

## Large Scale Design-Build Contract in Bangkok Subway Project

Obayashi Corporation JSCE Member Inoue Kiyohiko

### 1. INTRODUCTION

Construction of the first Subway System in Bangkok Thailand is currently ongoing. The Project is governed by the MRTA (Mass Rapid Transit Authority of Thailand) and was named M.R.T. Chaloem Ratchamongkhon Line. Funding for the US\$2 billion Project comes from a combination of Japanese Lending and Investment by the Concessionaire. All of civil engineering construction will be paid for directly by the MRTA using long term soft loan funding from Japan Bank for International Cooperation (JBIC) fund. The M&E Concessionaire will provide the Railway Systems, operate and maintain the systems for 25 years by finance of his own source. As one of the main civil work contract of the Project, The Underground Structures North Contract was awarded to ION Joint Venture (Italian-Thai Development, Obayashi Corporation and Nishimatsu Construction) in 1997. This 5 year Contract includes the design and construction of the civil, structural, architectural and E&M works for 9 underground stations and the connecting 10km twin tunnels which is about half of the length of the initial project. This paper describes an overview and organizational structure of the entire Project and noticeable aspects in design and construction of the Underground Structures North Contract.

### 2. PROJECT OUTLINE AND MANAGEMENT

The system approximately 22km long with 18 stations connected by twin single track bored tunnels of 5.7m internal diameter between 14m and 30m below road surfaces and a major Depot Facility. The projected ridership forecast is approximately 300,000 passengers per day for initial operations in 2004, and it is from the fares generated by this ridership that the M&E Concessionaire has projected recovery of his investment and profit. Six Contracts have been let on a Design-Build basis and the M&E Concession as illustrated in Figure 2. The five Contractors and the Concessionaire are required to coordinate the design and construction programs for compatibility. Project management is undertaken by MRTA's Project Management Consultant (MPMC). MPMC's responsibilities include overall coordination with all parties, provision of assistance and advice to MRTA to expedite

and control construction and providing advice for Contract. The Independent Certification Engineer (ICE) will be appointed by the Concessionaire with responsibility to certify contractual events, to monitor compliance and progress of M&E works and to confirm safety of the System for commencement of Revenue Service. Supervision of the design and construction has been conducted by Construction Supervision Consultants (CSC) and M&E Systems Consultant (MESIC). They provide close supervision of the activities of the Design and Construct Contractors to ensure conformance with contract requirements.



Figure 1. Project Route Plan

Key Word: Overseas Project, Design-Build, Lump Sum, Finance, Concession

Contact Place: Overseas Civil Engineering Dept. Tokyo Head Office, Obayashi Corporation

Shinagawa Intercity Tower B, 2-15-2, Konan, Minato-ku Tokyo 108-8502, Japan Tel:81-3-5769-1254

### 3. CONTRACT CONDITIONS

The Design and Build Contracts are governed by hybrid Conditions of Contract, however based on the international FIDIC system. Contract Price is by lump sum reimbursed on a pre-agreed Interim Payment Schedule basis and subject to the achievement of progress Milestones throughout the Contract Period. There are series of agreed Key-Dates progress requirements which are subject to liquidated damages for delay for non-achievement.

### 4. DESIGN

The Contractors take on the risk of Design under the Design-Build conditions via subcontract Design Consultants. All design work is subject to the approval of the supervision Consultants. The design of the permanent structures is basically in accordance with the British Standards and the design relating to fire safety follows NFPA 130 Standard. The design life for the main underground structures was stipulated as being 120 years, with aboveground structures having 50 years. Since Bangkok is a low lying area, flooding underground systems is one of the major concerns and the contract required protection to a level of 1 m above the 200 year return flood period. The ground conditions in Bangkok typically comprise soft clay to about 15 m depth, which is underlain by a 5-10m stiff clay layer, which in turn is underlain by a first sand layer. Draw-down of the groundwater table in the sand layer, as a result of previous deep well pumping, is still affecting the water pressure distribution. In the soft clay a hydrostatic water pressure starts at approximately ground surface. In the sand layer it starts at about -23m below ground level. This design profile was used to assess the structures in the short term. However, it was particularly important to design the completed structure to ensure adequate resistance against floatation for full groundwater recovery starting at ground level.

### 5. CONSTRUCTION

Top-Down construction using diaphragm walls around the station was adopted. Typically, the diaphragm walls are founded in the sand layer at depths 30 to 40m. The construction schedule has been arranged to allow the bored tunneling works to be carried out in parallel with the construction of the stations. To achieve this schedule, it was necessary for the tunneling machines to bore through three stations after the construction of the diaphragm walls but before the completion of excavation for the stations. In order to bore through the end reinforced diaphragm walls by tunnel boring machine, glass fiber reinforced plastic bars were used instead of steel bars at the location of the tunnels. The temporary tunnel linings erected in these three station boxes were removed during subsequent station excavation. Four number of Shield machines were used to excavate 18km of tunnels with an average tunneling progress of 300 m per machine per month in about 2 years period.

### 4. CONCLUSION

The major civil construction works have been completed without any significant problems. However some delay in revenue opening date from the original schedule is envisaged, this is due to delay to finalize the M&E Concession Contract. The delay is giving rise to some contractual issues due to Contractors not being able to achieve Key-Dates progress requirements, resulting in extensions of time and additional costs. Early project completion and commencement of services have been looking forward to by all the people in Bangkok.

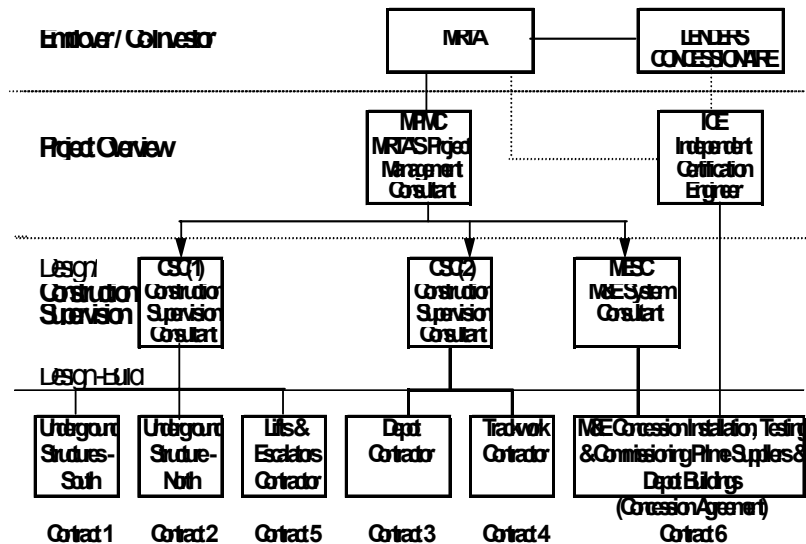


Figure 2. Project Organization