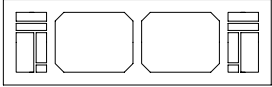


<b>TUNNEL NAME/LOCATION/DATE COMPLETED:</b> Liefkenshoek Tunnel; under River Schelde, Antwerp, Belgium; 1991		<b>T.80 - Liefkenshoek</b> 	
<b>TUNNEL TYPE AND USE:</b> Reinforced concrete box elements; Vehicular		<b>LANES/TRACKS:</b> Two tubes; two lanes each, with shoulders	
<b>NO OF ELEMENTS:</b> 8	<b>LENGTH:</b> 142 m	<b>HEIGHT:</b> 9.6 m	<b>WIDTH:</b> 31.25 m
<b>TOTAL IMMERSED LENGTH:</b> 1,136 m		<b>DEPTH AT BOTTOM OF STRUCTURE:</b>	
<b>UNUSUAL FEATURES:</b>	Specifically designed to carry vehicles with hazardous cargos. Designed to be fire and explosion resistant. Funded under a concession contract. Separate escape passageways provided for each tube. A simulation was done of an anchor dropping on the immersed elements, by impact tests on the in-situ tunnel. Dynamic responses were measured.		
<b>ENVIRONMENTAL CONDITIONS:</b>	Strong currents		
<b>FABRICATION METHOD:</b> All eight elements were built at the same time in a casting basin located in the harbour area. Each element was cast in six 23.65 m long segments. A cooling system was used to prevent cracks.	<b>OUTFITTING:</b> After all elements were finished, the dock was flooded and the dike was removed by a dredge. Transverse floats were used. A temporary post-tensioning system was used. The elements had to pass through a lock before entering the river.	<b>JOINT TYPE:</b> Gina and Omega gaskets	
<b>WATERPROOFING METHOD:</b>	The elements were divided into six 23.7 m long segments. Longitudinal prestressing was provided in the floor and roof. Carefully designed concrete was used: 1140 kg 4/28 gravel; 730 kg sand 0/5; 270 kg blast-furnace cement HL30; 80 kg flyash; 130 l water; and 3 kg superpasticiser.		
<b>PLACEMENT METHOD:</b>	A complete river and placement modelling study was carried out. The study showed that placement should be restricted to periods of neap to average tides to limit holding forces. A layer of trimming concrete was placed to reduce the freeboard without water ballast to 50 mm. Alignment towers 30 m high and other placement equipment was installed. The elements were towed using four 3,000 HP tugs. Other tugs were on standby. The element was supported on two support points on the tunnel in place, and on two jacks at the outboard end. Support pads 6 x 6 x 1.2 m were used.		
<b>FOUNDATION METHOD:</b>	Sand-water mixture was pumped through sandfill valves. To avoid siltation, this operation was started within one hour after the sinking operation was completed.		
<b>DREDGING METHOD:</b>	A cutterhead suction dredger		
<b>VENTILATION TYPE:</b>	Full transverse ventilation was used because of the hazardous cargo criteria		
<b>COVER AND TYPE:</b>	Special asphalt mattresses were incorporated in the tunnel cover design to protect the tunnel		
<b>ADDITIONAL INFORMATION:</b>	The interior of the tunnel was protected by 50 mm of insulation as a result of testing for a four-hour fire exposure. The tunnel design required some 50-60 kg of additional reinforcing to cope with a 5-bar explosion overpressure. OWNER: Ministry of Public Works and Transport DESIGNER: Haecon NV, TKB and TFD (Belgium) CONTRACTOR: Joint venture of De Meyer-Van Laere-Betonac		