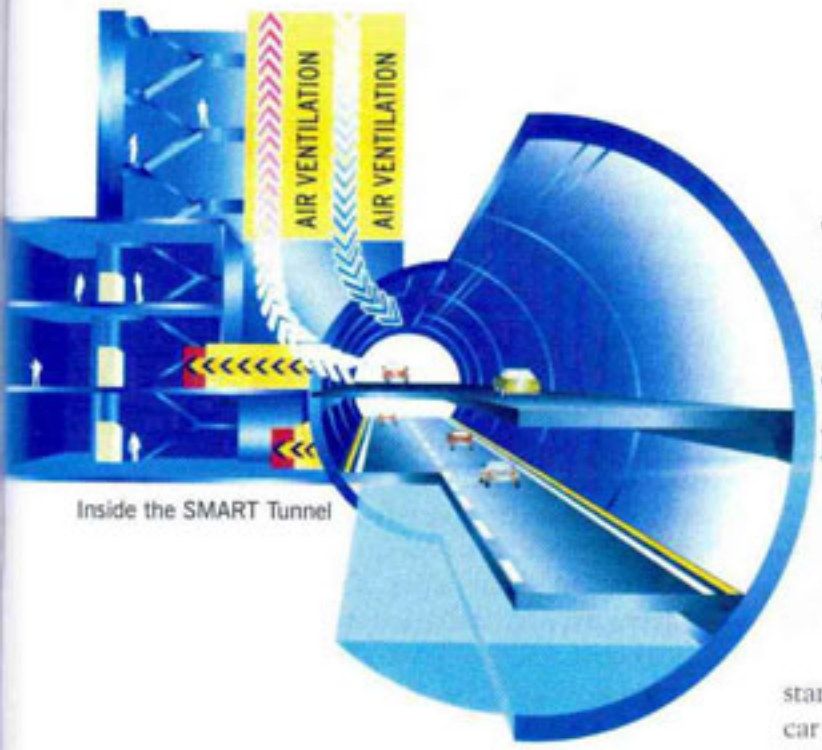
SMART WONDER



Inside the SMART Tunnel

TJCD presents smart solutions from Malaysia to alleviate periodic flooding problems in highways

If you thought Kuala Lumpur, the Malaysian capital was all about vertical growth with its landmark Petronas Towers or about horizontal progress with its new Kuala Lumpur International airport, the SMART project is all set to change this perception. It is taking development underground, literally. A large-scale collaborative endeavour worth two billion Malaysian Ringgit (exchange rate: one Malaysian Ringgit = Rs 11.4552, as on June 2005) is about to transform the cityscape of Kuala Lumpur.

The problem

When it rains heavily, the water from the Klang River floods the busy Kuala Lumpur city centre with increasing frequency. This has a direct impact on the traffic system, which comes to a standstill. Cars are submerged in underground car parks. The traffic load is shifted on to the overburdened ring roads, where the vehicles literally crawl for hours. This is detrimental to a progressive city like Kuala Lumpur, which is the financial and commercial hub of Malaysia.

Studies indicated that the critical city stretch of Sungai Klang between the Sg Klang/Sg Ampang confluence and Sg Gombak/Sg Klang confluence was a flood prone area. The low height of the Jalan Tun Perak Bridge (near Masjid Jamek) on the river further aggravated the problem, which resulted in frequent flash floods in the surrounding areas. Though the floodwater from the flash floods recedes rapidly in about two to four hours, the damaged caused is substantial. Apart from the flash floods, Kuala Lumpur also experiences Monsoon floods sometimes, which unlike the flash floods take days to ebb away.

The solution

Widening of the flood plains was ruled out due to the development of the city on the

What is SMART?

SMART is an acronym for Stormwater Management and Road Tunnel, a project under the Federal Government of Malaysia initiated to alleviate the flooding problem in the city centre of Kuala Lumpur. At the design stage of SMART, the dual-purpose concept was born from the ingenuity of the project proponents and the motorway tunnel was integrated into the system to relieve traffic congestion at the main Southern Gateway to the city centre. The project is implemented through a joint venture pact between MMC Berhad and Gamuda Berhad with the Department of Irrigation and Drainage, Malaysia and the Malaysian Highway Authority as the executing government agencies. The technical support comes from a joint venture of local design firm Sepakat Setia Perunding (sdn) Berhad with the London based Mott Macdonald group.
The SMART system will be able to divert large volumes of floodwater from entering the critical stretch of Sungai Klang via a holding pond, bypass tunnel and storage reservoir. This will reduce the flood water level at the Jalan Tun Perak Bridge, preventing spillover.

Frequent flooding is detrimental to the progress of Kuala Lumpur, which is the financial and commercial hub of Malaysia


TBM boring in progress

riverbanks. The only feasible method to control the flood was to tap the water upstream and divert part of the water before it entered the critical area. A large tunnel (11.83 m inner diameter, 9.7 km-long) was required to store and divert the floodwater. Thus, the ambitious SMART Project came into existence.

The floodwater would be diverted at the confluence of the Sg Klang and Sg Ampang into a holding pond. From there, the water would flow through the tunnel into a storage reservoir at Taman Desa before discharging into Sg Kerayong. Once completed, the SMART system will be able to divert large volumes of floodwater from entering this critical stretch via a holding pond, bypass tunnel and storage reservoir. This will considerably reduce the floodwater level at the Jalan Tun Perak Bridge, preventing spillover.

Capacity

The SMART tunnel design is capable of handling storm magnitudes of ARI (average return interval) 100 years using three-hour storm duration for peak flow capacity and six hour storm duration for flood storage. The retention capacity of the entire project is three million m^3 distributed in three important parts - the holding basin (600,000 m^3), the storage reservoir (1.4 million m^3) and the long tunnel in between (1 million m^3).

Extra benefit

A central 3 km-long section of the water tunnel would be used as a 2x2-lane road tunnel when the flood diversion is not in operation. The construction cost of this motorway tunnel would be recovered by toll collection concession from the government. This motorway tunnel will considerably ease the overall traffic situation. This double-deck tunnel, meant only for cars, will provide an alternative route for motorists from the Southern Gateway, i.e., Kuala Lumpur-Seremban Highway, Federal Highway, Besraya and East-West Link entering and exiting the city centre. With an operating speed of 50 km/hr, it will reduce traffic congestion at the Southern Gateway leading to the city centre. The travel time will be reduced drastically. Just to cite an example, the expected travel time from the Jalan Istana Interchange-Kampung Pandan is a mere four minutes compared to ten to fifteen minutes using the existing roads.

Components of the SMART system

- A stormwater tunnel 9.7 km in length
- A motorway tunnel (within the stormwater tunnel) 3 km in length

- Ingress and Egress connections to the motorway tunnel linking Kuala Lumpur-Seremban Highway

Ingress and Egress connections linking the motorway tunnel to Jalan Sultan Ismail and Jalan Tun Razak

- A holding basin at Kampung Berembang (off Jalan Ampang)
- A storage reservoir at Taman Desa (ex mining pond)
- A twin-box culvert to release flood discharge from storage reservoir
- An operation control centre complete with administration, supervision, river management and traffic management facilities for management, operation and maintenance of the SMART system

Operation of combined tunnel

The operation of the SMART system works on the three-principle mode of operation based on the flood discharge at Sg Klang/Sg Ampang confluence and the operation status of the motorway.

The monitoring system of the catchment area pre-warns the occurrence of floods. Under normal condition, where there is no storm or low rainfall, no floodwater will be diverted into the system (MODE I). During moderate storms, the SMART system will be activated and floodwater will be diverted into the bypass tunnel in the lower channel of the motorway. Up to this stage, the motorway section will remain open to traffic (MODE II). During major storms, MODE III will be activated and the motorway will be closed to traffic. Sufficient time will be allocated to allow the last vehicle to exit the motorway before the automated watertight gates are opened for floodwater to pass through. In this event, the full cross section of the tunnel will be available for water storage and diversion. The motorway will be re-opened to traffic within 48 hours after the closure.

Objectives

Stormwater tunnel

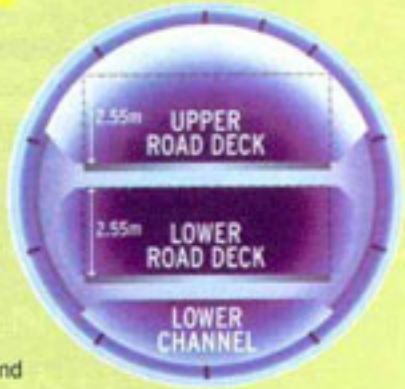
- To divert floodwater away and bypass the city centre
- To regulate and keep the water level in Sg Klang manageable throughout the year
- To improve the efficiency of the hinterland drainage within the city

Motorway tunnel

- To provide traffic relief on the main Southern gateway to the city centre from the South (KL-Seremban Highway) and the West (Federal Highway)
- To provide an alternative traffic dispersal system for the area
- To reduce travelling time

Stormwater Tunnel

Length: 9.7km
Diameter: 11.7m
Storage capacity: 1,000,000 cubic metres
Tunnelling method: Tunnel Boring Machine (TBM)
Origin of tunnelling technology: Germany
TBM type: Slurry Shield
Largest in South East Asia and 2nd Largest in Asia




The 3 km motorway

Once completed, the SMART system will be able to divert large volumes of floodwater from entering a critical stretch of the city

Safety measures

- Automated twin water-tight flood control gates at both ends of the Motorway Tunnel
- Four ventilation shafts divide the road tunnel into three, approximately one km-long sections. These powerful air ventilators would constantly renew the air and maintain the air quality within the motorway. To protect the ventilation system during floods, the systems consist of a series of shafts, each containing an exhaust and fresh air injector. This design

enables the fans to be situated outside the SMART tunnel and also allows for smoke control in the event of a fire

- The ventilation shafts also double up as escape staircases to the surface
- Cross passages are built at about every 250 metres
- Smoke doors provide smoke free environment
- Electrical compartment chambers provide a dry environment to equipment that cannot be submerged
- Fire fighting, telecommunication and surveillance equipment are available at one km intervals

Method of construction

Kuala Lumpur city sits on karstic limestone geology with high ground water table. The name Kuala Lumpur in itself explains the city's geological predicament. Kuala means 'river convergence' and Lumpur means 'mud.' The special features of karstic limestone include cliffs, pinnacles, cavities, collapsed cavities and sinkholes. Overlying these karstic limestone is loose alluvium - remnants of the previous extensive tin mining activities in the region. Moreover, the project work (including the Herculean excavation process) had to be accomplished through an already congested city. This in itself presented great challenges to the construction of the tunnel.

Due to the nature of the soil condition, a construction method that would have minimal negative impact on the geological condition of the soil was required. Hence, the tried and tested Slurry Shield Tunnel Boring Machines (TBM) were selected. Tunnel construction using TBM is the presently most advanced and cost effective method used across Europe.

Tunnelling

The Slurry Shield TBM was chosen after much research, study and survey. This machine is designed to overcome problems of groundwater drawdown. Two Slurry Shield TBM are being used in this project. Both have started from the JKR field area in Jalan Chan Sow Lin. The first machine, Tuah heads north under Jalan Tun Razak and Jalan Desa

SMART Facts

Who: A project undertaken by the Government of Malaysia - Department of Drainage and Irrigation Malaysia, Malaysian Highway Authority

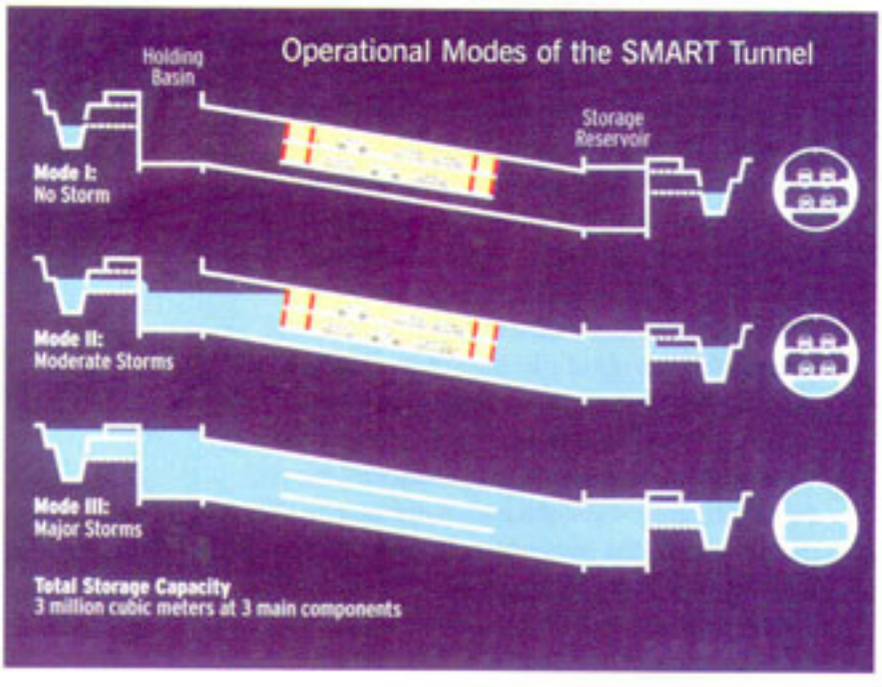
What: The longest tunnel project in Malaysia. One of its kind dual-purpose tunnel project incorporating stormwater and motorway

Where: A 9.7 km tunnel spanning across the city centre of Kuala Lumpur

When: Construction started in January 2003. Scheduled completion is December 2006

Why: 1. For flood mitigation and 2. As a means of reducing traffic congestion between the Southern Gateway and the city centre

Under normal condition, where there is low rainfall or no storm, no floodwater will be diverted into the system



About TBM

Shield length: 10.245 m
Shield weight: 1.500 tonnes
Total length: 70. 0 m
Cutterhead diameter: 13.260 m
Maximum advance speed: 30 mm/min
Minimum steering radius: 200 m
Total installed power: 8,200 kVA
Cutterhead electrical power: 4,000 kW

Pandan before terminating at the pond at Ampang, behind Gleneagles Hospital. The second machine, Gemilang heads south under Jalan Chan Sow Lin and the KL-Seremban Highway next to the Sg Besi airfield before terminating at the existing pond in Taman Desa. The TBMs will be carrying out 95 per cent of the entire tunnelling activity. The remaining five per cent will be done by using the cut and cover method.

Main parts of TBM

The slurry shield tunnel-boring machine consists of four main parts. The first is the Rotary Cutter Head with tungsten pick bits used for excavation of soil and disc cutters used for the excavation of rock. The second part of the machine is the Bulkhead located immediately behind the Rotary Cutter Head. This is where the pressured bentonite slurry shield is formed to provide stability during the tunnel excavation. The third part of this machine consists of hydraulic rams, which are used to propel the machine forward and keep the tunnel in its right alignment. The fourth and the last main part of the machine is the tunnel lining erector used to install the pre-cas t concrete lining of the tunnel.

Other parts of TBM

Other parts complementing the main parts are two boogies on rails that house electrical, slurry pumping, ventilation equipment and cable and pipes. The pre-cast concrete linings for the tunnel are transported continuously to the erector by boogies on rails. These linings are then hoisted and placed in the correct position in the tunnel with the help of vacuum pads attached to hydraulics arms. The arms are extended to keep the linings in place while the linings are bolted together. The void between the excavated ground surface and the linings is immediately filled with cement mortar grout under pressurised conditions to ensure all the voids are completely filled.

Exemplary achievement

The SMART Project has brought together diverse elements of the infrastructure industry with great success. Considering the magnitude of the challenges confronted by it, the SMART project is more than a floodwater or transport solution. In combining these two elements on such magnificent scales, it has elevated tunnelling to the higher levels of technical efficiencies and functional possibilities. This amazing project is an infrastructural marvel that will also serve as an example of what administrative willpower can achieve in order to solve problems. So far, the SMART project has successfully prevailed over all difficulties with tremendous excellence and is heading towards its scheduled completion time. At a time when the colossal expenses involved often work against the realisation of many ambitious tunnelling schemes across the world, the SMART Project definitely deserves a closer look for being an extraordinary dual-purpose solution.

The SMART Project has brought together diverse elements of the infrastructure industry with great success

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