

Overall Design of a Double-Deck Truss Single-Pylon Cable-Stayed Bridge

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Abstract: The main bridge in Lu'an is a double-deck truss single-pylon cable-stayed bridge with double-cable planes, featuring a span arrangement of 98 m + 105 m + 255 m + 300 m = 758 m. The structural system is a semifloating system with longitudinal restraints. The main girder is a composite steel truss structure comprising two transverse main trusses spaced at 26.1 m. The main trusses adopt a triangular (Warren) configuration, with a truss height of 10 m and a panel length of 15 m. The upper deck consists of an orthotropic steel deck, while the lower deck comprises an orthotropic composite deck. The pylon is designed as a water-drop-shaped tower with a total height of 164.670 m. A total of 32 pairs of stay cables is arranged in a spatial double-cable-plane fan configuration using steel strands with a standard tensile strength of 1,860 MPa. The basic cable spacing is 15.0 m along the deck and 2.5 m along the pylon. The stay cables are anchored at the girder ends using steel anchor boxes, while a combined anchorage system consisting of steel anchor beams and circumferential prestressing (directly anchored into the pylon walls) is employed at the pylon ends.

Keywords: single-pylon cable-stayed bridge; structural system; double-deck truss; orthotropic composite deck; bridge design

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1 Project Overview

According to the overall design scheme, the total bridge length within this project is 3.415 km, with two pairs of ground-level entrances/exits and two pairs of ramp entrances/exits being provided, as shown in Figure 1. The existing old bridge spanning the river will be demolished and replaced by a new double-deck truss bridge. Main and auxiliary traffic flows are separated vertically by the two decks: the upper deck serves the ring expressway, while the lower deck connects both the sides of the Pi River and accommodates nonmotorized traffic.



Figure 1 General layout of the bridge (unit: m)

2 Main Technical Standards

- (1) Design speed: 80 km/h for the mainline bridge and 40 km/h for auxiliary roads and ramp bridges.
- (2) Load grade: The vehicle load is City-A class; nonmotorized vehicle and pedestrian loads should comply with the *Code for Design of Urban Bridges* (CJJ 11—2011) (2019 Edition).
- (3) Design water level: 39.43 m (Once-in-a-century flood level).
- (4) Navigation: No navigation requirement.

- (5) Clearance: Vertical clearance for motor vehicle lanes ≥ 4.5 m; vertical clearance for nonmotorized vehicle lanes and sidewalks ≥ 2.5 m.
- (6) Seismic design criteria: Basic seismic intensity of VII degree, with a peak ground acceleration of 0.1 g.
- (7) Bridge design safety class: Class I, importance factor $\gamma_0 = 1.1$.
- (8) Design reference period: 100 years.
- (9) Design service life: 100 years.
- (10) Durability design environment category: Category I.

3 Overall Design

The main bridge is a double-deck truss single-pylon cable-stayed bridge with double cable planes, featuring a span arrangement of 98 m + 105 m + 255 m + 300 m = 758 m. The upper deck is 27.5 m wide, and the lower deck is 32 m wide. The general layout of the main bridge is shown in Figure 2.

The main girder is a composite steel truss structure, comprising two transverse main trusses spaced at 26.1 m. The main trusses adopt a triangular configuration, with a truss height of 10 m and a panel length of 15 m. The upper deck is an orthotropic steel deck, while the lower deck is an orthotropic composite deck.

The pylon is designed as a water-drop-shaped tower with a total height of 164.670 m. The pylon foundation is an integral pile cap. The side piers are double-column piers supported on separate pile caps. One abutment is provided on each side of the main bridge, and all abutments are founded on bored pile foundations.

A total of 32 pairs of stay cables is arranged in a spatial double-cable-plane fan configuration using steel strands with a standard tensile strength of 1,860 MPa. The basic cable spacing is 15.0 m along the deck and 2.5 m along the pylon. The stay cables are anchored at the girder ends using steel anchor boxes, while a combined anchorage system comprising steel anchor beams and circumferential prestressing (directly anchored into the pylon walls) is employed at the pylon ends.

The static system of the bridge is a semifloating system with longitudinal restraints: longitudinal fixed bearings are provided together with transverse wind-resistant bearings at the pylon; furthermore, at the other piers, bearings are longitudinally movable, while transversely, one side is fixed and the other side is movable. The longitudinal seismic system consists of shear-off fixed bearings at the pylon with viscous dampers provided for energy dissipation, while bearings at the other piers remain longitudinally movable. The transverse seismic system restrains transverse displacement of the main girder at the pylon by wind-resistant bearings, and friction pendulum seismic isolation bearings are adopted at the other piers (see Figure 2 for details).

4 Structural System Analysis

Modern cable-stayed bridges are multispan continuous flexible structures. Various bridge construction conditions require different restraint systems to obtain the optimal static and dynamic responses of a bridge structure.

4.1 Comparison of Static Systems

According to their mechanical behavior, the basic restraint systems of cable-stayed bridges can be classified into floating systems, semi-floating systems, pylon-girder fixed systems, and rigid frame systems [1–4]. The bridge under investigation has a truss girder; therefore, a pylon-girder fixed system or a rigid frame system will be structurally complex and difficult to construct, making both unsuitable for this project. The restraint system was thus selected primarily from three options: a floating system, a semi-floating system (without longitudinal restraint), and a semi-floating system with longitudinal restraint. The calculated results for these three systems are presented in Table 1.

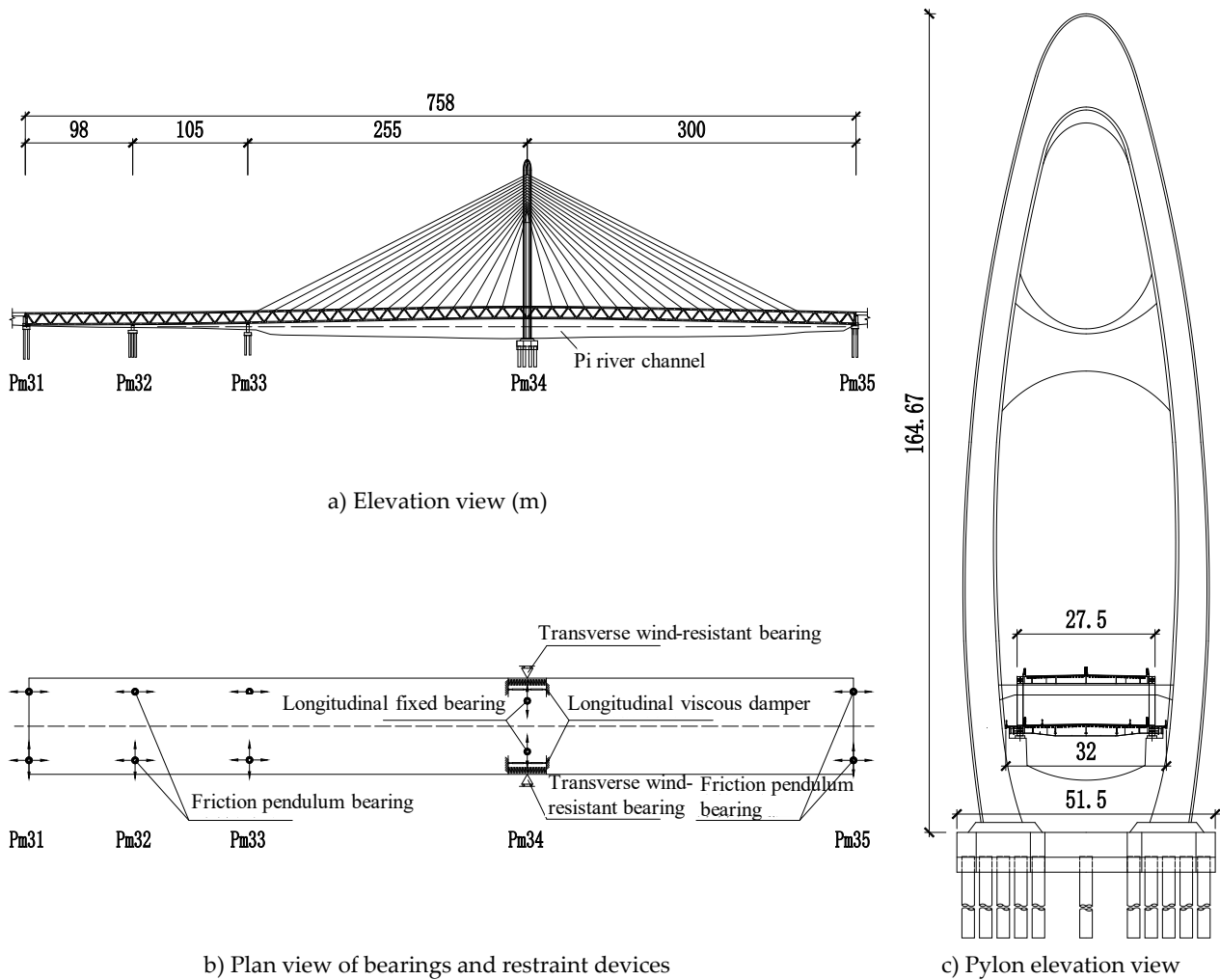


Figure 2 General layout of the main bridge (unit: m)

Table 1 Key structural response indices for different restraint systems

Restraint system	Lower chord stress at pier top under live load (MPa)	Tower base moment under 100-year wind (kN·m)	Tower top displacement under 100-year wind (m)	Girder end displacement under 100-year wind (m)
Floating system	26	1,387,366	0.906	0.880
Semi-floating system	43	1,388,860	0.908	0.882
Semi-floating with longitudinal restraint system	43	279,058	0.021	0.007

As shown in the above table, both the floating system and semi-floating system exhibit relatively large horizontal displacements at the girder end and pylon top, and the longitudinal bending moment at the pylon base induced by longitudinal loads is very high. By introducing longitudinal restraints at the pylon, the longitudinal bending moment at the pylon base and horizontal displacements of the girder and pylon can be considerably reduced. Moreover, because this bridge is a single-pylon cable-stayed bridge, the temperature-induced axial force in the main girder and longitudinal moment at the pylon base are very small, with negligible differences observed among the three restraint systems. Therefore, a longitudinal fixed restraint is adopted at the pylon to enhance the overall structural stiffness.

4.2 Comparison of Seismic Systems

Considering forces acting on the pylon and substructure, the shear-off force of the fixed bearings at the pylon is designed to be 10% of their vertical bearing capacity.

Under seismic action, the fixed bearings at the pylon are designed to shear off. Subsequently, two systems can be considered: a longitudinally movable system and a viscous damper system. The seismic responses under the E2 level for both systems are presented in Table 2. When viscous dampers are adopted, both the girder end displacement and pylon base bending moment under seismic action are reduced; therefore, viscous dampers are adopted in the longitudinal direction for seismic energy dissipation.

Table 2 Key structural response indices under E2 longitudinal seismic action for different restraint systems

Load case	Girder end Displacement (m)	Pylon base shear (kN)	Pylon base Moment (kN·m)
Longitudinally movable	0.226	72,615	668,640
Viscous damper	0.1	72,746	564,117

In the transverse direction, spherical steel bearings are adopted at the pylon to restrain the transverse displacement. Under seismic action, bearings at all other piers are designed to shear off. Subsequently, two systems are compared: a transversely free system and a seismic isolation bearing system. The calculated results are shown in Table 3. The transversely free system yields smaller shear forces and bending moments at the pier base under seismic action, but the resulting transverse displacement is excessively large, which is detrimental to structural safety. Therefore, seismic isolation bearings are adopted to reduce the transverse displacement of the main girder.

Table 3 Key structural response indices under E2 transverse seismic action for different restraint systems

Load case	Max. transverse displacement of main girder (m)	Shear force at pier base (kN)	Bending moment at pier base (kN·m)
Transversely free	0.293	1,035	2,502
Transverse friction pendulum bearing	0.086	1,481	6,355

Based on the above results, the static system of this bridge is selected to be a semi-floating system with a longitudinal restraint: transverse wind-resistant bearings and longitudinal fixed bearings are provided at the pylon; at all other piers, bearings are longitudinally movable, while transversely, one side is fixed and the other side is movable. The longitudinal seismic system consists of shear-off fixed bearings at the pylon with viscous dampers for energy dissipation, while bearings at the other piers remain longitudinally movable. The transverse seismic system restrains the transverse displacement of the main girder at the pylon using wind-resistant bearings, and friction pendulum seismic isolation bearings are adopted at the other piers.

5 Design of Main Girder

5.1 Main Truss

5.1.1 Main Truss Configuration and Truss Height

Common truss configurations for steel truss girders include the Warren truss, triangular truss (also known as the pure Warren truss), and N-shaped truss (also known as the Pratt truss) [5–8]. The truss height is primarily determined by structural load-bearing requirements and stiffness considerations [6]; for double-deck bridges,

clearance of the lower deck must be ensured [9]. Considering factors of under-bridge clearance, mechanical performance, steel consumption, and aesthetics, the triangular truss configuration is selected for this bridge, with a truss height of 10 m.

5.1.2 Structural Design of Main Truss

The main truss consists of two truss panels. Each panel comprises an upper chord, a lower chord, and diagonal web members. Integral panel points are adopted for truss joints. For connections between segments, a welded scheme is recommended in this design.

Both the upper and lower chords adopt a rectangular cross section. The top plate has a 2% cross slope, and the bottom plate is flat. The chord width is 1,200 mm, and the height at the centerline is 1,400 mm, as shown in Figure 3. For the upper chord, the thicknesses of the top plate and web plates range from 20 to 32 mm, while that of the bottom plate ranges from 16 to 32 mm. For the lower chord, the top plate thickness ranges from 16 to 36 mm, bottom plate thickness ranges from 16 to 50 mm, and web plate thickness ranges from 16 to 36 mm. The inner sides of the top plates of both the upper and lower chords are extended to facilitate butt connection with cross beams during construction. A 250-mm-wide connecting plate is welded to the outer web plate of the lower chord for butt connection with the top plate of the side-walk slab beam.

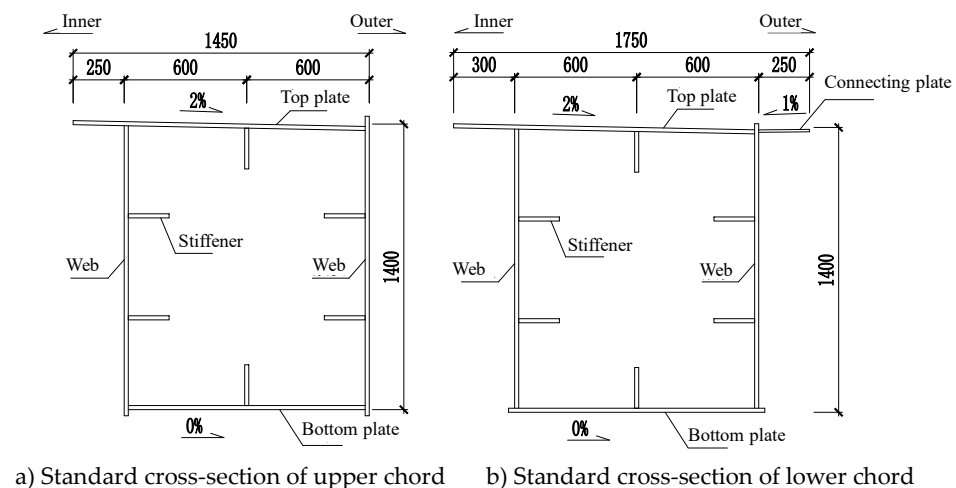


Figure 3 Standard cross-sections of chords (unit: mm)

The diagonal web members adopt a rectangular cross section. The width of the flange plate of the web member is 1,060 mm in the longitudinal bridge direction, with the thickness ranging from 24 to 45 mm, and it is stiffened with a longitudinal stiffener. The width of the web plate is 1,200 mm in the transverse bridge direction, with the thickness ranging from 16 to 45 mm, and it is stiffened with two longitudinal stiffeners. For the end vertical web members at the girder ends, the flange plate width is increased to 1,260 mm, with a thickness of 45 mm, and the girder is stiffened with two longitudinal stiffeners. The web plate has a width of 1,200 mm in the transverse bridge direction and is stiffened with two longitudinal stiffeners.

5.2 Deck System

5.2.1 Comparison of Longitudinal Girder Quantities for the Deck System

Currently, for long-span steel truss cable-stayed bridges completed both domestically and internationally, the relationship between the deck and main truss generally falls into two categories: the deck–truss separated system and deck–truss composite system [10–11]. When the main girder of a cable-stayed bridge is subjected to considerable axial compressive forces, the deck–truss composite system is beneficial for both the strength and stability of the main truss and can effectively

reduce the quantity of steel required [6]. Therefore, a deck–truss composite system is adopted for this bridge.

To avoid the problem of fatigue cracking in the steel deck under heavy-vehicle loads, the upper deck adopts an orthotropic steel deck, while the lower deck adopts an orthotropic composite deck, considering actual traffic demands as well as structural performance. During the design phase, the number of longitudinal girders in the deck system primarily between a single-longitudinal-girder system and a three-longitudinal-girder system was compared, as shown in Figure 4. Apart from the number of longitudinal girders, all other structural details of the two systems are identical.

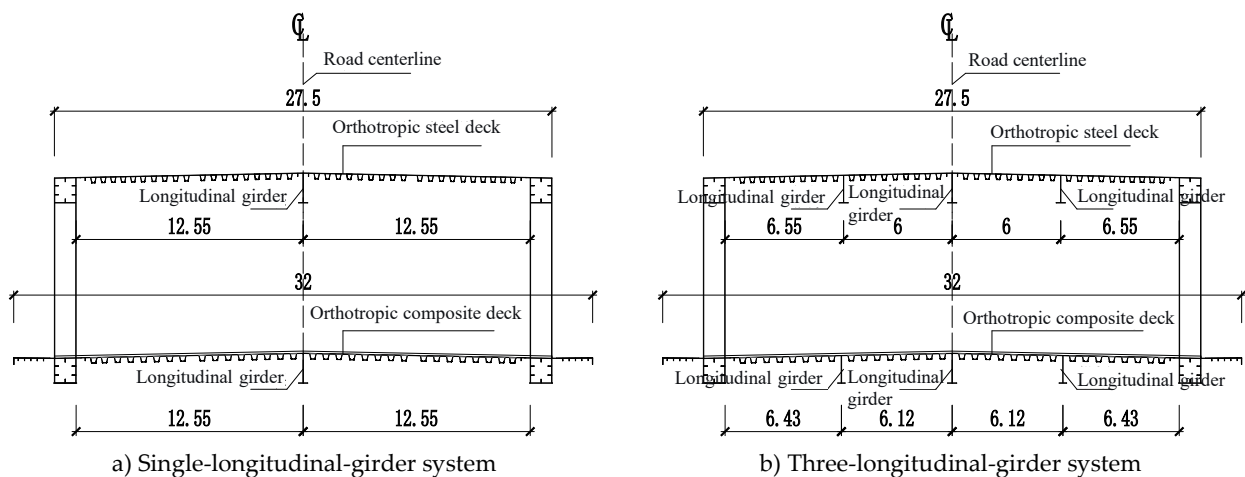


Figure 4 Comparison of longitudinal girder quantities for the deck system (unit: m)

The structural behavior of the deck system under different longitudinal girder arrangements is analyzed using ANSYS finite element software. The local analysis model has a length of 45 m in the longitudinal bridge direction. At the end nodes of the upper chord, translations in all three directions are constrained; furthermore, at the intermediate nodes of the upper chord and end nodes of the lower chord, vertical displacements are constrained. The steel structure is modeled using shell element Shell63, while the concrete deck slab is modeled using solid element Solid95. The analysis model assumes that no relative slip occurs between the steel deck plate and concrete deck slab; i.e., composite action between the two is achieved by sharing nodes at the interface. The loads considered include the self-weight of the structure, superimposed dead loads, and vehicle loads. The construction process is simulated using the element birth and death technique. The structural analysis model and boundary conditions are shown in Figure 5. The calculated results for the lower deck system under different longitudinal girder arrangements are presented in Table 4.

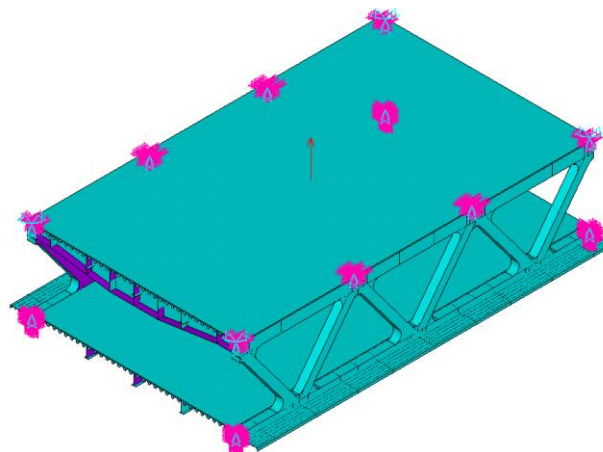


Figure 5 Finite-element model of the deck system

Table 4 Stresses in the main components of the lower deck system under different longitudinal girder arrangements (unit: MPa)

Component	Single-longitudinal-girder system	Three-longitudinal-girder system	Difference	Relative difference
Von Mises stress in bottom plate of main cross beam	234.6	239.0	−4.4	−1.9%
Von Mises stress in bottom plate of secondary cross beam	200.0	186.3	13.7	6.9%
Longitudinal tensile stress in steel deck plate	35.0	23.8	11.2	32.0%
Longitudinal compressive stress in steel deck plate	35.9	30.8	5.1	14.2%
Transverse tensile stress in steel deck plate	43.4	50.1	−6.7	−15.4%
Transverse compressive stress in steel deck plate	107.3	112.7	−5.4	−5.0%
Longitudinal tensile stress in U-rib	135.0	105.9	29.1	21.6%
Longitudinal compressive stress in U-rib	81.9	48.4	33.5	40.9%

The member dimensions of the single-longitudinal-girder system are further adjusted so that stress in the above main components is generally comparable to that in the three-longitudinal-girder system, and the steel quantities of the two systems are compared. The detailed results are shown in Table 5.

Table 5 Steel quantities of the lower deck system under different longitudinal girder arrangements (unit: kg/m²)

System	Main cross beam	Secondary cross beam	Longitudinal girder	Deck plate (including stiffeners)	Total
Single-longitudinal-girder system	47.8	32.5	12.8	162.5	255.6
Three-longitudinal-girder system	47.8	29.0	24.9	145.0	246.7

The following observations can be made from the above comparison: the longitudinal girders transfer part of the load to the panel-point cross beams; therefore, the main cross beam in the three-longitudinal-girder system is subjected to a higher stress than that in the single-longitudinal-girder system, whereas the secondary cross beam is subjected to a lower stress, consistent with general mechanical principles. The three-longitudinal-girder system provides better support to the deck plate than the single-longitudinal-girder system; consequently, the stress in both the deck plate and U-ribs is more favorable in the three-longitudinal-girder system. Furthermore, when the main components of both systems are scaled to achieve comparable stress levels, the single-longitudinal-girder system does not offer an advantage in terms of steel quantity. Although it involves fewer welding procedures and relatively simpler

construction, considering the stress in the deck plate and U-ribs of the first system, the three-longitudinal-girder system is ultimately selected. This choice ensures better structural performance, and the economy can be further improved through optimization of structural details.

5.2.2 Structural Design of the Deck System

The upper deck adopts an orthotropic steel deck with a standard panel length of 15.0 m. Box-shaped main cross beams are provided at the intersections of the diagonal web members and chords. The standard main cross beam has a height of 1.412–2.2 m, a width of 1.5 m, a web thickness of 14–24 mm, and a bottom plate thickness of 20 mm. Among main cross beams, I-shaped secondary cross beams are arranged at a standard spacing of 3.375 m. These secondary cross beams have a height of 1.412–1.663 m, a web thickness of 14–16 mm, a bottom plate width of 0.4 m, and a thickness of 20 mm. Three I-shaped longitudinal girders are provided transversely in each segment, arranged at the same height as the secondary cross beams. The longitudinal girders have a web thickness of 14 mm, a bottom plate width of 0.4 m, and a thickness of 20 mm. The deck plate is 16 mm thick, with U-ribs underneath at a standard spacing of 600 mm, as shown in Figure 6.

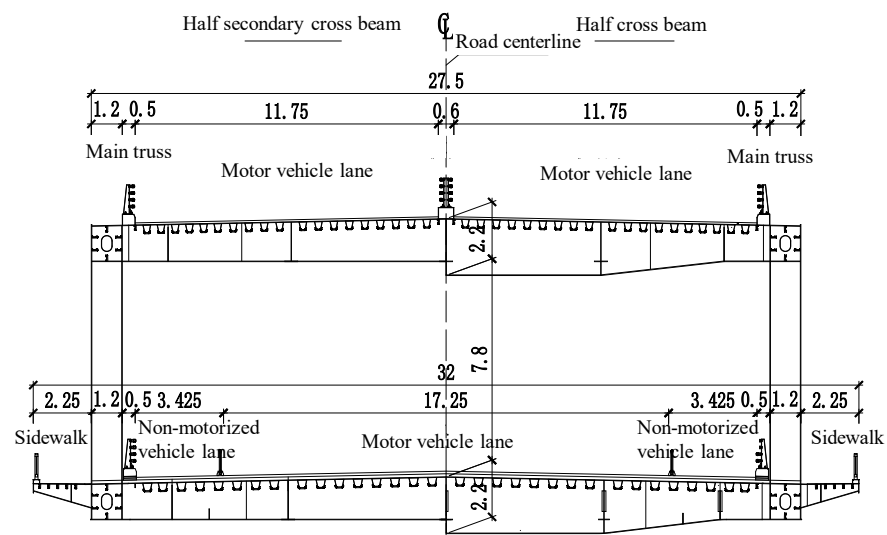


Figure 6 Layout of the upper and lower deck systems of the main bridge (unit: m)

The lower deck system adopts an orthotropic composite deck with a longitudinal and transverse girder system, which has a standard panel length of 15.0 m. It differs from the upper deck in the following aspects: the concrete deck slab substantially enhances the stiffness and load-bearing capacity of the deck structure; therefore, the standard spacing of the secondary cross beams is increased to 4.5 m, and that of the U-ribs is increased to 720 mm. Considering the local stability of the steel deck plate and its welding performance with shear connectors, the steel deck plate thickness is reduced to 12 mm. The concrete deck slab is made of C50 low-shrinkage hybrid fiber-reinforced concrete, with a steel fiber content of 80 kg/m³ and a synthetic fiber content of 1.1 kg/m³. According to structural and crack-resistance requirements, two layers of reinforcement are arranged in the longitudinal direction, and one layer is arranged in the transverse direction. For bridges spanning long distances, a thinner concrete slab is economically advantageous. Considering forces acting on the first and second systems as well as construction details such as the cover thickness, diameters of longitudinal and transverse reinforcement, and interlayer spacing [12], the thickness of the concrete deck slab is determined to be 120 mm. The deck slab is cast in stages and batches to improve its crack resistance. Shear connectors between the concrete deck slab and steel top plate are headed studs with dimensions of $\Phi 16 \times 90$ mm. The standard spacing is 360 mm (transverse) $\times$ 300 mm

(longitudinal) over the deck area and 240 mm (transverse) $\times$ 300 mm (longitudinal) over the chord area. At the locations of the vertical web members, the stud spacing is locally densified and adjusted to 120 mm (transverse) $\times$ 150 mm (longitudinal).

A nonmotorized vehicle and pedestrian deck system is provided outside the main truss on both sides. The standard length of the cantilever bracket is 2.25 m, with a root height of 0.938 m. A total of six viewing platforms is arranged along the bridge; at the center of each platform, the cantilever bracket length is 6 m, with a root height of 1.338 m. The web plate of the cantilever bracket is 14 mm thick, and the bottom plate is 0.4 m wide and 16 mm thick.

6 Design of Pylon

6.1 Selection of Pylon Axis

Through analysis of the distinctive culture of Lu'an, the Lu'an Guapian (Melon Seed Tea) is selected as the cultural theme for the landscape design of this bridge. In the bridge landscape design, embodiment of this theme is primarily expressed through two aspects.

First, the overall frontal shape of the pylon fully interprets the physical culture of Lu'an Guapian: the shape of Lu'an Guapian tea leaves resembles a single piece of melon seed, naturally flat and slightly curled at the edges. This flaky tea leaf, shaped like a sunflower seed, was originally called "Guaizi Pian" (a melon seed slice) and later simply as "Guapian," as shown in Figure 7a). Accordingly, the frontal shape of the pylon draws on the form of the "Guapian" leaf: the pylon top is slightly pointed yet rounded, the pylon shaft features a long, curved profile, and the base of the pylon is arc shaped, as shown in Figure 7b).

Second, the outer surface of the pylon cross beam adopts a decorative cultural relief landscape design, with the relief content depicting the leaf form of Lu'an Guapian tea. The decorative cultural relief landscape is created using concrete relief technology and is cast integrally with the pylon body. A special artistic formwork (i.e., formwork with the Guapian tea leaf pattern) is employed during concrete casting of the relief.



a) Lu'an Guapian (Melon Seed Tea)



b) Pylon axis

Figure 7 Styling of the pylon exterior

6.2 Structural Analysis of the Pylon

In terms of the mechanical performance, the primary goal is to minimize the bending moment in the pylon column as much as possible, and the pylon axis is optimized without compromising the aesthetic form of the pylon. The pylon of this bridge is designed in the "Guapian" shape, requiring an elegantly curved line to define the pylon axis. After comparison, a single circular arc with a radius of 350 m is adopted to form the pylon axis. The transverse bending moments in the pylon under dead load for different cross beam configurations are presented in Table 6.

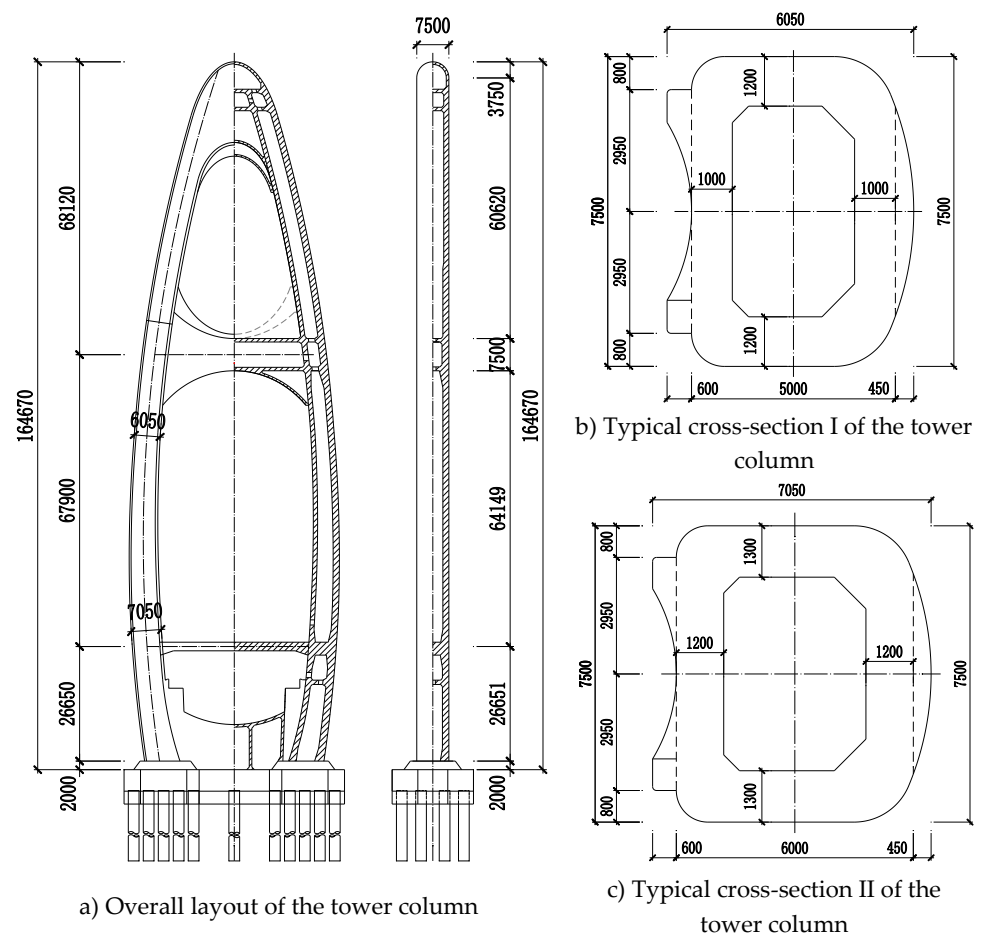
Table 6 Comparison of absolute transverse bending moments in the pylon column under dead load for different cross beam configurations

Cross beam configuration	Max. moment in upper pylon column (kN·m)	Max. moment in middle pylon column (kN·m)	Max. moment in lower pylon column (kN·m)
Without cross beam	311,116	358,451	1,547,364
With upper cross beam	208,607	277,571	1,026,013
With lower cross beam	189,314	459,749	352,927
With both upper and lower cross beams	96,790	214,550	352,680

The above analysis shows that, without impairing the aesthetic form of the pylon and without changing the pylon axis, adding an upper cross beam and a lower cross beam to the pylon is an effective structural measure to minimize the transverse bending moment in the pylon column. The position of the lower cross beam depends on the deck elevation, while that of the upper cross beam can be determined based on the desired pylon form and structural performance.

6.3 Structural Design

The main pylon of the bridge has a total height of 164.670 m, of which 132.978 m is above and 31.692 m is below the upper deck. The pylon consists of two separated tower columns, each defined by a longitudinal axis with a radius of 350 m, as shown in Figure 8. The maximum transverse width of the pylon is 49.088 m, and the width at the base is 41.886 m. The tower top gradually narrows following an elliptical curve. The longitudinal dimension of the pylon is 7.5 m everywhere except at the top, where it also gradually narrows following an elliptical curve; localized detailing is applied for aesthetic purposes.

**Figure 8** Structural details of the tower column (unit: mm)

Each separated tower column is a single-cell single-box reinforced concrete structure. The height of the upper pylon column is 68.120 m, of which the cable anchorage zone occupies 45.0 m. The wall thickness is 1.2 m in the longitudinal direction and is 1.0 m in the transverse direction. The upper cross beam is a prestressed concrete structure with a single-cell single-box cross section measuring 7.2 m × 4.0 m; the tower column is locally thickened at the cross-beam location. The height of the middle pylon column is 67.900 m, with a longitudinal wall thickness ranging from 1.2 to 1.3 m and a transverse wall thickness ranging from 1.0 to 1.2 m. At a distance of 2.181 m below the upper deck, a solid cross beam measuring 2.0 m × 5.0 m is provided, passing through the truss girder and being prestressed. The height of the lower pylon column is 28.650 m, with a wall thickness of 1.6 m. Within the bottom 8.5 m near the pylon base, the two columns are connected into an integral structure, forming a single-box six-cell variable-section reinforced concrete structure. The pylon is constructed using C50 concrete.

7 Stay Cables and Anchorage Systems

The longest stay cable of the bridge is approximately 277 m in length, and the shortest is approximately 83 m. Based on calculations, the stay cables are classified into four types: 61-wire, 73-wire, 91-wire, and 109-wire.

According to differences in force-transfer mechanisms and structural configurations, cable-to-girder anchorage devices commonly used in cable-stayed bridges with steel or steel-concrete composite stiffening girders can be broadly divided into three categories: the anchor box type, anchor plate type, and anchor pipe type [13–17]. For this bridge, the cable anchorage zones are arranged on the upper chords of the main truss. If the anchor plate type is adopted, the significant out-of-plane inclination angle of stay cables will be detrimental to the weld stress, and anchorage devices located above the deck will compromise the overall bridge aesthetics. Moreover, the upper chord of this bridge has a transverse width of only 1.2 m; if the steel anchor pipe type is used, local openings will need to be cut into the upper chords and diagonal web members, leading to complex local detailing, an unclear force-transfer path, difficulty in ensuring construction quality, and compromised structural safety. Based on the above considerations, the anchor box type is adopted for cable-to-girder anchorage.

For long-span cable-stayed bridges, cable forces are large, and among other solutions, steel anchor beams, steel anchor boxes, and circumferential prestressing (direct anchorage into the pylon walls) have traditionally been employed for cable-to-eyebrow anchorage [18–21]. The pylon of this bridge consists of two separated columns with relatively small cross-sectional dimensions; therefore, the expensive steel anchor box solution is not adopted. In addition, the maximum cable force in the main span reaches 1,300 tons. If circumferential prestressing alone is used, an excessively thick pylon wall is required. Hence, a combined anchorage system consisting of steel anchor beams and circumferential prestressing (directly anchored into the pylon walls) is adopted for the cable-to-eyebrow anchorage of this bridge.

8 Conclusions

This bridge is a double-deck truss single-eyebrow cable-stayed bridge with double-cable planes, featuring a span arrangement of 98 m + 105 m + 255 m + 300 m = 758 m. Based on analyses of the static and dynamic performances of the structure, a semifloating system with a longitudinal restraint is selected as the static system of the bridge. Longitudinally, viscous dampers are installed for energy dissipation and seismic response reduction. The transverse seismic system comprises wind-resistant bearings at the pylon and friction pendulum seismic isolation bearings at the piers. The main girder adopts a deck-truss composite system, which not only meets structural requirements but also reduces steel quantity. The pylon is designed to have a water-drop shape with a relief decoration, presenting elegant appearance that

blends harmoniously with the surrounding environment. The results of structural system analysis, comparison of longitudinal girder quantities for the deck system, analysis of the pylon cross-beam configuration, and other analyses of this bridge can serve as references for construction of similar bridges in the future.

Conflict of Interest Statement: The author declares that there is no conflict of interest regarding the publication of this paper.

Data Availability Statement: All data presented in this paper are theoretical data derived at the design stage. The original files have been desensitized, but the core data are presented in the paper. The relevant computational models and data can be obtained from the corresponding author for academic verification. The actual engineering scheme is subjected to construction drawings.

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