Building Department's Initiatives to Achieve Carbon Neutrality

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1. Introduction

The Building Department is engaged in research to realize buildings that meet the diversification and advancement of societal needs by bringing together knowledge and other expertise in the specific fields of structure, fire protection, materials, equipment, etc. This paper introduces an overview and trends of the research being undertaken by the Building Department to achieve carbon neutrality.

2. Promotion and expansion of wood use in mid- and high-rise buildings

(1) Initiatives to date

As a measure to absorb CO_2 to achieve carbon neutrality, it is required to expand the use of wood in the building sector, which accounts for more than 40% of wood demand. The key to creating new demand for wood is to promote wood use in mid- to high-rise buildings of four or more stories, where wood structure has not been popular. However, because buildings of four or more stories need to be fire-resistant, fire-resistant covering is required when wood is used for the main structural parts, and wood cannot be utilized in a way that shows it as it is.

In light of these current issues, in order to promote wood use in mid- and high-rise buildings by adopting the "wood-mixed structure building" (Fig. 1), which combines CLT and other wooden structures with RC structure, steel structure, and other fire-resistant members, we have conducted a comprehensive project named "Development of Design / Construction Technologies for Mixed Construction Buildings Using New Wood Material" (FY2017 - FY2021).

In this comprehensive project, based on scientific findings from various experiments, analyses, etc., design methods, etc. were developed for wood-mixed structure buildings from the viewpoints of structure, fireproofing, durability, etc. For example, (i) with regard to structure, for each member of wooden, RC, etc. we made it possible to use the conventional general structural calculation methods (Horizontal load-carrying capacity calculation, Allowable limit stress, etc. calculation, Allowable limit stress calculation) in calculation and analysis. Further, based on the concept of preventing damage to the joints between structures of different types, we developed a method for applying general structural calculation methods to wood-mixed structures and specifications for joints between structures of different types. (ii) With regard to fireproofing, we, based on the concept of using wood within a certain area surrounded by a frame of noncombustible materials, we developed fire compartment, fire spread prevention design methods that respond to increase in combustible materials, as well as fireproof covering design methods for joints. The results of a series of researches were reflected in the revision of the Building Standards Act (in 2018 and 2022) and related notifications to promote the use of wood in mid- and high-rise buildings. Under the revised law, a combination of "noncombustible members" in the main structure and "wooden structure" that allows a certain level of fire damage is recognized as a "fire-resistant structure." Consequently, it has become possible for fire-resistant buildings to use wood for main structures in areas separated from other structures for fire protection and to adopt a design to show wood on the surface (Photo 1).

In parallel, we are implementing the "Technological Development for Dissemination of Large-Scale Buildings that Contribute to Increased Demand for Wood" (FY2020 - 2023), a public-private R&D investment expansion program.

Fig. 1: Example for the prototype of wood mixed structure:
Wooden walls and floors with RC frame on each floor (Left: Exterior, Right: Interior)

Photo 1: Design to show the timber as it is, which is the main structural member
(left: medium-rise large-scale building, right: high-rise building)

Photo 2: Example of "vertical wood-mixed structure": Mixed structure where the structure differs depending on floors. In this case, the first floor is RC and the second to fifth floors are wood (CLT).

This project will develop more rational, generalizable, and general-purpose design methods and examples of specifications, etc., by extending the research results of the comprehensive project in order to further promote the use of wood in large buildings, which will contribute to increasing the demand for wood. For example, we are working on (i) the development of rational structural design methods for "vertical wood-mixed structure" (Photo 2), which has great advantages in terms of structural strength and cost for wood mixed buildings, and (ii) the development, etc. of rational standard specifications for composite floors of CLT and RC structure, for which there is no general construction method and the cost can be higher if fire-resistant covering and sound insulation measures are provided.

(2) Policy for future initiatives

"Green Growth Strategy for Carbon Neutrality by 2050 (Dec. 25, 2020)" states that by 2030 "material standards for the use of wood in high-rise buildings, etc. will be studied" and by 2040 "technologies for the widespread use of high-rise wooden structures will be established."

Since the Building Department has so far researched mainly focused on buildings with four to six stories, it is necessary to further research to realize and promote the use of wood even for buildings with higher stories. For example, we consider that it necessary to study the following by 2030. (i) Structure: Grasp of the long-term performance of wooden buildings of approximately 10 stories, and study to develop recommended specifications, etc. for joints between members to respond to increased external forces due to higher-rise buildings. (ii) Fireproofing: Study to develop fireproof covering for long time (120, 150, 180 minutes, etc.) fireproof structure and notified specifications for long-tune fire prevention equipment to prevent the spread of fire to upper floors, etc.

3. Promotion of the use of CO_2 saving concrete as new material

As a CO_2 source measure, the challenge is to reduce CO_2 emissions in cement and concrete, which, along with wood, are the main materials in the building sector.

Accordingly, it is necessary to promote the use of new concrete-based materials that contribute to CO_2 reduction ("new CO_2-saving concrete-based materials" (Fig. 2)), which are being developed by the private sector, etc., for building foundation and major structural parts such as columns, beams, and walls.

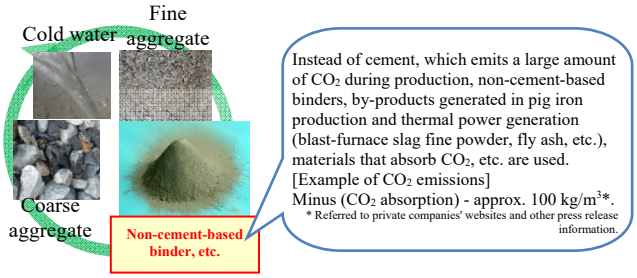

Fig. 2: Image of new CO_2-saving concrete-based materials

By the way, the Building Standards Act stipulates that materials that can be used for the main structural parts of buildings shall either conform to the Japanese Industrial Standards (JIS) or be certified by the Minister of Land, Infrastructure, Transport and Tourism. Various new CO_2-saving concrete-based materials currently being developed are not JIS-compliant materials and require individual ministerial certification. However, the notified standards for concrete used in the examination for ministerial certification do not, in the first place, expect materials that differ significantly from ordinary concrete in the constituent materials and their ratios, such as no use of cement.

Therefore, the Building Department has decided to implement a three-year plan, starting in FY2023 named "Research on evaluation indices for the application of new concrete-based materials to buildings that contribute to CO_2 saving." By clarifying the quality and performance of the new CO_2-saving concrete materials required to comply with the Building Standards Act, we aim for smooth and efficient ministerial certification and to expand their use in the main structural parts of buildings.

4. Conclusion

The Building Department intends to contribute to the realization of carbon neutrality by working on two major themes: further promotion of wood use in mid- and high-rise buildings and promotion of the use of new CO_2-saving concrete-based materials in buildings.

☞See the following for details.

1) Building Department's website
http://www.nilim.go.jp/japanese/organization/kenchiku/jkenchiku.htm