【Grant - in - Aid for Scientific Research on Innovative Areas(Research in a proposed research area)】
Interdisciplinary Area

Title of Project : Elucidation of the strategies of mechanical optimization in plants toward the establishment of the bases for sustainable structure system

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Research Project Number : 18H05484 Researcher Number : 40272009

【Purpose of the Research Project】

As environmental and population issues are worsening at the global level, efforts to build up a sustainable society are accelerating. The creation of a sustainable living space, in harmony with the surrounding environment, is one of society's most important endeavors, even in the fields of manufacturing, architectural design, and urban planning.

In recent years, approaches in engineering using biomimetics have been pursued. Additionally, studies on plant cell walls have demonstrated that plants are excellent structural systems that autonomously optimize their mechanical properties in response to various environmental factors.

Based on the above background, this research project aims to understand the mechanical optimization of plants on a multi-scale (molecular, cellular, tissue, and individual) level. Also, we aim to sublimate the mechanical optimization strategy of plants into new energy-saving / material-saving building designs, new material models, and to create a base for the next-generation of sustainable structural systems (Figure 1).

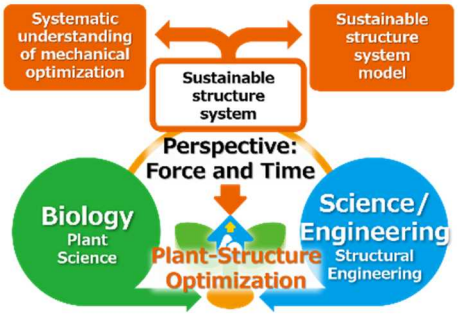

Figure 1. Research strategy and expected achievement

【Content of the Research Project】

In this area, we will create a foundation for a new principle of architectural structure system based on the "mechanical optimization strategies" hidden in various phenomena operated by plants. For this purpose, three research groups are set. Group A01 "System" will aim to understand the mechanical phenomenon at the organ-individual scale and will propose the new "building system". Group A02 "Module" will elucidate the mechanical phenomenon on the cell-tissue scale and will provide new module designs. Group A03 "Unit" will analyze the mechanical properties on the subcellular scale and will develop units (building materials) in construction.

【Expected Research Achievements and Scientific Significance】

One of the expected outcomes is the development of a new "structural system model" based on the mechanical optimization strategy of plants. We will thus utilize the knowledge of the structural-mechanical features that give plant cell walls their strength and plasticity to build up a next generation material model. It is also expected that "mechanical optimization" will be added to our knowledge of the growth strategies of plants, especially our insight into the fundamental principles for stable growth of organisms in harmony with the internal and external environments, which may rewrite the basic principles of biology. In addition, this research area is looking forward to the creation of a new scientific field that can directly contribute to the construction of a sustainable society. The academic achievement of this area will be relayed to social implementation technologies in the future. Particularly, we are expecting sustainable construction in harmony with various environmental factors unique to this country (earthquake, typhoon, temperature difference of the four seasons, etc.).

Furthermore, this research will contribute to the establishment of next-generation bio-based technologies, through the engineering of the functionalization of plant and their capabilities to respond to environmental stresses, thus generating plants that can withstand global environmental changes.

【Key Words】

Mechanical optimization: To change the body structure of living organisms into a mechanically optimized form during development and environmental response.
Sustainable structural system: A space structure with high sustainability even in exhaustion of resources and energy with constant changes in the environment.

【Term of Project】 FY2018-2022

【Budget Allocation】 1,180,500 Thousand Yen

【Homepage Address and Other Contact Information】

http://bsw3.naist.jp/plant-structure-opt/