Functional City Hall by Fusion of Design, Structure, and Facilities — Kama City Hall —

意匠・構造・設備の融合による機能的な市庁舎 ― 嘉麻市庁舎 ―


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Synopsis

Kama City is located in the central part of Fukuoka Prefecture, in the Chikugo region, and contains the headwater of the Onga River, the largest river in northern Kyushu. It is said that in ancient times, the blessings of the Onga River gave rise to rice cultivation. In modern times, the Chikugo region has seen the development of the coal industry. Surrounded by forests, Kama City is situated in the Kaho Basin and has climate and wind environments particular to the basin.

After the Kumamoto Earthquake in April 2016, the new city hall planned for Kama was one of the first publicly announced city hall proposals in Kyushu. The construction of the city hall needed to be completed by March 2020, which was the termination date for the special government bonds issued for the municipal merger that created Kama City. Hence, this plan was affected by natural and social factors such as the Kumamoto Earthquake and the municipal merger, respectively.

Therefore, the authors pursued a rational way of building the city hall to maximize the blessings of the Onga River with an environment characteristic of the basin while ensuring safety, security, and low initial costs. Considering this, it was decided that the best way to design the city hall was to fully consider the historical background and local environment of Kama City (**Fig. 1**).

Fig. 1 The Onga River and Kama City Hall

Structural Data

Structure: Reinforced concrete construction, partial steel frame construction
Foundation Construction: Ground improvement (deep soil mixing)
Site Area: 22,472.98 m^2
Building Area: 2,760.74 m^2
Total Floor Area: 9,652.99 m^2
Maximum Height: 24.72 m
Floor Heights: 4.35 m (1st floor), 3.6 m (2nd to 5th floors)
Owner: Kama City, Fukuoka Prefecture
Designer: KUME SEKKEI Co., Ltd.
Contractor: Asanuma Corporation
Construction Period: April 2018 – March 2020
Location: 1180-1 Iwasaki, Kama City, Fukuoka Prefecture, Japan

Fig. 2 View from the west

1. Design

(1) Reference Floor Plan

Because of the advantageous characteristics of the construction site, with a national highway on the west and the Onga River on the east, the core was placed to the west facing the highway and main approach, whereas the waiting lobby was placed in the center. In addition, U-shaped office spaces were created on the north, east, and south sides with views of the Onga River to ensure a compact flow of citizens and form comfortable office spaces with good views (**Fig. 3**).

(2) Section Plan

Because of the central location of the chamber, its steel frame was hung on the central reinforced concrete frame to achieve an efficient frame without disrupting the structural system of the standard floor. Furthermore, the crank-shaped void that surrounds the chamber area functions as an environmental device by promoting temperature difference ventilation (**Fig. 4**).

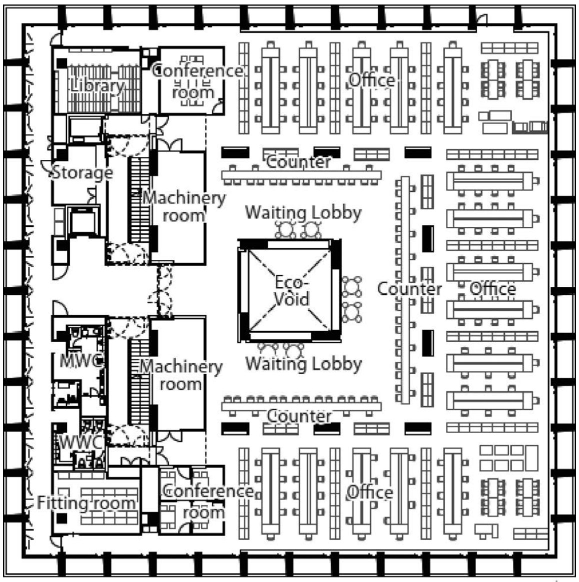

Fig. 4 Reference floor plan (3rd floor)

Fig. 3 North service counter on 1st floor

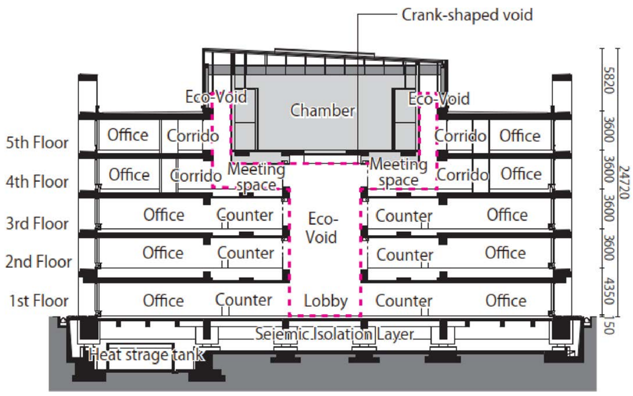

Fig. 5 Section plan

2. Structural Design

The superstructure plan was designed with dimensions of 43.2 m × 43.2 m, with outer and inner frames of 3.6 m and 7.2 m, respectively. The superstructure was designed using reinforced concrete to realize seismic resistance and sound insulation. Because the site is close to the Onga River, the first floor is set at GL + 1.2 m with an embankment in consideration of possible inundation during torrential rain.

The following are the design intentions for Kama City Hall and the characteristic technologies adopted to realize them (**Fig. 6**).

1. Triple tube frames with flat cross-section columns and beams.
2. A concrete exposed ceiling using steel pipe void slabs of prestressed concrete (PC) to avoid falling objects.
3. A square grid frame exterior design developed using reinforced concrete and adopting an outer frame structure using inverted beams that allow light and air to enter the rooms.
4. A basic seismic isolation structure to maintain the functionality of Kama City Hall after an earthquake.
5. Improving the grid roof frame and grid-like foundation of the chamber so that it harmonizes with the exterior design.

(1) Construction of Pier Tables

The superstructure was built using triple tube frames with flat cross-section columns and beams and eco-voids in the center to improve rigidity and stress-proof the entire building. Additionally, most of the seismic loading (60% or more) is borne by the flat cross-section inner frame.

Considering the effect of seismic isolation, the authors realized a highly flexible column-free space without requiring beams for the office spaces.

In addition, the square grid frame on the outside is used similar to that in the exterior design, whereas the flat cross-section columns in the interior are sign walls combining the structural and sign systems.

Instead of using typical counter guide signs that are usually hung above counters, number signs and section name plate signs with a real wood finish using local Japanese cedar are laid out on the columns (**Fig. 7**).

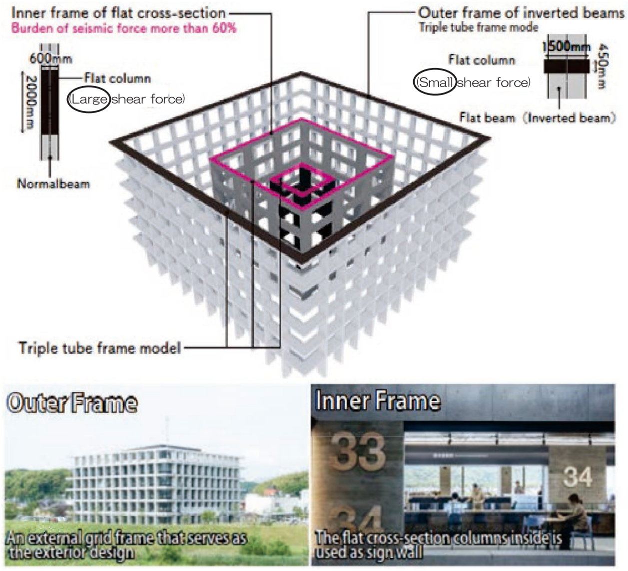

Fig. 7 Triple tube frame model

(2) Efficient Slab Structure Using Steel Pipe Void Slabs

The floor structure of the offices was developed using void slabs, wherein a 450-mm-thick cylindrical steel pipe is placed in the center of a slab to ensure flexural rigidity of the slab while reducing its weight.

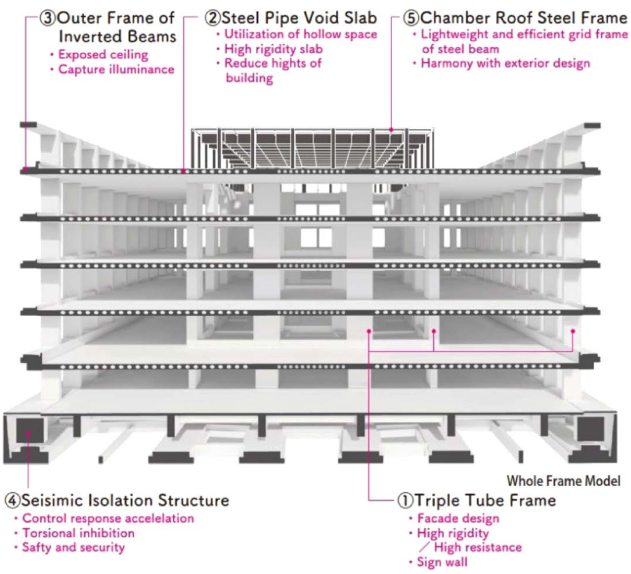

Fig. 6 Whole frame model

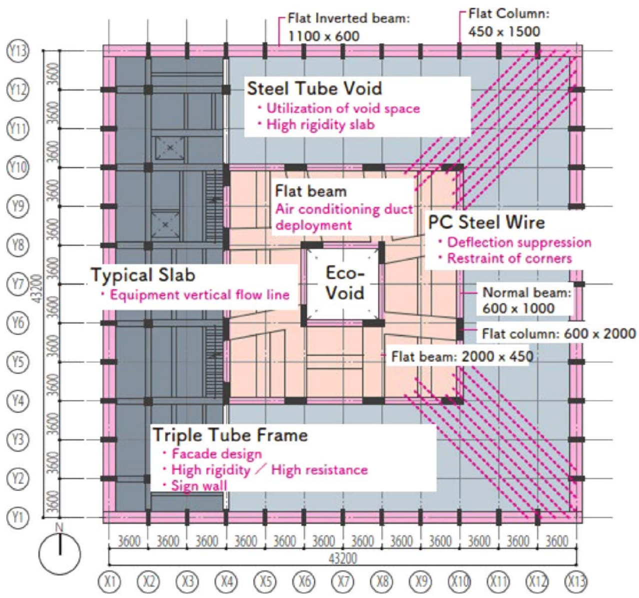

Fig. 8 Reference floor framing plan

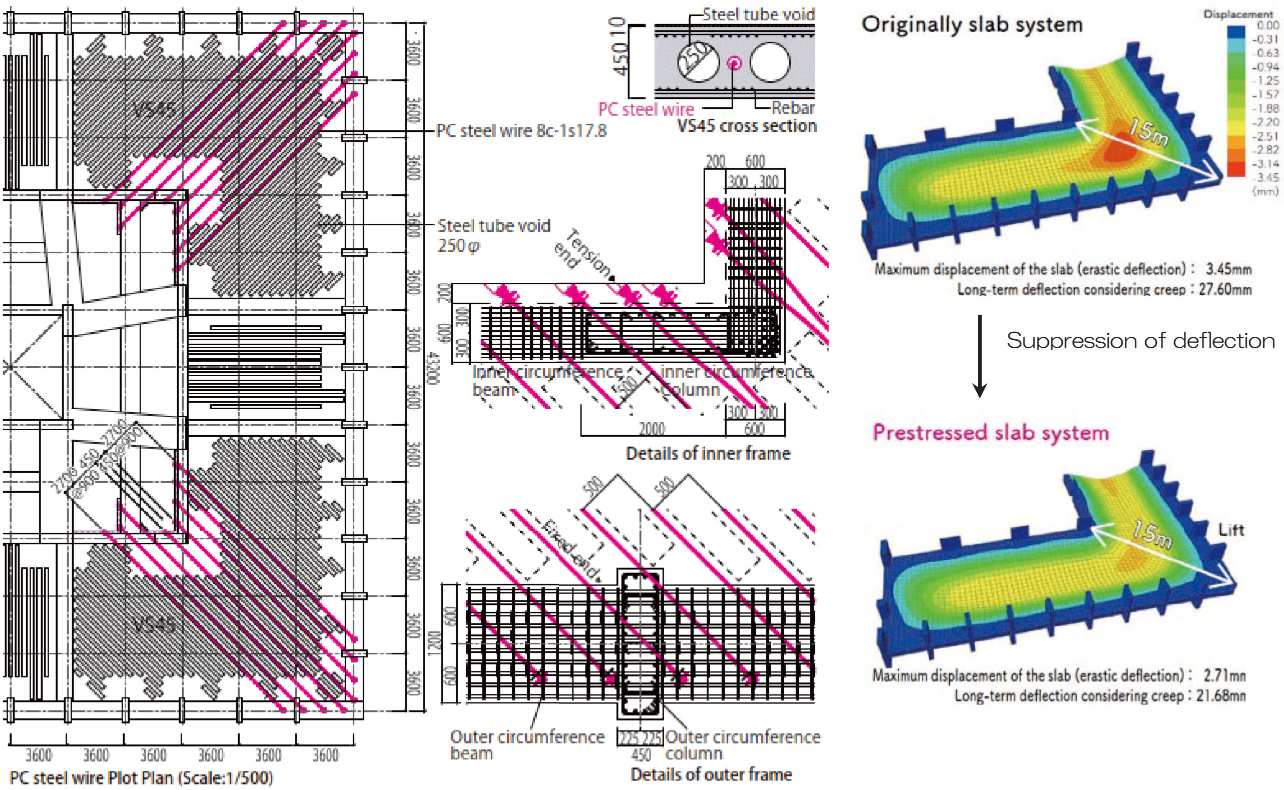

Fig. 9 Prestressed slab system

Flat inverted beams and normal slabs placed −350 mm from the top in the center of the waiting lobby area were used as the main route for the underfloor air conditioning ducts.

Normal cross-section beams and slabs were placed in the core area on the west, where vertical penetration (equipment development/vertical flow line) is concentrated; in other words, the slab structure was built using the right materials in the right places.

The void slabs in the offices have a maximum support length of 15 m from the inner frame to the outer frame in the normal direction of the corners. Therefore, PC steel wires were used to prevent cracks caused by creep (**Fig. 8**).

(3) Crack Suppression By Adopting Prestressed Concrete

The crack suppression effect of the prestress was confirmed using the finite element method, which showed that deflection was suppressed by approximately 20% at the center of a corner where the vertical deflection is greatest. Also, because of the additional compressive force (hoop effect) acting on a corner, the internal compressive stress acts on the wide slab, thereby suppressing cracks in the slabs of the office spaces.

Furthermore, because the concrete surfaces, including the exposed ceilings of the offices, have a large area, a silica-based admixture was used in the upper structure to suppress cracks and improve the concrete strength, thereby enhancing further the crack suppression effect of the PC steel wires (**Fig. 9**).

概　要

嘉麻市は福岡県のほぼ中央に位置し，1市3町が2006年に合併して誕生した市である。市の主な特徴は，北部九州最大の遠賀川の源流があり，遠賀川の恵みを享受することで古来より稲作文化が形成され，近代では石炭産業が発達した歴史がある。平面計画の基本は，遠賀川のある東側に開いたコの字形のフレキシブルな執務空間，中央部のエコボイド，外周部の扁平断面の柱梁である。執務空間のフラット形状の床・天井・梁は，PC鋼線を併用した鋼管ボイドスラブにより構成することで梁型無しの無天井化を実現すると共に，自然換気の風を遮ることなく取り入れる道筋となっている。また，外周部は3.6mピッチの扁平柱と扁平逆梁のアウトフレームにより，夏の直射日光は遮るが，遠賀川流域の水田にバウンドした太陽光は天井面を介して室内に届く設計とした。