

# Heathrow failures highlight NATM (abuse?) misunderstandings

Shani Wallis

In February 1999 the heaviest fines ever imposed following prosecution by the British Health & Safety Executive were levied against Balfour Beatty and Geoconsult following collapse of NATM station tunnels on the Heathrow Express Rail Link Project at Heathrow Airport in London in October 1994. Balfour Beatty, tunnelling contractor on the £ 440 million project, pleaded guilty to violating two counts of the country's Safety at Work Act 1974 and was fined £ 1.2 million plus £ 100,000 toward prosecution costs and were given 14 days to pay.

Geoconsult, as specialist designer to Balfour Beatty for the NATM works on the project, denied the charges but was found guilty by a jury of 12 after a 26-day criminal trial at the Old Bailey Criminal Crown Court and was fined £ 500,000 with £ 100,000 towards costs and was given two-and-a-half years to pay.

The two charges laid against each company were for failing in their duty to ensure the safety of their employees during construction of the NATM station tunnels at the CTA (Central Terminal Area), and failing to ensure the safety of those not in their employ (the general public), by exposing them to danger. For Geoconsult the charge included technical supervision of the works.

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Following a quite extraordinary trial – which has actually left no party to the proceedings unscathed – Geoconsult has lodged an appeal against both the conviction and the sentence. It claims that HSE “breached its paramount legal obligation to prosecute fairly” and that rulings on procedural orders “resulted in prejudice” against the company. Against the sentence it claims that the fine is excessive and overlooks guidelines that fines should reflect the gravity of the offence but should not imperil the existence of the company. The total £ 600,000 fine for Geoconsult is levied against an original contract value of £1 million and against a medium sized consulting engineering company. The \$ 1.3 million total fine for Bal-

four Beatty is set against an original contract value of £ 60 million and against a company within a large corporation that accounts for about 10 to 15 % of the group's £ 2 billion annual turnover. The fact that Balfour Beatty admitted guilt, the judge said, mitigated in its favour although it was made evident during the trial that Balfour Beatty “must bear greater responsibility for the collapse”.

One of the major losers in this case is the prosecuting agency itself. The HSE was severely criticised by the trial judge for its conduct of the case and was awarded only £ 200,000 of the £ 880,000 claim for costs. In the opening days of the trial and by chance, the defence team found that much of the prose-

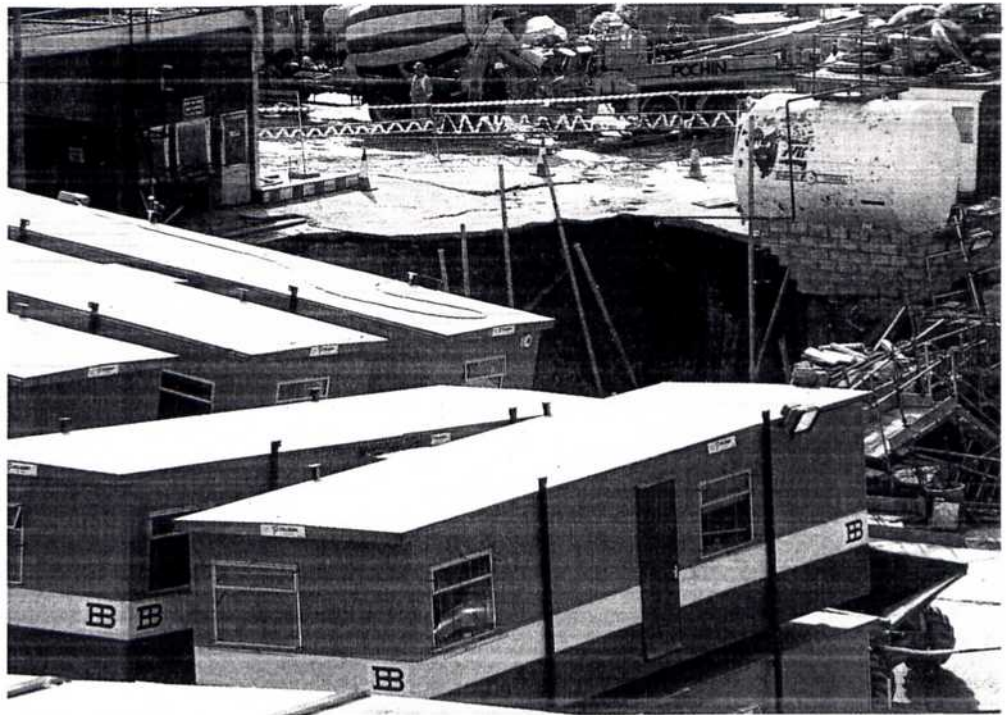
cution's main expert witness report had been directed in some cases written by leading HSE inspector. The report could not be relied upon as being independent and unbiased. As a result prosecution withdrew the report in entirety and the court allowed prosecution to depend on alternative expert witnesses Sir Alan Muir Wood and of John Hutchinson. These reports were introduced in prosecution at a preliminary hearing in November 1995 was said, to support the criminal and subsequently withdrawn expert witness report submitted by Mr Guy Lance of WS Atkins. In response, defence made application for the case to be dismissed on the grounds of “abuse” applied also for the expert witness of Muir Wood and Hutchinson to be disallowed as substitute. Both applications were denied and the case proceeded. This matter will be re-examined in Geoconsult's appeal. So although Balfour Beatty obtained a conviction, it was effectively fined £ 680,000 not including the cost of Lance report.

## The trial

During the trial, evidence revealed extremely poor workmanship; major flaws in construction management and questionable contract arrangements. Miners in tunnelling gangs told of a lack of culture in constructing the intricate joint of the NATM side-drift excavation sequence

Balfour Beatty's lowest bid £ 60 million contract was to build 8.8 km of shield-driven running tunnel and various NATM caverns including the underground station complexes at CTA and Terminal 4 on the estimated £ 440 million Heathrow Express Rail Link Project. Geoconsult was specialist NATM design engineer to Balfour Beatty. NATM was specified for design of the stations following a successful trial of the method in London Clay at Heathrow in 1992. The trial was designed and supervised by the UK office of Austria's Dr Sauer Company and was built by the Kier/Lilley/Kunz UK/German joint venture. This was the first use of NATM in London Clay and the method was subsequently adopted for the Waterloo and London Bridge stations on the Jubilee Line Extension of London's Underground. At no time in the trial did HSE or prosecution suggest that NATM as verified by the trial tunnel or designed by Geoconsult for the Heathrow Express was defective in any way. Prosecution and the HSE in its report “Safety of NATM with particular reference to London Clay” stated that NATM is a safe and appropriate tunnelling method in London Clay “providing enough care is taken” and that the Heathrow NATM structures now open to the public since mid 1998, are safe.

problems with blockages and delayed delivery of shotcrete; of regular changes in the personnel in the gangs and of little continuity of routine. Construction foremen and shift engineers told of pressures from management to improve productivity and make up for delays. Site and supervising engineers raised concerns about over-excavation of rounds by the miners; inexperience and lack of skill in the crews; and higher than expected surface settlement leading to inspection and repair of inverters where shotcrete was 50 mm instead of 250 to 300 mm thick; where there was insufficient overlap or no starter bars at all in construction joints; and where shotcrete was sprayed over rebound. Senior project management engineers questioned the apparent lack of an experienced supervision team; the apparent disregard of the many CARs (corrective action requests) raised by any engineer noticing poor workmanship; apparent disregard of SDNs (system defect notices) raised by the project management team for the attention of senior contract managers; the application of "self certification" as part of the construction contract; and early relaxation of the already disfunctioning auditing role by HEX of the contractor's self-certification system.



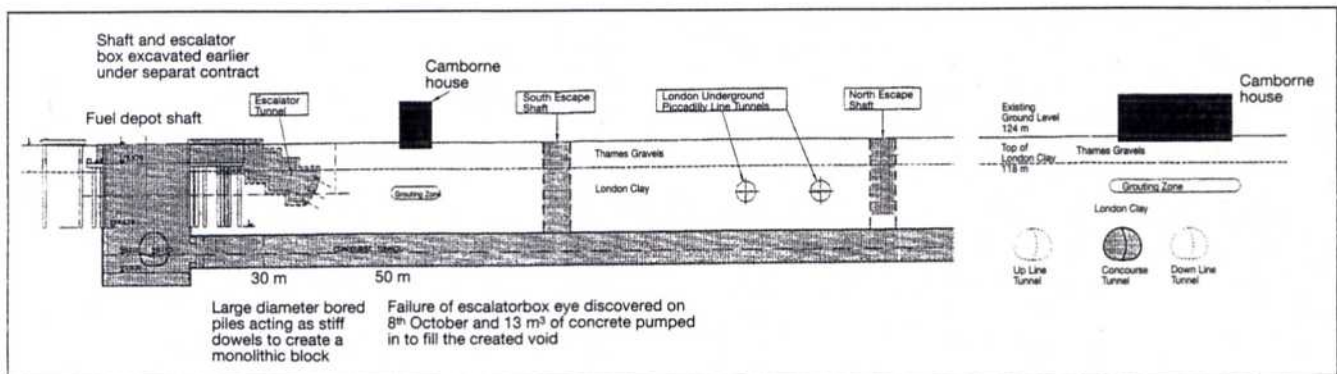
1 It was on the night of 21 Nov. 1994 that the Central Terminal Area station tunnels collapsed causing extensive damage to the surface

All of these flaws culminated in October 1994 with the ultimate collapse of the CTA NATM tunnels. Cracks in the shotcrete started to propagate farther, faster and grew wider during the early hours of the night shift (started at 7 pm) and teams were being moved from one area to another to try and repair cracks and replace lumps of shotcrete as they fell and wire mesh burst through the green shotcrete of earlier repairs.

Eventually the teams were ordered to vacate the tunnels at about 12am amid the sound of cracking and the sight of shotcrete particles raining down. At about 1am the abandoned tunnels started to collapse and continued over the two following days creating a hole on the surface and causing extensive damage to surface structures. All stabilised on the third day and with much of the underground cavity in-filled with concrete.

## The prosecution case

HSE as the prosecuting agency claimed that the collapse "was the worst civil engineering disaster in the United Kingdom in the last quarter of a century" and that it was only by chance that no-one was seriously injured or killed. As well as endangering the lives of the workers, prosecution suggested that the consequences for the public could



2 Section of the excavation works completed at the time of the collapse of the Central Terminal Area

