4. Study on Press-in Force for No. B Shaft

Contents

1. Plan for theory of settlement

In order for Caisson to reach a fixed depth due to gravitational act, the following formula shall be satisfied.

Insertion pressure ＋ Self weight ≧ Buoyancy ＋ Reaction force of skin friction ＋ Resistance force of cutting edge

(1) Self weight (Wc)

Figure section 1

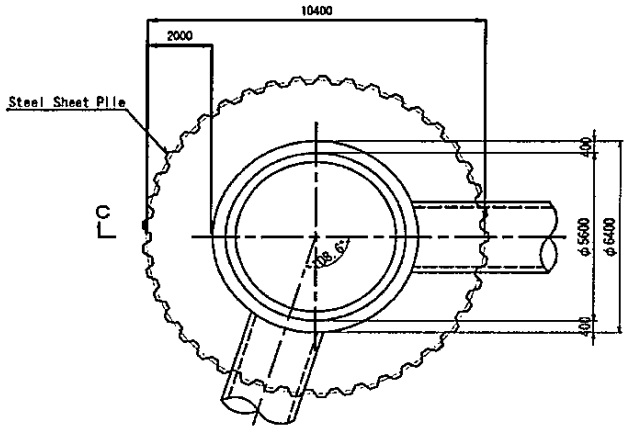


Figure section 2

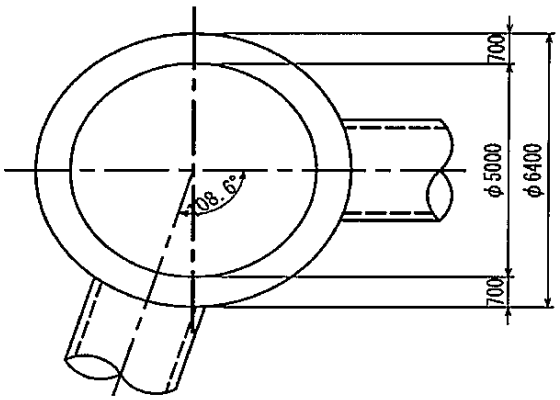
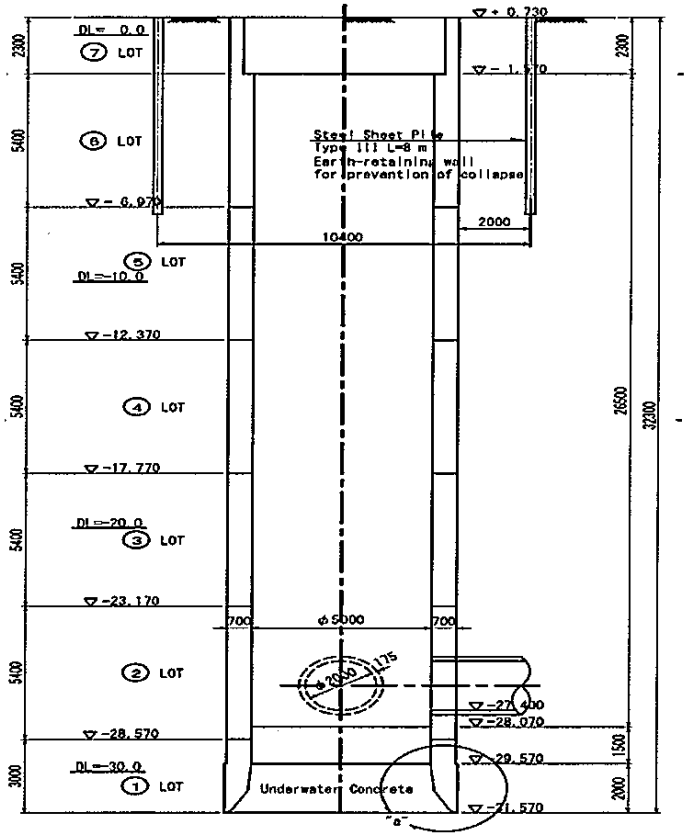


Figure section 3



1

As setting unit volume weight of reinforcing concrete at 25.0 (KN/m^3),

Lot	Volume of concrete (m^3)	Self weight (kN)	
		Weight of interval	Self weight
①	33.2	830.0	830.0
②	67.7	1692.5	2522.5
③	67.7	1692.5	4215.0
④	67.7	1692.5	5907.5
⑤	67.7	1692.5	7600.0
⑥	67.7	1692.5	9292.5
⑦	17.3	432.5	9725.0

(2) Buoyancy (U)

As for setting groundwater level at −2.49m

Lot	Depth (m)	Buoyancy (kN)
①	2.500	
②	7.900	634.2
③	13.300	1311.1
④	18.700	1988.0
⑤	24.100	2664.8
⑥	29.500	3341.7
⑦	32.300	3692.7

1

(3) Resistance force of skin friction (F)

$F = L \cdot Ha \cdot Fa$

To this, F: Resistance force of skin friction (kN)
L: Perimeter of Caisson (m)
Ha: Ground contact height of perimeter of Caisson (m)
fa: Skin friction (kN/m²)

The value of skin friction adopts recommended value from "Design guideline of press-in open Caisson" of the Hanshin Expressway Public Corporation as shown in below table.
However, in order to put NF sheet to the spot of friction cut, the value without combined use of promotion of settlement process in the interval from cutting edge to friction cut is calculated,
while the value with combined use of promotion of settlement in the interval of NF sheet is calculated.

Illustration by table-3.2(1) Table of skin friction (kN/m2) (In case without combined use of promotion of settlement process)

Soil	Resources			Actual measurements		Recommended value
	Desing and construction of intrusion method (Ohmsha)	Civil engineering handbook	Specification of highway bridge	Section of Uozakihama	Section of Sukematsu	
Clay	———	50.0～200.0	5.0～10.0	32.0	19.0～25.0	30.0
Silt	2.0～ 7.0	———		———	———	
Well tight silt	5.0～ 10.0	———		———	———	
Well tight sand	12.0～22.0	35.0～ 70.0	14.0～24.0	15.0～ 25.0	20.0～36.0	30.0
Sand mixed with gravel	14.0～24.0	———		———	24.0～30.0	
Gravel mixed with sand	17.0～26.0	———	22.0～31.0	———	24.0～44.0	100.0
Well tight gravel	22.0～31.0	50.0～100.0		80.0～130.0	———	
Notes			Actual value in good condtion without resistance of cutting edge attached with friction cut	Interval without NF sheet	Interval without NF sheet	

Illustration by table-3.2(2) Table of skin friction (kN/m2) (In case with combined use of promotion of settlement process)

Depth (m)	Literature *1	Actual measurements by other organization			Actual measurements		Recommended value
		Bypass of Hamadera	Shinfujigawa river	Kishuoohashi bridge	Section of Uozakihama	Section of Sukematsu	
0～ 5	2.0				6.0	7.0	5.0
5～10	6.0	25.0～39.0	15.0	17.0	6.0	8.0	10.0
10～15	10.0	(Average value)	(Average value)	(Average value)	10.0～20.0	14.0	15.0
15～	12.0				10.0～20.0	14.0～17.0	20.0
Notes		NF sheet jetting	NF sheet jetting	NF sheet jetting	NF sheet jetting	NF sheet jetting	

Literature*1 : Recommended value of catalog of NF construction method

Resistance force of skin friction

Lot	Depth of (m)	Resistance force of skin friction (kN)		
		Interval from cutting edge to friction cut	Interval of NF sheet	Total
①	2.500	20.42 × (1.990 × 30.0 + 0.010 × 30.0) = 1225.2	20.11 × (0.500 × 5.0) = 50.3	1275.5
②	7.900	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 0.900 × 10.0) = 683.7	1908.9
③	13.300	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 5.000 × 10.0 + 1.300 × 15.0) = 1900.4	3125.6
④	18.700	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 5.000 × 10.0 + 5.000 × 15.0 + 1.700 × 20.0) = 3700.2	4925.4
⑤	24.100	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 5.000 × 10.0 + 5.000 × 15.0 + 7.100 × 20.0) = 5872.1	7097.3
⑥	29.500	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 5.000 × 10.0 + 5.000 × 15.0 + 12.500 × 20.0) = 8044.0	9269.2
⑦	32.300	20.42 × (2.000 × 30.0) = 1225.2	20.11 × (5.000 × 5.0 + 5.000 × 10.0 + 5.000 × 15.0 + 15.300 × 20.0) = 9170.2	10395.4

Perimeter of Caisson

Interval between cutting edge and friction cut $\pi \times 6.500 = 20.42$ (m)

Interval of NF sheet $\pi \times 6.400 = 20.11$ (m)

3

(4) Resistance of cutting edge (Q) (from design and construction of intrusion published by Ohmsha)

As for the case of press-in Caisson, cutting edge is generally embedded in ground. In this situation, it cann be supposed that resistance force of cutting edge is bearring capacity in shallow ground.

Therefore, resistance on cutting edge is calculated from the formula which is generally used in construction of press-in Caisson.

$Q = A \cdot qd$

To this Q: Resistance force on cutting edge (kN)
A: Ground contact area of cutting edge (m^2)
qd: Ultimate bearing capacity of ground contacted with cutting edge (kN/m^2)

General formula $qd = C \cdot Nc' + \gamma_1 \cdot B' \cdot (Nr'/2) + \gamma_2 \cdot Df' \cdot Nq'$

To this C: Cohesion of soil (kN/m^2)
$\gamma 1, \gamma 2$: Unit volume weight of soil above and below cutting edge (kN/m^3)
B/: Ground contact width of cutting edge (m)
Df/: Ground contact height of cutting edge (m)
Nc/,Nr/,Nq/: Coefficient of bearing capacity

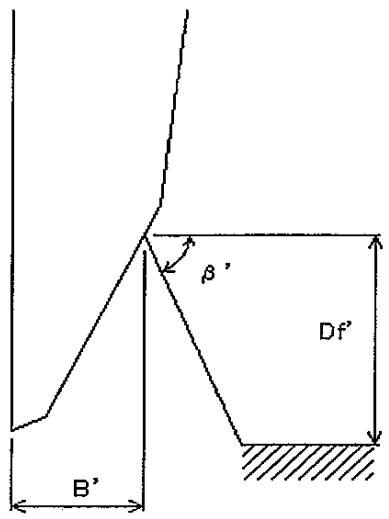
Coefficients of bearing capacity, Nc.Nr, and Nq decrease due to excavation condition in Caisson. This relatshionship is shown below formula with approximate reduction coefficient, kc, kr related to β, ϕ.

Reduction formula $qd = kc \cdot C \cdot Nc/ + kr \cdot \gamma 1 \cdot B/ \cdot (Nr/2) + \gamma 2 \cdot Df/ \cdot Nq/$

To this, kc, kr : Reduction coefficient of bearing capacity

As for calculation for resistance on cutting edge, the values of various factors of soil, (C, ϕ), and embedment depth of cutting edge shall be noted because they influence resistance greatly.
Therefore, embedment depth, (Df') and width of resistance of cutting edge, B' shall be determined based on workability, and assuming the condition of engulfment of earth and sand around cutting edge, and the condition of the tightness of earth and sand by press-in.
Accuracy of calculation of resistance of cutting edge is influenced by whether the above assumption is good or bad, which affects economy of construction.
Therefore, deliberate consideration shall be necessary.

Form of excavation of cutting edge



4

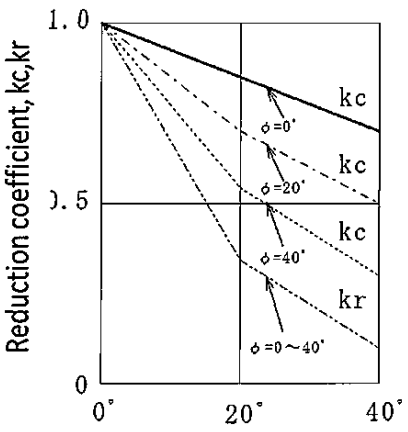
Angle of repose of soil

Soil	β' [Degree]	
	In water	In air
Sand	26	32
Sand mixing clay	18	37
Gravel	16	25
Gravel mixing clay	27	35
Gravel mixing sand and clay	18	35

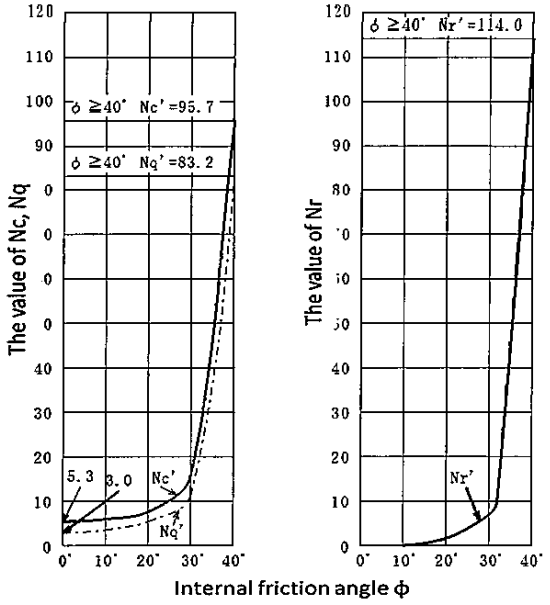
(Measured value by Seiichi Iiyoshi)

Average value of cohesion, C and internal friction angle, ϕ of soil

Soil	ϕ [Degree]	C[N／cm²]
Mudy sand	30	2.0
Well tight sand	34	5.0
Fluid clay	0	0.5
Well soft clay	2	1.0
Soft clay	4	2.0
Medium soft clacy	6	5.0
Tight clay	8	7.5



Reduction coefficient ,Kc, kr, from the value of Nc', Nr' by B'



The relationship with internal friction angle,φ and Nc', Nq', Nr'

Ultimate bearing capacity in contact ground of cutting edge

Lot	Soil	ϕ (Degree)	C (kN/m²)	$\gamma_{1,2}$ (kN/m³)	B′ (m)	Df′ (m)	Nc′	Nr′	Nq′	β′ (Degree)	kc	kr	qd (kN/m²)
①	Muddy sand	30	20.00	9.00	0.48	0.60	16.0	7.0	12.0	26	0.56	0.28	248.2
②	Muddy sand	30	20.00	9.00	0.59	0.80	16.0	7.0	12.0	26	0.56	0.28	270.8
③	Muddy sand	30	20.00	9.00	0.59	0.80	16.0	7.0	12.0	26	0.56	0.28	270.8
④	Muddy sand	30	20.00	9.00	0.59	0.80	16.0	7.0	12.0	26	0.56	0.28	270.8
⑤	Muddy sand	30	20.00	9.00	0.65	0.90	16.0	7.0	12.0	26	0.56	0.28	282.1
⑥	Tight sand	34	50.00	10.00	0.31	0.30	31.0	20.0	28.0	26	0.51	0.28	883.2
⑦	Tight sand	34	50.00	10.00	0.31	0.30	31.0	20.0	28.0	26	0.51	0.28	883.2

Resistance force of cutting edge

Lot	Soil	ϕ (Degree)	Df′ (m)	B′ (m)	qd (kN/m²)	A (m²)	Q (kN)
①	Muddy sand	30	0.60	0.48	248.2	9.1	2258.6
②	Muddy sand	30	0.80	0.59	270.8	11.0	2978.8
③	Muddy sand	30	0.80	0.59	270.8	11.0	2978.8
④	Muddy sand	30	0.80	0.59	270.8	11.0	2978.8
⑤	Muddy sand	30	0.90	0.65	282.1	11.9	3357.0
⑥	Tight sand	34	0.30	0.31	883.2	6.0	5299.2
⑦	Tight sand	34	0.30	0.31	883.2	6.0	5299.2

(5)Insertion pressure(P)

$P \geqq (U+F+Q)-Wc$

Lot	Load for sinking(kN)		Resistance force for sinking (kN)				Insertion pressure(kN)
	Depth (m)	Self weight (Wc)	Buoyancy (U)	Skin friction (F)	Resistance force on cutting edge (Q)	Total (U+F+Q)	P≧(U+F+Q) -Wc
①	2.500	830.0		1275.5	2258.6	3534.1	2704.1
②	7.900	2522.5	634.2	1908.9	2978.8	5521.9	2999.4
③	13.300	4215.0	1311.1	3125.6	2978.8	7415.5	3200.5
④	18.700	5907.5	1988.0	4925.4	2978.8	9892.2	3984.7
⑤	24.100	7600.0	2664.8	7097.3	3357.0	13119.1	5519.1
⑥	29.500	9292.5	3341.7	9269.2	5299.2	17910.1	8617.6
⑦	32.300	9725.0	3692.7	10395.4	5299.2	19387.3	9662.3

(6)Examination for sinking

Examination for sinking of building the following lot after each lot immerses

Lot	Load in building next lot(kN)		Sinking resistance(kN)	Judgement
①	2522.5	<	3534.1	OK
②	4215.0	<	5521.9	OK
③	5907.5	<	7415.5	OK
④	7600.0	<	9892.2	OK
⑤	9292.5	<	13119.1	OK
⑥	9725.0	<	17910.1	OK
⑦	※			

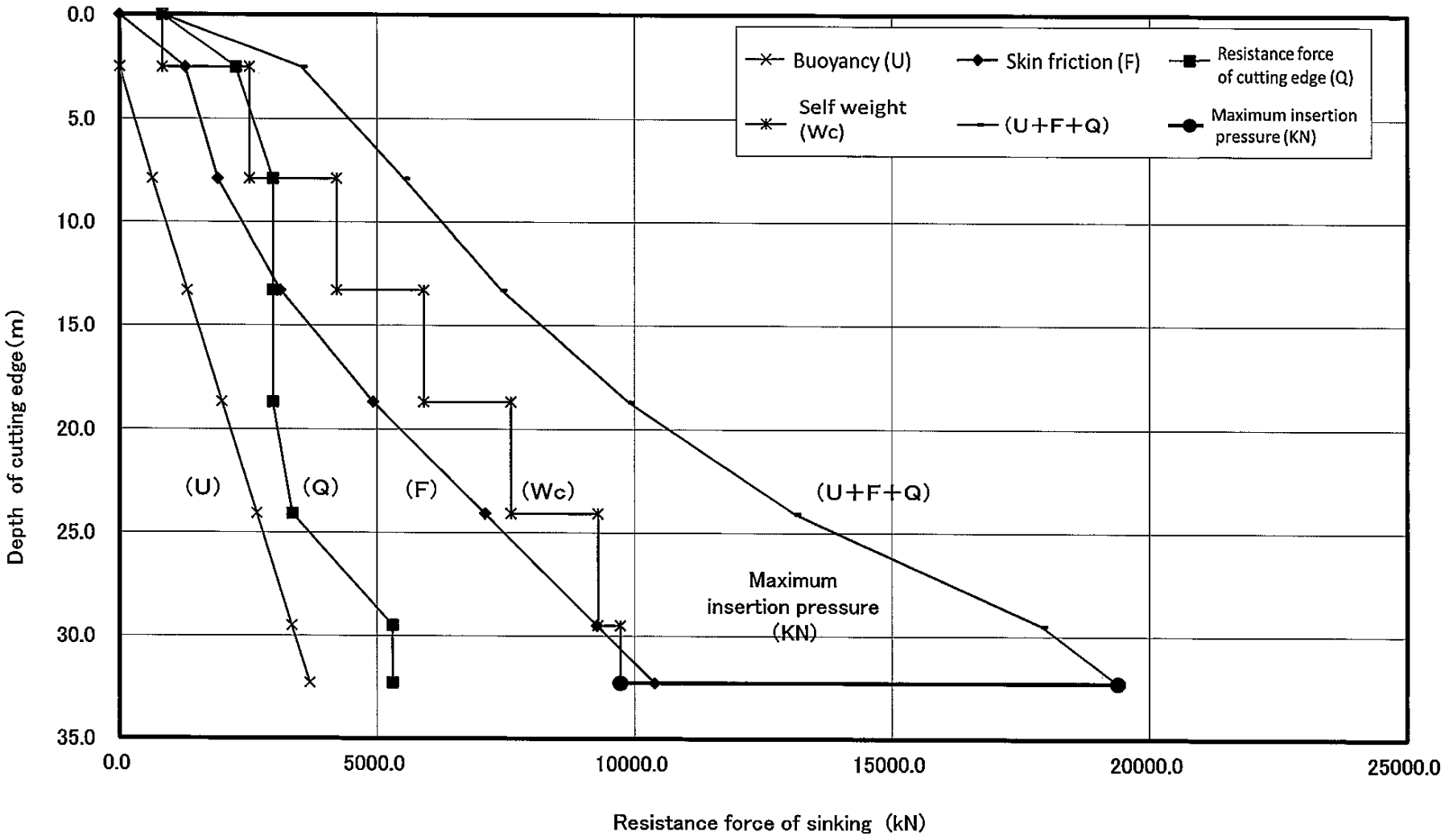
※In the last embedment of lot

In case of complete excavation of cutting edge part in the last embedment

Sinking resistance force= 3692.7(Buoyancy)+10395.4(Skin friction)+0(Resistance force of cutting edge)
= 14088.1 > 9725(Load for sinking)・・・・・OK

Therefore, there is no problem if the part of cutting edge is completely excavated.

(6) Relationship diagram of theory of settlement



2. Analysis of anchor for press fit

(1)The number of anchors and drawing force

If 4 anchors with the maximum pressure P≧9662.3 (kN) are laid and Caisson is pressed in, Drawing force (Pa) per one anshor shall be

$$Pa = \frac{9662.3}{4} = 2415.58 \fallingdotseq 2420 \text{ (kN/Number)}$$

(2)Steel wire of the anchor

JIS-G 3536

Nominal designation	Nominal cross sectional area (㎟)	Unit weight (kg/km)	Tension strength		Yield strength		Elongation %
			Tension load (kN)	Tensile stress (N/㎟)	Yield load (kN)	Yield stress (N/㎟)	
φ21.8 over 19	312.9	2,482	573	(1813)	495	(1568)	3.5

Pta = 0.65 × Tension load × 7Number ---------- Temporary anchor
= 0.65 × 573 ×7 = 2607 (kN) > Pa = 2420 (kN) ———— OK

(3)Embedment length of anchors(La)

$$La = \frac{Pa \cdot Fs}{\pi \cdot D \cdot \tau a}$$

To this, La:Embedment length (cm)
Pa:Drawing force of the anchor=2,420,000 (N)
Fs:Safety factor=1.5
D :Diameter of body of the anchor=13.5 (cm)
τa:Frictional resistance of peripheral surface of the body of anchors (N/㎠)

τa1: 14.40 (N/㎠) L1= 500 (cm)
τa2: 26.40 (N/㎠) L2= 250 (cm)
τa3: 13.20 (N/㎠) L3= 1000 (cm)
τa4: 35.00 (N/㎠) L4= 950 (cm)
τa5: 10.80 (N/㎠) L5= 600 (cm)
τa6: 35.00 (N/㎠) L6= X (cm)

※It is supposed that N value of sandy soil in the depth, (X) with 66.5m and deeper is 35 and over due to lack of information about soil boring log.

Pa・Fs ≦ π・D (L1×τa1+L2×τa2+L3×τa3+L4×τa4+L5×τa5+L6×τa6)

2,420,000×1.5 ≦ π×13.5 (500×14.40+250×26.40+1000×13.20+950×35.00+600×10.80+L6×35.00)

L6 ≒ 539(cm)

La = L1+L2+L3+L4+L5+L6

= 500+250+1000+950+600+539 = 3839(cm) ≒ 38.5(m)

9

Frictional resistance of peripheral surface of anchors

Type of ground			Frictional resistance (N/cm²)
Bedrock	Hard rock		150.0～250.0
	Soft rock		100.0～150.0
	Weathered rock		60.0～100.0
	Hard pan		60.0～120.0
Gravel	N value	10	10.0～ 20.0
		20	17.0～ 25.0
		30	25.0～ 35.0
		40	35.0～ 45.0
		50	45.0～ 70.0
Sand	N value	10	10.0～ 14.0
		20	18.0～ 22.0
		30	23.0～ 27.0
		40	29.0～ 35.0
		50	30.0～ 40.0
Cohesive soil	1.0c C= Cohesive C= (0.60～0.65) × N Value N/cm^2		

(4) Length of anchors

$L = La + Lf$

To this L: Length of anchors (m)

La: Embedment length = 38.5 (m)

Lf: Free length = 33.5 (m)

$L = 38.5 + 33.5 \fallingdotseq 72.0$ (m)

(5) Examining adhesion between steel wires of the anchor and the bodies of anchors (cement base)

$Pta = U \cdot La \cdot \tau 0$

To this, Pta: Adhesion betwen steel wires and bodies of anchor (N)

U : Perimeter of steel wire = $(6+\pi) \times 2.18$ = 19.93 (cm)

La: Embedment length ≒ 3850 (cm)

$\tau 0$: Adhesive stress between steel wires and bodies of the anchor = 100(N/cm²)

Pta = 19.93 × 3,850 × 100 = 7,673,050 (N) > Pa = 2,420,000 (N) ––– OK

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5. Calculation Sheets on Jacking Force (Route A-B)

Contents

Route A-B

Plan

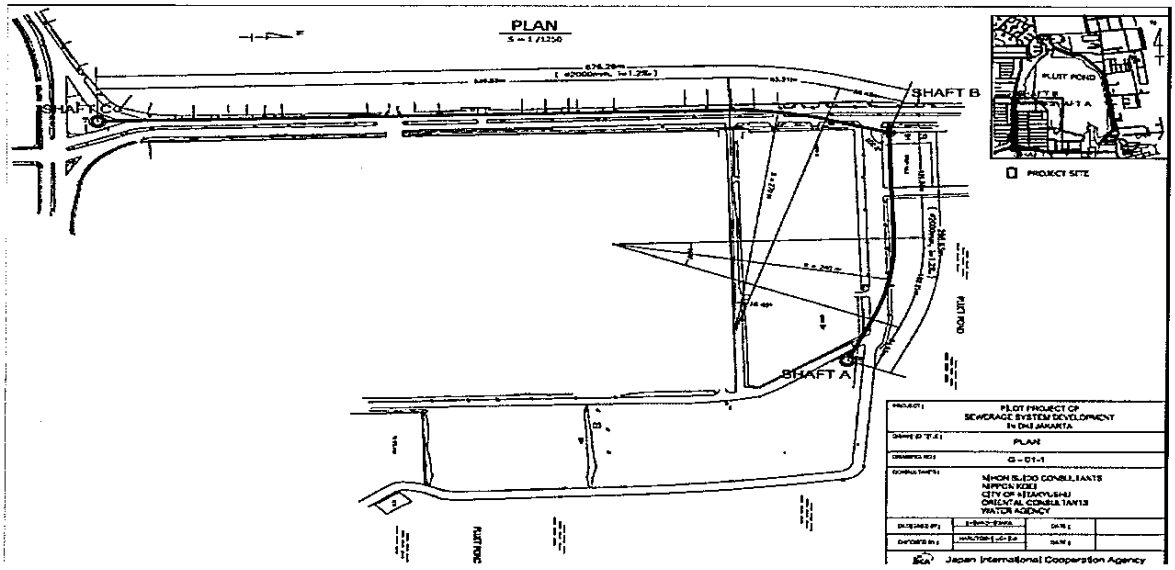
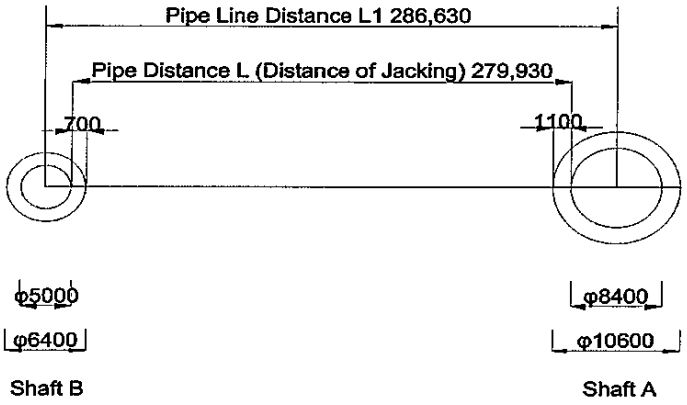


Figure Schedule of quantities (B-A)



(1) Input condition

Calculation condition

Gravitational acceleration	g	= 9.8	m/s^2		
·Specification of pipe					
Pipe diameter		D =	2.000	m	
Pipe thickness		t =	0.175	m	
Exterior diameter of pipe		Bc =	2.350	m	
Standard strength against outer pressure		P =	58.860	kN/m	(6.002 tf/m)
Weight of pipe		W =	28.730	kN/m	(2.930 tf/m)
Type of pipe			50	N/mm^2	(500 kgfpipe)
Effective diamter of pipe			2.310	m	
·Soil condition					
Unit volume weight of soil	γs	=	16.2680	KN/m^3	(1.66tf/m^3)
Internal friction angle of earth	ϕ	=	10.000	°	
Soil cohesion	C	=	17.787	kN/m^2	(1.815tf/m^2)
Adhesive force between pipe and soil	C'	=	4.900	kN/m^2	(0.5tf/m^2)
N Value	N	=	20		
Groundwater level	GL-	=	2.700	m	
Reduction coefficient of propulsion	β	=	0.350		

Table β Value in each soil

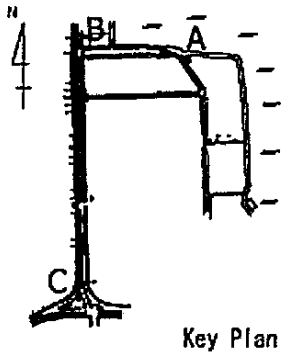
Soil	Reduction coefficient of propulsion
Cohesive soil	0.35
Sandy soil	0.45
Sandy gravel soil	0.60
Consolidated soil	0.35

Table value of adhesion C' between pipe and soil

Soil	Adhesifve force between pipe and soil	
	(kN/m^2)	(tf/m^2)
Cohesive soil	(N<10) 8.0kN/m^2	0.8tf/m^2
Consolidated soil	(N≧10) 5.0kN/m^2	0.5tf/m^2
Sandy soil	0.0kN/m^2	0.0tf/m^2

Borehole log

Measuring site map



Key Plan

Figure Borehole log A

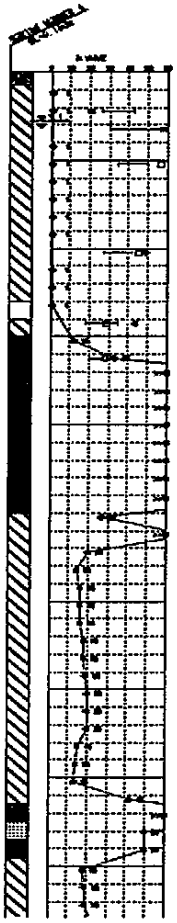
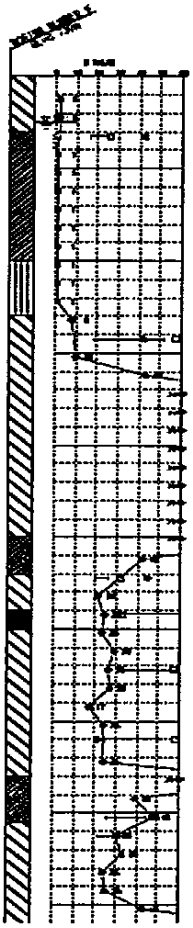


Figure Borehole log B Figure Borehole log C



·Construction condition

Earth covering	H	=	25.000	
propulsion extension	L	=	274.600	
Diamter of tunneling machine	Bs	=	2.370	
Allowance under pipe	Hb	=	0.800	(Normally0.80m)

(Head from soffit of pipe to soffit of wall of bearing pressure)

Adoption for middle pushing method is necessary.

·Condition of curved pipe jacking

Radius of curve (R1)	R1	=	240.000	m
Length of pipe jacking (l1)	l1	=	2.430	m

Distance of interval from departure to BC1	L 1	=	64.800	m
Distance of interval from BC 1 to EC 1	L 2	=	86.000	m
Distance of interval from EC 1 to arraival	L 3	=	123.800	m

(2) Calculation for propulsion ϕ2000 × L = 274.600 m

1)Propulsion by pipe jacking method of reverse circulation type is calculated from the following formula.

$F = Fo + fo \times L$

To the above formula

F	: Total propulsion	(kN)
Fo	: Resistance force of head	(kN)
fo	: Resistance force of jacking pipe	(kN/m)
L	: propulsion extension	(m)

$$Fo = (Pw+Pe) \times \pi \times \left(\frac{Bs}{2}\right)^2$$

Pw : Pressure inside chamber (kN/m2)

$$Pw = \gamma w \times \left(h' + \frac{Bs}{2} \right) + 20$$

γw : Unit volume weight of water (KN/m^3)

h' : Groundwater level (m)

$$h' = H - (GL-) - \left(\frac{Bs}{2} - \frac{Bc}{2} \right)$$

Pe : Cuting resistance (kN/m^2)

Pe = N Value × 10 (However, $150kN/m^2 \leqq Pe \leqq 500kN/m^2$)

Bs : Exterior diamter of excavator (m)

$$fo = \beta \{ (\pi \times Bc \times q + W) \times \mu' + \pi \times Bc \times C' \}$$

β	: Reduction coefficient of propulsion	
Bc	: Exterior diamter of pipe	(m)
q	: Uniform load applied to pipe	(kN/m^2)
W	: Unit weight of pipe	(kN/m)
μ'	: friction coefficient	(tan (ϕ/2))
C'	: Adhesifve force between pipe and soil	(kN/m^2)

①Design condition

Gravitational acceg = 9.8 m/s2

·Specification for pipe

Pipe diameter	D	=	2.000	m		
Pipe thickness	t	=	0.175	m		
Exterior diamter of pipe	Bc	=	2.350	m		
Standard external pressure strength	P	=	58.860	kN/m	(	6.002 tf/m2)
Pipe weight	W	=	28.730	kN/m	(	2.930 tf/m)
Pipe type			50	N/mm^2	(	500 kgf pipe)

·Soil condition

Unit volume weight of soil	γ s	=	16.268	kN/m^3	(	1.66 tf/m3)
Internal frictional angle of soil	ϕ	=	10.0	°		
Cohesion of soil	C	=	17.787	kN/m^2	(	1.815 tf/m2)
Adhesifve force between pipe and soil	C'	=	3.000	kN/m^2	(	0.306 tf/m2)
N value	N	=	20			
Groundwater level	GL-	=	2.700	m		
Reduction coefficient of propulsion	β	=	0.350			

Table β value in each soil

Soil	Reduction coefficient of propulsion
Cohesive soil	0.35
Sandy soil	0.45
Sandy gravel soil	0.60
Consolidated soil	0.35

·Construction condition

Earth covering	H	=	25.000	m
propulsion extension	L	=	274.600	m
Diamter of tunneling machine	Bs	=	2.370	m

2) Uniform load applied to pipe

Uniform load applied to pipe (q) is total of the following 2 types of load.

$q = w + p$

To the above formula

q	: Uniform load	(kN/m^2)
w	: Vertical uniform distribution load of soil	(kN/m^2)
p	: Live load	(kN/m^2)

・Vertical uniform distribution load of earth pressure (w)

Calculation by Terzaghi's theory

$$w = (\gamma s - \frac{2 \times C}{Be}) \times Ce$$

Ce : Coefficient of earth load of Terzaghi

$$Ce = \frac{Be}{2 \times K \times \mu} \left(1 - e^{-\frac{2 \times K \times \mu}{Be} H}\right)$$

$$= \frac{5.254}{0.353} \left(1 - e^{-\frac{0.353}{5.254} 25.000}\right)$$

$$= 12.116$$

Be : Width of soil loosness (m)

$$Be = Bt \times \frac{1 + \sin(45 - \phi/2)}{\cos(45 - \phi/2)}$$

$$= 2.450 \times \frac{1 + \sin(45 - 10/2)}{\cos(45 - 10/2)}$$

$$= 5.254$$

Bt : Inner diameter of tunnel (m)

$$Bt = Bc + 0.1$$

$$= 2.35 + 0.1$$

$$= 2.450$$

To the above formula

γs	: Unit volume weith of soil		γs	=	KN/m^3
C	: Cohesion of soil		C	=	kN/m^2
Bc	: Exterior diamter of pipe		Bc	=	m
K	: Coefficient of lateral earth pressure of Terzaghi		K	=	
ϕ	: Internal frictional angle of soil		ϕ	=	°
μ	: Coefficient of friction of soil	$(=\tan\phi)$	μ	=	
H	: Earth covering		H	=	m

Therefore

$$w = (16.268 - \frac{2 \times 17.787}{5.254}) \times 12.116$$

$= 115.072$ (kN/m2) (11.742 tf/m2)

・Live load

As for live load (p), load of rear wheel of T-25 stated in specification of road bridge and the interpretation is used. Generally, influence of front wheel is neglected.

$$p = \frac{2 \times Pt \times (1 + i) \times \beta'}{c\ (a + 2H \times \tan 45°)}$$

To the above formula

p	: Live load				
Pt	: Load of 1 rear wheel	=	100	kN	(10.204 tf)
a	: Ground contact length of wheels	=	0.200	m	
c	: Occupied width of car body	=	2.750	m	
i	: Impact coefficient	=	0.000		
β'	: Reduction coefficient	=	0.900		
H	: Earth covering	=	25.000	m	

Table1 Impact coefficient

H (m)	H≦1.5	1.5<H<6.5	H≧6.5
i	0.500	0.65-0.1H	0.000

$$p = \frac{2 \times 100 \times (1 + 0.000) \times 0.900}{2.75\ (0.200 + 50.000 \times 1.000)}$$

$= 1.304$ (kN/m2) (0.133 tf/m2)

From above resultsk, Uniform load applied to pipe (q) is the following

$q = w + p$

$= 115.072 + 1.304$

$= 116.375$ (kN/m2) (11.875 tf/m2)

3) Calculation for propulsion

①Propulsion in case of considering only straight line

・**Propulsion resistance per 1.0m**

$f_o = \beta \{(\pi \times Bc \times q + W) \times \mu' + \pi \times Bc \times C'\}$

To the above formula

β	: Reduction coefficient of propulsion		β =	0.350
Bc	: Exterior diamter of pipe	(m)		
q	: Uniform load applied to pipe	(kN/m^2)		
W	: Unit weight of pipe	(kN/m)		
μ'	: Friction coefficient	(=tan (ϕ/2))	μ' =	0.087
C'	: Adhesifve force between pipe and soil	(kN/m^2)		

f_o= 0.350 {(π × 2.350 × 116.375 + 28.730) × 0.087
+ π × 2.350 × 4.900 }
= 39.850 (kN/m)

・**Resistance force of head**

$F_o = (Pw+Pe) \times \pi \times \left(\frac{Bs}{2}\right)^2$

Pw : Pressure inside chamber (kN/m^2)

$Pw = \gamma w \times \left(h' + \frac{Bs}{2}\right) + 20$

γw : Unit volume weight of water 9.800 (KN/m^3) (1.0tf/m^3)

h' : Groundwater level 22.290 (m)

$h' = H - (GL-) - \left(\frac{Bs}{2} - \frac{Bc}{2}\right)$

$= 25.000 - 2.700 - \left(\frac{2.370}{2} - \frac{2.350}{2}\right)$

= 22.290 (m)

Pw=9.8× (22.290+1.185) +20

= 250.055 (kN/m^2)

Pe : Cuting resistance (kN/m^2)

Pe= 200.000 (kN/m^2)

Bs : Exterior diameter excavator 2.370 (m)

F_o = (250.055+200.000) ×π×1.404

= 1985.419 (kN)

・**Total propulsion**

$F = F0 + f0 \times L$

L : propulsion extension

F = 1985.419 + 39.850 × 274.600

= 12928.175 (kN) (1319.202 tf)

②Calculation for propulsion considering curve interval

pipe diamter	D	=	2.000	mm		
pipe thickness	t	=	0.175	mm		
The number of interval of curve line			1	Interval		
Head resistance	Fo	=	1985.419	kN	(202.594	tf)
Propulsion resistance per m	fo	=	39.850	kN/m	(4.066	tf/m)
Internal frictional angle of soil	ϕ	=	10.0	°		

Form of curved jacking

Radius of curve	R 1	=	240.000
Length of jacking pipe	l 1	=	2.430
Distance of interval from departure to BC1	L 1	=	64.800
Distance of interval from BC1 to EC1	L 2	=	86.000
Distance of interval of from EC1 to arrival	L 3	=	123.800

Calculation for propulsion resistance of curved line is generally from the following formula.

$$Fn = Kn \times Fo + f' \times \frac{Kn+1-K}{K-1}$$

Fn : Propulsion resistance in B.C. point

n : Number of pipe within curved line interval ≒ CL/l

CL : Curved line length (m)

l : Length of a jucking pipe (m)

≒ 86.000 / 2.430

≒ 35.4 (Number)

K : Coefficient of propulsion resistance of curved line $= \dfrac{1}{\cos\alpha - k \times \sin\alpha}$

α : Bend angle of pipe

$\alpha = 2\sin^{-1}\dfrac{\frac{1}{2(R-Bc/2)} \fallingdotseq \frac{IA}{n}}{}$

IA : Angle of intersection

$= 2\sin^{-1}\dfrac{2.430}{2(240.000 - 2.350/2)}$

$= 2\sin^{-1}\ 0.00509$

$= 0.583$ (RAD) (0.582976425°)

$K = \dfrac{1}{0.99995 - 0.5 \times 0.00977}$

$= 1.005$

k : Resistivity of shear between pipe and natural ground = 0.5

Fo : Propulsion resistance in E. C point

f' : Propulsion resistance per a jacking pipe

Calculation for propulsion of curved line interval

·Thrust of interval between arrival to E.C.1

F1 = F0 + L3 × fo

fo : 39.850 kN/m (1Propulsion resistance per m)

Fo : 1985.419 kN (Head resistance)

= 1985.419 + 123.800 × 39.850

= 6918.825 (kN) (706.003 tf)

·Thrust of interval from arrival to B.C.1

$F2 = Kn \times F1 + f' \times \dfrac{K^{n+1} - K}{K-1}$

K : 1.005

n : 35.4 Number (The number of jucking pipes from B.C.1 to E.C.1)

f' : 96.835 kN/number (Frictional resistance force per a jacking pipe)

$= 1.005^{35.3909} \times 6918.825 + 96.835 \times \dfrac{1.00496^{35.4} - 1.00496}{1.00496 - 1}$

= 11880.462 (kN) (1212.292 tf)

·Thrust within interval between arrival to departure (Total thrust)

F3 = F2 + L1 × fo

fo : 39.850 kN/m (1Propulsion resistance per m)

F2 : 11880.46 kN

= 11880.462 + 64.800 × 39.850

= 14462.729 (kN) (1475.789 tf)

4) Calculation for loading capacity of pipe

·Vertical loading capacity of pipe

Vertical loading capacity of pipe (qr) is expressed by the following formula.

$qr = \dfrac{1}{0.275 \times r^2} \times Mr$

To the above formula

qr : Vertical loading capacity (kN/m)

Mr : Resisting moment of pipe calculated from external pressure intensity (kN·m/m)

r : Radius of center of pipe thickness = 1.088 (m)

Mr = 0.318 × P × r + 0.239 × 28.730 × 1.088

P : External pressure intensity (from cracking load) = 58.860 (kN/m)

W : Pipe weight = 28.730 (kN/m)

Mr = 0.318 ×58.860 × 1.088 + 0.239 × 28.730 ×1.088

= 27.823 (kN·m/m) (2.839 tf·m/m)

$qr = \dfrac{1}{0.275 \times 1.088^2} \times 27.823$

= 85.547 (kN/m^2)

Moment (M) arising from pipe due to uniform load is the following considering free shoes with 120° .

$M = 0.275 \times q \times r^2$

M : Bending moment arising from pipe due to vertical uniform load (kN·m)

q : Uniform load (kN/m²)

$M = 0.275 \times 116.375 \times 1.088^2$

$= 37.849$ (kN·m/m) (3.862 tf·m/m)

Safety factor (f) of cracking arising from uniform load is calculated from ratio between resisting moment of pipe (Mr) and moment arising from pipe or ratio between loading capacity of pipe (qr) and uniform load (q).

$f = \frac{Mr}{M}$ or $f = \frac{qr}{q}$

$= \frac{27.823}{37.849}$ $= \frac{85.547}{116.375}$

$= 0.735 < 1.200$ $= 0.735 < 1.200$

Therfore, pipe is not safety. Therfore, type 2 pipe is required.

External (bending) strength of Type 2 pipe : 118 kN/m

Therefore,

$Mr = 0.318 \times 118.000 \times 1.088 + 0.239 \times 28.730 \times 1.088$

$= 48.300$ (kN·m/m) (15.140 tf·m/m)

$qr = \frac{1}{0.275 \times 1.088^2} \times 48.300$

$= 148.374$ (kN/m²)

$f = \frac{Mr}{M}$ or $f = \frac{qr}{q}$

$= \frac{48.300}{37.849}$ $= \frac{148.374}{116.375}$

$= 1.276 > 1.200$ $= 1.274 > 1.200$

The above calculation was made based on ϕ=10 and C=17.787 kN/m2.

Also in order to confirm stability, calculate as a clay of ϕ=0 and C=35.28 kN/m2, which is a practical condition.

$q = (\gamma - c/Be) \times H + p$

$= (16.628 - 35.28/2.957) \times 25.0 + 1.304$

$= 118.729$ (kN/m²)

$f = \frac{qr}{q}$

$= \frac{148.374}{118.729}$

$= 1.250 > 1.200$

・Loading capacity of pipe in the direction of propulsion

Allowable loading capacity of pipe (Fr) is expressed by the following formul

$Fr = 10^3 \times \sigma ma \times A$

To the above formula

Fr : Allowable proof stress of pipe

σma : Allowable average compressive stress of concrete (=13N/mm2)

A : Effective sectional area of pipe (m²)

$A = \frac{1}{4} \times \pi \times (Bg^2 - D^2)$

Bg : Effective diameter = 2.310 (m)

D : Inner diameter of pipe = 2.000 (m)

$A = \frac{1}{4} \times \pi \times (2.31^2 - 2^2)$

$= 1.049$ (m²)

$Fr = 1000 \times 13.000 \times 1.049$

$= 13641.816$ (kN) (1392.022 tf)

5) Calculatoin for reaction force of bearing pressure

Reaction force (R) is expressed by formula of passive earth pressure of Rankine.

$$R = \alpha \times B \left(\gamma s \times Ho^2 \times \frac{Kp}{2} + 2 \times C \times Ho \times Kp + \gamma s \times Ho \times h \times Kp \right)$$

To the above formula

R	:Reaction force			(KN)
B	:Width of bearing force	=	4.800	m
γs	:Unit volume weith of soil	=	16.268	KN/m^3
ϕ	:Internal frictional angle of soil	=	10.0	°
C	:Cohesion of soil	=	17.787	
α	:Coefficient (1.5～2.5)	=	2.000	
Ho	:Height of wall of bearing pressure	=	3.500	m
Kp	:Coefficient of passive earth pressure	=	$\tan^2(45° + \phi/2)$	
		=	$\tan^2(45° + 10/2)$	
		=	1.420	
h	:Covering of bearing pressure	=	Ha-Ho	
		=	28.150 − 3.500	
		=	24.650 m	
Ha	:Depth of wall of bearing pressure	=	H+Bc+Hb	
		=	25.000 + 2.350 + 0.800	
		=	28.150	
B	:Exterior diamter of pipe	=	2.35 m	
H	:Allowance under pipe	=	0.800 m	

(Head drop from soffit of pipe to soffit of wall of bearing pressure)

$$R = 2.0 \times 4.8 \left(16.268 \times 3.500^{2} \times \frac{1.420}{2} \right.$$

$$\left. + 2 \times 18 \times 3.5 \times 1.42 + 16.268 \times 3.500 \times 24.650 \times 1.420 \right.$$

$$= 21919.599 \text{ (kN)} \quad (2236.694 \text{ tf})$$

6) Maximum allowable Jacking Force

According to the above results of calculation

Total propulsion	F3	=	14462.729	(kN)	1475.789 (tf)
Loading capacity of pipe	Fr	=	13641.816	(kN)	1392.022 (tf)
Reaction force of bearing pressure	R	=	21919.599	(kN)	2236.694 (tf)
Effective propulsion of back pushing jack	Fme	=	15680.000	(kN)	1600.000 (tf)

$F3 > Fr$

Therefore,

Adoption of middle pushing method is necessary.

7) The number of intermediate Jacking Station

Possible propulsion by back pushing method is determined by $Fr = 13641.8$ (KN) (1392.02 tf)

Therefore,

$$Fm = F - Fr$$
$$= 14462.729 - 13641.816$$
$$= 820.913 \text{ (kN)} \quad (83.767 \text{ tf})$$

As for above, middle pushing method is used to deal with.

In case of D=2000mm, the number of installation of hydraulic jack enabled to install into one location of middle pushing is,

490 (kN) × 18 (Number) = 8820.000 (kN) (900 tf)

is the limit.

Possible propulsion in one location of mniddle pushing is

$$Fj = \frac{490.000 \text{ (kN)} \times 18 \text{ (Number)}}{1}$$
$$= 8820.000 \text{ (kN)} \quad (900 \text{ tf})$$

Therefore, the number of intallation of middle pushing (n) is

$$n = \frac{Fm}{Fj}$$
$$= \frac{820.913}{8820.000}$$
$$= 0.093$$

Therefore, one location is necessary.

6. Calculation Sheets on Jacking Force (Route B-C)

Contents

Route B-C

Plan

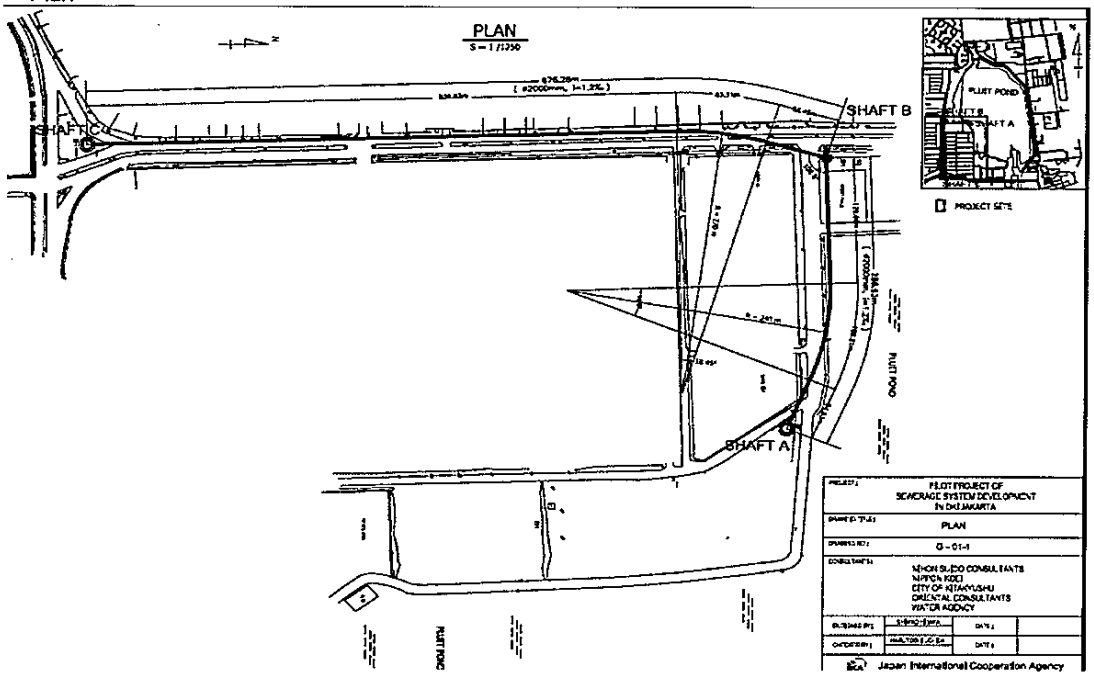
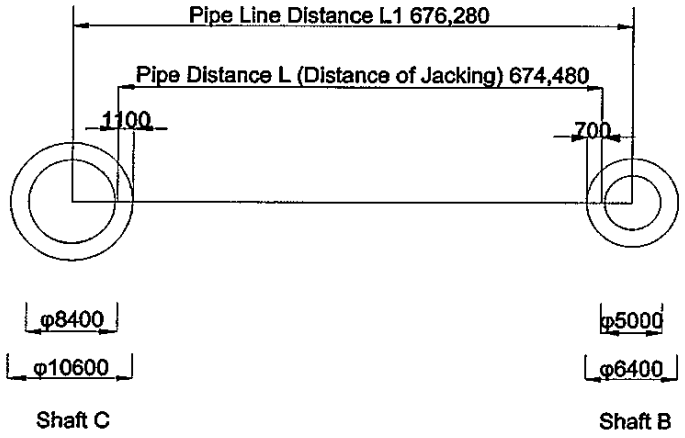


Figure Schedule of quantities (B-C)



(1) Input condition

Calculation condition

Gravitational acceleration g = 9.8 m/s^2

·Specification for pipe

Pipe diameter	D	=	2.000	m
Pipe thickness	t	=	0.175	m
Exterior diamter of pipe	Bc	=	2.350	m
Standard external pressure strength	P	=	58.9 kN/m (	6.002 tf/m)
			118 kN/m (	12.033 tf/m)
Pipe weight	W	=	28.730 kN/m (	2.930 tf/m)

Pipe type 50 N/mm^2 (500 kgf pipe)

Effective diameter of pipe 2.310 m

·Soil condition

Unit volume weith of soil γs = 16.268 KN/r.(tf/m^3)

Internal frictional angle of soil	ϕ =	10.0	°
Cohesion of soil	C =	17.787	kN/r(tf/m^2)
Cohesive between pipe and soil	C' =	4.900	kN/r(tf/m^2)
N value	N =	20	
Groundwater level	GL- =	2.700	m
Reduction coefficient of Propulsion	β =	0.350	

Table β value in each soil

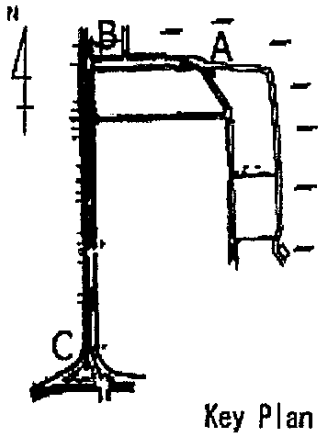
Soil	Reduction coefficient of Propulsion
Cohesive soil	0.35
Sandy soil	0.45
Sandy gravel soil	0.60
Consolidated soil	0.35

Table the value of adhesive between pipe and soil C'

Soil	Adhesive force between pipe and soil	
	(kN/m^2)	(t f/m^2)
Cohesive soil	(N<10) 8.0kN/m^2	0.8 t f/m^2
Consolidated soil	(N≧10) 5.0kN/m^2	0.5 t f/m^2
Sandy soil	0.0kN/m^2	0.0 t f/m^2

Borehole log

Measuring site map



Key Plan

Figure Borehole log B

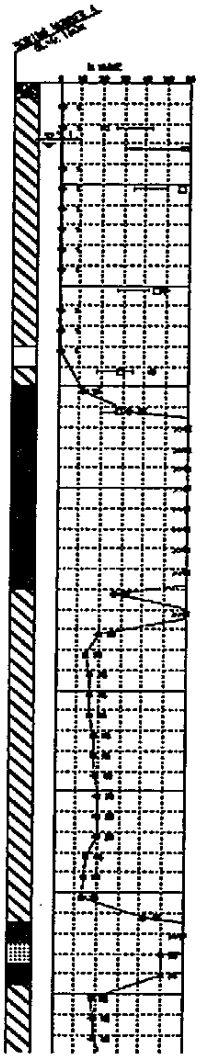
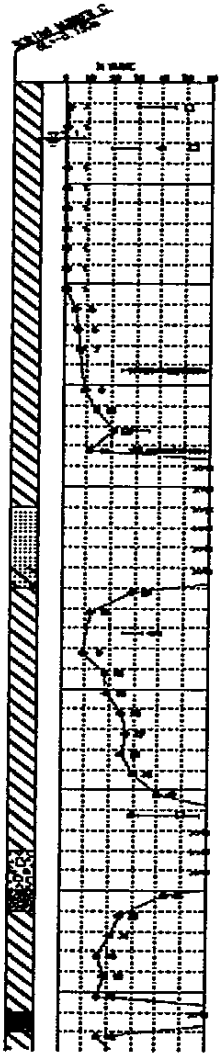


Figure Borehole log C



·Construction condition

Earth covering	H	=	25.000	m
Extension of propulsion	L	=	669.600	m
External diameter of tunneling machine	Bs	=	2.370	m
Allowance under pipe	Hb	=	0.800	m (Generally 0.80m)

(Head drop from soffit of pipe to soffit of wall of bearing pressure)

Adoption of middle pushing method is necessary

·Condition of propulsion of curved line

Radius of curve	R 1 =	270.000	m
Length of jacking pipe (l 1)	l 1 =	2.430	m
Distance of interval from departure to BC1	L 1 =	532.400	m
Distance of interval from BC1 to EC1	L 2 =	83.300	m
Distance of interval of from EC1 to arrival	L 3 =	53.900	m

(2) Calculation for propulsioıφ 2000 × L = 669.6 m

1) Propulsion by jacking method; muddy water system is calculated by the following formula.

$F = Fo + fo \times L$

To the above formula

F	:Total propulsion	(kN)
Fo	:Resistance force of head	(kN)
fo	:Resistance force of jacking pipe	(kN/m)
L	:Extension of propulsion	(m)

$$Fo = (Pw + Pe) \times \pi \times \left(\frac{Bs}{2}\right)^2$$

P : Pressure inside chamber (kN/m2)

$$Pw = \gamma w \times \left(h' + \frac{Bs}{2}\right) + 20$$

γw : Unit volume weight of water (KN/m3)

h' : Groundwater level (m)

$$h' = H - (GL-) - \left(\frac{Bs}{2} - \frac{Bc}{2}\right)$$

P : Cutting resistance (kN/m2)

Pe =N value × (However, 150kN/m2≦P e≦500kN/m2)

B : Exterior diamter of excavator (m)

$$fo = \beta \{\pi \times Bc \times q + W) \times \mu' + \pi \times Bc \times C'\}$$

β	:Reduction coefficient of Propulsion	
Bc	:Exterior diamter of pipe	(m)
q	:Uniform load applied to pipe	(kN/m2)
W	:Unit weight of pipe	(kN/m)
μ'	:friction coefficient	(tan (ϕ/2))
C'	:Adheisve force between pipe and soil	(kN/m2)

①Design condition

Gravitational acceleration g =10 m/s^2

·Specification for pipe

Pipe diameter	D	=	2.000	m	
Pipe thickness	t	=	0.175	m	
Exterior diamter of pipe	Bc	=	2.35	m	
Standard external pressure strength	P	=	58.86	kN/m	(6.002 tf/m^2)
Pipe weight	W	=	28.73	kN/m	(2.930 tf/m)
Pipe type			50	N/mm2	(500 kgf pipe)

·Soil condition

Unit volume weith of soil	γs =	16.268 kN/m3	(	1.66	tf/m3)
Internal frictional angle of soil	ϕ =	10 °			
Cohesion of soil	C =	17.787 kN/m2	(	1.815	tf/m2)
Adheisve force between pipe and soil	C' =	3 kN/m2	(	0.306	tf/m2)
N value	N =	20			
Groundwater level	GL- =	2.7 m			
Reduction coefficient of Propulsion	β =	0.35			

Table β value in each soil

Soil	Reduction coefficient of Propulsion
Cohesive soil	0.35
Sandy soil	0.45
Sandy gravel soil	0.6
Consolidated soil	0.35

·Construction condition

Earth covering	H	=	25 m
Extension of propulsion	L	=	669.6 m
External diameter of tunneling machine	B s	=	2.37 m

2) Uniform load applied to pipe

Uniform load applied to pipe (q) is sum of the following 2 types of loads.

$$q = w + p$$

To the above formula

q : Uniform load applied to pipe (kN/m2)
w : Vertical uniform distribution load of soil (kN/m2)
p : Live load (kN/m2)

· Vertical uniform distribution load of earth pressure (w)

Calculation by Terzaghi's theory

$$w = \left(\gamma s - \frac{2 \times C}{Be} \right) \times Ce$$

Ce : Coefficient of earth load of Terzaghi

$$Ce = \frac{Be}{2 \times K \times \mu} 1 - e^{- \frac{2 \times K \times \mu}{Be} H}$$

$$= \frac{5.254}{0.353} 1 - e^{- \frac{0.353}{5.254} 25.000}$$

$$= 12.116$$

Be : Width of soil loosness (m)

$$Be = Bt \times \frac{+ \sin (45 - \phi/2)}{\cos (45 - \phi/2)}$$

$$= 2.450 \times \frac{1 + \sin (45 - 10 / 2)}{\cos (45 - 10 / 2)}$$

$$= 5.254$$

Bt : Inner diameter of tunnel (m)

$$Bt = Bc + 0.1$$

$$= 2.35 + 0.1$$

$$= 2.450$$

To the above formula

γs	: Unit volume weith of soil	γs =	16.268	KN/m^3
C	: Cohesion of soil	C =	17.787	kN/m^2
Bc	: Exterior diamter of pipe	Bc =	2.350	m
K	: Coefficient of lateral earth pressure of Terzaghi	K =	1.000	
ϕ	: Internal frictional angle of soil	ϕ =	10.0	°
μ	: Coefficient of friction of soil (=tanϕ)	μ =	0.176	
H	: Earth covering	H =	25.000	m

Therefore

$$w = (16.268 - \frac{2 \times 17.79}{5.254}) \times 12.116$$

$= 115.072$ (kN/m^2) (11.742 tf/m^2)

・Live load (p)

As for live load (p), load of rear wheel of T-25 stated in specification of road bridge and the interpretation is used. Generally, influence of front wheel is neglected.

$$p = \frac{2 \times Pt \times (1+i) \times \beta'}{c\ (a + 2H \times \tan 45°)}$$

To the above formula

p: Live load			
Pt Load of 1 rear wheel	=	100	kN (10.204 tf)
a: Ground contact length of wheels	=	0.200	m
c: Occupied width of car body	=	2.750	m
i: Impact coefficient	=	0.000	
β' Reduction coeffieicnt	=	0.900	
H: Earth covering	=	25.000	m

Table 1 Impact coefficient

H (m)	H≦1.5	1.5<H<6.5	H≧6.5
i	0.500	0.65-0.1H	0.000

$$p = \frac{2 \times 100 \times (0.000) \times 0.900}{2.750\ (0.200 + 50.000 \times 1.000)}$$

$= 1.304$ (kN/m^2 (0.133 tf/m^2)

From above results, uniform load applied to pipe (q) is the following

$q = w + p$

$= 115.072 + 1.304$

$= 116.375$ (kN/m^2) (11.875 tf/m^2)

3) Calculation of Jacking Force

①Propulsion in case of considering only straight line

・Propulsion resistance per 1.0m

$fo = \beta \{\pi \times Bc \times q + W) \times \mu' + \pi \times Bc \times C'\}$

To the above formula

β	:Reduction coefficient of Propulsion		β = 0.35
Bc	:Exterior diamter of pipe	(m)	
q	:Uniform load applied to pipe	(kN/m2)	
W	:Unit weight of pipe	(kN/m)	
μ'	:Friction coefficient	(= tan (ϕ/2))	μ = 0.087
C'	:Adheisve force between pipe and soil	(kN/m2)	

$fo = 0.35 \{(\pi \times 2.35 \times 116.37539 + 28.73) \times 0.1$

$+ \pi \times 2.35 \times 4.9 \}$

$= 39.850$ (kN/m)

・Resistance force of head

$Fo = (Pw + Pe) \times \pi \times (\frac{Bs}{2})^2$

Pw :Pressure inside chamber (kN/m^2)

$Pw = \gamma w \times (h' + \frac{Bs}{2}) + 20$

γw : Unit volume weight of water 9.800 (K (1.0tf/m^3)

h' : Groundwater level 22.290 (m)

$h' = H - (GL-) - (\frac{Bs}{2} - \frac{Bc}{2})$

$= 25.000 - 2.700 - (\frac{2.370}{2} - \frac{2.350}{2})$

$= 22.290$ (m)

$Pw = 9.800 \times (22.290 + 1.185) + 20$

$= 250.055$ (kN/m^2)

Pe :Cutting resistance (kN/m^2)

$Pe = 200.000$ (kN/m^2)

Bs :Exterior diamter of excavator 2.370 (m)

$Fo = (250.055 + 200.000) \times \pi \times 1.404$

$= 1985.419$ (kN)

・Total propulsion

$F = Fo + fo \times L$

L : Extension of propulsion

$F = 1985.419 + 39.850 \times 669.6$

$= 28668.848$ (kN) (2925.4 tf)

②Calculation for propulsion considering curve interval

pipe diamter	D	=	2 mm	
pipe thickness	t	=	0.175 mm	
The number of interval of curve line			1 Interval	
Head resistance	Fo	=	1985.419 kN(202.6	tf)
Propulsion resistance per m	fo	=	39.850 kN(4.066	tf/m)
Internal frictional angle of soil	ϕ	=	10 °	

Form of curved jacking

Radius of curve	R 1	= 270 m
Length of jacking pipe	l 1	= 2.43 m
Distance of interval from departure to BC1	L 1	= 532.4 m
Distance of interval from BC1 to EC1	L 2	= 83.3 m
Distance of interval of from EC1 to arrival	L 3	= 53.9 m

Calculation for propulsion resistance of curved line is generally from the following formula.

$$Fn = K^n \times Fo + f' \times \frac{K^{n+1} - K}{K-1}$$

Fn : Propulsion resistance in B.C. point
n : Number of pipe within curved line interval $\fallingdotseq CL/l$
CL : Curved line length (m)
l : Length of a jucking pipe (m)

$\fallingdotseq$ 83.3 / 2.43
$\fallingdotseq$ 34.3 (Number)

K : Coefficient of propulsion resistance of curved line $= \frac{1}{\cos\alpha - k \times \sin\alpha}$

α : Bend angle of pipe

$$\alpha = 2\sin^{-1}\frac{l}{2(R-Bc/2)} \fallingdotseq \frac{IA}{n}$$

IA : Angle of intersection

$$= 2\sin^{-1}\frac{2.430}{2(\quad 270 \quad - \quad 2.350 \quad /2)}$$

$$= 2\sin^{-1}\ 0.00452$$

$$= 0.009039 \quad (RAD) \qquad (\ 0.517918\ ^\circ\ )$$

$$K = \frac{1}{0.99996 - 1 \times 0.009}$$

$$= 1.004581371$$

k : Resistivity of shear between pipe and natural ground = 0.5
Fo : Propulsion resistance in E. C point
f' : Propulsion resistance per a jacking pipe

Calculation for propulsion of curved line interval

·Thrust of interval between arrival to E.C.1

$F1 = F + L \times fo$

fo : 39.850 k (1 Propulsion resistance per m)
Fo : 1985.419 k (Head resistance)

$= 1985.42 + 54 \times 39.850$
$= 4133.3$ (kN) (421.8 tf)

·Thrust of interval from arrival to B.C.1

$$F2 = K^n \times F1 + f' \times \frac{K^{n+1} - K}{K-1}$$

K : 1.004581371
n : 34.27983539 Number (The number of jucking pipes from B.C.1 to E.C.1)
f' : 96.83502566 kN/Number (Frictional resistance force per a jacking pipe)

$$= 1.00458^{34.3} \times 4133.32 + 97 \times \frac{1.00458 - 1.004581371}{1.004581371 - 1}$$

$= 8323.1$ (kN) (849.3 tf)

·Thrust within interval between arrival to departure (Total thrust)

$F3 = F + L \times fo$

fo: 39.8498 kN/m (1 Propulsion resistance per m)
F2: 8323.1 kN

$= 8323.1 + 532.4 \times 39.8$
$= 29539.2$ (kN) (3014.2 tf)

4) Calculation for loading capacity of pipe

·Vertical loading capacity of pipe

Vertical loading capacity of pipe (qr) is expressed by the following formula.

$$qr = \frac{1}{0.275 \times r^2} \times Mr$$

To the above formula

qr : Vertical loading capacity (kN/m)

Mr : Resisting moment of pipe calculated from external pressure intensity (kN·m/m)

r : Radius of center of pipe thickness (m) = 1.0875 (m)

$M = 0.318 \times P \times r + 0.239 \times W \times r$

P : External pressure intensity (from cracking load) = 58.9 (kN/m)

W : Pipe weight = 28.7 (kN/m)

$M = 0.318 \times 58.860 \times 1 + 0.239 \times 28.73 \times 1.0875$

$= 27.8$ (kN·m/m) (2.839 tf·m/m)

$$qr = \frac{1}{0.275 \times 1.0875} \times 27.823$$

$= 85.547$ (kN/m2)

Moment (M) arising from pipe due to uniform load is the following considering free shoes with 120° .

$M = 0.275 \times q \times r^2$

M : Bending moment arising from pipe due to vertical uniform load (kN·m)

q : Uniform load (kN/m^2)

$M = 0.275 \times 116 \times 1^2$

$= 37.85$ (kN·m/m) (3.862 tf·m/m)

Safety factor (f) of cracking arising from uniform load is calculated from the ratio between resistance moment of pipe (Mr) and moment arising from pipe or ratio between loading capacity of pipe (qr) and uniformn load (q),

$$f = \frac{Mr}{M} = \frac{27.823}{37.849} = 0.7351 < 1.2$$

or

$$f = \frac{qr}{q} = \frac{85.547}{116.3753891} = 0.7351 < 1.2$$

Therfore, pipe is not safety.

Therfore, type 2 pipe is required.

External (bending) strength of Type 2 pipe : 118 kN/m

Therefore,

$Mr = 0.318 \times 118.000 \times 1.088 + 0.239 \times 28.730 \times 1.088$

$= 48.300$ (k (## tf·m/m)

$$qr = \frac{1}{0.275 \times 1.088^2} \times ##$$

$= 148.374$ (kN/m^2

$$f = \frac{Mr}{M} = \frac{48.300}{37.849} = 1.276 > 1.200$$

or

$$f = \frac{qr}{q} = \frac{148.374}{116.375} = ##### > #####$$

The above calculation was made based on $\phi = 10$ and C=17.787 kN/m2.

Also in order to confirm stability, calculate as a clay of $\phi = 0$ and C=35.28 kN/m2, which is a practical condition.

$q = (\gamma - c / Be) \times H + p$

$= (16.628 - 35.28 / 2.957) \times 25.0 + 1.304$

$= 118.729$ (kN/m^2)

$$f = \frac{qr}{q} = \frac{148.374}{118.729} = 1.250 > 1.200$$

・Loading capacity of pipe in the direction of propulsion

Allowable loading capacity of pipe (Fr) is expressed by the following formula.

$Fr = 10^3 \times \sigma ma \times A$

To the above formula

Fr : Allowable proof stress of pipe

σma : Allowable average compressive stress of concrete = 13.000 (N/mm2)

A : Effective sectional area of pipe (m^2)

$A = \frac{1}{4} \times \pi \times (Bg^2 - D^2)$

Bg : Effective diameter = 2.310 (m)

D : Inner diameter of pipe = 2.000 (m)

$A = \frac{1}{4} \times \pi \times (2.310^2 - 2.000^2)$

$= 1.049 \ m^2$)

$Fr = 1000 \times 13.000 \times 1.049$

$= 13641.816$ (kN) (1392.022 tf)

5) Reaction force of bearing pressure

Reaction force (R) is expressed by formula of passive earth pressure of Rankine.

$$R = \alpha \times B \left(\gamma s \times Ho^2 \times \frac{Kp}{2} + 2 \times C \times Ho \times Kp + \gamma s \times Ho \times h \times Kp\right)$$

To the above formula

R	: Reaction force		(kN)
B	: Width of bearing force	=	4.800 m
γs	: Unit volume weith of soil	=	16.268 KN/m^3
φ	: Internal frictional angle of soil	=	10.0 °
C	: Cohesion of soil	=	17.787
α	: Coefficient (1.5～2.5)	=	2.000
Ho	: Height of wall of bearing pressure	=	3.500 m
Kp	: Coefficient of passive earth pressure	= $\tan^2$	(45° +φ/2)
		= $\tan^2$	(45° +10.0/2)
		=	1.420
h	: Earth covering of bearing pressure wall	= Ha	− Ho
		=	28.150 − 3.500
		=	24.650 m
H	: Depth of wall of bearing pressure	= H	+ Bc + Hb
		=	25.000 + 2.35 + 0.800
		=	28.150
Bc	: Exterior diamter of pipe	=	2.35 m
Hb	: Allowance under pipe	=	0.800 m

(Head drop from soffit of pipe to soffit of wall of bearing pressure)

$R = 2.0 \times 4.8 \left(16.268 \times 3.500^2 \times \frac{1.420}{2} + 2 \times \times 3.500 \times 1.420 + 16.268 \times 3.500 \times 24.650 \times 1.420\right)$

$= 21919.599$ (kN) (2236.694 tf)

6) Allowable extension of back pushing propulsion

According to the above results of calculation

Total propulsion	F3	=	29539 (kN)	(3014.19917 tf)
Loading capacity of pipe	Fr	=	13642 (kN)	(1392.02207 tf)
Reaction force of bearing pressure	R	=	21920 (kN)	(2236.69382 tf)
Effective propulsion of back pushing jack	Fme	=	15680 (kN)	(1600 tf)

F3 > Fr

Therefore
Adoption of middle pushing method is necessary.

7) The number of installation of middle pushing
Possible propulsion by back pushing method is determined by
Fr = 13641.8163 (kN) (1392.0221 tf)

Fm = F − Fr
= 29539.152 − 13641.82
= 15897.336 (kN) (1622.1771 tf)

As for above, middle pushing method is used to deal with.

In case of D=2000mm, the number of installation of hydraulic jack enabled to install into one location of middle pushing is,
490 (kN) × 18 (Number) = 8820 (kN) (900 tf)
is limit.

Possible propulsion in one location of middle pushing is
$$Fj = \frac{490 \text{ (kN)} \times 18 \text{ (Number)}}{1}$$
= 8820 (kN) (900 tf)

Therefore, the number of intallation of middle pushing (n) is
$$n = \frac{Fm}{Fj} = \frac{15897}{8820} = 1.802$$
Therefore, 2 locations are necessary.

4.2 推進管

推進管の外圧強さ（曲げ強度）を表 1.4.2−1、外圧試験方法（曲げ強度試験方法）を図 1.4.2−1 に示す。

表 1.4.2−1　推進管の外圧強さ（曲げ強度）

単位：kN／m

呼び径	ひび割れ荷重		破壊荷重	
	1 種	2 種	1 種	2 種
200	31.4	62.8	47.1	94.2
250	32.4	64.8	49.1	97.1
300	34.4	68.7	52.0	103
350	37.3	74.6	55.9	112
400	39.3	78.5	58.9	118
450	42.2	84.4	63.8	127
500	44.2	88.3	66.7	133
600	46.1	92.2	69.7	138
700	48.1	96.2	72.6	143
800	35.4	70.7	57.9	106
900	38.3	76.5	64.8	115
1 000	41.2	82.4	71.6	124
1 100	42.7	85.4	78.5	128
1 200	44.2	88.3	86.3	133
1 350	47.1	94.2	98.1	142
1 500	50.1	101	110	151
1 650	53.0	106	122	159
1 800	55.9	112	134	168
2 000	58.9	118	142	177
2 200	61.8	124	149	186
2 400	64.8	130	155	195
2 600	67.7	136	163	203
2 800	70.7	142	170	212
3 000	73.6	148	177	221

備考　ひび割れ荷重とは、管に幅 0.05 mmのひび割れを生じたときの試験機が示す荷重を有効長 L で除した値をいい、破壊荷重とは、試験機が示す最大荷重を有効長 L で除した値をいう。

7. Study on Pit Mouth Protection by Chemical Grouting

(Shaft A, B, and C)

Contents

1. Study on the Loosened Earthcover Thickness

As depth of Launch and Reception shaft is deep, thickness of earth covering for the ground improvement around the shaft mouth protection is defined as loosened height and to check.

Calculation of the loosened area

$$h=\frac{D}{2}\left\{1+\sin\left(45°-\frac{\phi}{2}\right)\right\}$$

$$B_0=D\cos\left(45°-\frac{\phi}{2}\right)$$

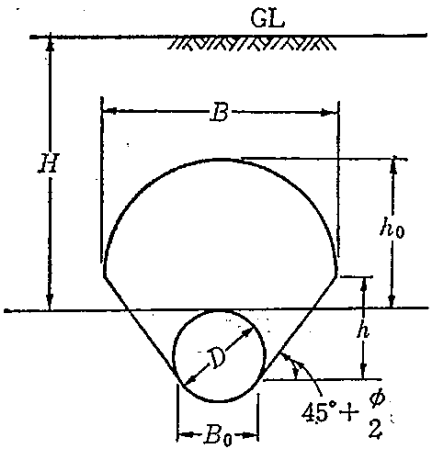
$$B=B_0+2h\tan\left(45°-\frac{\phi}{2}\right)$$

$$h_0=\frac{B}{2K\tan\phi}\left(1-e^{-K\tan\phi(2H/B)}\right)$$

where;

B : Loosened width
ho : Loosened height
φ : Angle of internal friction
H : Earth cover
D : Tunnel diameter
h : Height of sliding surface
K : Coeffi. of active earth pressure
γ : Unit weight of soil

Tunnel Diameter
D= 2.350 m
Earth Covering
H= 25.825 m
Internal friction angle of soil
φ= 5.0 °



Sliding suface height(h)
h= D/2·{1+sin(45°−φ/2)}
= 1.97 m

Loosened width(B)
B0= D·cos(45°−φ/2)
= 1.73 m
B= B0+2·h·tan(45°−φ/2)
= 5.34 m

Loosened height(h0)

$$h0=\frac{B}{2\cdot K\cdot\tan\varphi}\cdot\{1-e^{(-K\cdot\tan\varphi\cdot(2H/B))}\}$$

Coefficient of active earth pressure
K= {tan(45°-φ/2)}^2
= 0.840
∴ h0= 36.346 ×(1- 0.49138)
= 18.49 m

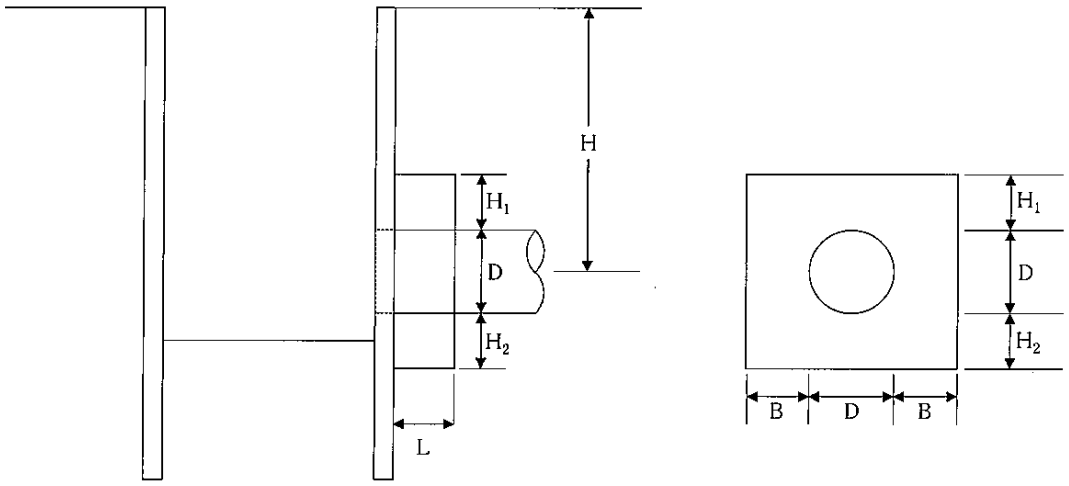
Loosened height from pipe center
h0'= h0+D/2
= 19.665 m

2. Study on Shaft Mouth Protection(Chemical Grouti Vertical Shaft A

Vertical Shaft No./ Jacking Shaft

(Shield Center GL-27.0m)

1. Study Conditions



- Radius of Shaft Mouth a= 1.175 m
- Diameter of Shaft Mouth D= 2,350 mm
- Depth from GL to center of H= 19.670 m
- Groundwater level GL- 2.830 m
- Surcharge q= 10.00 kN/m^2

Soil Layer to shield center(jacking)

Type of Soil		G.L.	thickness	γt	γ't	γt'·h	γt·h
1st layer	Gravel	0.800		18.00		0.00	0.00
▽G.Water 2nd layer	Clay	2.830		14.00		0.00	0.00
3rd layer	Clay	15.000	7.67	14.00	14.00	107.38	107.38
4th layer	Clay	25.000	10.00	18.00	18.00	180.00	180.00
5th layer	Clay	27.000	2.00	18.00	18.00	36.00	36.00
6th layer							
7th layer							
8th layer							
9th layer							
計			19.67			323.38	323.38

※submerged unit weight of soil : 9.0 kN/m3

- Soil constants C_0= 100.0 kN/m^2
  φ= 5.0 °
  γt= 18.0 kN/m^3
- Design cohesion of gro C' = 100.0 kN/m^2
- Safety factor Fs= 1.5

2. Calculation of the Improved Section

1) Improved thickness for the Upper Side

Improved thickness for the upper side can be decided based on the following formula which additional stress(plastic area) occurred along the perimeter of the cutting surface due to tunneling is considered.

$$\ln R + \frac{R \cdot \gamma t}{2 \cdot C'} = \frac{H \cdot \gamma t}{2 \cdot C'} + \ln(a)$$

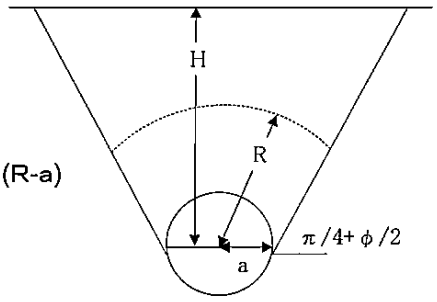
Substituting the values, the above will be as follows:

$$\ln(R) - 0.090\,R = 1.828$$

Obtain R by trial calculation, R = 4.25 m

Therefore, the improved thickness H1 is from H1=Fs·(R-a)

H_1= 4.62 m → 4.70 m



2) Improved thickness for the Lateral Side

Area to improve is defined as to an extent to a point of intersection of angle of collapse(45° +ϕ/2) and line H1 obtained from the above.

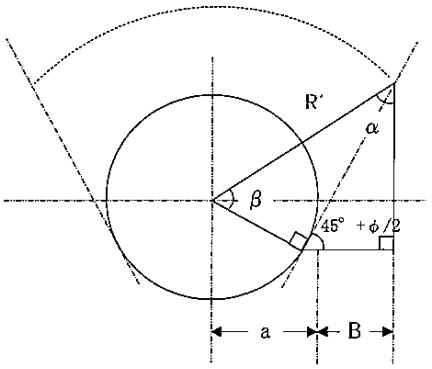
$\beta = \cos^{-1}(a/a+H_1)$

$a/a+H_1$ = 0.203

β = 78.29 °

θ = 45°+φ/2
= 47.50 °

α = 360°−(90°×2+β+θ)
= 180°-(β+θ)
= 54.21 °



Define thickness of lateral improvement as B

$B = (a+H_1)\times\sin\alpha - a$

= 3.53 m − 3.60 m

3) Improved thickness for the Bottom Side

Thickness can be obtained from force balance between uplift(U) acting on the bottom surface of th improved body , weight of the improved body(W) and resistant shear force of the improved body(F)

$$Fs = \frac{W + F}{U} \quad \text{(per unit length)}$$

$$U = (H' + H_2) \cdot D \cdot \gamma w$$

$$W = \gamma t \cdot H_2 \cdot D$$

$$F = 2 \cdot H_2 \cdot C$$

where;

· pipe diameter	D=	2.35 m	(a= 1.18 m)
· depth from GL to center of exc.	H'=	20.85 m	
· unit weight of soil	γt=	18.0	kN/m^3
· unit weight of water	γw=	10.0	kN/m^3
· design cohesion of the improved bod	C=	100.0	kN/m^2
· safety factor	Fs=	1.5	

and therefore,

$$U = 489.9 + 23.5 \cdot H_2$$

$$W = 42.3 \cdot H_2$$

$$F = 200.0 \cdot H_2$$

$$H_2 = 3.55 \text{ m} - 3.60 \text{ m}$$

Minimum improvement thickness is to be applied as a design value in case calculation results are lower than the minimum values indicated below.

According to the calculation results, the improved thickness of the upper, lateral and bottom side indicates more than the minimum values. However, as it is hard clay of N-value of 50 or more around the shaft mouth, minimum improved thickness can be applied for the purpose of water stop

	Calculation	Minimum improvement area		Applied
• Upper imp. Thk. H1=	4.7 m	2.0 m	→	2.0 m
• Lateral imp. Thk. B=	3.6 m	1.5 m	→	1.5 m
• Bot. imp. Thk. H2=	3.6 m	1.5 m	→	1.5 m

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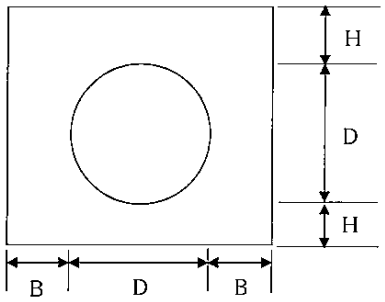
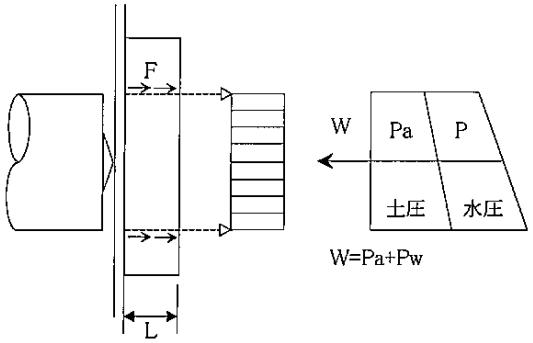
Minimum improvement thickness(m)

	D<1.0	1.0≦D <2.0	2.0≦D <3.0	3.0≦D <4.0	4.0≦D <5.0	5.0≦D <6.0	6.0≦D <7.0	7.0≦D <8.0
B	1.0	1.5	1.5	2.0	2.5	3.0	3.5	4.0
H_1	1.5	1.5	2.0	2.0	3.0	3.0	4.0	4.0
H_2	1.0	1.0	1.5	1.5	2.0	2.5	3.0	3.5
L	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0



4) Improved thickness at the front surface (at cutting edge)

Calculate improved thickness assuming that punching shear force of the improved soil is resistant to the both earth and water pressure acting on the mouth rear as indicated below



Mouth perimeter $L=2\times\pi\times a$ = 7.38 m
Mouth area $S=\pi\times a^2$ = 4.34 m^2

$\tan(45-\varphi/2)$= 0.916

Earth pressure

$Pa=(q+\Sigma\gamma t)\times\tan^2(45-\varphi/2)-2\times C\times\tan(45-\varphi/2)$

= 279.72 - 183.20 = 96.52 kN/m^2

Water pressure

Pw= 168.40 kN/m^2

External Force

W= (Pa+Pw)×S

= 1149.77 kN

Therefore, required improved thickness of L will be as follows:

L= Fs×W／I×C

= 2.34 m → 2.40 m

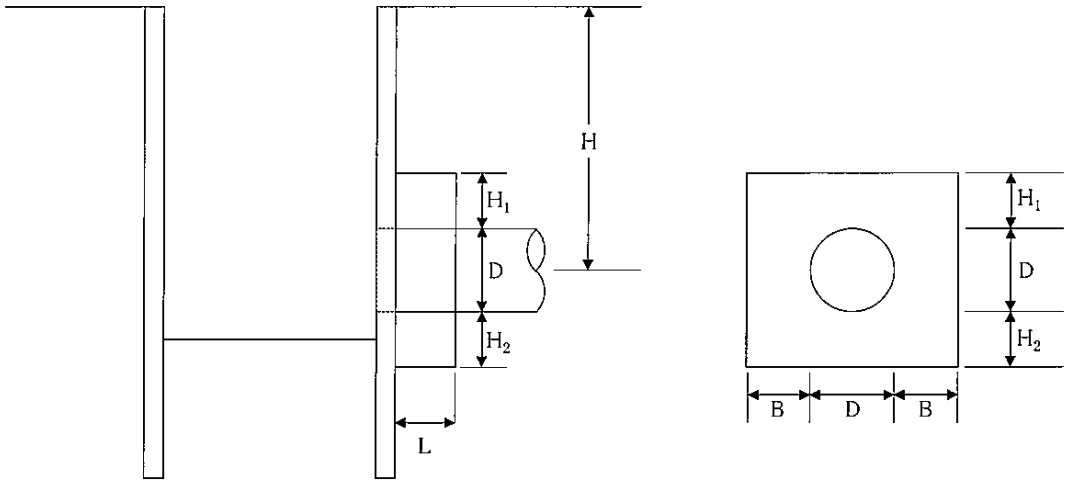
Minimum value = 3.0 m
Therefore,
Required imp. thickness = 3.0 m

3. Study on Pit Mouth Protection(Chemical Grouting Vertical Shaf B

Vertical Shaft No./ Jacking Shaft

(Shield Center GL-27.0m)

1. Study Conditions



- Radius of Shaft Mouth a= 1.175 m
- Diameter of Shaft Mouth D= 2,350 mm
- Depth from GL to center of H= 19.670 m
- Groundwater level GL- 2.830 m
- Surcharge q= 10.00 kN/m^2

Soil Layer to shield center(jacking)

	Type of Soil		G.L.	thickness	γt	γ't	γt'·h	γt·h
▽G.Water	1st layer	Clay	2.490		14.00		0.00	0.00
	2nd layer	Clay	3.000		14.00	14.00	0.00	0.00
	3rd layer	Sand	4.000		17.00	17.00	0.00	0.00
	4th layer	Clay	10.000	2.67	14.00	14.00	37.38	37.38
	5th layer	Silt	13.000	3.00	16.00	16.00	48.00	48.00
	6th layer	Clay	15.000	2.00	18.00	18.00	36.00	36.00
	7th layer	Clay	25.000	10.00	18.00	18.00	180.00	180.00
	8th layer	Sand	27.000	2.00	19.00	19.00	38.00	38.00
	9th layer							
	計			19.67			339.38	339.38

※submerged unit weight of soil : 9.0 kN/m3

- Soil constants C_0= 0.0 kN/m^2
  φ= 40.0 °
  γt= 19.0 kN/m^3
- Design cohesion of gro C' = 100.0 kN/m^2 (double packer method:sandy soil)
- Safety factor Fs= 1.5

2. Calculation of the Improved Section

1) Improved thickness for the Upper Side

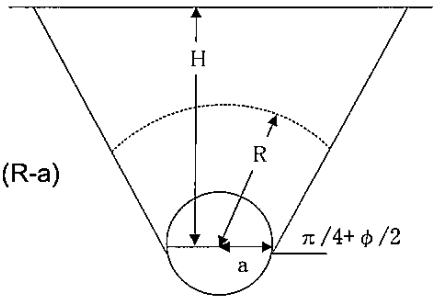
Improved thickness for the upper side can be decided based on the following formula which additional stress(plastic area) occurred along the perimeter of the cutting surface due to tunneling is considered.

$$\ln R + \frac{R \cdot \gamma t}{2 \cdot C'} = \frac{H \cdot \gamma t}{2 \cdot C'} + \ln(a)$$

Substituting the values, the above will be as follows:

$$\ln(R) - 0.095\,R = 1.908$$

Obtain R by trial calculation, R = 4.43 m



Therefore, the improved thickness H1 is from H1=Fs·(R-a)

H_1= 4.89 m → 4.90 m

2) Improved thickness for the lateral side

Area to improve is defined as to an extent to a point of intersection of angle of collapse(45° +φ/2) and line H1 obtained from the above.

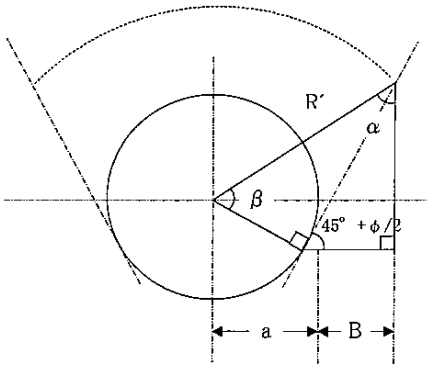
$\beta = \cos^{-1}(a/a+H_1)$

$a/a+H_1$ = 0.194

β = 78.81 °

θ = 45°+φ/2
= 65.00 °

α = 360°−(90°×2+β+θ)
= 180°-(β+θ)
= 36.19 °



Define thickness of lateral improvement as B

$B = (a+H_1)\times\sin\alpha - a$

= 2.41 m — 2.50 m

3) Improved thickness for the bottom side

Thickness can be obtained from force balance between uplift(U) acting on the bottom surface of th improved body , weight of the improved body(W) and resistant shear force of the improved body(F)

$$Fs = \frac{W + F}{U} \quad \text{(per unit length)}$$

$$U = (H' + H_2) \cdot D \cdot \gamma w$$

$$W = \gamma t \cdot H_2 \cdot D$$

$$F = 2 \cdot H_2 \cdot C$$

where;

- pipe diameter D= 2.35 m (a= 1.18 m)
- depth from GL to center of exc. H'= 20.85 m
- unit weight of soil γt= 19.0 kN/m^3
- unit weight of water γw= 10.0 kN/m^3
- design cohesion of the improved bod C= 100.0 kN/m^2 (粘土)
- safety factor Fs= 1.5

and therefore,

$$U = 489.9 + 23.5 \cdot H_2$$

$$W = 44.7 \cdot H_2$$

$$F = 200.0 \cdot H_2$$

$$H_2 = 3.51\ m - 3.60\ m$$

Minimum improvement thickness is to be applied as a design value in case calculation results are lower than the minimum values indicated below.

According to the calculation results, the improved thickness of the upper, lateral and bottom side indicates more than the minimum values. However, as it is hard clay of N-value of 50 or more around the shaft mouth, minimum improved thickness can be applied for the purpose of water stop

	Calculation	Minimum improvement area		Applied
• Upper imp. Thk. H1=	4.9 m	2.0 m	→	2.0 m
• Lateral imp. Thk. B=	2.5 m	1.5 m	→	1.5 m
• Bot. imp. Thk. H2=	3.6 m	1.5 m	→	1.5 m

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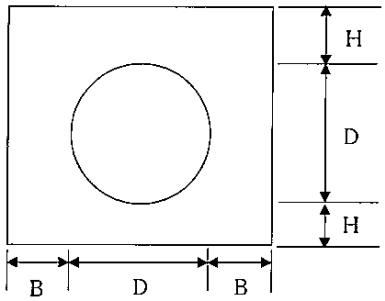
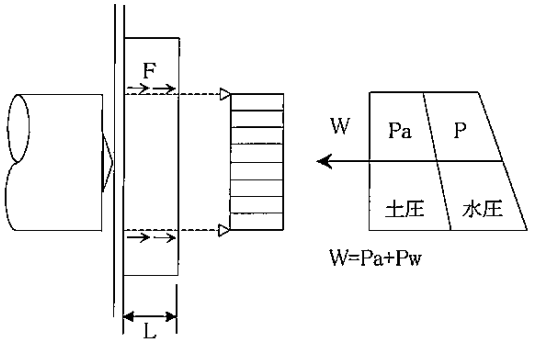
Minimum improvement thickness(m)

	D<1.0	1.0≦D <2.0	2.0≦D <3.0	3.0≦D <4.0	4.0≦D <5.0	5.0≦D <6.0	6.0≦D <7.0	7.0≦D <8.0
B	1.0	1.5	1.5	2.0	2.5	3.0	3.5	4.0
H_1	1.5	1.5	2.0	2.0	3.0	3.0	4.0	4.0
H_2	1.0	1.0	1.5	1.5	2.0	2.5	3.0	3.5
L	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0



4) Improved thickness at the front side (at cutting edge)

Calculate improved thickness assuming that punching shear force of the improved soil is resistant to the both earth and water pressure acting on the mouth rear as indicated below



Mouth perimeter $l=2\times\pi\times a$ = 7.38 m
Mouth area $S=\pi\times a^2$ = 4.34 m^2

$\tan(45-\varphi/2)$= 0.466

Earth pressure

$Pa= (q+\Sigma\gamma t)\times\tan^2(45-\varphi/2)-2\times C\times\tan(45-\varphi/2)$

= 75.87 - 0.00 = 75.87 kN/m^2

Water pressure

Pw= 168.40 kN/m^2

External Force

W= (Pa+Pw)×S

= 1060.13 kN

Therefore, required improved thickness of L will be as follows:

L= Fs×W／l×C

= 2.15 m → 2.20 m

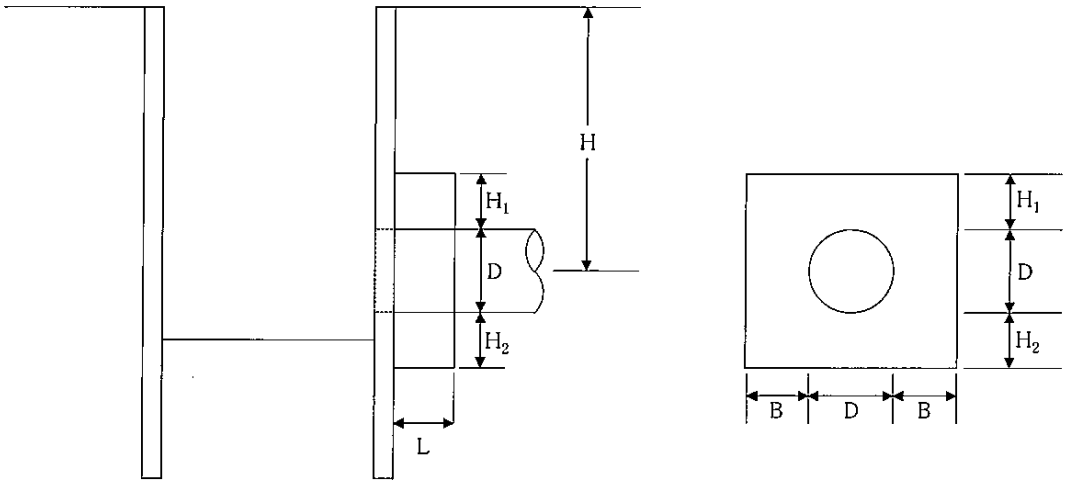
Minimum value = 3.0 m
Therefore,
Required imp. thickness = 3.0 m

4. Study on Shaft Mouth Protection(Chemical Grouti Vertical Shaft C

Vertical Shaft No./ Jacking Shaft

(Shield Center GL-27.0m)

1. Study Conditions



- Radius of Shaft Mouth a= 1.175 m
- Diameter of Shaft Mouth D= 2,350 mm
- Depth from GL to center of H= 19.670 m
- Groundwater level GL- 2.430 m
- Surcharge q= 10.00 kN/m^2

Soil Layer to shield center(jacking)

	Type of Soil		G.L.	thickness	γt	γ't	γt'·h	γt·h
▽G.Water	1st layer	Clay	2.430		14.00		0.00	0.00
	2nd layer	Clay	11.000	3.67	14.00	14.00	51.38	51.38
	3rd layer	Clay	16.000	5.00	16.00	16.00	80.00	80.00
	4th layer	Clay	19.000	3.00	18.00	18.00	54.00	54.00
	5th layer	Clay	21.000	2.00	18.00	18.00	36.00	36.00
	6th layer	Sand	24.000	3.00	19.00	19.00	57.00	57.00
	7th layer	Clay	27.000	3.00	18.00	18.00	54.00	54.00
	8th layer							
	9th layer							
	計			19.67			332.38	332.38

※submerged unit weight of soil : 9.0 kN/m3

- Soil constants C_0= 100.0 kN/m^2
  φ= 5.0 °
  γt= 18.0 kN/m^3
- Design cohesion of gro C' = 100.0 kN/m^2
- Safety factor Fs= 1.5

2. Calculation of the Improved Section

1) Improved thickness for the Upper Side

Improved thickness for the upper side can be decided based on the following formula which additional stress(plastic area) occurred along the perimeter of the cutting surface due to tunneling is considered.

$$\ln R + \frac{R \cdot \gamma t}{2 \cdot C'} = \frac{H \cdot \gamma t}{2 \cdot C'} + \ln(a)$$

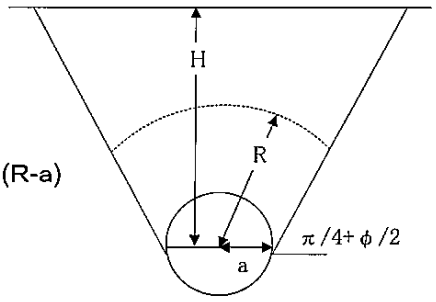
Substituting the values, the above will be as follows:

$$\ln(R) - 0.090\,R = 1.873$$

Obtain R by trial calculation, R= 4.39 m

Therefore, the improved thickness H1 is from H1=Fs·(R-a)

H_1= 4.83 m → 4.90 m



2) Improved thickness for the lateral side

Area to improve is defined as to an extent to a point of intersection of angle of collapse(45° +φ/2) and line H1 obtained from the above.

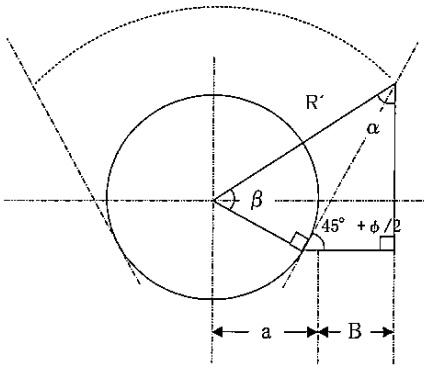
$\beta = \cos^{-1}(a/a+H_1)$

$a/a+H_1$ = 0.196

β = 78.70 °

θ = 45°+φ/2
= 47.50 °

α = 360°−(90°×2+β+θ)
= 180°-(β+θ)
= 53.80 °



Define thickness of lateral improvement as B

$B = (a+H_1)\times\sin\alpha - a$

= 3.67 m − 3.70 m

3) Improved thickness for the bottom side

Thickness can be obtained from force balance between uplift(U) acting on the bottom surface of th improved body , weight of the improved body(W) and resistant shear force of the improved body(F)

$$Fs = \frac{W + F}{U} \quad \text{(per unit length)}$$

$$U = (H' + H_2) \cdot D \cdot \gamma w$$

$$W = \gamma t \cdot H_2 \cdot D$$

$$F = 2 \cdot H_2 \cdot C$$

where;

- pipe diameter $D =$ 2.35 m ($a =$ 1.18 m)
- depth from GL to center of exc. $H' =$ 20.85 m
- unit weight of soil $\gamma t =$ 18.0 kN/m^3
- unit weight of water $\gamma w =$ 10.0 kN/m^3
- design cohesion of the improved bod $C =$ 100.0 kN/m^2
- safety factor $Fs =$ 1.5

and therefore,

$$U = 489.9 + 23.5 \cdot H_2$$

$$W = 42.3 \cdot H_2$$

$$F = 200.0 \cdot H_2$$

$$H_2 = 3.55 \text{ m} - 3.60 \text{ m}$$

Minimum improvement thickness is to be applied as a design value in case calculation results are lower than the minimum values indicated below.

According to the calculation results, the improved thickness of the upper, lateral and bottom side indicates more than the minimum values. However, as it is hard clay of N-value of 50 or more around the shaft mouth, minimum improved thickness can be applied for the purpose of water stop

	Calculation	Minimum improvement area		Applied
• Upper imp. Thk. H1=	4.9 m	2.0 m	→	2.0 m
• Lateral imp. Thk. B=	3.7 m	1.5 m	→	1.5 m
• Bot. imp. Thk. H2=	3.6 m	1.5 m	→	1.5 m

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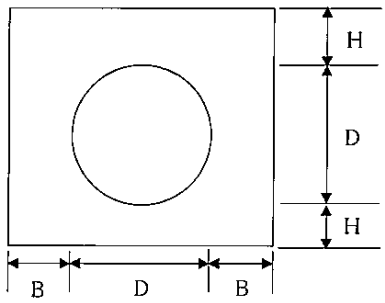
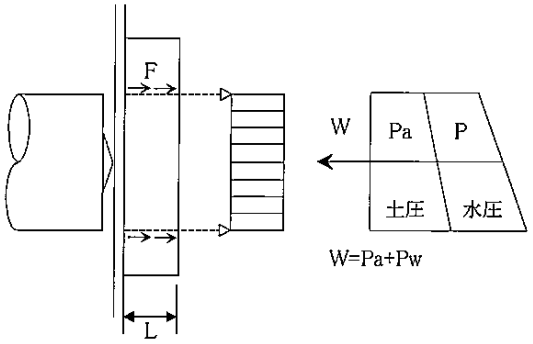
Minimum improvement thickness(m)

	D<1.0	1.0≦D <2.0	2.0≦D <3.0	3.0≦D <4.0	4.0≦D <5.0	5.0≦D <6.0	6.0≦D <7.0	7.0≦D <8.0
B	1.0	1.5	1.5	2.0	2.5	3.0	3.5	4.0
H_1	1.5	1.5	2.0	2.0	3.0	3.0	4.0	4.0
H_2	1.0	1.0	1.5	1.5	2.0	2.5	3.0	3.5
L	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0



4) Improved thickness at the front side (at cutting edge)

Calculate improved thickness assuming that punching shear force of the improved soil is resistant to the both earth and water pressure acting on the mouth rear as indicated below



Mouth perimeter $L=2\times\pi\times a$ = 7.38 m
Mouth area $S=\pi\times a^2$ = 4.34 m^2

$\tan(45-\varphi/2)$= 0.916

Earth pressure

$Pa= (q+\Sigma\gamma t)\times\tan^2(45-\varphi/2)-2\times C\times\tan(45-\varphi/2)$

= 287.28 - 183.20 = 104.08 kN/m^2

Water pressure

Pw= 172.40 kN/m^2

External Force

W= (Pa+Pw)×S

= 1199.91 kN

Therefore, required improved thickness of L will be as follows:

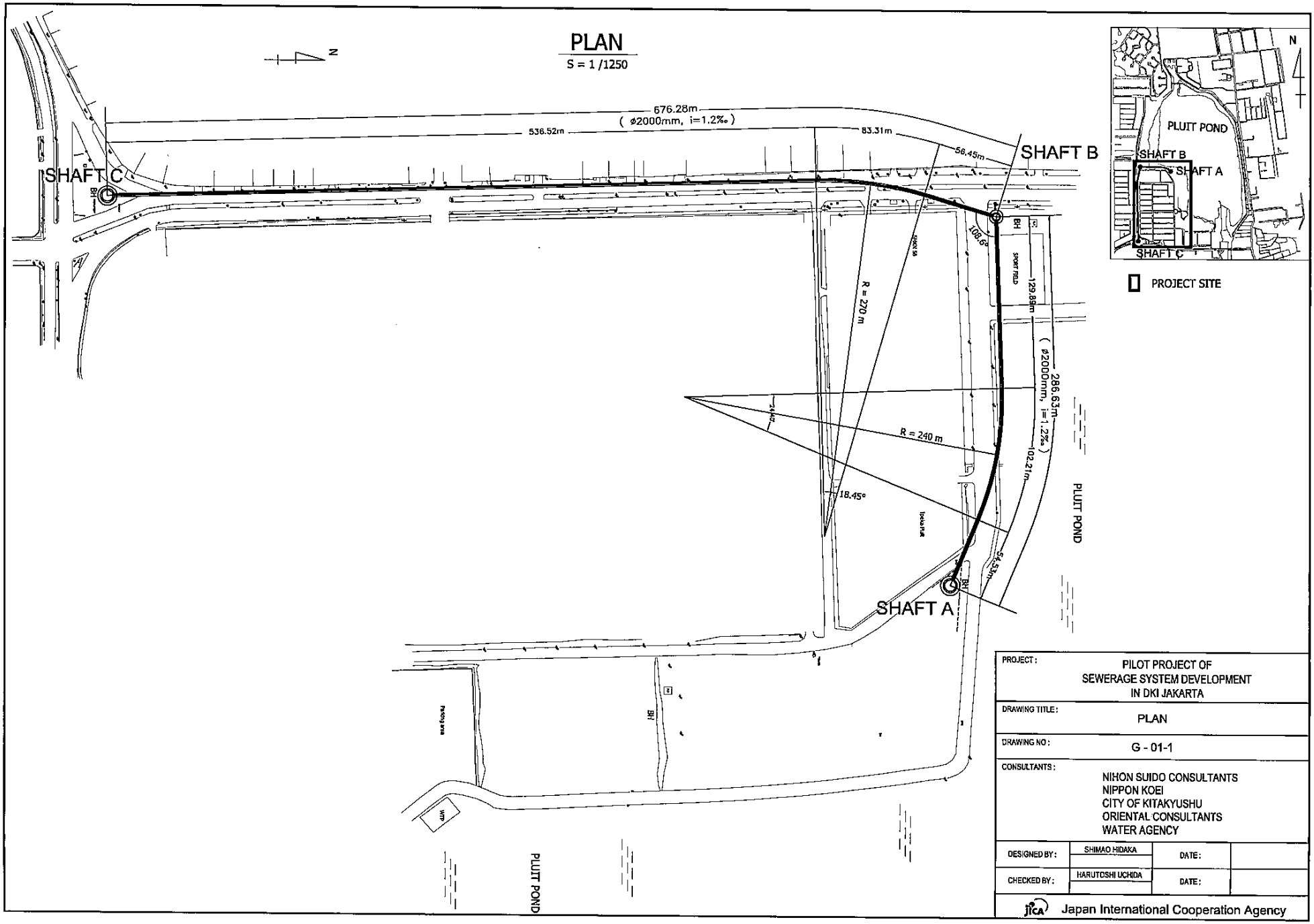
L= Fs×W／I×C

= 2.44 m → 2.50 m

Minimum valu 3.0 m
Therefore,
Required imp 3.0 m

8. Construction Schedule for the Pilot Project by Pipe Jacking Method

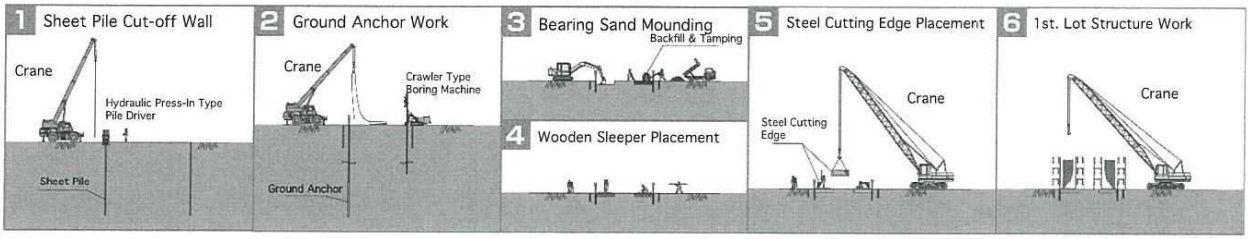
Contents

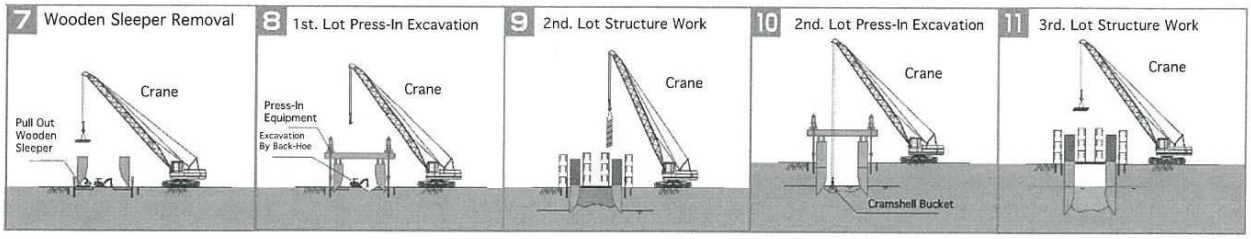


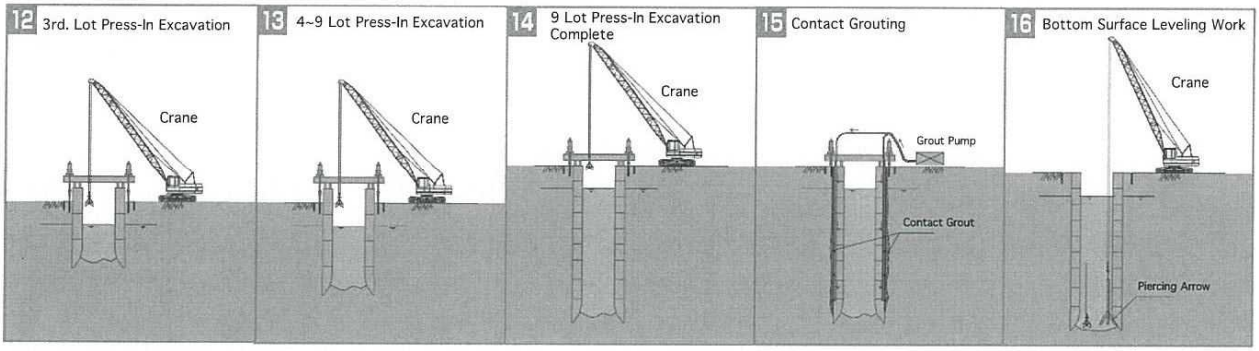
PROJECT :	PILOT PROJECT OF SEWERAGE SYSTEM DEVELOPMENT IN DKI JAKARTA
DRAWING TITLE :	PLAN
DRAWING NO :	G - 01-1
CONSULTANTS :	NIHON SUIDO CONSULTANTS NIPPON KOEI CITY OF KITAKYUSHU ORIENTAL CONSULTANTS WATER AGENCY
DESIGNED BY :	SHIMAO HIDAKA — DATE :
CHECKED BY :	HARUTOSHI UCHIDA — DATE :

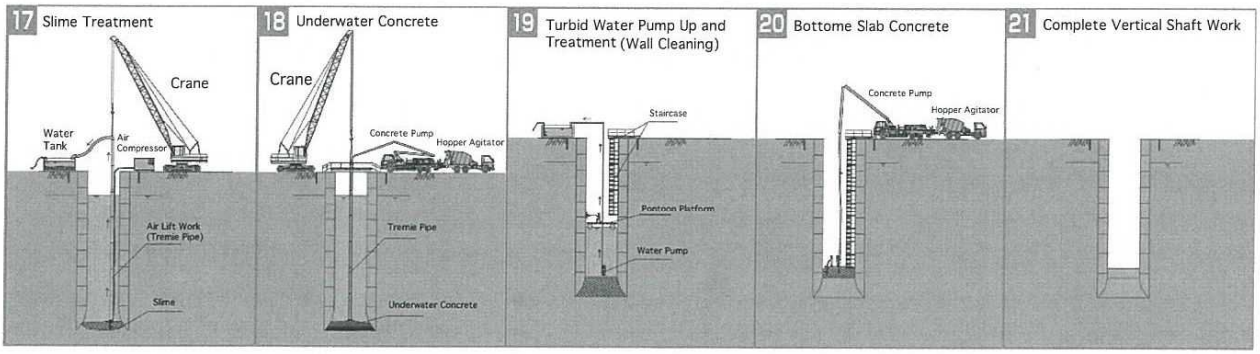
Japan International Cooperation Agency

Press-In Caisson Construction Flow-Chart









1. Construction Schedule for the Pilot Project by Pipe Jacking Method

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Mobilization (0.5)																								
Site Preparation (0.5)																								
Departure Shaft Construction (A) (12.0)																								
Pipe Jacking Preparation (A→B) (0.4)																								
Pipe Jacking (A→B) L=279.9m (2.1)																								
Arrival Shaft Construction (B) (8.7)																								
Departure Shaft Construction (C) (12.0)																								
Pipe Jacking Preparation (C→B) (0.4)																								
Pipe Jacking (C→B) L=670m																								
Preparation of Manhole Construction (0.4)																								
Construction of Manhole B (2.4)																								
Site Clearance (0.5)																								
Demobilization (0.5)																								
Total Construction Period (24.0)																								

* Manhole A and Manhole C are not plan to be constructed under the Pilot Project.

2. Breakdown of Construction Schedule

2.1 Shaft Construction Schedule

Condition; Day time construction from 8:00 to 17:00

2.1.1 Shaft A and C actual construction schedule

		days
1.	Precedent drilling construction work	43
2.	Construction of steel sheet pile cut-off wall	6
3.	Ground anchor work	17
4.	Bearing sand mounting	4
5.	Steel cutting edge placement	2
6.	1st Lot structure work	24
7.	2nd – 7th Lot structure work (6 lot x 15 days = 90 days)	90
8.	2nd – 7th Press in excavation	60
9.	Contact grouting, bottom surface leveling work and under water concrete work	20
10.	Bottom slab concrete	7
11.	Removal of cut-off wall	4
	Total	277

Number of available day = 277 x 1.3 = 360 days, 360days/30days/month = 12 months

2.1.2 Shaft B actual construction schedule

		days
1.	Precedent drilling construction work	25
2.	Sheet pile cut-off wall	5
3.	Ground anchor work	15
4.	Bearing sand mounting	3
5.	Steel cutting edge placement	1
6.	1st Lot structure work	16
7.	2nd – 7th Lot structure work (6 lot x 12 days = 72 days)	72
8.	2nd – 7th Press in excavation	40
9.	Contact grouting, bottom surface leveling work and under water concrete work	16
10.	Bottom slab concrete	5
11.	Removal of cut-off wall	3
	Total	201

Number of available day = 201 x 1.3 = 261 days, 261days/30days = 8.7 months

2.2 **Manhole Construction Schedule (Manhole B)**

Condition; Day time construction from 8:00 to 17:00

		day
1.	Scaffolding	1.0
2.	Installation of formwork	1.0
3.	Pouring the concrete	1.0
4.	Concrete curing	4.0
5.	Removing the formwork	1.5
	Total	8.5 days

Manhole construction period; 8.5 x 6 lots = 51.0 days
Upper manhole construction period; 6.0 days
Backfilling; 4.0 days

Total actual manhole construction period = 51 + 6 + 4 = 61.0 days

Number of available day for manhole construction schedule = 61.0 x 1.3 = 79.3 days, 79.3 days/30 days/month = 2.7 months

2.3 **Pipe Jacking Construction Schedule**

Condition; Day and Night time construction (two shifts)
First shift; from 8:00 am to 18:00 pm, Second shift; from 20:00 pm to 6:00 am

2.3.1 Between Shaft A (internal diameter 8.4m) and B (internal diameter 5.0m)
Distance between shaft A and B = 286.63m
Actual pipe jacking distance = 286.63 - 2.5 – 4.2 = 279.93 m
Construction schedule = 279.93 m/ 5.71 m/day =49.0 days,
Number of available day for pipe jacking construction schedule = 49.0 x 1.3 = 63.7 days, 63.7 days/30 days/month = 2.1 months

2.3.2 Between Shaft C (internal diameter 8.4m) and B (internal diameter 5.0m)
Distance between shaft C and B = 676.3m
Actual pipe jacking distance = 676.3 - 2.5 – 4.2 = 669.6 m
Construction schedule = 669.6 m/ 6.10 m/day =109.77 days,
Number of available day for pipe jacking construction schedule = 109.77 x 1.3 = 142.7 days, 142.7 days/30 days/month = 4.7 months

3. Breakdown of Pipe Jacking Construction

Working Progress per Day

- Normal Progress Rate per day m/8h

Diameter	ordinary soil sandy soil, viscous soil, gravel	hard soil
1800mm	6.7	4.2
2000mm	6.5	4
2200mm	6.1	3.8

- Correction of progress per day

Working progress = Normal Progress Rate x α x β x γ

α : compensation coefficient for used booster Jack

Booster Jack	1set	2set	3set
α	0.94	0.92	0.9

β : compensation coefficient for long span jacking

$\beta = 1 - 0.1 \left(\frac{L}{500} - 1 \right)$

L	270 m	670 m
β	1.046	0.96608

γ : compensation coefficient for curve construction

250 m ≦ R < 300 m

0.9 / 0.85

δ : : compensation coefficient for Others (δ1 : great deep、 δ2 : high water pressure)

δ1	δ2
0.9	0.85

L < 100m δ = 0.765

L ≧ 100 m δ = 0.9

Span A-B

Dia = 2000 mm

L : Total = 279.93 m 286.63 8.4 m 5 m

a : — 0≦L<100m = 50.33 m 54.53

b : C 0≦L<100m 49.67 102.21

c : C 100≦L 52.54 129.89 127.39

d : — 100≦L = 127.39 m

:

Normal Progress Rate = 8 m/day hard soil

Booster Jack = 1 set

α = 0.94

β = 1

γ = 0.90 / 0.85

δ = 0.77 / 0.90

		length m	R		α		β		γ		γ		δ			
a	— 0≦L<100m	50.33	8.00	x	0.94	x	1.00	x	1.00	x	1.00	x	0.77	=	5.79 m/day	8.69
b	C 0≦L<100m	49.67	8.00	x	0.94	x	1.00	x	0.90	x	1.00	x	0.77	=	5.21 m/day	9.53
c	C 100≦L	52.54	8.00	x	0.94	x	1.00	x	0.90	x	1.00	x	0.90	=	6.09 m/day	8.63
d	— 100≦L	127.39	8.00	x	0.94	x	1.00	x	0.85	x	1.00	x	0.90	=	5.75 m/day	22.14
		279.93														48.99

Average Progress Rate = 5.71 m/day

Span B-C

Dia = 2000 mm

L : Total = 669.6 m 676.3 8.4 m 5 m

a : — 0≦L<100m = 100 m 536.5

b : - 100≦L = 432.3 83.3

c : C = 83.3 m 56.4

d : - = 53.9 m

Normal Progress Rate = 8 m/day hard soil

Booster Jack = 2 set

α = 0.92

β = 0.97

γ = 0.90 / 0.85

δ = 0.77 / 0.90

		length m	R		α		β		γ		γ		δ			
a	— 0≦L<100m	100	8	x	0.92	x	0.97	x	1.00	x	1.00	x	0.77	=	5.5 m/day	18.19
b	- 100≦L	432.3	8	x	0.92	x	0.97	x	1.00	x	1.00	x	0.90	=	6.43 m/day	67.28
c	C	83.3	8	x	0.92	x	0.97	x	0.90	x	1.00	x	0.90	=	5.78 m/day	14.4
d	-	53.9	8	x	0.92	x	0.97	x	0.85	x	1.00	x	0.90	=	5.46 m/day	9.87
		669.5														109.74

Average Progress Rate = 6.10 m/day

Appendix-7

PREQUALIFICATION (P/Q) DOCUMENTS OF PILOT PROJECT

PILOT PROJECT
OF
SEWERAGE SYSTEM DEVELOPMENT
IN
DKI JAKARTA

PREQUALIFICATION DOCUMENT

October 2014

PILOT PROJECT OF SEWERAGE SYSTEM DEVELOPMENT IN DKI JAKARTA
PRE QUALIFICATION DOCUMENT

TABLE OF CONTENTS

CHAPTER I GENERAL

Please use standard PQ document.

CHAPTER II PREQUALIFICATION ANNOUNCEMENT

Procurement Committee (ULP) of Pilot Project of Sewerage System Development in DKI Jakarta will implement a public auction with prequalification using method 2 steps 2 envelopes for construction work under multi years contract and with a unit price contract:

1. Work packages

1.1 Title of work package : Pilot Project of Sewerage System Development in DKI Jakarta

1.2 Scope of work: The construction work to be carried out by the Contractor is specified as follows.

Description	Unit	Quantity
(1) Construction of Sewerage Pipeline Length of Pipeline is 962.9m in total. (286.6m between Shaft A and B, 676.3m between Shaft B and C)		
1) Pipe Installation		
Length of Micorotunneling Method between Shaft A and B	m	279.9
Length of Micorotunneling Method between Shaft B and C	m	669.6
2) Construction of Shaft and Manhole		
Shaft A	unit	1
Shaft B and Manhole B	unit	1
Shaft C	unit	1

The Work shall be carried out in accordance with the drawings, the specifications and the directions of PPK (committing officer) and the supervision consultant of the project (hereinafter called “the Engineer”).

The Contractor has to deeply investigate the exact location of existing underground utilities in advance to prevent the affection and to carry out the appropriate measures during the construction work. In addition, the contractor shall investigate the soil condition, groundwater level, and surrounding environment at the location of drive shaft and pipeline etc., in order to select an appropriate microtunneling technology. The construction work cannot make an impact to the neighboring private housing and the alignment of sewer main cannot be allowed to occupy the private lot. Moreover, the distance between the structures constructed in the project and the boundary of the inspection road shall be more than and equal to 5.2m at the location of wastewater treatment plant (Manhole A and B).

In addition, the Contractor must carry out the construction work, environmental measures, and safety control carefully during the construction.

Particular attention shall be given as the general obligations of the Contractor when working in the vicinity of existing utility services, street trees, and boundary of private lot.

1.3 Total Budget HPS : IDR*****

(HPS was calculation of the entire volume of work and the unit price with tax and profit)

1.4 Sources of Funding: APBN , budgeting 2015- 2017

2. Requirement for Participant

2.1 Business License : Construction Services Business License in Indonesia and/or the country where J/O company registers

2.2 Job Classification: Sewerage Works (No. SI002), Drainage Works (No. SI001)

2.3 Qualification : Non small

2.4 Participant will constitute:

a. Contractor which has the sufficient experience indicated in "c. Specific Construction Experience" in Clause D of Chapter IV, or

b. Contractor which has the Partnership/cooperation (KSO) with the contractor which has sufficient experience indicated in "c. Specific Construction Experience" in Clause D of Chapter IV, or

c. Contractor which will sublet the microtunneling and deep shafting works of the contract to the contractor which has sufficient experience indicated in "c. Specific Construction Experience" in Clause D of Chapter IV.

3. Schedule of Procurement

No.	Activity	Day and Date	Information
1	Announcement of Prequalification	Monday, November 3, 2014	
2	Registration and Retrieval of Prequalification documents	Monday, November 3, 2014	
3	Deadline for retrieval of Prequalification documents	Monday, November 10, 2014	
4	Deadline for Submission of Prequalification documents	Friday, November 21, 2014	PQ documents' preparation: 21 days
5	Prequalification Evaluation	Monday, November 24, 2014 - Friday, December 5, 2014	
6	Proposal of the Evaluation results Prequalification	Monday, December 8, 2014	
7	Determination of the Evaluation result Prequalification	Thursday, December 11, 2014	
8	Announcement of the result Prequalification	Friday, December 12, 2014	
9	Exception (refutation) Time	Monday, December 15, 2014 Friday, December 19, 2014	

4. Bidding of Pilot Project of Sewerage System Development in DKI Jakarta is conducted by Full e-procurement with prequalification.

5. Qualification document can be taken in form of softcopy and can be downloaded through website www.pu.go.id.

6. A person prohibited representing more than one firm in registering and retrieves documents.

7. USER ID can be obtained online from the website, www.pu.go.id.

8. If the participant has the difficulties/ impossible to insert the document into website, they will be a risk of participant.

9. If the fund is not available or not enough although the document has been approved, the limit of available budget for the activities will be increased. So the selection of the provider of materials and services (participant) is null and void (cancelled) and can not claim compensation.

CHAPTER III INSTRUCTIONS TO PARTICIPANTS (IKP)

Please use standard PQ document.

CHAPTER IV DATA SHEET OF QUALIFICATION (LDK)

A. Scope of Qualification

1. ULP Working Group Name:
Procurement Unit of Pilot Project of Sewerage System Development in DKI Jakarta

2. WG-ULP address:
.....

3. Websites: Ministry of Public Works (http:// www.pu.go.id)

4. a. Name of work package:
Pilot Project of Sewerage System Development in DKI Jakarta

b. A brief description of the work:
The construction work to be carried out by the Contractor is specified as follows.

Description	Unit	Quantity
(1) Construction of Sewerage Pipeline Length of Pipeline is 962.9m in total. (286.6m between Shaft A and B, 676.3m between Shaft B and C)		
1) Pipe Installation		
Length of Micorotunneling Method between Shaft A and B	m	279.9
Length of Micorotunneling Method between Shaft B and C	m	669.6
2) Construction of Shaft and Manhole		
Shaft A	unit	1
Shaft B and Manhole B	unit	1
Shaft C	unit	1

The Contractor has to deeply investigate soil condition, groundwater level, and surrounding environment at the location of drive shaft etc., in order to select an appropriate microtunneling technology. The construction work cannot make an impact to the neighboring private housing and the alignment of sewer main cannot be allowed to occupy the private lot.

B. Source of Funds

Fiscal Year : From 2015 to 2017

C. Submission of Document Fields Qualification

According to the schedule listed in the electronic procurement system.

D. Qualification Requirements

1. Participants Qualifying entities must have a business license and construction permit
.....
Construction Services Business License in Indonesia and/or the country where J/O company registers

2. Participants Qualifying Foreign Construction Services Business Entity must have proof of license Representative of Foreign Construction Services and conduct business cooperation with national companies in the form of partnerships, subcontracting, etc., in the event of a national company that has the ability in the field in question.

3. Has experience of construction work on subfields:
   Sewerage Works (No. SI002), Drainage Works (No. SI001)

a. Implementation of Work Experience /general construction work
   Experience the contract as the prime contractor, subcontractor, or management contractor at least three (3) contracts within 10 (ten) years, and the activity of at least 6 (six) months in each year.

b. Similar experiences Construction Work Participation as contractor, management contractor, or subcontractor, at least three (3) contracts within 10 (ten) years, each with a minimum value of *[Rp .....]* or equivalent, which has been successfully completed and has been handed to work with the kind of work tendered. The similarity is based on the physical size, complexity, methods, technology or other characteristics as described in Chapter ...., Technical Requirements.

c. Specific Construction Experience for the companies participate in the project:

   Works Main Events / Principal for a job contract or other similar carried out during the period of implementation of the above, experience in basic activities / main as follows:

   (i) Experience of long distance microtunneling works

   The Contractors must have the experience of microtunneling works under the following conditions being satisfied together:

   - the diameter of jacking pipe is more than and equal to 1,800mm for sewer pipe
   - the span between shafts is more than 500m

   (ii) Experience of curved microtunneling works

   The Contractors must have the experience of curved microtunneling works under the curvature radius being not more than 250m

   (iii) Experience of microtunneling works under the high groundwater pressure

   The Contractors must have the experience of microtunneling works under the groundwater pressure being more than more than 0.2 MPa (20m).

   (iv) Experience of the deep shafting work

   The Contractor must have the experience of shafting works for which excavation depth is more than 30m.

4. Has the capability of providing Personil[1] necessary for execution of the work as follows:

No	level of Education	Positions in the proposed work	Work experience (years)	Profession / Expertise
1	2	3	4	5
1	Civil/ Bachelor	Project Manager (Team leader)	More than 15 years for the microtunneling works. More than 5 years for the team leader of the project.	Civil/ Field supervision
2	Civil/ Bachelor	Site Manager	More than 10 years for the construction works	Civil/ Field supervision
3	Civil/ Bachelor	Site Engineer manager	More than 10 years for the construction works	Civil/ Field supervision
4	Civil or Mechanical/ Bachelor	Jacking Operator	More than 10 years as a operator of jacking pipe.	Operator of microtunneling jacking machine
5	Civil/ Bachelor	Geotechnical Engineer	More than 10 years for the civil work including shaft work.	Civil/ Construction of deep shaft
6	Civil/ Bachelor	Quantity Surveyor Manager	More than 5 years for the construction works	Civil/ Field supervision
7	Civil/ Bachelor	Quantity Engineer	More than 5 years for the construction works	Civil/ Field supervision
8	Civil/ Bachelor	Quality Engineer	More than 5 years for the construction works	Civil/ Field supervision
9	Civil/ Bachelor	Supervisor	More than 5 years for the construction works	Civil/ Field supervision
10	Environment/ Bachelor	Environmental Specialist	More than 5 years for the construction works	Environment/ Field supervision
11	Civil or Social/ Bachelor	Social Expert	More than 5 years for the construction works	Social/ Field supervision

The participants can nominate the staff of related foreign companies with the letter of agreement for the cooperation to the project.

5. Has a letter of financial support from government banks / private for .....
[at least 10% (ten percent) of the total value of HPS];

6. Has the ability to provide the equipment and material to carry out the construction work, namely:

Equipment

No.	Type	Capacity	Number
1	Machines for long distance and curved microtunneling works	φ2000mm	1unit
2	Slurry separation facilities		1unit
3	Machines for press-in caisson method		3unit
4	Clamshell		3unit

The participants can nominate the equipment of related foreign companies with the letter of agreement for the cooperation to the project.

Material (Jacking pipe)

Item	Requirement
Type	Precast Reinforced Jacking Concrete Pipe with collar
External Strength	Class II
Concrete Compressive Strength	50 N/mm^2
Dimension	2000mm
Joint Specification	JC-0.3MPa
Water Resistance	0.3 MPa (Water resistant under 0.4Mpa shall be tested in the factory)
Hydrogen Sulfide (H_2S) Resistance	Resistance under 10ppm of H_2S: The reinforced concrete jacking pipe which is made with the additive for H_2S resistance, or equivalent H_2S resistant jacking pipe shall be used. The inner lining pipe is not applicable considering the difficulty of quality control.

7. Has a TIN and has fulfilled tax obligations last tax year (the annual tax return) and has a monthly report of Article 21, article 23 (if there is a transaction), article 29 25/Pasal and VAT (for the Taxable Person) at least 3 (three) months in the current year. Participants can override this requirement by submitting a Certificate of Fiscal (SKF)

Annual tax returns for the years requested .....
[filled with attention to the bid submission and tax laws]

Tax returns for 3 (three) months starting in ... sd ...
[Name of the last month before the month names filled the deadline for bid submission date by taking into account tax laws]

F. Qualification Document (IKP_ Clause 6)

Add following subparagraph to Sub- Clause 6:

6.4 Participants have to submit the work experience sheet and typical as-built drawings, such as plane and longitudinal drawings, for **ALL** works which satisfy the requirement for the project indicated in sub-clause 3.c in LDK 4 "Qualification Requirement" and which were carried out within last 10 years. The format of work experience sheet is attached in Appendix C in Chapter VI.

G. Language of

Replace the clause 7 to the following:

Qualification Document (IKP_ Clause 7)	Qualification documents and all correspondence in the qualification process shall be written in Indonesian and/or English. The Integrity Pact (Chapter V), 2) Qualification Form (Chapter VI), 3) Certification of Bank Financial Support (Chapter VII), and 4) Agreement of Partnership/ Joint Ventures (Chapter VII) shall be written in Indonesian. And 5) Work Experienced Sheet and 6) evidence of the capability of participants to provide the equipment and material shall be written in English and with the explanation in Indonesian. The document which is written in foreign language other than English shall be translated in English.

1 The personnel in question is managerial personnel (skilled / unskilled) in the organization execution of work. For non-small enterprises do not include skilled workers and / or support personnel, while small enterprises implementing sufficient personnel (skilled labor).

CHAPTER V FORM OF INTEGRITY PACT

Please use standard PQ document.

CHAPTER VI QUALIFICATION FORM

I, the following:
Name: .....
[name of authorized representative of a business entity]
Occupation: .....
[fill in appropriate positions in the certificate of incorporation and amendments]
Acting for and on behalf of
: PT / CV / Firm / or other ..... [select the appropriate and entity name]
Address:
No. ..... Phone: ..... No.. Fax: ..... E-mail: .....
hereby certify that:

1. Legally I have the capacity to sign a contract by notarial act ..... [corresponding deed of establishment / amendment / authorization letter, state clearly the number and date of the deed of establishment / change / power of attorney. If the partnership / KSO then included additional letter Partnership Agreement / KSO];

2. Mine not as an employee of K / L / D / I [for employees of K / L / D / I, who was on leave outside the responsibility of the K / L / D / I is written as follows: "I am an employee of K / L / D / I was on leave outside the dependents K / L / D / I "];

3. Mine was not under criminal sanction;

4. Mine not being and will not be involved in a conflict of interests with the parties concerned, directly or indirectly in this procurement process;

5. Entity I represent are not included in the Black List, not in the custody of the court, not bankruptcy, and activities that do not was discontinued;

6. Incorrect one and / or all of the management entity that I represent not included in the Black List;

7. Data I / entities I represent are as follows:
A. Data Administration

1. Name (PT / CV / Firm /or other.): Status: ..... 2. Centre Branch 3. Headquarters Address: ..... No.. Phone: ..... No.. Fax: ..... E-mail: ..... 4. Branch Office Address: ..... No.. Phone: ..... No.. Fax: ..... E-mail: .....

B. Permits

1. Permit for Construction Services: a. Number ..... b. Date ..... 2. Validity of business license: ..... 3. Institution issuing business licenses: .....

C. Certificate of Business Entity

1. Certificate Entity: a. No. ..... b. Date ..... 2. Validity period: ..... 3. Institution issuing: .....

D. Permit or Other requirements (if required, in accordance with the work tendered)

1. Permit or conditions ..... *): c. No. ..... d. Date ..... 2. Validity of license or terms: ..... 3. Agency or licensing requirements: .....

*) Permit or conditions required under the legislation in force (eg for complex work may be required Certificate of Quality Management System (ISO) and / or Certificate Management System K3 (SMK3))

E. Legal Basis for Establishing Business Entities

1. Deed PT / CV / Firm / at a. Deed No. /b. Date/ c. Name of Notary
2. Last Amendment a. Deed No./b. Date/c. Name of Notary

F. business enterprises

1. Commissioner / Supervisor for a Limited Liability Company (PT)

No.	Name	KTP	Position in Enterprise

2. Directors / Management Entity

No.	Name	KTP	Position in Enterprise

G. Financial Data

1. Composition of Shareholding (PT) / composition of the partners (for CV / Firm)

No.	Name	KTP	Percentage

2. Tax

a. Taxpayer Identification Number: ..... b. Evidence Reports Last Tax Year (SPT Annual): No.. Date .... c. Proof of Monthly Reports (Three months): 1) Article 21: No.. Date .... 2) Income Tax Article 23 (if there are transaction this week. Date .... 3) Income Tax Article 29 25/Pasal week. Date .... 4) VAT: No.. Date .... d. Certificate of Fiscal *): No.. Date ....

*) When used by providers as a substitute letters b and c

H. Key Personnel Data (expert technical / business entities)

No	Name	Date / mm / yy birth rate	Education level	Position in work experience	experience Employment (years)	profession / expertise	year certificate / diploma
1	2	3	4	5	6	7	8
1				Project Manager (Team leader)			
2				Site Manager			

3				Site Engineer manager			
4				Jacking Operator			
5				Geotechnical Engineer			
6				Quantity Surveyor Manager			
7				Quantity Engineer			
8				Quality Engineer			
9				Supervisor			
10				Environmental Specialist			
11				Social Expert			

The participants can nominate the staff of related foreign companies with the letter of agreement for the cooperation to the project.

I. Data Tools

No.	type of Equipment	number	Capacity or output at this time	Brands and types	year of manufacture	Condition (%)	Current Location	Status "Ownership" (Millik / Rent / Other)
1	2	3	4	5	6	7	8	9
1	Machines for long distance and curved microtunneling works	1unit						
2	Slurry separation facilities	1unit						
3	Machines for press in caisson method	3unit						
4	Clamshell	3unit						
5	Jacking Pipe							

The participants can nominate the equipment of related foreign companies with the letter of agreement for the cooperation to the project.

J. Data Experience Company in the last 10 years (the highest value experience package according to the classification / subclassification required)

No.	Name of Work Package	Classification / subclassification Work	location	Task Giver / officer commitment		Contract		TEnd Date according to	
				Nama	Address and Phone	Number and Date	Value (Rp)	Kontrak	BA contracts Handover (PHO) (PHO)
1	2	3	4	5	6	7	8	9	10
1	Microtunneling work								
2	Shaft work								

The participants can nominate the experience of related foreign companies with the letter of agreement for the cooperation to the project.

The detail information and typical drawing of the above projects shall be indicated in the Work Experience Sheet.

K. Data Company Experience in the last 5 years

(used for assessment or SKP SKP = 6 = 1.2 N for non-small work packages)

No.	Name of Package	Job	Task Giver Location / Officer		Contracts/Subcontracts		Commitment End Date According to	
			Nama	A Address and Phone	Number and Date	Value (Rp)	Contract	Handover BA (PHO)
1	2	3	4	5	6	7	8	9

The detail information and typical drawing of the above projects shall be indicated in the Work Experience Sheet.

L. Work Being Performed data (for calculation SKP = KP - the number of packets being worked on)

No.	Name of Package	Job	Task Giver Location / Officer Committing		Contract		Plan the date the contract expires
			Nama	Address / Phone	Number and Date	Value (Rp)	
1	2	3	4	5	6	7	8

M. Working Capital
Letter of financial support from the Bank: Number: .....
Date: ..... Name of Bank: .....
Value: USD ..... (..... In case .....)

This statement I make with the real and full sense of responsibility. If later found that the data / documents that I submit are not correct and / or there is fraud, then I and I represent business entities willing to be liable to administrative penalties, sanctions inclusion in the Black List, a civil lawsuit, and / or reporting criminal to authorities in accordance with the provisions of the legislation.

..... [Place], ... [date] ..... [month] 20 .... [Years]
PT / CV / Firm / or other
..... [Select the appropriate and name]
[Affix the seal of Rp 6.000, - and signature]
(Full name of authorized representative of a business entity)
[Office of the business entity]

CHAPTER VII. INSTRUCTIONS FOR FILLING FORM PART QUALIFICATION

A. ADMINISTRATIVE DATA

B. Business License

C. Certificate of Business Entity

D. Permit or Other requirements (if required, in accordance with the Bidding Document)

E. Business Establishment of the Legal Basis

F. Management Agency (Supervisory / Management)

G. Financial Data

H. Data of Core Personnel

I. Data Tools

Filled with the kind, quantity, capacity or output that can be achieved in this time, the brand and type, year of manufacture, condition (in percentage), and the location of the current status of ownership / rental support (can be charged as your own / lease purchase / lease / contract or otherwise which are not being used in the implementation) of each facilities / equipment / supplies as required for the main job is tendered in accordance with the Procurement Documents. Working Group if necessary to prove the existence of tools and evidence ownership status must be shown at time of Proof Qualifications.

The procurement of required jacking pipe must be explained in the Qualification Form by attaching the certification or agreement of supplier. The name and capabilities of manufacturer including method to produce the jacking pipe and its test facilities shall be indicated.

J. Data Company Experience

Filled with the name of the work packages are selected from the value The highest package, classification / subclassification work, the location where execution of the work, the name and address / telephone of the assignor / Committing Officer, number / date and contract amount, date of completion of work packages according to the contract, and the date of the Minutes, handover (PHO), for each work package for 10 (ten) years.

Participants have to submit the work experience sheet and typical as-built drawings, such as plane and longitudinal drawings, for **ALL** works which satisfy the requirement for the project indicated in sub-clause 3.c in LDK 4 "Qualification Requirement" and which were carried out by participants within last 10 years. "Participants" mean prime company (at a minimum), JO members, and/or the related companies which provide staff and facilities to the prime company for the project. If the participants nominate the experience of related companies, they shall submit the letter of agreement for the project. The format of work experience sheet is attached in Appendix C in Chapter VI.

K. Data Company Experience in the last 5 years

Filled with the name of the work packages, the location where the execution work, the name and address / telephone of the assignor / Committing Officer, number / date and value of the contract, the date of completion of work packages according to the contract, and the date of handover Minutes (PHO), for each work package for 5 (five) last year.

Participants have to submit the work experience sheet and typical as-built drawings, such as

plane and longitudinal drawings, for **ALL** works which satisfy the requirement for the project indicated in sub-clause 3.c in LDK 4 "Qualification Requirement" and which were carried out by participants, JO members, and subcontractors within last 10 years. The format of work experience sheet is attached in Appendix C in Chapter VI.

L. Data of Works Being Carried Out

M. Working Capital

N. Partnership / KSO

For participants who form partnerships / KSO each member partnership / KSO shall complete the form of qualification for each qualifying business entity.

Agreement or supporting letter shall be submitted when the participant register the subcontractor's experience.

APPENDIX A - FORM OF AGREEMENT OF PARTNERSHIP / JOINT VENTURES (KSO)

Please use the standard form.

APPENDIX B - FORM OF CERTIFICATE OF BANK FINANCIAL SUPPORT

Please use the standard form.

APPENDIX C – WORK EXPERIENCE SHEET

Company name	

(No.____/____)

1) Project Name	
2) Country	
3) Contract period	(Total____months)
4) Contract amount	
5) Contractee	
Organization	
Address	
Person in Charge	
E-mail	
Tel/Fax	
6) Construction Condition	
Microtunneling work	
Maximum diameter	D_____mm
Maximum span	_____m
Minimum curvature radius	_____m
Groundwater pressure	_____MPa
Shafting work	
Excavation depth	_____m
Brief summary of construction work	
Typical drawing	*Please attach the typical as-built drawing (such as plan drawing).*
Completion certificate	Available/ not available *Please attach the completion certificate if available.*

CHAPTER VIII EVALUATION PROCEDURE QUALIFICATION

A. Qualification Document will be evaluated from the data on Sheet Fields

9. Deliver / fill list acquisition work is being done;

Comments from JICA Study Team
Applicants must have the specific construction experience which is stipulated in "D. Qualification Requirements" in chapter IV. Therefore, the definition of NPt shall be amended to "value experience in the appropriate specific construction experience within 10 (ten) years"

Appendix-8

TENDER DOUCMENTS OF PILOT PROJECT

PILOT PROJECT
OF
SEWERAGE SYSTEM DEVELOPMENT
IN
DKI JAKARTA

TENDER DOCUMENT

October 2014

PILOT PROJECT OF SEWERAGE SYSTEM DEVELOPMENT IN DKI JAKARTA
TENDER DOCUMENT

TABLE OF CONTENTS

CHAPTER I GENERAL

Please use standard document.

CHAPTER II INSTRUCTIONS TO BIDDERS (IKP)

Please use standard document.

CHAPTER III BID DATA SHEET (BDS)

A. Implementation of IKP and LDP

If there is conflict provisions written on Election Data Sheet (LDP) with instructions to participants (IKP) is used then the provisions of the Election Data Sheet (LDP).

B. Scope of Work

1. a. WG-ULP:
Procurement Unit of Pilot Project of Sewerage System Development in DKI Jakarta

b. WG-ULP address:
.....

2. Websites: Ministry of Public Works (http:// www.pu.go.id)

3. a. Name of work package:
Pilot Project of Sewerage System Development in DKI Jakarta

b. A brief description of the work:
The construction work to be carried out by the Contractor is specified as follows.

Description	Unit	Quantity
(1) Construction of Sewerage Pipeline Length of Pipeline is 962.9m in total. (286.6m between Shaft A and B, 676.3m between Shaft B and C)		
1) Pipe Installation		
Length of Micorotunneling Method between Shaft A and B	m	279.9
Length of Micorotunneling Method between Shaft B and C	m	669.6
2) Construction of Shaft and Manhole		
Shaft A	unit	1
Shaft B and Manhole B	unit	1
Shaft C	unit	1

The Work shall be carried out in accordance with the drawings, the specifications and the directions of PPK (committing officer) and the supervision consultant of the project.

The Contractor has to deeply investigate the exact location of existing underground utilities in advance to prevent the affection and to carry out the appropriate measures during the construction work. In addition, the contractor shall investigate the soil condition, groundwater level, and surrounding environment at the location of drive shaft and pipeline etc., in order to select an appropriate microtunneling technology. The construction work cannot make an impact to the neighboring private housing and the alignment of sewer main cannot be allowed to occupy the private lot. Moreover, the distance between the structures constructed in the project and the boundary of the inspection road shall be more than and equal to 5.2m at the location of

	wastewater treatment plant (Manhole A and B)). In addition, the Contractor must carry out the construction work, environmental measures, and safety control carefully during the construction. Particular attention shall be given as the general obligations of the Contractor when working in the vicinity of existing utility services, street trees, and boundary of private lot. 4. Duration of completion of work: Seven hundred thirty (730) calendar days
C. Source of Funds	This work was funded by the funding sources: APBN for Fiscal Year 2015-2016-2017 Total budget of ****.
D. Efficiency of Domestic Production	Price preference given to offer participants. Note: 1) price preference for goods / services in the country imposed on Procurement of Goods / Services financed pure dollars but only applies to the procurement of goods / services worth over Rp1.000.000.000, 00 (one billion IDR); and. 2) Preference is given to only the price of goods / services in the country with local content greater than or equal to 25% (twenty five percent). If the tendered work packages that meet the requirements 1) and 2) the preferences apply and the price charged "given"
E. Provision Explanation Document	1. Providing Explanations Bidding Document will be held on: According to the schedule listed in the electronic procurement system.
Selection and review of Field	2. Fieldwork will be held on: According to the schedule listed in the electronic procurement system.

F. Bid Documents

1. Having the ability to provide the personnel[6)] necessary for the execution of the work as follows:

No	level of Education	Positions in the proposed work	Work experience (years)	Profession / Expertise
1	2	3	4	5
1	Civil/ Bachelor	Project Manager (Team leader)	More than 15 years for the microtunneling works. More than 5 years for the team leader of the project.	Civil/ Field supervision
2	Civil/ Bachelor	Site Manager	More than 10 years for the construction works	Civil/ Field supervision
3	Civil/ Bachelor	Site Engineer manager	More than 10 years for the construction works	Civil/ Field supervision
4	Civil or Mechanical/ Bachelor	Jacking Operator	More than 10 years as a operator of jacking pipe.	Operator of microtunneling jacking machine
5	Civil/ Bachelor	Geotechnical Engineer	More than 10 years for the civil work including shaft work.	Civil/ Construction of deep shaft
6	Civil/ Bachelor	Quantity Surveyor Manager	More than 5 years for the construction works	Civil/ Field supervision
7	Civil/ Bachelor	Quantity Engineer	More than 5 years for the construction works	Civil/ Field supervision
8	Civil/ Bachelor	Quality Engineer	More than 5 years for the construction works	Civil/ Field supervision
9	Civil/ Bachelor	Supervisor	More than 5 years for the construction works	Civil/ Field supervision
10	Environment/ Bachelor	Environmental Specialist	More than 5 years for the construction works	Environment/ Field supervision
11	Civil or Social/ Bachelor	Social Expert	More than 5 years for the construction works	Social/ Field supervision

The participants can nominate the staff of related foreign companies with the letter of agreement for the cooperation to the project.

2. Having the ability to provide the equipment to carry out the construction work, namely:

No.	Type	Capacity	Number
1	Machines for long distance and curved microtunneling works	φ2000mm	1unit
2	Slurry separation facilities		1unit
3	Machines for press-in caisson method		3unit
4	Clamshell		3unit

The participants can nominate the equipment of related foreign companies with the letter of agreement for the cooperation to the project.

3. Subcontracted parts work[7)]

No	Type of Work subcontracted
1	
2	

Requirements subcontract construction work:
value offers> Rp 25,000,000,000, there Participants must subcontract, in the case of the Working Group set a list of work to be subcontracted, the Participant shall comply with the list.
Related to the job offer subcontracting eligible if:

a. Providers who bid at a price above IDR 25,000,000,000.00 (twenty five billion IDR) in collaboration with providers of Micro, Small Businesses, and small cooperatives, namely the subcontract most of the work is not the main job.
b. Providers do not subcontract a part / whole main job.
c. Small providers (including micro and small cooperatives) not subcontract work obtained.

4. As the main work[8)] is:

<table>
<tr><td>No</td><td>Main Job Type</td></tr>
<tr><td>1</td><td>Microtunneling work</td></tr>
<tr><td>2</td><td>Shafting work (press-in caisson)</td></tr>
<tr><td>3</td><td>Procurement of jacking pipe as follows:
<table>
<tr><th>Item</th><th>Requirement</th></tr>
<tr><td>Type</td><td>Precast Reinforced Jacking Concrete Pipe with collar</td></tr>
<tr><td>External Strength</td><td>Class II</td></tr>
<tr><td>Concrete Compressive Strength</td><td>50 N/mm^2</td></tr>
<tr><td>Dimension</td><td>2000mm</td></tr>
<tr><td>Joint Specification</td><td>JC-0.3MPa</td></tr>
<tr><td>Water Resistance</td><td>0.3 MPa
(Water resistant under 0.4Mpa shall be tested in the factory)</td></tr>
<tr><td>Hydrogen Sulfide</td><td>Resistance under 10ppm of H_2S:</td></tr>
</table></td></tr>
</table>

	(H_2S) Resistance	The reinforced concrete jacking pipe which is made with the additive for H_2S resistance, or equivalent H_2S resistant jacking pipe shall be used. The inner lining pipe is not applicable considering the difficulty of quality control.

5. As auxiliary / temporary as the main supporter of the work is:

No	Type of Work Support / While
1	Site preparation - Installation and removal of site sign board - Clearing and grubbing - Demolition and disposal of monument - Remove and grub large trees and the plantation - Transplantation of trees
2	Soil investigation
3	Contractor's temporary facilities
Dst	

6. Identification of hazards[9)]

No	Type / Type of Work	Hazard Identification & Risk type K3
1		
Dst		

6. Testing the quality / technical / function under certain conditions required for:
   a. Permanent construction materials:
      Precast Reinforced Jacking Concrete Pipe with collar
   b. Tools that are part of the permanent construction:
      No

G. Offer Currency and Payment
1. Currency used Rupiah
2. Payments made by way of installment (termin)

H. Period of Validity of Offer
The validity period of offers for 150 (one hundred fifty) calendar days after the deadline for bid submission.

I. Bid Security
1. Bid security amount is Rp. (..... .....)
[filled, large nominal between 1% to 3% of the total value of HPS]
2. Guarantee offer is valid for 150 (one hundred fifty) calendar days and the effective start date .....
[Filled in accordance with the submission deadline offers].

J. Submission of Bid Documents
According to the schedule listed in the electronic procurement system.

K. Deadline for
According to the schedule listed in the electronic procurement system.

Submission of Offers	
L. Bid Opening	According to the schedule listed in the electronic procurement system.
M. Threshold	*[for public tender if the evaluation of the technique using a knockout with a threshold, then the determination of elements and sub-elements were assessed technical and assessment criteria must be approved and / or using the criteria established by the first echelon of each Unit of Work Unit in accordance with the duties , the function and scope of the program;* *Determination usage thresholds include:* *1. The threshold value of each element:* *a. .....* *Dst .....* *2. Threshold value total: .....]*

The technical evaluation of the project will be carried out by knockout method with a threshold. The financial proposal will be opened only for the bidder who passes the technical evaluation.
Technical evaluation will be carried out by the submittal documents (bidding proposal) and the interview. The representative of the bidder (such as proposed Team Leader) shall make a presentation to explain their technical proposal and participated in the interview to confirm the applicants' performance when WG-ULP requests.

1 The threshold value of following technical elements:

a. **Construction method**: evaluation weight 30 %, threshold 70%;
b. **Construction time schedule** (do not exceed the time limit stipulated in the bidding document): evaluation weight 10 %, threshold 70%;
c. **Contractor's equipment and major materials:** evaluation weight 20 %, threshold 70%;
d. **Key personnel and staffing schedule**: evaluation weight 30%, threshold 70%;
e. **Pre RK3K**: evaluation weight 10 %, threshold 70%.

2 Thresholds total: 80% of total score

N. Disclaimer, Disclaimer and Appeals	1. Disclaimer addressed to Procurement unit of Pilot Project of Sewerage System Development in DKI Jakarta 2. Copies of objections addressed to: a. KDP ..... [fill in name of KDP] b. KPA ..... [fill in the name of the KPA] c. APIP ..... [fill in name of APIP] d. ..... [Filled officials who received the assignment to answer an appeal, if delegated] e. ..... [Filled Minister / Head of Institution / Regional Head / Head

of Institution]

3. Disclaimer appeal addressed to
.....
[fill in the name of the Minister / Head of Institution / Regional Head / Head of Institution or official who receives the assignment of answering an appeal, example: Minister of Public Works]

4. Copies of an appeal addressed to:
a. KDP ..... [fill in name of KDP]
b. WG-ULP ..... [fill in name of WG-ULP]
c. APIP ..... [fill in name of APIP Ministry / Agency / Local Government / Institutions]

O. Warranty Disclaimer Appeal

1. Guarantee Disclaimer Appeal addressed to Procurement unit of Pilot Project of Sewerage System Development in DKI Jakarta
[Fill in official name of WG-ULP].

2. Magnitude guarantees an appeal: USD ..... (..... .....)
[filled by 1% (one percent) of the total value of HPS]

P. Utilization of Domestic Production (IKP_ Clause 6)

Replace the Sub-clause 6.1 as follows:

Participants are obliged to prioritize the Indonesian workers and domestic production for the execution of construction work in Indonesia except for the type of work which Indonesian worker has sufficient experience and the Indonesian manufacturer can provide required quality of production.

Q. Language Document Selection (IKP_ Clause 10)

Replace the Clause 10 as follows:

Bidding documents and all correspondence in the procurement process shall be written in Indonesian and/or English as instructed hereunder.

Following documents indicated in Chapter IV shall be written in Indonesian.

A. FORM OF LETTER OF PARTICIPANTS SUPPLY AGENCY / PARTNERSHIP (KSO)
B. POWER OF ATTORNEY FORM
C. FORM PARTNERSHIP AGREEMENTS / JOINT VENTURES (KSO)
E. RECAP FORM SHAPE CALCULATION OF DOMESTIC COMPONENT (DCL)
F. FORM LIST OF IMPORTED GOODS
G. SHAPE SAFETY AND HEALTH PLAN CONTRACT (RK3K)
H. FORM DETAILS / DESCRIPTION UNIT PRICE WORK (HSP)
I. FORM OF BANK GUARANTEE OFFER

Following documents indicated in Chapter IV shall be written in English and with the explanation in Indonesian.

D. TECHNICAL BID FORM

R. Languages Offer (IKP_ Clause 15)

Replace the Sub-clause 15.1 as follows:

Bidding documents and all correspondence in the procurement process shall be written in Indonesian and/or English as instructed hereunder.

Following documents indicated in Chapter IV shall be written in Indonesian.

A. FORM OF LETTER OF PARTICIPANTS SUPPLY AGENCY / PARTNERSHIP (KSO)
B. POWER OF ATTORNEY FORM
C. FORM PARTNERSHIP AGREEMENTS / JOINT VENTURES (KSO)
E. RECAP FORM SHAPE CALCULATION OF DOMESTIC COMPONENT (DCL)
F. FORM LIST OF IMPORTED GOODS
G. SHAPE SAFETY AND HEALTH PLAN CONTRACT (RK3K)
H. FORM DETAILS / DESCRIPTION UNIT PRICE WORK (HSP)
I. FORM OF BANK GUARANTEE OFFER

Following documents indicated in Chapter IV shall be written in English and with the explanation in Indonesian.

D. TECHNICAL BID FORM

Replace the word “foreign language” in the Sub-clause 15.2 to the following:

“English”

CHAPTER IV BID FORM

A. FORM OF LETTER OF PARTICIPANTS SUPPLY AGENCY / PARTNERSHIP (KSO)

Please use standard document.

B. POWER OF ATTORNEY FORM

Please use standard document.

C. FORM PARTNERSHIP AGREEMENTS / JOINT VENTURES (KSO)

Please use standard document.

D. TECHNICAL BID FORM

Technical Bid Documents

1. Comments and Suggestions on the Technical Specifications.
2. The method of execution of work [provide a viable method implementation, realistic and stages can be carried out for completion of the work and is believed to depict main mastery in the completion of the work, and the stages of implementation that illustrates how the implementation of the work from beginning to end and can be justified technically];
2. Implementation schedule [not exceed the deadline as stated in the BDS];
3. Lists the type, capacity, composition and amount of equipment (if filed main equipment of different minimum entry qualification documents);
4. The list of key personnel who are placed in full (if filed different core personnel of stuffing qualification documents);
5. Piece of work that will be subcontracted [in accordance with the requirements as stated in the BDS]; and
6. Procurement plan of precast reinforced jacking concrete pipe with collar including supplier, specification of jacking pipe, and its quality control plan.

Note:
1) Equipment and personnel are delivered in bidding for 1 (one) package tendered work, if need equipment and personnel for other work packages must be from the equipment (to lease, contract, or other) and different personnel.
2) In order to evaluate the bidding document, the interview will be carried out.
3) The contents of technical proposal shall be indicated in working programme, method statements, environmental and safety management plans if the bidder is awarded.

E. RECAP FORM SHAPE CALCULATION OF DOMESTIC COMPONENT (DCL)

Please use standard document.

F. FORM LIST OF IMPORTED GOODS

Please use standard document.

G. SHAPE SAFETY AND HEALTH PLAN CONTRACT (RK3K)

Please use standard document.

H. FORM DETAILS / DESCRIPTION UNIT PRICE WORK (HSP)

Please use standard document.

I. FORM OF BANK GUARANTEE OFFER

Please use standard document.

CHAPTER V DRAFT CONTRACT FORM

Please use standard document.

CHAPTER VI GENERAL CONDITIONS OF CONTRACT

Please use standard document.

CHAPTER VII SPECIAL CONDITIONS OF CONTRACT (SCC)

A. Contact Address of the Parties as follows:	Unit CO: Name : Address : Website : E-mail : Fax : Provider: Name : Address : E-mail : Fax : *[Please fill in the required information]*
B. The Parties Legal Representative	Authorized representative of the Parties as follows: For KDP : For Providers : *[Please fill in the required information]*
C. Types Contract	Contract unit price
D. Effective Date of Contract	The contract is effective as of: ..... to ..... *[Including the defect notification period]*
E. Implementation Period	The implementation period for: **Seven hundred thirty (730)** calendar days from the date of start of work listed in SPMK.
F. Defect Notification Period	Defect Notification period is valid for: ..... *[Maintenance completed number of calendar days]* from the date of first delivery (PHO) work; or Defect Notification period is valid for: 365 to 730 calendar days (to be discussed) from the date of first delivery (PHO) piece of work that was able to function if there is a partial handover .
G. Quality Defect Repair	Late fee due to quality defects for every day of delay is equal to 1/1000 (one thousandth) of a quality defect repair costs. Timeline for quality defects in accordance with the estimated time needed for repairs and set by the KDP.
H. Lifespan of Construction	The design lifespan of the facilities constructed in the Contract is forty (40) years. The contractors shall insure against failure during a specified building: ___ years from the date of final delivery. *[Filled in accordance with the letter a design life for the life of the construction is not more than 10 (ten) years]*
I. Guidelines for Maintenance / Maintenance	Image "As built" and / or guidelines for the maintenance / maintenance must be submitted no later than: ..... (..... in case .....) calendar days / months / years after the date Stories signing ceremony early.
J. Bill Payment	The deadline agreed to the issuance of the CO for the payment of fees by installment bill is ..... (in letters ....) calendar days after the bill and supporting documents are not received by the CO disputed. *[Please fill in according to the normal condition in Indonesia]*

K. Liquefaction Warranty	Warranty melted and deposited on ..... *[Fill in the name of the State Treasury Office / Regional Cash]*
L. Actions Requires Provider	Other actions by providers who require the approval of KDP is: none *[state other than those already listed in the GCC, if any]*
M. Contracting CO or Supervisory Occupation	Other actions that require approval by the Provider Supervisor Job is: none *[state other than those already listed in the GCC, if any]*
M. Ownership Documents	Providers are allowed to use copies of documents and software resulting from the construction work with the following restrictions: ..... *[state restrictions / regulations are permissible in its use, for example : for research and research]*
N. Facilities	KDP will provide facilities such as: none *[State-owned facilities KDP can be used, if any]*
O. Compensation events	Including compensation events that can be compensated is ..... *[filled if there are other provisions of]*
P. Source of Funding	Procurement of contracts financed from the Construction Work APBN for Fiscal Year 2015-2016-2017
Q. Advance Payment	Advances given by 20% (in case ....) of the Contract Value
R. Occupational Health and Safety	K3 personnel required: ..... *[Expert filled K3 for high risk or moderate risk officer for the K3 or small]*
S. Payment Performance Work	Payment of work done by achievement: Monthly [filled by selecting Term / Monthly / Mass] Supporting documents required to apply for jobs bill payment achievements: ..... *[Specify document]* Determination and the amount of payment for the item of equipment and / or materials that become a permanent part of the main work (the material on site), defined as follows: 1 . Reinforced Concrete Jacking Pipe .... paid .....% of the contract price 2 ..... *[fill in the items of equipment / materials]* .... paid .....% of Contract price 3 ff ..... *[examples of equipment: escalators, lifts, stationary water pumps, turbines, electromechanical equipment; examples of materials fabrication: sheet pile, geosynthetic, conductors, towers, insulators; so materials example: precast concrete]*
T. Handover most jobs	In this contract enforced handover partly or partially to the following sections: 1 ..... 2 ..... 3. Etc. .. *[filled part of the work function and immediately used (if any)]*
U. Price adjustment (escalation / de-escalation)	Price adjustment given in terms of the formulation is given as follows: Hn = Ho (a + b.Bn / Bo + c.Cn / Co + d.Dn / Do + ...) Hn = Unit Price at the time they are made

	Ho = Unit Price at the time of the bid price; a = coefficient remains consisting of profit and overhead; In case the offer does not specify the amount of profit and overhead component then a = 0.15. b, c, d = coefficient of component contracts such as labor, materials, work tools, etc.; The sum a + b + c + d + ... etc. is 1.00. Bn, Cn, Dn = price index components at the time the work is performed (starting 13th month after signing the contract). Bo, Co, Do = the price index component to the 12th month after the signing of the contract. The formula above attention to the following matters: a) Determination of the coefficient of materials, labor, work tools, fuel, and set forth as an example as follows:

job	coefficient Components				
	a.	b.	c.	d.	a+b+c+d
Excavation by tool	0.15	....	....	....	1.00
concrete	0.15	....	....	....	1.00
reinforcing bar	0.15	....	....	....	1.00
	0.15	....	....	....	1.00
	0.15	....	....	....	1.00

	b) The price index used is sourced from the issuance of the BPS. c) In the event that the price index is not published by BPS, used price index issued by the technical agencies. d) the contract value adjustment formula specified as follows: Pn = (Hn1xV1) + (Hn2xV2) + (Hn3xV3) + ... etc. Pn = value after adjustment Contract Unit Price; Hn = new Unit Price of each type of component after work price adjustment using the adjustment formula Unit; V = volume of each type of component work performed. e) Payment of price adjustments made by the CO, if the provider has filed a bill with the calculations and data; f) Providers may submit periodically later than six (6) months.
V. fine	1. For this job big late fee for each day of delay is 1/1000 (one thousandth) of ..... *[total contract value or a value that is not part of the contract handed set when the partial handover]* 2. Financial sanctions against the realization of which is not in accordance with the DCL value imposed by the difference between the offer value DCL DCL deals with the realization of the value multiplied by the Offer Price, the maximum difference in the value of local content of 15% (fifteen percent)
W. Micro, Small and Small Cooperative	Sanctions to the provider if the violation of the provisions of the subcontract: a. If as a contractor, Provider Micro, Small and small cooperatives subcontract work, it will be fined ..... *[this provision to the value of the package under $ 2.5 billion, by filling in fine worth of work subcontracted to other parties or in accordance with prevailing regulations, for example, was fined worth of work to be subcontracted are listed in bidding documents]* b. If as a contractor, not a provider of Micro, Small and small cooperatives that do not subcontract work, it would be a fine ..... *[this provision to the value of over USD 25 billion package, by filling in fine*

	worth the work which will be subcontracted specified in the bidding documents or in accordance with prevailing regulations, for example, was fined worth of work to be subcontracted are included in the bidding documents] c. If as a contractor, not a provider of Micro, Small and small cooperative major subcontract work, it would be a fine ..... *[this provision to the value of over USD 25 billion package, with a fine worth filling in the main job subcontracted or in accordance with prevailing regulations, for example, was fined worth of major work subcontracted]*
X. Dispute Resolution / Dispute	In case of any dispute / disputes between the parties, the parties must first resolve the dispute through consultation and consensus. In terms of deliberation and consensus is not reached, the parties agreed to resolve the dispute / disputes through ..... *[filled court or arbitration]*
Y. Language to be used for the correspondences	Replace the first sentence with following: "All notices, requests, and/or approval under this contract shall be made in writing both in Indonesian and English,"
Z. Supervision work	Supervision work for the Contract will be carried out by the consultant as authorized representative of PPK (the commissioning officer) who is responsible for the execution of the work. The supervision consultant will be procured by DGLHD.

Appendix A - Special Conditions of Contract

Unit Price List, Sub-providers, Key Personnel, and Equipment

1. Unit Price List

Not provided for this pilot project.

2. Sub-providers

Not specified in this pilot project.

3. Key-Personnel

The key personnel for the pilot project is listed below:

No	Level of Education	Positions in the proposed work	Work experience (years)	Profession / Expertise
1	2	3	4	5
1	Civil/ Bachelor	Project Manager (Team leader)	More than 15 years for the microtunneling works. More than 5 years for the team leader of the project.	Civil/ Field supervision
2	Civil/ Bachelor	Site Manager	More than 10 years for the construction works	Civil/ Field supervision
3	Civil/ Bachelor	Site Engineer manager	More than 10 years for the construction works	Civil/ Field supervision
4	Civil or Mechanical/ Bachelor	Jacking Operator	More than 10 years as a operator of jacking pipe.	Operator of microtunneling jacking machine
5	Civil/ Bachelor	Geotechnical Engineer	More than 10 years for the civil work including shaft work.	Civil/ Construction of deep shaft
6	Civil/ Bachelor	Quantity Surveyor Manager	More than 5 years for the construction works	Civil/ Field supervision
7	Civil/ Bachelor	Quantity Engineer	More than 5 years for the construction works	Civil/ Field supervision
8	Civil/ Bachelor	Quality Engineer	More than 5 years for the construction works	Civil/ Field supervision
9	Civil/ Bachelor	Supervisor	More than 5 years for the construction works	Civil/ Field supervision
10	Environment/ Bachelor	Environmental Specialist	More than 5 years for the construction works	Environment/ Field supervision
11	Civil or Social/ Bachelor	Social Expert	More than 5 years for the construction works	Social/ Field supervision

The participants can nominate the staff of related foreign companies with the letter of agreement for the cooperation to the project.

4. Special Equipment

The special equipment applied for the pilot project is listed below:

No.	Type	Capacity	Number
1	Machines for long distance and curved microtunneling works	φ2000mm	1unit
2	Slurry separation facilities		1unit
3	Machines for press-in caisson method		3unit
4	Clamshell		3unit

The participants can nominate the equipment of related foreign companies with the letter of agreement for the cooperation to the project.

CHAPTER VIII TECHNICAL SPECIFICATIONS AND DRAWINGS

1. Scope of Works

1.1 Scope of the Works

The construction work to be carried out by the Contractor is specified as follows.

Description	Unit	Quantity
(1) Construction of Sewerage Pipeline Length of Pipeline is 962.9m in total. (286.6m between Shaft A and B, 676.3m between Shaft B and C)		
1) Pipe Installation		
Length of Micorotunneling Method between Shaft A and B	m	279.9
Length of Micorotunneling Method between Shaft B and C	m	669.6
2) Construction of Shaft and Manhole		
Shaft A	unit	1
Shaft B and Manhole B	unit	1
Shaft C	unit	1

The Work shall be carried out in accordance with the drawings, the specifications and the directions of PPK (committing officer) and the supervision consultant of the project.

The Contractor has to deeply investigate the exact location of existing underground utilities in advance to prevent the affection and to carry out the appropriate measures during the construction work. In addition, the contractor shall investigate the soil condition, groundwater level, and surrounding environment at the location of drive shaft and pipeline etc., in order to select an appropriate microtunneling technology. The construction work cannot make an impact to the neighboring private housing and the alignment of sewer main cannot be allowed to occupy the private lot. Moreover, the distance between the structures constructed in the project and the boundary of the inspection road shall be more than and equal to 5.2m at the location of wastewater treatment plant (Manhole A).

In addition, the Contractor must carry out the construction work, environmental measures, and safety control carefully during the construction.

Particular attention shall be given as the general obligations of the Contractor when working in the vicinity of existing utility services, street trees, and boundary of private lot.

1.2 Time for Completion

Time for Completion is 24 months.

2. Technical Specifications

The Technical Specifications for the Contract Package are attached separately under separate cover titled as follows:

(a) Division I –General Requirements, and

(b) Division II –Civil Works.

3. Drawings

The Drawings are attached separately under separate cover titled as follows:

(c) Division III- Drawings.

4. Supplemental Information

4.1 Proposal of Requirement of Contractors

The project has the following particular features and site conditions.

1) Difficulty of the construction work

The sewer construction works of the project shall be carried out by long-distance and curved microtunneling technology to prevent the social impact by the traffic congestion during the construction. In addition, planned depth of the jacking pipe and shaft is so deep that contractor shall carry out the construction work under the high groundwater pressure (about 30m).

2) Requirement of appropriate jacking pipe

Jacking pipe applied for the project requires enough strength enough to comply with the jacking force and external load. In addition, its joint has to withstand high groundwater pressure as mentioned above. The contractor needs to procure and apply appropriate jacking pipe.

The microtunneling technology with the conditions mentioned the above has not been applied in Indonesia and there is limited Indonesian contractor with the sufficient equipment and skill for the work.

Therefore, it is recommended for Indonesian contractor to establish JO or subcontract with foreign company which has sufficient experience and skill for the project.

4.2 Others

Please describe if any.

CHAPTER IX QUANTITY AND PRICE LIST

Information

1. Quantities shall be read in accordance with the Instructions to Bidders (IKP), General Conditions of Contract (GCC) and Special Conditions of Contract (SCC), Technical Specifications and Drawings.
2. Payments on achievement of work done by the actual quantity of work done as requested and measured by the Provider and verified by the Committing Officer (CO), and assessed according to the prices listed in the Bill of Quantities.
3. Prices in the Bill of Quantities shall be completed which has covered all the costs of work, personnel, supervision, materials, maintenance, taxes, profit, overhead (including the cost of K3) and set out in the Contract.
4. Prices must be included for each currency of payment. If the provider fails to include the price for a job then the work is deemed to have included in the price currency other payments in the Bill of Quantities.
5. All costs incurred to meet the provisions of the Contract shall be deemed to have been included in each eye of payment, and if there is no eye-related payments, the cost is to be deemed to have been included in the price of another currency payments.
6. WG-ULP will perform arithmetical correction for the error calculation with the following conditions:
   a. if there is a difference between writing a value in the numbers and letters on the offer letter that noted the value of the letter;
   b. multiplication result if an error occurs between the volume (units with a multiplication of quantity) at a unit price of rectification work is carried out, with the volume of work in accordance with the provisions specified in the Bidding Document and the unit price should not be changed; and
   c. if there is not written with the kind of work it will be complete clarification and assessment to proceed or not proceed in the evaluation of bids.

SUMMARY OF BILL OF QUANTITIES

Project Name: Pilot Project of Sewerage System Development in DKI Jakarta

Location: DKI Jakarta
Work Period : 2016-2017-2018 (24months)

BILL No.	DESCRIPTION	AMOUNT (IDR)
1	Preparatory Works	-
2	Shaft Construction	-
3	Pipe Installation:	-
4	Construction of Manhole	-
	Sub-total	-
	Contingency (10%)	-
TOTAL BID SUM *		* -
Value Add Tax (10%) **		-
Grand Total		-

(i) Total Bid Sum, written in words.
IDR:

(*) Carry Forward to Bid

(**) Add 10% of the sum of items 1 to 4 inclusive, for both foreign and local currency components

No.	Item of Works	UNIT	QUANTITY	UNIT RATE IDR	AMOUNT IDR
1	Preparatory Works				
1-1	Installation and removal of Site Sign Board (height: 5m , width: 3m)	site	3.00		
1-2	Mobilization and Demobilization	LS	1.00		
1-3	Soil Investigation: including Mobilization and Demobilization, Test Boring, Laboratory Tests and Preparation of Report as specified in the specification				
1-3-1	Sewer Line between Shaft-A to Shaft-B	m	40.00		
1-3-2	Sewer Line between Shaft-B to Shaft-C	m	120.00		
	Sub Total-1-3				
1-4	Survey : including Establishment /Construction of BM, Topographical survey, Center line survey, Levelling survey and preparation of Reporting& Drawings as specified in the specification.				
1-4-1	Topographical Survey	ha	5.0		
1-4-2	Line Survey	m	1,000.0		
1-4-3	Leveling Survey	m	1,000.0		
	Sub Total-1-4				
1-5	Clearing and Grubbing: including hauling to designated disposal Area(L=10km)				
1-5-1	Shaft-A site	m2	1,500.00		
1-5-2	Shaft-B site	m2	700.00		
1-5-3	Shaft-C site	m2	1,450.00		
	Sub Total-1-4				
1-6	Demolition and disposal of monument: including hauling to designated disposal Area(L=10km) (Shaft-C area)	LS	1.00		
1-7	Remove and grub large trees and the plantation due to 10 trees as compensation (Shaft-C area)	no.	2.00		
1-8	Transplantation of trees				
1-8-1	Shaft-A site	no.	5.00		
1-8-2	Shaft-C site	no.	7.00		
	Sub Total-1-7				
1-9	Contractor's Temporary Facilities				
1-9-1	Site Office	m2	150.00		
	Sub Total-1				

No.	Item of Works	UNIT	QUANTITY	UNIT RATE IDR	AMOUNT IDR
2	Shaft Construction				
2-1	Shaft A				
2-1-1	Earth-retaining work for Prevention of Collapse (Driving and removal of Steel Sheet PILE TypeⅢ L=8.0m): including material supply and construction)	m	928.0		
2-1-2	Excavation of Shaft by Press in Caisson Construction Method: including hauling to designated disposal Area(L=10km) and all associated works	m3	2,923.00		
2-1-3	Concrete of Wall and Basement (Fc=24N/mm2 with ordinary Portland cement): including supply, placement and formwork	m3	1,085.00		
2-1-4	Underwater Concrete(Fc=30N/mm2 with ordinary Portland cement): including supply and placement	m3	167.00		
2-1-5	Deformed Reinforcing Bars(SD345)of Wall and Basement: including supply, bending and placement	t	83.30		
2-1-6	Concrete cover of Top of the Shaft	set	1.00		
2-1-7	Installation Chain Link Fence (height : 3.0m) : including supply, fabrication and installation	m	60.0		
	Sub Total 2-1				
2-2	Shaft B				
2-2-1	Earth-retaining work for Prevention of Collapse (Driving and removal of Steel Sheet PILE TypeⅢ L=8.0m): including material supply and construction)	m	656.0		
2-2-2	Excavation of Shaft by Press in Caisson Construction Method: including hauling to designated disposal Area(L=10km) and all associated works	m3	1,072.00		
2-2-3	Concrete of Wall and Basement (Fc=24N/mm2 with ordinary Portland cement): including supply, placement and formwork	m3	418.00		
2-2-4	Underwater Concrete(Fc=30N/mm2 with ordinary Portland cement): including supply and placement	m3	46.00		
2-2-5	Deformed Reinforcing Bars(SD345)of Wall and Basement: including supply, bending and placement	t	40.42		
2-2-6	Demolished Concrete wall Height 2.3m of Top of Shaft : including disposal demolished concrete	m3	17.34		
2-2-7	Sandy Soil Backfill: including supply and placement	m3	66.28		
	Sub Total 2-2				
2-3	Shaft C				
2-3-1	Earth-retaining work for Prevention of Collapse (Driving and removal of Steel Sheet PILE TypeⅢ L=8.0m): including material supply and construction)	m	928.0		
2-3-2	Excavation of Shaft by Press in Caisson Construction Method: including hauling to designated disposal Area(L=10km) and all associated works	m3	2,815.00		
2-3-3	Concrete of Wall and Basement (Fc=24N/mm2 with ordinary Portland cement): including supply, placement and formwork	m3	1,046.00		
2-3-4	Underwater Concrete(Fc=30N/mm2 with ordinary Portland cement): including supply and placement	m3	167.00		
2-3-5	Deformed Reinforcing Bars(SD345)of Wall and Basement: including supply, bending and placement	t	79.97		
2-3-6	Concrete Cover of Top of the Shaft	set	1.00		
2-3-7	Installation Chain Link Fence (height : 3.0m) : including supply, fabrication and installation	m	60.0		
	Sub Total 2-3				
	Sub Total 2				

No.	Item of Works	UNIT	QUANTITY	UNIT RATE IDR	AMOUNT IDR
3	Pipe Installation:				
3-1	Sewer Line between Shaft -A to Shaft-B				
3-1-1	Precast Reinforced Jacking Concrete Pipe (2000 dia): including supply and transportation to Site	m	279.93		
3-1-2	Laying of Precast Reinforced Jacking Concrete Pipe (2000 dia): including pipe jacking, hauling of excavation material to designated disposal Area(L=10km) and all associated works	m	279.93		
3-1-3	Soil Improvement for Starting & Finishing Area : including drilling ,material supply and grouting	L	51,549.00		
	Sub Total 3-1				
3-2	Sewer Line between Shaft -C to Shaft-B				
3-2-1	Precast Reinforced Jacking Concrete Pipe (2000 dia): including supply and transportation to Site	m	669.60		
3-2-2	Laying of Precast Reinforced Jacking Concrete Pipe (2000 dia): including pipe jacking, hauling of excavation material to designated disposal Area(L=10km) and all associated works	m	669.60		
3-2-3	Soil Improvement for Starting & Finishing Area : including drilling ,material supply and grouting	L	51,811.50		
	Sub Total 3-2				
	Sub Total 3				
4	Construction of Manhole				
4-1	Concrete (Fc=24N/mm2 with ordinary Portland cement): including supply, placement and formwork				
4-1-1	Slab	m3	36.44		
4-1-2	Staircase	m3	9.84		
	Sub Total 4-1				
4-2	Deformed Reinforcing Bars(SD345): including supply, bending and placement	t	6.40		
4-3	Invert Concrete (Fc=16N/mm2 with ordinary Portland cement): including supply, placement and formwork	m3	25.42		
4-4	Mortar finishing t=2cm: including supply and placement	m2	24.20		
4-5	Installation of Reinforced Concrete Manhole Block : including supply and installation.	set	1.00		
4-6	Cast-in-place Concrete Manhole (for maintenance) : including supply, placement , reinforcement and form works.	set	1.00		
4-7	Manhole Cover (RC cover φ600mm) : including supply and installation	set	1.00		
4-8	Manhole Cover (Concrete Cover): including supply and installation	no.	4.00		
4-9	Ladder Rungs: including supply and installation	no.	24.00		
4-10	Rear Guard : including supply , fabrication and installation	set	1.00		
4-11	Stainless-Steel Balustrade(staircase rail and post) : including supply, fabrication and installation	m	134.02		
	Sub Total 4				

CHAPTER X OTHER FORMS OF DOCUMENTS

Please use standard document.