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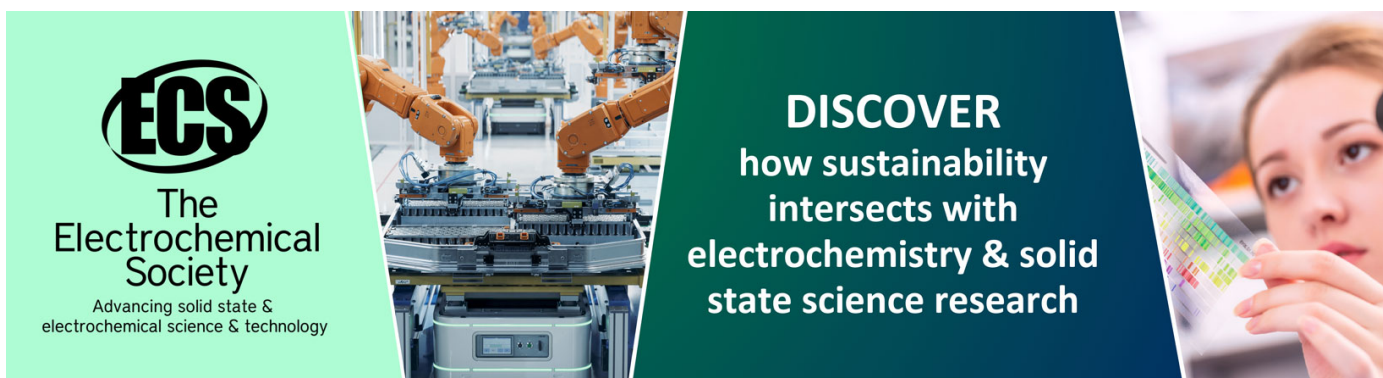
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The development status of construction equipment and technology in China

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Abstract. In recent years, with the continuous development of urbanization in China, construction equipment and technology in the field of building are developing rapidly. China has made much progress in this field, but there is also a gap in comparison. Rapid growth needs to follow the appropriate direction of development. In the future, China will further accelerate the speed of urban intensive construction, so it is of great significance to find a correct direction for the development of Chinese cities. Based on this purpose, this paper summarizes the current situation and rules of building equipment and technology in the view of the rapid development of modern architecture and related practical achievements. This article further analyses the building technology and equipment from the aspects of social culture, political economy, laws and regulations, and discipline development. The conclusion is that in the future development of buildings, the energy saving of construction equipment and technology will become an important symbol of construction technology progress. Finally, this paper puts forward the problems existing in the development of construction equipment and technology in China and the ways to solve these problems.

1. Introduction of Chinese architecture

From the background of modern Chinese architecture's development, Chinese architectural structure and quality mainly go through four stages.

The first stage was the period from the 1950s to the mid-1960s. The main purpose of the building during this period was to solve the residents' housing problems. The construction materials were relatively simple, the architectural styles were relatively common, and the quality of the buildings was not bad.

The second stage was the period from the subsequent 1970s to the 1990s, a period of reform and opening up for China. Especially during the 1990s, the rapid economic development led to large-scale construction, while, there was a shortage of technologies and resources. The architectural style of this stage began to be diverse, but due to the low level of construction technology, the quality of the building was unsatisfactory.

The third stage was from the 1990s until present. The nation's policies and regulations have gradually improved. The improvement of the construction supervision system, technical specifications, and improvement of corporate qualifications have greatly improved the overall construction technology level. The quality of construction has greatly improved, and the high-rise building construction equipment and technology have witnessed a rapid growth.



The fourth stage was the Chinese development into the "13th Five-Year" stage; Chinese architectural structure began to change gradually, in many fields in search of efficient, environmentally friendly and energy saving structure style. Construction equipment and technology also appeared and a new development direction was influenced by the construction structure.

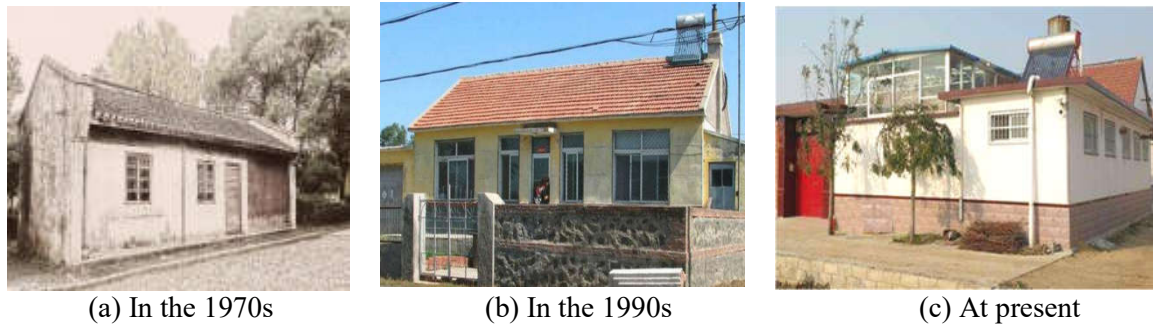


Figure 1. Rural Architecture Style in Northern China.

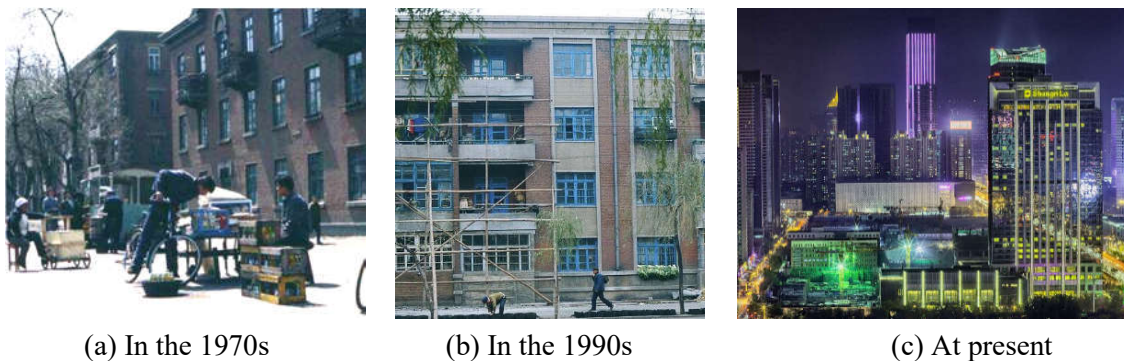


Figure 2. Urban architectural style of China.

Figure 1a, b, c and figure 2a, b, c are miniatures of rural and urban architectural styles in China. After the development of building structure, such as brick-wood, brick, steel and reinforced concrete, modern architectural design, construction and maintenance determine the appearance, applicability and service life of the houses. Among them, construction as the core link of building formation is a complex process. It is necessary to apply materials theory, mechanics, structural science, technology and so on to solve various problems in construction, to ultimately ensure projects' quality and construction's safety [1].

The rapid development of the Chinese economy in the past decade has accelerated the pace of urbanization in China. The changes in the new countryside and new cities can be described as earth-shaking. Buildings with low security have experienced new generations of upgrades. Self-built houses in City Village and old houses, which called for hidden safety concerns, have all been greatly improved. Looking at the overall situation, the development of architecture meets law of human settlements. In the 19th century, it was the stage of bridges' and roads' construction. In the 20th century, it experienced the development of high-rise buildings and above-ground space. In the 21st century, it will enter the challenge of joint development of above-ground space and underground space [2].

2. Present situation in construction technology

The planning, reconnaissance, design and construction constitute the processes of project construction. Construction technology as its final link has important significance for the construction project. With the development of urban buildings to vertical heights and underground structures, the scale of

construction projects continues to expand, resulting in breakthroughs in engineering that rely more on improvements in construction processes and construction equipment [3].

Construction technology will be divided into foundation engineering, structural engineering, and decoration engineering. In this paper, the development of building construction technology will be described in terms of lines instead of surfaces.

2.1. Foundation engineering

The technology development focuses on pile forming technology, deep foundation pit supporting technology and waterproof technology. The traditional precast concrete piles have been replaced by concrete cast-in-place piles and immersed cast-in-place piles because of noise pollution. At present, multi-pile optimal construction mode has been formed in Chinese foundation engineering, according to the conditions, the different pile bodies and corresponding construction methods can be chosen. The technology of deep foundation pit support should deal with the choice of complex construction process and the implementation of waterproofing works. Waterproof construction technology is mainly applied to water conservancy projects, bridges, and underground constructions. Construct and material waterproofing technologies are gradually established. Waterproofing methods have developed to form a combination of “defense, row, cut-off, and plugging”, which is suitable for the local conditions and comprehensive construction methods [4].

2.2. Structural engineering

The transportation of construction materials and the lifting of materials are the development directions of construction technology. The research of construction technology focused on noise control, identification of working conditions for power matching, reducing equipment wear, extending equipment life, reducing energy consumption, etc. While the construction equipment is designed and developed from a variety of equipment models according to the engineering form, the equipment type spectrum is also constructed.

The development of building structural materials is focused on reinforcing steel and concrete materials. For example, pre-stressed concrete technology has greatly improved the overall strength of the structure, making the reinforcement of concrete and concrete more stable, and the concrete mixing construction technology improves the performance of concrete as well. The traditional concrete that only meets the strength of the building is developed into a new type of concrete that can satisfy many performance criteria.

The development of concrete modification additives has also improved the anti-permeability, antifreeze, and anti-expansion saturation retardation properties of concrete construction. The formwork in structural construction has gone through the development of bamboo plywood, wood plywood, all steel formwork and all aluminium formwork system. In the future, the research of the concrete manufacturing process, the improvement of the forming precision of the formwork, the automatic processing and mechanized connection of the reinforced material in the concrete and the reduction the working strength of the employees will be the key issues. On the other hand, the progress of steel structure construction technology has solved the problems of long-span and earthquake resistance of buildings, greatly improving the development of assembly construction of building structures.

2.3. Decoration engineering

The standardization of curtain wall design and construction technology, vertical transportation technology and building external wall insulation technology have been formed. The development of various curtain walls has greatly improved the appearance, thermal insulation and heat protection of the exterior walls.

The progress of insulation materials and construction technology has also improved the overall technical level of decoration. The emergence and application of the automatic climbing frame constructional technology with mechanized greatly shortens the period of the high-rise building

decoration engineering. The general use of the high suspended access platform reduces the working strength of the construction personnel, improves the construction safety, and can complete the construction from the bottom to the top. The construction quality is guaranteed effectively, the construction site is saved and the operation efficiency is improved, but better equipment is needed to ensure the safety and efficiency of the construction.

2.4. Construction industrialization

The industrialization of construction is being popularized in China and the rapid development in the construction technology is lack of construction equipment and technology [5].

From the view of building construction technology in China, the construction process is a variety of parallel operations in limited time and space, many kinds of materials are supplied at the same time, and various kinds of equipment are operated in synergy. Therefore, it is of great significance to seek scientific and advanced construction technology and construction equipment, and to reduce the consumption of a large number of human, material and financial resources in the construction [6]. This requires a reasonable organization and management measures.

The current stage of its development has experienced system-to-item, coarse-to-fine, continuous accumulation of construction experience, formation of construction regulations and improvement of construction processes. At the same time, the complex construction technology, such as the application of top-down methods in high-rise building construction, can effectively improve the quality of construction projects. At present, the focus of the construction process is mainly on the quality, safety, progress, and cost of the project construction. And its development trend is the development of environmental protection, ecological impact, green materials and green construction.

There is a certain contradiction between the transformation of construction technology and the development of market economy. In the contemporary Chinese construction, it is urgent to improve the system and concept of the construction process. In addition, BIM technology is a new technology that is being vigorously promoted in the construction industry [7]. It is a major change in engineering and can effectively coordinate multiple parts. It can play an active role in the entire life cycle of the project.

3. Comparison of the development of construction equipment

To realize the sustainable development of buildings, it is necessary to implement sustainable development ideas throughout the life cycle of construction decision-making, design, construction, and operation. The construction process is a stage of concentrated influence on the environment, it is also the stage of direct consumption of resources.

The technical level of the equipment will directly affect the construction level of the project, and it is the key factor for its evaluation. Therefore, the design and manufacture of energy-efficient, environmentally friendly equipment will be more conducive to promoting the development of green construction.

Here is only a comparison of typical equipment in construction. First of all, the development of lifting equipment, large scale, multi equipment co-operation, mobility, preparatory convenience and equipment specialization are its development direction. The development of hoisting equipment diversity in China is shown in figure 3a, b, c, d.

Second, the development of concrete equipment. Concrete preparation, concrete transportation, and concrete molding are the major tasks for such equipment. The preparation equipment is developing in the direction of automation, informatization, refinement, and uniform mixing. The transportation equipment is developing in the direction of high, far, and adaptability. The molding equipment is developing in the direction of mold releasing easier, higher molding accuracy, simple assembly of complex shapes, and high-efficiency vibration forming. At the same time, concrete injection equipment is rapidly developed.

With regard to the construction of reinforced concrete structures, steel processing equipment is also being developed toward large-scale, integrated, and automation. The emphasis is on improving

equipment utilization, reducing the labour intensity of operators, and reducing material waste. Among them, the numerical control processing technology is better applied in the steel processing equipment. The development of piling equipment is based on the integration of mechanical and electrical fluid and information control technology, forming a series of piles, such as whole casing construction equipment, high end continuous wall grooving equipment, multi-function pile working equipment, water drilling equipment, large diameter DTH hammer, large vibration hammer and impact hammer. The last is the maintenance equipment outside the building, which is called the building maintenance units(BMU) in the European standard, which is often divided into two types, the permanent maintenance equipment and the temporary overhead operation platform, as shown in figure 4a, b, c.



(a) Large crane



(b) Machine cooperation



(c) Special lifting equipment



(d) Wheeled mobile crane produced by Xugong

Figure 3. Development of lifting equipment.

4. Problems in the development of construction technology

The rapid development of economy will inevitably lead to lax enforcement of the system. And the quality of construction is threatened. The problems presented in the development of construction technology can be analysed from the three levels of technology, systems, and concepts.

The main technical problem is that the rapidly expanding construction industry has caused the overall level of construction technology to be affected by the overall quality of the operators and the technical level of construction equipment.

It can be summarized as human factors and equipment factors. In the current rapid development of industrialized construction methods, it is obvious that a large number of qualified and qualified industrial operators and equipment are lacking.



Figure 4. Construction maintenance equipment.

In institutional aspects, due to insufficient technical conditions or human negligence, the disordered competition and extensive management lead to construction quality defects and regional safety accidents. The vicious competition within the industry that has no technological breakthrough gradually leads to serious obstacles in the development of manufacturing enterprises, lease companies and construction companies of construction equipment. Sell shoddy product, cutting materials, counterfeiting, price war, qualification instead of supervision become high-frequency words. This problem will lead to safety-related industries in building construction and become a high-risk industry where the path is sought in the fog and walks on the steel wire.

As for the concept, it is influenced by the target of short-term interests, which leads to problems in the development of building construction, such as the lack of implementation of a series of norms and the neglect of the environment and ecology. Building construction becomes an important factor causing environmental damage. China lacks the professional team of construction engineering. The composition of construction personnel is complex, the overall quality is not high, and the phenomenon of aging is serious, which forms a disadvantage to the construction process and systems and technology promotion, and limits the scale development of advanced construction technology.

5. Green building and green construction

At present, to "establish a sound green and low carbon cycle of the economic system, form a green development mode and way of life", is the concept of scientific development in the new era of China. It is a rare historical opportunity to further promote and accelerate the development of green buildings and related technologies.

During the construction process, a lot of resources and energy are consumed, and the pollution of waste water, waste gas, solid waste, dust, noise and strong light will bring risks to the environment safety. The "sustainable development" and "green" concept promotes "green construction" and avoids safety and environmental accidents under the overall goal of energy saving, water saving, material saving, land saving, and environmental protection. And also reduces the impact on the lives of ordinary people. In the process of transformation from volume construction to concept construction, we need to carry out specific research and exploration on green construction theory, method, management and technology for green building projects. And to find out the standards and technical measures for the green construction management suitable for Chinese development. Researchers should give full play to the advantages of methods such as field investigation, literature review, quantitative analysis, repeated argumentation, and laboratory tests. Correctly understand the necessity and urgency of green construction. In practice, the management ideas of green value are highlighted, with green construction technical measures and technical points as the core, the problems existing in the construction are constantly exceeded, and the problems are solved in time and effectively and reasonably. Formulate long-term measures to prevent problems from expanding and happening again.

The construction design and construction should be standardized from the aspects of green materials, green machinery, green work method, green mold frame, construction industrialization,

information, resources and recycling of waste. Improving green construction theory and developing green construction technology. Construction of green building promote harmonious, healthy and sustainable development of man, man and nature, man and society. This is of great significance not only for China and the world, but also for building an ecological community.

Beset by environmental and ecological problems, traditional buildings will gradually be replaced by sustainable green buildings. The energy saving green construction technology not only conforms to the goal of the sustainable development of the construction industry, but also conforms to the trend of technical development. The construction technology of mechanical automation is gradually replacing the artificial construction which can not control the quality of the construction steadily. The fine construction will gradually replace the old and extensive construction. Green construction technology instead of high energy consumption and heavy pollution construction technology, and eventually form a green construction system.

The concept of new architecture, such as green building, is mainly to solve the problems of some traditional buildings, such as the waste of resources, environmental pollution, and ecological destruction. After the green building thinking has been put forward, more attention has been paid to green construction technology in construction. In the development of modern green management technology and the process of construction, designers should fully consider the idea of saving materials, water saving, energy saving, land conservation and environmental protection, and integrate the protection of the living environment into the construction technology. At the same time, the concept of green building and green construction has the characteristics of environmental protection, which can reduce pollution to the environment and improve the ecological balance. In green construction, more attention is paid to providing comfortable working environment and safety guarantee for operators, reducing noise and improving work efficiency. The development of modern BIM technology provides more detailed and visualized advantages for building construction. It can cope with modern complex architectural structure, optimize the overall design scheme and construction process, improve the rationality and operability of construction technology, and gradually form a green construction system.

New concepts, new historical periods and changes are bound to bring many new opportunities, accompanied by challenges. In the process of its advancement and development, people can refer to mature manufacturing and look for green development routes with manufacturing technology. Combined with the current situation and trend, green building and green construction technology are put forward to further enhance the overall operation capacity of green construction. The top-level collaborative design and development of construction processes and technological innovation, and the development of innovative equipment such as building machines, will form an innovative system of construction technology to achieve energy-saving and environmental protection throughout the entire life cycle of a building. Figure 5 shows the busy construction process at a modern construction site.



Figure 5. Busy construction site at a modern construction site.

6. Development and reflection

The role of government policy is still the main driving force for the development of construction equipment and technology in China. The improvement of market position also has a selection. In the future, building construction technology will move toward information, automation, artificial intelligence, and environmental protection and energy conservation. The development of information technology will experience the stage of data collection - optimization - standard contrast - guidance output - fully automated control. At present, the information technology is in the information collection stage to improve the construction site process monitoring information collection and processing. On the other hand, a large number of operations, such as simulation, evaluation, prediction and management, will greatly improve the construction process of construction projects by using computer technology. The development of equipment and technology follows mutual infiltration and mutual influence. The rapid development of information technology in the future will inevitably affect the innovation of construction equipment and the improvement of construction process, prompting the development of simultaneous development. At the same time, we need to pay more attention to the induction and summarization of technology, and to combine fast and slow as the development planning method. The minor problems in the process of construction should be paid attention to, and the professional problems such as terrain, surrounding environment, building structure and protection measures can be fully taken into account. Forming a whole cycle of sustainable development, green and healthy business philosophy-getting rid of interests is the only goal pursued by enterprises, and they dare to shoulder their due social responsibilities.

The construction company must clarify the market demand and reflect on the long-term relationship between the market and the technology level of the enterprise itself. The company must continuously improve its own construction technology, introduce new equipment and new technologies at a proper time to adapt to market development, and actively learn advanced construction technology. To improve its own defects and create a new pattern of continuous, stable and healthy development in the industry.

Development goals: The construction company must correctly grasp the diversity of the construction plan and select the best construction technology and construction plan after scientific demonstration. According to different projects, choose suitable methods according to local conditions, adopt scientific and effective management to implement the construction process.

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