Design and Construction of Ginza Kabukiza

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Summary

This paper describes a structural solution for the design of a 29-stories high-rise tower, which has a large office space above the Kabukiza Theatre. In order to support 23 stories of office space above the theatre having a large void in plan, two numbers of 13m-deep mega-truss, spanning 38.4m, are installed at the fifth floor of the building. Steelwork is used as a primary material for the structure above ground and a hybrid response control system using buckling-restrained brace and oil damper is adopted in order to achieve a high seismic performance. This paper also describes the state-of-the-art erection process installing hydraulic jacks directly above the mega-truss at column bases of those supported by the truss, in order to keep the structure above the truss level during construction. The temple architecture of the previous Kabukiza is carefully restored by incorporating contemporary light-weight materials supported by steelwork.

Keywords: Kabukiza Theatre; Mega-truss; high-rise building; response control; hydraulic jack

1. Introduction and Architectural Outline

Ginza Kabukiza is a high-rise building to renew the Kabukiza Theatre and provide offices.

The fifth generation Kabukiza Theatre reproduces the external appearance, internal space, acoustics etc. of the previous fourth-generation.

The building has 29 stories above ground, 23 stories for office use at the higher level and 4 stories with a large void in plan for the theatre at the lower level. Between these two levels, a machine room and public contribution facilities are provided. (Photo 1, Fig. 1)

Photo 1: Overall view of the building

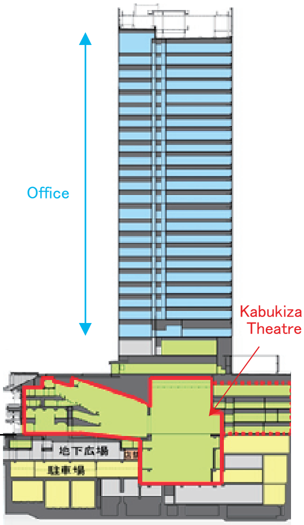

Fig. 1: Cross section in elevation

2. Structural Design

A steelwork structure was adopted to ensure high seismic performance for the multi-purpose building. A feature of the structural scheme is the provision of two Mega-trusses that supports 10 columns on the south side of the higher level (core side sections Y5, Y7). (Fig. 2)

Another measure adopted to procure adequate space for the theatre was to incline the nine columns on the north side from the 5th to 8th floors, providing an offset in column position of 1.6 m. (Fig. 4)

The building stands on a raft foundation. With a Mega-truss providing a large span space below, one of the issues faced was the design of the foundation beams. The solution was to create a "wall beam" by integrating using foundation beams with a load-resisting wall on the lowermost floor. (Fig. 3)

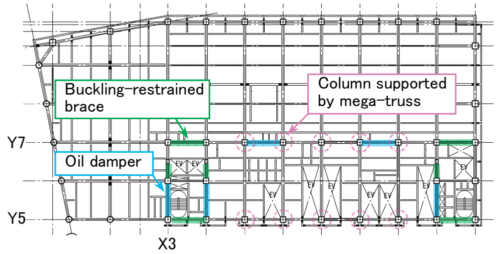

Fig. 2: Typical plan

The superstructure is a moment resisting structure using structural steelwork and CFT (concrete filled tube). Hysteretic and viscous dampers form a hybrid response control structure, to achieve high seismic safety. The lower level of the building was designed with a large margin of seismic safety to reduce deformation and damage during an earthquake. (Fig. 2, 3 and 4)

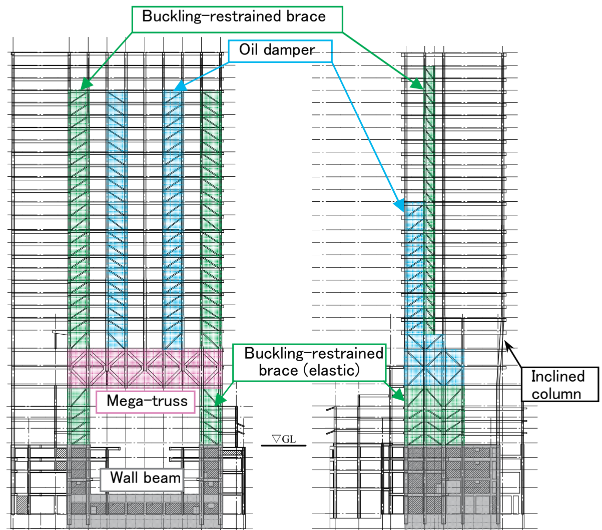

Fig. 3: Y7 Elevation

Fig. 4: X3 Elevation

3. Jacking up on Mega-truss

If normal construction procedures were adopted, large additional stresses would be imposed on the upper structure due to Vierendeel effect. In order to eliminate these stresses, it was decided early at the design stage, that jacking up the columns supported by the truss was necessary. By this way, a rational frame design was achieved for the upper level, and harmful deformation in the façade was prevented. Further, jacking ensured that the long term axial loadings of the columns supported by the truss were reliably transferred to the truss already, so that no more large redistribution of vertical loading during a major earthquake was avoided. (Fig 5)

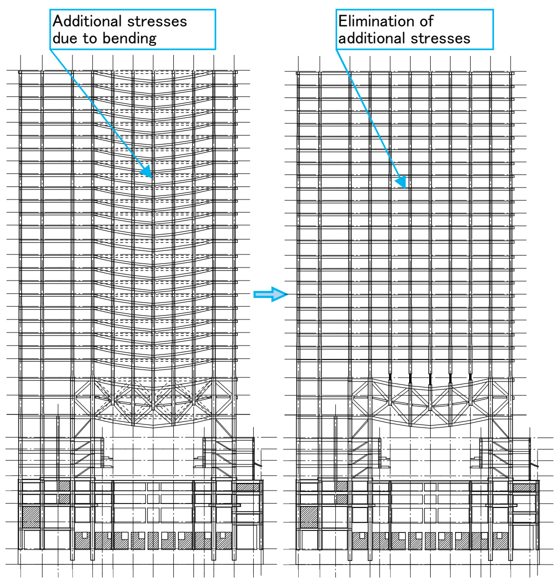

Fig. 5: Elimination of additional stresses by jacking

4. Conclusion

This paper describes the design and construction of the Mega-truss and the reproduction of the façade in the style of traditional temple architecture using structural steelwork. Highly accurate construction of the highest quality was achieved through close consultation and cooperation among the structural engineer, contractor and fabricators of the structural steelwork.