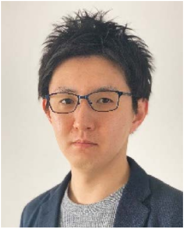
Office Building with Minimal Floor Height Achieved by Integration — ASAHI KOGYOSHA Head Office —

意匠×構造×設備が一体となり実現したミニマム階高でのオフィスビル — 朝日工業社　本社・本店ビル —

 *

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Synopsis

This building is an office building in Minato-ku, Tokyo, integrating the headquarters and head office functions of ASAHI KOGYOSYA, a company that designs and constructs air conditioning and sanitary facilities and manufactures and sells equipment. While the diagonal restrictions limited the height of the floors to a minimum, a comfortable space was realized through an interactive combination of design, structure, and facilities.

The building had to have nine floors to accommodate the necessary office functions, but because of the diagonal restrictions, the standard office floor height of 4,000 mm could not be accommodated, so the floor height had to be decreased to 3,600 mm.

Therefore, precast prestressed concrete (PCaPC) single T floor slabs (hereinafter referred to as ST slabs) were adopted for the floor of the office space, and an open and comfortable office space was realized by making the structure visible. The main façade is outframed with trapezoidal cross-section columns and beams to reduce the heat load from sunlight, and even the tapered portion of the trapezoid was considered part of the structural frame to pursue structural rationality. Furthermore, by making the structural frame in concrete as the finishing material, the authors were able to satisfy the client's request for a solid and rigid architectural expression.

The architecture, structure, and facilities, each play a leading role in this project, completing the function of the building as a single structure, which is also expressed visually (**Fig. 1**).

Structural Data

Building Name: ASAHI KOGYOSHA Head Office
Location: Tokyo, Japan
Owner: ASAHI KOGYOSHA Co., Ltd.
Architecture Design: NIPPON TOCHI-TATEMONO Co., Ltd. (now Chuo-Nittochi Co., Ltd.)
Engineering Design: NIKKEN SEKKEI LTD
Contractor: Shimizu Corporation
Construction Period: Aug. 2016 – Jan. 2018
Site Area: 748.14 m^2
Total Floor Area: 3,858.38 m^2
Number of Stories: 9 above ground, 1 underground
Maximum Height: 37.95 m
Structure: Steel reinforced concrete structure, part steel structure

Fig. 1 External view of building

1. Architectural Scheme

The project was aimed at improving business continuity, operational efficiency, and the work environment by integrating the aging headquarters and head office buildings across the street into a single building through an equivalent exchange and centralizing the dispersed functions of the two buildings into a new building.

The diagonal restrictions were extremely strict, and to accommodate the necessary functions, the goal was to use as much of the site as possible. A 20 m × (18 m + α) m rectangular area was combined with a 2.5 m × 15 m rectangular area as shown in **Fig. 2**. The main areas were designed to house the office space and core, while the northeastern part was planned as a meeting area. By sharing with the client from the planning stage that each portion should have a clear function, the combined plan layout worked effectively to create a new way of working for the client.

The office space is completely column-free by using a perimeter building frame and by constructing modules with ST floor slab ribs spaced at 1600 mm. Therefore, the space can be used without waste and is consistent with the desk layout and lighting layout at a spacing of 3200 mm.

The cross-sectional configuration achieves a clear ceiling height of 2900 mm by combining floor-blown air conditioning and ST floor slabs within a minimal floor height of 3600 mm (**Fig. 3**). The air conditioning system was designed to eliminate drafts and make the workers as comfortable as possible.

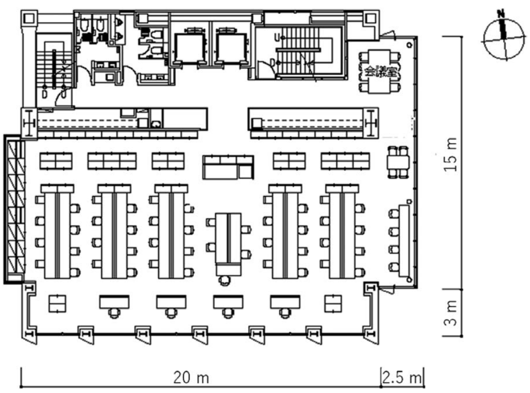

Fig. 2 Typical floor plan

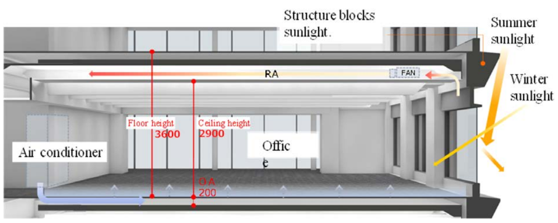

Fig. 3 Section view through the office area

2. Structural Scheme

(1) Overall Scheme

The structural challenges relating to the architectural plan were structural planning with minimal floor height and rational structural planning with harmony among design, structure, and facilities. To tackle these challenges, the designers combined the appropriate structural elements in the right places in accordance with the architectural plan.

The building was designed with ST floor slabs because the ceiling height of the office space had to be secured and the building had to be planned as a column-free space (despite the strict floor height restrictions). However, using ST slabs required the Y-directional structure to resist horizontal forces mainly on both end faces, but the building and facility plans did not allow for the installation of braces or other earthquake-resistant elements. Therefore, it was decided to use a rigid-frame structure with earthquake-resistant walls made of steel reinforced concrete (SRC), which can ensure both strength and rigidity simultaneously. The perimeter frame structure of the structure bear approximately 90% of the horizontal force.

In the X-direction, to make effective use of the building and equipment space around the core, the columns and beams on the core side are made of SRC, which has a small cross section but can secure the load-bearing capacity, while the stiffness is achieved by using buckling-restrained braces. Furthermore, oil dampers were installed, which not only improve the structural performance of the building but also reduce the interstory drift during mid-level earthquakes and prevent cracking of the exposed concrete (**Figs. 4** and **5**).

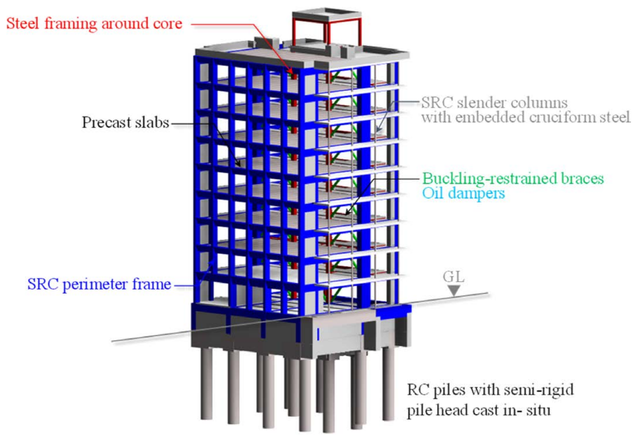

Fig. 4 Structural framing 3D model

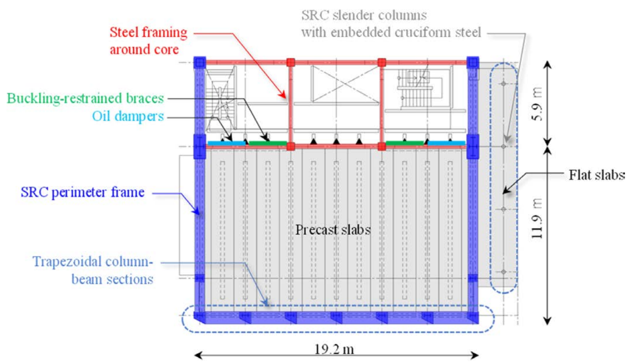

Fig. 5 Typical floor plan + structural labels

(2) Use of ST Slabs to Realize a Column-free Space and Minimal Clear Height

The office areas use ST floor slabs to realize a column-free space with a minimal floor height. The clear ceiling height is 2.9 m (2.7 m under the ribs) for a story height of 3.6 m. Each ST slab is a composite slab that is integrated by placing 110 mm of topping concrete on it. The space between the ribs of adjacent slabs is used as a smoke exhaust route and for indirect lighting to showcase the structure as it is (**Figs. 6** and **7**).

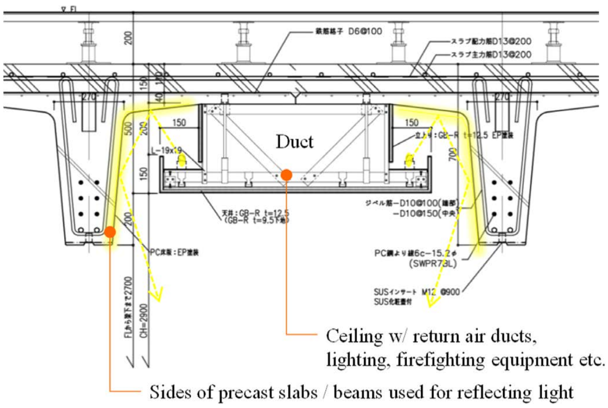

Fig. 6 ST floor slab and duct ceiling

Fig. 7 Office interior view

(3) Architectural Expression Achieved Using Trapezoidal Columns and Girders

The perimeter columns and beams that make up the south façade are trapezoidal in cross section to create a unique architectural expression of the building and to increase the sun-shielding effect. In ordinary RC (SRC) construction design, the structure is generally designed with rectangular cross sections, and short cantilever slabs are typically provided so that the structure fits within the façade. In this project, however, the trapezoidal cross section of the columns and beams is used as much as possible (**Fig. 8**). In other words, the exposed trapezoidal elements are not just for show but rather a match between *form* and *structure*. The sharp corner of the trapezoidal cross section where the columns and beams intersect is considered to have insufficient anchorage of the main reinforcement, so only that area is regarded as non-structural. The rational shape of the structure reduces the environmental load, and the façade design creates different views depending on the angle of view, time of day, and season (**Fig. 9**).

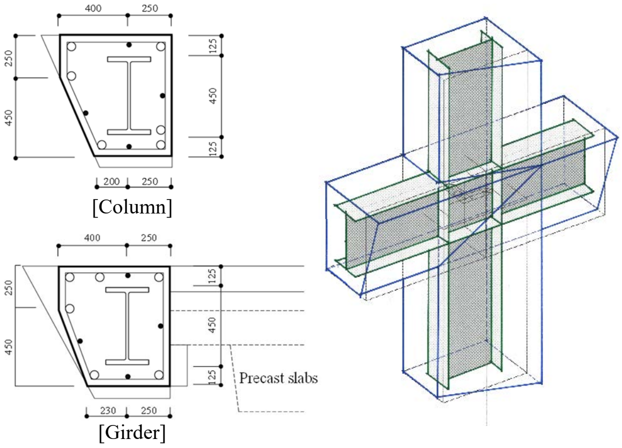

Fig. 8 Trapezoidal columns & beams + SRC concept

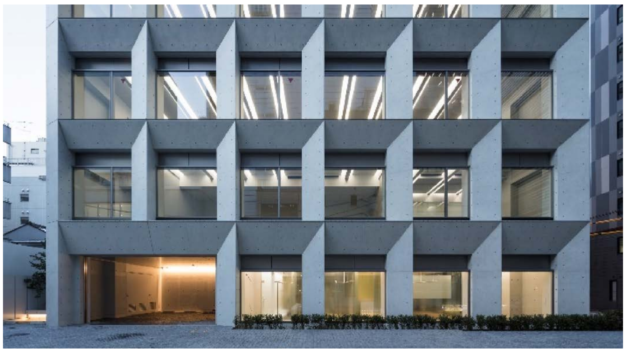

Fig. 9 Perimeter framed by trapezoidal members

(4) Slender Columns with Special Concrete Textures

The east façade was designed with narrow SRC columns including embedded cruciform steel plates to take advantage of the open and transparent glass elevation plan. The diameter of the columns on all floors is 250 mm, and the embedded steel is +-150 × 150 × 16~25 depending on the axial force, so that only vertical loads are borne. Although the columns have an SRC cross section, the embedded steel is designed to be within the long-term allowable stress for safety. As a result, a façade with a sense of transparency was created while expressing a concrete texture that is consistent with the overall design (**Fig. 10**).

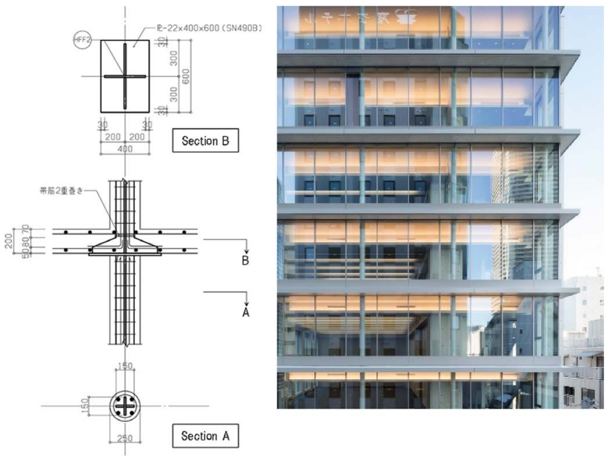

Fig. 10 Slender SRC columns

3. Construction

The south façade is a complex arrangement of steel frame and reinforcing bars, combining the columns and beams of a trapezoidal SRC structural frame. Even the tapered portion of the trapezoidal shape plays a role in the structural frame, and because the structural frame is part of the design, it was important not only to deliver the required performance of the structural frame but also to finish it beautifully, which was an extremely difficult task.

The design of this project was realized through repeated discussions between the designer and the constructor on how best to install the formwork stops, steel frame, and reinforcement, as well as through repeated trial runs of detailed drawings and mockups. The design, structure, and construction were integrated into the pursuit of beauty through repeated BIM (building information modeling)-based verification of the optimal separations and delivery of the steel frame and reinforcement bars as part of the design (**Fig. 11**).

The east façade was designed to provide a sense of openness in contrast to the south façade. The columns to receive the axial force of the flat slabs are minimalist SRC thin columns 250 mm in diameter. To finish the columns beautifully, they were assembled and installed on site as PCaPC members after the steel frame and reinforcing bars were assembled in a crisscross pattern. This method enabled the authors to create SRC slender columns of minimal size with a light finish (**Fig. 12**).

The project owner participated in the concrete pouring of some of the interior columns and shared the difficulties involved in constructing the new building. Thanks to the efforts of all parties involved, this project has been a success.

4. Conclusion

In this building, the designers aimed to realize a comfortable space within a holistic framework of Architecture × Structure × MEP (mechanical, electrical, and plumbing) by maximizing the characteristics of concrete.

Because of the variety of structural elements, the project was very difficult in terms of not only overall planning but also details. However, with the understanding and cooperation of the project owner, design architect, and constructor for the structural plan, this building was realized and received the 2019 Japan Concrete Institute Award for Outstanding Structure. The authors would like to take this opportunity to express their gratitude to all parties involved in the construction of this building.

Fig. 11 Slender SRC column site casting

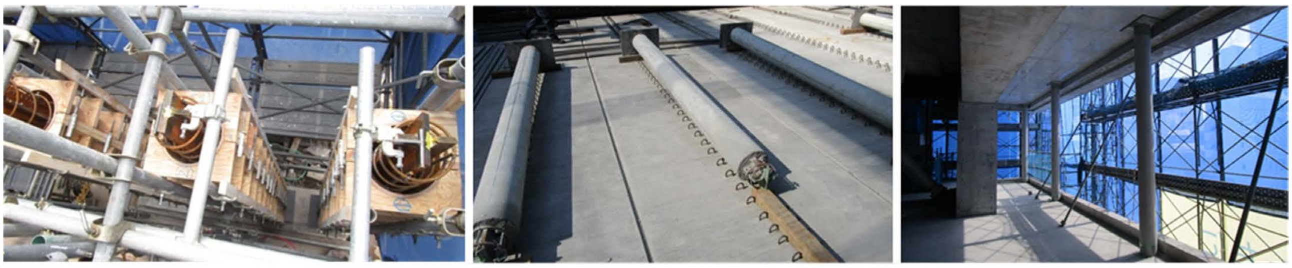

Fig. 12 Study and mockup of trapezoidal sections

概　要

空調衛生設備の設計施工会社で，先端産業向け精密環境制御機器の製造販売も手掛ける朝日工業社の本社・本店機能を統合したオフィスビル。斜線制限から階高が最小限に制限された中で，意匠×構造×設備をインタラクティブに組み合わせることによって快適な空間を実現している。

まず，執務空間の床に PCaPC 造の ST 床板を採用，構造体を表しにすることで開放的で快適な執務空間を実現した。南面ファサードは，台形断面の柱と梁を組み合わせたアウトフレームとし，日照からの熱負荷低減を図っているが，台形のテーパー部分まで構造躯体として評価し，構造の合理性を追求している。さらに構造躯体であるコンクリートは仕上素材も兼ねている。

建築・構造・設備がそれぞれ主役となり，一つの建築としての機能を完成させ，それが視覚的にも高いレベルで表現されている建築物である。