

Bored Tunnelling in Urban Environments – Design and Construction Issues: What Can Be A Problem and Why?



by Ir. Andrew Yeow Pow Kwei

TUNNELLING AND UNDERGROUND SPACE TECHNICAL DIVISION

THE Tunnelling and Underground Space Technical Division of the Institution of Engineers, Malaysia, recently organised a talk on ‘Bored Tunnelling in Urban Environments – Design and Construction Issues: What Can Be A Problem and Why?’ at Wisma IEM. Attended by 70 participants, the talk was delivered by Mr. Paul Heslop, the Technical Director of Amberg & TTI Engineering Pte. Ltd., Singapore. Mr. Heslop is a Chartered Engineer in the United Kingdom and a Professional Geologist in the United States of America (USA), who has extensive and diverse experience in the field of geotechnical and tunnel engineering. He provides consultation services to clients on major underground rail and road infrastructure projects.

According to Heslop, the successful design and construction of a bored tunnel project, especially when in an urban environment, present a unique set of challenges

for the owners, contractors and consultants involved. The speaker identified and discussed these challenges, highlighting what could go wrong, why it happened and how to best mitigate the risks involved. He also addressed a wide range of issues that are relevant to the client’s organisation, contractors and consultants associated with project planning, procurement, detailed design, statutory approvals, construction works, interfaces with third parties, construction supervision, instrumentation and quality control. Heslop also provided some recommendations on the key issues and risks that should be identified and addressed at each stage of a project.

Heslop then deliberated on the problems and issues that normally occur in tunnel projects from the planning stage to construction stage such as not getting the information needed, no permission for access from a third party, poor geotechnical interpretation and incomplete information. Consequently, these issues if not resolved could end up causing problems such as too many assumptions being made in the design, unforeseen or different ground conditions and obstructions encountered during construction, unexpected mixed face ground conditions and unplanned interventions, which are not uncommon in a tunneling project.

According to Heslop, the following are some of the key items that should be considered during the project planning stage:

- (a) **Project Overview** – What is the intended structure to be built and its purpose which includes the structure size and shape?
- (b) **Performance or Design Criteria** – What is the design life and constraints on movement, groundwater drawdown and vibration?
- (c) **Location** – Where can the structure be located with consideration of any adjacent sensitive structures and interfacing with third parties?
- (d) **Construction** – How will the structure be built with consideration on the excavation techniques and where will the work area or site access be located?
- (e) **Cost and Schedule** – What is the budget and schedule for the project?
- (f) **Contract** – How will the project be procured with consideration of what type of contract to be used and what are the approvals required?



APPLICATIONS

- Housing Development
- Port / Container Terminal
- Railway
- River & Dam Embankment and Landfill
- New Road Subgrade
- Airport Development
- Land Reclamation

SAVINGS

- Save on foundation and piling cost (Value Engineering)
- Save time on earthworks with less number of earthworks machine
- Save on material excavation and replacement
- Save surcharge time and material
- Save on maintenance of services etc after construction

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No. 7, Jalan BK 1/19, Kinrara Industrial Park, Bandar Kinrara, 47100 Puchong, Selangor, Malaysia.
Tel: +603-5631 8440 Fax: +603-5637 3717 E-mail: Ttmizi2000@yahoo.co.uk

In the second part of his presentation, the principle and key elements of a Geotechnical Baseline Report (GBR) was discussed with the salient points summarised below:

- GBR is a Contract Document for the allocation of commercial subsurface construction risk by setting a contractual baseline of site conditions for fair bidding and execution.
- Baseline is a contractual statement of the conditions to be encountered during subsurface construction and is used to determine when differing site conditions exist. It is always set at slightly worse than the expected conditions, depending on the risk allocation strategy of the owner.
- It is not a design document and shall not be considered as an interpretation of the ground condition, i.e. NOT a statement of geotechnical fact. However, it puts identification and allocation of ground risk at the forefront which could lower the cost of project.
- GBR is not for risk mitigation or safety.
- It must be clear and unambiguous to potential claims and shall clearly state what needs to happen and paid for in the event of a change.
- GBR must be finalised before the contract sum is determined.
- There is not necessarily an “error” if a baseline is exceeded and it does not necessarily contribute to an increase in the total outturn cost.
- Regardless of the baseline, responsibility for the safe execution of the Works always remains with the Contractor and it should not be an excuse for the Contractor for not performing the Works in accordance with the Contract Document.
- A commonly used guidance document in the USA (and now elsewhere) is the “ASCE Gold Book”.

Lastly, the speaker shared with the audience a case study and some of the lessons learnt from the Miami Port Tunnel Project as highlighted below:

- **Contract Setup:** The Public Private Partnership (PPP) Model had an agreed long term, guaranteed cost structure, with risks to be shared by all parties.
- **Innovation:** The Miami Tunnel Access (MAT) team (Concession) had allowed the length of risky cut and cover excavation to be reduced and the use of TBM to be maximised.
- **Contingency Fund:** The use of contingency fund to reduce Contractors adding contingency and the reduction of overall project cost.
- **Geotechnical Baseline Report (GBR):** The use of a 2-stage GBR by getting input from the Contractors and agreeing on the document before the start of work which reduced the future uncertainty in terms of claims.
- **Re-interpretation:** By looking at the geology and its impact on methodology, and not just the lithology, it had allowed the Contractor to select the correct means and method for the project.
- **Planning:** The allocation of adequate time for planning was the only way to achieve the best value solution.

During the Q&A session, Heslop responded to questions raised by the participants related to problems and challenges which might arise during bored tunnelling in urban environments. At the end of the talk, Heslop received a certificate of appreciation and a memento from the Session Chairman, Ir. Andrew Yeow. ■