19 Transport, storage and installation

19 Transport, storage and installation

If ductile cast iron pipelines are handled and installed correctly and professionally, a high degree of reliability and a long working life can be expected of them. Because of their specific properties ductile cast iron pipes, fittings and valves are suitable for various installation techniques and a large number of applications.

19.1 General

Pipelines for the transport of drinking water and wastewater, and also such applications as turbine and snowmaking equipment, are civil engineering projects – ones which involve high investment costs. Also correspondingly high are expectations of operational security and useful life. Therefore it is understandable that great importance is attributed to the choice of pipe material, manufacturing and above all correct handling and installation.

Experienced personnel need to be recruited for carrying out and supervising such projects who are able to assess the quality of the work in terms of standards EN 805 [19.1] and EN 1610 [19.2]. The companies used by the client must have the necessary qualifications for carrying out the work. It is important for the client to satisfy himself of the existence of these qualifications. This also applies accordingly for the choice of planning engineers.

Suitable evidence of the contractor's qualification may for example be possession of DVGW certification according to DVGW worksheet GW 301 [19.3]. There is a comparable provision in SVGW guideline W4-3 [19.4].

The increasing use of restrained push-in joints, especially when using trenchless laying techniques, prompted the development of a training and test plan for engineers installing metal pipes with push-in joints. DVGW worksheet W 339 [19.5] for specialists in joint technology for metal piping systems is applicable for this in Germany while SVGW guideline W4-3 [19.4] applies in Switzerland.

In Germany, civil engineering companies are increasingly requiring certification by the "Güteschutz Kanalbau" quality association for the installation of sewers and wastewater pipelines. This or similar certification is required for construction work in drinking water protection zones, in accordance with ATV-DVWK-A 142 [19.6].

19.2 Pipeline installation regulations

For the installation of pipelines, depending on the medium being transported, standards EN 805 [19.1] are to be followed for water pipelines and EN 1610 [19.2] for wastewater pipelines. For standards EN 805 [19.1] and EN 1610 [19.2] there are supplementary sets of rules available in different European countries to complete these. **Table 19.1** provides a summary for individual countries.

With pipelines for transporting the food "drinking water", the highest requirements are set not just for the components but also for the planning and construction engineers. European directive 98/83/EC [19.13] on the quality of water intended for human consumption has been implemented in the EU member states and is to be observed.

Table 19.1:
Summary of rules specific to individual countries as a supplement to EN 805 [19.1] and EN 1610 [19.2]

Country	Supplementary rules for	
	EN 805 [19.1]	EN 1610 [19.2]
Germany	DVGW worksheet W 400-2 [19.7]; DIN 2000 [19.8]	DWA-A 139 [19.9]; ATV-DVWK-A 142 [19.6]
Austria	OENORM B 2538 [19.10]	OENORM B 2503 [19.11]
Schwitzerland	SVGW guideline W4-3 [19.4]	SIA 190; SN 533190 [19.12]

19.3 Transport of ductile cast iron pipes, fittings and valves

Ductile iron pipes, fittings and valves for drinking water and wastewater pipelines are to be protected by appropriate means against damage and pollutions during transport and storage. EADIPS®/FGR® standard 74 [19.14] is to be followed for the packaging of fittings and valves.
The manufacturer's instructions for transport, storage and installation must be observed.

19.3.1 Transport and storage of pipes

19.3.1.1 Loading and unloading

Ductile iron pipes ≤ DN 350 are delivered as pipe bundles and larger ones as single pipes. The precise number of pipes per bundle, as well as the weight in each case, can be found in the manufacturer's documentation.

When loading and unloading pipes and pipe bundles by crane, lifting straps are to be used. Where individual pipes are unloaded using crane hooks, this must be done with wide, padded hooks **(Figure 19.1)** which are attached to the head ends as otherwise there is a danger of damaging the pipe and its coating.

Figure 19.2 gives an idea of how lifting tackle should be used for transporting pipes.

As an alternative to loading and unloading by crane, suitable forklift trucks can also be used.

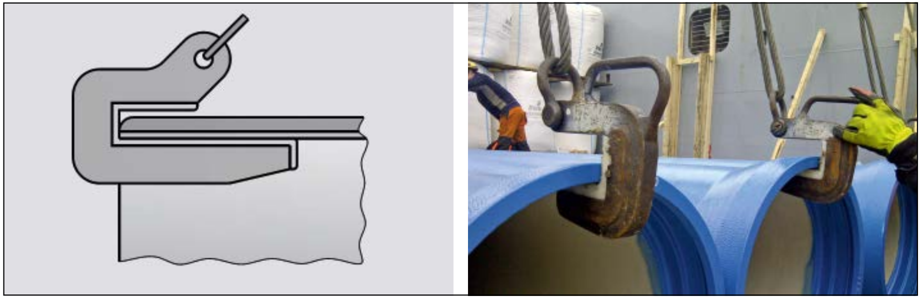


Fig. 19.1:
Padded hook for pipe transport

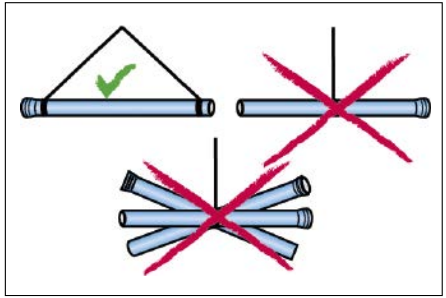


Fig. 19.2:
Attaching lifting tackle

Particular attention must be paid here to ensure that

- the pipes cannot tip sideways over the fork (the fork should be ≥ 1.5 m wide),
- the pipes cannot roll off the fork,
- the fork is sufficiently padded so that damage to the pipe is avoided.

During the loading and unloading process nobody must be beneath or on top of the pipe or pipe bundle, or within the hazard area of the crane.

Pipes and pipe stacks should only be set down on wooden beams or other suitable materials.
They should

- not be set down abruptly,
- not be shed by the vehicle,
- not be hauled or rolled,
- be secured against rolling and slipping,
- be stored on a level, load-bearing surface.

If ductile iron pipes are stored in a stack then they should be laid on wooden supports at least 10 cm wide, with a distance of approx. 1.5 m from the pipe ends **(Figures 19.3, 19.4 and 19.5)**.

Fig. 19.3:
Sleeper for stacking ductile iron pipes

The ductile iron pipes are prevented from rolling off flat wooden beams by nailing on wooden wedges **(Figure 19.6)**.

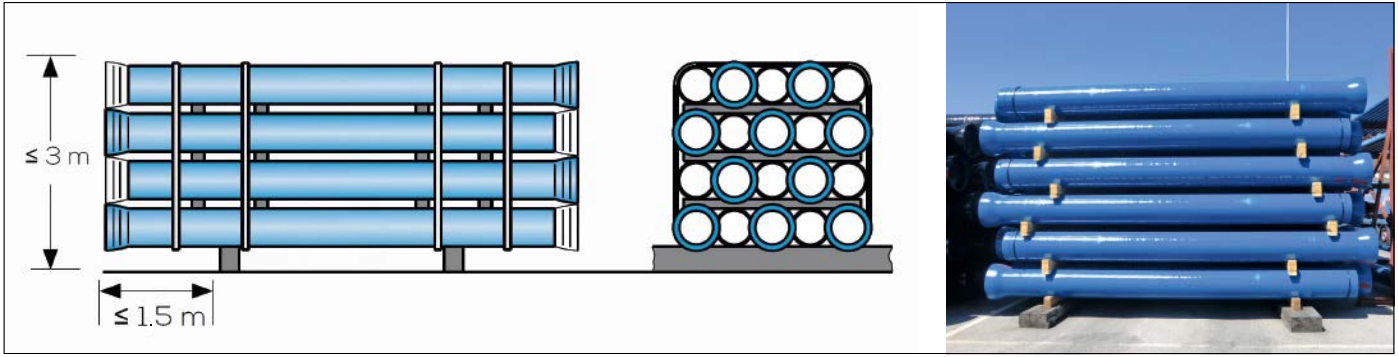


Fig. 19.4:
Arrangement of wooden supports for stacking ductile iron pipes

Fig. 19.5:
Ductile iron pipes set down
on wooden supports

Fig. 19.6:
Ductile iron pipes stacked with the help of wooden supports

Stacking heights for ductile iron pipes are stated in the manufacturer's information. Stacking heights of more than 3 m on the installation site are to be avoided for safety reasons.

Individual pipes are to be secured using wooden wedges **(Figure 19.7)**.

19.3.1.2 Opening up pipe bundles

The pipe bundles are secured with steel or plastic straps. The straps should only be cut using suitable tools (plate shears or side cutters) to avoid damage to the pipes and the risk of injury to personnel.

Before cutting the steel straps it is important to make sure that

- the pipe stack stands on firm ground which is as level as possible and does not slope,
- the pipes are secured against rolling and slipping,
- nobody is standing on or in front of the stack of pipes.

19.3.1.3 Distributing the pipes along the installation site

If the pipes are laid out alongside the pipe trench before being installed, they are to be placed on wooden supports or similar as already described and secured against slipping and rolling **(Figure 19.8)**. The protection caps on drinking water pipes should only be removed immediately before installation **(Figure 19.9)**.

19.3.2 Transport and storage of fittings

In accordance with EADIPS®/FGR® standard 74 [19.14] fittings should preferably be dispatched in cage pallets **(Figure 19.10)**. Consignment on disposable pallets is permissible for site deliveries **(Figure 19.11)**. Fittings must be stacked and arranged in such a way that they cannot damage each other.

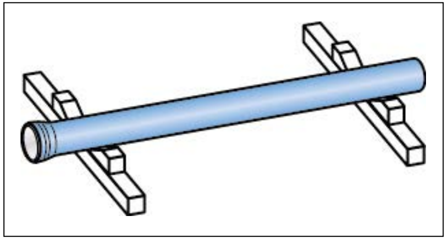


Fig. 19.7:
Securing individual pipes

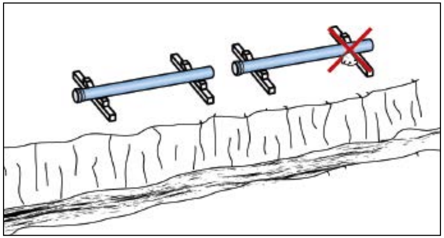


Fig. 19.8:
Securing ductile iron pipes on the installation site

Fig. 19.9:
The protective caps of ductile iron pipes for drinking water supply are only to be removed directly before installation

Fig. 19.10:
Ductile fittings in a cage pallet ready for dispatch

Fig. 19.11:
Preparation of fittings ready for dispatch on disposable pallets

Individual parts or articles which do not fit into a cage pallet are to be packed and dispatched on Europallets or disposable pallets. Wherever possible the individual parts should not project beyond the edge of the pallet.

The following advice [19.14] should also be followed for fittings:

- Up to DN 300 openings should be closed with the corresponding EADIPS®/FGR® protective caps.
- As from DN 350 openings are also to be closed by suitable means, e.g. covers in weather-resistant materials, shrink film or similar. When using steel straps, the coating of the fittings is to be protected at the points of contact with the steel straps.

Fig. 19.12:
Valves in a cage pallet ready for dispatch

19.3.3 Transport and storage of valves

According to EADIPS®/FGR® standard 74 [19.14] it is preferable for valves to be dispatched in cage pallets **(Figure 19.12)**. Consignment on disposable pallets is permissible for site deliveries **(Figure 19.13)**.

The stacking and arrangement must ensure that the parts cannot damage each other.

Fig. 19.13:
Arrangement of valves on disposable pallets ready for dispatch

The body ends must be protected in order to prevent the ingress of foreign matter and moisture. For valves with polymer or elastomer seats, it is important that these seats are also protected against UV radiation. The protective caps for valves with flange connections must correspond to EN 12351 [19.15]. Valves with polymer or elastomer seats must be delivered in such a way that the sealing material is not put under compressive stress. With all other valves, the closing device must be in the closed position during delivery.

Individual parts or articles which do not fit in cage pallets are to be packed and dispatched on Europallets or disposable pallets. Wherever possible the individual parts should not project beyond the edge of the pallet.

19.3.4 Storage of accessories

The manufacturer's instructions contain information about the storage of parts such as gaskets.

Explanations about the storage conditions for gaskets can be found in Chapter 13.3.9, taking account of ISO 2230 [19.16].

19.4 Installation of ductile iron pipe systems

The most important condition for the successful construction of these systems lies in following the manufacturer's installation instructions.

The condition of pipes, fittings and valves in ductile cast iron as well as accessories needs to be checked before installation.

19.4.1 Installation of pipes

DVGW worksheet W 346 [19.17] supplements the specific instructions and recommendations for cement mortar linings.

For ductile iron pipes with restrained flexible push-in joints the allowable operating pressure marking (PFA) is to be observed in accordance with EADIPS®/FGR® standard 75 [19.18] **(Chapter 3.6.1)**.

19.4.1.1 Cutting of pipes

The outside diameter of pipes up to DN 300 is at least up to 2/3 of the pipe length away from the spigot end in the permissible area **(Table 19.2)**, i.e. these pipes can be cut on site within this area. Individual manufacturers also allow larger cutting areas **(Figure 19.14)**.

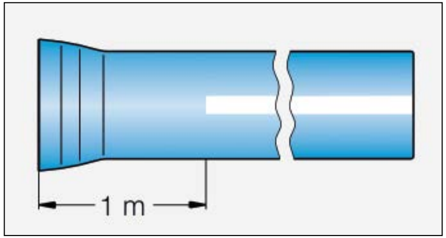


Fig. 19.14:
Example of marking on a ductile iron pipe – the pipe can be cut in the area with a longitudinal stripe

Table 19.2:
Permissible outside pipe diameters for cutting ductile iron pipes in mm

DN	$Dext_{max}$	$Dext_{min}$	C_{max}	C_{min}
80	99	95.3	311.0	299.4
100	119	115.2	373.8	361.9
125	145	141.2	455.5	443.6
150	171	167.1	537.2	525.0
200	223	219.0	700.6	688.0
250	275	270.9	863.9	851.1
300	327	322.7	1027.3	1013.8
400	430	425.5	1350.9	1336.7
500	533	528.2	1674.5	1659.4
600	636	631.0	1998.1	1982.3
700	739	733.7	2321.6	2305.0
800	843	837.5	2648.4	2631.1
900	946	940.2	2971.9	2953.7
1000	1049	1043.0	3295.5	3276.7
Dext = external diameter, C = circumference				

Fig. 19.15:
Ductile iron pipes > DN 300 suitable for cutting on site – marked with a longitudinal white stripe

Fig. 19.16:
Cuttable ductile iron pipes > DN 300 – marked with a red stripe on the socket – cutting of the pipes from the spigot end to up to 1 m before the socket end-face

Cuttable pipes above DN 300 are identified with longitudinal stripes **(Figures 19.15 and 19.16)**. All pipes are cuttable with certain manufacturers.

When shortening (cutting) the pipes, attention must be paid to accident prevention rules. For example angle grinders with resin-bonded stone disks, e.g. type C 24 RT Special in silicon carbide are used for cutting pipes **(Figure 19.17)**.

The swarf produced when cutting the pipes is to be removed.

The cut surfaces of the shortened pipes must be sealed again according to the manufacturer's instructions. The new spigot end is to be chamfered according to the original spigot end. The manufacturers provide directions for this in the installation instructions **(Figure 19.18)**.

After cutting and chamfering the pipe, the insertion marking (e.g. two white lines) is to be transferred to the new spigot end **(Figure 19.19)**.

Fig. 19.17:
Separation cut on a pipe

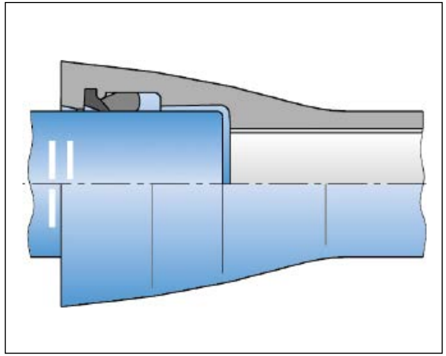


Fig. 19.19:
Spigot end with insertion marking

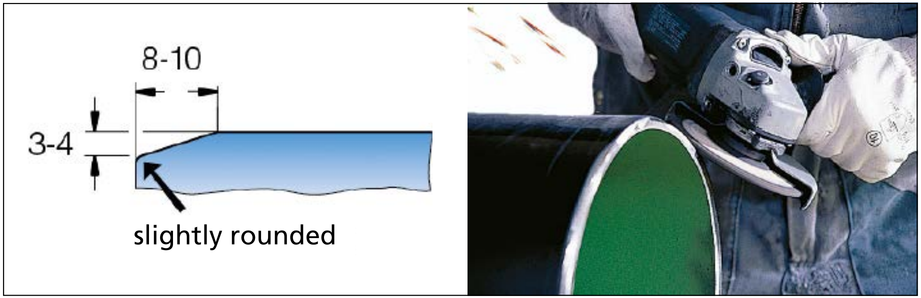


Fig. 19.18:
Example of how to chamfer a spigot end

19.4.1.2 Repair of any deformation of pipe ends occurring after cutting (rounding)

The spigot ends of larger diameter pipes or the cut ends produced after shortening pipes may not be perfectly round. However, by taking advantage of the elastic properties of the material, rounding the pipes is possible. To do this, e.g. a jack is put on the inside of the pipe. So as not to damage the cement mortar lining by this process, the jack is tightened between pieces of hardwood which are shaped to fit the inside of the pipe **(Figure 19.20)**.

Pipes with push-in joints > DN 1000 can generally be assembled without difficulty without any rounding device, even if some ovalisation has occurred due to storage and transport.

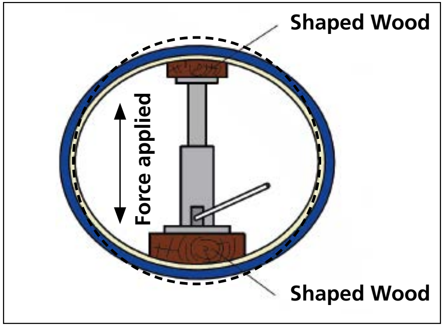


Fig. 19.20:
Rounding a pipe spigot end with a jack

Fig. 19.21:
Example of assembly equipment for pulling ductile iron pipes ≤ DN 300 together

19.4.1.3 Assembling push-in joints

Non-restrained push-in joints are described in **Chapter 8.2** and restrained push-in joints in **Chapter 9.2**.

Information is provided in the installation instructions from ductile iron pipe manufacturers for the installation of push-in joints covering cleaning, applying suitable lubricants, inserting rubber gaskets and checking the correct seating of the rubber gasket.

Appropriate assembly equipment is listed for the various nominal size ranges by the manufacturers of ductile iron pipes **(Figures 19.21, 19.22 and 19.23)**.

When assembling pipe joints using an excavator, a suitable intermediate layer is to be provided between pipe and excavator shovel, e.g. a shaped wooden block.

Insertion must be done smoothly and slowly. This ensures that the gasket is not pushed out of the retaining groove. The correct seating of the gasket can be checked by feelers after assembly. With all assembly techniques, the pipes must be aligned centrally and axially before and during the assembly of the pipes.

19.4.1.4 Assembling screwed socket joints

Screwed socket joints are described in **Chapter 1.3.3 (Figure 1.7)** and **Chapter 9.4.3**. For the assembly of screwed socket joints **(Figure 19.24)** special tools are required **(Figure 19.25)**. The manufacturer's installation instructions are to be followed.

Fig. 19.22:
Example of assembly equipment for pulling ductile iron pipes ≥ DN 350 together

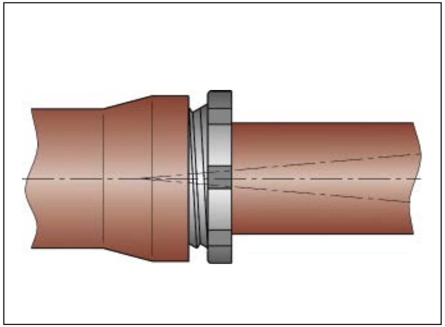


Fig. 19.24:
Screwed socket joint

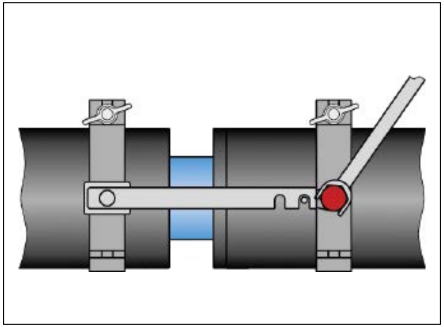


Fig. 19.23:
Assembly equipment for pulling pre-insulated pipes together

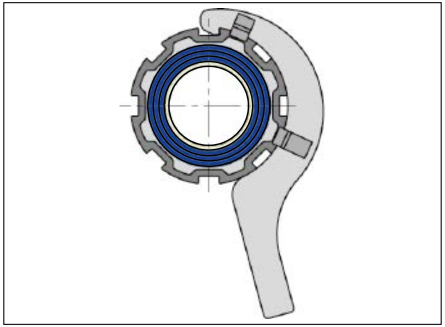


Fig. 19.25:
Hook wrench for assembling screwed socket joints

19.4.1.5 Assembling flanged joints

Flanged joints are described in **Chapter 1.3.1 (Figure 1.4)** and **Chapter 9.2**. Flanged pipes are dealt with in **Chapter 3.3.5 (Figure 3.13)**. The manufacturer's installation instructions are to be observed for the assembly of flanged joints; recommendations for the screw lengths for flanged joints can be found in EADIPS®/FGR® standard 30 [19.19].

19.4.1.6 Assembling bolted gland joints

Bolted gland joints are described in **Chapter 1.3.4 (Figure 1.8)**. The manufacturer's installation instructions are to be observed for the assembly of bolted gland joints **(Figure 19.26)**.

19.4.1.7 Welding onto ductile iron pipes

Chapter 18 (this chapter is being prepared) contains explanations about welding onto ductile iron pipes, such as the welding on of flanges, branches, outlets and puddle flanges as well as the application of welding beads for restrained pipes.

19.4.2 Installation of fittings

Fittings must not be cut, ground or otherwise processed.

19.4.2.1 Assembling push-in joints

With all assembly techniques, the fittings are to be aligned centrally and axially before and during the assembly of the push-in joint pipes. For the correct assembly of the joint the use of assembly equipment **(Figures 19.27 and 19.28)** is advisable. The manufacturer's installation instructions are to be followed.

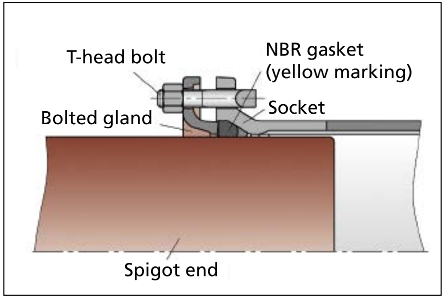


Fig. 19.26:
Representation of a bolted gland joint

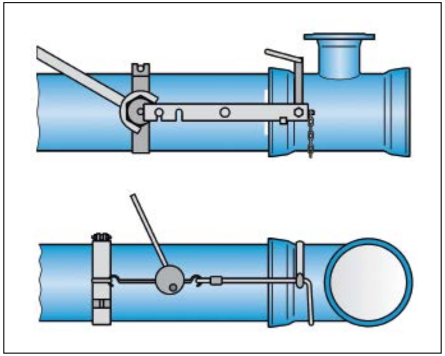


Fig. 19.27:
Use of assembly equipment specific to nominal diameter

Fig. 19.28:
Example of assembly equipment for nominal sizes DN 350 to DN 700

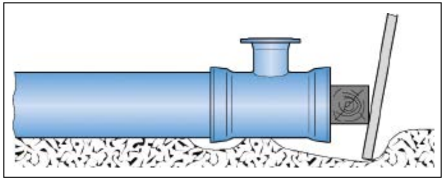


Fig. 19.29:
Assembly of a double socket tee on the spigot end of a ductile iron pipe

When assembling fittings using an excavator, a suitable intermediate layer is to be provided between pipe and excavator shovel, e.g. a shaped wooden block **(Figure 19.29)**.

19.4.2.2 Assembly of a connection branch

The assembly of a connection branch is done in a number of stages:

1. Drilling with the core bit **(Figure 19.30)**,
2. Drilling the holes for the retaining screws **(Figure 19.31)**,
3. Inserting the gasket, fixing the retaining screws **(Figure 19.32)**,
4. Final assembly of the connection branch **(Figure 19.33)**.

Burrs are to be removed from the drill holes. The cut surfaces of the drill holes are to be sealed according to the manufacturer's instructions.

Only carbide-tipped drill or core bits are to be used for drilling.

19.4.2.3 Welding on connection pieces and outlets

Explanations for welding on connection branches and outlets can be found in **Chapters 18.3.3 and 18.3.4** (these chapters are being prepared).

Fig. 19.30:
Drilling with the core bit

Fig. 19.31:
Drilling the holes for retaining screws of the connection branch

Fig. 19.32:
Gasket inserted and retaining screws fitted

Fig. 19.33:
The connection branch is positioned and then fixed to the ductile iron pipe with retaining screws

19.4.3 Installation, servicing and maintenance of valves

19.4.3.1 Installation

All packaging materials are to be removed from the valve. In order to protect e.g. gate valves from damage they should be transported using suitable lifting equipment such as wide belts. Chains and wire cables are to be avoided. Before installation the pipeline is to be inspected for contamination and foreign matter and cleaned if necessary. Care must be taken to ensure that the valves are accessible for operation and maintenance. For installation in the open air, the valves should be protected on site from direct exposure to the weather.

<u>Installation of flanged valves</u>
Steel-reinforced rubber gaskets are recommended for sealing the flanges. When assembling the valve the distance between pipeline flanges should be at least 20 mm greater than the face-to-face length of the valve to prevent damage to the mating surfaces and allow the gaskets to be inserted. The counter flanges of the pipeline must be plane-parallel and concentric. The connecting bolts must be tightened evenly, taking them crosswise, to avoid distortion strain. The pipeline is to be assembled tension-free. Adaptor and extension pieces facilitate assembly as well as removal for subsequent maintenance purposes. In Germany the installation guidelines according to DVGW worksheet W 332 [19.20], part IV are to be observed, as well as EN 805 [19.1].

<u>Installation of socket valves for ductile iron pipes</u>
Gaskets specific to the pipe are to be used **(Chapter 13)**. The spigot ends must be cleaned. Assembly should be carried out according to the manufacturer's installation guidelines. It is to keep in mind that different types of gaskets do not have a restraining effect **(Chapter 8)**. If necessary thrust resistance systems are to be used **(Chapter 9)** or thrust blocks installed, e.g. according to DVGW worksheet GW 310 [19.21]. SVGW guidelines W4-2 [19.22] and W4-5 [19.23] apply for Switzerland.

Installation of weld-end valves
With weld-end valves care must be taken to ensure that parts which are heat sensitive (e.g. coatings or elastomers) are not damaged.

Installation of tapping valves
The tapping process for tapping valves is described in **Chapter 7.5.4**. Only carbide-tipped drill or core bits are to be used for tapping **(Figure 19.34)**.

19.4.3.2 Servicing and maintenance

The relevant manufacturer's instructions are to be followed for the servicing of valves. Functional capability and tightness should be monitored in regular cycles at intervals of ≤ 4 years e.g. in accordance with DVGW technical information sheet W 392 [19.24]. Before commencing maintenance work all pressurised pipelines are to be depressurised and secured against repressurisation! Once the maintenance work has been completed, all connections are to be checked for tightness and firm seating.

Fig. 19.34:
Tapping ductile iron pipe using a tapping valve

19.5 Installation

19.5.1 Installation in an unshored trench

The planning principles of EN 805 [19.1] and EN 1610 [19.2] are to be observed. For construction work in Germany, for example, account should be taken of DIN 4124 [19.25] and ZTV A-StB 2012 [19.26].

Pipe trenches which are deeper than 1.25 m must be secured against the risk of collapse. This can be done by means of sloping or shoring the trench **(Figure 19.35)**. For unshored trenches up to a depth of 1.25 m there are no additional instructions to be followed for installing the pipes.

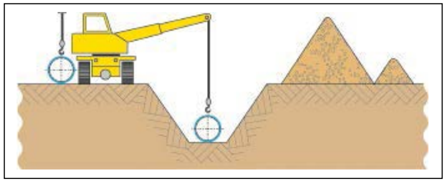


Fig. 19.35:
Sloped trench

19.5.2 Installation in a shored trench

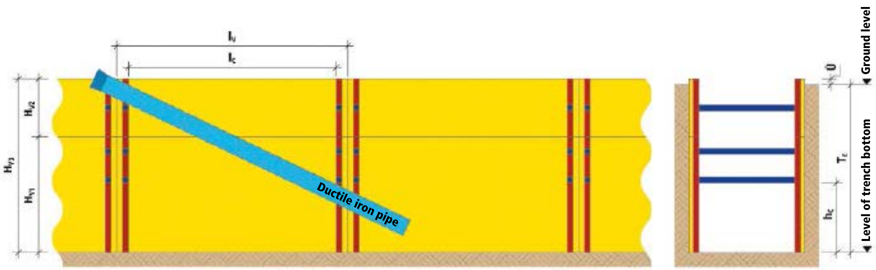
19.5.2.1 Inserting the pipe within one shoring unit

Two slings are placed around the pipe (one approximately in the middle and one in the socket area) and it is threaded into the trench beneath the lowest level of struts **(Figure 19.36)**.

19.5.2.2 Inserting the pipe within two shoring units

Where the lowest level of struts is very deep, geometric factors may mean that the pipe cannot be threaded in within just one shoring unit but that two units are required for this. In this case the slings have to be attached and removed. A secure fixing of the pipe must always be ensured here **(Figure 19.37)**.

Deeper anchoring of the shoring may mean that insertion over two shoring units and the deep layer of struts are not necessary.



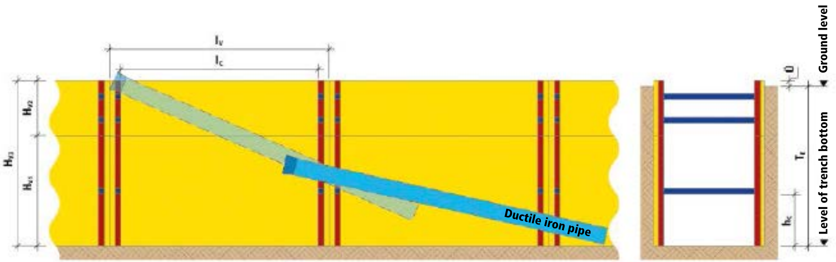
Key:

H_{V1} height of ground shoring	l_V length of shoring unit	T_E installation depth (= H_{V3} – Ü)	Shoring panels
H_{V2} height of top unit	l_c pipe passage length	Ü protrusion of shoring unit above ground level (= 0.1 m)	Vertical bars
H_{V3} height of shoring unit	h_c pipe passage height		Horizontal struts
	OK top		

Note:
The pipe manufacturer's installation instructions are to be observed; in Germany TB Bau specifications are also to be observed

Fig. 19.36:
Threading in within one shoring unit

Another possibility for avoiding threading over two shoring units is making the bottom of the trench deeper. In this case attention must be paid to the anchoring depth of the shoring. These alternatives do not necessarily apply for every shoring unit, but should only be used in areas where this makes sense. The pipes can then be threaded in at these locations and transported horizontally within the shored trench.



Key:

H_{V1}	height of ground shoring	l_v	length of shoring unit	T_E	installation depth (= H_{V3} – Ü)	Yellow	Shoring panels
H_{V2}	height of top unit	l_c	pipe passage length	Ü	protrusion of shoring unit above ground level (= 0.1 m)	Red	Vertical bars
H_{V3}	height of shoring unit	h_c	pipe passage height			Blue	Horizontal struts
		OK	top				

Note:
The pipe manufacturer's installation instructions are to be observed; in Germany TB Bau specifications are also to be observed

Fig. 19.37:
Threading in within two shoring units

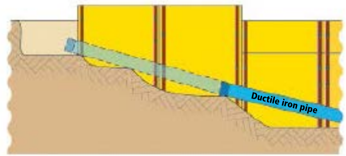
19.5.2.3 Head-on installation

With this technique the pipes are not introduced only after the shoring has been completed to its final depth but as the shoring is gradually lowered to graduated depth levels. To do this, the lifting gear takes up the pipe a number of times, each time laying it down on the slope until the bottom of the trench is reached. This installation method is suited above all for so-called travelling shoring in sections **(Figure 19.38)**.

19.5.2.4 Swinging in

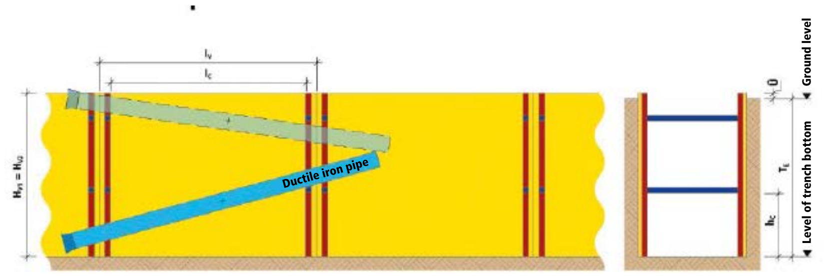
To swing in the pipe a sling is attached to its centre of gravity. By changing its inclination while simultaneously guiding it horizontally the pipe is positioned on the pipe bed inside a shoring unit **(Figure 19.39)**.

As the inclination and guiding of the pipe is assisted manually, attention needs to be paid to the secure attachment of the pipe; inclining the pipe too steeply is to be avoided.



Note:
The pipe manufacturer's installation instructions are to be observed; in Germany TB Bau specifications are also to be observed

Fig. 19.38:
Head-on installation



Key:

$H_{V1} = H_{V3}$ height of ground shoring
= height of shoring unit

l_V length of shoring unit
l_c pipe passage length
h_c pipe passage height
OK top

T_E installation depth (= H_{V3} – Ü)
Ü protrusion of shoring unit above ground level (= 0.1 m)

Shoring panels
Vertical bars
Horizontal struts

Note:
The pipe manufacturer's installation instructions are to be observed; in Germany TB Bau specifications are also to be observed.

Fig. 19.39:
Swinging in the pipe

19.6 Pipe trenches

19.6.1 Execution, working space

For the execution of excavation pits and trenches using traditional techniques, accident prevention regulations are applicable along with EN 805 [19.1] and EN 1610 [19.2] as well as their national supplements and regulation sheets as per **Table 19.1**.

In rural areas, away from roads, the use of trench cutters is becoming increasingly more common. Pipes in ductile cast iron can be installed in trenches produced in this way without problem.

Because of the high load bearing capacity of these pipes, there may be no need for "pipe benching" if local conditions permit; beneath roads, homogeneous compacting of the laying zone is necessary to prevent subsidence.

19.6.2 Trench bottom

The pipe trench is to be produced in such a way that the pipeline is supported along its whole length. Corresponding depressions (head access holes) are to be excavated in the trench bottom for the pipe joints **(Figure 19.40)**.

19.6.3 Pipe bed

The pipe bed must ensure an even distribution of pressure in the supporting area. As a rule, the existing soil is suitable as a pipe bed. Stone, rock and non-load bearing soils are not suitable for direct bedding.

If the trench bottom is suitable for bedding the pipes, then the trench bottom becomes the lower bedding. If a lower bedding of compactable sand, gravel sand or sieved soil has to be introduced, in its compacted condition it should be to a height of 100 mm + 1/10 of the outside diameter of the pipe, but at least 15 cm below the pipe shaft and at least 10 cm under flanges, sockets, attachments and fittings.

According to EN 805 [19.1], determining the thickness of the lower bedding layer is left to the planning engineer.

In EN 1610 [19.2] the thickness of the lower bedding layer is stated as 10 cm with normal soil conditions; with rocky or consolidated subsoils it should be at least 15 cm.

Figure 19.41 includes the terms used in EN 805 [19.1] and EN 1610 [19.2] for the subdivisions of the pipe-laying zone.

Table 19.3 gives a summary of the thicknesses of the lower bedding layer in the various national and European regulations. For pipes in ductile cast iron, the pipe manufacturers state a standard minimum value of 100 mm for the thickness of the lower bedding layer for all types of external protection of pipes.

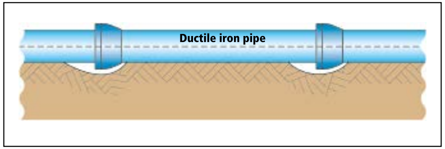


Fig. 19.40:
Trench bottom with head access holes

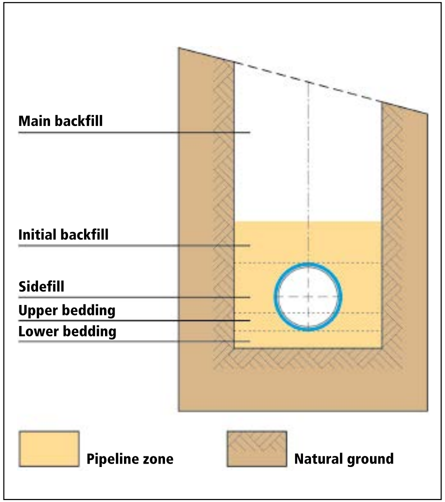


Fig. 19.41:
Pipeline zone and cover – terms according to EN 805 [19.1] and EN 1610 [19.2]

Table 19.3:
Thickness of the lower bedding layer

Thickness of the lower bedding layer [mm]					
Example	**EN 805 [19.1]**	**DVGW W 400-2 [19.7]**	**EN 1610 [19.2]**	**DWA A 139 [19.9]**	**EADIPS®/FGR®**
DN	No Data	100 + 0,1 da min. 150	min. 100 (normal) min. 150 (firm)	100 + 0.1 DN (normal) 100 + 0.2 DN (firm)	All type of coating
250	–	150	100 (normal) 150 (firm)	125 (normal) 150 (firm)	100
600	–	163	100 (normal) 150 (firm)	160 (normal) 220 (firm)	100

19.6.4 Embedding the pipes

Embedding is very important in determining the load and stress distribution over the circumference of the pipe.

For embedding purposes, suitable soil which will not damage the parts of the pipeline and the coating is to be filled in layers on either side of the pipeline and sufficiently compacted.

The thickness of the cover in the compacted state should reach a height of 15 cm above the crown of the pipe when more lightweight compaction equipment is used and 30 cm with heavier compaction equipment before starting on the compaction of the main filling.

Pipelines which are subject to a risk of floating must be provided with buoyancy protection.

19.6.5 Cover height

The cover height is the distance between the crown of the pipe and ground level. For drinking water pipelines it is important that they are installed at a frost-free depth. The limit values for cover heights at which ductile iron pipes can be installed without structural analysis are given in the applicable standards EN 545 [19.27] and EN 598 [19.28].

For cover heights outside the areas stated or more favourable installation conditions, separate static calculations may be necessary. Structural design is stipulated in e.g. ATV-DVWK-A 127 [19.29], Austrian standard B 5012 [19.30], [19.31] and SIA 190 [19.12].

19.6.6 Bedding material

A homogenous, well-compactable filling material is to be used as the pipe bedding material. The permissible grain sizes depend on the pipe coating and can be found in the pipe manufacturer's installation instructions. Before use, the bedding material is to be evaluated with respect to its corrosion likelihood according to DIN 50929-3 [19.32], [19.33], DVGW worksheet GW 9 [19.34] or Austrian standard B 5013-1 [19.35] and tested as regards its suitability for the pipe coating envisaged according to DIN 30675-2 [19.36].

19.7 Special pipeline installation cases

The features of certain important application cases are described below. Otherwise the Technical Department of the cast iron pipe manufacturer should be consulted for help with technical problems.

19.7.1 Pipelines in sloping and steep areas

When installing pipes in sloping and steep areas, additional forces come into play which require corresponding safeguarding measures depending on the gradient, such as restrained push-in joints and cross supports. As a rule this is necessary with gradients of more than 15°.

The installation of concrete, wood or heavy clay barriers prevents the backfilled pipe trench from acting like a drainage ditch and so allowing water to run under the pipeline.

19.7.2 Laying pipes uphill

Where the soil is sufficiently firm, there are cross supports which can support a pipeline on a steep slope. In such a case a concrete thrust block secures the bottom bend (at the foot) and the pipes to be installed upwards from there are driven so far into the socket that they stand in the base of the socket.

On the hillside itself then, depending on the gradient, every 2nd or 3rd pipe is secured behind the socket with a concrete block which is anchored in the natural soil **(Figure 19.42)**. At the same time the concrete blocks act as protection against the undercutting of the pipeline. Their dimensions are based on e.g. DVGW worksheet GW 310 [19.21]. Slopes on which landslides are to be expected require the installation of geotextiles as a slidable pipe surround in order to release the pipe from ground forces.

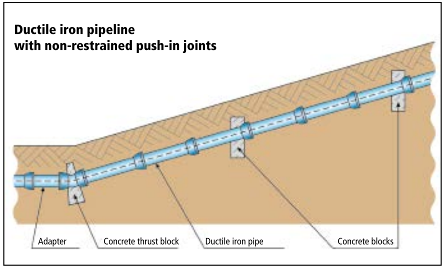


Fig. 19.42:
Uphill installation of pipes – ductile iron pipeline on a slope with concrete blocks

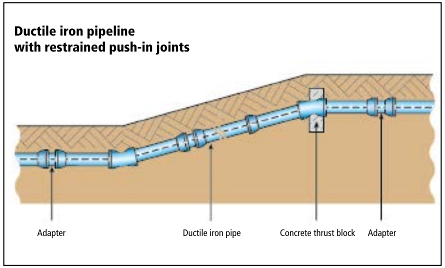


Fig. 19.43:
Downhill installation of pipes – restrained ductile iron pipeline with a concrete thrust block at the upper inflexion point

19.7.3 Laying pipes downhill

If a pipeline is to be installed downhill, then pipes with restrained push-in joints are to be assembled in such a way that the restrained locking is direct and prevents the slipping of the pipes.

The entire pipeline must then be secured at the upper end either by a fixed point (concrete thrust block or structure) or by a restrained push-in joint **(Figure 19.43)**.

A thrust block at the lower bend is not necessary if the horizontal section of pipeline leading to the inflexion point is fitted with restrained push-in joints over a sufficient length.

19.7.4 Installation in unstable ground

In soils with poor load-bearing characteristics, particular measures are to be taken to prevent the sinking of the pipeline. Particularly susceptible to subsidence are pipelines in boggy and peaty ground and in silty and organic soil types.

In most cases this can be managed by improving the subsoil, e.g. soil replacement, ballast beds or geotextile-gravel cushions. If these measures are not sufficient there is the possibility of installation on pile heads **(Figure 19.44)**. In normal cases ductile iron pipes only require one support per pipe **(Figures 19.45, 19.46 and 19.47)**.

In areas affected by mining, in some cases considerable subsidence can occur if the seams are not filled after mining is finished. As a rule, this causes tractive strains in the marginal zones of the subsidence and compressive strains in the middle. These can amount to up to 15 mm/m. Ground subsidence of up to 7 cm in five days has been observed, with gradient changes of 36 cm over a length of 40 m occurring in one month. Under these circumstances, pipelines should not be rigid. Pipes in ductile cast iron with their flexible push-in joints are particularly suitable. According to product standards EN 545 [19.27] and EN 598 [19.28] deflections in pipe and fitting sockets of up to 5° are possible.

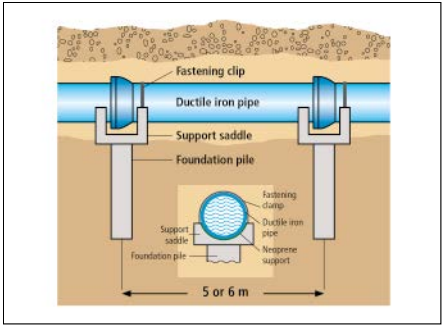


Fig. 19.44:
Pipeline on pile heads – double mounting

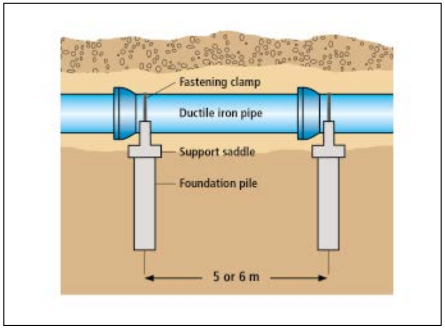


Fig. 19.45:
Single mounting of ductile iron pipes on piles

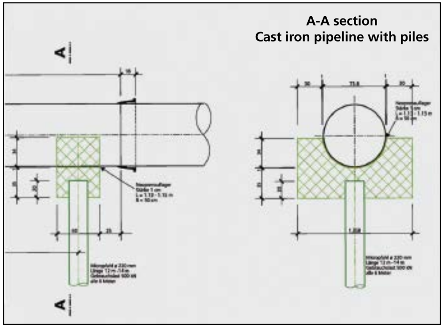


Fig. 19.46:
Example of a construction drawing for a concrete support saddle

Fig. 19.47:
Concrete support saddle with neoprene support for ductile iron pipes

19.7.5 Installation in groundwater

With high groundwater levels, the pipes are to be secured against buoyancy. With the kind of high groundwater levels which are often found in lowlands close to bodies of water, ductile iron pipes with restrained push-in joints can be assembled alongside the trench over a long stretch of pipeline and then lowered with a number of lifting devices **(Figure 19.48)**.

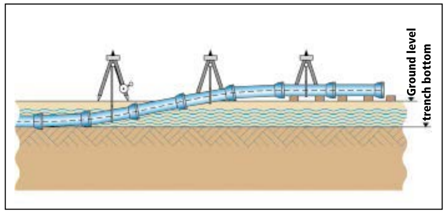


Fig. 19.48:
Pre-assembled pipeline being lowered into the trench

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