TECHNICAL NOTE 002

Lessons Learnt: Collapse of Nicoll Highway in Singapore, 2004

・ We excel through experience and learning ・

Version 02, Jul 2013

Keywords
'Undrained' soil parameters, works supervision, clarity in chain of command and in responsibility

Synopsis
It is noted that we have various live and potential projects that entail deep excavation, involving the use of steel sheet pile walls or diaphragm walls as a retaining system. This technical note revisits the collapse of Nicoll Highway in Singapore in 2004, hoping that we are reminded of the issues causing this fatal collapse and the lessons so learnt.

1.0 The Incident

The excavation concerned was 20m wide and 33m deep, measuring from the ground level, supported by 10 layers of waling and strutting, and 2 layers of jet-grout props. The failure started at the **9th level strutting connection**. Yielding of the connection allowed the diaphragm walls to deform, overloading the struts in levels above, causing them to buckle. This triggered a progressive collapse of the diaphragm walls. The failure was very rapid; only an hour elapsed between failure of the first strutting connection and the total collapse of the excavation.

2.0 Design Errors

The following design errors were reported in the inquiry:

- In the finite element analysis of the ground conditions, the mechanical properties of 'drained' soil were used for the highly plastic marine clays. This was a substantial error, leading to serious under-prediction of the forces acting on the temporary works. This in turn led to under-design in the temporary works in general.

NB – For the highly plastic marine clays found on site, '**Undrained'** soil parameters should have been used.

- In terms of the structural design of the waling and strutting system, the contractor's designer also misinterpreted the design code BS5950 in that the stiff bearing lengths were grossly over-estimated.

3.0 Construction Errors

In the installation of the waling and strutting system, the **load-spreading sprays** at the ends of the struts were **omitted**; and this omission was not picked up during the routine works supervision. Consequently, the entire axial load of each strut was directed into the waling beam through a single point of contact. Forces of about 4,000kN were being channeled through a detail designed with a capacity of 2,551kN.

4.0 Lessons Learnt

The key lessons from this event are:

- Trends of the temporary work during critical periods must be capable of being monitored.
- Those interpreting the analysis outputs must be competent to do so. The dangers of drawing conclusions from past behaviour, without careful consideration of the actual conditions, must be recognised.
- The management of uncertainty must be robust. There must be approved and tested contingency plans.
- The project must operate within a safety culture conducive to safe working. This means:
  - A 'stop work' procedure to be in place, clearly understood by all, and supported by management
  - Clarity in the chain of command and in responsibilities

- End -

For enquiry, please contact

Gary Chou
KMS / Technical Manager
Technical Department
Chun Wo Construction & Engineering Co Ltd
E gary.chou@chunwo.com
T 3758 8379
F 2744 6937