Analysis of Green Building Construction Technology in Construction Engineering

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Abstract: In view of the increasing demand for greening development in construction engineering and considering the current application status of green construction technologies, this study analyzes three major constructions principles, namely carbon priority to reduce resource and environmental emissions, efficient recycling and utilization of resources; ecological protection coordinated with construction. It summarizes construction of the overall process from pre-construction green plan preparing, to running of process green control and post-construction green acceptance evaluation. In addition, it describes optimization strategies such as equipment upgrades to fulfill green requirements, management model improvement for green assessment, and material control support for green traceability. Systematic integration and extraction of key points are performed at different stages, leading to the formation of a series of green construction technology application systems with safety and environmental protection perspectives, which collectively offer an operational approach for sustainable construction activities in civil engineering.

1. Introduction

The technology of green building construction is a branch with engineering nature in the system of general and specialty construction fields that implements low-carbon environmental protection ideas. Would have its major goals of lowering power use, lowering the influence on the surroundings, and improving the effectiveness in using resources. It applies the low-carbon and emission reduction requirement throughout the whole construction cycle by introducing energy-saving equipment, new environmental protection building materials and modular construction techniques. Based on the recycling mechanism of resources, this can realize classified disposal and reuse of waste resources and water resources, together with ecological protection measures, so that the construction disturbance to the surrounding environment is reduced. It is essential to prepare scientific scheme, strengthen modern process control and develop systematic evaluation method for acceptance, so that project quality can be guaranteed during the construction engineering implementation of this technology and the sustainable development of construction engineering practice be promoted. The trend of green and low-carbon transformation in construction industry development is very prominent soon. The traditional construction modes keep exposing out the problems of energy consumption, waste of resources and ecological damage during the development process which cannot satisfy the requirements in developing green building. In order to develop green building construction technology which is environmental-friendly, efficient and sustainable, it is important to study the specific implementation logic as well as standardizing the construction process while optimizing the application strategy. These key contents will be the focus of subsequent sections, and it also accommodates insights into green construction technology for scientific purposes.

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

2.1 Low-Carbon Priority: Reducing Consumption and Emissions

From the perspective of how much energy it uses, priority is given to clean energy and high-efficiency energy-saving equipment. The external light sources of the construction site lighting system should be low voltage, and try to use photovoltaic power supply combined with LED light sources to reduce grid electricity consumption. Construction machinery must be equipped with automatic idle shutdown devices, and power supply must be interrupted after exceeding 5 minutes of idling. On the one hand, for material low-carbonization, not only adding mineral admixtures in concrete mix proportions to reduce cement consumption, but also using aggregate grading technology and other measures can be a good way to reduce cement usage, improve concrete density and decrease energy consumption during later-stage maintenance. Focus on high-strength, lightweight metals (such as steel and aluminum) to minimize the amount of raw material used in the production stage which also reduces associated CO2 emissions [1]. The second is to establish a dynamic carbon emission monitoring mechanism which could assess the intensity of carbon emissions for each construction procedure, comparing it with industry standards, and implementing corrective measures in case of over limit quickly so that the total carbon emissions of construction can meet the requirements stated in green building evaluation standard. Realize dual control of environmental pollutant and carbon emission by controlling dust through enclosure spray system, mist cannon as well as construction noise using low-noise vibrators and sound barriers.

2.2 Efficient Resource Recycling and Utilization

In addition to sorting and recycling scraps of steel and concrete blocks, the differentiated treatment plans should be formulated according to the material performance. Scrap steel, for instance, can be cold straightened and reused as a non-structural material; concrete blocks can be crushed, screened and graded to serve as roadbed filler or recycled concrete aggregate having defined mix proportion/dosage ratio dictated by the structural strength. 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

Perform detailed design document review. In addition to refining basic indicators such as energy-saving rates and carbon emission intensity, we will also sort out application points of green technologies such as material parameters for external wall insulation systems and installation requirements for renewable energy equipment. Create an indicator decomposition table to decompose the overall targets as per each construction stage [4]. At this point in the scheme formulation phase, define specific implementation pathways according to site conditions and schedule suites. Choosing energy-saving equipment by comparing the energy efficiency ratio and operating costs of various brands, it is best to choose Grade 1 energy efficiency equipment. Waste recycling requires classification standards to be specified, the frequency of recycling and waste processing units must be established; dedicated channels for recycling must also need to be considered so that separate storage areas are created. Environmental monitoring points define the monitoring indicators, such as their frequency and who is responsible for it (Dust should be monitored every 2 hours; noise is monitored once each morning and evening). Carry out technical briefings in the form of "scheme explanation + case demonstration", to explain the construction requirements of green construction for various links for construction teams. To distribute and implement work instruction, key process specific training for the head to master Operational Key Points, in order to avoid misunderstandings that lead to inadequate scheme execution.

3.2 Implementation of Process Green Control

Setup a digital control platform for monitoring data of Energy consumption, Carbon & Waste Generation volume (real-time) The platform should come with auto comparative analysis charts. If energy consumption in any link exceeds the design indicator by 10%, an automatic warning should be displayed. Construction simulation, a branch of BIM technology, can be used in process optimization to predict several interdisciplinary conflicts (e.g., spatial clashes between pipelines and structural components), optimize the construction sequence (i.e., rework avoidance) that consumes material and energy waste. Modified construction schemes according to site conditions, as for those continuous rainy weather, concrete materials in outdoor air would be lost and affect the project schedule seriously, thus arrangements should be indoors without outdoor air [5]. Supervision and inspection conduct "daily patrols + regular checks". A dedicated safety officer can be expected to make daily verification of implementation of environmental measures like operating spray equipment and covering dust nets. Weekly joint inspections of different departments need to check the authenticity of data and completeness of records like waste recycling. Notify authorities about the identified problems by issuing rectification notices with deadlines and re-inspection criteria to ensure closed loop problem handling.

3.3 Post-Construction Green Acceptance Evaluation

When checking in the acceptance stage, check it one by one according to the follow-up green building evaluation standards. On-site testing to confirm energy-saving effects, such as obtaining U-values for the heat transfer coefficient of external walls and air tightness of doors and windows. The indicators for utilization of resources should be verified by checking the actual values of the recycling rate of waste and the recycling rate of water resources against design guidance. Ecological Protection: Evaluation of the restoration status of temporary land use and vegetation survival rates, etc [6]. Third-party professional agencies should be invited to evaluate. Based on the data obtained from tests conducted at site and construction records, an evaluation report should be prepared by the agency with regard to rationality of technology application, degree of indicator achievement achieved and effectiveness of environmental impact control for each project. The report will

highlight shortfalls including cause analysis for any aspect in which carbon emissions are above thresholds. Experience summary focuses on summaries of successful practices and lessons learned around construction process, as well as establishing a green construction technology manual. The purpose of this instruction should be to avow the optimization schemes in different cases, for example resource recycling mode under various terrain conditions, which could give a reference for other similar projects afterwards and encourage constant improvement and spread of green construction technology.

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

4.1 Technology Upgrades to Meet Green Demands

Generate research work on green technologies, setting up an industry technology trend tracking mechanism based on data accumulation to regularly obtain technical parameters and application cases of new energy-saving materials/construction processes. In the aspect of energy-saving insulation materials, mainly study thermal conductivity coefficient, compressive strength, service life and environmental performance of the materials to analyze energy-saving improvement compared with traditional materials. In the case of modular construction technology, do an analysis based on component prefabrication rate, on-site assembly time and cost comparison? Pick some parts of the project to implement on a pilot basis. Example: Start testing new insulating materials on the outer walls of a single building in terms of how they appear during operation, their construction cycle and energy-saving effects when constructing. An new photovoltaic panel installation processes power generation monitoring, will be in October to 2023 months. Verify technical feasibility and adaptability (pilot data) [7]. Once piloted successfully, create a marketing plan that clearly defines standards for construction, quality control points and equipment configuration requirements for the application of technology. It encompasses parameters such as bond strength, thickness when applied, and the establishment of standard operational procedures for transportation, hoisting, and splicing of modular construction components. Specialized technical training for construction personnel to master the operational key points of new technology, in order to avoid problems such as the adverse impact of poor connection between new and old technologies on construction quality and green effectiveness. Finally, you will reach the ultimate depths of adaptation between technology upgrades to green demands.

4.2 Refining Management Modes for Green Assessment

Develop an eco-friendly construction management system. Compile the "Green Construction Management Measures", clear all departments and personnel of green construction responsibilities, including: technical chart for green construction measures, control by on-site department, assess mode department collects monitoring data. Set up a green indicators database including core indicators such as energy consumption, carbon emission, waste recycle and water resources utilization with industry mega values and Project target values for each indicator. Layered, Top-down from the Green indicator → Split decays according to construction phase and work team. Disintegrate the overall energy-saving rate target of the project into phases such as foundation, main structure, decoration, and then breakdown it to electricity quota and fuel quota for each team. Define the assessment cycle (daily, weekly, monthly) and the person that collects data for each indicator [8]. The assessment methodology is achieved via a combination of process assessment + result evaluation. Gather indicator data in real-time via the digital platform; weekly reports enable team self-assessment. Additional bonus for teams that save more than their target, and interview under performing teams to produce a plan of corrective action. Perform aggregate assessments every monthend at a site level, piloting adjustments in scores based on implementation and results of checks, such as logbooks for waste recycling. Directly tie the assessment results to team performance and individual reviews Encourage construction personnel to take the initiative in enforcing green construction requirements through careful monitoring without management

becoming a mere formality.

4.3 Strengthening Material Control for Green Traceability

Screen the green building material supply chain. Create supplier portal or pairwise access to obtain green building materials certificate and environment performance test reports from suppliers. Check if the supplier has the qualifications for production and are they using eco-friendly manufacturing 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]. Following strictly the incoming inspection. Perform unified acceptance of incoming materials by the purchasing, technical and environmental departments. Validate material models, specifications and certification reports for consistency. On-site sampling of critical indicators (e.g. VOC content for coatings, thermal conductivity coefficient for insulation materials). Banned from entry Crossing into the site is strictly prohibited for those materials who fail tests. A separately established electronic traceability file for each batch of materials records the supply chain; including supplier information, production batch, test report number, arrival time and use location; achieve "traceable source, trackable destination" of materials. Conduct whole-process tracking management. Material Tracking Monitor the use of materials to ensure that green building materials are used as designed to prevent substitution with non-green materials. When the project is complete, compile material traceability files for each major portion of work; these represent key evidence that a green building will be accepted. To achieve whole-chain control over the construction process, strictly block non-green building materials from entering the site, and promote green construction quality from the source.

5. Conclusion

Research on green building construction in engineering projectsBased on the discussion above, it can be easily found that three principles should be followed for green building construction in engineering projects:1) Low-Carbon Priority (emission prevention of carbon and pollutants),2) Efficient Resource Recycling [improving efficiency of resource utilization],3) Ecological Protection Coordination (there exist some environmental impact). The green construction process should be carried out in an orderly manner from pre-preparation, process control to post-construction acceptance. Optimization strategies should address three areas: Technology, Management and Materials. Technological upgrades satisfy demand, improved evaluation bolsters management, and green traceability manages raw materials. The combination of these three areas ensures that green construction works — developing the right project, delivering the right project, and creating a positive outcome (benefits / efficiency).

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