PAM
SAINT-GOBAIN

Saint-Gobain PAM China
Address:Room 1808, 18th Floor,
Building No.5, Zi Yun Wisdom Plaza,
No. 19 Kazimen Avenue. Qinhuai
District, Nanjing, PRC

Customer service hotline:
400-8880-198
www.saint-gobain.com
www.pamline.com

Wechat official account

Scan

Official website

PAM
SAINT-GOBAIN

PAM Jacking pipe

DIP FOR JACKING IN TRENCHLESS CONSTRUCTION

CONTENTS

COMPANY PROFILE

PAM originates from the pipeline business of the Saint Gobain, which is one of the world's top 500 companies Founded in 1856 PAM is a world renowned brand of ductile iron pipes, dedicated to providing a complete and adapted high quality solutions for water supply and drainage network systems.

PAM's ductile iron water supply and drainage pipes and fittings, valves, stainless steel pipes and fittings can be applied in:

>> **Municipal water supply and sewage pipe network construction:** covering rain and sewage diversion, recycled water pipelines, integrated pipe galleries, subway supporting pipelines and other application scenarios;
>> **Water conservancy pipe network construction :** covering long distance water diversion pipelines such as water sources, reservoirs, rivers and hydraulic hubs, as well as small hydropower, agricultural water conversion, farmland irrigation and other pipelines;
>> **Special pipeline laying :** such as trenchless pipeline laying (HDD, and jacking pipe), anchor joint, etc.;
>> **Industrial parks and enterprises supporting water supply and sewage pipeline laying;**
>> **Building water supply and sewage pipelines;**
>> **Other applications: heating pipes, EAHE Elixair pipes, etc.**

With proprietary technology, quality products, and a high level of service to our customers, PAM enjoys a high reputation in the field of ductile iron pipe systems.

100 >> With business covering 100 capitals and 10,000 cities
5000 >> 50,000 project cases
1600 >> Over 160 years of experience in production and application of cast pipes
1600 >> Over 1,600 patents

In 1997 PAM appointed experienced management teams and technical specialists from France to take charge of the construction, operation and technical guidance of the plant in China The process requirements and quality standards of Chinese plants are consistent with those of European plants Thanks to PAM's more than 160 years of experience in cast pipe production, PAM China has a more advanced ductile iron pipe production line in the world, and its high quality products and services are highly recognized by the vast number of customers.
PAM China now has two major production bases in Maanshan City, Anhui Province and Rizhao City, Shandong Province, all of which have passed ISO 9001 international quality system certification and ISO 14001 international environmental management system certification, and the product quality conforms to relevant national and international standards.

	National standards	International standards	European standards
Ductile iron water supply pipes and fittings	GB/T 13295	ISO 2531	EN 545
Ductile iron sewage pipes and fittings	GB/T 26081	ISO 7186	EN 598

TRENCHLESS TECHNOLOGY

Trenchless construction technology is to lay and renew various pipelines without excavating the surface. Trenchless construction has the characteristics of no damage to the environment and no impact on traffic, and the construction of various underground pipelines can be carried out in some areas where excavation construction cannot be carried out, such as busy urban areas, historic sites protection areas, crop and vegetation protection areas, buildings, urban roads, and rivers and lakes.

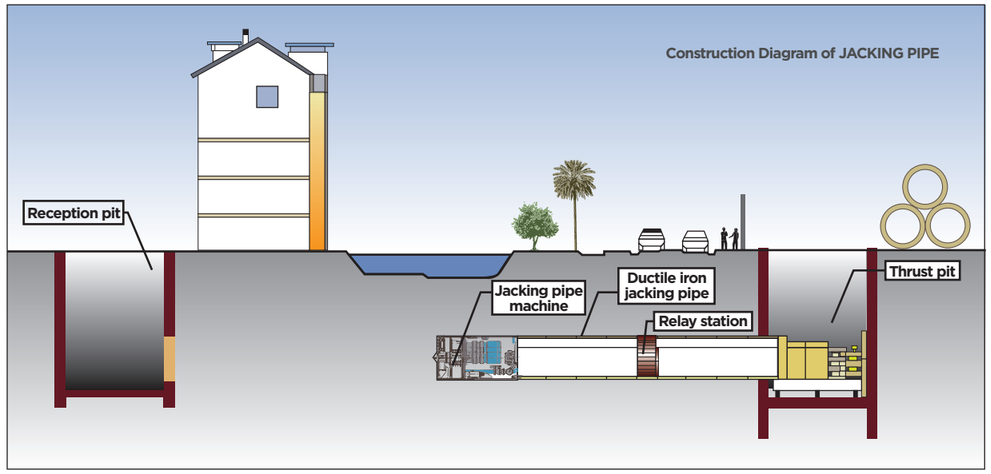
Benefiting from the rapid economic development and infrastructure construction in China, the trenchless technology has been developed rapidly in recent years. The common trenchless construction technology is horizontal directional drilling and pipe jacking.

Horizontal directional drilling (HDD) and pipe jacking (PJ) are widely used in China. However, due to the different construction processes, the HDD requires drilling and reaming at the position where the pipe is laid underground, and then sliplining the installed pipeline into the hole, and the diameter of the reaming should not be too large, otherwise it will easily lead to ground collapse and construction accidents. While the PJ construction adopts the method of digging and pushing at the same time, which pushes the pipe into the soil without reaming in advance, but the cost of the thrust pit and reception pit used in the construction is high.

By analyzing a large number of trenchless cases, from the perspective of construction feasibility and economy,PAM China recommends that:
>> Trenchless projects with DN1000 and below should be constructed by HDD;
>> Trenchless projects above DN1000 should be constructed by PJ.

Pipe Jacking (Pj) Trenchless Technology

Pipe jacking (PJ) is a trenchless technique widely used in China to lay pipelines underground using a jacking device,compared with other trenchless technologies, its characteristics include less impact on the surrounding environment, less construction land occupation, and large burial depth.



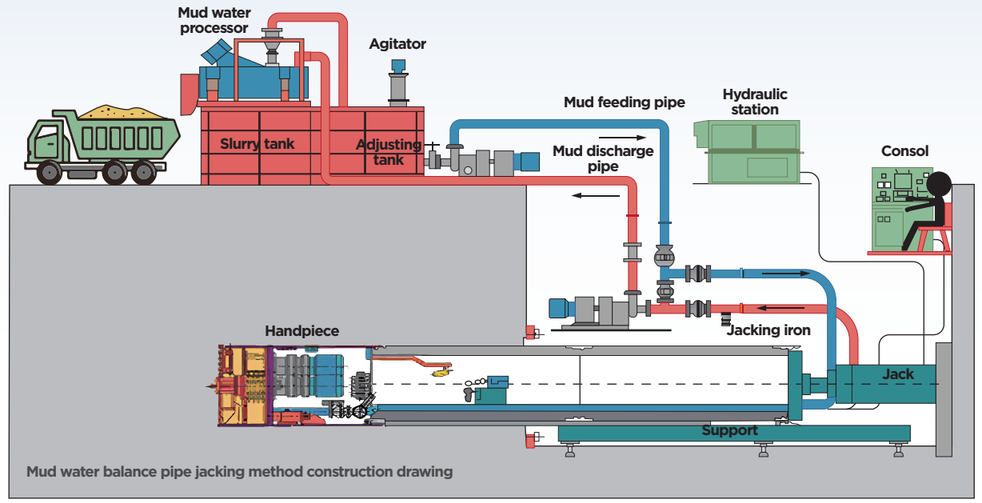
Note: Where the jacking distance is too long, causing the actual pushing force to exceed the allowable jacking force of the pipeline,a relay station should be added in the middle of the jacking pipe.

Construction method of jacking pipe

According to different geological environment and construction conditions, the available methods for jacking pipe construction include soil pressure balance and mud water balance. The difference between these two methods lies in the different ways of soil pressure balance and transportation. At present, the mud water balance PJ is the most widely used in China.

Mud-water balance pipe jacking method

The jacking pipe machine is used as the digging device, the jack is used as the jacking device, and the muddy water system is equipped to transport the soil outward. During the construction, the jacking pipe machine is responsible for cutting the soil in front of the pipe, while the jack will continue to push the pipe into the soil, and the soil excavated by the jacking pipe machine will be diluted into muddy water and discharged through the muddy water system. The method has the advantages of high jacking speed, high construction precision, less ground settlement and more safety.



Mud water balance pipe jacking method construction drawing

The key to the water mud balance PJ is to maintain the two balances during the jacking process at all times :

>> The jacking pipe machine is in a balanced state with the soil pressure and groundwater pressure of the soil layer it is located in ;
>> the amount of mud discharged and the amount of soil broken by the cutting tool of the jacking pipe machine are in a balanced state.

Requirements of jacking pipe construction for jacking pipe

Both jacking pipe construction methods have their own characteristics and can be selected based on field conditions and customer needs; however, both methods impose strict requirements on the jacking pipe:

>> Large allowable jacking force:

The technical requirements of jacking pipe construction are high, and rework is not allowed. Once it fails, it will cause huge economic losses. Therefore, the pipe itself should be able to safely withstand strong jacking force to meet construction needs;

>> Safe joint and convenient installation:

The jacking pipe construction should not be interrupted to avoid soil locking the pipeline. The jacking pipe joint should be installed quickly and have good sealing performance.

>> High ring stiffness:

The burial depth of jacking pipe construction is usually large, and the pipeline needs to withstand high soil loads and variable loads. While during the laying process, the soil around the pipeline cannot be compacted to provide support, which requires the jacking pipe to have high ring stiffness to resist pipeline deformation caused by external pressure.

>> High wear resistance:

Due to the complex distribution of underground soil layers and rocks, the external coating of pipes must have high wear resistance to protect the pipe body and anticorrosion coating from damage;

>> Corrosion resistance:

The jacking pipe pipeline is located in a trenchless area, making it difficult to repair and replace the pipeline. Therefore, the jacking pipe should have high corrosion resistance to improve the overall service life of the pipeline.

>> Deflection angle:

During the process of jacking pipe construction, due to soil settlement and force changes, it is difficult for the pipeline to maintain a straight line forward. The pipeline joint should have a certain degree of deflection ability to continuously adjust and correct the direction of jacking.

Requirements of jacking pipe construction for jacking pipe

Performance Analysis of Common JACKING PIPE

Comparison of Pipe Characteristics	Ductile Iron JACKING PIPE	Steel JACKING PIPE	Reinforced Concrete JACKING PIPE	Single Analysis
Joint type	Socket spi got	Welding type	Welding type	
Corrosion resistance	Excellent (70-100 years)	Poor (20-30 years), unable to transport corrosive media	Poor (10-15 years)	Longest service life of ductile iron jacking pipe
Head los s (inner wall roughness)	Good	Bad	Poor	Fine grinding of the inner wall of the ductile iron jacking pipe, manual lining of steel pipes, and vibrating lining of reinforced concrete
Pipe internal pressure resistance value	High (3 times PFA safety factor)	Relatively high (1.6-1.8 times PFA safety factor)	Low (1.0 times PFA safety factor)	Ductile iron jacking pipe has the highest safety
Anti-leakage	High	Relatively high	Low	Ductile iron jacking pipe has the best sealing performance
Resistance to localized ground settlement	High	Low	Relatively high	Rigid joint of steel jacking pipe cannot resist localized settlement
Construction difficulty	Low	High	Low	Professional welders are required for steel jacking pipe construction
Installation efficiency	High	Low	High	The installation efficiency of steel jacking pipe is the lowest
Construction costs	Low	High	Low	Under the same conditions, the steel jacking pipe will incur additional welding and anticorrosion costs
TCO	Moderate	High	High	Considering the purchase cost, construction cost, operation cost, maintenance cost and end of life cost,the comprehensive cost of ductile iron jacking pipe is the lowest
Comprehensive conclusion	According to the results of each single item, it is concluded that the ductile iron jacking pipe is more cost effective than the steel jacking pipe and the reinforced concrete jacking pipe			

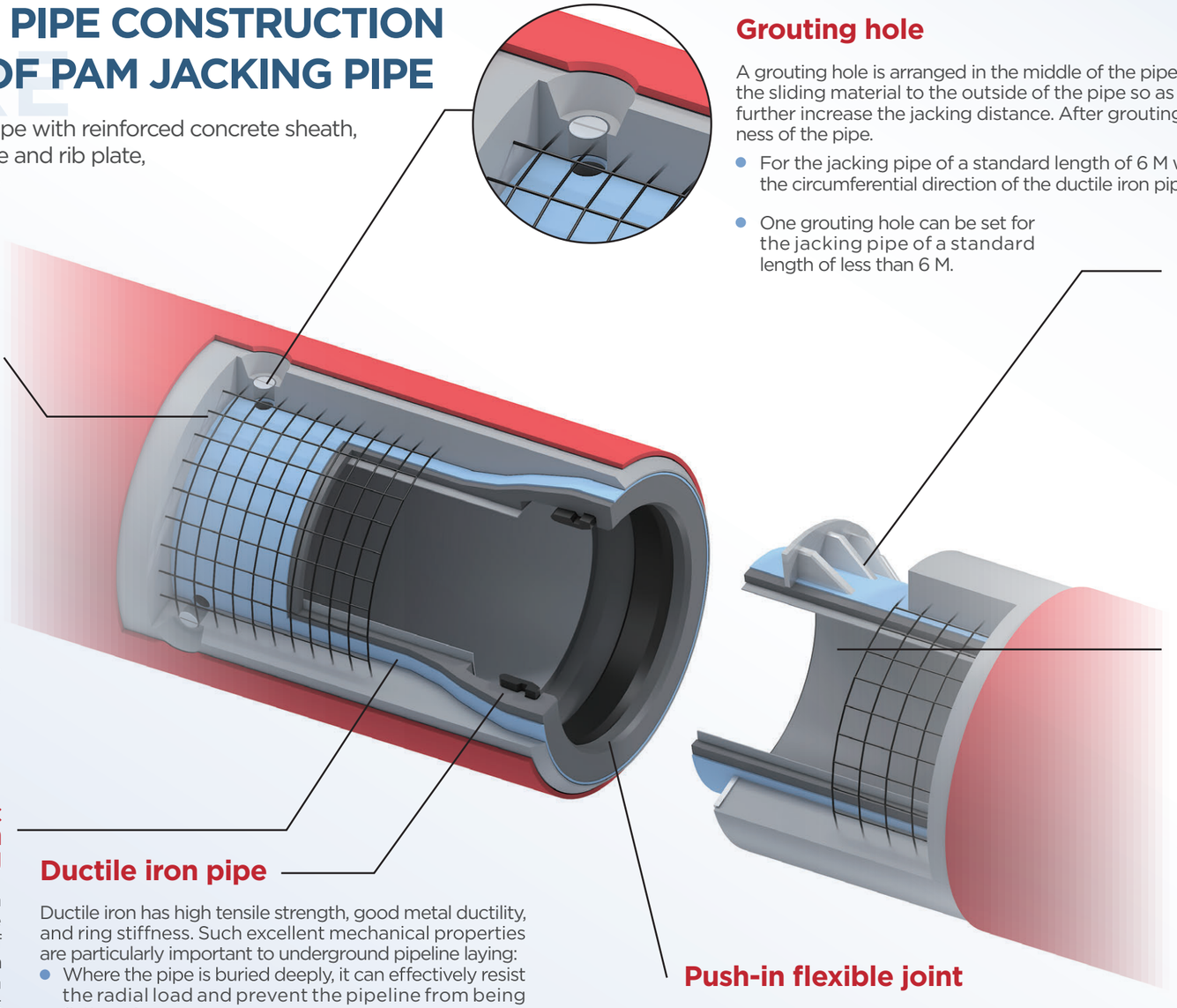
TRENCHLESS TECHNOLOGY

Ductile iron pipes are a widely used type of water supply and drainage pipe material. In order to meet the construction technical requirements of pipe jacking, PAM has developed a ductile iron jacking pipe suitable for jacking pipe construction , which meets the requirements of ISO13470, YB/T 4564, and T/CFA 02010202.4 standards.

The ductile iron jacking pipe manufactured by PAM has excellent corrosion resistance and impact resistance, coupled with a push inflexible joint that is fast to install and well sealed, making it more suitable for a wider range of applications. Ductile iron jacking pipes are widely used in trenchless construction in fields such as municipal engineering, water conservancy engineering, and construction engineering, which can be used for source water transportation, sewage discharge, rainwater collection, and other occasions. Ductile iron jacking pipe is widely used in practical applications due to its convenient installation and fast construction.

FOR TRENCHLESS PIPE CONSTRUCTION THE STRUCTURE OF PAM JACKING PIPE INCLUDES:

Ductile iron pipe with reinforced concrete sheath,
counter flange and rib plate,
Grouting hole



Reinforced concrete sheath

In order to cope with the scraping of underground soil, gravel and rocks during the jacking process, the pipe is wrapped with a layer of reinforced concrete sheath with corresponding thickness, which has excellent friction resistance and impact resistance, and can effectively protect the pipeline from damage.

The concrete itself also has anticorrosion function, and the zinc coating plays a multiple anti corrosion role to ensure the safety and service life of the pipe. In addition, the thick reinforced concrete layer makes the pipe body a smooth cylinder, covering the protruding socket, which can greatly reduce the resistance of the pipe jacking.

External coating-zinc external anticorrosion coating

As a buried metal pipeline, anticorrosion measures are very important, which is the key to ensure the long term effective use of the pipe. Zinc spraying has long been proven to be a very reliable external corrosion protection for ductile iron pipes. PAM first started the research of zinc coating in 1983, and formally adopted zinc coating on pipe products in 1958. After years of practice and research, a large number of data have proved the importance of zinc spraying for corrosion protection.

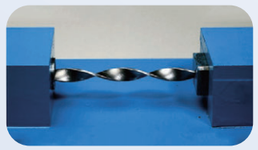
Ductile iron pipe

Ductile iron has high tensile strength, good metal ductility, and ring stiffness. Such excellent mechanical properties are particularly important to underground pipeline laying:

- Where the pipe is buried deeply, it can effectively resist the radial load and prevent the pipeline from being flattened.
- Where the distance of the pipeline is long, it can effectively resist the axial force and reduce the risk of deformation.

Compared with other types of pipes, K9 grade ductile iron jacking pipe can better adapt to the laying environment of large jacking force, large buried depth and high load.

Bend test



Tortion test for ductile iron material

Grouting hole

A grouting hole is arranged in the middle of the pipe and can be connected with a grouting conduit to convey the sliding material to the outside of the pipe so as to reduce the friction between the pipe and the soil and further increase the jacking distance. After grouting, the grouting hole shall be sealed to maintain the tightness of the pipe.

- For the jacking pipe of a standard length of 6 M with grouting holes, two grouting holes shall be set along the circumferential direction of the ductile iron pipe at an angle of 120 degrees;
- One grouting hole can be set for the jacking pipe of a standard length of less than 6 M.

Push-in flexible joint

Ductile iron jacking pipe adopts a Tyton push in flexible joint and is installed in a socket type. This joint has been tested by the market for a long time, and its safety has been fully verified. It is the most widely used joint in ductile iron pipes nowadays, which provides a solid guarantee for the connection quality of pipes and the safe implementation of projects.

Different from the welding joint of steel jacking pipe, the advantages of socket type joint lie in its simple installation and high construction efficiency. Moreover, on large diameter jacking pipes with DN1200 and above, PAM has also designed a super Tyton joint, using a fully soft gasket to further solve the problem of difficult installation of large diameter gasket.

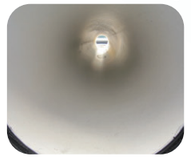
Counter flange and rib plate

An annular counter flange is welded at the spigot end, and a trapezoidal rib plate and a jacking plate are arranged for support. In the jacking process, the jacking flange is in contact with the end face of the socket, on the one hand, the thrust between the pipes is transferred, and on the other hand, the concrete sheath can be prevented from being damaged due to axial stress.

A high level of jacking force bearing capacity enables the ductile iron jacking pipe to have a longer pipeline distance in a one time jacking process, reduces the use of relay station, and reduces the overall construction difficulty and cost of the PJ.

Cement lining

The inside of PAM ductile iron pipe is coated with cement mortar protective layer by centrifugal coating, which is made of high quality and strictly tested cement raw materials and coated by computer controlled cement slurry mixing system and cement internal coating machine.



The quality of cement lining conforms to the national standard GB/T 17457, which ensures that the mortar is very solid, dense and smooth, that the surface of cast iron has good adhesion, no falling off, no scaling, and that the thickness is uniform, so as to ensure that every inch of the pipe is protected in every possible way.

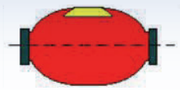
Jacking pipe for water supply

PAM ductile iron pipe jacking for water supply adopts the patented granulated BFSC (China's Invention Patent No. ZL 2011 1 0143028.7) or Portland cement mortar lining, which meets the hygienic requirements of GB/T 17219 standard, ensuring the stability of water quality and improving the operation efficiency of the pipe network.

Jacking pipe for sewage

The risks brought by various erosions are fully considered in the aspect of anticorrosion of the ductile iron jacking pipe for drainage produced by PAM. The high alumina cement used for anti corrosion in the pipe contains more than 50% of alumina, which has excellent anticorrosion and wear resistance, which can normally transport domestic sewage with pH value of 4 12, and can also transport sewage with pH value of 3 13.

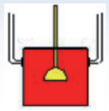
Production process flow of PAM JACKING PIPE



1. Medium frequency furnace

Molten iron refining

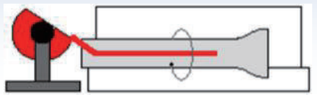
- Comprehensive testing of all raw materials
- Monitoring the chemical composition of each furnace of molten iron
- Measuring the temperature of each furnace of molten iron before discharge
- All monitoring data networked and



2. Spheroidisation treatment

Spheroidisation treatment

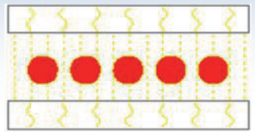
- Monitoring chemical composition of each ladle of spheroidized molten iron
- Measuring the temperature of each ladle of molten iron before casting



3. Centrifuge

Centrifugal casting

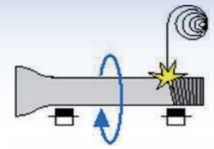
- The highest production efficiency in the world
- The first fully automatic pipe casting technology in China



4. Thermal treatment

Thermal treatment

- Intelligent temperature control
- Monitoring of metallographic structure and mechanical properties



5. Zinc spraying

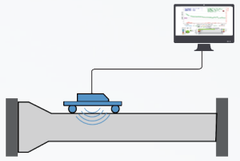
Zinc spraying

- Strict control of the amount of zinc sprayed
- Online monitoring, data traceability

6. Water pressure test

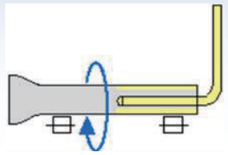
Water pressure test

- Water pressure test
- 100% water pressure test



Online wall thickness measurement

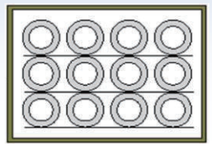
The first 100% wall thickness measurement technology in China



7. Cement internal lining

Cement internal lining

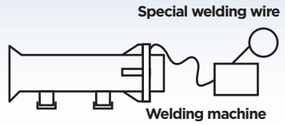
- BFSC used for water supply, which is the first in China
- High alumina cement used for sewage jacking pipe, with alumina content ⩾ 50%
- Monitoring incoming quality, internal lining materials, wall thickness and performance



8. Curing

Cement curing

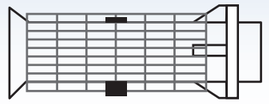
- Curing with blast furnace steam
- Intelligent temperature and humidity monitoring



9. Welding of jacking force structures

Welding of jacking force structures

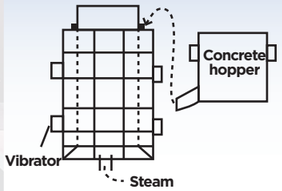
- Adoption of special welding wire
- Material, size and distribution quantity of stressed structure are verified by professional stress analysis software
- Jacking type testing machine to verify further design and welding procedure



10. Reinforcement cage installation and grouting hole fabrication

Reinforcement cage installation and grouting hole fabrication

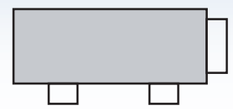
- Strengthen the overall structural strength of the encased concrete layer and improve the pressure resistance and bearing capacity of the jacking pipe
- Favorable for jacking installation in harsh soil environment



11. Concrete pouring and curing

Concrete pouring and curing

- Special mold design and vibration process ensure even and dense thickness of concrete layer
- High strength C40 concrete
- High temperature steam curing
- Online temper ature test system



12. External surface treatment and finishing

External surface treatment and finishing

- Continue second steam curing after repairing the concrete layer to ensure strength and adhesion
- With water based coatings to achieve zero VOC emissions

13. Finished product warehouse

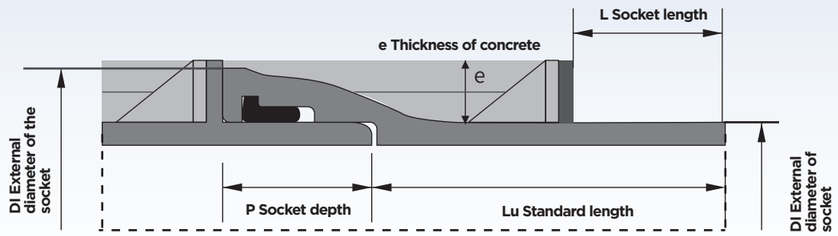
Finished product warehousing

- With WMS system to manage finished products in the warehouse area

Technical specification of PAM JACKING PIPE

Technical datasheet of jacking pipe

JACKING PIPE DN600 DN2000



Diameter	Joint	Wall thickness grade	Nominal wall thickness /mm	D1 Outer diameter of the socket /mm	DE Socket Outer Diameter /mm	P Socket depth /mm	Lu Standard length /mm	L Socket length /mm	Thickness of concrete /mm	Allowable pushing force /kN
DN600	TYT	K9	9.9	713	635	120		110	44	2720
DN700	TYT	K9	10.8	824	738	150		140	48	2720
DN800	TYT	K9	11.7	943	842	160		150	55.5	3300
DN900	TYT	K9	12.6	1052	945	175	3000	165	58.5	4140
DN1000	TYT	K9	13.5	1158	1048	185	4000	175	60	5080
DN1200	STD	K9	15.3	1373.7	1252.3	235	5000	195	64	7240
DN1400	STD	K9	17.1	1592.1	1458.9	245	6000	209	70	9020
DN1600	STD	K9	18.9	1815.9	1664.5	265		224	79	12360
DN1800	STD	K9	20.7	2032.2	1871.1	275		231	83	12360
DN2000	STD	K9	22.5	2259	2077.7	290		250	93	16970

Note: For the specific specification of 1m, 2m and other lengths of micro jacking pipe, please consult the customized product plan provided by the Technology Depart ment of PAM China

Standards for jacking pipe

Standard for production of jacking pipe products:

Ductile Iron Pipes for Trenchless laying (YB/T 4564-2016)

Ductile Iron Jacking Pipe for Trenchless Pipeline Construction (T/CFA 02010202.4 2023)

Ductile Iron Pipeline Systems for Trenchless Design and Instal-lation (ISO 13470 2012)

Standard for design and acceptance of jacking pipe construction:

Technical Specification for Pipe Jacking of Water Supply and Drainage Engineering (CECS 246 2008)

Design Standard for Pipe Jacking Engineering (DG/TJ 08 2268 2019)

Code for Construction and Acceptance of Water Supply and Drainage Pipeline Works (GB 50268 2008)

CONSTRUCTION GUIDELINES

With more than 160 years of experience in pipe casting and projects, PAM provides Chinese users with high quality ductile iron pipe products, as well as systematic solutions and professional and comprehen-sive technical services.

Survey

Pipe jacking operation is affected by soil quality and underground water; therefore, before construction with PJ, the environment along th e pipeline shall be surveyed .
Through professional analysis of the survey results, PAM's technical team calculates the strength and jacking force of the back wall, formulates ground-water preventive measures and estimates the environmental impact, to help customers design economical and reliable solutions.

Preparation before construction

Before construction, it is necessary to carry out disclosure of drawings and schemes, technical training of personnel, constr uct ion of thrust pitch and reception pitch, selection and installation of jacking pipe equip-ment.

With rich product application design ability and construction experience, PAM can provide all round profes-sional and technical training for customers, including providing relevant information of products, providing customers with training on installat ion , maintenance and repair of jacking pipes, helping customers under-stand and select suitable jacking pipes, so as to improve their use skills and maintenance capabilities.

Jacking pipe construction

Cleaning of socket and spigot

The inside of the socket, the outside of the spigot and the surface where the sealing rubber ring is placed shall be clean and free of residue.

Installation of gasket

Ductile iron jacking pipe for water supply shall be sealed with styrene butadiene (SBR) or ethylene propylene diene monomer (EPDM) gasket; and ductile iron jacking pipe for sewage, shall be sealed with NBR (nitrile) gasket. The physical properties of the gasket shall meet the requirements of GB/T 21873 specification. The gasket is bent into a cross shape or other shapes during installation. After placing, it is necessary to apply radial force to make it completely put in the seal groove, and check whether it is matched. Special lubricant should be used to lubricate the socket gasket and socket sealing area.

Placement of jacking pipe

The jacking pipe shall be lifted lightly on the track in the working pit. When the pipe is laid down, the pipe shall be prevented from colliding with the pit surface and the pit bottom. During jacking, the spigot shall face the direction of the soil layer and the socket shall face the direction of the jack. The jack shall not directly jack the spigot.

Connection of spigot and socket

When jacking the pipe, the socket of the pipe shall be protected.
PAM will arrange technical engineers with rich field experience to arrive at the pipe installation site to provide users with on site services such as pipe laying and removal, pipe stacking and installation guidance, so as to ensure the safe operation of the pipe network.

Construction precautions

Pipe lifting

Safety measures shall be taken during pipe removal to prevent slippage.

Sealing of openings

During underwater pipe jacking, a wall seal ring shall be installed at the reserved opening of the working well.

Grouting

When the jacking force increases and affects the pipe body and also affects the back wall of the working well, the bentonite can be injected to reduce the jacking force. The bentonite should be injected to the outer surface of the pipe through the injection hole of the pipe.

Relay station

In order to reduce the jacking force and extend the jacking distance, a r ela y station can be set on the pipe. The relay station is composed of socket and spigot, which is the same as the jacking pipe connection method for pipe jacking construction. A space shall be reserved between the socket and spigot for placing the jack in the relay station . For other matters, see Appendix A of T/CFA 020102024 for details, such as ground settlement prevention, pipeline deviation correction, and pipeline axis calibration.

Protection and repair of internal anti corrosion linings

The cement lining of the pipe shall be intact without damage, and the damaged ones can be repaired. It is impossible to repair a large area, and only the following damages can be repaired: the damaged area and the damaged quantity are in accordance with the following table, the damaged length is less than 1/4 of the pipe diameter, and the damaged pipe wall is not deformed.

DN	Single damage area ⩽	Number of damages/pipe ⩽
DN 600-DN 900	250 cm^2	3
DN 1000-DN 2000	1000 cm^2	4

Cement lining repair method

Any repair material used must not contaminate the medium being transported. The specific proportion of cement mortar for repair provided by the manufacturer can be used. Repair tools generally include wire brushes, brushes, spatulas. The repair process is as follows:
>> Turn the part to be repaired to the bottom, and use a hammer and a shovel to remove the damaged cement lining;
>> Remove the residual cement block with a metal brush, wet the edge of the cement layer of the part to be repaired, and then wait for a few minutes;
>> Fill the prepared cement mortar and press it to the thickness of the original cement lining layer;
>> Then smooth the surface and add some water or cover it with a damp cloth to prevent the cement from drying too quickly and causing cracks or detachment.

On site hydraulic test

The hydraulic test of trenchless construction pipe section shall be carried out separately from other pipes, and the hydraulic test shall conform to the requirements of GB 50268.

PAM's technical engineer will guide the construction personnel to carry out pipeline pressure test and pipeline docking at the construction site to further ensure the success of the project.

APPLICATION OF JACKING PIPE

Application scenarios of pipe jacking

Through analyzing a large number of trenchless project cases, PAM technical team recommends that **Pipe jacking method is adopted for the trenchless projects of pipelines of DN1000 or above** from the perspective of construction f easibility and economy.

- Crossing highways, rivers, above ground buildings, underground obstacles, water, e lectricity and gas pipelines;
- Trenchless laying in busy urban areas wi th little construction space;
- Trenchless laying in busy traffic area s to reduce traffic congestion;
- It is also suitable for laying pipel ines with particularly large burial depth.

Application cases of pipe jacking

Section 2 of the West South Interconnecting Trunk Pipe Project for Huzhou City Wat erworks
DN 2200 258 m Jacking pipe for water supply



Relocation Project of Sewer Pipeline for Phase II of Wuxi Metr o Line 4 DN 1400 108, 282 m / DN 1500 114 m Jacking pipe for drainage Pipeline Relocation
Project at Xinguang Road Station for Phase I of Wuxi Metro Line 5 DN 1200 180 m Jacking pipe for drainage



Construction Project of Effluent Pipeline for Harbin Qunlixi Wastewater Treatme nt Plant DN 1400 618 m Jacking pipe for drainage




Defect Remediation Project for Nanchang Xianghu Sewer Network DN 500 85 m Micro jacking pipe for drainage