

SCOSS – Standing Committee on Structural Safety

11 Upper Belgrave Street
London SW1X 8BH

Chairman: KATE PRIESTLEY MBA CQSW HFIHEEM FRSA
Secretary: JOHN CARPENTER CENG FICE FISTRUCTE FIOSH

SC/06/101

The Collapse of NATM tunnels at Heathrow Airport

Reference: HSE Books 2000 (now out of print but available from libraries)

In October 1994 a section of tunnel being constructed at Heathrow Airport collapsed; although there were no injuries, many people were put at risk and the consequential cost was significant. A number of the lessons arising from this collapse can be applied to engineering projects generally.

The tunnel was constructed using the ‘NATM’ (New Austrian Tunnelling Method) form of construction. The safety of this approach depends upon close monitoring as work progresses; it was the first time it had been used in London clay. In view of this an extensive full scale trial was undertaken at the site prior to initiating the actual works. The method involves the use of a sprayed concrete lining, applied in stages, and in such a manner that the ‘stand-up’ time of exposed clay is not compromised. (A good description is given in Appendix 1 of the HSE report).

The HSE report describes a number of significant decisions and actions relating to procurement and control (Paras 35-51) which impacted on risk management. These included:

- Differences between the trial and the main works
- Adoption of ‘D&B’ with the construction risk taken by the contractor
- Adoption of ‘self certification’
- Use of a new contract form (the NEC) which linked payment to satisfactory completion of work
- Pressure on the monitoring sub-contractor to minimise their costs at tender stage

The process of monitoring and evaluation was a critical aspect and the report reviews this in detail. Significant shortfalls were evident including decisions on tunnel construction being made without correlation with current data on the settlement of the ground surface above the tunnel.

The cause of failure

The HSE report cites the direct cause of the tunnel collapses as a chain of events involving:

- Substandard construction in the initial length of the CTA concourse tunnel
- Grout jacking that damaged the same length of the CTA tunnel plus inadequately executed repairs
- Construction of a parallel tunnel in failing ground
- Major structural failure and progressive failure in the adjacent ground along with further badly executed repairs

The HSE labelled this as having all the hallmarks of an ‘organisational accident’ The HSE report states that ‘Hazards were not identified by all the parties and risks were not controlled,

S:\Filing\G20 - G29\G28-Collapses and the like\Text reports etc\2006\December06\SC06.101 - Collapse of the NATM Tunnels at Heathrow Airport.doc

The Standing Committee on Structural Safety is an independent body supported by the Institutions of Civil and Structural Engineers and the Health & Safety Executive to maintain a continuing review of building and civil engineering matters affecting the safety of structures.

Tel.: +44 (0) 20 7235 4535 Fax: +44 (0) 20 7 235 4294/201 9165
Email: scoss@istructe.org.uk Website: www.scoss.org.uk

during construction, through the ‘defensive’ systems (ie. preventative management systems) used by the parties’. A full evaluation of the organisational issues and the technical details of the failure may be found in the report.

Lessons from the incident

Major accident potential

- 1 Major accident hazards are manifested in events that have a low probability of occurrence, but when they do occur they have major consequences in human and business terms. It is possible to overlook their importance because they are infrequent.

Hazard and risk management

- 2 Such incidents must be prevented through sound risk management.
- 3 The lessons from past failures need to be recognised
- 4 The need to carefully consider new technologies, or those projects with the potential to significantly affect workers or the public is particularly important.
- 5 Where measurement of movements is used to monitor risk then the data must reach and be assessed by managers in an appropriate timescale.
- 6 Organisational and human factors, as well as technical aspects, should be considered

Management systems etc

- 7 It is essential to reflect human and organisational factors when devising defence mechanisms
- 8 Defences can be affected by procurement, contract forms, and differing methodologies between companies.
- 9 Production pressures must be balanced by checks and balances; these must include for conflict management.
- 10 Remedial and maintenance activities require strong organisational procedures
- 11 Management systems should be led from the top, be inclusive, and promote good communication and decision making at the appropriate level.

Statutory framework

- 12 The statutory framework provides impetus and imperative to good engineering and management.

Post report note on lessons learned and the recovery solution

Given the scale of the collapse and the major implications for the project, it is useful to note the impressive response by BAA which in concert with its suppliers rapidly addressed the key lessons and delivered a very effective recovery solution. This embraced a fully integrated team approach combining risk management with technical innovation and, from an initial prediction of one and a half years delay, the project was opened just six months later than the original programme. The ‘single-team’ approach developed for the recovery solution is described by Powderham and Rust D’Eye (2003).

References

- 1 Powderham A. *Heathrow Express Cofferdam: Innovation and delivery through the single-team approach. Part 1: Design and Construction*
Civil Engineering Practice Spring/Summer 2003
- 2 Rust D'Eye C. *Heathrow Express Cofferdam: Innovation and delivery through the single-team approach. Part 2: Management*
Civil Engineering Practice Spring/Summer 2003

Rev 1