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DOS
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of
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BUILDING BRIDGES IN AFRICA

**ADAPTING DESIGN AND CONSTRUCTION
METHODS TO LOCAL CONDITIONS**

57th ECCE MEETING

30 MAY – 1 JUNE, 2013, LISBON, PORTUGAL



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**IN PORTUGAL, STARTING IN THE LATE SEVENTIES, AN
AMBITIOUS PROGRAM TO RAPIDLY BUILD A MODERN
HIGHWAY SYSTEM AND TO REFURBISH AND MODERNISE
THE EXISTING ROADWAYS WAS LAUNCHED**

- **SIMPLICITY OF CONSTRUCTION**
- **FEASIBILITY**
- **FUNCTIONALITY**
- **DURABILITY**
- **SAFETY**
- **ECONOMY**
- **AESTHETIC VALUE**

**THESE CONCEPTS PROVED HIGHLY SUITABLE FOR
DESIGNING AND BUILDING BRIDGES IN AFRICA**



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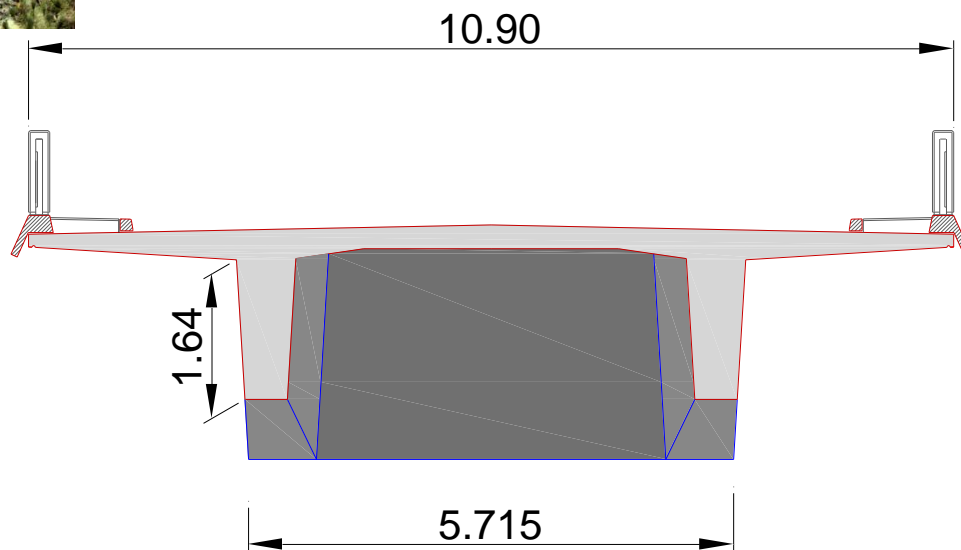


Zêzere River
Castelo do Bode Reservoir

DEVELOPMENT OF Π DECKS

SPAN-BY-SPAN CONSTRUCTION

ÁLVARO BRIDGE
1981





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DEVELOPMENT OF THE PILE/PIER CONCEPT



← **FÃO BRIDGE**
1994

Typical Spans - **45.00 m**
Ø Pile/Pier - **2.00 m**

**MONÇÃO INTERNATIONAL
BRIDGE**
1994

Main span - **100.00 m**
Ø Pile/Pier - **2.20 m**

NO NEED FOR PILE CAPS



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South Viaduct

DEVELOPMENT OF THE PILE/PIER CONCEPT

THE SOUTH VIADUCT OF THE VASCO DA GAMA BRIDGE

1998

SPAN-BY-SPAN CONSTRUCTION

3825 m long

22 km of Pile/Piers

Ø 2.00 and 1.80 m to depths of ~70 m



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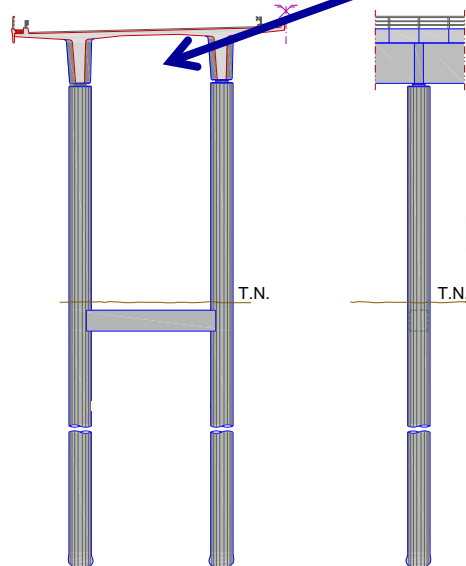


**DEVELOPMENT OF THE
PILE/PIER CONCEPT**

+

**DEVELOPMENT OF II
DECKS**

**TOTAL ELIMINATION OF CROSS-
BEAMS**



PILE/PIERS

**NO NEED
FOR PILE
CAPS**



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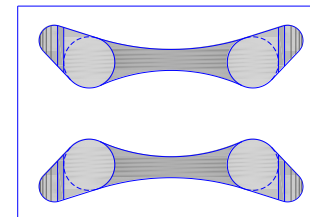
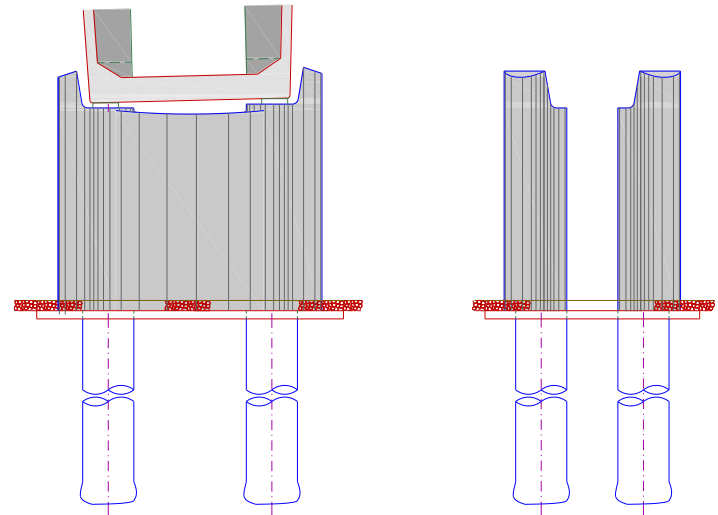


CANTILEVER BUILT BRIDGE
Pile/Pier concept with diaphragms
on top for aesthetic reasons

DEVELOPMENT OF THE PILE/PIER CONCEPT

SADO BRIDGE - 1998

A2 MOTORWAY



BRIDGE PIERS

Ø Piles - **2,50 m**



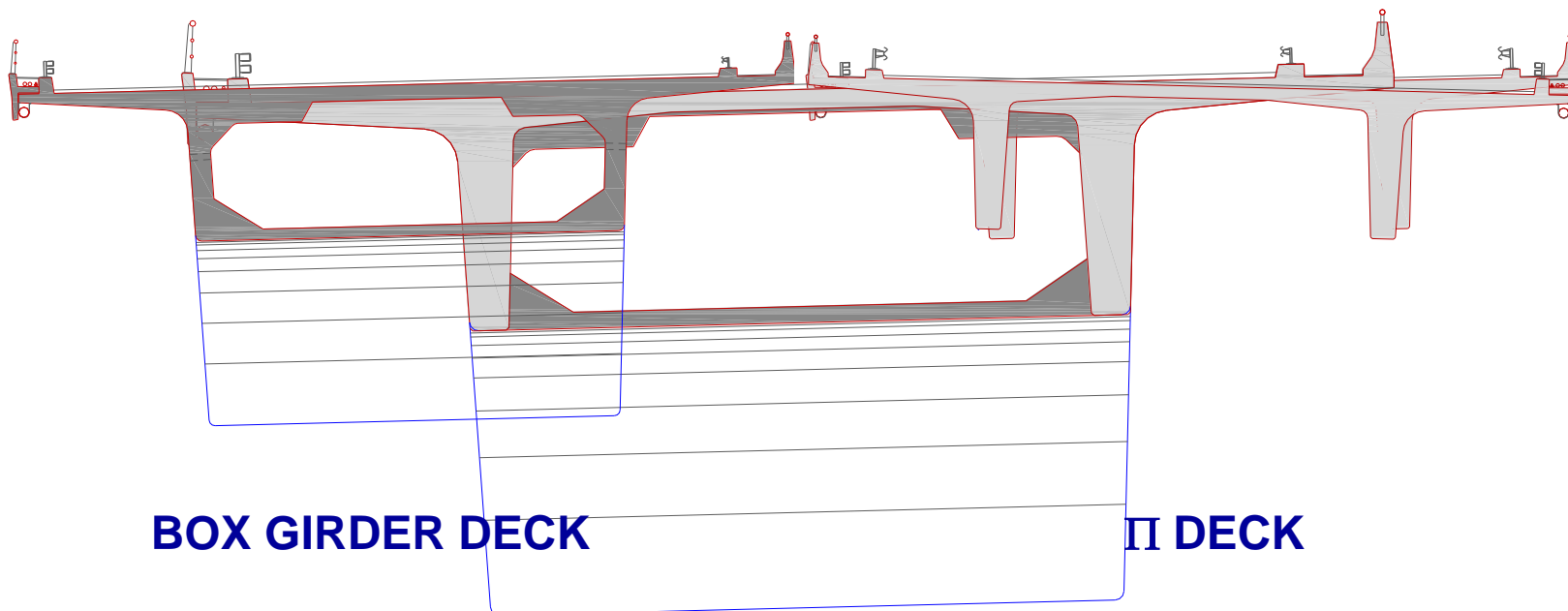
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SPAN-BY-SPAN AND BALANCED CANTILEVER CONSTRUCTION

VISUAL AND STRUCTURAL CONTINUITY BETWEEN THE TWO TYPES OF DECKS



BOX GIRDER DECK

PI DECK

CONTINUITY ACHIEVED



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SADO BRIDGE - 1998

PRANTO BRIDGE - 2008



MONDEGO BRIDGE - 2008

VISUAL AND STRUCTURAL CONTINUITY BETWEEN TWO TYPES OF DECKS BUILT BY DIFFERENT METHODS

SOME EXAMPLES

A2 AND A17 MOTORWAYS

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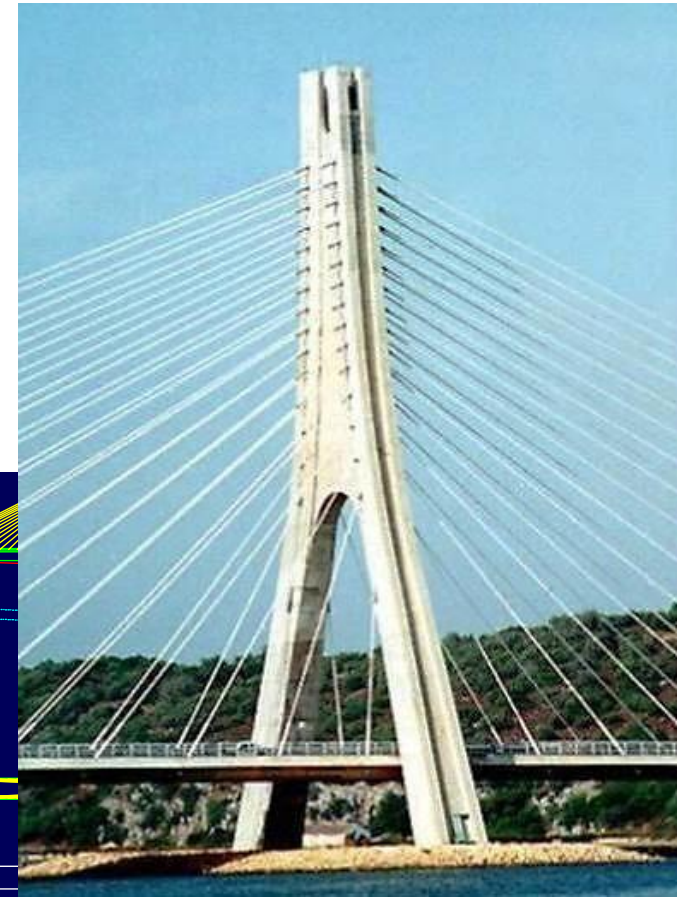
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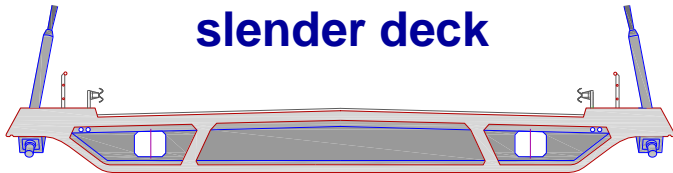
CABLE STAYED BRIDGES

ARADE BRIDGE

1991

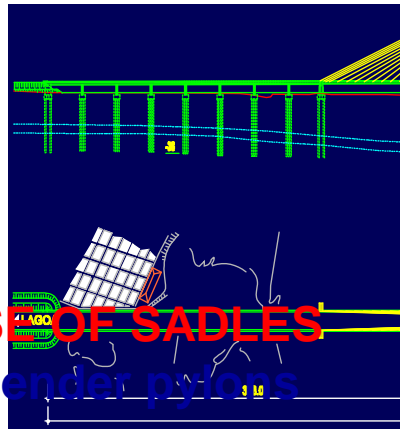


FULL SUSPENSION
slender deck



Deck height - 1,20 m

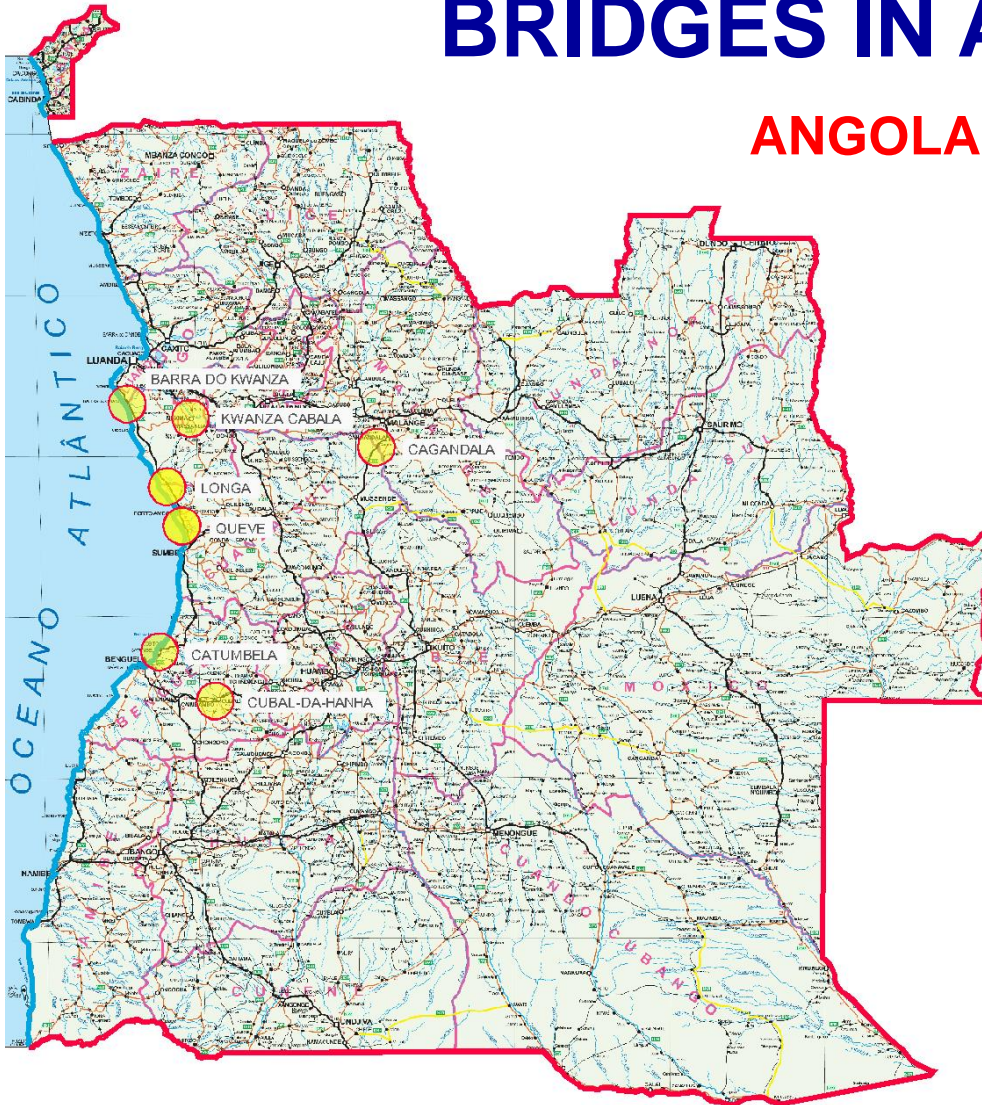
USE OF SADDLES
slender pylons



BUILDING BRIDGES IN AFRICA

BRIDGES IN AFRICA

ANGOLA



Angola has a very large road network that was, at the end of the civil war (1976 - 2002), almost totally destroyed either by war actions or by a total lack of maintenance



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TYPICAL INLAND CROSSINGS

ANGOLA

CROSSING THE RIVER



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TYPICAL INLAND CROSSINGS

ANGOLA



FREQUENT "SURPRISES"



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TYPICAL INLAND ROADS

ANGOLA

ROADS IN THE RAINY SEASON

September to May

TRAVELLING TO THE INAUGURATION OF THE NEW JOMBO BRIDGE



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TYPICAL LIVE LOADS

ANGOLA

CONSEQUENCES TO THE
~~CROSS BRIDGES~~
MAKESHIFT BRIDGE



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ABNORMAL LOADS

ANGOLA

Due to the increasing circulation of abnormal loads temporary steel decks on top of the existing ones have to be used and piers and foundations reinforced





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SHORT REVIEW OF LOCAL CONSTRAINTS ANGOLA

- Isolated and distant sites
- Poor or unavailable communications
- Heavy rainy seasons (September to May)
- Available materials and possible transports?
- Possible equipment's?



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ADAPTING DESIGN AND CONSTRUCTION METHODS TO LOCALLY EXISTING CONSTRAINTS

ANGOLA

PRECAST BRIDGE DECKS



PLAN



PLAN

BUILDING BRIDGES IN AFRICA



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ADAPTING DESIGN AND CONSTRUCTION METHODS TO LOCALLY EXISTING CONSTRAINTS

ANGOLA

PRECAST BRIDGE DECKS



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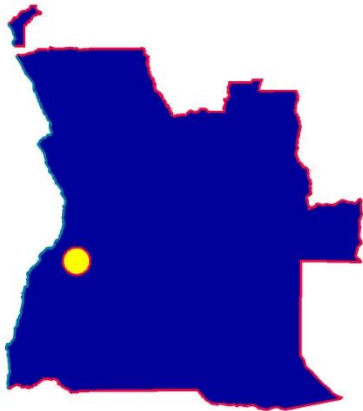
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DESTROYED ORIGINAL BRIDGE



ADAPTING DESIGN AND CONSTRUCTION METHODS TO LOCALLY EXISTING CONSTRAINTS

ANGOLA

CUBAL-DA-HANHA BRIDGE

CONDITION OF THE ACCESS ROAD



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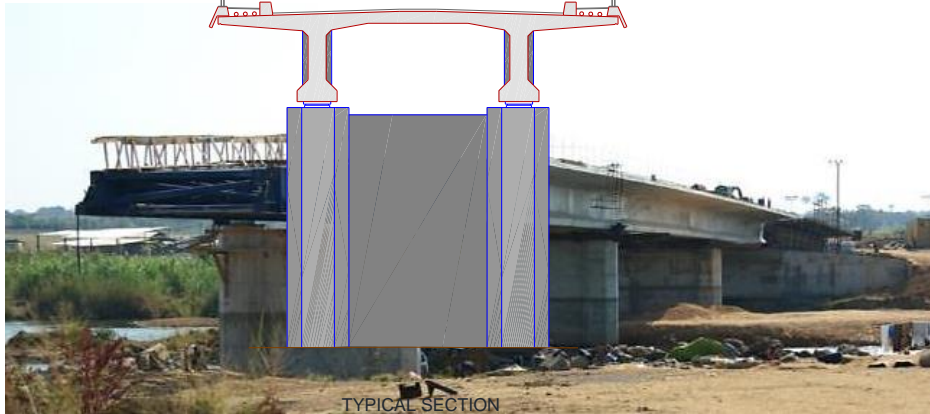
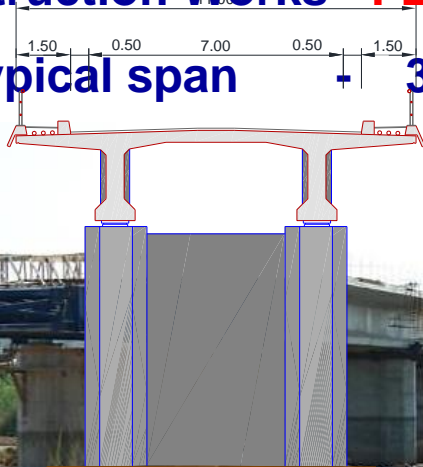


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INCREMENTAL LAUNCHED BRIDGE Construction Works - FEB08 - OCT09

Typical span + 30 m



CUBAL-DA-HANHA BRIDGE



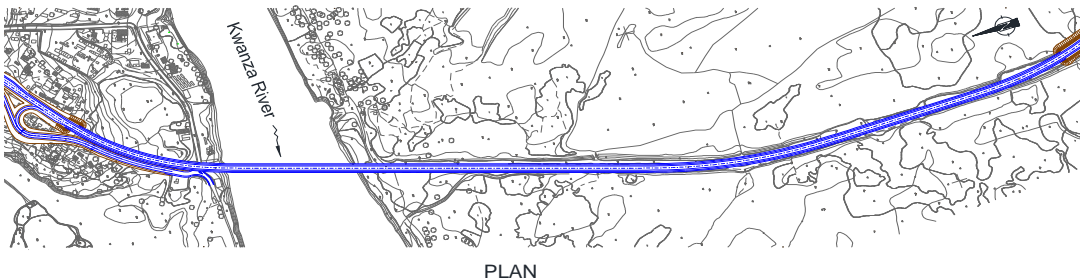
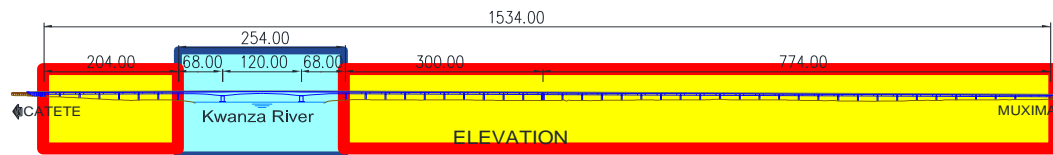
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17th SEPTEMBER BRIDGE KWANZA RIVER AT CABALA - ANGOLA

Completed - 2010
Total length of 11 spans - 1530 m
Maximum span of 430 local workers
Piles driven in 24 months - 75 m

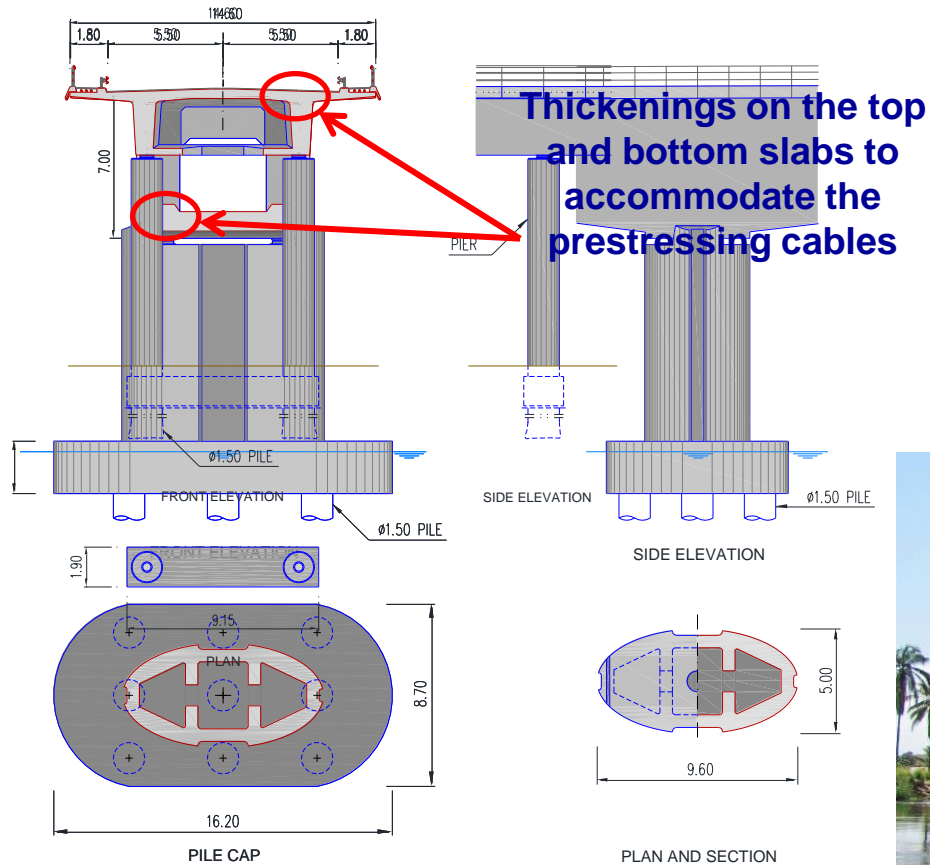


BUILDING BRIDGES IN AFRICA

17th SEPTEMBER BRIDGE KWANZA RIVER AT CABALA

ANGOLA

Construction Works
SEP08 - AUG10

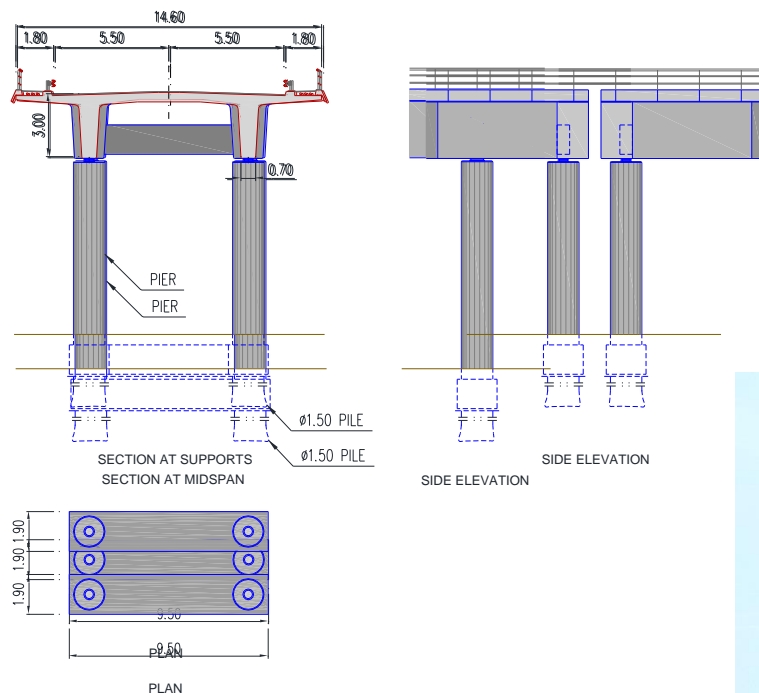


**TRANSITION BETWEEN BRIDGE
AND BRIDGE SPANS AND DECKS**



17th SEPTEMBER BRIDGE
KWANZA RIVER AT CABALA
ANGOLA

Construction Works
SEP08 - AUG10



TYPE PAIRS CROSS SECTION OF ACCESS/ADULTS DECKS

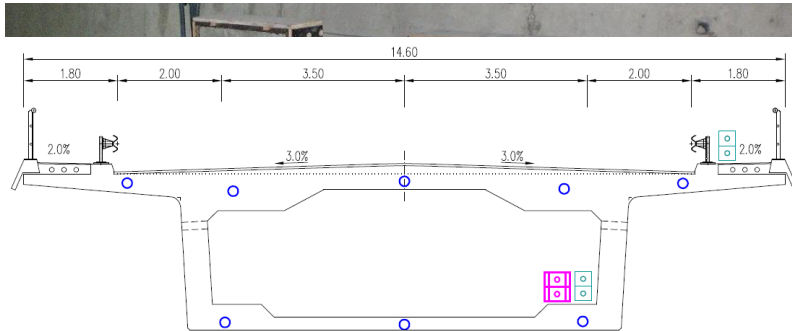
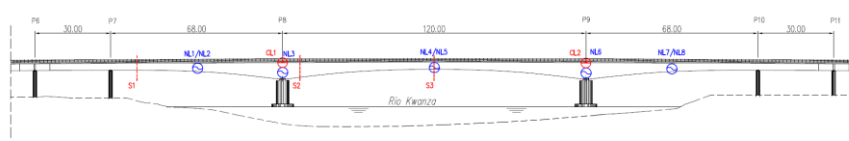




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17th SEPTEMBER BRIDGE KWANZA RIVER AT CABALA

ANGOLA

MONITORING PLAN - LNEC/LEA

LOAD TESTS

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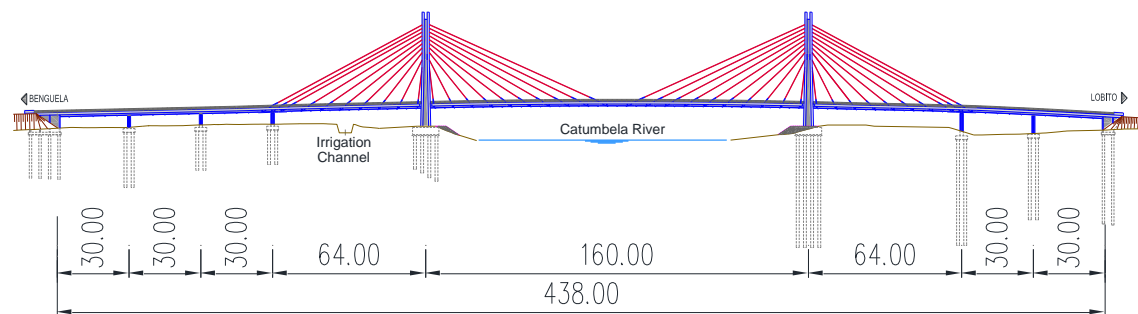


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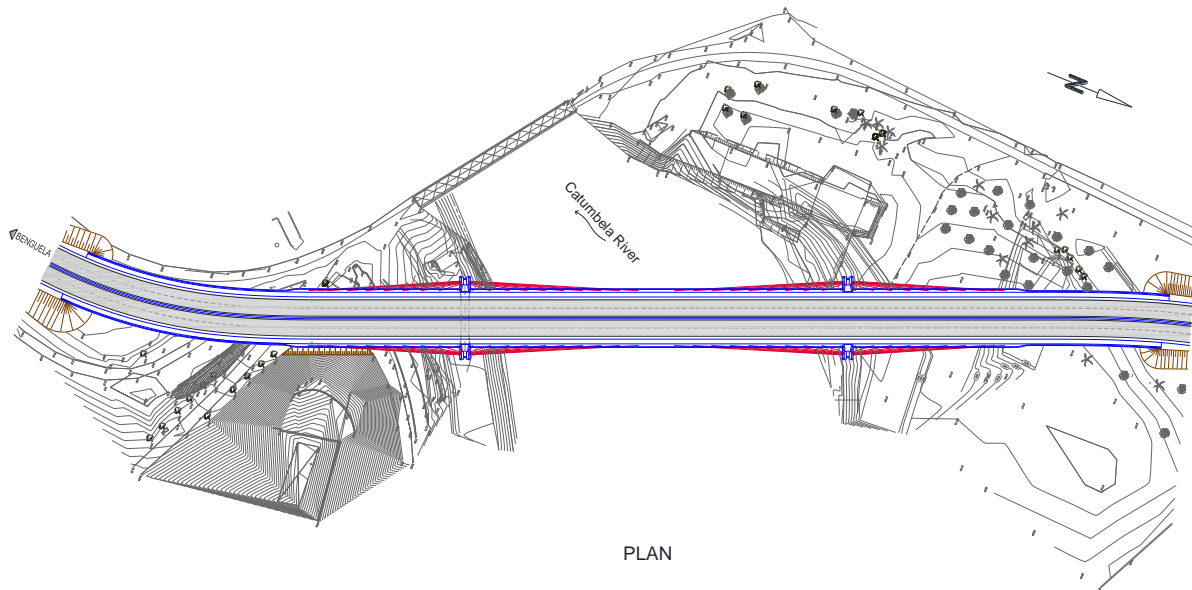


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4th APRIL BRIDGE CATUMBELA RIVER ANGOLA



ELEVATION



PLAN

LOBITO - BENGUELA MOTORWAY

Concluded - 2009
Total length 438 m
Main span 160 m
Width 24,5 m
Pylon height 47 m
Ø 1,20

Built in 2 years



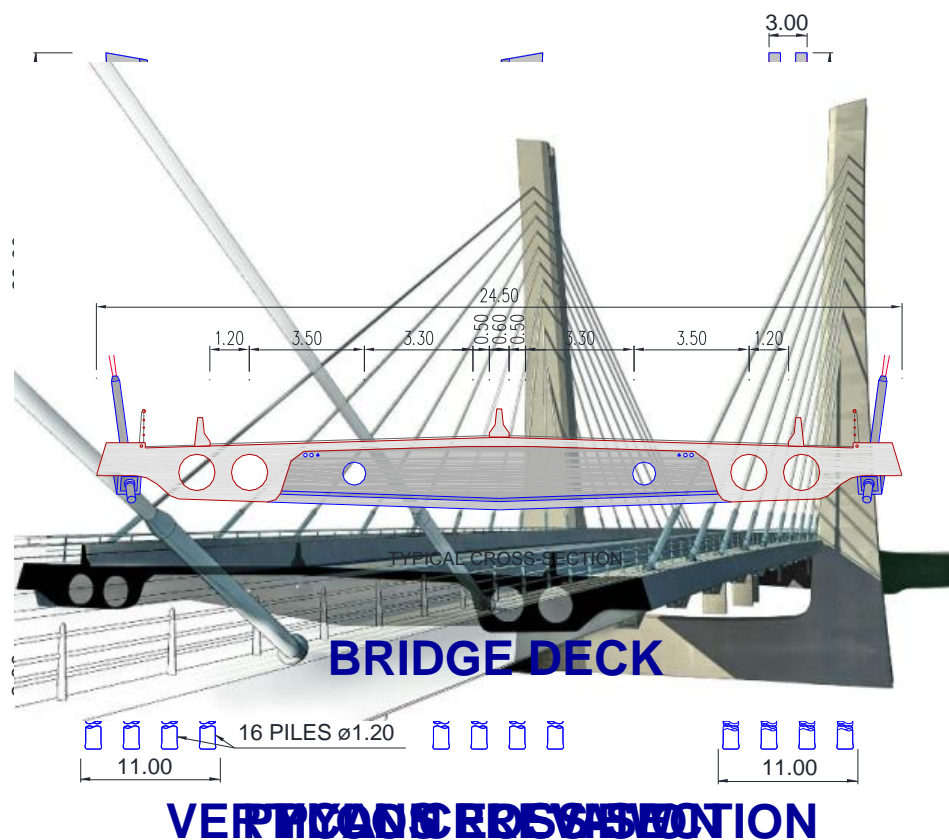
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4th APRIL BRIDGE CATUMBELA RIVER ANGOLA



BUILDING BRIDGES IN AFRICA



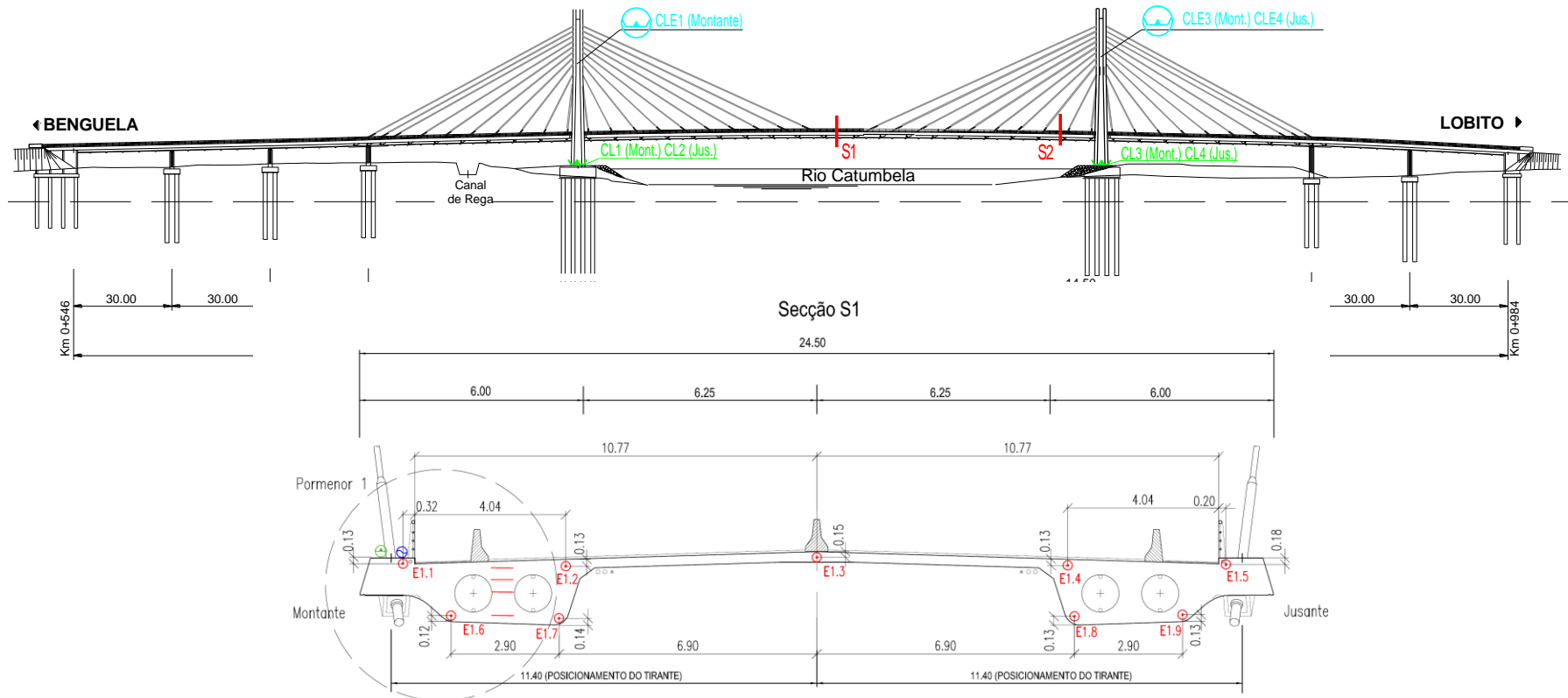
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MONITORING PLAN - LNEC/LEA

4th APRIL BRIDGE CATUMBELA RIVER



Data collected will be used as a training ground for technicians and behavior of bridges. Visits are organized for the students and Professors of the regional university

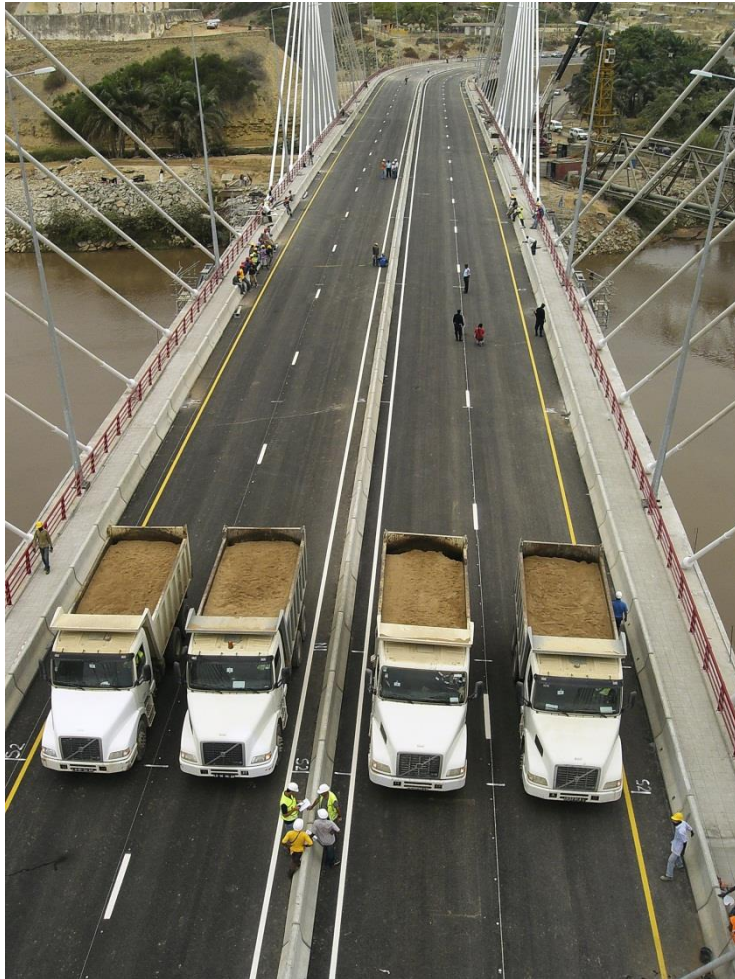
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4th APRIL BRIDGE CATUMBELA RIVER ANGOLA

LOAD TESTS - LNEC/LEA



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4th APRIL BRIDGE
CATUMBELA RIVER
ANGOLA
LOBITO - BENGUELA
MOTORWAY

FINAL VIEWS



FINAL VIEWS

BUILDING BRIDGES IN AFRICA



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**THE OPENING DAY OF THE FIRST
MODERN AND LANDMARK BRIDGE
BUILT AFTER THE INDEPENDENCE**

4th APRIL BRIDGE
CATUMBELA RIVER
ANGOLA
LOBITO - BENGUELA
MOTORWAY



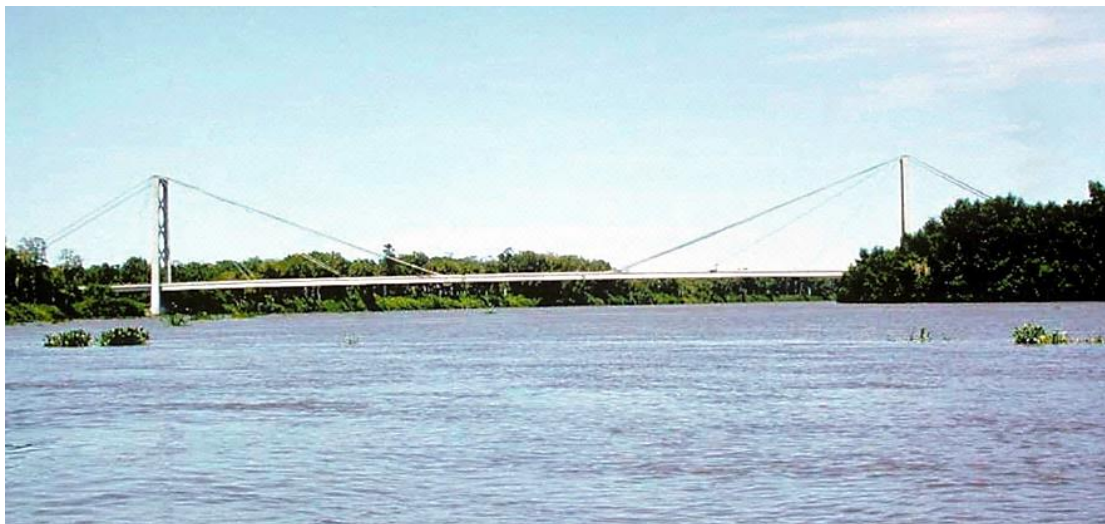
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REHABILITATION OF THE KWANZA BRIDGE ANGOLA

Concluded - 1975

Composite Deck

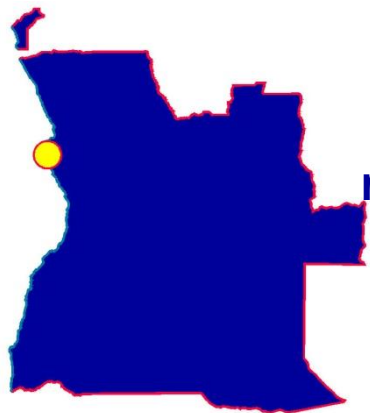
Main span - 260 m

Total length - 400 m

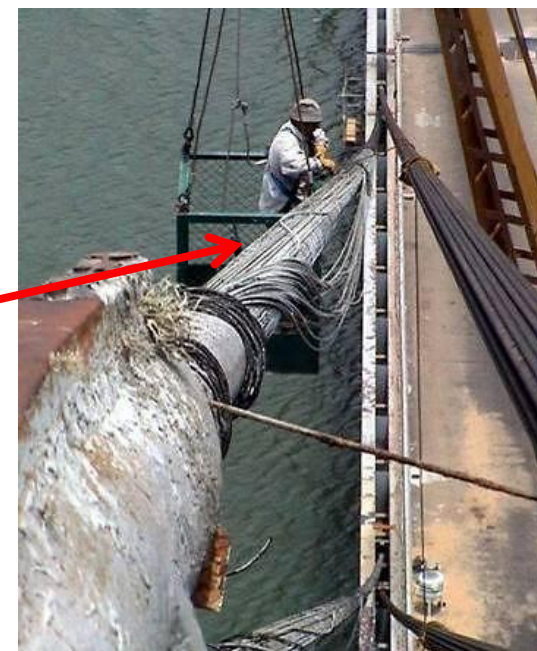
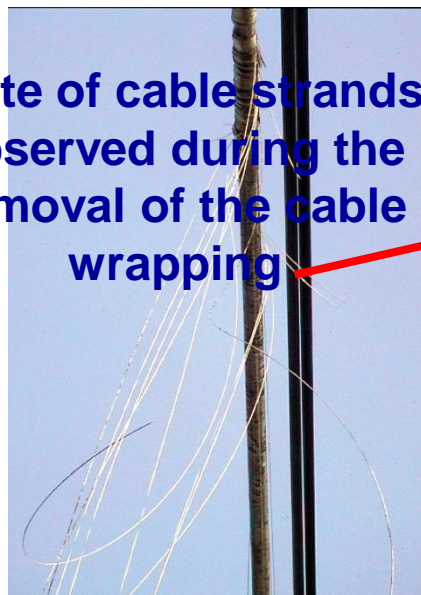
Temporary Bridge in 1978
installed in 1978 after the collapse
of one backstay

Views at the
beginning of the
rehabilitation works

DEC00 - APR03



State of cable strands
observed during the
removal of the cable
wrapping





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Early **2003** after
the Rehabilitation
Works



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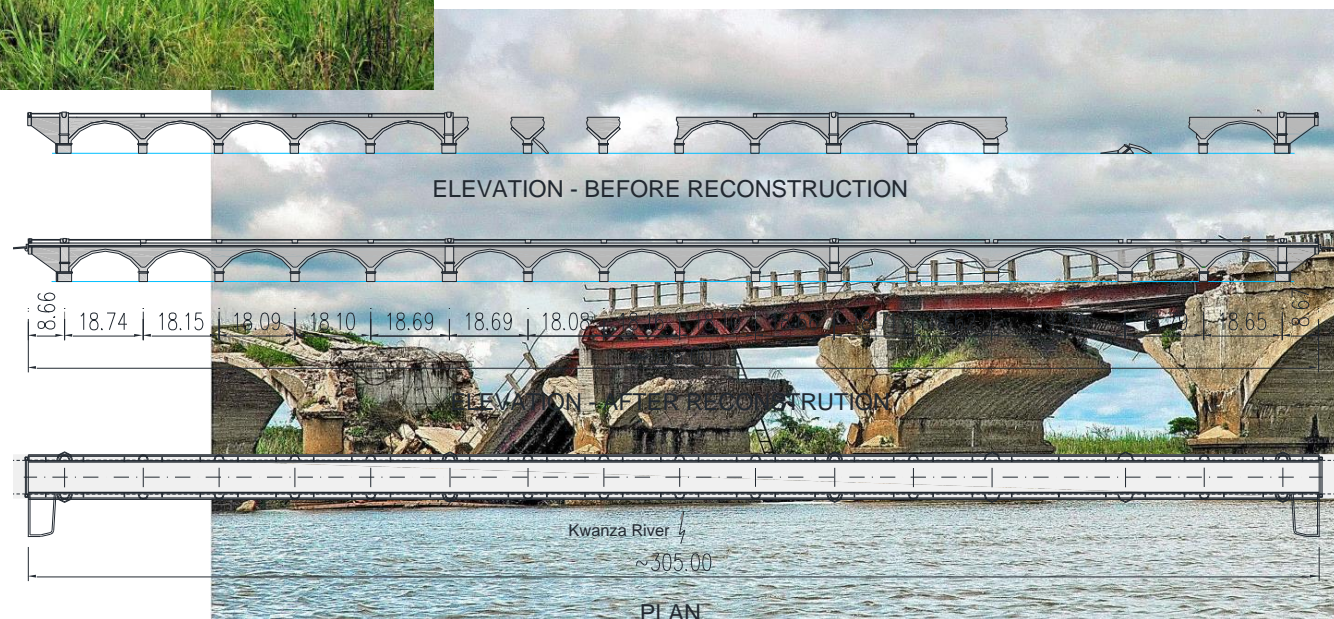
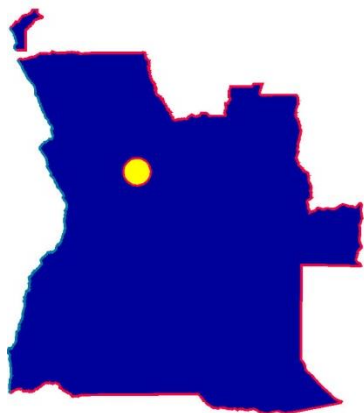


RECONSTRUCTION OF THE CANGANDALA BRIDGE

KWANZA RIVER
ANGOLA

The Bridge in 2006

Built in 1973



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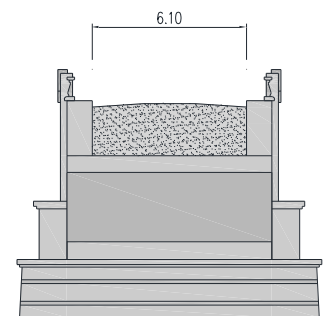


RECONSTRUCTION OF THE CANGANDALA BRIDGE

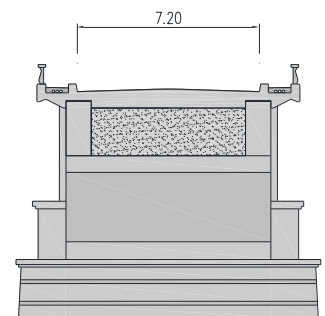
KWANZA RIVER
ANGOLA

The Rehabilitation Works

Considered as National Heritage



ORIGINAL
CROSS-SECTION



CROSS-SECTION
AFTER PLATFORM WIDENING



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**KEEPING THE ORIGINAL
PARAPET AND OVERALL
DETAILS DESIGN**

Considered as National Heritage



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FINAL VIEW FROM DOWNSTREAM

RECONSTRUCTION OF THE CANGANDALA BRIDGE

**KWANZA RIVER
ANGOLA**

**Rehabilitation Works
JUN08 - NOV10**

THE OPENING DAY



BUILDING BRIDGES IN AFRICA



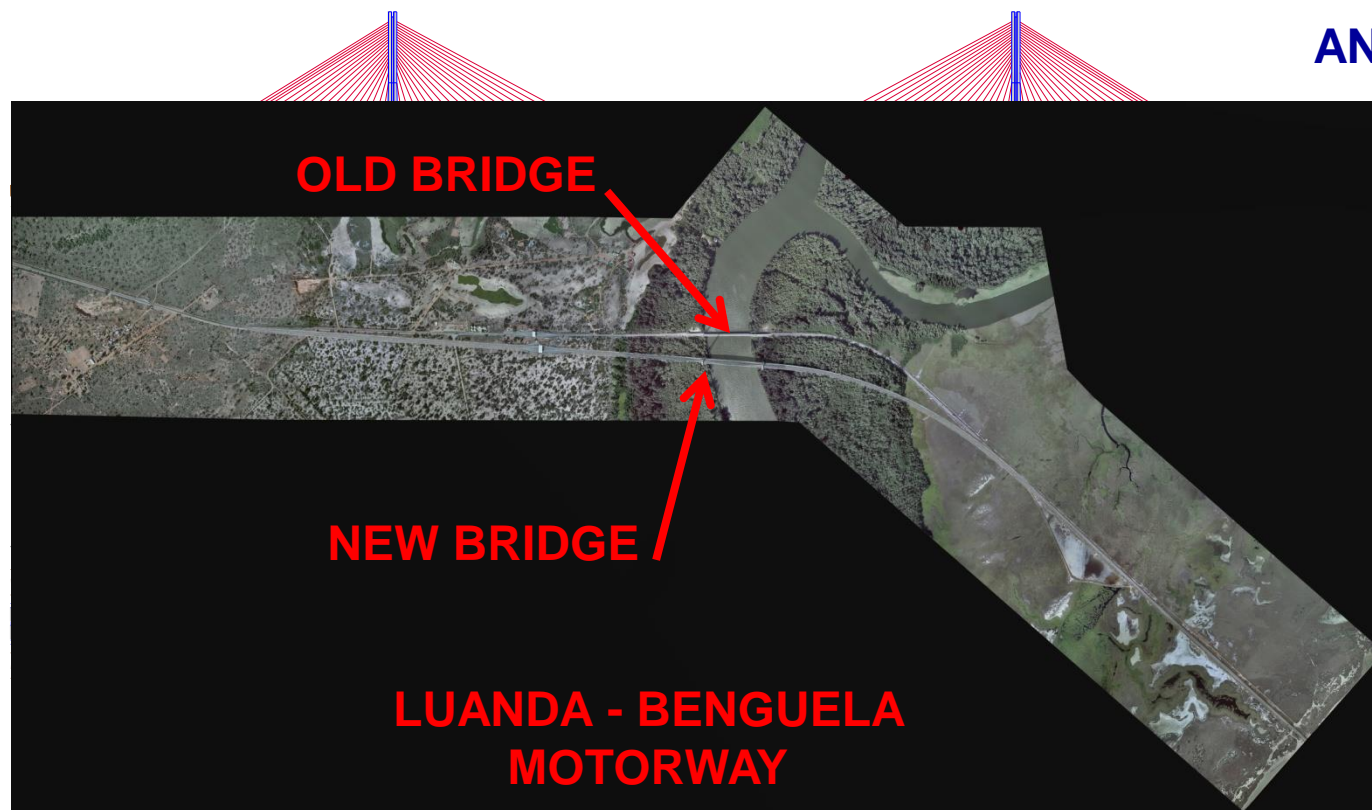
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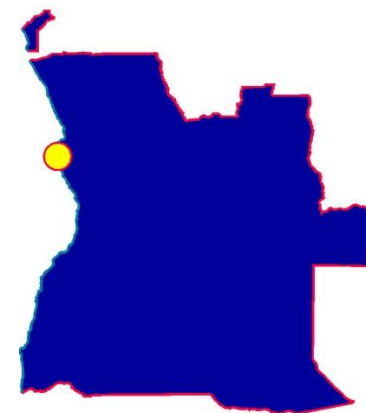
THE NEW KWANZA BRIDGE

ANGOLA



PLAN

TENDER CLOSED
CONTRACTOR
CHOICE PENDING



Total length - 626 m
Main span - 300 m
Pylons h = 90 m

FULL SUSPENSION

BUILDING BRIDGES IN AFRICA

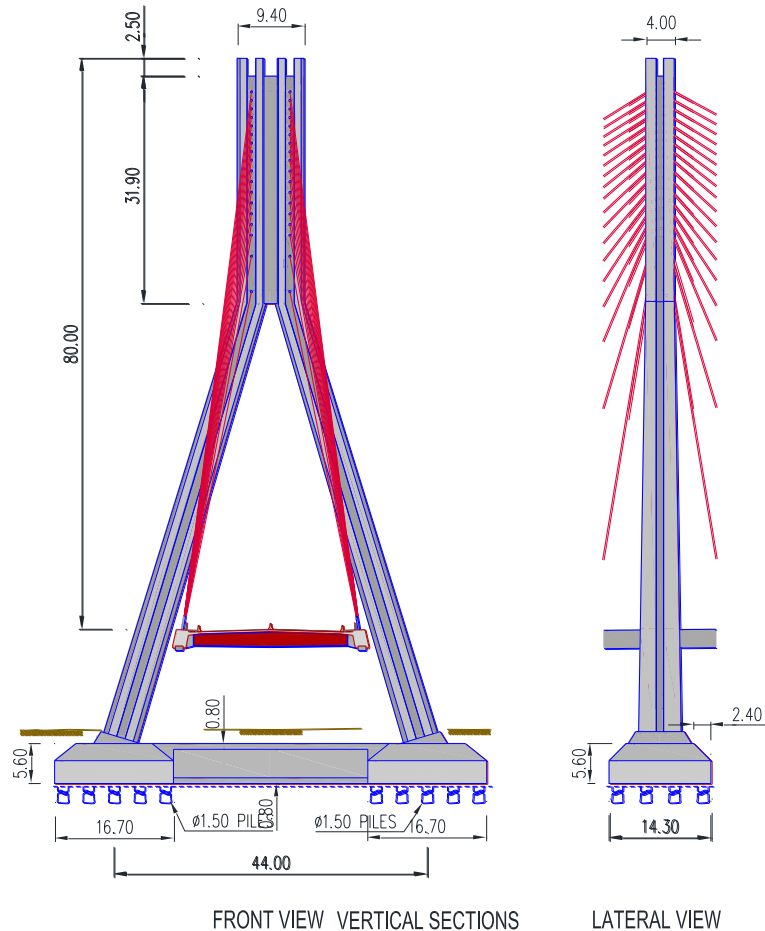


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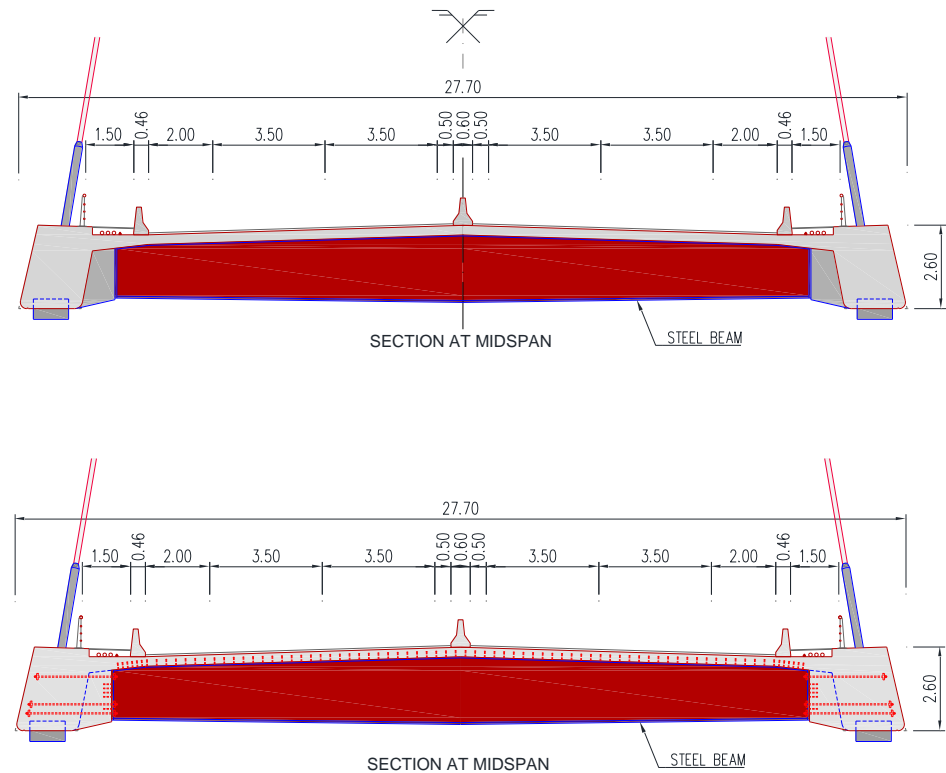


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THE NEW KWANZA BRIDGE ANGOLA



PYLONS



BRIDGE AND ACCESS SPANS

BUILDING BRIDGES IN AFRICA



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THE NEW KWANZA BRIDGE

ANGOLA

LUANDA - BENGUELA
MOTORWAY

PREVIEWS



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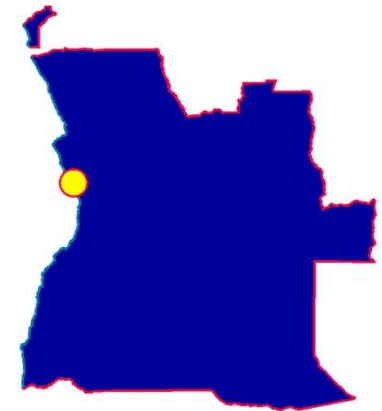
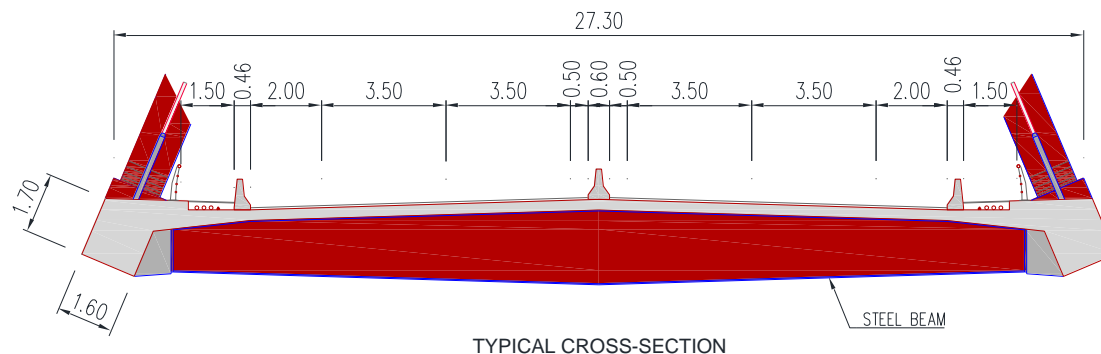
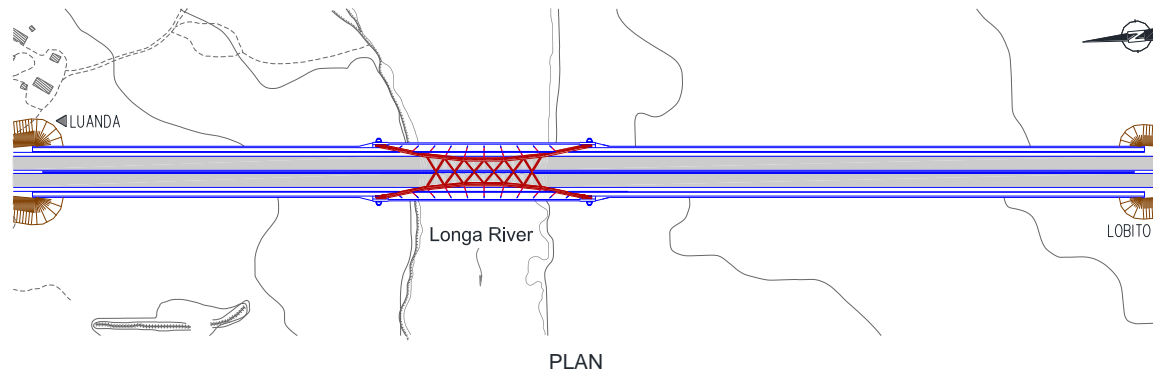
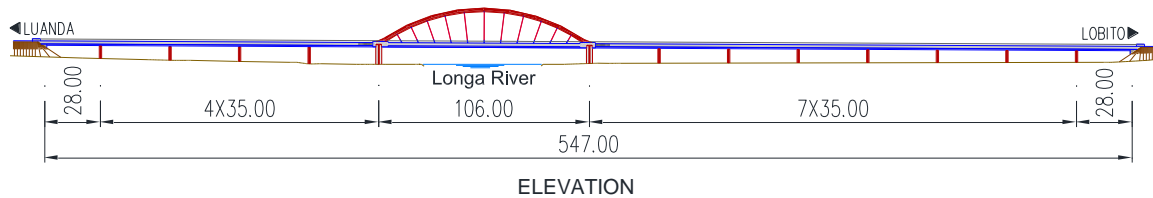


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LONGA RIVER BRIDGE

ANGOLA

LUANDA - BENGUELA MOTORWAY



Total length - 547 m

Main span - 106 m

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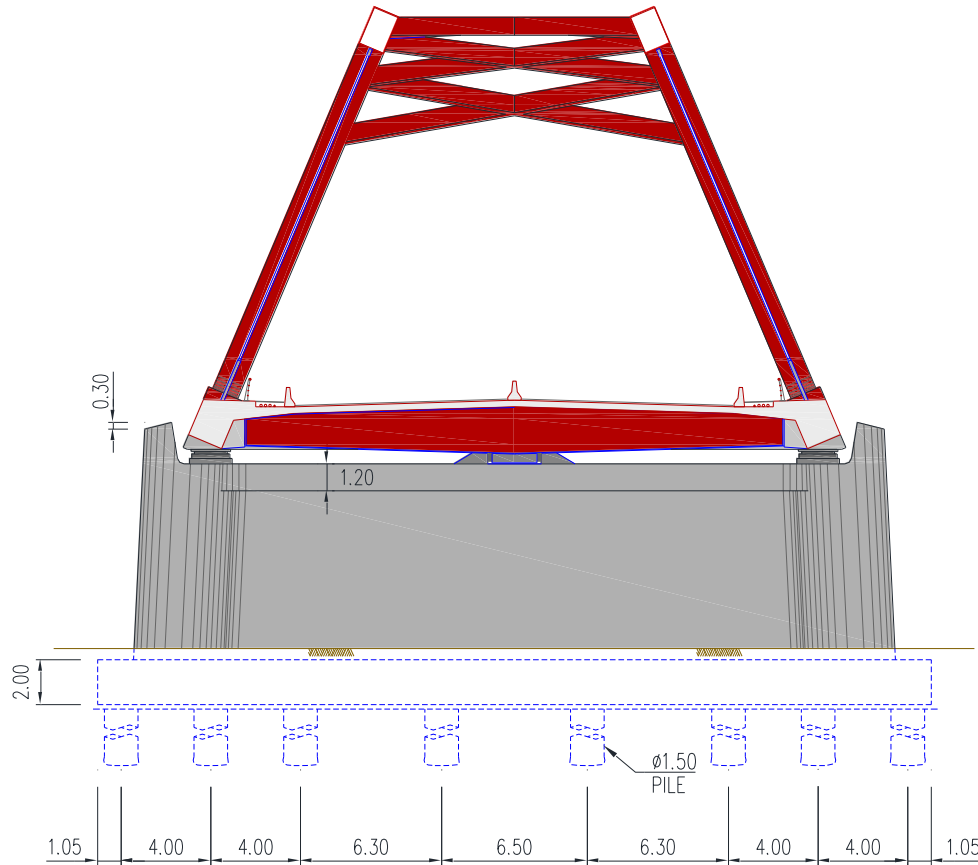


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LONGA RIVER BRIDGE

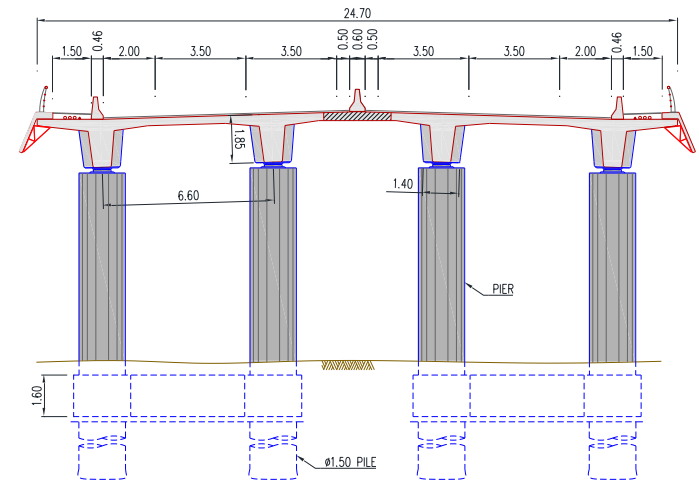
ANGOLA

LUANDA - BENGUELA MOTORWAY



TYPICAL CROSS-SECTION

BRIDGE



TYPICAL DECK CROSS-SECTION



PLAN

ACCESS VIADUCTS

BUILDING BRIDGES IN AFRICA



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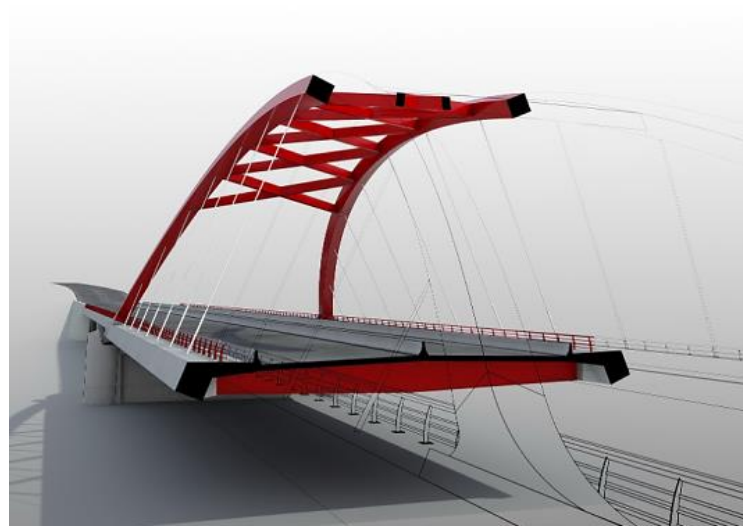
LONGA RIVER BRIDGE

ANGOLA

**LUANDA - BENGUELA
MOTORWAY**

**TENDER TO BE CALLED
NEXT YEAR**

PREVIEWS



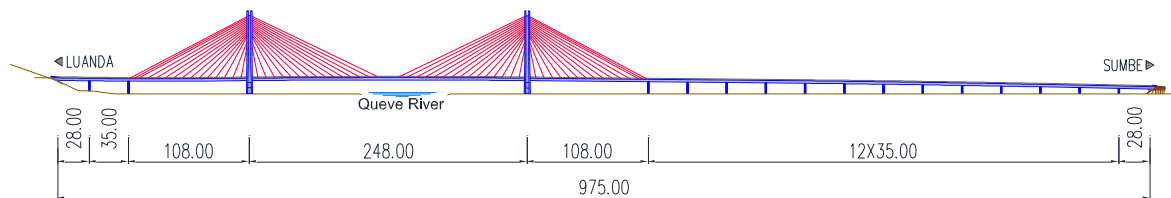
BUILDING BRIDGES IN AFRICA



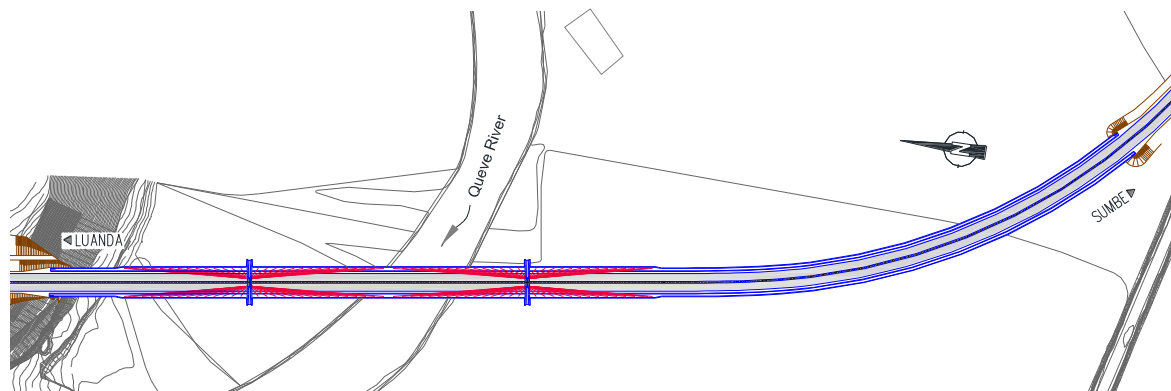
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ELEVATION



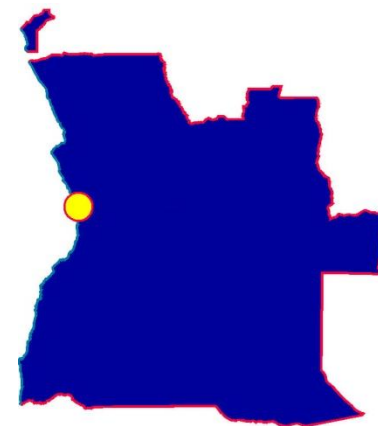
PLAN

QUEVE RIVER BRIDGE

ANGOLA

LUANDA - BENGUELA MOTORWAY

TENDER TO BE CALLED NEXT YEAR



Total length- 975 m

Main span - 248 m

Width - 24,50 m

Pylons - h = 80 m

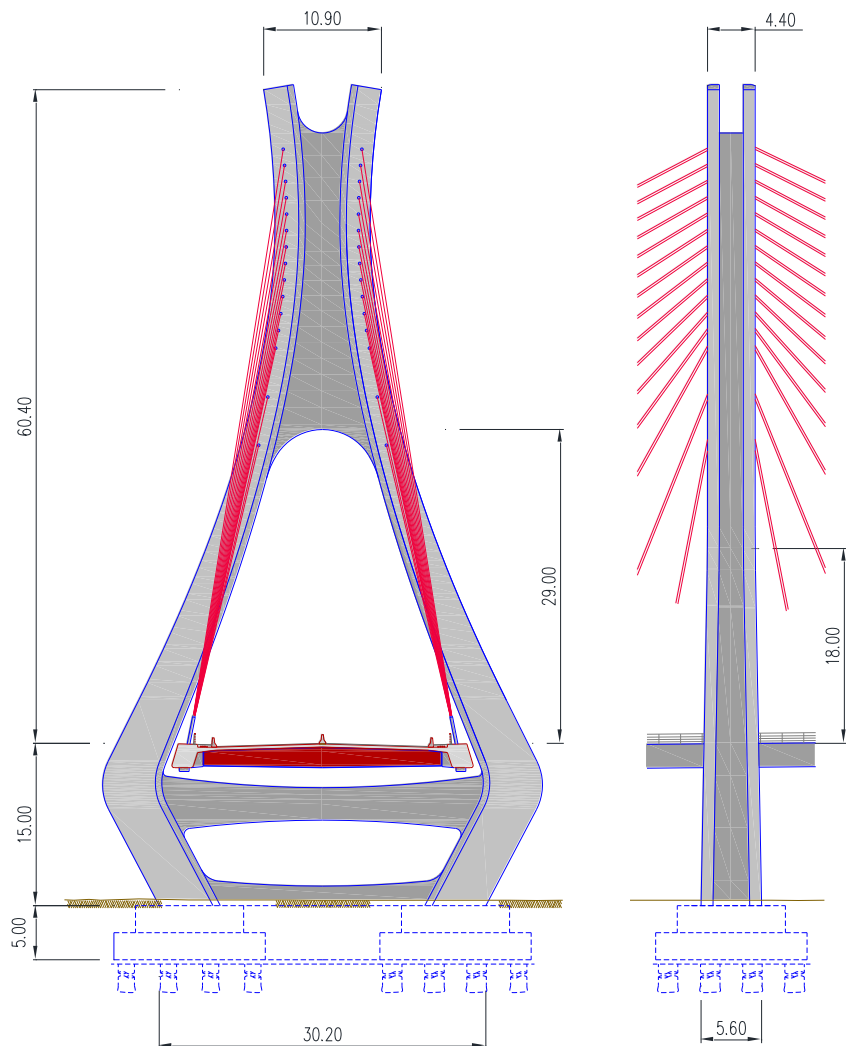
Piles - ø 1,80 m to depths of 80 m



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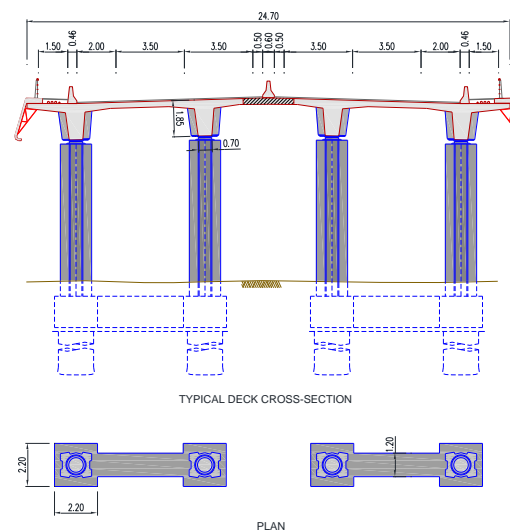
PYLONS

QUEVE RIVER BRIDGE

ANGOLA

LUANDA - BENGUELA MOTORWAY

FULL SUSPENSION



ACCESS VIADUCTS



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QUEVE RIVER BRIDGE

ANGOLA

**LUANDA - BENGUELA
MOTORWAY**

**TENDER TO BE CALLED
NEXT YEAR**

PREVIEWS



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THANK YOU

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