DCM(Deep Cement Mixing)

1 DCM-Introduction

2. DCM-Construct System

3. DCM-Design

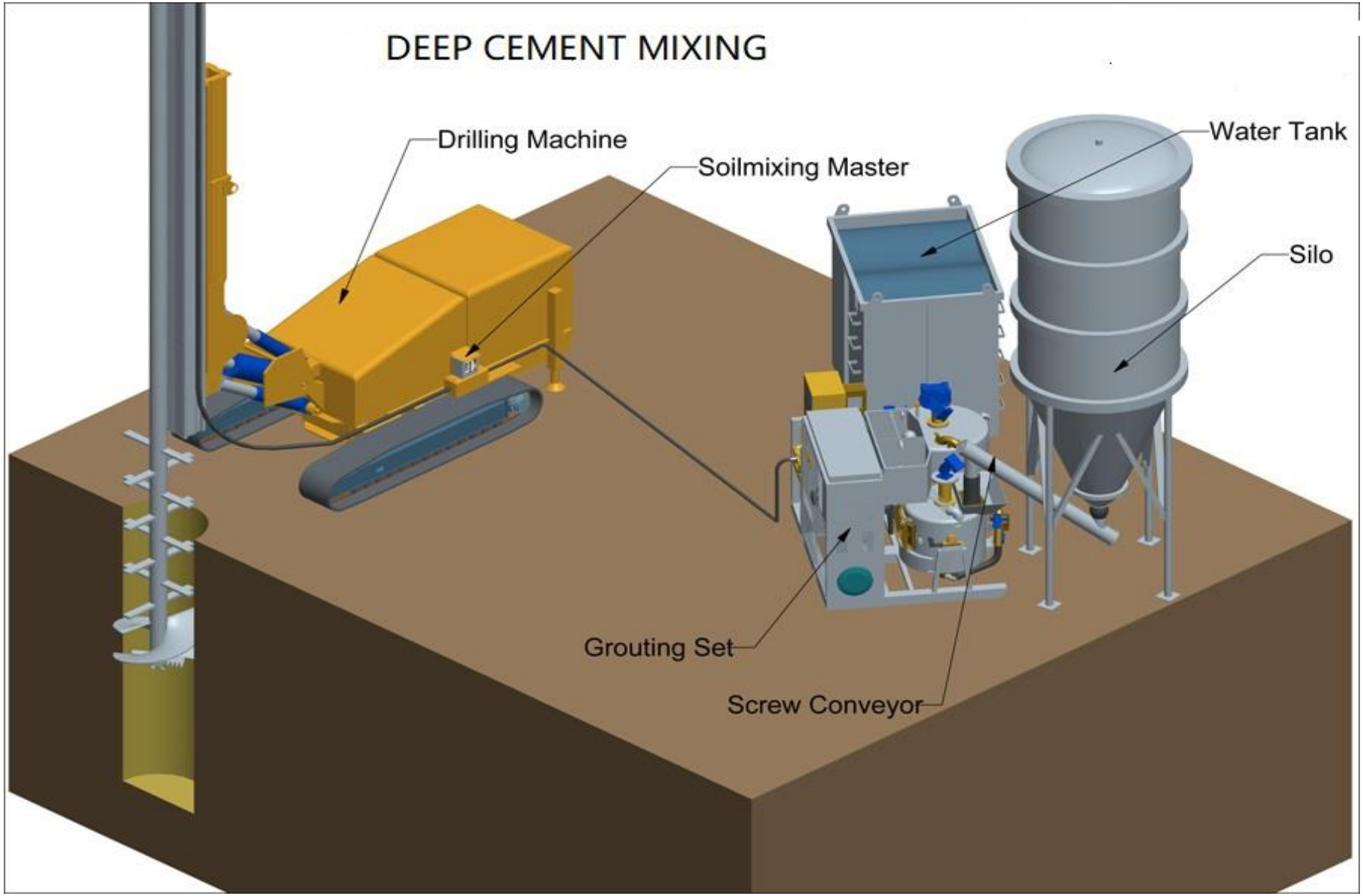
4. DCM-Project Case

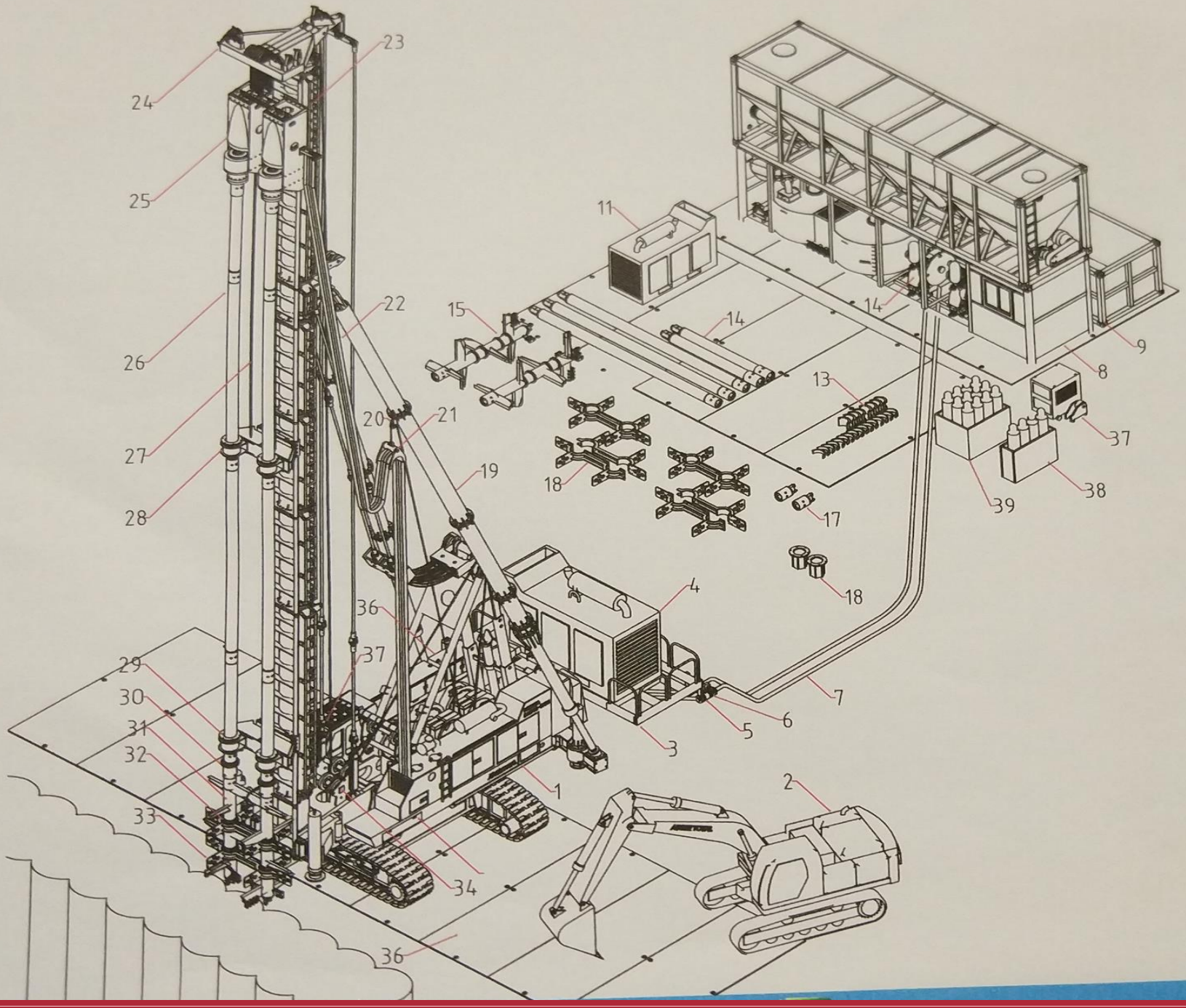
1. DCM - Introduction

Deep cement mixing (DCM) is an in situ soil treatment technology whereby the soil mixed with cement, in order to improve bearing capacity of soil.

In the deep mixing method, the ground is mechanically mixed in place and in depth by an auger machine while cement slurry is injected. After hardening of the soil-cement mixture, called soil mix material, soil-cement columns or rectangular soil mix panels are formed in the ground.

DCM - diagrammatic drawing

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2 .DCM - construct system

1. Auto Mixing Plant

- Vertical type (more capacity)
- Horizontal type(more safety)

2. Base Machine

- Hydraulic crawler-type(most widely used)
- Walking type

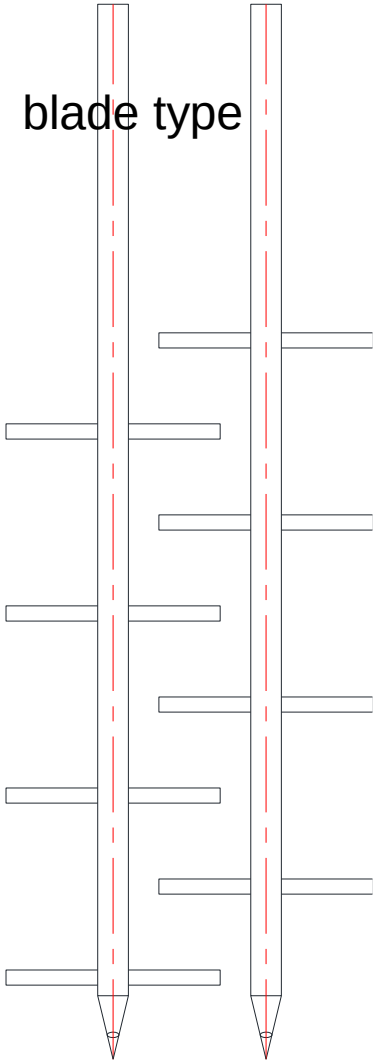
3. Drilling system

- Auger(50HP-250HP)
- Rod
- Drill bit(blade type, screw type, blade-screw type)


NISSHA
DH658-13

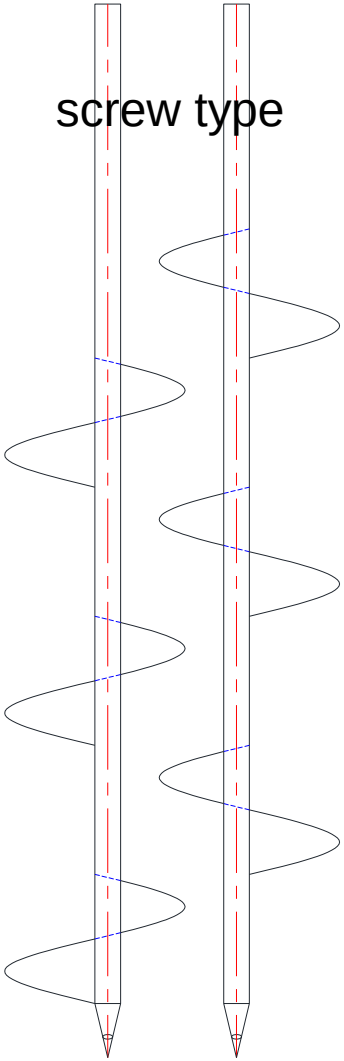

QQ:80937918

Drill bit type



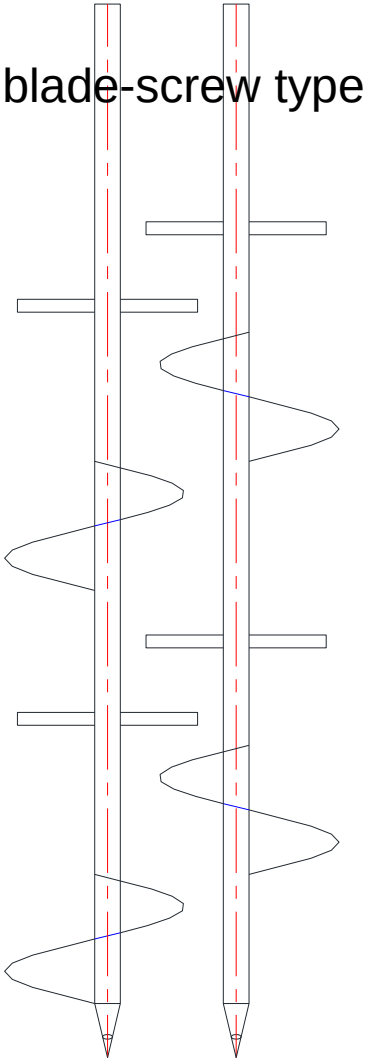
blade type

clay soil



screw type

mud soil



blade-screw type

sand soil

3. DCM – Design

- The strength class of cement should be not less than 32.5.
- The cement mix content can be 7%-20% .
- The water cement ratio of the cement slurry can be 0.45-1.5.
- UCS(28d) not less than 0.5MPa(waterproof curtain),0.8MPa(soil improvement).
- Used as waterproof, the permeability coefficient not over 1×10-7cm/s.
- The design of cement deep mixing is mainly to determine the displacement ratio and the length of the mix pile(determined by the bear capacity and deformation)

Soil	Materials content		W/C ratio
	Cement（%）	Bentonite（%）	
Clay soil	≥15	0	0.7～1.5
Mud soil	≥17	0	0.7～1.5
Sand soil	≥13	5~10	0.7～1.5
gravel soil	≥13	10~20	0.7～1.5

reference table

Blade rotation number

Total of rotations of mixing blades passing through 1 m shaft movement

$$T = \sum M \cdot \left(\frac{N_d}{V_d} + \frac{N_u}{V_u} \right)$$

over 350N/m

where

T: blade rotation number (N/m)

N_d : number of rotation of mixing blades during penetration (N/min)

N_u : number of rotation of mixing blades during withdrawal (N/min)

V_d : penetration speed of mixing blades (m/min)

V_u : withdrawal speed of mixing blades (m/min)

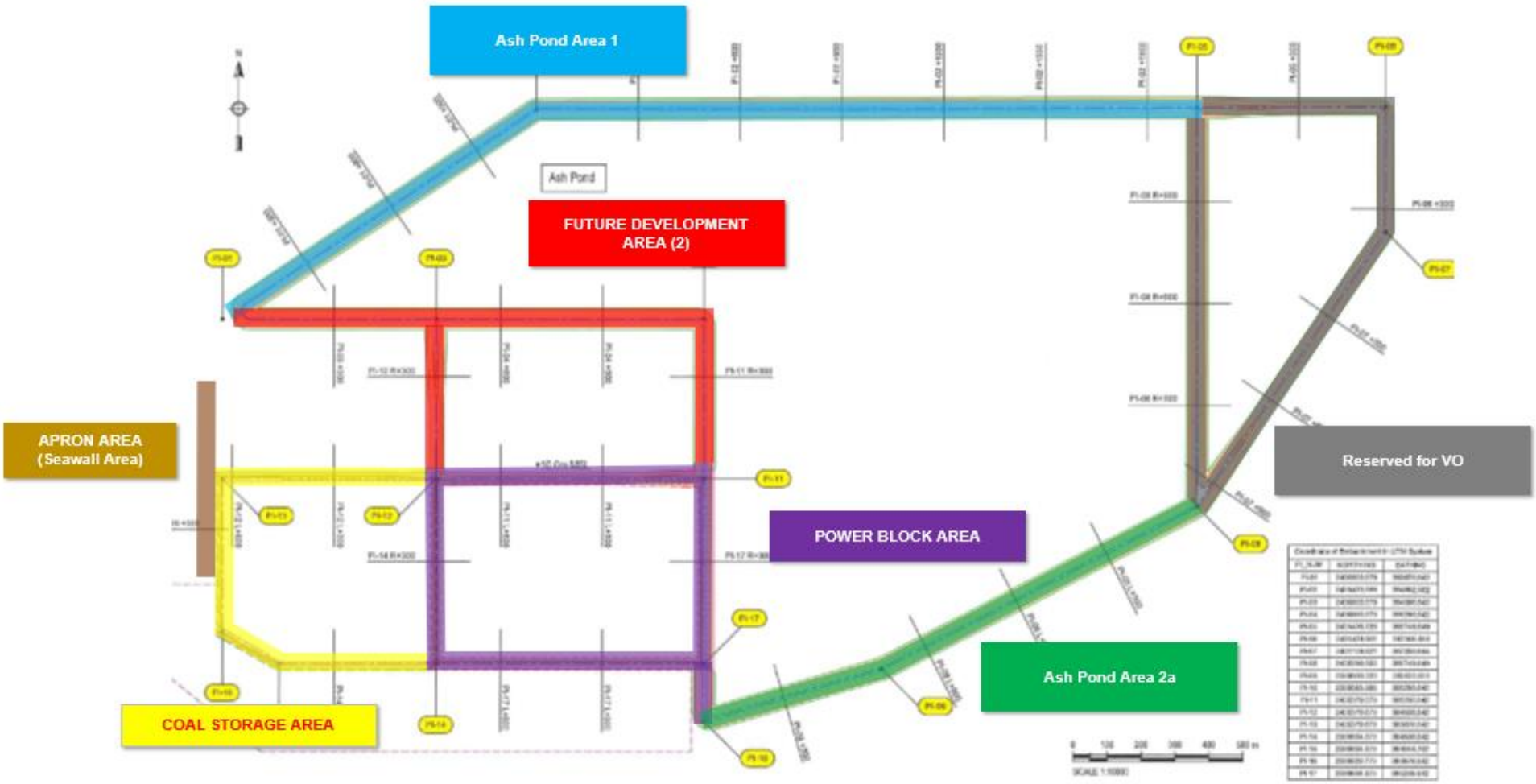
$\sum M$:total number of mixing blades

DCM – Project Case

Introduction

- Project Name: Matarbari Ultra Super Critical Coal-Fired Power Project, Bangladesh.
- Client: Coal Power Generation Company Bangladesh Limited (CPGCBL, State-owned company).
- Contractor: Sumitomo, Toshiba and IHI Corporation
- DMM sub-contractor: Geoharbour Group
- Project Period： 32 month(201805-202012).
- DMM Quantity: 1,463,300m^3

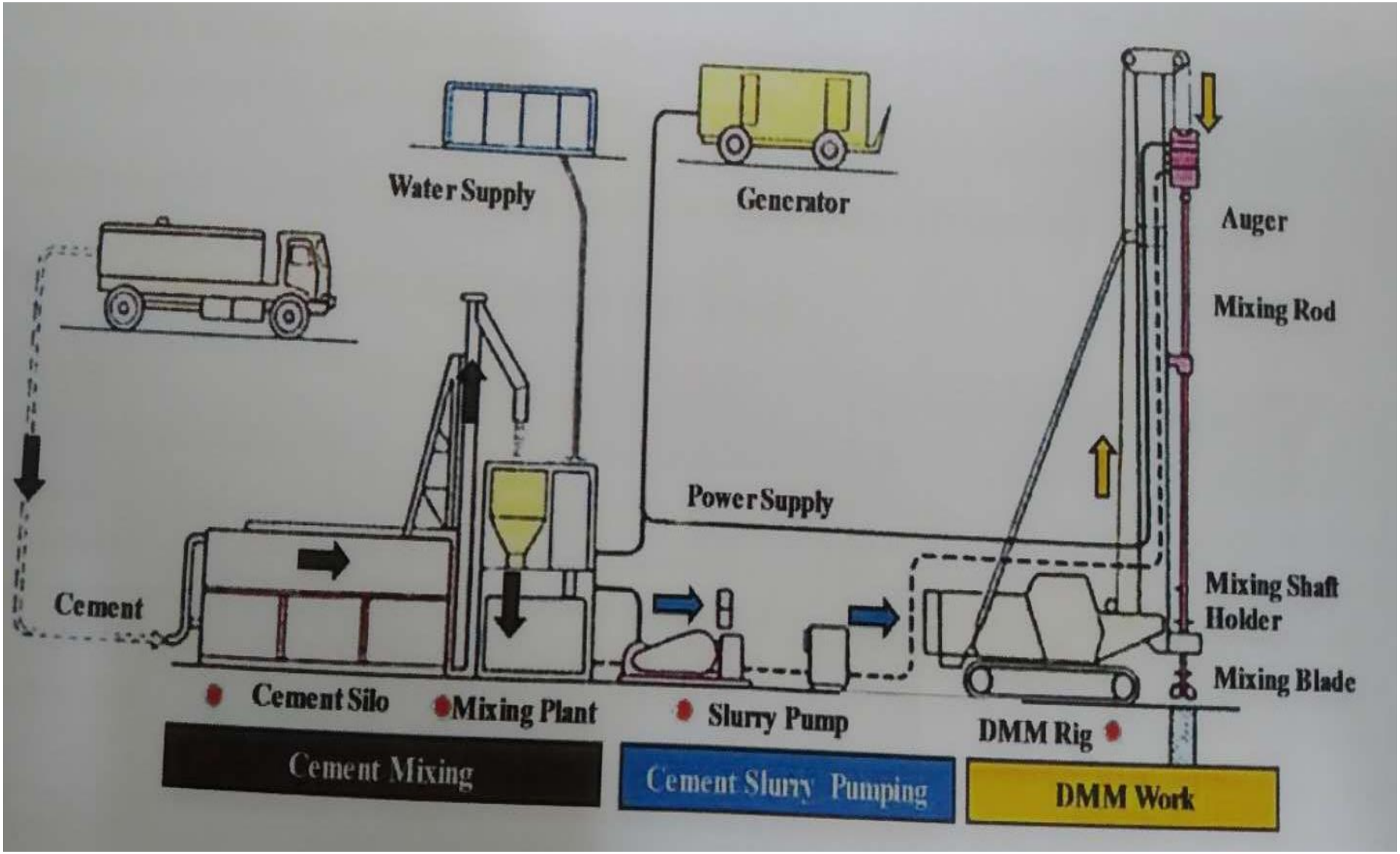
Layout for DMM Area



Scope of works

1) Trial mixing for determining mix design.
2) Preparation and installation of DMM column
3) Quality management (pre-survey boring and reporting, core sampling for 0.4% of DMM column)
4) Removal of upheaved soil.

Equipment

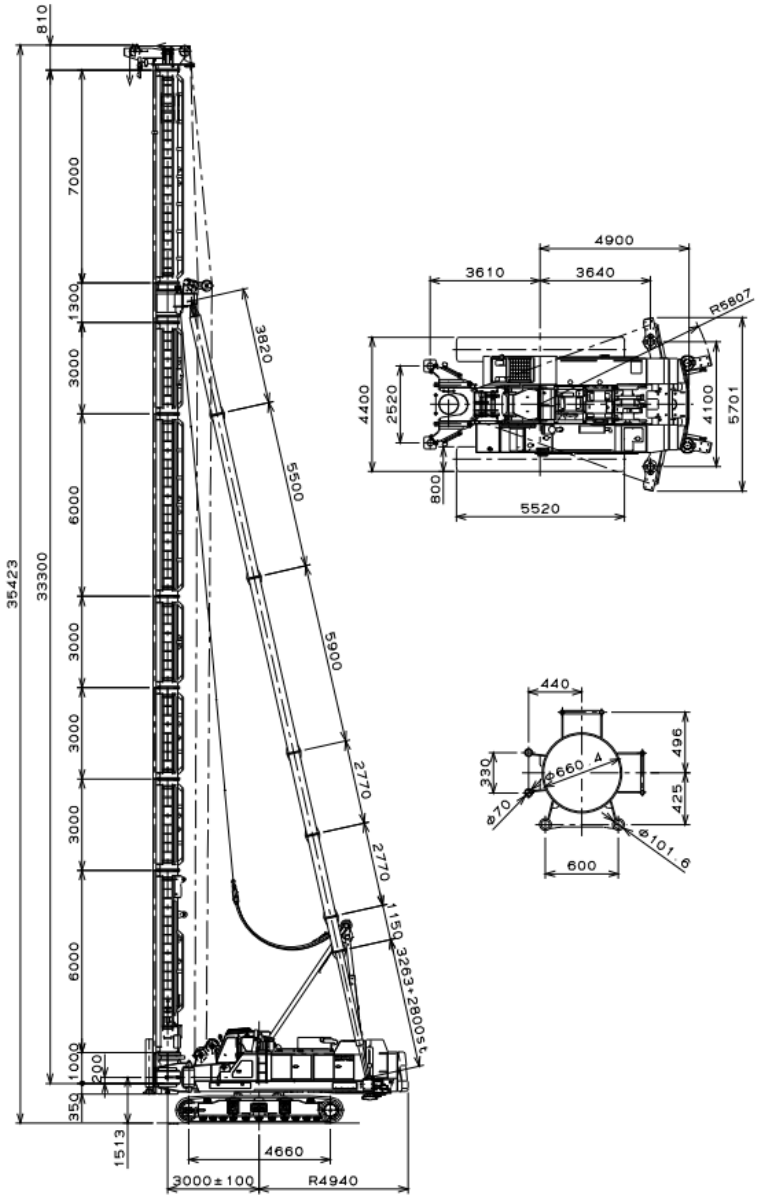

Water Supply
Generator
Auger
Mixing Rod
Power Supply
Cement
Mixing Shaft
Holder
Mixing Blade
Cement Silo
Mixing Plant
Slurry Pump
DMM Rig
Cement Mixing
Cement Slurry Pumping
DMM Work

Equipment

Summary of Equipment

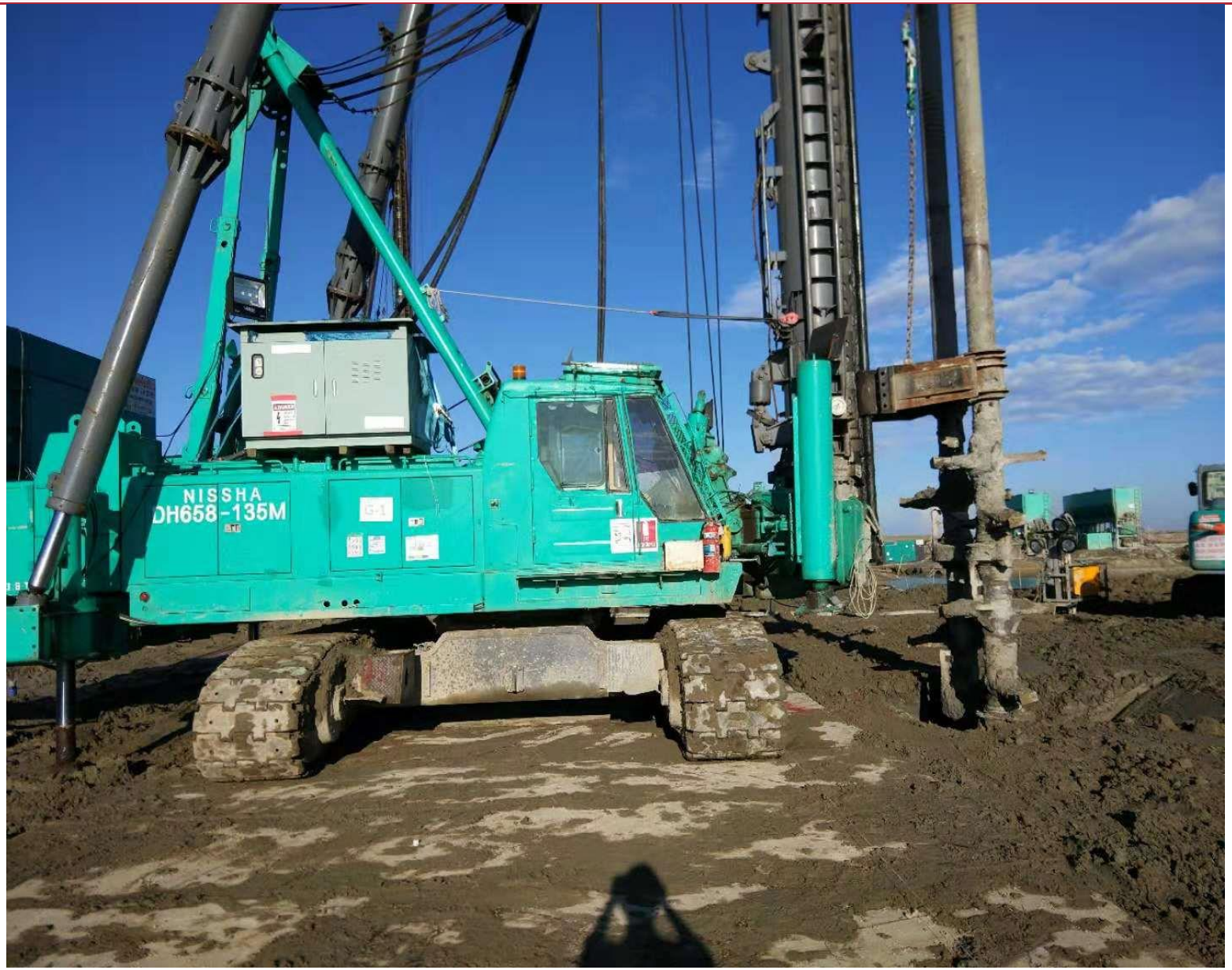
Description	Specification	Total			
		Duty	Standby	Spare	Unit
DMM Rig	Hyudraulic	4	1		set
Auger	150kW	4	1	1	set
Mixing bit	10 blades	4	4	1	set
Generator for DMM rig	600KVA	4	3	1	set
Mixing plant	400m^3/h	4	1	1	set
Generator for mixing plant	300KVA	4	2		set
Excavator	1.0m^3	5	2		set

DMM Rig



DH558-110t
DH658-135t
Nissha pile driving Rig

DMM Rig



Features for DMM Rig

Description	Classification	Specification
general dimension	width	5.2m
	height	7.345m
	length	7.88m
power unit	type	DH
	displacement	7961cc
	max torque	7.5kN/1600rpm
	fuel tank	250 liters
main hoist(front)	root dia & length	20mm*565m
	line speed	H64m/min,L32m/min
boom	basic length	21m
ground pressure	crawler belt width	800mm
	weight	47.3ton/135ton
	pressure	173kPa

Mixing plant

Up silo
Downside
mixing

Mixing plant

Monitoring system

- Slurry Rate, Volume

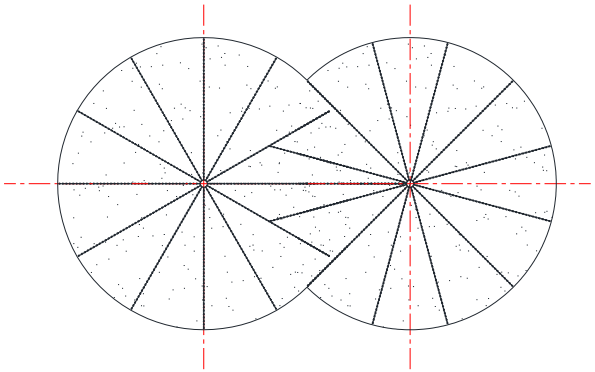
/ol

kin

Auger & Mixing Bit

Auger

- Double shaft auger
- Capacity:250HP
- **Mixing Bit**
- Diameter, 1200mm，2shaf
- Blades: 10numbers
- C to C: 1000mm of distance between both axis.
- 2.17m2 of improved area(deduct overlapping)



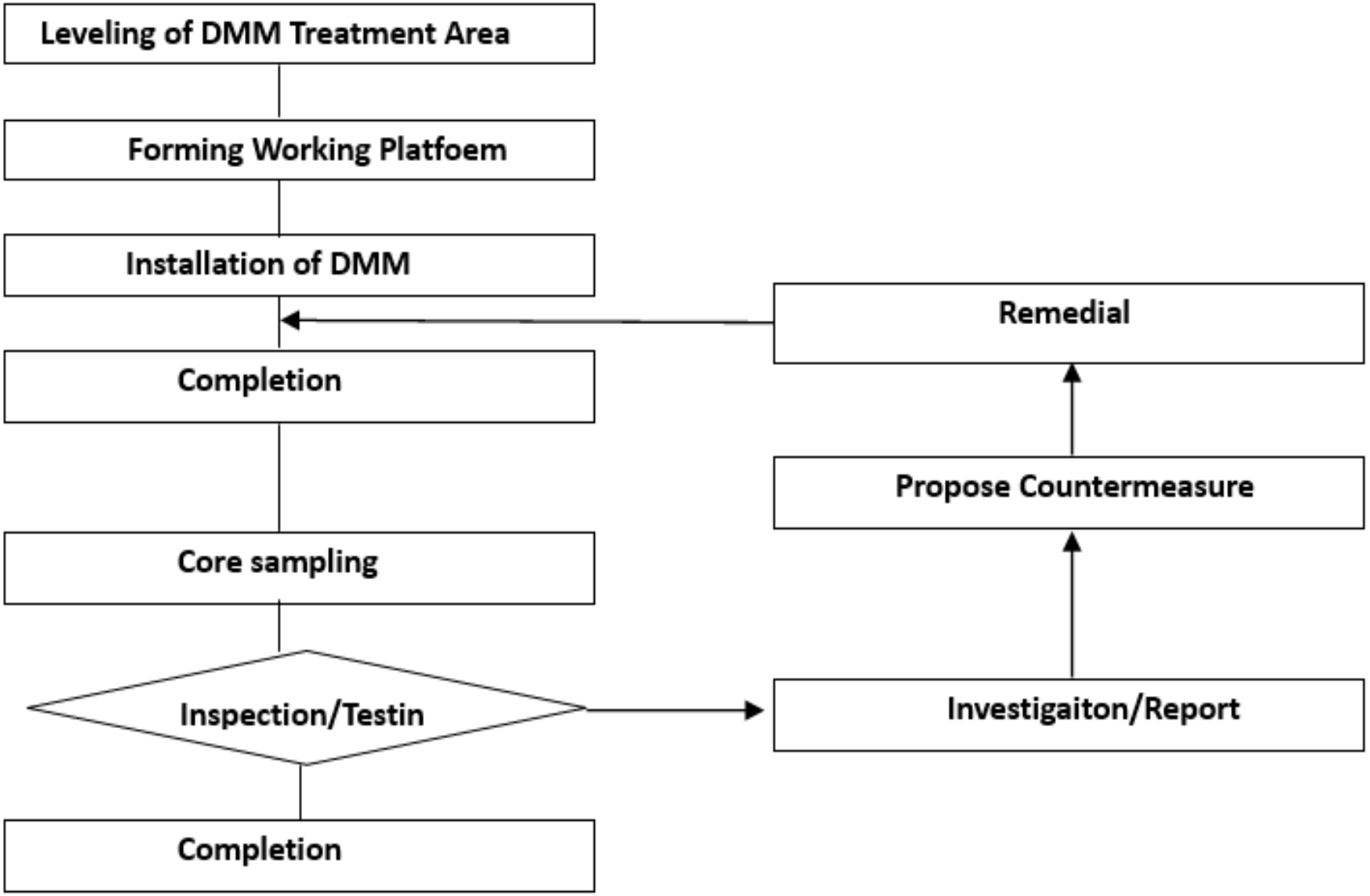
Mixing Bit

Mixing Parameters

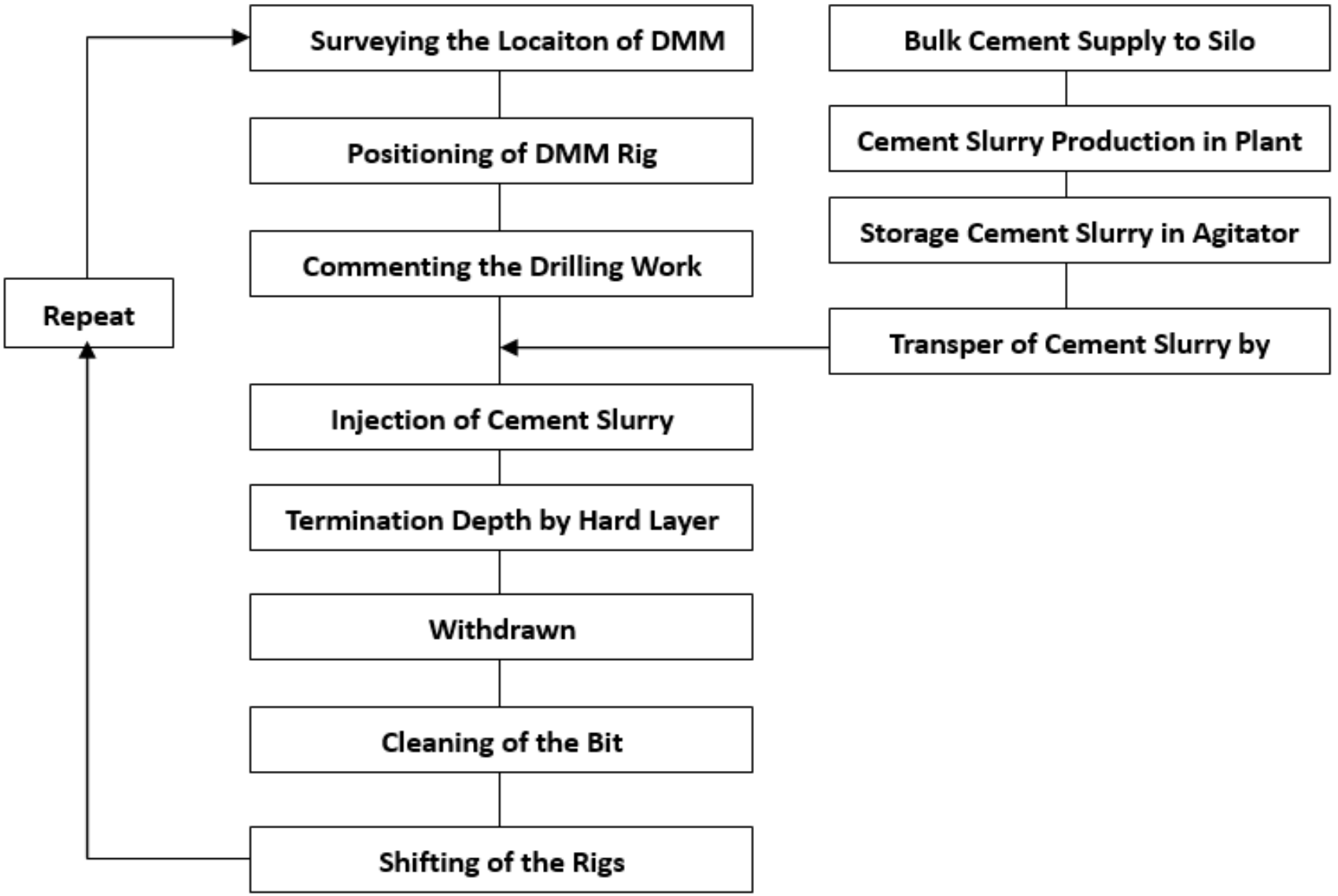
Introduction

- Cement: Ordinary Portland Cement(OPC)
- Water: Sea water
- DMM Quantity: 1,463,300m^3
- W/C ratio: 1.0
- Cement content：160-240kg/m^3

Work Flow for DMM Works



Sequence DMM installation



Sequence of penetration injection

1 Equipment setting

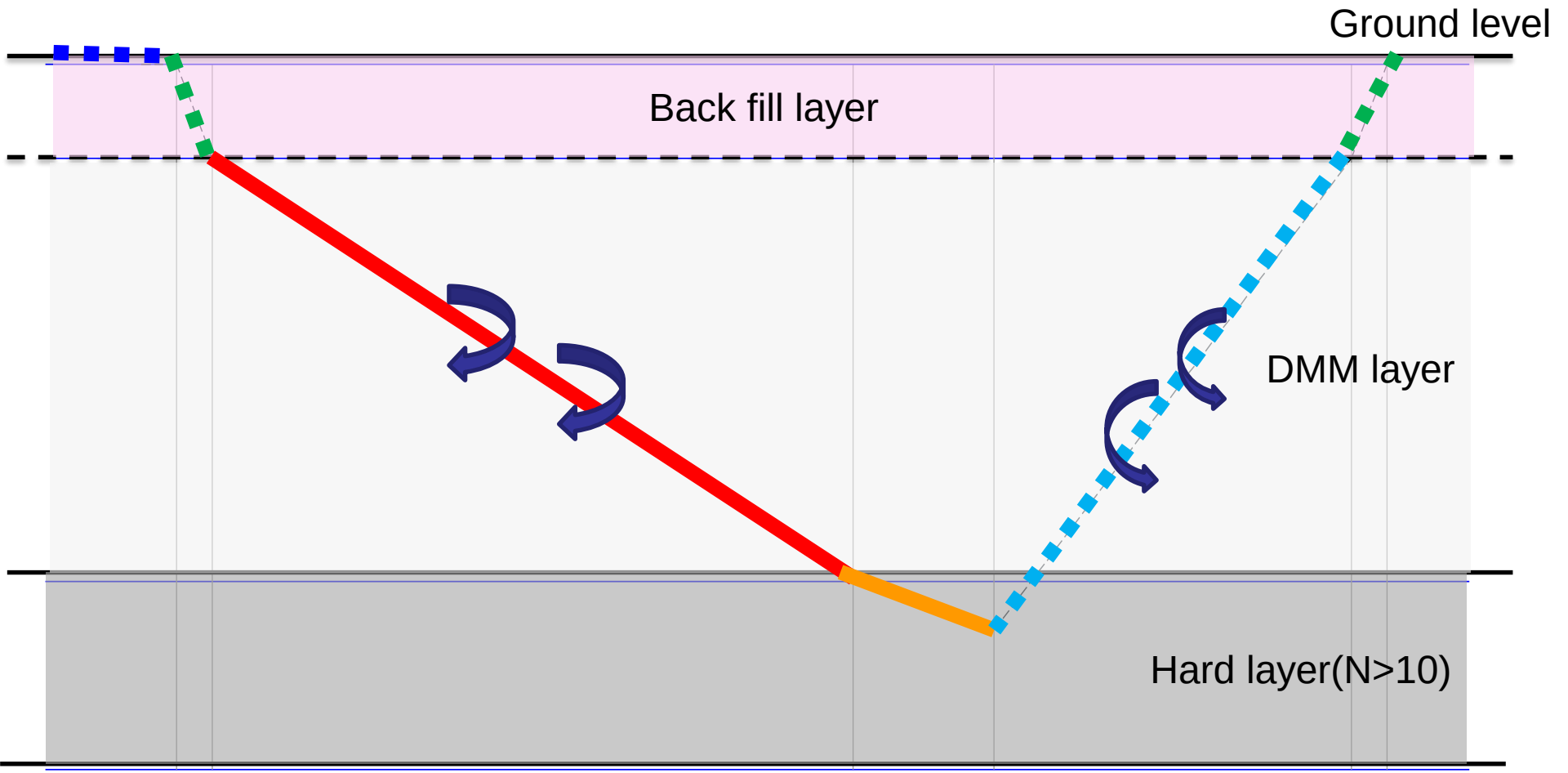
2 drilling to DMM Layer,2m/min

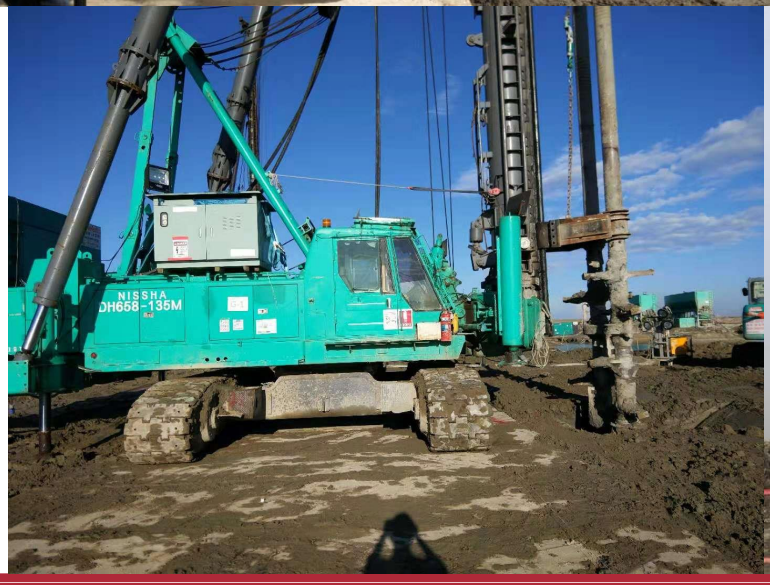
3 DMM layer drilling,0.5m/min

4 Hard layer drilling,0.25m/min

5 Withdrawal without Injection,1m/min

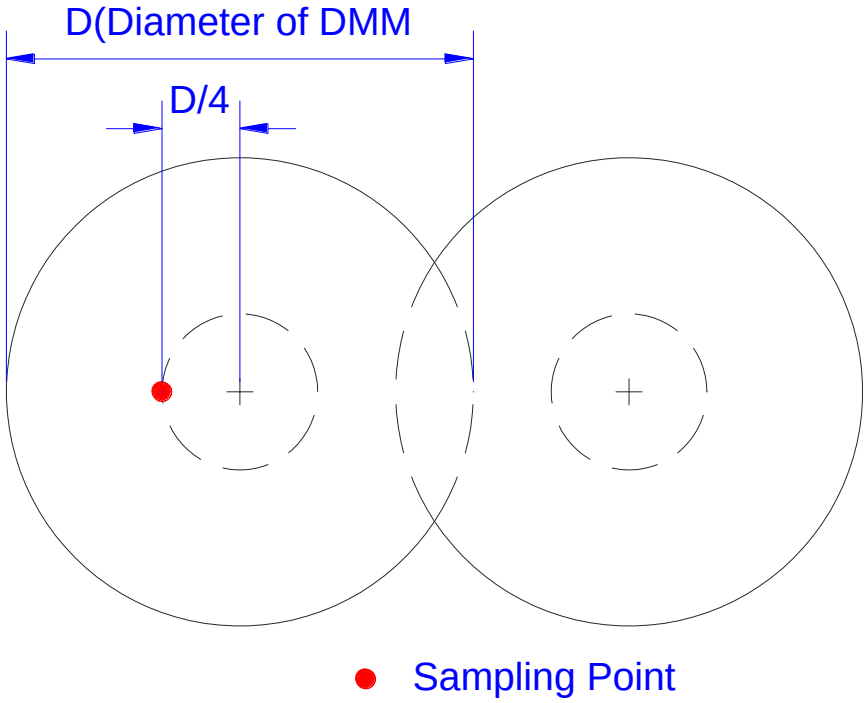
6 Withdrawal without Injection,2m/min



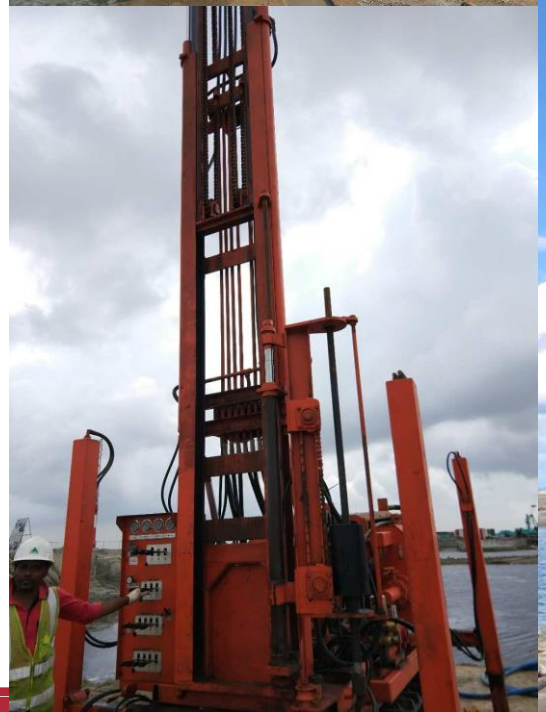

NISSHA
DH658-135M

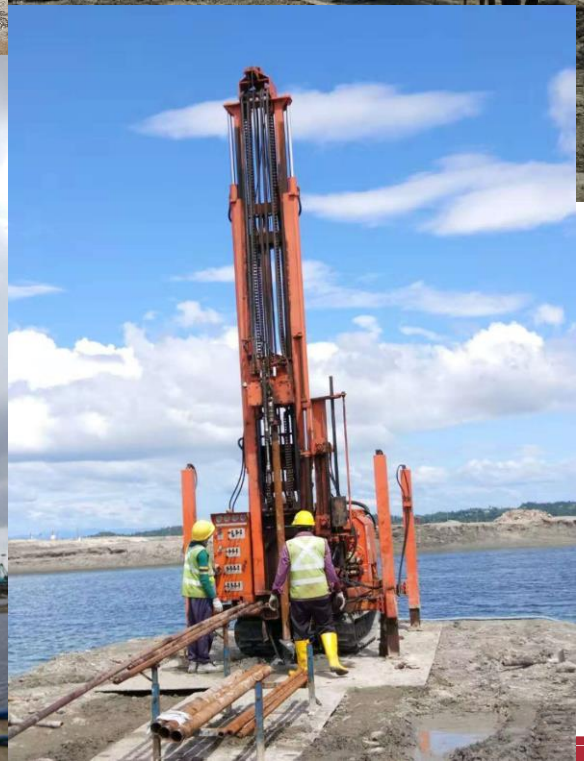
Coring

- 0.4% of the total DMM columns will randomly be sampled and tested
- Take 3 samples from the single DMM column
- Core samples will be taken after 20(twenty) days for visual check for the integrity and testing for unconfined compressive strength of the DMM columns.



Coring machine





Coring sample

SMW(soil mixing walls)

1 SMW-Principles

2. SMW-Advantages

3. SMW-Designs

4. SMW-Construction

5. SMW- Cases

1. SMW - Principles

Mix cement slurry with in-situ soil by special equipment to construct overlapping cement soil columns, then insert H-pile to the cement soil columns as walls. It is used as retaining wall and sealing structure.

The H pile can be pull out from ground after excavation work is completed.

SMW（Soil Mixing Wall） Development

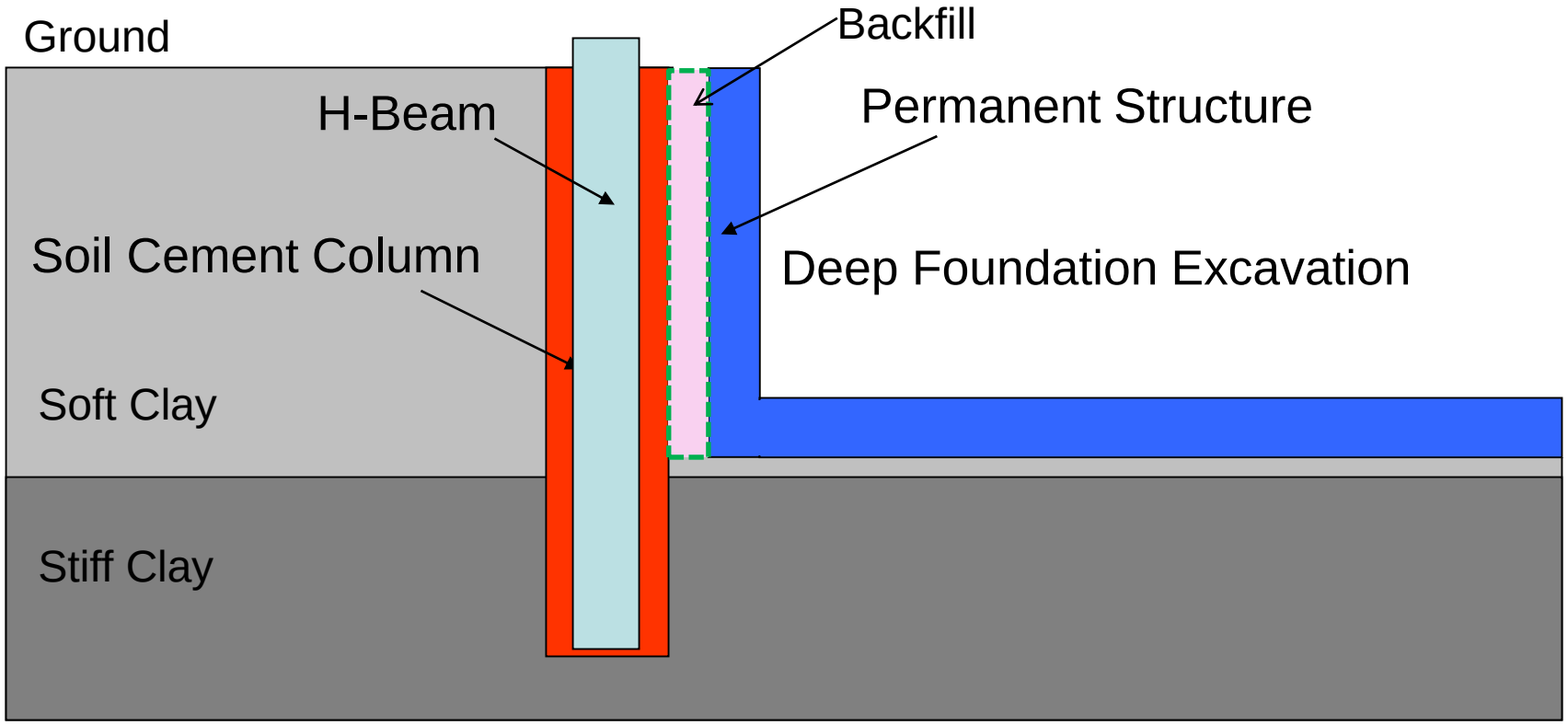
1) The Method is proposed in 1976 by Japan; Up to 1993, 50% deep foundation is by SMW;

2) SMW is also the most widely used method in Europe；

3） China, started this Method in 1987.
Shanghai first use SMW for 8m deep foundation in 1994.
Currently, Most deep foundation by SMW in is 5~20m.

1. SMW - Principles

- Soil Cement Column for Watertight
- H-Beam for bearing lateral earth pressure

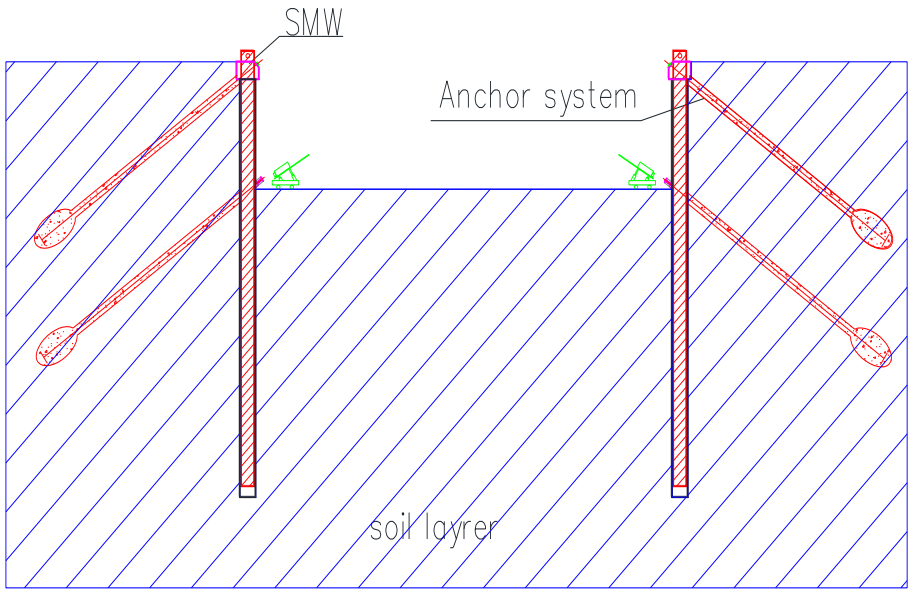


1. SMW - Principles

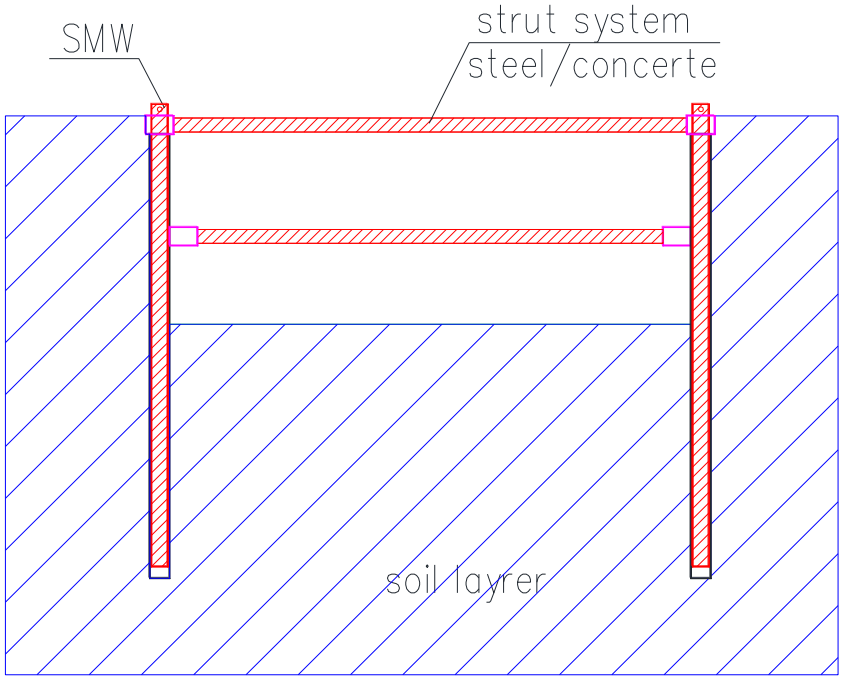
Finished SMW retaining wall

2. SMW-advantages

- 1) small to medium size rigs can be used.
- 2) Perfect **waterproof**
- 3) H pile **recycling use**, the in-situ soil is used as s construction materials, no waste mud are generated. **Saving energy and protecting environment**
- 4) Widely applicable scope in soil layer(slurry, silt, clay, sand soil) & strut system.
- 5) Simple construction procedure, **shorted construction period**
- 6) **Lower cost** compare with Diaphragm Wall,Secant Pile/Continous Pile.



SMW + anchor



SMW+ strut system

3. SMW-design

1. Design principles

- Safety (stability and material strength)
- Cost (ensure that H-pile can be recycled)
- Convenient construction

2. Cement content

- Cement content needs to be determined by mixture ratio test. Normally, cement content is around15%- 20%。

3. Embedment length

- 1) Embedment length of H pile

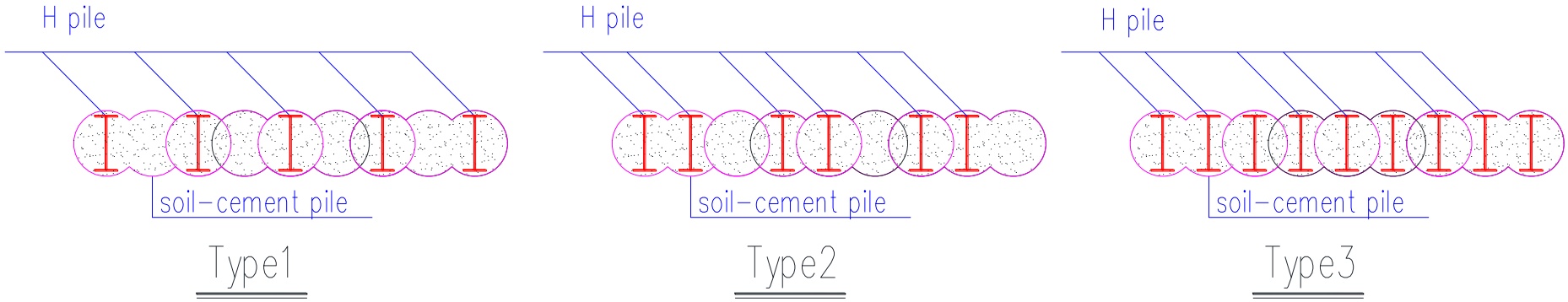
  Determined by ground stability, wall deformation, H-pile extraction condition .

- 2) Embedment length of soil-cement mixing pile

  Determined by ground stability, dewatering, and the embedment length of H pile.

3. SMW-design

4 Typical cross-section types

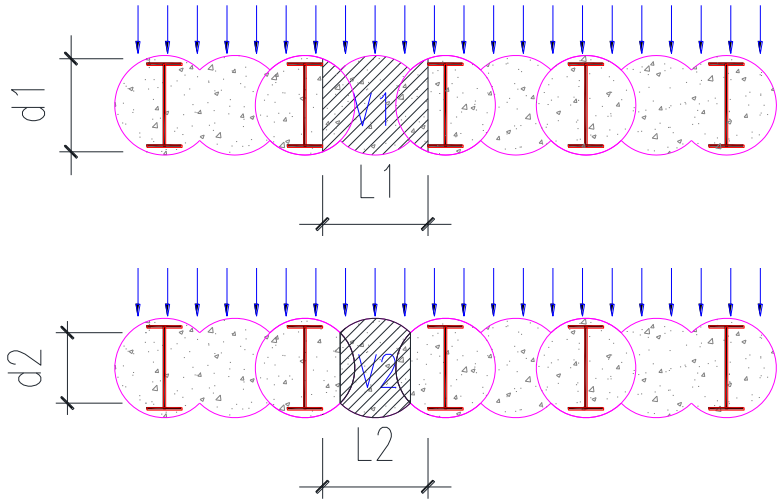


5 Calculation

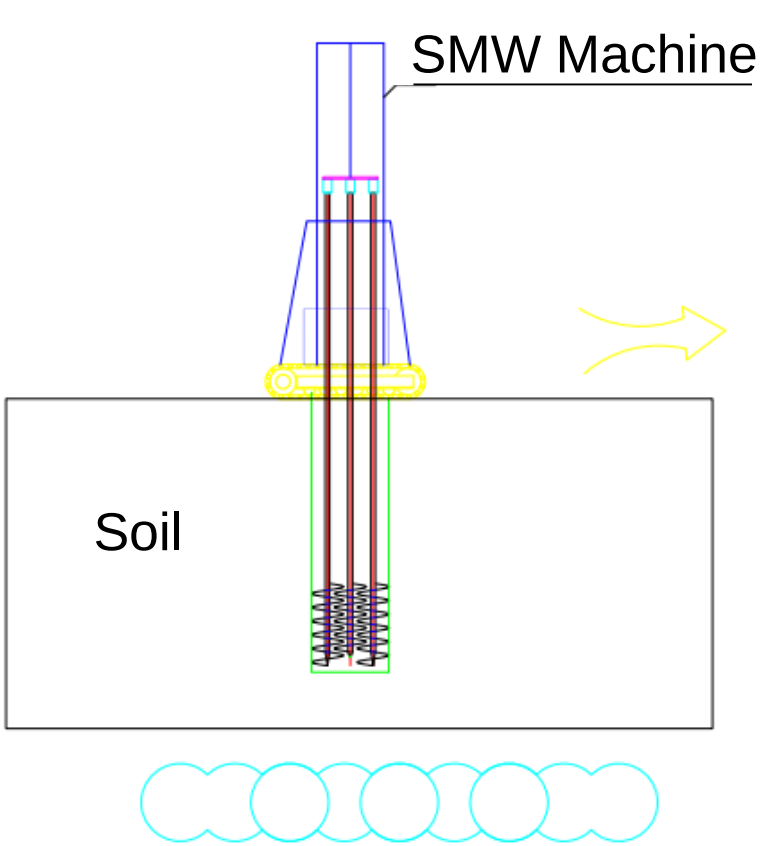
- All earth and water pressure will act on the H-pile.

6 Material strength check

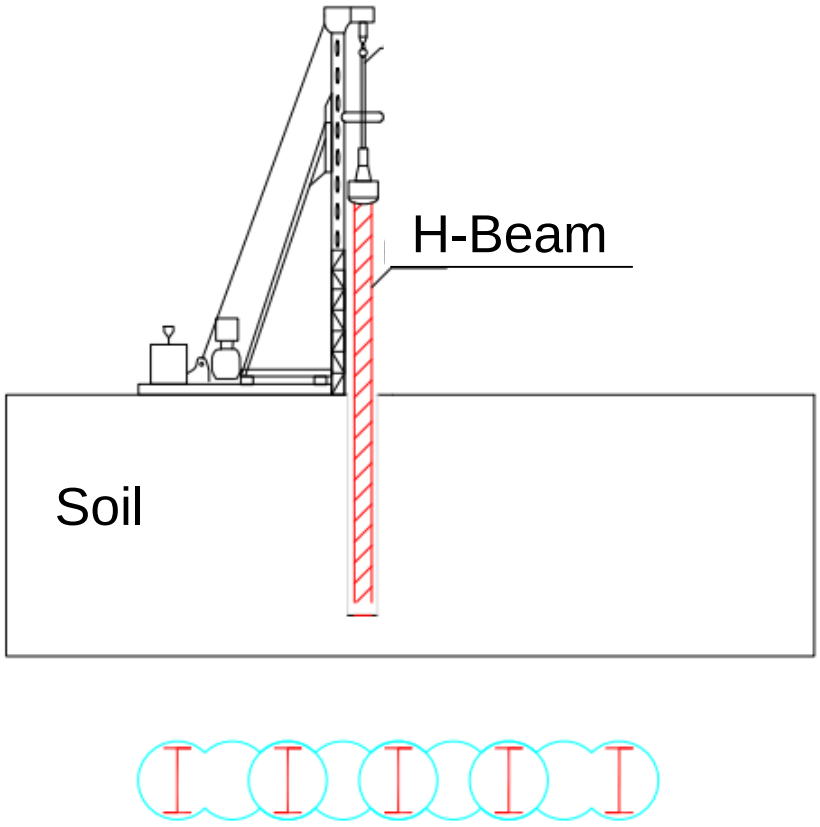
- Soil-cement mixing pile strength (shear)
- H-beam strength (bending, shear)



4 SMW - Construction



1) Soil Cement Column



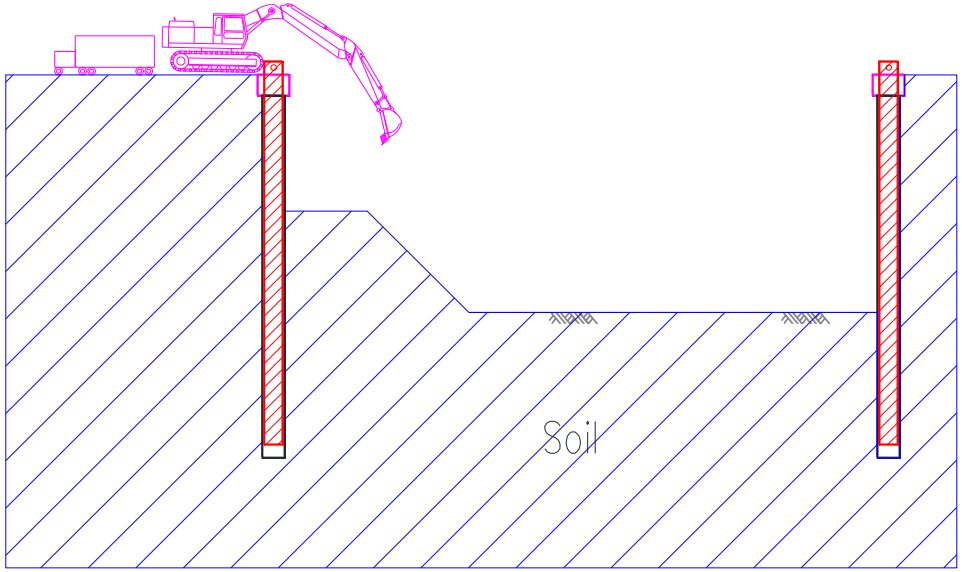
2) Install H-Beam

Remark:

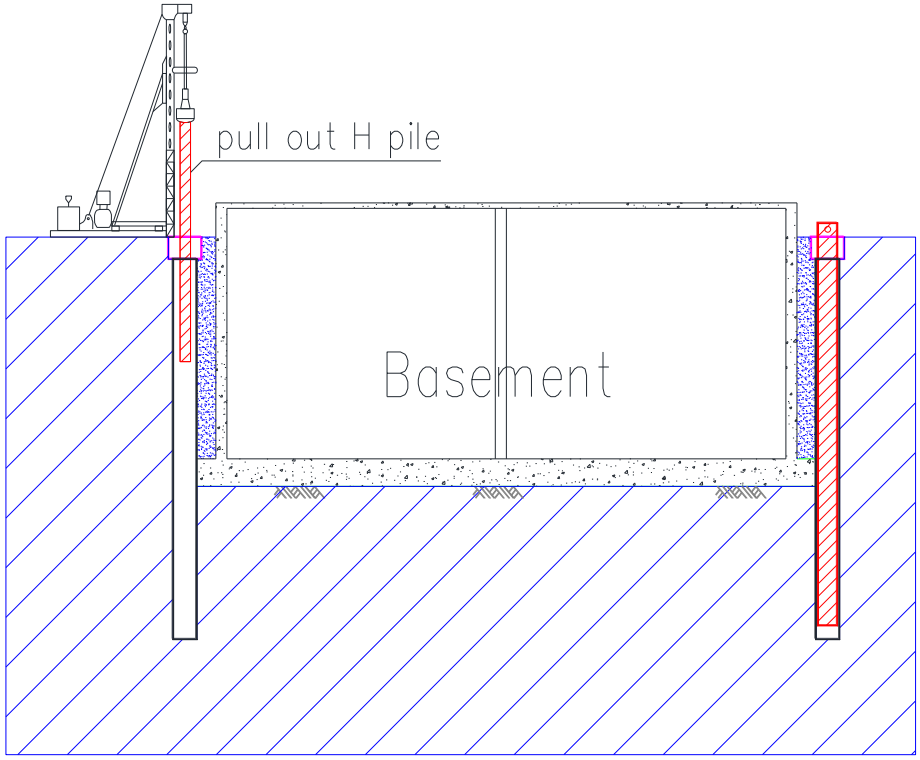
1) Before Install H-Beam, shall paint Drag Reducer on the H-Beam;

2) Install H-Beam shall finish within 30min after SCC finish.

4 SMW - Construction



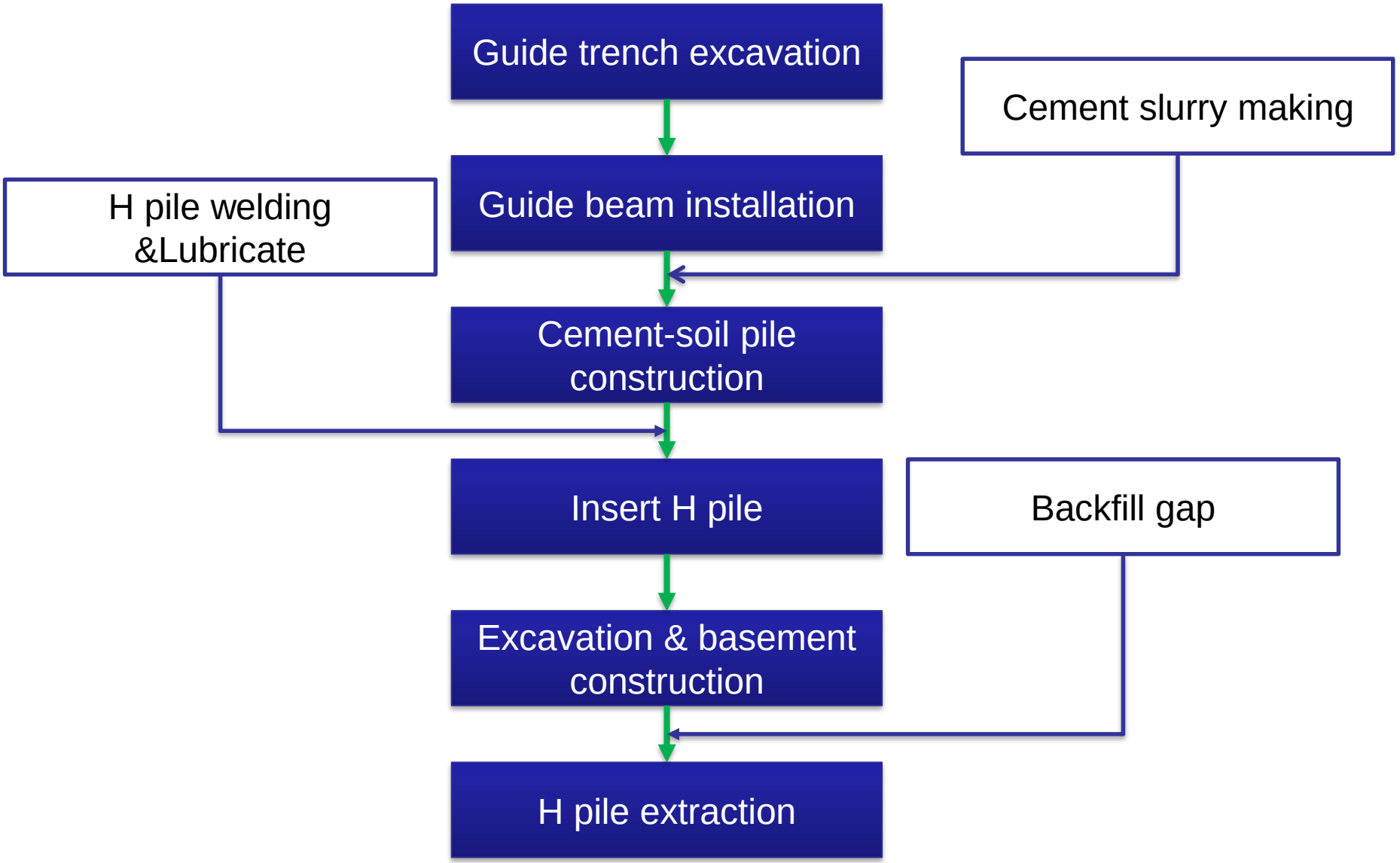
3) Excavation



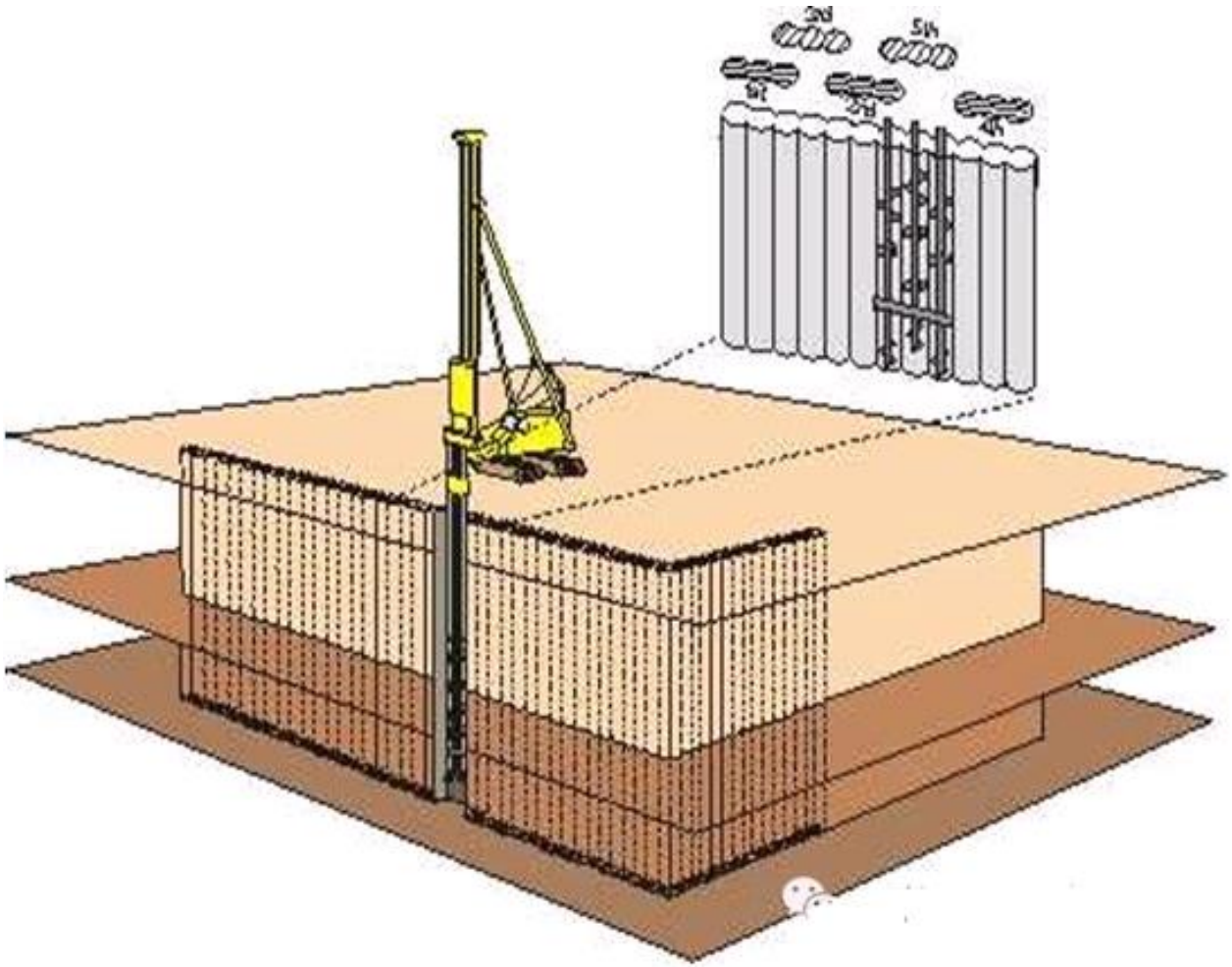
4) Remove H-Beam

Remark:
The gap between SCW and basement wall must be backfilled compacted by soil before H pile extraction working

4 SMW - Construction



4 SMW - Construction



SMW Method Sketch map

SMW Machines

550SMW Rig

850SMW Rig

M15 Rig

Pre-drill

Ground Solidation Rig

SMW 5000 Rig

SMW 5000型 Rig

SMW 7500 Rig

4 SMW - Construction

Soil mixing machine

4 SMW - Construction

Soil mixing machine

4 SMW - Construction

Mixing shaft

4 SMW - Construction

Steel H-pile

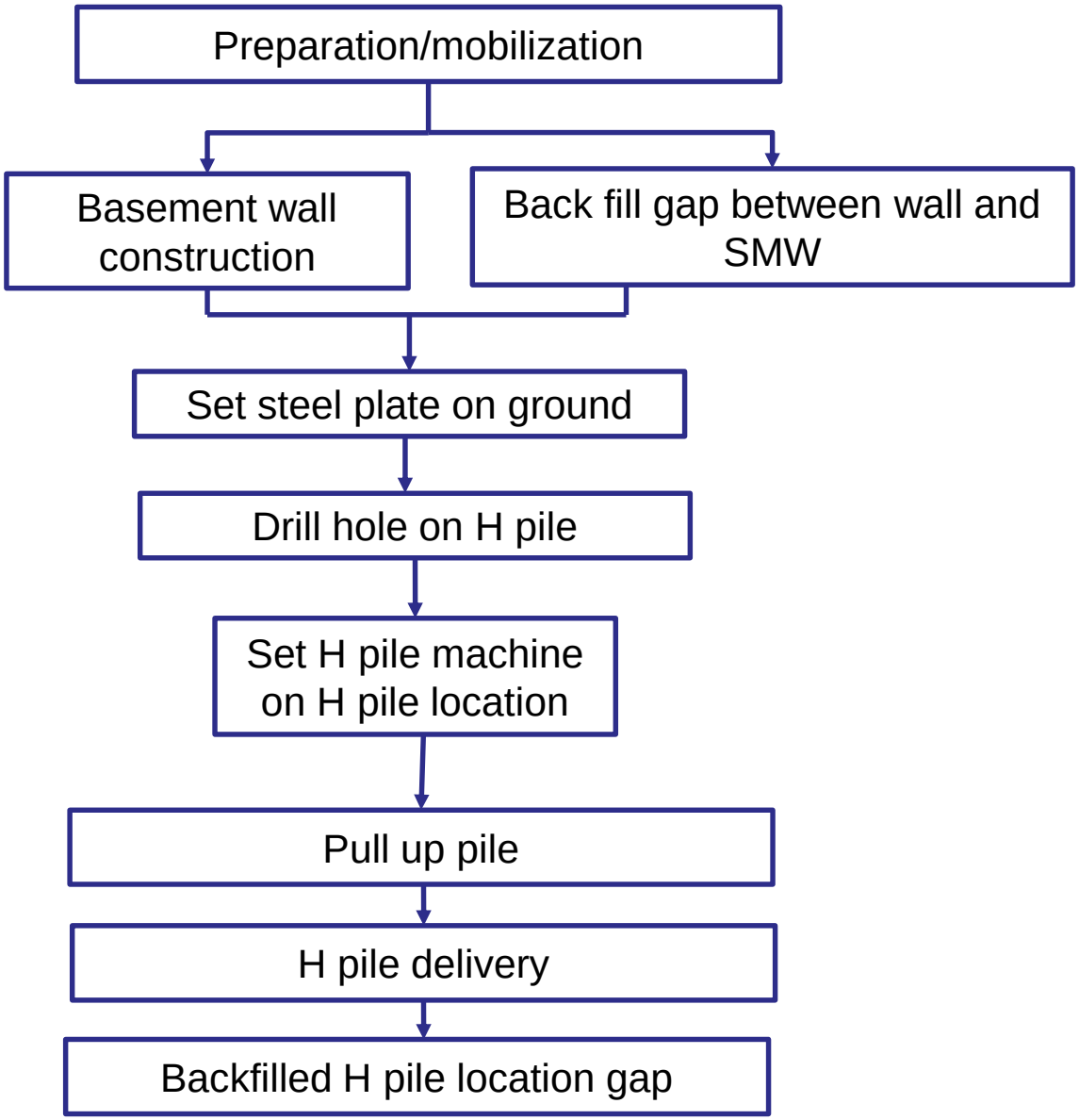
4 SMW - Construction

Inserting H-Beam

4 SMW - Construction

Excavation

H pile extraction work Sequence



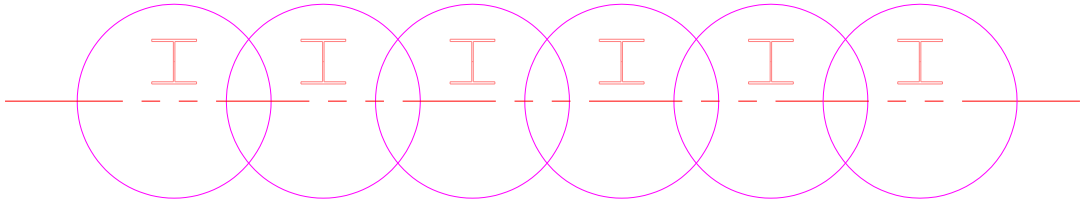
H pile extraction

Remove H-Beam after completion

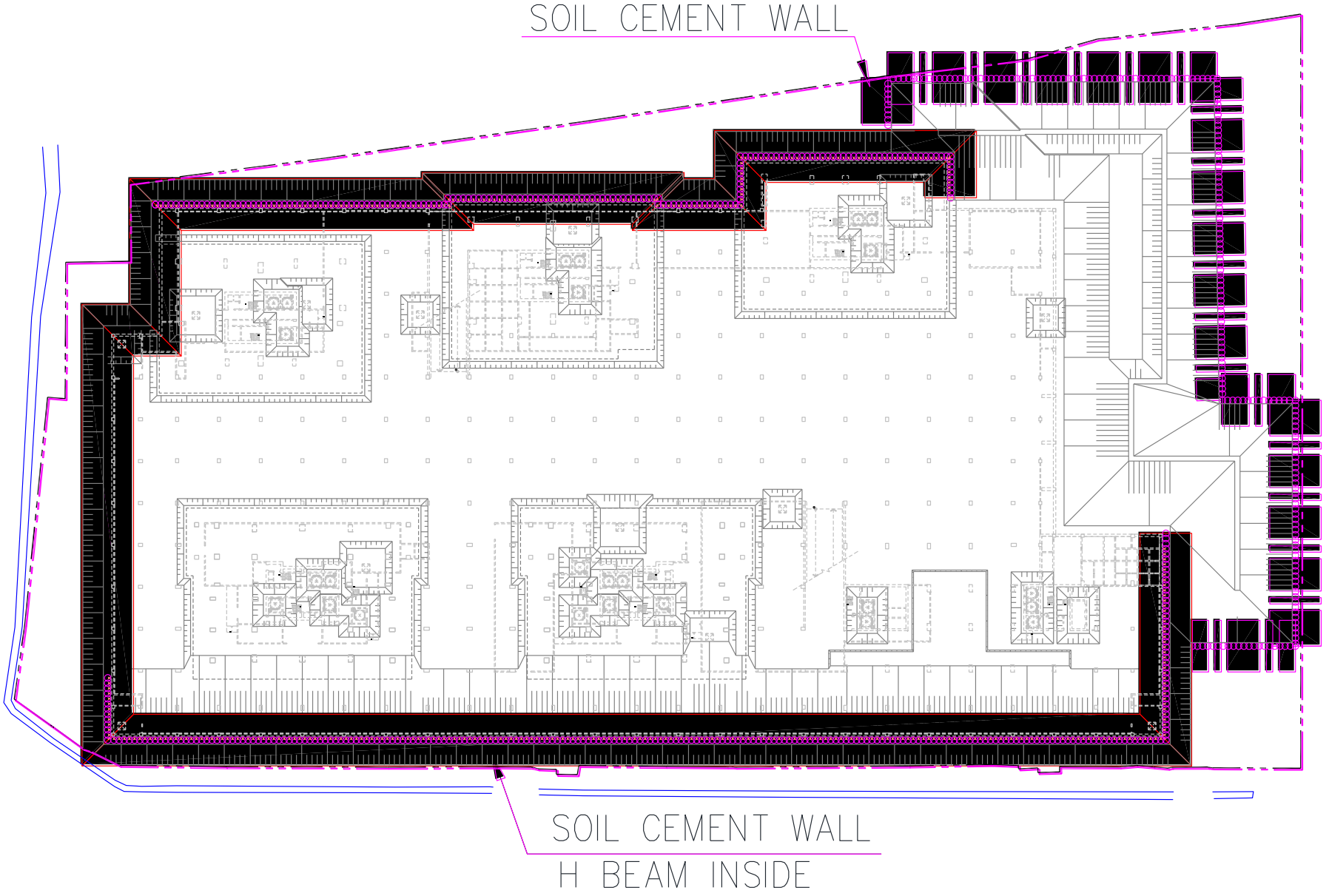
5 SMW Cases- Yangon Inno city Project

Introduction

- Yangong Inno City Development Project(Deep excavation works and retain wall works)
- Client: Inno city Development CO.,Ltd.
- Extension Length :750m
- Pile Quantity : 751 nos.
- SMW pile length:18m,20m
- Cement-soil column diameter: 1300mm(C.T.C,1000mm)
- H pile size:H300×300×10×15，H350×350×12×19
- Excavation depth: 11.5-18.6m
- SCW periods: 3 month



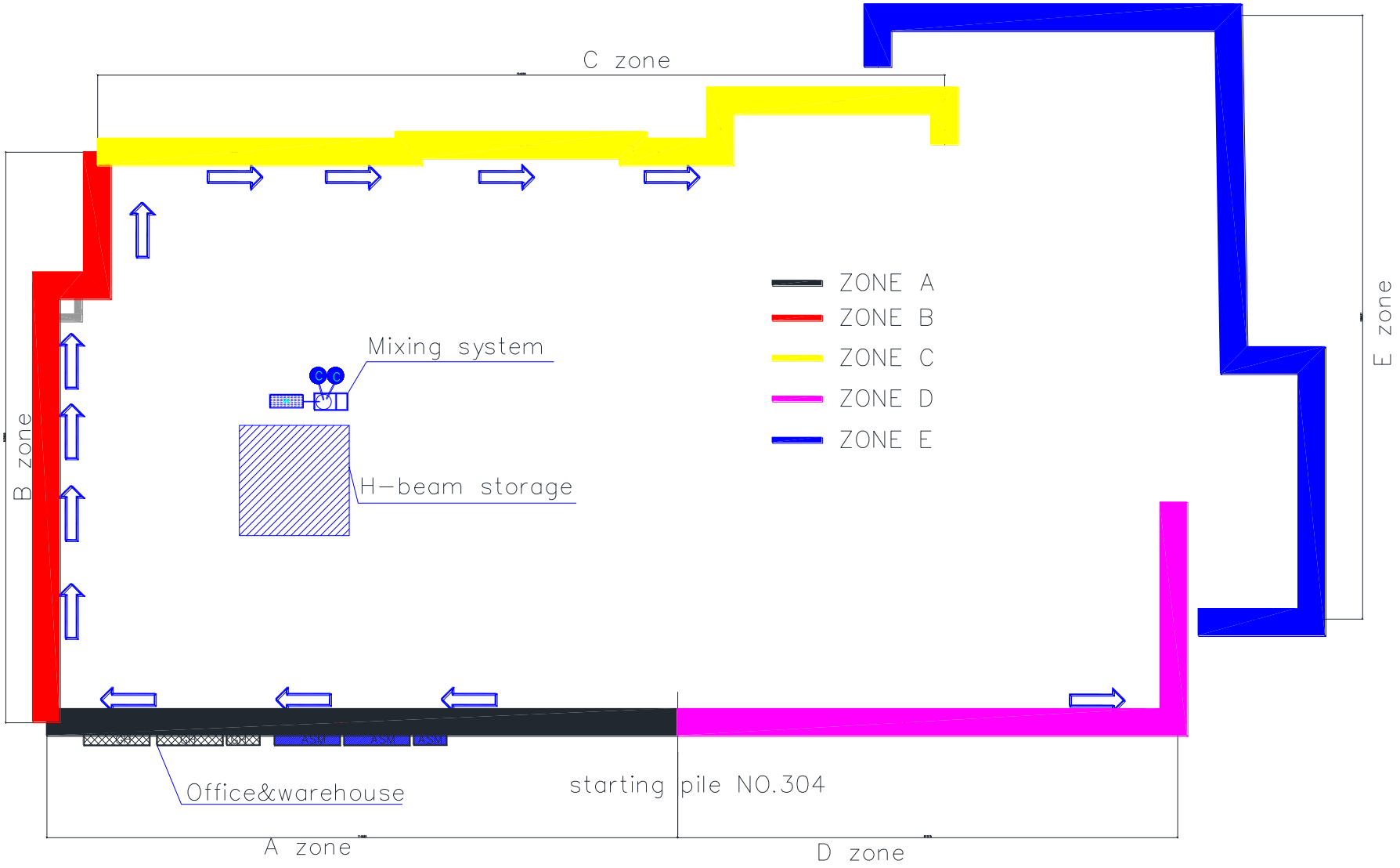
SMW layout



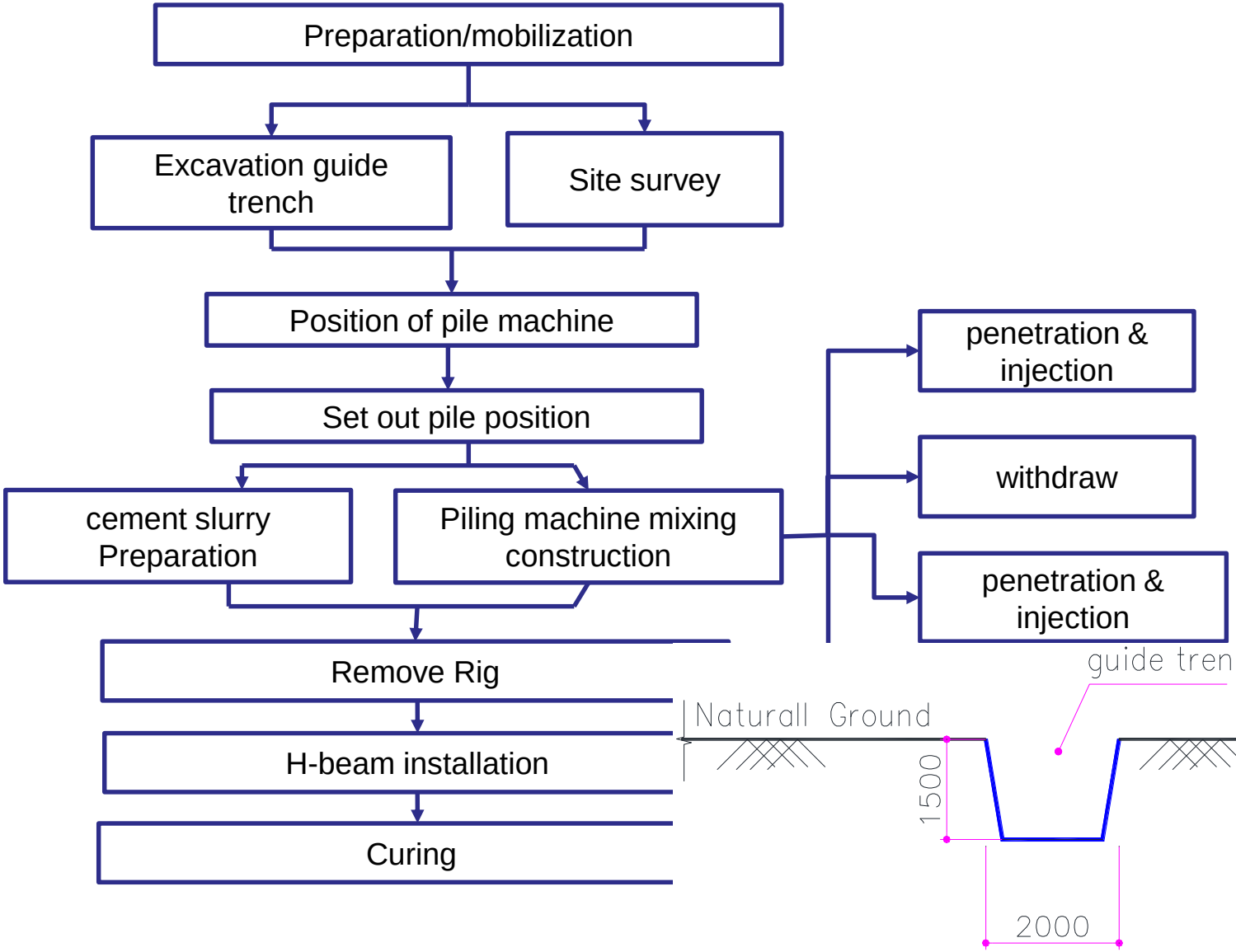
Equipment

NO.	EQUIPMENT NAME		PARAMETER/ CAPACITY	QUANTITY
1	Base machine(JZU180)		20×7m	1
2	Auger(SW300)		2×110kW	1
3	Shaft(GH1300)		2×Φ1300	1
4	Mixing system(JBZ-60)	mixing drum	30kW, 2.5m^3/drump	1
		Slurry storage drum	4.0m^3/7.5kW	1
		Water pump	2.2kW	2
		Screw conveyer	50t/h，7.5kW	1
		Silo	80t	1
		Air compressor	4.0kW, 0.55m^3	1
5	Vibratory hammer		45kw	1
6	Excavator(Dosan200)		0.8m^3	1
7	crane(KR250)		75Ton	1
8	Generator		800KVA/380KVA	2

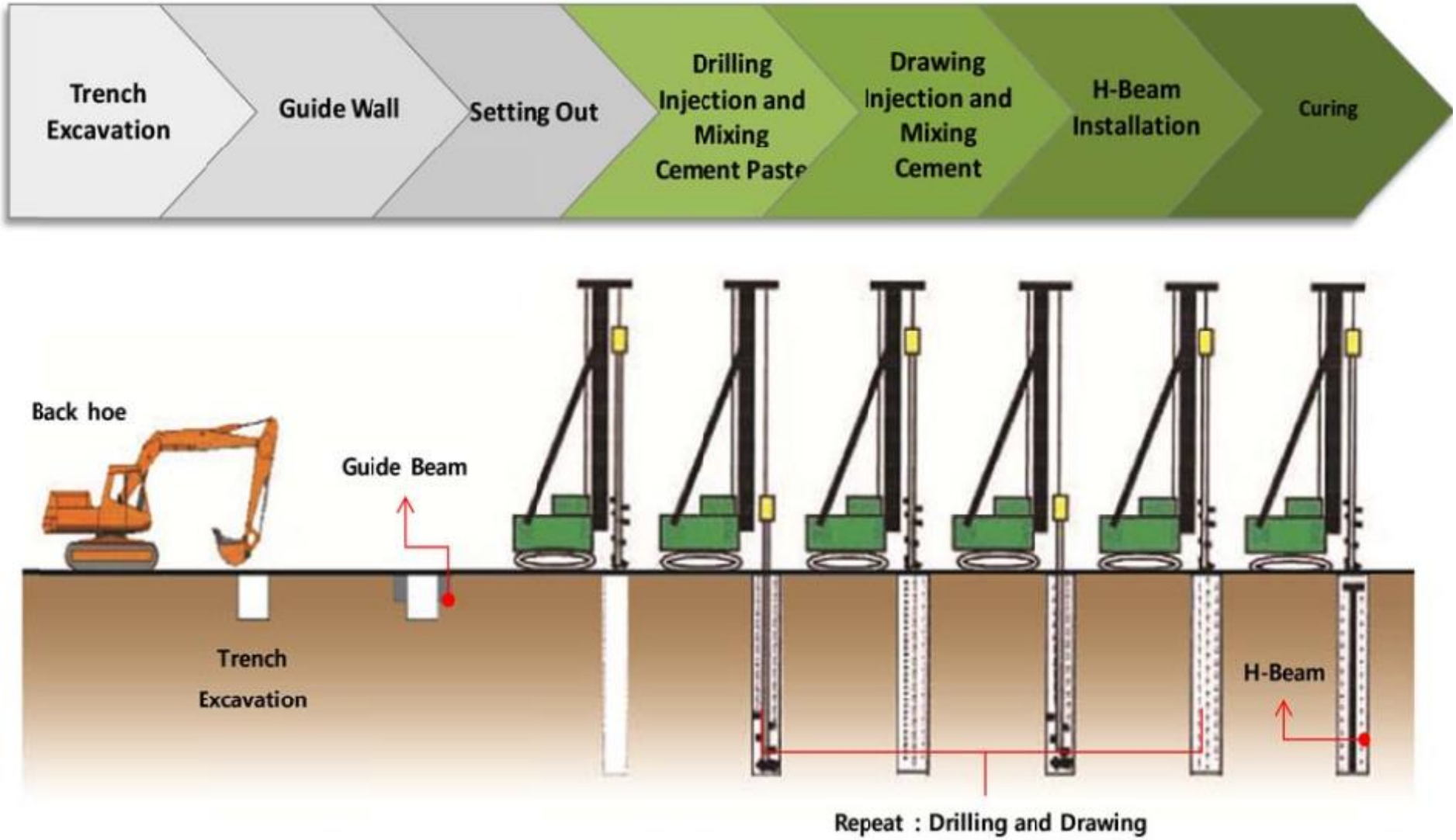
Layout plan for SCW working



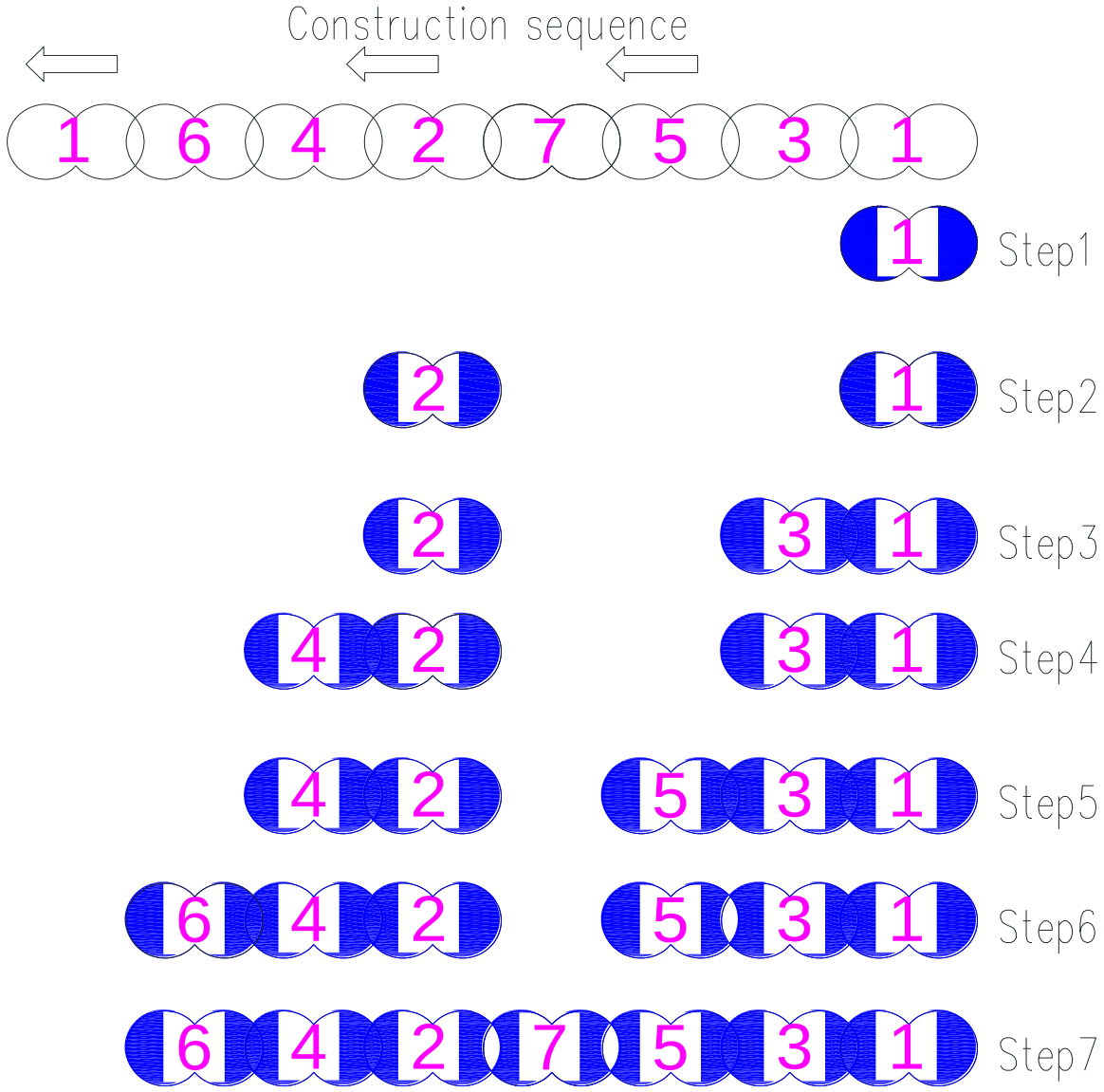
SCM Work Sequence



SCM progress



Construction sequence



interval construction pile distance should be not less than 6m to ensure continuous construction.

DCM Rig

Setting

Drilling & H beam setting

Insert H beam

Excavation

5 SMW-Cases

Shanghai Delong Plaza excavation (SMW + steel beam strut)

5 SMW-Cases

Shanghai South railway station excavation (SMW + steel pipe strut)

5 SMW-Cases

Nanjing Centeral Jindi excavation (SMW + steel frame strut)

5 SMW-Cases

Wuhan Donghu tunnel (SMW + anchor)

5 SMW-Cases

Wuhan Wenling tunnel (SMW + steel pipe strut)

5 SMW-Cases

Kunming tunnel ((SMW + anchor)

5 SMW-Cases

Nantong cross street excavation ((SMW + anchor)

In the Past 20 Years, the SMW System has been widely used to replace D-Wall, bore pile , Secant Pile, saving huge quantity of Steel Material (H-Beam) and Construction Quality is guaranteed.

GEOHARBOUR

Thanks!