

## **INCIDENT AT NICOLL HIGHWAY - TECHNICAL BRIEF**

### **Background**

The cut and cover excavation that collapsed on 20 April 2004 is part of Contract C824 of the Circle Line (CCL) project. The excavation work is within the Nicoll Highway contract boundary and is required for the construction of tunnels towards Boulevard station.

The main contractor for these works is Nishimatsu-Lum Chang Joint Venture. The client for the Circle Line project is the Land Transport Authority of Singapore (LTA). The scope of this design and build contract comprises of Nicoll Highway and Boulevard Stations, 1,600 m of cut and cover tunnels, and 800 m of bored tunnels.

### **Method of Construction**

The Nicoll Highway and Boulevard Stations and the cut and cover tunnels for the contract were being constructed using 'bottom-up' method. The diaphragm wall used at this section of the cut and cover tunnels is 800mm thick.

The excavation was kept open by a strutted system comprising of steel king posts, walers and struts. Struts are spaced at between 3.0-3.5m. Width of excavation is about 19.85m and about 33.5m deep.

Two layers of jet grout (JGP) were also installed to minimise deflection and ground movement during the excavation work. The first layer (1.5m thick) of JGP has been placed at about 28m below ground level and the second layer (3m thick) was installed 33.5m below the final formation level.

### **Incident**

On 20 April 2004 at about 3.30pm, a section of the temporary diaphragm wall supporting the excavation adjoining the Nicoll Highway Station box had collapsed. This caused soil subsidence of the immediate surrounding area that resulted in substantial damage to about 100m section of Nicoll Highway carriageway adjacent to the abutment of Merdeka Bridge. The incident had resulted in 4 fatalities. No motorists were travelling along that section of Nicoll Highway when the incident happened.

At the time of the incident, the excavation had reached the 9<sup>th</sup> level of struts (out of a total of 10 levels). The first layer of JGP had been excavated. The area of the collapsed zone was approximately 100m by 130m.

### **Immediate Safety Measures Taken at Site**

A damaged canal within collapsed area was blocked up to prevent tidal water from Kallang River from flowing into site. Canvas sheets were placed on slopes around the site and any open areas to protect the soil and slopes. Cracks in the ground around the site were filled with grout to prevent water seepage. These efforts were

effected to prevent further movement within the collapsed area and ensure the safety of the rescue personnel and the adjacent structures.

Surrounding buildings were inspected to ensure that they are safe for use. These buildings were continuously monitored and checked round the clock to ensure that they were stable and that the structural integrity of the buildings was not at risk.

Additional settlement markers were installed in the nearest building, Golden Mile Complex, to monitor movements of the building edge nearest to the collapsed site. Nine electrolevel beams (EL Beam) were installed to monitor movement of the building. Four additional inclinometers were installed to monitor lateral deflections in the soil. Readings are being taken every few hours.

Five EL Beams and 2 additional inclinometers have also been installed at Golden Mile Tower (the next nearest building which is about 200m from incident site) to monitor this building closely.

The approach slab before the abutment of the Merdeka Bridge which is just next to the incident site had also collapsed. A cut was made between the first and second spans of the bridge to separate the first span and mitigate the risk of the first span dragging down the entire bridge in the event of movement of the first span. This work commenced on 23 April. Eight prism points (to measure x-y-z movements) and 5 tiltmeters were installed to monitor the bridge.

### **Stages of Recovery**

The first stage of the recovery process was to start filling the immediate collapse site with 'foam' concrete, a low strength and low viscosity concrete. This type of concrete can flow into the small voids between the debris and displace the water that has flowed into the excavation. This was to stabilise the void and prevent further soil movement and subsidence of surrounding ground. Foam concreting commenced on 23 April. The low strength of the concrete mix allows it to be removed later when excavation re-commences following the recovery process.

This was then topped up by a layer of higher strength mass concrete in the second stage to form a roughly horizontal surface.

The third stage was to carry out localised filling of mass concrete, or backfilling of soil, to stabilise the outer areas of collapsed slopes.

The fourth stage is to remove whatever debris (steel beams) that can be removed from the top, i.e. the mass concrete platform.

The fifth and sixth stages are to backfill with soil below the Nicoll Highway and above the incident site up to original ground level.

The seventh stage is to reinstate Nicoll Highway.

The eighth and final stage of restoration works is to backfill all other sunken areas up to original ground level.

After the above restoration process has been completed, new retaining walls will be installed to re-commence excavation and resume construction. Details of these works are being worked out.

### **Additional Safety Measures Taken**

The day after the incident, all contractors on the CCL were asked to carry out additional checks and further review on the design and construction of all their temporary works. In addition, LTA has been asked to re-check to ensure that all the temporary works installed at site are done in accordance with the approved drawings.

LTA has also appointed an independent panel consisting of local geotechnical and structural experts to investigate into the cause of the collapse. The panel had also been tasked to review the design and construction of the works at this site as well as other works on the Circle Line.

LTA instructed that excavation work at all the other Circle Line sites to be put on hold until the design of the temporary works and the constructed temporary works are thoroughly checked and found to be in order.

All the Professional Engineers who had designed the temporary works have been asked to confirm in writing to the regulatory agency, the Building Control Unit (BCU), that the temporary works designs are adequate following their review.

The temporary works designs have also been sent to the Building & Construction Authority (BCA) to conduct an independent design and site audit. The Government has also appointed a Committee of Inquiry (COI) to ascertain the causes and circumstances of the incident and make recommendations to prevent the recurrence of such an accident in future.