Aesthetic design of a cable-stayed bridge

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Conception esthétique d'un pont à haubans

Ästhetischer Entwurf einer Schrägseilbrücke

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SUMMARY
The Aomori Bay Bridge is a 1.2 km long coastal road bridge. At the portion over the railway station and the bay, a 500 m long three-span continuous prestressed concrete cable-stayed bridge was planned and is now under construction. This paper deals with the aesthetic aspects of the cable-stayed bridge, such as the type of structure, color selection, and designs of parapets and other appurtenances which were considered at the design stage.

RÉSUMÉ
Le pont routier d'Aomori-Bay, qui franchit le port d'Aomori sur le littoral, a une longueur de 1.2 km. Le tronçon actuellement en construction, qui enjambe la gare et la mer, a été projeté comme un pont à haubans à trois travées continues en béton précontraint, d'une longueur totale de 500 m. La présente communication examine les aspects esthétiques dont il a été tenu compte au cours de l'étude de ce pont haubané, entre autres le type de structure, le choix des couleurs et la conception des accessoires comme le garde-corps.

ZUSAMMENFASSUNG
Die Aomori-Bay-Brücke ist eine Hafenstrassenbrücke mit einer Länge von 1,2 km. Für die Strecke über einen Bahnhof und die Bucht ist eine Drei-Feld-Schrägseilbrücke aus Spannbeton mit einer Länge von 500 m vorgesehen, die gerade im Bau ist. Im Text werden die ästhetischen, landschaftsbezogenen Aspekte bei den Überlegungen zum Entwurf der Schrägseilbrücke dargelegt, wobei u.a. Art der Konstruktion, Bestimmung der Farbe sowie Gestaltung des Zubehörs (wie z.B. Geländer) behandelt werden.

1. INTRODUCTION

Since its opening, Aomori Port has continued to expand in the east-west direction, encompassing a railway station. For the purpose of integrating port facilities and streamlining physical distribution, a harbor road spanning the railway station and the bay whose opening is scheduled for the summer of 1992 was planned (Fig. 1). Currently under construction as the main structure of the bridge portion (1,219m) of the harbor road, which has been named "Aomori Bay Bridge," is a 498m long, 25m wide prestressed concrete cable-stayed bridge with a central span of 240m, which is one of the largest bridges of its kind in Japan (Fig. 2).

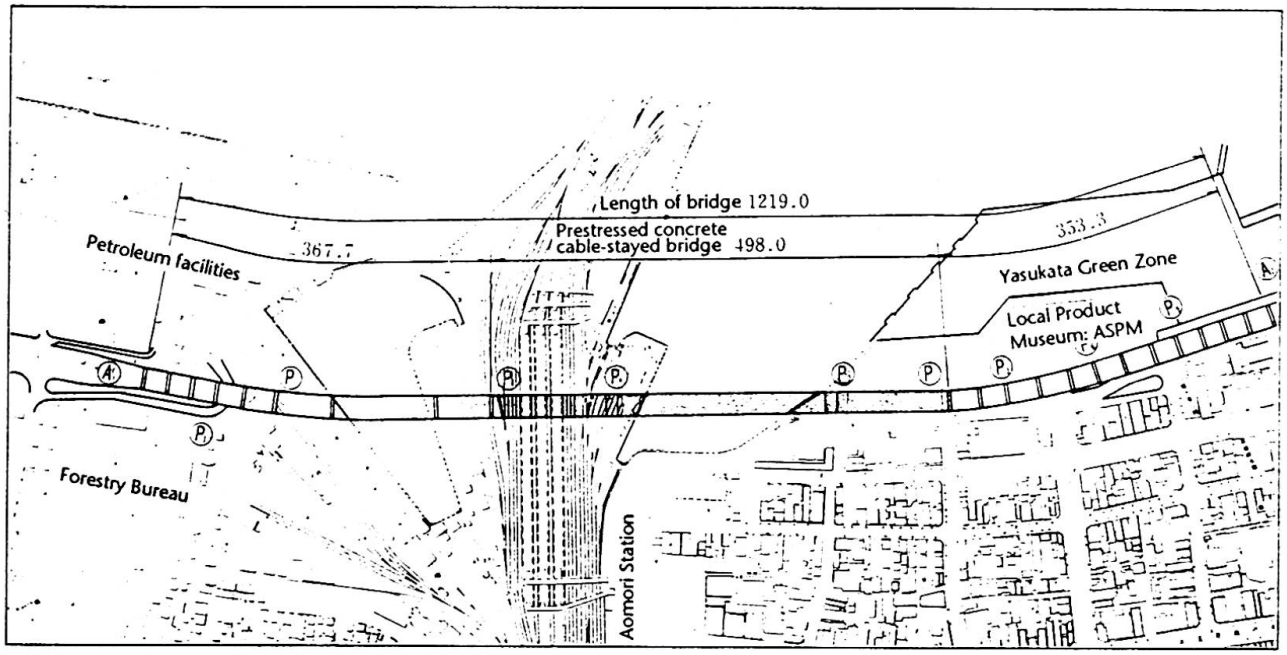

Fig. 1 Plan View of the Bridge Site

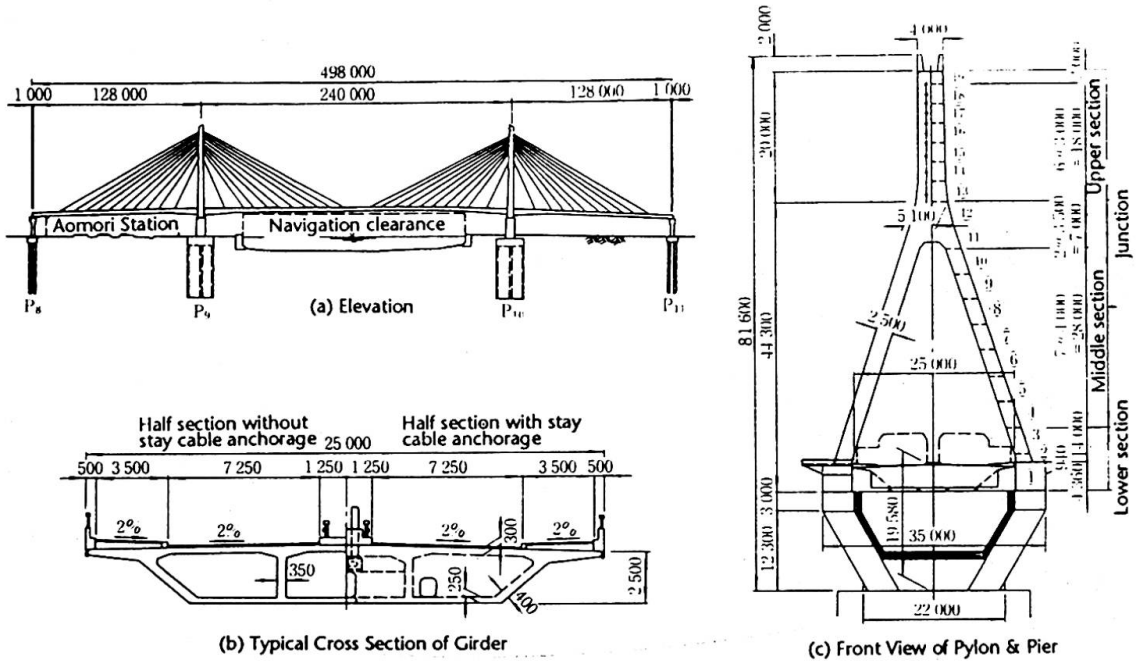

Fig. 2 General View of the Cable-Stayed Bridge

Under "Port Renaissance 21 Project," a port renewal project aimed, looking into the 21st century, at repositioning Aomori Port Area as an area which supports the prefectural capital of Aomori, establishing harmony among the functions of physical distribution, production and life supporting, and creating a richer and more humane harbor space.

In designing the above prestressed concrete cable-stayed bridge, therefore, various aesthetic elements were taken into consideration, positioning it as the monument of this waterfront project, so that the bridge as a structure goes well with and blends into the environment.

This paper outlines the aesthetic design of this cable-stayed bridge.

2. TYPE OF STRUCTURE

Since the bridge was to span the station and the bay, it was understood that the cantilever erection method was possible. With this condition in mind, various types of structures including structural materials were evaluated, and as a result the prestressed concrete cable-stayed bridge was adopted. A prestressed concrete cable-stayed bridge allows a variety of combinations of stay cable arrangement and tower configuration and thus a high degree of structural freedom. For the bridge under this project, a single-plane suspension system where points of suspension are located on the medial strip has been adopted, so that the tensioning of stay cables can be carried out in the box-girders and pedestrians and drivers crossing the bridge can enjoy landscapes. As for the configuration of pylons, inverted Y-shaped pylons which would match "ASPM," a pyramid-shaped local product museum adjacent to this bridge, were adopted, and high-strength concrete with a design strength of 60MPa was employed for a slender structure.

3. STUDY ON COLORING

In order to establish harmony with the environment and make the structure of the bridge as symbolic as possible, coloring for the bridge was studied, too. For this purpose, freely colorable FRP tubes (glass fiber reinforced plastic tubes) were used for cable tubes, and painting materials were selected after their durability was confirmed through a series of tests. After the color selection policy was established, background colors of the environment were investigated, and desirable colors were decided through color simulation.

3.1 Color Selection Policy

In anticipation of future port renewal projects, a lasting color scheme was to be selected. Color selection was made taking account of the following requirements:

1) The colors of the bridge should go well with those of the environment.
2) The colors of the bridge should be suitable for the structural characteristics of the prestressed concrete cable-stayed bridge.
3) Coloring suitable for a monument should be studied.
4) In consideration of a night-time lighting up plan, colors should be planned for a better lighting effect.
5) Since the huge bridge will cut the skyline substantially, dark colors should be avoided.
6) The bridge should be designed based on the understanding that it is a coastal bridge.

3.2 Results of Color Study Using Color Simulation

3.2.1 Stay cables

Stay cables have a characteristic structural beauty of cable-stayed bridges, and their large plane-like spaces have good color effects. Color simulation was performed for four sets of desirable colors, namely, (a) gold, (b) white, (c) gradation of reddish colors, and (d) gradation of blue-greenish colors. As a result, (a) gold, which can express heaviness and richness, is highly symbolic, changes its hues under natural sunlight, and has freshness and uniqueness, was adopted.

3.2.2 Pylons, piers and main girders

In deciding the colors of these elements, the stage effect to make the impressive gold of the stay cables look neat and symbolic was considered. Bright neutral colors were used as base colors, which were to be accented with small areas of the same or similar hues as stay cables or contrasting hues, so that a vivid impression was created.

4. STUDY ON LIGHTING

4.1 Planning Policy

In consideration of the color scheme mentioned above, lighting of the bridge was to be planned so that it harmonized with the lighting around the bridge and of the completed ASPM. The following requirements were considered:

1) The night view of the Aomori Bay Bridge should be made attractive by means of an effective lighting scheme.
2) Structural characteristics of the cable-stayed bridge should be emphasized, and the stage effects of individual elements of the bridge should be enhanced synergistically.
3) A silhouette of the bridge against the sky at night which is different from one under the sunlight should be created.
4) The lighting scheme should reflect the characteristics of the seasons.
5) An orderly night view of the bridge and ASPM should be created.

4.2 Findings from of the Study

1) When viewed at a close range, lighting up of the whole structure awakens a sense of oppression, making us feels as if the structure were going to hang over us.
2) Lighting of the overall pylons and stay cables will have an adverse affect on drivers crossing the bridge.
3) Lighting of the upper part of the pylons and stay cables will influence the environment only slightly and will be very effective.

From above, it was decided that the upper part of the pylons and the stay cables were to be lit up. In view of the white-green-blue coloring of ASPM, these three colors plus orange, which was to add warmth to the night view in winter, were adopted. Based on the results of a lighting test during construction, it was decided that the stay cables were to be lit up in four colors alternately, and the pylons in white only.

5. CONSIDERATON OF HARMONY WITH ADJACENT STRUCTURES

This cable-stayed bridge, which was to pass in front of ASPM, was expected to obstruct its view. Therefore, it was decided that a gate tower would be built

in front of ASPM and the gate tower would be designed so that harmony among the bridge, ASPM and the gate tower would be established (Fig. 3).

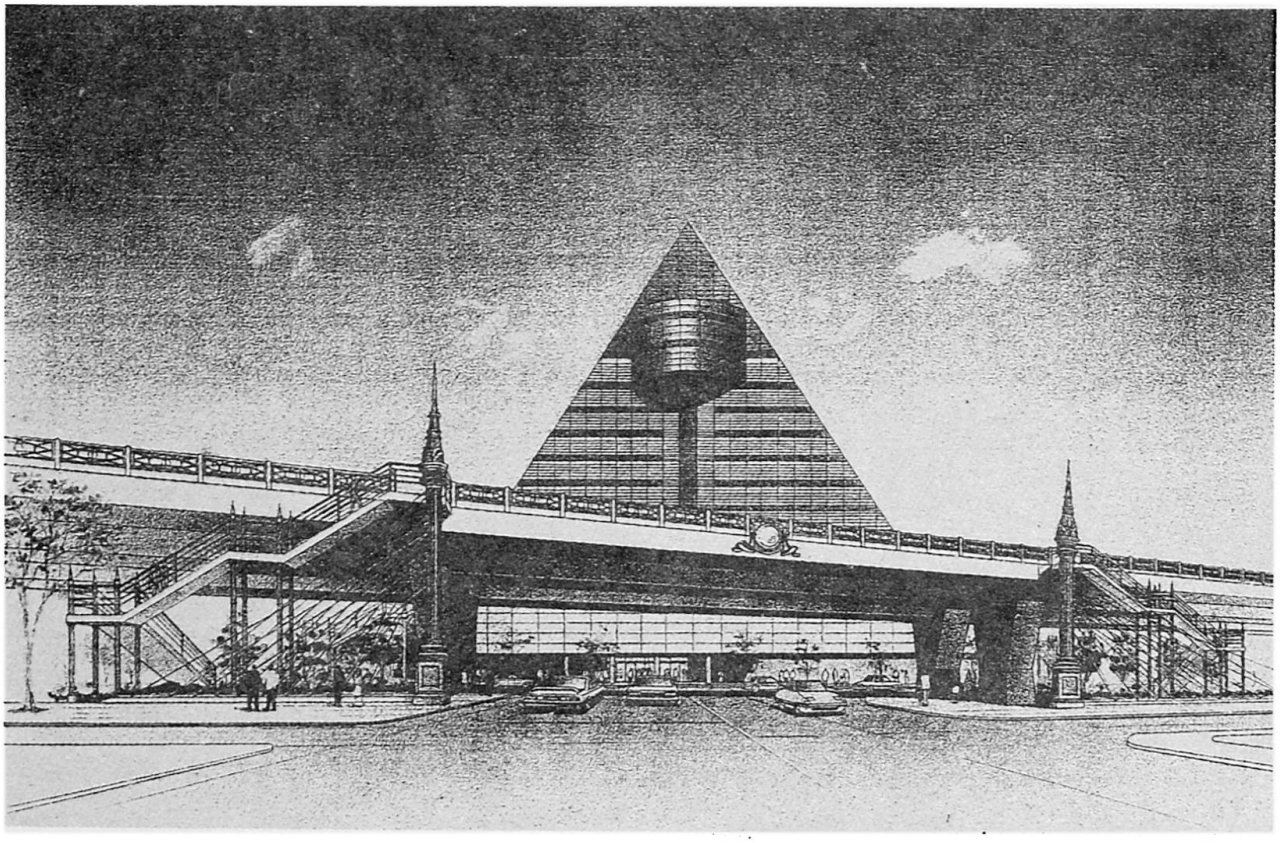

Fig. 3 Architectural View of the Gate Tower in front of ASPM

5.1 Policy of the Study

1) To visualize an image of Aomori making progress into the future and of stars which is the motif of the official symbol of the city of Aomori
2) To mirror and symbolize the history and tradition of Aomori Port
3) To create a design that matches the landscapes of a modern core city in the future, which is the goal of Aomori

5.2 Results of the Study

1) The unfavorable image of a bridge passing in front of ASPM was to be improved by creating the atmosphere of a gateway to ASPM and designing a story-telling expression.
2) Supports of classical designs in harmony with ASPM and the bridge were to be used so as to conjure up an image of marking the time of visitors to this place and ships entering and leaving Aomori Port like a wall clock marking each day with the light and shadow of the sun.
3) Being lit up at night, the gate tower was to be surrounded by a warm light, making us feel as if it were a lighthouse for people walking up and down the streets. In addition, expressions of ASPM were to be decorated colorfully so that ASPM in conjunction with the cable-stayed bridge would attract people's attention.
4) The monument at the center of the gate was to symbolize the history, tradition and culture of time.

6. AESTHETIC DESIGN OF PARAPETS AND OTHER BELONGINGS

Belongings, such as parapets, were also designed, taking account of harmony with the environment, so that pedestrians can enjoy peace of mind. Fig. 4 shows the designs thus worked out.

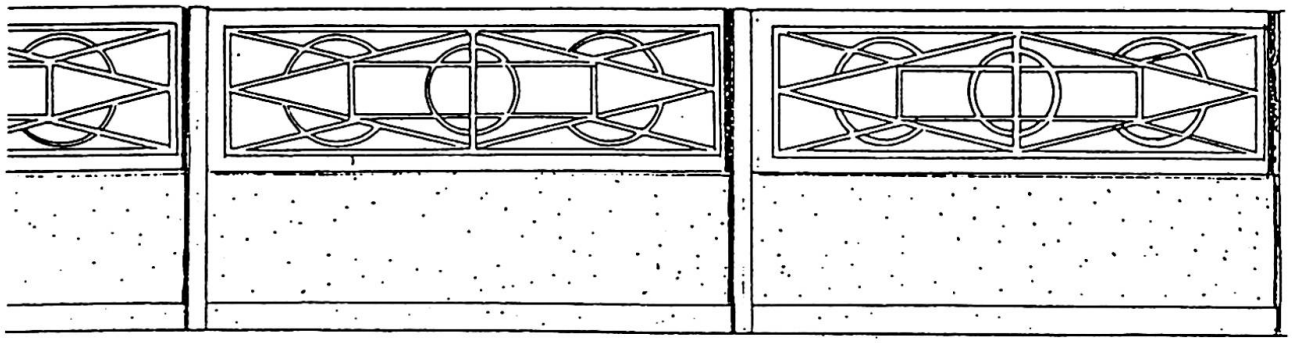

Fig. 4 Design of Parapets

7. CONCLUSION

The Aomori Bay Bridge, whose opening is scheduled for the summer of 1992, is now at the final stage of construction and is beginning to unveil itself. It is believed that various aesthetic considerations, as well as the unique structure of a cable-stayed bridge, will dramatize the existence of the bridge (Fig. 5).

Fig. 5 Photomontage of completed Aomori Bay Bridge