Project Report

Construction of J.P. Magufuli Extradosed Cable-Stayed Bridge (3.0 km) at Mwanza, Tanzania, near Kigongo / Busisi Ferry

Katelula Salum Kaswaga

Tanzania National Roads Agency, P.O. Box 11364 Dar es Salaam Tanzania.
* Correspondence: katelula@gmail.com & Katelula.kaswaga@tanroads.go.tz

Abstract: The J.P. Magufuli extradosed bridge is currently under construction. This bridge crossing Lake Victoria has an overall length of 3,000 m and a deck width of 28.45 m to accommodate 4 lanes of 3.5 m wide carriageways of vehicular traffic, a shoulder of 2.5 m+2.5 m for emergency parking and vehicle breakdown on each side, a 2.5 m+2.5 m footpath for pedestrians on each side, and a median of 2.45 m. The structural arrangement of the main bridge is 100 m+160 m + 160 m+100 m = 520 m, and the approach bridge prestressed concrete (PSC) beam bridge L = 2,480 m (including 31@40=1,240 m on each side). The superstructure is an extradosed bridge with an RCC deck with three RCC pylons 18.856 m in height. The girder heights at the mid-span and end-span are 5.4 m and 3.2 m, respectively. This paper discusses the construction aspects of the J.P. Magufuli bridge along with the details of a special traveling formwork (Form-Traveller) that is used to enable balanced cantilever construction, Pylons, PC House construction for the Pile Cap, and Deck Slab Partial Depth Panel for Deck Slab Construction.

Keywords: extradosed bridge; cantilever construction; travelling formwork; climbing formwork; deck slab panel; PC house; pile cap; pylons

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1 Introduction

The Government of Tanzania, Ministry of Works through Tanzania National Roads Agency (TANROADS), is constructing the 4-lane J.P. Magufuli Bridge. The bridge is 100% financed by the Government of Tanzania (GoT). The J.P. Magufuli Bridge will connect two districts: Misungwi (467,867 people) and Sengerema (425,415 people), in the Mwanza region. The bridge will provide an important link between the Mwanza Region and the surrounding western regions as well as neighboring countries such as Rwanda, Burundi, and Uganda. It thus has the potential to relieve poverty and promote economic growth in the project area and Tanzania at large. With an overall length of 3 km, the bridge will be the longest extradosed bridge in Africa and the second longest bridge with a stay cable system after the Suez Canal Bridge (3.9 km) in Egypt.

After the completion of this project, the travel time of the bridge across the lake will decrease from 2–3 hours to 4–6 minutes. The J.P. Magufuli Bridge will replace ferries (3 Nos) as the main crossing of Lake Victoria in this vicinity. The bridge is expected to accommodate significantly more traffic volume along the route and improve the safety of users at this lake crossing point. Currently, the ferries operated by TEMESA are the main means of crossing between the two sides. The ferries carry approximately 1,600 vehicles in each direction daily. During heavy rains, ferry operations are stopped for safety reasons.

The main features of the project are as follows: it spans a total length of 4.66 kilometers, with the road section extending 1.66 kilometers and having a width of 28.45 meters to accommodate four lanes. This road segment is divided into two parts:

the Kigongo side, which measures 1.16 kilometers in length, and the Busisi side, which is 0.50 kilometers long. A key component of the project is a bridge that stretches 3.0 kilometers, has a width of 28.45 meters and is designed for four lanes. The bridge comprises a main section constructed as an extradosed bridge (FCM) with a total length of 520 meters. Its span arrangement is configured as 100 + 2@160 + 100 meters, providing a maximum span of 160 meters. The bridge's pylons (Figures 1 and 2) reach a height of 18.856 meters. In addition, there are approach bridges that are 2,480 meters in length and are evenly distributed on both sides—each measuring 1,240 meters and consisting of 31 spans of 40 meters each.

The main bridge of J.P. Magufuli adopts a novel bridge type with a double-cable low tower cable-stayed structure and a main span of 160 m, a side span of 100 m and three sets of pylons. The three main towers/pylons lean out like open arms and open gates.

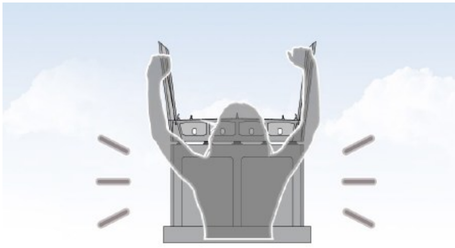


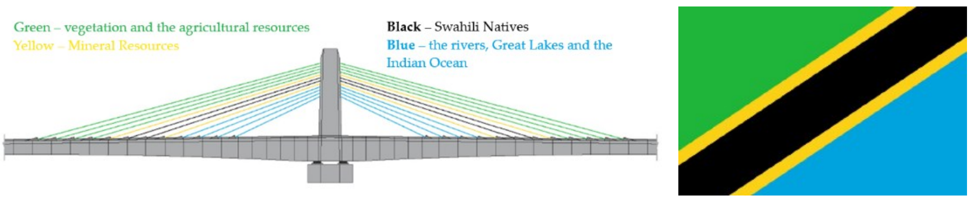
Figure 1 Arms Raised High (to evoke triumph and prosperity)

Figure 2 Wide open pylons offering clear vision for drivers

Figure 3 Lateral view

Triple A and the symbolic meaning and bridge concept (Figure 3).
Accessible – Important link for the Mwanza Region across Lake Victoria.
Advanced – Innovative and highly advanced construction methods.
Aesthetic – Bridge design in harmony with the surrounding landscape.

The arrangement and color of the external cables reflect the configuration of the flag of Tanzania (Figure 4).



a) Color of the External Cable b) Flag of Tanzania

Figure 4 The arrangement and color of the external cables reflect the configuration of the flag of Tanzania

2 General Arrangement of the Bridge

2.1 Main Bridge

The bridge has a total of 66 spans. The main bridge is an extradosed bridge, as shown in Figure 5. The spans have a layout profile of 100 + 2×160 + 100 = 520 m, the diameter of the main bridge piles is 2.5 m with a total of 84 piles, the pile cap adopts a rectangular pile cap, and the length, width and height are 35×27.5×4.0 m. The main bridge pier adopts a hollow shaft with a height of 16.219 for P32 & P34 and 17.066 m for P33 (Figures 6 and 7).

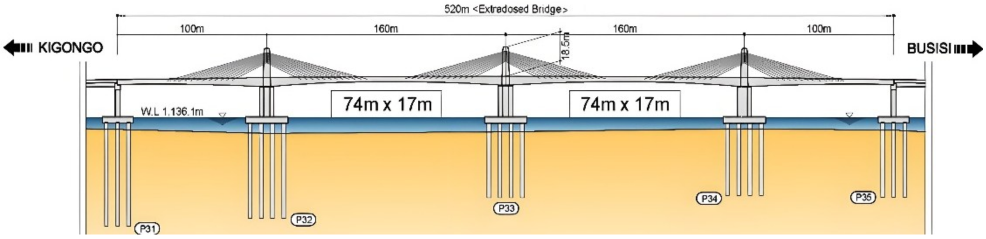


Figure 5 Main bridge profile (unit: m)

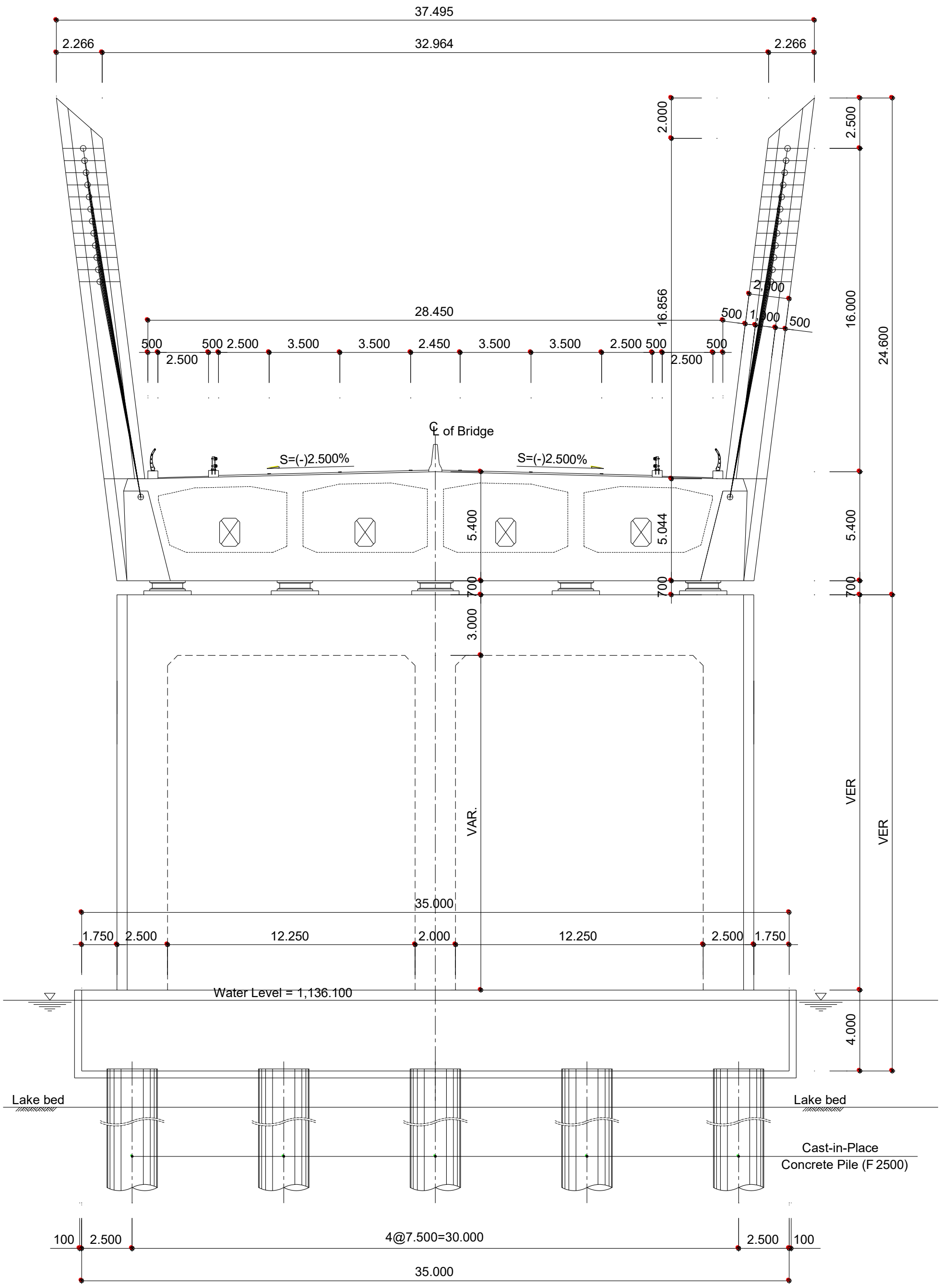


Figure 6 Pylon general arrangement (unit: m)

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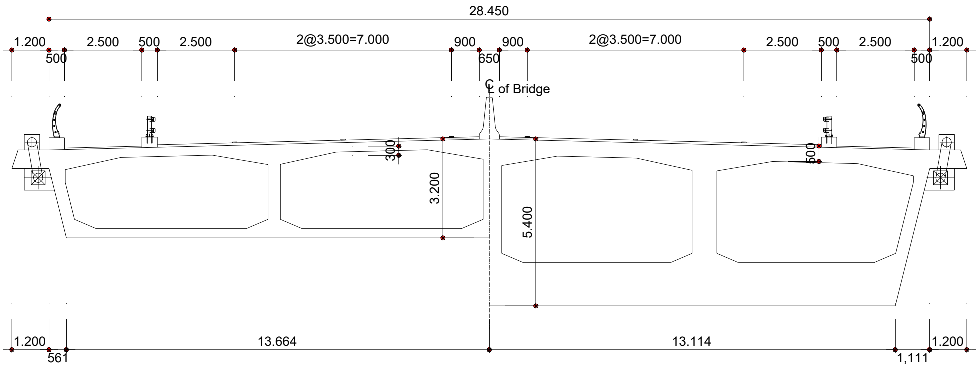

Figure 7 Main bridge cross section (unit: m)

2.2 Approach Bridge

The approach bridge adopts a pile foundation, pile cap, pier column, pier cap and prestressed concrete (PSC) I beam structure (Figures 8 and 9); the diameter of the approach bridge piles is 1.5 m, with a total of 720 piles; the pile cap adopts a rectangular pile cap; the length, width and height are 25.5×7.5×3.0 m; the diameter of the pier column is 2.5 m; and the height varies from 3.5–17.451 m. The precast I beam (Figure 10) is 1.8 m high, 1.1 m wide at the bottom, 0.9 m wide at the top, with 13 pieces per span, 62 spans in total, and 806 pieces.

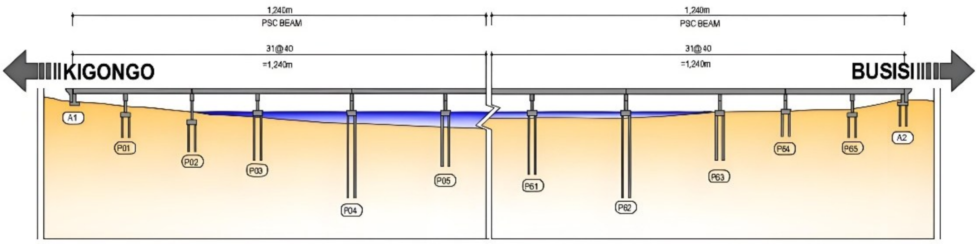

Figure 8 Approach bridge profile (unit: m)

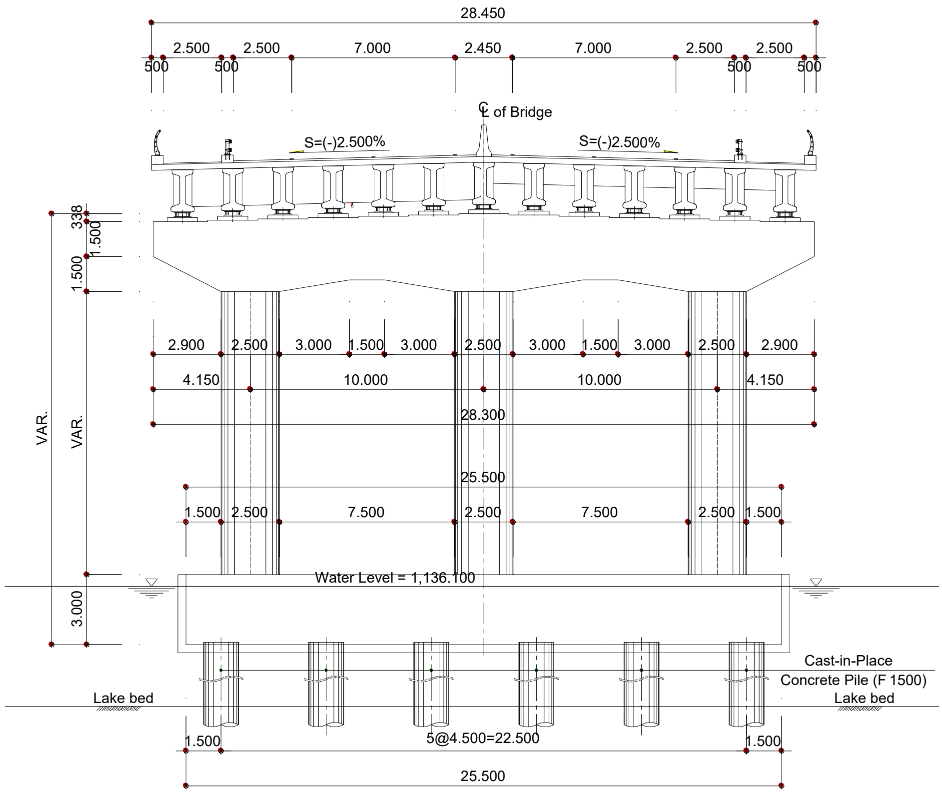

Figure 9 Pier general arrangement (unit: m)

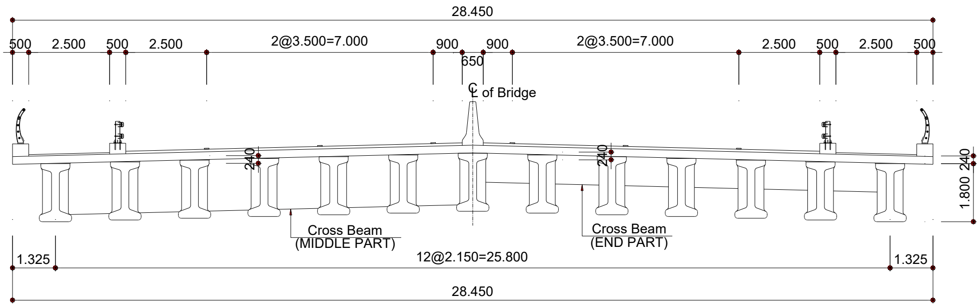

Figure 10 PSC beam general arrangement (unit: m)

3 Construction Methodology

Different methods of construction have been adopted for the construction of the J.P. Magufuli Bridge. This paper focuses on the methods used for the superstructure construction of the J.P. Magufuli bridge and, in particular, the construction of the extradosed segment (ED–segment).

The bridges are supported by twelve main cables per pylon, and each cable consists of 43 wires (diameter of ϕ15.2 mm).

The cable protection pipe is made of a high-density polyethylene (HDPE) pipe with an outer diameter of 200 mm and a normal thickness of 6.2 mm, and the butt joint is subjected to Butt-Fusion Welding.

3.1 Bridge Deck

The approach bridge deck of the J.P. Magufuli Bridge has a single span that is 28.45 m wide and 40 m long, with a total of 62 spans. The approach bridge is divided into two parts, namely, the Kigongo side, which spans from A1-P31 (31 spans), and the Busisi side, which spans from P35-A2 (31 spans).

The total length of the approach bridge is 2.480 km, comprising 1.240 km on each side, i.e., Kigongo and Busisi.

3.1.1 Bridge Deck Construction

The approach bridge deck thickness of the J.P. Magufuli Bridge is 240 mm. The bridge deck construction adopts partial-depth precast concrete deck panels that span between girders. According to the design, the span distance between the PSC beam gap is 1.25 m. Thus, the panel size to cover the gap between girders for this bridge is 1.45 m (length) × 0.5 m (width) × 0.05 m (thickness). With a 50 mm panel thickness, the cast-in-place (CIP) concrete topping will be 190 mm, which, when combined with 50 mm panels, acts compositely to provide the full structural thickness of 240 mm of a bridge deck.

3.1.2 Partial-Depth Precast Concrete Deck Panel

The panels are fabricated in the fabrication yard (Figure 11), inspected before being delivered and installed at the bridge site.

Figure 11 Fabrication yard of the partial slab depth panel

The panels are placed next to each other along the length of the girders and are generally not connected at the joints between panels, which are transverse to the span of the girders (Figure 12). The tops of the panels are intentionally roughened to ensure bonding and composite action with the CIP concrete.

Figure 12 Installation of a precast deck-slab panel and provision of a safe work zone

After the bridge deck slab panels are installed, the reinforcements are fixed above the panels before placement of the CIP concrete layer (Figure 13).

Figure 13 Reinforcement fixing prior to cast-in-place topping

Partial-depth precast concrete deck panels may have several advantages, including faster and safer construction, ease of design and improved quality.

(1) They reduce bridge construction duration;
(2) Eliminate the need for additional deck forming, saving time and money;

(3) Eliminate the time and cost of removing deck forms, especially where other stay-in-place forms are not allowed;
(4) Increase worker safety since panels are inherently stable and can be safely walked on (Figures 12 and 13).

3.1.3 Bridge Deck Casting

The concrete strength (f_{cu}) used for the deck slab complied with the project specifications of 40 MPa after 28 days.

The concrete of the bridge adopts a half-width of span-by-span casting. The deck finisher cooperates with manual vibration for levelling. The middle roadway area is cast and levelled by the deck finisher. The concrete surface elevation is controlled by the rail and the roller shaft of the deck finisher, as shown in Figures 12 and 13.

In the side walkway area (cantilever area), the elevation is controlled by steel bars arranged accordingly.

The concrete finishing machine used for the J.P. Magufuli bridge is set up to finish concrete for the entire width of the bridge by stage, starting with one side (Left-Hand Side) of the bridge of 14.24 m and finishing with the other side (Right-Hand Side) of 14.24 m. The finishing machine is equipped with many moving and functioning parts.

The bridge deck finisher adopts the mode of forward vibration and backward static rolling. It moves back and forth longitudinally to level the concrete. When the concrete is too high, it should be removed manually, and when it is too low, it should be replenished.

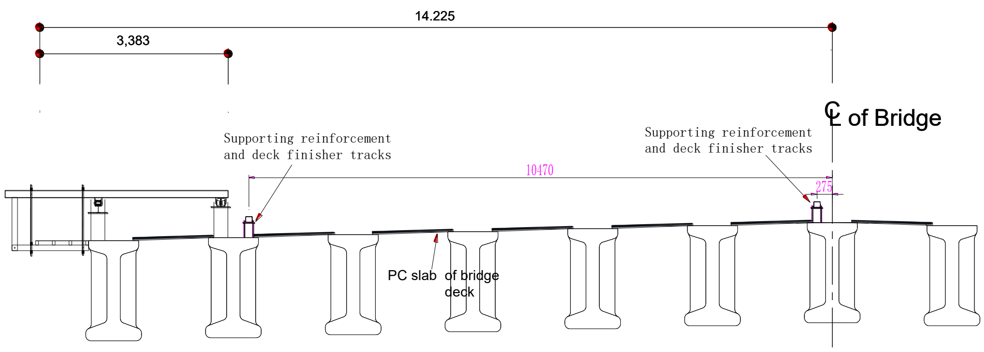

Figure 14 Layout of deck finisher rail (unit: m)

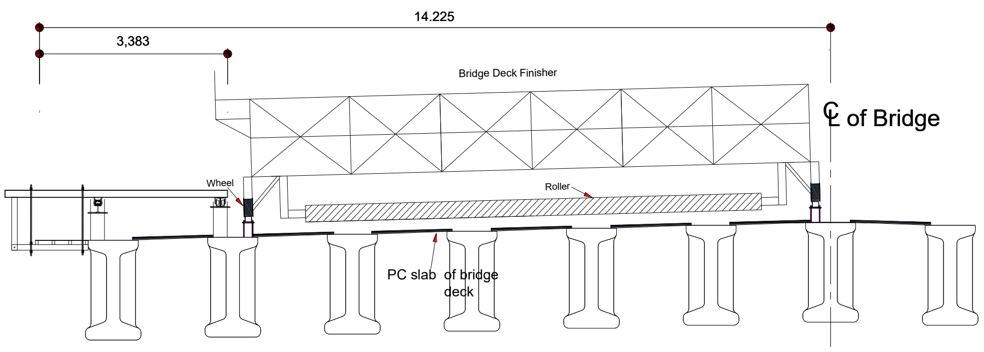

Figure 15 Diagram of deck finisher use (unit: m)

The rotating cylinder helps consolidate the concrete and finishes the concrete to the appropriate grade (Figure 16).

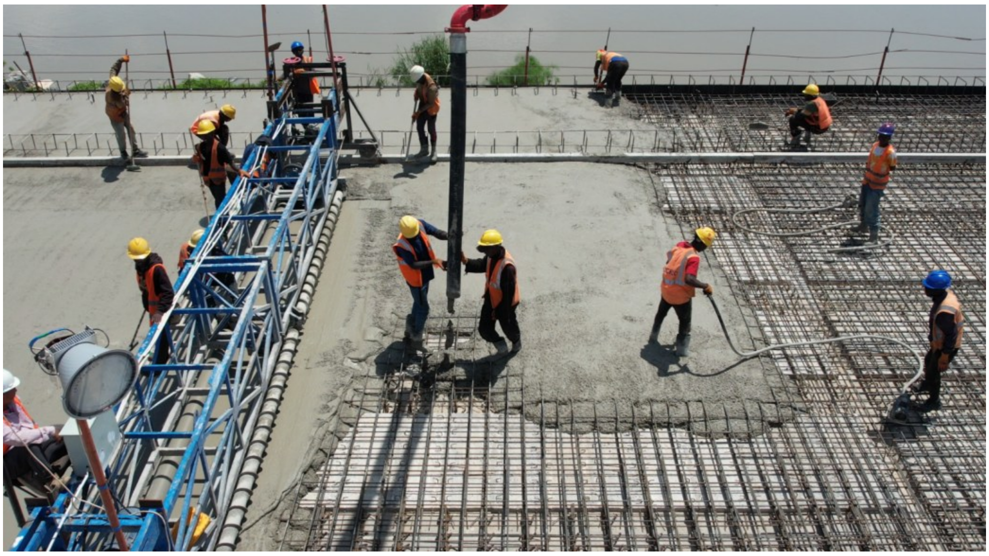

Figure 16 Deck slab concrete casting

3.1.4 Experiencing Challenges

There may be concerns about the panel cracking during fabrication, leading to some of the panels being rejected by the consultant. Panel rejection can be costly to the contractor. However, with good management and supervision, the issues of cracking were mitigated by proper detailing, and the contractor decided to reinforce the deck slab panels by adding strands and proper handling, storage, curing, and installation procedures.

After that, there was no rejection of the deck slab panels, and the construction proceeded smoothly.

3.2 Pylons

Pylons are constructed in segments: segments #1–#4 have a height of 3.97 m each, and the height of segment #5 is 2.976. After the concrete reaches the requirement of the mold to be removed, the formwork is moved to the next segment using a Tower crane.

Each segment of pylons is constructed with climbing formwork. The vertical main reinforcement is connected by a coupler. The bolts are tightened, forcing the bars against hardened steel locking strips until a specified torque is reached. The concrete class up to C60 is used to resist the substantial compressive load effects of the heavy concrete deck. For the general layout of the pylons, see Figures 17 to 21.

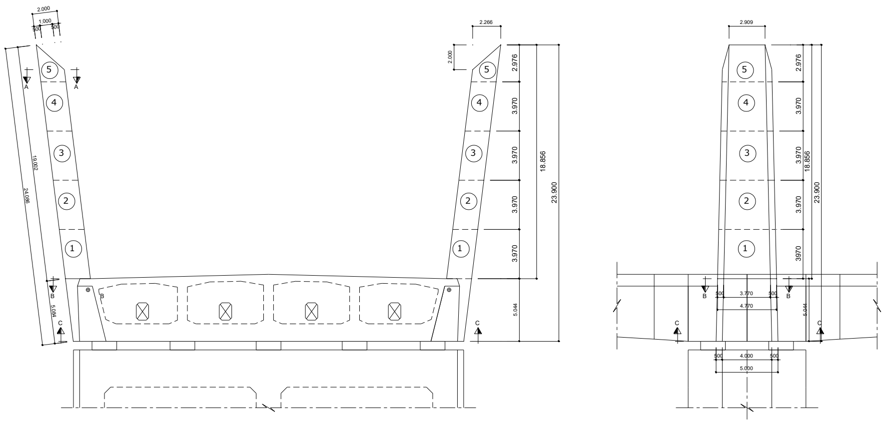

Figure 17 Schematic diagram of the pylon segment division (unit: m)

Figure 18 Completed pylon (18.856 m)

Figure 19 Aerial view showing the overall progress of the project as of 6th October 2024

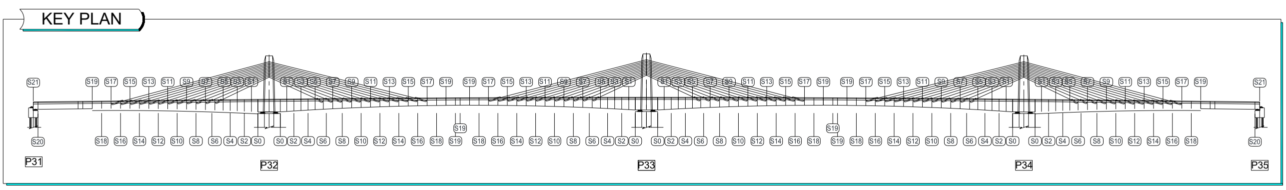

Figure 20 J.P. Magufuli-extradosed bridge typical cross section

Figure 21 Aerial view showing the overall progress of the project as of April 29, 2025

3.3 Form Traveller

Various types of bridge construction equipment have been adopted for the construction of long-span bridges. The cantilever form-traveller (or traveling formwork) is used for cantilever construction of cast-in situ bridge superstructures that are inaccessible to conventional methods of construction (refer to Figure 22). The Form traveller system is used for free cantilever construction of post-tensioned box girder and cable-stayed concrete bridges.

The form-traveller is used to support the formwork, bear the weight of the newly poured concrete, and provide a working platform for tensioning and grouting work and elevation adjustment.

The frame of form-traveller for this bridge was designed according to the extradosed segment lengths of 3 m, 3.5 m, and 4 m, with the heaviest sections having different lengths.

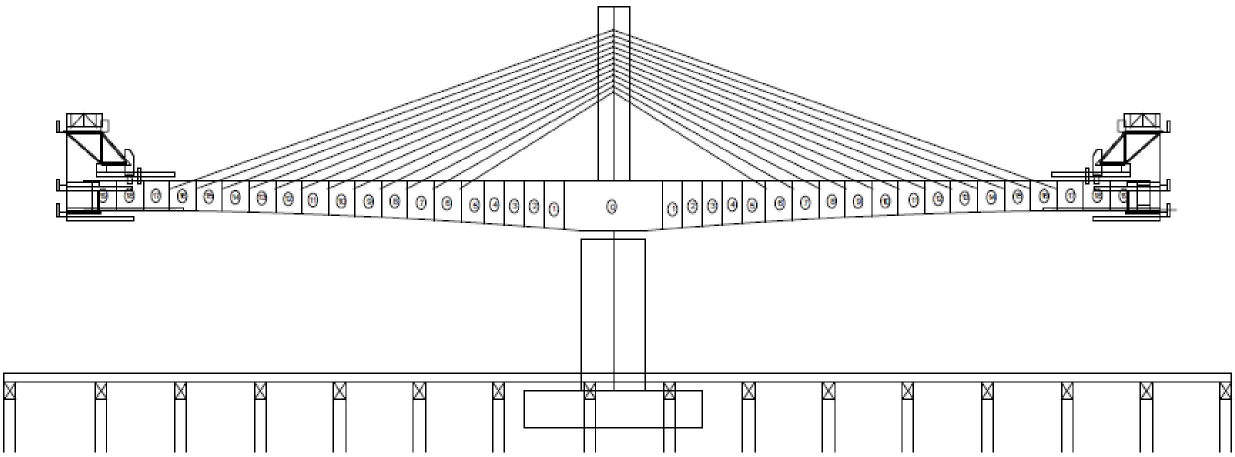

Figure 22 Construction of the balanced cantilever

The construction of the J.P. Magufuli Bridge adopts a self-designed and diamond-shaped form-traveller, which is made on site by a contractor and is composed of five diamond-shaped frames according to the structural form of the main bridge (Figures 23 and 24). The five main parts of the form-traveller are as follows.

(1) Main truss: five main trusses are arranged in the transverse direction, which are connected by a connection system and pins.
(2) Running system: includes a rail beam, a walking wheel, a guide beam, a movable ring, and a slide device.
(3) Anchorage system: During concrete pouring, downward pressure at the end of the main truss is provided to balance the overturning moment in front of the FT, including the anchorage beam and vertical anchor bar;
(4) Bottom platform: includes the front and rear lower beam, carrying beam, distribution beam, bottom formwork and walkway.
(5) Hanging system: Front upper cross beam, rear hanging, front hanging, inner guide beam hanging, etc.

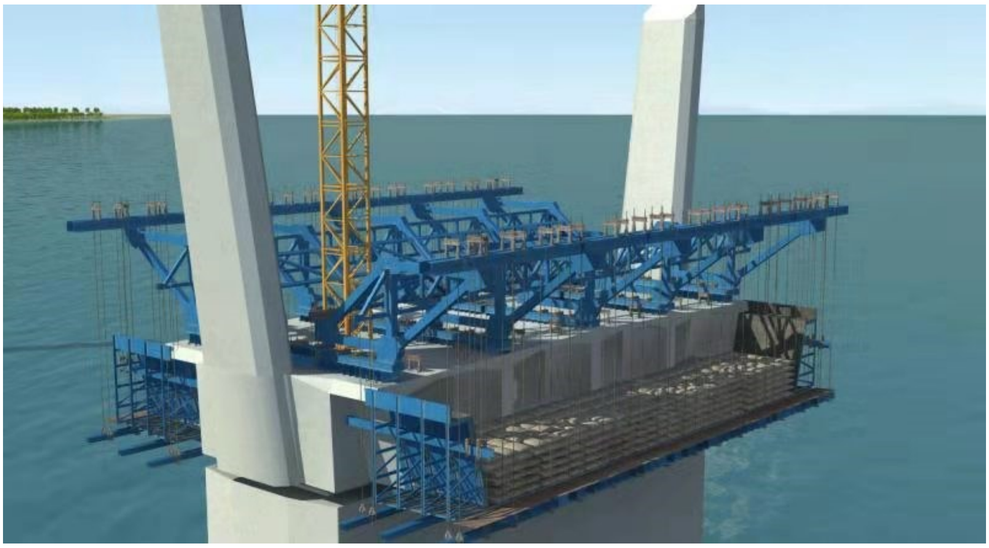

Figure 23 Form traveller for J.P. Magufuli Bridge construction

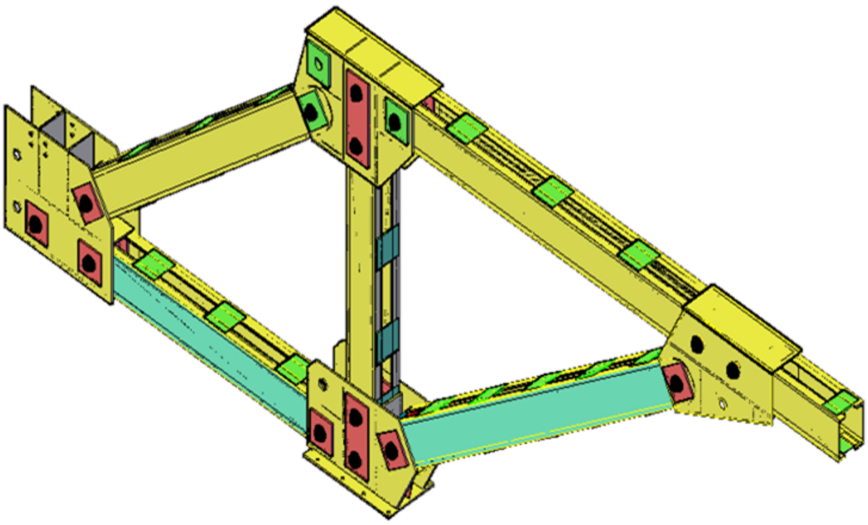

Figure 24 Diamond frame

3.3.1 Testing of the Form Traveller

After fabrication, the form-traveller is assembled and tested (Figure 25) in the following key performance areas.

(1) Stability and behavior at 1.2 times the design load;
(2) Measurement of deflection during loading and unloading;
(3) Calibration of the deflection behavior of the form traveller under a given load;

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(4) Operation of raising, lowering, and pushing the form-traveller.

Figure 25 Testing of the form-traveller

3.3.2 Construction Cycle of Segment

The form-traveller moves forward only after the tendon tensioning is completed in the previous segment (Figure 26). To meet the target construction cycle time, the concrete strength should reach 75% of C60 in 5 days. To achieve this, a conventional OPC CEM I 42.5 N type, fly ash, silica fume and superplasticizer admixture is used with no cement replacement.

The construction cycle of one segment was 19 days, but after the review of the methodology and the contractor working day and night, the construction cycle was reduced from 19 to 12 days.

Figure 26 Form-traveller casting standard segments

3.4 Overall Construction Sequence

Each span of the main girder is divided into blocks #0 to #19. The pier segment (#0) is 15 m long, 28.45 m wide, and 5.40 m high and is cast with a cast-in-place support. Segment #1-#19 cast with balanced free cantilever method with the form traveller in which Segment #1-#4 is 3.0 m long, Segment #5 is 3.5 m long, Segment #6-#19 is 4 m long and the key Segment is 2 m long.

The key segment will be cast with a hanging scaffold modified from the traveller formwork. The start segment and end segment of side span Piers P31 and P35 (19 m long, 28.45 m wide, and 3.2 m high at the center and 2.844 at the edge) and adopt a steel pipe bracket after being cast-in-place to conduct side span closure. The key segment construction sequence is carried out from the side span to the middle span.

3.5 Stay Cable Installation

The extradosed OVMAT–43 stay cable system (Figure 27) was adopted, with each cable consisting of 43 pieces and 15.2 mm single galvanized strands. Each strand is individually placed in saddle pipes which are parallel to each other and fixed with an anti-slipping key. The single strand is replaceable.

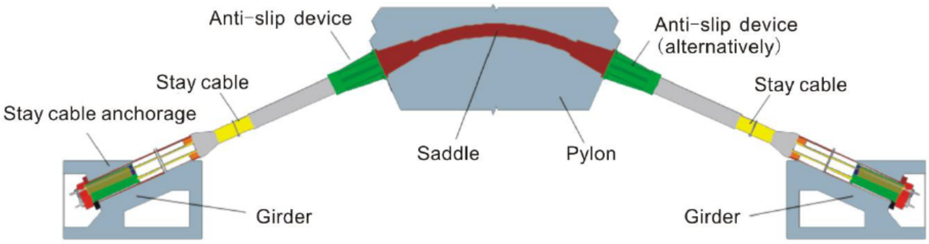

Figure 27 Layout of the cable system

The cable consists of a bundle of individually PE sheathed, low-relaxation, galvanized or epoxy-coated strands, and the void between the strand and the PE sheath is filled with anti-corrosive grease or wax (Figures 28 and 29).

Multi-layer protection system is adopted for the stay cable: galvanized-coated strands, anti-corrosive grease, an individual PE sheath, and a cable outer HDPE pipe.

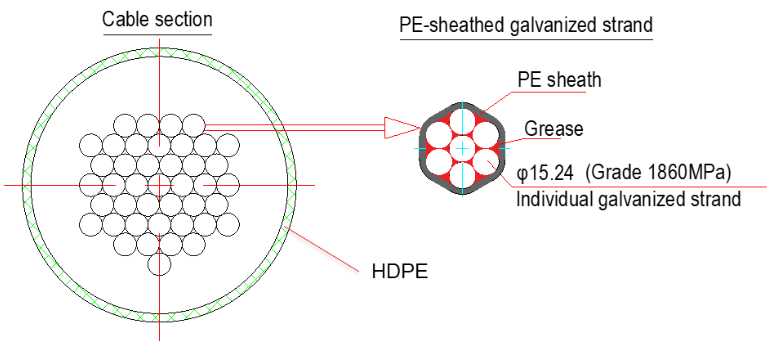

Figure 28 Cable section detail

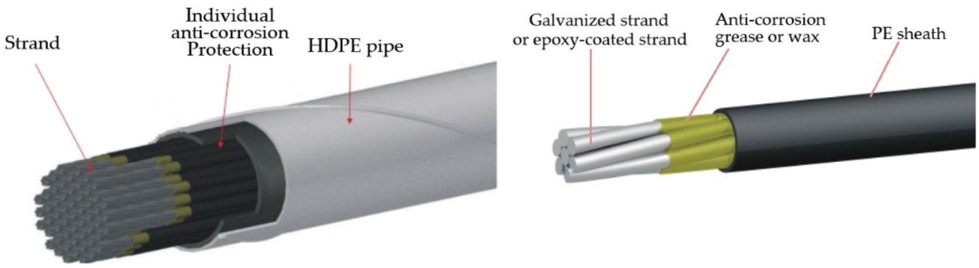

Figure 29 Cable detail

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4 Bridge Opening

President Samia Suluhu Hassan unveils the plaque to officially inaugurate the J.P Magufuli Bridge, a 3.0 km-long bridge with 1.66 km of connecting roads, at Kigongo in Misungwi District, Mwanza Region, today, June 19, 2025 (Figures 30 and 31).

Figure 30 Official opening of the J.P. Magufuli on June 19, 2025 by her excellency Dr. Samia Suluhu Hassan, the President of the United Republic of Tanzania

Figure 31 Official opening of the J.P. Magufuli on June 19, 2025 by her excellency Dr. Samia Suluhu Hassan, the president of the United Republic of Tanzania

5 Conclusions

The construction of the J.P. Magufuli Bridge (3.0 km) crossing Lake Victoria will be the second bridge to adopt extradosed technology in Tanzania after the completion of the Tanzanite Bridge (1.03 km) and the fourth bridge with a stay cable system after the completion of the Kirumi Bridge (223.3 m) and Nyerere Bridge (680 m), which adopted a cable-stayed bridge design.

Following the Government of Tanzania's emphasis on interlinking the country's transport corridor to improve the infrastructure system, many long-span bridges will be built in Tanzania to mitigate chronic traffic congestion and promote the balanced development of regions. The work on this project creates job opportunities and knowledge on long-span bridges and extradosed technology, mostly to Tanzania's engineers [1-5].

Conflict of interest: All the authors disclosed no relevant relationships.

Data availability statement: The data that support the findings of this study are available from the corresponding author, Kaswaga, upon reasonable request.

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AUTHOR BIOGRAPHIES

	**Katelula Salum Kaswaga** M.E., Professional Civil Engineer PE. Graduated from Beijing Jiaotong University in 2019, China. Working at TANROADS. Research Direction: Bridge Engineering Design and Construction (Cable-Stayed Bridge Expert). Email: katelula@gmail.com