Taiwan High Speed Rail Project,
Advancing Shoring Method

Client
Taiwan High Speed Rail Corporation.

Project
Over 127 km of 13 wide prestressed concrete viaducts were constructed; and 9 contractors designed and built 75 kms of viaducts using the ASM; Advancing Shoring Method.

Services
Independent Checking Engineer and Independent Site Engineer services.

Services period
1999 - 2007
Taiwan High Speed Rail Project, Contract C 210,

Movable Scaffolding System

Client
THSRC; the Taiwan High Speed Rail Corporation; the BOT concessionaire company responsible for the 345 km high speed rail project between Taipei and Kaohsiung.

Project
Design of two sets of MSS movable scaffolding system equipment for the Obayashi / Futsu JV; Contract C 210, advancing shoring construction.

Services
- Check calculations of an alternative MSS support proposal
- Drawing checks
- Preparing the design package for official submittal to and approval by THSRC
- Construction engineering support

Services period : 2000 – 2003

Background
Services were provided to Obayashi / Futsu; on C 210 for the design of two sets of 88 m long movable scaffolding system equipment.

The MSS equipment was used for the construction of 2,580 m of 40 m full span cast in place concrete box girder units for C 210 Contract.

The services also included engineering support during construction.

Taiwan is a highly seismic area and subject to severe earthquakes; and the MSS equipment for the elevated structure needed to be designed to withstand such ground movements.

The equipment design was carried out in accordance with the THSRC design specifications for bridge structures.
Taiwan High Speed Rail Project, Contract C 215,

Movable Scaffolding System

Client
THSRC; the Taiwan High Speed Rail Corporation; the BOT concessionaire company responsible for the 345 km high speed rail project.

Project
Design of three sets of MSS movable scaffolding system equipment for the Obayashi / Futsu JV; Contract C 215.

Services
- Check calculations of an alternative MSS support proposal
- Drawing checks
- Preparing the design package for official submittal to and approval by THSRC
- Construction engineering support

Services period
2000 – 2003

Background
Services were provided to Obayashi / Futsu on C 215 for the design of three sets of 88 m long movable scaffolding system equipment.

The MSS equipment was used for the construction of 40 m full span cast in place concrete box girder units for a total length of 7,240 m.

The designs of MSS equipment sets were carried out in accordance with the THSRC design specifications for elevated bridges.

Taiwan is a highly seismic area and subject to severe earthquakes; and the MSS equipment for the elevated structure needed to be designed to withstand such ground movements.

The construction method using the MSS system is where the formwork is assembled; and then advances from one span to the next without the need for reassembly. The MSS is self-propelling and is supported directly off the permanent works.
Taiwan High Speed Rail Project, Contract C 250

Advancing Shoring, Design Unit 03.04

Client
THSRC; the Taiwan High Speed Rail Corporation; the BOT concessionaire company responsible for the 345 km high speed rail project.

Project
Hochtief / Ballast Nedam / Pan Asia; HBP Joint Venture for Contract C 250, Design Unit DU 03.04.

Services
- Contractors consultant
- Equipment design

Services period: 2001 - 2003

Background
The Design Unit 03.04 alignment was located on the high speed railway line near Taichung. Services were provided to the HBP joint venture for the design of a set of 110 m long movable scaffolding system (MSS) equipment used for the advancing shoring method for the cast in place concreting of 18 x 45 m spans over a total length of 810 m.

The MSS equipment was supported by temporary works directly of the permanent works pier foundation.

The advancing shoring method is a system where the main formwork is assembled and then progressively advances from one deck to the next without the need for reassembly. It is usually self-propelling and supported directly off the permanent columns.

The high speed rail elevated bridge design was carried out in accordance with the THSRC design specifications for the project.

The dynamic behaviour of the bridge under train loading was checked by carrying out a rolling stock analysis in order to determine that vertical acceleration characteristics of the HSR structure; was well within the THSRC design specifications.

As Taiwan is a highly seismic area, subject to severe earthquakes, the elevated high speed rail structure needed to be designed to withstand severe ground movements.
Taiwan High Speed Rail Project, Contract C 250,
Advancing Shoring, Design Unit 14.05

Client
THSRC; the Taiwan High Speed Rail Corporation; the BOT concessionaire company responsible for the 345 km high speed rail project between Taipei and Kaohsiung.

Project
Hochtief / Ballast Nedam / Pan Asia; the HBP Joint Venture. The design and construct C 250; DU 14.05.

Services
- Preliminary design
- Detailed design
- Contractors consultant
- Equipment design

Services period
2001 - 2003

Background
The bridge alignment was located on the high speed rail link near Taichung.

Services were provided for the detail design and the construction support for the multiple span prestressed concrete high speed railway bridge in Design Unit DU 14.05.

The prestressed concrete box girders were 45 m length and designed to be built by the advancing shoring method of construction.

The advancing shoring method is a system where the main formwork is assembled and then progressively advances from one deck to the next without the need for reassembly. It is usually self-propelling and supported directly off the permanent columns.

The high speed rail elevated bridge design was carried out in accordance with the THSRC design specifications for the project.

The dynamic behaviour of the bridge under train loading was checked by carrying out a rolling stock analysis in order to determine the vertical acceleration characteristics of the structure.

The analysis assured that the HSR elevated structure was well within the requirements of the specifications.

As Taiwan is a highly seismic area, subject to severe earthquakes, the elevated high speed rail structure needed to be designed to withstand severe ground movements.
Taiwan High Speed Rail Project, Contract C 295,
Advancing Shoring Equipment

**Client**
THSRC; the Taiwan High Speed Rail Corporation; the BOT concessionaire company responsible for the 345 km high speed rail project between Taipei and Kaohsiung.

**Project**
Design and Construct C 295; for the Evergreen Construction / Italian Thai / PEWC; the EIP Joint Venture, for the design of fifteen sets of dual span movable scaffolding equipment.

**Services**
The equipment incorporated a quick and easy operating procedure and allowed the contractor to achieve the very high production rates necessary to complete the advancing shoring construction of Contract C 295 within the schedule requirements.

**Services period**
2001 - 2003

**Background**
Services were provided for the design of fifteen sets of movable scaffolding equipment used for the advancing shoring method to construct most of the rail bridges in C 295.

In order to meet the very exacting construction schedule for the high speed rail elevated line, the design of the equipment was based on the capability to cast two 35 m spans at one time.

It was essential that the equipment was designed to be as robust as possible to withstand the rigours of the fast rate of construction.

The advancing shoring construction in C 295 was 15.5 km in length.

Allowing the contractor to achieve the production of 2 x 35 m spans in 10 days for each of the fifteen sets of equipment.
Second Freeway, Contract WH 48 - 2, Taiwan

Advancing Shoring Equipment

Client
Black Stone Construction.

Project
Modification designs to one set of movable scaffolding system (MSS) equipment; for advancing shoring construction of the Second Freeway Contract WH 48 - 2.

Services period
2001 - 2002

Services
- Detail static calculations for the MSS equipment
- Drawings for modifications to the MSS equipment
- Discussion and meetings with the fabricator and contractor
- Inspection during the fabrication
- Final inspection of the assembled equipment in the fabrication yard
- Inspection of the assembled MSS equipment on site
- Construction engineering support

Background
Services were provided to Black Stone for modifications to the MSS movable scaffolding system equipment used for the advancing shoring construction of the 2 km long viaducts on Contract WH 48 - 2 near Chiayi.

Services also included the provision of construction engineering support to Black Stone during the advancing shoring construction.
Second Freeway, Chourn - Linbien, Contract C 384,

Advancing Shoring Equipment

**Client**
Raito Construction Company.

**Project**
The design of the advancing shoring equipment for the construction of cast in place, single cell, box girder units; 13 m wide, 2.5 m deep, and 1,860 m in overall length; with spans varying from 40 m to 43 m.

**Services**
The services were provided to Raito Construction for the design of 5 types of advancing shoring equipment used in the construction; and for engineering services during the construction of the Second Freeway, Contract C 384.

**Services period**
2000 – 2001

**Background**
Existing advancing shoring equipment used on an earlier Freeway Contract needed to be modified and required the provision of:
- static calculations and drawings of the equipment
- mechanical and electrical drawings for the advancing shoring equipment
- detailed calculations and drawings of the pier brackets
- meetings and inspections during the fabrication process
- final inspection at the fabrication yard of the assembled equipment
- operating manual; including detailed operating instructions
- inspection of equipment assembled on site

Construction engineering services were provided including:
- detailed calculations of all erection stages
- calculation of the stresses at each construction stage
- precamber for each construction stage
- providing the preset values for the bearings
- technical assistance and problem solving during the construction
- calculations of the effects of creep and shrinkage on the stresses
- calculate final stage stresses of the completed structure
- drawings for all concrete dimensions giving all information for construction
- shop drawings for all prestressing
- prestressing instructions given all information for stressing
Second Freeway, Contract C 321, Taiwan

Advancing Shoring Construction

Background
Engineering services were provided to Pan Asia for the advancing shoring and balanced cantilever construction on the Second Freeway C 321.

The services included modifications to an MSS equipment set, which was suitable for the construction all the advancing shoring bridges in C 321; and included:
- detail static calculations
- structural detail drawings
- mechanical drawings
- static calculations for the pier brackets
- structural drawings for the pier brackets
- discussion and meetings with the fabricator and contractor
- inspection during the fabrication process
- final inspection of the assembled equipment in the fabrication yard
- operating manual including detailed operating instructions
- inspection of the assembled MSS equipment on site

The project required the calculation of advancing shoring and balanced cantilever units; including the:
- detail calculations of all erection stages
- calculation of the stresses at each construction stage
- precamber for each construction stage
- the effects of creep and shrinkage on the stresses
- levels at all segment locations
- check of final state stresses of the completed structure
- drawings for all concrete dimensions
- shop drawings for all prestress cables
- prestress instructions
- check of the design and installation procedure for the bearings and expansion joints
- preset values for the bearings
- technical assistance during the construction

Client
Pan Asia Corporation.

Project
Engineering services provided for the construction of Contract C 321; by the advancing shoring method.

Services
One set of MSS; movable scaffolding equipment for the advancing shoring construction was designed and the services included overseeing all the construction engineering works.

All calculations were carried out in accordance with AASHTO and also local codes of practice as well as the Freeway Bureau specifications.

Services period: 2000 - 2001
Second Freeway, Contract C 318, Taiwan

Advancing Shoring Equipment

Client
Kung Shin Contractors, Taiwan.

Project
Second Freeway, Contract C 318, near Taichung, Taiwan.

Services
- Advancing shoring equipment design, fabrication
- Construction stage calculations
- Formwork and temporary works design
- Camber calculations and bearing presets
- Project planning, consulting and supervision
- Shop drawings

Services period
1999 – 2001

Background
The advancing shoring method ASM was selected for the construction of the 2,025 m long bridge in C 318.

The moveable scaffold system of the ASM was assembled and advanced progressively from one deck to the next without need for reassembly. It was self propelling and supported directly off the permanent columns.

Two sets of the moveable scaffold system equipment were designed for the Second Freeway Contract C 318. Each set weighing 670 tons.

The services also included:
- construction engineering
- construction supervision
- construction consultant
- design of all the construction stage calculations
- design of temporary works
Second Freeway, Chourn - LinBien, Contract C 385,

Advancing Shoring Construction

Client
Wan Chi Steel Industrial Company.

Project
The design of three sets of movable scaffold equipment (MSS); for the advancing shoring construction of Second Freeway, Contract C 385.

Services
- Design of the movable scaffolding system equipment
- Technical services
- Inspection during the fabrication
- Operating Manual
- Equipment check before the first launch
- Construction engineering services

Services period
1999 - 2001

- final inspection of the assembled equipment at the fabrication yard
- operating manual
- inspection of the assembled MSS equipment on site
- checking the equipment before the first launching operation
- detailed delivery schedule

Construction engineering services were provided as a consultant to Wan Chi Steel Corporation.

Three sets of movable scaffolding system equipment; MSS; were provided; having an approximate weight of 620 metric tons per set; used for C 385 construction.

The Second Freeway viaducts were two parallel, single cell, prestressed girders, 13 m wide and 2.5 m deep.

Construction engineering services were provided for the C 385 section which was 2,014 m long; with spans varying from 40 m to 45 m.

Background
The services were for the supply of the design and drawings for three sets of movable scaffold equipment (MSS) for the advancing shoring construction of C 385.

Also for engineering services during the fabrication, preassembly and the functional testing and erection of the movable scaffold equipment on site.

Services for the equipment design included:
- one set of structural drawings for the movable scaffold equipment
- outer form hydraulic specifications
- basic equipment specifications
- discussions and meetings with the fabricator and contractor
- inspection during the fabrication
Second Freeway, Contract C 323, Taiwan

Incrementally Launched Bridge

Client
Taiwan Area National Expressway Engineering Bureau, (TANEEB).

Project
Second Freeway, Contract C 323.

Services
- Special construction method
- Launching equipment design and fabrication
- Construction planning
- Consultant to TANEEB
- Construction supervision

Services period: 1997 – 2000

Background
Services were provided to TANEEB for the Second Freeway Contract C 323 constructed by the ILM; the Incrementally Launching Method.

Services were also provided for the:
- design and fabrication of the bridge launching equipment
- supervision during the bridge launching operations
Kao Ping Hsi Bridge Approach Viaducts, Taiwan

Second Freeway, Contract C 381

Advancing Shoring Equipment

Background
Advancing shoring equipment was designed for the construction of the two prestressed concrete approach viaducts to Kao Ping Hsi Cable Stay Bridge on the C 381 Second North-South Freeway.

Each equipment set weighed 700 tons and the superstructure had a combination of spans with a 3.2 m deep and 16.25 m wide deck.

The services were provided as the specialist consultant to the Taisai, Kawada, Raito and Pan Asia Joint Venture Contractors.

The bridge is located on the border of Kaohsiung and Pintung Counties crossing the Kao Ping River; and this section of the Second North-South Freeway was opened to the freeway traffic in January 2004.

Three sections of twin viaducts were constructed; being separated by an expansion joint, namely:
- Abutment A to P29: 389.5 m long
  36.2 m + 7 x 45.3 m + 36.2 m
- P29 to P21: 344.2 m long
  36.2 + 6 x 45.3 m + 36.2 m
- P21 to P13: 353.3 m long
  7 x 45.3 m + 36.2 m

Client
Taisai, Kawada, Raito and Pan Asia Joint Venture Contractors.

Project
The Kao Ping Hsi Bridge Approach Viaducts, Contract C 381.

Services
- Advancing shoring equipment design and fabrication
- Construction stage calculations
- Formwork design
- Camber calculations
- Project planning
- Specialist consultant to the joint venture contractors
- Site supervision
- Shop drawings

Services period: 1996 - 2000
Highway Contract E 811, Kaohsiung, Taiwan

Advancing Shoring Equipment

Client
BES Contractors, Taiwan.

Project
Provincial Highway Contract E 811, Kaohsiung, Taiwan.

Services
- Advancing shoring equipment design
- Construction stage calculations
- Temporary works design
- Camber calculations and bearing presets
- Project planning; consulting and site supervision
- Shop drawings

Services period
1997 – 1999

Background
Provincial Highway E 811 included the construction of four advancing shoring bridges with a total length of 980 m; and one 165 m long free cantilever viaduct having spans of 45 m + 70 m + 45 m.

The advancing shoring formwork was assembled and progressively advanced from one deck to the next without the need for any reassembly. The system was self-propelling and supported directly off the permanent works column.

Services included the construction engineering, the equipment design, for the supervision and construction consulting and for design checking during construction.

Two sets of the advancing shoring equipment; each weighing 580 tons, were used for the construction of E 811 prestressed concrete viaduct.

The viaduct deck was a double cell prestressed concrete box girder with a rounded deck shape; 22.8 m wide for a maximum span of 56.6 m.
Nanking River Bridge, Nanking, China

Advancing Shoring Equipment

Client
Nanking City Government, China.

Project
Nanking River Bridge, Nanking.

Services
- Moving scaffolding system, MSS equipment design
- Construction stage calculations
- Formwork design

Services period
1997 – 1999

Background
The advancing shoring method was selected for the construction of the Nanking River Bridge.

The method is a system where the main formwork is assembled and advances progressively from one deck to the next without the need for reassembly. It is self-propelling and supported directly off bridge columns.

One set of 109 m long (MSS) moving scaffolding system equipment was designed for the advancing shoring construction of the prestressed viaducts of the Nanking Bridge.

The weight of the equipment was 710 tons and the superstructure consisted of 12 x 50 m spans with a deck width of 12.4 m.

The equipment was designed with a special hanging bracket configuration to allow for ease of construction over the Nanking River.
Expressway No. 5, Contract C 220, Taiwan

Advancing Shoring, Tanbian Bridge

Client
Hsin Shung Construction, Taiwan.

Project
Taipei - Ilan Expressway Tanbian Bridge, Taiwan.

Services
- Construction stage analysis of the erection sequence
- Camber calculation
- Pretressing instructions

Services period
1998 - 1999

Background
The 30.8 kilometer Expressway is from the eastern suburbs of Taipei City to Ilan on the eastern coast of Taiwan; included 30 bridges.

The 480 m long Tanbian Bridge comprised of 3 x 40 m + 39 m + 6 x 43 m + 40 m + 23 m spans; all constructed by advancing shoring.
Second Freeway, Contracts C 325 A & B, Taiwan

**Advancing Shoring Method**

**Client**
Taiwan Area National Expressway Engineering Bureau; (TANEEB).

**Project**
The Second North - South Freeway Contracts C 325 A & B constructed by the advancing shoring method.

**Services**
- Project management
- Evaluation of the bridge type and construction method
- Preliminary and detailed designs

**Services period**
1996 - 1998

**Background**
The Second North - South Freeway Contracts C 325 A & B consisted of 15 bridges; namely:
- 12 advancing shoring bridges
- 2 balanced cantilever bridges
- 1 simply supported bridge

All the bridge types were single cell prestressed concrete box girders; 16.1 m wide.

The Wu Second Bridge spans from the west bank of the Wu River then turns southeast across the river and enters Wurih Town in Taichung from Kuaiguan in Changhua City.

The Bridge was 3,320 m long and had standard spans of 45 m. Some spans were 60 m long and the bridge was constructed by the advanced shoring method.
**Second Freeway, Contract C 398, Taiwan**  
**Advancing Shoring Equipment**

**Client**  
Taiwan Area National Expressway Engineering Bureau, (TANEEB).

**Project**  
Second Freeway, Contract C 398.

**Services**  
- Advancing shoring equipment design and fabrication  
- Construction stage calculations  
- Formwork design  
- Camber calculations and bearing presets  
- Project planning, consulting and supervision  
- Shop drawings

**Services period**  
1995 – 1998

**Background**  
The advancing shoring method was selected for the construction of the Second Freeway, Contract C 398.

Main forms were assembled and progressively advanced from one deck to the next without the need for reassembly. The forms were self-propelling and were supported on the permanent works columns.

Two sets of the advanced shoring equipment were designed for the construction of C 398 prestressed concrete viaducts.

Each set of equipment weighed 700 tons and the superstructure consisted of a standard 45 m span with a deck width of 12.45 m. The overall length of Contract C 398 was 2.88 km.

The responsibilities included the:  
- construction design  
- advanced shoring equipment design and fabrication  
- construction engineering  
- consulting services  
- construction supervision
Second Freeway, Contract C 330, Taiwan

Advancing Shoring Equipment

Client
Taiwan Area National Expressway Engineering Bureau, (TANEEB).

Project
Second Freeway, Contract C 330.

Services
- Equipment design and fabrication
- Construction stage calculations
- Formwork design
- Construction planning, consulting and supervision

Services period
1995 – 1997

Background
The advancing shoring method was selected for the construction of Contract C 330 on the Second Freeway.

The main formwork was assembled and advanced progressively from one deck to the next without the need for reassembly. It was self-propelling and supported directly off the permanent columns.

This was considered to be the fast construction method for the cast in place concrete viaduct which had 45 m repetitive spans.

Two sets of the advancing shoring equipment were designed for the construction of this prestressed concrete viaduct for the Second Freeway near Taichung.

Each set of equipment weighed 700 tons and the superstructure consisted of a standard 45 m span and a deck width of 16.1 m.
Seoul – Busan High Speed Line, Korea

Station Safety & Viaduct Design

**Client I**
Korea High Speed Rail Construction Authority.

**Project I**
New underground station in Daegu for the new high speed train service from Pusan to Busan.

**Services**
- Identification of hazards
- Recommendations on control and mitigations measures
- Recommendations on design modifications
- Tunnel layout design
- Ventilation studies

**Services period**
1996

**Background**
The Korea High Speed Rail Authority commissioned a study of the safety implications of the concept design of the new underground Daegu Station. Daegu Station was to be located 50 m underground and served by 6 tracks. Studies were undertaken to estimate the ventilation requirements needed during the underground construction activities.

An important factor for achieving a satisfactory level of safety for the passengers and railway employees at the station; was the configuration of the trackwork and tunnels, and particularly whether a twin rail track or a single rail track tunnel system should be adopted.

International best practices for the tunnel layout design were appraised, providing the recommendations to achieve satisfactory levels of safety.

**Client II**
Kumgang Construction, Korea.

**Project II**
High Speed Rail Viaducts, Korea.

**Services**
- Advancing shoring equipment design
- Formwork design
- Consulting services

**Services period**
1995 - 1998

**Background**
Three sets of advancing shoring equipment (movable scaffolding systems MSS) were designed for construction of the high speed rail elevated viaduct contract.

The services included the:
- design of MSS launching girders
- design of formwork systems
- equipment specifications
- factory inspections
- consulting and supervision
Taiwan Railway Administration, Miaoli, Taiwan

Advancing Shoring Bridge

**Client**
J & S Contractors, Taiwan.

**Project**
Preliminary and detailed design for the 1.5 km Miaoli Railway Bridge for the Taiwan Railway Administration.

**Services**
- Preliminary design
- Detail design

**Services period**
1993 – 1994

**Background**
Services were provided to the civil works contractor responsible for the construction of the elevated section of dual rail track thorough Miaoli City. The project was undertaken for the Taiwan Railway Administration to remove the at grade narrow gauge trackwork and provided for grade separated rail and road services in Miaoli City center.

The new elevated railway has:
- provided a grade separated rail system for the Taiwan Railway Administration (TRA)
- improved the TRA’s operations through the city center
- improved the road and pedestrian circulations in the city center
- provided an improved environment for the citizens of Miaoli