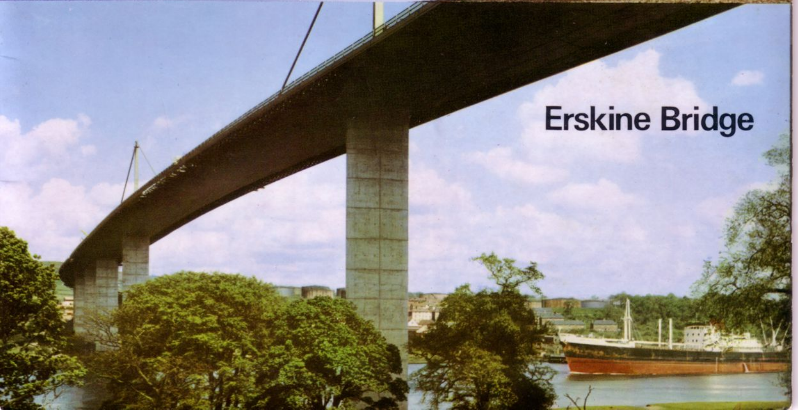
Erskine Bridge

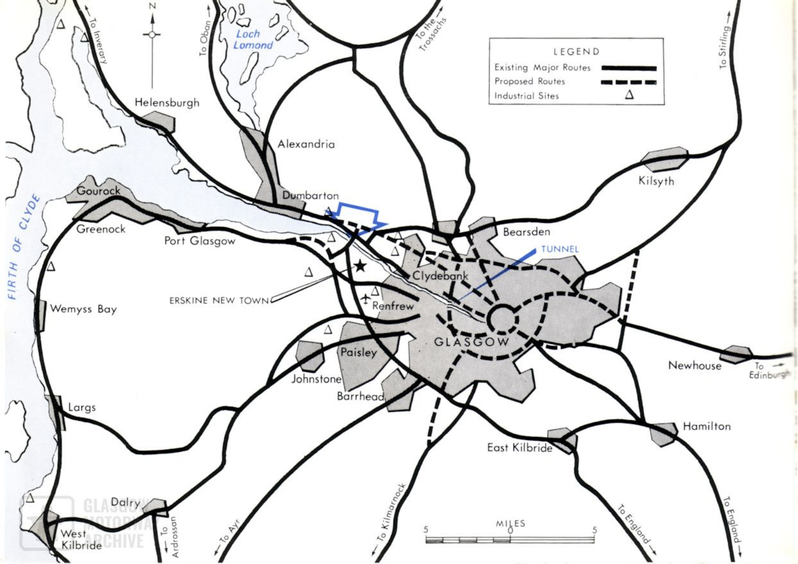


There has been a ferry across the Clyde at Erskine, some 9 miles west of Glasgow, for centuries, but even in the 1930's the growth of traffic made a bridge desirable. By the 1950's the continued increase in road traffic, and re-development of Clydeside, stressed the growing inadequacy of the ferry and in 1963 the County Councils of Renfrewshire and Dunbartonshire formed the Erskine Bridge Joint Committee. Aerial surveys, site borings and traffic studies were put in hand that together established the need, feasibility and viability of a high-level toll bridge at Erskine.

In December 1963 the Joint Committee retained Freeman Fox & Partners of London as their Consulting Engineers who recommended adoption of a continuous steel-box stayed-girder bridge with a 1000 ft main span over the estuary and a series of approach spans and approach roads connecting the trunk roads on each side of the Clyde.

To finance the project, the Joint Committee approached Central Government and the Scottish Development Department assumed responsibility for the work in September 1965. Freeman Fox & Partners continued as the Consulting Engineers for the project and were joined by W A Fairhurst & Partners of Glasgow in the design of the foundations and piers. The work was divided into four principal contracts: the foundations and piers; the bridge steel superstructure; the northern approach roads; and the southern approaches, including the toll area and administration building. Work commenced at site in April 1967. The whole project has cost about £10 million.

Many engineers and tradesmen both on and off the site have contributed to the successful conclusion of the project but an especial acknowledgement is due to the community of Old Kilpatrick and the Erskine Hospital who tolerated considerable but unavoidable inconvenience during construction with the utmost goodwill.



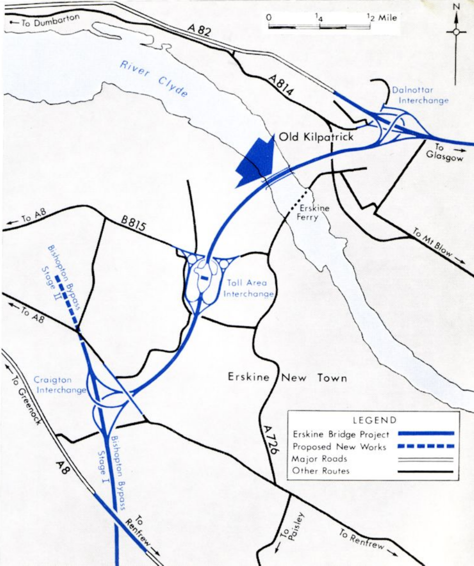
LEGEND
Existing Major Routes
Proposed Routes
Industrial Sites
N
To Inverary
To Oban
Loch Lomond
To the Trossachs
To Stirling
Helensburgh
Alexandria
Dumbarton
Kilsyth
Gourock
Greenock
Port Glasgow
Bearsden
TUNNEL
FIRTH OF CLYDE
Clydebank
ERSKINE NEW TOWN
Renfrew
Wemyss Bay
GLASGOW
Paisley
Johnstone
Barrhead
Newhouse
To Edinburgh
Largs
Hamilton
East Kilbride
Dalry
West Kilbride
To Ardrossan
To Ayr
To Kilmarnock
MILES
5
0
5
To England
To England

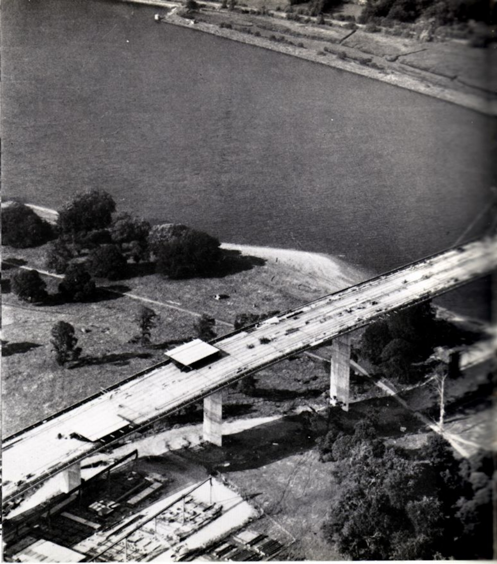
The bridge and its approach roads, built to trunk road standards with two 24 ft carriageways, provide an important north-south connection over the Clyde estuary 9 miles west of Glasgow between the A82 (Glasgow - Fort William - Inverness) and the A8 (Glasgow - Gourock). The A82, in addition to serving the west and north of Scotland, carries heavy commuter and tourist traffic between Glasgow and the Loch Lomond area and connects with the northern ring roads round Glasgow. On the south side, the road system serves Glasgow's international airport at Abbotsinch, the south bank of Clydeside and connects with several trunk roads to the south. The bridge thus forms an essential road link for all future developments on both sides of the Firth of Clyde and will provide a route that will enable both industrial and tourist traffic to avoid the centre of Glasgow.

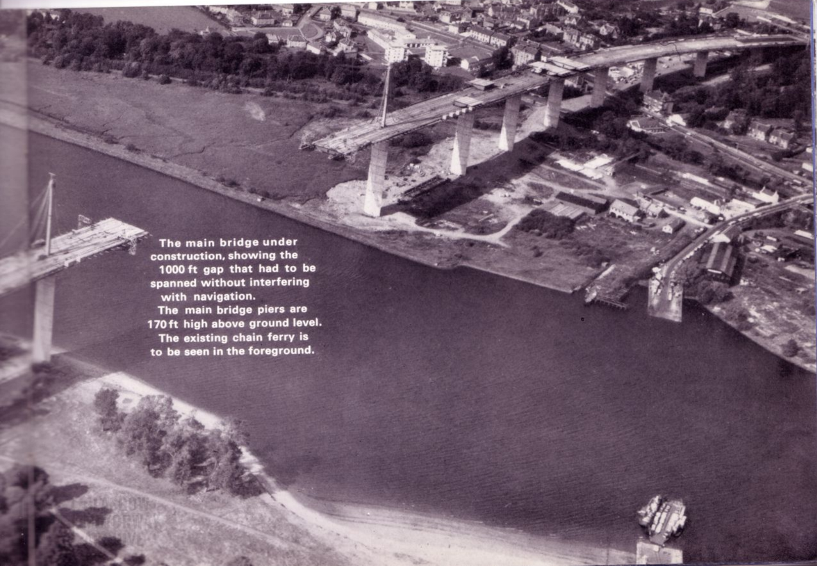
On the north side, traffic from the bridge is led on to the A82 by the Dalnottar Interchange which also provides local connections for the small township of Old Kilpatrick. To obtain free-flowing traffic routes, six new concrete bridges and two service culverts have been built, and the Dalnottar Burn has been put into a culvert that passes under the interchange.

The southern approaches comprise a mile of the new Bishopton Bypass, a three-level motorway interchange at Craigton, and about 1 mile of motorway leading through the toll area to the bridge itself. Local road connections that will have an especial value to Erskine New Town have been built in the toll area, where the bridge administration building is also located. These works include a two-level structure and three other bridges in reinforced concrete.

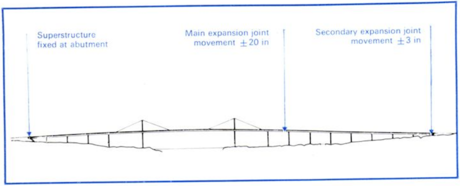
To minimise the intrusion of roadworks on the countryside, excavated material has been used to create a natural landscape, while tree planting and natural growth will be blended with the surroundings to maintain and enhance the environment.

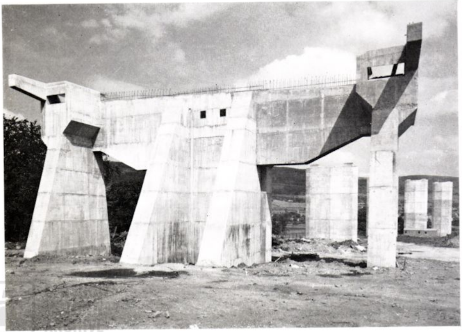






The main bridge under construction, showing the 1000 ft gap that had to be spanned without interfering with navigation.
The main bridge piers are 170 ft high above ground level.
The existing chain ferry is to be seen in the foreground.





The bridge superstructure is carried on fourteen reinforced concrete piers and two abutments. All fourteen piers have the same basic lozenge cross-section, designed to flex with movement of the superstructure with changes in temperature. The four tallest piers, two on each bank, carrying the main span and the principal side spans, are 175 ft high but are only 37 ft 2 in wide and 7 ft 6 in thick.

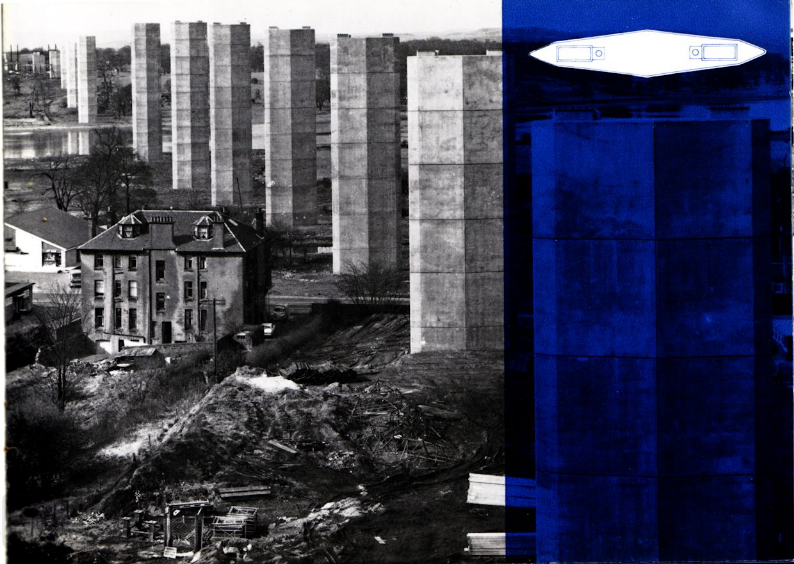
The height and importance of the piers are enhanced by the slenderness which is technically necessary. Architecturally, their form has been emphasised by making each face very slightly concave, so avoiding the tendency for tall piers to appear to bulge. Purpose-made steel shutters were used, allowing concrete pours 17 ft high. The shutters weighed 24 tons and were raised by a cat-head placed on top of the previous pour.

On the south side of the river, the piers and abutment are founded directly on the bedrock. On the north side all the pier and abutment foundations are supported on groups of piles. In places, near the river bank, it was necessary to drive the piles to depths of between 90 ft and 180 ft to reach sound rock and pre-bored holes up to 80 ft deep were drilled through tough boulder clay to facilitate pile driving.

Temperature expansion is allowed to take place at an expansion joint located north of the main spans. The bridge is fixed at the south abutment (illustrated left) which consists of three counterforts connected by a capping beam. A retaining wall design has been used for the northern abutment, where the deck is carried on secondary expansion bearings.

(Above) Location of the expansion joints. Except for the very short pier at the north end, the superstructure is carried at each pier on knuckle bearings.

(Left) The southern abutment during construction.



The roadway is carried on a continuous all-welded box girder of trapezoidal cross-section which is stiffened by diaphragms or bulkheads. The deck plates are stiffened by cold-formed V-shaped troughs; elsewhere stiffening is by bulb flats. All stiffening is continuous through the diaphragms.

The steelwork was fabricated in Fairfield-Mabey's Chepstow works into panels generally 56 ft long and brought by road to the site where they were assembled into complete boxes, adjacent boxes being matched on the ground before erection. Erection proceeded from both ends of the bridge. Exceptional accuracy in calculations and fabrication were required to ensure that the boxes, first along complex curves of the approaches and then sweeping up and over the river, met at mid-span.

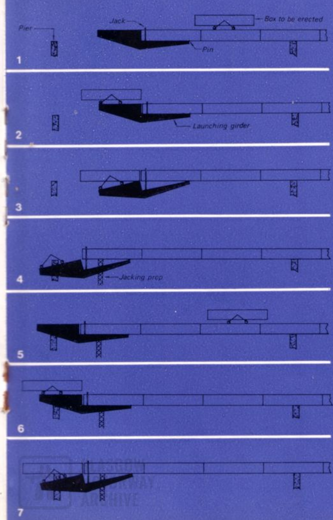
On both banks, the first spans were erected above trestles. Thereafter the boxes, weighing up to 170 tons, were put in place by cantilevering off erected steelwork as shown in the illustrations.

In the approach spans, the cantilevers were allowed to deflect under their own weight but, before the last box in each span was erected, the cantilever was jacked up about 4½ ft using a temporary prop to clear the next pier. In the 360 ft anchor spans, similar but larger props were used. In the 1000 ft main span, the deck had to cantilever 500 ft before closure. As soon as the masts were erected, temporary cables and then the permanent cables were used to support the cantilevers while the main span boxes were positioned using the launching beams as before.

The masts, placed centrally over the main piers, are exceedingly slender to provide clearance at the side of the narrow central reservation. They have been filled with high quality concrete to take advantage of the great strength of concrete within a steel casing and to eliminate internal painting.

With the box girder complete, the mastic asphalt surfacing was laid directly on the deck plate.

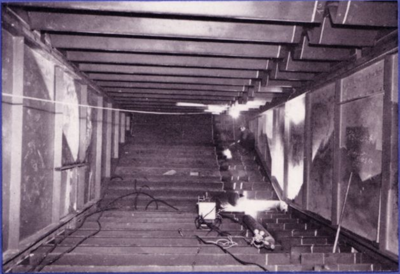
ERECTION SCHEME FOR GIRDERS



The bridge spans have been built up with 'boxes', by cantilevering off erected steelwork using a purpose-made launching girder. Each new box, on a trolley, was run out along the erected steelwork (1), placed on the launching girder (2), lowered to level (3) and, supported by the girder, welded into position. The launching girder was then moved forward and the process repeated.

When the last box in each span was to be erected (4, 5) a jacking prop was used to raise the span to allow the box to be erected above the pier (6, 7).

(Below) Making the welded joint between two boxes. The diaphragms and plate stiffening are clearly shown.



The northern approaches comprise the Dalnottar Interchange, which provides free-flow connections to and from the A82, and local connections with Old Kilpatrick. Construction involved six reinforced concrete bridges and two large culverts, as well as extensive earthworks.

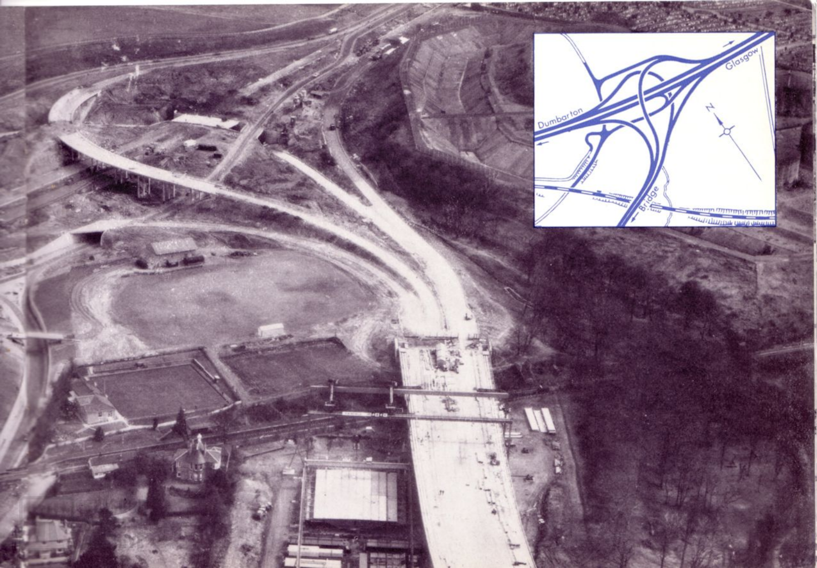
Disruption of the heavy traffic using the A82 during construction of the interchange was minimised by completing the slip roads to the north and south of the existing road and diverting the traffic off the old road while its alignment was brought up to modern standards and the bridges built. Major service diversions, including a trans-atlantic telephone cable and an 18 in gas main, were also necessary.

The sub-soil is a geological hotch-potch of soft silt, sands, gravel and boulder clay. In places, the water table was very high while nearby the boulder clay was so hard sheet piling buckled. Needless to say, each occurred in the most perverse locations.

An early task was to put the Dalnottar Burn, which runs through the area, into a 6 ft diameter culvert 1500 ft long, improving drainage and making earthmoving easier. The culvert was driven in heading under the A82 without interrupting traffic. The same culvert also carries a 42 in water main from Loch Lomond and a gas main has been laid through a steel sleeve.

The existing road from Old Kilpatrick to the A82, in a 30 ft cutting with dwellings at the top of the cut, had to be lowered 10 ft to pass under the A82. Local traffic and services were diverted and the road temporarily closed during construction of deep retaining walls that now support the sides of the cutting.

The north abutment of the bridge is in Lusset Glen, a local beauty spot, and great care has been taken to landscape the area.


Dumbarton
Glasgow
Bridge
N

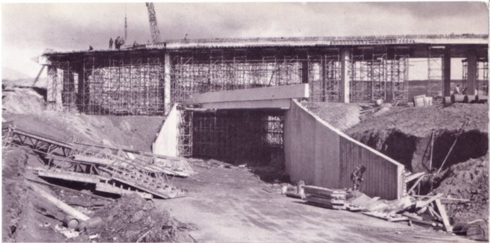
Craigton Interchange, shown below, is a three-level structure providing free-flow traffic connections between the M8 and the new Erskine Bridge road. On the opposite page, the interchange is shown under construction and the artist's impression shows its location in the road system

Work on the southern approaches included extending the Renfrew Bypass (M8) westwards for about a mile in the first stage of the Bishopton Bypass; constructing the three-level Craigton Interchange between the M8 and the Erskine Bridge Road which leads, via the toll area, to the bridge itself; and building the toll area (see next page) with a secondary interchange to the B815 (primarily to serve Erskine New Town) as well as the administration and maintenance areas. About 77,000 cu yd of excavated boulder clay from the toll area was used to form the high embankment approach to the south abutment.

In the southern approaches there are five reinforced concrete bridges. At the Craigton Interchange two of them share foundations to form a three-level structure: the lower single-span bridge carries the bypass over the north-bound slip road while the upper four-span bridge carries a south-bound slip road over both. In all the bridges, voided slabs were used to reduce the weight of the decking. There is also a box culvert 310 ft long under the high embankment behind the bridge abutment, provided to carry the 30 in water main from Loch Lomond.

Pavements are generally of composite construction, the upper courses of asphalt and bitumen macadams and the lower base of lean concrete. In places in the west of the area where the sub-soil was particularly poor, a 3 ft thick raft of quarry scalpings was used to carry the pavement and the lean mix concrete was replaced by layers of bitumen macadam to give a fully flexible construction.

Throughout the area landscaping and tree planting have aimed at preserving the natural environment.



The extensive services needed for the operation of the bridge and the collection of tolls are directed and mostly operated from a control room in the administration buildings adjacent to the toll area on the southern approach.

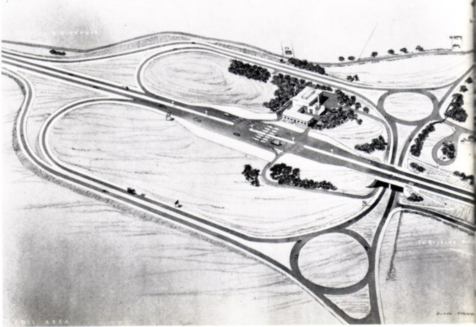
The buildings contain staff facilities, maintenance shops, strong room, a substation, a standby generator and garages for the fire tender and patrol vehicles, road sweeper, snow plough and tower wagon. The building exterior is in Fyfestone which is an exposed aggregate concrete building block.

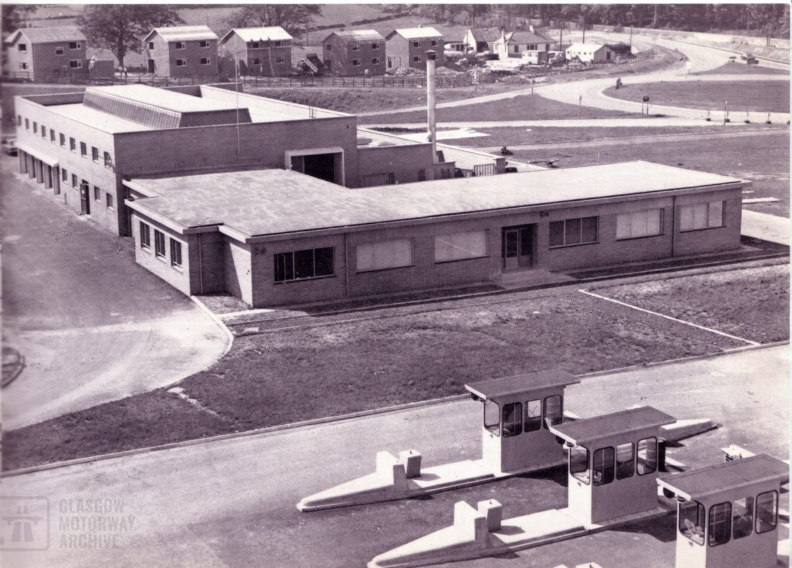
There are four traffic lanes in each direction through the toll booths, with provision for two additions each way when traffic requires. The toll collectors operate classification buttons which register in the control room and in a data processor (computer) which prints out detailed records of traffic and receipts.

Cabling to the booths and to the under-road heating in the toll area is carried in a services subway which extends under the administration building to the substation.

There are high-mast lighting installations in the toll area and at Dalnottar; the bridge and roadway between have double-arm columns in the median. High-pressure sodium 400W lamps have been used throughout.

There are seven remotely operated warning signs to indicate stop/slow/accident/high wind/skid risk. For communications there are public emergency telephones and the various service vehicles have two-way radio. There is closed-circuit television for road traffic surveillance and radar for river traffic surveillance; the latter is operated and used by the Clyde Port Authority through a short-wave radio link to their headquarters.





Facts and Figures

Erskine Bridge is a cable-stayed girder bridge with a main span of 1000 ft and principal side spans of 360 ft. In all, there are 15 spans and the total length of the bridge is 4334 ft. Clearance over high water is 180 ft. It has been designed to withstand winds of 130 mph.

There are two abutments and 14 piers, the highest of which are 175 ft high. In all, 28,500 cu yd of concrete and 1550 tons of mild steel bar reinforcement were used in their construction.

On the north bank, the piers are founded on clusters of piles, some up to 180 ft long; the total length of piles used was 43,000 ft.

The deck carries two 24 ft carriageways with a central median and a cycle track and footpath on each side.

The bridge deck is 97 ft 6 in wide in the approach spans and 102 ft 6 in wide in the main span. In the curved approach spans, the deck is superelevated for traffic speeds of 70 mph.

The deck is supported by a single central cable over each 125 ft mast and anchored in the median. Each cable is just over 700 ft long and comprises 24 strands of 3 in diameter. The 24 strands are clamped together to form a rectangular cable six strands wide by four strands deep. Prior to erection each strand was pre-stretched and marked to the required length under a dead load pull of 170 tons.

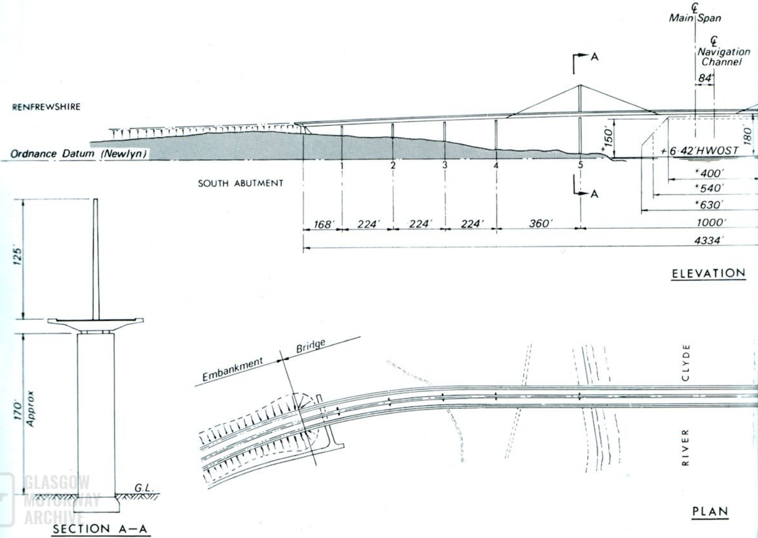
There are approximately 11,500 tons of high strength steel plate in the superstructure which is welded throughout. Site assembly operations involved over 25 miles of welds.

The bridge also carries four 24 in high-pressure water mains and two 15 in high-pressure gas mains, and other services for statutory undertakers.

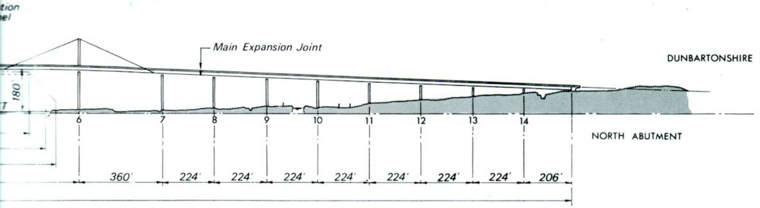
Roadway lighting is provided by 400 W high-pressure sodium-vapour lamps. In the toll area there are five 100 ft high masts each with six lamps and at Dalnottar there are 16 similar masts. Along the approach road from the toll area and across the bridge, 35 ft high double-armed masts each carry two lamps.

For traffic surveillance, there is a closed-circuit television camera on the southern bridge tower and another on a 40 ft mast at Dalnottar.

In the toll area, 8000 sq yd of roadway are heated by mineral-insulated cables. Supply voltage is 415 V (three phase) and the electrical load 1000 kW.

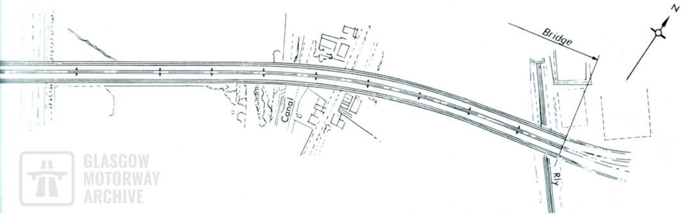


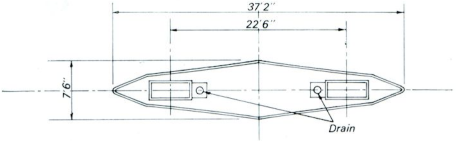
Main Span
Navigation Channel
84'
RENFREWSHIRE
Ordnance Datum (Newlyn)
150'
180'
+6·42' HWOST
1
2
3
4
5
SOUTH ABUTMENT
A
400'
540'
630'
168'
224'
224'
224'
360'
1000'
4334'
ELEVATION
125'
170' Approx
G.L.
SECTION A—A
Embankment
Bridge
CLYDE
RIVER
PLAN



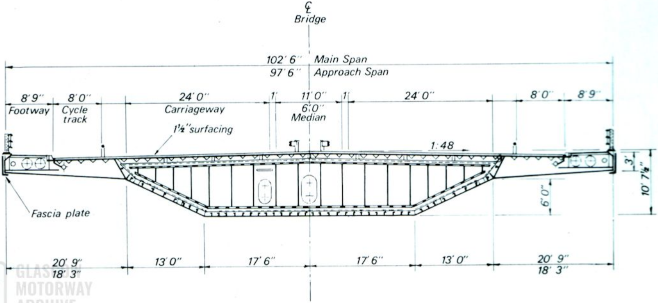
ON

* Denotes clearance during erection

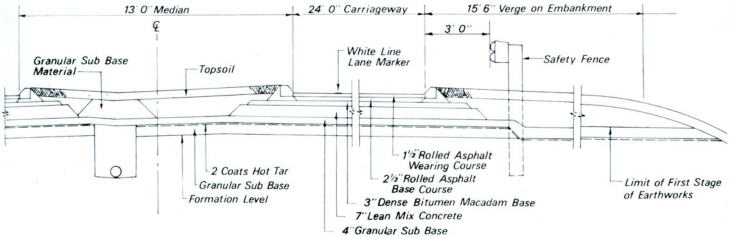




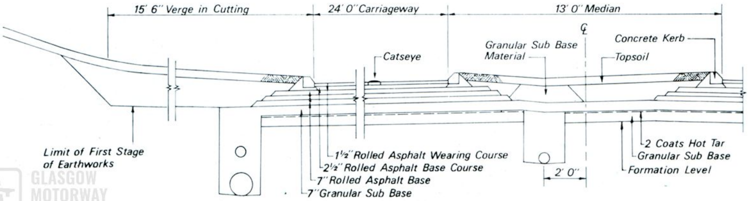
PLAN OF PIERS 4-7



TYPICAL CROSS SECTION



HALF SECTION OF ROAD ON EMBANKMENT – COMPOSITE CONSTRUCTION



HALF SECTION OF ROAD IN CUTTING – FLEXIBLE CONSTRUCTION

Many individuals and organisations have contributed to the completion of Erskine Bridge and approach roads. It is not possible to mention them all but amongst the foremost mention must be made of the following.

Authorities

Scottish Development Department
Erskine Bridge Joint Committee:
County Council of Renfrewshire
County Council of Dunbartonshire
Clyde Port Authority

Consulting Engineers

Erskine Bridge and approaches	Freeman Fox & Partners
Associated for main bridge foundations and piers	W A Fairhurst & Partners

Testing Engineers

Concrete and asphalt	Sandberg
Steel fabrication, shop painting	Rank Precision Industries Ltd
and radiography	Solus-Schall

Contractors

Bridge Foundations and Piers

Main contractor	Christiani-Shand Ltd
Pre-boring for piles	Cementation Ltd
Piling for main bridge foundations	A Johnson Construction Co Ltd

Bridge Steelwork Fabrication and Erection

Main contractor	Fairfield-Mabey Ltd
Steel	British Steel Corporation (General Steels Division)
Deck expansion units	Demag AG
Bridge cables	British Ropes Ltd
Paint (supplies)	Griffiths Bros & Co (London) Ltd
Painting (site)	Thomas Cotton Ltd
Pipework	British Steel Corporation (Tubes Division)
Bridge balustrades	Beachley Machinery Co Ltd
Asphalt surfacing	Limmer & Trinidad Lake Asphalt Co Ltd

Northern Approaches

Main contractor	Peter Lind & Co Ltd
Earthworks	Larry Webb (Plant) Ltd
Road surfacing	Val de Travers Asphalte Ltd

Southern Approaches, Toll Area and Administration Building

Main contractor	Whatlings Ltd
Earthmoving	Dick Hampton (Earthmoving) Ltd
Road surfacing	King & Co (Contracting) Ltd
Structural steelwork (Administration building)	British Steel Corporation (Constructional Eng'g Division)
HV switchgear	Yorkshire Switchgear Ltd
Transformers	C A Parsons Ltd and
Toll equipment	Automatic Control Engineering Ltd
Electrical plant, cabling and road heating installation	James Kilpatrick & Sons Ltd
Road heating cables	British Insulated Callenders Cables Ltd
Staff houses	Lawrence Construction Co Ltd
High-mast and roadway lighting throughout project	General Electric Co Ltd
Road signs	Percy Bilton Ltd