

# Saudi-Arabia: Bahrain causeway

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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 high 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.

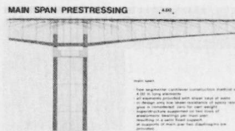
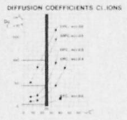
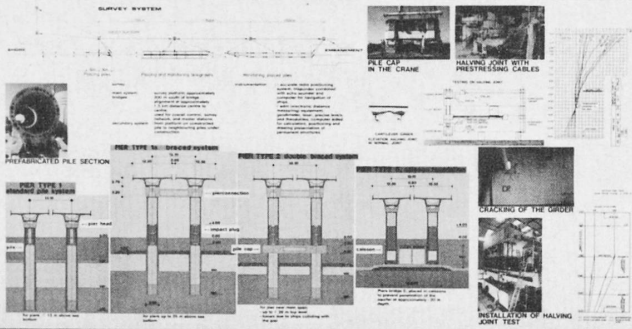
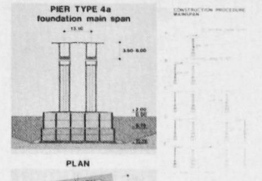
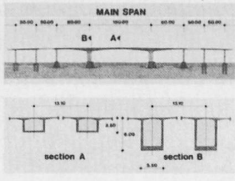
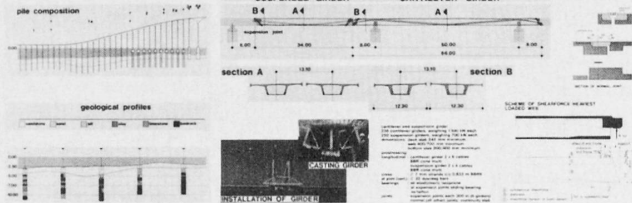
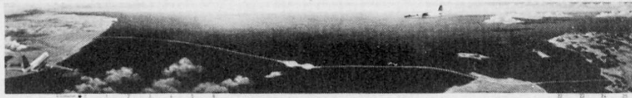
#### Materials

- Concrete quality :  $f_c = 40 \text{ N/mm}^2$  for prefabricated part of halving joint.  
 $f_c = 35 \text{ N/mm}^2$  for all structural elements.
- Reinforcement steel : Fe B 400 and Fe B 500 ( $f_y = 400 \text{ N/mm}^2$  and  $500 \text{ N/mm}^2$  respectively)
- Prestressing steel : Longitudinal prestressing, consisting of BBR CONA-MULTI 0,62" strands:  $f_{pu} = 1770 \text{ N/mm}^2$ .  
Transverse prestressing, consisting of BBRV 7 mm wires:  
 $f_{pu} = 1670 \text{ N/mm}^2$ .  
Inclined Dywidag bars in halving joints  $f_{pu} = 1035 \text{ N/mm}^2$

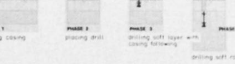
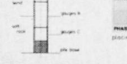
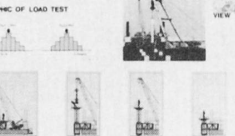
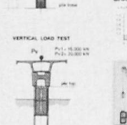
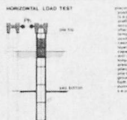
#### Soil conditions

- 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



**300 metres bridge per week**



**8 piles drilled and placed every week**