M6 Highway Collapse

With recognition of courageous and very successful projects, there were presentations also about disastrous failures. Nick Barton gave a presentation about his hypothesis and findings for possible causes of the fatal collapse of the Pinheiros metro station cavern on the Sao Paulo metro system in Brazil in early 2007[12]. The collapse claimed seven lives and is the topic to be presented at the June meeting of the British Tunneling Society in London at the ICE on Thursday, June 18, 2009. Barton suggested that designing metro systems at a deeper level to avoid the risk of sallow excavations in soft and weathered ground would be policy worth considering.

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Gallert station excavation on the Budapest Metro Line 4

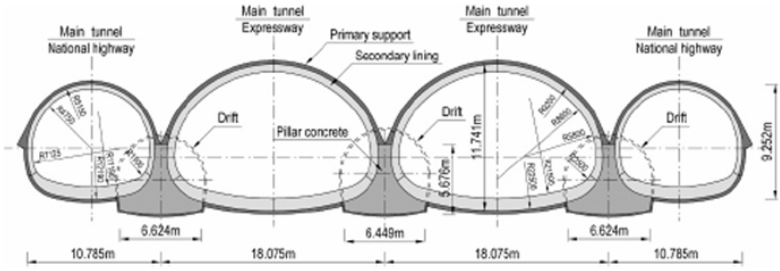
- 

Fig. 1 – Typical cross section of Shoji Tunnel

Design of the Shoji Transportation Tunnel in Japan[11]

Two paper presentations, and one of the post conference technical tours, was to a long tunnel on the new M6 highway project in Hungary which suffered a major collapse of the twin SCL/SEM tubes a year ago[13]. An initial failure saw a section of about 100m across both tubes collapse and a further 70m behind that collapse a week later. Following stabilization of the zone and installation of support diaphragm walls either side of the alignment, re-excavation of the tunnels through the failed alignment has commenced and was viewed by the technical tour visitors.

Aerial view of the twin tube M6 highway tunnel collapse

Although too recent for there to have been presentations about the disaster, there was discussion in the corridors about the open-cut excavation collapse on the Köln Metro in Germany in April[(14)] where recovery efforts of the historic data from the collapsed archive building is concluding and reconstruction of the failed track cross-over structure is being planned. Construction elsewhere along the new metro line has continued through the aftermath of the devastating failure event.

Speaking of different perspective disasters, Nasri Munfah of the USA addressed the vulnerability of underground infrastructure, particularly transit systems, to acts of terror following the incidents of the saran gas attack on the Tokyo subway system in 1995 to terrorists' attack in New York in September, 2001 and subsequently on the London Underground and the Madrid railway systems[(15)].

Nicoll Highway collapse

COVER STORY: Safety First in SMART tunnel project
Idros Ismail

Apr 25:
An innovative civil engineering works, the RM2 billion SMART tunnel project is currently under way in the heart of Kuala Lumpur. IDROS ISMAIL looks into the safety aspect of the project in the light of recent events.

THE recent highway collapse in Singapore highlighted the inherent danger in major excavation

works, especially in highly built-up areas, given the unpredictable behaviour of soils that are disturbed from their natural state.

While the causes will be investigated, the effects have been dramatic.

A 100-metre stretch of the Nicoll Highway crumbled when its foundations failed. Three bodies, including that of a Malaysian crane driver, have been found while one is still missing, believed trapped under the mangle of earth, machinery and steel that caved in.

Observers were quick to point to the mass rapid transit (MRT) line being constructed adjacent to the collapse.

The wall supporting a 20-metre deep open-cut excavation collapsed when the steel struts propping it buckled, evidence of the huge earth pressure the wall was subjected to.

The situation wasn't helped that the earth underlying the excavation is marine clay. Civil engineers will admit that marine clay is one of the most difficult types of soil to work in, especially when it involves deep excavations.

The Singapore incident only serves to remind us of one of the most fundamental laws of physics ? that for every action, there's a reaction.

Could it be that the huge earth pressure induced by the open-cut excavation was too much to handle by the temporary steel shoring works? Which brings us to the Stormwater Management and Road Tunnel (SMART) project in Kuala Lumpur ? the dual-purpose package that is expected to handle the city's flash flood problem and provide an easier access for motorists from the south directly into KL's Golden Triangle.

The 9.7-kilometre long tunnel, which incorporates three kilometres of double-deck motorway, commenced in January last year and is scheduled for completion in 2006.

So far, 25 per cent of the project has been completed. But the crux of the construction ? the tunnel excavation ? has yet to start. That aspect of the project would be the most challenging for the SMART turnkey contractor, MMCEG-Gamuda JointVenture.

According to the general manager of the consortium, Param Sivalingam, excavation is expected to start sometime late next month when the tunnel-boring machine (TBM) is assembled, tested and commissioned.

Costing a whopping RM200 million and manufactured in Germany, one TBM is currently in an advanced stage of assembly on site at the beginning of Jalan Cheras. It is one of two that would burrow through the entire length of the SMART tunnel.

A massive hole in the ground, measuring 150 metres long, 20 metres wide and 25 metres deep, has been excavated to accommodate the giant moles. This assembly shaft will also be the starting point of the tunnelling.

But the project is only a quarter way into its implementation, much of which has been confined to ancillary works such as retention ponds, drainage channels and above-ground entry and exit roads into the proposed tunnel.

It is inevitable that a project of such a nature and magnitude would raise public concern, especially with regard to the huge assembly shaft for the TBMs for groundwater table will be altered due to the inflow of water into the shaft.

Although the exposed surface of the shaft, including the base, will be grouted with cement to prevent ingress of groundwater, it is almost certain a large amount of water will make its way into the shaft.

Geologists say the lowering of water table in limestone formation will affect the bedrock's stability. And much of KL is underlain by such formation. In fact, the tunnel route is almost entirely underlain by limestone.

So with the attendant risks that go with the construction of the 13.2metre tunnel (almost as tall as a four-storey building) in Kuala Lumpur's limestone rock and alluvial soil, what measures are in place to ensure the safety of people and property? Already the residents of Ixora Apartments in Jalan Tun Razak have cause to be concerned. They have seen sinkholes and widening cracks in the building, and have been jolted by the sounds of blasting works near their residence.

The Drainage and Irrigation Department, the project manager, in a dialogue with the affected residents, has assured residents that safety is paramount and that the project will be halted if it is deemed necessary.

Well and good. But is there any guarantee that more sinkholes would not appear in the foreseeable future? The DID promptly directed an independent geo-technical and structural consultant to investigate the Ixora incident.

The contractor had undertaken immediate remedial works to arrest the problem before the sinkhole could expand and cause more serious effects.

To stabilise the "sink", concrete grout was pumped into the cavity to fill the void caused by the sinkhole.

Geo-technical engineer Dr Gue See-Sew, who has been involved in the investigations of many soil failures in the country, has completed a preliminary study of the sinkhole problem for the DID.

His main task was to check if the sinkhole had affected the building foundations.

"The good news is that the building is founded on micro-piles embedded into bedrock. So the foundation integrity is intact.

"The immediate measure is to drill a hole near the sinkhole to detect the cavity. Cavities, formed over millions of years by dissolution of limestone, are very common under KL's karstic condition.

"Loose soils from above the cavity are dislodged when the groundwater level is lowered due to excavation and collapses into the cavity. The concrete grout will ensure the sinkhole is stabilised," says Gue.

He feels that when the TBM assembly shaft is completely sealed to prevent ingress of water, the groundwater table will stabilise and rise to its normal level, thereby stabilising the areas around the shaft.

He says that the next phase of investigations is the close monitoring of columns, beams and other structural components of the building.

"More instruments to gauge soil movement and markers to monitor ground and building settlement have been installed.

"We are closely observing if there are any depressions in the ground caused by secondary movement of soil into the sinkhole." On residents' concern over the blasting works and the vibrations emanating from it, Gue says that the vibration intensity has been measured and been found to be within the permissible limits set by the authorities.

"The building is about 150 metres from where the blasting works were. As you know, the attenuation decreases with distance," he says.

"The vibration level at the Ixora entrance was 4mm per second, which is far below the allowed limit of 12mm per second. In fact, during blasting, the vibration level on the fifth floor was 0.8mm per second." The resumption of blasting works at the site will only be decided when the authorities are satisfied that it will not affect the safety of the residents, based on Gue's report.

But even as Gue is finalising his preliminary findings, more cases of sinkholes have appeared. The first three weeks of April have seen the occurrence of six numbers of sinkholes of varying sizes in the vicinity of the TBM assembly shaft.

The contractor had, in a dialogue with the affected residents, briefed them that immediate remedial grouting works had been done and assured that the situation would be closley

monitored.

As the contractor puts it: "We have to work on the assumption that the problem of sinkholes is linked to the excavation of the shaft. "Even if later we find out it's not our fault, we will attend to any complaints. We have to act as if the problem is ours." Whether that will satisfy the public remains to be seen as the project goes into high gear when the boring really starts.