

4. MAIN SPECIFICATION 主要緒元

4-1 Shield machine & Back up facilities 仕様

4-1-1 Shield machine シールド掘進機

(1) Shield shell

| | | | | |
|----|-----------------------------|---|------------------------------|------|
| a) | Front shield outer diameter | : | 6404 | mm |
| b) | Tail shield outer diameter | : | 6400 | mm |
| c) | Tail thickness | : | 40 | mm |
| d) | Tail clearance | : | 36 (24mm in tail brush area) | mm |
| e) | Overall length | : | 13334 | mm |
| f) | Overall length | : | 10204 | mm |
| | (from cutterhead to tail) | | | |
| g) | Overall length | : | 8874 | mm |
| | (shield shell) | | | |
| h) | Hood length | : | 750 | mm |
| i) | Ring girder length | : | 4370 | mm |
| j) | Tail length | : | 3754 | mm |
| k) | Tail sealing | : | Wire brush type 3 | rows |
| l) | Flow-back preventive plate | : | 1 | row |

(2) Thrust

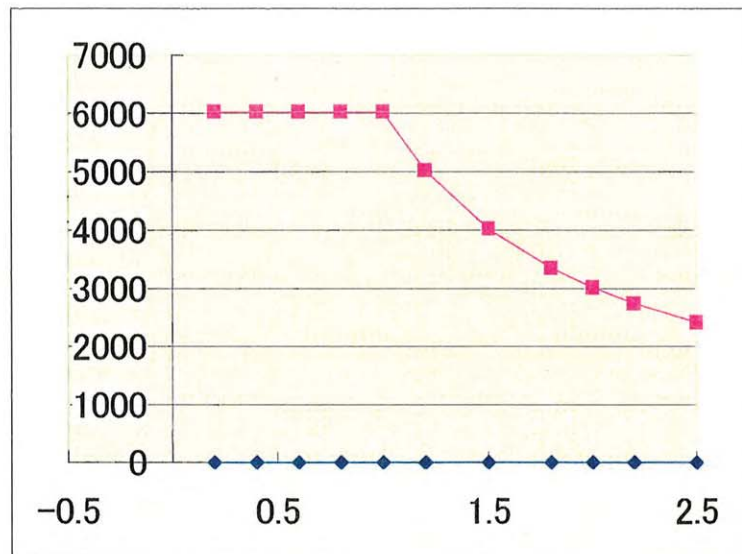
| | | | | |
|----|--|---|-------------------------------|--------|
| a) | Total thrust | : | 40000 | kN |
| b) | Stroke | : | 2150 | mm |
| c) | Extending speed | : | 10.0 | cm/min |
| | (in case all thrust cylinders are operated at the same time) | | | |
| d) | Picking rolling detector | : | Electric type, Plumb-bob type | |
| e) | Thrust cylinder speed stroke detector | | | |
| | Position | : | Cylinder No.1, 5 and 12 | |

(3) Articulation

| | | | | |
|----|--------------|---|------------------------|-----|
| a) | Angle | : | Horizontally ± 1.5 | deg |
| | | : | Vertically ± 0.5 | deg |
| b) | Curve radius | : | Minimum 305 | m |

(4) Cutterhead

- a) Type : Cutterhead with breasting plate
b) Support type : Intermediate support type
c) Excavation diameter : 6444 mm
d) Power : 800 kW
e) Speed : 0.2 – 2.5 rpm
f) Torque : 6031 kNm at 0.2 – 1.0 rpm
2412 kNm at 2.5 rpm



- g) Driving method : Hydraulic motor drive
h) Rotating direction : Clockwise and Counterclockwise
i) Cutting tools

- Drag bit^{NOTE1} : 104 No. of tungsten carbide tip type
Knife-edge bit^{NOTE2} : 24 + 17 No. of tungsten carbide tip type
Copy cutter^{NOTE3} : 2 No. of hydraulic cylinder type
Wear detection bit : 2 No. of hydraulic type

Note (fixation)

- 1: Drag bits are bolted to the cutterhead, and can be replaced from within cutter chamber.
- 2: 24 quantity of knife-edge bits are welded on the cutterhead.
17 quantity of knife-edge bits are installed into the 17 inch cutter saddle.
- 3: Copy cutter is integrated within the cutterhead.

(5) Man lock

| | | | |
|--------------|---|---------------------|-----|
| Type | : | 2-chamber man lock | |
| Quantity | : | 1 | set |
| Dimension | : | | |
| Diameter | : | Approximately Ø1500 | mm |
| Length | : | | |
| Main chamber | : | Approximately 1800 | mm |
| Sub chamber | : | Approximately 1500 | mm |

(6) Screw conveyor

a) Screw conveyor

| | | | |
|---------------------|---|----------------------------|-------------------|
| Type | : | Ribbon type screw conveyor | |
| Casing I.D. | : | 800 | mm |
| Speed | : | 1.0 to 14.5 | rpm |
| Torque | : | 91 | kNm |
| Capacity | : | 280 | m ³ /h |
| | | (when $\eta = 100\%$) | |
| Ribbon slide stroke | : | 550 | mm |
| Driving method | : | Hydraulic motor drive | |

b) Screw gate

| | | | |
|----------------|---|---|--|
| Type | : | Rear Exit and Knife gate type | |
| Driving method | : | Hydraulic cylinder actuated | |
| Safety device | : | Accumulator is provided, to supply hydraulic power in the event of electrical shut down | |

c) Bulkhead gate : to be located in the bulkhead invert
: scissors type gate

(7) Segment erector

| | | | |
|------------------|---|----------------|-----|
| a) Type | : | Ring gear type | |
| b) Speed | : | 0.2 – 2.0 | rpm |
| c) Turning angle | : | ±220 | deg |
| d) Push-in force | : | 220 | kN |

| | | | |
|---------------------------------|---|---|----|
| e) Lifting force | : | 150 | kN |
| f) Vertical stroke | : | 700 | mm |
| g) Slide stroke | : | 700 | mm |
| h) Internal free space diameter | : | Approximately 3290 | mm |
| i) Handling weight | : | Approximately 29 | kN |
| j) Control | : | Wireless control | |
| | | Pendant type (wire connected) controller will be prepared for incase wireless system had failure | |

(8) Soil pressure detector

| | | | | |
|-------------------|---|----------|------|-----|
| a) Bulkhead | : | Dia.80mm | x 5 | set |
| | | Dia.32mm | x 30 | set |
| b) Screw conveyor | : | Dia.32mm | x 2 | set |

(9) Injection port

Installed on

| | | | | |
|-------------------|---|-----------|-----|-----|
| a) Cutterhead | : | Dia.50mm | x 5 | set |
| b) Bulkhead | : | Dia.100mm | x 4 | set |
| c) Shield body | : | Dia.50mm | x 6 | set |
| d) Screw conveyor | : | Dia.50mm | x 4 | set |

(10) Backfill grouting and tail seal grease ports in the tail skin

| | | | |
|----------------------------|---|----------|----------------------|
| a) Backfill grouting ports | : | Dia.40mm | x 2 holes x 4 places |
| | | Dia.40mm | x 1 hole x 1 places |
| b) Tail seal grease ports | : | Dia.25mm | x 2 holes x 4 places |

(11) Hydraulic cylinder

| Description | Thrust (kN) | Stroke (mm) | Pressure (MPa) | Q'ty | Remarks |
|-------------------|-------------|-------------|----------------|------|---------|
| Thrust | 2500 | 2150 | 35 | 16 | |
| Articulation | 2500 | 250 | 35 | 14 | |
| Erector extension | 110 | 700 | 14 | 2 | |
| Erector slide | 70 | 700 | 14 | 1 | |
| Erector support A | 43 | 100 | 14 | 2 | |
| Erector support B | 43 | 300 | 14 | 2 | |
| Copy cutter | 200 | 120 | 21 | 2 | |
| Screw gate | 72 | 720 | 21 | 2 | |
| | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |

(12) Hydraulic pump

| Description | Delivery (l/min) | Pressure (MPa) | Speed (min ⁻¹) | Q'ty | Remarks |
|--------------------|------------------|----------------|----------------------------|------|---------|
| Thrust | 113 | 35 | 1800 | 1 | |
| Articulation | 25 | 35 | 1800 | 1 | |
| Erector cylinder | 63.7 | 14 | 1800 | 1 | |
| Erector turning | 115 | 21 | 1800 | 1 | |
| Copy cutter | 31.5 | 21 | 1800 | 1 | |
| Grease lubrication | 0.037 | 18 | 1800 | 2 | |
| Oil lubrication | 7.2 | 0.3 | 1800 | 1 | |
| Screw conveyor | 230 | 18 | 1800 | 2 | |
| Screw gate | 48.1 | 21 | 1800 | 1 | |

(13) Electric motor

Type : Totally enclosed fan-cooled outdoor type

| Description | Power (kW) | Pole (p) | Power source (V x Hz) | Q'ty | Remarks |
|--------------------|------------|----------|-----------------------|------|---------|
| Thrust | 75 | 4 | 480x 60 | 1 | |
| Articulation | 15 | 4 | 480x 60 | 1 | |
| Erector cylinder | 15 | 4 | 480x 60 | 1 | |
| Erector turning | 45 | 4 | 480x 60 | 1 | |
| Copy cutter | 11 | 4 | 480x 60 | 1 | |
| Grease lubrication | 0.2 | 4 | 480x 60 | 2 | |
| Oil lubrication | 0.75 | 4 | 480x 60 | 1 | |
| Screw conveyer | 75 | 4 | 480x 60 | 2 | |
| Screw gate | 18.5 | 4 | 480x 60 | 1 | |
| | | | | | |

(14) Hydraulic motor

| Description | Displacement (l/rev) | Torque x Pressure (kNm x MPa) | Q'ty | Remarks |
|----------------|----------------------|-------------------------------|------|------------|
| Cutter head | 25.73 | 78 x 22 | 10 | I= 1/102.9 |
| Erector | 1.613 | 5.39 x 21 | 2 | |
| Screw conveyer | 10 | 28 x 18 | 1 | |

4-2 Electric system 電気関係

(1) Electric system

Shield machine will be equipped with electric motor, lightning, electric control system, wiring and all other necessary facilities.

Actual work execution, design and manufacturing shall be carried out in accordance with all related laws and regulations

(2) Power source

- a) Power circuit : 480 V x 60 Hz x Ø3
- b) Control circuit : DC24, AC110V x 60Hz x Ø1
- c) Lightning : 110 V x 60 Hz x Ø1

(3) Operating method

| | |
|-------------------------|----------------------------------|
| Electric motor capacity | Starting method |
| Under 30 kW | Direct starting |
| Over 37 kW | Star-Delta starting |
| Operation switch | Push button switch Cam switch |

(4) Electric instruments

a) Power board, operation panel, terminal box, and erector operating box will be provided. Power board of waste water pumps will be of air purged type.

b) Place of installation

Each device shall be installed as following, for easy access and easy maintenance.

Power board : Back-up

Operating panel : Back-up

Terminal box : Back-up

Inside shield machine

Erector operating box : Inside shield machine

Wireless portable push button switch

(5) Lightning

a) Fluorescent light

Shield machine : 20 W x AC110 V x 10no.

Following carriage : 20 W x AC110 V x 34no.

b) Emergency light

Shield machine : 20 W x AC110V x 4 no.

Following carriage : 20 W x AC110V x 16no.

c) Spare electric plug

Shield machine : 0.5 kW x AC220 V x 2 no.

Following carriage : 0.5 kW x AC220 V x 3 no.

(6) Shield machine control system

a) Control method

Basically control shall be of manual type.

b) Measuring instruments

| Item | Range | Q'ty | | Remarks |
|----------------------------|-------------------------|----------|-----------|--------------|
| | | Detector | Indicator | |
| Thrust cylinder stroke | 0~2200 mm | 3 | 3 | No.1,5,12 |
| Thrust cylinder speed | 0~100 mm/min | | 3 | |
| Thrust pressure | 0~50 MPa | 4 | 4 | |
| Total thrust | 0~50000 kN | - | 1 | |
| Cutterhead power | 0~1000 kW | 1 | 1 | |
| Copy cutter stroke | -20~100 mm | 1 | 1 | |
| Screw conveyor speed | 0~20 rpm | 1 | 1 | |
| Screw conveyor pressure | 0~25 MPa | 1 | 1 | |
| Screw discharge volume | 0~500 m ³ /h | - | 1 | |
| Screw gate opening | 0~100 % | 1 | 1 | |
| Articulate cylinder stroke | 0~250 mm | 4 | 4 | No.4,8,11,14 |
| Earth pressure | 0~0.5 MPa | 5 | 5 | |
| Bearing oil temperature | 0~100 °C | 1 | 1 | |
| Man lock air pressure | 0~0.5 MPa | 2 | 2 | |

4-3 Following carriage 後続台車

- 1) Type : Portal shaped type, On-rail travel
- 2) Quantity : 10
- 3) Total length : Approximately 94.5 m
(measured from the machine tail)

4-4 Facilities on the back-up 後続設備

(1) Operation room (with air conditioner)

(2) Grease lubrication system

- Type : 20 L can type (ϕ 300 x 322)
- Quantity : 2 no.

(3) Tail grease system

- Type : 200 L drum can type
- Quantity : 1 no.
- Specification of pump : Air compressor drive type

(4) Hydraulic power system for operating the shield machine

(5) Industrial air compressor system

- Air reservoir tank capacity : 1 m³ x 1 set
- Compressor capacity : 37 kW x 7 bars x 5.6 m³/min

(6) Backfill grout injection system

1) Mortar storage and injection system

- Line : 5 lines from 5 delivery points
- Storage tank capacity : 6 m³ x 1 set
Agitating system incorporated
- Pump quantity : tube pump 5 sets)
- Specification of injection pump : 5.5kW x 50L/min x 25 bars x 5 sets
- Transfer pump : 11kW x 200 L /min x 15 bars x 1 set

2) Accelerator storage and injection system

- Line : 2 lines into segment inj. points

Storage tank capacity : 2 m³ x 1 set
 Pump type : tube type
 Pump quantity : 2 sets
 Specification of injection pump : 2.2kW x 30L /min x 20 bars

(7)Foam injection system

Line :2 independent lines with 4 sets of electric driven valves
 Storage tank capacity : 1.0 m³ x 1 set (Foaming agent)
 : 3.5 m³ x 1 set (Foaming solution)
 Foaming Solution Pump :11 kW x 2.5Mpa x 100 L/min x 2sets
 Water supply : approx. 144 L/min
 Compressed air supply : 3.0 Nm³/min
 Foam generators : 2 sets (in the shield machine)

(8)Bentonite/polymer injection system

Line : 1 independent line
 Storage tank capacity : 4.0 m³ x 1 set
 Injection pump :22 kW x 2.5Mpa x 280 L/min x 1set
 Transfer pump : 22kW x 288 L /min x 25 bars

(9)Power boad

(10)Transformers : 1600kVA x 1 no.

(11)Closed cooling water system

The cold water (min.840 l/min) is always supplied from the surface. The cold water cools down the circulating hydraulic oil of MHI supplied power packs as well as it cools the cooling water circulating in this system.

Tank capacity : Approx. 0.5 m³ x 1 set
 Pump :180 l/min x 1 MPa x 11 kW x 1no.
 Cooled equipment :Screw drive hydro.oil, soil seals and gear reducers

(12) Industrial water system

Tank capacity : 4 m³ x 1 set
Pumps : 800 l/min x 1 MPa x 22 kW x 1no.
(water injection from cutterhead)
: 200 l/min x 1 MPa x 5.5 kW x 1no.
(to foaming equipment)

(13) Waste water system

Tank capacity : (1m³ + 1m³=2m³) x 1 set
Pumps (Customer supply) : 40.5kW x 1no.
: 15 kW x 3no.

(14) HV cable storage box

1 box (without cables) is to be included.

The dimension and construction of the storage box is to be given by the client to MHI.

(15) Hose storage space

Not supplied. The hoses are to be placed on the segment behind the last gantry.

(16) Ventilation system

1. Main ventilation
Duct cassette : ϕ 1372mm x 150 m
2. 2nd ventilation
Ventilation fan : 750m³/min x 1no. (reversible)
Ventilation duct : ϕ 800

(17) Fire fighting system

Thermo sensor : 10
Smoke detector : 10
Fire extinguisher for power unit : Powder type
Fire extinguisher for power board : N₂ Gas type
Handling type fire extinguisher : 12 no.

(18) Gas monitoring system

- a) Monitoring gas : Methane & H₂S (CH₄ + H₂S)
Oxygen (O₂)
Carbon dioxide (CO₂)
Carbon monoxide (CO)
- b) Installation : 1) CH₄ + H₂S: 3 places
(2 places in the machine, 1 place near the power pack area)
2) O₂ + CO₂ + CO: 1 place
(near the operator cabin)
On the rolling platform

(19) Segment hoist

| | | | |
|----------------|---|------------|-------|
| Capacity | : | 2.0 | ton |
| Quantity | : | 2 | no. |
| Traverse speed | : | 10 | m/min |
| Lifting speed | : | 6.9 | m/min |
| Travel length | : | approx. 24 | m |

(20) Segment feeder

| | | |
|-------------------|---|-------------------|
| Stocking capacity | : | 1 ring (7 pieces) |
|-------------------|---|-------------------|

(21) Belt conveyor

Conveyor 1

| | | | |
|--------------------|---|------------|-------------------|
| Belt width | : | 800 | mm |
| Belt speed | : | Approx.85 | m/min |
| Length | : | Approx. 80 | m |
| Discharging volume | : | 280 | m ³ /h |
| Curve radius | : | 305 | m |

Conveyor 2

| | | | |
|--------------------|---|-------------|-------------------|
| Belt width | : | 1400 | mm |
| Belt speed | : | Approx.58 | m/min |
| Length | : | Approx. 2.5 | m |
| Discharging volume | : | 280 | m ³ /h |

(22) Gantry travel rail frame handling hoists

Slewable overhung hoists will be installed on the No.1 and No.10 gantries.

| | | | |
|--------------------|---|-----|------|
| Hoist capacity | : | 500 | kg |
| Quantity of hoists | : | 4 | sets |

(23) Advancing tail piece of tunnel conveyor

The advancing tail piece is to be installed on both sides of No.8 gantry depending on the 1st and 2nd drives.

The maximum tension acting onto the tail piece is 13.2 short ton (12 metric ton). All the necessary equipment regarding to the tail piece is to be supplied by the client.

4-5 Painting 塗裝

After the completion, the shield machine will be painted as follows.

Treatment for the under coating:

The rust of the painting surface will be carefully taken away by wire brush or sand paper.

The entire surface will be painted with anti-corrosive paint.

Final painting:

Painting would be done according to customer's colors indication.

Electric and hydraulic devices' color will be as maker's standard color.

4-6 Facilities which must be prepared by the customer

To operate the shield machine under proper conditions, following facilities must be prepared by the customer:

1) To keep temperature inside machine, segment erecting area, and manlock within 29°C, Tunnel chiller, Secondary ventilation system, and its related ducting must be provided.

2) To cool cutterhead driving units and cutter main seals, coolant water (T=20°C, Q=0.8m³/min, P=1.0 MPa, and no contamination) must be supplied to the shield machine, and its related piping, plumbing must be provided throughout the backup gantries.