Cairo Metro tunnel collapse

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A segment falling out of a ring is reported to be the cause of a sinkhole on a TBM metro tunnel drive in Cairo, Egypt. Details are scares but a knowledgeable source in Cairo, who wished to remain anonymous, told *TunnelTalk* that it was a segment at about the shoulder point in the previous ring that fell when the last segment of the subsequent ring was being inserted. The segment was in a ring just leaving the tail shield and its fall allowed water and soil to pour into the tunnel under the tailseal, filling the interior of the TBM and the tunnel and generating the ground loss that created the sinkhole crater on the surface.

Slurry filled sinkhole

The collapse occurred above the 9.4m-diameter Herrenknecht Mixshield being used to build the single-tube double-track running tunnel for Phase 1 of Cairo's Line 3 extension. Operated by the French-Egyptian construction JV led by Vinci and including Bouygues and Egyptian partners ARABCO and ORASCOM, the large slurry TBM was advancing under Al-Geish Street in the Bab Al-She'riya district.

There were no injuries and no structural damage to buildings in the area although 80 families in 10 buildings were evacuated pending safety inspections. A parked car also slid into the 15m-20m diameter x 20m deep sinkhole when it appeared on Thursday night, 3 September. Another six parked cars were saved from doing the same and traffic on Al-Geish Street came to a stop when people saw the street sinking.

It took three days to fill the sinkhole with more than 1,000m3 of concrete but this failed to stabilise the situation. The tunnel is being excavated beneath one of the oldest parts of Cairo through ground once covered by the Nile and comprising an upper 8m layer of mixed fill on base deposits of very soft, highly permeable sand and sandy-clay soils, all under a high groundwater table. The weight of the concrete on the soft materials caused a second ground collapse on the following Sunday night.

By Jon Jensen, Video Journalist, Cairo

Recovery of the situation has begun with operation of three grouting machines working around the clock to inject chemical grout, vertically and on inclines, to strengthen the soil around the TBM and the tunnel. This will support a 25m-deep excavation to uncover the TBM, repair the broken ring, and eventually clear out the buried TBM.

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Sheet piling or diaphragm walls are being considered for support of the recovery excavation and if the grout injection proves ineffective, ground freezing is an ultimate option.

For the moment, the tunnel and the TBM remain inaccessible from the access shaft. Above the TBM, the residents of the evacuated buildings have returned, local electricity, water and natural gas services, cut as a result of the collapse, have been restored, and the car swallowed by the crater has been recovered. Despite the old age of the buildings, there has been no structural damage although the condition of two buildings, one of them the local police station, remains under surveillance.

Cairo Governor Abdel-Azim Wazir and Cairo Metro owner, the National Authority for Tunnels (NAT), have established a committee to investigate the possible cause of the collapse. This is dependent on gaining access to the TBM operators' cabin and recovering data

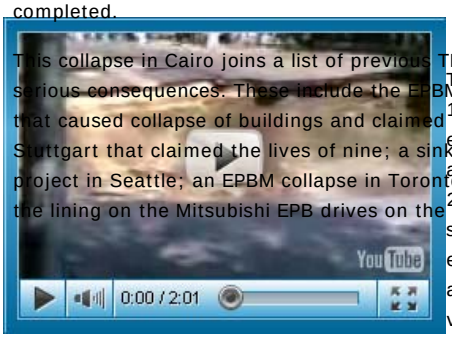
The veteran Mixshield was well into the 4.2km Phase 1 drive of Line 3

The veteran Mixshield was well into the 4.3km Phase 1 drive of Line 3 when the collapse occurred, and had about 1.2km left to excavate before its final breakthrough for the contract. Roussel and managers with the NAT were under contract or declined to comment when contacted by *TunnelTalk* and ahead of an official report due to be released once full investigation is completed.

about the final hours of the machine's operation before the collapse. Just why a remains a point of speculation. Was there an erector malfunction? Was there ins build of the current ring? Or was the bolting of the completed ring not installed a yet to leave the tailskin and come under the influence of the annular grout.

Line 2 running tunnel in operation

The Herrenknecht slurry TBM, has been working in Cairo since the late 1990s when it was introduced as a set of twin Mixshields used to excavate the tunnelled sections of the metro system's Line 2. The TBMs are fitted with vacuum segment erectors and have completed about 20km of running tunnel through the highly water charged sands and soils of the Nile Valley and under both arms of the river. During excavation of Line 2, an old hotel building was evacuated as a precaution and as the TBM passed through the building collapsed due to the vibration of the TBM and tunneling operations.



This collapse in Cairo joins a list of previous TBM tunnel sinkholes that had serious consequences. These include the EPBM collapse in Porto, Portugal that caused collapse of buildings and claimed a life; a sinkhole in Stuttgart that claimed the lives of nine; a sinkhole above the Mixshield working on the Brightwater sewer tunnels project in Seattle; an EPBM collapse in Toronto also caused by ground loss through the tailseal; and voids found behind the lining on the Mitsubishi EPB drives on the Beacon Hill transit tunnels in Seattle.

Courtesy Al-Ahram On-Line

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TunnelTalk was in communication with JV Project Manager, Rémy Roussel in Cairo when the incident occurred in early September. At the time the news being reported was an order by the Vinci-led JV of a new 9.46m diameter EPB TBM from NFM Technologies to excavate 5,138m of single-tube double-track tunneling through mainly clay, sand and sandstone conditions for Phase 2 of Line 3. Phase 3 of the Line 3 extension will continue the line westward with a new underpass of the River Nile, and Phase 4 will take Line 3 the last section east to the city's international airport.

References

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Sinkhole bothers Brightwater - *TunnelTalk*, March 2009
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