Birkenhead Mersey Tunnel Approaches Scheme

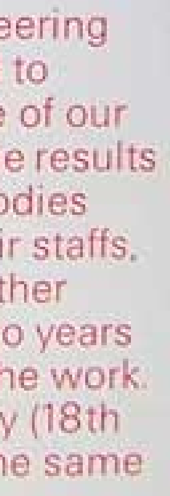
July 1969

Message from Alderman Hugh Platt, O.B.E., J.P.

It gives me the greatest pleasure to mark the opening of this great engineering project by recording this message in the special brochure commissioned to commemorate the occasion. We are now nearing the culmination of one of our efforts to resolve Birkenhead's serious traffic problems, and it highlights the results which can be achieved by hard work and co-operation between public bodies such as the Corporation and the Mersey Tunnel Joint Committee and their staffs, the Consulting Engineers and the Contractors. They have all worked together with a single objective—to get the job done on time. It is only just over two years ago that the then Minister of Transport performed the ceremony to start the work. There is also an historic connection in that 35 years ago almost to the day (18th July, 1934), King George V declared the Mersey Tunnel open to traffic—the same Tunnel as we are using today.

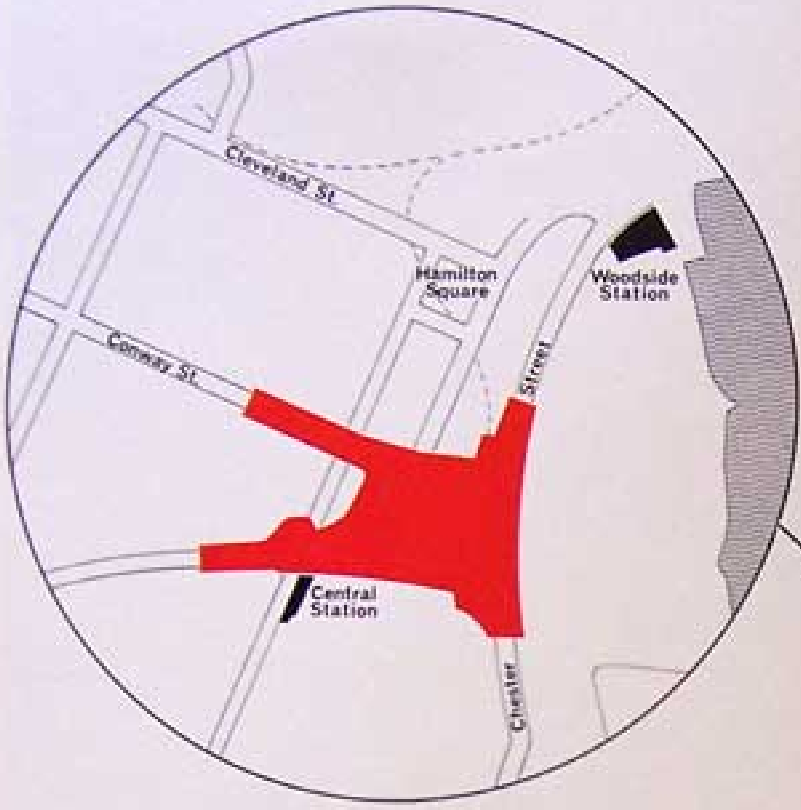
I am confident that this new complex of roads, viaducts and marshalling areas will improve the flow of traffic through the Tunnel and, of no less importance to Birkenhead, will help to relieve congestion in the centre of the town for many years to come.

Hugh Platt



Hugh Platt.

Introduction



Birkenhead Tunnel Approaches location

The main contract for the construction of the Birkenhead Mersey Tunnel Approaches Scheme commenced on the 16th March, 1967. Only 28 months later, on the 15th July, 1969, the new system was opened to traffic.
Subsequent contracts for the novel automatic traffic control system associated with the scheme were let after the main construction contract. These are due for completion by the Spring of 1970.
The following is a summary of some of the distinguishing features of the Approaches Scheme which are discussed in more detail in later sections of this brochure:

1 All the preparatory work, prior to the commencement of the construction of the Scheme, was completed in only 15 months. This included the preparation of designs, drawings, contract documents and all other documentation occasioned by negotiations with the statutory and other authorities involved and with local property owners and tenants.

2 Since the inception of the Scheme emphasis has been laid on achieving a high aesthetic standard. Study of the finished structures will demonstrate the engineers' success in attaining this end.

3 Completion of the construction programme on time must be attributed, in the main, to the excellent standard of relationships established both between the various companies and official bodies involved and between management and labour. There have been no major strikes on this project.

4 As an example of modern civil engineering, the Scheme incorporates two notable features: the design and construction of the viaduct sections with their hidden 'crossheads'; and the use, in the underpass, of bentonite diaphragm walling for the permanent structure.

5 Finally, the automatic electronic traffic control system, to regulate vehicle movement in the marshalling areas, represents a completely new concept and will be the first system of its kind in Europe when it comes into operation early in 1970.

The Problem

The Birkenhead to Liverpool Road Tunnel, under the River Mersey, was officially opened in 1935. It was named 'Queensway'.

At this time, the total number of vehicles on the roads of Great Britain numbered 2·6 million. By the mid-1960's the figure had grown to 13·3 million. The amount of traffic wishing to use the Queensway Tunnel had, of course, increased in similar proportions – although no exact records were kept for the early years of its use.

During peak flow periods in the 1960s, traffic wishing to use the Tunnel (in both directions) suffered not only from the restrictions of the capacity of the Tunnel itself but also from the state of the local roads in the surrounding 'feeder' areas.

On the Birkenhead side, the main commercial and shopping centre is less than a quarter of a mile from the entrance to the Tunnel.

Queues of vehicles, trying to enter the Tunnel, tailed back along the local routes – thus disrupting non-Tunnel traffic. In addition, although the break-down routine inside the Tunnel was highly disciplined, further delays were inevitably caused – once again affecting not only the commuter motorist using the Tunnel, but other traffic as well. It was therefore easy to conclude that until a solution could be found and implemented, Town traffic would continue to be brought to a standstill at peak periods.

The Solution

In 1964, Mr H. C. Oxburgh, Borough Engineer & Surveyor to the Birkenhead Corporation, drew up the concept of the Approaches Scheme.

The object was to provide for the free-flow of traffic in the centre of Birkenhead by segregating 'Tunnel only' vehicles from local Town and docks traffic and, in turn, to improve the efficiency of the Tunnel entry and exit arrangements.

The means of achieving this objective can be seen in the aerial photo-montage (below). A system of viaducts and underpasses would relieve local roads; whilst two marshalling areas, in front of the Tunnel entrance would accommodate waiting traffic.

The first step in the implementation of the Scheme was for the Corporation to obtain the necessary statutory powers and to this end, a Bill was deposited in Parliament at the beginning of 1965. It received the Royal Assent on the 5th August of the same year to become the Birkenhead Corporation (Mersey Tunnel Approaches) Act 1965.

At this stage, extensive work was carried out by the Town Clerk (then, Donald P. Heath, LL.B.), the Borough Engineer and Surveyor (H. C. Oxburgh), the Borough Treasurer (H. G. Lee), the Borough Valuer (J. H. Leach), and their staffs. These officers dealt with all the required legal and Parliamentary formalities. In addition, they examined the financial, engineering and traffic aspects of the Scheme and put the wheels in motion for the acquisition of land and properties. As well as the powers granted by the Act of Parliament, the Corporation implemented the Chester Street Clearance Area Compulsory Purchase Order of 1961.

In all, 179 Corporation houses, flats and private homes; 90 shops; 23 factories, workshops, yards, etc; 14 public houses and various other public buildings and sites were acquired. A large number of factories and workshops were successfully relocated – many on land or in buildings made available by the Corporation and 224 families were rehoused before work began on the new roadways at the Tunnel entrance. The cost of this part of the operation was in excess of £1 million.

Mr H. C. Oxburgh

Congested traffic in Conway Street, April 1967.

Aerial photo-montage giving an indication of the proposed Scheme within the existing environment at Birkenhead. The two marshalling areas, to hold queueing traffic waiting to enter the Queensway Tunnel, can be clearly seen in the centre of the picture.

Implementation

In September 1965, Brian Colquhoun and Partners were appointed consulting engineers for the Scheme.
Their role, working to the Corporation's instructions, was to carry out all necessary preliminary investigations and proceed immediately to the preparation of detailed designs and contract documents for the construction of the Scheme. This involved arranging sub-soil investigations on site, detailed traffic counts, and the examination and correlation of numerous records and statistics held by the statutory and other official bodies connected with Birkenhead. Designs, drawings and other contract documents were then prepared, and the consulting engineers put the main construction contract out to tender on behalf of the Birkenhead Corporation in December 1966. Two preliminary site clearance contracts were already under way by that time, and the consultants had established a temporary site office from which to supervise them. Between December 1966 and March 1967 the tenders for the main construction contract were submitted by the various contractors. These tenders were analysed by the consulting engineers, who then embodied their recommendation in a report to the Corporation. The contract was placed with Marples Ridgway Limited.

Complications

The site was complicated not only by being severely restricted on the surface by the particularly congested nature of the urban area but also due to the difficulties encountered below the ground. It embraces the main arterial roads to and from the Mersey Tunnel, four separate railway routes (partly in tunnel), the London/Liverpool/Glasgow G.P.O. trunk line, the C.E.G.B. 132kV cross-river electricity feeder, tidal sewers, and the primary mains from an adjacent gas works, in addition to all the normal urban network of pipes and cables.
In developing Mr Osburgh's initial road network plan the consulting engineers had to prepare detailed solutions to the many siting problems outlined. It was also essential, throughout the contract, to minimise disruption to road traffic in order not to try the patience of the motorist beyond endurance. Forward planning and careful co-ordination of the necessary re-routing and diversion works was found to be a key in maintaining the tight construction programme.

Supervision

In order to conduct the daily business of the construction programme the consulting engineers and main contractors set up site offices in Thomas Street at the centre of the working area.
The team from Brian Colquhoun and Partners numbered twelve staff, headed by the Resident Engineer. These were the people responsible for the overall supervision and co-ordination of the work on site.
Much of the specialised testing and inspection required was carried out by separate organisations appointed by the consulting engineers, but there was also a site laboratory for some of the routine testing work.
The main construction planning and progress control was carried out as a joint exercise between the consulting engineers and the main contractor with the aid of P.E.R.T. analysis.
Marples Ridgway's site supervisory and clerical staff totalled some forty people at the peak period. The craftsman complement reached 50, with general labour at 190. These totals do not include the large number of sub-contractors' workmen brought to site at various stages during construction.
In addition to the usual administrative and supervisory work undertaken in a contractor's site office, Marples Ridgway's site staff had to design many items of intricate temporary works and evolve special construction procedures to overcome the numerous awkward restrictions imposed by the congestion of the site and by the rigorous need to minimise interference with road and rail communications and service mains.

Constructional Features

The following pages of the brochure give a more detailed description of the design and construction methods used for the Approaches Scheme. They are featured in the following order:

1. **Viaduct Structures**
2. **Underpass**
3. **Railway Tunnels**
4. **General Works**
5. **Traffic Control**

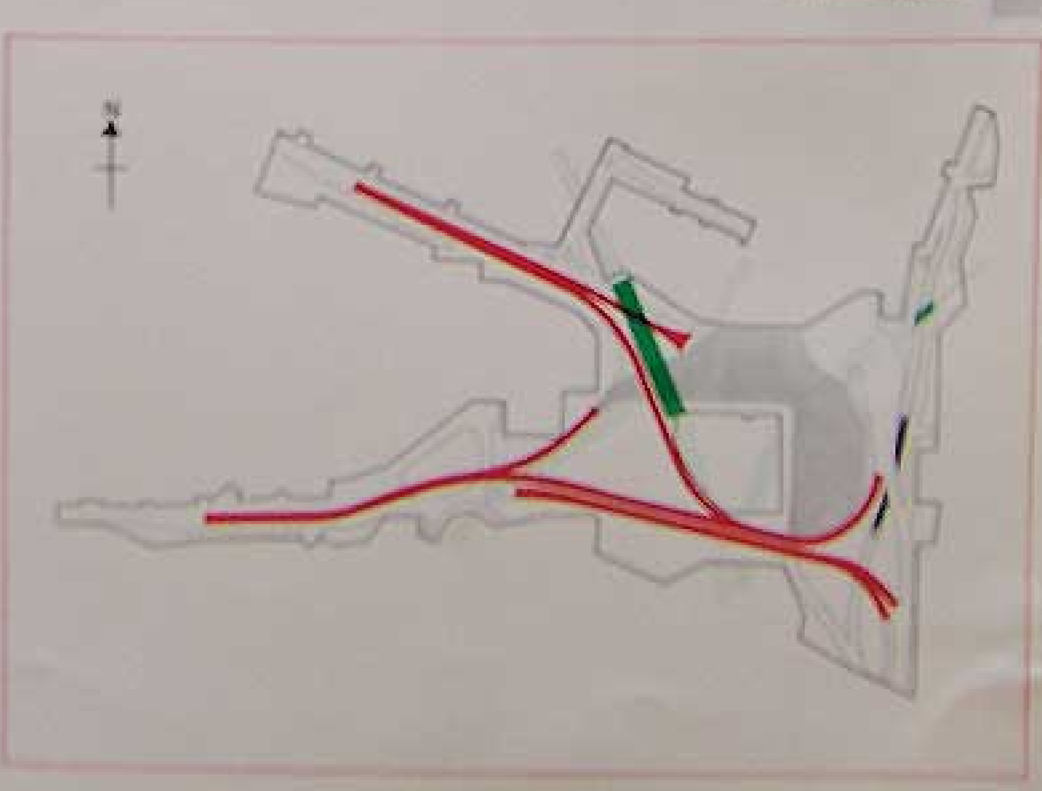
Schematic representation of the Mersey Tunnel Approaches. Coloured areas (keyed) represent the principle design and construction features described in this brochure.

Viaduct Structures

Underpass

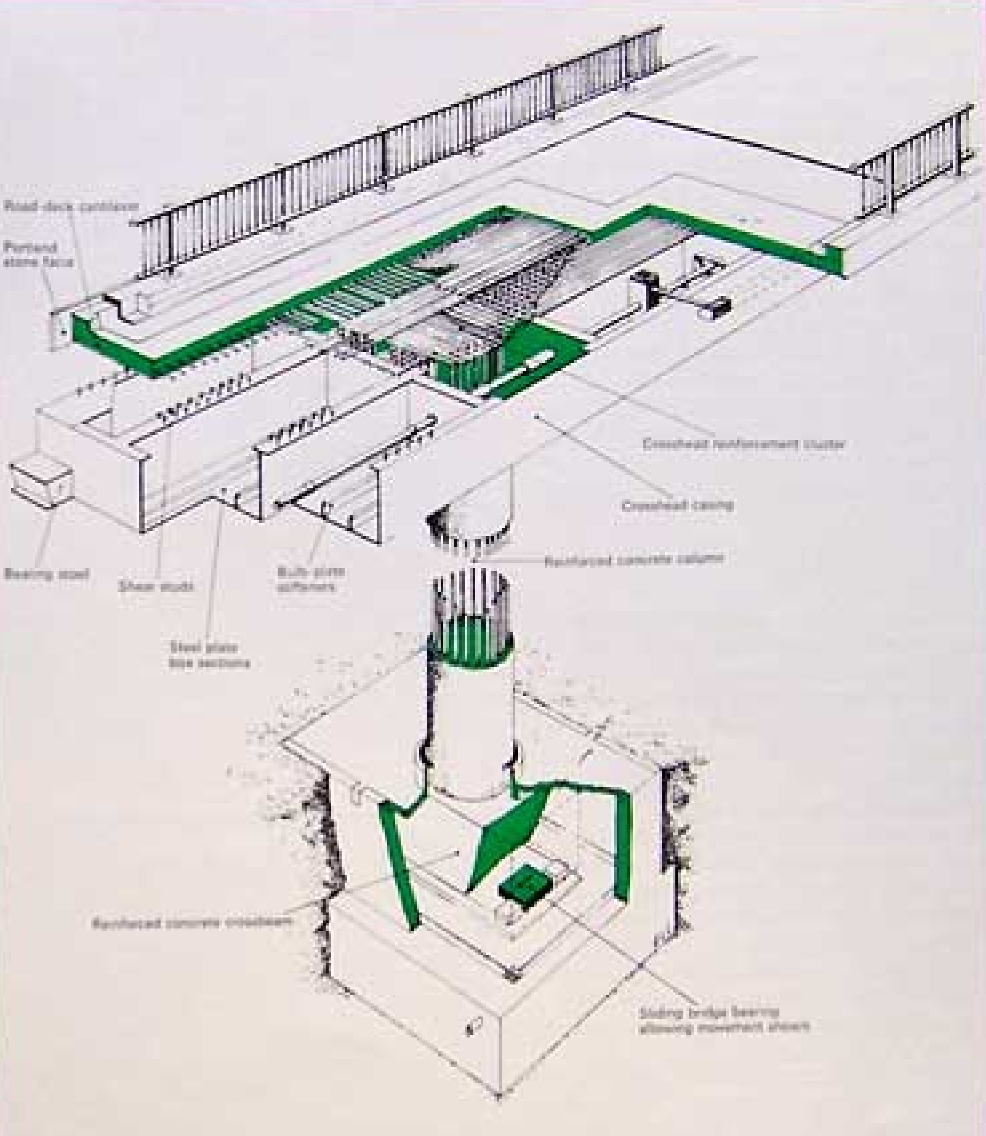
Railway Tunnels

Marshalling Areas



1/Viaduct Structures

Perspective cut-away of the viaduct 'crosshead' and column arrangement. The coloured sections emphasise the interesting features of this design.



Design

The elevated viaduct structures are based on the use of composite steel-concrete box girder sections, spanning between single columns. This arrangement was chosen for several reasons. The clean lines of the structure offer aesthetic advantages, both in their contribution to the general appearance of the viaducts and, in particular, in avoiding a forest of columns. The single column configuration also gave maximum scope for the development of a satisfactory ground level road network and minimised the extent of the foundations and hence the problem of locating these foundations so as to avoid the many railway tunnels and tracks and other vital services.

In order to keep the viaduct decks as low as possible, and thus keep the ramps as short as possible, while at the same time maintaining full M.O.T. clearance of all ground level roads, it was desirable to avoid having transverse beams supporting the viaduct girder at every column head.

A design was therefore evolved incorporating a hidden concrete 'cross-head' beam within the depth of the viaduct girder itself – as can be seen in the diagram on the right. The result of this arrangement made it impractical to provide the usual sliding bearings between the column head and the girder. It was therefore necessary to provide bearings at the foot of every alternate column in order to permit movement in the plane of the structure.

To limit the effects of temperature and stress movement, the viaduct structures were designed so that pairs of columns, monolithic with the girder they support, form portal frames with short cantilevers at either end. Between each portal group is a shorter span, supported via 'neoprene' pad bearings on the tips of the adjacent cantilevers.

Model Tests

Tests were carried out to confirm the soundness of the design of the 'crosshead'. These took place at the Imperial College of Science and Technology in London on a quarter full-size model.

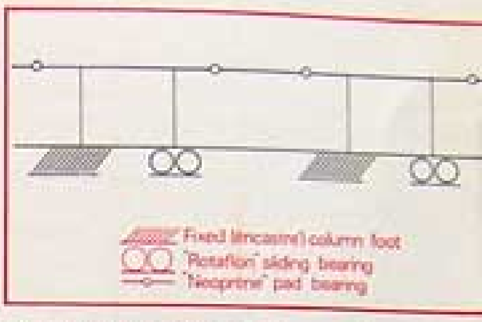
The prime intention was to determine the manner in which loads were transmitted from the steel elements of the structure through the 'crosshead' section into the reinforced concrete column.

A photograph of part of the viaducts, during construction, which illustrates the relationship of the decks and columns.

1/Viaduct Structures
Continued

The distribution of stresses was read 'electronically' on 120 strain gauges, under various imposed loading conditions. At the same time, investigations were made into the stiffness of the intermediate diaphragms and the effects of introducing access manholes in the bottom flanges of the spans.

Three series of tests were run. The first was kept within the working load range; the second was designed to study the effects of repeated and sustained applications of full working loads; and the final series was carried out to study the behaviour of the structure right up to failure. The conclusions drawn from the tests were all highly satisfactory and proved the adequacy of the 'crosshead' design.



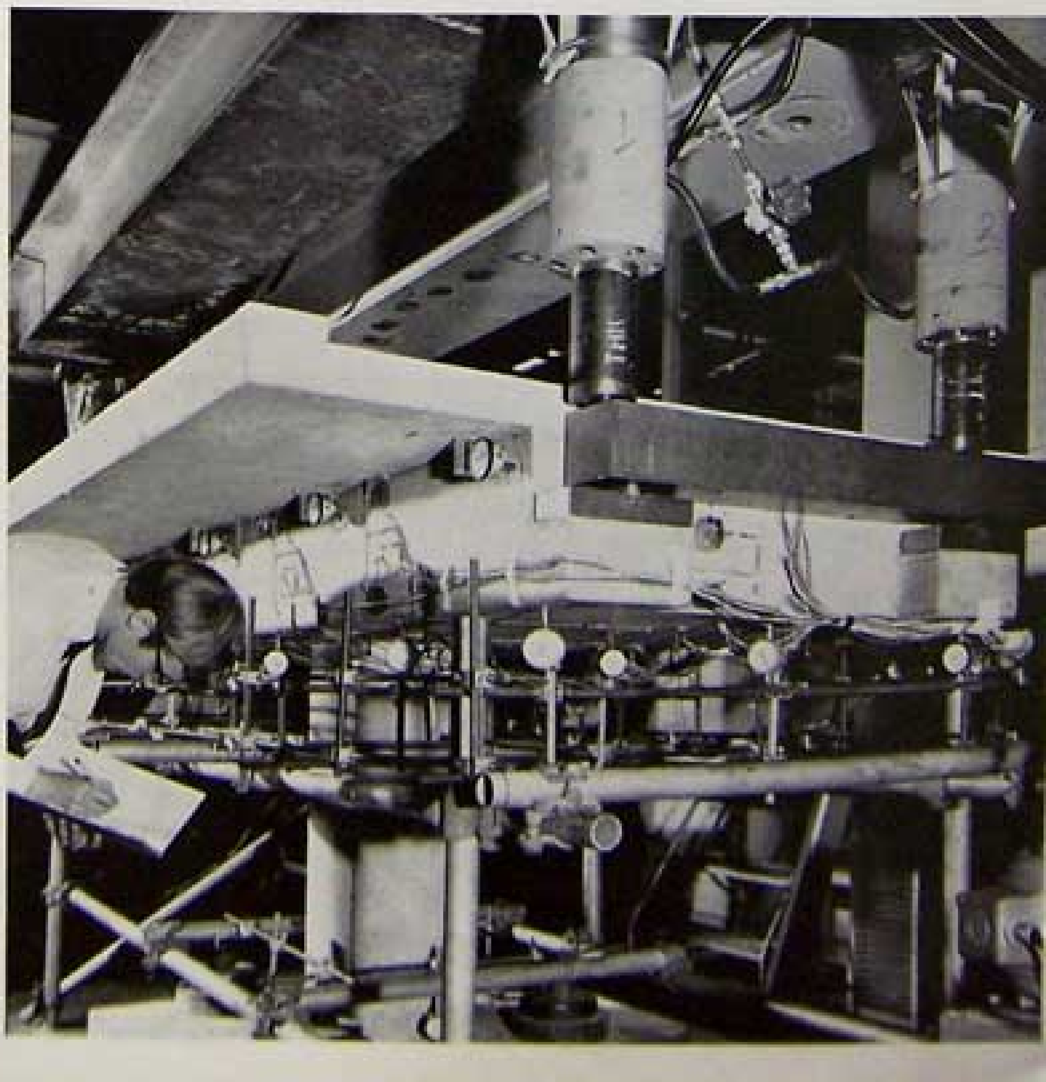
This diagram indicates the unusual structural format of the viaducts with bearings at the fe[et] of alternate columns.

Construction

In principle, the viaduct girders consist of two- or three-cell box girders of 12ft or 18ft total width respectively. The box girder acts compositely with the concrete deck slab (or, with the reinforcement in the deck slab in areas of hogging moment), but at the 'crosshead' the central webs are terminated at transverse diaphragms 5ft on either side of the column centre line. Since this 'crosshead' has to transmit longitudinal moments from the span to the column, elements of the longitudinal deck reinforcement are bent down to lap with extended column reinforcing bars, the whole of the 'crosshead' section being filled with concrete.

A similar reinforcement arrangement caters for the transverse and torsional moments which arise from the horizontal curvature and eccentric loading. The shear loading, normally carried by the steel box girder web, is transferred from the span sections into the concrete 'crosshead' block by shear studs on the diaphragms.

Due to the length of the spans (from 67ft to 110ft) and the width of the steel box girders (12ft and 18ft) used in the construction of the viaducts, and in order to facilitate site erection, the portal sections were, in general, fabricated in sub-assemblies. The maximum number of these was six per span. The entire structure was erected on trestles, prior to making the site connections.



Testing the 'crosshead' scale model at the Imperial College.

A view of one of the viaducts under construction showing the arrangement of trestles used to erect the steelwork.

The trestles were usually located at the 1/3 points for the portal spans and at the ends and centres of the 'drop-in' spans. For these supports the contractor used standard military trestling surmounted by purpose made grillages. The shuttering to the soffit of the cantilever deck slab was also supported from this trestling.
The longitudinal joints in the span sections were site welded, whilst the transverse joints were site bolted using high strength friction grip bolts. All welds were subjected to stringent gamma ray testing.

Finishes

Above deck level, the finishing works to the viaduct include the expansion joints; the galvanised and painted crash barrier/balustrades; the Portland stone riband on the parapet running edges; the kerbs and their backing of granolithic concrete; a mastic asphalt deck waterproofing layer; two layers of hot rolled asphalt; and the viaduct drainage system, the core of which is a 6 in cast iron main running throughout the length of every viaduct and connecting with the ground level drainage system at the bottom of the ramps. Road signs and markings constitute the final deck finishes.
The viaduct columns have been given a high-class finish by being clad with specially imported Venetian glass mosaic, applied with a plastic adhesive.
One aspect of particular interest on this Scheme has been the extensive use of various types of epoxy and polyester resin adhesives. These newly-developed fixatives were used, for example, for bedding and fixing of the expansion joint units and in the fixing of the Portland stone riband on the parapets.

2/Underpass

An adverse combination of awkward terrain levels and the presence of an existing railway bridge over Chester Street precluded the use of a viaduct grade separation of Chester-bound Tunnel traffic from the opposing Northbound stream moving to Woodside and the docks. Ruling gradients restricted Chester-bound Tunnel traffic to ground level. It was therefore necessary to provide a two-lane 20ft carriageway underpass to carry the Northbound Chester Street traffic below the outgoing stream.

Design

Two factors dictated the design and construction methods adopted. Firstly, throughout the construction period a minimum of one lane in each direction had to be kept open in Chester Street immediately to the East and work on the viaduct ramps and marshalling areas had to be able to proceed immediately to the West. These considerations meant that the working area outside the nett plan area of the underpass and its approach cuttings was severely limited. The second factor was time. In order to achieve the rapid completion demanded by the project, Chester-bound Tunnel traffic had to be diverted across the roof of the underpass as quickly as possible. It was decided that the adoption of the bentonite diaphragm walling process would satisfy these requirements. It would enable construction of the permanent reinforced concrete walls of the underpass to be carried out entirely from ground level without the need for an open excavation, sheet piling, or continuous working space outside the nett plan area. In addition, this process would mean that the reinforced concrete roof of the underpass could be built, and Tunnel traffic diverted over it, before the start of bulk excavation or the construction of the underpass floor.

Excavation in progress on the Chester Street underpass

Method

The method of utilising the bentonite process is represented in the diagrams on the next page. Construction of the diaphragm walls was carried out in two phases, the first lasting from July to September 1967, and the second, from February to May 1968.

During the first period the walls to the Southern approach cutting were built, together with that part of the covered section of the underpass needed to enable sufficient of the underpass roof slab to be completed to carry the traffic diversion.

The roof slab was cast using the graded ground surface and a thin concrete 'blinding' as the soffit form. The roof was waterproofed with mastic asphalt, and the stone and bituminous courses of the new roadway were constructed over it. Tunnel traffic was diverted onto the new roadway (i.e. the underpass roof) in March 1968.

The excavation work within the underpass was then a tunnelling process involving front-end loader and dump trucks. The next stage was to lay the drains below the underpass floor level, compact the ground surface, and construct the underpass floorslab.

Normal finishing operations then proceeded. The kerbs were laid, the brick dado wall was constructed, a water main and associated hydrants were installed, the asbestos lining and cornice lighting were fixed, paving flags were laid, and the road was finally surfaced with asphalt.

The diaphragm walls cannot be seen in the finished underpass. They are concealed by the asbestos lining which stands some 6in clear of them. Since the diaphragm walls cannot be made completely watertight, seepage water has to be allowed to run down to a catch-channel behind the lining. The water is carried from there into the normal drainage system.

In the underpass approaches, the diaphragm walls have been covered with 'gunite' – to this true surface the Portland stone facing has been fixed.

The covered section of the underpass is permanently lit with continuous cornice lighting. The open approaches are lit by the high masts common to the project as a whole.

Diaphragm walling by the bentonite process.

1 A specialised excavating machine digs a narrow trench using a hydraulically operated clam shell grab. The trench is continuously filled with bentonite mud which congeals on the earth faces of the trench, thus preventing them from collapsing.

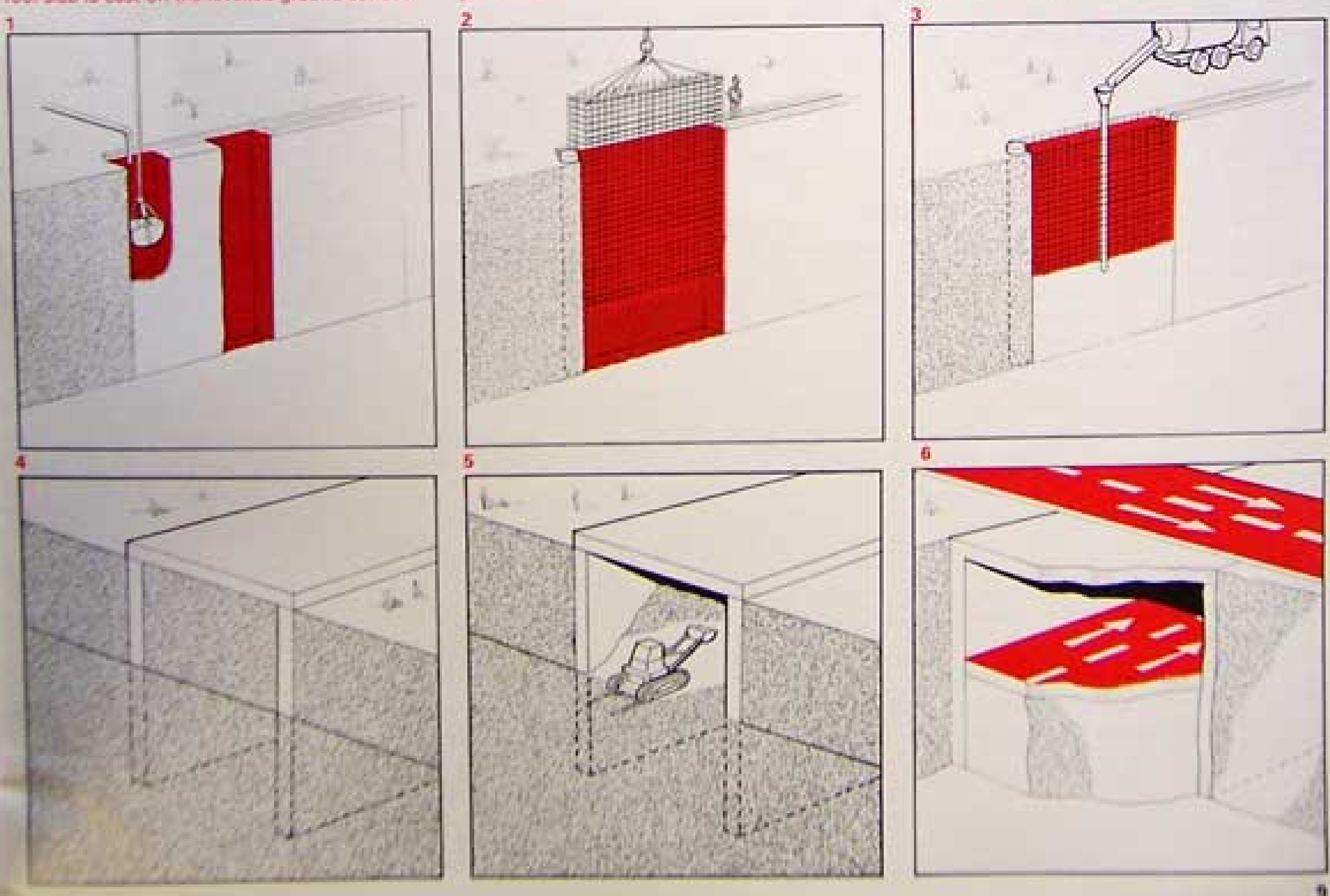
2 When a suitable length of trench has been excavated to full depth (up to 50 ft in parts of this Scheme) a pre-welded cage of reinforcing steel is lowered through the bentonite mud.

3 Concrete is poured into the trench around the cage, using a 'tremie' pipe. The bentonite mud is displaced as the level of the concrete rises, and is run off to a central reservoir pit.

4 The diaphragm walls complete, the underpass roof slab is cast on the levelled ground surface.

5 After traffic has been diverted over the underpass roof, excavation within the underpass proceeds.

6 The last part of the structure to be completed is the underpass road slab. Finishing works within the underpass then start.



3/Railway Tunnels

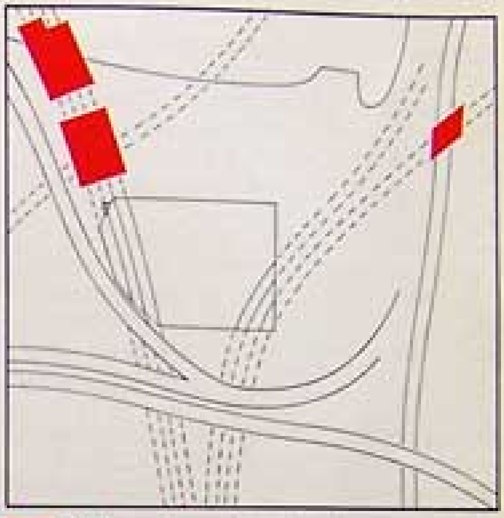
The site for the Approaches Scheme is laced with four separate railway routes (one single-track, two twin-tracks and one four-track), mostly in tunnel. These routes can be seen in the diagram on the right.
Two of these routes presented no problems. The Woodside railway tunnel had been strengthened more than 30 years ago, at the time of the construction of the Kings Square entrance to the Queensway Tunnel, and the low-level Mersey railway tunnel was sufficiently deep to avoid any problems other than those associated with deep bored piling operations. On the other hand in the North cutting of the new underpass, where the works lie close over the old Monks Ferry railway tunnel, strengthening of the old tunnel arch was needed.
The most extensive work in connection with these railway routes, however, was associated with the cut-and-cover railway tunnel beneath the Haymarket.

Haymarket

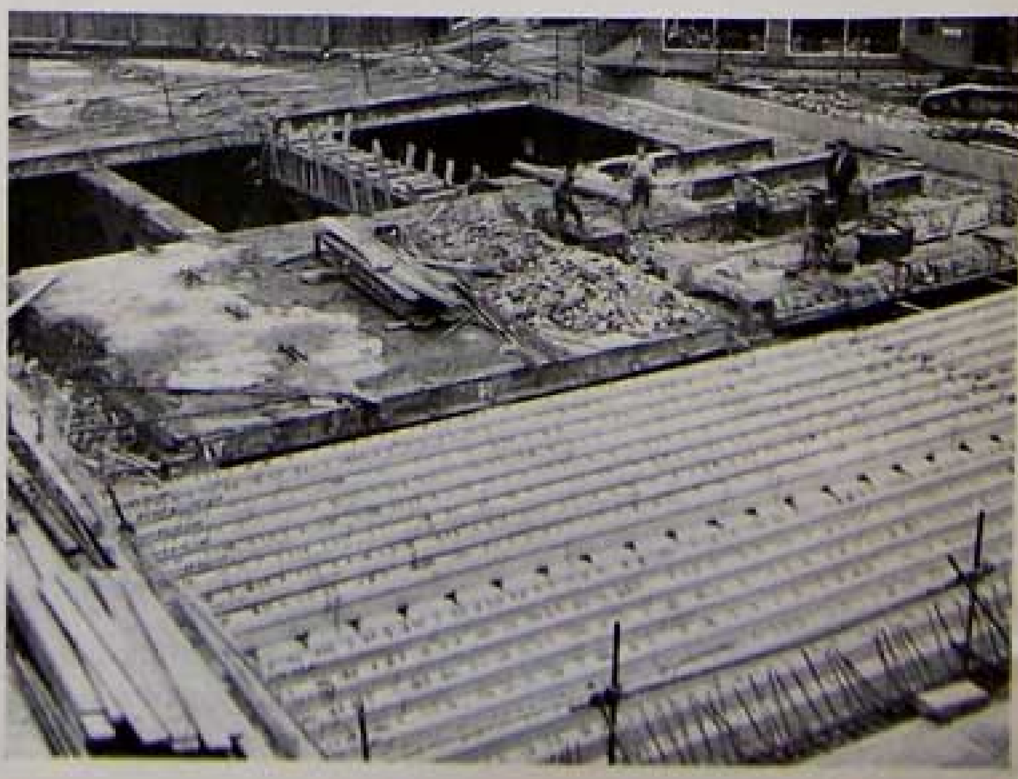
Carrying trains to and from the docks, the Haymarket Tunnel had satisfactorily withstood the effects of the road traffic above and the vibration within it for over 80 years. None the less it was not capable of supporting the new combination of additional earth surcharge required to bring the roads up to grade-level and the full M.O.T. live loading requirement.
It was therefore decided that a new roof would have to be constructed over the railway tunnel. This was designed to be carried out in several short stages in order to minimise interference with road traffic to and from the Queensway Tunnel; new electricity, gas and water mains also had to be installed across part of the new roof before existing mains over the old one could be removed; and whilst this programme was proceeding, trains had to continue using the tunnel.
At the same time, operations had to be phased with the construction of the adjacent roadway viaduct and the ramp which extends across the new roof to bring Conway Street traffic into the Northwest marshalling area. Suitable measures had also to be taken to deal with the various drains and sewers in the area.
The new roof comprises standard prestressed precast concrete beams in the form of an inverted 'T'.
The pile capping beams have been supported on a row of 2ft diameter concrete bored piles approximately 50ft deep and spaced at 10ft centres.
An interesting detail of the new roof's construction occurred where the Mersey railway crosses beneath the Haymarket railway tunnel. Here, it was impossible to maintain the 10ft spacing of the bored piles and a much deeper, heavier and longer reinforced concrete pile capping beam had to be constructed to carry the precast beams. These heavy capping beams span 60ft, clear across the width of the low-level tunnel, and are supported on 1 metre diameter bored piles extending 90ft down to bedrock.

Monks Ferry

The crown of the brick arch of the old Monks Ferry railway tunnel lies just below the new underpass road surface.
It was considered that the reduced depth of earth surcharge to the brick arch tunnel, combined with a high intensity of live-loading immediately over the crown, might result in the progressive failure of the arch.
It was therefore decided to build a reinforced concrete 'saddle' around the outside of the tunnel, down to the springline of the arch. This work was completed in advance of the general excavation work of the underpass North cutting, and was carried out in stages.



Railway Tunnel construction:
Haymarket (top left)
Monks Ferry (top right)



Progress picture showing the placing of the prestressed precast concrete beams during construction of the new roof to the Haymarket Railway Tunnel

4/General Works

In addition to the major viaduct, underpass, and railway tunnel structures, there has been a substantial amount of ancillary work on the site. Much of this has been concerned with improvement and alteration to the ground level road system. Particular roads which have been re-aligned, widened or improved include: Chester Street, Tunnel Road, Borough Road and the Clocktower roundabout, Conway Street (including the Conway Street/Argyle Street junction) and Hinson Street. A new route has been created to take Chester-bound Tunnel traffic over the roof of the new underpass.

Marshalling Areas

The traffic marshalling areas leading to the Tunnel entrance have been designed to come into full operation in conjunction with the automatic electronic traffic control system – described on pages 14 and 15 of this brochure. These areas will not, therefore, be fully functional until the early part of 1970. In the meantime, a limited benefit will be derived from their use as traffic reservoirs under ordinary Police control during the peak periods.
Although the marshalling areas form a prominent part of the visual impact of the project, they offer no unusual features from a constructional point of view.

Lighting

In sympathy with the general desire to create a scheme with pleasing aesthetic values, and bearing in mind the configuration of the new road system, it was decided to install 27 high mast lights at Birkenhead. These stand 100ft high and therefore, compared with conventional standards, give excellent illumination over a much wider area. The average spacing between masts is 240ft.
The masts are constructed from high strength, chrome-molybdenum seamless steel tubes which house a built-in winch mechanism for lowering the lantern carriage to ground-level for maintenance purposes. Each mast supports four 1000 watt MBF/U colour-corrected mercury-vapour fittings.

General

Some of the finishing operations will, of necessity, extend into the Maintenance Period after the major works have been completed and commissioned. These include the erection of some 300 warning and regulatory traffic signs, 46 informatory and directional signs to Worboys standard, the installation of pedestrian barriers and zebra crossings, and various landscaping works.

Road surfacing in progress.

This aerial view is taken looking Eastwards towards Liverpool. At the top of the picture can be seen one of Cammel Laird's dry docks. The viaduct entering from the left corner of the photograph carries traffic to Wallasey and New Brighton. The top road on the right is the route to Chester and the lower road on the right carries traffic to the mid-Wirral.

This picture was taken less than two months before the opening of the Scheme. Comparison with the original photo-montage on Page 3 shows the state of construction and finishing achieved only 25 months from the start of the project. This remarkable turn-round – in face of several major civil engineering problems – was only made possible by the high standard of co-operation which existed between the Client: The Birkenhead County Borough Council, the Consulting Engineers: Brian Colquhoun & Partners, the Main Contractors: Marples Ridgway Limited, and the many statutory authorities, sub-contractors and suppliers concerned with the project. There follows – on pages 16 to 20 – a list of organisations who contributed to the success of the operation.

A view of part of the viaduct system at Birkenhead taken at night, looking West. On the right can be seen the King Edward VII clock tower. The effect of the special high mast lighting can be appreciated by the brilliance of this picture which was taken using the street lighting only. There is a high mast off picture, above the viaduct to the right of this view.

5/ Traffic Control

As stated in the Introduction to this brochure, the overall aim of this Scheme has been to provide for the free-flow of traffic in the centre of Birkenhead by segregating 'Tunnel only' traffic from local Town and dock-bound vehicles and, at the same time, to improve the efficiency of the Tunnel entry and exit arrangements. Having constructed the necessary roads and marshalling areas, it is the job of the Traffic Control System (when it comes into operation in 1970) to effect the proper use of the Scheme. The system will, therefore, direct traffic coming from Birkenhead itself, and the Wirral, which wishes to use the Queensway Tunnel into the two marshalling areas located North-West and South-East of the entrance. Vehicles not wishing to proceed to the Tunnel will be segregated and onward directed.

Once in the marshalling areas, the object will be to control the traffic in an orderly, yet flexible, way by feeding lanes of vehicles to the manned Toll Booths in rotation. In this way, maximum efficiency will be achieved in feeding all users of the Tunnel through at peak capacity levels. It is, naturally, desirable that the first vehicles to enter the marshalling areas shall, as far as possible, be the first to leave.
When unavoidable delays do occur, vehicles will enter one of the marshalling areas, stop engines, and await their turn to proceed.
The system has been designed to cater for the peak Tunnel flow of 4500 vehicles per hour from Birkenhead to Liverpool (morning tidal flow conditions). The system is also readily adaptable to all intermediate conditions of traffic demand from 'no flow' to 'peak flow'. Similarly, provisions have been made for all conditions of traffic flow from Liverpool to Birkenhead. The system therefore, depends on suitable traffic directions to ensure the smooth and rapid dispersal of vehicles to and from the Tunnel.

Signs

Using the automatic traffic control system, directions will be given to vehicles at the approaches to the Scheme by means of internally illuminated signs on overhead gantries. Similar, but smaller, signs will be located at other strategic points on roads leading to and from the Tunnel. Some of these signs will have alternative 'secret' faces which will only be illuminated when diversionary routes have to be introduced to avoid a build-up of traffic or to deal with an emergency condition.

1 During off-peak periods traffic passes straight through the two marshalling areas to the Tunnel toll booths. During peak hours traffic is held and directed by the automatic system.

2 During peak hours vehicles enter any queueing lane except the one being released to the toll booths.

3 The right hand lane has been emptied and is now being refilled while the adjacent lane is released.

4 The cycle continues.

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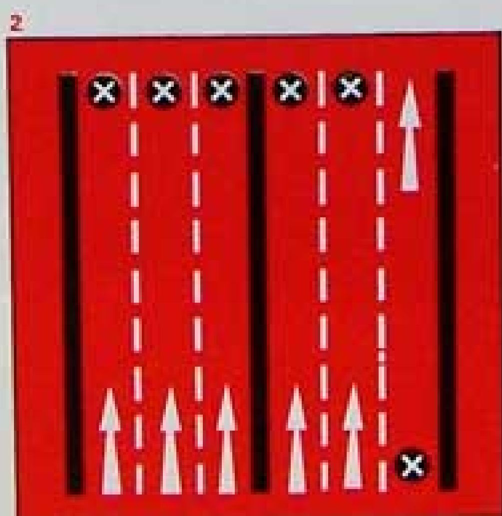

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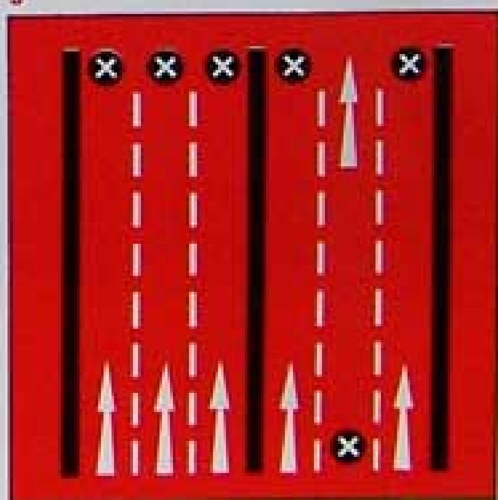

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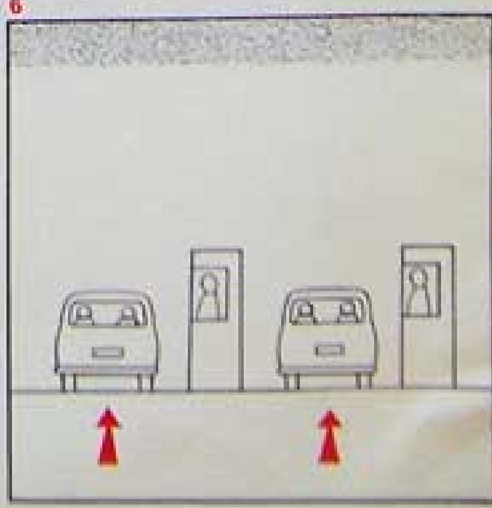


An indication of the traffic situation on the viaducts and approach and exit routes will be provided in the Tunnel's Control Room. Utilising information received from loop detectors, buried in the carriageways, the situation will be reproduced on a visual chart of the area. It will be possible when a diversion route seems desirable, for the Tunnel controller to illuminate the 'secret' signs automatically. This work will, of course, be carried out with the full co-operation of the local Police.

Marshalling Areas

Traffic will be controlled in these areas by means of signals on overhead gantries at both the 'entry' and 'exit' ends of the queueing lanes. The diagrams on these pages illustrate how the system will work. Loop detectors, buried at each end of a queueing lane, will provide the Tunnel's Control Room with information regarding both the presence and movement of traffic.

Control Room

The method of interpreting all the information received in the Control Room will be by the system's logic component. This will consist of wired solid-state circuits and they will relay whether or not the traffic routes or marshalling areas are empty, flowing freely, congested or persistently queueing. The visual presentation will be in the form of a mimic diagram. In the case of emergency situations or other special circumstances, human intervention will be made feasible by use of a special control panel. There will also be automatic indication and alarm if situations arise which require non-routine action.

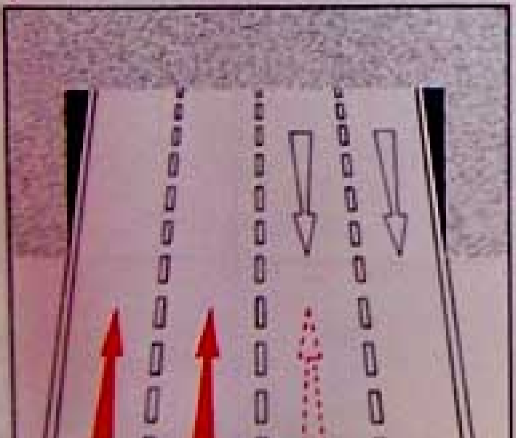
Normally, however, the logic component will regulate the traffic flow through the marshalling areas to the Toll Booths by comparing traffic demand with Tunnel capacity.

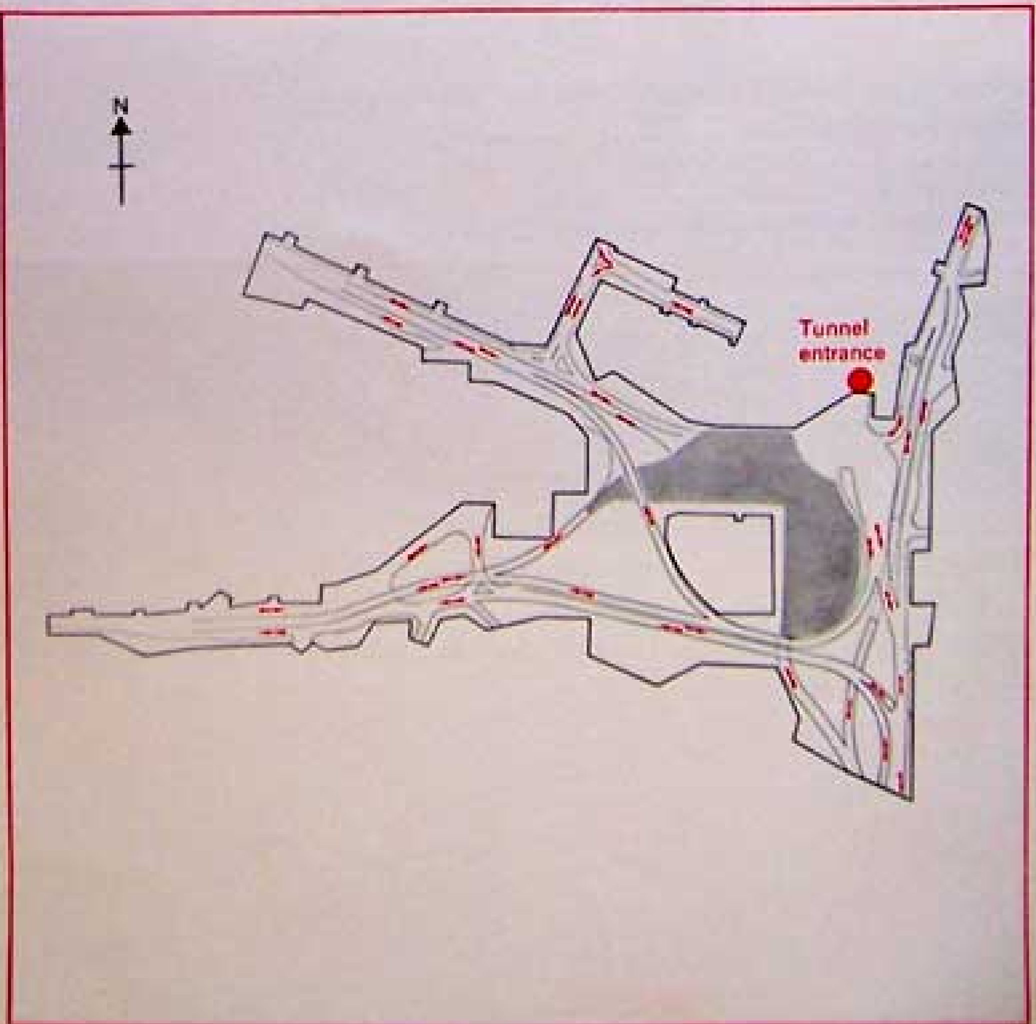
5 After release, the vehicles proceed to the Tunnel toll booths. Traffic from Liverpool is kept well clear of traffic entering and passes through its own set of toll booths.

6 Vehicles halt briefly at the booths to pay their Tunnel toll.

7 Once traffic reaches the Tunnel mouth the two-way flow follows the pattern already familiar to commuters.

7





Key (Diagram on right)

Marshalling Areas

Traffic flow through Scheme

Acknowledgements

Birkenhead County Borough Council

Mayor: Councillor George William Gill

Members of the General Purposes Committee:
Alderman Hugh Platt, O.B.E., J.P., Chairman
Alderman J. W. Oates, Deputy Chairman
Alderman G. F. Davies, J.P.
Alderman J. Furness, J.P.
Alderman C. S. McRonald
Alderman R. Pilkington
Alderman J. H. Roberts, J.P.
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Councillor J. R. A. Flynn
Councillor Miss E. M. Keegan
Councillor C. Pyke
Councillor Mrs P. A. Roberts

Town Clerk and Chief Executive Officer: Ian G. Holt

Deputy Town Clerk: A. Thelwell, D.P.A.

Mersey Tunnel Joint Committee

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Alderman C. G. Tompkins, M.Inst.M.

Clerk and General Manager:
S. T. Jones, F.I.C.E., F.I.Mun.E.

Principal Officers in charge of Scheme

Birkenhead County Borough Council:
Ian G. Holt, Town Clerk and Chief Executive Officer
A. Thelwell, D.P.A., Deputy Town Clerk
H. G. Lee, B.Sc.(Econ) F.I.M.T.A., Borough Treasurer
H. C. Oxburgh, B.Sc., M.I.C.E., F.I.Mun.E., M.T.P.I., Borough Engineer and Surveyor
D. Butterfield, M.I.C.E., M.I.Mun.E., A.M.I.H.E., Deputy Borough Engineer and Surveyor
W. T. Mitchell, M.I.C.E., M.I.Mun.E., A.M.I.H.E., Assistant Borough Engineer
J. H. Leach, F.A.I., Borough Valuer and Estates Manager

Brian Colquhoun and Partners:
P. Rushton, B.Sc., M.I.C.E., A.M.I.H.E., Engineer-in-charge
J. B. Shaw, B.Sc., M.I.C.E., M.ASCE, Co-ordinating Engineer
A. G. Lance, F.I.Struct.E., Chief Structural Engineer
G. R. Newman, B.Sc.(Eng.), M.I.C.E., M.I.Struct.E., Chief Structural Engineer
S. R. Gray, B.Sc., A.C.G.I., M.I.C.E., Senior Bridge Engineer
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R. S. Colquhoun, M.A., M.I.C.E., A.M.I.H.E., A.M.ASCE, Resident Engineer
J. Leech, B.Sc.Tech., M.I.C.E.
and then
J. A. Forster, B.Sc., Deputy Resident Engineer

Marples Ridgway Limited:
A. Sunderland, Ph.D., B.Sc., F.I.C.E., Director in charge
D. E. Shepherd, B.Sc., F.I.C.E.
and then
F. D. Unwin, B.A., B.A.I., M.I.C.E., Contract Manager
G. H. Greenbank, B.Eng., M.I.C.E., Site Agent
D. D. D. Lloyd, B.Sc., A.C.G.I., Site Construction Manager

Other Authorities Involved

Police:
Cheshire Constabulary

Statutory and other Authorities:
British Railways
Central Electricity Generating Board
G.P.O.
Merseyside and North-Wales Electricity Board
North-Western Gas Board
Wirral Water Board

Acknowledgements
Continued

Specialist Organisations

Special Crosshead Model Test at Imperial College of Science & Technology, London, by P. J. Clark, B.Sc.(Eng.), M.I.C.E. and A. R. Gent, B.Sc., Ph.D., M.I.C.E.; model constructed by Cammell Laird (Shiprepairers) Limited, Birkenhead.

Fabrication of structural steelwork	**Lloyd's Register Industrial Services**
Inspection and testing of precast beams	**Messrs Sandberg**
Laboratory tests on road materials	**Robertson Research Co Ltd**
Concrete cube tests (control series)	**Liverpool University**
Gamma Radiography	**Gamma Rays Ltd**

Principal Sub-contractors and Suppliers* to Marples Ridgway Ltd

Demolition	**G.T.B. Demolitions**
Concrete batching plant	**Pencrete Ltd**
Portland Cement	**Tunnel Cement Ltd***
Reinforcing Steel	**The Rom River Company Ltd***
Bored Piling	**The Cementation Company Ltd**
Underpass diaphragm walls	**Fondedile Foundations Ltd**
Underpass approach wall gunite	**The Cementation Company Ltd**
Underpass asbestos lining	**Nottingham Suspended Ceilings and Roofers Ltd**
Fabrication of structural steelwork	**United Steel Structural Co Ltd**
Site erection of structural steelwork	**Carter Horseley (Engineers) Ltd**
Site painting of structural steelwork	**J. D. & S. Tighe Ltd**
Supply of paints generally	**W. & J. Leigh & Co***
Portland stone ashlars	**The Stone Firms Ltd***
Fixing of glass mosaic to columns	**John Stubbs (Marble & Quartzite) Ltd**
Viaduct bearings and drain bellows	**Andre Rubber Co Ltd***
Viaduct expansion joints	**P.S.C. Equipment Ltd**
Viaduct and pedestrian balustrades	**Varley & Gulliver Ltd**
Polyester resin adhesives	**Stuart B. Dickens Ltd***
Bituminous and asphaltic roadworks	**Limmer & Trinidad Company Ltd**
Cable duct laying	**B.I.C.C. Co Ltd**
Prestressed precast concrete beams	**Dow-Mac Concrete Ltd**
Precast culvert units	**Evercrete Ltd**
Granolithic concrete and flagging (labour only)	**Campbell & O'Dowd**
Supply of precast kerbs and flags	**Premier Artificial Stone Co Ltd***
Engineering bricks class A Staffordshire Blue	**Ketley Brick Co Ltd***
Road markings	**Cromwell Contractors**
High mast and conventional lighting	**MANWEB/GEC Street Lighting Ltd**
Traffic signs generally	**Franco Traffic Signs Ltd**
Traffic crossing signals	**The Plessey Company Ltd**

Other Independent Contractors

Preliminary site investigation	**South Lancs Boring Co Ltd**
Preliminary demolition	**Valvine Ltd**
Removal of human remains from St Andrew's Churchyard	**W. F. Doyle & Co Ltd**
Automatic traffic control system	**Philips Electrical Ltd and Traffic Signs Division of Willings**
Documentary film of project	**Stevens, Shearer & Burrows Ltd**

General Information

Estimated project value excluding property acquisition	£3 million
Commencement date of main construction contract	16th March, 1967

Viaduct Structures

Total length of elevated carriageways	3680 ft
Total weight of structural steel	1625 tons
No of expansion joints	21
No of columns	37
Column foundations:	
No of reinforced concrete pile cap on 4 × 3 ft 6 in dia piles	20
No of 25 ft × 22 ft × 5 ft deep reinforced concrete spread footings	17

Ramps

Length of reinforced gravity walls, on mass concrete spread footings, with earth fill between	854 ft
Length of cellular construction on mass concrete spread footings	625 ft
Length of cellular construction situated part on tunnel roof, part on piled foundations	210 ft
Overall length of reinforced concrete gravity walls, on piled foundations, with earth fill between	325 ft

Underpass

Length of covered section	310 ft
Length of open cut approaches	800 ft
Average width	2 ft 10 in
Thickness of diaphragm walling	1 ft 8 in, 2 ft 0 in, 2 ft 3 in
Depth of diaphragm walling	25 ft to 50 ft

Traffic Marshalling Areas

Area of S.E.M.A.	9,000 sq yd
Area of N.W.M.A.	9,000 sq yd

Haymarket Railway Tunnel

Area of reconstructed roof	380 ft × 76 ft
Beam spans	40 ft 4 in and 35 ft 7 in
Total No of precast beam units used	414
No of piles – 24 in diameter	65

No of high mast lights	27
Power supply	440V, 3 phase

Mersey Tunnel Approaches Scheme

Readers of this brochure may also like to note that the Birkenhead County Borough Council has commissioned a film of this project which will be available, on release, later this year. Meanwhile, your enquiries will be welcomed addressed to:

Miss J. C. Redgrave,
Outlook Limited,
2 Basil Street, London S.W.3.

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