Design and Construction of a Hall with the Folded Plate Structural System Using Pre-Cast Concrete — SHOWAGAKUIN ITO MEMORIAL HALL —

PCa 部材を用いた折板構造によるホールの設計・施工 — 昭和学院伊藤記念ホール —


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* Katsuhide MURAKAMI, Dr. Eng.,: NIKKEN Sekkei, Ltd.
村上　勝英，博士（工学）：（株）日建設計
** Osamu MORISHITA: Taisei Corporation
森下　修：大成建設（株）
*** Kazutaka NAKAZAWA: P.S.Mitsubishi Construction Co., Ltd.
中澤　和崇：（株）ピーエス三菱
Contact: murakamik@nikken.jp

Keywords: Precast pre-stress concrete, folded plate structural system, trapezoidal shape
DOI: 10.11474/JPCI.NR.2014.25

Synopsis

Showagakuin Ito memorial hall is a two-storied hall accommodating 560 people, and the main structure is cast-in-place concrete (**Fig.1 and Fig.2**).
This building is constructed with the folded plate structure using pre-cast concrete plates, which is suited for the ceiling of necessary shape for halls.

Structural Data

Structure: RC + PCaPC structure
Number of stories: 2 Stories
Building use: Hall, Conference room
Floor Space: 2,030.13m^2
Total floor space: 2,422.32m^2
Eaves height: 11.3m
Total height: 12.6m
Owner: Showagakuin
Designer: Nikken Sekkei, Lid.
Contractor: Taisei Corporation.
Construction Period: Aug. 2007 – Feb. 2009
Location: Chiba Prefecture, Japan

1. Introduction

Generally, column-free space with a large span is necessary for a hall building. Moreover, it is generally preferred to have trapezoidal plan with non-parallel walls and non-flat ceiling which is not parallel to the floor from the viewpoint of the acoustics to decrease the reverberation time. Therefore, rugged shape is required for walls and ceiling to avoid having parallel planes.

Fig.1 Outside view of the building

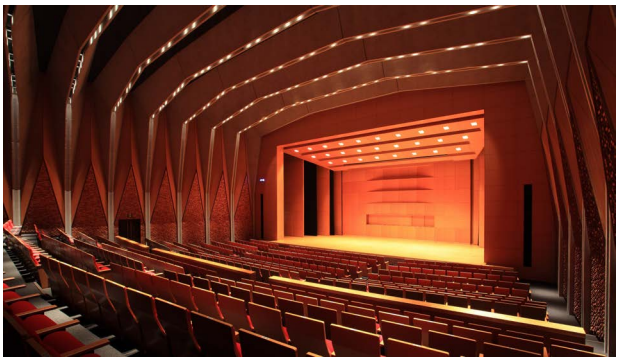

Fig.2 Inside view of the hall

Showagakuin Ito memorial hall is designed and constructed with folded plate structure using pre-cast concrete plates, which is suited for the ceiling of necessary shape for halls.

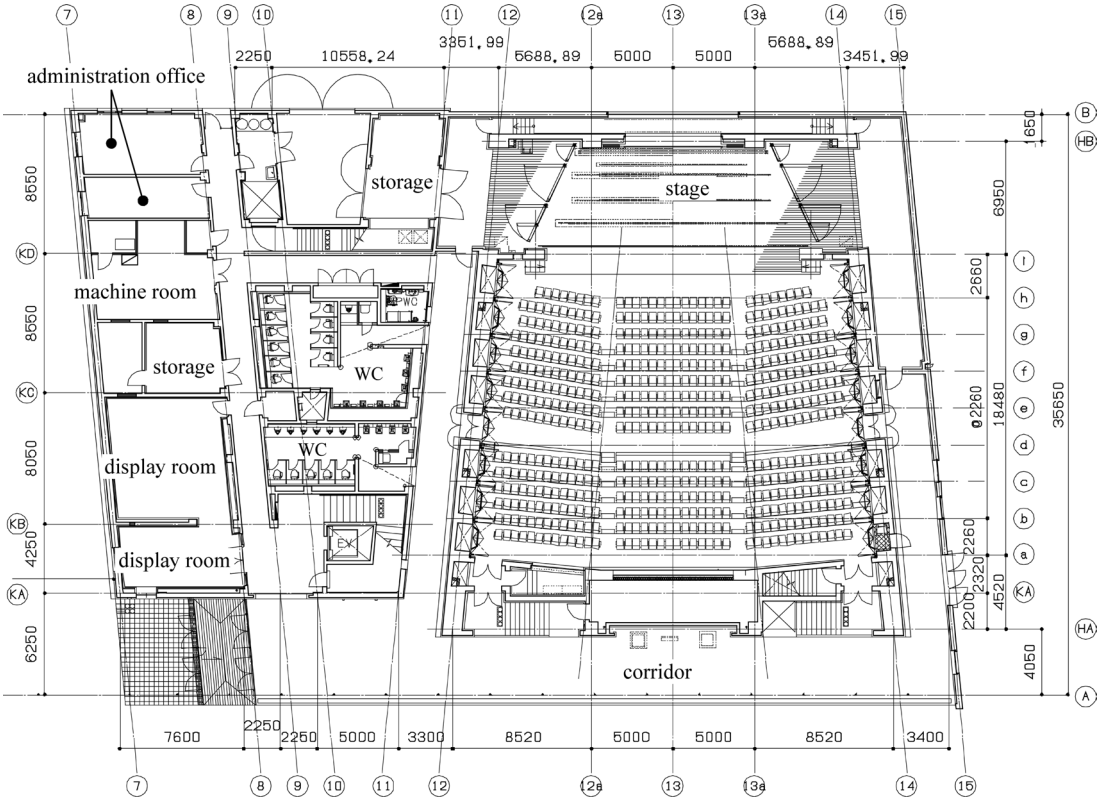

Fig.3 First floor plan

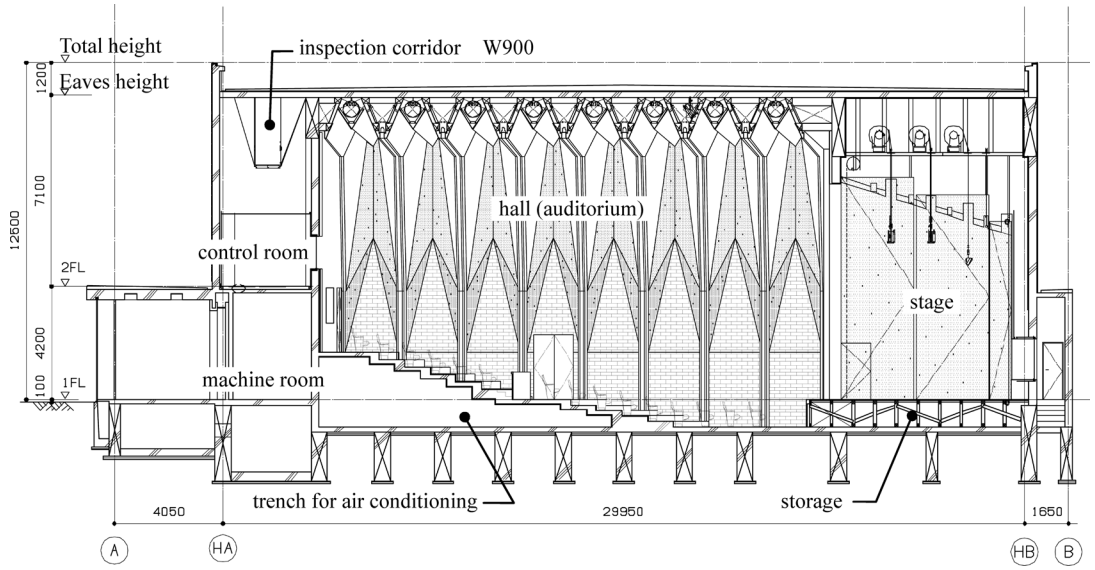

Fig.4 Elevation of the hall area

2. Design

The main structure of this building consists of moment-resisting frames and shear walls which are constructed with cast-in-place concrete. The hall area is a trapezoidal shape in plan, and beam span is between 23.2m and 25.8m. The finish of the folded plate structure is used as it is for the ceiling.

The columns are arranged at 2.26m pitch, and triangular folded concrete plates having depth from 1500mm to 2200mm and thickness of 150mm are placed. The roof slab of 150mm in thickness is placed on the top.

The reinforcement arrangement of the plates is decided with the stress distributions calculated using the FEA (elastic) of the folded plates under various load combinations.

3. Construction

Each flat plate is produced at a factory with the finish surface of the folded plates facing bottom in consideration of beauty of finish, easy-construction and the economy etc. Then, two plates are put into triangular shape to make a folded plate on site, and post tensioning method is employed for the joints between a folded plate and a cast-in-place column.

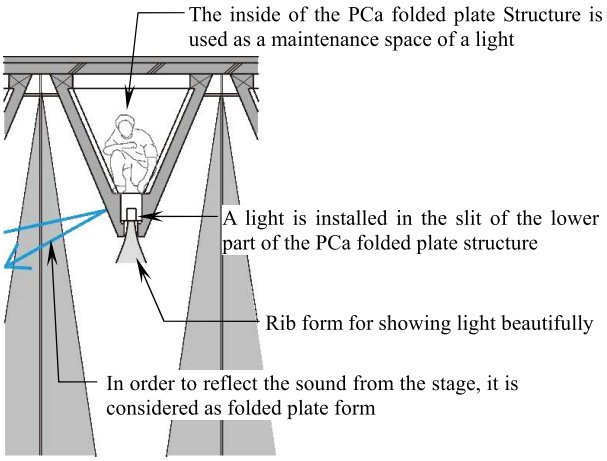

Fig.5 Section of a folded plate system of hall area

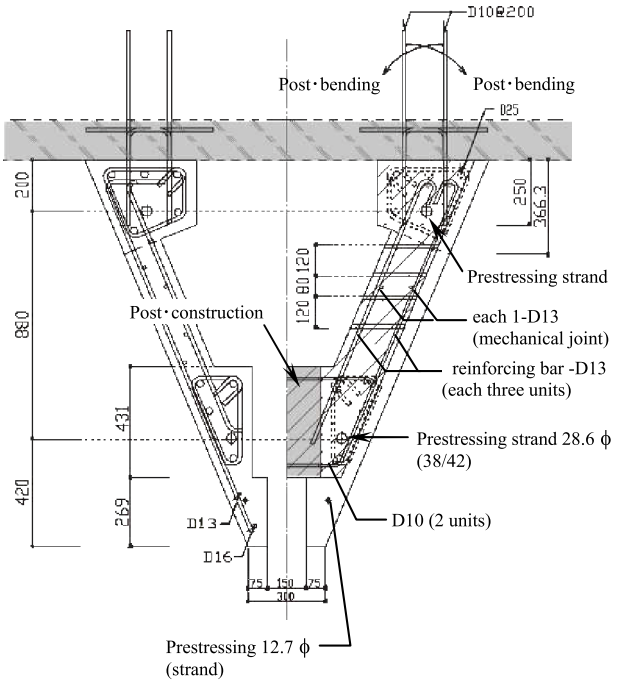

Fig.7 Detail of the section of a folded plate system

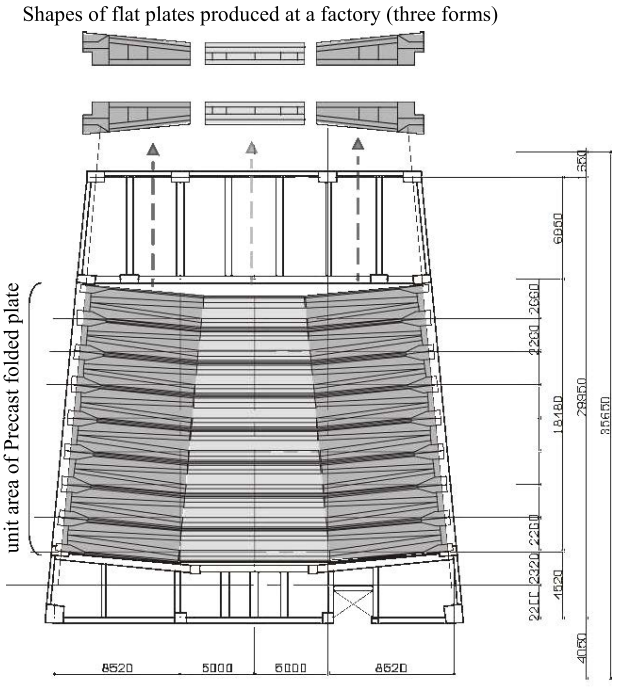

Fig.6 Framing plan of hall area

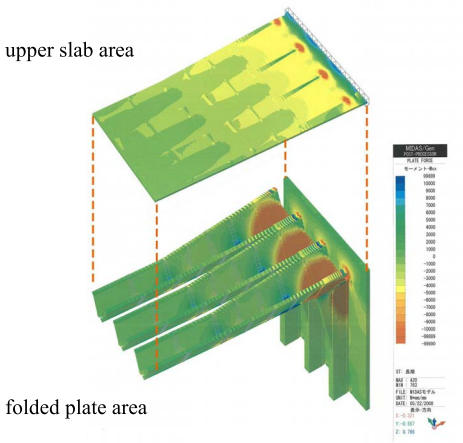

Fig.8 Permanent stress by the FEA

Fig.9 fitting up stand

Fig.10 Conditions of suspended members

Fig.11 Conditions of erection

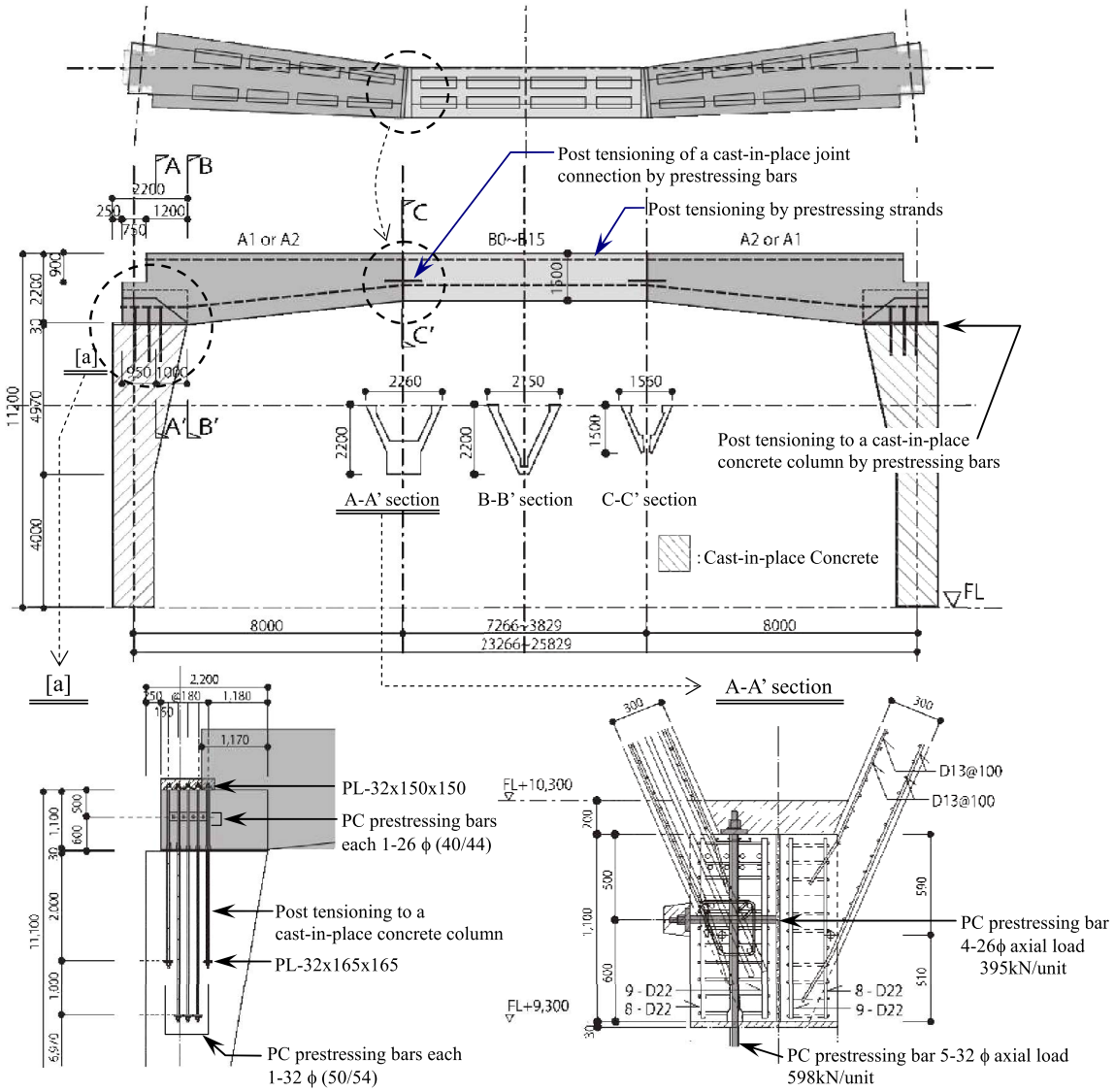

Fig.12 Framing detail of hall area

4. Conclusion

The mechanical and electrical systems can be built into the triangular space inside of the folded plate structure with pre-cast concrete plates for the hall ceiling.

The beautiful finishing ceiling and rationality for architecture are realized with the folded plate structural system of this building.

概　要

ホールには，一般的に無柱空間でスパンの大きい空間が必要である。またその形状は，音響の観点から残響時間が少なくなるように，平行な壁面を作らないような台形平面形状で，天井面も床面と平行にならないようにフラットにしないのが一般的である。そのため，壁や天井面には平行面を形成しない凹凸形状が求められる。

昭和学院伊藤記念ホールは，560人収容の 2 階建てのホールである。主要部分は現場打ち鉄筋コンクリート造としている。ホール部分は台形形状の平面とし，スパンが23.2～25.8m となる。この部分の屋根には，そのまま天井面の仕上げとなる折板構造を用いた。柱列を2.26m ピッチに設けて，1500～2200mm せいとなる厚さ150mm の三角形状の折板を配置し，その上に150mm の屋根スラブを設けた。折板部材は，仕上がりの美しさと施工性・経済性等を考慮して，折板の面が下面となるような板形状で工場製作し，現場にて三角形状の折板状態にして，屋根に架設していく。スパン方向の折板同士と現場打ちコンクリート柱は，圧着工法にて接合した。

ホールの天井面にプレキャストコンクリート板による折板構造を用いる事で，折板形状内の空間に設備システムを内蔵でき，屋根を支える構造システムそのものが美しい仕上がり面となり，合理的な建築物を造る事ができた。