Owner Responsibilities in the Selection of TBMs

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Presentation will cover

- ***Owner responsibilities***
- ***TBM Procurement Approach***
  - **Prescriptive vs. Performance**
- ***Survey of North American TBM rail projects***
  - **Procurement methodologies**
  - **Review of 6 major rail tunnel projects**
  - **Characteristics of Project TBMs**
  - **Trends in North American TBM procurement**

TBM Contracting approach

- ***Prescriptive.*** Owner defines TBM type, defines major TBM characteristics, requires specific means and methods for tunneling
- ***Mixed -*** Some TBM and tunneling methods are defined by owner, but contractor has significant options to meet required tunneling performance
- ***Performance.*** TBM characteristics selected and machine procured by contractor. Performance requirements specified in contract documents

Owner - Responsibilities

- **Satisfy Public Policy**
- **Operate an Efficient System**
- **Plan for the Future**
- **Design & Construct New Facilities**
- **Manage Effectively - be Accountable**

Owner - Resources

- Owner's Managerial & technical staff
- Planning and Environmental Consultants
- Consulting Management Engineers
- Consulting Design Engineers
- Consulting Construction Managers
- Construction Contractors & Suppliers, including TBM manufacturers

Owner - Management Approaches

1. Owner's staff performs all management, engineering and construction management,
2. Active and expert Owner staff, supplemented by expert / production consultants,
3. Owner performs only oversight of consultants who execute all program management, detailed design and construction management

Owner - Considerations for TBMs

- **Defined Baseline - including Scope, Schedule, Budget, Quality and Public Policy statements**
- **Tunneling sequences and drives**
- **Assessment of impact - adjacent settlement**
- **TBMs - Types and Characteristics**
- **TBMs - Procurement Strategy**
- **TBMs - Operational means & methods**
- **Risk analysis, management and mitigation**

TBMs - Types & Characteristics

- ***Basic machines* - Open or with some face support such as tables, breasting plates or doors, mechanized material removal**
- ***Intermediate machines* - Fully adjustable face support capability, integrated/mechanized erection and grouting systems**
- ***Advanced* - EPBM, Slurry, closed and/or convertible TBMs, automated operations**

TBM Procurement Strategy

- *Risk strategy*
  - Owner assumes most risk or,
  - Shift most risk to contractor
- *Design Capability*
  - Level of technical expertise, for the owner and consultants
- *Market history*
  - Contractor expertise and cost, schedule, quality performance
  - Prevalence of disputes, claims and litigation

Key factors in TBM selection

- *Risk strategy*
  1. *Owner takes risk - more Prescriptive Approach.* Minimize bidding unknowns to lower bid cost. Owner substantially involved in construction.
  2. *Owner shares risk - Balanced approach.* Decisions made by most capable party
  3. *Owner moves risk - Performance Approach.* Places trust in technical capabilities and goodwill of engineers and contractor

Goals & Objectives

- ***Owner.***

  Project is completed on time, within budget, and satisfies all performance and policy requirements
- ***Engineer.***

  Good design, controlled costs, satisfaction and recognition, reputation enhanced, future work
- ***Contractor.***

  Trouble-free and profitable job, no claims or litigation, project leads to future work

Management Factors

- ***It is very difficult to to satisfy the goals and objectives of all parties***
- It is necessary to achieve fairness and equity
- This requires good, well thought-out, strategic and risk management plans
- This is the owner's responsibility
- The underground industry is not good at early pro-active long-range strategic planning

Survey Intent, Rail TBM Projects

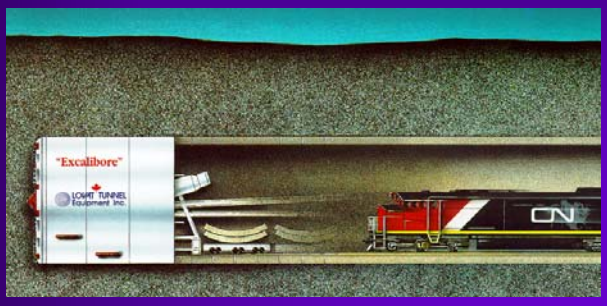
- Review project characteristics
- Review TBM types
- Review TBM sophistication
- Identify trends in North American TBM tunnel projects
- Categorize issues and best practices for future rail TBM tunneling projects

Survey Covered

- Characterization of 6 major North American rail/transit TBM projects
- Level of TBM definition
- Procurement Methodologies
- Trends - North American TBM procurement

St. Clair River Tunnel

- Railroad Tunnel under St. Clair river between Sarnia Canada and Port Huron USA.
- Minimum cover under river 4.6 m
- 9.5 m EPBM

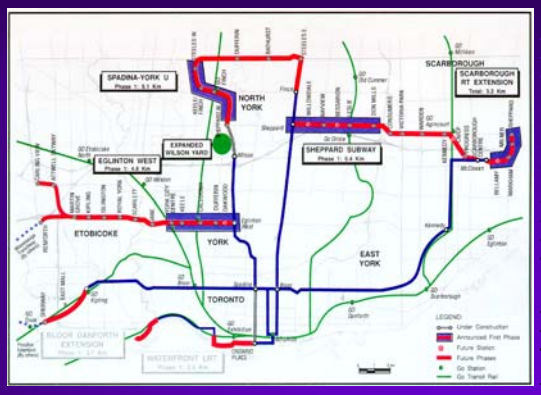


St. Clair River Tunnel

- Full Prescriptive Approach - TBM defined by owner with design consultants.
- Owner directly procured TBM and tunnel liners, with anticipated spares for problems
- First Negotiated Compressed Procurement process in the United States/Canada
- Adopted to save time and manage risk
- Contractors had TBM design input, tendered for TBM operation and liner installation

TTC Toronto - RTEP

- Total program $5 BCn
- Initial phase $1.5 BCn
- Includes Sheppard, Eglinton and Spadina extension.
- Strong management planning and local economic initiative



TTC Toronto - RTEP

- Full Prescriptive Approach - machine and tunnel liners defined and procured by owner
- Owner is Toronto Transit Commission
- Includes strong local economic stimulation

jobsOntario • Capital

- Approach used to save time, reduce unit cost of machines over multiple projects, ensure TBM availability, boost local economy

San Diego Outfall Tunnel

- 5.8 km long 3.3 m diameter outfall tunnel under the Pacific Ocean south of San Diego
- Strong seismic area, 15 active faults
- High internal and external water pressure, (7 bar)

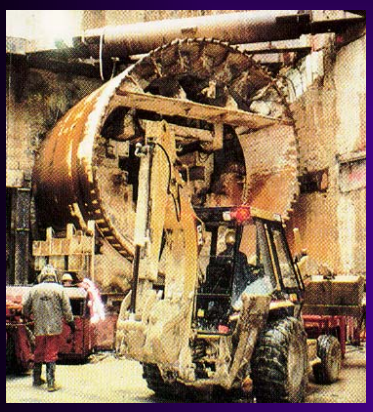
San Diego Outfall Tunnel

- Mixed procurement - high level of detail specified by owner / consultants with significant input from world-wide TBM manufacturers
- High external water pressure
- Partnering used to refine TBM and liner design
- Sophisticated EPBM with extensive provision for grouting / ground control

Washington Metro - WMATA

- 165 km mile transit system, 48% underground
- Many ground conditions, and tunnel types - digger shields, EPBMs, NATM
- Performance approach, with specific requirements including grouting, TBM basic characteristics

Washington Metro - TBMs

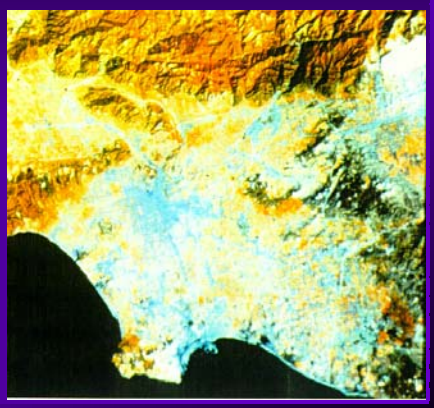


Elgood-Mayo open-face digger shield

6.45m Open/EPB TBM - Contract F6c

Los Angeles Transit Program

- $72.4 Billion / 150 km transit program
- 41% tunnel - 61.5 km
- Alluvial sands, silts and gravels, rock tunnel thru mountains
- Significant hydrocarbons
- High seismic levels



Los Angeles Transit Tunnels

- Segment 1 tunnels completed without significant tunneling problems
- Segment 2 problems in contract B-251
- Segment 3 will specify more sophisticated positive face control machines

Los Angeles - Previous Approach

- Standard North American industry practice - Performance based approach, specifying some TBM and some ground protection requirements
- Award to lowest responsible bidder
- Few settlement problems until contract B-251
- Eisenstein/Parker/Martin study found tunnel performance “equal to or slightly better than worldwide performance”
- Tunnel costs low compared world-wide

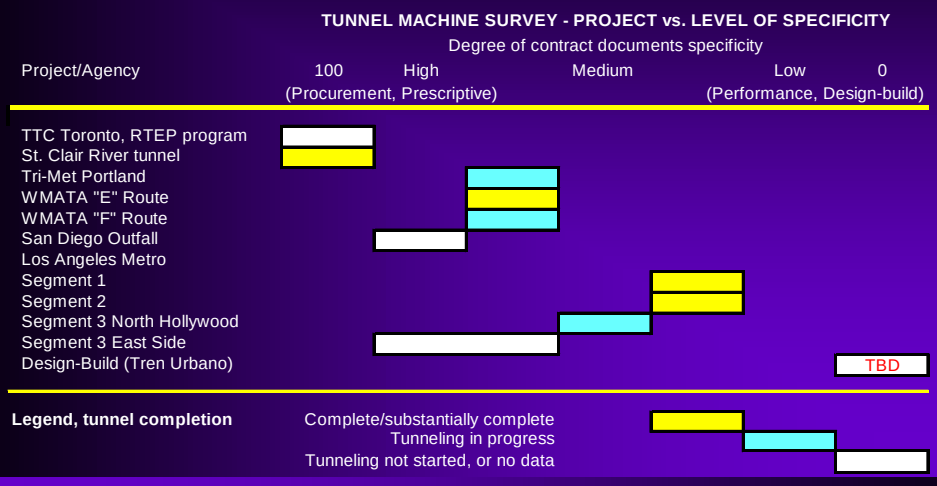
Los Angeles MRL Segment 3 East Side - Recommendations

- Require TBMs with positive face control
- Machines should be capable of operating in open mode for competent ground (Puente formation) and closed in less-competent alluvial soils
- Decision to operate in open or closed mode decided by MTA considering risk
- Ground control established as the governing design and construction criteria
- Defined monitoring / interpretation requirements

Survey / project summary

- ***Full prescription approach, with direct procurement of TBMs and tunnel liners:***
  - *St. Clair, RTEP Toronto*
- ***High level of detail specified by owner, TBM and linings procured by contractor:***
  - *San Diego, Washington, Portland*
- ***Mixed Approach*** *- Los Angeles*
- ***Performance approach*** *- all others*
- ***Design-build*** *- Tren Urbano Puerto Rico*

TBM Survey - Summary



Advantages / Disadvantages

- ***Prescriptive.*** Owner defines TBM type, defines major TBM characteristics, requires specific means and methods for tunneling
- ***Performance.*** TBM characteristics selected and machine procured by contractor. Performance requirements specified in contract documents

Advantages - Prescriptive

- **Schedule gain possible, perhaps 6-12 months if machine is procured by owner in advance**
- **Reduced contractor contingency on TBM**
- **TBM reflects all owner/engineer requirements**
- **More time to define machine requirements**
- **Ground stabilization defined by owner**
- **Responsibility clear for changed conditions**
- **No uncertainty about owner's responsibility**

Disadvantages - Prescriptive

- Owner is responsible for all TBM problems
- Contractor claims difficulties - “its the Owner’s TBM”
- Contractor must maintain Owner’s TBM
- Owner most clearly responsible to all parties
- Owner more responsible for claims / litigation
- Specifications must deal with maintenance, tunneling methodologies, production issues

Advantages - Performance

- Owner has less responsibility for TBM operation
- Owner procurement of TBM not required
- Contractor chooses TBM to suit his operations
- Project cash-flow reduced
- Number of TBMs can be decided by contractor
- TBM maintenance and production trade-offs are determined by contractor
- TBM removal and disposal by contractor

Disadvantages - Performance

- Owner has reduced input to TBM type, design and operating characteristics
- TBM is “low-bid” - satisfies minimums only
- May get unsuitable machine for ground conditions - adds cost and delay
- Owner usually still “approves” machine - takes some responsibility for selection
- Disagreements result in job problems, including more disputes, claims and litigation

TBM Survey - Conclusions

- Public “Low-bid” requirements cause contractors to select lower technology TBMs
- Owners are now more sensitive to settlement, tunneling rates and public, media and politics
- Owners move to more sophisticated TBMs if they consider risk/cost trade-offs and litigation
- Trend to more detailed specifications by owners, with consultants. Contractor must be responsible for “means and methods”
- More teamwork / strategic approach required