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.
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.
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.
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,
CONSTRUCTION OF IMM
Concrete Placed in Keel by Pump

Assembly of Unit and Installation of Internal and External Reinforcement

Form Concrete Keel and Fit Temporary End Bulkheads and Launch Unit (6,000 Tons)

Unit Towed to Jetty

Screed and Lay Barge "River Severn"

Lay Barge Lowering Unit after Placing Final Concrete to Produce Negative Buoyancy

Excavating Bed of Channel

Screeding Bed of Trench

Bucket Grab on Pontoon

Line to Anchor

Sea Bed

Screeded Bed

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

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
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
Plant annunciator
Vehicle height
gauge alarms
CO and petrol
vapour monitoring
Tolls monitoring
HT monitoring
Fan monitoring
Air duct door
monitoring
Toll alarms
Pump monitoring

SUPERVISOR
Toll booth communications
PABX telephone
Control room CO₂
operation
Ventilation duct
waterspray
Fan controls
HT switchgear
controls
Toll demand record
and counters
Loud address
system (staff)
Nadir sump waterspray
Ventilation controls

TOLL & PLANT
DESK

CCTV monitoring
Vehicle height
gauge alarms
Traffic light monitoring
Traffic signs monitoring
Fire alarm monitoring

PAX telephone
PABX telephone
Fire and police
direct telephones
Emergency telephone
CCTV camera control
Radio telephone
Traffic light control
Upper air-duct alarms
Fire alarms
Lighting control
Traffic sign control

CO and petrol vapour alert
Lighting levels
Water levels
Tolls processor
Fire alert

CO and petrol vapour recording and nadir
sump foam
Tunnel lighting
dimming control
Pumps control
Tolls recording
Fire alarms and fire
headquarters summons
CO₂ transformer and
HT switchgear
Traffic light control
in case of 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.
STATISTICS

MAIN
Total tendered sum – £18,667,000

CONTRACT
Contract period – 3 years

PRINCIPAL
Joint Consulting Engineers’ report
Granting of franchise by Hong Kong
Government to Hong Kong Cross-Harbour
Tunnel Co Ltd

DATES
Project out to tender
Tenders returned
Contract signed
Work began at site
Tunnel completed across harbour
First traffic through tunnel
Tunnel opened formally

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

April 1961

August 1965

October 1966

February 1967

June 1969

September 1969

February 1972

August 1972

October 1972

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
Ilser 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 Ceramicocat 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
<table>
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<th>Sub-contractors</th>
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<tr>
<td>Edgar Allen Aerex Ltd</td>
<td>Sheffield</td>
<td>Ventilation equipment</td>
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<tr>
<td>Ottermill Switchgear Ltd</td>
<td></td>
<td>Medium-tension switchgear</td>
</tr>
<tr>
<td>Ottery St Mary · Devon</td>
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<td>Distribution boards</td>
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<tr>
<td>Ottermill Products Ltd</td>
<td>Ottery St Mary · Devon</td>
<td>Communications</td>
</tr>
<tr>
<td>Pye Group</td>
<td>Cambridge</td>
<td>Toll registration equipment</td>
</tr>
<tr>
<td>Automatic Control Engineering Ltd</td>
<td>Sidcup · Kent</td>
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<tr>
<td>Concrete Utilities Ltd</td>
<td>Ware · Herts</td>
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<td>Crompton Parkinson Ltd</td>
<td>Derby</td>
<td>Cables</td>
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<td>BICC Ltd</td>
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<tr>
<td>Dale Electric of Gt Britain Ltd</td>
<td>Filey · Yorkshire</td>
<td>Stand-by generator</td>
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<td>Dancol Engineering Ltd</td>
<td>Feltham · Middlesex</td>
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<td>Alloa</td>
<td>Pumping</td>
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<td>A. Reyrolle &amp; Co Ltd</td>
<td>Hebburn · Co Durham</td>
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<td>Slough · Bucks</td>
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<td>CO₂ and foam systems</td>
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<td>Sunbury-on-Thames · Middlesex</td>
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<td>Durasteel Ltd</td>
<td>Greenford · Middlesex</td>
<td>Fire doors</td>
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<tr>
<td>Sir Howard Grubb Parsons &amp; Co Ltd</td>
<td>Newcastle-upon-Tyne</td>
<td>CO and PV detection systems</td>
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<tr>
<td>S. W. Farmer &amp; Son Ltd</td>
<td>London SE13</td>
<td>Canopy steelwork</td>
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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 Nansden 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

Designed and produced by Sidney-Barton Financial Advertising  Printed by Galbraith King  October 1972