

# South-to-North Water Diversion ( middle route )

China Institute of Water Resources and  
Hydropower Research ( IWHR )

# Contents

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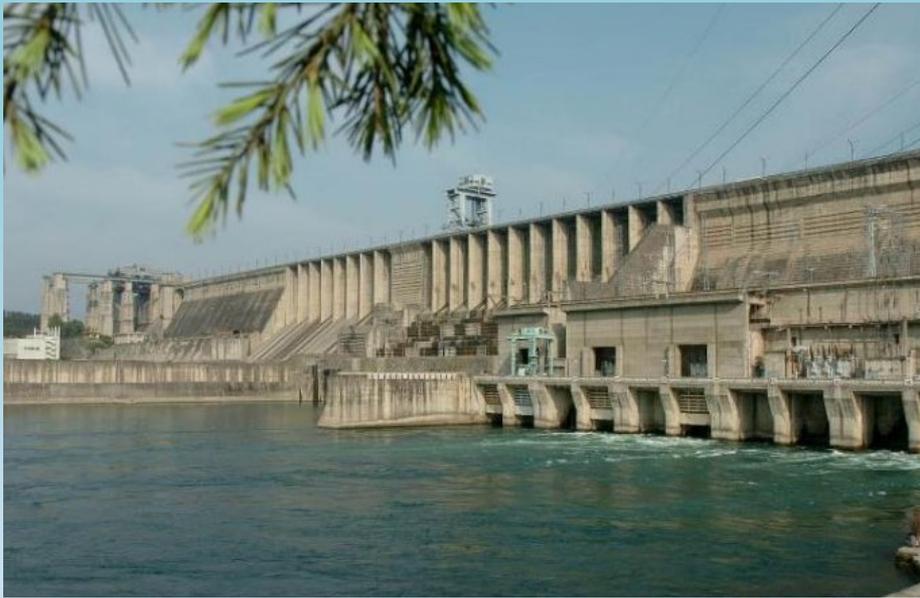
1 Canal

2 PCCP pipe

3 Tunnel

# 1 Canal

The middle route runs from [Danjiangkou Reservoir](#) to Beijing, on the [Han river](#), a tributary of the Yangtze River. The elevation of canal is 147m to 61m by [gravity](#) flow. The completed canal route is approximately 1432 km long, initially providing 9.5 km<sup>3</sup> of water annually. By 2030, water transfers is expected to increase to 12 to 13 km<sup>3</sup> annually.

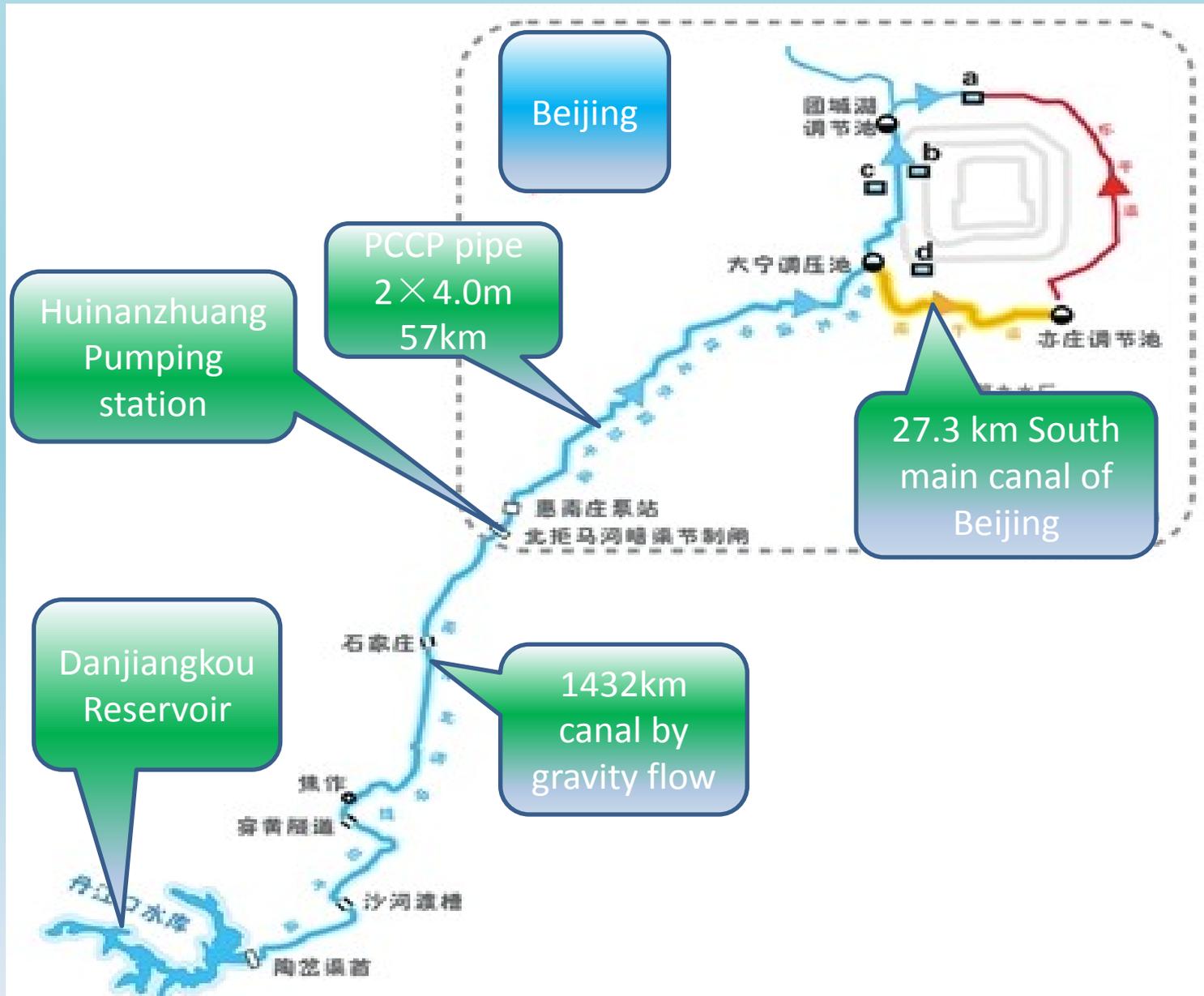


Danjiangkou Reservoir



Main canal gravity flow 1432km

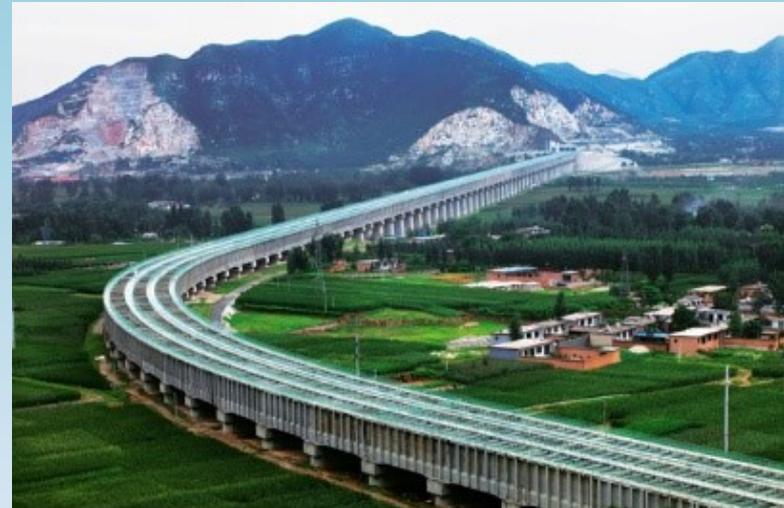
# 1 Canal



# 1 Canal

place	Design discharge(m <sup>3</sup> /s)	Design water elevation(m)
Canal head~Fang cheng	630	147.2~137.8
Pass the Yellow river	500	119.5
Entry Hebei province	415	106.0~91.3
Beijing	50	61.1

Slope is 1/25000 in the south of Yellow River, and 1/30000~1/15000 in the north of Yellow River. Design depth is 9.5m to 3.5m, and Bottom width is 56m~7m.



# 1 Canal — — — Pass through across the Yellow River



Pass under Yellow River , length 4250m, discharge  $500\text{m}^3/\text{s}$ , tunnel diameter  $2 \times 7\text{m}$ .



By TBM(tunnel boring machine)

# 1 Canal — — — flume



Duan he flum, length 1030m, discharge  $350\text{m}^3/\text{s}$ , increase discharge  $420\text{m}^3/\text{s}$



# 2 PCCP pipe

The main canal in Beijing is  $2 \times 4.0$  PCCP (inner diameter 4.0m, maximum outside diameter 4852mm), and total length is 57km. The design discharge is  $50\text{m}^3/\text{s}$ , increase discharge is  $60\text{m}^3/\text{s}$ , and the gravity flow is  $20\text{m}^3/\text{s}$ . Operations are the follows: discharge  $Q < 20\text{m}^3/\text{s}$  by gravity flow, and  $Q > 20\text{m}^3/\text{s}$  by pump at Huinanzhuang Pumping Station.



PCCP  $2 \times 4.0\text{m}$

# 2 PCCP pipe --- factory



PCCP factory

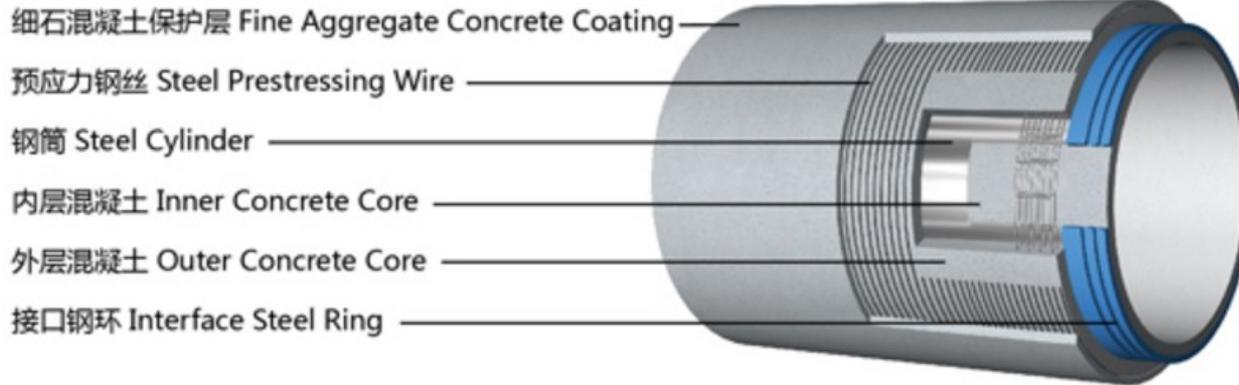


Formwork of PCCP

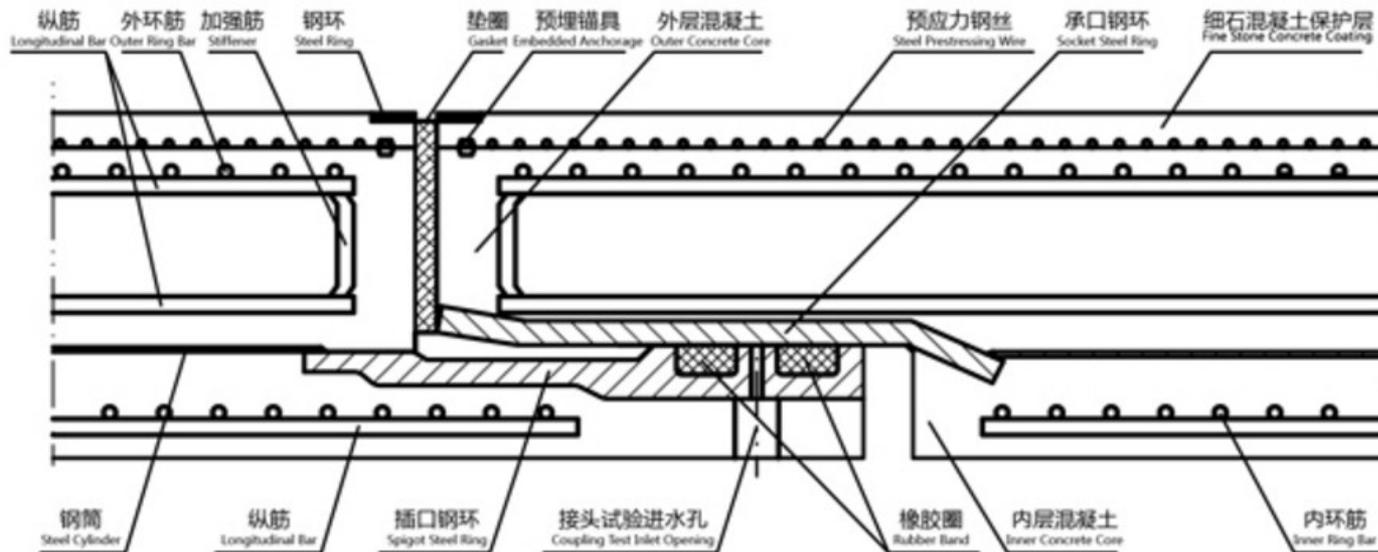
# 2 PCCP pipe — — structure

## Prestressed Concrete Cylinder Pipe For Jacking (PCCPJ)

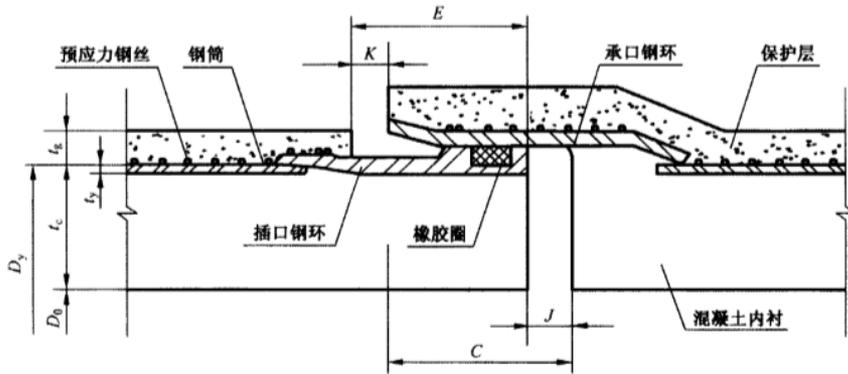
PCCPJ示意图 Sketch Map of PCCPJ



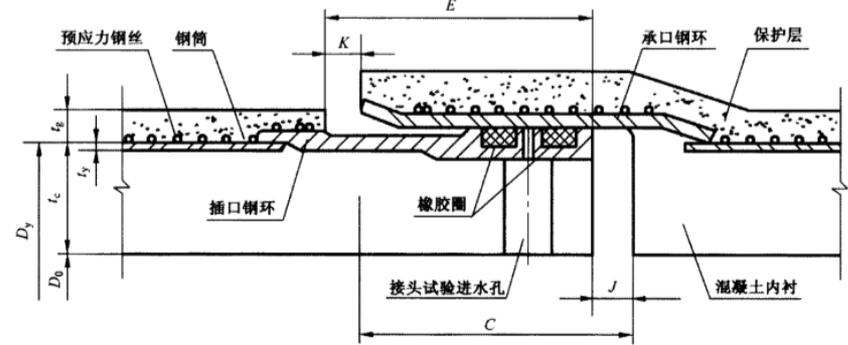
PCCPJ管子接头图 Drawing of PCCPJ Pipe Coupling



# 2 PCCP pipe – – standard



single rubber ring



double rubber ring

表 2 埋置式预应力钢筒混凝土管(PCCPE)基本尺寸(单胶圈接头) 单位:mm

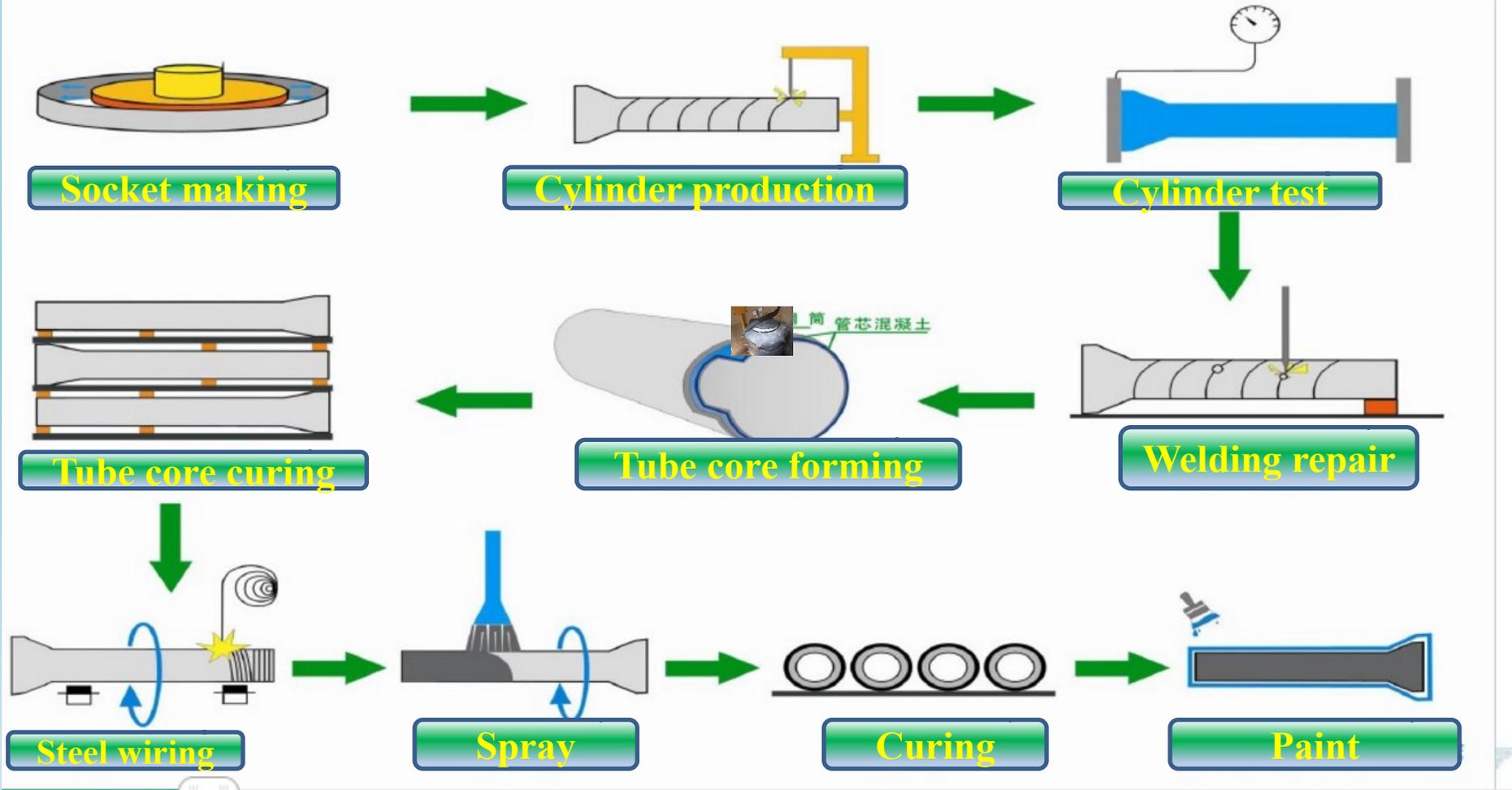
公称内径 $D_0$	最小管芯厚度 $t_e$	保护层净厚度	钢筒厚度 $t_y$	承口深度 $C$	插口长度 $E$	最小承口工作面内径 $B_0$	最小插口工作面外径 $B_1$	接头内间隙 $J$	接头外间隙 $K$	胶圈直径 $d$	有效长度 $L_0$	管子长度 $L$	参考重量/(t/m)
1 400	100	20	1.5	108	108	1 503	1 503	25	25	20	5 000	5 083	1.48
1 600	100					1 703	1 703						1.67
1 800	115					1 903	1 903						2.11
2 000	125					2 103	2 103						2.52
2 200	140					2 313	2 313						3.05
2 400	150					2 513	2 513						3.53
2 600	165	2 713	2 713	4.16									
2 800	175	20	1.5	150	150	2 923	2 923	25	25	20	5 000	5 125	4.72
3 000	190					3 143	3 143						5.44
3 200	200					3 343	3 343						6.07
3 400	220					3 553	3 553						7.05
3 600	230					3 763	3 763						7.77
3 800	245					3 973	3 973						8.69
4 000	260					4 183	4 183						9.67

表 3 埋置式预应力钢筒混凝土管(PCCPE)基本尺寸(双胶圈接头) 单位:mm

公称内径 $D_0$	最小管芯厚度 $t_e$	保护层净厚度	钢筒厚度 $t_y$	承口深度 $C$	插口长度 $E$	最小承口工作面内径 $B_0$	最小插口工作面外径 $B_1$	接头内间隙 $J$	接头外间隙 $K$	胶圈直径 $d$	有效长度 $L_0$	管子长度 $L$	参考重量/(t/m)
1 400	100	20	1.5	160	160	1 503	1 503	25	25	20	5 000	5 135	1.48
1 600	100					1 703	1 703						1.67
1 800	115					1 903	1 903						2.11
2 000	125					2 103	2 103						2.52
2 200	140					2 313	2 313						3.05
2 400	150					2 513	2 513						3.53
2 600	165	2 713	2 713	4.16									
2 800	175	20	1.5	160	160	2 923	2 923	25	25	20	5 000	5 135	4.72
3 000	190					3 143	3 143						5.44
3 200	200					3 343	3 343						6.07
3 400	220					3 553	3 553						7.05
3 600	230					3 763	3 763						7.77
3 800	245					3 973	3 973						8.69
4 000	260					4 183	4 183						9.67

# 2 PCCP pipe – – Production process

## Technological process

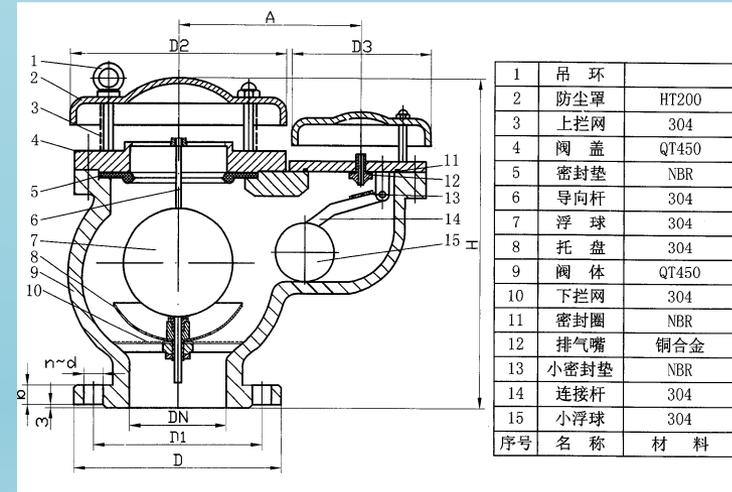


# 2 PCCP pipe – – –air inbreathe-release valve

There 101 air inbreathe-release valve well in 57km water supply pipeline, diameter 400mm.



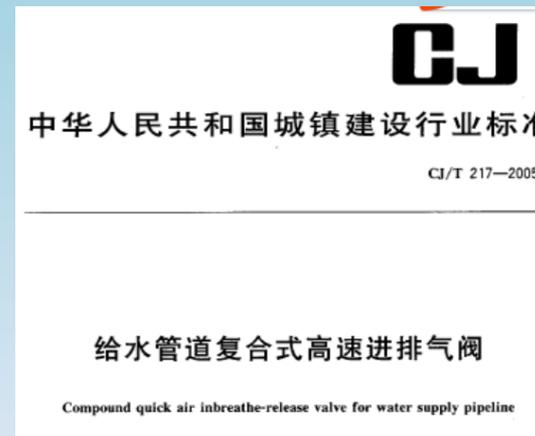
Valve well



Drawing



air inbreathe-release valve



Standard

# 2 PCCP pipe— — Huinanzhuang pumping station

Design discharge 60 m<sup>3</sup>/s, head of delivery 58.2m, total installed capacity 58.4 MW. installed 8 pump, discharge 10 m<sup>3</sup>/s , head of delivery 58.2m, capacity 7.3 MW.



# 2 PCCP pipe— — Daning pressure regulating pool



The function of Daning pressure regulating pool is pressure regulation and diversion.



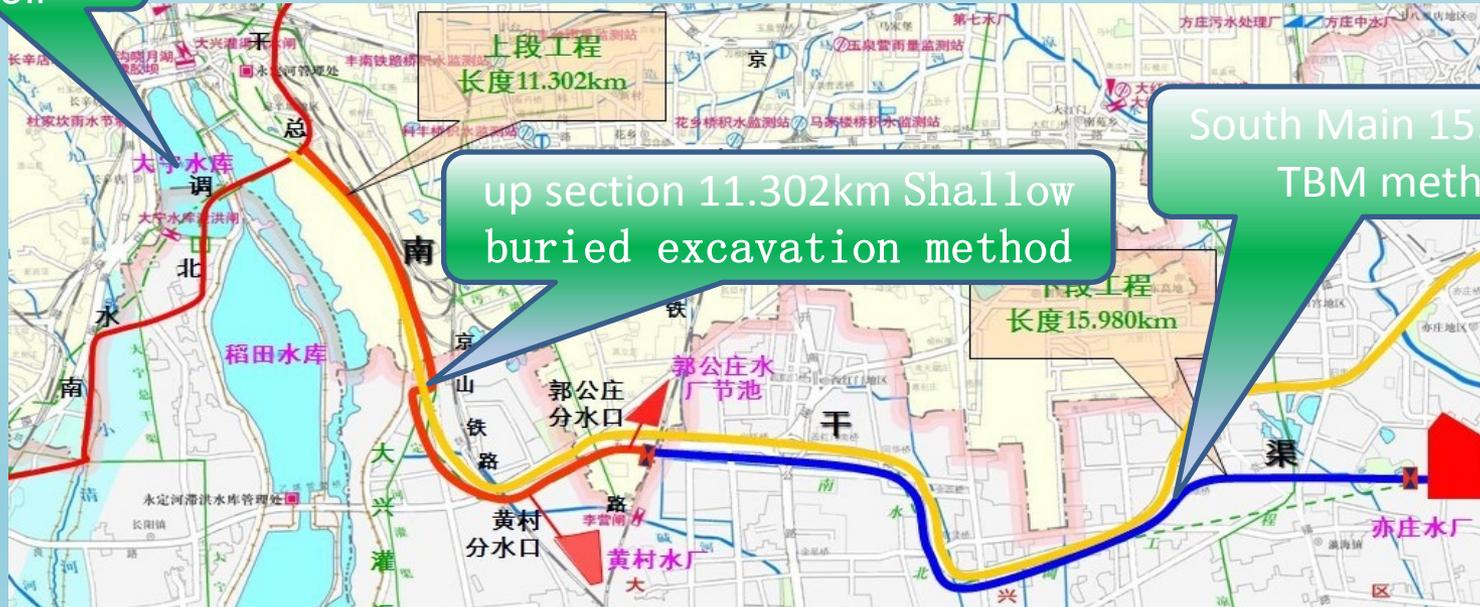
# 2 PCCP pipe – – Daning reservoir



The function of Daning reservoir is regulating water quantity, storage capacity 37 million m<sup>3</sup>, total area 1.34km<sup>2</sup>,

# 3 Tunnel – – Beijing south main canal

Daning reservoir



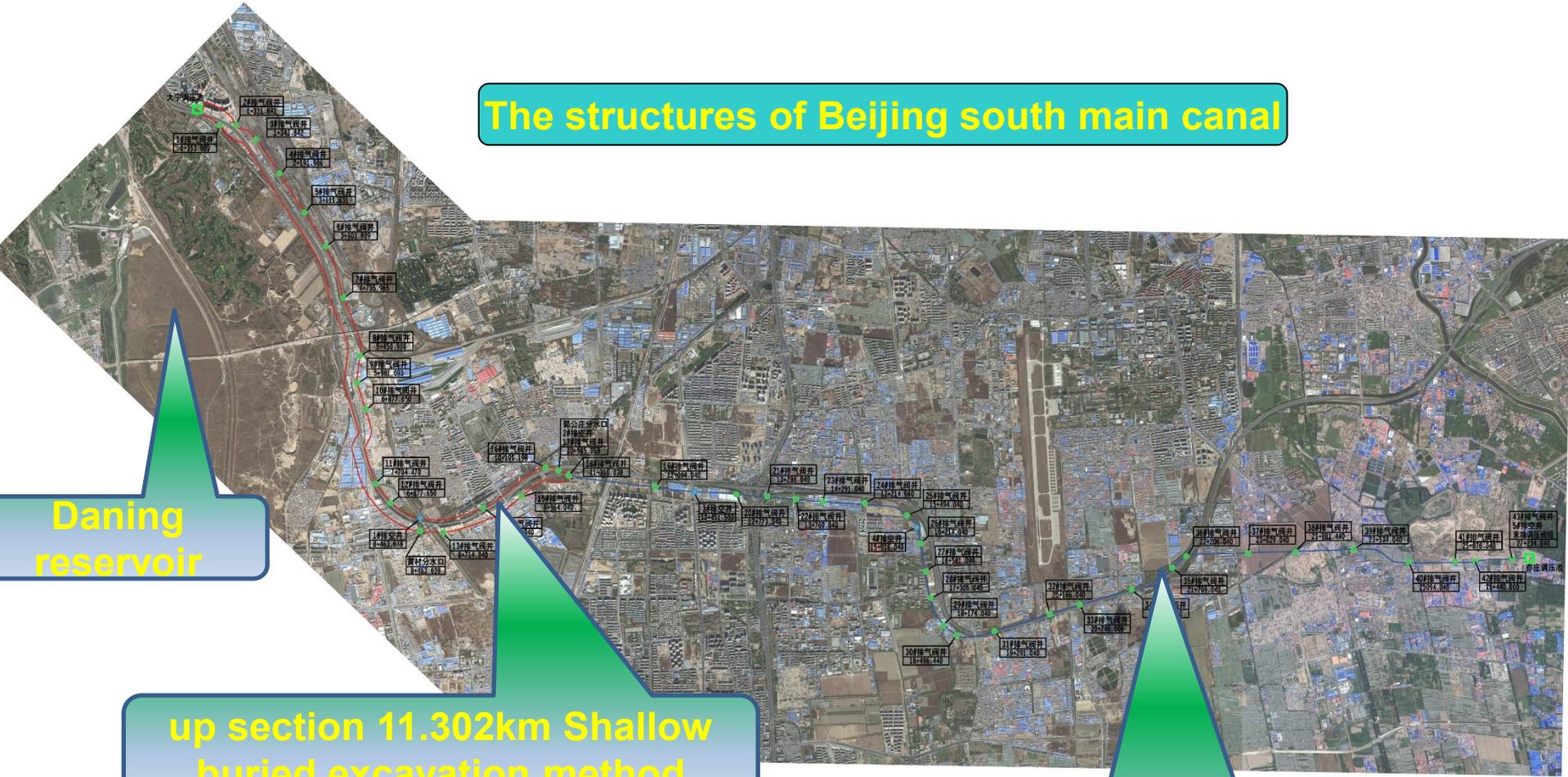
up section 11.302km Shallow buried excavation method

South Main 15.980km TBM method

The length of Beijing south main canal is 27.3km, up section 11.02km designed in shallow buried excavation method, and down section 15.980km by TBM(tunnel boring machine)

# 3 Tunnel – – Beijing south main canal

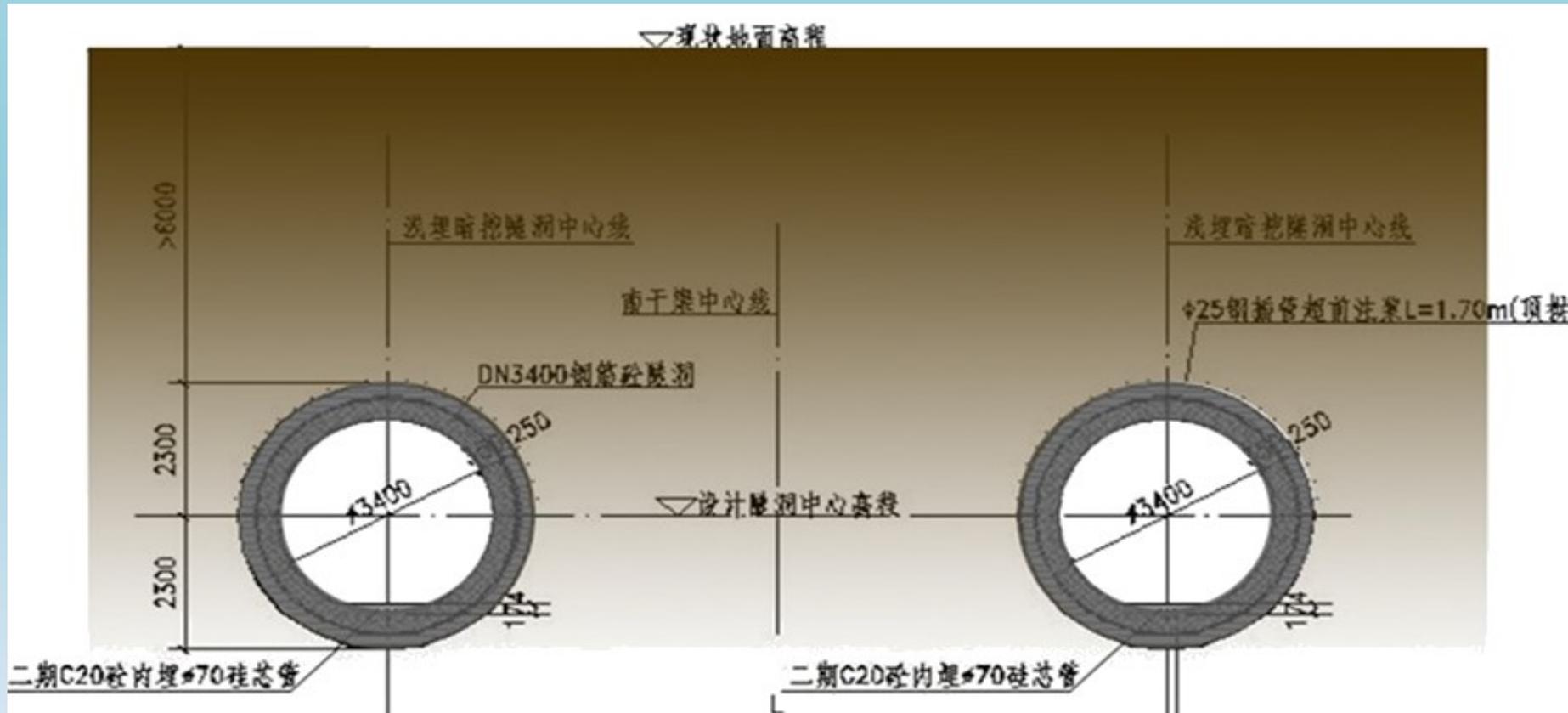
The structures of Beijing south main canal



# 3 Tunnel – – Shallow buried excavation method

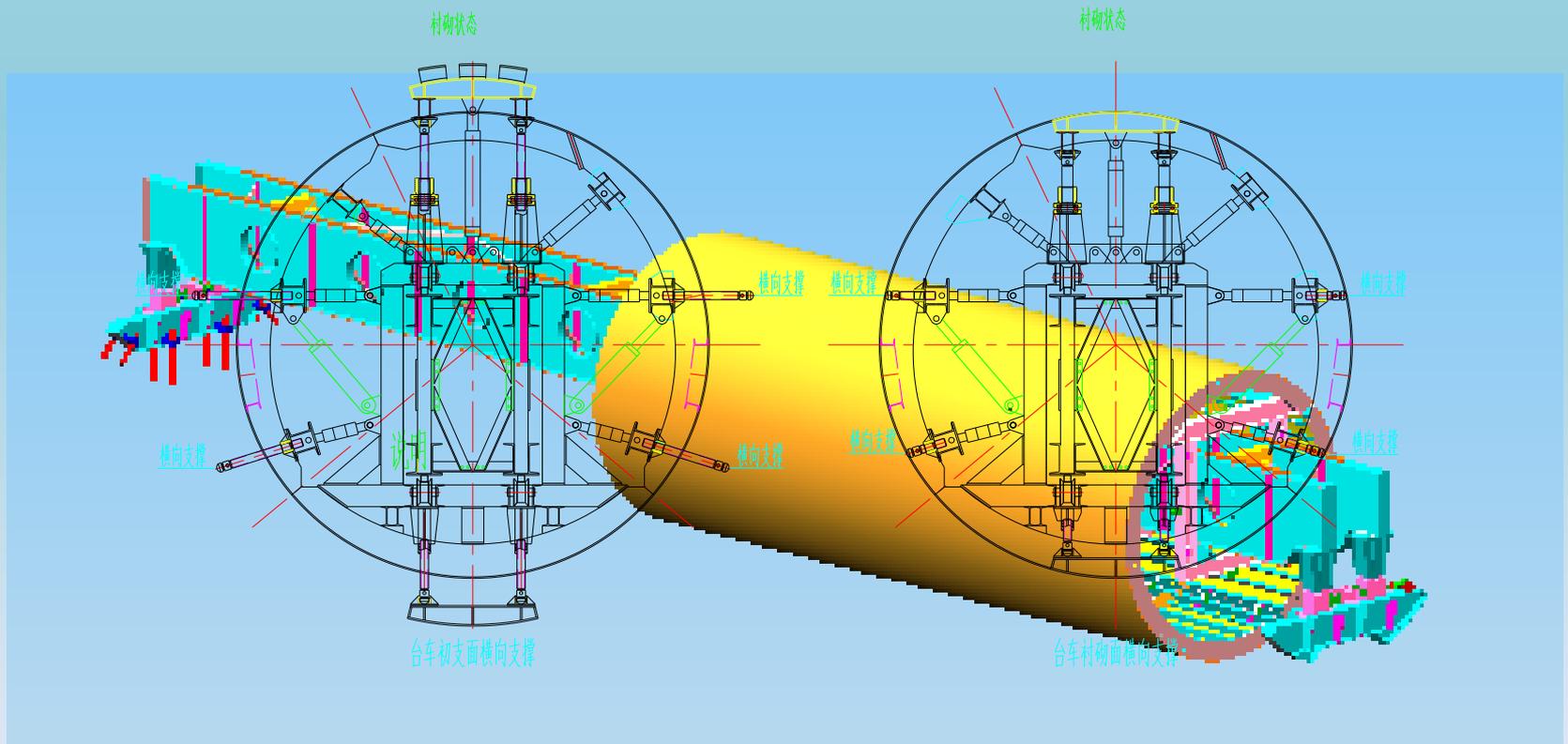
Up section 11.302km  
Shallow buried excavation method  
Increase discharge 35m<sup>3</sup>/s

2 × DN3400 tunnel,  
Design discharge 30m<sup>3</sup>/s



# 3 Tunnel – – Shallow buried excavation method

After the completion of construction excavation, reinforced concrete lining is constructed by trolley, inner lining thickness 300mm~350mm.



# 3 Tunnel – – Shallow buried excavation method



Outside lining construction



Excavation



Outside lining complete

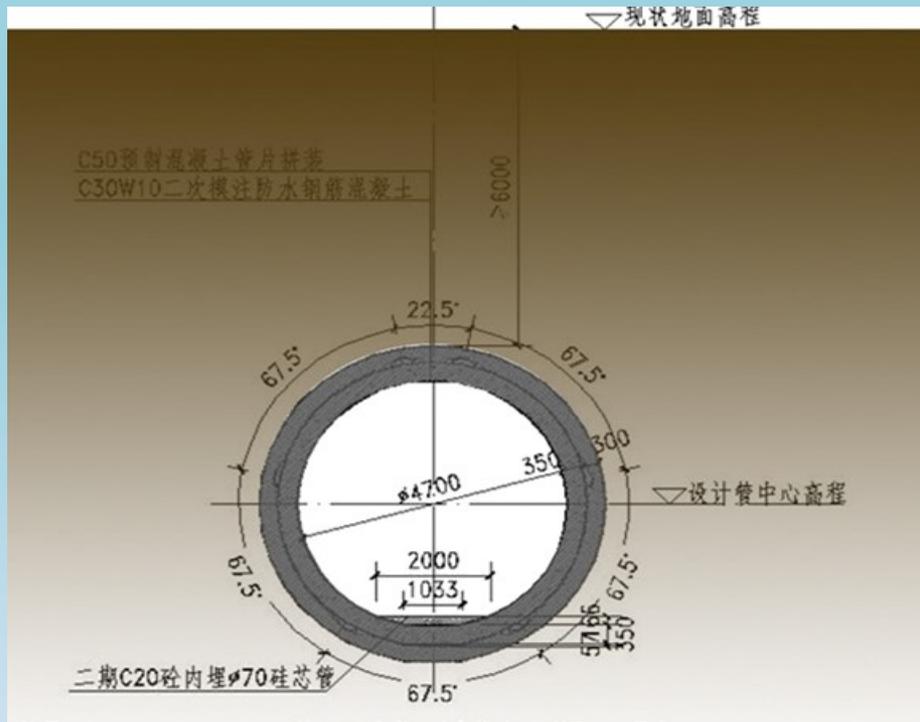


Joint

# 3 Tunnel – – – TBM(tunnel boring machine)

Down section 15.980km  
Inner lining thickness 300mm  
Design discharge 27m<sup>3</sup>/s

DN4700 tunnel,  
TBM(tunnel boring machine )method,  
Increase discharge 32m<sup>3</sup>/s.



Design section



TBM

# 3 Tunnel – – – TBM(tunnel boring machine)



Outside lining concrete block



TBM control room



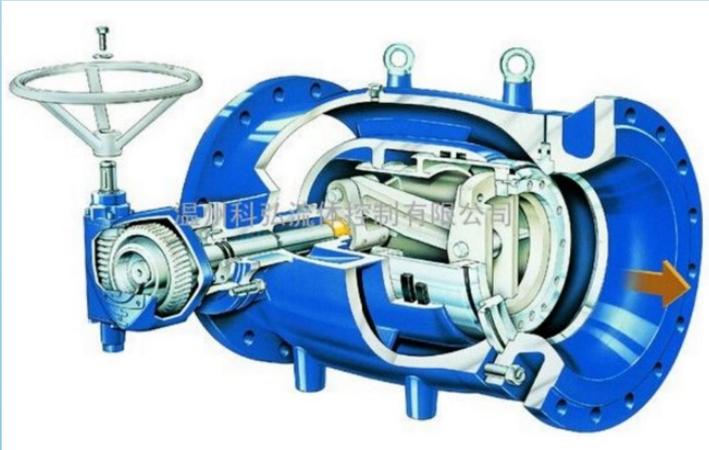
TBM Construction



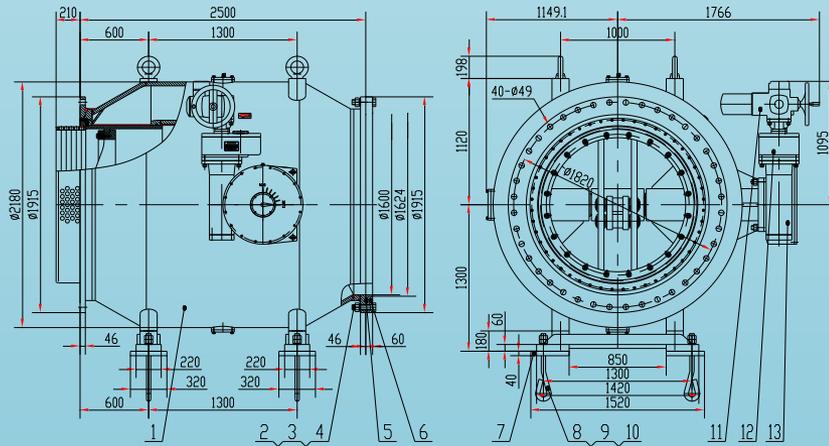
Outside lining complete

# 3 Tunnel – – flow control valve

Flow control valve can control the discharge precisely for water supply plant



Structure drawing



1. 向流式闸阀流量调节阀
2. 螺栓M45X180
3. 螺栓M45
4. 平垫圈45
5. 端法兰O形密封圈
6. DIN1600 配对法兰
7. 基础铁板
8. 地脚螺栓M43X600
9. 螺栓M42
10. 平垫圈42
11. 电动机ZSA16.1
12. 正齿轮箱
13. 蜗轮蜗杆

Drawing



Flow control valve



Controller

An aerial photograph of a large dam and reservoir. The dam is a long, low structure with a central spillway. The reservoir is a large body of water behind the dam. The surrounding landscape includes green fields, a road, and some buildings. In the background, there are mountains under a clear sky. The text "Thank you" is overlaid in red on the right side of the image.

**Thank you**