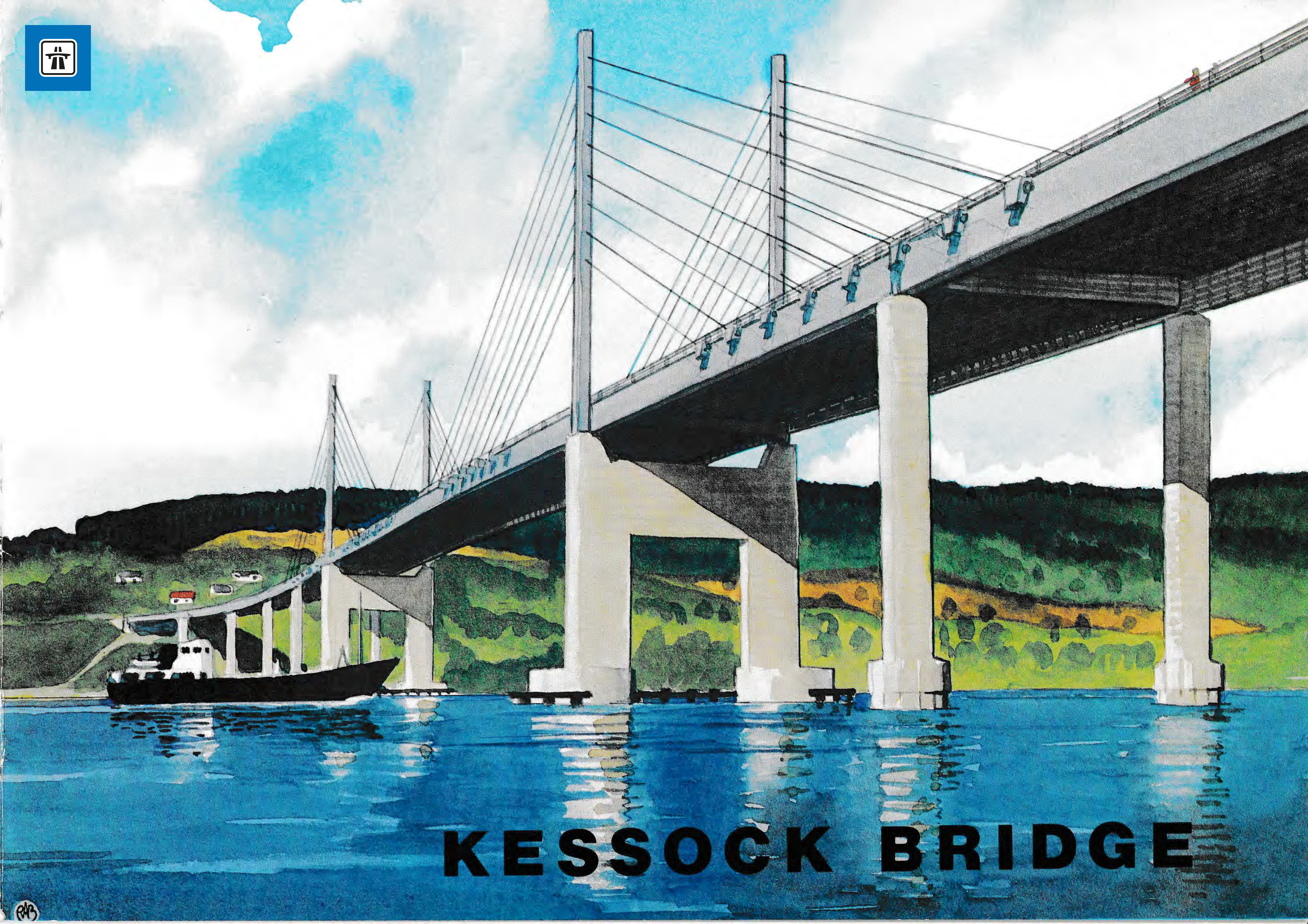


KESSOCK BRIDGE

HER MAJESTY QUEEN ELIZABETH THE QUEEN MOTHER

OPENED KESSOCK BRIDGE

ON 6th AUGUST 1982

Tenderer	*Sketch*	**Cost*
Cleveland Bridge/RDL (Dr. Homberg & T.H.E.S.)		17255
Laing (Maunsell)		18312
McAlpine/Dyckerhoff & Widman		19140
Monk/M.A.N./McGregor/Clarke Chapman (Atkins)		19527
Wimpey/Clarke Chapman/Highland Fab. (Babtie & Leonhardt)		20812
Taylor Woodrow/Campenon Bernard		24850

TABLE 1—
Kessock Bridge—analysis of tenders: March 1977

**Cost in units of £1,000*

The Scottish Development Department invited Design and Construct tenders for the bridge from six consortia in October, 1976, this being the first time this procedure had been used in the UK for a major bridge project.

Following assessment by the Joint Engineers and consultation with the Royal Fine Arts Commission for Scotland the Department awarded the contract in June, 1977 to the Cleveland RDL Kessock Consortium for £17.25 million. The bridge is being financed by the Scottish Development Department, assisted by a 20 percent grant from the EEC Regional Development Fund.

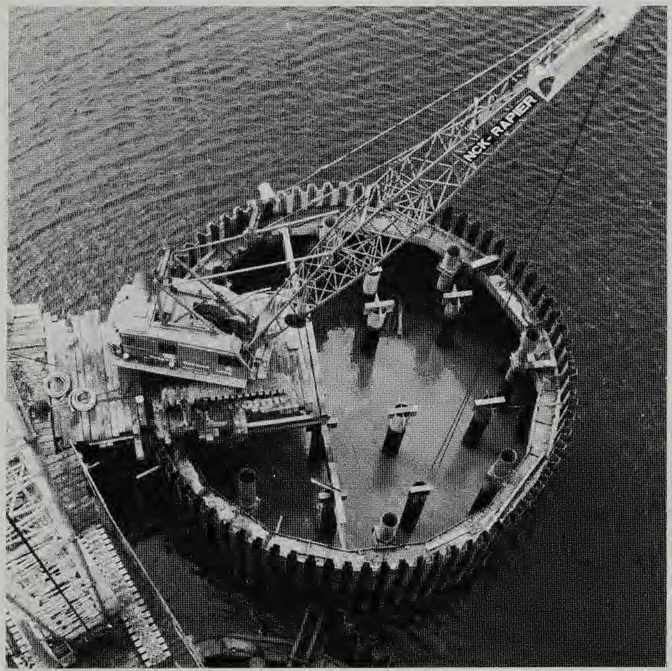
After an initial detail design period, work started on site in April 1978.

Construction of foundations, reinforced concrete abutments and piers was undertaken by the RDL Contracting Limited part of the Consortium. Rock causeways leading to steel tube piled jetties in deep water provided road access to all foundations which were constructed in open sheet pile cofferdams. At five piers steel H-piles were driven to depths of 60m below bed level. Tremie concrete was pumped underwater to seal the bases of the excavated cofferdams, so that the pier bases and cutwaters could be constructed in the dry.

All columns, including those at the main piers which are linked by 8m deep cross beams, were slipformed in pairs.

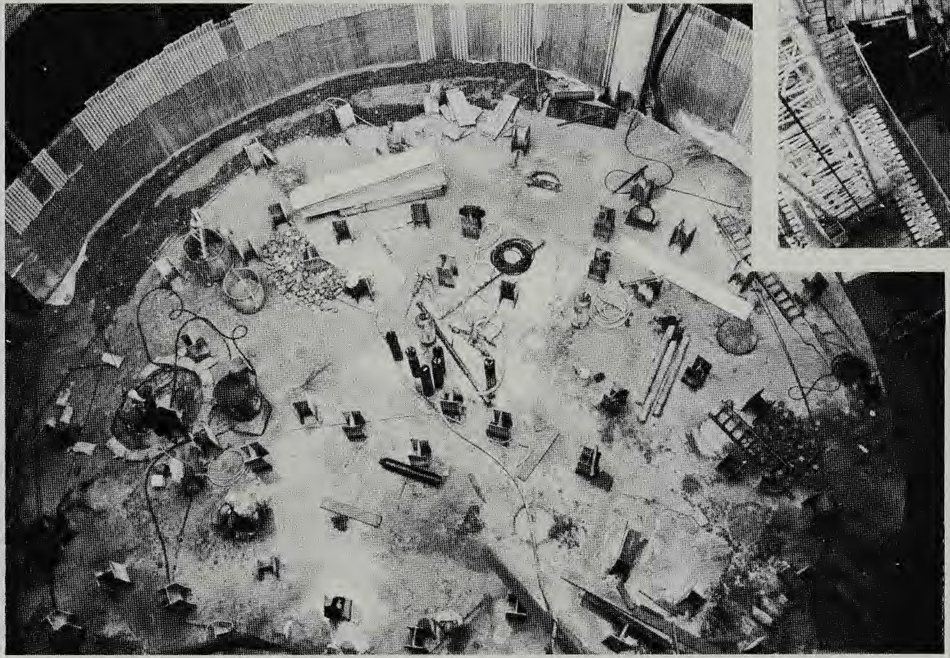
Waling being reassembled on location

South Approach access jetty under construction

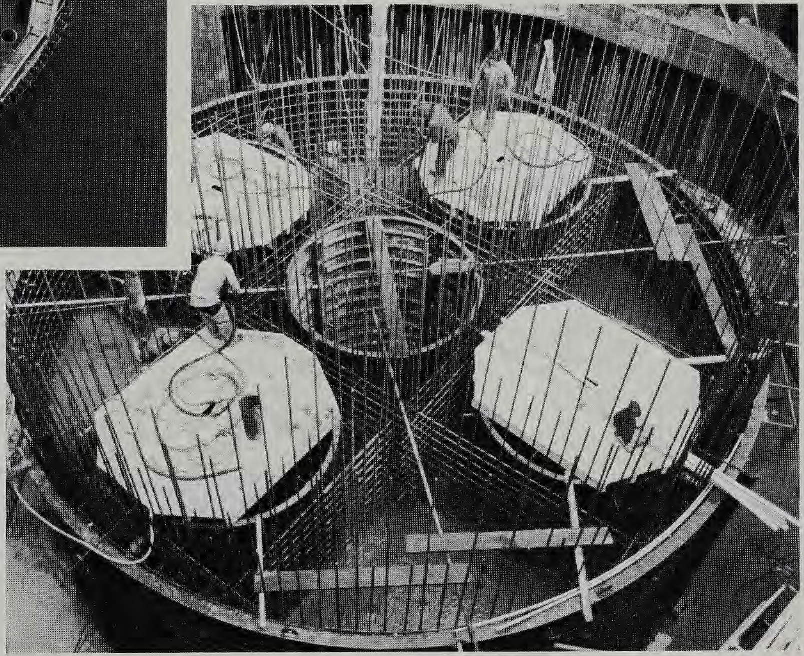


Excavation to 20 metres below top edge of cofferdam

Cofferdam dewatered



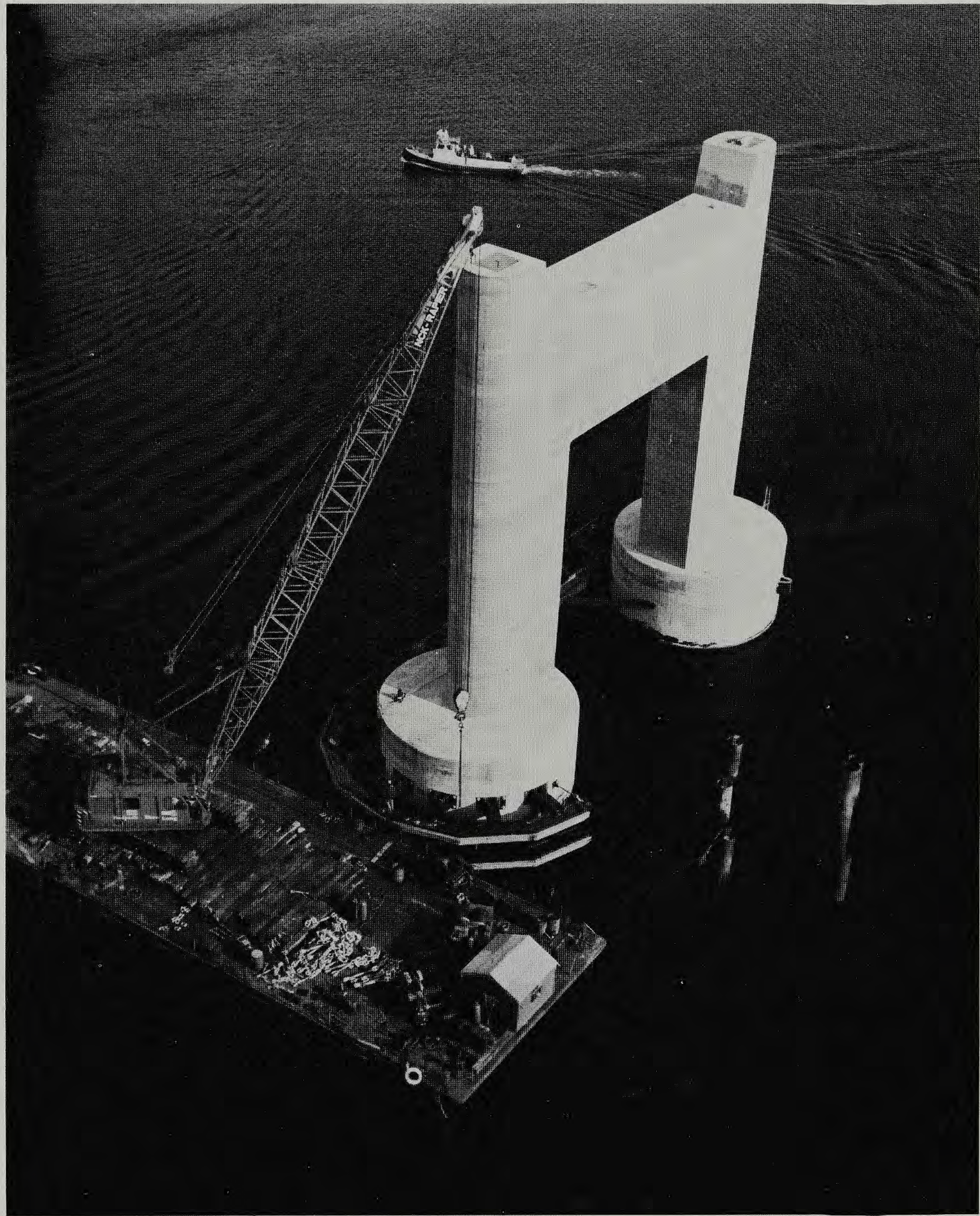
Cutwater under construction with steel void forms



Construction of the main pier foundations in 12m of fast flowing water presented RDL with their greatest difficulty. Each main pier is supported on cellular cutwaters which are constructed within 21m dia. circular cofferdams. To support 31m long steel sheet piles two tier steel lattice walings each weighing 120 tonnes were welded on shore with bolted joints which allowed 30 tonne units to be taken out for reassembly as shown. Each waling was then lowered from three tube piles to its required position and with five additional tube piles it was secured to the sea bed. After sheet piling and excavation to 6m below sea bed level up to 80 steel H piles were installed in each main pier cofferdam. 2½m of tremie concrete was pumped in under water to seal the base and after dewatering construction was able to proceed in dry conditions.

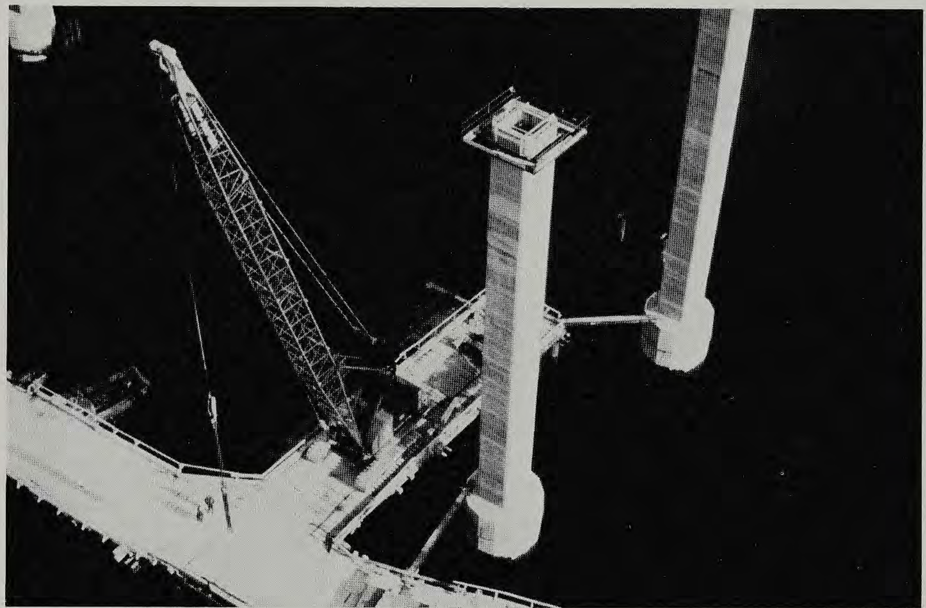
The south main pier requires to carry a vertical load of about 5500 tonnes, a wind load of over 500 tonnes with a longitudinal anchorage load of some 700 tonnes. Steel and rubber fenders protect the main bridge piers from ship impact.

Adjoining the main piers the pendel link piers were complicated by the need for a 4m deep recess to accommodate special steel hinge links which serve to anchor the deck but allow freedom for thermal expansion of the superstructure.

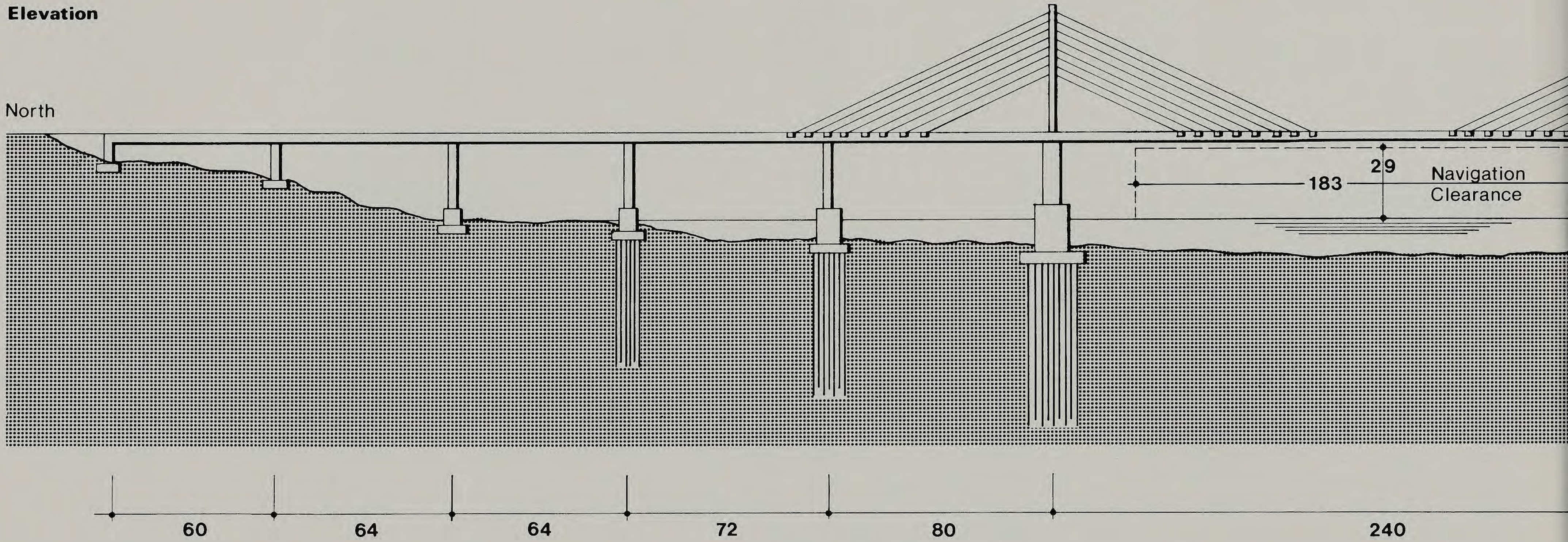


Main pier

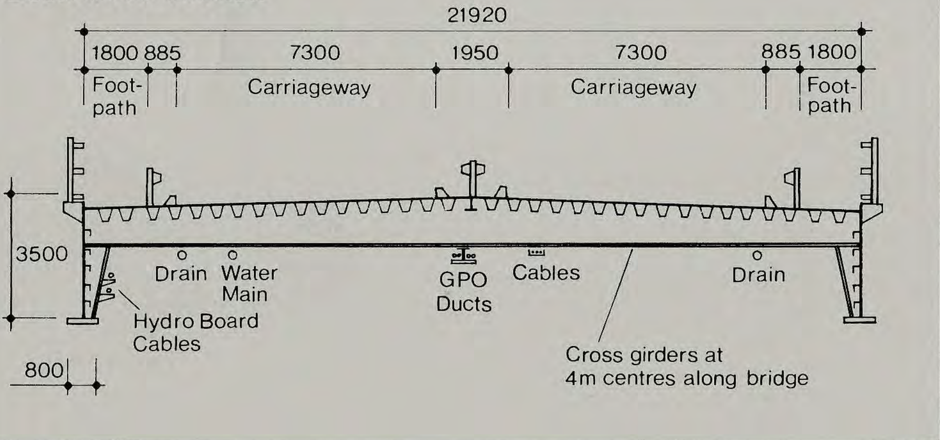
Pendel link pier 9 under construction



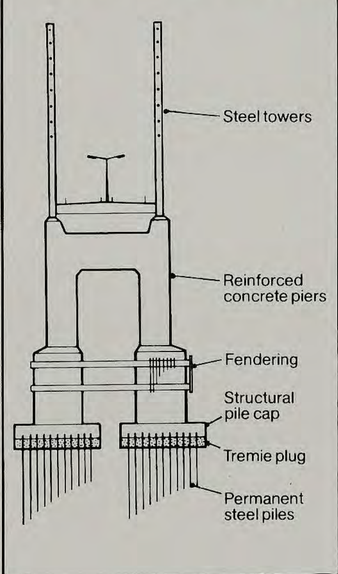
Elevation



Deck cross-section



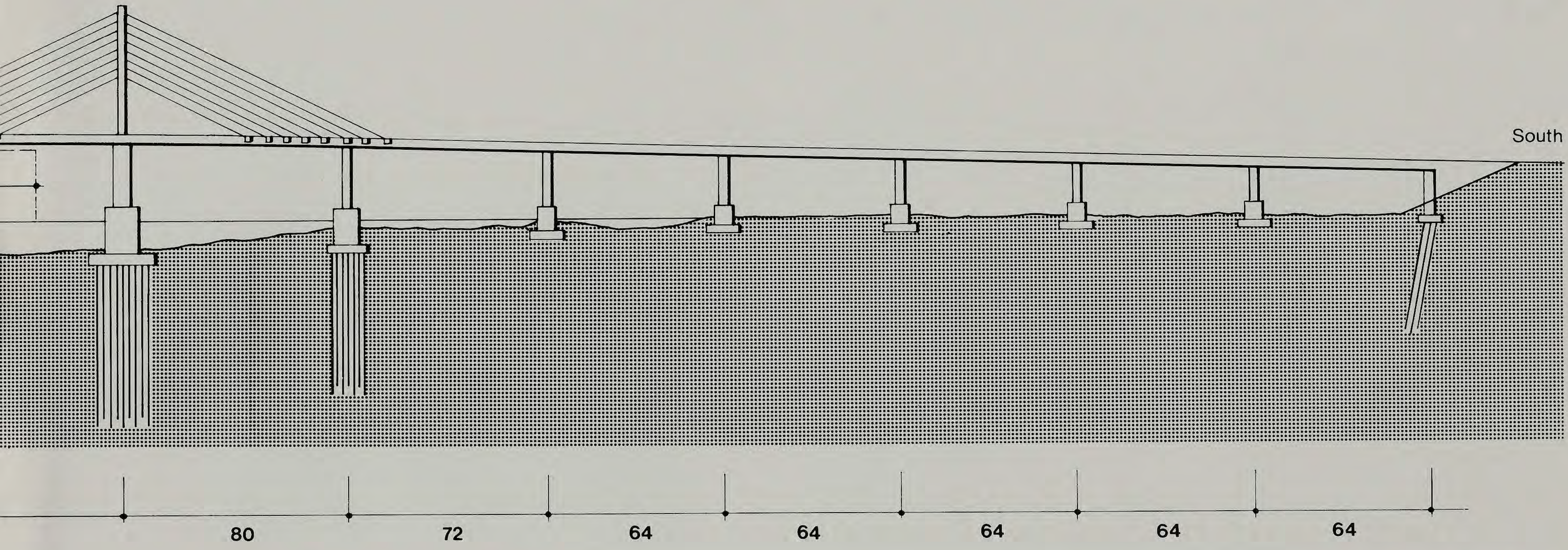
Section showing main piers

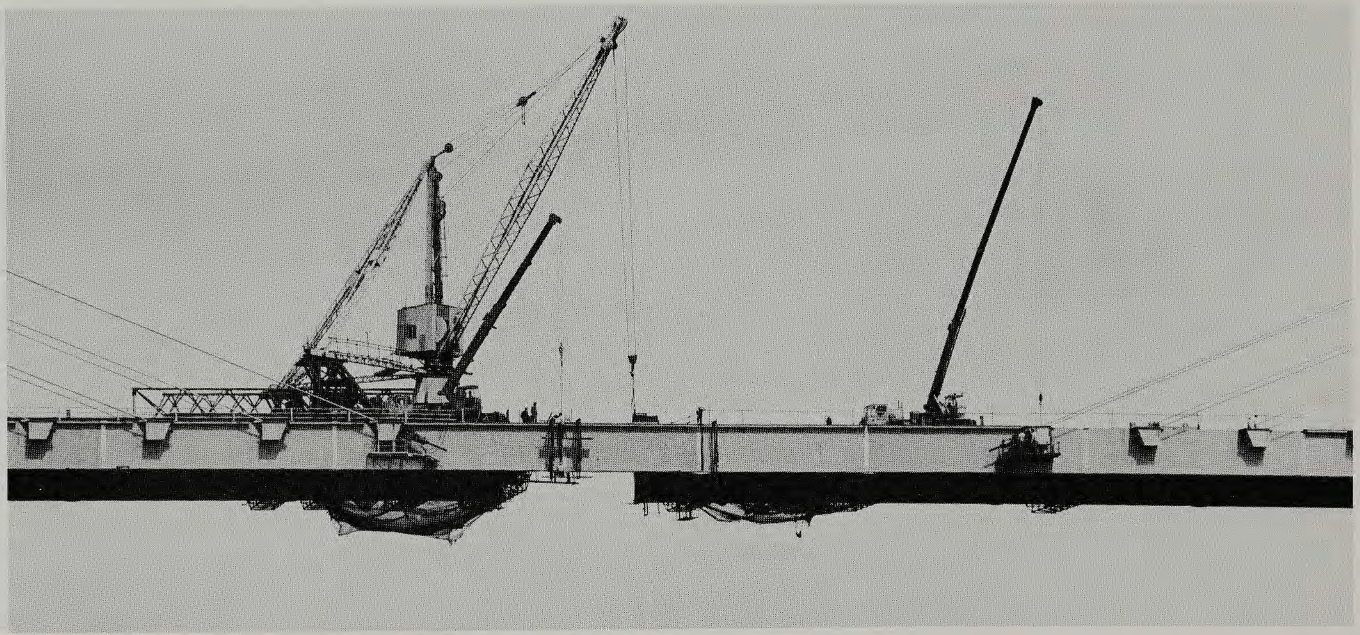


Kessock Bridge is the second largest cable stay bridge and the only one of its type in the United Kingdom. It is modelled on Rees Bridge which crosses the Rhine near Düsseldorf. The navigation span with 3500 tonnes of steel and 850 tonnes of asphalt is supported by groups of eight spiral strand steel cables up to 101mm dia in harp form. Secured at deck level to steel boxes bolted to the main girders the cables are anchored at their top end inside the four single cell steel towers.

Each tower is supported on rubber pot bearings which carry a vertical load of 2250 tonnes and, on the west side, the coincident wind load on a single bearing reaches 580 tonnes. In view of this severe loading the bearings were tested in a special 10,000 tonne rig in Switzerland.

The fully continuous steel superstructure is anchored longitudinally at the south main pier and slides over the remaining piers towards the abutments where expansion joints accommodate thermal movements of up to 500mm. Two 400 tonne hydraulic buffers are




Closing the gap

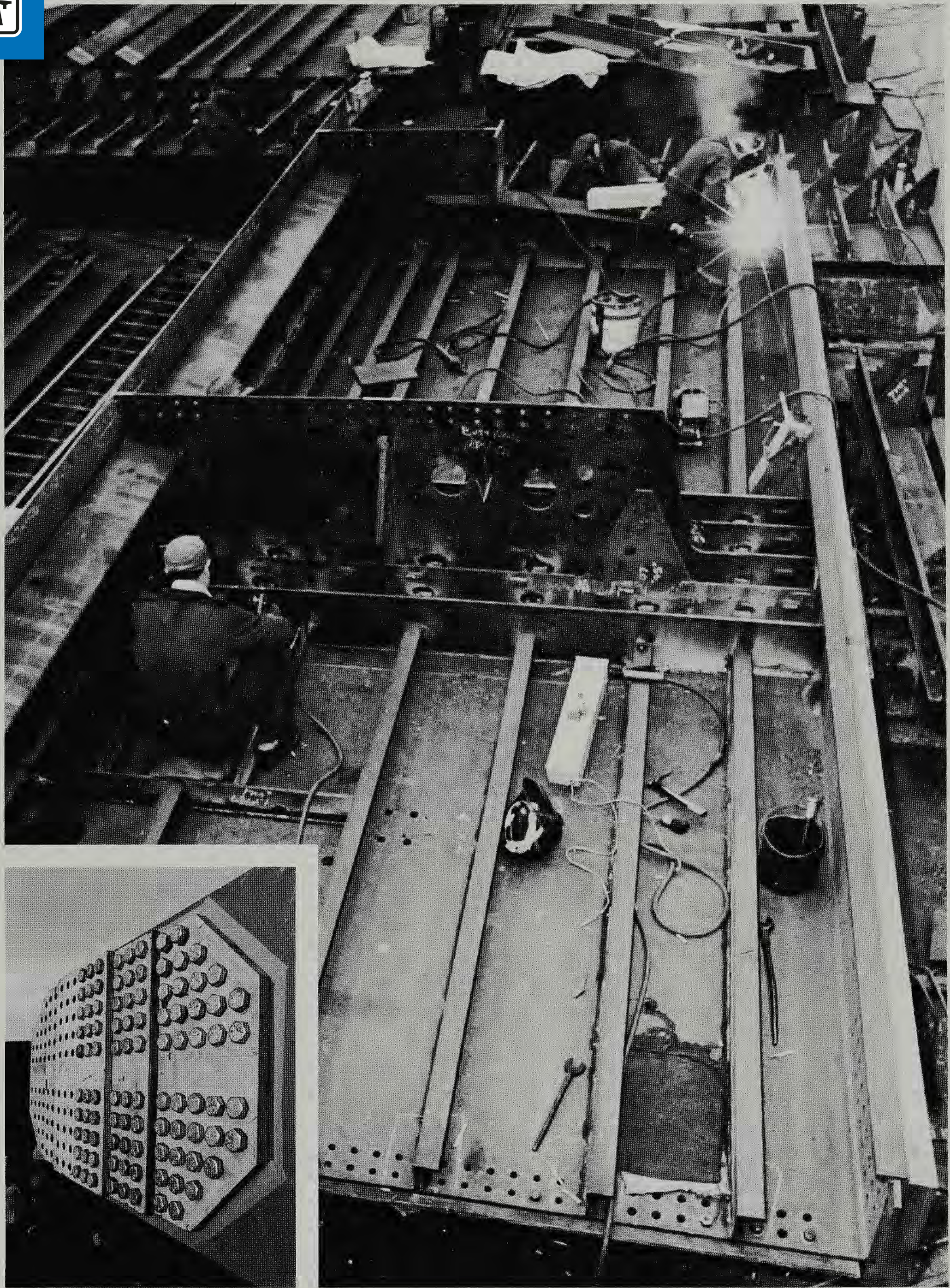
installed in the north abutment to withstand horizontal accelerations of one tenth gravity in the event of earth tremors associated with the Great Glen fault.

At Cleveland Bridge and Engineering works in Darlington 8890 tonnes of 50 grade steel were welded into 10 to 25 tonne pieces each 16m long which were delivered to site by road. All steelwork is grit blasted and some 25 tonnes of special paint is applied in five coats giving a protective film thickness of 0.25mm.

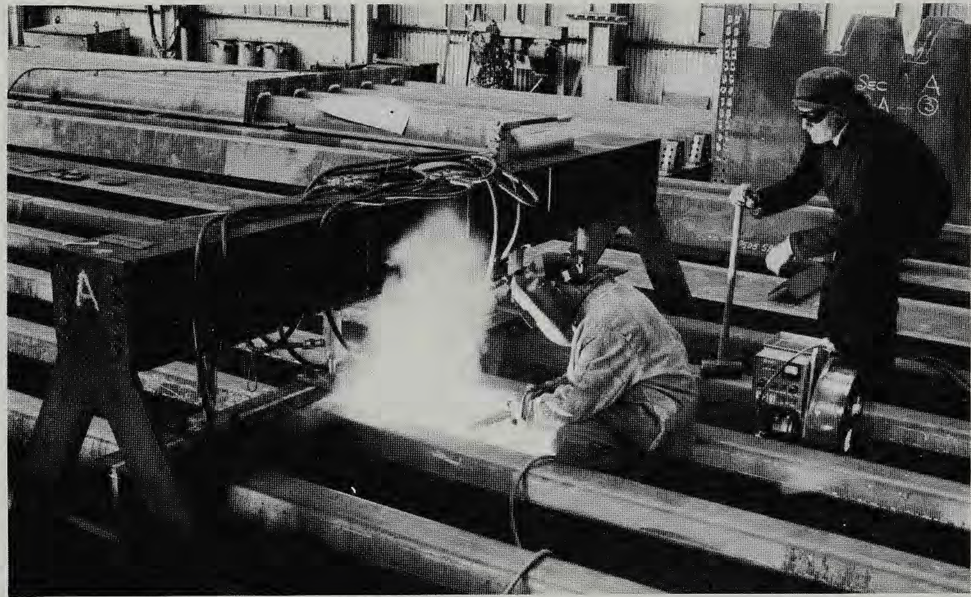
For the first time in Scotland mastic asphalt surfacing was laid by machine to a thickness of 38mm on the steel deck which is designed to carry 11¼ tonne wheel loads and vehicles up to 180 tonnes.

Glasgow University carried out tunnel tests on scale model sections of the bridge to determine the response of the deck and pylons to full scale winds. Should bridge movement exceed predetermined values special control vanes would be fitted to the main girders of the navigation span.

1



2

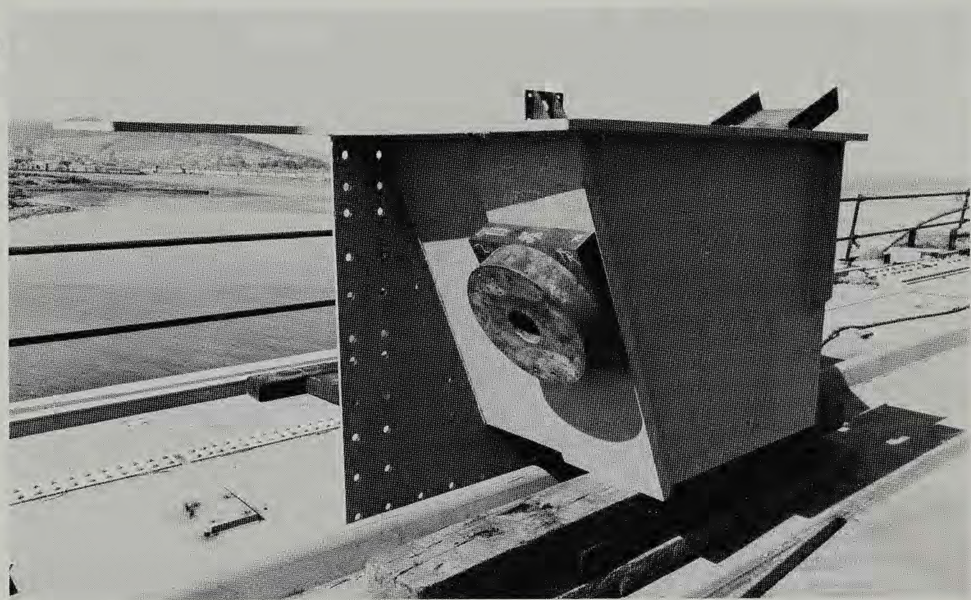


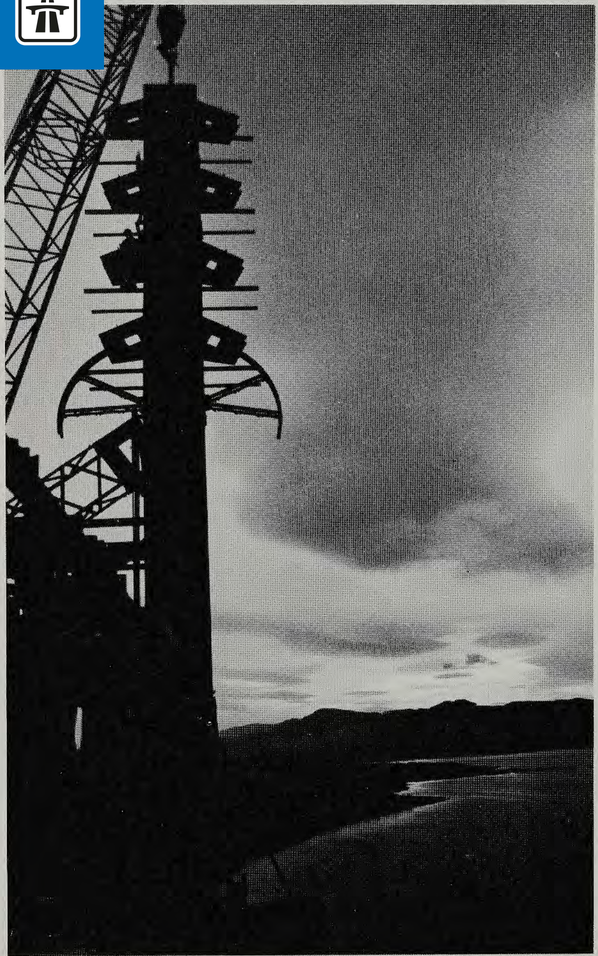
1 Pendel girder being assembled
(Inset) Bottom flange joint

2 Deck panel assembly

3 Cable anchorage

3





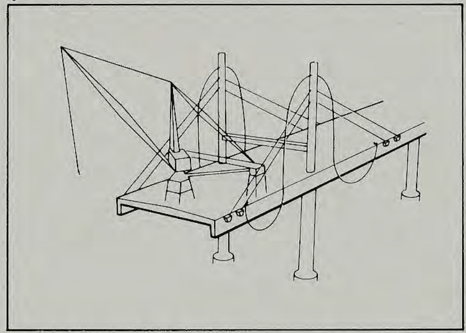
Erection of temporary pylon

The cantilever erection method for the 64m approach spans relies on temporary steel box section pylons set up over the forward piers.

From each pylon are taken three 101.4mm diameter cable stays, fore and aft, to support the cantilevered deck.

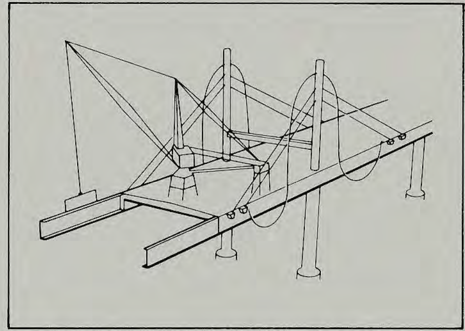
The sequence of erection of one 16m bay is shown on the right. A fourth set of stays is used on the 72m and 80m spans.

1



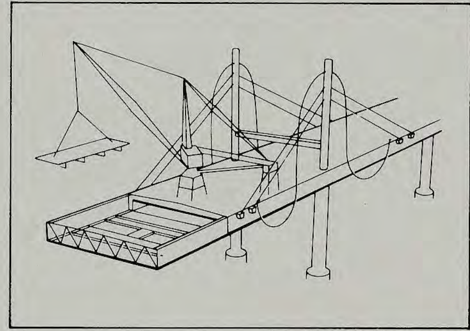
The first two 16m bays are erected in free cantilever. Two pairs of forestays and backstays are then attached and tensioned before the derrick is moved forward to the end bay.

2



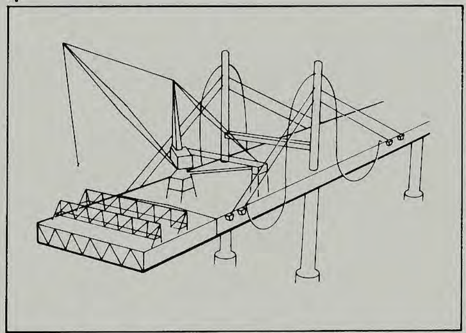
16m long plate girders are erected on each side and fully connected to the preceding girders with HSFG bolts before the crane is released.

3

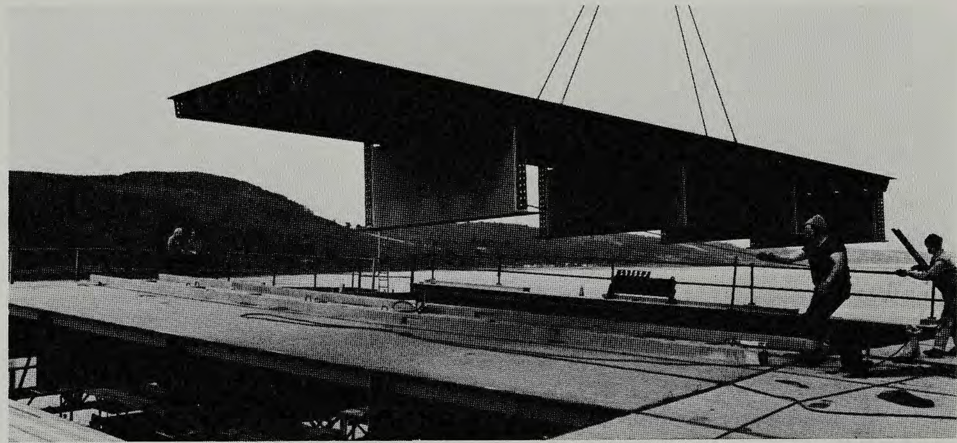


A temporary end cross frame is fixed across the front of the bay. Bolting-up gantries are run out on rails on the bottom flanges of the plate girders. Seven 16m long deck panels are placed.

4

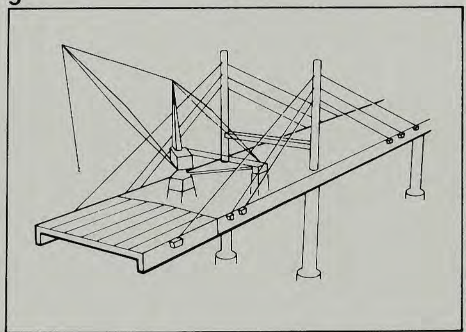


Two truss frames are placed transversely over the deck panels. They lift and support the panels at their correct level for deck plate welding and subsequent bolting of cross girders.



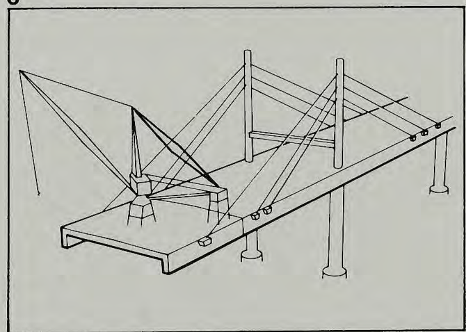
Erection of deck panel

5



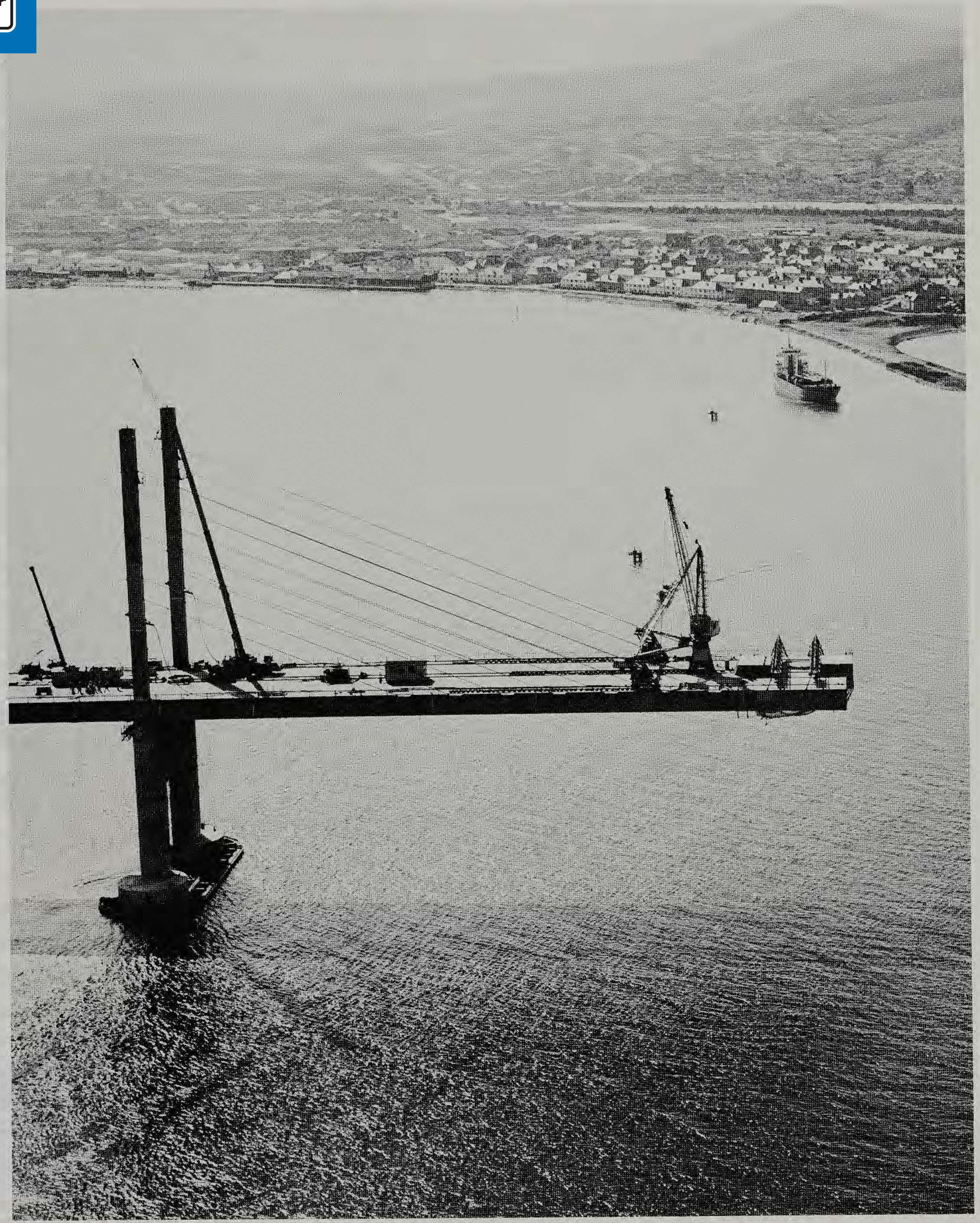
Before releasing the support frames, the longitudinal seams between deck plate and main girders are bolted. The third pairs of cable stays are then attached and tensioned.

6



The derrick is moved forward 16m, it then erects temporary wind bracing and bearings at the next pier before starting the fourth bay.

Reconstruction of A9 Trunk Road — Perth—Inverness—Ardullie



The A9 dates from the first half of the 18th Century when General Wade and his successors built the first true road between Perth and Inverness. Telford improved it in the early 19th Century but little further was done until the mid-1920's when improvements were carried out between Blair Atholl and Inverness; over the next 40 years short lengths were reconstructed but always on the existing line.

First announced by the Secretary of State for Scotland in 1971 the crossing of the Beauly and Cromarty Firths and the new route for the A9 across the Black Isle followed an earlier decision to embark upon the comprehensive redevelopment of the entire length of the A9 between Perth and Inverness. This involved building some 218 km (137 miles) of new road which was planned as one phased operation. The Scottish Development Department set up a multi-disciplinary special project team to speed up the reconstruction. They also appointed six firms of Consulting Engineers and Tayside and Highland Regional Councils as Agent Authorities to handle feasibility studies and subsequently to design and supervise construction.

Work started on site in November 1973 and is now virtually complete. The overall project has been handled as 30 separate schemes as shown on the adjoining table; only three schemes covering some 13 km (8 miles) are still in hand. The new road consists mainly of single 7.3m (24 ft) wide carriageway designed to the highest modern standard of alignment and giving maximum visibility for safe overtaking. Dual carriageway is being built over about a quarter of the route for engineering and topographical reasons and the single carriageway road has been designed so that a second carriageway can be provided if warranted in the future.

Kessock Bridge is the key to the northern section of the project and with its opening the full potential of the Black Isle Route and the Cromarty Bridge will be realised.

Client
Scottish Development Department,
Edinburgh
Design and Construction
Cleveland RDL Kessock Consortium
in association with
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West Germany and Trafalgar House
Engineering Services Ltd, Croydon
Joint Engineers
Crouch & Hogg, and
Ove Arup & Partners.

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