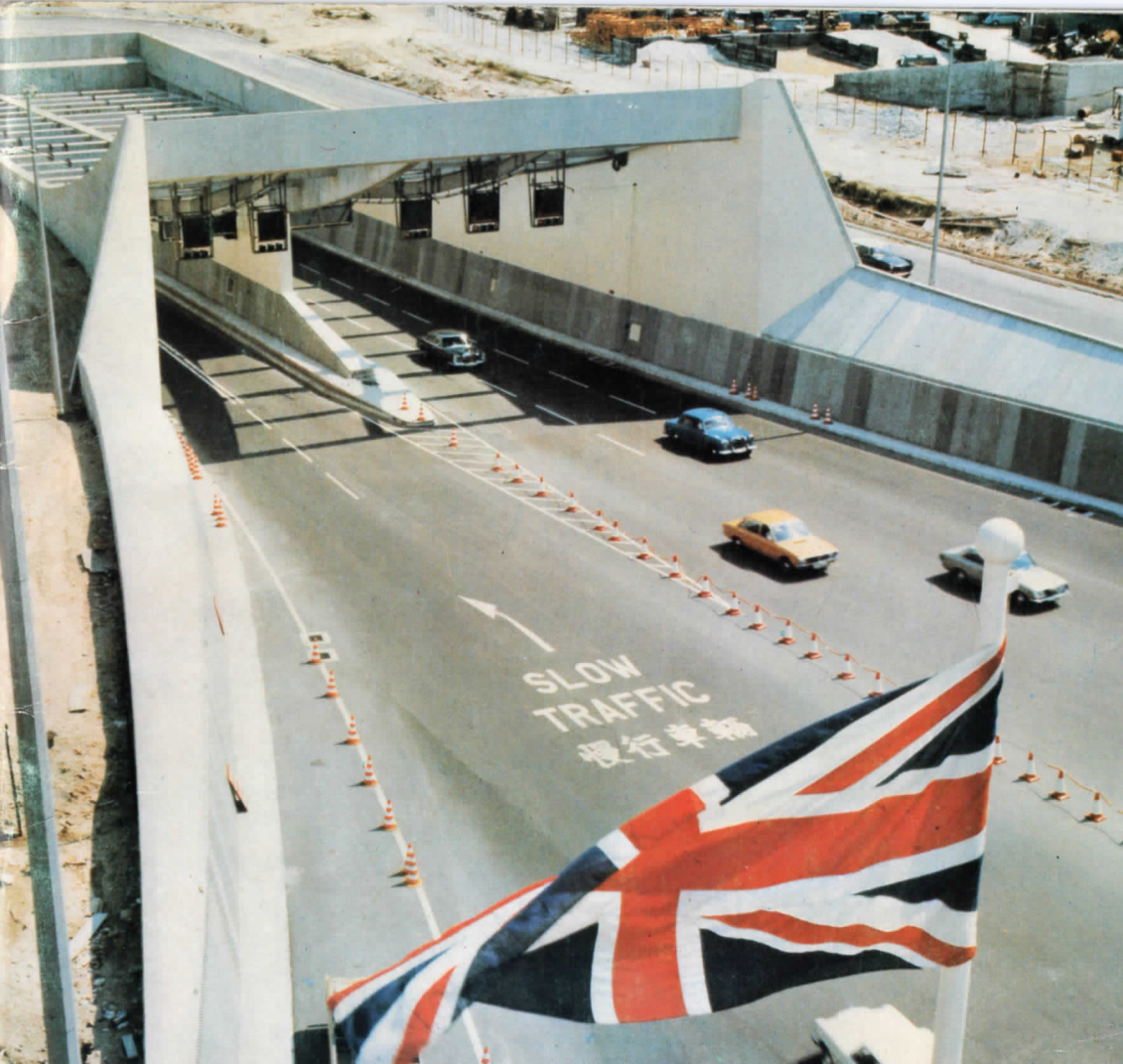


*JPM Cafferty.*



## **THE HONG KONG CROSS-HARBOUR TUNNEL**

*ROYAL OPENING  
21st October, 1972*



HRH THE PRINCESS ALEXANDRA

# **THE HONG KONG CROSS-HARBOUR TUNNEL**

*opened by HRH The Princess Alexandra*

*21st October, 1972*

## THE OWNERS

In 1959 a group of Hong Kong businessmen, with the support of the Hong Kong Government, founded the Victoria City Development Company Limited to promote a road crossing of the harbour and commissioned Scott Wilson Kirkpatrick & Partners and Freeman Fox & Partners as consulting engineers jointly to undertake a feasibility report and to prepare outline designs and estimates of cost.

In August 1965 the Government granted a franchise to the Cross-Harbour Tunnel Company Limited (successors to the Victoria City Development Company) to promote and operate a dual two-lane carriageway toll

tunnel sited between Hung Hom on the mainland and Causeway Bay on the island. The shareholders of the Cross-Harbour Tunnel Company at that time were :

Wheelock Marden & Company Limited  
Hutchinson International Limited  
Kwong Wan Limited  
Sir Elly Kadoorie Successors Limited

these firms also having been the principal shareholders in the Victoria City Development Company. In 1969, when the project was started, shares were also taken up by the Hong Kong Government and by the Hong Kong and Shanghai Banking Corporation.



## **CONSULTANTS AND CONTRACTORS**

### **CONSULTING ENGINEERS:**

Scott Wilson Kirkpatrick & Partners  
in association with  
Freeman Fox & Partners

### **ARCHITECTS TO THE ENGINEERS:**

Robert Matthew, Johnson-Marshall & Partners

### **MAIN CONTRACTORS:**

A consortium of:  
Costain International Ltd  
Raymond International Inc  
Paul Y Construction Co Ltd

### **PRINCIPAL SUB-CONTRACTORS:**

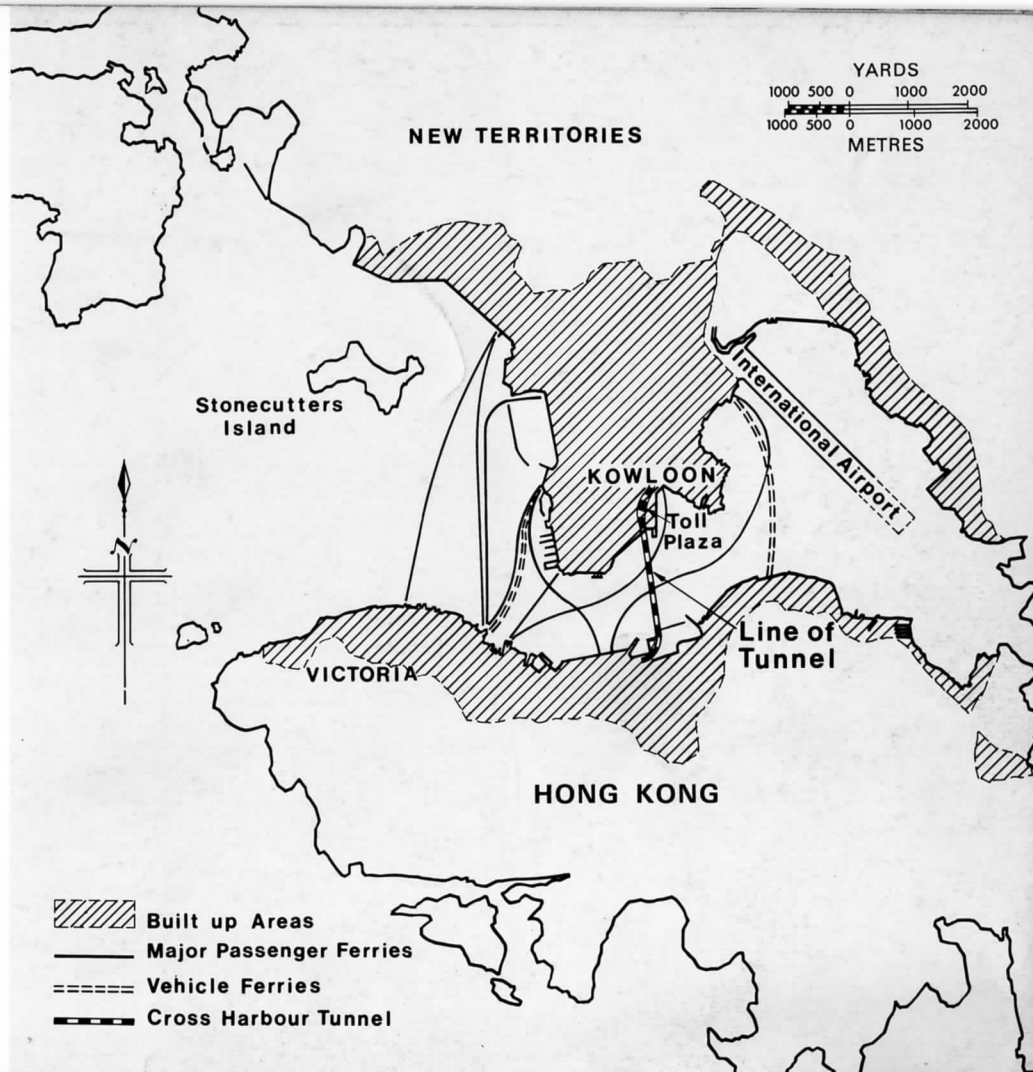
Redpath Dorman Long (Contracting) Ltd  
N. V. Philips' Gloeilampenfabrieken



The Hong Kong Cross-Harbour Tunnel has been built to meet the needs of the ever-growing traffic between the twin cities of Victoria, on the island of Hong Kong, and Kowloon on the mainland. Over the years, this traffic has been carried by numerous ferry services which, in 1970, carried a daily average of 16,700 vehicles and 655,000 pedestrians. The new tunnel has a daily traffic capacity of about 80,000 vehicles.

## FIRST CONSIDERATIONS

In 1950 a Hong Kong Government Committee reported on long-term plans for ferry services and, in the same year, an advisory committee, chaired by Mr. Lawrence Kadoorie, was



set up to acquaint the Government about the views of the public on the Committee's findings. In addition to commenting on the ferry services, the advisory committee urged that the Government should fully consider the provision of a cross-harbour road link. In 1954 the Government commissioned a report on a toll tunnel across the harbour and, in 1956, another interdepartmental committee, after considering this report, recommended against the Government constructing a tunnel but proposed that commercial interests should be permitted to carry out this work if they so wished. In consequence, in 1957, the Harriman Realty Company Limited began discussions with the Government with a view to constructing a road link.

In 1952 Mr. Guthlac Wilson, a founder partner of Scott & Wilson (later to become Scott Wilson Kirkpatrick & Partners), had made an independent proposal to Mr. K. B. Allport, the manager of the Harriman Realty Company (a subsidiary of Wheelock Marden & Company Limited), that a crossing could be a commercial proposition and at that time Scott & Wilson prepared an outline design for a long-span bridge. Following this study, they invited Freeman Fox & Partners to join them in developing these proposals.



The studies included an origin-and-destination traffic survey (undertaken by the Road Research Laboratory) as a basis for estimating future cross-harbour traffic and toll revenue. During the study and throughout construction of the tunnel, the consulting engineers have been advised on architectural matters by Robert Matthew, Johnson-Marshall and Partners, also of London.



*The old and the new*

*Left: Ferry boat*

*Right: One of the tunnel carriageways*



## TOLL TUNNEL FAVOURED

The consulting engineers submitted their report in 1961 and concluded that the construction of either a bridge or a tunnel was feasible and financially viable. There were, however, strong objections to the bridge proposals from both marine and aviation interests and hence the Hong Kong Government favoured a tunnel.

In the Autumn of 1965 the consultants for the feasibility report were re-appointed as consulting engineers for the project and they prepared detailed designs for a reinforced concrete immersed-tube tunnel. In October 1966, qualified contractors and consortia of international repute were invited to submit tenders for return by February 1967, based on either the Engineer's design or an alternative scheme of their own.

## CONTRACT ARRANGEMENTS

The successful tender, which was won against strong international competition, was submitted by a consortium led by Costain International Limited of London, supported by Raymond International Incorporated of New York and Paul Y Construction Company Limited of Hong Kong. The consortium's tender was based on an alternative steel-tube design for twin traffic ducts,

prepared by Parsons, Brinckerhoff, Quade and Douglas of New York.

This design contained considerable export content and enabled the consortium to offer attractive terms for deferred payment through a loan from Lloyds Bank of London, backed by the Export Credits Guarantee Department. Negotiations were begun with the consortium but had to be stopped in the middle of 1967 due to the financial uncertainties following the riots which occurred in the Colony at that time. Negotiations were, however, renewed in 1969 and a loan of £14.75 million offered, repayable within seven years of completion of the tunnel. The contract was signed on 26 June 1969.

The terms of the contract required the tunnel to be completed within three years, which gave very little time for the tender designs to be translated into approved working drawings. Design work produced in New York was routed through the contractors to the consultants in London, to the steelwork sub-contractor in Bedford, and thence back through London to Hong Kong. A rapport was quickly established between all parties which has been maintained throughout and has contributed greatly to the early and successful conclusion of the project.

## PROJECT PROGRESS

Work began on site on 3 September 1969. While construction plant and equipment to the value of £2 million was being mobilised, a contractor-designed bored-pile wall for the north approach was begun. A quarry was also acquired and developed. Simultaneously, the contractors began the design and construction of major temporary works: a slipway and jetty for launching, fabricating and fitting-out the tunnel units; a steel caisson for the north ventilation building; and the 1,800 ft long earth-filled retaining bund in 60 ft of water for the construction of the south approach. The screed-and-lay barge, developed specifically for handling and placing the screed and tunnel units, was designed and constructed within a period of 14 months at a cost of approximately £500,000, and the total cost of temporary works was in excess of £2 million. The first tunnel unit was laid on 29 December 1970 and the last unit finally positioned in February 1972. Traffic first used the tunnel in August 1972, and the work was thus completed in 2 years 11 months, one month shorter than the contract period. The tunnel is one of the longest immersed-tube tunnels in the world, and the longest underwater road tunnel in Asia.

*Right: Screed-and-lay barge, "The Severn River"*



## SCOPE OF PROJECT

In addition to the tunnel itself and the approach roads on both sides, the project comprised :

*the north and south ramps between the tunnel portals and the approach roads;*

*the toll plaza, situated on the north ramp;*

*the north and south ventilation buildings;*

*the administration building.*

## STEELWORK

The supply of the steelwork and its fabrication for the twin tubes was let by the consortium to Redpath Dorman Long (Contracting) Limited, a subsidiary company of the British Steel Corporation. Plain material delivered from the UK was fabricated on the site, using local labour supervised by UK personnel. Additionally, the company was responsible for fixing the reinforcing steel and wire mesh in the tunnel units for subsequent concreting by the main contractor, and for breaking through between the units after they had been joined together on the harbour bed.



*Right: Approach roads on the island*

*Far right: Part of control room  
showing closed circuit television*



## ELECTRICAL AND MECHANICAL WORK

This work, for which competitive tenders had already been obtained, was combined in one omnibus nominated sub-contract which the consortium was required to enter into prior to signing the main contract. The successful tenderer was N.V. Philips' Gloeilampenfabrieken of Eindhoven who, in turn, sub-contracted various parts of this work to specialist firms, some within their own organisation. The sub-contractors, with one exception, were British and the British export content of the sub-contract was therefore high, 84%. The sub-contract included the ventilation and pumping plant, tunnel lighting and all control systems such as traffic lights, communications, closed circuit television surveillance, and the toll collection and accounting equipment.

## APPROACH ROADS

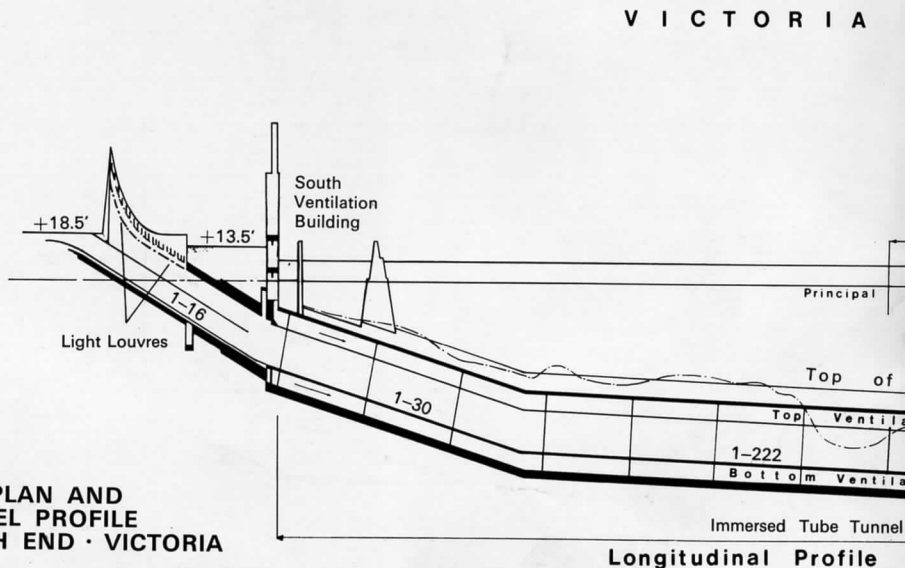
Simultaneously with the construction of the tunnel itself, the Hong Kong Government constructed extensive approach roads on both the island and the mainland to give access to the tunnel. The designs for these approaches were prepared by the consulting engineers on behalf of the Public Works Department and the roads were built by local Hong Kong contractors.



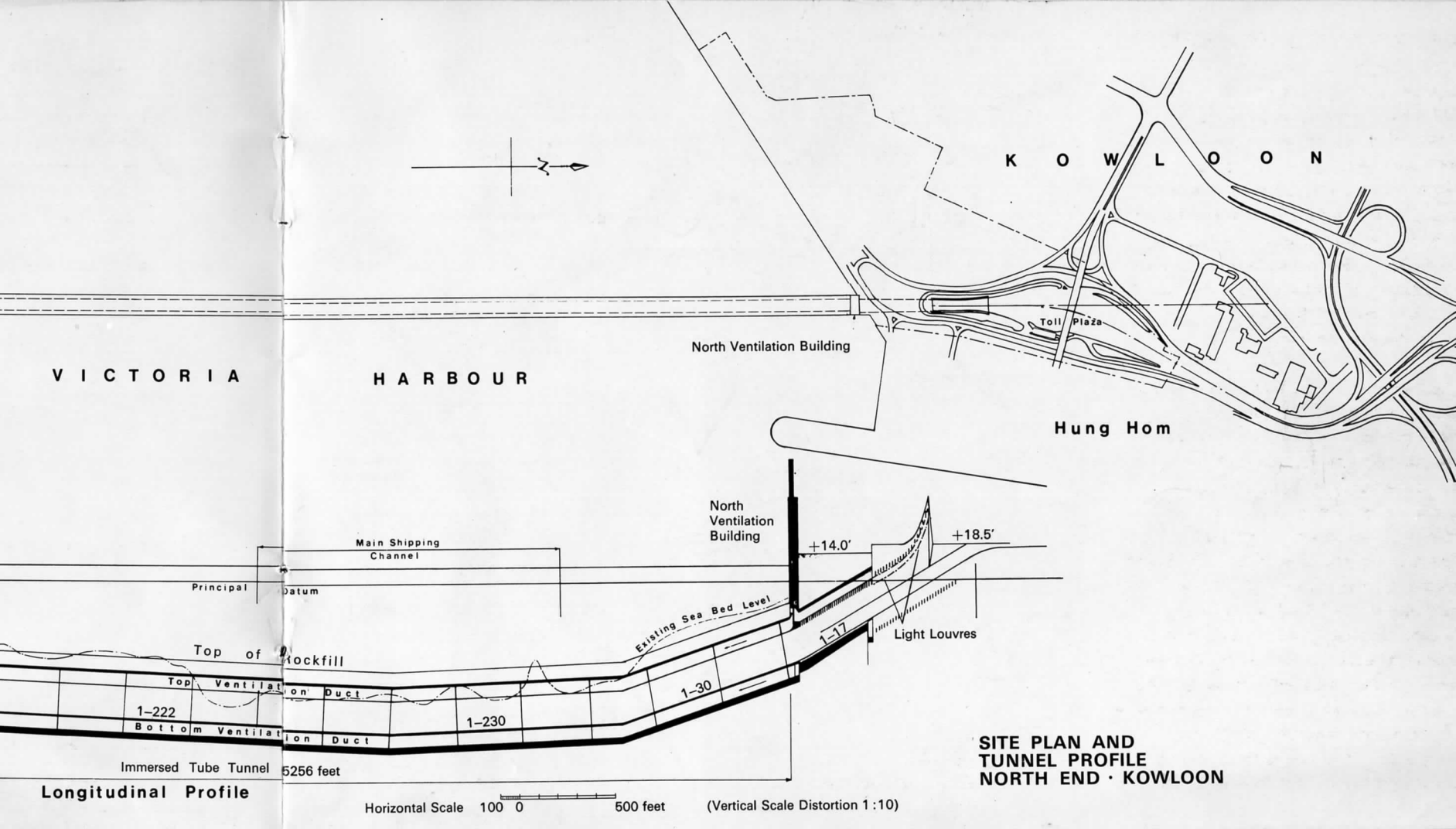
## DESIGN AND DIMENSIONS

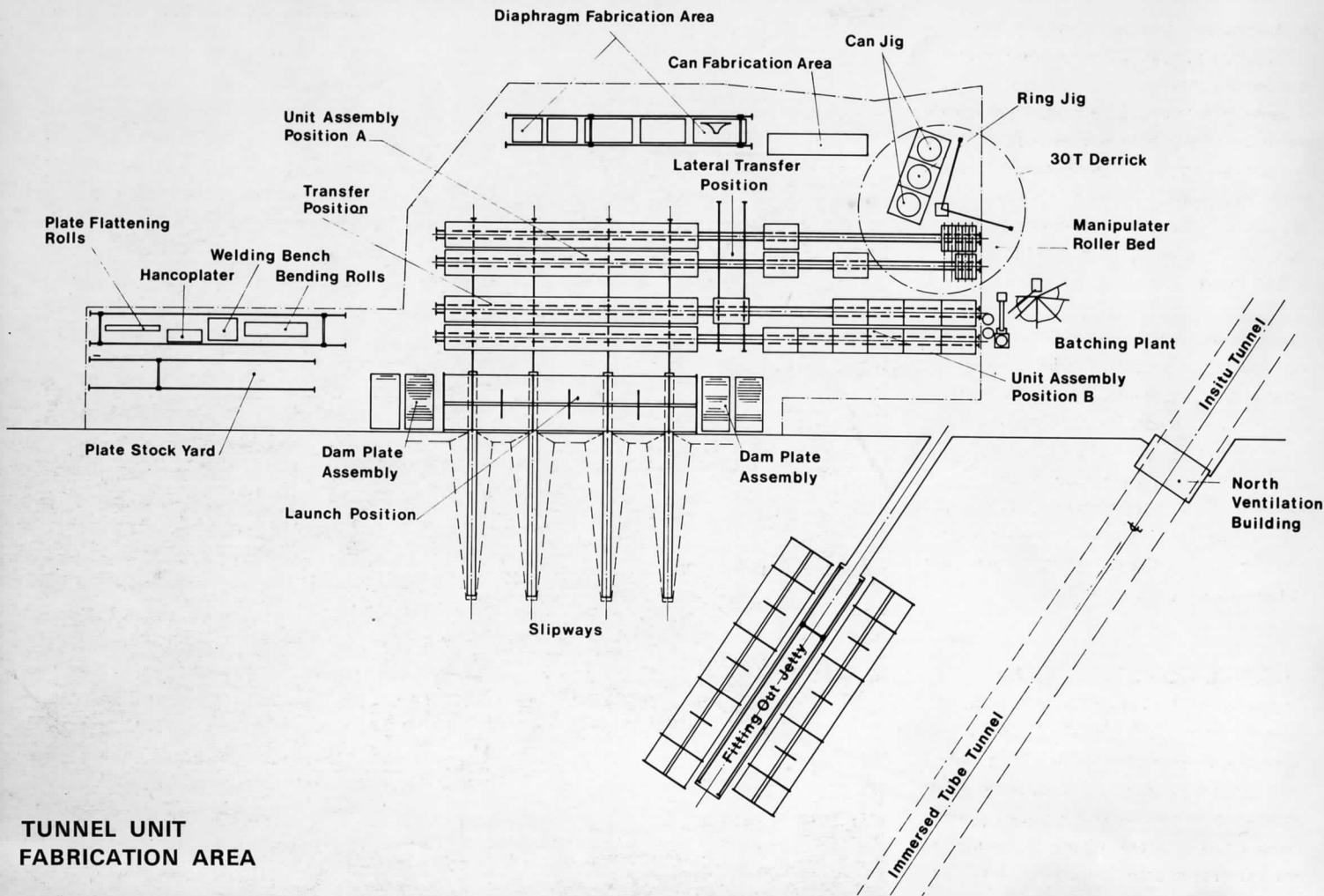
For the pre-contract design work an office was set up in London by Scott Wilson Kirkpatrick & Partners and Freeman Fox & Partners and was staffed by engineers from both firms working together as a single team. During this period many other tunnels in the world were visited and various methods of construction studied. Special investigations were also put in hand on hydraulic aspects, ventilation problems and such matters as the effects of ships' anchors on the rockfill protection over the immersed-tube tunnel.

The dimensions of the tunnel are shown on this page and p. 28. The tunnel, 6,088 ft long between portals, has dual two-lane carriageways, each 22 ft wide, with traffic headroom of 16 ft. At the exits, the gradients are about 1 : 16 and additional climbing lanes have been provided. On the mainland side the carriageways widen out to a toll plaza where there are 14 toll lanes with collection booths, six of which are reversible to allow for tidal flow conditions. The ventilation buildings, each containing ten axial flow fans, are sited at the ends of the submerged tunnel. Beyond both portals there are louvred sections, each 300 ft long, designed to provide a gradual transition between tunnel lighting and the light outside.



**SITE PLAN AND  
TUNNEL PROFILE  
SOUTH END - VICTORIA**





**TUNNEL UNIT  
FABRICATION AREA**

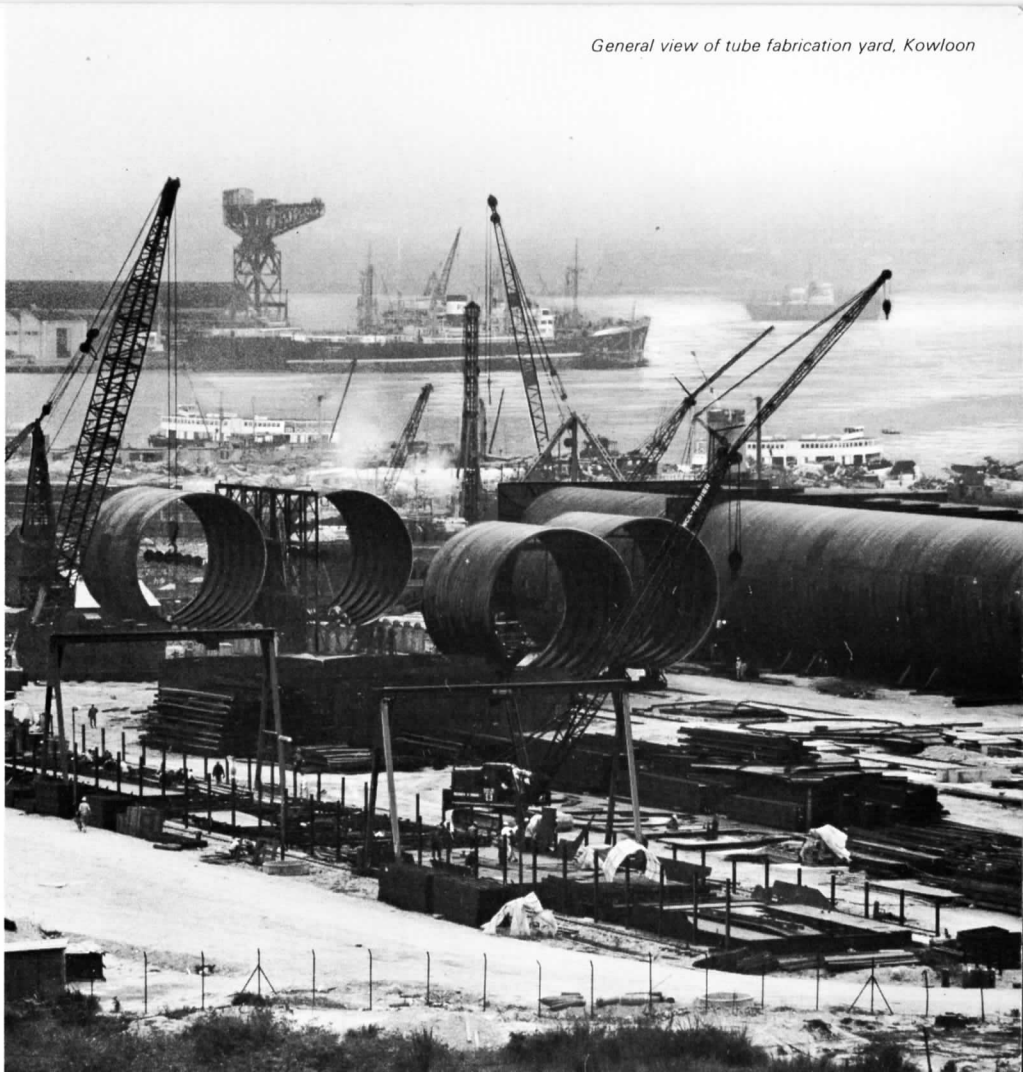
Both approaches to the tunnel and the ventilation buildings were constructed in reinforced concrete. On the Kowloon side, excavation for the approach ramp was made within bored pile retaining walls supported by temporary steel and permanent concrete struts and beams. On the island side, the ramp and ventilation building were constructed in-situ behind an earth and rockfill bund.

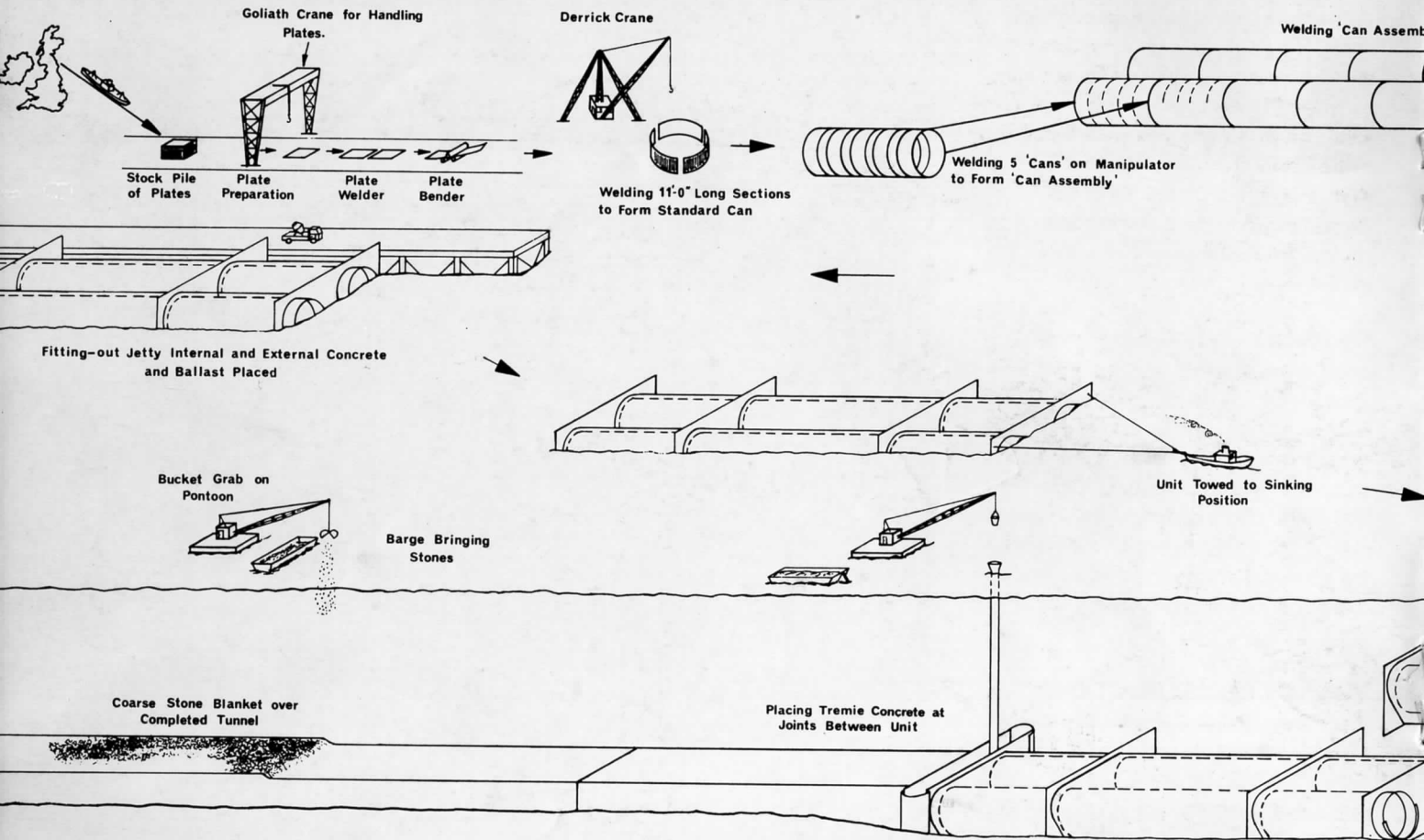
The northern ventilation building was constructed as a steel and reinforced concrete caisson that was floated into position and sunk on to a prepared foundation of crushed stone. It was built in Taikoo Dockyard and part of its internal sub-structure was completed after launching but prior to sinking. After it had been founded on the stone bed, the remainder of the sub-structure was built, followed by the superstructure.

## TUNNEL CONSTRUCTION

The immersed tunnel was built in 15 units, each between 325 ft and 371 ft long, and 73 ft wide. Each unit comprised two 34 ft diameter steel tubes welded from  $\frac{3}{8}$  in stiffened steel plate, with a concrete keel, sprayed concrete exterior and a concrete lining. The units, fitted with temporary-end dam plates,

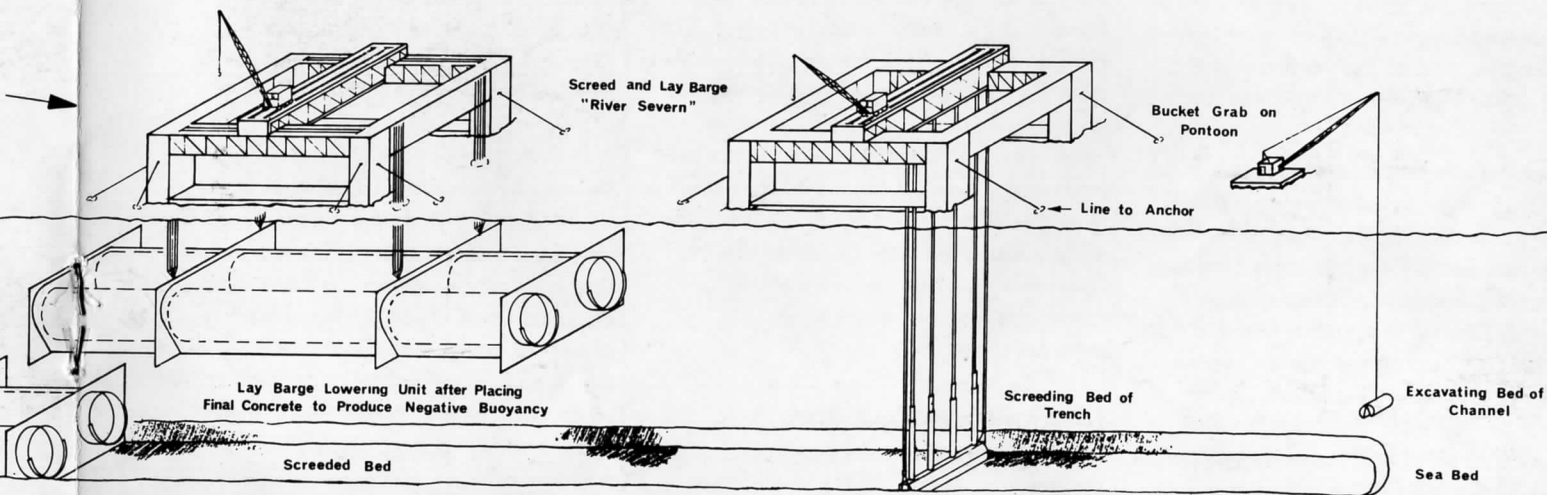
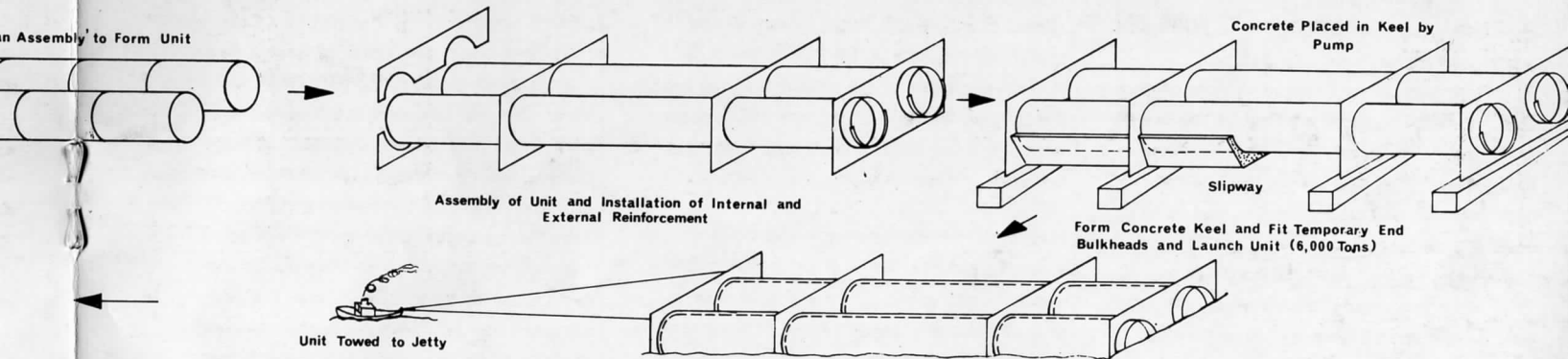
*General view of tube fabrication yard, Kowloon*





**CONSTRUCTION OF IMM**

in Assembly to Form Unit



F IMMERSED TUBE TUNNEL

were fabricated and assembled on shore and launched sideways into the harbour. At this stage they had a dead-weight of about 6,000 tons and floated well above the water with a high freeboard. They were then taken to the fitting-out jetty where the internal concrete was placed. When this had been done the units were only just buoyant and had a dead-weight of about 30,000 tons. They were then ready to be towed, one at a time, to the screed-and-lay barge located above each final position, there to be sunk on to a prepared screed and joined to the previous unit. The first unit was positioned on the mainland side after the ventilation building had been constructed and the tunnel was built forward until the south side was reached.

The original level of the harbour bottom along the line of the tunnel is shown on the tunnel profile diagram. Before each unit was moved into position, the bottom was dredged to allow a screed of crushed stone at least 2 ft thick to be laid. Preparation of the bottom and laying of the tunnel units were carried out from the purpose-built screed-and-lay barge, a twin pontoon structure that could be accurately set to level above the harbour bed; alignment was maintained using a laser beam directed across the harbour. The stone bed of crushed granite was placed from a

screed box of width equal to that of the trench and carried by trolleys running on rails on the deck of the screed-and-lay barge. Dredging was done by a Lima 2400 crane, with a 6 cubic yard bucket, mounted on a separate pontoon.

With the screed prepared, the units, with only a small freeboard, were floated into position within the pontoon. Tremie concrete was placed between the shoulders of the tubes to eliminate the buoyancy so that the units could be sunk on to the prepared bed. For much of the length of the tunnel the depth of water in the harbour was in excess of 70 ft. Detailed checks on the relative density of the water and of the concrete in the tunnel units were made regularly. The screed-and-lay barge operated independently of the tide level which had a range of about 8 ft. The actual sinking took one to two hours and was done at slack water. Since the immersed weight of each unit is small, the load from the tunnel on the screed is very small, so settlement is minimal.

## UNDERWATER JOINTS

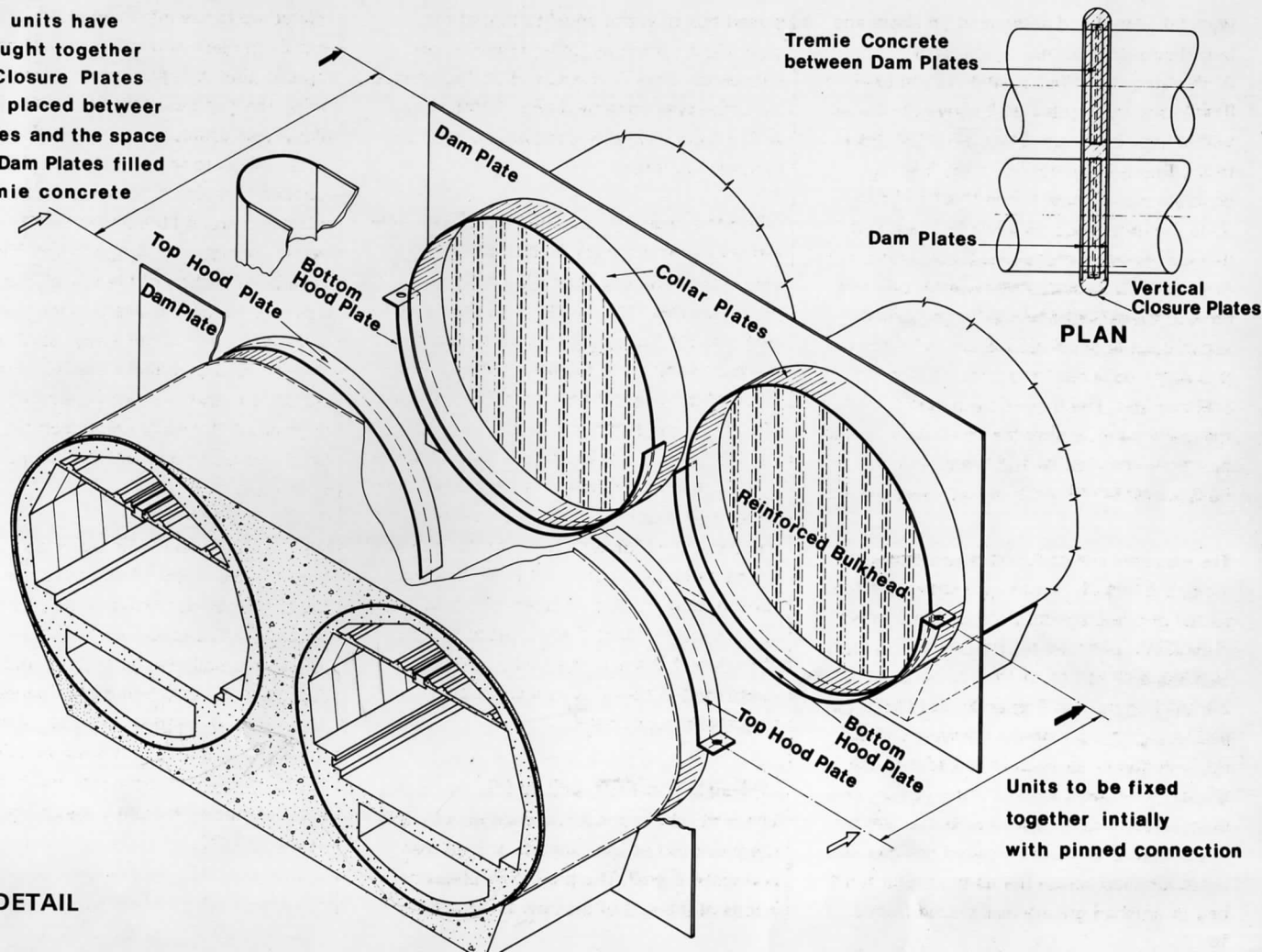
The method of connecting each new unit to the previous one was simple, well-proven and worked well. The projecting plates or hoods at the end of the new unit were

offered up to the matching plates of the unit already in place and attached by inserting tapered pins through register plates on both units. The gap between the overlapping plates was caulked and curved closure plates driven to form a coffer-dam around the junction. The space between the steel tubes and around them was then filled with tremie concrete. Working from inside the completed section of the tunnel, the space between the dam plates was then drained and the two plates cut away. Steel plates were welded in to make the steel tubes continuous and any cavity behind the closing rings grouted. Finally, reinforcement was fixed across the gap and the internal concrete completed.

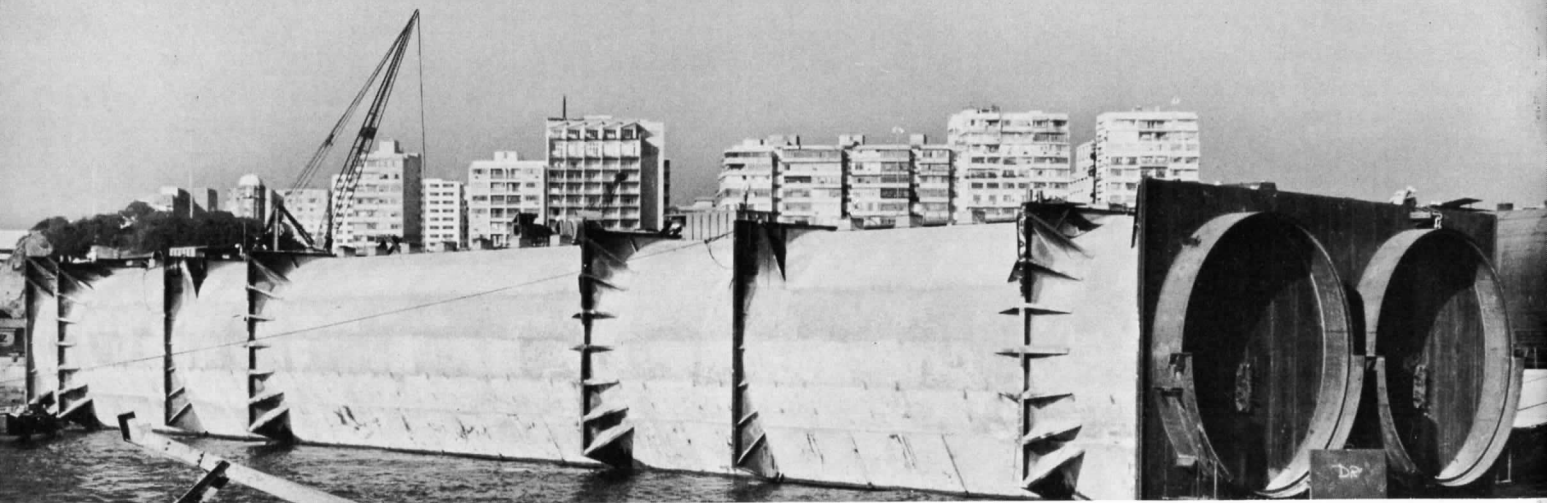
With each tunnel unit in place, the space between the unit wall and the sides of the trench was back-filled and the positioned unit covered with a coarse stone blanket, primarily to give protection against scour and anchor dragging. Construction of the tunnels proceeded across the full width of the harbour to join up with the ventilation building on the south side. The last unit was put in place and the tunnel "broken through" in February 1972.



After the units have been brought together Vertical Closure Plates are then placed between Dam Plates and the space between Dam Plates filled with Tremie concrete



**JOINT DETAIL**



*Tunnel unit during launching*

## **ELECTRICAL POWER SUPPLIED**

The electrical and mechanical equipment for the tunnel included switchgear and transformers for the supply of electrical power, lighting, ventilation plant, pumps and communication and control systems. Supervision of all tunnel operations is carried out from a central control room in the administration building.

The total power supply is 4.5 MVA obtained from two power companies, China Light & Power Company Limited in Kowloon and Hong Kong Electric Company Limited on the island. Normally the supply is shared, but the equipment is such as to enable either source to meet the full demand. The two supplies are totally independent, and interruption of one supply will still leave half the lighting and ventilation intact for the

few minutes necessary for full load to be switched on to the alternative supply. Should both supplies fail, an automatic 25 kW diesel generator system will provide power for essential services.

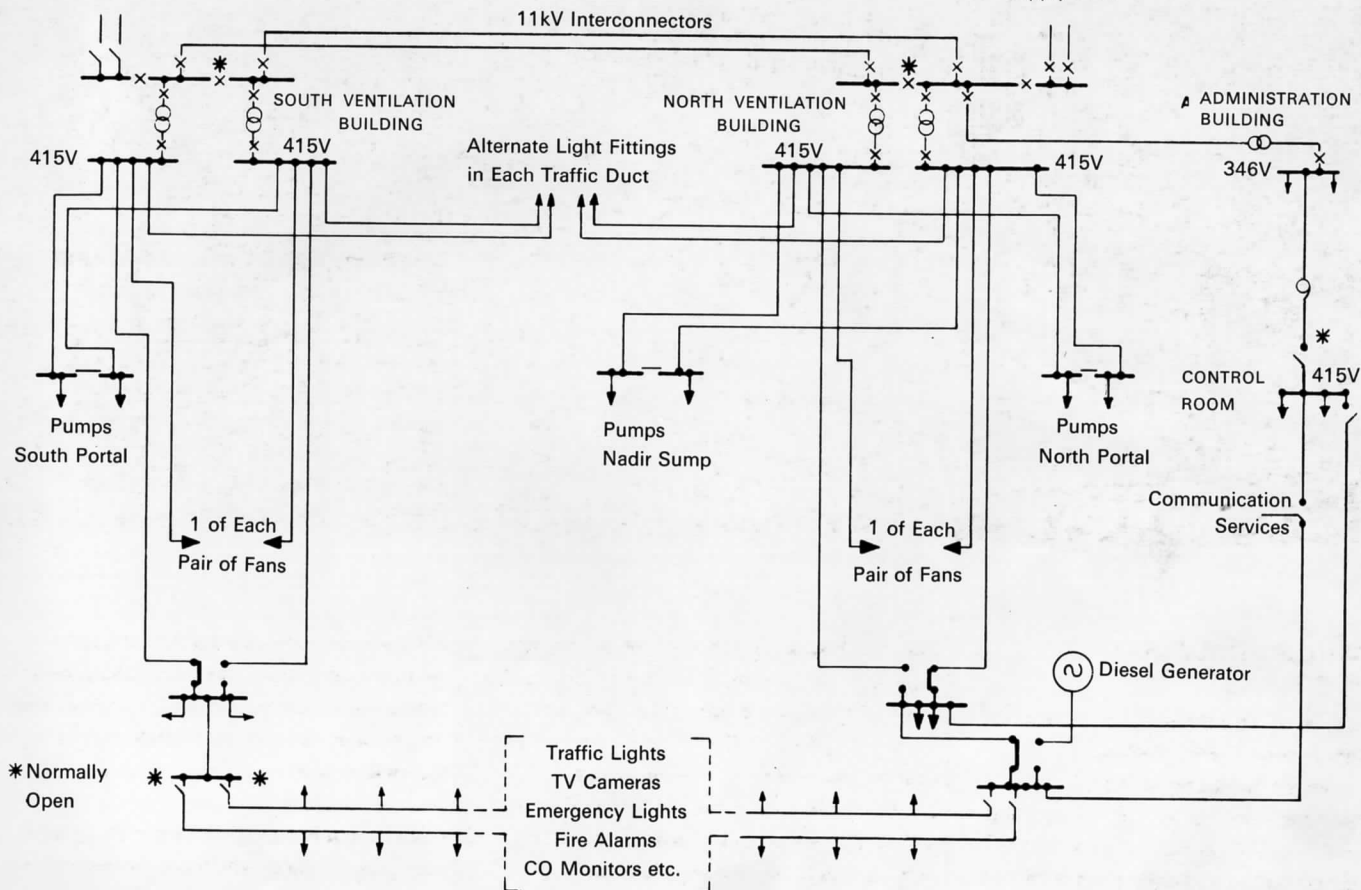
Power input is at 11kV to the switchgear and main transformers, which are located in the ventilation buildings. The main supply throughout the tunnel and its precincts is

HONG KONG ELECTRIC CO.

Supply 11 kV

CHINA LIGHT & POWER CO.

Supply 11kV



**SCHEMATIC DIAGRAM – DUAL POWER SUPPLIES**

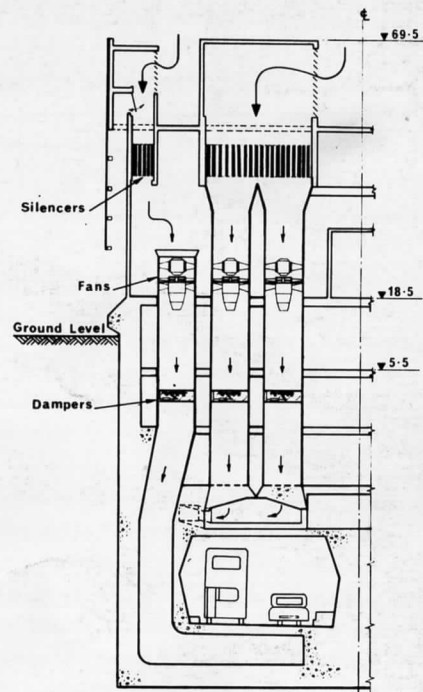
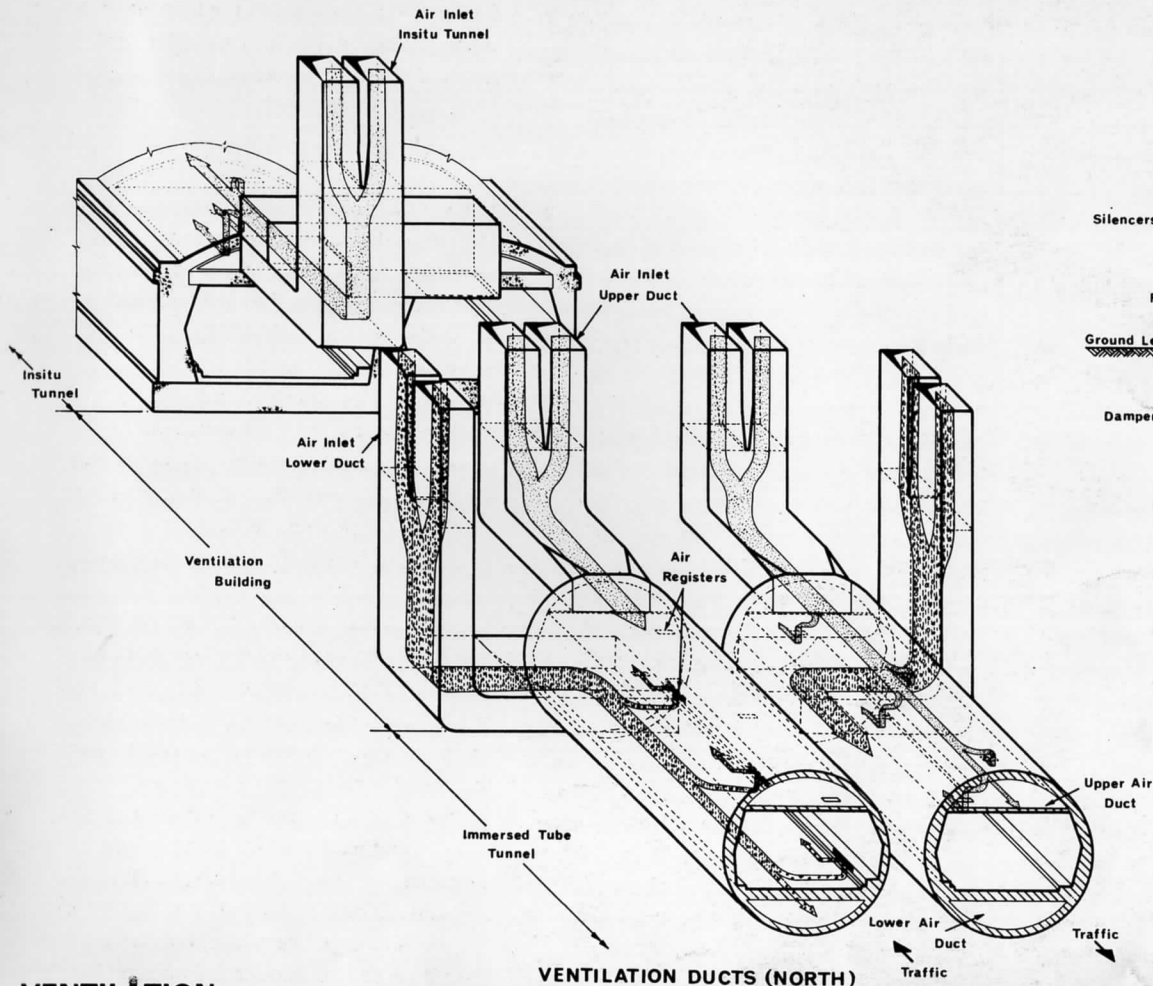


3-phase, 415 V, except at the administration building where a 364 V supply (the local standard voltage) is used.

## TUNNEL SERVICES

The heaviest electrical load arises from the ventilation fans. The ventilation system was designed in the light of model tests and full-scale tests on the Maas Tunnel in Rotterdam. A semi-transverse system was adopted in which fresh air is directed into each vehicle duct and exhausted via the portals. In total, the ventilation plant is able to supply 2.6 million cubic feet of fresh air per minute, corresponding to an average of 100 cfm per ft of traffic lane.

The dangerous component of vehicle exhaust is carbon monoxide and the level of this gas is continuously monitored in the tunnel to ensure that it never exceeds a dangerous value. Indication of the level in various parts of the tunnel is continuously displayed in the control room. The ventilation system ensures that the level of this gas is kept within safe limits. Normally, however, visibility is the criterion by which this system is operated. For the submerged section of the tunnel, fresh air is carried through the ducts in



**CROSS SECTION THROUGH  
VENTILATION BUILDING**

**VENTILATION**

the tunnel invert and above the ceiling, entry points being located in the kerbs and ceiling. On the ramp sections of the tunnel, air is only supplied for the up-grade carriageway.

To supply the fresh air, two-speed fixed-bladed axial-flow fans of 78 in diameter have been installed. In each ventilation building eight of these fans serve the submerged section, and two more the in-situ sections of the tunnel. To keep noise to tolerable levels, large silencers have been provided in the superstructure of the building.

Lighting through the tunnel is by fluorescent tubes placed longitudinally in fittings mounted in the ceiling end-to-end throughout the whole length. At the entrances, additional lighting is provided to assist the transition from daylight to tunnel lighting and similar but less additional lighting is provided at the exits. The level of illumination throughout is automatically adjusted to the level of illumination outside the tunnel; and the level of tunnel lighting at night is less intense than during the day. The plaza is lit from 65 ft high masts carrying special lanterns using high pressure sodium lamps. In addition great care has been taken over the tunnel finishes to enhance visibility. The ceiling is

formed of precast concrete panels coloured black on the underside. The walls are off-white in colour and have a slightly matt texture to avoid specular reflection but ensure easy cleaning. The road surface is a hard-wearing bituminous (hot-rolled asphalt) carpet.

The drainage system is designed to deal with all weather conditions, including the very severe rainfall that can occur in Hong Kong. There are two main pump-houses, one at each portal of the tunnel. Rainstorms are assumed to present the major capacity problem and pumping has been assessed on the basis of 1 in per hour steady rainfall with a heavy rainfall of 6 in per hour for 20 minutes superimposed. This level of rainfall will produce 190,000 gallons in one hour at the north portal sump and 100,000 gallons in one hour at the south portal sump.

## **TRAFFIC CONTROL**

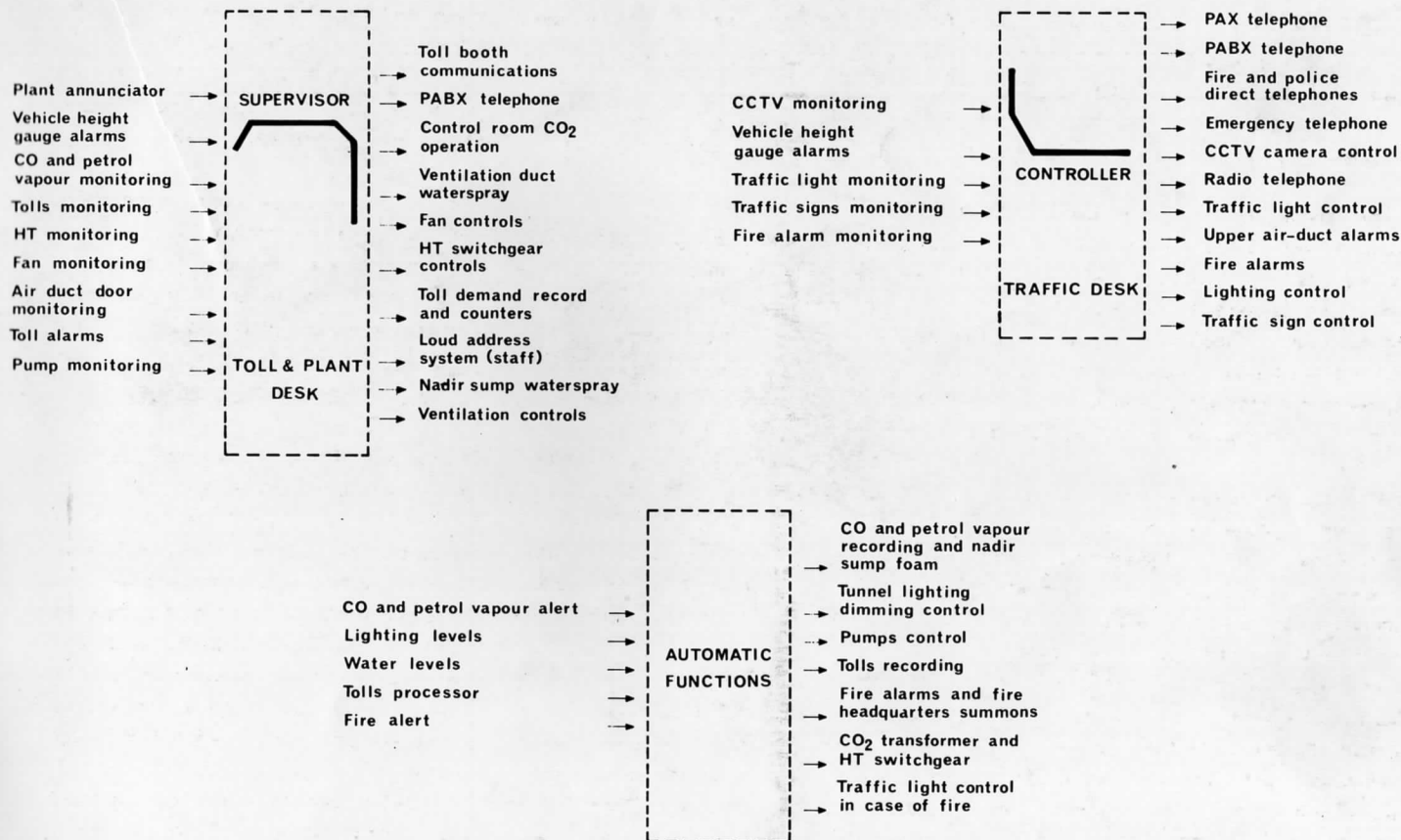
Traffic surveillance within the tunnel area is by closed-circuit television with one camera on the approach on each side of the harbour and cameras at about 1,000 ft intervals along the vehicle ducts – 19 cameras in all. Traffic control is effected by special high intensity traffic lights, using halogen lamps, at 700 ft intervals above each lane. The lights have three aspects: red and green, for “stop”

and “go”, and amber to warn of “obstructions ahead”. The CCTV pictures are displayed on monitor screens in the control room where mimic diagrams also display the operation of the traffic lights.

At all times, the passage of dangerous goods, and of very large or slow vehicles, will be restricted or prohibited; petrol tankers, for example, will use the tunnel only under escort and during limited periods.

## **TUNNEL MAINTENANCE SERVICES**

In the case of accidents, a heavy duty recovery vehicle has been provided, as also have a number of Land Rovers as patrol and light recovery vehicles. Special precautions have been taken against fire, and alarms and emergency telephones have been installed at close intervals along the tunnel. When an alarm is given, warnings will be received in the control room, toll plaza and the recovery vehicle garage, and the central Hong Kong Fire Control will be alerted; all traffic signals between the alarm and the entrance to the tunnel will turn red, so as to stop further traffic entering and to enable the fire brigade to get through. Two 4 in fire mains run the whole length of the tunnel with hydrants at close intervals, and fire



**CONTROL ROOM FUNCTION DIAGRAM**

extinguishers and other equipment have been provided both along the tunnel and on the recovery vehicles. If necessary the supply of air by the ventilation system can be specially controlled in this situation and the fans serving the ceiling ventilation ducts can be reversed so as to draw off any smoke.

A radio-telephone system provides communication between the control room and the patrol vehicles and portable sets inside or outside the tunnel.

## **TOLL COLLECTION**

Toll equipment of the most advanced type has been installed to ensure that traffic is not delayed by the collection of money and that there is a maximum security surrounding the collection and accounting of revenues. The drivers of all vehicles, without exception, will have to hand over money or a voucher purchased previously; there will be no passes. The system permits different scales of charges at different times so that off-peak reductions or peak-period premiums can be adopted.

The toll registration and recording equipment includes a small general-purpose computer that cross-checks and records every toll movement. Every toll collector is issued with a personalised key which has to be used to

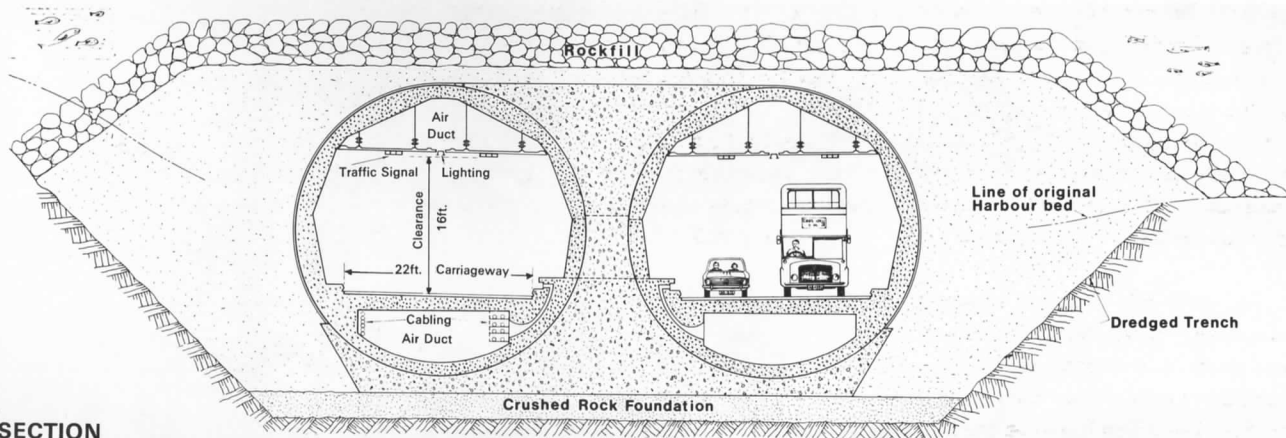
bring a toll booth into operation by freeing the traffic gate for operation and designating all subsequent recordings against the collector until he cancels the booth by removing his key. Each booth contains a register for recording the vehicle class and the type of each transaction, and for transmitting this information to the central computer. In the toll lane, a pressure strip registers the number of axles on the vehicle and consistent information is required from the pressure strip and the collector's register before a vehicle may proceed.

## **LABOUR FORCE**

It is impossible to be precise about the number of engineers and the size of the work force that have been involved in the construction of such a project as the road tunnel. However, the construction force on the civil engineering work reached a peak of 900 around the middle of 1971. The site work forces of the electrical and mechanical sub-contractors have numbered a maximum of 280.

*Right: Toll plaza and administration building, Kowloon*





**TUNNEL  
CROSS SECTION**

**STATISTICS****MAIN  
CONTRACT**

Total tendered sum – £18,667,000  
Contract period – 3 years

**PRINCIPAL  
DATES**

Joint Consulting Engineers' report  
Granting of franchise by Hong Kong  
Government to Hong Kong Cross-Harbour  
Tunnel Co Ltd  
Project out to tender  
Tenders returned  
Contract signed  
Work began at site  
Tunnel completed across harbour  
First traffic through tunnel  
Tunnel opened formally

*April 1961**August 1965**October 1966**February 1967**June 1969**September 1969**February 1972**August 1972**October 1972***PRINCIPAL  
DIMENSIONS**

Tunnel portal to portal length  
Submerged tube length  
Number of traffic ducts  
Carriageways (dual lane) width  
Maximum gradient out of tunnel  
Traffic headroom  
Minimum water depth over tunnel in  
main shipping channel  
Number of toll lanes  
Ventilation fan capacity  
Power supply

*6,088 ft (1852 m)**5,256 ft (1604 m)**2 dual lane**22 ft (6.7 m)**6% (1 : 16)**16 ft (4.88 m)**40.5 ft (12.34 m)**14**2.6 million c.f.m.**4.5 MVA*



**MAIN  
SUB-CONTRACTORS  
AND SUPPLIERS  
TO CONSORTIUM**

Paul Y Construction Co Ltd Hong Kong

Pyrok (Surface Treatment) Ltd  
Highbridge · Somerset

Wimpey Asphalt Ltd London W4

H. H. Robertson (UK) Ltd  
Ellesmere Port · Cheshire

W. Richards & Sons Ltd Middlesbrough

British Steel Corporation London WC1

Imperial Chemical Industries Ltd  
Stevenston · Ayrshire

Stressed Concrete Design Ltd  
London SW4

Cyril Parry Ltd London N10

The Taikoo Dockyard & Engineering Co  
Hong Kong

South Durham Steel & Iron Co Ltd  
Middlesbrough

McCall & Co Ltd Sheffield

Green Island Cement Co Ltd Hong Kong

Ilster Hutte/Peine West Germany

Frederick Parker Ltd Leicester

Nordberg Mfg Co London W4

Crompton Parkinson Ltd Newport

Messrs Propulsion Leiden · Holland

The Shell Company Hong Kong Ltd  
Hong Kong

*Administration Building*

*Sprayed Ceramicoat finish to  
walls and ceiling*

*Road surfacing*

*Galbestos cladding*

*Ceiling support steelwork*

*Structural steel and plate*

*Explosives, detonators, etc.*

*Rock anchor equipment*

*Design and detailing of tunnel  
lining formwork*

*Screed-and-lay barge and caisson  
for North Ventilation Building*

*Larssen sheet and box piles*

*Reinforcement*

*Cement*

*Peine piles*

*Crushing plant*

*Cone crushers*

*Stud welding equipment, batteries, etc.*

*Screed-and-lay barge design and  
co-ordination*

*Fuel and lubricating oils and equipment*

**SUB-CONTRACTORS  
TO N.V. PHILIPS'  
GLOEILAMPENFABRIEKEN**

Edgar Allen Aerex Ltd	Sheffield	<i>Ventilation equipment</i>
Ottermill Switchgear Ltd		<i>Medium-tension switchgear</i>
Ottery St Mary	Devon	
Ottermill Products Ltd	Ottery St Mary · Devon	<i>Distribution boards</i>
Pye Group	Cambridge	<i>Communications</i>
Automatic Control Engineering Ltd		<i>Toll registration equipment</i>
Sidcup	Kent	
Concrete Utilities Ltd	Ware · Herts	<i>Lighting columns</i>
Crompton Parkinson Ltd	Derby	<i>Cables</i>
BICC Ltd	London WC1	<i>Cables</i>
Dale Electric of Gt Britain Ltd		<i>Stand-by generator</i>
Filey	Yorkshire	
Dancol Engineering Ltd	Feltham · Middlesex	<i>Control systems</i>
Weir Pumps Ltd	Alloa	<i>Pumping</i>
A. Reyrolle & Co Ltd	Hebburn · Co Durham	<i>High-tension switchgear</i>
Otis Elevator Co Ltd	London EC3	<i>Lifts</i>
Franco Signs Ltd	Surbiton · Surrey	<i>Traffic signs</i>
Lindley Thompson Ltd	Slough · Bucks	<i>Transformers</i>
GEC Transformers (Hackbridge) Ltd		<i>Transformers</i>
Broadstairs	Kent	
Pyrene Co Ltd		<i>CO<sub>2</sub> and foam systems</i>
Sunbury-on-Thames	Middlesex	
Durasteel Ltd	Greenford · Middlesex	<i>Fire doors</i>
Sir Howard Grubb Parsons & Co Ltd		<i>CO and PV detection systems</i>
Newcastle-upon-Tyne		
S. W. Farmer & Son Ltd	London SE13	<i>Canopy steelwork</i>





## **ACKNOWLEDGEMENT**

*The Consulting Engineers wish to acknowledge the invaluable assistance given to them by various organisations (too numerous to list here) and, in particular, wish to thank the Cross-Harbour Tunnel Co Ltd and the Government of Hong Kong for the guidance given both in the planning and construction stages of this project.*



N.B. - This is ~~Handbanned~~ tunnel looking south.  
Car is facing wrong way.

**BROCHURE  
COMMISSIONED BY**

*Scott Wilson Kirkpatrick & Partners*

*Freeman Fox & Partners*

*Costain International Ltd*

*Redpath Dorman Long (Contracting) Ltd*

*N.V. Philips' Gloeilampenfabrieken*