Analysis of Green Building Construction Technology in Construction Engineering

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Abstract: Addressing the demand for greening development in construction engineering and based on the current application status of green construction technologies, this study analyzes three major construction principles: low-carbon priority for reducing consumption and emissions, efficient resource recycling and utilization, and ecological protection coordinated with construction. It summarizes the construction process encompassing preliminary green scheme preparation, implementation of process green control, and post-construction green acceptance evaluation. Furthermore, it elaborates on optimization strategies including technological upgrades to meet green demands, refining management modes for green assessment, and strengthening material control for green traceability. By systematically sorting out key points across various stages, a set of green construction technology application systems integrating safety and environmental protection is formed, providing a referential operational framework for green construction practices in construction engineering.

1. Introduction

Green building construction technology is a specialized technical system within the construction engineering field that practices low-carbon and environmental protection concepts. Its core objectives are reducing energy consumption, minimizing environmental impact, and enhancing resource utilization efficiency. By adopting energy-saving equipment, new environmentally friendly building materials, and modular construction techniques, it implements low-carbon and emission reduction requirements throughout the entire construction cycle. Relying on resource recycling mechanisms, it enables graded treatment and reuse of waste and water resources, combined with ecological protection measures to reduce construction disturbance to the surrounding environment. This technology requires scientific scheme preparation, dynamic process control, and systematic acceptance evaluation for implementation, ensuring project quality and safety, and promoting the sustainable development of construction engineering. The current trend towards green and low-carbon transformation in the construction industry is significant. Traditional construction modes increasingly reveal problems regarding energy consumption, resource waste, and ecological impact, struggling to meet the requirements of green building development. To promote environmentally friendly, efficient, and sustainable construction, in-depth research on the implementation logic of green building construction technology is necessary, clarifying construction principles, standardizing construction processes, and optimizing application strategies. The following sections will focus on these core contents, providing insights for the scientific application of green construction technology.

2. Construction Principles of Green Building Construction Technology in Construction Engineering

2.1 Low-Carbon Priority: Reducing Consumption and Emissions

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From an energy utilization perspective, priority should be given to clean energy and high-efficiency energy-saving equipment. The construction site lighting system should adopt a combination of photovoltaic power supply and LED light sources to reduce grid electricity consumption. Construction machinery should be equipped with automatic idle shutdown devices that cut power after exceeding 5 minutes of idling, reducing invalid fuel consumption. In terms of material low-carbonization, when optimizing concrete mix proportions, not only should mineral admixtures be added, but aggregate grading technology should also be employed to reduce cement usage, enhance concrete density, and lower later-stage maintenance energy consumption. For metal materials like steel and aluminum, prioritize high-strength, lightweight varieties to reduce material usage and production-stage carbon emissions[1]. Establish a dynamic carbon emission monitoring mechanism, calculate carbon emission intensity by construction process, compare it with industry benchmarks, and adjust measures promptly to ensure construction-wide carbon emissions comply with green building evaluation standards. Control dust through equipment like enclosure spray systems and mist cannons, and manage construction noise using low-noise vibrators and sound barriers, achieving dual control of environmental pollutants and carbon emissions.

2.2 Efficient Resource Recycling and Utilization

For solid waste treatment, beyond classifying and recycling scrap steel and concrete blocks, differentiated treatment plans should be formulated based on material properties. For example, scrap steel can be cold-straightened and used for non-load-bearing structures; concrete blocks can be crushed, screened, and graded for use as roadbed filler or recycled concrete aggregate, with the mix proportion/dosage of recycled aggregate precisely controlled according to structural strength requirements. Water resource recycling requires quality-based treatment and cascading use. Construction wastewater, after sedimentation, filtration, and disinfection, can be used for dust suppression and curing. Collected rainwater, after initial first-flush diversion treatment, can be used for site greening. Install intelligent water-saving devices and monitor water usage in real-time to avoid waste [2]. Optimize construction schemes to reduce resource consumption, adopting factory prefabrication and on-site assembly construction modes to minimize on-site material cutting waste. Use reusable designs for temporary facilities, such as movable panel houses and steel enclosures, which can be relocated to other projects upon completion. Enhance utilization efficiency and reduce project costs and environmental load through multi-dimensional resource recycling.

2.3 Ecological Protection Coordinated with Construction

Detailed ecological surveys must be conducted early in the construction phase. Beyond identifying ecologically sensitive areas, record the types of existing vegetation and soil types on the site, and develop specialized protection plans. Set up protective fencing for ancient and famous trees, and separately strip and store topsoil for later ecological restoration. During construction, strictly control the construction footprint. Layout temporary facilities to avoid ecologically sensitive areas. Construction access roads should use permanent-temporary combined designs to minimize damage to the original landform. Implement ecological protection measures: set up anti-seepage curtains in areas near water bodies to prevent construction wastewater from seeping in; cover exposed soil with dust nets or temporary vegetation to reduce soil erosion [3]. Upon project completion, carry out restoration work according to the ecological restoration plan. Replace the topsoil and restore original vegetation. Level and reclaim temporary land or restore it to green space. The effectiveness of ecological restoration needs acceptance checking against indicators like vegetation coverage rate and soil fertility, ensuring the construction's impact on the ecological environment is minimized, and achieving coordinated development between engineering construction and ecological protection.

3. Construction Process of Green Building Construction Technology in Construction Engineering

3.1 Preliminary Green Scheme Preparation

Conduct an in-depth review of design documents. Beyond clarifying core indicators such as energy-saving rates and carbon emission intensity, also sort out application points for green technologies like material parameters for external wall insulation systems and installation requirements for renewable energy equipment. Form an indicator decomposition table to break down overall targets into each construction stage [4]. During the scheme formulation stage, determine specific implementation paths based on project site conditions and schedule requirements. Selecting energy-saving equipment requires comparing the energy efficiency ratios and operating costs of different brands, prioritizing Grade 1 energy efficiency equipment. Waste recycling processes must clarify classification standards, recycling frequency, and processing units, designing dedicated recycling channels and storage areas. Environmental monitoring points need defined monitoring indicators, frequency, and responsible personnel (e.g., dust monitoring every 2 hours, noise monitoring once each morning and evening). Organize technical briefings using a "scheme explanation + case demonstration" model to clarify green construction requirements for each step to construction teams. Distribute work instructions and conduct specialized training for key processes to ensure construction personnel master operational key points, avoiding inadequate scheme execution due to misunderstandings.

3.2 Implementation of Process Green Control

For monitoring, set up a digital control platform to collect energy consumption data, carbon emission data, and waste generation volume in real-time. The platform should automatically generate comparative analysis charts. If energy consumption in any link exceeds the design indicator by 10%, the system should issue an automatic alert. For process optimization, use BIM technology for construction simulation to identify interdisciplinary conflicts in advance, including spatial clashes between pipelines and structural components, optimizing the construction sequence to reduce rework and associated material and energy waste. Adjust construction schemes based on site conditions; for instance, switch to indoor work during continuous rainy weather to avoid material loss and schedule delays caused by open-air construction[5]. Supervision and inspection should implement "daily patrols + regular checks". Daily inspections by dedicated safety officers should verify the implementation of environmental measures like the operation of spray equipment and the coverage of dust nets. Weekly joint inspections involving various departments should verify the authenticity of monitoring data and the completeness of waste recycling records. Issue rectification notices for identified problems, specifying deadlines and re-inspection standards to ensure closed-loop problem handling.

3.3 Post-Construction Green Acceptance Evaluation

During the acceptance phase, check the completion of indicators item by item against green building evaluation standards. Verify energy-saving effects through on-site testing such as measuring the heat transfer coefficient of external walls and the air tightness of doors and windows. Resource utilization indicators require checking actual data for waste recycling rates and water resource recycling rates, comparing them against design targets. Ecological protection requires inspecting the restoration status of temporary land use and vegetation survival rates, among others

[6]. Invite third-party professional agencies to conduct evaluations. The agency should issue an evaluation report based on on-site testing data and construction records, covering aspects like the rationality of technology application, degree of indicator achievement, and effectiveness of environmental impact control. The report should point out deficiencies, including cause analysis for any aspect where carbon emissions exceed standards. Conduct experience summaries sort out successful practices and lessons learned from the construction process, and formulate a green construction technology manual. This manual should clarify optimization schemes for different scenarios, such as resource recycling methods under complex terrain conditions, providing references for subsequent similar projects and promoting the continuous improvement and promotion of green construction technology.

4.Optimization Strategies for Green Building Construction Technology in Construction Engineering

4.1 Technology Upgrades to Meet Green Demands

Conduct research on green technologies, establishing an industry technology trend tracking mechanism to regularly collect technical parameters and application cases of new energy-saving materials and construction processes. For energy-saving insulation materials, focus on investigating their thermal conductivity coefficient, compressive strength, service life, and environmental performance, comparing the energy-saving improvement over traditional materials. For modular construction technology, analyze its component prefabrication rate, on-site assembly efficiency, and cost differences. Select partial areas of the project for pilot applications. For instance, trial new insulation materials on the external walls of one building, recording operational difficulties, construction cycle, and energy-saving effects during construction. Monitor the power generation efficiency and stability of new photovoltaic panel installation processes. Use pilot data to verify technological feasibility and adaptability [7]. Upon successful piloting, develop a comprehensive promotion plan clarifying construction standards, quality control points, and equipment configuration requirements for technology application. This includes standardizing operational procedures for transportation, hoisting, and splicing of components for modular construction, and specifying parameters like application thickness and bonding strength for new materials. Provide specialized technical training for construction personnel to ensure they master the operational key points of the new technology, avoiding impacts on construction quality and green effectiveness due to technical interface issues. Ultimately, achieve deep adaptation between technology upgrades and green demands.

4.2 Refining Management Modes for Green Assessment

Build a green construction management system. Formulate the "Green Construction Management Measures", clarifying the green construction responsibilities of various departments and positions (e.g., the technical department responsible for green technology schemes, the construction department for on-site implementation, the environmental department for monitoring data collection). Establish a green indicator database covering core indicators like energy consumption, carbon emissions, waste recycling, and water resource utilization, determining industry benchmark values and project target values for each indicator. Decompose green indicators layer by layer, breaking them down by construction phase and work team. Decompose the project's total energy-saving rate target into phases like foundation, main structure, and decoration, then further refine it into electricity and fuel quotas for each team. Clarify the assessment cycle (daily, weekly, monthly) and the person responsible for data collection for each indicator [8]. Implement the assessment mechanism using a combination of "process assessment + result assessment". During the process, collect indicator data in real-time through the digital platform, generating weekly team assessment reports. Award bonuses to teams that exceed energy-saving targets, and conduct interviews with under performing teams requiring them to formulate rectification plans. Conduct comprehensive assessments at month-end, combining the implementation status of on-site environmental measures and the results of checks like waste recycling records to adjust assessment scores. Link assessment results directly to team performance and individual evaluations. Motivate construction personnel to proactively implement green construction requirements through detailed assessment, avoiding management becoming a mere formality.

4.3 Strengthening Material Control for Green Traceability

Screen the green building material supply chain. Establish a supplier access mechanism requiring suppliers to provide green building material certification and environmental performance test reports. Verify the supplier's production qualifications and environmentally friendly production processes. Implement a one-vote veto for suppliers with records of environmental violations. Sign long-term cooperation agreements with qualified suppliers, clearly stating clauses guaranteeing the green performance of materials and compensation liabilities for failing to meet environmental indicators [9]. Strictly implement the incoming inspection process. Upon material arrival, conduct joint acceptance by the materials, technical, and environmental departments. Check the consistency of material models, specifications, and certification reports. Perform on-site sampling tests for key indicators (e.g., VOC content for coatings, thermal conductivity coefficient for insulation materials). Materials failing tests are strictly prohibited from entering the site. Establish an electronic traceability file for each batch of materials, recording supplier information, production batch, test report number, arrival time, and usage location, achieving "traceable source, trackable destination" for materials. Conduct whole-process tracking management. Regularly check material usage to ensure green building materials are used as designed, preventing substitution with non-green materials. Upon project completion, compile material traceability files as important evidence for green building acceptance. Prevent non-green building materials from entering the construction process through whole-chain control, ensuring green construction quality from the source.

5. Conclusion

Based on the above research, it is evident that green building construction in engineering projects must be guided by three principles: Low-Carbon Priority (controlling carbon emissions and pollutants), Efficient Resource Recycling (enhancing resource utilization efficiency), and Ecological Protection Coordination (minimizing environmental impact). The construction process must advance orderly through preliminary preparation, process control, and post-construction acceptance, ensuring green requirements are met at every stage. Optimization strategies should focus on three aspects: Technology, Management, and Materials. Technological upgrades meet demands, refined assessment strengthens management, and green traceability controls materials. The synergy of these three aspects guarantees the effectiveness of green construction, promoting projects that balance environmental protection andbeneficial result (benefits/efficiency).

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