High-strength Concrete Forming the Appearance of a Super-environmental Building: The Head Office Building of Shimizu Corporation

超環境オフィスビルの外観を形成する高強度コンクリート ― 清水建設（株）本社ビル ―


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Keywords: high-strength concrete, precast concrete, limestone, architectural concrete finishing, cedar board
DOI: 10.11474/JPCI.NR.2018.147

1. Introduction

The head office building of Shimizu Corporation completed in May 2012, is a “super-environmental office” that focuses on energy conservation, comfort, and emergency business continuity to contribute to the realization of a sustainable society. This building acquired the gold certification of the environmental performance evaluation system (LEED), for the first time by a domestic newly built office. The appearance of the building is shown in **Fig.1**. The exterior of the building is formed by a precast concrete (PC) frame using aluminum casting and architectural concrete finishing using a cedar board form, both of which use high-strength concrete. This high-strength concrete technology has improved crack resistance, ensured fire resistance and enhanced the design.

2. Outline of the Building Plan

This building has an isolation structure to give it the ability to maintain its function even after a large earthquake as a disaster prevention center in the area and to realize a large flexible space. The first floor is composed of portal pillars and a core wall. This space was planned for piloti and natural concrete finishing using the cedar board form to consider the ambient environment and visitors. The reference floor is composed of outer PC frames and the core wall, thereby realizing a commodious working space without columns.

Fig.1 Appearance of the building

3. Technology Overview

(1) Outline of PC Frame

The PC frame functions as both exterior equipment and structure. The cross-section of the PC frame is shown in **Fig.2**. The aluminum and concrete were insulated by spraying urethane foam onto the back of the aluminum cast. This urethane foam was also used for external insulation of the building. Shear connectors were set at intervals of roughly 800mm to prevent the aluminum cast falling off due to out-of-plane force. High-strength concrete of 80–48N/mm^2 was used for the PC frame. The use of limestone aggregate was examined to reduce cracks due to the heat of hydration and shrinkage as the concrete strengthened. Limestone aggregate was avoided in the high-strength concrete because the surface layer of the building frame was liable to explode upon heating during a fire. The fire resistance of the high-strength concrete using limestone aggregate was verified in the same way as for advanced fire resistant(AFR) concrete[1] mixed with short polypropylene fibers to prevent explosive fracture of high-strength concrete. The appearance of column members after the fire resistance test under load is shown in **Fig.3**. High-strength concrete mixed with short polypropylene fibers using limestone aggregate retained its structural strength without explosion[2]. Accordingly, high-strength concrete was realized that has excellent crack resistance.

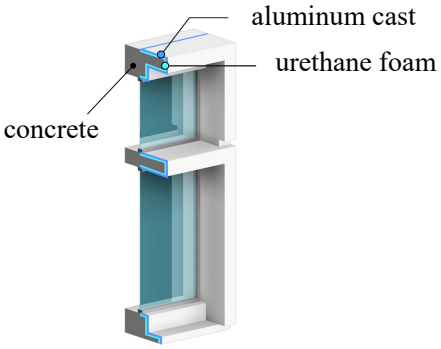

Fig.2 Cross-section of PC frame

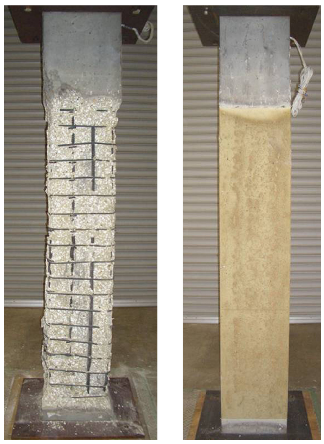

Fig.3 Appearance of column members after fire resistance test under load (left: no fibers)

(2) Architectural Concrete Finishing Using a Cedar Board Form

High-strength concrete of 60N/mm^2 was used for the core wall of the lower section and the portal pillars around the first floor. It was finished with architectural concrete using a cedar board form. Low-heat Portland cement and limestone aggregate were used to maintain aesthetic quality by suppressing cracks due to drying and temperature changes. The cedar board was whittled to emphasize the irregularity of the wood grain, and the form was assembled by changing the thickness of the cedar board. The carefully made form allowed for a non-monotonic design even in a large area. Meanwhile, high-fluidity concrete was used in consideration of its workability for intricate form shapes and the complicated arrangement of the bars. The surface finishing of the concrete was selected from paint coatings with high anti-fouling performance and to emphasize the characteristic texture of the cedar board. The final workmanship is shown in **Fig.4**. By adequately examining the specifications of the form, concrete, and finishing, a relaxed and elegant ambience was realized.

Fig.4 Appearance of final workmanship

4. Conclusion

This paper shows a case of using the original high-strength concrete for a PC frame with structure and design performance and architectural concrete finishing using the form of cedar board. Six years after completion, the building is maintaining its comfort and aesthetic performance. This project was honored with the Award of the JCI (Technical Award) in 2014. H. Hashida, T. Kenjo, K. Nakagawa, and K. Ishimizu of the Shimizu Corporation received the award. The author expects new grades of high-strength concrete to be produced in the future.

References

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