

# New Soil Freezing System Using Natural Refrigerants

Applied to the arrival of Shield Tunneling Machine



**ATMO**  
sphere

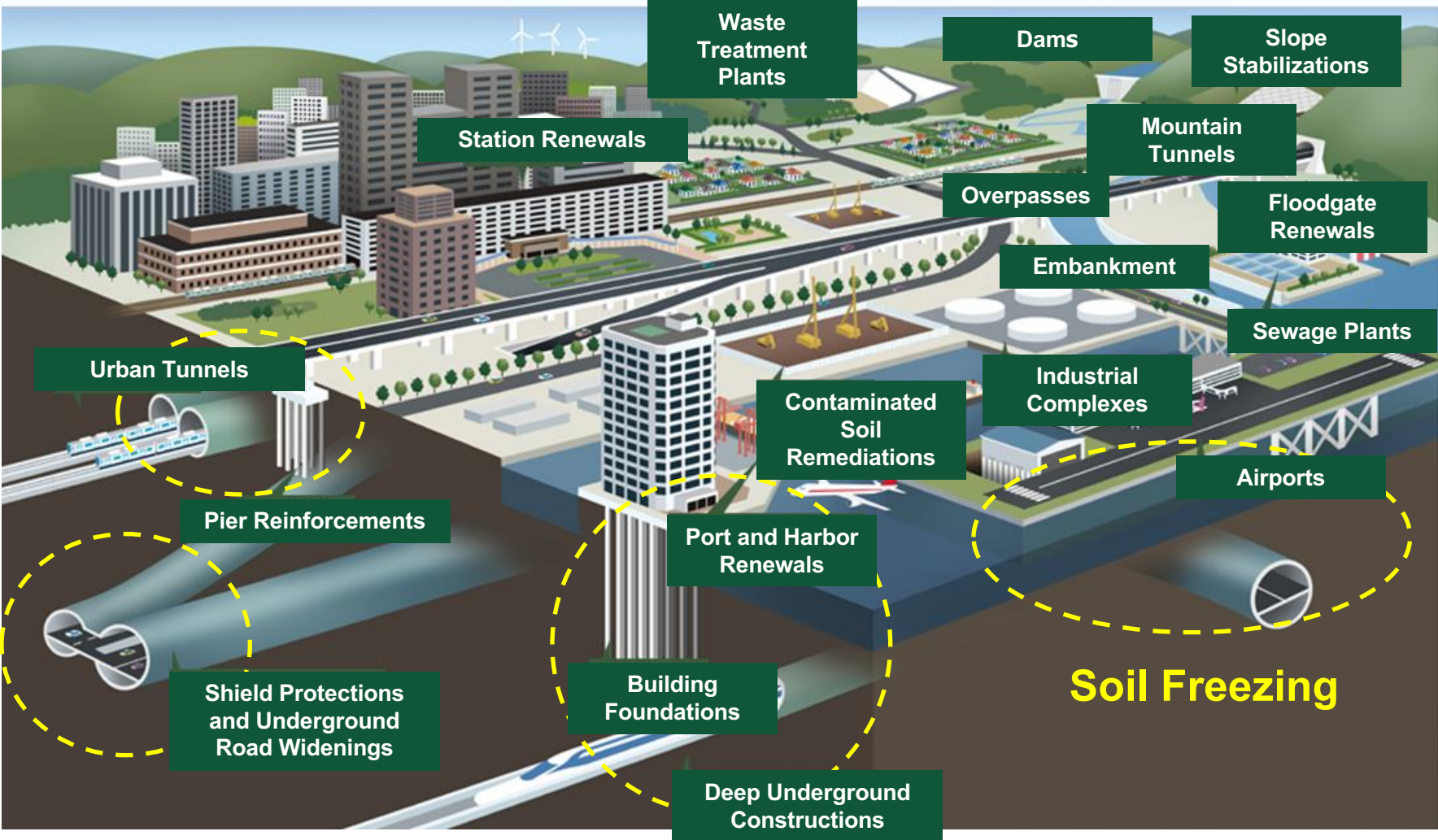
Business Case for  
Natural Refrigerants

13/02/2018 – Tokyo



**ケミカルグラウト株式会社**  
**CHEMICAL GROUTING CO.,LTD.**

# Our Services



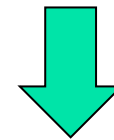
# Soil Freezing



Frozen Soil

## Soil Freezing

- changes soft soil to high strength Frozen Soil Block
- provides Perfect Water Seal
- enables to confirm Quality in Real-time by Monitoring the ground Temperature
- leaves No Industrial Waste in the ground



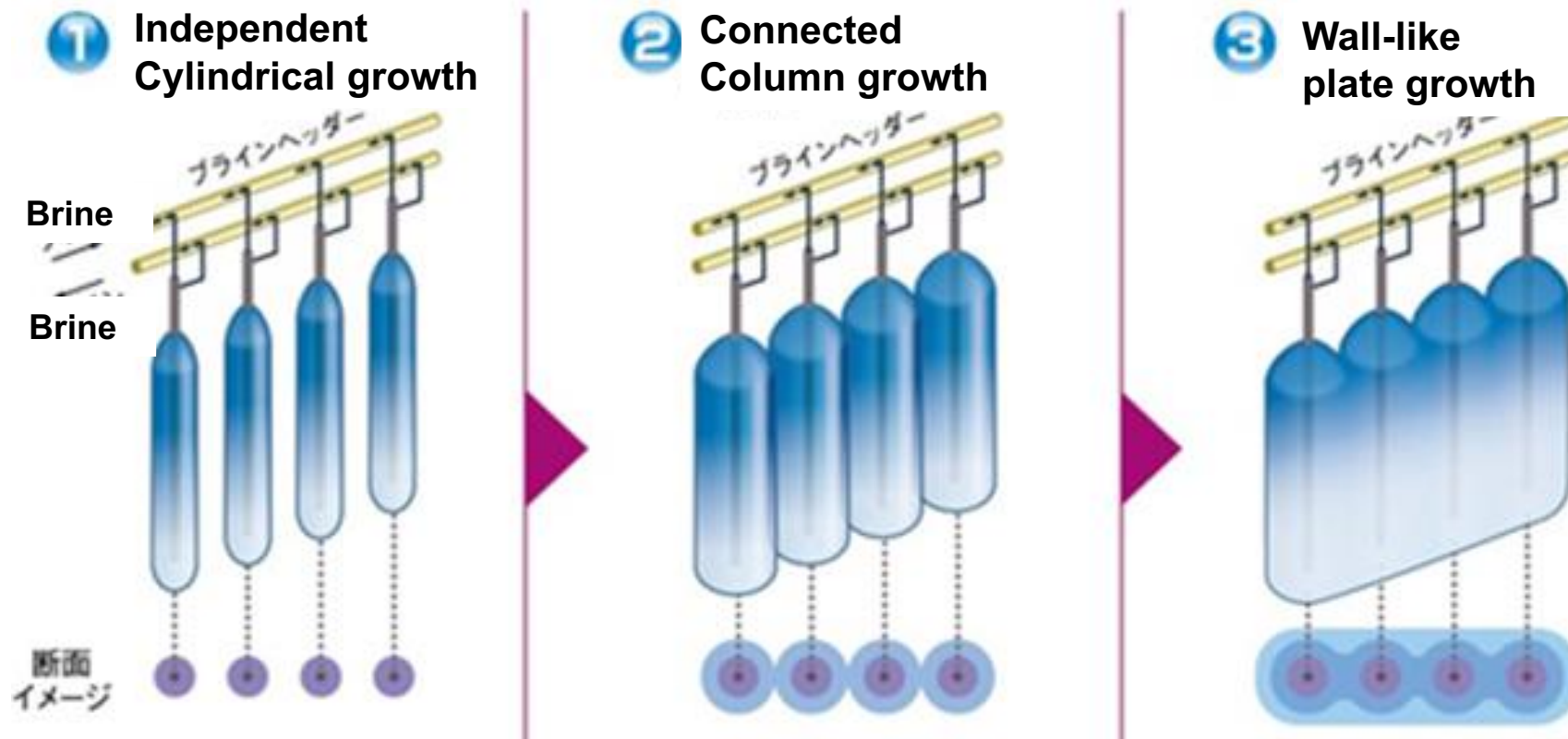
Applicable in Projects with Deep and Large Openings



# What is Soil Freezing?

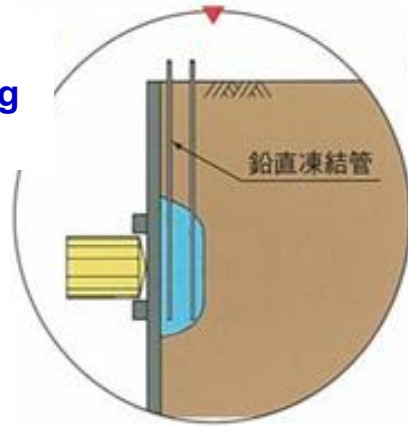
Soil Freezing is a Ground Improvement Technique

in which a Soil Mass of a Certain Geometry is Frozen Using Chilled Brine Circulated through the Freezing Pipes Installed in the Ground.

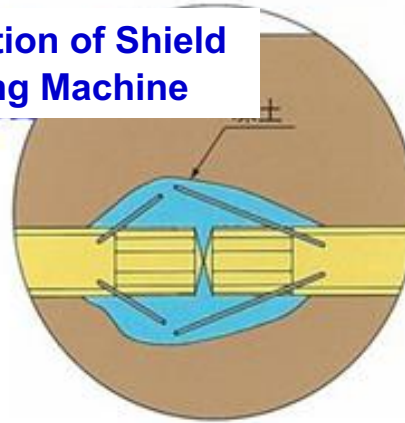


# Soil Freezing Applications

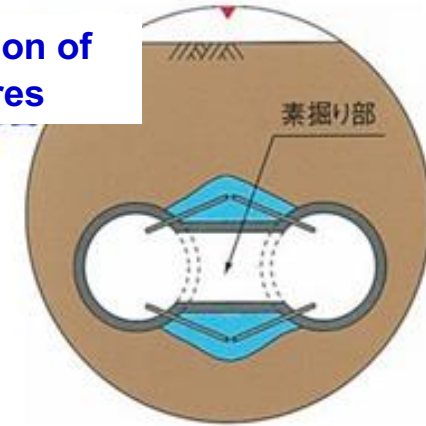
Departure of  
Shield Tunneling  
Machine



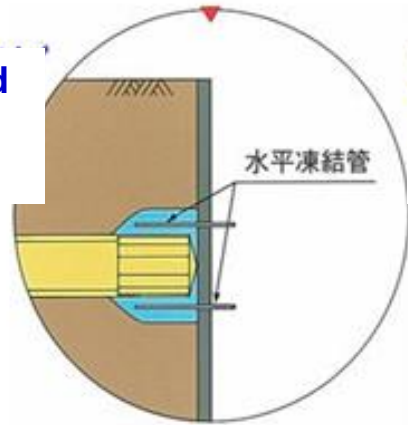
Connection of Shield  
Tunneling Machine



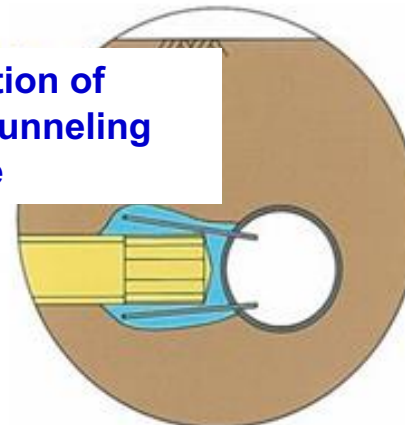
Expansion of  
Structures



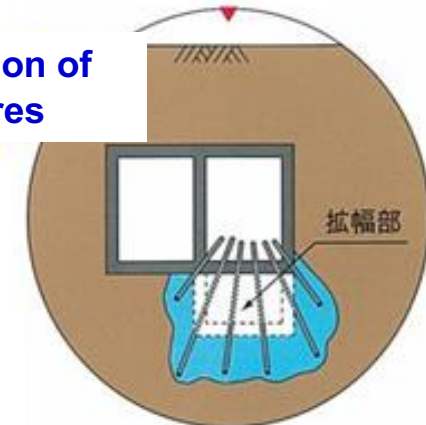
Arrival of Shield  
tunneling  
Machine



Connection of  
Shield Tunneling  
Machine



Expansion of  
Structures





# Operation Scenes



Freezing Pipe on Ground



Exposed Frozen Soil with Freezing pipes

# Background

to Introduce Natural Refrigerants (NH<sub>3</sub>/CO<sub>2</sub>) for Soil Freezing

- HCFC Refrigerant will be Banned in 2020.
- HFC will also be Restricted after 2025.
- Greenhouse Gases have Increased by 10.8% (vs 1990).
- Conventional Systems ⇒ HCFC



New System ⇒ NH<sub>3</sub>

- Reduce the Environmental Load

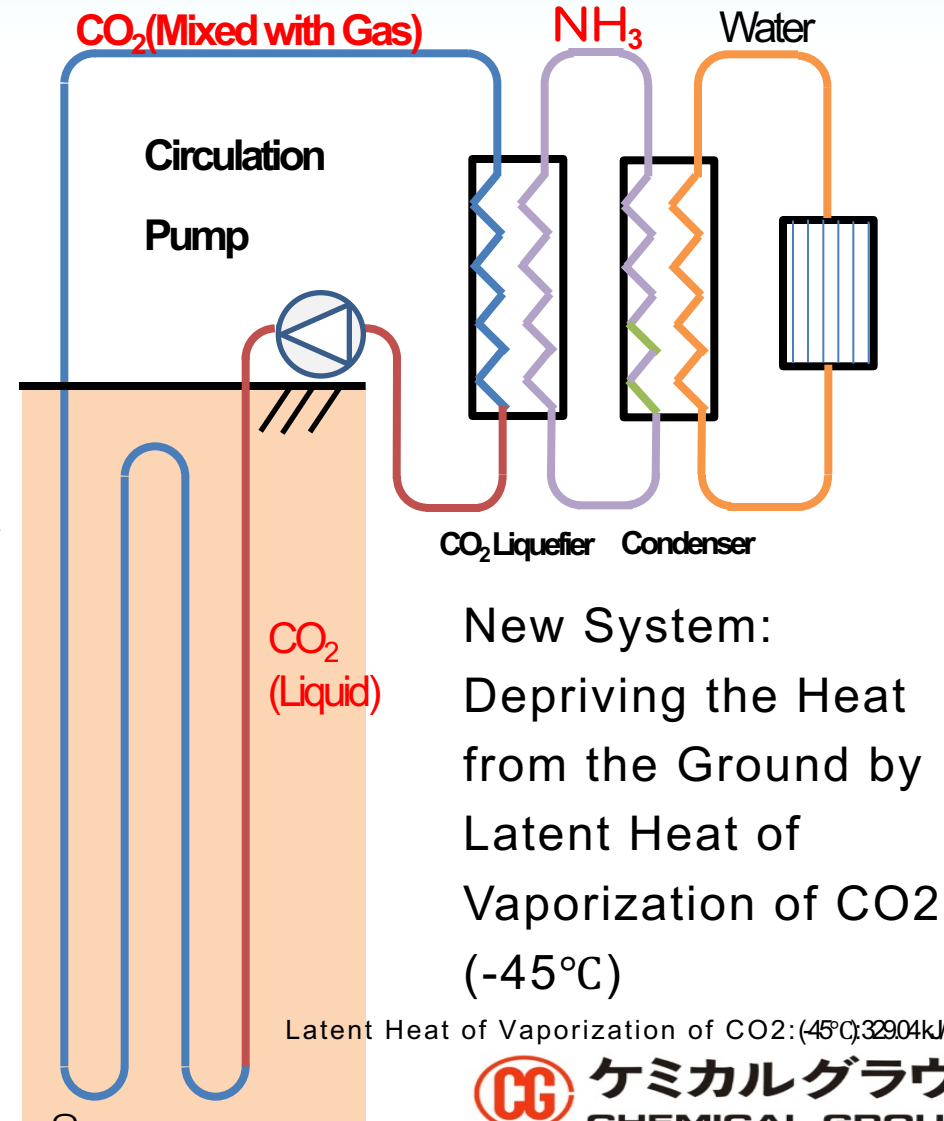
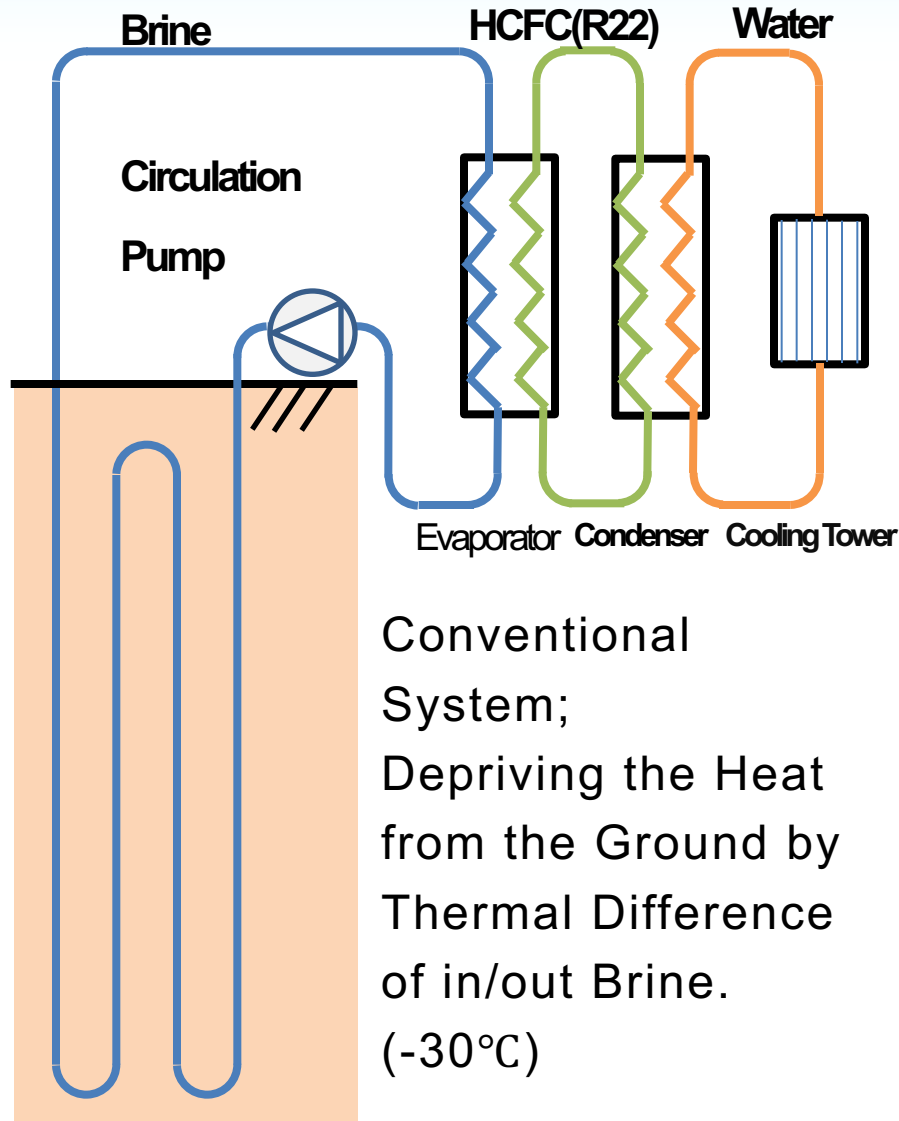
\*HCFC: HydroChlorofluorocarbon

\*HFC: Hydrofluorocarbon

## Global Warming Potential (GWP)

	Refrigerants	GWP
Conventional System	HCFC (R22)	1,810
	HFC (R404A)	3,920
New System	NH <sub>3</sub> (R717)	<1
	CO <sub>2</sub> (R744)	1

# NH<sub>3</sub>/CO<sub>2</sub> System





# Features of New Soil Freezing System

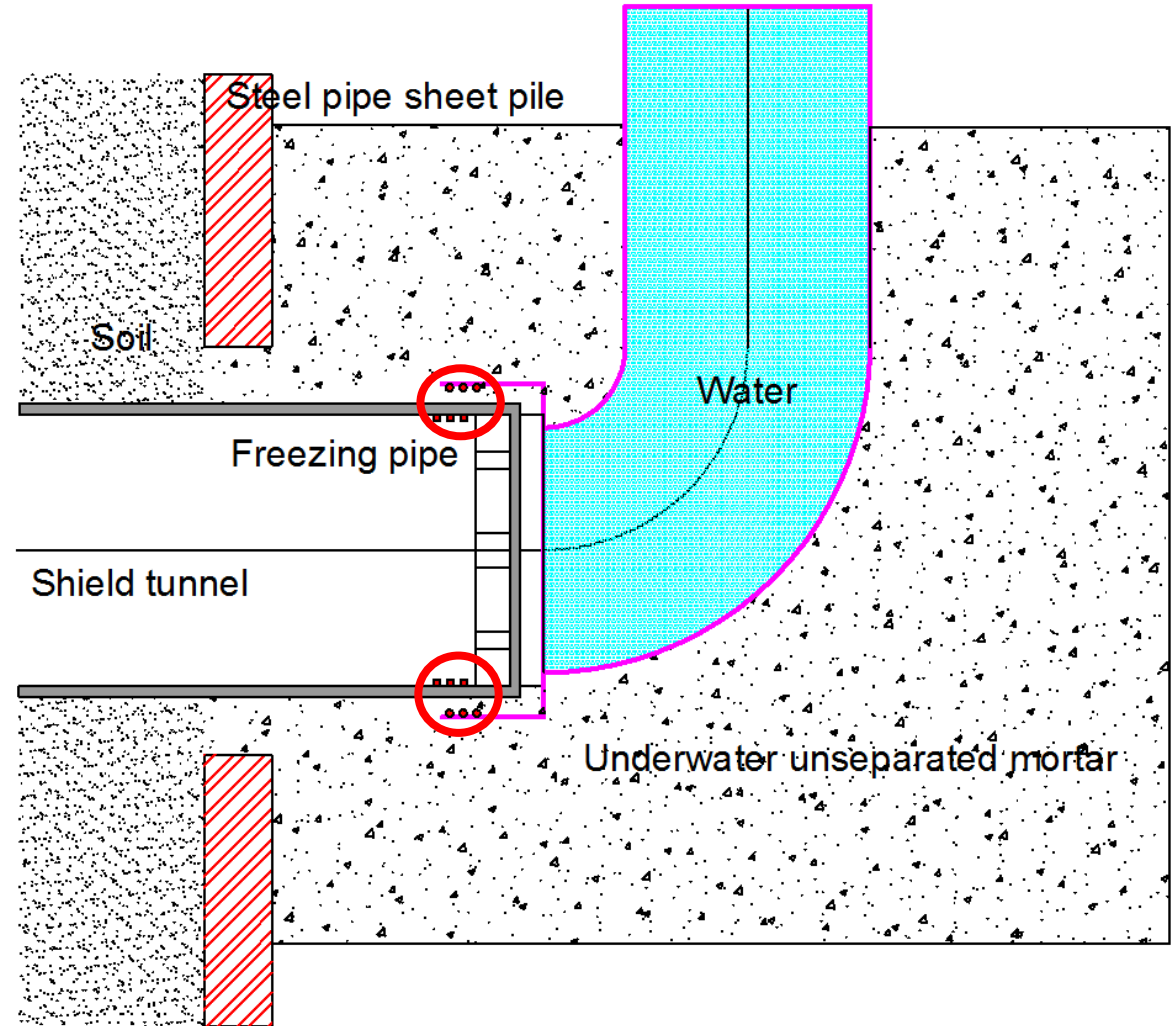
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- Mitigate Global Warming  
(Using  $\text{NH}_3/\text{CO}_2$ )
- Save 40% of the Conventional Power Consumption  
(High Efficiency of  $\text{CO}_2$  and Low Viscosity)
- Ease Piping Work  
(Compact and Lightweight Freezing Pipes)
- Shorten Freezing Time  
(Lower Freezing Temperature)

# Application for TBM arrival to the shaft



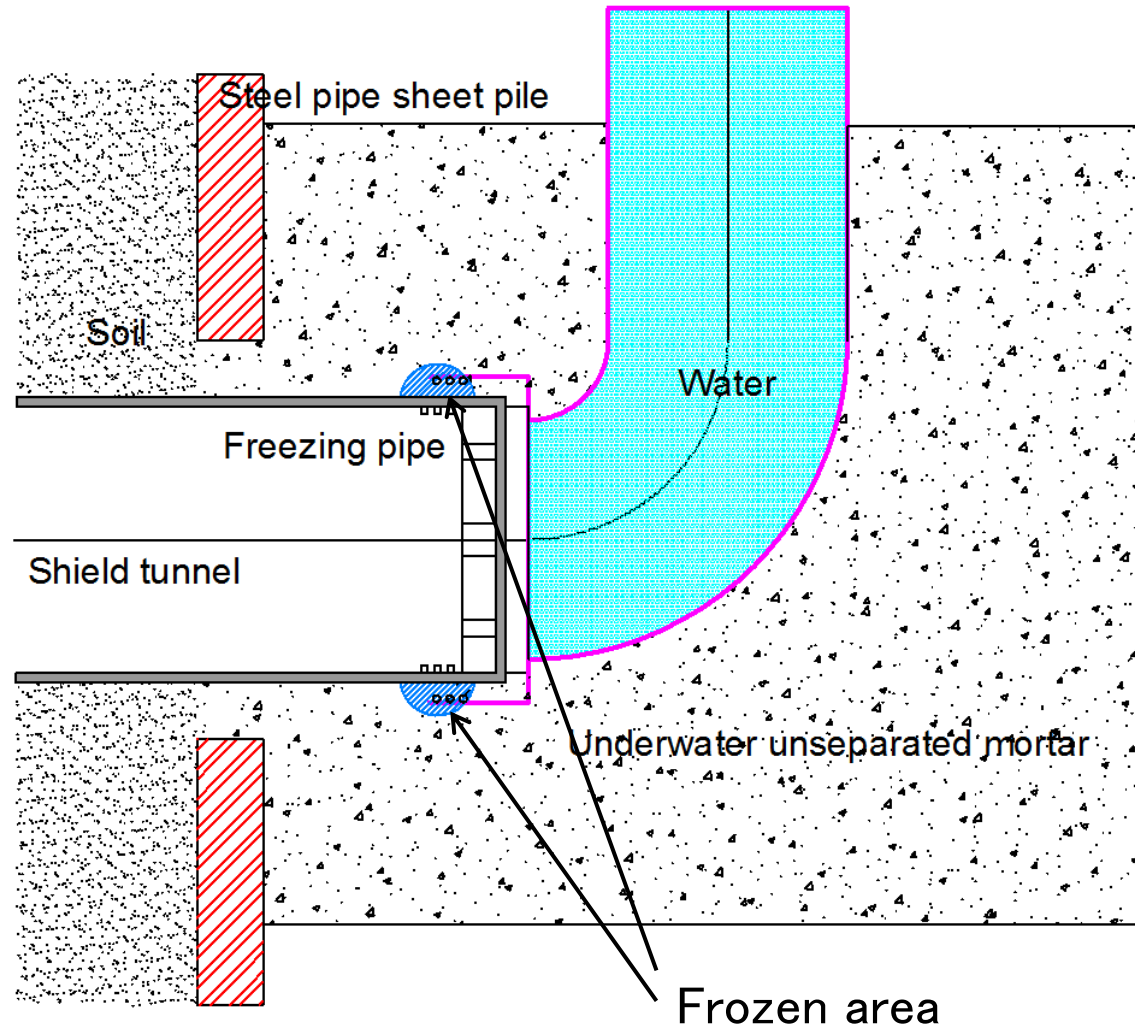
Refrigeration plant



# Application for TBM arrival to the shaft



Refrigeration plant





# Application for TBM arrival to the shaft



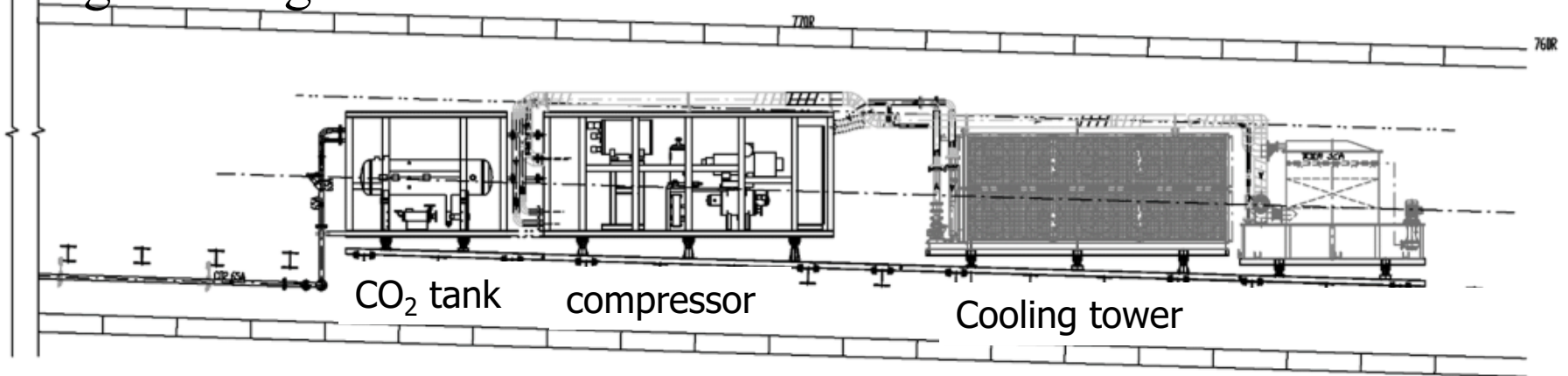
Bulkhead of shield machine



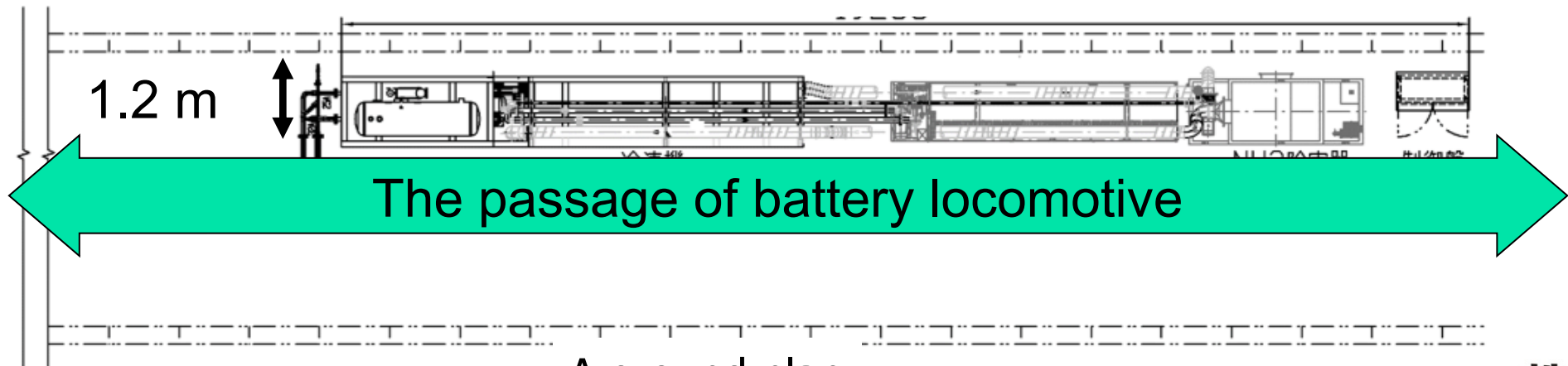
Exposed frozen area

# Application for TBM arrival to the shaft

- The width of refrigerator was limited within 1.2 meters not to interfere with the shield disassembling working.

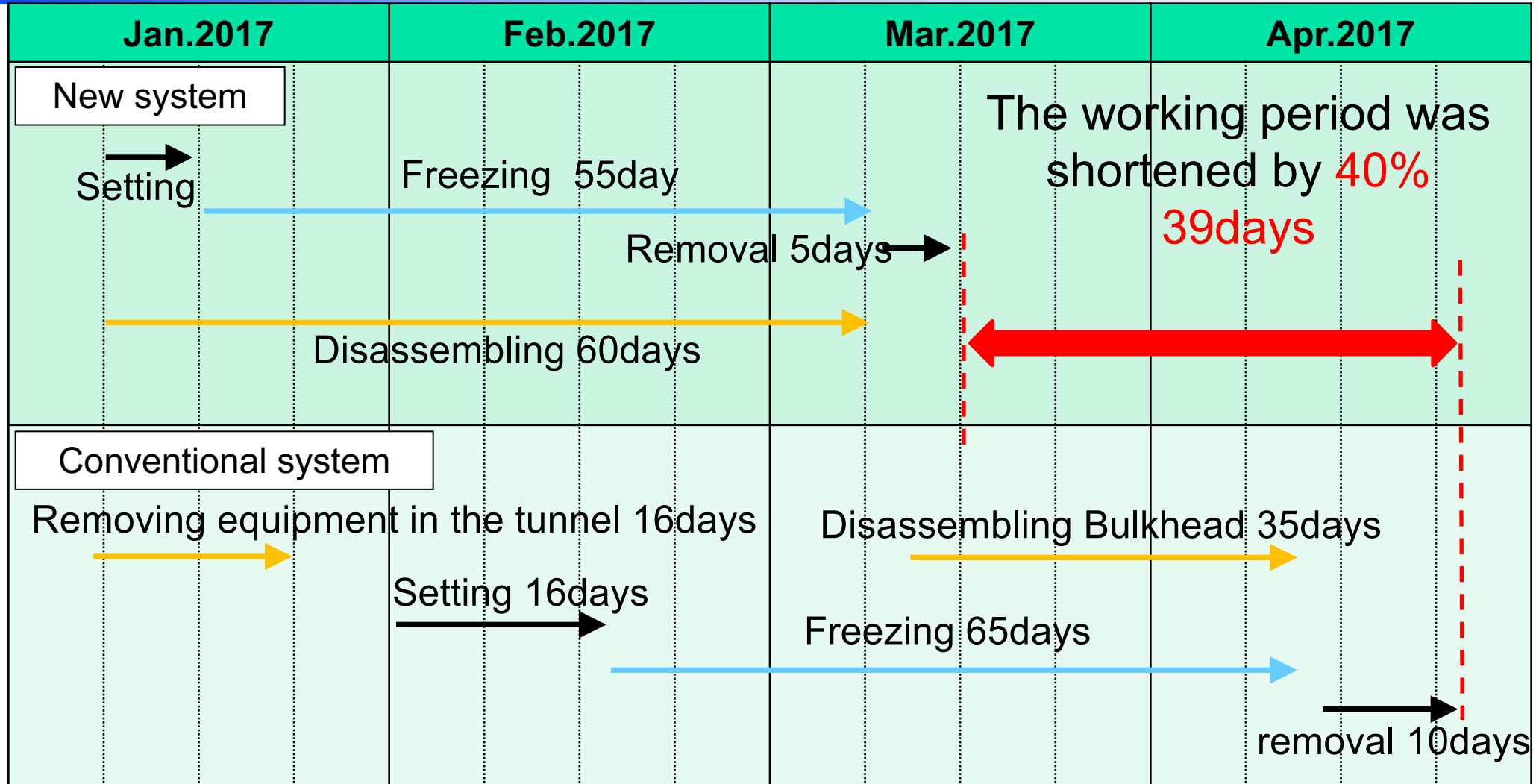


A cross section



A ground plan

# Application for TBM arrival to the shaft





# Conclusion

## **New Soil Freezing System with Natural Refrigerants**

- Contributed to Raise the Consciousness of the Global Environment Conservation in Construction Field.
- Introduced Natural Refrigerants to Soil Freezing
- Reduced CO<sub>2</sub> Emission Successfully by Decreasing Power Consumption to 40% off the Conventional System
- Shortened the whole disassembling period by 40%
- Succeeded the Application to TBM arrival completion

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**Thank you for your attention and interest.**