership for Green Architecture Engineering and Construction Project Teams: A Study of LEED Projects. Journal of Construction Engineering and Management, 148(12): 04022137.

[2] Xiong H, Luo M, 2023, An Emission Reduction Prediction Method of Green Building Engineering Based on Time Weighting. International Journal of Global Energy Issues, 45(3): 261–272.

[3] Zhang Y, 2024, Research on the Design of Green Buildings Based on Building Information Modelling (BIM) Technology. Architecture Engineering and Science, 5(3): 1–6.

[4] Jia H, 2023, The Application of BIM Technology in the Construction Management of Green Building Projects. Industrial Engineering and Innovation Management, 6(3): 1–6.