Matadi Bridge over the Zaire River

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VIII

Matadi Bridge over the Zaïre River

Le pont de Matadi sur le Fleuve Zaïre

Matadi-Brücke über den Fluss Zaïre

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SUMMARY
Matadi Bridge over the Zaïre River is a three-span continuously-stiffened suspension bridge which will be used for both railway and roadway. The main span length measures 520 m, while the side spans of 91 m do not have hangers. The suspended structure is a double-deck truss. The construction work is currently under way.

RESUME
Le pont de Matadi sur le fleuve Zaïre est un pont suspendu à trois travées continues, qui sera utilisé aussi bien par le chemin de fer que la route. La travée centrale mesure 520 m, tandis que les travées de rive, qui sont dépourvues de suspentes, ont une longueur de 91 m. La structure suspendue est une poutre triangulée comportant deux tabliers. Les travaux de construction sont actuellement en cours.

ZUSAMMENFASSUNG
Die Stützweite der Hauptöffnung der beschriebenen Hängebrücke beträgt 520 m. Die nicht aufgehängten Seitenöffnungen des durchlaufenden Versteifungsträgers haben Stützweiten von 91 m. Die obenliegende Fahrbahn dient als Strassenbrücke während die untenliegende für die Eisenbahn vorgesehen ist. Die Brücke stellt ein wesentliches Bauwerk der Eisenbahnlinie Banana – Matadi dar. Die Brücke befindet sich zur Zeit im Bau.

1. INTRODUCTION

The Matadi Bridge Project is based on the agreement between Japan and the Republic of Zaire, and the construction order was placed by OEBK (Organisation pour l'Equipement de Banana-Kinshasa), Zaire Government. In the bid opened in November 1978, the Japanese Consortium (C-IHI) received orders for all construction works including the superstructure and substructure of the bridge and the access road. The constructin is currently under way in the suburbs of Matadi City (Fig. 1).

2. REQUIREMENTS FOR THE PROJECT

The Matadi Bridge is a double-deck type suspension bridge used both as railway and roadway. The upper deck is used as a 2-lane road for the present, and will be expanded to be 4 lanes in the future by adding footwalks on the outer sides. A single track railway will be laid on the lower deck, which will be put into practial use after the railway routes on land are constructed.

The loadings and allowable stresses for the structure are based on the Zaire Standards in the Contracted Technical Specifications, while the design details are due to the Japanese Standards conserned.

The design live loads are as follows:

Roadway:	Uniform load	340kg/m^2
	Line load	1200kg/m
	Trailer load	As per Zaire Standards T-32 (32-ton trailer)
Railway:	Wheel load	As per Zaire Standards C-3 (Locomotive axle load 18 ton, wagon axle load 20 ton)
	Uniform load	7.4 ton/m (maximum loaded length 295m)

70 percent of the railway load should be used when fatigue effect due to running of trains is taken into account.

3. TYPE OF BRIDGE

At the beginning, four types of structures, namely (1) suspension bridge, (2) cable-stayed bridge, (3) arch bridge and (4) cantilever truss bridge, were compared. After the types (3) and (4) had been rejected mainly for economic reasons, a detailed comparative study of the types (1) and (2) were made with particular emphasis on the study of long span railway bridge.

As far as the fatigue of cable is concerned, the suspension type is advantageous because the dead load stress is always dominant in cable tension. On the other hand, the members of stiffening truss of a suspension bridge are subjected to greater stress variation due to the live load. Furthermore, the bending moment on the supports at the towers will be large in the present bridge. After careful investigation, it was found that these shortcomings would be solved by the use of appropriate erection method and the adjustment of side span length. The stability of the bridge against wind during and after the construction was also studied. Thus, the comprehensive studies both in technical and economic aspects resulted in the adoption of the suspension bridge.

In the next place, the configuration of the bridge structure was investigated. Considering the geographical conditions and the specific problems for the railway suspension bridge, the three-span continuously-stiffened suspension bridge without hangers in side spans was selected. The optimum side to main span ratio of the bridge (see Fig. 2) was determined by considering (a) large amount of alternate stresses caused at the intermediate supports of the stiffening truss, (b) negative reaction at end supports, (c) geographical and geological conditions in the side spans, including position of the anchorages, as well as amount of excavation, and (d) construction procedure.

4. SUPERSTUCTURE

4.1. Stiffening Truss (Fig. 3)

The stiffening truss itself is like in three-span continuous truss bridge, and has a double-deck structure; the roadway is laid on the orthotropic steel deck on the upper deck, while the railway is laid on the longitudinal girders on the lower deck.

The orthotropic steel deck is also composed as a cross section of the stiffening truss. The secondary stress due to bending in the rigid panel points occurs in the stiffening truss. Though this was included in the calculation of the cross sections, the members close to the intermediate support were subjected to conspicuous secondary stress.

Installation of the stiffening truss will be carried out by the cantilever erection method which is made progress from the towers on both river banks toward the center of the river.

4.2. Tower (Fig. 4)

The configuration of the tower was decided, among many alternatives, from the viewpoints of aesthetics, construction workability and structural feasibility. The tower shafts is inclined to adapt to the continuous stiffening truss, and the heights of two towers are different each other according to the geographical situations. The cross section of tower shaft is composed of four panels in a rectangular mono-cell form, and has constant external dimensions along the entire height of the tower.

The member joints were designed to be welded in the shop and to be connected by high strength bolts at the construction site. The main skin plates of the tower shafts were designed to transit 50 percent of the stress by means of the metal touch joints and the remainder by means of the high strength bolt joints.

4.3. Cable (Fig. 5)

Considering past experiences, the main cables of the suspension bridge with 520 meter span length have been determined to be the parallel wire cables which feature high sectional properties. After comparing the air spinning process with the PWS process for installation, the latter was adopted to minimize the indefinite factors and amount of work at the construction site.

The main cable cross section consists of the PWS 127, with 54 cable strands for the main span and 56 for the side spans. The two strands for the side span are anchored at the tower top saddle to improve the safety factor for cable sliding.

5. SUBSTRUCTURE

5.1. Geographical and Geological Features

Mountain ranges of about 400 meters high are located on both sides of the Zaire Rive, and the mountain feet form steep cliffs, entering into the river. The ground base on both sides of the river is composed of green schist of pre-Cambrian age. The surface soil and hard weathered bedrock layer are not very deep, about ten meters deep from the ground surface. Below this layer, there is a considerably hard rockbed suitable as a bridge foundation.

5.2. Anchorage

The anchorage should have a capacity to withstand the tension of 10,500 tons per main cable. The tunnel type and self-weight type for anchorage were compared, and the latter was selected for enconomical reasons. However, since there is a good bedrock to the shallow place, a conflicting problem was raised in determining the type of anchorage, in which the excavation of the bedrock should be minimized and the horizontal sliding resistance should be increased.

The anchorage seems to be a massive integral structure, but is divided into many chambers by thin walls, excepting the cable anchor frame embedded section. This leads to a substantial decrease of the concrete placement in high temperature, which presents difficult technical problems.

5.3. Pier Foundation

The pier foundation is required to support vertical force of about 9,500 tons per tower shaft. Studied first was a footing having wide range of supporting surface. It was made clear that it was difficult to cope with the complicated geological variation, and raised problems in excavation and economy. To solve those problems, the deep well foundation piles of 8 meters in diameter were layed out just under the tower shafts. To give sufficient rigidity to the top surface of the piles in the direction perpendicular to the bridge axis, they are connected by a beam of 8 meters in depth.

6. CONCLUDING REMARKS

The outline of the Matadi Bridge over the Zaire River was presented. the construction started in February 1979 and is expected to finish in 1984. When this project is completed, the bridge will be one of the largest suspension bridges in Africa, and will be the world's top-class railway suspension bridge.

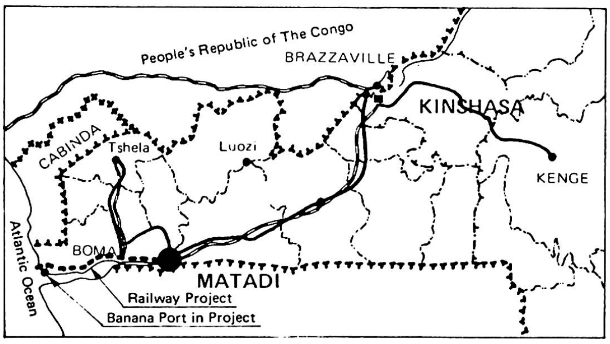


Fig. 1 Bridge Location

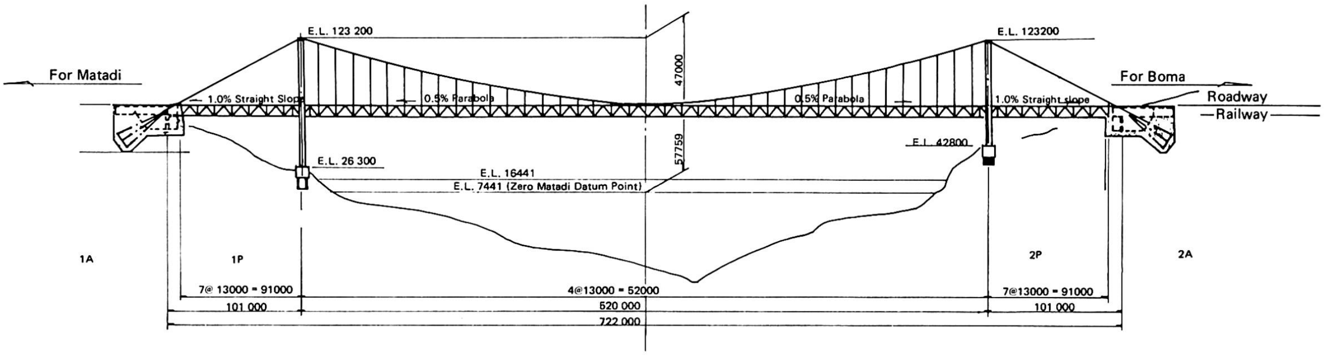
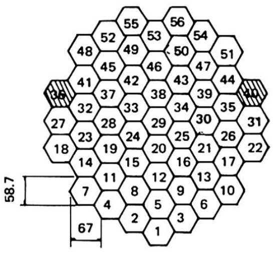


Fig. 2 General Arrangement



Arrangement of Main Cable Strands
(Before Wrapping)

* Shaded strands are used only in side spans.

Fig. 5 Cable

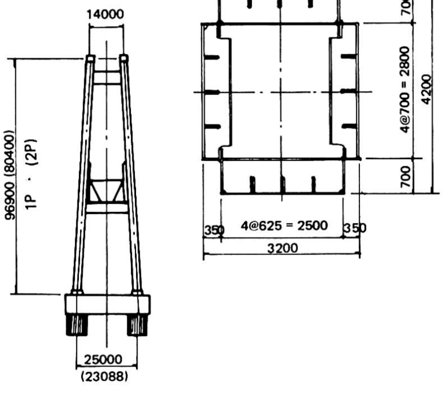


Fig. 4 Tower

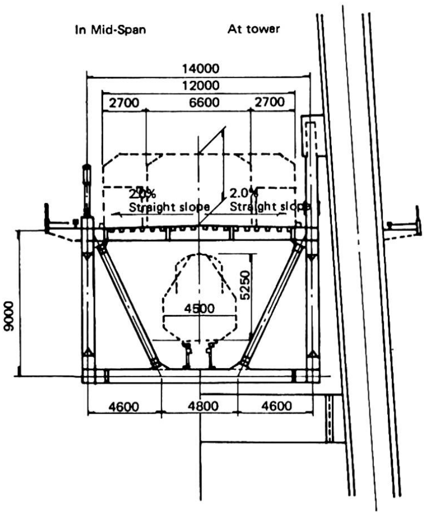


Fig. 3 Stiffening Girder