Ultra High-rise Building Adopting Various Structural Technologies

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Summary

Redevelopment of urban areas requires to solve many issues of the limited conditions of the construction site. In this project, two subway lines exist underground in the construction site, as well as the piles of the former building. In consideration of difficulties of the construction, it was intended to design a new high-rise building without removing the remained piles. To reuse the remained piles, it was necessary to minimize reaction forces on piles in the structural design. By installing seismic isolation system, seismic load could be minimized and by using ultra-high strength materials and light weight concrete, the total weight of the building decreased. As a result, the construction term and costs were reduced as well as the reuse of the piles. Furthermore, it was successful to decrease the environmental load.

Keywords: Reuse the remained piles of the former building; Intermediate level seismic isolation; CFT columns with high strength materials; PCaPC beams ; Fc 250 PCa columns

1. Introduction

A variety of performances are required in the design of the buildings developed in major cities, and planning and design that comprehensively checks these performances is advanced. The building volume is set taking into consideration the site construction conditions based on the limits on floor-area ratio and height, etc., prescribed in laws and regulations. Performance verification is carried out from various viewpoints such as environment, convenience of connection to infrastructure and the transport network, building function grade, landscaping, maintenance of function during disasters, etc., as well as social contribution and economics, and thereby the scheme becomes complete. The structure affects many of these required performances, so the structural design is an important task at each stage, such as overall building planning, scheme, design, construction, and maintenance.

Photo 1 Building external view

This building is a multi-use ultra high rise building constructed in Ochanomizu, in which various structural technologies have been applied. The structural technologies described here include technology for reuse of the existing building, seismic isolation structure, and advanced structural technologies using various concretes and special structural materials. By adopting these technologies in an integrated manner, building spaces with high usage value have been rationally achieved with an appropriate balance between cost and constructability.

2. Structural Technologies Adopted

The structural framing elevation is shown in Fig. 3. The special features of the site are that the ultra high rise office building is located above the Metro Chiyoda Line and the Marunouchi Line, and

there were many piles from the existing building on the east side of the site near the Metro. The structural technologies adopted to deal with these conditions were as follows.

(1)Technology to reuse the remained existing piles of the former building

(2)Intermediate level seismic isolation of the ultra high rise building

(3)Ultra high rise building using CFT columns with high strength materials

(4)Adoption of PCaPC beams and Fc 250 PCa slender columns

Also, a megatruss using high strength steel SA440C was used in the second story, as shown in Fig. 3. In this way the vertical structure load from the 3rd story and higher was stably dispersed to both sides of the Metro, thereby enabling the ultra high rise building to be built above the Metro.

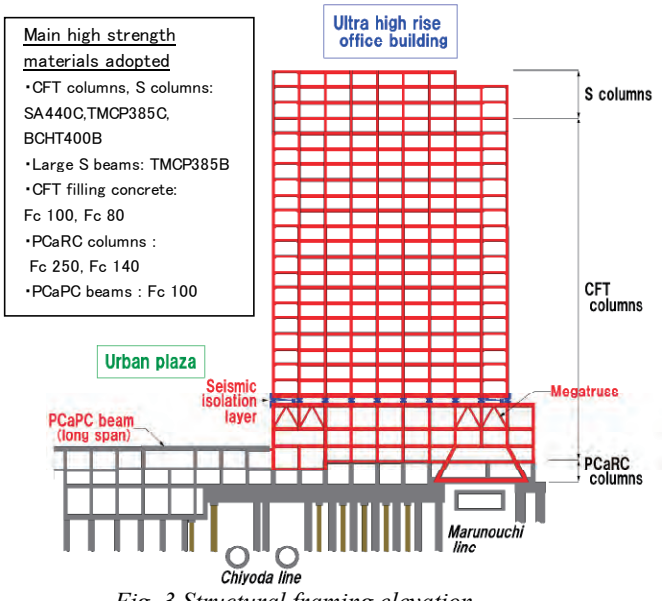

Fig. 3 Structural framing elevation

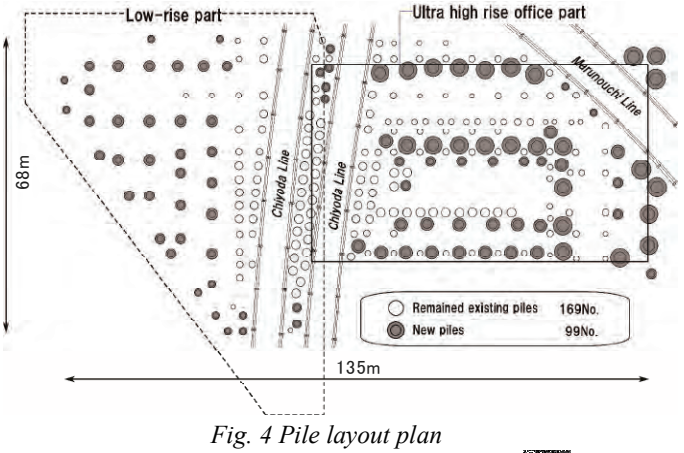

Fig. 4 Pile layout plan

3. Conclusion

This building was designed under the restriction that there were 2 Metro lines running underneath the site. Existing piles of the former building were left in place and reused, taking into consideration the effect of the building substructure on the Metro. This building was realized taking into account the effect on the Metro and reusing the remained existing piles was carried out based on surveys of the remained existing piles and soil-pile-foundation analysis technology. In addition by adopting an intermediate level seismic isolation structure, by reducing the cross-section of the structural members by appropriate combinations of ultra high strength materials, and by adopting type 2 lightweight concrete, γ=17 kN/m^3 , the building weight and the seismic forces were reduced, thereby reducing the load on the foundations. These measures greatly contributed to reducing the environmental load around the building. This project is an example of one solution for rebuilding and redevelopment in urban areas.

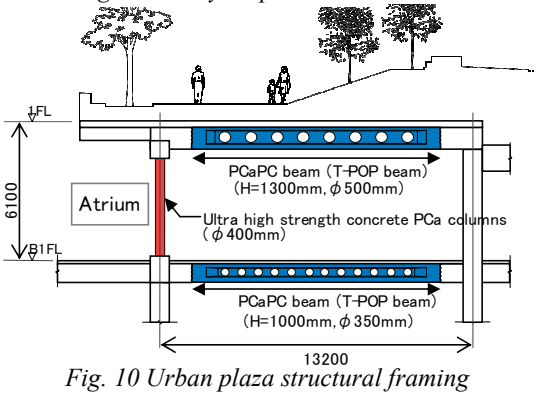

Fig. 10 Urban plaza structural framing