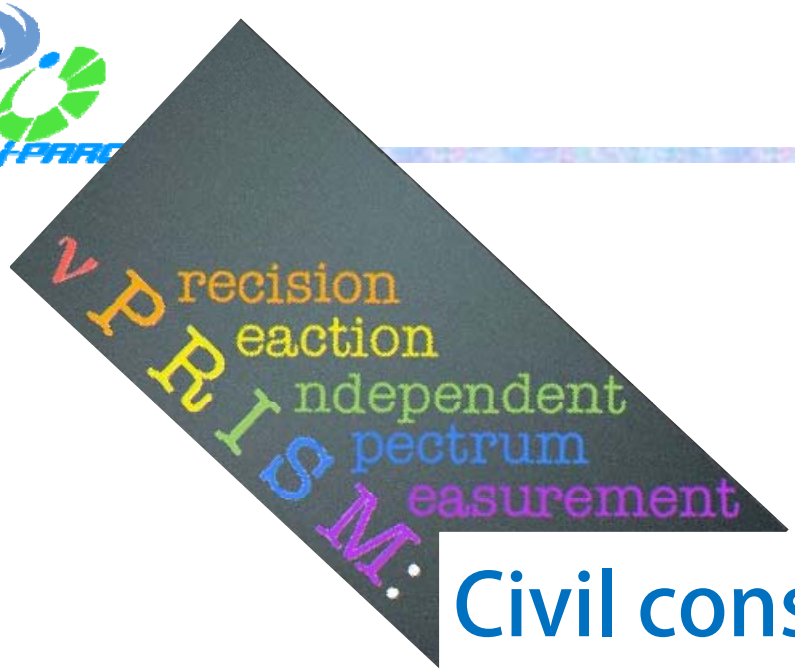

Civil construction status

Hide-Kazu Tanaka (ICRR)
T.Ishida (J-PARC/KEK)

July 23, 2014

Outline and my appologies..

T. Ishida
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KEK

- This talk is mostly based on materials for following presentations in the past, and no updates.
  - H.K.Tanaka, presentation at 1st WS at IPMU
    http://indico.ipmu.jp/indico/conferenceDisplay.py?confId=33
  - H.K.Tanaka, updates at an EVO m, Apr.02
    http://www.t2k.org/ndup/nuprism/meetings/20140402
  - T.Ishida, presentation at premeeting Apr.16
    http://www.t2k.org/ndup/nuprism/meetings/20140416premeeting
- Estimates from a general construction company (A) + a heavy industrial company (B)
  - Working for Hyper-K's construction estimates.
- A rough estimate from another general construction company (C)
  - Based on 2km detector construction estimates during 2001~2004.
- I have re-visited materials from these companies in detail before making further progress.

Tank Lining (Reminder)

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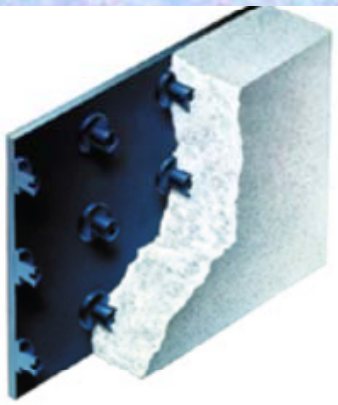
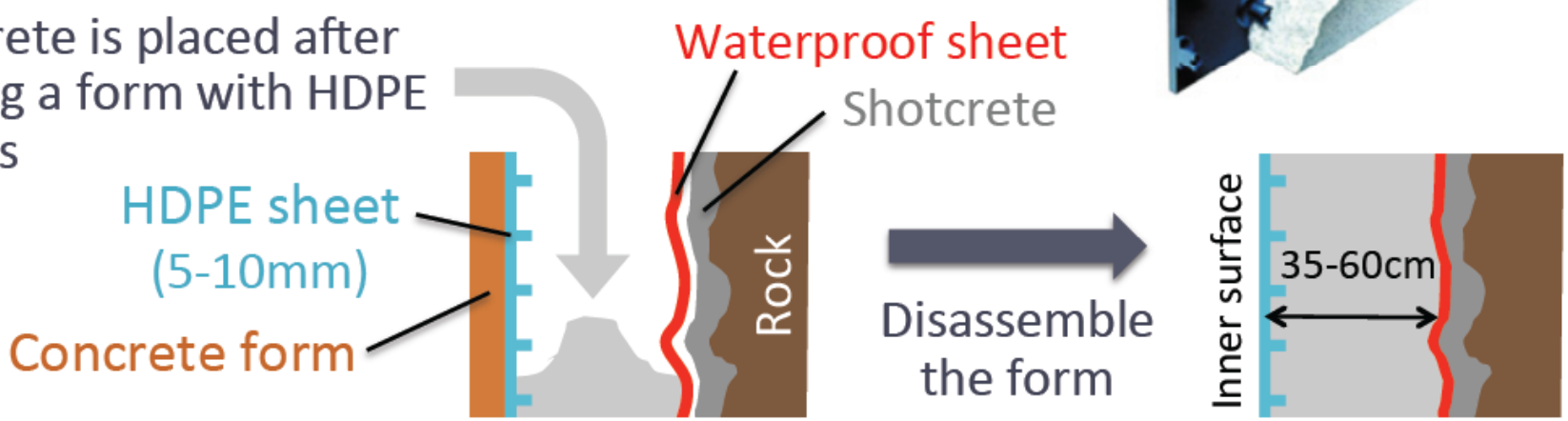
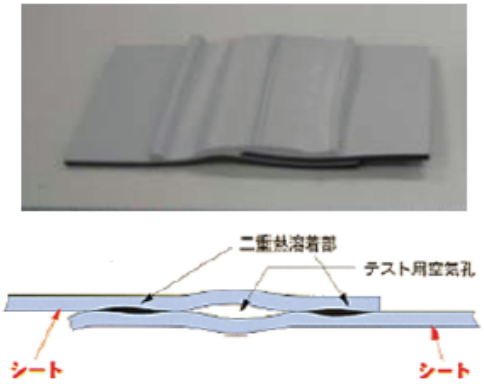
Tank lining consists of concrete and High Density Polyethylene (HDPE) sheet linings



Concrete is placed after setting a form with HDPE sheets





- Water permeability of HDPE sheet is very low
- Adjacent HDPE sheets are welded by heating
- Holes in a sheet (including welded part) can be found by pinhole test

Estimates for different construction methods: company (A)

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(Unit: Oku JPY; ~Million USD)

Method	PC	SMW	NAT	UR	RC
Survey	0.1 (L=70m)				
Designing	0.15				
Land prep.	0.15				
50m deep (construction time)	7.7 (1year)	5.9+ (1year)	5.3+ (1year)	7.5 (1year)	7.5 (1year)
80m deep (construction time)	Not applicable	Not applicable	Not applicable	Not applicable	12 (1.5year)

Cheapest

Recommended

- Pneumatic Caisson, Soil Mixing Wall, New Austrian Tunneling, Urban Ring, RC cast in-situ diaphragm wall

Drawing by heavy industrial company (B)

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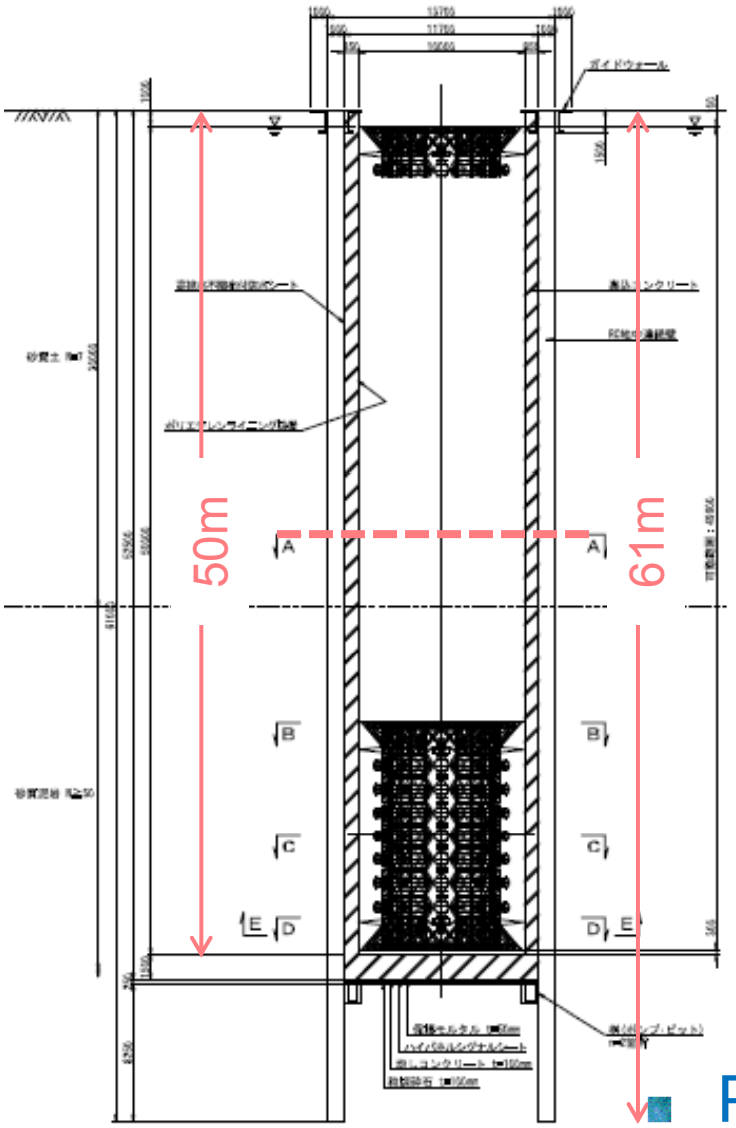

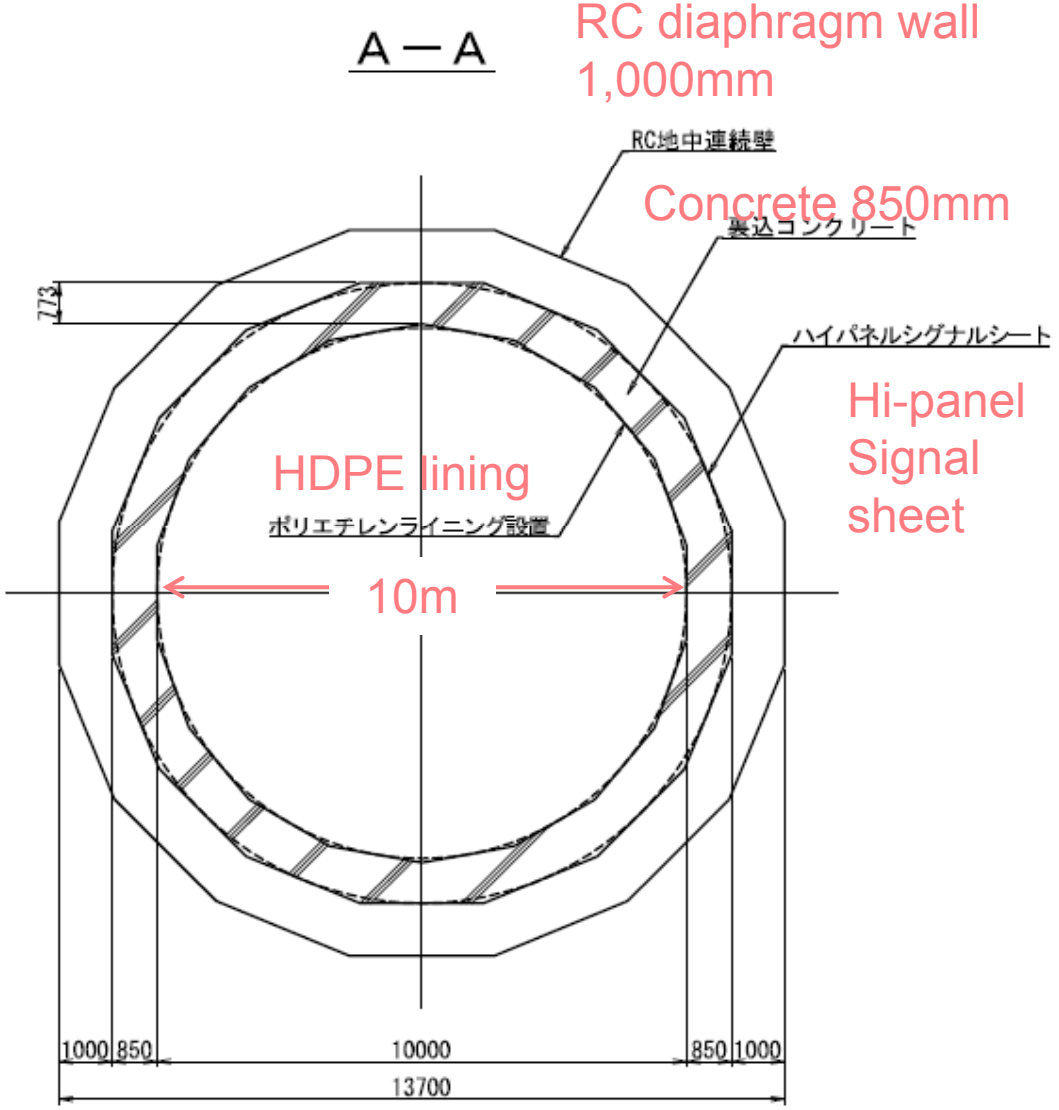

- RC diaphragm wall is assumed

Cast-in-site diaphragm wall method

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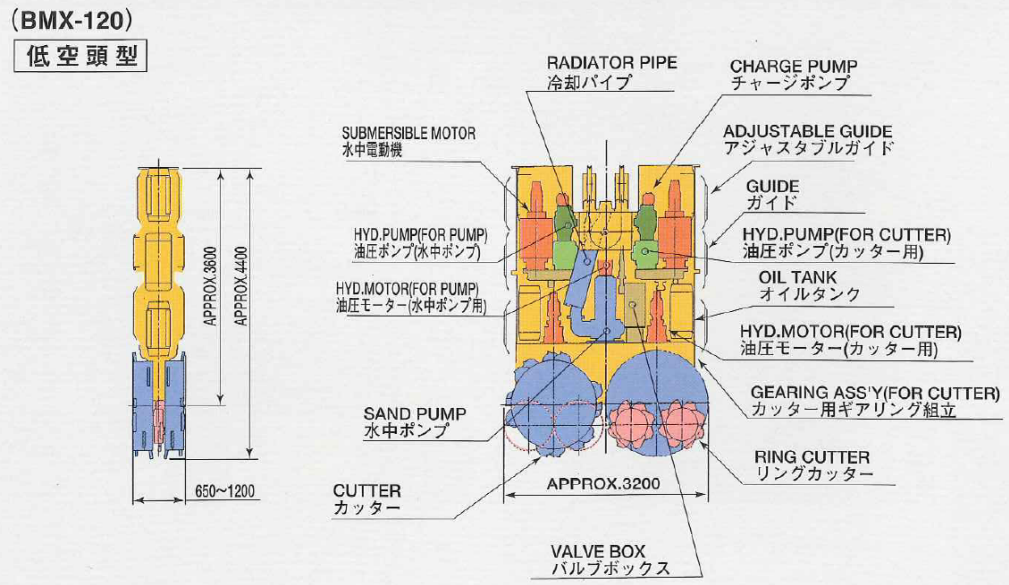

- K2K ND / T2K ND280 halls

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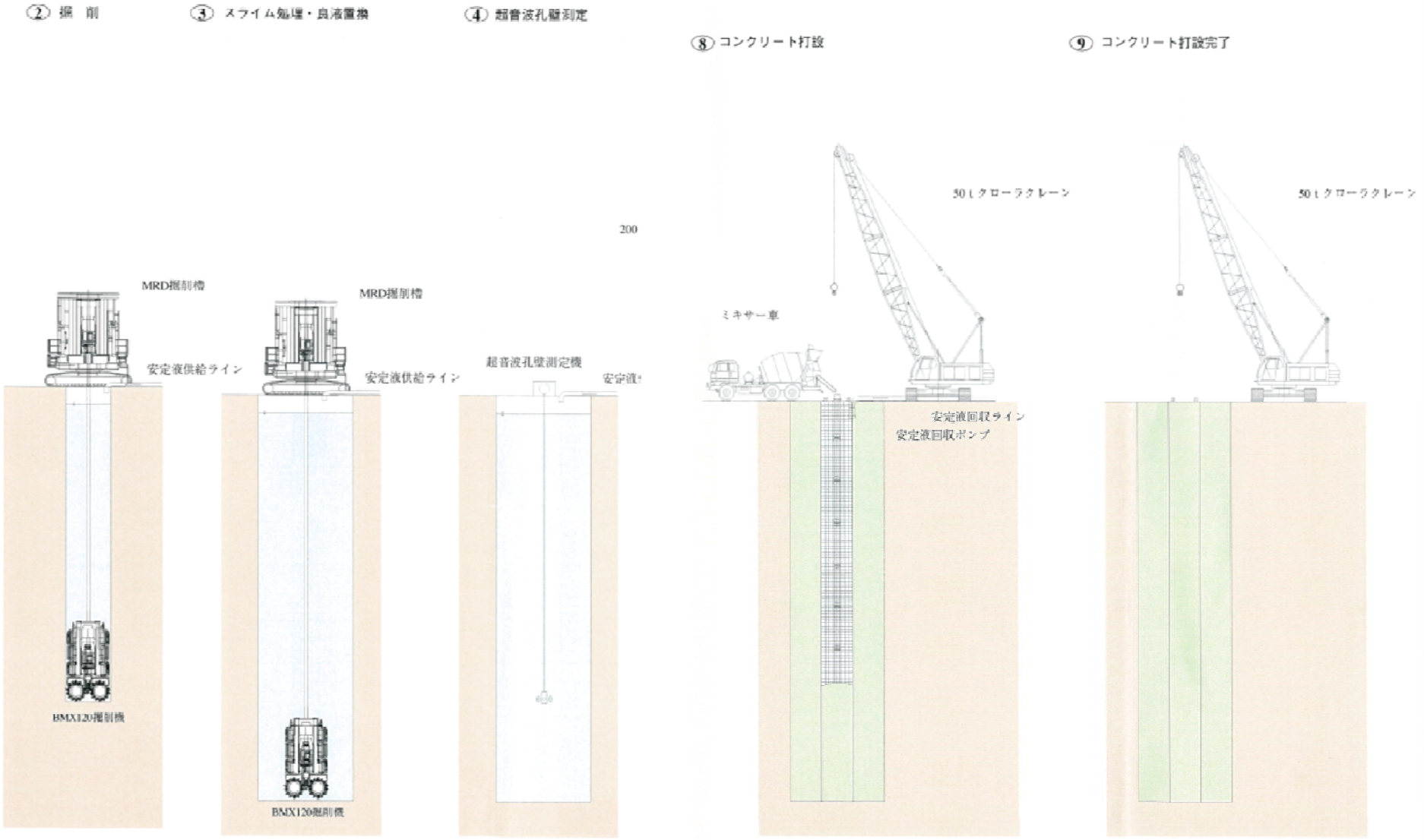

NATM: New Austrian Tunneling Method estimate by Company (C)

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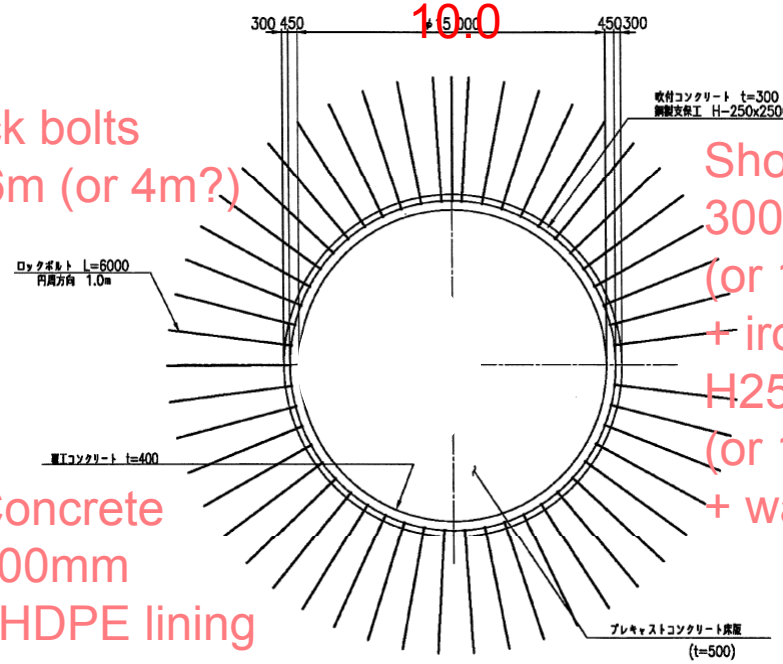
Soft strata consisting of the humus soil

TP+7.83

8.5

~50.

NATM
rock bolts
+iron beam
+shotcrete
Sand-mudstone
"soft rock"



Lock bolts
L=6m (or 4m?)

Shotcrete
300mm
(or 150mm?)
+ iron beam ring
H250 × 250@1m
(or 150x150@1.5m)
+ water proof sheet

Concrete
600mm
+HDPE lining

Ranges of estimates

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Civil Construction	Concrete+ HDPE Lining	PMT Support structure etc	Total
(A) 5.3+ α [NATM] 7.5 [RC wall]	(B) : (5.9) [RC wall]	3.1	(14.3)+ α
(C) 6+ α [NATM]		?	

- (A): hall construction by NATM・RC…
- (B): 850mm-thick concrete + HDPE lining + PMT support
  - assuming RC diaphragm wall of 1m thick exists in prior
- (C) includes HDPE lining as a part of civil construction

What is the factor α for NATM ?

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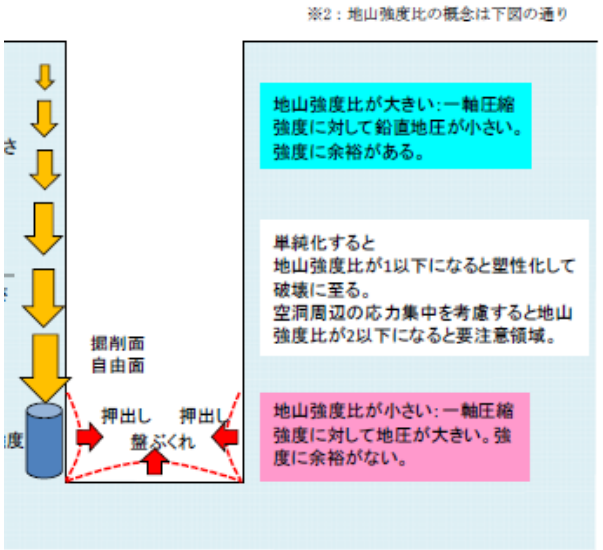
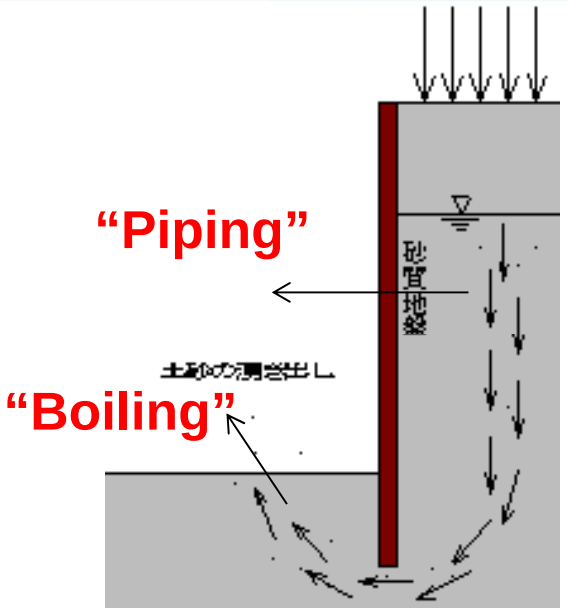
- NATM: after digging each ~1m, iron beam structure + shot-crete + lock-bolts to support wall are constructed.
  - During the digging process, side wall and bottom plane should stand by themselves.
- However, boring data@2km show:
  - Sand-mudstone is classified as "soft-rock", not strong enough (ex. compress strength: 2271kN/m2 = 22.7atm)
  - Water level under the ground is high.
  - The volcanic ash layers of several meter-thick with soft- coarse grains exist in the sand-mudstone, which are washed away easily by running underground water.
  - Sand-mudstone zone has lot of horizontal cracks and ones with 50~60 degree of tilting.
  - Total hydraulic head is higher for deeper sites, so upwelling may exist.
  - (Soft organic quality soil is distributed on thickness more than 5m near the surface.)





Horrible example: Soil Mixing Wall (SMW) at TS

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J-PARC
KEK

2007/02/23

2007/02/26

2007/03/01

- Underground water came out and never stopped !
- Similar situation can easily happen for NATM hall

Other methods by company (A)

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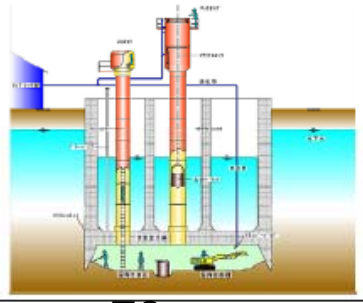
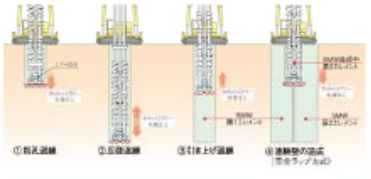
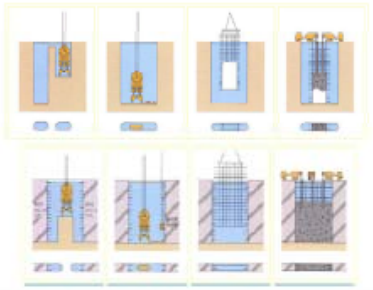
NATM | Pneumatic Caisson | Soil Mixing Wall | Urban Ring | RC cast in-situ diaphragm wall

山岳工法（NATM）	ニューマチックケーソン	改良土止水山留（SMW・CSM）	アーバンリング	地中連続壁（RC 連続壁）
山岳トンネルと同様に、1掘進長分（1m）掘削した後、円形鋼製支保工・吹付けコンクリート・ロックボルトで支保する。 掘削時の壁面と底面は、押えの無い自由面となるため、支保を施工するまで自立している必要がある。 掘削時に側壁・底面からの湧水を止めるのは困難で、土砂流出がある場合は事前に薬液注入などの補助工法が必要。	鉄筋コンクリートの円柱の下端部に気密性の掘削作業スペースを作り、圧気をかけて地下水の侵入を防ぎながら、円柱下端の刃先を掘削して全体を自重で沈下させる。 沈下した分だけ、地上で円柱を継ぎ足し、これを繰り返して所定の深度まで沈下させる。	オーガーからセメントミルクを噴射しながら、現地の土砂を撹拌して、改良土による止水留壁を造る。強度を確保するため、芯材として、鋼材（H鋼 or I ビーム）を挿入する。 掘削しながら 1m ごとに円形の鋼製支保工（リング支保工）を芯材のH鋼内面に接続させて支保する。	プレキャストコンクリート or 鋼製セグメントを、ジャッキで地盤中に圧入しながら内部を水中掘削する。 旋回式の機械掘削は実績では直径 5m 程度まで。それより大口径では、バケットによる水中掘削になる。	掘削泥水で坑壁の崩壊を防ぎながら、1エレメント幅 1m 程度長さ 2～3m の矩形の掘削を行い、かご状に組んだ鉄筋を吊降した後、水中コンクリートを打設し、地中に鉄筋コンクリートの壁を造る。 このエレメントをいくつも並べて、連続した山留壁を構築する。
				
地山条件による	70m max	45/65m	70m	140m
△ 地山強度比が小さい。 補助工法の費用が予測し難い。	○ 必要掘削径が大きくなる可能性あり	△ 止水性が不確実。	○ 実績では深度 70m が最大	◎ 止水山留壁の品質が高い。 深度 80m の立
5.3 5.3M+α	7. 7.7M)	5.9M＋α)	7.5 7.5M)	7. 7.5M (12M)
（地山強度比が 1 に接近）	適用不可	適用不可	適用不可	12.

△
Soil is weak.
Supplementary method (+α) is hard to estimate

○
Radius will Be large.

△
Hard to stop water
※TS had the problem !

○

◎
Water to be Stopped
※ ND280

Urban Ring

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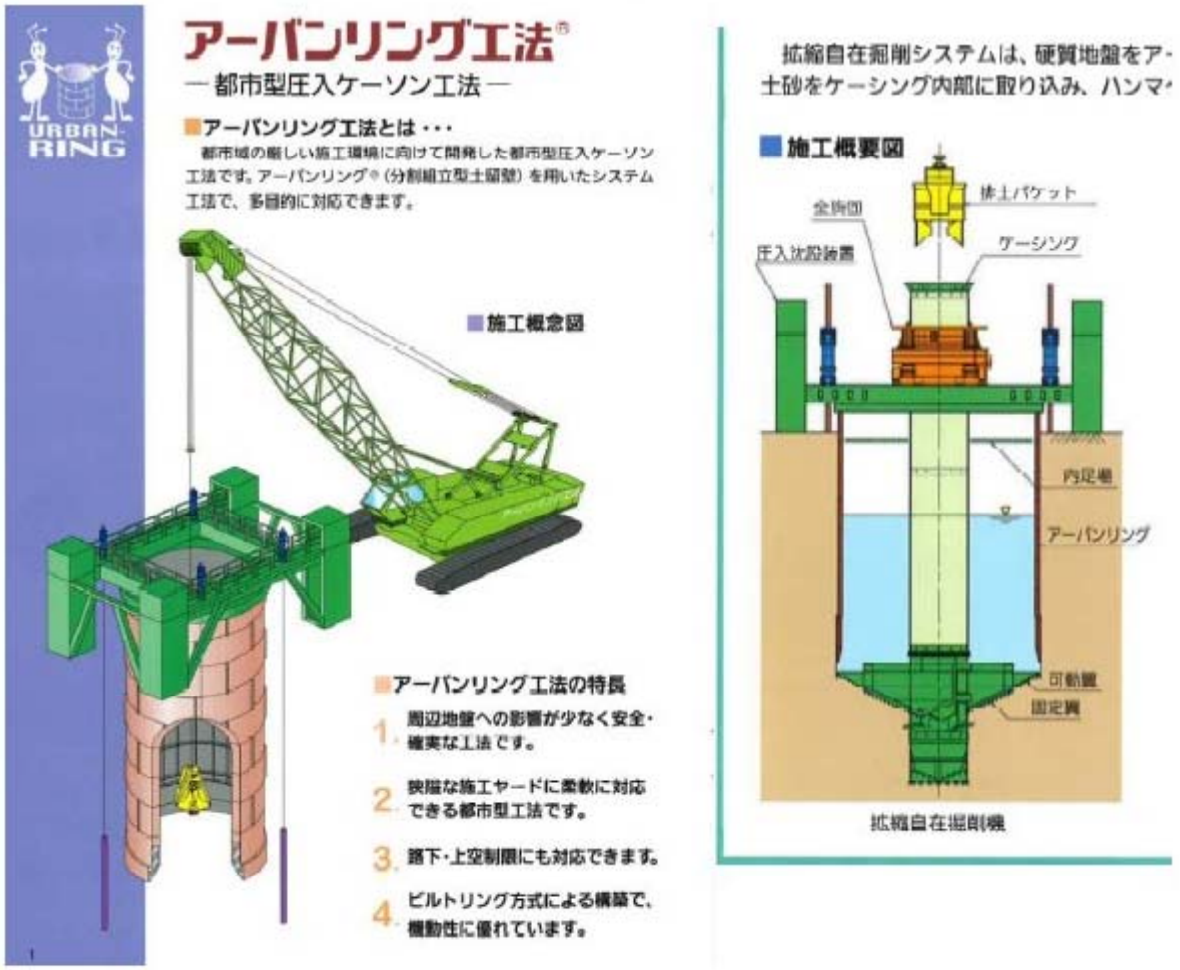

- Pre-cast concretes (metal segment) are indented into soil by jacks, inside soil was digged out in water
- Pre-cast concrete can be used as main body of the hall.

Pneumatic Caisson

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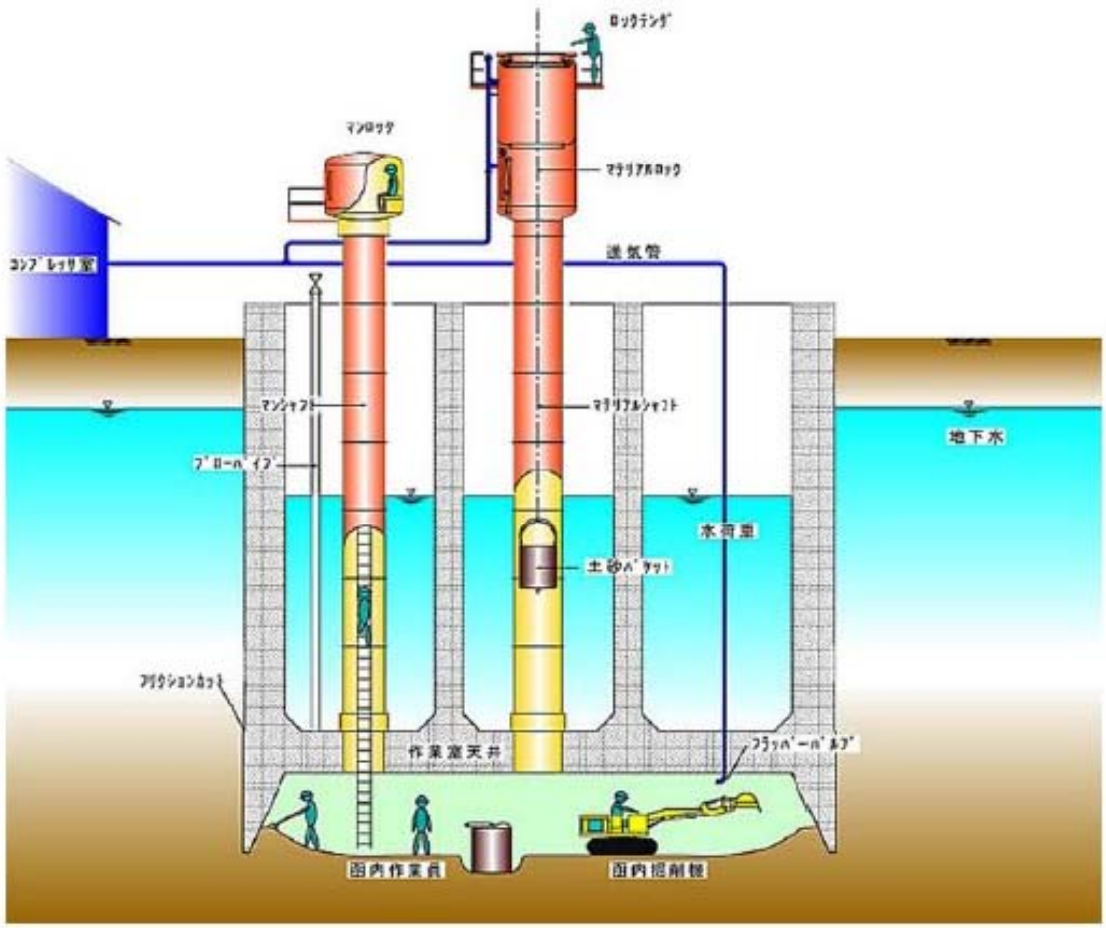

- Air-tight digging space under reinforced concrete structure. The digging space filled with pressure (~7atm)
- Structure will sink by its own weight.
- Diameter will become large

Geology of Tokai

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- In the last glacial age (70,000~10,000 years ago), sea level was -120m lower than now. Deep valleys were made on basement rock (tertiary period, sand-mudstone, 久米層)+diluvial uplands
- After the age, the Japanese archipelago experienced a rise in the sea level of over 100 meters during Jomon period(~10,000 years ago). 2~3m higher than now. The alluvial lowland was made at that period.

Soil quality expectation at 1.2km

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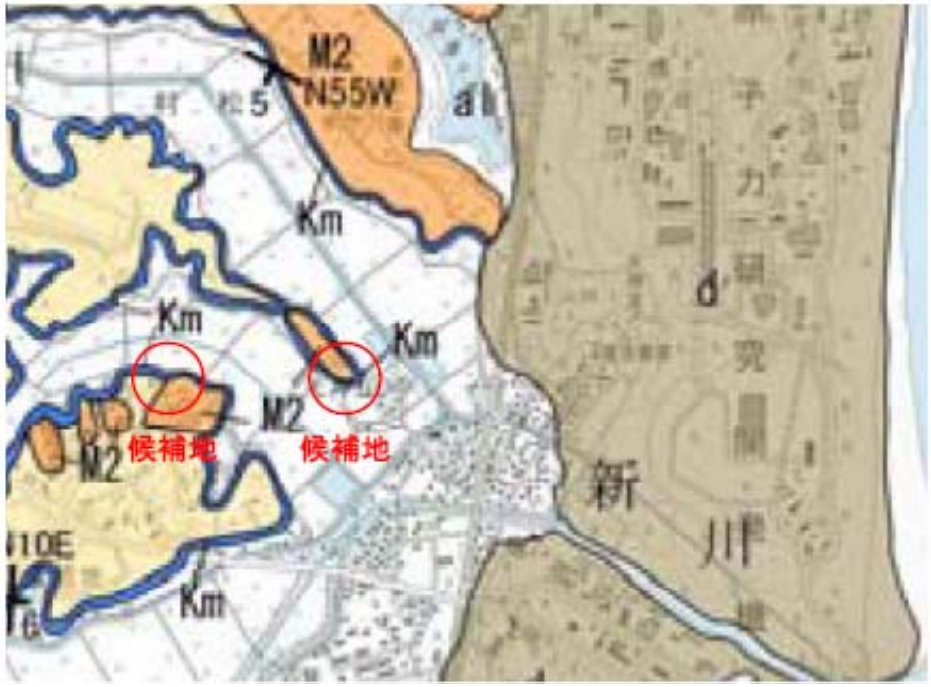

Quaternary

tertiary period

図−6　地質断面の想定

Expected cross section at 1.2km

* Just-on-place boring data needed

“Kume-layer”
Tertiary period (soft-rock)

Existing boring data

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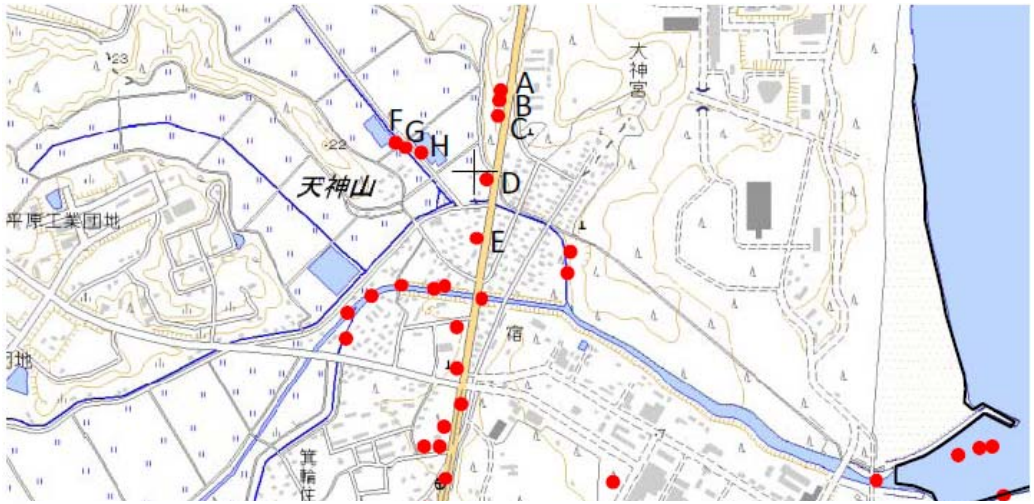


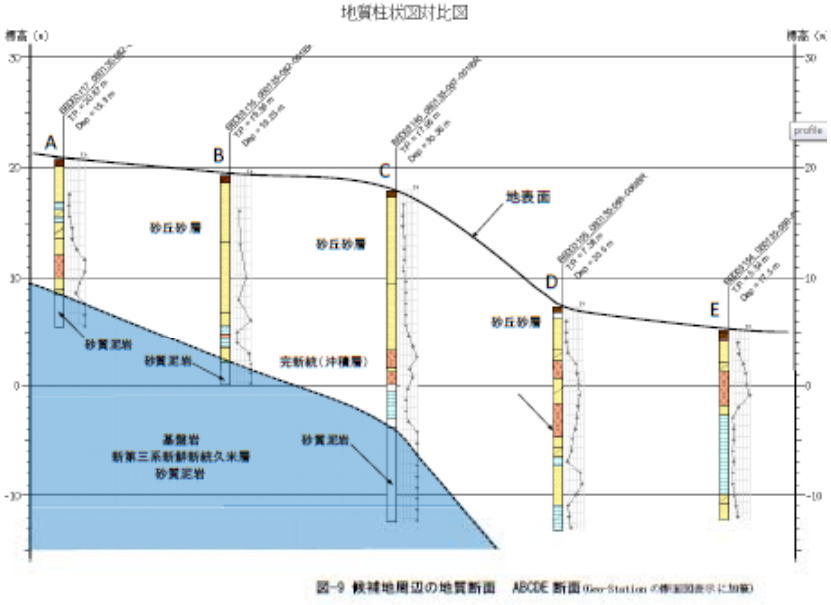
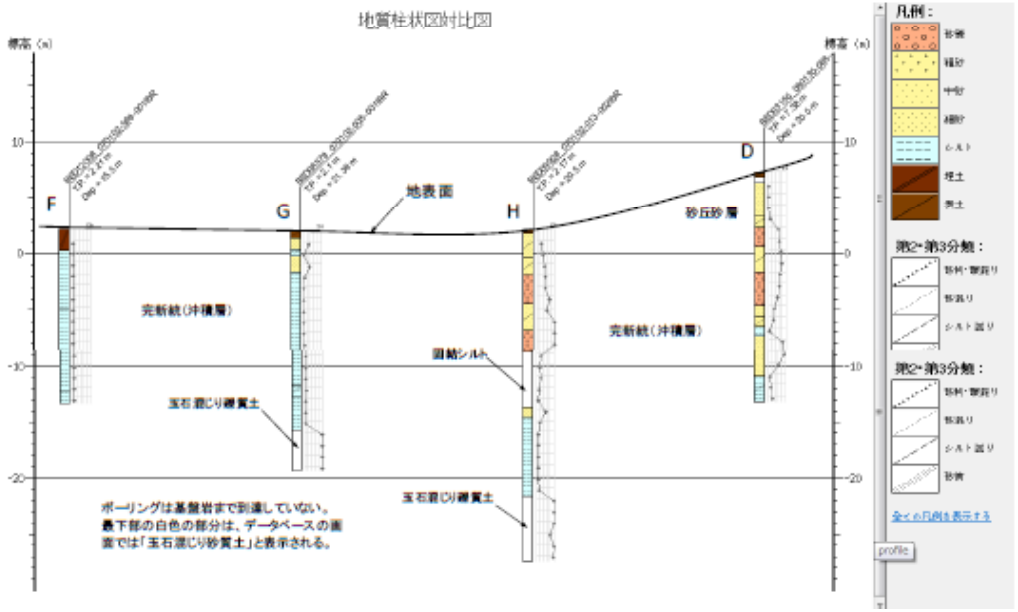


図-9 検峰地周辺の地質断面　ABCDE 断面(Geo-Station の標高図表示に加筆)



Summary

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- Rough cost estimate to make 10m-Φ×50m-D nuPRISM baseline design hall at 2km site (or similar soil condition): 6MUSD+α, with 3mm thick HDPE lining, based on New Austrian Tunneling Method, 9 month in total for construction.
- However, due to the high underground water level and soft rock condition observed a boring data at 2km cite, it is hard to anticipate/estimate additional cost "α" for this method.
- Condition of soil/water is so different from that of HK, so it is not certain whether HDPE for nuPRISM can work as HK's const. test.
- Urban ring method (Konaka-san suggested) or RC diaphragm wall look safer than NATM because of better water stopping capability.
- More discussions are necessary with expert companies.
- Detailed spec of HK lining is needed for further estimation by (C).
- For 1.2km site, soft-rock layer of tertiary period appears on surface, and no soft strata exists. It may be better condition for construction work than 2km cite.
- Just-on-place boring data are needed for 1.2 km.