Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht

Band: 12 (1984)

Artikel: Saudi-Arabia: Bahrain causeway

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DOI: https://doi.org/10.5169/seals-12284

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Saudi Arabia – Bahrain Causeway

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General

The Causeway incorporates 5 bridges and 7 embankments. The superstructure of the bridges consists of 2 separate boxgirders, each 12,3 m wide, prestressed in both longitudinal and transverse direction.
The bridges have a spanlength of 50 m and are constructed as a "Gerber" structure: alternatively cantilever girders of 66 m and drop in spans (suspende girders) of 34 m. Both cantilever and suspended girders have been prefabricated on shore and are placed in position as a complete unit.
The substructure consists of prefabricated hollow prestressed piles with an outer diameter of 3,5 m. Bridge no. 5 has been founded on caissons due to the presence of an aquifer. Bridge no. 3 incorporates the main navigation span. This navigation span has been constructed in accordance with the prefabricated segmental system.
Spanlengths: 80-150-80 m. The cast in situ piers rest on direct foundations.

Durability

Special measures have been taken because of the very aggressive environment:
- Blast furnace Portland cement (slag content 70-80%) has been used. This cement has a high sulphate resistance and a hight impermeability.
- A max Cl^- ion content of 0,1% by weight of cement has been prescribed for the concrete. As a result the sand, dredged from the sea, had to be washed extensively.
- Cover to the rebar for the piles 70 mm, for the superstructure 50 mm.
- The piles have been epoxy coated from -2,0 CD to +4,0 CD (splash zone).

Design criteria

In accordance with AASHTO, with some exceptions regarding the loading:
- lane loads : 10 kN/m' lane.
- trucks : 2 trucks, one of 600 kN and one of 300 kN.
- future pipeline : 10 kN/m', situated 4,5 m outside centre line of bridge
- earthquake : static load consisting of 6% of the permanent vertical load.
- ship collision : -56000 kN on each of the two mainspan piers.
  -28000 kN on each of the side piers of the mainspan.
  -varying load of 300-1000 kN for the piers adjacent to navigation spans.

Materials

Concrete quality : f_c = 40 N/mm^2 for prefabricated part of halving joint.
f_c = 35 N/mm^2 for all structural elements.

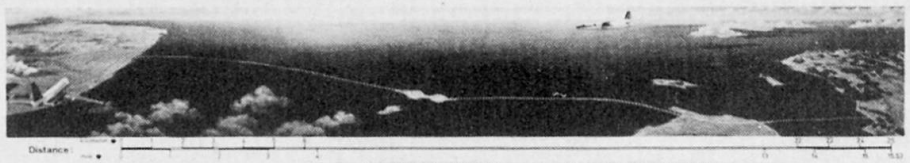
Reinforcement steel : Fe B 400 and Fe B 500 (f_y = 400 N/mm^2 and 500 N/mm^2 respectively)

Prestressing steel : Longitudinal prestressing, consisting of BBR CONA-MULTI 0,62" strands: f_{pu} = 1770 N/mm^2.
Transverse prestressing, consisting of BBRV 7 mm wires: f_{pu} = 1670 N/mm^2.
Inclined Dywidag bars in halving joints f_{pu} = 1035 N/mm^2

Soil conditions

- sea bottom 4.00 to 12.00 minus CD.
- top layer of caprock 0.00 - 3.00 m thick.
- soft soil (sand/clay) 2.00 - 8.00 m thick.
- soft rock of claystone/siltstone.

SAUDI ARABIA - BAHRAIN CAUSEWAY



Distance

pile composition

SUSPENDED GIRDER

CANTILEVER GIRDER

section A

section B

geological profiles

CASTING GIRDER

INSTALLATION OF GIRDER

BORDER STATION

MAIN SPAN

section A

section B

DIFFUSION COEFFICIENTS CLIONS

MAIN SPAN PRESTRESSING

PIER TYPE 4a
foundation main span

PLAN

MAINSPAN PIER TYPE 4A

MAINSPAN

SURVEY SYSTEM

PREFABRICATED PILE SECTION

PIER TYPE 1
standard pile system

PIER TYPE 2 double braced system

PILE CAP
IN THE CRANE

HALVING JOINT WITH
PRESTRESSING CABLES

CRACKING OF THE GIRDER

INSTALLATION OF HALVING
JOINT TEST

HORIZONTAL LOAD TEST

VERTICAL LOAD TEST

GRAPHIC OF LOAD TEST

SELF ELEVATING PLATFORM
IN OPERATION

VIEW TO NORMAL JOINT - CANTILEVER GIRDER

GIRDER ON ARRIVAL

WORK ISLAND

BORING AND PLACING PILES

PHASE 1
placing casing

PHASE 2
placing drill

PHASE 3
drilling soft layer with casing following

PHASE 4
drilling soft rock

PHASE 5
placing pile

PHASE 6
grouting rock

PHASE 7
grouting/pulling casing

PHASE 8
ready pile

300 metres bridge per week

8 piles drilled and placed every week