Progress of the Asian Site-Specific Design

ー Interim Report toward the TDR ー

Masanobu Miyahara

KEK CFS-Team

High Energy Accelerator Research Organization

Progress on the Asian Site-Specific Design

Contents

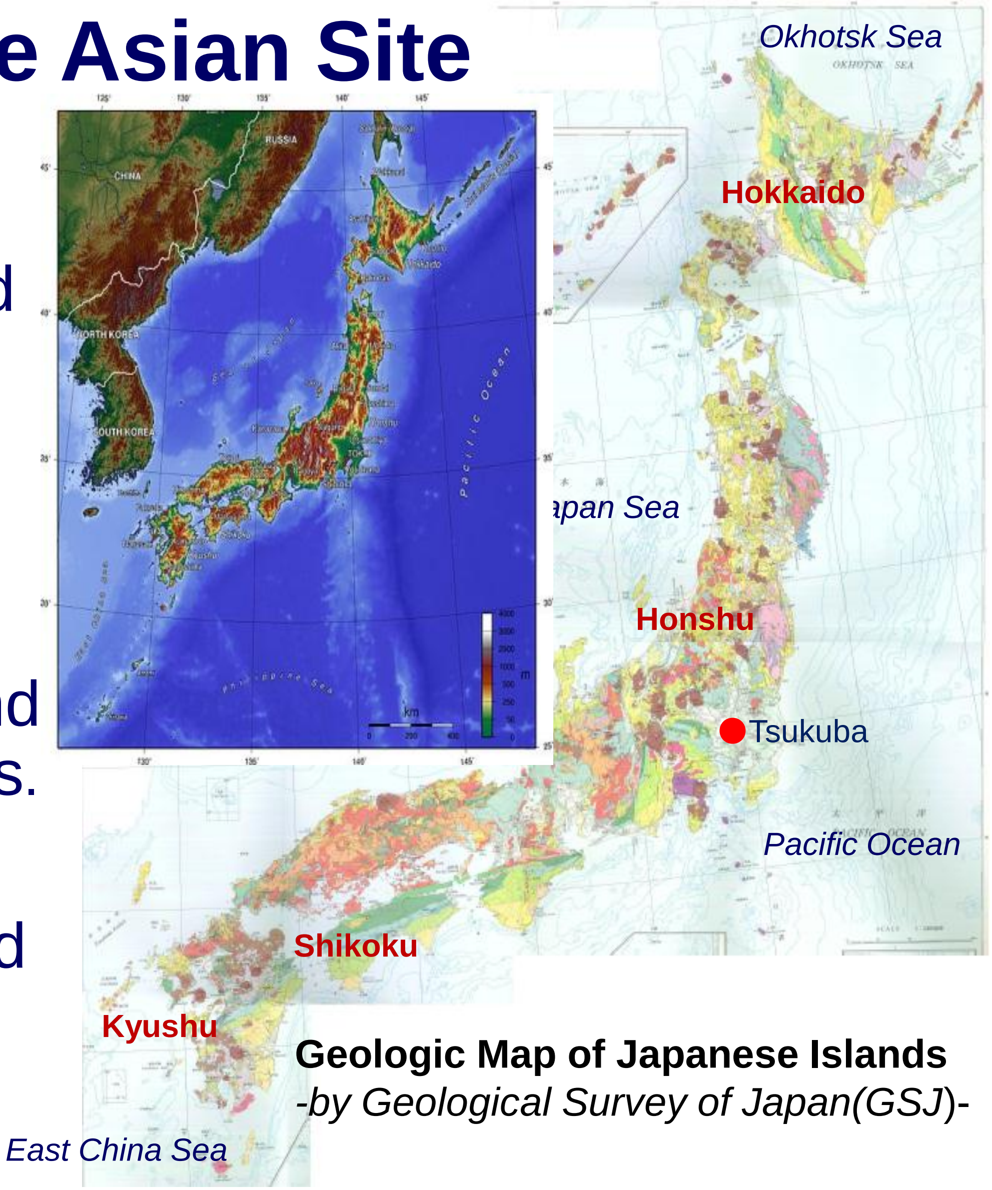
1. Background on the Asian Siting

- Two Candidate Sites
- Features of Japanese Mountain Site
- Essential Condition for Asian Siting

1. Background on the Asian Site

Outline of Japanese Land

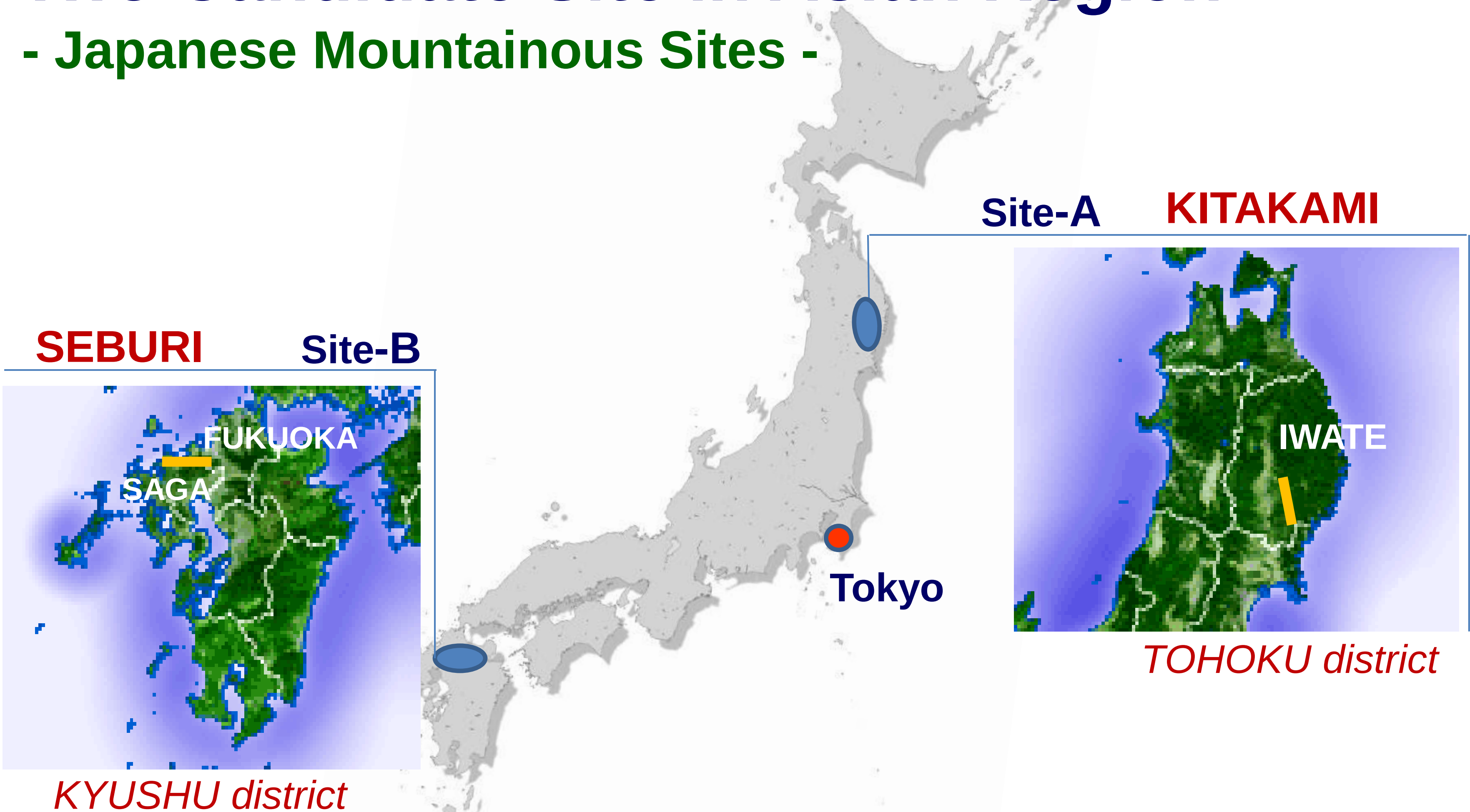
- 75% of the Land is occupied in a **Mountainous Zone**
- Plains is 10% of all Land.
- the Alluvial Plains; have been formed in Soft Ground carried by Flood, and is Vulnerable to Earthquakes.
- the Mountainous Area; is made with Hard Rock, and is generally Resistant to Earthquakes.



Geologic Map of Japanese Islands
-by Geological Survey of Japan(GSJ)-

Two Candidate Site in Asian Region

- Japanese Mountainous Sites -



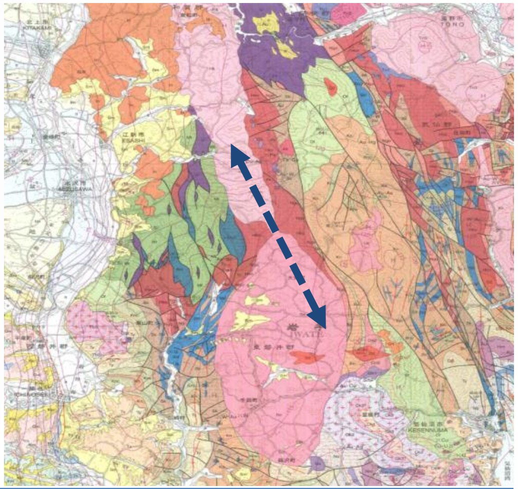
The Current Candidate Site in 2011

Common Features of Both Candidate Sites

■ Geology & Infrastructure

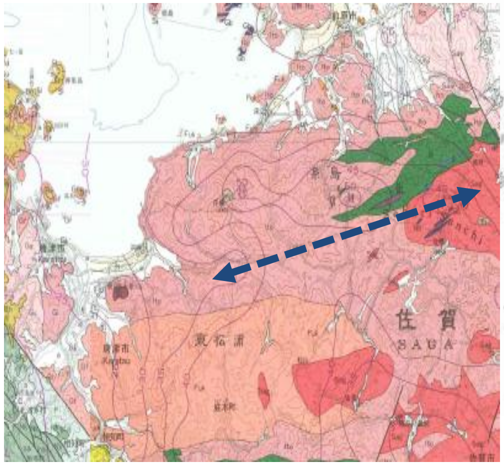
- Located in the Stable Granite Rock
- no Active Faults, no Volcano,
- Access Road to the Site.
- High-Voltage Transmission Line Near the Site.

Site-A



KITAKAMI

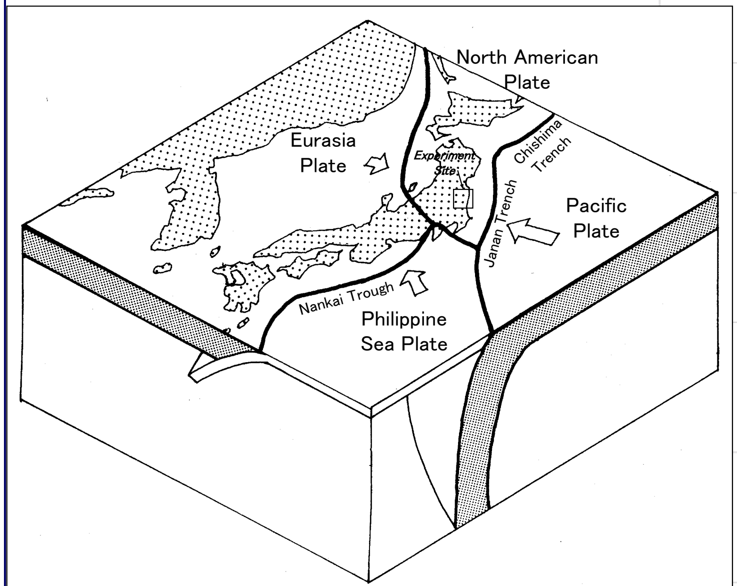
SEBURI Site-B



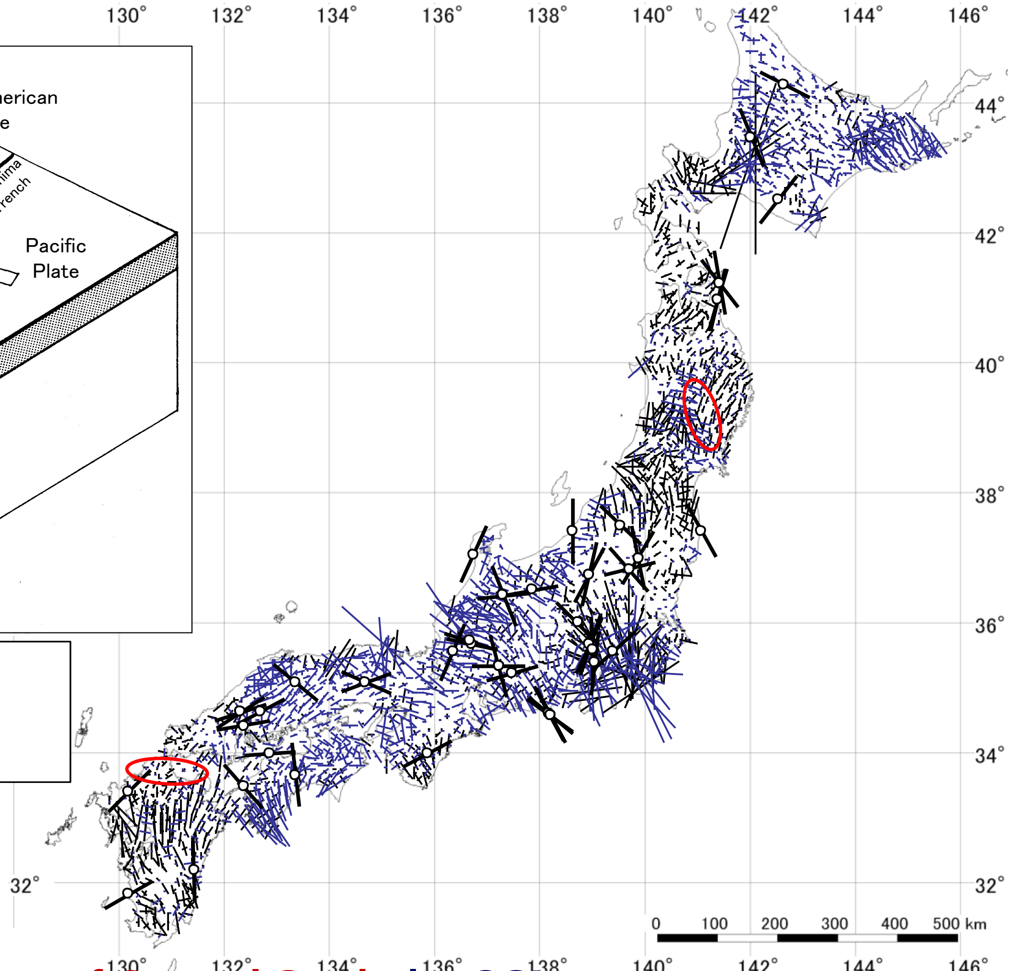
■ Social Background

- Local Government is active to Invite the ILC Project.
- University and Community are Positive to Cooperate the ILC Project.

Crustal Strain for 100 Years



Direction of σHmax
Compressive Crustal Strain
Extensional Crustal Strain



<Distribution Map of Crustal Strain by GSI>

— Two Candidate Sites are located in the Small Strain Area —

Essential Conditions for Siting

■ Geological Features for Tunneling (Cavern)

1. Locating on the Stable Bedrock Zone
2. Avoiding the Bad Ground such as the Following
   [Active Fault] [Volcanic Zone] [Fracture Zone]

■ Environmental Conditions

1. Exclusion of the Vibration Source such as,
   [Highway] [Railroad] [Rubble Ground] etc.
2. Separation with a Valuable Nature & Cultural Assets

■ Infrastructure & Social Conditions

1. Security of the Access Road for Construction Vehicle,
   Installation and Maintenance after the Completion
2. Ability for Electric Power Supply
   (High-Voltage Power Transmission Line)

2. Underground Facilities in Mountain Site

- **Outline of the Underground Facilities**
- **Access Method (Shaft or Tunnel)**
- **Tunneling Method (TBM or NATM)**

ーReference Case : Maraysia Projectー

2. Outline of the Underground Facilities in a Japanese Mountain Site

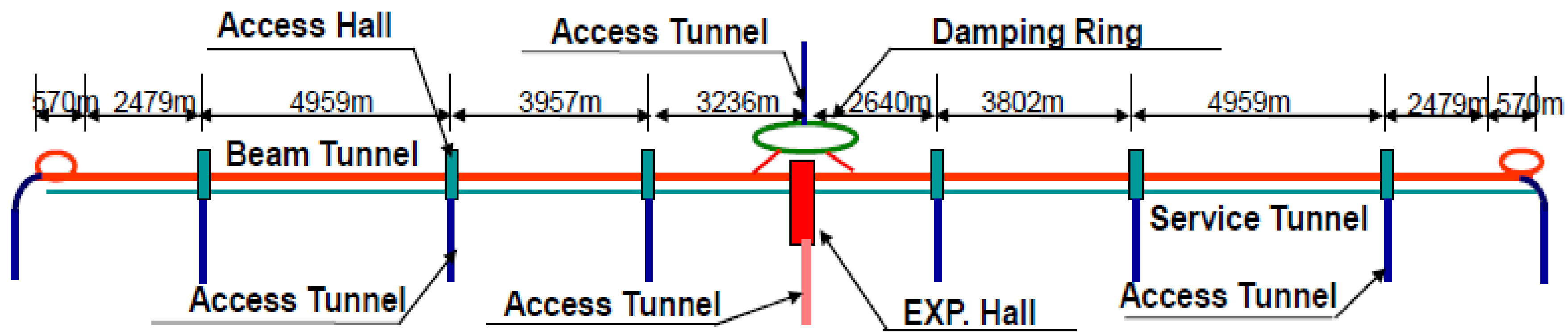
Tunnel Structures for ML, BDS, DR, RTML

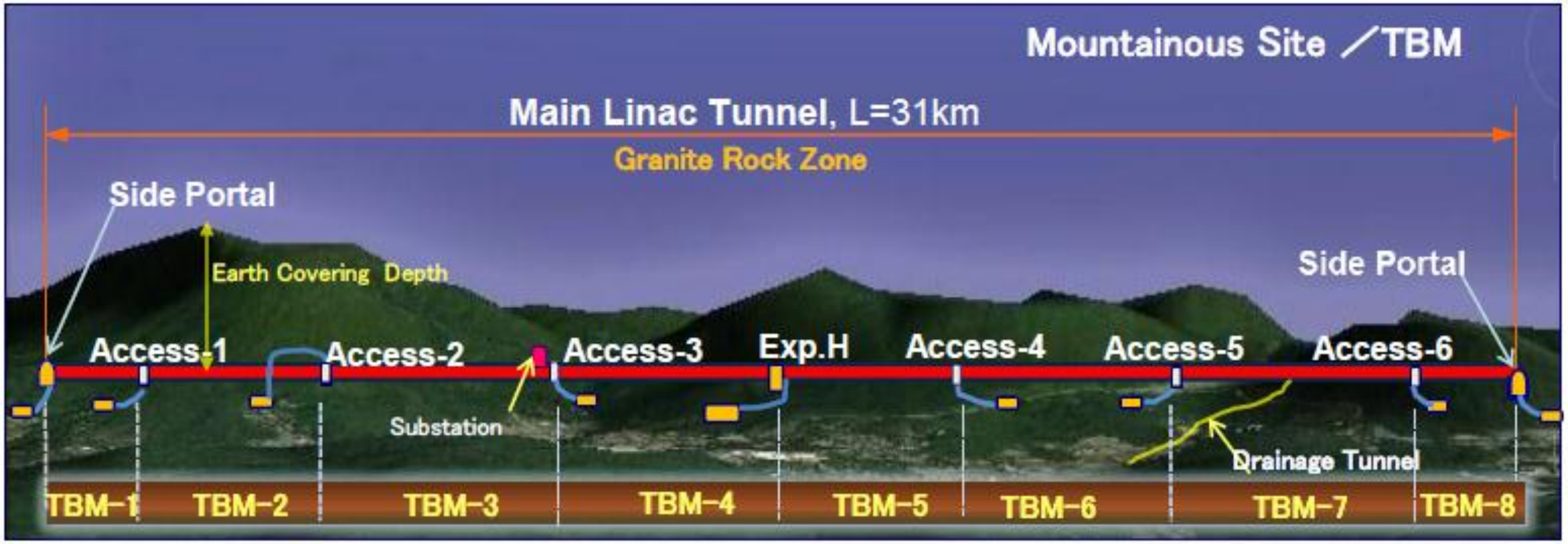
- ML Tunnel (include RTML) : 25km
- BDS Tunnel : 5.8km
- Damping Tunnel : 3.2km
- Access Tunnel (ML, DR, Detector Hall) : about 10km

Cavern Facilities for ML, Detector Hall

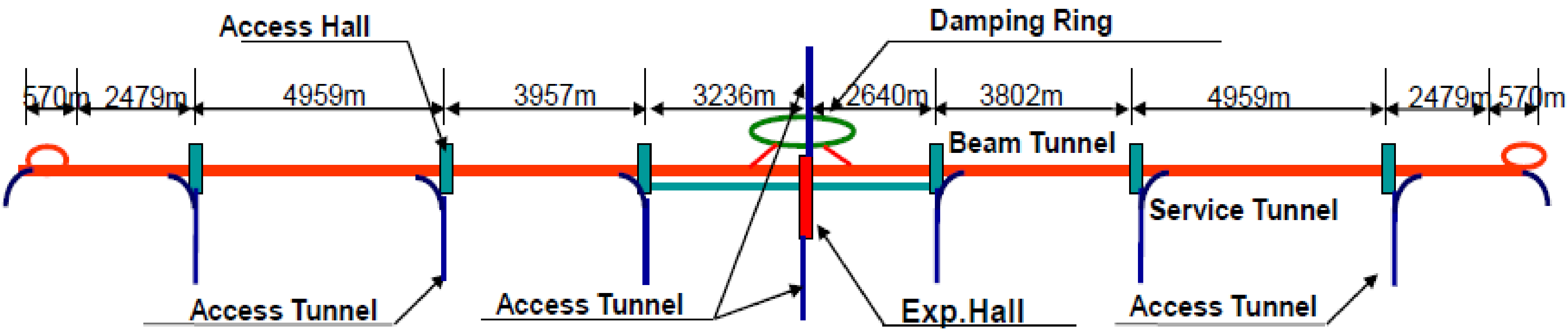
- Big Cavern for the Detector Hall.: 1
- Medium Cavern for Access Hall : 6
- Small Cavern for Substation and Machinery

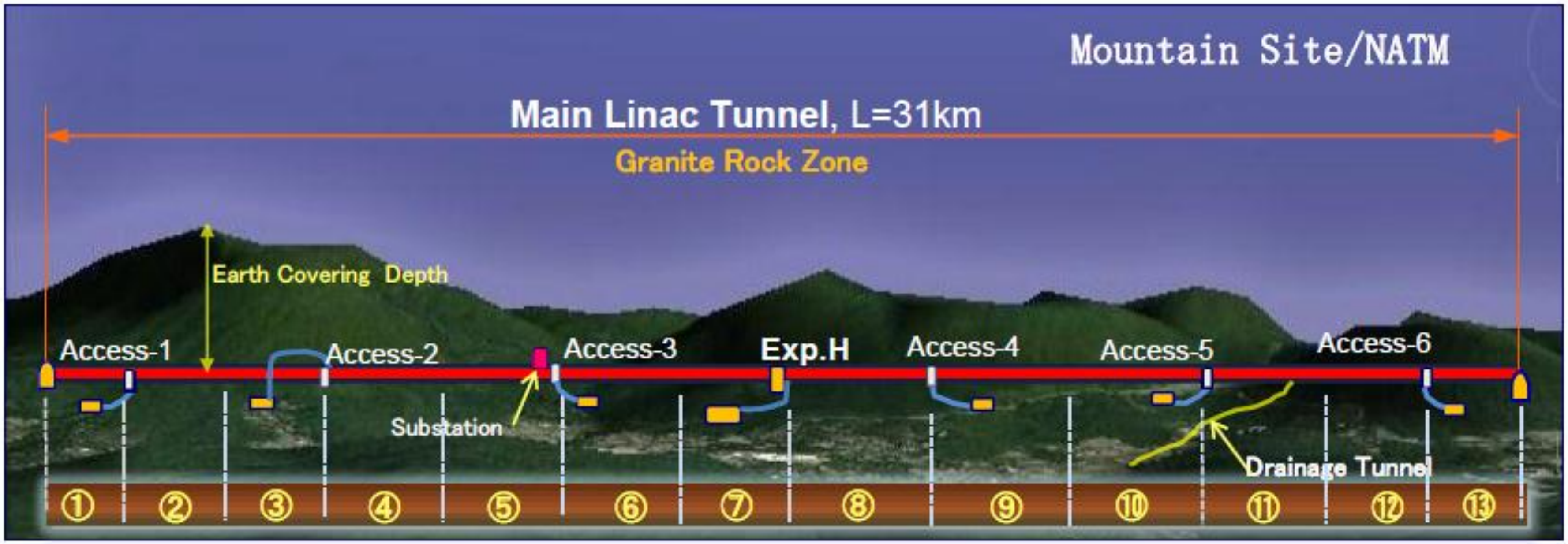
2.1 Underground Facilities in the Mountainous Site



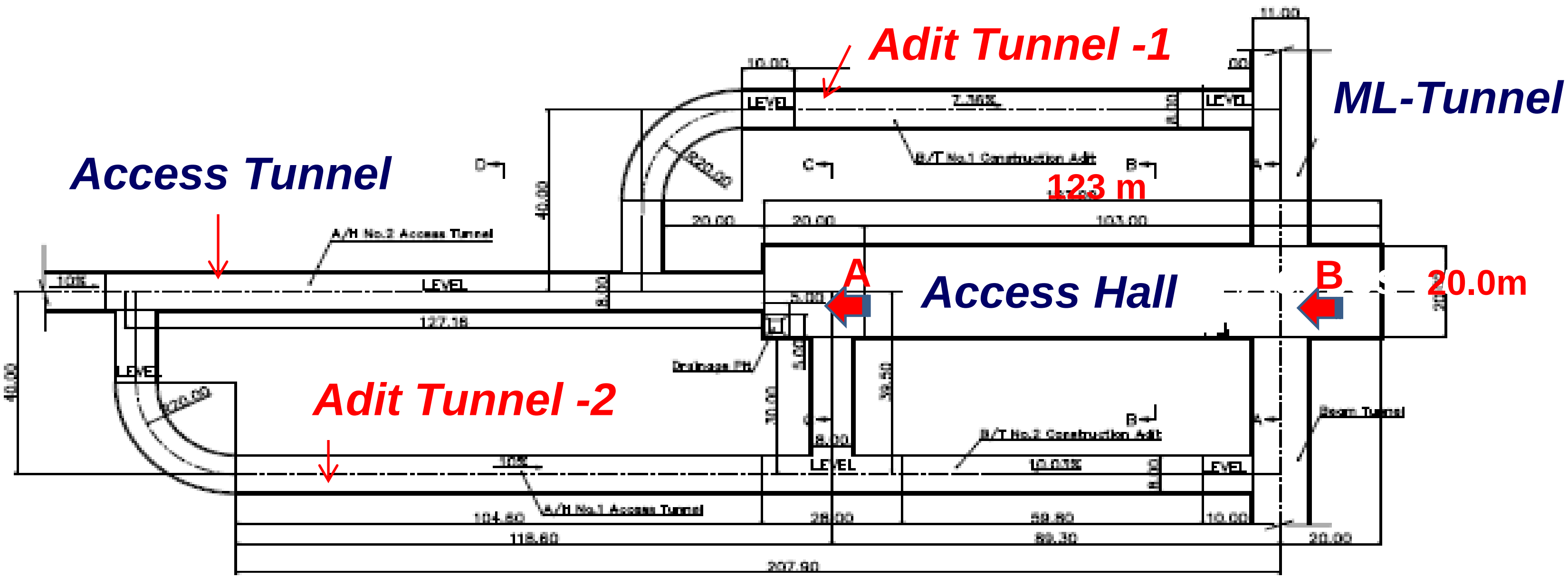


2.1 Underground Facilities in the Mountainous Site

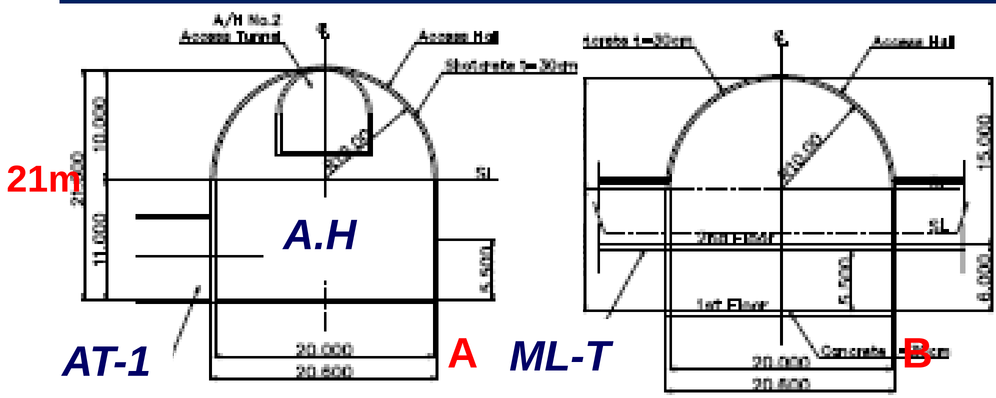




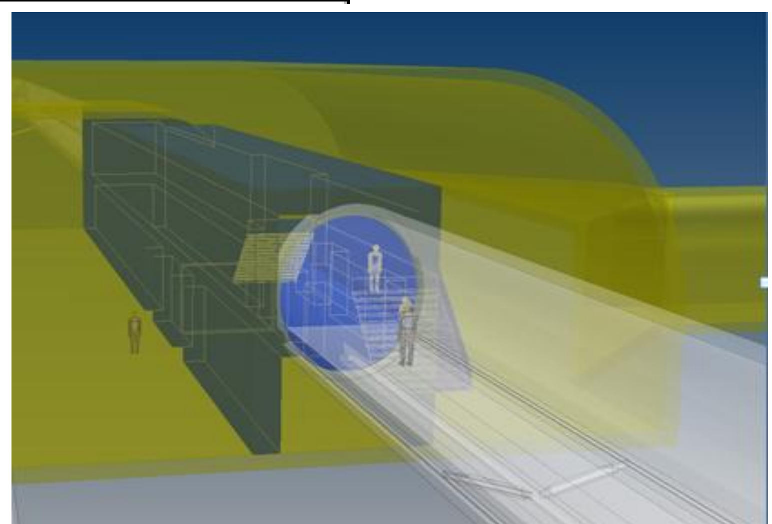
Access Hall Cavern



Access Hall Plan

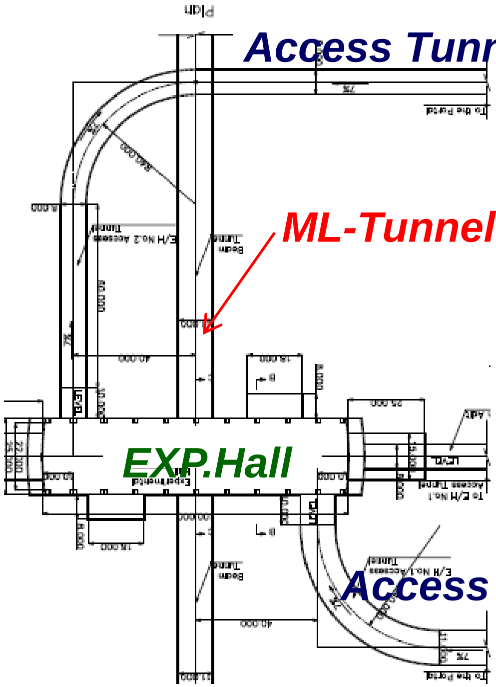


Access Tunnel Section



Access hall image

Detector Hall



Detector Hall Plan

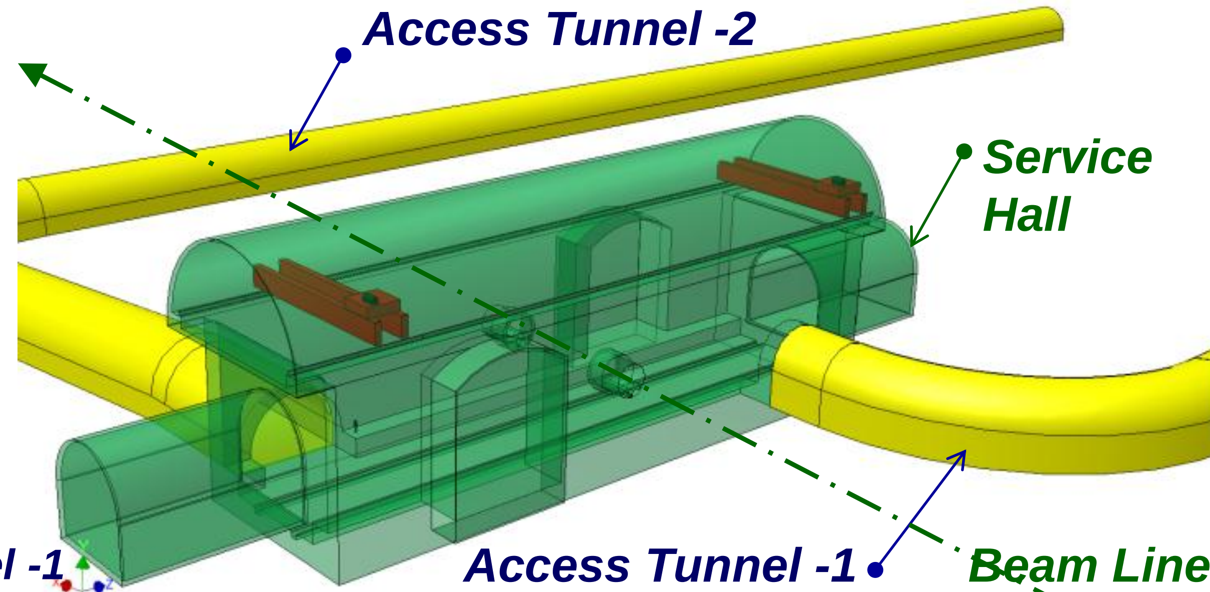
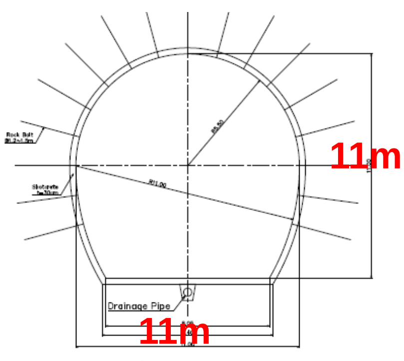
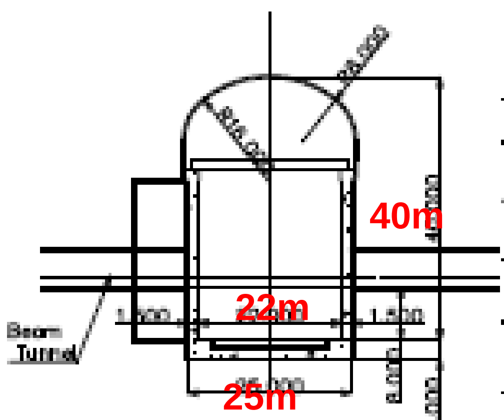


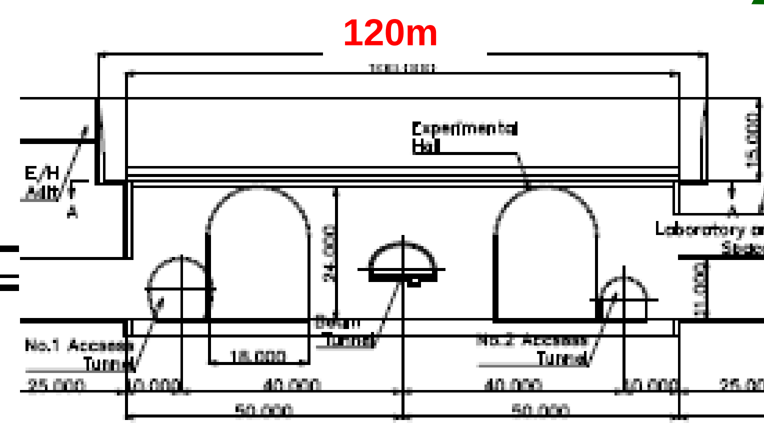
Image: Detector Hall



Access Tunnel Section



Hall Section



Longitudinal Section

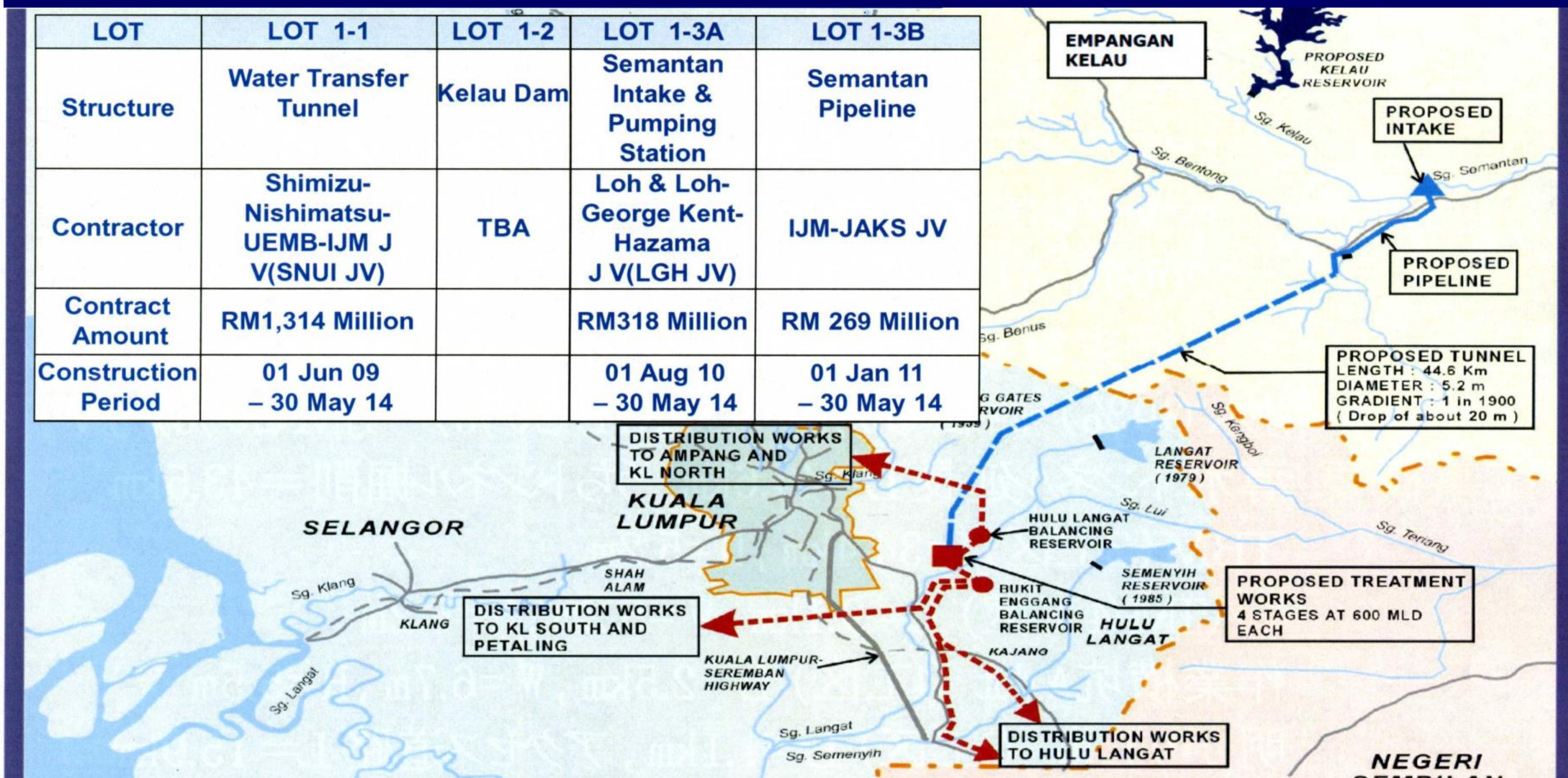
Preference Case for Tunneling in Malaysia

- Tunnel Construction of the ILC Scale Started.
- Site is Located in Mountainous Region.
- Geology is Granite, and very hard Rock.
- TBM & NATM are advancing simultaneously.

Preference Case for Tunneling in Malaysia

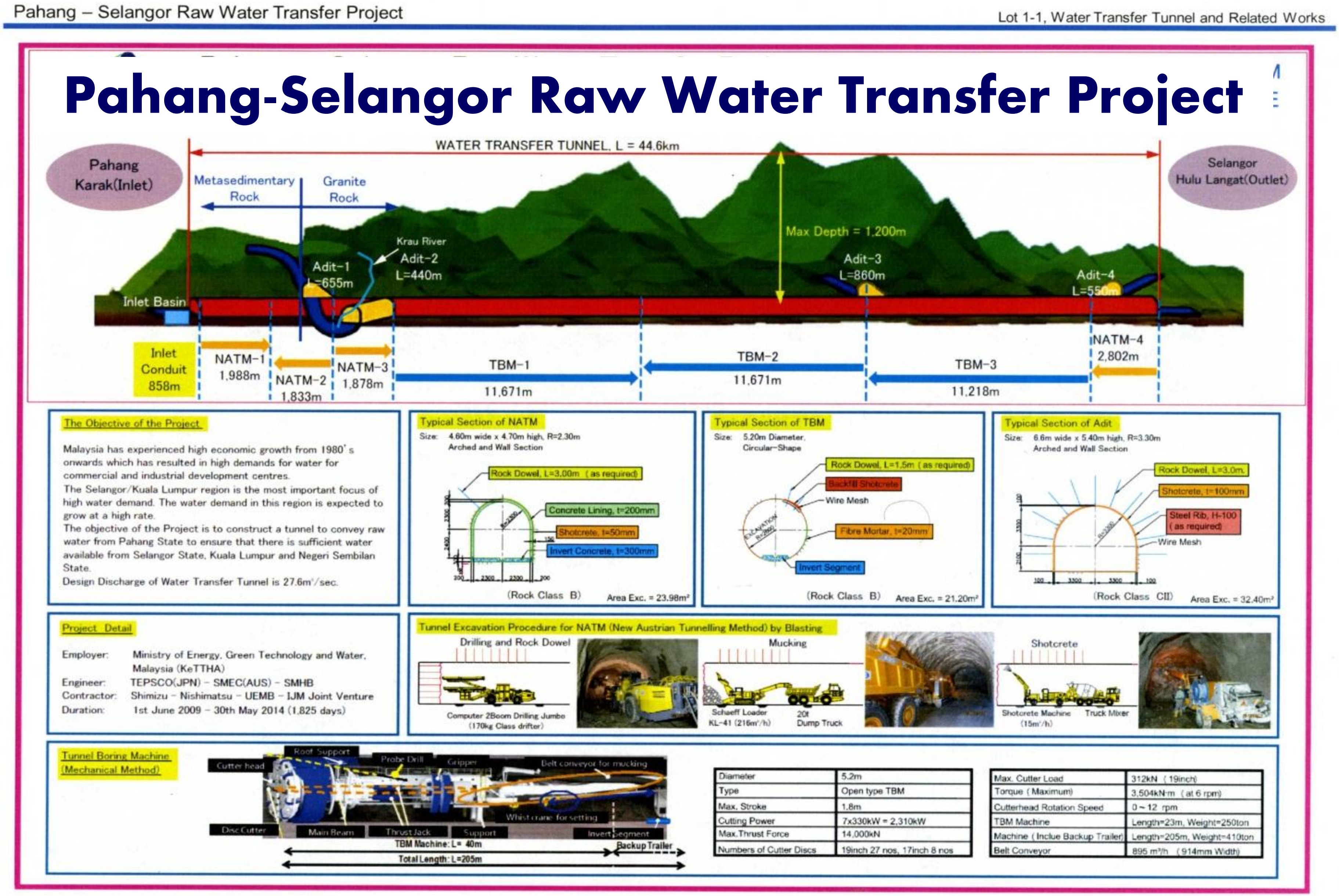
Pahang-Selangor Raw Water Transfer Project

LOT	LOT 1-1	LOT 1-2	LOT 1-3A	LOT 1-3B
Structure	Water Transfer Tunnel	Kelau Dam	Semantan Intake & Pumping Station	Semantan Pipeline
Contractor	Shimizu-Nishimatsu-UEMB-IJM J V(SNUI JV)	TBA	Loh & Loh-George Kent-Hazama J V(LGH JV)	IJM-JAKS JV
Contract Amount	RM1,314 Million		RM318 Million	RM 269 Million
Construction Period	01 Jun 09 – 30 May 14		01 Aug 10 – 30 May 14	01 Jan 11 – 30 May 14



■ **Raw Water Transfer Tunnel： 2.4million ton**

- Outline of Project -



Pahang – Selangor Raw Water Transfer Project

Lot 1-1, Water Transfer Tunnel and Related Works

Pahang-Selangor Raw Water Transfer Project

The Objective of the Project

Malaysia has experienced high economic growth from 1980's onwards which has resulted in high demands for water for commercial and industrial development centres.
The Selangor/Kuala Lumpur region is the most important focus of high water demand. The water demand in this region is expected to grow at a high rate.
The objective of the Project is to construct a tunnel to convey raw water from Pahang State to ensure that there is sufficient water available from Selangor State, Kuala Lumpur and Negeri Sembilan State.
Design Discharge of Water Transfer Tunnel is 27.6m³/sec.

Typical Section of NATM

Size: 4.60m wide x 4.70m high, R=2.30m
Arched and Wall Section

Typical Section of TBM

Size: 5.20m Diameter, Circular-Shape

Typical Section of Adit

Size: 6.6m wide x 5.40m high, R=3.30m
Arched and Wall Section

Project Detail

Employer: Ministry of Energy, Green Technology and Water, Malaysia (KeTTHA)
Engineer: TEPSCO(JPN) – SMEC(AUS) – SMHB
Contractor: Shimizu – Nishimatsu – UEMB – IJM Joint Venture
Duration: 1st June 2009 – 30th May 2014 (1,825 days)

Tunnel Excavation Procedure for NATM (New Austrian Tunnelling Method) by Blasting

Tunnel Boring Machine (Mechanical Method)

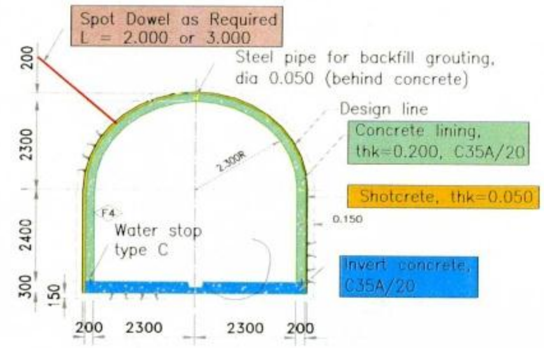
Diameter	5.2m
Type	Open type TBM
Max. Stroke	1.8m
Cutting Power	7x330kW = 2,310kW
Max.Thrust Force	14,000kN
Numbers of Cutter Discs	19inch 27 nos, 17inch 8 nos

Max. Cutter Load	312kN (19inch)
Torque (Maximum)	3,504kN·m (at 6 rpm)
Cutterhead Rotation Speed	0～12 rpm
TBM Machine	Length=23m, Weight=250ton
Machine (Inclue Backup Trailer)	Length=205m, Weight=410ton
Belt Conveyor	895 m³/h (914mm Width)

Tunnel Excavation Method

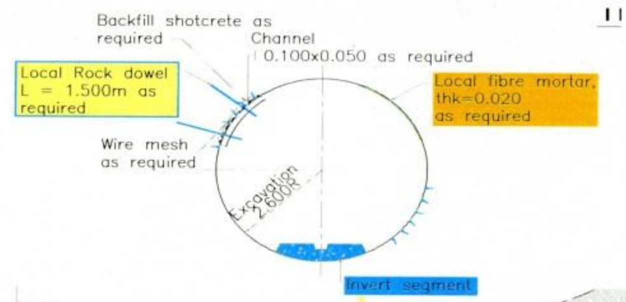
NATM

- Applied to Adit and NATM
  (11.6 km, Width 5.2m, Height 5.2 m)
- New Austrian Tunneling Method (1960')
- Drilling and Blasting
- Shotcrete, Rock Dowel&Steel Rib etc.



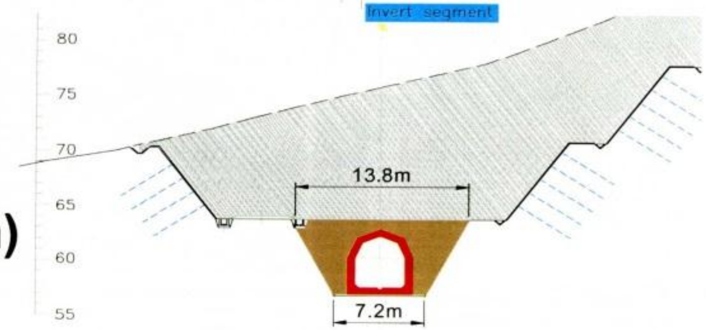
TBM

- Applied to TBM (34.4km, Dia. 5.2m)
- By Tunnel Boring Machine
- Fiber mortal, Rock Dowel&Steel Rib etc



Cut &Cover :

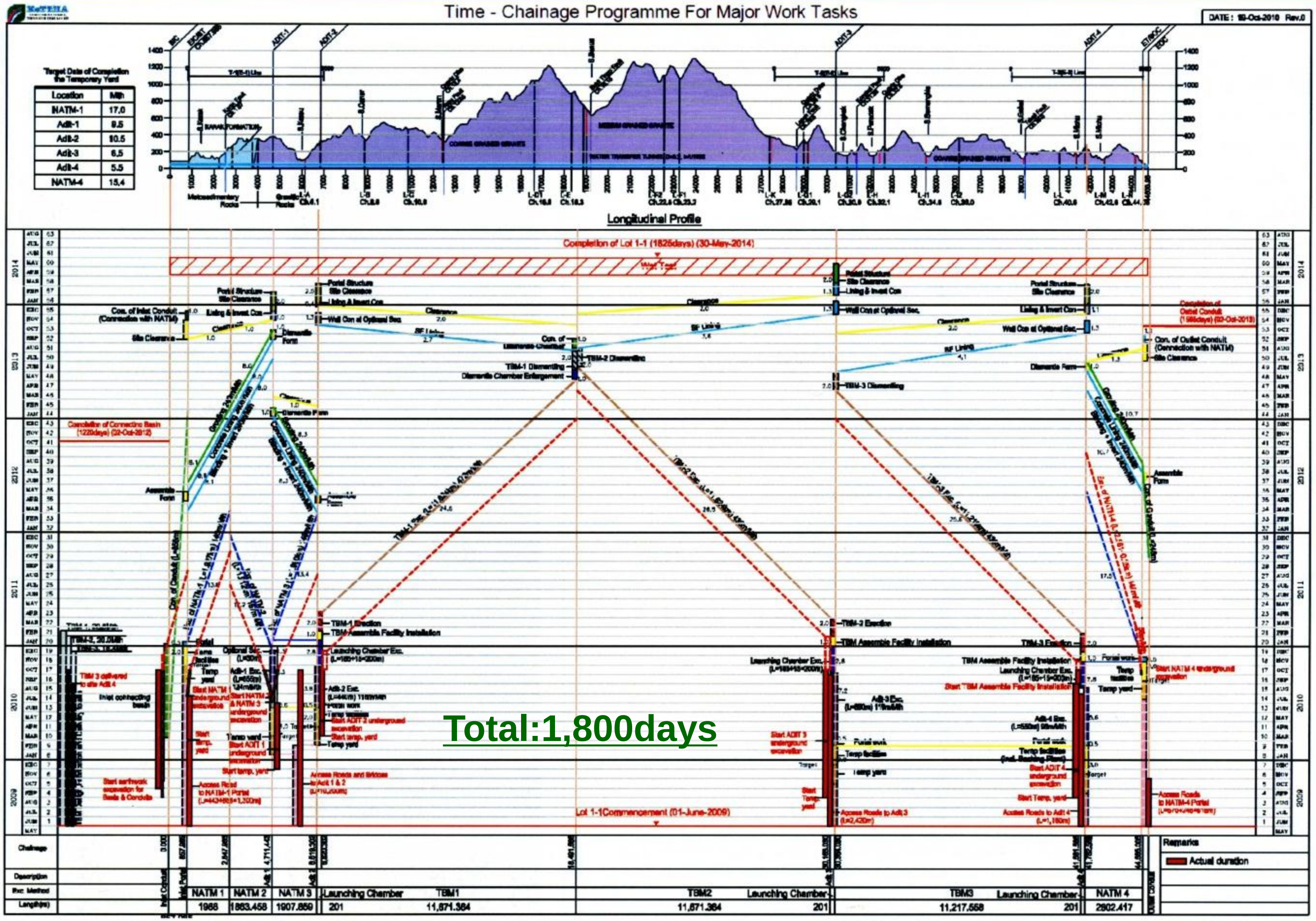
- Applied for Concrete Conduit
  (1.1km, Inner Width 4.0 m , Height 4.7 m)
- Excavation with Retaining Wall
- Fill upon the Completion of Structure



- Construction Schedule -

Pahang – Selangor Raw Water Transfer Project

Lot 1-1, Water Transfer Tunnel and Related Works



Total:1,800days

- Tunnel Boring Machine -

Pahang – Selangor Raw Water Transfer Project

Lot 1-1, Water Transfer Tunnel and Related Works

Tunnel Excavation Method for TBM

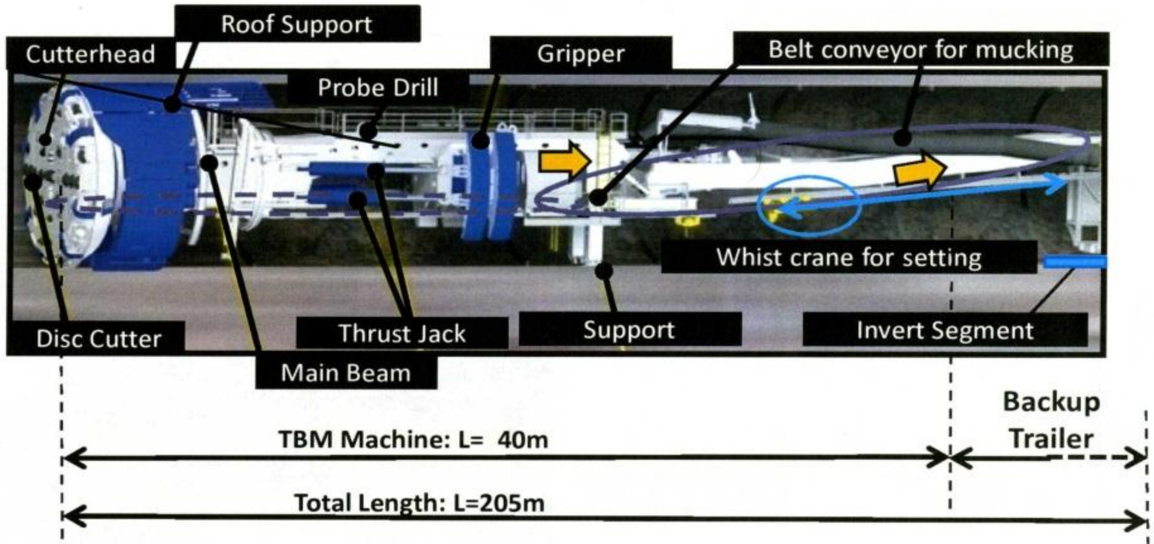
Applied to TBM (34.4km) by Tunnel Boring Machine, Fiber Mortal

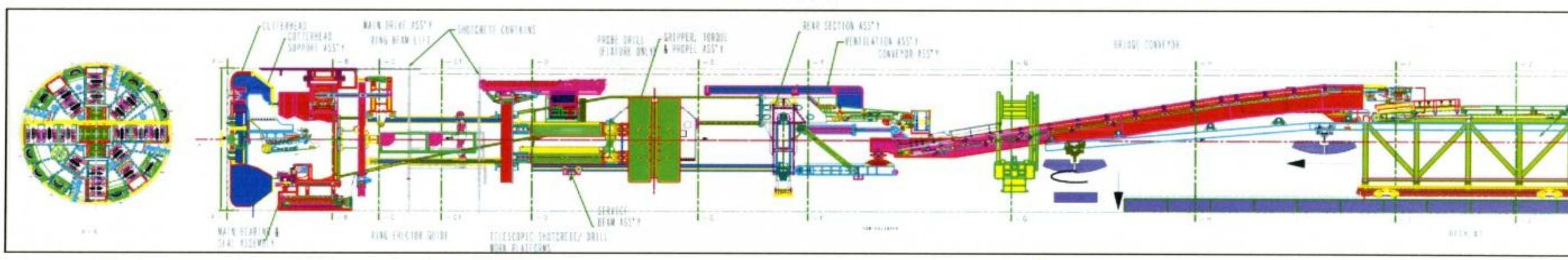
Specification of TBM

Item		Description
Diameter and Type		5.2 m, Open tyre
Maximum Stroke		1.8 m
Power		AC11,000V, 3-phase, 50Hz
Cutterhead Output		7X330= 2310 kW
Number of Cutter		19 inch 27 nos
		17 inch 8 nos
		Total = 35 nos
Total Thrust Force		14,000 kN (=3,500x4pcs)
Cutter Torque		Max. 4054 kN-m
Cutterhead Rotation Speed		0~12rpm
Mass of TBM Machine		250 ton
Belt conveyor	Width	914 mm
	Capacity	895 m^3/hr

Major Equipment for TBM

	Equipment	Type	Nos
Excavation	TBM Machine	Φ5.2m, Open Type	3
	Continuous Belt Conveyer	L=11.4km~11.8km	3
	Belt Conveyer for Adit	L=440m~860m	3
	Segment Grout Mixer	200Litre/min	3
Fibre Mortar	Mortar Shotcrete Machine with Compressor	2.2m3/hour	3+3
	Mortar Locomotive		6
Transportation	Diesel Locomotive	10 ton	9
	Material Cart	L=3.0m	18
Shotcrete	Agitator car	6m3	3
	Steel Fibre Shotcrete Machine	20m^3/hour	3
Drilling for investigation	Drilling Machine for investigation	COP1838 with Rod Changer	3
	Boring Machine for drain hole	RPD-100	1
Others	Gantry Crane	3.2ton	3
	Direction Control	Robotic Auto Navigation System	0
Total			64



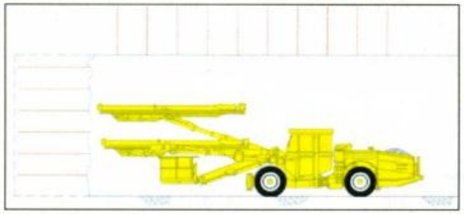


- Tunnel Excavation Machine in case of NATM -

Tunnel Excavation Method for NATM

Applied to Adit and NATM (11.6 km) New Austrian Tunneling Method from 1960' Drilling and Blasting, Rock dowel, Shotcrete

Drilling and Rock Dowel

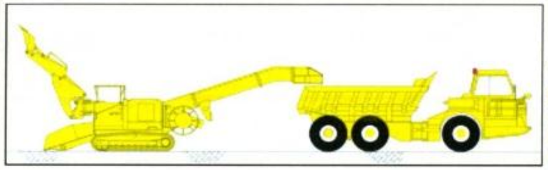


Computer 2Boom Drilling Jumbo
(170kg Class drifter)

Full Automatic Excavator

Computer Drilling Jumbo

Mucking



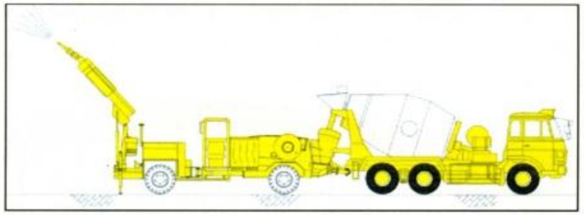
Schaeff Loader
KL-41 (216m³/h)

20t
Dump Truck

Schaeff Loader

Volvo 20T

Shotcrete



Shotcrete Machine
(15m³/h)

Shotcrete machine PM407P

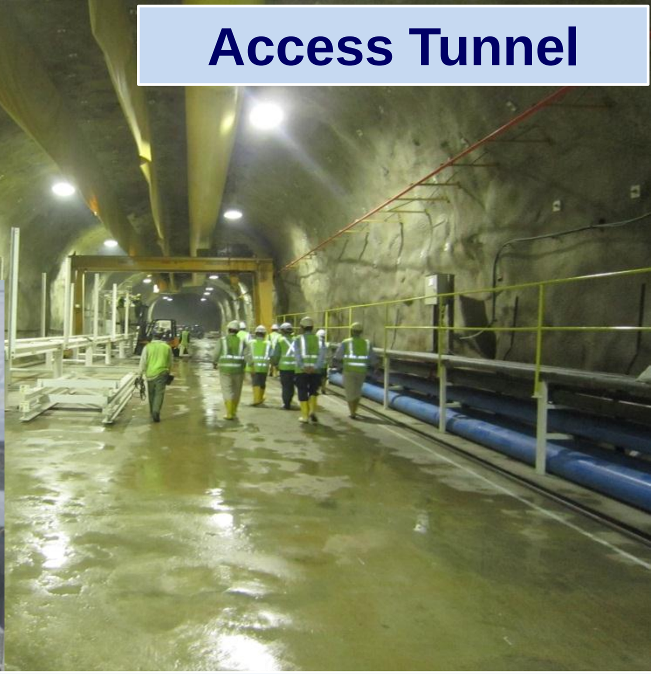
Equipment for NATM

	Equipment	Type	Nos
Excavation	Drilling Jumbo	Rocket Boomer L2C,or 352	4
	Breaker	PC128LS+1300kg	4
	Excavator	PC128LS(0.45m^3)	4
	Vehicle for Explosive	1 TONNE	4
	Vehicle for Explosive	4 TONNE	4
Mucking	Schaeff Loader	KL41	4
	Dump Truck	Volvo 20T	15
	Wheel Loader	KOMATSU WA200-3 1.4m^3	3
Shotcrete	Shotcrete machine	SIKA-PM407-P 4-20m^3/hr	4
	Truck Mixer	6.0m^3	8
Rock Dowel	Mortal Pump	MAI PUMP M400-NT	4
	Vehicle for Rock Dowel	2t Flat Truck	4
	Lorry Crane	4t Crane Truck	4
	Sub Total		**66**
Lining	Concrete Pump	55m^3/hr, 55kW	3
	Slide Formwork	L=12.0m	3
Grout	Grout pump	2ton Truck	3
Others in Tunnel	Power Supply Car	10ton Truck	6
	Dust Collector	1,200m^3/min+4tT	4
	Ventilation Fan	1,200 ~ 1,500m^3/min	4
	Truck Crane	4t	8
	Total		**97**

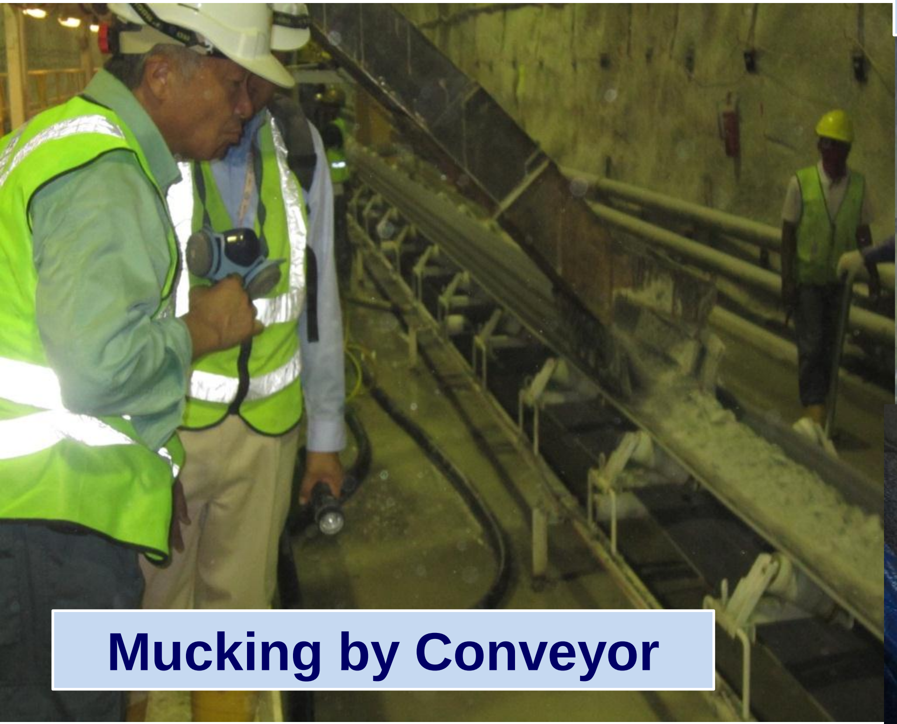
TBM Tunnel

Access Tunnel

TBM Tunnel

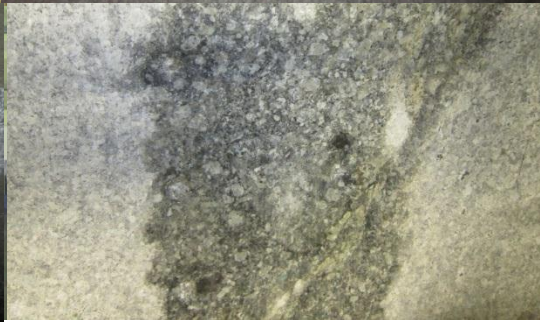


Access Tunnel



Mucking by Conveyor

Surface by TBM Excavation



Fracture, Crack

TBM Tunnel

Spring-water

Construction Base

Access Portal

Muck Loader, Muck Car, Disposal Area

Summary of Malaysia Inspection

Common Features with ILC Facility (in Japan)

- Facility Scale : Tunnel Length =45km
- Geology of the Site Location : Granite Bedrock
- Geography of the Location : Mountainous Region
- Tunneling Method : TBM, NATM, Access Tunnel

Clear Different Points

- The Rout Change by Geology : Possible
- Leakage of Ground Water : Permissible to some Extent
- Stability after Completion : Usual Accuracy

3. Consideration on Access Method

- Experience in Japanese Tunneling
- **Vertical Shaft** and **Access Tunnel**

■Table-1 List of Access Method in the Past (1)

No	Tunnel	Access Route	Incline Tunnel	Vertical Shaft	Shaft Depth (H: m)			Shaft Diameter (D: m)		
					H < 50	50<H<150	150 < H	6.0 <D< 9.0	9.0 < D	□
1	北陸	3	2	1			1	1		
2	桂城	4	4							
3	新清水	1	1							
4	六甲	6	5	1	1					1
5	安芸	3	3							
6	新関門	9	8	1	1					1
7	北九州	4	2	2	2			1		1
8	生田	2	1	1	1					1
9	福島	4	3	1	1					
10	蔵王	1	1							
11	榛名	6	4	2	1	1		2		
12	中山	3		3			3	3		
13	大清水	6	6							
14	塩沢	1	1							
15	青函	8	6	2			2	2		
Total		61	47	14	7	1	6	9		4

From the Literature Research of the Large Tunnel Cases in 1958～1986

■Table-2 List of Access Method in the Past (2)

No	Tunnel	Access Route	Incline Tunnel	Vertical Shaft	Tunnel Length (L: m)			Tunnel Gradient (i: %)		
					L < 500	500 <L<1000	1000 < L	0 < i < 10	10 <i< 20	20 < i
1	北陸	3	2	1	2			1		1
2	桂城	4	4		4					4
3	新清水	1	1		1					1
4	六甲	6	5	1	4	1				5
5	安芸	3	3		1	2				3
6	新関門	9	8	1	8				1	7
7	北九州	4	2	2	2					2
8	生田	2	1	1	1					1
9	福島	4	3	1	3				1	2
10	蔵王	1	1		1					
11	榛名	6	4	2	4					4
12	中山	3		3						
13	大清水	6	6		4	2			2	4
14	塩沢	1	1		1					1
15	青函	8	6	2	2	2	2			6
Total		61	47	14	38	7	2	1	4	41

From the Literature Research of the Large Tunnel Cases in 1958～1986

■ Access Method Example in the Past

1. **Vertical Shaft**
   - Depth: Half of the Examples is less than 50 m.
     Other Half is Over than 150m. Max=380 m.
   - Diameter: all Example is 6 ~ 9 m. 4 Example: Rectangle.
2. **Inclined Shaft (Inclined Tunnel)**
   - Length: Almost (80%) is less than 500 m.
   - Gradient: Almost All (90%) is more than 20% Slope.
3. **Common Method in the Past**
   - Steep Slope Tunnel is Common Method
   - Velt-Conveyor Method was Mainstream for Carrying out the Muck and other Construction Equipment.

■ Table-3 Access Examples in a Huge Tunnel (Railway)

Project	Tunnel	Length	Type	Size	Shape	Length	Slope	Mucking
TOHOKU-SHINKANSEN	ICHINOHE (2002)	25.8 km	Incline	W6.3*H4.8	Horseshue	411 m	6.0 %	Dump T
			Incline	W6.3*H4.8	Horseshue	524 m	10.0 %	Dump T
			Incline	W6.1*H4.7	Horseshue	552 m	10.0 %	T. Container
			Incline	W6.6*H6.0	Horseshue	1,015 m	10.0 %	Dump T
			Incline	W6.1*H4.9	Horseshue	1,251 m	10.0 %	Dump T
	HAKODA (2005)	26.5 km	Incline	W6.4*H5.0	Horseshue	718 m	8.7 %	Dump T
			Incline	34.0 ㎡	Horseshue	738 m	6.8 %	Dump T
			Level	30.0 ㎡	Horseshue	1,331 m	1.1 %	Dump T
			Level	W6.4*H5.0	Horseshue	948 m	3.6 %	T. Container
HOKURIKU-SHINKANSEN	IIYAMA (2007)	22.2 km	Incline	26.5 ㎡	Horseshue	230 m	9.7 %	B. Conveyor
			Incline	32.0 ㎡	Horseshue	765 m	12.0 %	Dump T
			Incline	27.0 ㎡	Horseshue	270 m	12.0 %	Dump T
			Incline	34.0 ㎡	Horseshue	710 m	10.0 %	B. Conveyor
			Incline	27.0 ㎡	Horseshue	523 m	7.5 %	D.T+B.C

From the Literature Research of the Large Tunnel Cases in 2002～2008

■ Access Method in Recent

1. Background

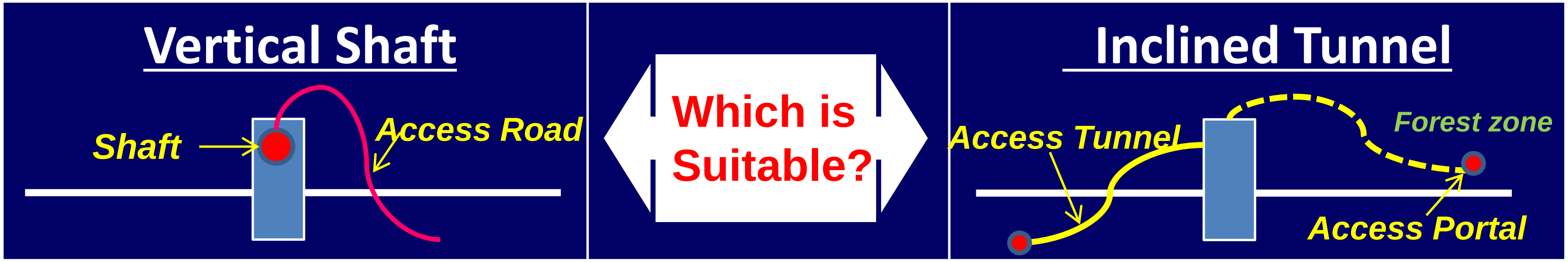
- Upsizing of the Tunnel Section (Road, Railway, etc) and the Construction Machine.
- Tire Method is in Use for Rapid Construction
- Serious Consideration of Safety

2. Actual Condition in Recent Years

- All Access Examples are Inclined Tunnel with the Horseshoe Shape by NATM.
- Cross Section Size: around 30 Square meters
- Tunnel Slope: Less than 12%

From the Literature Research in2002~2007 Completion

■ Comparison: Two Typical Acess Methods



Remarks		Topic		Remarks
Limited (Access Point)	△	**Locating (Portal)**	◎	Flexible (Access Portal)
Addition an Access Road	-	**Construct. Cost**	-	
	-	**Construct. Period**	-	
Operation only a Crane	△	**Muck Carrying**	○	Carrying by a Dump Truck
	-	**Water Drainage**	-	
Advantage by Shortness	○	**Ventilation**	△	Long Distance
Advantageous	○	**Maintainability**	△	Disadvantageous
Vertical Evacuation	△	**Safety (Refuge)**	○	by an Evacuation Vehicle
by a Crane	-	**Installation**	-	by a Trailer Truck

3.2 Consideration of the Access Method

Access Method to the Underground Facility should be Determined on a Case-by-Case In Synthetically Consideration of **Geographical Conditions**, **Cost**, **Construction Schedule** , and **Safety Issue**, etc.

Basic Specification in the Case of Access Tunnel

- Inner Section Size : W11.0 m×H11.0 m
- The Maximum Slope : < 7.0 % (for Installation)
- Incidental Facilities : Ventilation (Air, Smoke, He)
  Drainage Facilities, Safety Facilities (Evacuation)

4. Revision of the Asian Site-Specific Design

- Process of the Scheme Change
- Case Studies on Underground Structure Configuration (Interim Report)

4. Revision of Asian Site-specific Design

■ Process of the ML Tunnel Scheme Change

- Twin Tunnel Scheme (RDR, 2007)
- Single Tunnel Scheme with a Sub-tunnel (SB2009)

↓

- Single Tunnel Scheme without a Sub-tunnel (TDR)

■ Revision toward TDR

- Case Study about the Cost and Construction Schedule
  --- Most Suitable Design in a Mountain Site ---
- True Single Tunnel Configuration (TBM ⇔ NATM)

Japanese Configuration

RDR

Double Tunnel

SB2009

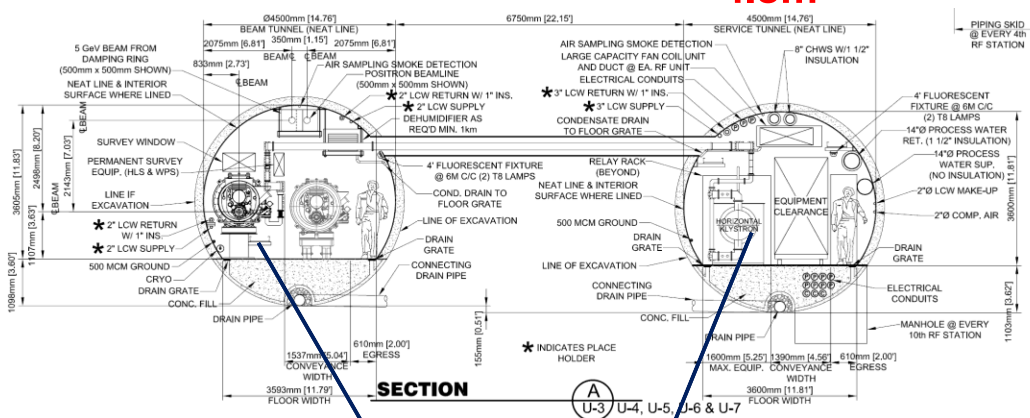
Single Tunnel

Beam Tunnel

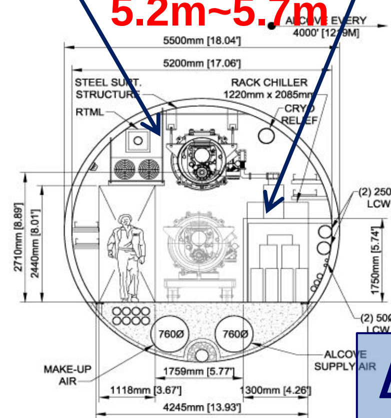
4.5m

Service Tunnel

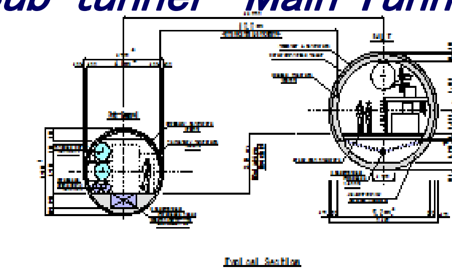
4.5m



5.2m~5.7m

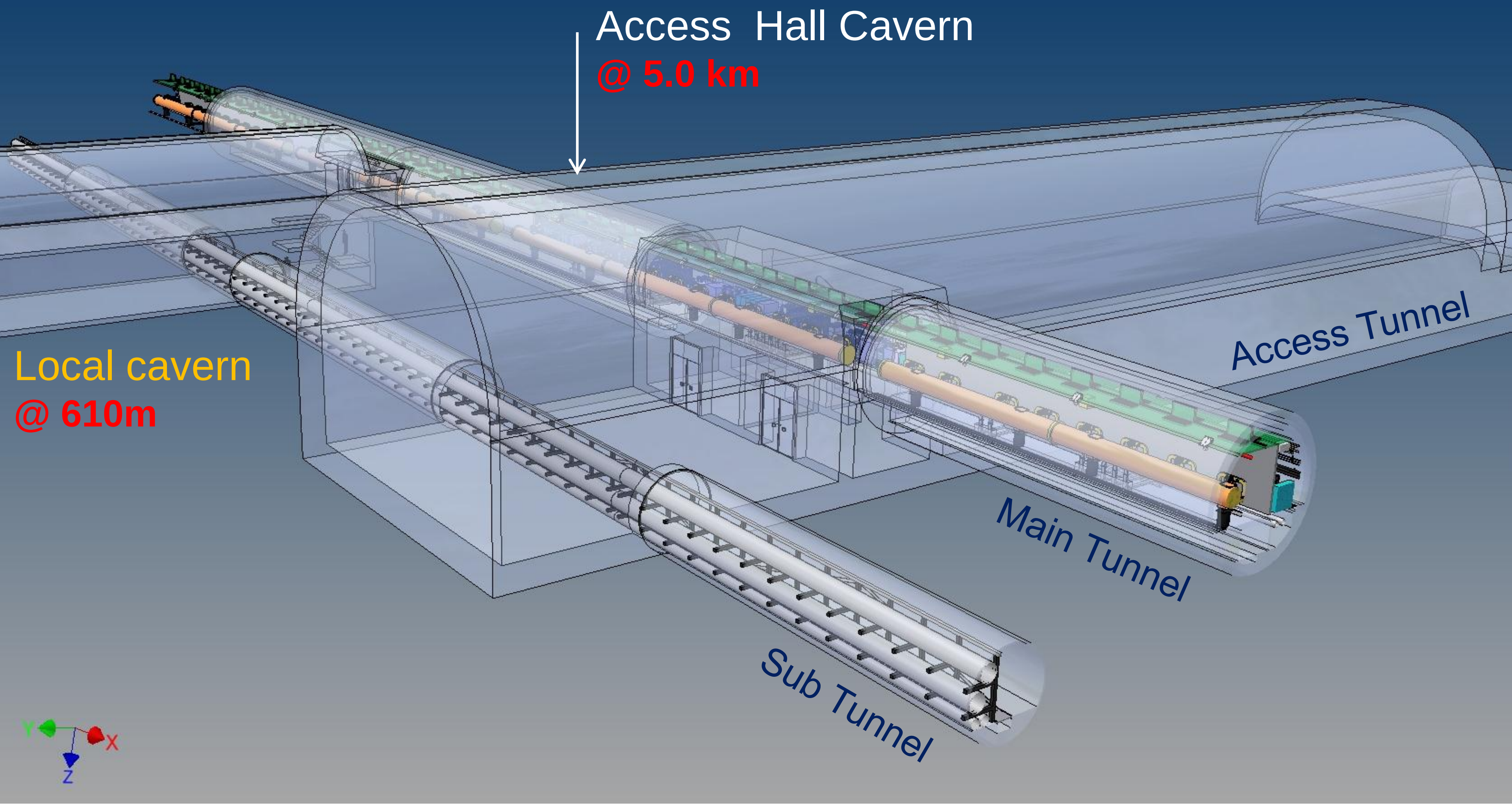


Sub-tunnel *Main Tunnel*

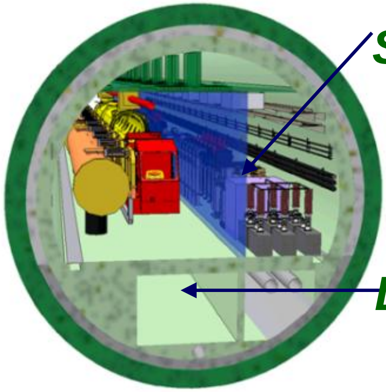


Distributed RF System (DRFS)

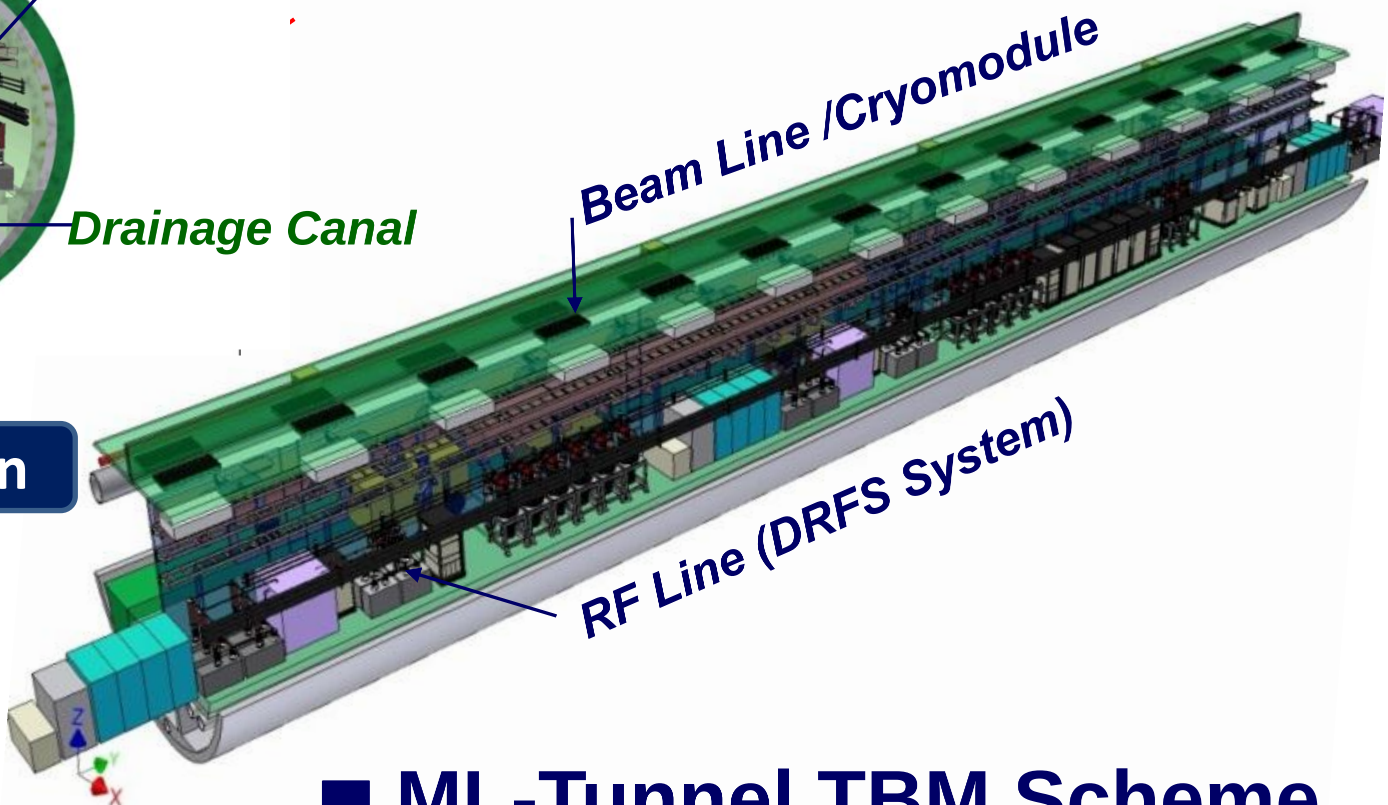
■ Japanese Scheme (2009)



ML-Tunnel Configuration

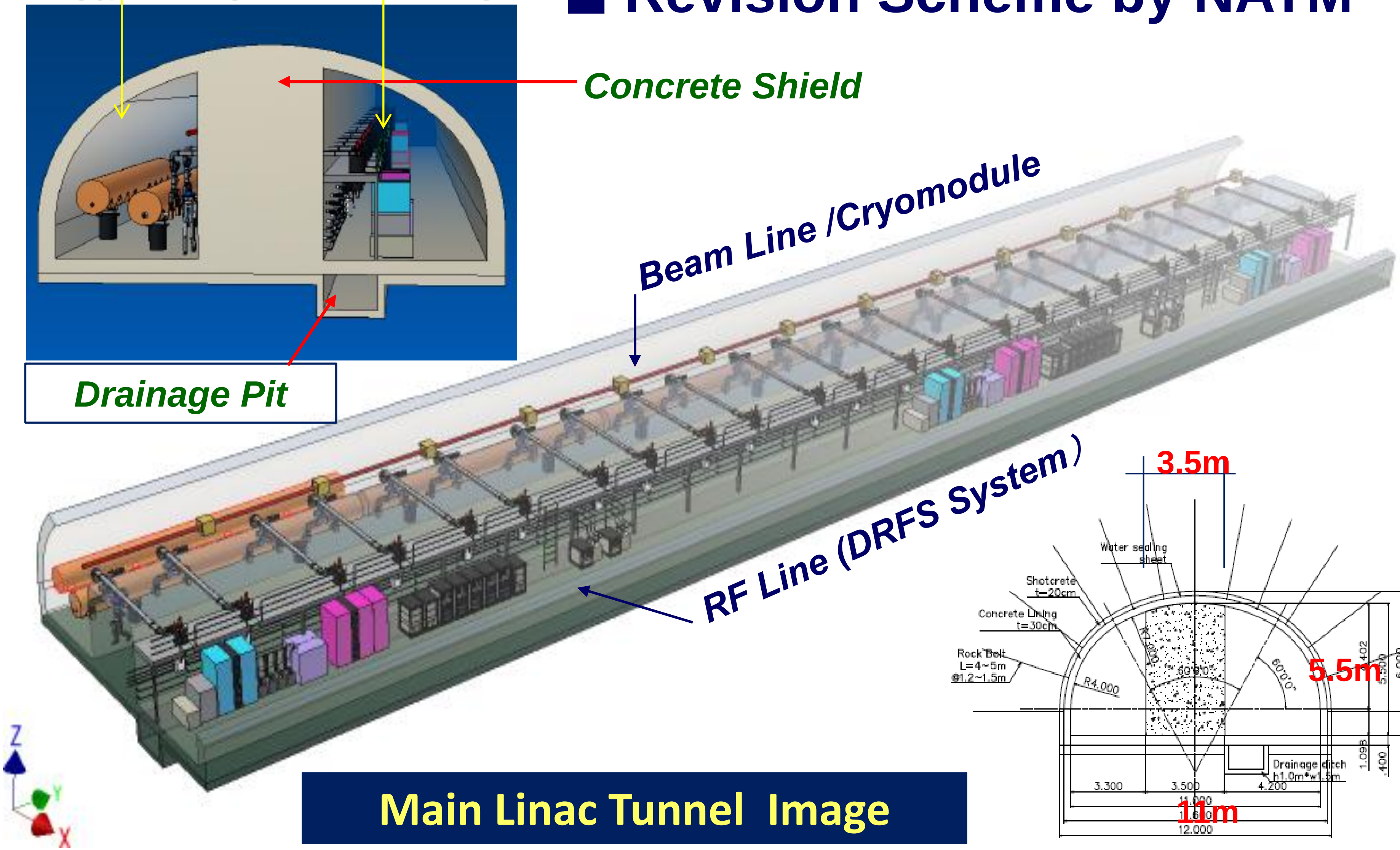


TBM Section



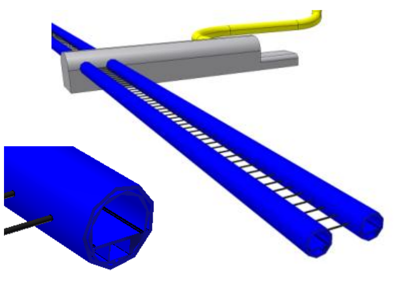
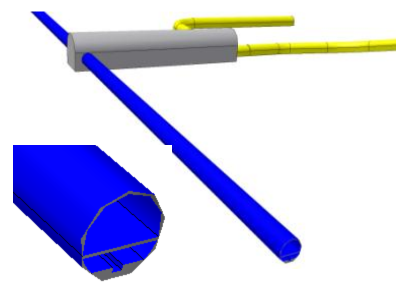
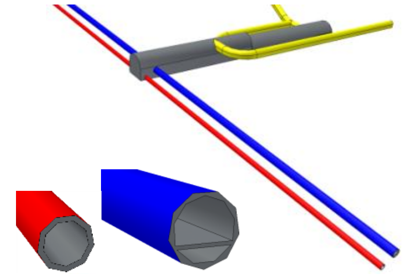
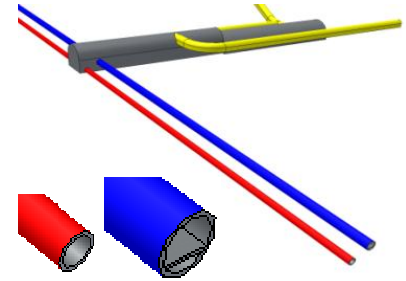
■ ML-Tunnel TBM Scheme

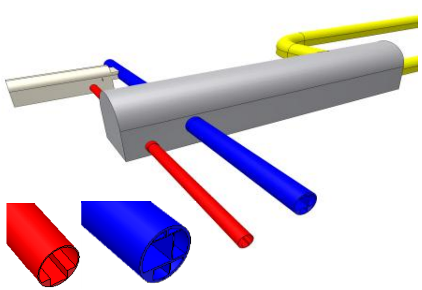
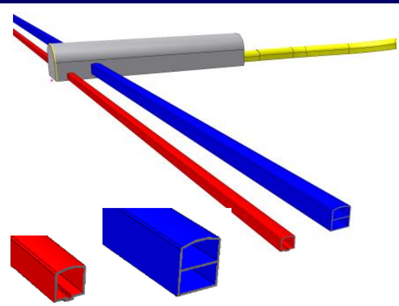
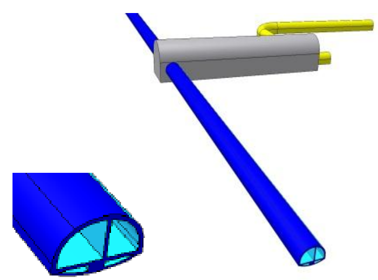
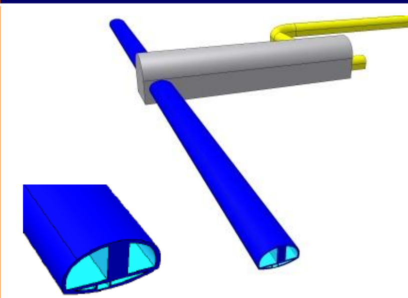
■ Revision Scheme by NATM



Main Linac Tunnel Image

Overview of the Cases

Case-1	Case-2	Case-3	Case-4
RDR D-T-R	RDR' S-T-R	XFEL JS-T-X	KCS JS-T-K
			
Circle／Double T	Circle／Single T	Circle／Single T	Circle／Single T

Case-5	Case-6	Case-7	Case-8
DRFS JS-T-D	DRFS JS-N-D	DRFS S-N-D	DRFS wS-N-D
			
Circle／Single T	NATM／J-Single T	NATM／J-Single T	NATM／J-Single T

■ List of the Comparison Cases

Tunnel Configuration	Tunnel Shape	HLRF Type
- Double Tunnel（D） - Single Tunnel （S） - Japanese ST. （JS）	- TBM-Circle Section - NATM-Warhead Section	- RDR - XFEL - KCS - DRFS

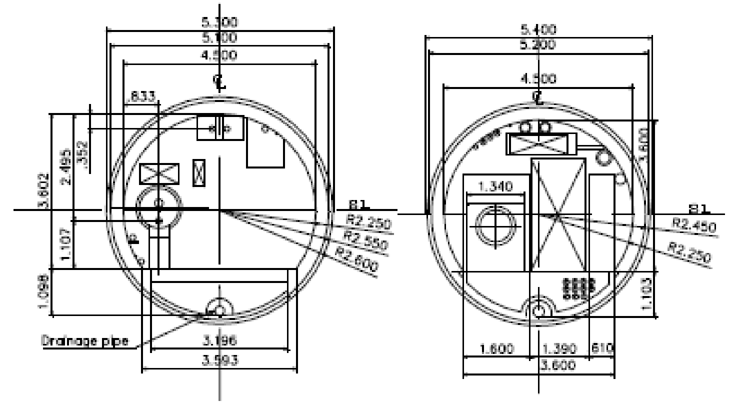
CASE-N0	Code		Method	HLRF	Remark
CASE-1	D-T-R	D	TBM	RDR	Service Tunnel
CASE-2	S-T-R	S	TBM	RDR’	
CASE-3	JS-T-X	JS	TBM	XFEL	Sub Tunnel
CASE-4	JS-T-K	JS	TBM	KCS	Sub Tunnel
CASE-5	JS-T-D	JS	TBM	DRFS	Sub Tunnel
CASE-6	JS-N-D	JS	NATM		Sub Tunnel
CASE-7	S-N-D	S	NATM		
CASE-8	wS-N-D	S	NATM		

Outline of Case Model (1)

CASE-1《D-T-R》 - Double Tunnel - TBM - RDR System

■ Original Plan based on RDR

- RDR Original Plan Which is Composed of Beam Tunnel and Service Tunnel.
- Borehole for the Wave guide is constructed between Beam Tunnel and Service Tunnel Tunnel at Intervals of 12m.
- An Access Hall is Arranged Every 5 km.



Beam Tunnel Service Tunnel

CASE-2《S-T-R》 - Single Tunnel - TBM - RDR System

■ Single, Large Section Tunnel based on RDR

- Single Large Tunnel include all ML Equipment.
- Beam Tunnel and Service Tunnel are separated with Horizontal Partition Slab.
- The Lowermost Trench in a Tunnel is utilized as a Groundwater Drainage Canal.

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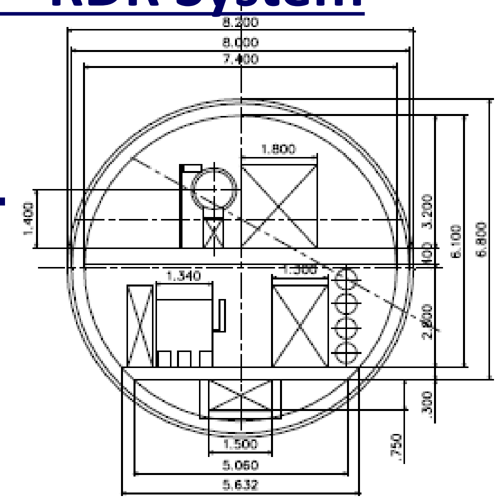
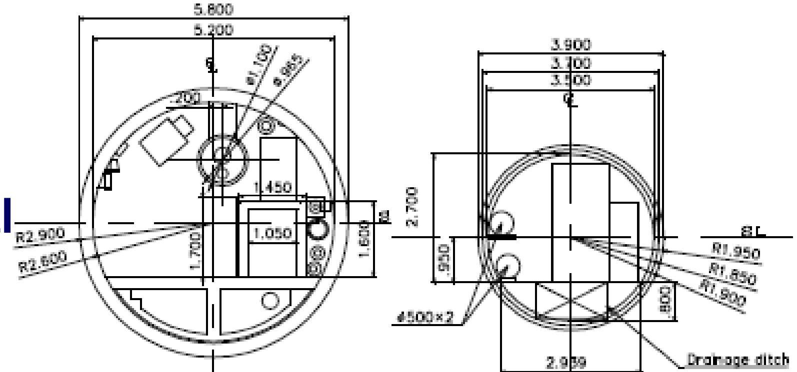


Outline of Case Model (2)

CASE-3 《JS-T-X》 - Single Tunnel - TBM - XFEL System

■ Layout Plan by the XFEL RF System

- Cross Section of the Beam Tunnel is the Same Size of XFEL's Tunnel in DESY.
- Sub-tunnel will be constructed for Cooling tl Water Piping, Drainage and Evacuation.
- Access Hall: a Big Cavern to Install the RF Equipment such as Pulse Modulator.

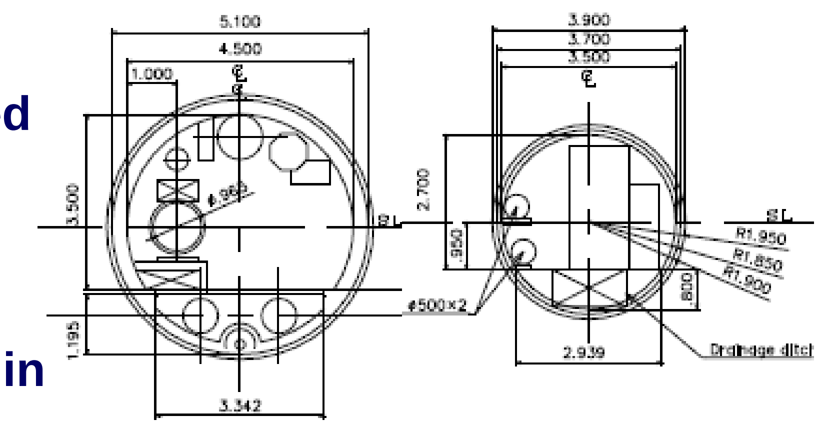


Beam Tunnel Service Tunnel

CASE-4 《JS-T-K》 - Single Tunnel - TBM - KCS System

■ Layout Plan by the KCS RF System

- Cross Section of the Beam Tunnel is planed at the Same Size of KCS's Tunnel.
- Access Hall is the Biggest Cavern in order to Install the Equipment like a Klystron.
- Access Hall is Arranged at intervals of within 2.5 km on the Main Linac Tunnel.



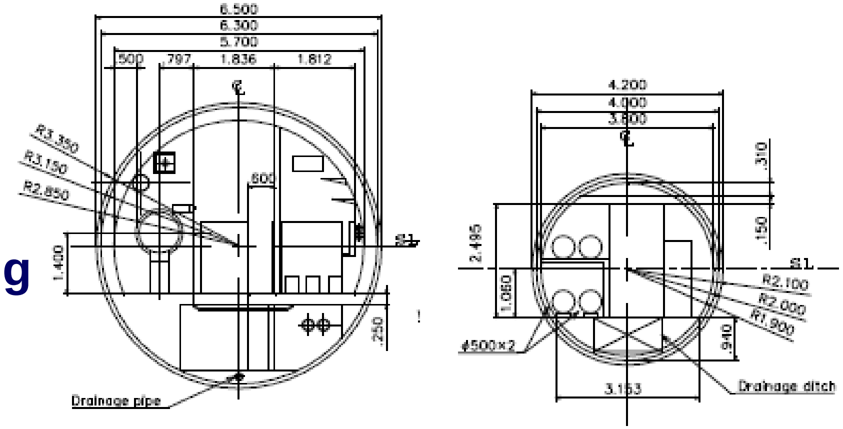
Beam Tunnel Service Tunnel

Outline of Case Model (3)

CASE-5《JS-T-D》 - (J)Single Tunnel - TBM - DRFS System

■ Layout Plan by the DRFS System

- Original Plan of Japanese Version Single Tunnel Configuration (2009)
- Sub-tunnel will be constructed for cooling Water, Drainage and Evacuation.
- It is Necessary to Arrange the Local Cavern every 600 m on the ML-Tunnel.

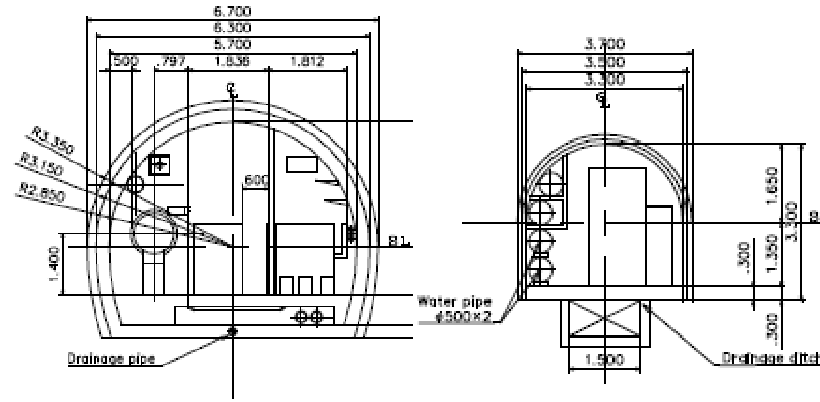


Beam Tunnel   Service Tunnel

CASE-6《JS-N-D》 - (J)Single Tunnel - NATM - DRFS System

■ NATM Version of Case-5

- Proposal Scheme which Changes TBM of the Case 5 into NATM.
- Cross Section of Both Tunnels is Horseshoe Shape by NATM.
- Adit Tunnel will be constructed in order to the Beam Tunnel and the Access Hall in parallel with NATM.



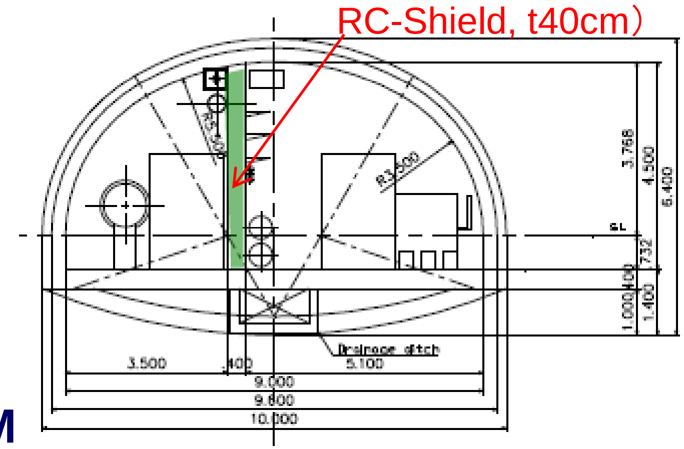
Beam Tunnel   Service Tunnel

Outline of Case Model (4)

CASE-7《S-N-D》 - Single Tunnel -NATM - DRFS System

■ Single, Large Tunnel Version by NATM

- Partition Wall (0.4 m) Separated the Beam Line and RF Zone, Protects the Electronic Devices from Radiation.
- Trench Under the Floor is used as a Groundwater Drainage Canal.
- BDS & DR Tunnel will be constructed by NATM

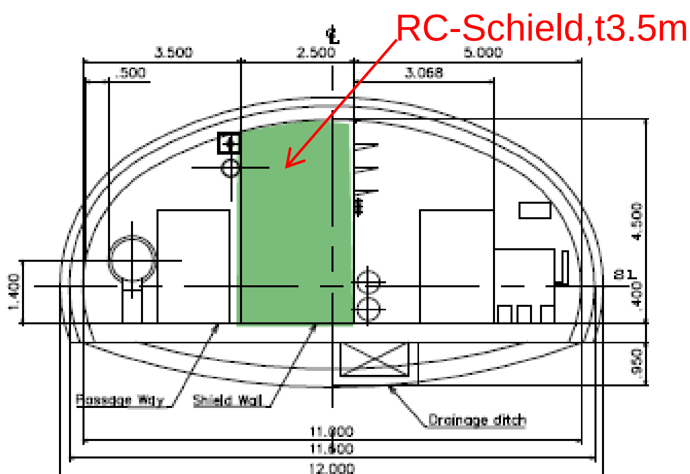


Beam Tunnel

CASE-8《wS-N-D》 - Single Tunnel -NATM - DRFS System

■ Improved Version of Case-7

- RC-Shield Wall of 3.5 m thickness Protects the Person in the RF Zone from Radiation.
- It is not Necessary to Arrange the Local Cavern (Machine Room) for Air-Conditioning and Cooling Water Supply.
- Refuge Path



Beam Tunnel

5. Summary

1. *Background of the Siting*
   - Asian Region have Two Candidate Sites.
   - Both Sites are located on the Stable Bedrock.

2. *Facility Arrangement in a Mountain Site*
   - We are Studying now Various Scheme for Civil Works of Underground Facility

3. *Consideration of Access Tunnel Issues*
   - Inclined Tunnel is suitable for Access to the Tunnel and Cavern in Japanese Mountainous Site.

4. *Revision of the ML-Tunnel Configuration*
   - New Configuration by NATM Tunneling is on Progress.
   - Technical Study about the Construction Cost and Construction Schedule is on Progress toward TDR.