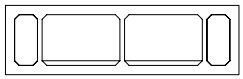
TUNNEL NAME/LOCATION/DATE COMPLETED: **Sydney Harbour Tunnel; Sydney, Australia; 1992**			**T.82 - Sydney Harbour** 
TUNNEL TYPE AND USE: Concrete box elements; Vehicular		LANES/TRACKS: Two tubes; two lanes each	
NO OF ELEMENTS: 8	LENGTH: 120 m	HEIGHT: 7.80 m	WIDTH: 29.4 m
TOTAL IMMERSED LENGTH: 960 m		DEPTH AT BOTTOM OF STRUCTURE: 25 m	
UNUSUAL FEATURES:	Most northern element was laid against the ventilation building. A short stub section of tunnel built into the ventilation building was provided with a sill beam to receive the first element. A cofferdam was built over and around the end of the element; a tremie seal to the sandstone rock was made at the front. To allow for differential settlement between element Nos 7 and 8, a special flexible joint was attached to the end of element No 7. A permeable form was used to improve durability of concrete for the elements.		
ENVIRONMENTAL CONDITIONS:	Very environmental sensitive area at scenic Sydney Harbour, with the Sydney Opera House almost in the alignment. These conditions led to the unique use of an adjacent bridge pylon for vent stack.		
FABRICATION METHOD: The elements were built in two groups of four in a graving dock. The elements have continuous reinforcement, but were cast in sections.	TOWING / OUTFITTING: Elements were cast in Port Kembla, 100 km away. Extensive model studies were undertaken to assure feasibility of tow. A freeboard of 0.5 m was used during tow. At the outfitting pier in Sydney, further ballast and placing equipment was installed, bringing elements to 10 cm of freeboard.	JOINT TYPE: Gina and Omega type of joint. A special prefabricated settlement joint was provided on element No 7, which was founded on sand. Element No 8 was connected into a sandstone wall and a tunnel was mined to it.	
WATERPROOFING METHOD:	A PVC membrane was used on the bottom. The sides and top were covered with an epoxy resin coating. Low heat of hydration with good impermeability to chloride ion penetration was achieved using a high replacement blend of Type A cement and ground granulated blast furnace slag. Suphate resistance was also good.		
PLACEMENT METHOD:	Transverse pontoons.		
FOUNDATION METHOD:	Sand-flow method utilizing pipes installed in the walls from the roof slab to the base slab. Element No 8 was supported on a foundation of cement-based grout. The other elements were founded on sand.		
DREDGING METHOD:	Alluvial deposits were dredged using a grab dredge. Sandstone deposits were dredged using a cutterhead suction dredge. Provisions made for blasting were not required.		
VENTILATION TYPE:	Semi-transverse, using side ducts. Pylons of the Sydney Harbour bridge were used as exhaust stacks at one end of tunnel		
COVER AND TYPE:	A 2 m cover of rock fill with rock armour flanks was provided. The rock fill was designed to absorb the impact of a falling anchor; the rock armour was designed to deflect an anchor dragged across the tunnel.		
ADDITIONAL INFORMATION:	CLIENT/OWNER: N.S.W. Ministry of Public Works and Roads DESIGNER: Main consultants: McDonald Wagner, Freeman Fox (HK) Rock tunnels and approaches: Mott, Hay & Anderson, Maunsell & Partners M&E: Parson Brinckerhoff, Gutterridge, Haskins and Davey Soil survey: Coffey and Partners CONTRACTOR: Sydney Harbour Tunnel Group: Transfield Pty Ltd 50% Kumagai Gumi Co Ltd 50%		