On the Sustainable Development and Realization of Civil Engineering

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ABSTRACT

The whole civil engineering process needs to be based on the constant consumption of resources and energy. When sustainable development becomes the theme of the entire society, civil engineering will inevitably face this problem. This paper discusses the realization of the sustainable development of civil engineering from several aspects such as the sustainability of civil engineering, the development of sustainable civil engineering materials and the evaluation method of sustainable civil engineering.¹

BACKGROUND

The Concept of Sustainable Development

Sustainable development is new concept put forward in the 1980s. Sustainable development refers to development that meets the needs of the present generation without jeopardizing the ability of future generations to fulfil their needs. In other words, it is refers to the coordinated development of economy, society, resources and environmental protection, which are an inseparable system, to achieve the purpose of developing the economy, the survival of humans and to protect the atmosphere, fresh water, sea, land and forests and other natural resources and environment, enable future generations to sustainable development and to live and work in peace and contentment.

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Sustainability in Civil Engineering

It is well known that the entire civil engineering process is built on the constant consumption of resources and energy. In recent years, with the speeding up of the urbanization process in China, the consumption of resources and energy is larger than before. In 2009, a research report of the strategic consulting project of "research on the development status and frontier development direction of civil engineering" established by the Chinese academy of engineering pointed out that China is the country with the largest resource and energy consumption of civil engineering in the world, and civil engineering industry has become the industry with the largest single energy consumption in the country. Every year, China consumes about half of the world's steel and cement for infrastructure construction, while cement and steel account for more than 30% of the total carbon emissions [1]. So it requires the civilian engineering will toward the orbit of sustainable development.

Resource and energy constraints have become increasingly prominent, and the carrying capacity of environmental ecology is approaching its limit. Therefore, the demand for high performance structural engineering technology is increasing day by day. So-called high performance structural engineering, namely civil engineering structure in the planning, design, construction, operation and demolition of the whole life cycle stages, with high safety performance, high construction performance, high service performance, high environmental protection performance, high durability, high maintenance and high economic performance. It is a key way for the sustainable development of civil engineering[2]. China's urbanization has entered a new stage of "high-speed promotion" to "quality improvement". As an important carrier and symbol of urbanization, civil structural engineering will surely become one of the core breakthroughs in improving the quality of urbanization in China[3].This paper discusses the realization of the sustainable development of civil engineering from several aspects such as the sustainability of civic engineering, the development of sustainable civil engineering materials and the evaluation method of sustainable civil engineering.

REALIZATION OF CIVIL ENGINEERING SUSTAINABILITY

The Sustainable Development of Civil Engineering in the Whole Life Cycle

The conservation of resources and energy is reflected in the entire life cycle of civil engineering, including from planning, design, construction, maintenance and demolition after completion, which should minimize the impact on the environment as much as possible, while giving full play to its social and economic effects.
PLANNING AND DESIGN STAGE

With the increasing expansion of civil engineering facilities, the application of system engineering theory and method has enhanced the level of planning and design. From planning site selection, scheme demonstration and preliminary design to construction drawing design, not only focus on the rationality and advancement of the scheme, environmental problems also mentioned the same important position. The attention to the environment directly affects the degree of entity in the construction, operation and final demolition and recycling of the environmental impact of each stage. Major civil engineering projects, such as large dams, can cause changes in the natural environment, affect ecological balance and agricultural production, etc. The social effects of such projects are both positive and negative [4]. In the planning, the advantages and disadvantages should be considered comprehensively. For example "Shanghai center", as China's tallest building, green, environmental protection, energy saving is the direction of development in its early project planning. It incorporated 43 green building technologies.

THE CONSTRUCTION PHASE

The construction stage is the process of large-scale change of the natural ecological environment, consumption of energy and resources. Copious quantities of building materials will be consumed during construction, which will generate dust, noise, waste pollution and so on. In the construction process with the idea of sustainable development, positive and effective measures will be taken to promote green construction, which will save resources and reduce negative impacts on the environment to the maximum extent, and realize energy saving, land saving, water saving, material saving and environmental protection. It named "four sections and one environmental protection". For instance, more than 2 billion yuan has been invested in the construction of the qinghai-tibet railway, accounting for 8 percent of the total project investment. To protect the fragile ecological environment of the qinghai-tibet plateau and reduce its impact on the ecology, the selection of lines is planned in accordance with the principle of "avoid by avoiding" and open up migration routes for wildlife. Construction site, access road, sand and stone field are repeatedly explored to to prevent damage to vegetation as much as possible.

The Hong Kong-Zhuhai-Macao Bridge has been rated by the Guardian as one of the "seven wonders of the modern world" and praised as "China's Mega Projects " by the media[5]. "Green environmental protection and sustainable development" is a pioneering idea put forward by the project. Island tunnel construction across the Chinese White Dolphin reserve area, especially for the construction of environmental protection requirements. The construction of artificial islands and the reinforcement of the foundation of the sea floor reflects the harmonious coexistence between man and nature[6].

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USE AND MAINTENANCE PHASE

In the actual use process of civil engineering, there will be damage or performance degradation of different degrees, which will affect its carrying capacity and durability, and even lead to serious engineering accidents, which will bring serious human casualties and economic losses and have serious social impacts. Around the world, America's modernisation process is advanced. Today's data suggest that America will spend $1.6 trillion in future to address the insecurity of existing projects, such as building rust caused by chloride ions. Therefore, from the moment the building is built, it should be ready for health monitoring, repair and reinforcement.

With the rapid development of modern sensing technology, computer and communication technology, signal analysis and processing technology and structural dynamic analysis theory, people have put forward the concept of structural health monitoring, which has brought revolutionary changes in the development of civil engineering. By installing various sensors on the structure, the structural health monitoring system can automatically and real-time measure the structure's environment, load and response, etc., evaluate the structure's health status, scientifically and effectively provide the decision-making basis for structural maintenance and management, ensure the safe operation of the structure and extend the service life of the structure.

STEPS OF DEMOLITION AND RECYCLING

Civil engineering structures will face elimination and demolition after reaching the normal life of design, which will inevitably cause environmental pollution and generate a large amount of construction waste. Construction waste takes up land, reduces soil quality, affects air quality, causes water pollution, and so on[7]. At the end of a building's life, it will become waste. These construction wastes can be completely transformed into renewable resources and renewable products.

Japan's aichi expo gives us a vivid lesson. In terms of materials, all kinds of building materials for the expo look high on the surface, but many of them are wasted. Taking reconstruction of "5.12 wenchuan earthquake" as an example, it is very important to use waste concrete as recycled aggregate to produce recycled aggregate concrete. The use of waste building concrete and waste bricks to produce coarse and fine aggregate can be used to produce concrete and mortar of corresponding strength grade or to prepare building materials such as masonry, wall board and floor tile. Solidified materials can also be included in the coarse and fine aggregate of roads.

Sustainable Development of Civil Engineering Materials

With the progress of science and technology and the increasing improvement of people's pursuit of the safety and comfort of living environment, engineering
structure also has new characteristics and new requirements, which is largely benefited from the application and development of new materials and new technologies with excellent properties. This includes not only steel and concrete as major structural materials, but also FRP composites (fiber reinforced plastic), ministerial and other new materials.

In recent years, with the development of super high-rise buildings and large-span spatial structures, higher requirements have been put forward for steel strength and other indicators. For example, national stadium used Q460E, water cube project used Q420 and CCTV new site used Q460, all of which were specially demonstrated. Adopting high strength steel can reduce the amount of steel, thus greatly reducing the consumption of iron ore resources. It can also reduce the environmental damage caused by resource exploitation, which greatly promotes the implementation of sustainable development.

The concrete material is widely used in civil engineering[8]. Concrete has gradually evolved from the simple structural material in the traditional sense into a new functional material with perception, repair and high damping. At present, intelligent concrete has been developed, such as self-sensing concrete, self-adjusting concrete and self-repairing concrete, which has significantly improved the safety and durability of concrete structures and opened up new ways for creating new structures and components.

As a kind of high-performance material, FRP composite material is light and high strength, has good fatigue and corrosion resistance, durability, convenient construction and good designability. With its excellent mechanical properties, FRP has been widely used in bridge engineering, civil architecture, Marine engineering and underground engineering, and received extensive attention in the field of structural engineering. For example, the use of FRP concrete or FRP-concrete composite structure can fundamentally address the issue of steel corrosion in Marine engineering.

Nanomaterials are one of the most dynamic innovative materials and have made remarkable achievements in recent years. As American scientists have estimated, "this microscopic substance, invisible to the human eye, is likely to revolutionize every field." Nano-composite building coating and nano-pore, super insulation materials have been gradually applied to engineering structures. The application of nano-photocatalytic technology in building materials, the application of nano-materials in waterproof sealing materials and the application of nano-materials in concrete materials is being extensively studied[9].

The research and development of the new materials and technologies mentioned above has greatly improved the engineering structure's ability to cope with sudden natural disasters such as earthquakes and hurricanes, and greatly reduced the frequency of accidents caused by environmental erosion, material aging and fatigue effect after long-term service of the engineering structure, thus improving the safety of the structure and disaster prevention and reduction ability.
Evaluation Methods for Sustainable Civil Engineering

The world economic cooperation and development organization has given four principles and one assessment factor to sustainable buildings. The first is resource application efficiency; the second is energy use efficiency; the third is pollution prevention; and the fourth is environmental harmony.

Some domestic scholars have proposed characterizing the sustainability of civil engineering by such indicators as unit time resource, energy consumption and the impact of unit time on the environment. At present, these indicators are only at the conceptual stage, and need to be further studied.

CONCLUSIONS

Therefore, civil engineering, as the pillar industry of the national economy, should take a long-term perspective and not only promote the sound and rapid development of the national economy, but also strengthen the conservation of energy and resources and the protection of the ecological environment.

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