High-strength Engineered Biomaterials Study and Development Needs in China

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Engineered biomaterials play a crucial role in the construction industry. The study and development of engineered biomaterials with high-strength are necessary to fulfill the construction requirements for medium and high-rise buildings and long-span bridges. Further promoting the localization of high-strength engineered biomaterials is crucial in terms of reducing CO_2 emissions, effectively utilizing land resources, and taking into account the unique structure of forest resources in China. The goal of this modification is to satisfy the rising demand for eco-friendly living spaces.

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Sustainable Development

Sustainable development has emerged as a consensus at the global level, particularly in the context of the construction industry, which is known for its significant energy consumption. Transitioning to green and low-carbon construction practices is becoming increasingly important to meet sustainable development goals. In this context, engineered biomaterials based on wood and bamboo have gained global attention due to their potential for energy saving and emissions reduction.

Compared to traditional structures such as brick, concrete, reinforced concrete, and steel structures, modern timber and bamboo structures consume considerably lower amounts of energy. Specifically, the energy requirement per square meter for wood structures is approximately one-sixth of that for brick-concrete structures, while bamboo structures use only a third of the energy that brick-concrete structures require. This remarkable reduction in energy consumption highlights the environmental efficiency of these materials. In the context of China's ambitious goals to reach a carbon peak by 2030 and achieve carbon neutrality by 2060, the development of modern wooden and bamboo structures is becoming increasingly important. These structures not only offer benefits in terms of carbon reduction but also contribute to carbon sequestration, making them a vital component in China's strategy to achieve its sustainability goals. Therefore, the promotion and implementation of wooden and bamboo structures can be seen as a crucial step towards fulfilling these national and global environmental commitments (Loss *et al.* 2018).

Efficient Land Utilization

Optimizing resource use and efficient land use are vital guidelines for natural resource management. High-strength engineered biomaterials, such as Cross Laminated

Timber (CLT), demonstrate notable advantages over traditional lightwood structures which typically consist of one or two layers (Ettelaei *et al.* 2022). CLT is characterized by stable material properties, high component load-bearing capacity, and high transverse stiffness (Li *et al*. 2021). These properties make it well suited for long-span structures as well as medium to high-rise buildings. An illustrative example is the 18-story student apartment at UBC University, which utilizes a frame-core-tubular structural system with CLT for horizontal structural components from the 2nd to the 18th floors. The introduction of high-strength Engineered biomaterials demonstrates effective utilization of construction land.

On the other hand, various high-strength engineered biomaterials, such as Cross Laminated Bamboo and Timber (CLBT) (Xiao *et al.* 2021), bamboo scrimber (Huang *et al*. 2019), glubam (Sun *et al*. 2020), compressed timber (Namari *et al.* 2021), *etc*., have been studied and developed. Such materials have excellent mechanical properties and are expected to provide an effective solution to China's pressing problem of limited construction land availability and utilize the country's rich bamboo resources for sustainable architectural development.

Unique Forest Resource Structure

China's unique forest resource structure is characterized by abundant bamboo and relatively scarce wood resources. Studies on bamboo structures, timber structures, and composite construction systems suited to the nation's particular needs have been conducted during the past thirty years. Considerable incremental progress has been made as a result of these efforts. Despite these advancements, China's use of bamboo and wood structures—which are mostly found in public buildings and landscapes—remains mostly in the demonstration phase. The high costs of design and construction technologies limit the widespread public acceptance of modern wooden structures, which frequently rely on imported materials. With roundwood imports valued at 57.95 billion yuan and sawn wood imports valued at 52.74 billion yuan, for a total value of 110.69 billion yuan (Li *et al*. 2022), China has emerged as the world's largest importer of wood.

Nonetheless, there is a growing market for ecologically conscious and green residential construction. Creating highly durable, engineered biomaterial structures that make use of China's unique forest resource structure could be a workable way to satisfy this demand. This strategy is in line with goals for excellent, sustainable human settlements and also efficiently utilizes available local resources.

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